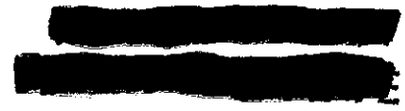
REPORT TO THE 1973 LEGISLATURE

CONCERNING THE ACTIVITIES OF THE

DIVISION OF FISHERIES REHABILITATION,

ENHANCEMENT AND DEVELOPMENT

ALASKA DEPARTMENT OF FISH AND GAME
JAMES W. BROOKS, COMMISSIONER



REPORT
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ABSTRACT

The report consists of four parts plus illustrative material (Chairman's copy only) as follows:

1. A brief description of statutory goals and program definitions;
2. Anadromous fisheries program;
3. Development program;
4. Administration and Support; and
5. Photographs of activities

1. Statutory goals and program definition

After examination of the division's statutory responsibilities (A.S. 16.05.092) an administrative decision was made to direct FRED activities toward non-regulatory programs in the amadromous, estuarine and marine environments. Two broad categories were further delineated for administrative purposes 1) Rehabilitation, maintenance and enhancement in anadromous, marine and estuarine environments and, 2) Development, both technological and economic.

The Division of Commercial and Sport Fisheries assists in establishing priorities for FRED. Initial priorities will be directed toward increasing the supply of salmon, revitalizing the clam fisheries and evaluating the commercial potential of whitefish in the Arctic, Yukon and Kuskokwim areas.

The program also emphasises cooperation with other agencies to use available expertise and to minimize cost.

2. The anadromous fisheries program

The anadromous fisheries program is designed to supplement natural reproduction using the latest appropriate technology always keeping in mind the importance of natural production. Ideally the anadromous program will result in the production of fry equal to optimum carrying capacity of the estuarine coastal and ocean environments.

The anadromous projects are composed of three categories or combinations thereof as follows: 1) Rehabilitation, 2) Maintenance and, 3) Enhancement.

Active and proposed projects are discussed for the southeastern, Central and AYK and Westward Regions.

There is a detailed discussion of the three saltwater rearing experiments. Experiments of this magnitude based largly upon theory are fraught with problems, the current activities are no exception. Survival of fish is one measure of progress. Preliminary data suggests the installation at Sitka has out performed those at Homer or Little Port Walter. An out break of vibriosis caused heavy mortality at Little Port Walter. Mortalities at Homer and to a large extent at Sitka have been caused by problems of salinity adaptation. Some disease related mortalities also occurred.

Salinity related mortality can be effectively reduced in future operation as reliable sources of freshwater are developed. Growth rates were variable with rapid growth of sockeye, particularly at Sitka. Progress has been made in understanding the relationship of salinity and growth. Additional studies will be conducted to evaluate optimum stocking densities and salinity.

Progress repo. s on the feasibility of salmon olt production in estuarine husbandry pens at Little Port Walter and Report of Progress on a pilot study of the feasibility of producing high quality salmon fry from gravel environments are included.

3) Development Program

The division proposed and implemented a comprehensive project designed to revitalize the clam industry on a sound biological basis while assuring the product is safe for human consumption.

Alaska's shellfish sanitation program is in nearly completed format, however changes in the Administrative Code are to be approved or not approved during the 1973 legislative session. If the changes are approved, this will greatly facilitate the realization of Alaska's enrollment into the National Shellfish Sanitation Program which means that fresh and frozen razor clams harvested commercially for human consumption may then be shipped in inter-state commerce to other member states and nations.

The whitefish development project on the lower Kuskokwim River has revealed that both potential domestic and export markets do exist. Evaluation of resource capability must accompany increased use in order to avoid overuse of a resource of considerable importance to the sustenance of local inhabitants.

4) Administration and Support

Administration and support services of the headquarter staff is designed to support the operational programs, to develop cooperative agreements with other agencies, to maintain program direction, and to monitor fisheries science developments on a world-wide basis.

5) Illustrative Materials

(See Resource Chairman's copy)

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REPORT TO THE LEGISLATURE OF THE ACTIVITIES OF THE DIVISION OF FISHERIES REHABILITATION, ENHANCEMENT AND DEVELOPMENT

The purpose of this report is to bring the Legislature up to date on the progress of the Division of Fisheries Rehabilitation, Enhancement and Development (Acronym FRED) as prescribed by A.S. 16.05.092. The first report submitted last year dealt mainly with the establishment of responsibilities, initial plan for coordination and staffing, and the initiation of certain projects. This report will deal mainly with the activities of the division after the formulative stage and will cover the following topics.

1. Brief description of the statutory goals of the division and subsequent program categories.
2. Resumé of objectives, methods, staffing, status of active projects, and proposed projects, within the Anadromous Program Category.
3. Resumé of objectives, methods, and accomplishments within the Development Category.
4. Staffing and objectives of the Administration and Support Program Category.
5. Photographic appendix associated with certain active and proposed projects.

STATUTORY GOALS OF FRED AND PROGRAM CATEGORIZATION

The division has the statutory responsibility (A.S. 16.05.092) to: (1) develop and continually maintain a comprehensive, co-ordinated state plan for the orderly present and long-range rehabilitation, enhancement, and development of all aspects

of the State's fisheries for the perpetual use, benefit and enjoyment of all citizens, (2) revise and update this plan annually, (3) encourage the investment by private enterprise in the technological development and economic utilization of the fisheries resources, and (4) through rehabilitation, enhancement and development programs do all things necessary to insure perpetual and increasing production and use of the food resources of Alaska waters and continental shelf areas.

Close examination of these responsibilities led us to the following conclusions:

1. That the division (FRED) would undertake those programs that were not regulatory in nature (responsibility of the Commercial and Sport Fisheries Divisions)and fell into the anadromous, estuarine and marine categories. The Sport Fish division would continue to initiate inland programs of rehabilitation and enhancement (primarily trout). This concept was discussed in detail in last year's report.
2. That the basic program categories for administrative planning, budgeting and implementation purposes should be:
   a) Rehabilitation, maintenance and enhancement
      (1) anadromous
      (2) marine and estuarine
   b) Development
      (1) technological
      (2) economic
   c) Administration and Support for (a) and (b)
3. That within these categories, program accent would dovetail with the needs of the species and people statewide, and by geographic location.
4. That the Commercial and Sport Fisheries divisions being the managerial divisions would identify for FRED the needs of the species and the people

and recommend on a priority basis the direction FRED should follow in order to meet these needs. Subsequently, the managerial divisions requested that FRED's efforts should be initially directed towards:

a) Increasing the supply of salmon (hence the concentration of dollars in the anadromous category)

b) Revitalizing the clam fisheries of Alaska by removing institutional barriers (relative to paralytic shellfish poisoning) and determining harvest potentials (hence the clam program in the development category)

c) Determining the potential harvest of whitefish populations thus attracting investment in this industry that might trigger a new source of income for the people in the Arctic, Yukon and Kuskokwim areas. (hence the initial whitefish investigations based in Bethel in the development category)

5. That the administration and support program would focus on: (besides traditional supervision, clerical support, etc)

a) Developing cooperative programs with other agencies with similar objectives. This approach would allow the state to draw on high quality talent and prevent non desirable duplication of efforts with a minimum expenditure of General Fund Dollars.

b) Keeping abreast of new techniques throughout the world (private and public owned) for possible application in Alaska.

c) Provide specialist service to the operational programs.

FISCAL 72 EXPENDITURES BY PROJECT AND LINE ITEM

ANADROMOUS	100	200	300	400	500	900	TOTAL
S.E. STREAM IMPROVEMENT	43,925	1,847	26,914	9,542	4,940	49	87,217
S.E. SALTWATER REARING	6,277	1,370	70,525	16,650	13,010	286	108,118
S.E. INCUBATION	5,923	24	203	13,284	17,707	4	37,145
S.C. SALTWATER REARING	5,621	3,841	44,394	10,822	2,718	3,578	70,974
WESTWARD INCUBATION	-0-	246	-0-	7,304	-0-	-0-	7,550
WESTWARD LAKE REHAB.	39,494	2,498	4,621	6,238	12,103	-0-	64,954
TOTAL ANADROMOUS:	101,240	9,826	146,657	63,840	50,478	3,917	375,958

ADMINISTRATION & SUPPORT	100	200	300	400	00	900	TOTAL
TOTAL ADMIN & SUP.	24,363	2,603	1,995	215	1,866	8	41,050
			VESSEL CHARTER			40,000	40,000

	100	200	300	400	500	900	TOTAL
TOTAL DIVISION	135,603	12,429	148,652	64,055	52,344	43,925	457,008

Note... The Development program was incorporated in the Divisions budget in FY 73

ANADROMOUS PROGRAM

ANADROMOUS PROGRAM

General Comments and Objectives

Alaska is blessed with a tremendous potential for increasing salmon production beyond historical levels of the past. However, as this division applies modern technology to increase production, whether it be incubation systems, supplemental rearing systems, or some other means, we must not forget the extremely valuable presently producing natural environment. We must develop a balanced program with the major emphasis remaining on regulation of our natural stocks for maximum sustained yield. We cannot, even if the technology were available, replace natural production with supplemental systems unless we are prepared to spend 2 Billion dollars. However, natural production may be augmented or improved by judiciously selecting those systems or projects that will return more dollars than expended.

The long range objective of the anadromous program (regulatory and non-regulatory) is to produce the average number of fry and smolts in a compatible manner that does not exceed the average carrying capacity of the estuarine, coastal and ocean pastures. In order to achieve this objective for the public owned salmon resource the following must be considered:

1. Allowance for the tremendous fry and smolt production capabilities of the presently producing environment whose output is controlled by regulation (governmental and environmental)
2. Realization that our presently producing spawning and rearing environments are part of an evolving, dynamic system that because of change can trigger decreases in production. Maintenance of this system is of paramount importance in the biological as well as the physical sense.
3. Take into account that extensive un-utilized spawning, and rearing areas exist that will not produce unless they are "opened" up by a program of fish ladder construction, supplemental production systems, etc.
4. Realization that the harvest of fish from efficient supplemental production systems must not trigger over-harvest or genetical decline of natural

stocks. Selection of supplemental system sites must be carefully considered.

5. Realize that private salmon culture systems may play a role in the future and make allowance for this development in a manner that will not cause a decline in the natural stocks or allow harvest of the public owned resource by private fish farmers.
6. Maintenance of the genetical integrity of natural stocks.
7. Allowance for a stringent disease control program for all projects - public or private.

ANADROMOUS PROJECT CATEGORIES

There are three basic non-regulatory project categories or combinations of the three, that may be employed by this division to achieve the principle objective:

1. Rehabilitation - to restore to previous historic harvest levels, those systems that have become dehabilitated because of "imbalanced" predator-competitor populations, lowered productivity levels, and destroyed or altered spawning environments. Rehabilitation of those systems that regulation alone cannot restore to previous production levels.
2. Maintenance, to maintain present harvest potentials by preventing the alteration of existing spawning and rearing areas by natural or man-made phenomena.
3. Enhancement, to increase present harvest potentials by bringing into production previously un-utilized spawning and rearing areas. These could be natural or man-made.

ANADROMOUS STAFF

The Division's Anadromous Program is carried out by three regional teams - Southeastern, Central-AYK and Westward. These teams who are responsible for planning, design, implementation, maintenance and evaluation, are distributed as follows:

Southeastern (Includes Yakutat)

Regional Biologist IV (Requested FY 74 - Juneau)

Regional Engineer (Juneau)

Fisheries Technician III (Ketchikan)

Fisheries Technician IV (Juneau)

Fisheries Technician IV (Sitka)

Fisheries Technician III (Requested FY 74 - Sitka)

Numerous Temporaries

Central and AYK Regions
(Cook Inlet, Bristol Bay, Prince William Sound, Arctic-Yukon-Kuskokwim)

Regional Biologist IV (Anchorage)

Regional Engineer (Anchorage - serves Westward also)

Assistant Engineer (Anchorage - serves Westward also)

Fisheries Technician III (Anchorage)

Fisheries Technician IV (Tutka Bay)

Fisheries Technician III (Requested FY 74 - Tutka)

Numerous Temporaries.

Westward (Kodiak, Chignik, Alaska Peninsula, Aleutians)

Regional Biologist IV (Kodiak)

Engineering Assistance obtained from Anchorage

Fisheries Biologist II (Kodiak)

Fisheries Technician III (Kitoi Bay)

Numerous Temporaries.

We anticipate as the anadromous program expands that the greatest staff expansion will take place in the Fisheries Technician category and this will be a function of the number of facilities that have to be maintained year round. Fisheries technicians in each of the regions are or will be also actively engaged in supervising habitat maintenance and improvement crews.

SUMMARY OF ACTIVE AND PROPOSED
ANADRAMOUS PROJECTS

FISCAL YEARS 1973 & 1974

SOUTHEASTERN REGION (INCLUDES YAKUTAT)

LOCATION	TYPE PROJECT	ACCOMPLISHMENTS FY 73	STATUS FY 74	NEW PROJECT PROPOSAL
Throughout	Stream Improvement	26 streams	Continue	
Throughout	Stream Improvement (Heavy Equipment)	Plan	Activate	Request funds $30,000
5 Locations	Fish ladder const.	Design of 5	Construct 3	
nan Creek	Fish ladder const.	Design	Activate	Request funds - $149,00
Auke Bay	Incubation	Second test	Third test	
Starrigavin	Saltwater Rearing	First test	Expanded - full field test	
Little Port Walter	Saltwater Rearing	First test	Alter design - test same capacity	
Borodino Lake	Lake Rehab.	Planning	Activate	Request funds - $124,400 first phase
Klawock Lake	Stream Improvement	--	Investigate	
Redoubt Lake	?	--	Investigate	
3 Locations	Fish ladders	--	Investigate	

CENTRAL AND A.Y.K. REGIONS

(BRISTOL BAY, COOK INLET, PRINCE WILLIAM SOUND, AYK)

LOCATION	TYPE PROJECT	ACCOMPLISHMENTS FY 73	STATUS FY 74	NEW PROJECT PROPOSALS
Packers Lake	Lake Rehab	Design	Construct and Implement	
Lower Jean Lake	Lake Rehab	Design	Construct and Implement	
..esire Lake	Lake Rehab	Divert Funds to Saltwater Rearing		
Delight Lake	Lake Rehab	Divert Funds to Saltwater Rearing		
Tutka Bay	Saltwater Rearing	Construct and first test	Expanded for full test	Request funds - $25,000
Cook Inlet Plan	Engineering and Hydro. Surveys	3 systems surveyed	Continue	
Control Creek	Fish ladder	Design	Construct	
Russian River	Fish ladder	Design	Construct	
Cook Inlet	Stream Improvement	Plan	Activate	Request Funds - $9,000
..ake and Mother Goose	Incubation and Freshwater Rearing	Plan	Activate	Request Funds - $600,000
Ugashik-Becharof	Freshwater rearing Encubation	Plan	Initial investigations	

CENTRAL AND A.Y.K. REGIONS (Continued)

LOCATION	TYPE PROJECT	ACCOMPLISHMENTS FY 73	STATUS FY 74	NEW PROJECT PROPOSALS
Salmon Lake (Seward Peninsula)	Lake Rehab	--	Initial Investigations	
Big Lake	Incubation	Initial Investigation	Plan	
Hidden Lake	Incubation	Initial Investigation	Plan	
China Poot	Incubation and Rearing	--	Initial Investigations	
Prince William Sound	Chum Incubation	Investigation	Continue Investigation	

WESTWARD REGION (KODIAK, PENINSULA ALEUTIANS)

LOCATION	TYPE PROJECT	ACCOMPLISHMENTS FY 73	STATUS FY 74	NEW PROJECT PROPOSAL
Kitoi Bay	Incubation	First test	Second test	
Kitoi Bay	Freshwater Rearing	First test	Second test	
Akalura Lake	Lake Rehab	Design and Impact Statement	Second Phase	Request Funds - $150,000
ızer Lake	Establishment - new sockeye run	Altered Intake	Continue	
Buskin River	Stream Improvement	Plan	Activate	Request Funds - $1,000
Dutch Harbor	Stream Improvement	Plan	Activate	Request Funds - $18,000
Apollo Creek	Fish ladder	Investigation	Design	Request Funds - $56,000
Middle Creek	Fish ladder	Investigation	Design	Request Funds - $81,000
Paul's Lake	Fish ladder	Design	Construct	
Karluk Lake	Incubation Competitor Control	Investigate	Plan	Request Funds - $25,000

ANADROMOUS

SOUTHEASTERN ALASKA REGION

DISCUSSION OF POTENTIALS, ACTIVE AND PROPOSED

PROJECTS

BACKGROUND

S.E. Alaska is noted for its abundance of lake and stream systems. Many of the lakes are blocked to anadromous fish by barrier falls. Pink salmon is the predominant species of salmon occurring in this region followed by chums, reds, cohos and kings. In 1941, the record catch of 3,631,491 cases of pinks was taken in S.E. Alaska. During 1936, in which the all time record pack of 8,454,908 cases for Alaska was set, 4,121,908 cases were packed in S.E. Alaska, of which nearly 3 million (2,959,774) cases were pinks.

REGION POTENTIAL

Although S.E. Alaska is currently capable of producing large numbers of salmon from existing streams and lake systems, there exists a wide range in potential for increasing and improving spawning and rearing areas for salmonids. Among the methods which can be used to accomplish this are installation of fish passes at falls which impede or prevent passage of anadromous fish to spawning and rearing areas, removal of logs and debris which retard or prevent salmon and trout passage, chemical treatment of lake systems to remove undesirable species which inhibit production of salmonids, artificial propagation to bolster existing runs or create new ones and planting of lake systems on an annual basis for use as natural rearing areas - lakes which are inaccessible to salmonids due to high barrier falls which are not economically feasible to ladder.

Coho and sockeye salmon offer a great potential for stocking of lake systems which currently do not support anadromous runs of salmon as they are particularly adapted to this type of environment.

Successful introduction of king salmon in streams where they are not currently present is a distinct possibility, utilizing fish that spawn in clear water tributaries of the Stikine and Unuk Rivers close to the intertidal zone which should adapt well in other mainland streams. This would be a long term project involving limited egg takes

compatible with the relatively small stocks utilizing these streams.

The objective in this case would be to establish a brood stock resulting from rearing the fry to smolt size (seaward migrants) thus producing a run of sufficient size to provide eggs for artificial propagation, rearing of fry or smolts, and establishing new runs in suitable locations.

SUPPLEMENTAL PRODUCTION

Supplemental production utilizing gravel incubation facilities holds a great deal of promise for enhancing pink salmon production. A pilot project located at Auke Bay is currently being conducted by the National Marine Fisheries Service and the Alaska Department of Fish and Game on land owned by the Territorial Sportsmen, Inc. This facility has the capability of producing at least one million fry annually.

In a laboratory test, cubic foot boxes seeded with 10,000 eggs per box produced 8,500 viable pink fry per box. This is a 5-to-10 fold increase in what would be expected in the natural environment.

Fry production in 1972 from gravel incubators utilizing only one-fifth of the potential egg deposition of the Auke Creek pink salmon escapement was roughly equal to natural production utilizing four-fifths of the potential egg deposition.

ANAN CREEK PROJECT PROPOSAL

New projects for FY 74 include the proposed installation of a permanent, all water stage fishway, which will adequately pass the required pink salmon escapement to the Anan Creek system. The existing structure is rapidly deteriorating and failed to handle the fish properly during the sustained high water flows last season resulting from runoff of the extremely heavy snowpacks.

Anan Creek, in Bradfield Canal near Wrangell, is a major contributor to the pink salmon harvest in S.E. Alaska and is renowned for its usual stable and high production. In 1931, over 600,000 pinks (613,604) were counted through the weir operated by the U.S. Fish and Wildlife Service.

A substantial loss of spawners due to adverse water flow conditions results in serious economic repercussions to the fishermen in the following cycle year.

Construction of the fishway would begin in 1973 with completion in 1974. Cost of the installation is expected to be $149,000.

