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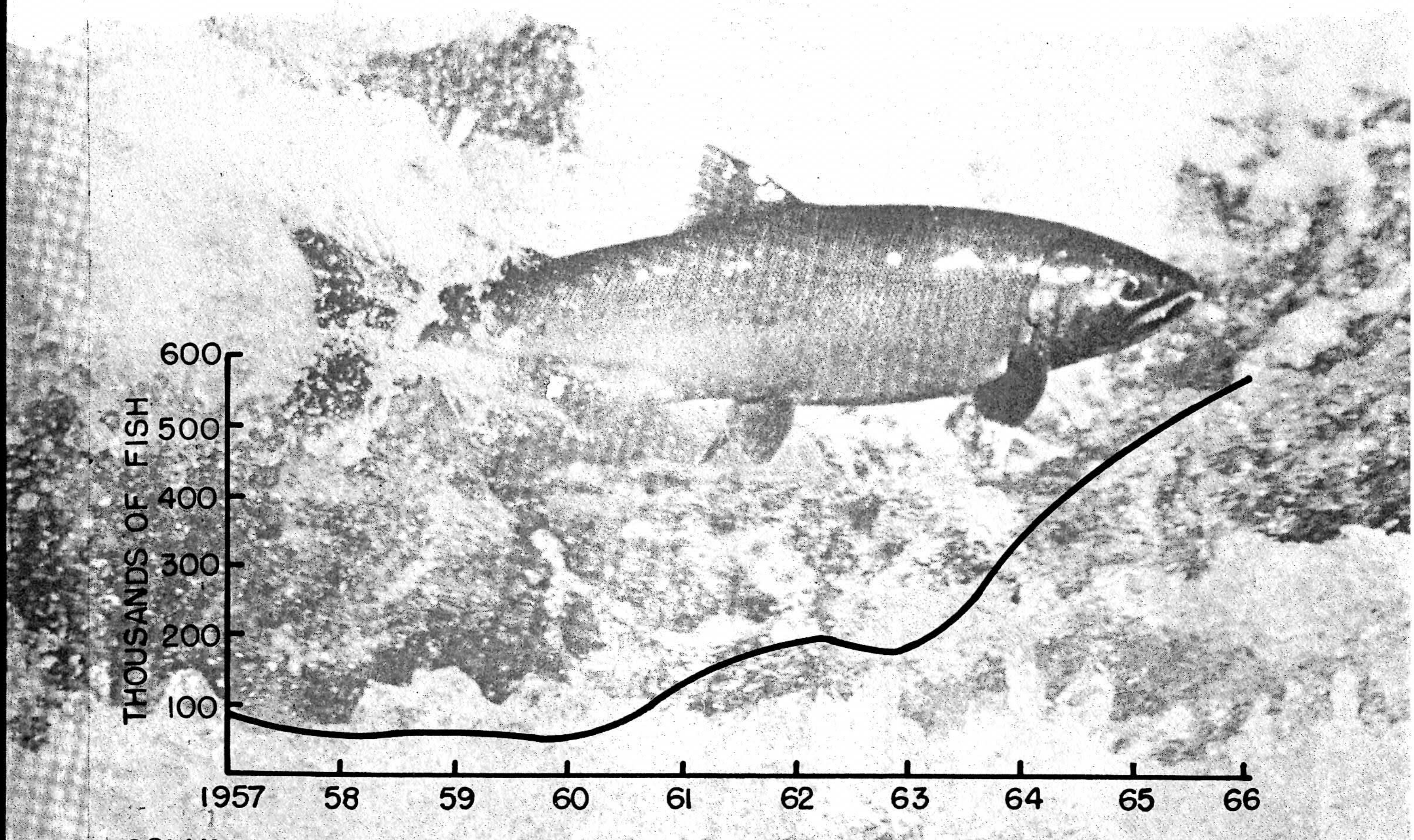
Northwest

~~A. Kenneth Johnson~~

Fish Culture Conference



COLUMBIA RIVER SPORT AND COMMERCIAL COHO SALMON LANDINGS.

Portland, Oregon

December 6-7, 1966

SEVENTEENTH ANNUAL NORTHWEST FISH CULTURE CONFERENCE

December 6 and 7, 1966

Enclosed are the proceedings of the 1966 Northwest Fish Culture Conference. No portion of these reports may be reproduced or quoted without written permission of the author(s) involved.

Thirty five speakers addressed a registered attendance of 236. Thanks to an excellent auditorium, well prepared high quality presentations, an interesting variety of topics, and an expert "stage crew," the program went along very smoothly. The reports were well received by the audience, the discussions were spirited, and there was occasional humor which blended to make an enjoyable session.

A sincere thank you is extended to the participants in the program. Their excellent cooperation made it a pleasure for me to serve as chairman. We are very much indebted to the office staff at the Clackamas Research Laboratory for preparing and sending the invitations, programs, and the proceedings. I also wish to thank the Oregon Fish Commission hatchery biologists for their assistance. They get the credit for the program being conducted without mechanical or other problems. Orville Dahrens designed the cover of the proceedings which gives an optimistic note to this year's work.

We also prepared an author-subject index of the first 17 conferences (except for 1953 when no proceedings were published). It is being mailed along with the 1966 proceedings. I hope this index will aid you to easily and quickly locate desired information.

Dr. Lauren R. Donaldson, College of Fisheries at the University of Washington, was nominated chairman of the 1967 conference. For the first time, we had to choose next year's host from formal applications. This is a very good indicator that the Northwest Fish Culture Conference is continuing to increase in prominence among fish culturists and others in the fisheries field.

Mr. Paul Cuplin, Idaho Department of Fish and Game, has invited us to hold the 1968 conference in Idaho. This invitation was well received by the conferees but, in keeping with custom, it will be voted on at the 1967 conference.

Wallace F. Hublou
Chairman, 1966

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THE EFFECT OF TWO DIFFERENT METHODS OF RELEASE ON THE SURVIVAL OF HATCHERY-REARED STEELHEAD

Harry H. Wagner
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Juvenile hatchery-reared steelhead are being used in increasing numbers to supplement the natural production of winter steelhead smolts in western Oregon coastal streams. Success depends in part on the elimination or reduction of factors which might adversely affect the wild stocks or reduce the number of viable hatchery smolts reaching the sea. Ideally, the stream is to serve only as a highway to the sea and not as a post-liberation rearing area for the hatchery product. In keeping with this end, it is essential that the hatchery fish migrate seaward shortly after release and not remain in the stream where competition and predation might result in the reduced survival of native and introduced populations.

Two facts have been established for the parr-smolt transformation in steelhead trout. The phenomenon is markedly size dependent and the transformation and resulting downstream migration are seasonal in occurrence. The timing of the migration is the primary concern of the present discussion.

On the Alsea River, the downstream migration period for wild smolts occurs from April through May with only a few fish observed prior to or after that interval. Peak movements have varied from mid-April to mid-May. It is apparent from these data that not all the wild fish undergo the parr-smolt transformation at the same time or at least not all are as receptive to stimuli which initiate the downstream migration.

It was thought that in a group of hatchery-reared steelhead which are released en masse on a preselected date some of the individuals might have been held too long and would have reverted back to a non-migratory form, or other individuals might be released before they were ready to migrate. The end result would be that some of them would take up residency in the stream for varying periods of time.

In 1963, 1964, and 1965, hatchery-reared steelhead at the Alsea Trout Hatchery were allowed to leave the rearing raceway voluntarily. The adult returns have been compared to the survival obtained from fish forced from the rearing area in mid-April. The forced liberation dates were based on knowledge of the migratory pattern of the wild fish, results of previous marking experiments, fish size, general appearance of the animal, changes in coefficient of condition, and stream flow.

In early February, the screens were removed from the outlet of the raceway and an opening 9 inches by 12 inches in dimension was provided in stop logs approximately 12 inches below the water surface. This submerged orifice allowed the fish access from the raceway to the stream via the water discharge system of the hatchery. We can only assume that the movement of fish out of the raceway was directed as a result of a change in the migration disposition of the animal and was not influenced by the position and/or geometry of the submerged orifice. At approximately 30-day intervals, the number of fish remaining in the raceway was determined from the total pounds and the fish per pound. In mid-May, the fish which had not migrated were forced out into the stream.

The 50% point in the movement of fish out of the raceway varied from mid-April to the first week in May. In 1963 the movement of hatchery fish occurred earlier and was more extensive than in 1964 and 1965. The migration pattern of 1963 is believed to be partially the result of a large number of freshets occurring that spring which perhaps provided a continuous flow of releasing stimuli. In general the movement pattern of hatchery fish from the raceway appeared similar to the movement of wild fish in the stream with respect to time.

An estimated 3.9% return (2,700 fish) was obtained from the voluntary release group in 1963 and a 4.4% (3,100 fish) from the April forced liberation. The estimated returns from the 1964 release show an 8.1% return (3,200 fish) from the voluntary group and a 9.6% (4,800 fish) return from the forced group. The returns from the 1965 release groups are not yet complete. When the 10 to 15% error associated with the estimates is taken into consideration the difference between returns from the two methods of release cannot be considered significant.

Under the conditions that the liberations were made, the voluntary release method has not enhanced the survival of the hatchery product when compared to the usual method of release where the fish are forced out of the pond on a preselected date. One reason for the similarity in survival of the two groups (forced versus voluntary) can be related to the movement pattern of the fish out of the raceway. Most of the voluntary movement occurred between mid-April and mid-May with the possible exception of an earlier movement for the 1963 voluntary release group. Consequently the release of hatchery fish in mid-May probably matched the migratory activity period of most of the smolts in the forced liberation group. Fish which were held in the raceway the first part of April which would have migrated if released apparently retained the migration urge or if they had reverted to a non-migratory form, their numbers were so few as not to alter the return substantially.

Previous experiments with respect to release time have shown on the Alsea River that fish released in April have a higher survival than comparable fish forceably released in March and February, indicating the necessity of releasing fish during the period of migratory activity for maximum survival. From the available data it appears that mid-April is the most favorable time for the forced liberation of hatchery-reared steelhead on the Alsea River.

MULTIPLE USE LIBERATION AND WEIGH-OUT TANKS

George V. Smalley
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Astoria, Oregon

At the Klaskanine Hatchery, we rear from 1.2 to 1.5 million coho fingerlings in a 3/4-acre circular lake. At the time of their release they average 15-17 fish per pound, and have a total weight of between 70-80,000 pounds. The lake outlet is located above a diversion dam supplying water to our sixteen 20 x 80 concrete rearing ponds. We prefer to release fish from the lake below the diversion dam. In past years this was accomplished by seining the fish from a 20 x 20 concrete sump pond located at the lake outlet. The fish were weighed, loaded into a liberation tank, and hauled below the dam for release. More recently, they were weighed and transported below the dam through a 6-inch pipe. The fish are smolting at time of release and the handling required for weigh-out caused much scale loss. The physical effort required to weigh this 35-40 tons of fish and an equal amount of water was excessive. It would take about five days to do this.

A much better method for weighing-out the fish has been devised. Twin liberation tanks were constructed and installed side by side below our dam. The lake level is lowered and the fish enter a screened chute and are diverted into a 4-inch pipe line which delivers them in water, a distance of approximately 240 feet downstream below the dam. They enter the weigh-out tanks, are weighed by displacement and released immediately. There is no handling by nets or seines. The number of fish passing through the pipe is controlled by manipulation of pond screens and dam boards in the chute.

Fish on leaving the pipe line are passed over an inclined bar grid equipped with a wiper curtain for removal of water and then drop into a tank of premeasured water. Plastic calibration tubes on the tanks are used for determining the amount of water displaced. A pinch clamp is placed at the water level before fish enter the tank. When desired level of fish has been reached, the grid is shifted to the other tank. A second clamp is set at the new level of water and fish and the inches of displacement is recorded. The outlet gate is then opened and fish are released into the stream. The tank is immediately refilled to a new starting level and clamp reset at the new position, and is then ready for a new load of fish.

The operation is continuous with fish movement controlled at approximately 1.5 tons of fish every 10 minutes. This allows adequate time to calibrate a tank, release the fish, and refill for the next group. The total fish in the lake can be moved in 8-10 hours with the only fish handled being the ones removed by net for counting for size determination. To obtain a representative sample of the entire group being released, 15-20 pounds are netted as they come off the grid midway to filling each tank. These are weighed and counted with figures recorded. Complete sample weights and number of fish in the samples are used to determine the overall average of fish per pound. Total inches of displacement are added and this total multiplied by 168 which is the pounds of water per inch of displacement. This figure is multiplied by 1.02 for a corrected fish weight to water ratio and the resulting figure of total pounds of fish released is multiplied by the number of fish per pound to obtain the total number of fish.

This system is fast, accurate, and easy on the fish which are in water except for the few seconds as they cross the bar grid before entering the tanks. Needless to say, it is also considerably easier on the crew.

These twin tanks were designed for multiple use. For transportation of adult salmon, they are mounted on a flat bed truck and keyed together for use as a twin-compartment single unit. Used for the first time this fall, we hauled as many as 300 adult coho for distances of up to 100 miles and for periods as long as 4 hours. Fish are sexed prior to loading, with males in one tank and females in the other. The tanks are identical. We plan to repaint one of the blue ones pink.

Each tank has three compartments with two overhead spray aeration pipes. Two pumps are used, each with a capacity of about 185 gallons per minute. Either or both pumps may be used for filling the tanks or during transit. A screened crossover pipe is used between tanks to maintain an even water level. The baffles between compartments are solid from the top to within a foot of the tank bottom which forces water pumped into each compartment to circulate to the tank bottom before it can return to the pump for recirculation. An outlet on the crossover pipe enables the release of tank water for tempering purposes. One pump is used to maintain normal circulation rate in the tanks while the other pump is bringing in exchange water which is regulated to equal the amount and rate that is being released.

Three sizes of outlet pipes are used. A 4-inch for fingerlings when hose is required for release. A 6-inch is necessary when used as stationary measuring tanks for our lake liberation. For adult liberation, 10-inch outlets are installed. All outlet bases are interchangeable on either tank, with about 20 minutes required to change from one size to another.

Six x 12-inch openings fitted with 4-inch high air scoops on the cover of each compartment force air entry. Screens for the vent openings are 14 x 20 inches and are recessed 1 inch into the tank to provide additional surface area for air passage. They also act as a baffle to reduce splash and water escapement.

We intend to use these tanks for unfed fingerling transfer and liberation. Fry baskets will be used and although untried, we expect to transport up to 1,000,000 in the two tanks. One compartment may be used for ice.

With the spray aeration pipe valves closed, the unit may also be used as a portable pumper for additional fire protection at our hatchery. We have used these tanks and pumps for washing off our roadways and parking area where a high pressure portable water supply was necessary.

Another rain-free week in late September or early October and we would have considered hauling water to maintain a flow through our rearing ponds or to coax a few chinook spawners into our holding pens.

RETURNS OF UMPQUA RIVER SPRING CHINOOK AND SUMMER STEELHEAD

Jerry A. Bauer
Oregon Game Commission
Roseburg, Oregon

It was pointed out in my paper last year that hatchery production had aided considerably in bringing the Umpqua spring chinook run back to where it is today. In 1946, the total run was less than 3,000 fish and the spawning run less than 2,000 fish. The runs since 1961 have averaged slightly over 9,000 fish, with hatchery fish contributing an average of 20% of the run. In particular, I commented that from 43,900 smolts of the 1961 brood stocked at 5.3 fish per pound in March 1963, a total of 2,883 adults were recovered through 1965, or 6.6% of the number stocked. To complete the story on this group of fish, an additional 368 adults have been recovered in the Oregon and California troll fisheries, California and Umpqua River sport fisheries, and counted across Winchester Dam. This figure of 7.4% return from the number stocked is the best in the program so far, and we are quite happy about it.

