1958

NINTH ANNUAL NORTHWEST FISH CULTURAL CONFERENCE

Attached are abstracts of all presentations (excepting one) made at the meeting held at the University of Washington Fisheries Center on December 3 and 4, 1958. These abstracts are presented as received from the authors without editing excepting for the most obvious of errors such as typographical or misquotation of dates.

The original presentations and the following abstracts as here presented represent extensive efforts by the contributing authors. In behalf of myself and those in attendance, I wish to extend a sincere "Thank You" to the contributing authors for making the 1958 Conference the worth while meeting that it turned out to be.

Mr. Ernest Jeffries, Oregon Fish Commission, Portland, Oregon was selected as Chairman for the 1959 Conference.

C. H. ELLIS
1958 Chairman

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TECHNIQUES IN PASTEURIZATION OF SALMON PRODUCTS
and
A REPORT ON THE AMBRETTE PELLET MAKING MACHINE

Duncan Law
Sea Foods Laboratory
Astoria, Oregon

Raw salmon viscera and carcasses used in feeds are known vectors for a number of the more virulent diseases that strike salmon. Other animal raising industries recognize that the feeding of raw carcasses and entrails of an animal back to the same species is a dangerous practice. Lack of a suitable food substitute for our hatchery salmon, however, has delayed the replacement of raw salmon viscera and carcasses. It has been noted that in certain areas as high as 65% of a hatchery diet is composed of salmon viscera.

Attempts have been made to treat or pasteurize raw salmon viscera to destroy the pathogens. These attempts have met with varying success. Burrows in 1954 reported that where cooked or pasteurized salmon viscera were used as feed for blue back fingerling relatively poorer growth was obtained as compared to the raw control. It was not established whether this effect was due to a drop in nutritional quality or a function of the decreased bind resulting from heat treatment. In subsequent pasteurization work using a steam jacketed kettle, the Seafoods Laboratory and the Oregon Fish Commission found that excessive heat treatment also had an adverse effect on palatability. It was further established that crusting and localized heating were problems whenever direct steam was used. Strong agitation coupled with the use of paddle scrappers in the kettles minimized the problem. A tentative pasteurization schedule of 140° F. for one half hour has been adopted.

To circumvent the problem of localized heating a tube type heat exchange unit was devised. A number of pumps were tried with a gear pump being the most satisfactory for pumping the visceral mass in our unit. Hot water was used as the heating medium. This tube type heat exchanger worked very satisfactorily. The pasteurized product was palatable to the fingerling. In addition the bind produced was often better than that with raw viscera.

A series of experiments designed to test the use of pasteurized viscera for starter diets indicated that the nutritional qualities had not been impaired by the heat of pasteurization. Thus it was assured that with palatability, nutrition, and bind established the problem of pasteurized viscera was solved.

Reports from hatchery men, however, proved otherwise. Much of the pasteurized viscera the hatcheries were getting was too "soupy" to be used without excessive amounts of meal to bind it. The first assumption was that this viscera was higher in water content. Moisture determinations ruled this out. It was quickly established that two types of salmon viscera were being pasteurized. The type from the Puget Sound area was pinpointed as being the low viscosity type. No trouble was encountered with Columbia River salmon viscera. The explanation for this difference appeared to lie in the fact that Puget Sound salmon have an active enzyme system whereas upstream migrating Columbia River salmon have an inactive enzyme system. Heat inactivation of the enzyme system in Puget Sound salmon viscera proved this idea to be right. A tentative schedule of enzyme inactivation (180^{o} - 5 minutes) was established. It must be pointed out however, that in all cases the Puget Sound viscera had a lower viscosity than the Columbia River viscera. This is due in part to the "come-up" time required to reach the enzyme inactivation temperature.

The successful pasteurization of salmon viscera raised the question of salmon carcass pasteurization. Attempts to pasteurize salmon carcasses alone with the equipment available were not successful. However, incorporating the carcasses during the visceral pasteurization was feasable. As high as 50% carcass to viscera ratio was used successfully.

A REPORT ON THE AMBRETTE PELLET MAKING MACHINE *

Duncan Law
Sea Foods Laboratory
Astoria, Oregon

The original processing equipment devised for the production of soft pellets from a premixed dough consisted of a heavy duty meat grinder and a centrifugal blower. The dough was forced from the grinder plate in spaghetti-like extrusions and dropped directly into the centrifugal blower. The centrifugal action chopped the extrusions into "bite-sized bits" which were put in trays, frozen and sacked. However, this product lacked size uniformity and contained an excessive amount of fines.

A number of different types of pelleting machinery was tested. It was noted that very few machines were capable of handling material with more than 25% moisture. Of the machines tested the Ambrette Extruder performed the most satisfactorily. In this report a series of slides were shown on how the Ambrette Extruder was adapted to the manufacture of soft pellets.

* Ambrette Machinery Corp.
156 = Sixth St.
Brooklyn 15, New York

TESTS OF DRY FEED FOR SALMON

Harlan E. Johnson
U. S. Fish & Wildlife Service
Cook, Washington

During 1958 a number of tests of dry feed for salmon were conducted at Bureau of Sport Fisheries and Wildlife hatcheries on the lower Columbia River. Most of the dry feeds used were purchases from J. R. Clark and Co. The production diet controls, hereafter referred to as "wet" diets, consisted of varying percentages of beef and hog liver, beef and hog spleen, salmon viscera, salmon eggs, salmon flesh, and turbot. The exact composition of the wet diets was changed frequently depending on the availability of the various components. All of the tests were conducted under production hatchery conditions.

Tests with silver salmon were run on a pond scale at Carson and Willard. The fry were started feeding in hatchery troughs and later transferred to 8' x 80' raceways. The first experiments were started as soon as the fish were ready to feed. In June, ponds of silvers that had been fed wet diets were converted to Clark's dry feed. Some of the tests will continue through the winter.

To date, none of the silvers fed Clark's feed have grown as fast as the wet diet controls. The conversion, of food as fed, was somewhat better with the dry feed but the costs per pound of fish produced were much higher with the dry feed. The mortalities on the dry diets were higher than on the wet feed. The silvers on Clark's feed were more uneven in size and there were more weak "pin-heads".

Clark's salmon feed was fed to a pond of fall chinook salmon at Willard for several months. A much smaller number of controls was fed the wet diet in two troughs and two troughs of fall chinook were fed Oregon Moist Pellets. Here again the growth was less and mortalities and costs higher on Clark's dry feed. The fish on the Oregon Pellets had a low mortality but grew slowly.

In all of the tests with silvers and fall chinook salmon it was difficult to get the fish to start eating the dry feed. This was true whether the fish were started on the dry feed as fry or converted after several weeks or months on wet feed. In some of the tests the fish on dry feed lost weight the first two weeks. After the fish were feeding well the growth rates on the dry and wet diets were more comparable but dry feed fish never recovered from the initial lag in growth and through October have not reached the size attained by fish on the wet diets.

A pond of spring chinook salmon at Carson that had been fed the wet production diet was converted to Clark's salmon on July 1. These fish have grown faster than those on the wet diet and the mortality and food conversion is better. The cost of fish produced was high on the dry feed. This is most encouraging test we ran with dry feed. Spring chinook salmon are difficult to rear and we often have considerable mortality and uneven sized fish on the wet diets. It is possible that further experiments may prove that dry feeds are superior to wet diets despite higher costs.

Although Clark's dry feed did not prove to be superior to the wet diets in most of these tests, I feel certain that eventually satisfactory dry feeds will be developed for salmon as they have for trout. The final evaluation, of course, is not the hatchery mortality, food conversion, etc. but the return of adult fish to the fishery and to the hatchery. This evaluation must depend on marking experiments in the future.

CHINOOK FEEDING OF PELLET FOOD

John Pelnar
U. S. Fish and Wildlife Service (Coleman Station)
Anderson, California

The feeding of pellet foods was attempted at the Coleman Station during the past year. The use of standard types of pellet foods proved unsuccessful. The J. R. Clark Company designed a special type of food called "Salmon Food", which shows considerable promise. However, we were unable to carry chinook salmon on a steady diet of this type food, and supplemental wet foods had to be given. Our trials were during a season of very high water temperatures, with interference by disease and other matters. The results were not completely satisfactory, but we think further efforts are justified, particularly in view of the high cost of wet foods prevailing.

The attached tables show the results of our efforts with Clark's salmon pellet food.

POND NO. 1 DRY FEED ORIGINAL NO. 228,052 ORIGINAL WT. 275 LBS. AVERAGE NO. PER LB. 829.19

Aver. Temp.	Month	Aver. No. Per Lb. End of Month	Loss	% Loss	Wt. at End of Month	Gain in Wt.	Conversion	Food Cost Per Lb.	Type of Feed and Remarks
51.9	April	300.7	3,127	1.37	748	473	2.11	.332	Clark's dry feed, with 2 feeds per week of 90% beef liver and 10% Clark's dry feed.
56.6	May	146.	2,731	1.21	1,522	774	1.79	.34	100% Clark's dry feed.
59.7	June	102.1	9,794	4.41	2,082	560	3.78	.718	100% Clark's dry feed. Conversion for first 15 days, 1.68, with an increase in losses starting on the 9th of June and continuing through June, with water temp. 60° and above after 9th of month.
63.3	July	60.	18,195	8.58	2,250	1,181	3.27	.441	100% Clark's dry feed to 14th, one feed production diet per day to 24th, 100% production diet remainder of month. Losses continued above normal with dry feed, decreased on productio[n] diet. Water temp. continued high with a daily high on the 27th of 71° and an average of 67°. 1,013 lbs. were planted on the 29th, totaling 60,780.
59.3	August	41.6	10,153	7.58	2,974	724	4.57	.868	100% Clark's dry feed. Water temp. decreased the latter part of the month and losses showed a marked decrease at the same time.
57.1	September	31.5	10,266	8.28	3,601	627	3.27	.621	100% Clark's dry feed. Loss continued above normal on dry feed although water temp. were down. Gain estimated.

POND NO. 1 (continued)

Aver. Temp.	Month	Aver. No. Per Lb. End of Month	Loss	% Loss	Wt. at End of Month	Gain in Wt.	Conversion	Food Cost Per Lb.	Type of Feed and Remarks
53.9	October	24.9	4,381	3.83	5,154	1,553	1.66	.266	100% Clark's dry feed, with 1 feed of fish on Tuesdays and Fridays.
48.7	November	17.7	4,937	4.74	5,934	780	3.41	.443	100% Clark's dry feed with 1 feed of fish Tuesdays and Fridays.

Red cell count August 7, 1958 - 1,225,000 November 12, 1958 - 1,220,000

POND NO. 2 DRY FEED AND PRODUCTION DIET ORIGINAL NO. 178,550 ORIGINAL WT. 544 LBS. AVERAGE NO. PER LB. 328

Aver. Temp.	Month	Aver no. Per Lb. End of Month	Loss	% Loss	Wt. at End of Month	Gain in Wt.	Conversion	Food Cost Per Lb.	Type of Feed and Remarks
56.6	May	161.8	565	.32	1,102	558	3.03	.281	Production diet entire month of May, losses low.
59.7	June	84.3	5,500	3.19	2,045	943	1.76	.334	100% Clark's dry feed. Increase in mortality noted on the 17th.
63.3	July	54	4,123	2.39	2,353	813	3.84	.368	100% Clark's dry feed first 10 days, procuction diet remainder of the month. Mortality remained at an above normal level.
59.3	August	47.8	4,706	3.83	2,796	443	5.22	.543	Production diet first 15 days, 100% Clark's dry feed remainder of month, with one feed of 100% fish Tuesdays and Fridays.
57.1	September	32.3	3,978	2.97	3,411	615	3.52	.451	100% Clark's dry feed, with 1 feed of 100% fish on Tuesdays and Fridays. Gain estimated.
53.9	October	26.3	4,473	3.45	4,991	1,580	1.58	.252	100% Clark's dry feed, with 1 feed of 100% fish on Tuesdays and Fridays.
48.7	November	19	3,170	2.6	5,941	950	2.8	.364	100% Clark's dry feed, with 1 feed of 100% fish on Tuesdays and Fridays.

Red cell blood count August 7, 1958 - 1,250,000 November 12, 1958 - 1,310,000

POND NO. 3 PRODUCTION DIET AND FISH ORIGINAL NO. 172,619 ORIGINAL WT. 528 LBS. AVERAGE NO. PER LB. 325

Aver. Temp.	Month	Aver. No. Per lb. End of Month	Loss	% Loss	Wt. at End of Month	Gain in Wt.	Conversion	Food Cost Per Lb.	Type of Feed and Remarks
56.6	May	155.5	* 7,020	4.13	1,065	537	3.03	.281	* 6,210 mechanical loss 5/6/58 100% production diet.
59.7	June	84.3	4,510	2.72	1,910	845	3.4	.605	50% Clark's dry feed & 50% production diet first 12 days, 100% Clark's dry feed remainder of month.
63.3	July	54.	3,662	2.83	2,400	1,010	3.23	.349	100% Clark's dry feed first 9 days, 100% production diet remainder of month. 34,320 planted 7/24/58, weight 520 lbs.
59.3	August	46.7	2,322	1.83	2,725	325	9.1	.616	100% production diet, with 1 feed 100% fish Tuesdays and Fridays.
57.1	September	32.1	2,670	2.1	3,457	732	5.9	.26	100% production diet, with 1 feed 100% fish Tuesdays and Fridays. Gain estimated.
53.4	October	27.2	2,082	1.69	4,824	1,367	3.39	.216	100% production diet, with 1 feed 100% fish Tuesdays and Fridays.
48.7	November	20.3	3,221	2.69	5,877	1,053	3.61	.235	100% production diet, with 1 feec 100% fish Tuesdays and Fridays

Red cell count August 7, 1958 - 1,340,000 November 12, 1958 - 1,1322,500

AMINO ACID REQUIREMENTS OF CHINOOK SALMON

Dr. John E. Halver
Western Fish Nutrition Laboratory
Cook, Washington

Feeding 40% protein to chinook salmon with the balance of amino acids supplemented to parallel that of whole egg protein, arginine, methionine, lysine, and histidine requirements were measured at 47° F. and 58° F. In addition, the arginine requirement was determined by feeding a 50% protein diet to chinook salmon at 52° F. A summary of the results of all amino acids quantitated to date indicate that the amino acid requirements are fairly independent of water temperature but may be dependent upon protein intake. Tentative values for the various requirements were described for arginine, histidine, threonine, methionine, lysine and tryptophan. Arginine was found to be the most effective supplement for increasing the nitrogenous intake of chinook salmon when the other indispensable amino acids are furnished, and the entire diet is still sub-optimum as far as total nitrogen requirement is concerned. Current plans contemplate determining the requirements of chinook salmon for the other four amino acids, leucine, isoleucine, phenylalanine and valine. A general discussion of the importance of supplying the fish with the optimum protein intake and sufficient indispensable amino acids to satisfy their requirement, was presented and possibilities of indispensable amino acids becoming limiting in certain commercially prepared fish diets was discussed.

