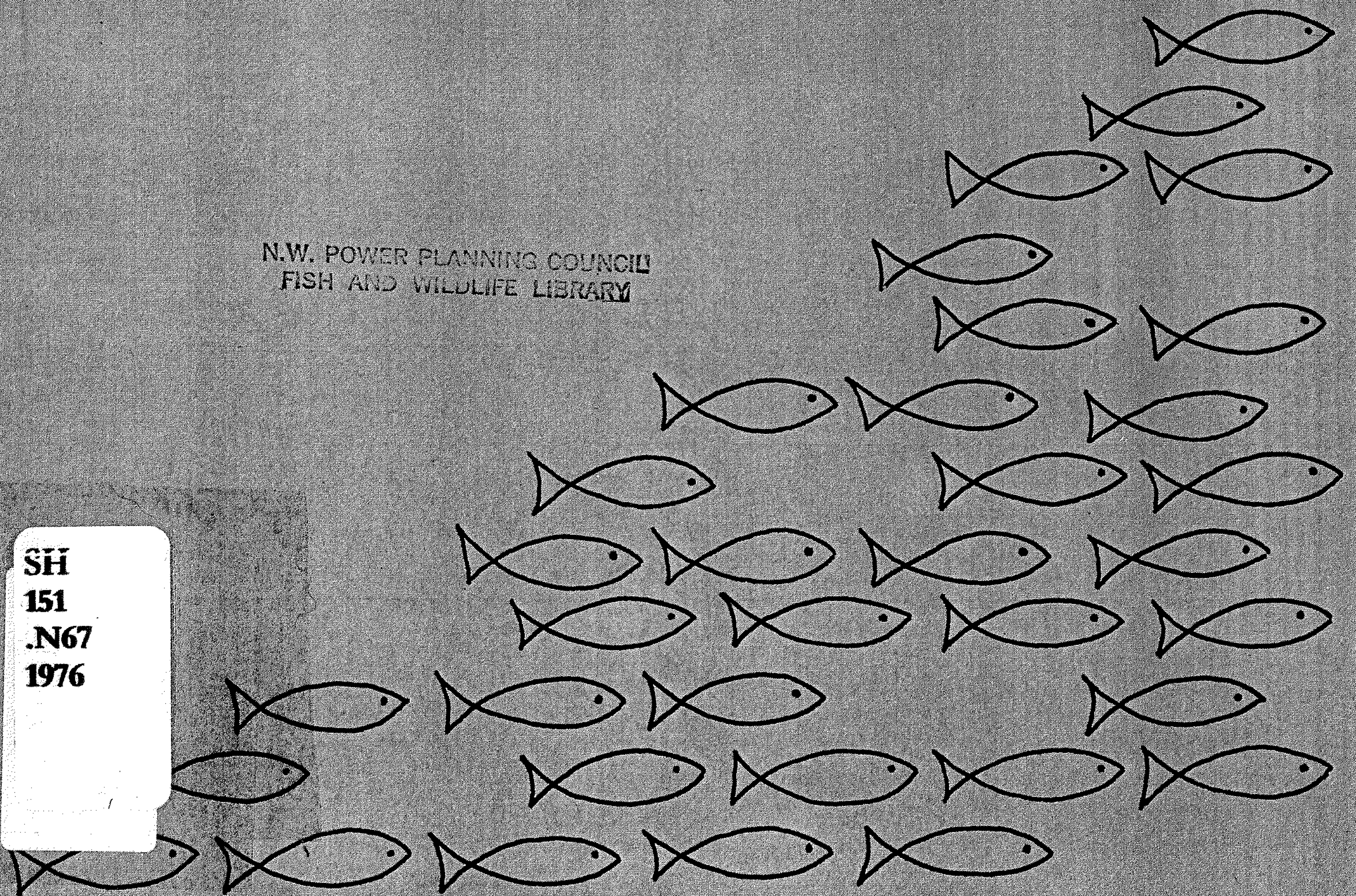
Harry Wagner

27th NORTHWEST FISH CULTURE CONFERENCE

Twin Falls, Idaho

December 1-2, 1976



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THE NORTHWEST FISH CULTURE CONFERENCE

Northwest Fish Culture Conferences are informal meetings for exchange of information and ideas concerning all areas of fish culture. Current progress reports of management practices and problems, new developments, and research studies are presented. Active discussion and constructive criticism are encouraged and furnish highlights of the conference. All persons interested in or associated with fish husbandry are invited to attend and to participate. Subject material is limited to topics that have direct application to fish culture.

The PROCEEDINGS contain unedited briefs or oral reports presented at each conference. Much of the material concerns progress of incompleted studies or projects. THESE INFORMAL RECORDS ARE NOT TO BE INTERPRETED OR QUOTED AS A PUBLICATION.

The cost of publishing this proceedings was provided for by registration fees collected at the conference, the Fishery Resources Program, University of Idaho, and the Idaho Water Resources Research Institute, University of Idaho.

PREFACE

The Twenty-Seventh Anniversary of the Northwest Fish Culture Conference was observed at the Blue Lakes Inn, Twin Falls, Idaho on 1-2 December, 1976. There were 198 persons in attendance from Idaho, Washington, Oregon, Wyoming, California, Montana, Oklahoma, Washington D.C., New York, Utah, Alaska, North Dakota, Michigan, New Jersey, Florida, New Hampshire, Colorado, Missouri, British Columbia, Alberta, and Manitoba. Not a bad showing for a low travel funds year!

The success of the conference is due, in very large part, to the untiring efforts of Irvin Brock, Travis Coley (The Mississippi Flasher), Terry Powell, John McNair, and especially, Martha Klontz (Aunt Martha). Thank you.

The financial contribution of the Idaho Water Resources Research Institute, University of Idaho is gratefully acknowledged.

G. W. (Bill) Klontz
Fishery Resources
University of Idaho

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ARTIFICIAL PROPAGATION IN THE COLUMBIA BASIN

Keynote Address
27th Northwest Fish Culture Conference

L. Edward Perry
Biological Services, Inc.
Pacific Northwest Regional Commission

I appreciate the opportunity to be with you at this meeting today. Many memories flash back to me as I think of the years that have passed since the first meeting of the Northwest Fish Cultural Conference was called in 1950 in Portland. Since I was involved in the operation of the Columbia River Development Program and we had considerable financing in the research of artificial propagation, I called the first meeting. The attendance was about 6 or 8. We met in the conference room of the Oregon Game Department, now the Oregon Department of Fish and Wildlife on Alder Street in Portland.

Each of the state and federal agencies reported on progress being made and we had a discussion that lasted all day. It was agreed that such a meeting was profitable and another should be held each year to assure better communications and a better understanding of the problems and the efforts that were being made to resolve them. We also agreed that the meeting should include supervisors of hatcheries, as well as any actively involved in the field.

Many fish have been released into the Columbia since then. Artificial propagation at that time was just gaining recognition, but it was still in dispute many places throughout the Northwest. The heavy financing being put in by the federal government was questioned by hard-line wild fish proponents. Alaska and Canada cast doubt on the value of any artificially reared fish. Many authorities, including leaders in salmon research at the University of Washington, Stanford University, and elsewhere, likewise felt that artificial propagation was a very poor substitute that might be destroying natural runs by contamination. Nevertheless, cooperative financing programs enabled both the state and federal agencies to make investigations they felt were necessary. The joint consideration of mutual problems brought about some surprising results. Many created more arguments, but gradually out of this developed advances that have brought artificial propagation to the prominence it now enjoys.

The development of the Oregon moist pellet was one of the outstanding accomplishments that brought more attention than any other step. It survived long and hotly disputed arguments in meetings of this group. Other advances brought improved survival, better growth, and in general, more efficient production. The improved design of hatcheries and the inauguration of reuse systems were major contributions. With new construction, there was obviously better and more efficient design. This also brought better operating procedures, improved spawning, improved feeding techniques and even an improvement of general housekeeping. The days of chopping fish feed with an ax from frozen blocks that were pulled out of the freezer are only faint memories of those who are about to retire. When I first saw such methods, I wondered if we were still in the days of our pioneers. It was only evidence that the amount of effort put into the fish management field was not in line with the expenditures for other research fields in this modern day.

When Dworshak Hatchery was built with its new reuse system, we assumed that we had reached perfection. The "greatest hatchery in all the world" was dedicated with great aspirations for the future of steelhead in the Columbia Basin.

One of the embarrassing reoccurances that we experience in the fishery field is our inability to cope with sudden surges of opportunity and financing. Often we are suddenly faced with authorized projects and ample funds for a crash program that we are unable to accomodate in the expected way. The result may be the construction or inauguration of something that is the best of our ability at the time, but the design really results from logical thinking of the best expertise, but without much proven experience. Seldom have we in the fishery field been able to say with confidence that the design of great new effort is guaranteed to work. Time has not permitted us to plan and design in the orderly fashion we would best like.

The design of Dworshak Hatchery was one of our greatest prides and joy. Spring Creek was built along the same lines. At the present time, I hear some say Dworshak should have been designed differently for improved operation and savings could have been made if certain short cuts were made. It just so happens that when the design was put on paper the experience (outside the laboratory) was not there. On the other hand, where else can you find a better place to work out the bugs of such a management tool. Some of the shortcomings of Dworshak are now being worked out through painstaking effort of research and management people who are the only ones capable of solving such problems. Dworshak will ultimately produce the runs of steelhead that were foreseen when it was designed. We should not forget, at the same time, that the detailed design was not always that which was recommended by the researcher or the manager. Problems frequently develop in conflict with other needs and usually fish are given second choice. Even though the second choice may be an expensive one.

The great drama, often considered a tragedy, of the salmon and steelhead of the Columbia River has been played before the public in numerous newspaper and research articles in the past few years. There has been a feeling among many that the Columbia River salmon and steelhead are gone beyond recovery. This is far from true. Admittedly, the runs of fish to the upper basin are in poor shape. They have gone downhill gradually and the present status of the run is very discouraging. Nevertheless, there is a sound forcast for improvement. There are many things on the horizon that assure the return of these fisheries to their strong condition of two or three decades ago.

There have been huge catches of chinook and coho offshore during the past few years. These are a credit to good management and to artificial propagation. The successful harvest in the troll fishery, both sport and commercial, last year can be attributed to the success of hatcheries raising coho and chinook in the lower Columbia Basin. This success has been enjoyed by the Canadians also.

The involvement of the Indians in the last few years has been played up by many. In fact, every questionable operation throughout the basin has been played up, each as a cause of the decline fo the fisheries. The people in Idaho have blamed the Indians and the gillnet fishermen. The fishermen in the lower river have blamed the Indians and the people in Idaho for cutting off the spawning runs. Only the troll fishery has been able to continue without much curtailment or suffering.

The real catastrophe has involved the runs of salmon and steelhead that originate in the Salmon and Snake River country in Idaho and Oregon. The accumulation of dams in the Snake River brought this to a head, when it was discovered by research that the loss of downstream migrants as they passed these dams often ended up with 95% being destroyed before they reached the river below Bonneville Dam. The natural mortality has always been great, but never this great. The effect of dams on adults is also serious and a problem we must face with greater emphasis, now.

We have been able to attack the loss of downstream migrants in a promising program of transporting them around the dams. When we learned the fish could be trapped in gatewells at the dams, screens were devised and as many fish as possible were diverted into the gatewells. From there they could be passed to trucks and hauled downstream. The operations at Little Goose and Lower Granite have caused increased survival as much as 16 times over controlled studies. Thus far, the benefit is not fully satisfactory and screens have not been installed at all turbines. Last year only about 17 percent of the downstream migrants could be trapped and hauled around the dams. A greater number could not be obtained because of high water taking fish over spillways and the limited number of turbines that are screened. This will improve. The plan for the future is to increase this to 50 percent in 1977 if at all possible and strive toward even more later as research and development point the way. Additional research is needed. There are areas where better survival can be obtained. These are being investigated. Ultimately, the transportation of fish around the dams could become a routine operation. It will not be so, however, until the research is adequate to demonstrate its value. The use of transportation in the upper Columbia Basin is also being looked at.

Artificial propagation in the Salmon and Snake River country is a big factor in the production of fish. The ponds at Dworshak and Rapid River Hatcheries are prominent. Rapid River Hatchery was one location that was seriously questioned when it was originally planned, but it has turned out to be a great influence on the spring chinook salmon runs. Niagara Springs Hatchery and the Pahsimeroi complex is another promising project for steelhead. The results from these efforts are encouraging.

If we look ahead, we see in the horizon more artificial propagation. Such puts greater demands on our ingenuity to solve new problems and develop more efficient operation. The last Congress signed authorization of the Lower Snake River Compensation Plan at a cost of $58 million. This Corps of Engineers' project provides for the construction of additional hatcheries in the basin to replace the fish that have been lost as a result of the four dams build on the lower Snake River. The program provides for producing an additional 9.16 million fall chinook, 6.75 million spring and summer chinook, and 11.2 million summer steelhead smolts at new hatcheries as soon as funds are appropriated. It is anticipated that the first appropriation of funds will come in F.Y. 1978. The location of these hatcheries has not been fully decided, but they probably will be in all three states. It has been suggested that eight or nine would be required to meet this demand including some production of resident trout. This increase compares with the present production in the Snake River Basin of 1.6 million summer steelhead and 3 million spring chinook. Although this project has been authorized the results can only be assured when funds are appropriated. Your help is sought in encouraging this appropriation either directly or through others you are working with.

The hatcheries on the upper Columbia operated by the Fish and Wildlife Service are presently being renovated to double their capacity. They are expected to produce 6 million young salmon and steelhead annually when this is completed.

There are also discussions for additional production of fish by the PUD's that are operating the dams in that reach of the river.

In the lower Columbia, plans of the State of Washington are being crystalized to increase production as part of an enhancement program to compensate for some of the reduction of catch that has been experienced in the lower river. Details of this proposal have not yet been worked out, but there will certainly be additional hatchery construction. There are other expansions and progress that will increase production in the lower river by some 700,000 pounds of smolts.

Now, we should look for a few minutes at the additional needs that we have in the field of artificial propagation to meet the demand.

Water supplies have always been recognized as most critical. The best hatcheries are produced from natural water of the quality and quantity that we consider ideal. Such supplies are becoming fewer and farther between. Those which do exist should be seized upon and assured for future use. Present water laws makes this difficult and a real challenge. Legislative help may be required. When a water supply is found that completely meets the criteria for good fish production, it is invaluable and should be guarded.

It is understandable that such supplies will not be adequate to meet all of the proposals for new hatchery construction, therefore, more investigation of reuse systems is needed. The breakthrough of reconditioned reuse systems has been accomplished. Great results have been demonstrated in several locations, yet there still remains some uncertainty of design and operation that must be resolved so we can have assurance enough to guarantee that our plans will work. Dworshak hatchery, or some similar location, would serve as a good laboratory to bring together the facts we have and enable research to resolve those that are still difficult. This should not be overlooked.

More efficient utilization of existing hatcheries is essential. Many hatcheries are operating at partial capacity and many are not producing the most desirable stock. An analysis of every existing hatchery is necessary to provide the efficiency that is demanded. The HATCH model of the Washington Department of Fisheries and NMFS is a step in this direction.

Good coordination among all of the hatchery operations in the Northwest is important. The present separation or political or geographic organizational lines causes limitations in the quality of our efforts. We should work together as a unit in the Columbia Basin, for example, and operate completely without selfish or jealous interests.

The evaluation of fall chinook hatchery operations that was made by National Marine Fisheries Service and its predecessor Bureau of Commercial Fisheries starting in the early 1960's has been outdated because of changes in hatchery management procedures. Much of our estimates of hatchery values and potentials are based on these studies. They should be repeated and updated.

More current information has been obtained on coho and spring chinook, but the large production of fall chinook is not being given justice to support the product that is presently being delivered.

Better understanding of hatchery stocks is needed. Much improvement has been made in the time of release and the size of release of fish but we still don't know enough about the various stocks in the basin and how they should be managed. We are presently trying to identify some of the stocks of the upper basin in an effort to develop a Columbia River model. We are lacking in knowledge about how these stocks contribute to the fisheries in the river and along the coast.

Basinwide planning is needed in the management of these stocks. It is poor policy to create an artificial supply of fish that would be superimposed on a delicate run of natural stock with the result that the heavy fishing on the artificial stock would decimate, or eliminate the remainder of the natural stock. It should be possible to mold the fisheries of the basin by manipulating production of hatcheries. We do know that we can change some habits of fish by these artificial means and we should do so. Efforts have been made only sparingly and they need to be intensified.

Another that is beginning to take shape is a better understanding of the homing instinct of salmon and steelhead. If we had better knowledge of how to imprint homing instinct on artificially produced fish we would be able to transfer them and handle them with greater assurance of returns. This is related to general management practices and also to the transportation around hazardous dams.

During the last few years, the courts have declared that the harvest of the salmon and steelhead must be shared with the Indians even to the extent of 50% of all runs that go through their traditional fishing areas. This requires a readjustment in the traditional fisheries and we have not been able to accomodate this in our economic structure. Attempts to regulate the troll fishery to assure greater survival for the gillnet fishery are meeting with unwelcome affront.

A new Canadian agreement is being disucssed between the United States and Canada. The effects of this agreement on the Columbia River and U.S. fisheries cannot be determined, but we know the impact will be significant. We hope it will be an improvement to us.

The new 200-mile limit law has created a new management council for the Pacific Coast. The overlap of this responsibility on all of the fisheries up and down the coast will be significant. It is too early to determine what will happen. Although this council was designed to assist in managing resources with the foreign nations, it also will affect the management of our domestic fisheries as well.

Within the Columbia Basin, a new Columbia River Fisheries Council is being organized. This is designed to improve the coordination of the fishery problems among the state and federal agencies and all other interested groups. This new council will include the directors of the four state fish and wildlife agencies, the regional directors of the two federal agencies, the four Indian tribes and the commercial and sport fishermen. Technical committees will bring together technical discussions and plans. What we are striving toward is a closer consideration of all technical aspects of the Columbia River problems to enable the managers to make truly informed, wise decisions on a basin-wide basis.

We can expect within the near future a new compact or commission in the Columbia Basin which will bring the State of Idaho into the legal management authority along with Oregon and Washington, and also more joint consideration of the sport fisheries.

Another effort that we are happy about is the inauguration of a new information exchange. We are beginning at the present time a newsletter program which will be issued about once a month and distributed to all interested people in the Columbia Basin to explain to them some of the important issues and help the public to understand them and be able to express their feelings about them. In January, we expect to have the first issue out and would appreciate your comments so that we can develop it to the point that will be productive. The resource should be produced and harvested for the benefit of the people of the Northwest. These people should all have a chance to know and understand what the issues are and express their concern over them. They can only do so if they are informed and we would like to make it easier for them to become informed.

