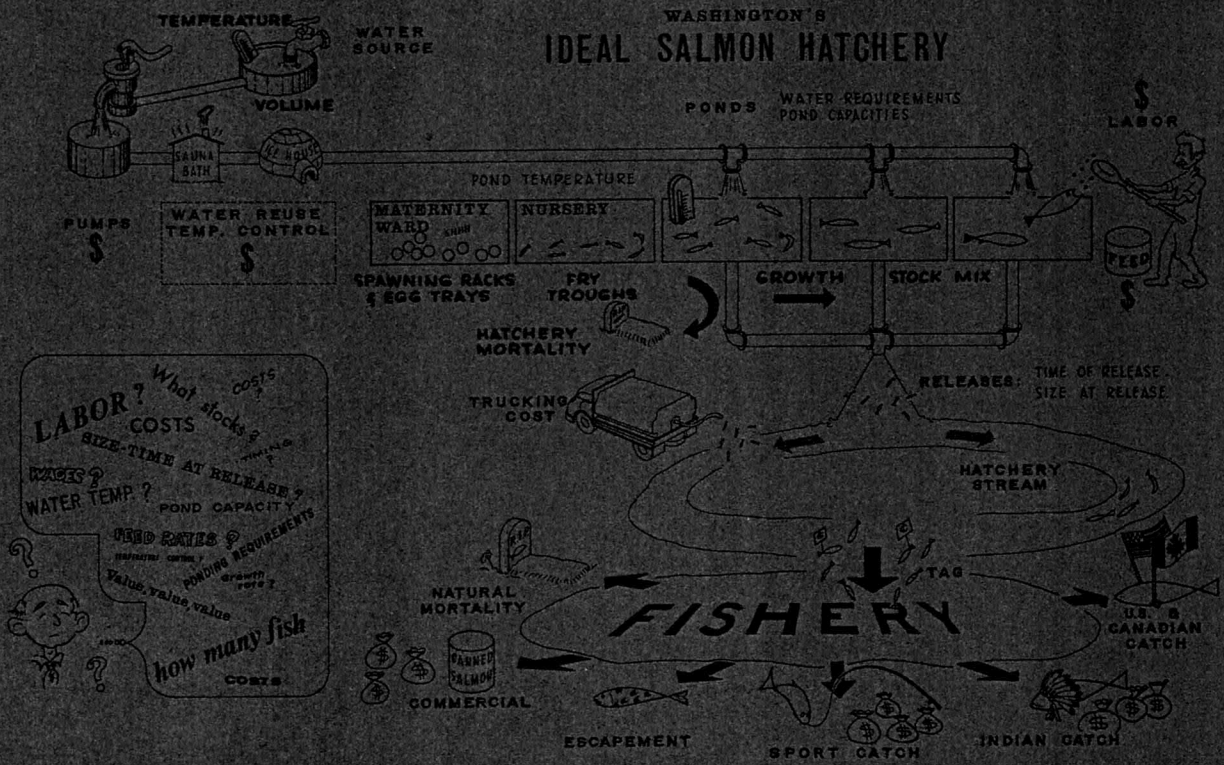
Kirk T. Beininger

23rd Annual Northwest Fish Culture Conference



, WASHINGTON—NOV. 30-DEC. 1, 1972

TWENTY-THIRD ANNUAL NORTHWEST FISH CULTURE CONFERENCE

November 30 - December 1, 1972

Seattle, Washington

Richard E. Noble, Chairman

23RD ANNUAL NORTHWEST FISH CULTURAL CONFERENCE

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SeaTac Motor Inn, Seattle, Washington

The conference was well attended, but down by approximately 100 people over the previous session. A summation of attendance, income, expenditures, and comments prepared by the Chairman's administrative assistant is included in the appendix.

The success of the proceedings was made possible by the able assistance of various members of Washington Department of Fisheries Hatcheries staff, and the Chairman was most thankful that their performance far exceeded the normal call of duty.

The actual participants and those in attendance only reinforced the Chairman's firm belief that fish culturists and their associates are some of the finest people to be found in the world.

The Chairman was able to revel in the limelight of an excellent meeting made possible by the full cooperation of all participants.

I wish to take the prerogative of the Chairman and dedicate the 23rd Annual proceedings to the original founders of the conference and especially to one of those who has had significant meaning to my life in Hatcheries, C. H. "Bud" Ellis. Thank you, Bud, for your guidance and belief in hatcheries and, on behalf of the fish culturist gang, thanks for making up the index supplement from 1967-1971.

My sincere thanks are extended to all who attended and participated in the conference, and especially to the vendors whose display donations made the banquet a success.

The proceedings are a compilation of the unedited brief of oral reports submitted at the conference. You are requested to obtain permission from the author(s) to quote or reproduce the reports herein.

Dr. L. Donaldson and Dr. Ernie Salo, University of Washington, will chair the 1974 conference and Ernie Jefferies, Chief of Hatcheries, Fish Commission of Oregon, is the Chairman for 1973.

Richard E. Noble
Chairman, 1972

BIOGRAPHY

Thor C. Tollefson was born in Perley, Minnesota, in 1901 and came to Tacoma at the age of 10. He was graduated from Tacoma's Lincoln High School and attended the University of Washington's School of Law. He received his degree in 1930 and began practice in Tacoma. He and Mrs. (Eva) Tollefson were married in 1934 and have three daughters.

Mr. Tollefson served as Prosecuting Attorney for Pierce County from 1939 until he was eleced to Congress in 1947, representing Washington's 6th District. He served in Congress for 18 years and became the ranking member of the House Merchant Marine and Fisheries Committee.

In 1965, Mr. Tollefson returned to the State of Washington and was appointed Director of the Washington State Department of Fisheries by Governor Dan Evans. He is a member of the International Pacific Salmon Fisheries Commission (which manages and regulates the sockeye and pink salmon runs of the Fraser River watershed) and a member of the U.S. State Department's Fishery Advisory Committee, which advises the State Department of Fishing problems in all waters bordering the U.S. Mr. Tollefson is also a member of the Inter-Agency Committee on Outdoor Recreation.

Director Tollefson is a member of the Lutheran Church. He is also a member of the Elks, Masons, Shrine, and Kiwanis organizations.

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R. E. Noble, Chairman

Thursday, November 30

CONFERENCE REPORTS

(ABSTRACT)

A NEW FISH HATCHERY AND REARING STATION FOR THE PROVINCE OF ALBERTA

W. P. Truch
Underwood McLellan & Associates Limited

The design developed for the new fish hatchery for the Province of Alberta consists of several features which set it apart from other similar facilities:

1. All components are housed in a totally enclosed structure including ponds as well as mechanical plant. Despite a total floor area of some 3 acres, the design is compact and lends itself to an efficient operation. All fish-rearing activities and related ancillary spaces are contained on the main floor level, with the related mechanical components nested directly below on the lower floor. An upper floor (Mezzanine) is devoted exclusively to public use, including the viewing of rearing activities and various displays and models.

2. The design has been centered around a schedule to accommodate the rearing of eight species of sports fish per annum, viz., rainbow trout, brook trout, brown trout, lake trout, cutthroat trout, Arctic grayling, kokanee, and coho. Projected capacity is 8,000,000 fish at 40/lb. for an annual production of 200,000 lbs.

3. The facility is located in a 45-acre park, known as the Pearce Estate, near the heart of downtown Calgary. Considerable emphasis has been placed in the total scheme to facilitate public education and to enhance the park-like surroundings as an attraction for both citizenry and tourists. Some 18,500 ft^2 of the total floor area of 132,300 ft^2 (14%) has been allocated for public use, including viewing galleries, aquaria, displays, and a lecture theatre.

4. The main water supply is ground water, with a supplemental surface source (the Bow River) also available. An extensive ground water development program, including a 1-year full-scale pump test, proved the worth of a carefully controlled well development program since water is, of course, the "life-blood" of the facility.

5. The hatchery process consists of a single-pass system for incubation and early rearing, and a re-use system for rearing from the 1-1/2- to 4-inch stocking size. Ten (10%) per cent make-up water will be either pre-treated well water or clarified effluent from the single-pass system (which is also pre-treated) depending on the time of year. Clarifiers (sedimentation tanks) have been incorporated to "knock out" the settleable solids from the biological filters backwash water. Sludge from the clarifiers will be directed to the City sewer.

At the time of writing, construction is 92% complete on the $5.1 million project, with startup slated for February 15, 1973.

PINK SALMON FRY PRODUCTION IN ALASKA

Jack E. Bailey
National Marine Fisheries Service
Auke Bay Fisheries Laboratory
Auke Bay, Alaska 99821

Fish hatcheries in Asia have the capability to release a billion chum salmon fry annually. Both the Russian and Japanese fish culturists claim favorable benefit:cost ratios for their hatcheries. In contrast, the history of failures of salmon fry hatcheries in North America need not continue to inhibit similar developments in this country. Many of the failures can now be attributed to disregard for the biology of the fish with consequent production of inferior fry and release of sac fry into environments that were inappropriate to their physiological capabilities. The technology now appears to be available to produce healthy fry and to correctly identify situations where increased fry production will actually produce greater numbers of returning adults.

Artificial spawning channels have produced significant return runs of chum salmon and the basic knowledge now appears to be available to do the same with hatcheries using gravel incubators. Hatchery systems may be more economical to operate and require less space and water than spawning channels.

A pilot fry production station was established in 1971 at Auke Creek near Juneau, Alaska, to study the biological feasibility of enhancing salmon runs by release of artificially produced fry. Pink salmon were selected for the pilot demonstration because of their simple 2-year life cycle.

The demonstration project is a cooperative effort by the National Marine Fisheries Service and the Alaska Department of Fish and Game.

The degree of success of the Auke Creek project will ultimately be evaluated on the basis of adult return from a planned release of approximately 1 million fry.

The natural escapement of pink salmon to Auke Creek does not provide sufficient eggs for such an experiment and the long-range plan is to evaluate the gravel incubators on the basis of fry quality while gradually building up the adult run for a full-scale test.

In this report, the incubator fry released in spring 1972 are compared with wild fry from Auke Creek. The comparisons include egg to fry survival; timing of seaward migrations; length, weight, and stage of development of migrant fry; and total lipid content of migrant fry.

The basic incubation unit was a box with perforated false bottom or grid of perforated pipes to achieve uniform distribution of water upwelling through eggs in gravel. The water was not filtered and no fungus prophylaxis was used after the eggs were seeded into the gravel. Particle size of the river gravel in this test ranged from 1/2- to 1-inch diameter.

The eggs were fertilized in September and held in trays and baskets until the eyed stage in October or November so that dead and infertile eggs could be removed before the eggs were buried in the gravel. The fry left the incubators in April at the same time that wild fry were migrating out of Auke Creek.

Large incubators, such as the 4 ft x 3 ft x 3 ft deep modification of the R. A. Bams incubator, produced up to 109,000 pink salmon fry per unit. Water flow was adjusted and controlled to maintain a relationship of about 7,500 eggs/gpm. The water supply was about 61% saturated with oxygen. The maximum rate of oxygen consumption amounted to about 0.02 mg O_2/fry/hour, and the oxygen level dropped no lower than about 57% saturation in the effluents from the incubators.

An important feature of gravel incubators is that the alevins are free to emerge and become free-swimming fry on their own volition. Thus, the question of when to terminate the incubation stage and begin exogenous feeding does not depend upon the judgment of a fish culturist or biologist. Emergence from the gravel is a natural response of the individual fish to the dictates of his own physiological state as conditioned by the nearly natural environment.

Under natural conditions, pink salmon fry leave the streambeds and enter estuaries just before or coincident with spring warming and the appearance of zooplankton blooms. Fry produced on flat tray incubators at Auke Creek attained their maximum weights and presumably the best stage of development for release March 28, at least 1 month before the spring warmup.

Pink salmon fry left the gravel incubators in April at the same time that naturally produced fry were migrating to sea from Auke Creek.

The average survival from eyed eggs to fry for Auke Creek eggs in three gravel incubators was 84%. These incubators produced 188,000 fry, the progeny of 159 females; whereas 737 females that spawned naturally in Auke Creek produced only 157,000 wild fry. Therefore, the incubators yielded roughly a sixfold advantage over natural spawning.

To compare size of fry in relation to incubation environment, weighted means and variances of pooled data were computed on the basis of the fraction of the migrant fry represented by samples of 50 fry. The comparisons indicated that size was influenced by source of eggs and by incubation environment. In gravel incubators, Sashin Creek eggs yielded longer and, with one exception, heavier fry than Auke Creek eggs. Auke Creek eggs in gravel yielded longer and, in some instances, heavier fry than Sashin Creek eggs in a tray incubator, however. Auke Creek wild fry were longer and heavier than gravel incubator fry of Auke Creek parentage, but the incubator fry had a higher average developmental index

($K_D = \frac{\sqrt{\text{weight in milligrams}}}{\text{length in millimeters}}$). The higher K_D index indicated incubator fry tended to migrate about 3 days before they attained maximum weight, whereas the average time of migration for wild fry coincided with attainment of maximum weight.

The total lipid content of gravel incubator fry (87 to 92 mg per 15-fry sample) was similar to that of wild fry (66 to 108 mg per 15-fry sample), whereas tray fry had a higher total lipid content (117.0 mg per 15-fry sample) at the time they reached maximum weight. Lipid content of tray fry dropped to the 75- to 93-mg range in April but by that time the tray fry were losing weight and appeared to be darkening in color, losing vigor, and taking on the general appearance of pinheads.

In conclusion, egg to fry survival of pink salmon in gravel incubators was satisfactory and the fry migrated to sea in April at the same time as wild fry, whereas tray fry were ready to migrate in March. Gravel incubator fry were intermediate in size between tray fry and wild fry. Some improvement in size of gravel incubator fry at Auke Creek will be sought through use of filtered water and coarser substrate in future tests.

COLE RIVERS HATCHERY

Ray Culver
Oregon State Game Commission
Trail, Oregon

The U.S. Army Corps of Engineers has launched into what is known as "The Rogue Basin Project", which will consist of three dams: the Elk Creek Dam, about 2 miles above the mouth of Elk Creek; the Applegate Dam, on the Applegate River near the California line; and the Lost Creek Dam, on the upper Rogue River just above the town of McLeod. Also included in the project is the Cole Rivers Hatchery which will compensate for the loss of spawning areas above the three dams and provide resident trout for reservoir stocking.

The hatchery is being built just below the Lost Creek Dam at river mile 153.6, and upon completion (sometime between March 1973 and June 1973) will be released to the Oregon State Game Commission for operation. Within the hatchery complex is a fish ladder, collection pond, six holding ponds, two brood trout ponds, 87 100-ft x 20-ft raceways, 26 25-ft circular ponds, 14 small circular tanks in the hatchery building, and 58 incubators. The inside tanks and incubators are supplied with both raw water and water through a filtered, heated re-use system. There is space available for future construction of an additional 25 raceways and 6 circulars. The tentative annual production will include 1,973,000 spring chinook, 206,000 coho, 100,000 summer steelhead, 460,000 winter steelhead, 168,000 rainbow legals, and 2,305,000 rainbow and kokanee fingerlings for a total of approximately 5,000,000 fish and 425,000 lbs.

As the hatchery is only slightly above normal river level, a low fish barrier across the river will form a small reservoir and provide a gravity water supply through underground conduit. The intake structure is provided with traveling screens and also a standby water intake immediately in front of the screens in event of trouble in that area. A dike has been provided between the river and the hatchery to prevent flooding of the facility. If the river becomes too high for normal gravity outflow, a bulkhead is lowered into the drainage structure and two 150 HP pumps force the overflow from the ponds into the river. The overflow from all rearing ponds can also be discharged through an upstream drainage conduit into a supply pool, and by manipulation of several gates put through the fish ladder, ladder entrance pool, or barrier diffuser conduit.

Normally, when the fish ladder is in operation, all outflow from the hatchery will be through the upstream drainage to provide more attraction for the fish. After the fish are in the collection pond, a sweep will force them into an anesthetic tank under the salmon spawning building, and a brail hoist will bring them to the sorting table or

truck chute. From the sorting table, the fish are transferred to the holding ponds through large fiberglass tubes supplied with water. To return the fish from the holding ponds, sweeps are provided to force the fish into a transport channel. A channel sweep will bring them to the anesthetic tank, brail hoist, and again to the sorting table. The hoist, collection pond sweep, holding pond sweeps, transport channel sweep, and exit gates are operated by one individual through a panel at the sorting table.

DESCRIPTION OF THE CAPILANO SALMON HATCHERY

Eldon Stone
Environment Canada Fisheries Service

The Capilano River, British Columbia, is a short coastal stream (less than 20 miles long) which flows through the municipalities of North and West Vancouver, entering Burrard Inlet immediately west of the Lions Gate Bridge. This river has historically been a good producer of coho salmon and steelhead trout, despite its small rearing area and limited productivity. Also, because of its location, the Capilano has lent itself quite favorably as a domestic water supply for the city of Vancouver and consequently has been dammed twice. The first dam, built in the 1880's, was located 6 miles above the mouth and was little more than an intake structure (13-ft high) which apparently had little, if any, affect on the rearing and spawning area of the river.

However, in 1954 the present Cleveland Dam, a 300-ft high structure, was built in its place 3 miles farther downstream, creating a reservoir 3-1/2 miles long, obliterating part of the spawning area but perhaps increasing the overall rearing area slightly. Although fish trapping facilities were built in conjunction with the dam and since 1954 all adult fish have been trucked over the dam, the total coho run has been reduced from 5,000 fish before the dam to approximately 1,800, and the steelhead (summer and winter) run is seriously threatened. Consequently, the Capilano was chosen for the first salmon hatchery in British Columbia.

Construction began on the Capilano Salmon Hatchery in March 1971 and was virtually completed by October 1972. The hatchery consists of 10 Burrow's type ponds, four adult holding ponds, and an incubation capacity of 2 million eggs. There is also provided some room for expansion in the future. The present production goal is 1 million coho, up to 500,000 chinook, and approximately 75,000 steelhead annually. Included in the hatchery complex are extensive public display areas, pollution abatement facilities, and two resident suites as well as the usual office, laboratory, and workshop area.

The Capilano River is a cold-water system with maximum temperatures of 55 F. We have a guaranteed river water supply of 20 cfs and a promise of 30 cfs for most of the year, however, at the present size we would rarely need more than 13 cfs. In addition to this, we have a seepage water supply of 1 cfs at a relatively constant temperature of 45 to 48 F. This supply can be heated for the incubation room and 4 of the 10 rearing ponds. The heating capacity is sufficient to maintain temperatures of 42 F for the rearing ponds on a single pass, regardless of the winter temperatures.

The pollution abatement facilities were designed essentially for hatchery effluent treatment, however, they can very easily be incorporated into a re-use system.

Of the three species to be cultured at the hatchery, only the coho and steelhead are native to the Capilano River. The coho run is somewhat unique, in that it commences in early June and continues right through into January, with the peak in July and August, thus exposing itself to the sport fishery for a period of at least 7 months. Information gained from our first year of operation, carried out during the hatchery construction, indicates that most of these fish spawn at the same time in November and December.

In anticipation of the hatchery, chinook smolts were introduced into the Capilano River from the Big Qualicum project on Vancouver Island in 1969, 1970, and 1971. Adult returns from these transplants were recorded in 1971 and 1972, however, all of the 40 adults that returned this year were males. To continue the transplant program, unfertilized chinook eggs were brought to the hatchery from Big Qualicum, fertilized with Capilano return males, and will be reared to release size next spring.

DEVELOPMENT OF GRAVEL INCUBATION HATCHERIES FOR PINK, CHUM, AND SOCKEYE SALMON ON THE QUINAULT INDIAN RESERVATION

Brian Allee
Quinault Reservation Resource Development Project

Historically, the runs of fish on the Quinault Indian Reservation were large but have declined continuously to the present. Causes for this decline have been attributed to many activities associated with man's expanding population and industrial growth. In an attempt to rehabilitate these declining runs, a number of artificial propagation techniques is being employed based upon the species involved. One of these techniques involves the use of gravel incubation hatcheries for the propagation of pink, chum, and sockeye salmon. These systems are designed specifically to operate without electrical power under field conditions and to be low in capital outlay and maintenance.

The rationale for using gravel substrate incubators is based upon work by United States and Canadian reserachers which indicates that chum and pink fry produced are comparable in "quality" and marine survival to wild fry and superior to fry produced in smooth substrate incubators. Studies by Poon and Emadi reported at the 22nd Annual Northwest Fish Culture Conference have shown that pink, chum, and sockeye are more active alevins than either species of Pacific salmon and require tactile support of the substrate to inhibit this activity. On this basis, two hatchery sites have been developed for field testing of shallow bed Netarts Gravel Incubators designed by Dr. William McNeil. Cooperative funding for these projects was secured from the Office of Economic Opportunity and ITT-Rayonier with technical assistance from the Economic Development Administration.

Both hatchery sites are composed of eight modular plywood units each capable of producing 400,000 fry at 50 gallons/minute. The potential area of substrate available within each unit is 198 ft^2 which yield a density of 2,000 eggs/ft^2. These systems are designed such that water-hardened green eggs are layered on screens above the shallow bed of gravel. Upon hatching, the alevins will drop through the screens to the crushed rock below. The size of this crushed gravel is 5/8 inch to 1-1/4 inch.

In cooperation with the National Marine Fisheries Service (Alaska region) and the Alaska Department of Fisheries, and with the permission of the Washington Department of Fisheries, 350,00 surplus even-year pink salmon eggs were obtained in order to test the feasibility and operational characteristics of the incubation facilities. These stocks were from Lovers Cove Creek on Baranof Island in Southeast Alaska.

Fish were dry spawned at Lovers Cove Creek on September 23, 1972, and were fertilized at the hatchery site 17 hours later. As a result of

the large amount of elapsed time, 23% of the eggs were unfertilized. Mortality on fertilized eggs to the eyed stage was only .1%. Hatching of these eggs had begun on November 27, 1972. These fish are programmed to be released as unfed fry in late January 1973. Also during the 1972 brood year, a small egg-take of 170,000 Quinault chum salmon and 130,000 Quinault sockeye salmon has been undertaken. The chum salmon are to be released as unfed fry but the sockeye salmon will be reared in floating pens in Lake Quinault for differing lengths of time and eventually released into the lake. In a similar way, eggs taken from Quinault steelhead trout will be incubated in these facilities in 1973 on a production basis and reared in Lake Quinault.

