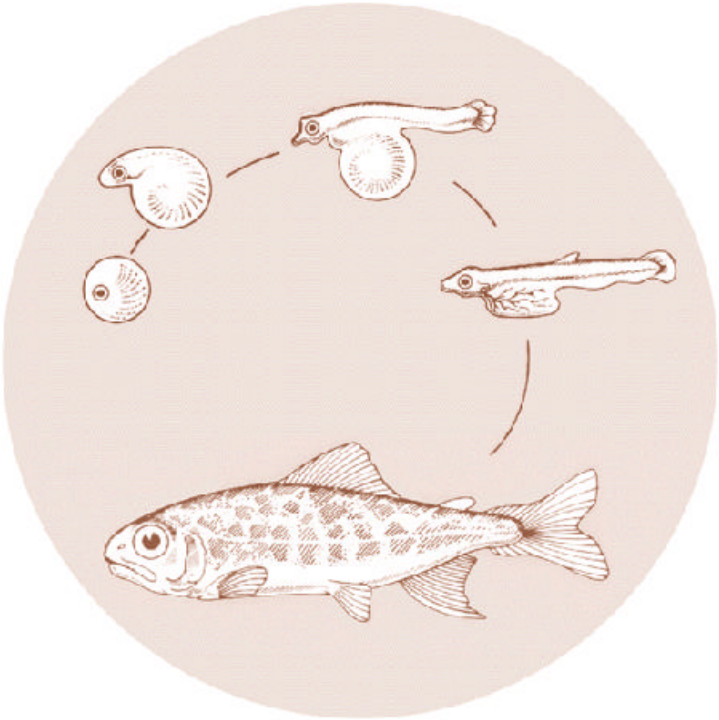
May 1993

INTEGRATED HATCHERY OPERATIONS
EXISTING POLICY AFFECTING HATCHERIES
IN THE COLUMBIA RIVER BASIN

COMBINED REPORTS



DOE/BP-60629-1

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views of this report are the author's and do not necessarily represent the views of BPA.

This document should be cited as follows:

Shelldrake, Tom - U.S. Fish and Wildlife Service, Chris Christianson - Oregon Department of Fish and Wildlife, Larry Peck - Washington Department of Fisheries, Bill Hutchison - Idaho Department of Fish and Game, Integrated Hatchery Operations: Existing Policy Affecting Hatcheries In The Columbia River Basin Combined Reports, Report to Bonneville Power Administration, Contract No. 1991BP60629, Project No. 199204300, 228 electronic pages (BPA Report DOE/BP-60629-1)

This report and other BPA Fish and Wildlife Publications are available on the Internet at:

http://www.efw.bpa.gov/cgi-bin/efw/FW/publications.cgi

For other information on electronic documents or other printed media, contact or write to:

Bonneville Power Administration
Environment, Fish and Wildlife Division
P.O. Box 3621
905 N.E. 11th Avenue
Portland, OR 97208-3621

Please include title, author, and DOE/BP number in the request.

INTEGRATED HATCHERY OPERATIONS: EXISTING POLICY AFFECTING HATCHERIES IN THE COLUMBIA RIVER BASIN

COMBINED REPORTS

Section I	U.S. Fish and Wildlife Service
Section II	Washington Department of Wildlife
Section III	Oregon Department of Fish and Wildlife
Section IV	Washington Department of Fisheries
Section V	Idaho Department of Fish and Game

INTEGRATED HATCHERY OPERATIONS: EXISTING POLICY AFFECTING HATCHERIES IN THE COLUMBIA RIVER BASIN

ANNUAL REPORT 1992

Prepared by:

Tom Shelldrake

United States Fish and Wildlife Service

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-362 1

Project Number 92-043
Contract Number DE-BJ79-91BP60629

MAY 1993

INTEGRATED HATCHERY OPERATIONS TEAM

Existing Policy's Affecting Hatcheries in the Columbia River Basin

U.S. Fish and Wildlife Service

LAWS

Anadromous Fish Conservation Act. **Public Law 98-304, October 30, 1965, authorizes the Secretaries of the Interior and Commerce to enter into cooperative agreements with the States and other non-Federal interests for conservation, development, and enhancement of anadromous fish, including those in the Great Lakes, and to contribute up to 50 percent as the Federal share of the cost of carrying out such agreements. Authorized are investigations, engineering, and biological surveys, research, stream clearance, construction, maintenance and operations of hatcheries and devices and structures for improving movement, feeding and spawning conditions. Also authorized is construction by the Bureau of Reclamation and the U.S. Army Corps of Engineers of water resource projects needed solely for such fish. The Service is authorized to conduct studies and make recommendations to EPA concerning measures for eliminating or reducing polluting substances detrimental to fish and wildlife in interstate or navigable waters, or their tributaries.**

Animal Welfare Act. **Also referred to as the Federal Laboratory Animal Welfare Act, and includes the Improved Standards for Laboratory Animals Act. Public Law 89-544, approved August 24 1966, as amended, directs the Secretary of Agriculture to regulate and insure the humane care and treatment of dogs, cats, and certain other animals used for research, experimentation, exhibition, and sale purposes, as well as to assure humane treatment of animals during transportation in commerce and to protect owners of animals from theft by preventing the sale or use of animals which have been stolen. The Act also directs consultation and cooperation with other Federal Agencies concerned with the welfare of animals in the establishment of standards and in carrying out other purposes of the Act. (See also the Lacey Act.)**

Colmbia Basin Project Act. **The Act of March 10, 1943, renamed and reauthorised the Grand Coulee Dam Project as the Columbia Basin Project. The Act of October 9, 1940, supplementing the Project Act, authorized the Secretary of Interior to contract with the State of Washington for maintenance and operation of fish hatcheries built as part of the fish protection program required on the Columbia Basin Project.**

Endangered Species Act of 1973. **The 1973 Act implemented the Convention on International Trade in Endangered Species of Wild Fauna and Flora, signed by the United States on March 3. 1973, and the convention on Nature Protection and Wildlife Preservation in the Western Hemisphere, signed by the United States on October 12, 1940.**

The Endangered Species Act provlded for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend, both through Federal action and by encouraging the establishment of State programs. The Act:

- **authorizes the determination and listing of species as endangered and threatened;**
- **prohibits unauthorized taking, possession. sale and transport of endangered species;**
- **provides authority to acquire land for the conservation of listed species, using land and water conservation funds;**
- **authorizes establishment of cooperative agreements and grants-in-aid to States that establish and maintain active and adequate programs for endangered and threatened wildlife and plants;**
- **authorizes the assessment of civil and criminal penalties for violating the Act or regulations; and**
- **authorizes the payment of rewards to anyone furnishing information leadlng to arrest and conviction for any violation of the Act or any regulation issued thereunder.**

Section 7 of the Endangered Species Act requlres Federal agencies to insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

Federal Aid in Sport Fish Restoration Act. This August 9, 1950 Act has been amended several times and was commonly called the Dingell-Johnson Act. It provides Federal aid to the States for the management and restoration of fish having "material value in connection with sport or recreation in the marine and/or fresh waters of the United States."

Federal Power Act. These public laws appear in Chapter 12 of the U.S. Code, Federal Regulation and Development of Power, Subchapter 1, Regulation of the Development of Water Power and Resources. The original statute was enacted in 1920. Many of the subsequent amendments have not involved resource issues: however, the 1935 and 1986 added new requirements to incorporate fish and wildlife concerns in licensing, relicensing and exemption procedures.

Federal Water Pollution Control Act. The original 1948 statute, the Water Pollution Control Act, authorized the Surgeon General of the Public Health Service, in cooperation with other Federal, State, and local entities. to prepare comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries and improving the sanitary condition of surface and underground waters. During the development of such plans due regard was to be given to improvements necessary to conserve waters for public water supplies, propagation of fish and aquatic life, recreational purposes, and agricultural and industrial uses.

Federal Water Project Recreation Act. This statute, as amended, declares the intent of Congress that recreation and fish and wildlife enhancement be given full consideration as purposes of Federal water development projects.

Fish and Wildlife Act of 1956. The Act of August 8, 1956, as frequently amended, establishes a comprehensive national fish, shellfish, and wildlife

resources policy with emphasis on the commercial fishing industry, but also with a direction to administer the Act with regard to the inherent right of every citizen and resident to fish for pleasure, enjoyment, and betterment and to maintain and increase public opportunities for recreational use of fish and wildlife resources.

Fish and Wildlife Coordination Act. The Act of March 10. 1934, authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with Federal and State agencies to protect, rear, stock, and increase the supply of game and fur-bearing animals, as well as to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife. The Act also directs the Bureau of Fisheries to use impounded waters for fish-culture stations and migratory bird resting and nesting areas and requires consultation with the Bureau of Fisheries prior to the construction of any new dams to provide for fish migration. The amendments enacted in 1946, require consultation with the Fish and Wildlife Service and the fish and wildlife agencies of the States where the "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified" by any agency under a Federal permit or license. The 1958 amendments added provisions to recognize the vital contribution of wildlife resources to the Nation and to require equal consideration and coordination of wildlife conservation with other water resources development programs, and authorized the Secretary of Interior to provide public fishing areas and accept donations of lands and funds.

Lacey Act Amendments of 1981. Under this law, it is unlawful to import, export, sell, acquire, or purchase fish, wildlife, or plants taken, possessed, transported, or sold: (1) in violation of U.S. or Indian law. or (2) in interstate or foreign commerce involving any fish wildlife. or plants taken possessed or sold in violation of State or foreign law.

Land and Water Conservation Fund. Public Law 88-578, approved September 3, 1964 (78 Stat. 897), created the Land and Water Conservation Fund, derived

from various types of revenue (primarily Outer Continental Shelf oil monies) and authorizes appropriations from the fund for: (1) matching grants to States for outdoor recreation projects, and (2) land acquisition for various Federal agencies.

Mitchell Act. The Mitchell Act specifically directs establishment of salmon hatcheries, conduct of engineering and biological surveys and experiments, and installing fish protective devices. It also authorizes agreements with State fishery agencies and construction of facilities on State-owned lands.

National Environmental Policy Act of 1969. Title 1 of the 1969 National Environmental Policy Act (NEPA) requires that all Federal agencies prepare detailed environmental impact statements for "every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment."

National Fish and Wildlife Foundation Establishment Act. The Act established the National Fish and Wildlife Foundation as a Federally chartered charitable, non-profit corporation to administer donations of real or personal property, or interests therein, in connection with Fish and Wildlife Service programs and conservation activities in the United States.

National Fish Hatcheries Acts. Authority for construction, operation, maintenance, transfer, and naming of fish hatcheries by the U.S. Fish and Wildlife Service is contained in a variety of specific and general statutes. Many of the older facilities were authorized by appropriation Acts, others as mitigation at water resource development projects, and still others by special Acts of Congress. As of October 1, 1991, there were 78 National Fish Hatcheries and two related facilities under U.S. Fish and Wildlife Service administration.

Pacific Northwest Electric Power Planning and Conservation Act. This 1980 statute authorized the establishment and operation of the Pacific Northwest Electric Power Planning Council, and provided that two persons from the States of Idaho, Montana, Oregon, and Washington to be appointed to the Council.

Pacific Salmon Treaty Act. **Public Law 99-5 approved March 15, 1985, implements the Pacific Salmon Treaty between the U.S. and Canada, January 28, 1985; establishes the requirements for Commissioners and the subsidiary Northern, Southern, and Fraser River Panels; and authorizes Federal regulatory preemption by the Secretary of Commerce to meet treaty obligations.**

Refuge Revenue Sharing Act. **Section 401 of the Act of June 15. 1935, provided for payments to counties in lieu of taxes, using revenues derived from the sale of products from refuges. Public Law 95-469, approved October 17, 1978, expanded the revenue sharing system to include National Fish Hatcheries and Service research stations. It also included in the Refuge Sharing Fund receipts from the sale of salmonid carcasses.**

Refuge Trespass Act. **The Act of June 25, 1948, consolidated penalty provisions of various Acts from 1905 through 1934, establishing and protecting fish and wildlife areas, and restated the intent of congress to protect all wildlife within Federal sanctuaries, refuges, fish hatcheries, and breeding grounds.**

Resource Conservation and Recovery Act **(RCRA). Public Law 94-580, October 21, 1976. as amended regulates the treatment, transportation, storage, and disposal of solid and hazardous wastes.**

Rivers and Harbors Appropriation Act of 1699. **Hatchery concerns include contaminated sediments associated with dredge or fill projects in navigable waters, and amendments which established the National Pollutant Discharge Elimination System Permits.**

Salmon and Steelhead Conservation and Enhancement Act. **Public Law 96-561, approved December 22, 1980, established a salmon and steelhead enhancement program to be jointly administered by the Departments of Commerce and Interior.**

Water Resources Development Acts of 1976, 1966, 1966, **and** 1990. **Pub1 ic Law 94-587, enacted October 22, 1976, included specific conservation measures**

for some water projects including the Lower Snake River Fish and Wildlife Compensation Plan. Addressed specific problems like the Yakima-Union Gap Flood Control Project, Washington. Section 406 established that mitigation would have to go forward with the project requiring mitigation. not afterward.

Wild and Scenic Rivers Act. Public Law 90-542 approved October 2, 1968, establishes a National Wild and Scenic Rivers System and prescribes the methods and standards through which additional rivers may be identified and added to the system. Public Law 99-663, approved November 17, 1986, established the Columbia River Gorge National Scenic Area in Oregon and Washington.

Youth Conservation Corps Act. Public Law 91-378, approved August 13. 1970, established permanent programs within the Departments of Interior and Agriculture for young adults to perform specific tasks on lands and waters administered under jurisdiction of these Secretaries.

AMINISTRATIVELLAWS

A number of laws of particular interest to Service hatcheries with respect to administrative matters are not listed.

AREA SPECIFIC AUTHORIZATIONS

Belloni Decision. Affirmed treaty rights and resulted in a management plan under U.S. vs. Oregon that establishes production on Service hatcheries.

Boltd Decision. Focuses on the dual trust responsibility borne by the Secretary of the Interior, namely, to protect in perpetuity both the Treaty-secured, court upheld fishing right itself, and the productivity of the fishery resources that are the subject of its exercise.

REGION ONE POLICIES

Broodstock Spawning, Egg Incubation, and Egg Handling Guidelines. As a matter of Regional fishery policy:

A spawning ratio of one female with one male be used when possible. Obviously, sex ratios, lack of ripe males, and the presence of significant numbers of sterile males will preclude the use of a 1:l spawning ratio at some stations.

The inspection of individual spawning adults will be maximized within the capabilities of Fish Health Centers with priority given to stocks with a history of serious disease like IHN and BKD.

Single female egg incubation is highly desirable and should be adopted when possible. Inspection of individual adults coupled with single female incubation will allow for segragation of eggs to prevent the spread of disease. Priorities will be set for retrofitting facilities for single female egg incubation on the basis of the presence of important diseases like IHN and BKD.

All eggs will be water hardened in iodophores and additionally disinfected prior to shipping and also on arriving at the receiving hatchery.

IHN positive eggs from a stock of fish usually evidencing some level of the disease will not be culled and destroyed, but should be maintained in separate lots for as long as possible. Destruction of eggs or fish that are detected as virus positive will be undertaken on a case-by-case basis.

Iodophored eggs from IHN positive parents, which have been individually incubated, will be transferred to IHN positive or negative stations that are within the enzootic area only when absolutely needed and then only on a case-by-case basis.

BKD positive eggs from a stock of fish usually evidencing some level of the disease will not be culled and destroyed but should be maintained in separate lots as long as possible.

Single female incubation units plumed with separate drains is most desirable. Lacking that capability, vertical incubators or other incubators can be used.

Transfer or Release of Fish or Eggs. It is the policy of the U.S. Fish and Wildlife Service (Service) in the Western Region that all transfers or release of eggs or fish involving the National Fish Hatchery System or Service research facilities shall be in compliance with all applicable Federal, Tribal, and State regulations and policies pertaining to fish health, fish stock management, and protected species status. Obtaining written approval from the appropriate Federal, Tribal, or State officials authorized to approve such actions is mandatory prior to any transfer or release.

Policy on Stocking Fish at Other than Designated Sites. Each station producing fish in the National Fish Hatchery System shall have a contingency plan for the handling and disposition of fish that, while on a distribution truck, cannot be delivered to the designated stocking site. This plan will be developed in cooperation with appropriate States, Tribes, and other cooperators, and will be as specific as needed to satisfy requirements of fishery managers and comply with any regulation regarding the stocking of State, Tribal, or other waters, unless exempted in writing by the regulating agencies involved.

FISH HEALTH MANAGEMENT POLICIES

Guidance. Fish husbandry and fishery management activities carried out by U.S. Fish and Wildlife Service personnel in the western region shall meet the requirements of the Service guidelines and this plan. These activities also will be guided by written and approved Pacific Northwest Fish Health

Protection Committee policies and shall be in compliance, in all cases, with published foreign, State, and Tribal regulations, administrative orders, and policies except where prior written permission for exception has been obtained.

Fish Disease and Pathogen Detection. Diagnostic, monitoring, and inspection work performed or supervised by Service fish health biologists in Region 1 will conform to the requirements set forth in the Service Guidelines. Written requests for any deviation from these requirements will be reviewed by the Assistant Regional Director for Fisheries and Federal Aid.

Prevention and Control of Fish Diseases.

The full development of essential fish propagation facilities, equipment, and personnel necessary to safely prevent or control fish diseases in Service installations is an established goal in Region 1. Pathogen-free water supply systems, effective hatchery sanitation, and state-of-the-art fish propagation practices all contribute to the success of Service programs. Therefore, the western region will assign a high priority to facility improvements that provide pathogen-free water supplies and improve fish disease prevention capabilities.

Whenever drugs, chemicals, or biologicals are used on Service facilities, they will be used in full compliance with U.S. Food and Drug Administration, U.S. Environmental Protection Agency, and pertinent State environmental regulations.

Whenever eggs or fish are transferred or released such transfers or releases will be in full compliance with foreign, Federal, State, and Tribal regulations, Service fish health guidelines, and the Service Implementation Guidelines for the National Brood Stock Program.

Emergency Disease Control. The confirmed detection of pathogens causing exotic diseases in Region 1 facilities will be met with swift and definitive containment and eradication measures guided by the National Emergency Disease Eradication Plan.

(VS10-PJSR-5634W)

INTEGRATED HATCHERY OPERATIONS: EXISTING POLICY AFFECTING HATCHERIES IN THE COLUMBIA RIVER BASIN

ANNUAL REPORT 1992

Prepared by:

Eniar Wold

Washington Department of Wildlife

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-362 1

Project Number 92-043
Contract Number DE-BJ79-9 1 BP60629

MAY 1993

INTEGRATED HATCHERY OPERATIONS TEAM

EXISTING POLICY AFFECTING HATCHERIES

WASHINGTON DEPARTMENT OF WILDLIFE

POLICY

POL-5101 Hatchery Releases to Produce Harvestable Steelhead

This policy applies to any hatchery releases intended to provide harvestable adult steelhead.

1. Hatchery Management Releases Adipose-Clipped Smolts Between April 15 and May 15. **Hatchery Managers will release only smolts (10 fish/pound or larger) where the objective is to provide adult steelhead for harvest. Hatchery Managers will ensure that all such smolts have been adipose-marked prior to release (see Policy 5104) and that they are released between April 15 and May 15.**

2. Regional Biologist and Washington Department of Wildlife (WDW) Pathologist Approve Smolt Releases For Other Periods. **The Regional Biologist and WDW Pathologist must approve any smolt releases made before or after the period of April 15 - May 15.**

3. All User Groups Must Be Allowed Reasonable Access to Steelhead. **Off-station planting sites must be chosen that allow all user groups reasonable access to the returning adult steelhead. The Regional Biologist will select off-station planting sites to meet user group accessibility. Consideration will also be given to the accessibility of the planting site to** the planting truck and to planting crew safety.

4. The Regional Biologist Will Minimize Impacts of Hatchery Enhancment on Wild **Stocks. The Regional Biologist will minimize the genetic and competitive impacts of hatchery fish on wild stocks whenever feasible through such strategies as:**

a. Selecting a hatchery stock with earlier return timing and spawning timing than the wild stock.

b. Keeping smolt numbers at a level that will not result in a large escapement of hatchery fish. Such factors as adult return rates, fishery efficiency, and the size of the wild run will be considered.

POL-5102 Hatchery Releases To Increase Wild Spawning Escapements

This policy applies to hatchery releases intended to provide adult steelhead to increase wild/natural spawning escapement.

1. Regional Fisheries Biologist Submits Rehabilitation Plan. The Regional Biologist submits a plan to the Anadromous Fisheries Program Manager for approval. The plan contains the following information:

a. Evidence that the wild run is not achieving a specified spawning escapement and is substantially below the reproductive potential for that stock and river system.

b. Feasibility of capturing, holding, spawning. hatching, and rearing suitable broodstock (see 2 below), including facility(ies) to be used and source of funds.

c. Procedures for evaluating the success of the rehabilitation effort (marking, coded wire tagging, branding and mark recovery).

d. Spawning escapement monitoring schedule.

e. Necessary management or regulation changes for protecting enhancement fish and wild fish from harvest.

f. **Alternatives to wild brood stock enhancement.**

2. Regional Fish Biologist Selects Suitable Wild Broodstock. **The Regional Biologist will select a suitable wild broodstock for the rehabilitation program. This should be the wild stock indigenous to the river system. If such a stock is not available, then other stocks from nearby streams of similar size and type may be considered.**

3. Hatchery Manager Releases Smolts Between April 15 and May 15. **Hatchery Managers will release only smolts (10 fish/pound or larger) where the objective is to provide adult steelhead that will escape fisheries and spawn. Hatchery Managers will release these smolts between April 15 and May 15 unless otherwise approved by the Regional Biologist and WDW Pathologist.**

4. Regional Biologist Terminates Project When Escapement Goals are Met. **The Regional Biologist will terminate rehabilitation enhancement once the spawning escapement goal set in the original plan has been met for four consecutive seasons.**

5. The Regional Biologist Prepares Annual and Final Reports. **The Regional Biologist will prepare an annual progress report for each rehabilitation enhancement project and submit it to the Anadromous Fish Program Manager by December 31. At the termination of a project, a final report will be submitted.**

POL-5103 Hatchery Releases To Utilize Unused Or Underseeded Rearing Habitat

This policy applies to all steelhead enhancement projects intended to take advantage of unused or underseeded rearing habitat in order to produce naturally-reared smolts.

1. Regional Biologist Submits Enhancement Plan. **The Regional Biologist submits an enhancement plan to the Anadromous Fisheries Program Manager for approval. The plan contains the following information:**

a. Evidence that the stream is underseeded or unutilized, and is not above a natural impassable barrier to steelhead passage.

b. Feasibility of capturing, holding, spawning, hatching, and rearing suitable broodstock (see 2 below), including facility(ies) to be used and source of funds.

C. Stocking density to be achieved.

d. Procedures for evaluating the success of the enhancement effort (electrofishing, marking/adult recapture, smolt trapping).

e. Necessary management or regulation changes for protecting enhancement fish and wild fish from harvest.

f. Alternatives to wild broodstock enhancement.

2. Regional Fish Biologist Selects Suitable Wild Broodstock. The Regional Biologist will select a suitable wild broodstock for the rehabilitation program. This should be the wild stock indigenous to the river system. If such a stock is not available, then other stocks from nearby streams of similar size and type may be considered.

3. Hatchery Manager Releases Fry Or Eyed Eggs. The Hatchery Manager releases enhancement fish as eyed eggs or fed fry (350-500 fish/pound). Eyed eggs will be planted in the stream between March 1 and April 30. Fry will be released between June 1 and October 31 when they have reached suitable size. Eggs and fry will be scattered in a manner simulating natural distribution patterns. Fry will be stocked at a density no greater than one fish per square meter of stream surface, as calculated at the time of planting.

4. Regional Biologist Wi II Terminate Enhancemen t After 5 Years. The Regional Biologist will terminate seeding enhancement after 5 years: except,

where an impassable artificial barrier to upstream migration exists seeding enhancement may proceed indefinitely if benefits are being realized.

POL-5104 Steelhead Marking, Tagging, and Branding

This policy applies to all steelhead fry, smolts, or adults that are marked, tagged, or branded.

1. Regional Biologist Coordinates Marking and Tagging in Region. The Regional Biologist:

a. Ensures that all smolts that are intended to provide harvestable adults are adipose-marked prior to release (unless specifically exempted by the Anadromous Fisheries Program Manager).

b. Submits tagging or marking proposals (other than adipose-only) to the Anadromous Fisheries Program Manager at least 2 months prior to actual tagging or marking. These proposals include:

- Purpose of experiment (including hypotheses and a plan for test and control groups)
- River system involved
- Type of mark, including consideration of replication
- Total number of fish to be released
- Number being tagged
- Recovery program

c. Transmits tagging results and tag recovery data from regional facilities and personnel to the Anadromous Fisheries Program Manager.

2. Anadromous Fisheries Program Manager is Mark Coordinator. The Anadromous Fisheries Program Manager (or his designee) is the WDW Mark

Coordinator, coordinating tagging and marking requests with the Pacific Marine Fisheries Commission (PMFC) and ensuring all PMFC marking protocols are followed.

POL-5105 Steelhead Enhancement Coordination

This policy applies to coordination of steelhead hatchery enhancement activities within the WDW and between the WDW and Tribal enhancement programs.

1. Regional Biologist Compiles Steelhead Planting Allotments. **The Regional Biologist compiles annual planting allotments for steelhead smolts, fry and eyed eggs, and submits them to Olympia by March 15.**

2. Allotment Review is Required. **The Hatchery Program Manager and the Anadromous Fisheries Program Manager must approve any change in planting levels that are more than 20 percent above or below the previous year's release for a given river.**

3. Information Exchange With Tribes is Required. **The Hatchery Program Manager will provide copies of WDW steelhead planting data to the Treaty Indian Tribes affected by those plants. The Anadromous Fisheries Program Manager will obtain Tribal steelhead planting data for Department files.**

4. Production Data is Shared With State and Federal Agencies. **The Hatchery Program Manager will provide WDW steelhead release data to other State and Federal agencies.**

POL-5106 Disposition of Excess Steelhead Juveniles and Eggs

This policy applies to steelhead eggs, fry, subsmolts, and smolts that are excess to WDW Program requirements as identified in Policies 5101. 5102, or 5103.

1. The Hatchery Program Manager Will Coordinate Distribution. **The Hatchery Program Manager will ensure that all WDW steelhead enhancement projects */ have adequate numbers of eggs or fry of appropriate stocks available. All steelhead eggs, fry, or smolts determined to be excess to WDW's programs will be offered to Treaty Tribes and other State fishery agencies.**

2. Release of Excess is Restricted. **The Regional Biologist must review all proposed releases of excess steelhead juveniles not covered under Policies 5101, 5102, or 5103 above, to ensure that there will be no adverse impacts to existing fish populations. All other excess steelhead juveniles must be destroyed.**

---

* **Cooperative rearing projects are considered to be WDW projects for the purpose of this policy.**

No fish or eggs from uncertified sources shall be used in hatchery programs without approval of a WDW Pathologist.

It shall be the responsibility of each regional fisheries biologist to quarantine and analyze for serious pathogens any eggs or fish from uncertified sources before incorporating them into any hatchery program. The risks of introduction of communicable, incurable diseases are high and must be prevented. Arrangements should be made with an agency pathologist to collect samples for viral analysis for any previously uninspected stocks that might be used in hatchery programs.

Any exceptions to this procedure must have written approval from a WDW Pathologist.

POL-5510 Predator Control at Hatcheries

This policy applies whenever the need exists to reduce or prevent predation by birds or animals at hatcheries.

1. Nonlethal Methods Should Be Used Where Possible. **Predator control will be conducted only by nonlethal methods except licensed trappers or hunters may take predators during an open season if local ordinance permit the activity.**

2. The Engineering/Lands Division Designs All Major Predator Control Systems. **Hatchery Managers will consult with Engineering for a preliminary design and cost estimate when need for a major control system such as netting and cyclone fencing arises.**

3. Predator Control Systems Should Target The Most Effective Predators. **Hatcheries should use systems that target the predator creating the major loss. Suggested nonlethal, low-cost predator control systems for the following species are:**

   a. **Herons: strobe lights, pulsating electric fence AV alarm, cracker shells**

   b. **Gulls: cracker shells, AV alarm, polyrope**

   c. **Mergansers: polyrope. cracker shells**

   d. **Otter: underwater sonic devices, pulsating electric fence**

4. Public and Employee Safety Must Be Considered. **The use of nonpulsating or direct current electric fences is prohibited. Safety must be considered when installing or operating all control systems.**

5. Cost-Effective Systems Should Be Used. **The annualized cost of the predator control system should not exceed the value of the annual fish loss.**

6. Wildlife Control Agents Should Remove Animals. **Hatchery personnel should refer predator control problems involving otter, mink, or other mammals to a Wildlife Control Agent.**

PRO-551OA Controlling Predators at Hatcheries

Action By		Action
Hatchery Employee	1.	**Observes fish loss or predator activity and informs Hatchery Manager.**
Hatchery Manager	2.	**Confirms employee's observation.**
	3.	**Identifies predator species.**
	4.	**Consults with either a Wildlife Control Agent or a U.S. Fish and Wildlife Service representative.**
Control Agent	5.	**Advises Hatchery Manager of preferred control method.** **The control expert may live trap and remove the offending predator or call in a licensed trapper.**
Hatchery Manager	6.	**Installs budgeted control devices and monitor their effectiveness.** **If effectiveness is proven, maintains system.**
	7.	**Consults with Engineering if a capital project control system is indicated.**
Engineer	8.	**Prepares preliminary design and cost estimate of major control system; informs Hatchery Manager.**

Hatchery Manager	9. **Writes justification for expenditure including annualized value of fish loss.**
	10. **Submits capital expenditure request through the regional office.**
	11. **Continues interim measures for control.**

TSK-5501A Controlling Predators At Hatcheries

When predator activity or fish loss is reported at a hatchery, the Hatchery Manager:

1. **Confirms predator activity and fish loss by:**

   a. **Early morning, late evening observations and predator counts.**

   b. **Comparing current inventory of fish with previous inventory.**

2. **Determines species of concern by:**

   a. **Early morning, late evening observations.**

   b. **Looking for sign, such as droppings and feathers.**

3. **Installs low cost devices after matching control method to predator.**

4. **Monitors effectiveness by repeating early morning, late evening observations, and comparing inventory.**

5. **Maintains system if it is proven effective.**

6. **If major control system is indicated, consults with Engineering for preliminary design and cost estimate.**

7. Writes justification for predator control expenditure. Include comparison of value of fish loss to system cost.

8. Submits capital expenditure request.

9. Continues interim measures for control.

GENETIC CONSERVATION AND MANAGEMENT PROGRAM FOR HATCHERY BROODSTOCK OPERATIONS

PREFACE

The objective of these guidelines is to define courses of action that can be taken in the WDW hatchery system that will help maintain the current and future genetic structure and diversity of the hatchery stocks of fishes, both resident and anadromous. Additionally, these guidelines serve as a tool for the education of fish culturists in the hatchery system.

Genetic variation is the primary resource of any successful fish breeding program. The goal for the management of a hatchery is dependent upon the purpose of the hatchery program. The two major hatchery program of interest are the commercial and fishery operations. The commercial setting consists of a selective program aimed at producing a fast growing fish with high feed conversions and accommodating behavior for an aquaculture setting. These programs start with a base population containing a large amount of genetic material. Through properly designed selective breeding processes these programs change the genetic composition by reducing its genetic variability. As selection continues, positive traits will gradually replace the negative traits.

The WDW programs, by contrast, are aimed at producing fish for release into the wild. For a program such as this, it is not always desirable to alter genetic composition of the base population to perform well under hatchery conditions. WDW should strive to maintain the "natural" genetic diversity, or increase the diversity if warranted, of the original population. It should be noted that in some natural populations the genetic structure can at times be less diverse than hatchery populations.

In both types of aquaculture management mentioned above, genetic composition of the stocks is a concern. Whether the goal is to alter the genetic

composition or maintain its original variability, genetic considerations are a must for proper management.

Throughout the history of aquaculture, many hatchery programs have failed to manage their genetic resources successfully. This is even true for the WDW. Crawford (WDW Publication 1979) suggests problems he believes are associated with inbreeding in his: "The Origin and History of the Trout Brood Stocks of the Washington Department of Game." Additional examples of potential inbreeding can be found within the WDW hatchery system such as the albinism that is persistent in Skamania stock summer steelhead. This recessive genetic trait is most likely attributable to the inbreeding associated with the supper steelhead (three salt) program conducted at the Skamania Hatchery during the 1970's. Finally, 20 years ago, the U.S. Fish and Wildlife Service attempted to artificially select a brown trout broodstock that was resistant to furunculosis. Ultimately, they were successful in this attempt but along with achieving this goal they found that the resultant progeny were now susceptible at a higher rate to bacterial gill disease.

One primary reason for historical program failures is that their program goals were not being clearly defined. A poor genetic management decision would be to use the same stock for pen rearing as well as to be released into the wild. The genetic goals for these two types of programs are very different and should not be accomplished concurrently with the same stock. In addition, established principles of population genetics and proper animal husbandry have often been ignored in the founding and maintenance of hatchery operations. It is often difficult to acquire large numbers of fish from which to initiate or perpetuate a hatchery population, but to ignore the reduction in genetic variation due to a small population size is to increase the probability that the hatchery program will fail to meet its goals.

The resultant effects of a loss in genetic variation has been well-documented for a variety of fishes. Allendorf and Utter (1979) have found rainbow trout (Oncorhynchus mykiss) with conspicuously low levels of genetic variation show poor survival. There are several reports of an increased number of

deformities in rainbow trout associated with the loss of genetic diversity (Aulstad and Kittlesen 1971; Kincaid 1976a. b). Brown trout (Salmo trutta) found to have a reduced level of genetic variation when compared with the presumed source population show an increased number of atypical morphology in addition to high mortality (Ryman and Stahl 1980). These studies are only a few of many that suggest a reduction in genetic diversity is hazardous to hatchery programs. Although these examples are quite pessimistic, they should not be taken to indicate that all hatchery populations have reduced amounts of genetic variation and diversity. Most hatchery populations of rainbow trout have approximately the same or greater amounts of genetic variation than the natural populations (Allendorf and Utter 1979; Busack et al. 1979).

The application of good genetic principles in the maintenance of hatchery stock is quite clear and straightforward. The first step is to define the goals of the hatchery program. WDW is only concerned with fish management and not aquaculture. The objectives of the WDW hatchery program is to produce fish that will be released into the wild to survive to a catchable size. This objective can be best broken down into four major components. They are to raise fish as: (1) catchable (legals) sized fish; (2) fry/fingerlings that will survive in the wild and grow to a catchable size; (3) release anadromous smolts that will survive and return as adults; and (4) have resident fish that will survive (carryover) into a future year as a larger catchable. The primary genetic goal of hatchery programs with these objectives is to minimize any genetic alterations caused by genetic drift, inbreeding, and adaptation to hatchery conditions.

This report was prepared through the joint efforts of numerous Hatchery Managers; including Bob Paulsen. Mike Albert, Larry Klube. Vince Janson, and Steve Robards, fish health specialits, and individuals from the Fish Management Division.

SELECTION OF BROODSTOCK POPULATIONS

Resident Trout

One of the first genetic decisions that is made when establishing a hatchery is its broodstock source. Broodstocks are often selected either from an existing hatchery stock, or a stock that is readily available. It is important that this decision is made with regards to the program goals and the genetic composition. The broodstock should be genetically suited to accomplish the goals of the hatchery program within the given environment.

Another example of where these genetic decisions are made is when it becomes time to augment the existing broodstock. The need for supplementation often occurs when situations arise that result in a large loss of broodstock, thus reducing the spawning numbers of a population. If left unattended, a "genetic bottleneck" occurs and the population's genetic diversity is reduced. When considering the origin for the additional broodstock, the most logical is the original broodstock source. In order to use the original fish stock, one must first determine how much the existing hatchery strain has genetically shifted from this source. One way to estimate this is to determine how well the population was genetically managed. Under a good genetic management program, sufficient consideration would be given to the genetic composure, and the original stock could be used for supplementation. Under a poor genetic management program, considerable genetic changes such as inbreeding would have taken place resulting in a hatchery-specific strain of fish. In this case, using the original broodstock source would alter the hatchery stock.

Alteration of an inbred population can have positive or negative results. The positive results would be what is termed "hybrid vigor." This were an inbred population is crossed with an outside population (usually an inbred one) with the resultant population having increased genetic variation in a uniform pattern.

Anadromous Trout

For anadromous salmonid populations, such as steelhead, a program must consider the importance of local adaptation. The tendency exists for resident and anadromous salmonids to evolve into genetically discrete populations based on environmental adaptation (via natural selection) over many generations (Behnke 1972; Ricker 1972; Ryman et al. 1979). There have been numerous studies to indicate that hatchery fish derived from local populations perform better in their native environment than do fish from other populations (Bams 1976; Reisenbichler 1982). "Wild" fish have the capabilities of providing significant genetic material to hatchery populations. Utilizing "wild" fish in a hatchery broodstock should be included whenever possible. Exact numbers (or percentages) must be decided on a case-by-case basis. These fish provide a source for the environmentally selected traits and help increase genetic diversity. Since our program goal is to maintain a large population of fish for the user group, it is in our best interest to maintain a stock of fish that is best adapted to survive to adulthood, and subsequent harvest or escapement, in each river system.

When it becomes necessary to supplement a spawning population with an outside source, several steps should be followed to maximize the potential genetic diversity and resultant success of the program. The initial consideration is the donor stock source. Ideally the donors should be from the same river system or a very similar one. The next step would be to spawn each group of fish separately and prevent intermixing. This will help maintain a large number of environmentally selected traits in the progeny as well as prevent a reduction of these traits.

GENETIC DRIFT

Problems encountered in a fish cultural program may be the result of genetic drift, inbreeding, etc. Genetic drift, by definition. is a random fluctuation

in the occurrence of a gene within a small population resulting in a gene fixation with a resultant loss of genetic diversity regardless of its adaptive value.

Minimizing the loss of genetic variation to genetic drift is a concern for hatchery populations. The equation to best estimate the expected loss of genetic variation is:

$$\frac{1}{2 \times (\text{Total number of males and females})}$$

(Equation #l)

This equation shows how much of the original genetic variation is lost per generation. The largest loss occurs when there is a significant reduction in the total spawning population size. It is important to note that even a 10 percent reduction in genetic variation has detectable harmful effects on vital traits such as growth rate and survival (Allendorf and Ryman 1987).

INBREEDING

Inbreeding, by definition, is the mating of related individuals. As a general rule the number of similar genes shared by two individuals is related to the relationship between parents. Two studies by Kincaid (1976a. b) have shown that a 25 percent reduction in genetic variation due to inbreeding resulted in: a decrease in fry survival (19 percent of the population), poor feed conversion (6 percent of the population), increased morphological abnormalities (38 percent of the population), decreased weight at 147 days (11 percent of the population), and 364 days (23 percent of the population). A resultant loss in fish health is much harder to quantify but it would be expected to follow these trends.

The extent of inbreeding can be established rather simply. A pedigree is required to provide the most accurate method. In most hatchery programs, this

is not available and or possible, so an estimate of inbreeding is produced from information taken from the existing population. The equation used for this estimate is identical to the equation used to determine the loss in genetic variability (Equation #l). The inbreeding equation is:

$$\frac{1}{2 \times (\text{Total number of males and females})}$$

(Equation #2)

This equation is used when the ratio of males to females is equal. As an example, a hatchery used a total of 50 broodstock fish, 25 of each sex. The rate of inbreeding can be estimated as follows:

$$\frac{1}{2 \times (50)} = 0.01 \text{ or } 1\%$$

This illustrates that each generation of fish produced when using a total of 50 broodstock fish will become more closely related at a rate of 1 percent per generation. Thus after 10 generations the inbreeding of the population will be approximately 10 times 1 percent (after compounding the inbreeding effect annually for these 10 years the inbreeding of the population will be 12.59 percent). As stated previously, it has been demonstrated that a reduction in genetic variability through inbreeding can result in an adverse effect on the quality of fish produced (Kincaid 1976a. b 1983). Simon (1988) expressly stated that "inbreeding should not be tolerated in hatchery populations intended for restoration or supplementation of wild populations."

When there are unequal numbers of males and females a different equation is used to determine the amount of inbreeding:

$$\frac{1}{8 \times (\text{number of males})} + \frac{1}{8 \times (\text{number of females})}$$

(Equation #3)

An example of this situation would be if 10 males were used to fertilize 150 females. The amount of inbreeding per generation would be:

$$\frac{1}{8 \times (10)} + \frac{1}{8 \times (150)} = 0.0133 \text{ or } 1.33\%$$

This shows there will be an inbreeding rate of 1.33 percent per generation using these numbers of fish. After 10 generations the inbreeding would be approximately 10 times 1.33 percent.

The ratio of males to females is just as important as the total broodstock number when considering the genetic structure of the population. For example; if the total number of broodstock was 160 with only 10 males for 150 females, according to Equation #2 the percent of inbreeding would be 0.3125 percent per generation. When in actuality, the inbreeding due to the unequal ratio of males to females would be 1.3 percent per generation.

As the ratio of males to females changes, so does the amount of inbreeding When the number of males approaches the number of females, the amount of inbreeding decreases proportionally. When dealing with returning steelhead; the ratio of males to females varies from generation to generation, making the equation for determining the amount of inbreeding quit complex. In this case it is recommended to come as close to 1:1 ratio (males:females) as possible.

Two major factors affect the rate of inbreeding in a populatio (1) the total number of broodstock, and the ratio between males and females. Inbreeding narrows the genetic composition in the future population. As the composition of each generation narrows, the total genetic resources are being reduced as well.

GENETICALLY EFFECTIVE POPULATION SIZE

The number of spawning individuals in a population does not necessarily determine the rate at which genetic diversity is being maintained or lost (genetic drift). Such factors as the number of progeny and the ratio of males to females also contributes to genetic diversity. To minimize the loss of genetic diversity it is necessary that all spawning individuals contribute to the population equally. The effects of unequal contribution are seen very clearly when examining the male to female ratio. For example, if a hatchery population of 200 spawning adults was 198 females and two males, one-half of the genetic composition of the progeny will be contributed by one of two males. The genetically effective population size of this future population will be a great deal less than 200.

The definition of genetically effective population size is: the size of a "model" population that would lose its genetic variation at the same rate as the population being considered. A "model" population is one which the ratio of male to female is 1:1, and the breeding is a random event. With a sex ratio such as this, each individual has an equal chance of genetically contributing to any of the offspring. When the male to female ratio deviates from a 1:l situation, an equation exists that will determine the genetically effective population size (Falconer 1981). Using the example described above, a population of 200 fish with 198 females and two males has a genetically effective population size of less than eight. This would indicate that this population of fish would lose its genetic diversity at a rate equal to a "model" population with four females and four males.

Additional factors can play a role in the size of the genetically effective population such as fecundity and fertility differences. Differences in these two factors can bring about an inequality in the contribution from each spawning adult. Variations between fertility and fecundity are not always biologically and genetically oriented. Differences in spawning procedures can alter the fertilization process or alter the number of gametes taken from each male or female. It is possible to maximize the genetically effective

population size through limiting the differences between gametes taken from each individual through good spawning practices. Such good hatchery practices can maintain or actually increase the genetically effective population size above and beyond the number derived from the number of parents spawned. This is possible since the "model" population will have inherent differences in contribution between individuals due to chance. Through equalizing the contribution of each individual, the genetically effective population size will be near twice the number of reproducing individuals (Denniston 1978).

RECOMMENDED PROCEDURES FOR MAINTAINING GENETIC DIVERSITY

The following recommendations are designed to help increase and maintain the genetic diversity of the current hatchery stocks of fishes managed by WDW. These recommendations are based on sound genetic management principles and will assist in providing user groups with quality fish while addressing the needs of the resources managed by WDW. The following procedures will be subject to modification depending on the various program and facility limitations. Prior to implementation of any genetic procedures, specific program goals must be defined.

RECOMMENDED PROCEDURES FOR RESIDENT TROUT

1. Maintain A Large Number Of Mated Pairs To Sustain The Future Population's Genetic Structure.

Numerous researchers have made suggestions as to the number of spawners required to maintain a population's genetic integrity and diversity. Some examples of these suggested numbers demonstrate the range involved. Herschberger (1981) has recommended that a minimum effective spawning population size of 250 pairs would be sufficient to maintain genetic variation. Stahl (1980) recommends that 30 mated pairs chosen at random from the total population would suffice. Soule (1980) suggests that considerably

more than 250 mated pairs would meet the long-term evolutionary requirements of a population. Kincaid (1976a) has recommended 100 breeding pairs, and then later suggested that there should be no less than 250 breeding pairs. From computer simulated results, the National Fish Health Research Laboratory (1984) estimates that 500 breeding pairs would be sufficient.

Greater than 250 breeding pairs should be spawned to maintain the genetic diversity and integrity of the WDW resident trout hatchery program.

2. Maintain A Random Mating Pattern and Avoid Any Deliberate Selection Of Breeding Pairs.

Artificial selection can alter the genetic structure in a population of fishes. Each time a spawner is chosen based on some particular characteristic such as size, color, or time of maturity, artificial selection is taking place. Through spawning adults with the genetic composition for a desired trait such as an earlier maturation time, or a larger size, or any other genetically determined trait, and reducing or eliminating those that do not have traits, the genetic structure of a population will be altered.

Only fish with obvious genetic deformities such as missing body appendages, scoliotic, or abnormal body structure should be eliminated from the broodstock. Fish which may have missing body appendages due to causes other than genetics may still be retained in the population. All other fish should be included to best represent the genetic integrity and variability of the population.

3. Maintain A Male to Female Ratio of 1:1.

As mentioned previously, a one to one male to female ratio is vitally important when attempting to maintain the genetic diversity within a population. A point that needs to be considered is when a male is used more than once. From a genetic standpoint a male is counted only once even though it may have been used to fertilize the eggs of several females at different

times. To avoid the problems brought about through reduced genetic diversity and inbreeding, use equal numbers of each sex.

To determine which males have, or have not been used, in the spawning procedures, separation or marking (tagging) may be necessary.

The use of equal numbers of males to females may be difficult to accomplish because of operational constraints. Efforts should be undertaken to meet this need.

4. Recruit Future Broodstock In A Proportional Manor According To The Egg-Take Per Spawning Period.

The use of fish for the future broodstock taken from a single spawning period should be avoided. Time of maturation is a genetically determined trait, and deliberate selection of a maturation period will alter the population's genetic structure via inbreeding. Individuals that are mature on a particular day are more likely to be closely related to one another than others chosen at random.

To maintain the current genetic composition of the population, the future broodstock should be selected from the total egg take. A method which will best fit the population of interest is to recruit the future broodstock in proportion to the number of eggs taken per spawn.

