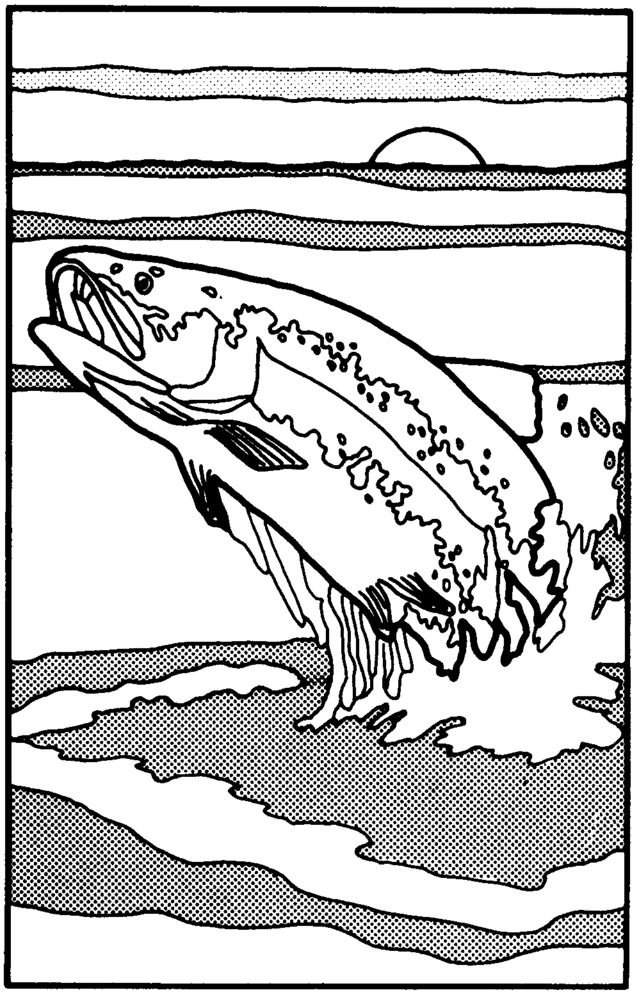
42nd ANNUAL NORTHWEST
FISH CULTURE CONFERENCE



December 3-5, 1991

RED LION INN

REDDING, CALIFORNIA

PROCEEDINGS

OF THE

FORTY-SECOND ANNUAL

NORTHWEST FISH

CULTURE CONFERENCE

DECEMBER 3-5, 1991

REDDING, CALIFORNIA

THE NORTHWEST FISH CULTURE CONFERENCE

The Northwest Fish Culture Conference is an annual informal meeting by and between fish culturists for the exchange of information and ideas about all aspects of fish culture.

The PROCEEDINGS contain abstracts and or talks presented at the conference. They are unedited, contain progress reports of uncompleted programs, and, as such, SHOULD NOT BE CONSIDERED A FORMAL, PEER-REVIEWED PUBLICATION.

ORGANIZING COMMITTEE

General Coordinator	Ken Hashagen
Registration	Roger Ellis
Exhibits	Don Estey
Audiovisual	Tony Nevison
Local Arrangements	Bob Corn
Raffle	Royce Gunter
Program	Ron Ducey
Proceedings	Ken Hashagen
Treasurer	Barbara Simpson

ACKNOWLEDGMENTS

The 42nd Northwest Fish Culture Conference was held at the Red Lion Inn in Redding, California from noon December 3 through noon December 5, 1991. This was the first time the California Department of Fish and Game was provided the opportunity to host the Conference.

There were a total of 376 attendees from California (146), Washington (79), Oregon (87),Idaho (22), British Columbia (20), Alaska (10), Utah (8), Montana (4), Nevada (2), and Wyoming, Illinois, North Dakota, and Colorado (each with 1).

As General Coordinator of the conference, I would like to thank the California Department of Fish and Game for their contributions of time for the organizing committee to plan the conference and for absorbing the cost of phone calls and preliminary mailings. The Committee Chairs are also due thanks for their efforts, as well as all those assisting them with committee activities.

This year 27 exhibitors displayed their products at the trade show/product display. Their contribution and participation was appreciated. Silver Cup, Rangens, and Moore-Clark, not only displayed their feeds, but hosted two social hours, which facilitated the exchange of ideas and information.

Many, many companies and individuals donated raffle prizes. They have been acknowledged with individual letters but their contributions were an important part of the overall meeting and much appreciated.

The speakers are acknowledged for their efforts in preparing their papers and traveling to Redding to present them. Thanks!

An lastly, but not last in importance, my thanks to Jean Anglin, who retyped portions of the Proceedings and readied it for the printer.

Ken Hashagen
General Coordinator
Northwest Fish Culture Conference

WELCOME

I would like to welcome you all to the 42nd Northwest Fish Culture Conference. As many of you know, this is the first time California has hosted the conference an we thank you for the opportunity.

In California, the sale of fishing licenses, many of them for the pursuit of hatchery reared fish, supports not only our hatchery system but many other functions in the Department as well. I'm sure that it is true for many of the states, provinces, and agencies represented here today. Hatcheries and their production are obviously important to those of us in the recreation business.

If hatcheries are important, then it makes sense to spend time and money to train the personnel operating them. The Northwest Fish Culture Conference is an excellent forum for training. My Department is sending everyone who wanted to attend. I understand several other agencies also use the conference for the same purpose.

Ron Ducey has put together an excellent program. I hope all of you will enjoy the program, as well as your stay in Redding.

Banky Curtis
Regional Manager, Redding
Department of Fish and Game

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SESSION 1

FISH HATCHERIES

FISH HATCHERIES OF CALIFORNIA

RICHARD J. BRYANT
California Department of
Fish and Game
Nimbus Fish Hatchery
2001 Nimbus Road
Rancho Cordova, CA 95670

I would like to take you on a very quick slide show of California's 22 fish hatcheries.

The State is broken down into five different Regions.

We have: (1) Planting base

(1) Quarantine station which also serves as both a hatchery and a planting base.

(11) Trout hatcheries

(8) Salmon and steelhead hatcheries

(1) Striped bass hatchery

We have approximately 170 permanent employees in hatcheries.

The cost to operate the entire hatchery system (salaries, fish food, maintenance, etc.) approaches $13 million annually.

The 170 permanent hatchery workers comprize about 10% of the DFG's total work force.

DFG operated hatcheries produce approximately 53 million fish for stocking in California waters each year.

REGION 1

Region 1 has three trout hatcheries and three salmon and steelhead hatcheries.

Iron Gate Salmon and Steelhead Hatchery - built in 1966

It is located on the Klamath River next to the Oregon Border; it has 6 permanent employees.

The 32 concrete raceways produce approximately 7 million salmon and steelhead of various sizes.

Mt. Shasta Trout Hatchery - established in 1888

It is located 60 miles north of Redding. It is one of three major broodstock hatcheries; it has 5 permanent employees.

The 16 concrete and 8 dirt ponds produce approximately 2½ million trout. The Hatchery produces 12½ million eggs.

Trinity River Salmon and Steelhead Hatchery - built in 1963

It is located 35 miles west of Redding on the Trinity River; it has 7 permanent employees.

The 80 concrete raceways produce approximately 5½ million salmon and steelhead.

Crystal Lake Trout Hatchery and Pit River Ponds - built in 1947

It is located 50 miles northeast of Redding; it has 8 permanent employees.

The 66 concrete raceways produce approximately 1.8 million trout.

Darrah Springs Trout Hatchery - built in 1947

It is located 30 miles southeast of Redding and has 9 permanent employees.

The 60 concrete raceways produce approximately 1½ million trout.

Mad River Salmon and Steelhead Hatchery - built in 1969

Located 85 miles west of Redding on the Mad River; it has 7 permanent employees.

The 60 concrete raceways produces approximately 1.4 million salmon and steelhead.

REGION 2

Has one trout hatchery, one striped bass hatchery, and three salmon and steelhead hatcheries.

American River Trout Hatchery - built in 1968

Located 12 miles east of Sacramento, the Hatchery has 7 permanent employees and 4 mobile employees.

The 60 concrete raceways produce approximately 1.4 million trout.

Nimbus Salmon and Steelhead Hatchery - built in 1955

The Hatchery is located 12 miles east of Sacramento on the American River and has 6 permanent employees and 4 mobile employees.

The 24 concrete raceways produce approximately 4.4 million salmon and steelhead.

Mokelumne River Salmon and Steelhead Hatchery - built in 1964

Located 25 miles southeast of Sacramento on the Mokelumne River; this facility has 5 permanent employees.

There are 6 concrete raceways and 2 rearing ponds, each 500-ft long, which produce approximately 3.3 million salmon and steelhead.

Feather River and Thermalito Salmon and Steelhead Hatchery - built in 1967

Located 70 miles north of Sacramento on the Feather River, there are 10 permanent employees.

The facility has 48 concrete raceways and 1 rearing pond 20 ft x 1400 ft. long; the Thermalito satellite has 24 concrete ponds. Together they produce approximately 15 million salmon and steelhead.

Central Valley Stripped Bass Hatchery - built in 1937

Located 12 miles south of Sacramento, the Hatchery has 4 permanent employees.

The 45 concrete ponds, each 40 ft. long, produce approximately 250,000 striped bass.

Region 3

This Region has a quarantine station, which also serves as a hatchery and a planting base, and one salmon and steelhead hatchery.

Silverado Fish Hatchery - built in 1977

Located 50 miles north of San Francisco, the Hatchery has 4 permanent employees.

The two concrete raceways are used to hold fish for restocking. The Hatchery stocks approximately 1.4 million fish.

Warm Springs and Coyote Expansion Salmon and Steelhead Hatchery - Built in 1980; the Coyote expansion was built in 1991.

Located 70 miles north of San Francisco on Dry Creek; it has 6 permanent employees.

Warm Springs - 20 concrete ponds 72 ft-long
Coyote Expansion - 8 concrete ponds 72 ft-long

Warm Springs produces approximately 1.5 million salmon and steelhead; Coyote is new and not yet in production.

Region 4

Has two trout hatcheries, one planting base, and one salmon hatchery.

Moccasin Creek Trout Hatchery - built in 1954

Located 60 miles east of Stockon; it has 8 permanent employees.

The 48 concrete raceways produces approximately 3 million trout.

Merced River Fish Installation - built in 1970

Located 75 miles northwest of Fresno on the Merced River; it has 2 permanent employees.

The 10 concrete raceways and the spawning channel (4,800 ft-long) produce approximately 500,000 salmon.

San Joaquin Trout Hatchery - built in 1955

Located 20 miles north of Fresno; it has 9 permanent employees.

The 56 concrete raceways produces approximately 1½ million trout.

Kern River Planting Base - built in 1939

Located 40 miles northeast of Bakersfield; it has 2 permanent employees.

The 4 concrete ponds, each 40 ft-long, is used to temporarily hold fish for restocking. The Base stocks about 250,000 trout in nearby waters each year.

Region 5

Has five trout hatcheries.

Hot Creek Trout Hatchery - built in 1941

Located 35 miles north of Bishop at an elevation of 7,100 feet. It is one of the three major broodstock hatcheries; it has 12 permanent employees.

The 48 concrete raceways produces approximately 2.3 million trout. The Hatchery produces up to 20 million eggs.

Fish Springs Trout Hatchery - built in 1962

Located 20 miles south of Bishop and has 6 permanent employees.

The 60 concrete raceways produces approximately 1.8 million trout.

Mt. Whitney and Black Rock Fish Hatchery - built in 1917

Located 40 miles south of Bishop and is one of three major broodstock hatcheries and has 11 permanent employees.

28 concrete raceways produce approximately 500,000 trout. The Hatchery also produces 15-20 million eggs.

Fillmore Trout Hatchery - built in 1942

Located 50 miles northwest of Los Angeles. They have 6 permanent employees.

The 40 concrete ponds produces approximately 1 million trout.

Mojave River Trout Hatchery - built in 1946

Located 65 miles northeast of Los Angeles; it has 5 permanent employees.

The 60 concrete raceways produce approximately 750,000 trout.

COASTAL CUTTHROAT TROUT ENHANCEMENT EFFORTS AT STONE LAGOON

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California Department of
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Mad River Salmon and
Steelhead Hatchery
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Stone Lagoon is a 320-acre body of brackish water located 30 miles north of Humboldt Bay. The sand spit breaks open to the ocean occasionally but not every year. This lagoon has a history of fish planting beginning in 1940 with steelhead from Humboldt County's Prairie Creek Hatchery. Since then it has been stocked with coho salmon, chinook salmon, steelhead, coastal cutthroat trout, and rainbow trout from various sources and hatcheries. Stocking was terminated in 1987 to facilitate a new coastal cutthroat management program. This program was instituted to revive a dwindling cutthroat fishery. The cutthroat fishery has been in a state of decline on the North Coast in general. Stone Lagoon was chosen as a possible restoration effort mainly because the location afforded greater control of the watershed and rehabilitation of its spawning stream. In addition, Stone Lagoon has a history of producing large fish and currently holds the State record for the largest cutthroat.

Private angling groups became interested in reviving the cutthroat fishery in the lagoon and the restoration of McDonald Creek in the late 1970's. McDonald Creek is the main spawning tributary for the lagoon. The creek had become aggraded due to logging and road building activities in the upper watershed. The lower reaches of the creek had streambank erosion problems caused by cattle grazing. Throughout the early 1980's restoration work was performed by Northcoast Flyfishers, Redwood Community Action Agency, and the California Conservation Corps. This work consisted of debris modification, fencing to exclude cattle, and riparian vegetation planting.

In 1985 and 1986 some followup bank armoring and instream structure placement was accomplished. Also, a hatchbox was established, which resulted in a release of 800 fry. Genetic analysis revealed a mixture of pure cutthroat and some cutthroat x rainbow hybrids. Funding for this project was dropped in the fall of 1986 and California Department of Fish and Game did not support it because it could not provide enough progeny to stock the lagoon adequately. Due to lack of funding and manpower, California Department of Fish and Game was not able to establish a coastal cutthroat trout management/enhancement program at this time. Humboldt State University (HSU) and the City of Arcata's Wastewater Aquaculture Program initiated a cutthroat trout broodstock development program whose goals were two-fold. The first goal was to establish a genetically diverse, pure cutthroat broodstock to be raised and held in saltwater ponds. The second goal was to produce sufficient smolts to evaluate an enhancement program at Stone Lagoon. This program was funded by the California Department of Fish and Game Threatened Salmonid Program.

The first phase of the program was to capture adult cutthroat by electroshocking three different creeks. Janes Creek, in the Arcata area, yielded 80 fish; they were given a left ventral fin clip. Widow White Creek in the McKinleyville area yielded 63 fish which were marked with a right ventral clip. McDonald Creek supplied 16 fish; they were given a left pectoral fin clip. Mature fish were held in fresh water at the Arcata Wastewater facility. Juveniles were put into a different pond at the same facility.

Eggs were taken from the mature fish, fertilized, water hardened, then transported to the HSU hatchery. Five Widow White Creek females, one McDonald female and six Janes Creek females, with an average length of 213 mm (8.4 inches), were spawned. From those 12 females, 3,078 eggs were taken, with an average fecundity of 256 eggs/female. This resulted in 1,825 sac fry, which were raised and kept in the HSU hatchery ponds.

In 1988, the first generation offspring were split into two groups. One group was kept at HSU for fresh water rearing and the second group (180 fish, 60 from each parental group) was transferred to the Arcata Wastewater Ponds for saltwater rearing. No additional broodstock was captured in 1988.

By 1989, the HSU hatchery was running out of room to raise the production fish. Eggs were taken at the HSU hatchery and transferred to Mad River Hatchery where they were put in Heath incubators through the button-up stage. They were put in troughs until they were feeding well and then moved outside to concrete raceways. The fish were provided with shade netting over a portion of the raceway. This provided a dark place for the fry to hide while they were small. When the fish were approximately 100/lb, Babington response feeders were installed to achieve faster growth rates. These fish were more secretive than our production salmon and steelhead and seemed to grow better on the demand feeders.

In the spring of 1990, the fish were freeze branded and given an adipose fin clip. The freeze branding was used to differentiate three size groups so that subsequent sampling by HSU students could reveal growth rates. After a month the fish were trucked to Stone Lagoon and released. Hauling densities used were the same as for our rainbow trout; however, our culturist recommends a 20-30% decrease to reduce stress.

In 1991, the same procedure was followed at Mad River Hatchery except the number of fish raised now exceeded the allotment for Stone Lagoon. The excess fish were not freeze branded but given an adipose fin clip and released into Big Lagoon, located a few miles south of Stone Lagoon.

Evaluation of the fish released is being done by HSU students and faculty. Recent land purchases and resource management programs by California Department of Parks and Recreation have given promise of more funding for continued stream rehabilitation, development of fishing facilities, and followup studies of the fish and lagoon environment. Future programs include limnology studies, sediment source surveys, growth rates studies, spawning surveys, and carrying capacity studies. Fishing regulation changes have been proposed to achieve a "trophy" trout fishery. This includes two-trout bag limit, 16 inches and larger, and artificial, single, barbless hooks only. There is now an advisory group including representatives of Trout Unlimited, California Trout, North Coast Flyfishers, Redwood Community Action Agency, California Department of Parks and Recreation, California Department of Fish and Game, California Conservation Corps, and Humboldt State University.

As the results of the studies become available, management of the fishery will adjust accordingly.

SOLOMON GULCH SALMON HATCHERY

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Valdez, Alaska 99686

ABSTRACT

The Solomon Gulch Hatchery in Valdez, Alaska has seen many changes since its inception in 1978. A review of the survivals, both egg to fry or smolt and fry or smolt to adult, is evaluated to look at overall success in the production. Several procedures are reviewed that show how a large production hatchery in the cold waters of coastal Alaska operates and maintains programs.

Valdez Fisheries Development Association (VFDA) was formed in 1978 by a group of Valdez residents concerned with the decline of salmon stocks in the areas of Valdez Port, Narrows, and Arm. The group which included commercial and sports fishermen along with others interested in the fishery, organized under the State Private Nonprofit Hatchery Act of 1974. The act allows local and regional organizations to establish hatcheries and fund capital costs initially through loans from the State. At that time the group developed plans to build a hatchery for three species of salmon at Solomon Gulch on the south side of Port Valdez where an adequate water supply already was being established by construction of the city's Solomon Gulch hydroelectric facility. In the interim, while the Solomon Gulch Hatchery went through planning, permitting, and construction stages, the Association, in 1981, began taking brood stock and incubating eggs at a small temporary facility next to Crooked Creek just east of Valdez on the north side of the port. By the time Solomon Gulch Hatchery opened in 1983, VFDA hatched pink salmon already were returning to Port Valdez.

Solomon Gulch Hatchery has a permitted capacity for 230 million pink salmon eggs, 18 million chum salmon eggs, 2 million silver salmon eggs, and 300,000 king salmon eggs.

Pink Salmon--The hatchery takes 300,000 fish each year for brood stock to gather and fertilize 230 million eggs. The eggs are incubated in the hatchery over winter. So far the hatchery has averaged about a 93% survival rate of eggs to fry. When the fry emerge in the spring they are moved to net pens in Port Valdez, where they are fed until they reach sufficient size for release. Some releases are timed with plankton blooms so the fry swim out into the best possible feeding conditions. Other fry are fed until they reach sufficient size to be able to avoid predation. They usually are released at dusk to limit predation by birds and other fish during their first 24 hours in the ocean environment. After a year at sea, the pinks return to Valdez Arm and Port. Survival rate over the first 7 years has averaged around 6% and ranged from 1.81% to 10.85%. In 1990, when adult returns reached full production, 10,189,000 pinks returned. Of those, 7,799,574 were caught in the common property fishery, and had a value of $7.8 million.

Silver Salmon: Silver salmon egg takes have grown to 2 million in 1990. The eggs are incubated over the winter until hatching in the spring. Egg to released smolt survival has averaged about 70% in the past 4 years. Silvers must spend about 8 months in fresh water incubators. After hatching, the fry are ponded into hatchery raceways where they are fed for another 14 months before transportation as smolts to salt water net pens where they are held for imprinting, fed and then released. Over the years, VFDA has enjoyed a phenomenal 10% return rate for silver salmon, reaching full adult production in 1989. In 1990 a total of 84,603 silvers returned to Port Valdez. Common property fishermen took 70,972 silvers including 25,000 on sport tackle.

Chum Salmon: With so many variables encountered in their long time at sea, have taken longer to establish at the hatchery. In 1990 hatchery personnel took 1.9 million eggs from 1,186 brood fish. An additional 800,000 chum eggs came from Prince William Sound Aquaculture Corp. The hatchery released 1.7 million fry in the spring of 1991. Chum salmon spend three or four years in salt water, exposing them much longer than the other species except kings to predators of all types. In addition, they tend to mill around in Prince William Sound through the summer before their fall run to the hatchery. As a result they stand a much higher chance of being intercepted in the commercial fishery. Where pink salmon show about a 6% return average and silvers around 10%, the best return percentage for chums at Solomon Gulch so far has been 2.13%.

Economics: Under the Private Nonprofit Hatcheries Act, hatcheries qualify for startup capital loans but then must be self-sustaining. Regional association are allowed to receive a fish tax from fishermen and processors. This revenue is unavailable to VFDA because it's a nonassociation hatchery. All operating costs and debt service funds must be recovered through the sale of fish. In the course of the run, a contract seine fisherman catches fish for the hatchery to sell to make up costs. Additional help comes from volunteers within the commercial seine fleet. The ideal ration is 70% of the return going to the common property fishery and 30% to the hatchery for brood stock and cost recovery. This contribution goal has been met by VFDA with pink salmon in every year but two since 1984. The accumulative contribution of pink salmon to the common property fishery to date is 73% since the beginning of the hatchery program.

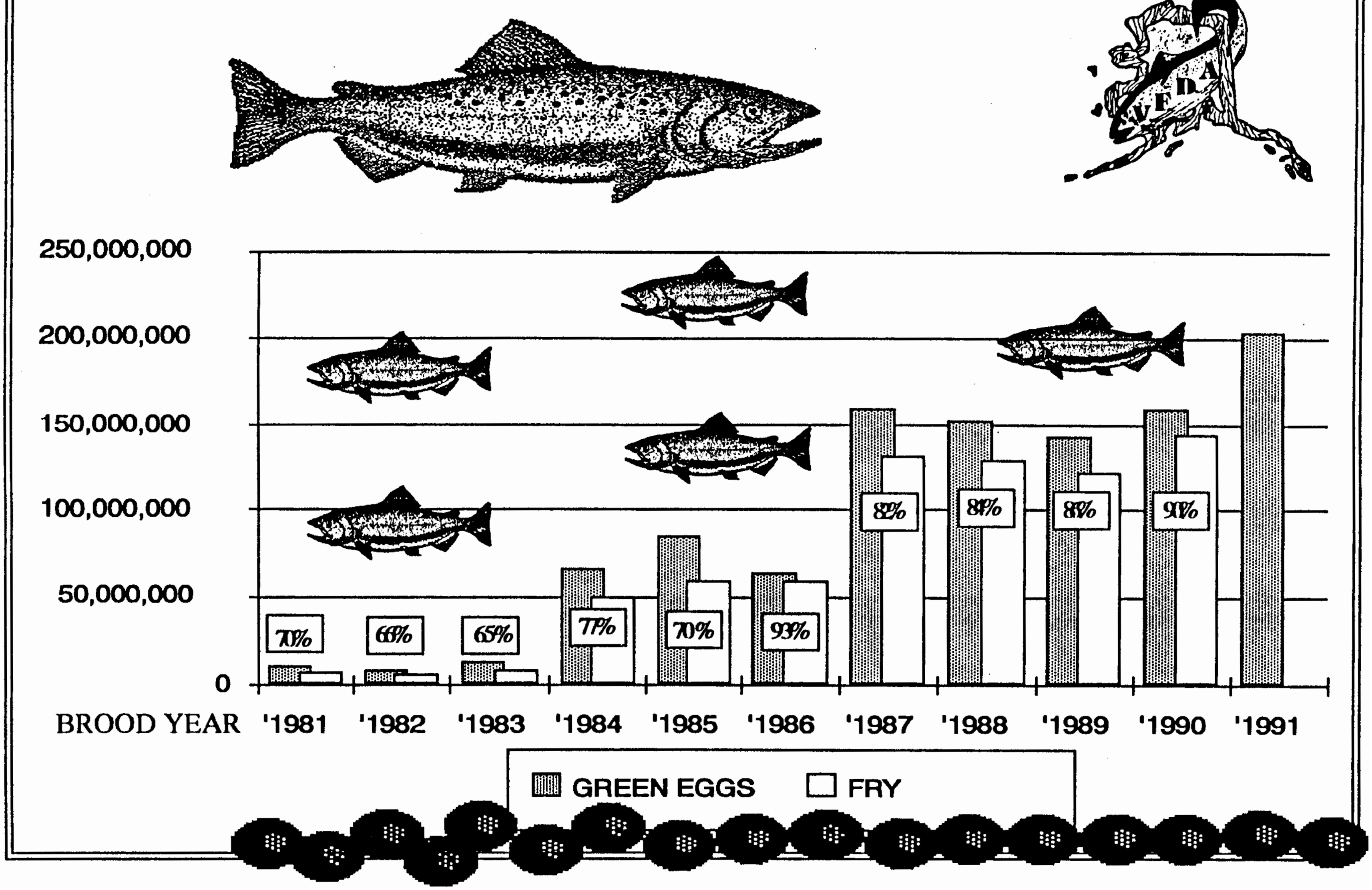
Related Projects: VFDA has begun a program of remote release sites for salmon fry in an effort to relieve the heavy fishing pressure in the hatchery's terminal harvest area. Since 1989, 50 million pink salmon fry per year have been released at Boulder Bay in Port Fidalgo. In 1990, the hatchery applied for permits to raise pink salmon incubation rates to 230 million per year. The additional fry were destined for release at a site near Naked Island and this particular stock would be dedicated totally to the common property fishery with the hatchery taking no brood or cost recovery fish from it. In another remote release, the hatchery has been putting 20,000 silver smolts into the water near the village of Tatitlek in an effort to enhance the personal use fishery for the village.

Lake Recovery: VFDA has been clearing weeds from Rode Lake near Valdez for the past 4 years in an effort to reclaim the lake and tributary streams for wild salmon stocks and for recreation. In recent years weeds have choked the waterways and blocked silver and red salmon spawning streams. Weed cutting is just the beginning of what might be a major project to return the lake to previous levels.

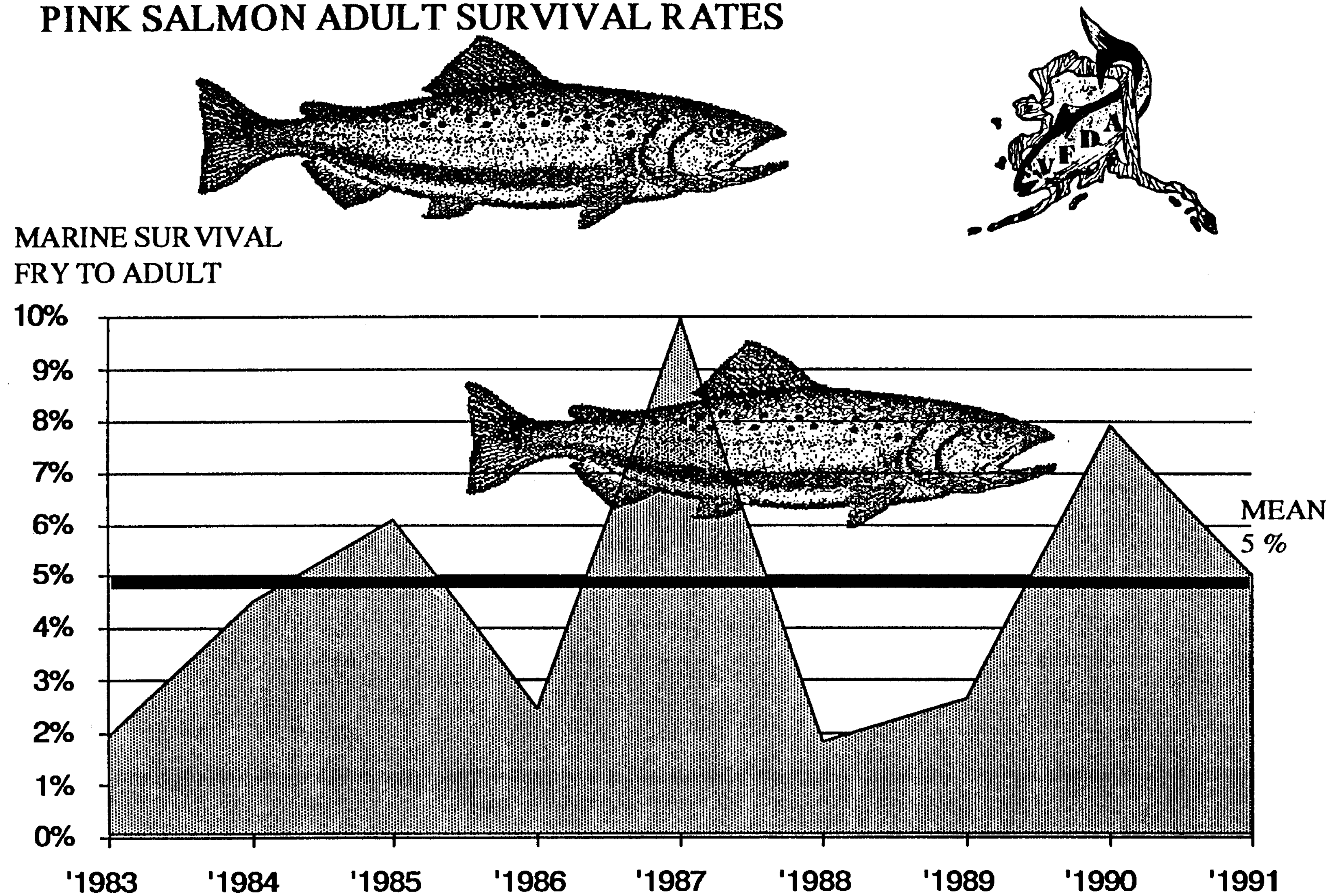
King Salmon: VFDA has a continuing project to establish a king salmon run in Port Valdez. Early efforts to imprint kings at Anderson Bay brought mixed results and the hatchery has begun a program to put the smolts in 6.5 Mile Creek just east of Valdez. The first of these, received from Prince William Sound Aquaculture Corp., went into the stream in June 1991.

Marketing: In the continuing struggle to meet its operating budget, VFDA has begun exploring creative ways of selling pink salmon taken for hatchery cost recovery. In particularly, hatchery officials are looking at the value-added market in convenience foods. The organization has been working with product developers, packaging corporations, experienced marketers and others in an effort to develop, process and market products to open new commercial outlets for pink salmon.

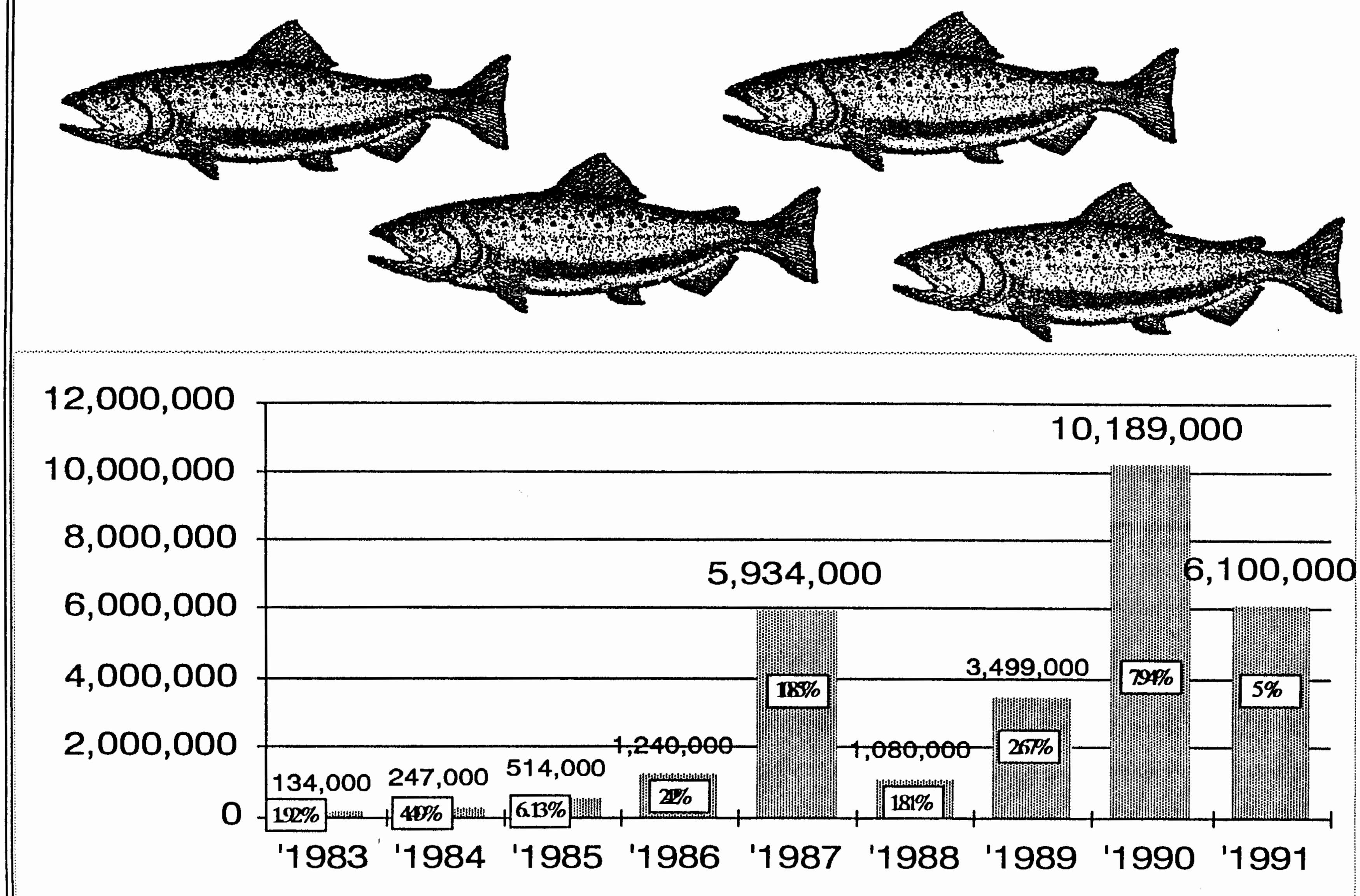
GREEN EGGS AND SALMON... EGG TO FRY SURVIVAL
VFDA PINK SALMON



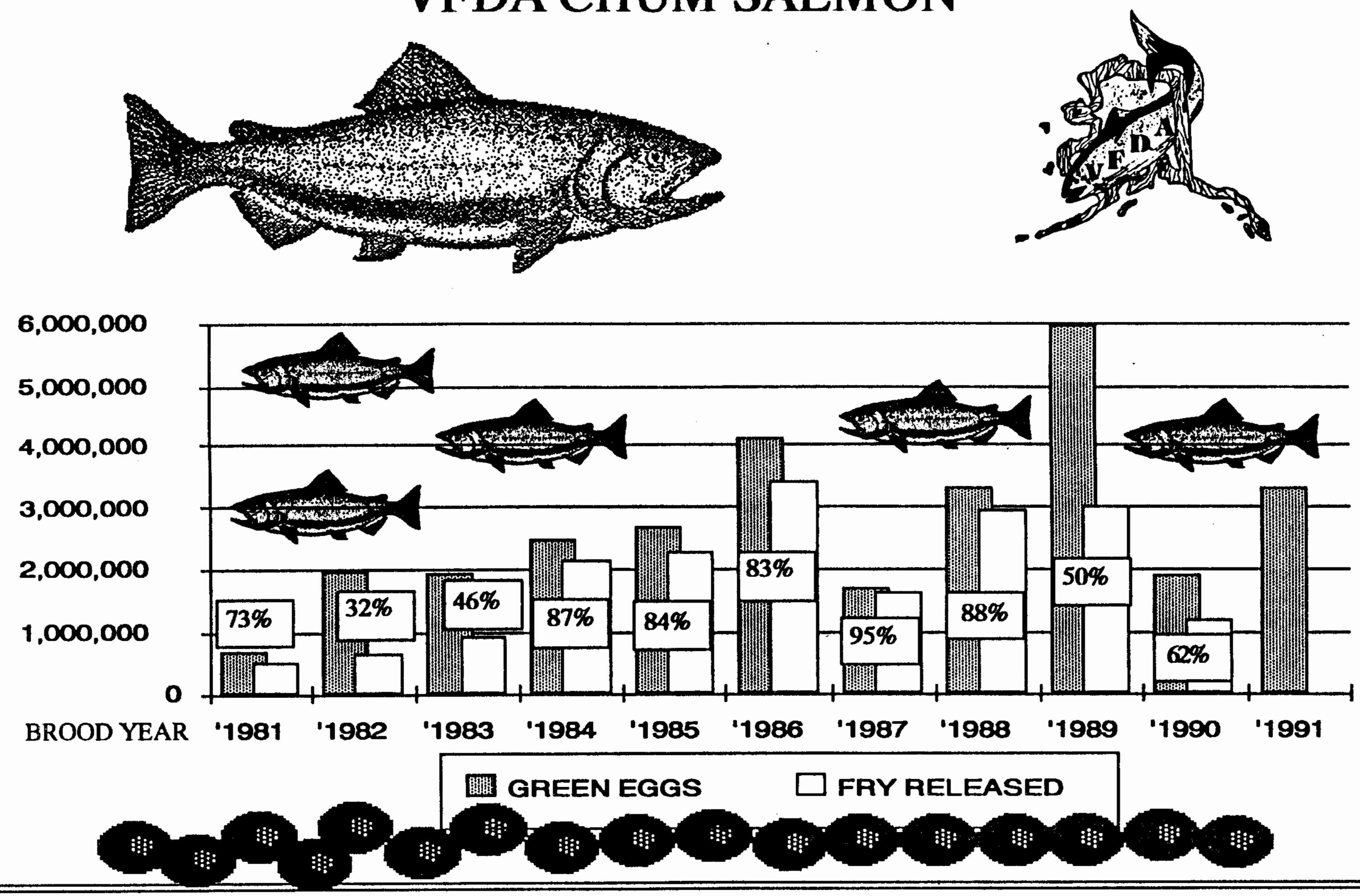
PINK SALMON ADULT SURVIVAL RATES

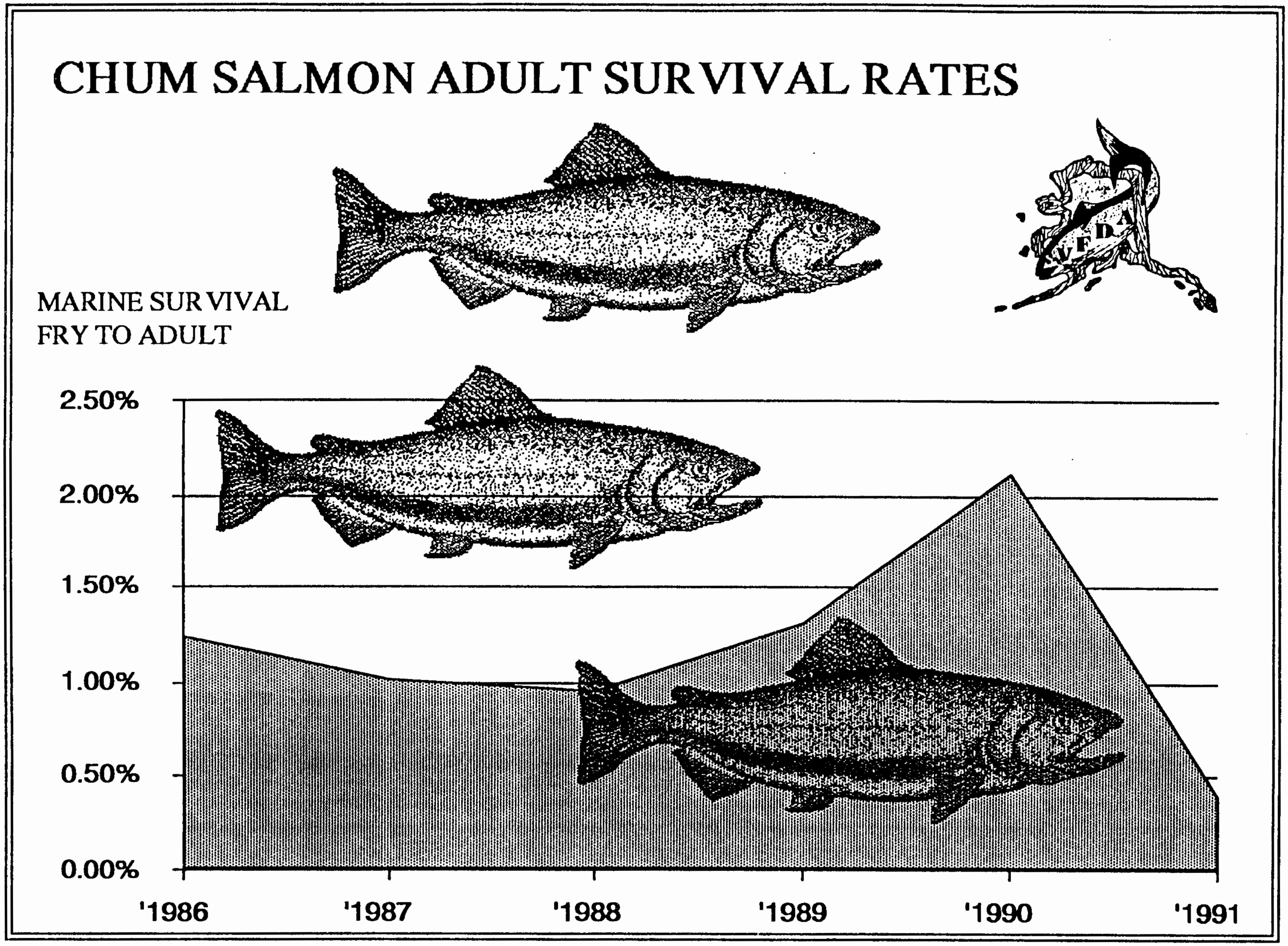


PINK SALMON ADULT RETURNS TO SOLOMON GULCH



GREEN EGGS AND SALMON... EGG TO FRY SURVIVAL
VFDA CHUM SALMON




CHUM SALMON ADULT SURVIVAL RATES
VFDA
MARINE SURVIVAL
FRY TO ADULT
2.50%
2.00%
1.50%
1.00%
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'1986
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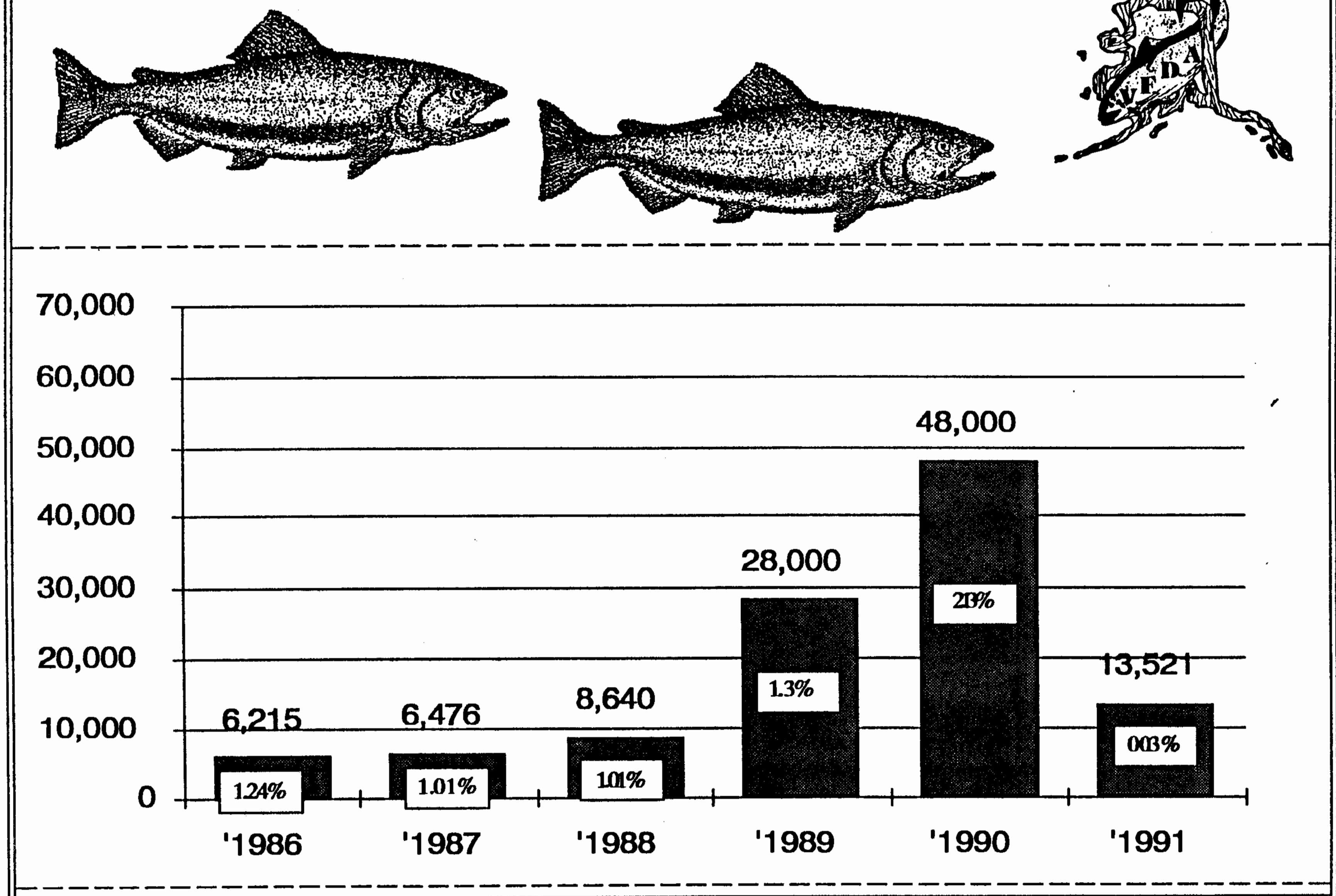
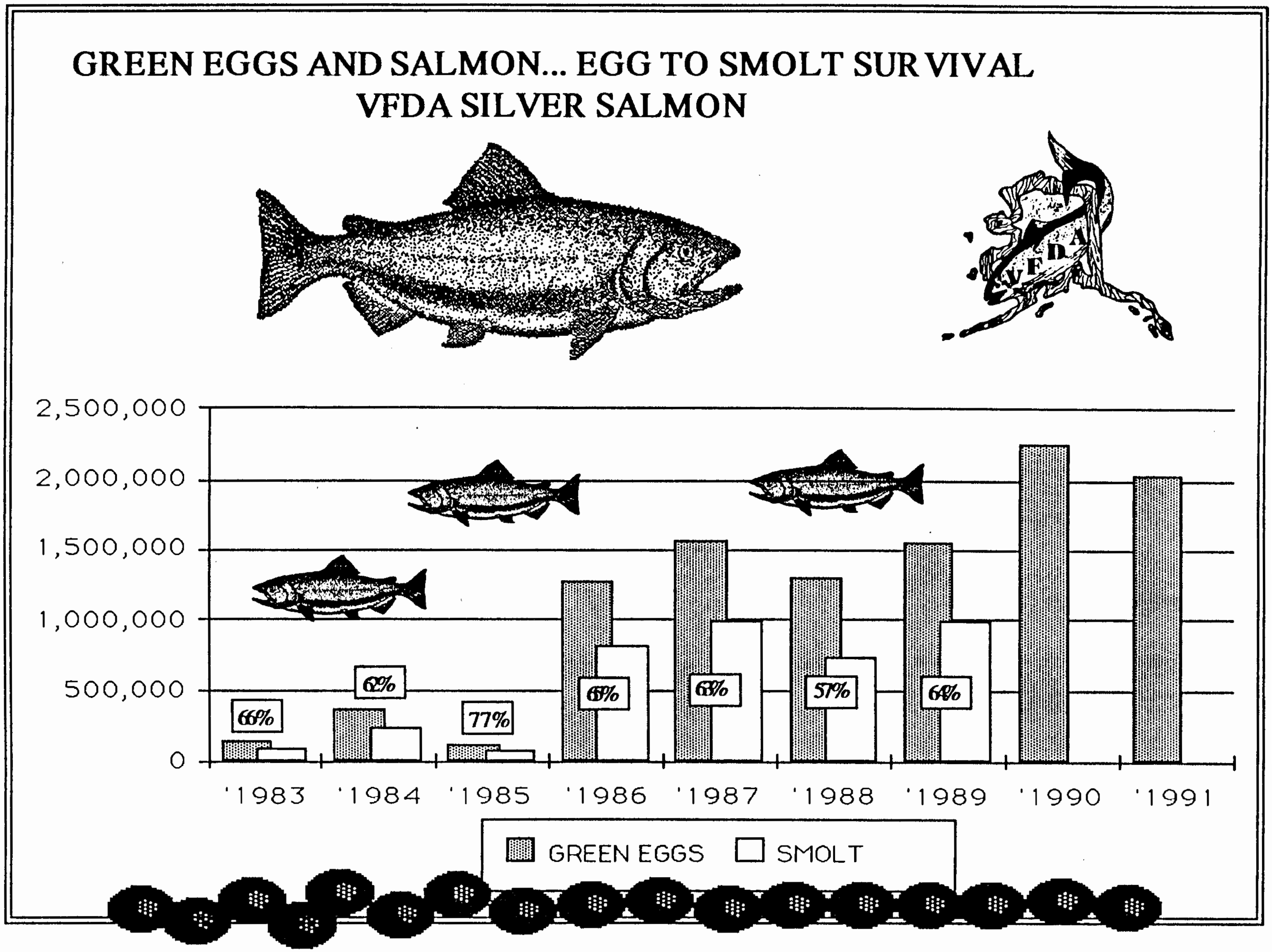
CHUM SALMON ADULT RETURNS TO SOLOMON GULCH