Aside from these more permanent hatchery sites, the future potential of these gravel incubation boxes seems to be in the area of stream enhancement and rehabilitation following deleterious land-use practices. In this manner, boxes could be viewed as highly portable units which would attempt to achieve a self-sustaining, naturally reproducing population in small watersheds and then be taken out.

CONTRIBUTION OF THE 1965 AND 1966 BROOD OF COLUMBIA RIVER HATCHERY COHO

Robert R. Vreeland
National Marine Fisheries Service
Portland, Oregon

In 1966, the Columbia Fisheries Program Office of the National Marine Fisheries Service embarked on a study to determine the contribution in numbers and value of Columbia River hatchery-reared coho to Pacific Coast fisheries.

Two broods of coho, 1965 and 1966, were marked for this study. The Columbia River was divided into four sections and each section was allocated a mark. The sections and assigned marks were (1) Columbia River mouth to the Cowlitz River, adipose right maxillary; (2) Cowlitz River to Bonneville Dam, adipose; (3) Bonneville Dam to The Dalles Dam, adipose left maxillary; and (4) above The Dalles Dam, dorsal adipose. The same marks were used for both broods except in the case of the section above The Dalles Dam which contained only one hatchery, Leavenworth National Fish Hatchery. The dorsal adipose fin clip was used for the 1965 brood and the dorsal adipose left maxillary and the dorsal adipose right maxillary marks for the 1966 brood at Leavenworth. Approximately 4.1 million coho were marked of the total production of 40.1 million 1965 and 1966 broods of Columbia River hatchery coho.

Sampling for these marks was carried out in the major Pacific Ocean fisheries from Pelican, Alaska, to Avila Beach, California, the Puget Sound fisheries, and the Columbia River fisheries in 1967 through 1969.

The following table shows the estimated contribution of the Columbia River hatcheries to the fisheries by region. The percentages are the portion of the coho in the fisheries sampled that originated from Columbia River hatcheries. The percentages are an average of both the 1965 and 1966 broods of coho.

Region	% hatchery
British Columbia	2%
Washington	23%
Columbia River	72%
Oregon	45%
California	37%

The estimated values of these catches of Columbia River hatchery coho are:

Region	Value
British Columbia	$0.2 million
Washington	$3.6 million
Columbia River	$1.6 million
Oregon	$3.3 million
California	$0.5 million
	$9.2 million

The cost of rearing each brood of coho was estimated to be $1.3 million. This yields an average benefit to cost ratio of 7 to 1.

RETURN OF TWO-YEAR-OLD ADULT COHO FROM SIX-MONTH SMOLTS

Lauren R. Donaldson
College of Fisheries
University of Washington
Seattle, Washington

At the 1969 Northwest Fish Culture Conference, we reported on some experiments we initiated with 1967 brood coho that were reared in warmed water to accelerate their rate of growth. The fish were released as fingerlings in late May, 6 months after the eggs were fertilized. Most of the young fish apparently migrated to sea soon after release. Those that survived returned from the sea in the first year as jacks, and in the second or third year as adult fish.

This program has continued with a marked increase in survival to adults. The young fish reared for release are selected from the progeny of 2-year-old adults that migrated to sea after 6 months of rearing. The data for the 1969 release of the F_1 generation from the 1967 release are summarized in Table 1. During the past three falls, 192 fish have returned to the pond on the campus. This is a return of 0.51% of the smolts released. A few more fish of this year class will return during the next few weeks to increase the survival members.

The 2-year-old coho salmon adults that return to the campus in the fall of 1970 were spawned to produce F_1 generation smolts with accelerated growth for release in the spring of 1971. Before release, the smolts were passed through a grader to divide the population approximately in half. The larger fish averaged 11.81 grams (38.5 per pound) at time of release. This segment of the population was marked by removal of the right ventral fin (RV) (Table 2). The smaller fish were marked with a left ventral clip (LV) and averaged 6.7 grams in weight (67.1 per pound).

So far this fall (November 20, 1972), 407 of the LV-marked fish, or 1.24% of the smolt release, have returned to the home pond. The larger smolts, marked RV, have had a higher return as 2-year-old adults, with 528 fish, or 1.70% of the smolts released, accounted for in the pond.

In the next few weeks and during the fall months of 1973, additional fish will return. However, we already have an abundance of fish and useful data for planning our next steps.

1. A portion of the fish returning to the pond are typical Puget Sound jacks. These fish, 1.5+ lbs., apparently stayed in the lake for an additional year after release, then went to the sea in the spring of 1972 and returned after 6 months in the salt water.

2. A second, and major portion of the population returning, apparently migrated out to sea as 6-month-old smolts and spent a year and a half feeding in Puget Sound. These fish, about 5 lbs., would have been available to Puget Sound sport fishermen. We plan to save for rearing and future release a segment of this part of the run in an effort to pick out a genetic strain that will stay in Puget Sound.

3. A portion of the adults apparently went to sea as 6-month-old smolts, and passed through Puget Sound on their way to the rich feeding grounds in the ocean. Some of the eggs harvested from these fish, 8+ lbs. in weight, will be reared for future release to evaluate the genetic factor, if any, that controls migration, growth, etc. This fast-growing portion of the run should also be useful stock for the rapidly growing marine aquaculture industry.

Table 1. 1969 brood year coho salmon, College of Fisheries, University of Washington.

Releases

Date	Mark	Number	Average weight (g)	Number per pound	Total weight (lb.)
May 25-27, 1970	Ad-LM	37,342	6.06	74.9	498.4

Returns

Sex	Number	Length (cm)	Weight (g)	Weight (lb.)	Per cent return
			1970		
Males	11	30.6-42.6	300-830		.03
Females	0				
			1971		
Males	85	31-64	330-3250	0.7 -7.16)	
Females	49	38-50	580-2200	1.28-4.85)	.36
			1972[1/]		
Males	21	46.5-80.6	1160-6450	2.56-14.2)	
Females	26	53.4-83.2	1620-7170	3.57-15.8)	.13

Total returns - 192
Percentage of release - 0.51
Returns per pound of fish released - 0.39

1/ Incomplete returns, November 20, 1972.

Table 2. 1970 brood year coho salmon, College of Fisheries, University of Washington.

Releases

Date	Mark	Number	Average weight (g)	Number per pound	Total weight (lb.)
May 28, 1971	LV	32,952	6.77	67.1	491.4
	RV	30,930	11.81	38.5	804.6
		63,882			1296.0

Returns, 1972[1/]

Sex	Mark	Number	Length (cm)	Weight (g)	Weight (lb.)	Per cent return
Males	LV	266	27.8-65.3	240-2980	0.53-6.56	0.81
Females	LV	141	26.7-67.6	270-3570	0.59-7.86	0.43
		407				1.24
Males	RV	304	32.0-73.6	390-5010	0.86-11.04	0.98
Females	RV	224	41.9-68.5	820-3780	1.81-8.33	0.72
		528				1.70

Total returns - 935
Percentage of release - 1.46
Returns per pound of fish released - 0.72

[1/] Incomplete returns, November 20, 1972.

POTENTIALLY HARMFUL PRACTICES

Dr. Loyd A. Royal
Washington State Game Department
Olympia, Washington

Summation by R. E. Noble

The liberation of hatchery-produced stocks of salmon and trout into the streams of the Northwest without careful consideration of the basic biology of the animal can eliminate or greatly endanger natural "wild" spawners.

Fresh water has a limited capacity capable of supporting the natural stocks in the various biologically and environmentally controlled niches.

Liberation of non-migrating trout or salmon into the streams imposes a demand beyond the capacity of the system, resulting in population reduction encompassing both "wild" and hatchery-produced salmonids. In event the hatchery fish have been selected so that the resultant returnees cannot mesh with the environmental constraints, then a reduction of the "wild" stocks is the end result.

Use of proper fish cultural practices can minimize this danger and actually increase total salmonid production to the system. Using the river as an "expressway" to the ocean is one of the prime requisits for fish culturists to consider. Release of migratory smolts should be the prime concern of those who manage the anadromous species of trout and salmon.

EARTHEN REARING POND FOR WINTER STEELHEAD PRODUCTION

Homer B. Clendenen
Oregon Game Commission

Cedar Creek Hatchery is located on Cedar Creek, a tributary of Three Rivers, which in turn is a tributary of the Nestucca River on the north coast, Tillamook County. It is a medium-sized hatchery for the production of anadromous fish.

At Cedar Creek we are pretty much like any other hatchery, looking for ways to raise production at the least cost. We have 13 ponds of different sizes and shapes, and most of the ponds are rather large, with capacities of 55,000 to 275,000 smolt-size winter steelhead.

In 1968 we started looking for a way to increase production at a minimum cost. We came up with the idea of using a large earthern pond to finish the rearing of winter steelhead to smolt size while water was available (not a new idea by any means) on land owned by the hatchery. We had room to build a 1/2-acre natural rearing pond.

Construction was started in the summer of 1969 and completed in late October of that year. The pond was put into use immediately, with the stocking of 250,000 graded and marked winter steelhead at 17.5 per pound. The pond is 270 ft long and 80 ft wide with an average depth of 4 ft. The water is introduced through a 24-inch steel pipe from the intake structure and upwells into a grated box. We use from 10 to 15 cfs of water while operating the pond.

In the 1970-71 rearing period, we placed 17,555 lbs. of fish at 14.5 per pound, or 255,000 fish, in the pond. The fish were graded and marked before placing in the pond to cut down on the handling later in the year. The following April we liberated 42,561 lbs. of fish at 5.8 per pound. We had a total production of 25,006 lbs. of fish on 28,880 lbs. of food, and conversion was 1.154. We use automatic feeders, which are placed around the pond. Our loss was 2.2% or 5,656 fish.

In the 1971-72 rearing period, we placed 18,477 lbs. of fish at 16.3 per pounds, into the pond, or 301,175 fish. We liberated 49,498 lbs. for a total production in the pond of 31,021 lbs. at 6.2 for 311,148 fish. This shows an overrun, but the loss records show that we had a loss of 3.1% and a conversion of 1.686, which is somewhat higher than the year before. I would say we loaded the pond a little over the maximum capacity, and also in 1971-72 we had extremely high and muddy water conditions for January, February, and most of March, with about a 25% loss of pond space because of the sand and silt.

We have a catch basin at the lower end of the pond, which is used during liberation. With the center screen removed and by lowering

the water slowly, we have experienced no trouble in getting the fish to move down from the main pond into the loading area where we crowd them into a catch basin for loading with a 6-inch fish pump.

During the past three rearing periods, we have produced 801,300 fish, with a total weight of 129,242 lbs., for a 6.2 average smolt size, with an average cost of fish per pound at 16.81 cents for food only.

With the water limitations at Cedar Creek, we can only use this pond during the late fall through the next spring. The pond is dried up after liberation, and all sand and silt is hauled out and disposed of and the pond made ready for the next winter's use.

We feel that the pond has done a good job in producing a good quality winter steelhead smolt, at a reasonable cost per pound. We have another pond somewhat larger in the planning stage at Cedar Creek.

SALINE SPAWNING OF RAINBOW TROUT AT ROARING RIVER HATCHERY

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Saline solutions were first used for live-spawning Siletz summer steelhead in 1965 at Roaring River Hatchery. The injection by syringe of a 1% solution, into the fish after the majority of the eggs had been taken, increased egg output by approximately 15%. Egg loss amounted to less than 5%.

In 1969, the saline method was adopted for spawning rainbow trout. Eggs from fish which appeared difficult to spawn were easily extracted. Very few eggs, if any, remained in the body cavity using the saline method, and hold-over shells and retained eggs ceased to be a problem. Egg breakage was nil. As the technique improved, egg production was increased by as much as 10% and production costs decreased.

Data from spawning operations with saline in 1972 are shown on the next page.

Equipment and methods utilized in saline spawning consist of a plastic milk bag similar to the dispensers used in restaurants. The bag is filled with pure water and salt (1%) and placed in a metal tank (steel or aluminum) capable of withstanding 10 to 15 lbs. pressure. Five to 10 lbs. of pressure is necessary to inject the saline solution through the vent into the body cavity. Brood fish weighing 6 lbs. require approximately 4 oz. of solution, while larger fish (up to 15 lbs.) require 8 oz.

Equipment list

Plastic bag - 5 to 10 gallon
Pressure regulator
Pressure tank - 5 to 10 gallon
Oxygen or scuba tank (compressed air)
Syringe tip (ear-type)
Line valve

It is concluded that larger numbers of quality eggs accompanied by a savings in time and money are accomplished by the saline spawning method. The technique is harmless to the adult fish.

1972 SALINE RESULTS

Brood fish by age classes	Number fish spawned	Total eggs	Eggs/fish without saline	Additional eggs/fish with saline	Total additional eggs saved with saline		
					Number	Per cent	Value at $3/M.
3-year fish							
Saline	15	82,050	4,348	1,122	15,165	18.48	
Control	14	66,885	4,459				
4-year fish							
Saline	30	266,760	8,018	874	24,510	9.18	
Control	30	242,250	8,075				
5-year fish							
Saline	30	273,510	8,315	802	26,670	9.75	
Control	30	246,840	8,228				
Total	150	1,178,295	41,443	2,798	66,345		$199
Average						12.47	

HOW DO STEELHEAD OF HATCHERY ORIGIN DIFFER FROM THEIR WILD ANCESTORS?

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In recent years, we have experienced large and consistent returns of fish of hatchery origin. They are the result of improved fish cultural procedures in such areas as nutrition, disease prevention, and treatment, as well as in rearing and releasing techniques. My concern is whether or not hatchery fish will continue to return from the sea as they do now or decrease in number as a result of some of our hatchery practices, in particular, brood stock selection. We might gain some insight into this problem by examining how and why stocks of hatchery fish differ from their wild ancestors, because the differences might be of predictive value.

Most of the material that will be drawn upon in discussing differences between hatchery and wild stocks concerns winter steelhead from the Alsea River in Oregon. The fish have been artificially propagated since 1936 at the Alsea Trout Hatchery on the North Fork of the Alsea River. It wasn't until the early 1950's that the hatchery program became intensive. Since the mid-1960's, no natural reproduction has occurred in the stream above the hatchery intake dam. Consequently, fish returning are predominantly of hatchery origin, a situation that has given rise to inbreeding in the brood stock.

Before discussing how hatchery-reared steelhead differ from their wild ancestors, we might briefly consider why they should. The biological attributes of living organisms are dependent upon genetic constituents and the environment. In some situations, inheritance prevails over environmental influences and in other situations the reverse is true. Generally, both factors are involved to some degree in the expression of biological traits.

Selection of brood stock can influence the genetic makeup of the progeny (Figure 1). Artificial selection has been the general rule with hatchery and wild brood stocks. The selection of adults for size, time of return, appearance, and other characteristics is routinely carried out by fish culturists. In terms of possible genetic effects, selection rarely produces anything new but it differentially preserves certain genetic traits. Many characteristics of the population can be lost by such selection.

Artificial selection continues during that portion of the juvenile phase of the life history taking place in the hatchery (Figure 1). Of equal importance is the absence of natural selection during the period. While we artificially select fish for rapid growth, we do not necessarily emphasize such attributes as viability, stamina, wariness or agility. In the stream and hatchery pond, survival is not totally random, but the selection pressures are probably quite different in the two environments.

Following the release of hatchery smolts into the natural stream, selection pressures change markedly. Artificial selection ceases, except for that associated with commercial or sport fishing, and natural selection becomes operative. Natural selection occurs not only during downstream migration and residence of the juvenile in the estuarine and marine environments, but during the upstream migration and natural spawning of adult fish as well.

It is logical from the above discussion to assume that adult hatchery-reared steelhead at Alsea Trout Hatchery differ genetically from their wild ancestors. I have listed six biological parameters that I consider basic to the continued well being of the hatchery stock (Figure 1). Most of the attributes are also important to the public who wish to utilize steelhead in a recreational fishery. In addition, some of the same attributes as well as others would also be of importance in assessing the impact of hatchery stocks on the native population.

My discussion today centers only on the continued well-being of the hatchery stock. Some of the parameters are in need of re-evaluation and my interpretation should be considered preliminary until additional data and analyses are available.

1. The marine survival of hatchery steelhead from smolt stage to adult is generally considered to be lower than that of wild smolts. Nevertheless, the survival of hatchery fish on the Alsea River improved in the 1960's, indicating that selection of adult brood stock and artificial rearing of juvenile fish have not in recent times degraded the survival potential of hatchery fish. It is, of course, possible that some degradation in survival related to genetic changes has occurred but has been compensated for by improved nutrition and rearing techniques so that it is not apparent in survival estimates.

2. Life history patterns have been altered. We see less variation in the life history of hatchery-reared steelhead than we do in wild fish. The 3- and 4-year ocean steelhead have largely disappeared. Such might be primarily the result of environmental influences rather than inheritance. Hatchery smolts tend to be larger than wild migrants, and larger smolts spend less time in the marine environment. We have also seen fewer repeat spawners in hatchery stocks.

3. In size, hatchery fish appear to be roughly comparable to wild fish, if they have spent an equal amount of time at sea. Thus, the hatchery fish appear to have maintained growth rates in the marine environment comparable to wild fish. Here the interpretation is complicated because hatchery smolts are larger than wild smolts at entrance to the sea, and returning adult hatchery fish leave the sea earlier, on the average, than do wild steelhead.

4. Fecundity of hatchery steelhead also appears to be stable and comparable to wild fish. Fertility and fry survivals seem stable but need to be evaluated more carefully.

5. The seasonal movement patterns of adult hatchery-reared steelhead differ from their wild ancestors. Fish returning to the hatchery migrate earlier into fresh water than did their ancestors. This appears to be primarily a result of genetic selection.

6. Sex ratios remain stable and approximate one male per female.

The above parameters have remained relatively constant for winter steelhead on the Alsea River through several generations of fish subjected to artificial propagation that have been marked by a high degree of inbreeding. The winter steelhead used in the hatchery program appears to be adapted to a protected fresh-water rearing period followed by a rapid downstream migration to the sea upon release. Consistent adult returns of from 3 to 5% have been obtained. Consequently, the hatchery stock appears to be stable, and there is no indication of reduced survival capacity. Differences between the hatchery stock and their wild ancestors are partly related to changes in the gene pool and partly in response to the hatchery environment. It is difficult to separate out the genetic effects because we know so little about the heritability coefficients of some of the attributes. The lack of knowledge complicates establishing meaningful guidelines for brood stock selection.

It is essential that key hatchery populations of steelhead and other species be monitored periodically for changes in important biological parameters in order to insure the continued success and improvement of hatchery programs. It is equally important that we understand the importance of the environment and inheritance, respectively, in the expression of certain attributes.

Figure 1

HOW DO ADULT HATCHERY STEELHEAD DIFFER FROM THEIR WILD ANCESTORS?

WHY?

BROOD STOCK SELECTION

NATURAL (WILD-TYPE)
1. ARTIFICIALLY SELECTED
2. RANDOM-BRED

HATCHERY STOCK
1. ARTIFICIALLY SELECTED
2. RANDOM-BRED
3. INBRED

JUVENILE FISH IN HATCHERY

ARTIFICIAL SELECTION OPERATING
1. RAPID GROWTH

NATURAL SELECTION ABSENT
1. STABILITY
2. STAMINA
3. WARINESS
4. AGILITY

FOLLOWING RELEASE OF HATCHERY SMOLTS

(DOWNSTREAM MIGRATION-ESTUARINE & MARINE ENVIRONMENTS-UPSTREAM MIGRATION)

ARTIFICIAL SELECTION ABSENT

NATURAL SELECTION OPERATING

HOW?

BIOLOGICAL PARAMETERS

1. SURVIVAL - LOWER BUT STABLE
2. LIFE HISTORY - ALTERED BUT STABLE
3. SIZE (GROWTH) - STABLE & COMPARABLE
4. FECUNDITY - STABLE & COMPARABLE
5. MOVEMENT - ALTERED BUT STABLE
6. SEX RATIO - STABLE & COMPARABLE

TRENDS IN FISH HATCHERY POLLUTION CONTROL CRITERIA

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Fish culturists throughout the country are presently concerned about the pending establishment of regulatory guidelines for fish hatchery pollution abatement. Developments of the last few years have brought us to a point where reasonable guidelines are desperately needed so that abatement programs may proceed in an orderly and logical manner.

In October of this year, far-reaching amendments to the Federal Water Pollution Control Act were approved by Congress. This new law calls for application of the "best practical" pollution control technology by July 1, 1977, and the "best available" pollution control technology by July 1, 1983. Both "best practical" and "best available" are to be determined with economic feasibility as a consideration. There is one section which deals specifically with aquaculture, and that section reads as follows:

> "The Administrator is authorized, after public hearings, to permit the discharge of a specific pollutant or pollutants under controlled conditions associated with an approved aquaculture project under Federal or State supervision.
>
> "The Administrator shall by regulation, not later than January 1, 1974, establish any procedures and guidelines he deems necessary to carry out this section."

It is too soon to tell how this section will be implemented; however, it is unlikely that it will represent a loophole allowing hatcheries to continue discharging waste water without some pre-treatment.

Both the northwestern and midwestern regional offices of the Federal Environmental Protection Agency are currently considering effluent standards which would require an 80 to 90% reduction in hatchery-produced suspended solids (SS) and Biological Oxygen Demand (BOD). These requirements seem unreasonably stringent. The emphasis on BOD reduction is especially inappropriate in view of the dilute nature of hatchery waste water. The average BOD of hatchery waste water runs around 5 to 10 ppm. By comparison, domestic sewage has a BOD of 15 to 30 ppm after secondary treatment. Hatchery waste water will generally not bring about significant depletion of oxygen in receiving waters. Also, reduction of BOD has no effect on the nutrient content of hatchery waste water.

