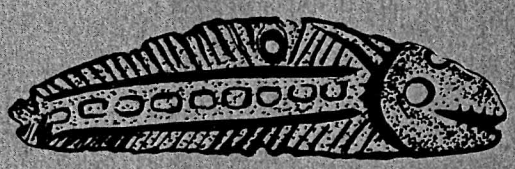
Harry WAGner



Northwest Fish Culture Conference

Vancouver Washington Dec 5-7, 1978

PROCEEDINGS

of the

Twenty-ninth Annual

NORTHWEST FISH CULTURE CONFERENCE

December 5-7, 1978
Vancouver, Washington

Chairman
David A. Leith
U.S. Fish and Wildlife Service

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 uncompleted studies or projects. THESE INFORMAL RECORDS ARE NOT TO BE INTERPRETED OR QUOTED AS A PUBLICATION.

PREFACE

The Twenty-Ninth Annual Northwest Fish Culture Conference was held at the Inn at the Quay, Vancouver, Washington on December 5-7, 1978.

There were over 320 people in attendance from Alaska, Arizona, Arkansas, California, Colorado, Idaho, Massachusetts, Montana, Maine, Nevada, New Hampshire, Oregon, Utah, Washington, West Virginia, British Columbia, Newfoundland, Saskatchewan, Bangladesh, Egypt, Ghana, Indonesia, Nepal, Nigeria, Philippines, Sri Lanka, Sweden, and Thailand.

I sincerely thank all who participated for helping to insure a successful conference. I particularly appreciate the efforts of the session chairmen Marvin Smith, Steve Leek, Wayne Olson, Gerald Bouck, Joe Lientz, Jack McIntyre, John Miller, and Laurie Fowler who kept the program on track and running smoothly.

Very special thanks are due Laurie Fowler, Sharon Peek, Trudi Powell, Joe Banks, and Richard Anderson for exceptionally fine jobs in handling mailings, program preparation, typing, lodging and facilities arrangements, audio-visual aids, refreshments, and all the many details that go into making a good meeting.

Included herein are complete reports, summaries, or abstracts of papers submitted by speakers for inclusion in the proceedings. Publishing costs were provided for by registration fees collected at the conference.

The 1979 conference will be hosted by the Oregon Department of Fish and Wildlife. The Washington Department of Fisheries "volunteered" to host the 1980 meeting.

David A. Leith

TABLE OF CONTENTS

GENERAL

WATER QUALITY

GENETICS

INCUBATION

PHYSIOLOGY

NUTRITION

DISEASE

General

RELATIONSHIP BETWEEN AQUACULTURAL DEVELOPMENT AND INSTITUTIONAL CHANGE

by

Jerry E. Clark*

ABSTRACT

Increasingly, economists are turning their attention to the role institutions and institutional change have on the "economics" of business enterprises. This is probably most true when one looks at the work of marine economists struggling with the concepts of common property resources, limited entry, and joint ventures. The purpose of this presentation is to examine this interest in institutions by economists, defend their interest, and argue for an even more intimate relationship between "economic" and "political or institutional" research.

Specifically, it will be argued that institutions are human conventions which are constructed to meet or satisfy human wants. One such want or desire is economic gain or protection from loss. It therefore may bear fruit to examine the role economics plays in the development of institutions. In other words, economists may find it advantageous to sometimes treat institutions as endogenous variables in their models. This is quite different than the more traditional exogenous approach, where the sole attention paid is in how they affect economic variables.

*This work is being carried out under a research grant sponsored by the Oregon State University Sea Grant College Program, supported by NOAA, Office of Sea Grant, Department of Commerce, under contract #04-8-M01-144. The author is a Research Assistant with the Department of Agricultural and Resource Economics, Oregon State University.

Finally, brief reference will be made to specific kinds of research which might be undertaken with institutions and institutional change as endogenous factors. An example would be research to examine the potential winners and losers in a proposed institutional change, estimate their likely gains or losses, and predict or review their subsequent political activity with respect to the institutional change.

SALMON RANCHING IN OREGON

by

Edwin Cummings
Oregon Department of Fish and Wildlife

Private salmon hatcheries were built on the Rogue and Clackamas rivers in the 1870's. By 1900 the government had taken over operation of all salmon hatcheries in the state. As hatchery diets and rearing techniques improved in recent years, private citizens again became interested in propagating salmon. Research by Oregon State University, at Whiskey Creek with inexpensive streamside incubators, increased public interest. At private citizen request, the 1971 legislature enacted laws to allow private chum salmon hatcheries in Oregon. These laws were amended in 1973 to include coho and chinook salmon. The Oregon Department of Fish and Wildlife is charged with administering these laws and has passed administrative rules to further define the laws and regulate private hatchery matters.

Requirements for obtaining a permit may include submission of a rather extensive application depending on how large a project is proposed. A $100 application fee is required for each species to be released. When applications are received by the Department of Fish and Wildlife, they are reviewed for completeness and compliance with restrictions as to site location, species, etc. Copies are provided to our district biologist, regional headquarters, Environmental Section, Fiscal Section, Research

Section, Fish Division staff, and to the applicable county planning agency for comment. Each examines the application as it applies to their respective area of expertise. For instance, the district biologist looks at the proposed site with the applicant and provides comments relative to that site and local management implications. All comments are collected for input to an overall review or evaluation of the proposal. After review by the Department staff a hearing is held either before a hearings officer or the Fish and Wildlife Commission to accommodate input by interested parties, the applicant, and staff. Requirements of Oregon Statutes and Administrative Rules guide this procedure. If the hearing is conducted by a hearings officer, a finding of fact and recommendation is prepared for consideration by the Commission which must make the final decision for the agency. This decision can be appealed to the courts by any group accepted as a party in the hearing.

Items considered in the evaluation are the financial and technical ability of the applicant to accomplish his proposal, the effects of his proposed program on public fish runs, and management requirements in the area of operation and elsewhere. Compliance of the proposal with statewide planning goals and coastal guidelines are also considered.

Salmon released by private operators are public property and are subject to public sport and commercial fisheries until they return to the operator's trap. Trap operators must have individual commercial fishing licenses and the company must have a wholesale fish dealer's license. A poundage tax must be paid on all salmon harvested. Hatchery-reared fish must be marked insofar as practical before release to allow separation from wild fish when they return to the trap. Nonpermit species and wild fish must be released upstream or upbay for natural spawning. Facilities

are inspected by ODFW to assure compliance with the law and permit requirements. The Department is required by law to charge for inspections or services provided. Permits can be altered or withdrawn, for cause, through due process by the Commission if major problems threaten natural runs. The Department must be notified of changes in key personnel, financing, or major changes in operation.

Fish reared in private salmon hatcheries are considered part of the state salmon production program. The species and numbers to be released from a private salmon hatchery are controlled by the Department of Fish and Wildlife. Separate release permits are required for each release of fish.

Fish from private hatcheries contribute to the ocean fisheries. Adults returning to the bay provide a sports fishery and allow the state some management alternatives for smolts from public hatcheries.

Permits have been authorized for 11 chum, 5 chinook, and 4 coho operations at a total of 13 release-recapture sites located from the Columbia Estuary to south of the Rogue River. Since 1971, seven operators have released about 4 million chum. Chinook and coho operators have released a total of about 3 million chinook and 16.5 million coho. Hatching facilities vary from the streamside chum incubator to the more usual freshwa incubation facilities with Heath incubators. Rearing is handled in tanks or ponds or saltwater facilities.

Permits now authorize production of 37.8 million coho, 42.0 million chinook, and 100.5 million chum. However, the shortage of eggs has been a limiting factor in private salmon hatchery development. The Department of Fish and Wildlife attempts to make surplus eggs available to private

salmon operators and can increase the number of eggs available if given enough lead time. Eggs are provided in limited numbers as seed stock rather than in production lots. However, in the last 2 years there have not been any surplus chum eggs available within Oregon and both coho and chinook eggs have been in short supply. We have authorized import of eggs for release in selected estuaries to test the return rates of imports, their contribution to the fisheries, and to evaluate release strategies.

Oregon law also provides for an annual wildlife propagation license which allows rearing and sale of game fish but not release-capture. When used in combination with the private salmon hatchery permit, this license allows an integrated system of initial rearing at an inland hatchery, then transfer for final rearing and release at a coastal release point. This system is being used by three companies in Oregon. Oregon operators are also using contract facilities in Washington state to handle some of their freshwater rearing requirements.

Two operators have installed isolation facilities to allow transfer of green eggs prior to the completion of virus examinations. Most of the companies are using OSU's diagnostic service. One company has hired its own pathologist but continues to use the OSU lab for necessary verification.

Oregon law requires transportation permits, import permits (with disease exam certification) for live fish or eggs. Release permits are also required for each separate release of fish. Total release by species can be limited by the overall operation permit.

Enabling legislation for private salmon hatchery operation is too recent to really be able to tell much about how successful these operators will be. Initial plants of salmon were relatively small and do not give a true picture of returns to be expected from large-scale production. Larger releases and future returns will provide a better indication of what can be expected in the area of profit-loss.

Operators continue to be optimistic about future success. The state continues to be cautious in making predictions. We, with help from private operators, are examining the effects of large relases on estuaries and evaluating return and contribution rates from both government and private facilities. Juveniles are marked and recovered from the bays to determine stay time. Tagged fish are recovered in the ocean, bays and at traps to determine contribution, and return rates of selected stocks.

Obviously there is a limit for expansion of ocean salmon ranching. However, several state, federal agencies, and counties continue to expand their hatchery programs. Results of current development and evaluation will dictate the limitations which must be imposed on future development of private and public facilities. In the meantime, expansion of private hatcheries will be limited by the number of permits issued, limits on numbers of fish released by a permittee, generally a poor availability of suitable sites for operations, and zoning or construction restrictions from state and local planning groups.

In spite of many limitations and the comparatively short development time since 1971, private salmon hatcheries are beginning to be a major factor in production of salmon within the state. They will, as do our state hatcheries, contribute salmon to existing ocean fisheries from California to Alaska.

THE PACIFIC SALMON HATCHERY PROGRAM OF THE U.S.S.R.

by

Lauren R. Donaldson
College of Fisheries
University of Washington

At the invitation of the U.S.S.R. salmon biologists from Canada, Japan, U.S.A. and U.S.S.R. spent the first two weeks of October attending the First International Conference on Biology of the Pacific Salmon. The meetings were held at South Sakhalinsk, Sakhalin Island, a large island off the eastern coast of Siberia.

During the conference fifty-four (54) papers were presented on many aspects of salmon biology. In addition to the formal part of the program, discussion groups met for more informal exchange of research data, and field trips to research stations, industrial plants, fish markets and hatcheries were an informative part of the program.

The Russian salmon populations were historically very large. Over-fishing resulted in a very drastic reduction of some populations, especially in the Amur River. Reduction in the quota to the Japanese fishery and a much improved and expanded hatchery program on Sakhalin Island have increased the Soviet catch and the escapement to the hatcheries.

The 1977 Soviet salmon catch was reported as 140,000 M.T., double the 1976 catch. The 1978 catch, from preliminary figures, will again show an increase. For comparison, the U.S. salmon catch for 1977 was 152,545 M.T., with 82% or 124,855 M.T. from Alaska.

The Soviets operate 16 hatcheries on Sakhalin Island and 2 in the Kuril Islands (see Figure 1). These hatcheries in 1977 released a total of 844 million pink and chum salmon fry. Of this total 397.5 million were pinks, 288 million chums, and 3 stations released a combined total of 158.5 million pinks and chums.

Most of the hatcheries were built by the Japanese and were acquired by the Soviets following the takeover of the islands at the end of World War II. They use ground water with a low head through the very long shallow raceway incubation channels.

The Lesnoy pink salmon hatchery on the east coast of the island was visited October 7, 1978. The egg take was over for the season with 36 million eggs in the hatchery. Eggs are taken during late August and early September when the stream temperature is 13° C.; it was 8.8° at the time of our visit. During the winter the water temperature drops to 0.1 to 0.2° C. Fry are released, unfed, during May and June when the temperature of the sea and food level is optimum.

The hatchery channels are stocked with eggs at the rate of 2,200 eggs per tray, with 35,000 eggs per square meter of gravel. Water flow is at the rate of 1 liter per second per million eggs.

Each year one million fry are adipose marked at the Lesnoy hatchery. The recovery of marks showed a high of 10.4 percent for catch and escapement. The average pink catch returns to the hatcheries in U.S.S.R. is about 2.5 percent.

A definite effort is made to prevent problems by keeping every part of the hatchery clean. The gravel in the channels is chlorinated before stocking with eggs. Formalin and malachite green treatments are used each week.

We were told the total incubation mortality at Lesnoy was 2.5 percent.

The Kalinsky chum hatchery on the west coast, Sea of Japan, side of the island was visited on October 9, 1978. The chum run in this small stream was started in 1951 with 4 million eggs from other rivers. By 1976 the run had increased to 245,000 returning fish. The 1978 run was about half over at the time of our visit; 400,000 fish had returned and 105 million eggs had been harvested. By mid-November the returns had exceeded 800,000 fish, or about 1 percent of the release.

The water source for this hatchery is mostly from a seepage source. Temperature is 6-7° C. in September and drops to 0.5 by February.

The fry start feeding as early as February and are fed a diet of pollack roe until their release in May and June at a weight of 0.8-0.9 grams and the sea temperature has increased to 3+° C.

The salmon hatchery program for the Pacific zone of the U.S.S.R. is scheduled to increase by 0.5 billion each 5 years to a total release of 3 billion by the year 2000.

A number of programs of the U.S.S.R. are of interest to fish culturists; a few might be listed.

Lake fertilization programs on Sakhalin Island and on Kamchatka have increased nutrient levels in lakes from five to ten-fold the natural levels. This technique is being applied to sockeye producing lakes.

Geothermal water, waste heat from thermoelectric power plants and atomic power stations are being used for rearing salmon to accelerate growth. The Kamchatka region, especially, has vast amounts of geothermal water that are scheduled for salmon rearing. It is projected to produce, by the end of this century, 23,000 to 25,000 metric tons of salmon, 6 to 8% of the total salmon production, with heated water sources.

The Soviets started a program in 1956 to introduce pink salmon into the Murmansk region. To date a total of 104 million eyed eggs have been transferred from the Pacific to the Atlantic. The odd year runs are now well established and produce 190-200,000 fish annually. The even year transplants, on the other hand, have not yet reached a return level that is self sustaining. The difference in the survival of the even and odd year transplants introduces many areas of interest to biologists.

The Soviets believe they can increase the salmon populations to the historical level if they can reach an agreement with Japan to eliminate the very destructive ocean net fishery.

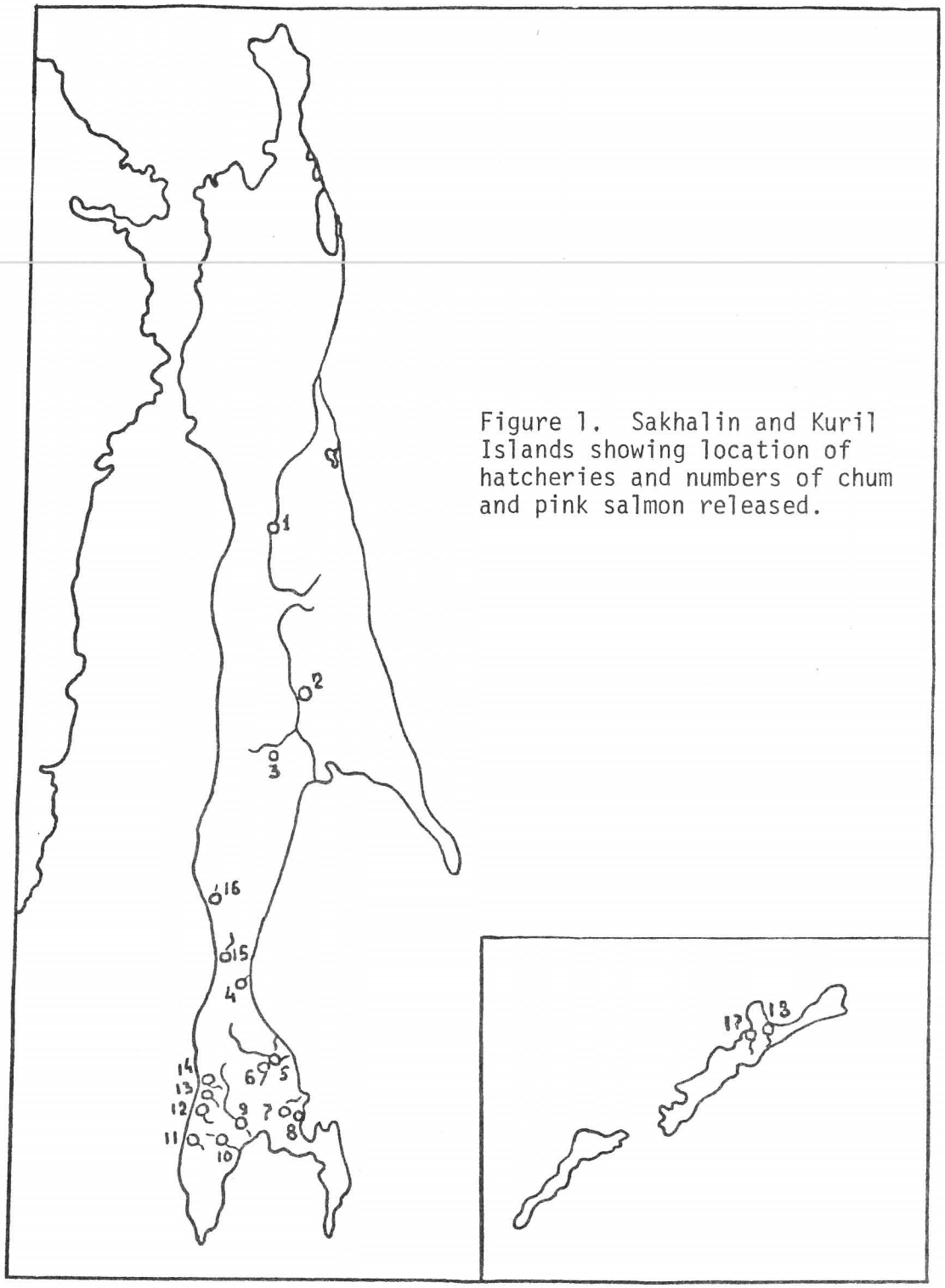


Figure 1. Sakhalin and Kuril Islands showing location of hatcheries and numbers of chum and pink salmon released.

