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LAWS OF ALASKA

1990

Source

CSHB 432(Res)

Chapter No.

91

AN ACT

Prohibiting finfish farming; and providing for an effective date.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

THE ACT FOLLOWS ON PAGE 1, LINE 9

Permitted to become law without signature
Actual Effective Date: July 1, 1990

AN ACT

Prohibiting finfish farming; and providing for an effective date.

* Section 1. FINDINGS. Based on a legislative examination of the potential effects of allowing finfish farming in the state on the common property resources and on the overall economic well-being of the state; the number of serious concerns associated with finfish farming and the need for study of finfish farming that has caused the legislature to enact two moratoriums on finfish farming and establish a nonlegislative task force to study the issue and to report its findings and recommendations to the legislature; a review of the final report of the Alaska Finfish Farming Task Force which notes several possible benefits and some serious risks of finfish farming; the need for the legislature to take action before the current moratorium on finfish farming expires on July 1, 1990; the recommendation of the task force that the legislature not extend the moratorium, but make a final determination to either allow or prohibit finfish farming; and the testimony and evidence received; the legislature finds that

(1) the state has the healthiest stocks of wild salmon and other wild finfish in the world and benefits from thriving commercial, sport, and subsistence fisheries for these fish and a growing tourism industry related to sport fishing;

(2) the people, economy, and environment of the state are dependent in large measure upon the continued health of the state's wild finfish resources;

Chapter 91

(3) serious risks are posed by commercial finfish farming, including the spread of disease among wild fish by farmed fish, genetic intermingling of wild fish stocks with genetically manipulated farmed fish, degradation of water quality near finfish farms, and land use conflicts over the siting of commercial finfish farms;

(4) the state has invested significantly in marketing efforts to promote Alaskan finfish as wild and natural fish products, and this investment in developing the reputation of Alaskan finfish would be lost by allowing commercially farmed finfish to be produced and marketed from Alaska;

(5) the cost to the state to regulate the commercial finfish farming industry would be high;

(6) few jobs would be generated by a commercial finfish farming industry in the state;

(7) the state is responsible for ensuring the protection and wise use of the renewable natural resources of Alaska and providing a framework for a sound economy;

(8) a long-term decision must be made regarding the future of commercial finfish farming in the state;

(9) avoiding harm to the state's wild finfish, land, and water resources must take precedence over the development of a new speculative and potentially harmful commercial finfish farming industry;

(10) the best interests of the state are served by prohibiting commercial finfish farming.

* Sec. 2. AS 16.40 is amended by adding a new section to read:

Sec. 16.40.210. FINFISH FARMING PROHIBITED. (a) A person may not grow or cultivate finfish in captivity or under positive control for commercial purposes.

(b) This section does not restrict

1 (1) the fishery rehabilitation, enhancement, or development
2 activities of the department;

3 (2) the ability of a nonprofit corporation that holds a
4 salmon hatchery permit under AS 16.10.400 to sell salmon returning
5 from the natural water of the state, as authorized under AS 16.10.450,
6 or surplus salmon eggs, as authorized under AS 16.10.420 and 16.10.-
7 450;

8 (3) rearing and sale of ornamental finfish for aquariums or
9 ornamental ponds provided that the fish are not reared in or released
10 into water of the state.

11 (c) In this section "ornamental finfish" means fish commonly
12 known as "tropical fish," "aquarium fish," or "goldfish," that are
13 imported, cultured, or sold in the state customarily for viewing in
14 aquaria or for raising in artificial systems, and not customarily used
15 for sport fishing or human consumption purposes.

16 * Sec. 3. This Act takes effect July 1, 1990.
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11/18/91

Dear Senator Eliason:

I came across this item
in the International Herald Tribune
last week about the Norwegian
government bailing out fish
farmers. Makes it tough on Alaska
fishermen! Thought you'd be
interested in seeing this.

Regards
Drake Kaplan

EUROPEAN TOPICS

U.K. Health Drink Pulled From Stores

The British police ordered all bottles of Lucozade, a popular brand of health drink, to be withdrawn from stores and returned to suppliers Wednesday.

The police arrested seven men and three women during raids in four cities after uncovering allegations that suspected animal rights activists had plotted to contaminate bottles of the orange-colored effervescent drink.

SmithKline Beecham, the manufacturer, said it estimated that more than 5 million bottles would be withdrawn on Wednesday. The company said the alleged contamination plan affected only bottles on shelves, not those with wholesalers, in warehouses, in the distribution chain or at factories. Both the police and SmithKline said they were uncertain what contaminant might have been used.

SmithKline Beecham, a pharmaceuticals group, is believed to be a target for animal rights activists because it uses animals for laboratory research. The incident was described as the latest in a series of "consumer terrorism" cases to hit British companies.

A police spokesman said: "It is extremely unlikely that contaminated bottles have already been placed on shelves, but other people not yet arrested may still try to plant contaminated bottles."

European Snowcaps Face Warming Trend

Global warming could leave many European mountains snowless by 2100, environmental experts said this week. David Pitt and Sten Nilsson, authors of the book "Mountain

World in Danger," said tourism would be the first casualty of a change in climate.

"The predictions on global warming indicate that more and more villages as you move up in altitude would be affected by loss of snow," Mr. Pitt said at a press conference in Geneva. "Many resorts which have built their industries around skiing could be affected."

The authors, whose study was backed by the United Nations Environment Program and the UN-sponsored Alp Action group, predicted that a northward move in European rainfall patterns would destroy the ice-covered area of the Earth.

Around Europe

Norway's government and banks have agreed to rescue fish farmers from bankruptcy in a deal that may let East European countries buy a 32,000-ton surplus of frozen salmon at rock-bottom prices. The government is to provide a loan of 400 million kroner (\$65 million), while a consortium of 10 banks — huge creditors of the fish farmers — will provide 335 million kroner. The frozen salmon "will be sold to noncommercial markets, possibly to East Europe and the Soviet Union," a Fisheries Ministry spokesman said.

The waters of Belgium's Schelde estuary must be getting less polluted, because seals have returned to it for the first time in more than 30 years. A couple of seals and their pups have settled in the river northeast of Antwerp, offering an indication that the waters contain more oxygen and less heavy metals than in the past, according to Belgian scientists. But their new home is already threatened, because the area has been earmarked as a dumping site for toxic dredging sludge, according to the Dutch newspaper De Stem.

Sytske Looijen



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APRN

VOICES OF ALASKA

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DRAFT

MEMO

TO: Governor Walter Hickel

THRU: Commerce Commissioner Paul Fuhs

FROM: Donna Parker

RE: WORLD SALMON SUMMIT

Over the past decade the world salmon supply has increased while markets for salmon have remained relatively static. This has caused prices for both wild and farmed salmon to plummet. A WORLD SALMON SUMMIT, hosted by the Governor of Alaska, could be used to forge agreements between the international salmon players that would expand market opportunities and increase the price paid to salmon fishermen, farmers and processors.

Enhancement programs in Alaska have enjoyed spectacular success at the same time salmon farmers in Norway, Scotland, Canada, Chile, and Japan have dramatically increased production. Some have concluded that the Alaskan salmon industry should take on the salmon farmers and battle to win back their market share. Such a battle would be a tragic mistake.

All salmon, both wild and farmed, are a wonderful source of protein. Unfortunately, American consumers have yet to be convinced of its outstanding value. U.S. per capita consumption of all meat, poultry and fish products is currently 175 pounds per year. Consumption of salmon is about 1.5 pounds per year. It is a misdirected effort for salmon fishermen and farmers to scrap in the corner for a measly 0.8% of the market. It also confuses the consumer and further erodes salmon market shares.

If we really want the amount of market share necessary to sustain a healthy salmon industry, we have to join forces with the salmon farmers. By pooling our financial resources, we can butt heads with the big boys in the chicken, beef and pork industries.

Only through aggressive promotional campaigns can we persuade more Americans to eat salmon. We can do this by supporting a generic promotion program for all salmon.

The legal mechanism to do this already exists. Under the Fish and Seafood Promotion Act we can form a SALMON MARKETING COUNCIL. This would be funded by a levy on both foreign imports and domestic production and have as a single goal, the promotion of salmon in the American marketplace. More than 40 other commodity groups have found such promotion works including our competitors. In the beef and pork industry which now reap the benefits of having national marketing councils.

This does not reduce the need for the Alaska Seafood Marketing Institute or private company promotion. While a SALMON MARKETING COUNCIL would work to convince American consumers to "Eat Salmon," ASMI could follow-up with an "Eat Alaskan Salmon" campaign.

But no matter how good or healthful our product is, it will not sell itself. If the international players can agree to support the funding of such an effort, we will have gone a long way toward gaining our rightful market share. By increasing the domestic demand for salmon, the state's salmon industry will become less dependent on the Japanese market. By increasing the global demand for salmon, prices will return to levels that will help sustain our economy in a time of reduced oil revenues.

If a WORLD SALMON SUMMIT were hosted in Alaska, it would gain domestic and international prestige for the Alaskan seafood industry. It would also allow the state to wield additional clout in a global market that helps drive the state's economy. Associated press coverage would not only provide marketing leverage, but would help educate state residents on the importance of the seafood industry to the Alaskan economy. And finally, if the major international players are able to forge joint marketing efforts, it may lay the foundation for OPEC-style production agreements which would further help stabilize the price and insure the future high value of salmon.

ALASKA STATE LEGISLATURE · SENATE

SENATOR RICHARD I. ELIASON

LABOR & COMMERCE COMMITTEE, CHAIRMAN

RESOURCES COMMITTEE

RULES COMMITTEE

SPECIAL COMMITTEE ON HIGH SEAS

SALMON INTERCEPTION

SELECT COMMITTEE ON

LEGISLATIVE ETHICS



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TO: Alaska Finfish Farming Task Force

FROM: Senator Dick Eliason

DATE: December 13, 1989

RE: Comments on the Alaska Finfish Farming Task Force's
Draft "Report to the Alaska Legislature"

I would like to commend the Task Force for its dedication and hard work. The job of studying so much in such a short time is a tough assignment. The draft report seems well done and without glaring factual errors. I am concerned however about a few items that need some clarification, and a few that are a bit misleading. I appreciate this opportunity to comment on some of my concerns about the report.

DISEASE

In recommendation number 1 on page 5, the statement that the industry can be accommodated without significant threat of disease to existing stocks if the State continues to meet its responsibilities concerns me. It is true that that will REDUCE the risk of disease problems, but there are always risks remaining due to problems with enforcement of laws and regulations. With fish farms in operation there will always be the potential for lack of compliance which could bring devastation to natural stocks. Unless you can positively guarantee that laws and regs will not be violated, there IS a risk. Furthermore, in dealing with all the variables of biology, pathology, weather conditions, and so on which are beyond human control, foresight, and regulation, there are even more risks. We simply cannot truthfully state that current state regulatory systems eliminate disease risks. I suggest that this recommendation be amended to state that, "The risk of disease can be REDUCED if the State...."

