

SCOMM

75:13

as presented to
UFA

HOW TO PREVENT PEN-REARED SALMON IN ALASKA

by Chip Thoma

The complex issue of regulated mariculture in Alaska will be decided this year by the Legislature. The degrees of permissability for mariculture could be myriad, should legislators choose to accept the range of arguments put forth by the Ak. Mariculture Association (AMA). As they are the only recognized entity supporting this activity, it is time to observe, research, and respond to their lobby efforts.

Thus far the AMA has employed a benign arrogance toward environmental concerns, a hasty, glowing analysis of the present and future salmon markets, and a hysteric approach to the legislative process. All of these errors have produced a negative reaction by legislators and staff toward AMA's efforts to pen-rear salmon in Alaska. It is an opportune time to decide what level of banning is appropriate; full and complete or a long-term moratorium. I believe the votes are presently there in both houses, yet the depth of their convictions border on the shallow side. If you want more than a three to five year moratorium, a documented, convincing case for banning must be presented to the Legislature and the states newspaper.

RESPONSE TO AMA/STURGULEWSKI

Both the association and the Senator have adopted a laissez-faire approach to fisheries management. Especially regarding salmon, this works greatly in the UFA's favor. Responding to fiction with fact is your strong suit. As the problems with salmon mariculture are common to every nation and state being used as examples for Alaska, the UFA should

demonstrate the disturbing similarities and deny that remedies exist to such basic conflicts. Alaska should not experiment with fin-fish mariculture because its application is neither wanted nor needed. It simply makes no sense, a phrase that should be reinforced throughout the Legislature; pen-rearing salmon no sense in Alaska.

I would usually expect opposition to engender great, organized opposition by the Anchorage business community, but the issue of habitat protection for salmon has finally hit hard over the Mat-Su timber plan. The controversy is paving the way to carve out a large constituency of support among Anchorage voters to ban pen-rearing. The polls show a determined 75% striving for a constant, preserved quality of life, especially when the question concerns fish and wildlife. The problems associated with salmon mariculture do not justify the environmental risks that would have to be taken to solve them, just as the problems of roading and logging the Susitna River system cannot be overcome by proceeding with the sale in order to prove that some habitat can be protected. If the UFA case is presented well to Anchorage, you can count on the level of interest that has surrounded the habitat/logging controversy.

ISSUES OF SIMILARITY IN MARICULTURE

- DISEASE** has thus far been restricted to fish within the pens, but causes losses due to vibriosis and algae blooms such as hetero sigma. In Port Townsend last year, 30,000 penned salmon died of severe liver disease, its toxic cause still unknown.
- POLLUTION** such as waste from fish pens can accumulate below, decreasing both species diversity and dissolved oxygen, while increasing the biomass of sulfur bacteria.
- CHEMICALS** introduced through fish feeding have increased antibiotic and insecticide use dramatically; up to 150 lb/ac. of tetracyclines are now used in Norway. This could create resistant bacterial strains, plus unknown effects on surrounding areas and organisms.

LAND and WATER USE has greatly impacted water quality, anchorage sites, traditional commercial fishing areas, local homeowners and recreational uses.

INVESTMENT PATTERNS are similar throughout Europe and the West Coast;

Norwegian ownership has accompanied the technology, now estimated to comprise 70% of the b.c. operations.

LOW EMPLOYMENT, both numbers and wages, seems to be a standard for the industry. Rather than job intensive, mariculture is increasingly technological. Salmon farms now average between 3 and 6 employees, at an average \$6/hr. Canadian. The total B.C. employment for 125 operating farms is 600, hardly an economic salvation.

ESCAPEMENT from pens is a known factor, 2% or more into the common waters. Pen-reared Pacifics can mix with wild stocks, creating new strains and impairing the wild gene pool.

GOVERNMENT SUPPORT and sponsorship has been a main factor in salmon mariculture's dramatic growth. Fisheries biologists find new, private sector employment where few regulations impede the industry, in Norway, B.C. and Washington.

ECONOMIC DISRUPTION by this industry threatens the commercial fishery. Norway is eliminating its gillnet fleet while B.C. predicts an erosion of employment. Salmon dumping could become commonplace.

TRENDS and indicators show more Norwegian ownership, disturbing impacts on the wild fishery, increased pen escapement as industry grows, more chemical use and gene manipulation and an emphasis on Atlantic salmon mariculture. A 1990 glut is also predicted.

REGULAR TO ALASKA

WILD SALMON HABITAT length. The last five years investment are clear that stocks have rebounded. Should not be tampered with. More fresh/frozen facilities are the answer to year-round markets and community stability.

WHOLESOMENESS AND NUTRITION are the key to a wider, sustained market for wild salmon. Its Omega 3 content cannot be duplicated by farmed salmon unless it is introduced chemically.

FISH FOOD AVAILABILITY and cost is the prime factor in fish farm production. The base of fish food is herring and stocks have tumbled in the North Pacific. If growth continues in B.C. and begins in Alaska, allocations may have to be made from the commercial fishery. 66,000 tons of herring needed for Alaska!

AS FISH & GAME MONIES dwindle, the legislature is being asked to approve an activity requiring testing, monitoring and siting costs. Millions have been spent to do this elsewhere, and will here.

A PROPOSED LOBBY PLAN FOR THE LEGISLATURE

- FEB 11 Press conference held by UFA Board Members and the Director announcing results of your meeting and continuing opposition to pen-rearing of salmon.
- FEB11 - MARCH 7 Concentrate on Bush Caucus, Fairbanks delegation
- MARCH 7 Production and Distribution of a 20 page Handbook on Salmon Mariculture and implications for Alaska. The previous pages could serve as an outline for detailing the disturbing similarities that exist in Norway, B.C. and Washington State.
- MARCH 15 Introduce a bill banning salmon mariculture in Alaska
- MARCH 16 Bring a panel of three B.C. experts to Juneau to explain the negatives of fish farming in the province. Members should include Geoff Meggs of the UFAWU newspaper, Mr. Meggs choice of a commercial fisherman and perhaps John Brookbank of Wash., who has organized the opposition there.
- March 16-May 10 Organize statewide response campaign to the House and Senate Resource Committees, copied to all Anchorage legislators. This would be time for "My Turn" articles, a Daily News in-depth report, etc.

RESUME

Theodore P. 'Chip' Thoma

Age: 38

Occupation: Writer, fisherman

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EDUCATION

1966 - Graduate, Gonzaga College High School, Washington, D.C.

1966-67 Xavier University, Cincinnati, Ohio (history)

1968-70 Montgomery College, Takoma Park Maryland (social sciences, history)

1969-70 Maryland University, College Park, Md. (political Science)

MILITARY SERVICE

1967-70 U.S. Marine Corps Reserve, radar technician, Andrews AFB, Honorable Discharge

WORK HISTORY

1970-71 Shingle Sawyer and Packer, M.R. Smith Shingle Mill, Beaver, Washington member, Shingleweavers Union, Carpenters Affiliate

1971-73 Democratic Party organizer, Alaska, co-chairman for State party platform Founder and Editor, Alaska Guardian, publication of Democratic Party

1973-74 Founder and Editor, Alaskan Fisherman, publication of United Fishermen of Alaska. First explanation of Limited Entry, 200 mile limit, hatcheries.

1974-76 Teamster steward, pipeline worker, Prudhoe Bay to Chandalar Pass. Worked as fireman, long haul driver, expeditor.

1976-80 Commercial fisherman; seine, gillnet, troll and longline. Fished salmon, halibut, cod, herring and crab in Southeast Alaska. Also, as contract employee with State Legislature, was chief organizer of 'Future Frontiers Conference and facilitator for two seasons of Legislative Intern Program.

1981 Operated Adventure Based Education, wilderness/kayak adventures similar to Outward Bound.

1982 Began political consulting business, Penguin Promotions, clients including Alaska Committee (retain capital in Juneau) and 30 legislative candidates.

1983-84 Public Information Officer, Alaska Division of Elections

1985 Sport Fishing guide, halibut and salmon, Sitka, Alaska

1986 Began Skagway Steetcar Company, antique car company in 1893 Alaska goldrush town

NOTE: From 1971-82 I also served as a voluntary lobbyist for many public interest groups on specific legislation before the State legislature.

suggested title: TO FISH OR FARM ?

The complex issue of regulated mariculture in Alaska will be decided by the Legislature within the next few months. Depending on the outcome, fishermen throughout the state could see new attempts by the private sector to establish floating fish farms for growing salmon, oysters, shrimp and mussels. The most controversial proposal is to allow the pen-rearing of Pacific salmon, primarily kings and coho. Whether Alaska adopts this policy, as Norway, Washington and British Columbia have already, is up to a Legislature that is presently inclined to forbid pen-reared salmon and try anything else that looks feasible. But your letters ~~calls~~ could have a big influence on the final outcome. A Legislator's incl ~~is~~ greatly reinforced by election year opinions from the voters.

Presently, commercial fishermen such as the UFA and the environmental community oppose pen-rearing of salmon because of the many diseases and genetic changes associated with the penned habitat. Unlike state hatcheries and private-non-profit ranching facilities, the pen-reared salmon are not bred for disease-free release and return through the common fishery. These salmon are bred to "lard up" on fish food within a two year period and are then sold fresh as 6-9 pounders. Their genetics are altered by the food to make them fat and docile, but new evidence from Norway is showing large escapement from the pens and spawning in the natural streams by these farmed stocks. It is an unavoidable situation that we cannot tolerate in Alaska. *Add sentence, paragraph 4.*

The British Columbia experience has been an unregulated nightmare, with over 125 salmon farms beginning in the last 5 years and hundreds more with applications approved. None of these are "Mom and Pop" farms, but corporations owned primarily by Norwegians, traded on the B.C. stock exchange, yet hiring only an average 5 employees per farm at low wages. Oyster, shrimp and mussel farms need even fewer hands, so promises of unemployment salvation would never come true in Alaska.

To the end of
Paragraph 2

Many of the B.C. and Washington penned salmon have been lost to disease caused by lack of dissolved oxygen, yet are still dumped on the market when it occurs, as the "hetera" disease is not harmful to man. Washington's penned salmon industry is dominated by Domsea, a firm purchased recently by Norwegian investors who plan to switch from Pacific to Atlantic salmon that "lard up" faster, while increasing production by four times. Now there is a strong prediction on the West Coast that a farmed-salmon market glut will occur in the next few years, driving the profits for all salmon way down and certainly questioning whether an Alaskan industry with the highest initial costs and transportation can survive. It really makes no sense to launch into such a program in Alaska while we have the benefit of watching the B.C. experiment as it unfolds. I strongly suspect that the eventual market of the mid-1990's desires a wild, nutritious salmon, caught by Alaskan fishermen in traditional harvests.

Legislators need your views on the issue of pen-reared salmon. Should Alaska join other states and nations in this industry or continue the harvest of our wild fishery without such interference?

contact Chip Thoma 463-4935



UNITED FISHERMEN OF ALASKA

MANY OPPOSE FISH FARMING

211 4th Street, Suite 106
Juneau, AK 99801
907-586-2820
March 1, 1988

We COMMERCIAL FISHERMEN depend upon wild salmon stocks. Unlike Norway and Scotland, Alaska's wild salmon stocks have not been depleted. With 43% of the world's wild salmon, we Alaskans have much to lose from DISEASE and GENETIC mutations from escaped pen-fish.

But not just commercial fishermen fear disease and genetics. UFA agrees with SPORT FISHERMEN who fear genetic dilution of wild, fighting fish, and who fear parasites and diseases bred in salmon "feedlots" being spread to our wild fish.

We share concerns of Alaska's SUBSISTENCE users, who see our common fish resources diverted to corporate profits. With British Columbia's example, foreign national corporations now own two-thirds of the fish-farms. As smaller B.C. fish-farms have been taken over by foreign corporations, ugly memories of the fish-trap era return. As further insults, SUBSISTENCE users will find areas around fish-farms OFF-LIMITS to fishing, hunting, and trapping.

UFA shares concerns of HEALTH-CONSCIOUS CONSUMERS who prefer their Alaskan salmon without artificial coloring and antibiotics, who seek the nutritional and aesthetic advantages of wild salmon, and who would be alarmed by newspaper reports of fish-kills of pen salmon from disease, pollution, and algae blooms.

UFA fears further FISCAL impact to state agencies that can neither meet their present responsibilities, nor take on new ones. Hatcheries are now being shut down. Several commercial fisheries are not even understood, much less managed.

We also share the concerns of OUTDOOR RECREATIONALISTS and wilderness seekers. We fear that choice public lands and prime public waters will be LOCKED UP by net-pens, with "no trespassing" signs posted at the entrances of bays we formerly fished, kayaked, and anchored in.

UFA shares the concerns of the outdoor TOURISM and GAME GUIDING businesses, who fear the "land-rush" of net-pens to remote areas will impair wilderness values needed for their success.

UFA shares the concerns of LOGGERS who will suffer restrictions on tow-boat traffic, log transfer facilities and rafting sites, and clearcutting in watersheds draining into net-pen areas.

UFA shares the concerns of ENVIRONMENTAL groups who see **

- ** treasured scenic areas and wilderness anchorages spoiled;
- ** seals and otters being shot for intruding upon net-pens;
- ** bears and eagles being shot in upland garbage dumps;
- ** more trespass cabins and conflicts with upland users;
- ** no planning between federal upland managers and state agencies;
- ** no long-range planning to prevent net-pen siting conflicts.

UFA as well as ENVIRONMENTAL groups do not rest easily on the assurances of government agencies, who say, if only given enough budget, they can handle all problems, large and small.

Salmon Farming in Alaska: Myths and Facts

Myth: Alaskas wild salmon won't be harmed by farmed salmon.

Fact: the Norwegian government has begun establishing farm-free zones near salmon streams and are establishing a gene bank: they have discovered that 10 to 57% of the fish in their streams aren't wild, but instead are escaped farmed salmon.

Myth: No one can afford to buy into commercial fishing these days. The only way to get into the salmon business is through salmon farming.

Fact: Prices in last month's Alaska fisherman's Journal for complete fishing packages range from \$30,000 to \$500,000 depending on the fishery. Last month, Paul Fuhs (president of the Alaska Mariculture Assoc.) said establishing a salmon farm would cost from \$300,000 to \$1,000,000. A fisherman begins to make money the very first year; a farmer must wait at least two to three years.

In addition, Rodger Painter (Alaska Mariculture Association) and Judy Brady (commissioner, DNR) have recently admitted that, because of the magnitude of capital and operational costs, fish farming will not be a mom and pop operation.

Myth: Fishermen are opposing salmon farming in order to legislate their competition out of existence.

Fact: Salmon farming is being done around the world and Alaskan fishermen must contend with this competition by better quality control and more aggressive marketing. Fishermen oppose its establishment in Alaska for four primary reasons: 1) it will put common property resources into private hands; 2) it will sap State money and personnel from existing fisheries programs; 3) it will primarily benefit wealthy corporate and foreign investors; 4) it will harm Alaska's economy by harming Alaska's fisheries.

Myth: Farmed salmon won't compete for markets with wild salmon and they'll help keep the price high.

Fact: If a product is in demand, scarcity drives the price up and a large supply lowers it. When Norwegian farmers dumped their salmon on the European market early this year (before they were killed by virus), the price for Alaska's salmon in France went down 50¢ a pound. Adding farmed salmon on top of wild salmon in the market is like having a banner season when the price drops because of the quantity available. Farmed salmon now compete directly with all top quality wild salmon, and farmers want to enter the frozen market too.

Myth: Salmon farms will pay their own way because they are willing to pay a tax just like fishermen.

Fact: Rodger Painter (executive director of the Alaska Mariculture Association) has said it would be unreasonable to tax salmon farmers until they'd begun to make a profit. Since it would take a farmer two to three years to make even the first sale, there will be a substantial period of time with State money going out and nothing coming in. The most logical source for this State money is current commercial fisheries programs, which are already being cut back.

Myth: The State can limit the size of farms to keep them locally owned.

Fact: Norwegians have found that small farms aren't profitable. There and in B.C. small farmers have either formed associations or been bought out by large corporations.

Myth: Salmon farmers can regulate themselves: they don't need the State telling them how to run their business.

Fact: Government has an obligation to protect the welfare of the public and the public's resources. It must, at a minimum, check the quality of a product being sold for human consumption, see that environmental standards are being maintained, and monitor use of public tidelands. If government turned its responsibilities over to salmon farmers, the high costs would be prohibitive to someone on a tight budget.

Myth: Thousands of new jobs for Alaskans will be created by salmon farms.

Fact: According to British Columbia's Ministry of Agriculture and Fisheries, the average salmon farm employs only six people. It would take 166 farms to create 1000 jobs in Alaska. In B. C. many of the most highly paid jobs have gone to Norwegians, since they are experienced in the business. The Alaska Legislature has been unsuccessful in requiring local hire. How many Alaskans will be hired?

Myth: The spin-off benefits will be a shot in the arm for local economies.

Fact: According to "B.C. Business" (Oct. 87) Norwegian investors included strings in their finance packages: they required monopolies on construction and supply purchase so operators were unable to take advantage of competitive prices and local merchants received few benefits. In addition, the Norwegians' share of the profits returned to Norway with the investors.

Myth: We'll be able to keep this an Alaskan business.

Fact: Bill Hall (Alaska Commercial Fishing and Agriculture Bank) has said neither CFAB nor any other Alaska bank is willing to loan money for salmon farms. Start up and operating costs will be financed either by foreigners or by corporations such as Weyerhaeuser, British Petroleum, Mitsubishi, Union Carbide and the Campbell Soup Company. Business owners rarely ignore their partners' needs, goals or desires.

In addition, the B.C. fish farming industry is currently 65-90% Norwegian controlled. The largest fish farm in Washington has been recently purchased by Global Aqua, a Norwegian company.

Myth: Norway isn't subsidizing their salmon farms so Alaska won't have to either.

Fact: According to Commissioner Tony Smith (Dept. of Commerce and Economic Development) Norwegian fish farm subsidies include: capital grants; guaranteed loans for start up costs and capital investments; a 50¢/kilo subsidy for all international shipments; salmon egg production; research; price supports; a guaranteed minimum income and vacations for workers. They have budgeted \$14.7 million for these programs for next year. What reason is there to think Alaskan farmers won't need State financial help?

Myth: Salmon farms won't hurt the environment.

Fact: They will certainly change the environment: algaecides are used to prevent growths on the nets; fish food containing additives and massive quantities of fecal matter are deposited on the ocean floor; dead fish which have been fed antibiotics are prey for other species, thus entering the food chain.

UFA Framework for Compromise

We support:

1. Siting criteria to protect the environment and current users
2. Shellfish farming policy in statute
3. Sea vegetable farming policy in statute

We strongly oppose:

1. Finfish farming
2. Private for-profit finfish hatcheries
3. Any unregulated aquatic farming that may jeopardize fish or their environment, directly or indirectly

Mariculture -

discussed points of agreement

1. an indefinite ban on offshore salmon farming in the ocean
2. Formation of task force to investigate the risks and benefits of mariculture production in and outside Alaska, to Alaska's fishing industry. A report made to the legislature the following session.
3. Offshore salt water mariculture with non-salmon species, specifically, Arctic Char, Rainbow Trout, Steelhead, Sheefish
4. Senator Eliason's siting process with 2 year sunset clause for review of process.
5. Sales of brood stock outside Alaska limited to shellfish only.
6. Alaska's raw fish tax applied to ~~pay for~~ mariculture industry to pay for cost of regulation and use of public waters.
7. Onshore salt water and fresh water mariculture for all species on private lands. Effluent water treated to ADF&G standards.

— hatcheries

—

(B) the number of hatchery-produced fish taken for the hatchery harvest requirement, to be used to pay for the hatchery's reasonable operating and capital costs, at current market prices for the species involved;

(7) "permit" means a private nonprofit salmon hatchery permit, issued by the commissioner, which has not been suspended or revoked;

(8) "PNP coordinator" means the salmon rehabilitation and enhancement coordinator of the private nonprofit hatchery program within the Department of Fish and Game;

(9) "regional comprehensive salmon plan" is a document that integrates and assembles all relevant information regarding the development and protection of the salmon resource, for a specific long-range period of time, into a strategic plan for an established region of the state;

(10) "rehabilitation" means a strategy directed toward restoring debilitated natural stocks to optimum production levels; rehabilitation strategies consist of regulatory and nonregulatory activities; nonregulatory activities are directed at increasing the survival of debilitated brood stock and include removal of migration inhibitors, stream restoration, incubation and subsequent planting of eyed eggs, fry and fingerlings, lake fertilization and predator-competitor control;

(11) "salmon stock" means a population of salmon of a single species identified with a specific water system or portion of a water system, which share a common spawning period;

(12) "special harvest area" means an area designated by the commissioner or the Board of Fisheries where hatchery returns are to be harvested by the hatchery operators, and, in some situations by the common property fishery; and

(13) "terminal harvest area" means an area designated by the commissioner, Board of Fisheries regulation, or department emergency order where hatchery returns have achieved a reasonable degree of segregation from naturally occurring stocks and may be harvested by the common property fishery without adverse effects. (Eff. 3/31/85, Reg. 93)

Authority: AS 16.05.020
AS 16.05.092
AS 16.10.375
AS 16.10.475

Chapter 41. Transportation, Possession, and Release of Live Fish

Article

1. Scope of Regulations (5 AAC 41.001)
2. Permit System Established (5 AAC 41.005 — 5 AAC 41.060)
3. General Provisions (5 AAC 41.070 — 5 AAC 41.100)

Article 1. Scope of Regulations

Section

1. Application of this chapter

5 AAC 41.001. APPLICATION OF THIS CHAPTER. The provisions of this chapter govern the transportation, possession, or release of live fish transplanted for or cultivated for human consumption or sport fishing purposes, or as part of an aquaculture program for scientific, educational or propagative purposes. Unless specifically provided, the provisions of this chapter do not apply to the cultivation of ornamental fish. Additionally, the provisions of this chapter do not apply to the transportation, possession, or release of fish taken for commercial, sport, or subsistence purposes.

Authority: AS 16.05.251 (a) (4), (8) and (10)

Article 2. Permit System Established

Section

5. Permit required
10. Uniform application procedures
20. Inspection for disease of brood stock
30. Permit issuance or denial
40. Amendments to the permit
50. Permit conditions
60. Retention of permit for inspection

5 AAC 41.005. PERMIT REQUIRED. (a) No person may transport, possess, export from the state, or release into the waters of the state, any live fish unless the person holds a fish transport permit issued by the commissioner or his authorized designee, and the person is in compliance with all conditions of the permit and the provisions of this chapter. A fish transport permit will be issued for a fixed term subject to the provisions of (c) of this section.

(b) A fish transport permit authorizes only that operation specified in the permit. Any change of species, brood stock, or location requires a new permit. Any other change requires an amendment to the permit.

(c) The commissioner shall suspend the permit, or particular provisions of the permit including amendments, if he finds

(1) on the basis of new information or changed circumstances, that the permitted activity will adversely affect the continued health and perpetuation of native, wild, or hatchery stocks of fish; or

(2) the permittee has failed to comply with permit terms or the provisions of this chapter.

(d) Notwithstanding the expiration, termination or suspension of a fish transport permit, each permittee is responsible for the obligations arising under the terms and conditions of the permit, and under the provisions of this chapter.

Authority: AS 16.05.251 (a)(4),(8),(10) and (12)

5 AAC 41.010. UNIFORM APPLICATION PROCEDURES. (a) Each applicant for a fish transport permit shall submit the following information to the department:

(1) identification of each species and location of the stock to be transported, possessed or released;

(2) the destination of the transported fish and the release site;

(3) the number of fish and their life history stage or age;

(4) a descriptive history of previous transport, if any;

(5) a statement on the health or condition of the fish, including a disease history of the stock, a disease history of the hatchery or rearing facilities through which they may have passed, and any previous disease treatments or vaccinations, or, if the disease history is incomplete or unavailable a brood stock inspection and certification pursuant to 5 AAC 41.020;

(6) isolation measures planned to control disease during transport, including a description of containers, water source, depuration measures, and plans for disinfection;

(7) a description of proposed egg-take methods;

(8) the source of water for rearing and proposed effluent discharge location;

(9) identification and status of native stocks in the area of taking, retention and release site, including a statement of expected interactions with other stocks in these areas;

(10) the method of transport or release and the expected date of transport or release;

(11) the purpose and expected benefits of the transport or release; and

(12) evaluation plans.

(b) A completed application must be submitted to the department regional office in the region in which the proposed transport or release will occur.