I. Ado-Tymovsky	55,0	mln.indiv.c	IO. Taranaysky	40,5	ρ
2. Pobedinsky	I8,0	ρ,c	II. Vatutinsky	II,5	ρ
3. Buyuklovsky	38,5	ρ,c	I2. Sokolnikovsky	23,0	c
4. Pugachovsky	59,0	ρ	I3. Yasnomorsky	I6,0	c
5. Sokolovsky	I02,0	ρ,c	I4. Kaliningky	84,0	c
6. Bereznikovsky	66,0	ρ	I5. Urozhayny	9,5	ρ
7. Lesnoy	35,0	ρ	I6. Aynsky	30,5	ρ
8. Okhotsky	35,0	c	I7. Kurilsky	I26,5	ρ
9. Anivsky	I9,0	ρ	I8. Reydovy	75,0	c

ρ - pinks - 397.5 Chum & Pink - 158.5

c - chums - 288 Total - 844

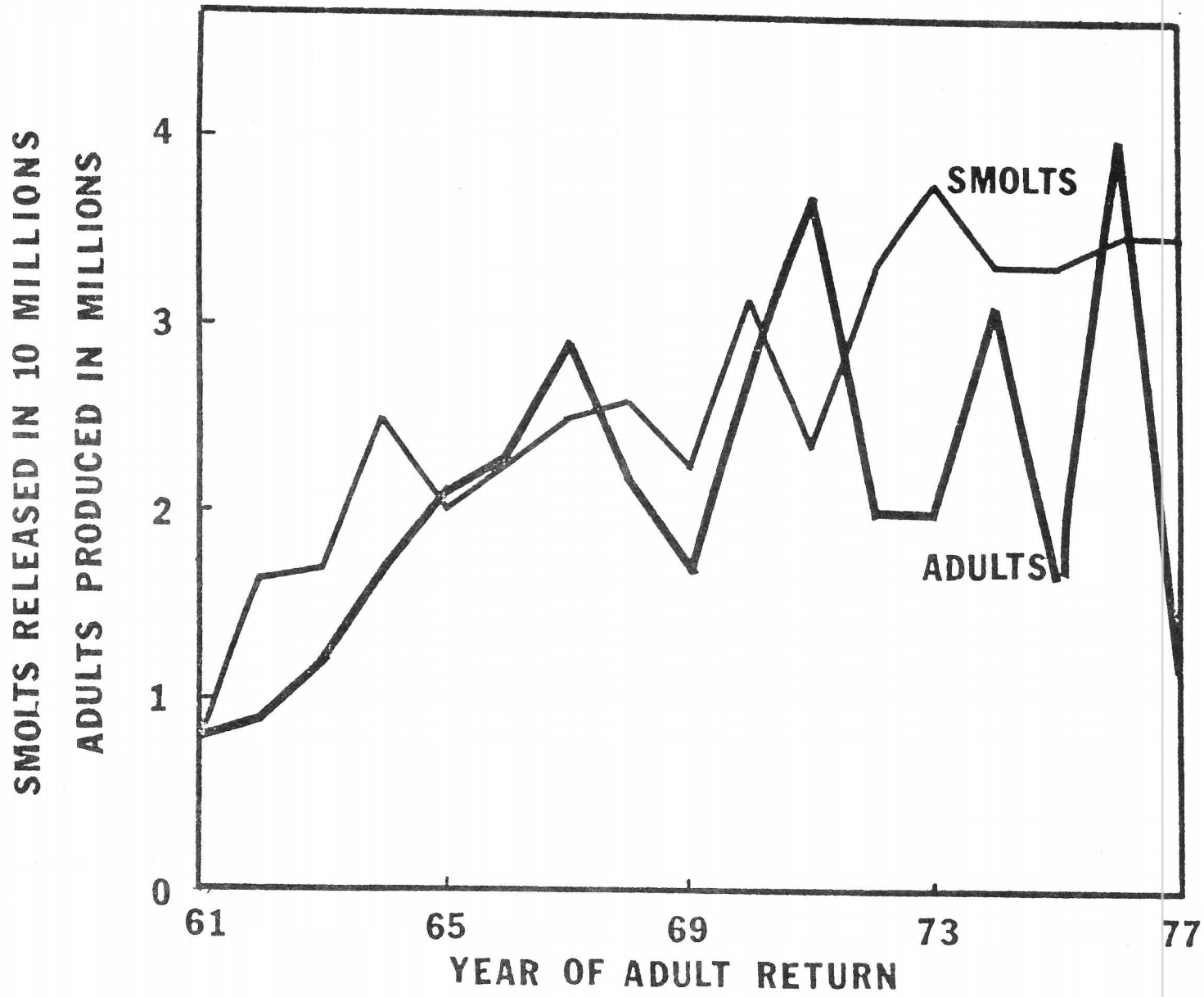
ARE WE PROPERLY MANAGING OUR HATCHERY COHO STOCKS?

by

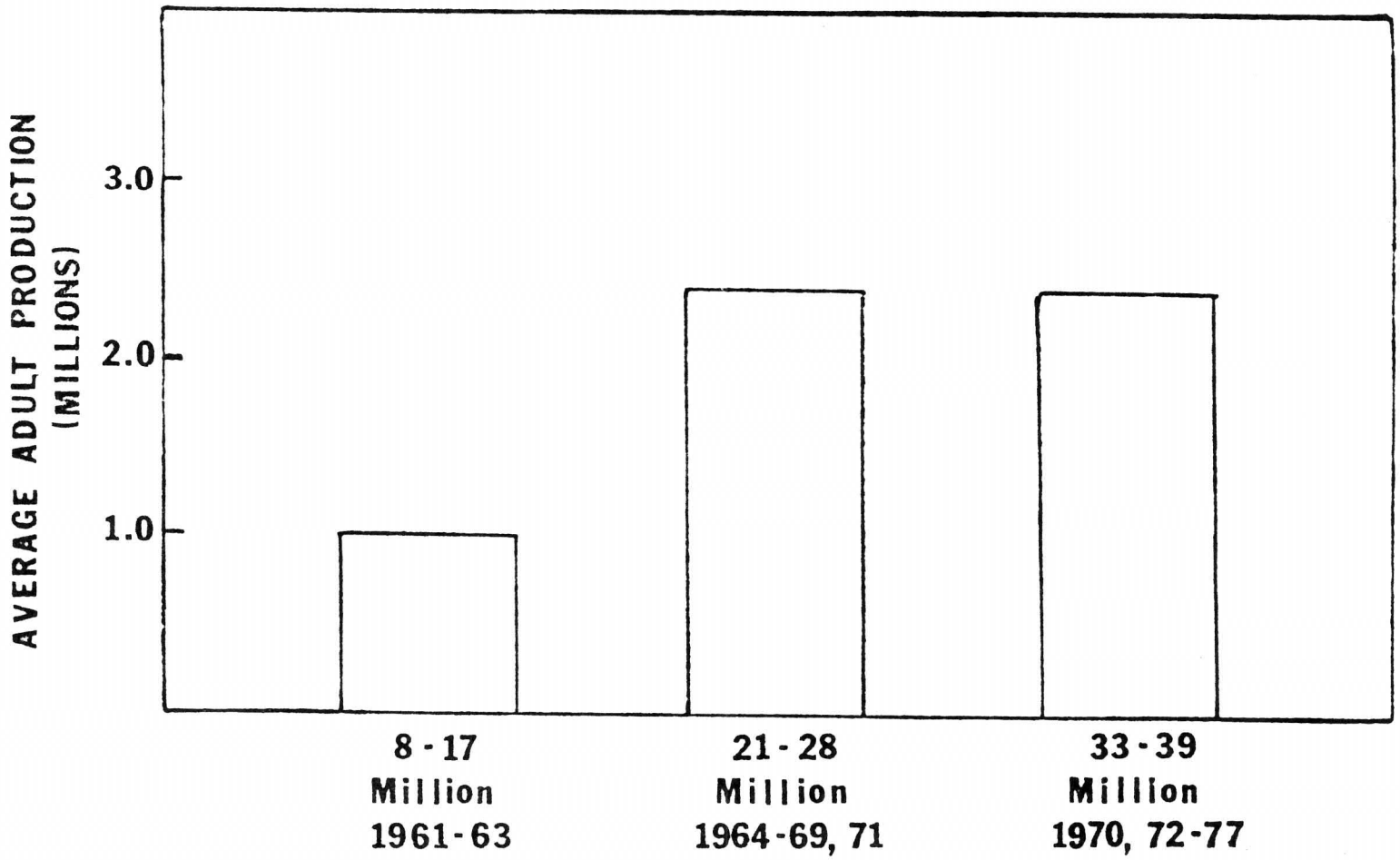
Robert T. Gunsolus
Oregon Department of Fish and Wildlife

Record numbers of coho were harvested by the ocean fisheries in 1976, yet this was followed in 1977 by the worst run in 15 years. Production of adults in 1978 was well below the 15-year average, and preliminary data indicate an even poorer run in 1979. I would like to discuss what I think is happening to our coho stocks, and how hatchery fish are affecting their management. Data presented refer primarily to the area south of the Washington coast, including the Columbia River.

Coho stocks were at a low level during the 1950's; but as more smolts were released from hatcheries, the number of adults contributing to the fisheries and counted in the escapement also increased (Figure 1). Beginning in the late 1960's, the trend of adult production began leveling off with violent fluctuations between years. Meanwhile, releases of hatchery smolts continued to increase. Releases of 21-28 million smolts in the late 1960's resulted in as many adults on the average as releases of 33-39 million smolts in the 1970's (Figure 2). This strongly suggests that some factor is limiting production of adult coho.



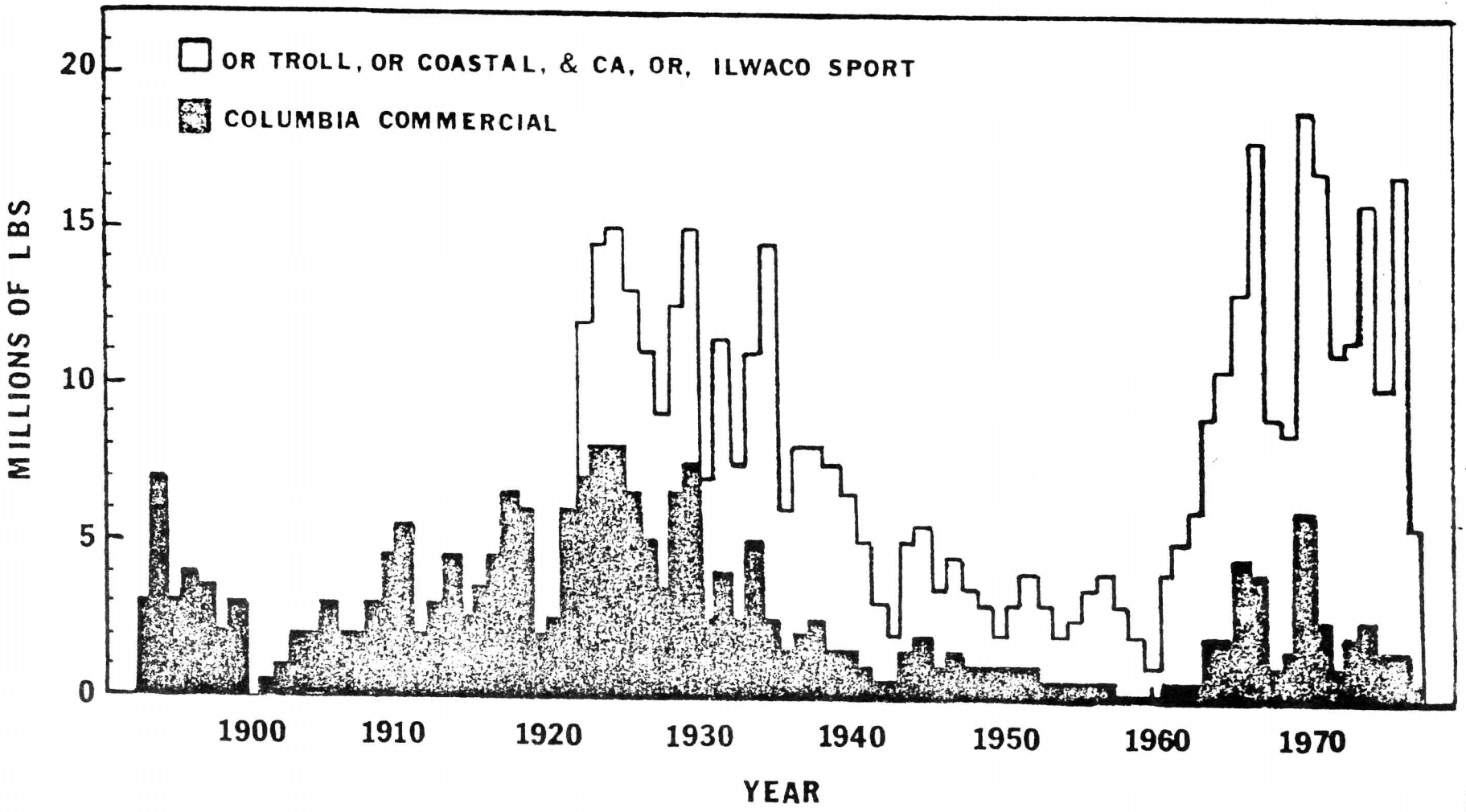
(FIGURE 1) RELATION OF HATCHERY SMOLTS RELEASED AND ADULTS PRODUCED 1 YEAR LATER



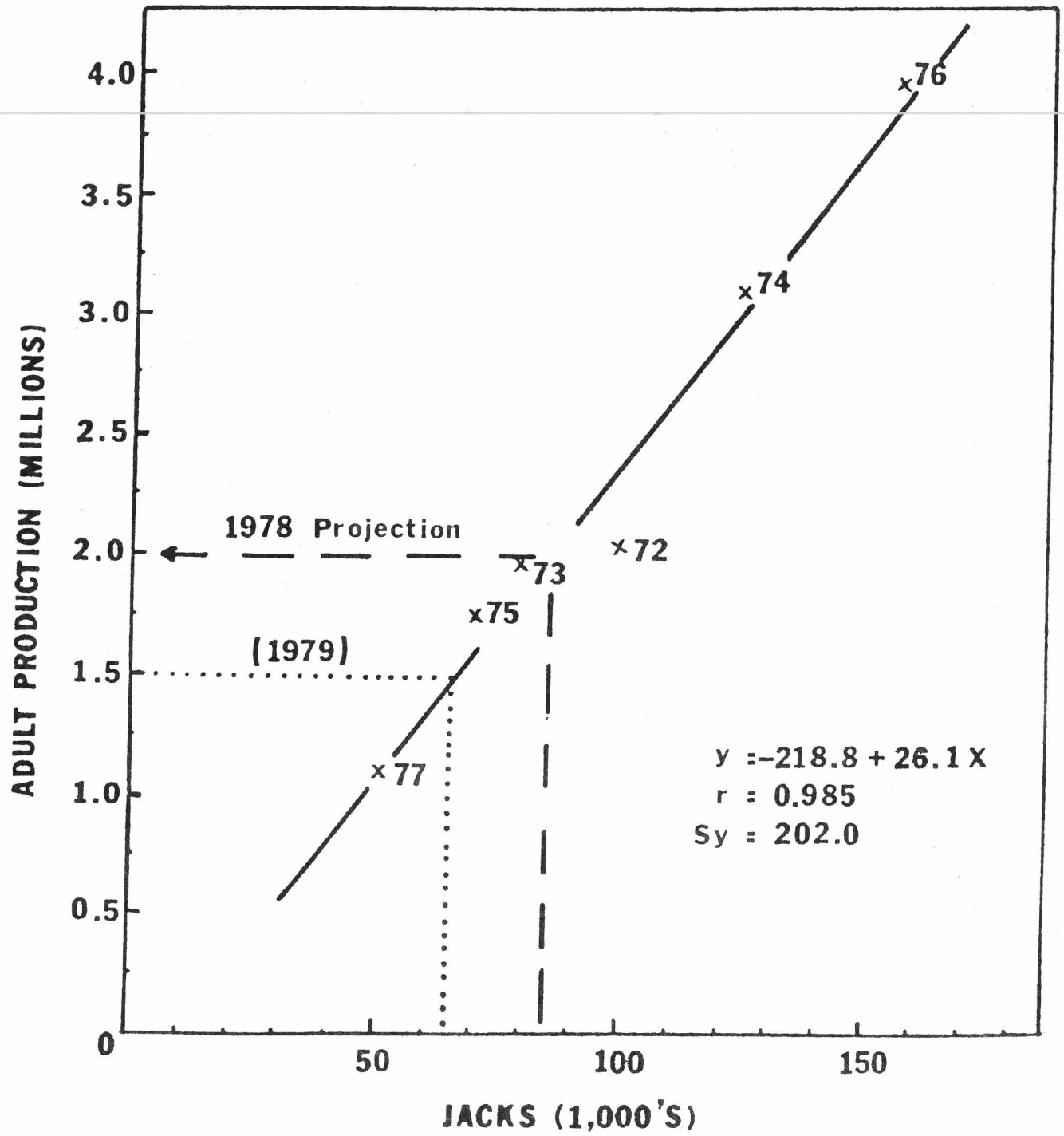
(FIGURE 2) AVERAGE ADULT COHO PRODUCTION VS DIFFERENT LEVELS OF SMOLT RELEASES, 1961-77

Fluctuations in numbers of adults is nothing new. Historically, abundance of coho as measured by landings (Figure 3) has always fluctuated, sometimes as violently as in recent years. In work conducted in the 1950's, smoker found that abundance of coho in Washington streams was related to total annual runoff. To put it another way, I think he demonstrated that the freshwater environment limited the production of juveniles which in turn limited the production of adults. But now that hatcheries have taken the ceiling off smolt production, it seems logical that the limitation is no longer in freshwater areas.

In 1977 the salmon management staff of the Oregon Department of Fish and Wildlife began looking to the ocean for the cause of the limitation. Because we had a good relationship between the production of coho jacks and adults (Figure 4), we reasoned that whatever affected survival occurred between the time of smolt release and the return of jacks, or in the coho's first summer in the ocean. Eventually we looked at upwelling (Figure 5), and related a weighted Bakun upwelling index off Oregon to the adult production the following year. We found a reasonably good relationship after 1968 considering that we had not included the escapement of wild coho in our production value and had not been able to exclude Washington coastal and Puget Sound stocks harvested in our production area. We observed that upwelling also affected the size of adults maturing that same year, but that total numbers of fish present did not seem to affect their mature size. At this time our staff is satisfied that upwelling, or something related directly to upwelling, is somehow limiting the number of juvenile coho surviving in the ocean; and to increase

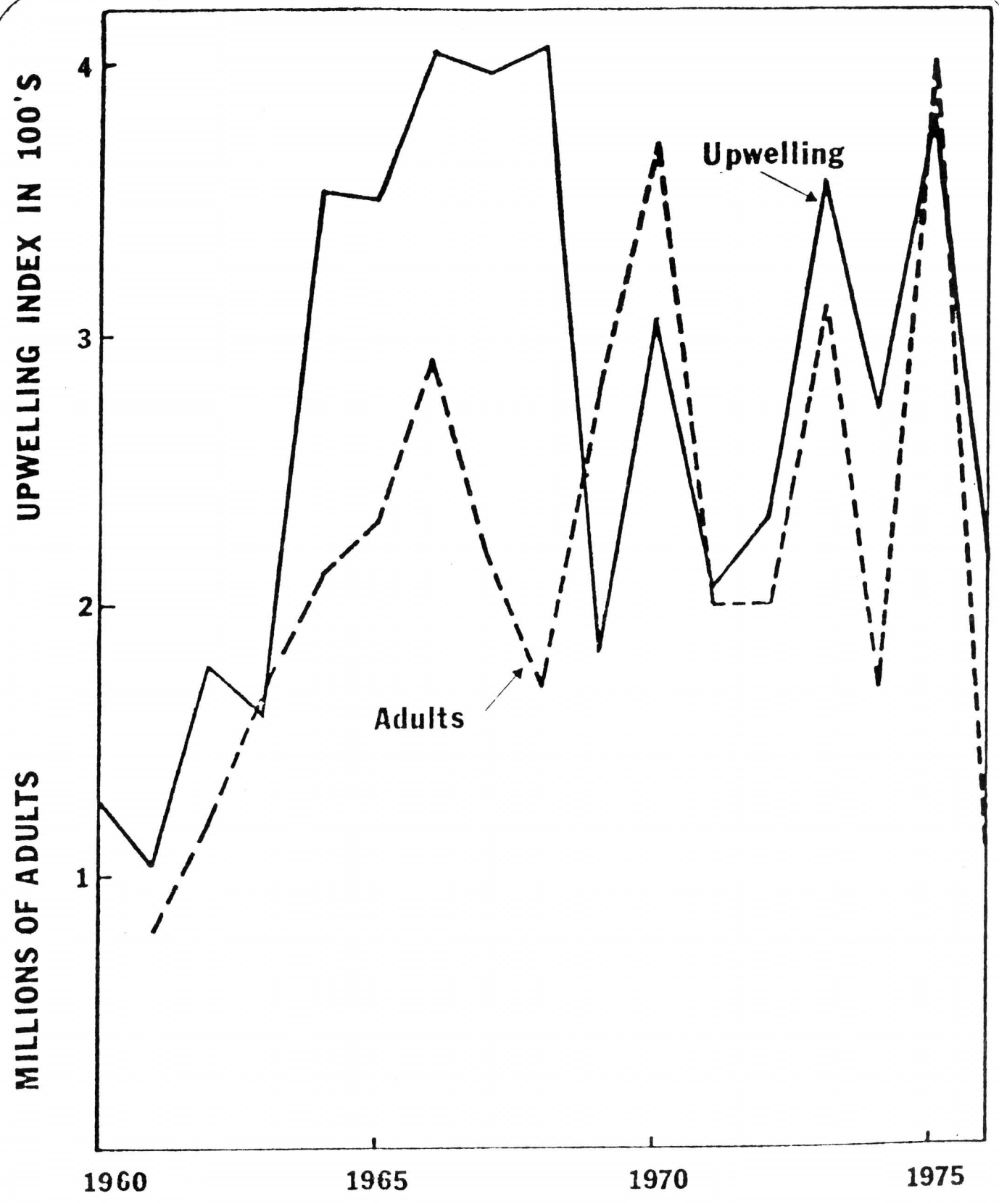


(FIGURE 3) COHO LANDINGS IN MILLIONS OF LBS



(Figure 4)