SAFETY

J. T. Barnaby
U. S. Fish & Wildlife Service
Portland, Oregon

As a result of interest in our job, and our desire to do it in the best possible manner, we lose site of the fact that modern living is filled with hazards. People are getting hurt every hour of the day, both on and off the job. We tend to forget all about SAFETY until someone gets hurt. Then, of course, it's always the other fellow that gets hurt, and consequently there is no need for us, as an individual, to think any more about it. Yet the cold, stark fact remains that we are having accidents in our fish-cultural operations, and in connection with all phases of work related to fish-culture. Whether the work involves the trucking of supplies, the study of the nutritional requirements, the diseases to which fish are subjected to, or whether we are involved in the actual handling of the adult fish, the eggs or the resultant fry, accidents of some sort seem to occur.

We are not alone in having accidents. They are occurring in all phases of Government work. At the very highest level of Government there is a growing determination that the frequency of accidents must be reduced. I know this is true as far as the Federal Government is concerned, and I am quite sure it is equally true insofar as the State government is concerned. We are instructed to be more SAFETY conscious, and in connection with the performance of every job to make sure that it is being carried on in as safe a manner as possible.

As far as the Fish and Wildlife Service in the Pacific Region is concerned, we are initiating a 4-point program with the determination that we will cut down our accident frequency rate. We are convinced that accidents can be prevented.

This program calls for the dissemination of information to make all personnel SAFETY conscious. We are proceeding on the old advertising axiom --- that to get a story across, you should tell it often and tell it differently.

Secondly, we are starting an analysis of types of accidents and location of occurrence. The purpose of this is to find out just where we are having accidents, what is causing those accidents, and how they can be prevented. For example, if there is a certain type of hazard which is resulting in a lot of accidents, such as having heavy objects drop on a person's toes, we will give special emphasis to guarding against injuries of that particular nature. In other words, as we learn more about where we are having accidents we are going to step up our educational program in that direction.

Thirdly, we are going to accentuate our incentive awards program relative to SAFETY. We are going to present plaques to stations which have a good SAFETY record, and we are going to give cash awards to any of the personnel who have good ideas which will result in furthering the SAFETY program.

Fourthly, we recently amended every individual's job description in the Fish and Wildlife Service, of the Pacific Region, from the janitors to the Regional Directors. This amendment states in no uncertain terms that SAFETY is a specific part of the individual's job.

Up to the time of this job description amendment, SAFETY was considered to be inherent in everyone's job. However, now, no one can say "I didn't know." It is spelled out in plain, direct language.

Also, a statement has been put on the performance rating that will be used in March 1959. That statement reads as follows: "In each of the above rating elements, consider effectiveness in supporting SAFETY programs and preventing accidents to personnel or equipment." Thus, when an individual is being rated on his performance during the past year, it is the responsibility of the rating official to give serious consideration to the individual's actions relative to SAFETY. And then the SAFETY Board is going to have the prerogative of looking over every performance rating so that it can, if it desires, express its view as to how an employee should be rated on SAFETY.

There are some individuals who contend that an accident by its dictionary definition, is something that occurs unexpectedly and consequently, cannot be prevented. It is conceded that there are a few accidents that cannot be prevented or, at least, are not the fault of some of the parties concerned, but these are relatively few. We are convinced that accidents can be prevented. And, so help me, we are going to reduce the number of accidents in this Region.

I cannot emphasize too strongly that every one of you should spend at least a few minutes every day thinking about the SAFETY program. You should never start a job, or instruct anyone else to do a job, without stopping just for a minute to consider what hazards are involved in that particular job, and if there is any way of eliminating, or reducing, the hazards. Please, give SAFETY your personal attention. Remember, accidents can be prevented.

FEEDING SILVER SALMON AT QUILCENE HATCHERY (DRY FEED)

Ed. Horn
U. S. Fish and Wildlife Service
(Fish Cultural Station) Quilcene, Washington

With the results obtained in our 1957 rearing program of silver salmon on dry feed, we were determined to rear the entire lot during 1958 on dry feed.

Having a large amount of meat products on hand, we started all but one-fourth of the silver fry on wet feed; the one-fourth were started on Clark's trout feed.

The silver fry at first feeding on Feb. 19, 1958 ran 1252 per pound, and the weight of the lot was 1070 pounds, which equals 1,339,640 fish.

The one-fourth of this lot reared entirely on dry feed were liberated in Capitol Lake during the week of August 15, 1958 at 40 per pound after 179 days feeding. This planting was necessary to give us pond space at the hatchery for the remainder of the silvers in this lot.

The three-quarters of this lot were converted to dry feed on May 1, after 70 days of feeding and ran 460 per pound. The silvers started on dry feed ran 300 per pound at this time.

The overall picture in it's entirety as of November 1, 1958: Number of fish on hand or liberated 1,246,830 for a weight of 31,266 pounds, minus the 1070 pounds, weight at first feeding equals a total production of 30,196 pounds. Size of fish at November 1, 1958, 35 per pound.

The complete program from first feeding to November 1 is 255 days.

The mortality over the entire program for the entire lot was 92,810 or 6.8 per cent. Of these losses 68,905 or 75% of the total losses occurred while the fish were being fed on the meat diet.

To produce this 30,196 pounds of fish gain we used 53,763 pounds of feed including both wet and dry, costing $7,715.61.

The conversion on feed being 1.8 pounds costing .25¢ over the entire feeding program of the 255 days.

Water temperatures running from 44° in February to a maximum of 55° in August, making an average water temperature during the feeding program of 49.75 degrees F.

This following chart was prepared after we fed dry feed by automatic feeders from the swim up stage fry. While these tests prove very little, it is very short. At the outset we fed at 15 minute intervals over a 12 hour day, then tried to increase feeding to keep up with the growth of the fish. We had to give up as we passed the amount the feeders could dispense. At the finish we were feeding every two minutes. In each of two minutes. In each of five hatching troughs we screened off the three center pockets or 48 inches of a 16 inch trough and put in five pounds of silver fry at 1252 per pound or 6,260 fry. Four troughs were fed with four different dry feeds and the last the control was fed on a meat diet. The meat control was discontinued after 63 days as we went off the meat diet outside and would have had to grind for this one trough alone. For what it is worth - chart:

<u>The following figures are cumulative-from start to finish- average water temperature 48.68 F.</u>

Type feed	Duration	Amt. fed (lbs.)		Gain (lbs.)		Conversion	Mortality	
A	*3/7-4/3 28 days	3.44		2.0	None	1.72	49	Lost
B	3/7-5/23 77 days	21.0	Close in size	21.25	240	1.037	230	.036
C	3/7-5/23 77 days	18.0	Large & small	12.25	303	1.47	1104	.16%
D	3/7-5/23 77 days	17.75	All small	8.0	472	2.22	121	.019
Control	3/7-5/8 63 days	30.0		15.0	310	2.0	47	

* Fingerlings in this lot were lost on April 13, due to a clogged spigot.
On Clark's Crumbles we fed about 20% under their feeding chart. Crumbles cost $1375.00.

Starting - 50% pork liver + 50% beef liver. Two weeks - 49% viscera, 49% beef and pork liver, 2% diet sol. and salt to bind.

These figures may not prove a thing, but actually what we intended to prove was the feeding method. By this test I am satisfied that the method of feeding little and often is near the answer in order to sustain steady growth and with the best possible conversion, even if you are using an all wet diet. This test also makes me believe that we are using the right feed (dry feed) at this particular station.

FEEDING DRY FEED TO SOCKEYE SALMON

Alfred C. Gastineau
U. S. Fish and Wildlife Service
Leavenworth, Washington

This is our second attempt to use dry foods as a complete diet for rearing sockeye salmon fingerlings. Our results are somewhat clouded from above normal water temperatures experienced during the month of August and from inadequate water flow. However, we were able to correct both of these and in the end result, it did not have too great an impact on the experiments.

We used Fishes Wishes, Rangen's and Clark's Rainbow trout feeds in our trials. The group receiving Fishes Wishes broke in 50 days, but because of the erratic operation of their mechanical feeder it was thought they were starved. We put them on our regular diet until the mortality was back to normal and the remaining fish appeared to be in good shape. The diet was again tried, feeding by hand, but this time they broke in 27 days so this part of the trial was terminated.

The experiments were initiated as soon as the fish commenced feeding and were terminated at the normal liberation time, a period of 249 days.

The fish were started and reared in hatchery troughs for 87 days then transferred to outside ponds at which time the numbers of fish were reduced.

At start, the fingerlings numbered 3,514 per pound. They were fed every half hour during the eight working hours of the day, each feed was divided in half then two passes were made in the feeding. In other words, the first half of feed was fed to all the troughs then the process repeated with the second half. The food was floated on the water until the fish were of size when it was no longer necessary.

When the fish numbered approximately 1,130 per pound the number of feeds were reduced to eight per day; then to six per day at 480 per pound and finally when they were 330 per pound the frequency of feeding was reduced to four per day. The making of two passes was carried out the entire period.

Clark's fry fine and Rangen's No. 1 was fed the first 26 days, then changed to Clark's fry coarse and Rangen's No. 2. When the fish reached 300 to the pound the food size was changed to Clark's Crumbles and Rangen's No 4 and 5, and continued to the end of the season.

At the end of the season we had the most uniform fish that we had ever seen at this station. They were nearly twice the size of the control group, which was fed our production diet. The conversion was cut almost in half and the cost of food per pound of fish gained on Clark's was less than the control and Rangen's higher. The fish withstood handling very well, which was in reverse of the experience we had last year when we experimented with Clark's only.

The weak spot in using dry feeds for sockeye salmon fingerlings is the mortality, which was about seven times greater than the controls. The Clark's heavy mortality occurred in the size group from about 1,550 per pound to 180 per pound, the greatest loss occurring in size 470 per pound to 330 per pound when 16.3% was lost in a two week period.

With Rangen's, heavy loss was experienced from the very beginning, the peak being reached in about the same size group as Clark's when we lost 11.89% in the two week period. It was noted that the mortality in both diets was predominately the smallest fish and fish that appeared to have eaten for some time then quit feeding and starved to death.

It appears that our production diet maintains and gives growth to the runts as well as the large fish, the mortality being in all sizes.

DRY FEED EXPERIMENT ON SOCKEYE SALMON FINGERLINGS FROM LOT 7LH-70 FROM
INITIAL FEEDING, February 1, to April 28, 1958, LEAVENWORTH STATION

Average Temperature - 44.9	16 Troughs Control on Regular Wet Diet	16 Troughs On Clark's Dry-pellet Feed	8 Troughs On Rangen's Dry-pellet Feed
No. per pound, 2/1/58	3,514.3	3,514.3	3,514.3
No. per pound, 4/28/58	812	660	821
No. fish on hand, 2/1/58	281,144	281,144	140,572
Mortality 2/1 to 4/28/58	6,649	11,841	12,450
No. fish on hand 4/28/58	274,495	269,303	128,122
Percent mortality	2.37%	4.21%	8.86%
Weight in pounds, 4/28	338	408	156
Weight in pounds, 2/1	80	80	40
Gain in weight in pounds	258	328	116
Percent gain in weight	322%	420%	290%
Food fed in pounds	842	648	283
Conversion	3.26	1.97	2.44
Food cost per pound fish gained	.347	.420	.505
Period April 29 to October 7, 1958 - Average temperature 54.68			
No. per pound, April 29	812	660	821
No. per pound, October 7	85.4	42.7	51.9
No. fish on hand, April 29	240,180	235,642	112,107
Mortality for period	7,061	62,547	29,126
No. fish on hand, October 7	233,119	173,095	82,981
Percent mortality	2.94	26.55	25.98
Weight in pounds, October 7	2,729	4,058	1,599.5
Weight in pounds, April 29	296	357	136.5
Gain in weight in pounds	2,433	3,701	1,463
Per cent gain in weight	822	1,037	1,072
Food fed in pounds	11,371	7,683	2,938
Conversion	4.67	2.08	2.01
Food fed per pound fish gained	.372	.294	.408

SUMMARY FOR REARING PERIOD FEBRUARY 1, to OCTOBER 7, 1958

	16 Troughs Control on Regular Wet diet	16 Troughs On Clark's Dry-pellet Feed	8 Troughs On Rangen's Dry-pellet Feed
Total gain in weight in pounds	2,691	4,029	1,579
Total food fed, Feb. 1, to Oct. 7	12,213	8,331	3,221
Average cost per pound	.0815	.1469	.2033
Total conversion	4.54	2.07	2.04
Food cost per pound of fish gained	.370	.303	.416

Control Diet

Beef liver	23%
Hog liver	28%
Turbot	33%
Solubles	5%
Hog spleen	3%
Beef spleen	4%
Seal meal	3%
Salt	1%

TEMPERATURE AVERAGES AND MORTALITY PERCENTAGES BI-WEEKLY PERIODS
FEBRUARY 1, THROUGH OCTOBER 7, 1958 - FEEDING PERIOD DRY FEED EXPERIMENT
LOT 7LH-70, LEAVENWORTH, WASHINGTON STATION

Periods	Average Temperature	Controls Mortality	Clark's	Rangen's
2/1 to 2/17	44.0	.70%	.87%	1.28%
2/18 to 3/3	44.8	.34	.37	.70
3/4 to 3/17	45.0	.37	.37	.64
3/18 to 3/31	45.6	.32	.62	1.92
4/1 to 4/14	45.8	.33	.62	3.34
4/15 to 4/28	44.0	.60	1.44	1.29
4/29 to 5/12	45.0	.19	5.39	2.29
5/13 to 5/26	46.0	.42	16.3	8.34
5/27 to 6/9	49.2	.42	4.19	11.89
6/10 to 6/23	56.6	.22	.27	2.14
6/24 to 7/7	56.1	.30	.087	.17
7/8 to 7/21	62.2	.43	.21	.15
7/22 to 8/4	60.6	.32	.22	.12
8/5 to 8/18	60.6	.37	2.07	.06
8/19 to 9/1	60.3	.06	.11	.26
9/2 to 9/15	57.3	.04	.06	2.19
9/16 to 9/29	51.1	.05	.07	1.16
9/30 to 10/7	51.6	.02	.03	.02

IMPROVEMENT IN THE CUTTHROAT PROGRAM FEEDING DRY FEED

John M. Johansen
Washington State Department of Game
Olympia, Washington

The Washington Department of Game has raised cutthroat for liberation in our higher elevation lakes for many years. These lakes were first planted by pack-back, later by mule string and now by airplane or small planting truck.