Settleable solids are, on the other hand, more of a real problem since they may form bottom deposits downstream from hatcheries. Bacterial oxidation of deposited material can cause anaerobic conditions to develop locally with accompanying noxious odors and deleterious effects

on aquatic life. Also, a large portion of the nutrients discharged from hatcheries is associated with solids. Relatively large quantities of settleable solids are discharged from hatcheries during pond and raceway cleaning. Fortunately, these solids settle rapidly and a high percentage can be removed by a few hours of detention. Removal efficiency may be further increased by a combined aeration-detention system.

A 90% reduction in BOD and suspended solids, such as is being considered by EPA, could probably be achieved only by conversion to a semi-closed water re-use system. Re-use systems have significant advantages for fish rearing, in addition to greatly reducing waste discharges. These advantages include a several-fold increase in rearing potential on a fixed water supply, as well as control over temperature, pathogens, and parasites. These systems appear economically attractive when new hatcheries are updated. However, the expense may be prohibitive for some sectors of the fish culture industry, particularly if a crash implementation schedule is envisioned.

MONITORING THE EFFICIENCY OF WATER RECONDITIONING PRE-TREATMENT FACILITIES WITH BIOASSAY TECHNIQUES

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Water reconditioning systems are extremely vulnerable to disease epizootics if the supplemental water is contaminated. Supplemental water from closed springs and wells are usually fish pathogen-free, while surface water obtained from rivers and lakes is usually contaminated.

Since reconditioning systems require relatively small amounts of supplemental water, disinfection of incoming surface water is not only possible but an absolute necessity to prevent epizootics.

At Dworshak National Fish Hatchery, pre-treatment equipment for supplemental water includes an electric grid, pressure sand filters, and ultraviolet lights. River water is pumped to a reservoir facility and travels by gravity flow to an electric grid where voltage (480 volts) is applied to stainless steel plates arranged in parallel. Water from the electric grid is then treated with alum for coagulation before reaching pressure sand filters. After filtration, the water passes through a series of ultraviolet lamps for the final treatment of supplemental water.

In order to determine the efficiency of the pre-treatment facility, procedures to bioassay the effluent from each unit were established. Disease-free fish were placed in hatching jars supplied with untreated water; effluent water from the electric grid; effluent water from the electric grid and sand filters; and effluent water from the electric grid, sand filters, and ultraviolet lights (supplemental water for reconditioning system). Two hatching jars were used at each station. This allowed for testing the effect of the effluents on fish over a long period of time (9 months) in one jar and short time exposures (2 and 4 weeks) in the other. All jars were loaded with 100 fish at the start of each test and supplied with a flow of 1/2 gallon per minute. Examinations of fish for bacteria and parasites were made at 2-week intervals. Total bacteria counts from each water supply using the standard plate count method were also made at 2-week intervals.

Results

1. Counts of bacteria in the effluent from the ultraviolet lights increased with the age of the bulbs and as the quartz protective shield became dirty. The ultraviolet unit was made more effective when the quartz tubes were cleaned every 2 months with a hot (65 C) citric acid bath. Annual replacement of ultraviolet bulbs is necessary to maintain adequate purification.

2. High counts of bacteria from the effluent of the sand filters indicated a high bacteria load within the sand filters. Bacteria in the sand filters were reduced by a 24-hour 200 ppm chlorine bath.

3. Ichthyophthirius was diagnosed on fish reared in untreated river water and in effluent water from the electric grid. This indicates that the sand filter is the effective pre-treatment unit for controlling "Ich".

4. Eggs and miricidia of the blood fluke, Sanguinicola, were found in fish reared in untreated river water but not in fish reared in any of the other effluents indicating that the electric grid is effective in controlling the blood fluke.

5. Furunculosis, Aeromonas salmonicida, was diagnosed from fish reared in the supplemental water. This water had been exposed to the electric grid, sand filters, and ultraviolet light. The infection occurred after the turbidity of the effluent from the sand filter increased to 70 Jackson Turbidity Units (JTU) and the efficiency of the ultraviolet unit dropped to 60%. No furunculosis has been diagnosed when turbidity has been less than 10 JTU and ultraviolet irradiation has been maintained above the recommended minimum level of 16,000 microwatt-seconds/cm^2.

6. The infective agent of Epistylis was not killed by the water disinfection unit.

Conclusions

Since water reconditioning systems are extremely vulnerable to disease epizootics, supplemental water must be treated to reduce the numbers of fish pathogens. Pre-treatment of supplemental water with an electric grid, sand filters, and ultraviolet lights can be successful in reducing the numbers of fish pathogens.

Bioassay of the effluent from each unit of a disinfecting system is an effective method for determining the efficiency of each unit and to reveal the deficiencies in such a system. It is an excellent method to test a new system and to monitor any system in production.

BUFFERING REQUIREMENTS IN FISH HATCHERY RECONDITIONING RE-USE SYSTEMS

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Fish hatcheries are presently being designed to include water reconditioning systems. These reconditioning systems will primarily consist of trickling or submerged filters in which ammonia produced by the fish is removed, in part, by bacterial conversion to nitric acid. This nitric acid, along with carbon dioxide produced by the fish, can cause a decrease in pH sufficient to make the water unsuitable for re-use.

Buffering the water will maintain the pH at a suitable level. However, a rational basis for design of a buffering system had not been previously developed. Consequently, on May 26, 1972, the Walla Walla District of the Corps of Engineers, the Bureau of Sports Fish and Wildlife, and the National Marine Fisheries Service, sponsored a study at Bonneville Fish Hatchery that would result in design criteria applicable to a buffering system.

Carbonate plays an important role in buffering a natural water system. Inorganic constituents dissolved in water originate from minerals and the atmosphere which provides the acid that reacts with the bases of rock minerals. That is

$$CO_2 + \underset{\text{calcite}}{CaCO_3} + H_2O \longrightarrow Ca^+ + 2\ HCO_3^- \qquad (10)$$

or

$$CO_2 + \underset{\text{albite}}{NaAlSi_2O_8} + 5.5\ H_2O \longrightarrow Na^+ + HCO_3^- + 2\ H_4SiO_4 + 0.5\ \underset{\text{kaolinite}}{Al_2Si_2O_5(OH)_4} \qquad (11)$$

These and similar reactions provide the buffering alkalinity (HCO_3^- and CO_3) of natural water systems. For a water system, in addition to dissolution from the atmosphere, carbon dioxide is produced during the biological respiration/oxidation of organic matter. Respiratory activities of aquatic biota contribute carbon dioxide to a water system while photosynthesis assimilates and converts carbon dioxide into organic matter as described by the following:

$$nCO_2 + nO_2 \underset{\text{respiration}}{\overset{\text{photosynthesis}}{\rightleftharpoons}} (CH_2O)_n + nO_2 \qquad (12)$$

It should be noted that increase in carbon dioxide (normally expressed as H_2CO_3) increases both acidity and total concentration of carbonic species of a water system. However, this increase in H_2CO_3 does not affect the alkalinity as does the addition of strong acid. See equation.

$$ALK = (HCO_3^-) + 2\ (CO_3^-) + (OH^-) - (H^+)$$

A simple model, showing some characteristics of the carbonate system of natural waters, is provided by equilibrating pure water with the atmosphere which contains a constant partial pressure of carbon dioxide. Distribution of the solute species of this model can be illustrated mathematically.

Based on the mathematical derivations, the pH values of a water system can be graphically determined with the aid of Figures 1 and 2. Figure 2 is self-explanatory. However, the application of Figure 1 requires further explanation. The following example describes the proper use of Figure 1.

Assume the water supply has an alkalinity of 50 mg/1 as $CaCO_3$ and 5 mg/1 carbon dioxide. If there is 3 mg/1 NO_3-N produced during nitrification and CO_2 content increases to 15 mg/1 due to metabolism, what will be the pH value when the system reaches steady state?

(Solution)

(1) The alkalinity of water supply is

$$\frac{50 \text{ mg/1}}{50 \text{ mg/meq}} = 1 \text{ meq/1}$$

(2) Use the equation $C_T = Al^k + (CO_2\ (aq))$

$$(C_T = 1 \text{ mm/1 } (C) + \frac{5 \text{ mg/1}}{44 \text{ mg/m mole}}$$

$$= 1.119 \text{ m mole/1}$$

Note: For bicarbonate alkalinity 1 meg = 1 mm

(3) With al^k and C_T Point A is located

(See Figure 1)

(4) 3 mg/1 NO_3-N will reduce the alkalinity

by $\frac{3 \text{ mg/1}}{14 \text{ mg/meq}} = 0.214 \text{ meq/1}$

Note effect of acid base addition.

(5) Draw a line from Point A vertically downward to Point B (Figure 1) with the difference in alkalinity equivalent to 0.214 meq/l.

(6) The increase in CO_2 from 5 to 15 mg/l will increase

C_T by $\frac{15-5 \text{ mg/l}}{44 \text{ mg/m mole}} = 0.227$ mm/l

Note effect of carbon dioxide addition.

(7) Draw a line horizontally to the right to Point C with the increase in CO_2 content equivalent to 0.227 mm/l.

(8) Point C is located on a line of pH 6.5. Therefore, the steady state pH of the water system will be 6.5.

Additionally, Figure 1 can be used to determine the change in pH and CO_2 of a water when various buffering chemicals are added. If a hydroxide substance is added (e.g., lime or caustic soda), the position of the water on Figure 1 moves vertically. If a carbonate substance is added (e.g., soda ash or calcium carbonate such as in oyster shell and limestone), the position of the water moves upward at a slope of 2 to 1. In both cases, the concentration of the buffering chemical added is measured vertically using the alkalinity scale.

The following is a summary of the conclusions presented in the report, "A Study on Buffering Requirements for Bonneville Fish Hatchery Water Reconditioning System".

Various buffering systems, fixed-bed and chemical feed, with different buffering materials, were studied. All the systems were tested under conditions similar to those predicted for the proposed Bonneville Hatchery reconditioning system. The systems were operated with straight water flow-through, and with a portion of the water flowing through with dilution as well.

All the data obtained from this study were reduced to useful form with the aid of computer techniques. In general, the results of this study support the following:

1. All the systems studied (fixed-bed with oyster shell or limestones) and chemical-feed with lime, soda ash, and caustic soda) were able to control pH value within desirable range. Therefore, any of these methods can be used for buffering water in a reconditioning system.

2. For a fixed-bed system, buffering capacity was found to be proportional to actual contact time and contact surface area, and inversely proportional to the sizes of the media.

3. The measured buffered capacity of the chemicals, lime, soda ash, and caustic soda, compare well with the theoretical value.

4. The alkalinity increase of the total flow required in a water reconditioning system is the same regardless of whether the whole or a portion of the flow passes through the buffering unit. However, the economy of a fixed-bed unit depends upon size of media used if partial buffering with dilution is considered. In general, running only a portion of the recirculating flow through the buffering unit is more economical when the small media are used. However, the situation is reversed when the medium or larger sizes of media are used.

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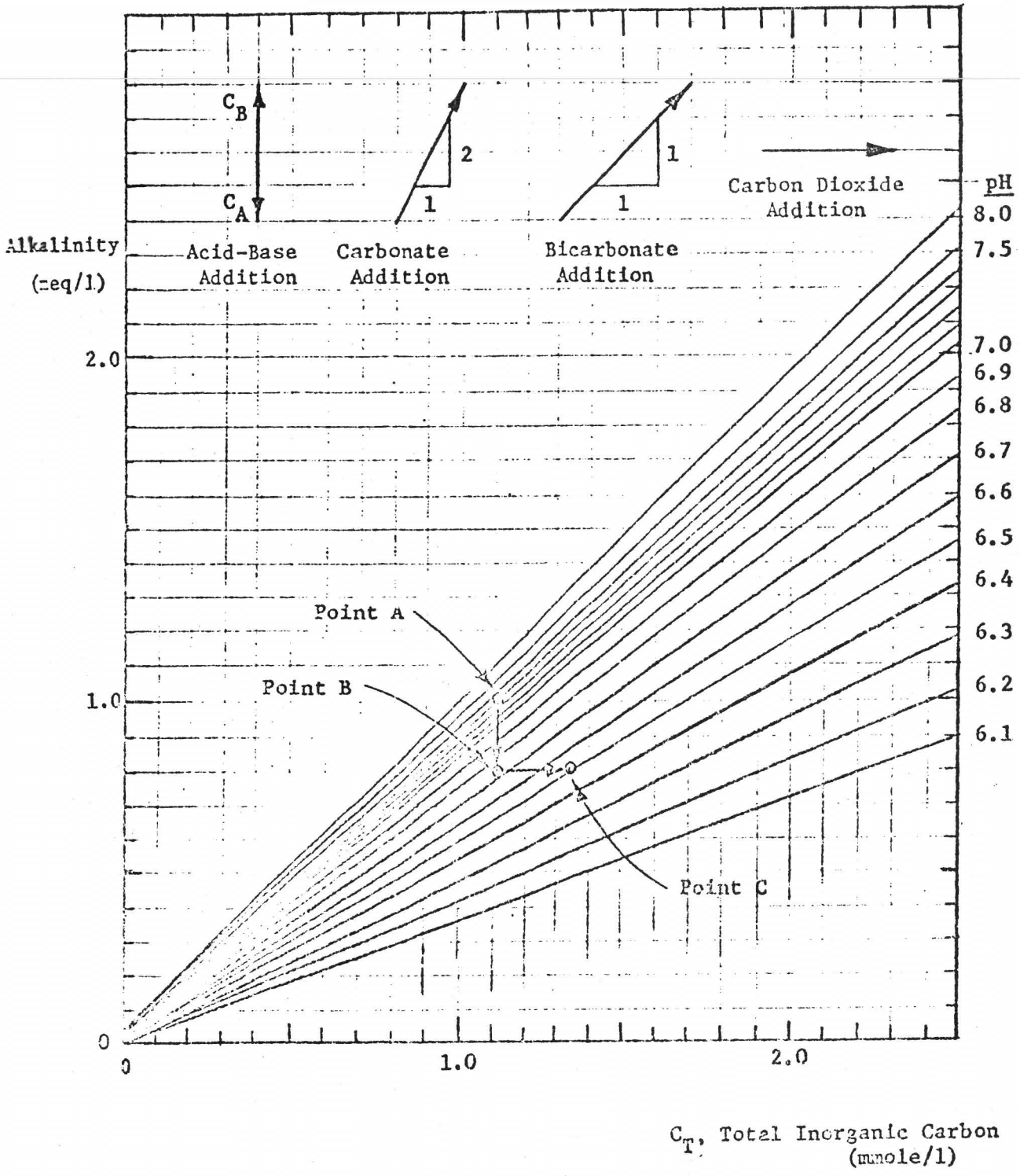

Figure 1. Alkalinity, C_T, and pH Relationship. [After Deffeyes(1)]

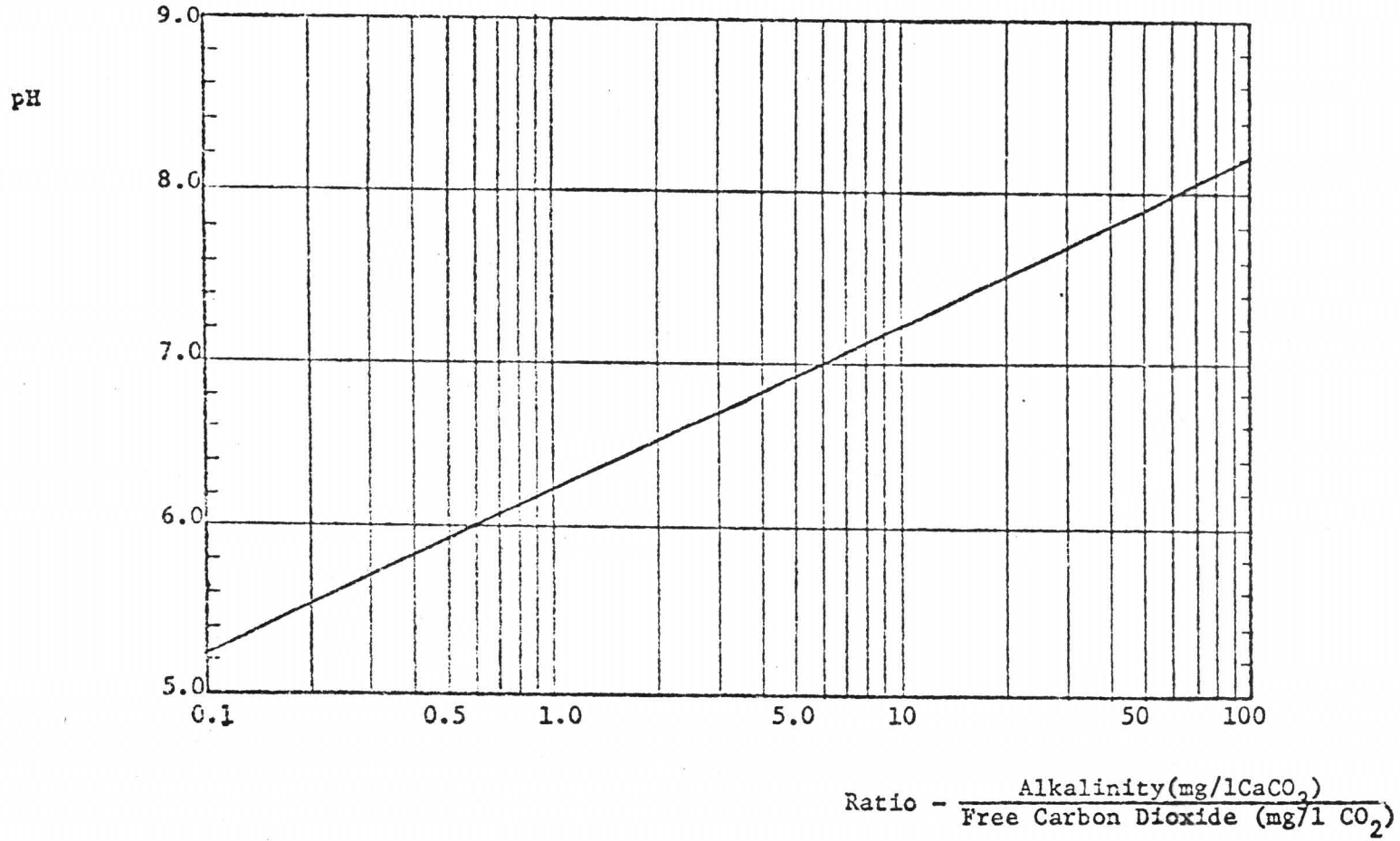

Figure 2. pH versus Alkalinity/CO_2 Ratio. [After McKee(3)]

FISH-CARRYING CAPACITY IN A WATER RECONDITIONING RE-USE SYSTEM

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Introduction

Current methods of determining fish-carrying capacity (lb/gpm) are mainly based on oxygen requirements. However, under certain circumstances, oxygen requirements are not the only limiting factor. Therefore, the projection of fish-carrying capacity solely based on oxygen requirements is not acceptable under certain conditions. These special conditions may include high pH and metabolite levels. For a single-pass hatchery, the metabolite of most concern is ammonia because of its toxicity to fish. Therefore, the determination of fish-carrying capacity should be based either on oxygen requirements or acceptable ammonia levels, depending upon which is the controlling factor. For a single-pass hatchery which has a water supply with desirable pH and temperature, the oxygen requirements predominate. Nevertheless, the ammonia level may govern, particularly if the water supply has a high pH which increased the toxicity of ammonia. Elevated ammonia concentrations may predominate in re-use systems where water is not adequately treated prior to re-use. Other metabolites, such as CO_2 and organics, dissolved or suspended, may also govern the carrying capacity if they are present at a high concentration, because they have been found to be directly or indirectly toxic to fish. These metabolites are seldom found in high enough concentrations to cause significant effects on fish in a single-pass system.

The determination of carrying capacity in a reconditioning re-use system is becoming popular due to (1) the scarcity of quality water supplies, (2) the increased demand for game and commercial fishes, and (3) proposed stringent pollution abatement programs. While most emphasis is placed on the increase in fish production in a reconditioning re-use system, the proper methods for determining fish-carrying capacity cannot be ignored.

Many publications regarding reconditioning re-use systems are available. However, few or none of these discusses procedures for determining the carrying capacity of reconditioning re-use systems.

To help understand the system and its application, I would like to discuss various methods of determining carrying capacity. Due to the limited time available, I cannot discuss the techniques in detail. Rather, various factors and their inter-relationships in regulating carrying capacity in a re-use system will be described.

Hatchery Water Reconditioning Re-use System

Logically, it is desirable to understand first what a hatchery water reconditioning re-use system is. What elements (components) does a

reconditioning re-use system consist of? What are the functions of the components and their design and operating factors? How do these factors affect fish-carrying capacity?

A hatchery water reconditioning re-use system can be defined as a system that combines the rearing units with one or more water treatment processes (which may include reconditioning-treatment, pre- and post-treatments) to allow utilization of a water supply for the rearing of more fish than would be possible in a conventional single-pass system.

Fish-Carrying Capacity in a Reconditioning Re-use System

General

In a single-pass system, prior to determining the carrying capacity, it is necessary to know the water temperature, oxygen levels (influent and effluent), oxygen consumption rates (calculated based on fish species, sizes, and temperatures). For a reconditioning re-use system, in addition to these parameters, it is necessary to know the efficiency of the reconditioning treatment, degree of water re-use, type of food and rate, modification of water temperature, ammonia production rates, acceptable ammonia levels (mainly dependent on temperature, pH, and exposure time), and pH (dependent upon CO_2 and alkalinity).

Methods of determining carrying capacity

Various options exist for approximating carrying capacity. These options are dependent upon individual circumstances. However, major alternatives may include the following:

1. Determination of carrying capacity (CC) based on oxygen requirements (Or) with proper control of pH, when the degree of water re-use (R) and efficiency of treatment (E) are constant.