For example, 400 new broodfish will be needed to replace this year's 4-year old fish. On the first spawning day only 8 percent or 32 fish of the future broodstock would be taken from this egg-take. On the second spawn, 20 percent of the egg-take goal was taken. From this spawning day you would take 20 percent or 80 of your future broodfish. This procedure would continue throughout the total spawning period.

5. Equalize The Contribution Of Each Spawning Adult.

Fecundity and fertility differences between spawning adults should be minimized in an attempt to maximize the genetic variability within a population. As stated previously we can actually increase the genetically effective population size if these differences are minimized. A method to minimize these differences is to measure (or at least approximate) the gametes taken from both males and females to insure that all fish contribute equally. This would result in a slight egg loss per spawn since the number of eggs contributed by females producing large numbers would be reduced. The milt contributed from each male should also be measured (at least a volume estimation) to help avoid differences between males regardless of gametes produced.

A good approach to help minimize contribution differences between males is to collect milt from several males that will be used for fertilization, and fertilize the eggs with this mixture rather than adding milt into the eggs one male at a time. When you add milt from one male at a time to the eggs there is a probability that a good portion of the eggs will be fertilized by this one male before sperm from another male can be added (especially if the eggs and milt are being stirred or mixed). The effects of this later procedure are virtually the same as using the first male to fertilize the entire lot of eggs.

Another alternative would be to spawn fish in distinct family units of one male to one female. This would insure that eggs from one female are fertilized by sperm from one male. It should be recognized that this may be difficult to accomplish under current operational situations.

Recognizing the difficulty in minimizing the differences between females under production conditions, any initial effort may be best spent in reducing the differences in gametes used between spawning males. It should also be acknowledged that the amount of viable sperm per volume of milt from

each male will be different. However, under production conditions there is no rapid way to monitor this.

6. If Inbreeding and Loss Of Genetic Variation Rave Reduced The Overall Fitness Of The Progeny, Supplementation Of The Current Gene Pool May Be Required.

The reintroduction of sperm or eggs from wild fish or other sources of fish may be desirable in some situations. When performed correctly, supplementation can help minimize the divergence from the original broodstock population without severely altering the current hatchery stock. There appears to be no ideal proportions of these augmentations from other populations, but a 10 percent contribution every second or third generation should be adequate under most situations.

Careful consideration is necessary when choosing the source population from which additional genetic material will be used. The source population should be one that will help produce fish best suited for the program environment(s).

RECOMMENDED PROCEDURES FOR ANADROMOUS TROUT

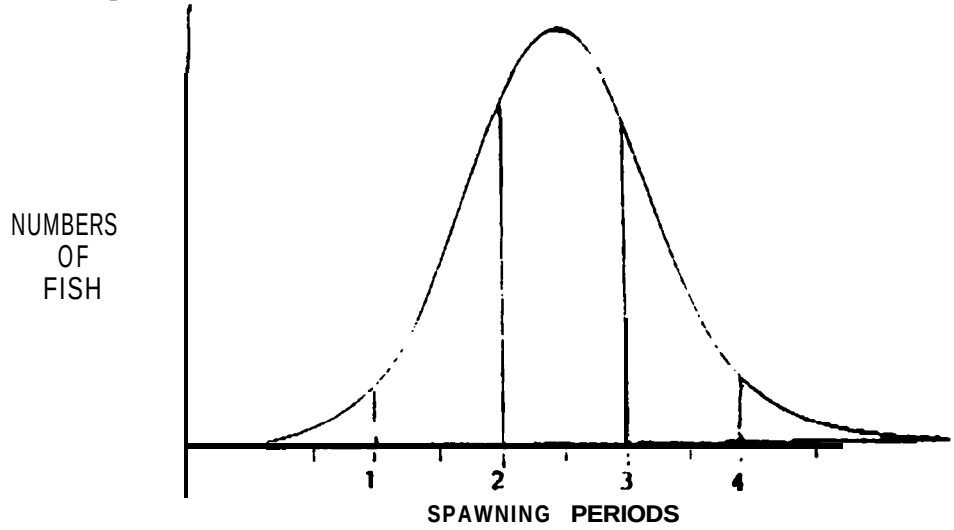
1. Distribute The Progeny Of Each Spawn In A Uniform Fashion Therefore Preventing Additional Selection Via Distribution.

As we take the necessary steps to spawn the required numbers of adult fish, the method by which egg lots are distributed for planting can alter the genetic composition of the future broodstock population. Although the effect of this may be rather subtle it still must be considered to avoid reversing the effects of good spawning practices.

For example, there has been a good return of steelhead back to the hatchery trap and 2.0 million eggs are collected. Throughout the spawning a

male to female ratio of 1:1 has been maintained. The program goal for release from the hatchery only requires 500,000 of these eggs. The remainder are programmed for distribution to other facilities. How the eggs are chosen for each program will alter the "genetically effective population size" of the future steelhead population. For instance, if eggs are chosen in whole lots, this will reduce the number of contributing adults to approximately 200 of each sex. Conversely, if the broodstock program eggs are chosen from all lots this will increase the number contributing adults to approximately 500. Therefore, steps should be taken to assure that the smolt production released from the broodstock hatchery is from all spawners, or as many as possible.

The procedure described above can be illustrated according to the "bell" shaped distribution curve below:



It is recognized that it may not be possible to select broodstock replacement from all spawners within the broodstock population. Under ideal situations, if 5 percent of the eggs are taken from each of spawns one and seven, 10 percent each from spawns two and six, 15 percent each from spawns three and five, and 40 percent from spawn four, then broodstock replacement should come from each of those spawns in as close a percentage as was expressed by the percentage of original spawn. Operational constraints may make it necessary to take broodstock replacement from fewer spawns. However, it is stressed that broodstock replacement should come from a minimum of three of the spawns illustrated previously.

2. Maintain A Sufficient Sample Of The Existing Gene Pool. **In order to maintain a sufficient sample of the genetic structure of the existing population the entire run should be spawned proportionally. An example of how a hatchery may not acquire a sufficient sample is as follows: if it has been decided to spawn the first 400 gravid adults that reach the trap rather than spawn every adult, this decision has reduced the future genetic composition of the population via temporal selection. Theoretically, all fish stocks are composed of spatially and temporarily adapted subpopulations. By only taking the first 400 ripe adults, this has effectively eliminated the genetic contribution of the remainder of the run. In this example, temporal selection has restricted the possibility of obtaining a good sample of the total returning population of steelhead.**

3. Maintain A Random Mating Pattern and Avoid Any Deliberate Selection Of Breeding Pairs. **Refer to the section under "RECOMMENDED PROCEDURES FOR RESIDENT TROUT" on page 21.**

4. Attempt To Equalize The Contribution Of Each Spawning Adult. **Refer to the section under "RECOMMENDED PROCEDURES FOR RESIDENT TROUT" on page 23.**

5. Attempt To Maintain A Male To Female Ration Of 1:1. **Refer to the section under "RECOMMENDED PROCEDURES FOR RESIDENT TROUT" on page 23.**

6. If Inbreeding and Loss Of Genetic Variation Nave Reduced The Overall Fitness Of The Progeny, Or The Number Of Returning Fish, Supplementation Of The Current Gene Pool Hay Be Desirable.

The reintroduction of sperm or eggs from wild fish or other sources (hatcheries) may be desirable in some situations. When supplementation is performed correctly it can help minimize the divergence from the original broodstock population without severely altering the current hatchery stock. There appears to be no ideal proportions of these augmentations from other populations, but a 10 percent contribution every second or third generation should be adequate under most circumstances. Caution must be taken not to

adversely impact the escapement of the natural stock which may be used for augmentation.

If the situation calls for the addition of new genetic material, one must carefully examine the original and the potential source populations. In most situations, next to the existing population, the next best performer would be a population originally from the same source (if it has been managed correctly). The next best performer would be a population originally from the same river system. If these type of populations are not available, choose from a population that has similar characteristics to the original stock in regard to run timing, freshwater distance traveled, and type of river system. Limit the introduction (enhancement) to a maximum of two foreign stocks at any one point in time. One foreign stock introduced at a given time is more desirable from an evaluation process. The disease history of any foreign stocks should be considered during any selection process.

RESIDENT AND ANADROMOUS SUMMARY

The previous recommendations are structured in a manner that is consistent with genetic conservation and management techniques. This document is designed to assist the hatchery personnel in maintaining genetically sound spawning practices. Program or research goals at times may be to alter through selection or manipulation a populations genetic structure. These type of programs are not contradictory to the previous recommendations as long as the goals are well-defined. All programs can benefit from proper spawning practices that are designed to maintain a populations genetic structure.

The previous recommendations are summarized as follows:

1. Maintain a large number of mated pairs in a spawning population. Two hundred fifty mated pairs is the minimum number desired for broodstock integrity.

2. **Maintain a random spawning/mating technique.**

3. **Maintain a ratio of one male to one female (1:l) whenever possible.**

4. **Recruit future broodstock according to the proportion of the egg take per spawning period.**

5. **Equalize, to the degree possible, the contribution of each spawning adult used during the spawning process.**

6. **Should supplementation be required, carefully consider all the available options.**

POL-5514 Fish Medication at Hatcheries

This policy applies to all hatcheries and rearing ponds for use of drugs for therapy, disinfection, and anesthetic purposes.

1. Only Authorized Drugs May Be Used. **All drugs must be registered by Federal regulatory agencies or authorized by Department of Wildlife pathologists.**

2. Pathologist Responsible For Providing A Current List of Approved Chemicals. **A current list of chemicals approved for hatchery use is to be provided by pathologists to all hatcheries and rearing ponds. The list is to include information on basic chemical applications, safe dilution levels or neutralization procedures, and fish holding periods following treatment before release into State waters.**

3. Chemicals Must Be Handled According To Label Instructions. **The hatchery or rearing pond manager and staff are responsible for the proper handling techniques in chemical applications. All chemicals must be handled**

according to label instructions and/or Material Safety Data Sheets which outline precautions for safe handling and use.

4. Chemicals Must Be Properly Stored.

The hatchery or rearing pond manager and staff are responsible for the proper storage of all chemicals. Chemicals must be stored according to label instructions and in a manner that will minimize risks of container breakage or chemical spillage and contamination of surrounding work areas and natural ecosystems.

Chemicals must be stored in a designed chemical storage area. The chemical storage area should be a cool, dry, well-ventilated, and well-lighted room or building. The storage area should be insulated to prevent freezing Or overheating. The area should be locked to prevent entry by unauthorized individuals.

All chemicals are to be stored in their original containers. If a container is found to be leaking, the contents are to transferred to a container that has held the same chemical. If such a container is not available, a clean container of similar construction is to be used and labeled correctly prior to transfer.

5. Hatchery Managers Responsible For Holding Treated Fish On Station. The hatchery or rearing pond manager is responsible for holding fish on station for a specified time following certain medicinal treatments.

6. All Incoming Eggs Must Be Disinfected. The hatchery or rearing pond manager and staff are responsible for disinfecting all incoming eggs from other stations.

7. Planting Trucks Must Be Disinfected. Planting trucks used at a facility with a history of virus problems must be disinfected before being used at other stations. The receiving hatchery or rearing pond manager and

staff are responsible for disinfecting planting trucks to be used at their facility.

8. Small Equipment Items Are Not To Be Transferred. **Small equipment items such as nets, plastic buckets, or any items made of wood are not to be transferred from one station to another.**

Action By	Action
Hatchery Manager	**Considers fish treatment and contacts pathologist.**
Pathologist	**Inspects and discusses the problem with the Hatchery Manager and recommends chemical treatment. Provides technical information on a particular product as needed.**
Hatchery Manager	**Applies the drug as instructed, dilutes, or neutralizes the chemical to a "safe" level if required, and discharges the water. Consults the approved list of chemicals for disinfecting incoming eggs or for disinfecting planting trucks and equipment. Dilutes or neutralizes the chemical to a "safe" level and discharges the chemical or treated water.**

POL- Salmonid Disease Control

This policy applies to coordination of salmonid disease control activities within the WDW and between the Department of Wildlife, Washington Department of Fisheries, and those federally recognized Treaty Indian Tribes within the State of Washington that have agreed to support this policy.

1. Policy Developed By Fisheries Co-Managers Will Be Followed. **The Salmonid Disease Control Policy Of the Fisheries Co-Managers of Washington State, developed by the WDW, Northwest Indian Fisheries Commission, the Washington Department of Fisheries, and the U.S. Fish and Wildlife Service and dated July 10, 1991, will be used by the WDW for the control of salmonid fish diseases.**

POL-403 SALMONID DISEASE CONTROL OF THE FISHERIES CO-MANAGERS OF WASHINGTON STATE

POLICY

It shall be the policy of the Fisheries Co-Manager of Washington State to protect fisheries resources by preventing importation, dissemination, and amplification of pathogens known to adversely affect salmonids. This policy sets forth the minimum fish health standards. A Co-Manager may implement additional practices or measures at their facilities at their discretion. Further, acknowledging that many complex fish health situations will arise, it shall be the policy to foster open and frequent communication between Co-Managers and Co-Operators to jointly resolve these issues without endangering the fisheries resources. This policy supersedes the Washington Department of Fisheries and Department of Wildlife policy entitled "Fish Disease Control."

DEFINITIONS

Accredited Inspector. **An individual holding one of the following certifications:**

- **American Fisheries Society (AFS) - Fish Health Inspector**
- **Canadian Fish Health Officer**
- **United States Title 50 Inspector (Code of Federal Regulations, Title 50, Chapter 1, Subchapter 8, Part 16)**

Anadromous Broodstock. **All adult salmonids collected or captured from the waters of Washington State, for the purpose of collecting eggs and/or milt, which have spent part of their life cycle in saltwater add free ranging or as captive fish held in marine net pens. Adult fish collected or captured temporarily but released unspent are not considered broodstock.**

Assumed Pathogen Prevalence Level (APPL). **The percent of any lot of fish (i.e. 2 percent or 5 percent) that is assumed to have a pathogen at a detectable level using tests outlined in the AFS "Fish Health Blue Book." This level is used to determine the sample size needed to provide a 95 percent confidence level of finding the specified pathogen.**

Captive Broodstock. **All adult salmonids which have been reared full term in captivity in freshwater for the purpose of collecting eggs and/or milt. This includes stocks which are landlocked for their entire life cycle.**

Co-Managers. **Federally recognized Treaty Indian Tribes within Washington State and the State of Washington.**

Co-Operators. **All government agencies and entities other than the Co-Managers involved in the rearing and transfer of salmonids in Washington State.**

Confirmed Viral Identification. **The identification of a replicating viral agent by serum neutralization assay or other confirmatory test agreed to by the Co-Managers.**

Egg Disinfection. **The exposure of water-hardened or eyed eggs to a buffered iodophor solution containing at least 100 ppm active iodine for not less than ten (10) minutes. The minimum ratio of iodophor solution to eggs (volume to volume) will be one (1) part iodophor solution to one (1) part eggs. Once this ratio is met, discard the used solution and replace it with fresh disinfectant.**

Epizootic. **The occurrence of an infectious disease which results in an average daily mortality of at lest 0.1 percent within a specific rearing unit for five (5) consecutive days.**

Fish. **Live fin fish, eggs, or gametes thereof including food fish (RCW 75.08.011) and game fish (RCW 77.08.020).**

Fish Health Blue Book. **The most recent edition of "Procedures for the Detection and Identification of Certain Fish Pathogens," published by the Fish Health Section of the AFS.**

Health Management Zone (HMZ). **A geographic area containing one or more watersheds from which the transfer of live fish or gametes are controlled for fish health management purposes. Facilities which have specific pathogen-free water supplies can be islands within an HMZ and have less restrictions on egg and fish transfers out of their facilities than their surface water counterparts. Separate HMZs are listed in the Interim Implementation Plan (Section VII) for eggs and for fish. The Fish Health Management Zones (FHMZ) are small than the Egg Health Management Zones (EHMZ) because of the higher level of risk associated with fish transfers.**

Inspect ion. **The collection and examination of a statistically valid sample of fish tissues and/or fluids for the listed pathogens by or under the supervision of an accredited inspector. Methods used will be those described in the "Fish Health Blue Book" or others mutually agreed to by Co-Managers' fish health staff.**

Iodophor Water-Hardening Eggs. **The exposure of recently fertilized eggs (not more than five(5) minutes exposure to water to a buffered iodophor solution containing at least 75 ppm active iodine for not less than sixty (60) minutes. The minimum ratio of iodophor solution to eggs (volume to volume) will be one (1) part iodophor solution to one (1) part eggs. Discard the used solution once the ratio has been met.**

isolation. **The process of keeping a group of eggs or fish physically separated from other groups at the same facil ity for the purpose of preventing cross-contamination with possible pathogens. This is accomplished by incubating/rearing in separate containers which are separated by walls or curtains and without the reuse of each others' incubation/rearing water. A group may consist of an entire lot of fish or be a smaller unit of one lot,**

such as 1 day's spawn. Separate equipment is also preferable, but reuse of equipment is acceptable if it is adequately disinfected between isolation units.

Lot of Fish. A group of fish of the same species and age that originated from the same discrete spawning population and that have always shared a common water supply. In the case of adult broodstock, various age groups may comprise the same "lot" provided they are of the same species and have shared the same water supply while brood fish.

Presumptive Viral Identification. The detection of a replicating agent in cell cultures inoculated with fish tissues or fluids. Presumptive identification is made when cytopathic effect (CPE) is replicated in cell culture.

Quarantine. Keeping a group of eggs or fish isolated as defined above with the following restriction: effluent from eggs or fish in quarantine will be disinfected with a residual level of at least 2 ppm chlorine for a minimum of ten (10) minutes of contact time or by other methods acceptable to relevant Co-Managers.

Release. The liberation of captive fish into public waters of Washington State that results in their being free-ranging.

Relevant Co-Managers. Those Tribes and State agencies which could experience fish health impacts from fish or egg movements within their area of concern.

Reportable Pathogens. The following pathogens are reportable:

Viral - Infectious hematopoietic necrosis virus (IHNV)
Infectious pancreatic necrosis virus (IVNV)
<u>Oncorhynchus masou</u> virus (OMV)
Viral hemorrhagic septicemia virus (VHSV)

Bacterial - Renibacterium salmoninarum
Strains of Aeromonas salmonicida and
Yersinia ruckeri that are resistant to oxytetracycline (Terraamycin) or ormetoprim potentiated sulfadimethoxine (Romet)

Parasite - Myxobolus cerebralis

Sanitize. The process of eradicating a fish pathogen from a facility and/or its water supply. Recommended procedures are outlined in Section 6 of the Pacific Northwest Fish Health Protection Committee's Model Policy.

Specific Pathogen-Free Water. Water which is free of specified reportable pathogen(s). This includes untreated groundwater; water which has been treated to approved standards with chlorine, ozone, ultraviolet light. or equivalent; or is demonstrated to be fish-free. Untreated surface water that is free of anadromous stocks is determined to be specific pathogen-free if for the past 3 consecutive years all captive brood stocks and susceptible juvenile stocks on station have been inspected without detection of the specified reportable pathogen. Inspections must have been conducted using at least the number of fish required to meet the 5 percent APPL and the time period between adult or juvenile inspections must be at least eleven (11) months. In addition, any diagnostic cases involving any stock on site during the same 3 years must have been free of the specified reportable pathogen(s).

Transfer . Any movement of fish into or within Washington State to include any movements between hatcheries, rearing facilities, watersheds, or the appropriate Health Management Zones.

Watershed. Geographically distinct river basins which have separate saltwater entrances. May include one or more primary river systems.

Water Supply. **The spring, well, stream, river, estuary, or other body of water used in the incubation/rearing of eggs or fish.**

IMPORT AND TRANSFER PERMITS

Transfers of live fish, eggs, or gametes into or within Washington State are allowed under a permit system implemented by the Co-Managers. The permit system consists of a formal notification process of all proposed egg or fish transfers to all relevant Co-Managers and documentation that the fish or eggs meet the fish health requirements specified in this policy.

A. Egg and Fish Transfer Notification Process

1. Future Brood Document Process:

All Co-Managers and Co-Operators will incorporate their planned program of egg and fish transfers and releases for the coming year (August through August) into the Future Brood Document process coordinated by Washington Department of Fisheries (WDF); see Figure 1.

All proposed programs will be exchanged and reviewed by Co-Manager's fish health staffs for consistency with the fish health policy between June 1 and July 1. A five (5) year history of reportable pathogens of all facilities and watersheds will be available for review during this time. Final approval of the Future Brood Document will be done on a watershed-by-watershed basis and will require signatures of all relevant Co-Managers by August 1. Upon final approval, the document will become accepted as the Current Brood Program and all transfers and releases listed within will be approved pending results of fish health inspections.

2. Changes To The Future Brood Document:

Any transfer or release of fish which has not been listed in the Current Brood Document requires the requesting Co-Manager or Co-Operator to

notify all relevant Co-Managers a minimum of 5 working days prior to the proposed transfer or release. Changes can be made using WDF's standard application form, SC-161 (Appendix 1), or any other firm that supplies similar information. If the transfer or release is consistent with this policy and there are no objections from relevant Co-Managers within 5 working days after notification, then the transfer or release is approved.

B. Fish Health information Required For Transfer

The following fish health information is required to be completed and on file with or received by the Co-Manager or Co-Operator of the receiving facility a minimum of 2 working days prior to the actual transfer of eggs or fish:

1. Information Required For Egg Transfers:

a. A completed copy of the parental brood stock inspection report; and

b. A 5-year history of reportable pathogens found within the facility and watershed, if this transfer was not part of the Future Brood Document review process.

2. information Required For Fish Transfers:

a. All egg transfer requirements listed above in Section 8.1.; and,

b. A completed pre-transfer/release fish health examination report for that lot as stipulated within this document in C.l.b., below; and

C. A summary of a11 epizootics and diagnostic cases experienced by that lot.

C. it shall be the responsibility of the receiving facility Co-Manager or Co-Operator to verify that the transfer has been approved and all required fish health reports are completed and received prior to allowing entry of eggs or fish onto their facility.

However, eggs may be transferred or imported prior to completion of the parental broodstock inspection report provided they are kept in isolation if transferred within an EHMZ or, in quarantine if transferred between EMHZs. The receiving facility Co-Manager or Co-Operator must obtain a copy of the completed fish health inspection report prior to releasing the eggs or fish from isolation or quarantine.

D. Imports from outside the United States must also be accompanied by a "Title 50" (50 CFR 16.13(inspection report.

E. A transfer/release request may be denied on the basis of the disease history of the stock and/or facility as determined by the relevant Co-Managers.

FISH HEALTH REQUIREMENTS FOR EGG AND FISH TRANSFERS

Restrictions on egg and fish transfers in Washington State are attempting to reduce pathogen dissemination within HMZs and prevent it between HMZs. Interim EHMZs and FHMZs are identified and explained in Section VII.

A. Egg Transfers Within An EHMZ

1. Eggs from anadromous broodstocks may be transferred within an EHMZ provided the spawning adults are screened for reportable viral pathogens at the following minimum assumed pathogen prevalence levels (APPL):

a. Transfers within watershed--ovarian fluid and kidney/spleen tissues sampled at the 5 percent APPL.

b. Transfers between watersheds but within EHMZ--ovarian fluid sampled at the 2 percent APPL and kidney/spleen tissues at the 5 percent APPL.

2. Eggs from captive broodstocks may be transferred within or between watersheds within an EHMZ provided the spawning adults are screened for reportable viral pathogens at the following minimum APPL:

a. If the transfer is within watershed or the broodstock and site have a negative history for the last three (3) consecutive years--ovarian fluid and kidney/spleen tissues are sampled at the 5 percent APPL; or

b. If the transfer is between watersheds and the broodstock and site have a negative history, but it is less than three (3) years-ovarian fluids are sampled at the 2 percent APPL and kidney/spleen tissues at the 5 percent APPL.

3. All eggs have been water-hardened in iodophor prior to entering the incubation area. If eggs are later transferred to a new facility, they must also be disinfected upon receipt.

4. Eggs are held in isolation at either the sending or receiving facility until the adult health inspection report is completed and received by the facility Co-Manager or Co-Operator.

5. If the adult broodstock test positive for a reportable viral pathogen, suspect eggs can only be transferred within watershed or to another watershed within their EHMZ where the specific virus has been detected within the last five (5) years. Eggs become suspect when:

a. Parents test positive from the suspect eggs' particular spawn day or isolation unit. if the unit is more then 1 day's spawn; or

b. Parents were not tested but of the same lot as positive parents; or

C. Parents tested negative but the eggs were exposed to virus by incubating on surface water containing adults from a positive lot.

If suspect eggs have been previously transferred to a hatchery in another watershed where the specific viral pathogen has not been detected in the last 5 years, the eggs must be returned to the hatchery of origin or be destroyed. The only exception would be if the eggs are maintained at an approved quarantine research facility. Eggs from particular spawn dates can still be transferred as long as conditions in 8.1. below are met.

6. If eggs are to be transferred from a watershed where a reportable viral pathogen has been detected within the last 5 years to a watershed where it has not been detected within the last 5 years, then conditions in 8 below must be met (i.e.. movement out of an EHMZ).

B. Egg Transfers Outside Of An EHMZ

1. Eggs from anadromous stocks may be transferred outside an EHMZ only if:

a. All adults from a specific spawn date, whose progeny are to be transferred, have had their sex products (ovarian fluid and milt) or kidney/spleen tissues screened for viruses at the 100 percent level. If sex products are screened, kidney/spleen tissues will be also screened at the 5 percent APPL. If the adults are from an EHMZ with a positive isolation of IPNV in the previous 5 years, they must have their kidney/spleen tissues screened at the 100 percent APPL. All samples from that spawn date must be negative; and

b. Eggs are incubated on specific pathogen-free water in isolation (maximum unit being the one lot, minimum for transfer in 1 spawn day) until transferred. Or they can be held in quarantine at the receiving facility until the adult health inspection report is completed.

2. Eggs from captive broodstocks may be transferred outside of an EHMZ only if they meet all the conditions in 8.1. above; or

a. The broodstock from which the eggs come are reared in reportable virus-free water; and

b. The eggs in question are incubated in reportable virus-free water; and

C. The parental broodstock have been tested and found negative for reportable viral pathogens at the following APPL:

(1) If the broodstock and site have a negative history for the last 3 consecutive years--ovarian fluid and kidney/spleen tissues sampled at the 5 percent APPL; or

(2) If the stock or site does not have a negative 3-year history--100 percent sampling of sex products or kidney/spleen tissues from males and females, and, if sex products are sampled, kidney/spleen tissues sampled at the 5 percent APPL; or,

(3) If a facility has been sanitized and brood are the result of introduction of eggs from inspected brood--ovarian fluid sampled at the 2 percent APPL and kidney/spleen at the 5 percent APPL.

3. All eggs have been water-hardened in iodophor prior to entering the incubation area. If eggs are later transferred to a new facility, they must also be disinfected upon receipt.

4. Identification of a reportable viral pathogen in adult broodstock will prevent the transfer of all eggs taken from that particular spawn date to another EHMZ unless they are to be held in an approved research quarantine facility. If eggs have previously been transferred to a hatchery in which the reportable viral pathogen has not been detected within the last

5 years, the eggs must be returned to the hatchery of origin or destroyed. Eggs from other spawn dates can still be transferred as long as their parents test negative and all conditions above are met.

C. Fish Transfer Within A FHMZ

1. Fish may be transferred within a FHMZ provided that all of the following reports are completed and on file with or received by the Co-Manager or Co-Operator of the receiving facility of 2 working days prior to the transfer:

a. An adult health inspection report on parental broodstock. The screening for this report will be at a minimum of the APPLs in A.1. and 2. above (note the differences between FHMZ and EHMZ).

b. The specific lots to be transferred must have an onsite pre-transfer/release health examination if they have been on untreated surface water. This examination is to be conducted by the relevant Co-Manager's or Co-Operator's fish health staff no longer than 6 weeks prior to transfer. Pathologist is to examine fish from the lot which is to be transferred for clinical signs and test for the presence of pathogens. An onsite pre-transfer/release health examination is not required for any lot which has been reared full term on specific reportable pathogen-free water.

C. A summary of all epizootics and diagnostic cases experienced by the lots to be transferred.

d. A S-year history of reportable pathogens found within the facility and watershed, if this transfer was not part of the Future Brood Document review process.

2. Fish transfers between watersheds within a FHMZ are permitted provided that the transfer does not expose the receiving watershed to a

reportable bacterial or parasitic pathogen which has not been detected there within the last 5 years.

3. Fish which test positive for a reportable viral pathogen will not be transferred out of their natal watershed unless the transfer is to an approved quarantine research facility.

4. Transfers of fish with exposure to a reportable viral pathogen can occur between watersheds within a FHMZ if both watersheds are positive for the specific reportable viral pathogen within the last 5 years. The fish must be sampled 4 weeks prior to transfer at the 2 percent APPL for reportable viral pathogens and be negative. Fish are considered exposed in the following situations:

a. Parents tested positive from their particular spawn day or isolation unit, if the unit is more than 1 day's spawn; or

b. Parents were not tested but were of the same lot as the positive parents; or,

C. Parents tested negative but the fish were incubated/reared in surface water containing adults from a positive lot.

5. If fish are to be transferred from a watershed where a reportable viral pathogen has been detected within the last five (5) years to a watershed where it has not been detected within the last five (5) years, then conditions in D below must be met (i.e., movement of fish outside of a FHMZ).

D. Fish Transfers Outside Of A FHMZ

1. The conditions in C.l and 2, above (fish transfers within a FHMZ) must be met before any fish can be transferred outside of a FHMZ.

2. Fish may be transferred outside of a FHMZ if:

a. The fish are to be transferred from fresh to saltwater or from salt to freshwater; or,

b. The fish have been reared on specific reportable pathogen-free water; and,

(1) All anadromous adults from a specific spawn date, whose progeny are to be transferred, have their sex products (ovarian fluid and milt) or kidney/spleen tissues screened for reportable viral pathogens at the 100 percent level. If sex products are screened, kidney/spleen tissues will also be screened at the 5 percent APPL. If the fish are from a FHMZ with a positive IPNV isolation the adults must have their kidney/spleen tissues screened at the 100 percent level. All samples from that spawn date must be negative; or,

(2) The facility has no anadromous adult stocks and the parental broodstock have been tested and found negative for reportable viral pathogens at the following APPL:

(a) If the parental broodstock and site have a negative history during the last 3 consecutive years--ovarian fluid and kidney/spleen tissues sampled at the 5 percent APPL; or,

(b) If the stock or site does not have a 3 year history- 100 percent sampling of sex products (ovarian fluid and milt) and kidney/spleen tissues sampled at the 5 percent APPL.

(c) If a facility has been sanitized and brood are the result of introduction of eggs from inspected brood--ovarian fluids sampled at the 2 percent APPL and kidney/spleen tissues at the 5 percent APPL.

3. Fish movements outside of an FHMZ are permitted as above in D.2 above, provided that the transfer does not constitute a new exposure this year of a reportable bacterial or parasitic pathogen to the receiving facility or water supplies affecting other facilities, and the transfer is acceptable to the relevant Co-Managers.

4. Fish which test positive for a reportable viral pathogen will not be transferred out of their natal watershed unless the transfer is to an approved quarantine research facility.

5. Fish reared on surface water containing anadromous adults cannot be transferred out of their zone except for conditions specified in D.2.a (i.e., transfer to salt water).

DIAGNOSIS AND PATHOGEN REPORTING BETWEEN CO-MANAGERS MD CO-OPERATORS

A. Presumptive and confirmed identification of any replicating viral agent within any stock and/or site will require notification of Co-Managers' and Co-Operators' fish health staff in writing within 2 working days to allow for increased sampling or other control measures at facilities within the affected area.

B. Epizootics due to undetermined cause(s) or reportable pathogens will require notification in writing (within 2 working days) of the relevant Co-Managers' and Co-Operators' fish health staff.

C. Semiannual reporting of all reportable pathogens will occur between Co-Manager and Co-Operators. This exchange currently takes place through the Pacific Northwest Fish Health Protection Committee's Model Fish Health Program.

D. Semiannual meetings will occur between the Co-Managers' and Co-Operators' fish health staffs to ensure good communications.

HEALTH INSPECTION PROCEDURES

A. The minimum procedures for inspection are described in the current edition of the AFS "Fish Health Blue Book."

B. Co-Managers or Co-Operators, with mutual agreement, may utilize new procedures that are technically superior.

C. Specimens submitted for viral assay will be tested on EPC (Epithelioma Papillosum Cyprini) and CHSE-214 (Chinook Salmon Embryo 214) cell culture systems or other systems as agreed to by Co-Managers' and Co-Operators' fish health staffs.

INTERIM IMPLEMENTATION PLAN

The Co-Managers recognize that certain components of this policy cannot be implemented without modifications to some enhancement facilities and that necessary funding may take several years to obtain. Therefore, it will be the responsibility of the Co-Manager's lead pathologists to identify in the Future Brood Document Review process each of their proposed egg or fish transfers which do not meet this policy. These lists will be provided at the Co-Managers' annual program review to highlight necessary changes to facilities or programs. The lead pathologists will also provide any recommended changes to this policy at the Co-Managers' annual program review.

Below are the interim egg and fish health management zones. The interim management zones for fish transfers are smaller than those for eggs because of the higher level of risk associated with fish transfers.

A. Egg Health Management Zones

1. Puget Sound tributaries north of the Lake Washington watershed up to the Canadian border, including the San Juan Island (FHMZs 1-3 listed below).

2. **Lake Washington watershed.**

3. **Tributaries of East Kitsap Peninsula and Puget Sound south of the Lake Washington watershed.**

4. **Hood Canal and Port Gamble tributaries.**

5. **Strait of Juan de Fuca tributaries.**

6. **Pacific Coast tributaries north of Grays Harbor (FHMZs 8-11 listed below).**

7. **Grays Harbor and Willapa Bay tributaries.**

8. **Columbia River watershed.**

B. Fish Health Management Zones

1. **Puget Sound tributaries north of Swinomish Slough up to the Canadian border, including the San Juan Islands.**

2. **Skagit watershed.**

3. **Puget Sound tributaries south of and including the Stillaguamish watershed down to the Lake Washington watershed.**

4. **Lake Washington watershed.**

5. **Tributaries of East Kitsap Peninsula and Puget Sound south of the Lake Washington watershed.**

6. **Hood Canal and Port Gamble tributaries.**

7. **Strait of Juan de Fuca tributaries**

8. Tributaries south of Cape Flattery down to and including the Ozette watershed.

9. Quillayute watershed.

10. Hoh watershed.

11. Queets and Quinault watersheds.

12. Grays Harbor tributaries.

13. Willapa Bay tributaries.

14. Columbia River watershed.

It is the Co-Managers' intent to implement the HMZs during year one (August 1, 1991). However, fish transfers which do not meet the policy will still be allowed, provided that proper notification/approval occurs, and the transfer does not expose a watershed to a reportable pathogen where it has not been detected within the last 5 years. After August 1, 1997, general dispensation from the policy as allowed above will no longer occur. Further, on an annual basis the FHMZs will be reviewed in an attempt to reduce their size as is determined to be appropriate.

Exceptions to this policy will be allowed on a case-by-case basis as approved by relevant Co-Managers.

FUTURE BROOD DOCUMENT REVIEW PROCESS

The Future Brood Document (HATPLAN) is the mechanism used to annually notify and update all fisheries Co-Managers of hatchery escapement needs, egg requests, production plans, and proposed transfers of eggs and fry. The review process is as follows:

WDF solicits future brood plans
(January)

↓
↓

Co-Managers and Co-Operators update and submit plans
(February-March)

↓
↓

Draft Future Brood Document produced
(April-May)

↓
↓

Co-Managers, Co-Operators, and Fish Health Technical Staff review plans on a watershed basis
(June)

↓
↓

Final Draft Document produced and mailed for signatures
(July 1)

↓
↓

Co-Managers review and sign final document
(returned by August 1)

↓
1

Current Brood Program
(August 1)

APPENDIX

WASHINGTON DEPARTHENT OF FISHERIES

APPLICATION No_____

for Import or Transfer of Live Fin Fish and/or
the Viable Sexual Products thereof in Washington State
(Please print or type Items 1-10)

1. Name of Applicant or Agency_____
2. Project Manager_____ Phone Number_____
   Hailing Address_____
3. Objective of Proposal : ❚ Import ❑ Export ❑ Transfer ❑ Release
   Explanation (Include name of shipping facility):_____
4. Species (common)_____ (scientific) _____
5. Origin-Sate _____ watershed _____ Facility _____
6. Number (eggs/fish) _____Size (# per lb.) _____ Brood Year_____
7. Destination of stock (provide map)_____
   _____ Sec._____ Twnshp. _____ Rng. _____
8. Detail transport equipment and procedures (include dates) _____
9. Disease history of stock. shipping facility and watershed of origin (include history for the past 5 brood years)
   'Virus – IHNV_____ IPNV_____ Egtved virus_____ Others_____
   (Bacteria – BKD_____ Aeromonas salmonicida_____Yersi ni a ruckeri _____
   Parasite – Myxobol us cerebral i s_____ PKD_____ Ceratomyxa Shasta_____
   *List the date of the most recent isolation by the respective pathogen.
10. Date of Last Disease Inspection_____ Inspecting pathologist _____
    Pathologist's Address_____ Phone No. _____
    (attach signed Pathologist's report to application)
    Dates of Disease Inspections in past 5 years (include name of Inspecting Pathologist_____
11. Applicant's Signature_____ Date_____

PERMIT

Comments_____

Provisions _____

_____ Expiration Date_____

Failure to comply with any provisions of this permit or to perform any act not included in this permit shall be ground for revocation of this permit and shall constitute a gross misdemeanor (RCW 75.58.0.10. WAC 220-20-039. WAC 220-77).

❑ Approve ❑ Not Approved Date_____
❑ Additional provisions attached

INTEGRATED HATCHERY OPERATIONS: EXISTING POLICY AFFECTING HATCHERIES IN THE COLUMBIA RIVER BASIN

ANNUAL REPORT 1992

Prepared by:

Chris Christianson

Oregon Department of Fish and Wildlife

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-3621

Project Number 92-043
Contract Number DE-BJ79-91BP60629

MAY 1993

INTEGRATED HATCHERY OPERATIONS TEAM

Existing Policy's Affecting Hatcheries

OREGON

A. Definitions

635-07-501 As used in this Division and Division 40:

1. "Anadromous" means fish which migrate from saltwater to freshwater for spawning.

2. "Aquaria species" means those [nongame] fish commonly sold in the pet store trade for use in home aquaria. "Aquaria" are any tanks, pools, ponds, bowls or other containers intended for and capable of holding or maintaining live fish and from which there is no outfall to any waters of this State.

3. "Aquatic habitat" means the waters which support fish or other organisms which live in water and which includes the adjacent land area and vegetation (riparian habitat) that provides shade, food, and/or protection for those organisms.

4. "Area" means a stream, a lake, a group of streams or lakes, or a portion of the ocean managed for or with a common stock of fish, or for protection of a stock or stocks of fish.

5. "Biological requirements" refers to those environmental conditions such as water quality, water quantity, and available food that are necessary for fish to grow and/or reproduce.

6. "Brood stock" means a group of fish, generally from the same population, that are held and eventually artificially spawned to provide a source of fertilized eggs for hatchery programs.

7. "Brood year" means the year in which more than 50 percent of the adults in a population of fish spawn.

8. "Compensation" means activities that replace fish, or their habitat lost thrugh development or other activities.

9. "Depressed" means below establishment goal such as a fish production or escapement goal shown in a management plan or below the level of production or escapement that the Commission determines to be an optimal level.

10. "Disease" means problems caused by infectious agents, including such as parasites or pests, and by other conditions that impair the performance of the body or one of its parts.

11. "Enhancement" means management activities including rehabilitation and supplementation that increase fish production beyond the existing levels.

12. "Fish" means all game fish as defined by ORS 498.009 and food fish as defined by ORS 506.036, which live or could live in the waters of this State.

13. "Fish Hatchery" means a facility at which adult broodstock are held, or where eggs are collected and incubated, or where eggs are hatched, or where fish are reared for release and harvest.

14. "Fry" means fish which have recently hatched and which have not been fed.

15. "Foreign" means fish which originate through human intervention from a different population.

16. "Gene conservation group" means a genetically distinct cluster of one or more populations within a taxonomic species that resulted because gene flow between the cluster and other populations of the same species has been zero or very low over sufficient geological time.

17. "Genetic engineering" means the introduction of the genetic material into an organism's genotype through molecular genetics techniques.

18. "Genetic Resources" means the kind and frequency of genes found within a population or collection of populations.

19. "Genotype" means the kinds of and the combination of genes possessed by an individual.

20. "Goal" means a statement of intent which leads to policy, rules, and operation plans for implementation of a Department Program.

21. "Hatchery fish" means a fish incubated or reared under artificial conditions for at least a portion of its life.

22. "Hatchery Program" means a program in which a specified hatchery population is planted in a specified geographical location.

23. "Hold fish" means to capture and/or remove live fish in or from the waters of this state and/or maintain live fish in captivity but does no include fish held live for less than 1 day for examination and release without transfer from the waters where caught or collected.

24. "Indigenous) means descended from a population that is believed to have been present in the same geographical area prior to the year 1800 or that resulted from a natural. colonization from another indigenous population.

25. "Management Plan" means:

a. A plan adopted by the Fish and Wildlife Commission which provides the basic framework goals, policies, and objectives for managing a resource, geographic area, watershed (waterbody) or species; and
b. Which may include specific information or alternatives relative to how the goals and policies may be achieved.

26. "Mitigation" means to lessen the impact of activities or events that cause fish or habitat loss.

27. "Naturally Spawned" means fish produced in the natural environment a the result of natural reproduction without the aid of humans.

28. "Nongame Fish" means any fish other than those specifically defined as game fish in ORS 496.009.

29. "Objective" means a specific statement of planned results ot be achieved by a predetermined date. Attainment of objectives represents measurable progress toward attainment of the broader goal.

30. "Operating Principle" means a mandatory direction or approach to carry out a Department program.

31. "Operation plan" means an action plan developed by the Department that generally addresses how the objectives in a management plan for harvest or production of a species shall be attained.

32. "Optimum" means the desired fish production level as stated in management plans or set by specific Commission action.

33. "Phenotype" means any characteristic of an organism that is determined by the organism's genes, genotype, and the environment.

34. "Policy" means mandatory direction or constraints that provide the framework for Department programs.

35. "Population" means a group of fish spawning in a particular area at a particular time which do not interbreed to any substantial degree with any other group spawning in a different area or in the same area at a different time.

36. ""Population fragmentation" means the process by which natural or human-caused events cause a single, large breeding population to be broken up into two or more smaller new breeding population.

37. "Presmolt" means a juvenile anadromous fish which has fed and reared by is not yet a smolt.

38. "Production" means the number or pounds of fish raised in a hatchery or resulting from natural spawning and rearing in freshwater, estuarine, or ocean habitats; also used in reference to harvest.

39. "Propagation of fish" means the spawning, incubating, and/or rearing of fish by a human for sale, release, or other uses.

40. "Rehabilitation" means short-term management actions which may include fish stocking. habitat improvement, harvest management, or other work, that restore fish populations depressed by natural or man-made events.

41. "Rehabilitation fish" means a fish from a hatchery program that has wild-type phenotypes and is used for one life cycle in a program to rebuild a depressed population of wild fish.

42. "Risk" means the extent to which, a management practice may reduce population productivity or cause an undesirable change in genetic characteristics of a population.

43. "Sensitive" means those fishes that have been designated for special consideration pursuant to ORA 635-100-040.

44. "Significant or substantial" means a condition of sufficient magnitude such that it is likely to influence continued natural production at optimum levels.

45. "Smolt" means a juvenile salmon or trout that is capable of initiating a seaward migration and is capable of living in the sea.

46. "Species hybridization" means the crossing of two different taxonomic species.

47. "STEP" means Salmon Trout Enhancement Program.

48. "Stock" means an aggregation for management purposes of fish populations which typically share common characteristics such as life histories, migration patterns, or habitats.

49. "Stray" means a hatchery fish that spawns naturally in a location different from the location intended when the fish was stocked.

50. "Supplementation" means continued planing of fish to maintain or increase fish abundance in areas where natural production is insufficient to meet management objectives.

51. "Taxonomic species" means a group of fish that have been assigned a scientific name in the form of genus and species by the American fisheries Society Committee on Common and Scientific Names of fishes.

52. "Transgenic fish" means fish that have genes or groups of genes that have been transferred from another organism through the process of genetic engineering.

53. "Wild fish" means any naturally spawned fish in the taxonomic classes, Agnatha, Chondrichthyes. and Osteichthyes, belonging to an indigenous population.

54. "Wild Fish Management" means all of the constraints, operating principles, and direction embodied in both the Natural Production Rules and the Wild Fish Management Rules.

55. "Wild-type phenotype" means the kind of phenotype possessed by individuals in a wild population.

B. General Fish Management Goals

1. Fish Management Goals, 635-07-510.

a. The overriding goal of fish management is to prevent the serious depletion of any indigenous fish species through the protection of native ecological communities, the conservation of genetic resources, and control of consumptive uses such that fish production is sustainable over the long term.

b. Consistent with 635-07-510(b), hatchery fish shall be managed primarily for the maximum benefit to consumptive users.

2. Fish Management Policy, 635-07-515

a. Achievement of management goals necessitates the following policies relative to production and harvest of the species.

b. Fisheries shall be managed to obtain the most favorable continuing benefits, including protection of genetic resources, quantity and value of food produced, fishing opportunity, economic values, social and aesthetic benefits, which accrue to those who want to see fish or to those who use fish as an indicator of environmental well-being and favorable biological benefits.

c. The fish resources shall be allocated based on biological requirements and sharing principles adopted by the Fish and Wildlife Commission, constraints of Oregon Statutes, Administrative Rules, court rulings, and other socioeconomic criteria.

d. When attempting to rehabilitate natural production, the agency shall consider all viable alternatives, including habitat protection and improvement, artificial propagation, and harvest management.

e. Waters of this State shall be managed according to species and/or area management plans, adopted by the Fish and Wildlife Commission in public hearing which set forth goals, policies and objectives for management of species waterbodies. or areas. Until formal plans are adopted, management shall continue within existing guidance of statute, and administrative rules.

f. Hatchery production must contribute to adult abundance as spawning stock or harvestable surplus to be accepted as a management option.

g. An incidental harvest in public fisheries of a depressed stock may be allowed in a fishery targeted on a healthy stock. The requirement for rehabilitation and/or supplementation of the depressed stock may be a consequence of such harvest.

h. Separate hatchery operational plans and production programs may reflect specific compensation or production requirements of various agency contracts, agreements, or management needs beyond the agency's control and thus may not individually meet all policies or management goals. Hatchery operational plans and production programs which are a departure from agency policies and management goals shall be subject to Commission review in public hearing before adoption or amendment.

i. Proposals to introduce species of fish including hybrids new to a watershed or waterbody shall be subjected to agency review and authorization through adoption of appropriate management plan(s) by the Fish and Wildlife Commission in public hearing.