GENETICS

I have several comments on the section on genetics. First, it would seem appropriate and useful in the findings section to

provide information on just how many fish typically do escape from farm net pens. The report states that it happens, but the size of the problem is not revealed. There is statistical information, particularly regarding Norway's experience, which would be a valuable addition to this section of the report.

Secondly, the treatment of the concept of "genetic sanctuaries" in the report is troubling. After presenting a long list of serious genetics concerns in the findings section, the report only concludes that we should stick to the state's current genetics policies, and form a committee to make sure those policies are followed. It also "concurs" with the notion of establishing genetic sanctuaries. This seems to be a placebo, and not a real solution to the potential destruction of wild stock genetic material.

After years of experience with fish farming, Norway has found that escaped farm fish spawn in rivers up to 20 kilometers away, and they have declared that fish farms will not be located within 20 kilometers of salmon rivers. In the areas being considered for fish farming in Alaska, primarily Southeast, distances between salmon streams are short. Setting aside areas which are isolated enough to be truly protected from intermingling would be difficult at best. It also seems that even if such sanctuaries could be useful in preservation of some genetic stocks, there is no recognition in the report of the importance of determining which stocks are most crucial, designating the necessary sanctuary areas, and making them off-limits, as a **THE VERY FIRST STEP** in the process of site selection for a fish farm industry. In order to even make the idea of sanctuaries a constructive suggestion, it needs to include details, conditions, and a timeframe. It is misleading to suggest that it is really a solution to the problems and risks recognized in the report's findings.

A further point on the suggested ad hoc committee on genetics: It would be useful to have the report elaborate on the idea; Who will be on the committee? How will it function? And most importantly, will it have some enforcement power? It will need to have some enforcement abilities, and be set up to operate without pressures and influence from those with political and economic interests in the fish farming industry. The committee must have the expertise and clout to make and carry out sound biological decisions.

USER CONFLICTS

On page 14, recommendation number 2 should be revised to state that there should be a state law which clearly spells out that no finfish farming will be allowed in or adjacent to State and federal parks, monuments, and wilderness areas. There is no point to not being definite about whether it should be allowed, or leaving it to some agency to arbitrarily decide on

a case by case basis. The fact is that fish farming is simply NOT compatible with parks, monuments and wilderness areas. Those areas have been given those designations for a reason, and commercial fish farming ventures DO NOT belong there.

COST OF REGULATION

On page 15, the discussion of the cost of regulation should clearly note that since state revenues are on the decline and state expenses are ever increasing, the costs incurred by state government in the start-up, regulation, and monitoring of the finfish farming industry will have to come out of something else. There is no extra money around to simply add money to the budget to cover the new expense. It is most likely that agencies with responsibilities for this new industry (such as Fish and Game and D.E.C.) will be forced to cover the added work out of their own programs. This is particularly distressing as the funding will probably come from trimming the very programs that will need strengthening if fish farming is permitted.

COSTS AND BENEFITS

One serious shortcoming in this section of the report probably stems from the fact that some things have become so well known to you that they seem obvious and were not spelled out in the report for the benefit of those who are not aware of them. It is the lack of anything in the report explaining where the money for fish farming in Alaska would come from. The report does say that since insurance is not likely to be available, it is also unlikely that traditional lending institutions will be willing to finance these ventures. I understand that at your last teleconference you discussed the statement in your report (page 18, (f)) that, "Non-Alaskan investment in the finfish farming industry would lead to the exportation of profits." That only implies that IF there were any non-Alaska investment, some profits would leave the state. It doesn't say whether much or any non-Alaskan investment could be expected.

It is clear from your teleconference discussion that the task force members realize that indeed a very large percentage, perhaps virtually all, of the financing and ownership of any fish farming ventures in Alaska will either be by out-of-state or foreign investors. But nothing in your report would indicate to the reader that this is the case. It does seem that the report is incomplete without acknowledgement of the fact that the only likely source of large-scale investment and ownership in fish farming in Alaska will be large out-of-state corporations, and such groups as the Norwegian fish farming industry which has already expressed eagerness to move into Alaska. I don't believe your report presents all of the most pertinent factors for making a decision about legalization of

fish farming without spelling out who is going to finance and own the industry here.

On page 18, benefit (a) states that, "for every 25,000 pounds of fish, one job is created." I believe that this is a factual error. All of the information I have seen suggests that the average fish farm will employ from two to four people. Perhaps your figures are based on a scenario where fish farms are established in areas with no existing fisheries infrastructure, and where you could assume that a large number of support services jobs, such as fish processing jobs, would be created. This is simply not the case in Alaska. I believe your numbers are far too optimistic about the number of new jobs that could be created.

Also, if you are going to discuss numbers of jobs involved, it would be more useful to use figures to explain it in terms of actual numbers of jobs per farm, rather than per pound of fish. And how well are such jobs likely to pay?

MARKETABILITY OF ALASKA SALMON

Page 24 (a): The word "only" seems inaccurate. It would be better to say that there are three "major" factors. There are others. For example, marketability is also affected by such things as public perception, the image the consumer has of our fish. This was clearly a concern after the Exxon oil spill and for a period of time after the botulism incident in canned salmon several years ago.

GENERAL FINDINGS AND RECOMMENDATIONS

One final comment: I understand that the Task Force may discuss the possibility of recommending an "incremental start-up" of fish farming in Alaska, a sort of "compromise position." I believe that approach by the state would be a cop out. If we have enough reservations about this industry to fear full-scale development of it, then there is simply too much at stake to even begin to dabble in it.

We have the healthiest natural salmon runs in the world here, and thriving commercial, sport and subsistence fisheries which are vitally important to the economy of the state and the lives of many of our citizens. Why jeopardize all that? Furthermore, even incremental start-up would require huge investments of time and money for regs, siting work, pathology and biology, monitoring, etc. We should have learned from past experiences in such things as agricultural development, that there is a tendency to throw good money after bad once you've ventured into something, even if it is ultimately not viable.

This is not a case where free enterprise can be allowed to simply give something a try on its own without affecting anything else. State money would be spent, new threats of disease and genetic intermingling are introduced, markets are affected, siting conflicts begin. With just one farm here, we would never again be able to advertise that if you buy Alaskan salmon you can be sure it is wild, unadulterated salmon. We stand to lose a lot, and calling it "incremental" does not mask the fact that it has begun.

Alaska State Legislature

Senate Resources Committee

Senator Bettye Fahrenkamp, Chairman
Senator Jay Kertula, Vice Chairman
Senator Dick Eliason
Senator Steve Frank
Senator Rick Halford
Senator Arliss Sturgulewski
Senator Fred Zharoff

P.O. Box V
Juneau, Alaska 99811
(907) 465-4907



MEMORANDUM

TO: All Senators

FROM: Senator Bettye Fahrenkamp

DATE: May 1, 1990

RE: Finfish Farming Compromise

I have developed legislation that would ban most forms of commercial finfish farming, including farming in marine waters or natural lakes and ponds. The measure also would prohibit the farming of salmon in salt water pumped to land-based farms.

The effect of this bill is to fully authorize the form of finfish farming already endorsed by the legislature. The current moratorium provides an exemption for fish farming in "a privately owned freshwater body that has no outlet to state water." This language was drafted in consultation with Senator Eliason who later authored a letter of intent urging the Board of Fisheries and Alaska Department of Fish and Game to implement the provision.

This legislation is designed to provide policy clarifications requested by the Board of Fisheries and to impose a tight regulatory regime on upland tank finfish farming.

This is the narrowest of possible alternatives to a total ban on finfish farming, and alleviates any concern about the biological, environmental and economic issues raised during the four-year legislative debate. Under the terms of the bill, Alaska would have the most restrictive finfish farming program in the world.

While the measure would eliminate many of the most promising opportunities for Alaska in finfish farming, it would allow the private sector to proceed with the tank farming of arctic char, kokanee (landlocked sockeyes), rainbow trout and pan-sized coho salmon. This bill provides no hidden subsidies and would extract a fair level of taxation for the state to recover regulatory costs.

The three-year moratorium on finfish farming is scheduled to lapse on July 1, and this undoubtedly will lead to litigation

because of the vague nature of existing laws. While I prefer to avoid this unfortunate situation, my offer to draw both sides into negotiations have been rebuffed.

A full copy of the draft bill is attached. Following are highlights of the measure.

Prohibition of Marine Finfish Farming

The measure would prohibit the net pen rearing of all finfish. This is a straight forward ban with no moratorium or sunset clause, and would be coupled with a deletion of existing statutes which the Department of Law says would authorize finfish farming in the absence of a moratorium.

Prohibition of Land-based Salmon Farms Producing Full-Sized Salmon

Farmers would not be allowed to pump salt water to land-based salmon farms, virtually eliminating the ability to produce full-sized salmon competing with markets of commercial fishermen. Pacific salmon could be farmed only in fresh water, land-based farms, which produce "pan-sized" salmon. These products compete in separate market niches than Alaska salmon harvested by commercial fishermen.

Prohibition of Finfish Farming in Natural Lakes or Ponds

The farming of finfish in natural lakes or ponds would be prohibited. This would prevent any intermingling of farmed and wild stocks.

Authorization of "Tank Farming" of Finfish

Finfish farming would be restricted to tanks or artificial ponds and "raceways." The Alaska Department of Fish and Game would have authority to regulate the structural integrity of fish farming structures and to require facilities be outside of the influence of tidal zones and floodplain.

Prohibition of Exotic Species

The existing statutory ban on importation of Atlantic salmon is extended to all non-indigenous stocks of salmon. The Board of Fisheries' existing authority to authorize the importation of non-indigenous species of shellfish and aquatic plants for stocking aquatic farms is extended to other species of finfish. ADFG believes this is a fundamental protection against the spread of disease to native stocks from aquatic farms.

Protection of Native Stocks

ADFG is provided open-ended authority to impose any conditions necessary to aquatic farming permits to protect natural stocks, including requirements for the treatment of wastewater discharges

to prevent the spread of disease to natural stocks and the pollution of fish and wildlife habitats.

By adding finfish to the statutory definitions of aquatic farms and aquatic farm products, ADFG is directed to develop a comprehensive disease management and control program for finfish farms and hatcheries. The statute also provides ADFG with authority to inspect finfish farms and hatcheries and requires the destruction and disposal or quarantine as necessary to protect native stocks.

The Department of Environmental Conservation is authorized to restrict the use of chemicals and establish requirements as necessary to protect human health.

Common Property Ownership of Broodstock

One of the most complex sections of the draft legislation would provide finfish farmers with limited property rights of broodstock. The state would be provided with continued ownership of the finfish genetic pool and farmers would be prevented from obtaining patents on genetically developed farm stocks.