(c) If the commissioner or his authorized designee determines that an application is incomplete and that further information is necessary, the department will return the application to the applicant with a description of the deficient information.

(d) The commissioner or his authorized representative will approve, condition, or deny a permit within 45 days after a completed application containing all of the applicable information listed in (a) of this section has been received in the appropriate regional office. (In effect before 1982; am 7/25/82, Reg. 83)

Authority: AS 16.05.251(a)

5 AAC 41.020. INSPECTION FOR DISEASE OF BROOD STOCK. If the disease history of the brood stock is unavailable or incomplete as required by 5 AAC 41.010(a)(5), an inspection of the brood stock to detect fish disease must be scheduled by the applicant and conducted by the fish pathology section of the department, or by a person designated by the fish pathology section. The applicant must submit samples of the brood stock as directed by the fish pathology section for the purpose of inspection. The applicant will receive a certification from the fish pathology section upon successful completion of the inspection.

Authority: AS 16.05.251(a)(4),(8) and (10)
AS 16.05.868

5 AAC 41.030. PERMIT ISSUANCE OR DENIAL. (a) The commissioner or his authorized designee will issue a fish transport permit if it is the department's determination that the proposed transport, possession or release of fish will not adversely affect the continued health and perpetuation of native, wild, or hatchery stocks of fish; or

(b) The commissioner or his authorized designee will issue a fish transport permit with terms and conditions attached if it is the department's determination that the terms and conditions are necessary to protect the continued health and perpetuation of native, wild, or hatchery stocks of fish.



UNITED FISHERMEN OF ALASKA

211 4th Street, Suite 106
Juneau, AK 99801
907-586-2920

March 17, 1988

Dear Alaskan:

UFA OPPOSES fish farms -- saltwater or freshwater, in tanks or in net pens. The following enclosures support our position.

- * *A one-page briefing paper summarizing why UFA feels that large numbers of Alaskans should OPPOSE fish farms.*
- * *A series of annotated news articles and commentary based on several themes such as...*

Genetics. We take alarm at reports of domesticated escapees from netpens mingling with the few remaining wild stocks in the Atlantic salmon spawning streams of Norway.

Disease. We further take alarm at reports of disease from farmed fish destroying salmon in Norway's streams, at reports of diseased farm salmon being released in Canadian waters, at photographs of diseased fish in garbage dumps in Canada.

Conflicts with other water and land users, the "lock up" of public bays. We don't like fish farmers firing guns to frighten off recreational boaters in B.C. We don't like net pens anchored where we fish or set crab pots.

Nutrition. Why would health-conscious fish consumers want pen-reared salmon, with lower oil content, mushy flesh, and artificial coloring?

Foreign or corporate ownership of Alaska's fish. Small farms in B.C. have gone bankrupt to be bought out by large foreign corporations, setting an unnerving example.

- * *Position papers and letters that further explain the opposition of UFA and other groups to mariculture.*
- * *References and bibliography.*

We hope you will study this report and other information on fish farming. We ask you to join us in our support of shellfish and algae aquaculture and in our opposition to fish farming.

Kate Graham
Executive Director



UNITED FISHERMEN OF ALASKA

211 4th Street, Suite 106
Juneau, AK 99801
907-586-2820

MANY OPPOSE FISH FARMING

March 15, 1988

Alaska's COMMERCIAL FISHERMEN, who depend upon wild salmon stocks, oppose fish farming. Alaska's wild salmon stocks have not been depleted, as they have been in Norway and Scotland, and with 43% of the world's wild salmon, we Alaskans have much to lose from **DISEASE** and **GENETIC MUTATIONS** from escaped pen-fish.

Commercial fishermen are not the only ones who fear the risks inherent in fish farming. **SPORT FISHERMEN** also fear genetic dilution of wild, fighting fish and are concerned that the parasites and diseases bred in salmon "feedlots" would spread to our wild fish.

UFA shares the concerns of Alaska's SUBSISTENCE users, who see our common fish resources diverted to corporate profits. Note British Columbia's precedent: foreign national corporations now own two-thirds of the fish-farms. As smaller B.C. fish-farms have been taken over by foreign corporations, ugly memories of the fish-trap era return. As further insults, **SUBSISTENCE** users will find areas around fish-farms **OFF-LIMITS** to fishing, hunting, and trapping.

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- * no planning between federal upland managers and state agencies;
- * no long-range planning to prevent net-pen siting conflicts.

Like these environmental groups, UFA is uneasy with the assurances of government agencies, who say, if only given enough budget, they can handle all problems, large and small.

###

THE NEED TO SAFEGUARD THE GENETIC DIVERSITY OF WILD STOCKS

Genetic diversity makes wild salmon special. The legendary ability of wild salmon to return and spawn in the streams of their birth creates a genetic link bonding them to a specific ecosystem of the earth. Thus each stream cultivates its own stock of salmon. The genetic material of the salmon in that stream does not mingle with the genetic material of any other salmon. Thus, even if disease or disaster should wipe out one stream's stock, salmon in adjoining streams may not be adversely impacted.

Wild salmon's selection of specific spawning streams is akin to investors' protection of their money: wise investors put their money in many small accounts rather than in one large one. The survival of wise investors and wild salmon is based on this principle.

From this principle comes a basic policy of the State designed to safeguard these natural genetic differences: transporting salmon eggs or breeding stock from one region of Alaska to another is not allowed.

The siting criterion for fish farms also comes from this principle. Escapees from fish farms have little "homing" sense; that is, they don't know which stream to return to spawn in. Escaped salmon may stray into several areas when the urge to spawn takes over them. Therefore, fish farms should be located far away from spawning streams.

Therein lies a dilemma. How can you keep fish farms close enough to their source of eggs or broodstock to maintain the genetic character of the region, yet far enough away that escapees do not enter the stream to spawn? And exactly what are the safe maximum and minimum separation distances? As yet there are no scientifically-based answers to these critically important questions.

DO NOT CONFUSE THE GENETICS OF WILD, HATCHERY, AND PENNED FISH

- ***HATCHERY fish breeders seek to mimic wild stocks.***

They promote Type "A" aggressive fish, with hyperactive traits. They breed fish to compete and mate with wild stocks. Hatchery fish, like wild stocks, chase their prey and, in turn, escape predators. Their genes remember the strength of the chase, their muscles flex with the test of speed, their flesh tastes of the stamina of the ocean. The slow ones, the weak ones don't survive.

- ***PENNED fish breeders seek genetic traits unlike wild stocks.***

They seek tame fish, docile and of broken spirit. Penned fish swim in circles, preying upon sinking food pellets. Breeders unnaturally select genes which tolerate stresses of confinement, overcrowding, and noise. Diseased pen-reared fish survive on the crutches of vaccines, antibiotics, chemicals, and dietary additives. Their flesh feels soft and, without red dye in the food pellets, looks pasty white.

Renegade Norwegian farm salmon polluting wild runs

"Renegade" salmon from Norway's fish farms are destroying important characteristics and genetic differences between farm and river salmon, says Professor Harald Skjervold, following the discovery this autumn that up to 57 percent of the salmon stocks in some Norwegian rivers are of the farm variety.

If the genetic pollution continues at its present rate, the hereditary variations among some of the river species will be halved within seven years. Nature takes tens of thousands of years to fit the salmon to its special environment, and in the light of this fact, the present developments are alarming, says Skjervold.

The head of the Directorate for Nature Management, Helge Vikan,

also finds the latest findings disquieting and stresses the vital importance of preserving the most valuable of the salmon species in the genes bank now being built up in Trondheim, incidentally the first of its kind in the world.

Sperm from 47 species of Norwegian river salmon were stored in the bank last year, and this number will be doubled by the end of 1987. Vikan blames the extensive genetic pollution in rivers on the import of smolt. This import is not only responsible for spreading disease, it is also a major hazard for river salmon, says Vikan. He intends proposing to the Ministry of Environment that the Directorate be involved in the assessment of smolt import licenses.

• Despite the complete absence of environmental impact studies, salmon farmers are importing Atlantic salmon eggs to supplement domestic supplies. In Norway, disease outbreaks have been traced to imported stock.

Current policies to import Atlantic salmon eggs amount to an act of 'biological insanity'

he said some research has been undertaken on oysters to ensure they are not grown too densely for "profitable growth".

Francesca Dixon, the fisheries department official responsible for monitoring aquaculture applications, told the farms are placed at least half a mile from streams to avoid disease transfer. Is it

"We know there is some impact have all the answers." In fact many locations in John's major salmon mission "there are farms"

Meanwhile, the Norwegian ministry of environment has begun a campaign to create aquaculture free zones around salmon bearing streams. Fears of disease spreading to wild stocks and genetic pollution have prompted the move according to the latest issue of *Fish Farming International*. "The rapid increase in salmon cage

farms is worrying the Ministry of Environment in Norway which wants to see fish farming barred from declared zones in the country's fjords," the magazine states. "The background for this initiative is the fear that diseases will be spread from farms to salmon rivers and the risk of genetic pollution."

The battle to protect wild salmon stocks here has been continuing and the DFO now says changes, along the lines of the Norwegians, are necessary.

NORWEGIAN "Renegade Salmon" are mingling with wild stocks. Salmon that were released or escaped Norway's fish farms are returning as spawning adults and creating "genetic pollution." If the run-away rate continues, scientists predict variations among some of Norway's wild stocks will be halved within seven years. The Norwegian Directorate for Nature Management reports that genes from wild salmon found in 47 different rivers were stored in a sperm bank in 1986 and that twice that number will be stored in 1987. The sperm bank is reportedly the first of its kind in the world. Fears about disease infestation from farmed fish to wild stocks continue as well. The UK-based Atlantic Salmon Trust reports that the parasite Gyrodactylus salaris is destroying stocks of wild salmon in Norwegian rivers. The parasite has reportedly killed 300 tons of wild salmon. Officials believe too little attention is being paid to the danger of spreading disease and parasites from fish farms to wild stocks.

Norway:

Wild-salmon endangered by bred-salmon

Fleeing bred-salmon can become a danger to wild-salmon. This is claimed by the Norwegian Researcher Lars Petter Hansen, Director of the Administration for Nature. Examinations have shown, that one of ten salmon which are caught have either fled from the breeding-plants or are from

brood which was set out in Norwegian rivers. Further more it was found that fled bred-salmon, becomes «homeless» and starts to spawn in any river he finds by chance.

It is assumed, that the rising number of cultivation-plants lead to the point, where the number of salmon which flee, will increase. Both the Norwegian researchers, as well as researchers of the International Council for Ocean-Research are in this respect in-

terested to ascertain, what effect the bred-fishes have on the wild stock, Hansen declared. The Directorate is about to develop a method, with the aid of which it will be possible to determine whether it is a fled-salmon from the cultivation, or a wild fish.

If this is successful, one could prevent fled cultivated-fish from leading to a wrong assessment of the stocks of wild salmon, so that the Administration can ascertain whether this has already lead

to a strong diminishing of the wild stock and constitutes a problem.

In the course of a test, to determine the pure wild fish-stock in the rivers, the Directorate is now about to establish a gene-bank. Last but not least it is important for the breeding plants to return to nature and to bring forth the lost hereditary factors again, which have been lost during the development of the salmon towards a «domestic animal», Lars Petter Hansen declared.

WHY FISH FARMING WORSENS DISEASE RISK

Several factors aggravate disease problems in fish farms, whether incubated in net pens or in tank farms.

• CONFINEMENT

Disease and parasites thrive where their hosts are densely packed, such as in fish farms, feedlots, and so forth. Disease organisms prefer to be safe inside their hosts rather than outside. Outside, in clean water or clean soil, it's only a matter of time before disease organisms die. Thus, disease organisms thrive in or near fish farms, where the distance between hosts is short, where the nets and structures attract slime and growth, and where the bottom is fouled with energy-sustaining filth and uneaten food.

• DIET

Dry food pellets, normal fish farm fare, do not seem to suit Pacific salmon so well as Atlantic salmon. Dry food requires rehydration after ingestion and forces the fish to process more water through its body, thus inducing more stress. Pacific salmon seem to prefer fresh or frozen feed. With either feed type, Pacific salmon will not eat well if frightened or stressed. If the feed does not contain proper nutrients, the penned salmon will not develop resistance to disease.

• LACK OF EXERCISE

The restraints of confinement limit the fitness and health of penned salmon. This not only impairs the resistance to disease but also impairs muscle tone, which accounts for the mushiness of penned salmon's flesh.

"THE IMPORTANT

QUESTION, then, is not whether these organisms pose a present health threat, or ecological threat.

"The proper question is:

can these organisms, and this ecosystem, and these humans tolerate the eutrophic burden that will be imposed by a full-blown fish pen industry?

"It is our belief that there are many too many questions that need resolution, of a public health nature, and of an ecological nature, before we proceed further."

Professor Arthur H. Whiteley

"Some relationships between pathogenic bacteria and salmon net pen culture"

Pacific Fisheries Legislative Task Force, Olympia, Washington, February 7, 1987

stully m in Sea- n the uing 'de- ofit-on- to ed of . e mounted a n...
...stully tha... a powerful politi... in Alaska, where one of the world's largest salmon fishing fleets has so far blocked efforts to establish salmon farms.

Perhaps more serious is the battle to keep the fish free of a bacterial kidney disease that has bankrupted some salmon farms in Scotland and Ireland and decimated the fish stocks of at least one British Columbian venture.

Environmental groups that previously agitated for an end to whaling and to commercial seal... mounted a n...
W& gia 600 1 soun deep, essent h...

Disease threatens Norway's farms

Norwegian researchers say their country's salmon farmers cannot afford the massive losses to disease that that claimed as much as 8,000 tonnes of salmon last year alone.

They are pointing the finger at the failure of the industry and the Norwegian government to provide adequate research facilities and funding for local veterinarian services.

According to *Fish Farming International*, a London-based aquaculture publication, veterinarian services in Norway are being overwhelmed.

"Our government does not seem to realize how easily this nice new industry could be destroyed," said Knut Hjelmeland, a senior research scientist at the

Foundation of Applied Research in Tromsø.

"Disease can spread so quickly that almost overnight fish farming can be stopped."

The comments confirm fears pinpointed by the UFAWU in submissions to the Gillespie inquiry on aquaculture in B.C. B.C. fish farmers have almost no veterinary capability and rely on the Pacific Biological Station for their only fish health laboratory. Diseases originating in farmed stock could spread to valuable wild salmon runs.

Proposed federal aquaculture regulations would only require fish farmers to monitor fish health themselves and to report outbreaks detected by their own staff. Canada lacks even Nor-

way's ability to monitor, research and control fish disease.

Hjelmeland pointed to the disaster suffered in 1985 by 30 Norwegian farms infected by furunculosis imported in diseased salmon smolts from Scotland. (Canada forbids the import of smolts, but allows egg imports under strict controls.)

And hitra disease, which is not found in B.C. salmon, is raging on Norwegian farms, killing up to 25 percent of the stocks in some areas.

The fish farmers association says it cannot afford more training a research because of financial pressures, an attitude Hjelmeland condemned as "a very expensive way of saving money."

Farm fish diseases killing the wild stocks in Norway

The Atlantic Salmon Trust has warned Norway's neighbours that diseases from fish farms may spread to wild stocks in their countries.

But Canadian officials say farmed fish won't infect wild stocks in Canada because of strict regulations controlling fish management and the importation of eggs.

In letters to the agriculture ministers for England, Scotland and Wales, the trust warns of the "dire threat to wild salmon from diseases now sweeping Norway."

The letter, written by the trust's director Rear Admiral John MacKenzie, states: "Insufficient attention is being paid to the dangers of the spread of disease and parasites from fish farms to wild stocks. With the explosion of salmon farming in the British Isles, I consider it essential, that everyone concerned with the well-being of wild salmon should be aware of what continues to happen in Norway."

The parasite in question is *Gyrodactylus salaris*, and it has wiped out about 300 tons of salmon in Norway's commercial and river fishing catches, according to an article in the England-based *Shooting Times*.

In Canada, DFO's head of aquaculture Ron Ginetz dismissed any suggestion that farmed fish could have the same impact on wild stocks here as they have in Norway.

"My personal opinion is that I am not overly concerned with a threat to wild stocks from diseases indigenous to this coast," he said. "I am concerned about the importation of exotic diseases from other parts of the world."

"The Norwegians have not paid much attention to wild fish stocks and the protection of them," he said. "Canada has the most stringent fish protection

(regulations) anywhere in the world."

After an initial round of Atlantic salmon egg imports several years ago, the industry is now limited to 300,000 at a time. Because of the stringent environmental considerations, this restricts the import of Atlantic eggs to a few operators.

These eggs come from only one farm in Scotland where the farm meets government standards.

Eggs are also allowed from Washington or Alaska, but the regulations are so tough, it is almost impossible to bring in the eggs.

"We sent a message to the industry that permission would

be difficult to obtain," he said.

Already some Atlantic salmon have escaped from the pens and are mixing with the wild stocks. Ginetz confirmed fishermen's reports that the fish escaped in the Johnstone Strait area, but he said the DFO was not concerned about the impact of the fish on the wild stocks.

Meanwhile, the UFAW is organizing a major tour of Norway to investigate the fish farm industry and see what the impacts on the wild stocks have been.

As well, the group will look at the Norwegian government's regulation over the farms and how successful they have been in controlling the problems.



• A former employee of a fish farm says his boss dumped thousands of pounds of diseased fish into the ocean. The DFO says there are no regulations that can stop a fish farmer from doing this. Above, a farmer has dumped his fish in the local dump.

DFO says no restrictions on dumping diseased fish

A former employee of a fish farm says his boss dumped 20,000 pounds of diseased fish into the ocean, a move DFO officials say is perfectly legal at this time.

The allegation is contained in a Dec. 10 letter from Serge Cote of Tobino to the DFO, and also alleges fish with disease and antibiotics were processed and sold to the public.

It's a charge Ron Ginetz, head of DFO's aquaculture department, says is probably true, but the department can't do anything about it at this time.

"The procedure is not something we condone, but there are no regulations in place to control that activity," he said. "We are in the process of developing regulations to prevent this."

Ginetz also revealed that no regulations exist at the present time to prevent the sale of farmed fish with antibiotics or other kinds of drugs in them to the public.

And the jurisdictional problems between the federal government and the provincial government continue to hamper proper enforcement.

Ginetz said as a result of the letter he directed the local fisher-

ies officers in Tobino to request the farmer stop the practice of disposing of dead fish in this manner.

In his letter Cote alleged on July 25 that Belcher Point Fish Farm processed 430 farmed salmon that were "showing high evidence of B.K.D. and Vibriosis infection."

"That fish coincidentally was under antibiotic treatment and with full knowledge of this, was sent onto the consumer market," he alleged.

Ginetz said the farming industry has asked members to hold fish for 40 days in a drug free state before sending them to market.

But he agreed the fish could go right onto the market without any check on the amount of antibiotics or other drugs contained in the fish.

"We're trying to create a standard but there hasn't been sufficient time to do this," he said. "We're all waiting for regulations and standards."

He said both the federal and provincial government are working on regulations. The federal government inspects fish headed for foreign markets and the provincial government is in charge

of inspection of domestic fish sales.

But Ginetz said the provincial government does not do much inspection since most fish is bound for foreign markets.

Safe levels of drugs in farmed fish must be set by the Health and Welfare department and then DFO would be in charge of enforcing them.

While Ginetz estimates the DFO is spending between \$2.5 million and \$3 million on aquaculture now, more will be needed to properly police the regulations.

"For the sake of the industry itself, in order to survive, it better clean up its act," he said.

The B.C. Salmon Farmers' Association has sent out a bulletin advising farmers not to dump diseased fish into the ocean, Ginetz said.

New regulations to control dumping and the level of drugs are expected no sooner than May of 1988. At that time a number of regulations will be introduced by the federal government.

Another area of concern is the amount of pollution beneath the pens. He said the DFO is planning to monitor this situation to ensure problems don't develop.

"Disease outbreaks have plagued the life of fish farmers through the years... The hitra disease of Norway is clearly the most frequent cause of loss there. It appears to be a reoccurring event. The insurance industry of Norway has posed the question of whether this disease is an insurable risk or whether the losses caused by the disease should be regarded as a normal calculable operating expense which should be excluded from the insurance industry.

"The overtones of these thoughts parallel the thoughts of underwriters about BKD [bacterial kidney disease] in British Columbia.

"The losses in Norway due to hitra disease were enormous last year. Losses due to the disease and early slaughtering could be as high as 8000 tons or \$65,000,000."

*Ian Angus, Vice-President,
Sedgwick Tomenson Inc,
International Insurance Brokers,
of Vancouver, B.C., in a speech
before the 1987 Sitka aquaculture
conference.*

Salmon 'feedlots' in Northwest



Washington's fish-farming advocates run into shoals of environmentalist protest

By Cheryl Sullivan
Staff writer of The Christian Science Monitor

Port Townsend, Wash.

When John Pitts looks out over the wind-rippled waters of Washington's Puget Sound, he sees untapped potential. This particular body of water, says the state's aquaculture coordinator, is unusually suited to feed the world's ravenous appetite for fresh salmon.

When Robert F. Hull gazes out at these waters from the bluffs of pastoral Port Townsend, he also likes what he sees. But he and some of his neighbors say the introduction of salmon pens along the shoreline here would threaten water quality, other marine animals, and their own ways of life.

Determined opposition to salmon farming here has virtually stopped the fledgling industry's growth. Four of the counties that ring the Puget Sound area have declared year-long moratoriums on additional salmon-pen operations, and most counties that recently granted fish-farming permits have seen their decisions appealed by local residents.

"Fish farms," snorts Mr. Hull, who has helped to organize local opposition to salmon-pen proposals. "They're nothing but feedlots - for fish instead of cattle. They generate huge amounts of waste products, which are not pleasant things to go swimming, boating, waterskiing, or clamming in."

Unlikely as it may seem, the controversy here traces its roots back to Norway, which pioneered the technique of raising salmon in captivity. In the mid-1960s, with its wild salmon runs depleted and

"Floating mariculture generates large amounts of solid wastes in the form of feces and unutilized feed..."

"Accumulation of organic-rich sediments occurred around most culture facilities reviewed."

"The culture of finfish will produce about 0.7 lbs of feed and fecal waste for every pound of fish produced."

"At most existing culture sites, heavy accumulation of this material occurs directly beneath the culture structure and in the immediate vicinity."

Dr. Donald P. Weston
"The Environmental Effect of Floating Mariculture in Puget Sound," University of Washington, 1986.

A fish farm producing 100 tons of fish per year dumps the same pollution load as the raw sewage of a city of 2000 people.

New algae bloom hits Gulf salmon farmers

An unexpected algae bloom wiped out to 10 percent of the farmed salmon in some aquaculture operations in the north end of the Gulf of Georgia last month, says the fisheries department.

"Some fish farmers are not at all keen to broadcast how much fish was lost," said Dorothy Kieser, a fish pathologist at the Pacific Biological Station.

The bloom of chaetoceros algae erupted in the Campbell River area April 1 and lasted just over a week, she said, but the department was unable to estimate how many farms were affected.

Fish farms on the Sunshine Coast suffered significant losses last summer during an outbreak of heterosigma algae and smaller outbreaks hit farms during the fall, she said.

Are B.C. farms prone to serious losses from algae? Kieser said that "Norwegian and Scots experts claim to have occasional problems that are not as problematical as it appears to be here. It's early to tell."

The algae blooms are part of marine life and would go unnoticed if farms were not affected, she said. Farmed fish are killed by gill damage or oxygen depletion because of the algae. Wild fish simply leave the area.

Although farmers are required to report losses above a certain percentage every day, none have reported algae losses because of the April outbreak.

But one farmer told the *Campbell River Courier* in mid-April that his operation in Hoskyns Channel lost "between 5,000 and

10,000" of its approximately 60,000 400-gram chinooks because of the algae.

Kieser said the blooms are normal for the area and occur cyclically. She said it is "too early to tell" if marine conditions will adversely affect fish farming in the area.

Studies find TBT in B.C. farm fish

Provincial tests on farmed fish have found traces of the deadly toxin tributyltin (TBT) in the tissue and both levels of government are moving to ban the use of the chemical for any marine use.

Farmers who have used TBT on their nets have been advised that the fish should not be sold until it is given a clean bill of health. Even trace amounts in seawater are deadly for shellfish and bivalves. The product is banned in several European countries.

But the provincial government does not appear willing to release the findings of its studies to the public at this time.

No safe level of TBT in fish has been established and debate in the scientific community still exists over proper testing methods.