3. Operating Principles for Natural Production Management, 635-07-523. The following principles are intended to provide direction to the natural production management programs of the Department.

a. Competition, predation, and disease: Introductions of fishes of the same or different species as those already present may seriously reduce natural production through competition for food and space or through predation. Introductions of disease may also reduce natural production. The Department shall oppose any actions that allow competition, predation, or disease to prevent meeting natural production objectives of management plans.

b. Use of hatchery fish: Where there are existing hatchery programs and the potential for enhancement of natural production exists, hatchery programs shall be designed to make full use of this potential.

4. Purpose of Wild Fish Management Rules, 635-07-525. These rules are established to guide the management and conservation of genetic resources of wild fish in Oregon. Although direction with respect to natural production is provided by OAR 635-07-521 through 635-07-524, additional guidance is required to assure that genetic resources of wild fish are protected.

5. General Policies of Wild Fish Management, 636-07-526.

a. **Protection of genetic resources shall be the priority in the management of wild fish to assure optimum economic commercial recreational, and aesthetic benefits for present and future generation of Oregonians.**

b. **It is the policy of the Department to implement the Wild Fish Management Rules for all populations of wild fish except those populations specifically exempted by the Commission in accordance with OAR 635-07-528.**

c. **It is recognized that management of some populations may not currently be fully consistent with these rules. However, it is the Department's long-term goal to bring these populations into compliance, with the exception of populations specifically exempted by the Commission in accordance with OAR 635-07-528.**

6. Operating Principles for Wild Fish Management, 636-07-527. **The Department recognizes that the operating principles developed to implement this policy are associated with varying levels of uncertainty. These principles shall be continuously revised as better information becomes available. In addition to the operating principles of the Natural Production Rules (OAR) 635-07-521 through 635-07-524), the operating principles set forth in this section apply to the management of populations of wild fish.**

a. **Wild populations of the following species shall be managed under these operating principles:**

(1) **Oncorhynchus clarki, commonly known as cutthrouat trout;**
(2) **Oncorhynchus keta, commonly known as chum salmon;**
(3) **Oncorhynchus kisutch, commonly known as coho salmon;**
(4) **Oncorhynchus mykiss, commonly known as steelhead (anadromous form or Rainbow trout (non-anadromous form);**
(5) **Oncorhynchus nerka, commonly known as sockeye salmon (anadromous form) or kokanee (non-anadromous form);**
(6) **Oncorhynchus tshawytscha, commonly known as chinook salmon;**
(7) **Salvelinus confluentus, commonly known as bull trout;]**
(8) **Prospium williamsoni, commonly known as mountain whitefish;**
(9) **Acipenser transmontanus, commonly known as white sturgeon;**
(10) **Acipenser medirostris, commonly known as green sturgeon;**
(11) **All fishes that have been designated as sensitive, pursuant to OAR 635-100-040; or threatened or endangered, pursuant to ORS 496.172 through 496.192 and OAR 635-100-100 through 635-100-130.**

b. **Other wild fishes as information on their status becomes available.**

c. Interbreeding of hatchery and wild fish: The interbreeding of hatchery fish with wild fish of the same taxonomic species poses risks to conserving and utilizing the genetic resources of wild populations. To reduce this risk, naturally spawning hatchery fish, whether originating from onsite releases or from strays from other release sites, shall be limited by both number in the natura1 spawning population and genetic characteristics. Options consistent with these rules are:

(1) Release no hatchery fish;
(2) Release hatchery fish that meet the following minimum standards and limit the number of hatchery fish in the naturally spawning population to 50 percent or less of the breeding population:

(a) Originates from the same gene conservation group
(b) Originates from the same wild population;
(c) After brood stock is initiated, incorporates at least 30 percent wild fish on the average every brood year;
(d) Twenty-five percent or less of the wild donor population is taken for hatchery brood stock in any year;
(e) No intentional artificial genetic changes occur; unintentional artificial changes are avoided;
(f) Wild-type phenotypes are maintained in hatchery fish;
(g) The hatchery program shall be monitored annually and evaluated every 10 brood years to determine if the standards in paragraphs (a) through (f) are being met. If the standards are not being met, the number of hatchery fish spawning in the natural population shall be decreased as directed in subsection d. of this section.

d. Release hatchery fish, but limit the number of hatchery fish spawning in the natural population such that the further the deviation from the requi rements of subsection (b) of this section the lower the proportion of hatchery fish that shall be allowed to spawn in the natural population consistent with current Department guidelines. Hatchery fish that do not at least meet the standards in paragraphs (a), (b). and (d) in subsection (b) ot this section shall be restricted to less than 10 percent of the naturally spawning population.

e. Special Rehabilitation Programs: Use of hatchery fish in a program to restore a depressed population shall meet the requirements of subsection (b) of this section (2) of this rule provided, however, that if the Department finds that strict adherence to such requirements is likely to prevent restoration of the population the Department may allow use of hatchery fish subject to the following conditions:

(1) Deviations from the standards in subsection (b) of section (2) of this rule shall not occur for more than one life cycle unless approved by the Commission;

(2) The rationale for the deviation shall be documented in written form;

(3) Specific standards and guidelines for the rehabilitation program shall be documented in written form.

f. Species hybridization: Species hybridization which results in the production of offspring with reduced reproductive capacity is detrimental to wild populations. The Department shall not authorize introductions of nonindigenous fish into locations where species hybridization may be expected to occur.

g. Transgenic fish: The Department shall not authorize the release of transgenic fish into locations where such fish may gain access to wild fish populations in accordance with OAR 635-07-545.

h. Competition, predation, and disease: Releases or transplants of fish of the same or different species, including hybrid fish, may seriously reduce the survival of wild fish through competition for food and space or through predation. Introductions of disease may also deplete a wild population. An extreme level of mortality from these sources poses a risk to conserving and utilizing the genetic resources of wild populations. The Department shall oppose any actions that allow mortality from competition, predation or disease to cause a population to experience a decline in abundance that if continued would likely reduce the number of spawners to 300 breeding fish. In addition, ;where a population has been depressed to a level of 300 or fewer spawners, the Department shall support and advocate actions to correct the cause of such population decrease.

7. Wild Fish Management Exemption Procedure, 635-07-528. The Commission may decide,at the request-of any person, the Department, or on its own initiative, to determine whether a population shall be exempted from wild fish management.

8. Implementation of Wild Fish Management Rules, 635-07-529.

a. In implementing the Wild Fish Management Rules, the Department shall select strategies that are feasible and biologically sound, and shall consider both cost and social and economic impacts.-

b. The Department shall not release hatchery fish into wild fish populations if such activities are not already occurring, without authorization in a basin plan approved by the Commission or an exemption of the wild population in accordance with OAR 635-07-528.

c. The Department shall develop guidelines to make determinations of population extinctions consistent statewide. Findings of extinctions shall be provided for public review and reported to the Commission and public in fish management plans or in the biennial wild fish management report, as appropriate.

d. **Progress toward achieving consistency with these Wild Fish Management Rules shall be reported to the Commission during the first 6 months of each biennial, prior to preparation of the next biennial budget. Beginning in 1991, each such biennial report shall include, by species, the following information:**

(1) **Documentation of the management history of each wild population, which shall be based on best available information. This shall include the current status of the population and a history of habitat change, harvesl, and hatchery introductions;**
(2) **A list of populations of ;wild fish not currently managed consistent with the Wild Fish Management Rules;**
(3) **Identification and description of the problems preventing the Department from achieving consistency with the Wild Fish Management Rules for each of these populations;**
(4) **A discussion of any segment of a population that has been reduced or lost, and an evaluation of the cause and consequences of this reduction or loss on the long-term genetic status of the population;**
(5) **Identification of those species or subspecies that have a limited world-wide distribution.**

9. Sale of Salmon and Trout and Their Eggs, 635-07-530.

a. **The Department will sell salmon and trout or the eggs of salmon and trout after first assuring that within the capability of the Department to do so, the policy of the State as set forth in ORS 496.012 relating to trout and ORS 506.109 relating to salmon (food fish) has been met and that such fish and eggs are surplus to the fish production needs of the State as determined by the Department in accordance with the established general priority for use of salmon eggs and fingerlings and in accordance with statutes relative to handling of surplus property.**

b. **Within established priorities, eggs will first be sold to those prospective purchasers who will directly or indirectly provide the greatest benefit to the public fisheries of Oregon.**

10. Releasing Resident Fish in Prviate Waters, 635-07-535.

a. **Public waters wwhere reasonable access use fees are assessed to recover maintenance costs or from which fish will migrate to waters open to public access.**

b. **Private ponds from which the Department may take fish for releasing in public waters.**

c. **Ponds where there are Department supervised experimental programs to explore pond management procedures.**

11. General Policies for Hatchery Fish Gene Conservation, 635-07-540.

a. Hatchery fish populations shall be managed to maintain genetic diversity, to assure that the populations meet the management objectives for which they are produced, and to maintain their optimum biological; and economic value.

b. Further policies and operating principles for hatchery fish gene resource management are provided in the Natural Production Policy (OAR 635-07-521 through 635-07-525). the Wild Fish Management Policy (OAR 635-07-525 through 635-07-529), the Fish Management Plans (OAR Chapter 635, Division 500). the Salmon Management rules (635-07-800), and 635-07-810 through 635-07-830.

12. Implementation of Hatchery Fish Gene Conservation, 635-07-641.

a. It is the intention of the Department to develop and implement management objectives for all hatchery programs in the state. The management objectives shall include a statement of intent and a description of the hatchery programs. These management objectives shall be developed as existing basin plans are reviewed and new basin plans are adopted under OAR Chapter 635, Division 500.

b. For existing hatchery programs and for new hatchery programs that are implemented prior to the development of management objectives in basin plans as directed ins section (1) of this rule, the Department shall compile or develop management objectives that include a statement of intent and a description of the hatchery programs as would be required in the basin plans.

c. After the development of the management objectives the Department shall develop operational guidelines to implement the hatchery program and accomplish the objective. These guidelines are intended to maintain the genetic resources of the hatchery populations, and shall be consistent with the Wild Fish Management Policy hatchery standards provided in OAR 635-07-527(2)(b) or approved by the Commission under OAR 635-07-527(2)(c).

13. Inspection of Fish for Disease, 635-07-550.

a. The Department will maintain a fish disease inspection program for both public and private fish rearing facilities except shellfish will not be inspected by Department pathologists.

b. Reasonable costs may be charged for fish disease inspections conducted at the request of private growers.

c. Any group of live fish eggs found to have been imported into Oregon without a Fish Transport Permit are subject to seizure and destruction by the Department. To prevent seizure, the owner must immediately undertake to have the fish or eggs inspected for disease by an individual recognized by the Department as competent in the diagnoses of fish diseases. Such fish or

eggs must be held and not released or moved to any other facility until the owner has obtained a completed disease examination report described in OAR 635-07-605(5)(a).

d. Inspection of fish under section (1) of this rule will be made at the expense of the owner and must be completed prior to issue by the Department of a Fish Transport Permit.

e. Any fish which are found to be infected with any disease (including parasites and pests) that the Department determines will adversely affect the health of the fish populations of this State must be treated or destroyed, at the expense of the owner, as directed by the Department.

14. Transport of Diseased Fish, 635-07-555.

a. Live fish suspected by the Department of have a disease infection may not be transported from one watershed to another within this state or exported from this State without the written consent of the Department.

b The Department may restrict or prohibit transport of infected fish, or fish which may be infected, to or from certain watersheds or areas within watersheds.

15. Grounds for Revocation of Licenses and Permits, 635-07~560. Failure to comply with the requirements of OAR 635-07-550 or 635-07-555 shall be grounds for the revocation of any Fish Propagation License; Fish Transport, or STEP Permit.

16. Fish Disease Control Policy, 635-07-565. It shall be the policy of the ODFW to protect the fish resources of the State by preventing the importation or introduction, to new waters or areas, those fish disease agents known to adversely affect hatchery or natural production of fish.

17. Disease Control, 635-07-570. Fish diseases will be classified by category of concern:

a. Category I. 'Emergency' fish diseases are those for which there is no known treatment and which have never been diagnosed as occurring in Oregon.

b. Category II. 'Certifiable' diseases are highly contagious, may cause catastrophic losses, do not have a known cure and may or may not have been found in Oregon.

C. Category III. 'Reportable' diseases are those infections which may be enzootic in stocks and/or watersheds but are not necessarily of such concern as to prevent all transfer or release of fish. This category includes drug resistant strains of fish disease agents otherwise falling in Category IV.

d. Category IV. 'Historical' diseases are related primarily to the area, waters, or facility either here or in another State or country in which fish are raised or those for which an intermediate host is found in other than the fish themselves. This category also includes Categories I through III diseases if previously found at a particular facility but which do not now occur at that location. The record of agents in this category seldom prevent transfer or release of fish if the disease agent has not occurred within the past 3 years of fish rearing, or fish are appropriately treated for disease prior to transfer, or the agent also occurs in the receiving water.

18. Disease Agents by Category, 635-07-575. Fish diseases identified by category are set out in Table 1. FWC 25-1984, f. 6-21-84, ef. 7-l-84.

19. Fish Health Examination Procedure and Requirements, 635-07-580.

a. Health or disease inspections of finfish shall be conducted according to procedures outlined in the American Fisheries Society Fish Health Blue Book or the Fish Health Protection Regulations Manual of Compliance of Canada.

b. For import or transfer of fish, other than fish reared for release under a private salmon hatchery permit pursuant to ORS 508.700. an annual health examination, including examination of salmonid brood stock for IHNV, IPNV, and VHSV, is required by a pathologist acceptable to the Department. However, the Department may issue a Fish Transport Permit to import into this State live fish without the examination report if the Department finds:

(1) It is not scientifically possible to complete a disease examination prior to the time the fish eggs or larvae mature to a stage at which they cannot be safely transported; and

(2) The fish or eggs are to transported to and held in an isolation facility approved by the Department until such time as the holder of the permit can obtain a completed disease examination report.

C. Live fish or eggs found to be infected with any disease that the Department determines may adversely affect the health of the fish populations of this state are also subject to the provision of OAR 635-07-550 through OAR 635-07-560.

d. The Department shall require monthly health examination, by a pathologist acceptable to the Department, of all fish reared for release pursuant to a private hatchery permit, and may so require of fish propagation licensees as well.

e. If losses of fish exceed 0.1 percent per week (Sunday through Saturday) in any rearing or incubation center, unless otherwise provided in an approved operational plan, private hatchery permittees (and propagation licensees when so required by the Department) shall:

Table 1
(635-07-575)
DISEASE AGENTS BY CATEGORY

Disease of Finfish	Category I Emergency	Category II Certifiable	Reportable	Category IV Historical
Viral Hemorrhagic Septicemia (VHS)	X	X	X	X
Myxosoma cerebralis		X	X	X
Channel catfish virus	X	X	X	X
Infectious Hematopoietic Necrosis Virus (IHN)		X	X	X
Proliferative kidney disease (PKD)			X	X
Viral Erythrocytic Necrosis (VEN)			X	X
Yersinia ruckeri			X	X
Reinbacterium salmonarum			X	X
Aeromonas salmonicida			X	X
Drug resistant strains of disease agents			X	X
Ceratomyxa Shasta			X	X
Infectious agents endemic to the rearing site but not included above				X

(1) Examine live and dead fish from each pond of concern, and if required by the Department, at the entire facility, immediately;
(2) Notify in writing, postmarked within 48 hours, or facsimile transmission within 48 hours to the Fish Division (Portland) and the Fish Pathology Section (Corvallis) of the location, extent, and probable cause of such losses and provide as soon as possible written documentation of a Department-approved treatment regimen planned to control the fish disease; and
(3) Provide within 7 working days a copy of the disease examination record upon completion of appropriate tests when applicable.

20. Import or Transfer of Fish Restricted, 635-07-585.

a. Transfer or import requests may be denied or conditioned on the basis of disease history of the shipping station or watershed, current disease inspection report, or disease known to occur in the watershed to which fish would be shipped; i.e., potential loss of fish due to their susceptibility to pathogens indigenous in the receiving water supply.

b. The Oregon exporter and importer (recipient) are responsible for obtaining required permits and compliance with regulations necessary to transport fish within Oregon, export fish from Oregon, or import fish to Oregon from any other state, province or country.

C. It is unlawful to ship fish into Oregon from outside the United States which do not meet U.S. Fish and Wildlife Title 50 regulations in addition to Oregon fish import and transport regulations.

d. No susceptible fish may be imported, exported, or transferred from a site or area where a Category I disease has been found until such time as that site has been declared acceptable for fish rearing by Department pathologists.

e. No fish which have, or are from a station or area with a recent or continuing history of Category II disease may be imported, exported, or transferred except as authorized by the Department for transfer to locations where the same disease agent already occurs.

f. Transfer or import of fish with Category III diseases may be restricted until such time as the fish to be transferred have successfully been treated for that or those disease(s).

g. Transfer or import of fish from facilities where Category III and IV diseases or agents have occurred may be restricted until acceptable treatment or improved history record (more years after disease outbreak) requirements have been met depending upon the specific disease, its effect, and general distribution.

h. Annual examination (station check) of salmonids sampled at a particular hatchery for Myxosobolus cerebralis, shall meet Oregon requirements for importation of fish from that facility to Oregon, provided the facility does not have a history of Myxosobolus cerebralis and has not received fish from an infected site or area, i.e., samples of brood stock at originating site or the young fish held at the originating site have been examined for certification and the results are acceptable.

i. Anadromous fish or their progeny which have been exposed to water from mainstem Columbi River or its tributaries shall not be transferred to other waters in the State except after acceptable disease examination results and consultation with Department pathologists.

j. Anadromous fish or their progeny which have been exposed to waters of Oregon coastal rivers shall not be transferred to waters of the Columbia River and its tributaries except after acceptable disease examination results and consultation with Department pathologists.

k. The Department may authorize transfer of salmonids from the Columbi River or its tributaries to an accepted isolation facility for scientific study pursuant to the objectives of projects acceptable to the Department.

21. Sanitation of Imported Eggs and Equipment, 635-07-590.

a. Imported eggs and their shipping containers shall be disinfected at the approved destination using methods acceptable to the Department. (A list of acceptable disinfecting agents and methods is available from the Department.)

b. Equipment or water used in any phase of fish culture which could be contaminated through use or storage shall be disinfected prior to its transfer to use in another facility or watershed.

22. Transgenic Fish, 6350-07-595. **Fish that have been modified through genetic engineering and are released into wild populations have the potential of causing adverse ecological and genetic impactas. The Department shall consider releases of transgenic fish to pose a serious risk to wild populations. The Department shall not authorize the release of transgenic fish into locations where such fish may gain access to wild fish populations.**

23. Permit Required to Transport, Hold, or Release Fish, 635-07-600.

a. Except as provided in OAR 635-07-620 and in sections (3) and (4) of this rule, any person shall have in possession a Fish Transport Permit in order to:

(1) Transport live fish into, within, or out of this state;
(2) Hold any live fish in the waters of this state; or
(3) Release or attempt to release any live fish into the waters of this state.

b. A separate Fish Transport Permit shall be obtained for each release site but not for each delivery of fish made to a site during the authorized permit period, provided the total number of fish delivered does not exceed the number authorized to be transported under the permit.

c. Section (1) of this rule shall not apply to:

(1) Aquaria species intended for aquaria use;
(2) Shellfish taken for personal use or fish taken in duly authorized commercial fisheries; or
(3) Activities authorized under a STEP Permit (OAR 635-07-115);
(4) Federally licensed projects which have been approved by the Department;
(5) Activities authorized under a Scientific Collection Permit issued by the Department.

d. A valid Department egg or fish shipment report, or copy thereof, may be used in lieu of a Fish Transport Permit to transport, hold, or release live eggs or fish sold or provided by the Department.

e. The Department may refuse to issue a Fish Transport Permit on the following grounds:

(1) The holding or release of the fish specified in the application will be the first introduction of that species into the waters of the holding or release site;
(2) The Department finds the holding or release of the fish specified, either singly or in combination with the holding or release of fish under other permits, would tend to adversely affect existing fish populations in or below the holding or release site; or
(3) The applicant has violated any terms of any statute or regulation, or any license, permit, or operational plan issued by the Department.
(4) The applicant has failed to pay any sums it owes to the Department or which are owed to the Department under any license or permit it holds or the benefits of which it enjoys.

24. Permit Application, 635-07-605.

a. Any person wishing to obtain a Fish Transport Permit shall complete and submit to the Department the appropriate permit application form. Application forms are available upon request from the Oregon Department of Fish and Wildlife, P.O. Box 59, 2501 SW. First Avenue, Portland, Oregon 97207.

b. The Department may prescribe such terms and conditions in a permit as it deems necessary, including but not limited to, the period of time (usually 30 days) during which the transportation and/or release of fish is authorized.

c. Fish may be held for an indefinite period of time under a Fish Transport Permit. The permit, or a copy thereof, shall be made available for inspection upon request by the Department or the Oregon State Police.

26. Shipping Requirements, 635-07-610.

a. Any person shipping live fish or eggs within or out of this state shall provide a Fish Transport Permit to ;the carrier or affix such permit to the shipping container.

b. Any person shipping live fish or eggs into or through this state shall provide to the carrier or have affixed to the shipping container a Fish Transport Permit or a record showing:

(1) Name and address of person shipping fish or eggs into this state or of holder of Fish Transport Permit or Fish Propagation License;
(2) Name and address of consignee; and
(3) Number of each species of fish or eggs in the shipment.

c. Section (1) of this rule shall not apply to shellfish taken for personal use or fish taken in duly authorized commercial or sport fisheries, except when transported as live fish or eggs for release.

26. Unlawful Import and Release, 635-07-615.

a. Fish which are imported or released in violation of these rules or the laws of this state are subject to seizure or destruction by the Department at the expense of the person or company who imported or released those fish.

b. The Department may in its discretion prescribe alternative methods in lieu of destruction to control illegally imported fish.

C. The Department is not liable for the cost of destroying fish or for the cost of the fish destroyed.

d. The person or company who imported fish illegally shall be held liable for incidental kill of any other species due to or during destruction of illegally imported fish.

27. Revocation of Fish Transport Permit, 635-07-625.

a. The Commission may revoke a Fish Transport Permit in accordance with the applicable provisions of ORS 183.310 through 183.500 if the holder of the permit has violated any of the terms or conditions of the permit or any statute or regulation.

b. Revocation of a Fish Transport Permit is in addition to and not in lieu of other penalties provided by law.

C. Fish Propagation License (Authorization to Propagate, Rear, and Sell Live Fish)

License Required, 635-07-660.

a. Except as provided in section (3) of this rule, any person shall obtain a Fish Propagation License in order to propagate, rear for sale or sell any live fish.

b. A separate Fish Propagation License shall be obtained for each rearing site and shall be renewed annually.

c. Section (1) of this rule shall not apply to:

(1) The propagation and sale of nongame aquaria species in aquaria;
(2) The operation of salmon hatcheries regulated under ORS 508.700 through 508.745 and OAR Chapter 635, Division 40 as further clarified at OAR 635-07-680;
(3) Activities authorized under a STEP Permit (OAR 635-09-115).

d. The Department may attach to the fish propagation license any terms and conditions it deems necessary to achieve compliance with Oregon laws or rules.

e. The Department may refuse to issue any fish propagation license if:

(1) Applicant fails to meet any of the deadlines specified in OAR 635-07-655;
(2) The propagation of the fish specified in the application will be the first introduction of that species into the watershed in which the proposed facility is located;
(3) The Department finds the operation, as proposed by the applicant, would tend to be harmful to existing fish populations in or below the site of the proposed propagation facility;
(4) The Department finds the applicant violated any terms of any license, permit, or operational plan issued by the Department'
(5) The Department finds the applicant has failed to comply with any statute, rule, or reporting requirements relevant to the operation of the propagation facility; or
(6) The applicant has failed to pay any sums it owes to the Department or which are owed to the Department under any license or permit it holds or the benefits of which it enjoys.

D. Fish Species – Sturgeon

1. Purpose, Policy and Definition, 635-07-700.

a. These rules establish a special permit system for the orderly development and conduct of an experimental program for the rearing of Columbia River white sturgeon in fish propagation facilities and to provide for the collection of oversize female sturgeon for egg taking. The total amount of oversize female sturgeon that may be collected by all persons issued permits under these rules shall not exceed eighteen (18) per calendar year as further provided in OAR 635-07-710 (2)(a).

b. For purposes of OAR 63a5-07-700 through 635-07-720 "oversize sturgeon: means: Columbia River female white sturgeon over six (6) feet in length.

2. Obtaining Sturgeon and Eggs for Propagation, 635-07-705. Any person desiring to propagate sturgeon must develop sturgeon brood stock from which to take eggs to continue the sturgeon propagation operation. Oversize sturgeon shall not be collected on a continuing basis to support either experimental or production rearing. Sturgeon and eggs to provide seed for propagation and development of brood stock for a fish propagation facility may be obtained in the manner described in subsections one to three of this section.

E. Fish Species – Salmon Management

1. Maintenance of Genetic Variability, 635-07-800.

a. Genetic variability of Oregon salmon stocks shall be maintained in wild and hatchery fish.

b. Hatchery breeding programs for each fish stock shall be designed to maintain diversity in characteristics such as time of migration, time of spawning, age at maturity, and age specific size.

c. Notwithstanding other restriction on importation of salmon:

(1) Chum salmon eggs may be imported for release south of Cascade Head on the Oregon coast or in tributaries of the Columbia River where wild populations do not exist.
(2) Pink salmon eggs may be imported for release to establish a brood stock in Oregon by private pink salmon hatchery permittees if eggs to be imported meet the requirements of fish transport and disease control regulations.

2. Depressed Wild Stocks of Salmon, 635-07-805. **Depressed wild populations of salmon, in particular coho and chinook, may be rehabilitated or supplemented with hatchery fish to optimize future natural production if such actions are consistent with wild fish management.**

F. Hatcheries – General

1. Salmon Size and Time at Release, 635-07-810. **Salmon will be programmed for release at a size, a time of year. and in such a manner that their release will contribute to attainment of management goals, management plans, and accepted programs, provided:**

a. Smolts must be of a size and released at a time at which they are expected to move directly to the ocean.

b. Presmolts may be released to supplement natural production for rehabilitation in freshwater or in estuaries.

2. Salmon Release Program, 635-07-815. **Hatchery produced salmon shall be programmed, reared, and released in such a manner as to achieve the optimum harvest of the hatchery product while protecting natural production and the genetic resources of wild fish.**

3. Priority of Fish Releases, 635-07-817.

a. To control the number of hatchery fish spawning with wild fish, the total number of hatchery fish to be released in waters managed for wild fish shall be limited. Opportunities to release hatchery fish shall be distributed in the following priority order:

(1) Department programs including public hatchery production and the STEP have first priority.
(2) Other publicly funded programs including Federal hatcheries and state programs funded under Restoration and Enhancement have second priority.
(3) Private salmon hatcheries authorized under OAR Chapter 635. Division 40, have third priority.

b. Authorization of fish releases under these rules shall be made annually during development of the Department's fish production and release schedule, in the year preceding proposed fish releases.

4. Salmon Production Programs, 635-07-820.

a. Salmon Hatchery Programs proposed for public hatcheries and private salmon hatchery permittees will be provided for ODFW staff review and planning prior to commencement of egg collection each year to include at least

(1) Rearing location;
(2) Species;
(c) Egg source or stock;
(d) Number to be released;
(e) Expected size at release;
(f) Expected time of release;
(g) Special treatment, marks, handling, etc.;
(h) Release site or project.

b. Revisions of accepted salmon hatchery programs due to unforeseen shortages of eggs, changes in facility availability or status, or necessary management adjustments must be reviewed and accepted by ODFW staff prior to implementation of the proposed revisions.

c. Transport and release authorization must be obtained from ODFW fish culture staff prior to moving fish between facilities or releasing fish. No authorization will be given if fish do not reasonably meet criteria shown in previously approved programs for release size, time, and mark rate, or if disease control regulations are not met.

d. Summaries of releases, by hatchery and site (including STEP projects) will be prepared by ODFW at completion of releases for the year.

5. When Salmon Eggs are Surplus, 635-07-82s. For the purposes of ORS 508.730, the following criteria shall be used in determining when all natural and artificial fish production needs of the State have been met:

a. General limitations--salmon eggs will not be declared surplus unless and until the capacities of all public hatchery facilities contributing fish for release in Oregon waters, including coastal streams and Columbia River and tributaries, having been filled, and approved rehabilitation and enhancement programs, including STEP, have been provided for. However, the Department recognizes that certain constraints may limit hatchery production

to less than full capacity, including available finances, legislative direction, Commission policy, and status of stream/water body management plans. The Department may not be able to locate, determine, or accommodate all areas of need at any one time.

b. Biological limitations--biological factors which limit numbers of salmon eggs that can be utilized in meeting State needs are:

(1) Fish carrying capacity of a given stream or water body;
(2) Probability of disease transfer to naturally produced stocks;
(3) Maintenance of genetic integrity or compatibility of stocks;
(4) Impacts of other species of fish.

6. General Priority for Use of Salmon Eggs and Fingerlings, 635-07-830. Salmon eggs and fingerlings will be used or distributed in the following priority:

a. ODFW Program including public hatchery production and STEP.

b. Federal fish hatcheries in Oregon.

c. State and Federal fish hatcheries located on the Columbia River outside Oregon.

d. Educational use.

e. Private salmon hatcheries in Oregon.

f. Other State and Federal fishery agencies in Alaska, California, and Washington.

g. Wildlife Propagation License holders in Oregon.

h. State and Federal fishery agencies in the remainder of the USA.

i. Private salmon hatcheries in the remainder of the USA.

1. State and Federal fishery agencies in other countries.

k. Private hatcheries in other countries.

G. Oregon Hatchery Guidelines

The State of Oregon has extensive fiscal and biological investments in hatchery programs that have objectives ranging from rehabilitation of wild populations to routine stocking of hatchery fish for angling opportunity.

This plan emphasizes the need for management to establish clear objectives for the use of hatchery fish in a basin. Hatchery guidelines are a tool to achieve those objectives. To comply with Sections 4 and 8 of the Fish Management Policy and the Wild Fish Policy, these guidelines should be followed in all hatchery operations, including STEP fish propagation programs.

Although the specifics of hatchery operations transcend the boundary Of species plans, these guidelines do not appear together in a single agency document to date. Therefore, those general guidelines necessary to the successful implementation of the Steelhead Plan are given below.

In addition to the specific stock transfer guidelines given previously, hatchery operational guidelines are needed for brood stock selection, rearing and release, and evaluation of adult return.

Guidelines are just that--guides to operation. Inherent in this plan is recognition that constraints of holding, incubation, and ponding space, water flows, and personnel severely limit our present ability to follow these guidelines in total. In fact, this approach is far beyond our present hatchery capabilities and individual costs will have to be identified depending upon the objectives chosen in basin plans. However, physical and personnel constraints to the following guidelines should serve as the basis for priorities in the budgeting process. The following recommendations draw heavily upon the work of Hershberger and Iwamoto (1980).

1. Broodstock Guidelines

a. If brood development is necessary, choose the stock on the basis of the stock transfer guidelines. If a local broodstock is not available, give consideration to breeding donor females with local males.

b. <u>Broodstock Population Size</u>

(1) Where the number of returning adults is not a limiting factor, a minimum of 200 adults with equal numbers of each sex (100 males and 100 females> should be spawned every generation. Every effort should be made to maximize the contribution of each adult. To insure this occurs, careful attention must be given to the techniques of fertilization. Individual matings provide more diversity than pooled sperm due to differential sperm activity between males.

(2) The concept of maximizing contribution of each adult becomes a critical issue in "small egg take" situations. This issue must be addressed under three separate circumstances.

(a) When a population is judged to exhibit characteristics that are desirable to preserve, necessitating maintenance of the population as a separate,distinct unit, then a random assortment of adults should be used to produce the next generation (e.g., Fishhawk Lake steelhead brood returning to North Nehalem Hatchery).

(b) When it is necessary to supplement a population with outside sources (this does not apply to infusing wild fish into an existing brood stock), several steps should be followed to assure the best result possible.

First, all adults returning in the original population should be spawned together. Second, a donor stock should be selected and milt from the original stock should be used to fertilize eggs from the donor stock. This may tend to increase inbreeding, but it will also tend to increase the odds that favorable genes from the original population will be incorporated into the genetic makeup of subsequent generations.

(c) When a wild population is being rehabilitated or developed as a new broodstock, guidelines are needed to establish a minimum broodstock population number, yet not take too high a proportion of the original stock. The intent of this guideline is that brood programs be based on representative samples, yet minimize inbreeding.

Implementation in specific cases should consider the status of the wild run and the desirability of or need to release a portion of the smolts produced back into the donor system as "payback."

C. Broodstock Composition

(1) Established hatchery stocks used in Wildfish Policy Option b management (wild plus hatchery), need to incorporate wild fish into the hatchery breeding program. Breeding programs to accomplish this guideline need to be designed by someone with a genetics background.

Unless a planned, directed selection program is being conducted, spawning adults should not be chosen from a limited part of the total return; that is, adults should be taken from all portions of the run on the bias of return date, size, and age to maintain the genetic diversity of the original stock. The physical constraints of existing facilities and programs limit this at present. For summer steelhead, time of availability to the fishery is usually the consideration, and is not necessarily related to spawning time, as in winter steelhead.

If directed selection is approved by the Fish Division, program goals must be defined by the District Biologist and specifically addressed. In addition, a followup assessment of the effects of the program should be conducted to assure the goals are being achieved. Detailed and complete records of numbers of fish by week, sex, and length (representative subsample) need to be taken of all stocks returning to a hatchery in order that an accurate assessment of their biological characteristics can be made. These records should be the basis for the choice of adults to be used in spawning. If it is not feasible to measure lengths of all adults, at least those spawned should be measured.

(2) Age Composition

- Random selection will be the general rule, unless specifically excepted by the above process.
- If the objective is to mimic the age composition of the wild stock n the system, alternatives may be to infuse wild donors, or identify the age composition of the wild fish and spawn hatchery adults proportionately.
- In any case, document age composition of fish spawned by either take scale samples from all brood fish at the time of spawning, subsampling brood fish for scales (at least 60 fish) or recording fin marks where these are used to separate ages at return.

(3) Time of Spawning

- The general concept of guidelines for time of spawning was developed for winter steelhead in which time of availability to the catch is related to time of rever entry, migration rate, maturation, and to time of spawning. For summer steelhead, availability to the catch is related to river entry, migration, and holding patterns and may not be influenced greatly by spawning time. This bears further investigation. The concept of spawning time in hatchery production of steelhead for Option b streams is to spawn brood stock proportionate to the characteristics exhibited in the original (wild) stock as best as known and possible. For streams in which a race is managed for Option c, the only timing consideration is availability to the fishery and the long-term productivity of the hatchery stock.

Summer Steelhead

- For broodstock tagged or captured earlier on the basis of availability to the fishery and held several months until mature, time of spawning will be the range exhibited by the brood (this assumes spawning and run timing are unrelated).

- For broodstock captured immediately prior to spawning (e.g., upper Columbia River stocks). care should be taken to spawn fish across the range of natural spawning times, proportionate to their abundance.

- If adults are recycled through the river to increase the fishery, those adults must be marked to distinguish them from uncounted fish. This will allow identification of fish by return time for broodstock retention.

Winter Steelhead

- Broodstock should be selected proportionate to the present run timing or toward the historical wild run timing unless an alternative approach has been approved by the Steelhead Coordinator and the region receiving the smolts. For example, 25 percent of the egg-take destined for smolt production could come from the early portion of the run/spawning, 50 percent from the middle, and 25 percent from the late portion.

  Specific dates for these cutoffs will be determined for each broodstock. In the above example, if early egg-take needs were not met, at least 75 percent of the egg-take would be taken by the end of the midportion of the run. It is recognized that up to 25 percent extra eggs could be taken from the middle of the run in case no later fish appear. These middle 25 percent would be the thinouts if extra fish are on hand. This guideline assumes that the intent is to mimic the wild run and the example assumes the wild run has a statistically normal distribution of spawning time. Any major deviations from this guideline due to management objectives or physical constraints of the rearing station must be approved by the appropriate region, the Freshwater Program Manager, and the Steelhead Coordinator.

- The stream that is the broodstock source will receive the full (e.g., 25-50-25) run timing distribution in its allocation. This can be accomplished by mixing progeny from all egg takes in each pond prior to allocation or by hauling some fish from each progeny group to the same stream at liberation. This is the general guideline for accomplishing the entire run timing distribution in offstation releases as well.

- Remember, all efforts at a spawning distribution can be defeated by liberation techniques (e.g., all progeny from early spawners in one river).

- Other special management objectives may require timing distribution other than the general guideline. These programs must address potential impacts on wild fish (within Option b streams and adjacent Option a streams).

a. General

- Insure that rearing conditions are as uniform as possible for all groups of fish. All groups should have an equal opportunity to express their genetic potential for growth. This would best be done by keeping progeny from different egg-take times in separate ponds to avoid competition and allow target feeding to achieve similar size between ponds before mixing.

- Problems with pond design and flows impeding compliance with this guideline need to be brought before Fish Preparation and Freshwater Program review processes prior to beiennial budget development.

- Continue to improve inventory methods.

b. Size Objectives

- Size of smolts at release from individual hatcheries should be determined from all available biological data. This may differ slightly by release location relative to he stock used.

- Until new information becomes available, the general target sizes of smolts at release will be:

  (1) Winter steelhead: minimum of 6f/lb; and

  (2) Summer steelhead: minimum of 5f/lb.

  Where individual data sets indicate improved survival will accrue. these minimums may be replaced with a different size, taking into consideration feeding costs and the survival rate relative to the cost.

- Length frequencies should be made at the end of the summer rearing period. These will serve as the basis for deciding whether or not to grade.

- Length frequencies of all representative groups will be measured at all hatcheries within 2 weeks prior to release. Representative groups will be chosen on the basis of uniform pond features, similar densities, and production or experimental groups.

C. Thinning and Grading Practices

- Thinning is a process of randomly reducing the population to management program needs without changing the size, sex, or genetic makeup of the population. Grading is a process by which the population is segregated into various size groups for the purposes of achieving good growth, preventing competition between fish of differing sizes with their larger kin, and obtaining fish of the correct threshold size to meet management requirements. Furthermore, the total weight of fish in any one group can be more accurately determined for computing the amount of food to feed by percentage of body weight, if the fish are of a similar size. If the smaller fish throwing out the progeny of later spawners and fish that will be older at maturity (e.g., "3-salts"). It may be desirable to rear extremely small gradeouts for a second year to add to the genetic variability of the stock.

- All attempts should be made at the time of grading, thinning, or inventory to mix fish in and between ponds to insure that each allocation receives a mix of progeny of early, middle, and late spawners.

  There is a need to know the best time and locations to release "thinouts." Experiments should be conducted to evaluate the survival of thinouts and the potential for competition with naturally produced fish. Pending results of future evaluations, thinouts should only be released where the District biologist identifies a need and the liberation is consistent with basin plans.

d. Pond Densities

- A high priority should be place on setting density guidelines for steelhead at each station, according to the particular pond designs, chemical makeup of the water, water source, and temperature.

- Uniform rearing densities should be provided for all groups. except research groups requiring special rearing conditions.

- Pond densities should be recorded on hatchery records and sent to the Portland office for their records.

e. Nutrition

- Diet studies should be evaluated for survival to the adult steelhead stage, as well as for juvenile characteristics such as growth and food conversion efficiency.

f. Disease Prevention and Treatment

- Do not overcrowd.
- Keep stress to a minimum.
- Keep ponds clean.
- Maintain adequate flows for the number of fish being reared.
- If above normal losses start occurring, contact pathologists at once.
- Keep diseased fish away from water supplies.

g. Growth Rates

- At minimum, size estimates should be made every 2 months.

- Fish Culture will provide each station with a guide to how many weight samples are needed at several fish/lb ranges to yield accurate weight estimates.

- An updated inventory of numbers of fish on hand (not just size) should be taken at a size of approximately 25/lb or larger, but early enough to enable adjustments in program.

- Guidelines need to be developed by managers at each station for targeting growth month-by-month to achieve the size objective at release.

h. Time of Release

Guidelines for time of release have generally dealt with the spring release of smolt-age steelhead where the objective has traditionally been to achieve the best survival and adult return. All District programs utilizing releases of smolt age steelhead will utilize the following checklist to arrive at or verify an appropriate time of release:

(1) When do the wild steelhead smolts migrate downstream in the system to be stocked?

(2) The time of release chosen for an Option b stream should minimize the residence of smolts, therefore competition with wild fish in the stream.

(3) Are there disease, temperature. or predation considerations that can be circumvented by the release time chosen?

(4) Does the smolt release schedule make the most advantage of flows?

(5) Does the release of hatchery smolts cause a significant harvest of wild smolts in a trout fishery that could be reduced by an alternate release schedule or location?

(6) Under Management Option C streams (managed primarily for hatchery steelhead), smolts could be released at a time that allows their harvest as trout as well as adults. Here the consideration could be the time that yields the greatest mix of recreational benefits.

The above guidelines may require the purchase of additional liberation equipment, to be fully implemented.

No guidelines have yet been developed for time or size at release of steelhead presmolts for the purpose of rehabilitating a wild stock. Research is underway that will provide material for development of these guidelines.

i. Location of Release

(1) Consideration: SUPPLEMENTATION OF CATCH

The objective could be target fishing areas or dispersal (multiple sites) over a wide area. The District biologist will have to consider in the design:

- the efficiency of the program, e.g., the cost of extra trucking versus benefits at the release site upon adult return;
- the maximum impact on the target catch; and
- the minimum adverse impact on wild harvest rate and straying of hatchery fish into Option a management streams.

(2) Consideration: SUPPLEMENTATION OF SPAWNING

The objective is to seed rearing areas. Consideration in design:

- release above the fishery to encourage adults to return to areas above the fishery upon return (rehabilitation also);
- release location should be an area in need of supplementation; and
- information need--evaluate the assumption that release areas are attracting the fish.

(3) Consideration: HATCHERY BROODSTOCK

The objective is to release sufficient smolts in the proper locations to assure the required egg take, without large surpluses.

Appendix 7. Guidelines for Stocking Salmonids in Streams

Introduction

Adult escapements are inadequate to attain optimum stocking of juveniles in many streams with natural spawning populations. Other stream systems have been recently opened to anadromous fish or are located above stream barriers that may require annual releases to either develop or sustain production of desirable species in ODFW management programs. Consequently, many productive habitats are now underutilized by anadromous salmonids and require plants of juvenile fish (fed or unfed fry) from hatcheries or the Salmon and Steelhead Enhancement Program (STEP) egg boxed to achieve desired stocking levels.

To obtain optimum results, managers need to: (1) supplement depressed stocks with fish that closely mimic the natural spawning population in the target watersheds; and (2) control density-dependent mortality. In normal circumstances, survival decreases as density increases which reduces the probability that an individual fish will survive to the next stage in its life history. If insufficient eggs are produced by the wild stock, then supplemental releases are justified to bring the level of smolt production up to the maximum number any particular stream system can sustain. However, there is no justification for stocking additional fish if the natural spawning population is sufficient to attain the maximum recruitment of smolts from the system. This would only serve to increase the mortality rate in the wild stock.

Indiscriminate or excessive stocking of juvenile fish may be wasteful and counterproductive to the intended management goals of enhancing and perpetuating wild stocks. The problem has become acute in recent years following the growing popularity of STEP's egg incubation program and the Department's efforts in transplanting presmolts. Guidelines are needed to identify populations that could benefit from stocking programs and to estimate the number of juveniles required to increase the populations to levels consistent with maximum smolt yields.

A workshop was convened to discuss the problem and review various approaches used to determine stocking rates in streams. Three models were discussed at the meeting. Although the models were similar, some differences were identified that needed to be resolved. Following this meeting, a task team was formed to blend the various methods and produce guidelines for biologists and STEP volunteers. The task team developed the following guidelines and models for stocking coho, steelhead, cutthroat, and chinook. These guidelines apply to Section 5 of the Fish Management Policy and Wild Fish Management Policy.

STOCKING GUIDELINES

Coho, Steelhead, and Cutthroat Trout

Habitat Quality Index (HQI)

Detailed analyses of stream productivity and estimates of juvenile abundance are generally lacking; however, spawning ground counts, stream mileages, areas, general characteristics of the habitat, and obvious physical factors limiting production are often available as a general guide to stocking requirements. Existing information on habitat and species requirements can be combined into an HQI system to determine stocking levels. This is done by comparing the potential ideal condition for the stream to rear a particular species with the potential limiting factors or less than optimum habitat actually present in the stream designated for stocking.

Each stream is rated on the criteria summarized in Tables 1 and 2 for any particular species. Based on the criteria, the stream is designated into one of five HQI categories defined as follows:

(1) Poor habitat with little or no potential for rearing the species.

(2) Marginal habitat with the capability to rear the species but has several obvious deficiencies.

(3) Fair habitat with fewer deficiencies than in streams with HQI 2.

(4) Good overall, but lacking in one or two criteria.

(5) Optimum conditions for the species throughout the area.

Stocking Rates

Stocking rates (F_i) for coho, steelhead, and cutthroat corresponding to each HQI index are summarized in Table 3. Rearing potentials at maximum production in streams where HQI = 5 are assumed to be 1,700 smolts/mile or 3.35 fry/square yard for coho (10 percent survival of fry to smolt) and 1,021 steelhead and 384 cutthroat/mile or 0.84 fry/square yard (8 percent survival of fry to smolt). The derivations of these estimates are documented in supplements A and B. The number of females required to achieve maximum production in streams where HQI is <5 is proportionately smaller than in streams were HQI = 5 (Table 3).

Stocking rates are calculated in terms of miles and yards because most of the existing inventory data is in this form. To convert to metric units, multiply the stocking rates in Table 3 by 0.6214 to obtain fry/km and 1.196 to obtain fry/square mile.

Appendix Table 7-1. Optimum physical stream characteristics useful in differentiating habitat preference of salmonid species.

Parameter	Species			
	Coho	Chinook	Steelhead	Cutthroat
Percentage pools	50-80%	50%-100%	<50%	40-60%
Gradient	<3%	2%	1-5%	1-20%
Stream order	2-5	<5	2-5	<2
Maximum Temperature	<65 F 18 C	<73 F 23 C	<73 F 23 C	<73 F 23 C

Appendix Table 7-2. Physical stream characteristics useful in evaluating stream quality.

Parameter	Species			
	Coho	Chinook	Steelhead	Cutthroat
Cover	Woody structure	Pool depth	Boulders and wood	Wood, volume boulders
Channel profile	Flat	Moderately flat	Steep	Undercut banks
Riparian vegetation	Presence of riparian vegetation important for all species. Vegetation type (fir, alder) and age of vegetation determine quality.			