The Pacific Northwest Regional Commission has been active in this coordination program; the development of a new Columbia River model, some experimental ponds, an estuary study, and several other projects. The Commission consists of the three governors of Idaho, Oregon and Washington and a federal cochairman. They have made available funds to assist in the analysis of many difficult problems and the development of solutions. They financed the study that I coordinated with the state and federal fishery agencies. They are also financing the inauguration of this coordination program which I have just described.

Within another year, I would anticipate a great improvement in the runs of the Columbia River not only as a result of increased survival and production, but also through good understanding and close working relations. With a new compact to bring all of the states together, a better understanding of the resource problems by the public, and a closer working relations of the official agencies and with the Indians and the user groups, I see nothing but improvement.

It behooves those who are working with artificial propagation to identify the problems you see and assist in their resolution. Great emphasis is being placed on the ability of the hatcheries to bring the salmon and steelhead up to a high level. With this combined effort the doldrums of the recent past, and the fish wars that have been stimulated, and the enemies that have almost developed, can be eliminated. We see a bright picture ahead.

FISH HATCHERIES AND REARING FACILITIES
Chambers Creek Basin
Tacoma, Washington

Arthur E. Westrope, Mgr.

The Chambers Creek Basin fish facilities are located on Chambers Creek near Tacoma, Washington. The facility includes three structures - the South Tacoma Hatchery, Chambers Creek Hatchery, and the fish trap and ladders.

Water source for the South Tacoma station is a series of springs which maintain a 56 degree temperature the year around. The fish species reared at the facilities are Winter Run Steelhead, Summer-Run Steelhead, and Rainbow Trout.

The physical description of the South Tacoma Hatchery would include a hatchery building with 120 troughs, 16 - 80 foot creek ponds, 12 - 40 foot round ponds, 2 - 10x100 raceways, and one rearing pond 2 surface acres.

The domestic Rainbow broodstock have been selected over the years to spawn early. By selecting the brood replacements from early spawners and holding the broodfish in this water temperature, we now start spawning between the 10th and the 15th of August. By the end of September, we have taken about 4 million eggs, with spawning dropping off in October. Rainbow eggs and fry are shipped throughout western Washington and the Upper Columbia River hatcheries in Washington state.

Around November 25th each year, we start operating the steelhead trap near the mouth of Chambers Creek. This dam was constructed for industrial water for the Boise Cascade Corp. and Glacier Sand and Gravel Company, and because of their interests, they maintain the upkeep of the ladders.

There is a need for 2600 to 3000 Steelhead adults for our Winter-run Steelhead spawning operation. Over the years, the Chambers Creek run of Steelhead has been selected to spawn in December and mid-January. The total egg-take required to meet our allotments is about 5 million.

Fry are shipped to the Beaver Creek Hatchery and the Aberdeen Hatchery in March and April. During June, July and August, we are grading and shipping fingerlings to rearing ponds on the Skagit, Stillaguamish, Snoqualmie, and Green Rivers. The size of these rearing ponds is from a few acres to 200 acres. Fish released into the rearing ponds are from 100 to 120 per pound.

Scheduling of the transfer of fingerlings to the rearing ponds is planned on the basis of water temperature. The pond with the coldest water temperature receives the earliest fish. The Tokul Creek Hatchery, located near Snoqualmie Falls, will receive its allotment of fingerlings as early as the middle of June; while Barnaby Slough, located on the Upper Skagit will receive fingerlings in the middle of August. By the following April and May, the yearlings are smolting and ready to migrate.

Due to the relatively warm water (56 degrees) at the South Tacoma Hatchery, we hatch and rear several of the late runs of Steelhead. For example, the late Cowlitz run spawns in May; while the Skookumchuck River Steelhead spawn in late April and May.

The Summer-run eggs are shipped to South Tacoma Hatchery from the Skamania Hatchery. Adult Summer-runs are transferred from the Skykomish River to the South Tacoma Hatchery where they are held and spawned in February.

The Chambers Creek Hatchery is our satellite station. It consists of four 100' x 26' raceways equipped with Garon fish feeders. The hatchery has 120 inside troughs. The water source is a combination of spring and creek water. The spring temperature is 54 degrees the year around.

A PRELIMINARY REPORT ON THE EFFECT OF SIZE AND TIMING ON GILL ATPase ACTIVITY OF SOCKEYE SALMON (*O. nerka*)

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INTRODUCTION

Efficient management of propagated species of anadromous salmonids requires knowledge about the various parameters influencing migration behavior. Improper release timing of hatchery fish may result in prolonged freshwater residence thus reducing growth and increasing stress to the river or estuarine ecosystem. Immediate transition from fresh to salt water is necessary to minimize stocking impact.

One method of identifying migration tendency is the presence of elevated levels of gill Adenosine Triphosphatase (ATPase). Zaugg and Wagner (1973) and Zaugg and McLain (1970,1972) have associated elevated gill ATPase activity with migration behavior and salt water adaptation in coho and chinook salmon and steelhead trout. In general a twofold increase of gill ATPase over baseline levels was considered to represent smoltification. Similar increases would be expected in other salmonids. The purpose of the study was to use gill ATPase levels to determine the optimal size and timing of accelerated Quinault River sockeye salmon to aid in the management of the species.

METHODS

Two groups of sockeye salmon from the Lake Quinault accelerated growth and early release program (Feldmann and Figg, 1975) were used in the study period. The large fish of the experimental stock, averaging 7.4 cm, were expected to exhibit varying levels of ATPase activity. The control stock was comprised of small fish averaging 4.9 cm and were expected to exhibit baseline levels of gill ATPase.

Twenty-five fish from each of the stocks were sampled on June 28, July 2, July 6, and July 10, 1976. Weights and lengths were obtained concurrently with removal of the gills from each fish.

Gill ATPase was analyzed by the Ewing and Johnson method (1976). Since sockeye salmon ATPase had not been analyzed to date, extractions were made using the formulation for coho salmon ATPase. While exact quantities of gill ATPase might be masked, relative levels remained undisturbed.

Data were analyzed by analysis of variance and covariance.

RESULTS AND DISCUSSION

ATPase levels for each stock were plotted separately against length and weight. The experimental stock exhibited two distinct levels of ATPase activity dependent upon fish size for the first three time periods with no apparent size dependency in the fourth. Clustering occurred below 6.5 cm and greater than 6.5 cm (Figure 1). Similar clustering occurred for fish less than 2.5 grams and those greater than 2.5 grams. Therefore, the experimental stock was segregated into two smaller groups (1 and 2) according to size.

ATPase activities were compared between these subgroups over the four time periods by two way analysis of variance. Mean ATPase activities in the large fish (greater than or equal to 6.5 cm) were approximately two times greater than the smaller fish (less than 6.5 cm) for the first three time periods. ATPase activities for the two subgroups were not significantly different, however, in the fourth time period (Table 1, Figure 2).

Since gill ATPase activities in group 2 did not change over time and remained at low level, they were compared with the control stock for differences. The control stock averaged 4.9 cm in length and was considered to exhibit presmolt levels of gill ATPase. Analysis of variance showed no difference between group 2 and the control groups ATPase levels over time. Therefore, group 2 exhibited presmolt levels of ATPase.

The effect of time upon ATPase activity was evaluated by two way analysis of variance. The treatment effects were size and time. Significant differences were found in ATPase activities as a result of length and interaction with effects but not as a result of time alone (Table 2). Similar results were found when weight was substituted for length as one of the independent variables.

DISCUSSION

Variation in migration timing is the result of environmental and genetic factors affecting development and behavior. Age at migration, for example, is influenced by species timing and development. Chum and pink salmon migrate at emergence, chinook at 6 to 12 months from fertilization and coho, sockeye and steelhead reside in freshwater one, two or more years before migration to sea. In nature available food resources and temperature regimes are two of many environmental characteristics which limit growth potential and development timing and consequently influence migration tendency.

In yearling release hatchery programs adequate nutrition is provided to achieve migration size well before the natural migration period so that differential migratory behavior is not observed. In accelerated growth programs with 0-age release, fish size and timing become more critical factors. ATPase activity has been associated with size, timing in yearling coho and steelhead. ATPase activity levels have not been examined in sockeye salmon to date and certainly not in accelerated stocks. The purpose of this experiment was to find the influence of size and timing on gill ATPase activity and define release requirements for accelerated sockeye salmon.

TABLE 1

ANCOV OF ATPase Activities for Two

Size Groups of Experimental Stock Brood Sockeye Salmon

Date	Groups	Mean ATPase	Slope	F
6-28	X 6.5 cm(1)	2.5	1.2	29,2774***
	X 6.5 cm(2)	6.2	2.7	
7-2	1	2.0	.03	37.28***
	2	6.3	2.97	
7-6	1	2.6	.02	5.56*
	2	5.5	.62	
7-10	1	3.3	-.18	1.11
	2	3.1	.008	
6-28	X 2.5 gms(1)	2.7	1.81	19.86***
	X 2.5 gms(2)	6.2	2.24	
7-2	1	2.5	.78	38.95***
	2	6.5	1.26	
7-6	1	2.6	-.14	5.56*
	2	5.5	.69	
7-4	1	3.4	-1.63	.22
	2	3.1	-.20	

* =.05 significance level
*** =.001 significance level

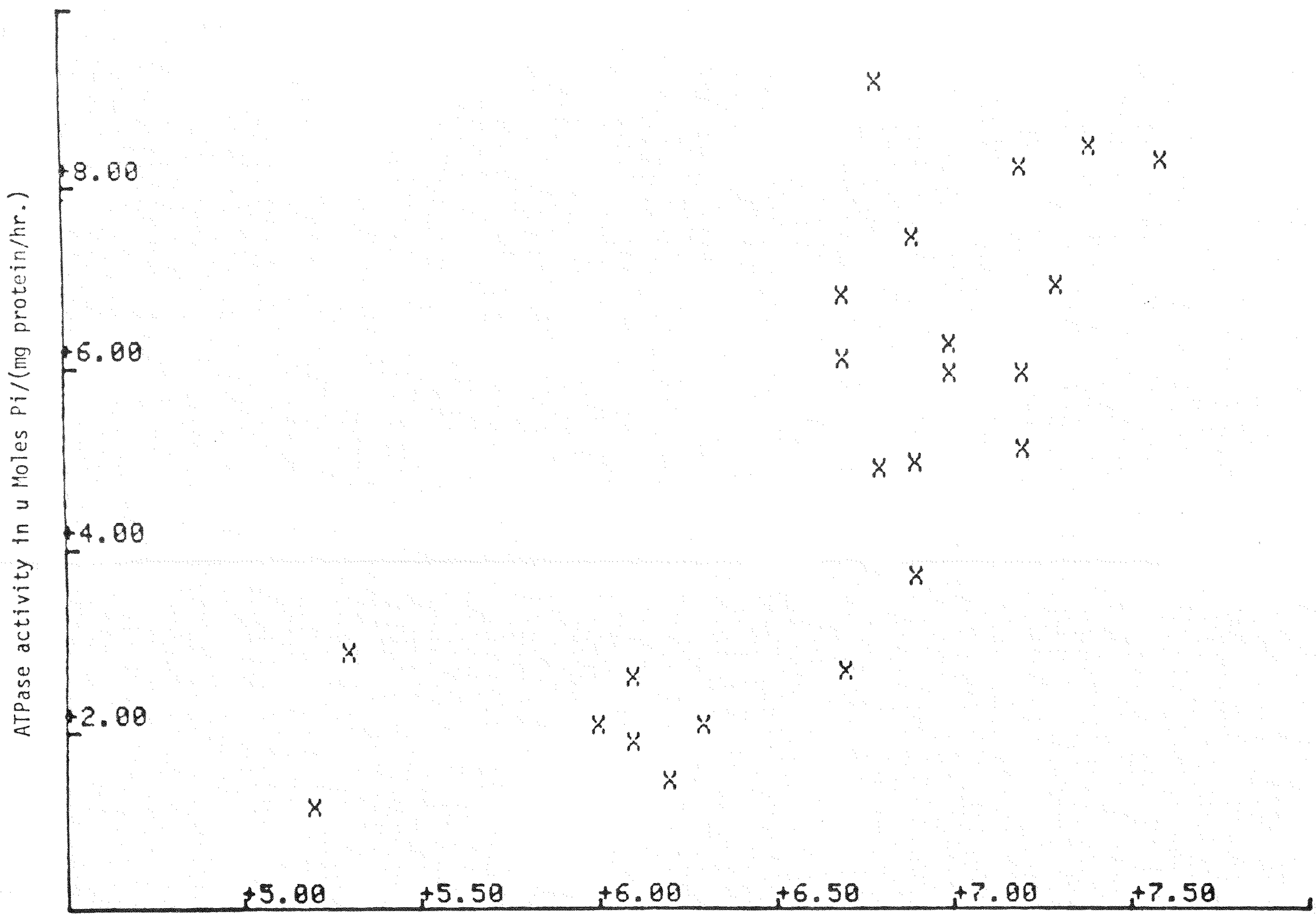

Figure 1. Length versus ATPase activity in period 2 of 1975 Brood Quinault Sockeye Salmon.

TABLE 2

Two Way Analysis of Variance of ATPase Activities Between Two Size Groups Within the Experimental Stock of 1975 Brood Sockeye Salmon Fingerlings

A. Length and time are treatments.

B. Weight and time are treatments.

A

SOURCE	DF	MS	F	
Total	73			
Main Effects	4	39.89	17.52	***
Length (A)	3	109.28	47.99	***
Time (B)	1	5.95	2.61	
Interaction	3	17.18	7.54	***
Error	66	2.28		

B

SOURCE	DF	MS	F	
Total	72			
Main Effects	4	37.99	16.14	***
Weight (A)	3	93.46	39.71	***
Time (B)	1	5.94	2.52	
Interaction	3	14.41	6.12	***
Error	65	2.35		

*** = .001 significance level

Size Effects

Migration is influenced by release size. Feldmann (1974) and QDNR-ED (1976) have reported coho released at a size smaller than necessary for migration delayed migration until adequate size was reached. In the QDNR-ED experiment 0-age fingerlings at an average size of 100 mm migrated seaward. Smaller fish of the population moved upstream and delayed their migration. Many of these fish migrated over the next two months as their size increased to the necessary 100 mm. Still others delayed for the entire winter and migrated the following spring. Size at release is an integral portion of immediate migration. Recent research suggests that size may have an effect on ATPase activity (Zaugg and McLain, 1970, 1972). Because ATPase activity is associated with both size and migration tendency, it is a good indicator of the minimum size required for stock migration. The experimental stock used in the study was 0-age Quinault sockeye fingerlings in an accelerated growth and early release program. The stock grew well gaining nearly 1700% in weight in 115 days. Individual size varied but the stock averaged 2.82 grams and 7.4 cm per fish, approximately the same size as migrating wild fish one year older (6.75 cm) (Tyler and Wright, 1974). Plotting of the raw data revealed clustering by about two sized grouping less than 2.5 grams or 6.5 cm, Figure 1. Analysis of variance showed significant differences between ATPase levels corresponding to those size groupings with the larger fish having ATPase levels two times higher than the group 2. Zaugg and McLain (1970,1972) reported twofold activity increases in ATPase activity in parr to smolt transformation. Since the small fish did not at any time exhibit elevated activity, it is evident that a threshold size is necessary for migration. It appears that the size is approximately 6.5 cm or 2.5 grams. These sizes may vary from population to population, but is is interesting to note the 6.75 cm size of wild migrants. It is suggested that this size limitation is directly responsible for the small migration of observed in one sockeye group in 1974 (Tyler and Wright, ibid).

It might be speculated that acceleration rather than size caused the difference. Since all reared sockeye grew at rates far superior to any wild stock, and yet not all had elevated ATPase levels, it is doubtful that rapid growth itself was responsible for the elevated ATPase activity.

Timing Effects on ATPase Activity

Stock timing acts somewhat independently of size. Migration research on the Queets River, Quinault Reservation, for example, has shown that artificially propagated native fall chinook salmon released into the river in the early summer delayed some five to seven weeks before moving out of the system (QDNR-ED, 1975). Many of the fish were larger at release date than wild fish at migration. And they were substantially larger at migration than the wild year class. It appeared that migration tendency was independent of size and dependent upon photoperiod or some other environmental cue. It is supposed that these fish had exceeded essential migration size as evidenced by the smaller wild fish, but before the acceptable time period. Similar results could be expected from yearling coho released at 100 mm in the dead of winter. While they may exceed necessary migration size, they are not within the stock migrational time frame and would not move until the spring.

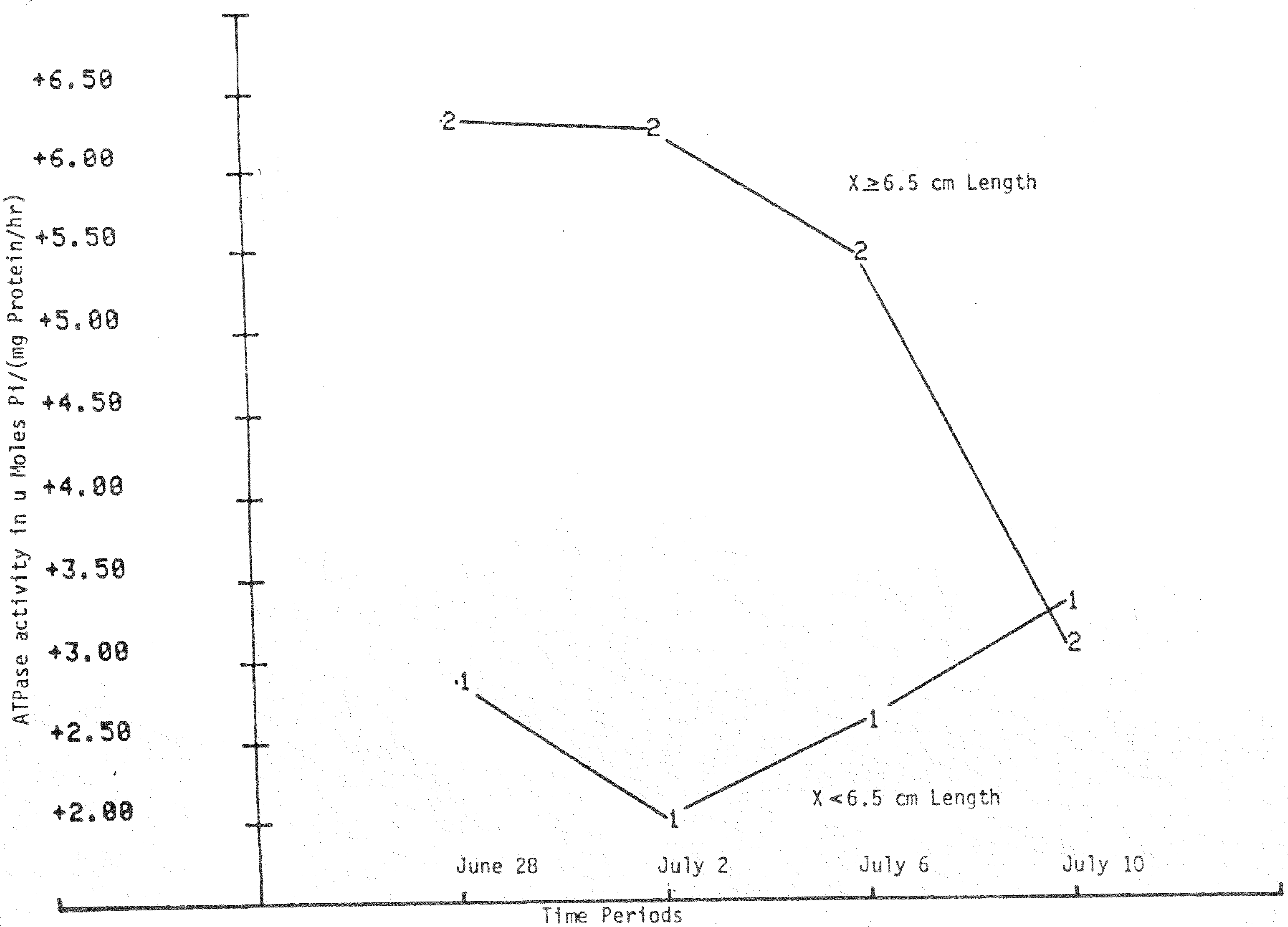

Figure 2. Average ATPase activity of two subgroups within the experimental stock of 1975 Brood Sockeye Salmon Fingerlings. (1) $X < 6.5$ cm (2) $X \geq 6.5$ cm

Migration timing is intimately associated with photoperiod. Work by Wagner (1973), Zaugg and McLain (1970, 1972) and Zaugg and Wagner (1973) indicates the impact of photoperiod in migration as adjustments to photoperiod caused smolt sized fish to migrate at various times during the year. Elevated ATPase activity has also been associated with migrational timing with twofold increase during the normal migration period (Zaugg and McLain, 1970, 1972).