"There is a scarcity of information on how it (TBT) affects humans but you want to err on the safe side," said Charles Campbell, chief technician of Services Product Inspection in federal fisheries. "In the long run the only solution is to get the damn stuff out of the environment."

Banning the use of TBT in the marine environment ... boat owner

Atlantic salmon fish kill at Hadlock said not infectious

Death from liver ills for several thousand pen-reared Atlantic salmon over the past two years at Sea Farms of Norway's Hadlock, Washington, site is being investigated by the State Department of Ecology. (ED: A wood alcohol distillery was located in the old days, where now stands a shoreside resort in the bus-stop community on the south end of Port Townsend Bay.)

"Severe liver disease," apparently caused by a toxic substance, is the cause of death noted in a study by ... to Sea Farms of Norway, ... by the Fisheries ... state

Toxic pollutant feared cause of pen-reared salmon deaths

Marine Environment
staff reporter

Atlantic salmon are dying at a fish ... in Port Townsend Bay and ... believe pollution may be the ...

Arthur Kent, a fish pathologist ... a Seattle Marine Research ... at Seattle, said that by ... Oct. 23, he expects to have ... other salmon fish are dying, just like ... a Farm of Norway fish farm ... Hadlock and Indian Island.

Since 1986 about 23,000 pen-reared ... salmon in the Hadlock and

and hundreds more to smelter Sea ... Farms of Norway operation here. Glen ... have become victims of a fatal ... liver disease, said Kent. The Glen ... was a total operation, closed last year, ... a company spokesman said.

The pen disease is peaking in Kent ... and company officials because the ... dead salmon in Port Townsend Bay ... come from the same stock as those be ... ing successfully raised north of Ender ... Hook in Port Angeles.

Another fish crop in Brierley ... Farms in Port Townsend Bay off the ... head haven has also been unaffected.

Kent, who's investigating the fish ... kill, said he's collected perch, herring ... and cod from the waters of the

Hadlock operation and expects to ... have later this week whether the wild ... fish suffer from the same liver disease.

He said evidence indicates the liver ... disease is not caused by bacteria, ... virus, or a lack of oxygen, but is likely ... related to some type of pollution. "We ... have strong evidence it's a water-borne ... disease," he said.

"I don't want to speculate on the ... source at this point," he said. "I feel ... there's a severe pollution problem af ... fecting these fish. We don't know the ... source."

Meanwhile investigations from the ... federal Environmental Protection ... Agency and the state Department of ... Ecology are examining fish tissue

from affected and non-affected fish.

One worry is cancer, said Kent. ... "We haven't seen any cancer ... associated with it, but the types of le ... ucemia we see here are found in fish that ... ultimately develop cancer," he said.

"If the fish survive there's a strong ... possibility they'd develop cancer," ... Kent said.

Seattle plans to coordinate the ... federal and state efforts and as a back ... up "anything that would potentially ... release pollutants into the environ ... ment," said Kent.

That includes the naval installation ... at Indian Island, if hazardous ... materials from that site are found to be ... polluting Port Townsend Bay, he said.

and Paper Corporation's mill in the ... Township, said that although the Port ... Townsend Paper Corporation has ...

Dick Dushkoff, DOE's industrial ...

Department, said that although the Port ... Townsend Paper Corporation has ...

... Continued on Page 4-16



• This newly established fish farm on the north end of Vancouver Island is importing Atlantic salmon eggs in a controversial move to introduce a new species to the west coast. The farm is being developed by a foreign corporation which operates in Scotland as well.

... little
to site selec-
... sprung up in bays
without enough tidal action
to wash away pollutants and
near major spawning paths
for wild salmon. Otters and
marine mammals that tried to
make a meal of the farmed
salmon often ended up shot
full of lead.

Even recreational boaters
felt the bite of the fish farm-
ers' wrath. In some instances,
recreational boaters found
their favorite bays roped off
by fish farmers, who fired
gun shots to ward off visitors.

Last year, British Colum-
bia declared a moratorium on
salmon farm per-
... commis-

8 The Fishermen's News - January 1988

Alaska aquaculture conferees fear...another fish trap era, foreign and big business take-overs



by Marilyn E. George

No subject is being debated as much as the pros and cons of aquaculture in Alaska. A three day aquaculture confer-
ence in Sitka from Nov. 19-21, 1987, was an eight member panel on... having one person as a part-time business. His group has been...

The aquaculture boom is going bust for coastal communities which find salmon farms obstructing navigation, polluting local waters and threatening other foreshore uses. Sunshine Coast residents are calling for a moratorium on new aquaculture developments.

By GEOFF MEGGS

SALMON farming's golden bubble is bursting for communities around the Strait of Georgia.

Angered by the way the provincial government is ramming through foreshore leases and concerned at the absolute absence of research on the environmental impacts of the new industry, they're demanding a moratorium on the approval of new salmon farms.

The industry's growth rate is staggering. In 1984, only 10 farms were operating and their production totalled 107 tonnes. By 1988, the provincial government expects more than 100 farms to produce between 7,000 and 8,000 tons of fish ranging up to nine pounds in weight.

Sunshine Coast residents attending a seminar March 10 on the use of the foreshore learned that environmental impacts of the farms include:

- sewage equal to the annual production from a five-acre salmon farm;
- development of antibiotic-resistant bacteria from pens where drugs are used;
- discharge of up to nine pounds of antibiotics per ton of fish.

FISH FARM FIASCO

after hearing the day's debate that the government's "disregard for orderly evolutionary process with checks and balances is cause for grave concern."

Noting that SFAB members fear salmon farms will carry disease into the wild stocks, he warned that "when you work with foreshore and mariculture you're tampering with Mother Nature and she has a way of stalling you in the back."

The result of the seminar was a vote by Sunshine Coast Regional District to call for a provincial moratorium on salmon farm leases until full-scale research is completed.

The moratorium would last for a period of more than two years.

At the seminar, residents also learned that the aquaculture industry is growing rapidly.

FARMERS VS FISHERMEN ON THE SUNSHINE COAST

As finfish farms spread coastwise, wild stock fishermen are finding traditional fishing grounds closed

IN two of his last four crab trips to Knight Inlet, fisherman Dunc Shields, operator of the *Hermosa*, found salmon farm pens moored on top of his traps.

"I was fishing one week and the next I found pens with 400-pound anchors set over the gear," he said. "The farmer was running down the floats shouting, 'I've got \$3 million worth of spring salmon in there, clear the area.'"

"I had to pull my gear out from one side of the pen, cut the lines and drag the rest out from the other side," Shields recalls. "With those anchors out, I can't set there again."

Shields' experience is typical of the growing conflict between the runaway growth of salmon farming and long-standing commercial fishing operations.

But the study now date Agri John Sa morator area.

The fishing and Only Ass ers inf Al

Commissioner J. Anthony Smith, Alaska Department of Commerce and Economic Development, testifying before the President's Export Council Subcommittee on Foreign Trade Practices.

"The Norwegian Government continues to provide extensive financial and non-financial supports to Norwegian salmon farming..."

"The Government assists small-scale farmers by guaranteeing loans... The guaranteed loans finance the start-up costs and initial capital investments associated with salmon farms. Loans for the erection of buildings in areas with low levels of economic development may be granted with a repayment of up to thirty years...the fund may permit exemption from installment payments and deferment of interest payments for a period up to five years...special capital grants are also available through the Norwegian Government. Grants to salmon farms in the northern-most region are available to cover up to 40 percent of capital investment costs."



"In the 1970's, the Norwegian Government subsidized the construction and planning of an extensive road-sea-air transportation system to link the coastal areas with inland salmon... The Government also forged an important partnership with the Scandinavian Airline System (SAS) to ship salmon to various world markets. The Government pays SAS a \$0.50 per kilo subsidy for all international shipments... Direct flights, not justified by passenger volume, go from Bergen to Seattle and other important U.S. markets, and space is always made available for salmon shipments."

"Price supports have also been established for the Norwegian fish farmer... If the market price falls below the minimum level, the Government will subsidize the farmer to cover his costs."



"The Ministry of Fisheries extends free disease-diagnostic services to all farmers. Due to a shortage of trained fishery pathologists, the Government has encouraged the development of university curricula to study fish health diseases. All Norwegian salmon operations also have access to a full range of advisory services on density of stocking, diets and feeding regimes, and harvesting processing and packaging."



"This magnitude of R&D financing underscores how aggressively the Norwegian salmon industry has been targeted for assistance. Indeed, in 1985, aquaculture was designated one of four top priority areas for industrially oriented research funding... Other studies have focused on population genetics, improving flesh color and body oil content..."



"These subsidies dramatically reduce the price of farmed salmon, which would otherwise be far too expensive for foreign purchasers."

"The insurance industry's attitude to aquaculture provides another clue to the inherent risk in the industry. Insurers are the most skilled risk assessors available in society and their approach in insuring aquacultural provides an excellent insight into the realities everyone involved in aquaculture must face. If they, the most skilled assessors in society, are considering getting out of aquaculture insurance, or if they are seeking to restrict the cover that they give to fish farms, then, surely, that is a warning to everyone."

*Ian Angus, Vice-President,
Sedgwick Tomenson Inc.,
International Insurance Brokers,
of Vancouver, B.C., in a speech
before the 1987 Sitka aquaculture
conference.*

"Only one careless producer selling infected fish can tarnish the image of the industry. The liability exposure can be measured and consequential effect on markets can be devastating. One need only look at the canned salmon industry as an example."

*Ian Angus, Vice-President,
Sedgwick Tomenson Inc.,
International Insurance Brokers,
of Vancouver, B.C., in a speech
before the 1987 Sitka aquaculture
conference.*

Going for Atlantics In Washington State

PUGET SOUND—Washington state salmon farmers may be on the verge of a momentous decision, a decision that may impact salmon farming in British Columbia and Alaska. Three out of the state's 11 salmon farms have decided to go with Atlantics rather than cohos.

Reports last fall suggested that if this decision is followed by the remaining farmers in the state, it could have a major impact on marketing farmed salmon. Atlantics, according to some experts, grow faster and are more disease resistant than cohos. This

means that larger Atlantics could be produced by the farmers, and subsequently sold for a higher price.

According to a report in the *Seattle Times*, coho give a return of \$.75-\$1.50 to the dollar, while Atlantics give \$3-\$4 return.

A change to Atlantics could be the start of market competition between Washington and British Columbia. B.C. farmers have focused on coho, with the government there frowning on the introduction of Atlantic salmon and possible new diseases.

B.C. Salmon Farms Continue to Increase

VICTORIA—Salmon farming in British Columbia continues to grow, say the preliminary results of a survey conducted on the province's salmon farms by the B.C. Ministry of Agriculture and Fisheries.

As reported by *Canadian Aquaculture Magazine*, the survey shows 113 operational farms as of the end of November 1987. Another 38 sites were licensed but not yet operating. This brings the total to 151.

To show how much the industry is growing, the survey compared the number of operating farms in 1987 vs. the number in 1986. The Sunshine Coast, for instance, had 45 farms by the end of 1987 compared to 34 in 1986. Campbell River/Desolation Sound

had 30 farms vs. 12 farms a year earlier. Northwest Vancouver Island had 8 farms last year compared to 3 farms the year before.

This growth in numbers has meant a corresponding growth in holding capacity, according to the *Canadian Aquaculture* report. In 1986, total holding capacity was about 3,717 tons. At the end of 1987, capacity had jumped to 16,990 tons.

These farms employ a number of people, and the B.C. government wanted to get a handle on how many. According to the survey results, 544 people are employed by B.C. fish farms. That total is broken down to 318 full-time farm employees, 137 part-time employees, and 89 office employees.

NORWAY

Norway's salmon are in danger. For two years now the organisation of Norwegian salmon-farmers, Norsk Fiskeoppdretts A/S and the marketing organisation Fiskeoppdretternes Salslag in Bergen and Trondheim have suffered losses of up to 60 per cent of their farmed resources.

A fish is ecologically running out of turn.

A mixed form of susceptibilities led to all sorts of illnesses and the breakdown of the salmon immunity system as well as to enormous losses in Norwegian farming. The 55,000 tons of farmed salmon which were to be delivered by Norway this year to their main markets (USA, Japan, France, Germany and other European countries), were at first reduced to 50,000 tons and then to 47,000 tons and now, one considers it lucky if 45,000 tons can be reached.

For in this year too, as one could hear at the big aquaculture Fair in Trondheim «Aqua Nor», it is expected that the salmon farmers will slaughter and sell the underweight youngsters, instead of waiting for their fishes to be hit by the devastating illness. So in this year too there will be Norwegian small salmon on sale.

The Norwegian farmers have suffered an additional loss through the «Smolts» (young salmon) farmed in Scotland, which they used for their cultivation of salmon, since these too were hit by the sickness. So the farmers sue the Government for the payment of 135 million Kroner (around 37 million Deutsche Mark) compensation, because the young salmon had been examined by an official veterinary-medical team and no harmful signs found. At the first level of the proceedings 30 farms in Trondheim have received 109 million Kroner damages paid, as demanded.

A «Salmon-Police» is to protect the Norwegian salmon stocks — after two years of breakdowns of the resources

The magic word is «Marinet»



A computer system «Marinet» is to solve Norway's salmon problems.

At the end this is still one of the clearest cases, because the source was known.

But in the other cases of illness, which have hit the salmon in the Fjords — especially with the sort of «Hitra» illness, named after the small island facing Trondheim, where this illness was first discovered — one is helpless and at a complete loss.

But Norway has always been flexible, when it became necessary to call upon new technological developments, to overcome various problems. Clear is that the salmon families from which so far the Norwegian farm-salmon have

been taken have been suffering from a mixture of water quality (low value of hydrogen), strain during breeding, overbreeding and being too closely kept in the salmon cages. In this respect it will be necessary to find a more resistant salmon potential, which does not include the so far existing immunity problems of a salmon family. And so one is grateful to this problem for angles.

We visited
for salmon
near
two

B.C. salmon farmers learning the pitfalls

VICTORIA (AP) - Take all the pitfalls of traditional farming - weather pests and acts of God. Now complicate them with inexperience and still-developing technology and you get an idea of the headaches facing British Columbia salmon farmers.

"At this moment, fish farming is probably more risky than any other kind of farming because everyone is still learning and there are a lot of hurdles to get over," says Rick Deegan of the B.C. Agriculture Ministry.

"The only good thing about the industry," adds Garth Hopkins of the B.C. Salmon Farmers Association, "is that there is such an atmosphere of excitement and newness that the farmers tend to forget their problems."

"Virtually every company is finding a better kind of equipment or inventing it. Almost every day (companies) are finding better ways to raise their fish."

Algae destroyed fish

Last year, some companies had their entire salmon stock wiped out by naturally occurring algae. Others have lost substantial numbers of fish because of a bacterial kidney disease and still others have had fish munched by predators, from killer whales and seals to eagles, bears and cougars.

In January, inquiry commission David Gillespie made recommendations for regulating the industry. Since then the ban has been in stages and new licenses are issued.

One of the biggest problems



* Norwegian firm plans to produce 1,000 tons of salmon annually from a new land-based tank farm near Nanaimo. The project would not be permitted in Norway.

Nanaimo salmon tank farm would be illegal in Norway

Premier Bill Vander Zalm and Norwegian investors linked arms April 23 in Vancouver to announce the building of a massive fish tank farm near Nanaimo.

Using new technologies, Hagensborg Resources Ltd. will build a \$7 million land-based facility aimed at producing 1,000 tons of fish annually.

Ironically, the mere size of the farm would make it illegal in Norway where the government keeps farm sizes down to prevent corporate concentration.

"I have no knowledge about anything like this in Norway," said Norwegian Consul General Odvar Mosnesset. "This is a little surprising, it's so large."

Mosnesset also said the Norwegian government has placed restrictions on investment in farms because it wants "to have small firms instead of large companies coming in."

Unlike B.C., where farms are controlled more and more by large companies, Norway has seen many commercial fishermen get into fish farming because the commercial fishery was destroyed.

Hagensborg president Carsten Hagen said the government supported Norwegian fishermen getting into fish farming.

"You have a more socialistic government (in Norway) so they support fishermen," he said.

Hagen said the proposed tank



* Premier Bill Vander Zalm was on hand to welcome Norwegian entrepreneur Carsten Hagen to B.C.

farm could not be built in Norway under the present laws.

The new mega-farm will rely on the public hatchery system to guarantee enough eggs to make the farm viable.

UFAWU secretary treasurer Bill Procopation said the new farm will dump 1.5 tons of waste into the ocean every day.

"This farm will cost \$7 million, create only 12 jobs and potentially pollute the ocean," Procopation said.

Vander Zalm told the press conference the government supports the development of a strong aquaculture industry.

He described the aquaculture boom as a "super new industry" for B.C.

Procopation refuted Vander Zalm's claims, pointing out that the industry remains out of control and a potential threat to wild stocks.

He predicted the next step would be ocean ranching, where farmers release their fish to the ocean and harvest them when they return to spawn.

"That would be the final blow to a common property resource and result in the loss of millions of dollars annually to B.C. communities," he said.

Controversy surrounded the development of the farm when local residents opposed it because of the intrusion into a rural residential area.

The residents are also opposing the dumping of the sewage in Dadds Narrows.

Questioned at the press conference, Hagens denied there was any pollution problem at all.

At the local Nanaimo Regional District director of planning John Magor said the company did not need local approval before proceeding. He said the area is zoned for fish farming, but cautioned no one imagined strong aquaculture industry.

Fish farming in tanks doesn't solve the problems. While tank farming may ease some fish farming problems, it worsens others.

The table below shows, on an issue-by-issue basis, how upland tank farming will be better or worse than net pens anchored in marine waters.

PROBLEM/ISSUE	TANKS vs. NET PENS
GENETICS	
Magnitude	• fewer adult escapees
Domesticity	• tamer fish in tanks, less "wild" genes
DISEASE	
Incidence	• perhaps more, with stress in tanks
Transmittal to Wild Stock	• less probability with tanks
Diagnosis/Treatment	• easier with tanks
Sick/Dead Fish Disposal	• easier with tanks
Biocides	• used more with tanks
ENVIRONMENT	
Waste Generation	• same volume
Waste Treatment	• upland facilities required
Waste Disposal	• upland fish food/fecal site required
Site Cleanup	• more bonding needed for tanks
Hazardous Chemicals	• more controls/bonding for tanks
HABITAT	
Predation	• less seals, more bears with tanks
Attraction Nuisance	• no diversion of migrating fish
Bottom Deposits	• none in marine waters with properly operating tanks
Algae	• less fish kills with properly operating tanks
USER CONFLICTS	
Navigation	• less impact with tanks
Commercial Fishing	• less displacement with tanks
Subsistence	• less fishing impact; more hunting and trapping impacts with tanks
Logistical Traffic	• same
Intertidal	• docks needed
Upland	• more impact with tanks
Timber/Mining Conflicts	• perhaps lessened with tanks
Recreation Conflict	• less for kayakers, more for hikers
IMPACT ON AGENCIES	
Hatcheries	• same diversion of eggs/smolts from public to private hands
Permitting	• more for upland activities
Budget	• same drain upon staff, budget to issue permits, inspect sites
SOCIO-ECONOMIC	
Ownership	• higher capital/operating costs for tanks mean larger corporations
Complexity	• more training for tank operators
Risk	• more mechanical failures with tanks
Insurance	• same, not available for either
Bank Financing	• same, not available for either
Nutrition	• less consumer appeal with tank fish

The following communities and organizations have submitted resolutions or positions in opposition to (or expressing serious concerns about) the pen rearing of salmon:

Communities

Kenai Peninsula Borough
Edna Bay Community, Inc.
City of Port Alexander
City and Borough of Sitka
City of Craig
City of Wrangell
Ketchikan Gateway Borough
City of Tenakee Springs
Sitka Chamber of Commerce

Organizations

Craig Fish and Game Advisory
SW Regional Fish and Game Council
Northern Southeast Regional Aquaculture Assn.
Alaska Sport Fish Association
Alaska Trollers' Association
Southeast Alaska Conservation Council
Alaska Environmental Lobby
Seafood Producers Cooperative
Southeast Regional Fish and Game Council
North Pacific Fisheries Association
Cook Inlet Fisheries Coalition
Cordova District Fishermen United
Hoonah Fish and Game Advisory
Sitka Conservation Society

The preceding pages contained opening paragraphs and highlights from various articles and technical papers. The sources for those pieces are listed below. UFA keeps files of these articles, and copies are available upon request.

GENETICS

"Renegade Norwegian farm salmon polluting wild runs." *The Fishermen's News*, January 1988

"Farmed Salmon Affects Wild Stocks." *The Latest Developments in West European and Canadian Fisheries*, National Marine Fisheries Service, June 1987

"Salmon farm owner to switch harvests." *Anchorage Daily News*, C-4, January 9, 1988

"Norwegian 'renegade salmon' are mingling with wild stocks." *Pacific Fishing*, March 1988

"Farm Salmon Stock Fears in Ireland and Norway." *Fish Farming International*, p. 32, June 1987

"Norway: Wild-salmon endangered by bred-salmon." *Fish International*, p. 31, 4/87

DISEASE

"Farm fish diseases killing the wild stocks in Norway." *The Fisherman*, January 23, 1988

"Norwegian Salmon Farms Hit By Virus." *The Latest Developments in West European and Canadian Fisheries*, National Marine Fisheries Service, August 1987

"Norwegian Farmed Salmon Disease." *The Latest Developments in West European and Canadian Fisheries*, National Marine Fisheries Service, July 1987

"Disease threatens Norway's farms." *The Fisherman*, p.18, September 18, 1987

"Atlantic salmon fish kill at Hadlock said not infectious." *The Fishermen's News*, January 1988

ENVIRONMENT

"Toxic pollutant feared cause of pen-reared salmon deaths." *The Leader* October 1987

"Salmon 'feedlots' in Northwest." *Christian Science Monitor*, June 23, 1987

"Mariculture Pollution." *Marine Pollution Bulletin*

"Pollution problems in Norwegian fish farming." Bjorn Braaten et al, Institute of Marine Research, Austevoll Marine Aquaculture Station, Storebo, Norway 1983

"You can't have it both ways." *Fish International*, p. 31, April, 1987

ENVIRONMENT, continued

"The effect of salmon farming on the benthos of a Scottish sea loch." J.R. Brown et al, *Journal of Experimental Marine Biology and Ecology*, 109: 39-51, 1987

"The environmental effects of floating mariculture in Puget Sound." D.P. Weston, University of Washington, Seattle, 1986

"The interaction between fish farming and the marine environment." R.J. Gowen et al, University of Stirling, Scottish Fish Farming Conference, February 1987

"Studies find TBT in B.C. farm fish." *The Fishermen*, May 22, 1987

"New algae bloom hits Gulf salmon farmers." *The Fisherman*, March 22, 1987

"Some relationships between pathogenic bacteria and salmon net pen culture." A.H. Whiteley, Pacific Fisheries Legislative Task Force, Olympia, Washington, Feb 7, 1987

NUTRITION

"Fatty acids controversy between farm and wild fish continues." Tim St. Clair, *The Fishermen's News*, p.1, July 1987

"Salmon trollers' gourmet market." *Christian Science Monitor*, November 24, 1986

"In the Pink." *Forbes*, March 1987

"What's Up Down on the Salmon Farms." *Seafood Leader*, Winter 1987

BRITISH COLUMBIA

"All's not well down on the farm." *The Fisherman*, August 16, 1985

"Aquaculture: the Boom Out of Control." *The Fisherman*, June 23, 1986

"Fish Farm Flasco." *The Fishermen*, April 18, 1986

"Conference on aquaculture poses threat." *The Fisherman*, June 23, 1986

"Disease, egg supply limit farm growth." *The Fisherman*, April 16, 1987

"As finfish farms spread coastwise, wild stock fishermen are finding traditional fishing grounds closed." *The Fisherman*, April 16, 1987

"Nanaimo salmon farm would be illegal in Norway." *The Fisherman*, May 22, 1987

"The Norwegian Connection." *BC Business*, October 1987

"Some fish farmers predict B.C.'s salmon farmers will ultimately switch to farming Atlantic salmon." *Seafood Leader*, Spring 1987

"DFO says no restrictions on dumping diseased fish." *The Fisherman*, January 23, 1988



UNITED FISHERMEN OF ALASKA

211 4th Street, Suite 106
Juneau, AK 99801
907-586-2820

February 1, 1988

The Honorable Steve Cowper
Governor, State of Alaska
P.O. Box A
Juneau, Alaska 99811

Dear Governor Cowper:

You will recall from our previous conversations with you that United Fishermen of Alaska has taken a firm stand opposing finfish mariculture in Alaska. This does not mean that we are against all forms of mariculture. We recognize that there is a great need to diversify our state's economy, and we are working with your administration in many ways to help do that. But we are also firmly committed to protecting the existing livelihoods of tens of thousands of Alaskans.