(VS10-PJSR-3294W)
(11/09/92)

INTEGRATED HATCHERY OPERATIONS: EXISTING POLICY AFFECTING HATCHERIES IN THE COLUMBIA RIVER BASIN

ANNUAL REPORT 1992

Prepared by:

Larry Peck

Washington Department of Fisheries

Prepared for:

U. S . Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-3621

Project Number 92-043
Contract Number DE-BJ79-9 lBP60629

MAY 1993

INTEGRATED HATCHERY OPERATIONS TEAM

Existing Policy's Affecting Hatcheries

WASHINGTON DEPARTMENT OF FISHERIES

WRITTEN POLICY ON HATCHERY PROGRAM PROCEDURES

1. Program Development

A. Basic Program Developed in Salmon Culture. **The Assistant Chief, Assessment and Development (A&D) has the responsibility for developing the draft program based upon:**

1. Input from Regional Operations Managers who have a significant role in the process through continual communication with the A&D Section. The Operations Managers' primary role in programming is to assure that the program is operationally feasible and practical.

2. A&D Assistant Chief's personal understanding of harvest management strategies and agency objectives.

3. Quality Control aspects identified through continuous monitoring and input from the Quality Control Supervisor.

4. Operational efficiency considerations.

5. Recent past programs.

6. Current standing stock of fish.

B. Internal Review of Salmon Culture Draft Production. **The draft program is circulated by the Assistant Chief A&D to any interested party within Washington Department of Fisheries (WDF) but especially to the Harvest Management Chief and the Regional Harvest Management Assistant Chiefs. After an adequate review period, comments are returned to the Assistant Chief A&D and the draft program is adjusted to accommodate any changes required by Harvest Management, Administration, etc.**

C. External Review of WDF Draft Production Program. **The clean draft program is available to all interested parties but is specifically distributed to Tribal entities. The communication can now occur through an interactive computer program. Ideally the draft program should be distributed to the Department of Game and the U.S. Fish and Wildlife Service (USFWS) for their comments. These agencies as well as Tribes are obligated to reciprocate with draft programs.**

D. Finalized Program. Historically the program was "finalized" by printing and distribution of a bound volume commonly known as the "Red Book." Presently the program is "final" only in the sense of the most recent computer update being declared the final version. I believe it is a necessity to have a discrete beginning point with a clean program but the dynamic and continuing nature of updating makes the "beginning" point for a "final" program somewhat arbitrary. It does seem reasonable that the product of the external review process should be an agreed-upon program. at least for a brief moment in time.

II. Program Updating

Deviations from the basic program will occur continually, most commonly due to:

- Deviations from expected egg take
- Auditing and updating of standing populations
- Catastrophic diseases
- Physical catastrophe
- Change in management requirements
- Direction from Administration
- Improvements in basic hatchery management

Immediately upon identification of a need to deviate from the current program, the A&D Section will quantify the extent of deviation and implement a Salmon Program internal review and decision process which will:

- Characterize the deviation
- Examine program alternatives
- Select the desired alternative, i.e., compensation, backup, reallocation, etc.

The A&D Section will then update the program and cause the update to be implemented through the Regional Operations Managers.

III. Comunication of Program Updates

A. Modes of Comunication. it is recognized that the dynamic nature of the program necessitates a process for continuing communication of program changes. This communication is at three levels; hatchery manager, Salmon Program, and Tribes.

1. Hatchery Manager. Communication of program changes will be made to the Hatchery Manager by the Regional Operations Manager or by the A&D Assistant Chief-or designee. This-level of communications is ongoing and normally does not pose a problem.

2. Salmon Program. Salmon Program involvement in II above, should suffice as communication of program changes in that representatives will be involved in the ongoing decision process. Use of the interactive computer program will serve as the general communications link and Salmon Program members have the opportunity to continually monitor the program status.

3. Tribes. Communicating program updates to the Tribes is the most challenging communication problem and requires a more formalized approach than used within the Salmon Program. Each program update will be entered into the interactive computer program as a normal result of the process described in II above. The question then is how to cue the Tribes to look for a program update or deviation from the version they have most recently seen. Some alternatives are:

a. Each Tribe establish a voluntary periodic perusal of the program.

b. We call each Tribe each time the program changes.

c. We use the computer mail system to notify a specific Tribe of a program change. The Tribes still must voluntarily look for a flag indicating a computer mailing.

d. We use computer mailing to notify NWIFC and they are responsible for notifying the Tribe to check to interactive computer program for production change.

We prefer to institute alternative d.

IV. Record of Program Changes

In the past the record of proqram chanqes has been informal, usually in the form of a collection of memos to hatcheries detailing specific actions. There was not method to provide tracking capabilities to outside recipients of the bound "Red Book." With the use of the new interactive computer program; several alternatives for program tracking are available.

- Each user could have a copy of the program printed at their local terminal, collecting a copy for each program change.
- A log of program changes is routinely kept in the computer and a specific audit of program changes could be obtained under the request to Salmon Culture.
- The exiting log of changes could be more "humanized" and could be made a part of the interactive computer program. Each user with access to a terminal could call up a complete chronological record or program updates for any given hatchery.

We prefer this alternative and are prepared to develop the capability to carry it out.

V. Schedul ing Requirements

Several states in program development would be served by specific scheduling deadlines. These stages are listed below but deadline dates have

not been assigned. Salmon Culture and Harvest Management representatives will jointly develop a schedule that will guarantee compatibility of program development and court ordered requirements for status reports.

- Mail out requests for Tribal and Co-op program proposals.
- Receive Tribal and Co-op program proposals.
- Develop basic program draft in Salmon Culture.
- Circulate Salmon Culture draft program for internal review.
- Receive comments from internal review.
- Distribute WDF draft program for external review.
- Receive comments from external review.
- Resolve conflicts with Tribes/Co-ops.
- Distribute final program July 1.

Stock Transfer Guidelines

The following is a list of cultured stocks of coho, chinook, and chum salmon that may be released from specific Washington State hatcheries. The use of each stock within each hatchery has been prioritized; those with a 1 adjacent to their stock titles are the most desirable, stocks with higher numbers are considered to be progressively less well-suited.

COHO

Facility	Program	Acceptable Stocks
Nooksack	Normal	1 Nooksack River
		2 Clark Creek
Skagit	Normal	1 Clark Creek
	Early	1 Baker River
Skykomish	Normal	1 Skykomish River
Issaquah	Normal	1 Issaquah Creek
		2 Green River
Green River	Normal	1 Green River
Puyallup	Normal	1 Puyallup River
		2 Green River
		3 Minter Creek
Minter Creek	Normal	1 Minter Creek
		2 Green River
		3 Puyallup River
		4 Any south Puget Sound

COHO (continued)

Facility	Program	Acceptable Stocks
Garrison Springs/ Coulter Creek	Normal	1 Minter Creek 2 Any south Puget Sound
South Sound Pens/ Lake Sequalitchew	Normal	1 Minter Creek 1 Skykomish River 2 Any south Puget Sound 3 Any Puget Sound Sound
George Adams	Normal	1 George Adams
	Summer	1 Hood Canal returns 2 Baker, Soleduck, Capilano
Hood Canal	Normal	1 Hood Canal 2 George Adams
	Summer	1 Hood Canal returns 2 Baker, Soleduck, Capilano
Dungeness	Normal	1 Dungeness River 2 Elwha River
Elwha	Normal	1 Elwha River 2 Dungeness River
Soleduck	Normal	1 Soleduck River fall
	Summer	1 Soleduck River summer
Humptulips	Normal	1 Humptulips River 2 Any Grays Harbor stock
	Late	1 Late Satsop River
Simpson/ Skookumchuck	Normal	1 Satsop River 2 Any Grays Harbor stock
	Late	1 Late Satsop River
Willapa	Normal	1 Willapa River 2 Any Willapa Bay stock
	Late	1 Late Satsop River
Nemah	Normal	1 Nemah River 2 Any Willapa Bay stock
	Late	1 Late Satsop River
Naselle	Normal	1 Naselle River
	Late	1 Late Satsop River

COHO (continued)

Facility	Program	Acceptable Stocks
Cowlitz	Type N	1 Cowlitz River type N (Early, middle, and late components)
Washougal	Type N	1 Washougal River type N 2 Any Cowlitz River type N
Elokomin	Type N	1 Elokomin River type N 2 Any Cowlitz River type N
	Type S	1 Elokomin River type S 2 Any Cowlitz River type S
Lewis River/ Speelyai	Type N	l.Lewis River type N 2 Any Cowlitz River type N
	Type S	1 Lewis River type S 2 Any Cowlitz River type S
Lower Kalama	Type N	1 Kalama River type N
Kalama Falls	Type S	1 Kalama River type S
Grays River	Type S	1 Grays River type S 2 Toutle River type S
Toutle	Type S	1 Toutle River type S
Klickitat	Type N	1 any Cowlitz River type N
Rocky Reach	Type S	1 Any Cowlitz River type S

CHINOOK

Facility	Program	Acceptable Stocks
Nooksack	Fall	1 Nooksack River fall 2 Samish River fall 3 Skookum Creek fall
	Spring	1 Nooksack River spring
Samish	Fall	1 Samish River fall 2 Nooksack River fall
Skagit	Fall	1 Skagit River fall 2 Samish/Nooksack fall
	Spring	1 Skagit River spring
	Summer	1 Skagit River summer
Skykomish	Fall	1 Skykomish River fall 2 Green River fall
	Summer	1 Skykomish River summer
Issaquah	Fall	1 Issaquah Creek fall 2 University of Washington fall 3 Green River fall
Green River	Fall	1 Green River fall
Puyallup	Fall	1 Puyallup River fall 2 Green River fall
Minter Creek/ Fox Island/ Coulter Creek	Fall	1 Minter Creek fall 2 Deschutes River fall 3 Puyallup River fall 4 Any south Puget Sound fall
Deschutes	Fall	1 Deschutes River fall 2 McAllister Creek fall 3 Any south Puget Sound fall for yearling release
McAllister/ Schorno	Fall	1 McAllister Creek fall 2 Deschutes River fall
Garrison Springs	Fall	1 Garrison Springs 2 Minter Creek 3 Deschutes River
George Adams/ McKernan Hood Canal	Fall	1 George Adams fall 1 Hood Canal fall 2 Deschutes fall

CHINOOK (continued)

Facility	Program	Acceptable Stocks
Hood Canal	Spring	1 Hood Canal/Quilicene River spring 2 Dungeness River spring 2 Soleduck River spring
Dungeness	Fall Summer Spring	1 Dungeness River fall 1 Dungeness River summer 1 Dungeness River spring
Elwha	Fall	1 Elwha River
Soleduck	Fall Summer	1 Soleduck River fall 1 Soleduck River summer
Humptulips	Fall	1 Humptulips River
Simpson/ Satsop	Fall	1 Satsop River fall 2 Any Grays Harbor fall
Willapa	Fall	1 Willapa River 2 Any Willapa Bay fall
Nemah	Fall	1 Nemah River fall 2 Any Willapa Bay fall
Cowlitz	Fall Spring	1 Cowlitz River fall 1 Cowlitz River spring
Elokomin	Fall	1 Elokomin fall 1 Any lower Columbia River Tule stock
Grays River	Fall	1 Grays River fall 1 Any lower Columbia River Tule stock
Lewis River	Fall Spring	1 Lewis River fall 1 Lewis River spring 2 Cowlitz River spring
Kalama Falls	Fall Spring	1 Kalama River fall 1 Kalama Falls spring
Lower Kalama	Fall	1 Kalama River fall
Washougal	Fall	1 Washougal fall 1 Any lower Columbia River Tule stock

CHINOOK (continued)

Facility	Program	Acceptable Stocks
Klickitat	Spring	1 Klickitat River spring
	Fall	1 Upriver bright (Priest Rapids fall) 2 Mid-Columbia River, Snake River mix fall
Ringold Springs	Spring	1 Mid-Columbia River spring 2 Cowlitz River spring
	Fall	1 Upriver bright fall
Priest Rapids	Fall	1 Priest Rapids fall 2 Mainstem Columbia River upriver brights
Wells/Similkameen/ Methow pond	Summer	1 Upper Columbia River summer trapped at Wells Dam
Dryden pond	Summer	1 Wenatchee River summer
Chiwawa	Spring	1 Chiwawa River spring
Methow	Spring	1 Methow River spring
Chewuch	Spring	1 Chewuch River spring
Twisp	Spring	1 Twisp River spring
Lyons Ferry	Fall	1 Snake River fall
Tucannon	Spring	1 Tucannon River spring

SOCKEYE

Facility	Program	Acceptable Stocks
Lake Wenatchee		1 Wenatchee River

CHUM

Facility	Program	Acceptable Stocks
Nooksack	Normal	1 Nooksack River
Samish	Normal	1 Samish River 2 Maritime Heritage Center
Skagit	Normal	1 Skagit River
Skykomish	Normal	1 Skykomish River
I ssaquah	Normal	1 Issaquah 2 Any south Puget Sound stock
Green River	Normal	1 Green River 2 Any south Puget Sound stock
Puyallup	Normal	1 Puyallup 2 Any south Puget Sound stock
Minter Creek	Normal	1 Minter Creek 2 Elson Creek */
Coulter Creek	Normal	1 Coulter Creek
Garrison Springs	Early Late	1 Garrison Springs early stock 1 Garrison Springs late stock
John's Creek	Early Late	1 John's Creek early stock 1 John's Creek late stock
McAllister	Normal	1 McAl lister Creek
Hood Canal/ George Adams	Normal	1 Hood Canal
McKernan	Normal	1 George Adams 1 McKernan
Humptulips/ Simpson/ Satsop Springs	Normal	1 Grays Harbor stocks
Willapa/Nemah/ Naselle	Normal	1 Willapa Bay

*/ Elson Creek stock #! until adults return to Minter.

SPAWNING GUIDELINES FOR WASHINGTON DEPARTMENT OF FISHERIES HATCHERIES

The attached spawning guidelines were prepared in an effort to complement and supplement the "Genetics Manual and Guidelines for the Pacific Salmon Hatcheries of Washington" (Hershberger and Iwamoto 1981). This manual does an excellent job of discussing, in detail, the potential genetic implications of hatchery practices. In addition, it provide an overview of basic genetic principles and current techniques available for measuring and analyzing genetic variability. In this paper, I examine those genetic considerations associated with spawning techniques commonly used in WDF hatcheries. Consideration has been given to population sizes, workload requirements of the hatchery crew, and genetics. A set of recommendations are presented which can give the hatchery manager some flexibility in evaluating each of the stocks returning to his hatchery. Thus, permitting him to match the techniques necessary to preserve the genetic diversity in that stock, with the size of the population and the manpower and facilities required to carry it out.

When we talk about hatchery salmon, we are dealing with a fish that is not a totally domesticated animal. In nearly all cases, hatchery fish spend at least 50 percent, and for some species, as much as 90 percent of their life cycle in the natural environment. From the the smolt stage on, a hatchery fish is exposed to the same natural selection pressures as a wild fish. Clearly, though hatchery stock could be different from a totally wild population, especially for characteristics associated with early-life history. In addition, there are great differences in the densities of fish in hatcheries as contrasted to natural environments. Consequently, there are good grounds for expecting behavioral and physiological conditioning in hatchery populations which may affect the way hatchery fish respond to some natural selection pressures after release. Also, the fish are subjected to artificial selection pressures associated with fishing rates, gear size selectivity, and others.

Once the fish are released, hatchery managers have no control over what happens to their fish. When it comes time to spawn, they can only work with what returns. Therefore, the spawning procedures used at a hatchery are extremely important. In fact, they could be considered the most important step in perpetuating the hatchery salmon source. It is therefore, imperative that we be knowledgeable about the possible genetic consequences associated with spawning and rearing operations.

All salmonid stocks exhibit some form of specificity to their environments. Thus, these stocks are composed of individuals bearing genotypes that are flexible enough for the particular environmental conditions they will experience. Consequently, hatchery stocks possess an inherent amount of genetic diversity and it is this genetic diversity that gives the population the flexibility to deal with the natural and artificial selection pressures to which it is subjected. The task for hatchery managers is how to preserve and perpetuate this genetic diversity.

Before discussing how this can be accomplished, it is appropriate to emphasize a ew important points about selection. It is not uncommon for spawning crews to apply selection pressures during the spawning operation. For instance, they may preferentially spawn fish possessing certain physical characteristics (e.g., size. color, etc.). This type of selection can either be deliberate or inadvertent. The important point is not whether these types of selection pressures are good or bad, but unless a planned, directed selection program is conducted, we have no way of knowing if these selection pressures will be beneficial or not. Planned breeding programs with all types of animals have demonstrated that when you select for a given trait, you also can select against other traits. In order to apply selection correctly, you must maintain a control population in which no planned selection is taking place. Then you can reliably measure the gains for the selected trait or inadvertent selection against other traits. Therefore, spawning crews should avoid applying arbitrary selection pressures unless specifically directed to so so. Rather, they should concentrate on measures to preserve and protect the total amount of genetic diversity available in that population

Genetic diversity must be viewed as being a product of the total population and, therefore, the greater the numbers of males and females within the population contributing to the next generation, the greater the odds of preserving the genetic diversity available within that population. Obviously, we could perhaps maintain the genetic diversity simply by spawning every returning fish; indeed this may be possible with small population sizes. However in most cases, our hatcheries deal with large populations and it can be physically impossible to spawn every fish because of limited manpower, incubation space, and spawning facilities. In addition, it is not uncommon for populations to return in numbers far greater than that necessary to meet the escapement and production goals of a hatchery.

Therefore, the enclosed spawning guidelines were developed to describe the spawning techniques that should be used under four commonly occurring situations. Generally, all WDF hatchery stocks can be readily assigned to the proper case or situation. It was felt that this approach would give the hatchery manager some flexibility in evaluating each of the stocks returning to his hatchery. A hatchery manager can then match the techniques necessary to preserve genetic diversity in that stock with the size of the population and the manpower and facilities required to carry out his program.

There four cases are as follows:

CASE 1. Adult return egg take potential is below the desired escapement goal. Also would include egg banks.

CASE . Adult return egg take potential is above the desired escapement goal, but every available female will be spawned. The egg surplus will be shipped out and used in the production goals of another facility. (Common case with Puget Sound fall chinook.>

CASE 3. The egg take potential is well above the desired escapement goal and there is no need to spawn every female. (Common case with Puget Sound coho.)

CASE 4. Where the station goal is to preserve specific run timing segments or where cutoff dates are used to separate any of the following: spring, summer, fall chinook; early, normal, late chum; summer, fall, normal, north, or south coho.

Specific spawning guidelines associated with each of these cases are provided.

In addition, sections are presented which discuss spawning procedures and problems which are common to any of the four cases. These sections include:

- Importance of population sizes.
- Determination of male to female ratios.
- Practices used in the fertilization of eggs.
- Selection of egg take to be retained by hatchery for perpetuation of the run.
- Use of jacks.

IMPORTANCE OF POPULATIONS SIZES

It is important to understand why the size of the population is so important. For example: If we had an infinitely large random-mating population, mathematical probabilities indicate that it would remain stable for any gene frequencies or genotype frequencies which are represented in that population, if there were no factors tending to change these frequencies, and they are characterized by two different processes. The first is called systematic and it includes the effects of selection, migration. and mutation. The second basic process is called dispersal, and this process arises in small populations strictly from the effects of sampling. The dispersal process includes the effects of inbreeding and random drift.

All of these processes: selection, mutation, migration, inbreeding, and random drift are discussed in detail in your genetics manual.

If selection is avoided during the spawning process we can, for all practical purposes, ignore the effects of migration and mutation. However, the impacts of genetic drift and inbreeding can still manifest themselves under a nonselective breeding program. Particularly, if the number of adults spawned is small and if only a few males have been used to fertilize the collected eggs.

MALE TO FEMALE RATIOS

The introduction suggested that generally all WDF hatchery stocks can be readily assigned to one of four types or cases. For a moment, consider

CASES 1 and 2. These cases have one point in common; that is, all returning females within the population are spawned. The number of males we choose to spawn in each case, therefore, represents the limiting factor in terms of available genetic diversity. CASE 2 populations are usually much larger than Case 1 populations and tend to be more successful. CASE 1 stocks may represent an effort to establish a new stock or they may be an existing stock, which for some reason (fishing pressure, environmental factors, etc.) is not performing as well as we would like. In addition, egg bank stocks which have been included in CASE 1 generally are small populations which are not geared towards emphasizing production, but rather, maintaining the stock at an appropriate size to preserve diversity for future use.

It is recommended that a male to female ratio of 1 to 1 be the goal each day you spawn a CASE 1 stock. The male to female ratio used in spawning CASE 2 stock should be no greater than 1 to 3 if more than .5 million eggs are expected to be taken that day. If the egg take is expected to be less than .5 million, a 1 to 1 male to female ratio should be used.

CASE 3 stocks are similar to CASE 2 in that the spawning populations tend to be large. In fact, they are generally so large that there is no need to spawn every female. In many cases, the egg take goal can be reached by only using a fraction of the total available females.

It is here in CASE 3 stocks where random drift and inbreeding associated with subsampling populations have the greatest opportunity to distort gene frequencies. In many situations CASE 3 stocks will be coho. There are, in addition to the problems associated with sample size, some operational problems associated with disposal of surplus adults coupled with high egg take demands for cooperative programs, Indian Tribes, and egg sales, etc. Therefore, a balance between the need to secure eggs and maintain a desired amount of genetic diversity needs to be established.

It is recommended that for CASE 3 stocks, the male to female ratio for egg takes to be retained for station releases be 1 to 1. Egg takes to be used for egg sales, Co-ops, and Tribes, etc. should follow the criteria established for CASE 2 stocks.

For determination of male to female ratios for CASE 4 stocks, the following procedure is recommended. Each stock should be examined individually within the run timing or separation dates used and relegated to the appropriate CASE - 1. 2, or 3 and treated accordingly.

Males should not be spawned more than once unless there is a severe shortage in the population, a situation which might occur in some Case 1 populations. When determining male to female ratios in this situation, a male is only counted once, regardless of how many times it is spawned.

PRACTICES USED IN FERTILIZATION OF EGGS

The techniques used for fertilizing eggs during spawning can have a large influence on the number of males contributing their genetic material to the offspring. Experimentation has shown that sperm become highly mobile when introduced into ovarian fluid. Thus. when milt from one male is added to eggs from several females and stirred, the probability is high that almost all of the eggs will be fertilized before the milt from other males is added. Consequently, the number of males actually contributing genetic information to a population can be much less than the number being "milked" into a spawning container. Therefore, the surest method of achieving the desired male to female ratio is to collect milt from the proper number of males in a separate container and use this mixture for egg fertilization. Do not allow this procedure to delay fertilization. If, for example you spawn into 5-gallon buckets, fertilize the eggs when the bucket is appropriately full. The proper number of males in the sperm mixture would be determined by the desired male to female ratio and the number of females spawned into the bucket.

SELECTION OF EGG TAKE TO BE RETAINED BY THE HATCHERY FOR PERPETUATION OF THE RUN

Which eggs to retain is not an important consideration for CASE 1 stocks since they are by definition, underescaped. However, for stocks that fall into the CASE 2, 3, and 4 categories, this is an important problem because if great care is not exercised in the determination of which eggs are to be retained, much of the effort expended during the spawning operation can be negated. During spawning, selection was avoided; however, if only a small segment of the egg take is retained, the number of adults contributing to the next generation is greatly reduced and selection would be applied. Therefore, selection of egg take to be retained by the hatchery should include as many spawning days as possible.

Generally, each hatchery manager has at his disposal, a fixed amount of incubation, starting, and rearing facilities for each stock in his total production goals. Starting the fish is perhaps the area of greatest concern since it is desirable to minimize age differences of the fish placed within a given starting vessel. However, it is not as important to minimize age differences of fish placed into difference starting vessels. The majority of stocks classified as CASE 2 and 3 will be coho and chinook. Therefore, the hatchery manager generally has some time to regulate fish size differences between starting vessels before making splits. In some cases, he might be able to make the splits without combining fish from different vessels. Because each facility has its own, unique water, pond space and species mixture problems, it will in essence, be left up to the hatchery manager to ensure that the egg take retained at the hatchery includes as many spawninq days as possible, commensurate with incubation, starting, and rearing facilities.

THE USE OF JACKS IN SPAWNING OPERATIONS

Sexual maturity in salmon is controlled in part by a genetic predisposition to mature at a certain size and by environmental factors associated with the growth pattern of the fish. Size can be directly related to growth rates which in turn, also have genetic and environmental components. The genetic disposition for growth rate and size at maturity can be considered fixed within any given fish but may differ between individuals of populations. The expression of this genetic potential can be regulated by the environmental conditions the fish are subjected to such as diet, water temperature, etc. From this we could hypothesize that fish which have a genetic predisposition to become jacks are generally the fastest growing segment of the hatchery population. Indeed, there is some evidence that the incidence of jacks in a population can be influenced by hatchery rearing practices and delayed release.

At present, we do not know what other genetic factors might be associated with the genes responsible for early maturation or jack determination. Most importantly, we do not know what role these other genes might play in the ultimate survival of the fish.

Therefore, when we make the decision to eliminate jacks from the spawning population, we run the risk of reducing or eliminating the frequency of genes responsible for fast growth, or other seemingly desirable traits.

In natural spawning populations, with the exception of pinks, there is the possibility that genetic material can be exchanged among fish originating from different brood years. This is especially true for chinook and chum populations which typically are made up of 2, 3, 4, and 5-year old individuals. However, in coho salmon, if we exclude jacks the potential for this type of genetic exchange is severely limited.

One could argue that jacks should be used in a manner equivalent to their occurrence in the returning hatchery population. For example: if 10 percent of the returning fish are jacks, then 10 percent of the total individuals used to perpetuate the run should be jacks. However, in many cases the gear used in commercial fisheries can artificially increase the ratio of jacks in the returning hatchery population from what it was before the fish entered the fishery. Also, the ratio of jacks in a population can be affected by hatchery practices during rearing and thus, this proportionate approach most likely will overestimate the contribution that jacks should make.

Clearly, since our goal is to preserve and perpetuate the total genetic diversity within the population, jacks should be included in the spawning population. The problem is how cane we ensure that the genes associated with jacks be incorporated into our populations at an appropriate level. The best way to do this is to introduce jacks into each spawning population at a level high enough to ensure that the gene frequencies associated with them are maintained in the population, but at a level low enough to offset the distortion associated with fishing pressure or hatchery practices. Based on the fact that most hatchery populations will be represented by at least 100 or more individuals, an introduction rate of no more than 2 percent should be adequate.

Therefore, I am suggesting that you spawn jacks, but at a level of 2 percent of the total number of both male and female fish spawned that day.

GENETICS MANUAL AND GUIDELINES FOR THE PACIFIC SALMON HATCHERIES OF WASHINGTON

Genetic factors have long been recognized to play an important role in our attempts to conserve natural biological resources. With the vast range and diversity of habitats that Pacific salmon occupy, the maintenance of genetic diversity becomes a very complex issue. Additionally, the importance of these species as commercial and sport fisheries' products and the degradation of and heavy demands on their fresh water habitats have led to a significant enhancement effort. The consequences of this from a genetic perspective are the addition of another level of complexity and some uncertainty. Together, they have generated a plethora of claims and counter-claims concerning the interactions of various genetic factors and management and culture approaches. Based on the facts that the current level of understanding of the genetics of Pacific salmon is more advanced than for most commercially harvested species and that these species have been subjected to "state-of-the-art" analytical methods, it would seem that some of the confusion is unwarranted.

An easy, and rather convenient explanation for some of the confusion would be the complex genetic system of Pacific salmon; undoubtedly this is at least partially accurate, but we feel there is more to it. A large part of these problems can be ascribed to our lack of attention to training and providing guidance to the people, the hatchery managers and their crews, who have the most to do with the genetic composition of enhanced Pacific salmon populations. Final determination of the genetic composition of enhanced salmon stocks is in the hands of these people, especially during the spawning season. Thus, this manual was designed for hatchery managers to provide a background in genetics as it relates to salmon culture by indicating

CHAPTER I

GENETIC GUIDELINES FOR HATCHERY PRODUCTION

As the following chapters in this manual will described, there is a growing technology available for the assessment of our salmonid resources. Additional contributions from more established areas of plant and livestock breeding may be applicable in formulating practical and efficient selection programs for stock development. In fact, the volume of information that must be digested and assessed, at first State hatchery system and the diverse program objectives at individual hatcheries, flexibility rather than rigid adherence to the guidelines should be the context in which the guidelines are applied. Weise and conscious decisionmaking on the bases of the proposed guidelines is our rationale for their presentation. To aid in this assessment, we have appended page references to each guideline from which the principles and theory behind each may be consulted.

A. Broodstock Population Size

1. The total number of returning fish and numbers of each sex must be considered when selecting adults for spawning. We recommend where the number of returning adults is not a limiting factor that a minimum of 200 adults with equal number of each sex (100 males and 100 females) be taken every generation. Every effort should be made to maximize the contribution of each adult. To insure this occurs, careful attention must be given to the techniques of fertilization. [Chapter III, pp. 57-62; Chapter IV, pp. 65-69.1

2. The concept of maximizing contribution of each adult becomes a critical issue in "short egg take" situations. This issue must be addressed under two separate circumstances.

a. When a population is judged to exhibit characteristics that are desirable to preserve, necessitating maintenance of the population as a separate, distinct unit, than all returning adults should be used to produce the next generation.

b. When it is necessary to supplement a population with outside sources, several steps should be followed to assure the best results possible. First, all adults returning in the original population should be spawned together. Second, the donor stock should be limited to one, or possible two sources, preferably from the same, or similar river system. Finally, if possible milt from the original stock should be used to fertilize eggs from the donor stock. This may tend to increase inbreeding, but it will also increase the odds that favorable genes from the original population will be incorporated into the genetic constitution of the donor population. [Chapter IV, pp. 63-65 and 69-71.]

Deviations from either of these recommendations (a likely circumstance) should be judged on their likelihood to preserve and transmit the genetic characteristics of the original population with the least amount of inbreeding.

B. Broodstock Composition

1. A representative portion of each run should be taken as a gamete source to maintain the genetic diversity of the original stock. Unless a planned, directed selection program is being conducted, spawning adults should not be chosen from a limited part of the total return; that is, adults should be taken from all portions of the run on the basis of return date, size, and age. [Chapter III, pp. 24 and 57-62; Chapter IV, pp. 63-65 and 69-71.1

2. If directed selection is practiced, program goals must be defined and specifically addressed. In addition, a followup assessment of the effects of the program should be conducted to assure the goals are being achieved. [Chapter III, pp. 44-57; Chapter IV, pp. 71-81.1

3. Detailed and complete records need to be taken of all stocks returning to a hatchery in order that an accurate assessment of their biological characteristics can be made. These records should be the basis for the choice of adults to be used in spawning. [Chapter IV, pp. 63-65 and 78.1

4. The location, size, and identification of natural spawning stocks in close proximity to the hatchery should be assessed. Mixing of and hatchery stocks should be avoided. If some mixing is unavoidable, determine the choices of stocks and methods of approach that are available to minimize the magnitude of genetic change. If possible, monitor the performance of the stocks after transfer to assess whether the correct decisions were made. [Chapter III, pp. 24-43; Chapter IV, pp. 61-65, 69-71, and 78-79.1

5. Where two or more stocks of the same species return to the same hatchery, separation of these stocks during the spawning and rearing cycles must be carefully followed. These stocks should also be periodically analyzed to determine if separation is being maintained satisfactorily. [Chapter III, pp. 24-43; Chapter IV, pp. 61-65. and 77-82.]

6. Hybrids between species may be accidentally created in a multispecies hatchery. Where there is an indication that a returning adult may be a hybrid, perform, or have performed tests to determine that possibility. In any event, do not spawn questionable adults. [Chapter III, pp. 24-43.]

7. In spawning channels, overcrowding should be avoided to insure that natural mating processes can occur. In addition, presorting of adult fish is not advised unless there is a grossly abnormal sex or size distribution. [Chapter III, pp. 57-62; Chapter IV, pp. 65-69.]

C. Choice of Offspring

1. Fish for planting from an individual hatchery should be derived from as many spawning adults as possible. This can be facilitated by keeping part of egg groups rather than using only total egg lots from a limited number of females. [Chapter IV, pp. 65-69.]

2. Insure that rearing conditions are as uniform as possible for all groups of fish. All groups should have an equal opportunity to express their genetic potential for growth. [Chapter III, pp. 44-57.]

3. Selection of offspring at smoltification should be discouraged until the majority of each group shows signs of smoltification. This is to balance sex-related differences in growth rate which may affect returning adult sex ratios if performed indiscriminately. [Chapter IV, pp. 71-76.]

4. Timing of smolt releases at individual hatcheries should not be determined by past hatchery history but by determination of optimal times indicated by all available biological data. [Chapter IV, pp. 63-65.]

CHAPTER I I

BASIC GENETIC PRINCIPLES

GENETICS: DEFINITION AND BASIC CONCEPTS

Genetics is the scientific study of the inheritance of and variability in the biological traits of a plant or animal. Examples of genetics can be seen in the plants and animals around us. For instance, by observing the sons and daughters of one family, we can see that they often resemble their parents. This is because the parents and their offspring have some similar genetic material; the sons and daughters inherited this from their parents.

On the other hand, the offspring do not look exactly like their parents, so they must have some genetic material that is different. Thus, there is also variability among individuals which is caused by genetic differences. Genetics involves the study of both the similarities and difference among biological organisms and the application of this information to alter the biological characteristics of many plants and animals, including fish.

A large part of the study of genetics is based on the variability in apparent traits (for example, body color, scale pattern, or eye color) among organisms and thus there is a significant emphasis on these biological traits. However, it must be remembered that the genes contained in the nucleus of each cell contain the basic "blueprint" for every characteristic of an organism and thus affect every biological trait of a plant or animal. Consequently, any trait we can see or measure is in some way a result of genetic influence. The extent of this influence may vary and change somewhat with external conditions, but there is always some genetic role.

Measurement and alteration of the genetic characteristics of fish, or any other animal is accomplished most easily when complete control can be exercised over the entire life cycle. With this control we can define the matings we want, or need to make, raise the fish under controlled conditions to remove the effects of external factors, and select the individuals with the most desirable traits to perpetuate the stock. However, when we consider management of natural resources some, or all of these controls are lost, making the assessment and use of genetic characteristics somewhat more difficult.

What must be done in the arena of resource management is to use the natural genetic constitution of the organisms with which we are concerned. In the process of evolution, natural selective forces have chosen the combination of traits that will best enable organisms to survive in their natural environment. These traits may or may not be apparent to us, but we know that unique combinations of genes develop in response to specific environmental influences. Thus, to some degree we are able to characterize a collection of organisms of the same species (or population) by their genetic differences. Since these genetic differences are transmitted between generations in a

predictable manner and we know some of the biological and physical factors that influence them we can derive important information on the population of interest. Thus, while we do not have the control that we desire on natural populations, analysis of genetically-defined traits can assist in their management and manipulation.

The characteristics of the genetic system permit us to address many problems that are faced in fisheries work. These include such areas as alteration of stocks to meet specific fishery needs, assessment of the genetic similarity or difference between populations, and catch/escapement estimates of specific groups. Thus the scope of the application of genetic principles to the management of fish resources is very broad and the potential applications are just beginning to surface.

BASIC GENETIC UNIT AND ITS METHOD OF TRANSMISSION

Before we can hope to work with ways to use genetic methods in fish management and culture, it is necessary to understand what the genetic material is, how it is transmitted, and how we can recognize genetic differences. The basic unit of importance is termed a gene and is the factor that determines a biological characteristic of a plant or animal. Structurally a gene is a linear array of chemicals in a specific order that "code" for the synthesis of other larger chemicals. The "gene code" has been determined and we are now able to "read" what the code says and even synthesize genes to make specific materials. The number of genes in an organism is probably between 2,000 and 10,000. This number varies somewhat between species, but is constant within one species.

The genes are located on larger structures, called chromosomes, within the nucleus of the cells of a plant or animal. The number of chromosomes within a species is constant, and is generally characteristic of a particular species. In most organisms almost every cell contains two of each chromosome, and thus each gene occurs in pairs. In the reproductive cells that form eggs or sperm a special process, meiosis, occurs so that each egg, or each sperm receives only one-half of the number of chromsomes found in other cells; that is, each sex cell has one member of each pair of chromsomes. Consequently, when fertilization occurs each sex cell contributes one-half of the genetic material to the embryo. This process is shown diagrammatically in Figure 1. It is important to note from this diagram that each parent contributes an equal amount of genetic material to its offspring.

If we now look at only one gene on one chromosome, we can see that it is transmitted from parent to offspring in the same way. This is shown in Figure 2. In this diagram we have shown the genes being transmitted for two generations. You can see, by comparing the genes in the offspring of the Fl and F2 generations with their respective parents. how variability and similarity can be explained in genetic terms. All of the offspring in the Fl generation and one-half of the offspring in the Fl to look different from their parents, and in the F2 one-half may look the same and one-half may look different. It must be remembered that in living organisms there are

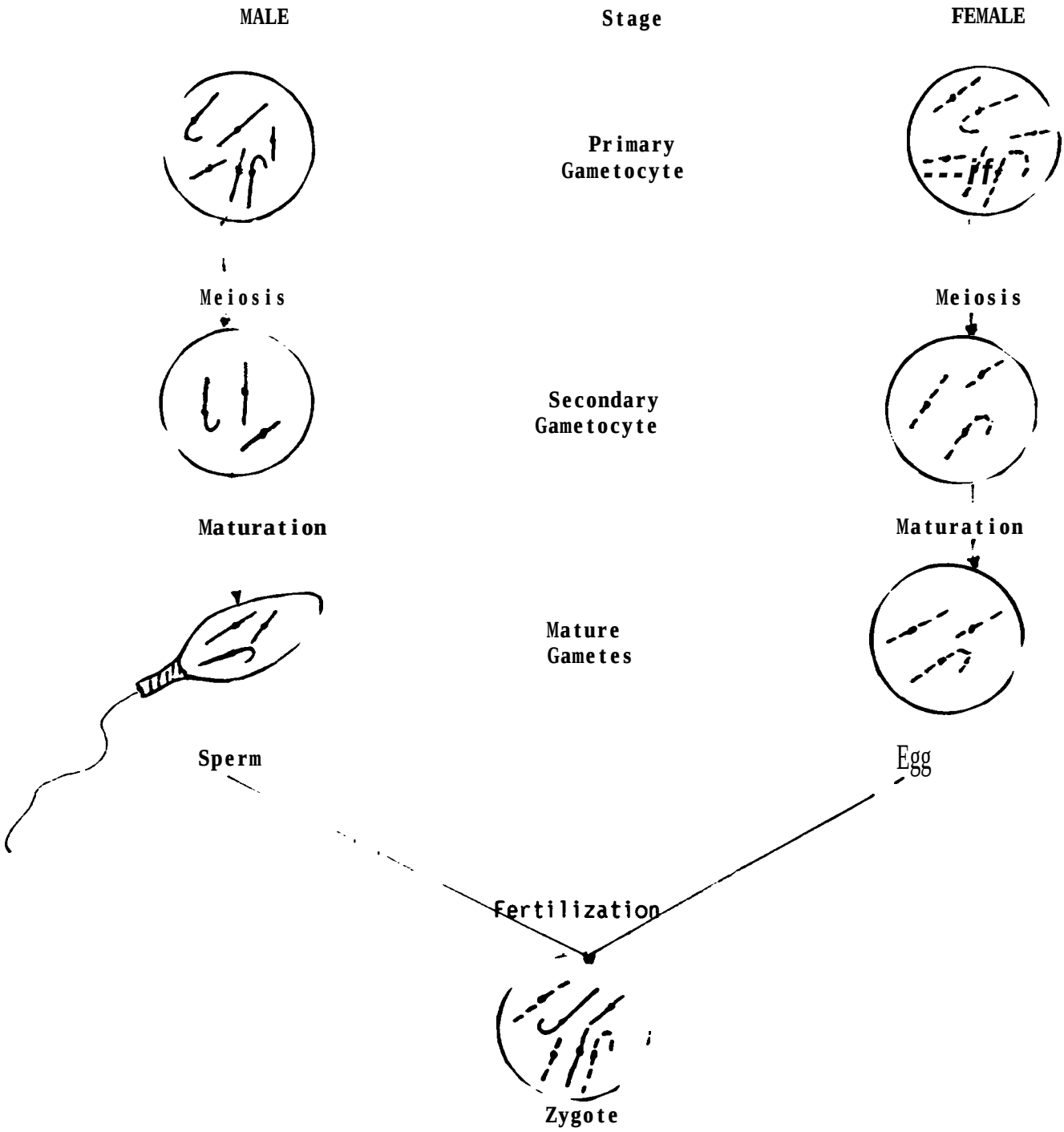


Figure 1. Sex cell formation and fertilization in an animal with three pairs of chromosomes

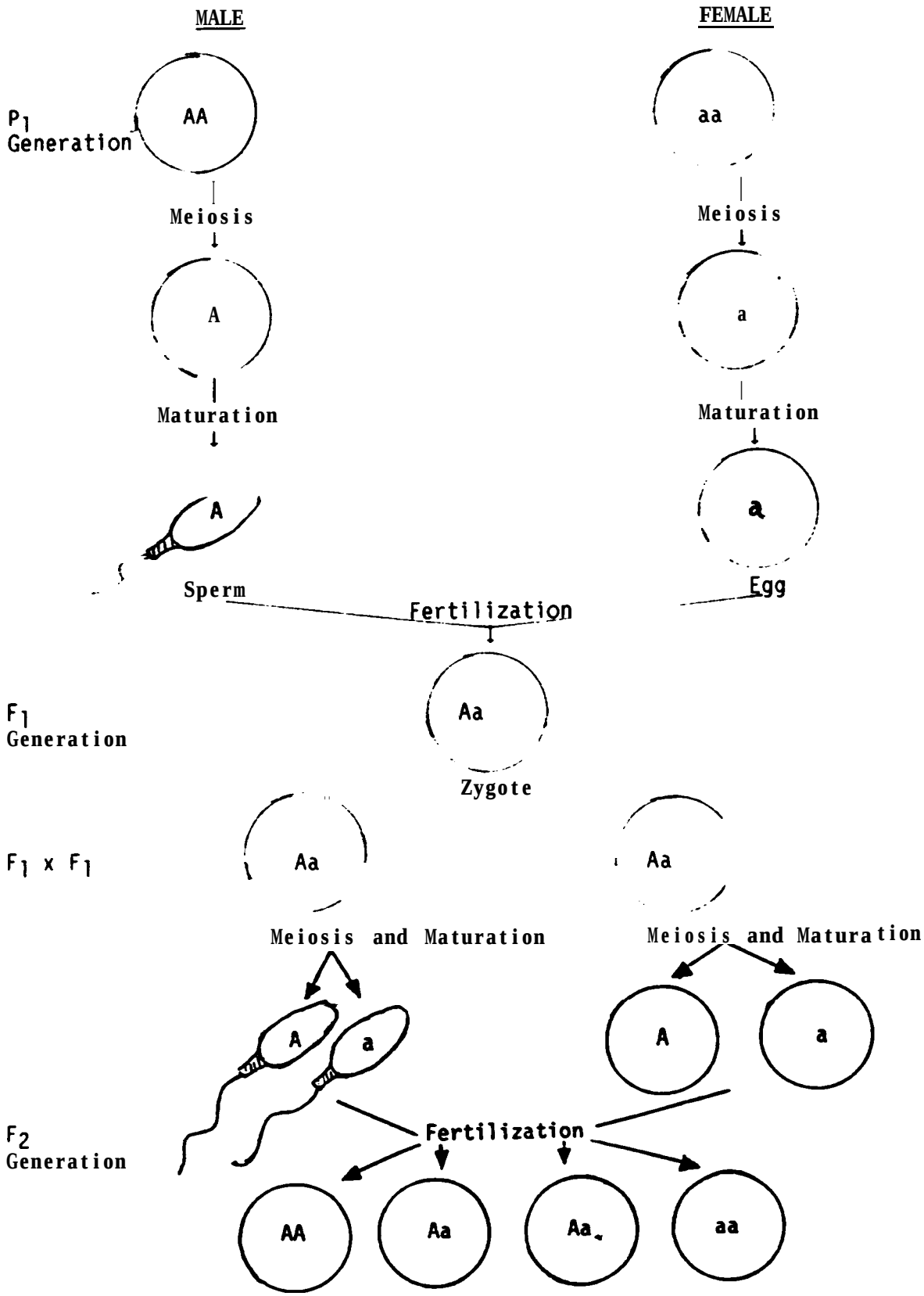


Figure 2. Sex cell formation and fertilization with one gene on one chromosome.

many more genes going through the same process, and the results may be altered somewhat from this simple example. However, this process is the only way that genes are transmitted from parent to offspring in fish, and most other animals.

One other characteristic that should be pointed out about this process is its inherent predictability. That is, every gene in a fish goes through the steps shown in Figure 2. Every egg and sperm cell contains one copy of each gene the parent contained and these combine at random to form a zygote (fertilized egg) containing a "set" of genes from the male and a "set" of genes from the female. Since these events are random, the gene expression in the offspring can be predicted and analyzed on the basis of probability. Analysis of specific crosses by use of probability predictions is the only way to unequivocally define genetic differences.

EXPRESSION OF GENES AS BIOLOGICAL TRAITS

You have seen how genes are transmitted between generations. However, in fish, or any other animal we cannot see the genes so we must rely on their expression as a change in something we can see or measure. In genetics the trait we can see or measure is called the phenotype. A few examples of some studied phenotypes in fish are shown in Table 1. The examples shown in Table 1 are only a few of the possible phenotypes that could be listed, but they show the diversity of traits that can be recognized.

Table 1. Phenotypic differences in fish with documented genetic explanations.

Phenotype	Type of expression and species in which demonstrated
Body color differences	Albino - many species of fish; blue and gold - *Cyprinus carpio*.
Scale pattern differences	Complete lack of scales (mirror); variable scale patterns (linear and scattered); normal amount and pattern (scaled) - *Cyprinus carpio*.
Fish size	Weight and length differences - many species.
Resistance to disease	Variability in resistance to furunculosis (*Salvelinus fontinalis*), IHN (*Oncorhynchus nerka*), and Vibrio (*Salmo salar*).
Smoltification	Increased percentage of smolts - *Salmo salar* and 0 *kisutch*.
Fecundity	Variation in number of eggs/female *Salmo gairdneri*.
Incubation and rearing mortality	Variation in mortality of eyed eggs and fry - *Salmo salar* and S. *gairdneri*.
Protein variation	Changes in electrophoretic migration rate of proteins - many species.

The major problem that arises in utilizing phenotype analysis is that there are other factors that also change biological traits and can result in a phenotype that does not apparently agree with the expected genotype (genetic factors that determine a trait). There are three factors that are most important in genetic work with fish.

A. The first factor is the interaction of two forms of the same gene. As you will recall from the previous section, every organism has a pair of each gene. The members of this pair could be the same, or they could be different. The genetic term for different forms of the same gene is allele. When there are two different alleles present you would expect to see or measure a change in the phenotype compared to when there are similar alleles. This is generally observed when the phenotype is measured by a electrophoresis of proteins.