GREEN EGGS AND SALMON... EGG TO SMOLT SURVIVAL
VFDA SILVER SALMON
VFDA
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'1983
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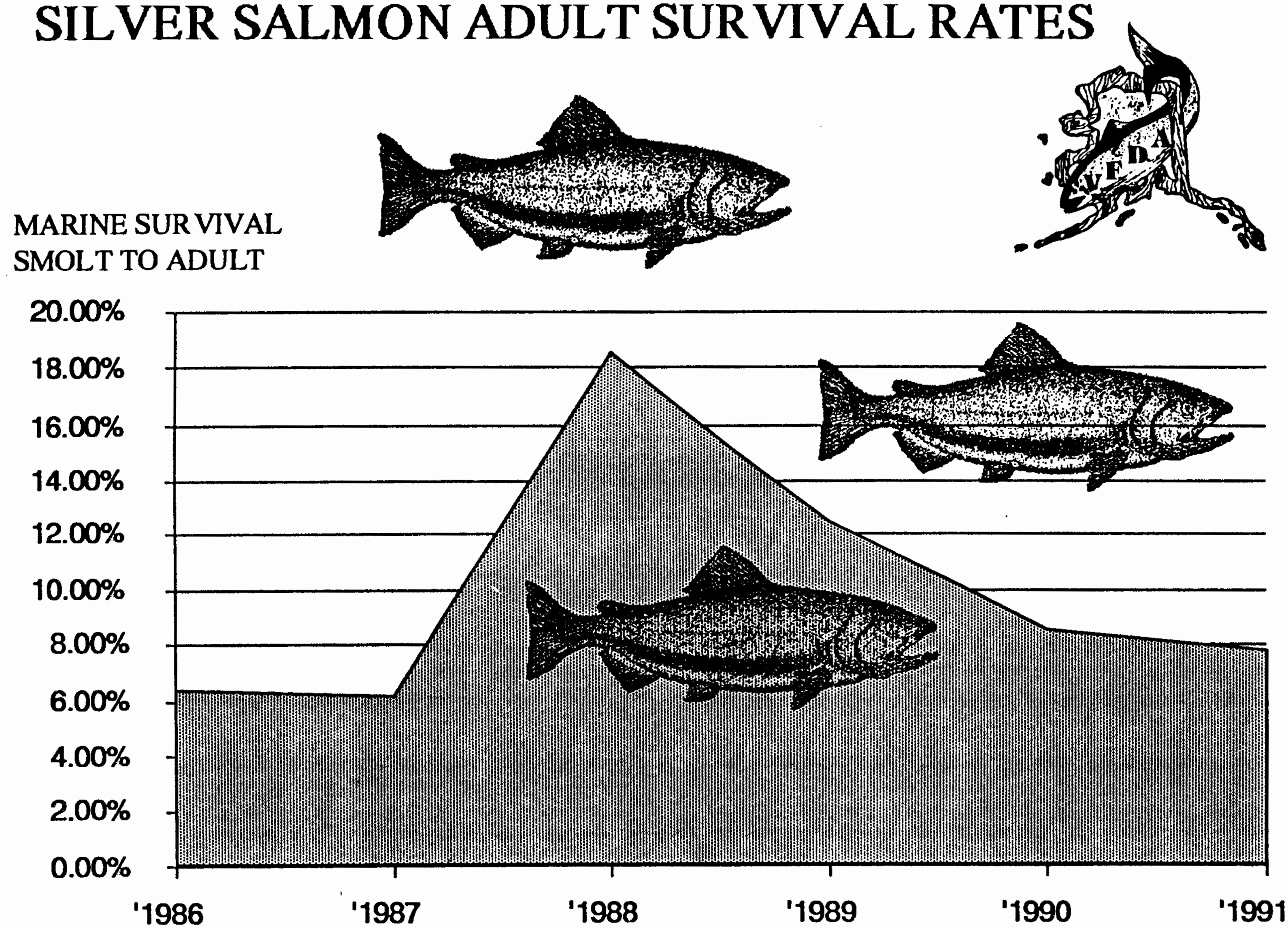
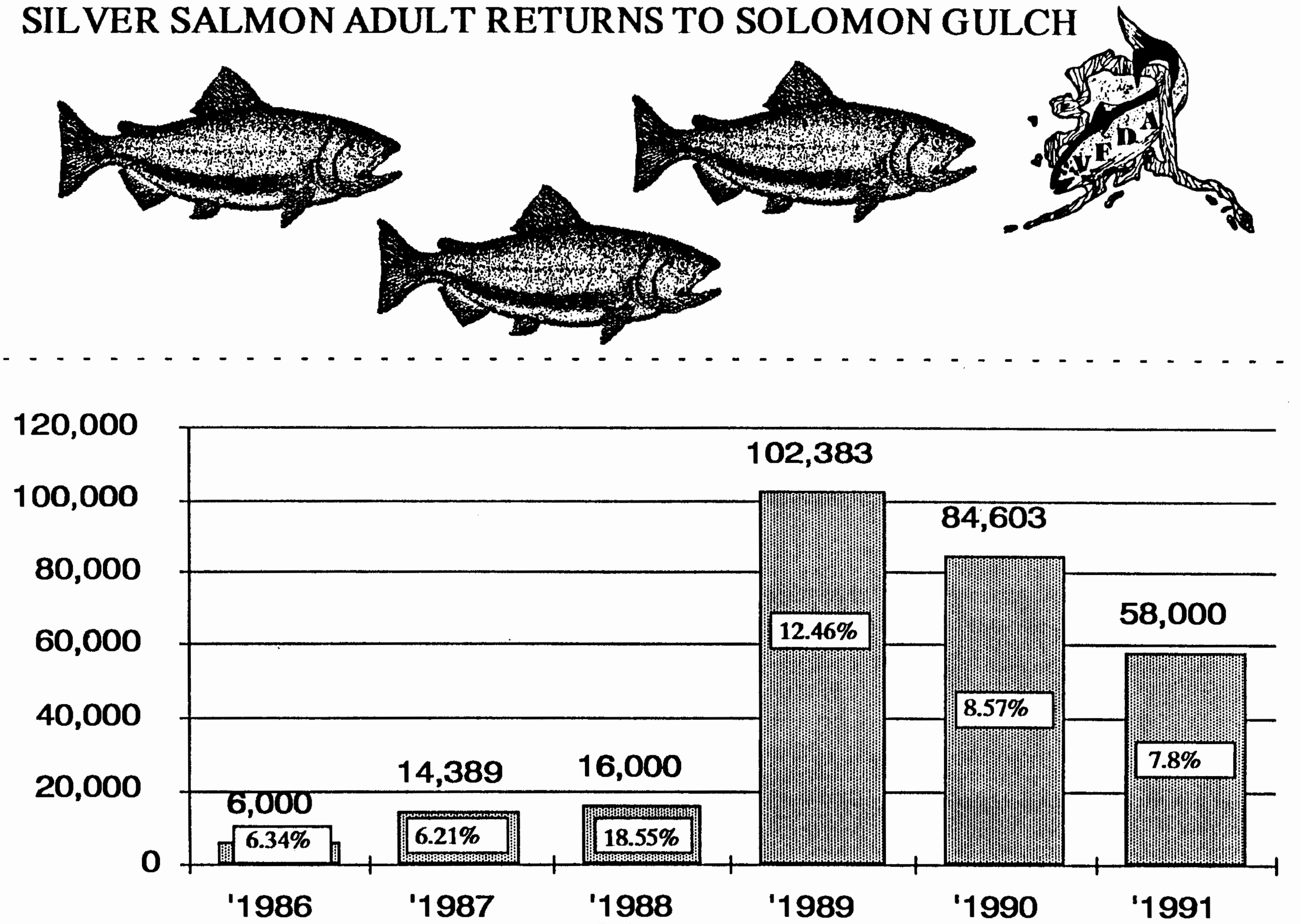
GREEN EGGS
SMOLT

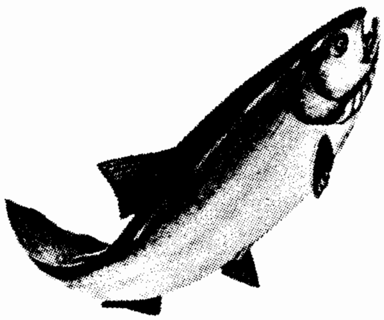
SILVER SALMON ADULT SURVIVAL RATES

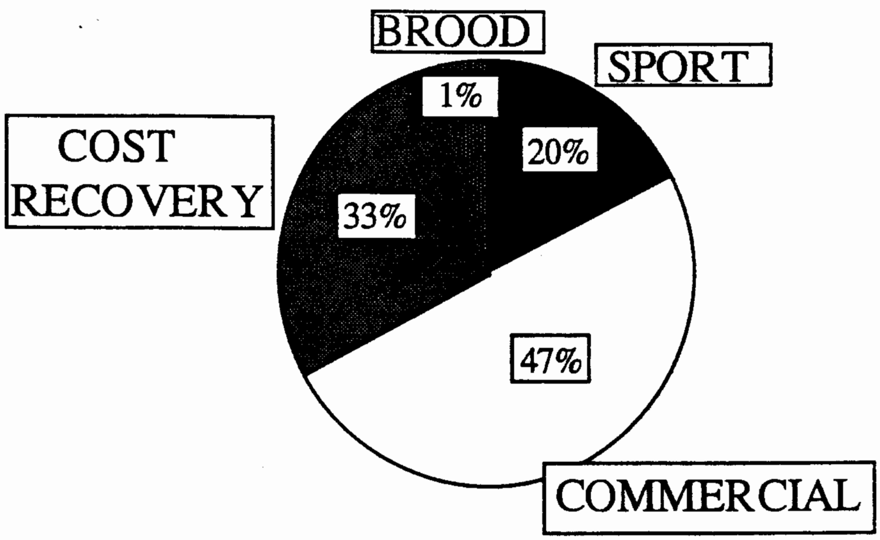


SILVER SALMON ADULT RETURNS TO SOLOMON GULCH



COHO SALMON ADULT RETURNS





TOTAL ADULT RETURNS 123,000

COMMERCIAL FISHERIES HARVEST	58,000
SPORT FISHERY HARVEST	24,000
VFDA COST RECOVERY HARVEST	40,000
BROOD STOCK	1,000

From a release of 742,000 fry in 1990

OVERVIEW OF THE YAKIMA/KLICKITAT FISHERIES PROJECT

STEVEN LEIDER
Washington Department of Wildlife
Kalama Research Station
Kelso, Washington

ABSTRACT

When Congress passed the Pacific Northwest Electric Power Planning and Conservation Act in 1980, they provided a mechanism for creation of the Northwest Power Planning Council and development of a regional Fish and Wildlife Program to address the impacts of hydroelectric dams on fishery and wildlife resources in the Columbia River basin. The Council recognized the restorative potential for anadromous fish in Washington's Yakima and Klickitat river systems and supported planning of an interagency supplementation project called the "Yakima/Klickitat Fisheries Project" (YKFP). This project is designed to be a long term effort to rebuild wild runs using progeny of naturally spawning returns from hatchery releases. The YKFP is now in the advanced stages of planning, and is expected to begin operations in about 1996, pending the outcome of an ongoing process of environmental impact (EIS) review. A primary emphasis of the YKFP will be to evaluate whether two concurrent goals can be achieved: (1) increase natural production and harvest opportunities, and (2) avoid unacceptable adverse genetic impacts to supplemented populations. In the planning process considerable attention has been paid to monitoring and experimental design needs, obtaining baseline genetic information on supplemented stocks, design of hatchery facilities and ponds in support of the required experimental needs, and development of genetically suitable hatchery operation practices. Given continued support by involved agencies and the public, and adequate funding from the Bonneville Power Administration, results from the YKFP should greatly aid our understanding of the degree to which hatchery production programs can be used to bolster harvestable wild runs while simultaneously protecting their genetic resources. This has special significance as populations of wild anadromous fish continue to approach threatened and endangered status in many parts of the Pacific Northwest.

PUBLIC OUTREACH AT DWORSHAK NATIONAL FISH HATCHERY

WAYNE H. OLSON, Hatchery Manager
Dworshak National Fish Hatchery
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Ahsahka, Idaho 83520

ABSTRACT

A series of colored slides was presented showing Dworshak's Public Outreach Event for National Fishing Week "1991". Further information regarding this presentation is available from the Hatchery.

Dworshak National Fish Hatchery in Idaho, held an "OPEN HOUSE", on June 15, 1991. With nearly 1,500 people in attendance, an overflowing parking lot throughout the day, beautiful weather, dedicated employees assisting, and 504 kids fishing--what more could one expect. Video and photos recorded the day--but one must have been there to actually "feel" the excitement and see the expressions on kid's faces after a most successful and positive fishing experience.

The success of this year's "Open House and Kids Free Fishing Day" is assurance for similar activities of this type in future years. Dworshak is making plans for next year's fun filled activities to be held on June 13, 1992.

A PIONEERING EFFORT IN TROUT CONSERVATION

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ABSTRACT

In 1931, following a shipment of 25,000 golden trout (Oncorhynchus aguabonita) eggs to the State of Colorado from California's Mt. Whitney Hatchery, Colorado reciprocated with 30,000 eggs from their Trapper's Lake stock of Colorado River cutthroat (Oncorhynchus clarki pleuriticus). Recognizing the unique character of this fish, J. O. Snyder, Chief of the California Bureau of Fish Culture, directed Mt. Whitney Hatchery Superintendent George (Jim) McCloud to rear and plant them with special care. McCloud's order was followed faithfully by his hatchery personnel. In 1953, Superintendent of Regional Fish Hatcheries Leon A. Talbot, who had been involved in the project in 1931, related this story to Phil Pister, a new seasonal aid in the Bishop Office of the California Department of Fish and Game. Talbot ended with a prophetic statement that: "Them little fellers may be valuable to someone some day."

Talbot's prophecy proved amazingly accurate, when in 1986 biologists from the U.S. Fish and Wildlife Service requested a shipment of the descendants of these fish to bolster stocks in Colorado, which showed indications of hybridization with other cutthroat subspecies. The story that follows relates the drama of this successful relocation from the Williamson Lakes (lying underneath the north shoulder of 14,375 foot Mt. Williamson) into the Bench Lake drainage of Rocky Mountain National Park on August 19, 1987, more than a half-century later.

SESSION 2

GENETICS/BROODSTOCK

IMPRINTING AND TRAPPING COHO SMOLTS IN PONDS USING CONSTANT WASTEWATER-SEAWATER FLOWS, APRIL 1991.

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ABSTRACT

Three decades after the City of Arcata approved the concept of studying the rearing of salmon juveniles in wastewater-seawater mixtures at the city's sewage treatment facility on Humboldt Bay, a pumped flow of disinfected STP effluent mixed with Humboldt Bay seawater became available for fish culture applications. During April 1991 mixtures were used to imprint smolts and operate an out-migrant coho smolt. During April 1991, two ponds were used for the study. One pond reared rainbow trout with supplemental feeding. A second pond reared coho that fed only on natural foods. This paper documents: the water quality in both ponds under the wastewater-seawater additions; size, growth and behavior of out-migrant coho; trout and coho survival rates in the ponds; bacterial levels in pond water and trout flesh; food habits of coho and trout; and polyculture of sturgeon for pond sanitation. Operational problems and improvements in existing recirculating fry rearing and egg incubation systems and future programs are also described.

INTRODUCTION

Rearing of smolts in 1/3-acre ponds supplied with stabilized mixtures of seawater and Arcata oxidation pond effluent began with pilot-project experiments in 1971. Such rearing was under static conditions with only minor additions or removals of seawater or wastewater made to maintain pond salinity and/or pond water levels. In April 1990, we initiated the first use of a flow-through operation. Disinfected effluent from Arcata's sewage treatment plant (STP) was piped to South Pond (Figure 1) to imprint coho smolts with a mixture of Humboldt Bay water and STP effluent (Allen and Hull 1990). In March 1991, this water delivery system was enlarged to allow mixtures of STP effluent and Humboldt Bay seawater to be used in a flow-through mode to meet salmon culture functions as follows:

1. Freshwater for salinity control in ponds,
2. Nutrients for maintaining pond productivity during smolt grow-out,
3. Water to operate out-migrant (smolt) traps,
4. Water for smolt imprinting studies, and
5. Water for attracting returning adults and operating a fishway and adult trap.

This paper reports on the use during March and April 1991 of seawater-wastewater mixtures for the first four functions noted above. Primary emphasis of this report is on trapping, size, and behavior of coho smolts associated with the water quality during the continuous flow of wastewater and seawater through the ponds in April 1991.

MATERIALS AND METHODS

Effluent Delivery System

Pump and piping for bringing treated wastewater effluent to South Pond for imprinting coho smolts was first installed in spring 1990 (Allen and Hull 1990). This system was extended in March 1991 to allow delivery of water to the SE corner of Yearling Pond No. 2 (YP_2) (Figure 1). A pump was placed in the sump of South Pond near the pond headgate which allowed mixing of saltwater with the treated wastewater. South Pond outlet was baffled to provide a 2-foot water level over the pump at low tide. A 4-inch knife valve in the seawater pipe allowed for controlling the final salinity of the seawater-wastewater mixture which entered the SE corner of YP_2 after passing through a 27-cubic foot concrete mixing box fitted with forced-air aeration. Water pumped into YP_2 then flowed into Yearling Pond No. 1 (YP_1) through a 4-inch diameter pipe located between YP_1 and YP_2. In March 1991, an 8-inch diameter pipe was installed through the north bank of YP_1 to drain from YP_1 into South Pond. Both YP_1 and YP_2 were operated as static systems during the 1990-91 rearing season until March 1991, when the new flow-through wastewater-bay water delivery system was initially tested. Continuous flow-through operation began in April. Pumps were turned off over-night on several occasions in response to water quality concerns and hydraulically overloading YP_2 when the 4-inch drain between YP_1 and YP_2 was unable to all handle flows entering YP_2 (rainfall, recirculated smolt trap water, wastewater-bay water). South Pond headgate remained opened during the entire 1990-91 season except for 2 days when treatment plant effluent and bay water were used in a static system to imprint coastal cutthroat trout prior to release to Humboldt Bay.

Hatchery Improvements

Closed System Incubator

Egg incubation used four banks of Heath Trays, with 8 trays per bank. Water was pumped to the trays from a 500-gallon reservoir located below ground on the outside of the north wall of the "fish barn". Water returning from the incubator to the 500-gallon reservoir passed through a counter-current foam fractionator for removing egg hatching enzymes and dissolved organics located in the reservoir. Water leaving the incubator passed through a short commercial-type plastic Bio-Media fixed-film reactor for additional water quality treatment.

Recirculating Rearing System

Fry and fingerlings were reared in an upgraded recirculating system also located in the fish barn adjacent to ponds (Allen et al. 1989; Allen and Hull 1990). The system contains approximately 2,000 gallons total volume with a maximum flow of 45 gpm at operating volume (Bukosky 1990) (Figure 2). The largest unit (approximately 800 gallons) is a two-chambered reservoir which has the anterior chamber fitted with layered plastic floor matting, volcanic rock, and oyster shell. The three trickling filter units contained plastic and oyster shell media with water fed to the media by rotating spray bars. A greenhouse unit of about 200-gallon capacity utilized a native plant (pennywort, Hydrocotyle umbellata) in 1990-91 for nitrogen removal. About 10% of the recirculated water was passed through a UV-sterilizer unit not shown in Figure 2. The recirculating system, when allowed sufficient conditioning of bacterial beds prior to fish rearing and supplemented with aqua-bacta-aid (ABA) bacterial media, was very efficient in reducing NO_2 and NH_3 (Bukosky 1990).

SOURCE OF FISH

Coho salmon used in DSM studies in YP_1 came from eggs taken from adults returning to the Humboldt County fish hatchery located on Lost Man Creek, a tributary to Prairie Creek which flows into Redwood Creek near Orick, Humboldt County, California. About 5,500 fry available from incubation and rearing conducted both at the Arcata facilities and at the Humboldt State University fish hatchery were placed in SP_1 for summer rearing on pellet feeds. On 27 November 1990, 1,900 parr (12 cm fork length and 19 fish per pound) (34% survival) were marked with a RV clip and released into YP_1. The coho parr in YP_1 were then allowed to grow to smolting on natural food organisms in the pond.

Trout for stocking Klopp Lake in the Arcata Marsh and Wildlife Sanctuary were reared in YP_2. Shasta-strain fingerling rainbow trout (3,900; 100/lb) from HSU were transferred to the Arcata recirculating rearing system on 19 May 1990, and grown until 7 November 1990, when 3,320 advanced fingerlings (17/lb; 85% survival) were released unmarked into YP_2. The trout were fed at 1.5% body weight per day using Rangen Silver Cup dry pellets.

Coastal cutthroat trout fingerlings (1,350; 15/lb) were obtained from the HSU hatchery and placed into SP_1 on 29 November 1990 following removal of coho. These trout were surplus production from a joint program between HSU, California Department of Fish and Game, and the City of Arcata to develop a coastal cutthroat brood stock for enhancing recreational fisheries in northern California coastal lagoons. On April 5, 1990, 1,073 coastal cutthroat trout averaging 3.7/lb were removed from SP_2 (70% survival). Of these 896 were marked by removal of the right maxillary and released into South Pond for imprinting and migration to Humboldt Bay. The remaining were retained at the Arcata ponds as broodstock.

Coho egg and fry rearing in the Arcata recirculating systems suffered serious losses from operational problems. The major units of the rearing system were constructed in 1989, upgraded in early 1990, with additional improvements in the summer of 1991. Units were re-arranging to maximize the limited floor space in the fish barn and to upgrade the efficiency of rearing and incubating system filters. The incubation system went on line only a short time before arrival of eggs, as did the rearing system prior to transfer of fry from incubators. There was insufficient time to allow the systems to establish the necessary microbial population on the filter media. Also a supply of ABA did not arrive until after coho incubation and rearing. Hatching began 1 week after receiving eggs in temperatures of 50°F. Sac fry in the incubator began showing signs of stress within days after hatching. Total NH_3 of 6.0 mg/l and NO2 beyond the scale on our Hach Kit (>1 mg/l) was associated with a pH level of 7.5. Numerous water changes caused NH_3 levels to drop but NO_2 levels remained elevated. Fry mortalities were high and stress was being shown by fry after a month. In addition to water quality in recirculating systems, eggs developed coagulated yolks and stressed fry developed a series of bacterial diseases and asuspected but unconfirmed columnaris-like disease. Disease problems were treated with Romet-B antibiotic, as well as formalin and salt baths. Less than 5% of eggs received survived for release into SP_1 in early July. HSU coho fry added later in the season to the recirculating system survived at a much higher rate (approximately 50%). When larger rainbow fingerlings reared in the conditioned system during summer survivals approached normal levels (85%). Improvement in the system performance was due to properly matured and functioning bacterial beds.

Smolt Collecting

During April 1991, smolts were removed from Yearling Pond No. 1 using two different smolt traps. Smolts have been removed from YP_1 since its construction in 1981 by a trap located in the southwest corner of the pond (Figure 1). A downstream current is simulated by pulling water through a 1-ft diameter pipe located about 2 ft below the surface of the pond into a sump fitted with a cone entrance. Water pumped through the trap was recirculated to YP_2, which returned to YP_1 by a pipe connecting the two ponds (Figure 1). Outlet from YP_1 to South Pond consisted of three 10-ft lengths of 8-inch diameter asbestos/concrete water pipe. The first 20/ft of pipe leading from YP_1 was level, with the last 10-ft with a slight decline. Water leaving the pipe drained into a 2 cubic foot smolt collecting box located just inside the south bank of South Pond (Figure 1). The box was housed in a water basin made of cinder blocks lined with hypolon. The collecting box was a rebar framed covered with 1/4 inch vexar mesh. A plywood lid fitted with a small rectangular opening guided water and smolts from the outlet pipe into the trap. A vexar collar prevented smolts from escaping into South Pond during extreme high tides when the box became inundated. Water was about 3 inches deep at the entrance to the pipe draining YP_1. Flow from YP_1 to South Pond when seawater-wastewater mixtures were being pumped into the pond system was roughly 150 gallons per minute maximum. Pumped flow via the subsurface pipe into the SW corner smolt trap was 50 gallons per minute. Water flow out of YP_1 was not constant (due to operational changes and rainfall as noted previously) with most flows roughly twice that of the SW smolt trap.

The YP_1 SW smolt trap with subsurface entrance was operated during the entire coho rearing period since it was part of the water recirculation between yearling ponds as noted previously. The smolt trap located at the end of the YP_1 drain to South Pond (North Bank trap) was placed into operation during the afternoon of 13 April 1991. Both traps were then operated continuously until the afternoon of 26 April when YP_1 was drained and remaining coho were removed.

Water clarity in YP_1 was sufficient to readily observed smolt behavior around the entrance to North Bank trap. An observation blind of brush was constructed on the west side of the trap entrance. A plywood sheet was extended about 1 ft over the entrance to the pipe. From the blind smolts could be observed at a distance of only a few feet. A special study as described later utilized smolt catches and observed smolt behavior at the pipe entrance.

Smolts were removed from traps as frequently as time, personnel, and need required. Smolts removed were counted and measured for fork length (centimeters). The degree of regeneration of RV clips, if any, was recorded, and regenerated fins reclipped. Smolt condition and pathologies were recorded for each fish. After capture and processing, smolts were released immediately into South Pond for migration to Humboldt Bay during tidal exchanges.

Smolts not migrating from YP_1 to South Pond were removed on 26 April by pond draining and seining. All smolts were hand counted and released into South Pond for imprinting and migration to Humboldt Bay. A random sample was held for length/weight analyses. Regenerated RV fin clips in smolts from pond draining were not reclipped.

Monitoring the degree of residualization of DSM smolts trapped and released into South Pond was conducted before residual smolts in YP_1 pond were removed by draining. Single sweeps were made with a 10-foot minnow seine through the South Pond sump at low tide on 23 and 24 April 1991.

WATER QUALITY

Water quality values within the Arcata sewage treatment system and effluent discharged to Humboldt Bay were obtained from the Department of Public Works monitoring records required under their NPDES permit (Table 1). The permit requires monitoring of STP effluent entering the Arcata Marsh and Wildlife Sanctuary enhancement ponds since the discharge goes to a public recreation area (Outfall No. 2), and for STP discharges to Humboldt Bay, "waters of the state" (Outfall No. 1). STP effluent to the AMWS is disinfected by chlorination but not dechlorinated, while the effluent entering Butcher Slough (Humboldt Bay) is a mixture of secondary-level treated water from the treatment plant and AMWS effluent which is both disinfected using chlorine and dechlorinated with sulfur dioxide (Table 1).

Physical and chemical parameters of pond waters were studied only sporadically during the fish rearing season from November 1990 through March 1991 (Table 2). From September 1990 through March 1991 temperature, salinity, dissolved oxygen, and clarity were determined for each pond each month. With the introduction of seawater-STP effluent establishing a flow-through regime, sampling frequency was increased to daily observations, except weekends, and total N-ammonia, nitrite, nitrate and pH were added to the monitoring. Sampling of water from the mixing chamber was also conducted during the flow-through experiment. From 27 March through 26 April sampling sites for pond water were at the outlet pipes to YP_2 and YP_1. Previous studies of YP_1 have shown that the forced air aeration system employed in both ponds effectively prevented stratification, with pond waters always well mixed. Pond water values from late March through April are reported graphically (Figures 3,4).

Nitrogen values were obtained by use of a Hach ammonia test kit designed for marine use. In spring 1990, such a kit was compared with values taken with an Orion 701 ammonia probe (Petersen 1991). Three tests were run. A test was a simultaneously comparing of values obtained by the kit and the probe on four freshwaters (H.S.U. tank rearing catfish; H.S.U. recirculating system's sump; H.S.U. wildlife building recirculating aquarium sump; and a small spring outside the H.S.U. fish hatchery that drains water from under the H.S.U. men's gymnasium). Hach kit was also used to obtain values on the known standard solutions prepared for the Orion probe calibration curve. Hach literature states error as high at +16% can occur in testing very low salilnity water, distilled or fresh waters. Petersen's results showed a 30% difference with some values with a 70% difference. Differences were maximum at the lower ammonium concentrations

(0.01 and 0.01 ppm NH_3-N). Therefore, nitrogen species values must be viewed as first approximations to true values and are primarily useful for temporal comparisons within our systems.

Water quality in YP_1 and YP_2 rearing ponds was quite similar throughout the year except for clarity. In mid-October YP_1 became clear (Secci disc disappearance always beyond the range of the instrument: >100 cm) and remained clear during April when marsh-oxidation pond effluent was pumped into YP_2 (Figure 3). With the large complement of trout in YP_2 under a 1 1/2% body weight per day feeding program plus the addition of marsh-oxidation pond effluent, the clarity of YP_2 decreased, and oxygen levels often fell below 5.0 mg/l. When levels fell below 5 mg/l, oxygen was added by spray-pumping of recirculated pond waters. Gasoline-powered water pumps (2-inch/3-inch diameter delivery pipes) were used singly or together as necessary. Salinity (low of 14 ppt to high of 17 ppt) fluctuated in YP_2 in response to the ratio of baywater and effluent pumped into the pond (Figure 3). Dissolved oxygen and pH values in YP_1 were higher than YP_2 during April (Figure 2), but fluctuations in values in the two ponds paralleled each other. Temperatures in both ponds were uniformly cool (15°C) for April in comparison to recent years, with little variation around the 15°C level (Figure 3, YP_1 temperatures only).

The level of total ammonia in the STP-seawater mixtures delivered to YP_2 was routinely higher than could be measured with Hach Kit. Total ammonia dropped to a 1-2 mg/l range in YP_2 and was always less than 1 mg/l in YP_1 (Figure 4). High levels of nitrite characterizing incoming treatment plant effluent-bay water mixtures produced high levels (1.5-3 mg/l) in YP_2 in early April, with values falling below 0.5 mg/l in both ponds during the remainder of the month. Low nitrate values in incoming marsh effluent were elevated in both YP_1 and YP_2, and with parallel fluctuations occurring in both ponds throughout April (Figure 4).

YP_1 water was always clearer than YP_2 whose values also had much greater daily variability, with YP_2 pond always having a visually noticeable phytoplankton population (Figure 3). Both the particulate matter in bay waters and photoplankton associated with treatment plant effluent (values up to 20 mg/l) (Table 1, Outfall No. 1) contributed to the lessened clarity in YP_2. Treatment plant effluent entering YP_2 during April had BOD values of 11 mg/l or less (Table 1) thus contributing to the pond's oxygen demand and contributing to the lower DO levels.

Although we attempted to control clarity by trying to encourage the establishment of <u>Entomorpha</u> (macrophytic algae) by planting the algae harvested from Humboldt Bay, the ponds were eventually dominated by a brown chain-diatom which heavily colonized all of the underwater reefs constructed of brush and tree branches and especially those in YP_1.

Ponds were initially filled with baywater in September, then diluted with treatment plant effluent during September and October. A bioassay with rainbow trout was conducted using a floating pen in YP_2 in late October and produced a 40%

temperature 54°F and a salinity of 16.7 ppt) produced no mortalities. Trout were mortality (water temperature 60°F (15.5 C), 21 ppt salinity, and D.O. 6 mg/l). A second bioassay on 1 November (with water transferred to YP_1 on 27 November 1990 as noted previously. The single cage bioassay served for both ponds since a constant recirculation of water was maintained between ponds.

RESULTS

Survival and Growth

About 1,600 coho smolts and 13 parr were recovered from YP1 representing an 85% survival over the 150-day rearing period (Table 3). Trapping removed 42% of the smolt population by 26 April when the pond was drained. Most smolts were from 13-15 cm and averaged 16 fish per pound in weight. Only a few smolts attained 17 cm, in contrast to coho parr grown in SP_1 during the summer which were fed pellets and produced smolts up to 20 cm (Figure 5). These larger smolts found in SP_1 were released to South Pond, not to YP_1. Coho in YP_1 in 1991 did not develop a bimodal length distribution. Fast-growing parr are characteristic of coho reared in hatcheries under artificial feeding. A bimodal population developed in the coho reared in YP_1 in 1990 under supplemental feeding (Allen and Hull 1990).

Coho smolts taken in the North Bank smolt trap (14 cm mode) averaged slightly larger than the smolts recovered from pond draining (13 cm mode) (Figure 5). Size of smolts during out-migration varied little in mean and range in size in both the North Bank trap (Figure 6) or the SW trap (Figure 7), with smolts in both traps about 14 cm in length.

Shasta-strain rainbow trout reared in YP_2 with supplemental feeding had a 75% survival, averaged 2.1 fish per pound, and had developed a marked bimodal size distribution. An estimated 60% of the fish averaged over 22 cm fork length and appeared to have a high condition factor. The smaller-sized trout were comprised of many fish that had not grown much over their initial average planting weight of 17.2 fish per pound.

The inadvertent release of rainbow trout into YP_1 provided a fortuitous opportunity to compare the size of trout feeding only on natural foods with the same stock reared in the same culture water but under an artificial feeding regime (Table 4). Trout in YP_1 under the relatively low population density of coho and trout, grew on the average as large as trout in YP_2. In addition YP_1-reared trout were all relatively large with but a single mode, in contrast to the bimodal length distribution of YP_2 trout. Trout growth in YP_1 probably was related to the relatively large supply of natural food to each trout. Energy from food could be primarily used for growth due to the availability of readily defendable feeding territories. Food supply-territoriality and dominance interactions could have produced both the stunted trout and exaggerated bimodal size distribution in YP_2, as well as the opposite in YP_1 (no stunted fish, and with a large mean size with little variance). Payne (1972) demonstrated this possibility for trout in tank experiments.

Time of Migration

Coho

Two peaks of coho smolt migration were observed during April 1991. The first occurred on new moon (15 April), and the second beginning just prior to pond draining and the approach of full moon (26 April) (Figure 8). All migration occurred during a period of very uniform pond temperatures beginning on April 1 when water temperatures rose to around 15°C and remained virtually unchanged throughout April (Figure 9). Pacific storm tracks during this period either went to the north or south of the project site, with only minor weather fronts passing through the area. The initial pulse of smolts followed a day when the only significant rainfall occurred during the smolt outmigration study period. It was also a period of decreasing barometric pressure (Figure 9), which preceded the peak out-migration period from April 14 to 18 (Figure 8).

Most trapped smolts released to South Pond had migrated to Humboldt Bay prior to pond draining on 26 April as shown by only three RV coho seined from the sump on low tide on 23 April and two RV coho smolts on 24 April 1991. Similar rapid emigration to Humboldt Bay from South Pond was also recorded in spring 1990.

Smolt traps in YP_1 were only in operation simultaneously during 13 days of the out-migration period studied (Table 5). These data showed no obvious preference by smolts for either surface or submerged trap entrances, trap location around the pond, as well as no correlation with volume of water operating the traps.

Shapovalov and Taft (1954) observing wild coho in Waddell Creek, noted that:

"The migrating fish move downstream in schools. The size limits of those schools have not been determined, but those seen were composed of some 10 to 50 individuals. It is possible that their size is influenced by the size of the stream and the total population of migrants. It is likely that individuals of the same general size school together."

The senior author, on 14, 15, and 17 April, made a special study of smolt migration in YP_1 in an attempt to determine if coho smolts were schooling by size. The procedure was to clear the North Bank smolt collecting box, then to observe smolt behavior at the mouth of the pipe entrance. When smolts had streamed or schooled off the pipe or smolts had actually been observed entering the pipe, the trap was then emptied again of smolts (Table 6). During the 3 days, eight clearances of the trap produced catches of from zero to four smolts on six attempts and seven smolts on two attempts. The small number caught plus the range in size of smolts did not indicate any schooling by size of smolts trapped. Despite no conclusions from the study of trapped smolts, the size of smolt schools and average size of individual smolts in the schools in front of the North Bank pipe entrance observed from the blind seemed to conform to Shapovalov and Taft's suppositions.

Some singular behavioral events were recorded during the specialized study. Chumming with masticated french fries could bring swarms of smolts from deep water adjacent to the pipe entrance. Some of these smolts actually chased food down the pipe only to return to the pond. Smolts recorded as entering the pipe dashed in head-first, and in a single instance, one smolt from a school of three seen entering the pipe, re-emerged after several seconds in the pipe. There was no factor that could be associated with times of largest smolt trap catches (17 April, 26; 7 smolts). On 26 April large schools were passing close to the pipe, while on 17 April very little streaming of schools of smolts were noted off the pipe entrance (Table 6).

A second method of studying the possibility of schooling by size was that of plotting length frequency of smolts taken in traps during 4 days of peak out-migration (Figure 10). The traps were on opposite sides of the pond and could be attracting smolt schools containing difference sized fish. On 2 days (15, 17 April), smolt lengths in the two traps were similar and during two days (14, 16 April) there were differences in size of smolt trapped at the two different trap locations. We intuitively felt that there was schooling by size, as noted previously, particularly on several days when initial migrants trapped were larger than fish taken late in the day, but there were days when average size in traps did not change during a day's catches. Since the range in size of the entire smolt population was narrow, daily mean size of smolts may have masked actual schooling by size in the small schools entering the traps (Figures 5,6).

Smolt catches on other days had interesting idiosyncratic patterns. Wastewater-seawater supply to YP_2 was cut off on 20 April as part of managing oxygen levels in the pond. Water flows in the North Bank trap dropped to only 30 gallons per minute. No schooling or streaming was noted off the North Bank trap. Both North Bank and SW corner trap caught only two smolts (Table 6). On 21 April, however, 43 smolts were taken in the SW corner as compared to only a single smolt in North Bank trap.

Our records are ambiguous as to whether North Bank trap flows had been restored to normal levels. On 24 April a dramatic shift of wind from a WNW direction to SW occurred without any noticeable change in barometric pressure. This change in weather did not produce any change in out-migration behavior. A dramatic increase in out-migration was recorded for the night of 25 April, when the third largest daily catch occurred. During the day a small storm front passing the study site resulted in the second largest rainfall of the migratory season (Figure 8). No noticeable barometric pressure change was shown in the records. The wind shifted from SW to NNW by late afternoon. Since there was no change in water flow or temperature, and the new moon effect was not a factor, what actually were the environmental cues to the DSM behavior remains ambiguous. We were not able to record any day-time behavior on 26 April since the traps were inoperative early in the morning due to pond draining.

Other singular but interesting observations included the absence of any streaming or schooling on 18 April following the third largest trap catch on 17 April; 18 April was a dull, overcast, windless day. On 15 April, when the peak daily catch was recorded, the day-time catch in the NW trap (subsurface entrance) was virtually zero until late in the afternoon when most of the smolts seemed to have schooled and entered the trap in one or two large schools.

Influence of depth of pipe entrance on smolt catches was also analyzed by noting the number of days in which traps had the highest, lowest, or similar catches (less than five fish difference in trap catches) (Table 7). The number of days with higher, lower, or similar catches in the two traps either by day or night, or combined, were almost the same. Night-time catches could have resulted from early-morning movements but we made no over-night collections of trap catches to study this possibility.

<u>Trout</u>

We had planned to operate the YP_2 smolt trap for examination of the possibility that migratory behavior might be exhibited by Shasta-strain rainbow reared in YP_2. State planting policy directed all production to be released into Klopp Lake for recreational fishing. Consequently, we did not operate a smolt trap in YP_2. We were, however, able to study out-migrant behavior of rainbow trout released in error to YP_1 as noted below. Of the total 60 trout recovered from YP_1, 4 smolt-like trout were actually recovered from traps from 13-18 April (Table 4) and another 5 trout of the 37 recovered on 28 April during pond draining were deemed "smolt-like" from external appearances. Size of trout taken in traps were slightly smaller than the size of smolt-like trout recovered on pond draining (Table 4). Thus about 15% of the Shasta-strain rainbow reared in the brackish-water environment exhibited some smolting characteristics, either external appearance or DSM behavior, or both.

Trout and Coho Feeding Habits

Over 60 (Table 4) of the rainbow trout released into YP_1 by mistake prior to coho stocking represented a potential source of predation on coho. Gillnets and seal bombs proved ineffective in removing the trout from the pond. During late March and April, feeding habits of rainbow trout and coho was studied by examining the digestive tracts from fish recovered by angling, from smolt traps, and during pond draining (Table 7). Whole items were enumerated wherever found throughout the digestive tract, otherwise only gross estimates of numbers were recorded. Volume of materials in cardiac and pyloric portions of stomach was recorded in quantitative categories by visual estimation as full, 3/4, 1/2, 1/4, 1/8, and 0 (empty or trace). Range in size of selected ingested items were measured in millimeters.

No evidence of rainbow trout feeding on coho were found as no vertebrae, scales, or other fish skeletal elements were recovered from trout stomachs (Table 7). The only predation on coho was recorded for a 40 cm broodstock coastal cutthroat that apparently entered YP_1, in mid-March from South Pond during a period of high tides. Presumably the fish knocked out a temporary screen installed in the drain pipe between YP_1 and South Pond. The cutthroat was one of several broodstock being held in a partially covered holding tank located adjacent to South Pond. The cutthroat presumably jumped out of the tank, and rolled down the bank into South Pond. The coho smolt was freshly consumed and might have been eaten during pond draining when smolts would be vulnerable to predation.

Rainbow consumed considerable plant material that covered YP_1 pond bottom. We suggest this was probably a technique for consuming the amphipods colonizing diatom mats. Rainbow trout were feeding much more vigorously than coho. Only 20% of trout stomachs were empty while 60% of the coho were empty (Table 7). In trout 43% of the cardiac portion of the stomach were empty, while in coho 100% of the cardiac stomach had no food items. Trout also ingested many incidental non-food items, as well as isopods. In contrast, coho were apparently consuming single amphipods and were avoiding ingesting plant materials and associated items. Flesh color probably reflected these differences in feeding, with trout flesh bright orange and that of coho white or pink.

The lack of predation on coho by the more aggressive trout in YP_1 may have been related to the relative light stocking densities of the two species in the pond, the presence of more than adequate food supplies provided by pond benthos, and the availability of underwater reefs to provide suitable feeding territories for each species.

The occurrence of large amounts of plant material in rainbow trout diet feeding on brackish-water pond biomass has been reported previously during pilot project rearing experiments in

North Pond in 1980 (Allen et al. 1980; pp. 48-51). The plant community in the 1980 experiment was dominated by Entermorpha sp. and a blue-green benthic algae both of which were consumed in large amounts by rainbow trout.

Public Health Studies

Rainbow trout in YP_2 were designated for release into Klopp Lake of the Arcata Marsh and Wildlife Sanctuary for immediate public recreational fishing. Thus we took samples of pond water and of fish to the Humboldt County Department of Public Health for determining bacterial levels. Water sampled contained a 5 MPN/100 ml level of fecal coliform, well below the 14 MPN/100 ml standard set for Arcata effluent discharges to Humboldt Bay. The study of bacterial levels in trout flesh involved a blind test using three trout obtained from three different hatcheries (Table 8). Acceptable public health limits for oysters from Humboldt Bay commercial operations is 230 MPN/100 grams of tissue of fecal coliforms (E.C. Broth 44.5°C water bath incubation for 24 hours). Trout from all three rearing facilities had values of 20 MPN/100 gms of tissue or less, an order of magnitude lower than the commercial-oyster growing standard.

The lack of any bacterial contamination of salmonids released from the Arcata system in 1991 is consistent with the results of previous studies. Allen et al. (1979) reported potential human pathogens in gut and internal organs but not in flesh of coho smolts reared in North and South ponds during pilot project studies when primary-treated oxidation pond water was used in culture mixtures.

The low potential public health risks associated with the Arcata-reared trout and salmon as studied to date is congruent with the prediction of virtually no risks to Humboldt Bay bivalves from disinfected STP effluent produced by the advanced biological treatment units (oxidation ponds and wetlands) as placed into operation in 1986 (Allen and Gearheart 1980).

POND MANAGEMENT AND BIOLOGY

Historically, coho parr are rarely taken in out-migrant traps. In the 1990-91 trapping season, only a single parr was trapped, plus an additional six coho designated as presmolts. These coho had all typical smolt characteristics except retaining a yellow skin pigmentation. Only 10 parr were found in the 927 coho removed from YP_1 on draining. Size of presmolts was similar to that of the entire population in the pond (Table 9, Figure 5). Most parr recovered were only 10-11 cm in length.

The complete netting of our ponds in response to predation by night-crowned herons (Nycticorax nycticorax) correlated with substantial improvements in survival rates of coho as shown by the almost complete absence of "beak-marked" coho (Allen et al. 1989). Rearing of European geese (Anser anser) inside our fenced ponds also has contributed to increasing survival rates by the geese's strong territorial behavior apparently excluding night herons (Allen and Hull 1990). In 1991, beak-marked fish were found in the coho trapped or recovered on pond draining (Table 10). There were, however, times when netting over the SW smolt trap developed gaps. The pond was also accessible to night-herons prior to pond draining when installation of our pumping equipment breached protective pond netting. Previous night-time observations of bird behavior at the ponds have shown such opportunities to gain access to the ponds are almost simultaneously exploited by night-herons. During pond-draining in April 1991, we found a great blue heron adjacent to an open seam in bank netting hunting along the receding waters edge. These breaches of our pond netting probably account for the few beak-marked coho recorded in 1991. No other externally obvious pathologies or marks were found on 1991 pond-reared coho except eroded gill opercula (Table 10).

Smolts taken in DSM traps expected to return as adults should show little fin regeneration while returning adults from smolts removed on pond draining will have some adults with poor fin clips
(Table 11). This difference might allow for an estimate of possible differences in survival between voluntary migrating trapped smolts and smolts undergoing stress from seining on pond draining. This would be our second study of seining stress. No difference was recorded in adults that returned in 1977 that were released after being trapped or seined as smolts (Miyamoto 1979).

Pond management has included the use of white sturgeon (Acipenser transmontanus) to remove moribund or dead juvenile salmonids and consume any excess pellet feeds that reach the pond bottoms during periods of turbid water. In January 1989, we had 19 sturgeon averaging 2.5 lb/fish and 55 cm total length. These sturgeon were in SP_2 with trout brood stock. In the fall of 1990, these sturgeon were removed from SP_2 after having grown to 4.9 lb/fish and 67 cm average total length, and placed into YP_2 with the Shasta-strain rainbow trout. All 19 sturgeon were recovered on draining YP_2 in April 1991 and returned to the SP. No dead or moribund trout were recovered from the YP_2 pond bottom on draining. We feel that sturgeon polycultured with yearling or broodstock fish assists in maintaining fish health, however, we are less certain if the technique can be used with fingerlings. We anticipate an experiment with fingerlings of the same species reared with and without sturgeon to provide data on this pond management technique. We are also anticipating having mature sturgeon available for spawning.