The farmers would be allowed to sell eggs, smolt and live fish only to other farmers or the state, but would have full property rights to the sale of fish for human consumption or related purposes. Farmers would not be allowed to export live broodstock for use in non-Alaska farms, or to "patent" a genetic strain.

Penalties

Farmers who culture species prohibited by statute (Atlantic salmon and non-indigenous Pacific salmon) or not specifically authorized by the Board of Fisheries would be subject to class C felony penalties. Other offenses would be subject to class B misdemeanor penalties.

Taxation

The draft legislation also clarifies that aquatic farm products are subject to the Fisheries Business Tax.

Labeling

All farmed finfish produced in Alaska would be required to be labeled as "aquatic farm products" at the point of first sale to eliminate any confusion with fish harvested by commercial fishermen.

Original sponsor(s):

1 IN THE SENATE

2 CS FOR SENATE BILL NO. ()

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 SIXTEENTH LEGISLATURE - SECOND SESSION

5 A BILL

6 For an Act entitled: "An Act prohibiting the aquatic farming of finfish in
7 marine or estuarine water of the state and natural
8 freshwater lakes and ponds; relating to commercial
9 finfish farming and aquatic farm and hatchery per-
0 mits, the fishery business tax, and commercial cul-
1 ture of fish for exhibition or aquarium purposes; and
2 providing for an effective date."

3 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

4 * Section 1. FINDINGS AND POLICY. (a) Based on a legislative exami-
5 nation of the potential effects of allowing finfish farming in the state on
6 the common property resources and on the overall economic well-being of the
7 state; the number of serious concerns associated with finfish farming and
8 the need for study of finfish farming that has caused the legislature to
9 enact two moratoriums on finfish farming and establish a nonlegislative
0 task force to study the issue and to report its findings and recommenda-
1 tions to the legislature; a review of the final report of the Alaska
2 Finfish Farming Task Force which notes several possible benefits and some
3 risks of finfish farming; the need for the legislature to take action
4 before the current moratorium on finfish farming expires on July 1, 1990;
5 the recommendation of the task force that the legislature not extend the
6 moratorium, but make a final determination to either allow or prohibit
7 finfish farming; and the testimony and evidence received; the legislature
8 finds that

(1) the state has the healthiest stocks of wild salmon and other

1 wild finfish in the world and benefits from thriving commercial, sport, and
2 subsistence fisheries for these fish and a growing tourism industry related
3 to sport fishing;

4 (2) the people, economy, and environment of the state are depen-
5 dent in large measure upon the continued health of the state's wild finfish
6 resources;

7 (3) risks are posed by commercial finfish farming in open fin-
8 fish farming facilities and systems in marine, estuarine, and fresh water
9 of the state, including the spread of disease among wild fish by farmed
10 fish, genetic intermingling of wild fish stocks with genetically manipulat-
11 ed farmed fish, degradation of water quality near finfish farms, and land
12 use conflicts over the siting of commercial finfish farms;

13 (4) the state has invested significantly in marketing efforts to
14 promote Alaskan finfish as wild and natural fish products, and this invest-
15 ment in developing the reputation of Alaskan finfish would be undermined by
16 allowing commercially competitive farmed finfish to be produced and mar-
17 keted from Alaska;

18 (5) the cost to the state to regulate a marine-based commercial
19 finfish farming industry would be high;

20 (6) the state is responsible for ensuring the protection and
21 wise use of the renewable natural resources of Alaska and providing a
22 framework for a sound economy;

23 (7) a long-term decision must be made regarding the future of
24 commercial finfish farming in the state;

25 (8) avoiding harm to the state's wild finfish, land, and water
26 resources must take precedence over the development of a new commercial
27 finfish farming industry in the natural marine, estuarine, or fresh water
28 of the state;

29 (9) the best interests of the state are served by prohibiting

1 commercial finfish farming in the natural marine, estuarine, and fresh
2 water of the state and authorizing closed-system finfish aquatic farms at
3 upland locations.

4 (b) It is the policy of the state that

5 (1) scientific research projects relevant to the commercial
6 finfish farming industry be incorporated into the fishery research programs
7 of the Department of Fish and Game and the University of Alaska;

8 (2) aquatic farming of Arctic char and Dolly Varden, steelhead
9 and rainbow trout, sablefish, and sheefish, as well as Pacific salmon be
10 permitted in the state at upland locations.

11 * Sec. 2. AS 16.05.940(14) is amended to read:

12 (14) "[FISH OR] game farming" means the business of prop-
13 agating, breeding, raising, or producing [FISH OR] game in captivity
14 for the purpose of marketing the [FISH OR] game or game [THEIR] prod-
15 ucts, and "captivity" means having the [FISH OR] game under positive
16 control, as in a pen [, POND,] or an area of land [OR WATER] that is
17 completely enclosed by a generally escape-proof barrier; [IN THIS
18 PARAGRAPH, "FISH" DOES NOT INCLUDE SHELLFISH, AS DEFINED IN AS 16.40.-
19 199;]

20 * Sec. 3. AS 16.40.100(a) is amended to read:

21 (a) A person may not, without a permit from the commissioner,
22 construct or operate

23 (1) an aquatic farm; or

24 (2) a hatchery for the purpose of supplying aquatic plants,
25 finfish or shellfish to an aquatic farm.

26 * Sec. 4. AS 16.40.100(b) is repealed and reenacted to read:

27 (b) A permit issued under this section authorizes the permittee,
28 subject to the conditions of AS 03.05 and AS 16.40.100 - 16.40.199, to
29 acquire, purchase, offer to purchase, transfer, possess, sell, and

offer to sell stock and aquatic farm products that are used or reared at the hatchery or aquatic farm.

* Sec. 5. AS 16.40.100(c) is amended to read:

(c) The commissioner may attach conditions to a permit issued under this section that are necessary to protect natural fish and wildlife resources, including standards for

(1) prevention and control of disease at a hatchery or aquatic farm;

(2) treatment of water discharged by a hatchery or aquatic farm to prevent the spread of disease and pollution of fish and wildlife habitats;

(3) siting, design, and construction of hatchery and aquatic farm facilities to ensure the structural integrity of these facilities and to provide protection from floods and tides.

* Sec. 6. AS 16.40.100(d) is repealed and reenacted to read:

(d) Notwithstanding other provisions of law, the commissioner may not issue a permit under this section for the farming of or hatchery operations involving

(1) a subspecies, race, or variety of Pacific salmon that does not occur and reproduce in the state or the water of rivers that cross the border between the state and Canada;

(2) Atlantic salmon.

* Sec. 7. AS 16.40.100 is amended by adding a new subsection to read:

(e) The commissioner may not issue a permit under this section for aquatic farming of finfish in the marine or estuarine water of the state or in natural freshwater lakes or ponds. The commissioner may issue a permit for aquatic farming of finfish, other than Pacific salmon, in freshwater or saltwater; aquatic farming of Pacific salmon may be permitted only in freshwater. Aquatic farming of finfish may

1 be permitted only at an upland location in tanks, raceways, or man-
2 made ponds approved by the commissioner.

3 * Sec. 8. AS 16.40.105 is amended to read:

4 Sec. 16.40.105. CRITERIA FOR ISSUANCE OF PERMITS. The commis-
5 sioner shall issue permits under AS 16.40.100 on the basis of the
6 following criteria:

7 (1) the physical and biological characteristics of the
8 proposed farm or hatchery location must be suitable for the farming of
9 the finfish, shellfish, or aquatic plant proposed;

10 (2) the proposed farm or hatchery may not require signifi-
11 cant alterations in traditional fisheries or other existing uses of
12 fish and wildlife resources;

13 (3) the proposed farm or hatchery may not significantly
14 affect fisheries, wildlife, or their habitats in an adverse manner;
15 and

16 (4) the proposed farm or hatchery plans and staffing plans
17 must demonstrate technical and operational feasibility.

18 * Sec. 9. AS 16.40 is amended by adding a new section to read:

19 Sec. 16.40.115. ASSISTANCE TO FINFISH AQUATIC FARMS. (a) The
20 department and the Board of Fisheries shall promote the development of
21 finfish aquatic farms by assisting finfish aquatic farms in obtaining
22 finfish brood stock from surplus production of brood stock by state
23 hatcheries and private hatcheries authorized under AS 16.10.400 or
24 from wild stocks of finfish.

25 (b) The department may obtain brood stock from a private
26 hatchery authorized under AS 16.10.400 on behalf of an aquatic farm or
27 hatchery authorized under AS 16.40.100, if the private hatchery and
28 the aquatic farm or hatchery execute an agreement that the aquatic
29 farm or hatchery will compensate the private hatchery for the value of

1 the brood stock received through the department. The acquisition of
2 brood stock on behalf of an aquatic farm or hatchery under this sub-
3 section is contingent upon no charge or fee being assessed against the
4 department by the private hatchery for obtaining brood stock on behalf
5 of the aquatic farm or hatchery.

6 * Sec. 10. AS 16.40.120(a) is amended to read:

7 (a) A person may not acquire aquatic plants, finfish, or shell-
8 fish from wild stock in the state for the purpose of supplying stock
9 to an aquatic farm or hatchery required to have a permit under AS 16.-
10 40.100 unless the person holds an acquisition permit from the commis-
11 sioner. The commissioner may not issue an acquisition permit to ac-
12 quire finfish from wild stock in the state unless

13 (1) the permit applicant has received a finfish brood
14 stock license issued under AS 16.40.125; and

15 (2) if the permit is for acquisition of Pacific salmon,

16 (A) surplus Pacific salmon brood stock is not avail-
17 able from a state hatchery or a hatchery authorized under AS 16.-
18 10.400; and

19 (B) the Board of Fisheries has allocated Pacific
20 salmon to be taken from wild stock under the permit.

21 * Sec. 11. AS 16.40.120(c) is amended to read:

22 (c) The commissioner shall specify the expiration date of an
23 acquisition permit and may attach conditions to an acquisition permit,
24 including conditions relating to the time, place, and manner of har-
25 vest. Size, gear, place, time, licensing, and other limitations
26 applicable to sport, commercial, or subsistence harvest of aquatic
27 plants, finfish, and shellfish do not apply to a harvest with a permit
28 issued under this section. The commissioner [OF FISH AND GAME] shall
29 issue or deny a permit, other than a permit to acquire Pacific salmon.

1 within 30 days after receiving an application.

2 * Sec. 12. AS 16.40 is amended by adding a new section to read:

3 Sec. 16.40.125. FINFISH BROOD STOCK LICENSE. (a) An aquatic
4 farm or hatchery that holds a permit issued under AS 16.40.100 to
5 engage in the propagation, farming, or cultivation of finfish may

6 (1) obtain finfish stock only from

7 (A) the department;

8 (B) another aquatic farm or hatchery; or

9 (C) a private hatchery authorized under AS 16.10.400
10 through a transaction arranged under AS 16.40.115(b); and

11 (2) possess finfish only under terms of a finfish brood
12 stock license issued by the department.