A good example of this is an analysis of the "West Virginia Centennial Golden Trout" as reported by Wright (1971). These trout are a rich gold color with the rainbow stripe along their sides, but with a dark eye color which distinguishes them from the pink eyed albino rainbow. They arose from a single female and are distinct from the California golden trout (Salmo aquabonito). These golden trout were crossed with normal colored rainbow to produce an Fl generation, all of which had an intermediate color caused by an intermediate number of melanophores (bodies in the fish skin containing the pigment melanin); these fish were labeled "palomino" trout. Two Fl fish were then crossed to produce an F2 generation. The results are shown below:

	By Phenotype	By Genotype
Pl	Normal color x Golden	GG x GG'
	↓	1
	↓	
Fl	All "Palomino"	GG'
Fl x Fl	Palomino x Palomino	GG' x GG'
	↓	↓
	↓	↓
F2	93 normal; 188 palomino; 80 golden	GG: G'G:GG':G'G'
		25% 50% 25%

In this case each combination of alleles, or genotype, resulted in a different recognizable phenotype. This type of inheritance is termed incomplete dominance and can be recognized by the phenotypic ratio of 1/4:1/2:1/4 in the F2 generation.

Question #1: What phenotype ratios would you expect if you crossed (a) Golden x Palomino, or (b) Golden x Golden?

However, there are some cases where one number of an allelic pair will show a stronger expression than the other and will effectively "hide" the presence of the other. A good example of this is the albino trait shown in many fish. An example of crosses with this trait is shown below:

	By Phenotype	By Genotype
Pl	Normal color x Albino	AA x aa
	↓	1
	↓	1
Fl	All normal color	Aa
Fl x Fl	Normal color x Normal color	Aa x Aa
	↓	↓
	↓	1
F2	75% Normal color:25% Albino	AA:aA:Aa: aa
		75% 25%

In this case the normal gene (A) is dominant over the albino gene (a), which is said to be recessive. Thus, in some cases a normal colored fish would have only normal genes (AA) and is termed homozygous (like alleles); in other cases there may be one normal and one albino gene (Aa), which is termed heterozygous (unlike alleles). In order to eliminate a possible error in genotype classification further crosses must be performed and analyzed.

Question #2: What crosses would need to be made to find which F2 offspring possessed the two different alleles? What results would you expect?

B. The second factor is the interaction of different genes. Every fish has many genes, and in some cases more than one pair of genes will affect a single phenotype. Probably the best studied example of this in fish is the different scale patterns found in common carp (Cyprinus carpio). Four common types of scale pattern are shown below, with the genes that determine the different phenotypes.

Scale Pattern	Phenotype	Genotype
Scaled	Body normally covered with scales	SSnn, Ssnn (Must have one S and both nn)
Scattered	One row of scales under dorsal fin; few scales scattered on rest of body	ssnn (Must have ss and nn)
Linear	One row of scales under dorsal fin; one row of scales on lateral line	SSNn, SsNn (Must have one S and one N)
Leather	No scales on body	ssNn (Must have ss and one N)

Thus, or definition of scale pattern in carp two genes must be present in a specific combination to yield a certain phenotype. For example, the scaled pattern is expressed when there is one "S" gene and two "n" genes. If we change one "n" gene to "N" (or recessive n to dominant N), the pattern (phenotype) is changed to linear. Without analyzing the crosses between the various phenotypes, the number of genes determining this trait could be misinterpreted and lead to errors in future work.

Question #3: What phenotypes would you expect if you crossed a scattered scaled carp (ssnn) by a linear scaled carp (SsNn)?

C. The final factor is one we are all familiar with and is perhaps the most difficult to handle. Everyone is aware that the size of a fish can be greatly affected by conditions in rearing such as food supply, stocking density, temperature, and oxygen content of the water. In addition to these, there are genes which can alter the size. Thus it follows that there is some interaction of genes and the environment. A good example is work done by Edwards and his co-workers (1977) on rainbow trout. In this work 10 families were each fed diets with different carbohydrate levels and the fish were measured after 24 weeks. The results are shown in Table 2. Within the families tested, the genes determining growth are basically the same. However, because of the different environmental conditions (different diets) the expression of the genes is altered. This is shown by a change in growth performance rank of a particular family among the various diets. The phenotype we can measure (growth in this case) is a result of the interaction of the genes and the environment in which the genes are expressed. How these two effects are separated for further use will be discussed in a later section. Without a knowledge of the types of crosses that were made in this work, it would be easy to interpret the differences as begin genetically determined even though this is not the entire explanation.

With all three of these factors acting in the expression of genes, how can you decide whether an observed biological difference is due to genetic variability or other factors? The only way to get this information is to make the appropriate crosses and analyze the offspring that are produced. The types of crosses that are necessary depend on the traits you are interested in and could possibly involve several generations of analysis. However, the most important condition that must be met is that the biological characteristic must be passed on to subsequent generations in a predictable way.

Table 2. Mean weight gain (gm) of rainbow trout in each of 10 families after 24 weeks on three diets containing different proportions of their metabolizable energy as carbohydrate. Families are also ranked in order of growth performance (1 = best, 10 = poorest growth).

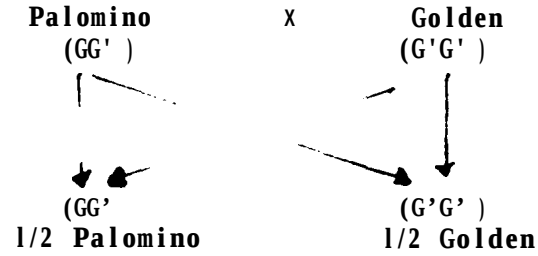
	17% Carbohydrate diet		25% Carbohydrate diet		38% Carbohydrate diet		Mean	
Family	Weight gain	Rank	Weight gain	Rank	Weight gain	Rank	Weight gain	Rank
a	169	10	120	10	87	10	125	10
b	211	9	174	9	147	4	177	9
C	226	5	189	8	141	8	185	8
d	219	7	205	6	147	4	190	7
e	219	7	217	4	138	9	191	6
f	236	3	237	2	142	6	205	3
g	238	2	234	3	158	2	210	2
h	231	4	206	5	142	6	193	5
i	253	1	198	7	150	3	200	4
j	223	6	267	1	174	1	221	1
Mean	223		205		143		190	

Answer to Questions

Question #l.

a. Based on the crosses performed so far, we know that golden trout have the genotype GG'and palomino trout have the genotype GG' If we make a cross with these two types of trout, the offspring will get one gene from each parent. Consequently, there are two

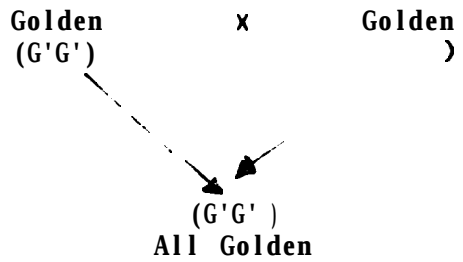
type (genotypically) of offspring possible from this cross, GG'and G'G'. Diagrammatically the cross would be:



Therefore, the offspring would be of two phenotypes, palomino and golden. To calculate the ratio of each type we need to look at how the parents' genes will be distributed among the offspring. The golden parent has only G' genes and thus will transmit this type of gene to every offspring. On the other hand, the palomino parent has to types of genes, G and G', in equal proportions (l/2 of each). Thus, l/2 the offspring will et the G gene and l/2 the G" gene. The result of combining these two will be that l/2 the offspring have a genotype G'G' (golden). Thus, the expected phenotypic ratio will be l/2 palomino and l/2 golden.

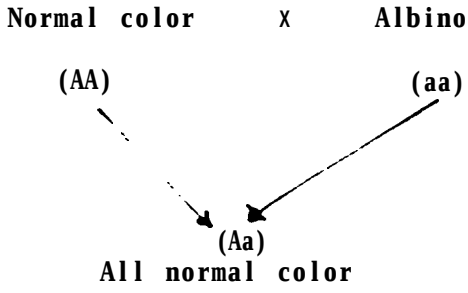
The general probability rule that is used in genetics to calculate these estimates is the "probability of independent events." This rule states that the probability of two independent events occurring together is the product of their separate probabilities. This rule is commonly used in calculating the "odds" in gambling situations. In this cross, the probability that an offspring will receive a G' gene from the golden parent is 1.0 since the G' is the only type this parent contains. The probability that an offspring will receive a G' gene from the palomino parent is l/2 since there are tow types of genes present. Thus, the probability that an offspring will G'G' (golden) is 1 x l/2 = l/2. The same reasoning is used to calculate the probability of an offspring being palomino (GG' . From this we can say we expect l/2 the offspring to be golden and l/2 to be palomino.

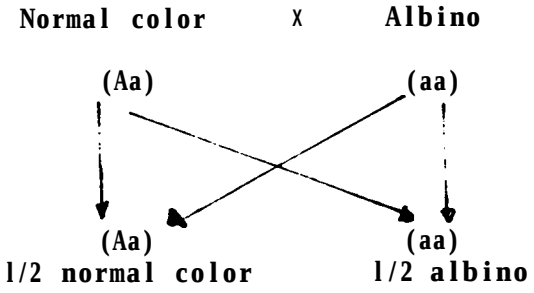
b. If two individuals that are pheotypcially golden are crossed, we would expect that all (100 percent) of the offspring would be golden. The only genes that either parent has to transmit to its offspring are G' genes. Thus, unless another male "sneaks" in the the only type of offspring possible for this trait is golden. Diagrammatically the cross is:



Question #2.

Phenotyp ically 75 percent of the F2 will have a normal body color, but some of these will have homozygous AA genotypes and some will have heterozygous Aa genotypes. What we need to do is to find some way of determining which normal phenotypes contain the recessive (a) gene and which do not. This can be done by "test crossing" with a salmon that transmits only recessive genes for this trait and thus will not "hide" the genes transmitted by the salmon in question. Consequently, what needs to be done is to cross normal colored individuals from the F2 with albino (aa) individuals and analyze the offspring they produce. The results expected would be as follows:



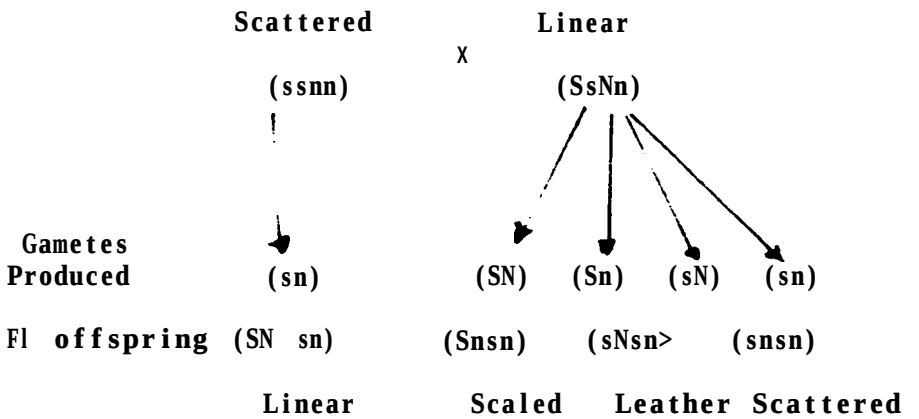


By analyzing the body color of the offspring produced from different crosses you can determine whether the parent salmon was homozygous (AA) for body color genes or heterozygous (Aa) for body color genes. Those that were homozygous parents will yield 50 percent normal color and 50 percent albino.

Question #3.

This question is a little different from the previous two in that two different genes, each with two alleles are involved rather than just one gene with two alleles. The basic approach to the analysis is the same, except you have to remember each gene must be represented in the egg and sperm cells produced. Since combining of different genes is a random event (with some exceptions), the gametes produced will

contain all combinations of the alleles of the two genes. The cross of scattered x linear scaled carp can be shown diagrammatically as follows:



You can see that the linear scaled carp will produce four different egg or sperm cells based on the various combinations of different genes. Only one type can be produced by the scattered carp. After random combination during fertilization, you would expect offspring of all four types of scale pattern differences.

CHAPTER I I I

MEASUREMENT AND ANALYSIS OF GENETIC VARIABILITY

Since genes have some influence on every biological trait in an organism, a genetic analysis could be performed on any characteristic you want to choose. This could range from run timing to the length of the fish or the number of chromosomes a fish has. However, there are some practical limitations to your choice that must be considered. The first of these is whether there is sufficient variability in the measurement you are making. A genetic study can only be conducted when there is variation in the trait. Second, the reasonable limitations of the measurement you are taking must be considered. If the differences among the variants are so small that no realistic progress will be realized, or the measurement is so complex that unreasonable effort is considered. Finally, and perhaps most importantly is a consideration of whether the analysis will provide answers to the questions that are being asked. Each trait and each type of genetic analysis will provide only a limited amount of information; if the information obtained does not address the question you are asking then other systems must be used. This area will be addressed more specifically as we consider the different types of analyses that can be used with fish.

There have been primarily three types of genetic analyses utilized in fisheries. These include cytogenetic analysis (chromosome work). singe gene analysis (mainly electrophoretic analysis), and quantitative analysis (work with traits such as growth, survival, migration timing, etc.). With the development of many new types of techniques, particularly molecular biology, this list will undoubtedly grow as we learn how to apply them to fish. However, since most work in the near future will of necessity be based on the techniques we have available now, these will be emphasized. In this chapter we will cover briefly the basic theory and methodology for each type of analysis and describe the type of information each provides.

Chromosomal Analysis--Cytogenetic and Cytotaxonomic Analyses

Compared to the work in other animals, chromosomal analysis in fish is at a rather primitive stage. The procedures currently applicable to the preparation of fish chromosome spreads are still crude compared to those in other animals, which limits the amount of information that can be obtained from a set of analyses. Part of the problem is due to the difficulty in working with chromosomes in fishes. Application of techniques developed for mammalian cytology has improved the consistency of getting good preparations with fish tissue. In general, fish chromosomes are smaller than chromosomes in other vertebrates, and the species of major interest in the Pacific Northwest (those of the family Salmonidae) are in a group of fishes characterized by a large number of chromosomes. For example, listed on the next pages are the diploid chromosome numbers for some of the salmonids that are dealt with in this area.

Common Name	Species	Diploid (2N) number
Chum salmon	Oncorhynchus keta	74
Chinook salmon	Oncorhynchus tshawytscha	68
Coho salmon	Oncorhynchus kisutch	60
Sockeye salmon	Oncorhynchus nerka	58
Pink salmon	Oncorhynchus gorbuscha	52
Rainbow trout	Salmo gairdneri	60
Coastal cutthroat	Salmo clarki clarki (coastal)	70
Interior cutthroat	Salmo clarki lewisi (interior)	64
Atlantic salmon	Salmo salar	58
Brook trout	Salvelinus fontinalis	84
Dolly Varden	Salvelinus malma	82

Because of the problems in working with fish chromosomes, analyses include mostly counting the number of chromosomes and defining their physical characteristics. This is sufficient to provide a significant amount of information because for the most part the number of chromosomes and their physical structure are constant for a given species of plant or animal. Since chromosomes are the principal carries of genetic information. via their DNA (deoxyribonucleic acid, the major chemical constituent are generally accompanied by severe and often lethal biological changes. Thus, constant number and physical integrity of chromosomes are necessary for the continuation of the species.

Basic Methodology

Before going further with a discussion of what chromosome analysis will provide in the way of biological information, let us examine how chromosomes are analyzed. Chromosomes are found only in the structure of the cell called the nucleus. In the normal functioning cell nucleus it would be impossible to recognize individual chromosomes. These nuclear constituents are normally in thin strands and look basically like what would result if you gave a l-year old child a ball of yarn to play with. During cell division a series of processor occur which cause the chromosomes to condense and become recognizable as individual structures. The total process is termed mitosis, and is the method by which each cell reproduces an exact copy of itself. The steps in this process are shown in Figure 3.

In the process of mitosis there is one stage (metaphase) where the chromosomes are maximally condensed and, in addition, they are aligned in a two-dimensional array on the equatorial plane of the nucleus. This provides a double advantage for analysis: (1) the chromosomes are in a physical state where they are distinct units that can be visualized, and (2) they are arrayed on a plane so we can use a microscope to see them without too much difficulty.

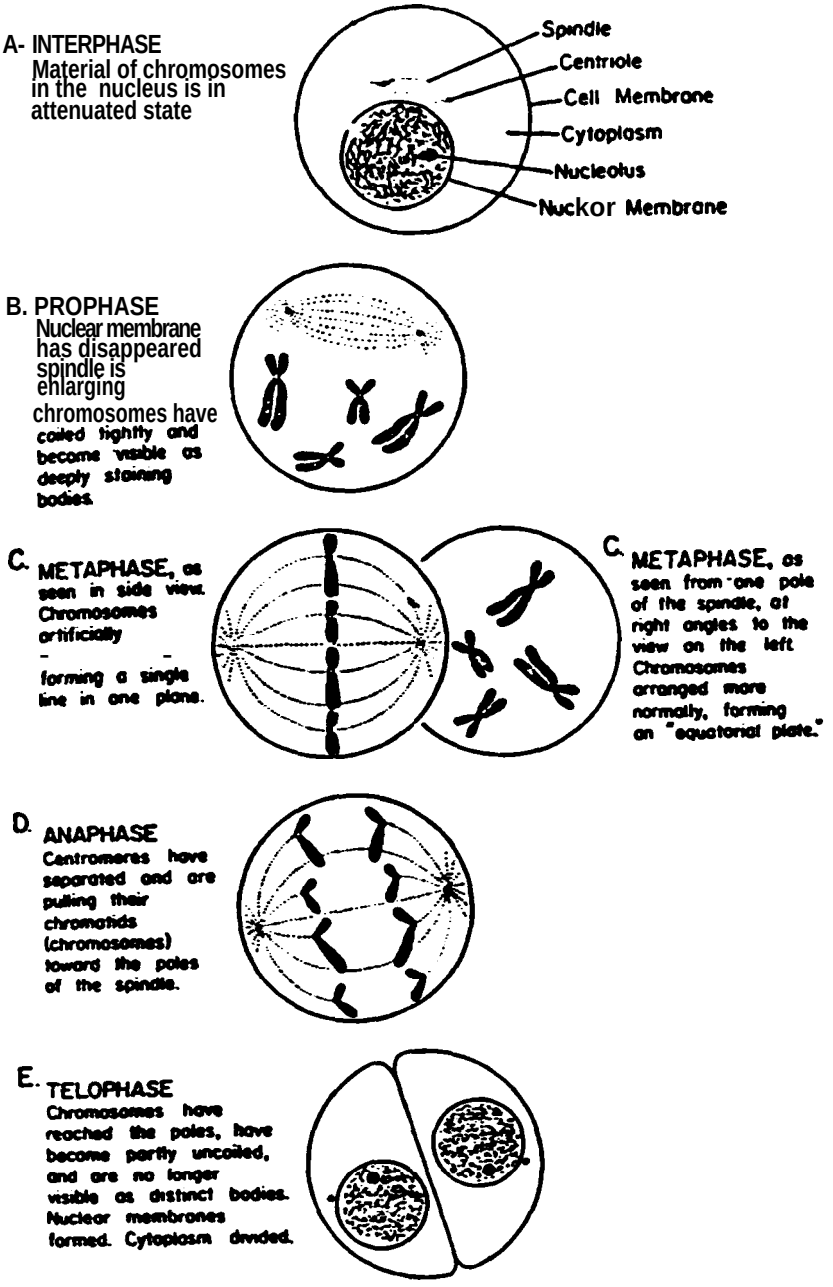


Figure 3. The major phases of mitosis. From Moody (1975).

Consequently, the basic procedure to obtain chromosome preparations for analysis consists of treating a rapidly dividing tissue (e.g., gill filaments, anterior kidney, regenerating fins, or cultured cells) with a chemical to stop mitosis at the metaphase stage. The cells are then treated to facilitate chromosome analysis, stained with a DNA-specific stain, applied to slides, and observed under a microscope. More details on specific procedures can be obtained from Denton (1973). If the procedure is correctly conducted, you should observe something similar to what is shown in Figure 4.

You are probably wondering what genetic information this group of darkly stained bodies will provide. First, the number of chromosomes within a species of fish is constant (some of them are given on pages and). Thus, counting the number of chromosomes in a small group of fry whose species you cannot otherwise identify will provide a positive identification. Along with this, hybrids between two species can be determined by chromosome analysis. A hybrid should have a chromosome count intermediate between the two parents. For example, (2N = 60) salmon, any hybrids between these two species (they have been known to occur in some hatcheries) should have diploid numbers of 64. This type of analysis gives you unquestionable data concerning hybridization.

Recent research with rainbow and steelhead trout has shown that some variation in chromosome numbers occurs within this species. For example, Thorgaard (1977). demonstrated that steelhead trout had chromosome counts that varied between 58 and 64; further, the number seemed to be characteristic for a specific population. For instance, Quinault River winter steelhead had 2N = 58 while those from the Cowlitz River had 2N = 59 and 2N = 60. Thus, chromosome numbers could possible be used to identify certain stocks of steelhead. Additionally, Thorgaard demonstrated differences in chromosomes between the two sexes (sex chromosomes) in rainbow trout and sockeye salmon. Consequently, chromosome analysis could be used to identify the sex of very young fish and provide a way of assessing the relative performance of the two sexes in the hatchery or in the natural environment.

Finally, missing chromosomes or pieces of chromosomes have been shown to have very strong pathological effects in humans and other animals. If we conduct karyotypic analyses (pairing of like chromosomes according to physical characteristics), as shown in Figure 5, we may be able to identify gross genetic problems in a population and eliminate the fish which carry these abnormalities.

The major problems with this type of analysis are the time it take for the analysis (optimistically about 2 1/2 days of hard work for a few fish), and the special skills and equipment it requires. However, chromosome analysis does provide information that is not readily available by other means.

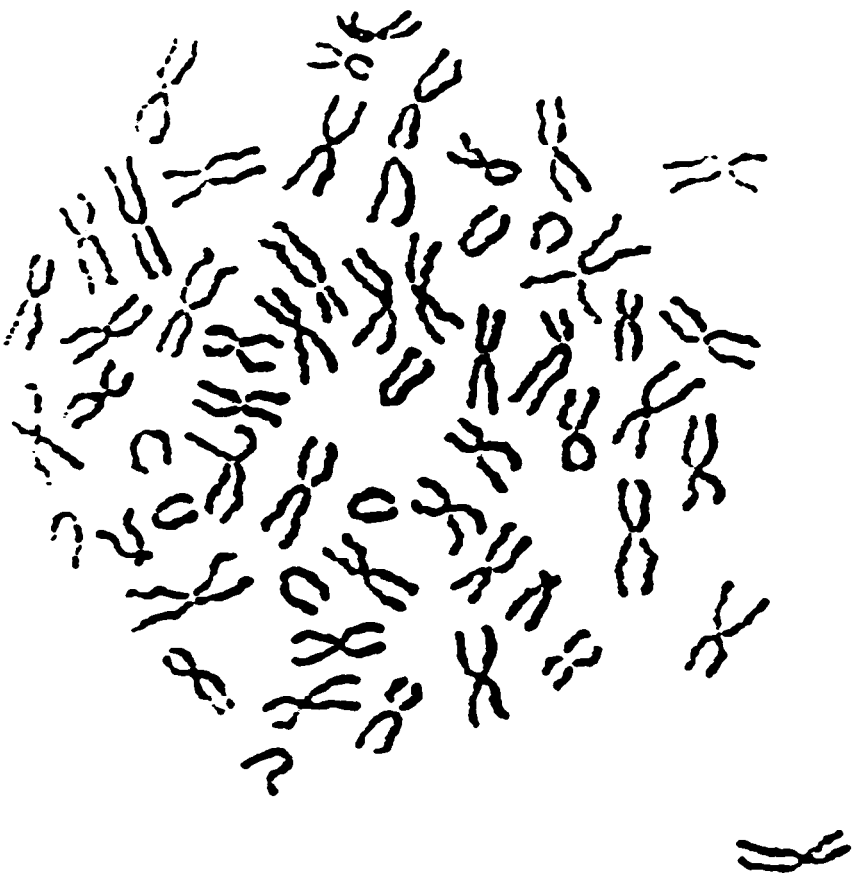


Figure 4. Metaphase spread from a winter fun steelhead female from the Cowlitz River population. This cell was obtained by white blood cell culture and shows a diploid (2N) chromosome number of 58. From Thorgaard (1977).

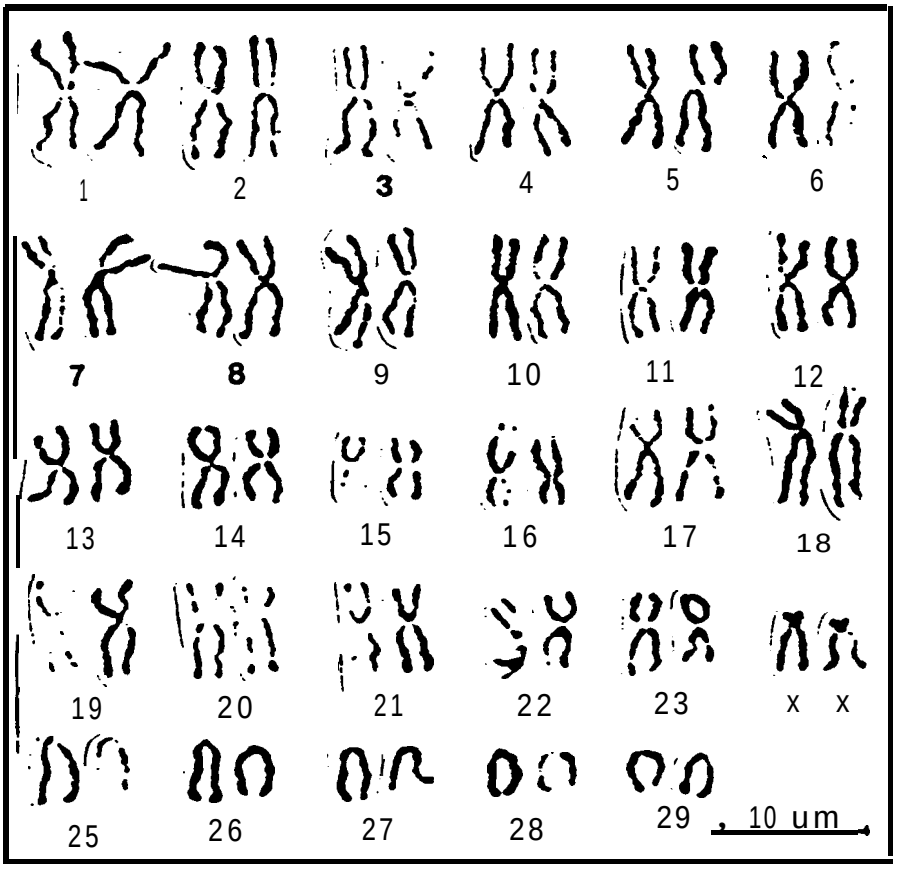


Figure 5. Karyotype of a metaphase spread from a winter run steelhead female. The diploid (2N) chromosome number = 56. From Thorgaard (1977).

Single Gene Analysis

Examination of the various areas encompassed by the science of genetics will reveal that most of the theory is based on the behavior of single genes. In fact, the major impetus for the advancement of genetics was the realization that genetic differences were caused by single, discrete units. Also, the analysis of single genes has had a very important role in solving a number of fisheries-related problems. For example, single genes may be used to identify and characterize different stocks. By using single genes as a natural "mark" we can differentiate stocks and follow what they do for several generations, since these differences are passed on to the young by reproduction (spawning). Consequently, it is important to recognize biological differences caused by single genes and learn how they are analyzed to provide information on fish populations.

There is no definite rule on what type of biological trait will show single gene differences more than others. In actuality every trait is affected by single gene variation. Some are just more apparent than others. The traits we work with on a single gene basis are generally those we can easily see and analyze. A good example of this is albinism in trout or salmon. The presence of two doses of the albino gene in a fish results in a complete lack of black pigmentation and we can easily see such fish. Wore detailed analysis of the albino gene has shown a decreased growth rate and a change in the biochemistry of the fish. However, the way we analyze this trait is by looking at the body color to determine whether the albino gene is present or not. A quick look through the genetics literature shows that a large part of single gene analysis is on apparent body or eye color changes.

Not many of these types of differences have been found and used in studies on salmon and trout. The reason is that a difference that we can easily see is also very apparent to other animals, and fish with these traits do not survive long enough to transmit their genes to the next generation. However, in tropical fish where external color is beneficial, or in cultured stocks where color is not so important for survival, we have found that most of this variation can be explained by one ore relatively few gene differences. Some of these are listed in Table 1.

For salmon and trout, we have had to resort to other analyses to identify differences due to single genes. Early work in this area involved analyzing blood types in fish. Blood types have been shown to be due to single gene differences in humans and many other animals. Application of this analysis with salmon and trout demonstrated the presence of blood types similar to those found in other animals. However, the analytical procedures involved in defining this trait were too difficult for routine work, necessitating a search for other methods of analysis.

The electrophoretic separation of proteins was the technique found to be most useful. It is currently the one most prevalently used in fisheries. Without going into detail, this procedure allows us to separate and identify physical differences in proteins. Some of the reasons for using electrophoresis are

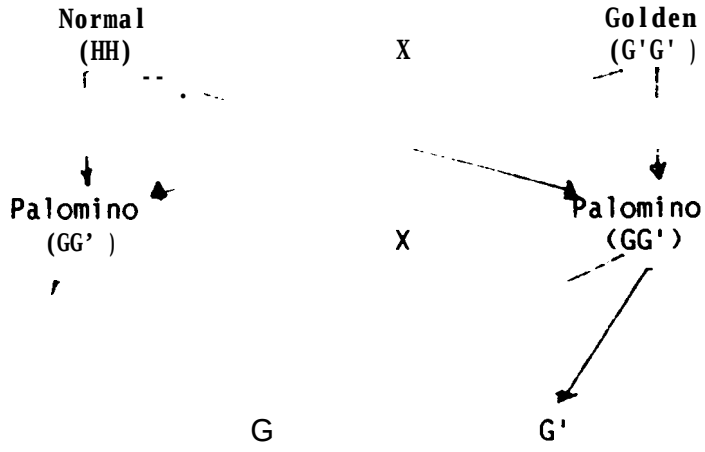
that (1) it "uncovers" many genetic differences that cannot be seen or analyzed by other methods; (2) it is a rapid, easy method of analysis, and (3) it allows a direct assessment of single gene differences. If you would like more detail on the procedures and methods of analysis for electrophoresis, May (1975) is an excellent resource.

Once we can identify single gene differences in fish, what analyses can be conducted and what information can this give us about the fish being reared? There are two levels of analysis that are used with single genes. The first is the study of how the differences are transmitted between generations, i.e., how the genetic variation is inherited. The analysis is performed by simply crossing a male and a female fish and analyzing the offspring they produce. The number of generations required and the details of determining the gene differences will vary with the trait being analyzed, but the basic approach is always the same. In fact, this type of approach is central to all genetic analysis.

To illustrate how cross analysis is used for single genes, we will examine a body color difference in rainbow trout reported by Wright (1973). He found three color types in the hatchery strains of rainbow trout he was working with: (1) Normal-colored; (2 golden (very light color like an albino, but with black pigment in the eyes); and (3) an intermediate color (much lighter than the normal color, but darker than the golden). This last group was labled “palomino" because of its similarity to the color types in horses. In addition to the unique color, the palomino trout exhibited a more rapid growth rate than the other types and would thus make a good "novelty" fish for certain programs. However, a knowledge of how this trait is transmitted to the next generation (inherited) is needed before it can be used in breeding.

An analysis of these body color traits was conducted by first crossing a normal-colored fish with a golden fish. The first generation offspring (Fl) were all intermediate in color, or palomino. These palomino fish were then crossed (one male x one female) to produce a second or F2 generation. When the offspring from several of these crosses were counted according to body color, the results were approximately l/4 normal color, l/2 palomino, and 1/4 golden. In one family where 361 offspring were counted, 93 were normal color, 188 were palomino, and 80 were golden. These observed values are very close to what would be expected if the l/4 : l/3 : l/4 ratio were exactly met (90 : 180 : 90, based on a total of 360). The crosses are shown diagrammatically in Figure 6.

What this tells us about the inheritance of the palomino color is that only one gene determines this color difference and it is caused by a combination of the allele for normal color (G) and the golden allele (G')--in genetics language there is a lack of dominance. In addition, there are several concepts basic to understanding genetics that can be pointed out with this example. First, in the parents (normal and gold) the phenotypes were caused by each fish possessing two alleles of



	G	G'
G	Normal (GG)	Palomino (GG')
G'	Palomino (GG')	Golden (G'G')

Figure 6. Inheritance of palomino and golden colors in rainbow trout. Proposed genotypes are shown in parentheses below the phenotypes.

the same type (homozygous). When these were crossed (normal x gold), each contributed one gene to the offspring, making them all heterozyqous (two alleles of different types). In the next generation the same thing happens, except that now the parents each have different alleles (one normal and one gold). These are distributed equally in the sex cells and combine randomly to produce the offspring. With this situation we can predict the types of offspring that should result and test statistically what is actually observed.

Second, you will notice that it takes two generations of crosses to determine what the actual inheritance of the genetic differences is. With this example we have the advantage of hindsight and can associate the right combination of genes with the observed phenotypes. But if only the phenotypes were available, not much analysis would be done until the different phenotypes in the F2 generation were counted.

Finally, this type of analysis can be used for more than one gene at a time. As long as the expression of each gene can be recognized, the analysis is simply a summation of the separate traits. Sometimes there are interactions among genes or alleles that can yield seemingly different results. However, the interpretations all based on the same system of gene transmission. In fact, if you can visualize this process occurring with the 20,000 or so genes that a salmon contains, you have the basis for the entire explanation for biological differences in the salmon species.

At this point you are probably wondering what all this had to do with practical problems in fish culture. In large part this type of specific analysis will probably never be used in production culture situations. However, all the crosses you perform yield these results many times over. This method of gene transmission in central to all other levels of analysis: This is the only way gene differences and similarities are carried from one generation to the next! Thus, this is the method by which the biological system is continued.

The second level of analysis in which we can use single gene differences is the study of populations. If we could sample a group of fish from one hatchery for all the genetic variability they contain, what would we be likely to see? First, there would probably be no two fish exactly alike. There would be a great variety of genes and combinations of these genes. The second thing we would find, if we repeated this analysis in the next generation and counted the different genes in both cases, the same percentages would occur in each instance. This is because a population needs a specific array of genes to exist in the environment in which it is found. Clearly, we are unable to conduct such analyses, but we can analyze a small sample of the genes in a population and get the results indicated above.

One thing this characteristic allows us to do is identify populations on the basis of the genes they contain. Many State hatcheries have already contributed to this type of analysis by donating 200 or more fish for electrophoresis. The objective was to characterize each stock by the distribution of the single gene differences it contained. To illustrate, suppose the coho salmon in hatchery "I" area analyzed and found to have three genes (A, B, and C) in the following percentages:

A - 70 percent
B - 20 percent
C - 10 percent

If we analyze this same stock for 20 years, we should get these same results. On the other hand, if there is a change in these numbers, it is an indicator that something in the environment or in the handling of the fish has changed. For example, if the number of adults used in spawning is decreased dramatically (e.g.. from 2,000 to 200), there will probably be a big change in the percentage distributions of the three genes. We cannot definitely say

whether the change in the gene distribution will be good or bad for the stock because in most instances we do not know how the genes affect the biology of the fish. Generally, however, changes in the direction of decreased genetic variation (for example, complete loss of the C gene) results in negative effects on such traits as fecundity, growth, and survival. This is the same in some ways as what is obtained from too much inbreeding.

To take this illustration a little further, suppose we do the same analysis on coho salmon from hatchery "II." which is physically located near hatchery "I" and whose fish are caught in the same fishery. The results from this second hatchery are:

A - 20 percent
B- 5 percent
C - 75 percent

The results will not allow us to analyze individual fish and determine whether they are from one hatchery or the other, since the genetic variants are the same (all A, B, or C). However, a change in the percentages in either hatchery may be a result of mixing of the two hatchery stocks since the frequencies are quite different. For example, if the frequency of C started to increase in hatchery "I," this could be due to some straying of fish from hatchery "II."

The same type of analysis can be used in the situation where two, or more different stocks of the same species are maintained in the same hatchery, for example the Cowlitz and Toutle coho stocks at the Wahougal Hatchery. In this case, the two stocks are fairly well separated in run timing, but some overlap does occur, providing the potential for crossing between the stocks. By determination of single gene differences between the two stocks and subsequent analysis of the fish in each generation, an assessment can be made whether the stocks are being kept as separate groups or inadvertently mixed. Mixing will be indicated by changes in the alleles each group contains or changes in the gene frequencies of one group or the other. The value of conducting this assessment is that mistakes in crossing can be corrected, or remedial measures taken before the integrity of the two stocks is completely lost.

The other area where these results can be very useful is in determining the contribution of each hatchery to a common fishery. To exemplify, suppose we sampled the fishery and analyzed the fish for the genes mentioned above and obtained a frequency for the C gene of 40 percent. If the two hatchery populations are the only ones to contribute to this fishery, we can answer the question of how much each provides to the catch. The general relationship is as follows:

$$F_m = p_I + (1 - P_I)F_{II}$$

where Fm = gene frequency in the mixture (fishery)

F_I = gene frequency in hatchery "I" stock

F_{II} = gene frequency in hatchery "II" stock

P_I = proportion in population "I"

1 - PI = proportion in population "II"

Substituting our values, we obtain:

$$0.40 = p_I(0.10) + (1-p_I)\ (0.75)$$

$$0.40 = 0.10\ p_I + 0.75 - 0.75\ p_I$$

$$0.65\ p_I = 0.35$$

$$PI = 0.54 \qquad 1-p_I = 0.46$$

Thus, in this sample, 54 percent of the fish are from hatchery "I" and 46 percent are from hatchery "II."

This is a simple, and probably unrealistic example, but it illustrates one of the values of single genes as markers when they are analyzed in mixtures of fish from different populations with different gene frequencies. The mixtures can be assessed by use of a simple summation of the gene frequencies times the proportion of each group. It is the same result you would expect from a classical mark and recapture study. As we find more gene differences we will be able to analyze more complex mixtures. In the near future the role your fish play in the ocean or net fishery may soon be outlined by use of this method.

There is one major and very important difference between the single gene marks and those we apply by fin clip, brand, or coded-wire tagging. The single gene differences are part of the biology of the fish and will not be lost after one generation. Furthermore, we know how these genes are transmitted from parents to offspring and can use this to determine what fish spawn together by analyzing the fry they produce. To illustrate this, suppose that fish from hatchery "I" are programned to be planted into a stream to enhance an already existing, but marginally producing population of coho. To solve this problem you need to know how many of the fish from the hatchery will return and spawn to improve the production. The native population is analyzed and found to contain only the B and C genes. Thus, you only spawn adults in hatchery "I" that contain the A gene (in genetic language they are homozygous AA types). This will produce smolts for planting that contain only the A gene. When these fish return as adults to the stream in which they are planted, any

offspring they produce by spawning will contain the A gene. Diagrammatically, the result may look something like the following:

	Native Fish	"Planted" Hatchery Fish
Adult Genotypes	BB, CC, BC	AA
Genes Present in Eggs and Sperm	B and C	A
Genotypes in Offspring	BC, BB, CC	AB, AC, AA
	Produced by Native Fish	Produced by Hatchery Fish and Crossing of Hatchery X Native Fish

Thus, by knowing the genes the hatchery fish contain and those in the naturally producing fish, we can determine if there is a contribution to the next generation by the planted group. With some knowledge of numbers of each type it is also possible to estimate the amount of contribution. This illustration is similar to work being done on steelhead by the WDG at the Kalama Hatchery. A similar approach has also been used in chum salmon management, and several hatcheries have contributed to this effort. Another use of single gene differences is the estimation of the genetic similarity of two or more stocks of salmon. Perhaps this does not seem too important to you at first glance. However, if you consider that the genetic composition is the basis for the successful biological functioning of any animal, then it would seem important to determine how much genetic similarity exists between stocks that are being put together in a hatchery. For this analysis we need data on as many single genes as we can measure and a computer to provide the analysis. Consequently, the procedure will not be illustrated, but the basic idea is that the more similar the various single gene differences, the more closely related the groups analyzed.

To summarize the use of single gene differences, presently the broadest application of this level of genetic variability is with the study of stocks and the determination of how they behave and are related. However, these gene differences can be used to mark hatchery stocks to enable assessment of how they contribute to the fishery and to spawning populations. Analysis of single gene differences by electrophoretic separation of proteins provides a fairly rapid assessment of a large amount of genetic information and gives a good cross-section of genetic variation.

Analysis of Quantitative Traits

So far in this chapter on genetic techniques. we have discussed some diverse topics ranging from chromosome analysis to the detection and analysis of

single gene variation. These areas of investigation share one common virtue--that is, they all have fairly simple and obvious genetic explanations. For example, albinism in rainbow trout and scale characteristics of the common carp are defined by one, or at most, a few genes. Regardless of which form of a particular trait is expressed, the genetics explanation is clear cut or at least definable after the suitable crosses are made. If all traits behaved similarly, life for geneticists and hatchery managers alike would certainly be idyllic.

Unfortunately, most traits of importance in fish culture cannot be defined in terms of a few genes. We cannot, for example, increase the growth of hatchery-reared sockeye by selecting for gene "A" or its alternate form, "a," or decrease susceptibility to cold water disease by eliminating one aberrant chromosome from the chromosomal complement of a stock of chinook. The point we wish to make here is that most traits we deal with in hatcheries are controlled by many genes with each gene having a small but still significant role in the ultimate expression of the trait. Because of the larger number of genes involved, it is virtually impossible to isolate the influence of single genes and define their relative importance. A list of traits controlled by many genes could be almost endless, encompassing the physically apparent ones such as length, weight, feed conversion efficiency, fecundity, egg viability and egg size, as well as those such as circulating plasma throxine levels and rate of deposition of yolk material in a developing egg which require complicate physiological measurements.

Over the thousands of years that man has been domesticating and breeding wild animals, the importance of such traits has not gone unnoticed. It is a vital part of human nature to improve the status quo regardless of whether the objective is fleece quality in sheep or shank length in turkeys. In the crudest form, these attempts at improvement resemble what is commonly referred to as "barnyard selection." In its most sophisticated form it is referred to as systematic selective breeding, and is largely based on research within the past 50 years. A significant part of genetics research has been developed around the study and improvement of these traits. Because these traits require numerical measurements and statistical analysis, the field of inquiry has been labeled quantitative genetics.

To reiterate, quantitative genetics involves the study and characterization of traits controlled by many genes acting in concert. Analysis of quantitative traits requires numerical description. The essential requirements are therefore that variation be present and that this variation can be measured either at the physical or physiological level.

Two fundamental genetic concepts are involved with quantitative traits in conjunction with the idea of many genes with small effects. The first is that relatives tend to resemble each other, and the closer the relationship, the closer the resemblance. The resemblance between parents and their offspring may be described as the basis of selective breeding. Regardless of the methods used, the ultimate goal is to improve the performance of subsequent generations by judiciously selecting the individuals contributing the eggs and

sperm for those generations. The "better" the quality of individuals used in the parental generations, the higher our expectations that their progeny perform as desired. One of the aims in quantitative genetics is therefore to describe how the degree of resemblance between different sorts of relatives can be used to predict the effects of selection and also to develop the methods to efficiently do this.

The second concept is that control over quantitative traits is not completely genetic in origin. This can be best illustrated by the following relationship:

Phenotype (P) = Genotype (G) + Environment (E)

The phenotype is the measurement made and has actual dimensions such as 100 mm fork length, 10 g body weight, 3000 eggs per female. The genotype component is comprised of all genetic factors affecting the trait, and the environment includes all nongenetic influences. In terms of fish husbandry, the environmental component can be described by rearing temperature, static and metabolic loading densities, feeding levels, social interaction, etc. To clarify the relationship among phenotype, genotype, and environment, consider the following examples:

Example 1:

We will arbitrarily define a particular genotype as contributing 10 cm to length at a given age. We then measure two fish with the <u>same</u> genotype but reared under two densities. We find that Fish #1 under density #l has a length of 15 cm, and Fish #2 under density #2 has a length of 17 cm. Through subtraction, we see that density #l contributed 5 cm (15-10) and density #2 contributed 7 cm (17-10) to the lengths of each fish. In other words, all else being equal. the environmental differences were responsible for 5 and 7 cm differences in length, respectively. A similar effect was shown in density studies with spring chinook salmon at the Cowlitz Hatchery. Although the fish were all similar genetically, those in a low density environment were somewhat larger at release as yearling than those in a high density environment.

Example 2:

In this example, the alternate case is examined. Here, two individuals of different genotypes but reared under identical environments are measured. We set the environmental effect as being 5 cm. Fish #l is 15 cm, and fish #2 is 17 cm. The genotypic effect is thus 10 cm for fish #l and 12 cm for fish #2 (1705).

The mechanics of determining the genetic and environmental effects are largely based on statistics. A summarization of the procedures is as follows:

1. A number of planned crosses are made so that the relationships among progeny are established and known. There is considerable flexibility in designing these relationships, but the most common ones are fullsibs (share the same male and female parents), half-sibs (share on parent), and parent offspring.

2. Data are then collected on the traits of interest and analyzed through a statistical technique called the analysis of variance.

3. After this preliminary analysis, the results are then recomputed using a system of equations developed for particular mating designs. The final result is a number of estimates--the two most important are called the <u>phenotypic variance</u> (V_p) and the <u>additive genetic variance</u> (VA). The ratio (V_A/V_p) f these estimates provides us with an estimate of the proportion of the variation in each trait which can be improved via genetic selection. This indicator, the <u>heritability</u> estimate abbreviated as h^2, is one of the cornerstones of quantitative genetics.

The heritability estimate can range from a high of 1 to a low of 0. If $h^2 = 1$, the phenotypic variance for a trait is comprised entirely of additive genetic variance and selection would be effective. If h^2 approaches 0, then selection would be correspondingly ineffective. Thus, from the standpoint of whether a selection program should be attempted or not, having some idea of the heritabilities for the concerned traits is essential.

We have compiled a list of heritability estimates for various traits of salmon and trout in Tables 3 and 4. A quick glance at the tables would indicate the most production traits have high h^2 values, and the potential for effecting improvements through selection are correspondingly high.

Table 3. Heritability Estimates for Rainbow Trout (Salmo gairdneri).

Trait	h^2	Source
Fertility	.23	Gall 1975
Eyed egg mortality	0.15-0.20 ±.06-.07	Kanis et al. 1976
Alevin mortality	0.14-.06 ±.03-.02	Kanis et al. 1976
Egg volume	.20-.52	Gall & Gross 1978a
Egg size	.20-.32	Gall & Gross 1978a
Egg number	.20-.44	Gall & Gross 1978a
Post-spawn female wt	.50	Gall & Gross 1978b
Post-spawn male wt	.31	Gall & Gross 1978b
120 day wt	0.58	Gall & Gross 1978a
175 day wt	0.60	Gall & Gross 1978a
271 day wt	0.52	Gall & Gross 1978a
326 day wt	0.48	Gall & Gross 1978a
460 day wt	0.66	Gall & Gross 1978a
610 day wt	0.74	Gall & Gross 1978a
150 day wt	0.26-0.29	Kincaid 1972
150 day wt	0.09 ± 0.10	Austad et al. 1972
150 day wt	0.16 ± 0.14	Austad et al. 1972
280 day wt	0.29 ± 0.20	Austad et al. 1972
280 day wt	0.37 ± 0.23	Austad et al. 1972

Table 4. Heritability estimates for salmon.