The North Umpqua River has long been famous for its summer steelhead fishing and was started by such renowned anglers as Zane Grey and General Mott. When we talk of the Umpqua summer steelhead we are primarily talking about the tributary Steamboat Creek. It is felt that over 70% of the summer steelhead run spawns and rears in Steamboat Creek. Historical records indicate that the summer run was in the magnitude of 10,000. Since 1946, the fish runs of the North Umpqua have been enumerated at the ladder over Winchester Dam. In the period 1946-1956 the summer run averaged approximately 3,300 fish. During this period the run fluctuated between 2,000 and 5,000 fish, with a rather steady decline toward 2,000 fish at the end of the period. In 1955, our program began with the collection of brood fish at the Winchester ladder in August. Brood fish were collected here because of their availability and the feeling a better cross section of brood stock was present. During the start of our program (1957-59), the summer run averaged about 2,100 fish. The first returns were seen in 1959. Since 1959, the runs have averaged nearly 4,100 fish, and this year's run of 6,185 was the largest since the counting station was built. Table 1 shows that artificially produced fish have contributed to the runs from a low of 595 adults to this year's high of 3,046 adults.

In the present program, the summer steelhead brood fish are collected from the ladder over Winchester Dam starting right after the Fourth of July. The brood fish are transported to a dirt holding pond at the Rock Creek Hatchery. The first eggs are generally taken in late February, and the egg take is generally completed by the first week in April. The eggs are eyed at Rock Creek, then shipped to the Bandon Hatchery for hatching and rearing. The smolts are then trucked back to the North Umpqua for stocking.

Our total plants have ranged between 16,000 and 100,000 fish annually. However, plants of fish that have basically smolted by March have ranged between 16,000 and 55,000 fish. In experimenting with size and time at release, we have found that our best returns come from a smolt four to eight fish per pound released in March. Nearly all of the 100,000 fish released in 1966 met these requirements and a good return is expected. Returns from fish

Table 1. Summer steelhead counts over Winchester Dam, 1959-66.

Year	Total run of fish	Number of fish from artificial production
1959	2,049	693
1960	2,732	951
1961	3,141	754
1962	3,072	1,456
1963	4,827	1,916
1964	2,900	595
1965	5,428	1,976
1966	6,185	3,046

in this size group have ranged between 3 and 9% of the number stocked. Fish in the size groups exceeding 10 fish per pound have returned from 0.0 to 1.5% of the number stocked. Table 2 summarizes the number, size, and time of stocking for hatchery-reared summer steelhead into the North Umpqua River since 1958.

Most of our releases have been made below Winchester Dam. A definite delay in migration has been observed in the area the smolts are stocked. Most of the hatchery steelhead entering the fishery as adults are taken within 15 miles of the place where they were stocked and only a few were taken as far as 40 miles upstream. Experiments with area of release are presently being conducted by stocking at Winchester (114 miles from the ocean), Rock Creek (148 miles from the ocean), and Steamboat Creek (167 miles from the ocean).

When our first hatchery adults returned, we were somewhat concerned with their quality. The returning adults were considerably smaller than their wild counterparts. Table 3 illustrates a comparison of wild against hatchery adults. We feel that we are now bringing back an adult of near equal quality to the wild fish. It is felt that several factors have contributed to this: better brood fish selection, better hatchery techniques (diets, etc.), and increased knowledge of the wild stocks resulting in better utilization of the hatchery product.

In summary, we have progressed from 2,000 fish populations to a high of nearly 12,000 spring chinook last year and a 6,185 summer steelhead run this year with hatchery fish contributing 25.0% to the chinook run and 50.0% to the steelhead run, and we are greatly encouraged by both programs.

Table 2. Umpqua summer steelhead stocked, 1958-66.

Brood year	Number of fish stocked	Size stocked (fish/lb.)	Date stocked
1956	2,500	4.0	March 1958
	16,500	11.4	" "
1957	34,700	8.7	March 1958
	13,600	16.8	April 1958
1958	34,700	8.1	March 1959
1959	8,000	7.4	March 1960
	8,200	8.9	April 1960
1960	42,300	10.0	March 1961
	41,000	13.4	April 1961
1961	36,600	10.3	March 1962
	60,700	12.1	May 1962
1962	31,000	10.2	March 1963
	27,100	21.1	March 1963
1963	41,200	8.2	March 1964
	41,100	11.4	March 1964
	11,600	20.0	March 1964
1964	26,300	9.0	March 1965
	3,500	8.0	April 1965
	29,500	9.8	May 1965
	14,400	15.0	May 1965
1965	92,200	7.0	March 1966
	7,900	7.9	April 1966

Table 3. A comparison of average lengths between wild Umpqua summer steelhead adults and hatchery produced adults.

Pattern	Wild fish Fish size (inches)		Pattern	Hatchery fish Fish size (inches)	
	Smolt	Adult		Smolt	Adult
2/1	6.7	19.8	1/1	9.3	15.3
2/2	5.7	24.4	1/2	6.7	22.6
2/3	5.1	27.5	1/3	5.8	26.6

A LARGE VOLUME MALACHITE GREEN DISPENSER

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Fish Commission of Oregon
Madras, Oregon

Most of us have had to treat fish held in ponds where it has been inadvisable or impossible to shut off the incoming water during treatment. Therefore, we have had to resort to flush types of treatments. In general, flush treatments are not completely satisfactory because it is very difficult to control treatment concentrations unless a suitable method is available for adding chemicals at a constant rate to a known volume of incoming water. In many cases pond inflows are fairly large and a practical apparatus has not been available for adding the large volume of chemicals required.

We were faced with such a problem this year at the Pelton Pilot Hatchery. We were holding adult spring chinook and wanted to treat them with malachite green to control fungus infection. The fish were being held in a pond supplied with water at a rate ranging from 1,500 to 3,000 gallons per minute and it was not possible to readily manipulate the flow. Since we could not turn off the water and use recirculated bath treatments we had to add the chemical to the incoming water. In order to administer 1-hour treatments at 1 part per million, we fabricated a large constant siphon shown in Figure 1.

This apparatus employs a floating constant-head siphon mounted in a 54 gallon barrel. The same amount of water was always used in this barrel and the amount of dry malachite varied to the pond flow at time of treatment. An inverted "U" shaped siphon tube was made primarily of 1/4-inch water pipe with the discharge side approximately 18 inches longer than the intake side. The intake leg was passed through the center of a float and attached to a coupling welded to a steel plate. The float consisted of four circular 3/4-inch thick pieces of plywood nailed together and waterproofed with fiberglas resin. The float was made one inch smaller than the inside diameter of the barrel and a piece of 3/4-inch diameter steel rod was mounted on top of the float to counterbalance the weight of the siphon tube. Two valves were incorporated in the siphon to facilitate priming and starting the dispenser. One valve was located in the intake side just above the float and the other at the top of the siphon.

To prime the siphon, the outlet is stoppered, the valve next to the float is closed, and the tube filled through the top valve. Flow is started by closing the filling valve, opening the valve just above the float, and removing the outlet stopper.

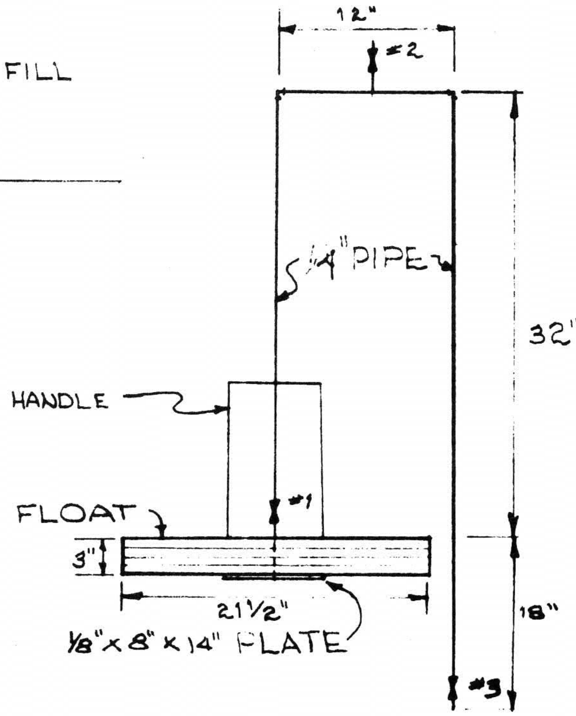
This particular dispenser will deliver 2,800 cubic centimeters per minute or approximately 44.4 gallons in a 1-hour period. Any other delivery rate that may be desired can be attained simply by using discharge pipes of different lengths. Since this is a floating siphon with constant head the flow will remain the same until the float touches the barrel bottom. At that time about 1/2 gallon of solution remains and flow continues at a reduced rate for about $1\frac{1}{2}$ minutes.

This apparatus is simple to make and materials cost about $15.00.

Figure 1. CHEMICAL DISPENSER BY KEITH D. MOORE

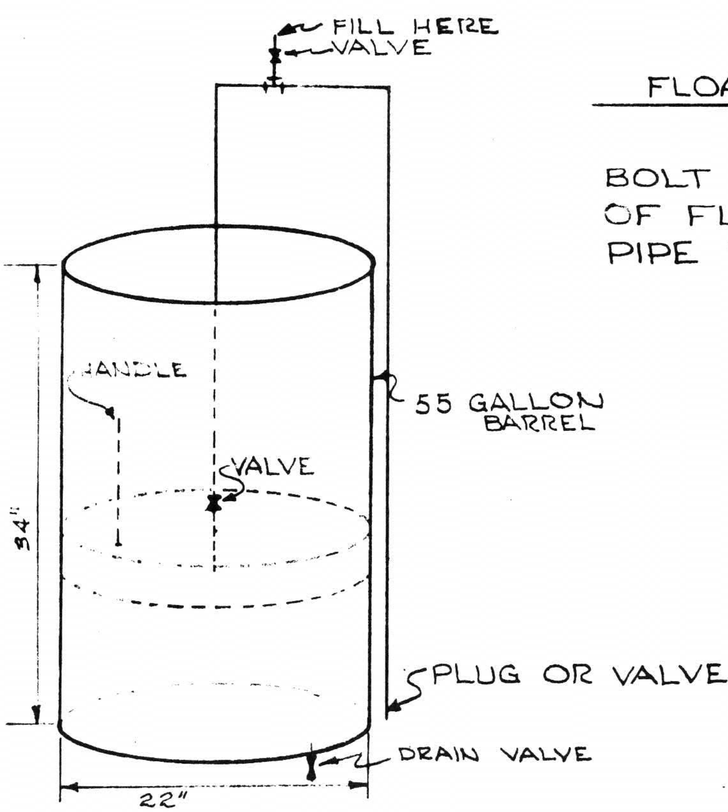
TO START

CLOSE VALVE NO. 1 & 3.
OPEN VALVE NO. 2 & FILL
CLOSE VALVE NO. 2
OPEN VALVE NO. 1 & 3



FLOAT DETAIL

BOLT PLATE TO BOTTOM OF FLOAT & THREAD 1/4" PIPE INTO PLATE.



ASSEMBLED DISPENSER

THE CATCH AND MIGRATION OF HATCHERY COASTAL CUTTHROAT TROUT IN OREGON RIVERS

John Rayner and Richard D. Giger
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Corvallis, Oregon

Important coastal cutthroat trout fisheries exist in lakes and streams along the Oregon Coast. Until recently, very limited information was available on the ecology and most efficient use of this fish, either as wild or hatchery stocks.

Research has been in progress on coastal lakes since 1961 and on coastal rivers and estuaries since 1965. Delbert Skeesick and David Hansen have been the investigators on the lake studies, which have centered around Munsel Lake near Florence, and Ross Bulkley on the river and estuary studies on the Siuslaw and Alsea rivers.

Releases of marked fish, creel sampling, trapping, and netting have been used to obtain information on catch, angler effort, migration, growth, survival, food habits, and other life history aspects.

Lake studies have shown that cutthroat and rainbow trout provide good stocks for these waters. Although the total seasonal catch for the two species was equivalent, stocked cutthroat were cropped much faster than rainbow trout, indicating a greater vulnerability to angling. Migration data collected since 1962 at the Munsel Lake weir indicated that an average of only about 5% of the stocked cutthroat migrated out of the lake. A number of marked Munsel Lake fish were recovered in the nearby Siuslaw River estuary fishery, as well as in other river systems, and an interest developed in the source of stocks and magnitude of catch in the estuary and river fisheries.

Estimates of the catch and angler effort for the 1965 Siuslaw and Alsea tidewater fisheries, and of the 1966 Alsea River fishery, are presented in Table 1. It is evident that angling effort is quite high.

Tidewater fisheries, which take cutthroat during their spawning migration, are largely sustained by natural reproduction in the two estuaries studied. In the Siuslaw estuary, hatchery fish comprised 7 to 21% of the catch over a 4-year period. In the Alsea estuary, 4% of the catch was of hatchery origin in 1965.

The river fisheries occur at the opening of the trout season, and are supported, in contrast, by hatchery fish released prior to the season. In 1966, 89.6 and 81.8%, respectively, of the Siuslaw and Alsea river catch were hatchery fish.

Age composition of the 1965 Siuslaw tidewater catch indicates that hatchery fish migrate to the ocean soon after release, spend a single summer there, and return on a spawning migration in the year of release (Table 2). The spawning run of wild fish is composed primarily of fish which have spent three years in fresh water and a single summer at sea.

Table 1. Catch statistics of the 1965 Siuslaw and Alsea tidewater fishery (with 95% confidence limits), and of the 1966 Alsea River fishery.

Total angler trips	Total angler hours	Total boat trips	Total boat hours	Cutthroat catch
		SIUSLAW		
13,324 ± 388	73,143 ±2,900	6,443 ± 173	32,923 ± 717	6,314 ± 276
		ALSEA		
30,935 ± 977	116,825 ±3,454	13,251 ± 417	48,290 ±1,434	7,844 ± 334
		(river) 1/		
	13,728			9,810

1/ Week days not included.

Table 2. Age composition of cutthroat in the 1965 Siuslaw tidewater catch sample.

	Sample size	Per cent in age group I	II	III	IV	V	VI
Hatchery fish	73	68.5	8.2	8.2	15.1	0.0	0.0
Wild fish	605	0.0	3.8	70.1	24.5	1.3	0.3

Research goals, based on these preliminary studies, include a greater emphasis on the role of wild cutthroat, the production of more sea-run fish, and continued evaluation of hatchery releases.

ANALYSIS OF HATCHERY PERFORMANCE BASED ON INDEXES OF EVALUATION WITH COMMENTS ON THE INFLUENCE OF MORTALITY

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INTRODUCTION

The most important consideration in evaluating trout hatchery performance is the quality of the fish liberated. A brief description of the importance of quality in the three broad classifications of our trout cultural program in Washington follows: (1) small fingerling, (2) migrants, (3) legal. Our Lake Management program is largely dependent on returns of approximately 14,000,000, 50 to 200/# fingerling planted in May and June. The commercial diets have improved nutrition, quality, and also the size at liberation. Better returns to fishermen in the three months to two years after planting are the result. The migrants consist of winter and summer-run steelhead and sea-run cutthroat and number approximately 3,000,000 at 6/# annually. The quality of migrants raised in semi-natural rearing ponds developed in the last several years has improved. The fish are firm, trim, and lively. The quality of these fish is also indicated by increased returns to the fishery. The quality of these released fish has generated competition with hatcheries to produce a better product. Although quality of the legal program release is less critical, the public acceptance of the "put and take" portion is important. Good appearing, well-shaped fish are usually of good quality.

DESCRIPTION OF INDEXES OF EVALUATION

In my paper for this convention last year, I gave four indexes which are useful in evaluating a single fish rearing facility or a total fish rearing program. These are: (1) pounds of fish produced, (2) cost per pound of fish raised, (3) number of pounds of fish produced per man per year. Anyone of these might not give a value of proficiency, but used in combination, some very interesting comparisons may be made. The overall hatchery performance which is based on the total of 24 hatchery and three semi-natural rearing ponds for the July 1, 1965-June 30, 1966 period is compared with last year and representative years in the past.