13 (b) A finfish brood stock license allows an aquatic farm or
14 hatchery to possess, propagate, farm, and cultivate finfish under the
15 following conditions:

16 (1) the licensee may farm and cultivate finfish for produc-
17 tion of aquatic farm products for food and finfish byproducts;

18 (2) the licensee may propagate finfish for production of
19 finfish stock, subject to regulations adopted by the department;

20 (3) the licensee may not sell or otherwise transfer live
21 finfish or live finfish gametes except for

22 (A) production of food and finfish byproducts; or

23 (B) farming and cultivation by another aquatic farm or
24 hatchery that holds a finfish brood stock license, provided that
25 the sale or other transfer is approved by the department;

26 (4) the licensee surrenders all rights and interests in the
27 genetic material of finfish brood stock and its succeeding generations
28 to the department;

29 (5) the licensee surrenders all rights to patent or

1 otherwise create commercial rights in genetic material of finfish
2 brood stock and its succeeding generations to the department.

3 * Sec. 13. AS 16.40.130 is amended to read:

4 Sec. 16.40.130. IMPORTATION OF AQUATIC PLANTS, FINFISH, OR
5 SHELLFISH FOR STOCK. A person may not import into the state an
6 aquatic plant, finfish, or shellfish for the purpose of supplying
7 stock to an aquatic farm or hatchery unless authorized by a regulation
8 of the Board of Fisheries.

9 * Sec. 14. AS 16.40.140(a) is amended to read:

10 (a) A private hatchery required to have a permit under AS 16.-
11 40.100 may sell or transfer stock from the hatchery only to the de-
12 partment or to an aquatic farm or other hatchery that has a permit
13 issued under AS 16.40.100, except that

14 (1) shellfish stock may also be sold or offered for sale to
15 an aquatic farm or related hatchery outside of the state;

16 (2) finfish stock may be sold or transferred only to the
17 department or to an aquatic farm or other hatchery that has a permit
18 issued under AS 16.40.100 and a license issued under AS 16.40.125.

19 * Sec. 15. AS 16.40.140 is amended by adding a new subsection to read:

20 (f) A person who holds a permit issued under AS 16.40.100 and
21 who sells a finfish aquatic farm product shall conspicuously label the
22 container in which the product is sold as containing a finfish aquatic
23 farm product. The department shall adopt regulations implementing
24 this subsection.

25 * Sec. 16. AS 16.40.160 is amended by adding a new subsection to read:

26 (b) The commissioner shall adopt regulations prohibiting the use
27 of lethal means to control vertebrate predators at hatcheries and
28 aquatic farms and establish guidelines for the use of nonlethal means
29 to control vertebrate predators at hatcheries and aquatic farms.

1 * Sec. 17. AS 16.40.170 is amended to read:

2 Sec. 16.40.170. PENALTY. Except as provided in (b) of this
3 section, a [A] person who violates a provision of AS 16.40.100 -
4 16.40.199, a regulation adopted under AS 16.40.100 - 16.40.199, or a
5 term or condition of a permit issued under AS 16.40.100 - 16.40.199,
6 is guilty of a class B misdemeanor.

7 * Sec. 18. AS 16.40.170 is amended by adding a new subsection to read:

8 (b) A person who holds a permit under AS 16.40.100 and who
9 knowingly engages in, or attempts to engage in, aquatic farming of a
10 finfish species, subspecies, race, or variety that is not authorized
11 by a permit and license issued by the commissioner under AS 16.40.-
12 100 - 16.40.199 is guilty of a class C felony.

13 * Sec. 19. AS 16.40.199(2) is amended to read:

14 (2) "aquatic farm product" means an aquatic plant, finfish,
15 or shellfish, or part of an aquatic plant, finfish, or shellfish, that
16 is propagated, farmed, or cultivated in an aquatic farm and sold or
17 offered for sale;

18 * Sec. 20. AS 16.40.199(5) is amended to read:

19 (5) "hatchery" means a facility for the artificial propa-
20 gation of stock, including rearing of juvenile aquatic plants, fin-
21 fish, or shellfish;

22 * Sec. 21. AS 16.40.199(8) is amended to read:

23 (8) "stock" means live aquatic plants, finfish, or shell-
24 fish acquired, collected, possessed, or intended for use by a hatchery
25 or aquatic farm for the purpose of further growth or propagation.

26 * Sec. 22. AS 16.40.199 is amended by adding a new paragraph to read:

27 (9) "Pacific salmon" means pink salmon, chum salmon, coho
28 salmon, sockeye salmon, or chinook salmon.

29 * Sec. 23. AS 16.40 is amended by adding a new section to read:

1 ARTICLE 3. FISH FOR EXHIBITION OR AQUARIUM PURPOSES.

2 Sec. 16.40.210. COMMERCIAL CULTURE OF FISH FOR EXHIBITION OR
3 AQUARIUM PURPOSES. (a) The department may issue a permit for the
4 possession, propagation, and sale of native or exotic fish or their
5 eggs for exhibition purposes or for stocking aquariums and private
6 ornamental ponds.

7 (b) The board may adopt regulations relating to activities
8 permitted under this section that are necessary to protect native
9 stocks of fish.

10 * Sec. 24. AS 43.75.015 is amended by adding a new subsection to read:

11 (d) Aquatic farm products produced at an aquatic farm are sub-
12 ject to the tax levied under this section.

13 * Sec. 25. This Act takes effect immediately under AS 01.10.070(c).
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ALASKA STATE LEGISLATURE · SENATE

SENATOR RICHARD I. ELIASON

LABOR & COMMERCE COMMITTEE, CHAIRMAN
RESOURCES COMMITTEE
RULES COMMITTEE
SPECIAL COMMITTEE ON HIGH SEAS
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SELECT COMMITTEE ON
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**** PRESS RELEASE ** FOR IMMEDIATE RELEASE ** PRESS RELEASE ****

ELIASON PROPOSES LAW TO BAN COMMERCIAL FISH FARMING

¹⁹⁹⁹
JAN. 19, 1989. Senator Dick Eliason (R-Sitka) today introduced legislation to prohibit commercial finfish farming in Alaska.

"It's clear to me that the serious risks to Alaska and our fishery resources far outweigh any potential benefits from finfish farming. We stand to lose much more than we could ever gain," Eliason explained. "In my view it would be highly irresponsible to allow it. Quite a few of my colleagues seem to agree that the time has come to make a final determination on this and get on with other issues," he said, referring to co-sponsorship of the bill by many Senate members.

Prior to introducing the legislation, Senator Eliason studied the final report of the Finfish Farming Task Force, a non-legislative group which released its final recommendations to the legislature earlier this week. One of the report's recommendations is that the legislature act to resolve the finfish farming issue, rather than extending the current moratorium.

The question of whether to allow the commercial farming of finfish has plagued the state Legislature for several years. Two consecutive moratoriums temporarily prohibiting finfish farming have been enacted, the last of which expires July 1 of this year.

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ALASKA STATE LEGISLATURE · SENATE

SENATOR RICHARD I. ELIASON

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1/19/90

SETTLING THE FISH FARMING DEBATE:

NOW IS THE TIME TO SAY "NO"

Senator Dick Eliason

After four years of discussion on the subject of mariculture, the time has come for the Legislature to end the debate on fish farming and resolve the matter once and for all.

The grave problems associated with fish farms operating in other states and countries, the testimony of witnesses from Ketchikan to Bristol Bay expressing staunch opposition to the legalization of fish farm operations, and the findings and recommendations contained in the recently released report of the Finfish Farming Task Force have led me to introduce legislation prohibiting commercial finfish farming in Alaska.

Several years ago, when the issue of fish farming was first raised, the Legislature recognized the need to proceed slowly and withhold action until more information could be gathered. We have enacted two consecutive moratoriums on finfish farming and in 1988 called for a non-legislative task force to examine the key issues pertaining to finfish farming in Alaska and providing a well-balanced report to the legislature. The group, which completed its work this month, has done a commendable job of laying out the pertinent facts, noting several possible benefits and some serious risks, and leaves

to the legislature the disposition of the issue. One of the main conclusions in the report is that the legislature should not simply extend the current moratorium on finfish farming (expiring in July), but should instead enact a law either allowing or prohibiting finfish farming.

The legislation I introduced, Senate Bill 397, reflects the concerns addressed in the task force report. In evaluating the costs and benefits of fish farming identified in the report, it seems apparent to me that the serious risks outweigh any potential benefits. These risks include the spread of disease among wild fish by farmed fish, genetic intermingling of wild fish stocks with farmed fish unsuited to survival in the wild, degradation of water quality near finfish farms, and land use conflicts over farm siting. The report acknowledges that these potential threats to Alaska's valuable fishery resources and the environment can never be eliminated if fish farming is permitted, they can only be minimized.

Minimizing the risks would be accomplished largely through state regulation, which would necessitate a substantial expenditure of public funds. I don't believe the public would support such an expenditure when there it is unlikely that a fish farming industry can succeed here, and nobody can guarantee the absolute protection of wild fish stocks upon which commercial fishing, subsistence harvests, recreational fishing, and increasing sportfish-based tourism depend.

Although the proposed ban on finfish farming is necessitated by the legislature's responsibility to protect Alaska's natural resources, I have some additional personal concerns. The proponents of finfish farming speak of "employment" and "economic development." The truth is that fish farms employ very few people, approximately 3 people per farm. Is that worth risking harm to resources which currently support, among other things, Alaska's commercial fishing industry: our largest employer and second only to "Big Oil" in terms of its value to the state in dollars? Furthermore, I am concerned about the fact that most of the private sector investment in any finfish farming industry in Alaska will not be by Alaskans. Even if the industry were to make a profit here, much of it would leave the state.

We are fortunate to have resisted jumping into such a volatile enterprise -- lucky that during our moratoriums we have been able to learn from others' mistakes. We have seen genetics and disease problems cropping up at Norwegian fish farms, water contamination problems in Washington, and some of British Columbia's leading fish farms on the brink of bankruptcy, due in part to a glut of farmed salmon on the world market requiring many to sell below cost.

A couple of other good things emerged from the extended debate stimulated by the proposal of mariculture legislation. The question of shellfish and sea vegetable cultivation was divided from the fish farming issue during the course of legislative work on the issue. This has, in turn, given rise

to a fledgling industry to which Alaska has given both its blessing and the benefit of a comprehensive regulatory process.

Another positive aspect of the long discussion on the issue was the great degree of public participation which was achieved. Public awareness of the implications of launching a fish-farming industry in Alaska led to the expression of concern, and finally staunch opposition from the majority of Alaskans interested in the issue.

In response to all that we have learned, the responsible course of action is for the legislature to now move swiftly in adopting legislation prohibiting finfish farming and thus settling the debate once and for all.