We have always had trouble rearing cutthroat from wild eggs. The fish were slow growing, with a tendency to anemia, and high mortality. We were aware that these conditions were due to a deficiency in the diet, but were able in certain stations to provide a good program feeding a large percent of liver. Some stations were able to raise cutthroat to 500 to the pound, but most of the fish liberated were 1000 to the pound.

We have used the dry diet for two years and it has made a terrific change in the program. The smallest fish planted are now 500 to the pound and the majority are 200-300 to the pound. These fish were in much better condition, with less mortality and carry better during transportation.

We are able to cut the magnitude of our entire program from egg-taking to liberation of the fish and have a better program, planting healthy fish from 200-500 to the pound rather than fish in fair condition from 500-1000 to the pound.

We had remarkable results at the Colville Hatchery this past season with the following results. These were Kings Lake eggs.

Number of green eggs received	517,991
Total egg mortality	8,260
Total fry mortality	27,538
Percent mortality approximately, from eggs to planting	7%
Total planted	482,193
Average size of fish planted	221 per pound
Age of fish planted	$3\frac{1}{2}$ months
Total pounds of fish planted	2,184
Pounds of food fed per pound, of fish gained	1.7
Food cost per pound of fish gained	30.6

As a comparison for size of cutthroat fry planted over a period of years at the Colville Hatchery, which produced the best cutthroat fry from the wet diet, we have the following figures.

These sizes of fish are taken from the planting records of three of the larger lakes for the years 1955 to 1958. All of these lakes receive the same amount of fish every year and the age of fish is the same from year to year.

	1955	1956	1957	1958
Average size	720	590	557	216

Approximate number planted each year, 375,000.

Age of fry planted each year 3½ months.

Due to the success of feeding dry food to cutthroat we will be able in the future to provide a better program with less fish than we were able to provide with the wet diet.

DRY FEED EXPERIMENTS AT EAGLE CREEK STATION

John R. Parvin
U. S. Fish and Wildlife Service
U. S. Fish Cultural Station (Eagle Creek)
Estacada, Oregon

A decision was made to test commercial dry fish food products on the feeding of silver salmon at this station. There were three brands of dry feed tested. These will be designated as "A", "B" and "C".

Date initiated: April 4, 1958

Plans for testing:

"A" to be fed the entire period of the test.
"B" to be fed the entire period of the test.
"AB" "A" to be fed until water temperature reaches 50° F. then "B" to be fed until water drops to 50° F., then "A" to be fed. This was done so that any difference in protein requirements of silver salmon might be apparent as "B" analyzed higher in protein than "A". The change to "B" was made on May 17, 1958.

"C" to be fed the entire period of the tests.

In addition to the dry feeds tested a control was set up which was fed the wet production diet used at this station. This varied somewhat with the availability of constituants. It was approximately 10% beef liver, 25% hog liver, 20% hog or beef spleen, 35% turbot, 5% distiller's solubles and 5% meal. Two percent salt was added as a binder. This was mineralized salt.

Four hatchery deep troughs were stocked initially with 15 pounds each (60 pounds) of fry which were fed the diets listed above. This made a total of 20 troughs used in the tests. The number of fish involved was design ed so that later each group of four troughs would constitute a pond. At the time the tests started, all fish involved had been fed no other product.

This report will show the status of each of the groups being fed at the time any change in the program is made.

From the beginning it was apparent that those fish being fed diet "B" were refusing to take food as they should. In order not to jeopardize the fish, diet "B" was discontinued on April 25, 1958. A summary of the results to this date follows:

	"A"	"AB"	"B"	"C"	Control
Percent gain	64	56	33	36.9	69
Conversion	1.56	1.33	2.6	12.0	3.2
Number per lb.	676	713	835	813	649

Due to poor growth factor and the high conversion diet, "C" was discontinued on May 28, 1958. A summary of results follows. All data is cumulative.

Diets	"A"	"AB"	"C"	Control
Percent gain	453.7	340.0	213.0	471.1
Conversion	1.38	1.86	4.45	2.6
Number per lb.	245	327	522	236

As the summer progressed, it became apparent that the mortalities on diet "AB" were exceeding diet "A" and the controls. It was decided to discontinue diet "AB" on September 10, 1958. At the time of release, on November 25, 1958 , the fish on this diet would not handle satisfactorily. Handling loss amounted to approximately 700 in this pond. The loss in the other ponds was very nominal. A summary of results to September 10, 1958 follows:

Diets	"A"	"AB"	Control
Percent gain	2851.3%	2573.3%	3088.9%
Conversion	2.45	2.35	3.69
Number per pound	41	44	37
Cost per lb. of production	.337	.370	.29
Percent mortality 8/1 to 9/10/58	2.53%	8.63%	1.9%

The tests on diet "A" and the control were continued and will continue until release approximately February 15, 1959. All fish were weighed on December 1, 1958 with the following results:

Diets	"A"	Control
Number per pound	23.7	26.2
Conversion	2.34	3.99
Food cost per pound of production	.338	.327
Average cost of food per pound	.1147	.0819
Total net weight of gain	1808 lbs.	1487 lbs.
Total food fed	4227 lbs.	5960 lbs.
Mortalities 8/1/58 to 11/30/58	3.64%	2.5%

In addition to the silver salmon which were fed on dry diets, we have two year classes of steelhead trout which are being fed diet "A". Three hundred forty-four thousand steelhead trout of the current year's egg take have been fed nothing but the dry feed. The statistics on this lot follows:

Date started to feed, approximately July 1, 1958.

Percent loss, July 31 to October 31, 1958, .46%. Conversion 1.66.

Number per pound, 52. Food cost per pound of production, .247.

The apparent good results being obtained on other lots prompted us to convert a lot of yearling steelhead trout to dry feed diet "A". The statistics for this lot follows:

Date converted, August 15, 1958. Number per pound, 18.

Date last data available, October 31, 1958. Number per pound, 9.

Conversion, August 15, 1958 to October 31, 1958, 1.9.

Food cost per pound of production, .266.

EFFECT OF MOISTURE IN CHINOOK SALMON DIETS

A. N. Woodall
Bureau of Sport Fisheries and Wildlife
Western Fish Nutrition Laboratory
Cook, Washington

To explain the lack of success in rearing fall chinook salmon on dry, pelleted diets, it was postulated that they are incapable of putting sufficient moisture in their stomach to permit complete digestion and absorption of the nutrients from the diet. Results of a feeding trial in which percent moisture in the diet was varied from 7.5 to 70 percent by the addition of water to a commercially available "good" dry pellet, were presented. Improved growth response and conversion ratios were noted for intermediate moisture levels. Data was presented to show that the falling off of the growth response for higher moisture levels can be attributed to lowered nutrient intake. Since the diets were fed ad libitum and the total wet weight of food consumed per gram of fish remained relatively constant, it was concluded that the fish ate all they could hold but that when a large part of the bulk was water the intake of nutrient was insufficient for maximum growth.

PROGRESS REPORT ON NUTRITION RESEARCH

Wallace F. Hublou
Oregon Fish Commission
Sandy, Oregon

Introduction

Since 1955 the Oregon Fish Commission has been conducting production type feeding studies in conjunction with the Seafoods Laboratory of Oregon State College. The product being tested, in these studies, was a pelleted fish food which was formulated after several years of preliminary diet experiments conducted in a joint study by the two agencies named above.

Detailed progress reports of the production feeding studies conducted from 1955-57 can be found in the 1955, 1956, 1957 reports of the Northwest Fish Cultural Conferences.

Procedure

The formula of the experimental pellet has been altered considerably since 1955. At present the formula is as follows:

Meal mixture -- 60% of the diet.

- Cottonseed oil meal
- Herring meal
- Crab solubles
- Wheat germ
- Distillers solubles
- Corn oil
- Antioxidant
- Vitamin supplements

Fish mixture -- 40% of the diet.

- Turbot
- Tuna viscera

This mixture of 60% meal and 40% fish is quite moist and when pelleted makes what we call a "soft pellet". These pellets may be made prior to use but must be stored under refrigeration. Information as to the manufacturing process involved in making soft pellets can be found in the report by Duncan K. Law, Oregon State College.

No attempt was made to feed the same amount of hatchery diet and soft pellets. The hatchery diet was fed in accordance with the normal hatchery procedure; the soft pellets were fed partly on an "ad libitum" basis and more recently according to a feeding chart which regulates the food to be fed according to fish species, size, and prevailing water temperatures.

The frequency of feeding has varied from several times a day for small fish to as little as one feeding every other day to older fish in cold water.

The hatchery diets have been spoon fed; the soft pellets have been fed by broadcasting over the surface of the pond.

Results

A summary of the economically-important results of the eight production pellet feeding trials completed thus far is found in Table 1.

In each of the feeding studies the experimental pellet was compared with the regular hatchery diet being fed at the hatchery where the experiment was being conducted.

The calculated food cost to produce a pound of fish by feeding the experimental pellet ration has been found to vary from 16.6 to 24.3 cents under experimental conditions. The food cost to produce a pound of fish by feeding the standard hatchery diet has been found to vary from 39.0 to 54.0 cents. These cost figures do not take into account the cost or preparation and handling of either diet.

The amount of soft pellets fed was only 44 per cent of the amount of the regular hatchery diet fed. Also, the food cost of the soft pellets was only 47 per cent of the cost of the regular hatchery diets. Further, the cost to produce a pound of fish by feeding the soft pellet ration was only 44 per cent the cost to produce a pound of fish with the regular hatchery diets.

The results of these feeding trials show very clearly the savings in food cost when feeding soft pellets when compared to the regular hatchery diets fed by the Oregon Fish Commission.

We have found the feeding of soft pellets to be a practical method of food presentation. Considerable savings in manpower, such as food preparation, handling, feeding, and, pond cleaning are also realized by feeding soft pellets. Also, there is less storage space required, less water pollution from leaching food, and the fish produced are generally more even in size.

Most of the fish reared in these production experiments have been marked by fin clipping. The returns so far are complete for only two broods of silvers reared at the Sandy Hatchery. In both cases the recoveries of fish fed the soft pellets have been slightly more than for those reared on hatchery diets.

Discussion

Important problems thus far encountered in feeding the soft pellets are rancidity, anemia and sporadic fish kills. The rancidity problem can be overcome by the use of antioxidants and proper handling of food. When the fish become anemic it is believed that rancidity was the primary cause. Results of recent tests to solve the fish kill problem have indicated that the afflicted fish were suffering from a nutritional deficiency or toxic condition caused by the high level of linseed oil meal in the diet. Fish which had been sick were cured by deleting the linseed oil meal. The present soft pellet formula does not contain any linseed oil meal.

The present soft pellet formula is not as efficient when fed to fish smaller than approximately 300 per pound. Until further information is obtained, a "starter diet" will be fed the smaller fish. Recent experimental work on "starter diets" has shown that beef liver fed in an equal amount with pastuurized salmon viscera has produced very satisfactory results.

Table 1. Summary of Production Diet Studies; Sandy, Oakridge, Klaskanine, and OxBow Hatcheries, 1955-58

Experiment Description Hatchery, Brood Yr. & Species	Time Fed (Weeks)	Pounds Food fed	Pounds Fish Produced	Food Conversion As fed	Food Conversion Dry	Food cost Per pound Fish Produced
Sandy - 1954 Silvers						cents
A. Experimental pellet	38	1,841	801	2.30	1.35	23.2
B. Hatchery diet	38	5,029	754	6.67	2.38	54.0
Sandy - 1955 Silvers						
A. Experimental pellet	37	1,452	640	2.27	1.37	16.6
B. Hatchery diet	37	3,295	609	5.41	1.84	39.0
Oakridge - 1955 Spring Chinook						
A. Experimental pellet	26	1,204	516	2.33	1.46	17.0
B. Hatchery diet	26	2,371	476	4.98	1.66	43.3
Oakridge - 1956 Spring Chinook						
A. Experimental pellet 1/	33	3,966	1,560	2.54	1.66	23.6
B. Hatchery diet	33	9,972	1,711	5.83	1.80	47.8
Oakridge - 1956 Blueback						
A. Experimental pellet	9	924	380	2.43	1.59	20.7
B. Hatchery diet	9	2,223	394	5.64	1.82	46.8
Klaskanine - 1956 Silvers						
A. Experimental pellet	29	5,853	2,590	2.26	1.48	19.2
B. Hatchery diet	29	11,376	2,001	5.69	1.95	40.4
Klaskanine - 1957 Steelhead						
A. Experimental pellet 2/	22	1,974	846	2.33	1.52	19.8
B. Dina-Fish Pellets 3/	6	756	204	3.70	3.10	31.4
C. Hatchery diet	16	3,539	644	5.50	1.91	39.0
OxBow - 1957 Fall Chinook						
A. Experimental pellet						
1. Starter diet 4/	5	1,021	203	5.04	1.42	67.0
2. Pellets, pulverized	7	785	275	2.86	1.87	24.3
3. Combined (1 & 2)	12	1,806	478	3.78	1.68	42.4
B. Hatchery diet	11	3,611	594	6.08	1.60	51.7

1/ Beef liver substituted for fish portion of pellet for last 7 weeks of experiment.