We are aware that you have a position favoring mariculture under certain specific conditions. We realize it is our job to work with you to develop a mariculture program to benefit Alaskans as you have stated in your eight criteria. We believe that the proposed finfish activities will not meet your criteria.

One of your criteria, for instance, requires protection of the biological integrity of natural stocks. In an issues paper prepared recently, the FRED Division of the Department of Fish and Game says it can do this only if (1) imports of non-indigenous species remain prohibited, (2) it can continue to fulfill its duty to control fish disease, and (3) enough money is appropriated to provide the additional services necessary. UFA thinks those are some very big "ifs".

You may not be aware that the finfish farmers in Washington and British Columbia are greatly increasing their use of Atlantic salmon because they are easier to grow than Pacific salmon. It is hard for us to believe that Alaskan farmers will never want to switch to the more profitable Atlantic salmon. By allowing salmon farms we will create a situation leading to high expectations for profits. When those expectations are not met, then the argument will probably be made that "we must raise Atlantic salmon to be competitive in world markets; otherwise we'll go bankrupt."

UFA believes that this argument in favor of importation will put too much pressure on decision makers and we will lose these protections for wild stocks.

You may not be aware that less than a year ago Norway discovered that at least 10% of the fish in their streams were actually escapees from farming operations. That estimate has recently been increased to 57%. In response to this disturbing news, Norway has established a multi-million dollar gene bank. Norway, with its years of experience in finfish farming, has been unable to prevent the possibility of genetic pollution of their wild stocks, and is just now learning of the problems associated with the industry. UFA does not think Alaska should bank on succeeding where Norway has failed.

You may not be aware that there have been times when FRED Division, in performance of its duty to control fish disease, has had to order the destruction of a hatchery's entire broodstock. This, of course, has been a serious economic blow, but the hatcheries are non-profit and so never questioned the order. If this were to happen to a private for-profit fish farm, particularly during the early stages of development, might there not be some resistance to such a devastating set-back? This would be particularly true for the smaller, financially marginal operations.

You, more than anyone in the state, are aware of the increasing demands being placed on a dwindling supply of government money. FRED Division right now faces the prospect of closing four hatcheries, built with public bond money, due to a lack of operating funds. It is hard for us to believe there will be adequate funding available for the additional services required to regulate finfish farming. And if there is such money available, we think it should be used first to restore full funding to the hatcheries which, after all, provide year-round jobs for Alaskans in addition to the fish they add to the common property resource.

We have been encouraged by numerous signs of interest by the Legislature in passing some sort of mariculture legislation this year. We do not believe that legislators would be so irresponsible that they would simply allow the moratorium on finfish farming to expire, creating a de facto industry. We are confident they will pass legislation that will give guidance to the growing interest in shellfish and sea vegetable farming, which would allow economic development to go forward while resolving some of our concerns. We believe that this legislation will provide for mariculture which Alaskans can participate in without incurring debt to foreign banks.

We have been discouraged to hear representatives of the Alaska Mariculture Association say they think no progress is being made on this issue. It is an extremely complex subject, requiring far-reaching policy decisions, and we are grateful our elected officials are not taking it lightly or looking for a quick solution. This is especially true in light of the fact that progress is being made. Many legislators and many of your

agency personnel have done extensive research and held lengthy discussions in an effort to educate themselves and clarify the questions. We think AMA's comments only create more tension and divisiveness and do not promote a rational resolution to this issue.

We appreciate your very sensible stand on mariculture and the work your administration has done to identify the key issues which need to be resolved. UFA believes we can develop an expanded shellfish and sea vegetable program in Alaska that will provide an economic boost for our communities and will be more beneficial to Alaskans over the long run than jumping on the salmon farming bandwagon.

Sincerely,

A handwritten signature in cursive script that reads "Kate Graham".

Kate Graham
Executive Director

Salmon Farming in Alaska: Myths and Facts

Myth: Alaska's wild salmon won't be harmed by farmed salmon.

Fact: The Norwegian government has begun establishing farm-free zones near salmon streams and are establishing a gene bank: they have discovered that 10 to 57% of the fish in their streams aren't wild, but instead are escaped farmed salmon.

Myth: No one can afford to buy into commercial fishing these days. The only way to get into the salmon business is through salmon farming.

Fact: Prices in last month's Alaska Fisherman's Journal for complete fishing packages range from \$30,000 to \$500,000 depending on the fishery. Last month, Paul Fuhs (president of the Alaska Mariculture Assoc.) said establishing a salmon farm would cost from \$300,000 to \$1,000,000. A fisherman begins to make money the very first year; a farmer must wait at least two to three years.

In addition, Rodger Painter (Alaska Mariculture Association) and Judy Brady (commissioner, DNR) have recently admitted that, because of the magnitude of capital and operational costs, fish farming will not be a mom and pop operation.

Myth: Fishermen are opposing salmon farming in order to legislate their competition out of existence.

Fact: Salmon farming is being done around the world and Alaskan fishermen must contend with this competition by better quality control and more aggressive marketing. Fishermen oppose its establishment in Alaska for four primary reasons: 1) It will put common property resources into private hands; 2) it will sap State money and personnel from existing fisheries programs; 3) it will primarily benefit wealthy corporate and foreign investors; 4) it will harm Alaska's economy by harming Alaska's fisheries.

Myth: Farmed salmon won't compete for markets with wild salmon and they'll help keep the price high.

Fact: If a product is in demand, scarcity drives the price up and a large supply lowers it. When Norwegian farmers dumped their salmon on the European market early this year (before they were killed by virus), the price for Alaska's salmon in France went down 50¢ a pound. Adding farmed salmon on top of wild salmon in the market is like having a banner season when the price drops because of the quantity available. Farmed salmon now compete directly with all top quality wild salmon, and farms want to enter the frozen market too.

Myth: Salmon farms will pay their own way because they are willing to pay a tax just like fishermen.

Fact: Rodger Painter (executive director of the Alaska Mariculture Association) has said it would be unreasonable to tax salmon farmers until they'd begun to make a profit. Since it would take a farmer two to three years to make even the first sale, there will be a substantial period of time with State money going out and nothing coming in. The most logical source for this State money is current commercial fisheries programs, which are already being cut back.

Myth: The State can limit the size of farms to keep them locally owned.

Fact: Norwegians have found that small farms aren't profitable. There and in B.C. small farmers have either formed associations or been bought out by large corporations.

Myth: Salmon farmers can regulate themselves: they don't need the State telling them how to run their business.

Fact: Government has an obligation to protect the welfare of the public and the public's resources. It must, at a minimum, check the quality of a product being sold for human consumption, see that environmental standards are being maintained, and monitor use of public tidelands. If government turned its responsibilities over to salmon farmers, the high costs would be prohibitive to someone on a tight budget.

Myth: Thousands of new jobs for Alaskans will be created by salmon farms.

Fact: According to British Columbia's Ministry of Agriculture and Fisheries, the average salmon farm employs only six people. It would take 166 farms to create 1000 jobs in Alaska. In B. C. many of the most highly paid jobs have gone to Norwegians, since they are experienced in the business. The Alaska Legislature has been unsuccessful in requiring local hire. How many Alaskans will be hired?

Myth: The spin-off benefits will be a shot in the arm for local economies.

Fact: According to "B.C. Business" (Oct. 87) Norwegian investors included strings in their finance packages: they required monopolies on construction and supply purchases so operators were unable to take advantage of competitive prices and local merchants received few benefits. In addition, the Norwegians' share of the profits returned to Norway with the investors.

Myth: We'll be able to keep this an Alaskan business.

Fact: Bill Hall (Alaska Commercial Fishing and Agriculture Bank) has said neither CFAB nor any other Alaska bank is willing to loan money for salmon farms. Start up and operating costs will be financed either by foreigners or by corporations such as Weyerhaeuser, British Petroleum, Mitsubishi, Union Carbide and the Campbell Soup Company. Business owners rarely ignore their partners' needs, goals or desires.

In addition, the B.C. fish farming industry is currently 65-90% Norwegian controlled. The largest fish farm in Washington has been recently purchased by Global Aqua, a Norwegian company.

Myth: Norway isn't subsidizing their salmon farms so Alaska won't have to either.

Fact: According to Commissioner Tony Smith (Dept. of Commerce and Economic Development) Norwegian fish farm subsidies include: capital grants; guaranteed loans for start up costs and capital investments; a 50¢/kilo subsidy for all international shipments; salmon egg production; research; price supports; a guaranteed minimum income and vacations for workers. They have budgeted \$14.7 million for these programs for next year. What reason is there to think Alaskan farmers won't need State financial help?

Myth: Salmon farms won't hurt the environment.

Fact: They will certainly change the environment: algaecides are used to prevent growths on the nets; fish food containing additives and massive quantities of fecal matter are deposited on the ocean floor; dead fish which have been fed antibiotics are prey for other species, thus entering the food chain.



Southeast Alaska Conservation Council

SEACC • P.O. Box 021692 • Juneau, Alaska 99802 • (907-586-6942)

MARICULTURE

The controversy surrounding mariculture continues in the '88 legislature and has prompted an influx of new bills and a revision of last year's legislation. Mariculture, the farming for profit of shellfish, finfish, and sea vegetables in marine environments, has raised many issues of concern for the commercial fishing industry, conservationists, and recreational users of Alaska's tidelands and navigable waters.

After thorough investigation and debate, the Southeast Alaska Conservation Council (SEACC) opposes finfish farming in Alaska because of its potential for serious environmental degradation of our coastlines. SEACC believes a moratorium on other forms of tideland development, including shellfish and sea vegetable farming and floating lodges, is imperative until comprehensive regional planning has been accomplished and sufficient funds are secured to effectively enforce and monitor adopted regulations and policies. Current policy promotes tideland development without taking into full account its potential for resource use conflicts and environmental impacts.

SEACC has a deep concern about the potential loss of important fishery habitat. A broad acceptance of fish farming could reduce the incentive to retain the natural habitat of wild salmon stocks and open the door for increased logging and road building in important fish habitat areas. In other countries, the fish farming industry has followed the destruction of wild stocks and their habitat. Alaska's wild runs are still strong and deserve proper protection. Another SEACC apprehension is that the historic uses of our coastal areas will be eroded as bays, inlets, and coves become sites for mariculture operations or fishing lodges.

Pending mariculture legislation must include provisions that statutorily prohibit the development of tidelands adjacent to all wilderness areas and state parks, high value fish and wildlife habitat areas, Critical Habitat Areas, popular recreation areas, important subsistence areas, bird rookeries, marine mammal haul outs, estuarine habitat for shellfish and benthic organisms, and anadromous fish streams. Legislation should also clearly outline siting criteria and provide guidelines for the planning and development processes. Development should focus on the tidelands of interested private property holders, and areas suitable for development should be nominated through the public process. The permit and leasing processes should include commitment bonds, development schedules, and restrictions on permit and lease transfers to prevent tideland speculation. Clean up bonds should be required to ensure site rehabilitation and structure removal in case of site abandonment. All proposed developments must be subjected to public review, and annual review should be mandated to ensure compliance with the laws.

FALSE ISLAND-KOOK LAKE COUNCIL, Tenakee Springs • LYNN CANAL CONSERVATION, Haines • TAKU CONSERVATION SOCIETY, Juneau
NARROWS CONSERVATION COALITION, Petersburg • FRIENDS OF GLACIER BAY, Gustavus • TONGASS CONSERVATION SOCIETY, Ketchikan
PELICAN FORESTRY COUNCIL • FRIENDS OF BERNERS BAY, Juneau • WRANGELL RESOURCE COUNCIL • SITKA CONSERVATION SOCIETY
ALASKA SOCIETY OF AMERICAN FORESTDWELLERS, Pease Lake • JUNEAU GROUP SIERRA CLUB • YAKUTAT RESOURCE CONSERVATION COUNCIL

necessary to make permits non-transferable or to limit permit transfer payments to the amount of investment the permit holder has made in construction of facilities. Ownership of the tidelands will remain with the state and the state agencies must have the right to review and control transfers of tideland permits. Privatization through site development will occur to some extent, but it is necessary and possible to minimize this impact. The public must be involved in scoping and siting processes and beyond to ensure public use and access is maintained and the responsible agencies actively protect these rights in developed areas.

These issues can best be addressed through comprehensive regional planning and related siting and permitting processes that include extensive public involvement. Final plan implementation should be in accordance with the public's interest.

ADDITIONAL PROBLEMS WITH FINFISH MARICULTURE

The issues already discussed are common to all types of tideland development. However, finfish mariculture presents additional problems and impacts that must be dealt with, including:

WATER QUALITY The food, wastes and chemicals involved in fishfarming are of a much greater magnitude than shellfish or sea vegetable farming. They have the potential to bury in nutrient rich wastes existing habitat for crab and other types of shellfish, thus depleting oxygen levels. These wastes also affect the benthic organisms that salmon fry feed on.

PREDATION Marine mammals and birds will be drawn to a penned food source, and the predator control employed by mariculturists is of concern to the environmental community. Violations of the Marine Mammal Protection Act and the Bald Eagle Protection Act are possible.

UPLAND EFFECTS Support facilities for fish farms are liable to be more extensive than for other types of mariculture, and therefore will have greater impact on the uplands. Also, there is a great deal of concern that with the capacity to create fish, the maintenance of wild fish habitat will have diminished support. The fish farming industry has traditionally followed the destruction of wild stocks and their habitat, but our wild runs are still strong and deserve proper protection.

Issue paper prepared by Laura Dameron 2/11/88



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MARICULTURE IN THE 1988 LEGISLATURE

Due to the raging controversy surrounding mariculture in the '87 legislature and the many issues raised during the days of public testimony before the House Resources committee, Representative Johnny Ellis (D-Anch.) and Senator Dick Eliason (R-Sitka) are presently revising last year's bills to reflect public concerns. Mariculture, the farming for profit of shellfish, finfish, and sea vegetables in marine environments, is a major issue for the commercial fishing industry and recreational users of Alaska's tidelands and navigable waters.

After much consideration and debate, the Alaska Environmental Lobby has concluded that we must oppose finfish farming in Alaska because its long-term effects would be detrimental to our coastal environment. We cautiously support other forms of tideland development, including shellfish and sea vegetable farming and floating lodges, with the provision that there be a strong planning process wherein environmental concerns will be addressed.

The most important aspect of any tideland development is the siting process. Intensive public participation is a necessary component of that process which should, we feel, address the following concerns:

CONFLICTING USES Historic uses of both tidelands and adjacent uplands should be documented to avoid user conflicts. Such uses include recreation, tourism, anchorages, navigable waters, and areas of subsistence and commercial harvest. Natural estuarine habitat for shellfish must be protected, as well as uplands designated as wilderness areas or marine parks.

UPLAND EFFECTS Upland development to support mariculture facilities is a grave consequence of tideland development. The federal or state agency responsible for uplands adjacent to potential mariculture sites must be involved in siting and permitting to minimize the effects of upland support facilities accompanying tideland development. No mariculture should occur adjacent to uplands in protected status.

CUMULATIVE IMPACTS The cumulative effects of tideland development must be recognized and minimized. We see comprehensive regional planning as the best means of avoiding over-development of an area.

WATER QUALITY The flushing capacity as well as the other marine qualities of potential development sites must be considered to prevent degradation of existing water quality. Potential problems resulting from the introduction of fungicides and other chemicals into our waters will not be fully mitigated but can be minimized by proper siting.

PRIVATIZATION OF PUBLIC RESOURCES In order to avoid tideland and upland speculation, thereby creating a de facto disposal program, it will be

ALASKA CENTER FOR THE ENVIRONMENT • ALASKA CHAPTER, SIERRA CLUB • JUNEAU GROUP, SIERRA CLUB • SITKA GROUP, SIERRA CLUB
KNIK GROUP, SIERRA CLUB • DENALI GROUP, SIERRA CLUB • ANCHORAGE AUDUBON SOCIETY • ARCTIC AUDUBON SOCIETY
DENALI CITIZENS' COUNCIL • ALASKA FRIENDS OF THE EARTH • JUNEAU AUDUBON SOCIETY • KACHEMAK BAY CONSERVATION SOCIETY
KENAI PENINSULA AUDUBON SOCIETY • KODIAK AUDUBON SOCIETY • LYNN CANAL CONSERVATION • ALASKA WILDLIFE ALLIANCE
SITKA CONSERVATION SOCIETY • NORTHERN ALASKA ENVIRONMENTAL CENTER • SOUTHEAST ALASKA CONSERVATION COUNCIL

Planning and siting must address the following concerns:

CONFLICTING USES. Historic uses of both tidelands and adjacent uplands should be documented to avoid user conflicts. Such uses include recreation, tourism, anchorages, navigation, and areas of subsistence and commercial harvest.

UPLAND EFFECTS. Construction of upland support facilities is a major consequence of tideland development. The federal or state agency responsible for managing adjacent uplands must be involved in siting and permitting to minimize negative impacts.

CUMULATIVE IMPACTS. The cumulative effects of tideland development must be recognized and minimized through comprehensive regional planning.

WATER QUALITY. The flushing capacity as well as other marine qualities of potential development sites must be considered to prevent degradation of existing water quality. The food and organic wastes produced by fishfarming may bury existing habitat for crab and other types of shellfish in nutrient rich wastes, depleting oxygen levels. These wastes also affect the benthic organisms that are a food source to salmon fry. Potential problems resulting from the introduction of fungicides and other chemicals into our waters will not be fully mitigated but can be minimized by proper siting.

PREDATION. Mariculture facilities must be designed and sited to avoid attracting marine mammals and birds to a penned food source. The Marine Mammal Protection Act and the Bald Eagle Protection Act may not be sufficient to prevent unlawful predator control by mariculturists.

SEACC believes that, in the correct context, some forms of coastal development can be of value to both the State of Alaska and its citizens. However, the key to responsible decision making lies in knowing the likely results of various development scenarios. We do not feel that this has been accomplished yet.

SEACC is a grassroots conservation organization comprised of 13 member groups located in 11 communities from Yakutat to Ketchikan and represents the interests of a wide variety of people with an assortment of lifestyles. It has been their overwhelming request that SEACC work to help ensure that family well being, community stability, and quality of life do not suffer at the hands of irresponsible commercial development on state tidelands. These goals can be achieved as the public is provided the opportunity to participate in planning based on the best available information.



Grand Camp
Alaska Native Brotherhood

ALASKA NATIVE SISTERHOOD AND BROTHERHOOD
74TH ANNUAL CONVENTION
HAINES, ALASKA
OCTOBER 20-25, 1986

RESOLUTION NO. 27

TITLE: FISH TRAPS ERA

WHEREAS, The proposal for private fish farming has been gaining momentum, and

WHEREAS, This lucrative business will be limited to a few financially capable interests, and

WHEREAS, The amount of competition such ventures will impose on commercial fishermen will be similar to that caused by the early days of the fish trap era, and

WHEREAS, It took many years for Alaskans to finally eliminate the fish trap, NOW

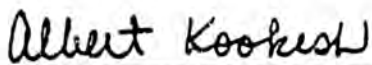
THEREFORE BE IT RESOLVED that the Grand Camp Convention of the Alaska Native Brotherhood and Sisterhood assembled in Haines, Alaska during the week of October 20-25, 1986 vigorously oppose any laws or navigational permits that may be proposed to allow another fish trap to be once again used in Alaskan waters, and

BE IT FURTHER RESOLVED that copies of this resolution be sent to the Department of Fish and Game and the Board of Fisheries.

ATTEST:

I certify that this resolution was adopted by the ANB-ANS Grand Camp in Convention at Haines, Alaska during the week of October 20-25, 1986.


Richard Stitt, Grand President


Albert Kookesh, Grand Secretary

Past ANB Grand Presidents
Roy Peratrovich
Alfred Widmark
Cyrus Peck

Frank Peratrovich
Patricia J. Paul
Thomas Jackson
John Hope

Frank See
Walter Soolefi
Richard Stitt
Steven V. Hotch

Nelson D. Frank
Frank O. Williams
Herbert Hope
Robert R. Martin

Roy Peratrovich, Grand President Emeritus
Cyrus Peck, Sr., Grand Secretary Emeritus
Mildred Sparks, ANS Grand President Emeritus



Biological Interactions of Natural and Enhanced Stocks of Salmon in Alaska

Interim Report from the Cordova Workshop, November 10-15, 1991

Editors

Ole A. Mathisen
School of Fisheries and Ocean Sciences

Gary L. Thomas
Prince William Sound Science Center



Juneau Center for
Fisheries and Ocean Sciences
UNIVERSITY OF ALASKA FAIRBANKS



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I.

EXECUTIVE SUMMARY

O. A. Mathisen and G. L. Thomas

Genetic Considerations

It was agreed at the workshop that wild stocks in Alaska contain the genetic resources necessary for continued production of salmon under shifting environmental conditions. The Genetic Policy of Alaska¹ acknowledges that genetic diversity buffers biological systems against disaster, either natural or human-induced. There was almost universal agreement that maintaining genetic diversity both within and between local populations is essential for the long-term sustained production of Alaskan salmon.

A distinction must be made between preservation and conservation. In the strict sense preservation implies leaving everything untouched, which excludes enhancement activities, while conservation denotes enhancement, which is in conformity with the inherent characters of the stocks being enhanced.

The same basic principle of the importance of genetic variability (both within and between stocks) applies equally well to the management of hatchery brood stocks. Loss of genetic variability can be brought about by inbreeding and selection; the rate of loss can, however, be reduced using a large number of spawners and approximately a 50:50 sex ratio. To minimize impacts of hatchery fish on native stocks, phenotypic variation in brood stocks should reflect the variation observed in wild populations. However, this should not preclude that there may be opportunities to use genetic differences to avoid interaction between hatchery and wild stocks.

Homing and Straying

The homing ability of anadromous species leads to reproductive isolation of the various populations in their distinct environmental setting, which results in genetic adaptations to the local environment. Some hatchery fish with specific but different genetic characteristics will stray into wild populations. If they successfully interbreed with wild fish, the fitness of locally adapted populations may decrease.

Although the imprinting process is an important factor in homing, our knowledge about the imprinting process is still very limited. Additional studies are especially critical for species involved in remote releases.

Improperly imprinted fish tend to home less accurately. Introduced populations and salmon whose rearing history involves displacement or changes in water source often stray more than members of native stock and those released on-site.

The genetic impact of strays on local gene pools depends not only on the prevalence of straying and the mating success of the strays, but also on the differential survival of the populations. Because remote released fish may have a high straying rate, continuation of

¹Alaska Department of Fish and Game Genetic Policy. 1985. R. Davis, ed. Special Report of the Division of Rehabilitation, Enhancement, and Development. 25 p. (Appended to the Legislative Review of the Alaska Salmon Enhancement Program by the Senate Special Committee on Domestic and International Commercial Fisheries, Feb. 19, 1992.)

remote site releases without knowledge of the underlying biological processes may lead to loss of the original genetic diversity through undesirable gene flow from hatchery populations to wild populations.

Because of the potentially negative consequences, a funding base should be established so that appropriate research of these problems can commence without delay. At the same time, remote site releases should be limited until their effects on the adjacent wild stocks are understood and can be considered.

Ocean Carrying Capacity

Density dependent growth in the ocean or nearshore marine environment has been documented more exactly in recent years, especially for Bristol Bay sockeye salmon and Japanese chum salmon. In Japan the size of chums has been decreasing, and the average ages of the returning chums have increased in recent years.

For Alaskan pink salmon there is strong evidence that survival and final length or weight are largely determined by the growth conditions when the pink larvae reach the estuaries and while they continue to feed in inlets and nearshore waters. For sockeye salmon, it appears that final size is largely determined during the last months of ocean residence. The average length or weight of pink salmon decreased sharply in 1991, for both North American and Asian stocks. This coincided with record catches in the Far East, 216,248 metric tons or about 216 million fish, as well as large catches in Alaska, about 128 million fish. In an even year like 1992 the Far East catches will be down, and reduced catches are also expected in North America. The length or weight to be observed in 1992 should, therefore, contribute greatly to our understanding of the carrying capacity of the North Pacific Ocean for salmon.