INDEXES OF EVALUATING FISH REARING FACILITIES

Year	Pounds of Fish produced	Cost per pound($)	Food conversion factor	Employees	Pounds produced per man
1953-1954	683,066	0.78	5.3	70	11,551
1963-1964	1,475,277	0.63	1.9	78	18,861
1964-1965	1,350,472	0.72	2.0	78.5	17,200
1965-1966	1,441,208	0.67	1.9	79	18,243

The additional 90,736 pounds produced in 1965-66 over the preceding year is the major reason for the decrease from 72¢ to 67¢ per pound of fish produced. This cost does include salaries, operations, and what hatchery maintenance the hatchery crew performs, but no capital investment or construction costs by the Engineering Division. Because of the inflation pattern of our entire economy with increased salaries and operations cost, it is unlikely that we will be able to hold this unit cost this year. The most promise of maintaining and even decreasing our cost per pound is to increase the pounds produced per man. The only way to achieve this objective is to have a high ratio of raceways, holding ponds, and/or semi-natural rearing ponds per fish culturist. In order to have many fish rearing facilities per employee, it is necessary to have automatic feeders, sorters, and mass production methods in every fish rearing operation. We have found that the production per man is higher in semi-natural rearing ponds than a conventional hatchery. Two new installations which will be operated by our department are now under construction, which will include these concepts. The hatchery on the Cowlitz River is being built by Tacoma P.U.D. and the rearing impoundment on the Columbia River by Douglas County P.U.D. These installations are so designed with automatic feeding, fish handling, and high ratio of fish rearing raceways or ponds per employee. There are two other actions which can improve the pounds of production per man. The first is to abandon unproductive stations and the other to utilize productive stations closer to capacity. The transportation of fish from one place to another is easier as roads and equipment have been improved; it is not necessary to rear the fish close to liberation areas.

The food conversion factor may vary depending on the quality of the food and the proportion of the total poundage of each species reared. Summer-run steelhead, for example, take more food to raise one pound of fish than the other species.

The two important items that we have to consider regarding the conversion factor is the proficiency of the fish culturist and a high quality diet. The reduction of the conversion factor from 2.0 to 1.9 this last year in our total operations means a saving of $15,000.

MORTALITY AND ITS RELATION WITH INDEXES OF EVALUATION

We have always tried to decrease our mortality of eggs, fry, and fingerling in our hatcheries and will continue to make every effort to do so. Nevertheless, we do have several stations which have high mortalities. We have a station at 56 F which produces rainbow eggs during September, October, and November. Egg mortality has been 15% and higher and fry loss from the eggs received at other stations has been 20% and sometimes higher. Despite these high mortalities, the early eggs and early fry and fingerling contribute very substantially to our program. We have another warm water station 57-58 F with high egg and fry mortality. Both of these stations have favorable index evaluations compared to other stations. Compensation can be made in providing program totals, if high mortalities are experienced in eggs and fry less than 800/#. The cost of the food is relatively minor and the evaluation indexes will not suffer appreciably. High mortalities in large fish, however, cannot be tolerated for the cost per pound, conversion factor, and production per man per year would be adversely affected.

We will confine our efforts to reduce mortalities wherever they occur. Should higher than normal mortalities occur in eggs and fry where program demand fish of a certain size and warm water hatching and rearing is the answer, a favorable evaluation of these stations may be possible.

CONCLUSION

The most important consideration of fish reared for liberation is quality. A favorable conversion factor depends on good fish cultural practices and high quality food. The most promise of maintaining or decreasing our costs of raising a pound of fish will be to produce more pounds per man per year. To do this, we must automate, have a high ratio of fish rearing facilities per employee, and if possible, abandon nonproductive stations. If relatively high mortality occurs in eggs and small fry, the evaluation of the facility based on Indexes of Evaluation may not be changed appreciably.

WHEN IS A SALMON A TROUT OR A CHARR OR VICE VERSA?

William M. Morton
Bureau of Sport Fisheries and Wildlife
Portland, Oregon

HISTORICAL BACKGROUND

Every fishery worker in this audience who has any interest in salmonid taxonomy or systematics is well aware that the Atlantic salmon is really a trout; that the silver trout of the State of Washington is really a salmon; and that the lake trout, brook trout, and the Dolly Varden trout are really not trout at all--they are all charrs. There is now, today, as there has been for the past 50 years, a grave question in many minds as to whether we Americans are really making full use of the ancient English names of salmon, trout, and charr in their most meaningful and logical manner.

Let me take a few minutes to refresh your collective memories on the historical origins of these three English names. The name salmon was brought to England by her Norman Conquerors in 1066. Most authorities claim the word developed from a Greek word meaning "the leaper", and that it had been in use on the continent in some form or other since the time of Christ. The old Anglo-Saxon word for the same fish was trutt or trutts--pronounced exactly the way our Canadian friends to the north still pronounce trout. I have as yet found no reference to any other meaning of the word other than as an Anglo-Saxon vernacular name for this fish.

The first real complete book on the Fishes of the British Isles entitled Pesciduim Britanicum written in Latin and published in 1661 by Willoughby gives the first written use of all three common names for these common forms of salmon existing in Britain. The No. 1 and most sought after was the anadromous form salmon, (today's Atlantic salmon Salmo salar), followed by the river or brook trout, (today's Brown trout Salmo fario), and lastly a third and smaller form found in the many lakes and tarns of the islands called "Charre." Willoughby was the first to point out that these charre had no black spots on their backs or sides and no teeth in the roofs of their mouths. This fish, of course, is today's circumpolar Arctic Charr, Salvelinus alpinus. The word charr comes from the Gaelic word ceara which means red and alludes to the red or orange color that develops on spawning males along the belly or abdomen of the Arctic charr in particular, and to a lesser extent in males of the genus Salvelinus in general.

About 100 years after Willoughby the eminent Swedish Systematist Carl Von Linne first published his masterful thesis Systema Naturae in 1759, in which he placed all three British salmon in the genus Salmo. About 150 years after Willoughby (in 1829) another Swedish ichthyologist named Nilsson finally set the charrs apart in a separate genus Salvelinus, (this name is derived from "living in a spring" which is appropriate as our charrs generally live in the coldest waters on earth). Although this is a very valid genus--Swedish scientists among others--were still using Salmo for charrs as recently as 10 years ago!

The next step came in 1861 when an American medical army officer Dr. George Suckley published his brief monograph describing the new genus

Oncorhynchus (hooked snouts) for our Pacific salmon. The latest step in salmonid classification is Vladikov's recent (1963) submission of the subgenus Parasalmo for our Pacific trout which I will discuss in more detail in a few minutes. So much for historical background. Now let me get at my main thesis.

THE GENERAL PROBLEM

I wish to make it clear that my subject today has nothing to do with modifying the specific or Latinized names originally established by the Linnaen system of binomial nomenclature. These names are fixed by an international court or committee or code which has a well established and orderly set of rules for changing or modifying such names when necessary. I am speaking today only about the three common or local English names for salmon.

Common names of countries, cities, people, places, birds, fish, etc., are usually established and maintained by popular usage. They are subject to change at any time by appeals to courts, by pressure groups, by popular vote and similar means. Most local groups are loathe to part with common names or terms (vernacularisms) which have become so much a part of their family or communal culture. It, therefore, takes a long time and much education of the younger set to achieve permanent adoption of such changes as we propose here today. The American Ornithologists Union has revised their list of common names for our 1,500 species of American birds five times since their first list was published in 1886. We fisheries people have revised our list of common names for our 500 species of American fish only once since our first list was published in 1948; so you can see we are just "cutting our eyeteeth" in this field. Although I enjoy euphonic or melodic names, I much prefer those that have some meaning or relativity to the animal or plant or place so named. That is why I am so deeply concerned about the common names of salmon.

To begin with I believe that the name salmon should now be shifted exclusively to the genus Oncorhynchus. Since about 1890 this group of fishes has become known universally as salmon probably because tinned or canned salmon at about 10¢ per can was once an ubiquitous and staple food on tables of all classes of people all over the world, especially between 1900 and 1930 or 1940. It would appear to me that this should be our true salmon of modern times because world-wide popular usage has made it so. Limiting the term salmon to the genus Oncorhynchus would avoid much of the confusion that exists in the minds of millions of people as to what is a salmon and what is a trout. These Pacific salmon all have at least three characteristics in common that are not found in any other genera of the Family Salmonidae: 1) all adult males develop a snout instead of a kipe; 2) an anal fin that is longer than deep (i.e. 13 plus fin rays); and 3) no Pacific salmon ever saw either its parents or its progeny (i.e. adults die after spawning once).

I believe the name trout should be confined exclusively to the genus Salmo and the ancient and often missused name of "Salmon Trout" should be applied only to Salmo salar. This of course will bring a violent reaction from a few thousand anglers in Maine or Labrador and from all of the members of the Salmon and Trout Association in London of which I am a dues paying member, but it is in line with such drastic modern trends of changing times as Friday is no longer Fish Day, etc. Major characteristics of the Pacific trout of Vladikov's recent subgenus Para-salmo compared to Salmo are:

> Para-salmo trout are spring spawners; endemic to Pacific drainage; have no red spots, and have poorly developed kipes; whereas Salmo trout are fall spawners; endemic to Atlantic drainage; have red spots and well developed kipes in spawning males. Both groups have black spots and teeth in roof of mouth which are lacking in the charrs.

Some of the general characteristics of the genus Salvelinus (charrs) which are not found in the foregoing genera of salmonids are: 1) no black spots, 2) no teeth in roof of mouth, 3) lower fins bordered anteriorly with white, yellow, or black, and 4) scales almost invisible. Charrs share a few characteristics with the genus Salmo (but not with Para-salmo) inasmuch as they are usually fall spawners and often have red spots on their sides.

After I retire in a year or so I hope to provide further evidence that our American charrs fall rather readily into two groups: brook charrs and lake charrs as I have already indicated in three papers published so far in 1943, 1955 and in 1965.

Although the English term "charr" was commonly used by all of our basic American fishery writers such as Goode, Jordan, and Evermann in their early descriptive literature, the name never "caught on" with American fishermen except in Arctic America, Western Canada, and at Lake Pend Oreille in Idaho. Principal reason probably stems from the much more common English usage of char (when spelled with a single r) to denote any organic compound that has been heated to the point where it has turned black or become "charred"; or the general concept of a person who scrubs floors. Neither of these meanings can be even remotely connected to the name of this fish. When this term is spelled with two r's it has only one connotation, i.e., a fish belonging to the genus Salvelinus. If you keep your eyes open as you travel about the country you will frequently note signs of char (1 r)--broilers over eating places meaning the meats are broiled over briquets or charcoal. If you ever see one charr (double r) broiler as I did in Sweden last fall, it means just that--they specialize in broiled charr, listed as "Rodigen Rollard" on the menu.

Our last list of common names published in 1960 uses Arctic char (and misspells it with a single r, as your editor did who prepared the program you have in your hand) so we have a precedent for extending its use to other species as the public becomes educated and willing to call a salmon a salmon, a trout a trout, and a charr a charr. My immediate protest to the committee will not be too strong to eliminate the euphonious albeit ridiculous names of sockeye, chinook salmon, or Dolly Varden trout for the more universal and meaningful names of red salmon, king salmon or western brook charr. This will probably take another hundred years and a new generation to accomplish.

My only real gripe with the Committee on Common Names at the moment is their stubborn refusal, without reason or supporting research, to at least permit me a choice as to whether I wish to misspell charr or not. I defy the committee, or anyone in this audience, to give me one good reason for spelling this word with one r when using it to denote a fish of this genus of American salmonids. If there are any good reasons for so doing then let me take this list of reasons for spelling it either way before any impartial editorial review board and if I lose my case I'll drop my crusade. I am in deep sympathy with the general policy of all fishery agencies to adopt and perpetuate the terminology and spelling of the monumental work our committee on common names for fishes has done. But when they force me by this policy to knowingly misspell one of these terms, this is autocratic, undemocratic, and the very reason my Massachusetts ancestors once dunked the King's tea bags in Boston Harbor. I come from a long line of such rebels, gentlemen, and the spelling of "charr" versus "char" is today my cup of tea.

STATUS OF MICHIGAN'S SALMON PROGRAM

David P. Borgeson
Michigan Department of Conservation
Lansing, Michigan

Between 1940 and 1960 the sea lamprey invaded lakes Huron, Michigan, and Superior causing wide scale destruction of large predator species, particularly the lake trout.

In the near absence of predators, a new invader, the alewife, soon exploded into staggering abundance.

With discovery of a selective lamprey toxicant, the control of lampreys and the rehabilitation of the lake trout in the Great Lakes seems assured.

A great opportunity still remains, however, that of converting the prolific pelagic alewife into a high quality sport and commercial fish. The lake trout, being a deep-water bottom fish, is ill suited to the task. Since no good pelagic predators existed in the three upper lakes, we looked elsewhere, finally settling on the Pacific salmons for introduction.

Coho from Oregon eggs were successfully reared in Michigan hatcheries and released into three streams in the spring of 1966.

From a plant of 400,000 smolts in the Big Manistee River drainage roughly 1,500 jacks were caught by anglers this fall and to date 3,000 have returned to a weir placed at the release site. The fish averaged about three pounds each with extremes one and eight. It was established that they did eat alewife. About 1% were females, 15 of which were spawned with the eggs and early development appearing normal.

Coho also returned in encouraging numbers in the other two release streams.

Plans call for two more years of coho plants from western eggs, (Oregon, Washington and Alaska) plus the introduction of King salmon in 1967 from Washington eggs.

Long range plans for hatchery expansion to produce 30,000,000 smolts for Michigan waters of the upper Great Lakes are underway.

THE FIRE LAKE HATCHERY

Joe Wallis
Alaska Department of Fish and Game
Anchorage, Alaska

The Fire Lake Hatchery is the major station of the Sport Fish Division of the Alaska Department of Fish and Game. It is located 17 miles from Anchorage, and is near to transportation center to facilitate easy transport of fish and eggs into and away from the station. At one stage or another, virtually all the fish used in the sport fish management program are handled at the station. Fish or eggs are either planted directly from the hatchery, or transferred by truck or plane to locations throughout the state.

Our program consists of hatching and rearing trout, salmon, and grayling, and fish are planted as fry or fingerlings during their first summer into selected waters. Most of the effort is directed toward planting lakes principally near the road system and with emphasis on rehabilitated lakes. We have no program of rearing catchable trout, and with an abundance of lakes available, it is doubtful if we will ever need such a program. We work to some extent with anadromous runs in selected areas. This phase of our operations is still largely experimental, but is increasing in importance.

The current program involves from about three million to five million eggs and fry of all species. We now work with rainbow, lake, and Dolly Varden trout, silver and king salmon, and grayling.

Facilities consist of: Heath incubators for trout and salmon; glass jars for incubation of grayling; aluminum troughs indoors in which all fish are started on feed; 25-foot diameter wood stave outdoor rearing ponds; and automatic feeders which dispense dry feed to all troughs and ponds. Fish are reared in the outdoor ponds only during the summer.

Water is obtained from Upper Fire Lake through an intake which can be manipulated to obtain water from various depths in the lake. The intake pipe is affixed to a tower in the lake, and the depth is manipulated by use of a cable and winch. It permits use of water about 38 to 40 F from the depths during winter, thus eliminating problems with lines and intake screens freezing in subzero temperatures. It also permits us to select the most suitable water temperature from the lake during summer months.

We have a problem with the water supply in a build-up of gasses in the pipe line during summer months. This is due to release of dissolved gasses in the water as pressure is lessened when water in the pipe approaches the lake surface. It is necessary to "bleed" the gas from the line frequently during the summer. Gas-bubble disease was a problem in the past, and was probably associated with supersaturated nitrogen levels in incoming water. This was solved by installation of baffle aerators at the inlets.

Prolonged periods of water temperatures of 38 to 40 F result in very slow development and a poor start in feeding fish. In an attempt to alleviate the problem, we conducted experiments utilizing Roger Burrows' recirculation principle last spring. Four troughs in the hatchery were supplied with water directly from the lake as a control, and four troughs equipped with filters and a recirculating system served as the test facility. In the test apparatus, water drained from the troughs into a wooden settling sump beneath the troughs, then down through a rock and oyster shell filter into another sump from which it was pumped back to the head of the troughs. Make-up water was added directly to the troughs from the main supply line at a rate to provide a complete interchange each 12 hours. Space heat in the building was the only heat source, and was adequate for the purpose of this experiment. Water in the system was warmed approximately 10 F, from 40° in the incoming water to 50° in the recirculating system. Water temperature could be controlled easily by adjusting the quantity of new water added.