ANAN CREEK FISHWAY BENEFIT COST ANALYSIS:

Desired escapement above block - 250,000 fish

Potential egg deposition - 1,500 eggs per female

Probability of high water velocity block - once in four years - or 0.25

Estimated fish loss (failure to negotiate block) if high water occurs -

$$\frac{150,000}{250,000} = 60\%$$

Annual average loss therefore - (0.60)(0.25)(250,000) = 37,500 fish

Lost egg deposition - (37,500)(1,500) = 5.62×10^7 eggs

Given 10% over-winter survival - $(5.62 \times 10^7)(0.10) = 5.62 \times 10^6$ emergent fry

Given 2% open ocean survival - $(5.62 \times 10^6)(0.02) = 1.124 \times 10^5$ returning adults

Assume 25¢/lb. value, average weight 3 lb/fish - $(1.124 \times 10^5)(0.25)(3)$ +

$84,500 annual loss

Assume annual maintenance at $10,000 - $84,500 less $10,000 = $74,500

Capitalized value given 20 year life and 6% interest - (74,500)(11,470) = $853,000

Cost of fishway construction - $149,000

$B/C = \frac{853,000}{149,000} = 5.7$

BARANOF ISLAND PROJECT PROPOSAL

A cooperative project with the National Marine Fisheries Service and the USFS is proposed to enhance production of coho and/or sockeye salmon in two major lake systems (total surface acres 687) and 3 minor lake systems (total surface acres 53) located on the south end of Baranof Island. The NMFS field station at Little Port Walter will serve as a base of operations with a major input from their scientific staff. Cost of treating Borodino and Osprey lakes with rotenone to remove undesirable fish species is budgeted at $124,000 for FY 74 ($104,000 rotenone, $20,000 support costs).

Preliminary studies to develop new nursery areas for coho salmon fry was begun in 1969 by the NMFS when 12,000 fry from Sashin Creek (surplus to the rearing capacity of the stream) were stocked in Tranquil Lake (nearly 4 surface acres) near Little Port Walter. This lake previously supported no fish life. Overall survival from the fry migrating in 1970 and 1971 was 57%, much greater than that of the natural environment of Sashin Creek. An additional system also devoid of fish life, Ludvig Lake (surface acres-41) was stocked with 102,000 coho fry in June 1972 and Tranquil Lake was restocked at the same time with 10,000 fry. The coho fry exhibited good growth in both Ludvig and Tranquil Lakes in the summer of 1972, and a substantial outmigration of smolts is expected in the spring of 1973.

PORT WALTER PROJECT BENEFIT COST ANALYSIS

Rearing potential of Lakes involved in project - 740 surface acres

Fry for stocking (2,000 per surface acres) - 1,480,000

Assume 50% survival to smolt stage - 740,000

Assume 320,000 smolt leave system each spring

Assume 10% ocean survival to the adult stage - 32,000

Assume 1 to 1 sex ratio and 3,000 eggs per female - 740 females & 740 males to trigger system annually

Surplus for harvest - 32,000 - 1,480 = 30,520

Assume $3.50 value for coho = $106,820 annually to fishermen

Initial costs for program 124,000 + 20,000 (NMFS) = $100,000

*Assume operational costs $20,000 for next 5 years of return = $100,000

Total cost to trigger 5 years of return = $220,000

Value of 5 years of harvest = $534,100

$B/C = \frac{534,000}{220,000} = 2.4$ After system is established annual B/C would be

$$\frac{106,000}{20,000} = 5.3$$

* National Marine Fisheries Service will be contributing scientific talent at a cost of approximately $50,000 a year for detailed scientific monitoring (5 year period).

This type of endeavor appears to hold great promise for increasing the production of both coho and sockeye salmon in similar lake systems located throughout S.E. Alaska.

HEAVY EQUIPMENT RENTAL

Rental of heavy equipment for use in removing large log jams in southeast was requested for FY 74 where the use of light equipment, chainsaws, and winches, is not feasible. Rechanneling of some streams may be necessary where the main flow has been diverted by the presence of large log jams. $30,000 has been requested for this operation. The objectives of this program is to provide access for the salmon to spawning areas and to recover areas covered with logs and debris.

STREAM PROJECTS 1972

During the calendar year 1972, 26 streams were improved by removal of logs, debris and beaver dams to permit access of salmon to spawning areas and to recover spawning area rendered unusable by the presence of logs, limbs, etc. This program was funded by FRED and administered by the Division of Commercial Fisheries. Much of the material removed was wind-thrown trees resulting from the severe storm occurring on Thanksgiving Day of 1968.

In the Ketchikan-Craig area, work was accomplished on four streams, begining on April 24 and ending June 25. Over half of the total work was spent on one of these streams. The Lewis chain saw winch was the primary piece of equipment used to remove wind-throw and proved to be capable of removing surprisingly large logs with mininum disturbance to the stream bottom and banks. Stream clearance projects are as follows:

1. Location - North Shore of Soda Bay, west coast of Prince of Wales Island. One-half mile of streambed was cleared of windfall and other debris. This allowed a total of 1 mile of stream to be readily accessible to anadromous fish. Three beaver dams, partial blocks to salmon, where removed by hand. Draining of pools and removal of debris opened up an estimated additional 32,000 square feet of spawning gravel for pink, chum, and coho salmon. Total cost of this project was $9,360 including salaries, vessel charter, supplies and commodities. It is apparent that the use of heavy equipment at this site would have been more economical considering the time interval, May 13 through June 15 and total cost.

2. Location - Head of Ham Cove, Dall Island

A beaver dam ninety feet in length approximately 1/4 mile above tidewater was a major block to salmon passage. Work began on April 25 and was completed on April 27. Removal procedure was simple, a grapple hook is pulled through the dam using a chainsaw winch. 75,000 square feet of spawning gravel was made accessible to salmon plus an additional 1,000 square feet previously flooded. Total cost of this project was $1,750.

3. Location - North shore of Port St. Nicholas, about 1-1/2 miles west from the head of the bay.

Both sides of the stream had been logged for approximately 1/3 mile about 15 or 20 years ago. Log and debris jams were numerous in this area and channel changing had occurred as a result of these jams. Some of the debris in the stream was a result of logging and some from a slide located on an upstream tributary. A channel change in an area where an eroding clay bank was introducing silt into the stream was required. The channel diversion was successfully completed by construction of a wing dam with a log and rocks.

All partial barriers to salmon were eliminated over the first 1/3 mile of the stream. Foot surveys during the summer showed that the channel diversion was working successfully and on the last inspection, 1,750 chum salmon and 425 pink salmon were observed spawning in the project area.

On site work began April 28 and the project was completed on May 11. Total cost of the project was $4,340.

4. Location - West side of Johnson Cove, Moira Sound

This stream (Johnson Creek) with 1-1/2 miles of spawning area between tidewater and the lake had a potential barrier to anadromous fish composed of a large log jam and windthrow area several hundered feet above tidewater.

The log jam and windthrow was removed thus making the 1-1/2 miles of stream bed more accessible to pinks, chums, sockeye, coho and steelhead. Approximately 16,000 square feet of spawning gravel was recovered by removal of the wind-throws.

Work started on June 19 and was completed June 25th. Total cost of the project was $2,160. On the last ground inspection of this stream, which covered the first quarter mile, 1,375 pinks, 650 chums and 1,800 carcasses were counted. The number of carcasses indicated that the peak of spawning had occurred quite sometime earlier.

In the Petersburg-Wrangell area, 10 streams were worked on as follows:

1. Location - S.E. corner of Hole-in-the-Wall Bay on northern Prince of Wales Island.

This stream is accessible to salmon for 1 mile. It is utilized by pinks, chum and coho salmon with a five year average (1968-1972) peak escapement of 4,550 pinks.

An old log jam just above the intertidal area which was catching debris, covering spawning gravel and changing the stream bed was removed along with the tops of two windfalls which were covering excellent spawning gravel. The recovered area totaled 540 square feet. 325 pinks and 13 chums were observed using the area cleared by the log jam removal during the peak surveys of 1972.

2. Calder Creek

Location - Head of Calder Bay in Shakan Bay on the northern portion of Prince of Wales Island. The stream has 2 forks that join at the upper limit of the intertidal area and is accessible to anadromous fish for approximately 1 mile. The five year peak escapement (1968-1972) average is 35,700 pink salmon and 310 chum salmon. Coho salmon utilize this stream with the highest escapement of 1000 recorded in 1950.

Work required was removal of a log entanglement in the intertidal area plus windfall timber in the first 800 feet of both forks.

The trees creating the intertidal entanglement were limbed. The peak survey on Sept. 9, 1972, revealed 390 pinks and 7 chums in the cleared area of the east fork and 257 pinks and 21 chums were utilizing the cleared area in the west fork. Accessibility of anadromous fish to the upstream areas of both forks was improved by the stream clearance.

3. Streets Lake.

Location: West side of Etolin Island

Runs of up to 20,000 pinks have previously been recorded and it is also utilized by chums plus coho and sockeye which migrate to the lake. Recent wind-thrown timber resulted in log entanglements intermittently throughout the entire length of the stream. Some logs and debris left in the stream from previous logging added to the problem of hindering migrating fish and covering spawning area.

The stream was cleared of all major logs,branches and debris to a distance of 950 feet upstream. 3,000 square feet of spawning area for pinks and chums was recovered and migration of all species thru this lower area has been improved.

4. Whale Pass Creek

Location - Northeast corner of Prince of Wales Island.

Weir counts over the past five years (1967-1971) resulted in an average escapement of 46,500 pinks, 375 chums and 1,565 cohos. It is also a good sportfishing stream with runs of steelhead and cutthroat trout..

A windfall with a new beaver dam completely blocked upstream migration of salmon and steelhead. About 25 feet of the log and dam were removed, opening up one half mile of the stream for pink salmon spawning and providing access for coho and steelhead to the two lakes. During the peak survey, 1,500 pink salmon were above the former barrier.

5. Ohmer's Creek

Location - 22 miles south of Petersburg.

This project consisted of removal of wind-blown trees and debris as a training session for stream clearance project leaders and crew members. In two days 2,600 square feet were cleared. This stream has 1.5 miles of potential spawning area and is utilized by pink, chum, and coho salmon.

6. Location - At the head of Port Camden on Kuiu Island.

This stream has a great potential for production of fall run chums but beaver dams have presented a continuous problem for the past 13 years. Trapping efforts in this area during the 1971-72 season were fruitless and the beaver may no longer be present.

Portions of seven beaver dams and over a dozen trees were removed exposing approximately 6,800 square feet of spawning gravel.

7. Location - At the head of Security Bay on the north end of Kuiu Island.

This stream is primarily a fall chum salmon producer with a small run of pinks and a few coho. Peak counts have averaged 8,800 chums from 1968 to 1972. Depending upon escapements, it has supported both an extensive subsistence fishery and a fall purse seine fishery.

An old beaver dam and a number of windfalls were removed in the lower 1,500 feet of this stream. In addition, many more trees were limbed in this area to prevent debris accumulation. 1,250 square feet of spawning gravel was cleared. A ground survey in October disclosed that utilization of the gravel was over 90% at the previous site of the old beaver dam with 170 chums spawning there. Other clearance locations added only a small portion of the total gravel cleared and correspondingly fewer fish were utilizing these.

8. Location - At the southern terminus of inner Piller Bay on the west coast of Kuiu Island.

This stream has its origin in Kutlaku Lake and supports a good run of pink salmon. Sockeye, chum, coho, and cutthroat trout also utilize this system.

Wind-thrown logs near the lake outlet were removed clearing about 450 square feet of spawning gravel and making the riffles above the wind-thrown area more suitable for salmon use by increasing the water velocity.

9. Glenn Creek.

Location - At the head of the southeast arm of Port Houghton, eastern Stephens

The upper half of the intertidal area and the first .7 miles of the stream is the primary spawning area. The five year average escapement (1968-72) for this stream is 31,360 pinks and 2,770 chums. Major log jams of trees, branches, stumps and debris occupied 512 feet of the stream. This area was cleared of all major logs and debris. A helicopter was used on this project to determine the feasibility of lifting logs from the stream. It proved very successful when organized properly, resulting in considerable less damage to the stream bed than that caused by dragging them through the stream. During the peak of the run on August 15, 1972, 5,950 square feet of the cleared area was being utilized by 1,725 pinks and 131 chums. Some additional debris had washed out and some of the previously deposited silt had been removed by normal flushing action of the stream.

10. Sandborn Canal Creek.

Location - At the head of Sandborn Canal in Port Houghton. It has a gentle gradient for 3 miles with excellent spawning gravel plus .2 miles of intertidal area used heavily by pink and chum slamon. The five year average escapement (1968-72) for this stream is 91,200 pinks and 16,300 chums. The removal of logs and debris resulted in recovery of 5,800 square feet of spawning gravel and improved access of spawners to the area upstream.

In the Sitka area, seven streams which had previously been logged were cleared as follows:

1. Location - Katlian Bay, Baranof Island, South Fork.

Spawning in this stream occurs primarily in the intertidal zone which covers an extensive area on the tide flats. A high of 50,000 pinks and chum escapement occurred in 1969.

Stream clearance work was concentrated in the intertidal zone and 1/4 mile upstream. An estimated 2,000 square feet of spawning gravel was recovered.

2. Katlian River

Location - Baranof Island, Katlian Bay north of Sitka.

The clearance work, removing logs and debris, was concentrated in the lower part of the stream for about 1/4 mile above the intertidal zone where most of the spawning takes place. Runs of up to 27,000 have occurred here in recent years.

1,000 square feet of spawning gravel was recovered.

3. Noxon Creek

Location - Baranof Island.

Clearance work was concentrated in the intertidal zone and one quarter mile upstream and consisted of removing logging debris, logs, leaning trees and roots. 2,000 square feet of spawning gravel was recovered. In recent years spawning stocks of up to 60,000 pink and chum salmon have used this stream, mostly the intertidal and lower area.

4. Location - Fish Bay, center of head, Northwest shore of Baranof Island.

This river is one of the most important salmon producing streams in the Sitka area with escapements of 100,000 pinks and chums observed in recent years. An estimated 11,000 square feet of spawning area was recovered by removal of debris and larger material.

Channel diversion was averted by clearing of the obstructions.

5. Rodman River

Location - Rodman Bay, Baranof Island.

Escapements of 75,000 spawners, usually 90% pinks and 10% chums, have been recorded in this system in recent years. It is also one of the major salmon streams in the Sitka area.

1,500 square feet of spawning area was recovered. High water conditions precluded further work on these streams.

6. Location - Appleton Cove, east of Rodman Bay.

In recent years, a high escapement of 17,000 pinks (90%) and chums (10%) have been recorded in this stream.

Clearance work was done just above the intertidal zone where several trees, stumps and debris blocked the stream channel.

1,000 square feet of spawning area was recovered and upstream access of fish accomplished.

7. Saook River

Location - Saook Bay, north shore of Baranof Island.

Pinks and chum salmon escapements of over 50,000 have been noted in recent years with most of the spawning occurring in the intertidal zone.

Clearance work was concentrated in this zone for a short distance upstream. An estimated 3,500 square feet of spawning gravel was recovered by removal of the obstructions.

High water conditions prevented further work on this system.

In the Juneau area stream clearance was performed on 5 streams as follows:

1. Basket Bay Stream

Location - East shore of Chicagof Island.

This excellent spawning stream flows underground for short distances at 2 locations. If debris clogs the underground passage, barriers result for anadromous fish.

Wind-throw removal from the stream above the first cavern recovered approximately 700 square feet of gravel and precluded blocking of the underground passage. High water halted work at this point.

2. Location - Wachusett Cove, Northeast shore of Chichagof Island.

Intensive windthrow existed at this stream, much of which was removed and the larger windfalls limbed to prevent debris accumulation.

Approximately 1,100 feet of spawning gravel was recovered.

3. Location - Pleasant Bay, east shore of Admiralty Island.

A large windfall resting over spawning gravel caused the stream to shift around and island on the left bank. Removal of the tree reclaimed approximately 400 square feet of gravel. 2,000 pink salmon were observed spawning in the riffle that was cleared.

4. Tenakee Creek

Location - Northeast shore of Chichagof Island.

Following clear cut logging, four trees bordering the stream were windthrown into it. Approximately 1,450 square feet of spawning gravel was reclaimed upon removal of the trees and debris. A complete barrier to upstream migration was removed at the upstream terminus of the logging activity opening approximately 1 mile of stream to coho spawning and rearing.

5. Location - Mile 39 Haines Road

Logging debris from a 5 year old site had completely choked this stream. The stream had a series of debris barriers resulting in 400' being unavailable for spawning. Silt in most pools was a foot deep and fish migration through this area was not possible. After debris removal, the water velocity increased thus washing out the silt and approximately 5,500 square feet of spawning gravel was recovered. In years past, this stream was noted for coho spawning.

BENEFITS ACCRUED FROM STREAM CLEARANCE

A total of $87,216 was spent for stream clearance in S.E. Alaska during the period April 17, to June 30, 1972.

As this was the first time stream clearance work was conducted on a large number of streams in S.E. Alaska, much was learned about improving the methods employed and how to improve planning to achieve the greatest benefit from the dollars spent.

The ultimate benefits resulting from this work will be evident only by assessing the increase of returning spawners over a period of years to the various streams.

Lacking such information, an immediate means to estimate results can be obtained by assuming that gravel reclaimed will be used by salmon and compute the benefit cost analysis accordingly. Sheridan (1969) uses 0.275 as the constant for calculation of harvestable surplus from natural production of pink salmon. Using this constant, and the Sitka area as an example, the following table can be constructed for pink salmon production in 1974.

Stream	Gravel S/F Recovered	Surplus Production	Cost
South Fork-Katlian	2,000	550	3,097.
Katlian River	1,000	275	2,212.
Noxon Creek	2,000	550	4,424.
Fish Bay	11,000	3,025	7,962.
Rodman River	1,500	412	3,097.
Appleton Cove	1,000	275	1,769.
Saook River	3,500	963	3,539.
	TOTAL	6,050	26,100.

The total dollar benefit for the seven streams is $3,025.00 per year using an average pink salmon price of $0.50 each. Calculation of the benefit/cost ratio follows:

YEAR	COST	DISCOUNTED COST	BENEFIT	DISCOUNTED BENEFIT
0	$26,100.	$26,100.	0	0
1	00.	00.	0	0
2	00.	00.	$3,025.	$3,025.00
3	00.	00.	3,025.	2,874.00
4	00.	00.	3,025.	2,730.00
5	00.	00.	3,025.	2,594.00
6	00.	00.	3,025.	2,464.00
7	00.	00.	3,025.	2,341.00
8	00.	00.	3,025.	2,224.00
9	00.	00.	3,025.	2,112.00
10	00.	00.	3,025.	2,007.00
11	00.	00.	3,025.	1,907.00
12	00.	00.	3,025.	1,811.00
13	00.	00.	3,025.	1,721.00
14	00.	00.	3,025.	1,635.00
15	00.	00.	3,025.	1,553.00
16	00.	00.	3,025.	1,475.00
17	00.	00.	3,025.	1,401.00
18	00.	00.	3,025.	1,331.00
19	00.	00.	3,025.	1,265.00
20	00.	00.	3,025.	1,202.00
Totals	$26,100.	$26,100.	$57,475.	$37,670.00

$$B/C = \frac{37,670}{26,100.} = 1.4434$$

Benefit cost ratios for other clearance projects varied greatly dependent upon the amount of work required and the area made available for spawners, whether by removal of one barrier or by extensive clearance.

The dollar value of the benefit cost ratio is not a complete indicator of the benefits realized.

Following are additional advantages:

1. Potential debris barriers have been removed, which could have stopped salmon migration or caused stream channel diversion.
2. Better visibility for both ground and aerial surveys have resulted.
3. Local workers were able to be employed.

Further stream clearance work is planned for this coming spring, mid April through June, as follows:

1. Kadashan Creek in Tenakee Inlet on Chicagof Island.
2. Basket Bay Creek on east coast of Chichagof Island. Complete work begun last spring on this important salmon producer.
3. Johnston Creek in Gambier Bay on Admiralty Island.
4. Donkey Bay Creek in Pybus Bay on Admiralty Island.
5. Woewodski Harbor Creek, Eliza Harbor, on Admiralty Island.
6. Eliza Creek, Eliza Harbor on Admiralty Island.
7. Corner Bay Creek, Tenakee Inlet, on Chichagof Island.
8. Trocadero Bay, stream on right at head of bay, on Prince of Wales Island.

*9. Swan Cove Creek, Seymour Canal, on Admiralty Island.

*10. Nadzuhini Creek, west coast of Prince of Wales Island

* Will be done if schedule permits.

FISHPASS CONSTRUCTION - 1973

Fishpass construction is scheduled for 5 locations in S.E. Alaska as follows:

1. Salt Lagoon, George Inlet on Revillegegado Island (near Ketchikan)
2. Aiken Cove in Moira Sound on Prince of Wales Island.
3. Klakas Lake system on Prince of Wales Island.
4. Survey Creek on Kosciusko Island.
5. Pavlof River on Chichagof Island.