2/ Experiment discontinued after 22 weeks because of sporadic fish kills in experimental pellet group.

3/ Diet discontinued after six weeks of feeding due to steady increase in mortality and because of reluctance on the part of the fish to eat the food.

4/ An all meat starter diet was fed for the first 5 weeks at which time the fish averaged 550/lb. and were considered large enough to eat the pulverized pellets.

DISEASE PROBLEMS WITH DRY DIETS IN SILVER SALMON

B. J. Earp
Washington Department of Fisheries
Seattle, Washington

During 1958, the State of Washington Department of Fisheries used commercial dry pelleted feeds quite extensively throughout all hatcheries in the silver salmon rearing program and the diseases occurring in these fish were carefully observed. All fish were started on the standard hatchery meat diet and the dry pelleted feed was introduced after the fish had been reared approximately 90 days.

In most cases the fish adapted themselves readily to the change in diet and made exceptional progress on the pelleted feeds. Only in isolated instances was the dry feed poorly received and this was usually observed in ponds of fish of smaller than average size. A few ponds which failed to adapt were returned to the standard meat diet for a short period of additional growth and were then successfully converted to the dry diet.

Some outbreaks of acute infection were observed at different hatcheries throughout the state, but no significant difference in disease histories could be determined between the fish receiving the dry diets as opposed to those receiving the standard hatchery meat diet until the dry diets had been fed for approximately 60 days. At this time, some increase in mortalities developed in most ponds receiving the pelleted feed and a very considerable increase in the incidence of *Octomitus* infestation was observed in the affected fish.

Increasing numbers of debilitated fish were observed frequenting the quieter waters of the ponds and it was these individuals who contributed most significantly to the increased daily mortality. While examination of the debilitated fish revealed heavy *Octomitus* infestations it was also found that the largest and most vigorous fish were also universally infected with the parasites which to all outward appearances caused them no harm. At the same time, no significant increase in *Octomitus* was observed in the fish maintained on the standard hatchery meat diet.

Mortalities, expected to rise steadily, remained instead relatively stable at less than 1% of the remaining population per week. The debilitation of a segment of the population did not result in an increase in the incidence of acute infectious disease. It was postulated that only the less precocious feeders in any given group, which failed to adapt well to the dry diets, were those which became emaciated, collected in the quiet waters and subsequently provided the recruitment to the daily mortalities. Debilitated fish were, of course, heavily infected with *Octomitus* but there was also no evidence that they had fed actively for a considerable period of time and were, in fact, starving to death.

After some 90 to 120 days of rearing, the dry diets were terminated with the exception of a few experimental groups. The balance of the silver salmon were returned to the standard hatchery meat diet. The experimental groups will be continued on the dry feeds for the duration of the normal rearing period. No other significant disease history has developed in these fish to the present time.

A TECHNIQUE FOR THE DETECTION OF ACID-FAST ORGANISMS IN FISH TISSUES

Richard L. Westgard
Washington Department of Fisheries
Seattle, Washington

A survey of the incidence of acid-fast bacteria in salmon and steelhead trout is being conducted in the Columbia River basin. A method was developed to detect the presence of these organisms and determine their bacterial density per gram of tissue.

In fish tissue, acid-fast bacteria form in nodes and nodules. Because of this non-dissemination the bacteria might often go undetected by daubing tissue on a slide for a smear stain. To overcome this the tissue was liquified with 3% NaOH for 16-20 hours at a 40°-43° C. A 33 ml. aliquot was taken and centrifuged at 16,000 r.p.m. for 30 min. The centrifugate was dispersed in 1 1/2 ml. of water and .05 ml. pipetted to an area of 5 sq. cm. on a slide. The slide was stained with the Ziehl-Neelsen technique and 1 sq. mm. of area examined under oil immersion.

For every organism seen in 1 sq. mm. of area examined there are approximately 1 million organisms per gram of tissue. This was calculated by taking a measured quantity of liver and seeding with a known quantity of acid-fast bacilli. The liver was processed and examined by the complete digestion technique. The lowest bacterial density per gram of liver that would consistantly give 1-10 organisms per sq. mm. of area examined was the final figure used.

A comparative study was made between digest-concentrate and the standard smear technique. 1,234 fish livers were examined. 41 or 3.3% were positive by the smear method and 56 or 4.5% positives were found by digest-concentrate technique. This was a 36.4% increase in positives of the latter over the first. A combination of both methods gave a total of 77 positives or 6.2% of the number examined. This is a yield of 87.9% increase over the smear method and a 37.8% increase over the digest-concentrate.

A PROGRESS REPORT ON FISH DISEASE RESEARCH

James W. Wood
Oregon Fish Commission
Oakridge, Oregon

The survey program concerned with the determination of the incidence of tuberculosis in salmon and steelhead entering the Columbia River is being continued. Weekly samples of blueback, chinook, silver, and steelhead livers are collected from the gill-net fishery landings and examined for tuberculosis during the open seasons. The groups of fish that have been examined to date are shown in Table 1.

Table 1. Incidence of Tuberculosis Among Gill-Net Caught Salmon and Steelhead in the Columbia River, 1957-58.

Species	Year	Number of Fish Examined	Number of Tuberculous Fish	Per Cent
Blueback	1957	584	4	0.7
"	1958	432	3	0.7
Chinook	1957	2,456	135	5.5
Steelhead	1957	1,221	15	1.2
Silver	1957	1,099	91	8.3

Large fluctuations, seasonal in nature, were noted in the weekly percentage of tuberculous chinook and silver salmon. These fluctuations, coupled with fluctuations in the catch, may change the percentages of tuberculous chinook and silvers shown in Table 1, when weighed for the year.

The comparison of the incidence of tuberculosis in adult hatchery-reared salmon with that in adults of natural origin is being continued. Stocks of adult salmon of likely natural origin examined during 1956-58 were not found to be tuberculous. These wild fish included fall chinook from the Snake River, silvers from Tenmile Lakes, and spring chinook from Oregon tributaries of the Snake. In contrast, the incidence of infection among fin-marked adults of the same species returning to Oregon hatcheries was very high, in some instances 100 per cent. It should be mentioned that the stocks of wild fish were chosen from areas widely separated from the rearing or release of hatchery propagated salmon so as to avoid confusion with artificially reared fish.

Columnaris disease was observed to be severe among various stocks of adult spring chinook during the summer of 1958. Large numbers of adults are known to have died in the South Santiam, Middle Fork Willamette, and Trask Rivers. Water temperatures in the 70's were observed in the South Santiam and Trask Rivers during mid-summer while the water temperature in the holding area on the Middle Fork Willamette reached a high of only 63° F. in early October.

RED MOUTH

Robert R. Rucker
U. S. Fish and Wildlife Service
Seattle, Washington

Bacteria are divided into two major groups by their reaction to a stain devised by Dr. Gram -- gram positive and gram negative. You are all familiar with a Gram positive organism -- kidney disease, however, most bacterial fish diseases are caused by Gram negative organisms. Gram negative organisms are further subdivided into groups according to the number and/or location of flagella on them. One of these types of Gram negative organisms which has no flagella is the etiologic agent of furunculosis. The second type is a group possessing a single polar flagellum and are called monotrichic bacteria. This group, according to the literature, is a common cause of bacterial diseases of fish. The German literature for years has mentioned this type as the cause of dropsy in carp and also rainbow trout. In the past populations of young carp were subjected to the disease to develop a resistant strain -- the susceptible fish died, while the resistant fish developed an immunity to the infection and thus survived. Since the development and relative cheapness of antibiotics, carp nowadays are injected with a single dose of chloromycetin, which apparently controls dropsy. A similar organism in this country was described (by Wagner & Perkins) from commercial rainbow trout hatcheries in California as the cause of red mouth disease of rainbow trout. Their description of the disease is as follows: the fish become dark in color, the oral cavity becomes reddish, inflammation may develop at the base of the fins, the spleen appears almost black, and the intestine becomes inflamed, especially at the distal portion -- the contents of which become a yellow liquid. In the terminal stages of the disease, the fish may exhibit a cork-screw swimming. They found that gyrodactylus infections were always present when red mouth disease was diagnosed and considered them important in the transmission of the disease because of the skin abrasions they cause, which would permit entry of the bacteria. They also found that infections developed when the temperatures reached about 70°F. and that it was rare to find an infection in the winter time.

Ross Nigrelli isolated a pseudomonad from a group of cichlids which we might consider in this group. He found that this organism would kill fish in a few hours when inoculated. When growth from a culture was rubbed on the skin of healthy fish, death occurred within one or two days; when the organism was fed, lesions were found in 10 to 20 days. This is an interesting point because the rainbow trout in Idaho notoriously become infected with red mouth the day after being handled. Leo Margolis described a similar type organism from pike in Canada from a disease which he called "red sore". Ross Nigrelli mentions that the members of the genus Pseudomonas are particularly noted for the fact that they are not easily affected by most antibiotics. The control of any pseudomonad infection whether it occurs in fish, domestic animals, or man, is therefore a challenge to bacteriologists and clinician.

Another group of Gram negative organisms possess flagella all around the periphery which is known as peritrichic flagellation. In 1950, cultures from fish exhibiting symptoms of red mouth were sent to me from which I isolated a Gram negative organism with peritrichic flagellation. Therefore, I assumed this type to be the cause of red mouth -- not the monotrichic organism attributed as the etiologic agent in the literature. The peritrichic organism responded to therapy while the monotrichic form, to my knowledge, always has been quite resistant to treatment. Leo Margolis described this type of organism from diseased suckers in Canada. He was able to produce the disease only by heavy inoculations of the organism, indicating that it was not very pathogenic. We have found that this type of organism isolated from Hagerman has a low virulence.

The fourth type of organism that we could categorize by its flagellation would have to have a tuft of flagella at one or both ends--lophotrichic.

Last August I made a trip to Hagerman and obtained cultures from fish having red mouth disease. At that time I brought back infected fish, held them above healthy rainbow trout in a trough, and cultured the healthy fish after they became sick and died. John Ross found that the organism isolated from the fish at the Hagerman station was identical to the organism from the experimental fish subjected to infection by diseased fish from Hagerman. Typical symptoms of red mouth disease developed among these fish indicating that we had another etiologic agent of the disease. Therefore, where we once considered the monotrichic form as the etiologic agent of red mouth disease, and later the peritrichic form, (don't forget furunculosis can give some similar symptoms) we now consider the lophotrichic organism as yet another agent or red mouth disease of rainbow trout. In other words, similar symptoms can be produced by more than one organism.

The present measure for combating the disease is sulpha therapy which I consider to be a stop gat measure until better controls are found. Prophylactic measures should be considered, that is, maintaining a disease - free stock and maintaining sterile techniques. For the future, vaccination measures could be considered and/or the development of stocks resistant to red mouth disease.

CHEMOTHERAPY OF HEXAMITA SALMONIS (OCTOMITUS)

William T. Yasutake
Western Fish Nutrition Laboratory
Cook, Washington

A preliminary experiment was initiated to test whether the 23 compounds supplied by various pharmaceutical houses were more effective than the presently known compounds, Carbarsone and calomel, as a chemotherapeutic agent for Hexamitaisis (Octomataisis) in the chinook salmon. The compounds were fed at two different levels: 0.2% and 1.0% of the wet weight of the diet. At the lower concentration, 4 compounds gave diets that were palatable to the fish, were non toxic and proved effective in irradicating hexamitaisis. However, at the higher concentration, only 3 compounds proved effective. A full report on the above experiment is being submitted for publication.

REVIEW OF FISH FARMING IN WASHINGTON STATE

R. T. Pressey
Washington Department of Fisheries
Seattle, Washington

Introduction

Undoubtedly the greatest problem confronting those vested with salmon management is to maintain this valuable resource in the face of civilization's depredations. The Administration's fish farm program is designed for this purpose.

Washington State history reveals that prior to 1880 only local and Indian fishermen reaped an annual harvest from abundant salmon runs throughout accessible waters of the State. At present multi-million dollar commercial and recreational industries are supported by these stocks despite rigid fishing restriction. Not only local fishermen but nationals from Canada and Japan, and natives of Alaska, Oregon and California exploit salmon from Washington State nursery grounds. It is indeed doubtful if present salmon production can survive further fishery expansion.

Combined with man's direct reduction of fish stocks in his fishery participation are the myriad of indirect results of his civilization which take a tremendous toll of the productive capacity of this resource. Among these are the power and reclamation dams which divert water for electricity and irrigation, the logging industry which devastates the watershed for fish production, and pollution which renders water unsuitable for fish or fish food survival.

Available clean, high quality water for salmon production is limited today, and with the advance of civilization further limitation may be expected. Fish farming, therefore, is a solution to the problem of salmon maintenance by the process of earmarking certain fresh salt water sites strictly for the purpose of mass salmon rearing.

Description

Essentially a fish farm may be established in any of three particular sites. The Department at present utilizing natural lakes with outlets to sea, artificially constructed lakes such as are formed behind dams or are excavated in gravel pits and river oxbows, and natural salt water lagoons which are freshened by daily tidal action. A number of considerations enter into the selection of a site. The outstanding of these are enumerated below:

1. It must be of sufficient size (5 acres or more) to assure economical feasibility.

2. The State must either own, or acquire through five or more year leases, the use of the body of water so that initial expense may be absolved through the benefits of long-term increased production.