Senate
TESTIMONY BEFORE ~~HOUSE~~ RESOURCES

BY SEN. ELIASON

(d Senate floor)

HB 432, PROHIBITING FINFISH FARMING
or SB 195
or SB 397

When the issue of finfish farming first surfaced several years ago, I knew that it would be of the utmost importance to the district I represent in the state Senate. My district includes Sitka, a major center for Alaska's seafood industry, as well as the "iceworm district" which is made up of thousands of miles of coastline and dozens of coastal communities.

From the beginning I have had a keen interest in the issue and have studied it carefully. I have visited fishfarms in both Washington and Norway, read extensively, and talked with hundreds of people on the subject.

I must admit that at first I was excited about the prospects for this new industry, and enthusiastic about investigating its potential in Alaska. But it was also clear that this was a MAJOR policy decision for this state and had to be done with great care and complete information. The more I've learned, the more I've come to realize just what a terrible mistake it

would be for us to allow a finfish farming industry to gain even a small foothold in this state.

I believe that the three years of moratorium we've had have been extremely beneficial. By not rushing into this new venture, we have had time to study it further, and to learn from the experiences in other states and nations where fish farming is underway. And what a lesson it has been!

Many of the areas that jumped on the finfish farming bandwagon are now experiencing enormous problems including bankruptcies, large numbers of fish escaping from farms, disease and genetics problems which are jeopardizing natural stocks, and very bad market conditions leading to the dumping of farmed fish on the market at a loss. Far fewer jobs have been generated than many people had been led to expect.

We can learn from all this. And while we note the problems in the industry elsewhere, there is an additional factor for us to consider here. In the other places where finfish farming has been legalized, they didn't have strong natural stocks to worry about - either they never had them or they had already destroyed them. Here in Alaska we have the healthiest natural runs of salmon and many other species of finfish in the world. The seafood payroll in Alaska in 1988 topped one billion dollars - more than the combined payrolls for the oil and gas,

tourism, mining and forest products industries. Now THAT is a lot to risk.

And it WOULD be at risk with the introduction of finfish farming in Alaska. And I do NOT mean because of any economic competition. With the enormous quantities of farmed fish already glutting world markets, Alaska's seafood already has that competition. The small amount that would be added to that by fishfarming in Alaska would not make a difference. Where the risk lies is in the potential dangers to our natural stocks upon which all of our commercial, sport and subsistence use depends.

As the Finfish Farming Task Force Report points out, the dangers involved in the development of the farming industry can, with enough regulation, funding, and enforcement, be MINIMIZED. Not eliminated, but minimized. To even minimize the risks we would need to spent large amounts of state money, time and personnel to set up tight regulation and monitoring, pathology services, enforcement personnel, and so on. And as we know all too well, there is simply no extra state money sitting around to do this with. We would end up chopping it off some other state program, probably other resource management programs, to fund the necessary state oversight.

WHY would we spend that kind of money, and/or take those kinds of risks with some of the most important resources in the

state, to try to start an industry that offers so LITTLE potential benefit to the state? I support economic diversification --- WHEN it makes sense. We should be able to see when something is better left untouched.

I believe that you will be asked by some fishfarming advocates to perhaps ban netpens for salmon, but to allow SOME fish farming --- a LITTLE fish farming, maybe upland tanks, or non-salmon species, or some other small slice of the pie.

Please don't be fooled by this approach. We know from past experience how easy it is to fall into the trap of throwing good money after bad to bail out a floundering venture. We know how easy it is to be pressured into easing restrictions, weakening our resolve, once an industry is going and is in financial trouble.

Whether we have two fish farms or 100, and whether they are saltwater net pens or upland tanks, the state must resolve the whole question of broodstock acquisition, must invest a great deal of state funding for siting, permitting, regulatory functions, enforcement, pathology services, etc.

With even one fish farm, we can never again advertise that "If it's from Alaska, it is wild natural fish." With more and more consumer awareness of the huge amounts of antibiotics and other drugs and chemicals used, and disease and pollution

problems involved in fish from fishfarms around the world, a consumer backlash at some point could make the the claim of "all natural" the best marketing edge Alaska's finfish has ever had.

Even more important to the question of allowing "a little" fish farming is the "foot in the door" argument - a little fishfarming now will certainly lead to more and more of it.

After initial involvement and expense by the state, and after allowing private businesses to invest time and money and get started, we are not likely to go back later and repeal it even if it is found to have detrimental effects. On the contrary, if the industry is allowed to start, and then runs into financial troubles (which it is clear it would from the economic crisis this industry is already experiencing worldwide) the state is most likely to add a bit more area, relax the restrictions, invest more and more money and time in trying to make the industry more "viable."

This has been exactly the case in British Columbia. There they began the industry with a tight restriction prohibiting Atlantic salmon. But once the farms were established and began to struggle, they repealed that ban to bail them out.

We spoke with people in the Washington state legislature and found that they have experienced a similar phenomenon. As soon

as their "little" industry was underway, they became a very real political force, lobbying and forming political coalitions with other special interest groups to gain passage of measures they wanted.

NO KIND of finfish farming is completely without risks to Alaska's water quality and fisheries resources. And no kind of finfish farming shows much potential of bringing economic benefit to the state. And no kind of fishfarming is worth risking its eventual expansion into the other methods and species, or more massive scale, which we know pose the greatest potential harm.

Let's not be misled into believing that allowing this industry to begin is "farsighted." Recognizing a bad deal when it comes along, and preventing our state and its resources from suffering inevitable negative impacts, - THAT is farsighted.

I hope you will read over the articles in your folders to get an idea of the experiences other states and countries have had with finfish farming - the problems with disease, chemicals, pollution, and so on.

I urge your passage of HB 432.

6

Approach fish farming with a degree of caution

By SEN. RICHARD I. ELIASON

There is a groundswell of interest in Alaska and around the world in the mariculture/aquatic farming industry, including the farming of finfish, shellfish and sea vegetables. Alaskans are actively exploring economic development possibilities, and the concept of launching a new renewable resource industry is a tantalizing one. Enthusiasm, however, needs to be tempered with prudence.

The states and foreign countries currently involved in intensive fish-farming have become involved because their natural stocks are no longer strong. However, the opposite is true in Alaska. Our wild salmon stocks yield harvests among the most abundant in the world.

Alaska now produces 43 percent of the worldwide total wild salmon, and 90 percent of all the wild salmon produced in the U.S. It's no exaggeration to assert that salmon is a mainstay of the state economy.

The actual economic impact of Alaska's salmon harvest is worth many times the harvest value. Processing alone can nearly double the value of the catch. The seafood industry, in which salmon play the leading role, provides more jobs than any other.

The state's natural fishing resources and the industry they support must be protected. Conscientious stewardship of Alaska's valuable seafood resources is of overriding importance. If Alaska proceeds with finfish farming, the



cost of this stewardship will increase significantly.

Concern has been expressed about the potentially negative effect of fish farms on water quality. Water pollution from fish feces, unconsumed feed and land-based farm operations must be carefully controlled, necessitating the careful development of siting guidelines and a process for site reviews. The appropriate regulatory agency must have funding to carry out monitoring and enforcement. A means for resolving disputes over use of coastal waters must be created: Many of the best prospective sites for finfish farming are cherished as safe harbors by fishermen and recreational boaters.

The subject of fish disease has generated heated controversy. Indigenous fish diseases are found in natural stocks, but most are self-limiting in the wild. Wild fish tend to be dispersed, and are not subject to the stress of a pen-rearing environment. The effects of large concentrations of biomass in a limited area are largely unknown. The presence of unconsumed fish feed and feces provides a nutrient-rich environment conducive to the growth of bacterial populations harmful to fish, and no matter how clean the environment of a pen, there is always the risk of disease: bacterial, viral and parasitic.

most disturbing aspect of the of fish disease is that most are easily transferable. pens are not designed to adequately safeguard against escape- of farm fish, wild fish can be attracted to the proximity of the pen by the presence of nutrients, and some diseases can even be borne in the water by currents. One can only speculate upon the impact of intensive pen-rearing of salmon on wild fish stocks. It won't necessarily be detrimental, but not enough scientific research has been conducted to prove that it won't be detrimental.

If private for-profit pen-rearing of salmon is authorized, the state will have to determine what government's regulation and support role will be. To what degree should the state regulate salmon farms to insure their stocks are healthy? Is Alaska willing to expend public funds to gear up for a large-scale application of technical disciplines including fish-disease control? Failure to do so has been a source of a number of British Columbia's problems in its trouble-plagued experience with salmon farming.

The Norwegian government subsidies have effectively reduced the price of their farmed salmon enabling that nation to become a leader in this new industry. Assistance takes the form of capital investment subsidies, capital grants, salmon shipping and transportation subsidies (including the creation of a complete road-sea-air system), and salmon product and price subsidies.

If private for-profit pen-rearing of salmon is authorized, the state will have to determine what government's regulatory and support role will be.

The government provides support in the areas of research and development, quality control, advisory services, free disease-diagnostic services and marketing assistance including international trade provision.

These forms of government support make Norway a formidable competitor and will enable that nation to outstrip the United States as a leading fish exporter by 1990. By that time, worldwide farm production of the premium species of salmon may account for half of total production of fresh and frozen salmon available on the world market. Some industry analysts predict that the supply of Atlantic salmon will overtake the demand by 1990.

Given this scenario, will Alaska fish-farmers be able to compete successfully? Just in order to gear up for the industry, the state would need to make operating budget appropriations to various agencies. How much support can the state afford to provide, or not to provide? Where will the money come from?

Will we take resources away from our existing rehabilitation and product promotion efforts which have already been cut from significant budget cuts two years? Will we really be giving them away from one group to another? (500 gillnetters will be losing their business next year — possibly.)

There may indeed be a need for mariculture in Alaska, but unanswered questions about market conditions, profitability, fish and its impact on nature and the degree to which the state is willing to support and subsidize the industry point to a cautious approach to finfish farming.

□ Sen. Richard I. Eliason is a member of the Fisheries Subcommittee of the Natural Resources Committee in the Alaska Legislature. He was one of the first Alaskans who traveled to Norway in 1978 to study Atlantic salmon farming.