Comparison of group 1 and 2 showed no significant impact of timing upon ATPase activities in general (Table 2, Figure 2), while a significant decline in ATPase over time occurred for groups (6.5 cm and 2.5 grams). The two way analysis of variance demonstrated that time interaction with size rather than time alone was responsible. Peak ATPase levels, twofold activity, were observed on June 28, July 2 and July 6. By July 10 ATPase levels had fallen to presmolt levels (Figure 2). A time limit on elevated ATPase activity of the first week in July appears evident. Therefore time had a significant effect on the ATPase activity and presumable migration tendency on fish greater than or equal to 6.5 cm length or 2.5 grams in weight. Fish reaching or exceeding those values within or before the first week of July would achieve migration. Other fish not reaching the size within time limit would not migrate until the following year. Of interest here is the time range available to migration. Tyler and Wright (ibid) captured wild smolts in their downstream trap in mid-April. This is not the earliest date, however, as migration had begun before trapping. A preliminary estimate of migration time range of April 1 through July 1 is proposed. Further study will determine the amount of variance which occurs about this range. Our research does not preclude the possibility of other controlling mechanisms in migration response. Given the natural temperature cycle and adequate nutrition, the predominant controlling mechanisms, however, are size and photoperiod.

From the data, therefore, the following preliminary conclusions are made:

1. Size affects ATPase activity in Quinault sockeye salmon. Fish less than 6.5 cm or 2.5 grams do not exhibit evaluation levels of gill ATPase.

2. Timing affects gill ATPase in fish longer than 6.5 cm. Fish which have not migrated by the first week in July will not do so until the following spring.

3. Gill ATPase is unaffected by growth rate.

4. The Ewing Johnson method of ATPase extraction is an efficient method for characterizing variance in gill ATPase levels within stocks.

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AQUACULTURE IN IDAHO

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ABSTRACT

Idaho currently ranks third behind Washington and Oregon, in that order, in numbers of existing hatchery facilities. However, the commercial food fish industry in Idaho produces 15-20 million pounds of rainbow trout and channel catfish annually in 69 currently licensed facilities. This is approximately 90% of the nation's commercial processed trout production. The Idaho Department of Fish and Game currently operates 17 hatcheries throughout the state. In FY-1974 the Department released 9.3 million spring chinook salmon, 0.3 million summer chinook salmon, 6.7 million steelhead, and 5.2 million rainbow trout. During the same period the three U.S. Fish and Wildlife Service hatcheries in Idaho released 1.8 million steelhead, 3.0 million kokanee, 1.5 million rainbow trout, and 0.8 million spring and summer chinook salmon. Therefore, in terms of pounds of fish produced, Idaho leads the nation in trout and salmon production.

The majority of the commercial fish farms (46 out of 69), one National Fish Hatchery, and three Idaho Department of Fish and Game hatcheries lie along a 25-mile stretch of the Snake River extending from Twin Falls downstream to Hagerman. The current standing crop; i.e., pounds of fish on hand each day, in these hatcheries is estimated at 6-7 million pounds. At a dietary efficiency of 65% and at an average feeding level of 3% of body weight (based upon current practices), these facilities discharge an extimated 63,700-73,500 pounds of biological contaminants daily into the Snake River.

A PRELIMINARY MARKET ANALYSIS OF DOMESTICALLY PRODUCED RAINBOW TROUT*

Lewis E. Queirolo and Richard S. Johnston

ABSTRACT

The principal objective of this study was to isolate and identify the factors governing the demand for domestically produced rainbow trout in a representative west coast market, and assess the impact on that demand, if any, of the introduction of pan size salmon. The approach taken in this demand study was to identify those variables hypothesized to determine supply and demand for rainbow trout. Several testable hypotheses concerning the anticipated relationships were specified. It was hypothesized that a negative relationship would exist between the price of trout at the brokerage level and the quantity demanded at that level. Conversely, the price of trout at the wholesale level was hypothesized to be positively correlated with the quantity of trout demanded at the brokerage level. Further, the signs on the coefficients of variables accounting for wholesale price of substitute items were expected to be negative, while similar prices at the brokerage level should be positive, based upon the hypothesis. It was hypothesized that the presence of Japanese trout in the market place would have a negative impact on the quantity of domestically produced trout demanded. Personal disposable income was hypothesized to be positively correlated with the quantity of trout demand. Expectations were that seasonal factors tend to cause trout demand to fluctuate cyclically.

An econometric simultaneous equations model was specified from which estimates of the paremeters of the demand equation were obtained using two-stage least-squares techniques. A recognition of the limitations associated with the available data set necessitates the emphasizing of the <u>preliminary</u> nature of these results.

Data on quantities and prices of rainbow trout and equivalent price series for hypothesized substitutes were obtained through personal interviews with market participants and close observers thereof.

The results of the study, while preliminary, tend to support the original set of hypotheses concerning the interrelationships between quantity of domestic trout demanded and own-price, the price of close substitutes and seasonal demand fluctuation. Somewhat unexpectedly, the regression seems to have uncovered a negative income / demand relationship for rainbow trout. It raises some interesting questions which might best be addressed in terms of hypotheses for future analysis.

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* This work is a result of research sponsored in part by the Oregon State University of Sea Grant College Program, supported by NOAA, Office of Sea Grant Department of Commerce, under contract #04-6-158-44004.

THE MODEL

The market network was statistically approximated by the use of an econometric simultaneous equations model. Ultimately, the demand equation at the wholesale level was quantitatively estimated using two-stage least-squares techniques. The wholesale level was selected because there were fewer gaps in the data at this level than at the retail level. The results of the regression are reported below and the interested reader is encouraged to explore this somewhat more technically detailed section. However, for the reader who is not familiar with, or particularly interested in, the statistical techniques for the derivation of an econometric model and it's coefficients, there would be no loss of continuity if he/she chose to proceed, at this point, to page

The economic model developed in an attempt to approximate the wholesale level of L.A. distributional network for rainbow trout is specified as follows:

$$(1)\quad Q_d^{wt}/N_t : P_{b_t}^{wt},\ P_{w_{t-1}}^{rt},\ P_{w_{t-1}}^{rms},\ P_{b_t}^{wlrgt},\ P_{w_{t-1}}^{rpss},$$

$$D_2,\ D_3,\ D_4,\ Y/N_t,\ D_t^{imt}$$

$$(2)\quad Q_s^{wt}/N_t : P_{b_t}^{wt},\ P_{b_{t-1}}^{wnyt},\ T$$

and assumes the identity,

$$(3)\quad Q_d^{wt}/N_t = Q_s^{wt}/N_t = Q^{\substack{total \\ trout}}/N_t$$

where the colon is read "depends on", a comma is read "and", [Foote, 1958, p. 8]* and the variables are defined as follows:

Q_d^{wt}/N_t = quantity of rainbow trout demanded at the wholesale level, per capita, in time t.

$P_{b_t}^{wt}$ = price of rainbow trout from broker to wholesaler in time t. This price is hypothesized to be endogenous and simultaneously determined with quantity demanded in this model.

$P_{w_{t-1}}^{rt}$ = price of rainbow trout wholesale to retail in time t-1. This price is hypothesized to be an important explanatory varible in the simultaneous determination of

Q_d^{wt}/N_t and P_t^{wt}. The argument follows that the price received in the latest preceding period, i.e., t-1, will contribute to the determination of demand for rainbow trout in time t. Thus,

$P_{w_{t-1}}^{rt}$ becomes a predetermined variable owing to the lag.

$P_{w_{t-1}}^{rms}$ = price of medium salmon wholesale to retail in time t-1. Medium salmon is hypothesized to be a close substitute in consumption for rainbow trout thus contributing to the determination of the demand parameters for trout. Again, this variable is lagged to

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* Analytical Tools for Studying Demand and Price Structures. Richard J. Foote. United States Department of Agriculture, Agricultural Handbook No. 146, 1958.

account for the most recent historical price information available to the wholesaler when he makes his current buying decisions.

$P^{rpss}_{w_{t-1}}$ = price of pan size salmon wholesale to retail. The argument for the inclusion of this variable is identical to that made above for P^{rms}_{w}.

Y/N_t = per capita personal disposable income for the Los Angeles SCSA in time t. This variable is exogenously determined and is hypothesized to account for demand determining forces resulting from general economic conditions.

D^{imt}_t = a binary variable included in the demand equation to reflect the potential influence of Japanese trout, as a demand shifter, upon total quantities of domestic rainbow trout moving through the L.A. market in time t.

D_2, D_3, D_4 = a series of binary variables intended to detect any significant seasonal shift in demand on a quarterly basis. Several preceding studies on seafood demand have tentatively identified seasonal fluctuations in demand owing to, it has been hypothesized, such factors as religious holidays, traditional non-seafood main course dishes, i.e., Thanksgiving turkey, Christmas ham, etc. Industry sources, interviewed during this analysis, are divided as to the significance and timing of such seasonal shifts in demand for rainbow trout. It would seem, therefore, to be a natural hypothesis to investigate.

Equation (1), then, is the per capita demand equation for rainbow trout in the Los Angeles wholesale market.

Equation (2), the supply equation, contains in addition to $P^{wt}_{b_t}$:

Q^{wt}_s/N_t = quantity of rainbow trout supplied to brokers for sale in L.A. in time t. The variable is expressed in per capita terms.

$P^{wnyt}_{b_{t-1}}$ = price of rainbow trout from broker to wholesaler in time t-1 for the Fulton Fish Market, New York. The variable is hypothesized to account for shifts in supply resulting from variation in the price for rainbow trout in alternative markets.

T = variable "time" accounting for supply shifters not otherwise observable given the available data.

All prices are deflated by the Wholesale Price Index for "Farm products, processed foods, and feeds", U.S. Bureau of Labor Statistics. Income, Y, is deflated by the Consumer Price Index, U.S. Bureau of Economic Analysis. The variable N_t is the population of the Los Angeles standard consolidated statistical area, in time t, as reported by the U.S. Bureau of the Census.

The identity $Q^{wt}_d/N_t = Q^{wt}_s/N_t = Q^{total}_{trout}/N_t$ specifies an equilibrium condition in which quantities supplied are exactly equal to quantities demanded, i.e., it is assumed that there are no inventories held at the brokerage, wholesale, or retail levels in this market.

Several specifications (i.e., functional forms) of this basic economic model were hypothesized and quantitatively estimated using two-stage least-squares techniques.* The most satisfactory in terms of R^2, F, and t statistics is reproduced below.

The results of the first stage of the 2SLS regression, where in $\hat{P}_b^{wt}$, predicted price, is estimated in terms of all the exogenous variables in the model are:

$$\hat{P}^{wt}_{b_t} = \underset{(2.68)}{.0123} + \underset{(2.79)}{.00334}\, P^{rt}_{w_{t-1}} + \underset{(.974)}{.00087}\, P^{rms}_{w_{t-1}}$$

$$- \underset{(-.9505)}{.000136}\, D_2 + \underset{(.7088)}{.000112}\, D_3 + \underset{(.578)}{.00076}\, D_4$$

$$- \underset{(-1.16)}{.0000166}\, T - \underset{(-.656)}{.0000169}\, D^{imt}_t + \underset{(3.45)}{.320}\, P^{wlrgt}_{b_t}$$

$$- \underset{(-2.67)}{.0486}\, P^{rpss}_{w_{t-1}} + \underset{(.960)}{.1273}\, P^{wynt}_{b_{t-1}} - \underset{(-2.71)}{.00000326}\, Y.N_t$$

R^2 = .910032 F - statistic 22.9889, 11, 25 d.f.

In the second stage quantity dependent equation, $\hat{P}^{wt}_{b_t}$ is included as an explanatory variable and yields:

$$Q^{wt}_d/N_t = \underset{(4.37)}{.0175} + \underset{(2.04)}{.00726}\, P^{rt}_{w_{t-1}} + \underset{(.632)}{.000051}\, P^{rms}_{w_{t-1}}$$

$$- \underset{(-1.76)}{.000282}\, D_2 + \underset{(1.53)}{.000328}\, D_3 + \underset{(.278)}{.0000459}\, D_4$$

$$- \underset{(-1.18)}{.0000388}\, D^{imt}_t + \underset{(2.05)}{.5607}\, P^{wlrgt}_{b_t} - \underset{(-1.97)}{.0632}\, P^{rpss}_{w_{t-1}}$$

$$- \underset{(-3.91)}{.00000439}\, Y/N_t - \underset{(-2.35)}{1.549}\, \hat{P}^{wt}_{b_t}$$

R^2 = .5912 F - statistic 3.6155; 10, 25 d.f.

Durbin-Watson Statistic 1.667

where the t-values are in parenthesis below the coefficients.
The critical t-value, α = .10 is 1.316.

The period of analysis is May, 1972-December, 1975, inclusive, and the observations are monthly.

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* For a complete review of the alternative model specifications and resulting statistical evaluations the reader is referred to, "Substitutional Relationships Between Rainbow Trout and Pan-size Salmon: A Market Demand Analysis", Lewis Queirolo, 1976, Oregon State University.

A SUMMARY OF THE REGRESSION RESULTS

In terms of the relationships postulated at the outset of this analysis concerning the market demand for rainbow trout, the results of this two-stage least-squares estimation were most interesting. Pan size salmon has consistently been hypothesized to be a close substitute in this market for domestically produced rainbow trout. The results of this analysis tend to support this hypothesis. The variable accounting for the price of pan size salmon enters the regression at a statistically significant level and with the expected sign. Data limitations with regard to pan size salmon precludes the estimation of a cross-price elasticity figure. It is, however, possible to conclude with some certainty that pan size salmon does serve as a substitute in consumption, i.e., a demand shifting factor, for rainbow trout. By re-computing the demand equation with data from those periods which pan size salmon was not present in the market it was discovered that the appearance of pan size salmon does shift the demand curve for rainbow trout and that the magnitude of the shift may vary with the season of the year. That is, based upon these results, it appears that the presence of pan size salmon in the market during certain seasonal periods may have a more pronounced impact on demand for rainbow trout than it would during other seasonal periods. While the results are only preliminary this hypothesis would seem to merit additional attention. Perhaps there is a "trout" season and a "pan size salmon" season in terms of consumers' purchasing decisions. On the other hand, seasonality may be more supply- than demand-related.

Own-price of rainbow trout is represented at both the retailer's level and the broker's level by $P^{rt}_{w_{t-1}}$ and $P^{wt}_{b_t}$, respectively. Both price variables enter the regression at statistically significant levels and with the expected signs on their coefficients. In the case of the price of rainbow trout from wholesaler to retailer the relationship was expected to be positive. That is, as the price the wholesaler is able to command for rainbow trout from his retail customers increases he will demand greater quantities of rainbow trout from his broker(s). The magnitude of this price sensitivity is reflected by the price elasticity, calculated in this case to be 5.99. The relationship is price elastic, in as much as, a 1% increase in the price received by the wholesaler in the previous period for rainbow trout would be expected to result in nearly a 6% increase in the quantity demanded at the brokerage level, <u>ceteris paribus</u>. This elasticity figure is calculated at the <u>mean</u> value of the variables.

On the other hand, the price elasticity for rainbow trout at the broker to wholesaler level was calculated to be -9.08, once again highly price elastic. That is, if the price of rainbow trout which the wholesaler must <u>pay</u> were to decline by 1%, the quantity demanded at wholesale would increase by 9.08%, <u>ceteris paribus</u>. Therefore, a reduction in the price of rainbow trout at the brokerage level, i.e., by producers, would be expected to <u>increase</u> total revenues accruing to the fish culturists as a result of their increased sales of rainbow trout to the L.A. market. This assumes that the retail price of rainbow trout does not change in response to the quantity change. This is probably unrealistic and, therefore, any assessment of the effect on total revenue increases at the brokerage level of a retail price response would have to be incorporated into any decision strategy based upon the results of this analysis. Unfortunately the available data do not permit a quantitative evaluation of the magnitude of a retail price response to a decrease in brokerage prices. This would seem to be another topic deserving of further research.

Per capita personal disposable income, deflated by the consumer price index, entered the regression with a negative sign. This is contrary to the hypothesized influence of income on quantity of rainbow trout demanded. There are several possible explanations for this result. The negative coefficient may be the product of statistical problems within the data set. It is, of course, not theoretically inconceivable that, over some range, rainbow trout is in fact an "inferior good", as the negative income coefficient would imply. To an economist the term "inferior good" refers to a good with a negative income elasticity. The word "inferior" is used "only to describe the income elasticity of a good ..." [Ferguson and Gould, 1975, p. 43].* When, over some range, a good is observed to be "inferior" the implications are that as income increases the consumption of that good will decrease. This is not so difficult to imagine when one recalls that income can be perceived as a proxy for "all other goods." In this sense for example, as a consumer increases consumption, including that of alternative food proteins such as beef, pork, poultry, and other seafoods, the utility he obtains from consuming rainbow trout may be diminished over some observed range. During the period of this analysis the "real" per capita income in the Los Angeles standard consolidated statistical area has in fact been declining. It has simultaneously been observed that per capita consumption of trout has been on the increase. This may be the result of the rapid rise in the real prices of other goods for which rainbow trout serves as a potential substitute, while the real price of rainbow trout has remained relatively constant or at least has increased more slowly. If this were the case then consumers would maximize their utility subject to the increasing constraint applied by declining real income, by substituting away from the more price inflated food items in favor of rainbow trout, thus producing the erroneous conclusion that rainbow trout is an "inferior good". This is only conjecture at this point owing, once again, to a lack of suitable data on these several food protein commodities. But it appears to be another hypothesis worthy of further quantitative investigation. The possibility exists that over the long run, recalling the very short time series available for use in this analysis, one might hypothesize the true relationship is actually positive. If sufficient data were available one would, in fact, observe a positive income/quantity relationship, assuming this hypothesis is correct. Coincidently, the economic conditions existing during the duration of this analysis have been atypical in terms of the historically established pattern. The years 1972 through 1975 have seen price freezes, record inflation and unemployment, and a decreasing real personal disposable income. All of these factors may have served to generate an anomolous income/quantity relationship during the period observed in this analysis. Data restrictions preclude any evaluation of this hypothesis.