Management of Mixed-Stock Fisheries

Pink salmon.—For pink salmon (*Oncorhynchus gorbuscha*) the most successful hatcheries are found in Prince William Sound, where returns range from 30 to 40 million fish. However, data presented at the workshop pointed out the need for larger escapements of the wild stocks in the region before these runs would reach their maximum productivity. In order to increase escapements, mixed stock fisheries must be reduced and enhanced stocks harvested closer to the hatchery. Such a management scheme could reduce the quality of the fish and the value of hatchery production.

If enhancement activities are conducted over broad areas, the risk of losing genetic diversity is increased. It might be suggested that new hatcheries be confined to restricted areas, at least until our knowledge of straying and the importance of genetic structures and variates has been expanded vastly.

Chum salmon.—Some chum salmon (*O. keta*) hatcheries have been very productive. Harvest of mixed stock fisheries at a high rate of exploitation, however, can result in an excessive harvest rate on the less productive stocks. Tagging or marking of enhanced and wild fish stocks or both chums and pinks followed by in-season test fishing can be used to design a harvest strategy to maximize harvest of enhanced stocks in mixed wild and enhanced areas while meeting escapement goals for wild stocks. Because chum salmon operations are smaller in scale than for pink salmon, interaction problems are not as visible. Chums deteriorate

rapidly in terminal areas, which makes large-scale chum enhancement projects difficult for optimizing effects.

Coho salmon.—For coho salmon (*O. kisutch*), as for all other species of Pacific salmon, the statutes and regulations are to manage for the natural stocks with enhancement as a supplemental tool. Most of the production of coho in southeast Alaska is from natural stocks; the average harvest of enhanced coho from 1986 through 1990 was 8.1% of the total harvest. Even though enhanced cohos represent a small percentage of the total production, similar concerns exist regarding straying and inbreeding, especially with projected future increases in the enhancement program. Other concerns, such as predation by coho salmon on pink salmon larvae and juveniles, are surfacing, although no conclusive research has been conducted to date. Coho smolts today are commonly released after the pink salmon larvae have left the estuaries, but the pink fry or juveniles may not leave the inshore area before July, which leaves ample time for predation to become a reality.

Since most coho smolts are tagged with coded wire, there are means available to study the changes brought about by expanded enhancement programs.

At the present time, the coho enhancement program appears to be meeting the original legislative intent of supplementing the harvest of coho salmon while not negatively impacting wild stocks.

Chinook salmon.—The chinook salmon (*O. tshawytscha*) is the least abundant but the most prized salmon species. Fifteen enhancement programs operate at the present time in southeast Alaska, but none were built on extant wild chinook streams. Four primary hatchery stocks, derived from regional wild stocks, are used. Movements of eggs between hatcheries are carefully regulated based on stock, disease history, and location of hatchery.

The small numbers involved—average harvest since 1985 has been only 19,590 chinooks or 10.2% of total production—seemingly have had no adverse effect. If numbers of enhanced chinook should increase, some interaction problems may arise, especially due to straying. It is noteworthy that although the production of wild chinook salmon in southeast Alaska is small, it is increasing.

Sockeye salmon.—Sockeye salmon (*O. nerka*) stocks are less enhanced than other species at the present time. There are several attempts to accelerate the smolting process for early releases to sea after 3 months or so in freshwater. Many large streams have populations of sockeye which migrate to sea after 3 months' rearing in the rivers or estuaries, but these races are not always used in sockeye enhancement projects.

In view of the anatomical and physiological changes taking place at time of smoltification, the early releases carry with them the possibility of improper imprinting and subsequent straying at time of return unless natural zero age sockeye are used for brood stocks (Ebbesson, abstract).

Atlantic Salmon

The Atlantic salmon (*Salmo salar*) has been under enhancement for 40 to 50 years in Norway and Sweden under two different regimes and with different results.

Large-scale enhancement of the Atlantic salmon commenced in Sweden in the late forties when most of the major streams were developed for hydroelectric power, thus eliminating most of the natural habitats. In order to compensate for this loss, one hatchery

was built for each stream and smolts were released only in the stream of their origin. This program proved so successful that the Swedish salmon stocks were not only maintained, but increased. In later years, an intensified high seas fishery has increased the total fishing mortality. The enhanced stocks have been able to tolerate it, but this rate of exploitation has placed an undue strain on the small remaining natural stocks of salmon, which are in decline. In spite of the success of their hatcheries, the Swedes are managing their salmon fisheries with primary focus and priority on natural populations, by attempting to bring the harvest back to the estuaries and eliminating the mixed stock fisheries. According to the Swedes, management without a primary focus and priority on natural populations is a serious mistake.

In order to satisfy the demand of its rapidly expanding pen farming of the Atlantic salmon, Norway allowed free import of smolts from a number of European countries and from any stream in Norway with a smolt surplus. What was not anticipated was the large number of salmon escaping from the farm pens, with the result that some rivers contain spawning stocks made up of 80% or more of cultured fish. Attempts are under way to create sperm banks in order to save what may be left of the original gene pool, if any.

Conclusions

As our knowledge of salmon increases, there is emerging a picture of an organism closely tuned to its environment as an integral component in a complex environmental system. Synchrony between stock characteristics and the environment requires working with the native gene pool and avoiding contamination from other sources. Early enhancement projects in Alaska did not pay enough attention to the origin of the brood stocks in order to get started, and a number of sources were used and eggs have been shifted around, especially for chinook and coho. So far there is little evidence of harmful effects, probably because of the low level of enhancements as well as our inability to measure the effect.

The contrast between what has happened in Sweden and in Norway contains some important guidelines for good and less desirable enhancement practices. It points out the need in new enhancement projects to work in conformity with the life history strategies of the enhanced stocks of salmon and not consider the most convenient procedures from a construction or operational standpoint.

II. INTRODUCTION

The Problem

Hatchery operations of salmon and trout have been in progress for more than a century in Europe, North America, and Asia. For a long time little effect was apparent on the natural stocks because the operations were small or were generally unsuccessful due to a lack of understanding of the reproductive process and survival mechanisms in salmonid species. In later years new knowledge and better techniques brought about major changes in salmonid enhancement programs throughout the world, especially in Alaska.

Non-profit hatchery operations and ocean ranching were legalized by the Alaska State Legislature in 1974. This occurred when natural production of salmonids was at low levels, which also coincided with cool ocean temperatures. The objective of the hatchery and ocean ranching programs was to supplement the production of natural fish during years of low abundance. In the beginning, enhancement was on a limited scale and not a problem, but in recent years with favorable survival conditions both natural and enhanced stocks have reached unprecedented levels of abundance. Further complicating matters has been a dramatic increase in the world supply of salmon. During the last few years the cumulative production of salmon has created such an oversupply that markets have been saturated and prices for some species have collapsed, profoundly affecting fishing, processing, and marketing of Pacific salmon.

The growth and success of the hatchery and ocean ranching programs has also created concern about the potential effects of enhanced fish on natural stocks of Alaskan salmon. Conflicts have arisen between the non-profit enhancement organizations and the State's regulatory agencies, who manage by protecting the escapement of natural stocks. The Alaska Legislature established this agency policy in order to protect wild stocks of Pacific salmon from potentially irreversible changes. Despite the magnitude of the enhancement programs and Alaska's mandate to protect wild salmon stocks, no environmental impact statement has been required for developing the enhancement programs.

In 1991 the Prince William Sound Science Center and the University of Alaska Fairbanks began planning a workshop on the biological interactions of natural and enhanced fish stocks in Alaska. The workshop followed four international symposia on hatchery and wild salmon interactions: (1) in 1990 at the Institute of Nature Conservation, Norway; (2) in 1991 at the Department of Fisheries and Oceans, Nanaimo, British Columbia, Canada; (3) in 1991 at the University of Idaho, Moscow, Idaho, and at Washington State University, Pullman, Washington, which was sponsored by NATO; and (4) in 1991 at the University of Hokkaido, in Hokkaido, Japan.

In the 1991 Alaska State Legislature, four study groups prepared background material on wild and hatchery interaction issues for a legislative examination and debate. The present workshop was independent of these legislative study groups, but complementary because of its focus on the *biological* questions related to salmon enhancement. For practical purposes in the workshop, salmon enhancement is used synonymously with ocean ranching, and pen farming, lake fertilization, or other indirect measures, such as habitat manipulation, were not addressed.

Goals and Objectives

In recent international scientific meetings the enhancement of salmon production has been challenged for its potentially detrimental biological impacts. Since Prince William Sound and southeast Alaska have significant salmon enhancement programs, it was thought appropriate to bring together a group of scientists and public to examine the biological basis for maintaining strong coexisting stocks of natural and enhanced salmon stocks in Alaska. This issue has raised specific concerns that are related to the effects of enhancement on the genetic composition, behavior, survival, and fitness of natural stocks, and the carrying capacity of the marine ecosystem. The goal of this workshop was to define the scientific basis for demonstrating a biological impact of enhanced salmon on natural stocks, the nature and magnitude of the impact, and identifying available and missing information. With this goal in mind this workshop examined (1) evidence, or lack of, that enhanced stocks are affecting the genetic composition and behavioral characteristics of natural stocks of salmon in Alaska, and (2) the potential for a limited ocean carrying capacity for rearing salmon.

III. THE PROCESS

The workshop was convened in Cordova, Alaska, from November 11 to 15, 1991, and was hosted by the Prince William Sound Science Center. The participants represented three categories: international experts, national experts outside Alaska, and experts from inside Alaska. The participants were asked to prepare abstracts, submit papers for publication, and bring information related to the workshop's goal and objectives. The public was invited to attend and participated in all phases of the process.

The workshop was organized into four primary sessions:

- 1) Genetic and behavioral characteristics of natural and enhanced stocks.
- 2) Ocean carrying capacity limitations on salmon rearing.
- 3) Mixed-stock management problems.
- 4) Case histories of natural and enhanced stocks.

A report was prepared for each section where the participants mainly relied upon their own knowledge and experience supplemented by the background papers presented at the beginning of the workshop. Time did not permit extensive analysis of individual salmon fisheries in Alaska. The conclusions reached and recommendations made should therefore be considered as the best advice this group could make at this time by pooling their combined experiences and wisdom accumulated over many years. In many cases it was impossible to make definite statements because of lack of knowledge and research. The only prudent course of action is a conservative approach to avoid making irreversible decisions in management of the state's renewable resources, which are the inheritance of all people of Alaska and not a few selected groups.

Following the workshop the conveners, Dr. Mathisen and Dr. Thomas, served as editors in assembling this report of the workshop and publishing individual papers in a peer-reviewed journal. As conveners we sought consensus, but in recognition of the complexity of this issue and the limited amount of information available for evaluating issues, where differences could not be resolved by the present level of understanding, we attempted to document the disagreement and suggest future avenues of research to resolve the disputes.

IV. RESULTS

A.

BIOLOGICAL INTERACTIONS OF WILD AND ENHANCED STOCKS OF SALMON IN ALASKA: GENETIC CONSIDERATIONS

*F. W. Allendorf, R. J. Everett, A. J. Gharrett, M. K. Glubokovsky, W. Jones,
T. P. Quinn, J. E. Seeb, W. Smoker, and F. M. Utter*

SALMON MANAGERS ARE STEWARDS OF A PUBLIC RESOURCE. They are obliged to conserve the genetic diversity of wild salmon stocks. This diversity is the insurance for the future productivity of the resource; this diversity is essential to the continuing survival of the resource. Managers are obliged to hold paramount the genetic diversity of wild stocks in any calculation of costs and benefits of salmon enhancement. Carrying out this obligation is difficult because despite convincing evidence for the genetic basis of stock diversity, science has inadequate knowledge of this diversity. In many cases there is convincing evidence of genetic structure which includes genetic differences among populations of salmon as well as differences within populations that relate to productivity. However, in many other instances knowledge is limited. In the absence of specific information, managers must assume that spawning populations are genetically distinct and that even within populations there are important genetically based differences.

Our recommendations for managing wild and enhanced stocks of salmon in Alaska to conserve genetic diversity reflect the collected knowledge of participants in the workshop.

Recommendation 1.—Follow the Alaska Department of Fish and Game Genetics Policy in all enhancement programs. Understanding of the conservation biology and genetics of salmon is advancing rapidly; therefore, it is important that the policy be reviewed by the scientific community frequently.

Recommendation 2.—Develop and use effective methodology to monitor the genetic makeup (genotype and phenotype) of natural salmon stocks and to measure the extent of introgression by straying fish. Monitoring should be continuous and a prerequisite of all enhancement projects and should focus on the parent stream used for broodstock and the most vulnerable neighboring streams.

Recommendation 3.—Develop and use the best available mark or tag technology (e.g., coded wire, otolith, genetic) to determine the extent of straying by hatchery and wild stocks.

Recommendation 4.—Treat all remote release sites as *de facto* hatchery operations. Increased straying is likely from releases at a distance from hatcheries and such releases should be evaluated accordingly. Monitor remote releases for straying and introgression into wild stocks and change practices or terminate the releases if introgression is observed.

Introduction

The central goal of salmon management, as trustee of the resource, is to conserve and stabilize productivity of fishery resources and increase them where possible. In this workshop Allendorf and Washington each presented historical examples that rapid expansion of

hatchery production coupled with increased exploitation rates usually results in the eventual collapse of the wild stock (option A, Fig. 1). In contrast, a more measured rate of increase can be sustained and, thus, is preferred in the long term (option B, Fig. 1). Option B shows the result of increasing production while also protecting the genetic integrity of wild stocks. It is difficult to resist the opportunity to maximize production in the immediate future. Nevertheless, history demonstrates that this is an unwise choice for a variety of reasons.

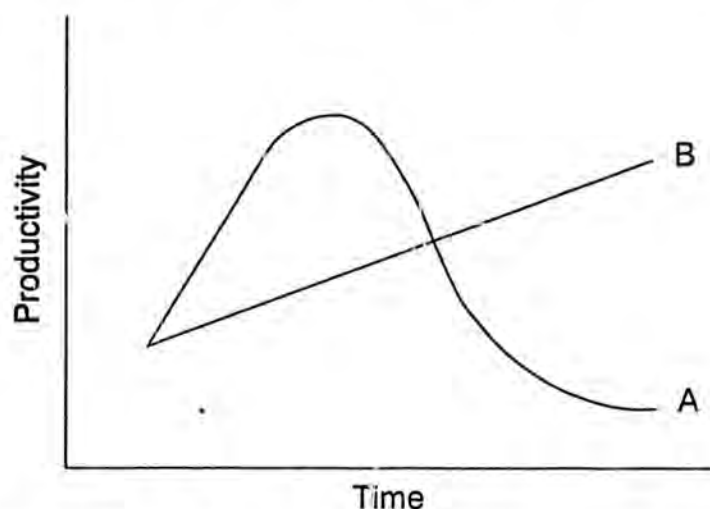


FIGURE 1.—Effects of maximizing immediate increase in productivity without regard to sustainability of the resource. Option A shows likely effect of the single objective of maximizing productivity. Option B shows likely effect of acting to increase productivity while safeguarding genetic resources.

For example, the abundance of coho salmon in the lower Columbia River, having been reduced by a period of severe overfishing below the hydroelectric dams, was greatly increased by the production of very few hatchery stocks. Enhancement was accompanied by greatly increased fishing pressure that, in combination with straying from hatchery stocks, has resulted in the extinction of wild stocks of coho salmon in the lower Columbia River. Washington (this workshop) added that the total catch of coho in the U.S. Pacific Northwest has decreased to less than 1 million fish since 1988 from an average of more than 2 million in the 1970s; this has been accompanied by a reduction of nearly 50% in the number of eggs per female since around 1970 in some hatcheries.

The Columbia River situation with coho and other salmon has been incorrectly labeled as "meat vs. museums." That is, we can either use the salmon as a resource or lock them up to preserve their genetic diversity. This characterization is untrue and dangerous; if we don't protect genetic diversity there won't be any resource to use in the future. A group of biologists at a recent workshop concluded that "sustainable increases in salmon and steelhead productivity in the Columbia River Basin can only be achieved if the genetic resources required for all forms of production, present and future, are maintained in perpetuity."

The genetic diversity of our natural stocks of salmon is the only insurance to protect fisheries resources in the future. In recognition of that fact, the Alaska Department of Fish

and Game (ADFG) developed its Genetics Policy in 1985. The policy is based upon the principle that the long-term productivity of Alaska's fisheries resources depends on the genetic resources necessary for continued production in an uncertain future. The team of scientists and resource managers, representing both the private and public sectors, wrote, "Certainly in Alaska, where wild stocks are the mainstay of the commercial fishery economy, it is necessary to protect these stocks through careful consideration of the impacts of enhancement activities." The authors recognized that in Alaska, hatchery production is meant to stabilize or augment wild stock production, not to replace it. The precedence of wild stock diversity must continue as the first principle in salmon enhancement in Alaska.

The ADFG Genetics Policy is based on the principle that diversity buffers biological systems against disaster, either natural or human-induced. In this report we discuss the biological basis for maintaining genetic diversity within and among local populations of salmon in Alaska. We discuss possible interactions between wild and enhanced populations and the importance of maintaining their genetic diversity, and make a series of recommendations to protect these important resources.

Interactions of Enhanced and Wild Populations

Hatchery supplementation of natural production of salmonids, which has been practiced for well over 100 years, has increased the harvest of salmonid fisheries in some instances. However, problems involving long-term survival and loss of diversity of wild stocks have arisen as a direct result of these practices. The conflicts are both genetic and nongenetic.

The genetic concerns are derived from the large number of distinct local populations that have arisen from the strong homing instincts of anadromous salmonids and the differential patterns of natural selection among rivers. Examples were presented by Allendorf, Everett, L. Seeb, J. Seeb, and Utter at the workshop. Reproductive isolation of these populations in their distinct environmental settings has resulted in genetic adaptations to the local environment. Examples were described by Brannon, Smoker, and Gharrett. As a result of both inadvertent and intentional unnatural selective pressures in the hatchery environment and bottlenecks, hatchery stocks often diverge genetically from their wild counterparts.

Inevitably, some hatchery fish will stray into wild populations (Quinn, this workshop). The genetic outcome of such straying is unpredictable. Hatchery fish that successfully produce progeny when they interbreed with wild fish (introgress into the wild population), may reduce fitness of the local populations. Reduced fitness may result from the displacement of locally adapted genes or the disruption of coadapted gene complexes (described by Gharrett at this workshop). Introgression can only be detected through genetic monitoring. Hatchery fish that do not successfully produce progeny when they interbreed with wild fish directly reduce the productivity of that wild population, and may—in the extreme—lead to its extirpation.

Hatchery practices may erode the homing precision of the enhanced populations, resulting in an increased tendency to stray into wild populations (as described by Quinn). It is important to emphasize that even a small straying rate from a large hatchery may produce a large number of strays in comparison to local wild stocks. If the number of strays is large enough, it will almost certainly overwhelm the native fish, regardless of any survival differential favoring the wild stock.

The return of large numbers of enhanced fish also can make conservation of wild populations difficult. In the absence of programs that monitor interactions of enhanced and wild fish, large numbers of hatchery strays can mask the decline of wild fish. Consequently, the estimates of escapement and returns-per-spawner made by fisheries managers may be inaccurate. Furthermore, behavioral interactions with hatchery fish may affect the migratory behavior of wild fish; a disproportionate abundance of hatchery fish may increase the likelihood of interception of wild fish near the hatchery.

The objective of Alaska hatchery management is primarily to stabilize and secondarily to increase the harvest. The difficulty is that hatchery stocks tolerate much higher exploitation rates than wild stocks. As a result, wild stocks mingling with hatchery fish during harvest may be exploited at intolerably high rates, significantly threatening genetic diversity. Such management conflicts should be addressed prior to development of a production facility.

There are a number of additional biological concerns related to hatchery and wild stock interactions. These include increased potential for disease transmission from hatchery to wild stocks, potential of competition for food resources which may be limiting particularly for young fish, and the attraction of more predators than normal.

Importance of Genetic Diversity Among and Within Stocks

The productivity (fitness) of a regional system of salmon stocks depends on variation among populations. It is likely, for instance, that different stocks may feed in different parts of the marine environment or may use an area at different times, as suggested by Brannon and Washington. A system that relies on a variety of stocks is more likely to take advantage of localized areas of abundant food and to avoid density-dependent effects of overpopulating such localized areas.

Similarly, Smoker and Gharrett pointed out that an important component of the productivity of a stock is the phenotypic variability for numerous traits such as size, age, migration and spawning times, or emergence times. Most such phenotypic traits have a significant genetic component. For a stock which faces unpredictable environments from generation to generation, genotypic and phenotypic variation in a population increases the likelihood that its members will distribute to different places and times where opportunities for food, growth, and survival may present themselves. Maintenance of genetic variation within a population is analogous to "bet hedging."

Geneticists are able to obtain biochemical genetic information with which populations can be characterized and often differentiated. However, these are very simple characters that usually have little effect on the productivity of a population. More critical to the production of a population are the much more complex life history traits. We are just learning which of these characteristics have important genetic components and how to identify and monitor those traits. With currently employed biochemical genetic techniques, science can document introgression of individuals and genes from one salmon population to another; however, we are not yet able to measure the effects of this introgression on population productivity.

Hatchery Broodstock Management

It is inevitable that enhanced fish will stray into wild stocks. Wild stocks close to the source of the enhanced fish will probably receive relatively more strays. Because it is not yet possible to project the effects of the interactions between enhanced and wild fish, proper hatchery broodstock management has a critical role in conservation of the genetic diversity of wild stocks. At the same time it has an important positive relationship to the hatchery stock.

The importance of genetic variability, both within stocks and between stocks, has implications both for donor stock selection and for the actual management of broodstocks. Donor stocks must be chosen judiciously to optimize their hatchery performance and minimize their effects on local wild stocks. Broodstock management practices in hatcheries can alter the genetic composition of a hatchery stock. The primary causes are inbreeding and selection, whether inadvertent or directed. Inbreeding which results from using too few parents can rapidly reduce genetic variability. Domestication selection, an unavoidable consequence of hatchery production or inadvertent selection of broodstock (e.g. for size or timing,) usually results in some loss of variability. Loss of genetic variability from inbreeding can be reduced by using a large number of spawners and approximately equal numbers of males and females.

Phenotypic variation in broodstocks should reflect variation observed in wild populations in order to reduce the effect of inadvertent selection. The broodstock should include an array of individuals that represent the extent of variation normally observed in a population, especially with respect to timing (migration, spawning, smolting, emergence), and size (and correlated traits such as fecundity, egg size, age). Even if the practice is inconvenient, hatchery broodstock managers should use spawners from the entire stock. Failure to do so is likely to cause the loss of the stock's valuable variety of traits. Particular practices that perhaps should be avoided are inadvertent selection for run timing (for example, using the earliest returns to ensure adequate egg numbers) and selection against jacks.

It is important that broodstock managers monitor the performance of the broodstock over the generations. Without a recorded history, changes will not be apparent. If changes are not apparent and understood, broodstock management practices cannot adapt to changes. At the least, the broodstock manager of a hatchery stock should monitor such fitness-related traits as timing of migration and maturation, size and age of spawners, and egg size and egg number in spawners.

Recommendations

Therefore, we recommend the following policies and activities.

Policies

1. *Abide by established genetic policy.*

The Alaska Department of Fish and Game, with public input, has developed a genetic policy. The policy was written to protect Alaska's valuable salmon resource. Wild stocks are the mainstay of the Alaska fishery economy; hatchery enhancement is meant to supplement but not to replace them. Hatchery programs must be carefully designed to

protect wild stocks, and all aquaculture programs, present and future, should be reviewed for compliance with the ADFG Genetic Policy.

2. *Assume that all local populations are genetically distinct.*

Unless otherwise indicated, spatially or temporally distinct spawning aggregations should be presumed to be reproductively isolated populations.

3. *Use best possible marking or tagging strategies to monitor interactions between hatchery and wild populations and the genetic "health" of wild and enhanced populations.*

Marking techniques might include coded-wire tags, otolith marking, genetic marking or other methods appropriate to the species and logistical constraints of the facility. Genetic marking would be especially valuable for monitoring introgression of hatchery stocks with natural populations. Genetic stock identification or other appropriate techniques should be used to facilitate in-season management of mixed-stock harvests.