Listen to concerns about fish farming's dangers

By SEN. DICK ELIASON

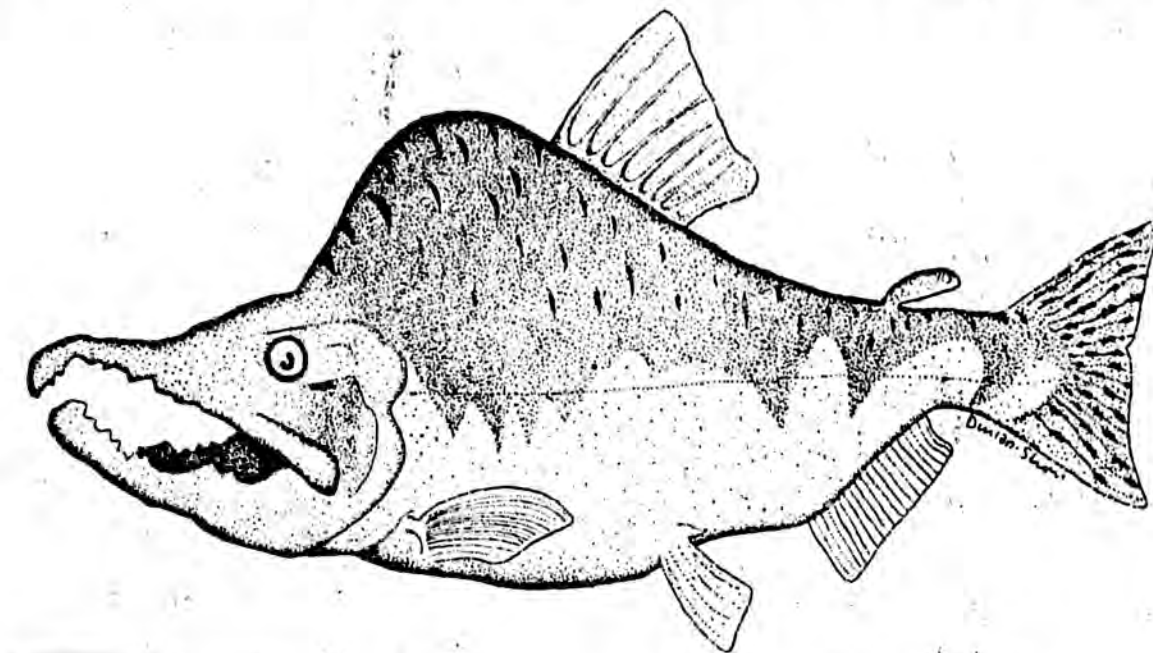
SITKA — The legislature's extension of the moratorium on finfish farming in Alaska reflects the overwhelming opposition to salmon farms expressed by residents of coastal areas.

Fishermen, environmental organizations, recreational and other user groups, as well as a great number of individual citizens accepted the legislature's invitation to speak out on the issue during an extensive series of public hearings in coastal communities throughout the state. To the question of whether Alaska should allow development of salmon farms to begin this year, the response has been a resounding "No!"

It might be easy for legislators representing Interior and Southcentral Alaska to support a swift resolution of the conflict over fish farming. Indeed, the cause has become a popular one in areas which will not bear the potential negative impact on the fishing industry occurring as a result of fish farming.

It would be most unfair to residents of coastal areas, who have expressed opposition to salmon farming, if their representatives were to blithely ignore their legitimate concerns.

Many questions remain unanswered in the areas of land use management/siting, potential negative impact on the existing fishing industry, and threats presented to healthy natural stocks by diseases prevalent on fish farms. Until these questions are resolved, divisive legislative debates over the issue can



be expected to continue.

One can learn a great deal from the experience of other countries which have been in fish farming for years. There is a great deal of information available, and much of it is conflicting information, which really facilitate the legislature in reaching a single conclusion or promptly resolving the mariculture debate.

The catastrophic effects of fish disease from farmed fish infecting dwindling natural stocks have been documented in Norway — the world's leader in salmon farming, and the

world's pioneer in growing halibut.

Our neighbor to the south, British Columbia, has shown us how likely it is that any economically feasible level of salmon farming activity would be fueled by outside investment, exclude "ma & pa" operations, create a few low-paying, menial jobs (which would never replace the value of jobs lost in the fishing industry) and generate profits which would flow directly outside.

Alaska's natural stocks are among the most abundant in the world. We offer the world a vanishing commodity — wild salmon. It is

COMPASS
POINTS OF VIEW FROM OUR COMMUNITY

well worth ensuring that our healthy stocks remain as free as possible from disease. The fishing industry is the state's leading employer.

In light of the unknown effect fish farming would have on fishing industry employment, it is worth ensuring that we retain the employment opportunities that the fishing industry and its support sectors now provide.

There has been much speculation about the expense to the state of mariculture development, particularly regulatory costs. It is worth ensuring that we adequately fund the budget for existing commercial fisheries programs, and continue to expand marketing and product quality improvement efforts.

It is only reasonable that the Alaskans who would be most affected by the state's move into salmon farming should be given the opportunity to speak out, and that their voices should be listened to. The legislature list and acted accordingly in choosing to extend the moratorium on salmon farming in Alaska.

☐ Sen. Dick Eliason represents District B in the State Senate.

Opinion

by Senator Dick Eliason

Alaska's reluctance to open the door to fish farming has disgruntled the handful of people pushing for the establishment of the industry here, but it's clear that imposing the temporary moratorium on finfish farming in Alaska's coastal waters was a step in the right direction, and permanently outlawing it is the wisest choice we can make for the future.

The salmon farming industry is in its infancy in neighboring British Columbia and Washington, and developments there relating to disease, pollution, and site location merit our attention.

Salmon farming operations must perpetually guard against disease, and the prospect of disease spreading from farmed fish to wild fish is frightening. A shock wave of alarm reverberated throughout the Northwest early this year when a fish disease known as VHS, never before seen in North America, mysteriously broke out at two salmon ranching operations in Washington.

All the diseased fish at the facilities were destroyed and buried, however unless samples taken this fall from spawning salmon reveal that the fish are free of VHS, the case is not closed. If the disease is present, the entire Soes River may have to be poisoned. The demise of a salmon-spawning river is a high price to pay, but the toll will be even greater if the disease spreads.

Two fish farming companies in B.C., including the province's second largest, were recently fined for dumping diseased fish into open ditches near the ocean. The carcasses were eaten by bears and eagles, providing a route for the disease into the food chain.

Battle in Washington

In Washington, a battle is raging between the burgeoning salmon farming industry, and a coalition of private landowners and fishermen. Landowners are worried about the negative impact of the farms on waterfront property values, as well as environmental and visual pollution. Fishermen are concerned about the threat of fish disease, damage to the marine environment attributable to massive quantities of organic wastes, use of antibiotics at fish farms, and escaped farm fish breeding with native stocks. Such issues would spark even greater controversy in Alaska due to public ownership of most proposed sites and adjacent uplands, and the multitude of natural stocks at risk.

Farmed Salmon Glut

A significant challenge facing salmon farming operations just gaining a foothold in the market is the current global glut of farmed salmon. This predicted oversupply has created intense competition in the U.S. market, causing farmed salmon to be dumped on the market at a price below cost, and in turn causing a major reduction this season in prices for fresh salmon from Alaska.

These market conditions really put the squeeze on newcomers to the salmon fishing industry, and those with high production/operating costs. If Alaska had promoted fish farming when the topic was first debated, Alaska product would have been hitting the market now, and the higher-cost Alaska operations would likely have gone under.

Global expansion of the industry, its rapid growth in Chile (which has no native salmon stocks and offers some of the lowest production costs in the world), and a supply which already outstrips demand indicate that, from an economic perspective alone, it would be a foolish gamble for Alaska to jump into the arena at this time, or at any time in the foreseeable future.

Protection

Alaska must be dedicated to protecting and developing her existing fishing industry. It is the state's leading industry based on a renewable resource, worth hundreds of millions of dollars, and has for many years provided the greatest number of non-government jobs; the health of the industry is critical for local economies large and small. We cannot afford to jeopardize this valuable industry by putting natural stocks at risk; our economy could be completely upended.

The potential of fish farming to devastate Alaska's wild fish stocks is greater than that of a major oil spill. If rivers need to be poisoned to eradicate fish disease, as they have been in Norway, if the clear waters of Alaska become polluted by fish farming operations, if our natural salmon stocks are crossbred with fish lacking characteristics for survival in the wild, we will suffer catastrophic economic consequences.

Focus on Strengths

In order to hold her own as well as possible in an international marketplace in which Atlantic salmon are gaining market share at an alarming rate, Alaska must focus on improving finfish quality, securing markets for the products which are her specialty (such as wild Pacific salmon from unpolluted waters), and to protecting our valuable fishery resources from the threat of degradation posed by fish farming.

Senator Dick Eliason represents Senate District B, stretching from Metlakatla to Yakutat. He is a member of the Senate Resources Committee, and a Chairman of the Senate Labor and Commerce Committee.

FORUM

Lawmakers should ban fish farming in Alaska

by Dick Eliason

ANCHORAGE — After four years of discussion of mariculture, the time has come for the legislature to end the debate and ban commercial finfish farming in Alaska. The current economic outlook for fish farming is bleak, and does not provide any indication for jeopardizing a natural resource base which supports subsistence, and valuable commercial fisheries. Economic development is important to the state, however, one must weigh the potential detriment of each economic development prospect against the potential benefits.

Unlike the other states and countries that have pursued fish farming, Alaska has a wealth of healthy natural fish stocks. These support a seafood industry worth \$1 billion in Alaska which in 1988 exceeded \$1 billion. That's more than the combined value of Alaska's other leading industries: oil and gas, tourism, mining and forest products.

A fish farm, which costs about \$1 million to start and takes two years to realize the earliest income, employs an average of three people. Financing for fish farm ventures in Alaska would likely come from investors in other states and nations, and a large share of any profits flowing out of state.

Fish farms in other states and in nearby British Columbia have been forced to sell their products at or below cost due to a glut



of farmed fish on the market, and some have faced bankruptcy. Profitability is, at best, uncertain.

The report submitted to the legislature by the (non-legislative) Finfish Farming Task Force states that the potential negative impacts of fish farming on natural stocks cannot be eliminated, a finding with which even fish farming advocates reluctantly agree.

The chief areas of concern which have emerged during the course of the fish farming debate in Alaska are those of water quality, siting, and hazards to natural stocks.

Water pollution is hard to sidestep in an operation which generates tons of oxygen-demanding waste. One typical fish farm using net-pens produces pollutants equivalent to untreated sewage from about 10,000 people, according to a Washington state report. Hormones and antibiotics given the fish are part of this waste, and their use is believed a threat to public health.

The likelihood of irreversible damage is greatest, however, in the threat to natural stocks posed by disease, accidental escape-

ment, and genetic intermingling, all of which have presented genuine problems in Norway, the world's most advanced fish farming nation.

Despite advanced technology and massive government subsidies supporting the industry, thousands of diseased fish escape from farms, threatening wild stocks.

Even when disease exists in wild fish, fish farms have indicated higher rates of infection near net pens. Renegade farm fish, even if they are free of disease, may constitute a threat by competing for space in rivers inhabited by wild fish, and inbreeding can weaken the qualities which suit a fish for life in the wild (such as the ability to migrate).

These various risks to wild stocks can be minimized, according to fish farm proponents, with proper controls, siting guidelines and adequate funding. The cost of these controls and the attendant layers of bureaucracy would be considerable, and regulations would be ineffective unless accompanied by rigorous enforcement efforts.