All elasticities have been calculated at the mean and should only be interpreted as being indicative of the results of very small changes about the mean value.

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* Microeconomic Theory. C.E. Ferguson and J.P. Gould, fourth Ed., Irwin, Inc., 1975.

The need for additional analysis in this area seems indisputable based upon the interesting but very tentative results of this study. Any further quantitative examination of the proposed model and hypotheses resulting from it must await the release of more complete, detailed data, which to now have not been forthcoming. Perhaps the responsibility for the absence of broader industry participation can be traced to a failure to communicate clearly the project's goals and objectives. It is the fervent hope of the authors that this study serves primarily to identify critical issues, ask the relevant questions, and pose provocative alternative explanations as a means of informing all interested parties of the potential contributions accruing when and if such questions can be objectively answered. The only means to this end lies in the broadest possible participation by those industry members serving the major U.S. markets.

THE RANGEN TROUT RESEARCH PROGRAM

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INTRODUCTION

Rangen, Inc. was begun in 1929 as a home town ice company and in the past 58 years has grown to be one of the largest privately owned corporations in the Pacific Northwest and one of the largest and oldest manufacturers of dry trout and salmon diets in the world. The company has grown through service to an expanding and diversifying agricultural industry to include several divisions; general domestic animal feeds, seeds, beans, grains, fertilizers, agricultural chemicals, and trucks and equipments. A small but very important division of the company is its fishery division.

FISHERY DIVISION

The Fishery Division of Rangen, Inc. was created in the 1950's in order to meet the needs of a local growing commercial rainbow trout industry in the Snake River valley. The division was instrumental in formulating efficient dry production diets for both trout and salmon.

In 1960, the company foresaw the need for trout and salmon nutrition research to be done on a practical production size basis and began construction of their present research hatchery. The facility is located 35 miles west of Twin Falls, Idaho, near Hagerman. The facility has since been used for hundreds of studies utilizing computer assisted least-cost formulated diets on a production basis. The hatchery has also become a leader in implementing new ideas in fish culture and providing a testing ground for inovative techniques of hatchery design and management.

PATHOLOGY LABORATORY

In 1976, the Fishery Division undertook construction of a new modern fish pathology and analytical laboratory to complement their research undertakings, the commercial trout and salmon industries, and supporting areas. The two thousand square foot facility includes a disease isolation wet laboratory where experimental lots of fish can be maintained and challenged under controlled conditions with total disease isolation; a general pathology laboratory which includes sections for hematology, serology, parasitology, bacteriology and histology; an analytical laboratory with complete chromatographic and electrophoretic capabilities, super-cold freezers, high speed centrifugation, lyophilization, and etc. This laboratory is capable of taking a fish apart molecule by molecule as well as analyzing feeds and feed components and doing special assay techniques such as drug residue studies, enzyme activities and biological fractionations. A glassware and media preparation room, together with a virology laboratory complete the complex.

OBJECTIVES OF THE NEW LABORATORY

The primary objective of the new fish pathology laboratory is to provide a confidential fish disease diagnostic, certification and consultative service to the fish culture industry. Diagnostic expertise will be provided for trout, salmon, catfish, and any other cultured aquatic animal where possible and utilize the most modern and efficient techniques. The laboratory will be available to do disease certification on fish, eggs, and fish products as may be required by law and to play an active role in working towards an effective yet practical approach to disease control. Consultative activities will be directed toward disease prevention and good management practices rather than treatment and control after the fact. In general, the laboratory will represent the interests and viewpoint of the private industry whenever possible to professional organizations and regulatory agencies.

Applied research studies will be undertaken to develop improved techniques and procedures of fish disease prevention, diagnosis, treatment and control. Programs currently underway include studies on vaccines, chemotherapeutics, antibiotics, techniques of rapid serological surveillance and diagnosis of disease, and the enzootic activity of infectious disease in both cultured and wild populations.

New diet formulations to meet the ever changing needs and demands of an expanding industry will continue to be tested and developed. Diet formulations suitable for trout and salmon in both fresh and salt water will be formulated to yield optimal production at a minimum of cost with available components.

The laboratory also hopes to assist in the training and instruction of individuals in the trout and salmon industry, universities, state and federal agencies by making our staff and facilities available where needed and helping to coordinate and execute informative and timely workshops and short courses pertinent to the needs of the industry. We propose to undertake these and other programs from a position of mutually rewarding cooperative exchange of ideas, facilities, and expertise with other segments of the industry and invite the opportunity to do so.

Rangen, Inc. and its Fishery Division are proud to play an active part in a growing and vital commercial fish culture industry and particularly that of the Snake River valley of Idaho. We invite you to come and see our facilities and exchange ideas on problems of mutual concern to the industry. Thank you.

SOME ASPECTS OF THE PROTEIN/ENERGY REQUIREMENTS OF SPRING CHINOOK SALMON

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ABSTRACT

The protein and fat energy requirements of spring Chinook salmon (*Oncorhynchus tshawytsha*) were investigated in two separate feeding trials. The first trial involved rations formulated to yield protein contents of 59, 52, 44, and 35% (dry wt.) each at fat levels of 26, 22, 17, and 12% (dry wt.) with moisture contents of 39%. Herring meal and round turbot served as sources of ration protein with herring oil providing added dietary fat. Cellulose was used as a bulk filler; gum guar served as a binder; vitamins were provided by the Oregon vitamin premix and 70% liquid choline chloride; and rations were stabilized with BHA and BHT. Duplicate lots of 200 fish (ave. initial wt. : 2.71 gm) held in circular tanks provided with 11.7°C water were fed twice daily, 5 days/wk., for 16 wk.

The second feeding trial evaluated rations formulated to contain protein contents of 52, 47, 42, 37, and 32% (dry wt.) each at fat levels of 28 and 19.1% (dry wt.) with moisture contents of 34%. Herring meal and autolysed and deboned herring (round)/tuna viscera (34.4 parts) served as sources of ration protein. Other formulations components were similar to those used in the first trial except the binder fraction was composed of a reduced amount of gum guar in combination with pregelatinized tapioca starch. Duplicate lots of 400 fish (ave. initial wt. : 24.86 gm) held in circular tanks provided with 5.3°C water were fed once daily, 6 days/wk., for 11 wk.

In both trials, herring meal, herring oil and cellulose were variable components; all remaining components were constant within each feeding trial.

Reduced water temperatures decreased the total feed requirement of spring Chinook salmon, but not their requirement for dietary protein concentration. The level of protein needed for a maximum growth rate (ave. gm of body protein gain/fish/day) was dependent upon fat energy supplies. The gross dietary requirement for fish protein and marine fat to yield a maximum rate of body protein gain is estimated by a series of increasing protein and decreasing fat relationships lying within the following ranges:

	Protein (% dry wt.)	Fat % (dry wt.)	
Max:	52	18	:Min
Min:	45	28	:Max
Range:	7	10	:Range

The dietary fat requirement in relation to protein content for maximum rate of body protein gain may be somewhat higher in "cold" water than "warm" water. Dietary fat was estimated to be about 1.8 times as efficient in replacing protein in rations yielding sub-maximum rates of body protein gain (80 and 60% of the maximum rate of body protein gain observed within each trial) for "large" juvenile fish in "cold" water (5.3°C) as "small" juvenile fish in "warm" water (11.7°C).

CAROTENOID DEPOSITION IN PEN-REARED SALMONIDS FED DIETS CONTAINING OIL EXTRACTS OF RED CRAB (*Pleuroncodes planipes*)

John Spinelli and Conrad Mahnken

ABSTRACT

Carotenoid concentrates were prepared by extracting comminuted whole red crab (*P. planipes*) with soya oil (Fig. 1). Using a 3-stage batch countercurrent process, concentrates containing 155 mg carotenoid per 100 grams of oil were produced.

OMP-type pellets containing 3, 6, and 9 mg carotenoids per 100 grams of ration were prepared and fed to coho salmon for 120 days. The amount of carotenoids that deposited in the flesh of the fish was related to the carotenoid content of the diet and the size of the fish. Fish fed diets containing 6 and 9 mg carotenoid per 100 grams of feed were more highly pigmented than those fed 3 mg per 100 grams, but there was only a slight difference in carotenoid content between fish fed 6 and 9 mg per 100 grams of feed. In general, after 120 days of feeding, only those fish weighing over 225 grams were considered to be good-to-excellent in color. Analyses of the fish showed that there was no correlation between their fat content and the amount of carotenoid in the flesh. Other analyses indicated that coho grown in salt water and rainbow trout grown in fresh water did not have identical flesh carotenoids when they were fed identical diets.

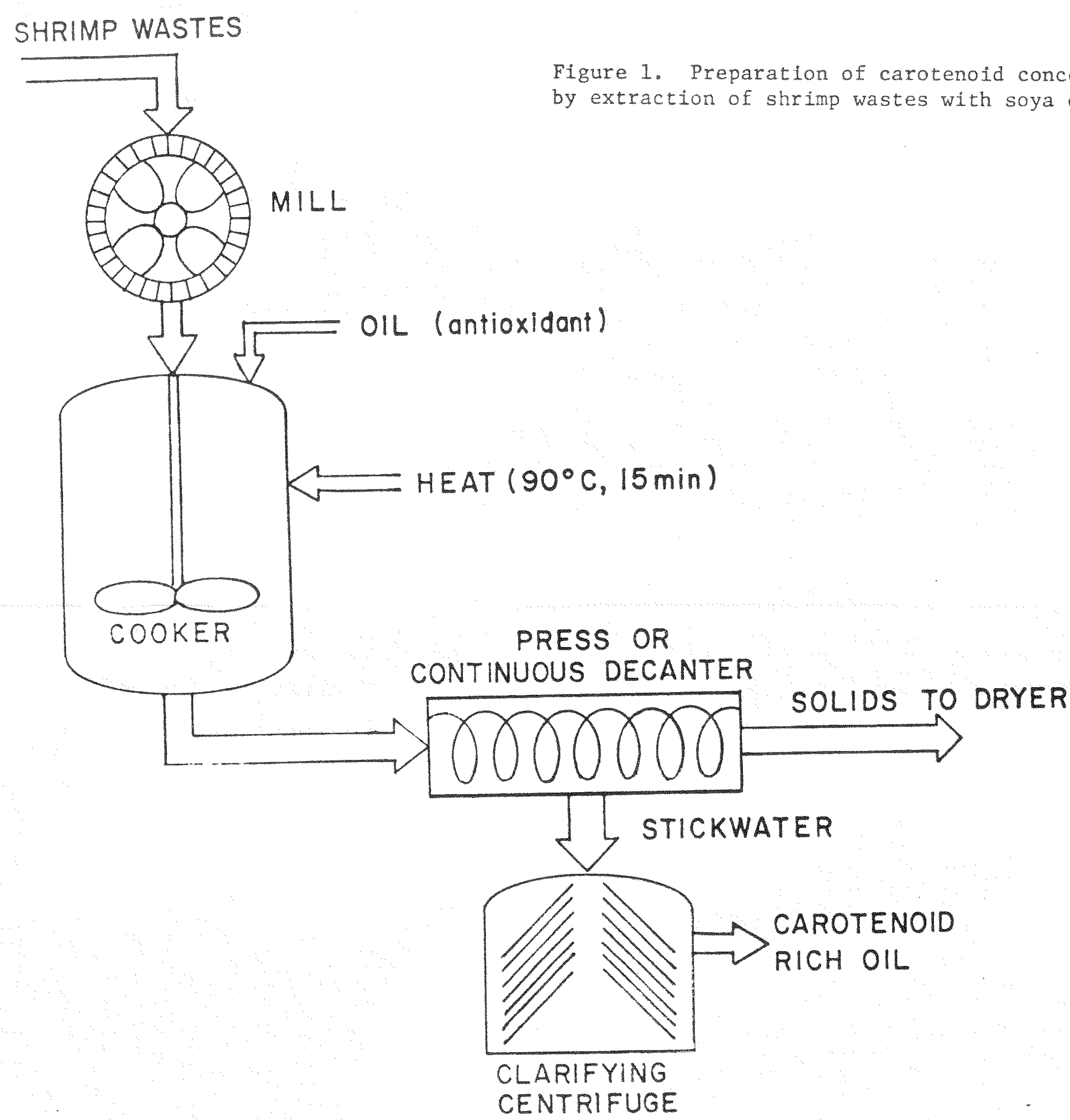

Figure 1. Preparation of carotenoid concentrates by extraction of shrimp wastes with soya oil.

EFFECTS ON GROWTH OF SALMONIDS FED DIETS CONTAINING SINGLE-CELL PROTEIN DERIVED FROM YEAST AND BACTERIA

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Single cell protein (SCP) is a generic term used to describe microcellular proteins derived from bacteria, yeasts, molds and algae. These materials are being developed for use as feed or food constituents and can be grown on a variety of carbon source substrates.

The utilization of yeast single cell proteins grown on hydrocarbons as a protein source for fish has been studied on carp, eel, and rainbow trout. In these fishes, the growth rate and feed conversion were little affected by a partial replacement of the fish meal in the diet by yeast, but complete replacement resulted in reduced growth and feed efficiency. Japanese investigators tried to improve the quality of yeast proteins by adjusting the amino acid balance with a supplement of crystalline amino acids and were able to enhance growth, but the improved diets were still inferior to fish meal based commercial diets.

Bacterial single-cell proteins have advantages over yeast SCP in having a higher protein and sulfer amino acid content, but bacterial SCP remains relatively untested as a protein source in salmonid diets. The purpose of our research was to test partial and complete replacements of both forms of SCP in salmonid diets.

METHODS

Rainbow trout (*Salmo gairdneri*) and coho salmon (*Oncorhynchus kisutch*) were fed a commercial feed formulation supplemented with various levels of single cell protein (SCP) Experiments were conducted first in four-foot diameter freshwater tanks using rainbow trout and followed by more detailed testing in saltwater pens using coho salmon (Table 1).

Table 1.--Single cell protein experiments.

Experiment	Single cell protein source	Experimental animal	Percent of SCP substituted for fish meal in OMP diet	Duration of experiment (Days)
1	*Candida* yeast	Rainbow trout	0, 25, 40	120
2	*Candida* yeast	Coho salmon	0, 25, 50, 75, 100	210
3	*Methylophilus* bacteria	Rainbow trout	0, 25, 50, 75, 100	168
4	*Methylophilus* bacteria	Coho salmon	0, 50, 100	ongoing

All fish were weighed at 30-day intervals after being anesthetized with MS 222. The experiments ranged in duration from 120-210 days. All fish were fed on a fixed ration ranging from 1-2% of their body weight per day over the experimental period. Experimental diets were the Oregon Moist Pellet (OMP) with from 0-100% of the fish meal portion replaced by either yeast or bacterial SCP. The yeast, *Candida* sp. is a product of the Daininppon Company in Japan and is grown on a substrate consisting of normal paraffins and tradenamed "Viton." The bacterial SCP (*Methylophilus methylotrophus*) was produced by Imperial Chemical Industries in Great Britain. It is tradenamed "Pruteen" and is grown on a substrate consisting of methanol, ammonia and nutrient salts.

RESULTS - YEAST SCP FEEDS

No reduction in growth or feed conversion was observed in rainbow trout fed OMP where up to 40% of the fish meal was replaced with yeast SCP. Fish meals can be replaced with up to 50% SCP in OMP fed to coho salmon without affecting growth. Higher levels of replacement cause decreased growth, with a reduction of 40% in weight gain experienced when all the fish meal is replaced by yeast SCP.

Supplementation with DL-methionine was clearly demonstrated to enhance growth at SCP replacements above 50%, but growth was still not comparable to either the control or 25% replacement diets. A reduction of 25% in weight gain was still evident at 100% replacement even with methionine supplementation.

Reduced growth is in part due to reduced protein 31% vs. 37%) in the yeast SCP diets, but the major cause is believed to be low nutritive value resulting from deficiencies in the sulpher-containing amino acids. When compared to fish meal, yeast SCP is low in cystine, isoleucine, leucine, methionine, phenylalanine, tryptophan and valine, and falls below the minimum requirement for sockeye for cystine, methionine and phenylalanine. Methionine alone was insufficient to restore full growth in diets where more than 50% of the fish meal is replaced by yeast SCP. The data are contrary to Japanese work that has shown methionine as a supplemental amino acid retarded growth at all levels tested. Japanese researchers have found that the quality of petroleum yeasts in trout feeds could be improved by supplementing cystine and arginine but growth was still inferior to fish grown on commercial fish meal based diets. It is possible that arginine, although available in sufficient quantity in petroleum yeast, is less available to salmonids and is also limiting.

RESULTS - BACTERIAL SCP FEEDS

Bacterial SCP on the other hand was successfully used as a complete replacement for fish meal in OMP. Rainbow trout showed no reduction in growth on isocaloric OMP diets where up to 100% of the fish meal was replaced with bacterial SCP. Although bacterial SCP is lower than fish meal in four essential amino acids (isoleucine, leucine, phenylalanine and valine) it falls below the dietary requirement for sockeye only in the case of phenylalanine.

PROGRESS REPORT OF VACCINATIONS AS A MEANS OF CONTROLLING DRUG RESISTANT BACTERIAL OUTBREAKS IN WASHINGTON GAME DEPARTMENT HATCHERIES

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When the causative agents of bacterial diseases develop resistance to routine chemical therapeutic compounds, alternative methods of control must be found. Usually this involves a more refined method of chemical introduction or a more effective chemical or both. The chemicals of choice for oral administration to control internal systemic bacterial are now limited to sulfa drugs and tetracycline. It appears now that the use even of these may be further threatened by federal regulation. These two drugs have geen in general use for so long that many of the bacteria once controlled by them are now partially or completely resistant to them. An example is the Enteric Redmouth bacteria in steelhead at a few of our hatcheries and rearing ponds.