Two experiments were conducted to determine if use of the system was feasible, and to observe the effect of warmer water on growth. Both tests were conducted using silver salmon fry as test animals. In the first experiment, fish in the control lots grew from 2100/pound to 1850/pound in a 1-month period, while those in the experimental lots averaged 1750/pound at termination. In the second experiment, the control fish grew from 2100/ pound to 1850/pound during a 6-week period, and the experimental lots averaged 1450/pound at termination.

In both experiments, fish in the recirculated water grew more as a result of higher temperatures. However, growth of all lots was poor; I feel this was a result of an inadequate diet.

Overall results of the experiments indicated that recirculation of rearing water is a feasible method of warming water during the period we need warmer water. In a current expansion proposal for increasing the capacity and capabilities of the hatchery, we have included plans to recirculate the water used for early indoor rearing.

"FOLLOW THE FISH"
A SELF-GUIDED TOUR OF BONNEVILLE HATCHERY

Morrie Naggiar
Oregon Fish Commission

The Oregon Fish Commission's Bonneville Salmon Hatchery is located just off Interstate Highway 80 N, the Columbia River Highway, some 40 miles east of Portland. Because of its proximity to Bonneville Dam, its location in a popular recreational area, and its easy accessibility from a major population center, the hatchery hosts many thousands of visitors each year. It has been estimated that from 250,000 to 500,000 visitors a year view the Bonneville grounds. Most of these people come in private vehicles although the station is a regular stop on the Gray Line scenic tour of the Columbia Gorge and school groups frequently make the hatchery the focal point of an educational trip.

For a visitor who has little or no knowledge of fish cultural activities, an unguided tour of most fish hatcheries has little to offer. Rows of troughs in a building, and most often during his tour the troughs are empty; a battery of cement ponds, sometimes dry, sometimes with hordes of tiny fish which he cannot see well enough to guess at their identity; and miscellaneous buildings and structures stuck around here and there. But they come to the hatcheries anyway because, for better or worse, fish culture is the epitome of conservation activities to most people.

So here we have a "captive" audience, wanting to be informed and entertained. But how to do this without tying up hatcherymen who already have their hands full with the routine duties of a production hatchery. Some early attempts were made in this direction. At the close of the Oregon Centennial Exposition in Portland in 1959, some of the material used by the Commission in its display was moved to Bonneville as the basis for an exhibit. A former storage balcony in the main hatchery building was utilized for this purpose. It was a start in the right direction but was not thorough in its coverage nor completely satisfactory in appearance.

During the spring of 1966 a project to expand and update the Bonneville display was launched. Some of the basic requirements of the display were: it would provide answers to most of the questions commonly asked about hatchery operations; it would expose the public to general information about other activities of the Fish Commission; and it would make minimum demands on the time of hatchery personnel for maintenance.

Initial plans were drawn up for a self-guided tour of the hatchery grounds, patterned after the nature walk idea so popular in some of our state and national parks. The theme "Follow the Fish" seemed appropriate for the purpose. With the basic plan in mind we were able to hire an artist who had had conservation agency experience. By late June 1966 we were able to officially open the self-guided tour at Bonneville Hatchery. Its acceptance has been enthusiastic.

With the thought that at least some of the techniques used in this display will be of interest and use to others faced with the problem of getting public relations mileage out of their captive audiences, let's "follow the fish" on a short slide tour of the Bonneville display.

° 1
° 2 (Numbers in margin refer to slides. These are available on loan from the I&E Section, Oregon Fish Commission, Portland)
° 3
° 4
° 5
° 6

Before we began development of the self-guided tour, there were no signs clearly marking the hatchery grounds. Similar buildings in the general vicinity are associated with the Corps of Engineers' Bonneville dam operations. Because of possible confusion, and to properly identify the Fish Commission as operating the hatchery, appropriate signs were erected at both sides of the hatchery on the access road. These were made at the state prison in Salem.

° 7 Station #1 - Location Sign

This is a 4' x 8' map of the hatchery grounds. The self-guided tour route is designated with a dotted line and main display areas are designated by number. On one side of the board there is a brief explanation of hatchery operations and what the visitor will see at different times of the year.

A smaller sign attached to the edge of the roof which covers the sign indicates this as the start of the self-guided tour.

Station #2 - Rearing Ponds

° 8 Location of this sign is such that visitors face away from the ponds when reading the descriptive material. This is a matter of safety and convenience in locating the sign where it would not block the access road. A variety of colors was used on the outdoor interpretive signs.

° 9 Another view of Station #2 from across the rearing ponds. This shows the general appearance of these outdoor signs. They are glass fronted, have an upswept roof, and are mounted on two legs set in cement.

° 10 Close-up of the explanatory material on the rearing ponds, how many fish of what species are reared and for how long, a drawing of coho and chinook fingerling, and related facts.

° 11 These are some of the fish signs painted on the blacktop. They guide the visitor from one station to another on this self-guided tour.

° 12 Closed

° 13 Station #3 - Balcony Display

° 14 Arrow pointing to balcony display

° 15 Aquarium at foot of stairs

° 16 Foodfish cut out with captions
° 17 Photo display - "Your Fish Commission in Action"
° 18 Roto-sho - "Salmon For the Future" 33 slides with narrative 7 minutes
Sawyer Roto-Matic projector, Cousino sound repeater
Total cost $543
° 19 Oregon shellfish display
° 20 Central panel - salmon life cycle and cut outs of 5 species
° 21 Commercial fishing gear
° 22 Photo display - "Fishing for Sport and Market"
° 23 & 24 On the ledge - outline drawings, white on light blue, various types of commercial boats, sport boat, sport lures, flashing buoy light, crab pot w/preserved crabs
° 25 hatchery troughs from the balcony
troughs painted rust brown on outside, white inside. Good appearance.
° 26 panels over entrance
° 27 & 28 details of three subjects The Columbia River, Bonneville Hatchery, The Salmon Cycle.
° 29 & 30 Over stairs - Dams on the Columbia River system, FC installations

Station #4

° 31 Sturgeon pond - large sign visible from the parking lot
° 32 interpretive display

Station #5

° 33 Experimental ponds - old dirt ponds used only occasionally
° 34 close up - tagging and marking fish

° 35 Lewis and Clark Monument

Station #6

° 36 Back view of sign
° 37 Front view - gray and pink
° 38 Close up of pellet sign

Station #7 - Adult holding pond

° 39 Close up of sign, outline of ponds with legend to identify parts
° 40 Distant view with sign board in foreground

Trout pond - display pond. Big rainbows - Donaldson's

° 41 Feeder in foreground
° 42 Close up of pellet machines

° 43 Sign - Leaving Bonneville

Cost -	materials and equipment	$2,143.75
	artist @ $550 month x 3	1,650.00
	Total	$3,793.00

Assistance of others - I&E, fish culture, engineering not included. Considered part of regular duties with Commission.

MARKING JUVENILE SALMON BY IMMERSION IN DMSO-TETRACYCLINE SOLUTIONS

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ABSTRACT

The combination of tetracycline as a marking agent and dimethyl sulfoxide (DMSO) as an adjuvant for absorption provides a means of marking juvenile Pacific salmon by an immersion method. Four tetracyclines were initially investigated: demethylchlortetracycline (DCTC); oxytetracycline (OTC); chlortetracycline; and pyrrolidino-methyltetracycline (PMTC). Two of these were studied in detail: demethylchlortetracycline (DCTC) because of its good marking qualities and favorable absorption rate; oxytetracycline (OTC) because of its low cost and pending clearance by F.D.A. as a fish marking agent. Both DCTC and OTC were found to provide a detectable though variable quality mark in the vertebrae of sockeye, chinook and silver salmon larger than a count weight of 100 per pound; immersion time and concentration necessary in OTC was more than twice that in DCTC at the same DMSO proportions. Smaller fish tolerated DMSO-OTC solutions better than DMSO-DCTC solutions and only pink and chum were found to have consistent good quality marks. No differential growth between marked and unmarked pink salmon or silver salmon was noted.

THE INTERNATIONAL IDENTIFICATION SYSTEM

R. Keith Farrell & Lynn D. Winward
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Pullman, Washington

Compare the problem of a cattle rancher trying to improve his herd and control disease with a hatchery superintendent planting his fish. Assume this cattleman's animals are planted in a thousand acre field, must pass through a feed lot in Dodge City, and end up in a Chicago packing plant.

First, the cattleman wouldn't believe that such a large pasture as the Pacific Ocean was possible; and, further, he would be horrified at the mixing of his stock with such multitudes of other animals. With no fences, rustlers thousands of miles away could steal his stock. With no one to tell him when his animals were dying, he would be at a loss to take preventive action for the future generations of stock. What chance would he have to start the best of production testing programs if he could only mark a fraction of his herd. The poor fish culturist must start his operation with his barn so crowded that disease outbreaks are a constant nightmare, and end up with a large part of his success or failure being evaluated after the marketing is done, by people he doesn't know, in a thousand different places.

The easy identification of animals remains a problem to all people engaged in research and industry. This is as true for the fisheries industry as any other animal industry.

The cattleman has used neck chain numbers, ear tags, tattoos, and a hot branding iron to help solve his problem. He would be shocked at the lack of a neck for a chain and an ear for a tattoo. He might even be tempted to try a little leg clipping except that legs are so few in number.

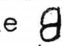
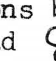
The cattleman felt he had his ownership problems solved 2,000 years B.C. when he started to use fire branding. For 4,000 years he has used this system--dreaming up new pyroglyphics for each new ownership brand. At the present time this system has developed into a limiting bottleneck, brought about by the lack of individual marks to handle the problems of interstate shipment.

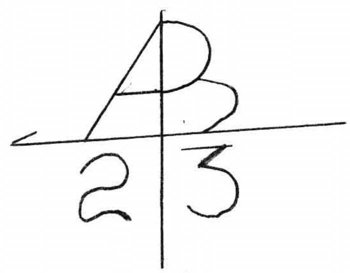
The use of tags and tattoos has been of great help to the cattle industry but has not met all the problems of permanence, legibility, and uniformity of registration.

The National Cattlemans Association has suggested that an ideal identification mark for cattle should be permanent, very legible, cheap, and produce little damage to the animal. I think this is what the fish culturist is looking forward to as well. I would like to add one other characteristic to a fish marking system. It should be completely automatic and capable of marking fish at speeds of a machine gun. Let's think big and say that some day we will be able to mark every fish from every hatchery in the world, with a different hatchery ownership mark. Let's think even bigger and say that we may be able to have a mark for each group of fish (on a different management, or disease program) individualized. It isn't hard to envision a revolution in fisheries if we could accomplish such an end.

At the present time, the livestock industry is hoping to achieve such a revolution. Let's take a look at the progress in this area.

The international animal identification mark.

I am suggesting putting the old brand registry book on the shelf and starting new--unencumbered by the mistakes of 4,000 years. The system should be as simple as possible and yet allow for great numbers of different marks. The proposed new system uses the letters of the alphabet and the numbers 0 through 9. These letters and numbers have been designed so that each figure has a mirror image. (For example  is the mirror image of B). Then by designing a system around a horizontal and vertical line we can achieve a great number of variations by simply laying the  on his back or on his face  or on his head  . We can take his mirror image and do the same thing. If we now place these figures in the quadrants formed by our horizontal and vertical lines, we can vary each figure position in such a way as to make in excess of 6 billion individual marks. Such a mark would look like this:



The tattoo

The tattoo has been used with success on animals. The major disadvantages in higher animals have been that the small dots grow apart and dilute as the animal grows; and on black animals the tattoo does not show up very well. We have had success on dark animals by using green tattoo ink. We have also been pleased with the preliminary results obtained by utilizing the hydro-jet technique. This technique puts millions of tiny particles into the skin over a wide area. By using a stencil between the animal and the jet, we could produce an international mark. In higher animals, this technique has been proposed for such jobs as lip tattoos on race horses and the marking of white pigs. The marking of fish with the hydro-jet in our laboratory has been accomplished with India ink. The black ink on rainbow trout was not dramatic enough to suit us. The green tattoo ink was dramatic but particle size interfered with our jet injection device.

Melanocyte manipulation

The melanocyte is a one-celled gland that secretes color pigment. If we could control the melanocytes' activity in a predetermined pattern, our mark would be legible. The melanocyte has been stimulated by X-irradiation, freezing, and chemical techniques. It has been destroyed by X-irradiation and by freezing. Freeze branding of animals, at the present time, is of greatest interest to us. In domestic animals we can easily destroy the melanocytes of hair follicles and of the skin. We can also consistently destroy the hair follicle itself (produce a bare area of skin) with the same technique. Melanocyte stimulation (producing darker hair and skin) is not as easily accomplished.

Hair growing from the frozen hair follicle in which melanocytes have been either destroyed or stimulated, grows to greater length during the first hair growth cycle. Frozen follicles in which the melanocyte has been destroyed have continued to produce white hair for at least 17 months. (We expect this change to be permanent).

The skin itself has not responded in the same manner as the hair. Many animals with a white area of skin, depigmented by freezing, show a slow migration of color back into the depigmented areas. In some of these animals, the repigmentation does not return the skin to the original darkness of color. Repigmentation seems to be stimulated by sunshine. Some haired animals have not shown this marked pigment migration back into a depigmented area. The fish that we have freeze-branded in our laboratory responded in a manner similar to a hairless brand in other animals. These fish were on another experiment and were destroyed at the end of two months. At that time the brand was quite legible. Lynn Winward recently resumed a limited fish branding study on 100 rainbow trout in the Little Spokane hatchery at Spokane, Washington. This study was designed to compare melanocyte stimulation and melanocyte destruction. At the present time there has been no mortality and they report legible brands.

A study of the differences between melanocyte stimulation and destruction will be attempted as mortality occurs. The final outcome of melanocyte studies in fish remains to be seen.

We need to emphasize the need for greater support in the whole field of animal identification research. We must convince our leaders in the United Nations, the World Health Organization, and all international government agencies that this is the area that will produce the greatest rewards for all fields of endeavor in all animal industries, including game and fisheries. Adequate identification is necessary for the evaluation of our problems; and indeed, we must evaluate our problems to find the solutions.

TETRACYCLINE MARKING AND THERMAL BRAND STUDIES - A PROGRESS REPORT

Irv Jones
Fish Commission of Oregon
Clackamas, Oregon

The Food and Drug Administration has the joint application sent in by the Fish Commission of Oregon and the Bureau of Commercial Fisheries for clearance of oxytetracycline for marking bone tissue of salmon fingerlings. They have agreed that data on efficacy and safety is sufficient but have asked for supplemental applications from producers of the Oregon Pellet to register the producers to handle drug-containing feed.

At Oxbow Hatchery, near Bonneville Dam, we recovered 65 fin-marked adult 1963-brood coho salmon which had been fed tetracycline hydrochloride at four different sizes: 290, 100, 50, and 25 per pound. Doses were one gram drug per kilogram of fish at a temperature of 45 F. Examination of the centrum bones from the adults showed that 83% retained the first mark, 99% the second, 100% the third, and 97% the fourth mark.

Half of the fin-marked 1963-brood coho released from Oxbow Hatchery had left ventral clips and had been branded two seconds with the letters "FC" on the left side forward of the dorsal fin and above the lateral line. Thirty of the 65 returnees were left-ventral clipped and all of these showed visible brands.

Jack coho salmon returning to Siletz Hatchery this year showed good to excellent marks produced by therapeutic feeding of TM-50 (oxytetracycline) over 8 to 10 days when fish were fingerlings. Dosages were 0.4 and 0.5 grams active ingredient per kilogram of fish.

Feeding tests with TM-50 were conducted at Sandy Laboratory to test palatability of the product. Fingerling coho readily ate diets containing less than 3% TM-50. Above that level, palatability problems were apparent and tetracycline mark intensity was less at some of the higher attempted dosages.