Total cost of the projects is estimated to be $180,000.

Pink, chum and coho, and in some instances, sockeye salmon are prohibited or inhibited from passage upstream during spawning migration by the presence of total or partial blocks in these systems. Klakas Creek and Pavlof River contain runs of sockeye salmon. Extensive spawning area for pinks, chums, and coho will be made accessible by installation of fishpasses. Construction is planned for the winter season when low water levels occur.

A total of 44 hours was spent in engineering surveys plus 76 hours in review of potential sites and final selection, surveys of alternate sites, survey write up and cost development and preparation for survey trips in 1972. The fishways are currently in the design stage.

ANADROMOUS

CENTRAL AND AYK REGIONS

DISCUSSION OF POTENTIALS, ACTIVE AND PROPOSED

PROJECTS

I. OVERALL REHABILITATION AND ENHANCEMENT DIRECTION

Arctic - Yukon - Kuskokwim Region

Potentials: Under investigation.

Arctic Area: Salmon Lake - Seward Peninsula. Total sockeye run in this system has ranged between 2,000 - 14,000 fish since 1963. Over exploitation is suggested in depletion of the run during recent years. Require biological, physical and chemical data from system in addition to feasibility study. Regulatory rehabilitation may be only action necessary.

Unalakleet River - Norton Sound. Beaver dams and log jams may be limiting available spawning areas of chum, pink, silver and king salmon. Need to evaluate if problem exists. Rehabilitation would involve stream clearance.

Yukon area: Extensive area lacking a complete or workable inventory. Potential presently undetermined.

Kuskokwim area: Barren lakes exist on Kuskokwim River system which may have sockeye spawning and rearing potential. Background and feasibility studies required prior to thoughts of rehabilitation. Barren lakes include Klak Lake, Kisaralik Lake, Aniak Lake, Kanuktik Lake and Whitefish Lake (Hoholitna River)

Central Region

Potential: Under investigation. Preliminary data analysis suggests production increase feasible in certain areas using supplemental

rehabilitation and enhancement methods.

Bristol Bay area: Most systems at optimum sockeye production. Problem areas require background data and feasibility studies.

NUYAKUK RIVER SYSTEM

Tikchik Lakes
Nishlik
Slate
Upnuk
Chikuminuk
Chauekuktuli
Nuyakuk

Numerous spawning grounds and large rearing area available. Spawners are lacking. Need feasibility studies. May encounter predator problems (char). Cannot manage seperately from major system (Wood River) in district. Run protection limited by ability to identify stock in fishery.

Enhancement recommendations: freshwater rearing, gravel box incubation, spawning channels. Logistics poor.

WOOD RIVER SYSTEM

Wood River Lakes
Grant
Kulik
Beverley
Nerka
Aleknagik
Little Togiak

Spawning and rearing potential available. Possible limiting factor is predation by char on juvenile salmon. Predators concentrate at lake inlets and feed heavily on out-migrant smolt. Majority of char are resident fish. Salmon smolt are highly parasitized.

Rehab considerations: reduce predator populations or smolt vulnerability.

Recommendations: fencing, occlude water during smolt migration by silt or chemical methods, artificial feeding of predators. Selective poisoning and gill netting not favorable with sport-fishermen. Predator control would be conducted annually.

SNAKE RIVER SYSTEM

Lake Nunavaugaluk: Poor producer particularly characterized by limited spawning grounds, moderate standing crops of phytoplankton and zooplankton, high transparency, low mineral content, and less organic material in suspension than other Nushagak lakes plus slow growth rates of resident species. Char appear to be dominant species. Lake has surface area of 33.2 square miles, 3 primary streams with mean depth of 200 feet and maximum depth of 537 feet - rehab problem. Records indicate system did at one time produce at a much higher level of production. Management problem is difficulty of separating Snake River bound fish from the other important races in the Nushagak district (i.e., Wood, Igushik and Nuyakuk River stocks).

Enhancement or rehabilitation opportunities excellent particularly for incubation and freshwater rearing.

KVICHAK RIVER SYSTEM

Lake Iliamna
Lake Clark

Good producers. Good spawning areas and plenty of fry and smolt in peak spawning years. Enhance rearing potentials during peak years with operation of spawning channels or gravel incubators.

Kakhonak Lake Fish barrier represented by 30 foot falls in river. Spawning and rearing potential available. System drains into Iliamna which supports own run. Present spawning potential in Iliamna may be greater than rearing potential. Run management questionable due to stock separation problems. Need evironment and feasibility studies.

BRANCH RIVER SYSTEM (Alagnak River)

Nonvianuk Lake
Nulik Lake
Kukaklek Lake
Battle Lake
McNeil Lake
Pirate Lake

Spawning potential available. Minor system to Kvichak. Producing at moderate level. High altitude lakes with slow growing fish. Unable to manage independently from major systems in district (Naknek - Kvichak). Require background studies.

EGEGIK RIVER SYSTEM

Becharof Lake

Low producer. No basic productivity, total available spawning area, spawning success, nursery area utilization or freshwater survival data available. From limited smolt sampling records available it apparently produces relatively large smolt. Observations of the spawning grounds have shown them to be rather limited with the possibility of considerable super-imposition at high spawning levels. The degree to which different areas of the lake are being utilized for rearing is unknown. The possibility exists that limited spawning areas or early fry-rearing areas restrict production. Tremendous rearing potential possible.

Recommendations: environment and feasibility studies with possible enhancement by artificial spawning areas or freshwater rearing.

UGASHIK RIVER SYSTEM

Ugashik Lakes

Production at low level. Good rearing potential with possible spawning area limitations. Basic productivity and environment studies lacking. Need to identify limiting factors.

Mother Goose Lake: Limited spawning area. Require background data and feasibility study. Probable excellent system for testing out theory.

Cook Inlet area: Rehabilitation programs are underway on a few systems. An extensive biological, physical and chemical inventory is being conducted throughout the area on all productive and potential salmon systems. Results of the programs and investigations are reported elsewhere.

Rehabilitation direction includes studies to increase fry production in selected lakes such as Big and Hidden Lakes. Methodology is presently developmental but may involve some type of incubation system.

Sockeye rearing potential exists in the upper Susitna River drainage, however, fish access through Devil's canyon is questionable. Construction costs of a fish pass facility may be prohibitive but operation of incubation systems in the upper drainage (i.e., Lake Louise) or adult transplants from the Copper River are feasible.

Prince William Sound area: Under investigation.

Staff Involved: Includes numerous professional personnel (biologists and engineers) and numerous non-professional personnel (fishery technicians - temporary and permanent) of the Commercial Fisheries, Sport Fisheries and FRED Division as well as other agencies (i.e., U.S. Forest Service).

Proposed Projects FY 74

1. Becharof Lake Enhancement

Location: Becharof Lake - Bristol Bay.

Objectives:
1. Determine factors limiting freshwater production of sockeye.
2. Determine growth rates of young sockeye in Becharof Lake.
3. Conduct environment and feasibility surveys.
4. Explore various methods of increasing sockeye production.
5. Initiate a program of enhancement.

Background: Low producers. No basic productivity, total available spawning area, spawning success, nursery area utilization or freshwater survival data available. From limited smolt sampling records available it apparently produces relatively large smolt. Observations of the spawning grounds have shown them to be rather limited with the possibility of considerable superimposition at high spawning levels. The degree to which different areas of the lake are being utilized for rearing is unknown. The possibility exists that limited spawning areas or early fry rearing areas restrict production. Tremendous rearing potential may be available.

Methods: Depend on environmental and feasibility surveys with possible enhancement by artificial spawning areas or freshwater rearing.

Overall Timing: Surveys - 1973-1975

Enhancement - 1976+

2. Ugashik Lakes Enhancement

Location: Ugashik Lakes - Bristol Bay.

Objectives:
1. Determine factors limiting freshwater production of sockeye.
2. Determine growth rates of young sockeye in Ugashik Lakes.

3. Conduct environment and feasibility surveys.

4. Explore various methods of increasing sockeye production.

5. Initiate a program of enhancement.

Background: Production at a low level. Good rearing potential with possible spawning area limitations. Basic productivity and environment studies lacking. Need to identify limiting factors.

Methods: Depend on environmental and feasibility surveys with possible enhancement by artificial spawning areas or freshwater rearing.

Overall Timing: Surveys - 1973-1975

Enhancement - 1976+

3. Preliminary Feasibility Surveys

Location: Upper Cook Inlet

System: Upper Susitna River

Objective: Establish salmon run.

Methods: Provide fish passage through Devil's Canyon or establish production by freshwater rearing, gravel incubation, adult transplants.

Time: 1973-1976

System: Big Lake

Objectives: Enhance sockeye run.

Methods Restore production by freshwater rearing or gravel incubation methods.

Time: 1973-1976

System: Various

Objective: Eliminate barriers to salmon migration

Methods: Stream clearance methods

Time: Continuous.

II. ACTIVE STREAM PROJECTS

1. Russian River Fishway

Location: Kenai Peninsula

Objectives:
1. Provide a fish passage over a high water fish barrier by a steeppass or other means.
2. Maintain a relatively constant spawning level in proportion to the run by allowing salmon passage at all water stages.

Background: Migration route for red, king and silver salmon spawning in the Russian Lakes system. Rainbow trout and dolly varden are indigenous to the area. Lake system reportedly provides excellent spawning for early run red salmon. Sockeye escapement for a 12 year period during 1960-1971 ranged from a low of 26,460 in 1961 to a high of 66,411 fish in 1963 with a total average of 49,500. A falls in the river located approximately 300 yards below Lower Russian Lake may be a partial or total barrier to migrating salmon at certain high water stages.

Methods: Conduct biological and engineering feasibility surveys followed by program design, construction and implementation. Preliminary plans indicate utilization of a steeppass or a modified fish ladder.

Overall Timing: 1972-1973+

Status: Active, initiated in 1972. All survey and topographic work is completed. Activities are now in the study phase of design with results expected in January or February 1973. Submission of an environmental impact statement is anticipated as U.S. Forest Service (Chugach National Forest) and U.S. Fish and Wildlife Service (National Moose Range) lands are involved. Project

Stream projects continued

completion pending negative impact.

2. Control Creek Fishway

Location: Control Creek - Prince William Sound.

Objectives: 1. Provide a fish passage over a 4-6 foot falls fish barrier by a steeppass or other means.

2. Increase available spawning area to pink and chum salmon.

Background: Small run of pink and chum salmon utilize systems for spawning. Falls are a complete barrier to fish migration.

Methods: Conduct biological and engineering feasibility surveys followed by program design, construction and implementation. Preliminary plans indicate utilization of a steeppass to ladder the falls.

Overall Timing: 1972-1973+

Status: Active, initiated in 1972. All survey and topographical work is completed. Activities are now in the study phase of design with results expected in January or February 1973.

III. ACTIVE LAKE PROJECTS - 1972

1. Lower Jean Lake

Location: Kenai Peninsula.

Objectives: 1. Rehabilitation of sockeye run by elimination of competitor species.

2. Evaluate long term effects of rehabilitation upon sockeye survival and production.

3. Evaluate control structure.

4. Establish rehabilitation and enhancement guidelines.

Lake projects continued

Background: A relatively small lake (115 surface acres) on the Kenai River system supporting a run of 100-150 sockeye salmon along with rainbow trout and a sizable stickleback population. Predation and competition plus lack of spawning grounds may be limiting factors in sockeye production. The lake is on the road system and used regularly for sport fishing.

Potential Benefits: The lake is too small to anticipate any major gain in commercial production but is an ideal place in a rather controlled situation to experiment in eliminating predation and competition and testing the effect of this action on the resident sockeye population.

Methods: Essentially use the Bear Lake approach to rehabilitation. Conduct biological and engineering feasibility surveys followed by program design, construction and implementation. Preliminary plans indicate construction of a fish barrier with would enable selective passage and enumeration. In terms of upstream migration the structure would enable enumeration and sampling of fish entering the lake at the same time preventing entrance of undesirable species such as sticklebacks. In regards to out-migration the structure would allow for collecting and enumeration of smolt. Attempts to initially eradicate all species from the lake would be made utilizing rotenone. Following water detoxification introduction of sockeye would be made by various methods such as natural reproduction, direct fry plants or through gravel incubation systems. Rainbow trout would also be introduced under controlled conditions to maintain the sport fishery and study species inter-relationships.

Overall Timing: 1972-1974+

Status: Active, initiated in 1972. Project defined. Biological direction under study. Limnological and inventory studies are continuing. Engineering design in developmental stage with topography mapping completed. Direction results expected February or March 1973. Submission of an environmental impact statement is anticipated as U.S. Department of the Interior (National Moose Range) lands are involved. Project completion pending negative impact.

2. Packers Lake

Location: Kalgin Island - Cook Inlet.

Objectives:
1. Determine factors limiting sockeye production.
2. Explore various methods of rehabilitation or enhancement in restoring sockeye production.
3. Establish guidelines in rehabilitation or enhancement of sockeye system.

Background: Sporadic records available since 1927 indicate system supported between 30,000 (1939) - 1,000 (1956) reds and a small run of silver salmon. No data for years 1960-1971. Aerial survey conducted 10/5/72 produced a count of 3,700 spawners. Limited spawning area in inlets. Good gravel along shore with primary spawning occurring along northern end of lake. Ten feeder streams blocked by beaver dams with boggy environments resulting upstream. Dams do not affect lake level. Lake approximately 506 surface acres. Rainbow trout fishing indicated as good. Brown trout reportedly stocked in 1952 with none taken in gill nets during 1969 survey. Other competative species include sticklebacks and dolly varden.

Potential Benefit: May provide commercial production on a limited basis with strict regulative control. Possible rearing area for sockeye.

Methods: Conduct biological and engineering feasibility surveys followed by program design, construction and implementation. Preliminary plans indicate construction of a fish barrier which would enable selective passage and enumeration. In terms of upstream migration the structure would enable enumeration and sampling of fish entering the lake at the same time preventing entrance of undesirable species such as sticklebacks. In regards to out-migration, the sturcture would allow for collection and enumeration of smolt. Feasibility or necessity of competitive species eradication is questionable until additional biological data regarding sockeye production become available and limiting factors are analyzed.

Present recommendations are to construct a fish passage control structure and evaluate natural production in all aspects while exercising restrictive exploitation of the present run.

Overall timing: 1972-1974+

Status: Active, initiated 1972. Project defined. Biological direction under study. Limnological and inventory surveys are continuing. Engineering, design in developmental stage with topography mapping completed. Direction results expected in February or March 1973.

3. Desire Lake

Location: Kenai Peninsula.

Objectives: 1. Obtain pre-rehabilitation data.

2. Determine factors limiting salmon production.

3. Evaluate feasibility of rehabilitation system.

Background: Limited data available. An aerial survey during July 1972, revealed 1,800 red salmon spawners on the west shore of the lake with several schools seen in the lake center.

Potential Benefits: Cost may out-weigh short term benefits.

Methods: Undefined as yet, under investigation.

Overall Timing: 1972 - ?

Status: Project progress seriously hampered by unfavorable weather and access. To date, conditions have not allowed any surveys to be conducted in this system. Recommend extensive biological, engineering, and economic surveys prior to inception of any rehabilitation program.

4. Delight Lake

Location: Kenai Peninsula.

Objectives: 1. Obtain pre-rehabilitation data.

2. Determine factors limiting salmon production.

3. Evaluate feasibility of rehabilitation system.

Background: Lake of 680 surface acres. An aerial survey during July 1972 revealed a total of 2,500 red salmon spawning on west side beaches. Dolly varden observed in lake.

Potential Benefits: Undefined as yet, under investigation.

Overall Timing: 1972 - ?

Status: Project progress seriously hampered by unfavorable weather and access. To date, conditions have allowed only a single limnological survey to be conducted in this system. Recommend

extensive biological, engineering and economic surveys prior to inception of any rehabilitation program.

IV. SUPPLEMENTAL SYSTEM DEVELOPMENT

Saltwater Rearing

Location: Kachemak Bay - Cook Inlet.

Objectives:
1. Evaluate feasibility of saltwater rearing of salmon fry.
2. Determine marine survival of rearing fry.
3. Development and application of saltwater rearing pens to restore, establish and enhance salmon runs.

Methods: Utilize floating pens to rear salmon fry to smolt under controlled conditions in an essentially natural environment

Accelerate growth with supplemental feeding, eliminate predation and competition plus prematurely acclimate fish to saltwater.

Conduct and monitor various experiments for obtaining desired results. Artificial marking by use of tags will identify fish for survival studies.

Overall Timing: Project initiated 1971. Assessment phases 1972-1974. Production 1974+

Status: Phase I assessment plus site selection and design of Phase II facilities in progress.

Results: Preliminary data review indicates system may be feasible. First year's operation revealed problems in system design and operational techniques. An insufficient freshwater supply, acclimation to high salinities at too rapid a rate and a disease outbreak are the major factors involved in producing a 89 percent mortality. Although desired results were not realized the first year, data is now available to continue on with the program in an expanded experimental capacity with some degree or even total success realized.

ANADROMOUS

WESTWARD REGION

DISCUSSION OF POTENTIALS, ACTIVE AND PROPOSED

PROJECTS

Background

The Westward region is composed of three geographic areas - the Kodiak-Afognak Islands, Peninsula-Aleutians and Peninsula (Chignik) - which also form the three basic fishery management areas. Fisheries rehabilitation and enhancement projects were active in the Kodiak area as a function of the Commercial Fisheries Division before establishment of the new Division of Fisheries Rehabilitation, Enhancement and Development (FRED) in 1971. Supplemental production of salmon eggs and fry was provided by the Kitoi Research Hatchery on Afognak Island to support the Kodiak projects.

With the organization and assignment of full-time rehabilitation and enhancement responsibilities to FRED; significant advances have been made during the first year's operation in the region. Feasibility surveys of potential enhancement projects were expanded for the first time to the Alaska Peninsula. Construction of two fish ladders and several stream clearance projects are being proposed for the Peninsula area in Fiscal Year 1974 as a result of these surveys. Two new pilot projects were initiated at the Kitoi Station to evaluate salmon fry production by use of gravel incubators and freshwater rearing of sockeye fry to the smolt stage. Both methods have great promise in restoring depleted sockeye runs on Kodiak and Afognak Islands. In addition, studies were begun to solve streambed compaction and underground channel problems limiting salmon production in two stream systems close to Kodiak.

The major priority in this region is the restoration and enhancement of sockeye runs in the Kodiak area. Immediate goals are to restore the once famous Karluk and Akalura Lake sockeye runs to historic levels. To attain these goals, we are developing extensive plans in cooperation with NMFS and BSF&W involving a large-scale rehabilitation of lake rearing areas and increasing fry densities in the lakes by supplemental production methods. This work would naturally progress to other lake systems that offered potential in the region.

An Environmental Impact Statement is being prepared by the BSF&W for the Akalura Lake Rehabilitation project on the National Wildlife Refuge. We hope for early approval so that we can proceed with scheduled plans.

Activities at Karluk Lake for the past three years has provided necessary background documentation to define some of the more critical problems depressing sockeye production. Examination of these factors indicates a complexity of inter-related developments over the years requiring a multi-disciplined approach and combination of methods in successfully re-building the salmon run.

A "highlight" of the 1972 season was the return of an estimated 70,000 sockeye escapement to Frazer Lake on southwest Kodiak Island. The Department takes great pride in the establishment of this salmon run -- one of the first successful sockeye introductions on the Pacific Coast. The lake has a potential of supporting a run in the magnitude of 1.0 to 1.2 million that could be attained, at the present rate of increase, by the late 1980's.

The project was begun by planting sockeye eggs in inlet streambeds in

in the early 1950's. The first adult salmon returned in 1956 to the base of the 30-foot falls that blocked anadromous fish passage into the lake. That year only six fish were packed over the falls. In 1962, the Department constructed a steeppass fishladder for passage of ever-increasing numbers of salmon over the falls. The natural return has been supplemented in the 1960's by the transplant of 30,000 sockeye spawners and the plants of 2.4 million fry and 8.5 million eyed-eggs.

Fishladder improvements at Frazer Lake were begun in 1972 and will be completed in 1973 with funding approved by the 1970 legislature. Evaluation of fish passage facilities and capacity to accommodate increasingly greater numbers of salmon will be a primary responsibility of FRED in future years. It is anticipated that additional funding will be requested for expansion of the Frazer ladder in FY 1975.