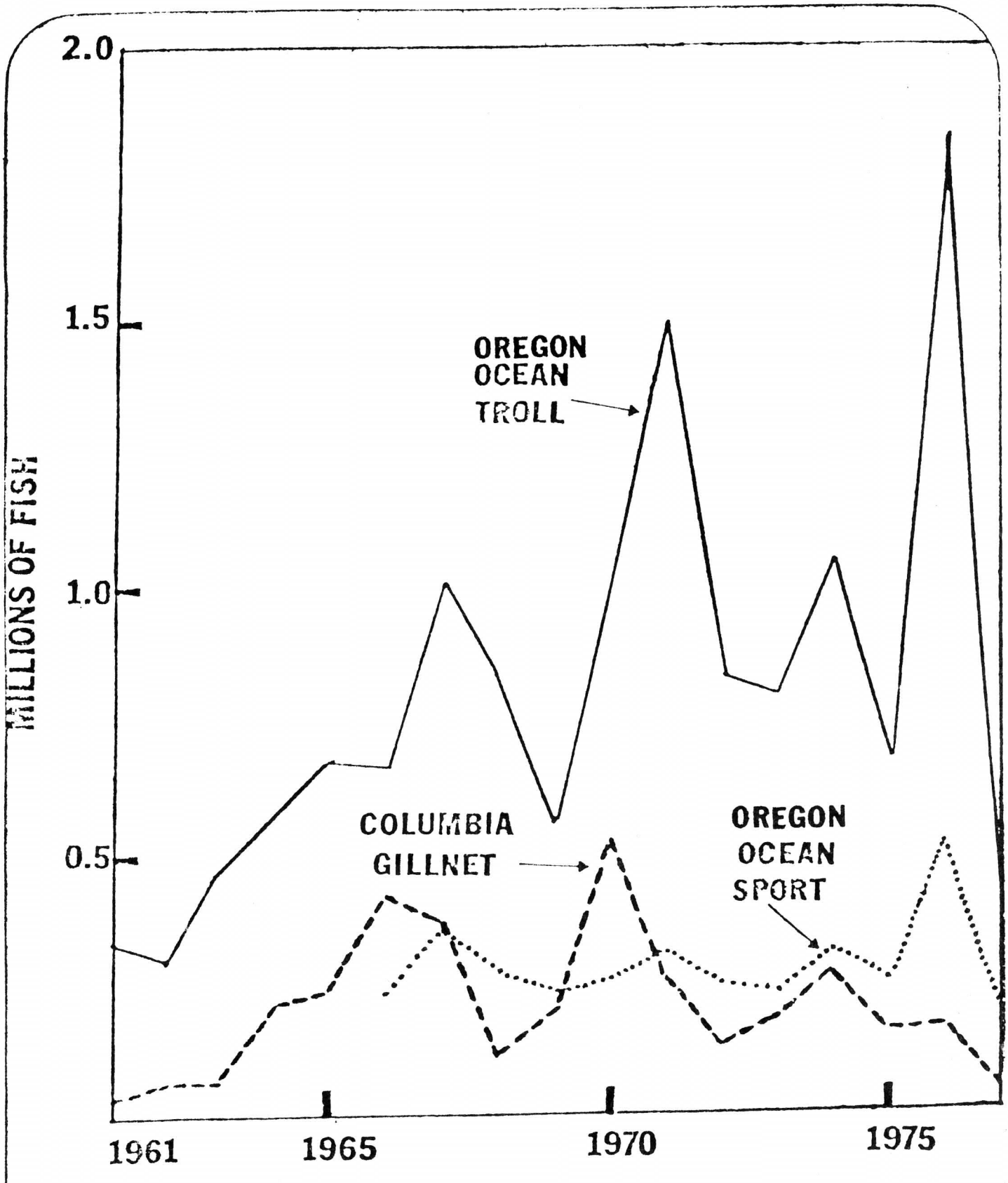
COHO JACKS OF THE PREVIOUS YEAR VS ADULT PRODUCTION, 1972-77



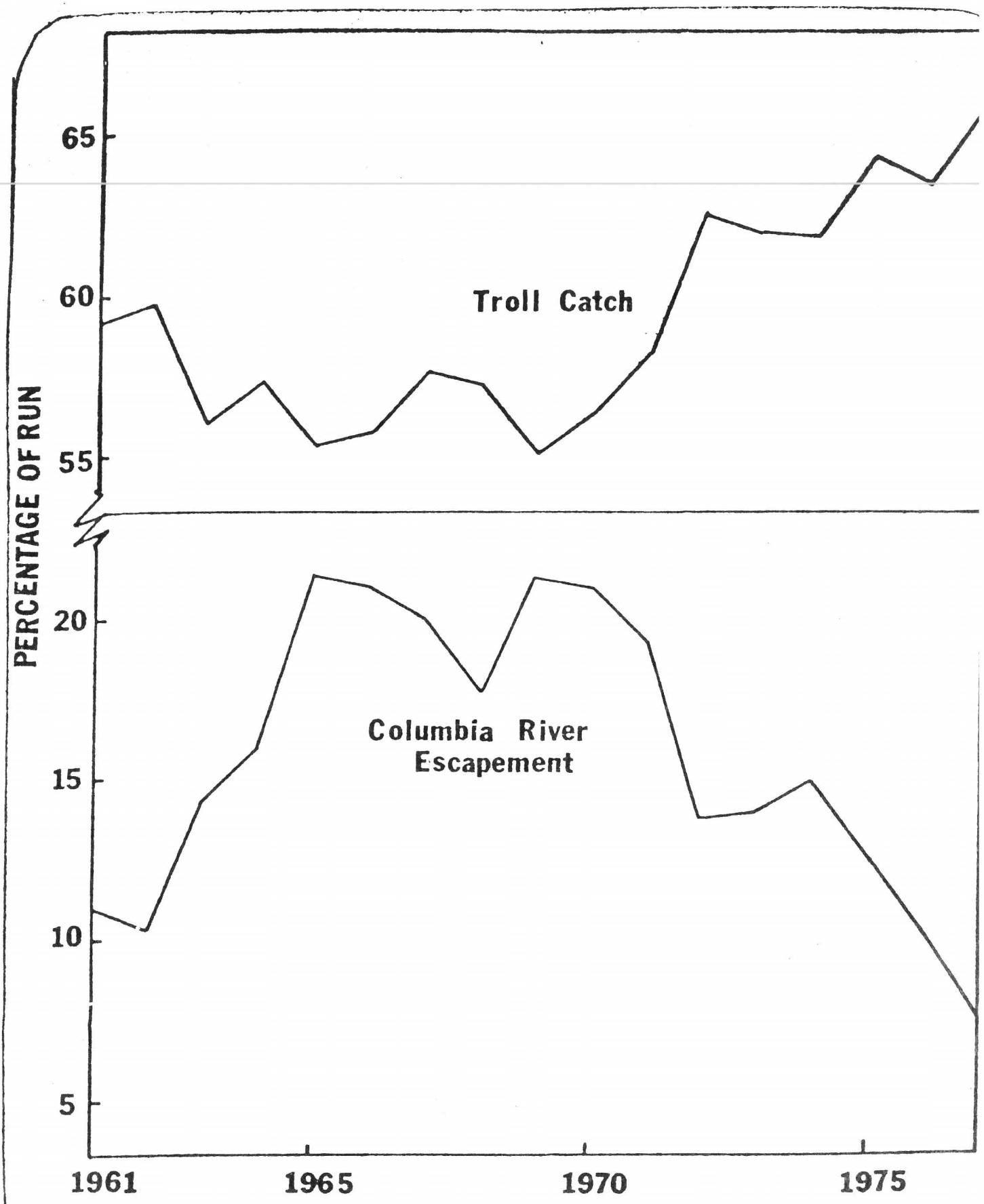
(Figure 5) **OREGON UPWELLING INDEX COMPARED WITH ADULTS IN FOLLOWING YEAR**

production we need to somehow circumvent this limitation, perhaps by releasing fish at a more optimum time as related to upwelling. The release of more hatchery juveniles is not resulting in a greater number of adults produced, and may be reducing survival of wild juveniles if in fact they are competing with one another for survival.

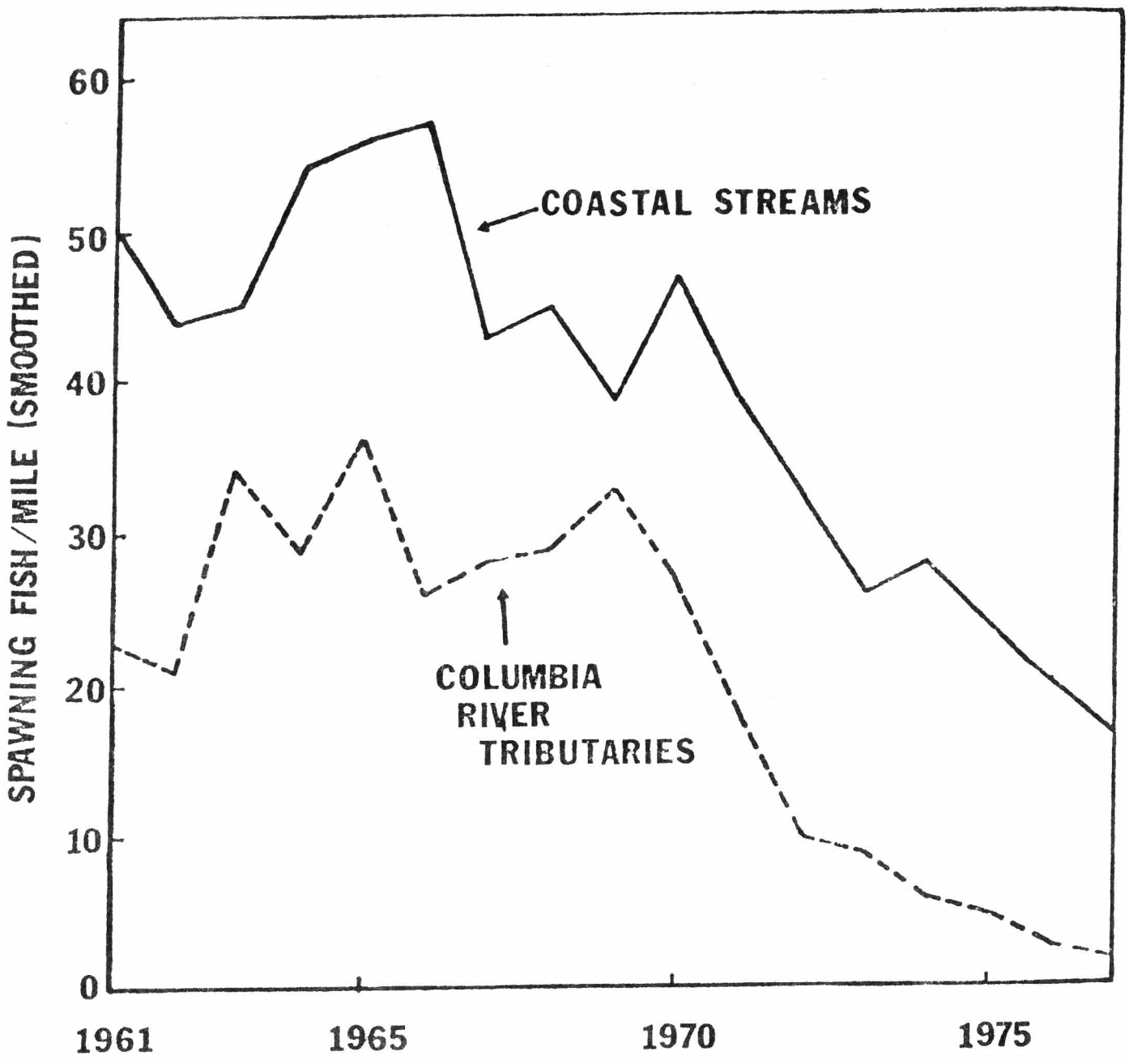
The increase in production of adult coho resulting from the release of more and better hatchery smolts has also affected their harvest. Figure 6 shows the harvest trends of the Columbia River and Oregon ocean sport and troll fisheries. Most noticeable is the upward trend of the catch by the troll fishery. Figure 7 provides an interesting comparison between the troll catch and the escapement into the Columbia River. The values are plotted as percentages of the total number of coho accounted for in the catch and escapement south of the Washington coast. The initial increase in the Columbia River escapement and decrease in the percentage caught by the troll fishery occurred as hatchery production increased in the early 1960's and before the troll fleet began targeting on the newly abundant coho. As the fleet targeted more on coho the percentage escapement ultimately dropped to the 1960 level. The point to note here is that the 1960 escapement was largely wild fish while the 1977 value was mostly hatchery fish. The inference is that the wild stocks are being harvested to a very low level. The fact the escapements of wild fish have declined is verified by the trend of counts of wild coho spawning in Oregon coastal and Columbia River tributaries (Figure 8).



(Figure 6) LANDINGS OF COHO SALMON



(Figure 7) TROLL CATCH VS COLUMBIA RIVER ESCAPEMENT



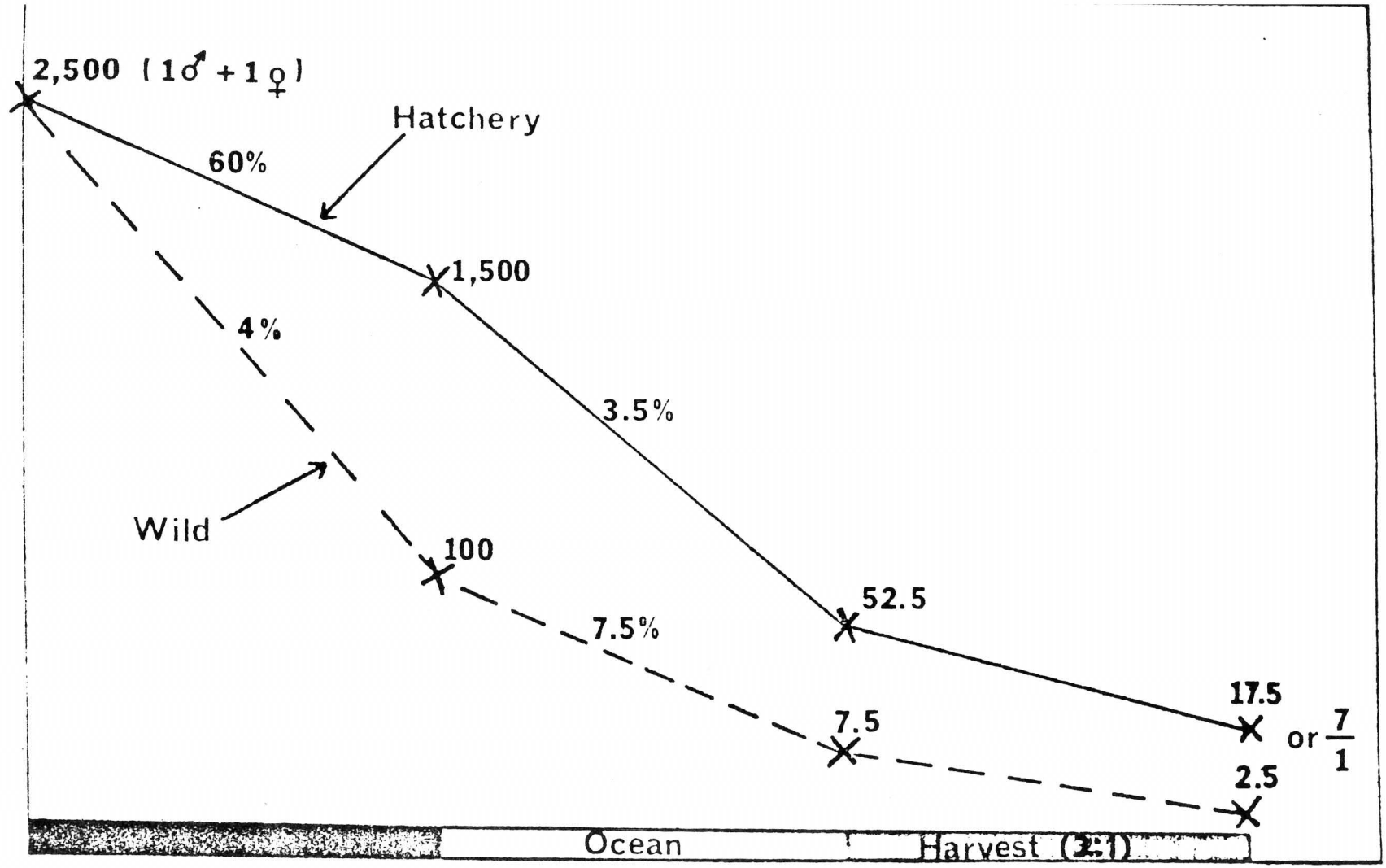
TREND OF ESCAPEMENT OF WILD COHO TO OREGON COAST

(Figure 8) AND COLUMBIA RIVER TRIBUTARIES

How, then, have hatchery fish affected the escapement of wild fish. Not just by the fact that they are present in greater numbers, but because they can withstand a greater harvest rate. Survival rates of wild and hatchery stocks obtained from Salo and Bayliff's studies at Minter Creek (Figure 9) show that 7 hatchery fish would return to Minter Creek for each wild fish. When the survival rate for wild fish at Minter Creek is compared with the average egg to smolt survival rate currently found at ODFW hatcheries, 9 hatchery fish would return to spawn for each wild spawner.

The increased harvest rate by the ocean fisheries has resulted in the catch to escapement ratio soaring to over 7:1 for some hatchery stocks of Columbia River coho. While hatchery stocks apparently can withstand these catch rates, the data indicate that wild stocks cannot.