A pelleted diet containing 1.2% TM-50 was fed to coho fingerlings 200 per pound at six water temperatures ranging from 45 F to 65 F. Total dosages were 0.3 gram drug, active ingredient, per kilogram of fish. Treatment periods were dependent on temperature and varied from 10 to 5 days. Mark quality on this test was fair to good and all fish were marked, indicating the feasibility of marking small fish even at low temperatures. Substantial savings in drug cost could be realized in applying marks at small fish sizes and reduced dosages.

APPLICATION OF RESEARCH DEVELOPMENTS AT THE SALMON-CULTURAL LABORATORY

Roger E. Burrows
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Salmon-Cultural Laboratory
Longview, Washington

Film was presented which demonstrated application of research in fish-cultural procedures to production operations. Included were pictures of electrical diversion weir, collection of scales and lengths from spawning fish for age analyses, and recovery of tetracycline-marked jacks.

The components of the vertical incubator and its operation were demonstrated. The rectangular-circulating rearing ponds converted from 8 x 80 raceways and in use at Abernathy were shown together with the technique of placing the turning vanes in the sockets. Flow patterns and food distribution by the ponds were demonstrated.

The models used in the development of both the rearing and incubating reuse systems were shown together with the prototype reconditioning system used to operate 3, 17 x 75, rectangular-circulating rearing ponds. The construction of the filters and the equipment required for operation including 40 hp, 1,800 gpm circulating pump, 3, 15 x 50 filters, a 10-foot diameter aeration tank supplying 15 feet of operating head, a chiller and heat exchanger capable of heating or cooling 180 gpm 5 F, and the action of a 1,000 cubic feet per minute air pump for agitation of surface oyster shell during backflushing of filters were demonstrated in the film.

WATER REUSE

Fred W. Bitle
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Leavenworth, Washington

The water program at the Leavenworth National Fish Hatchery is the use of Icicle Creek water, through approximately 6,600 feet of concrete pipe, to our screen and settling chamber. This Icicle Creek water is gravity fed and is used from April to mid-November.

For the balance of the year, which is our winter time, we use well water, temperature at 45 to 46 F. At the start of our pumping season the temperature is at a constant 46 F and water table at 13' below ground. As the season progresses the water temperature drops to 44 F and water table to 39'.

We have three wells, capacity of 800, 900, and 1,200 gallons per minute estimated. I believe we receive more water than the wells are rated, because in the hatchery we have 288 troughs and calculate 10 gallons per minute, thus would be 2,880 gallons.

The water is discharged from each one-half of the hatchery to a main drain near our first row of ponds. Stopping the water at this point by use of steel plate construction we are able, by the use of a 15 horsepower motor and short lift pump to push the water into the main water line under the ponds, thus using the same piping.

Icicle Creek water is immediately available by opening a valve in pump house No. 1 should we have a power failure, which is not uncommon in our area, but fortunately they are not of long duration.

With the 46 F water in small Foster/Lucas type ponds and the air temperature at -17° we find a little freezing at the immediate area of the screen.

Oxygen content of well water when first entering hatchery troughs is 12.5 ppm, upon entering first series of ponds is 9.2 ppm, and being pumped to second series of ponds is 8.1 ppm.

From briefly talking with pump engineers and our hatchery biologist it is not at all impossible to reuse this water again through our third bank of small Foster/Lucas ponds.

The following few slides show the installation of the second pump and the adaption of the manhole to give us a well of water and still allow with the manipulation of gates and valves a drain within the same manhole for use in cleaning the first row of ponds.

FISH CONSERVATION

Wendell Smith
Idaho Power Company
Boise, Idaho

A film and narration of the salmon and steelhead program required by Idaho Power Company and conducted by Idaho Department of Fish and Game.

ATTEMPTS TO CONTROL EARLY MATURATION OF COHO SALMON

Harold W. Lorz
Fish Commission of Oregon
Corvallis, Oregon

Introduction

In recent years salmon hatcheries along the Pacific Coast and especially those of the lower Columbia River have been plagued with large numbers of early maturing (jack) coho salmon. Jacks are for practical purposes useless and wasted as well as causing extra work in landing and disposal. It is unfortunate that these fish, having passed through the most critical period of their life, should return at too small a size to be of optimum economic value. If method(s) could be developed for converting a substantial number of these early maturing males into 3-year-old adults, without lowering the existing survival rates of adults, many additional fish would be available for the commercial and sport fisheries.

Preliminary information indicates that a relationship exists between the size of fish at time of release and the percentage of jacks returning. At the same time it appears that survival of adults is increased by rearing yearlings to a larger size.

Methods

In the present study, retardation of early maturation was attempted by the use of X-irradiation, incorporation of a synthetic estrogen in the diet and two feeding levels to rear fish to two distinct sizes.

Previous investigations on the effects of X-irradiation on testicular tissue have shown that spermatogonia are most sensitive to X-rays which cause inhibition of mitotic division with a subsequent gradual disappearance of germ cells and final reduction in production of spermatozoa. It was hoped that whole body X-irradiation of pre-smolts would impede development of the gonad and thus reduce the number of early maturing males.

Big Creek Hatchery, 20 miles east of Astoria, was chosen as the site for the majority of the work. Coho of the 1963 brood were used for the X-irradiation and synthetic estrogen portion of the study and the 1964 brood was utilized for the two feeding levels part of the experiment.

The experiment was so designed that all irradiated fish and their controls, as well as a portion of the hormone fed fish and their controls, would be reared to maturity in both fresh- and salt-water ponds. The majority of fish fed hormones and their controls were allowed to migrate to the ocean with subsequent study of returning jacks and adults.

Irradiation of the coho yearlings was carried out during February and March 1965, prior to smoltification, at the Radiation Biology Laboratory, Oregon State University. Following a palatability study, it was decided that 200 mg of diethylstilbestrol (per gram of diet) would be incorporated into the diet and fed to the fish in one hatchery pond until the time of their release. Fingerling coho received the hormone-supplemented diet from

November 6, 1964 to April 13, 1965 (time of release), except for five days, when the fish were fed oxytetracycline pellets.

Results

1963-brood coho

A total of 16,690 jack coho were checked (September-December 1965) at the Big Creek weir located three miles upstream from the confluence of Big Creek and Columbia River. Of this total, 1,372 were marked fish that had been released as smolts in April 1965. Of the marked fish, a return of 1,117 control diet (2.6% of smolts released) to 255 hormone diet (0.56% of the smolts) was recorded. These data are shown in Table 1. These numbers are minimal values as fish taken by sport fishermen and any spawning below the weir are not included.

This fall (1966) adults of the 1963 brood returned to Big Creek Hatchery. These data are also shown in Table 1. All adults entering Big Creek were not able to migrate upstream, and a number were forced to spawn below the weir, as the trap had to be closed during the peak migration to allow safe removal and handling of the fish already trapped.

Table 1. 1963-brood coho--jack and adult returns at Big Creek, 1965-66.

	200 mg Diethylstilbestrol	Control
Number smolts released	44,969	42,250
Mean fork length of smolts	135 mm	144 mm
Number of jacks	255	1,117
Per cent return as jacks	0.56	2.6
Mean fork length of jacks	40.2 cm	43.2 cm
Number of adults (to December 5, 1966)	105 M: 107 F (212)	244 M: 271 F (515)
Per cent return as adults	0.47	1.22
Per cent total return	1.04	3.86

Early Maturation of Coho Salmon Held in Fresh- and Salt-water Ponds

The coho salmon being held at Bowmans Bay, Washington (salt water) and at Big Creek (fresh water) were individually inspected in November 1965 for signs of sexual maturity. All fish from which sexual products could be expressed were killed and preserved. A total of 193 early maturing males were obtained from salt water and 390 from fresh water. No early maturing females were noted. The number and per cent of precociously maturing fish from the two environments is shown in Table 2, according to their respective treatments. In all cases, more fish matured in fresh water than in salt water. This increased maturation may have been due to the difference in growth of the fresh-water fish during their second year of life, as they were considerably larger and more uniform in size than their salt-water reared counterparts.

Table 2. Number and per cent early maturation of 1963-brood coho males reared in fresh- and salt-water ponds.

Treatment	Salt water			Fresh water		
	No. mature	No. in group	% of group	No. mature	No. in group	% of group
200 r	18	675	2.7	55	798	6.9
400 r	26	663	3.9	55	765	7.2
600 r	26	665	3.9	35	766	4.6
800 r	22	650	3.4	60	723	8.3
Control	27	560	4.8	37	700	5.3
200 mg diethylstilbestrol	16	843	1.9	38	914	4.2
Control	29	923	3.1	78	966	8.1
Extra large smolts	29	190	15.3	32	201	15.9

1964-brood coho

As mentioned previously, preliminary data indicated that there is a relationship between the size of fish at time of release and the per cent returning jacks. Table 3 presents some of the accumulated data on this brood year. The two marked groups are also compared to general hatchery production. Of the large smolts released, 2.6% returned as precocious males, which is identical to the return of the 1963-brood coho controls. A total of 11,661 jacks had been recorded to December 5, 1966 at the weir but this number is minimal as many were withheld from the trap during peak migration.

Table 3. Per cent return of 1964-brood coho jacks, Big Creek, 1966.

	High food ration	General hatchery production	Low food ration
Number released March 16, 1966	59,984	1.7 million	83,649
Mark	Anal & RV	Unmarked	Anal & LV
Mean fork length of smolts	155 mm	129 mm	114 mm
Number of jacks to Dec. 5, 1966	1,590	9,921	150
Per cent jack return	2.65	0.58	0.18

A. Kenneth Johnson

USE OF DOMESTIC RAINBOW, STEELHEAD, AND GOLDEN TROUT IN HEPATOMA STUDIES

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The domesticated rainbow trout, Salmo gairdnerii, has been compared with the migratory, steelhead rainbow and with the golden trout for their relative sensitivity to the toxic effect and to the hepatomagenicity of aflatoxin.

It has been found that continuous feeding of eight ppb aflatoxin B_1 to each of these three species for 15 months results in a much higher incidence of hepatoma in the domestic rainbow, a lower incidence in the golden trout and the lowest incidence in the steelhead. The reverse is true with respect to the toxic effect.

Table 1. Relative sensitivity of trout to aflatoxicosis and hepatomagenicity of aflatoxin.

Species	Incidence of hepatoma 15 months on diet containing 8 ppb B_1 1/ (per cent)	Relative degree of aflatoxicosis 2/
Domesticated rainbow	85	C
Golden trout	18	B
Steelhead rainbow	6	A

1/ These figures refer to the percentages of fish with nodes, and not to the numbers or sizes of nodes which are also quite dissimilar in the three species.
2/ The relative degrees of toxic liver damage have been obtained from feeding trials and from tests involving aquarium trout.

The supporting data for these conclusions will be presented as part of a more comprehensive report.

AFLATOXICOSIS IN COHO SALMON AND CHANNEL CATFISH

Charlie E. Smith
Bureau of Sport Fisheries and Wildlife
Western Fish Nutrition Laboratory
Cook, Washington

Mortality and liver histopathology was produced in coho salmon and channel catfish when force fed aflatoxin B_1 in the amounts shown in Table 1.

Table 1

Catfish mortality			Coho mortality		
15 mg/kg bw 1X	8/10	Day 10	15 mg/kg bw 1X	0/10	Day 28
10 mg/kg bw 1X	3/10	Day 10	10 mg/kg bw 1X	0/10	Day 28
5 mg/kg bw 1X	2/10	Day 10	3 mg/kg bw 5X	8/10	Day 21
3 mg/kg bw 5X	4/10	Day 10	1 mg/kg bw 10X	10/10	Day 21
1 mg/kg bw 5X	2/10	Day 10	Controls 10X	0/10	Day 28

Liver histopathology generally varied from cellular vacuolation with scattered karyolysis, karyorrhexis and pyknosis of liver cell nuclei to severe massive necrosis of up to 90% of the cells in a liver section.

Regeneration and repair were both noted in H & E stained sections of salmon liver. Neither process was apparent in catfish liver sections.

Salmon tolerated large single doses of 15 mg/kg body weight. Liver cell damage was moderate and no mortality occurred by Day 28. However, when five daily doses of 3 mg/kg body weight were administered, both severe liver cell damage and a mortality of 8/10 had occurred by Day 21. Conversely, when catfish were fed a single dose of 15 mg/kg body weight and five daily doses of 3 mg/kg body weight, mortalities of 8/10 and 4/10, respectively, had occurred by Day 10 along with corresponding severe liver cell damage.

Mild histopathological changes were observed in several other organs from both salmon and catfish.

DEVELOPMENT OF THE OREGON STARTER MASH

Dwain Mills
Fish Commission of Oregon
Clackamas, Oregon

It is very difficult to make the Oregon Pellet in a particle size suitable for use as a starter diet. Similar ingredients fed as a mash might be more practical as a starting ration.

We tested various mash diets derived from the Oregon Pellet formula during two starter diet experiments conducted with fall chinook in January and March 1966.

In the first experiment, different wet fish levels were tested to determine the amount required to produce satisfactory growth. Corn Gluten meal and gum guar were used in the mash diets instead of cottonseed mash and kelp meal, because they seemed to produce fewer lumps. The results of this experiment (Table 1) indicated that the Oregon Pellet formula could be fed in mash form and that no more than half of the wet fish should be deleted from the diet.

Table 1. Results, 1966 Clackamas starter diet experiment No. 1 1/ January 26 to February 16, 1966.

Diet	Per cent wet 2/ fish in diet	Ave. fish weight gain (%)	Food conversion (dry weight)
Oregon Pellet (control) 3/	40	48	3.0
Mash	40	52	3.0
"	32	51	3.0
"	23	53	2.8
"	13	39	3.8
"	0	1	-

1/ Mortality rates were all less than 2% and not significantly different.
2/ Fresh frozen.
3/ 1/32-inch diameter.

In the second experiment the most practical mash diet from the first experiment (23% wet fish) was tested with the following modifications: higher fat levels, soybean oil in place of corn oil and the addition of 10% skim milk.

The results (Table 2) indicated that the mash diet containing corn oil (15% total dry weight fat level) and 10% skim milk was the most successful ration and it produced significantly better weight gain and a better food conversion than the Oregon Pellet control. Its composition is summarized in Table 3 and compared with the Oregon Pellet formulation.

Table 2. Results, 1966 Clackamas starter diet experiment No. 2
March 16 to April 18, 1966. 1/

Diet	Fat level 2/ (% dry weight)	Ave. fish weight gain (%)	Food conversion (dry weight)
Oregon Pellet	10	117	1.8
Mash/w corn oil	10	103	2.0
	15	94	2.2
	20	90	2.3
Mash/w corn oil and 10% skim milk	10	124	1.8
	15	131	1.7
	20	120	1.8
Mash/w soybean oil	10	93	2.3
	15	96	2.2
	20	93	2.2

1/ Mortality rates were all less than 2% and not significantly different from the control.
2/ Calculated.

Table 3. Composition (%) of Oregon starter mash and Oregon Pellet.

Ingredient	Oregon starter mash	Oregon Pellet
Cottonseed meal	-	22.00 1/
Corn gluten meal	10.00	-
Dried skim milk	10.00	-
Herring meal	33.00	22.00
Crab or shrimp meal	5.00	4.00
Wheat germ meal	3.50	3.00
Distiller's dried corn solubles	3.50	3.00
Kelp meal	-	2.00
Gum Guar	2.00	-
Vitamin mix	1.50	1.50
Corn oil	6.90	1.80
Choline chloride	0.50	0.65
Antioxidant (Tenox IV)	0.10	0.05
Tuna viscera	12.00	20.00
Turbot	12.00	20.00 2/

1/ Corn gluten meal has also been used successfully.
2/ Or, pasteurized salmon viscera, or dogfish.

This starter mash was submitted to further testing in production trials at the Commission's Marion Forks Hatchery during the spring of 1966. Mr. Howard Drago, superintendent at the Marion Forks Hatchery, will report the results of those experiments.

PRODUCTION FEEDING TRIALS WITH OREGON STARTER MASH

Howard V. Drago
Fish Commission of Oregon
Idanha, Oregon

Dwain Mills described the laboratory development of the Oregon Starter Mash, and now I will tell you about production trials with this new starter diet at Marion Forks Hatchery.