The FRED program in the region consists of 14 projects, many of them initiated this year after feasibility surveys, to accomplish a wide range of salmon rehabilitation and enhancement (Table 1). Since many of these projects are just beginning, no new activities are proposed for FY 1974, other than the progressive expansion (construction of new ladders, Akalura outlet facility, etc.)which will be necessary for successful completion of the existing projects on schedule. Feasibility surveys will lead to other potential FRED projects which will be proposed on a priority basis in future years. Also, some existing projects may be terminated after an in-depth evaluation of feasibility.

Our regional staff, headquartered in Kodiak, consists of two permanent fishery biologists, one permanent technician and temporary seasonal technicians. We have engineering support from two engineers based in Anchorage. The Hatchery Services section provides two technicians who assist in the

Table 1. -- Summary of FRED projects by Management Areas in the Westward Region

Management Area		Project Title	Type of Project	Principal Species
Kodiak	1.	Salmon egg incubation Studies - Kitoi Station	Supplemental Production	Pink Sockeye
	2.	Freshwater Salmon Rearing - Kitoi Station	Supplemental Production	Sockeye
	3.	Akalura Lake Sockeye Restoration	Rehabilitation	Sockeye
	4.	Karluk Lake Sockeye Restoration	Rehabilitation	Sockeye
	5.	Frazer Lake Fisheries Enhancement and Evaluation	Enhancement	Sockeye, Chum, Chinook, pink
	6.	Buskin River Stream Improvement	Enhancement	Pink
	7.	Salmon Egg Toxicity	Experimentation	Sockeye
	8.	Feasibility Surveys	Determination	Anadromous Fish
Peninsula Aleutians	1.	Dutch Harbor Stream Improvement	Enhancement	Pink
	2.	Apollo Creek Fish Passage	Enhancement	Pink
	3.	Middle Creek Fish Passage	Enhancement	Pink
	4.	Feasibility Surveys	Determination	Anadromous Fish
Chignik	1.	Feasibility Surveys	Determination	Anadromous

Kitoi Hatchery operation.

We are developing cooperative efforts with other agencies whenever possible to take advantage of their expertise and services. A few examples are:

1. The Soil Conservation Service is doing the preliminary engineering survey on the Kalsin River project. A stream diversion channel would possibly be of mutual benefit in stream stabilization (preventing ranch land erosion) and providing fish access to potential spawning areas.
2. The Bureau of Sport Fisheries and Wildlife is preparing the Environmental Impact Statement for the Akalura rehabilitation project. All projects on the Kodiak Wildlife Refuge requires a close working relationship with Bureau personnel
3. The U.S Forest Service constructed a steeppass fishladder at Seal Bay on Afognak Island in 1972. In the spring of 1973, a portion of the pink slamon fry produced from the new gravel incubators at Kitoi will be planted at Seal Bay in a cooperative venture, to re-establish the pink salmon run to the system -- this will be the first practical application of this new incubation concept in Alaska.
4. The National Marine Fisheries Service has expressed a desire to cooperate in the Karluk sockeye restoration project. We anticipate a meeting with them this winter to develop a cooperative plan of action for Karluk.

ENHANCEMENT PROJECTS

1. FRAZER FISHERIES ENHANCEMENT AND EVALUATION

Location - Frazer Lake, southwest Kodiak Island

Objectives - (1) Establish sockeye smolt indexing to derive a reliable estimate of number of smolt outmigrants and age-weight-length composition of smolt as a measure of productivity. (2) Evaluate present fish ladder system in terms of increased salmon runs and anticipated target escapements. (3) Explore alternative methods of fish passage at the falls. (4) Continue enumeration and size and age composition sampling of salmon returns. (5) Continue monitoring salmon spawning area utilization and distribution in the lake system.

Methods - (1) The number of sockeye smolts leaving Frazer Lake will be determined from an index count of smolts passing through a photo-electric counter installed in a downstream migrant weir. Daily samples of smolt will be taken for determination of age, weight and length. (2) Salmon passage rates will be determined relative to fish densities and timing of marked fish. Various ladder improvements or modifications will be explored to increase passage rates and capacity. (3) The engineering staff will survey alternate methods for fish passage at the falls. (4) Returning adult salmon will be counted and sampled. (5) Spawning areas will be surveyed to monitor sockeye utilization and distribution.

Time Period - (Phase I, 1972-75) Completion of improvements on existing ladder, establish indexing procedure, evaluate ladder improvements (Phase II, 1976-77) Construct alternate passage

facilities if required, ladder operation and maintenance, salmon return monitoring and smolt indexing responsibility shifted to research staff. (Phase III, 1978-80+) Maintenance, operation, evaluation and improvement, if necessary, of fish passage facilities.

Status - Active, long range enhancement and evaluation project until target escapements attained, present fishladder problems solved and improvements completed.

2. Buskin River Stream Improvement

Location - Kodiak

Objectives - (1) Restore compacted spawning area in stream by ripping streambed and loosening substrate. (2) Improve intergravel water flows and dissolved 0_2 content. (3) Increase potential spawning area, egg survival and pink salmon production.

Methods - (1) A tractor-crawler with ripper will be contracted to rip a 1400-foot stretch of streambed to a depth of about 3 feet. (2) Substrate dissolved 0_2, nitrate and nitrite samples will be taken from control and ripped areas before and after ripping. (3) Spawning area usage, egg survival and salmon production will be evaluated by survey counts on the spawning grounds and hydraulic sampling to derive estimates of egg deposition and pre-emergent fry.

Time Period - (Phase I, 1972-73) Pre-improvement studies and environmental clearance for project. (Phase II, 1973-74) Improvement action implemented. (Phase III, 1974-78) Post improvement studies and evaluation.

Status - - Active, initiated in 1972. Assessment of present pre-restoration condition and pink salmon distribution within stream in progress.

4. DUTCH HARBOR STREAM IMPROVEMENT

Location - Dutch Harbor, Aleutian Islands

Objectives - (1) Removal of old bridges either blocking salmon runs presently or in the future (bridges were constructed when Dutch Harbor was an active military base and are no longer usable). (2) Clearance of driftwood jams obstructing fish passage in streams that could potentially support salmon runs. (3) Re-opening and maintaining a lake outlet that has been blocked by sand and build-up of a beach within the last several years. The system could potentially support sockeye and coho runs.

Methods - (1) Bridges and driftwood jams blocking salmon migration will be removed by burning, blasting and cutting. (2) Opening and maintaining a lake outlet stream will be accomplished by contracting with a local rancher. (3) Sockeye and/or coho will be re-established in the lake by egg or fry plants. (4) Cursory evaluation by aerial survey counts.

Time period - (Phase I, 1972-73) Obtain environmental, public and ownership clearance for bridge removal. (Phase II, 1974-78) Implement clearance projects, re-establish salmon by fry or egg plants and evaluation by aerial survey counts.

Status - Preliminary survey completed 1972. Stream clearance is tentatively scheduled Spring 1974

5. Apollo Creek Fish Passage

Location - Unga Island, Acheredin Bay

Objectives - (1) Provide fish passage over 8-foot falls by steeppass ladder or other means. (2) Increase

pink and chum salmon production of stream by providing access to approximately eight miles of additional spawning area (approximately 538,600 square feet).

Methods - (1) Engineering surveys and design work will be accomplished. (2) Ladder and materials will be purchased and transported to the site. Installation will be either by the Department or a contractor (4) Evaluation by aerial and foot surveys and pre-emergent fry sampling.

Time period - (Phase I, 1972-73) Environmental clearance, engineering site survey and design work. (Phase II, 1974-75) Ladder installation. (Phase III, 1975-80+) Annual ladder maintenance and improvements, evaluation of salmon passage and spawning above falls.

Status - Preliminary survey completed 1972. Engineering survey and topographic mapping is scheduled for 1973. Ladder funding being requested 1973 Legislature.

6. Middle (Humpy) Creek Fish Passage

Location - Alaska Peninsula, Pavlof - Canoe Bay

Objectives - (1) Provide fish passage over two 4-foot falls and one 18-foot falls by steeppass ladder and/or other means. (2) Increase pink and chum salmon production of stream by providing access

to approximately five miles of additional spawning area (approximately 897,600 square feet).

Methods - (1) Engineering surveys and design work will be accomplished. (2) Ladder and materials will be purchased and transported to the site. Installation will be either by the Department or a contractor (4) Evaluation by aerial and foot surveys and pre-emergent fry sampling.

Time period - (Phase I, 1972-73) Environmental clearance, engineering site survey and design work. (Phase II, 1974-75) Ladder installation. (Phase III, 1975-80+) Annual ladder maintenance and improvements, evaluation of salmon passage and spawning above falls.

Status - Preliminary survey completed 1972. Engineering survey and topographic mapping is scheduled for 1973. Ladder funding being requested 1973 Legislature.

REHABILITATION PROJECTS

1. Akalura Sockeye Restoration

Location - Akalura Lake, southwest Kodiak Island

Objectives - (1) Restoration of the Akalura Sockeye run by lake rehabilitation to eliminate predator and competitor species from sockeye rearing areas. (2) Evaluate long term effects of rehabilitation upon sockeye survival and production. (3) To establish guidelines and feasibility of rehabilitation and replanting techniques in restoring and establishing sockeye runs in Alaska.

Methods - (1) Sockeye smolt output and adult salmon returns are monitored before rehabilitation. Pre-rehabilitation studies are conducted on factors (Zooplankton composition and density, spawning areas, times of spawning of various salmon species, etc.) that may be altered by rehabilitation. (2) An outlet control structure will be constructed and the lake system rehabilitated with a liquid-emulsifiable toxicant. (3) Sockeye will be re-introduced into the system by supplemental methods. (4) Post-treatment assessment, monitoring and evaluation of sockeye productivity, effects of rehabilitation and supplemental methods of fry input.

Time period - (Phase I, 1972-75) Pre-treatment assessment, environmental clearance. (Phase II, 1975-76) construct outlet control structure and rehabilitate lake. (Phase III, 1976-1980) Monitor and improve outlet control structure (if necessary) re-establish sockeye by supplemental methods. (Phase IV, 1980+) Long term (20 year[four, 5-year sockeye cycles]) evaluation of restoration project.

Status - Active, pre-treatment assessment and monitoring pending approval of Environmental Impact Statement.

2. Karluk Sockeye Restoration

Location - Karluk Lake, southwest Kodiak Island

Objectives - (1) obtain pre-rehabilitation data on present sockeye usage of Karluk spawning areas that were historically the most productive. (2) Determine potential optimum target escapement for Karluk Lake. (3) Determine factors possibly limiting freshwater survival of sockeye. (4) Determine migration behavior and growth rate of young sockeye in the Karluk system. (5) Explore various methods of re-establishing discrete spawning segments of the run that have been eliminated resulting in under-utilization of some major spawning areas.

(6) Explore various methods of increasing survival of sockeye fry input into the main lake basin (i.e. freshwater rearing, elimination of competitor species, rehabilitation of pre-rearing areas, etc.). (7) Initiate a major program of sockeye restoration to re-build the Karluk run.

Methods - (1) The sockeye escapement is counted and sampled for age, weight and length composition. Escapement is also monitored into a tributary lake which was historically a major spawning area. (2) Detailed assessment will be conducted in 1973 to determine quantity and quality of available spawning area and rearing area (lake volume). (3) Data are collected on factors possibly limiting sockeye productivity (plankton composition and density, stickleback migrations and concentrations, etc.) (4) Index net samples of fry are captured at various locations to indicate migration timing and fry size. In the spring of 1973, fry will be marked upon leaving spawning sites and recovered upon leaving pre-rearing areas and entering the main lake. (5) Objectives 4-7 will be accomplished by State-Federal cooperative effort involving a variety of supplemental production, rehabilitation and managerial techniques. (6) Detailed assess-

ment and evaluation of restoration measures will be conducted. (7) Research will be established to provide a scientific approach to management of the Karluk run.

Time period - (Phase I, 1972-74) Collection of background data to provide guidelines for restoration measures and evaluation. Initiate a cooperative venture with NMFS and formulate a restoration plan. (Phase II, 1975-79) Restoration and assessment systems implemented. (Phase III, 1980+) Long term evaluation, assessment and management of Karluk sockeye run.

Status - Active, initiated in 1969. Initial feasibility surveys completed in 1970, pre-rehabilitation assessment and monitoring in progress on the ThumbLake tributary. Spawning area utilization and distribution work in progress. Present work is aimed at providing basic guidelines for restoration measures that are the most feasible.

SUPPLEMENTAL PROJECTS

1. Salmon Incubation (Gravel Media Incubators)

Location - Kitoi Hatchery, Afognak Island

Objectives - (1) Evaluate system production of high quality fry at maximum survival rate. (2) Evaluate marine survival of incubator produced fry.

(3) Development and application of incubator units to remote streams and lakes to restore, establish and enhance salmon runs.

Methods - (1) Incubator units are installed and loaded with gravel-rock media and eggs. (2) Fry output will be counted and samples taken to determine fry quality in comparison to wild and trough produced fry. (3) A portion of the fry will be marked by fin clipping from each test unit and Kitoi Creek (next to the hatchery). Estimates of marine survival will be determined by the ratio of marked salmon returning. (4) The system will be evaluated and improved to develop self-sustaining units suitable for remote field application.

Time period - (Phase I, 1972-73) Initial installation and trial run. Experimentation with pink and sockeye salmon at varied densities. Determine if water filtration necessary. Initial evaluation of fry quality. (Phase II, 1973-74) Improvements of system design and operation. Repeat incubation experiment. First major marking program of fry releases. (Phase III, 1974-78) Continue evaluation, experimentation and development of incubation systems.

Examine adult salmon returns for marked fish to determine marine survival. (Phase IV, 1978-80) Final evaluation and development stage of field incubator units-application to remote sites.

Status - Active, initiated in 1972 with installation of four incubators (150,000 sockeye eggs and 350,000 pink salmon eggs) and one incubator without eggs running on unfiltered water. This system is a new concept with the potential for producing a great number of fry that are as strong as wild, naturally produced fry.

2. Freshwater Salmon Rearing

Location - Kitoi Hatchery, Afognak Island

Objectives - (1) Evaluate feasibility of freshwater rearing of sockeye salmon fry. (2) Determine freshwater and marine survival of reared fry. (3) Development and application of freshwater rearing pens to restore, establish and enhance salmon runs.

Methods - (1) Sockeye and pink salmon fry were reared in concrete tanks throughout the summer. Samples of fish are taken periodically to determine size and growth rate. Records are kept on mortality, diets, treatments, water flow and temperatures, etc.

(2) In late fall, 1900 of the young fish were marked by fin clipping and released in Little Kitoi Lake. The number of out-migrant smolt and adult salmon produced from the marked fish will be recorded. (3) About 1000 young fish are being held in the hatchery over winter to continue evaluation of freshwater rearing and growth. (4) A freshwater rearing pen will be designed for further development of the technique. (5) Field application of rearing pens will be evaluated on the basis of increased fry survival to smolts and adult salmon.

Time period - (Phase I, 1972-73) Initial rearing of salmon and release of marked juvenile fish. Evaluate smolts produced from fish marked and released in the fall. (Phase II, 1973-75) Design proto-type freshwater rearing pen(s). Repeat rearing of fry at hatchery and floating pen(s) in lake. Evaluate survival of fish released from pen(s) at varied rearing periods. (Phase III, 1975-80) Evaluation of adult salmon survival from pen reared fish. Final evaluation and development stage of freshwater salmon rearing--application to remote sites.

Status - Active, initiated in 1972. Excellent survival and terrific growth of sockeye fry (30 mm in May to 107 mm in October). The benefit of this system

is the potential production of a great number of young sockeye of a large seaward migration size in a single summer season. Natural mortality of sockeye fry during 1 to 3 years of normal lake residence is usually greater than 90 percent. Supplemental freshwater rearing units offer the possibility of eliminating or greatly reducing this mortality and providing an immediate output of smolt from a lake system.

EXPERIMENTAL PROJECTS

1. Salmon Egg Toxicity

Location - Kitoi Hatchery or alternate site to be selected.

Objectives - (1) Determine if Pro-Nox® fish toxicant is lethal to eggs in the streambed at concentrations of 1.5 p.p.m. (2) Determine degree of toxicity and mortality of eggs and fry. (3) Provide a basis for deciding if salmon spawning is of value before chemical rehabilitation of streams and lakes or if salmon should be prevented from entering systems before treatment.

Methods- (1) A site will be selected that is a typical inlet stream with a gravel streambed. All fish will be excluded from the site. (2) Eyed sockeye eggs will be planted in both a control (untreated) and test (treated) plot. A toxicant drip station will be run for a 5-day period. (3) Egg samples will be examined periodically from both plots to

determine survival rates and the total fry produced from the plots will be recorded.

(4) The effects of toxicant will be based upon a comparison of periodic and total survival rates of fry from the treated and untreated control plots.

Time period - (Phase I, 1972-73) Selection of site, based on winter observations and obtaining materials for experiment. (Phase II, 1973-74) Obtain eggs and eye in the Kitoi Hatchery. Implement experiment, collect fry samples and trap total fry produced from each plot, evaluate and report results.

Status - Active, initiated in 1972. This experiment is designed to provide more conclusive evidence on toxicant effects on salmon eggs after deposition. The results will be of considerable value in determining if salmon should be allowed to spawn before rehabilitation projects or instead, not allowed entry and sacrificed for spawn or transplanted.

FEASIBILITY SURVEYS

1. Kodiak Area

Location - Kodiak and Afognak Islands

System	Objective	Proposed Action	Status
1) Horse Marine Lake	Enhance salmon runs and production	1) Ladder or channel falls in outlet stream. 2) Increase spawning and rearing productivity.	Preliminary feasibility survey completed 1970, Inactive 1972. Proposal recommendation 1971.
2) Silver Salmon Lake	Establish sockeye run	Rehabilitate and increase lake volume. Establish run by incubation technique.	Preliminary feasibility completed 1970. Inactive 1972. Proposal recommendation 1971.
3) Afognak Lake	Enhance Sockeye run	Restoration of tributary spawning areas.	Preliminary surveys scheduled for 1973-74.
4) Spiridon Lake	Establish sockeye run	Divert outlet stream into Little River to provide fish access, plant sockeye.	Biological survey completed 1971. Engineering survey scheduled for 1973-74.
5) Bauman's Creek	Eliminate barrier falls Provide additional spawning area for pink salmon.	Ladder a series of falls to allow access of pink salmon.	Preliminary feasibility completed 1972-determined unfeasible.
6) Kaguyak River	Eliminate barrier falls Provide additional spawning area for pink salmon.	Ladder a series of falls to allow access of pink salmon.	Preliminary feasibility survey completed 1972-recommend removal of 2 beaver dams only. No falls exist.
7) Uganik Lake	Enhance sockeye run	Flow control of lake inlet. Research sockeye abundance and utilization.	Preliminary feasibility survey scheduled for 1973-74.
8) Waskanareska River	Eliminate barrier falls Provide additional spawning area for pink salmon	Ladder falls to allow access of pink salmon	Preliminary feasibility survey completed 1972-determined unfeasible. Small falls is barrier only on lc tide.

System	Objective	Proposed Action	Status
9) Zacher River	Improve pink salmon access	Re-channel river	Preliminary feasibility survey scheduled for 1973-74.

2. Chignik Area

Location - Alaska Peninsula (Chignik)

1) Kujulik (502)	Enhance salmon run, provide fish access to additional spawning area	Ladder falls	Preliminary feasibility survey scheduled for 1973-74.
2) Kilokak	Improve pink salmon	Re-channel and maintain surface flow at stream mouth.	Preliminary feasibility survey scheduled for 1973-74

3. Alaska Peninsula Feasibility Surveys

Location - Alaska Peninsula. (Cold Bay)

1) Thinpoint Lake and Lagoon	Increase sockeye production and reduce smolt predation	Deepen lagoon by re-channeling. Improve smolt passage.	Preliminary survey conducted 1972. Further evaluation of problem recommended.
2 Ocean River	Improve salmon entry into system. Prevent shifting of river (alternates yearly between Bering Sea and Ilnik Lagoon)	Channel and stabilize river mouth	Preliminary feasibility survey scheduled for 1973-74.

BRIEF ON ANADROMOUS SUPPLEMENTAL PRODUCTION SYSTEMS

There are three major components in any supplemental controlled or partially controlled production system. These are, incubation, rearing, and spawning or egg take. All three are necessary if production is to be increased. Within each of these components there are various methods of achieving the desired out put. Some methods are superior to others, some will be useful in one area of the state but not in another area.