4. *Remote releases of hatchery fish should be conducted in a manner that minimizes potential gene flow to wild populations.*

Remote releases have been identified as a source of heightened gene flow from hatchery populations to wild populations. The use of remote releases should be approached conservatively. Best available practices should be used to insure maximum imprinting. Juveniles for remote releases should be held for an appropriate amount of time for imprinting at a release site possessing a freshwater source devoid of conspecifics. A remote release site, even if designed for complete mop-up fisheries, should be considered to be a *de facto* hatchery site (see Genetic Policy for broodstock/hatchery site guidelines).

Activities

1. *Keep genetic policy current and pertinent to Alaska's resources and industry.*

2. *Describe genetic population structure to identify genetically distinct populations and to describe genetically distinct components within populations that may contribute to long-term stability.*

Traits examined should include life history, production, and molecular genetics. Populations should be surveyed prior to any aquacultural activity to provide a baseline for subsequent genetic monitoring. The genetic consequences of hatchery production on adjacent populations should be evaluated during phased-in expansion, and production increases should be halted at the first indication of adverse effect.

Local populations may consist of temporally or spatially distinct components that contribute to the productivity and long-term survival of these populations. This sub-structure should be identified and considered when making management decisions.

3. *Monitor wild and hatchery stocks for extent of straying and introgression.*

Long-term monitoring of genetic traits of adjacent wild populations should accompany any aquaculture program. Again, production strategies should be adjusted to eliminate any observed straying or introgression.

4. *Evaluate the homing of remote-released fish to make the practice as safe as possible.*

Evidence is accumulating that the remote release of salmon away from natal hatcheries can increase straying. Such remote releases are often advocated as production or management tools despite this increased risk. All remote releases should be treated in the same manner as releases from hatcheries and should be evaluated accordingly. They should be monitored for straying, and where straying is observed, for introgression into wild stocks. Remote releases should be planned conservatively and should be modified or terminated if introgression is observed.

B.
OCEAN CARRYING CAPACITY
R. T. Cooney

THEORETICALLY, POPULATIONS OF CONSUMERS IN MARINE ECOSYSTEMS exist in dynamic equilibrium with naturally occurring levels of food. It is generally believed that when environmental factors favor greater-than-average survival in a population, the biomass per individual will be reduced if forage populations limit growth. This density-dependent "effect" has been observed in historic salmon population data. For pink salmon particularly, but including the other species as well, the largest returns are generally composed of smaller fish, whereas the smaller runs are usually characterized by larger individuals (see workshop abstracts by Rogers, Eggers, Ida, and Pearcy). These size trends occur in both wild and enhanced salmon populations, but there are exceptions (Olsen, workshop abstract).

As enhanced stocks grow in response to improved culturing techniques and release strategies that favor greater survival, there will eventually be an upper limit to the ability of coastal, shelf, and oceanic ecosystems to support these stocks. In the past, nature has conspired to produce periods of greater or lesser wild salmon abundance in the Gulf of Alaska. These natural trends are now being augmented by ocean-ranched salmon in increasing numbers. In view of the success of ocean ranching in Alaska and elsewhere, it is not unreasonable to formally begin investigating what is presently understood about the carrying capacity of the ocean, and recommend actions that will improve this understanding before limitations on ocean growth are exceeded. Unusually small adult sizes of some species of salmon this past year (see abstracts by Olsen and Rogers) are indicators to some that the problem of sufficient ocean forage is more immediate than generally acknowledged. However, without information about the other factors that influence growth (temperature fields and migratory feeding patterns), alternative explanations cannot be ruled out.

Carrying Capacity Concerns

Production-related density-dependent growth leading to smaller-than-average sizes of maturing individuals is a concern for several reasons. Japanese ocean-ranched chum salmon have been declining in size and increasing in age at maturity over the past decade in concert with increasing hatchery production (Ida, workshop abstract):

	1975	1980	1985	1990
Adult age, yr	3.30	3.90	4.47	4.20
Mean weight, kg	2.42	3.39	3.54	3.12

These fish exhibit reduced condition factors and lower fecundity with smaller size, a distinct biological impairment. Pushed to the limit, unregulated hatchery production could theoretically produce very small fish with greatly reduced reproductive and market potential. Of perhaps greater concern is the effect that international ocean ranching practices may have on all salmon stocks (wild and hatchery) that use the northern Pacific Ocean as a feeding ground. Because there is competition for food and overlapping ocean distributions, greatly increased production by one or two countries could conceivably affect the growth conditions

for all stocks using the region. Moreover, it is not known what effect the increase in salmon production could have on the overall structure and function of coastal, shelf, and oceanic ecosystems. Salmon share forage resources with other consumers (fishes, marine mammals, and seabirds), some of which may be seriously disadvantaged by increased salmon abundance.

It is not known exactly how adult size is influenced by growth during each of the major life-history stanzas (early marine, oceanic or adult migration). Some contend that both size and abundance are determined by events occurring during the first 2-4 months of early ocean residence, perhaps due to competition occurring in large schools of juveniles. Other observations indicate that growth during the later stages of the oceanic migration (prior to spawning) most influences adult size. Rogers (workshop abstract) observes that for Bristol Bay red salmon, growth constraints are associated with the last year at sea, presumably resulting from dense schooling during the spawning migration. Clearly, understanding which variables influence adult size is fundamental to any long-term evaluation of salmon management and enhancement.

Workshop Recommendations

(1) In order to understand where growth reduction may be occurring, studies documenting the growth histories of individuals using scales, coded-wire tags and otolith structure are needed. The technologies for these studies are available and should be applied in long-term investigations of salmon and their feeding environments. Parallel but interacting studies are recommended, such as: (a) growth studies of juveniles and returning adults (in the escapement and/or commercial catch) to elucidate interannual and seasonal patterns of growth relative to the numbers of wild and hatchery salmon released and surviving to adulthood; and (b) studies of the growth environment of the fish to include nearshore distributions of wild and hatchery fry, temperature and salinity conditions, current patterns, and the kinds and abundances of forage stocks present.

When possible, mass marking techniques (thermal and other) should be used to identify ocean-ranched juveniles released from hatcheries. The ability to separate wild and hatchery fish will establish a powerful tool for comparing growth and survival during all phases of their life histories.

(2) Direct estimates of losses to predators have not been possible in most cases. Observations at some hatcheries suggest that large fish (cod, pollock, and other) and birds (terns, gulls) occasionally concentrate around net pens to feed on fry escaping or being released. However, beyond published accounts of salmon preying on other salmon (cohos on pinks and chums), very little information is available in the literature about the direct effects of other fish and bird predators. Furthermore, little is known about which other fish share food resources with juvenile and adult salmon. The problem of carrying capacity will eventually have to be addressed in terms of how matter and energy are distributed in food webs supporting the salmon. These food webs do not ignore other consumers in the system.

We recommend that all hatcheries keep records of the obvious occurrence of fish and bird predators each year. Casual observation suggests that predation pressure varies from year to year, and perhaps location to location. In addition, emerging technology in quantitative acoustics provides a highly efficient means to "survey" stocks of predators within

geographic regions. Information on the biomass and relative size of "targets" could be used to begin assessing variability in other fish populations.

We also recommend that field studies of juvenile and adult salmon feeding dependencies also collect food information on incidentally captured species to further our understanding of which other consumers share or compete for specific forage stocks.

Observations of recent marine mammal declines in the North Pacific (sea lions, fur seals) suggest, among other factors, that some major change in forage stocks is probably occurring. While the nature of these changes is not fully understood, any ocean-wide shift in forage abundance must be viewed as potentially interactive with the salmon portion of the ecosystem. We recommend that this broader phenomenon be followed closely for correlation with salmon production and adult size changes.

(3) It is generally believed that overall levels of salmon survival are set early in the life history of each species. This means the "critical period" occurs in the freshwater or nearshore coastal environments. We recommend that ongoing investigations, like Cooperative Fisheries and Oceanographic Studies (CFOS), designed to characterize the growth environment for juvenile pink and chum salmon each year in Prince William Sound, be continued and when possible, extended to other regions of Alaska. CFOS includes research contributions from the Alaska Department of Fish and Game and the non-profit hatcheries in the region and oceanographic observations and experimental studies from the University of Alaska (temperatures, current fields, meteorology, food field composition and energetics). An expansion of this study to other regions of the state as an Alaska Ocean Watch program would provide critical and now missing insight about salmon production responses to growth conditions experienced by juveniles each year.

CFOS is using satellite and RF-linked oceanographic buoys and satellite-sensed thermal and optical information of the northern Gulf of Alaska to characterize the coastal and shelf growth environment for salmon each year. These technologies are available and should also be applied to other regions of the state.

(4) An immense state- and federally-funded research program on salmon is now in its concluding phase in Prince William Sound as part of the damage assessment following the grounding of the Exxon Valdez in March, 1989. To date, only a tiny fraction of that information has entered the public domain. Because much of the research focused on the freshwater and early marine stanzas of resident salmon, that database is potentially of great value relative to questions about the carrying capacity of the region. The workshop recommends a speedy release of all data (salmon and other) so that the results of these studies can be examined from the perspective of wild and hatchery salmon growth and feeding dependencies on the region.

(5) The international scope of carrying capacity issues requires that questions concerning production limitation in the open North Pacific Ocean be pursued through multinational cooperative management and research programs. Open-ocean studies of salmon growth and ecology and the oceanic environment may need to be renewed if density-dependent growth and mortality is demonstrated from the oceanic (different from the near-shore coastal) phase of salmon life history. Jointly sponsored U.S., Canadian, Japanese and

Soviet investigations could address the broader question of oceanic food limitation on salmon growth in those parts of the North Pacific that serve as the major feeding regimes.

(6) Several large federally funded and mandated studies of the atmosphere and ocean, responding to questions about global change, have components in the North Pacific. These programs (like the World Ocean Circulation Experiment [WOCE], and the Coastal Ecology Program) will provide data that should contribute to a better understanding of nearshore ocean processes in relationship to the larger oceanic environment. The workshop recommends that, whenever possible, advantage be taken of these large-scale oceanographic and meteorological studies to build databases relevant to the issue of carrying capacity and wild and hatchery stock interactions in Alaska and elsewhere.

Summary

Workshop participants evaluated several examples where the time-series of the size of both wild and hatchery salmon in the Gulf of Alaska suggested that food-limited density-dependent modification of adult size is occurring. Although a theoretical evaluation of the effects of present levels of fry feeding (wild and hatchery) on forage stocks in Prince William Sound demonstrated only minor apparent effects (Cooney, abstract in this report), this assessment was based on several untested assumptions.

Workshop participants agreed that salmon production in the North Pacific at some as-yet-to-be-determined level will be limited by food stocks in coastal, shelf, and oceanic environments. The level at which this will occur cannot be predicted from present information. However, Japanese chum salmon appear to be approaching a size limitation that is seriously impairing their reproductive potential, condition factor, and market value. This has not been observed for wild or hatchery salmon in Alaska, although record or near-record returns of pink salmon to most regions of Alaska last year were characterized by unusually small individuals. Much smaller than average red salmon have been observed recently in Bristol Bay.

This workshop recommends several courses of action to establish a framework for monitoring the growth environment and sizes of Pacific salmon. These efforts will track the carrying capacity issue and provide information to the management and enhancement sectors for mitigative purposes should that become necessary in the future.

C.
MANAGEMENT

Management of Mixed Stock Fisheries

O. A. Mathisen

THE BASIC PHILOSOPHY GOVERNING SALMON MANAGEMENT in Alaska is to separate the harvest by individual stocks. In practice this is difficult to achieve and there are all degrees of mixed fisheries. Until recently the high seas salmon fisheries intercepted large numbers of all species and stocks of North American and Asian origin. The next level of mixed fishery is harvest along the migratory path of adult salmon. A classical example is the False Pass fishery in western Alaska. There are many "cape" or outside fisheries both in southeast Alaska and Prince William Sound and elsewhere which operate on mixed stocks. Even in the estuaries of many large rivers fishing is on the mixed stocks belonging to that river or watershed or adjacent ones.

Mixed fisheries may not be detrimental as long as the different stocks have approximately the same survival rates. Otherwise the weaker races will decline with time. This is especially true in fisheries where enhanced stocks represent a strong and dominant component. If enhancement is successful the survival of the progeny to the larval or smolt stage is usually several percent higher than for the progeny from natural stocks, as demonstrated for pink salmon in Prince William Sound (Cooney abstract). Consequently, the fishing mortality which can be imposed on enhanced stocks for full utilization in a mixed fishery is higher than the natural stocks can sustain and they decline in numbers. This has happened in Sweden and Norway with the Atlantic salmon (Heggberget and Eriksson abstract), in the Columbia River and other Washington and Oregon coastal rivers for chinook and coho salmon (Washington abstract), and it may happen in Robertson Creek chinook hatchery in British Columbia if production there is expanded beyond its current level.

Larger escapements seem to be warranted for the natural runs of pink salmon in Prince William Sound according to the presented data (Eggers abstract), which implies that the present harvest rate on mixed stocks will have to be reduced to protect the weaker stocks of wild pink salmon.

Mixed stock harvest conflicts could have been avoided to a large extent if the planning process of enhancement installations had considered the distinctive biological requirements of the salmon populations being enhanced, and especially the timing of the returning adults. If enhanced stocks and natural runs overlap in space and time, mixed fisheries must be limited to an exploitation rate which the weakest of the natural stocks can tolerate while delaying the harvest of enhanced stocks until they reach the terminal areas. This of course is undesirable for pinks and chums whose truncated maturation process reduces their quality in the terminal areas. Thus, without sufficient biological criteria on the interaction of wild and hatchery fish, the management philosophy of "weakest run" provides at least a conservative if not the "best" criteria for predicting the limit for enhancement programs.

In other Alaskan fisheries, the chinook and coho fisheries of southeast Alaska, the harvest of mixed stocks is common rather than the exception. The absence of adverse effects is attributed to the relatively minor contribution of enhanced stock to the average harvest of

these two species, 10.2% and 8.1%, respectively, since 1985 (Amend, this workshop). Were these percentages to increase, the situation might change drastically.

There is no reason not to believe that the two factors, survival rate and abundance relative to the natural stocks, will operate differently for any species of salmon. Management of enhanced stocks therefore reverts back to setting a rate of exploitation in mixed fisheries compatible with what the natural runs can tolerate and harvesting the excess enhancement production in the terminal areas. Because of the deterioration of the quality of the fish during the maturation process in pinks and chums, the exploitation rate on the weakest natural runs in the mixed fishery will ultimately determine the limits of the production of enhanced stocks, if wild stocks are to survive and preserve their genetic integrity.

Another alternative is to manage for enhanced stocks. One might successfully argue for this in light of our success in domestication and hybridization of terrestrial animals. However, this involves the risk of losing the production of enhanced stocks, if a calamity like diseases should decimate them one year. It might be difficult to rebuild such stocks unless there are sufficient wild stocks left to restore production. Whether Alaska is ready to embark on such a management strategy requires a very careful and cautious analysis.

For the enhancement installations already in operation an acceptable management strategy is to monitor the harvest in mixed fisheries and determine the contributions from enhanced and wild stocks and regulate the exploitation rate so that the desired escapement of wild fish can be secured. But this is a costly process involving extensive tagging or marking experiments combined with thorough recovery programs. Unfortunately, no explicit funding exists in the state's management budget or in the operational budgets of the hatcheries for such undertakings.

In future enhancement projects some of the problems discussed above can to a large degree be avoided by judiciously selecting sites and broodstocks which are in conformity with the life history strategies of the stocks of fish being enhanced.

Harvest Management of Mixed Stocks of Enhanced and Wild Pink and Chum salmon

D. D. Railey

AMPLE EVIDENCE EXISTS IN PACIFIC SALMON HARVEST MANAGEMENT that harvesting has occurred above their sustainable capacity. Hatchery production in many cases has been a response to low production caused in part by environmental factors aggravated by over-harvesting. Evidence also exists that wild stocks can be harvested beyond their sustainable capacity when mixed with the more abundant and more productive enhanced stocks.

Depending on their productivity, wild pink and chum stocks may be able to sustain harvest rates of 50-70% while enhanced stocks should be able to sustain harvest rates of 85-95%. In British Columbia where enhanced and wild stocks coexist, exploitation level is based on the lower wild stock productivity and often on the weakest stock. Additional harvest of enhanced stocks is then carried out in terminal harvest areas. This is the procedure used to manage the south coast of British Columbia chum stocks passing through Johnstone Strait.

Data on the productivity of wild stocks is important both annually and during the fishing season in order to adjust harvest to meet fixed escapement goals. In the above example pre-season estimates via test fisheries and catch sampling for marked enhanced stocks are critical for management to fixed escapement goals. Careful management is especially critical when productivity is low. Pink salmon productivity has been related to Gulf of Alaska air temperature (Tom Royer, pers. commun.), which would indicate that pink salmon production may be lower in the future. Changes in stream flows from logging on the watershed are also known to seriously reduce the freshwater productivity of wild pink and chum stocks. Harvesting the forests in Prince William Sound and lower marine survivals for all regions in Alaska have the potential to result in wide variability in wild pink and chum productivity.

In order to maintain or increase wild pink and chum populations while maintaining or increasing enhanced production and maximizing its harvest the following recommendations should be considered.

(1) Marking of enhanced and wild pink and chum salmon stocks, both juvenile and adult, could and should be used to design a harvest strategy to maximize harvest of enhanced stocks in mixed wild and enhanced areas while meeting escapement goals for wild stocks. Use this data during and after fishing season to estimate wild and enhanced components of the catch. Research into mass marking of juvenile salmonids should be funded.

(2) Institute test fisheries in various locations (catch to be used to pay for charter) throughout the fishing areas to evaluate their use in wild escapement management. Sample catches for marks. These charters could also be used for adult tagging for timing and migration studies.

(3) Study the freshwater productivity of wild stocks by estimating egg deposition and fry output in index streams. This is especially important if escapement goals are increased to determine if increased escapement results in higher fry output. This should also be carried out in streams before and after logging.

(4) Evaluate the effect of logging on egg-to-fry survival and spawning habitat capacity.

(5) Consider increasing the escapement goal to maximize wild productivity.

(6) Evaluate the timing and migration of wild stocks and use stocks which will minimize wild and enhanced mixed fishery interception.

(7) Evaluate future enhancement for site location and stocks selected to minimize wild stock interception. Manageability should be a major criterion in the permission process.

(8) Hold a small workshop of pink and chum management biologists from Alaska, British Columbia, and Washington to make recommendations for the management of enhanced and wild pink and chum stocks in Prince William Sound and southeast Alaska.

Can Wild and Enhanced Coho Stocks Coexist in Southeast Alaska?

D. Amend

THE ALASKA LEGISLATIVE MANDATE DURING THE DEVELOPMENT OF STATUTES and regulations for the Alaska enhancement program was to manage for the natural stocks while enhancing salmon to supplement natural production. The enhancement of coho salmon in southeast

Alaska started in the mid-1970s by the FRED division and the private non-profit operations started in the early 1980s. These programs have now matured and production has stabilized.

The average annual harvest of coho salmon from 1980 through 1988 was 1.71 million. The average harvest of enhanced coho from 1986 through 1990 was 8.1% of the total harvest, but the average in the future, based on current production, is expected to average about 16%.

Coho in southeast Alaska are harvested primarily by trollers but significant harvest occurs by the drift gillnet and seine fleets as a by-catch during the conduct of traditional fisheries. Although some coho are harvested from Canadian systems, most are produced from southeast Alaska systems. Because most of the coho harvested in southeast Alaska are from natural production, it is important to maintain the wild coho stocks.

Enhancement Strategy

The enhancement strategy in southeast Alaska follows three basic courses: (1) release from freshwater raceways as smolts into adjacent rivers, (2) release from marine net pens as smolts at remote locations following an imprinting period, and (3) release of fed fry into non-anadromous lake systems and the fish emigrate after rearing and smolting in the lake. Typically, broodstock were secured from local wild stocks and the fry reared in hatcheries located on non-anadromous systems which are not near natural producing stocks. Fish released as smolts are typically reared about 18 months in a hatchery, and the fish return after about 18 months at sea. Fish released as fed fry are reared to about a 1 gram size in the hatchery, but they complete the remainder of their life cycle similar to wild coho.

Threats and Concerns

There are both intraspecies and interspecies concerns. The intraspecies concerns include wild stock interactions due to straying or competition and management implications. Interspecies concerns primarily involve predation.

There have been no documented negative impacts of enhanced coho on wild coho in Alaska. Hatcheries in southeast Alaska are located on non-anadromous systems; therefore, the smolts do not compete with wild stocks in the freshwater phase after being released. Coho salmon imprint well to the site where they are released and there have been no documented straying problems. Consequently, there have been no documented genetic problems. Potential exists for future problems if hatchery stocks become inbred and significant straying occurs. Continued monitoring is required. In addition, research should better define minimum conditions for imprinting for remote release programs. Enhancement practices should continue to follow policies that would minimize inbreeding or increased straying.

The recent past average of 8% enhanced coho salmon in the harvest has not been a management problem. Even with production capacity at a maximum, the forecast is to average 16% of the harvest. All coho releases include a coded wire tagging program. This allows managers to account for the hatchery contribution to the harvest. Due to the low percentage of enhanced coho in the total harvest, there should be no future management concern. However, the coded wire or marking programs should continue to avoid potential problems of local abundance near hatchery sites.

The interspecies concerns are primarily coho smolts preying on pink fry and to a lesser extent on chum fry. The scientific literature well documents that coho smolts will eat pink fry and in preference to chum fry. In areas where there is a high abundance of coho smolts, the potential exists for the coho to have a significant impact on pink salmon populations. Whether coho are a limiting factor overall to pink salmon abundance is a much broader question which can only be answered by resolving the overall predator-prey relationship among all predators. The coincidence of coho and pink abundance cycles appears to argue against coho limiting pink abundance. However, this does not resolve the concern of high coho abundance near hatcheries where wild pink fry are migrating.

Several studies have been conducted in southeast Alaska to answer concerns about coho preying on pink salmon fry. The results were inconclusive. Pink fry were occasionally found in the stomachs of coho fry, but the problem could not be fully resolved. Early life histories of pink salmon fry showed that they typically spend a short time in the inter-estuaries and 90% of them migrate offshore by late May. In order to minimize the impact period, hatchery releases of coho smolts have been delayed to after June 1. Although this is not considered to be the optimum release time for coho (mid-May would be better), satisfactory survival rates for coho have occurred. This appears to be a satisfactory compromise in order to reduce the concerns of high abundance of hatchery coho negatively impacting pink populations.

Conclusions and Recommendations

Enhanced coho stocks can coexist with wild coho stocks as long as current policies and practices are maintained. Coho hatcheries should not be located on anadromous systems or near major coho producing systems. Hatchery practices should be followed to minimize inbreeding and practices which would increase straying should be avoided. The current level of production should not be a management concern but tagging programs should be maintained to resolve concerns of local abundance. Research is needed to better define the conditions for optimum imprinting and the predator-prey relationship between coho smolts and pink fry should be better defined. The coho enhancement program in southeast Alaska appears to be meeting the original legislative intent of supplementing the harvest of coho salmon while not negatively impacting wild stocks.

Can Abundant Wild and Enhanced Stocks of Chinook Salmon Coexist in Southeast Alaska?

W. R. Heard

CHINOOK ARE THE LEAST ABUNDANT SALMON IN ALASKA but are among the most highly prized and are often at the center of controversial fishery issues. Coastwise declines in the wild chinook stocks, especially in Washington, Oregon, and British Columbia, along with mixed stock ocean-troll fisheries in both countries, were among the major factors leading to the Pacific Salmon Treaty between Canada and the United States.

One reason for the focus on chinook in the treaty was oceanic migration patterns of many stocks that migrate in a northwesterly direction along the U.S. and British Columbia

coastlines. Many stocks of chinook become vulnerable to distant area fisheries. The troll fishery in southeast Alaska was especially important because it caught large numbers of non-Alaska chinook originating from southerly stocks. Among other things, the treaty called for limiting such interceptions of chinook between countries and states and for initiating a coordinated rebuilding program of depressed stocks along the coast. Other treaty provisions include a limited quota on numbers of chinook that could be caught in certain fisheries and an option for developing new stocks or groups of enhanced fish that could be harvested by the country or state of origin in addition to fish counted under the quota.

Chinook salmon hatcheries and significant related enhancement programs in southeast Alaska increased from two in 1976 to fifteen in 1990. New hatchery add-on provisions of the treaty were a major incentive for much of this development and the basic goal of this effort was to provide more chinook of local origin for southeast Alaska fisheries. The primary targeted user groups for chinook salmon in this region are the commercial troll and marine recreational troll fisheries.