3. Whether the body of water is fresh or saline, it must have a simple exit to the sea.

4. It must be accessible to motor vehicles for construction purposes initially and for hatchery planting trucks subsequently.

5. The costs of diking, if needed, and of outlet facilities must fall within favorable cost-benefit levels.

The fresh water lakes in use and considered for the future all have either tributary feeding streams or seasonal spring flow contributing to the water supply. This is necessary to assure reduced extreme temperatures, to increase natural food production and to improve outlet flow conditions. Each lake is treated initially with rotenone or other toxicants to remove undesirable fishes and is then equipped with screening to prevent re-contamination. The screens serve further to prevent rearing salmon from escaping the pond. Most areas will be equipped with downstream trapping devices so that migrants may be counted and survival information gathered concerning the rearing period. Salmon are planted after the lake has cleared up from toxicant introduction, and are reared for periods varying from three to twelve months.

The salt water fish farm is operated exactly like that for lakes except that outlet screening facilities must provide for a daily water interchange during high tide. As in the case of fresh water tributary contribution, tidal interchange cools, provides food and prevents stagnation and fouling.

Present Program

During 1958, nine fresh water and two salt water farms were in operation. Since the fish farm program for salmon is in its infancy, essentially commencing in 1958, the initial number of salmon reared therein may be minimal. Present indications are that larger numbers may be planted without overcrowding than have been introduced this first year. Nevertheless, nearly 6 1/2 million young salmon have been reared to exceptional seaward migrant size under the new program (Table 1).

The present program is suited to adjust to the natural habitat of the various species of salmon. Since fall chinook, chum and pink salmon migrate to sea as fry or small fingerling, it is the Department's practice to rear these species in predator free salt water lagoons. Silver salmon, however, are physiologically developed to rear in fresh water for over one year prior to seaward migration. Accordingly, these are the main constituents of the lake rearing program.

Table 1 portrays the planting data for the individual fresh and salt water sites during 1958. In the case of fresh water, two areas, Lake Pleasant and Greenleaf Slough, represent fish farms at which the Department is jointly operating, with the State Department of Game, a program of fish rearing. In these two instances trout or steelhead are sharing the area with silver salmon and for this reason the initial salmon plants have been held considerably below the capacity of the area to rear. The Capitol Lake program is somewhat abnormal because this lake represents the outlet of the substantial Deschutes River and therefore is difficult to treat for predator eradication. In addition, it must be open during much of the year for normal up and downstream migrant salmon and steelhead. Lake Melbourne is being used as an experimental area where problems such as growth, survival, benefits of fertilization, effects from bird predation, etc., are analyzed. The remainder of the fresh water lakes are used strictly as production areas, the sole purpose of which is to increase the number of available salmon to the commercial and sport fisheries.

Until further knowledge concerning the capacity of a lake to rear salmon has been gained, an approximate planting rate of 5000 fish per surface acre of water is maintained. Though lake planting was late during 1958, fish will be introduced to the rearing areas in June of each year. These are released as yearling migrants during April and May of the following year at average sizes ranging from five to nine inches. Following the release, the lake is replanted with the next year's brood of silver fingerlings.

In the spring of 1958, a full year of fresh water silver salmon rearing was recorded following the downstream migration of the 1956 brood planting of Melbourne lake. Here, the survival from planting until release was not known, because fish probably escaped during high water when the counting facility was inoperative. In the winter of 1958 and 1959, nearly 30,000 migrants entered the Melbourne lake downstream counting facility. This fact indicates that a number undoubtedly left the lake the previous winter uncounted because the facility had not been installed at the time. A similar midwinter migration the previous year would have doubled the survival figures. Secondly, it is expected that bird predation at this wilderness lake is high. In December, 1958, it has been estimated that only approximately half of the fish planted in the year had survived. Several of these same fish, however, have been kept in live boxes immersed in the lake where they are protected from predation by birds. Nearly 100% survival has been maintained in the predator free live boxes.

There are two primary advantages of a fresh water fish farm program over the normal hatchery rearing program for silver salmon. This species must be reared for a full year in fresh water to significantly enhance the commercial and sport catch in successive years. In the hatchery, this is costly and pond rearing space becomes a limiting factor. The fish farm, consequently, increases rearing space as many fold as the availability of lakes for this purpose. Secondly, feeding is reduced to a minimum because natural food organisms present in the fresh water pond contribute to this function. To enhance natural food production most Western Washington lakes need fertilization by inexpensive basic organic or inorganic substances. To illustrate the success by which fish can grow in a fertilized area the comparative growths of Pricketts lake fish and those in a normal hatchery pond are illustrated. After nearly a year of hatchery rearing and feeding, silvers reach an average size of approximately 50 fish to the pound. Pricketts lake fish, planted in April at 380 to the pound, had grown to the fantastic size of 13 per pound by December. If exceptional fresh water growth is an answer to provide greater numbers of fish in the catch, a substantial contribution has already been made from the fish-farm program.

The salt water fish farm differs from that in fresh water in principally three ways. Though silver salmon are used experimentally in salt water rearing, fall chinook, chum and pink salmon are the species designated for rearing here. Since most lagoons are not freshened by stream flow, a necessary constituent of the area is daily tidal interchange which prevents water fouling, cools temperatures, and is the main provider of the food supply. Further, it is unlikely that salt water lagoons will require either fertilizing or feeding because in most cases a substantial tidal interchange renders the area self-sustaining.

Kennedy's lagoon on Whidby Island is the first salt water area in history to be placed into use strictly for salmon rearing. This area is connected to the open sea through a four foot culvert which allows flow into the lagoon at the tide levels above 6 1/2 feet and outflow during the remainder of the tidal period. It is a ten surface acre pond with an average depth of approximately four feet.

After treatment for removal of predator and competitor fish, screens have been installed to prevent re-contamination and to withhold the rearing salmon. In March, 1958, a fry plant of 300,000 pink and 500,000 chum salmon was introduced. These fish averaged approximately 1200 to the pound. They were released by screen removal in June weighing about 200 to the pound. Of importance is the fact that during the vulnerable early life history of these juveniles, the lagoon reared fish increased in weight six-fold in predator free water without artificial feeding !

Following the chum and pink fingerling release, the lagoon was restocked with 50,000 each of ninety-day hatchery reared silver and chinook salmon which weighed approximately 175 per pound. This group was released in October weighing 10 to the pound and measuring over six inches in average length. During the winter of 1958-59 a third crop is being reared, consisting of approximately 45,000 silver fingerling. At the same time 200,000 silver fingerling are rearing in Keyport lagoon near Bremerton which became available for this purpose in September, 1958.

One of the important features of the salt water fish-farm is that itprovides double-cropping during each year and is therefore able to contribute large numbers of salmon annually to the ocean. In general the pink and chum juveniles will be released during early summer when they exhibit a natural desire to leave the shoreline areas. With the aid of herring, crab and shrimp introductions for sustained food production, it appears likely that phenomenal, predator-free growth can be achieved with chinook and silver salmon during the remainder of the year.

Future Program

The tentative fish farm planting schedule for 1959 is shown on Table 2. Under this schedule over 11,000,000 juvenile salmon will be reared during the approaching year, an increase of nearly two-fold from that undertaken in 1958. A constant vigilance is maintained to seek and secure additional suitable sites for this purpose and if funds are made available a number of new areas may be in production by the end of the year. Several lakes are under consideration at present including the 6500 acre Ozette Lake in Northwest Washington. Among the salt water areas considered for fish famms are some which are three to four times larger than any presently under production.

Of particular importance in 1959 is the acquirement of fish farm sites in Eastern Washington. The areas under consideration such as the watersheds of the Yakima, Okanogan, Tucannon and other rivers have three factors in common which place them in a desirable category for the purpose. Initially, all are supplied with the mineral rich water that originates east of the Cascade Mountain Range. Chemical constituents that need be introduced to western lakes through fertilization are already present in these bodies of water. Secondly, as the power and reclamation programs of the area continue to encroach upon the salmon habitat, the need for alternate rearing sites becomes emphatically increased. A third important consideration involves the fact that in Eastern Washington the valuable spring chinook and sockeye salmon races are those which are most likely to be jeopardized by the multi-water use developments. It is therefore mandatory that the Department's management program be extended, to benefit these stocks. That blueback salmon will adjust to fish farming is almost assured. The success of rearing spring chinook salmon, which have not responded to artificial propagation, will be determined experimentally.

As civilization continues to move westward, the maintenance of the natural resources of the Pacific Northwest become increasingly difficult. This is particularly true of the valuable salmon stocks which need both fresh and salt water in which to grow, survive and reproduce. The factor of using those bodies of water which are still available for capacity salmon rearing is beneficial. Fish farming is not a panacea for all salmon problems but it is a management tool which in just one year of operation is showing promise.

Table 1. Fish Farms--Plants of Salmon Fry

Fall Chinook

Fish Farm	Surf. Acre	Cal. Year	Brood Year	Number Planted	Date Planted	Hatchery Source	County
Kennedy's Lagoon (S)	10	1958	1957	50,007	6/12/58	Skagit	Island
Capitol Lake(F)	300	1958	1957	1,854,033	3/4-5/58	Green R.	Thurston

Total Fall Chinook - - - - - - 1,904,040

Silver

Fish Farm	Surf. Acre	Cal. Year	Brood Year	Number Planted	Date Planted	Hatchery Source	County
Kennedy's Lagoon (S)	10	1958	1957	50,336	6/7/58	Bow. Bay	Island
Capitol Lake (F)	300	1958	1957	300,115	8/14-20/58	Quilcene U.S.FWS	Thurston
Capitol Lake (F)		1957	1956	100,045	10/8-10/57	Green R.	Thurston
Capitol Lake (F)		1958	1957	222,210	8/6/58	Simpson	Thurston
Lake Melbourne(F)	45	1957	1956	150,440	9/26/57	Minter Cr.	Mason
Lake Melbourne(F)		1958	1957	192, 317	9/10/58	Hood Canal	Mason
Lake Pleasant (F)	500	1957	1955	51,135	3/19/57	Simpson	Clallam
Lake Pleasant (F)		1957	1956	75,750	7/9/57	Dungeness	Clallam
Lake Pleasant (F)		1958	1957	200,000	8/12/58	Dungeness	Clallam
Lake Erdman (F)	18	1957	1956	33,575	5/10-14/57	Minter Cr.	Mason
Lake Erdman (F)		1958	1957	98,390	9/22/58	Minter Cr.	Mason
Cranberry L. (F)	171	1958	1957	199,112	6/18/58	Green R.	Mason
Cranberry L. (F)		1958	1957	197,400	6/16/58	Issaquah	Mason
Cranberry L. (F)		1958	1957	432,910	7/14/58	Simpson	Mason
Keyport Lagoon(S)	15	1958	1957	202,300	9/11/58	Green R.	Kitsap
Pricketts Lake(F)	80	1958	1957	847,061	3/4-8/58	Green R.	Mason
Pricketts Lake(F)		1958	1957	164,562	4/8/58	Minter Cr.	Mason
Johnson's Slough (F)	10	1958	1957	60,403	7/15/58	Willapa	Pacific
Greenleaf Slough (F)	51	1958	1957	47,386	10/7/58	Washougal	Skamania
Silver Springs(F)	6	1958	1957	10,000	9/9/58	Green R.	Thurston

Total Silvers- - - - - - - - 3,635,447

Fish Farm	Species	Cal. Year	Brood Year	Number Planted	Date Planted	Hatchery Source	County
Kennedy's Lagoon (S)	Chum	1958	1957	561,600	4/7/58	Green R.	Island
Kennedy's Lagoon (S)	Pink	1958	1957	335,000	3/28/58	Hood Canal	Island

Total Chums ... 561,600 Total Pinks ... 335,000 Total salmon ...6,436,087 (as 10/27/58)

(S) Salt Water (F) Fresh Water

Table 2. Planting schedule for Washington State salmon fish farms for 1959

Silver salmon

Cranberry Lake	1,200,000
Erdman Lake	100,000
Melbourne Lake	200,000
Prickett's Lake	210,000
Pleasant Lake	500,000
West Lake	250,000
Silver Springs Pond	50,000
CleElum Ponds	200,000

Silver salmon

Miscellaneous, fresh water	500,000
Keyport Lagoon	300,000
Raab's Lagoon	75,000
Old Channel Lagoon	75,000
Johnson Slough	200,000
Greenleaf Lake	150,000
Blue Creek	50,000

Spring Chinook

Easton Ponds	200,000

Fall chinook

Kennedy's Lagoon	200,000
Raab's Lagoon	75,000
Old Channel Lagoon	75,000
Johnson Slough	200,000
Greenleaf Lake	150,000
Blue Creek	50,000

Chum salmon

Kennedy's Lagoon	1,500,000
Keyport Lagoon	2,000,000
Raab's Lagoon	1,000,000
Old Channel Lagoon	2,000,000

TEMPERATURES AND COLUMBIA RIVER CHINOOK SALMON EGGS

P. A. Olson
Biology Operation, Hanford Laboratories
General Electric Company, Richland, Washington

Studies were made on the temperature tolerance of eggs and young of chinook salmon. The temperature of the control was adjusted to follow a seasonal trend typical for the southcentral portion of the Columbia River (Priest Rapids locality). This section supports a fall run of chinook which spawn between the middle of October and the middle of November. River temperatures during the spawning period have been observed to reach 62° F., so this race spawns at temperatures near the upper limit of the temperature range for salmon. In general, the river temperatures range from the mid to high fifties during major spawning, reach a minimum approaching 36° in mid-winter, and the mid-fifties by early June.

A local stock of eggs was not available so the first test was run using eggs from Green River stock of the Washington State Department of Fisheries. The test extended from October 30, when the eggs were spawned, until the fingerlings were liberated on June 9. Other experimental lots averaged about 5° colder and 2° F., 4° F., and 6° F. warmer than the control throughout the greater part of the test. Table 1 presents the summary of mortality results.