Species			
0. nerka	Resistance to IHN	0.30±3.3	McIntyre & Amend 197
0. tshawytscha	Time to hatch	.14±.23	Hickey 1978
O. kisutch	Contribution to fishery	.11	McIntyre & Johnson 1
	FW growth (120-210 days post-fert.)	.25-.62±22-.25	Iwamoto et al. 1979
	SW growth (net pens) (330-450 days post-fert.)	.12-.26±.11-22	
	Smolt percent	.25±.17	
	Atlantic Salmon		
S. salar	Uneyed egg mortality	0.32-0.12±.06-.03	Kanis et al. 1976
	Eyed egg mortality	0.05-0.11±0.04-0.03	Kanis et al. 1976
	Alevin mortality	0.04-0.01±0.01	
	FW growth rate - wt	.27-.33	Refstie & Steine 19
	FW growth rate - IN	.30.38	Refstie & Steine 19
	Two-year wt in sea water	0.34	Gunnes & Gjedrem 19
	Two-year IN in sea water	0.33	Gunnes & Gjedrem 19
	Resistance to Vibrio	0.10	Gjedrem & Austad 19
	Smolt percent at 1 year	0.06	Refstie et al. 1977

We use these h^2 estimates to make predictions of selection gains. For example, suppose the h^2 estimate for weight of adult pink salmon returning to a hatchery is 0.30. What improvements in weight can be expected after one generation of selection? The only additional information required is: (1) The average weights of the entire returning population, and (2) The average weights of those fish chosen as broodstock. Suppose those values are 4.0 pounds for the entire population and 5.0 pounds for the selected fish. By subtracting the population mean from the mean of the selected group (5.0-4.0). we obtain 1.0 pounds which we will call the selection differential. Now all that remains to do is to multiply the h^2 estimates by the selection differential or for this example, 0.30 times 1.0 = 0.30. This means that after one generation of selection, the mean weight of all fish returning to the hatchery will be approximately the original population mean weight plus the additional expected weight gain or 4.0 + 0.30 = 4.30 pounds.

Let us take another example. Suppose we were interested in breeding a stock of fish resistant to furunculosis. Our hypothetical values for this case are:

a. h^2 = 0.10
b. Mean survival of total population = 0.70.
c. Mean survival of selected group = 0.80.

We insert these values into our equations and find that the selection differential is 0.8 - 0.7 = 0.10. The product of the selection differential and the h^2 estimate is (0.1 x 0.1) which is equal to .01. This would indicate that after one generation of selection, we would predict a 1 percent improvement in resistance to furunculosis.

Thus, we see that once we have h^2 estimates predictions of expected gains are fairly easy to determine. One word of caution though: Heritability estimates are derived for the genetic constitution of a specific population reared under specific environmental conditions. Remember the relationship between the phenotype, genotype, and environment. If either the genotype or environment is changed, accompanying changes in the other variables may result. This point is also applicable when selection is practiced over several generations on the same stock of fish. Even if environmental conditions remain constant, genetic changes due to the selection system may lead to changes in the h^2 estimate and consequently response of the population to selection.

Any closed population under selection will eventually reach a point where selection becomes ineffective. This point is called the selection plateau. The number of generations necessary to reach that point and the maximum progress possible before the plateau is reached are related to and are functions of the initial variability of the trait, the intensity of selection, and the number of genes responsible for the trait. For example, a trait such as length or weight with high variability and large number of involved genes under moderate selection can probably be selected for 10 generations without any appreciable decrease in selection gains. Conversely, a trait with moderate genetic variability such as time of return can be altered only to a

limited extent. Generally, traits that are related to the reproductive fitness of an organism (time of return, age at spawn) are alterable only within a relatively narrow range. Natural selection through the evolution of the species has defined the ranges in which the species can survive. If those ranges are exceeded by artificial selection, the opposing force of natural selection will buffer those changes.

Types of Selection

Once h^2 estimates have been derived, the next critical step is determining the mechanics of the selection process. There are really two major ways by which the genetic characteristics of a population can be changed. The first is by selecting the individuals providing eggs and milt, and the second is the way the selected individuals are crossed. Our concern in this section regards the selection of the spawning population.

The simplest and perhaps most efficient and practical approach under salmonid production conditions is individual or mass selection. Here, selected parents are chosen solely on the basis of their individual performance. For example, let us consider a stock of chum salmon with an average return weight of 3 pounds. If our selection goal was to increase the size of subsequent generations, we would attempt to use only those individuals exceeding say, 4.0 pounds. Separate criteria might also be used for the two sexes if large differences were apparent.

Individual selection is obviously very easily performed. To be effective, however, the trait selected for must have relatively high h^2 value (preferably .20 or higher). There is also the inherent problem of causing high levels of inbreeding by indiscriminate selection either by maintaining small numbers of brood stock or by mating related individuals together. To illustrate these points, remember that by selective breeding we are capitalizing on the fact that related individuals will tend to resemble each other more than unrelated ones. In a selection scenario, it is thus fairly easy to visualize a circumstance where the progeny from one cross happen to be distinctly superior relative to progeny from other crosses. Under individual selection, those individuals would increase the level of inbreeding with perhaps some undesired effects.

There are other types of selection which minimize the chances of inbreeding but all unfortunately, require some means of identifying families. (Families are distinct groups of individuals which share some sort of blood relationship--they may be full brothers and sisters, half-brothers and sisters, first cousins, etc.). Those types of selection are:

1. Family selection--entire families are retained or eliminated for broodstock.
2. Sib selection--selection based on performance of brothers or sisters.

3. Progeny testing--selection of broodstock based on performance of progeny. Inapplicable to salmonids except for species spawning more than once per generation.
4. Within family selection--best individuals from each family selected on individual merit.
5. Combined selection--integrates family and within family selection--i.e., best individuals from best families chosen. Equal to or greater in efficiency than other types of selection.

Multiple Trait Selection

Our discussion on selection has been limited to considering one trait at a time and selecting for that one trait alone. Wore realistically, selection is performed on several traits during the life cycle of salmonids with improvement desired for all traits. For example, we might wish to increase fecundity, egg viability, ponding and release weight for stocks returning to the hatchery. The optional types of selection available for use are: tandem selection, independent culling, index selection, and indirect selection.

Tandem selection involves selecting from trait a in generation 1, trait b in generation 2, back to trait a in generation 3, and so on. Tandem selection effectively disrupts the continuity of the selection process. Selection progress may therefore be slow and sporadic since selection for a particular trait is not exercised every generation. To be effective, progress made for a particular trait has to remain stable while the other traits are selected for. This is an unlikely prospect. An example of tandem selection can be visualized in the case where production goals in a hatchery are revised every few years either due to changes in managers or from departmental directives.

Independent culling involves selecting for all traits simultaneously but establishing minimum acceptable values for each trait. All individuals failing to meet the minimum criterion for any of the traits is rejected regardless of its performance for any of the remaining traits. For example, three females have the following values:

	Body Weight	Egg Viability	Ponding Weight
Female 1	2.0 kg	.90	.35 g
Female 2	3.0	.80	.25
Female 3	3.3	.95	.20

Culling levels are established as 3.0 kg for body weight, .80 for egg viability and .25 g for ponding weight. Female 1 fails to meet the body weight criterion and is immediately rejected even though she greatly exceeds the requirements for egg viability and ponding weight. Female 2 is retained because her performance meets all the selection minimums. Female 3, like female 1, is rejected because of low ponding weight although her weight and egg viability are the highest among all three females. Under independent

culling then, an individual will be rejected for mediocre or even average performance for a given trait. Demonstrated superiority in other traits is not considered.

The alternative scheme is to attach relative importances to each of the traits, monitor the individual or group performance for each trait, sum up the scores for all the traits, and then select individuals or groups of individuals relative to their overall scores. The type of selection practiced in this case is called index selection because selections based on an indexed score. Application of this type of selection relative to the data for the three females in the preceding example is as follows:

1. Economic weights are attached to the three traits. Suppose we consider egg viability to be three times as important as female weight and twice as important as ponding weight.

2. The performance of each female is multiplied by the corresponding economic weight and the scores are summed.

	Body Weight x 1	Viability x 3	Ponding Weight x 2	Sum
Female 1	2.0 x 1 = 2.0	.90 x 3 = 2.7	.35 x 2 = .70	5.40
Female 2	3.0 x 1 = 3.0	.80 x 3 = 2.4	.25 x 2 = .50	5.90
Female 3	3.3 x 1 = 3.3	.95 x 3 = 2.85	.20 x 2 = .40	6.55

3. The females are then selected on the basis of their scores. Index selection is actually more involved than the above example because it requires additional genetic data, but the basic idea remains the same. In terms of efficiency. the selection index is never less efficient than independent culling and tandem selection. However, it does require more recordkeeping and genetic estimates. These requirements considerably decrease its usefulness in terms of practicality under production conditions.

The fourth and last type of selection considered is indirect selection. Here, selection is performed on one trait in anticipation that a corresponding change will occur with another trait. For example, suppose length at smoltification is the trait we are primarily interested in, but due to space limitations we are unable to rear all fish to smolt size. The solution here would be to start culling out individuals at an earlier period, at fingerling size for example. However, unless we know that fingerling and smolt lengths are correlated out attempts at efficient selection may be futile. If the genetic relationship for the two traits is high and positive, we may be fairly certain that the desired result will follow selection of fingerlings. In some instances, indirect selection will also produce a larger response than selecting directly for the trait in question.

Potential Problem Areas in Selective Breeding Programs Broodstock Size and Composition

If you recall the examples of predicting selection gains for weight of returning adults and disease resistance, the h^2 estimate was multiplied with the selection differential. And, the selection differential was found by subtracting the population mean from the mean of the selected individuals. Within a single generation, the only variable which we can manipulate is the mean performance of the individuals chosen as broodstock. By increasing the difference in means between the selected fish and the population, the predicted gain would be expected to be larger. Thus, it is tempting to maximize this difference. Maximizing the difference, however, requires that a smaller portion of the entire population be selected for broodstock. A point will soon be reached where: (1) The number of selected adults will be too few to produce the desired production progeny, or (2) The rate of inbreeding becomes too high. Because projecting production quotas are defined more by practical considerations, our concern in this selection is to deal with the possibility and avoidance of inbreeding.

Inbreeding by definition is caused by the mating of related individuals. In general, the number of identical genes shared by progeny becomes larger as the degree of relationship between the parents increases. In human populations marriages between closely related individuals are restricted by law. The major reason for these restrictions is that by inbreeding, genes that were previously hidden begin expressing their effects. Some of the effects may be undesirable or deleterious to the genetic health of the population.

There are only limited data on the effects of inbreeding with salmonids and these are primarily from experiments with trout and Atlantic salmon. These data suggest that increased levels of inbreeding may lead to decreased marine survival in Atlantic salmon and increased frequency of abnormalities and decreased hatchability, fry survival and growth in rainbow trout. Similar consequences may be expected for Pacific salmon.

The amount of inbreeding can be calculated rather simply. The most accurate method requires information on the relationship among individuals of the existing population and with their ancestors. In most production programs, those relationships are unknown, so we must rely on estimates derived from information gathered from the present population only. What we need in this case is the actual number of males and females contributing gametes to the next question.

If the number of males and females is equal, then the rate of inbreeding may be equated to:

$$\frac{1}{2 \times (\text{Total number of males and females})}$$

For example, suppose we used a total of 50 fish of each sex or 100 fish total as broodstock. The rate of inbreeding can then be calculated as follows: $\frac{1}{2x\ (100)} = .005$. Thus, using 50 males and 50 females each generation will increase the inbreeding of the population at the rate of .005 per generation. After 20 generations, the total amount of inbreeding in the population will be 20 times .005 or 10 percent.

When the numbers of each sex are unequal, a slightly different formula must be used:

$$\frac{1}{(8 \times \text{number of Males})} + \frac{1}{(8 \times \text{number of Females}}$$

In a hypothetical example, 10 males are used to fertilize 90 females. Inbreeding per generation would then amount to 1/8 x 10 + 1/8 x 90 = 1/80 + 1/720 = .014 or 1.4 percent per generation. After 20 generations, inbreeding in the population will be 20 times .014 or 28 percent. If however, five males were used to fertilize 95 females, inbreeding after 20 generations would amount to 52 percent.

We see then that at this point two factors may affect the rate of inbreeding in a population: (1) The total number of male and female spawners and (2) The ratio between the numbers of males and females comprising the spawning population. From our examples, we can unequivocably state that inbreeding will increase when we limit the total number of spawners and/or severely restrict the number of spawners of either sex. However, what happens if the population size also fluctuates from generation to generation. An example of this situation could be if either production quotas are drastically reduced for several years and then increased or if the number of spawner escapement is low because of external reasons. In that case, the generation with the smallest number of spawners will have the largest effect on inbreeding rate.

This discussion on inbreeding would not be complete without mentioning some of the beneficial uses of planned inbreeding. Inbreeding has been used extensively in agriculture, primarily with plant crops. Its use has been concentrated in the production of genetically uniform strains and in the production of inbred lines for subsequent crossing with other lines. Extensive use of the latter has been responsible for the development of many of the corn varieties currently grown. Inbreeding has also been used to uncover rare recessive alleles so that they may culled from a breed.

The consequences of small population sizes and composition are not limited to potential inbreeding problems. Artificially propagated fish are usually the progeny of fewer fish than wild fish simply because of higher viabilities and survival under culture conditions. From an escapement of 1000 fish, perhaps only 2 to 3 hundred will be needed to sustain the production demands of the hatchery. There are two possible genetic consequences which may result from our selection of the spawners.

The first is that we may not get an adequate sample of the existing gene pool. For example, suppose a hypothetical stock has a return time extending from October to December with the peak of the run in late October. Because of manpower shortages, we decided to spawn the first 300 ripe individuals reaching the rack. If we do this, subsequent generations may lack the genetic flexibility of the original population. Since fish stocks are theoretically composed of temporally and spatially adapted subpopulations, this may reduce the overall fitness of the population. By taking those first 300 individuals, we have effectively negated the genetic contribution of the rest of the run. We have severely limited the possibility of obtaining a good sample of the stock of fish returning to the hatchery.

Second, we may have a reduction in genetic variability due to the loss or fixation of genes. The loss of fixation of genes may lead to gene frequency distributions which are determined exclusively by our sampling scheme. This in turn may lead to genotypes with decreased fitness because random sampling rather than selection has determined their existence in the population.

In this short section, we have discussed ways by which decisions based on broodstock size and composition may have far-reaching consequences on artificially propagated fish. Those considerations are even more serious considering that determinations of number and choice of spawning adults are just the initial two of a large number of forces hatchery reared fish will be exposed to during their cultured phase. We must remember that all stocks of fish exhibit some form of specificity to their environments regardless of whether in the hatchery, spawning/incubation channels, net-pens, or in the wild. We must ensure that these stocks have genotypes with flexibility for the particular conditions for which they are selected. A large amount of that flexibility may be maintained by avoiding inbreeding and random drift through avoidance of limited population sizes.

CHAPTER IV

USES OF GENETICS IN FISH CULTURE

Before we begin to delve into the uses of genetics in fish culture, it is important to understand the biological organization of salmon stocks. Based on numerous studies of the life history and other characteristics of salmon, and trout, it is almost universally accepted that: (1) these species are subdivided into many reproductive units that are somewhat distinct based on geographical location and time of spawning, and (2) this subdivision if facilitated and maintained by the homing behavior of the adults.

The genetic consequences of these characteristics are twofold. First, initial genetic variation will tend to be maintained and not be spread over the whole species. If all spawning groups were completely separated, there would be no chance for gene differences to be spread to other groups, since the only way genes are transmitted is by reproduction. Second, each group will adapt genetically to its freshwater environment to enhance survival in these conditions. This will cause even more gene differences among the various groups. The sum of both of these factors will be a wide array of genetically diverse stocks, each of which will have its own set of biological characteristics and production capabilities. It follows logically, although not practically, from this that to do the best job at enhancing and conserving these stocks we should identify and then culture each one separately. While this ideal would be nice to follow and scientifically more secure, the expenditure of time and effort for the amount of benefit would be questionable; besides we do not yet have adequate methods to allow us to unequivocally distinguish the stocks. As a result, most hatcheries probably utilize more diverse groups composed of several biological stocks. In other cases the hatchery stock may have been started from completely "foreign" groups. Whatever the situation, through the processes of selection and adaptation these either changed genetically to allow them to survive or went to extinction.

If we genetically analyze those hatchery populations that are successful, we find that there is still a large amount of variability present. Thus, even though we expose a group of fish to more consistent conditions in a hatchery they apparently do not develop a total genetic homogeneity. A number of explanations could be forwarded for this observation, but probably the most important is that the stock retains genetic variability as a means of protecting itself against extinction. It has been shown in a number of studies that, in general, the most successful animals are those with high amount of genetic variability.

One way of illustrating how this works is to use an example of a specific trait in salmon. Time of return to spawn, a trait which is genetically influenced, can be characterized by a "typical" expression. For example, the chinook salmon that return to the University of Washington have a peak return about the third week of October. The expression of this trait is defined by

many factors, including genetic and environmental ones. Current information indicates that water temperature and flow are the most important environmental determinants. Environmental conditions vary from year to year, so if a stock is to survive it must have genotypes that will allow some reproduction even if the optimum conditions are not present. Thus, the population has some genotypes that will allow return and spawning at suboptimal temperatures and water flows. Consequently, there are a variety of genotypes, not one specific genotype, resulting in a characteristic "set" of genes. For a trait such as return time, this is expressed as variation around a mean value.

Since cultured salmon must "fit" into the natural environment during their life cycle, methods must be used that do not seriously change or limit the genetic variation inherent in the population. Based on genetic analyses, there are three major factors that can potentially alter the genetic constitution of populations. These are population size, migration, and selection. These factors can be handled and the effects minimized by procedures that are rather easily integrated into hatchery production conditions.

Population Size

Based on concepts derived from genetic theory, the only way that no genetic change can be guaranteed in populations is if they are of infinite size. Clearly this is unlikely in most salmonid populations even in a natural situation. Assuming the theory is close to correct, how can a population exist that shows no genetic change? The answer is that there are a number of other factors that play a role also. However, our major concern here is not to discuss the reality of the situation, but to show what the genetic effects of decreased population size are and how these can be avoided.

The genetic results of a decrease in population size are basically the same as what would be expected with inbreeding. That is, within a population there will be a decrease in genetic variability and an increase in harmful genes. The biological expression of these effects is a loss in reproductive performance and a general loss of viability; that is, there will probably be higher egg and fry mortalities, and growth rates and associated characteristics (e.g., conversion efficiency) will be lower than normal. These are obviously effects that are not desirable for production hatcheries, so some attention should be given to conditions that may lead to this result.

One obvious way that population sizes are decreased is by overharvesting, but this not under direct control by the hatchery so no more mention will be made here. The most prevalent way that population size is decreased by hatchery procedures is by limiting the number of adults that are used to spawn the next generation. This is done in obvious ways such as using a small number of males and females for spawning. However, there are more subtle ways that also need to be avoided.

You will recall from the previous chapter that the change in inbreeding in a population can be approximated by the following formula:

$$\Delta F = \frac{1}{8\ (\text{no. of males})} + \frac{1}{8\ (\text{no. of females})}$$

As pointed out, this change in inbreeding is mainly dependent on the least numerous sex. Quite often under production conditions one male is used on several females, which effectively decreases the number of males that spawn. For example, if you consistently used one male for every four females, and you needed 200 females for production, this would mean that the change in inbreeding coefficient per generation would be:

$$\Delta F = \frac{1}{8(200)} + \frac{1}{8(200)} = .003$$

whereas, if you made sure the same number of males and females in spawning this value would be:

$$\Delta F = \frac{1}{8(200)} + \frac{1}{8(200)} = .001$$

This rather simple precaution reduces the increase in inbreeding by a factor of 3.

In addition, a male can only be counted once even though he is used on several females at several different times. Thus, to take an extreme example, if you set aside 20 males for a day of spawning and these are used over and over for several hundred females, the number of males is still only 20. Each male used is only counted once regardless of how many times he is used. The best results and the least amount of inbreeding are obtained when equal numbers of each sex are used.

One thing that needs to be pointed out here is that the techniques you use for fertilization of eggs during spawning can have a large influence on the number of males contributing their genetic material to the offspring. It has been shown through experimentation that with artificial spawning as carried out in a hatchery, sperm from the milt enters the egg prior to the addition of water for activation. Thus, if you add milt from one male to a lot of eggs from several females and stir the mixture, the probability is high that almost all of the eggs will be fertilized before milt from other males is added. The result from this is that the number of males actually contributing to the population is actually much less than the number being "milked" into the egg buckets. The effect is the same as just using the first male for spawning.

Consequently, to keep the actual male contribution high a good approach is to either collect milt from a number of males in a separate container and use this mixture for egg fertilization, or make sure the egg lots are not stirred before milt from all the males required is added.

The other area that we need to answer is how many animals should be used in spawning to minimize genetic changes. With our increased capability to raise fish with minimal mortalities it is often tempting to decrease the number of adults to a minimum to avoid overpopulation of the hatchery. However, too large a decrease will lead to the effects noted earlier after several generations. Based on rather meager data from a variety of organisms, it is recommended that the breeding population should be at least 50 (25 pairs) for the short-term and 500 situations where resources and facilities do not allow so much reproduction; however, values within this range should encompass most situations and provide useful guidelines.

Even if you take the necessary steps to spawn adequate numbers of adult salmon, the method by which groups of fertilized eggs are chosen, or sorted for planting from your hatchery can alter the spawning population size. This rather subtle effect is best explained by use of an example. Suppose you get a good return of chinook salmon back to the rack and you collect 4.0 million eggs. During spawning you make an effort to use equal numbers of males and females (about 800 of each sex). However, your target for release from the hatchery requires only 1.0 million of these eggs, so the rest are programmed for distribution to other stations. How you choose the eggs for your hatchery will greatly alter the effective size of your chinook population. If you simply choose whole egg lots from only 200 of each sex (assuming 5,000 eggs per female); that is, egg lots from only 200 females will provide enough for your needs. On the other hand, choosing 1.0 million by taking one-half of each of the eggs you produced will increase the number of contributing females to about 400. Again we may be stretching reality with our illustration, but the point to be made is that attention to he method of selecting egg lots for rearing and subsequent planting can help sidestep potential problems that arise from limiting the population size. Thus, effort should be expanded to assure the smolt population planted from your hatchery is from as many spawners as possible.

Migration

This factor must be considered in its broadest sense. Migration occurs as a natural phenomenon in salmon populations, and we cause massive migration in many cases by transplanting stocks among streams and hatcheries. The effects on the genetics of the populations are the same in both instances, but the magnitude of the change is very much different. In general terms, the genetic change can be determined by the following relationship:

$$A = m (q_m - q_o)$$

Where Δq is the change in gene frequency, m is the proportion of new immigrants in each generation, q_m is the gene frequency among the immigrants, and q_o is the gene frequency among the native population.

To exemplify the use of this equation, suppose we had a population of 200 adults in a natural population and 100 adults returned to that population from a hatchery plant of smolts. Further, by measuring one gene we find that the natural population had a frequency of one allele of 0.15 (q_o) and the frequency of the same allele in the hatchery returnees was 0.45 (q_m). The change in gene frequency could be calculated to be:

$$\Delta q = \frac{100}{300} (0.45 - 0.15) = 0.10$$

This means that the frequency of this allele in the natural population after spawning would be 0.25 (0.10 + 0.15).

If you consider this relationship carefully, you can see that the rate of genetic change hinges on two factors: (1) the rate of immigration; the higher the proportion of immigrants the greater the potential change; and (2) the difference in gene frequency between immigrants and natives; the greater the difference between the two populations, the larger the change will be.

What this means on a practical basis is that when fish are transplanted to a stream with an existing population, or moved between hatcheries, the larger the number moved in and the greater the genetic difference between the two groups the more significant the genetic change will be. In most cases we do not have a good measure of the genetic differences among the groups, but if the magnitude of the transplant is very large there will be a genetic change regardless of the differences in gene frequencies. We cannot assess whether the results of this change will be positive or negative because many other factors must be considered. However, there will be a decrease in genetic variation within the species as the two groups become more similar in genetic constitution.

Another area where migration probably has large effects is with populations in proximity to a hatchery. In this case a very large group of probably genetically unique fish from the hatchery is released into one stream, hopefully to immediately migrate to saltwater. When these fish mature, the assumption is made that they all return to the hatchery pond and none find their way to other streams. While homing of salmon is precise, there is a real chance that some straying occurs. In fact, based on recent evidence, straying may be rather prevalent in some species and may be necessary to retain the viability of the populations. However, hatchery introductions are of large magnitude and are done generation after generation, possibly

resulting in a large amount of consistent migration into adjacent populations. Consequently, the groups will become more genetically similar and any differences will eventually disappear.

The concern here is that the differences that exist between the populations may be important for their survival and perpetuation. While pressures from the environment in the form of selection will eventually cause the genetic system to become adapted, this is a much slower process and can easily be "swamped" by migration effects. In addition to the "swamping" effect, introduced genes may actually be deleterious to a population, or the migration could cause the loss of genes crucial to survival. Either of these changes may affect a native population, resulting in the irreplaceable loss of its original genetic constitution. Therefore, genotypes with unique biological expression and functions that could have possibly been used in the future to improve production are lost.

Selection

Selection is the third factor that can change gene frequencies. It is a process that has a rather simple theoretical basis, but becomes very complex when considered in a real situation. Every time you choose a pair of spawners on the basis of some particular phenotype (for example size or time of spawning) you are performing selection. By allowing those salmon that have the genes that determine larger size, earlier return time, or some other desirable trait to spawn, and eliminating those that do not have these genes, the percentage of "desirable" genes will increase in the population. This is very basically how the process of selection works to effect genetic change. The use of this approach in directed breeding programs was covered in Chapter II in some detail.

There are several aspects of selection that need to recognized as having some direct influence on hatchery operations. The first of these is basically a conflict between natural and artificial selection. The process of selection is the method by which natural populations genetically adapt to the environment in which they live. It does not happen much differently from the description in the preceding paragraph, except for a much lower magnitude of retention and elimination of various phenotypes. Consequently, the rate of genetic change is much slower. In addition to the rate and magnitude of change in natural vs. artificial selection, the basic type of selection is usually different.

We can define three different ways that selection can act; these are shown graphically in Figure 7. The curves represent the frequency distribution of a trait such as length in a population. Selection can favor phenotypes at one extreme of the phenotypic distribution, this is termed directional selection and is the type generally practiced in hatcheries and designed programs. When selection favors phenotypes that are intermediate in the distribution, it is said to be stabilizing (or normalizing). Selection simultaneously favoring phenotypes at both extremes of the phenotypic distribution is termed disruptive. Although all three types probably occur, there is ample evidence that stabilizing selection is the most common in natural populations.

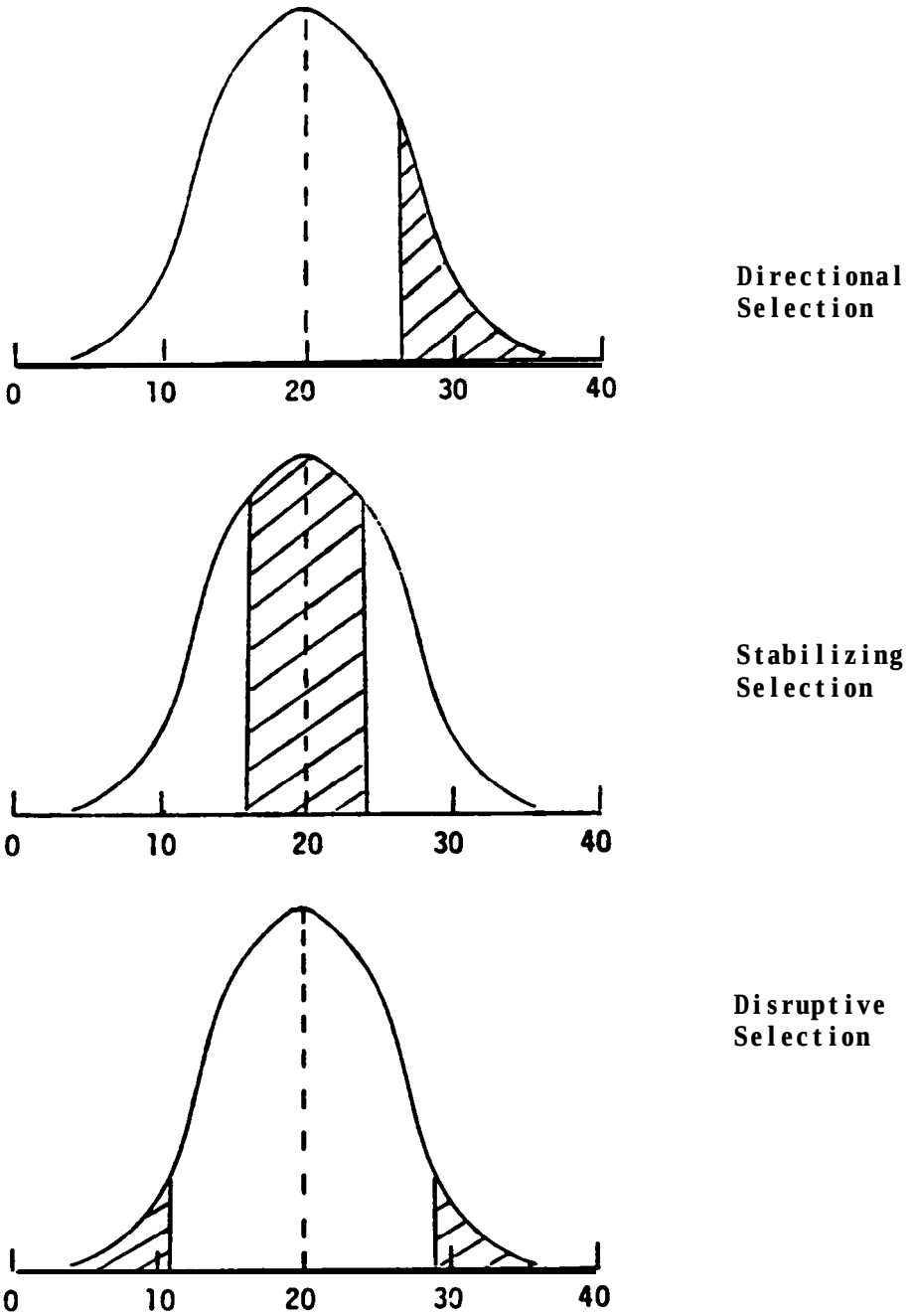


Figure 7. Three fundamentally different modes of selection. The curve represents the distribution of phenotypes in the population. In each case the shading represents those individuals favored by natural selection.

The conflict between the type of selection occurring naturally and that which is practiced on salmon in the hatchery is the crux of a potential problem. Most commonly in natural circumstances selection acts to maintain gene frequencies at a level that maximizes the adaptation of a population to a particular set of environmental circumstances. Those salmon that have genotypes which are well-adapted will survive better and be represented as the most frequent type in a distribution analysis. Thus, stabilizing selection will maintain genetic adaptation most effectively. On the other hand, in the majority of instances the goal of artificial selection is to change the whole mean value of the population either up or down. This is best accomplished by reeding salmon at either end of the distribution, i.e., directional selection. The result may be a "destabilization" of the genetic composition of the population, or the "improvement" may be in opposition to what is needed for natural well-being. Additionally, with directional selection genetic variation is decreased. While this does not universally affect populations negatively, date to date indicates that heterozygosity is an important aspect of natural populations.

You may wonder why there is so much concern with natural population characteristics when our major emphasis is on salmon hatchery practices. This arises because of the way enhancement hatcheries operate. Control and artificial manipulation is exercised only on the freshwater phase of the salmon's life cycle. The remainder of the cycle is spent in a "natural" environment and salmon must have the genetic capabilities to cope with this experience. These characteristics are best observed, studies, and hopefully emulated from naturally reproducing groups.

Two other factors are also of importance. First, part of the freshwater phase is for the purpose of reproduction, an aspect we exercise complete control over in hatcheries. Since genes are transmitted between generations by reproduction, we also exercise control over the genetic characteristics of the population. There is thus ample opportunity, with or without the proper care, to change the genetics of a salmon population propagated by a hatchery. The second factor stems from the integrated nature of the genetic system. If you cause a change in one trait in a positive way, there may be change in some other trait, possibly in a negative direction. This type of reaction has been shown many times in animal breeding programs. For salmon hatcheries this could mean that a change in a trait important to more efficiency in the hatchery (e.g., earlier return time to spawn) would result in some other trait important to natural adaptation being altered in a negative manner. The crucial point about these two factors is that we do not yet have adequate techniques to measure the impact of such changes. Therefore, the best approach, we feel. is to attempt to minimize possible negative effects by careful, thoughtful programs based on solid genetic principles.

Selection, as a method of genetic change, can also be approached from a somewhat different perspective. Most of our thinking on the effects of selection to this point has been directed toward minimizing genetic change so hatchery-produced salmon are similar to natural populations. It is possible to use selection in a positive sense by conducting defined programs to improve

the performance of the stocks managed by hatchery production. The method of approach and some of the inherent problems are covered in Chapter II, but some further comment is appropriate here. In the hatchery, control is exercised over reproduction, which is a basic requirement for a designed selection program. With careful thought and planning a program could be initiated to improve traits of importance to the fishery and to management (e.g., return timing, adult size, survival to adulthood, growth rate, etc.). This type of approach will be mandatory for commercial ocean ranching if it is to advance. Perhaps in our rapidly changing world we need to change our approach of preservation of naturally occurring genetic components to some emphasis on selecting characteristics that are advantageous to salmon.

Application of Specific Methodology

We mentioned at the beginning of Chapter II that one of the major concerns in using genetic analyses, as with any analysis, is that the proper technique be employed to answer the questions asked. Although you may not be directly involved in conducting genetic analyses, we feel it would be beneficial to identify some of the areas important to salmon culture and indicate the genetic approach that would be best utilized. Three general areas can be cited to be the most immediately applicable to current salmon hatchery concerns. These are definition of stocks, monitoring changes in stocks, and directed genetic alteration. Many more specific areas could be mentioned under each of these, but the details are more appropriate to programs at individual stations.

A. Definition of Stocks (Populations)

From a genetic perspective, stocks (or populations) are the units we should be dealing with in hatchery culture and management. This is the smallest unit of a species that is continuous over time and is about the largest unit we can handle on an analytical basis. Consequently, we need to be able to identify and define a stock on more than a geographical or a temporal basis, since these two criteria do not always coincide with a biological description of a stock. Ideally, we should utilize all available types of genetic analyses to do this satisfactorily. Realistically, some or our analytical approaches (e.g., quantitative analysis> are extremely difficult to use in this area and are only marginally applicable in most circumstances.

The analytical procedure most commonly used to define stocks has been single gene analysis by electrophoretic separation of proteins. The reasons for this are many, but the primary ones are the quality and quantity of genetic information obtained and the rapidity of the analysis. For stock definition and identification, the data of most interest are distinct gene variants and the frequencies of these variants. If the gene frequencies differ statistically or unique genotypes are found in one group, this is considered evidence for separate stocks. This evidence must, however, be interpreted with some knowledge of the physical and biological distribution of

the group you are working with. Similar gene frequencies in two hatchery populations that are 200 miles apart on different river systems, or have a 3-month difference in spawning time cannot realistically indicate a single stock.

The other two types of genetic analysis, cytogenetics and quantitative analysis, can potentially be utilized also but with a greater degree of difficulty. Chromosomal, or cytogenetic analysis is inherently more time-consuming and its use in separating and identifying populations is still somewhat tenuous. Quantitative genetic analyses require rather exacting and extensive experimental control that is not generally available. This effectively removes it from consideration in most production organizations. However, based on current genetic thinking, the traits that can be approached by quantitative techniques may be the most critical to the genetic well-being of a population and thus should be more extensively investigated.

B. Monitoring Changes in Stocks

In large part salmon hatchery programs are designed to improve return by improving the survival during freshwater residence. This basically entails spawning naturally-returning adults, rearing the offspring until they are ready to migrate to saltwater, and planting the young fish back into the natural environment. Consequently, to assure these "cultured" fish are able to compete effectively in the natural environment, genetic alterations should be minimized. Additionally, genetic changes are usually indicative of some type of change in the environment or biology of the organisms. Thus, genetic change can be used to assess whether modifications to hatchery methodology are required.

Again, any of the analyses we discussed can be utilized for measurement, but probably the most useful is single gene analyses with quantitative analysis coming in a distant second. The basic effect we look for with single gene analysis is a change in gene frequencies over time. This requires that we have good baseline information on the population of interest to assess the magnitude and significance of any changes.

C. Directed Genetic Alteration

From a different perspective, directed genetic change in a population can be a very effective tool in hatchery operation and assessment. Within this area there are two basic approaches that should be pointed out. These two approaches differ primarily in the number of genes that are being manipulated.

The first approach is to alter one or a few genes in a stock of fish to enable recognition of the stock, or some segment of it. We can use the predictability of gene transmission to increase the frequency of selected genes in a population or introduce a new allele into a stock. For example, using the illustration of rainbow trout body color from Chapters I and II, we could cross normal x albino trout and know we would get all palomino trout.

If all our stock was of this type, the fish could easily be monitored in the fishery, on the spawning grounds, or on return to the hatchery. Alternatively, a special group of salmon that, for example, had higher fecundity could be bred with this genotype, so we could recognize them when spawning.

Clearly this particular gene would not be a good one to use because it "stands out." but there are genes that can be used in the same manner and are less apparent (e.g., electrophoretically variable proteins). Basically, what is accomplished is the incorporation of a biological "mark" into the salmon, not unlike fin-clipping, branding, or coded-wire tagging. The major advantage of the genetic mark is that it cannot be lost since it is a part of the biological system. Also, the genetic mark will be transmitted to the next generation, making it unnecessary to retag the offspring.

The second approach is changing quantitative traits such as growth, return to the fishery, disease resistance, fecundity, etc., through a planned genetic approach. Most of these traits are determined by a large number of genes and are more directly involved with the production requirements of the hatchery. The techniques and analyses necessary for this approach have been covered previously and thus only some general considerations will be given here.

It is safe to say that with the proper breeding and selection scheme we could alter any variable trait in a salmon population. However, there are two areas which must be considered before a decision is made to embark on such a program. First, is there enough benefit in changing the trait to warrant the effort necessary to change it? This is usually assessed in terms of a set of goals for a specific program. Coals must be define before a program is undertaken, or the effort expended is quite often wasted. Second, it must be recognized that changes in one direction with one trait are likely to result in changes in other traits. Consequently, there must be a realization there may be a price to be paid for improvement in a specific set of traits for one aspect of hatchery operation.

On the more positive side, it is generally recognized among fish geneticists that the potential exists for some significant improvement through selection and breeding of our salmon resources. With typical salmon hatchery operations we have the capability of changing numerous traits that will benefit hatchery production and return to the fishery. The major aspect that must be addressed is the primary goal of the program. Whether we plant it or not, selection will change the genetics of the population. It is better to know where we are going with this change than realize too late that we went somewhere we did not want to.

GLOSSARY OF GENETIC TERMS

Allele	One of two or more alternate forms of a gene.
Chromosomes	Structures within the cell nucleus composed of deoxyribonucleic acid (DNA) which contain the genes and convey genetic information from generation to generation.
Cytogenetics	The study of chromosome number and structure.
Diploid	The condition in which two of each type of chromosome (pairs) are present in the cell nucleus.
Dominant	One allele completely masking the expression of the alternate allele.
F_1	The first generation of offspring from a cross (short for first filial generation).
F_2	The second generation of offspring from a cross produced by crossing two F_1's.
Gamete	One of two alternative types of sex cells produced by sexually reproducing organisms; sperm from the male parent and eggs or ova from the female parent.
Genes	Individual elements located on chromosomes which carry genetic information for specific biological traits.
Genotype	The genetic constitution of an individual.
Heterozygote	An individual having two different alleles of a gene (for example, Ax).
Homozygote	An individual having the same two alleles of a gene (for example, AA or aa).
Meiosis	A process of cell division shown only in sex cell formation in which the genetic material is reduced to one-half of normal.
Mitosis	The process of cell division in which two exact copies of a cell are made.
Nucleus	The part of a cell containing the genetic material, or the chromosomes.
Phenotype	The trait seen or measured, which is produced by the effects of both the genotype and the environment.

GLOSSARY OF GENETIC TERMS (Continued)

Recessive	An allele which is masked in expression by the presence of a an alternate dominant allele.
Zygote	A fertilized egg.

POL-403 SALMONID DISEASE CONTROL OF THE FISHERIES CO-MANAGERS OF WASHINGTON STATE

I. POLICY

It shall be the policy of the Fisheries Co-Manager of Washington State to protect fisheries resources by preventing importation, dissemination, and amplification of pathogens known to adversely affect salmonids. This policy sets forth the minimum fish health standards. A Co-Manager may implement additional prac ices or measures at their facilities at their discretion. Further, acknow edging that many complex fish health situations will arise, it shall be the po icy to foster open and frequent communication between Co-Managers and Co-Operators to jointly resolve these issues without endangering the fisheries resources. This policy supersedes the Washington Department of Fisheries and Department of Wildlife policy entitled "Fish Disease Control."

II. DEFINITIONS

Accredited Inspector. An individual holding one of the following certifications:

- American Fisheries Society (AFS) - Fish Health Inspector
- Canadian Fish Health Officer
- United States Title 50 Inspector (Code of Federal Regulations, Title 50, Chapter 1, Subchapter B, Part 16)

Anadromous Broodstock. All adult salmonids collected or captured from the waters of Washington State, for the purpose of collecting eggs and/or milt, which have spent part of their life cycle in saltwater add free ranging or as captive fish held in marine net pens. Adult fish collected or captured temporarily but released unspent are not considered broodstock.

Assumed Pathogen Prevalence Level (AAL). The percent of any lot of fish (i.e. 2 percent or 5 percent> that is assumed to have a pathogen at a detectable level using tests outlined in the AFS "Fish Health Blue Book." This level is used to determine the sample size needed to provide a 95 percent confidence level of finding the specified pathogen.

Captive Broodstock. All adult salmonids which have been reared full term in captivity in freshwater for the purpose of collecting eggs and/or milt. This includes stocks which are landlocked for their entire life cycle.

co-managers. Federally recognized Treaty Indian Tribes within Washington State and the State of Washington.

Co-Operators. **All government agencies and entities other than the Co-Managers involved in the rearing and transfer of salmonids in Washington State.**

Confirmed Viral Identification. **The identification of a replicating viral agent by serum neutralization assay or other confirmatory test agreed to by the Co-Managers.**

Egg Disinfection. **The exposure of water-hardened or eyed eggs to a buffered iodophor solution containing at least 100 ppm active iodine for not less than ten (10) minutes. The minimum ratio of iodophor solution to eggs (volume to volume) will be one (1) part iodophor solution to one (1) part eggs. Once this ratio is met, discard the used solution and replace it with fresh disinfectant.**

Epizootic. **The occurrence of an infectious disease which results in an average daily mortality of at lest 0.1 percent within a specific rearing unit for five (5) consecutive days.**

Fish. **Live fin fish, eggs, or gametes thereof including food fish (RCW 75.08.011) and game fish (RCW 77.08.020).**

Fish Health Blue Book. **The most recent edition of "Procedures for the Detection and Identification of Certain Fish Pathogens," published by the Fish Health Section of the AFS.**

Health Management Zone (HMZ). **A geographic area containing one or more watersheds from which the transfer of live fish or gametes are controlled for fish health management purposes. Facilities which have specific pathogen-free water supplies can be islands within an HMZ and have less restrictions on egg and fish transfers out of their facilities than their surface water counterparts. Separate HMZs are listed in the Interim Implementation Plan (Section VII) for eggs and for fish. The Fish Health Management Zones (FHMZ) are small than the Egg Health Management Zones (EHMZ) because of the higher level of risk associated with fish transfers.**

Inspect ion. **The collection and examination of a statistically valid sample of fish tissues and/or fluids for the listed pathogens by or under the supervision of an accredited inspector. Methods used will be those described in the "Fish Health Blue Book" or others mutually agreed to by Co-Managers' fish health staff.**

Iodophor Water-Hardening Eggs. **The exposure of recently fertilized eggs (not more than five(5) minutes exposure to water to a buffered iodophor solution containing at least 75 ppm active iodine for not less than sixty (60) minutes. The minimum ratio of iodophor solution to eggs (volume to volume> will be one (1) part iodophor solution to one (1) part eggs. Discard the used solution once the ratio has been met.**

Isolation. **The process of keeping a group of eggs or fish physically separated from other groups at the same facility for the purpose of preventing cross-contamination with possible pathogens. This is accomplished by incubating/rearing in separate containers which are separated by walls or curtains and without the reuse of each others' incubation/rearing water. A group may consist of an entire lot of fish or be a smaller unit of one lot, such as one day's spawn. Separate equipment is also preferable, but reuse of equipment is acceptable if it is adequately disinfected between isolation units.**

Lot of Fish. **A group of fish of the same species and age that originated from the same discrete spawning population and that have always shared a common water supply. In the case of adult broodstock, various age groups may comprise the same "lot" provided they are of the same species and have shared the same water supply while brood fish.**

Presumptive Viral Identification. **The detection of a replicating agent in cell cultures inoculated with fish tissues or fluids. Presumptive identification is made when cytopathic effect (CPE) is replicated in cell culture.**

Quarantine. **Keeping a group of eggs or fish isolated as defined above with the following restriction: effluent from eggs or fish in quarantine will be disinfected with a residual level of at least 2 ppm chlorine for a minimum of ten (10) minutes of contact time or by other methods acceptable to relevant Co-Managers.**

Release. **The liberation of captive fish into public waters of Washington State that results in their being free-ranging.**

Relevant Co-Managers. **Those Tribes and State agencies which could experience fish health impacts from fish or egg movements within their area of concern.**

Reportable Pathogens. **The following pathogens are reportable:**

Viral - **Infectious hematopoietic necrosis virus (IHNV)**
Infectious pancreatic necrosis virus (IVNV)
Oncorhynchus masou virus (OMV)
Viral hemorrhagic septicemia virus (VHSV)

Bacterial - **Renibacterium salmoninarum**
Strains of Aeromonas salmonicida and Yersinia ruckeri that are resistant to oxytetracycline (Terraamycin), or ormetoprim potentiated sulfadimethoxine (Romet)

Parasite - **Myxobolus cerebralis**

Sanitize. The process of eradicating a fish pathogen from a facility and/or its water supply. Recommended procedures are outlined in Section 6 of the Pacific Northwest Fish Health Protection Committee's Model Policy.