2. Determination of CC based on Or with proper control of E when pH and R are constant.

3. Determination of CC based on Or with proper adjustment of R when pH and E are constant.

4. Determination of CC based on Or with adjustments of pH and R when E is constant.

5. Determination of CC based on Or with proper adjustments of pH and E when R is constant.

6. Determination of CC based on Or with proper adjustments of R and E when pH is constant.

7. Determination of CC based on Or with proper adjustments of pH, R and E.

(a) CC based on Or if Or controls.

(b) CC based on NH_3 if NH_3 controls.

In summary, the above methods are based first on oxygen requirements and secondly on the regulation of toxic ammonia levels through the control of pH, R and E, since the resultant ammonia level and its toxicity are dependent upon E, pH, and R. Choice of the best alternative will vary depending upon local conditions.

Regulation of feeding seems to be an alternative since ammonia production rate is proportional to feeding rate. However, for normal hatchery operation, reduction of feeding rate is not practical. This practice may be used for emergency control.

The aforementioned methods should help in properly adjusting fish-carrying capacity in a reconditioning re-use system. Examples showing detailed calculations for these possible alternatives cannot be discussed here because of limited time.

UPDATING ULTRAVIOLET LIGHT WATER PURIFICATION

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I would like to mention at the start that by now everybody in the industry is fully aware of the benefits of ultraviolet in the fish cultural field. It has been mentioned many times today by other speakers; but what I think people should realize is that it is a very specialized field. One can count all the manufacturers on one hand and out of these obviously not everybody is interested in fish culture. We will do our best to be as general as possible in talking about the current status of ultraviolet, even though this means leaving out some interesting information.

Ultraviolet is becoming a more and more sophisticated technology and as a result, naturally, the first controlling devices in such a specialized field have been a bit complicated to the average person, especially in smaller groups with few engineers or scientists. We believe the industry as a whole has a responsibility now, not only for developing newer and better units, better suited to your field, but also to, if you will pardon expression, make them more idiot-proof, easier to handle, easier to control, easier to run. This is extremely important.

For example, Einor Wold mentioned earlier the problems of checking lamps. I think everybody in the industry today has, at least as an optional availability, meters to check the lamps automatically and check the ultraviolet transmission automatically, eliminating this type of troublesome, time-taking and labor-consuming work. Furthermore, this depends on the type of lamp that is used and the major lamp producers. For them, germicidal ultraviolet lamps are a very small field compared to, for example, regular fluorescent lamps. In fact, it might be of interest to you that germicidal lamps were developed in the process of researching and developing fluorescent lamps by Westinghouse years ago. It was a by-product and it still is a "by--product" for those companies that make it. The interest is increasing, but not to the point where they are willing to do real work. The result is that it falls on the ultraviolet purification equipment manufacturers to do this kind of research.

For example, one of our major states ran a test during the last few years that might be of interest to you. In a 2-year period they had only a 3% failure and replacement necessity of lamps. At the end of those 2 years, the lamps were tested and while they were still marginally good, it was still cheaper to replace all of them rather than one at a time when trouble developed. But the same type of lamp, that is the same number from another manufacturer, might not give nearly the results according to tests run in our laboratory. A typical example of this occurred recently when someone on a bid specified a new long-type lamp. Since only one is officially in the catalog (lamp manufacturers do a lot of private label work if you give them enough business) they didn't realize the weakness of this lamp for water purification use. Because

the manufacturers do not put out enough information, you cannot completely blame them, that they did not realize that this long lamp is actually 40% less effective **germicidally the way it is used in** fish culture water treatment, than two smaller lamps. The manufacturer and the buyer think they are getting a good buy, they are buying cheaper lamps, less connections, less parts, less ballasts, etc.; but in the long run, they are getting much less treatment, and 40% is a lot!

I think another responsibility that the industry has is to come out with clear, better literature so that not just the scientific personnel or the chief engineers can understand it, but the people that are going to be working with the equipment can understand it better. We feel that it falls on the shoulders of the industry to do this. One thing we get asked constantly is, what dosage is necessary to kill a certain organism? I would say this question originates 99% of the time by the fish culture field as compared to all the other industries that use ultraviolet water purification, because in most other industries, they are only concerned with a few organisms, coliforms, and others which are well known and, consequently, there is not much of a problem. There is a problem with the various diseases that **concerns you.** While there are some figures available, most of the published figures up until now vary. Because it is so difficult to measure dosage and there is no ASTM regulation which states a definite way of measuring dosage, everybody has sort of developed his own by-guess and by-gosh method. Some of the researchers, and you can't blame them, have had access to even less information with the result that you can cite three different pieces of literature on saprolegnia that have dosages of 10,000, 25,000 and 39,000 - all on the same organism.

One thing you will all be happy to know is that as soon as the money is allotted, the BSFW is going to start on a cooperative research program to define and tie down as much as possible, dosages for various diseases because people are buying too much ultraviolet - more than they need, spending a lot of extra money, making it more expensive than is necessary.

I suspect that it will be a year before the money is allotted and everything is going, but the Bureau is going to issue semi-annual reports so that everybody will have these figures which we think will prove valuable to all concerned.

The use of ultraviolet in recycling systems is also a subject of frequent discussion. Almost all modern recycling systems utilize ultraviolet treatment for the make-up water. It has often been suggested that a high volume, low dosage ultraviolet system placed after the organic filter would both keep the organisms' count low and under control; and provide an insurance policy against possible epizootic.

Also vital is a good filtration system which will not allow organisms too large for the particular ultraviolet system to pass. Bill Walsdorf ran some tests where, purposely, a 50-micron filter was used with a ultraviolet system which had a high enough dosage output to kill all 15 or even 20 micron organisms, according to known literature. Epistylis, generally rated at 40± microns, came through and were not killed by the ultraviolet. This illustrates the risk of using sand filters. Dr. John Fryer reported a few years ago that he took the effluent from a sand filter, put it through a Millipore filter, backwashed this - and found particles of 40 and even 50 microns. If these were organisms in a recycling system, one can easily see the danger.

EFFECTS OF METHYLMERCURY EXPOSURE ON SEA WATER ADAPTATION OF JUVENILE COHO SALMON AND STEELHEAD TROUT

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We constructed a model of methylmercury intoxication in anadromous salmonids, based on evidence that methylmercury is the predominant mercury form found in salmonids from the Pacific Northwest, and evidence that mercury compounds can cause histological damage to gills and kidneys of fish. Accumulation of methylmercury in rearing areas and along migratory routes was hypothesized to inhibit sea water adaptation, partly because of effects on the gills and kidneys. We then conducted laboratory experiments with coho salmon and steelhead trout to test some aspects of the model.

In order to conveniently measure the concentration of mercury in the water and in the fish, Hg-203 labeled methylmercury chloride was used. Partly because of the expense of this chemical, we chose to use a static water exposure system. Fish were transferred every 24 hours to newly prepared methylmercury solutions and aeration was used to maintain a relatively constant water quality. Gas chromatographic analysis of stock solution and a few water samples indicated that 98 to 100 % of the radioactivity measured by gamma ray spectroscopy was indeed methylmercury.

Using 10 fish at each of 10 methylmercury chloride concentrations, the 96-hour LC-50 was found to be 38.9 ppb Hg for 6.5 gm coho salmon in our water (21-34 ppm $CaCO_3$) at 15 C using this static water system. Based on these data, 7-day salinity tolerance tests were conducted. As indicated by the graph, in both replicates, 50 to 100% mortality was observed in coho exposed to 20 to 32 ppb Hg for 96 hours and then transferred to two-thirds sea water, while controls and fish exposed to 10 ppb Hg were able to survive the two-thirds sea water for 7 days. Regardless of previous methylmercury exposure, all fish survived in fresh water without mercury added for 7 days.

Six to 8 gram steelhead trout responded to the salinity tolerance test in nearly the same manner as the coho salmon. In one replicate, there was no mortality in two-thirds sea water after a 96-hour exposure to 20 ppb Hg, but these fish displayed symptoms which typically preceded death in two-thirds sea water.

The concentration of mercury in the coho at the end of the salinity tolerance test correlated well with the previous methylmercury exposure and with the observed toxicity. Fish exposed to 32 ppb Hg accumulated about 9 ppm Hg (whole body).

Steelhead exposed to 32 ppb Hg for 96 hours, accumulated only 5.6 ppm Hg (whole body) or about 60% of what coho accumulated when similarly

exposed. Tissue from the gills and arch and kidney accumulated 25.5 and 24.4 ppb Hg, respectively. Joe Wales of the OSU Department of Food Sciences helped analyze histological studies of these tissues. A proliferation of cells was observed between the secondary lamellae of the gills, suggesting inhibition of gas and salt exchange between the fish and the water. Degeneration of kidney tubules was also observed. This may have resulted in a diuretic effect which would have dehydrated the fish in two-thirds sea water.

Examination of coho sub-samples just prior to transfer from methylmercury solutions to two-thirds sea water failed to show gross histological changes in the gills and kidneys associated with the observed mortality, however, physiological changes may have occurred. We, therefore, suggest that physiological changes in these tissues which decrease the ability of these organs to maintain water and salt balance in the fish may be part of the mechanism of action by which methylmercury can inhibit the sea water adaptation of the fish. Our data point out the need for considering this critical sea water adaptation period when setting water quality standards for methylmercury, and other chemicals, to insure maximum production of anadromous salmonids.

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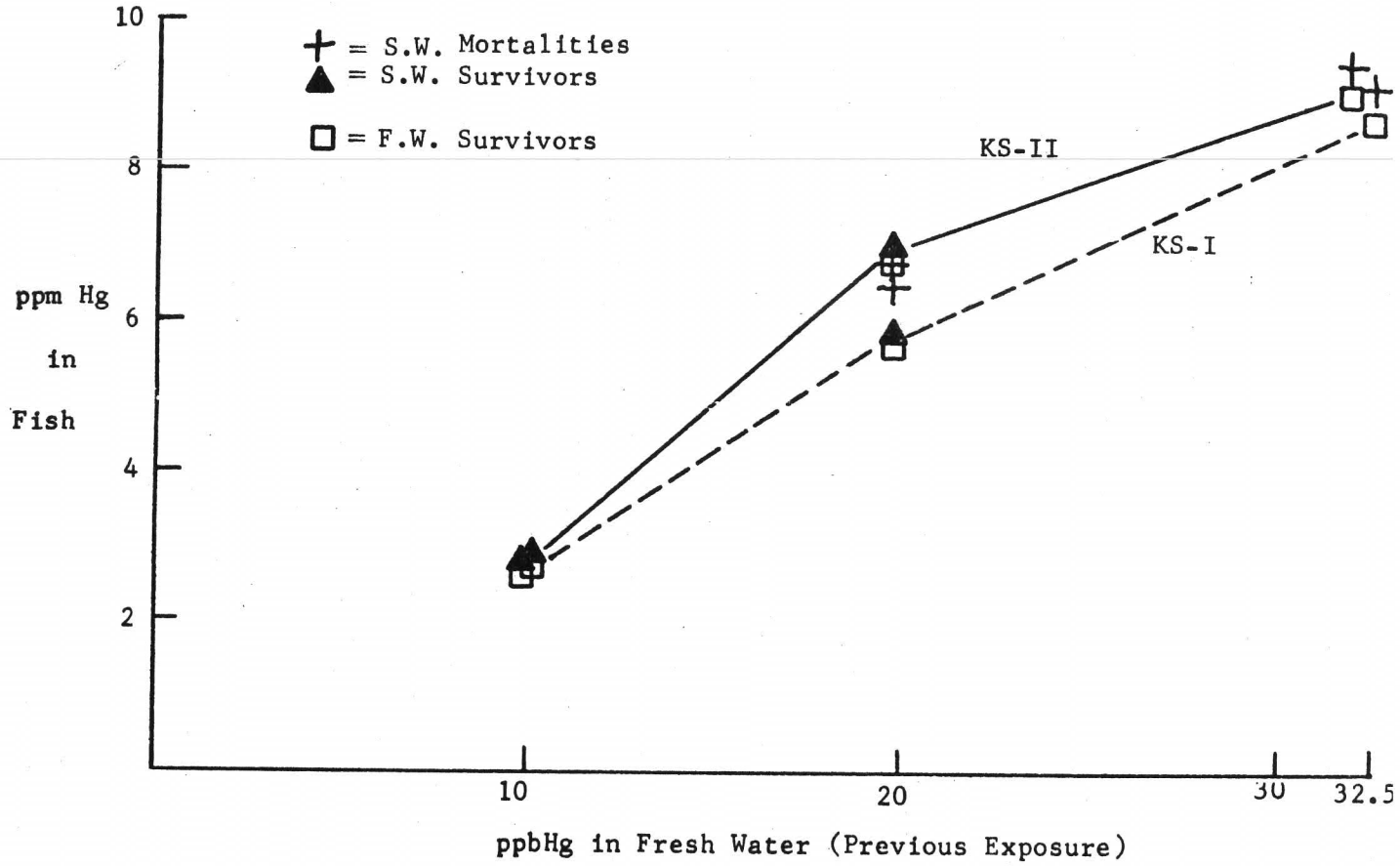
Mercury Accumulation in Coho Salmon

at End of Salinity Tolerance Test



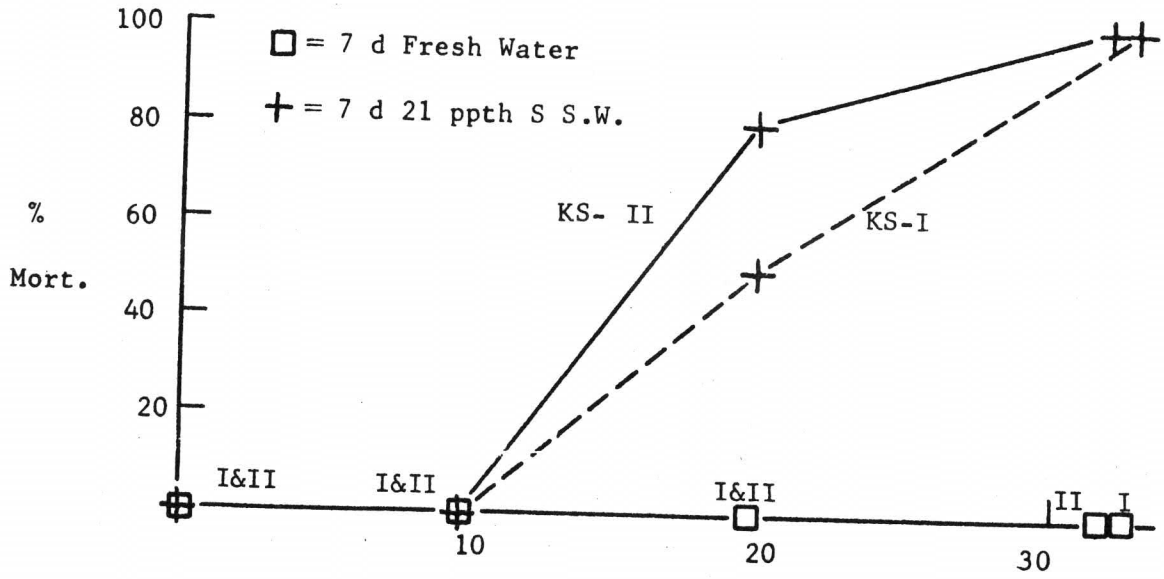
Mercury Accumulated in Steelhead Trout

During 96 hr Exposure to Methylmercury (32.2 ppb Hg)

Tissue	Number of Fish Sampled	ppm Hg ± S. D.
Whole Body	5	5.6 ± 0.4
Liver	3	29.9 ± 3.6
Gill & Arch	3	25.5 ± 2.0
Kidney	3	24.4 ± 3.0
Brain	3	5.0 ± 0.6
Epax. Muscle	3	1.9 ± 0.6

Coho Salmon: Percent Mortality

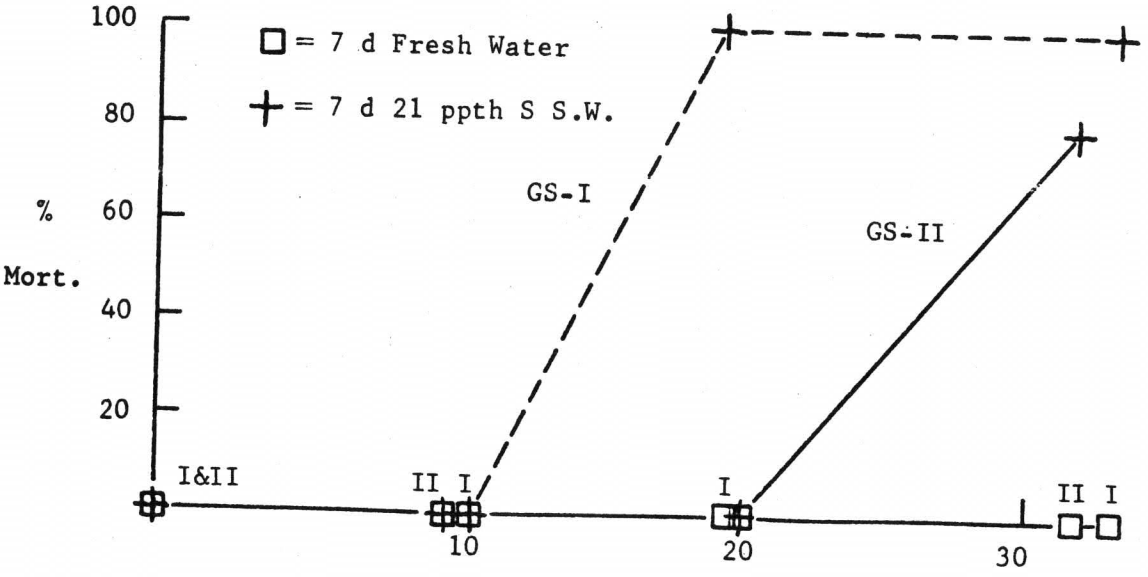
During Salinity Tolerance Test



ppb Hg in Fresh Water (previous Exposure)

Steelhead Trout: Percent Mortality

During Salinity Tolerance Test



ppb Hg in Fresh Water (Previous Exposure)

ADVANTAGES OF ACCELERATED INCUBATION IN TEMPERATURE CONTROL SYSTEMS

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The Grays River installation has, for the past 4 years, been fortunate in obtaining unfed fall chinook fry from the Abernathy Salmon Culture laboratory. The advantages of obtaining this stock, which has been incubated in the temperature control re-use water system at Abernathy, is basically the longer feeding period afforded by the accelerated incubation. These fry have usually been obtained during the first part of December, whereas our natural stock is not ponded until 1 month or more later. The ultimate net result of the increased rearing period has been gratifying. The release sizes have ranged from 32 fish per pound to 56 fish per pound by the end of May, while our natural stock, reared to mid-June, averages approximately 100 fish per pound. Conversion ratio of the Abernathy stock this past year equaled 1.18 while the Grays River stock converted at 1.69. Stamina tests conducted at the Abernathy facilities have rated these fish as excellent.

All is not peaches and cream though. At the Grays River installation the past 3 years, we have been plagued with some of the dirtiest water imaginable due to new logging and road building operations taking place in our headwaters. As a result, there are days on end that it is impossible to even see a fish in the ponds. Nevertheless, we still continue with our normal feeding schedule and the little devils must find some of it to eat because they keep growing. When the fish had clear water, as 4 years ago, the growth rate was 18% better in spite of the fact they are transferred from a warm-water environment during incubation to cold-water rearing. To summarize the topic, it must be assumed that the re-use, filtered, temperature control-type installation for incubation produces better quality fish, more poundage, and better conversion even when the rearing is conducted in adverse water conditions.

CONTROL OF LOW TEMPERATURE DISEASE IN DEEP-TROUGH INCUBATION UNITS

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Experimental work, under the direction of James Wood, pathologist for the Washington Department of Fisheries, has been conducted at the Simpson Hatchery and other installations in an effort to find the causes and cures for outbreaks of low-temperature disease at susceptible hatcheries. This experimentation has revealed that reduced water flows in incubators lessened the occurrence of low-temperature outbreaks. Also, it was found that if the coho were incubated in shallow troughs with an average water flow of 5 gpm, they were not plagued with the severe outbreaks of low-temperature disease that developed in deep trough incubation units requiring water flows of 12 to 15 gpm.

These findings, as gratifying as they were, did nothing to solve the dilemma of the 100% deep trough incubating installations, such as the Grays River Hatchery.

We have found that by stocking the upper sections of our deep troughs, that is the first five stacks, with our fall chinook eggs we could maintain a minimum DO reading at the outfall of our troughs of 7 ppm with a 5 gpm inflow. There is usually a minimum of a 3 weeks' spread between the harvest of our fall chinook eggs and the harvest of our coho eggs. Therefore, we stock the lower section, or the last four stacks of our deep troughs with coho eggs. The fall chinook hatch first and are able to utilize the initial oxygen content of the water and the coho eggs, whose oxygen demand is less, still are adequately supplied with an outlet DO level of 5 ppm or over. As the coho start to hatch, it has sometimes been necesesary to increase the flow to 7 gpm.

This procedure may seem like it would be quite confusing keeping the various egg takes segregated, but the program has paid off with reduced incubation loss due to low temperature disease of approximately 20%.

THE EFFECTS OF TEMPERATURE ON THE PROGRESS OF BACTERIAL KIDNEY DISEASE IN EXPERIMENTALLY INFECTED JUVENILE COHO SALMON

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The present experiment was designed to determine the effects of a wide range of temperatures on juvenile coho salmon experimentally infected with the caustic agent of bacterial kidney disease. Eight temperatures ranging from 74 to 39 F at 5° intervals were used in this study. Each fish to be experimentally infected was injected i.p. with about 2.5 x 10^8 organisms contained in 0.05 ml saline. Control fish received the same volume of sterile saline.

Table 1 shows the effect of water temperature on kidney disease losses 110 days after the fish were infected. The data represent the combined results from two groups of experimental and control fish at each temperature. At the highest temperature tested, 74 F, fish in both the experimental and control tanks died at the same rate, indicating losses were not caused by the kidney disease bacterium.