Most hatcheries in the region were developed with principles to have minimal impacts of hatchery fish on endemic wild stocks of chinook. Alaska Fish Genetic and Pathology Policy statements were important guidelines for selecting chinook hatchery sites, brood stocks, and enhancement practices. Unlike chinook hatcheries in many other regions, none were built on extant wild chinook streams. Most are located on islands 50 km to 200 km distant from wild stocks that are, with one exception, on the mainland. Four primary hatchery stocks, derived from regional wild stocks, are in use in different parts of southeast Alaska. Three other stocks have been involved in supplemental enhancement of their depressed natal runs. Chinook brood stock selection for use in hatcheries and other enhancement efforts in this region is important because of differences in ocean migration patterns that result in different fishery contribution potentials for target fisheries. Upriver stocks from larger transboundary rivers (Taku, Stikine, Alsek) tend to have longer, more distant ocean migrations than stocks from shorter coastal streams. Movement of eggs between hatcheries is carefully regulated based on stock, disease history and location of hatchery.

A formal interagency chinook plan for the region, with an annual annex update, provides oversight guidance on hatchery and other chinook enhancement activity within the region. The Chinook Plan Team and Plan Annex also serves as an annual monitor of individual hatchery broods relative to stock performance, fishery contributions, and marine survival. Production from both hatchery and wild stocks of chinook salmon in southeast Alaska has steadily increased in recent years. Regional hatchery contributions to southeast Alaska fisheries have grown from an average annual catch of about 5000 fish (1980-85) to an actual estimated catch of 79,546 fish in 1991. After pre-treaty hatchery fish and risk factor adjustments are made, the hatchery add-on allowance for 1991 becomes 65,546 fish. One long-term goal of enhancement in southeast Alaska is to provide 100,000 add-on chinook to the commercial troll fishery. Total estimated escapements of wild chinook stocks in the region have doubled from an average of 43% of target goal (1975-80) to 84% (1986-90). Target escapement goals for several wild chinook stocks within the region are increasing as better knowledge of spawner distributions within river systems becomes available.

In view of the general increases in both hatchery and wild chinook production in southeast Alaska and taking into account the conservative approaches used in development of the chinook enhancement program, there do not appear to be major problem areas of adverse hatchery stock-wild stock interactions in this region. The only known possible exception involves small numbers of adult hatchery chinook recovered in non-natal areas. The majority of these known chinook strays have been recovered from areas without natural chinook runs, although a few hatchery fish have been found in some wild chinook streams. There is some concern for the specific stock presently used for hatchery and enhancement activity in the greater Juneau area because of the proximity of the Taku River and possibility of hatchery strays into that system. Steps are in progress to use a more suitable hatchery stock in this area. In other regions of Alaska where there are chinook hatchery and enhancement activities, including Cook Inlet, there also are no known major adverse enhanced stock-wild stock interactions.

Management of Mixed Enhanced and Wild Salmonids in British Columbia

D. D. Bailey

MIXED SPECIES AND STOCKS IN BRITISH COLUMBIA salmon management have been a problem since the Department of Fisheries first began to actively manage the fisheries. Overfishing, habitat destruction from forestry, industrial, and urban expansion, and poor marine survival all combined to seriously depress stocks in the 1960s and early 1970s.

The Salmonid Enhancement Program (SEP) was designed to double salmon catches in two phases starting in 1977 over a span of about 15 years. Fishery management plans were also devised to rehabilitate depressed stocks through conservation and enhancement. This paper will address enhanced and wild fishery management for chum salmon throughout British Columbia and for coho salmon in Georgia Strait.

SEP projects were planned to minimize species and stock management problems by selecting sites where terminal harvests were possible and where all stocks and more than one species were usually enhanced. Because of the high value of chum salmon roe in the late 1970s this species was the most enhanced in the early phases of SEP. Chinook were also enhanced because of the severely depressed state of many of the stocks. Species such as sockeye and pink salmon were enhanced at a lower rate particularly in the North and Fraser until international management treaties were negotiated.

SEP is still a bit player in enhancement with only 10% of the 1985 to 1989 mean catch of enhanced origin (Table 1). Except for chum at 33%, the catch of enhanced salmon for all other species is less than 15% of the total catch.

SEP has 11 major chum salmon facilities producing 90 million fed fry and 100 million unfed fry annually. Fed fry are produced from Japanese style hatcheries and unfed fry from spawning channels. An additional 5 million fed fry and 25 million unfed fry are produced from small facilities, mostly improved side channels.

TABLE 1.—SEP production, 1985–89 average.

Species	Total Catch (millions)	SEP Catch (millions)	% SEP	Technology
Sockeye	9.3	1.1	12	Lake fert./channel
Chinook	0.9	0.1	11	Hatchery
Coho	4.2	0.6	14	Hatchery
Pink	18.4	0.4	2	Hatchery/channel
Chum	4.3	1.4	33	Hatchery/channel
Total	37.1	3.6	10	

SEP chum enhancement maintains the genetic integrity of each stream and only releases fry into the stream of origin unless the stream is barren or has reached a very low level. It also attempts to utilize all portions of the run, although there is a tendency to enhance the early to middle portion of the run because of the tendency to ensure the project reaches its egg target. Because a hatchery works with a number of stocks, broodstock collection is a mix of enhanced fish and naturally spawning stocks.

Fishery Management of Enhanced Stocks

Pre-season estimates of returns for enhanced stocks are supplied by SEP to management biologists based on past survival of the enhanced stock and average age composition of return. Because of the high variability of survival and age of return, pre-season estimates are of limited reliability. In-season management through test fisheries and biological sampling are critical for management of enhanced and natural stocks.

At Pallant and Kitimat, where enhanced chum presently make up less than 20% of the total catch in the major fishing area (Table 2), total abundance of all stocks drives the fishing plan. Snootli chum were originally enhanced to buffer the high harvest rate on chum during the harvest of Area 8 pinks. Snootli hatchery has been so successful that its stocks make up only about 8% of the Area 8 chum escapement yet have risen to comprise 40% of the Area 8 chum catch. Harvesting of these enhanced stocks has increased harvest rates from the pre-enhanced average of about 8% to 76% between 1985 and 1989.

"Harvesting this very productive enhanced stock in the mixed stock traditional fishing areas at a high harvest-rate suitable for the enhanced stocks results in an excessive harvest rate on the less productive natural stocks. . . . The significant benefits of enhancement can be realized without serious loss of enhancement only if excess production is assessed through scientific index fisheries and harvested terminally to protect natural chum stocks." (Central Coast SSMP Report, DFO Internal Report 1991)

At Conuma and Nitinat, virtually all the chum stocks have been enhanced and the fishery is managed to achieve escapement goals for the mixed enhanced and wild stocks returning to the native streams. At both sites the fishery is conducted terminally with minimal interception of passing stocks.

Clockwork Strategy

In the Johnstone Strait Fraser River Study Area (i.e., all streams on the east coast of Vancouver Island and on the adjacent mainland plus the Fraser River) a plan was initiated in 1983 to try to rebuild the depressed chum stocks to historic levels in 12 to 15 years by limiting fishing to a predetermined harvest rate schedule. Wild escapement levels would be raised from the previous 10-year average of 1.2 million to 1.8 million in the 1983 to 1986 period and then in stages every four years to 2.5 million in 1995. For 1987 to 1990 the total stock would have to be greater than 3.0 million (i.e. 2.0 million wild escapement goal and 0.9 million enhanced production plus 0.1 million U.S. production) before fishing would take place. Depending on stock size, harvest rate could increase to a maximum of 40% when stock size was over 5.2 million (Table 2).

TABLE 2.—Clockwork harvest rate schedule for Johnstone Strait, 1987-90.

Wild Stock (millions)	Total Stock (millions)	Harvest Rate (%)
0-2.0	0-3.0	10
2.0-2.7	3.0-3.7	20
2.7-4.2	3.7-5.2	30
over 4.2	over 5.2	40

Early season (third week of September) commercial fisheries and all-season test fisheries in Johnstone Strait are used to estimate total run size. Analysis of mark returns from in-season sampling of chum catches is used to estimate enhanced production.

As a result of this strategy, harvest rates of East Coast of Vancouver Island chum (Puntledge, Big Qualicum and Little Qualicum) and Fraser chum (Inch, Chehalis, and Chilliwack) in Johnstone Strait totaled only 21% and 29%, respectively, from 1984 to 1989 (Table 3).

An additional terminal harvest for East Coast Vancouver Island stocks has raised harvest rates to 64% for these stocks. A minor terminal harvest in the Fraser River increased the total Fraser harvest rate to 35%. The late timing Fraser enhanced stocks have had a lower harvest rate because of a late timing component which misses being harvested. In 1985, a new strategy was put in place to select eggs from those portions of the escapement of the component stocks which migrate in the middle portion of the Fraser timing. Weather problems and market quality make late Fraser fisheries undesirable. Harvest of early timing Fraser chums conflicts with the valuable migration of North Thompson steelhead. We are just starting to evaluate the success of this strategy of selecting the mid timing.

As a result of these low harvest rates on Fraser enhanced chum excess escapements have occurred chiefly to Chehalis Hatchery. In 1989 Chehalis had a surplus of 27,000 chums. Because of the depressed nature of many of the stocks, these surpluses have increased the natural spawning escapement.

TABLE 3.—Production of enhanced chum salmon, 1984–89 total.

Hatchery	Catch Area	Enhanced Catch	Exploitation Rate (%)	% of Catch Enhanced
Pallant	Area 2E	273,656	54	20
Kitimat	Area 6	42,620	29	9
Snootli	Area 8	990,569	89	40
Conuma	Area 25	218,858	46	55
Nitinat	Area 21	3,099,608	74	72
ECVI	Johnstone Strait	627,539	21	18
	Area 14	1,341,795	44	70
	Total	1,969,334	64	
Fraser	Johnstone Strait	372,507	29	10
	Area 14	15,896	1	2
	Fraser	70,473	5	37
	Total	458,876	35	
ECVI + Fraser	Johnstone Strait	1,000,046	23	28
	Area 14			72
	Fraser			37
Total		7,053,521	65	

Georgia Strait Coho Problem

Declining coho stocks in the Strait of Georgia are believed to have been caused by overfishing and habitat loss. Currently, about 40% of the Georgia Strait troll and sport catch is made up of Canadian enhanced salmon. Exploitation rates have averaged 80% (1985 to 1988) compared to the 65–70% considered acceptable for wild coho stocks.

Management of the Georgia Strait coho stocks is complicated by the fact that they are harvested in troll, net, and sport fisheries, both inside and outside Georgia Strait. A consultation process has been occurring through which options for rebuilding can be developed and evaluated with all interested parties. These include habitat protection and restoration, enhancement, and harvest restrictions.

One of the most interesting proposals is for all hatchery fish to be marked and sport regulations would set a higher bag limit for marked than for unmarked fish. Wild fish would be conserved, while hatchery benefits would increase. Fewer enhanced coho would return to the hatcheries where their market value is low. The catch of enhanced Georgia Strait coho averaged 578,000 for the 1985 to 1989 period. Hatchery coho surpluses average approximately 100,000 for the same period. Commercial harvest limitation is complicated by the fact that many Georgia Strait coho are caught incidental to large sockeye, pink, and chum fisheries. Whatever options are chosen, the decision will not be an easy one.

D.

INTERACTIONS BETWEEN WILD AND CULTURED SALMON IN NORWAY AND SWEDEN

T. G. Heggberget and T. Eriksson

ATLANTIC SALMON SMOLTIFY AND LEAVE FRESHWATER at sizes between 12 and 17 cm. The smolt ages vary between 1 and 6 years, depending on growth conditions during the presmolt freshwater period. The salmon return to freshwater to spawn after 1–4 years, at sizes from 1 to 25 kg.

Some significant life history variations between stocks exist. Examples of variations between stocks are: timing of spawning, timing of emergence of fry, timing of smolt migration, timing of return migration, and age and size at maturity. Atlantic salmon in Norway are genetically distinct from the Baltic salmon.

Norway

In Norway there are three main sources of cultured fish (1) presmolt salmon released for general enhancement of stocks, (2) smolts released to compensate negative effects due to hydropower development and ocean ranching along the coast, and (3) escapees from pen farms along the coast.

There are about 500 streams with natural stocks of salmon in Norway. The production of farmed salmon in Norway was about 150,000 tonnes in 1991, while the natural production was about 2000 tonnes.

A number of problems have occurred. Due to pen farming activities a great number of farmed salmon have escaped and are now mixing with the wild stocks. Proportions of cultured fish in spawning populations have increased during the last decade, and now exceed 80% of the total number of spawners in some streams. Parasites and diseases introduced with import of smolts from other countries have been transferred to wild stocks with some dramatic effects; high mortality of wild salmon has occurred both due to the parasitic monogenean *Gyrodactylus* and due to furunculosis. Ecological interactions—for instance, competition during spawning and presmolt stages—between wild and cultured fish have been observed. Interbreeding may result in erosion of local adaptations in wild stocks of Atlantic salmon in Norwegian streams. As well, ocean ranching increases fishing pressure on wild stocks.

Several attempts to minimize the negative effects of interactions between cultured and wild fish have been or are being tried: conversion from pen farming to land-based salmon farming; minimizing numbers of strayers from ocean ranching to wild stocks; releasing in connection to rivers, not directly in the sea; harvesting ocean-ranched fish apart from wild stocks; releasing away from important salmon streams; emphasizing locally and regionally based salmonid aquaculture and not transporting live fish material between regions; and practicing effective and intensive health control of release material.

Sweden

The Baltic stocks of Atlantic salmon have been exploited by humans for many centuries. At the end of the 19th century salmon spawned in 60–70 rivers in the Baltic. From 1940

onwards many of the large salmon rivers were dammed and destroyed as spawning habitats. To compensate for the losses hatcheries were established at the rivers used for hydroelectric power production.

Several problems persist. Most of the natural populations have disappeared due to human activities in the rivers. Today between 80 and 90% of the catches in the fishery have a hatchery origin. The catches are dominated (80-90%) of offshore catches on mixed stocks and represent a high exploitation rate on wild stocks. Wild stocks are unable to cope with the present exploitation rate while the reared stocks can, due to high egg-to-smolt survival in the hatcheries. Thus only about 20-25% of the production potential in the natural rivers is actually met today. Management plans are proposed, including a reduction of the offshore fishery.

V.
ABSTRACTS

A.
GENETIC CONSIDERATIONS

Conservation of Salmonid Fishes: Why, What, and How

F. W. Allendorf

Three questions must be addressed before we can develop objectives and methods for conserving salmonid fishes: (1) Why should we preserve salmonid fishes? (2) What should we attempt to preserve? and (3) How should we conserve salmonid fishes? It is important to address the issue of why we want to conserve salmonids in order to unify our efforts and to obtain the resources that are necessary to do it. The question of what we should be preserving is an important and perhaps surprisingly difficult one. Loss of local salmonid populations is occurring throughout the world. We cannot halt this ongoing process; that is, we cannot conserve all local salmonid populations. Therefore, choices and compromises must be made. How do we best use our limited resources to conserve genetic diversity in salmonid fishes? Our first priority should be to protect extant wild populations and their habitat. The loss of genetic diversity is usually irreversible. Therefore, our primary efforts should be to prevent such losses.

**Do Culture Conditions of Hatchery-Reared Salmon
Affect Return and Straying of Adults?**

S. O. E. Ebbesson

Available data indicate that caution should be exercised in rearing certain species of salmon under accelerated growth regimes; additional research is needed to determine if such regimens result in straying. We know from our experience in Alaska with accelerated rearing programs for chinook salmon, for example, that the result is significantly lower returns of adults and returns characterized by a high percentage of jacks. The reasons for this are unknown, but a better understanding of factors affecting smolt transformation and development in general are likely to lead to augmentation of current rearing strategies which will result in better developed smolts. Recent studies have revealed the importance of thyroid hormones on olfactory imprinting and development in general.

Studies comparing saltwater survival of yearling and zero-age coho salmon have showed differential rates of survival related to the timing of release into salt water and to the timing and extent of the plasma thyroid hormone surge. In a 1982 study by Dickhoff and others, about 5 times as many yearling smolts survived as compared to zero-age smolts. Those data, taken together with the information that the thyroid hormone surge (T_4) during smolt transformation in the zero-age fish was half the amplitude of the yearlings', indicate that in addition to poor survival as postsmolts, some zero-age fish may not imprint properly on the stream where they are released. The reason for that is that thyroid hormones play an

essential role in olfactory imprinting. Our studies on brain chemistry and brain circuitry changes during smolt transformation revealed sequential surges of select neurotransmitters before, during, and after the plasma T_h surge. Irregularities in any of these surges may result in inadequate imprinting or lead to inadequate brain development, which in turn could affect subsequent behavior and survival.

There is to my knowledge no direct evidence for straying of zero-age fish, but research in this area should, in my view, be carried out before accelerated rearing programs are implemented.

Adaptive Importance of Genetic Infrastructure in Salmon Populations

A. J. Gharrett and W. W. Smoker

Genetic differences among populations of Pacific salmon are well known, both for neutral biochemical traits and to a lesser extent for quantitative, ecologically adaptive traits. This knowledge is the basis for present day genetic policy which seeks to conserve the genetic variation which underlies that variability. There is increasing evidence of adaptively important genetic variability within populations; that is, genetic infrastructure. In Auke Creek pink salmon, for instance, there is genetically based variability of timing of anadromous migration that is important to the survival of offspring. The adaptability and productivity of commercially important populations are dependent on that infrastructure and rational resource management should seek to conserve it.

Homing, Straying, and the Interaction Between Wild and Hatchery-Produced Salmon

T. P. Quinn

This paper reviews studies on the patterns of straying of adult salmonids from their river or hatchery of origin, with an emphasis on Pacific salmon. The prevalence of straying varies greatly among populations. In general, introduced populations and salmon whose rearing history involves displacement or changes in water source may stray more than native stock and those reared and released on-site. Normal hatchery practices do not necessarily increase the tendency of salmon to stray, although evidence indicates that this may occur. While a generalized estimate of the proportion of salmon that stray would be useful, none seems appropriate because rivers and hatcheries vary so greatly in their tendency to produce and attract strays. There is evidence that the offspring of hatchery-produced salmon may be less viable than those from local wild fish, hence straying between hatcheries and spawning grounds is cause for concern. Whether or not strays actually affect local gene pools depends not only on the prevalence of straying but on the degree of assortative mating and differential survival between populations. At present, fundamental gaps in our understanding of the genetic and environmental factors influencing straying hinder accurate prediction of the levels and consequences of straying.

Complementary Uses of Ecological and Biochemical Genetic Data in Identifying and Conserving Salmon Populations

F. M. Utter, J. E. Seeb, and L. W. Seeb

This paper addresses the need to define distinct population segments within species of salmonid fishes. The focus is on identifying the smallest detectable population with unique sets of characters (i.e., a "species" under the phylogenetic species concept); such units require identification prior to any subsequent groupings under which individual populations may ultimately be managed. The inability of stream distances between populations to identify ancestral discontinuities excludes such measurements as a basis for estimating relationships. The requirement for genetic information in distinguishing populations has been met through characters reflecting ancestral lineages (including adequate biochemical genetic surveys and some meristic information), and those reflecting local adaptations (such as timing of migration and spawning, and distinct temperature tolerances). These different types of genetic information comprise complementary data sets for distinguishing populations because they reflect different evolutionary processes and time scales. Within distinct ancestral groupings defined by biochemical genetic data (supplemented with some meristic information) may exist adaptively distinct populations that cannot be distinguished in the absence of life history and ecological information. Examples are summarized in which a logical process has been applied for distinguishing populations including an initial survey focusing on identifying ancestral groupings followed by a systematic search for adaptive distinctions within these groupings.

Genetic Stock Identification Study of Yukon River Chum and Chinook Salmon

R. L. Wilmot, W. J. Spearman, R. Everett, and R. Baccus

The United States and Canada opened negotiations in 1985 concerning the allocation of Yukon River chum and chinook salmon. Approximately 90% of the in-river harvest is by U.S. fishermen. An unknown proportion of this catch would have returned to the Canadian portion of the Yukon Drainage. In order to negotiate an equitable treaty between the two countries, it is necessary to determine what proportion of the U.S. harvest is of Canadian origin. In 1987, the U.S. Fish and Wildlife Service began a genetic stock identification (GSI) study in the Yukon River to address this problem.

Tissue samples were taken from 34 chum salmon populations and 30 chinook salmon populations and genetically characterized using enzyme electrophoresis. Nineteen variable characters were used to analyze the population structure of Yukon River chum salmon, and 22 variable characters in chinook salmon. Genetic separation between the summer run and fall run of chum salmon was very good as determined using simulations of stock mixtures of given contributions of each stock. Separation between U.S. fall run stocks and Canadian fall run stocks was also good. Estimates down to the stock level are not reliable for management purposes at this time. Resolution of an additional known 14 variable characters, and the use of mtDNA variation, may allow reliable estimates to the stock level. Genetic separation between U.S. and Canadian chinook stocks was very high as determined by simulations.

Separation was also very good for subgroups within both the U.S. and Canadian groups. Accuracy down to the stock level is substantially better for chinook salmon than for chum salmon, but is still not reliable for management purposes. Resolution of an additional 13 variable characters, and use of mtDNA variation, may allow discrimination to the stock level.

Samples have been taken from the mixed-stock fishery at the mouth of the Yukon River and estimates of stock contribution were calculated for the years 1987-90. Due to legal problems concerning management of the Yukon River fishery, these results will not be released until a thorough peer review of the data.

B.

OCEAN CARRYING CAPACITY

A Theoretical Evaluation of the Carrying Capacity of Prince William Sound, Alaska, for Juvenile Pacific Salmon

R. T. Cooney

Present levels of feeding on zooplankton resources by wild and ocean-ranched juvenile Pacific salmon in Prince William Sound are estimated to be between 1% and 4% of the annual macrozooplankton production in the region. When annual fry losses to early ocean mortality are taken into account, the feeding demand associated with growth rates averaging 3-4% of the body weight per day fall to 0.4-1.6% of the total herbivore production and 1.5-5.0% of the macrozooplankton production. Uncertainties associated with the numerous assumptions used in this analysis are discussed in relation to what is understood about the biology and ecology of salmon in Prince William Sound and elsewhere.

Density Dependent Changes in Chum Salmon, *Oncorhynchus keta*, Returning to Iwate Prefecture, Japan

H. Ida

In the last two decades in Iwate prefecture, Japan, hatchery operations were prolonged in order to overcome several problems: (1) to reduce natural mortality in early life stages, (2) to supply food for increased numbers of fry from hatcheries, and (3) to adjust the time of release from the hatchery, where fry hatch much earlier than in the natural beds because of higher temperature of incubating water in the hatchery.

Release after feeding of chum fry started in the early 1970s in Iwate, and the method prevailed throughout the prefecture in the later seventies. In addition to this feeding in freshwater, feeding of fry in cages set close to shore started in the early eighties. The rate of return of adults to Iwate for brood year 1970 was 0.82%; for 1975 it was 1.52%; and for 1985, 3.50%. Thus, the rate of return increased serially. In the earlier stages of this change, feeding or prolonged hatchery operations seemed to accelerate maturation, especially in males; the number of precocious 2-year-old males ("jacks") reached 25-30% in some rivers. There was a tendency toward decreased mean age and mean size, but this lasted only a few years.

Size of fry at the time of release was increased from about 1 gram in the 1970s to several grams in the early 1980s. Mean age and weight of adults returned were as follows.

	1975	1980	1985	1990
Mean age	3.3	3.90	4.47	4.27
Mean weight (kg)	3.42	3.39	3.54	3.12

On the whole, the effort of raising chum fry up to a certain size seemed to increase the survival rate of their early life history stages in coastal areas. At the same time, the number of fry released from Iwate prefecture increased from 30 million in 1970 to 400 million in 1990. Both of these efforts accelerated the biomass of chum salmon originating from Iwate, and as a result growth was stunted and the mean age at maturity was increased.