This bacteria was effectively controlled with 2% sulfamethazine and/or 4% level Terramycin until about 3 years ago, when virulence seems to have increased. Terramycin at 8% level was necessary to barely control the epidemics. In 3 instances, even 8% Terramycin would not control. From one of these 3 resistant strains of ERM, bacterial cultures were taken from moribund fish, cleaned up, grown in mass, formalin or heat killed, and injected into 2,222,260 steelhead fingerlings by hyperosmotic infiltration vaccination in Spring, 1976.

The steelhead for all rearing ponds having any history of redmouth epidemics were vaccinated at the hatchery before shipment to the ponds. Two ponds were left as controls at one hatchery. In the Spring, 1976, the steelhead migrants in the Swofford Rearing Pond were infected at about the 20% level with ERM of a slightly different strain (at least the obvious pathology was not so severe) carried by frogs, tadpoles, and probably crayfish indigenous to the pond. At another hatchery, the ERM bacteria was isolated from fish, crayfish, and frogs in the water supply.

So far, (this being December 1976), there have been no outbreaks of ERM in any hatchery or rearing pond -- either in the vaccinated fish or the two control ponds.

Another bacterial outbreak that so far defies identification and treatment, occurred in the rainbow brood stock at one of our brood stations. At first, I diagnosed hemmorrhagic septicemia from all the obvious signs in the moribund fish. The older the fish, the more obvious the signs were; mortalities were significantly higher in 4, 5, and 6 year old rainbows. This broodstock was checked repeatedly for virus and were consistently found negative. However, large quantities of Lactobacillus bacteria were found in all moribund fish. Cultures were taken, grown in mass, heat killed, resuspended in saline solution, and this vaccine was injected subcutaneously into the dorsal sinus located below and in front of the dorsal fin. At spawning, we also injected some fish with Liquemycin®, injectable Terramycin, and left some for controls. The Lactobacillus vaccine apparently doesn't work; mortalities were significantly higher than in the controls. Those injected with Liquemycin® were some where in between.

We use Cornwall® automatic filling syringes for all injections, whether vaccine or antibiotic.

The same equipment was used to inject erythromycin phosphate (reconstituted powder) into all the rainbow broodstock at another station for Kidney Disease (KD). Part of the brook trout brood stock at yet another brood station were likewise injected with erythromycin phosphate for KD. Losses in the brook trout were 50% lower in the vaccinated group.

The first time we used the Cornwall® syringes was at the South Tacoma Hatchery to inject 20,000 winter-run steelhead migrants with a bivalent vibrio vaccine by intraperitoneal injection. The vaccine was prepared from 1 part 1669 vibrio isolate and 3 parts 1575 isolate, both from the Manchester aquaculture project. The adults from the 20,000 vaccinated migrants and another 20,000 unvaccinated migrants (control) will return this winter (1976-77).

AGGLUTININS TO THE REDMOUTH BACTERIUM IN THE BLOOD SERUM OF RAINBOW TROUT

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The scope of this report is to describe and explain the application of the Redmouth slide agglutination test. By this procedure, circulating anti-Redmouth bacterium agglutinins are detectable in the blood serum of trout following outbreaks of Enteric Redmouth Disease. Agglutination tests of trout serum from three consecutive years of trout farm inspections established the reliability of this technique. Then the Redmouth pathogen was found in dead or dying fish, Redmouth agglutinins were also found in the blood serum of live fish from the same lot. If Redmouth agglutinins are demonstrated in the blood serum of Rainbow Trout, this fact can be considered indirect evidence that fish from this lot harbor the Redmouth organism.

The study emphasizes a 1974 serum survey of trout from 15 different hatcheries. Redmouth agglutinins were found in trout serum from four of these hatcheries. Redmouth bacteria were isolated and identified from dead or dying trout from three of the four hatcheries.

MATERIALS AND METHODS

Blood Collection. Trout were anaesthetized in a solution containing MS-222 (Tricaine methanesulfonate) or in a MS-222 quinaldine mixture. After the trout were immobilized, blood samples were taken from a minimum of 58 fish with an 18-20 gauge hypodermic needle. The caudal method proved superior and we have continued to use this method because of convenience and dependability. The blood was expelled into 6 x 50 mm or 10 x 75 mm culture tubes. The smaller tubes were heparinized to aid in the separation of serum from the cellular constituents. The samples were covered and iced before transporting to the laboratory where they were maintained at 6°C for 24 to 72 hours; after which the sera were tested for agglutinins.

Preparation of Cell Suspension. The bacterin was prepared from a RM stock culture (72-61A) which was obtained during an outbreak of ERM at the Glenwood Hatchery in April, 1972. These cells were killed in 1% formalin v/v, incubated at 37°C for 24 hours, centrifuged at 1979 x G, washed three times in 0.9% w/v saline and standardized to a 3% transmission at 520μ in a Bausch and Lomb Spectronic 20. Initially some tests were completed using different concentrations of RM agglutinins. Merthiolate was added to the bacterin at a concentration of 1:5000 w/v.

Slide Agglutination. The serum portion of the blood was drawn from each sample with a Pasteur pipet. One drop of each serum sample was added to a ceramic ring (12 ceramic rings per slide; each ring had a diameter of 14 mm). Using a Pasteur pipet, one drop of cell suspension was added to each serum sample. After mixing, the reactants in the ceramic rings were read for agglutination after a two to three minute interval. An oblique light from a small desk lamp was used to help detect "clumping" of the bacterin suspension. One drop of bacterin was added and mixed with one drop of saline and one drop of rabbit anti-RM antiserum. These reactants served as negative and positive controls.

Isolation and Identification of RM Bacteria. Using aseptic procedures, kidney or spleen smears from available dead or dying trout were streaked onto furunculosis agar slants during hatchery inspections. Cultures from the organ smears identified as the RM bacterium were in conformance according to presumptive and confirmatory diagnostic schemes adopted by the Fish Health Section of the American Fisheries Society (1974).

RESULTS

In 1973, there were epizootics of ERM at the Kamas and Midway State Hatcheries. The mortality at Kamas from this stress-triggered disease was several thousand brood and catchable Rainbow Trout. The records showed a loss of 28% of the brood trout. Records of the catchable Rainbow Trout were not available. Kidney Disease stress and other problems contributed to the high mortality, but the presence of the RM pathogen was a big factor in the loss of these fish. At the Midway State Hatchery mortality of catchable Albino Rainbow Trout was reported as a 25-30% loss during the epizootic.

During 1973, trout sera from 12 hatcheries were checked for RM bacterium agglutinins. Kamas and Midway State Installations were the only hatcheries where RM agglutinins were demonstrated in trout serum. The same two hatcheries were exclusive in that fish from these hatcheries were the only fish in which RM bacteria were isolated and identified.

In 1974, Kamas tabulated a loss of 676 spawners (21%), 276 recruitments (8.2%), and 7,532 catchables (8%). Midway had no apparent problem with the disease after the Albino Rainbow Trout were planted. During inspections of other hatcheries in 1974, trout sera from 15 hatcheries were checked for RM bacterium agglutinins. Three commercial hatcheries and the Kamas State Hatchery had fish which were positive for humoral RM bacterium agglutinins. Redmouth bacteria were isolated and identified in three of the four hatcheries.

In 1975, fish from 13 trout farms were checked for RM bacterium agglutinins. Two commercial hatcheries had fish which were positive for humoral RM bacterium agglutinins. Redmouth bacteria were isolated and identified in one of these hatcheries and had been identified in the other hatchery the previous year.

DISCUSSION

It is evident from the data collected that RM bacterium agglutinins are present in the blood serum of Rainbow Trout following outbreaks of Enteric Redmouth. Three consecutive years of trout farm inspections demonstrated that RM bacterium agglutinins are present in trout serum from fish lots known to have had fish harboring the RM pathogen.

The coefficient of contingency and independent chi square tests showed good correlation and significance between the presence of RM agglutinins in the blood serum of surviving trout and the presence of the pathogen in moribund fish at the installations investigated during 1974 inspections.

The slide agglutination test is a quick reliable test for detecting asymptomatic fish harboring the RM pathogen. This technique could and should be used by fisheries personnel as a screening device in obtaining fish free from this disease.

ACKNOWLEDGEMENTS

Mr. Ronald Goede, Mr. Grant Collett, Mr. Earnest Dean and Mrs. Nelma Gates of the Utah Division of Wildlife Resources Fisheries Experiment Station have all helped in the completion of this report. Ron has given support and editorial comments. Grant has identified all cultures classified as the etiological agents of Enteric Redmouth. Ernie has set up hatchery inspections and Nelma has helped with laboratroy work and in typing this report.

Mr. Dennis Anderson of the Fort Morgan, Colorado Fish Disease Control Center is credited with identifying RM bacteria in trout from one of the commercial trout farms.

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HATCHERY RELEASES AND SUBSEQUENT RETURN OF SUMMER STEELHEAD ABOVE AND BELOW A DAM

by

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Foster Dam was constructed on the South Santiam River in spring 1969 by the U. S. Army Corps of Engineers for the Willamette River Basin. Hatchery-reared summer steelhead smolts were released above and below this dam for partial compensation of native winter steelhead whose spawning grounds were covered by the reservoir. Facilities were constructed to pass additional native steelhead into the South Santiam River above the reservoir but no downstream migrant facilities were built. It was assumed that smolts could pass through the dam's spillway or turbines.

Similar groups of Skamania summer steelhead were reared at South Santiam Hatchery and released above and below Foster Dam to test this assumption. Apparently the downstream migration of smolts released above Foster Dam was adversely affected and subsequent adult returns were reduced (Table 1).

Table 1. Adult returns from similar groups of hatchery summer steelhead released above and below Foster Dam.

Release year	Percent returns below Foster Dam	Percent returns above Foster Dam
1971	1.6	0.4
1972	2.1	1.8
1973	0.7	0.02
1974	0.8[1/]	0.3[1/]

[1/] These data are incomplete as they don't include returning 3-salt adults.

A possible solution to this problem was to release all hatchery smolts below Foster Dam. It was assumed the returning adults would pass through the upstream facility at Foster Dam without delay. Adults did enter Foster trap without delay but began recycling through the dam's turbines. To estimate the amount of recycling groups of adults were tagged and released in forebay. Recycled adults were monitored at Foster trap, from angler returns, and from turbine killed mortalities below the dam. Over 44% of some groups of smolts released below the dam recycled as adults. Only 14% of the adults recycled that were released in Foster Reservoir as smolts. Approximately 50% of all adults recycling were killed as they passed through the turbines.

The cause of recycling may have been due to the preciseness of the homing instinct or the recycled fish may have been attracted to the turbines by water flow. Four groups of 100 fish each were released varying distances from Foster Dam to determine the cause of recycling (Table 2). Since more adults recycled from a release 2.4 miles above the turbine entrance than from the forebay release, it appears that the preciseness of homing instinct was the major cause of recycling.

Trucking the adults above the reservoir into the South Santiam River reduced but did not eliminate recycling.

Table 2. Disposition of adult summer steelhead released at varying distances above Foster Dam.

Release location	Distance from dam (miles)	Number released	Total percent recycled
Reservoir forebay	0.0	100	41
Head of reservoir	2.4	100	52
Cascadia	10.3	100	20
Falls Creek	16.4	100	18

POTENTIAL IMPACT OF ARTIFICIAL PROPAGATION OF ANADROMOUS SALMONIDS ON WILD POPULATIONS

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ABSTRACT

Artificial propagation of anadromous salmonids can impact wild populations of salmon and trout. Initiation of stocking programs generally results in increased fishing effort which may result in overharvest of wild fish. Hatchery fish spawning in the stream can provide some compensation for reduced numbers of wild spawners; however, behavioral differences between hatchery and wild fish may cause hatchery fish to be less successful than wild fish. When hatchery fish spawn in the stream they impact the wild gene pool and may influence factors affecting growth, survival and other performances. Hatchery fish may also impact wild populations by competing with wild fish for food and space resources in stream, estuary and ocean. Discharge of hatchery effluents into streams may affect physical, chemical and biological parameters of water quality, thereby impacting growth and survival of wild fish. The extent of the potential impacts discussed above is not known and will vary between streams.

Hatchery practices can be manipulated so as to reduce the impact on wild populations. Juvenile competition in the stream can be minimized by releasing smolts at the proper time and size to insure rapid migration to sea. The genetic impact can be minimized by using native wild fish for brood stock to initiate the hatchery program and in subsequent generations, and by minimizing artificial selective pressures such as selection for early time-of-return and rapid growth rate in the hatchery environment.

EXTENDED RESIDENCE OF HATCHERY FALL CHINOOK SALMON IN ELK RIVER, OREGON

P. E. Reimers and G. L. Concannon

ABSTRACT

Juvenile fall chinook salmon, *Oncorhynchus tshawytscha* (Walbaum), in the natural population in Elk River usually migrate to the ocean in late summer or autumn at average sizes annually varying from 11 to 13 cm. The initial rearing program at Elk River Hatchery simulated this life history. However, in an attempt to increase production from the hatchery above the capacity for autumn releases, 409,092 short-term reared juveniles were released on June 25, 1971 at an average size of 8.9 cm (9.7 g). Many of the released fish did not migrate to the ocean immediately after release from the hatchery but remained in the river until autumn. Overall rate of survival to return of fish in the June release was poor (0.31%) compared to rates for fish in various autumn releases (3.28 to 5.75%). Scale analysis suggested that most returning spawners came from the largest fish at release (ave. 9.6 cm), had remained in the river the river after release, grew on the average 2.8 cm, and migrated to the ocean in autumn at 12.4 cm. The experimental release in June was considered unsuccessful because of the poor return and the potential competitive impacts of extended hatchery residents on the natural population of juveniles rearing in the river.

FIN CLIPPING YES OR NO

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Marking of fish by removal of one or more fins has long been a means of identifying groups of fish for creel census or identifying and evaluating returns of anadromous fish to the fisherman or hatchery. Other methods such as wire coded tags, branding and feeding of drugs have also been used.

There has always been the question of how much damage "by crippling" is done in removal of one or more fins from the fish. Nicola and Cordone reported in the Transactions of the American Fishery Society Vol. 102 (4) on effect of fin removal on survival and growth of Rainbow Trout in Castle Lake California. According to their report, removal of the adipose fin may reduce survival by 50%, removal of a ventral fin may reduce survival by 60% to 70%, and removal of pectoral or dorsal fins may reduce survival by as much as 70% to 80%. Other reports have found or implied varying degrees of impact of marking on fish in terms of survival or growth.

The Alsea Hatchery, located on the North Fork of the Alsea River approximately forty river miles from the Pacific Ocean, has in recent years been primarily a winter steelhead production facility. Our annual production of winter steelhead smolts is around 750,000 fish with an allocation of from 100,000 to 150,000 fish liberated in the Alsea River. The fish are usually marked in the fall when approximately 15 fish per pound. We have not had any losses at the hatchery from marking. The wire coded tag and feeding of tetracycline have both been used as a method of identification by other fish culturists but require killing of the fish to recover the mark. This is not satisfactory for our needs as we do not kill the fish when spawning, and surplus fish to our spawning program are hauled from the hatchery trap to other streams to spawn naturally; also in the last few years we have had a genetic study that requires identification of the fish before spawning.

Our marking program was not designed as a survival experiment. This report is an attempt to evaluate the results of fin clipping on fish survival over the past sixteen years.

Our research division has worked with winter steelhead at the Alsea Hatchery since the 1950's and have utilized fin clipped fish to evaluate the hatchery program throughout that time period. This report will utilize data collected as part of their effort in terms of adult returns to the fish trap by mark groups, by release sites, and by single versus multiple fin marks. Some years we planted 50% of our fish in the lower 20 miles of the river. The return to the hatchery trap of these fish was only about one third of those planted at the hatchery, however, creel census indicated their survival and return to the river was equal to fish planted in the upper river. I have used a multiplier of 3.3 to adjust the lower river returns in relation to upper river returns.

Table #1 shows the % return of planted fish over the past 16 years. The general trend has been stable and slightly upward. Modern techniques and improved diets are undoubtedly responsible for this trend.

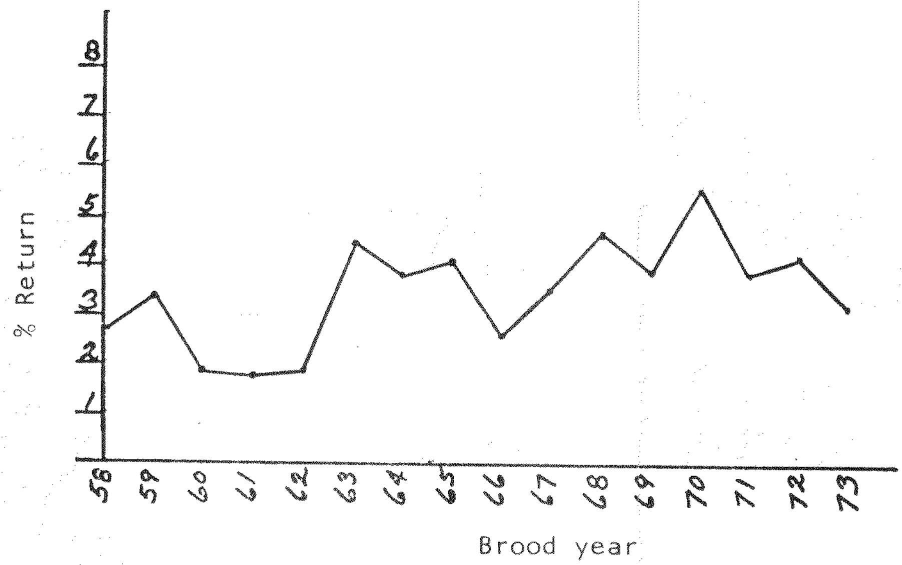

Table #1. Return of Marked Fish to Hatchery.

For the brood years 1969 through 1972, in order to reduce costs, we marked only 50% of our fish, therefore, if the removal of fins does in fact cripple a fish and influence his survival, it would seem that the ratio of unmarked to marked fish would increase considerably in the return to the hatchery trap. In contrast, our data does not indicate this.

Table #2 is the trap count showing the percent of marked fish in relation to the entire run. The 1969 through 1972 returns, when doubled to compensate for the 50% mark, show a comparable return for two of the years and apparently "exceeded" 100% in both 1970 and 1971.