Specific Pathogen-Free Water. Water which is free of specified reportable pathogen(s). This includes untreated groundwater; water which has been treated to approved standards with chlorine, ozone, ultraviolet light, or equivalent; or is demonstrated to be fish-free. Untreated surface water that is free of anadromous stocks is determined to be specific pathogen-free if for the past three (3) consecutive years all captive brood stocks and susceptible juvenile stocks on station have been inspected without detection of the specified reportable pathogen. Inspections must have been conducted using at least the number of fish required to meet the 5 percent APPL and the time period between adult or juvenile inspections must be at least eleven (11) months. In addition, any diagnostic cases involving any stock on site during the same three (3)) years must have been free of the specified reportable pathogen(s).

Transfer. Any movement of fish into or within Washington State to include any movements between hatcheries, rearing facilities, watersheds, or the appropriate Health Management Zones.

Watershed. Geographically distinct river basins which have separate saltwater entrances. May include one or more primary river systems.

Water Supply. The spring, well, stream. river, estuary, or other body of water used in the incubation/rearing of eggs or fish.

III. IMPORT AND TRANSFER PERMITS

Transfers of live fish, eggs, or gametes into or within Washington State are allowed under a permit system implemented by the Co-Managers. The permit system consists of a formal notification process of all proposed egg or fish transfers to all relevant Co-Managers and documentation that the fish or eggs meet the fish health requirements specified in this policy.

A. Egg and Fish Transfer Notification Process

1. Future Brood Document Process:

All Co-Managers and Co-Operators will incorporate their planned program of egg and fish transfers and releases for the coming year (August through August) into the Future Brood Document process coordinated by Washington Department of Fisheries (WDF), see Figure 1.

All proposed programs will be exchanged and reviewed by Co-Manager's fish health staffs for consistency with the fish health policy

between June 1 and July 1. A five (5) year history of reportable pathogens of all facilities and watersheds will be available for review during this time. Final approval of the Future Brood Document will be done on a watershed-by-watershed basis and will require signatures of all relevant Co-Managers by August 1. Upon final approval, the document will become accepted as the Current Brood Program and all transfers and releases listed within will be approved pending results of fish health inspections.

2. Changes to the Future Brood Document:

Any transfer or release of fish which has not been listed in the Current Brood Document requires the requesting Co-Manager or Co-Operator to notify all relevant Co-Managers a minimum of five (5) working days prior to the proposed transfer or release. Changes can be made using WDF's standard application form, SC-161 (Appendix 1), or any other firm that supplies similar information. If the transfer or release is consistent with this policy and thre& are no objections from relevant Co-Managers within five (5) working days after notification, then the transfer or release is approved.

B. Fish Health Information Required for Transfer

The following fish health information is required to be completed and on file with or received by the Co-Manager or Co-Operator of the receiving facility a minimum of two (2) working days prior to the actual transfer of eggs or fish:

1. Information Required for Egg Transfers:

a. A completed copy of the parental brood stock inspection report; and

b. A five (5) year history of reportable pathogens found within the facility and watershed, if this transfer was not part of the Future Brood Document review process.

2. Information Required for Fish Transfers:

a. All egg transfer requirements listed above in Section III.B.1.; and,

b. A completed pre-transfer/release fish health examination report for that lot as stipulated within this document in Section IV.C.1.b.; and

c. A summary of all epizootics and diagnostic cases experienced by that lot.

C. It shall be the responsibility of the receiving facility Co-Manager or Co-Operator to verify that the transfer has been approved and all required fish health reports are completed and received prior to allowing entry of eggs or fish onto their facility.

However, eggs may be transferred or imported prior to completion of the parental broodstock inspection report provided they are kept in isolation if transferred within an EHMZ or, in quarantine if transferred between EMHZs. The receiving facility Co-Manager or Co-Operator must obtain a copy of the completed fish health inspection report prior to releasing the eggs or fish from isolation or quarantine.

D. Imports from outside the United States must also be accompanied by a "Title 50" (50 CFR 16.13(inspection report.

E. A transfer/release request may be denied on the basis of the disease history of the stock and/or facility as determined by the relevant Co-Managers.

IV. FISH HEALTH REQUIREMENTS FOR EGG AND FISH TRANSFERS

Restrictions on egg and fish transfers in Washington State are attempting to reduce pathogen dissemination with HMZs and prevent it between HMZs. Interim EHMZs and FHMZs are identified and explained in Section VII.

A. Egg Transfers Within An EHMZ

1. Eggs from anadromous broodstocks may be transferred within an EHMZ provided the spawning adults are screened for reportable viral pathogens at the following minimum assumed pathogen prevalence levels (APPL):

a. Transfers within watershed--ovarian fluid and kidney/spleen tissues sampled at the 5 percent APPL.

b. Transfers between watersheds but within EHMZ--ovarian fluid sampled at the 2 percent APPL and kidney/spleen tissues at the 5 percent APPL.

2. Eggs from captive broodstocks may be transferred within or between watersheds within an EHMZ provided the spawning adults are screened for reportable viral pathogens at the following minimum APPL:

a. If the transfer is within watershed or the broodstock and site have a negative history for the last three (3) consecutive years--ovarian fluid and kidney/spleen tissues are sampled at the 5 percent APPL; or

b. If the transfer is between watersheds and the broodstock and site have a negative history, but it is less than three (3) years-ovarian fluids are sampled at the 2 percent APPL and kidney/spleen tissues at the 5 percent APPL.

3. All eggs have been water-hardened in iodophor prior to entering the incubation area. If eggs are later transferred to a new facility, they must also be disinfected upon receipt.

4. Eggs are held in isolation at either the sending or receiving facility until the adult health inspection report is completed and received by the facility Co-Manager or Co-Operator.

5. If the adult broodstock test positive for a reportable viral pathogen, suspect eggs can only be transferred within watershed or to another watershed within their EHMZ where the specific virus has been detected within the last five (5) years. Eggs become suspect when:

a. Parents test positive from the suspect eggs' particular spawn day or isolation unit, if the unit is more then 1 day's spawn; or

b. Parents were not tested but of the same lot as positive parents; or

C. Parents tested negative but the eggs were exposed to virus by incubating on surface water containing adults from a positive lot.

If suspect eggs have been previously transferred to a hatchery in another watershed where the specific viral pathogen has not been detected in the last five (5) years, the eggs must be returned to the hatchery of origin or be destroyed. The only exception would be if the eggs are maintained at an approved quarantine research facility. Eggs from particular spawn dates can still be transferred as long as conditions in Section IV.B.1. below are met.

6. If eggs are to be transferred from a watershed where a reportable viral pathogen has been detected within the last five (5) years to a watershed where it has not been detected within the last five (5) years, then conditions in Section IV.B. below must be met (i.e., movement out of an EHMZ).

B. Egg Transfers Outside of An EHMZ

1. Eggs from anadromous stocks may be transferred outside an EHMZ only if:

a. All adults from a specific spawn date, whose progeny are to be transferred, have had their sex products (ovarian fluid and milt) or kidney/spleen tissues screened for viruses at the 100 percent level. If sex products are screened, kidney/spleen tissues will be also screened at the 5 percent APPL. If the adults are from an EHMZ with a positive isolation of IPNV in the previous five (5) years, they must have their kidney/spleen tissues screened at the 100 percent APPL. All samples from that spawn date must be negative; and

b. Eggs are incubated on specific pathogen-free water in isolation (maximum unit being the one lot, minimum for transfer in 1 spawn day) until transferred. Or they can be held in quarantine at the receiving facility until the adult health inspection report is completed.

2. Eggs from captive broodstocks may be transferred outside of an EHMZ only if they meet all the conditions in Section IV.B.l. above; or

a. The broodstock from which the eggs come are reared in reportable virus-free water; and

b. The eggs in question are incubated in reportable virus-free water; and

c. The parental broodstock have been tested and found negative for reportable viral pathogens at the following APPL:

(1) If the broodstock and site have a negative history for the last three (3) consecutive years--ovarian fluid and kidney/spleen tissues sampled at the 5 percent APPL; or

(2) If the stock or site does not have a negative three (3) year history--100 percent sampling of sex products or kidney/spleen tissues from males and females, and, if sex products are sampled, kidney/spleen tissues sampled at the 5 percent APPL; or,

(3) If a facility has been sanitized and brood are the result of introduction of eggs from inspected brood--ovarian fluid sampled at the 2 percent APPL and kidney/spleen at the 5 percent APPL.

3. All eggs have been water-hardened in iodophor prior to entering the incubation area. If eggs are later transferred to a new facility, they must also be disinfected upon request.

4. Identification of a reportable viral pathogen in adult broodstock will prevent the transfer of all eggs taken from that particular spawn date to another EHMZ unless they are to be held in an approved research quarantine facility. If eggs have previously been transferred to a hatchery in which the reportable viral pathogen has not been detected within the last five (5) years, the eggs must be returned to the hatchery of origin or destroyed. Eggs from other spawn dates can still be transferred as long as their parents test negative and all conditions above are met.

C. Fish Transfer Within A FHMZ

1. Fish may be transferred within a FHMZ provided that all of the following reports are completed and on file with or received by the Co-Manager or Co-Operator of the receiving facility of two (2) working days prior to the transfer:

a. An adult health inspection report on parental broodstock. The screening for this report will be at a minimum of the APPLs in Section IV.A.l. and 2. (note the differences between FHMZ and EHMZ).

b. The specific lots to be transferred must ha an onsite pre-transfer/release health examination if they have been on untreated surface water. This examination is to be conducted by the relevant Co-Manager's or Co-Operator's fish health staff no longer than six (6) weeks prior to transfer. Pathologist is to examine fish from the lot which is to be transferred for clinical signs and test for the presence of pathogens. An onsite pre-transfer/release health examination is not required for any lot which has been reared full term on specific reportable pathogen-free water.

C. A summary of all epizootics and diagnostic cases experienced by the lots to be transferred.

d. A five (5) year history of reportable pathogens found within the facility and watershed, if this transfer was not part of the Future Brood Document review process.

2. Fish transfers between watersheds within a FHMZ are permitted provided that the transfer does not expose the receiving watershed to a reportable bacterial or parasitic pathogen which has not been detected there within the last five (5) years.

3. Fish which test positive for a reportable viral pathogen will not be transferred out of their natal watershed unless the transfer is to an approved quarantine research facility.

4. Transfers of fish with exposure to a reportable viral pathogen can occur between watersheds within a FHMZ if both watersheds are positive for the specific reportable viral pathogen within the last five (5) years. The fish must be sampled four (4) weeks prior to transfer at the 2 percent APPL for reportable viral pathogens and be negative. Fish are considered exposed in the following situations:

a. Parents tested positive from their particular spawn day or isolation unit, if the unit is more than 1 day's spawn; or

b. Parents were not tested but were of the same lot as the positive parents; or,

C. Parents tested negative but the fish were incubated/reared in surface water containing adults from a positive lot.

5. If fish are to be transferred from a watershed where a reportable viral pathogen has been detected within the last five (5) years to a watershed where it has not been detected within the last five (5) years, then conditions in Section IV.D. below must be met (i.e., movement of fish outside of a FHMZ).

D. Fish Transfers Outside of A FHMZ

1. The conditions in Section IV.C.1. and 2. (fish transfers within a FHMZ) must be met before any fish can be transferred outside of a FHMZ.

2. Fish may be transferred outside of a FHMZ if:

a. The fish are to be transferred from fresh to saltwater or from sale to freshwater; or,

b. The fish have been reared on specific reportable pathogen-free water; and,

(1) All anadromous adults from a specific spawn date, whose progeny are to be transferred, have their sex products (ovarian fluid and milt) or kidney/spleen tissues screened for reportable viral pathogens at the 100 percent level. If sex products are screened. kidney/spleen tissues will also be screened at the 5 percent APPL. If the fish are from a FHMZ with a positive IPNV isolation the adults must have their kidney/spleen tissues screened at the 100 percent level. All samples from that spawn date must be negative; or,

(2) The facility has no anadromous adult stocks and the parental broodstock have been tested and found negative for reportable viral pathogens at the following APPL:

(a) If the parental broodstock and site have a negative history during the last three (3) consecutive years--ovarian fluid and kidney/spleen tissues sampled at the 5 percent APPL; or,

(b) If the stock or site does not have a three (3) year history--100 percent sampling of sex products (ovarian fluid and milt) and kidney/spleen tissues sampled at the 5 percent APPL.

(c) If a facility has been sanitized and brood are the result of introduction of eggs from inspected brood--ovarian fluids sampled at the 2 percent APPL and kidney/spleen tissues at the 5 percent APPL.

3. Fish movements outside of an FHMZ are permitted as above in Section IV.D.2., provided that the transfer does not constitute a new exposure this year of a reportable bacterial or parasitic pathogen to the receiving facility or water supplies affecting other facilities, and the transfer is acceptable to the relevant Co-Managers.

4. Fish which test positive for a reportable viral pathogen will not be transferred out of their natal watershed unless the transfer is to an approved quarantine research facility.

5. Fish reared on surface water containing anadromous adults cannot be transferred out of their zone except for conditions specified in Section IV.D.2.a. (i.e., transfer to salt water).

V. DIAGNOSIS AND PATHOGEN REPORTING BETWEEN CO-MANAGERS AND CO-OPERATORS

A. Presumptive and confirmed identification of any replicating viral agent within any stock and/or site will require notification of Co-Managers' and Co-Operators' fish health staff in writing within two (2) working days to allow for increased sampling or other control measures at facilities within the affected area.

B. Epizootics due to undetermined cause(s) or reportable pathogens will require notification in writing (within two (2) working days) of the relevant Co-Managers' and Co-Operators' fish health staff.

C. Semiannual reporting of all reportable pathogens will occur between Co-Manager and Co-Operators. This exchange currently takes place through the Pacific Northwest Fish Health Protection Committee's Model Fish Health Program.

D. Semiannual meetings will occur between the Co-Managers' and Co-Operators' fish health staffs to ensure good communications.

VI. HEALTH INSPECTION PROCEDURES

A. The minimum procedures for inspection are described in the current edition of the AFS "Fish Health Blue Book."

B. Co-Managers or Co-Operators, with mutual agreement, may utilize new procedures that are technically superior.

C. Specimens submitted for viral assay will be tested on EPC (Epithelioma Papillosum Cyprini) and CHSE-214 (Chinook Salmon Embryo 214) cell culture systems or other systems as agreed to by Co-Managers' and Co-Operators' fish health staffs.

VII. INTERIM IMPLEMENTATION PLAN

The Co-Managers recognize that certain components of this policy cannot be implemented without modifications to some enhancement facilities and that necessary funding may take several years to obtain. Therefore, it will be the responsibility of the Co-Manager's lead pathologists to identify i the Future Brood Document Review process each of their proposed egg or fish transfers which do not meet this policy. These lists will be provided at the Co-Managers' annual program review to highlight necessary changes to facilities or programs. The lead pathologists will also provide any recommended changes to this policy at the Co-Managers' annual program review.

Below are the interim egg and fish health management zones. The interim manaqement zones for fish transfers are smaller than those for eggs because of the higher level of risk associated with fish transfers.

A. Egg Health Management Zones

1. Puget Sound tributaries north of the Lake Washington watershed up to the Canadian border, including the San Juan Is land (FHMZs l-3 listed below).

2. Lake Washington watershed.

3. Tributaries of East Kitsap Peninsula and Puget Sound south of the Lake Washington watershed.

4. Hood Canal and Port Gamble tributaries.

5. Strait of Juan de Fuca tributaries.

6. Pacific Coast tributaries north of Grays Harbor (FHMZs 8-11 listed below).

7. Grays Harbor and Willapa Bay tributaries.

8. Columbia River watershed.

B. Fish Health Management Zones

1. Puget Sound tributaries north of Swinomish Slough up to the Canadian border, including the San Juan Islands.

2. Skagit watershed.

3. Puget Sound tributaries south of and including the Stillaguamish watershed down to the Lake Washington watershed.

4. Lake Washington watershed.

5. Tributaries of East Kitsap Peninsula and Puget Sound south of the Lake Washington watershed.

6. Hood Canal and Port Gamble tributaries.

7. Strait of Juan de Fuca tributaries

8. Tributaries south of Cape Flattery down to and including the Ozette watershed.

9. Quillayute watershed.

10. Hoh watershed.

11. Queets and Quinault watersheds.

12. Grays Harbor tributaries.

13. Willapa Bay tributaries.

14. Columbia River watershed.

It is the Co-Managers' intent to implement the HMZs during year one (August 1, 1991). However, fish transfers which do not meet the policy will still be allowed, provided that proper notification/approval occurs, and the transfer does not expose a watershed to a reportable pathogen where it has not been detected within the last five (5) years. After August 1, 1997, general dispensation from the policy as allowed above will no longer occur. Further, on an annual basis the FHMZs will be reviewed in an attempt to reduce their size as is determined to be appropriate.

Exceptions to this policy will be allowed on a case-by-case basis as approved by relevant Co-Managers.

FUTURE BROOD DOCUMENT REVIEW PROCESS

The Future Brood Document (HATPLAN) is the mechanism used to annually notify and update all fisheries Co-Managers of hatchery escapement needs, egg requests, production plans, and proposed transfers of eggs and fry. The review process is as follows:

WDF solicits future brood plans
(January)

↓
↓

Co-Managers and Co-Operators update and submit plans
(February-March)

↓
↓

Draft Future Brood Document produced
(April-May)

↓
↓

Co-Managers, Co-Operators, and Fish Health Technical
Staff review plans on a watershed basis
(June)

↓
↓

Final Draft Document produced and mailed for signatures
(July 1)

1
1

Co-Managers review and sign final document
(returned by August 1)

↓
↓

Current Brood Program
(August 1)

APPENDIX

WASHINGTON DEPARTMENT OF FISHERIES

APPLICATION

NO_____

for Import or Transfer of Live Fin Fish and/or
the Viable Sexual Products thereof in Washington State
(Please print or type Items 1-10)

1. Name of Appl i cant or Agency_____
2. Project Manager_____ Phone Number_____
   Mailing Address_____
3. Objective of Proposal : ☐ Import ☐ Export ☐ Transfer ☐ Release
   Explanation (Include name of shipping facility):_____
4. Species (common)(s c i e n t i f i c)_____
5. Origin-Sate_____ watershed Faci 1 i t y_____
6. Number (eggs/fish)_____ Size (# per lb.) _____ Brood Year_____
7. Destination of stock (provide map)_____
   _____ Sec. _____ Twnshp. _____ Rng. _____

a. Detail transport equipment and procedures (include dates)_____

9. Disease history of stock, shipping facility and watershed of origin (include history for the past five brood years)
   *Virus - IHNV_____ IPNV_____ Egtved virus_____ Others_____
   (Bacteria - BKD_____ Aeromonas salmoni cida_____Yersi nia ruckeri_____
   Parasite - Hyxobol us cerebral is_____ PKD_____ Ceratomyxa shasta_____
   *List the date of the most recent isolation by the respective pathogen.

10. Date of Last Disease Inspection_____ Inspecting Pathologist _____
    Pathologist's Address_____ Phone No._____
    (attach signed Pathologist's report to application)
    Dates of Disease Inspections in past five years (include name of Inspecting Pathologist_____

11. Appl i cant's Signature_____ Date_____

PERMIT

Comments_____

Provisions_____

_____ Expi rati on Date_____

Failure to comply with any provisions of this permit or to perform any act not included in this pemit shall be ground for revocation of this pemit and shall constitute a gross misdemeanor (RCW 75.58.0.10, WAC 220-20-039, WAC 220-77).

☐ Approve ☐ Not Approved Date_____
☐ Additional provisions attached

AQUACULTURE DISEASE CONTROL

WAC 220-77-010 INTENT. **The intent of this chapter is to establish rules to protect the aquaculture industry and wild stock fisheries from a loss of productivity due to aquatic diseases or maladies. These rules will identify the conditions that will be required for transfer and importation of live aquaculture products and the circumstances when action will be taken to control disease. These rules have been developed jointly by the Department and the Department of Agriculture.**

WAC 220-77-020 DEFINITIONS--AQUACULTURE DISEASE CONTROL. **For purposes of this chapter, the following definitions apply:**

1. "Aquaculture products" **are defined as private sector cultured aquatic products propagated, farmed, or cultivated on aquatic farms under the supervision and management of an aquatic farmer, or such products naturally set on lands under the active supervision and management of an aquatic farmer.**

2. "Disease" **is defined as infection, contagious disease, parasite, or pest, occurring on or within the aquaculture product or on or within the water and substrate associated with the aquaculture product, or an occurrence of significant mortality suspected of being of an infectious or contagious nature.**

3. "finfish" **is defined as live fish, fish eggs, or fish gametes, but not to include aquaria species commonly sold in the pet store trade when raised in indoor containers, indigenous marine baitfish, or mosquito fish.**

4. "Shellfish" **is defined as all members of the phyla mollusca, arthropoda, and echinodermata.**

5. "Epizootic" **is defined as the occurrence of a specific disease which can be detected in 50 percent of the mortality or moribund individual fish in an affected container, and which results in an average daily mortality of at least one-half of 1 percent of the affected individual fish for 5 or more days in any 30-day period.**

6. "Marine plant" **is defined as nonvascular plants belong to the phlya Chlorophyta, Phaeophyta, or Rhodophyta and vascular plants belonging to the family Zosteraceae when growing in marine or estuarine waters, and includes the seeds, spores, or any life-history phase of the plants. "Marine plants" do not include aquaria plants or phytoplankton.**

7. "Working day" **is defined as any day other than Saturday, Sunday, or a Washington State holiday.**

8. "Department" **is defined as the Department of Fisheries.**

9. "Quarantine" is defined as isolation of the organism in a Department approved facility.

10. "Pest" is defined as parasite, parasitoid, predator, or fouling agent.

WAC 220-77-030 FINISH AQUACULTURE DISEASE CONTROL

1. It is unlawful for any person to import into or transport with the State of Washington finfish aquaculture products without first having obtained a permit to do so issued by the Department. A copy of the permit shall accompany the finfish aquaculture products at all times within the State of Washington, and must be presented upon request to Department employees.

2. The Director may impose permit conditions as necessary to ensure the protection of aquaculture products and native finfish from disease when the Director concludes that there is a reasonable risk of disease transmission associated with the finfish aquaculture products.

3. Upon confirmed diagnosis of viral hemorrhagic septicemia, or confirmed diagnosis of whirling disease, infectious hematopoietic necrosis, or infectious pancreatic necrosis in a previously uninfected lot, the Department must be notified by the end of the following working day after diagnosis by an accredited pathologist.

4. The Director will issue, upon request, a pamphlet containing policy guidelines for importers and transferors of finfish aquaculture products.

5. The Director will issue or deny a permit within 30 days after a completed application containing all requested information is received by the Department.

6. Violation of these rules or the conditions of the permit may result in the suspension or revocation of the permit.

7. In the event of denial, suspension or revocation of an importation or transfer permit, the affected person may appeal the decision to the Director. Additional appeals may be made through the Administrative Procedure Act (Chapter 34.04 RCW). A suspended or revoked permit will remain suspended or revoked during the appellate process.

WAC 220-77-040 SHELLFISH AQUACULTURE DISEASE CONTROL.

1. It is unlawful for any person to import into or transport within the State of Washington shellfish aquaculture products for planting in Washington waters, without first having obtained a permit to do so issued by the Department. A copy of the permit shall accompany the shellfish aquaculture products at all times within the State of Washington, and must be

presented upon request to Department employees. Possession of an oyster transfer permit issued under RCW 74.24-.llO will meet the requirements of this subsection.

2. The Director may impose permit conditions as necessary to ensure the protection of aquaculture products and native shellfish from disease when the Director concludes that there is a reasonable risk of disease transmission associated with the shellfish aquaculture products.

3. For established species and established routes of commerce, the Department will issue import and transfer permits if the following criteria are met:

a. A regular pattern of importation with no more than a l-year time lapse between importations.

b. Documentation of recent mortality and disease history of the shellfish aquaculture product in the are of origin showing a lack of significant mortality.

c. Verification that there has been no introduction of diseased stocks into the area of origin.

d. Documentation that the shellfish aquaculture product proposed for import is from the approved area.

4. For established species not from established routes of commerce. the Department will additionally require the following before deciding whether to issue an import or transfer permit:

a. Documentation of mortality and disease of the shellfish aquaculture product for the past 10 years from the area of origin, together with similar information for closely related species, if deemed necessary.

b. A history of those diseases in the area of origin that may affect aquaculture products or native fauna and flora.

c. When applicable, documentation of an agreement with the appropriate governmental agency with management responsibility in the area of origin.

5. For nonestablished species, the Department will additionally consider the following criteria, which will require the importer to provide a detailed life history and comply with the requirements of SEPA:

a. The capability of the receiving facility to hold the shellfish aquaculture product in quarantine.

b. The ability of the shellfish aquaculture product to naturally reproduce or interbreed with endemic species in State waters.

c. The ability of the shellfish aquaculture product to Compete with or prey upon endemic species.

6. For purposes of verification of the disease-free status of shellfish aquaculture products in subsections 3, 4, and 5 of this section, the Department may require sufficient samples for histological evaluation either prior to or after subjecting the shellfish aquaculture products to stress tests to detect latent disease conditions. In the event of failure to obtain permit approval, consideration will be given to introduction after hatchery production of a second generation stock.

7. Violation of these rules or the conditions of the permit may result in the suspension or revocation of the permit.

8. In the event of the denial, suspension, or revocation of an importation or transfer permit, the affected person may appeal the decision to the Director. Additional appeals may be made through the Administrative Procedure Act (Chapter 43.04 RCW). A suspended or revoked permit will remain suspended or revoked during the appellate process.

WAC 220-77-050 AMPHIBIAN AQUACULTURE DISEASE CONTROL.

1. It is unlawful to import into the State of Washington amphibian aquaculture products without having first obtained a permit to do so issued by the Director.

2. It is unlawful to possess African clawed frogs for aquaculture.

WAC 220-77-060 MARINE PLANT AQUACULTURE DISEASE CONTROL.

1. It is unlawful for any person to import into the State of Washington marine plant aquaculture products without having first obtained permit to do so issued by the Department. A copy of the permit shall accompany the imported marine plant aquaculture products at all times until the initial point of entry into the marine environment, and must be presented upon request to Department employees.

2. The Director may impose permit conditions as necessary to ensure the protection of aquaculture products and native marine plants from disease or pests when the Director concludes there is a reasonable risk of disease or pest transmission associated with marine plant aquaculture products.

3. For Porphyra yezoensis and P. tenera, the Director will issue import and transfer permits if the plants are in the form of:

a. Unialgal conchocelis culture of free living material; or

b. Conchocelis-phase culture in shells after the shells and conchocelis have been washed and soaked in fresh water for at least 24 hours; or

c. Blade phase on netting after 2 weeks at a temperature of minus 20 degree centigrade or lower.

4. For import of other species the Department will consider at least the following criteria, which may require the importer to provide a detailed life history and comply with the requirements of SEPA:

a. The ability of the marine plant aquaculture product to naturally reproduce or interbreed with existing species in State waters.

b. The ability of the marine plant aquaculture product to compete with existing species.

5. Importation of marine plant aquaculture products for scientific study in a laboratory or under other controlled conditions is allowed without having obtained a permit when measures are taken to prevent release of the products or release of their gametes, spores, or tissue fragments into State waters. The Director may inspect facilities to ensure appropriate control measures.

6. For purposes of verification of the disease-free status of the marine plant aquaculture product in subsection 3, 4, and 5 of this section, the Department may require sufficient sample for evaluation. In event of failure to obtain permit approval, consideration will be given to introduction after laboratory production of a second generation.

7. It is unlawful to transfer marine plant aquaculture products between any of the following geographic areas without having first obtained a transfer permit: Columbia River; Pacific Ocean waters; Willapa Harbor; Grays Harbor; Puget Sound. No transfer permit is necessary for transfer within any of the geographic regions described above. When required, a copy of the transfer permit shall accompany the marine plant aquaculture products at all times until the products are reintroduced into State waters, and the transfer permit must be presented upon request to Department employees.

8. Violation of these rules, or the condition of any permit may result in suspension or revocation of the permit.

9. In the even of denial, suspension, or revocation of an importation or transfer permit, the affected person may appeal the decision to the Director. Additional appeals may be made through the Administrative Procedure Act (Chapter 34.04 RCW). A suspended or revoked permit will remain suspended or revoked during the appellate process.

WAC220-77-070AQUACULTUREDISEASECONTROL--EMERGENCYPROVISIONS.

1. The Director may take the following emergency enforcement actions when evidence indicates these actions are necessary to protect aquaculture products and native stocks from disease or severe mortality from an unexplained source:

a. Deny issuance of an import or transfer permit.

b. Quarantine the aquaculture products.

c. Confiscate or order the destruction of the aquaculture products.

d. Require removal of the aquaculture product from State waters.

2. Confiscation or destruction will be ordered without a hearing if confirmed diagnosis by an accredited pathologist is made that finfish aquaculture products are infected with the causative agent of viral hemorrhagic septicemia (Egtved virus).

3. For finfish, shellfish, amphibian, and marine plant aquaculture products:

a. Isolation may be ordered without a hearing when aquaculture products are transferred without appropriate inspections or permits or transferred in violation of the conditions of a permit.

b. Isolation may be ordered without a hearing when evidence demonstrates that aquaculture products, previously imported, may introduce a disease not known to occur in Washington.

4. For finfish aquaculture products, an epizootic of whirling disease, infectious hematopoietic necrosis or infectious pancreatic necrosis may result in quarantine, confiscation, or destruction, subject to the aquatic farmer's right to an emergency departmental hearing, if confiscation or destruction are ordered.

5. For shellfish aquaculture products, an outbreak of serious mortality in which contagious disease is suspected may result in quarantine or require removal of the suspected diseased shellfish aquaculture products from State waters, subject to the aquatic farmer's right to an emergency departmental hearing, if removal from State waters is ordered.

6. When there is evidence that continued presence of aquaculture products in State waters may cause disease that would harm other aquaculture products or native fauna or flora, the Director may order quarantine. confiscation, destruction, or removal from State waters. Except as provided for in subsection 2 and 3 of this section, the aquatic farmer has a right to a departmental hearing. In the event the Director has ordered emergency action

of confiscation, destruction, or removal from State waters, the Director shall give notice to the affected aquatic farmer. At the time of notice of emergency action, the affected aquatic farmer may request an emergency departmental hearinq. If reauested. the hearing will take place no later than the third working day after notice is received by the aquatic farmer. The hearing will be presided over by a hearing officer appointed by the Director, who will consider the severity of the disease outbreak, remedies, and alternate courses of action. The hearing officer shall present a recommendation to the Director. The Director will then review the emergency action and, if appropriate, order confiscation, destruction, or removal from State waters. If so ordered, the emergency action will take place no sooner than 48 hours after the order. If no request for an emergency departmental hearing is received, the emergency action of confiscation, destruction, or removal from State waters, may take place immediately after the third working day after the notice is received by the aquatic farmer.

7. If the Department refuses to issue an import or transfer permit, or orders quarantine or isolation of aquaculture products, the aquatic farmer has a right to a hearing under the Administrative Procedure Act (Chapter 34.04 RCW).

Policy relating to the import or transfer of "private sector cultured aquatic products" (RCW 15.85.020).

1. The Director recognizes that several transfers from one facility to others may occur in a given year (January 1 to December 31). It will be permitted to make an unlimited number of such transfers that year provided that:

a. A permit or copy of the permit issued by the Director accompanies each transfer.

b. Each lot of fish or eggs, transferred is specifically listed in the transfer permit.

c. No change has occurred in the disease status of the lot of fish or eggs, transferring facility, or water supply or transferring facility between the time of last inspection and the time of transfer.

d. At least one inspection of the same species in the water supply from which the fish are to be transferred has been conducted within the preceeding 12 months.

2. Except for eyed eggs and sperm from inspected male broodstock, live fish, eggs, or gametes of any salmonid will not be imported into Washington State from outside North America. These imports will be allowed by the Director only if all the following conditions are met:

a. All eyed eggs to be imported and eggs fertilized with imported sperm must be:

(1) Incubated in specific pathogen-free water (i.e., Egtved virus, Myxobolus Cerebralis, IHNV, IPNV) at country of export.

(2) Disinfected in iodophores upon arrival at receiving facility.

(3) Held in quarantine at receiving station from time of arrival to ninety (90) days after swim-up. Department of Fisheries will be notified by phone and in writing of place and time of importation and time of swim-up. Notification will be at least 10 days prior to'the occurrence of these events.

(4) Prior to removal of fry from quarantine, the fry will be inspected by an accredited pathologist for viral pathogens. Results of this inspection will be reported to the Director.

(5) Department of Fisheries will be notified within 24 hours by phone and writing if mortality during quarantine exceeds 0.5 percent/day of any lot.

b. The parent broodstock of the eggs or sperm to be imported must be:

(1) Inspected according to the most current Title 50 Regulations (U.S. Title 50) by a Title 50 inspector approved by the Director.

(2) In addition to the Title 50 inspection, the parent broodstock must also be inspected for IHNV and IPNV. These inspections must be conducted according to the methods prescribed in the most current edition of the "Blue Book."

(3) The identification of any replicating virus in tissue culture may be ground for denial of an import permit.

c. Records must be made available to the Department of Fisheries prior to import of that document:

(1) All inspections of broodstocks from egg-taking/rearing facilities.

(2) All inspections of juveniles or other fish at the rearing facilities.

d. Importation of eyed salmonid eggs and salmonid sperm from outside North America will only be considered after an accredited pathologist approved by the Director has:

(1) Inspected rearing/shipping facilities.

(2) Examined health records as required in Section 2.c.

(3) Documented that the eggs were incubated in specific pathogen-free water as stipulated in Section 2.a.

(4) Examined laboratories and procedures of pathologists conducting fish health inspections to ensure proper methodology is being followed.

(5) The cost of the inspections shall be paid by the importers of the eggs/sperm, excluding the inspector's salary. The cost shall be determined by the Director and prorated among the importers. The Director shall specify the time and manner of payment.

e. The eggs/sperm will be contained in a shipping container which, at the time of offer for entry into Washington State, will have attached the Title 50 certification, and approved Washington State import/transfer permit, and an affidavit signed by the Title 50 inspector vouching for the origin of the eggs/sperm (i.e., specific facility(s) which was the source of the eggs/sperm).

(VS10-PJSR-4709W) 10/27/92

INTEGRATED HATCHERY OPERATIONS: EXISTING POLICY AFFECTING HATCHERIES IN THE COLUMBIA RIVER BASIN

ANNUAL REPORT 1992

Prepared by:

Bill Hutchison

Idaho Department of Fish and Game

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-362 1

Project Number 92-043
Contract Number DE-BJ79-9 1 BP60629

MAY 1993

INTEGRATED HATCHERY OPERATIONS TEAM

Exinsting Policy's Affecting Hatcheries

IDAHO

A. INTRODUCTION

1. Purpose

Title 36, Idaho Code, declares fish and wildlife to be the property of the State of Idaho and mandates the Idaho Fish and Game Commission to "preserve, protect, and perpetuate such wildlife and provide for the citizens of the State and as by law permitted to others, continued supplies of such wildlife for hunting, fishing, and trapping." Under the Commission's guidance, the Idaho Department of Fish and Game (Department) manages the fish and wildlife of the State.

Anadromous fish management efforts encompass the fish management, research, and hatchery sections of the Department. Management activities include manipulation of fish population levels, hatchery production, fish habitat protection and enhancement, and development of harvest regulations for anadromous fish.

2. Historical Review

a. Species Review

Idaho's hatchery capacity and production of chinook and steelhead has increased in an attempt to offset losses to natural production and migration survival. Between 1980 and 1990, artificial production of salmon and steelhead essentially doubled. Hatchery-produced adults, fry, and smolts have been used to attempt to rebuild naturally-produced populations. However, contrary to expectations, low smolt-to-adult rates due to migrant juvenile mortalities have generally held hatchery supported chinook runs at or below maintenance levels of abundance.

Hithout improved smolt-to-adult survival, current artificial production programs will fail to produce consistent harvestable surpluses of adult salmon. Furthermore, recent studies (Reisenbichler and McIntyre 1977; Chilcote et al. 1986; Nickelson et al. 1986) of wild and hatchery fish interactions in the natural environment emphasize that healthy wild fish populations represent a critical genetic resource necessary for maximising natural production from existing habitat and can represent a source of broodstock to assure continued strength of hatchery programs. Elements of genetic fitness and diversity that make a wild population successful cannot be replaced by hatchery fish over the long term.

Hatchery steelhead programs have been successful and Idaho hatchery steelhead are now a major component of summer steelhead runs entering the Columbia River. In general, Idaho's harvest of hatchery steelhead has increased to levels equal to or exceeding harvest in the 1960s. Since the mid-1980s, marked smolts have enabled anglers in terminal areas to selectively harvest hatchery fish and minimize impacts on naturally-produced fish. Steelhead hatchery capacity has increased tremendously since the 1960s when Idaho Power Company initiated spring chinook and steelhead artificial production in the Salmon drainage as mitigation for the construction of the Hells Canyon Dam complex. Hatchery-produced adults, fry, and smolts have been used in attempts to supplement and enhance naturally-produced populations.

Fall chinook hatchery propagation efforts, initiated following construction of Hells Canyon Dam, were unsuccessful. Attempts were also made to expand fall chinook production in the Clearwater drainage with plants of eggs in the 1960s. Currently, Lyons Ferry Hatchery, Washington, rears fall chinook from broodstock obtained by trapping adults at Ice Harbor Dam and adult returns to the hatchery. Prior to completion of Lyons Ferry, the Snake River Egg Bank Program collected adults at Ice Harbor Dam and transferred adults and eyed eggs to other facilities for rearing to develop a Snake River fall chinook egg source.

b. Spring, Summer. and Fall Chinook

Idaho Power Company and the Department have experimented with rearing fall chinook at Oxbow Hatchery, but poor water quality and high temperatures have limited production. There has been no hatchery production of fall chinook above Lower Granite Dam in recent times. The Lyon's Ferry fall chinook program, located downstream from Little Goose Dam, was initiated during the 1980s to perpetuate Snake River fall chinook as part of the Lower Snake River Compensation Program (LSCRCP). Plans call for Idaho Power Company to develop a fall chinook mitigation program capable of producing 1,000,000 smolts for release at points in the Snake or Columbia Rivers, as determined by the fishery agencies. To date, fall chinook eggs have not been available from Lyon's Ferry to initiate an Idaho Power Company mitigation program.

Even though chinook hatchery capacity increased with the addition of the Clearwater Anadromous Fish Hatchery (CAFH) satellite ponds, return of sufficient broodstock to maintain artificial production programs remains questionable under current migration conditions. Estimates of recent smolt-to-adult return rates for Idaho's hatchery chinook have been less than 0.3 percent. Lou water years generally also translate into low, warm water at hatchery facilities which affects early rearing survival and prespawn mortality. Hatchery production of quality fish which can survive under existing adverse conditions will become even more crucial in the next decade. However, initial results from erythromycin feeding are promising. Fish fed erythromycin during rearing appear to have decreased levels of Bacterial Kidney Disease (BKD) at release but as yet, it is now known if this translates into improved smolt-to-adult survival.

Steelhead hatchery production supports Idaho's anadromous fish harvest management program. Record harvests have occurred over the last 5 years. Hatchery smolt capacity increased with the addition of Magic Valley Steelhead Hatchery in 1985. Spawning escapement goals generally have been met, but daily and season bag limits have often been reduced to ensure that egg needs were met. Minimum length restrictions have been in place since 1988 to protect B-run broodstock returning to the East Fork Salmon River in an attempt to provide sufficient numbers of eggs to establish this run. Smolt-to-adult survival back to hatchery racks have generally ranged from 01.2 to 1.4 percent for A-run fish and 0.1 to 0.7 percent for B-run fish for recent adult return years. These survival percentages include fishery exploitation rates in Idaho.

B. ANADROMOUS FISH PROGRAM GOALS, POLICIES, AND STRATEGIES

1. Long-Range Anadromous Fish Program Goals

Compatible with the Statewide goals, long-range goals specific to the anadromous fish program are as follows:

- Maintain genetic diversity and integrity of both naturally-produced populations and artifically-produced fish used for natural production enhancement. Maintain natural production and productivity of wild and natural anadromous fish populations, where natural production potential is significant,

- Survival should support: annual harvest seasons; productive, self-sustaining populations of naturally producing fish; and hatchery escapement goals.

The Department will maximize opportunity to fish for and harvest hatchery-produced fish, contingent upon maintaining long-term hatchery production and productivity, and minimizing impacts to naturally spawning populations. Short-term determination of annual sport fishing opportunities will be based on the best available scientific information.

Genetic Considerations. Over the last decade, wild fish did not rebuild while hatchery production increased. As a result, an imbalance of wild and hatchery spawners has occurred. Excessive hatchery spawners may pose significant risks to wild fish population maintenance and for accomplishing short- and long-term genetic management strategies and objectives. Fisheries geneticists, managers, and user groups have elevated concerns about salmon and steelhead genetics and the potential for management practices to degrade long-term stock productivity by changing heritable traits. Genetic uncertainties question whether the viability of hatchery populations can be sustained without infusions of new genetic material which incorporates evolutionary history of wild fish, and warn against the alteration of the genetic composition of native fish by hatchery fish introgression.

2. Policies and Principles

The following fisheries policies are from the "IDFG Policy Plan, 19902005."

Policy 1. Idaho waters will be managed to provide optimum sport fishery benefits.

Principles:

- Natural, wild, and hatchery stocks will be managed to provide long-term fishery benefits at optimal levels of production.
- Known stock harvest opportunities for hatchery salmon and steelhead will be developed.
- Current, established hatchery operations will be managed primarily to provide fish for harvest and secondarily to provide fish for supplementation programs. Hatchery produced salmon and steelhead smolts for harvest and sustaining general hatchery production will be marked prior to release.
- Fishing opportunity on hatchery stocks will be constrained to the extent necessary to maintain hatchery production at or above 80 percent of hatchery design smolt capacity.
- Future development of Idaho Snake River fall chinook and sockeye artificial propagation and harvest will be compatible with genetic and natural production preservation guidelines.

Policy 2. Wild native populations of resident and anadromous fish species receive priority consideration in management decisions.

Principle:

- Smolt release sites and strategies for hatchery fish will be selected to minimize risk of straying and spawning with wild fish.

Policy 6. Hatchery-reared fish will be stocked to establish or reestablish depleted fish populations, and to provide angling opportunity to the general public.

Principles:

- Hatchery production programs will be managed to minimize adverse effects on wild and natural anadromous fish populations.
- The Department supports supplementing specific populations using a conservation hatchery concept and evaluating results through adaptive management while research results are being assembled.

- Hatchery production of fish for harvest will be managed to maintain hatchery productivity, produce the greatest percentage of returning adults, and maximize return to the Idaho angler.

- Hatchery production for rebuilding natural production will be managed so that hatchery fish remain genetically and behaviorally compatible with the natural populations to the greatest extent possible.

- Possible supplementation for rebuilding will utilize natural rearing habitat to produce smolts and subsequent adults. Adults that return will be for spawning, production of future generations, and rebuilding populations sustained by natural reproduction to harvestable levels.

- Population supplementation for harvest augmentation will utilize natural rearing habitat to produce smolts and subsequent adults. Adults that return will be used for harvest.

- Eggs or carcasses of adult salmon or steelhead returning to anadromous fish hatcheries will not be sold.

- Rearing of anadromous salmon or steelhead for commercial purposes in private hatcheries outside of Department control will not be allowed. Anadromous fish such as coho released into lakes and reservoirs where they are not intended to migrate to the ocean are exempt from this principle.

Policy 7. The Department will strive to maintain the genetic integrity of wild native stocks of resident fish and naturally managed anadromous fish when using hatchery supplementation.

Principles:

- Wild, native stocks will not be supplemented.

- Hatchery fish used for supplementation will be representatives of stock endemic to the drainage to be supplemented or, as second priority, of stock from adjacent and environmentally similar drainages.

- Maintaining adequate escapement of natural spawning fish adjacent to hatchery brood collection weirs will be given priority in hatchery management decisions so that the genetic fitness of natural populations needed to support long-term natural and hatchery productivity are sustained.

Policy 8. Non-native species of fish will be introduced only in waters where they are not expected to adversely impact stocks of wild native fish.

Principles:

- Reintroduction of non-native coho or sockeye will only be undertaken if feasibility studies indicate that significant potential impacts on existing species and stocks of fish will not occur.

- Introduction of exotic nonanadromous fish species will be undertaken if feasibility studies indicate that significant impacts on existing species and stocks of fish will not occur.

3. Five Year Management Strategies

The following anadromous fish management strategies will guide the program through the next 5 years. Strategies for wild, natural, and hatchery fish management attempt to mesh the long-term goals outlined above with the biological reality of low run sizes in the near term.

Management during the next 5 years will focus on maximizing wild and natural production opportunity while producing fishery opportunity with hatchery propagation. This will include increasing public awareness of anadromous fish production issues including migration survival problems and habitat needs, maintaining natural production and genetic resources, maintaining a secure wild fish management program, and minimizing hatchery and natural fish interactions.

a. Fish Manaqement Strategies and Definitions

Idaho's anadromous fish management encompasses two types of production, natural and hatchery, and three classes of fish based on definition of production and broodstock history: wild, natural, and hatchery fish. Artificial production recruits and sustains fish populations in a controlled artificial spawning and rearing environment, generally a hatchery.

Wild fish are native fish which have no history of hatchery or non-native fish outplanting or supplementation, or a limited amount unlikely to have had genetic impact. Wild fish sustain themselves as an interbreeding, isolated unit throough natural production. Their genetic makeup is assumed to be similar to or evolved from ancestral broodstock by natural selection.

Natural fish also result from natural spawning, but are either not of native broodstock, or have had opportunity to breed with introduced hatchery fish. Genetic material may be different from native broodstock because of these factors.

Hatchery fish are sustained by some degree of artificial production, generally or several generations. They are released and return as adults for spawning and subsequent artificial production of their progeny. Genetic material is likely different from native and natural broodstock of the production area because of the influences of artificial rearing on genetic selection. Or, behavior may be different due to adaptation to the hatchery environment.

b. Wild Fish Manaaement Strategy. Idaho has the greatest production potential for wild salmon and steelhead in the Columbia Basin. Wild fish management will emphasize genetic conservation to preserve fitness of those populations. The Department will implement actions and regulations to achieve production and harvest objectives for wild fish so that life history and genetic resources of those fish is not altered directly. Stocking of anadromous fish into wild fish populations or into their production streams will not occur. Release strategies of hatchery-produced fish will minimize residualism of those fish as juveniles and straying as adults. Production, research, and harvest programs will be designed to avoid reduction of genetic diversity and integrity of wild populations. Population abundance will be increased by improving survival of juveniles and adults with priority on those major mortality factors related to juvenile and adult migration through the hydroelectric system and regional fisheries. Use of wild anadromous fish may be considered for captive broodstock programs. Donor stocks capable of providing gametes without jeoparidising their status are scarce, but some may be available for experimentation and evaluation.

c. Hatchery Fish Manaaement Strategy

Idaho's anadromous fish stocks possess unique genetic material enabling them to sustain the long rigorous journey to the ocean as juveniles and back to Idaho as adults. It is imperative that the genetic resources for long migrations contained in wild stocks be preserved. Hatchery stocks often differ from the original parent stock. Differences in allele frequency are thought to be a result of natural selection for the hatchery environment, genetic drift due to the use of progeny inbreeding and intensive selection, resulting in reduced viability and genetic diversity. Management of hatcheries has focused on providing large numbers of smolts to enable sufficient adult returns to perpetuate hatchery production, produce fish for supplementation, and provide harvest opportunity. Most of Idaho's anadromous fish hatcheries were build as mitigation for lost production. Given the important role hatcheries have and will continue to play in Idaho's anadromous fish program, the Department has reassessed objectives of its salmon and steelhead hatcheries. Updated objectives are as follows:

(1) Produce fish that maintain optimum survival to adults through disease control, fish culture practices, and release strategies.