We conducted the first trial for 5 weeks, using spring chinook salmon. Each of four 25-foot circular ponds was stocked with approximately 105,000 unfed fry averaging 1,270 per pound. Oregon Starter Mash was fed to two ponds, while a liver-fish diet was fed to two other ponds as control.

The mash was prepared by Bioproducts of Warrenton, Oregon. Its formula was essentially the same as the most successful diet described by Dwain. The liver-fish diet was composed of equal parts beef liver, pork liver, and pasteurized salmon viscera.

The fish were fed all they would eat 8 to 10 times a day, seven days a week, from April 4 to May 9, 1966. Water temperatures during this time ranged from 38 to 44 F and averaged only 40 F.

Both diet groups started to eat very slowly, probably because of the cold water. However, it appeared that the fry fed the mash started to eat sooner than those with the liver-fish diet. The liver-fish control was well bound for this type of diet and floated very well. The mash floated for only a short period before slowly sinking.

Results at the end of the trial are shown on the first slide. These figures are averages for the two ponds fed each diet.

Table 1. Summary of results, Marion Forks spring chinook starter diet trial.

	Oregon Starter Mash	Liver-fish control
Fish size (No./lb.)	804	983
Lot weight gain (%)	53	29
Food conversion (as fed)	2.6	7.8
Mortality (%)	3.1	0.3

The fish fed Oregon Starter Mash averaged 804 per pound after five weeks, while those fed the liver-fish diet averaged only 983. This excellent growth produced by the mash was greater than any produced by starting diets tested during the last three years at Marion Forks. The 2.6 conversion of these production groups was almost as good as the biologists got under test-tube conditions at Clackamas.

Mortality associated with the mash, 3.1%, was considerably greater than the 0.3% in the control ponds. Mortality in the control was exceptionally low, and we do not consider 3.1% to be excessive during the first five weeks of feeding.

We found that the mortality in the mash ponds was related to an internal fungus. This fungus was found only in these two ponds this year, although it has been found in past years with other diets. Efforts to produce the fungus in control fish by feeding them the mash following the trial were not successful.

We concluded that the Oregon Starter Mash was a good diet for starting spring chinook fry in cold water.

Our second feeding trial was with steelhead trout. This time we compared the Oregon Starter Mash with Clark's Chinook Mash. In additon, we tried automating the Oregon mash.

Each of six hatchery troughs was stocked with 33,333 fry averaging 2,851 per pound initially. Four troughs were fed by hand, two with Clark's mash and two with Oregon mash. Two more troughs were fed Oregon mash by using four Allen Fish Food Dispensers. These automatic feeders were mounted between adjacent troughs and fed a trough from each side, as shown in this slide.

The feeding trial was conducted for 37 days, from July 11 to August 17, 1966. Water temperature during this period averaged 53 F. The hand-fed fish were fed at half-hour intervals, while the automatic feeders were operated every 10 minutes. Both groups were fed during a 12-hour feeding period each day.

Final results are summarized on the next slide. The figures are the average for two troughs of fish.

Table 2. Summary of results, Marion Forks steelhead starter diet trial.

	Oregon Starter Mash automated	Oregon Starter Mash hand fed	Clark's Mash hand fed
Fish size (no./lb.)	662	671	710
Lot weight gain (%)	204	203	173
Food conversion (as fed)	1.8	1.9	2.7
Mortality (%)	5.8	10.4	12.2
Hematocrit (%)	38.2	31.7	29.9

Steelhead fed the Oregon Starter Mash were larger at the end of the trial than those started on Clark's Chinook Mash. Actually, they were closer in size at the end of the trial than at any other time. For instance, on the 16th day of the trial, when half the fish in each trough were removed, the automated Oregon mash fed fish averaged 1,408 per pound, the hand-fed Oregon mash 1,396 per pound, and the Clark's averaged only 1,774 per pound.

Starting these steelhead on Clark's Chinook Mash resulted in large numbers of pinheads. These pinheads eventually died and the remaining fish were quite satisfactory in size. Few pinheads were observed in the troughs fed Oregon mash. However, an outbreak of *Trichodina* hit the Oregon mash fish very hard during the last couple of weeks. This epidemic noticeably retarded their growth and brought the mortality up near that of Clark's. Most of this mortality was in only one of the two troughs, however. The Clark's fish did not seem to be greatly affected by *Trichodina*.

Automating Oregon mash did not appreciably improve growth. We took good care of the hand-fed fish and it would be difficult for a machine to improve on this even though it could feed more often.

We concluded that the Oregon Starter Mash was a satisfactory diet for steelhead.

IDAHO PRODUCTION DIET TESTS, 1966

Paul Cuplin
Idaho Fish and Game Department
Boise, Idaho

Diets tested

Diet testing during the year included substitution of ingredients for herring meal and dried skim milk; addition of paprika, xanthophyll and canthaxanthin to the diet as possible flesh coloring agents; testing seven fry diets in a 60-day feeding test with cutthroat trout fry; a new feeding table was compared with the New York State Hatchery feeding charts.

Acknowledgment

All diets were formulated in cooperation with Dr. A. M. Dollar, University of Washington. Thanks go to Hatchery Superintendents B. D. Ainsworth, Sr., Harvey Albrethsen, E. O. Bailey, Leland Batchelder, Walter Bethke, Calvin Coziah, James Dayley, Norman Floyd, Frank Gaver, the late L. W. Gaver, Hark Misseldine, and their respective hatchery crews who carried on the experiments.

Test procedure

Fifteen thousand rainbow trout were used in most cases as the starting number of fish on each test. Fish were reduced in poundage when density exceeded one pound per cubic foot of water or .5 pound per cubic foot at Mackay Hatchery. All fish were started on the Number One fry feed (Table I). Feeding of the test diet began when fish were large enough to accept Number Two fry feed.

Vitamins

A standard vitamin concentrate (Table II) was added to all feeds at the rate of ten pounds of vitamin concentrate per one ton of finished feed.

Duration of tests

Feeding tests extended for 8 months in most cases. The length of each test is listed in Table V.

Diet cost

The Idaho Open Formula Diet is now being furnished to the Department at a cost of $8.74 per 100 pounds which includes 75 cents for the vitamin concentrate. Experimental diets are supplied at a rate of $10.85 per 100 pounds including vitamin concentrate. Cost analysis was not attempted.

Diets tested, rainbow trout

The diets that were compared in feeding tests appear in Table I. The poultry feathers and meat scrap meal listed in Diet A are an attempted substitution for herring meal. Diet B was tested to determine if a 10% level of herring meal would be adequate in the diet.

Fry diets tested with cutthroat trout are listed in Table III. This was a sixty-day test with 16,000 fish in two replicates for each diet.

Flesh color tests

Rainbow trout 8 to 10 inches in length were fed the Open Formula Diet containing 1% paprika for a two-month period. Xanthophyll from marigold petals was added at the rate of .25, .5 and 1 pound per 100 pounds of Open Formula Diet. One per cent canthaxanthin was added to the diet. Fish were fed for a two-month period with the exception of the canthaxanthin fish which have been fed for only one month at this writing.

Per cent of body weight

A new feed table (Table VIII) calculated by Dr. A. M. Dollar was compared with the New York State feeding chart.

Results

The results from the ingredient substitution tests are listed in Table V. The production diet gave better results than either of the test diets. The A and B diets could be used if herring meal could not be obtained, however, fin erosion was excessive on the A diet fish and each of the two diets required approximately one-half pound of fish feed more to produce a pound of fish than did the production diet.

Cutthroat trout feeding tests

Results of cutthroat diet tests are listed in Table VI. Mortalities were excessive this year. High mortalities can probably be attributed to the stock of wild cutthroat eggs more than the diets used. Mortalities were relatively low during two previous years of testing. The meat scrap-pea meal diet was the leader. The high mortalities in all groups casts some doubt on the results of this series of tests. Further testing is needed before any conclusion can be reached.

Trout flesh color tests

No color was noted in 8- to 10-inch rainbow trout fed for two months on a diet containing one per cent paprika, a diet containing .25 per cent xanthophyll and .5 per cent xanthophyll. A light yellow color was present in fish fed for two months on a diet which contained one per cent xanthophyll. Fish fed a diet containing one per cent canthaxanthin showed no flesh color at the end of one month.

Feeding level test

A new feeding level table was tested for comparison with the New York State Hatchery feeding table. The results appear in Table VII. The results are varied. The new feeding table is as much as three per cent less in the lower range temperature and small sizes of fish than the old table. Performance was poor in this area for the new table. Once the fish reached 90 per pound, the new table produced better results than the old table.

Table I

Idaho Production Diet Tests, 1966

Test Diets

Ingredient	No. I Fry Diet	Production Diet	66 A	66 B
Herring meal	69	31		10
Meat scrap meal		10	10	10
Blood meal	7	5	15	10
Soybean flour meal		10	15	26
Whey		8	5	5
Feather meal			8	
Skim milk			4	4
Oatmeal flour	4		8	
Wheat middlings		20	20	20
Durabond		1		
Lecithin	5			
Paprika				
Brewer's dried yeast	5	5	5	5
Kelp meal		3	3	3
Condensed fish solubles	1	1	1	1
2250A - 300D feeding oil	3	2	2	2
Herring oil	2			
Vitamin premix	0.5	0.5	0.5	0.5
Iodized salt	3.5	3.5	3.5	3.5

Table II

Idaho Vitamin Concentrate*

Vitamin E	not less than	6,000 IU
Riboflavin	not less than	9,000 milligrams
D-Calcium Pantothenate	not less than	5,000 milligrams
Niacin	not less than	10,000 milligrams
Ascorbic Acid	not less than	20,000 milligrams
Vitamin B_{12}	not less than	2 milligrams
D-Biotin	not less than	60 milligrams
Thiamine Hydrochloride	not less than	9,000 milligrams
Pyridoxine Hydrochloride	not less than	2,000 milligrams
Folic Acid (without zinc folate)	not less than	300 milligrams
Choline Chloride	not less than	25,000 milligrams

Plus carrier to give a total weight of one (1) pound.

* Added at the rate of 10 pounds per ton of feed.

Table III

Cutthroat Trout Diets

Ingredient	No. 1 fry	66 Ct A	66 Ct B	66 Ct C	66 Ct D	66 Ct E	66 Ct F	66 Ct G
Fish Meal (B. C. Herring)	69	67	42	42	50	67	62	-
Meat scrap meal	-	-	-	-	-	-	-	45
Blood meal	7	5	24	24	12	5	5	20
Greenfield pea meal	-	-	-	-	-	-	-	14
Brewer's yeast	5	5	5	5	5	-	-	2
Oat flour	4	8	8	-	4	8	8	4
Lecithin	5	-	-	-	-	-	-	5
A & D feeding oil	3	3	3	3	3	3	3	3
Herring oil	2	2	2	2	2	2	2	2
Salt	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Vitamin premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Fish solubles	1	6	12	12	10	6	6	1
Soybean flour meal	-	-	-	-	10	-	-	-
Dried Brewer's grains	-	-	-	8	-	-	-	-
Wheast	-	-	-	-	-	5	10	-
Minimum protein	58	57	57	57	57	57	57	-
Maximum fat	16	11	9	9	10	11	11	-

Table V

Results of Feeding Tests at Idaho Fish and Game Department Hatcheries, 1966

Station	Diet	Duration of test in months	Pounds of feed per pound of fish	Mortality percent	Hematocrit readings
American Falls	A	7	2.23	5.9	35.4
	C		1.77	2.39	34.0
	I*		1.87	2.96	
	NY*		1.96	7.3	40.6
Ashton	B	8	2.31	16.9	3.52
	I		2.00	14.7	36.0
	NY		1.99	12.3	36.1
Grace	B	8	2.17	.92	29.6
	I		1.64	.77	35.4
	NY		1.70	.64	36.2
Hagerman	B	1	3.95	.14	
	C		2.27	.14	
	D		1.23	.14	
Hayspur	A	4	1.84	.36	
	I		1.30	.26	
	NY		1.36	.13	
Mackay	A	8	1.98	.32	43
	B		1.90	.40	38
	I		1.50	.18	36
	NY		1.40	.31	38
Twin Falls	B		2.19	1.28	
	NY		1.86	1.29	

*I Idaho Production Diet with Idaho feed chart.
NY Idaho Production Diet using the New York State Hatchery feeding chart.

Table VI

Cutthroat Trout Feeding Tests
Warm River Fish Hatchery, 1966.

Diet	Pounds of feed per pound of fish	Mortality
Ct A	2.71	30.0
Ct B	2.60	30.4
Ct C	4.91	47.7
Ct D	3.74	46.0
Ct E	3.23	39.4
Ct F	2.50	28.6
Ct G	1.88	26.2
Number 1 fry diet	13.30	55.8

Table VII

Feeding Table Comparison

Station	Table	Number Months	Conversion	Mortality Percent	Hematocrit Readings
American Falls	I	7	1.87	3.0	
	NY	"	1.96	7.3	41
Ashton	I	8	2.00	14.7	36
	NY	"	1.99	12.3	36
Grace	I	8	1.64	.8	35
	NY	"	1.70	.6	36
Hayspur	I	4	1.30	.3	
	NY	"	1.36	.1	
Mackay	I	8	1.50	.2	38
	NY	"	1.40	.3	38

Table VIII

Provisional Food Allowance Table for Idaho Open Formula Diet

Water Temp. Deg. F.	Number Rainbow Trout Per Pound 2540	2540-1200	1200-480	480-200	200-90	90-35	35-20	20-12	12-7	7-5	5-3.5	3.5-2.5	2.5
40-44	3.4	3.0	2.8	2.6	2.4	1.8	1.4	1.4	1.0	1.0	1.0	1.0	1.0
45-50	3.6	3.4	3.2	2.9	2.6	2.4	2.0	1.6	1.4	1.2	1.0	1.0	1.0
51-57	4.6	4.4	4.0	3.8	3.4	3.0	2.5	1.8	1.6	1.4	1.0	1.0	1.0
58-62	5.2	5.0	4.8	4.8	4.4	4.0	3.0	2.4	1.8	1.4	1.2	1.0	1.0

Table calculated by Dr. A. M. Dollar

MARINE FISH FAT IN SALMON DIETS

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Feeding trials were conducted to test a purified Menhaden oil fraction as a source of essential fatty acids in chinook and silver salmon. The marine fat obtained from the Menhaden oil was found to contain about 79% docosahexaenoic acid.

Two groups of fry, one of chinook and one of silvers, were fed a diet containing no fat to deplete their fat reserves. At the end of 13 weeks on the fat free diet, both chinook and silver demonstrated pronounced fat deficiency symptoms such as blonding or depigmentation and poor growth. The fish were then set out in five replicate groups of 100 per trough. The diets fed to both chinook and silvers differed from the laboratory's complete test diet mainly in the fat content. Fat levels were as follows: fat free, 3% triolein, 0.1% marine fat with 2.9% oleic acid, 0.1% linoleic acid with 2.9% triolein and 1% linoleic acid with 2% triolein. The choice of fatty acids and the levels used was based on results of previous studies conducted at the laboratory and the supplies available. The fish were fed twice daily, six days a week. Water temperature was maintained at about 10 C. Visual color estimates were made periodically to measure influence of fat material on repigmentation. The feeding trial period with the various fat diets was terminated after six weeks due to the fact that the supply of marine fat was exhausted.

As evidenced by weight gain response in the silvers, the marine fat-oleic acid diet performed about as well as the linoleic-triolein diets and considerably better than the 3% triolein diet. The fat-free group demonstrated the least weight gain and suffered the highest mortality. There were no significant differences between the groups of silvers with regard to repigmentation or proximate analysis. The chinook on the marine fat-oleic diet showed the least weight gain of the chinook groups even less than the fat free group. The marine fat seemed to assist the repigmentation process in the chinook. From the results observed, it appears that chinook were unable to utilize the marine fat containing the docosahexaenoic acid and that it might have been slightly toxic to them. Silver salmon appear to be able to utilize the marine fat about as well as linoleic acid. Thus, there seems to be a species difference between chinook and silver salmon in fatty acid requirements.