We are not yet confronted in Alaska with problems that Washington, Oregon, Idaho, and California have -- namely the loss of natural spawning and rearing areas caused by heavy industrialization.

We therefore can be discerning and select those components and methods that will return the most favorable benefit/cost ratios. Furthermore, we can select those methods that are the most technologically advanced for use or testing under Alaska conditions and that will utilize to the maximum what we already have in abundance -- uncontested freshwater sources, thousands of acres of under - or non-utilized rearing areas. Construction of a total system in concrete (egg take-incubation and rearing) does not make sense, for example, in Bristol Bay where tremendous rearing area is available. Nor would it make sense to construct Heath or trough incubation facilities in that area for sockeyes when evidence indicates a poor quality fry will be produced by those methods.

It is of paramount importance that before we begin construction of any more major hatchery systems (all components) that a rational plan for the use and testing of supplemental systems in Alaska be developed that will

1. Take advantage of our tremendous untapped natural rearing areas (saline and freshwater)
2. Reflect a realistic approach to increasing demands on species by areas and user.

SALTWATER REARING

Background

Three experimental saltwater rearing units were designed, constructed, and put into operation by July of 1972, one at Little Port Walter (South end of Baranof Island), the second at Starrigavin Bay (near Sitka) and the third at Kasitsna Bay (near Homer).

There are three basic methods whereby low or varying concentrations of saline water may be used in one system to rear salmon from fry to the pre-smolt or smolt, stages.

These are:

1. pump saltwater to a shore based facility and blend with an input of freshwater to achieve the desired salinity level. (Similar to the system used at Bergen,Norway for Atlantic salmon).
2. Locate estuaries where a natural freshwater lens is present and impound or curtain off the whole system or construct floating pens within this lens. This system is employed at Little Port Walter in a cooperative program with the National Marine Fisheries Service.
3. Reverse the Bergen,Norway procedure and pump or gravity feed freshwater to saltwater and encapsulate and blend to the desired salinity level at a floating installation. This is the system we are testing at Sitka and Homer.

Each one of these systems has its strengths and weaknesses. But all of them are based on the hypothesis that maximum growth can be realized when the salinity level in the water is similar to the fishes blood (10-12 ppt). This growth rate will probably exceed (Otto 1971 FRBC) freshwater growth rates if useful temperature regimens are available. Since temperatures in Alaska are on the cool side it is of paramount importance that we develop systems that are capable of controlling salinities.

Why did we choose the natural lens and the introduction of freshwater to saltwater as the most logical approach and use floating structures? A few of the major reasons are:

1. Construction of floating installations may utilize water sources stemming from lakes that are perched, remote and adjacent to saltwater. Units can be constructed and modularly transported. Large excavations, and padding for shore based rearing ponds is not needed.
2. Natural tidal flows may be used after fish have become adapted to full strength sea water as a source of oxygen, a supplemental food source and a cleansing medium.
3. It is possible, though more experimentation is needed, that the same system may be used to ripen returning adults for egg takes that will retrigger the cycle.
4. Logistics of fish transport are simplified.

What are some of the strengths and weaknesses of the natural lens versus the controlled encapsulated artifical lens? Both systems will be subjected to various diseases and importance of disease prevention and control cannot be overstressed (hence the request for a fisheries pathologist in the budget).

Major strengths of the floating pens within a Natural lens (Little Port Walter):

1. Cheaper construction cost - do not need a piping and pumping system. May be able to build larger pens if the lens warrants it.
2. Power requirements are less.

Major weaknesses of the floating pens with a natural lens:

1. Temperature is not controllable.
2. Cannot control salinity (a key factor). The lens may expand or contract depending on stream flows or shift according to wind direction.
3. Fish cannot be easily treated with external prohylaxis unless removed from the pens.

Major strengths of the encapsulated artificial lens (Sitka and Homer):

1. Temperatures can be manipulated as an aid not only to growth but in disease prevention.
2. Salinities can be controlled for maximum growth and in some instances this ability may aid in disease control.
3. Prophylaxis may be introduced into the system without removing the fish from the pens.
4. The ability to tap deeper warmer water during the winter will allow growth during that time period.

Major weaknesses of the encapsulated artificial lens.

1. Loss of power (unless freshwater is gravity feed) could cause problems. Can be counteracted by stand-by units.
2. Possible loss of freshwater due to line breakage or an altered water source.

Results to Date

The three production prototype test units were installed and in operation by early July. Since this was the first test of the systems we expected to encounter many unknowns -- such as disease,weaknesses in design, site problems, predators, and salinity adaptation problems. These are realities in any newly constructed system that is based on theory. However, despite the effect of controllable and uncontrollable factors we are optimistic concerning the role that these types of systems may eventually play in the enhancement of salmon fisheries in Alaska where environmental conditions permit. We have much to learn concerning these systems, many unknowns to meet, but results thus far are encouraging.

A summary of the Little Port Walter operation (a cooperative project) by Bill Heard of the National Marine Fisheries Service, follows this section of the report. The remainder of this section is devoted to summarizing the first six months of operations at the three units. These are preliminary data and detailed analysis will not be completed until next summer. We still have a major portion

portion of the winter in front of us.

SUMMARY OF SURVIVALS AS OF DECEMBER 31, 1973

Table 1 lists by unit, species, numbers stocked, mortalities and probable causes, and numbers on hand as of January 1, 1973.

It is obvious from these preliminary data that the system at Sitka thus far out performed the systems at either Homer or Little Port Walter. Heavy mortalities at Little Port Walter were caused by a severe outbreak of vibriosis the latter part of July and early August. Mortalities at Homer and to a large extent those at Sitka, were primarily caused by salinity adaptation problems or water source problems. Losses to certain kinds of diseases did occur at those two units but we did not experience any mass mortalities caused by vibriosis. (Outbreaks of that disease have caused high mortalities at Manchester, Washington). One major point should be made, a high percentage of these mortalities (water source problems) can be prevented in next years operation since we understand salinity tolerance levels and much more reliable freshwater sources will be available. With the addition of a pathologist on the staff (requested FY 74 budget) an extremely active, timely disease prevention and control program will be initiated. (We had to wait as long as two months for pathologists reports from the lower forty-eight laboratories.) Despite the threat of untreatable diseases we are confident that we can prevent a high percentage of those problems we experienced this year from occurring during next years operation.

TABLE I. Stocking densities by species and location.
Mortalities by species, major cause and location.
As of December 31, 1972 - Sitka and Homer
As of November 30, 1972 for Little Port Walter

UNIT	TYPE	SPECIES	ESTIMATE NUMBER STOCKED	LOSSES TO CANNIBALISM ESCAPE-PREDATION, ERRORS IN ESTIMATING ORIGINAL STOCKING DENSITY	COUNTED MORTALITIES	MAJOR CAUSE	NUMBER ON HAND	% SURVIVAL
Sitka	Artificial lens	Coho	289,700[1/]	116,900	61,000	O,B,C, W	111,800	64.7[2/] (38.6)[3/]
Sitka	Artificial lens	King	37,400	1,900	19,700	O,W,	15,800	44.5 (42.2)
Sitka	Artificial lens	Sockeye	8,300	2,180	4,170	O,K,	1,950	31.9 (23.5)
TOTALS:			335,400	120,980	84,870		129,550	60.4 (38.6)
Homer	Artificial lens	Coho	231,900	77,100	136,000	O,B,W,	18,800	12.1 (8.1)
"	Artificial lens	Kings	42,000	18,700	17,900	O,B.W.	3,600	15.5 (8.1)
TOTALS:			273,900	95,800	153,900		22,400	12.6 (8.2)
Little Port Walter	Natural lens	Coho	279,000	No estimates	260,000	V,B,	19,000	(6.8)
Little Port Walter	Natural lens	Kings	48,000	No estimates	36,000		12,000	(25.0)
Little Port Walter	Natural lens	Sockeye	8,000	No estimates	7,600		400	(5.0)
TOTALS:			335,000	--	303,600		35,000	(10,4)

1/ 15,000 Cohos shipped to Little Port for experimentation during the winter

2/ % survuval calculated on the basis of observed mortalities and corrected stocking densities

3/ Calculated on estimated numbers at start and on hand January 1, 1973

Observed Mortality Key
O - Osmoregulatory failure
B - Bacterial Gill Disease
C - Costia
K - Kidney Disease
W - Water flow interruption
V - Vibriosis

SUMMARY OF SIZE INCREASE

The effect of osmo-regulatory induced mortalities, and mortalities from diseases, and cannibalism, within the pens,will obscure the true growth picture. However, it is pretty obvious (Table II) that a reasonably rapid rate of growth was achieved at Sitka and Little Port Walter. This is particularly true of sockeye at Sitka. The picture at Homer was not encouraging except that we actually retarded growth there (to some extent at Sitka) because salinities during the adaption process were too high. We anticipate achieving maximum growth under existing temperature regimens next year because we have a clearer understanding of the effects of salinity on growth. It is significant however, to note that growth was taking place during the early part of the winter.

Detailed triplicated experiments will be conducted during next year's operation to determine optimum stocking densities and salinities.

TABLE II. Comparison of growth expressed in number of fish per pound.

	WEIGHT BY MONTH			
COHO SALMON	JUNE 30	AUGUST 31	OCTOBER 31	DECEMBER 31
Sitka	503	144	118	75
Homer	500	328	181	151
Little Port Walter	634	168	139	Not available
KING SALMON				
Sitka	962	221	125	78
Homer	156	124	77	78
Little Port Walter	At Hatchery	72	43	Not available
RED SALMON				
Sitka	256	Fish delicate, did not sample		7
Homer	Not stocked			
Little Port Walter	300	86	Experiment discontinued	

PROGRESS REPORT ON THE FEASIBILITY OF SALMON SMOLT PRODUCTION IN ESTUARINE HUSBANDRY PENS AT LITTLE PORT WALTER

By

William R. Heard and Roy M. Martin

The National Marine Fisheries Service has agreed to submit to the Alaska Department of Fish and Game copies of semiannual progress reports of work done under terms of a cooperative agreement to test the feasibility of rearing salmon smolts in seawater husbandry pens. This report covers the first reporting period July 1 to December 31, 1972.

PROGRESS REPORT, JUNE-DECEMBER 1972, ON THE FEASIBILITY OF SALMON SMOLT PRODUCTION IN ESTUARINE HUSBANDRY PENS AT LITTLE PORT WALTER

BACKGROUND AND OBJECTIVES

During the past 8 years the National Marine Fisheries Service (NMFS) has conducted studies on the freshwater ecology of coho salmon in Sashin Creek at the Little Port Walter (LPW) field station to learn what factors influence smolt production. These and other studies suggest the availability and productivity of freshwater nursery areas generally limit smolt recruitment to the ocean. In Sashin Creek for example the annual smolt production of 1,500-3,000 individuals is fairly stable in spite of a 3- to 4-fold variation in annual fry recruitment to the stream from spawning beds.

An outgrowth of coho studies in Sashin Creek has been the development of studies on the biological feasibility of artificial smolt production by rearing fry in estuarine husbandry pens. The concept developed from observations of natural occurring nomad fry that survive and grow in intermediate surface water salinities of the LPW estuary during the summer months. Two small groups of coho fry (from 1968 and 1969 brood-year progeny) were reared in a 1-year period to smolt stage in estuarine pens. This established the ability of coho fry, under conditions in the LPW estuary to grow and survive through fry and presmolt parr stages and to undergo on a regular seasonal basis, a normal parr-smolt transformation. Both groups of pen-reared smolts were marked and released in the estuary, the release coinciding with the peak of wild smolt outmigration from Sashin Creek. Adult returns, after 16-18 months at sea, exceeded 10 percent of the number released in both pen-reared smolt groups. This established that imprinting and homing can occur in estuarine pen-cultured smolts and provided a rationale that this type of culture might be a viable method of artificially producing salmon smolts.

During the spring of 1972 the Alaska Department of Fish and Game (ADF&G), with primary responsibility for managing Alaska's salmon stocks including the development of enhancement programs to supplement natural production, expressed a desire to work closely with NMFS at LPW on a cooperative basis to test and develop the concept of smolt husbandry in estuarine pens. ADF&G simultaneously developed plans for two additional pilot estuarine husbandry systems, one at Kasitsna Bay in Cook Inlet and one at Starrigavin Bay near Sitka, to test the concept under different geographical and environmental conditions. The initial objectives of the pilot estuarine husbandry systems are to investigate the numerous aspects of early salinity adaptations of salmon fry and presmolt parr and to develop procedures for feeding and handling fry-parr-smolt in estuarine pens including evaluations of pen design, methods for cleaning pens, determination of food conversion, and growth capabilities under various salinity-temperature patterns.

LITTLE PORT WALTER FACILITY

Estuarine pen-rearing of salmon fry at LPW is possible because of a shallow intermediate salinity surface layer of water overlying deeper higher salinity water. This surface "lens," with salinities from near 0 to 10-15 °/oo and ranging from 6 to 16 inches in depth, developes from the freshwater discharge of Sashin Creek into LPW. Salmon fry that normally begin postemergent feeding in freshwater rearing areas are placed in small-mesh starter pens confined to shallow depths in the surface water. As fry increase in size, starter pens are lowered in the water column, providing exposure opportunities to gradually increasing salinities. Through this stepped exposure to higher salinities and as growth and increased salinity tolerance occurs, fry are eventually moved to other larger and deeper pens that encompass the complete range of vertical salinity gradients in the estuary. The dynamic fluctuations that occur in the salinity-depth relationship of the surface layer makes salinity acclimation under these conditions a generalized rather than a precise process. A notable feature, possibly of important significance is that at no time in the process are fry restricted to deeper high salinity water. Within the general vertical salinity gradients present, fry are free to occupy any stratum.

Husbandry Float

The estuarine rearing facility at LPW is centered in and around a 65- by 65-foot float structure divided into five primary compartments for culture pens (Figure 1). The float has a 3-foot-wide walkway around its periphary plus interconnecting walkways around individual compartments. The husbandry float is joined to the main 90-foot-long by 12-foot-wide LPW service float by a 10- by 30-foot connecting float covered with an open-walled roofed structure. This structure known as the "birdhouse" serves as a storage and staging area for work around the husbandry float. In addition to culture pens in the principal compartments of the husbandry float (the main compartments are readily subdivided for smaller pens) other culture pens can be positioned along the outside margin of the husbandry float.

Culture Pens

The culture pens consist of a flotation collar or other support structure and a rectangular-shaped nylon mesh net suspended in the water column. Several shapes and mesh sizes of nets were used at LPW. The principal nets used were 4 by 8 by 4 feet deep by 1/8-inch mesh (starter pens), 12 by 12 by 12 feet deep by 1/4- and 3/8-inch mesh, and 10 by 20 by 8 feet deep by 1/4-inch mesh.

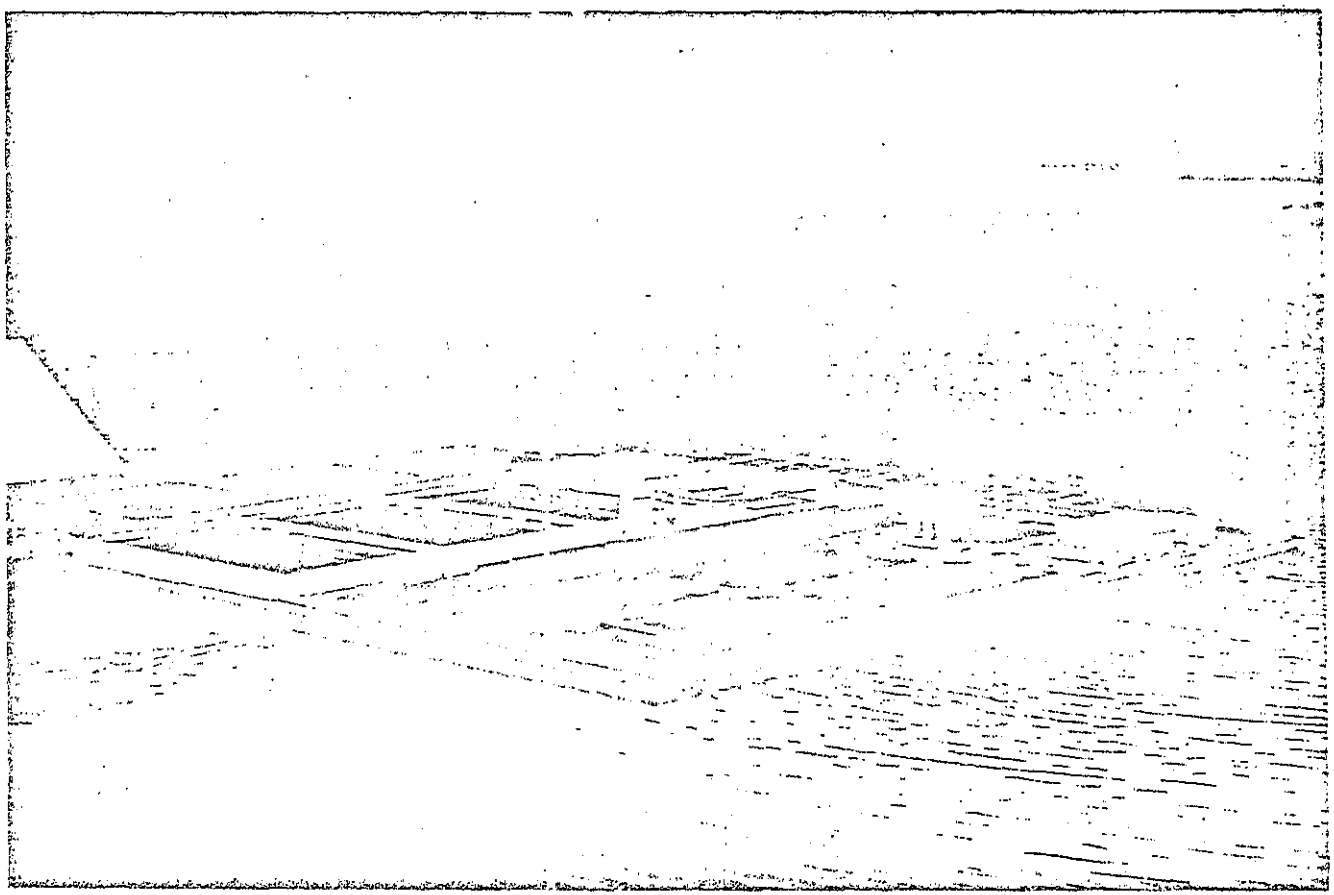

Figure 1.--Estuarine husbandry float at Little Port Walter showing general arrangement of culture pens in late June 1972 when fry were in shallow starter pens. Sashin Creek enters the estuary in the upper right corner of the photograph.

SALINITY-TEMPERATURE

Salinity features at LPW are strongly influenced by rainfall patterns, freshwater discharge from Sashin Creek, and daily and monthly tidal fluctuations. Surface isohalines are lowest in the stream mouth and increase toward the outer part of the estuary. They generally are lower along the northwest shoreline where the husbandry float is located than along the opposite shoreline. Salinity values in the shallow surface lens are in constant flux, illustrated by readings from two locations at high and low slack water during June 1972 (Table 1). The rate of change in surface salinities at a given point is erratic. On June 12 surface salinity inside a starter pen with coho fry was 12.9 °/oo at low slack water. One-half hour later this value dropped to 8.3 °/oo and further declined to 8.0 °/oo in the subsequent 6-hour period preceding high slack water.

Surface temperatures at LPW are affected by ambient air temperature, temperature of Sashin Creek discharge, and to a lesser extent by seawater temperatures in Chatham Strait. The temperature of deeper high-salinity water primarily reflects seawater temperatures in Chatham Strait. During the summer low-salinity surface water averages 4 to 8° F. warmer than the deeper seawater. In winter the relationship is reversed with surface water 2 to 4° F. cooler than deeper water. Average daily temperatures from June to December 1962 at 0 and 6.6 foot depths (Figure 2) were taken from weekly thermographs.

SOURCES OF FRY FOR REARING

Fry used for estuarine rearing studies at LPW in 1972 originated from two sources: (1) fry produced from eggs incubated in an experimental incubation facility at LPW; and (2) fry flown to LPW from eggs incubated at ADF&G hatchery at Fire Lake near Anchorage. All fry originating from the Fire Lake Hatchery were initially flown from Anchorage to the ADF&G estuarine rearing facility at Sitka before they were delivered to LPW.