Although the mean day of death was shortest at the higher temperatures, the greatest mortality occurred at the lower temperatures. At 69 F, 23% of the fish died in the experimental group compared to 6% in the controls. At 64 and 59 F, losses caused by the kidney disease organism increased to 50% and 76%, respectively. In the range of temperatures between 69 and 54 F, each 5° decrease resulted in about a 25% increase in the number of mortalities.

The disease process was most active at 54 and 49 F. By the 70th day after infection, 90% of the experimental fish at these temperatures were dead. At 44 F, although the infection progressed at a much slower rate, over 90% of the experimental fish died from kidney disease. The progress of infection was slowest at 39 F. Sixty per cent of the coho injected with the kidney disease bacterium and held at this temperature had died when the experiment was terminated at 110 days. The rate of loss indicated that had the experiment been conducted an additional 60 days, the mortality would have reached 90%.

Numerous observers have indicated that changes in water temperature will result in an increased mortality among populations of fish infected with kidney disease. The survivors after 110 days at 39 F were moved up to 54 F. This caused an immediate increase in the death rate. In contrast, no increase in the death rate occurred when the survivors at 69, 64, and 59 F were moved down in temperature to 54 F. This suggests these higher temperatures are much more unfavorable for the survival of the kidney disease bacterium in its host.

This work was supported by Environmental Protection Agency Grant 18050 DIJ.

Table 1. Effect of water temparture on losses in juvenile coho salmon experimentally infected with the causative agent of bacterial disease.[1/]

Temperature	Group	Total mortalities[2/] No. fish recovered	Per cent mortality	Mean time from infection to death in days
69 F	Experimental	10/44	23	26
	Control	3/50	6	
64 F	Experimental	22/44	50	29
	Control	2/50	4	
59 F	Experimental	38/50	76	37
	Control	0/50	0	
54 F	Experimental	42/42	100	39
	Control	0/50	0	
49 F	Experimental	47/48	98	52
	Control	1/48	2	
44 F	Experimental	41/44	93	73
	Control	1/48	2	
39 F	Experimental	26/44	59	>83
	Control	1/50	2	

1/ At 110 days after the fish were experimentally infected.

2/ Combined results of two groups of fish at each temperature.

THE EFFECTS OF TEMPERATURE ON CERATOMYXA SHASTA DISEASE IN EXPERIMENTALLY INFECTED JUVENILE RAINBOW TROUT AND COHO SALMON

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This study was undertaken to delineate the effects of temperature on the disease process caused by the protozoan, Ceratomyxa shasta. For this investigation, rainbow trout and coho salmon juveniles were used as host animals. Eight constant water temperatures were maintained for these experiments. They ranged from 74 F to 39 F at 5° increments. Experimental fish were exposed to the infectious unit of C. shasta while held in a live-box submerged in the Willamette River near Albany, Oregon. The rainbow trout were exposed for 48 hours during September 1970 and coho salmon for 72 hours in September 1971. The average water temperature during exposure in 1970 was 60.7 F and 59.4 F in 1971. Control fish were held in disease-free water. All fish were fed Terramycin to prevent bacterial interference.

After exposure, the experimental and control groups were divided and acclimated to their respective temperatures. All fish that died during the experiment were examined. Only when specimens contained the spore stage of the protozoan were they considered positive for the disease.

A summary of results obtained utilizing the rainbow trout host is presented in Table 1. At 74 F, trout infected with C. shasta died rapidly (mean day of death = 14.1 days), and many fish succumbed prior to spore formation. With the 74 F mortality equal to the 69 F mortality, it can be seen that the same proportion of the population died of C. shasta at each temperature down to 39 F. At 39 F, however, no fish exhibited C. shasta disease after 237 days. The mean day of death of C. shasta infected fish increased logarithmically as temperature decreases, doubling approximately every 10 F drop in temperature.

Table 2 summarizes the results of the experiment utilizing coho salmon hosts. With coho salmon, the proportion of the population infected with C. shasta decreased with decreasing water temperature, a contrast to the results obtained with rainbow trout. However, as in the case of rainbow trout, the mean day of death of coho dying of C. shasta increases logarithmically with decreasing temperature.

Both species of fish used in these experiments were from stocks which have never been exposed to C. shasta. Therefore, the data presented here probably represent the maximal effect of C. shasta on these two species.

This work was supported by Environmental Protection Agency Grant 18050 DIJ.

Table 1. Effect of water temperature on losses in juvenile rainbow trout experimentally infected with *Ceratomyxa shasta*.[1/]

Temperature (F)	Group	Per cent mortality	Per cent infected with *C. shasta*	Mean day of death of *C. shasta* infected fish
74	Experimental	100.0	52.0	14.1
	Control	0	0	--
69	Experimental	98.0	72.0	18.6
	Control	0	0	--
59	Experimental	92.0	86.0	42.3
	Control	0	0	--
54	Experimental	95.5	75.0	56.6
	Control	0		
49	Experimental	80.0	80.0	87.8
	Control	0	0	--
44	Experimental	77.5	75.2	155.5
	Control	0	0	0
39	Experimental	0	0	--
	Control	0	0	--

[1/] Combined results of two groups of fish at each temperature.

Table 2. Effect of temperature on losses in juvenile coho salmon experimentally infected with Ceratomyxa shasta.[1/]

Temperature (F)	Group	Per cent mortality	Per cent infected with C. shasta	Mean day of death of C. shasta infected fish
74	Experimental	96.0	60.0	12.2
	Control	0	0	--
69	Experimental	92.0	84.0	22.1
	Control	8.0	0	--
64	Experimental	57.7	53.3	38.5
	Control	0	0	--
59	Experimental	21.3	21.3	39.7
	Control	0	0	--
54	Experimental	24.0	22.0	86.8
	Control	0	0	--
49	Experimental	2	2	146.0
	Control	0	0	--
44	Experimental	0	0	--
	Control	0	0	--
39	Experimental	0	0	--
	Control	0	0	--

[1/] Combined results of two groups of fish at each temperature.

AN EVALUATION OF TWO RAINBOW TROUT STRAINS FOR RESISTANCE TO *CERATOMYXA SHASTA*

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Two strains of rainbow trout were tested for their resistance to infection by *Ceratomyxa shasta*. These strains were obtained by spawning fish which have survived repeated exposures to the disease and presumably were resistant to it. The first strain was obtained over the last few years by the California Department of Fish and Game. The second was obtained from wild trout from the Deschutes River by Oregon State Game Commission personnel.

These strains and two control groups were held in live-boxes in the lower Deschutes River during July and August 1972 to compare susceptibilities of the groups to *Ceratomyxa*. The rainbow trout control groups were obtained from the Oak Springs and Roaring River Hatcheries (OSGC) and were known to be susceptible to *C. shasta*. Mortalities were collected three times each week. Detection of *Ceratomyxa* spores was made by examining wet mounts prepared from the intestines of all fish exposed. The data are presented in the accompanying table.

Both the California and Deschutes River strains were resistant to infection by *Ceratomyxa*. The California strain exhibited the highest resistance but had a 51% total mortality. This was probably due to bacterial fish pathogens acquired during exposure. *Aeromonas liquefaciens* has been the predominant fish pathogen isolated from the California strain held at other locations.

The symptoms and pathology of the *Ceratomyxa* infected Deschutes River strain were much less extensive than those of either control group. This indicates that the Deschutes River rainbows had a lowered intensity of infection. Since the Deschutes River strain had the highest overall survival, it would be the best choice for stocking waters of the Deschutes River system containing the infectious agent of *Ceratomyxa shasta*. Some hatchery problems such as slow growth and a high conversion factor were encountered. Even considering these problems, the use of resistant stock does offer a reasonable solution to the management of waters containing the infectious stage of *C. shasta*.

This study has been supported by the Oregon State Game Commission.

Table 1. Resistance of four rainbow trout strains to infection by *Ceratomyxa shasta*.

	Strains tested			
	Oak Springs Hatchery	Roaring River Hatchery	California	Deschutes River
No. fish recovered	466	245	238	713
Total per cent mortality	98	96	51	15
No. fish infected with *C. shasta*	460	237	0	72
Per cent fish infected with *C. shasta*	99	97	0	10

VIBRIO IMMUNIZATION STUDIES

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and

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Laboratory tests indicate that a simple wet whole cell vaccine (Type III) prepared from Vibrio anguillarum is as effective in the immunization of fall chinook as a lyophilized sonicate preparation. The Oregon Moist Pellet is a satisfactory production diet for oral administration of the vaccine. An oral treatment of 8 milligrams of Type III vaccine fed 45 days provided acceptable levels of immunity in fall chinook. Survival of fall chinook in Lint Slough, a salt-water rearing impoundment, was 40% in 1972 as compared to 10% for years when no vaccine was fed. Acquired immunity to vibriosis was lost following an extended rest period. Vaccine made from Vibrio anguillarum isolates originating in Germany and Italy provided lower levels of protection than those from the Lummi Indian Reservation and Manchester, Washington, when tested against vibriosis in Lint Slough. Oral immunization of 18-month-old Atlantic salmon provided moderate protection against vibriosis. Oral immunity of fall chinook did not provide as high a level of immunity as injection. Injection of Vibrio vaccine provided good protection against vibriosis; however, this method is impractical for large-scale hatchery operation at the present time. Oral immunization appears the most feasible method for large-scale immunization. Levels of immunity obtained in small controlled laboratory feeding tests have been difficult to duplicate in large-scale hatchery evaluation tests. Field tests are in progress to determine whether or not vibriosis is a signicant factor contributing to ocean mortality of juvenile fall chinook salmon.

TO TRANSFER OR NOT TO TRANSFER: THIS IS THE QUESTION

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It is generally accepted that the purpose of the multitude of conservation agencies' fish hatcheries is to increase the numbers of fish available to sport and commercial fishermen. This purpose is being realized in many ways. As a result, there have been an increased number of hatchery facilities producing tremendous numbers of fish. Along with increased production, there have been ever-increasing transfers of fish from one watershed to another - all under the guise of increasing the net worth - namely, productivity - of a fishery. For the most part, however, authorizations for transferring fish from one area to another have come from an administrative office, often without too much regard for the opinions of fishery biologists or hatchery personnel. In the majority of cases, there are no adverse effects. In those cases where adverse effects do occur, they are often chalked up to experience. Some classic examples of this are found in the records of Boween National Fish Hatchery, Berlin National Fish Hatchery, the Roundhouse Trout Farm in Michigan, and many others.

Fundamentally, several questions should be answered before a group of fish is moved from one watershed to another. First, what will be the net accomplishment of the transfer? In most cases, the answer is not apparent. We, in fisheries, are no more endowed with foresight than are politicans, no matter what the polls show. So educated guesses must be made or, as some of us call it, a S.W.A.G. Second, what are the risks from a disease standpoint? If the group of fish in question has survived an outbreak of infectious disease, i.e., bacterial, viral, or parasitic, their disease status can be classified as: non-carrier, incubatory carrier, or clinically ill. In all probability, all three classes exist and as such are potential transmitters of the disease-producing organism. This depends upon how recently the outbreak occurred.

If the fact that the fish in question harbor the organism and may transmit it to other fish is accepted, then what might occur following the transfer? There are four possible disease states that could occur in the transferred fish, depending upon the nature of the organism: (1) no disease outbreak, (2) an outbreak precipitated because of the stress incurred during transport, (3) an existing low-grade outbreak arrested, and (4) an existing low-grade outbreak enhanced. In the resident fish in the new location, there are two possible effects: (1) no subsequent problems with the disease, and (2) subsequent disease problems involving the establishment of a chronic carrier condition or an outbreak of varying magnitude. The latter effect is influenced by the degree of susceptibility to the introduced disease-producing organism.

It then follows that, if the risk potential is valid, measures must be taken to detect the disease-producing organism in the fish to be transferred and then measures taken to remove or, at least, diminish the risk potential. It is not easy to detect micro-organisms in carrier fish. The techniques for doing this are, at best, in the development stage and their accuracy leaves a great deal to be desired. Perhaps a more prudent and less time-consuming method to reduce the disease risk potential would be to expose the fish to be transferred to one of the short-term, high-evel, anti-bacterial, or anti-parasitic regimens. The rationale for this action is based upon the occurrence of the disease previously. This could be considered a prophylaxis but it should be more appropriately called treatment in the face of an outbreak. This has been successful in fish suspected of harboring intestinal and superficial bacteria and parasites. However, there are no known methods of removing the carrier state of viruses, certain bacteria, and internal parasites by chemical means. The only known way of removing the carrier fish harboring these organisms is to not have the disease in the first place.

In summary, each proposed transfer of fish into a new watershed must be carefully weighed in terms of expected gain to the fishery, past history of infectious diseases, and the possible risk to the introduced fish and the fish residing in the new watershed. These considerations can be realistically evaluated only through the combined efforts of management and administration.

MECHANICAL EGG PICKER

Neil VanGallen
Colorado Division of Wildlife

The mechanical fish egg picker as developed by VanGallen detects dead eggs by photo-electric cells on associated electronic circuits. The actual ejection of the eggs is accomplished by the use of compressed air.

The unit weighs approximately 35 lbs., has a sorting speed of 110,000 eggs per hour, and will also sort for size. The rotating disc can be selected to sort either salmon or trout eggs, and has been field-tested by sorting over 32 million trout and salmon eggs without causing injury to the eggs tested. Tests included the use of eggs from rainbow, brown-trout, brook trout, cutthroat trout, kokanee salmon, and chinook salmon.

PRELIMINARY RESULTS OF THE 1969 BROOD COHO TIME AND SIZE AT RELEASE STUDY

Robert C. Hager
Washington Department of Fisheries

A clear picture of the detailed aspects of the effect of time and size at release of hatchery-reared fish is vital to the most effective management of any salmon hatchery system.

In order to determine the impact of time and size at release of hatchery-reared coho on survivals and contribution, nearly 400,000 1969 brood yearling coho were identified and released from the Washington Department of Fisheries' Toutle River Salmon Hatchery during the spring of 1971.

The general experimental design, shown in Table 1, consisted of three programmed periodic spring releases of fish at approximately 15 and 26/lb. Two additional groups bracketing these sizes were released in conjunction with the groups released in April. These groups were split on the basis of length in order to monitor the relationship of size to survival within a generalized size group. Growth rates of the study groups were controlled through the adjustment of feeding rates in order to produce the specific average sizes at the scheduled release times.

All groups were identified with adipose fin clip-coded wire tag combinations. Group tag loss levels ranged from 2.1% to 12.1%, and the actual number of tagged fish released totaled 364,648 fish (Table 2).

The final group length and weight samples were taken on the date of release. Sample sizes, mean lengths, and group length ranges are shown in Table 3.

Results

The return of jacks in 1971 was monitored for returning tagged fish. The total return of jacks from tests groups was minimal, numbering less than 100. Unfortunately, all samples were lost prior to tag recovery.

Returning adults were sampled systematically for tagged fish. Estimates of the number returning, including the per cent return, are shown by group in Table 4.

The per cent survivals of the returning fish, displayed in Table 5 for ease of interpretation, indicate a direct positive effect of both size at release and time of release on the percentage of fish returning to the hatchery rack.

At this time, these hatchery recovery data and the associated fishery recovery information have not been carefully correlated. Future analyses of these data include processing through the existing hatchery model systems.

Table 1. Experimental design of the 1969 brood reared coho release timing study.

	1971 release date		
	March 15	April 15	May 15
Size at release (fish/pound)	15 26	10 15 26 40	15 26

Table 2. Actual tagging and release data of the 1969 brood reared coho release timing study.

Actual release date	Actual size at release	Tag code (white-yellow-)	Initial number tagged	Per cent tag loss	Total effective tags at release[1/]
March 16	25/lb.	light blue-green	45,994	12.1	39,965
March 16	16	red-yellow	35,026	5.1	33,071
April 20	30 (small)	gray; red-oxide red	57,771	3.5	52,788
April 20	30 (large)	blue-pink	33,669	6.4	29,842
April 20	26	light blue-red	46,290	3.9	43,422
April 20	15	red-pink	35,348	5.9	32,959
April 20	13 (small)	light blue-orange	30,878	2.3	30,012
April 20	13 (large)	light blue-blue	29,271	2.1	28,509
May 17	28	light blue-yellow	45,198	3.1	40,395
May 17	15	blue-light green	34,983	2.5	33,685
Total			394,428		364,648

[1/] Adjusted for tag loss and pond mortality.

Table 3. Length frequency sampling summary of the 1969 brood reared coho release timing study.

Plant date	Fish/pound	Mean length	Length range	n
March 16	25	117.6	72-145	303
March 16	16	130.7	72-159	310
April 20	30	112.1	76-137	330
April 20	26	117.7	77-151	367
April 20	15	138.8	62-172	317
April 20	13	146.6	115-183	301
May 17	28	117.8	70-153	389
May 17	15	138.7	77-170	325

Table 4. Estimated number of tagged coho returning to Toutle Hatchery, 1972.

Release date	Size at release (fish/lb.)	No. tags released	Estimated No. of returning adults	Estimated per cent return
March 16	25	39,965	235	0.59
March 16	16	33,071	270	0.82
April 20	30 (small)	52,788	263	0.50
April 20	30 (large)	29,842	153	0.51
April 20	26	43,422	346	0.80
April 20	15	32,959	411	1.25
April 20	13 (small)	30,012	524	1.75
April 20	13 (large)	28,509	539	1.89
May 17	28	40,395	413	1.02
May 17	15	33,685	486	1.44

Table 5. Estimated per cent adult returns of the 1969 brood time and size at release groups.

General size at release	Release date		
	March 15	April 20	May 15
30		0.50%	
26-28	0.59%	0.80%	1.02%
15-16	0.82%	1.25%	1.44%
13		1.82%	

RESULTS FROM GRADING COHO EGGS

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Fish Commission of Oregon
Bonneville, Oregon

Grading eggs by size as a possible means of reducing fork length variation in yearling coho was studied at Bonneville Hatchery with 1969 brood coho eggs using an egg grader developed by Joe Honchosky, Fish Commission of Oregon hatcheryman.

The grading machine delivered three size groups which contained some egg size overlapping but each of the three groups, measured as separate lots, showed a distinct difference in average egg size. The machine was able to grade approximately 100,000 eggs per hour and although one man can operate the grader, a second man was used to transport eggs.

Prior to grading, five lots were designated for the study:

Lot 1 ungraded: A control group

Lot 2 graded-mixed: Eggs having been run through the machine and re-combined

Lot 3 small: That group of eggs which fell through the narrow widths of the sizing lines

Lot 4 medium: That group of eggs which came from the center of the sizing lines.

Lot 5 large: Those eggs which fell through the wider spans of the lines.

After grading, various lots of eggs and resulting fry and fingerlings were kept separate but were treated similarly using regular hatchery procedures. Swim-ups were ponded from March 16 to March 30, 1970. Oregon Moist Mash and Pellet feeding was on a demand basis until May 1, 1970, at which time all fish were put on a feed schedule designed to produce fish averaging 15 fish per pound after one year of rearing. Amounts fed were based on pounds of food per 1,000 fish per month.

Data compiled during the study were analyzed by Earl Pulford, Hatchery Biology Supervisor, Fish Commission of Oregon. The results from Lot 2 graded-recombined eggs were comparable to Lot 1 ungraded eggs throughout the study and are not included in this report.

Table 1 shows number of eggs per ounce, per cent eyed egg-fry mortality, and number of fish per pound at time of ponding for the four lots reported. Egg size was not significantly related to eyed egg-fry mortality. Egg size versus fish per pound at ponding does reveal a significant relationship with larger eggs producing larger fish at time of ponding.

Rearing results up to liberation on March 29, 1971, are shown in Table 2. Egg size versus per cent fingerling mortality shows the fish from large eggs having significantly higher mortality. Food conversion was uniform throughout the lots. Although there was a difference in fish per pound at time of ponding, this difference had disappeared by liberation time. Actually the fish per pound difference had ceased within 5 months of rearing. The per cent gain in average fish weight of the fish from various lots did show a significant difference during the rearing period. This would be attributed to the feeding schedule which allows the smaller fish to be fed at a higher per cent body weight than the other lots and the larger fish to receive a lesser per cent body weight.

Fork length measurements taken at time of liberation are shown in Figure 1. Size variation of the three graded lots are similar to the ungraded lot. As with the fish per pound results, size variation was comparable after 5 months of rearing.

The grading of coho eggs as the only change in regular rearing procedures at Bonneville Hatchery did not reduce the size variation of the resulting fingerlings.