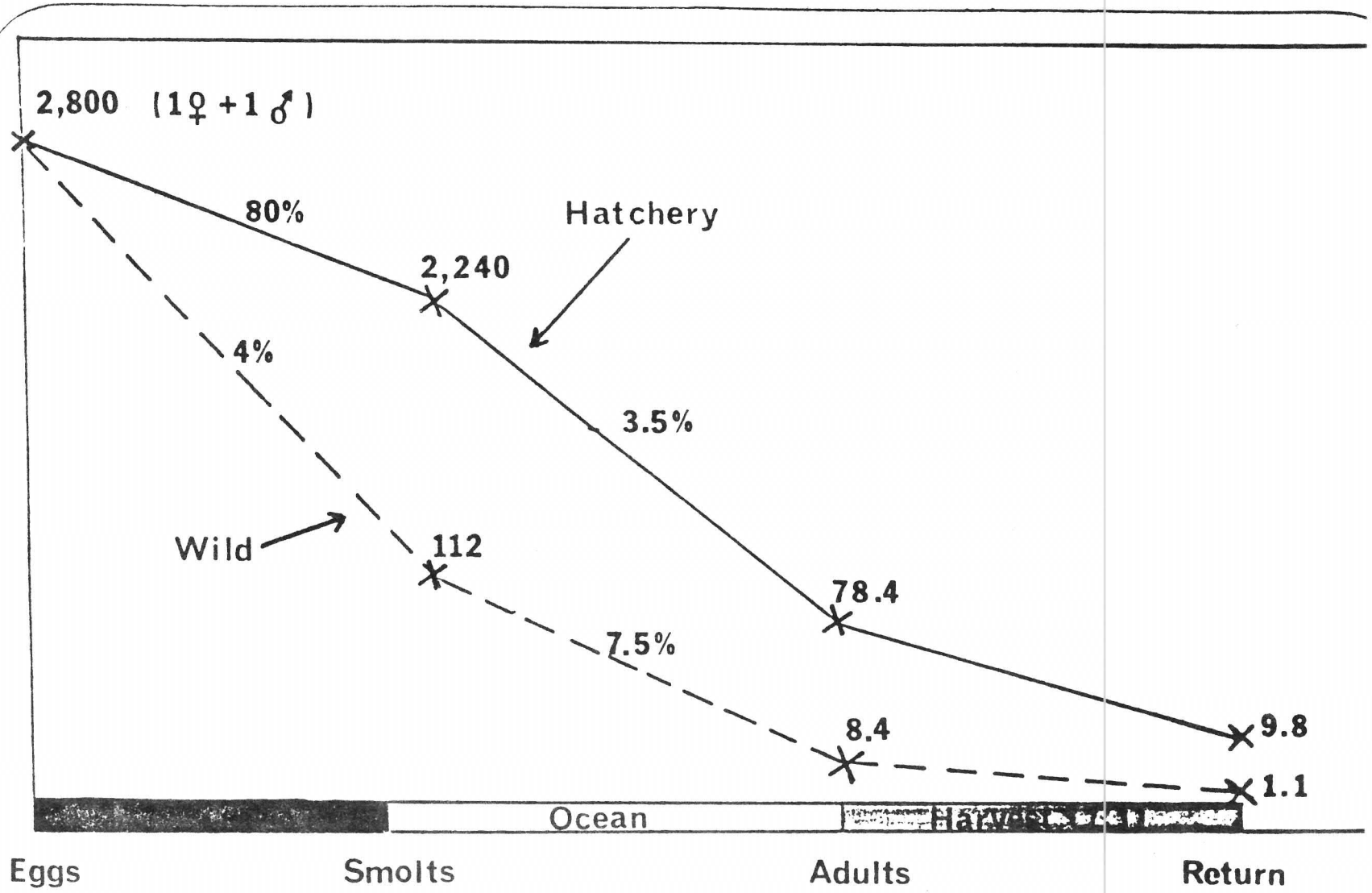
In answer to the question "Are we properly managing our hatchery coho stocks?" I'll leave that answer to you.



(Figure 9)

SURVIVAL OF HATCHERY AND WILD 1/ COHO PRODUCED IN MINTER CREEK, WASHINGTON (Studies Conducted From 1937-54)

1/ Freshwater survival with optimum numbers of spawners



(Figure 10)

EXPECTED SURVIVAL OF COLUMBIA RIVER STOCKS OF HATCHERY AND WILD COHO BASED ON MINTER CREEK SURVIVAL STUDIES, OREGON HATCHERY SURVIVAL RATES, AND A 7:1 HARVEST TO ESCAPEMENT RATIO

Water Quality

RECENT ADVANCES IN BIOFILTER PERFORMANCE

by

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

ABSTRACT

During the past 10-12 years, there has been increasing interest in raising fish in recycled water systems. The two major reasons for this interest are (1) to make the available water go further, and (2) to make the available water more suitable for raising fish, especially with respect to temperature.

Conceptually, hatcheries using recycled water systems consist of two biological systems - each operating independently of the other. That is, the fish in the system must be raised as though they were in an open water system and the biofilter must operate as though there were no fish in the system. To be sure, each provides a service for the other but each must not be dependent upon the other for life support.

To some, that last statement might sound somewhat paradoxical. How can the fish not be dependent upon the biofilter, when the task of the biofilter is to remove the nitrogenous waste products which are injurious to the fish above certain levels? Also, how is the biofilter going to function optimally without the fish providing the nitrogenous waste products for it to utilize? As recently as six months ago, I

asked the same questions. The answers were not easy to come by, and I do not admit or even allude to having the questions answered; but I think we have come a long way.

Our approach to defining the biological requirements of a functioning biofilter system centered around our setting up closed, fish-free biofiltration systems and simulating the fish derived inputs.

The first of many inputs measured was NH_3-N oxidation to NO_3-N. The biofiltration systems - four of them - were "fed" NH_4Cl daily at levels equivalent to multiples of 0.012 mg/1 NH_3. This base level was chosen because, according to several studies, is the level above which fish growth would be adversely effected. During the ensuing weeks the daily levels of dissolved oxygen, hardness (total and calcium), alkalinity (carbonate), pH, carbon dioxide, ammonia (both NH_3 and NH_4^+), nitrite, nitrate and temperature were determined according to standard methods using Hach chemicals.

After nearly 16 months of isolating and testing various chemical components, we have established that optimum biofilter performance at 11-15° C is dependent upon pH, hardness (magnesium and calcium), dissolved oxygen, inorganic carbon, and rate of water flow through the medium. The recommended levels are:

pH	7.5-8.4
D.O.	> 80% saturated
Hardness	
Mg^{++}	> 80 mg/l
Ca^{++}	> 100 mg/l
Alkalinity	> 50 mg/l as HCO_3^-
Water flow	1-2 gpm/ft^2 of medium

The required conditions can be maintained by adding oyster shell (for Ca^{++} and CO_3^{--}), $NaHCO_3$ (for inorganic carbon), and $MgCl_2$ (for Mg^{++}) to the system. In addition to the inorganic chemicals required for optimal bacterial nitrification in a biofilter, the system should be supplied with an outside nitrogen source, thus, not relying on the fish-derived NH_3-N. We have used NH_4Cl in an aqueous drip over an 8-hour period daily at a level to maintain 0.02-0.03 mg/l NH_3 (calculated) in the entire system. The NH_4Cl should be added to the intake of the biofilter and, if there is 100% nitrification, the effluent from the biofilter should be 0.00 mg/l NH_3. This has been the case in our studies.

The daily feeding of the biofilter with NH_4Cl is analogous to feeding fat and protein to fish. The nitrifying bacteria require nitrogen as an energy source and the fish use organic carbon as an energy source. If either is deprived of its respective energy source, growth virtually ceases.

In conclusion, according to recent unpublished data from Dr. Meade's group at the University of Rhode Island, the chemical requirements we have determined for optimum biofilter performance are compatible with the environmental requirements for fish - particularly salmonids. The next step taken was to connect the two biological systems; namely, the fish and the biofilter, and monitor the effects throughout the presmolt rearing period.

Early this past November, juvenile steelhead at 50/lb. were put into two steady state biofilter systems. One system was fed NH_4Cl and the other was not - supposedly. However, as it turned out, a mix-up in communication occurred and both systems were fed NH_4Cl. For two weeks the fish showed no evidence of being adversely affected by the chemically manipulated systems. However, because of the lack of an untreated control, the test was discontinued to be reinitiated at a later date.

NATURAL ZEOLITES IN FISH CULTURE

by

Dennis W. Leonard
Anaconda Company

Natural zeolites are minerals consisting essentially of alumino silicate, crystallized into molecular sized cavities connected by a series of channels. These zeolites possess several unique properties of which two are important to this meeting.

First, they have properties of adsorption for such gases as H_2S, SO_2, CO_2, H_20 and others. These are not listed in any particular order of selectivity, since different zeolites will preferentially adsorb different gases, at times adsorbing as much as 25% of their own weight.

Gas adsorption is principally according to the molecule size of the sorbate gas. Molecules smaller than the zeolite cavity will be adsorbed whilst larger gas molecules are rejected. Hence the term 'molecular sieve' which is often used to describe zeolites.

In addition to this adsorption according to size, zeolites do possess preferential selectivities for certain gases. For example, sone zeolites will prefer carbon dioxide to that of methane or nitrogen to oxygen, thus permitting gas separation and/or purification.

The second important property of zeolites is their ability to ion-exchange with certain ions. The cations of NH^+., Cd., Cu., Zn.,

Ba., Pb., Cs., and others are readily exchangeable with the zeolites alkali cations.

There are over 30 different types of natural zeolites found in different parts of the world. Only a few, however, are found in commercially minable quantities, of which clinoptilolite has particular interest to those in the fish culture field.

Millions of tons of clino can be found in the U.S.A. being located in many Western areas. It is very important to realize that the properties of clino vary enormously between different deposits, particularly regarding their purity, physical strength and their power to adsorb or ion-exchange.

When zeolites were first discovered 200 years ago, their value was not appreciated. However, during the past 25 years things have changed.

In the late 1960's, Mercer and Ames of Batelle Northwest, showed clino had excellent ion-exchange capacity for ammonia in aqueous solution. This led to the construction of a 100,000 q.p.d. pilot plant being built at Lake Tahoe where it was demonstrated that up to 97% ammonia could be removed from sewage effluent.

Since then, work by Slone of New Mexico University, Kramer, Chin and Mayo, the Seattle aquarium, Nichols of Jungle Laboratories to name just a few, have demonstrated that clino has a vast potential for controlling ammonia levels in waters in which many types of fish are reared.

While further detailed studies need to be conducted, much of which is already underway, sufficient is known to date to ensure that

clinoptilolite can be of considerable assistance in fish culture. The objective behind this short discussion is to increase the awareness of that which is known, regarding the use of clino.

The process of removing ammonia out of water is simple and the following slides show schematically a full scale production unit now operating at Truckee, on Lake Tahoe where discharged effluents are controlled to less than 1 ppm NH_4.

Once the zeolite ion-exchange capacity has been loaded to a point of ammonia breakthrough at 1 ppm or whatever level has been predetermined, the clino is regenerated by a saline solution. The regenerant solution is then stripped of its concentrated ammonia. The stripped ammonia can be reacted with various reagents to form commercially acceptable products.

As was shown with domestic sewage, laboratory work, supported by some pilot plant studies have demonstrated clino will lower ammonia levels in waters that hold various kinds of of fish whether they be for use as food or for sport.

Total ammonia levels can readily be held at levels below 0.5 ppm. It was mentioned earlier that both NH_3 and NH_4 can be removed. NH_3 by adsorption and NH_4 by ion-exchange.

It is important to realize that the lowering of total ammonia in aqueous conditions is by ion-exchange removing the NH_4, ion. The unionized NH_3, that is toxic to fish, is reduced as a result of the remaining ammonia maintaining an NH_4/NH_3 equilibrium according to the temperature and pH of the particular water. For example, if we had a total ammonia of 0.5 ppm, with a pH of 8.3 at 75° F, approximately

.05 ppm NH_3 would be present and as pH and temperature drop, so will that percentage of NH_3.

It has been shown that the rate of flow of water through clino beds affect the kinetics and hence the total ammonia removed. There is good evidence to suggest that the flow should not exceed 12-15 BV/Hr.

It is also known that zeolite within a bed or column is not necessarily loaded uniformly, and in fact in most cases of normal flow rates, the loading of the ammonia will certainly not be uniform. This is shown schematically.

The effect of using clino in the transporting of fish have been studied. TILIPIA HYBRIDS were able to live for twice as long during transportation if zeolite were included with the holding water. Similar studies reveal equally successful results with SWORD fish.

When unwashed clino is placed into static water which is then subject to a slight motion, a white turbidity develops. The level of turbidity is directly proportional to the quantities of zeolite.

Prewashing of the clino will reduce that turbidity and several washings can almost eliminate it.

We currently are running tests, again with fish transportation, but using prewashed clino to see if it is this turbidity that has any detrimental health effects.

The main influencing factor upon NH_4 ion-exchange is the amount and type of competing cations present along with the ammonium ion, of those cations that will effect the exchange of NH_4. Pottasium is highly selective to clino sites followed very closely by NH_4., with

calcium and magnesium less exchangeable. Due to the concentration of sodium in salt water, however, clino is very ineffective in removing NH_4 in the presence of so many Na cations. However, a method has been developed to overcome this problem.

It has been shown that NH_3 can be transferred through a membrane when salt water is on one side and clean water on the other side of the membrane.

The unionized form, after permeating the membrane to the clean water, converts to the NH_4/NH_3 ratio according to whatever pH is being maintained on that side.

Initially a high pH was used within the clean water as it was believed this gradient would increase the rate of premeation. However, it has since been established that in fact it is helpful to reduce the pH to around 4.0. This also greatly assists the total amount of ammonia removed by the clino due to increasing the NH_4 percentage.

The rate of permeation is dependent upon constant agitation on both sides of the membrane. Air bubbling on the saline side is adequate whilst upon the clear side more movement is needed. These slides show schematically this system in operation.

Clino and other zeolites have been introduced to fish diets by taking fine zeolite powder, and mixing it with conventional bulk fish food prior to flaking or pelletizing.

Early results are showing a slight weight gain in the order of 3-5% when between 5-7% of zeolite is added. Four different zeolites are showing considerable promise, but the economics of producing clino will favor that particular type. Currently we are determining the effect

upon ammonia levels within the fish holding waters when fish have a zeolite contained diet. The motive behind this is as a result of our tests with fish transportation when a marked decrease in amonical odor was detected with fish sealed in bags containing clinos.

Considerable work is still underway but time does not permit us to go into further discussions today.

NITROGEN GAS REMOVAL USING PACKED COLUMNS

by

David E. Owsley
U.S. Fish and Wildlife Service

ABSTRACT

Supersaturation of nitrogen gas continues to be a problem in hatchery water supplies. It usually goes undetected unless frequent monitoring is being conducted. Some hatcheries are aware of the fact that nitrogen gas may be a problem but do not have the equipment or technique to monitor for nitrogen gas. Development of the Weiss saturometer makes this equipment and techniques available. If nitrogen gas can be determined to be a problem, the next step is to eliminate or alleviate it in the water supply. There have been various methods used to try to reduce supersaturation of nitrogen gas. These methods range from simple to elaborate and costs vary accordingly. A degasser has been developed at Dworshak National Fish Hatchery that is simple in design and economical. It is a very efficient degasser as compared to the other methods and has a broad scope of use. It can be used with flows ranging from 10 to 10,000 gallons per minute to reduce nitrogen gas from over 130 percent saturation down to or near 100 percent saturation. This new degasser is called the "packed column". The packed column is not only effective at removing excess nitrogen gas but is also a highly efficient means of aerating water.

Genetics

A STATUS REPORT ON THE EFFECT OF THE USE OF A GENE MARKER ON SURVIVAL IN HATCHERY SUMMER STEELHEAD

by

Bruce A. Crawford
Mark W. Chilcote
Steven A. Leider
Washington Department of Game
Fishery Management Division
Research Section

INTRODUCTION

In 1974, a study was begun on the Kalama River to explore the early life history and intraspecific relationships of wild and hatchery origin steelhead trout with special emphasis on spatial distribution, survival, growth, racial composition, gene flow and residualism (Johnston, et al. 1975). A major portion of this study has been the measurement of gene flow between hatchery origin and wild steelhead through the use of a gene marker.

With the assistance of Fred Utter and Fred Allendorf, National Marine Fisheries Service, the A' gene of the disomic locus for the protein alphaglycerophosphate dehydrogenase (AGP) was selected as the marker. The A' gene occurs naturally in the wild Kalama River summer steelhead at very low levels (less than 4%), but is more common in Skamania Hatchery steelhead (10%). Consequently, a selective breeding program was begun at Skamania Hatchery (source of summer-run

steelhead plants in the Kalama River) to maximize the differences between the gene frequency of the AGP A' gene in the wild steelhead and the planted hatchery fish.

Through the introduction over successive years of genetically marked hatchery fish, it will be possible: 1) to measure the contribution of the progeny of hatchery steelhead to wild steelhead recruitment; 2) to determine if selection against hatchery F_1 wild progeny occurs, and at what stage of their life history; and 3) to estimate the overall impact of hatchery fish upon the gene pool of the wild stock.

The validity of the information obtained is dependent upon the neutrality of the AGP A' gene. If there is selection either for or against the A' gene, then the apparent changes in the A' gene in the watershed may not reflect the effects of the wild environment upon the progeny of an "average" hatchery fish, but may reflect the effects of environmental selection on fish possessing the A' gene. In order to verify that the AGP A' gene is neutral, survival and return rate information is necessary.

METHODS

At Skamania Hatchery, the summer steelhead population genotype for AGP is typically 81% homozygous for the A gene, 18% heterozygous, and less than 1% are homozygous for the A' gene. In order to increase the frequency of the A' gene for AGP a selective breeding program was initiated in the winter of 1974.

Males at the hatchery were tagged with a numbered Floy FD-67 anchor tag for identification, and a sample of skeletal muscle was taken with a dermal punch (Crawford et al. 1977). The muscle samples were analyzed through the process of starch-gel electrophoresis in order to obtain

the AGP genotype. All males homozygous for the A' gene were identified and separated for eventual breeding with females randomly selected from the hatchery holding pond. When maturation occurred, enough eggs were fertilized with the selected males to produce approximately 100,000 smolts. This procedure was repeated for three more years.

After mating, the eggs were transferred to the Vancouver Hatchery where they were kept to fingerling size before being returned to the Skamania Hatchery for extended rearing. During the egg and fry stage, survival data from the selectively bred group and from the regular Skamania stock were collected and compared.

Prior to smolting fish from brood years 1975 and 1976 were externally marked with a right ventral fin clip and a left ventral fin clip, respectively, before their release into the Kalama River in 1976 and 1977. This provided us with a means of measuring the stability of the gene marker over time as the various saltwater year classes returned from the sea.

RESULTS

Selective breeding was accomplished in the winters of 1974-1977. The number of homozygous males used and general information is provided in Table 1.

The resultant genotype of the F_1 progeny from the various matings are summarized in Table 2.

Table 1. -- AGP A' gene mating regime 1975-1978.

Spawning Season	Total males Sampled	Total A'A' Males	Approximate Number of Females	Female Genotype AA	AA'	A'A'
1974-75	250	5	30	.81	.18	.01
1975-76	500	2	30	.81	.18	.01
1976-77	495	7	30	.81	.18	.01
1977-78	519	19*	30	.81	.18	.01

*Some genetically marked jacks from 1974-75 season appeared in the group.

Table 2. -- Genotype of F_1 progeny prior to their release into the Kalama River.

Brood Year	Sample Size	AA	AA'	A'A'	P	Q	CI
1975	100	.00	.86	.14	.43	.57	± .070
1976	50	.04	.82	.14	.45	.55	± .099
1977	100	.00	.86	.14	.43	.57	± .070
1978*	129	.02	.89	.09	.46	.54	± .062

*Preliminary data

Selectively bred smolts from brood years 1975-1977 were released respectively in the springs of 1976-1978. The final group of genetically marked smolts will be released in May, 1979.

Survival data from genetically marked and regular Skamania summer steelhead eggs and fry are shown in Table 3.

During 1977 and 1978, genetically marked, fin-clipped steelhead returned to the Kalama River. From the release of the 1975 brood year smolts in the spring of 1976, we have sampled returning one year and two year ocean resident fish at the Kalama Falls Hatchery fishway trap (Crawford et al. 1978) which were marked with a right ventral fin clip. Left ventrally marked steelhead from brood year 1976 were also sampled after spending one year of ocean residence. The genotypes of the returning adult F_1 progeny are summarized in Table 4.

Table 3. -- Comparative survival of selectively bred F_1 progeny and regular Skamania stock.

Strain	Brood Year	Eggs Received	Eggs Loss (%)	Fry Received	Fry Loss (%)
SELECTED F_1 PROGENY	1975	303,408	31,072 (10.2)	272,336	6,038 (2.2)
	1976	194,704	8,160 (4.2)	186,544	7,108 (3.8)
	1977	144,126	14,382 (10.0)	129,744	14,940 (11.5)
	1978	164,088	18,972 (11.6)	145,116	16,776 (11.6)
average			(9.0)		(8.9*) (7.3)
SKAMANIA	1975	538,802	50,246 (9.3)	488,556	(no data)
	1976	775,002	71,494 (9.2)	703,508	33,931 (4.8)
	1977	1,586,407	156,500 (9.9)	1,429,907	225,111 (35.7)
	1978	1,568,297	156,818 (10.0)	1,411,478	160,939 (11.4)
average			(9.0)		(10.6)

*Average with 1975 omitted.

Table 4. -- Genotype of F_1 progeny returning as adults to the Kalama River.