The floatplane fry hauling from Sitka to LPW was generally an efficient and successful operation. A single-engine Norseman aircraft on floats was fitted with a 120-gallon hauling tank. Provisions were made to diffuse free oxygen through water in the tank. After an initial test flight with 11 pounds of coho fry on June 22, 40-60 pounds of fry were routinely hauled on the 45-minute flight from Sitka to LPW without significant handling loss.

The numbers and origins of each group of fry initially used in estuarine rearing studies at LPW in 1972 are listed by species below.

Coho

All coho fry used, including those from Fire Lake Hatchery via Sitka were from Sashin Creek stock. Approximately 0.8 million Sashin Creek coho eggs were shipped from LPW to Fire Lake Hatchery during the fall of 1971.

Table 1.--Salinity depth readings taken at high and low slack tide stages at two locations on the estuarine husbandry float at Little Port Walter in June, 1972.

Date	Inside of Culture Pen				West Edge of Float			
	Low Tide		High Tide		Low Tide		High Tide	
	Depth in Feet				Depth in Feet			
	0	0.8	0	0.8	0	4.0	0	4.0
	°/oo[1]		°/oo		°/oo		°/oo	
June 1	--	--	7.1	7.6	7.9	28.9	6.1	24.7
2	7.5	8.5	7.2	7.2	6.7	26.6	6.2	27.2
3	7.1	8.2	5.2	6.8	6.3	28.5	2.6	29.6
4	6.4	6.8	11.2	11.4	5.6	27.4	8.4	22.3
5	7.0	7.4	5.2	8.4	4.7	25.7	5.6	20.0
6	5.6	7.8	7.4	7.4	4.6	27.0	4.0	28.8
7	--	--	3.8	4.4	--	--	2.5	28.7
8	3.2	4.7	5.0	5.2	2.0	31.0	3.7	28.4
9	6.5	7.3	5.0	5.9	7.7	31.8	4.5	31.1
10	7.3	7.6	5.4	6.0	5.7	31.9	4.8	25.2
11	8.6	9.8	6.0	9.6	5.0	30.7	4.4	30.4
12	12.9	14.1	8.0	8.9	8.9	31.4	5.5	29.0
13	9.0	9.8	6.4	8.0	6.7	31.4	4.8	31.0
14	6.6	8.7	--	--	6.6	31.4	--	--
15	7.8	12.5	5.8	7.4	3.5	31.8	5.9	32.6
16	4.1	4.1	4.9	6.7	3.1	31.0	6.1	31.4
17	7.6	7.6	6.9	7.6	3.2	32.0	3.8	32.2
18	--	--	10.8	11.6	--	--	13.0	29.4
19	--	--	4.0	6.6	--	--	3.6	32.0
20	7.5	9.3	6.8	9.4	7.8	31.3	6.6	31.6
21	--	--	7.2	9.6				
22	6.8	9.0	4.8	6.4				
23	7.2	8.2	7.7	8.0				
24	9.5	11.0	12.1	14.4				
25	11.9	14.7	7.2	9.3				
26	9.1	12.8	5.3	5.1				
27	8.6	10.3	--	--				
28								
29								
30								

[1]Salinity determined from an ENDCO refractometer. These data are uncorrected for a known 5-10% bias in refractometer readings.

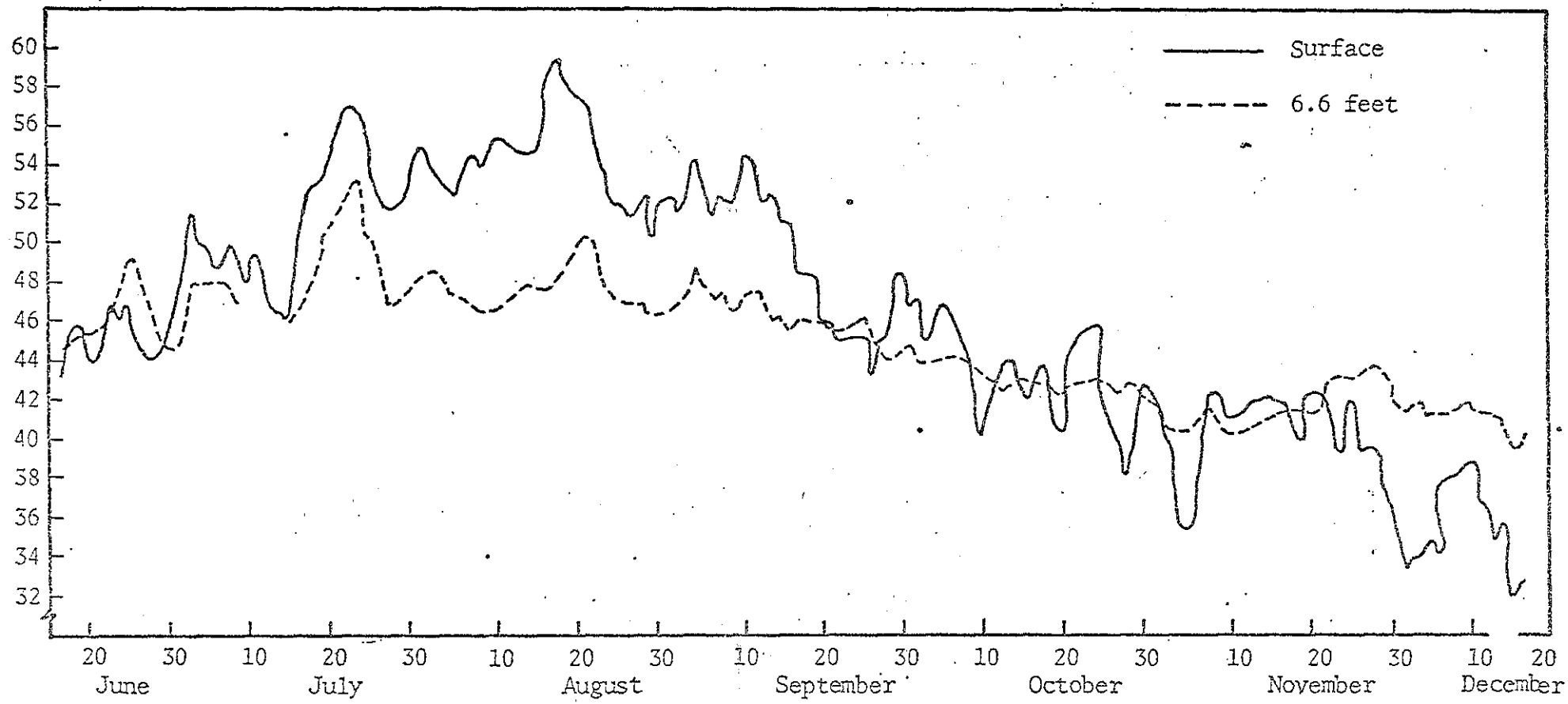

Figure 2.--Average daily temperature, late June to mid-December 1972, from surface and 6.6-foot depth at estuarine husbandry float, Little Port Walter.

On June 22-23 approximately 171,000 coho fry were delivered at LPW from Fire Lake Hatchery via Sitka. These fish are designated Coho Group 1. They averaged about 700/pound on arrival at LPW.

During June and early July, 98,800 coho fry from LPW incubation sources were used in beginning husbandry studies. Initially these fry were separated according to incubation histories (gravel boxes or Heath tray), however, following a severe vibriosis epidemic in late July-early August all coho fry from this group were combined and are designated Coho Group 2. They initially averaged about 1,200/pound.

On October 10, 10,000 coho fry were delivered to LPW from Sitka. These fish were similar in origin to Coho Group 1 but had undergone pen culture at Stika during the period from late June to early October. They were delivered to LPW following heavy vibriosis losses of Coho Groups 1 and 2 to provide sufficient fish to test the LPW husbandry facilities under winter conditions and to provide sufficient smolts for imprinting-homing studies in spring 1973. These fish are designated Coho Group 3. They averaged from 100-150/pound on arrival at LPW.

A fourth group of coho fry were initially used in a separate study where fry are stocked in lakes. These fry were incubated in gravel boxes at LPW and stocked in nearby 40-acre Ludvik Lake on June 27. Fry from this planting that passed downstream through a weir structure at the lake outlet were placed in estuarine husbandry pens at LPW. About 9,000 fry left the lake, mostly during flood-stage water conditions in late August, September, and October. They are designated Coho Group 4. They ranged from about 300 to 150/pound when they were placed in estuarine pens.

Spring Chinook

On July 18-19, 48,000 spring chinook fry were delivered to LPW from the Fire Lake Hatchery via Sitka. These fry originated from the Carson National Hatchery stock on the Columbia River. They averaged about 150/pound on arrival at LPW.

Fall Chinook

In mid-December 1971, 10,000 eyed fall chinook eggs from the University of Washington Donaldson stock were taken to LPW for incubation in Heath trays. Approximately 8,000 fry from these eggs that averaged about 1,100 fry/pound were initially used in husbandry studies in late June 1972.

Sockeye

On June 24, 8,000 sockeye fry were delivered to LPW from Fire Lake Hatchery via Sitka. These fry originated from a Cook Inlet stock. They averaged about 300/pound on arrival at LPW.

HUSBANDRY OPERATIONS

General husbandry operations fell into three categories: feeding, pen cleaning, and status assessment of fry groups. Oregon Moist Pellet fish diet, either in starter mash or pellet form, was used during the period. Feeding schedules varied seasonally and according to size of fry. In general, during June-August, fry were fed 8-12 times each day; in September-November they were fed 4-6 times daily; and in December 2-4 times daily. Fry were usually fed to satiation at each feeding.

During the period June-mid-September the 1/8-inch-mesh starter nets (4 by 8 by 4 feet deep) were usually cleaned of fouling growths at about 10-day intervals by transferring fry to clean nets and washing the fouled nets in a washing machine. The few larger 1/4- and 3/8-inch-mesh nets used during the summer were cleaned at irregular intervals by removing the fish and washing the net on a deck surface with water under pressure from a gasoline-driven centrifugal pump. During the fall and winter when all fish were in 1/4- or 3/8-inch-mesh nets, growths of fouling organisms were minimal.

Chronological Status of Fry Groups

Chronological status of fry groups including the number and sizes of husbandry pens in use and the number and sizes of fry for each group at periodic intervals throughout the reporting period are summarized in Table 2. Fall chinook fry are excluded from Table 2 because little information was collected before most of this group died during a mid-summer vibriosis outbreak. Losses to all groups from vibriosis were severe.

Vibriosis Epidemic

Excluding Coho Groups 3 and 4 that did not start until fall, all fry groups were in low-salinity, surface-water starter pens by mid-July. Approximately 850 pounds of fry were arranged in 22 pens adjusted so 1 to 1.5 feet of the pen depth was in water. In the most crowded pens fry densities approached an estimated 1.5 pounds of fry per cubic foot of water volume; average densities for all pens probably ranged from 0.6 to 1.0 pounds per cubic foot. Under these conditions during

Table 2.--Chronological status of salmon fry groups in culture pens, Little Port Walter, June-December, 1972.

Group Designation	Date	Culture Pens (number)	Culture Pens (type)[1]	Total Weight (pounds)	Fish per Pound (number)	Total Fish (number)	Fork Length Mean (mm)	Fork Length Range (mm)
COHO GROUP 1[2]	June 23	6	A	228.6	693	158,400		
	July 7	8	A	297.6	575	171,000		
	July 13[3]	8	A		450		45.9	34-58
	July 29[3]	8	A		284		50.1	35-63
	→*Aug. 18	4	A	79.0	195	15,400		
	Aug. 21	3	A	59.4	195	11,600		
	Aug. 28[3]	3	A		168		61.8	44-74
	Sept. 6[3]	3	A	66.4	153	10,200		
	→Sept. 8	1	B					
	→Oct. 2	1	B	48.0	129	6,200		
	Nov. 11[4]	1	C	52.0	148	7,700	65.3	50-86
COHO GROUP 2[5]	June 26	4	A	64.5	1,167	75,300		
	July 7[3]	4	A	99.9	912	91,100		
	July 14[3]	4	A	118.4	835	98,800	38.4	33-44
	July 29[3]	4	A				43.3	35-53
	→Aug. 21	2	A	14.4	350	5,000		
	Aug. 28[3]	2	A		284		49.3	35-65
	Aug. 31[3]	2	A	18.7	262	4,900		
	Sept. 9[3]	2	A	20.5	236	4,800		
	*Sept. 20	1	B	25.3	220	5,600	55.2	39-73
	*Oct. 2	1	B	21.5	116	3,600		
	Oct. 18[6]	1	B				62.7	51-81
	Dec. 1	1	E	14.0	192	2,700	61.8	49-77
COHO GROUP 3[7]	Oct. 10	1	C	100	~100	10,000		
	Nov. 11[4]	1	C		135		67.2	49-98

Table 4.--Continued.

Group Designation	Date	Culture Pens (number)	Culture Pens (type)	Total Weight (pounds)	Fish per Pound (number)	Total Fish (number)	Fork Length Mean (mm)	Fork Length Range (mm)
COHO GROUP 4[8]	Sept. 20	1	A	31.0	115	3,600		
	Oct. 2	1	B	47.4	108	5,100		
	Nov. 30	1	C	48.9	103	5,000	75.7	53-97
SPRING CHINOOK	July 19	8	A	314	154	48,300		
	July 31	2	B	384				
	Aug. 21	1	D	216	81	17,500		
	Aug. 28	1	D		72		80.9	56-98
	Sept. 18	1	D		57		87.5	65-104
	Sept. 29	2	D	290	48	13,900		
	Nov. 13	2	D		41		96.2	73-118
					45		94.2	69-114
SOCKEYE	June 24	1	A	26.6	300	8,000		
	July 14	1	A	31.5	228	7,182	60.6	49-73
	July 29	1	A				67.3	46-82
	Aug. 21	1	A	9.9				
	Aug. 31	1	A	10.4	86	900		
	Sept. 9	1	A	10.3	82	800		
	Oct. 25	1	A			~400	discontinued	

[1]Pen A is starter pen 4 by 8 by 4 feet (1/8-inch mesh)
Pen B is 10 by 20 by 8 feet (1/4-inch mesh)
Pen C is 12 by 12 by 12 feet (1/4-inch mesh)
Pen D is 12 by 12 by 12 feet (3/8-inch mesh)
Pen E is 6 by 6 by 6 feet (1/4-inch mesh)

[2]Sashin Creek stock coho flown to LPW from Fire Lake Hatchery via Sitka, June 22-23, 1972.

[3]Data are pooled average for fish group; data shown are available for the number of individual pens indicated.

Table 2.--Continued.

[4]After data indicated were collected, all Coho Group 1 and Coho Group 3 fish were combined in Type C pen.

[5]Sashin Creek stock incubated at LPW, originally separated by incubation histories.

[6]After data indicated were collected, approximately 15 pounds of coho averaging about 260 per pound were added to Group 2 fish. The added fish were late emerging fry from LPW incubation plus some fry from Sashin Creek. Many were too small for retention by 1/4-inch mesh.

[7]Sashin Creek stock coho from Fire Lake Hatchery and reared in estuarine pens at Sitka mid-June to Oct.9, 1972.

[8]Sashin Creek stock coho fry planted in Ludvik Lake June 27 that migrated out of the Lake primarily during Aug.-Oct. floods.

→ denotes major loss of fish to vibriosis.

* denotes major loss of fish to mechanical causes.

a period of warm sunny weather in late July and early August a serious disease epidemic developed in all fry groups at LPW. Rapidly increasing mortalities initially occurred in Coho Group 1 but quickly spread, in about 1 week, to all fry groups. In early August daily mortalities reached 10-20 percent of the surviving populations in most pens.

Two groups of coho fry were shipped to the Western Fish Disease Laboratory (WFDL)--one group on July 27 and another on August 2. No pathogenetic agent was diagnosed from the July 27 specimens, however, the August 2 specimens were heavily infected with a bacterium tentatively identified as Vibrio sp. Subsequent culture test of the bacterium confirmed the tentative diagnosis.

Between 90 and 98 percent of the coho, sockeye, and fall chinook fry died from vibriosis. Spring chinook mortalities during the same period amounted to about 70 percent. Oregon pellets medicated with oxytetracycline (veterinary-grade Terramycin, TM50) were fed all groups beginning around August 10 but it is believed the virulence of the disease was too advanced for the broad-based antibiotic to have much immediate effect. A low-level mortality (0.1 to 0.5 percent per day) believed to be primarily from residual chronic effects of the earlier epidemic, continued in all groups throughout the late summer and early fall period. A secondary major disease outbreak also presumably caused by Vibrio occurred in Coho Group 1 in early September when daily mortalities rose to 2 to 5 percent of the surviving population (200-400 fry per day).

The slightly less net loss of spring chinook fry over other fry groups during the vibriosis outbreak may have been due to (1) differences in handling of fry groups, (2) larger size of spring chinook fry, or (3) greater resistance of these fry to the disease. After the epidemic was underway, all fry groups except spring chinook were retained in starter pens in surface water. To alleviate crowding the spring chinook fry were transferred from eight starter pens on July 31 into two 1/4-inch-mesh pens 10 by 20 by 8 feet deep. This moved spring chinook fry into deeper, cooler, and higher salinity water and lowered their density from about 0.9 to about 0.2 pounds of fry per cubic foot of water volume. These fry averaged about 150 per pound when the transfer was made--apparently large enough to adjust to the abrupt salinity change--at least to the extent the net loss during the vibriosis epidemic was less than in other fry groups. Other fry groups were too small during the epidemic to move from 1/8-inch-mesh starter nets.

Three factors, warm surface water temperatures, prior disease stress, and crowding are believed to have contributed to the severity of the outbreak of Vibrio. Maximum daily surface water temperatures in late July and

early August were frequently at or near 60° F., a level known to favor vibriosis. Before arrival at LPW all fry groups originating from the Fire Lake Hatchery had received prophylactic treatments for bacterial gill disease. These fish also apparently had bacterial fin rot because shortly after arrival at LPW they were noted to have badly frayed and missing fins, usually pectoral fins. On July 24, 92 percent of the mortalities and 38 percent of the live fish in one pen of Coho Group 1 fry had one or more pectoral fins missing. A comparison of frayed or missing fins between fry in Coho Groups 1 and 2 in late July (Table 3) indicates damaged fins were more prevelant in the former group. The pre-Vibrio bacteral infections fry from Fire Lake Hatchery had on arrival at LPW were undoubtedly aggravated by crowding in the starter pens.

Other Losses of Fry

Although most mortality among fry groups at LPW was attributable to disease factors, significant losses did occur from other causes, notably mechanical losses associated with handling fry and predation by larger fish chewing into culture pens. Three significant mechanical losses occurred and on three occasions juvenile cod (Gadus macrocephalus) entered pens and preyed on fry.

On August 18, about 4,000 Coho Group 1 fry died when an aluminum frame supporting a pen of these fish grounded at low tide and dewatered the pen. On August 21, an unknown number (estimated at 2,000 to 3,000) of spring chinook fry escaped during pen-transfer operations. After they escaped, several schools of these fry were noted swimming near the culture pens. A purse-seine-like net was used to recapture about 1,500 of the fry.

The third mechanical loss was not a single event but a situation that occurred each time fry were transferred into larger mesh nets. When these transfers were made, some smaller, slow-growing fry invariably escaped through the larger meshes. This loss of fry, to some extent predictable, was considered acceptable in trying to best utilize available pens. Notable losses from this cause occurred on August 21 with spring chinook fry, on September 8 with Coho Group 1 fry, and on October 18 with Coho Group 2 fry.

A large school of many thousands of juvenile cod occupied the LPW estuary during September and October. Young cod 6 to 12 inches in length were frequently noted around culture pens and associated float structures. The cod gained entrance to culture pens, we believe, by trying to injest mortalities lying against the webbing on the inside

Table 3.--Occurrence of missing or badly frayed fins in two groups of coho fry in LPW estuarine pens, July 28-29, 1972.

	FRY EXAMINED (number)	MEAN FORK LENGTH (mm)	FRAYED OR MISSING FINS (number)	(percent)
COHO GROUP 1				
Pen 1	109	49.8	37	34
2	106	50.7	15	14
3	116	49.6	12	10
4	72	51.5	11	15
5	128	50.5	23	18
6	109	49.0	41	38
7	121	50.8	28	23
8	108	49.2	34	31
Group Mean	N=869		N=201	23.1
COHO GROUP 2				
Pen 1	71	41.2	0	0
2	60	45.3	6	10
Group Mean	N=131		N=6	4.6

of the net. Trying to swallow the dead fish through the webbing, the cod in effect chewed into the net. Once a hole developed in the webbing, other cod swam into the net. On two of three occasions, 10 or more cod entered a net before they were detected (probably a maximum 12- to 18-hour period). All three nets involved in these losses were 10 by 20 by 8 feet deep of thin-twined 1/4-inch-mesh webbing. Unknown numbers of fry from Coho Groups 1 and 2 were lost to this type of predation.