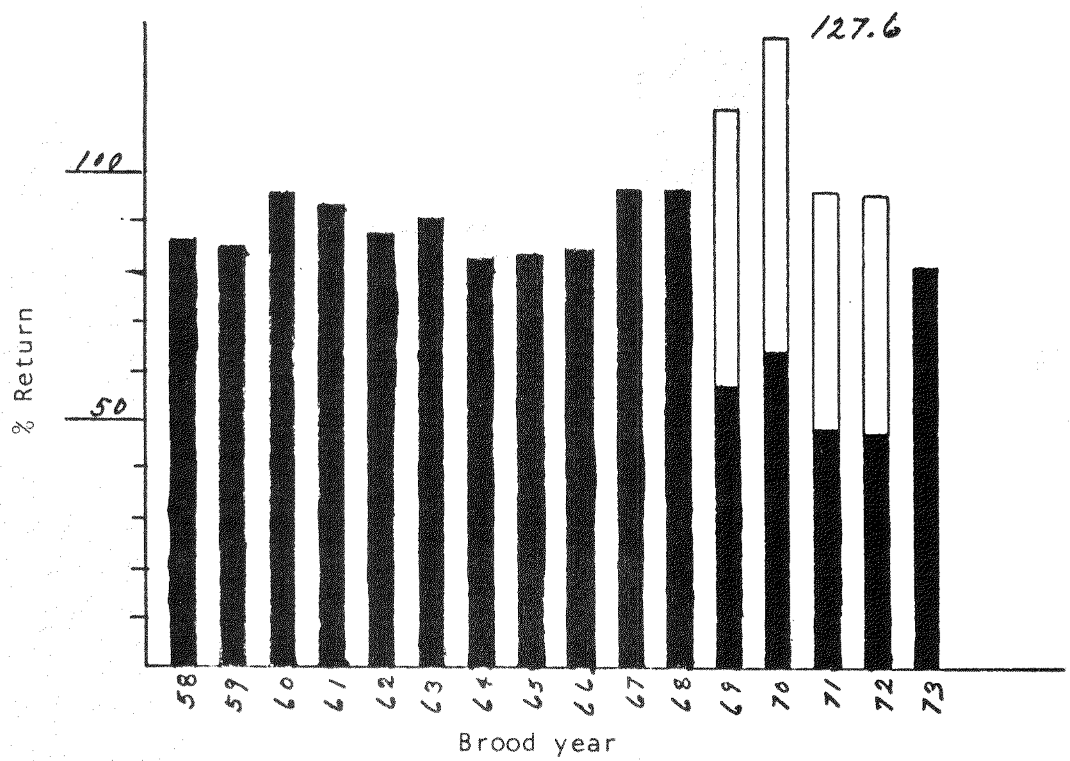

Table #2. Marked Fish in % of Total Trapped.

Chart #3 shows the return of single and multiple marks. There is apparently no significant difference between the returns. Most of these groups individually represent a release of from 30,000 to 50,000 fish with various combinations of adipose, ventral, maxillary, and pectoral marks, both multiple and single. Marked fish released from brood years 1958 through 1973 annually averaged from 100,000 to 150,000.

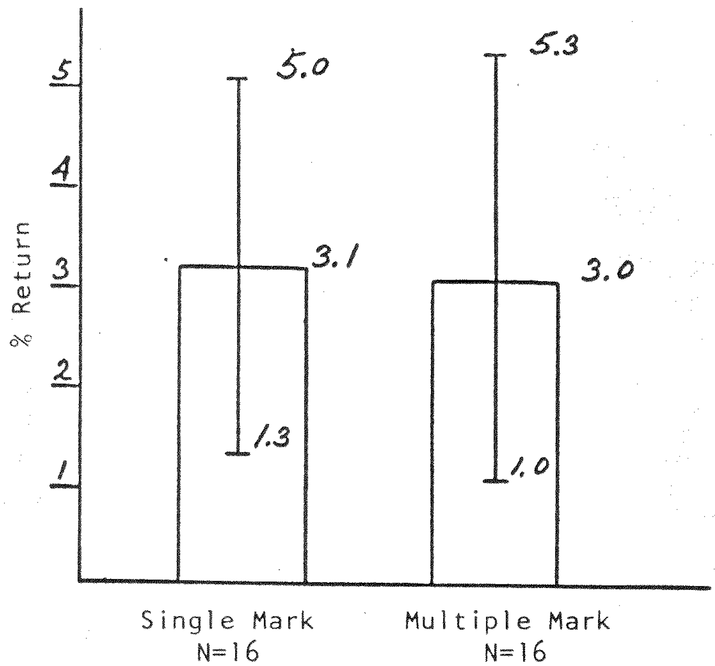

Table #3. Return of Single and Multiple Marked Fish to Hatchery.

Single Marks	% Return	Multiple Marks	% Return
LV	2.62	AD LV	2.43
"	1.66	" "	4.07
"	3.87	AD RV	1.14
"	4.45	" "	4.65
"	4.24	LV RV	3.39
"	4.06	" "	1.41
RV	2.22	" "	1.52
"	3.13	" "	1.02
"	5.04	LV LM	4.05
"	1.76	" "	2.52
AD	1.28	LV RM	3.80
"	2.81	" "	3.28
"	2.08	RV LM	4.23
LP	2.21	" "	3.82
RP	4.40	RV RM	5.30
RM	3.88	" "	2.57
		AD LV RV	4.69
		" " "	1.70
		" " "	2.45
Average - 3.1		Average - 3.0	
Range - 1.3-5.0		Range - 1.0-5.3	
N = 16		N = 19	

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Growth Response of Chinook Salmon to Herring Oil of Various Qualities

by

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ABSTRACT

Studies conducted by the Oregon Department of Fish and Wildlife indicate that the use of good quality herring oil in a diet has a marked effect on ocean survival of salmon. The present criteria of good quality herring oil used for fish food is limited to the following as found in the Oregon Moist Pellet Bid Specifications:

> "Herring oil - Stabilized with 0.3 percent BHA-BHT (1:1) - to contain less than 3 percent free fatty acids and not be alkaline reprocessed."

These specifications thus clearly define free fatty acids as the sole measurement of quality.

Confirmation of herring oil survival studies could complicate the supply logistics for herring oil if the present quality standards are found to be rigid. It should also be noted that if "good quality" herring oil is a factor in survival, processors of herring oil would be anxious to know what quality criteria are to be used in order to evaluate whether changes in production methods to meet these criteria would be economically justified.

This study was designed to determine the growth response of Chinook salmon to varying levels of free fatty acids and to explore other criteria that might be used as indices of quality.

Six samples of commercially available herring oil with varying levels of free fatty acids were incorporated into the OMP-2 formulation and mechanically pelleted in a commercial type pelletizer. Each

of the six rations were fed to duplicate tanks of 175 Chinook salmon fingerling that had been randomly distributed into 3-foot circular tanks. The tanks were artificially illuminated and located indoors.

A flow of 2 gpm of 53°F spring water was piped into each tank. The fish were fed two times daily six days a week on a timed ad lib basis until the fish reached 100 fish to the pound. Thereafter the fish were fed only once a day, six days a week. The diet feeding period was 16 weeks.

Herring oils with free fatty acid contents, calculated as oleic, ranging from 1.20 - 10.89% that had been added at the 5.95% level in the OMP-2 formulation yielded no significant affect on feed consumption, weight gain, feed conversion or mortality. Blood hematocrit levels varied significantly.

Although the varying free fatty acid levels did not significantly affect the parameters mentioned, the herring oils with free fatty acid levels of 2.47% or less yielded the best weight gains and conversions. Oils with free fatty acid levels of 3.84% or greater yielded a slightly poorer growth response.

Of the indices examined other than the free fatty acid, only the total N content of the oil yielded any, though not significant correlation, with fish weight gains, feed consumption and conversion. The blood hematocrit levels varied significantly but they did not correlate with any of the herring oil quality indices examined.

CONCLUSIONS

1. A sixteen week feeding trial using elevated levels of free fatty acid marginally affected the growth response of Chinook salmon. The results of this investigation indicate that if levels of herring oil with higher than 3% free fatty acid are used, a potential for a slight reduction in growth response exist.

2. Of the methods studied, oxidative rancidity measurements, such as provided by TBA and peroxide test, do not serve as indicators of the nutritional quality of oil in terms of growth response. Autolytic indices such as represented by total N content of the oil, and free fatty acid content appear to have some value as quality indices, with the total N content indices more closely aligned with growth response. The difficulty with total N determination in oil may be a deterrent to the use of this method.

ASCORBIC ACID DESTRUCTION IN MOIST DIETS

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ABSTRACT

Ascorbic acid (vitamin C) was determined (2,6-Dichloroindophenol Method) on various moist diets (32 - 65 percent moisture) after subjection to refrigerator and room temperatures for selected time periods. Ascorbic acid was found to be stable (no detectable loss after several months) in moist diets kept frozen at -10°C. However, when these moist diets were removed from frozen storage, their ascorbic acid content rapidly declined. The vitamin C content of moist diets stored at refrigerator temperatures (4 - 8°C) decreased 85 percent after three days, and decreased 81 percent after 11 hours at room temperatures (18 - 20°C). These losses do not include the destruction of ascorbic acid during diet preparation which may exceed 50 percent in some processes. The impact of this destruction of vitamin C in moist diets is not known, but the potential exists for a nutritional deficiency of vitamin C in salmonids fed diets which have been stored and handled under poor temperature regimens.

GROWTH RATE DIFFERENCES IN SUBPOPULATIONS OF QUINAULT SOCKEYE SALMON

Cary Feldmann and Martin Figg

INTRODUCTION

The sockeye salmon (*O. nerka*) is the most economically important species to the Quinault Indian Nation. Stocks are well below historic level, however, requiring considerable restoration effort. Aside from proper harvest management and stock assessment, artificial propagation is integral to the enhancement of the species. Since the sockeye reside naturally in Lake Quinault, the pens there were ideally located for investigation of some aspects of life history and the impact of environment on development.

Wild sockeye salmon juveniles reside in freshwater one to two years before migrating to sea. Growth and development during this period are influenced by various environmental and genetic factors. Emergence timing, for example, varies from population to population and ranges of several days to several months have been recorded. Later spawning portions of the sockeye population at Cultus Lake, B.C., respond to environmental temperature with compensatory growth enabling all fry to emerge about the same day in the spring. Exact emergence timing appears necessary for stock survival as the last spawned eggs must increase developmental rates to catch the early fish at emergence. Little is known whether such a mechanism occurs during feeding stages before migration and what role environment plays. A study began in the spring of 1975 at the Quinault Indian Nation to investigate some portions of these and other questions.

METHODS

Two stocks of native Quinault sockeye salmon separated by approximately one month in emergence timing were reared in net pens at Lake Quinault. Each stock was maintained at .33 lbs./ft.^{3} density. The stocks were fed O.M.P. in appropriately sized particles at approximately five percent body weight per day. The ration was divided equally and distributed four times daily. Mortalities were removed daily. Nets were cleaned bi-weekly to remove fouling organisms.

Average weight for each group was obtained periodically by averaging two random samples of no less than two hundred fish each. Temperature was recorded daily at the pens at a depth of ten feet below the surface of Lake Quinault. The data was analyzed by analysis of covariance with weight transformed by natural logarithms.

RESULTS AND DISCUSSION

1974 Brood Year Experiment

Temperature was recorded continuously during the rearing period. Temperature ranged from a low of 43°F (6.1°C) on March 15 to 57°F (13.9°C) on July 8. Since the two experimental stocks entered and were released from the rearing program on different dates, they received different numbers of temperature units. The early stock, Sockeye I, received 1,886 TUs in 103 days while the late stock, Sockeye II, received 1,928 TUs in 98 days. To minimize the temperature induced differences in growth rate between the two groups, however, a growth period common to both groups was selected for analysis (Table 1). During the period April 21-July 1 both groups grew rapidly with 1,000 to 1,200 percent weight gains observed.

To find whether differences in growth rate existed between the two groups over time, regression analysis was employed. The analyses produced two useful values for each of the stocks, a slope representing a log-linear growth rate and a R^2 value. The slopes of the two lines were .03097 for Sockeye I and .03884 for Sockeye II. R^2 values are representative of the amount of variance attributable to the independent variable time and each group exceeded .98 (1 is perfect). Covariance analysis drew attention to a significant difference between the slopes of the two regressions with the Sockeye II group growing faster per unit of time than Sockeye I (Table 2, Figure 1).

To evaluate the influence of temperature units on growth rate, similar analysis was conducted on the two stocks with cumulative temperature units substituted as the independent variable. The slopes of the two lines were .00137 for Sockeye I and .00175 for Sockeye II. R^2 for the early stock was a .95 and .98 was exhibited by the late stock. Covariance analysis revealed a significant difference between the two stocks with Sockeye II stock growing faster (Table 2, Figure 2).

1975 Brood Year Experiment

In the spring of 1976 a similarly constructed examination of subpopulation growth rate differences was conducted. A 67-day period between April 20 and June 26, 1976, common to the two experimental stocks Sockeye I and Sockeye II was selected for analysis. The spring of 1976 was substantially colder than in 1975 and the Sockeye I and II's received only 1,584 TUs in 115 days and 1,328 TUs in 81 days, respectively. Growth by both stocks during this period was excellent, however, with 1,000 to 1,400 percent weight increase observed.

Log-weight over time regression analysis for the two groups produced a slope of .03213 for the early group, Sockeye I, and .03817 for the late group, Sockeye II. Covariance analysis showed a significant difference between the slopes with Sockeye II again growing at a faster rate than Sockeye I (Table 2, Figure 3).

Covariance analysis was again used to measure temperature influence on growth rate. The Sockeye I group slope of .00196 was not significantly different from the .00211 slope of the Sockeye II group (Table 2, Figure 4).

Comparisons Between Years

Growth rates between years were compared by time and temperature units to find whether the subpopulation growth rates varied from year to year. It was found that the growth rates 1974 and 1975 Sockeye I were not significantly different over time. Furthermore the 1974 and 1975 Sockeye II growth rates did not differ significantly over time (Table 2). Comparisons of growth rates over temperature units showed that both 1975 groups grew at significantly faster rates per temperature unit than the 1974 groups (Figs. 5, 6, 7, 8).

Several distinct points of interest have been revealed by this study: 1) For two years the later stock (Sockeye II) grew at a significantly faster rate than the early stock (Sockeye I); 2) Growth rates in similarly timed stocks did not differ significantly from year to year; 3) The stocks responded differentially to temperature from year to year; and 4) Similarly timed stocks differed significantly in response to temperature from year to year (Table 2, 1,2,3,4,5,6,7, and 8).

While it is evident that the late stock, Sockeye II, grew at a faster rate than the early stock, Sockeye I, in both years, the reasons for the differences are not clear. Temperature regimes were substantially different in the two years as were the growth rates in response to temperature. Given an innate difference between the early and late subpopulations, it would be expected that the relative differences between the subpopulations would continue from year to year but that absolute rates would vary as a result of response to temperature regimes. In the study the temperatures differed substantially from 1975 to 1976, but neither the relative nor the absolute growth rates varied. Each subpopulation therefore adhered to a specific growth rate that acted independently of the temperature regime. It is speculated however, that the innate growth rate is restricted to a temperature range, the limits of which are undefined at the present time.

One possible explanation for the differential growth rates is size dependent growth rates. Fish of differeing sizes may grow at different rates as a function of their size. In this study the early fish, larger than the late fish on any given date, may have experienced a reduction in their growth rate as they grew larger. Aside from the closeness of fit in the R^2 values it is doubtful that a selective advantage could be derived from reduced growth rate during the oprimal temperature and feeding period of the late spring. More likely is the suggestion that the late subpopulation exhibits an innate compensatory growth rate permitting it to better utilize available food resources into growth. Growth rate differences such as this are hidden in nature as limited nutrition restricts growth potential.

Therefore, the following preliminary conclusions are proposed about the Quinault River sockeye salmon population:

1. The Quinault River sockeye salmon population has subpopulations which exhibit differential growth rates with the late stock possessing compensatory growth characteristics.

2. Relative and absolute growth rate differences remain constant from year to year.

3. Growth rates in this population are innate characteristics and act somewhat independently of temperature.

TABLE 1

Weight, Temperature and Days of Rearing of 1974 and 1975 Brood Year Quinault Sockeye Salmon (during Common Rearing Periods)

1974 Brood Year Sockeye

	Group I		Group II			
Date	Wt.	Ln Wt.	Wt.	Ln Wt.	TUs	Days
4-21	.49	-.71	.21	-1.38	0	0
5-12	.97	-.03	.39	- .94	163	21
5-22	1.6	.47	.57	- .56	550	31
5-29	1.8	.59	.81	- .21	692	38
6-6	2.5	.92	1.2	.18	872	46
6-13	2.6	.96	1.5	.4	1043	53
6-20	3.3	1.19	2.4	.88	1218	60
7-1	4.5	1.5	2.7	.99	1462	71

1975 Brood Year Sockeye

	Group I		Group II			
Date	Wt.	Ln Wt.	Wt.	Ln Wt.	TUs	Days
4-20	.39	.06	.23	- .47	0	0
5-4	.64	.55	.34	- .08	100	14
5-11	.78	.75	.52	.35	325	21
5-18	1.06	1.06			444	28
5-25	1.36	1.31	.78	.75	569	35
6-1	1.67	1.51	1.0	1.00	695	42
6-9	2.3	1.83	1.6	1.47	789	50
1-15	2.7	1.99	1.8	1.59	961	66
6-26	2.95	2.08	2.6	1.96	1185	67

TABLE 2

Covariance Analysis of 1974 and 1975 Brood Year Quinault Sockeye Growth Rates

Comparison	Brood Year	Group	R^2	Slope	F	DF
Wt. v. Days	74	I	.98	.03097X	9.338***	1,12
	74	II	.98	.03884X		
Wt. v. TUs	74	I	.95	.00137X	5.063*	1,12
	74	II	.98	.00175X		
Wt. v. Days	75	I	.98	.03213X	6.622*	1,13
	75	II	.99	.03817X		
Wt. v. TUs	75	I	.96	.00196X	2.961	1,13
	75	II	.98	.00211X		
Wt. v. Days	74	I	.99	.02904X	.030	1,21
	75	I	.98	.02873X		
	74	II	.97	.03451	.004	1,18
	75	II	.98	.03467		
Wt. v. TUs	74	I	.98	.00157X	19.307***	1,20
	75	I	.98	.00206X		
	74	II	.98	.00173X	10.565**	1,18
	75	II	.99	.00211X		

* = .05 significance level
** = .01 " "
*** = .001 " "

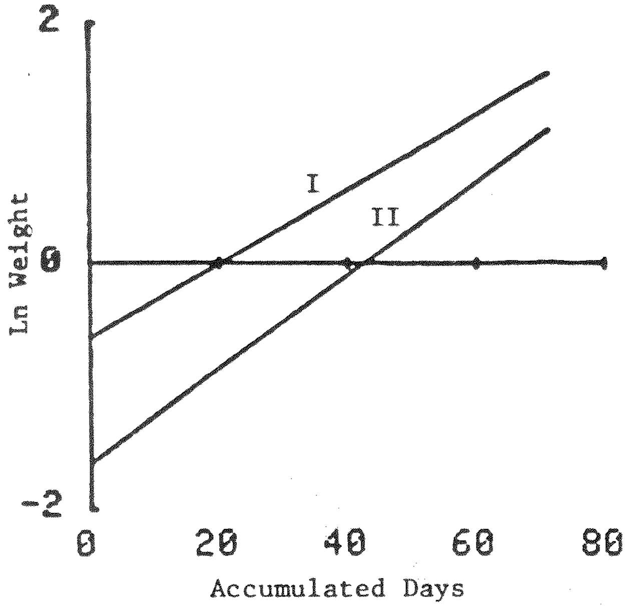

Fig. 1 1974 brood sockeye over accumulated days.