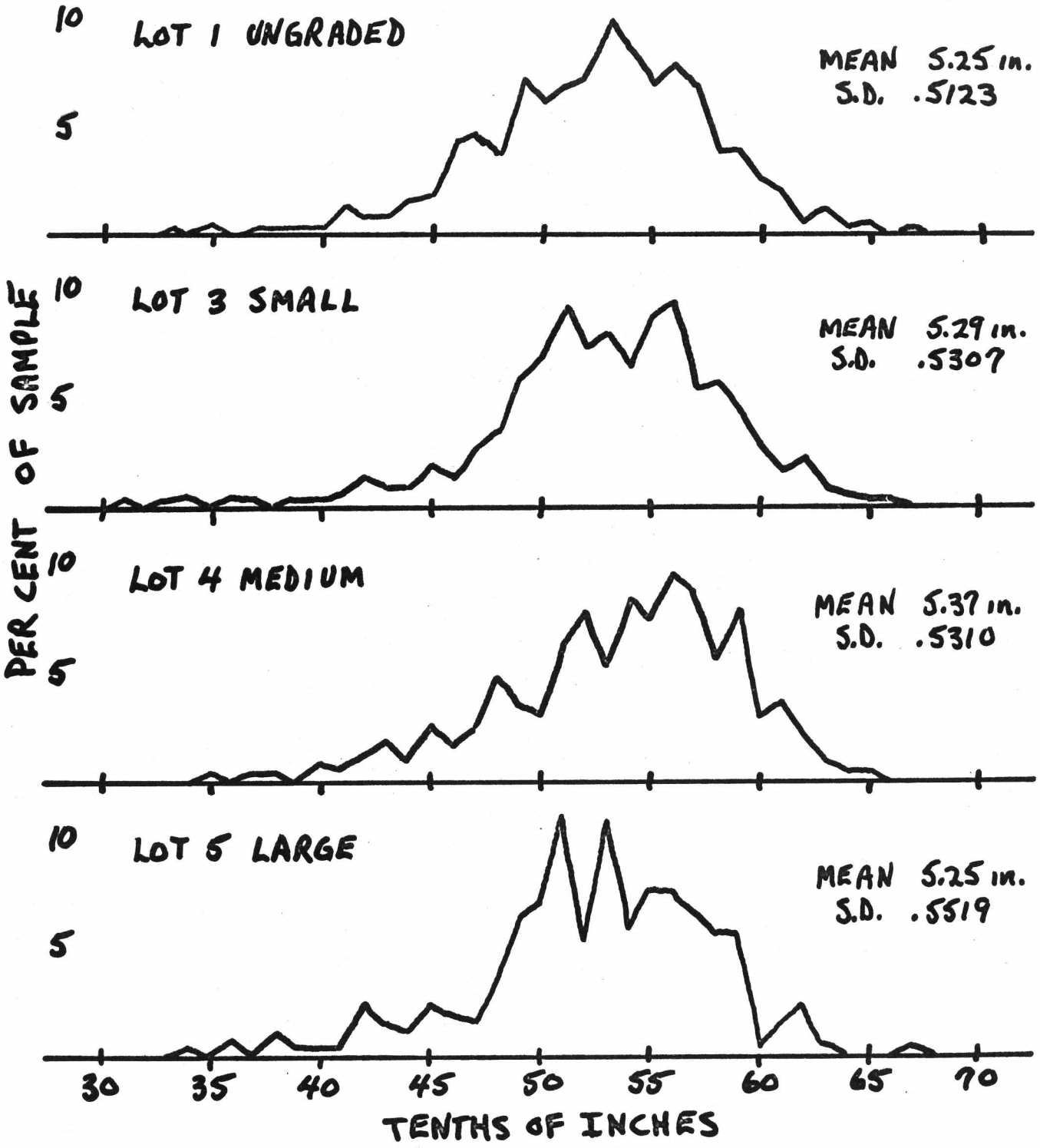
Table 1. Eggs per ounce, per cent eyed egg-fry mortality, and fish per pound at time of ponding of 1969 coho graded and ungraded eggs.

Lot number	Eggs per ounce	Eyed egg-fry per cent mortality	Fish per pound at ponding
1 ungraded	75	1.5	1,182
3 small	81	1.1	1,271
4 medium	70	1.1	1,114
5 large	61	1.3	1,023

Table 2. Per cent fingerling mortality, food conversion, average fish per pound at liberation, and gain in average fish weight of 1969 coho from graded and ungraded eggs.

Lot number	Fingerling mortality (Per cent)	Food Conversion	Average fish per pound (March 26, 1971)	Gain in average fish weight (Grams)	Gain in average fish weight (Per cent)
1 ungraded	.6	1.9	15.5	28.88	7,521
3 small	.9	1.9	15.2	29.48	8,259
4 medium	1.0	1.9	14.7	30.45	7,481
5 large	1.5	2.0	15.2	29.40	6,636

FIGURE 1
FORK LENGTH MEASUREMENTS OF 1969 COHO
AT TIME OF LIBERATION
MARCH 26, 1971



A HOLDING DEVICE USED WHILE SPAWNING SALMON

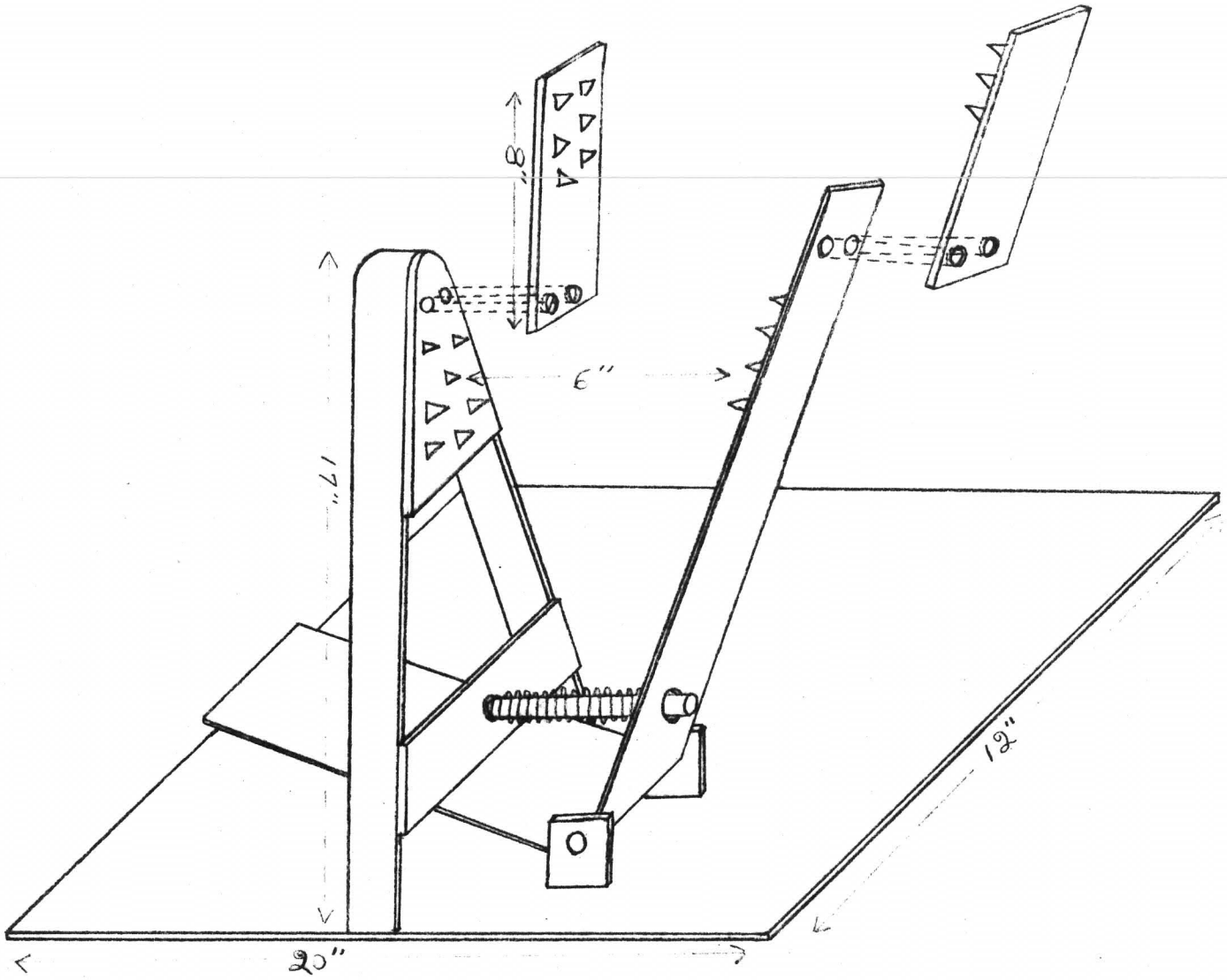
B. J. Cossette
Washington Department of Fisheries

During the spawning operation, the female salmon is held vertically by the gill cover while making the incision and shaking out the eggs.

The holding device shown has two main functions. It clamps down on the peduncle area of the fish and arrests all tail movement which could upset the egg container or spew eggs clear of the container, and it helps support the weight of the fish.

The holder is fabricated of 1/4-inch plate and bar steel. One side is rigid, the other is hinged. The holder is activated by stepping on the spring-loaded foot plate which returns to the open position when the foot is removed. The teeth are 40d nails, cut short and welded on. Upright extensions are added to accommodate coho or other smaller fish, extensions removed for chinook.

After several hours of spawning, the user is able to stand upright without that nagging backache, sore arm, and with less spilled eggs.



A HOLDING DEVICE USED WHILE SPAWNING SALMON

THE USE OF PERFORATED PLASTIC CONTAINERS AS REARING CAGES FOR SMALL LOTS OF FISH

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Many times, the fishery worker is faced with the need to conduct short-term experiments or feeding trials using small numbers of fish. However, too often production ponds, tanks, or raceways are not suitable for managing these small groups of fish. Several large tanks or ponds may have to be used to keep these groups separate. At our trout laboratory, we found ourselves wasting water and space by rearing small numbers of fry or fingerlings in very large tanks. Permanent facilities for maintaining these small lots of fish would also be wasteful, since these facilities would be used only a few months each year. Our idea was to use small rearing cages that could be suspended into existing tanks, thereby confining each lot of fish to a more manageable unit. These cages needed to be economical, lightweight, durable, non-toxic, maintenance-free, and easily set up and stored. Perforated plastic containers meet all of these requirements.

Most plastic containers presently available can be easily perforated using a high-speed drill. The common moto tool or hobby tool is good for drilling holes into plastic. These drills operate at 30,000 rpm and can make excellent perforations to 1/8 inch in diameter using good quality steel bits. Using this equipment, a 6-gallon plastic bucket can be perforated with 5,000 holes in 40 minutes. The wide variety of plastic containers enables the fishery worker to choose the size and shape best suited for his particular needs.

We have not established definitive stocking rates for the perforated buckets we are now using. For most applications, manageable space is a more important consideration than water supply. Our main objective in using these rearing cages is to confine the fish to a more manageable area. We have found that small lots of fish feed much better and are less frightened when reared in this manner. Also, the use of these perforated cages facilitates handling and transfer by eliminating the need for netting the fish; the plastic cage is easily detachable and can be used as its own "net".

The perforated container approach could also be applied to other aquaculture practices. These containers can be used as egg or fry baskets or for keeping genetic stocks separate while the fish are young. They could be used as "live boxes" for pollution assays in lakes and streams. With snap-on plastic lids, these perforated cages would be virtually predator-proof. Other uses could be applied in shellfish research and production or for monitoring egg and fry survival in stream gravel.

In summary, the plastics industry offers the biologist a wide variety of containers which can be easily perforated for use as fish rearing cages. These plastic cages are economical, lightweight, durable, and maintenance-free. They are especially suited for use in conjunction with existing hatchery facilities which will enable the fishery worker to scale down his rearing capability for better management of space and water. This perforated container principle can also be adapted for use in other aquacultural practices.

PROGRESS AND PROBLEMS IN THE MARINE CULTURE OF PACIFIC SALMON

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National Marine Fisheries Service biologists have been conducting fundamental research at the Northwest Fisheries Center's Manchester, Washington station since 1969. Research attention has been focused on the development of floating net-pen rearing systems, the relationships of temperature and dietary ration to growth and food conversion, the acceleration of growth, a brood stock development program, a demonstration commercial pilot farm, several cooperative sport fishery enhancement programs, and a serious disease study program.

As a result of the research conducted at Manchester, rapid progress in the culture of Pacific salmon in salt water has been made. A summary of the progress to date is as follows:

1. Between 50 and 60% of a stock of coho salmon from normal hatchery egg production can be accelerated in growth and successfully introduced into salt water as zero-age fish in July at 160 to 180 days post swim-up and a size of 16 grams.

2. Accelerated coho can be grown to a size of 200 to 600 grams in salt water at 13 months post-fertilization on commercially available dry diets.

3. Brood stock from accelerated coho can be brought to maturity in salt water at 2 years post-fertilization. The size ranges from 2 to 5 kilograms. Fecundity will range from 1,500 to over 3,500 eggs. The degree of fertility is now being studied. This can be accomplished entirely on dry diets.

4. Chinook salmon can be successfully grown to a size of 200 to 500 grams in salt water by 16 months post-fertilization.

5. Both coho and chinook salmon can be grown in salt-water pens in Puget Sound at a rate in excess of 1 million pounds per surface acre per year.

6. Both coho and chinook salmon released from floating pens at Manchester after extended rearing in salt water exhibit a high degree of residency and a high rate of contribution to the sport fishery.

A summary of the problems associated with salt-water rearing is as follows:

1. We have not been successful in rearing chum or pink salmon to maturity.

2. Chinook salmon have been reared to maturity in 3 years at a size of 3.5 to 4.5 kilograms, but the egg survival through the eyed stage is negligible.

3. The two greatest obstacles to the development of vigorous brood stock are kidney disease and a brood diet.

4. The early rearing problems are almost entirely disease associated. These are: (1) Vibrio anguillarum, which can occur at almost anytime during the spring, summer, and fall, (2) furunculosis, Aeromonas salmonicida , which can be carried with fish from freshwater and erupt at a later date, and (3) kidney disease, Cornybacterium sp., which can be a serious problem at anytime after the first winter in salt water.

5. The homing responses of salt-water reared fish are altered. This may have a significant bearing on the possible dilution of gene pools, and may be undesirable.

GROWING SALMON BY THE NUMBERS

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Center for Quantitative Science
University of Washington

A mathematical growth model has been developed that predicts daily or weekly growth of salmonids reared in a hatchery environment. This model is based on the concepts of energy flow and uses daily ration, water temperature, and initial fish size as input data. The equation coefficients are related to relevant biological parameters which can be easily measured by laboratory or hatchery experiments. By this means, the model can hopefully be adjusted to fit any situation of diets, species, or rearing facilities.

The model has adequately predicted the growth of salmon over the ranges of .5 to 30.0 grams, zero to maximum rations, and 40 to 54 F. Figures 1, 2, 3, and 4 are examples where the growth curve predicted by the model (denoted by dashed lines) is very similar to the observed growth curve (denoted by solid lines). All the values of the coefficients in the growth model are identical for these four simulations except the one that accounts for the moisture content of the diets. The growth is predicted from the starting fish size, the weekly values of the food fed, and water temperature listed in the hatchery records. The arrows in the figures denote the point in time when the simulation is started or restarted. The predicted growth curve for the Minter Creek fall chinook fed an Abernathy dry diet almost exactly reproduces the observed sizes (Figure 1). The predicted growth in Figure 2 for a particular lot of Klickitat spring chinook is almost as good. The temperatures at the Klickitat Hatchery are near 50 F year-round. The simulated growth for the production lot of the 1969 brood Minter Creek coho goes astray very early. For this reason, the simulation was restarted on month 11 (1 month = 28 days). The predicted growth for the second simulation reproduced the observed quite well. The 1970 brood coho at the Sandy Hatchery in Oregon were fed an Oregon moist diet for about 3 months then switched to an Abernathy dry diet. The simulation was restarted on a later date for both feeding periods. As in the previous cases, the predicted values are very close to the observed sizes. During the first half of month 15, the water temperatures at Sandy dropped to approximately 35 F, yet the model predicted a substantial growth that did not occur. This suggests the model in its present form may not be accurate below 40 F.

The model was primarily developed to predict salmonid growth for the computer simulation model, HATCH, being built by the Washington Department of Fisheries and the Center for Quantitative Science at the University of Washington to evaluate hatchery rearing and release strategies. Now that the growth model is functional, it has a number of other uses. For example, the model could be used to forecast

feeding schedules a year in advance as the Fish Commission of Oregon does for its coho program. With minimum effort, these forecasts could be updated as often as needed. The model can be used in designing new growth experiments as it provides a means to "dry lab" the experiments. Also, the model can compare diet experiments where rations, temperatures, and fish sizes are not necessarily the same between tests. The model should have considerable value in programming growth for those stations with the elaborate temperature control equipment. Because of the complexity of the growth model, high-speed computers are necessary to perform the calculations, and this may hinder its day-to-day use.

The present form of this growth model should not be considered permanent. It will require continued adjusting and updating as the needs arise, and as we learn more about growth.

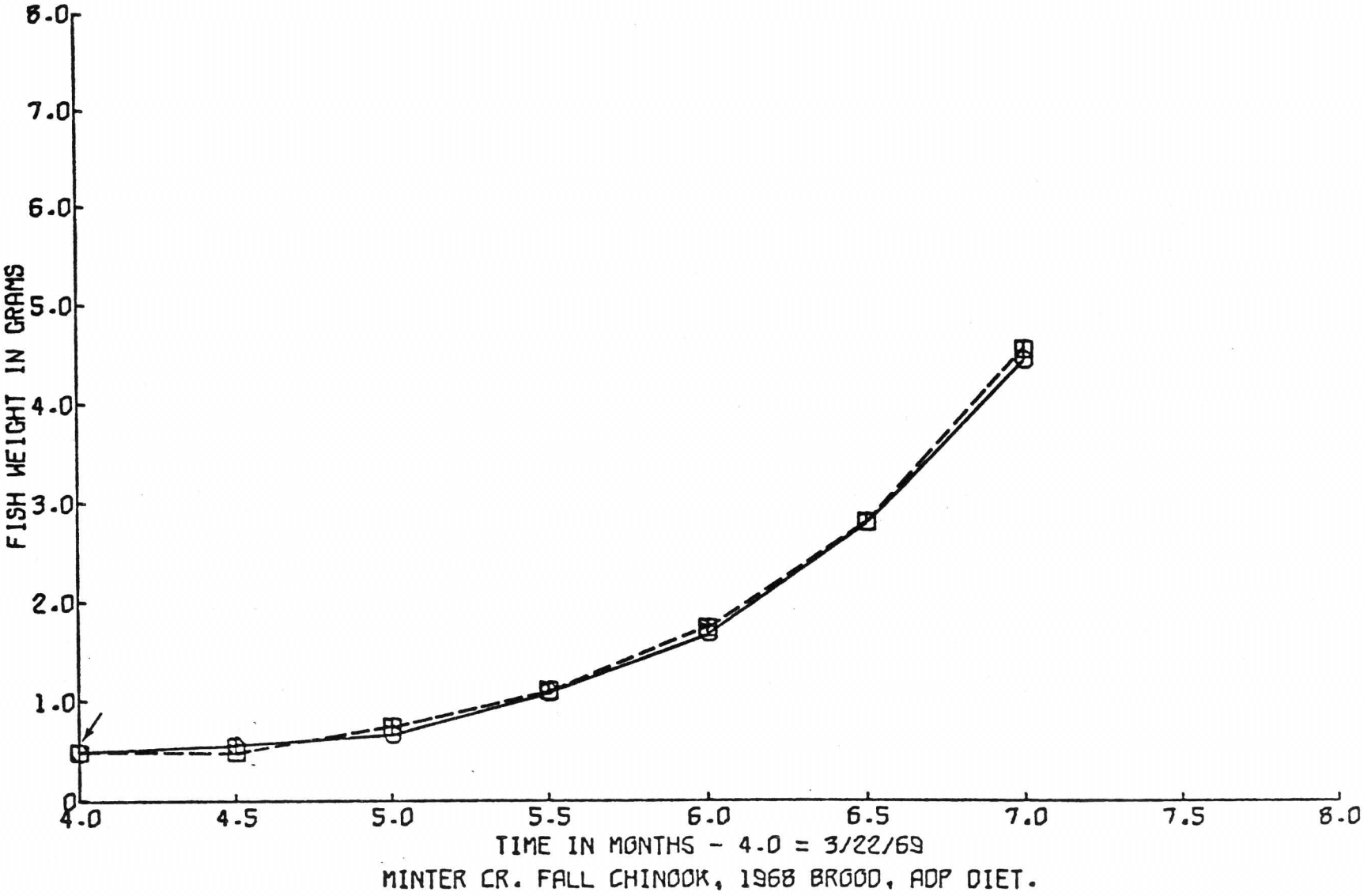

Figure 1. The plot of observed growth (——) and predicted growth (---) for Minter Creek fall chinook, the arrow indicates the simulation starting time.