Sample Year	Brood Year	Mark	Sample Size	AA	AA'	A'A'	P	Q	CI
1977	1975	RV	49	.00	.92	.08	.46	.54	± .100
1978	1975	RV	128	.00	.91	.09	.45	.55	± .062
1978	1976	LV	28	.03	.90	.07	.48	.52	± .131

DISCUSSION

Selective breeding to increase the incidence of the A' gene in the hatchery plant was successful in all four years. Based upon the known genotype of regular Skamania stock, and the known genotype of the males, the predicted genotype of the F_1 progeny was .88 AA' and .12 A'A'. The observed values (shown in Table 2) were not significantly different than the predicted genotype ($_8X_{.05}=1.74$). In the 1976 and 1977 brood, however, 4% and 2% of the sample were homozygous for the A gene. As there should have been none of these in the F_1 progeny, and the number observed is too few to be a result of misidentification of a male, it must be concluded that a few regular Skamania stock were inadvertently mixed with the selectively bred group at the hatchery during grading.

Survival data compiled at Vancouver Hatchery on the selectively bred F_1 progeny and regular Skamania stock showed identical egg mortality in both groups and slightly less fry mortality in the F_1 progeny than in the regular Skamania stock.

To date, two and three year old summer steelhead from the 1975 brood release and two year old fish from the 1976 brood have returned to the Kalama River. For all three groups a consistent change in the percentage of AGP AA' and A'A' genotypes was observed. Each group returning from the sea displayed a higher proportion of AA' individuals and a lower proportion of A'A' individuals (Table 5).

Table 5. -- Apparent change in F_1 progeny genotype over time.

Brood	Age	AA'	A'A'	n
1975	1.0	.86	.14	100
	1.1	.92	.08	49
	1.2	.91	.09	128
1976	1.0	.85	.15	48
	1.1	.93	.07	28

None of these apparent changes are statistically significant (χ^2_a = .10), it is important to assess the possibility of selective forces reducing the survival of fish with A'A' genotypes. If one assumes that the data observed is an accurate representation of the actual percentage of genotypes present, then the relative survival of fish with the AA' is nearly twice that of fish with A'A' genotypes. The potential effect this survival difference may have on the overall fitness of hatchery fish marked with the A' AGP gene can be explored through a series of equations described by Lewontin (1974) and the overall fitness of the genetically marked hatchery fish can be estimated. In this case, the average fitness for regular Skamania steelhead ($\bar{w}$ = .98) is greater than the estimated average fitness of a genetically marked hatchery steelhead ($\bar{w}$ = .83). Therefore, if selection occurs to the degree suggested by the data, then the effect of using the A' gene as a marker for tracing the production from hatchery fish would be to lower the overall survival of the resulting progeny by 15%. It

must be emphasized that this prediction of the reduced survival is merely conjecture at this point. There is no statistical evidence that supports this hypothesis.

No apparent difference was observed in the return timing of one and two ocean resident fish. Genetically marked one salt fish typically returned in August and September, while 2 salt fish arrived from April to November.

Final evaluation of these data will be possible in 1980 when all three saltwater age classes will have returned from the 1975 and 1976 broods.

ACKNOWLEDGEMENTS

This study has been financed by funds furnished to the Department of Game by the National Marine Fisheries Service. Thanks are due to the staff of the Skamania, Vancouver and Kalama Falls hatcheries for their assistance and cooperation in selective breeding and in compiling survival information.

LITERATURE CITED

Crawford, B.A., S.A. Leider, and J.M. Tipping, 1977. Technique for rapidly taking samples of skeletal muscle from live adult steelhead trout. Prog. Fish Cult. 39:125.

Crawford, B.A., S.A. Leider, J.M. Tipping, and M.W. Chilcote. 1978. Kalama River steelhead investigations. Washington Department of Game Fish Research Report. 111pp.

Johnston, J.M., W. Young, and R.M. Woodin. 1975. Kalama River investigations, progress report for fiscal year 1975. Washington Department of Game. 82 pp.

Lewontin, R.C. 1974. The genetic basis of evolutionary change. Columbia University Press. NY 346 pp.

COMPARISON OF RAINBOW TROUT STRAINS IN HATCHERY AND FIELD TESTS

by

Harold L. Kincaid
U. S. Fish and Wildlife Service
Fish Genetics Laboratory
Beulah, Wyoming 82712

SUMMARY

Five strains of winter-spawning rainbow trout and all combinations of two strain crosses among them from the 1977 year class were evaluated in the Fish Genetics Laboratory standardized environment and in field tests as fingerling plants. The objective of the study was twofold: (1) to measure strain differences in the two environments and (2) to compare the performance of pure strains with that of strain crosses.

Performance data for the five strains in the standardized rearing environment show substantial differences in percent crippled fry, mean fish weight, and feed conversion (Table 1). The more rapid growth rate of the Standard (W-Std.) Strain over the other strains was established by 245 days and continued to increase thereafter. Similarly, the slower growth rate of the McConaughy was established by 245 days. Growth rates of the remaining three strains were intermediate and have been nearly identical throughout the test. Feed conversions show exactly the same pattern as growth rates.

Performance data from strain crosses between the five test strains through 364 days of age showed that several crosses did better than the best strain in the test. Comparing the strain crosses to the standard strains, it was found that 50% had a higher percent hatchability, 83% had a lower frequency of crippled fry at swim-up, 31% had a higher fry survival, 53% had heavier mean fish weight at 147 days, and 8% had heavier mean fish weight at 364 days of age. Individual strain crosses tended to be intermediate to the parent strains in their overall performance in the standard rearing environment. A few crosses, however, outperformed both parent strains for attained weight and feed conversion at one year of age.

Field testing of strains and strain crosses was conducted in FGL Pond, a two-acre spring-fed pond located at the Fish Genetics Laboratory. Fish were individually marked with stainless steel tags implanted in the gut prior to planting. Fish were planted on top of an existing population in October, 1977, when they weighed about 23 grams (20 fish per pound). Fish were recovered at six and twelve months after the initial stocking by a combination of 1,000 rod hours of fishing followed by 104 hours of gill net operations at each recovery period. Performance of the five strains during the field study showed some differences in growth and recovery rates (Table 2). Attained weight at both recovery periods was approximately the same for all strains except the Fish Lake, which was heavier at six months but lighter at twelve months. Percent recovery at six months showed the Standard to return in large numbers (38%), the

Fish Lake and New Zealand at an intermediate level (20%), and the Sand Creek and McConaughy at a lower level (13%). Twelve month recovery showed that the Fish Lake and New Zealand returned at a 4-6% rate, the McConaughy and Standard at a lower rate, and the Sand Creek did not show up in the catch at all. Clearly the Standard Strain contributed most to the fishery early, while the Fish Lake and New Zealand provided the better sustanined fishery under the test conditions.

Performance of the different strain crosses during the field test was varied but did reveal some trends. At the six-month recovery, crossbreds tended to be intermediate to the two parent strains in mean weight and intermediate to lower in percent recovery. At the twelve-month recovery, however, crossbreds tended to be 10-15% heavier in weight than the heavier parent strain and were recovered in frequencies two to three times that of the best strain in the test (Fish Lake - 4%). Total recovery during the two recovery periods was about the same for pure strains and crossbreds, but crossbreds provided much more uniformity in recovery rate.

Results from this preliminary study show that large differences in both hatchery and field performance occur between strains which should be of value to fishery managers. The Standard Strain in particular was much superior to the other strains (in this test) in both test situations. Evaluation of strain crosses as an alternative to pure strains for use in fishery management suggested that some crosses were very promising; in particular, those crosses involving the Standard and Sand Creek strains. Care should be exercised before

entering into a strain crossing program, however, since only about 10% of the crosses examined in this study yielded improved performance over the best parent strain.

TABLE 1 - PERFORMANCE OF 1977 YEAR CLASS STRAINS IN STANDARD REARING ENVIRONMENT

	STRAIN				
Strain Number:	10	13	14	16	18
Strain:	Fish Lake	New Zealand	Sand Creek	W-Std.	McConaughy
Domestication:	Wild	Wild	Semi-Wild	Hatchery	Wild
Maturity:	2-3	3	2-3	2	3
% Hatch	69	77	79	80	83
% Fry	91	85	93	94	89
% Crippled	1.8	2.5	3.9	3.8	2.1
Mean Weight					
147 Day	3.8 (119)	2.5 (182)	3.4 (134)	3.5 (130)	2.8 (162)
245 Day	28.8 (16)	21.5 (21)	25.9 (18)	32.8 (14)	23.9 (19)
364 Day	103.1 (4.4)	99.1 (4.5)	97.0 (4.7)	142.1 (3.2)	85.6 (5.3)
455 Day	236 (1.9)	201 (2.3)	226 (2.0)	271 (1.7)	135 (3.4)
637 Day	480 (0.9)	486 (0.9)	479 (0.9)	579 (0.8)	364 (1.2)
Feed Conversion	1.8	1.8	1.8	1.5	2.0

Note: Numbers in parentheses are number of fish per pound.

TABLE 2 - PERFORMANCE OF 1977 YEAR CLASS STRAINS IN FIELD STUDY

	STRAIN									
Strain Number:	10		13		14		16		18	
Strain:	Fish Lake		New Zealand		Sand Creek		W-Std.		McConaughy	
Domestication:	Wild		Wild		Semi-Wild		Hatchery		Wild	
Maturity:	2-3		3		2-3		2		3	
Plant Weight (g)	24	(19)	21	(22)	21	(22)	27	(17)	23	(20)
Age of Plant (Days)	275		280		285		276		286	
6 Mo. Recovery										
Mean Weight (g)	97	(4.7)	69	(6.6)	70	(6.5)	77	(5.9)	69	(6.6)
% Recovery	20		19		13		38		13	
Catchability	75		100		75		97		54	
12 Mo. Recovery										
Mean Weight (g)	129	(3.5)	190	(2.4)	-		199	(2.3)	205	(2.2)
% Recovery	4		6		0		2		3	
Total Recovery										
% Recovery	25		25		13		41		17	

Note: Numbers in parentheses are number of fish per pound.

Incubation

UPWELLING INCUBATION BOXES FOR ATLANTIC SALMON

SALMO SALAR

by

J.P. Davis, D.J. Meerburg and T.R. Porter
Research and Resource Services
Fisheries and Environment Canada
P.O. Box 5667
St. John's, Newfoundland A1C 5X1
Canada

ABSTRACT

Deep substrate incubators, currently in use for Atlantic salmon enhancement on the Exploits River, Newfoundland are described, both physically and as to their biological usefulness. During their first year of operation (1975-76) two substrates (gravel and AstroTurf) were used; in the second and third years (1976-77, 1977-78) only AstroTurf. Each box produced approximately 400,000 fry with survivals consistently above 80%. Fry quality measurements, including length, weight and developmental condition factors, were compared between substrates, between years and between boxes and the semi-natural fry of a spawning channel. No significant differences ($t._{.05}$) were determined. Water quality measurements indicated that flows used through the boxes were sufficient to maintain the eggs and fry, even at the high energy demand time of hatching to first emergence. Premature emergence (by a week) was controlled by exposing the surface of the substrate with continuous light until the yolk sac was completely absorbed.

The use of upwelling deep substrate incubators will be continued for enhancement purposes. They are relatively inexpensive to construct, require minimum maintenance and manpower, and are capable of producing good quality Atlantic salmon fry.

MASS INCUBATION AT WDF HATCHERIES

by

Robert W. Foster
Washington Dept. of Fisheries

ABSTRACT

Washington Department of Fisheries in current years has had increasing needs for incubation facilities. In efforts to reduce capital costs Washington Pond Trays have been used but in some situations the loss of rearing space has important programming considerations and water quality should be of fairly good quality. Two methods have been developed for the incubation of large numbers of eggs, one involves using existing deep troughs with slotted plate inserts, the other is an adaptation of the upwelling system to a 3 foot x 3 foot tray.

The use of existing deep troughs is economical and space effective. A plate is cut to the dimensions of the deep trough section and rests on the original pegs. In the space where formerly 250,000 eggs were eyed now over 1,000,000 can be eyed with no adverse difference in mortality. At Skagit Hatchery near Marblemount, 1,101,497 coho and chum eggs were incubated in one deep trough and a mortality of 3.3 percent was experienced, the normal percent mortality of control groups ranged from 4 to 5 percent. This method is now being used at other hatcheries with success.

Flows must be carefully watched to prevent agitation of the eggs. The flow in a trough is kept near 6 gpm.

The other method uses an upwelling box built similar to the Japanese eyeing box with the addition of trays. The box is approximately 40 inches square. A plate is used to provide control of inflowing water and a small channel is used to convey the outfall to a drain.

Approximately 500,000 eggs fit easily into the box and 30 gpm is adequate for incubation to the swim-up stage. The large size of the trays requires 2-4 persons to work in the boxes but the volume of eggs handled is large.

The prototypes were constructed of 3/4" exterior plywood and a prototype has been constructed of fiberglass. The trays are constructed of 2" x 2" fir and the screen is 10 mesh fiberglass (13 mil dia.).

Cleaning of the eggs is accomplished by fluctuating the water level. The plate method concentrates the dirt within the first few sections.

Physiology

T201B A NEW SAFE AND POTENT ANESTHETIC FOR FISH

by

Dr. Donald F. Amend and Natalie G. Yusen
Tavolek Inc.

ABSTRACT

Many drugs have been used for non-lethal immobilization of fish, with only one, MS222, having limited approval by the Food and Drug Administration (FDA). All are relatively toxic, have a narrow spectrum of activity on fish, or have undesirable side effects such as involuntary muscle movements.

This report describes a new fish anesthetic that is water soluble, has a wide safety margin on 40 species of teleost fish tested, is effective at one-tenth the concentration of MS222, and does not change the water pH. It has undergone extensive tests in humans and other animals and been approved for use in several European countries. It is safe, non-carcenogenic, non-teratogenic, and is readily metabolized by a single pass through the liver. In animals it is cleared from all tissues within 24 hours.

Because of its potent anesthetic properties and safety, we have evaluated T201B for potential use on fish. After 18 months of testing, both in our laboratory and by various cooperating scientists, we feel it has potential use for: (1) sorting and tagging fish, (2) spawning fish, (3) tranquilizing fish for transportation to reduce stress, (4) collecting fish on reefs or in lakes, (5) research purposes anytime fish must be immobilized for examination.

The effective concentration range for anesthesia is between 1 and 5 ppm. In most cases 2.5 ppm is safe and effective. The induction time to Stage III anesthesia (quietly lying on the side with slow opercular movements) depends upon the dose used, but usually is between 15 seconds and two minutes.

Fish are also tranquilized (the fish is still upright but movement is minimal) at approximately one-tenth the anesthetic dose; 0.04 to 0.16 ppm. Again the effective tranquilizing dose depends upon the species of fish.

The safety margin is at least five-fold. For anesthetic uses, the four minute LC_{50} is between 4 and 80 ppm depending on the species.

T201B appears to have many advantages over MS222 and quinaldine. The longer recovery time of fish in T201B is not believed to be a disadvantage because it gives a person a longer handling time without the fish recovering. In solution it is colorless and odorless, eliminating the obnoxious odor and oily appearance of quinaldine. Although some involuntary muscle movement is encountered with T201B (this usally occurs as an initial jerk when touched), this can be controlled by varying the dosage rate.

Tavolek is currently pursuing registration through FDA. Much work remains especially for metabolite and residue studies. It undoubtedly will be several years before it can be marketed.

EFFECTS OF TEMPERATURE ON GROWTH RATE OF BROOK TROUT, SALVELINUS FONTINALIS

by

William P. Dwyer
U.S. Fish and Wildlife Service

ABSTRACT

Brook trout were acclimated to 4, 7, 10, 13, 16, and 19 C water. Growth rates were measured every 14 days for 140 days.

Temperature units per inch growth were calculated and statistical analysis showed that the 10 & 13 C treatment at 14.7 & 14.5 TU/inch growth, respectively, were significantly lower (more efficient) than the remaining treatments. The 4 C treatment required 38.7 TU/inch growth which was significantly higher.

There were significant differences in growth rates. Statistical analysis of both the fish length and weights showed significant differences. The 13 & 16 C treatments were significantly larger than the 19 C treatment in both length and weight. The 10, 7, and 4 C treatment sizes followed in order.

Condition factors were measured upon termination and increased from .81 at 4 C to a high of 1.25 at 19 C, each treatment being significantly larger than the preceding. Hematocrit, leucocrit and serum protein were analyzed at termination and each showed a general increase with temperature. Hematocrit increased from 34.7%

at 4 C to 44.5% at 16 C then decreased to 37.5% at 19 C. Leucocrit increased from 0.8% at 4 C to 1.36% at 19C. Serum protein increased from 4.2 g/dl at 4 C to a high of 5.95 g/dl at 19 C. However, it should be noted that since the blood work was only done at the end of the growth experiment there is no way to remove the effect of size from the data.

DOWNSTREAM MIGRATION AND GILL (Na + K)-ATPase ACTIVITY IN AN ARTIFICIAL STREAM

by

Charles E. Hart
Oregon Dept. of Fish and Wildlife
Corvallis, Oregon

ABSTRACT

Through the use of Pelton ladder as an artificial stream for studying downstream migration, a strong relationship was noted in 1978 between the timing of migration and peak levels of gill (Na + K)-ATPase activity in hatchery maintained juvenile spring chinook (Oncorhynchus tshawytscha). Similar timing of migration was noted in 1977 without the corresponding elevated levels of gill (Na + K)-ATPase. In both years individual migrants displayed elevated (Na + K)-ATPase levels while low levels were exhibited by nonmigrants. A relationship appears to be present between size and photoperiod such that a critical size is required by a certain point in the photoperiod cycle for the initiation of both downstream migration and increases in gill (Na + K)-ATPase activity. Three models to describe the relationship between the initiation of downstream migration and elevated levels of gill (Na + K)-ATPase were discussed.

BIOASSAYS FOR SCREENING POTENTIAL IMPRINTING ODORANTS

by

W. A. Sandoval and C. B. Schreck
Oregon Cooperative Fishery Research Unit
Department of Fisheries and Wildlife, Oregon State University
Corvallis, Oregon 97331

ABSTRACT

Two short bioassays, orientation conditioning and cardiac conditioning, were used to demonstrate how coho salmon (Oncorhynchus kisutch) can detect, recognize, and discriminate an odor that does not attract or repel fish. Post-smolt salmon at 16.5 cm were used in the tests.

For the orientation conditioning, 25 fish were placed in each of four Y-mazes. Each maze was treated with one of the following compounds: phenethyl alcohol (3×10^{-3}mg/L), morpholine (5×10^{-5}mg/L), phenethyl alcohol and morpholine (3×10^{-7}mg/L and 5×10^{-5}mg/L, respectively), and water (control).

Two trials, scent present (S+) and scent absent (S-), were conducted each day. During the S+ trials, the maze was scented, and those fish moving from the leg of the Y-maze to the scented arm were given a food reward. During S- trials, the fish were observed for an equal period of time but were not given the scent or food. At the end of each trial, the fish in the arm were counted and the number recorded as an S+ or S- response, respectively. The sequence of S+S- observations were randomized to minimize temporal conditioning of the fish. A condition response, fish moving into the arm during

S+ trials and avoiding the arm during S- trials, was demonstrated by the three groups of fish treated with the scents. The phenethyl alcohol-treated group of fish averaged 7 S+ responses and 0 S- responses per day during the last 11 days of the experiment. The morpholine-exposed group averaged 3 S+ and 0 S- responses, and the phenethyl alcohol-morpholine combination averaged 13 S+ and 0 S- responses. The control fish treated with nonscented water averaged 1 response per day for both S+ and S- trials. Each of the three scent-treated groups was presented with the other two scents at the end of the experiment. The phenethyl alcohol-morpholine conditioned group did not respond to the phenethyl alcohol or morpholine scents individually. Neither of the phenethyl alcohol- nor morpholine-conditioned fish responded to the mixture of the two odors, as follows:

		Fish Conditioned To		
		M-P	M	P
Tested Against	M-P	+	-	-
	M	-	+	-
	P	-	-	+

During the Cardiac Conditioning experiment, the fish's heartbeat was monitored during repeated paired presentations of a scent, phenethyl alcohol or water (control), and a mild electric shock. The differences between the average heart rate (beats per 2.5 seconds) just before the scent was added (reference beat) and the average heart rate during the presence of the scent but before the shock (test best) was used as an indicator of a cardiac response. A positive difference indicates the heart rate slowed during the scented period; i.e., cardiac response.