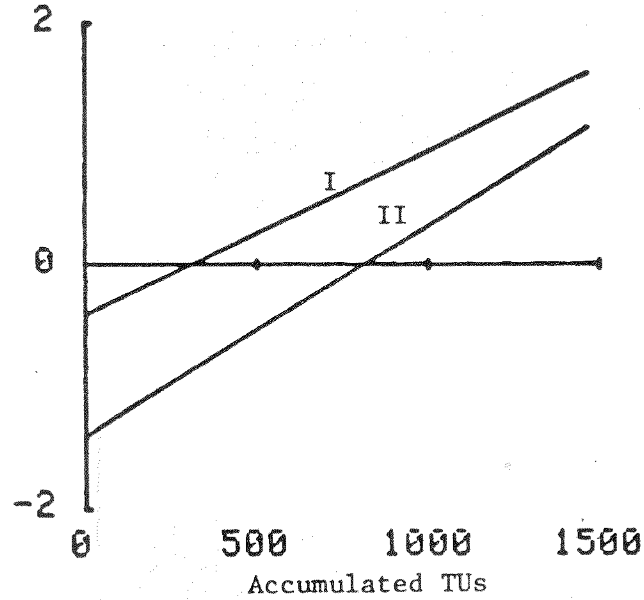

Fig. 2 1974 brood sockeye over accumulated temperature units.

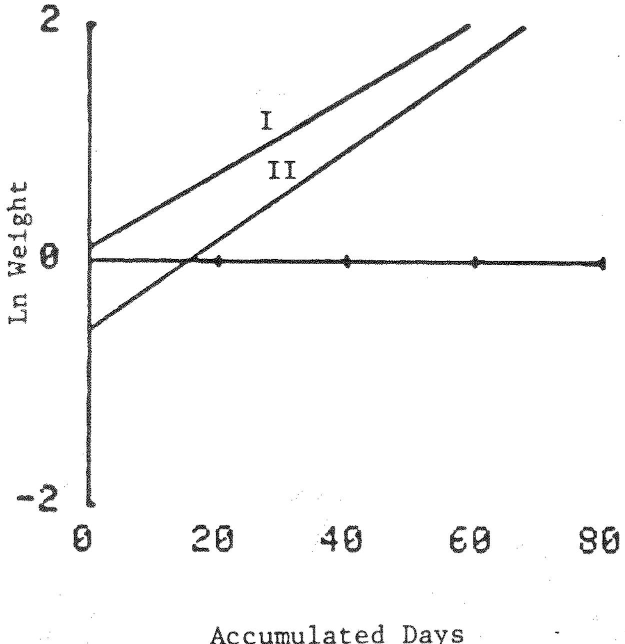

Fig. 3 1975 brood sockeye salmon over accumulated days.

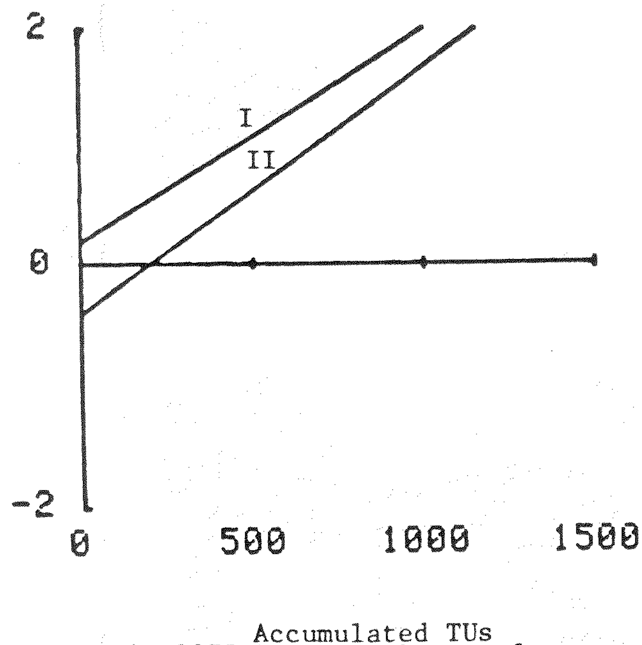

Fig. 4 1975 brood sockeye salmon over accumulated temperature units.

Figs. 1,2,3,4 Growth rate comparisons between subpopulations of Quinault River sockeye salmon by year over accumulated days or temperature units.

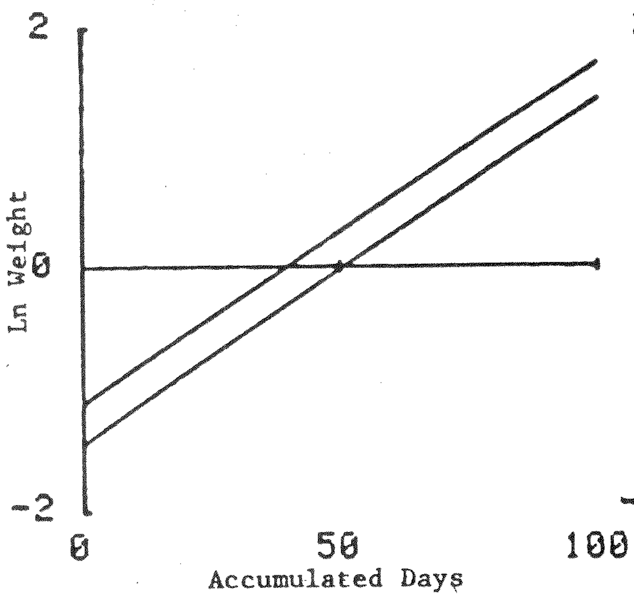

Fig. 5 Sockeye I (Early stock) over accumulated days

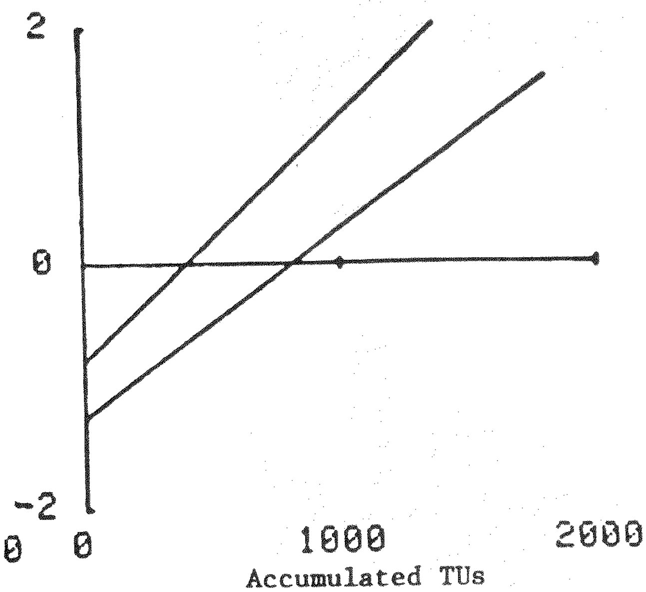

Fig. 6 Sockeye I (Early stock) over accumulated Temperature Units

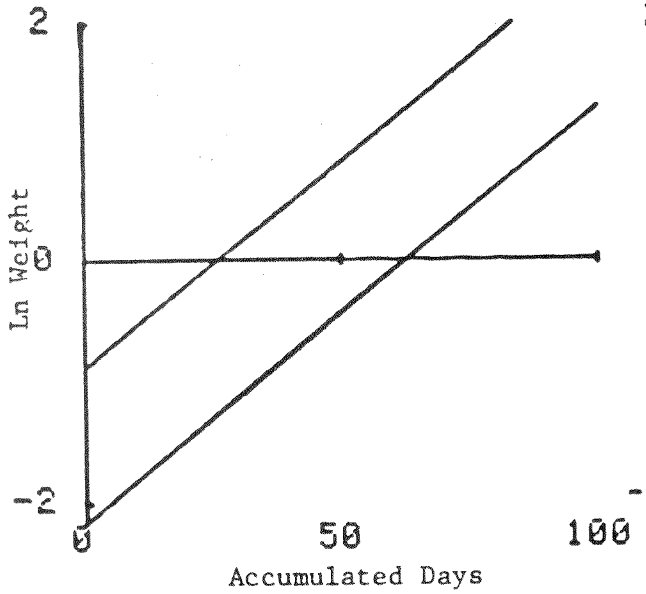

Fig. 7 Sockeye II (Late stock) over accumulated Days

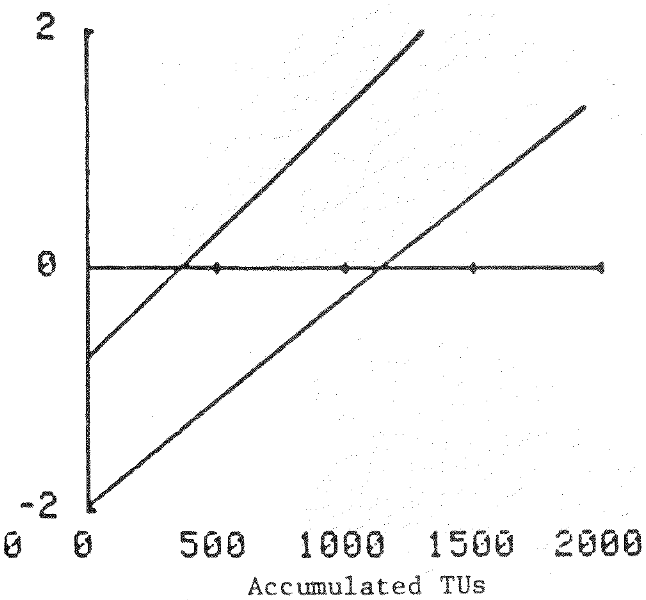

Fig. 8 Sockeye II (Late stock) over accumulated Temperature Units

Figs. 5,6,7,8 Growth rate comparisons between the 1974 and 1975 brood year Quinault sockeye salmon by subpopulation over accumulated days or temperature units

RELATIVE SURVIVAL OF TWO TRANSFERRIN PHENOTYPES IN BIG CREEK COHO SALMON: A PRELIMINARY REPORT

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INTRODUCTION

In 1973 we reported to this Conference that preliminary data obtained from Big Creek coho salmon suggested that fish with transferrin phenotype-AC survived to make a greater contribution to the catch and escapement than did transferrin phenotype-AA. Crosses were made with the parents of the 1973-brood to produce two groups of offspring: one group of AA-types and one group of AC-types. This report describes the relative yields of these groups to the 1976 fisheries and the escapement of 2 and 3-year olds.

METHODS

Blood samples were obtained from 266 mature coho salmon at Big Creek Hatchery near Astoria, Oregon in November 1973. Each fish was marked with a numbered tag before it was returned to the holding pond. The transferrin phenotype of each fish was determined by methods described in Utter et al. (1970). One week later, eggs from AA-type females were fertilized with sperm from AA and CC-type males yielding groups of AA-type and AC-type offspring, respectively.

The two groups of offspring were reared in separate facilities until the fish approximated 5-6 cm in length when they each received a coded wire tag that identified them as to their transferrin phenotype. The adipose fins were removed from 3 percent of each group and all fish were put into a single raceway to be reared until they were released in April 1975. Immediately prior to release, adipose marked fish were removed from the raceway and their coded-wire tags removed. These fish were used to estimate mortality for each group and the numbers of fish that did not receive or lost a coded-wire tag. Prior to release, each fish was marked by removing its adipose fin.

Tags from 2-year-old males (jacks) returning to Big Creek Hatchery in 1975 were removed and decoded. During 1976, tags recovered by Pacific Coast management agencies from the troll fisheries and the Columbia River gillnet fishery were accumulated along with tags from fish returning to Big Creek Hatchery in November 1976. These data then were used to calculate yield for the experimental groups.

RESULTS AND DISCUSSION

Total yield of AA-type fish was slightly greater than the AC-type fish (Table 1). Yield of AC-types as 3-year olds was greater than the AA-types. These differences appear to have resulted from the significantly different yield values for 2 and 3-year old males. AA-type males had a greater propensity to mature as 2-year-olds than did AC-type males which matured and gave a significantly higher yield value as 3-year-olds.

Table 1. Yield values (adults/smolts released) for the 1973-brood Big Creek coho salmon. Yield values for AA and AC transferrin phenotypes were compared with a test described by Sokal and Rohlf (1969, p. 607).

		Yield					
			Escapement		Total		
	Release	Fishery	Males	Females	2 year olds	3 year olds	Total
AA	34,200	0.31	0.10	0.13	0.18	0.57	0.74
AC	29,713	0.32	0.17	0.14	0.07	0.64	0.70
P(AA=AC)		0.66	0.02	0.76	<0.01	0.25	0.57

The mechanisms producing these differences are not readily apparent. Data collected from fish of other brood years at Big Creek indicate that the yield of jacks is positively correlated with size of the smolts at release. Perhaps juveniles of the AA-transferrin phenotype had greater growth rates than the AC-types and; thereby, produced a greater yield of jacks. This hypothesis has not been tested for the 1973-brood.

The results indicated that increasing the frequency of the transferrin AC-phenotype in the Big Creek coho salmon smolts will reduce the proportion of numbers released that return as jacks and increase the yield of 3-year-olds. Based on these results, the increase in yield of 3-year-olds produced by AC-type smolts would be expected to be approximately 12.3 percent greater than that produced by AA-type smolts.

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TEMPERATURE UNITS PER INCH OF GAIN PER 30 DAYS (TU/INCH GAIN) ITS SIGNIFICANCE AND USE

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In every fish growing situation whether in a hatchery or in the wild there is an absolute maximum rate of growth (100% of Metabolism) for that fish at that temperature. That maximum growth rate is determined by many things, including:

1. Species and even strain of fish
2. Diet composition and availability
3. Water temperature
4. Environmental condition
5. Magic or secret Hokus Pokus

Although fish culturists are generally locked into specific diets, species, water conditions, rearing facilities, there still remain three <u>Major</u> variables that must still be manipulated in order to approach the 100% metabolic rate; they are,

1. Feed level
2. Water requirement - Load Factor
3. Space requirement - Density Factor

The maximum integrated levels of these three are not known for all situations but must be established at each location. The concepts apply to all salmonids.

A review of the works by Robert Piper, particularly the Bozeman Information Leaflet No. 1, "A Review of Carrying Capacity Calculation for Hatchery Rearing Units", will give insight into how these variables interrelate. Briefly, however, if fish are fed below what they want, they simply will not grow at a maximum rate. If they are not given enough flowing water commensurate with the feed level, they become stressed for oxygen to metabolize the food, and if they are overcrowded, they reach a psychological point that inhibits their growth.

In experimenting with these three variables, we found that we could increase growth, as measured by inches per 30 day gain, by simply increasing the feed level beyond that traditionally prescribed. We continued increasing feed levels until conversion increased and inches/30 days stopped. Both changed at the same time. The secret was to hold the load factor and density factor very low so that they did not interfere. Later we increased the load factor and density factor separately until we learned the maximum for all three, thereby obtaining the maximum utilization of both water and space.

The results of large scale field tests at Bozeman FCDC, Hagerman NFH, and Willard NFH using rainbow, cutthroats, and cohos showed that there was much more growth potential in our situation than was being utilized by traditional methods. As an example with rainbow trout:

	Traditional Feed level Hatchery Constants	gain inches/30 days	Maximum Feed level Hatchery Constants	gain inches/30 days
Hagerman 15°	10	0.75"	22	1.5"

Obviously we are utilizing the heat available for metabolism better at a gain of 1.5''/30 day than at 0.75''. By simply dividing the inch gain into the fishes body temperature (that of the water) we come out with a measure of efficiency.

Traditional	Maximum
$\frac{15}{0.75''} = 20$ TU/in gain/30 days	$\frac{15}{1.5''} = 10$ TU/in gain/30 days

Traditionally, we had been utilizing only 50% of the metabolic potential of the fish in our situation.

At Bozeman, with almost identical conditions of feed and species, etc., but with a different temperature and feed level, we expect different maximum gains.

	Traditional Feed level Hatchery Constant	gain inches/30 days	Maximum Feed level Hatchery Constant	gain inches/30 days
Bozeman 10°C	8	0.6''	12	0.9''

Again, by dividing the temperature of the fish by the gain in length, we measure the efficiency of growth.

Traditional	Maximum
$\frac{10}{0.6''} = 18$ TU/in gain/30 days	$\frac{10}{0.9''} = 11$ TU/in gain/30 days

Traditionally, we were getting about 60% of maximum metabolism at Bozeman.

DISCUSSION

To waste this growth potential is to waste labor by requiring men to spend twice as many months to care for the fish. It also wastes full utilization of our physical facilities by cutting the maximum poundage output (for commercial growers this should be very important). But mostly, what are we doing to the fish through partial starvation by underfeeding? This is not to imply that maximum growth is always what is desired or necessary; that comes by defining what is needed.

The significance of the figure TU/in. gain/30 days (once we have established our own maximum) lets us know as good managers when we are efficiently using the heat available for metabolism. It is only one more indicator tool which we have to evaluate our success. It ranks with our other indicators of efficiency, such as:

1. Visual observation of behavior
2. Production goals
3. Conversion
4. % mortality
5. Growth rate

Each and every species we have tried has different maximum metabolic rates and produce different results with these indicators.

Although this figure is important to us in assessing our own situation, it also gives us a standard of comparing our performance with other hatcheries. As demonstrated at Hagerman and Bozeman, about 10 TU/in. gain/30 days is approaching maximum when feeding Federal open formula diet to rainbow trout with similar feed methods, etc. When other federal hatcheries do not approach this performance then the manager can search for reasons. Likewise, all fish culturists can establish base lines of performance in their situation to use for measuring future performance, locate problems, or improve performance.

HOLDING SUMMER STEELHEAD ADULTS OVER TO SPAWN SECOND YEAR

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The Oregon Department of Fish and Wildlife, (Oregon Game Commission) recognized in 1955 that a remnant run of summer steelhead existed in the Siletz River, located on Oregon's central coast. If brood fish could be captured for a fish culture program without further depleting the run, it's potential could be utilized in other coastal streams.

Efforts were made in 1956-57 with nets to collect brood fish. Very few fish were captured due to the rugged terrain and rocky river bottom. In 1958 the brood fish collecting operation was moved some 60 miles inland to the Siletz Falls, where a fish ladder was located and a trap was installed. This effort was successful. The run over the ladder was 300 in 1955, and was increased to 3,500 in 1976.

At this point a hatchery program was initiated to build up the Siletz run and establish stock in other coastal streams. The need of 300,000 eggs to produce 200,000 smolts at 6 to 7 per pound would require 100 females and 30 males.