The wide range of experimental procedures investigated during 2 decades of pilot project and demonstration studies with wastewater-seawater system have always been part of a long-term goal of producing a comparatively inexpensive method of rearing smolts. Intuitively, we have felt such a goal could be reached by duplicating the life cycle of wild populations of cultured species. One of the most extensive, and probably still the most informative studies on coho life cycles were those of Shapovalov and Taft (1954) conducted for 9 years (1934-1942) at Waddell Creek, a small coastal stream entering the Pacific Ocean north ofSanta Cruz, California. The study involved only wild stocks of coho in the drainage. A second comprehensive study of coho life cycles was that of Salo and Bayliff (1958) conducted at Minter Creek, Puget Sound, Washington, utilizing primarily hatchery releases. Wild coho stocks in Minter Creek allowed comparing behavior and survival of wild stocks to hatchery releases. The Minter Creek study spanned 18 years (1938-1955). Despite the considerable geographic distance between Waddell Creek and Minter Creek, the timing of coho out-migration was remarkably similar (primarily mid-April through May). The data for Waddell Creek are summarized in Table 12. The Minter Creek data are summarized by Salo and Bayliff (1954, p. 26):

"The largest numbers of seaward-migrating silver salmon occur between April 15 and June 1 (Figures 19-23)".

Size of the smolts from the two systems were equally similar (10-13 cm). The Waddell Creek coho sizes are summarized in Table 13. Only a limited amount of data on size of wild fish were presented by Salo and Bayliff (1954, Figure 25) since the primary emphasis of their study was on evaluating hatchery release techniques. Data on wild fish in the spring of 1953 trapped as downstream-migrant showed coho sizes ranging from 7 to 14.5 cm, but with the mean fork length barely over 10 cm. We suggest that the routine hatchery operations unconsciously leads to the production of large smolts since feeding fish is psychologically satisfying. There are also studies which have shown that the release of larger-sized smolts does give higher survivals in some circumstances over returns from smaller-sized smolts released at the same facility. There is, however, reason to believe that releasing overly-large smolt is not necessary to give satisfactory or even optimal results. Salo and Bayliff (1954, p. 72) write:

"The greatest returns from natural spawning at Minter Creek are incapable of analysis because the fish were not marked. Gross examination of the annual escapements shows a slight downward trend corresponding to the brood years when most of the eggs or fish had been planted into stream other than Minter Creek (Tables 2 and 7, Figure 44). This trend continued until 1952, when an outstanding escapement of wild fish (unmarked) reversed the trend..."

The effect could have been from straying of wild fish into Minter Creek in 1952. To date, the best return of wastewater-seawater reared coho smolts at Arcata occurred in pilot project operations involving the 1974 brood from Noyo River, California. The smolts ranged from 8 to 12 cm, with the bulk of the population between

10 and 12 cm (Allen 1976, Figure 9). Details of the smolting process of this cohort were described by Del Sarto (1980) and the recovery of adults by Miyamoto (1979).

Yearling Pond No. 1 could be retained exclusively for rearing coho smolts without supplemental feeding, however, pond productivity will be enhanced by the use of the fertilizing effects of the wastewater-seawater supply now available to the ponds. Incrementally loading of the pond would to find the density at which the systems natural productivity is incapable of producing 10-11 cm parr, the minimal size required by the species for smolting. A steadily improving quality of water the should accompany these studies since wetland units of the Arcata sewage treatment system have not yet reached their peak efficiency. Hardstem bulrush at the outlet to the AMWS (Allen and Couch 1988, Figure 1, Marsh C Pump Station) finally reached design density and during the summer of 1991 consistently produced water with BOD and SS values of 2 mg/l or less. There was also an increasingly lowered waterfowl-related bacterial content in Marsh water.

FUTURE MANAGEMENT AND PROGRAMS

During the summer of 1991, two construction projects were completed which will facilitate future operations. The first was at the suggestion of the Regional Water Quality Control Board. A deep-well was placed between the effluent discharge chamber and the effluent pipe leading to Humboldt Bay. The marsh STP effluent mixtures now being used at the aquaculture ponds are now classified as "waters of the state", thus relieving Humboldt State University from legal responsibilities of discharging Arcata effluents which might be in violation of state standards. The second construction project was the replacement of the temporary trapping system utilized in spring 1991 with a permanent concrete trap. The permanent trap is located directly within the north bank of YP_1. The new trap is 6 ft long, 5 1/2 ft wide, and 3 ft deep, with an approximate operating depth of about 2 ft. Discharge is through the existing 5 inch diameter pipe leading to South Pond. A flat piece of concrete was fitted immediately under the entrance pipe. A waterproof plastic plate with a black on white grid painted onto the surface will be mounted on the flat concrete piece. Under clear water conditions, we hope to be able to estimate size of smolts schooling or streaming past the pipe entrance.

In the summer of 1991, the city of Arcata returned primary responsibility for the operation of the aquaculture facilities to the Humboldt State University Fisheries Department. A 1/2-time wastewater-coordination position was created jointly by University and Arcata. Two broad historic philosophies can be drawn upon by the Department of Fisheries at Humboldt State University and the City of Arcata to shape the kinds and priorities of future fish culture activities at the Arcata wastewater-seawater facilities. The primary historic program has been that of education, both in the restricted sense of formal instructional activities by university classes and in the broader sense of general public education on wastewater treatment and reuse. The educational functions served by all the elements of the present Arcata Marsh and Wildlife Sactuary, of which the seawater-wastewater pond and associated facilities is a part, was one of two activities identified by the California Regional Water Quality Control Board as acceptable for meeting the "enhancement" provisions of the California Bays and Estuaries Policy required for Arcata's continued discharge of STP effluent into Humboldt Bay in an upgraded system placed into operation in 1986. Historical overview and technical aspects and of the enhancement issue are available in Bretnall (1984) and papers in Allen and Gearheart (1991). A continuance of a program for wastewater utilization in aquaculture can lead to results equally as important as the more visible results from using wastewater to improve wildlife habitat in artificial marshes. The use of wetlands as a sewage treatment technology is spreading rapidly (Bastian 1991) whereas a salmonid production system relying mainly on a wastewater ecosystem is unique to Arcata. The second major philosophy that could shape some of the future specific activities of the seawater-wastewater pond system is to move toward an increased stocking rates in the ponds to allow for future comparisons of the efficacy of wastewater for a production facilities with more traditional culture systems. This program would require the continued development, improvement, and testing of all elements in the Arcata system which involves a wide range of scientific topics. The most immediate topics that students and faculty could pursue would be the evaluation of imprinting and homing. The first meaningful field test could occur during the 1991-92 adult salmonid migratory season underway at the time of this paper. We have 7,700 CWT coho smolts potentially returning. We had predicted a reasonable return, assuming average ocean survival, but at this writing (late November 1991) we report but a single CWT return from a recreational fishery off Crescent City. Below normal rainfall has again restricted freshwater flows from Jolly Giant Creek into Butcher Slough needed to attract adults from Humboldt Bay.

Another important fish cultural topic for future study is the effects on fish production in ponds from increases in pond benthos when wastewater-seawater mixtures are added in a constant, or at least intermittent mode, via the newly installed water mixing and delivery system. In 1991 the coho finally surviving both the indoor engineering problems and summer rearing in SP_1 and placed in YP_1, migrated to South Pond as smolts of excellent quality. The final standing crop of these smolts in YP_1 was 100 lb, representing only a scant net increase in biomass (Table 14). The low net production recorded for coho smolts in YP_1 during the 1991 season combined with the results from previous studies, will serve as the basis for comparing biomass productions under sustained wastewater fertilization.

At this writing, probably the limiting unit now in the Arcata system for an expanded overall production is a limiting biomass capacity of the summer rearing units (SP_1, SP_2, Figure 1). For holding caged trout in specialized studies, holding brood stock in a brackish-water habitat, and similar fish culture activities, both SP_1 and SP_2 have been successful. There is, however, an upper limit to the total production of fingerlings which appears to be density-dependent for these summer ponds. A management change to improve coho survivals from fry to smolting would be to move advanced fry directly from the fry recirculating rearing system in the barn into the production ponds (YP_1, YP_2). Should this procedure in conjunction with improved natural foods from fertilization improve total production significantly, another major advancement will have been made to fully demonstrate that the Arcata program is a feasible salmonid aquaculture system for other coastal areas (Allen 1988).

The senior author plans to summarize data gathered from 1971 to 1991 in both pilot and demonstration studies to provide additional comparative data base upon which the degree of success of future activities can be measured.

ACKNOWLEDGMENTS

The City of Arcata has been supporting wetland development and management, urban stream enhancement, recreational fishing, water quality monitoring, as well as the salmonid culture using wastewater, within the Department of Public Works under the term "Aquaculture". Under increasing budget constraints being faced by governmental agencies at every level, we particularly wish to acknowledge Arcata's continued support of the salmonid culture program. City employees, especially in the sewage treatment and streets departments, have assisted the project by supplying equipment and support at critical times. Mr. Steve Tyler, sewage treatment plant superintendent, has been particularly supportive during the past year. Equally supportive since the inception of the salmonid rearing program has been Mr. Frank Klopp, Director of Public Works. Those who assisted in monitoring the water quality in wetlands, fish ponds, and the oxidation ponds included Melissa Bukosky, Cara McCormich, and John Lange, Humboldt State University students in fisheries and wastewater aquaculture assisted in pond draining in April. There were other volunteers and work study students we wish to acknowledge; Stasia Anne Allen, Todd Flannigan, and Tom Wallace. For the cooperation of the Humboldt County hatchery at Prairie Creek, Fish Action Council of Humboldt County operate an adult trapping system on Prairie Creek, and the Humboldt State University Fisheries Department fish hatchery, in supplying surplus eggs and fry, we are gratefully indebted. We extend our deep appreciation for the assistance of Delores Neher, California Cooperative Fishery Research Unit, who typed drafts and prepared the final manuscript.

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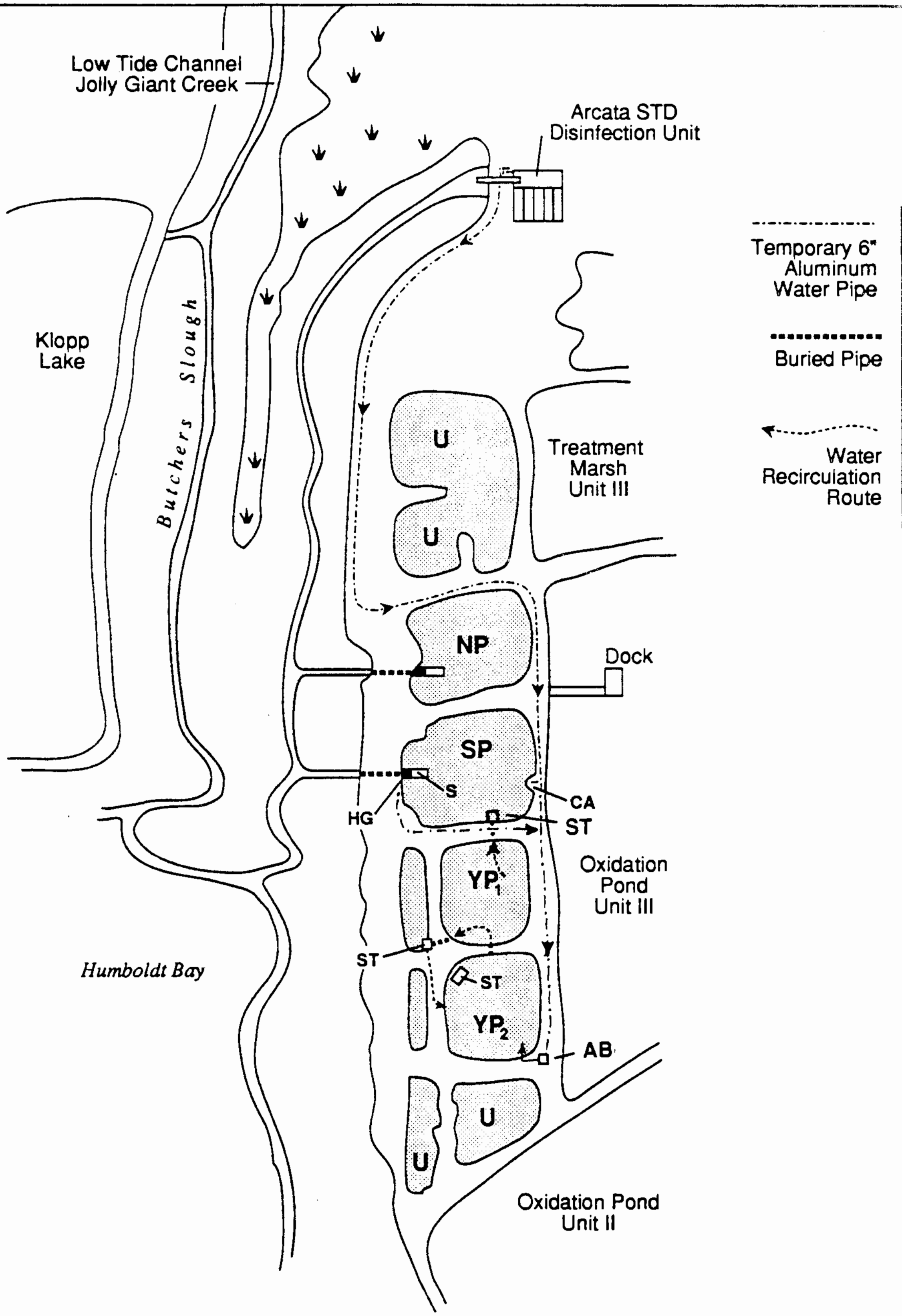

Figure 1. Physical facilities in operation, Arcata Wastewater salmon aquaculture facilities, May 1, 1990. [NP: North Pond; SP: South Pond; RF: Rock Filter; S: Concrete Sump; HG: Headgate; ST: Smolt Trap; YP1: Yearling (Winter Pond) No. 1; YP2: Yearling (Winter Pond) No. 2; U: Undeveloped future aquaculture units.] AB: Aeration Basin; CA: Cascade Aeration

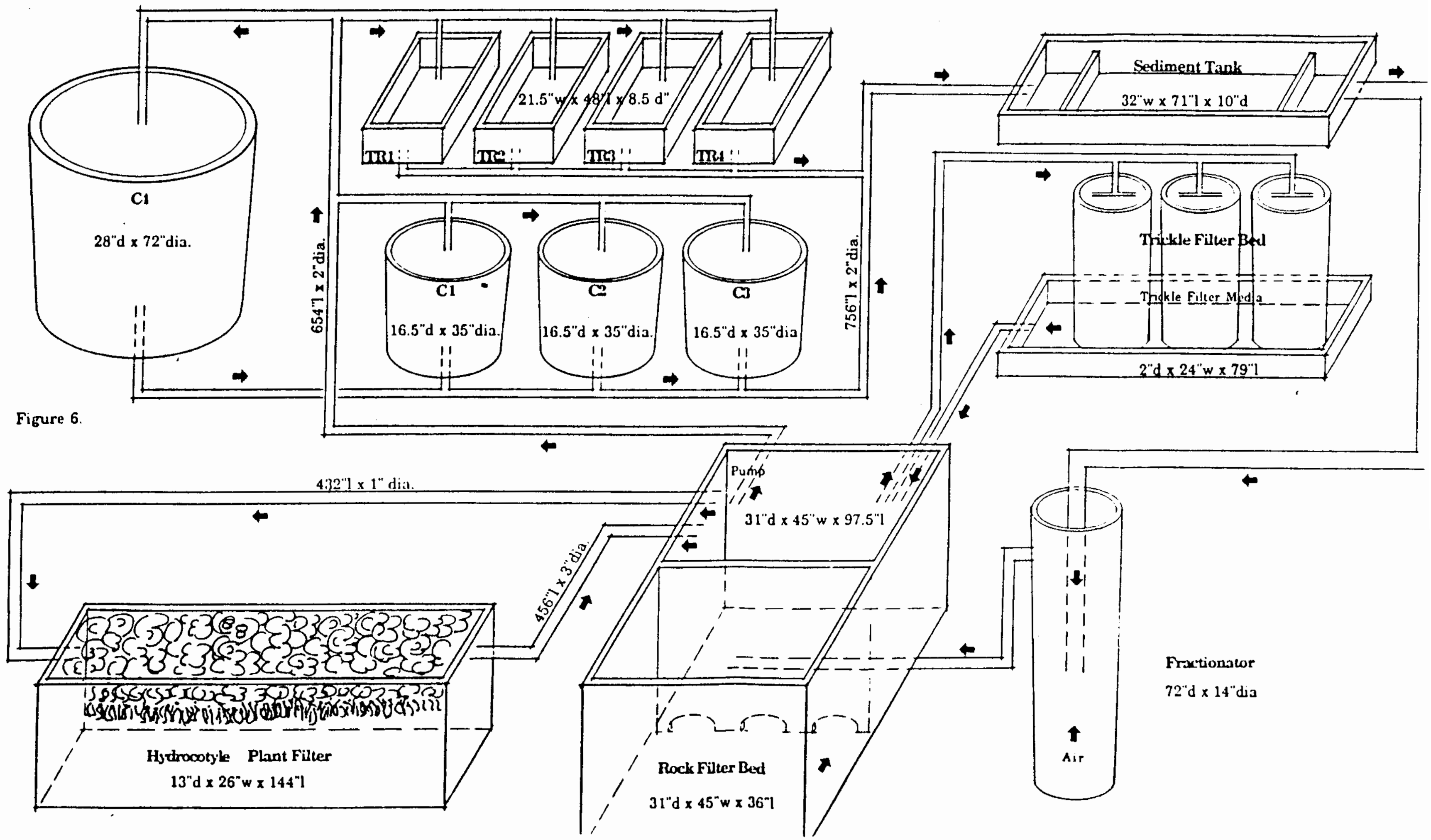

Figure 2. Size and arrangement of units in recirculating fry and fingerling rearing system, AWAAP fish barn, spring 1991 (from Bukosky 1991).

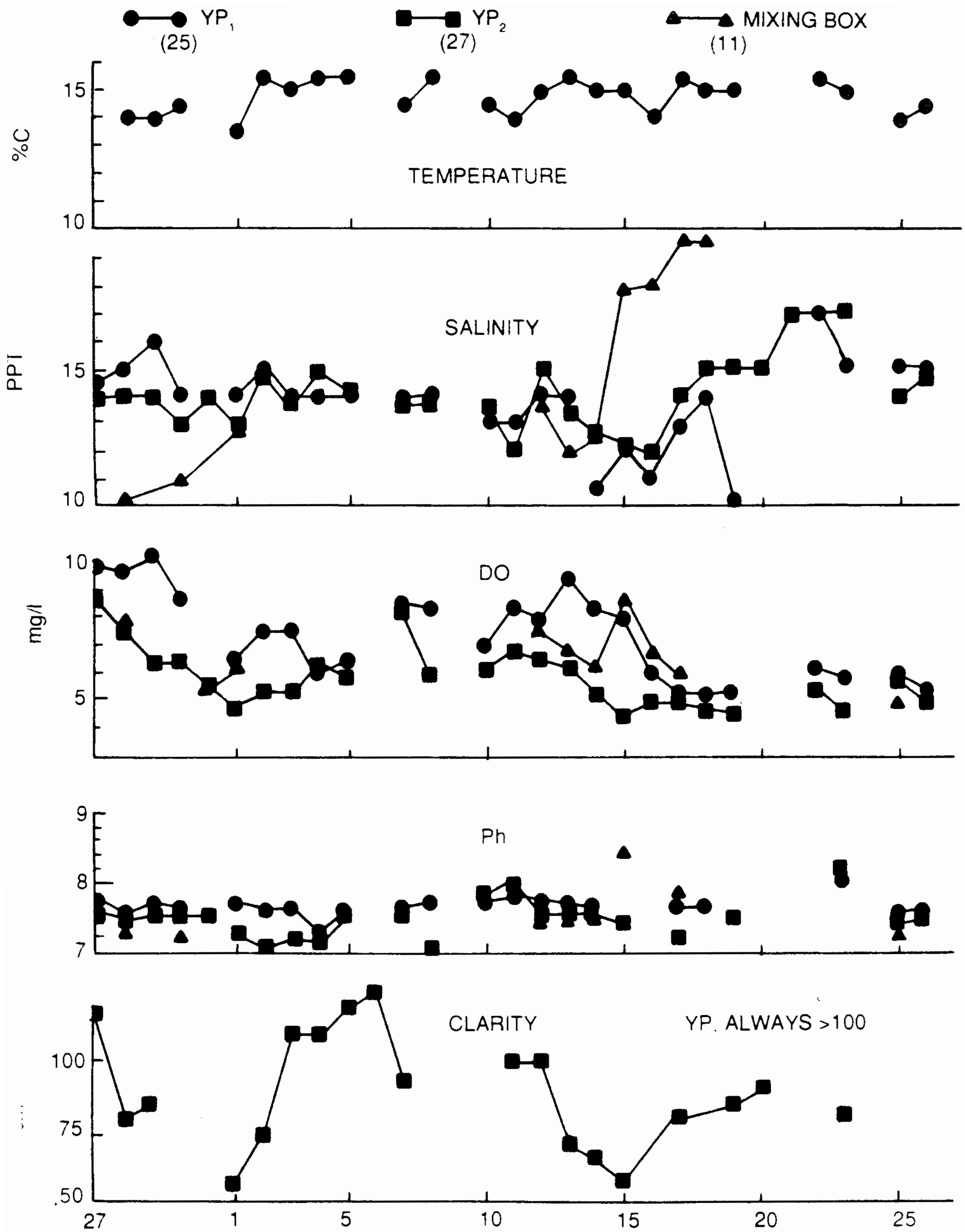

Figure 3. Physical water quality parameters, Yearling Ponds No. 1 and 2, March 27-April 26, 1991.

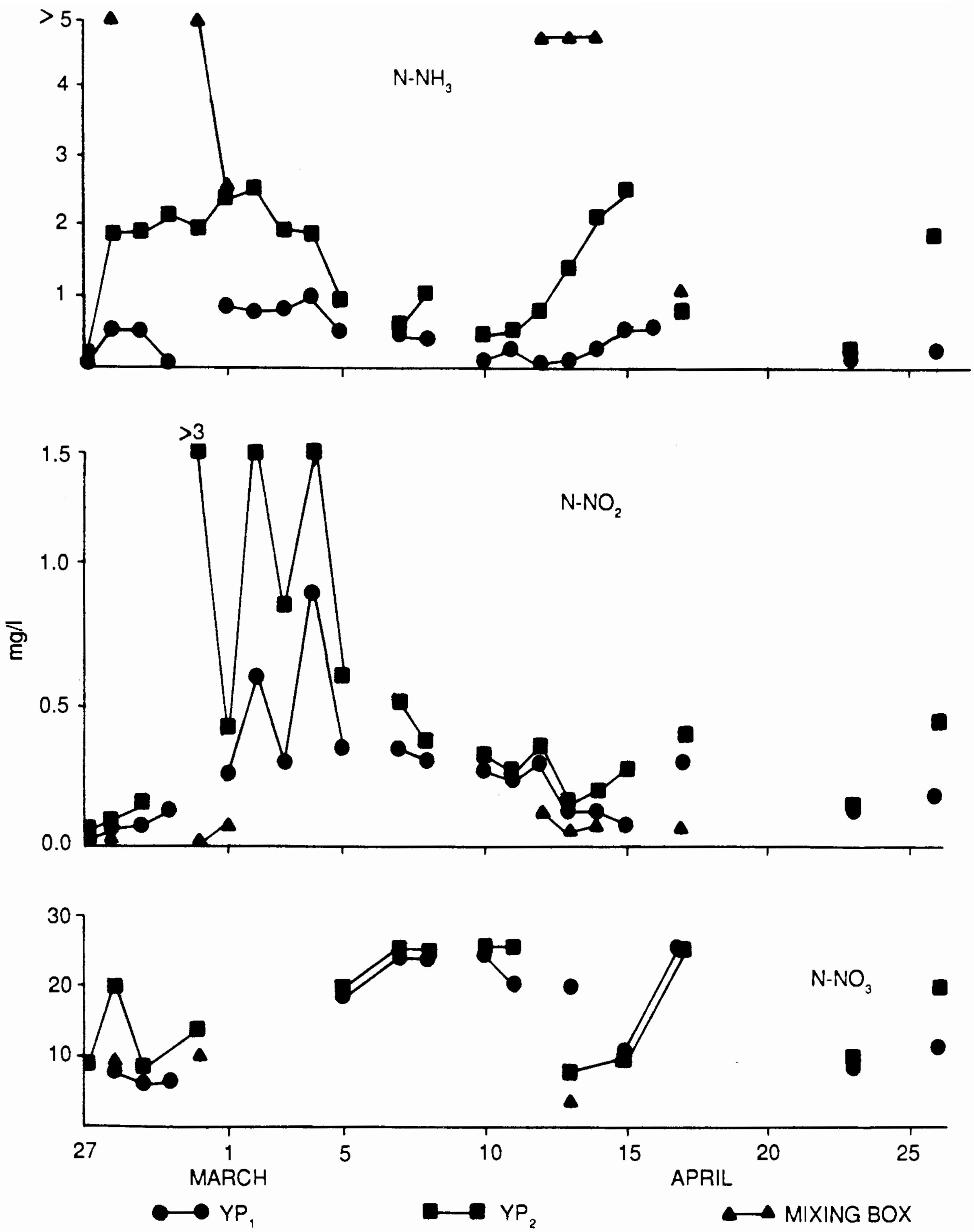

Figure 4. Nitrogen water quality parameters, Yearling Ponds No. 1 and 2, 27 March-April 26, 1991.

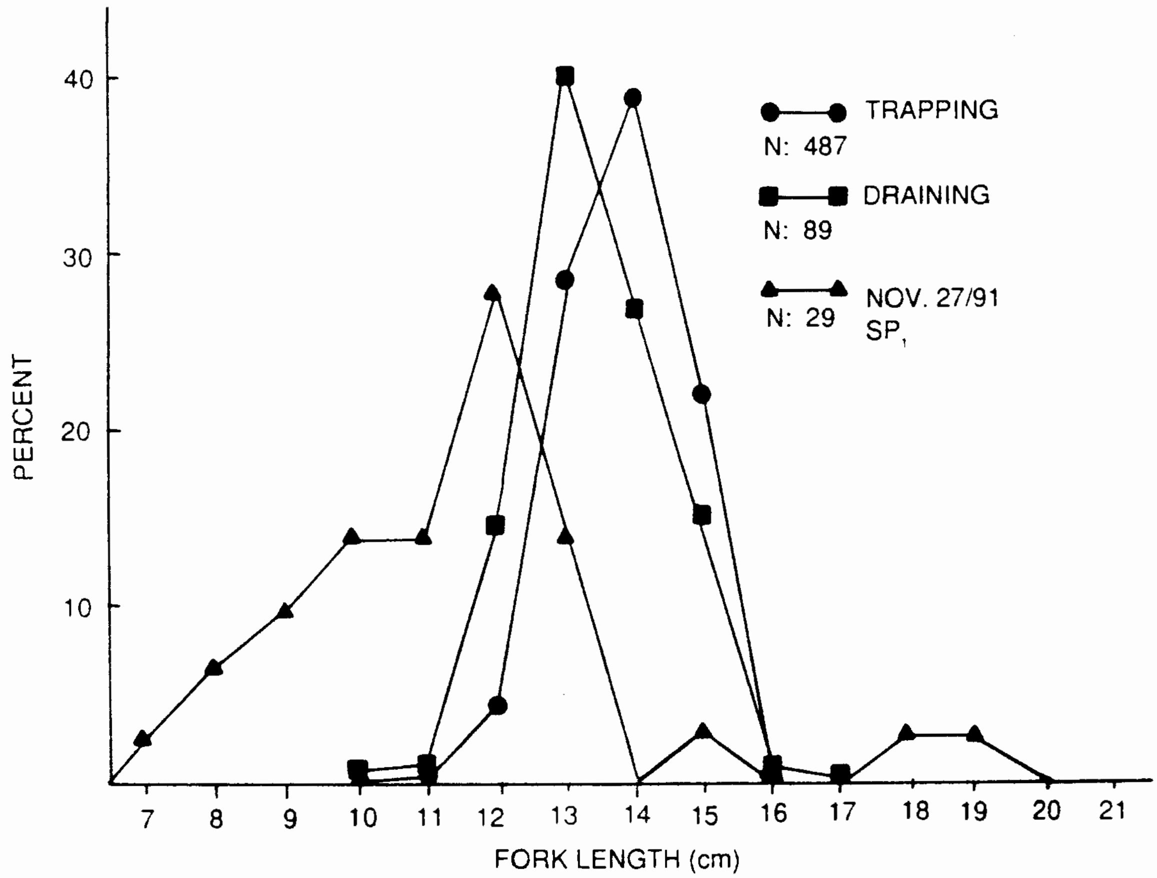

Figure 5. Length-frequency of coho juveniles removed from Summer Pond No. 1, 27 November 1990, and of smolts removed from Yearling Pond No. 1 by smolt traps and by pond draining, spring, 1991.

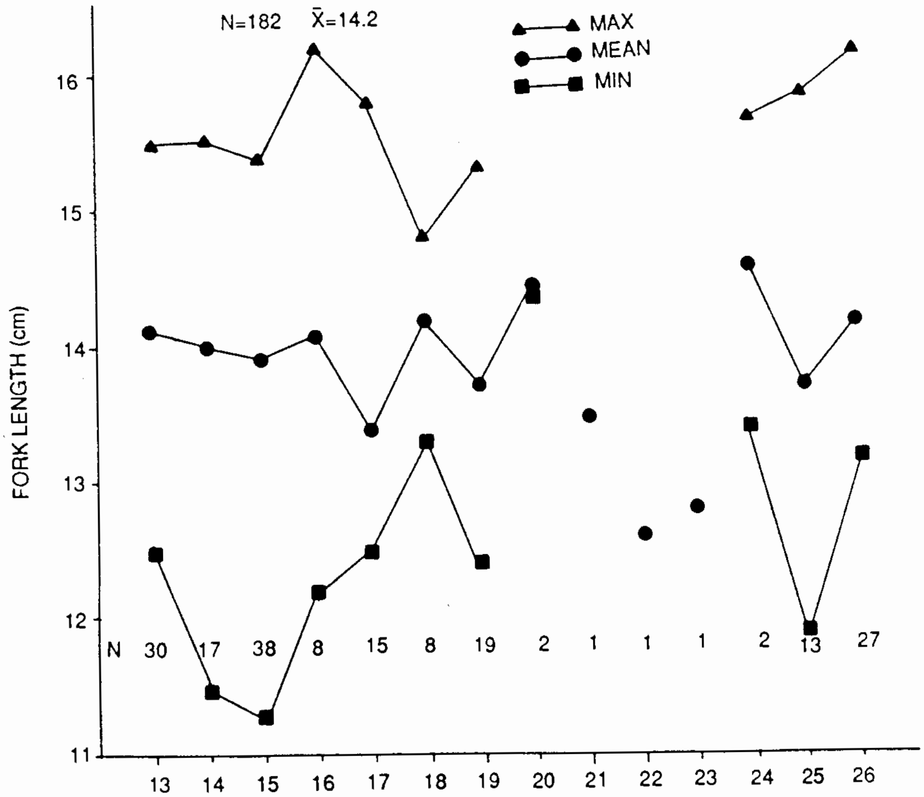

Figure 6. Maximum, mean, and minimum fork length in centimeters of smolts, Yearling Pond No. 1, North Trap, 13-26 April 1991.

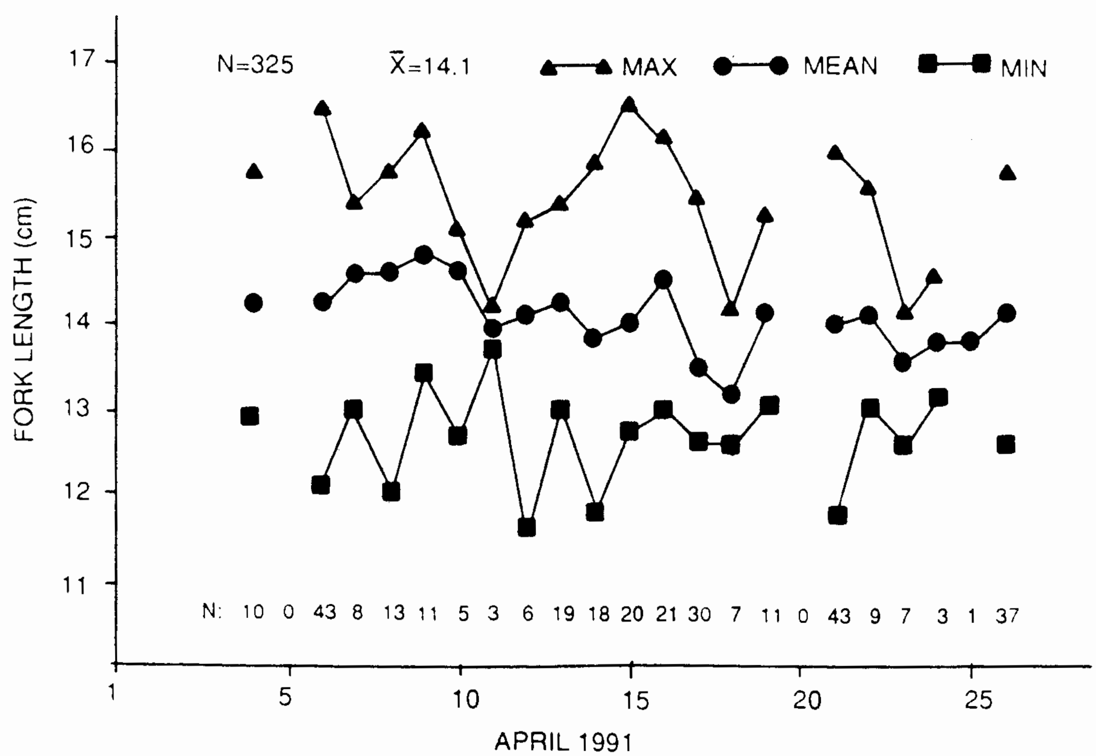

Figure 7. Maximum, mean, and minimum size of coh smolts, Southwest Trap, Yearling Pond No. 1, 1-26 April 1991.

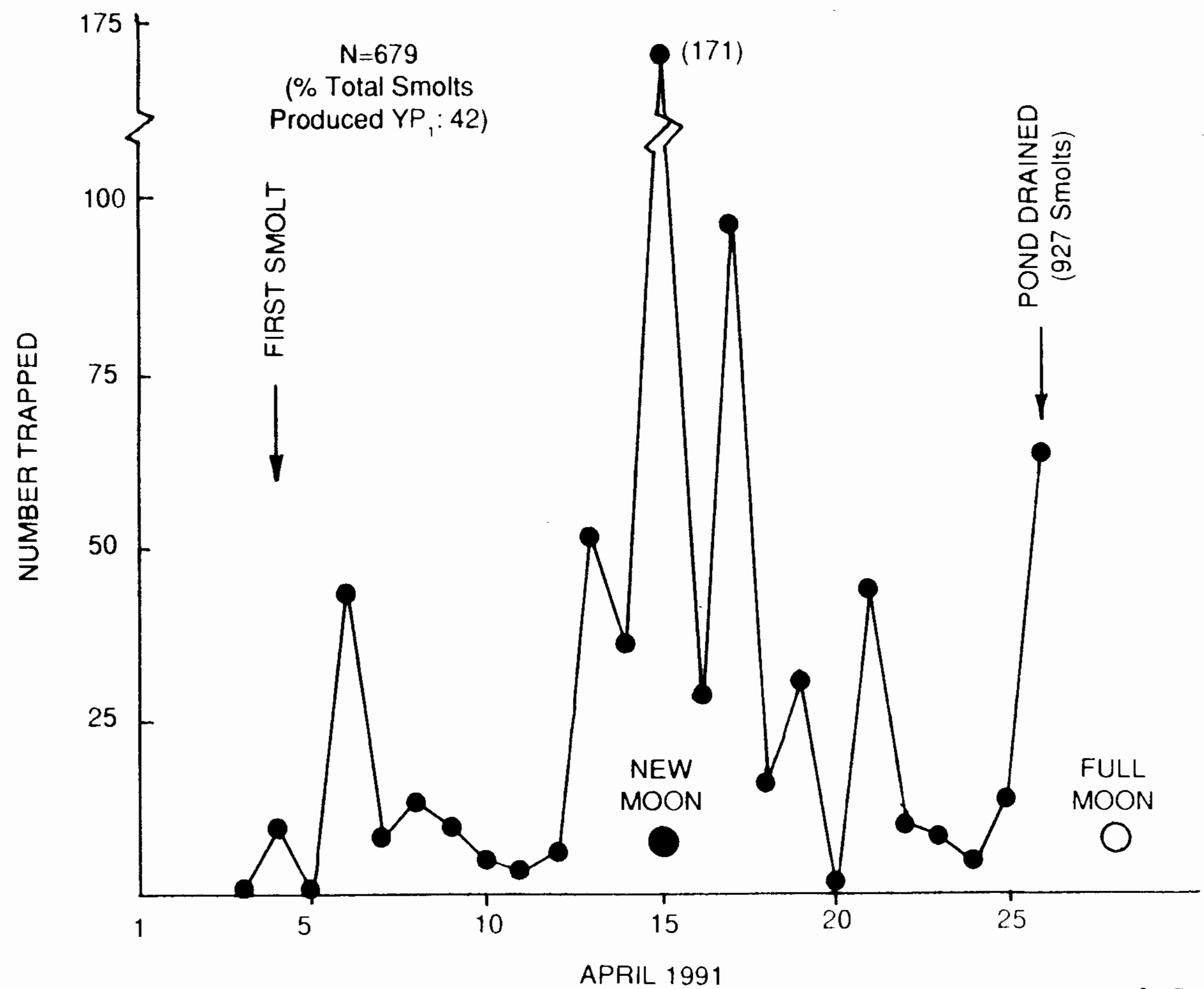

Figure 8. Combined daily catch of coho smolts in North Bank and Southwest trap, Yearling Pond No. 1, April 1991.

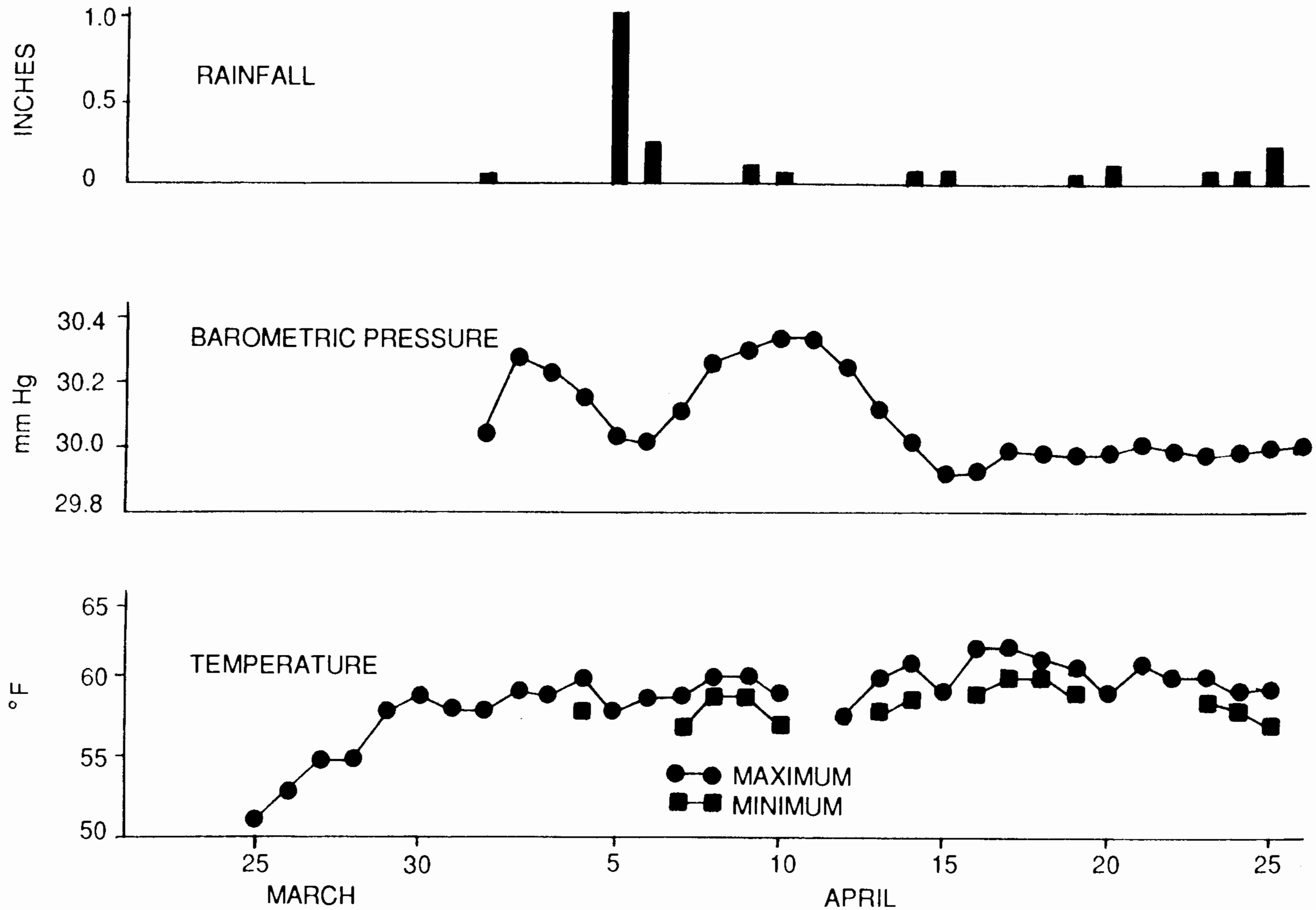

Figure 9. Daily rainfall and barometric pressure measured at Eureka, California, and maximum and minimum water temperatures, Yearling Pond No. 1, 25 March-26 April 1991.

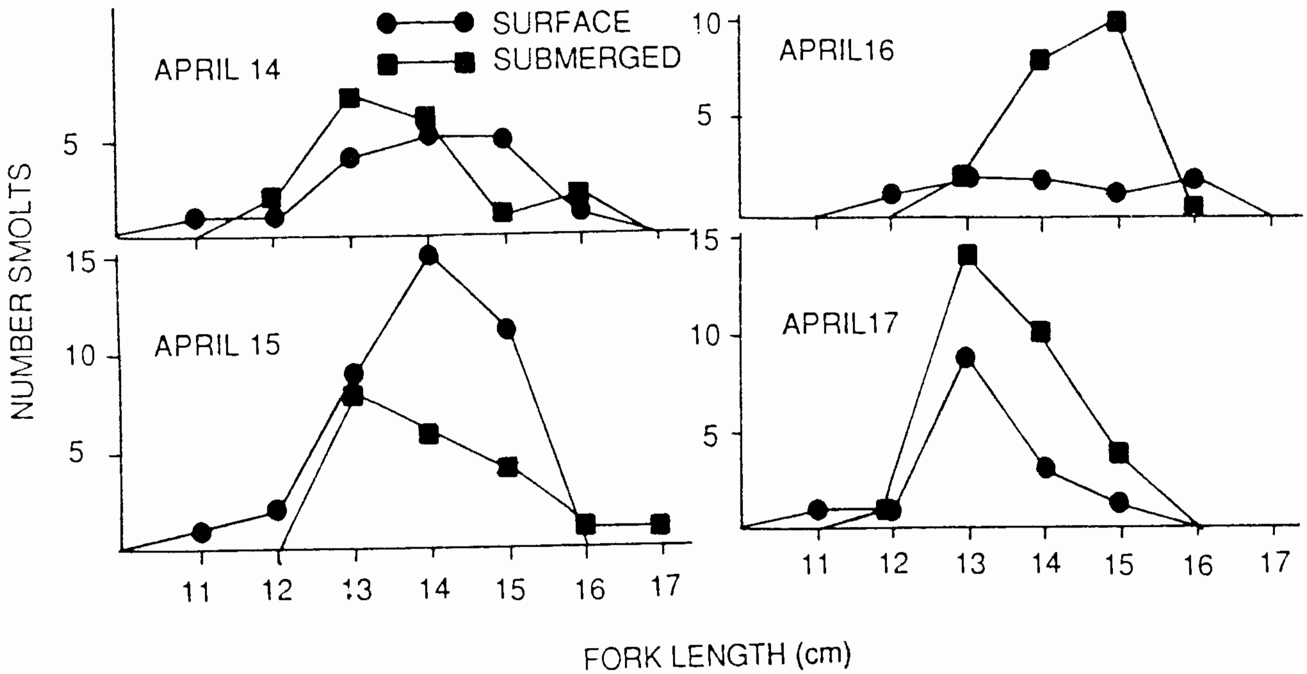

Figure 10. Comparison of fork length in centimeters of daily catches of coho smolts in North Bank and Southwest smolt traps, Yearling Pond No. 1, 14-17 April 1991.

Table 1. Water quality, City of Arcata STP and Marsh and Wildlife Sanctuary sewage and wastewater flows, March - April 1991.

Parameter	Month	Influent (Sewage)			Outfall #2 (STP effluent entering AMWS)			Wetland Effluent (Effluent Leaving AWMS)			Outfall #1-Discharge to Butcher Slough. (Wetland effluent, or STP effluent, or mixture of both)		
Volume (MGD)		Min	Mean	Max	Min	Mean	Max				Min	Mean	Max
	Mar	1.9	2.6	4.1	0.02	1.4	3.3	NA			0.2	2.5	5.3
	Apr	1.6	2.0	3.2	0.08	1.1	2.4	NA			0.08	1.4	2.7
BOD (MG/L)		30-Day Mean		Daily Max	30-Day Mean		Daily Max	30-Day Mean		Daily Max	30-Day Mean		Daily Max
	Mar	126		160	24		34	17		25	18		22
	Apr	225		379	8		11	36		53	8		11
SS (MG/L)	Mar	152		187	18		24	41		95	15		24
	Apr	200		359	14		19	12		18	14		19
Seattleable Solids (ML/L)	Mar	NA			0		0	0		0	0.1		0.1
	Apr	NA			0		0	0		0	0		0
Coliforms (MPN)		Median	Max		Median	Max		Median	Max		Median	Max	
Total	Mar	NA			<2	<2		8	26		<2	<2	
	Apr	NA			<2	<2		110	500		<2	<2	
Fecal	Mar	NA			<2	<2		8	21		<2	<2	
	Apr	NA			<2	<2		33	33		<2	<2	
PH		Min	Max		Min	Max		Min	Max		Min	Max	
	Mar	NA			7.4	7.4		NA			8.0	8.0	
	Apr	NA			7.3	7.3		NA			7.3	7.7	
Other[1,2]													

[1]Toxicity: No LC 50 in any water tested (excluding influent) using rainbow trout and mosquito fish.

[2]Oil and grease: No values above 5 MG/L in any water tested (excluding influent)

Table 2. Physical-chemical conditions, yearling Pond No. 1 (YP_1) and Yearling Pond No. 2 (YP_x), September 1990-March 1991.

Pond	Date	Temperature				Dissolved oxygen				Salinity				pH				Clarity			
		Min	Mean	Max	N	Min	Mean	Max	N	Min	Mean	Max	N	Min	Mean	Max	N	Min	Mean	Max	N
YP_2	Sep 90	-	72	-	1	-	5.2	-	1	22.5	25.1	27.8	2	-	-	-	-	-	-	-	-
	Oct	55	60	68	9	4.5	5.8	6.8	5	14.2	19.1	27.2	12	-	-	-	-	-	-	-	-
	Nov	54	57	59	3	-	-	-	-	-	-	-	-	-	7.5	-	1	-	-	-	-
	Dec	40	47	58	5	9.6	10.3	11.0	2	17.0	19.8	24.0	6	7.5	7.8	8.0	2	-	100	-	1
	Jan 91	48	48.5	49	2	7.8	9.9	12.0	2	15.0	16.0	17.0	2	7.6	7.7	7.8	2	>100	>100	>100	2
	Feb	45	51	57	4	6.3	7.9	9.6	7	15.0	15.3	16.0	4	7.5	7.8	8.3	4	70	83	100	4
	Mar	54	55	57	4	-	4.6	-	1	13.0	13.5	14.0	4	7.8	8.0	8.5	4	75	94	>100	4
YP_1	Sep 90	-	71	-	1	-	5.8	-	1	15.4	28.3	27.7	4	-	-	-	-	-	40	-	4
	Oct	58	62	68	-	5.8	7.6	8.5	5	19.5	22.5	27.0	10	-	-	-	-	60	79	100	4
	Nov	52	55	58	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dec	42	47	50	5	8.6	9.8	11.0	2	16.0	19.8	21.0	4	8.0	8.0	8.0	2	-	>100	-	-
	Jan 91	40	46	49	3	10.4	10.5	10.6	2	15.0	15.7	17.0	3	-	7.8	-	1	-	>100	-	-
	Feb	47	52	57	4	7.2	9.4	11.2	4	14.0	15.0	16.0	4	7.1	7.9	8.3	4	>100	>100	>100	4
	Mar	54	55	56	4	-	-	-	-	13.0	14.5	16.0	4	7.8	8.0	8.3	4	-	-	-	-

Table 3. Summary of production, survival, and out-migration of coho smolts reared in wastewater-seawater mixtures, Yearling Pond No. 1, 27 November, 1990-26 April 1991.