(2) Provide fish at various life stages that can be utilized for harvest, supplementation, reintroduction, and research purposes. Emphasis for marked general production fish will be harvest.

(3) Develop hatchery practices that can be used with wild or natural brood stock progeny that will minimize the domestication of those progeny and be suitable for returning them to the natural rearing habitat.

(4) Develop genetic guidelines for broodstock selection at anadromous fish traps and spawning sites to maximize genetic diversity and prevent loss of genetic material. In addition, utilize technology to identify hatchery stocks in order to improve genetic management, thus preventing artificial changes in allele frequencies.

(5) Mark hatchery smolts prior to release to avoid mixed stock harvest conflict and to maximize harvest and natural production management options.

Hatchery programs will be managed to maintain hatchery productivity and produce the greatest adult return rates. Broodstock for harvest-oriented programs will be managed for specific traits, primarily productivity and maximized returns to target fisheries (timing distribution, catchability, and disease resistance).

Uncertainties exist as to how to maintain stock productivity over the long term. Major considerations are broodstock and fish health management. At present most facilities utilize one male spawned with one female to optimize opportunity for genetic variation. Broodstock are utilized from the entire run across time. A nonselection standard is maintained to preclude selection for or against any particular characteristic, except prevalence of transmissible diseases. Relative to fish health, the Idaho Augmented Fish Health Monitoring Project, funded by Bonneville Power Administration, was designed to upgrade and standardize fish health monitoring procedures used by anadromous fish producers. Its purpose was to collect and evaluate fish health information, and determine if fish health could be effectively used in mitigation programs (Hauck 1990). Slated to conclude in fiscal year 1991, this Columbia Basin project currently includes seven Idaho facilities. Fish health diagnostic and monitoring services will be continued through the facilities. Fish health diagnostic and monitoring services will be continued through the Department's Eagle Fish Health Laboratory. A new facility, constructed with funds from the LSRCP and the Department, was completed in 1991.

Emphasis will be be placed on developing marking techniques to visually identify hatchery fish. Marking is needed for harvest opportunity as well as to refine operations of weirs and brood selection procedures to achieve the related natural management objectives. Continued research and management studies producing solutions and reduction of mortality of hatchery smolts during migration will be critical to the success of all hatchery programs.

Some hatcheries will be managed specifically to provide the best supplementation product for evaluation of natural production benefits. During the next 5 years, conservation hatchery strategies and guidelines will be developed and assessed. Natural brood will be taken from existing populations in tributaries where adult escapement is sufficient. Progeny will be handled as near naturally as possible to minimize influence of artificial spawning and rearing habitat. Measures of success will be external to the hatchery and related to fitness in the natural environment--how well do the fish return to spawn and produce progeny that also survive to produce offspring.

d. Natural Fish Management Strategy

Similar to wild fish, actions and regulations will be implemented to achieve production and fishery objectives for natural fish so that the existing life history and genetic resources of those fish is not altered directly by management. Supplementation of natural stocks with hatchery fish has not yielded desired results and rebuilding. Poor contribution of supplemented populations is likely caused by the same low smolt-to-adult survival as wild fish. While this survival bottleneck exists, rebuilding through supplementation or other production mechanism is unlikely. Improved survival conditions will allow productive natural stocks suited to their environment to rebuild; those unsuited to the environment will not, and supplementation may be used as a management tool. Until survival conditions improve, no method of testing suitability exists. Therefore, supplementation of natural stocks during 1992-1996 will be conservative. Donor stocks capable of providing gametes without jeopardizing their status are scarce, but some may be available for experimentation and evaluation.

Supplementation of existing natural populations with hatchery fish to increase abundance will be limited to regionally coordinated and Department approved studies. This is a significant departure from the standard supplementation practice of the past. Emphasis will be directed at improving natural fish management practices above hatchery weirs. Techniques to identify natural fish are needed to direct the appropriate changes.

The following are specific items that have been identified to address hatchery productivity improvements:

(1) Continue to research marking procedures for chinook which will not significantly lower survival;
(2) Continue to address and budget fish hatchery facility modifications. Priority actions will include:

    (a) fish health improvements such as disease-free water supplies;
    (b) fish stock management improvements such as individual incubation and isolation facilities;
    (c) rearing modifications for supplementation fish such as shared structures or variable velocity; and
    (d) evaluation of release sites, time, and fish size to minimize interaction with natural and wild fish and maximize adult returns.

(3) Develop and continue existing research on various anadromous fish rearing density studies, including BKD segregation efforts, and include additional research on fish transportation techniques and procedures. Incorporate rearing and transport densities found to maximize adult return rates into standard hatchery practices; and

(4) Promote more interaction with resident fish programs, exercising proper management procedures, to include fish stocking, imported egg management, inter-hatchery transfers of products and equipment, implementation of fish health policies, and development and use of common hatchery data bases.

Release of marked hatchery steelhead will continue to be managed to distribute returning fish in time and space so that all local areas have opportunities for harvest and so that anglers can spread to as much area as possible. It will be important to continue evaluation of both onsite and offsite releases to determine if objectives are being met, and to retain flexibility to make adjustments.

Chinook smolts and presmolts released for the spring 1992, outmigration from Sawtooth, South Fork Salmon River, Crooked River, Red River, and Powell weirs, and in El Dorado and Papoose Creeks were ventral fin clipped to identify them as hatchery-produced salmon. Visual identification of hatchery-produced salmon is necessary to minimize harvest impacts to naturally-produced salmon and hatchery-produced salmon released for supplementation purposes. When adult returns from these releases are projected to adequately meet hatchery and weir return needs, harvest opportunity for marked hatchery fish is anticipated. As juvenile and adult survival through the hydrosystem increases, harvest opportunity for anglers will be developed in the North Fork Clearwater River, South Fork Clearwater River downstream from the confluence of American and Red Rivers, and in the mainstem and Middle Fork Clearwater upstream to Powell. In the Salmon River, areas will include the mainstem, downstream from Sawtooth weir, South Fork Salmon River downstream from the weir, and Little Salmon River. Currently, low survival rates and lack of marked hatchery salmon preclude harvest opportunity in most areas until 1994, when all returning hatchery salmon will be marked. However, harvest opportunity will occur when hatchery needs are projected to be met, within the principles identified in "Policy #1."

Hatchery operations have included production of salmon and steelhead juveniles in excess of needs for hatchery smolt releases which have been used for population supplementation to enhance natural production. To date, supplementation of natural production with hatchery production has not resulted in self-sustaining natural populations. In some cases, it appears that indiscriminate outplanting of juveniles has reduced total adult returns and impacted productivity potential. Current supplementation research and genetics guidelines recommend curtailing unevaluated supplementation because of the genetic risks posed to depressed natural populations and the uncertainty of benefits for producing more adult fish, given the current excessive rate of mortality. The expectation for vastly improved survival of hatchery production during this plan period is not optimistic. Until uncertainties regarding supplementation are resolved, the emphasis for hatcheries will be on production of fish to provide fishing opportunity.

Supplementation and harvest augmentation will become discrete programs. This modification will be most evident in the Clearwater drainage. Terminal broodstock collection at Red River and Powell satellite facilities, will be primarily for supplementation research. Broodstock to support smolt production for harvest is expected to mainly come from the Dworshak National Fish Hatchery (DNFH) and Kooskia National Fish Hatchery (KNFH) rack returns. Thus, offsite smolt releases, such as from the Clearwater Anadromous Fish Hatchery, will generally provide supplementation and broodstock development.

e. Steelhead Broodstock Development

Wild steelhead parr in some of the Salmon River Canyon tributaries and Fish Creek in the Lochsa drainage have been at high levels of abundance. These populations can provide opportunity to trap spawners to produce juveniles for upper Salmon and upper Clearwater River introduction. The upper Salmon River is a major potential production area, but introduced Snake River steelhead stock has not reestablished self-sustaining populations. The Salmon River native stock may be better suited for Stanley Basin production conditions to meet the objective of establishing a productive, naturally sustained, steelhead population. There is also concern regarding suitability of Dworshak NFH broodstock for supplementing natural populations. Extensive supplementation in the South Fork Clearwater has not yet provided tangible increases in natural production.

C. DRAINAGE MANAGEMENT PLANS

1. Snake River Drainage

a. **Snake River, Mouth of Clearwater River to Hells Canyon Dam.** There is an adult salmon and steelhead trap just below Hells Canyon Dam on the Oregon side of Hells Canyon Reservoir which collects broodstock for the Oxbow Hatchery. The hatchery and adult trap are owned by Idaho Power Company. Adult salmon trapped at Oxbow Hatchery are transferred to other hatcheries for spawning and rearing. Adult steelhead are spawned at Oxbow, and eggs are transferred to Niagara Springs Hatchery for smolt rearing, or reared to the fry stage at Oxbow Hatchery. Steelhead and spring chinook smolts or presmolts are released annually below Hells Canyon Dam to provide broodstock for the hatchery program and fish for harvest. Experimental rearing of fall chinook at Oxbow Hatchery occurred in 1989.

b. **Chinook and Steelhead Objectives and Programs, 1992-1996**

Continue to release hatchery chinook and hatchery steelhead smolts into the Snake River at Hells Canyon Dam. Coordinate numbers and use of srnolts released at Hells Canyon Dam with Oregon, Idaho Power Company, and respective Indian Tribes. Release adequate number of spring chinook and steelhead smolts to provide adult returns capable of supporting fisheries and broodstock needs. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on artificial rearing capacity, smolt-to-adult survival, harvest, and broodstock availability and needs.

When surplus is available, release adult steelhead from the Oxbow Trap into urban fishery areas.

Coordinate with Idaho Power Company to implement hatchery improvements to potentially include: (1) Upgrade water source to a disease-free status by the use of well water or ozonation which includes degassing capability; (2) Research adult steelhead injections with Oxytetracycline to decrease prespawning mortality and reduce the vertical transmission of Flexibacter psychrophilus (a bacteria); and (3) Incorporate a full spectrum fish disease sampling and egg culling or segregation program for steelhead to reduce the possibility of disease transmission to other rearing facilities.

Continue to ad-clip hatchery steelhead prior to release and harvest only marked fish. Develop a visible mark for hatchery chinook and mark hatchery chinook prior to release for harvest identification.

Allow natural production to sustain existing populations of steelhead in minor tributaries. Limit outplanting of hatchery spring chinook into minor tributaries to support supplementation research.

Do not outplant any unmarked hatchery anadromous fall chinook into the Snake River Basin above Lower Granite Dam and structure release strategies that minimize straying into mainstem Snake natural production area.

2. Clearwater River Drainage

a. Lower Clearwater River-Mouth to South Fork Including the North Fork

DNFH was constructed and completed in 1971 to mitigate for the loss of anadromous fish production in the North Fork due to the construction of Dworshak Dam. The original mitigation was limited to steelhead because Lewiston Dam had previously blocked access for chinook to the North Fork. Following construction of the dam, the North Fork has been exclusively devoted to artificial production with DNFH and the CAFH being located in the lower 1 mile of this stream. The lower North Fork still provides limited rearing of juvenile salmon and steelhead.

Chinook and Steelhead Objectives and Programs, 1992-1996. Continue to evaluate adult salmon and steelhead returns and harvest to develop seasons that ensure hatchery escapement needs are met, minimize surplus fish into the hatchery, and maximize catch and harvest opportunity. Structure non-Treaty chinook harvest seasons to ensure anglers opportunity to harvest hatchery fish surplus to hatchery escapement needs.

Continue releases of hatchery steelhead and spring chinook smolts for harvest augmentation. Adjust smolt releases to achieve 30 hours per steelhead or better and 60-80 percent exploitation, when possible. Coordinate smolt releases with the Nez Perce Tribe.

Release adequate numbers of salmon and steelhead smolts to provide adult returns capable of producing 1.4 million spring chinook smolts and 2.3 million steelhead smolts at DNFH. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and broodstock availability and needs.

Trap additional chinook adults as needed at DNFH to account for broodstock needs for Crooked River satellite facility, production at CAFH, and fry-parr and smolt production for supplementation evaluation. Establish adult steelhead hatchery escapement needs for onsite production and outplants.

Continue fish health research to improve hatchery fish survival. Continue Hatchery Evaluation Program under the LSRCP funding to assess rearing and release strategies to improve survival.

Complete development of an operating and production plan for CAFH. Develop a hatchery plan that will minimize change of introducing infectious diseases from the Clearwater River or DNFH to the CAFH. Coordinate production plan with the Nez Perce Tribe. Incorporate broodstock needs into DNFH weir management. Incorporate supplementation evaluation fish needs (quantity and quality) into hatchery operations. Produce presmolts capable of surviving and overwintering in the natural environment. Develop hatchery management techniques that will reduce or avoid competition between hatchery fish and natural fish. Develop hatchery management techniques that will ensure separation of fish stocks in the hatchery and reduce domestication of progeny from natural broodstock.

Continue to ad-clip hatchery steelhead prior to release and harvest only marked fish. Mark hatchery chinook when having marked hatchery fish may increase harvest opportunity or facilitate broodstock management.

Cooperatively with the Nez Perce Tribe, identify tributaries with wild A-run steelhead populations. Do not outplant hatchery steelhead into these areas. Allow natural production to sustain existing wild populations. Do not outplant any steelhead into the Selway; retain this drainage strictly for natural production of wild B-run steelhead.

Manage hatchery supplemented Clearwater River anadromous fish stock so that straying into wild steelhead production tributaries and the Selway River is minimized.

Allow natural production to sustain existing natural populations to preserve genetic integrity. Limit outplanting hatchery fish to support supplementation evaluation, Nez Perce Tribal Hatchery development in Lolo and El Dorado Creeks, and areas devoid of natural salmon and steelhead production.

b. **South Fork Clearwater River**

Both chinook and steelhead were reintroduced into the drainage beginning in the early 1960s. Up to 50 percent of DNFH steelhead production has been released into the South Fork since 1981. The intent of the program was to redistribute adults between Orofino and Kooskia in the mainstem Clearwater and into the South Fork for increased fishing opportunity. Also the program was intended to enhance natural production by allowing hatchery adults to spawn in the wild.

Reintroduction efforts have been considered successful in the South Fork for providing a fishery in the river as well as enhancing fishing and harvest opportunity between Orofino and Kooskia in the mainstem Clearwater. However, whether releasing DNFH steelhead in the South Fork is increasing natural production remains questionable. From the long history of steelhead outplants in this drainage, it can only be concluded that hatchery smolt releases do return adults that satisfy harvest and fry production can be substantial after spawning.

Spring chinook juvenile densities have also been influenced by substantial outplanting of hatchery fish. Sustained natural production due to this practice has not been measured. The Nez Perce Tribe is developing plans for pond to rear spring chinook presmolts in Mill and Newsome Creeks. The Tribe is also investigating production of fall chinook.

Major management issues for the South Fork will be completion and integration of the plans for production at CAFH and Nez Perce Tribal Hatchery facilities. Broodstock availabil ity nd survival rates will be major factors affecting hatchery and natural production.

Chinook and Steelhead Objectives and Programs, 1992-1996.

Implement chinook supplementation evaluation activities, proposed in Red, Crooked, and American Rivers, and Newsome and Meadow Creeks, including Johns Creek as a control. Coordinate with Nez Perce Tribe supplementation activities. For supplementation evaluation, rear approximately 80,000 presmolts at Red River pond using Red River broodstock. Rear approximately 400,000 presmolts at Crooked River using DNFH/KNFH broodstock or Rapid River broodstock. Develop marks to differentiate natural. supplementation, and harvest augmentation fish in treatment streams.

Modify weir management to utilize natural production areas. Refine long-term escapement goals for adult fish to be released upstream of the Crooked and Red Rivers weirs for natural production.

During this planning period, release 2/3 of the spring chinook returning to Red River above the weir for natural production and retain the remainder for supplementation broodstock. Release up to 45 pairs of natural spawners into Crooked River and Relief Creek (Crooked River tributary) to research seeding levels and optimal smolt production. Augment Crooked River research broodstock needs with hatchery adults, if necessary. Release varying levels of steelhead, up to 500 pair, into Crooked River to research seeding levels and optimal smolt production. Release all naturally-produced steelhead above the weir and augment with hatchery steelhead to meet Crooked River research needs.

Over the long term, as marked chinook return, release known naturally-produced spring chinook above the weirs up to proposed escapement goals, and incorporate supplementation broodstock needs into weir management. Release natural steelhead above the weirs up to the goals. As the escapement goals for natural production above the weirs are met, begin incorporating naturally-produced chinook and steelhead into hatchery production.

Incorporate rearing practices at satellite ponds that provide fish capable of surviving to the ocean and will not compete significantly with naturally-produced fish. Maintain the genetic integrity of natural populations and minimize domestication caused by hatchery rearing practices.

Evaluate sustained benefits to natural production from outplanting steelhead in the South Fork by discontinuing DNFH steelhead releases into Newsome Creek and monitor evidence of sustained production by subsequent parr and redd enumeration.

Continue to release marked hatchery steelhead smolts and begin marking hatchery spring chinook smolts from DNFH/KNFH complex for harvest augmentation. Implement smolt releases from CAFH for harvest augmentation. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, nd broodstock needs and availability. Utilize satellite ponds for chinook smolt acclimation. Adjust smolt releases to achieve at least 30 hours per adult steelhead harvested and 60-80 percent exploitation, when possible.

Trap additional chinook adults at DNFH to provide for broodstock needs for Crooked River satellite facility.

Investigate feasibility of rearing harvest augmentation chinook presmolts in addition to supplementation fish at Red River pond when smolt production capacity at CAFH is reached. Pond presmolt production or harvest augmentation would be a second priority.

Release marked surplus hatchery spring chinook juveniles into American River. Release surplus hatchery spring chinook adults into Crooked River, per research needs, and American River.

Continue to ad-clip hatchery steelhead prior to release and harvest only marked fish. Mark hatchery chinook prior to release when having marked hatchery fish may increase harvest opportunity or facilitate broodstock management, adjust marking schedule to minimize fish health problems.

Continue to monitor naturally-produced juvenile steelhead densities above the Power weir. When densities maintain at least 50 percent of potential parr carrying capacity, trap a portion of the run for use in Clearwater Hatchery for release into selected South Fork tributary such as Crooked River and discontinue use of DNFH broodstock. Use alternative mark to identify returning fish for broodstock.

d. Middle Fork Clearwater River

KNFH is located at the mouth of Clear Creek. It was constructed in the late 1960s to enhance spring chinook returns to the Clearwater. The hatchery maintains an electric weir at the mouth of Clear Creek to intercept adult chinook and steelhead. Some adults of both species escape upstream of the weir, but natural production levels are low. Adult fish are transported to DNFH for spawning.

Continue to release hatchery steelhead and spring chinook smolts for harvest augmentation. Adjust smolt releases to achieve at least 30 hours per adult steelhead harvested and 60-80 percent exploitation, when possible.

Release adequate numbers of chinook smolts to provide adult returns capable of producing 0.8 million chinook smolts at KNFH. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and brood stock availability and needs.

Continue fish health research to improve hatchery fish survival.

Continue to ad-clip hatchery steelhead prior to release and harvest only marked fish. Mark chinook as necessary to meet production and harvest objectives.

e. Lochsa River

Chinook supplementation began in the early 1970s in the Lochsa drainage. Fry, primarily from Rapid River broodstock, have been released into the major tributaries, while White Sand Creek has received most of the released smolts. However, there has been little evaluation to document any sustained natural production as a result of supplementation activities. This will be one of the questions addressed by chinook supplementation research which is scheduled to take place in several Lochsa tributaries.

In 1989, a collection facility for adult chinook and a rearing pond for fall presmolts were constructed at Powell. This is a satellite facility for the LSRCP CAFH. To date, almost all adult chinook trapped at the weir have been passed upstream for natural production. Fingerlings stocked into the pond for final rearing have come from DNFH broodstock.

Steelhead supplementation in the Lochsa ceased in 1983. Concern arose about releasing DNFH steelhead which were carrying high titers of IHN virus. Also, concerns about genetic introgression of hatchery broodstock was a factor in establishing a policy not to further supplement the Lochsa with DNFH steelhead. This policy will continue through this planning period while an effort is made to develop an indigenous broodstock by trapping adult steelhead returning to Fish Creek for use in steelhead supplementation research and evaluation.

Chinook and Steelhead Objectives and Programs, 1992-1996. Implement chinook supplementation evaluation activities proposed for Squaw, Crooked Fork, White Sands, Big Flat, Papoose, and Pete King Creeks, including Brushy Fork Creek as a control. Rear approximately 50,000 spring chinook presmolts at Powell pond using upper Lochsa brood stock. Develop marks to differentiate natural, supplementation, harvest augmentation fish in treatment streams.

Work with the Nez Perce Tribe to develop fish release programs that preserve genetic resources of naturally spawning chinook and steelhead. Refine long-term escapement goals for adult fish to be release upstream of the Powell weir for natural production.

During this planning period, release at least 2/3 of the spring chinook returning to the Powell weir above the weir for natural production and retain the remainder for supplementation broodstock.

Over the long term, as marked chinook return, release known naturally-produced spring chinook above the weir up to proposed escapement goal, and incorporate supplementation broodstock needs into weir management. As spring chinook escapement for natural production above the weir is met, begin incorporating naturally-produced chinook into hatchery production.

Incorporate rearing practices at satellite ponds that provide fish that are capable of surviving to the ocean and will not compete significantly with naturally-produced fish. Maintain the genetic integrity of natural populations and minimize domestication caused by hatchery rearing practices.

Do not supplement Fish Creek drainage with either chinook or steelhead to evaluate natural production and potential for rebuilding.

Evaluate adult hatchery chinook returns to develop seasons that ensure hatchery escapement needs are met, minimize surplus fish returning to the weir, and maximize catch and harvest opportunity. Structure non-Treaty chinook harvest seasons to ensure anglers an opportunity to harvest hatchery fish surplus to hatchery escapement needs.

Continue to release hatchery spring chinook smolts for harvest augmentation. Mark hatchery chinook prior to release when having marked hatchery fish may increase harvest opportunity or facilitate broodstock management.

Implement marked spring chinook smolt releases from CAFH for harvest augmentation. Utilize satellite ponds for chinook smolt acclimation. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and broodstock needs and availability.

Refine methodology to discriminate between natural and hatchery salmon stocks to allow differentiation for harvest and production management.

Investigate feasibility of rearing harvest augmentation presmolts in addition to supplementation fish at Powell pond where smolt production capacity at CAFH is reached. Pond presmolt production for harvest augmentation would be a second priority to production of supplementation evaluation fish.

Continue to evaluate feasability of collecting steelhead at the Powell weir. Continue to monitor naturally-produced juvenile steelhead densities above the Power weir. When densities maintain at least 50 percent of potential parr carrying capacity, trap a portion of the run for use in Clearwater Hatchery for release into selected South Fork tributary such as Crooked River and discontinue use of DNFH broodstock. Use alternative mark with ad-clip to identify returning fish for broodstock.

f. **Selway River**

Between 1961 and 1979, over 45 million eggs from primarily spring, but also summer and fall chinook were placed in the Selway drainage. Originally, eggs from wild Salmon River stocks, including Middle Fork, South Fork, Lemhi, and upper Salmon, were merely placed in trenches in the upper Selway River, while eggs from adults from lower Columbia River stocks were placed in Bear Creek. Then, in the mid-1960s, three incubation channels were developed at Indian Creek, Running, Creek, and Ditch Creek. The majority of eggs placed in Running and Ditch Creeks from 1964-1979 came from adult spring chinook trapped at Bonneville Dam, while the majority placed in Indian Creek came from the Salmon River. Fall chinook, collected in the Columbia River, were planted in the lower Selway.

During the Clearwater Reintroduction Program, various life stages of chinook were outplanted into the Selway drainage. This practice ceased after 1979, until 1985 when about 1.5 million eggs from Rapid River stock were outplanted at Indian Creek. From 1985 until the present, the chinook population has been managed as natural production area, without any further hatchery infusion. Although there appeared to be some initial success in reestablishing chinook production in the Selway with egg outplants, restoration efforts have been overwhelmed by poor migration survival. Currently, the spring chinook population is very underseeded, with parr densities averaging only 2 percent of estimated carrying capacity for the 1985-1989 period. In C-channel habitat, which is more conducive to chinook production, the average has been slightly higher at 11 percent.

Chinook and Steelhead Objectives and Program, 1992-1996.

Manage hatchery supplemented Clearwater River steelhead stocks so that straying into the Selway is minimized.

Develop experimental Selway River spring/summer chinook supplementation actions in cooperation with the Nez Perce Tribe and Idaho chinook supplementation technical committee. Focus on selected tributaries of the upper Selway above Hhite Cap Creek to minimize genetic introgression into existing populations. Evaluate broodstock needs and identify potential broodstock sources and availability. Develop methods to monitor and evaluate production.

Refine techniques, including potentially marking all hatchery chinook, to discriminate between natural and hatchery fish for harvest and production management.

3. Salmon River Drainage

a. Lower Salmon River, Mouth to French Creek

Through the 1980s, both A-run and B-run hatchery steelhead have been stocked into this river section at the mouths of tributaries to stage returning adults for harvest. Most of the hatchery smolts have been released in the mainstem Salmon River near the mouths of Slate and Hammer Creeks. The average annual steelhead harvest, from fall 1985 through spring 1990, from the mouth of the Salmon River to the Little Salmon River was 2,572 hatchery steelhead, or 17 percent of the Salmon River steelhead harvest. During the early 1970s, prior to current hatchery programs, this section of the river supported about 38 percent of the Salmon River steelhead harvest.

To assist with rebuilding, hatchery steelhead parr and fry have been released in several tributaries, particularly those with road access, including Slate, French, and Partridge Creeks. Monitoring of parr densities of supplemented, A-run natural production steelhead populations indicate that some of the tributaries averaged 38 percent of estimated potential parr production for 1985-1989. However, parr densities for B-type stream channels, which are more conducive to steelhead production, averaged 53 percent. For wild, A-run steelhead populations, which includes similar tributaries in the Snake and Lower Clearwater Rivers, parr densities averaged 98 percent of potential in monitored stream sections for 1985-1989.

No chinook have been stocked in the lower Salmon section, other than the Little Salmon drainage, discussed in a separate section. Production results from wild chinook and perhaps strays from the Rapid River program. Habitat is underseeded and parr densities average less than 5 percent of potential production. Because of low runs in 1989 and 1990, no increase in production is expected in the near term.

The Nez Perce Tribe, under the auspices of the Northwest Power Planning Council's Fish and Hildlife Program, is developing plans for spring chinook rearing ponds and an adult trapping site in the Slate Creek drainage on United States Forest Service lands. Potential production would be 500,000 presmolts; natural production above the ponds would also be maintained. Hatchery construction is expected to begin within this planning period but harvest and natural production benefits are not expected in the next 5 years. Allocation of spring chinook adults for broodstock development and natural production, and development of harvest management plans will be major issues.

Chinook and Steelhead Objectives and Programs, 1992-1996. Continue to ad-clip hatchery steelhead prior to release and harvest only ad-clipped fish.

Continue to evaluate adult return and steelhead harvest by river section to develop steelhead seasons that ensure hatchery escapement needs are met, minimize surplus fish into the hatchery, and maximize catch and harvest opportunity. Utilize hatchery smolt releases in the lower Salmon to provide fish to the available fishing area.

Develop A and B-run stocking recommendations for the lower Salmon by the end of this planning period which will meet anglers needs. Adjust smolt releases to achieve 30 hours per steelhead or better, when possible.

Support Nez Perce Tribal efforts to develop rearing ponds for spring chinook presmolts in Slate Creek.

Encourage the Nez Perce Tribe to collect Slate Creek spring chinook scales from carcasses to establish scale patterns for wild and hatchery chinook differentiation for future production management. Encourage the Nez Perce Tribe to establish spring chinook redd counts in Slate Creek to develop adult escapement trend.

b. **Little Salmon River Drainage.** Management of this drainage emphasizes hatchery production tp provide fish for sport and Treaty harvest as the first priority. Idaho Power Company's Rapid River Hatchery has the capacity to produce 3 million spring chinook salmon smolts annually, for release into Rapid River, the Little Salmon River, and the Snake River at Hells Canyon Dam. Excess eggs have also been supplied for programs outside the Salmon drainage such as the Grande Ronde and Clearwater Rivers. Sport fishing on Rapid River Hatchery chinook, primarily in the Little Salmon, has provided the only Idaho chinook sport fishing opportunities in the 1980s. Harvest by non-Treaty anglers averaged 906 chinook from 1985 through 1990. The Rapid River fishery has also been very important to the Nez Perce Tribe who harvested an average of 1,892 fish from 1985 through 1990.

Hatchery steelhead smolts are produced at rearing facilities located outside the drainage. Little Salmon River steelhead smolt plants are designed to provide harvest opportunity in the Salmon River in the Riggins area. The average number of hatchery fish harvested in the Little Salmon River since this program was implemented in 1985 is 671.

Hatchery steelhead fry plants have been made in the mainstem Little Salmon, Hazard Creek, and Boulder Creek to bolster natural production. Adults have returned from these plants, but their contribution to long-term natural production is unknown. Hatchery chinook fry plants have been made in Boulder Creek and in the mainstem Little Salmon.

There are wild steelhead and summer chinook salmon runs which ascend Rapid River above the hatchery. The wild steelhead run size averaged 87 fish, 1985-1990. These fish demonstrate different adult migration timing than the hatchery steelhead being released in the Little Salmon River. The wild steelhead generally arrive at Rapid River April through May. Parr densities of wild A-run steelhead streams, including Rapid River averaged 98 percent of estimated carrying capacity during 1985-1989. Summer chinook have been separated from the hatchery-produced spring chinook based upon timing and fish condition when they arrive at the weir. No hatchery juvenile salmon or steelhead have been outplanted above the weir.

Chinook and Steelhead Objectives and Programs, 1992-1996. Continue to release hatchery steelhead and spring chinook smolts for harvest augmentation. Continue to release spring chinook at the hatchery rack and the Little Salmon River to spread out harvest opportunity.

Continue releasing A- and B-run steelhead into the Little Salmon River through 1992. Provide code wire tag (CWT) groups for both A- and B-run steelhead for 1991 and 1992 releases. Evaluate CWT adult returns in angler harvest through 1995 to determine benefits to harvest provided by A- and B-run steelhead in the lower Salmon and Little Salmon Rivers.

Evaluate straying of returning Rapid River Hatchery chinook released in the Little Salmon River and determine whether an acclimation pond in Little Salmon to key adults back to upper Little Salmon for a fishery is needed. Potential sites: Boulder Creek, Stinky Springs area.

Release adequate numbers of salmon and steelhead smolts to provide adult returns capable of producing at least 2.5 million spring chinook smolts at Rapid River Hatchery. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and broodstock availability and needs.

Share up to 2 million eggs surplus to smolt needs with Oregon Department of Fish and Wildlife for use at Lookingglass Hatchery and with hatcheries in the Clearwater drainage for smolt production.

Outplant spring chinook adults surplus to egg needs in th Little Salmon River, Panther, Creek, and Yankee Fork to provide sport and Tribal fishing opportunity. Continue to outplant hatchery chinook fry into Boulder Creek and marked hatchery steelhead fry into Hazard and Boulder Creeks for harvest augmentation.

Improve Rapid River Hatchery fish survival. Coordinate with Idaho Power Company to implement hatchery improvements to potentially include: (1) Upgrade incubation water source to a disease-free water source; (2) Evaluate potential for ozonation of fish rearing water to reduce the incidence of fish disease such as Erythrocytic Inclusion Body Syndrome and BKD; and (3) Construct a concrete fish holding and spawning facilities to reduce prespawning mortality.

Evaluate presmolt and smolt release strategies and return rates and evaluate rearing and truck loading densities to derive optimum adult return rates.

Incorporate a full spectrum disease sampling and egg culling or segregation program to reduce the possibility of disease transmission to other rearing facilities. Investigate culling eggs from high titer BKD adults. Evaluate benefits to adult return provided by erythromycin feeding. Monitor BKD levels of returning adults.

Continue to ad-clip hatchery steelhead and harvest only marked fish. Evaluate need for acclimation ponds in the Little Salmon to minimize straying of hatchery steelhead into natural production areas. Release only wild steelhead above the Rapid River weir.

Continue summer chinook selection based on physical appearance and timing criteria for release above the Rapid River Weir. Evaluate and refine methods to separate spring and summer chinook at the weir. Release summer chinook above the weir for natural production and retain spring chinook at Rapid River Hatchery for hatchery production.

Develop a steelhead broodstock for the lower Salmon and Little Salmon River Hatchery smolt release programs.

Explore Rapid River Hatchery stock identification techniques at mainstem Columbia and Snake Rivers adult detection facilities.

c. Salmon River Canyon, French Creek to Middle Fork Salmon River

Chinook and Steelhead Objectives and Programs, 1992-1996. Continue to not outplant hatchery steelhead or salmon into the mainstem Salmon River or tributaries between French Creek and Panther Creek. Allow natural production to sustain existing wild populations. Manage hatchery supplemented Salmon River anadromous fish stocks to that straying into Salmon River Canyon tributaries is minimized.

Continue to ad-clip hatchery steelhead prior to release in Idaho and harvest only ad-clipped fish.

Maximize harvest and fishing opportunity on hatchery-produced steelhead contingent upon achieving hatchery escapement needs.

Continue to use smolt releases in the mainstem Salmon River upstream of the Canyon to provide a harvestable component in this river section. Develop smolt release schedule that optimizes catch rates for hatchery fish between upper and lower Salmon River releases, and maximizes harvest of surplus hatchery steelhead.

d. South Fork Salmon River

Chinook and Steelhead Objectives and Programs, 1992-1996. Structure hatchery steelhead smolt releases in the Salmon River to minimize straying into the South Fork Salmon River. Manage hatchery summer chinook in the South Fork Salmon River to minimize straying into the Secesh.

Do not outplant Summer chinook trapped at the South Fork Salmon River trap into Johnson Creek until management implications of baseline genetic identification of summer chinook in the South Fork Salmon River and Johnson Creek are evaluated. Make management recommendation regarding Johnson Creek summer chinook supplementation and broodstock early in this planning period.

Implement chinook supplementation evaluation activities, proposed in the upper South Fork Salmon River with controls in Johnson and Lake Creeks. Rear smolts at McCall Hatchery and release into natural production areas in treatment streams as part of supplementation research evaluation. Annual release numbers to be based on 50:50 balance of hatchery and natural fish spawning or rearing in the natural environment. Develop marks to differentiate between natural, supplementation, and general hatchery production/harvest augmentation chinook.

Refine long-term escapement goals for summer chinook to be released upstream of the South Fork weir for natural production.

During this planning period, continue to release at least 1/3 of the adult chinook returning to the weir until marked chinook return or differentiation is achieved through other methods. Then, release only naturally-produced chinook above the weir unless supplementation adults are released as part of the evaluation. Evaluate methods to ensure that fish released above the weir utilize the entire production area.

Over the long term, as marked hatchery summer chinook begin returning, release naturally-produced summer chinook upstream of th weir up to the proposed escapement goal. Incorporate supplementation broodstock needs into weir management. As the escapement goal for natural production above the weir is met, begin incorporating naturally-produced salmon and steelhead into general hatchery production.

Continue to harvest only ad-clipped hatchery steelhead adults in the mainstem Salmon River. Regulate Idaho mainstem steelhead and salmon sport harvest to maximize South Fork Salmon River spawning escapement. Continue to maintain salmon and steelhead non-Treaty harvest closures in the South Fork drainage as necessary.

Continue to release hatchery summer chinook smolts for harvest augmentation. Evaluate feasibility of developing an acclimation pond on the upper South Fork Salmon River near Knox Bridge.

Release adequate numbers of summer chinook smolts to provide adult returns capable of producing 1 million smolts at McCall Hatchery. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and broodstock availability and needs.

Refine methodology to discriminate between natural and hatchery salmon stocks to allow differentiation for harvest and production management. Complete marking survival evaluation at McCall Hatchery. Develop management recommendations regarding marking of hatchery production as data analysis suggests.

Develop strategies to provide fishing and harvest opportunity for hatchery summer chinook when weir escapement is expected to exceed spawning escapement needs. Utilization of surplus hatchery adults for Tribal harvest in areas would be negotiated. Proposed harvest areas will be evaluated for suitability.

Evaluate feasibility of developing acclimation pond to return hatchery summer chinook to the weir and limit interactions with natural and wild fish. Evaluate potential for developing a rearing pond to increase artificial production for summer chinook harvest augmentation in the South Fork drainage.

Coordinate with the United States Fish and Wildlife Service through the LSRCP to implement hatchery improvements to potentially include: (1) Provide a cool well water source at the South Fork Trap to reduce prespawning mortality; (2) Incorporate a full spectrum fish disease sampling land egg culling or segregation program for chinook to reduce the possibility of disease transmissions; (3) Construct a false

floor for the South Fork Trap to facilitate handling of adult chinook; and (4) Upgrade incubation water to disease-free water source.

Continue fish health research to improve hatchery fish survival. Continue Hatchery Evaluation Studies under the LSRCP funding to assess rearing and release strategies.

e. **Middle Fork Salmon River Drainage**

Chinook and Steelhead Objectives and Programs, 1992-1996. Continue to not outplant hatchery salmon or steelhead into the Middle Fork Salmon River drainage. Allow natural production to sustain existing wild populations.

Structure hatchery steelhead and chinook releases in the Salmon River to minimize into the MFSR.

4. **Lemhi River Drainage**

Chinook and Steelhead Objectives and Programs, 1992-1996. Allow natural production to sustain existing natural populations to preserve genetic integrity. Limit outplanting of hatchery chinook to support supplementation evaluation.

Implement chinook supplementation research and evaluation activities. Renovate the Lemhi weir to collect Lemhi River broodstock to evaluate use of in-basin broodstock for supplementation and to document sustained natural production. Rear and release approximately 106,000 smolts for supplementation evaluation using Lemhi broodstock. Annual release numbers to be based on 5:50 balance of hatchery and natural fish spawning or rearing in the natural environment. Develop marks to differentiate between natural and supplementation fish for evaluation.

Evaluate feasibility of using Hayden Creek Hatchery as a production facility to rear supplementation fish by 1993.

Continue to not supplement steelhead populations with hatchery fish. Enumerate adult returns at the renovated weir.

5. **Pahsimeroi River Drainage**

Chinook and Steelhead Objectives and Programs, 1992-1996. Implement chinook supplementation research and evaluation activities. Rear smolts at Pahsimeroi Hatchery and release into natural production areas. Annual release numbers to be based on 50:50 balance of hatchery and natural fish spawning or rearing in the natural environment. Develop marks to differentiate between natural, supplementation, and hatchery production fish for supplementation evaluation.

Develop guidelines to release chinook and steelhead adults above hatchery weirs for natural production. Refine long-term escapement goals for fish to be released upstream of the Pahsimeroi weir for natural production.

During this planning period, continue to release at least 1/3 of the adult chinook returning to the Pahsimeroi weir until marked chinook return or differentiation is achieved through other methods. Continue to release only natural steelhead above the weir up to proposed escapement goal.

Over the long term, as marked hatchery summer chinook begin returning to the Pahsimeroi weir, release known naturally-produced summer chinook upstream of the weir up to the proposed escapement goal, and incorporate supplementation broodstock needs into weir management. As escapement goals for natural production above the weir are met, being incorporating natural produced salmon and steelhead into hatchery production.

Continue to release marked hatchery steelhead smolts onsite for harvest augmentation and also release marked hatchery steelhead smolts at inriver sites. Evaluate release sites and adjust smolt releases to achieve at least 30 hours per adult steelhead harvested and 60-80 percent exploitation, when possible. Mark hatchery chinook prior to release when having marked hatchery fish may increase harvest opportunity or facilitate broodstock management.

Release adequate numbers of salmon and steelhead smolts to provide adult returns capable of producing 1 million smolts at Niagara Springs Hatchery. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and broodstock availability and needs.

Transfer surplus hatchery steelhead adults and eggs to Magic Valley or Hagerman National Fish Hatchery for rearing. Release additional surplus hatchery steelhead adults and marked juveniles into drainages which have underutilized habitat including Panther Creek, Yankee Fork, North Fork, and Little Salmon River.

Coordinate with Idaho Power Company to implement Pahsimeroi Hatchery improvements to potentially include: (1) Upgrade water source to a disease-free status by the use of well water or ozonation; (2) Construct concrete raceways or ponds for final rearing to reduce disease prevalence; and (3) Incorporate a full spectrum fish disease sampling and egg culling or segregation

program for chinook to reduce the possibility of disease transmission to other rearing facilities. Continue fish health monitoring.

Coordinate with Idaho Power Company to implement Niagara Spring Hatchery improvements to potentially include: (1) Enlarge existing incubation system to reduce incubator density to less than 100,000 eggs to improve water flow and egg survival; (2) Install new early rearing vats to decrease existing density problems and improving survival; (3) Modify effluent pipe to increase flow from incubation and early rearing vats; (4) Provide predation protection by installing bird screening of final rearing raceways; and (5) Develop adequate space to rear 400,000 pounds of steelhead smolts without exceeding discharge standards, as necessary.

Evaluate adult steelhead and summer chinook return rates with regard to rearing densities, feed studies and for steelhead, truck loading densities and transport mortality. Determine if transport and release techniques can be improved. Begin to evaluate acclimation by releasing Niagara Springs steelhead in Pahsimeroi settling ponds.

Continue to ad-clip hatchery steelhead smolts prior to release and harvest only ad-clipped fish in he mainstem Salmon River.

6. **East Fork Drainage**

Chinook and Steelhead Objectives and Programs, 1992-1996. Implement spring chinook supplementation evaluation activities, tentatively proposed in Herd Creek and upper East Fork. Rear smolts at Sawtooth Hatchery from East Fork broodstock, and release into natural production area. Annual release numbers to be based on 50:50 balance of hatchery and natural fish spawning or rearing in the natural environment. Develop marks to differentiate between natural and supplementation fish for evaluation. Through this planning period, convert hatchery production and broodstock role to supplementation of natural production and evaluation.

Continue to ad-clip hatchery steelhead smolts prior to release and harvest only ad-clipped fish in the mainstem Salmon. Maintain adult salmon and steelhead harvest closures in the East Fork as necessary to maximize natural production of steelhead and salmon.

Continue to release marked hatchery steelhead smolts for harvest augmentation.

Release adequate numbers of steelhead smolts to provide adult returns capable of producing 1 million B-run steelhead smolts, reared at Magic Valley. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and broodstock availability and needs.

Continue fish health research to improve hatchery fish survival. Continue Hatchery Evaluation Studies under LSRCP to assess rearing and release strategies. Evaluate acclimation of smolt releases or other methods to avoid dropout of adult hatchery steelhead and spring chinook complementary to supplementation evaluation.

7. **Yankee Fork**

Chinook and Steelhead Objectives and Programs, 1991-1996. Continue to release marked hatchery steelhead and hatchery spring chinook for harvest augmentation. Continue to release spring chinook fry into enhanced Yankee Fork dredge ponds for final rearing.

8. **Upper Salmon River - Middle Fork to Headquarters**

Chinook, Sockeye, and Steelhead Objectives and Programs, 1992-1996. Continue to evaluate captive, indigenous, wild broodstock program to secure sockeye smolts and hold them to maturity for spawning.

Intercept sockeye adults at Snake River dams for spawning and rearing.

Collect kokanee spawners in selected Stanley Basin lakes for spawning and enhancement to investigate the-potential of producing anadromous progeny.

Continue to not outplant hatchery summer chinook into the upper Salmon River. Allow natural production to sustain existing wild population.

Manage hatchery supplemented Pahsimeroi summer chinook stock so that straying into the upper Salmon River is minimized.

Develop methods to separate hatchery and naturally-produced salmon when they return to weirs as adults.

Implement chinook supplementation evaluation activities proposed in upper Salmon River and Alturas Lake Creek, with use of North Fork Salmon River and Valley Creek as controls. Rear smolts at Sawtooth Hatchery and release into natural production areas of treatment streams. Annual release numbers to be based on 50:50 balance of hatchery and natural fish spawning or rearing in the natural environment. Develop marks to differentiate natural, supplementation, and hatchery-production fish for supplementation evaluation.

Continue to ad-clip hatchery steelhead smolts prior to release and harvest only ad-clipped steelhead in the mainstem Salmon River. Maintain adult salmon and steelhead harvest closures above the Sawtooth weir and upper Salmon tributaries as necessary to maximize natural production of steelhead and salmon.

Develop release strategies for hatchery steelhead smolts that minimize impacts to naturally-produced salmon and steelhead, and maximize return to angler creel and Sawtooth weir. Evaluate acclimation of steelhead released at Sawtooth weir. Document hauling and release mortality of steelhead released at Sawtooth. Determine if transport and release techniques need to be improved.

Continue to release marked hatchery steelhead smolts and hatchery spring chinook smolts for harvest augmentation. Mark hatchery chinook prior to release when having marked hatchery fish may increase harvest opportunity or facilitate broodstock management.

Release adequate numbers of salmon and steelhead smolts to provide adult returns capable of producing 1.6 million spring chinook smolts at Sawtooth Hatchery and 1.5 million steelhead smolts at Hagerman National Fish Hatchery and 500,000 steelhead smolts at Magic Valley Fish Hatchery. Other production levels may be proposed to enhance smolt-to-adult survival. Smolt release numbers will be based on capacity, smolt-to-adult survival rates, harvest, and broodstock availability and needs.

Release marked hatchery steelhead surplus to smolt production needs at inriver sites, Yankee Fork, or Panther Creek. Release surplus hatchery spring chinook into Yankee Fork. Release surplus hatchery steelhead adults into Panther Creek and Yankee Fork.

Coordinate with the United States Fish and Wildlife Service through LSRCP to implement hatchery improvements including disease-free water and baffles for outside raceways to improve cleaning, provide shade, and improve fish distribution.

Continue fish health monitoring and research additional disease sampling and culling or segregation programs which may be incorporated to reduce the possible transmission of fish disease. Continue Hatchery Evaluation Studies under LSRCP to assess rearing and release strategies. Utilize densities that provide maximum adult return rates. Research the acclimation of steelhead smolts at the Sawtooth site and the resulting return rates. Develop a marking program that will provide hatchery personnel the capability of distinguishing between hatchery and natural returning adult chinook with minimal impact on return rates.

(VS10-PJSR-3801W)