IODINE METABOLISM IN ADULT CHINOOK SALMON

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In the spring of two successive years, migrating adult chinook salmon were intercepted upon their arrival at Bonneville Dam. The fish were held in covered cement raceways with running fresh water at a temperature of 6 ± 1 C. The water contained a natural concentration of 0.25 µg I^{127}/l. On four occasions (late April, early May, August, and September), randomly selected groups of fish received an intraperitoneal injection of carrier-free radioiodine I^{125}. Following injection, at pre-established intervals, four to six fish were sacrificed by a blow to the head. In rapid succession the fish were bled, the thyroid region and representative samples of muscle, liver, gonads, head kidney, and kidney removed. Serum samples were prepared for scintillation counting of the radioisotope as well as microchemical determinations of the stable I^{127}. The isolated thyroid region was homogenized and digested for 24 hours at 37 C with a proteolytic enzyme (Pancreatin). Aliquots of this hydrolyzate were used for I^{125} counting, microchemical determinations and chromatographic separation of the thyroid metabolites. Weighed samples of the remaining tissues were subjected directly to scintillation counting and microiodine determinations.

Between late April and mid-September, as fish attained sexual maturity, the iodine content of the thyroid region and serum dropped to a third of their original values. The thyroidal I^{127} decreased from 30.3 to 12.5 µg I/100 ml serum, and the organically bound iodine decreased from 20.1 to 7.0 µg I/100 ml serum. Maximum concentrations of total serum radioiodine appeared within 24 hours after injection in all groups of adults. The rate at which iodine was concentrated in the thyroid region decreased between late April and September with values (average of 2% injected dose at 336 hours) not attaining their maximum within the limited sampling period. Paper chromatography showed an increased incorporation of the radioiodine into the intrathyroidal iodo-amino acids in August and September even though the rate of thyroidal uptake had dropped. This phenomenon was attributed to an intensification of the metabolic processes associated with sexual maturation coupled with an attempt to maintain homeostasis in the presence of a decreasing I^{127} thyroid pool.

STARTING DIETS AND THE RESULTS OF THE 1966 FEEDING TRIALS

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1965 starting diets

During the fall of 1965, we initiated a series of experiments with the objective of developing a starting diet for fall chinook salmon. Our approach was to use our basic meal mix which consists of salmon carcass meal, dried skim milk, cottonseed meal, wheat germ meal and to add soybean oil and water in varying amounts so that the final product was essentially a dry mixture. These diets were fed by merely sprinkling them on the water surface.

The results indicated that the fish utilized high-calorie diets better than low-calorie diets and a high-protein-high-calorie diet was better utilized by fish in warm water than in cold water. Results at Eagle Creek National Fish Hatchery using the Abernathy starting diet produced larger fish than a starting diet of a mixture of Clarks and Oregon moist pellet.

1966 feeding trials

The 1966 feeding trials were designed with the following objectives: (a) to test the newly formulated Abernathy soft pellet against the ricer fed Abernathy diet; (b) to test the protein quality of the Abernathy pellet against the protein quality of the Oregon moist pellet; (c) to test the contribution of the B-complex vitamin package used in the Abernathy diet as well as the effect of the addition of other vitamins to this package; (d) and to test the contribution of a mineral mixture.

Results revealed (1) the pelleted diet to be more efficient than the ricer fed diet; (2) the protein quality of the Abernathy pellet was superior to that of the Oregon diet; (3) the B-complex vitamin package did not contribute to the diet; (4) and the feeding of vitamin C or a mineral mix tended to effect hematological values.

THE USE OF SULFONAMIDES AND ANTIBIOTICS ON TWO DISEASES OF ADULT SALMON [1/]

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Sulfonamides and antibiotics have been used in hatchery diets of juvenile salmon (Oncorhynchus sp.) and steelhead trout (Salmo gairdneri) to combat infectious fish diseases.

Addition of drugs to the diet of juvenile fish is economically feasible, but adult salmon or steelhead returning to the parent stream are non-feeding animals, so methods of administration other than voluntary feeding must be employed.

Before any untried drug is administered, its effectiveness in inhibiting bacterial growth should be determined, and the possibility of drug toxicity investigated.

A tube dilution sensitivity test (Frobisher, 1957) was conducted on 17 antibiotics and 2 sulfonamides (Table 1). In this test a known quantity of drug was metered into a known volume of broth media. The drug solutions were sterilized by membrane filtration through a 0.22 micron millipore filter. After the required amount of drug was added to each tube, a loopfull of the appropriate cells from a broth culture was added. Aeromonas salmonicida and Chondroccus columnaris were subjected to this test. Their respective media were Mueller-Hinton and Myxobacteria broth.

The tubes were incubated at 20 C for 144 hours, then observed for bacterial growth (turbidity). The drug concentration in the tube exhibiting no visible growth was considered the minimum effective drug level. The drugs most effective in vitro and most available commercially were selected for toxicity tests on adult and jack coho salmon (O. kisutch). These are listed in Table 2. All antibiotics were administered intramuscularly (I.M.). The injection site was midway between the lateral line and the insertion of the dorsal fin. A compressed air unit called the "hypospray" was tried without success. The sulfonamides were force fed.

The maximum antibiotic dosages administered were four times the therapeutic levels recommended by Merck and Co. (1960). The maximum applied quadrasulfa dosage was 80 times the therapeutic level while sulfamethazine was 1,000 times the recommended quantity.

In vitro drug effectiveness is shown in Table 1. Except for tetracycline-HCL, the tetracyclines, polymyxin-B, colistin, and chloromycetin were extremely effective in controlling the growth of A. salmonicida, while penicillin was the most effective in inhibiting the growth of C. columnaris.

1/ This work was supported by contract funds from the Bureau of Commercial Fisheries.

Of the 11 drugs tested for untoward reactions of adult coho (Table 2), only polymyxin-B produced adverse reactions. All fish given I.M. injections of polymyxin-B died within 24 hours.

Forced feeding appeared to be a feasible method for administering sulfas and no adverse reactions of mortalities were observed. However, the volume of a one-gram sulfa tablet produced physical stomach rupture in 1 1/2- to 2-pound coho.

Table 1. Minimum effective drug level (mcg/ml) on *Aeromonas salmonicida* and *Chondrococcus columnaris*. 1/

Drug	*A. salmonicida*	*C. columnaris*
Chloromycetin	< 1	> 200
Chlortetracycline	< 1	> 200
Colistin	< 1	145
Demethylchlortetracycline	< 1	> 110
Erythromycin	6	> 200
Humatin	40	10
Kanamycin	40	10
Neomycin	40	10
Nitrofurantoin	3	> 200
Nitrofurazone	3	> 200
Oxytetracycline	< 1	> 110
Penicillin	--	.006
Polymyxin-B	< 1	> 110
Pyrrolidinomethyltetracycline	< 1	> 110
Seromycin	25	> 200
Streptomycin	40	80
Tetracycline-HCL	< 12.5	>200
Quadrasulfa	>200	> 200
Sodium Sulfamethazine	>200	> 200
Saline	--	0.8(%)

1/ Determined by serial tube dilution sensitivity tests.

Table 2. Drug toxicity tests on adult coho salmon in 50 F water.

Drug	Route of adminis- tration	Maximum dosage used (mg/lb. fish)	Mortality after 96 hours (%)
Chloromycetin	I.M.	100	0
Chlortetracycline	I.M.	20	0
Colistin	I.M.	10	0
Demethylchlortetracycline	I.M.	20	0
Oxytetracycline	I.M.	20	0
Penicillin	I.M.	20	0
Polymyxin-B	I.M.	3.5	100 1/
Pyrrolidinomethyl- tetracycline	I.M.	10	0
Tetracycline-HCL	I.M.	20	0
Quadrasulfa	Oral	400	0
Sulfamethazine	Oral	5,000	0
0.85% Saline (control)	I.M.	2 ml	0

1/ 24 hours.

LITERATURE CITED

Frobisher, Martin. 1957. Fundamentals of Microbiology.

Merck, Inc. 1960. The Merck Index of Chemicals and Drugs.

MERCURIALS IN THE HATCHERY: SOME FACTORS INFLUENCING THE TOXICITY OF TIMSAN (ETHYL MERCURY PHOSPHATE) TO RAINBOW TROUT

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Dissolved oxygen, temperature, and hardness of water are the most critical variables influencing the toxicity of heavy metals to fish, especially zinc. These three variables were investigated to determine what influence they might have on the toxicity of Timsan to rainbow trout.

Production and albino rainbow trout from the Quilcene National Fish Hatchery were exposed to Timsan at 2 ppm for 1 hour using three different concentrations of oxygen, temperature, and water hardness. The three oxygen ranges tested were 10 ppm and above, 6-9 ppm, and 4-6 ppm. The oxygen concentration was manipulated by using bottled pure oxygen, compressed air, and bottled nitrogen. The nitrogen was used to "blow off" the excess oxygen in the test water to obtain the lower 4-6 ppm oxygen range. Dechlorinated city water was used at 68 F, 60 F, and 55 F for the three temperature ranges. The three water hardness levels tested were 20, 60, and 86 ppm expressed as calcium carbonate. The hardness was varied by adding calcium chloride and magnesium sulfate to the city water. The biomass in each test lot never exceeded 11 g. of fish per liter of water.

Toxicity increased directly with the water temperature and hardness, but inversely with the oxygen concentration. High water temperature and hardness with a low oxygen level resulted in the loss of 81% of the production trout, but not a single fish died with low water temperature and hardness and a high oxygen level. Of the three variables tested, the oxygen concentration appeared to be the most critical, but the water temperature was also important. There was a definite trend that increasing water hardness increased loss of fish, but this is contrary to that reported for other heavy metals. The test was repeated using naturally hardened water (well water), and the same trend of increased loss with increasing hardness was confirmed.

There was no conclusive difference in the toxicity of Timsan on the production of rainbows or the albinos.

Water temperature is watched closely while treating fish in most of our hatcheries today, but the oxygen level is often neglected. It is recommended that measures be taken to increase the dissolved oxygen in the water while treating fish by using bottled oxygen, compressed air, or a sprinkling system. Other factors such as over crowding, feeding before treatment, excitement of fish, etc. should not be neglected because these factors can influence the rate of oxygen consumption. Treating fish at hard water stations should be done with some extra precautions.

MERCURIALS IN THE HATCHERY: ABSORPTION, DISTRIBUTION, AND RETENTION OF TIMSAN (ETHYL MERCURY PHOSPHATE) IN RAINBOW TROUT

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Single and multiple exposures of Timsan were administered to rainbow trout at 2 ppm for 1 hour to determine the rate of absorption and distribution and sites of retention of mercury in treated fish.

Following a single 1-hour exposure, gill tissue contained 160 times more mercury than the water in which the fish were exposed, which shows that gill tissue rapidly concentrates mercury from the water. However, the amount of mercury contained in the gills was found to vary under different environmental conditions (water temperature, dissolved oxygen, etc.), and is believed to be a function of the respiration rate.

Mercury contained in the gills was transferred to the blood (red blood cells), and maximum blood concentrations of mercury (3.4 ppm) occurred 32 hours after exposure. Mercury in the gills was eliminated within 2 days but the mercury in the blood was not eliminated until about 8 weeks later. Mercury accumulated in the liver and kidney much slower than in any other tissue. Peak levels of mercury occurred in about 3 days in the liver (3.0 ppm) and about 3 weeks in the kidney (2.6 ppm). Mercury persisted in the liver for about 20 weeks but the kidney still contained significant concentrations of mercury 7 months after exposure (1.8 ppm).

Except for the gills, mercury is slowly eliminated by the tissues of rainbow trout; therefore, mercury can be readily accumulated in fish which are repeatedly exposed to it. When daily exposures are given, mercury is accumulated mainly in the blood, but when weekly exposures are administered, mercury is accumulated mainly in the kidney. All other tissues including the muscle tissue contain relatively little mercury, and the mercury which is found in these tissues follows an absorption and elimination pattern similar to the blood, indicating that the mercury in these issues in only a reflection of the amount of mercury being carried in the blood.

Fingerling salmon, which were given 5 daily exposures of Timsan, were fed to 2-year-old chinook salmon held in a closed recirculated marine system. After 30 days of feeding, increased mercury levels occurred in the 2-year-old fish, and the highest concentration of mercury was found in the liver (30 ppm). Other tissues which contained high mercury levels were the large intestine (23.6 ppm), posterior kidney (17.5 ppm), and blood (15.9 ppm). All other tissues were comparatively low in mercury.

It was concluded from these studies that mercury (Timsan) is readily absorbed by the gills of rainbow trout, transferred to the blood, metabolized in the liver, and stored in the kidney where it is very slowly eliminated. It was also demonstrated that mercury could be transferred from one fish to another by feeding treated fish to untreated fish.

THE FURUNCULOSIS FAD

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For the past 64 years hatcherymen of this country have cussed and discussed furunculosis disease in salmon and trout. In the middle to late 1930's, this disease nearly put an end to the artificial propagation of trout in many areas of the United States. In the 1940's we began to forget furunculosis. This complacency was brought on and supported by the feeding of sulfa drugs to prevent or cure the disease. In the 1950's new drugs were introduced into fish feeds so that furunculosis and other infectious diseases were pushed further down the list of The 10 Most Serious Diseases. By the 1960's the organism, Aeromonas salmonicida, began to resent being ignored and became increasingly more drug resistant. Furthermore, it was being introduced into new hatchery systems by transporting live fish from one watershed to another.

The matter of drug resistance is very serious in many of our trout and salmon hatcheries. In the Washington Department of Fisheries hatchery at Issaquah, there is now no known therapeutic agent that will effectively handle the furunculosis organism--and this is not the only hatchery experiencing this. Also furunculosis is not the only disease to exhibit drug resistance. We know how drug resistances occur in some hatcheries--mainly through the prophylactic feeding of the drugs to prevent the disease. Now that we have limited this practice, what do we do? We cannot sit around and wait for the organisms to lose this characteristic. I venture to say that if we do this, we'll not have very many fish left to worry about getting the disease.

The matter of transporting diseases from one area to another has not created too ideal a situation either. History books contain several examples of what happened when an infectious disease of humans was introduced into a not previously exposed population. Take for example, measles in the Polynesians and tuberculosis in the Eskimos. The results were terrible. The same principles apply to populations of fish, and I am using furunculosis merely as a horrible example of all the infectious diseases of fish. I could just as easily use IPN or Myxosoma as examples of diseases we have transported from one place to another.

Earlier I asked what are we going to do about the problems. To answer this we must go back 2-3 years when John Ross, Tosh Yasutake, and I decided to find out what this disease we call furunculosis really is. We began by studying it at 8-hour intervals throughout its course from the time of infection to the point where the fish were nearly dead. From this we found that the disease was primarily a toxemia due to a very potent endotoxin released by the bacterial cells when they either died naturally or were killed by the host.

This past spring, while we were investigating the nature of the toxin and its role in immunity, another aspect of furunculosis appeared. We learned that if yearling coho at Quilcene NFH went to sea in April after having had a bout with furunculosis in late January and early February, better than 50% of them died of the disease within a few weeks. The quantitative data was obtained at Bowman's Bay, but many fish that had died of furunculosis were picked out of Quilcene Bay.

By May of this year we were in high gear to get an oral vaccine tested. Jim Wood will present the data from the Issaquah Hatchery, and Don Overholser will present the data from the Siletz Hatchery. I might add that without these two men this program would not be where it is today. It has been successful beyond our wildest hopes.

In summation, in order to control the many infectious diseases of trout and salmon, we must describe each of the infectious diseases just as we have with furunculosis. This is fundamental. Without this knowledge we really have no starting point. The next step is to make an immunizing agent and test it under hatchery conditions.

BUT, until we can go through each of the problem diseases we must plead with you to consider the long range effects of prophylactic use of various agents and, more important, the problems that may be and are created by moving infected stocks of fish around.