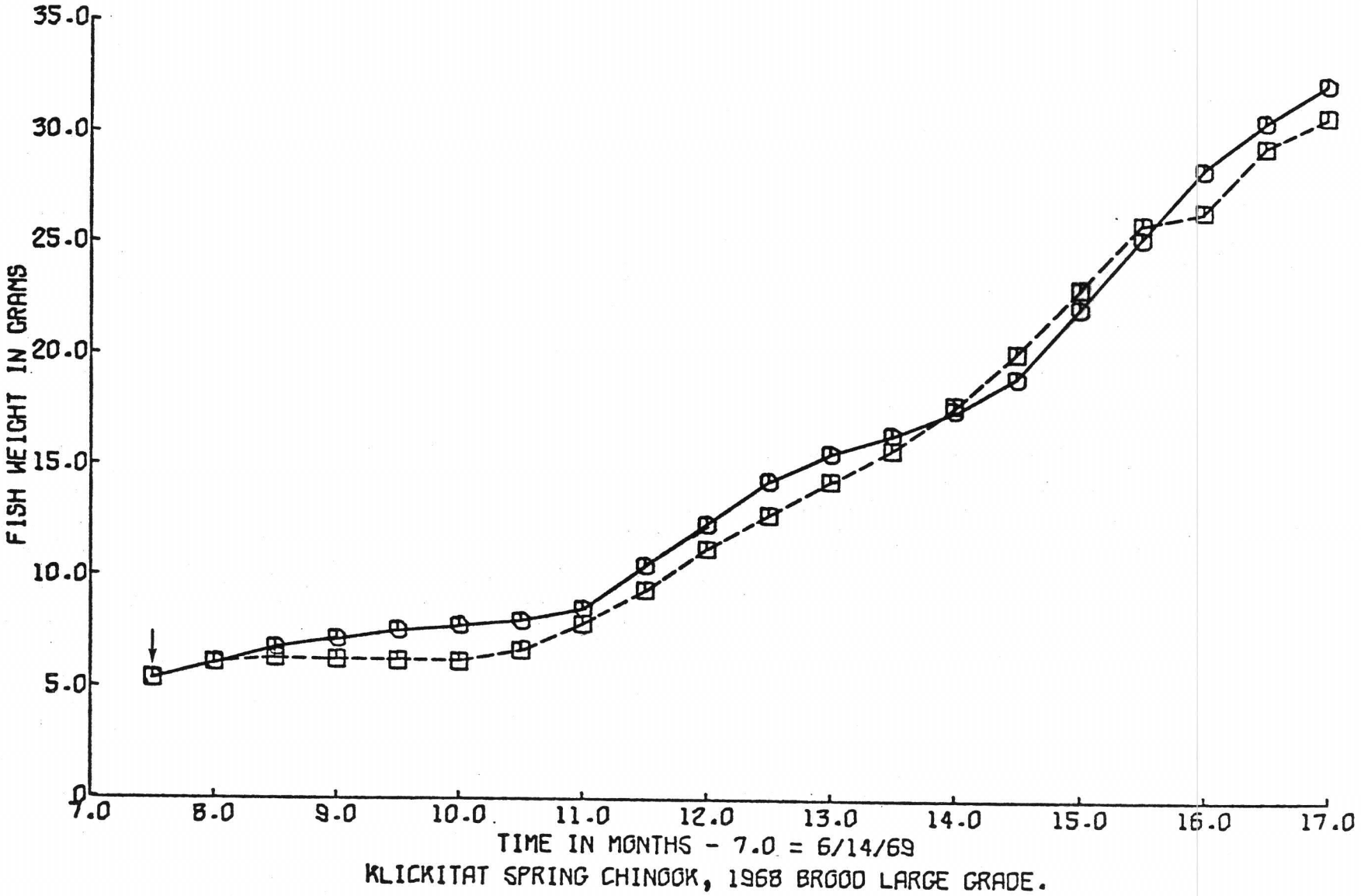

Figure 2. The plot of observed growth (——) and predicted growth (---) for Klickitat spring chinook, the arrow indicates the simulation starting time

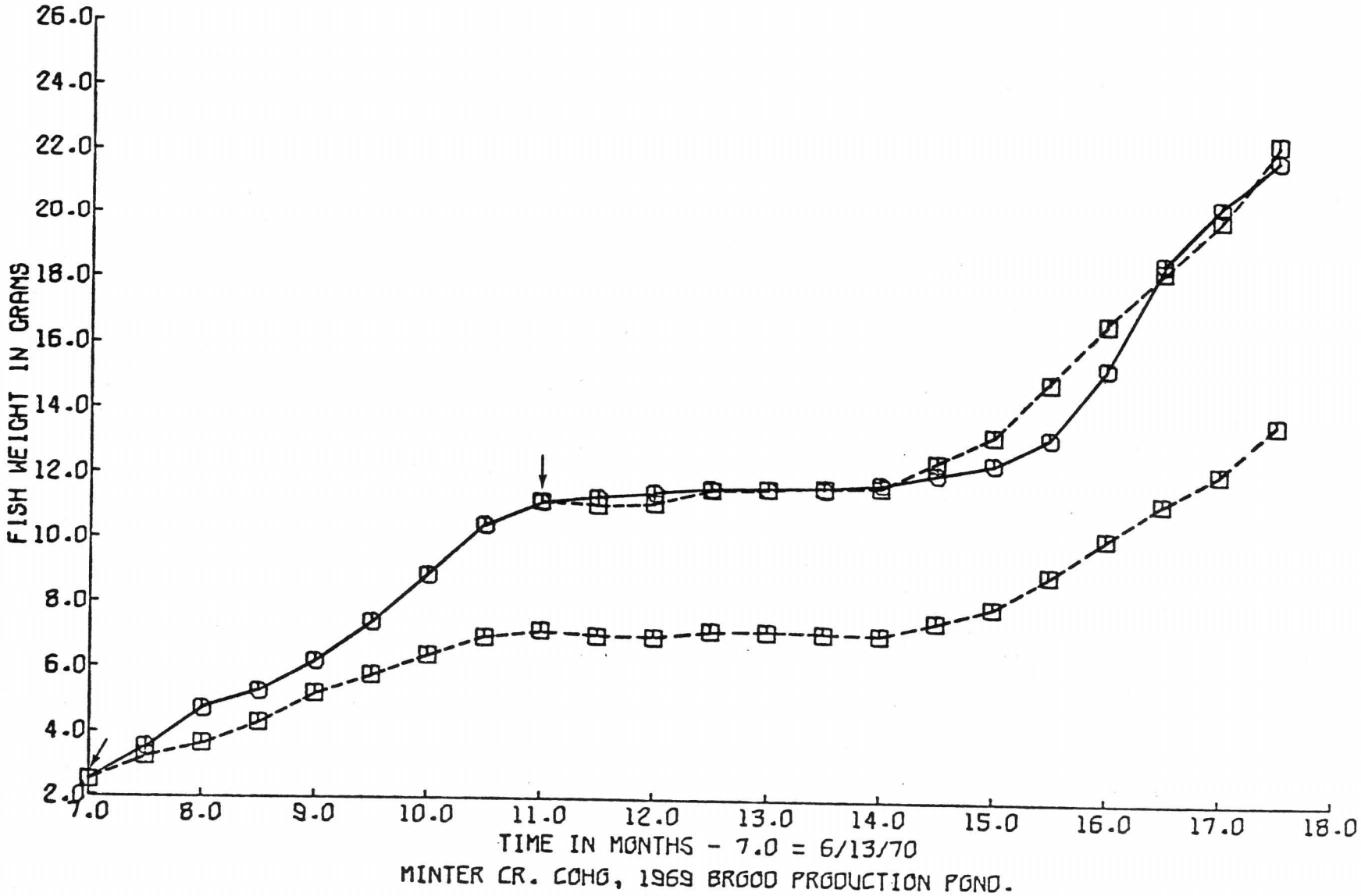

Figure 3. The plot of observed growth (——) and predicted growth (---) for Minter Creek coho, the arrows indicate the time when the simulation is started and later restarted.

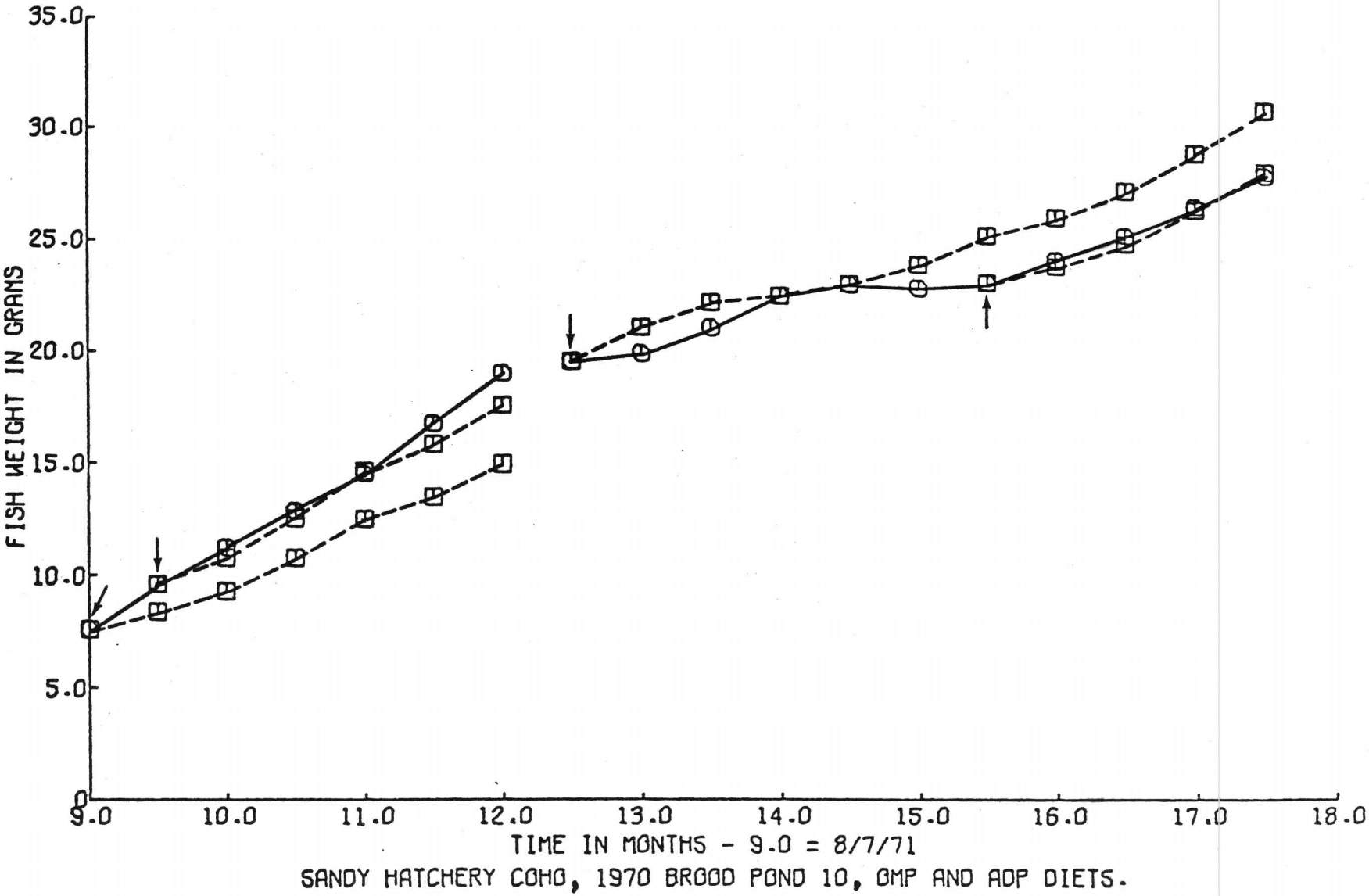

Figure 4. The plot of observed growth (——) and predicted growth (---) for Sandy Hatchery coho, fed OMP first and then Abernathy diet after month 12.5. Arrows indicate starting times.

BRACKISH WATER ENVIRONMENTS FOR RAISING FISH

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Facilities are being developed for controlled variable salinity studies on salmonid fishes during their transition from a fresh-water to sea-water environment. Nutritional and physiological changes will be measured during this critical period of their life cycle at the newly established Marrowstone Field Station near Port Townsend, Washington.

Effects of treatment on the migratory behavior of test groups will be measured in adjacent streams.

Preliminary tests show that rainbow trout and coho salmon can be raised successfully in brackish water environments of 10 ppt and 20 ppt salinity. Rainbow trout weighing 6 g each were distributed into duplicate groups of 50 fish each and fed test diets containing 30, 35, 40, 45, 50, 55, or 60% protein for 10 weeks. A protein requirement of 40% protein was established for the rainbow held in 10 ppt salinity and 45% protein for the fish in 20 ppt salinity. At the end of 10 weeks, the average weight of those fish receiving an adequate protein diet tripled. Mortality for this period was 2% and 9%, respectively, for the groups held in 10 ppt and 20 ppt salinity.

Similar procedures with yearling coho salmon showed a 40% protein requirement for groups held in either 10 ppt or 20 ppt salinity. Mortality in the two groups was 2.1% and 2.7%, respectively.

Many technical problems face aquaculturists before the ocean approaches its potential as a food-producing system. What combination of food, temperature, and density produces the biggest and healthiest fish? When is the optimum time for converting these fish into a sea-water environment? The answers to these questions can be obtained from facilities similar to those being developed at the Marrowstone Field Station.

A CHINOOK SALMON MARICULTURE PROJECT IN PUGET SOUND, WASHINGTON

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University of Washington
Seattle, Washington

The Fisheries Research Institute is currently engaged in the second year of a 2-year mariculture program, involving pen-rearing of chinook salmon at several sites in Puget Sound. The objectives of this work are five-fold: (1) to explore new sites in Puget Sound, expanding the pen-rearing work of the National Marine Fisheries Service at Manchester, Washington, (2) to compare growth rates at different sites, using standard rearing and feeding methods, consistent fish stock, and type of food, (3) to analyze the effects of some environmental factors (temperature, salinity, flow, dissolved oxygen, light) on growth of pen-reared chinook salmon, (4) to utilize the optimal ranges of these environmental variables, together with the oceanographic records for Puget Sound, to isolate sites for possible future salmon mariculture activities, and (5) to study the movements of released pen-reared fish.

The early results of the first year's rearing program were summarized in these proceedings in 1971. The final results can now be included. The Washington State Department of Fisheries provided us with 1970 brood year chinook from Hood Canal Hatchery. In July 1971, 300,000 chinook fingerlings were distributed among four sites in Puget Sound: Clam Bay, near Manchester; Squaxin Island, near Hartstene Island; Kiket Island, near La Conner; and Big Beef Creek, a brackish water area on Hood Canal.

At the time of transfer to the sites (July 1971), chinook salmon averaged 37/lb. Sizes at release averaged 3.8/lb. at Big Beef Creek (mid-February 1972), 3.1/lb. at Manchester (early February), and 2.7/lb. at Squaxin Island (early March). This reflects a growth of up to 1347% within 8 months of pen rearing. The releases could be larger if the experimental design of this project were not to standardize feeding methods throughout the Sound in order to compare growth rates. After 8 months of rearing, about 76% of the original fish were released, with a maximum release of 85% at one of the sites. This includes fish removed or killed in handling, and any unexplained losses of fish. Known natural mortalities during the 1971-72 season amounted to 7.6%. The two significant sources of mortality were Vibrio and aquatic bird predation (in spite of pen covers).

At the conclusion of the 1971-72 season, pen-reared fish were released by Robert Abbott of the Fisheries Research Institute at two sites in Puget Sound in April 1970: Case Inlet and Manchester. Returns of the Carlin-type tags to date have been 13.5% (106). Sport and commercially recaptured fish have tended to follow a distinctive pattern. Those released in the south Sound (Case Inlet) have tended to remain in the

southern Sound, while those released at Manchester have been generally recaptured in the central Sound. Most recaptures were within the first 10 months.

Recaptures of 1972 released chinook have been quite poor. Of the 1,281 anchor-tagged fish released, only 10 have been recaptured in the first 9 months -- all released at Squaxin Island. There appears to be a distinct difference between retention or recognition of Carlin and anchor tags. Returns of both anchor and head tags have tended to show chinook are staying in somewhat localized regions of the Sound. Several dozen 2-year-old jacks have been recaptured in Big Beef Creek and the Deschutes River. The stock is originally from Finch Creek, via Hood Canal Hatchery.

During May 1972, 45,000 Finch Creek chinook were transported to the four current rearing sites: Squaxin Island, Manchester, Kiket Island, and Friday Harbor. The latter site replaces the Big Beef Creek site of the previous year. As of November 28, chinook range in size from 7.0/lb. at Friday Harbor to 4.4/lb. at Squaxin Island. Growth rates at all sites are lagging behind those of last year, reflecting the colder water temperatures of the current season. Again, Vibrio and aquatic birds have been the source of most mortalities. Birds were responsible for substantial deaths and escapes at Kiket Island in early November; and the work there has since been terminated.

TRAINING FISH WITH UNDERWATER SOUND -- PRACTICAL SUGGESTIONS

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Fisheries Research Institute
University of Washington

Experiments using underwater sound to train trout in a 1/4-acre pond proved highly successful, but a similar effort to train trout and chinook salmon in a pen and call them back after they were released into Puget Sound proved unsuccessful. The factors responsible for the contrasting results were poorly understood and suggested that better information on the auditory responses of trout was needed. The great interest shown by the fish culture industry prompted a search for off-the-shelf components which could be assembled by the skilled layman and purchased at reasonable cost.

It was found that by using a Heathkit Foghorn-Hailer, MD-19, a University Sound Underwater loudspeaker, UW-30, and a regular 12-volt car battery, an adequate underwater acoustic fish trainer could be built for approximately $250. Several alternatives exist, but are not discussed here as they were not used.

Tests on the auditory response of individual trout were carried out in Fern Lake with the cooperation of Dr. Lauren Donaldson. An auditory response curve was determined showing an upper frequency limit of 800 cps and an optimum frequency range between 100 and 200 cps. Further tests indicated that trout respond almost exclusively to the near-field effect, setting an effective range for even the best off-the-shelf equipment at approximately 10 meters. Social interaction and other cues, such as time, can greatly increase the effectiveness of an acoustic training radius. Training schedules that produce the acoustic signal at one point and feed at another cannot be expected to work, and the fish cannot be expected to tell the direction of the sound source under most situations.

ESSENTIAL FATTY ACIDS REQUIREMENT AND THE NUTRITION OF TROUT

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A review of recent experiments conducted at Oregon State University on the fatty acid requirements of rainbow trout (1, 2, 3, 4, 5, 6). The data presented demonstrate that trout require in their diet ω-3 fatty acids, or the linolenic series. No requirement could be shown for the ω-6, or linoleic fatty acids. The optimum level of ω-3 fatty acids which permits maximum growth is 1% or more of the dry weight of the diet. Symptoms of fatty acid deficiency are poor growth; elevated tissue levels of ω-9 fatty acids, particularly 20:3ω9; necrosis of the caudal fin; fatty, pale liver; dermal depigmentation; increased water content; shock syndrome accentuated by stress; increased mitochondrial swelling; increased respiration rate of liver homogenates; heart myopathy; and lowered hemoglobin level.

Fatty acid analysis of some commercial rations and certain purified test diets showed them to be low or deficient in ω-3 fatty acids. Some sources of ω-3 fatty acids are fish oils; fish meal; fish products, horsemeat, and linseed and soya oils.

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QUANTITATIVE PROTEIN REQUIREMENTS OF RAINBOW TROUT

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University of Washington
Seattle, Washington

A stock of rainbow trout (Salmo gairdneri) has been developed and maintained at the College of Fisheries, University of Washington, Seattle, over the past 40 years, with the objective of (Inter alia) providing stocks of trout that are better adjusted to management needs. These fish attain sexual maturity at 2 years of age, producing approximately 11,000 eggs 4.8 mm in size. The fish can tolerate higher temperatures and their disease resistance has increased, thus reducing further the number of brood fish that are needed.

Three-week-old fingerlings of the 1971 brood year were paired fed isocaloric diets containing 30, 35, 40, 45, and 50% protein at ambient temperatures of 16 C to 27 C for 10 weeks. An equal number of fingerlings from the same bulk lot was fed Complete Test Diet #8 of the Western Fish Nutrition Laboratory, Cook, Washington. This lot served as the control. The diets contained 28,000 calories per kilogram and the energy contribution from fat was constant in all the diets.

The objectives of the study were to determine the quantitative protein requirements of the fish and to find out whether the level of dietary protein intake had any effect on the chemical composition of the carcass.

The growth pattern of each treatment lot and proximate analysis for protein, ash, lipid and moisture of fish samples from each treatment lot at the start and end of the experiment were the basis for determining the effects of dietary protein variables.

The relatively high temperatures (16 C to 27 C) experienced during this experiment had a depressing effect on the growth rate of the fish and also induced severe outbreaks of diseases. However, proper sanitation and chemical control measures helped to prevent high mortalities. Mortalities for all treatments ranged between 0.8 and 3%.

The rate of growth increased with increasing protein concentration in the diet, but Almquist-type plots of growth index $\left(\frac{\text{Gain in weight}}{\text{Food consumed}}\right)$ showed consistent inflection points at the 40% protein level after 8 weeks (Figure 1), indicating a drop in protein requirements with age after 3 months from 50 to 40%.

The chemical composition of the fish tissue was altered significantly ($p > .05$) by the levels and components of ingredients in the diets and by the ratio of energy calories to protein calories in the diets. There was a general increase in the per cent of protein in the carcass in relation to the amount in the diet; also, the amount of body fat increased as the amount of dextrin in the diet was elevated. Fat was deposited at the expense of water, but there were no significant differences in the amount of ash in the tissues.

Since protein is probably the most important ingredient in fish rations from the standpoint of cost and effect on growth, the results reported here would probably be of practical value not only to hatchery workers, but to fish farmers.

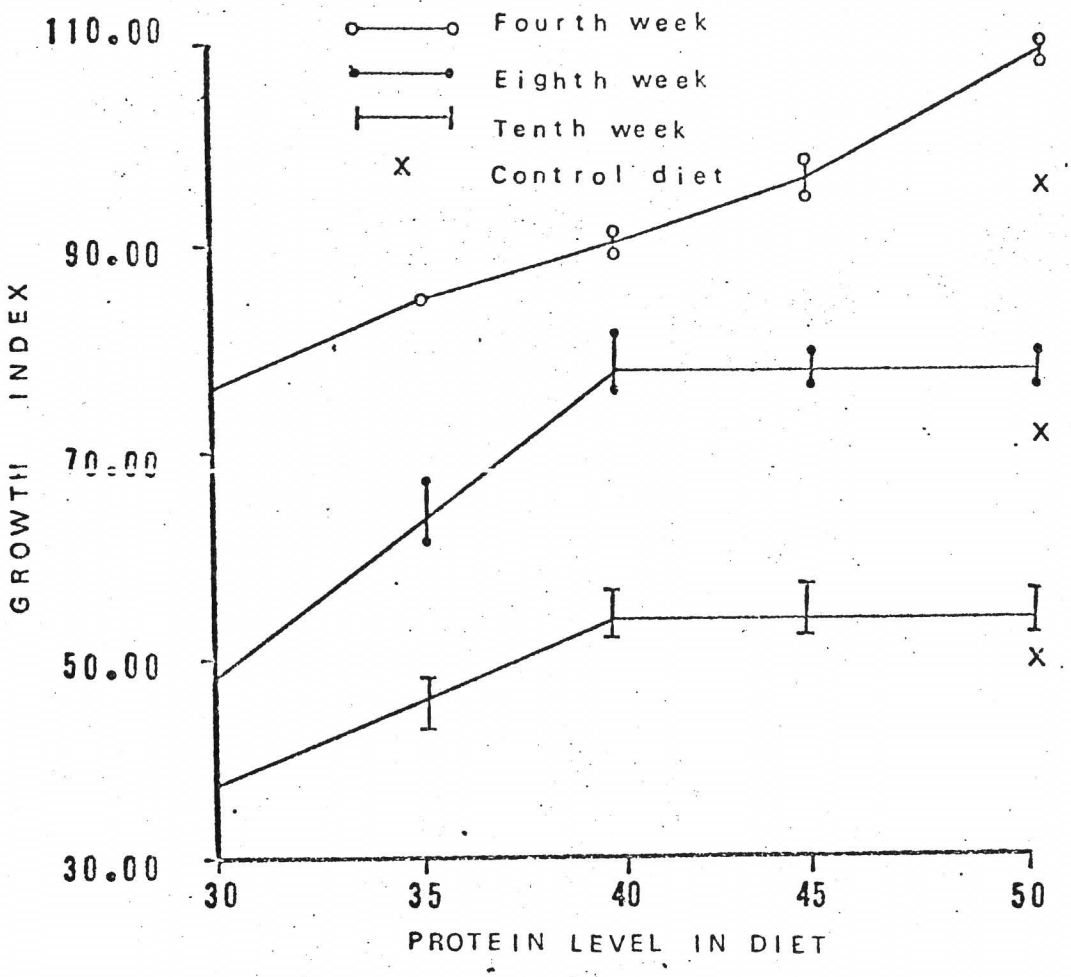

Figure 1. Protein (N x 6.25) requirement of rainbow trout fingerlings. Diets were approximately isocaloric and fish were pair fed for ten weeks at ambient temperatures of 16 to 27 C. The protein requirement shifted from 50 to 40 percent after eight weeks.