A negative or no difference indicates the heart rate increased or did not change during the scented period; i.e., no cardiac response. The 8 fish tested with phenethyl alcohol showed an average decrease in heart rate of 0.200 heartbeats per 2.5 sec during the last eight trials of the test. The 4 fish tested with water (controls) showed an average increase of 0.283 heartbeats per 2.5 sec during the same period.

The bioassays, orientation conditioning and cardiac conditioning, discussed above, provide a methodology for identifying odor imprinting compounds that will have the greatest probability of success during field test. Cardiac conditioning can be used to determine the minimum concentration of the odor the fish can detect. Orientation conditioning is recommended to be used first to determine the neutrality of the odor with respect to attraction and repulsion of fish and, secondly, to demonstrate that the fish can recognize and discriminate the odor.

VARIATIONS IN PARR-SMOLT TRANSFORMATION OF COHO AND CHINOOK SALMON FROM HATCHERIES IN THE COLUMBIA RIVER DRAINAGE

by

W. S. Zaugg
National Marine Fisheries Service
Aquaculture Field Station
Cook, Washington

ABSTRACT

During the past nine years numerous experiments have been conducted to attempt a determination of the exact relationship between increasing levels of Na^+-K^+ stimulated ATPase (NaK-ATPase) activity in gills of salmonids and transformation to smolts. A great majority of these studies have shown a close relationship between these two phenomena, and also with associated seaward migration and saltwater adaptability. However, the occurrence of an elevation in gill NaK-ATPase activity as an obligatory physiological event in the smolting process has not gone unquestioned.

This year additional evidence was obtained by personnel at the University of Washington and the National Marine Fisheries Service to support the concept that an increase in gill NaK-ATPase activity is indeed an integral part of the smolting process. This evidence, which by itself appears to be an excellent indicator of smoltation, is the observation that serum thyroxine concentrations increase in coho undergoing parr to smolt transformation. Increases in levels of serum thyroxine and gill NaK-ATPase activity were concurrent - both events taking place at the same time in all seven stocks of coho examined.

Gill NaK-ATPase activity was used as a measure of smolitification in several stocks of coho and chinook salmon during the spring and summer of 1978 at several hatcheries in the Columbia River system. These studies indicated the following:

(1) Yearling Carson stock spring chinook held at the Oregon State Marion Forks hatchery underwent more rapid smolitification than yearling spring chinook native to the North Santiam held under the same conditions.

(2) Cowlitz stock yearling coho held at the Oregon State Big Creek hatchery showed approximately a two-week later initiation of the smolting process compared to Big Creek stock.

(3) Gill ATPase profiles of fall chinook from June to September and October at Spring Creek NFH, Bonneville, Willard NFH, and Kalama Falls differed greatly. Differences were apparently due to size, hatchery water temperature, disease and/or disease treatments.

(4) Fall chinook released from Spring Creek NFH (river mile 167) on 19 May at about 45/lb. and an average gill NaK-ATPase activity of 18, were caught at Jones Beach (river mile 47) for a period of 10 days (May 22-31). Fall chinook released from the Kalama Falls hatchery (river mile 85) at a larger size (about 28/lb.) on 15 Sept, with an average gill NaK-ATPase activity of 3, were caught at Jones Beach for a period of 59 days (Sept 16 - Nov 13).

(5) Migrants captured at Jones Beach generally had higher gill NaK-ATPase activities than were observed at release.

(6) Recent observations (November) of decreased gill NaK-ATPase activities and parr-like characteristics in fall chinook captured at Jones Beach raise the question as to the possibility of some fish residualizing in the lower Columbia River.

Nutrition

STABILITY OF ASCORBIC ACID IN MOIST PELLETIZED FISH RATIONS

by

David L. Crawford and Duncan K. Law
Seafoods Laboratory
Department of Food Science & Technology
Oregon State University
250 - 36th Street
Astoria, OR 97103

John W. Westgate
Oregon Department of Fish and Wildlife
17330 S. E. Evelyn St.
Clackamas, Oregon 97015

David A. Leith
Abernathy Salmon Cultural Development Center
U. S. Fish and Wildlife Service, U.S.D.I.
1440 Abernathy Creek Road
Longview, Washington 98632

SUMMARY

A marked loss of ascorbic acid occurs during the preparation, frozen storage and thawing of the Oregon moist ration. Based upon determined levels in a complete dry mix, an estimated 18.9% of the calculated levels of ascorbic acid can be lost during the first 5 min. of mixing wet with dry components. Only an additional 6.9% was lost if mixing was continued 30 min. The displacement of adsorbed gases on the finely divided particles of the dry mix by water yields an initial high level of oxidative potential. The concentration and temperature dependent exponential decomposition of ascorbic acid through preparation to the frozen pelletized state ranged from 18.9% (5 min.) to a range of from 25.8 to 34.8% at 30 min. or the estimated production time for a 1000 lb. batch of formulation.

Ascorbic acid decomposed according to a linear function in frozen storage (-17.5°C; 0°F) at an estimated rate of 0.7 mg/100 gm ration/day yielding a potential loss of 63 mg/100 gm over a 90 day storage period. Alteration of decomposition from an exponential function at temperatures above freezing to a linear function in the frozen state reflected the rate limiting effect of free water over ascorbic acid concentration.

Losses during thawing prior to feeding were markedly dependent upon thawing temperature. A 16-hr. thaw period simulating hatchery practices resulted in a loss of 29.9-53.7% of the ascorbic acid content of the frozen pellet; at 25°C the loss ranged from 89.2-97.2%. The range of decomposition rate emphasized by results observed at 2°C reflected an apparent marked influence of ration component characteristics on the stability of ascorbic acid.

The water content, pH conditions and catalytic cation concentration of the Oregon moist ration highly favors ascorbic acid decomposition. While time and temperature relationships can sometimes improve ration concentrations retained at feeding time, significant improvements would require alterations in the feed system that would be cost prohibitive.

The stability of two commercial sources of ascorbic acid with ethylcellulose ($\simeq$ 1% wt/wt) (Hoffman-LaRoche, Inc.) and partially hydrogenated soybean oil ($\simeq$ 30% wt/wt) (Durkote vitamin C 150-70; Durkee Foods) protective coatings was determined in the Oregon moist ration. The ethylcellulose coated product did not improve stability over the crystalline product. A marked improvement in stability through preparation, frozen storage and thawing was observed for the fat coated product.

Comparisons in identical formula yielded a 32.5% loss for crystalline ascorbic acid over a 3.4% loss for the fat coated product during a 20 min. preparation schedule. The crystalline product decomposed at a rate of 0.7 mg/100 gm. ration/day at -17.5°C (0°F); the decomposition rate for the fat coated product was 0.2 mg/100 gm ration/day. The fat coating transformed the decomposition from an exponential function to a much more temperature independent linear function at temperatures above freezing. Access of water into the coated particle largely defined the rate and course of decomposition. Losses during a 16 hr. thaw of 53.7 and 97.2% for the crystalline product over 14.8 and 24.7% for the fat coated product were observed at 2 and 25°C, respectively.

The protection afforded ascorbic acid by a fat coating from water and its associated soluble components in moist rations could yield a significant improvement in levels available to fish. Relationships observed in comparisons within identical formula matrix showed that a supplementation of 100 mg of crystalline and fat coated ascorbic acid/100 gm would yield an estimated 23.1 and 77.5 mg/100 gm, respectively, through preparation, 30 days storage at -17.5°C (0°F) and a 16 hr. 2°C thaw period. Development of information verifying the bioavailability of ascorbic acid protected with a fat coating would advance the level of nutrition provided fish and provide a potential system for protecting a complete water soluble vitamin complement in moist rations.

CHANGES IN THE ION-BINDING CAPACITY OF HEAT-TREATED SOY

by

John C. Wekell, Research Chemist
and
John Spinelli, Supervisory Research Chemist
Utilization Research Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service, NOAA
U.S. Department of Commerce
2725 Montlake Boulevard East
Seattle, Washington 98112

ABSTRACT

In earlier feeding studies with trout, it was found that the addition of calcium or sodium phytate to casein-based, purified diets caused significant reductions in growth. In other experiments in which soy meal (whole or dephytinized) was substituted for fish meal, reduction in growth was also noted. Furthermore, at high levels of substitution (100%) high mortalities were also observed. In this latter study in which all fish meal was replaced with soy, the survivors were sacrificed and the blood, liver, and kidney were analyzed for zinc. It was found that the zinc levels were significantly lower than those in fish on an OMP (Oregon Moist Pellet) control diet. Even in those fish fed a diet containing dephytinized soy meal, the zinc levels were lower than those in fish on the OMP-control diet but higher than in those on a straight soy-meal diet.

In light of these data and the reported ability of soy and soy fractions to bind various trace metals, in vitro metal-binding studies were instituted that might explain these findings and the poor performance of soy meals in trout diets.

In our studies, soy-bean fractions appear to bind various trace metals to a considerable degree. For example, soy insolubles, prepared by removing the soluble material from defatted soy flour with salt-phosphate buffer, can remove large amounts of ferric and zinc ions from solutions at pH 7.6. With dephytinized insolubles the ability to bind calcium and magnesium ions is reduced sharply; on the other hand, ferric-ion binding remains unchanged, but zinc binding is slightly reduced.

Roasting whole fat soy beans at 230°C (followed by defatting) does not appear to change the insolubles' capacity for iron, calcium and magnesium; however, it appears that zinc binding is increased slightly with longer roasting time (20 min).

If defatted soy flour, prepared from whole soy beans roasted at 230°C for various lengths of time, is exposed to trace metals in buffer, then dialized against the buffer containing EDTA, then fractionated into two obvious fractions (insoluble and supernatant), some differences in binding of metals are observed. In the insoluble fraction there is a decreased affinity for iron (Fe^{+3}) with increased roasting time but no change in binding of zinc, magnesium, or calcium. In the supernatant fractions of the samples given a 20-min roast, the iron concentration increases to almost seven-fold that of the nonroasted soy flour; however, only slight increases in zinc, magnesium, and calcium concentrations are observed with the longer roasting times. If the supernatant fraction is treated with an equal volume of ethanol and the precipitated material is analyzed for metals, it is found that the iron concentration in the precipitate increases dramatically (about ten-fold) with longer roasting times (up to 20 min), while the other metals (zinc, magnesium, and calcium) increase slightly.

Soy insolubles appear to have a high capacity to bind iron and zinc. However, in the presence of EDTA, binding of iron and zinc to soy insolubles is drastically reduced. This is in accord with reports that the inclusion of EDTA in some poultry diets appears to increase zinc availability. Our laboratory findings indicate that endogenous phytate may play a role in binding of calcium and magnesium, but its role in binding of zinc and iron is not clear. In fact, our findings indicate that other factors may be involved in the binding of iron and zinc.

Disease

LABORATORY AND FIELD CHALLENGES OF STEELHEAD TROUT VACCINATED AGAINST ENTERIC REDMOUTH DISEASE

by

Kevin H. Amos
Washington Department of Game

ABSTRACT

Steelhead trout at the South Tacoma hatchery (Washington Department of Game) were vaccinated against enteric redmouth disease using the submersion method in 1976, 1977, and 1978. No clinical ERM was observed in either the vaccinates or the controls at any time during the past three years.

At the same time, in addition to the vaccination program, an overall health management program was in effect.

This past year laboratory challenges have been taking place at the Evergreen State College. Four treatment groups were challenged with varying levels of live bacteria. The four groups were:

1) vaccinated once with a saline pre-dip,
2) vaccinated once without a saline pre-dip,
3) vaccinated twice with a saline pre-dip both times, and
4) an untreated control.

The results indicate that the immunized fish had twice the survival over the unimmunized controls. The data also seems to indicate the saline pre-dip is unnecessary in the vaccination procedure.

CELLULAR ANTIBODY RESPONSE IN RAINBOW TROUT TO YERSINIA RUCKERI O-ANTIGEN

by

Dr. Douglas P. Anderson
U. S. Fish and Wildlife Service
National Fish Health Research Laboratory
Kearneysville, West Virginia

ABSTRACT

Rainbow trout were exposed to a Yersinia ruckeri O-antigen preparation by pouring the antigen suspension into the ambient water. The passive hemolytic plaque assay was used to follow the resultant occurrence of specific antibody producing cells in the fish spleens by isolating the individual leukocytes from the organ and placing the suspension into an agar matrix with sheep red blood cells labeled with the Y. ruckeri O-antigen. After the agar solidified, complement was overlaid on the agar slide, activating the lysis of the labeled sheep red blood cells surrounding the leukocytes producing the specific antibody. The specific antibody producing cell could be observed by microscope in the center of the plaque.

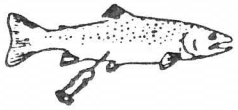
At Leetown, West Virginia, where spring water temperatures of 11± 1°C are constant throughout the year, antibody producing cells were first detected in fish on day 9 after antigen exposure, maximum numbers of cells were detected on day 16, and few were found after day 23. The circulatory antibody was not detected until 20 days after exposure; maximum titers were detected on day 30.

It is believed that the passive hemolytic plaque assay is a good method for early detection of the efficacy and potency of bacterins and vaccines in fish, provided the antigen can be effectively attached to the surface of the heterologous red blood cell as has been done with this model using the Y. ruckeri O-antigen.

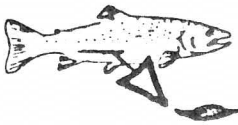
SCHEMATIC DIAGRAM

PASSIVE HEMOLYTIC PLAQUE ASSAY

INJECT TROUT WITH ENTERIC REDMOUTH (ERM) DISEASE O-ANTIGEN



SAMPLE SPLEEN AFTER HOLDING FISH 2 WEEKS AT 17°C



MACERATE SPLEEN TO DISPERSE CELLS

FILTER CELL SUSPENSION TO REMOVE CLOTS

SHEEP RED BLOOD CELLS (SRBC)

ERM O-ANTIGEN

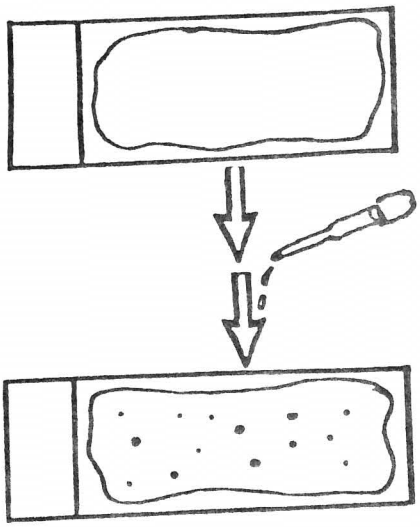
LABELED SRBC

WARM, FLUID AGAROSE

MIX IN TEST TUBE, POUR ON SLIDE, SET TO GEL

INCUBATE 4 HOURS THEN ADD COMPLEMENT

AFTER 2 HOURS, CLEAR PLAQUES APPEAR AROUND TROUT LYMPHOCYTES RELEASING SPECIFIC ERM ANTIBODY THAT LYSES ERM-LABELED SRBC



BIOLOGICS: THEIR PREPARATION AND DISTRIBUTION

by

Ora W. Dixon
U. S. Fish and Wildlife Service
National Fish Health Research Laboratory
Kearneysville, West Virginia

ABSTRACT

The Biologics Section of the National Fish Health Research Laboratory was begun in 1974. The development of this service stemmed from the need for biological reagents for rapid serodiagnosis of fish diseases. Primary objectives include the production of antisera and antigens and providing standardized protocols to aid the diagnostician in more rapid approaches to solving disease problems by immunological methods. The section is staffed by Dr. Douglas P. Anderson and Mrs. Ora W. Dixon.

The Biologics Section contributes to fish health by providing a service that reaches personnel interested in fish health, such as diagnosticians, researchers, or fish culturists -- commercial, Federal, state, or university based. Primarily, the Section functions for the U. S. Fish and Wildlife Service and has primary obligations and responsibilities to Federal hatchery biologists. There is no charge for the reagents which are made available upon receipt of letterhead request, so that documentation and justification of the services are provided.

A great quantity of individual antisera have been distributed since 1974. Requests have been filled from foreign countries and most areas of the United States and the District of Columbia.

International distribution of biological reagents, in addition to continuous feedback of results, proves that concern for improving fish health is shared worldwide. The Biologics Section will endeavor to improve present standardizations and continue to provide service to fish health personnel.

BIOLOGICS FILE -- GENERIC LIST

ANTISERA

VIRAL DISEASES

polyvalent infectious pancreatic necrosis virus (IPNV)

infectious hematopoietic necrosis virus (IHNV)

viral hemorrhagic septicemia virus (VHSV, Egtved)

channel catfish virus (CCV)

duck viral enteritis (DVE)

anti-*Herpesvirus salmonis*

BACTERIAL DISEASES

Cytophaga psychrophila (coldwater)

Flexibacter columnaris

Psuedomonas fluorescens

Edwardsiella tarda

Aeromonas hydrophila (liquefaciens)

Vibrio anguillarum (Manchester)

Vibrio anguillarum (1669)

Aeromonas salmonicida (furunculosis)

Corynebacterium salmoninus sp. n. (bacterial kidney disease)

Yersinia ruckeri (enteric redmouth)

REFERENCE CONTROL SERUMS

goat normal (preimmunization)

rabbit normal

EXPERIMENTAL REAGENTS

anti-lysozyme

rabbit peroxidase antiserum

rabbit rainbow trout whole serum antiserum

rainbow trout immunoglobulin

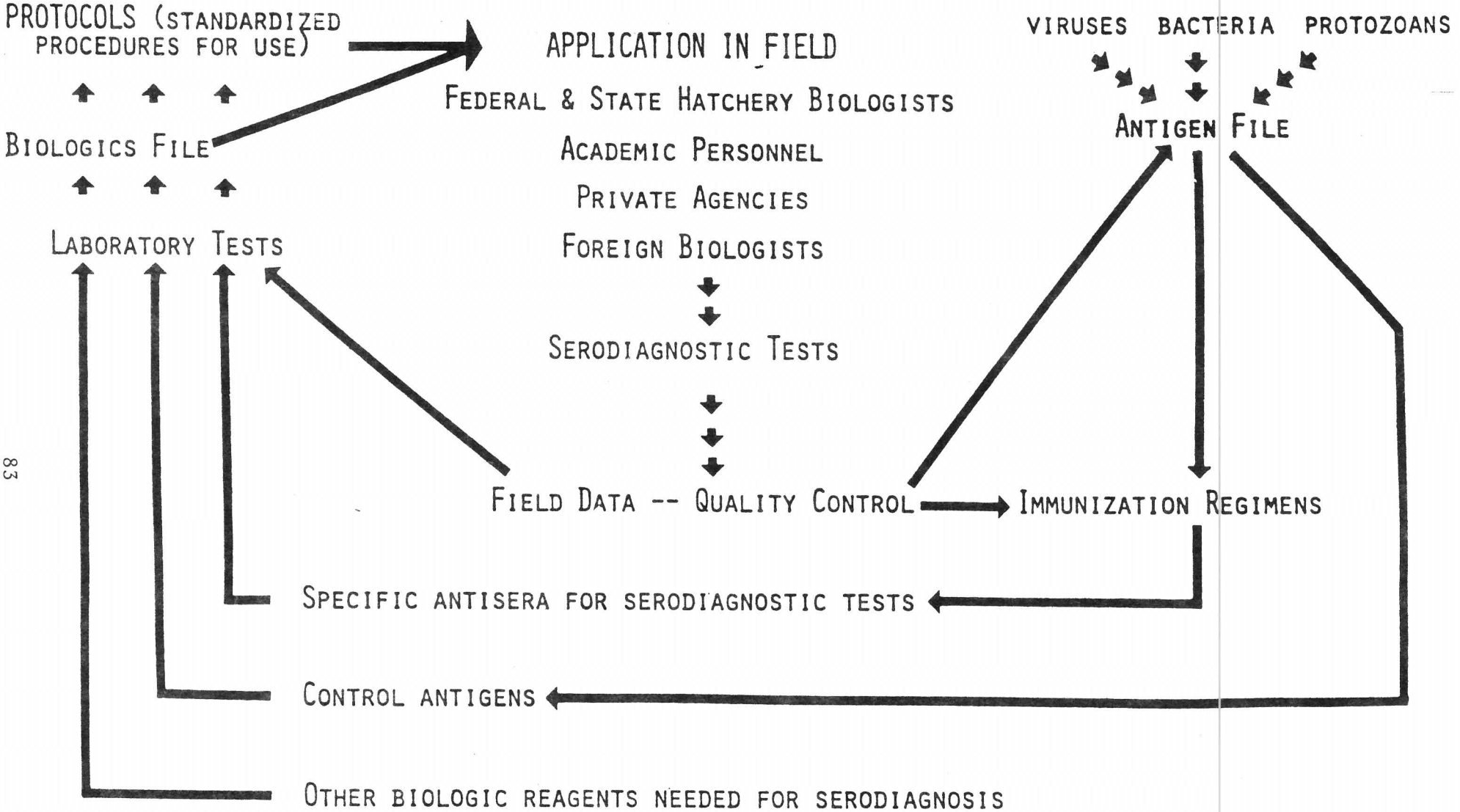
for fluorescent antibody tests

FITC labeled goat anti-kidney disease

FITC labeled rabbit anti-*A. salmonicida*

FITC labeled rabbit anti-*V. ruckeri*

Biologics
National Fish Health Research Lab.
Route 3, Box 50
Kearneysville, West Virginia 25430



BIOLOGICS ORGANIZATIONAL FLOW CHART

NATIONAL FISH HEALTH RESEARCH LABORATORY

KEARNEYSVILLE, WEST VIRGINIA

ONSET AND DURATION OF IMMUNITY OF SIX SALMONID SPECIES VACCINATED WITH HIVAX* VIBRIO ANGUILLARUM BACTERIN

by

James K. Flynn
Tavolek Inc.