Table 1. Mortalities of Green River Chinooks
Exposed to Different Temperature Conditions
(1952-53)

Initial Temperature	% Mortality			
	Eggs	Fry[1]	Fingerlings[2]	Total
52.2° F.	6.8	2.3	2.4	11.0
57.2 (Control)	9.5	2.0	3.0	14.0
59.2	19.4	6.8	18.1	38.6
61.2	43.4	23.3	35.2	71.9
63.1	80.2	64.0	59.8	97.1

[1]Fry stage is from hatching to start of feeding.

[2]Owing to different developmental rates, the fingerling stage was much longer in the warmer lots than the colder.

Excessive mortalities in all temperatures above those of the control is evident. Even the control temperature appears above optimum since there was a significant increase in egg mortality (5 per cent level of probability) of the controls over the coldest lot. The marked susceptibility to increased temperatures by this strain of eggs is not surprising, however, since under natural conditions it would be incubated in temperatures well below 50° F.

The following year similar tests were run. However, in addition to again testing Green River stock, a pair of ripe chinook salmon was captured on spawning grounds of the Columbia River just below Priest Rapids thus enabling a temperature study to be made on the local stock. Again the control temperature followed a seasonal trend typical for the locality. Other experimental lots averaged about 4° F. colder and 2° F., 4° F., and 8° F, warmer than the control throughout the greater part of the test.

The second Green River test extended from November 3 until May 4. Table 2 presents the summary of mortality results.

Table 2. Mortalities of Green River Chinooks
Exposed to Different Temperature Conditions
(1953-54)

Initial Temperature	% Mortality			
	Eggs	Fry	Fingerlings	Total
50.2° F	4.2	1.2	(Never reached)	5.4
53.8 (Control)	4.0	1.0	1.0	5.9
55.8	5.8	1.2	9.1	15.4
57.9	8.2	1.0	2.0	11.0
62.0	13.7	9.8	30.6	46.0

Increased mortalities over those of the control resulted in those with initial temperatures of 55.8° and warmer.

The test on the local Columbia River stock extended from Oct. 26 until May 4. Table 3 presents the summary of mortality results.

Table 3. Mortalities of Columbia River Chinooks
Exposed to Different Temperature Conditions
(1953-54)

Initial Temperature	% Mortality			
	Eggs	Fry	Fingerlings	Total
52.9° F.	6.4	1.5	(Just Reached)	7.8
56.9 (Control)	7.9	2.0	7.0	16.1
59.0	6.2	1.1	3.0	10.1
60.9	8.7	1.8	0.0	10.4
65.2	10.8	45.9	56.4	79.0

Consistent mortality above that of the control occurred only in the warmest lot. The results of this single experiment indicated that the eggs could begin incubation at temperatures as high as 61° F. without significant loss.

DOWNSTREAM MIGRATION OF SILVER SALMON
TIMING-AGE-SIZE
JACK SILVERS - GROWTH OR INHERITANCE

R. E. Noble
Washington State Department of Fisheries
Seattle, Washington

What stimulates a salmon fry or fingerling to move to salt water? Is it size, age, water temperature? What happens when young salmon are released prior to the time of natural migration? Will silver salmon migrate during the fall of the year?

The answers to these questions are not easily answered. In an effort to attain more information regarding some of these questions in regard to silver salmon, several experiments and observations have been made at Minter Creek. First, a brief resume of the natural silver migration at Minter Creek.

Each spring after young silver salmon emerge from the gravel, there is a downstream movement of young fry, during February and March. It has not been determined if this is an actual migration or not. The numbers of fry correlate with the egg potential deposited in the stream; i.e., the greater the egg potential the greater the number of fry moving downstream.

If the young fry are returned some distance upstream, they remain and their survival approximates that of the overall stream survival. No data are available on what the survival would be if these fry were released below the weir at Minter Creek.

Young silver fry have been placed directly into salt water without adverse effects, indicating it is possible for the fry to move into salt water without suffering a mortality due to high salinities. It should be pointed out, however, that silvers beyond this fry stage have been placed into high salinities and suffered extreme mortalities, unless tempered very gradually. The true downstream migration of silvers, at Minter Creek, occurs during the spring months (February, March, April, May and June) - the fish having remained in the stream for 12 to 14 months. Approximately 90% of the migration occurs during the last week of April and the first two weeks of May. This is one factor that has remained amazingly constant in the 20 year history of Minter Creek.

A few silvers remain in the stream and migrate as two-year old fish and a few marked silvers have actually been observed to migrate as three-year old fish. The two and three year old fish are no larger than "yearling" migrants. Indications are that if all silvers do not reach a certain size by one year of age they will hold over for the second year and even the third. Obviously, there is no exact demarkation of size that limits migration; that is, fish above 60 mm. migrate, and below this, they do not. Undoubtedly, it is a matter of gradation; of fish below a certain size, the percentage of holdovers increases with decreased size. It has also been noted that size influences the pattern of the spring migration - the smallest fish moving down during February, March and early April - the largest migrants during May and tapering off to smaller fish again late in May and during June.

From this information, it is obvious that size has a definite role in the migration of silver salmon. The question then arises as to what would be the behavior of silvers reared to migratory size prior to their normal time of migration and released in the stream. The first experiment along this line was with the 1952 brook silvers.

A group of silvers which had all the appearances of migratory fish (silvery coloration and large size, lengths from 132 to 197 mm.) were hand picked from the hatchery ponds, marked and placed above the weir at Minter Creek on December 3, 1953. No migration occurred until the last week of April, 1954, the same time as the natural migration of silvers from Minter Creek.

The second experiment was with the 1957 brood silvers, Chambers Creek stock. These fish were from an early egg take and because of ideal water temperature, the eggs had hatched and the fry were feeding by January 1958. On May 12, 1958, 2,000 of the average sized fingerlings (mean length 96 mm. and weight 9.1 grams) were marked and released above the counting weir at Minter Creek. At the time of release the 1956 brood natural migrants were still migrating downstream. Four days after the release, the marked silvers appeared at the counting weir. Between the 23rd of May and the 25th of June, 1,627 of the marked fish were counted for an 81.4 per cent stream survival.

On July 21, 1958, 1,000 Green River silvers with migratory appearance (silvery color, and large size, mean length 104mm and weight 15.1 grams, or 30 per pound) were marked and released three miles above the weir at Minter Creek. An equal number of Minter Creek stock silvers were released at the same time. The Minter Creek stock were smaller fish, 50 per pound, however, they did have the migratory appearance. Four days after the release a few marked fish from each group were trapped at the weir.

Twenty percent of the Minter Creek stock and 8.4% of the Green River stock migrated past the weir. The greatest number of these fish moved downstream shortly after their release. No migration of any kind was observed after August 10, 1958.

A length sample of the migrants indicated that none of the Green River silvers under 106 mm. moved out of the stream, and, in the case of the Minter Creek stock, fish measuring from 89 mm. to 196 mm. were observed. If these silvers had been released earlier, i.e., May or June, it is surmised that the stream survival would have been similar to that of the Chambers Creek stock, near 80%.

Observations on a group of 1957 brook silvers released from the Washington Department of Fisheries, Hood Canal station, gave some noteworthy data.

The silvers had been converted to 100% salinity at the hatchery and gave no evidence of distress. The fingerlings were liberated into Hood Canal on Nov. 22, 1958, and immediately great numbers returned to fresh water. It was noted that a stream approximately one-half mile away contained large schools of these fish. The fingerlings in the hatchery stream (Finch Creek) moved back and forth with the tidal influence, always remaining in the fresh water portion.

The "jacks" returns to date are as follows:

Force fed silvers	28/lb.	113 mm.	32,540 released	19 Jacks	(.058%)
Starvation	88/lb.	70 mm.	32,540 "	6 "	(.018%)
F_2 Jacks	38/lb.	106 mm.	29,116 "	23 "	(.079%)
Production	43/lb.	93 mm.	105,655 "	32 "	(.03%)

As yet it is impossible to form any conclusions on the returns of the 1956 brood because not only growth and hereditary are involved, but also survival.

A high correlation exists between the number of "jack" silvers and the number of adults on the following year.

A high number of "jacks" is usually indicative of a high number of adults for the following year, which is undoubtedly related to overall survival.

In summary, it is probably safe to say that genetic factors are the primary cause of "jacks", with growth and environmental conditions causing variables in the observed results.

A NEW TYPE FISH TRAPPING FACILITY

David L. Ward
California Department of Fish and Game
Sacramento, California

Trinity Dam, now under construction on the Trinity River, a tributary to the Klamath River in northern California, is an earth-fill structure, 397 feet high. It will form a reservoir behind the dam 28.9 miles long, and impound 1,800,000 acre-feet of water when full. The reservoir will have a surface area of 13, 400 acres.

The Trinity project, being built by the U. S. Bureau of Reclamation, is a multiple-use project; irrigation, electric power and flood control. The Trinity Dam, when complete, will forever cut off the salmon (king and silver) and steelhead from their ancestrial spawning ground, and plans are being made to construct a hatchery immediately below the dam to partly compensate for the lost spawning area.

Gravel for constructing the dam is being taken from the streambed for a distance extending about 12 miles upstream. At present, the entire stream flow in the river is being diverted through a concrete-lined tunnel, with velocities such that fish cannot negotiate the tunnel. In effect, the section of the Trinity River from immediately below the tunnel and for a distance about 12 miles upstream is not accessible or usable as spawning grounds for the salmon and steelhead. To protect the salmon and steelhead in the Trinity River during the construction period and until the new hatchery can be completed, perhaps in 1961, a plan for trapping the salmon and steelhead and hauling them around the construction zone has been put into operation. The trapping facility is, so far as we know, the first of it's kind, and is an abrupt departure from anything previously employed. We believe the installation may be of interest to some of you here.

The trapping facility consists of a weir set at an angle across the river; this prevents the fish from traveling farther upstream. The weir is so built that its operation is not affected by stream flow conditions, even at peak spring runoff periods.

Just below the weir, on one side of the river, is a fish ladder. The salmon and steelhead ascend the ladder and pass into a holding tank 68 by 12 feet, with a water depth of about four feet. The fish congregate there until enough of them are present to warrant hauling them above the construction area and releasing them to spawn naturally.

At the upstream end of the holding tank is an artificial waterfall created by water welling up between the holding tank and a 12 by 12 foot anesthetic tank. The waterfall is covered by a metal grill. The anesthetic tank holds about 1,500 gallons of water, to which is added 75cc. of quinaldine (approximately 12 p.p.m.)

Fish in the holding tank, jumping at the waterfall, suddenly find themselves in the anesthetic tank as they slither across a horizontal grill separating the two. If the fish are unwilling to jump at the waterfall, a gasoline engine powered sweep, mounted on four wheels which ride on rails atop the sides of the holding tank, is put into operation.

The sweep carrier is run to the lower end of the holding pool and a sweep grate is lowered to the tank bottom. Then the carrier is run forward, slowly driving the fish ahead. When it reaches the upper end of the pool, the sweep, which has a horizontal projection on the bottom, is raised just as a forklift raises a load of pallets. This forces the fish over the waterfall and into the anesthetic tank where, seconds later, they become anesthetized and sink toward the bottom which slopes three ways toward the end of a built-in escalator.

The drugged fish are carried on the escalator from the tank to the top of a fish hauling truck. The tank truck is filled with clear, cool, well-aerated water, and the fish revive within a matter of seconds. They are now ready for the ride upstream to the release site on the river about 16 miles above the construction zone. Untouched by human hands, the uninjured and gently-handled fish are then once again strictly on their own.

The cost of the trapping facility, including four fish hauling trucks at $ 18,000.00 each, is about $ 300,000.00.

EXPERIMENTAL SALMON HATCHING IN FLOATING SCOWS

C. F. Brittain
Washington State Department of Fisheries
Seattle, Washington

After the development of a relatively expensive egg and fry cabinet, the question arose in the department in regard to exploration of other possible less expensive hatching methods that might be used to hatch surplus salmon eggs.

We thought perhaps other possible uses and advantages might well be:

1. To provide additional hatching space on available surface water without the expense attendant with a conventional hatchery setup.

2. To provide a method of hatching fish and delivery of same to areas not open to conventional planting trucks and equipment for fry or fingerling delivery.

3. To provide a method of stocking lakes and other water impoundments where hauling facilities were not available or in use elsewhere (egg delivery would also be less expensive).

As a result of these ideas and conversations, we determined to experiment with hatching salmon eggs in flat, screened bottom containers. Slide #1.

These were made of wood and tapered in the form of a sled runner on the ends to provide additional circulation of water. The size of the two wood-sided scows used was 17"x23"x2" deep, inside measurement, and 17"x23"x4" deep. The other container used was a regulation deep trough, wood-sided tray 12"x16"x2", inside measurement. The three type trays were covered throughout the experiment with black visqueen (a plastic material) held in place with thumb tacks. The location chosen for the experiment was a large dirt pond located adjacent to the hatchery, and supplied by over flow water from six (6) conventional fish ponds at out Puyallup station. Slides #2 and 3.

It was anticipated that the critical period for hatching in such a container would be the few days just prior to hatching, as it usually is in conventional troughs in a hatchery where special care must be exercised to avoid smothering of eggs during this period. It was assumed that no problem of egg fungus would be present as the incubation-to-hatching period was to be of short duration, preferably a few days only. Fall chinook eggs were used for the test and successive loadings were calculated as follows on each type container used:

The first tray loading was @ 8 eggs per square inch.

The second tray loading was @ 12 eggs per square inch.

The third tray loading was @ 16 eggs per square inch.

The loading of eight eggs per square inch constituted a single layer of eggs on the screened bottoms.

Slides #4, 5 and 6: Show the 12"x16"x2" deep trough trays. These trays were loaded as follows: 1,660 eggs, 2,492 eggs, 3,322 eggs

Slides #7, 8 and 9: Show the 17"x23"x2" wood scows which were loaded as follows: 2,492 eggs, 3,738 eggs and 4,984 eggs.