A NEW APPROACH TO SALMON TAGGING -- "THE TAGGING TRAILER"

Gerald Schurman
Washington Department of Fisheries

Early last spring (1972), the Washington Department of Fisheries embarked upon a 2-year program designed to evaluate the hatchery contribution of coho, fall chinook, and specialized production groups on enhancing the Puget Sound sport and commercial fisheries.

As this special evaluation program was expanded to include other needed studies, it became a State-wide project involving nearly all of the Department's salmon hatcheries and requiring the tagging of approximately 10 million salmon over this 2-year period.

In order to reach this goal, it became evident that a new approach in tagging operations was going to have to be devised, thus the development of the tagging trailer, utilizing the new magnetic coded wire tagging equipment.

The trailer is a specially modified unit, 8-ft wide and 46-ft long, which up to now has served as an experimental unit. But time has proven it to have the flexibility and utility necessary for effective utilization of the wire tagging equipment.

To begin with, using eight jacks for support, the trailer is positioned at the hatchery. The power is then hooked up to a permanent plug which has been wired especially for the trailer. Next the 1 HP submersible pump is put into the nearest pond to supply filtered water to the trailer. The inside of the trailer is then set up and readied for a crew consisting of 10 women.

The fish to be tagged are then crowded in the pond, seined, and carried to the trailer in 5-gallon buckets. A side port is removed from the trailer and the fish are poured into a large holding tank. From here they are anethetized and, for the purpose of identification, adipose fin clipped. The clipped fish then pass through a transfer pipe to other holding tanks where they are re-anethetized and tagged. After tagging, the fish pass through a quality control device which first magnetizes the tag, then counts both the tagged and non-tagged fish and thirdly separates the tagged from the non-tagged fish. The non-tagged fish are then put through the tagging process again while the tagged fish enter a floating live box where they are treated with malachite and returned to the pond where they are retained until their programmed release date.

The tagging trailer, since beginning operation, has indeed proven to be a very versatile and flexible unit in both set-up and operation. It has satisfactorily minimized the operational impact of tagging upon the hatcheries where the tagging is done, reduces fish handling and resulting mortalities, and generally expedites the entire operation.

The present unit, since last spring, has tagged in excess of 3 million salmon. It utilizes five tagging machines and has an average production of 20,000 fish per each 7-hour shift. The tag loss runs in the vicinity of 0 to 5%, but has run higher, on very few occasions, because of special circumstances. The cost of tagging, with all variables averaged in, runs approximately $30 per 1,000 tagged fish. The complete unit, except for tagging machines, cost nearly $8,000 and with tagging equipment is worth about $40,000.

"ZAP" A PRACTICAL APPLICATION OF THE LASER FOR MARKING FISH

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Portland, Oregon

To evaluate fishery management programs and conduct fishery research, it is necessary to have an effective means for the identification of fish. Laboratory experiments at Washington State University indicate that the ruby laser produces a visible mark that could be used for this purpose. The laser beam disrupts the dark pigment cells (Melanophores) in the skin resulting in a dark-appearing mark.

The first field tests of the laser were conducted at the Toutle River Hatchery in April 1971. The objective of this study was to determine the permanence of the laser mark. A group of 115,000 1970 brood yearling coho was marked and released in April 1971.

The ruby laser unit was located beside a fish tank. The laser gun was located in front of a small window in the tank enabling it to mark the fish underwater. Anesthetized fish were placed on a revolving drum and laser marked when the drum passed in front of the window.

Approximately 200 of these coho were held in salt-water holding pens for observation. Laser marks were visible for 6 months; however, after 7 months, the marks disappeared. During the experiment, the capacitor unit malfunctioned and was partially or fully responsible for the mark disappearance. The energy output of the laser is critical; it must remain consistent to obtain a permanent mark.

All coho salmon returning to the hatchery will be examined for laser marks. So far this fall, no coho jacks have returned with a laser mark.

The laser unit has the potential of producing an efficient means of marking fish. Repairs have been completed on the laser and marking will begin at the Elokomin Hatchery this spring (1973).

THE FINE STRUCTURE OF THE EPIDERMIS AND PIGMENT CELLS OF SALMONID SKIN: THE EFFECT OF LASER TREATMENT

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In fish, as other vertebrates, black (melanin-containing) pigment cells consist of a cell body and numerous dendritic arms. Color changes from dark to light occur when the pigment granules move from the outstretched arms of the cell into the central area. In a lased region of fish skin, the black color cells, the melanophores, lose their capacity to move the pigment granules to the center of the cell. Therefore, the lased zone appears dark in contrast to the surrounding normal skin. The necessary first phase of a study of lased melanophores is to describe their normal structure, where they are located in the skin, and what the cells around them are like.

The epidermis of coho salmon below the dorsal fin (the area where laser branding is applied) is about five cell layers thick and is separated from the underlying dermis by a thin basal lamina. The extensive dermis consists of loose connective tissue, overlapping scales, a dense band of collagenous tissue, and is interspersed with several cell types such as fibroblasts and pigment cells. The pigment cells are located in several strata of the dermis: above and below the scales, in the loose connective tissue, and below the dense collagenous layer (stratum compactum). Epidermal melanophores are rare and small; and are probably similar to the micromelanocytes described by Parker (1940) in the catfish, Ameirus nebulosus.

Electron microscopical examination of the pigment cells of the coho salmon reveals a group of cells that is similar in many ways to the color cells of amphibians (Bagnara, et. al., 1968) but are not as highly organized into discrete units. The types of fish color cells include reflecting cells (iridophores), black pigment cells (melanophores), and red or yellow pigment cells (xanthophores). Melanophores lies somewhat below the iridophores with dendritic melanophore processes extending upward around the compact iridophores. Cells containing red or yellow pigment granules are scattered above the melanophore-iridophore complex. Lightening of the skin hue occurs when the black pigment granules move toward the cell body allowing more light to be reflected by the iridophore as well as affecting an overall decrease in absorptive area.

In lased fish, the whole pigment cell system appears to be disrupted. Four weeks after branding, paralyzed melanophores populate the lased region and there are few iridophores. This region, therefore, is very dark in color. The fate of the red and yellow pigment cells is unknown. The ultrastructure of the lased pigment cell system including the long-range effects is currently being investigated.

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PRECISE GROWTH MEASUREMENTS OF LIVE, UNANESTHETIZED FISH BY PHOTOGRAPHY

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The usual weighing procedures for obtaining growth measurements of live fish cause significant stress. Harmful factors in the process include anesthetization, desiccation, oxygen starvation, and damage to the skin from blotting and handling. The accuracy of weighing is affected by variation in the amount of water carried on the fish's surface. These problems are most severe when small fish are used.

The photographic technique described here reduces stress by minimizing handling and eliminating the need for anesthetizing and blotting the fish. The method involves obtaining a high resolution photograph of the side view of the fish and a precise measure of the area of the fish image. The dry weight of the fish is calculated from a correlation between the area of the fish and dry weight as previously determined in calibration experiments.

To obtain adequate side-view photographs of fish, a plexiglass holding device[1/] was used to position the fish in perfect side-view and in focus before a camera. The holding device is fastened inside an aquarium and has a place to put notation for identifying the fish and experiment and a calibration rectangle. An electronic flash (1/1,000 of a second duration) eliminates any degradation of the photographic image caused by movement of the fish. Very high resolution film (e.g., Kodak High Contrast Copy Film[2/]) is required in order to give photographic images that can be used for precise measurements of the fish images. These films must be processed in developers (e.g., H & W Control Developer Concentratre; H & W Co., St. Johnsbury, VT) specially formulated to reduce the extreme contrast characteristics of very high resolution films. Otherwise, it would be impossible to see the entire outline of the fish.

A photographic enlarger and a polar planimeter are used to measure the area of the fish in each photographic negative. The image of the fish and calibration rectangle are projected onto a small white card attached over the tracing pin of the polar planimeter. A dot on the card is positioned to lie exactly over the tracing pin. A precise area of the fish's side-view is obtained by tracing the outline of the projected image of the fish with this dot. Measured fish areas are corrected based on the known area of the calibration rectangle.

1/ Photographs, dimensions, and construction details of the holding device are available from the author.

2/ The use of trade or corporate names does not imply official endorsement by the U.S. Department of Agriculture to the exclusion of others.

Corrected fish areas are used with the dry weights, in an initial calibration experiment, to construct a regression line. The relationship established by this line is then used to determine the dry weight of experimental fish based on their corrected areas.

An initial calibration experiment was conducted in which 100 juvenile coho salmon, 2 to 5 inches long, were photographed and their areas determined. These fish were then oven-dried for 58 hours at 70 C and weighed. The weights and areas were transformed to natural logarithms and a regression equation determined. The relationship between weight and area is $W = aA^b$ or logarithmically, $\ln W = \ln a + b \ln A$, where W = weight, A = area, a and b are constants. The equation is $W = 0.000\ 258\ A^{1.56825}$ or in logarithmic form, $\ln W = 10.56543 \pm \ln A$ with an r^2 of 0.824. The additional effort involved in this technique will signficantly reduce stresses on the fish associated with the usual weighing procedures and will eliminate the error caused by variations in the amount of water on the fish's surface. The entire process of measuring 100 fish, excluding generation of the regression equation, requires approximately 6 man-hours.

USE OF STEELHEAD IN THE MANAGEMENT OF THE NORTH UMPQUA

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The 1972 summer steelhead run over Winchester Dam on the North Umpqua River totaled 13,732 fish. Although this is a decrease from the record run of 16,185 fish in 1971, the decline was predicted on the basis of estimated returns from hatchery releases. Under the present management program, hatchery releases have been reduced to 150,000 smolts annually. Adult hatchery steelhead contributed 10,570 fish, or 77%, to the 1972 run. Table 1 presents a history for summer steelhead passing Winchester since 1946 and for the contribution of hatchery fish since 1959.

Table 1. Summer steelhead counts at Winchester Dam, 1946-1972.

Period	Average run	Averages for hatchery contribution	
		Number of fish	Per cent of run
1946-50	3,149		
1951-55	3,439		
1956-60	2,395	833	34.3
1961-65	3,874	1,339	34.6
1966-70	9,338	6,631	71.0
1971-72	14,958	12,120	81.0

The first releases of hatchery summer steelhead were made into the North Umpqua in 1958. Experimentation at the beginning of this program was directed toward producing a smolt meeting particular criteria so as to insure the best possible return of steelhead adults. All releases were restricted to the Winchester site at River Mile 119. As adult returns increased, a definite delay in migration was observed within 15 miles of the exact spot the smolts were released. Within the holdup area, hatchery steelhead were making up 80 to 90% of the angler's creel. Thirty miles upriver, hatchery steelhead were contributing less than 10% of the angler's creel. In addition, few fish were observed reaching the upriver spawning areas.

Present experiments have been aimed at spreading the returning adult steelhead throughout the North Umpqua fishery and to establish returning adults in reclaimed spawning tributaries. Smolt releases have been made at Winchester (RM 119), Whistler's Bend (RM 133), Susan Creek (RM 154), Wright Creek (RM 160), Island Camp (RM 167), and Canton Creek (a spawning tributary at RM 173).

A total of 20,000 smolts was released annually into Canton Creek, a spawning tributary to Steamboat Creek, over the past 3 years. Returns over Winchester Dam have averaged 5.9% of number stocked for those 3 years. Scuba inventories within Canton Creek have resulted in individual counts of from 50 to 362 fish. Adult steelhead from Canton Creek releases have made up as high as 57.2% of the individual counts. A marked adult was observed spawning on a man-made spawning bar in Pass Creek 3 miles upstream from the Canton Creek release site.

The Oregon Punch Card Report indicated 8,396 steelhead were harvested in the North Umpqua in 1971. At the beginning of our hatchery program, anglers were averaging less than 400 steelhead per year. For the past 5 years, the angler harvest has averaged 6,366 fish. Hatchery-produced steelhead are contributing heavily to the sports fishery of the North Umpqua from RM 110 upstream to RM 180. Table 2 illustrates how the steelhead fishery has increased nearly 25 times from 1953 to 1971.

Table 2. Harvest statistics for the North Umpqua, 1953-1971.

Period	Average number steelhead	Average number salmon
1953-55	329	212
1956-60	443	280
1961-65	1,361	569
1966-70	5,500	2,132
1971	8,396	2,481

In summary: hatchery-produced summer steelhead are making up 77% to 85% of runs of 13,000 fish and higher past Winchester Dam on the North Umpqua River. Returns from hatchery smolt releases for the past 5 years have averaged over 7.0% and broken down into returns of 9.2% from releases between RM 119-133, 6.6% from releases between RM 154-167, and 5.9% into a spawning tributary at RM 173. Release of smolts at selected sites has produced a successful adult fishery over a 70-mile section of the North Umpqua. Adult steelhead of hatchery origin are the dominant reason for an increase of 25 times in the sport fishery harvest. By selection of release sites, returning hatchery adults have been placed into desired areas on side-spawning tributaries.

I cannot close without updating the spring chinook program on the North Umpqua. The 1972 run over Winchester Dam totaled 16,423 fish. This is the second highest count since the station was built in 1945. Fish of hatchery origin contributed 8,467 fish, or 51.6%, of the run. Table 3 presents a history of spring chinook runs past Winchester Dam and the contribution from hatchery releases. Table 2 shows that the salmon sports fishery has increased more than 10 times since the program was started. As a sidelight, "The 1970 Fin Mark Sampling and Recovery

Report for Salmon and Steelhead from Various Pacific Coast Fisheries", reported 1,743 spring chinook of Umpqua origin harvested, and there is some evidence that this figure may be low.

Table 3. Spring chinook counts at Winchester Dam, 1946-1972.

Period	Average run	Averages for hatchery contribution	
		Number of fish	Per cent of run
1946-50	2,745		
1951-55	5,908	929	14.7
1956-60	5,355	822	15.3
1961-65	8,671	1,911	22.0
1966-70	11,863	4,498	37.9
1971-72	13,176	6,167	46.8

NOTES ON CONFERENCE ARRANGEMENTS

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Washington Department of Fisheries
Olympia, Washington

Since there were no previous conference reports, it was extremely difficult to estimate meal attendance. Twenty-four hours is required by most establishments, with allowances for a 10% leaway. The reservations for the banquet were particularly difficult to determine. Cost of the meal, location of the meeting, and the proximity of other eating facilities and entertainments have an effect on meal attendance. We had to make an aggressive sales pitch to get our required 200 since we had made arrangements for 225. We reduced the number of the luncheon as soon as the bulk of our registration was completed. This was before the 24-hour deadline. We did have to add an extra table of 14 for lunch, but this was done in sufficient time to rearrange tables and settings.

Banquet entertainment was considered because some of the staff felt that some people might consider $5.50 too high a price for dinner. Since the State of Washington cannot pay out money for entertainment, it was decided to allow vendor displays, asking $100.00 per vendor. This donated money could logically be used for entertainment and meal tips. The troupe hired was "Drums of Polynesia" and provided an hour's entertainment for $250.00. The entertainment was secured through the suggestions offered by a former caterer, and a firm which specializes in entertainment listings. Local Musicians Unions also can provide suggestions and probable costs.

Pre-planning for a conference without pre-registration is very difficult. Early response by potential attendees is a must.

Of the 436 letters first mailed out, there were no responses from approximately 300 people. A second letter with an enclosed addressed and stamped postcard brought better results. A total of 244 people confirmed their attendance by the day before the meeting, and enabled us to have name tags made up ahead of time. Pre-registration with pre-payment of fees and meal reservations would save considerable time for the host committee. At least two people are needed for registration the first morning, three being preferrable because of the number of people requesting receipts for expense accounts.

Students who wished copies of the proceedings mailed to them had to be registered. If they did not wish proceedings, they attended free.

Registration was set at $1.50 per person or $1.25 if the attendee took advantage of a package deal of registration and the two planned meals. Charges for meals were based on cost plus State sales tax. The amounts were set so that change would be easy to make, and a cash fund of $35.00 in quarters and dollar bills was needed. The

Motor Inn provided both the fund and a cash box. Rather than having individuals be responsible for tipping, an amount was determined by us on our final bill for all meal and coffee break gratuities and this was covered by the surplus from our vendor donations.

By having two planned meals, we were able to secure special room rates and also were able to have the meeting rooms at no cost. Sleeping reservations were left to the responsibility of each person or group attending. A block of reservations was set aside by Sea-Tac Motor Inn, supposedly all in the same wing. However, full guest capacity the night previous to the meeting left many conferees unable to secure rooms until 1:00 PM, and they were scattered throughout the entire complex.

Total registered attendance - 309		
Banquet attendance - 200		
Luncheon attendance 167		
Vendor displays 4		
Income		
Registration		
144 at $1.25 (package deal)	$180.00	
165 at $1.50	247.50	
Total		$ 427.50
Banquet		
199 at $5.50	$1,094.50	
2 at $5.50 paid at door	11.00	
		$1,105.50
Luncheon		
171 at $3.25	$555.75	
Unaccountable registration and meals	25.00	
		$ 580.75
		$2,113.75
Vendor display donations		
Silver cup	$100.00	
Garo auto. fish feeders	100.00	
G.V. Alst Co.	100.00	
Heath Tecna	100.00	
Total		$ 400.00
Total income		$2,513.75
Expenses		
Banquet	$1,050.00	
SS tax	52.50	$1,102.50
Luncheon	501.00	
SS tax	25.05	526.05
Coffee - 3 urns at $30.00	90.00	
SS tax	4.50	94.50
Projection machine rental		18.13
Gratuity for services		218.82
Discount for Canadian money		1.00
Telephone tolls		.35
		$1,961.35
Entertainment		250.00
Total expenditures		$2,211.35
Income	$2,513.75	
Expenditures	2,211.35*	
Surplus to be applied to Proceedings		
Printing cost	$ 302.40	

* The Washington Department of Fisheries absorbed the cost of name tags, paper, and postage. Name tags cost $18.14; postage spent on initial letters, follow-up letters, and enclosed stamped postcards was $62.88.

August 8, 1972

Proceedings of the Northwest Fish Culture Conference

1967 through 1971

In 1966, Wallace Hublou, Chairman for that year, prepared an index by author and subject of the proceedings of the Northwest Fish Culture Conference from 1950 (when 21 persons were in attendance) through 1966 (when a registered attendance of 236 took place).

Having been a member of the "Conference" since its inception, and having a continued and vital interest in this valuable meeting, I have felt the need for an updated index and have so reacted.

The present index covers the five years of 1967 through 1971. So as to provide continuity the same generalized subject index as formed by Hublou has been used.

For some ease of identification a very few new catagories have been added to Hublou's subject index, namely: "Costs," "Fish Production," "Shellfish Culture," "Management," "Quality (water-fish)," and "Smoltification".

I have suggested to R. E. Noble, Chairman of the 1972 Conference, that inclusion of this index in the proceedings of the 1972 Conference might be desirable. If it develops that the inclusion cannot be realized then individual copies may be obtained from the Washington Department of Fisheries.

C. H. "Bud" Ellis
Chief Hatchery Management
Washington Department of Fisheries
Chairman 1952, 1958 and 1963

CHE:bk

Proceedings of the Northwest Fish Culture Conference
1967 through 1971

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HISTORICAL RECORD OF NORTHWEST FISH CULTURE CONFERENCE

Date	Where Held	Host Agency	Chairman
1950	Portland, Oregon	Fish and Wildlife Service	Perry
1951	Wenatchee, Washington	Fish and Wildlife Service	Burrows
1952	Seattle, Washington	Wash. Dept. of Fisheries	Ellis
1953	Portland, Oregon	Oregon Fish Commission	Cleaver
1954	Seattle, Washington	Fish and Wildlife Service	Rucker
1955	Portland, Oregon	Oregon Game Commission	Rayner
1956	Seattle, Washington	Washington Game Dept.	Millenbach
1957	Portland, Oregon	Fish and Wildlife Service	Johnson
1958	Seattle, Washington	Wash. Dept. of Fisheries	Ellis
1959	Portland, Oregon	Oregon Fish Commission	Jefferies
1960	Olympia, Washington	Wash. Dept. of Game	Johansen
1961	Portland, Oregon	Oregon Game Department	Jensen
1962	Longview, Washington	U. S. Fish and Wildlife	Burrows
1963	Olympia, Washington	Wash. Dept. of Fisheries	Ellis
1964	Corvallis, Oregon	Oregon State University	Fryer
1965	Portland, Oregon	U. S. Fish and Wildlife	Halver
1966	Portland, Oregon	Oregon Fish Commission	Hublou
1967	Seattle, Washington	University of Washington	Donaldson
1968	Boise, Idaho	Idaho Dept. of Fish and Game	Cuplin
1969	Tumwater, Washington	Washington Game Dept.	Johansen
1970	Portland, Oregon	Oregon Game Commission	Jensen
1971	Portland, Oregon	Bureau of Sports Fish and Wildlife Service	Smith
1972	Seattle, Washington	Wash. Dept. of Fisheries	Noble
1973		Oregon Fish Commission	Jefferies