ABSTRACT

Salmonids immersed in properly prepared Vibrio bacterin have been protected against Vibrio anguillarum. The onset and duration of immunity are important from a management and economic standpoint.

Six species of salmonids were vaccinated with HIVAX Bacterin by the immersion method at various sizes from 0.2g to 4.5g per fish. The vaccinated groups were challenged periodically up to 500 days post-immunization.

Onset of immunity occurs with coho, sockeye, chum and pink salmon when vaccinated at one gram. Chinook salmon and rainbow trout must be 2.0 gram at vaccination to develop immunity.

Size of fish at immunization and not age is the more important factor in determining onset of immunity.

Duration of immunity varies with size at vaccination and with species of fish. The larger the size at immunization the longer the duration of immunity. For duration longer than one year, salmonids should be larger than three grams at vaccination.

RELATIONSHIP BETWEEN VIBRIOSIS SUSCEPTIBILITY AND FISH LOADING DENSITY

by

Rowan Gould and Stan Smith
U. S. Fish and Wildlife Service

ABSTRACT

Rainbow or steelhead trout (Salmo gairdneri) as well as coho salmon (Oncorhynchus kisutch) were placed at various loading densities ranging from 0.5 to 4.6 lbs. per ft^3 in 83 L holding troughs receiving 2 L per min. of 20 ppt brackish water (11.5 - 7 C). Subsequently, groups were challenged by waterborn exposure to equal concentrations of virulent, Type I Vibrio anguillarum (HI-163). Results of three rainbow and steelhead challenges demonstrate that mortality increases as the loading densities increase, especially at the highest loading densities. Parallel challenge of rainbow trout and coho salmon with the same bacterial culture resulted in significant mortality in the trout groups and insignificant mortality in the salmon groups. Mean-time-to-death within a challenge did not change at the lower loading densities but was shorter at the high density. Ambient water temperature in the troughs decreased during the timespan challenges were performed. The mean-time-to-death increased significantly as temperature decreased.

THE EFFECT OF CHORIONIC GONADOTROPIN AND FOLLICLE STIMULATING HORMONE ON ASYMPTOMATIC CARRIER SOCKEYE SALMON FEMALES AND IMPLICATIONS OF INFECTIOUS HEMATOPOIETIC NECROSIS VIRUS CONTROL

by

Roger S. Grischkowsky
Fisheries Rehabilitation Enhancement
and Development Division
Alaska Department of Fish and Game

Daniel M. Mulcahy
National Fisheries Research Center
U.S. Fish and Wildlife Service

ABSTRACT

In order to better support hatchery egg take operations and provide data for egg source decision making attempts were made in 1977 and 1978 to accelerate ripening of sockeye salmon (Oncorhynchus nerka) females using gonadotropins. The experiments in 1977 utilized human chorionic gonadotropin (HCG, 1.2 IU/g) and follicle stimulating hormone (FSH 0.005 U/g) and were conducted by both authors and their parent agencies. The 1978 experimentation used only FSH (0.024 and 0.005 U/g) and was accomplished by the senior author and his co-workers. Field work was conducted in the Lake Nerka area, Wood River system in north Bristol Bay Alaska. Injections were intraperitoneal. Analyses included a statistical coverage of maturation data for both years, an infectious hematopoietic necrosis (IHN) virus incidence of ovarian fluid and IHN virus 50% tissue

culture infective dose ($TCID_{50}$) determination for 1977 only. The 1977 experiments were conducted for 5-6 days and were terminated by bears. In 1978 samples were collected through to death of all the fish which took 17 days post injection.

No accelerated maturation was present in 1977 but was readily apparent in 1978 for FSH. Viral incidence was not affected by hormone treatment but titers were reduced with the addition of FSH and increased by HCG ($p < 0.001$). FSH depressed the level of IHN virus in carrier fish as much as 3 logs after injection. A comparison of the overall mean $TCID_{50}$/ml values indicated HCG 1.37 logs higher than its control and FSH 1.79 logs lower than its control.

FSH at both levels in 1978 ripened sockeye to the ripe-wet egg stage ($p < 0.005$ to < 0.001) and to the combined ripe-dry egg and ripe-wet egg stage ($p < 0.025$ to < 0.001). FSH also caused a decrease in the number of green (immature) fish compared with controls ($p < 0.025$). Acceleration of ripening with addition of FSH was dose dependent with the higher level exhibiting the fastest reduction in the number of green fish ($p < 0.005$), increase in the numbers of ripe-wet fish ($p < 0.001$), increase in the numbers of ripe-dry plus ripe-wet fish ($p < 0.001$) and increase in the number of dead fish following sequential maturation through ripe-wet stage ($p < 0.005$). No correlation was present between the addition of FSH and the spawn out condition. The median points for the developmental stages provide a rough guide to the number of days maturation was accelerated. Between the higher dose level and the control are 2 days for the green stage and the ripe-wet stage and 3 days for the death stage. Between the two

doses of FSH are 2 days for the green stage, 1 1/2 days for the ripe-wet stage and 1/2 day for the death stage.

Viral incidence and $TCID_{50}$ ovarian fluid samples for the 1978 experiment will be analyzed for IHN virus control implications.

THE "ONE-EYE" DISEASE OF RAINBOW TROUT (*Salmo gairdneri*) AT THE KOOTENAY TROUT HATCHERY IN BRITISH COLUMBIA

by

George K. Iwama
Fish and Wildlife Branch
British Columbia

ABSTRACT

Several physical characteristics and the mortality pattern of a disease called "one-eye" in rainbow trout fry reared at a British Columbia hatchery are presented. Experiments were conducted with production fish to study the effects of elevated temperature, low loading density, different commercial diets and reduced pond surface abrasion on the occurrence and incidence of eye damage. All factors except diet had no significant effect on either the normal occurrence and incidence of eye damage or on the mortality levels. Clark's diet inhibited the incidence of eye damage during the months when the highest mortalities and incidence of eye damage occurred. Horizontal transmission of this disease did not occur. A pathogen associated with this condition of eye loss was not found.

DEVELOPMENT OF A COMMERCIAL VACCINE FOR ERM

by

Dr. Keith A. Johnson
Tavolek Inc.

ABSTRACT

A licensed, commercial vaccine for REMOVAX* Enteric Redmouth Bacterin has been developed by TAVOLEK for immersion or shower delivery. These delivery systems allow for rapid mass immunization of salmonids. Both delivery systems have resulted in protection from waterborne challenge by Yersinia ruckeri in the laboratory and under culture conditions in the field.

Continuing laboratory tests have shown that rainbow trout can be successfully protected by the 20 second immersion method after they reach a size larger than two grams (225/lb.). Protection in fish this size continues at a diminishing level through 250 days. More solid protection which should continue for a longer period of time has been obtained with fish larger than three grams (150/lb.). Field duration of immunity tests have confirmed results and were used to formulate the recommendation that rainbow trout, steelhead and chinook salmon be vaccinated by the immersion method at a minimum size of three grams to provide sufficient protection during hatchery residence.

*Trademark

Serological and cross protection studies have been done with a variety of isolates from North America. The results indicate that protection following vaccination with REMOVAX Bacterin was effective against challenge with all isolates tested.

VIRAL ERYTHROCYTIC NECROSIS DISEASE:

INCIDENCE, TRANSMISSION AND IMPLICATIONS

by

Dan Mulcahy and John R. MacMillan
National Fisheries Research Center
Seattle, Washington
U. S. Fish and Wildlife Service

ABSTRACT

Viral Erythrocytic Necrosis (VEN) formerly Piscine Erythrocytic Necrosis (PEN), is a disease described in at least 20 marine fish species from the Atlantic Coast. On the Pacific, the disease has been found to occur in chum and pink salmon and Pacific herring. The disease is diagnosed by examination of stained blood smears for the presence of basophilic, round inclusion bodies in erythrocytes.

We have found VEN in returning adult chum salmon from 4 of 5 Puget Sound hatcheries. The infection rates ranged from 3% to 17%. Herring collected in Puget Sound had an infection rate of 43% in young-of-the-year fish to 4% in fish 4-8 years old.

All the salmonid species tested were susceptible to VEN virus by intraperitoneal injection of infected chum blood, when fish smaller than 1.2 g were used. Larger fish were often refractory to infection. When fry were used, all individual fish of susceptible size developed the disease, with the time required for the appearance of inclusions varying from 2 days (chum salmon, brook and brown trout) to 7 days (rainbow trout). Larger fish of each species

required longer periods to develop characteristic inclusion bodies. Inclusion bodies were never seen in control fish. When injected with VEN-infected blood from Pacific herring, 100% of chum salmon fry developed the disease. Water borne transmission of the disease occurred with chum salmon, and brook trout, but not pink salmon or rainbow trout.

Artificial infection of fish with EN virus caused a significant erythroblastosis in 2-3 weeks. Before this, hematocrits in chum salmon fry fell from 40% to as low as 4% within 28 days. Individual hematocrits were as low as 2%. Although anemia can be severe, death directly attributable to VEN is rare. Secondary effects of the infection may be more significant. Fish with VEN were 2.6 times more susceptible to Vibrio anguillarum than were control fish, with the mortality occurring sooner.

Fish with VEN (mean hematocrit 15%) succumbed to dissolved oxygen levels of about 2-5.5 ppm while control fish (mean hematocrit 31%) survived until lower oxygen concentrations (0.9 - 2.4 ppm). The oxygen concentration present at the time of death was highly correlated with the degree of anemia.

Fish with VEN are less tolerant of osmotic shock as measured by serum sodium levels and hematocrit upon seawater challenge. Serum sodium levels in infected fish had a greater variation than in control fish.

THE USE OF SEAWATER TO CONTROL *Saprolegnia* ON THE EGGS OF PINK SALMON (*Oncorhynchus gorbuscha*)

by

Sidney G. Taylor
Northwest and Alaska Fisheries Center Auke Bay Laboratory
National Marine Fisheries Service, NOAA
P.O. Box 155, Auke Bay, AK 99821

ABSTRACT

Seawater was tested as a fungicide on pink salmon (*Oncorhynchus gorbuscha*) eggs in two experiments at Auke Creek Hatchery, southeastern Alaska. *Saprolegnia diclina* was the only fungus found on infected eggs and it was effectively controlled with seawater treatments. In the first experiment, involving gravel incubators, survival from fertilized eggs to fry was 68% with seawater treatments and 41% with no treatments. The survival difference between treated and nontreated incubators was significant. In the second experiment, involving standard tray incubators, survival from the green to eyed egg stage was 96% when seawater was used, 1977 brood, and 95% when malachite green was used, 1971 to 1976 broods. The survival difference between seawater and malachite green treatments was not significant. It appears that seawater treatments are a safe, effective method for controlling fungus on pink salmon eggs.

A SUMMARY OF THE BACTERIAL KIDNEY DISEASE PROGRAM AT RAPID RIVER CHINOOK SALMON HATCHERY

by

L. R. Wimer
Idaho Department of Fish and Game
Rapid River Hatchery
Riggins, Idaho

INTRODUCTION

Rapid River Hatchery, constructed in 1964 by Idaho Power Company and operated by the Idaho Department of Fish and Game, had been on the line for only a short five year period when the first devastating outbreak of bacterial kidney disease (BKD), Corynebacterium spp. occurred.

From October, 1969 to February, 1970 an epizootic of such magnitude occurred that during March of 1970 it became necessary to destroy and bury nearly 1.8 million presmolts of the 1968 brood year. In December of the following year another outbreak of BKD was eminent. BKD increased until liberation during March when direct contact with the fish was no longer possible. It was noted during that outbreak that most of the mortality due to BKD was found in the group of fish handled and marked during October, 1971. 12.5% of the marked fish died from BKD during that outbreak while less than one percent of the unhandled fish died. A further look into the 1969-1970 manifestation showed that these fish too had been handled, due to overcrowded

conditions, prior to that outbreak. Little was then known about the causative agent for BKD but the general opinion at the hatchery was that the handling of the fish during the late summer and fall months had caused the problems. Therefore, it became hatchery policy to not handle any of the presmolts after July 1 and all fish used for pound counting were to be released into the river and not back into the rearing facilities. If losses could be minimized using these techniques, BKD could be lived with...

In 1973 another aspect of the problem became evident. 37% of the returning adults died in the holding ponds before spawning. Nearly all of these prespawning mortalities exhibited visible lesions of BKD, as did 49% of the spawned fish. Approximately 6,600,000 eggs had been lost due to the mortality. This kind of a loss could not be lived with...

Assistance from the Dept. of Fishery Resources at the U. of I., Moscow, Idaho was requested and a BKD control program was initiated.

METHODS AND RESULTS

In 1974, three 100 fish lots of the returning adults were given subcutaneous injections of Erythromycin phosphate (Abbott), Spectinomycin (Abbott), and distilled water. Only four of the Erythromycin PO_4 injected fish showed visible signs of BKD at spawning time or as pond mortalities. It was then decided that a subcutaneous injection of Erythromycin PO_4 at 5 mg(active)/lb (11 mg/kg) of body weight, along side the anterior insertion of the dorsal fin would be an effective means of control.

In 1974 and 1975 selected egg takes were water harderned immediately after fertilization in a 2 mg/l aqueous solution of Erythromycin PO_4 for 30 to 60 minutes. Resultant fry and controls were reared at the hatchery and examined at the U. of I. The untreated lots developed BKD while the treated ones did not. A beneficial spin-off from this treatment was that the treated eggs developed less fungal invasion prior to hatching.

Flooding during 1974 made it necessary to move four raceways of presmolts from the 1973 brood to other raceways during the late summer months. This late handling apparently precipitated another outbreak of BKD. Erythromycin (Gallimycin - 50) was top dressed to the OMP II feed at a rate of 4 gm(active)/100 lbs. body weight and fed to three of the four raceways for 14 days. At the end of the treatment the incidence of visible BKD lesions in the mortality had dropped from 100% to approximately 25% in the treated groups while the untreated fish experienced a 100% incidence. Mortality was never high in any of the four raceways and three to four weeks after treatment, incidence of BKD lesions was equal among all raceways. It became apparent that a 21 day treatment was necessary.

In 1975, two of every three returning adults were given the subcutaneous injection with a Cornwall pipetting system. Of the injected adults that survived to spawn, four percent had BKD lesions opposed to 31% in the uninjected spawners. Total mortality had decreased to seven percent from 37% in 1973 and 26.7% in 1974.

In October of 1975, the presmolts of the 1974 brood year were administered a 21 day prophylactic feeding of Gallimycin-50 at 4 gm/100 lbs. body weight. No clinical outbreak of BKD occurred in these fish.

In 1976, 4,210 of the returning adults were given a single injection of Erythromycin PO_4, 2,032 were given a double injection (the second approximately 30 days after the first), and 100 fish were left uninjected. Total pond mortality that year was 14.5%. Percent visible lesions in the pond mortality was 2.5% in those injected once and 0.6% in those injected twice. Percent visible lesions in the spawned fish was 5.6% - injected once and 2.6% - injected twice. Visible lesions occurred in the uninjected fish at a rate of 11% in the spawned fish and 100% in the pond mortality.

5,000,000 eggs were water hardened in a 1 mg/l solution of Erythromycin PO_4 for one hour immediately after fertilization. 8,000,000 eggs were left untreated and shipped to other stations. The results, as reported by the U. of I., were the same as during 1975.

During October, the 21 day Gallimycin-50 prophylaxis was administered to the 1975 brood year presmolts with the same favorable results as before.

The returning adults arrived early enough in 1977 to enable us to give each of them two injections with the following results: Total mortality - 10.8%, visible BKD lesions in pond mortality - 0.6%, visible BKD lesions in spawned fish- 0.74%.

9.2 million of the eggs taken in 1977 were treated as in 1976 and 4.8 million were left untreated. Results proved as beneficial as before. Again, the 1976 brood year presmolts were given the 21 day Gallimycin-50 treatment. No BKD occurred in these treated fish.

Methods had to change during 1978 and a noticeable change in results also occurred. The water soluble, crystalline form of Erythromycin PO_4 was no longer available which necessitated the use of the large animal injectables "Erythro-200" and"Gallimycin-200" (Erythromycin, Abbott). Each of these formulations contain 200 mg/ml Erythromycin PO_4 in an oil base. These much thicker formulations required the use of a Roux Multidose syringe instead of the Cornwall pipetting system. 3,735 returning adults were given a single injection at a rate of 11 mg/kg, and 2,000 received two injections (approximately 30 days apart) of the same products at the same rate. Approximately one half of the injections were subcutaneous as before and one half directly into the dorsal sinus. Two 100 fish lots of the adults were tagged according to injection type and no differences were apparent in effectiveness. Total mortality for the 1978 brood fish was 20.8%. Incidence of visible BKD lesions in the injected pond mortality was 7.6% in those injected once and 6.8% in those injected twice. Incidence of lesions in the spawned fish was 9.3% - injected once and 8.6% - injected twice.

The resultant 10,000,000 eggs from this year's fish, except for a small control lot, were water hardened in a sugar based formulation of Erythromycin PO_4, "Gallimycin PFI - Poultry Formula Improved" at a

rate of 1 mg/l for one hour. The experimental and control lots are still under investigation at the U. of I. Eye up at the hatchery was approximately 2.5% lower than in the past; however, our colleagues at the Dept. of Fishery Resources, U. of I., have stated that preliminary findings are proving this formulation to be as effective in combatting BKD as the pure, crystalling form.

The 1977 brood year presmolts did not receive the 21 day treatment of Gallimycin-50 this year. No clinical signs of BKD have been noted.

DISCUSSION

The water soluble, crystalline form of Erythromycin PO_4 appears to be the ideal formulation for treatment of BKD at Rapid River whether in injecting adults, feeding presmolts, or water hardening eggs. The inability to acquire the drug in this form during 1978 resulted in unexpected problems during the injection phase of the program. The Cornwall pipetting system used in the past had to be abandoned because the spring and valve assemblies became clogged with a fatty precipitate and became inoperable. The system was replaced by the Roux multi-dose syringe. Initially, 16 and 18 gauge needles were used with the Roux syringe but these produced a hole large enough for much of the injected substance to escape. Filling with 20 gauge needles became too difficult due to the viscosity of the formulations so it became necessary to fill the apparatus with a 16 gauge needle and administer injections with a 20 gauge needle.