Smolts trapped, April 7-26					
Southwest Corner of Pond (Submerged entrance)		369			
North Bank of Pond (Surface Entrance)	310			679	
Smolt removed on pond draining April 26					
Smolts or presmolts		914			
Parr or post parr	13				
Other removals					927
			6		
			1,612		

Table 4. Number and size of rainbow trout recovered from Yearling Pond No. 1, 1990-91.

Method of Recovery	N	Length (cm) Min	Mean	Max
Pond draining	37	18.5	22.4	24.4
(smolt-like)	(5)	(21.5)	(22.4)	(23.0)
Angling	14	16.5	20.5	23.4
Smolt trap	4	20.2	21.8	22.5
Gillnet	5	--	--	--
Seal bombing	?	--	--	--
Total	60			

Table 5. Diurnal catches of coho smolts in trap with surface (Sur) (North trap) and submerged (Sub) (SW trap) entrances, Yearling Pond No. 1, April 1991.

	Individual traps							
	Night		Day		Sur and Sub combined		Day and Night combined	
Date	Sur	Sub	Sur	Sub	Night	Day	Sur	Sub
13	-	11	31	10	(11)	41	(31)	21
14	4	16	13	3	20	16	17	19
15	33	2	94	42	35	136	127	44
16	4	15	0	10	19	10	4	25
17	41	10	16	30	51	46	57	40
18	7	5	1	3	12	4	8	8
19	15	2	4	10	17	14	19	12
20	2	0	0	0	2	0	2	0
21	1	27	0	16	28	16	1	43
22	0	2	1	7	2	8	1	9
23	1	4	0	3	5	3	1	7
24	2	3	0	0	5	0	2	3
25	13	1	0	0	14	0	13	1
26	27	31	-	(6)	58	(6)	(27)	(37)
Totals	150	119	160	136	210	253	252	211
	(14-26 Apr)		(13-25 Apr)		(14-25 Apr)		(14-25 Apr)	

\- Trap not in operation during period.

( ) Data incomplete for period and thus not usable in comparisons.

Table 6. Field observations of coho smolt behavior at entrance to North Bank trap and trap catches, April, 1991.

Date	Period of Observation: Start	Period of Observation: End (Trap emptied)	Smolts Trapped	Smolt behavior off pipe entrance
14	0928	1945	0	Two smolts at pipe entrance and both appeared to have entered.
	1100	1126	7	Large schools actively streaming past pipe entrance.
	1203	1230	0	One school of 20+ smolts passed pipe entrance.
	1232	1245	2	No streaming or schooling but smolts could be readily chummed to pipe entrance. One smolt seen dashing head-first into pipe.
	1317	1330	1[1]	As above. A few coho chased chum into pipe entrance then returned to the pond.
15	1212	1223	1	One small school passed pipe entrance.
	1258	1328	4	Small schools (up to 6 fish) or single fish were testing pipe entrance. Three smolts seen to enter but one returned to pond. Saw one single smolt dish into pipe and not return.
17	1400	1430	7	No streaming or schooling but many smolts immediately off pipe entrance in deeper water as evidenced by chumming. Observed three smolts enter trap head-first.

[1]Pre-smolt.

Table 7. Summary of qualitative and quantitative differences in digestive tract contents of yearling rainbow trout and coho salmon, and cutthroat trout, Yearling Pond No. 1, 27 March-26 April 1991.

Item	Rainbow trout	Coho salmon	Cutthroat trout
Number of tracts examined	16	5	1
Stomach fullness (cardiac plus Pyloric Sections)			
> 1/2	11	0	0
> 1/8-< 1/2	2	2	1
Empty	3	3	0
Maximum number of whole animals counted in any one stomach			
Corophium	>100	>20	0
Gammarids	>100	10	0
Isopods	32	0	0
Number of digestive tracts with item			
Stocks (15-23 mm)	3	0	0
Pebbles (5-15 mm)	3	0	0
Pine needles (10-11 mm)	1	0	0
Seed pods (6 mm)	1	0	0
Plant materials	15	1	0
Fish	0	0	1*

*Coho smolt 140 mm.

Table 8. Bacterial analysis of combined lateral muscle from three yearling rainbow trout sampled from Humboldt County fish rearing facilities, 22 April 1991.

Facility	Total Plate Count (35^0C/48 hrs)	Coliforms (MPN/100 gms)	Fecal Coliforms (MPN/100 gms)
City of Arcata Yearling Pond No. 2 (YP_2)	4,700	310	20
Humboldt State University	<3,000	110	<20
Mad River Hatchery, CDFG	3,200	3,500	<20

Table 9. Recovery of parr and presmolt coho juveniles in Yearling Pond No. 1, Arcata WWA System, March-April 1991.

Date recovered	Place of recovery	Number	Life Stage[a]	Size
29 March	SW trap	1	Parr	119
9 April	SW trap	1	Presmolt	135
13 April	North trap	1	Presmolt	135
14 April	North trap	1	Presmolt	150
15 April	North trap	2	Presmolt	113,135
18 April	SW trap	1	Presmolt	133
26 April	Pond draining			
	Hand count	3	Presmolt	121,121,126
		8	Parr	97-120 (x:111)
	Random sample	2	Parr	97,111
	Total	20		

[a]Presmolts have typical smolt characteristics but were retaining yellow skin color of parr.

Table 10. Summary of pathologies in coho salmon examined from Yearling Pond No. 1, Arcata WWA System, March-April, 1991.

Source of recovery	Eroded Operculum				"Beak Marked"	Other	Total
	Left	Right	Both	Total			
Smolt trapping	2	0	0	2	4	1	7
Pond draining							
Hand Count	3	3	1	7	4	0	11
Random Sample	0	0	0	0	0	0	0
Total	5	3	1	9	8	1	18

Table 11. Rate of RV fin regeneration in DSM coho smolts, North Bank trap, Yearling Pond No. 1, April 1991.

Fork length (cm)	Estimated degree of regeneration: None	1/8	1/4	1/2	3/4	Complete (or released unmarked)	Combined
11	1	0	1	0	1	0	3
12	5	1	4	0	0	0	10
13	18	9	10	10	5	1	53
14	25	17	18	9	3	1	73
15	12	5	5	5	6	0	33
16	4	0	2	0	0	0	6
Totals	65	32	40	24	15	2	178
Percent	36	20	22	13	8	1	100

Table 12. Major periods of downstream migration of yearling coho smolts, Waddell Creek, California 1934-1942 (adapted from Table 15, Shapovalov and Taft 1954).

Year	"Modal" periods by two-week intervals	Range in days	Percent of total run in period
1934	15 Apr - May 5	21	70
1935	29 Apr - May 26	27	59
1936	29 Apr - May 19	21	75
1937	6 May - May 19	14	60
1938	13 May - May 26	14	76
1939	15 Apr - May 12	27	91
1940	12 May - Jun 2	21	78
1941	6 May - May 26	21	80
1942	6 May - May 26	21	63

Table 13. Fork length (mm) of yearling DSM coho salmon, Waddell Creek California 1934-1942 (adapated from Table 16, Shapovalov and Taft 1954

Fork length (Upper bound of 5 mm interval)	Number of migrants	Percent total migr
< 90	88	0.5
95	314	1.8
100	1,016	5.8
105	2,141	12.2
110	3,426	19.4
115	3,824	21.7
120	3,373	19.2
125	1,910	10.8
130	898	5.1
135	369	2.1
140	122	0.6
145	60	0.3
>150	78	0.4
	17,609	100.0

Table 14. Production summary, juvenile trout and salmon rearing, Arcata recirculating fry rearing system and wastewater-seawater aquaculture ponds, 1990-91 rearing season.

Species	Rearing system	Rearing dates	Days reared	Net gain (pounds)	Total food fed	Conversion ratio
Rainbow	Recirculating system, tanks and troughs	16 May 90- 7 Nov 91	144	160	233	1.5
	Yearling Pond No. 2	9 Nov 90- 28 Apr 91	169	189	990	1.0
Cutthroat	Summer pond No. 1	29 Nov 90- 5 Apr 91	155	201	433	2.2[1]
Coho	Recirculating system	No data due to operational problems				
	Summer Pond No. 1	31 Jul 90- 11 nov 91	72	70.5	206	2.9
	Yearling Pond No. 1	11 Nov 90- 26 Apr 91	158	3.0	--	--

[1]Uncorrected for 23 large coho brood stock reared with the cutthroat that were recovered from an initial 30 coho stocked.

THE USE OF HORMONES TO ADVANCE FINAL MATURATION

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Some extensive work has been done over the past 20 years to determine the effectiveness of the use of various hormones to stimulate maturation at various stages of gonadal development. In production fish culture situations, final maturation of maturing individuals can be cause for concern.

The uses of hormones at Kootenay Hatchery can be traced back to the 1985 brood fish workshop held at Ennis N.F.H., Ennis, MT. Reports presented by Dave Erdahl and Marty Fitzpatrick indicated that the use of the hormone LHRHa in production situations gave good results at a reasonable cost for the final maturation of lake trout and coho salmon.

For the past 12 years we have worked with the late maturing Gerrard strain of rainbow trout at Kootenay Trout Hatchery. Changing conditions at the hatchery such as the change from creek water to entirely well water, and the construction of an enclosed building over our rearing and brood ponds, have caused us problems in brood stock maturation. We have also been involved with a regional bull trout spawning program located on the upper Columbia River. Wild male bull trout have had a notorious reputation for losing their desire or ability to spermiate under captive conditions. Because of the problems arising in these two groups of fish, it was decided to give the new "wonder drug," LHRHa a try. LHRH (also called GnRH - gonadotrophin releasing hormone) is a hormone secreted by the hypothalamus that stimulates the pituitary gland to release luteinizing hormone (or gonadotrophin). A luteinizing hormone is a hormone from the anterior lobe of the pituitary gland that in females stimulates the corpora lutea, and, in the male, the interstitial tissue in the testis. The small "a" stands for analogue which means that it is similar to the thing it is replacing.

Let's take half a step back. In rainbow trout, the main environmental stimuli regulating reproduction is photoperiod. Although it is unclear as to the exact mechanism involved, the endocrine system is stimulated to begin the maturation process when certain light conditions occur. The reproductive state of rainbow trout is ultimately controlled by the hypothalamus, which is part of the brain (Fig. 1). The hypothalamus controls the action of the pituitary gland - this is done through hormones, not through direct nerve transmission. The pituitary secretes gonadotrophins (or luteinizing hormones) which act on cells within the ovaries or testis to induce the formation of, or maturation of, gametes. As well, these gonadotrophins alter the activity of other cells within the gonad to synthesize and secrete steroids for other stages of the maturation process. The gonadal secretions finalize gonadal maturity, release of gametes as well as affect the brain.

With the work we have done by introducing LHRHa (and later Ovaprim), we were attempting to supplement the fishes' insufficient efforts to produce its own GnRH (gonadotrophin releasing hormone) with a look like (or analogue), LHRHa. Again, this causes the pituitary to secrete the gonadotrophins. Using this method is close to natural as the fish is stimulated to produce its own gonadotrophins. And it does work best when the fish are well into the maturation process.

Our first testing began in the winter of 1987 with our rainbow trout brood stock. We were primarily concerned with females that were maturing over a 5 to 6 week period, in particular the "stragglers" toward the end of the spawning period. Although we tested the hormone on males, it was very much secondary concern. In these tests we used 50 females, 25 injected with a single 5ug/kg dose of LHRHa, with 25 females being non-injected controls, (see Appendix 1 for description of the injection method). Also 9 males were treated with the single injection of LHRHa, and 10 were non-injected controls. It appeared that maturation was advanced in the females on the 5th day, but normal ovulation brought the control fish almost to the same level by the 9th day from injection, Fig. 2. Although data were incomplete, it was noted that injected males produced sperm earlier in greater amounts.

In view of some success with our male rainbow trout, a somewhat ill-fated attempt was made in the fall of 1987 to re-stimulate male bull trout to spermiate using LHRHa. Some spermiation was noted but no data were collected.

A duplication of the 1987 test with our Gerrard rainbow trout brood stock was set up in 1988, excepting we tried using a 20 ug/kg dose of LHRHa. However, there appeared to be no differences between injected and non-injected controls, males, (Fig. 3), or females (Fig. 4). It was later learned through personal communication with some Montana fisheries staff that they had found similar mixed results when using LHRHa; it seemed to be some problem with the chemical received from the manufacturer. One thing this test did show is that it should be valid to utilize non-injected fish as controls (i.e. not having to inject controls with saline injections). This result left us rather discouraged and we decided to put hormones aside.

One cause for concern in some maturation situations is the effects of stress on developing fish. Under some stressful conditions, i.e. wild fish capture for egg collecting programs, fish may release (from the hypothalamus) a gonadotrophin releasing inhibitor. This lowers the level of gonadotrophin being secreted, thus slowing down, or stopping the maturation process. Dopamine appears to be the dominant chemical in this reaction. In 1989, a newly developed product became available called Ovaprim. From my understanding, ovaprim utilizes LHRHa with the addition of domperidone, an effective dopamine inhibitor. Clyde Park, Alberta Fish and Wildlife, had obtained very good results when male cutthroat trout were injected with Ovaprim at a field station. Because of their apparent success, we felt it would be worthwhile to try Ovaprim.

Our first project using Ovaprim injections involved bull trout at the Hill Creek spawning Channel, a regional fisheries site, in the fall of 1989. Concerns had been brought to us regarding the relatively poor success they were having in bringing captured adults, and in particular males, to maturity. And it should be noted that in about 10 years of capturing and holding bull trout adults, there was only one recorded case of a male that was not spermiating at capture, that began to spermiate after. Almost invariably, once the fish are captured, with all of the handling that ensues, males only decline in their sperm production. In these tests, various holding techniques from a semi-natural stream to enclosed boxes were used in combination with single Ovaprim injections at a rate of 0.5 ml. Ovaprim/kg of fish. The injected males held under the most natural conditions had a higher percentage of spermiating males, plus it also brought fish into spermiation from a non-spermiating condition, Fig. 5. There was no difference in the rate of maturation of the females, Fig. 6. Our conclusion from that experiment was that if sufficient spermiating males are on hand from the beginning, the need to inject Ovaprim is not necessary, however it appears to be capable of bringing non-spermiating fish to maturity. In other words, "if it ain't broke, don't fix it."

Well, in Feb. 1990, things were "broke"; our Gerrard rainbow trout males were not producing sufficient sperm on the first day of spawning. We decided to set up a test involving two injection regimes of Ovaprim, a full dose in a single injection, and a two stage treatment, with 25% injected on Day 0, and the remaining 75% on Day 3. A full dosage is 0.5 ml. Ovaprim/kg of fish weight. A third group was kept as an uninjected control. The test showed a fairly dramatic result in favour of the two stage injected group, see Fig. 7.

In view of these positive results (we thought we'd finally hit the jackpot with the two stage injection), we had the opportunity to test bull trout again in the fall of 1990. We set up a similar single stage injection, two stage injection and control group experiment. Unfortunately, experimentally, almost all of the males were spermiating at the beginning of the test, Fig. 8. One bright note was that only one fish was brought tospermiation and that was a single stage injected fish. Otherwise, the injected fish showed an early peak of performance, but dropped off more rapidly by the end of the test period. The uninjected control group that was spermiating well at the beginning were the most consistent sperm producers. If it ain't broke...

In an attempt to duplicate our 1990 result on our Gerrard brood stock males, we set up a similar test in Feb. 1991. The results from the two stage injection were not dramatically superior, in fact the single stage injection performed better, Fig. 9. It is interesting to note that on the first day of our test Feb. 1st, we made a major shift in our photoperiod regime, which may be the cause for the decline in the number of spermiating control males, and the somewhat lack lustre performance of the two stage injected fish. But the injected fish did show the trend to come into spermiation in spite of the photoperiod problems.

Our 1991 spawning season was very unusual, probably as a result of our poor photoperiod regime. Some of the females that had come into maturity at the normal time (Feb.) seemed to stop developing, and quite a few apparently immature females were brought to maturity because of the photoperiod change. There was a large number of females in this second group that went into a holding pattern after the initial egg collection from this group in late April. Because of this decline in ripeness we decided to inject the fish with Ovaprim to try to bring the fish to maturity. The first fish injected were 10 large 7 year old females. It was decided to try a double the normal dosage. This had fairly drastic results,; within 4 days 4 were dead, and the other six were spawned out in 2 weeks. In view of the extreme nature of the double dosage, we went back to a single injection at the normal dosage for 40 females. Fifty percent were spawned within two weeks, Fig. 10. The remainder we culled from the program. We began spawning the second group on Apr. 27, Fig. 11. By mid-May very little was happening. On May 23rd we injected 80 females with a single injection, full dose treatment. Within 2 weeks, 45% were spawned, and in view of the slowness of the remaining fish it was decided to reinject the with another single full dosage of Ovaprim on June 7th. Within the next 2 weeks, 48% of the fish were spawned. To us this showed real practical application of Ovaprim, in that we would not otherwise have hit our egg production target. A further note to the strangeness of this holding pattern of our brood in 1991: our males produced sperm throughout the whole period, i.e. January to June when normally a spermiation period of 6 - 7 weeks is normal.

What would I leave you with?

1. If your spawning regime is going along normally, you're happy with it, don't worry, be happy! Hormone injections are probably not for you.

2. If your fish are in the final stages of maturation and you need to close off your program, Ovaprim may be able to help.

3. If males are not spermiating, spermiation can usually be induced if the fish are close to maturation.

4. If you are planning to inject fish, kill a fish and test your skill at injecting a needle into the body cavity without damaging the various tissues and organs. Males are more difficult to inject than females. Other than killing off some females from overdosing them, we have reached the stage where it is a rarity to kill a fish from a misplaced injection.

5. In various tests, egg survival and fry quality are not jeopardized by injection of Ovaprim or LHRHa. The only difference could be that egg size may decline especially if the fish are a little farther from maturity when they are injected.

Appendix I

Generalized Procedure of Hormone Injection (Ovaprim)

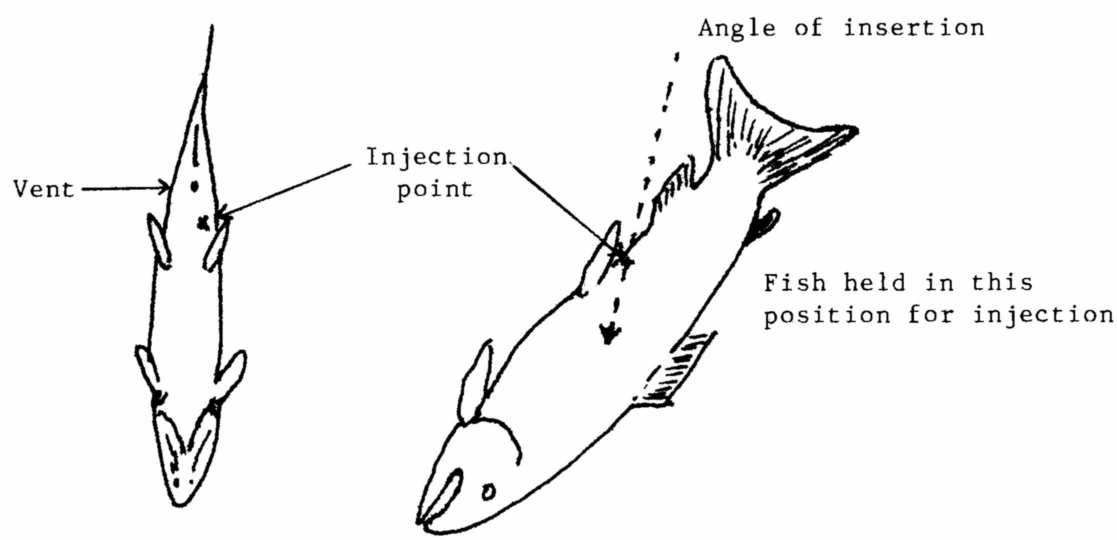
1. Preload disposable syringes (we use 3 ml.) with Ovaprim. Needles must be removed to load Ovaprim as it is very viscous. Load slightly more than you anticipate using.

2. Anaesthetize fish.

3. Weigh fish and calculate dosage. It is handy to have a chart made up with dosages for the various weights you may encounter. Dosage for Ovaprim is 0.5 ml Ovaprim/kg of fish, i.e. a 3 kg fish would be injected with 1.5 ml Ovaprim.

4. One person is required to hold the fish head down, at about a 45 - 60 degree angle, while a second person does the injection. The injection is made ventrally about half way to the base of the ventral fins. Do not put the needle into the egg mass, and try to avoid intestines, etc.; the injection should be made into the body cavity. If you find you are injecting into tissue, (which can be determined by feeling the injection area as the injection is being made), reposition the needle. It is a good idea to sacrifice a fish of each sex prior to injecting the whole group to determine if your needle placement is correct.

5. Use gloves and avoid skin contact, this stuff is pretty potent.



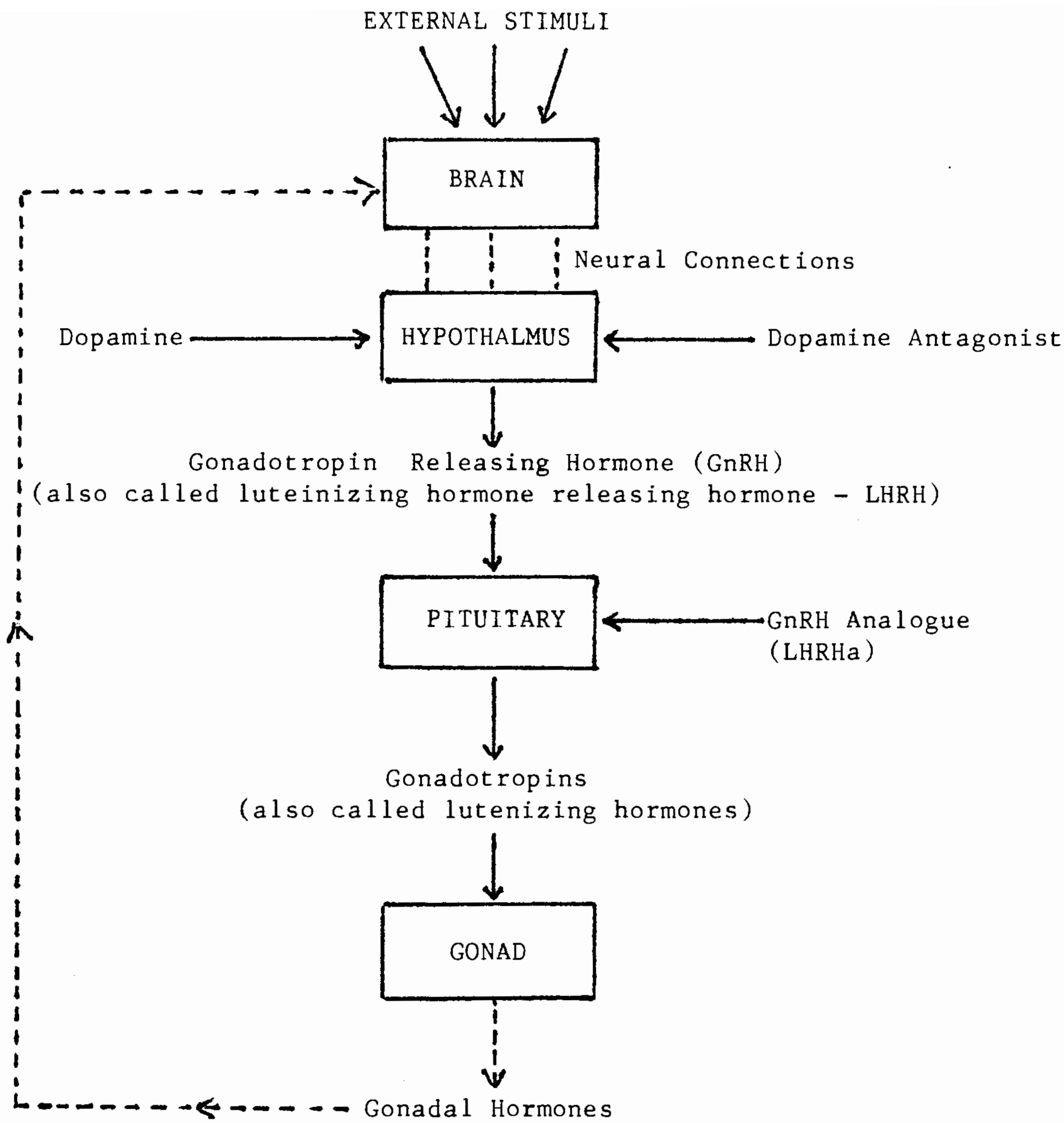


Fig. 1. Diagramatic sketch of the maturation process of salmonids

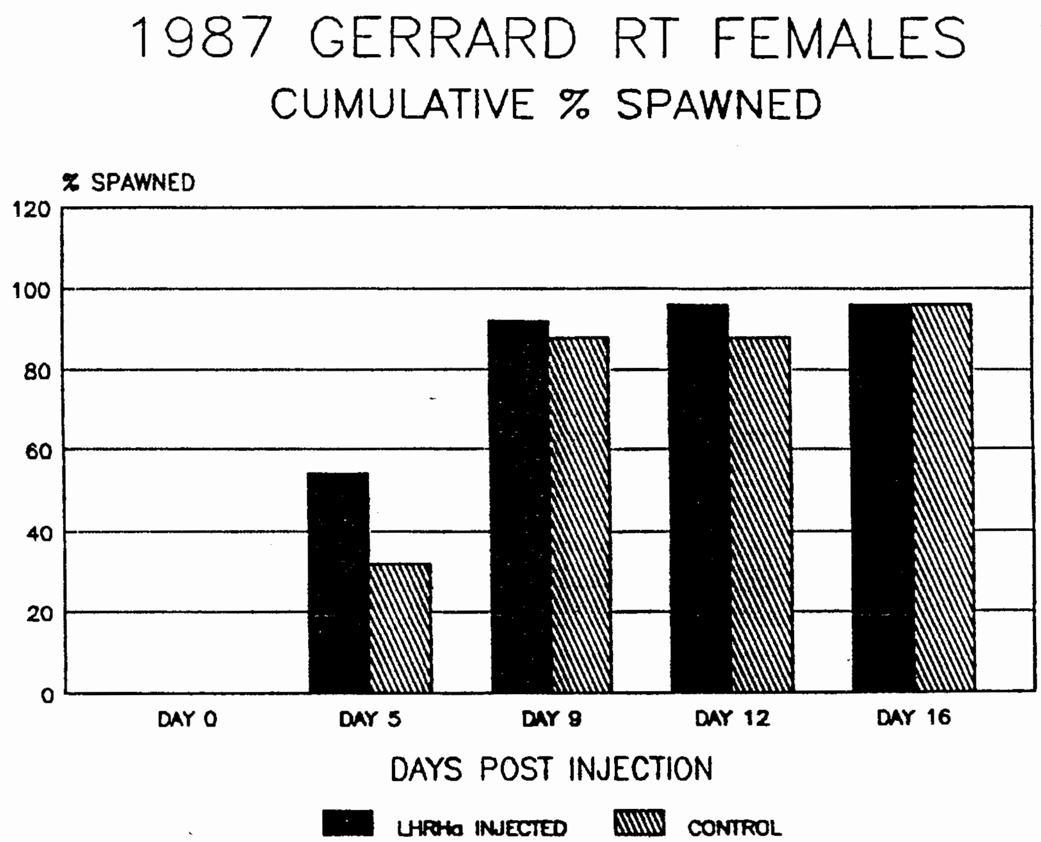


Fig. 2. Single 5ug LHRHa/kg injection vs. non-injected controls

1988 GERRARD RT MALES

DAILY % SPERMIATING

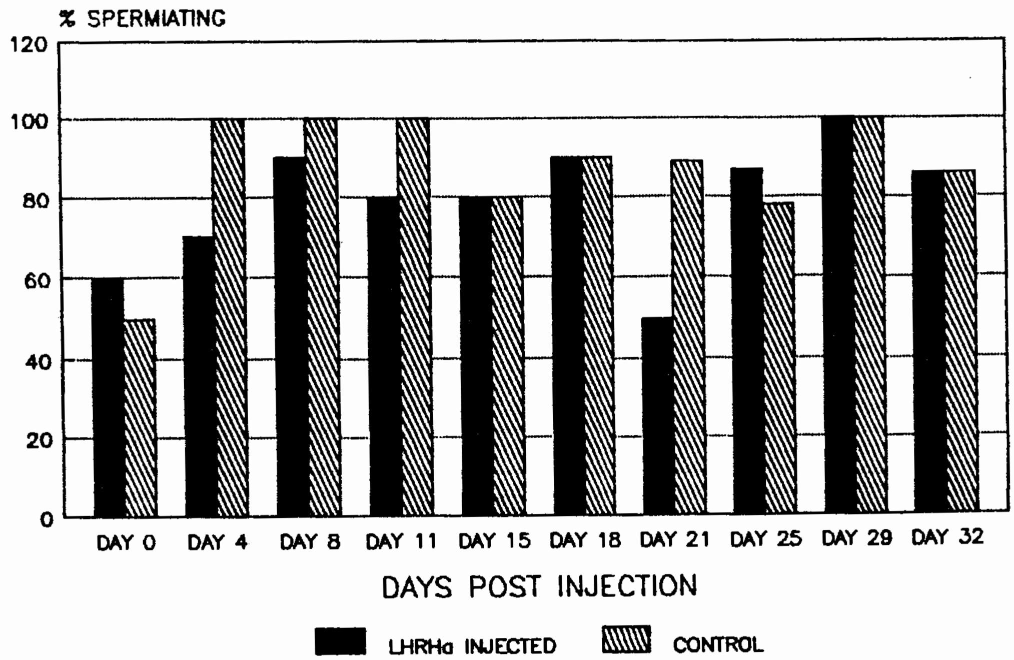


Fig. 3 Comparison of 20ug LHRHa/kg vs non-injected controls
note: suspect ineffective LHRHa

1988 GERRARD RT FEMALES

CUMULATIVE % SPAWNED

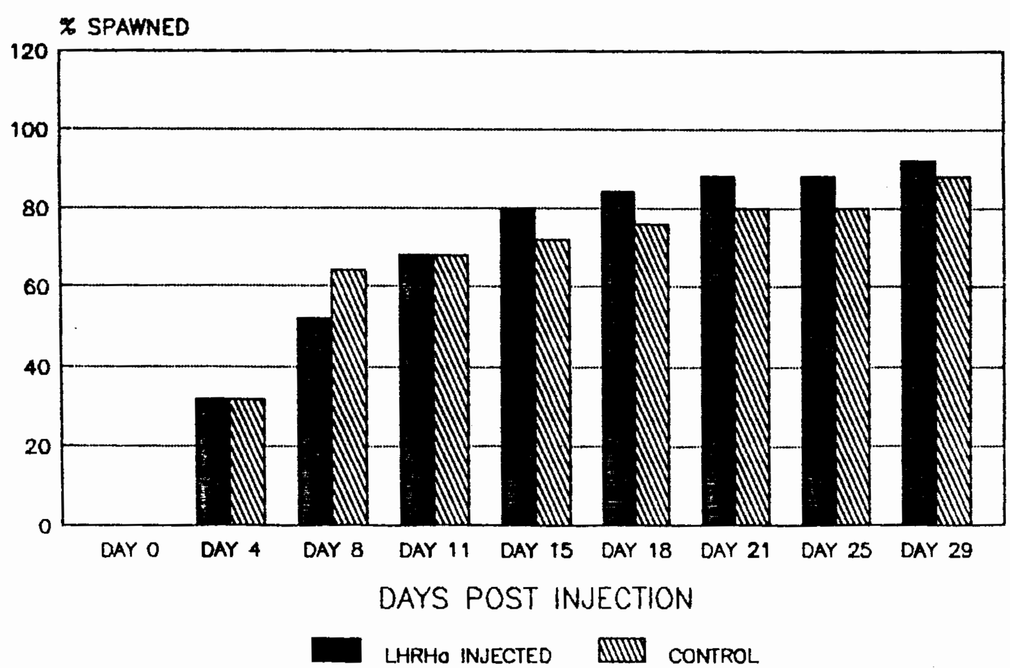


Fig. 4. Comparison of 20ug LHRHa/kg vs non-injected controls
note: suspect ineffective LHRHa

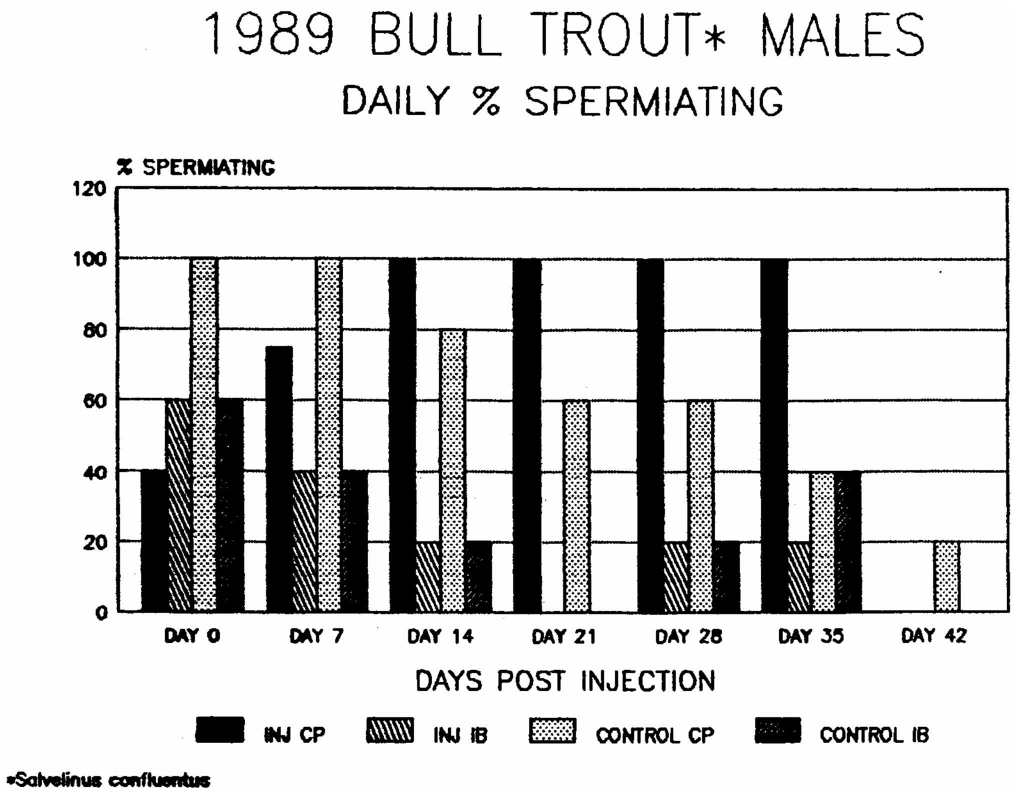


Fig. 5. Comparison of single stage 0.5ml Ovaprim/kg injection vs non-injected controls in two different holding situations, i.e. corner pool of a spawning channel (CP) & isolation boxes (IB)

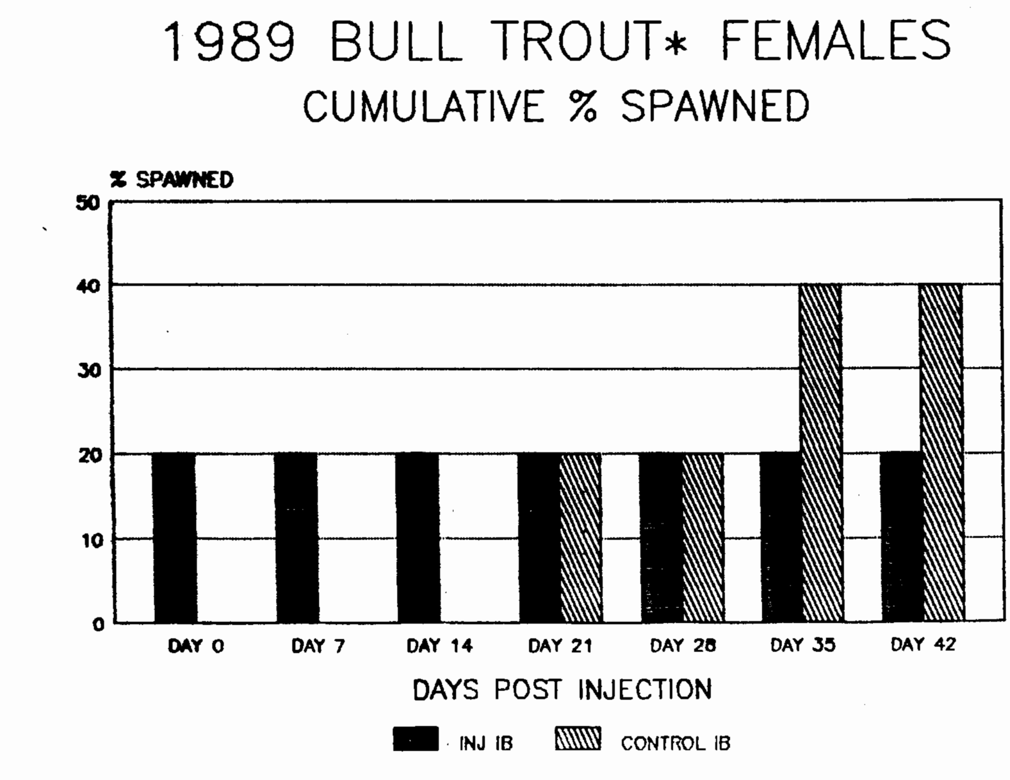


Fig. 6. Comparison of single stage 0.5ml Ovaprim/kg injection vs non-injected controls held in isolation boxes (IB)

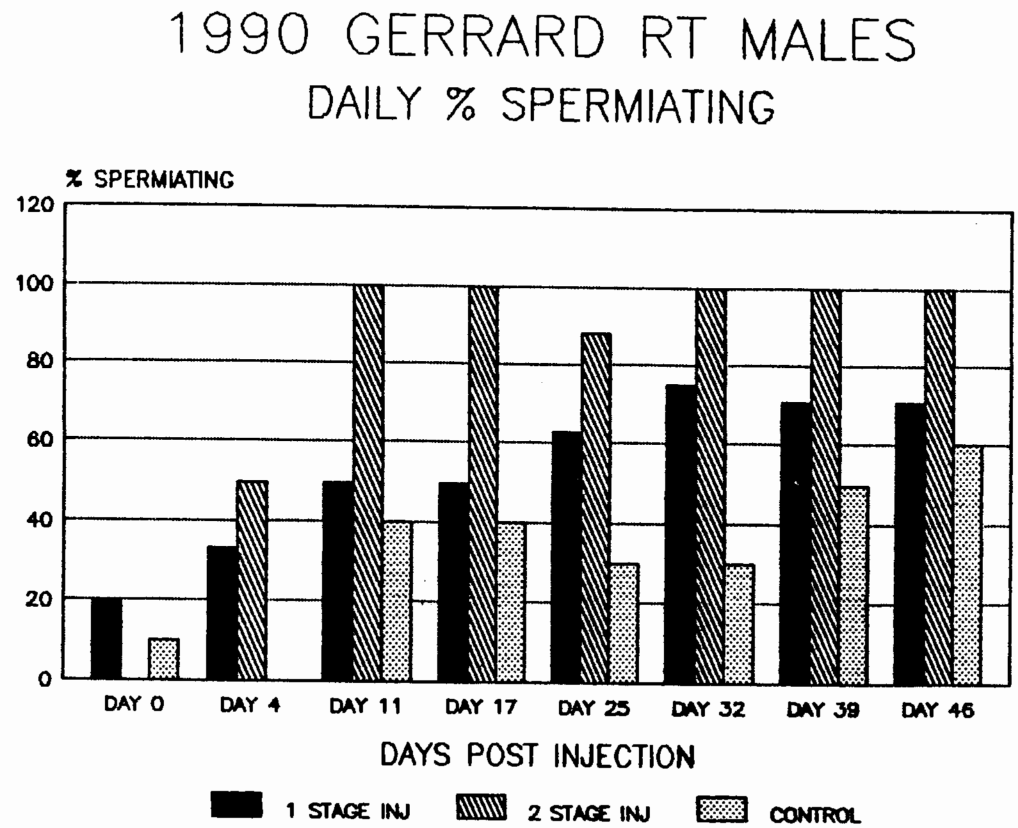


Fig. 7. Comparison of single stage and two stage 0.5ml Ovaprim/kg injections vs non-injected controls

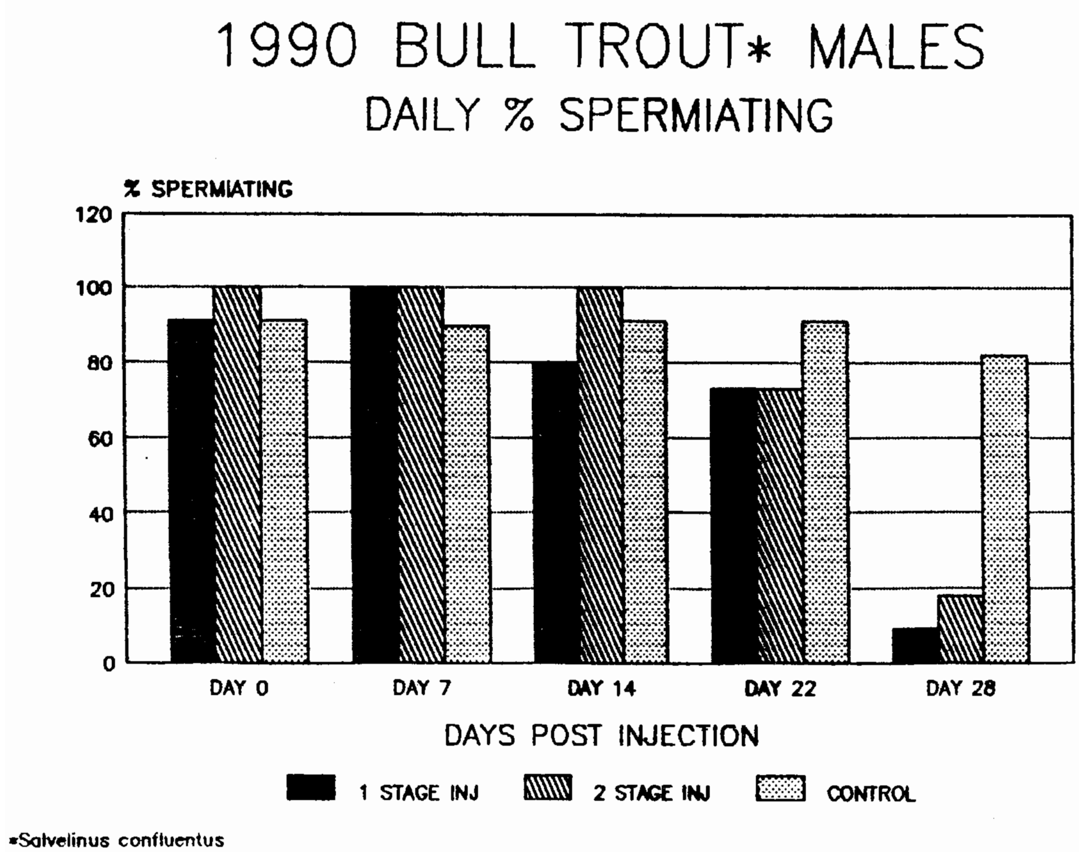


Fig. 8. Comparison of single stage and two stage 0.5ml Ovaprim/kg injections vs non-injected controls

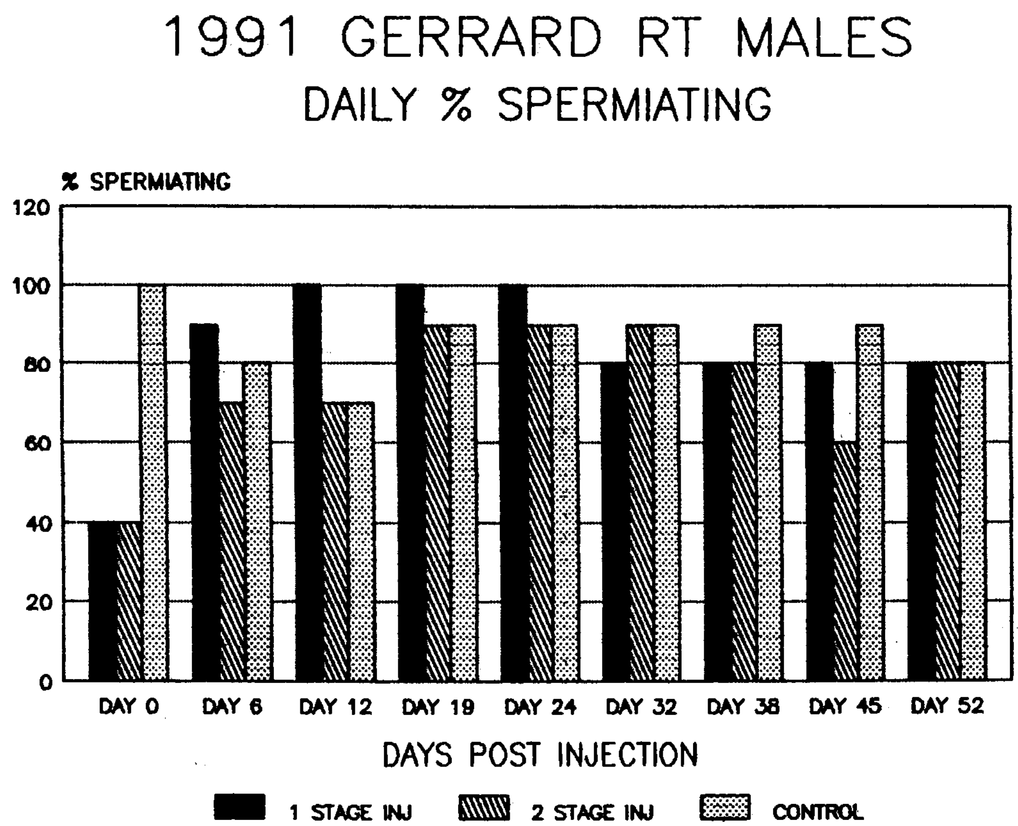


Fig. 9. Comparison of single stage and two stage 0.5ml Ovaprim/kg injections vs non-injected controls

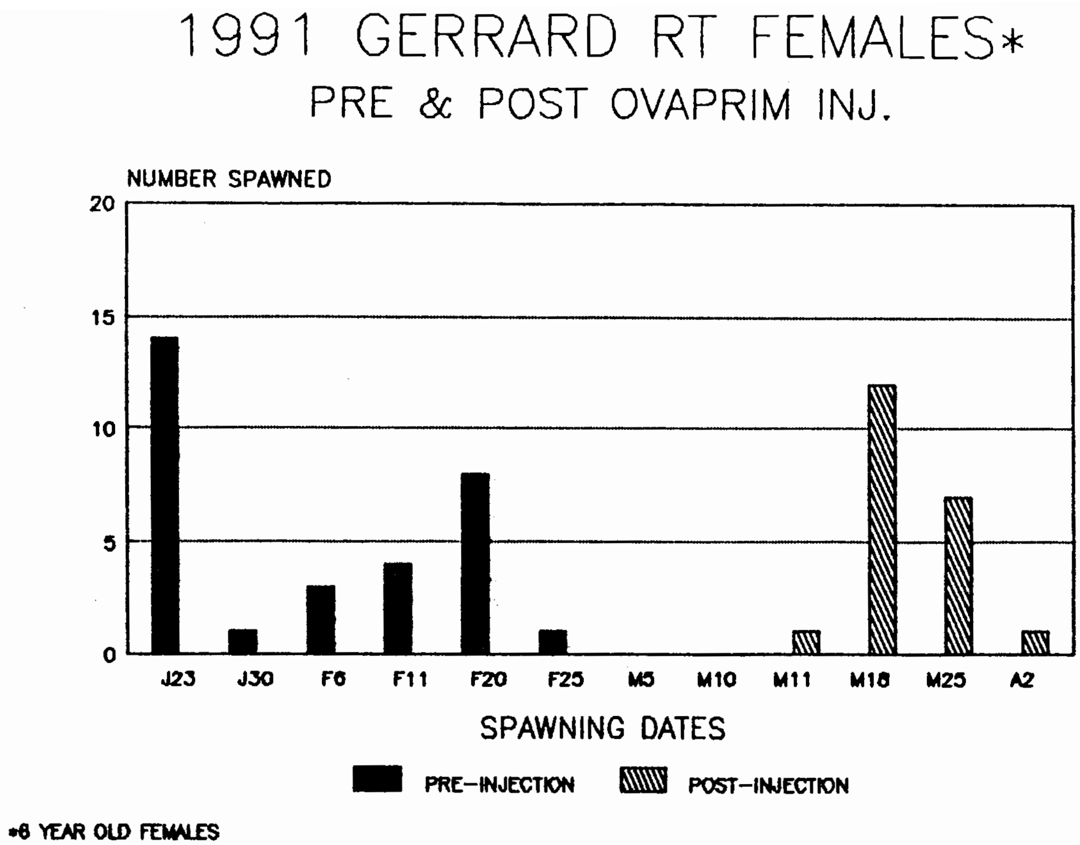


Fig. 10. Results of single stage 0.5ml Ovaprim/kg injections on brood stock females

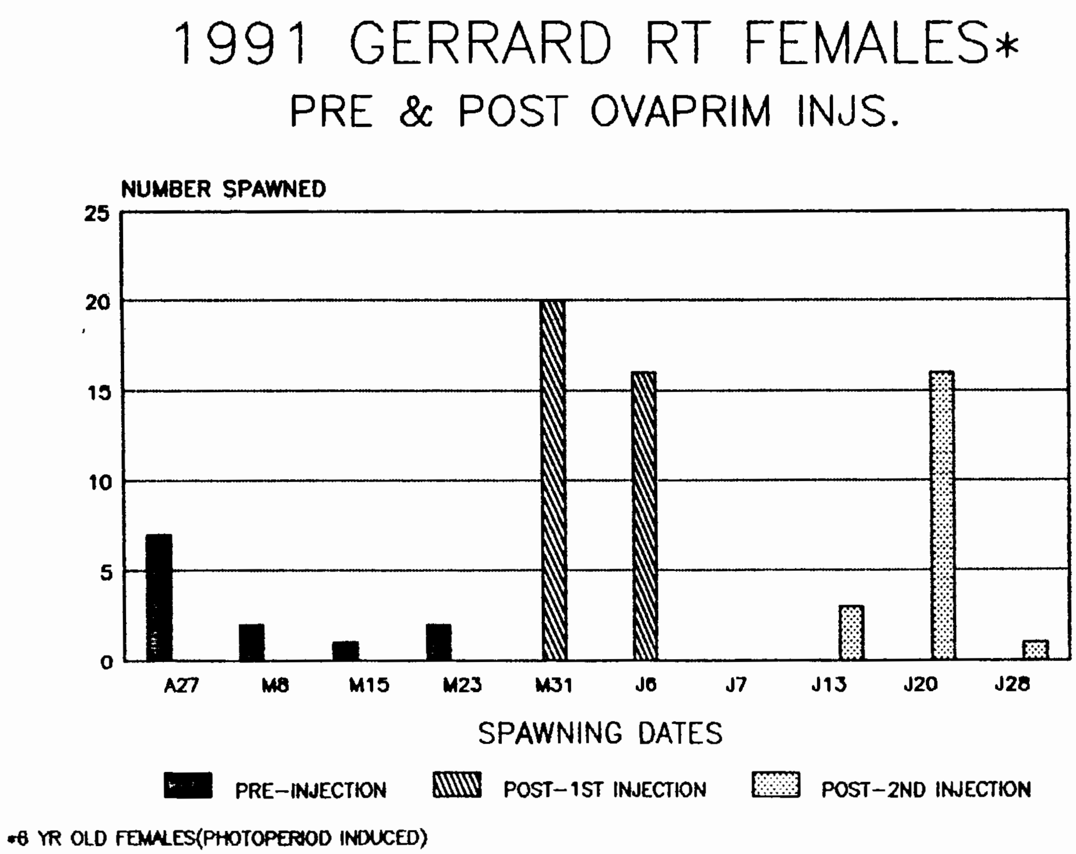


Fig. 11. Results of single stage 0.5ml Ovaprim/kg injections on brood stock females

SURVIVAL OF COHO SALMON SMOLTS IN SALT WATER FOLLOWING EXPOSURE TO CERCARIA OF THE SALMON POISONING FLUKE, NANOPHYETUS SALMINCOLA

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ABSTRACT

Coho salmon, Oncorhynchus kisutch, smolts were held in live boxes in six different sites in Grays Harbor, WA, where the salmon poisoning fluke, Nanophyetus salmincola, is endemic. The fish were transferred to seawater (29 ppt) after 5, 9, or 14 days exposure. Salmonid mortality was directly related to the number of metacerceria found in the posterior third of the kidney. Metacercerial load was positively correlated with live box placement and holding time in the live box.