DISCUSSION

Heavy vibriosis losses dominated attempts to acclimate fry to intermediate salinities in estuarine culture pens at LPW in 1972. No disease problems were detected at LPW during the summer of 1969 and 1970 when two small groups of coho fry (roughly 300 in 1969 and 12,000 in 1970) were acclimated to estuarine culture pens and reared to smolts the following spring. A comparison of surface water temperatures at LPW during July and August in 1969, 1970, and 1972 (Table 4) indicates that while August temperatures were notably higher in 1972, average July temperatures in 1972 were actually lower than in 1969 and 1970. This suggests that while high August temperatures in 1972 undoubtedly added to the severity of the vibriosis outbreak, temperature itself may have had less influence in causing conditions that led to vibriosis than stress from crowding and prior disease factors.

Surviving coho fry in 1972 did not grow well, possibly due to residual stress associated with vibriosis. A comparison of coho fry growth in estuarine pens at LPW in 1970 and 1972 (Figure 3) reveals that 1972 growth was considerably below 1970 although warmer August temperatures in 1972 should have accelerated growth (assuming no disease problems).

Temporal and spatial aspects of salinity acclimation under the estuarine husbandry approach at LPW are not precisely known. In addition to the general procedure of culture in intermediate surface salinities before fry are moved to deeper pens with higher salinities, certain threshold fry sizes with a seasonal growth sequence may be necessary for fry to completely adapt to this type of culture.

A series of salinity tolerance challenges were made with fry from Coho Groups 1 and 2 in June and July by submerging fry in live cages at depths where salnities were 30 °/oo or greater. Fork lengths of fry averaged around 38 to 40 mm in June and 46 to 48 mm in July. Although results of these tests are clouded by attendance disease problems, in general they indicate coho fry in these size groups after rearing for 1 month in

Table 4.--Surface water temperatures of Little Port Walter inner bay estuary, 0800 to 1000 hours during July and August, 1969, 1970, and 1972.[1]

	JULY			AUGUST		
DAY	1969	1970	1972	1969	1970	1972
1	49	50	44	50	51	--
2	52	49	45	50	51	53
3	50	51	48	50	52	53
4	50	50	46	51	51	52
5	49	49	45	51	51	51
6	50	48	45	52	51	51
7	50	48	45	51	51	53
8	52	48	45	51	51	53
9	50	47	46	50	51	51
10	48	48	45	50	52	52
11	48	49	47	50	53	53
12	48	49	47	50	51	53
13	47	49	46	50	51	54
14	48	49	45	48	51	54
15	50	49	46	48	50	54
16	50	49	49	48	50	54
17	50	49	49	47	49	56
18	51	49	49	47	49	58
19	51	49	49	48	49	58
20	51	48	50	47	49	55
21	52	49	51	48	49	56
22	51	49	53	47	49	57
23	51	49	54	48	49	53
24	50	49	--	48	49	51
25	51	50	55	49	50	52
26	51	50	53	49	50	51
27	51	52	51	49	49	50
28	51	53	50	48	50	52
29	51	54	50	49	51	50
30	50	53	50	49	50	50
31	50	52	50	49	50	50
Monthly Mean	50.10	49.58	48.26	49.10	50.32	53.00

[1]1969 and 1970 data were taken from hand-held thermometer readings on main service float, 1972 data are from recording thermometer on husbandry float.

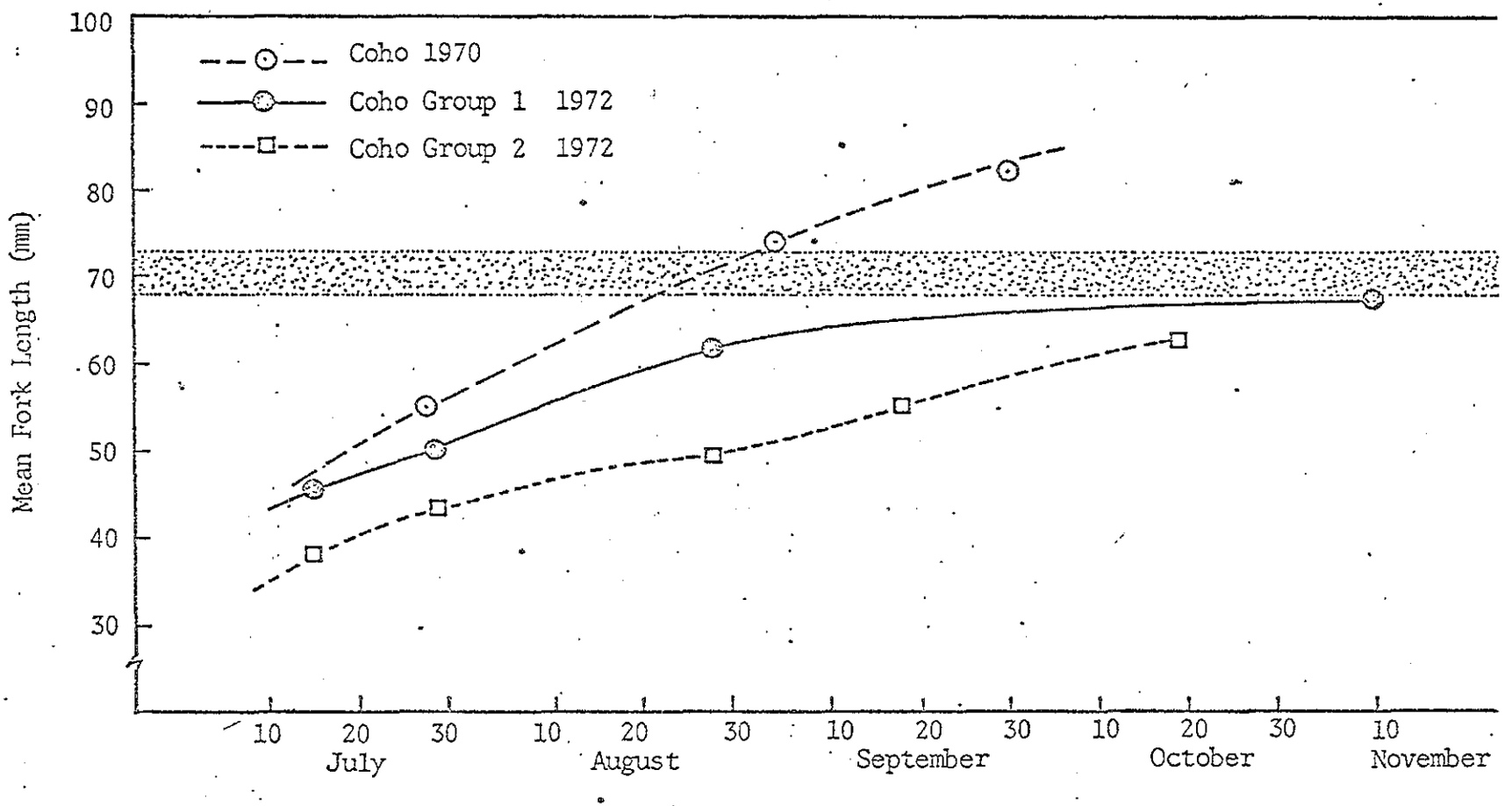

Figure 3.--Comparative growth of coho salmon fry in estuarine pens at Little Port Walter in 1970 and 1972. Shaded area represents possible threshold size required for complete salinity acclimation under Little Port Walter conditions.

low-salinity surface water still could not survive prolonged confinement in high salinities. Again an important consideration may be that in regular husbandry pens at LPW where fry encounter high salinities they have access to low-salinity surface water. Comparative tests should be made on salinity acclimation processes in natural vertical gradients and in individual homogeneous salinities.

Some lines of circumstantial evidence suggest a theoretical threshold size for complete salinity acclimation of coho and chinook fry under LPW husbandry conditions at roughly 68 to 73 mm fork length and 3 to 4 grams weight (150 to 115 fish/pound). Coho fry reared at LPW in 1970 attained this size range in late August (Figure 3) and they continued to grow and survive well in late summer and fall. Spring chinook fry were in this size range when delivered to LPW in mid-July 1972. Following 2 weeks of acclimation culture in low-salinity surface water these fry were moved into deeper high salinity pens. In spite of heavy vibriosis losses this group of fry survived and grew better than any group at LPW in 1972, exceeding 90 mm in length and 50 fish/pound in weight by mid-November (Table 2). Most Coho Group 4 fry from Ludvik Lake were in or close to this theoretical threshold size when they were placed in estuarine husbandry pens. This group of fry also survived and grew well, reaching 76 mm in length in late November. Conversely, Coho Groups 1 and 2 fry never quite reached the theoretical threshold size during the main growth period (July through September) and their subsequent growth was poor (Figure 3). Coho Groups 1 and 2, however, were among the fry hardest hit by vibriosis and general observations suggested that vibriosis mortalities in these two groups may have been biased toward larger, faster growing fry.

REPORT OF PROGRESS ON A PILOT STUDY OF THE FEASIBILITY OF PRODUCING HIGH QUALITY SALMON FRY FROM GRAVEL ENVIRONMENTS

By

Jack E. Bailey

National Marine Fisheries Service has agreed to submit to Alaska Department of Fish & Game copies of biannual progress reports of work done under terms of a cooperative agreement to design, construct, and test pilot gravel incubation facilities for production of high quality salmon fry. This reports the first six months, July 1, to December 31, 1972, of the work agreement for fiscal year 1973.

SALMON PHYSIOLOGY

BACKGROUND AND OBJECTIVES

The National Marine Fisheries Service (NMFS) and the Alaska Department of Fish & Game (ADF&G) agreed in August 1971 to work together at the Auke Creek experiment station to develop a system of producing high quality salmon fry which could be used for mass releases to enhance or rehabilitate depleted stocks. The agreement is subject to annual approval by both agencies. The annual review and approval to continue the work was completed June 5, 1972. (See attached Cooperative Agreement). The successful development of a system for artificial production of salmon fry will constitute substantial progress in a major area of mutual interest, viz. establishing the scientific and technical base for aquaculture to aid industrial initiatives.

The key to successful production of high-quality fry is the incubation of the alevins in a gravel environment which equals or exceeds the natural environment in certain important characteristics. That is, the artificial environment must provide physical support; darkness; adequate oxygen; freedom from silt, predators, toxicants, and disease; and protection from dessication and freezing. The resulting fry must equal wild fry in size, behavior, energy reserve, and ability to return from sea to the site of release as mature adults.

Gravel incubators seeded with pink salmon eggs at Auke Creek in 1972 demonstrated survival to the emergent fry stage better than five times the survival of naturally spawned eggs in Auke Creek. Similar incubators developed by R. A. Bams in British Columbia have yielded a six-fold increase in survival to the emerging fry stage. Thus, the concept of incubating eggs in a carefully controlled gravel environment appears to have good potential as a management tool in situations where there is an identified need for increased fry production.

A complete test of a fry production system must eventually include an evaluation of adult returns. Given the present state of the art of marking pink salmon fry, an evaluation of adult returns would require the release of approximately one million fry from the Auke Creek Experiment Station. The natural Auke Creek escapement will not provide sufficient eggs for such a study. Because of genetic considerations, it is deemed unwise to introduce large numbers of eggs from any donor stream to Auke Creek. The long-range plan is to evaluate fry production systems at Auke Creek on the basis of fry quality while gradually building up the adult run for a full-scale test at some future time. Counts of adult pink salmon at the Auke Creek weir have been recorded as follows:

Year	Adults
1967	3,761
1968	2,638
1971	2,090
1972	1,768

The only estimate of fry production was in April 1972 when a hydraulic pump census indicated there were 157,000 fry in the streambed above the weir and 16,000 fry below the weir. In addition to the wild fry, approximately 181,000 incubator fry were released from the Auke Creek Experiment Station.

The immediate objectives for fiscal year 1973 are to: (1) release a substantial number of pink salmon fry from gravel incubators; (2) evaluate mechanical problems and cost of operating a water filter/ultraviolet purifier system; (3) compare quality of fry produced in filtered and irradiated water with quality of fry produced in untreated water and, (4) acquire the equipment and expertise to fin clip substantial numbers of pink salmon fry for future tests of ocean survival.

The evaluation of the incubator test results in the spring of 1973 will be on the basis of survival from eyed egg to emergent fry, fork length of preserved fry, wet weight of preserved fry, timing of emergence, stage of development at time of emergence, and energy reserve as measured by fat content of emergent fry. This report of progress describes work completed toward accomplishment of the stated objectives during the period July 1, to December 31, 1972.

Building and Water Supply

A 24-foot x 44-foot heated building has space for a water filter and sterilizer system, (Figure 1) tray incubators and gravel incubators with one million egg capacity, and the fry censusing and sampling equipment. The building is located on the bank of Auke Creek near the fish counting weir where eggs can be collected from the salmonids: pink salmon, chum salmon, coho salmon, sockeye salmon, Dolly Varden trout, and sea run cutthroat trout that utilize the Auke Creek Lake drainage system.

Water is supplied through a buried 4-inch PVC pipe which is connected to the

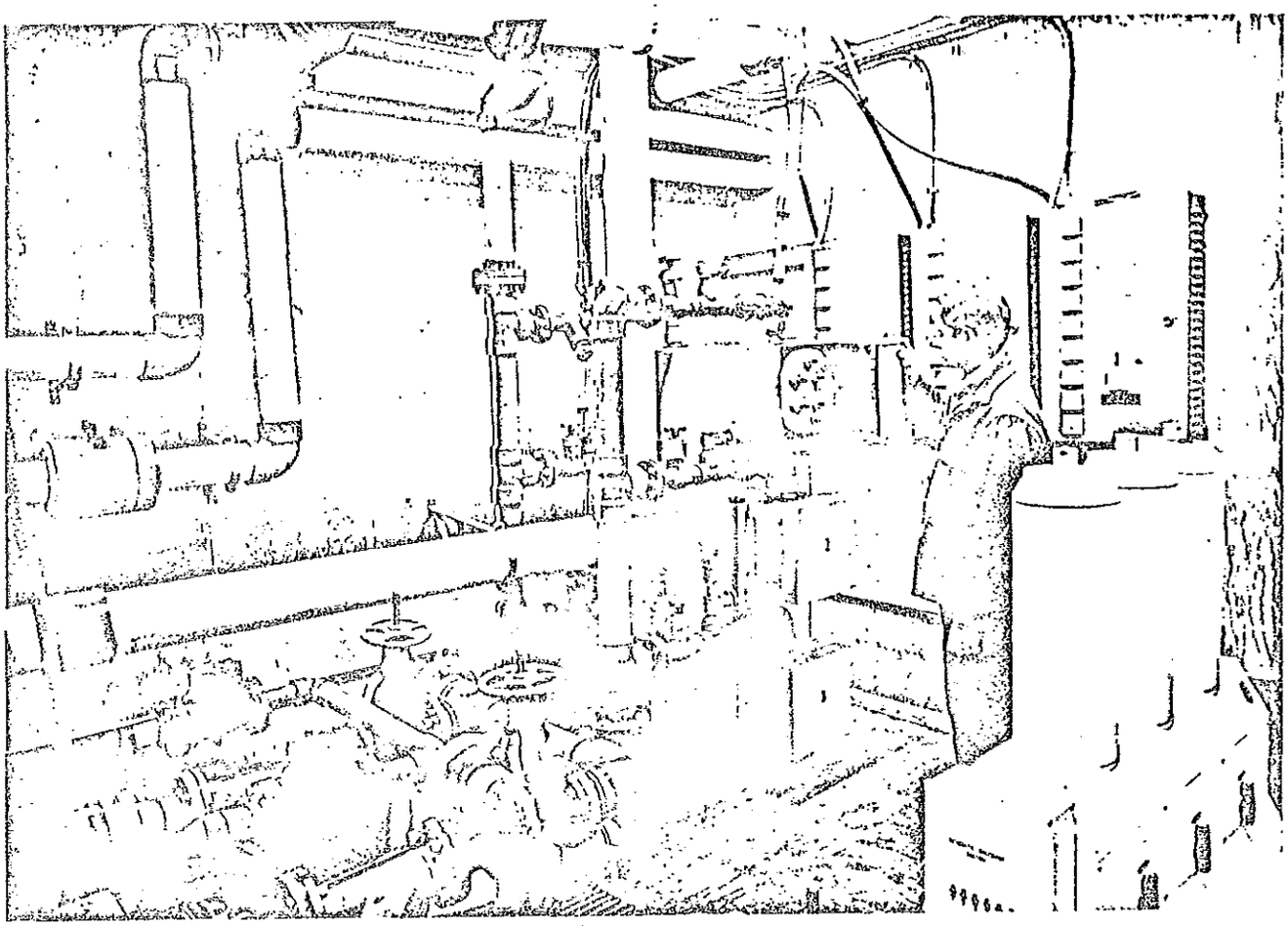

Figure 1.--The three-bowl filter, right foreground, and ultraviolet water purifier are designed to provide 150 gallons per minute of treated water to incubators at the Auke Creek Station.

14-inch wood stave pipeline from Auke Lake. This 14-inch pipeline also carries freshwater to the Auke Bay Fisheries Laboratory.

The Auke Lake water carries a load of organic material that settles out in form of rod-shaped particles 3 to 5 microns in diameter and 10 microns or more in length. The particles, when accumulated in a mass, have the brown color and general appearance of peat. Because these particles clog the gravel interstices of incubators, it is deemed advisable to filter the water. Ultra-violet sterilization of the filtered water is also recommended because filter media tend to become sources of bacterial contamination. The filter-sterilizer system installed at the Auke Creek fry production facility is designed for a continuous flow of 150 gallons per minute. It uses spun polypropylene fibers in wound cartridges as the filter media. The cartridges are available in 1, 3, 5, 10, and larger micron ratings. We have begun the tests with 10 micron cartridges and will test finer ratings only if the 10 micron size is not effective.

Water temperature in the incubators was 7° C. (45° F.) August 8, 1972, at the beginning of spawning and 6.5° C. (44° F.) September 22, 1972, at the end of spawning. The incubation temperature gradually dropped during October and November and stablized at 3.8° C. (39° F.) November 28, 1972. The seasonal temperature pattern in Auke Creek follows the same general pattern of cooling during October and November, but the creek water is warmer in late summer and fall, and cooler in the winter than water from Auke Lake. Stream temperature dropped from 15° C. (59° F.) to 9.2° C. (48° F.) during the spawning season. Winter stream temperatures ranged from 0° to 2° C. (32° to 36° F.).

The dissolved oxygen content of Auke Lake water ranged from about 8 to 10 mg/liter during the 1970-71 and 1971-72 incubation periods. The oxygen level remained in the range 8 to 10 mg./liter during the period September through December, 1972, and the oxygen levelcof incubator effluents did not drop below 8 mg./liter during this period.

Eggs

Pink salmon eggs for the incubator study were obtained from Auke Creek. The eggs were taken by incision from females that had been killed by a blow on the head and bled by cutting the caudal artery. Care was taken to avoid contamination of the eggs with blood, slime, or water. Three to five females were spawned into a plastic pail and sperm from an equal number of males was added. The eggs were then gently mixed and washed with fresh water.

A total of 1,768 adults were counted during the period August 12, to October 5, 1972, as they entered the fish counting weir en route to upstream spawning areas. We did not count the intertidal spawners below the weir. About 48 percent of the adults that entered the weir were females. Eggs were taken from 386 females while 459 females were released to spawn naturally above the weir and 10 females were sacrificed for fecundity counts. The eggs from these 386 females represented approximately 46 percent of the potential egg deposition for upstream Auke Creek. If the incubators function satisfactorily, these eggs have the potential of returning about five times as many spawners to Auke Creek as will return from the 54 percent of the eggs that were deposited in the stream by natural spawning.

A total of 667,659 eggs were taken from 386 females. The average 1,730 eggs per female represents about 85 percent of the average fecundity (2,035 eggs/female) at Auke Creek this year. Most of the 15 percent loss of eggs was caused by killing females that were not completely ripe, but some of the loss was due to females spawning in the pens.

The eggs were incubated to the eyed stage in screened trays. The tray incubators were covered with black plastic sheets to protect the eggs from light. Malachite green treatments, 15 ppm for one hour at 10-day intervals, were used to control fungus growth. The pickoff of dead eggs amounted to 6.8 percent of the 667,659 eggs taken. The eggs had an average count of 609 eggs per 100 ml. of displaced water and a mean weight of 0.1678 gm./egg.