The results of these injections do not show as favorably in 1978 as in the previous four years. Many factors such as timing of

brood entrance to the facility, water conditions, new drug formulations, incidence of BKD in parent fish, etc., could have caused these results. The over enthusiastic approach to using Erythromycin PO_4, in any form, resulted in all fish being injected with the new formulations this year leaving no uninjected fish for control. The drugs had been used successfully at other stations during the past year precluding concern over ill effects from these formulations; but the fact that no control was used in the program this year makes it impossible to state whether or not the large animal injectable, oil based formulations are as effective or less effective than the pure crystalline form of Erythromycin PO_4.

The customary prophylactic feeding of Gallimycin-50 was not administered to the 1977 brood presmolts this year because all the eggs from which these fish resulted were water hardened with the drug. It is the opinion at the hatchery that the main reservoir for BKD at Rapid River is the diseased female and the vector for the disease is the infected egg. As of this date, not one presmolt of this year class has shown clinical signs of an infection of BKD.

If this trend continues, it may only be necessary to inject returning adults and water harden resultant eggs with Erythromycin PO_4 for an adequate BKD control at Rapid River.

Management

AN APPROACH TO SYSTEMS ANALYSIS OF FISH HATCHERY PERFORMANCE

by

Phil Downey
Fishery Resources
University of Idaho

ABSTRACT

An aquaculture system is composed of at least 46 factors, which can be categorized into five identifiable components; namely, fish, water, container, nutrition, management.[1] Each factor (such as feeding rate, water flow, etc.) directly affects overall production; i.e., growth, in a fish culture facility. In addition, many of these factors can interact with other factors and thereby alter production indirectly. In the past, a great deal of emphasis has been placed on the direct effects of a particular factor with little attention directed to how it might interact and indirectly influence overall productivity. Systems analysis, however, attempts to assess all effects, interactive and direct, to determine the overall production of a system.

To illustrate how various factors might interact and indirectly affect production, consider the following example. To meet new production goals, a fish culturist wants to increase the growth rate of his fish. To accomplish this task he begins feeding the fish more, increasing the feeding rate from 2.4% to 3.2% of body weight per day. A few inventory periods later he discovers that the fish are not

---

[1] Klontz et al. 1978.

growing at this new anticipated growth rate. What could possibly have happened? In this example there are four ways by which increasing the feeding rate can alter growth and production of a facility (Fig. 1). Food could be assimilated, converted to fish biomass and thus, enhance overall production (path 1). The remaining three ways, which indirectly affect growth and production are actually detrimental to production goals. Increasing feed results in higher ammonia-nitrogen levels in the water. If ammonia-nitrogen concentration exceeds 0.012 ppm, gills become hyperplastic, and oxygen transport across the gills decreases (path 2). In addition, fish are producing more carbon dioxide (CO_2). CO_2 decreases the oxygen affinity and carrying capacity of blood hemoglobin (path 3). More food means more solids in the ponds. Solids decrease the amount of oxygen available to fish by increasing the oxygen demand on the system (path 4).

At this point one might ask to what extent does each path influence overall production? To answer this question more exact information would be required. These qualitative relationships, depicted above, need to be transcribed into exact mathematical relationships. External factors, such as temperature and pH of the water, need to be included, since they dictate the rate at which these various chemical reactions occur. In short, presently it is difficult to evaluate precisely the actual contribution of each path to the net production of a system.

In conclusion, a simple management process, increasing feeding rate, can, directly and indirectly, affect production of a facility. Systems analysis considers all relationships in an effort to assess the net effect of a particular management strategy on the system's production.

REFERENCE

Klontz, G.W., I.R. Brock and J.A. McNair (1978): Aquaculture Techniques: Water Use and Discharge Quality. Res. Tech. Compl. Rept., Proj. A-054-IDA.

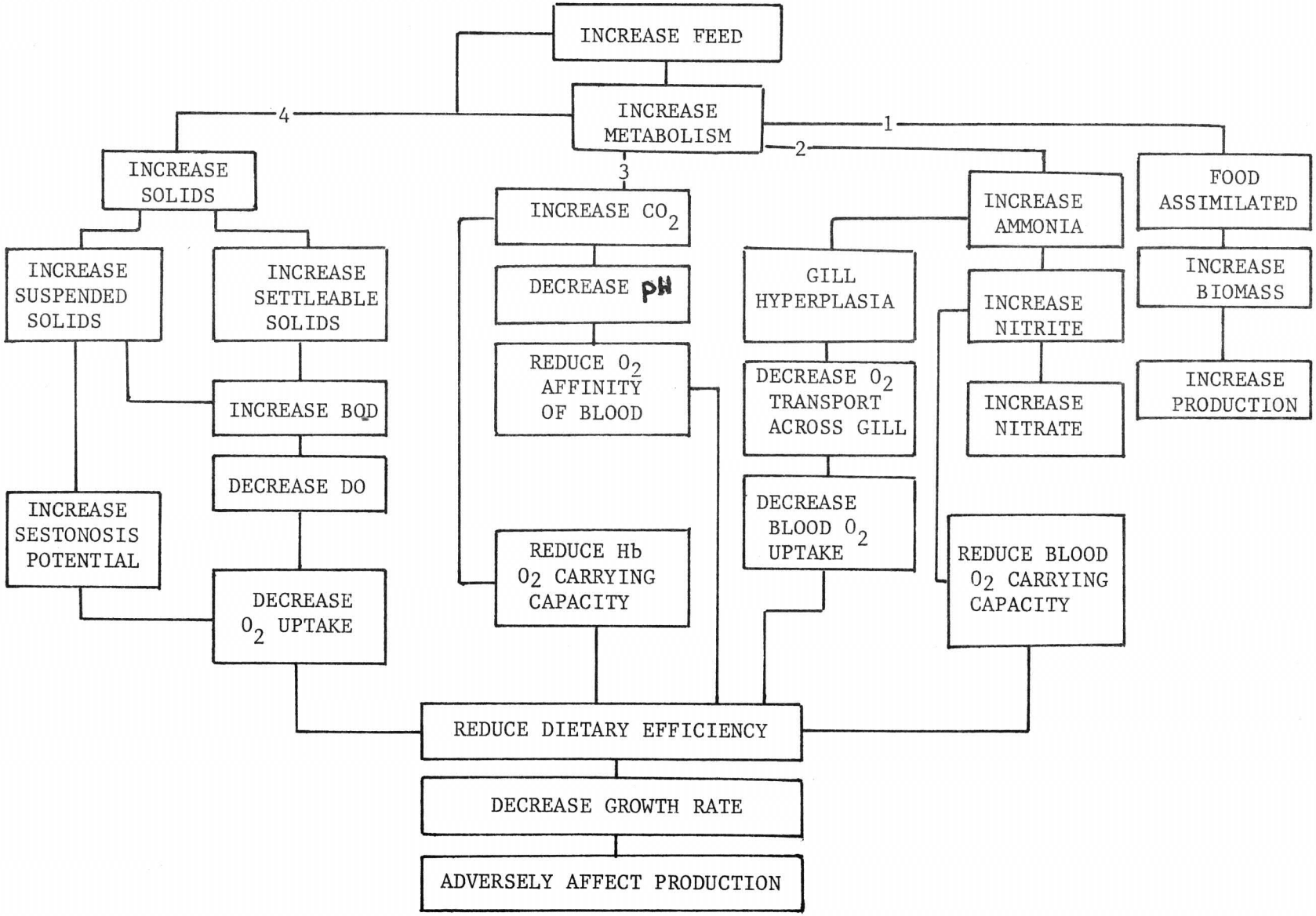

INCREASE FEED
INCREASE METABOLISM
4
1
2
3
INCREASE SOLIDS
INCREASE CO_2
INCREASE AMMONIA
FOOD ASSIMILATED
INCREASE SUSPENDED SOLIDS
INCREASE SETTLEABLE SOLIDS
DECREASE pH
GILL HYPERPLASIA
INCREASE NITRITE
INCREASE BIOMASS
REDUCE O_2 AFFINITY OF BLOOD
DECREASE O_2 TRANSPORT ACROSS GILL
INCREASE NITRATE
INCREASE PRODUCTION
INCREASE BOD
DECREASE DO
INCREASE SESTONOSIS POTENTIAL
DECREASE BLOOD O_2 UPTAKE
REDUCE Hb O_2 CARRYING CAPACITY
REDUCE BLOOD O_2 CARRYING CAPACITY
DECREASE O_2 UPTAKE
REDUCE DIETARY EFFICIENCY
DECREASE GROWTH RATE
ADVERSELY AFFECT PRODUCTION

Figure 1.

PREDICTING WEIGHT GAIN OF FISH IN AN AQUACULTURE SYSTEM

by

Rick Focht
Fishery Resources
University of Idaho

ABSTRACT

Currently, estimation of feeding rates is being done using either the feeding chart method prepared by Deuel et al. (1952) or the feeding formula method developed by Haskell (1959). Each method has its disadvantages which may lead to significant errors in estimating feeding rates.

Data from a feeding trial showed that groups of fish fed for a specific weight gain consistently fell short of the expected values, even though the predicted growth rates were 80% of the maximum for a specific water temperature. From this study the question was asked: "What is a realistic method for estimating weight gain which takes into account other growth-influencing factors found in an aquaculture system?"

In a study currently underway growth rates will be evaluated under several different environmental situations. In addition, factors affecting feeding efficiency will be studied, the most important one being diet quality. Proximate analyses will be done on samples of fish, feed and feces to determine the nutrient composition and digestible energy content of a particular lot of feed. An indirect method of determining digestibility, using a nonabsorbable indicator in the feed, will also be tested.

REFERENCES

Deuel, C.R., D.C. Haskell, D.R. Brockway and O.R. Kingsbury (1952): New York State Fish Hatchery Feeding Chart, 3rd Ed. N.Y. Conservation Dept., Albany, N.Y.

Haskell, D.C. (1959): Trout Growth in Hatcheries. New York Fish and Game Journal 6(2):204-237.

AN INCREMENTAL SAMPLER

by

Robert W. Foster
Washington Department of Fisheries

ABSTRACT

During 1978 it was proposed to begin a several year program of coded-wire tagging a fixed percent of all coho and chinook releases from many WDF facilities.

It was necessary to develop a rapid and gentle way to sample a fixed percent of a possibly unknown sample randomly. Previously the 'pie sampler' was the accepted method but this was laborious. The advent of the tomato pump for fish movement provided and ideal transportation system and efforts were directed towards developing a mechanical sampling apparatus which could be combined with the pump.

The method chosen was to make a unit consisting of a dryer to remove the majority of the water from the fish, a sampler section with two water jets to control fish direction and a system of hoses to return the fish to the pond (figure 1). The action of the jets is similar to the quality control mechanism of the coded wire tag machine. The two water jets (figure 2) are controlled by solenoids activated by a digital valve sequencer developed by Keith Jefferts of Northwest Marine Technology. The unit is powered by two 12 volt wet cells attached in series.

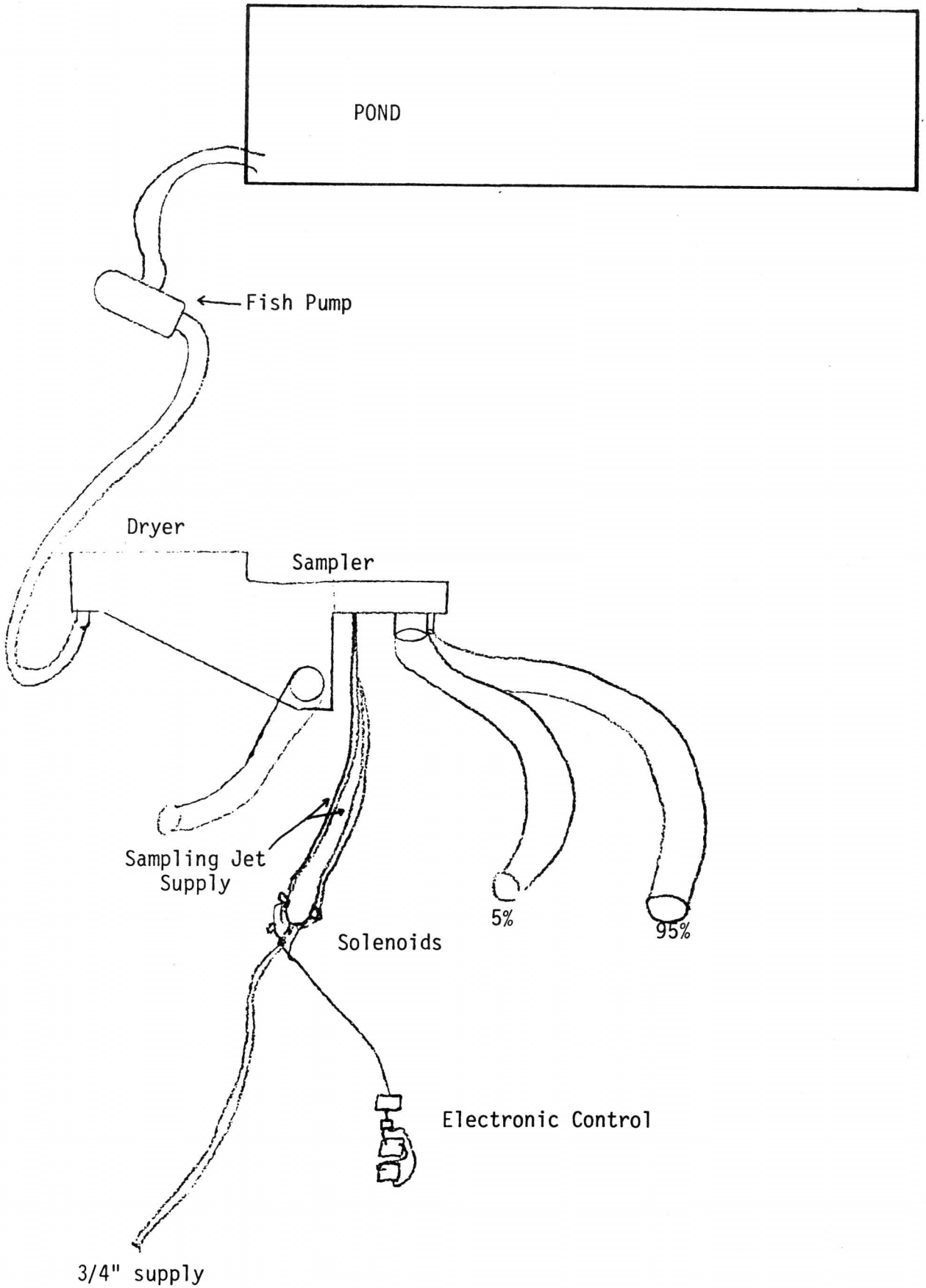


Figure 1. Sampling unit

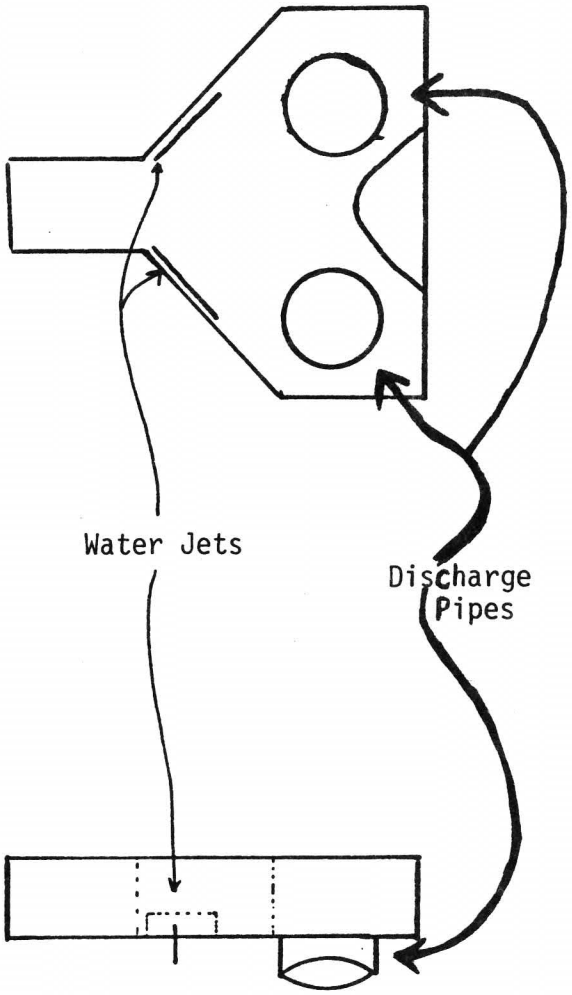


Figure 2. Sampler

The unit is set up near the pond to be sampled and attached to a garden hose for sampling water and to a fish pump to supply the fish. The sampling unit operates continuously on a time sequence basis. The current model is adjustable for the length of sampling to be from 1 to 3 seconds. The sampling jet operates 5% of the time and the other jet operates for 95% of the time. The solenoid valves are rapid acting and no time delay is discernible. The water jets are flat boxes constructed of plexiglass with rapid refill time.

Fish are crowded to the pump intake fairly evenly and the unit has a throat to reduce the occurrence of large masses of fish entering the sampling area. After being forced to one side or the other the fish are returned to the pond via flexible hoses.

During one sampling period a group of 2,500 fish were pumped through the sampler with the 5% portion being counted each time. Results are tabulated in Table 1.

Table 1. -- 2,500 Fish Sample

Trial	Setting[1]	Length[2]	Sample
1	1	5	140
2	1	5	140
3	1	5	139
4	1	5	125
5	1	5	125
6	1	5	133
7	1	5	113
8	1	5	129

$\bar{x} = 130.5$

[1] length of time of sampling jet in seconds

[2] length of time to pass the fish through the sampler

After the initial series of samples some modifications were made in jet size and shape and to the dryer. The new model is undergoing continued testing but preliminary results on a sample of 40,000 fish show a narrow grouping of 2,000 fish being in the sample.

Appendix

NORTHWEST FISH CULTURE CONFERENCE

HISTORICAL RECORD

YEAR	LOCATION	HOST AGENCY	CHAIRMAN
1950	Portland, Oregon	Fish & Wildlife Service	Perry
1951	Wenatchee, Washington	Fish & Wildlife Service	Burrows
1952	Seattle, Washington	Washington Dept. of Fisheries	Ellis
1953	Portland, Oregon	Fish Commission of Oregon	Cleaver
1954	Seattle, Washington	Fish & Wildlife Service	Rucker
1955	Portland, Oregon	Oregon Game Commission	Rayner
1956	Seattle, Washington	Washington Dept. of Game	Millenbach
1957	Portland, Oregon	Fish & Wildlife Service	Johnson, H.E.
1958	Seattle, Washington	Washington Dept. of Fisheries	Ellis
1959	Portland, Oregon	Fish Commission of Oregon	Jeffries
1960	Olympia, Washington	Washington Dept. of Game	Johansen
1961	Portland, Oregon	Oregon Game Commission	Jensen
1962	Longview, Washington	Fish & Wildlife Service	Burrows
1963	Olympia, Washington	Washington Dept. of Fisheries	Ellis
1964	Corvallis, Oregon	Oregon State University	Fryer
1965	Portland, Oregon	Fish & Wildlife Service	Halver
1966	Portland, Oregon	Fish Commission of Oregon	Hublou
1967	Seattle, Washington	University of Washington	Donaldson, L.R.
1968	Boise, Idaho	Idaho Fish & Game Dept.	Cuplin
1969	Olympia, Washington	Washington Dept. of Game	Johansen
1970	Portland, Oregon	Oregon Game Commission	Jensen
1971	Portland, Oregon	Fish & Wildlife Service	Smith, M.A.

NORTHWEST FISH CULTURE CONFERENCE

HISTORICAL RECORD
(CONTINUED)

YEAR	LOCATION	HOST AGENCY	CHAIRMAN
1972	Seattle, Washington	Washington Dept. of Fisheries	Noble
1973	Wemme, Oregon	Fish Commission of Oregon	Jeffries
1974	Seattle, Washington	University of Washington	Salo
1975	Otter Crest, Oregon	Oregon State University	Donaldson, J.
1976	Twin Falls, Idaho	University of Idaho	Klontz
1977	Olympia, Washington	Washington Dept. of Game	Morrow
1978	Vancouver, Washington	Fish & Wildlife Service	Leith
1979	Portland, Oregon	Oregon Dept. of Fish & Wildlife	
1980		Washington Dept. of Fisheries	