Factors Affecting Marine Growth of Bristol Bay Sockeye Salmon

D. E. Rogers and G. T. Ruggerone

Growth of Bristol Bay sockeye salmon in freshwater and in the last few months at sea, had been shown to be dependent on their density (higher density, poorer growth) and temperature (colder temperature, poorer growth). In both 1990 and 1991, the sockeye salmon returning to Bristol Bay was unusually small; i.e., for a given age and sex the fish were smaller than expected from the number of fish in the run and the prevailing spring temperatures. The pronounced increase in North Pacific salmon catches in recent years combined with the small size of sockeye in Bristol Bay prompted a reexamination of the factors influencing marine growth. We estimated the annual runs of sockeye and chum salmon in the North Pacific (central and western Alaska plus Asia) and compiled air and water temperature statistics for southwestern Alaska from 1952 to 1991. We estimated the annual mean lengths and weights of adult sockeye in Bristol Bay runs during 1959-91 and marine growth was estimated from scale measurements on samples from Nushagak sockeye catches during 1959-89. We used data plots, linear correlation, and step-wise multiple correlation analyses to relate the various measures of abundance (Bristol Bay, western Alaska, Asia, sockeye and chum) and measures of temperature (air and water for various monthly combinations).

The inclusion of numbers of sockeye and chum salmon from other areas did not improve on the inverse correlation between numbers of Bristol Bay sockeye and the mean lengths in the run. The inclusion of sea surface temperatures during late winter improved the multiple correlation (only April-May had been used before); however, the overall correlation with Bristol Bay lengths was poorer with the addition of the 1990 and 1991 observations. Scale radii measurements of Nushagak sockeye during each year at sea (1956-88) indicated that growth was positively related to temperature during the first (ages 1.2 and 1.3) and second (age 1.3 only) years at sea. Growth during the last year at sea of age 1.2 and 1.3 sockeye was not correlated with sea surface temperature nor salmon run size. Scale growth during the first and second years at sea was not correlated with adult length; however, growth during the third year (age 1.3) was positively correlated with adult length. These data indicate that abundance of Bristol Bay sockeye most affects their growth in the final months before their return, which is a time when they are probably most concentrated.

Table: PWSAC Adult Pink Salmon Weight Relative to PWS Return

J. Olsen

PWS PINK RETURN	YEAR	AFK		WNH		CCH	
		LB.S	KG	LB.S	KG	LB.S	KG
15,723,637	1980	3.30	1.50			?	?
22,085,837	1981	3.50	1.59			?	?
23,051,963	1982	3.20	1.45			?	?
16,696,998	1983	3.00	1.36			?	?
26,476,567	1984	3.40	1.55			?	?
28,254,589	1985	3.30	1.50			?	?
12,771,529	1986	3.40	1.55			?	?
31,544,027	1987	3.60	1.64	3.65	1.66	?	?
13,126,476	1988	3.10	1.41	3.48	1.58	?	?
24,157,149	1989	3.30	1.50	3.45	1.57	3.65	1.66
43,831,188	1990	3.00	1.36	2.99	1.36	2.97	1.35
38,354,826	1991	2.40	1.09	2.33	1.06	2.43	1.10
	1992						
	1993						
	1994						
	1995						
	1996						
	1997						
	1998						
	1999						
	2000						
24,672,899	AVG						
	1980-91	3.21	1.46	3.18	1.45	3.02	1.37
	1980-90	3.28	1.49	3.39	1.54	3.31	1.51
	MIN	2.40	1.09	2.33	1.06	2.43	1.10
	MAX	3.60	1.64	3.65	1.66	3.65	1.66

Regression Output:

Constant	3.51
Std Err of Y Est	0.31
R Squared	0.14
No. of Observations	12.00
Degrees of Freedom	10.00
X Coefficient(s)	-0.00001
Std Err of Coef.	0.00001

Interactions and Environmental Carrying Capacity Limitations of Natural and Artificial Stocks of Salmonids

P. M. Washington

Artificial propagation of salmonids has been practiced for more than a century. In theory, this practice allows the production of almost unlimited amounts of fish. The practice was developed and used to mitigate losses of smolts formerly produced in natural habitats, and evolved to reduce the high mortality of the early freshwater life of anadromous salmonids. Stocks used in hatcheries were selected to produce more easily handled fish. Short pulsed hatchery runs currently provide the basis for many coastal net fisheries.

Artificial facility releases can produce salmonids up to ocean carrying capacity. Oceanic salmonid yield potential is limited by both density-dependent and -independent factors. Monoculture has produced localized density limiting production, but actual production limitation may not be approached until the use of all niches and niche subsets approaches maximum.

Fisheries precluding individual stock management should be terminated before extinctions of wild stocks result. Harvest policies can no longer be to the detriment of wild stocks. Artificial propagation based policy has reduced genetic diversity, manipulated adult size and age downward, and had profoundly negative impacts upon wild stocks.

C.

MANAGEMENT

Overview of Salmon Enhancement Programs in Southeast Alaska

D. F. Amend

All five of the Pacific salmon species are being enhanced by hatcheries in southeast Alaska. Non-hatchery enhancement is not included in this report. Hatcheries are operated by the FRED Division of the Alaska Department of Fish and Game, the Northern and Southern Southeast Regional Aquaculture Associations, and private non-profit corporation. Hatcheries played a minor role in the commercial harvest prior to 1985. Since 1985, the average annual harvest of enhanced chum salmon has been 695,700 (31.2%), chinook 19,590 (10.2%), coho 195,650 (8.1%), sockeye 58,480 (2.4%), and pink 475,000 (2.1%). At full production the percentage of enhanced salmon in the commercial harvest is expected to be about 66.4% chum, 32.5% chinook, 18.2% sockeye, 16.2% coho, and 5.8% pinks. The annual value to the commercial fleet has averaged \$8.4 million annually and at full production is expected to average \$36.8 million annually. The annual 3% enhancement tax paid by fishermen has averaged \$2.39 million. Cost recovery is conducted only by the two regional aquaculture associations and the private non-profit corporations. The annual revenue generated from cost recovery is estimated to be about \$2 million.

The Perpetual Oversight of Hatchery Programs

E. L. Brannon

A major concern of fisheries biologists and managers has been the perception that hatchery fish are inferior to wild fish, and the belief that hatchery fish tend to degrade natural populations. These perceptions are not without foundation, but the problems are the fault of how we have managed hatcheries, and not with either concept or the potential which hatcheries can offer. The perpetual oversight that we have demonstrated consistently throughout our history of fisheries management has been to ignore the fact that fish populations are an integral component in a complex environmental system. If we neglect the requirements that populations have, and hence the traits they possess to synchronize their life history with specific environmental constraints, failure is guaranteed. Although appropriate technology is the key in producing healthy fish, the absolute critical component for success of the hatchery concept is the seed stock used for propagation. Synchrony between stock characteristics and the environment cannot be sacrificed, which means that every possible effort must be extended on working with the native gene pool and avoiding contamination from other brood sources. Adherence must be given to the stock concept in the use and management of hatcheries.

Trends in Abundance of Hatchery and Wild Stocks of Pink Salmon in Cook Inlet, Prince William Sound, and Kodiak, Alaska

D. M. Eggers, L. R. Peltz, B. G. Bue, and T. M. Willette

Trends in pink salmon (*Oncorhynchus gorbuscha*) abundance, production, and average weight of hatchery and wild stock catches, were examined for the years 1960 through 1990 for the lower Cook Inlet, Prince William Sound, and Kodiak Island areas. The abundance of wild pink salmon was the sum of catches and escapement, which were aerial survey index counts expanded by age and sex composition. Abundance of hatchery stock was the sum of the estimated contribution of stocks to catches and the returns to the stock. Production estimates were calculated as the sum of hatchery stock returns from fry released and wild stock returns from escapement. Hatchery runs have increased since the late 1970s and currently exceed wild stock runs. The total central Gulf of Alaska runs of pink salmon have increased and average weights have decreased since the early 1970s. Since the construction of hatcheries, wild pink salmon runs in Kodiak and Cook Inlet have not declined; however, in Prince William Sound a marked decrease in wild stock runs has coincided with the increase in hatchery runs. Return per spawner for wild stocks and survival of releases for hatchery stocks were similarly affected by ocean temperatures. The recent decline in Prince William Sound wild pink salmon runs is believed to be the result of lower wild stock escapement levels due to the heavy exploitation of weak to moderate wild stock runs.

Gene Frequencies, Risk Assessment, and the Management of Hatchery Production of Pacific Salmon

J. E. Seeb

The legislative mandate of the Alaska Department of Fish and Game (ADFG) is the "enhancement and development of all aspects of the state's fisheries for the perpetual use, benefit and enjoyment of all citizens" (Alaska Statutes Title 16). The legislature accompanied this mandate with the requirement that enhancement of crucial native stocks should only be undertaken if careful consideration indicated that they can be conserved in the presence of hatchery management (Title 16; ADFG Genetics Policy).

Native stocks of salmon are important because they not only are the mainstay of the Alaska fisheries economy, but they also represent thousands of years of adaptive evolution. Reproductive isolation, through homing, leads to between-population genetic differences. This component of genetic variation is responsible for adaptive fitness to diverse environments, a factor which permits different stocks of salmonids to thrive under different environmental regimes; and it is the factor that provides for optimal sustained production of wild stocks given the vagaries of environmental variation.

Hatchery production of enhanced fish can relax many of the pressures of selection on a population. While such a stock may thrive in a hatchery and produce fish for harvest, after several generations it may lose some of the genetic traits that made it optimally fit for response to the natural environment. Thus it is important that hatchery fish only be used to truly enhance harvests, and they must be kept from replacing the important wild stocks from which they were derived.

Of paramount concern (this symposium) is the loss of genetic integrity of the isolated salmon populations that can result if hatchery practices lead to increased straying of hatchery fish (and their interbreeding with the native populations). As a part of its effort to protect wild stocks, ADFG is conducting (and proposing) genetic research such as: (1) genetic stock identification (GSI)—genetic screening to determine stock boundaries, provide GSI data to identify hatchery and wild stocks in mixed stock fisheries, genetic marking to monitor straying of hatchery fish; (2) risk assessment and genetic monitoring—evaluation of the genetic consequences of new or increased hatchery production during phased-in expansion, monitoring of changes in fitness and possible effects on wild stocks, conducting long-term monitoring of hatchery and wild stock genetic diversity, modifying hatchery strategies if called for; and (3) use of best possible breeding practices to maintain fitness and genetic variability.

The ADFG believes that this recommendation of a conservative hatchery management strategy incorporating genetic monitoring will facilitate responsible development of the fishery resource. Strict adherence to this strategy will help ensure that hatchery enhancement does not cause any genetic alteration resulting in the loss of these important wild stocks.

Population Genetic Structure of Chum Salmon: Identification of Wild and Hatchery Fish in Mixed Fisheries

L. W. Seeb

The control and management of mixed-stock harvest of chum salmon is one of the most difficult problems facing salmon managers today. Interception of chum salmon exacerbates allocation issues and may contribute to conservation problems in certain areas. Genetic stock identification (GSI) is the primary tool which is being implemented to address these mixed-stock interception issues. Through GSI analyses, scientists can identify the origin and amounts of the different stocks harvested in mixed-stock areas. These values can be used both in-season and post-season to insure conformance to international treaties, to allocate future harvests by nation and user group, or to separate hatchery from wild stocks. They can also be used to adjust harvest areas or times to protect important depleted stocks, the extinction of which would represent an irreversible loss of distinct population segments of the species.

Genetic data from chum salmon have been collected for over a decade by many state, federal, and provincial agencies along the Pacific Rim. These data show that chum salmon subdivide genetically not only into large regional groups, but also one a finer scale into local genetic races. Federal and state agencies have invested considerable resources in the collection of data from stocks originating from Washington, southeast Alaska, Russia, and Japan; the Canadians have likewise gathered extensive data from British Columbia populations. Yet, with the exception of stocks inhabiting the Yukon River and Bristol Bay, no database currently exists for the remaining Alaskan stocks which comprise approximately 40% of the chum salmon production of North America. Many of these stocks have not been sampled because they inhabit remote areas difficult to access. The Alaska Department of Fish and Game has placed a high priority on obtaining genetic data from these stocks.

Further development of the Prince William Sound chum salmon genetic database would allow for identification of wild stocks adjacent to hatchery installations. The current chum salmon broodstock in Prince William Sound is a heterogeneous group originating from multiple sources and timings. The effect of hatchery stocks on the wild stocks within Prince William Sound could be monitored through GSI techniques to insure the continued health of these important wild stocks.

D.

ATLANTIC SALMON

Status of Wild and Hatchery-Propagated Swedish Salmon Stocks After 40 Years of Hatchery Releases in the Baltic

T. Eriksson and L-O. Eriksson

The Baltic stocks of Atlantic salmon have been exploited by humans for many centuries. Especially during the last century, salmon populations have been subjected to dramatic changes in spawning stream access, fishing patterns, and fishing pressure.

At the end of the 19th century salmon spawned in 60-70 rivers in the Baltic proper. From 1940 onward, many of the large salmon rivers were dammed, most of them below the lowest spawning rapids for salmon. Methods for rearing salmon up to the smolt stage were developed and the first smolt releases were around 1950. The number of smolts released in Swedish rivers gradually increased to between 2 and 2.5 million by the middle of the 1980s. During the last 10 years other countries have started salmon release programs, resulting in an annual release of about 3 million smolts. The smolt releases have been successful, showing high survival rates of stocked fish. Today, only about 20 rivers, most of them in Sweden, are attainable for natural spawning runs. The runs are very weak.

Before the second world war the Baltic salmon fishery mainly consisted of coastal and river catches of spawning migrators ascending the rivers. After the war an offshore drift gillnet fishery developed, nowadays making up the major part of the total catch. As a consequence, the spawning runs of wild salmon have decreased dramatically. One hundred years ago the natural production of salmon smolts from the Baltic salmon rivers was around 7-8 million smolts annually. In the early 1970s the wild smolt run to the Baltic was about 2 million. At present, only about 0.5 million wild smolts are released to the whole Baltic proper, which is only about 20% of still remaining smolt carrying capacity of the rivers.

The offshore fishery on mixed populations in the central Baltic proper leads to an extremely high fishing pressure on the Baltic salmon stocks. Stocks are unable to cope with the present exploitation rate. As a result, the number of spawners in natural streams gradually diminishes. In the absence of a compensatory program, a reduction in stock size of the magnitude shown by wild salmon in the Baltic would decrease catch per unit effort to such a degree that a salmon fishery would be meaningless. At present, however, about 90% of the salmon smolts leaving Baltic rivers are of hatchery origin. Depending on extremely high egg-to-smolt survival rates the reared stocks can withstand this high exploitation. It is concluded that the success of hatchery enhancement programs in combination with the lack of effective regulations allowing a high catch per unit effort in the offshore fishery, explains a major part of the sad fate of the remaining wild salmon stocks in the Baltic.

A biologically sound management program for the Baltic salmon is bound to include a stop (or strict regulation) of the offshore fishery on mixed stocks. Salmon stocks should be exploited in relation to the carrying capacity of individual populations, by a more terminal fishery at the coast, or in rivers.

However, an established offshore fishery in the main Baltic, including (at least) seven nations, has so far made any kind of regulations difficult. A recent and, hopefully, more accessible management program is a compromise, suggesting a ban on salmon fishing outside 24 nautical miles from the coast. The fishery closer to the coast will be supported by net-pen delayed releases of salmon at selected areas along the coast of the Baltic main basin. The proposed offshore fishery regulation would increase escapement considerably, while total catch (in tons) would remain unchanged. If the proposal is accepted, we estimate that most wild salmon stocks would have a possibility to recover within 3-4 generations. If not, we believe that the fate of all the wild salmon stocks in the Baltic is extinction within a few additional salmon generations.

Interactions Between Wild and Cultured Atlantic Salmon: A Review of the Experience in Norway

T. Heggberget

About 500 streams in Norway support Atlantic salmon. Most of the Norwegian salmon populations are characterized by small numbers of fish. Physical conditions, for instance water flow and temperature regimes, vary significantly along the Norwegian coast. Analyses of age and size at maturity, timing of spawning, and timing of smolt migrations clearly support the hypothesis of ecological adaptation to different physical environments. The differences in life history patterns are results of different selection pressures on salmon under varying physical conditions.

Proportions of cultured salmon have increased together with the rapid growth of the Norwegian salmon farming industry, and a maximum of 80% cultured fish in spawning populations have been observed. The sources of cultured salmon in Norwegian streams are fish released for general enhancements of stocks, ocean ranching, and escapees from the fish farming industry. Escapees from closed pen operations are the main source of cultured fish in nature.

The most striking effect of the increasing numbers of cultured fish so far has been the introduction of parasites and diseases. In recent years more than 30 populations of salmon have been completely wiped out by the monogenean *Gyrodactylus*, and high mortality of adult salmon due to furunculosis has been observed in some streams. The long-term effects of genetic interbreeding might result in extra mortality of wild fish due to erosion of local adaptations.

VI. ACKNOWLEDGMENTS

This workshop was sponsored by the Prince William Sound Science Center (PWSSC) and the School of Fisheries and Ocean Sciences (SFOS), University of Alaska Fairbanks. Co-chairpersons were Dr. Ole A. Mathisen, SFOS, and Dr. Gary L. Thomas, PWSSC. The list of contributors includes Pew Charitable Trust, University of Alaska Fairbanks, Alaska Department of Fish and Game, Pacific Seafood Processors Association, Prince William Sound Aquaculture Association, and Sealaska Corporation. We want to extend special thanks to Ms. Nancy Bird and Ms. Penelope Oswalt for their efforts to make the workshop a success.

VII.
AGENDA
Workshop on the Biological Interactions of Natural and Enhanced
Stocks of Salmon in Alaska

Saturday, November 9

Participants arrive during the day.

Sunday, November 10 *Open to the public*
First Morning Session - 8:30-10:00 a.m.

Opening remarks:

1. Gary L. Thomas, Director Prince William Sound Science Center
2. Goals of the Conference - Ole A. Mathisen, Univ. of Alaska-Juneau
3. Prince William Sound Aquaculture Corporation - John McMullen, President
4. State Genetic Policy - James E. Seeb, Alaska Dept. of Fish & Game

Session 1 -- Ocean carrying capacity
10:30-12:00

1. *A theoretical evaluation of the carrying capacity of Prince William Sound, Alaska for juvenile Pacific salmon.* R. Ted Cooney, School of Fisheries and Ocean Sciences, University of Alaska, Fairbanks
2. *Density dependent changes in chum salmon, *Oncorhynchus keta*, returning to Iwate Prefecture, Japan.* Hitoshi Ida, Kitasato University School of Fisheries Sciences, Sanriku-cho, Kesen-gun, Japan
3. *Factors affecting marine growth of Bristol Bay sockeye salmon.* Donald E. Rogers, Fisheries Research Institute, University of Washington, Seattle, Washington
4. *Interaction in natural carrying capacity limitations for natural and enhanced stocks of salmon.* Percy M. Washington, GAIA NW, Inc., Seattle, Washington
5. *The carrying capacity of the North Pacific Ocean.* William G. Pearcy, Oregon State University, Corvallis (Summary)

Session 2 -- Management of mixed stocks
1:30-3:00 p.m.

1. *Trends in abundance of hatchery and wild stocks of pink salmon in Cook Inlet, Prince William Sound and Kodiak, Alaska.* Doug M. Eggers, Chief Fisheries Scientist, Alaska Department of Fish & Game, Juneau, Alaska
2. *Management of mixed enhanced and wild salmonids in British Columbia.* Don D. Bailey, Salmon Enhancement Division, Department of Fisheries and Ocean, Vancouver, Canada

3. *Gene frequencies, risk assessment and the management of hatchery production of Pacific Salmon.* James E. Seeb, Alaska Department of Fish & Game, Anchorage, Alaska

Session 3 -- Summary and general discussion
3:30-4:30 p.m.

Monday, November 11 *Open to the public*

Session 4 -- Basic Genetic Structure
8:30-10 am Session Chair: James E. Seeb

1. *Conservation of genetic diversity in salmonid fishes: why, what and how.* Fred W. Allendorf, Division of Biological Sciences, Missoula, Montana
2. *The predictive value of stream distances for estimating genetic relationship in salmonid species.* Fred M. Utter, National Oceanic and Atmospheric Administration (NOAA), Seattle, Washington
3. *Population genetic structure of chum salmon: identification of wild and hatchery fish in mixed fisheries.* Lisa W. Seeb, Alaska Department of Fish & Game, Anchorage, Alaska
4. *The importance of fine genetic structures in natural populations.* Anthony Gharrett, School of Fisheries and Ocean Science, University of Alaska, Juneau, Alaska

Session 4 continued
10:30-12:00

5. *Quantitative genetic variation of life history traits in pink salmon.* William Smoker, School of Fisheries and Ocean Science, University of Alaska, Juneau, Alaska
6. *Genetic stock identification of Yukon River chum and chinook salmon.* Richard L. Wilmot, U.S. Fish & Wildlife Service, Anchorage, Alaska
7. *Genetic relationships among Pacific salmon of the Bristol Bay area of Alaska.* Rebecca J. Everett, U.S. Fish & Wildlife Service, Anchorage, Alaska

Session 5 -- Straying
1:30 - 2:00 pm

1. *Homing, straying and the interaction between wild and enhanced stocks of salmon.* Thomas P. Quinn, Fisheries Research Institute, University of Washington, Seattle, Washington
2. *Do culture conditions of hatchery reared salmon affect return and straying of adults?* Sven Ebbesson (abstract only)

Session 6 -- Long Term Case Histories

2:00-3:00 pm

1. *Interactions between wild and cultured Atlantic salmon -- A review of the experience in Norway.* Tor G. Heggberget, NINA, Norsk Institutt for Naturforskning, Trondheim, Norway
2. *The status of wild and hatchery propagated Swedish salmon stocks after 40 years of hatchery releases in the Baltic rivers.* Torleif Eriksson, Swedish University of Agricultural Sciences, Department of Aquaculture, Umea, Sweden

Session 6 continued

3:30-5 pm

3. *The perpetual oversight of hatchery programs.* Ernest Brannon, University of Idaho, Moscow, Idaho
4. *The Soviet experience in the field of salmon interactions.* Mikhail Glubokovsky, Institute of Marine Biology, Far East Branch, Vladivostok, USSR
5. General discussion

Tuesday, November 12

Field trip to Wally Norenberg Hatchery at Esther Island (western Prince William Sound) --

Wednesday, November 13

Session 7 -- Interactions in Prince William Sound

8:30-10 am

1. *Overview of Ocean Ranching in Prince William Sound,* Jeff Olsen, Operations Manager, Prince William Sound Aquaculture Corporation, Cordova, Alaska

Session 7 continued

10:30-12 noon -- *Interactions in Prince William Sound*

Session 8 -- Interactions in Southeast Alaska

1:30-3 pm Session Chair: Ole Mathisen

1. *Southeast Alaska Chinook; Fisheries, management, enhancement, wild stocks and treaties.* William R. Heard, National Marine Fisheries Service, Auke Bay Laboratory, Auke Bay, Alaska
2. *An Overview of the Pink, Chum and Coho Enhancement programs in Southeast Alaska.* Donald F. Amend, Southern Southeast Aquaculture Association, Ketchikan, Alaska

Session 8 continued

3:30-5 pm -- ***Interactions - General discussion***

Thursday, November 14

Session 9 -- Interactions regarding other species, especially sockeye

8:30-10 am

Session 9 continued

10:30-12 Noon

Session 10 -- The Working Party: Writing sessions divided into sub-groups

1:30-5:00 pm Session Chairs in charge of each group

Friday, November 15 *Open to the public*

Session 11 Concluding Session

Session Chair: Gary Thomas

8:30-10 am Session leaders will present a short discussion of the findings of their working group followed by an open discussion session and approval of reports and documents.

10:30-noon Open discussion session continues.

Afternoon Departures

VIII.
LIST OF MANUSCRIPTS SUBMITTED

R. T. Cooney

A Theoretical Evaluation of the Carrying Capacity of Prince William Sound, Alaska, for Juvenile Pacific Salmon

T. Eriksson and L-O. Eriksson

Status of Wild and Hatchery-Propagated Swedish Salmon Stocks after 40 Years of Hatchery Releases in Baltic Rivers

A. J. Gharrett and W. W. Smoker

Adaptive Importance of Genetic Infrastructure in Salmon Populations

T. G. Heggberget

Interactions Between Wild and Cultured Atlantic Salmon: A Review of the Experience in Norway

T. P. Quinn

Homing and Straying of Wild and Hatchery-Produced Pacific Salmon

D. E. Rogers and G. T. Ruggerone

Factors Affecting Marine Growth of Bristol Bay Sockeye Salmon

F. M. Utter, J. E. Seeb, and L. W. Seeb

The Predictive Value of Stream Distance for Estimating Genetic Relationship in Salmonid Species

P. M. Washington

The Interactions and Environmental Carrying Capacity Limitations of Natural and Artificial Stocks of Salmonids

IX. LIST OF PARTICIPANTS

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