Siletz summer steelhead brood have been taken annually in July since 1958. In 1973, trapping was expanded from June-July early trapping, to include September-October late trapping. The fish were transported some 80 miles to Roaring River Hatchery, located on the west slopes of the Cascades. Here they are held in water that has a maximum summer temperature of 56° F., in ponds 20' x 70' x 5' depth, with an under water inlet, and partial covering, until they spawned in March and April. During this holding period from June to March, 7 to 10 months, the steelhead brood received no feed. Their condition was very good at spawning time. From these brood, 200,000 smolts are released annually into four major coastal streams (see Table 1).

Table 1. Annual releases from the 1975 brood, 76 release Siletz summer steelhead.

Number Released	Release Site	Year	Projected Total Run	% Hatchery
80,000	Siletz River	1958	7,000	85%
50,000	Nestucca River	1962	5,000	90%
50,000	Wilson River	1967	2,000	90%
20,000	Kilchis River	1972	*	*

* Data not available

After the brood fish program was established, we recognized the difficulties that were initially experienced in obtaining brood for the Siletz Program, so the following experiment was initiated: We picked 24 fish from the spawned Siletz summer steelhead to hold over to spawn the second year. The fish selected were all 2/salt fish. The group was made up of 4 wild fish, (1 male; 3 females); 20 marked hatchery stocked fish, (5 males; 15 females). The 4 wild fish failed to accept feed and were lost. The 20 marked fish accepted food well. Five fish were lost from unknown causes.

After feeding the fish one year, they were checked at the same time we checked the regular group for ripeness. Our findings were that most of the test fish were over-ripe and partly spawned out. All 11 females had produced eggs and they averaged 2 lbs. heavier than the preceeding year, a gain from 8 lbs. to 10 lbs.

From 4 fish, we salvaged 6,000 eggs and from these ponded 5,480 fish and fed for 12 months. After grading, 3,280 fingerling smolts were available for stocking. Positive identification was established by fin marking the anal fin before release of the fish on May 12 at 10 to the pound, 50% smolted, one mile above the trapping site.

Two years after release 1 fish was recovered in the fishery below the trapping site, 2 fish were checked in the trap while we were selecting brood stock, and 1 fish was recovered in the fishery above the falls, making a recovery of 4 fish. The 4 fish were from a sample of 9% of the total run over the ladder, making a 1.21% return of the test fish.

In summary, this experiment indicates that where a run of fish is depleted, or a year group of brood is lost, a supplemental hatchery program can replace and establish new stocks by using adult steelhead that can be fed and spawned the second year.

RAPID RIVER HATCHERY

Progress Report

Since 1960, Idaho's hatchery contribution to the Columbia River anadromous fish runs has grown from a small beginning of 535,000 fall chinook planted in Idaho waters to a full-fledged effort to enhance these runs.

In 1964, Rapid River Hatchery was built by Idaho Power Company as part of the mitigation of fish losses caused by their dams on the Snake River. The purpose of the hatchery was to try to transplant the spring chinook salmon to the Salmon River drainage from the Snake River. Most of the operation costs are still funded by Idaho Power Company, and some costs are borne by Columbia River Project. The Niagra Springs and Pahsimeroi hatcheries were built in 1966 to relocate the Snake River steelhead runs to the Salmon River, also a part of Idaho Power Company's mitigation. About this same time, Hayden Creek Hatchery was built on the Lemhi River by the Idaho Department of Fish and Game, National Marine Fisheries Service, and the University of Idaho. Dworshak National and Kooskia National hatcheries were added in the late 1960's.

By 1973, these facilities were producing 8¼ million spring chinook, ¼ million summer chinook, and nearly 13 million steelhead. Production declined somewhat in 1974 and 1975 because of poor downstream survival of smolts through the lower Snake River and Columbia River dams and pools. Some encouraging increases occurred in 1976. I'm sure that since President Ford has signed the Lower Snake Compensation bill, that Idaho's hatchery contributions to the Columbia River anadromous fish runs will increase dramatically over the next few years.

With this background information, I would like to tell you of my main area of responsibility, Rapid River Hatchery. In 1964, the hatchery production program began with 349 adult spring chinook that were trapped at the Oxbow Dam fish facilities on the Snake River, and transported by tank trucks to Rapid River Hatchery located about 7 miles southwest of Riggins, Idaho, on the Salmon River drainage.

These adults were spawned artificially, and 887,000 eggs were taken. In 1966, we released 580,000 smolts, and in 1968 the first adults returned to Rapid River. We took 3,416 adults from the trap that year, a nearly 10:1 ratio to their parent stock. Since that time we have returned nearly 70,000 fish to the hatchery, including nearly 10,000 jacks. Our largest return ever was in 1973 when over 17,000 fish were taken from the trap. A table will be published with the proceedings of this meeting that shows year by year production and returns. In the 12 years of the hatchery existence, we have spawned over 24,000 female salmon, and have taken nearly 94 million eggs. We have released over 27 million salmon smolts that averaged 21 fish per pound, 5 inches in length, and the smolts had a total weight of nearly 1,310,000 pounds.

Rapid River Hatchery is the main source of spring chinook salmon eggs for the entire State of Idaho. This year we have supplied eggs to the Clearwater River reintroduction porgram, Sandpoint Hatchery, Mullan Hatchery, Hayden Creek Hatchery, and Mackay Hatchery.

Since 1970, we have eyed an average of 8 million eggs per year, hatched over 5 million per year, released about 3 million smolts per year, and planted out 1.5 million young of the year. We supply the fish that are released from Decker Pond near Stanley, Idaho, and for the new rearing and release pond just completed near Red River Ranger Station on the South Fork of the Clearwater drainage. We also plant young of the year fish in the Lemhi and Clearwater River drainages.

For the past three years we have been working with the National Marine Fisheries Service on a summer chinook enhancement program. Adults are trapped at Little Goose Dam and the fish are hauled to Rapid River Hatchery where they are held and spawned. The eggs are taken to the McCall Hatchery for hatching and rearing. All smolts are then planted back into the South Fork of the Salmon River, a native summer run stream.

We provide, as nearly as possible, a natural environment for our spring chinook salmon at Rapid River. Eggs are incubated in raw Rapid River water, and the fry are moved directly from the incubators to 12 concrete raceways. Each raceway measures 100 x 6 x 3 feet, and is loaded with 420,000 fry. Feeding is accomplished with nine Allen feeders per raceway.

In past years we have experienced some trouble with malnutrition as we started the fry on feed. We used Oregon Moist Pellet, Formula II, starter mash and when we attempted to move the fish to larger sizes, the fish showed a high percentage of malnourished pinheads. As high as 25% of the fish died at that point. By experimentation, the problem was best corrected by placing the fish in the raceways at 1650 temperature units, and starting them on a mixture of equal parts of starter mash and 1/32 pellets. The fry seemed to learn to "hit" the larger particles even through they couldn't always swallow them, and malnutrition losses dropped to less than 5%.

In May or early June, when the fish are about 200 per pound, they are moved to large earthen rearing ponds. A flow of 16 to 18 C.F.S. of Rapid River water is supplied to each pond. The smaller of the two ponds, 200 x 80 x 4 feet, has a rearing capacity of 1.1 million smolts. The larger pond is 400 feet long and can rear 2.3 million fish. We place the appropriate number of fish in each pond that it is capable of holding at maximum size. The fish are never handled again! This will be explained in a few minutes.

In late January, when the fish are about sixteen months old, the screens are removed from the downstream ends of the ponds, and all mercury vapor lights are shut off. This allows a six week period of normal daylight and darkness prior to the normal peak of emigration in March and April. The fish leave the ponds best when the water warms to 47 degrees, the phase of the moon is either new or full, and the daylight and darkness periods are about equal.

Some Bacterial Gill Disease occurs in the raceways each spring. Since the hyamine based compounds are highly toxic to chinook in our water, we use a 3% salt solution to treat the disease.

Kidney disease is our main problem disease at Rapid River. In 1969 we lost over one million sub-smolts to K.D., and had another bad outbreak in 1971. Snieszko and Axelrod concluded that the most likely portal of entry into the fish was through a break in the skin. Both of our serious outbreaks of K.D.

were preceeded by a fall handling, so in an attempt to reduce handling, none of the fish are ever touched with a net or seine after July 1. All fish used for pound counts are released into the river rather than back into the ponds.

Kidney Disease organisms are brought to Rapid River by returning adult fish. After our spring chinook run ends in mid-July, all native summer run chinook are allowed to go above the hatchery to spawn naturally in Rapid River. This provides a constant source of infection in the hatchery water.

Elimination of handling is not always possible, because in years of late spring runoff, our raceways sometimes fill with sand and silt from the river. Since 1973, and following research by the University of Idaho, we have treated all fish in the station with a prophylactic treatment of "Gallimycin" (Erythromycin Thiocyanate) at a 4% level for twenty-one days. The drug treatment and the changes in management have nearly eliminated K.D. as a factor in our rearing program.

Kidney Disease is also a major factor in adult holding pond mortalities. Inspections of adults at spawning time revealed an incidence of 44% infected fish in 1972. This increased to 49% in 1973. Holding pond losses had increased from 6% in 1970 to an all time high of 37% in 1973. At this point, Dr. Klontz and Kevin Amos began their K.D. study at the hatchery. Kevin reported his preliminary findings to the conference last year.

Tests in 1974 indicated that Erythromycin Phosphate might be effective and easy to apply. In 1975, two out of every three fish were injected with the drug as they were taken from the trap. Results were considered excellent, as only 4% of the adults that received the injections had K.D. at spawning time, and prespawning mortality dropped to less than 7%. Progeny of the drug injected adults were kept separated from progeny of uninjected fish, and no congenital defects that could be related to the drug usage were found.

In 1976, the earliest arriving fish received an injection at the trap, and another about a month later in the ponds. Of this group, only 5% died before they could be spawned. We placed one hundred uninjected fish from the middle of the run into a second pond, and 44% of them died prior to spawning, and all the mortalities had gross K.D. lesions. All of the remaining fish were given a single injection as they were taken from the trap. These fish died at a rate of 14% and 20% of the dead fish had K.D. The indication is that, at least for Rapid River Hatchery, one shot of Erythromycin Phosphate is good, two injections are better, and with no injections the disease would soon be out of control.

As a further precaution, all eggs from females that had Kidney Disease lesions were water hardened in a 1 ppm solution of the Erythromycin Phosphate. All eggs that were water hardened with the drug were kept separate from the untreated eggs, and so far, have an identical eye-up and hatch rate as the untreated eggs. The only apparent difference was the Ery-phos treated eggs did not fungus as readily as untreated eggs.

Ceratomyxa and Columnaris were confirmed in both the spring and summer chinook runs this year. The University of Idaho Kidney Disease study team, Dr. Klontz and Travis Coley, have a proposal pending to include these diseases in the study next year.

Rapid River fish have been used to pilot several new approaches to downstream problems. We have cooperated with the National Marine Fisheries people on their downstream survival and timing studies, and the homing imprint and transportation studies that have led to the current effort to truck smolts around the Lower Snake and Columbia River dams and pools. We have also participated in many branding and tagging studies. Al Marati of Oregon Department of Fish and Wildlife, has had over eight hundred tags that he applied to adult salmon at Bonneville Dam for his power peaking study returned to him from Rapid River, from the 1974 and 1975 migrations. We have also worked with Roy Wahle of National Marine Fisheries Service, on his economic evaluation studies.

Let me quote to you from the report prepared by Mr. Marati in 1975. "Rapid River Hatchery located on the Little Salmon River near Riggins, Idaho, is the single most important spring chinook hatchery in the entire Columbia River drainage. Sixty-one per cent of all tag recoveries in the Salmon River drainage came from Rapid River Hatchery." Fish produced at Rapid River Hatchery now make up 7% of the Bonneville Dam count, and 40% of the Lower Granite Dam count of spring chinook. This does not take into consideration the Rapid River contribution of eggs, fingerling, and smolts planted in other waters, but only what return to the hatchery. When the Rapid River fish are deducted from the total run over Lower Granite Dam, it's easy to see that Idaho's wild runs of spring chinook are in real trouble. Next year, we expect that Rapid River's percentage of the total run could be even higher than this year.

We are not as numerous or long-established as downriver anadromous hatcheries, but we are working hard, so that some day soon the sportsmen of Idaho will be able to take a fair share of the harvest of these great fish. Thank you.

Returns of spring chinook salmon to Rapid River Hatchery and production of smolts

Brood year	Number of eggs per female	Number of eggs taken	Number of smolts released	Year released	Aver. length at release mm	(in.)	Number per kg. at release	(lb.)	Number of kg. released	(lbs.)
1964	4,874	887,000	580,000	1966	121	(4.8)	49.8	(22.6)	11,639	(25,664)
1965	4,541	604,000	480,000	1967	117	(4.6)	51.1	(23.2)	9,383	(20,690)
1966	3,697	2,296,000	1,460,000	1968	116	(4.6)	55.1	(25.0)	26,484	(58,400)
1967	3,537	2,055,000	900,000	1969	118	(4.6)	52.9	(24.0)	17,006	(37,500)
1968	3,671	6,640,000	3,172,000	1970	127	(5.0)	44.1	(20.0)	71,925	(158,600)
1969	3,655	5,171,697	2,718,720	1971	123	(4.8)	46.3	(21.0)	58,711	(129,463
1970	4,136	14,560,280	2,809,200	1972	128	(5.0)	42.8	(19.4)	56,747	(125,132)
1971	3,507	6,038,785	2,908,425	1973	129	(5.1)	37.5	(17.0)	79,358	(174,989) 4/
1972	3,941	15,072,604	2,707,917	1974	128	(5.0)	38.6	(17.5)	69,005	(152,162)
1973	3,912	13,510,465	3,373,700	1975	137	(5.4)	32.6	(14.8)	105,987	(233,708) 4/
1974	3,924	6,890,186	3,564,640	1976	125	(4.9)	40.6	(18.4)	87,638	(193,206) 4/
1975	3,894	8,503,606	3,225,830 5/	1977						
1976	3,762	11,492,878								
Total		93,722,501	27,404,679						593,883	(1,309,514)
Average	3,927	7,209,423	2,491,334		124	(4.9)	44.7	(20.3)	53,989	(119,047)

4/ Includes smolts planted in the southfork of the Clearwater River.

5/ On hand October 1, 1976, for release in the spring of 1977. They are not included in the total number of smolts released.

Returns of spring chinook salmon to Rapid River Hatchery, percentage of return, survival to spawning, and enumeration of eggs, fry, and smolts produced, with size and poundage.

Brood year	Snake R. return (adults)	Rapid R. return (adults)	Percent adults returned to Smolts released	Rapid R. return (Jacks)	Percent Jacks returned to Smolts released	Total percent returned	Mortality Prior to spawning	Number of females spawned
1964	349						16%	182
1965	408						21%	133
1966	1,511						18%	621
1967	974			1,039	0.19%		11%	581
1968	351	3,416 1/	0.59%	740	0.15%	0.78%	2%	1,809
1969	672	2,817 1/	0.56%	1,043	0.15%	0.71%	8%	1,415
1970		6,470	0.44%	887	0.10%	0.58%	10% 2/	3,520
1971		3,357	0.37%	1,754	0.06%	0.47%	19% 2/	1,722
1972		12,310 3/	0.39%	943	0.04%	0.44%	15% 2/	3,825
1973		17,054 3/	0.54%	286	0.001%	0.57%	37% 2/	3,454
1974		3,457	0.12%	538	0.002%	0.14%	27% 2/	1,756
1975		4,428	0.15%	573	0.002%	0.17%	7% 2/	2,184
1976		6,342	0.23%	1,741	0.052%	0.26%	15% 2/	3,055
Total	4,265	59,651		9,544				24,257
Average	711	6,628	0.38%	954	0.075%	0.46%	16%	1,866

1/ Excess adults over 2,700 holding capacity at Rapid River hauled to Stolle Meadows and McCall Hatchery.

2/ Mortality to 1970 were total to first day of spawning, after 1970 were total thru spawning.

3/ Excess over 8,000 holding capacity at Rapid River were hauled to Little Salmon River, Salmon River, and Clearwater River.

SUMMARY OF 1976 RAPID RIVER SPRING CHINOOK DATA

Prespawning Mortalities:

- Double injected fish - 5.02% of which 3.9% had gross Kidney Disease lesions.
- Single injected fish - 32.6% of which 36.0% had gross Kidney Disease lesions.
- Uninjected - 44.0% of which 100% had gross Kidney Disease lesions.

Incidence of gross Kidney Disease lesions at spawning:

- Double injected fish - 2.7%
- Single injected fish - 7.5%
- Uninjected fish - 14.9%

DWORSHAK NATIONAL FISH HATCHERY
PROGRESS REPORT

Wayne H. Olson, Hatchery Manager
Joe C. Lientz, Area Hatchery Biologist

Objectives:

1. Dowrshak anticipates 8 million steelhead eggs this year. From this total 4.5 million eyed eggs are needed to assure an adequate survival of fingerlings through the summer season. Eyed eggs can be made available to the State of Idaho if numbers exceed the anticipated total or if survival to the eyed stage is higher than normal.

2. Production of a high quality steelhead smolt for release at 200-mm. size, 2,000,000 (1 yr.) at 335,000 lbs. and 400,000 (2 yr.) at 80,000 lbs. Above all a quality steelhead capable of returning to Dworshak.

3. To establish a strong communications network and working relationship with others interested in reuse systems, steelhead production and fish health.

Present Outlook:

As of December 1, Dworshak is carrying an approximate total of:

415,000 yearlings (2 yr.) at 30,000 lbs.
2,050,000 fingerlings (1 yr.) at 40,000 lbs.
106,000 rainbow at 8,000 lbs.

The 2.4 million steelhead smolts will be released beginning April 20 - May 2 this year.

Water Reuse Systems:

To date, several experiments have been conducted or are being conducted to find more efficient methods of operating the filter systems at Dworshak in order to produce a better quality steelhead. Some of these experiments are:

1. An air backwash system for cleaning the filter beds.
Ten filter beds were equipped with 3 miles of piping and 1,600 fittings to design an air backwash system to clean the filter media.

2. Preactivation of filter beds.
For the first time, System II and III biofilters were activated by "seeding" to establish a sufficient population of nitrifying bacteria. The preactivation was accomplished by circulating water heated to 80°F with ammonium hydroxide added through the filter beds.

3. Mineral enrichment of the water supply.
The water supply for the Dworshak hatchery is extremely low in minerals and has been compared to distilled water. Efforts have been

made to increase hardness and supply the needed minerals. Through the mineral salt additions a healthier fry and smolt may be produced. The additional chloride may provide some protection to nitrite toxicity in reuse systems.

4. <u>Removal of supersaturated nitrogen gas</u>.
   A degasser, patterned after a system developed and used in Sweden, was installed in the incubator room. Nitrogen gas levels were reduced to 100.5-102 percent during operation.

5. <u>Other tests and pilot studies planned</u>.
   a. Treatment and treatment levels for reuse systems.
   b. New media for filter beds and sand filters.
   c. More emphasis on loadings and density levels for reuse systems.
   d. Environmental and physiological parameters associated with nitrite toxicity. Emphasis will be on steelhead trout production in reuse hatcheries.