ORAL IMMUNIZATION OF JUVENILE COHO SALMON [1/]

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This report describes an experiment in which 600 juvenile coho salmon (Fish Commission of Oregon, Siletz Hatchery) were protected against Aeromonas salmonicida, the causative agent of furunculosis, by oral administration of a vaccine. The 600 fish were divided into four lots of 150 each and placed in 35 gallon circular tanks. Individual lots were fed Oregon Pellets containing the vaccine (200 mg. vaccine per kg. of diet) for an initial 14-day period. Lot one received the initial vaccine administration in March, lot two in April, and lot three in May. After the initial feeding, these three lots received booster feedings of vaccine once each week through July. Lot four received the initial 14-day vaccine feeding in April but was not given the weekly booster feedings. In addition to these groups, 150 fish (lot 5) were held as controls and received no vaccine. Another group of 2,000 fish was held as an additional group (lot 6). The differences between control lots five and six were the number of fish and the size of the tanks in which they were held. Lot five was held in the same size tank as were lots one through four while lot six was held in a circular tank with a 211 gallon capacity. The standard hatchery feeding schedule employed by the Commission was used to determine the amount of daily ration for the test fish.

The fish used had never received drugs during or prior to this test. All losses in lots one through five were autopsied to determine the cause of death, and 58% of the losses in lot six were autopsied.

Deaths caused by furunculosis were first observed on May 28, 1966, and were the result of a natural and predictable occurrence of the disease in coho salmon at this hatchery. Losses reached epizootic proportions by mid-June and continued through July.

The results of the experiment are summarized in Table 1. There were no deaths due to furunculosis in lots one or two. In lots three and four a 0.7% loss caused by this disease was observed during the course of the experiment representing one death in each of these two lots. The loss of nonvaccinated fish (controls) was 22.2% in lot five and 37.0% in lot six.

1/ This work was supported by funds received from the Fish Commission of Oregon through a contract with the Bureau of Commercial Fisheries.

Table 1. Results of oral immunization of juvenile coho salmon against A. salmonicida, the causative agent of furnnculosis.

Lot no.	Number of fish per lot	Starting date	Total amount vaccine fed in mg.	Deaths due to furunculosis %	Loss from causes other than furunculosis--%
1	150	3/7/66	57.7	0.0	3.3
2	150	4/5/66	51.9	0.0	4.6
3	150	5/5/66	53.5	0.7	4.6
4	150	4/18/66	24.9	0.7	4.0
5	150	No vaccine fed	0.0	22.2	4.0
6	2000	No vaccine fed	0.0	37.0	11.7

The total amount of vaccine given lot four was approximately one-half that given lots one through three. The reduced amount of vaccine fed this group did not adversely affect the protection afforded these fish against furunculosis. Deaths from causes other than furunculosis were observed during March and April. This loss was due to sampling of fish for certain immunological tests and cold water disease caused by Cytophaga psychrophila.

The significant information gained from this experiment is the difference in losses observed between vaccinated and nonvaccinated fish.

These data show the vaccine used in this experiment can protect juvenile coho salmon against furunculosis. This test did not clearly define the amount of vaccine needed to protect the fish or precisely how long before an infection it must be administered.

ORAL IMMUNIZATION OF JUVENILE COHO SALMON UNDER HATCHERY PRODUCTION CONDITIONS

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SUMMARY

1. The oral immunization of the local stock of 1965-brood silver salmon at Issaquah Hatchery with 0.025 mg of Furunculosis Sonicated Antigen (FSA) per fish reduced the loss due to furunculosis disease to approximately one-half that in comparable control ponds.

2. The level of FSA fed in the Issaquah experiment proved to be less than the optimal level desired. Loss attributable to furunculosis disease varied from 2.44 to 9.35% in ponds fed FSA compared with 4.55 to 18.16% in the control ponds.

3. The optimal level of FSA for disease control is thought to be from 0.05 to 0.10 mg per fish. Using the upper level, the cost represents an expenditure of $200 to $300 per 1,000,000 fish. Comparisons are made with the costs of sulfamethazine and Terramycin treatments. The latter are precluded, however, if disease outbreaks involve resistant strains of the causative bacterium.

4. Control of furunculosis disease by feeding nf180 in a reconstituted dry diet was only partially effective. In addition, the dry diet (Oregon Pellet Meal) was unsatisfactory for producing growth.

5. The primary source of furnuculosis disease at Issaquah Hatchery appears to be in the water supply. The demonstration of sulfa and Terramycin resistant strains of <u>Aeromonas salmonicida</u> during the initial infection of the Skykomish, as well as the Issaquah, stock of silvers circumstantially precludes the source as arising from parent stock. Diagnosable furunculosis has not been present at Skykomish Hatchery, at least during the last six years, and none of the tetracycline drugs have ever been used at that hatchery.

6. The loss rate due to furunculosis disease appears associated with the pond stocking rate. In comparable ponds at Issaquah Hatchery, 9.2% of a pond of 60,000 fish died from the disease compared with 12.3% in a pond of 80,000 fish.

THE PRODUCTION OF A FISH TOXIN IN HATCHERY REARING PONDS

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Last summer at Washougal Hatchery a silver fingerling mortality occurred when a large gravel bottom, cement sided pond, was two-thirds drained for a routine cleaning. A D.O. was taken immediately and was 5-6 ppm. Before it was over 180,000 fish died; a 60% mortality. The gills of the afflicted fish turned bright red to red-orange.

Since this was not an infectious disease and not O_2 deficiency, a toxin was suspect in the slurry that had been riled up from the pond being drained. Some of the bottom slurry was sucked out and put into fresh water and fish added. A control using the same fresh water with no mud was used.

Fish in the muddy water were distressed in 6 minutes, half were dead in 15 minutes and all 30 succumbed in 20 minutes. D.O. was 6 ppm; pH, 6.8; ammonia nitrogen, 0.3 ppm. Control fish were OK after 1 hour.

An analysis of the toxic water proved negative for pesticides, herbicides and lethal dissolved gasses. Transitional elements were normal and the pH was 6.8-7.0. Toxicity was not destroyed by boiling for long periods thus eliminating bacterial exotoxins as the cause. The toxin passed an .8u filter but not a .45u filter. Concentration by boiling down and ether extraction isolated the toxin in a yellow greasy amorphous material. One drop per liter of water of this extract will kill fish in 10 minutes.

Since the toxin is biodegradable at room temperature in 2 days and 2 weeks in the refrigerator, it was reasoned the ponds should lose their toxicity in a short time. This was not the case. Autoclaved water maintains its toxicity. It followed then that either the pond was producing the toxin or it was coming from the water supply.

A bioassay with bottom muck from numerous places up and down river was made as well as in the standard all cement ponds. All were negative. This narrowed the field down to decomposing food and/or fecal material or a toxin produced by a protist in the pond.

After numerous attempts of trying to culture and test bacteria, algae and fungus with no success, luck played its part. A growth was noticed on the sump walls and was tested by shaking it in pure water and testing this water with fish. A typical mortality as before occurred complete with bright red to red-orange gills.

This growth appears to be an aquatic phycomycete that reproduces with intercalary chlamydospores. The toxin was extracted from the growth. To date we are endeavoring to eliminate this phycomycete from the pond bottom and sump walls.

OCCURRENCE OF WHIRLING DISEASE OF TROUT IN THE WEST

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The disease of rainbow trout commonly known as whirling disease has been prevalent in some eastern hatcheries since 1956. This disease had not been reported in any of the western hatcheries until last year when for the first time it was diagnosed from rainbow trout fingerlings which had been sent to the Western Fish Disease Laboratory. The specimens came from a private hatchery in California.

In June of this year rainbow trout fingerlings were received from a state hatchery in Nevada. Clinical signs described by the biologist were those associated with whirling disease: tail chasing and black tail. Although cartilagenous tissue erosion and degeneration along the middle ear were observed in the initial samples, no spores were seen grossly or histologically. In specimens received two months later, tentative diagnosis was confirmed when extensive spore infection (*Myxosoma cerebralis* etiologic agent of whirling disease) was observed. This is an inportant factor that biologists should keep in mind--that fish exhibiting clinical signs typical of whirling disease may not necessarily have spores in the middle ear area. It may take as long as four months post-exposure before spores may be seen.

Mode of infection is still not clearly understood. One thing is generally known: once the disease invades a hatchery, it is difficult to eradicate. With stringent aseptic methods it may, however, be controlled.

Excellent references giving detailed information to biologists and hatchery personnel regarding *Myxosoma cerebralis* are listed below.

Hoffman, G. L. 1962. Whirling disease of trout. U. S. Fish and Wildlife Service, leaflet 508.

Hoffman, G. L., Clarence E. Dunbar, and Arthur Bradford. 1962. Whirling disease of trout caused by *Myxosoma cerebralis* in the United States. Fish and Wildlife Service, Special Science Report, Fisheries No. 427.

OCCURRENCE OF THE PROTOZOAN PARASITE *CERATOMYXA SHASTA*[1/] AMONG SALMONID FISHES IN OREGON WATERS

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This project was initiated to determine the incidence, distribution and species of fish affected by *Ceratomyxa shasta* in Oregon waters. Returning adult Pacific salmon and steelhead trout were chosen for the survey because they were known to be susceptible to infection and *Ceratomyxa* was believed to be important cause of prespawning losses.

Spring and fall chinook, coho salmon, and steelhead trout are susceptible to this disease; however, the degree of susceptibility varies quite markedly. Returning adult fall chinook and steelhead sampled at locations west of the Cascade Range have a lower incidence of infection than spring chinook and coho west of the Cascades.

All coho samples obtained from the Columbia River basin contained individuals infected with *Ceratomyxa*. The infection was greatest the Bonneville and Sandy hatcheries, approximately 75% of these fish were infected. The only coastal river sample found to contain coho infected with *Ceratomyxa* was taken from the Nehalem River. Fish that reached the hatchery but died before the start of spawning operations were obtained from the Klaskanine and Sandy hatcheries. The incidence of *Ceratomyxa* infected fish in these samples was in both cases greater than in samples obtained during spawning. The incidence was 22% greater in mortalities obtained from Klaskanine Hatchery, and 14% greater in mortalities obtained from Sandy Hatchery.

Spring chinook samples obtained from coastal river locations (Trask and Rock Creek hatcheries) were not infected with *Ceratomyxa*. Infected spring chinook were found in all Willamette River tributaries surveyed. The incidence was greatest (28% at Dexter Dam) in fish which had migrated the farthest distance up the river. *Ceratomyxa* in dead fish obtained from the Dexter Dam holding pond was over twice that found in spawned fish from this same location. There was a noticeable difference in spore numbers between dead and spawned fish. Smears made from infected spawned fish, seldom contained more than ten spores, whereas smears from mortalities often contained 20 to 30 spores per microscopic field (high dry).

1/ This work was supported by funds received from the Fish Commission of Oregon through a contract with the Bureau of Commercial Fisheries.

The incidence and distribution of Ceratomyxa in fall chinook was different from that found in coho or spring chinook. The coastal sample obtained from the Trask Hatchery contained one infected individual. The Klaskanine River was the only tributary on the lower Columbia that contained infected fall chinook, eight per cent of the fish in this sample were infected. The infection was much greater in fall chinook sampled at the Oxbow holding pond on the Snake River than in fish obtained from sites on the lower Columbia River. Sixty five per cent of the fish from the Oxbow holding pond were infected. The incidence of Ceratomyxa in prespawning mortalities at the Oxbow holding pond was identical to that found in adults killed at spawning.

Samples of steelhead obtained from the Big Creek Hatchery and Pelton Dam contained fish infected with Ceratomyxa. The number of spores per smear of infected steelhead tissue was low when compared to the number observed in smears from coho and spring chinook. No steelhead mortalities were obtained.

The incidence of Ceratomyxa in adult salmonids does not appear to be related to the size and sex of the animals. The incidence of Ceratomyxa is related to the distance traveled upriver during the spawning migration. Ceratomyxa infected fish were more prevalent in spring and fall chinook spawning sites on tributaries of the upper Willamette and Columbia rivers.

Geographically, Ceratomyxa is widely distributed throughout the survey area and was found in all areas of the Columbia River basin sampled. Coastal river systems found to contain infected fish were the Nehalem and possibly the Trask. No infected fish were observed in samples taken from rivers farther south. The incidence of Ceratomyxa in coastal rivers decreased progressively from the Columbia River southward. The Trask River observation could indicate that a very low natural infection exists there or that the one infected fish was a stray. Straying of infected fish may be a method for spread of the parasite.

Ceratomyxa infection of adult salmon probably occurs during the fresh-water phase of the life cycle. The evidence for this was derived primarily from samples taken in coastal streams. If the disease was contracted in the ocean, the incidence of infection among each coastal species sampled would have been identical. Instead the incidence of the disease decreased progressively southward from the Columbia River.

Recently, wild rainbow trout at Davis Lake and Round Butte Reservoir on the Deschutes River were found to be infected with Ceratomyxa. These fish could act as a possible source of infection for juveniles raised in water supplies below these areas. Rainbow and possibly other trout could serve as a reservoir of infection for resident and anadromous salmonids.

CHONDROCOCCUS COLUMNARIS ANTIBODY PRODUCTION IN COLUMBIA RIVER FISHES

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Incidence of Chondrococcus columnaris disease in yearling rainbow trout which were exposed to natural infection as fingerlings, suggests yearlings are often immune and frequently carriers of the disease. These trout with known exposure to C. columnaris produced agglutinating antibodies in their blood sera but no antibodies developed in trout reared in columnaris free water. Columnaris agglutinating titers were developed in yearling rainbow trout using semi-monthly injections of attenuated C. columnaris plus Freund's complete adjuvant. Maximal titers of 1:5120 were obtained by 12 weeks post injection.

C. columnaris exposure of Columbia River fish populations were surveyed using the presence of columnaris agglutinating antibodies in blood sera of fishes as an indicator of exposure. Monthly blood serum samples from sites located near Bonneville, McNary, Hanford, and Wenatchee on the Columbia River demonstrated a single annual cycle of columnaris antibody production related to water temperature and re-exposure of fish to the pathogen. A decline in antibody production and titer magnitude was observed during periods of low water temperatures following infestation. A sharp increase and a greater magnitude in columnaris antibody formation was observed during warmer water temperatures and re-exposure of fish to the pathogen. High agglutinating titers up to 1:5000 have been found for some individual fish, but in most instances the usual high titers were 1:640. Based on agglutinating titer formation and isolating of C. columnaris, the McNary site showed evidence of significantly higher columnaris exposure of fish. Time of initial exposure of fish to C. columnaris varied at the different sampling sites. From these observations, we conclude that antibody production in Columbia River fishes is a valid criterion of exposure to the disease. C. columnaris disease is endemic throughout the river system and McNary appears to be a foci of infection.

ANNUAL NORTHWEST FISH CULTURE CONFERENCES
HISTORICAL RECORD

Year	Location	Host Agency	Chairman
1950	Portland, Oregon	Fish & Wildlife Service	Perry
1951	Wenatchee, Washington	Fish & Wildlife Service	Burrows
1952	Seattle, Washington	Washington Dept. of Fisheries	Ellis
1953	Portland, Oregon	Fish Commission of Oregon	Cleaver
1954	Seattle, Washington	Fish & Wildlife Service	Rucker
1955	Portland, Oregon	Oregon Game Commission	Rayner
1956	Seattle, Washington	Washington Dept. of Game	Millenbach
1957	Portland, Oregon	Fish & Wildlife Service	Johnson, Harlan
1958	Seattle, Washington	Washington Dept. of Fisheries	Ellis
1959	Portland, Oregon	Fish Commission of Oregon	Jeffries
1960	Olympia, Washington	Washington Dept. of Game	Johansen
1961	Portland, Oregon	Oregon Game Commission	Jensen
1962	Longview, Washington	Fish & Wildlife Service	Burrows
1963	Olympia, Washington	Washington Dept. of Fisheries	Ellis
1964	Corvallis, Oregon	Oregon State University	Fryer
1965	Portland, Oregon	Fish & Wildlife Service	Halver
1966	Portland, Oregon	Fish Commission of Oregon	Hublou
1967	Seattle, Washington	University of Washington	Donaldson