INTRODUCTION

Two major river systems empty into Grays Harbor in Southwestern Washington. The Humptulips has a 245-square mile watershed and discharges into the north side of Greys Harbor in an undeveloped area, while the Chehalis has a 2,200-square mile watershed and discharges into the narrow east end of Greys Harbor. Unlike the area around the mouth of the Humptulips River, the highly developed area around the mouth of the Chehalis River contains two pulp mills which discharge 48 to 50 million gallons of pulp mill effluent per day, along with several landfills, log storage areas, and sewage treatment plants which contribute pollutants to the east end of Greys Harbor. In addition, the navigation channel in the inner harbor is regularly dredged, which adds suspended sediments to the water column (Fig. 1).

Since the late 1950's, biologists with Washington Department Fisheries (WDF) have observed that a higher percentage of coho, Oncorhynchus kisutch, and chinook salmon, O. tshawytscha, released in the Humptulips River have been harvested from the ocean than coho and chinook salmon released from the Simpson Hatchery on a tributary of the Chehalis River. In 1973, WDF placed coded-wire tags (CWTs) into two groups of 100,000 fall chinook that were being reared at the Simpson Hatchery northeast of Aberdeen. One of these groups was trucked and released into the Humptulips River, while the other was released near the

Hatchery into the Chehalis River system. The release into the Humptulips contributed 18 times as many fish to the ocean fisheries as those released in the Chehalis River basin (Seiler 1989).

In 1980, WDF began a long-term research effort to evaluate the production and survival of wild and hatchery coho salmon in the Grays Harbor area. In each brood year between 1980 and 1985, both wild and hatchery coho salmon survived and were caught in the ocean fisheries in significantly higher numbers from the Humptulips River when compared to those from the Chehalis River (Seiler 1989; Seiler, Pers. commun.) (Figs. 2 and 3).

Over the last several years, a multi-agency effort (including EPA, NMFS, WDF, and various other state and local agencies) has been mounted to determine the reasons for the fish loss from the Chehalis River. As part of this research, NMFS personnel placed coho salmon smolts in live boxes at numerous locations throughout Greys Harbor and, after exposure for up to 2 weeks, surviving fish were taken to Manchester to evaluate their long term survival in salt water. One portion of this work examined the relationship between infestation of the cercaria of the salmon poisoning fluke, Nanophyetus salmincola, and the long term survival of coho salmon smolts.

The life cycle of the salmon poisoning fluke involves a definative host and two intermediate hosts. The cycle starts when eggs in the feces of the definitive mammal host are shed into the water of a stream. The eggs soon hatch as free-swimming miracidia. These miracidia search out and enter a specific snail, Juga plicifera, where they multiply. They then leave the snail as cercaria, which move about until a chance encounter with a small fish. They burrow into the fish, where they encyst as metacercaria. The fish must then be eaten by a mammal to complete the cycle. The metacercarial cysts are carried through the digestive system where they develop and attach themselves to the walls of the intestine. The mature flukes shed eggs into the feces of the definative host. The principal mammalian hosts are the raccoon and the spotted skunk, but a wide variety of predators, both wild and domestic, have been found to shelter this parasite including the dog and cat (Schlegel et al. 1968). Nanophyetus is itself a carrier of another pathogen, Neorickettsia helminthoaeca, which can cause death in dogs (Wood 1978; Booth et al. 1984). Important intermediate fish hosts include the chars, trout, and salmon (Bennington and Pratt 1960).

Nanophyetus is found west of the Sierra Nevada and Cascade mountains from the Sacramento River in northern California to the southern end of the Olympic mountains in southwestern Washington.

Its occurrence is limited to waters which are the habitat of the graceful keeled horn snail, J. plicifera, (Booth et al. 1984). This snail prefers muddy-sand bottoms of small and medium-sized lakes and slow-flowing streams which contain large rocks, pilings, bridges, old planks, and other debris (Bennington and Pratt 1960; and Clarke 1981).

While Nanophyetus metacercaria are found encysted in almost every tissue of juvenile salmon, most metacercaria are found in the kidney, muscles, and fins (Wood 1980; Unpublished). Counts of over 450 cysts have been reported in the posterior one-third of the kidney of juvenile coho salmon (Harrell and Deardorff 1990). Following penetration of the fins, the cercaria have been observed entering the blood vessels between the fin rays and migrating down these vessels to the base of the fin. Passage to the kidney is thought to be by way of the renal portal system (Baldwin et al. 1967; Bennington and Pratt 1960).

METHODS AND MATERIALS

Six sites were established in Grays Harbor, the mouth of the Chehalis River, to expose coho salmon smolts to various suspected pollutants and pathogens. Four sites were in estuarine areas subject to industrial and urban discharges, one site was in a non-industrial estuarine area, and one site was in a non-industrial freshwater area (Montesano, WA) (Fig. 1). Each site had two nylon-mesh net-pens, each 2.4 x 2.1 x 1.8 m deep, suspended from a well anchored floating frame.

Unvaccinated, unmedicated coho salmon smolts from the WDF Humptulips Hatchery were used to stock all live-boxes. Fish were subsampled from each site on day 5, 9, and 14 of the test. Approximately 300 fish were placed in one of the nets, from which fish were removed on Day 5 and Day 9 post-exposure, and 200 fish in the second net, from which fish were removed only on Day 14. Initial density in the net containing 300 fish was below 1.75 kg/m^3. On Days 5, 9, and 14, approximately 100 fish were removed from each live-box and transported to seawater net-pens at the NMFS Field Station at Manchester, WA, near Seattle. Tanks containing approximately 150 gallons of water collected from each live-box site were used to transport the coho salmon smolts. Water in the tanks was aerated with oxygen for the duration of transport, usually 3 hours. On arrival at Manchester, each group was acclimated to seawater for 30 minutes by gradually replacing the hauling water with ambient seawater (29 ppt salinity). Each test group was then transfered in seawater to a 1.2 x 2.1 x 1.5 m deep nylon-mesh net-pen.

Fish were fed Oregon Moist Pellet three times daily after transfer to seawater. Dead fish were removed daily and examined for bacterial pathogens. In addition, counts were made of the number of metacercarial cysts of N. salmincola in the posterior third of the kidney of all mortalities.

Two separate live-box trials were conducted: Series 1 beginning April 22, and Series 2 beginning May 12, 1989. Each series of trials was followed in saltwater for at least 16 weeks.

RESULTS AND DISCUSSION

At the end of 10 weeks in seawater, all three groups from Montesano site had suffered over 75% mortality, while all groups from the five estuarine sites had suffered less than 25% mortality (Fig. 4). Cumulative saltwater mortality ranged from a high of 95% after 14 days exposure at Montesano, Washington, to a low of 75% after only 5 days exposure at the same site. After 10 weeks in seawater, mortality increased in all test groups from the five estuarine sites due to an outbreak of vibriosis.

A significant increase in the average number of cysts found in the posterior third of the kidney was found in all groups exposed at Montesano, Washington, while groups from the five estuarine sites consistently showed fewer cysts ($P > 0.01$). In the first series, estuarine groups averaged less than 30 cysts per fish, while the Montesano groups averaged from 40 to 72 cysts per fish. In the second series, the estuarine groups averaged less than 50 cysts per fish, while the Montesano groups averaged from 74 to 136 cysts per fish. In both series of tests, the average number of cysts in the posterior third of the kidney in all estuarine groups was similar to the average number of cysts found in fish at Humptulips Hatchery at the start of a particular series of tests.

Salmon mortality was directly related to the number of metacercaria found in the posterior third of the kidney. When the average numbers of metacercaria in mortalities from each group were plotted against percent group mortality, a sigmoidal relationship was seen (Fig. 5).

Subsequent examination of the Montesano site revealed high concentrations of _J. plicifera_, which would explain the large numbers of metacercaria found in the posterior third of the kidney of coho salmon smolts placed in that live-box. Since all other sites were in seawater, the fish placed in those live-boxes were protected from additional "strikes" of _N. salmincola_ metacercaria, which require freshwater.

These results suggest a reason why the coho salmon from the Chehalis River contribute to the fishery at a lower rate than those from the Humptulips River. It could be that many coho salmon from the Chehalis River enter the inner harbor with heavy parasitism from _N. salmincola_ and encounter the additional stress of industrial and urban pollution which compromises their transition to seawater.

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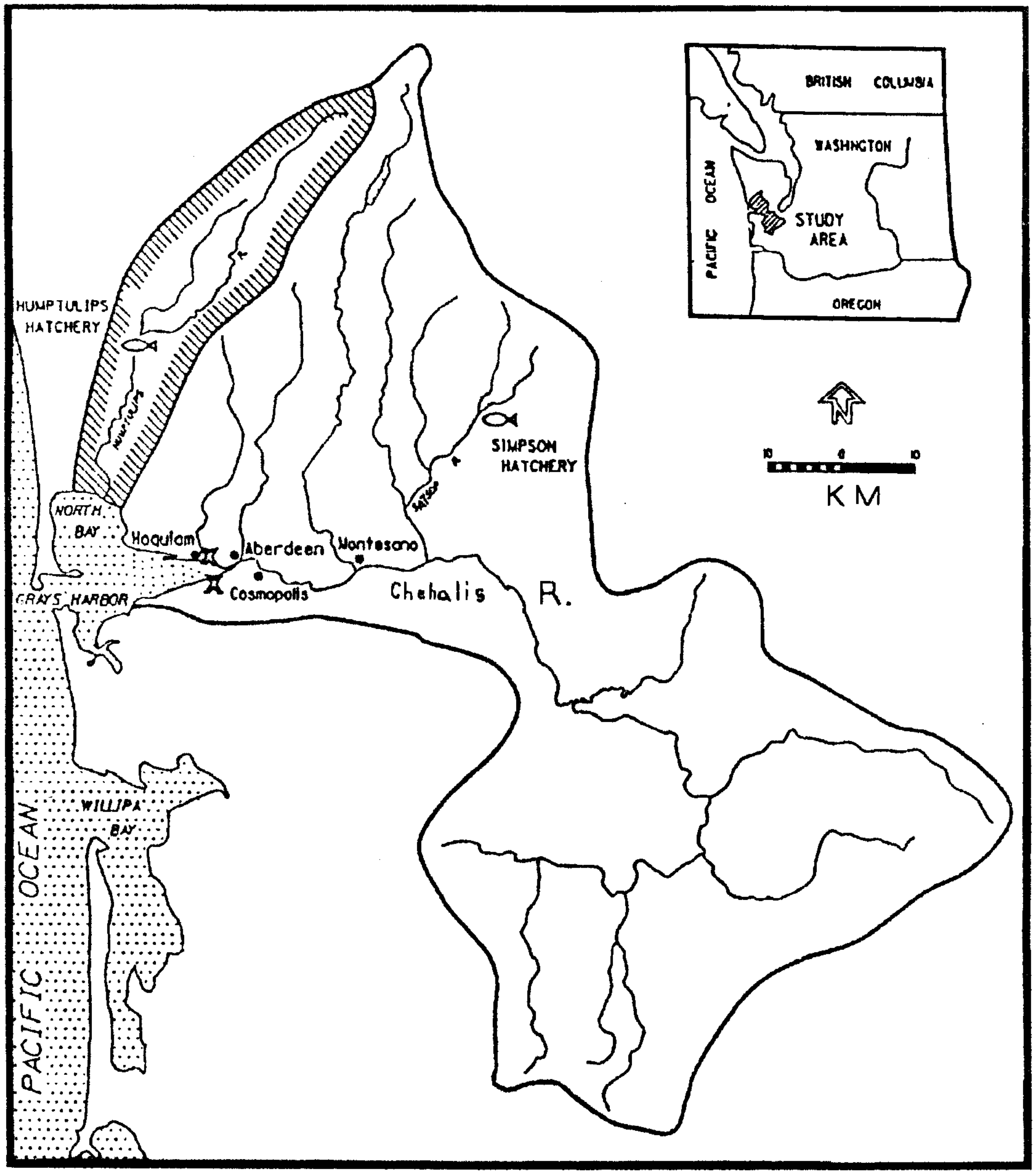

Figure 1. Chehalis River Basin, site of Nanophyetus research.

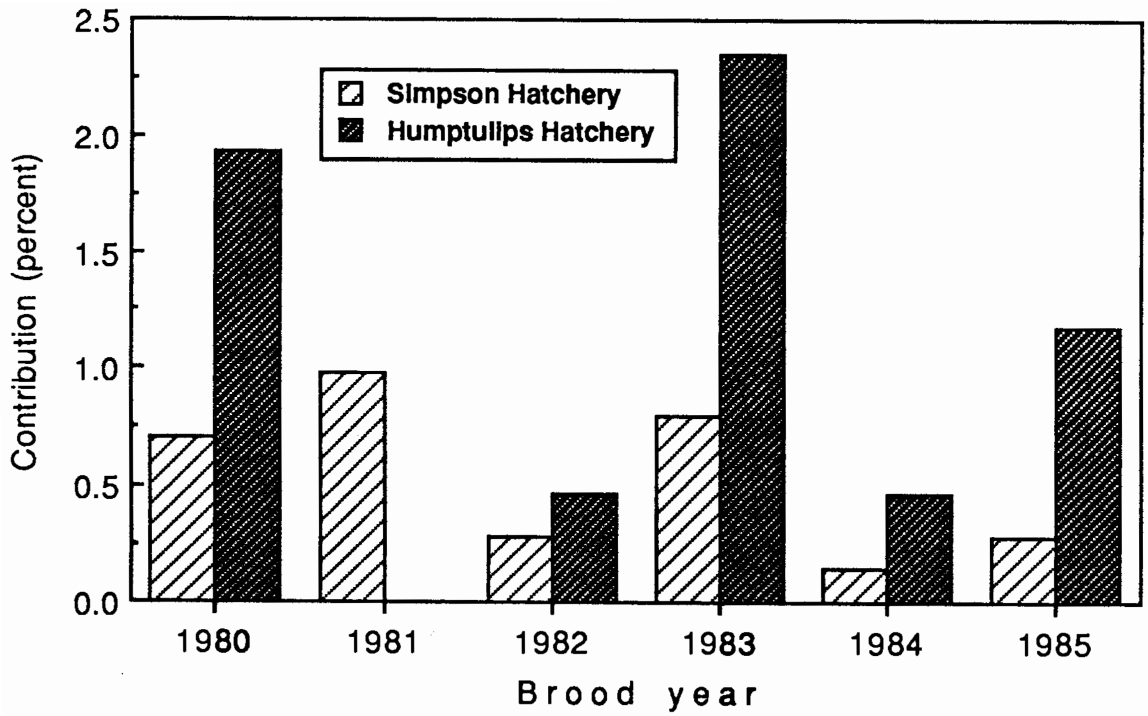

Figure 2. A comparison of the contribution rates of Simpson (Chehalis watershed) and Humptulips hatchery coho salmon to ocean fisheries. In 1981, no Humptulips fish were tagged because of a disease outbreak at the hatchery (Seiler, 1989).

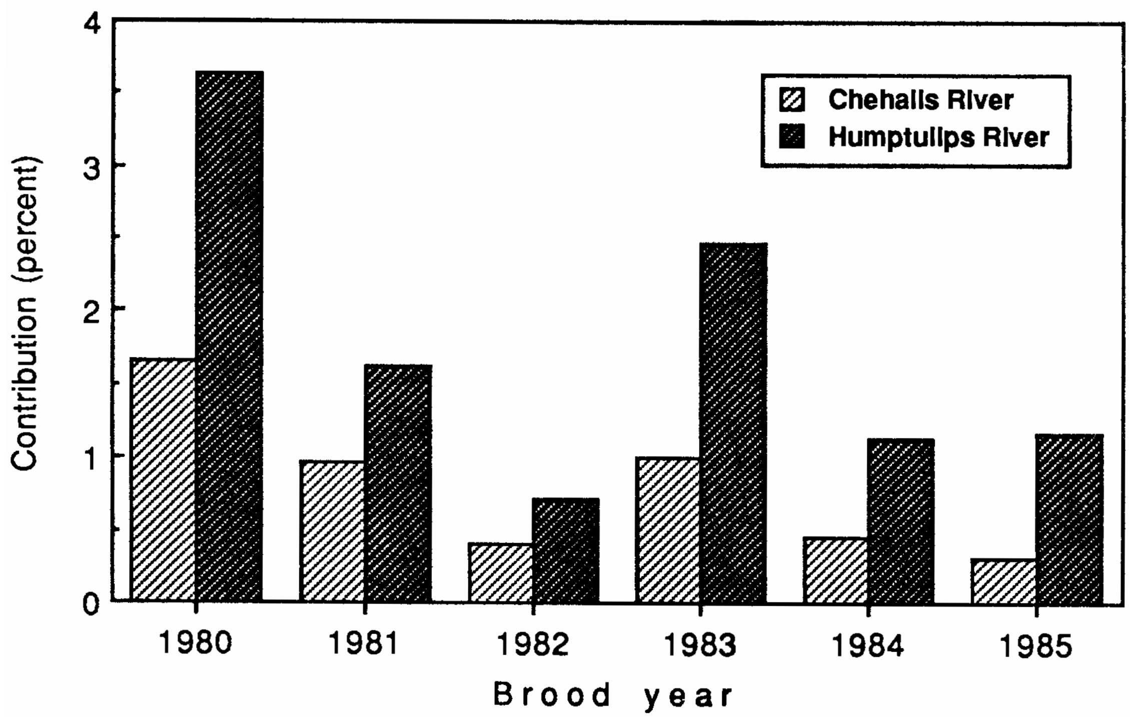

Figure 3. A comparison of the contribution rates of Chehalis and Humptulips wild coho salmon to ocean fisheries (Seiler, 1989).

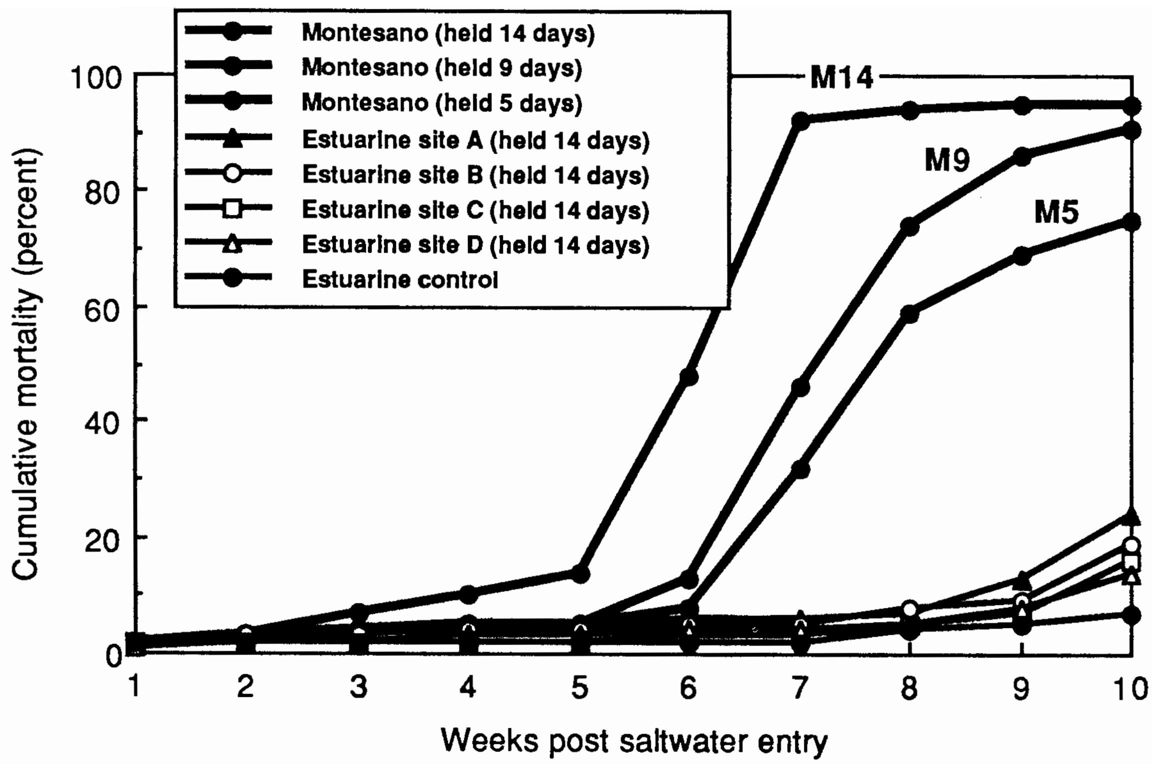

Figure 4. Cumulative saltwater mortality of coho salmon smolts held at Montesano, Washington, on the Chehalis River compared to similar groups of coho salmon held at various estuarine sites in Grays Harbor groups experienced an outbreak of vibriosis at week ten.

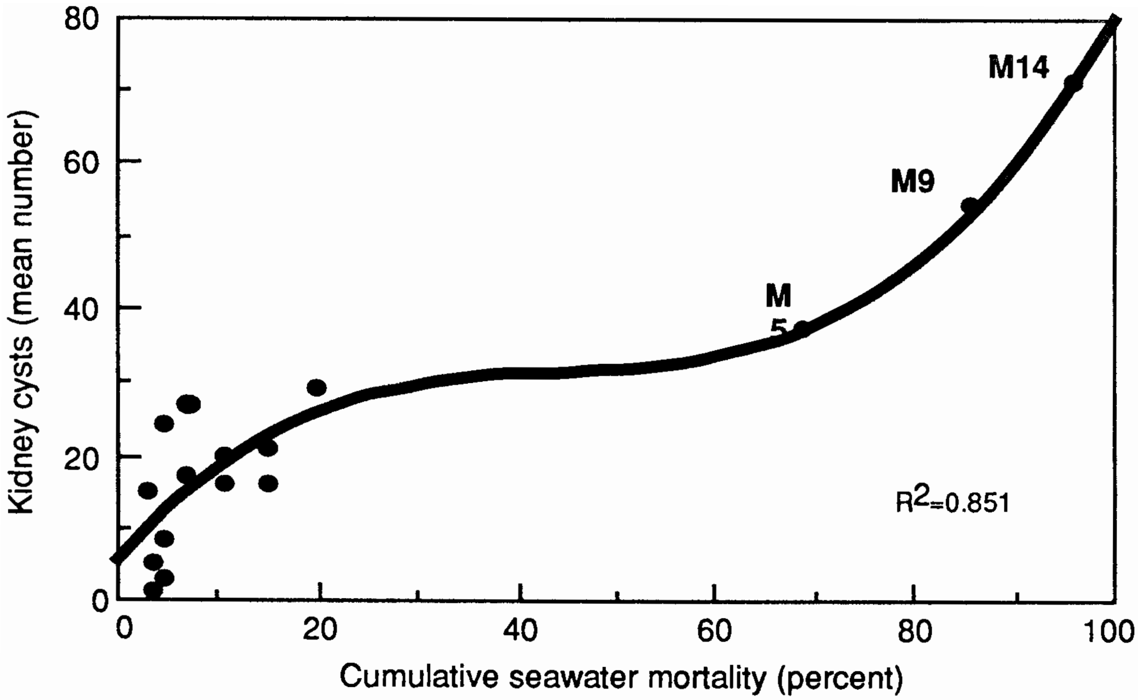

Figure 5. The relationship between the number of *Nanophyetus* cysts in the posterior third of the kidney and the survival of juvenile coho salmon smolts after 10 weeks in seawater.

BI-ANNUAL SPAWNING RAINBOW TROUT

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My presentation is on a strain of fish we raise that spawns every 6 to 7 months, produces over 10,000 eggs per female per year, and some of the problems associated with this bi-annual spawner. First, where are these fish raised and why?

Hot Creek Hatchery is located in Mono County at an elevation of 7,100 ft. Climate in the winter ranges from -30 to 80°F in mid summer. Four major springs supply the water needed for fish culture operations. Two of the springs that supply the production raceway series have a water temperature ranging from 59 to 63°F. Another spring supplying the series where the 2-year old broods are raised is 54°F and the final spring produces 52°F water for our 3-year old broods. At present we spawn five subspecies of rainbow trout including the RT-Coleman, which spawn from mid-November through the first week in January and the RT-Kamloops Junction, a wild trout strain raised at Junction Reservoir, which spawn from mid-April through the first week in June.

We also receive golden trout and cutthroat eggs through June before we spawn the RT-Erwin and RT-Hot Creek which spawn from late June through late August. Finally, the RTH-Wyoming spawn from the middle of October through late November. We also air plant golden, cutthroat, and Kamloops trout. In between all this, we plant fish ranging from fry to broodstock. It takes six Fish and Wildlife Assistant I's, three Fish Culturists, two Managers, and up to four Seasonal Aides to maintain operations at this installation.

The Hot Creek Strain (RTH) is the only strain in which selective breeding procedures have been used. Originally, this was a fall spawning strain, but with the need to produce earlier eggs to meet production goals, this stain became a summer spawning strain through selective breeding, reaching its spawning peak in mid-August.

A brief history of the RTH strain: In 1933, eggs from fall spawning fish were received at Hot Creek Hatchery, forming the nucleus of our stock. In 1975 and 1976, sperm from 30 RT Virginia rainbow trout males from Mt. Shasta Hatchery were shipped to Hot Creek Hatchery to fertilize eggs from RTH females.

This step was primarily experimental and was designed to determine the spawning time, spawnability, and production potential of the progeny at Hot Creek. Two years later, when these crosses were spawned, the onset of spawning was found to occur about July 15, approximately 1 month earlier than start of spawning for RTH broodstock.

One year later these RTV X RTH broodstock were spawned back with RTH broodstock, forming the nucleus of a new broodstock that is genetically 25% Virginia strain and 75% Hot Creek strain.

One of the biggest problems we faced with the RTH broodstock was that the males were late maturing, requiring pituitary hormone injections to induce spawning. Fertility was consistently 10 to 20% lower than other broodstock raised at the Hatchery, with the blame usually falling on the males.

Other hatcheries raising the RTH's usually suffered higher than normal losses during the fingerling stage and occasional gill bleeding during stressful situations such as handling, grading, and transportation. The decision has been made to slowly eliminate the RTH's and replace them with another strain that spawns at the exact same period so that operations can be maintained.

In 1987, we received the RT-Erwin (RTE) strain from Montana. This strain spawns during the same period that the RTH's. The RTE's entered the spawning season at 2-years of age in great form, especially the males, which is a rarity for RTH males.

RTE broodstock are slightly smaller than RTH broodstock of the same age and produce about 500 eggs less per female: A 2-year RTH female has about 3,900 eggs at 440 per oz.; a 2-year RTE female has about 3,400 eggs at 470 per oz.

Fertility was ranging from 65 to 75% for the RTE's in 1990 but dropped to about 60% this year. Production hatcheries that raised RTE and RTH side by side for a comparison are not sure that the RTE should be the strain to replace the RTH, claiming the RTE's didn't handle stress any better than the RTH. With other strains being evaluated to replace the RTH's, it seems that the RTH broodstock is trying to hang on, but in reality it has caused us more problems by spawning every 6 to 7 months. Now, lets get to what the RTH's should be doing, and what they started doing about 3 years ago.

As I had mentioned earlier, the RTH broodstock spawns as a 2-year-old, with the spawning peak being the second week of August. The example I'll use is RTH, year class 1988. On June 23, 1990, RTH spawning commenced. Immediately 40 out of 60

2-year-old females were overripe. The 40 overripe females were stripped and set aside for planting out. These females would not be kept for 3-year-old spawners because of their overripe condition. That year we would keep 1,500 females that were in excellent condition and spawned between late June through the first week in September.

About the second week in October, we inventory and restrip these 1,500 females and move them down to the lower hatchery where we'll spawn them as 3-year-olds in mid summer the following year. But on February 26, 1991 we started sorting and spawning these very same females that had spawned 6 to 7 months earlier as 2-year-olds. How did we know to start checking these fish that had spawned only 6 months ago? By accident, usually someone picks up a dead fish or two out of the brood series that are full of eggs. That same day, approximately 400 of the 1,500 females were overripe. Our guess was that they probably would have been ready the first 2 weeks in February. We continued sorting and spawning through April 12.

In order to see when these females would spawn again we decided to mark some of these fish. If they spawned again in 6 months it would be too late in the season. So on March 8th, 66 females were fin clipped with a left pectoral mark after spawning them; on March 28, an additional 149 females were fin clipped right pectoral for future reference. On October 1, exactly 6 1/2 months after these females were spawned, they were found to be ripe with viable eggs, but the eggs were too late since all egg shipments had been completed.

Out of the 1,500 females approximately 960, or roughly two thirds, were spawned or stripped out during the spring. Only 288 of these 1,500 females spawned during their normal spawning period as 3-year-olds. Out of 6 million eggs produced that summer, only 1.6 million came from 3-year old fish, with the bulk of the egg production falling on the 2-year-old females. I believe that most hatchery managers would prefer eggs from 3-year-old fish if they could get them. Not knowing when your broodstock is going to spawn can create some problems!

Some of the problems caused by these bi-annual spawners; first of all, from mid-January through mid-March used to be the time we could catch up with our maintenance at the Hatchery and work on our vehicles. Now we were forced into sorting and spawning or just stripping these fish because we really didn't have a need for these eggs. During the spring, egg fertility is extremely low, ranging from 15 to 30%.

A 2-year-old female in the summer produces an average of 3,900 eggs at 440 per oz. The same female 6 1/2 months later produces 5,100 eggs per female, but at only 650 per oz. with poor fertility. Normally the eggs are bigger at the second spawning of most fish, but not for these bi-annual spawners. The same female 6 1/2 months later produces 5,800 eggs at 315 per oz., with excellent fertility, which is normal for this 3-year-old fish.

Why the low fertility in the spring? We thought the sperm might be the cause so we checked the sperm under the microscope and found motility lasting from 30 to 90 seconds in this solution. That should fertilize eggs, but we decided to try sperm from spring spawning RT-Whitney (RTW) or Kamloops (RTKJ) for fertility comparison against a control group. On April 19, we received sperm from RTW males from Mt. Whitney Hatchery. The dry spawning method was used. Eggs from 20 RTH females were fertilized with RTW sperm and eggs from 20 RTH females fertilized with RTH sperm were used as the control group. An equal number of eggs were incubated side by side for comparison. When fertility counts were taken, both groups increased their fertility by only 10%. Now we knew the eggs were to blame for the poor fertility. The slight increase in fertility for both groups indicated we were probably receiving a few more viable eggs because we were getting closer to the normal spawning period. During the spring, not only are the eggs smaller, but there seems to be a little less ovarian fluid during spawning, although the eggs flow freely.

I believe that most of these eggs are not reaching the full degree of ripeness in order to be fertilized during the spring. This year we also noticed a higher number of these fish getting fungus just before we spawned them. It is probable that with all the handling, and the fact that these fish are producing eggs twice a year that their immune system is weakening and they could be vulnerable to pathogens as well.

Why are these fish spawning ever 6 months? We don't know. Some believe its genetic that, with our selective breeding practices, we're growing the fish larger at a quicker pace with some fish reaching 5 pounds in 2 years. Our location, with thermally heated water being used to raise our fish, should also affect the Coleman stream (RTC). I think it could be a combination of some of these practices. Approximately 30 years ago there was an article written about RTH spawning twice a year, but it wasn't specific on the number, or time period between spawning.

What we do know is that these bi-annual spawners have created more work and given us more headaches at an installation that is extremely busy all year. We really don't have the time and manpower to study this broodstock in order to determine why they're producing eggs twice a year.

Economically, its not feasible to raise 1,500 female broodstock and only utilize 288 during the spawning season. If our 2-year-olds start spawning twice a year in greater numbers, we could fail to meet our egg allotments.

Right now we're coping with this problem, it is imperative to be able to control this broodstock so that it can work for us and not against us in order to meet our objectives, or replace it with another strain.

This coming year it is anticipated that our 2-year-old RTH will have the high number of bi-annual spawners. The RTE's, who spawn exactly the same time as the RTH, have also had a small percentage of bi-annual spawners. Only the RTC and RTKJ have kept their annual spawning characteristics at Hot Creek Hatchery and we hope they remain that way!

WHITE RIVER SPRING CHINOOK SALTWATER BROODSTOCK PROGRAM

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ABSTRACT

Saltwater broodstocking can be successfully used to rapidly enhance egg production for endangered stocks. It provides maturing salmon protection from predators as well as all fisheries. It takes a relatively small number of fish (3,500 for instance) to produce a large number of eggs. Saltwater broodstocking can be a useful tool for resource managers concerned with enhancing salmon stocks with severely limited adult escapement potentials. The White River Restoration project is a case in point. The Washington Department of Fisheries (WDF) in conjunction with Tribal and Federal agencies has been seriously involved for over 15 years with restoring the depleted run of spring chinook to the White River, located in southern Puget Sound. Since 1989, WDF has transferred 3,500 yearling smolts from its freshwater enhancement facility to the South Sound Net Pen Complex, a cooperative saltwater rearing facility operated jointly by WDF and the Squaxin Island Tribe. In 1990, a proportion of the 1987 brood reached maturity. This group of 3-year-old females provided our program with 161,000 eggs. In 1991, the 1987 brood reached maturity as 4-year-olds and a proportion of the 1988 brood matured as 3-year-olds, providing our program with over 1.2 million eggs! Over 70 adults still remain from the 1987 brood year and the majority will most likely mature as 5-year-old females.

INTRODUCTION

Washington Department of Fisheries began restoration of White River spring chinook in 1974. A major concern confronting White River resource managers was how to restore a severely depleted run of fish to a river system with so many unresolved environmental problems. To overcome this difficulty, resource managers from state, federal, and tribal agencies moved to create an offsite broodstock program consisting of a anadromous component and a saltwater (net pen) component. The program involved removing the run of spring chinook from the White River to an environmentally "safe" system where the stock could be rebuilt over time. During the rebuilding period environmental problems associated with the White River relating to both upstream and downstream fish passage on the are being addressed and corrected. The first priority of the project has been to maintain and build up the run offsite. The second priority has been to reintroduce the run into the White River with surplus progeny from the broodstock program.

Stock reintroduction began in 1989. The White River Fish Hatchery, operated by the Muckleshoot Indian Tribe, has been the site for initial rearing and planting of the endangered stock back into the native system. For a history of the early broodstock program refer to WDF unpublished (1986).

Our report will focus on the saltwater broodstock portion of the restoration project at the South Sound Net Pens (SSNP). The South Sound Net Pen complex is jointly managed by the Washington Department of Fisheries and the Squaxin Island Tribe. Three major net pen complexes consisting of 73 individual units are located adjacent to Squaxin Island in Peale passage (Figure 1). For the past 18 years the complex has been dedicated to chinook and coho smolt production. However, beginning in 1987, several pens were set aside to accommodate a broodstock enhancement program for the White River Restoration Project.

BROODSTOCK REARING STRATEGIES

Freshwater

Early rearing of the broodstock takes place at the WDF freshwater enhancement facility located at Hupp Springs Hatchery in South Puget Sound. During the freshwater phase, the fish are given three prophylactic treatments of ethromycin thiocyanate (Gallimycin-50p) as a preventative measure against Bacterial Kidney Disease (Renibacterium salmoninarum RS). The first treatment is administered when the fish are approximately 1.5 grams. The second treatment is administered when the fish are approximately 8.5 grams. The final treatment occurs when the fish are approximately 22 grams. Six weeks before the yearlings are transferred to saltwater, they are given a vibrio vaccination. The immersion method is used for this inoculation. At the time of transfer another vibrio vaccination is administered. This treatment is given in the tank truck as the fish are transported to the saltwater site.

Saltwater Phase

Transfer

Fish are transferred in early April to SSNP as yearling smolts. At the time of transfer, the fish weigh approximately 55 to 75 grams. The fish are transported in freshwater by a 1,000-gallon tank truck. Upon arrival at the saltwater loading site the fish are transferred to a waiting fish tank barge which will ferry the smolts to the net pens. By mixing freshwater from the tank truck with saltwater from the fish barge the smolts are tempered for salinity and temperature on route to SSNP. Fish handle very well during and after transfer. Initial loss has remained less than 0.5%.

Rearing Densities

All 3,500 fish are placed in one net pen (each unit provides 8,300 ft^3 of space). Initial loading density is 0.06 lb/ft^3. When the density in the pen approaches 0.3 lb/ft^3, the fish are split into four separate pens for final outgrowing. At this time (usually 5 months post transfer), the fish are approximately 500 grams each. During this time, the fish are inventoried and 2-year-old micro jacks are culled from the population. These light loading densities allow the fish to remain free from further handling until the following September. Densities decline throughout the rearing period due to the removal of maturing fish as 3 and 4 year old broodstock. Our maximum rearing densities are: (2 year fish = 0.30 lb./ft^3; 3 year fish = 0.25 lb/ft^3); (4 year - 5 year fish = 0.20 lb/ft^3) (Figure 2). The following chart lists the fish we presently carry on site and the densities at which they are reared.

Brood/year	Age	Number	Average length(CM)	Maximum density (lbs/ft^3)	Number of pens
1987	4 Plus	75	70	.20	1
1988	3 Plus	1060	56	.25	4
1989	2 Plus	3200	34	.32	4

Feeding Strategies

Feeding rates were designed to maximize growth. Temperature fluctuations are moderate and allow for steady growth rates (Figure 3). Fish were feed to satiation throughout most of the rearing cycle. As the fish approached maturity in the 4th year, the feeding rate was reduced from satiation until no feeding 1 month prior to transfer. Feed reduction began 2-months prior to freshwater transfer (Figure 4). Maturing 3-year-old fish were not taken off feed prior to transfer to freshwater. As the fish approached maturity, the amount of feed to satiation declined. Satiation levels for yearling fish appeared to be approximately 3.0% body weight. Satiation levels for 3-year-old fish were approximately 2.0%. By the 4th year, fish would only feed at approximately 1.2% body wt. Biomoist feed III was used throughout the rearing program.

Rearing Loss

Of the original 3,500 smolts, at least 50.1% survived to sexual maturity. Various loss accounted for the remaining percentage:

Otter predation------------------17.9%
Fish showing no growth-----------10.4%
Caprellid-------------------------2.3%
Unaccounted loss-----------------18.3%
Vibrio----------------------------1.0%

Caprellids are amphipods which attached themselves to the net pens. During the spring and early summer their numbers increase. During these population explosions, immature caprellids can attach themselves to the fish. Large numbers of attached caprellids can disable and kill fish by attacking gill and skin tissue. During the infestation net pens are changed on a weekly basis. This procedure has proven effective in preventing losses from caprellids but this remedy is very labor intensive.

Unaccounted losses are discrepancies showing during inventories, is most likely due to: vandalism, inaccurate estimates of otter predation, and fish showing no growth.

Adult Handling

Maturing adults are removed from the general population beginning in early September. Both 3 and 4 year fish from successive year classes were maturing. Fish are transported in 1,000-gallon tank trucks back to the freshwater enhancement site at Hupp Springs. Two methods of transport were used in the fall of 1991. The first method involved loading the tanker trucks on large National Guard landing craft. The landing craft were moored alongside the net pen complex where adults could easily be loaded into the tankers. This method reduced the amount of handling on the adults. Two problems were evident during this process: the landing craft could only work during high tide periods and while the landing craft were "holding" on the beach, the prop wash dug large holes in the beach, disrupting clam beds. The fish transport barge was the second method used to move fish to freshwater. Fish were loaded onto the barge and transported to a landing area where they were then loaded onto the tank trucks.

Two problems were also evident in this method of transport: Fish were handled twice, which may have increased hauling mortality, and transport time was substantially increased compared with the landing craft method.

Mature fish were dipped from the net pens, inoculated with Erthyromycin (ethro-200), and placed in the transport barge. To reduce stress on the adults, we used sanctuary nets and rubber innertube carriers while moving them from the pens to the barge. This process kept the fish in water a majority of the time.

A total of 1,141 adult broodstock was transported to freshwater holding sites; 184 adults were shipped to the new White River Hatchery. The balance were moved to Hupp Springs. The following chart lists the distribution of the 1141 adults by age and sex.

Age	Sex	Number	Percentage
3-year-old (1988 Brood)	Male	442	38.8
	Female	236	20.7
4-year-old (1987 Brood)	MALE	35	3.0
	Female	428	37.5
TOTALS		1,141	100.0

Over 70 adults still remain on site from the 1987 brood. A majority of these adults will mature as 5-year-old females. The age class for the 1987 brood group indicated that the fish which matured as 2 and 3 year products were predominantly males while the fish which matured as 4 year products were predominantly, females (Figure 5).

Results of Spawning Saltwater Broodstock

Over 80% of the fish transferred to freshwater survived to spawning. Broodstock were spawned over a 1-month period beginning on September 23, 1991. The last spawning occurred on October 20, 1991. It is of interest to note that the anadromous broodstock were generally 2 weeks earlier in their spawning time than the saltwater broodstock.

Approximately 1.2 million eggs were spawned from the saltwater broodstock females. This represents a substantial increase in egg production compared with previous brood years (Figure 6). Preliminary results indicate egg viability to be approximately 65%. Egg fecundity for 4 year fish is approximately 3,200 eggs per female, while 3 year females appear to average 2,300 eggs per fish. Four year females averaged 68 cm in length fork, while 4 year males averaged 58 cm.; 3 year females averaged 51 cm. while 3 year males averaged 44 cm.

SUMMARY

Saltwater net pen culture can provide resource managers with a ready tool for enhancing weakened fish stocks. A dramatic increase in available spawning stock can be accomplished in a relatively short time (Figure 7). A relatively small number of smolts reared in captivity can provide a substantial egg bank within 2.5 years of saltwater rearing. As fish grow, a high number of males mature as 2 and 3 year products. By the time 4 year fish mature, over 85% of the adults appear to be females. By the 5th year, over 90% of the remaining stock appear to be females.

ACKNOWLEDGMENTS

We wish to acknowledge the following personnel who provided valuable technical and fish cultural support for the broodstock program at SSNP: Past and present fishery personnel from the Squaxin Island Tribe including J. Barr, A. Whitener, and A. Krise. WDF hatchery personnel from Minter Creek, Hupp Springs, Fox Island, and Deschutes as well as personnel from our Salmon Culture office. L. Harrell from the NMFS office at Manchester. Thanks to A. Appleby and R. Foster from WDF for writing and graphic support.