Incubators and Test Conditions

Fry produced in four gravel incubators, two receiving filtered/u.v. treated water and two receiving unfiltered/raw water will be compared with fry from a screened tray incubator and wild fry from Auke Creek. The Bam's box gravel incubators measure 4'x4'x4' deep and utilize a system of perforated pipes and horizontal layers of graded gravel to achieve uniformity of upwelling flow through the eggs and gravel. We could not obtain perforated plastic sheet stock for false bottoms so could not include NMFS incubators in the 1972-73 tests.

Bams' Box:

The grid of pipes in the Bams box is comprised of a 2-inch PVC pipe manifold that feeds water to eight pairs of 3/4-inch PVC cross pipes placed on 6-inch

centers. The cross pipes have pairs of 5/64-inch holes drilled 45° from vertical and placed on 3-inch centers. The coarse gravel substrate in which the grid of pipes is buried and which supports the eggs, is river gravel that had been washed and graded to remove all particles under 3/4 inch and over 1-1/4 inch in diameter. A 3-inch layer of birdseye gravel acts as a pressure plate to achieve uniform water velocities in all parts of the box. The layer of birdseye gravel is also river gravel washed and graded to remove all particles under 1/8-inch and over 1/4-inch in diameter. The boxes were loaded by placing the pipe grid on the bottom and packing a 6-inch layer of coarse substrate around and on top of it. This was followed by the 3-inch layer of birdseye gravel. Then followed six 3-inch layers of coarse substrate, each receiving 1/8th of the box total of eggs. The last layer of eggs was topped off with 6 inches of coarse substrate. About 4 inches of open water was left at the top where emergent fry can swim to the outlet on the side of the box. For each layer, the eggs were simply scattered over the entire gravel surface (in upwelling water) and the next layer of gravel was added by hand shoveling, working from the walls of the tank toward the center.

Two Bams' boxes designated B and C were loaded with 150,000 eggs each, Table 1. Water flow to boxes B and C was filtered and ultraviolet irradiated whereas water flow to boxes A and D was unfiltered and untreated. Boxes A and D were loaded with 150,000 and 158,000 respectively. Flow to boxes A, B, and C was set at 75 liters/minute (20 gpm) and the flow to box D was 79 liters/minute (21 gpm).

Table 1.--Auke Creek Experiment Station--1972-73

	A	B	C	D
Boxes	4x4x4	4x4x4	4x4x4	4x4x4
Area, m^2	1.4864	1.4864	1.4864	1.4864
Volume, substrate & eggs, m^3	1.246	1.246	1.246	1.246
Flow, liters/minute	75	75	75	79
Water treatment	untreated	treated	treated	untreated
Eggs, number	150,000	150,000	150,000	158,000
Eggs/m^3 of substrate, number	120,385	120,385	120,385	126,806
Eggs/liter/minute, number	2,000	2,000	2,000	2,000
Apparent velocity, $cm^3/hr./cm^2$	303	303	303	319

Tray Incubator:

A standard hatchery incubator of 8 vertically stacked trays was seeded with 1,000 eggs in each of 4 trays. Water flow was set at 5 gallons per minute. An additional two trays were seeded with 1,000 eggs per tray and a single layer of 3/4" to 1-1/4" river gravel. The fry produced on the flat screen trays will be compared with gravel incubator fry and creek fry. The hatchery incubator will also provide a source of fry samples with which we can establish the basic parameters of an index to stage of development

$$\left(k_D = 10 \sqrt[3]{\frac{\text{weight in mg.}}{\text{length in mm.}}} \right)$$

based on lengths and wet weights of preserved fry.

Evaluation

On the basis of past experience, we expect fry to emerge from the incubators and migrate to Auke Bay in April, 1973. The evaluation of the incubators will be on the basis of survival from eyed egg to emergent fry, fork length of preserved fry, wet weight of preserved fry, timing of emergence, stage of development at time of emergence, and energy reserve as measured by fat content of emergent fry. Samples of incubator fry, and samples of creek fry (at least 100 fry per sample when available) will be preserved in 10 percent formalin at weekly intervals during the period of emergence. The preserved fry will be stored for six weeks before measurements are taken. Additional weekly samples of fry (three 10-fry samples per week) will be frozen for the fat analyses. Total lipid will be measured by Soxhlet extraction.

Equipment is being purchased and space and facilities are being prepared to fin clip fry at Auke Creek. Clearance has been obtained from Pacific Marine Fisheries Commission to release 1972 brood hatchery fry with AD-LV fin marks and wild fry with AD-RV fin marks.

Because of inexperience with operational characteristics of the filter system, a substantial amount of unfiltered water bypassed the system and entered the "filtered water" incubators. A change in flow rate October 20, 1972, may have stirred up a large quantity of the organic sediment in the 14-inch wood pipeline and this material apparently settled in the gravel of all four incubators. The attempt to evaluate effectiveness of the filter system may be confounded by this unfortunate circumstance.

DEVELOPMENT PROGRAM

DEVELOPMENT

RAZOR CLAM PROJECT

AND CLAM RESOURCE DEVELOPMENT PROJECT

Objectives

1. To collect supportive data showing that razor clams from major growing areas in Alaska are safe for human consumption.

2. To actively coordinate sanitary surveys and sampling programs.

3. To pursue the necessary steps for clearance of razor clam growing areas for commercial harvest for human consumption.

4. To collect vital life-history data.

5. To determine accurate censusing methods for management of various razor clam populations in Alaska.

6. To up-date the commercial harvest history of razor clams in Alaska.

7. To provide an account of general growth characteristics of razor clams from many growing areas in Alaska.

8. To study the effects of various harvest techniques.

9. To study the value of mala culture techniques.

Methods

1. Study plots were established at several locations in the Cordova-Hinchinbrook Island-Katalla area to collect data and specimens pertinent to vital life-history studies, and stock estimates.

2. Drift drogues were released and recovered for information concerning local currents, larval drift, and occurence of PSP.

3. Established key sampling stations in the Cordova - Katalla area and coordinated the establishment of key sampling stations in the Polly Creek area in Cook Inlet, and the Swikshak area on the Alaska Peninsula for routine collection of specimens to be bioassayed in monitoring for the occurrance of PSP.

4. Participated in Sanitary Surveys of the Cordova - Katalla razor clam growing areas and coordinated the steps leading to the Sanitary Surveys at Polly Creek and Swikshak.

5. Compiled documents and data for administration of a workable shellfish sanitation program. Direct participation with State and Federal health people.

Time period involved in overall project

Total time: 3 1/2 years.

Phases completed:

1. The State of Alaska Shellfish Sanitation Program...
    a. Preparatory activities for administration of ....
    b. A summary of the working program in three parts.

2. The razor clam industry in Alaska...
    a. Geographic locations of known areas.
    b. Commercial harvest history.

3. A study to determine various profiles of the population structure on the low tide terrace for application to yield estimates.
    a. Investigational techniques employed.
    b. Drift drogue release and recovery.
    c. Density profiles on the low tide terrace.
    d. Age by tide level.
    e. Length by tide level.
    f. Growth increment by tide level.
    g. Substrate and exposure -- their role as variables affecting survival and density on the low tide terrace.
    h. Survey techniques to delineate growing areas.

4. Analysis of growth.
    a. Comparison of growth rates among several areas in Alaska.
    b. Walford lines and critical size.
    c. Discriminant functions as an aid to stock separation and identification.
    d. Age, length, and weight relationships.

5. Sexual characteristics, spawning, and fecundity.
    a. Sex ratio.
    b. Growth of males versus females.
    c. Age, length, sexual maturity and related dimorphism.
    d. Fecundity estimates.

6. Determination of density indicators from hydrological and meteorological variables.
    a. The Little Mummy Island study.
    b. The multiple regression; its significance and meaning.

7. Methods of estimating population size.
    a. Four methods discussed.
    b. Examples given.

8. Mortality, survival and life tables.
    a. Standing stock estimates by age class.
    b. Predicted production less natural mortality.

9. Sub-tidal dredging for razor clams.

10. Relocation and mortality of marked clams.

All of the above listed completed phases are included in a 410 page manuscript entitled, "A critical analysis of some razor clam (Siliqua patula Dixon) populations in Alaska" by R. B. Nickerson.

Results to date

1. The razor clam growing areas of Cordova, Swikshak, and Polly Creek are approved for commercial harvest of razor clams for human consumption.

2. Fresh and frozen razor clams obtained commercially for human consumption from these areas may be shipped in intra-state commerce only.

3. Alaska's Shellfish Sanitation Program is in nearly completed format, however changes in the Administrative Code, Title 7, Division 1, Chapter 2, Subchapter 3, Part 5 as recommended by F. D. A. officials are to be approved or not approved during the forthcoming Legislative Session in January, 1973. If the changes are approved, this will greatly facilitate the realization of Alaska's enrollment into the National Shellfish Sanitation Program which means that fresh and frozen razor clams harvested commercially for human consumption may then be shipped in inter-state commerce to other member States and nations.

4. Positive results obtained from objectives 1 through 7.

Phases of project to be carried out in FY 74

Objectives 8 and 9.

Activities for the period January 1, 1972 to July 10, 1972:

Completion of data analysis and compilation of the razor clam manuscript.

Activities for the period July 11 to December 31, 1972:

Initiated studies pursuant to the Clam Resource Development Project.

Objectives of the Clam Resource Development Project

1. To collect vital life-history data and determine accurate censusing methods for the management of various latently important hardshell clam species in Alaska.

2. To collect and submit on a routine basis and to coordinate the collection and submittal on a routine basis of various latently important hardshell clam species (as well as razor clams) for bioassay in order to create background data relative to PSP.

3. To work with State and Federal Health and State Public Safety people on expansion of the shellfish sanitation program as pertains to commercially important hardshell clam species.

4. To determine the effects of various methods of commercial harvest techniques on target species, on the biological community, and on the habitat itself.

5. To formulate and investigate methods that would favor production increase of target species.

Methods

1. Establish study areas for various species to achieve objectives #1, #4, and #5.

2. Establish and coordinate the establishment of key sampling areas and sampling schedules of the various species involved, to achieve objective #2.

3. Maintain (and expand in some instances) the working relationship and liason among the various State and Federal people and agencies involved with the Shellfish Sanitation Program.

Time period involved in project to date

6 months

Phases in progress

1. Butter clam (Saxidomus giganteus)
    a. Collection of data pertinent to establishment of density profile on low tide terrace for yield estimates.
    b. Collection of data relative to length, weight, sex ratios, sexual maturity, and seawater temperatures by time period.
    c. Collection of data relative to growth by employing various methods of mark and recovery.
    d. Collection of data relative to rates of natural mortality in natural and artificial habitats.

2. Littleneck clam (Protothaca staminea)

    a. Same as for butter clam as described above.

    b. Ditto

    c. Ditto

    d. Ditto

3. Experimentation with methods to facilitate discernment of annuli on valves of various pelecypod molluscs.

Results to date

1. Realization of specie-specific zones of occupation and coincident density profiles on the low tide terrace.

2. Data analysis on remaining topics not finalized.

Phases of project to be carried out in FY 74

1. Objectives 8 and 9 of Razor Clam Project.

2. Continue work on butter clams and little-neck clams as described above.

3. Establish sampling stations for hardshell clams in the Cordova area, and coordinate subject in other areas for PSP bioassays.

4. Initiate studies (as described for butter clams) on soft-shell clams (Mya), cockles (Clinocardium), and surf clams (Spisula) if time permits.

WHITEFISH DEVELOPMENT PROJECT

Introduction

A limited study of the Lower Kuskokwim whitefish resource was initiated in 1966 for the purpose of collecting basic information on species occurrence, life history, migration patterns, population sizes, fishing methods and degree of utilitzation.

It was known that no extensive commercial fishery existed but that considerable utilization occurred for subsistence use.

Realizing that whitefish is very palatable and commands a high price in many areas of the lower 48 states, it seemed apparent that eventually there would be a market developed for fish inhabiting the Kuskokwim and adjacent river systems.

In order to be prepared for management of such a fishery, it appeared advisable to begin collecting information before rather than after the fact. A sudden burgeoning fishery on a species about which little is known creates a situation not conducive to sound management.

Whitefish Fisheries Potential

The two species of whitefish present in the lower Kuskokwim River are the broad whitefish and the humpback whitefish with the former being the most abundant.

During the 7 year period observed 1966-1972, there has been little change in the level of commercial whitefish catch in the Bethel area with the bulk of the harvest taken in August incidental to the salmon catch. In 1971, 6,977 whitefish and 75 sheefish were sold with a return to the fishermen of $3,912.35. (1972 figures not yet available). The above harvest is below that which could be marketed locally. A total of 18,000 whitefish (approximately 55,000 lbs.) were sold in Bethel stores during 1967-1970. Fishermen earned about $11,000 for this catch. It is estimated that the market would have taken nearly 4 times that amount with the resultant increase in earnings to the fishermen. Similar unfilled market demands probably exist in most of the larger native communities and in Anchorage

and Fairbanks.

Based on past correspondence with prospective out-of-state buyers there is a potential market in the middle and eastern United States for 2-5 million pounds of Alaska whitefish of good quality. However, a few trial shipments have been judged inferior due to the dark skin color of Yukon-Kuskokwim delta whitefish. Whitefish taken in Canada and the Great Lakes region from deep, clear water lakes are silvery in appearance by comparison. It is possible that the skin color problem could be overcome through advertising or different marketing techniques such as preparation of completely finished products as planned by one operator at Bethel next year (pickled, smoked, fishballs). Shipment of fully processed products would also reduce freight costs thus making out of state marketing more feasible.

Status of Research

In 1970, an additional position was filled in the Division of Commercial Fisheries for the purpose of conducting full-time studies of freshwater fishery resources, primarily whitefish. Prior to that time, investigative work on this species was limited by the demands of the salmon fishery management responsibilities.

Effective July 1, 1972, this program was transferred to FRED.

The major finding to date is that the Kuskokwim River whitefish stocks intermingle throughout the 600 miles of the river. A tagging project was carried out on the Kialik River,in 1972, a tributary of the Kuskokwim River, located 32 miles below Bethel. Tags have been recovered throughout the drainage with 2 recoveries from the Nikolai area, 565 miles above the tagging site. In addition, they have been recovered in the estuaries and sloughs near the river mouth.

Operation plans for FY 74 are as follows:

WHITEFISH STUDIES--MAIN KUSKOKWIM RIVER

A. Location: Lower Kuskokwim River

B. Personnel: Project leader (F.B. III) and Bethel office Fisheries Technicians (catch sampling only).

C. Timetable: Year-round (periodic).

D. Objectives:

1. Obtain water temperatures and water chemistry data throughout the year.

2. Determine age, sex, size, sexual condition, physical condition and food habits of whitefish taken incidentally during the commercial coho salmon season.

3. Attempt to recover fertilized whitefish eggs to determine if main river spawning occurs.

E. Procedures:

1. Water temperatures and water chemistry data will be monitored at Bethel at least once a month.

2. Sample incidental whitefish catches during August at Bethel using standard catch sampling techniques.

3. Ekman dredge will be used in attempt to recover whitefish eggs through the ice during late fall-early winter in various locations.

WHITEFISH STUDIES--RECONNAISSANCE SURVEYS

A. Location: Yukon and Kuskokwim Rivers with primary emphasis in the Yukon-Kuskokwim delta.

B. Personnel: Project leader (E.B.III).

C. Timetable: As time allows during July-October.

D. Objectives: Determine species composition/abundance, age, sex and size composition and seasonal movement-migration information for whitefish in various locations.

E. Procedures:

1. Access to survey areas will be by float aircraft. Duration of surveys will be one or two days in each area.

2. Only 2-4 separate areas will be surveyed annually. The following areas are listed according to priority:

   a. Enrayak-Eek River system
   b. upper Johnson River
   c. lower Innoko River
   d. A "closed" lake to be determined but located in the delta area
   e. Kashunak River
   f. Dall Lake
   g. Izaviknek River
   h. Black River-Nunavakanuk Lake
   i. Anuk River
   j. Mud Volcano Lakes
   k. Whitefish Lake (Hoholitna River)
   l. Whitefish Lake near Aniak
   m. Holitna River

3. Physical description of area will be made (average and maximum depths, bottom composition, water clarity and color, water temperature, etc. Portable water chemistry kits will be used to determine O_2, pH, H_2S and hardness levels.

4. Gill nets of varying mesh sizes will be fished. For each unit of gear the hours fished and numbers of fish by species captured will be recorded by date and area.

5. All fish captured in good condition will be tagged with FD-67 dart tags and released. Information to be recorded for each fish tagged includes: release area, date of release, gear, species, tag number, type and color, fork length and, in addition, a scale sample should be taken.

6. As time allows sample fish not tagged for age, sex, size, sexual condition, physical condition and food habit information.

WHITEFISH STUDIES--MARKETING SURVEY

A. Personnel: Project leader (F.B. III).

B. Timetable: Winter of 1972-1973.

C. Objectives:

1. Determine market requirements for whitefish in and outside Alaska in regards to numbers of fish by species, size, condition, etc.

2. Inform prospective buyers and processors of the species of fish available in Yukon-Kuskokwim delta area and their size, condition, etc.; provide marketing samples.

D. Procedures: Questionnaires (with forwarding letters) will be mailed to all known buyers and processors in and outside Alaska.

The incumbent in the Whitefish Development Project is the only Department of Fish and Game representative during most of the year in the Yukon-Kuskokwim Delta area and as such must perform Departmental duties as follows:

1. Answer questions and explain intent of all Department regulations, trapping, hunting, sport fishing, and commercial fishing.

2. Handle and seal the furs and skins taken in the area, including being the major sealer of beaver in the State. Sealed 985 beaver in 1972 besides the wolves, wolverine, and bear.

3. Appear on KYUK radio and television weekly and write news releases for the local newspaper.

4. Talk to classes at the Regional High School on Natural resources and Eskimo history.
5. Department representative at the interagency meetings in Bethel of all local State and Federal agencies.

6. Work with local fishermen on the use of more efficient fishing methods and gear, primarily ice fishing techniques.

A detailed report on the findings of investigative work conducted on whitefish in the Yukon-Kuskokwim delta is being prepared.

Efforts will continue on documentation of subsistence use for whitefish in this area. Whitefish and pike catches for this use are believed to be very large, possibly 500,000 to 1,000,000 fish annually.

ADMINISTRATION AND SUPPORT PROGRAM

ADMINISTRATION AND SUPPORT

Present staff of this program in the Headquarters office consist of a Director, Deputy Director (who is also handling Southeastern Region Anadromous), and a secretary.

Clerical support for the regional and field offices is provided by a part time-temporary ckerk typist in Anchorage, and a permanent part time clerk in the Cordova office.

Objectives of this program within the overall budget structure of the Division are to:

1. Provide administrative and clerical support for the operational programs (Anadromous and development). This service must be adequate or operational personnel are forced into spending too much time on such matters, thus reducing their operational efficiency and the number of accomplished programs. Hence the request for a clerk typist in the Central Region.
2. Provide specialist service for the operational programs. As supplemental production systems increase in number disease occurrence will likewise increase. It is of paramount importance that the services of a pathologist be secured on a full time basis. We cannot wait two weeks for a fish disease report to come back from Washington or Utah. In that length of time a disease may have decimated the population. Hence, the request for a full time Fisheries Pathologist.
3. Develop cooperative agreements with other agencies with similar responsibilities that are to the best interest of the state. Four such agreements have already been drawn up. These are:
   (a) Saltwater Rearing Prototype (Natural Lens) with the National Marine Fisheries Service.

(b) Bam's Box Incubator Test with the National Marine Fisheries Service.

(c) Overall agreement with the U.S. Forest Service who will provide survey and inventory data and on certain projects, technical assistance.

(d) Demonstration experiment of Coho and Sockeye rehabilitation of the South end of Baranof Island with the National Marine Fisheries Service and U.S. Forest Service (requested for F.Y. 74)

Several other possible cooperative projects are in the discussional stage, these are Karluk and Snake Lake. It is obvious that if the high calibre scientific talent of other agencies with similar responsibilities can be channeled into mutually desired projects that the objectives of the operational program may be achieved with a minimum of state dollars and a maximum of scientific talent.

4. Maintain overall direction of the programs in response to public needs on a priority basis.

5. Provide the staff with the latest information pertaining to advances in fisheries systems throughout the world.

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