Slides #10, 11 and 12: Show the 17"x23"x4" wood scows which were also loaded with: 2,492 eggs, 3,738 eggs and 4,984 eggs.

Incubation periods on these test lots were from November 18, 1957 through February 17, 1958. Average water temperature for the above period was 41.5° F.

TABLE B FALL CHINOOK

Slide No.

1. Showing type scow used.
2. Location picture, dirt pond at Puyallup station.
3. Location picture, dirt pond at Puyallup station.

Slide No.	Type of Scow	Loading	Egg and Fry loss	Date Started	Date Hatch	Date Term.	Water Ave.Temp.
4.	Deep trough tray 12"x16"x2"	1,660	19	11/18/57	12/12/57	1/29/58	41.2°F.
5.	" " " "	2,492	1,243	"	"	"	41.2°F.
6.	" " " "	3,322	1,660	"	"	"	41.2°F.
7.	2" Scow 17"x23"x2"	2,492	12	11/15/57	11/19/57	"	41.2°F.
8.	" " " "	3,738	36	"	"	"	41.2°F.
9.	" " " "	4,984	46	"	"	"	41.2°F.
10.	4" Scow 17"x23"x4"	2,492	63	12/12/57	12/22/57	2/17/58	42.4°F.
11.	" " " "	3,738	2,115	"	"	"	42.4°F.
12.	" " " "	4,984	4,984	"	"	"	42.4°F.

From the above experiment we know it is successful to hatch eggs under the conditions as set forth here, provided the surface water is quiet and loadings do not exceed a single layer of eggs on a screened bottom surface.

For general information we have again this year set up a scow hatching experiment differing from this one in these respects:

An attempt is being made to test scow type containers with both fall chinook and silver salmon eggs. Also, the incubation period will be from eggs initially taken through the egg sack absorption period.

A new scow has been constructed which has a dimension of 17"x23"x3" deep, complete with sliding plastic cover tray for darkness effect and protection.

Locations have been chosen in:

1. A dirt lagoon at Puyallup station.

2. A conventional fish pond (which is populated) at Hoodsport.

3. A large lake with minimum overflow (Lake Melbourne).

4. A large lake with good overflow (Cranberry Lake).

All scows are duplicated, one tray of each lot will be treated (1/30,000 for 30 seconds) once weekly for fungus with Malachite Green, and one will be untreated. Population loadings were held to a single layer of eggs.

The only adverse report to date, from these experiments, is a report of severe losses from rough wave action in the lots at Lake Melbourne.

Inspection of other lots indicate average losses. These tests will be written up at the close of this year's experiment.

SALMON PROPAGATION COST IN TERMS OF CATCH OF ADULT FISH OF HATCHERY ORIGIN

John Rayner
Oregon State Game Commission
Portland, Oregon

The following summary of the results obtained from stocking silver salmon at 5.05 per pound indicates the excessive cost involved in terms of the adult fish returned. Fish stocked at such a large size tend to return in large part as jacks in both sexes, with a consequent excessive loss of poundage in the adults.

The fish were of the 1952 brood year, all marked (BV), and were planted in March, 1953, at approximately fifteen months of age. Since they were from several hatcheries of differing water temperatures, the length of rearing time varied.

There were 131,000 fish weighing 26,000 pounds.

The cost of rearing was \$ 22,532 or \$ 0.86 per pound.

The troll fishery recovered 1,294.

The number of fish required in the troll fishery to equal the cost of rearing was 14,055.

The cost of each adult fish returning to the river or caught in the troll was \$8.70.

The value of each adult fish, river and troll, was \$ 1.60.

The percentage of recovery, river and troll, was 1.97.

The cost per pound of adult fish recovered was \$ 1.09.

ENVIRONMENTAL FACTORS IN REARING PONDS

Roger E. Burrows
Salmon Cultural Laboratory
Entiat, Washington

That the environment created by the rearing pond affects the fish both during the rearing period and after its release is becoming more and more apparent. Our investigations at present are concerned primarily with two evaluations, first with the factors within the ponds which limit production, and, second, the different characteristics of various pond types. Other investigators principally Brett, Black, Hoar, Miller, and Nielson have been investigating the factors which influence survival after release. Some of the most recent work of Brett and Miller with artificially propagated stock indicates that the conditions under which the fish are reared has a most important effect on their survival after release. The substance of these investigations pertinent to our work is that the ability of the fish to maintain themselves in a water current is dependent on their previous conditioning and that this ability is a prime factor in survival.

The evidence is beginning to mount indicating the necessity for exercise in hatchery-reared fish. In raceways with sufficient inflow to produce 6 theoretical interchanges per hour (250 g.p.m. in a 4 x 40 pond or 1,000 g.p.m. in an 8 x 80 pond) the maximum current velocity is .05 foot per second. In recirculating types of ponds velocities of much greater magnitude may be attained with much smaller proportionate inflows. Normally the maximum velocities are regulated to speeds of .8 to 1.0 foot per second and in no case are the minimum velocities below .05 foot per second and this only in the Foster-Lucas pond. The effect of pond velocities on the stamina of the fish merits further investigation and we hope to explore this problem at least in part, in 1959.

The studies of the environmental conditions in rearing ponds during the summer have proved most enlightening. Many of the discrepancies which we could not explain previously are now beginning to make sense. Many of our previous concepts have been radically changed.

Our original program called for sampling the various pond types prior to both cleaning and feeding. We encountered extremely low concentrations of ammonia and urea at this time and found no appreciable build-up in concentrations as the poundage of fish increased. We then began sampling at intervals throughout the day and found radical differences in the amounts of the two waste products. We extended our sampling periods from 12 to 18 and finally 24 hours at hourly intervals with, to us at least, rather surprising results.

In general the patterns were as follows: The low ebb in both urea and ammonia occurred between 7:00 and 8:00 a.m. Both products started to rise after feeding but urea more sharply and at higher levels than ammonia. The first peak for both products occurred about five hours after the first feeding. From here on the patterns of the two differed quite sharply with ammonia starting on a constant decline but the urea declining slightly and then rising to a second peak approximately 5 hours after the second feed. During the night the concentrations did not decline on a normal curve but rather as a series of plateaus with rather abrupt drops between them.

The patterns of the three pond types tested differed as to the heights of the peaks and the levels of the plateaus but the trends were similar. Drops in the average temperature blunted the peaks and the overall heights of the curve indicating a reduction in the rate and amount of excretion.

During each test the ponds were not cleaned. To determine the effect of cleaning the different pond types were fed, cleaned, and allowed to refill with samples taken prior to feeding, prior to cleaning, at the maximum drawdown, half full, full, and at hourly intervals thereafter for an 8-hour period. Cleaning after feeding altered the patterns very drastically. Instead of a gradual build-up the concentrations of both ammonia and urea rose very abruptly during the periods while the ponds were filling correlated, of course, with the volume of the pond and the rate of inflow. In all pond types, however, the levels were at least 15 percent higher after cleaning than when the ponds were allowed to remain uncleaned. Obviously, pond cleaning is best accomplished before the fish are fed when the rate of excretion is at a minimum.

Based on our experiments and present analyses of the data, the limiting factors which we have studied are oxygen, urea, and possibly ammonia. The three pond types under study have different limitations with regards to these three factors.

Oxygen: Oxygen is, of course, a limiting factor in the carrying capacity of a pond. The lower limits of a favorable environment, the requirements of the fish, and the characteristics of the pond types are as follows:

1. If the minimum oxygen level in the pond is reduced below 5 p.p.m. the uptake of the fish is reduced indicating an unfavorable environment and an oxygen starvation.

2. At the normal activity level the oxygen requirement of 4 to 6 inch chinook fingerling at temperatures above 55° F., is 0.5 p.p.m. per pound of fish per gallon of water per minute inflow.

3. An increase in the activity level, in this case correlated with feeding, increases the oxygen requirement to 1.0 p.p.m. per pound of fish per gallon of water per minute inflow.

4. In the 4 x 40 raceway ponds a sharp oxygen gradient exists. With an oxygen-saturated inflow further attempts to increase the oxygen content in raceways are futile because the pond water at the upper end of the pond is from 80 to 90 percent of saturation and extremely difficult to aerate. The carrying capacity in raceway ponds in terms of oxygen is, therefore, limited to the oxygen contained in the inflowing water.

5. In the recirculating ponds tested, including the Foster-Lucas, rectangular, and the circular, the oxygen gradient is slight. If the fish loads are sufficient to seriously deplete the oxygen content such a condition exists throughout the pond. Under such conditions aerators are very effective. In the rectangular pond we have demonstrated that it is possible to increase the oxygen content by 33 per cent by installing aspirators on the submerged inflow jets. Recirculating ponds have a much greater potential carrying capacity in terms of the oxygen requirement than do raceways.

Urea: Our experiments indicate that urea may be the principal excretory product limiting the carrying capacity of rearing ponds. The urea level in the pond water is influenced by the excretion rate of the fish which is not uniform but is accelerated by feeding and increases in water temperature. The conditions under which the ponds are operated such as the volume of inflow, rate of theoretical interchange, density of fish, and flow patterns within the pond, also influence the concentration of urea.

1. High levels of urea, above 0.5 p.p.m., for continued daily exposures in excess of 12 hours per day for a period of 3 weeks, appear to be conductive to the development of diseases of environmental origin, particularly gill disease.

2. In raceway ponds the development of a sharp urea gradient in urea concentrations allows a portion of the fish to remain in the upper area of the pond which contains the lesser urea level. In raceways the rate of water inter-change in relation to the pounds of fish is the prime factor in the creation of a tenable environment. In the 4 x 40 raceways with a 2-foot water depth, 125 g.p.m. of inflow are required to reduce the maximum urea concentration by 50 percent in the upper half of the pond. When the inflow is reduced by half and the density of fish remains the same the upper half of the pond is subjected to urea levels of 60 to 70 percent of the maximum and even the minimum concentration approximates 50 percent of that at the outflow. There is, then, an optimum stocking level in relation to the inflow in raceway ponds if the advantages of a sharp urea gradient within the pond are to be maintained. Raceways of larger size but of the same general proportions should have similar characteristics. The objective is, of course, to keep as many fish as possible in an environment which contains a maximum of 0.5 p.p.m. of urea for a period of less than 12 hours per day. A narrow, short pond would appear to be the most efficient raceway. If such ponds are stocked to the optimum, little if any benefit can be derived from the re-use of the waste water unless some method can be developed to radically reduce the urea content.

3. In the rectangular-recirculating pond the urea gradient is slight and varies within the pond dependent on the rate of excretion. The excellent flow pattern within the pond moves the urea to the outflow at a rate comparable to that of the raceway. Because of the slight and varied gradient, however, all of the fish are exposed to essentially the same urea concentration. In this type of pond a tenable environment is created by the dilution of the urea concentration in the greater volume of water per weight of fish contained in the pond. For this reason maximum inflows and maximum loadings are <u>not</u> the optimum. A 16 x 50 rectangular pond can maintain 1,400 pounds of fish with a 215 g.p.m. inflow. Reduce the inflow to 130 g.p.m. and the pond will still support 1,000 pounds of fish in an even more favorable environment. A 40 percent reduction in the inflow decreases the carrying capacity by less than 30 percent because the excretory products are diluted to tolerable levels within the pond. High water temperatures, in the sixties, reduce carrying capacities and low temperatures, in the forties, increase because of their effect on the excretory rate.

4. In the Foster-Lucas type pond, which is recirculating but possesses an extremely poor flow pattern, the urea collects in the eddies and then feeds back into the main circulation of the pond. As a result the urea concentrations do not reach the peaks that occur in either the raceway or rectangular ponds but the length of exposure to what are indicated to be deleterious levels are prolonged. This pond type is particularly conducive to gill disease and it is in this pond type where prolonged exposures to urea at relatively high levels occur. It is possible to correct this condition to some extent by reducing the number of inflow jets thereby increasing the water velocity which in turn creates a more erratic flow pattern in the pond and clears the eddies. This pond can only be operated satisfactorily at twice the dilution factor of the rectangular.

<u>Ammonia</u>: The amount of ammonia contained in water is relatively easy to determine. For this reason ammonia has been used as a measure of the deposition and accumulation of metabolic waste products in rearing ponds. The following are the conclusions drawn from this summer's work where both ammonia and urea were measured.

1. Ammonia diffuses rapidly through the water and appears to dissipate quite readily. Only under the most unfavorable conditions have we encountered ammonia above 0.4 p.p.m. and then only for short periods of time. In contrast concentrations of 1.0 p.p.m. of urea are not unusual and concentrations of 0.5 p.p.m. and above occur for periods of 10 to 12 hours in all the pond types studied when the fish loads are heavy.

2. The concentration of ammonia and urea are loosely correlated but the amount of ammonia is not necessarily an index of the level of urea. Usually the amount of urea is 2 to 3 times that of the ammonia present and continues at comparatively high levels after the ammonia disappears from the pond water.

3. Our investigations this summer do not support the hypothesis that the ammonia concentration in a pond is an adequate index of the concentrations of other waste products.

4. Ammonia concentrations and the time of occurrence differ but slightly between the various pond types which leads us to believe that ammonia is of little consequence in the creation of an unfavorable environment.

Other Metabolic Waste Products: Of the other waste products, we have adapted tests for uric acid and creatine to pond water. Neither of these products occur in sufficient quantity to show more than traces by our methods of measurement. Our previous work with carbon dioxide led us to believe it to be of little significance. Creative and the amides remain to be explored but the work this summer indicates that urea is at least one of the metabolic waste products and possibly the critical one in the environment of rearing ponds which limits the carrying capacity.

Obviously much remains to be done. We hope this winter to demonstrate under controlled conditions the effect of prolonged exposure to predetermined concentrations of urea and ammonia on the fish. A rather elaborate setup using running water carrying a fixed concentration will be necessary to eliminate the contributions made by the fish under test. We feel that the surface to this problem has been broken and that all that remains now is to dig in.