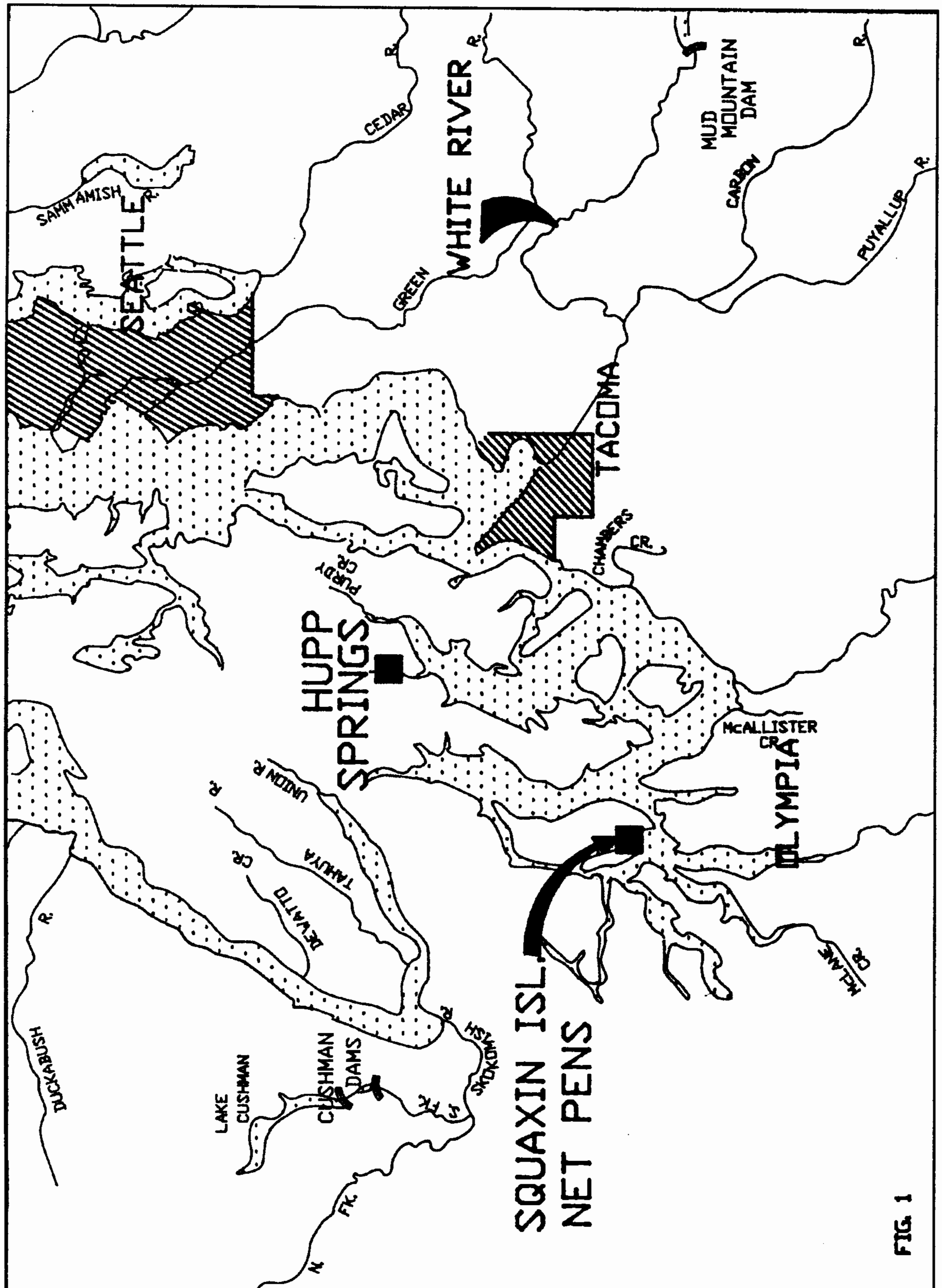
SEATTLE
SAMMAMISH R.
CEDAR R.
WHITE RIVER R.
GREEN
MUD MOUNTAIN DAM
CARBON
PUYALLUP R.
TACOMA
CHAMBERS CR.
PURDY CR.
HUPP SPRINGS
McALLISTER CR.
OLYMPIA
McLANE CR.
UNION R.
TAHUYA R.
DEWATTO CR.
DUCKABUSH R.
SKOKOMISH R.
LAKE CUSHMAN
CUSHMAN DAMS
S. FK.
N. FK.
SQUAXIN ISL. NET PENS

FIG. 1

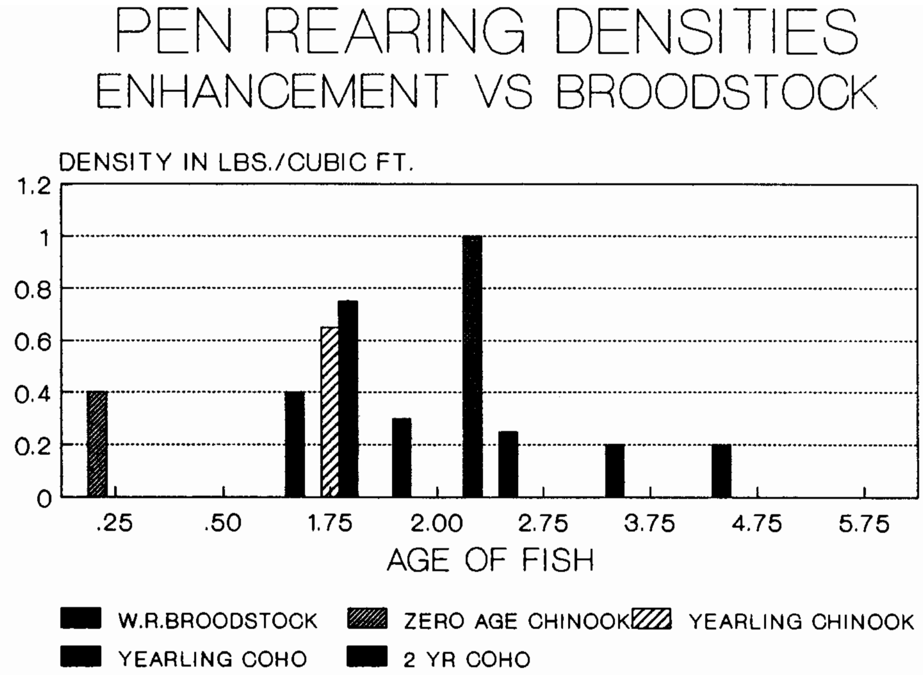

FIGURE 2

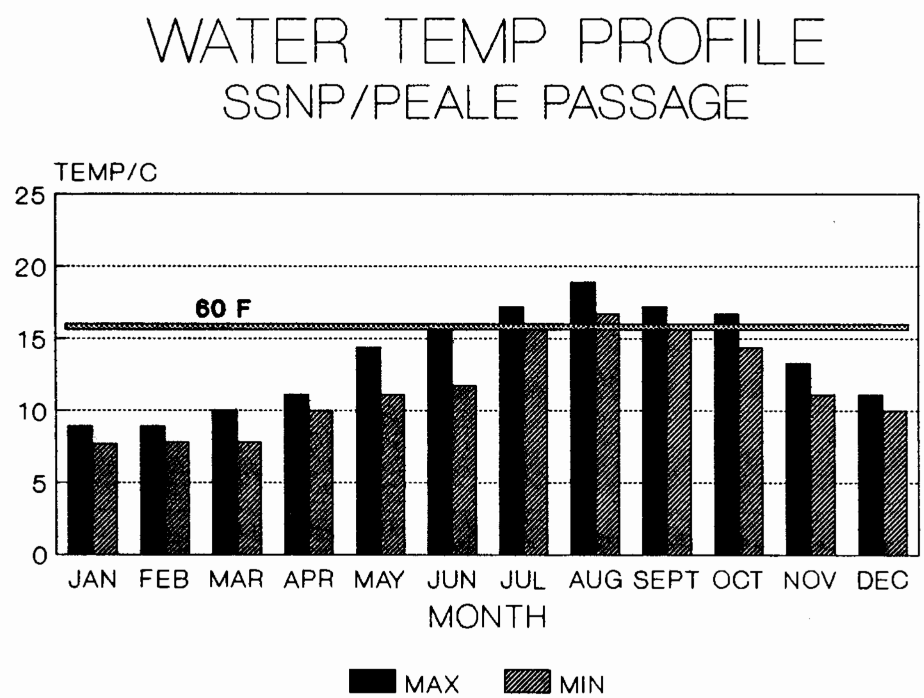

FIGURE 3 SAMPLING DEPTH-.5 METERS

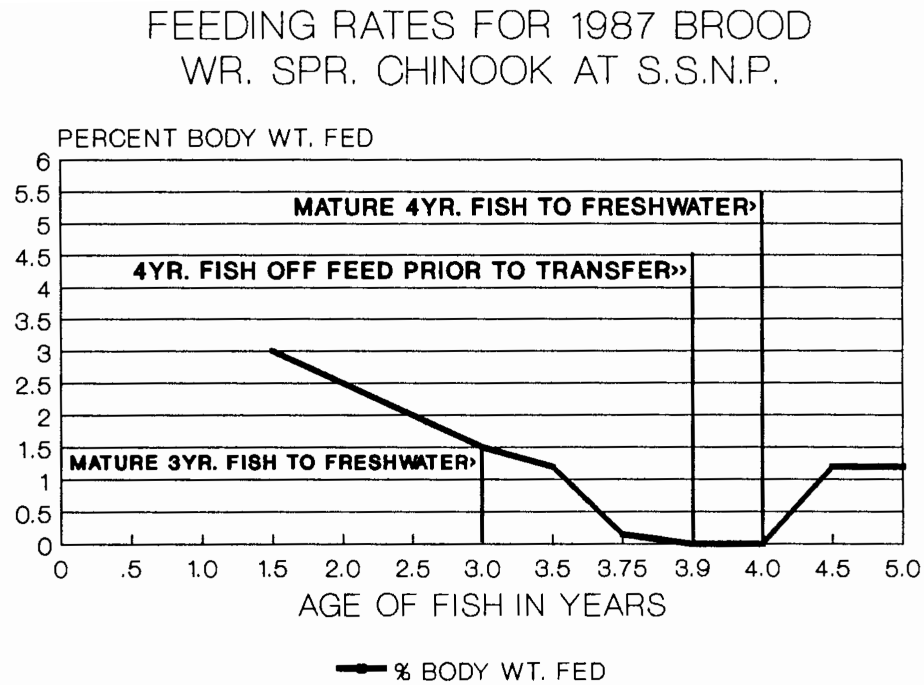

FIGURE 4

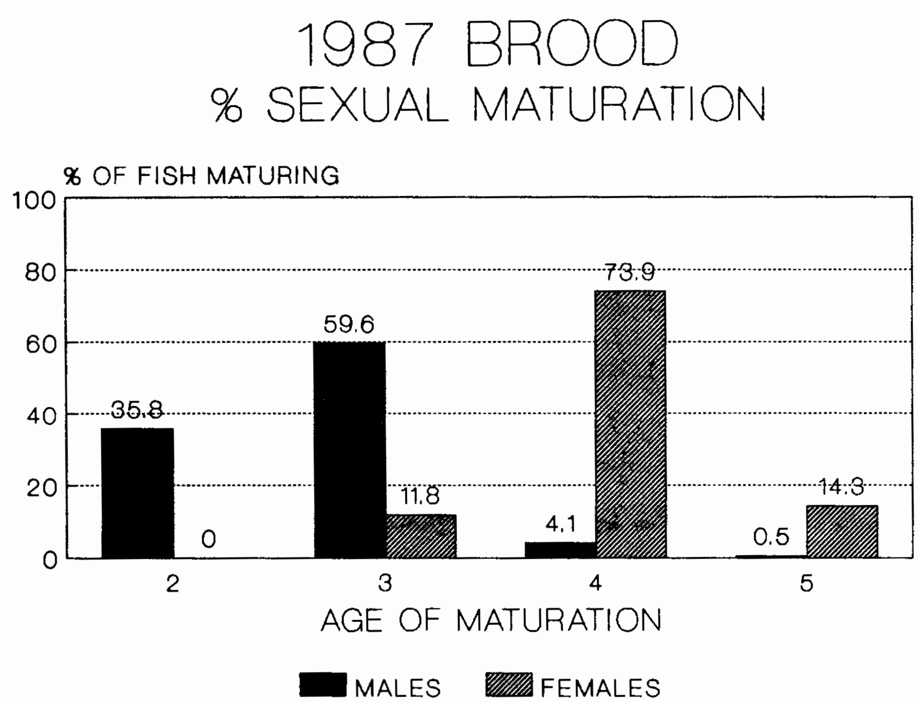

FIGURE 5

WHITE RIVER TOTAL EGGS
1979-1992

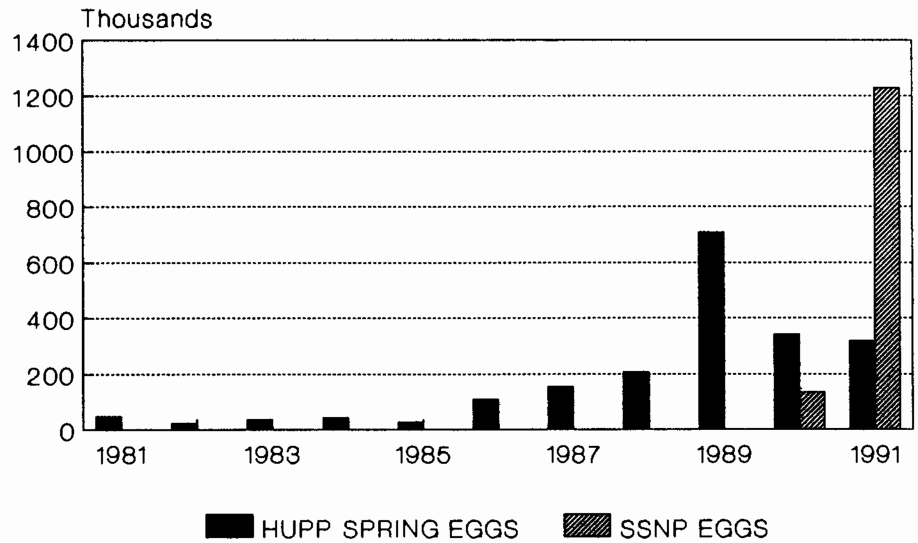

FIGURE 6 3YR AND 4YR EGGS COMBINED

WHITE RIVER ADULT SPAWNERS
1979 TO 1992

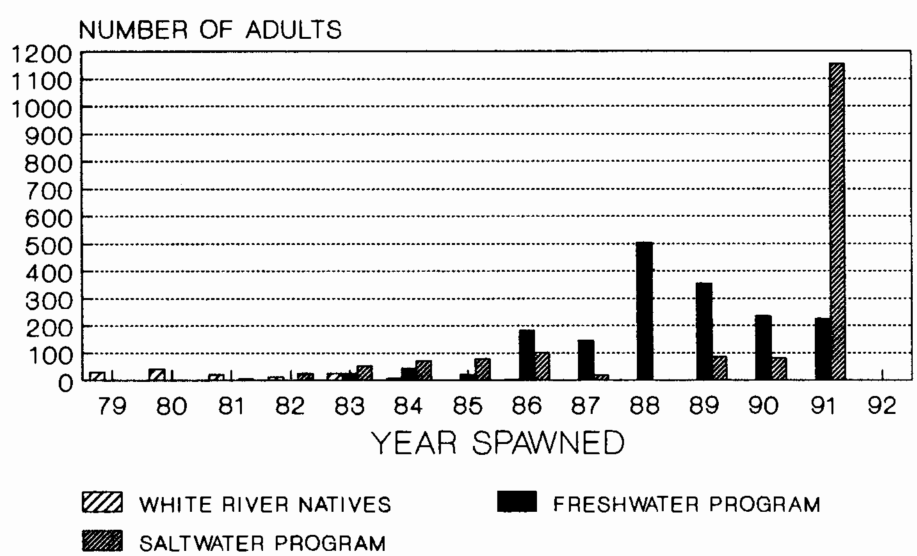

FIGURE 7 3 AND 4YR COMBINED

TWO-STAGE TROUT BROODSTOCK SELECTION PROGRAM

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ABSTRACT

The Two-Stage Broodstock Selection Program was developed by Graham A. E. Gall (Geneticist, University of California, Davis) in 1977, for the California Department of Fish and Game.

The programs goals were to develop, through genetic means, quality broodfish which will improve the economics of egg production as well as the productivity of catchable-sized trout. Catchable trout of today are now 2.0/lb or larger.

The selection program in its present form consists of two selection stages addressing five desirable traits; egg size, egg number, hatchability, yearling size, and time of spawning.

This report will be an overview of the selection process without delving too much into the genetics of the selection program.

INTRODUCTION

In California, selective breeding has been carried on since 1938; selection has been limited almost entirely to rainbow trout, both spring and fall spawning strains.

The Mount Shasta strain (RTS) of rainbow trout is a winter spawner (Dec-Feb) to which the two-stage selection program is being applied.

The fish are spawned at Mt. Shasta Hatchery and eggs from broodstock pairings are sent to Darrah Springs Hatchery. Darrah Springs a production trout hatchery with constant 57°F water, is where the future broodstock are reared for 2 years. During this 2-year period, the broodstock will be selected to obtain certain desirable characteristics as part of the selection program.

The characteristics which produce the highest quality catchables and at the same time result in lower production costs are:

a) Egg size
b) Egg number
c) Hatchability
d) Yearling size
e) Time of spawning

METHODS AND MATERIALS

a) Two-year old RTS rainbow broodstock were utilized in the selection program.

b) Sperm extender - in the amount of 8 oz extender/pan of eggs. Formula for sperm extender:

1) To 12 oz of warm water add the rest of the ingredients.

2) Glycine - 9.5 oz

3) Tris buffer - 14.0 grams

4) Common salt - 21.0 grams

c) Use of idophors for water hardening - Argentyne is recommended because of its buffering capability.

1) 100 ppm active iodine for 15 minutes

2) 100 ppm = 1 part Argentyne to 100 parts water.

d) OHAUS LUME-O-GRAM SCALE (1,000 gram capacity/2 gram readability)

FIRST STAGE - BROODSTOCK SELECTION (MT SHASTA HATCHERY)

a) 100 single pair matings are made at specific times during the spawning season. These matings are done in three spawn groups with a 2 week interval between spawn groups (i.e. 30,40,30).

b) At the time matings are made for each spawn group, the eggs from each female are fertilized with sperm from a male from any family (as determined by family mark) other than the family to which the female belongs.

c) To minimize inbreeding, an equal number of females and males would be sampled from each parental family present in the broodstock population.

d) After the broodstock have been sorted, a mating scheme is prepared to minimize the number of "duplicate" matings.

e) One female and one male are spawned into a suitable container. Eight ounces of sperm extender is added to the dry pan containing ova and sperm.

f) Fertilized eggs are water hardened in Argentyne, then transported to Darrah Springs Hatchery for size and volume determinations and incubation.

g) Spawning weights and family marks of individual parents are recorded.

FIRST STAGE - BROODSTOCK SELECTION (DARRAH SPRINGS HATCHERY)

a) Eggs are treated again in Argentyne, as a preventative against disease transmission between hatcheries.

b) Single pair matings are measured for volume displacement of female's entire spawn and also egg size.

c) 2,000 eggs from each pairing or total eggs fertilized are counted and retained in their own egg basket.

d) Unfertilized eggs and dead fry are inventoried until the 20 select families are determined.

e) All data from 100 pairings, including egg size and fry loss, are utilized as part of a computer analysis to rank families resulting in the 20 families selected.

f) 1,000 fry from each of the 20 selected families are fin clipped with their individual family marks. The 20 family marks used from year to year remain constant.

g) Fry with family fin clips are then raised to one year of age, at which time the second stage of the broodstock selection program begins.

SECOND STAGE BROODSTOCK SELECTION (DARRAH SPRINGS HATCHERY)

a) Total broodstock population as yearlings are separated into their three distinct spawn groups.

b) Within each spawn group, 500 random weight counts are taken and recorded per family mark.

c) A frequency count from the 500 random samples is prepared to obtain a minimum cut-off weight which will yield 95% of required brood fish.

d) Population to be selected can be mechanically graded to reduce the number of small fish present in population. At Darrah Springs we <u>don't</u> mechanically grade our broodfish.

e) Of total broodfish needed, no more than 10% can be contributed by one family.

f) Yearlings are selected for size and lack of obvious deformities.

g) Selected broodstock are raised until August or September, then shipped to Mt Shasta Hatchery.

TABLE 1. Comparison of Broodfish-Weights, Egg Size/Volume, and Yearling Size

	Weight/oz.		**Egg Size/volume**		**Yearling**
Year	Female	Male	Eggs/oz	Vol/eggs	Avg/grams
1976	21.6	27.5	416	196	--
1977	32.7	23.8	328	177	--
1978	19.3	23.8	393	148	--
1979	22.3	26.3	391	230	249
1980	32.4	39.0	360	236	232
1981	27.8	34.5	334	308	267
1982	39.3	50.9	362	339	212
198	39.0	48.7	341	324	360
1984	34.3	46.9	356	308	347
1985	40.2	47.7	329	385	260
1986	43.7	54.6	345	397	158
1987	39.3	49.8	332	381	222
1988	31.4	40.9	366	275	261
1989	31.6	41.3	330	341	227
1990	37.3	45.2	354	314	341
1991	38.2	44.6	315	337	--

The data reflected above are averages of the 100 crosses and random weights of yearlings.

DISCUSSION

A close look at Table 1 indicates the two-stage broodstock selection has achieved success in several areas. Egg size since 1976 shows a dramatic size increase of approximately 100 eggs per ounce and the volume of eggs produced has increased by about 33%.

The yearling size (in this author's mind) is also influenced by circumstances such as crowding, disease, and management practices. I believe this is the area where the greatest fluctuations of size will be seen, but there have also been advances here.

The rewards of a genetic broodstock selection program are quality broodstock, high performing fingerlings and improved economics of catchable-sized fish (2/lb or larger).

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SESSION 3

HATCHERY EQUIPMENT

MOIST INCUBATION OF RAINBOW TROUT OVA

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ABSTRACT

Moist incubation is a procedure that involves the incubation of eggs without submergence in flowing water. A major advantage of moist incubation is that one can control temperature by the use of a refrigeration system, thereby controlling the rate of embroynic development. This ability allows the fish culturist greater flexibility in planning the hatching and shipments of eyed eggs.

Preliminary data suggest that moist incubation using chilled water would provide hatcheries with a simple and inexpensive means of improving egg production capabilities.

AN IMPROVED FISH MARKING TABLE

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All hatchery steelhead in the State of Washington have to be adipose clipped. When the clipping began, it was left to the individual managers to solve the logistics, without spending any money. We got the job done by building marking tables from 2 x 4 lumber, netting, and burlap. But we often had unacceptable losses, especially in hot weather. Also, the process was inefficient, which is important when you pay eight people regular culturist wages to clip 3.5 million fish as we do at the South Tacoma Hatchery every year.

An improved fish marking table has greatly reduced clipping mortality and also increased efficiency. The table is put together from aluminum, 3/8-inch plywood, and stainless steel fasteners. The frame and the legs are 3/16 aluminum angle. The table also uses 1/4 aluminum flat and thin aluminum plate. This combination of materials is strong, easy to assemble, and much lighter than tables made from wood.

There are four fish markers on each side of the table. Each clipping station consists of a Rubbermaid tub with anesthetizing solution entering through the sidewall and discharging through a center drainpipe. A frame with a netting pouch sits on top of the tub. A thin rod divides the pouch into two compartments. There is a 4-inch kitchen strainer with handle for every station.

Anesthetizing solution is pumped by a battery-powered bilge pump ($25, Teal manufacture) from a 50-gallon insulated reservoir through PVC pipe that connects to the tubs with fuel line. Discharge is picked up by 1½-inch PVC pipe. A large strainer prevents adipose fins from plugging up the pump. Fish are transported back to the pond in a gutter made from 6-inch PVC pipe.

The fish are pre-anesthetized in MS-222 by one person, who also delivers the fish to the rest of the crew. The concentration is 0.2 grams per gallon. At this low concentration, it takes minutes for the fish to "go out", but it is also safe to leave them in for several minutes; so the anesthetizer immediately returns to the table to clip with the others without worrying about the fish. The secondary solution that circulates through the table is moderately weaker at 0.17 grams per gallon, which helps keep the fish properly anesthetized.

When the table starts running out of fish, the crew evens out the remaining fish by passing them around with their strainers. The anesthetizer then supplies a fresh batch into the empty half of the netting, grabs another netfull from the pond, and returns to the clipping table. Through this method, everybody has anesthetized fish on the table practically all the time.

The kitchen strainer serves a second purpose. The crew drops the clipped fish straight down into the strainer. The fish are transferred to the center gutter when the strainer is full, which is faster and easier than flipping each fish individually. Also, this system is less costly, and weighs less, than setting up a system of drop holes and plumbing similar to the set-up in marking trailers.

The mortality during clipping season used to be an ongoing concern. We have reduced the losses to mechanical damage only. It is now almost impossible to over-anesthetize. Also, the fish stay wet all the time. They do not overheat because we monitor the temperature in the solution that circulates through the table. Even in 90° weather, we only change the solution once a day. The reason is that we continuously cool it off by putting in fish that are pond temperature. The less frequent changing of a weaker solution than in the past has saved on expensive MS-222.

One great benefit from the new table is the general well-being of the fish after clipping. The following day they often are back to full appetite. A possible reason for this is that the pump appears to pick up air bubbles in the reservoir, thereby super-saturating the water with oxygen, which may aid in the recovery from the anesthetic.

The crew likes the table in spite of the subtle pressure of having fish ready for clipping at all times. They particularly liked an experiment in which we raised the temperature in the circulating solution 8°F on a cold and rainy day. This kept their hands warmer and did not seem to hurt the fish.

Total costs, which included two marine deep-cycle batteries and a battery charger, were less than $400. The table should be easily adaptable for tagging.

CONTINUOUS CLEANING SYSTEM FOR RACEWAYS

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ABSTRACT

After years of using various systems and methods to remove solids from fish rearing units, the author and crew of Hagerman Hatchery has developed a cost effective method of continuously removing the settlable solids from linear rearing ponds. The system uses air bubbled from lead keel tubing laid along the length of the raceway to create an uplift of water that suspends the solids so the linear flow through the raceway can carry these solids from the rearing unit. The tubing is solely supplied in the United States by John Hinde, Co. for use in aerobic sewage treatment. The hatchery system uses a high volume, low pressure blower to produce a large bubble rising at a rate of 1.6 feet per second. This creates a large uplifting current along one wall of the raceway that carries the solids up and keeps it suspended as long as the uplift current is maintained. This system is useful in raceways up to 12 ft wide and 2.5 ft deep. Length of the raceway is determined by the length of tubing the operator cares to lay in the raceway. Hagerman has used this system in raceways up to 500 ft long.

Costs to clean approximately 1 mile of raceways at Hagerman include:

A) $ 4,000.00 for air blowers

B) $ 5,000.00 for 5,000 linear feet of tubing

C) $ 1,000.00 for electrical hook up

Total $10,000.00 to set up.

D) $ 375.00 per month for electricity for an average of 10 months per year.

SWINGING INTO THE "90's" WITH BAFFLES

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ABSTRACT

Personnel at Cabinet Gorge Hatchery have developed a unique procedure for cleaning their raceways using a modified baffle design. Baffles are constructed of lightweight, high-density black polyethylene sheets held in place at the top by a PVC brace and saddle arrangement, and at the bottom by a 3/4-inch diameter piece of rebar. This design allows the baffles to "swing" when the standpipe is knocked over, forcing a rush of water across the bottom which removes waste and unwanted debris from the system.

HATCHERY IDEAS AND INNOVATIONS

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Working on a fish hatchery often gives rise to the discovery of good ideas and improvements in fish culture. The ideas presented herewith are a few of many. It is my hope that at least one of these several ideas may be of use to each facility. This is the prime purpose in the undertaking of this project. Not all of these things are new but they are all worth examining.

At Soleduck Hatchery they have built a very useable vexar storage rack. It keeps vexar organized and accessible. It's made of plywood and therefore relatively inexpensive to build.

McAllister Creek Hatchery uses a rack built to fit incubation trays. The rack is suspended from the trough walls. The tray is set in it and light egg loss is easily picked right from the tray. McAllister also uses a thin board mounted vertically over tray plugs on their vertical stack. This eliminates any possible loss from a popped plug.

At the Naselle Hatchery, the crew actively looks for ways to improve on their facility. This spirit of invention gives rise to several useful innovations. The following are but a few:

A debris brush that will fit between verticle stack trays, as well as a plug puller for popping out tough rubber plugs. How about an ovarian fluid draining rack that features slotted screen buckets for easy fluid collection in addition to a tray holder. This rack really speeds up the job of putting down eggs.

Other ideas at Naselle include a rolling Heath Stack. This was built for moving trays of water-hardened eggs to incubation areas for eyeing. A chain link fence has been installed across the head end of their adult pond, thus reducing any risk of injury to the jumping adults and any losses that may occur as a result. This also protects the fish from injury that could be sustained if harder restraints were used.

Naselle's adult brail, which is used mainly for coho, makes the handling of these rowdy fish quick and easy. Crowd fish in, then raise up to hip high for fast sorting at arm's length with a lot less stooping over.

For ponding fry, they have converted a tote by adding lids and a 4-inch valve. It can haul 120,000 plus fry at a time, and the facility tractor can be used to move it, rather than tying up a truck with a planting tank.

More from Naselle includes a shear log, floating across the front of their intake structure. Water going into the hatchery passes under the log. A spray bar, fastened to the log, drives leaves away from the intake area and keeps screens much cleaner.

The use of PVC pipes which are mounted in the adult pond, makes sorting fish in to spawning area, upstream, or in to other parts of the pond a snap. Just slide the fish down the right tube.

At the Wells Hatchery, spray bars which are mounted over the adult pond reduces both jumping and over exposure to the sun.

A loss picking net, angled to fit into corners makes this chore much easier.

Also at Wells, a transfer tube support made of rebar and chain is adjustable and easy to build.

The Eastbank Hatchery uses a rubber innertube to help in the loading of adult fish for transport. Fill the tube with pond water, slip fish inside, and carry to the truck. The fish, once inside the tube, usually will become very docile and are therefore easy to load. This method also reduces risk of injury to fish during the process.

Humptulips Hatchery used to have problems during spawning, as the carcasses piled up in their tank and slid over the drain, plugging it off. The solution was simply to put an expanded steel mesh fence around the drain... end of problem.

A special head chopper is used at the Washougal Hatchery to remove the snouts from marked fish. It is easier and safer than using a butcher knife.

This is not their only addition to this project. They also use insulated feed boxes on the ponds to keep the feed cold, not only making it easier to handle, but also maintaining the vitamin content.

A counter-weighted hook is used for spawning at the Willapa Hatchery. This is very similar to the one shown from Big Creek Hatchery in Oregon a few years ago. They added this wrinkle: the counterweight is made of PVC pipe filled with lead ingots. It therefore is adjustable to fit the size of the fish you are spawning.

The drying rack used for spawning at Lyons Ferry has been fitted with a spray bar that washes blood away from the gills of their females.

Lyons Ferry also have transfer tube supports. They are made of wood which make them very sturdy and stable.

Every hatchery seems to have its favorite type of fish club. At Lower Kalama Hatchery they use a club made of solid aluminum stock. Lightweight, it is still an efficient fish killer.

A potential problem at many stations is that of having to lower pond levels to spawn during peak adult loadings. At Nemah Hatchery they eliminated this problem by putting a brail at the end of their trap pickets. Crowd in the fish, lower the gate behind them and raise the entire expanded steel floor to whatever depth you wish to work.

It would be a great help on any hatchery to know what your flow was at a glance. Lewis River has made a flow measuring device that mounts on the outflow dam boards, giving an easy reading on outflow.

Lewis River also has an excellent portable outdoor formalin treatment system. It can easily be moved by tractor and includes quick couple hoses, flow meter, electric cords, safety strap, and varible speed pump.

Klickitat Hatchery has eliminated the worry of over-treating eggs by putting their system on an automatic timer. A warning light shows the treatment is in progress and an on/off switch is there for premature stopping of the treatment, should this become necessary.

The Issaquah Hatchery has made the handling of suction lines a much less cumbersome job. They now use a portable hose reel to pull in and coil their hoses. This saves wear and tear on both culturists and hoses.

When sorting several species of fish and counting numbers of males, females and jacks, a pile of counters can be a nightmare. At Bonneville they have gone to using color coded buttons to help keep this a more organized task, reducing stress and mistakes.

Power costs are a major factor in the operation of any facility. At Priest Rapids they have mounted strip curtains inside the freezer door. This, along with a Mars air curtain keeps cold air in and costs down.

Another handy idea hailing from Priest Rapids is having a pipe diagram on the wall. It is backed with cork board and shows every pipe and valve on the hatchery. Color coded pins are used to mark all open, closed or partially opened valves. One glance and you know what is running and what is not.

Toxic chemicals are a must on any hatchery. One problem that exists is having a good eye wash station near the location of the chemicals being used. Green River Hatchery has mounted an eye wash station on a pallet, thus allowing it to be moved from location to location as needed.

The problem of disposing of adult carcasses at Elokomin Hatchery has been greatly aided by the purchase of a self-dumping tote. Mounted in the back of a truck, one person now does in less time what was once the job of two.

The descriptions given here are very general at best. Each of the contributing facilities complete address is listed in the sources cited. If something sounds of interest, please contact that Hatchery for greater detail.

ACKNOWLEDGMENTS

Dick Johnson and Ed Maxwell, hatchery managers for the Washington State Department of Fisheries, for greatly aiding in the gathering of this material. Also Mike Dell, Grant County P.U.D.; for the use of his equipment in the research of this material.

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Wells Salmon Hatchery Box 3 Azwell Route Pateros, Washington 98846

Eastbank Salmon Hatchery 13246 Lincoln Rock Rd. East Wenatchee, Washington 98802

Humptulips Salmon Hatchery PO Box 129 Humptulips, Washington 98552

Washougal Salmon Hatchery 585 Washougal River Rd. Washougal, Washington 98671

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Klickitat Salmon Hatchery 301 Fish Hatchery Rd. Glenwood, Washington 98619

Issaquah Salmon Hatchery 125 West Sunset Way Issaquah, Washington 98207

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REINVENTING THE CLEANING BAFFLE

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The South Tacoma Hatchery has been in operation since the early 1920's. Six cfs water at 56°F makes the Station a key facility for meeting size requirements at several coldwater hatcheries and rearing ponds.

During various phases of reconstruction, the universal principle of saving money by replacing an existing structure with a similar structure was followed, with little regard for new developments in the field of fish culture. Particularly over the last decade, this, together with increased program demands, added to the burden of the crew and also caused increased fish health problems.

The introduction of cleaning baffles has helped alleviate some problems at the Station. The first place we put baffles was in the creek raceways. South Tacoma has seven 10 x 100 ft raceways in series that utilize the same 600 gpm of water. The only aeration occurs between ponds where the water drops to the next level. We use brooms to clean and we discharge waste at the lower end of the raceways.

Three baffles now keep the upper part of each pond self-cleaning. The baffles consist of a sheet of 6 mil black plastic that hangs from a 2 x 4 board. A piece of rebar keeps the baffle weighted down. One baffle hangs from the upper rack to get the waste to start moving. The other baffles are held in place by wedges between the walls and a short crosspiece attached to the 2 x 4 board. This simple method gives total flexibility in where to position the baffles.

Flexibility is important, because we have gradually experienced that the effectiveness of the baffles is determined not only by the velocity of the water, but also by the density and size of the fish. The more fish you have in your raceway, and the bigger they are, the better the cleaning action at a certain velocity. The fish determine the position of the last two baffles.

These cleaning baffles save employee time. Also, they reduce the stress on the fish because normal flow is interrupted for shorter periods of time.

For our 12 intermediate raceways, we built baffles as part of a strategy to increase carrying capacity through reduced stress. These raceways are 4 x 30 ft and shallow. Maximum flow is 100 gpm. The baffles consist of a piece of aluminum plate which hangs from a piece of 2 x 2 lumber. Sponge material attached to the sides helps seal along the walls, which forces the water to go underneath the baffle. This design makes them easy to move, which we felt was important because we intended to use them for cleaning by moving them gradually downstream. In this manner, you can concentrate the waste in the very low end without breaking up the fecal particles and without dropping the water level.

This method of cleaning is not any faster than the conventional broom and draw-down, but the fish do like it. We have tripled the carrying capacity by increasing flow only 50% (to get a better velocity), by increasing volume 25% (through drain plug extensions and dam boards on the side walls), and by reduced stress, which has included the cleaning baffles.

The South Tacoma rainbow broodstock are kept in deep 10 x 100 ft raceways. Flow averages 700 gpm per raceway. The rainbow get the last of the water and the quality is not good. The spawners pick up all the pathogens that drift out of the upstream ponds. In addition, they have had a very bad copepod problem. They also have a long history of fungus infestations, which caused mortality, particularly among the males during spawning season.

Hoping to get rid of the copepods by flushing out the juvenile stages, we crowded the broodstock to the upper end of the raceways and dropped the water level as far as we dared. This more or less doubled the velocity of the water, with the fish being contained in approximately 25% of all available space. Also 2 days of electrofishing got rid of stray fish, including sticklebacks, in an upstream open ditch.

The copepods have disappeared, but even better, the changes seem to have totally eliminated the fungus problem. The fish have never looked better and have never survived spawning better than this year. For example, we would normally lose 300 3-year-old males (approximately one-third) during the second month of spawning. This year we lost 6 males during the same month, and could outplant almost as many fish after the spawning season as we started with.

Baffles play a role in this set-up also. One baffle sits inside the section with fish to keep the waste from piling up in the upper end. This baffle, together with the velocity of the water, the density, and the size of the fish, keeps the upper section self-cleaning. A series of baffles below the rack keeps the long empty section self-cleaning, which otherwise would have build up hugh accumulations of waste that would need to be removed on a regular basis. As of now, the waste drifts out continuously, at levels that satisfy NPDES requirements. If this continuous discharge cannot be accepted, we will build an abatement system; by pulling the lower two baffles, we can trap and concentrate the waste for either pumping or discharge into the abatement pond.

The baffles in the brood ponds consist of sheets of discarded aluminum roofing material attached to a frame of 2 x 4 lumber. Legs ensure the correct distance between the baffle and the floor in the pond and also offer support when the baffles are wedged in.

DESIGN AND USE OF PRE-SPAWN PVC CONTAINMENT TUBES

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ABSTRACT

Holding pre-spawn chinook salmon in individual PVC containment tubes can be an effective tool for fish culturists faced with limited hatchery holding tank space or in place of holding tanks as is the case in many remote streamside spawning stations. Using Schedule 120 PVC pipe, measuring 10 to 12 inches in diameter by 36 to 48 inches long, 102 chinook salmon (55 females, 47 males) were held at the Mokelumne River Hatchery for 5 to 26 days. Thirty females were spawned with 20 males over the 26-day period, with a pre-spawn mortality percentage of 45% females, 57% males, and 50% combined. Fertility was low because of over ripe eggs due to high in-stream water temperatures. Anesthesia was not used and some females were determined to be still "green" when checked inside the tube. Recommendations for further use of containment tubes are; to utilize thicker schedule pipe in a smaller dia. 8"-10", use heavy vinyl coated wire 10 gage 1"X 1"mesh for front and back doors, Anesthetize fish in stream when possible prior to checking ripeness or allow fish to calm down in stream partially outside the tube to prevent females from tensing abdominal muscles giving a false degree of ripeness.

INTRODUCTION

In the fall of 1990, the California Department of Fish and Game, Inland Fisheries Division and the State Water Control Board initiated an ambitious project designed to preserve and protect the genetic integrity of the fall run American River chinook salmon. Four years of drought had lowered Folsom Lake to 30% of its capacity and a hot summer brought the temperature of the American River and the water supplied to Nimbus Hatchery to 68°F in mid-September.

With the fall run about to begin and water temperatures well above egg incubation temperatures of 52°F to 57°F (Piper et al. 1982) the decision was made to trap and transfer migrating chinook salmon from the American River to the Mokelumne River Hatchery where water temperatures were a suitable 57°F. The salmon would be held there until ripe and then spawned. Due to the limited space at the Mokelumne River Hatchery, the eggs would be water hardened there and then transported to the Feather River

Hatchery, where they would be incubated and hatched. The salmon fry would be held at Feather River hatchery until the water temperature in the American River cooled to 60°F or less and then be trucked back to Nimbus Hatchery to be reared and released. The plan also stipulated that trapping and transfer of adults would cease when the American River water temperature reached 60°F.

METHODS

On October 15th, two portable in-stream fish traps were placed in the American River near the 16th St. bridge in Sacramento, California in an effort to trap migrating salmon before they reached the upper river. The traps were checked daily and fish captured were to be transported to the Mokelumne River Hatchery. After 10 days, the traps yielded only two fish.

During the same 10-day period, 75 to 150 salmon gathered near the entrance of the Nimbus Hatchery fish ladder. On October 25th and 26th the ladder was opened and 102 chinook salmon were trapped and transported to Mokelumne River.

Fish arriving at the Hatchery were placed into the adult migrant trap to be sorted by sex and degree of ripeness and placed into PVC holding tubes. Tubes were spray painted with one of four symbols that identified the sex and the location trapped.

X = male trapped at 16th St. bridge
T = female trapped at 16th St. bridge
I = male trapped at Nimbus Hatchery
O = female trapped at Nimbus Hatchery

After the fish had been placed in tubes and marked, they were transported to a holding pond on the hatchery grounds. The pond was divided into three areas:

Area 1 held females with approx. 1-7 days until ripe, Area 2 females 7+ days until ripe, Area 3 held all males.