From Norway to British Columbia there have been documented cases of flagrant violations of regulations, including the release of diseased fish into the wild (to spare the expense of proper disposal) and the improper dumping of diseased carcasses (in one case an open trench enabled scavengers to provide a route for the disease into the food chain).

The legislature has a constitutional mandate to manage natural resources for the maximum benefit of Alaskans. To gamble with these resources at public expense simply irresponsible.

Our stewardship of Alaska's natural resources, her lands, her waters, and her fisheries, involves both development and conservation. The public interest would best served by our unfailing commitment to managing Alaska's fisheries resources according to sustained yield principles, maximizing returns through controlled harvesting and enhancement, providing incentives for shore-based processing, continuing marketing and quality assurance campaigns, and protecting the marine environment from pollution.

The moratorium on fish farming now in place will expire in July. Legislation has been introduced which would ban commercial finfish farming in Alaska.

Legislative committees are now taking public testimony on this issue. If the legislature lives up to its constitutional mandate, Alaska will refuse to flirt with the potential catastrophe which could be brought about by fish farming and will institute prohibition.

□ Sen. Dick Eliason represents District B in the Alaska State Legislature. He is chairman of the Senate Labor and Commerce Committee, a member of the Senate Resources Committee.

FORUM

Pen-farmed salmon industry requires more research

By SONJA CORAZZA

Alaska fishermen's concerns over genetic pollution and disease problems associated with escaped pen-farmed salmon are not unwarranted.

Thirteen to 20 percent of all farmed fish escape, as documented by Norwegian scientists and European countries, and large numbers can escape from pens.

The escapees can spawn in rivers up to a proven distance of 20 kilometers from their net pens.

As a consequence of this research, and with great concern for the genetic integrity and survival of their wild salmon stocks, Norway has just imposed a series of new regulations on their pen-

COMPASS

POINTS OF VIEW FROM OUR COMMUNITY

farmed salmon industry. No salmon farms will be located within 20 kilometers of salmon rivers, and entire fjords will be closed to farming where salmon rivers are present.

This past December in Jarvis Inlet, B.C., 300,000 pen-farmed salmon escaped in winter storms that hit Canada. Floating net pens were found for miles up and down the coast.

Norwegians have lost tons of their pen-farmed salmon to a deadly salmon disease *furunculosis*, and last summer 5,000 fish infected with

furunculosis escaped in Norway. Despite intensive efforts to capture the diseased fish, an infected fish was found in a freshwater stream.

In order to control disease in pens, Norway's use of antibiotics in pen farming has risen 170 percent in the past two years to reach a level of 48 tons, more than the use in animal husbandry and human use combined.

With the present focus on health and nutrition, how does this reliance on antibiotics fit our view of pen-farmed salmon as a healthy addition to our diets?

Norway's most severe threat to wild stocks is from the parasite *gyrodactylus salaris*, which has wiped out

30 wild salmon rivers. This parasite entered Norway via imported salmon eggs from Sweden. Importing eggs had been prohibited, but those regulations were overturned by farmers with economic concerns.

The chemical rotenone which kills the parasite destroys everything in the rivers, hence the loss of wild salmon by the tons in Norway.

In the state of Washington, which two years ago allowed the importation of Atlantic salmon for the economic benefit of their farmers, a report was released on fin fish farming and disease. It stated that the VHS disease carried by Atlantic salmon had never been

found outside of Europe and that there was little likelihood of it ever being a problem.

Now, VHS has been found and millions of their eggs and fish are being destroyed. VHS is particularly fatal for rainbow trout and steelhead.

Domesticating Pacific salmon takes three to four generations of fish and the gene pool may be reduced for docile characteristics. It is possible the migration instinct may breed out of wild salmon, and scientists are concerned interbreeding could affect the wild salmon's ability to migrate.

Ownership of the pen farming industry continues to be an issue. In Washington state a local fish farmer

is suing foreign corporations, primarily Norway, for attempting to monopolize the industry.

Who would own the in Alaska? Alaska is entirely the world leader in ocean ranching and the program is responsible for at least \$80 million in revenue and 2,300 jobs.

The Alaska State Legislature should fund the culture Task Force, a forum where legitimate concerns about fin fish farming to be researched.

□ Sonja Corazza is a member of the United Fishermen of Alaska, Mariculture Committee.

Virus threatens state's salmon and steelhead hatcheries

By Jane Hadley
and George Foster
P-I Reporters

State and federal biologists have destroyed almost 4 million fish and eggs at two Washington state hatcheries because some of the fish were infected with a fatal

viral disease that has never before occurred in North America.

The hatcheries have been quarantined, but the virus may already have spread into valuable Pacific salmon and steelhead stocks, alarmed fisheries experts say. The disease has previously infected European commercial

trout operations.

"The worse-case scenario is that every hatchery would become infected," Joseph Blum, director of the Washington state Department of Fisheries, said yesterday.

"The hatchery world throughout the U.S. has been put on alert. The word is out and traveling

quickly," said David Klinger, a spokesman for the U.S. Fish and Wildlife Service's regional headquarters in Portland.

The virus, which cannot be treated and is always fatal to infected fish, poses no risk to human health, even if a contaminated fish is eaten, according to

the state fisheries department. Two hatcheries, the Makah Hatchery near Neah Bay and the Glenwood Springs Hatchery on Orcas Island, are being disinfected. No fish or eggs can enter or leave the facility, said Klinger.

Coho, chum, fall chinook, and steelhead were destroyed.

The virus first showed up in December at Glenwood Springs, a joint private-state salmon rearing operation.

A short time later the virus appeared at the U.S. Fish and Wildlife Service's Makah Hatch-

See **VIRUS**, Page A7

Virus: Threat to hatcheries

From Page 1

ery on the Olympic Peninsula. But the virus was not positively diagnosed until last week.

The disease, called viral hemorrhagic septicemia or "VHS," has previously been reported only in continental Europe, where it has caused "significant fisheries losses" at commercial trout operations, according to the fisheries department.

Blum said a little over 300 million young fish and 60 million eggs are produced annually in the state. The fish and eggs destroyed this week would amount to about 1 percent of that.

"Obviously, it's a significant number of fish," said Klinger. And the Makah hatchery fish also are considered especially valuable because the hatchery is so close to the open ocean that the fish have a very high survival rate, he said. But the possibility that the disease might spread to other hatcheries is now the main worry.

Glenn Yokoyama, manager of the University of Washington's fish hatchery on Portage Bay, said if fish and eggs were transferred into or out of the infected hatcheries after the virus discovered but before the quarantine was put into effect, it would heighten the chances the disease would spread.

Bob Byrne, a spokesman for the state Department of Wildlife, said department biologists are concerned that the virus will

"The likelihood of this virus showing up someplace else at some point is pretty high," he said.

Top fish disease experts throughout the Northwest met in Medford, Ore., this week to discuss the virus and other matters, according to the state fisheries department.

The disease causes the blood-forming tissues of the kidneys to degenerate.

The disease could have been introduced by certain fish species, or by ships or travelers carrying contaminated water.

"The possibilities are bilge water from vessels or that people who travel worldwide pick it up on their boots, or that other fish could have it," Blum said. "My understanding from our technical folks is that black sea bass are a carrier. Atlantic salmon have been known to have it."

The new disease may well fan the flames of the controversy over salmon net pens and other aquaculture operations in the state. Opponents have insisted that net pens pose the risk of introducing new fish diseases, while supporters have downplayed the risk. The favored fish at net pen operations is the Atlantic salmon.

The state has 13 net pen operations, most of which raise Atlantic salmon, and a number of new ones are proposed.

Hatcheries in this state have been plagued by a virus for many years known as IHN. Since 1982 the UW's hatchery has had to test each egg and young salmon individually for the presence of IHN.

Senator Eliason

The recent articles commenting on the success of Norway's fin fish farming industry have ignored the high price that Norway has paid in fish diseases that have ravaged their industry and destroyed thirty of their wild salmon rivers, and the very real fears their scientists have concerning genetic pollution of their wild stocks of salmon.

Norwegian salmon farmers, in the business for twenty years, find themselves continually fighting new diseases that have required the slaughter of tons of pen-farmed salmon. A group of farmers, who lost their harvest either to furunculosis (a disease that kills 60% of affected stocks) or to government control of diseased fish, is suing the Norwegian government for \$25 million dollars. Farmers themselves are demanding that 100 more fish veterinarians specializing in disease control be hired before anymore fish farm permits are issued... those in addition to 60 fish disease specialists and nearly 150 fish veterinarians already working around the country.

Norway's use of antibiotics for controlling these diseases rose over 170% last year to reach 48 tons. This is more than the amount used for animal husbandry and humans combined. With our focus on health and nutrition how does this use of such large quantities of antibiotics affect our view of pen farmed salmon? Scientists have expressed concerns of effects on the food chain and the increase of human resistance to antibiotics.

Last summer in Norway 5,000 farmed salmon infected with the deadly furunculosis escaped into their waters. Despite their best efforts to blockade and capture the sick fish, an infected fish was found in one of their rivers. "If the disease spreads to natural stock, the situation may be out of control in Norway," their scientists warned. Studies by three Norwegian fish biologists conclude that disease in farms can

lead to higher infection rates of wild stocks in the vicinity of the net pens even if the disease itself may already exist in the natural stocks.

The fish farm disease that kills wild salmon in rivers and has destroyed 30 wild salmon rivers in Norway is *Gryodactylus salaris*, a parasite that entered Norway via infected smolts from Sweden. The only way to clean up the rivers is by the use of a chemical called rotenone. Unfortunately along with killing the parasite, it also kills every other

living thing in the river, including wild salmon. A top Norwegian scientist says, "I feel we are on a sharp edge with diseases. If we have the *Gryodactylus salaris* in more rivers we may just accept our wild salmon is extinct."

It has recently been suggested that one of the reasons that Alaskans might be interested in a pilot project in salt water would be to assess the probability of fish escaping. We don't have to experiment... it is documented. At least 13% of farmed salmon escape and there are occasionally very large numbers that escape. For instance, this last December in Jarvis Inlet, B.C. an estimated 300,000 fish escaped from their pens in winter storms and residents reported many net pens floating up and down the coast. Also, in Washington State, commercial fishermen have reported substantial numbers of escaped farmed salmon in their catches. Should these escapees concern Alaskans?

Svein Mehli, head of Norway's Directorate for Nature Management, which is responsible for protection of wild salmon, appeared in Washington State on December 14 as an expert witness on fish disease and genetic pollution. He testified that up to 40% of the fish in many of their rivers is now of farmed stock origin and says they are very concerned about the genetic effects of farmed salmon on wild stocks. "We are very afraid it could affect their ability to migrate," he said. Three major fisheries institutes in Norway have reported that escaped farmed salmon do spawn in rivers. In order to combat this threat, Norway has implemented new zoning regulations this year... **no salmon farms will be located within 20 kilometers of salmon rivers, and entire fjords will be closed to farming where salmon rivers are present.**

In Alaska, using indigenous species that would take at least three generations to tame (until they had lost their basic will to survive in the wild) and the resulting genetic pollution from escaped fish could pose the same threat. Although the magnitude of that threat would be related to the population size and density in individual streams, spawning escaped salmon would still be a danger, especially in streams with small populations.