All our tests to date indicate that the rate of inflow is the limiting factor in the carrying capacity of rearing ponds. The pounds of fish per gallon per minute of inflow, the, becomes the principal criterion for judging the efficiency of rearing ponds. Using this criterion the rectangular pond is still the most efficient pond type tested to date.

PROGRESS SUMMARY OF WASHINGTON'S HATCHERY EXPERIMENTS

C. H. Ellis
Washington Department of Fisheries
Seattle, Washington

The four year program of marking fall chinook salmon and liberating them in various places on the Columbia River, by truck hauling and water barging, was completed in the spring of 1958 with salmon of the 1957 brood.

Meanwhile, preliminary data on returns of 2, 3 and 4 year old fish (resulting from previous barging liberations of marked salmon of brood years 1954, 1955 and 1956) were presented and discussed.

Extensive straying of the returnees was in evidence, Table 1, with the extent of straying evidently dependent on planting procedures (See liberation procedures described in Fisheries Research papers, Washington Department of Fisheries, Vol. 1, No. 4, March 1956).

The returns of the four year old chinook in the transfer (import vs local stock) ~~experiments~~ appeared in the fall of 1958. The trend followed that of younger fish for previous years; i.e., local stock far outproduced imported stock where the imported stock was from another drainage basin area. In the case of returns to Nooksack and Minter Creek (such stations being in the same drainage basin as Green River), the returns of the local stock were equaled, or exceeded by returns of the import stock.

FALL CHINOOK SALMON TRANSFER EXPERIMENT

		IMPORT STOCK (Green River)				LOCAL STOCK (station listed)			
		Number Marked Juveniles	Age and No. Returning			Number Marked Juveniles	Age and No. Returning		
Hatchery	Brood Year	Released	2 yr.	3 yr.	4 yr.	Released	2 yr.	3 yr.	4 yr.
Willapa	1954	56,811	0	0	0	58,286	0	1	5
Nemah	1954	59,501	3	0	0	58,259	23	52	59
Simpson	1954	59,681	0	0	0	57,836	0	0	0
Nooksack	1954	50,058	0	2	33	46,562	1	14	10
Minter Cr.	1954	48,574	1	18	19	69,287	1	6	12

The returns of three year old chinook, progeny of experimental ag crosses, returned to the Deschutes River in 1958. The experimental crosses were designed to determine whether or not precocious parents would tend to produce precocious offspring, particularly of the female sex at three years of age.

DESCHUTES RIVER GENETICS EXPERIMENT

Brood Year	Cross Used	Number of Marked Fish Released	Number 2 yr. Olds Returning to Deschutes Fishway in 1957	Number of 3 yr. Olds Returning to Deschutes Fishway in 1958
1955	"A" 2 year males crossed with 3 yr. females	103,500(Ad&RV)	168 males	10 females 195 males 205 total
1955	"B" 3 year males crossed with 3 year females	117,945(AD&LV)	79 males	17 females 260 males 277 total

Cross "A" produced a very significantly greater number of two year old fish (all males) than did Cross "B". Cross "A" produced 4.9% females in the three year old fish, while Cross "B" produced 6.1% females, not a significant difference. Both crosses produced less females as three year olds than was apparent among non-crossed (run-of-the-river fish) three year olds in the Deschutes in 1957, of which 11.9% were females.

Returns of three year old chinook to the Hood Canal hatchery substantiated a previous experiment on the Samish River (reported in Vol. 87 (1957) Transactions of American Fisheries Society), whereby chinook salmon converted to salt water over a five day period, had significantly higher survival than fish that had been converted to salt water and reared in salt water for 45 and 90 additional days, respectively.

HOOD CANAL CONVERSION EXPERIMENT
1955 BROOD CHINOOK SALMON

Rearing History Before Release	No. Released	Returns to Hatchery: 2 yr. Olds, 1957	Returns to Hatchery: 3 yr. Olds, 1958
99 da. fresh plus 5 da. salt water	35,541	7	4
99 da. fresh plus 45 da. salt water	35,625	1	0
99 da. fresh plus 90 da. salt water	35,025	1	0

Although the relative survivals on the Hood Canal experiment were similar to the Samish experiment, the total survivals of all lots was far below those of the Samish experiment. It is anticipated that some of this could be due to straying, inasmuch as the Hood Canal returns were to the small mother stream of Finch Creek as compared to the return to a sizeable river, such as the Samish.

CORRECTION

Because of procedures in trimming edges of this publication, the title and footnote of the table on the opposite page have been somewhat mutilated. In their correct totals they should read as follows:

"PRELIMINARY RECORDINGS OF MARKED FISH RECOVERIES FROM COLUMBIA RIVER BARGE EXPERIMENT"

"* Calculated recoveries for the Ocean Troll and Columbia River gill nets have not yet been made; however, when such is done, it will multiply actual recoveries by four or more."

FROM COLUMBIA RIVER BARGE EXPERIMENT

Area and Year of Recovery		FIN MARK AND LIBERATION POINT: Ad-LV Col.R. at Skamokawa by Barge from Lyle		RV Main Col.R. at Skamokawa by truck		Ad-RV Mouth of Klickitat by truck		LV Klickitat River at Hatchery		LVIM Klickitat River at Hatchery		AN Elokomin River at Hatchery by truck	
		Act.	Cal.	Actual	Cal.	Act.	Cal.	Act.	Cal.	Act.	Cal.	Act.	Cal.
Col. R.	1956	8	32	2	8	2	8	4	16	0	-	2	8
Gill net	1957	38	144	60	244	24	96	49	164	4	-	17	68
	1958	76	0	58	-	38	-	49	-	2	-	23	-
Col. R.	1956	4	16	6	24	1	4	1	4	0	-	2	8
Sport	1957	2	8	4	16	2	8	8	32	0	-	0	-
Catch	1958	7	35	8	40	4	20	8	40	0	-	0	-
*Ocean	1956	0	-	0	-	0	-	0	-	0	-	0	-
Troll 1/	1957	146	-	100	-	137	-	100	-	0	-	126	-
	1958	54	-	177	-	64	-	92	-	14	-	4	-
Ocean	1956	12	113	11	99	5	43	11	105	0	-	4	41
Sport	1957	16	106	17	121	20	148	22	153	5	37	5	36
Ore&Wn	1958	4	37	8	77	5	42	6	54	2	14	0	-
Elokomin	1956	1	-	13	-	0	-	0	-	0	-	21	-
Hatch.	1957	2	-	8	-	0	-	0	-	0	-	36	-
	1958	4	-	15	-	0	-	3	-	0	-	84	-
Kalama	1956	0	-	1	-	0	-	0	-	0	-	5	-
Hatch.	1957	0	-	3	-	0	-	1	-	0	-	14	-
	1958	0	-	1	-	0	-	0	-	0	-	6	-
Klicki-	1956	0	-	0	-	3	-	2	-	0	-	0	-
tat	1957	0	-	22	-	7	-	96	-	1	-	0	-
Hatch.	1958	1	-	5	-	16	-	118	-	14	-	0	-
Little	1956	0	-	1	-	0	-	0	-	0	-	0	-
White	1957	2	-	1	-	3	-	2	-	0	-	1	-
FWLS	1958	1	-	1	-	8	-	0	-	0	-	0	-
Spring	1956	0	-	0	-	0	-	0	-	0	-	0	-
Creek	1957	0	-	1	-	0	-	2	-	0	-	1	-
FWLS	1958	0	-	3	-	0	-	4	-	0	-	0	-
Big	1956	0	-	0	-	0	-	0	-	0	-	0	-
White	1957	0	-	0	-	3	-	1	-	0	-	0	-
FWLS	1958	0	-	0	-	2	-	3	-	0	-	0	-
Big	1956	0	-	0	-	0	-	0	-	0	-	0	-
Creek	1957	10	-	11	-	0	-	0	-	0	-	41	-
O.F.C.	1958	1	-	1	-	1	-	0	-	0	-	19	-
Bonne-	1956	0	-	0	-	0	-	0	-	0	-	0	-
ville	1957	10	-	1	-	7	-	0	-	0	-	0	-
Hatch. O.F.C.	1958	2	-	0	-	1	-	0	-	0	-	0	-
Herman	1956	0	-	0	-	0	-	0	-	0	-	0	-
Creek	1957	3	-	1	-	2	-	0	-	0	-	0	-
Hatch. O.F.C.	1958	2	-	4	-	3	-	0	-	0	-	1	-
Washougal	1956	0	-	0	-	0	-	0	-	0	-	0	-
Hatch.	1957	0	-	0	-	0	-	0	-	0	-	0	-
W.D.F.	1958	1	-	2	-	0	-	1	-	0	-	0	-
Eagle	1956	0	-	0	-	0	-	0	-	0	-	0	-
Creek	1957	0	-	0	-	0	-	0	-	0	-	0	-
	1958	1	-	2	-	1	-	2	-	0	-	0	-
Other	1956	0	-	0	-	0	-	3	-	0	-	0	-
Col.R.	1957	1	-	0	-	0	-	0	-	0	-	0	-
Hatch.	1958	0	-	2	-	0	-	0	-	0	-	0	-

* Calculated recoveries for the Ocean Troll and Columbia River gill nets have not yet been made, however; when such is done, it will multiply actual recoveries by

A REVIEW OF THE PITUITARY EXPERIMENTS AT THE ENTIAT SALMON-CULTURAL LABORATORY

Bobby D. Combs
U. S. Fish and Wildlife Service
Entiat, Washington

Experiments have been conducted since 1951 to determine if the injection of gonadotrophic materials into adult blueback salmon would accelerate sexual maturation.

The gonadotrophic substances tested included salmon pituitary glands, carp pituitary glands, a mammalian gonadotrophin, and an estrogen compound. Salmon pituitaries were utilized both as whole glands and as fractions. The 1958 experiment tested pituitary fractions that were ACTH-free. The results of these experiments may be summarized as follows:

1. Injection of macerated whole salmon pituitary glands into adult salmon accelerated markedly the development of spawning coloration and other secondary sex characteristics and ripened males as early as 3 days after injection. Spawning of females was advanced as much as 35 days, however all early spawned eggs were of poor quality and sustained prohibitive losses.

2. Carp and mammalian pituitary materials and the estrogen compound had no measureable effect on the rate of development of spawning coloration or of time of spawning.

3. The ACTH-free salmon pituitary fractions tested hastened the development of spawning coloration but did not advance spawning.

While it appears that the use of injected gonadotrophic materials to accelerate maturation of salmon is possible, these experiments indicate that the method is too involved to be practical for large scale operations.

THRESHOLD TEMPERATURES FOR THE NORMAL DEVELOPMENT OF BLUEBACK SALMON EGGS

Richard G. Bigej
U. S. Fish and Wildlife Service
Entiat, Washington

A series of experiments have been initiated at the Salmon Cultural Laboratory to determine the threshold temperature for the normal development of blueback salmon eggs incubated at a constant temperature. Only the lower threshold temperature has been determined at this time.

The temperatures tested were 35°, 37.5°, 40°, 42.5° and 50° F. Using egg mortality as the criterion for establishing the threshold temperature, the lower threshold for blueback eggs incubated at a constant temperature was found to be between 40° and 42.5° F. The differences in mortalities between the lots of eggs indicate that progressively less survival can be expected from eggs incubated at constant temperatures as the temperatures decrease from 42.5° to 35° F. At a constant incubating temperature of 35° F. mortalities as great as 80 percent may be expected.

Although the lower threshold for blueback eggs was found to be the same as that found for chinook eggs in a previous experiment, the differences in mortalities between the two species indicate that blueback eggs can tolerate water temperatures below 42.5° F. better than chinook eggs.

The results of this experiment indicate that blueback salmon eggs spawned and incubated at temperatures of 40° F. and below will have higher than normal mortalities.

These experiments point out that size is probably just one of several motivating factors involved in the downstream migration of silvers. The one surprising feature was that of getting silvers to migrate one year ahead of schedule, ie., the Chambers Creek stock.

It will be extremely interesting to observe the returns from this particular group of silvers. To date there are no returns to Minter Creek as precocious males. If these silvers spend their normal time of three years in maturing, the returning adults may be as large as chinook salmon. The size of silvers brings up another point of interest and that is: What causes "jacks"? Many have maintained that silver "jacks" are the exceptionally large migrants; others have suggested hereditary traits.

In an attempt to obtain some information along this line, several experiments were undertaken at Minter Creek. The first experiment was a controlled cross between adult female silvers and known "jack" silvers (marked), 1953 brood. Other experiments in progress at the same time afforded a comparison on survival.

An interesting size gradation occurred on outgoing migrants of the 1953 brood and the resultant returns gave a very interesting pattern of size, correlated with age of maturity.

TABLE 1. Five marked lots of migrant silvers, showing mean length in millimeters at time of migration and age of returns:

Mean length of Downstream Migrants		Dorsal Mark 84 mm		Adipose Mark 94.0		Anal Mark 97.6 mm		Adipose Anal mark 100 mm		Jack Progeny 104 mm	
Age at maturity		Numb.	%	Numb	%	Numb	%	Numb	%	Numb	%
Jacks	2's	0	0	13	3.4	17	3.8	23	4.7	4	8.7
	3's	61	64.2	366	94.1	421	95.2	464	95.1	39	84.8
	4's	34	35.8	10	2.5	4	1.0	1	.2	3	.5
TOTALS		95		389		442		488		46	

Accelerated growth of fish has on numerous occasions indicated a tendency toward early maturity and conversely stunted growth has prolonged the age of maturity. The experiments at Minter Creek indicates this relationship to be a factor in the maturity of silvers.

To follow through on the "jacks" versus growth question, experiments were continued with the 1956 brood silvers. In the fall of 1956, the females that returned from the 1953 "jack" experiment were crossed with known "jacks" and the resultant fingerling marked and released. For comparative purposes, one group of regular hatchery production silvers were force fed and another group placed on a starvation amount of feed. These two groups of fish were given identifying marks and released with the "jack" progeny. All of the hatchery production silvers released into Minter Creek were marked and will serve to give another comparative group.