Stream flow ->	AREA 1	AREA 2	AREA 3
	O O O	O O O O	I I I I I
	O O O	O O O O	I I I I I

Fish were placed in shallow depressions dug 4 to 5 inches deep and slightly longer and wider then the containment tubes. The tubes were placed in the pond with the fish facing upstream and anchored by collapsing the excavated rock and gravel from the depression around the front, back, and sides of the tube. Tubes were arranged in a side by side front to back stagger allowing each tube adequate flow with minimal disturbance by forward fish movements.

```
Stream flow ->        AREA 1        AREA 2         AREA
                      ________________________________________
                      - - -         - - - -        - - - - -
                      - - -         - - - -        - - - - -
                      = = =         = = = =        = = = = =
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This arrangement also made it easier to move through the pond with minimal disturbance while checking individual females for ripeness.

Fish were checked twice a week and moved accordingly. Ripe females were taken to the hatchery building along with the number of ripe males needed to fertilize the eggs. Eggs were taken and water hardened in the hatchery incubators. Water hardened eggs were then bundled in cheesecloth and immersed in milk cans to be trucked to Feather River for incubation and hatching.

MATERIALS AND CONSTRUCTION

Tubes - PVC/ABS drain or sewer pipe. 1/4 + wall thickness, 36 to 48 inches long, 8 to 10 inches diameter.

Doors - 10 gage + 1 inch x 1 inch mesh vinyl coated wire; 12 to 14 inches long, 7 to 9 inches wide

Fasteners - 4 to 6 inches long x 1/2 to 3/4 inches rubber strip or other elastic cord

3/8 to 1/2 inch pop rivets and rivet gun

3 inch, 16 gage wire to be shaped into a "S" hook

Size of tube was determined by the size of the fish to be held:

Fish < 32 inches = 36 inches x 8 inches

Fish < 44 inches = 48 inches x 10 inches

Fish > 44 inches = Make tube 4 to 6 inches longer than fish x 10 inches or 12 inches

Cut doors to size allowing 1 to 1½ inch space on the sides and 2 inches top and bottom.

Using a table saw or circular saw cut two ½ inch wide x 10 to 12-inch long slots on both ends of the PVC pipe about 2 inches in from the end. Slots should directly oppose each other.

Doors should slide freely in and out but without excess room on the vertical sides. Place what will be the front door in the slots with approximately 2 inches exposed on the top and bottom.

With a hammer or pliers bend the exposed four corners of the wire down onto the tube toward the other end. This should secure the front door where the head will be.

At the other end, repeat the step just described except only bend one side, the top or bottom. This enables removal of the back door only one way.

Take the rubber strip and poke two holes, one in either end.

Drill a hole for the pop rivet or other fastener opposite the bend in the back door approximately 1 inch from the end of the tube.

With the pop rivet gun or other fastener (nut/bolt) secure the rubber strip to the tube. Rubber strip should be directly opposing bends in the wire of the back door.

Place one end of the "S" hook through the hole in the rubber strip.

Slide back door in place until it firmly seats to the top of the tube. Hold door in place by securing "S" hook to the center of the wire.

Place a mark to indicate the front of the tube as well as the top.

Always place fish with head to the front and the front of the tube upstream.

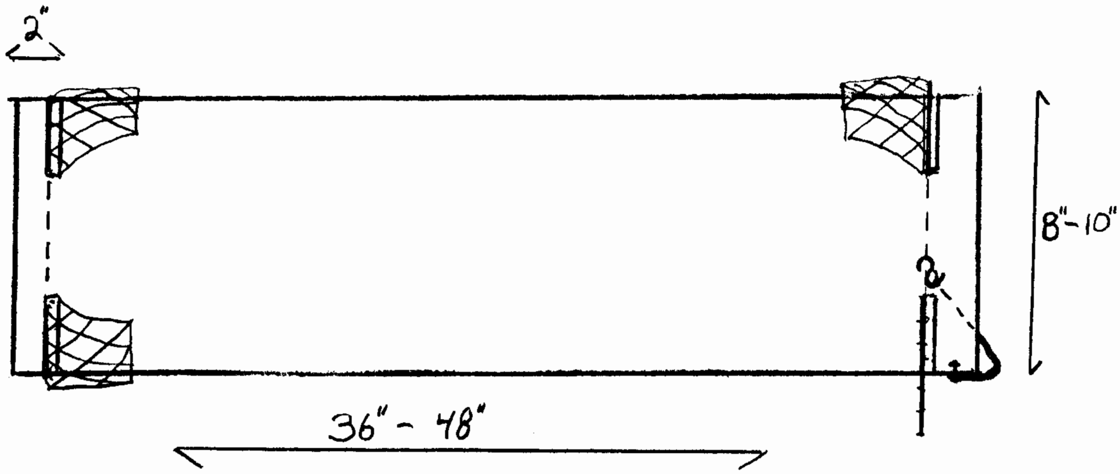
RESULTS

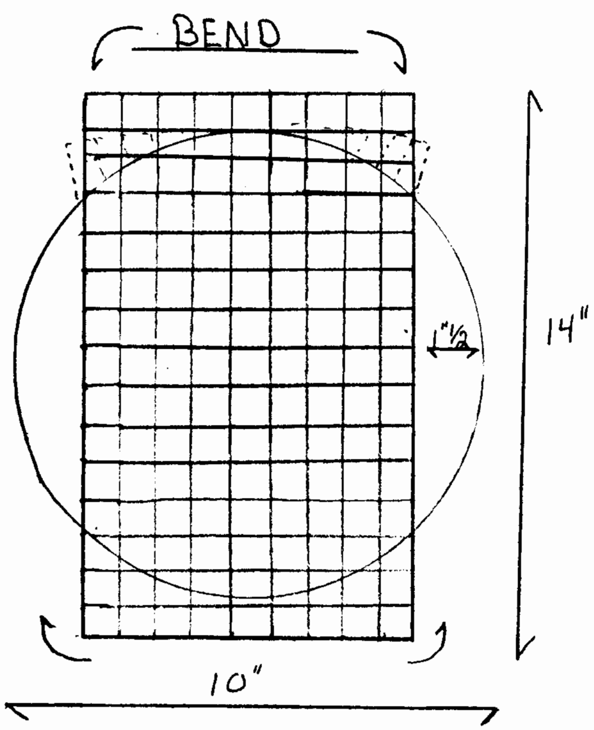
A total of 102 chinook salmon was delivered on October 25th and 26th to the Mokelumne River Hatchery from Nimbus Hatchery in Sacramento, California. Fifty-five females and 47 males were placed in containment tubes and held for a period of 7 to 26 days. During this time, 30 females were spawned and 25 died in the containment tubes; 20 males were used to fertilize eggs and 27 died in the containment tubes. A combined pre-spawned mortality of 51% was experienced.
Low fertility was experienced at the Feather River Hatchery. Several incubator trays of eggs were completely lost to fungus prior to the eyed egg stage. After being addled and picked, only 4 of the lot of 15 trays remained. The reason for the high loss was thought to be poor in-stream checking of ripe females.

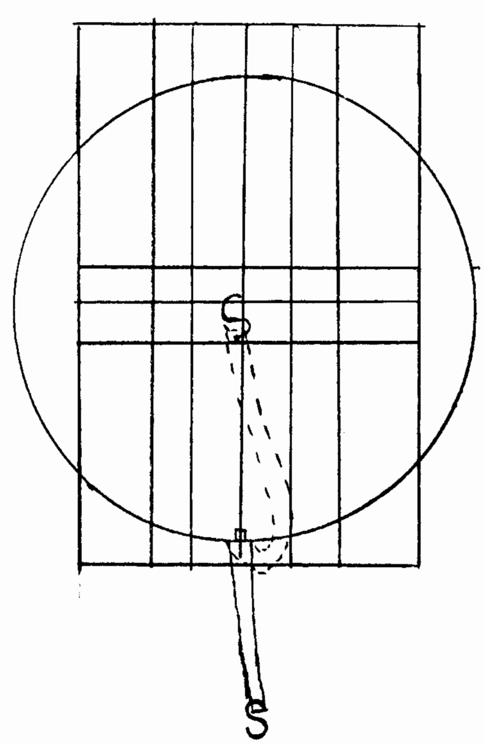
Females were checked while still in the tube without any anesthesia. After an initial outburst when the fish tail was grasped, the person checking would feel for ripeness. It seemed that many of the females were tensing abdominal muscle when being checked. This led to false readings and subsequently overripe females were the only fish that seemed ripe.

PVC CONTAINMENT TUBE

FRONT







SESSION 4

OONE/OXYGEN/FILTRATION

MECHANICAL FILTRATION - USES IN FISH CULTURE

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ABSTRACT

Mechanical filtration uses include removal of large organic debris from in flow and separating waste feed and feces from hatchery discharges. Various means of separating solids from liquids are examined. These include sedimentation, microfiltration, sand filters, and cartridge filters. Applications for each are explored and recommendations made concerning best use. Special emphasis is placed on the amount of waste generated when feeding fish. Design considerations are viewed for sedimentation basins and microfiltration.

AN OVERVIEW OF THE COWLITZ HATCHERY OZONE SYSTEM

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ABSTRACT

The recently completed ozone water treatment facility at the Cowlitz Trout Hatchery was profiled. The system is able to treat up to 20 cfs of water in 5 cfs increments. Major components included liquid oxygen to supply oxygen, ozone generators, contact basins, degassing towers, relift pumps, and a laboratory. System monitoring quickly became routine and most monitoring was conducted by hatchery personnel. Although design problems were encountered, neither production nor sentinel fish became infected with *Ceratomyxa shasta*.

OXYGEN INJECTION - USES IN FISH CULTURE

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ABSTRACT

Oxygen, while often controversial, has nevertheless proven itself as a valuable tool to the hatchery manager. Supplemental oxygen has probably been used the longest in transportation of fish but other uses include maintaining production, during periods of low water or high temperature, improving oxygen content of undersaturated inflows, increasing production, and stripping nitrogen. Various means of mixing oxygen with water are explored in context of their ability to perform. Focus is on safe, appropriate use of oxygen in a hatchery environment.

SESSION 5

FISH FEED AND FISH REARING

FISH NUTRITION
THE OREGON PERSPECTIVE

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ABSTRACT

Oregon's Fish Nutrition Section provides services to hatcheries in four areas: feed recommendations and use, trouble shooting, quality control and feed specifications, and feed programming.

Hatchery managers select fish feed from a list of approved diets created by nutritional services. Fish feed is purchased through fixed price contracts, not low bid. Nutritional services staff conducts field evaluations to obtain information about feeds. No consistent differences in survival in the hatchery or after release have been demonstrated in tests on commercial fish feeds.

Nutritional services staff relies on hatchery personnel to keep informed about feed problems. Recent trouble shooting problems involved undersized or oversized pellets, excessive fines, feed with an off color, and feed with worms. Physical and chemical tests are performed on diets in question. Improperly made feed is returned to the manufacturer.

Quality control inspections of feed manufacturing plants are conducted when open formula feeds are being made. Hatchery staff are responsible for monitoring the quality of closed formula feeds. Oregon encourages hatchery managers to use fresh food.

Nutritional services staff specifies the formulation and processes for the manufacture of open formula feed. Open formula means the diet's ingredients and manufacturing processes are specified by the State.

A computer model is used to do feed programming. The model is based on temperature units. It helps hatchery managers get their fish to the prescribed size at time of release by forecasting fish size and feed requirements for salmon and trout. It is available to anyone with a computer and symphony software, or feed schedules can be prepared and mailed to the hatchery.

A COMPARISON OF PVP IODINE AND FORMALIN AS A MEANS OF FUNGUS CONTROL IN COHO SALMON EGGS

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Introduction

The use of formalin in incubators as a fungicide has become the accepted norm during the last 4 years. Although it is quite effective at controlling fungus growth, there are many disadvantages to its use. According to the U.S. Department of Labor, Occupational Safety and Health Administration, formaldehyde vapors have caused cancer in laboratory animals. As a result, OSHA has placed formaldehyde on the A-2 list of suspected carcinogens for man. It is irritating to the skin and eyes and, in sufficient quantities and/or concentrations, has proven to be lethal to fish and eggs. These considerations provided the motivation to seek an alternative chemical for controlling fungus growth. In addition, there was interest in attempting to minimize the impact of hazardous chemical use on man, fish, and the environment.

Washington Department of Fisheries (WDF) has been using PVP iodine as an egg disinfectant since 1986. Therefore, it was a logical choice for testing as an effective fungicide during the incubation period. The following experiment was conducted to evaluate and compare the effectiveness of PVP iodine and formalin for fungal control.

Methods

On November 5, 1990, randomly selected coho eggs were obtained from the normal spawning operation at the Skykomish hatchery and were divided into four, approximately equal, groups. Each group was placed into a half-stack (8 trays) of vertical style incubators. Each incubator tray contained approximately 10,000 eggs. Group 1 was designated as the control group and received no treatments, Group 2 was treated with formalin utilizing the California flush method, Group 3 was treated with a stock solution of PVP iodine at a 50 ppm concentration (active ingredient), and Group 4 received treatments of PVP iodine at 100 ppm concentration.

The standard method for treating eggs at Skykomish is the California flush. This is normally accomplished by adding 160 ml of a stock solution of formalin (1/2 water, 1/2 formaldehyde) to the top tray in the incubator stack. This amount of solution provides the recommended amount of formalin (20 ml) for each gallon of water per minute of inflow (4 gpm). This treatment is applied to the eggs on an every other day basis, and is the exact procedure used to treat the eggs in experimental Group 2. For Groups 3 and 4 the same procedure was use as in Group 2, only the chemical and its concentration was varied. For Group 3, 160 ml of PVP iodine 50 ppm concentration was used and for Group 4, 160 ml of 100 ppm PVP iodine was used. The control group received no chemical flushes.

The treatment of the eggs started 3 days after initial fertilization and continued up to the time that they were ready to be shocked. After shocking, the dead eggs were removed by the use of a salt dip and hand picking.

It was at this point in the incubation process that the best evaluation of the experiment could be conducted. The evaluation was done using two criteria: 1) A visual comparison of the groups and 2) determining the number of dead eggs resulting from fungus growth in each group.

Results

There was no effective means of measuring the amount of fungus growth that was occurring in the incubation trays. However, three different individuals observed the eggs in each test group prior to shocking, and each one agreed that there was no obvious difference in the amount of fungus in groups 2, 3, and 4 but there was a significantly greater amount of visible fungus growth in the control group.

These observations were reinforced when the numbers of dead eggs were determined after shocking and picking. The percentage of egg loss for Group 1 was 17.9%, Group 2 was 5.4%, Group 3 was (4.9%) and Group 4 was (4.8%) (Table 1).

Table 1. Comparison of Egg Loss Due to Fungus Growth in Coho Salmon Eggs, Using Various Chemical Fungicides.

Test group	Chemical control	Number of eggs in group	Number of eggs lost	Percentage of eggs lost
1	None	98,400	17,600	17.9%
2	Formalin	95,800	5,200	5.4%
3	PVP iodine 50 ppm	94,300	4,600	4.9%
4	PVP iodine 100 ppm	96,200	4,600	4.8%

Analysis

The high percentage of egg loss that occurred in the control group reflects the need for the regular use of an effective fungicide. There was a possibility that the 1 hour water hardening of eggs, at the time of fertilization, might reduce or eliminate the need for chemical treatments entirely. This did not prove to be true.

There was only a 0.6% difference in egg loss between Groups 2, 3, and 4. A difference of less than 1% was not considered significant to hatchery operations. However, for the purposes of this experiment, it can be said that the PVP iodine used to treat Groups 3 and 4 was just as effective, if not more so, than the formalin used on Group 2. These results show that we now have an alternative to formalin for the control of fungus.

The source of water to the incubators in this experiment was from May Creek and variable in temperature. Maximum temperature during this experiment was 47°F. May Creek is susceptible to debris and levels of high turbidity during periods of heavy rains. This was a frequent condition during the experiment.

It would have been an advantage to be able to replicate Groups 3 and 4 to further substantiate these results. This option was not exercised because of the potential negative outcome of using PVP iodine and a relatively low abundance of eggs for experimental testing.

Conclusion

Given the fact that PVP iodine performed as well as formalin, there are a number of benefits that justify utilizing it as our chemical of choice. These include cost effectiveness, health and environmental impacts, and the fact that regulatory agencies are calling for a reduction in the amount of formalin usage.

Under the current WDF guidelines, formaldehyde is only available from a single supplier at a cost considerably greater than iodine. In comparison, the cost associated with mixing 1 gallon of stock solution of formalin is equal to 49.4 gallons of stock solution of 50 ppm PVP iodine.

The amount of each chemical necessary for controlling fungus is significantly different, and once again favors the use of PVP iodine. In a 1 gallon stock solution of formalin there is 700 ml of formaldehyde compared to .4 ml of active iodine in a 1 gallon stock solution of 50 ppm PVP iodine. This would result in asubstantially lower amount of chemical being introduced into the environment. Also, the fumes and irritating effects to the skin and eyes are much less severe in PVP iodine than in formaldehyde. Additionally, the carcinogenic potential associated with formaldehyde is another reason to consider the use of PVP iodine.

After considering all factors, it is quite clear that the benefits of PVP iodine far outweigh those of formaldehyde as a fungicide. Further testing of PVP iodine will continue at the Skykomish Hatchery to determine if the above results can be replicated and if it remains effective at all incubation temperatures. It is also necessary to determine effectiveness with species other than coho salmon. Further testing to determine if PVP iodine remains effective when applied using injection systems or drip methods is also warranted.

REARING DENSITY, FEEDING STRATEGIES AND WATER TEMPERATURE AS FACTORS AFFECTING DORSAL FIN EROSION IN JUVENILE STEELHEAD TROUT

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ABSTRACT

In steelhead trout, Oncorhynchus mykiss, dorsal fin erosion is sometimes used as an indicator of smolt quality, fish with intact dorsal fins being perceived in better shape than those suffering from severe erosion. Fin erosion has been attributed to many factors, including underfeeding, vitamin deficiencies, sunburn, bacterial and/or parasitic infection, water degradation, abrasive tank surfaces, rough handling, and fin nipping.

We theorized that in at least some instances, fin erosion could be controlled if we directly or indirectly reduced the frequency of physical encounters among fish. We tested that hypothesis by evaluating the effects of changing density index, water temperature, and feeding strategy in a factorial experiment. Test tanks were stocked for density indices of .5, .2, .1, and .02. A fifth density treatment involved fish individually isolated in floating cages. Two water temperatures were evaluated, 15°C and 10°C (59°F and 50°F). Feeding strategies included feeding a full ration every day and alternating 2-week periods of feeding and fasting. Conditions on the control treatment were as follows: a targeted density index of .2, 15°C water, and feeding a full ration every day. Data were evaluated by analysis of variance (ANOVA), using Duncan's test to distinguish significant differences among treatment means.

Relationships among dependent variables were tested by correlation. Fin erosion developed progressively over the six-month experiment. Dorsal Fin Index correlated inversely with age, length, and weight of fish (DFI = dorsal fin length x 100 / total fish length). DFI was strongly influenced by isolation and by rearing density. For the fish individually isolated in cages, DFI averaged 10.2, about the same as for a wild steelhead. The fins of the fish raised in community tanks at the lowest density index (.02) were also in good condition (8.6), although they were significantly shorter than for the isolated fish. However, with higher density treatments, DFI fell rapidly (to 4.9, 3.9, and 3.5 with density indices of .1, .2, and .5 respectively). Increasing density index improved feed:gain ratios and slightly depressed survival, but had no clear effect on weight gains, condition, or carcass composition.

Water temperature had a strong significant effect on DFI. Cold water slowed growth rates, but clearly improved DFI, whether the fish were compared at equal age or at equal length. The effects of density and temperature were also strongly interactive. At the lowest density index, there was no significant difference in DFI due to temperature (8.6 at 15°C vs. 8.9 at 10°C), but that was not the case at higher densities. At 15°C, fin length declined rapidly as we increased the density index. In colder water, there was no reduction in DFI until we reached a density index of .5. In other words, within normal ranges of density and temperature, temperature had the stronger effect on DFI, but the effects of temperature and density were not independent. The low temperature treatment also improved survival slightly and altered carcass composition by increasing water content at the expense of fat and protein deposition.

Food deprivation, by fasting, did not appear to have much effect when we compared fish only by age. However, the food-deprived fish were smaller than their siblings, and the effect was different when we compared fish at equal length. Food-deprived fish clearly lost fin tissues at a smaller size than fish fed every day. The food deprived fish exhibited carcass composition trends similar to fish reared in 10°C water. Feed:gain ratios improved significantly when feed rations were cut back.

Under the conditions of this experiment, dorsal fin condition was maximized either by rearing the fish at a reduced temperature, or by rearing them at a very low density. Practical constraints may preclude major changes to density index, water temperature, or species

selection at many hatcheries. However, the combined effects of increasing temperature, increasing density, and feeding strategy are both interactive and additive. That means we have several ways to reduce the severity of dorsal fin erosion in an intensive raceway culture system. Research is continuing on other treatments for steelhead raised at high density and in 15°C water.

CONTROL OF DEFORMED SACFRY WITH INCUBATOR SUBSTRATE

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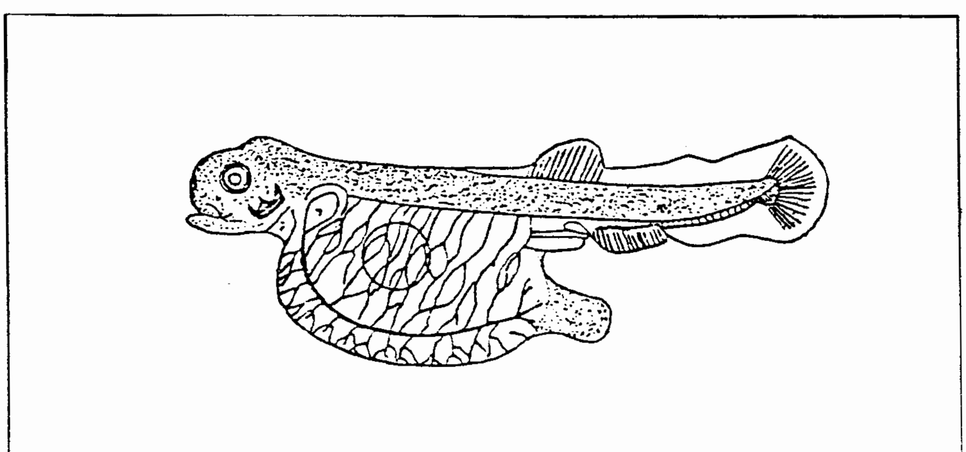
ABSTRACT

Deformed steelhead, Oncorhychus mykiss, sacfry and increased mortality were observed in newly hatched steelhead at the Eastbank Hatchery. The deformed sacfry were characterized by a bulb-like extension of the posterior portion of the yolk sac. Installation of Vexar substrate reduced the incidence of deformed sacfry and mortality. The deformed sacfry and increased mortality were probably caused by increased water velocity due to baffle plates in the troughs.

INTRODUCTION

Deformed steelhead, Oncorhychus mykiss, sacfry and increasing mortality were observd in newly hatched steelhead at the Washington Department of Wildlife Eastbank Hatchery. Deformities were characterized by a bulb-like extension of the posterior portion of the yolk sac (Figure 1). Similar deformed sacfry were observed in other salmonids (Dumas 1966; Jochimsen and Bedell 1968; and Emadi 1973). This paper describes the deformed sacfry, the cause of the problem, and the use of Vexar substrate to control the deformed sacfry and reduce mortality.

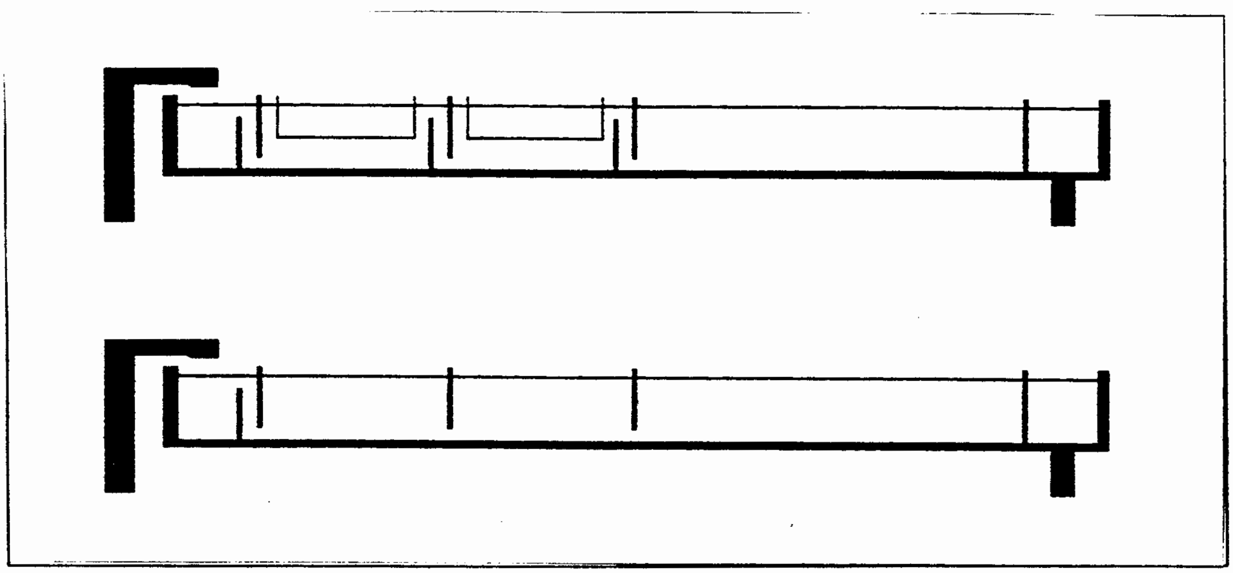
FIGURE 1. Deformed Sacfry (from Emadi 1973)



MATERIALS AND METHODS

Summer steelhead eyed eggs were received at the Eastbank Hatchery in two lots. The two lots were designated as egg take 2 and 3. The egg lot designated egg take 2 was 1 week older than egg take 3. The eggs were disinfected with 100 ppm iodophor for 10 minutes upon receipt and placed in egg baskets in troughs. Each trough contained two baskets of eggs separated by baffle plates. Baffle plates were installed to cause the water to upwell through each egg basket. At hatching, the sacfry drop to the bottom of the trough. The incubator baskets and bottom baffle plates were removed (Figure 2).

FIGURE 2. Diagram of Incubation Trough with Baskets and Baffles (top) and Rearing Trough with Baffles (bottom).



Well water, with temperatures from 51 to 54°F, was used for incubation and rearing. Water inflow ranged from 9 to 14 gpm.

Deformed sacfry and increasing mortality was noted in egg take 2 at 1 week post-hatch. The fish were examined by the fish pathologist and samples were collected for bacteriological and virological examination.

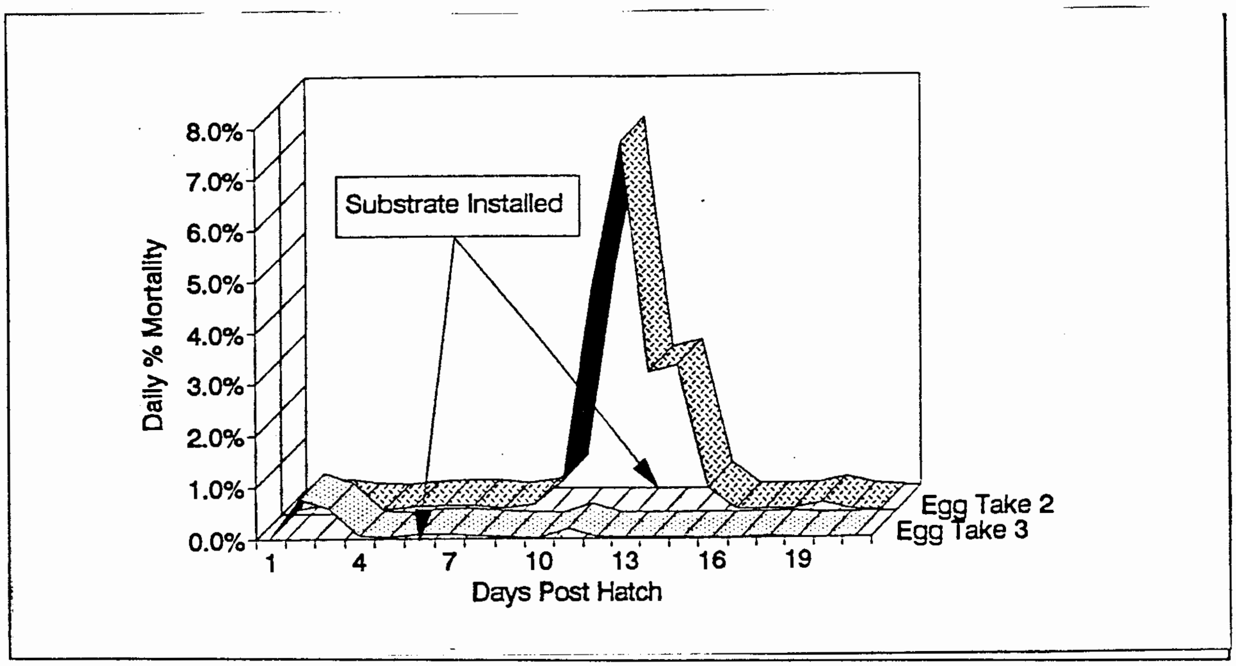
Incubator substrate composed of three layers of 3/4 inch x 3/4 inch Vexar netting wire tied together, was installed on the trough bottom on Day 13 post-hatch for egg take 2 and day 6 post-hatch for egg take 3. Daily mortality was removed and recorded for 21 days post-hatch.

RESULTS AND DISCUSSIONS

Deformed steelhead sacfry and increasing mortality were noted at 1 week post-hatch in the fish from egg take 2. Bacteriological and virological examination of the deformed steelhead sacfry were negative for pathogens.

Since mechanical injury was suspected to be the cause of the deformity and mortality, Vexar incubation substrate was added to the troughs. The daily mortality declined following the addition of the substrate to the fish from egg take 2 and the deformities and mortalities were prevented from occurring in the fish from egg take 3 (Figure 3). Total percent mortality for 3 weeks post-hatch was 18.3 % for the fish from egg take 2 and 2.1 % for the fish from egg take 3.

FIGURE 3. Daily Percent Mortality.



The probable cause of the deformed sacfry and mortality was increased water velocity due to the removal of the bottom baffle plates following hatching. Calculated water velocity for troughs without baffles was 0.02 ft/sec, whereas, the water velocity near the baffle plates was 0.06 ft/sec or a three fold increase. Increasing water velocity has been identified as a cause of similar deformities in other salmonids (Emadi 1973). The Vexar substrate was effective in preventing the deformities and the mortalities by providing protection from high water velocities. In addition, the removal of all baffle plates would have also resulted in the prevention of deformities and mortalities.

CONCLUSIONS

1. Deformed steelhead sacfry were caused by increased water velocity due to baffle plates.

2. Vexar substrate controlled the incidence of deformed steelhead sacfry and greatly reduced the post hatch mortality.

ACKNOWLEDGMENTS

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IMPROVING SURVIVAL OF HATCHERY REARED FISH BY RESTORING NATURAL FRIGHT RESPONSES

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INTRODUCTION

Leavenworth National Fish Hatchery's traditional rearing techniques may change spring chinook behavior and contribute to high post release mortality. Research has shown that fish learn to recognize many stimuli, including food, predators, and habitat (Suboski and Templeton 1989). The hand-feeding method and open ponds currently used may teach fish to respond unnaturally to an overhead stimulus. Instead of swimming away toward a dark area for safety, fish swim toward overhead movement.

OBJECTIVE

The focus of this experiment (study) is to determine whether the fish's natural fright response could be restored through the use of automatic belt feeders and partially covered ponds, thus improving survival after release.

METHODS

Spring chinook fry were randomly selected for control and treatment groups. Each group was reared in 10 fiberglass tanks from December 15, 1990 through March 1, 1991, with 33,000 fish per tank. Treatment tanks were partially covered and fed by automatic belt feeders. The control group fish were reared using traditional techniques (hand-fed and no covers provided). On March 1, each group was transferred outside to three standard 8 ft x 80 ft raceways of 99,000 fish each. Raceways with treatment fish continued to be provided with belt feeder and covers. The final split occurred June 1, when each group was transferred into two Foster Lucas ponds of 42,000 fish each and one raceway of 28,000 fish. They will remain in these rearing units until release in May 1992.

To distinguish between groups after release, fish were adipose clipped and coded-wire tagged following the final split.

OBSERVATIONS

After 45 days, control group fish responded to overhead stimuli (i.e. human feeders) by swimming towards the movement. Treatment fish exhibited a natural fright response (i.e. swimming away from stimulus to dark areas and ceasing to swim while under cover) when exposed to overhead movement.

By mid-summer, control group fish responded to overhead stimuli by swimming vigorously toward the movement and boiling at the surface in anticipation of being fed. Treatment group fish continued to exhibit the natural fright responses.

Additionally, treatment group fish were observed remaining close to the pond bottom directly below the covered areas. They appeared to be organized and territorial in contrast with the control group fish.

POST STUDY (EXPERIMENTAL) OBSERVATION

During the final split (June 1), a group of excess treatment fish was transferred into ponds without covers and automatic belt feeders. Initially, fish continued to exhibit the natural fright responses. Within 30 days, fish behavior was the same as that of the control group fish.

SUMMARY

Whether traditional hatchery practices impair the (overhead) fright response to avoid predation is not yet firmly established. It is clear; however, that hatchery reared fish often fail to seek cover after release. (Raney and Lachner 1942; Vincent 1960; Roadhouse et al, 1986)

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BENEFITS OF ACCLIMATING JUVENILE SALMONIDS BEFORE RELEASE

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ABSTRACT

Coho salmon and steelhead were acclimated for about 3 weeks at Minthorn Springs Acclimation Facility on the Umatilla Indian Reservation. Control groups that had been held at the Hatchery were transported to the acclimation facility and released at the same time as the acclimated groups.

Survival of coho salmon of the two tag codes of acclimated fish (1.06 and 1.00%) was significantly greater than that of the tag code of the control fish held at the hatchery (0.56%). Less dramatic differences were seen in the steelhead. Survival estimates for the three tag codes of acclimated fish ranged from 0.48 to 0.73%, while those of the control fish were significantly lower and ranged from 0.28 to 0.68%.

The greater survival in the acclimated groups of coho salmon may be due to increased smoltification in this group as evidenced by a visual smoltification index. The potential disease problems that may have been associated with the abnormal appearance of gills observed in the steelhead retained at the hatchery make it impossible to conclusively attribute increased survival to acclimation.

No adults from acclimated or control groups were recovered in areas that would suggest much straying was occurring. If we assume that both acclimated and

control adults were equally vulnerable to harvest, the percentages of returns to the total number of adults surviving can be used as a second index of straying. Ratios were similar for both groups of coho salmon. Lower percentages of non-acclimated steelhead (28%) compared to the acclimated fish (39%) suggested that homing accuracy may have been improved by acclimation.

SESSION 6

POTPOURRI

PREDATOR CONTROL
or
WATCHING YOUR HATCHERY PRODUCTION FLY AWAY

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Websters new world dictionary, defines a predator as living by plundering or robbing. This broad definition covers all living things that naturally or illegally prey on the valuable resource we strive so hard to produce. Predators range in size from the pillage of high sea drift nets, illegal gill nets, poachers and snaggers, down to the natural predators such as sea lions, harbor seals, river otters, squaw fish, and a large variety of birds. You will note that as my list of predators becomes physically smaller it gets closer to the hatchery situation over which we, as Fish Culturists, have some degree of control. The large predators of the two legged variety have the most significant economic and biological impact on the resource. All large natural predators are well protected by existing laws. Political action, enforcement, and prosecution of two-legged predators is the only method of predator control that could improve adult returns, providing us with more of the resource available for legal harvest, natural production, and hatchery enhancement.

Since adult predation at the hatchery level is not a major problem, especially from natural predators, this report will look at the physically smaller varieties of natural predators that have a direct impact on hatchery production programs.

COMMON HATCHERY PREDATORS

A typical hatchery contains multiple species of fish at various stages of growth, confined in a variety of pond designs, at extremely high population levels as compared to a natural stream.

This scenario provides a highly visible and in most cases easily accessible smorgasbord for hatchery predators.

Birds, by far, are the largest predation problem affecting hatchery facilities. Birds not only gobble up large quantities of our hatchery production but redeposit our digested resource all over the hatchery, which not only is a factor in the spread of disease but occasionally is a direct airborne assault on unsuspecting and unprotected hatchery workers.

In a November 1990 Southern Regional Aquaculture Center publication by Allen Stickley Jr. avian predators were grouped into three categories referred to as "Swimmers","Waders" and "Fliers".

The swimmers category includes cormorants, pelicans, mergansers, and other varieties of ducks. The waders category contains primarily egrets and all varieties of herons. The birds classified as fliers are various species of gulls, terns, kingfishers and ospreys or fish hawks.

"Fliers" and "Swimmers" normally rely on a direct airborne assault on your hatchery ponds while birds in the "Waders" category can be referred to as walk-ins. Gulls, originally classified as fliers, should be placed in all three categories. Once a gull leaves its natural environment at the city dump and visits your facility for dessert, it will quickly invite every friend and relative in a 10-mile radius to your facility for the full-meal-deal. Gulls will fly in, walk in, and swim around until your pond population disappears. Once they find your pond and gain access there is very little you can do as a hatchery manager that works as a non-lethal deterrent.

CONSUMPTION RATES

Just how many fish can one bird eat? Daily consumption figures are available by species and are generally based on a percentage of body weight. The larger the bird the more it eats. The more friends it invites to dinner, the more fish that fly away. Lets look at two persistent and common hatchery predators as examples.

1. American Mergansers - .5 - 1.0 lb of fish per day

2. Gulls - .3 - .5 lb of fish per day

The above consumption rates refer to feeding in a natural environment. Put these birds in a hatchery pond and the consumption rates will increase like turning a kid loose in a candy store. Now lets take an unprotected half-acre pond of yearling coho at 50 fish/lb with a starting population, in November, of 500,000 and add 6 daily mergansers and 12 Bonapart Gulls and see what happens by 1 December.

6 mergansers	x	1 lb per day	x	30 days	x	50 fish/lb	=	9,000
12 gulls	x	.5 lb per day	x	30 days	x	50 fish/lb	=	9,000
				Total Fish Consumed				18,000

This small number of birds spread out over 10 - 12 hours of daylight feeding time, only a portion of which is being observed by hatchery personnel, would likely be considered a minor predator problem. At a 3.6% loss rate per month, in 7 months by May release over 25% of the pond population would have been consumed, a loss of nearly 130,000 fish. Let's carry what appears as a relatively minor predation loss to the local hatchery crew to a dozen facilities across the state and we are now looking at a total fish loss of 1.5 million fish. Turn the loss of 1.5 million fish into a dollar cost based on $2.55 per pound, a generally accepted production cost figure, using an average size of 35 fish/lb we are looking at a figure of over $100,000 fed to the birds. That kind of money would pay for a lot of predator control measures.

METHODS OF PREDATOR CONTROL

Hazing, or scare tactics can be somewhat effective on certain bird species. Acceptable scare tactics are only slightly more effective than saying boo-shoo-go away! to the more persistent species of birds. A wide variety of pyrotechnics are available for hatchery use. Pyrotechnics consist of rockets, screamers, aerial bombs etc. They are normally launched by a .22 cal. primer cap in a specially designed starter pistol. Propane air cannons with irregular timing devices on the firing mechanism are a common bird control device. Other types of scare tactics include: scarecrows, recorded distress calls, roving patrols with loudspeakers, and even remote control aircraft, to name a few.

Once a predator problem does develop in significant numbers, most scare methods will have limited results. Aggressive species, such as gulls, mergansers, and certain species of herons, are quick to learn that no harm results from the irritating noise that interrupts their feeding process. The birds either ignore the noise of leave momentarily and then return to lunch.

Disadvantages of scare tactics are as follows:

1. Cost factors of consumable pyrotechnic devices can be significant over the long term.

2. Constant loud noises could disturb the neighbors.

3. Scare tactics can be labor intensive.

4. Scare tactics produce limited results.

5. Scare tactics must be started early and target small numbers.

6. Once birds become accustom to the distractions, the tactic becomes ineffective and the problem still exists.

IS PREDATION A PROBLEM AT YOUR FACILITY?

If you answer this question with a yes, maybe, or could be, than the problem is probably more serious than you believe. Determining the numbers lost to predation is extremely difficult unless frequent inventories are taken. A good indicator that a serious problem exists would be unrealistic increases in feed conversion efficiencies. If the increase in size and poundage of the fish on the books exceeds the amount of feed being fed then it becomes obvious that the number of fish on the books exceeds the actual number of fish in the pond. If your product is being stolen by predators it is costing you money. In private aquaculture losses directly affect profit margins. In state and federal facilities direct dollar costs are more intangible but the tax dollars invested are still being digested by predators.

The State of Washington has determined an average production cost of $2.55 per pound of fish. Using this figure as a standard and estimating annual poundage lost to predation, the dollar cost to the facility can be determined. The dollar cost of predation is the best guide post when deciding if predator control is necessary, how much should be spent on protecting the resource and does the savings gained out weigh the cost of protection in the short term - long term.

LET'S KEEP THE BIRDS OUT!

There are nearly as many types of exclusion barriers as there are hatcheries. I will limit the remainder of this report to a list of factors that should be considered when selecting the method of predator control that will work best for your facility.

FACTORS TO CONSIDER WHEN SELECTING PREDATOR CONTROL

1. How much predation is taking place? (convert to dollars)
2. Facility design (types-sizes-location of ponds)
3. Crew access requirements
4. Variety of species to be excluded
5. Local climate and weather extremes
6. Safety factors
7. Dual purpose considerations (shade for example)
8. Life span or replacement costs
9. Maintenance requirements
10. Labor costs

In conclusion, nearly every hatchery suffers a degree of loss due to predation. The loss of fish to natural predators in the environment we can not control. In the artificial environment of a hatchery facility we can and must eliminate or significantly reduce our losses in every way possible. We as fish culturists are not only obligated by the dollars and cents aspects of doing business but by our far reaching responsibility to protect the resource we were hired to propagate and preserve.

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John Penny - WDW
Joni Packard - National Marine Fisheries Service
Seattle Post Intelligencer - Copywrited
"Herschel" side.

For further information on any examples of exclusion barriers shown during the slide presentation contact the author.

AERIAL FINGERLING STOCKING PROGRAM

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ABSTRACT

Aerial planting of fingerling rainbow trout, Oncorhynchus mykiss, and eastern brook trout, Salvelinus fontinalis, from San Joaquin Hatchery plays a vital role in the fisheries management of wilderness lakes of the central Sierra Nevada mountains. About mid-July, 90 high country lakes are aerial stocked each year with 450,000 rainbow trout and 60,000 eastern brook trout fingerlings. This annual stocking of fingerlings insures quality fishing opportunities for those anglers who hike or pack into the beautiful wilderness areas of the rugged Sierra's. A slide show was used to describe the program.

OVERVIEW OF PRIVATE AQUACULTURE IN CALIFORNIA

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ABSTRACT

A distinguishing characteristic of the California aquaculture industry is its diversity. California's industry produces at least a dozen different species, and is conducting research and development on several more. The three most commercially important species are catfish, trout, and oysters. California is an industry leader in species like abalone, striped bass, hybrid striped bass, and sturgeon. While the industry is still relatively small, it has the potential for great expansion. It is estimated that the industry has been growing at a rate of about 20% per year over the last 8 years. Annual gross sales by producers are estimated to be currently around $40 million. California is prominent in aquaculture research and development, leading in areas such as abalone culture, development of intensive rearing systems, and domestication of white sturgeon.

1991

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BIGGS, CA 95917

DAVIS, GREG
OREGON DEPT. OF FISH & WILDLIFE
STAR RT B BOX 12
CASCADE LOCKS, OR 97014

DAVIS, JOHN
U.S. FISH & WILDLIFE SERVICE
CARSON NFH
CARSON, WA 98610

DE COTEAU, LINDA
LUMNI SKOOKUM HATCHERY
4073 LUMMI SHORE ROAD
BELLINGHAM, WA 98226

DECAMPOS, JAMES
CALIFORNIA DEPT. OF FISH & GAME
RT 1 BOX 208
MAMMOTH LAKES, CA 93546

DELARM, MIKE
NAT. MARINE FISHERIES SERVICE
911 NE 11TH AVE. RM. 620
PORTLAND, OR 97232

DIMMICK, LARRY E.
OREGON DEPT. OF FISH & WILDLIFE
STAR RT. BOX 750
CASCADE LOCKS, OR 97014

DITTENTHOLER, THOMAS
YAKIMA INDIAN NATION-FISHERIES
P.O. BOX 151
TOPPENISH, WA 98948

DIVINE, GARY
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 606
RED BLUFF, CA 96080

DIXON, GLEN
DEPT. OF FISHERIES & OCEANS
BOX 61
DEWDNEY, BC VOM1HO

DORRIS, BEN
OREGON DEPT. OF FISH & WILDLIFE
P.O. BOX 282
CASCADE LOCKS, OR 97014

DOWELL, DOUG
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 247
FRIANT, CA 93626

DUCEY, RON
CALIFORNIA DEPT. OF FISH & GAME
2001 NIMBUS RD.
RANCHO CORDOVA, CA 95670

DURAN, DANIEL
CALIFORNIA DEPT. OF FISH & GAME
4700 HWY 99E
OROVILLE, CA 95965

DYSART, DOUGLAS
U.S. FISH & WILDLIFE SERVICE
34288 SE RAINBOW ROAD
ESTACADA, OR 97028

EAGAR, ROY
J.L. EAGAR, INC.
P.O. BOX 476
N.SALT LAKE, UT 84054

EDSALL, DON
U.S. FISH & WILDLIFE SERVICE
780 CRESTON HATCHERY RD.
KALISPELL, MT 59901

EICHMAN, JIMMIE
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 910
BIG PINE, CA 93513

ELLIS, ROGER
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 247
FRIANT, CA 93626

ENGELHARDT, MELVIN M.
U.S. FISH & WILDLIFE SERVICE
34286 SE RAINBOW RD. #A
ESTRACADA, OR 97023

ENOS, ED
CALIFORNIA DEPT. OF FISH & GAME
8638 LAKEVIEW RD.
HORNBROOK, CA 96044

ENOS, SUSANNE
CALIFORNIA DEPT. OF FISH & GAME
8638 LAKEWIEW RD.
HORNBROOK, CA 96044

ESTEY, DON F.
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 158
CLEMENTS, CA 95227

ETTRICH, RICHARD
WASHINGTON DEPT. OF FISHERIES
11416 17TH AVE CT N W
GIG HARBOR, WA 98335

EVENSON, MIKE
OREGON DEPT. OF FISH & WILDLIFE
236 COLE RIVERS DR.
TRAIL, OR 97541

EWING, DICK
OREGON DEPT. OF FISH & WILDLIFE
850 SW 15TH ST.
CORVALLIS, OR 97333

FALLON, MICHAEL
ALASKA DEPT. OF FISH AND GAME
P.O. BOX 5267
FT. RICHARDSON, AK 99505

FARINAS, MANUEL A.
WASHINGTON DEPT. OF WILDLIFE
MPO41L STEEL HEAD RD.
WASHOUGAL, WA 98671

FARMER, RUSS
BIOPRODUCTS, INC
1935 NW WARRENTON DRIVE
WARRENTON, OR 97146

FAULHABER, DON
OREGON DEPT. OF FISH & WILDLIFE
42255 FISH HATCHERY DR.
SCIO, OR 97374

FETZNER, DALE DUAINE
DFO/SFP ENHANCEMENT OPS
RR#3
QUALICUM BEACH, BC VOR2t0

FONT, MELODY
WASHINGTON DEPT. OF WILDLIFE
130 HATCHERY LANE
GOLDENDALE, WA 98620

FONT, RUDY
WASHINGTON DEPT. OF WILDLIFE
130 HATCHERY LANE
GOLDENDALE, WA 98620

FOOTT, J. SCOTT
U.S. FISH & WILDLIFE SERVICE
RT 1 BOX 2105
ANDERSON, CA 96007

FORKNER, GARY R
CALIFORNIA DEPT. OF FISH & GAME
850 TAYLOR LANE
COLFAX, CA 95713

FORNER, ED
U.S. FISH & WILDLIFE SERVICE
911 NE 11TH
PORTLAND, OR 97232

FORTIER, ROD
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 1083
BLUE LAKE, CA 95525

FOSS, DOUG
CLEAR SPRINGS TROUT CO.
561 S. MAIN
SODA SPRINGS, ID 83276

FRANK, DENNIS
PROTECT A COVER
12310 HWY 99 BAY 123
EVERETT, WA 93204

FREW, TOM
IDAHO DEPT. OF FISH AND GAME
RT 1 BOX 247
HAGERMAN, ID 83332

GALLAGHER, KEN
CALIFORNIA DEPT. OF FISH & GAME
1662 HATCHERY RD.
ARCATA, CA 95521

GANZHORN, JACK
PENINSULA COLLEGE
1502 E. LAURIDSEN
PORT ANGLES, WA 98302

GARLOCK, DEVAN
OREGON DEPT. OF FISH & WILDLIFE
HC 30 BOX 142
CHILOQUIN, OR 97624

GARRISON, BOB
OREGON DEPT. OF FISH & WILDLIFE
1411 N.W. ALTA VISTA DRIVE
CORVALLIS, OR 97330

GORRIE, WAYNE
PRA MANUFACTURING, LTD
P.O. BOX 774, STATION A
NANAIMO, BC V9R5M2

GRAF, DENNIS
DIVERSIFIED OVA-TECH LTD.
BOX 819
LUMBY, BC V0E2G0

GRAF, MARY ELLEN
DIVERSIFIED OVA-TECH LTD.
RR# 1S19 C-23
VERNON, BC VIT6L4

GRAYBILL, JAMES R.
MT. HOOD COMMUNITY COLLEGE
26000 SE STARK ST.
GRESHAM, OR 97030

GREGG, T. R.
ENGINEERED PRODUCTS
P.O. BOX 30
PHILOMATH, OR 97370

GRIBBLE, MIKE
OREGON DEPT. OF FISH & GAME
82115 FISH HATCHERY LANE
ENTERPRISE, OR 97828

GRIDER, ROBERT
CALIFORNIA DEPT. OF FISH & GAME
STAR RT. 1 BOX 26
INDEPENDENCE, CA 93526

GROH, JIM
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 159
MOCCASIN, CA 95347

GROVE, TOM
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 159
MOCCASIN, CA 95347

GROVER, MIKE
OREGON DEPT. OF FISH & WILDLIFE
STAR RT. BOX 74
IDANHA, OR 97350

GUNTER JR., E. ROYCE
CALIFORNIA DEPT. OF FISH & GAME
3246 SKAGGS SPRINGS RD.
GEYSERVILLE, CA 95441

GUTIERREZ, COLINDA
CALIFORNIA DEPT. OF FISH & GAME
1660 HATCHERY RD.
ARCATA, CA 95521

HAMELBERG, SCOTT
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 667
RED BLUFF, CA 96080

HAMMOND, NORM
OREGON DEPT. OF FISH & WILDLIFE
15020 CHANCE RD.
TILLAMOOK, OR 97141

HAMSTREET, CHARLES
U.S. FISH & WILDLIFE SERVICE
7791 FISH HATCHERY RD
LEAVENWORTH, WA 98826

HARDY, KRISTI
CALIFORNIA DEPT. OF FISH AND GAME
P.O. BOX 343
CLEMENTS, CA 95227

HARMER, PAUL
UTAH DIVISION OF WILDLIFE RESOURCES
1596 WEST NORTH TEMPLE
SALT LAKE CITY, UT 84116

HARN, JUDY
CALIFORNIA DEPT. OF FISH AND GAME
P.O. BOX 158
CLEMENTS, CA 95227

HARRIS, STEVE
WASHINGTON DEPT. OF FISHERIES
5941 FISH HATCHERY LANE
MARBLEMOUNT, WA 98267

HARRISON, LARRY
CALIFORNIA DEPT. OF FISH & GAME
#3 N. OLD STAGE ROAD
MT. SHASTA, CA 96067

HARTMAN, DIXIE
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 151
SNELLING, CA 95369

HASHAGEN, KEN
CALIFORNIA DEPT. OF FISH AND GAME
1416 NINTH STREET
SACRAMENTO, CA 95814

HATFIELD, DOUG
WASHINGTON DEPT. OF FISHERIES
14418 383RD AVE SE
SULTAN, WA 98294

HAWES, BRYAN
CALIFORNIA DEPT. OF FISH & GAME
1664 HATCHERY RD.
ARCATA, CA 95521

HAWKINS, CLARENCE J.
WASHINGTON DEPT. OF FISHERIES
2244 US HWY
ETHLE, WA 98542

HAYNIE, MIKE
CALIFORNIA DEPT. OF FISH & GAME
407 W. LINE ST.
BISHOP, CA 93514

HAZELEUR, RICHARD C.
CALIFORNIA DEPT. OF FISH & GAME
TRINITY RIVER HATCHERY
LEWISTON, CA 96052

HEWITT, JOHN
RANGEN, INC.
P.O. BOX 706
BUHL, ID 83316

HILLWIG, LEE
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 1450
WEAVERVILLE, CA 96093

HOLLOWAY, DOC
GEOTHERMAL AQUACULTURE
P.O. BOX 2
CANBY, CA 96015

HOLM, MIKE
WASHINGTON DEPT. OF WILDLIFE
6653 RD K. NE #C
MOSES LAKE, WA 98837

HOLMES, JOHN A.S.
U.S. FISH & WILDLIFE SERVICE
1440 ABERNATHY RD.
LONGVIEW, WA 98632

HOLWAY, JIM
SALMONOID TECHNOLOGY
32500 SE RAINBOW RD.
ESTACADA, OR 97023

HOUSTON, ALLEN J.
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 689
WEAVERVILLE, CA 96093

HUBLEY, ROD
CALIFORNIA DEPT. OF FISH & GAME
RT. 2 BOX 1113
BURNEY, CA 96013

HUDSPETH, BOB
OREGON DEPT. OF FISH & WILDLIFE
ROUTE 1 BOX 443
MAUPIN, OR 97037

HULBROCK, BOB
CALIFORNIA DEPT. OF FISH & GAME
1416 NINTH ST.
SACRAMENTO, CA 95814

HUTCHINSON, BILL
IDAHO DEPT. OF FISH & GAME
600 S. WALNUT BOX 25
BOISE, ID 83707

ICKES, DAVE
CALIFORNIA DEPT. OF FISH & GAME
3 N OLD STAGE RD.
MT. SHASTA, CA 96067

JENKINS, DON W.
CALIFORNIA DEPT. OF FISH & GAME
STAR RT. 1 BOX 100
INDEPENDENCE, CA 93526

JENSEN, GREG
JENSORTER, INC.
20225 HARVEST LANE
BEND, OR 97701

JENSEN, LOREN
OREGON DEPT. OF FISH & WILDLIFE
43863 GREER DRIVE
LEABURG, OR 97489

JOHNSON, DON
OVA - TECH.
BPX 4072
LOWE-NICOLA, BC VOK1YOO

JOHNSON, RICHARD
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 667
RED BLUFF, CA 96080

KASTNER, ANNA
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 247
FRIANT, CA 93626

KEOWN, KEITH
WASHINGTON DEPT. OF FISHERIES
2111 BETHEL NE
OLYMPIA, WA 98506

KERWIN, JOHN
WASHINGTON DEPT. OF WILDLIFE
600 CAPITAL WAY N
OLYMPIA, WA 98501

KINGSBURY, SUSAN
AQUA SEED CORPORATION
1515 DEXTER AVE. N SUITE #406
SEATTLE, WA 98109

KOLLENBORN, GREG
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX X
KERNVILLE, CA 93238

KUROSAKA, CAROLYN
CALIFORNIA DEPT. OF FISH & GAME
1416 NINTH ST. RM 1251
SACRAMENTO, CA 95831

LASITER, CINDY
ALASKA DEPT. OF FISH & GAME
2030 SEA LEVEL DR. #205
KETCHIKAN, AK 99901

LAWSON, CHARLOTTE
BRITISH COLUMBIA GOVERNMENT
34345 VYE ROAD
ABBOTSFORD, BC V254N2

LEIDER, STEVE
WASHINGTON DEPT. OF WILDLIFE
804 ALLEN ST., SUITE 3
KELSO, WA 98626

JOHNSON, AL
CALIFORNIA DEPT. OF FISH & GAME
RT. 2 BOX 1113
BURNEY, CA 96013

JOHNSON, RICHARD
MUCKLESHOOT INDIAN TRIBE
25305 SE MUD MOUNTAIN RD.
ENUMCLAW, WA 98022

JONES, TERRY
OREGON DEPT. OF FISH & WILDLIFE
STAR RT. BOX 71
IDANHA, OR 97350

KEELER, MIKE
MACON SPRINGS FISH HATCHERY
RT. 2, BOX 10
PAYNES CREEK, CA 96075

KERR, BRAD
BIOPRODUCTS INC.
1935 NW WARRENTON DRIVE
WARRENTON, OR 97146

KEYS, CHARLES T.
CALIFORNIA DEPT. OF FISH & GAME
BOX 8
PAYNES CREEK, CA 96075

KNUTSON, CHUCK
CALIFORNIA DEPT. OF FISH & GAME
1416 NINTH ST.
SACRAMENTO, CA 95814

KRAKKER, JOE
U.S. FISH & WILDLIFE SERVICE
4696 OVERLAND RD. RM. 560
BOISE, ID 83705

LARSON, LENNY
CEDC FISHERIES PROJECT
250 36TH ST.
ASTORIA, OR 97103

LAW, DUNCAN
CEDC FISHERIES PROJECT
250 36TH ST.
ASTORIA, OR 97103

LAWSON, DOUGLAS A.
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 18
AHSAHKA, ID 93520

LEITH, DAVID A
U.S. FISH & WILDLIFE SERVICE
1440 ABERNATH ROAD
LONGVIEW, WA 98632

LEWIS, MARK
OREGON DEPT. OF FISH & GAME
850 SW 15TH STREET
CORVALLIS, OR 97333

LINDSAY, JAMES N.
CALIFORNIA DEPT. OF FISH & GAME
HCR 67 BOX 26
INDEPENDENCE, CA 93526

LOVDENSLAGER, DR. ERIC J.
HUMBOLDT STATE UNIVERSITY
FISHERIES DEPT. HUMBOLDT ST.U.
ARCATA, CA 95521

MAHONE SR., BILL
MAKAH FISHERIES MANAGEMENT
P.O. BOX 343
NEAH BAY, WA 98357

MARSHALL, BRUCE
VMG INDUSTRIES
858 GRAND AVE.
GRAND JUNCTION, CO 81501

MATTHEWS, CONRAD
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 159
MOCCASIN, CA 95347

MC BAIN, GRANT
FED. FISH - CANADA
BOX 10
MADEIRA PARK, BC VOW3AO

MCCLOUD, MICHAEL
CTUIR
P.O. BOX 143
PENDLETON, OR 97801

MCCORMACK, M.L. "DOC"
CALIFORNIA DEPT. OF FISH & GAME
RT 2 BOX 1113
BURNEY, CA 96013

MCKNIGHT, SCOTT
MOORE-CLARK CO. INC
P.O. BOX M
LACONNER, WA 98257

MEYER, ALAN
OREGON DEPT. OF FISH & WILDLIFE
RT. 1 BOX 764
ASTORIA, OR 97103

MIGALSKI, CHUCK
CALIFORNIA DEPT. OF FISH & GAME
3246 SKAGGS SPRINGS RD.
GEYSERVILLE, CA 95441

LIEBERMAN, ELIOT
ARGENT LABORATORIES
8702 152ND AVE. NE
REDMOND, WA 98502

LOFY, PETER
UMATILLA TRIBE
211 INLOW HALL EOSC
LA GRANDE, OR 97850

LUDTKE, MARTIN
CALIFORNIA DEPT. OF FISH & GAME
7329 A SILVERADO TRAIL
NAPA, CA 94558

MALLAK, MARSHALL
OZONE RESEARCH & EQUIPMENT CO.
3840 N. 40TH AVE.
PHOENIX, AZ 85019

MARSHALL JR., LAIRD E.
CALIFORNIA DEPT. OF FISH & GAME
RT 2 BOX 1113
BURNEY, CA 96013

MAYO, RON
MONTGOMERY ENGINEERS
2375 130TH NE
BELLEVUE, WA 98040

MCCARVER, DENISE
WASHINGTON DEPT. OF FISHERIES
13246 LINCOLN ROCK ROAD
E. WENATCHEE, WA 98802

MCCOLLUM, PAUL
VALDEZ FISHERIES DEVELOPMENT ASSN.
P.O. BOX 125
VALDEZ, AK 99686

MCGEHEE, JERRY
IDAHO DEPT. OF FISH & GAME
4156-A AHSUHKA ROAD
AHSAHKA, ID 83520

MCNAIR, DONALD E.
CALIFORNIA DEPT. OF FISH & GAME
2001 NIMBUS ROAD
RANCHO CORDOVA, CA 95670

MIETHE, HARLEY
OREGON DEPT. OF FISH & WILDLIFE
RT 4 BOX 594
ASTORIA, OR 97103

MILNE, JOHN
MOORE-CLARK CO. (CANADA) INC.
1350 EAST KENT AVE
VANCOUVER, BC V5X2Y2

MITCHELL, MATTHEW
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 910
BIG PINE, CA 93513

MIYAMOTO, JOE
EAST BAY M.U.D.
500 SAN PABLO DAM ROAD
ORINDA, CA 94563

MOFFETT, JEFFREY
CALIFORNIA DEPT. OF FISH & GAME
HCR BOX 26
INDEPENDENCE, CA 93526

MONTGOMERY, CAROLE
WASHINGTON DEPT. OF FISHERIES
972 GREEN MTN RD.
MOSSYROCK, WA 98564

MOODY, GREGORY
THE PACIFIC LUMBER CO.
BOX 37
SCOTIA, CA 95565

MORINAKA, JERRY
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 26
INDEPENDENCE, CA 93526

MULLEN, ROBERT E.
OREGON DEPT. OF FISH & WILDLIFE
4192 NORTH UMPQUA HIGHWAY
ROSEBURG, OR 97470

MULLER, MICHAEL
WASHINGTON DEPT. OF FISHERIES
6255 MT. BAKER HWY
DEMING, WA 98244

MURPHY, JAMES H.
CALIFORNIA DEPT. OF FISH & GAME
7329 SILVERADO TRAIL
NAPA, CA 94558

NANDOR, GEORGE
OREGON DEPT. OF FISH & WILDLIFE
24500 S. ENTRANCE RD.
ESTACADA, OR 97023

NEALEIGH, GEORGE W.
SILVER CUP FISH FEED
P.O. BOX 155
MANZANITA, OR 97130

NELSON, CHRIS
NELSON & SON/SILVER CUP FEEDS
P.O. BOX 57428
MURRAY, UT 84157

NEVISON, TONY
CALIFORNIA DEPT. OF FISH & GAME
3 N. OLD STAGE RD.
MT. SHASTA, CA 96067

NEWCOMB, TIM
U.S. NAT. MARINE FISHERY SERVICE
2725 MONTLAKE BLVD. E
SEATTLE, WA 98112

NEZGOD, BILL
PCI OZONE & CONTROL SYSTEMS, INC
1 FAIRFIELD CRESENT
WEST CALDWELL, NJ 07006

NORIEGA, CARLOS
CALIFORNIA DEPT. OF FISH & GAME
9288 ELK GROVE FLORIN
ELK GROVE, CA 95624

NOVOTNY, ANTHONY J.
MARINKA INTERNATIONAL
1919 E. CALHOUN
SEATTLE, WA 98112

O'TOOLE, PATTY
CONFED. TRIBES OF WARM SPRINGS
P.O. BOX C
WARM SPRINGS, OR 97761

OATES, JON

2000 MCKENZIE APT. 2
BELLINGHAM, WA 98226

OCHS, JIM
INDUSTRIAL PLASTICS
740 S. 28TH ST.
WASHOUGAL, WA 98671

OGLE II, WILLIAM H.
CALIFORNIA DEPT. OF FISH & GAME
1335 MINI
CLOVIS, CA 93612

OLNEY, MIKE
YAKIMA INDIAN NATION-FISHERIES
P.O. BOX 151
TOPPENISH, WA 98948

OLSON, CRAIG
N.W. INDIAN FISHERIES COMMISSION
6730 NARTIN WAY E.
OLYPIA, WA 98506

OLSON, WAYNE H.
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 18
AHSAHKA, ID 83520

OSBORNE, GARY L
WASHINGTON DEPT. OF FISHERIES
13246 LINCOLN ROCK RD
EAST WENATCHEE, WA 98802

OTTO, WILLIAM K.
OREGON DEPT. OF FISH & WILDLIFE
P.O. BOX 197
IDLEYLD PARK, OR 97447

OVERTON, PAT
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 247
FRIANT, CA 93626

OVERTON, SHAD M.
CALIFORNIA DEPT. OF FISH & GAME
STAR RT 1 BOX 208
MAMMOTH LAKES, CA 93546

OVERTON, SHANE
CALIFORNIA DEPT. OF FISH & GAME
BOX 8
PAYNES CREEK, CA 96075

OWENS, LOUIE
MAGIC VALLEY HELI-ARC
BOX 511
TWIN FALLS, ID 83301

OWSLEY, DAVID E.
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 18
AHSAHKA, ID 83520

PAAPE, GREG
CALIFORNIA DEPT. OF FISH & GAME
2689 FORESTVIEW
OROVILLE, CA 95966

PACE, ALLEN
U.S. FISH & WILDLIFE SERVICE
UNDERWOOD
UNDERWOOD, WA 98651

PANTANO, SAL
GEOTHERMAL AQUACULTURE
P.O. BOX 2
CANBY, CA 96015

PARSONS, JIM
CLEAR SPRINGS TROUT CO.
P.O. BOX 712
BUHL, ID 83316

PATTERSON, LEE ROY
CALIFORNIA DEPT. OF FISH & GAME
#5 TABLE MNT. BLVD.
ORVILLE, CA 95966

PELLISIER, RENE
VALDEZ FISHERIES DEVELOPMENT ASSN.
P.O. BOX 125
VALDEZ, AK 99686

PELTON, ERIC
U.S. FISH & WILDLIFE SERVICE
61.75 R SR14
UNDERWOOD, CA 98605

PENNY, JOHN
WASHINGTON DEPT. OF WILDLIFE
1210 OKANOGAN
WENATCHEE, WA 98801

PETERSON, DON
B.C. FISHERIES BRANCH
780 BLANSHARD ST.
VICTORIA, BC A8V1X5

PETERSON, LARRY
U.S. FISH & WILDLIFE SERVICE
1011 EAST TUDOR RD.
ANCHORAGE, AK 99503

PHALEN, VIRGINIA
U.S. FISH & WILDLIFE SERVICE
3059B NAT. FISH HATCHERY RD.
HAGERMAN, ID 83332

PICKETT, ASHANNA M.
WASHINGTON DEPT. OF FISHERIES
2284 SPENCER RD.
SALKUM, WA 98582

POE, SIDNEY D.
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 47
YOUNTVILLE, CA 94599

POOL, BOB
CALIFORNIA DEPT. OF FISH & GAME
2101 NIMBUS RD.
RANCHO CORDOVA, CA 95670

POOL, HERBERT
CALIFORNIA DEPT. OF FISH & GAME
9715 BIG OAK WAY
UPPER LAKE, CA 95485

PRATSCHNER, GREG
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 549
LEAVENWORTH, WA 98826

QUINONES, ARMANDO
CALIFORNIA DEPT. OF FISH & GAME
STAR RT 1 BOX 208
MAMMOTH LAKES, CA 93546

RABY, JON
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 667
RED BLUFF, CA 96080

RADFORD, LINDA
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 666
FILLMORE, CA 93016

RAMSDEN, GARY R.
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 227
LEWISTON, CA 96052

RANKIN, JOHN
IDAHO DEPT. FISH & GAME
RT.1, MAGIC VALLEY HATCHERY
FILER, ID 83328

RASMUSSEN, ULF
WASHINGTON DEPT. OF WILDLIFE
7723 PHILLIPS ROAD SW
TACOMA, WA 98498

RASMUSSON, S. CLEGG
OREGON DEPT. OF FISH & WILDLIFE
RT. 2, BOX 2198
CLATSKANIE, OR 97016

REDFERN, DENNIS A.
CALIFORNIA DEPT. OF FISH & GAME
STAR RT 1 BOX 208
MAMMOTH LAKES, CA 93546

REIFF, STEVE
REIFF MANUFACTURING
RT 4 BOX 183
WALLA WALLA, WA 99362

REY, RALPH
MOORE-CLARK CO. (CANADA) INC.
1350 EAST KENT AVE.
VANCOUVER, BC V5X2Y2

REYNOLDS, RANSE W.
CALIFORNIA DEPT. OF FISH & GAME
2001 NIMBUS RD.
RANCHO CORDOVA, CA 95695

RHINER, TERRI J.
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 162
LEWISTON, CA 96052

RIEBEN, DAVID
OREGON DEPT. OF FISH & WILDLIFE
RT 4 BOX 594
ASTORIA, OR 97103

ROBARDS, STEVE
WASHINGTON DEPT. OF WILDLIFE
HCR BOX 52
CHELAN, WA 98816

ROBART, RANDY
OREGON DEPT. OF FISH & WILDLIFE
ROUTE 1 BOX 443
MAUPIN, OR 97037

ROBINSON, BUD
WASHINGTON DEPT. OF FISHERIES
934 9TH AVE #4
LONGVIEW, WA 98632

ROBINSON, JIM
OREGON DEPT. OF FISH & WILDLIFE
RTE 2, BOX 418
BANDON, OR 97411

ROBINSON, JOE
CALIFORNIA DEPT. OF FISH & GAME
6370 DESCHUTES RD.
ANDERSON, CA 96007

RODRIQUEZ, JESSEE
IDEAL HORIZONS
P.O. BOX 1707
RUTLAND, VT 05701

ROGERS, DAVID
OREGON DEPT. OF FISH & WILDLIFE
43863 GREER DRIVE
LEABURG, OR 97489

ROHRER, BRET J.
MACON SPRINGS FISH HATCHERY
RT. 2, BOX 10
PAYNES CREEK, CA 96075

ROLEY, DENNIS
BIOPRODUCTS
1935 N.W. WARRENTON DRIVE
WARRENTON, OR 97146

ROSSOW, DICK
PURINA MILLS, INC.
1125 PAULSON ROAD
TURLOCK, CA 95380

ROWAN, GERALD
CTURI
P.O. BOX 638
PENDLETON, OR 97801

RUETH, JOHN
U.S. FISH & WILDLIFE SERVICE
1125 16TH ST. ROOM 209
ARCATA, CA 95521

RUSHTON, KIM
CALIFORNIA DEPT. OF FISH & GAME
17231 COTTONWOOD CREEK RD.
HORNBROOK, CA 96044

SANDERS, STEPHEN W.
CALIFORNIA DEPT. OF FISH & GAME
2101 NIMBUS RD.
RANCHO CORDOVA, CA 95670

SCHLICHTING, DONALD
CALIFORNIA DEPT. OF FISH & GAME
5 TABLE MT. BLVD.
ORVILLE, CA 95965

SCHUYLER, SCOTT
SKAGIT SYSTEMS COOPERATIVE
P.O. BOX 368
LA CONNER, WA 98257

SEEFELDT, MIKE
CALIFORNIA DEPT. OF FISH & GAME
2101 NIMBUS RD.
RANCHO CORDOVA, CA 95670

SEYMOUR, STEVE
WASHINGTON DEPT. OF FISHERIES
3725 DANA
BELLINGHAM, WA 98225

SHAW, TOM
U.S. FISH & WILDLIFE SERVICE
1125 16TH STREET, RM 209
ARCATA, CA 95521

SHELDRAKE, TOM
U.S. FISH & WILDLIFE SERVICE
911 N.E. 11TH AVE.
PORTLAND, OR 97232

SHIPLEY, STEPHEN
BELLINGHAM TECH COLLEGE
1940 18TH ST. #1-105
BELLINGHAM, WA 98225

SHUDES, ROGER
U.S. FISH & WILDLIFE SERVICE
RT 1 BOX 2105
ANDERSON, CA 96007

SIMMONS, ORVILLE
CALIFORNIA DEPT. OF FISH & GAME
BOX 8
PAYNES CREEK, CA 96075

SIPLE, JOHN T.
IDAHO DEPT. FISH & GAME
RT. 1, P.O. BOX 543
BONNERS FERRY, ID 83805

SAMRA, RON
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 247
FRIANT, CA 93626

SCHAEFFER, LESLIE
OREGON DEPT. OF FISH & WILDLIFE
17330 SE EVELYN ST.
CLACHAMAS, OR 97015

SCHNEIDER, RICH
CLEAR SPRINGS TROUT CO.
P.O. BOX 712
BUHL, ID 83316

SCOTT, B. SHANE
FISH PRO, INC.
3870 SE ST. HWY. 160
PORT ORCHARD, WA 98366

SENSING, COMMON
COMMON SENSING
7595 FINCH RD. N.E.
BAINBRIDGE IS., WA 98110

SHAW, HARRY T.
U.S. FISH & WILDLIFE SERVICE
3059D NATIONAL FISH HAT. ROAD
HAGERMAN, ID 83332

SHAWE, VICTOR
OREGON DEPT. OF FISH & GAME
43182 N. RIVER DRIVE
SWEET HOME, OR 97386

SHEPARD, ELLEN
CALIFORNIA DEPT. OF FISH & GAME
3246 SKAGGS SPRINGS RD.
GEYSERVILLE, CA 95441

SHRIER, FRANK
PACIFIC POWER & LIGHT
920 SW SIXTH AVE.
PORTLAND, OR 97204

SIAZ, EILEEN
CALIFORNIA DEPT. OF FISH & GAME
BOX 8
PAYNES CREEK, CA 96075

SIMPSON, BARB
CALIFORNIA DEPT. OF FISH & GAME
1416 NINTH ST.
SACRAMENTO, CA 95814

SMITH, CHARLIE
U.S. FISH & WILDLIFE SERVICE
4050 BRIDGER CANYON RD.
BOZEMAN, MT 59715

SMITH, CRAIG
OREGON DEPT. OF FISH & WILDLIFE
61374 PARRELL ROAD
BEND, OR 97702

SMITH, R.Z.
N.M.F.S
911 NE 11TH, SUITE 620
PORTLAND, OR 97232

SMITH, ROSS
UTAH DIVISION OF WILDLIFE RESOURCES
1596 WEST NORTH TEMPLE
SALT LAKE CITY, UT 84116

SOHLER, ROBERT
OREGON DEPT. OF FISH & WILDLIFE
15020 CHANCE ROAD
TILLAMOOK, OR 97141

SPARROW, HUGH

1655 WARREN GARDENS
VICTORIA, BC V8S159

STALEY, JERRY
CALIFORNIA DEPT. OF FISH & GAME
1234 E. SHAW
FRESNO, CA 93710

STANLEY, CHARLIE
OREGON DEPT. OF FISH & WILDLIFE
33465 HWY 22
HEBO, OR 97122

STEDRONSKY, WAYNE
OREGON DEPT. OF FISH & WILDLIFE
STAR RT B BOX 526
CASCADE LOCKS, OR 97014

STEGE, ED
U.S. FISH & WILDLIFE SERVICE
MP.O.O9L COLTO LOOP
COOK, WA 98605

STICKELL, TRENT
OREGON DEPT. OF FISH & WILDLIFE
P.O. BOX 59
PORTLAND, OR 97030

STONE, KATHY
U.S. FISH & WILDLIFE SERVICE
MP 61.75 SR14
UNDERWOOD, WA 98561

STRATTON, MIKE
OREGON DEPT. OF FISH & WILDLIFE
17330 S.E EVELYN ST.
CLACKMAS, OR 97015

STREIG, DAVE
MONTEREY BAY SALMON & TROUT PROJECT
825 BIG CREEK ROAD
DAVENPORT, CA 95017

STROM, CHARLIE
YAKIMA INDIAN NATION-FISHERIES
P.O. BOX 151
TOPENISH, WA 98948

SYMONS, TOM
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 203
INDEPENCENCE, CA 93526

TANSLEY, BILL
OREGON DEPT. OF FISH & WILDLIFE
P.O. BOX 130
CAMP SHERMAN, OR 97730

TETI, PAT
PISCES COMPUTING, LTD.
3025 TENTICTON STREET
VANCOUVER, BC Z5M3C5

THACKER, JIM
OREGON DEPT. OF FISH & WILDLIFE
4192 N. UMPQUA HWY.
ROSEBURG, OR 97470

THOMPSON, RICHARD
CALIFORNIA DEPT. OF FISH & GAME
7995 RESERVOIR ROAD
OROVILLE, CA 95966

THORSON, BILL
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 549
LEAVENWORTH, WA 98826

TIPPING, JACK
WASHINGTON DEPT. OF WILDLIFE
2101 HWY 508
ONALASKA, WA 98570

TOWNSEND, BILL
TROUT LODGE
P.O. BOX 1290
SUMNER, WA 98390

TREMBLAY, DEAN
ARGENT LABS
#180 4631 SHELL RD.
RICHMOND, BC VG84M6

TRUE, KIMBERLY
U.S. FISH & WILDLIFE SERVICE
3704 GRIFFIN LN. SUITE 101
OLYMPIA, WA 98501

UPLINGER, RICHARD M.
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 910
BIG PINE, CA 93513

VAN REE, GARY
GLOBAL AQUA
11405 GATE RD. S.
OLYMPIA, WA 98502

VARELA, DWIGHT
U.S. FISH & WILDLIFE SERVICE
20462 WOMACK AVE.
RED BLUFF, CA 96080

VISSCHER, LARRY
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 25486
DENVER, CO 80225

WAGNER, PAUL
PYRAMID LAKE FISHERIES
STAR ROUT
SUTCLIFFE, NV 89509

WAINWRIGHT, DUANE L.
U.S. FISH & WILDLIFE SERVICE
710 HIGHWAY 395
GARNERVILLE, NV 89410

WAKEFIELD, BOB
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 159
MOCCASIN, CA 95347

WALKER, BOB
U.S. FISH & WILDLIFE SERVICE
RT 1 BOX 2105
ANDERSON, CA 96007

WALKER, DERALD
OREGON DEPT. OF FISH & WILDLIFE
62374 PARRELL ROAD
BEND, OR 97702

WARREN, DELL
WARREN WATER BROOM
ROUTE 4 BOX 543C
ASTORIA, OR 97013

WARREN, KEITH
CEDC FISHERIES PROJECT
250 36TH ST.
ASTORIA, OR 97103

WARREN, ROGER
OREGON DEPT. OF FISH & WILDLIFE
226 COLE RIVERS DRIVE
TRAIL, OR 97541

WATERS, MARVIN
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 247
FRIANT, CA 93626

WEIGARD, DAVID
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 667
RED BLUFF, CA 96080

WEISS, GARY
CALIFORNIA DEPT. OF FISH & GAME
916 HIGH ST.
ORVILLE, CA 95965

WELCH, RANDY
CALIFORNIA DEPT. OF FISH & GAME
BOX 8
PAYNES CREEK, CA 96075

WELCH, TONY
CALIFORNIA DEPT. OF FISH & GAME
BOX 8
PAYNES CREEK, CA 96075

WELLS, STEPHEN
OREGON DEPT. OF FISH & WILDLIFE
580 FISH LAKE RD.
BUTTE FALLS, OR 87522

WESTERHOF, RICK
BPA
11740 S.W. SUMMERCREST PLACE
TIGARD, OR 97223

WIANT, DAVID
ZEIGLER BROS, INC.
P.O. BOX 95
GARDNERS, PA 17324

WILL, ROBERT
ROWDY CREEK HATCHERY
P.O. BOX 328
SMITH RIVER, CA 95567

WILLIAMS, GARY L.
CALIFORNIA DEPT. OF FISH & GAME
STAR RT. L BOX 26
INDEPENDENCE, CA 93526

WILLIAMS, NORMAN
MUCKLESHOOT INDIAN TRIBE
34900 212 AVE. SE
AUBURN, WA 98002

WILLINGHAM, EDDY
MARISOURCE
P.O. BOX 9037
TACOMA, WA 98409

WILLIS, MEL
CALIFORNIA DEPT. OF FISH & GAME
601 LOCUST
REDDING, CA 96001

WINGFIELD, BILL
CALIFORNIA DEPT. OF FISH & GAME
2111 NIMBUS ROAD
RANCHO CORDOVA, CA 95670

WOODY, STAN
WASHINGTON DEPT. OF WILDLIFE
28 BEAVER CREEK ROAD
CATHLAMET, WA 98612

YARBROUGH, JIM
CALIFORNIA DEPT. OF FISH & GAME
1520 NORTH ST.
SANTA ROSA, CA 95404

YEAGER, GARY W.
OREGON DEPT. OF FISH & WILDLIFE
P.O. BOX 292
NEHLEM, OR 97131

ZIMMERMAN, BRIAN
UMATILLA TRIBE
P.O. BOX 638
PENDLETON, OR 97801

WINFREE, ROBERT
U.S. FISH & WILDLIFE SERVICE
3059F NFH ROAD
HAGERMAN, ID 83332

WINTERS, RANDY
OREGON DEPT. OF FISH & WILDLIFE
RT.2, BOX 151
IRRIGON, OR 97844

YAMASHITA, MAS
CALIFORNIA DEPT. OF FISH & GAME
1416 9TH ST.
SACRAMENTO, CA 95814

YASKOVIC, JOHN
OREGON DEPT. OF FISH & WILDLIFE
P.O. BOX 59
PORTLAND, OR 97207

YOO, SCOTT
CALIFORNIA DEPT. OF FISH & GAME
P.O. BOX 365
BIG PINE, CA 93513

ZYLMAN, RACHAEL
U.S. FISH & WILDLIFE SERVICE
P.O. BOX 549
LEAVENWORTH, WA 98826

1991

VENDORS

LIST OF VENDORS AT 1991 NWFC

1. AquaSeed Corporation
   1515 Dexter Ave. No, Suite 406
   Seattle, WA 98109

   Attn: Susan K. Kingsbury

2. Aquionios, Inc.
   1072 Kilburn Rd.
   Gurnee, IL 60031

   Attn: Mike Blake

3. Argent Laboratories
   8702-152nd Ave. NE
   Redmond, WA 98052

   Attn: Eliot Lieberman

4. BioProducts, Inc.
   P.O. Box 429
   Warrenton, OR 97146

   Attn: Russ Farmer

5. Christensen Net Works
   230 Bayside Rd.
   Bellingham, WA 98225

   Attn: Scott Christensen

6. Common Sensing, Inc.
   Antelope Rd.
   P.O. Box 208
   Clark Fork, ID 83811-9998

   (208) 266-1541

7. J.L. Eagar, Inc.
   P.O. Box 476
   North Salt Lake, UT 84054

   Attn: Roy Eagar

8. Engineered Products
   P.O. Box 30
   Philomath, OR 97370

   Attn: T.R. Gregg

9. Ideal Horizons
   P.O. Box 1707
   Rutland, VT 05701-1707

10. Industrial Plastics
    740 S. 28th Street
    Washougal, WA 98671

11. Jensorter, Inc.
    20225 Harvest Ln.
    Bend, OR 97701

    Attn: Greg Jensen

12. Magic Valley Heli-ARC & MFG
    198 Freightway Street
    P.O. Box 511
    Twin Falls, ID 83301

    Attn: Louie Owens and
    Linda Owens

13. MariSource a division of
    Flex-a-lite Consolidated
    P.O. Box 9037
    Tacoma, WA 98409

    Attn: Eddy Willingham and
    Rainer Willingham

14. Moore-Clark Co., Inc.
    813 South 2nd Street
    P.O. Box M
    La Conner, WA 98257

    Attn: Scott McKnight

15. Ozone Research and Equipment
    Corp.
    3840 N. 40th Avenue
    Phoenix, AZ 85019

    Attn: Marshall Mallak

16. PCI Ozone and Control
    Systems, Inc.
    1 Fairfield Crescent
    West Caldwell, NJ 07006

    Attn: William Nezgod

List of Vendors at 1991 NWFC (continued)

17. Pisces Computing Ltd.
3025 Penticton Street
Vancouver, B.C. Canada V5M 3C5

Attn: Pat Teti

18. Point Four Systems, Inc.
2702 Clarke Street
Port Moody, B.C. Canada V3H 1Z1

Attn: Robert Barrott

19. P.R.A. Manufacturing Ltd.
Box 774, Station A
Nanaimo, B.C. V9R SMZ

Attn: Wayne Gorrie

20. Protect-A-Cover
12310 HWY 99 @ 124
Everett, WA 98204

Attn: Dennis Frank

21. Purina Mills, Inc.
1125 Paulson Road
Turlock, CA 95380

Attn: Dick Rossow

22. Rangen, Inc.
P.O. Box 706
Buhl, ID 83316

Attn: John Hewitt,
Tim O'Keefe, and
Laurie Fowler

23. Reiff Mfg., Inc.
Rte. 4 Box 183
Walla Walla, WA 99362

Attn: Steve Reiff

24. Silver Cup
P.O. Box 57428
Murray, UT 84157-0428

Attn: Chris Nelson and
Bill Nealiegh

25. Star Valley Trout Ranch
P.O. Box 1266
Afton, WY 83110

Attn: Scott Carlisle

26. VMG Industries, Inc.
88 Grand Avenue
Grand Junction, CO 81501

Attn: Bruce Marshall and
Karen Marshall

27. Zeigler Bros., Inc.
P.O. Box 95
Gardners, PA 17324

Attn: David Wiant

1991

RAFFLE PRIZE CONTRIBUTORS

DOOR PRIZES - 42ND PNWFCC
December 3,4 & 5, 1991

GIFT DONOR	ITEM #	RECIPIENT
LURH-JENSEN & SONS, INC. (Oregon)	# 1 Hook Sharpeners	Gift Package A, B, C & D
MICHAELS OF OREGON CO	# 2 Camo Fanny Pack	Jack Tipping - Washington Dept. of Wildlife
BERKLEY (Iowa)	# 3 12 Pkgs. Power Worms 12 Spls. Fishing Line	Gift Package A, B, C, D, E, F, G, H, I, J, K, & L
LANSKY SHARPENERS (New York)	# 4 Lansky Folding Sharpener	Mark Lewis - Oregon Dept. of Fish and Game
LANSKY SHARPENERS (New York)	# 5 Lansky Sharpening system	Douglas Dysart - U.S.F&W.S. Oregon
GANDER MOUNTAIN (Wisconsin)	# 6 Hunter's Day Pack	Bill Tansley - Oregon Dept. of Fish & Wildlife
COLEMAN OUTDOOR PRODUCTS (Kansas)	# 7 Deluxe Outdoor Cooker/Fryer	Mike Gribble - Oregon Dept. of Fish and Game
CABELAS (Nebraska)	# 8 $25 Gift Certificate	George Nandor - Oregon Dept. of Fish & Wildlife
BUCK KNIVES (El Cajon, CA)	# 9 Buckskin Folding Knife	Terry Jones - Oregon Dept. of Fish and Game
WORDEN'S LURES (Washington)	# 10 2 Doz Rooster Tail	Gift Package A, B, C, D, E, F, G, H, I, J, K & L

WRIGHT & McGILL CO (Colorado)	# 11 Ultra-light Spinning Rod	Trent Stickell - Oregon Dept. of Fish & Wildlife
WRIGHT & McGILL CO (Colorado)	# 12 Polo Shirt	Greg Kollenborn California Fish and Game
WRIGHT & McGILL CO (Colorado)	# 13 Polo Shirt	Dan Barrett - Oregon Dept. of Fish & Wildlife
LEATHERMAN TOOL (Oregon)	# 14 Large Leatherman Tool	Ulf Rasmussen - Washington Dept. of Wildlife
HUNTER'S DEPOT (Rohnert Park)	# 15 Fishing Vest	John Davis - U.S.F&W.S. Washington
HUNTER'S DEPOT (Rohnert Park)	# 16 Fishing Vest	George Bowden - Alaska Dept. of Fish and Game
HUNTER'S DEPOT (Rohnert Park)	# 17 Fishing Vest	Greg Jensen - Jensorter - Oregon
LYLES TACKLE & TRAVEL (Santa Rosa)	# 18 2 plastic Ocean Jigs	Gift Package K & L
OUTDOORSMAN OF LAKE TAHOE	# 19 Ugly Stick Fishing Rod	Leslie Schaeffer Oregon Dept. of Fish & Wildlife
FOOTHILL DISTRIBUTING (Redding)	# 20 Budweiser Cooler	Colinda Gutierrez California Fish and Game
LONGS DRUG STORE (Redding)	# 21 Rod & Reel Combo	Anna Kastner - California Fish and Game

MUELLERS (Red Bluff)	# 22 Seat Covers	William Ogle - California Fish and Game
ENTERPRIZE AUTO PARTS (Redding)	# 23 Auto Booster Cables	Doc McCormack - California Fish and Game
ENERGY MASTERS (Redding)	# 24 Motorcycle Battery Charger	Don Peterson - British Columbia Fisheries
THE FLY SHOP (Redding)	# 25 Fly Fishing Print	Randy Robart - Oregon Dept. of Fish & Wildlife
THE FLY SHOP (Redding)	# 26 Fishing Flies & 4 Bottles Wine	Kimberly True - U.S.F&W.S. Washington
THE BOW RACK (Redding)	# 27 Assorted Hunting Gear	Kathy Stone - U.S.F&W.S Washington
THE BOW RACK (Redding)	# 28 Assorted Hunting Gear	George Allen - Consultant, California
RALEYS (Redding)	# 29 26" Mega Duffle	Alan Meyer - Oregon Dept. of Fish & Wildlife
RALEYS (Redding)	# 30 Igloo Playmate Kooltunes Ice Ch.	Paul McCollum - Valdez Fisheries Development Assn.
RALEYS (Redding)	# 31 Igloo Playmate Kooltunes Ice Ch.	Armando Quinones California Fish and Game

ACE HARDWARE (Redding)	# 32 Mailbox & Case of Wine	Dick Anderson - U.S.F&W.S. Washington
CARL'S TIRE & AUTO (Redding)	# 33 Traction Cables	Jim Adams - California Fish and Game
CROSS PETROLIUM (Redding)	# 34 Chevron Motor Oil	Chuck Hamstreet U.S.F&W.S. Washington
VONS, INC (Mammoth Lakes)	# 35 Coleman Cooler	Rance Reynolds - California Fish and Game
KITTREDGE SPORTS (Mammoth Lakes)	# 36 $25 Gift Certificate	Jim Groh - California Fish and Game
SNOW GOOSE INN (Mammoth Lakes)	# 37 One Night's Lodging	Laird Marshall California Fish and Game
THE TROUT FLY (Mammoth Lakes)	# 38 Sweatshirt	Mel Engelhardt - U.S.F&W.S. Oregon
RICK'S SPORT SHOP (Mammoth Lakes)	# 39 Diawa Rod	James Graybill - Mr. Hood Comm. College, Oregon
VONS FOOD STORE (Bishop)	# 40 Rod & Reel Combo	Sal Pantano - Geothermal Aquaculture - California
TOPAZ LODGE (Gardenerville)	# 41 Rod & Reel Combo	John Kerwin - Washington Dept. of Wildlife
TOPAZ LODGE (Gardenerville)	# 42 2 Doz. Hats.	Gift Package A, B, C, D, E, F, G, H, I, J, K, L, & misc.

PAYLESS DRUG (Bishop)	# 43 10 Worm Cups	Gift Package A, B, C, D, E, F, G, H, I & J
CULVER'S SPORT SHOP (Bishop)	# 44 Knife	Keith Keown - Washington Dept. of Fisheries
STEVE'S AUTOMOTIVE (Bishop)	# 45 Workhorse Lantern	Jim Parsons - Clear Springs Trout, Co. Idaho
THRIFTY DRUG Bishop)	# 46 Rod & Reel Combo & Creel	Jon Yaskovic - Oregon Dept. of Fish & Wildlife
MAHOGANY SMOKED MEATS (Bishop)	# 47 Gift Certificate 1 lb. Smoked Jerky	Ken Hashagen - California Fish and Game
PAYLESS DRUG (Redding)	# 48 Reel	Bob Wakefield - California Fish and Game
PAYLESS DRUG (Redding)	# 49 Explorer Flashlight	Denise McCarver - Washington Dept. of Fisheries
P.R.A. (Exhibitor)	# 50 Belt Feeder	Bill Wingfield - California Fish and Game
CHRISTENSEN NET WORKS (Exhibitor)	# 51 Fishing Vest	Eric Pelton - U.S.F&W.S. California
JENSORTER (Exhibitor)	# 52 Stainless Steel Thermos	Rod Hubley - California Fish and Game

V.M.G. (Exhibitior)	# 53 Audio Disc - Trout Quintet	Steve Arnold - British Columbia Government
STAR VALLEY TROUT FARM (Vendor)	# 54 Mag-Lite flashlight	Chuck Keys - California Fish and Game
P V RANCH & HOME (Modesto)	# 55 Rod & Reel Combo	Jerry Ayers - California Fish and Game
P V RANCH & HOME (Modesto)	# 56 Rod & Reel Combo	Bob Pool - California Fish and Game
HALES & SYMONS (Sonora)	# 57 T.V. Trays (5)	Dawn Kori Bumpass Oregon Dept. of Fish and Wildlife
HERB BAUER SPORTING GOODS (Fresno)	# 58 Copper Cookware	Steve Reiff - Washington
PAYLESS DRUG (Sonora)	# 59 Rod and Reel combo	Randy Welch - California Fish and Game
CAL RICE INDUSTRY ASSO. (Sacramento)	# 60 Rice Gift Box	Gift Package N, O, P & Q
CREEKSIDE SPORTS (Murphys)	# 61 Knife and Sheath Kit	Bill Townsend - Trout Lodge Washington
SONORA AUTO PARTS (Sonora)	# 62 Pocket Tee Shirt	Steve Sanders - California Fish and Game
LAKE DON PEDRO MARINA (La Grange)	# 63 Houseboat Vacation	Derald Walker - Oregon Dept. of Fish & Wildlife

CAMP CITY SURPLUS (Fresno)	# 64 Camp Blanket	Paul Wagner - Pyramid Lake Fisheries, Nevada
CAMP CITY SURPLUS (Fresno)	# 65 Rain Pancho	Rich Schneider - Clear Springs Trout, Co. Idaho
PARKER'S TRUE VALUE (Merced)	# 66 Pizza Pan & 3 Bottles Wine	Jim DeCampos - California Fish and Game
ARDISON CHARTERS (Merced)	# 67 Elkhorn Belt Buckle	B. Shane Scott - Fish Pro, Inc. Washingtion
ARDISON CHARTERS (Merced)	# 68 Moose Horn Belt Buckle	Gary Aitken - Kootenai Tribe of Idaho
GLORYHOLE SPORTS (Angles Camp)	# 69 Fishing Line	Gift Package F
AQUIONICS (Exhibitor)	# 70 $50 Cash	Richard Johnson Muckleshoot Indian Tribe Washington
GUN SPORT (Sonora)	# 71 Fish Hook Sharpener, Hat & 3 Bottles Wine	Dennis Redfern - California Fish and Game
Totem's Sport Shop (Oakdale)	# 72 12 Pkgs Magic Worms	Gift Package A, B, C, D, E, F, G, H, I, J, K & L
Merced Fly Fishing Club	# 73 Fishing Flies and Aluminum Case	Kim Rushton - California Fish and Game

AlCORN'S SPORTING GOODS (Fresno)	# 74 Hunting Vest	Linda Radford - California Fish and Game
GUN SPORT (Sonora)	# 75 Collapsible Water Container	Jim Thacker - Oregon Dept. of Fish & Wildlife
YOSEMITE SHOOTING RANGE AND GUN SHOP	# 76 500 .22 Shells & 3 Bottles Wine	Dan Duran - California Fish and Game
BILL WHITEHOUSE GUN SHOP (Merced)	# 77 12 ga. Shotgun Shells 3 Bottles Wine	Bill Nealeigh - Silver Cup Feeds Oregon
YOSEMITE SHOOTING RANGE AND GUN SHOP	# 78 12 ga. Shotgun Shells 3 Bottles Wine	Wayne Olson - U.S.F&W.S. Idaho
BALLICO FARM AND HOME SUPPLY	# 79 Lunch Tote Cooler	Bob Corn - California Fish and Game
ARGONAUT GUN SHOP (Modesto)	# 80 California Atlases	Jeff Moffat - California Fish and Game
MOORE-CLARK (Exhibitor)	# 81 Filet Knife	Steve Harris - Washington Dept. of Fisheries
MOORE-CLARK (Exhibitor)	# 82 Filet Knife	John Holmes - U.S.F&W.S. Washington
MOORE-CLARK (Exhibitor)	# 83 Eveready Flashlight	Gilbert Banuelos California Fish and Game

MOORE-CLARK (Exhibitor)	# 84 Coleman Lantern	Robert Winfree - U.S.F&W.S. Idaho
MOORE-CLARK (Exhibitor)	# 85 Fishing Vest	Jim Robinson - Oregon Fish and Game
MOORE-CLARK (Exhibitor)	# 86 Coleman Personal Ice Chest	Steve Seymour - Washington Dept. of Fisheries
PAYLESS DRUG (Bishop)	# 87 Plano Magnum 1152	David Rieben - Oregon Fish and Game
MARTINS ROD AND REEL (Kernville)	# 88 Rod Holder, Hat & Wine	Greg Pratschner - U.S.F&W.S. Washington
RIVER KERN GENERAL STORE (Kernville)	# 89 Reel	Penny Booth - California Fish and Game
SIERRA SPORTING GOODS (Kernville)	# 90 Reel	Harvey Andrusak British Columbia Environmental Fisheries
DISCOUNT BAIT AND TACKLE (Wofford Heights)	# 91 Silstar Spinning Rod	Kathy Clemens - U.S.F&W.S. Washington
ZEIGLER BROS, INC. (Exhibitor)	# 92 $100 Gift Certificate	Serge Birk - Trinity River Restoration Pgm. California
ZEIGLER BROS, INC. (Exhibitor)	# 93 Swiss Army Knife	Michael Fallon - Alaska Dept. of Fish and Game
EAGAR, INC. (Exhibitor)	# 94 $25 Gift Certificate	Ross Smith - Utah Division of Wildlife Res.

POINT FOUR SYSTEMS (Exhibitor)	# 95 Cordless Screwdriver	Gary Van Ree - Global Aqua Washington
SILVER CUP (Exhibitor)	# 96 Mens Wrist Watch	George Carnes - Alaska Dept. of Fish and Game
SILVER CUP (Exhibitor)	# 97 Womens Wrist Watch	Carol Montgomery Washington Dept. of Fisheries
BIO PRODUCTS (Exhibitor)	# 98-1 Gerber Folding Knife	Allen Houston - California Fish and Game
BIO PRODUCTS (Exhibitor)	# 98-2 Gerber Folding Knife	Dennis Graf - British Columbia
BIO PRODUCTS (Exhibitor)	# 98-3 Gerber Folding Knife	Bob Anstead - Scanmar - British Columbia
BIO PRODUCTS (Exhibitor)	# 98-4 Gerber Folding Knife	Dave Ickes - California Fish and Game
BIO PRODUCTS (Exhibitor)	# 98-5 Gerber Folding Knife	Al Johnson - California Fish and Game
BIO PRODUCTS (Exhibitor)	# 98-6 Gerber Folding Knife	Tony Curran - Macon Springs Fish Hatchery California
IDEAL HORIZONS (Exhibitor)	# 99 Home or Lab, UV unit	John Rueth - U.S.F&W.S. California
REIFF FIBERGLASS CO (Exhibitor)	#100 Tackle Box	Lenny Larson - CEDC Fisheries Project Oregon

OZONE RESEARCH & EQUIP. (Exhibitor)	#101 $20 Cash	Barbara Simpson - California Fish and Game
THE FLY SHOP (Redding)	#102 Fishing Flies & 4 Bottles Wine	Kevin Ceccato - California Fish and Game
RED LION INN (Redding)	#103 4 Glasses & Wine	Joe Robinson - California Fish and Game
ARGENT CHEMICAL (Exhibitor)	#104 Book - Within a Rainbowed Sea	Judy Harn - California Fish and Game
Argent Chemical (Exhibitor)	#105 Book - Game Fish of North America	William Rainer - Marisource - Washington
ARGENT CHEMICAL (Exhibitor)	#106 Book - Altas of the Oceans	Eileen Siaz - California Fish and Game
P.V. RANCH & HOME SUPPLY (Redding)	#107 Shimano Rod & Reel Combo	Bill Thorson - U.S.F&W.S Washington
DELL WARREN (Exhibitor)	#108 Water Broom, hat & 2 Bottles Wine	Dave Rodgers - Oregon Dept. of Fish & Wildlife
IVY'S AUTO PARTS (Lone Pine)	#109 Hunting Vest	David Wiant - Zeigler Bros. Pennsylvania
TOPAZ LODGE & WINERIES	#110 Hat & 2 Bottles Wine	Larry Harrison - California Fish and Game
TOPAZ LODGE & WINERIES	#111 Hat & 2 Bottles Wine	Clegg Rasmusson Oregon Dept. of Fish & Wildlife

TOPAZ LODGE & WINERIES	#112 Hat & 2 Bottles Wine	Gregory Moody - The Pacific Lumber Co. California
MARISOURCE FLES-A-LITE (Exhibitor)	#113 13" Color Television	Pete Brown - British Columbia Fisheries
RANGEN (Exhibitor)	#114 Remington 700 BDL Rifle - .270 win.	Randy Winters - Oregon Dept. of Fish & Wildlife
TOPAZ LODGE & WINERIES	#115 Hat & 6 Bottles Wine	Patrick Cushman U.S.F&W.S. Washington
TOPAZ LODGE & WINERIES	#116 Hat & 6 Bottles Wine	Steve Robards - Washington Dept. of Wildlife
TOPAZ LODGE & WINERIES	#117 Hat & 6 Bottles Wine	Michael McCloud CTUIR Oregon
TOPAZ LODGE & WINERIES	#118 Hat & 6 Bottles Wine	Jan Ireland - California Fish and Game
TOPAZ LODGE & WINERIES	#119 Hat & 6 Bottles Wine	Tom Symons - California Fish and Game
TOPAZ LODGE & WINERIES	#120 Hat & 6 Bottles Wine	John Rueth - U.S.F&W.S. California
TOPAZ LODGE & WINERIES	#121 Hat & 6 Bottles Wine	Tom Dittentholer Yakima Indian Nation Fisheries Washington
TOPAZ LODGE & WINERIES	#122	Larry Dimmick - Oregon Dept. of Fish & Wildlife

The Following Were Misc Donations Combined Into One Prize, Numbers Designate Doner

1,3,10,42,43,72 & 2 Bottles Wine	# A Gift Package	Victor Shawe - Oregon Dept. of Fish and Game
1,3,10,42,43,72 & 2 Bottles Wine	# B Gift Package	Scott Yoo - California Fish and Game
1,3,10,42,43,72 & 2 Bottles Wine	# C Gift Package	Virgina Phalen - U.S.F&W.S. Idaho
1,3,10,42,43,72 & 2 Bottles Wine	# D Gift Package	Jerry Morinaka - California Fish and Game
3,10,42,43,72 & 2 Bottles Wine	# E Gift Package	Tom Shaw - U.S.F&W.S. California
3,10,42,43,69,72 & 2 Bottles Wine	# F Gift Package	Cindy Lasiter - Alaska Dept. of Fish and Game
3,10,42,43,72 & 2 Bottles Wine	# G Gift Package	Richard Davidson California Fish and Game
3,10,42,43,72 & 2 Bottles Wine	# H Gift Package	Gary Weiss - California Fish and Game
3,10,42,43,72 & 2 Bottles Wine	# I Gift Package	Larry Peterson - U.S.F&W.S. Alaska
3,10,42,43,72 & 2 Bottles Wine	# J Gift Package	George Clark - California Fish and Game

3,10,18,42,72 & 2 Bottles Wine	# K Gift Package	Ken Bourne - Oregon Dept. of Fish & Wildlife
3,10,18,42,69,72 2 Bottles Wine	# L Gift Package	Richard Hazeleur California Fish and Game
RICE GROWERS ASSOCIATION (Sacramento)	# M Rice Gift Box 3 Bottles Wine	Randy Winters - Oregon Dept. of Fish & Wildlife
RICE GROWERS ASSOCIATION (Sacramento)	# N Rice Gift Box 3 Bottles Wine	Dale Fetzner - British Columbia
RICE GROWERS ASSOCIATION (Sacramento)	# O Rice Gift Box 3 Bottles Wine	David Weigard - U.S.F&W.S. California
RICE GROWERS ASSOCIATION (Sacramento)	# P Rice Gift Box 3 Bottles Wine	Mike Evenson - Oregon Dept. of Fish & Wildlife
RICE GROWERS ASSOCIATION (Sacramento)	# Q Rice Gift Box 3 Bottles Wine	Roger Shudes - U.S.F&W.S. California