Alaskans who imagine that we could control diseases better than other countries because we have a large hatchery system and would not be forced to import eggs or smolts need to examine the situation in Washington State

areas have overturned strict fish regulations banning the importation of foreign stocks at the economic pressure of fish farmers who find that native wild stocks are slow to domesticate and growth rates are not rapid. The already domesticated Atlantic salmon is the economic savior of fish farmers. Fish biologists were mystified at the reversal of their regulations and a Canadian biologist wrote that his government was playing "Russian Roulette with our wild fish stocks." That same economic pressure forced Norway to lift their ban on importation and the result was the *Gryodactylus salaris* parasite that has caused such a tragedy in their country. Acquisition of eggs or smolts from hatcheries or river systems is also a major public policy issue for Alaskans to consider. The only experimental on-land tank farm in Alaska acquired its eggs from a northern sport fish hatchery... that may be fine as long as the public, through the Board of Fish process, has an opportunity to comment. The demand for eggs in British Columbia has created conflicts between sport and commercial fishermen and fish farmers.

In Washington, a local fish farmer is now suing in U.S. District Court alleging that foreign national interests, primarily Norwegian, have made an attempt to monopolize the commercial farming industry in his state. 80% to 95% of the fin fish farming industry in both Washington and British Columbia is owned by Norwegian Corporations. Could Alaska escape such a fate? It's doubtful.

There seems to be a plentiful supply of pen-raised salmon these days... it's starting to go into freezers in Europe as well as being sold fresh. Alaska is presently the world leader in ocean ranching. The State's hatchery programs are responsible for at least 80 million dollars in resident income and 2300 resident jobs.

Last year's mariculture legislation, which addressed shellfish and aquatic plant farming, also called for an Alaska Mariculture Task Force to study the issues relating to fin fish farming (especially, salmon pen rearing). We believe that this Task Force should be funded now to give all concerned parties and the Legislature an approved forum in which to study and assess the impacts of fin fish farming on Alaska. Alaska contains 48% of the wild salmon in the world... we should not let the winds of economic development sway our way of thinking. It is imperative that we fully understand the consequences of our actions and protect the future of our uni-

information, contact UFA's office in Juneau at 586-2820 or 1-800-478-FISH. *

Editor's Note: This article was provided by the United Fishermen of Alaska, Mariculture Committee. For more

Excerpts



UNITED FISHERMEN OF ALASKA

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

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.

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

UFA shares the 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.

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 GUIDING businesses, who fear the "land-rush" of farms to remote areas will impair wilderness values essential for their success.

UFA shares the concerns of LOGGERS who will suffer restrictions on tow-boat traffic, log transfer facilities and rafting sites, and logging 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.

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.

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.

"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.*

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.

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 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

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.

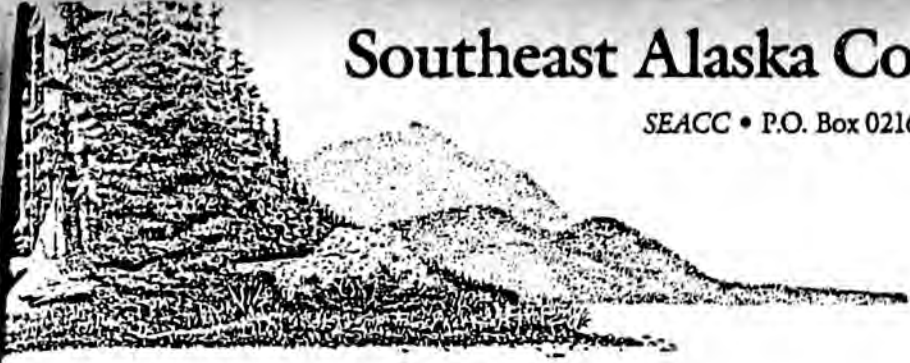
In addition, the B.C. fish farming industry is currently 65-90% Norwegian controlled. The largest fish farm in Washington has been recently purchased by Global Aqua, a Norwegian company.

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

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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.

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 • KACHEWAK 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.

UFA TESTIMONY TO HOUSE RESOURCES ON HB 432 MARCH 13, 1990

Good evening, my name is Sonja Corazza. I am co-chair of United Fishermen of Alaska's mariculture committee. We support this bill prohibiting finfish farming in Alaska. Our statewide newspapers have lately run articles on the competition Alaskan salmon is getting from farmed salmon. But salmon farmers are in a competition battle with each other and small farms worldwide are losing out to large businesses. B.C. farmers had a economic shake out this fall and large processing companies ended up the winners, buying out small farmers at 20 cents to the dollar. On some farms workers had not been paid in several months and finally walked off the job leaving hungry and dead fish for the Canadian government to dispose of.

Less well known is that Norway is in the same boat. It is estimated that for every fall in price of one Norwegian crown ten small farmers go bankrupt, and Norway is trying to curb new development. Last year Norway increased their production by 80% and ended up freezing a large number of fish. Chile, a country with extremely low labor costs and warm water temperatures is so productive they fear their industry is overcapitalized. We have strong wild runs and successful enhancement programs. Wild salmon as a renewable resource remains our best hope in these days of markets flooded with farmed salmon.

Wild salmon need protection of salmon streams and certain wetlands to survive. Unfortunately, many see salmon farming as a way to avoid protection of salmon habitat. We have a letter from a logging company in S.E. which explains the steps their company took to protect salmon streams but then goes on to say that it was all needless because "Norwegians can grow fish cheaper in bathtubs." He was wrong, Alaskan fish eat free & healthy meals in the North Pacific Ocean; the costs of growing fish are astronomical. How unfortunate some people think wild salmon and the environment are expendable if domesticated fish can be pulled out of tanks. To commercial fishermen, wild fish may be our economic mainstay but they are also a natural treasure.

We are concerned about the budgetADF&G is 1.5 million dollars underbudgeted now. We have commercial fisheries pouring hundreds of millions of dollars into our State and the State has not dedicated enough money to properly assess stocks or do research. We strongly feel that any newly funded money must go into these programs. While working on shellfish mariculture regulations SE shellfish farmers told me about leases that had not been checked in three years..empty logs holding mariculture permits. DNR said they did not have the personnel or money to adequately monitor

all the sites. NO TIME, NO MONEY, NO STAFF...that is the song of the resource agencies. How can anyone ask for funds to go into new programs that are very likely to be dominated by foreign corporations, when the cornerstones of Alaska's resident fisheries are being damaged by underfunding? Finfish farming would not produce any measurable economic benefits for at least five years from its start. The salmon fleet has a capital investment of \$800 million in vessels and onboard equipment and \$900 million in permits. Alaskan residents hold nearly 80% of all salmon permits. The salmon industry pays raw fish tax, license fees, and fuel taxes. Every year salmon fishermen in this state tax themselves \$4 million a year for our Ocean Ranching programs.

Egg surplus from hatcheries is a hot topic. A Department of Fish and Game report states, "The principle reason salmon smolts would be surplus to the common property fishery is that the present ocean ranching program is operating below capacity due to funding constraints." While other countries envy us our success and are trying to improve their own programs, Alaska is neglecting her own. In the fisheries world our biologists are famous and in Alaska we're putting them out of work. This past year there was a major shortage of chum salmon eggs in Southeast. Coho in the northern region of Southeast did not fare well. If a finfish farm had been looking for eggs this last year they'd have been in trouble. No one can assume that a large number of surplus eggs is available and from ADF&G's statement we must assume they should not be any surplus eggs.

If fish farming were allowed in Alaska with a ban on imports of eggs, the pressure to legalize egg imports would not stop because Pacific salmon is not economically profitable to raise. Last spring a company in Washington State destroyed 1,000,000 chinook fry because they would have lost money raising the fish to maturity and marketing them. The company switched to Atlantic salmon. Would future legislatures resist pleas of economic hardship due to an importation ban? Washington State and B.C. did not and now there are hundreds of thousands of escaped farmed salmon in their waters.

Salmon in Alaska are a common property resource which no Alaskan should take for granted. We may squabble over fish allocations but the public as a whole has fish to argue over. Salmon farmers want private hatchery rights...private ownership of one of our most valuable resources. We strongly believe that control of Alaska's egg supply should always remain under control of the State for the good of all the people. All anadromous fish in Alaska are fully allocated between commercial, sport, subsistence and personal use fishermen. If the State of Washington had not exported salmon eggs Chile would not be their competitors in the

marketplace. Nor would Japan have a chum salmon run. Washington gave away the goose that laid the golden egg. Alaska must not make the same mistake.

There is one strong opinion coming from Dutch Harbor that fin fish farming is the best thing since king crab. Dutch Harbor relies on bottom fishing (which is dominated by factory trawlers from Seattle) and crab stocks and herring. Salmon is not a critical issue for Dutch Harbor but it is the economic lifeline for the rest of Alaska's coastal communities.

UFA thanks you for your time tonight and we urge you to pass this bill. Thank you.

Sources of my information
are:

1. "1989 May Issue of "Fish
International Magazine"
(European)

2. Alaska Seafood Industry Study

3. Bill Heard - NOAA

4. FRED Report

ng gillnetters off 1990

Overall roe herring season on the bay
Nov. 29, 1989, when the first gillnet
designated XII set out to harvest its

Though the even-platoon members landed 1,640 tons in a two-day stretch in mid-January, they suffered slow fishing until going over the top on Feb. 5. Roe counts averaged 14.3% for evens, 13% for odds and 11.6% for the XH boats — all up from last season. "Some fish even hit

— Mick Kronman

April 1990

April 14-18 National Fishermen
**VHS disease appears
again in Wash. hatchery**

The virus, which has killed up to 90% of the fish at trout farms in Europe in the past, was detected for the first time in North America at hatcheries on the Olympic Peninsula and Orcas Island in Puget Sound in

The Lummi tribe says it will lead an effort to establish a research program to determine the source of the VHS in U.S. waters.

— Brad Matsen

West Coast Shake-out

Supply and demand tremors rattle B.C. growers.

by Peter Chettleburgh

THE SHAKE-OUT has begun. Sagging salmon prices, excessive debt, high interest rates and a worldwide glut of salmon have triggered a period of consolidation in the west coast salmon farming industry. On the East Coast where prices are firmer and farmers have been more conservative in their approach there is still a margin of profit, but it too is narrowing as prices continue to slide in the face of skyrocketing worldwide production (220,000 tonnes in '89).

Everyone said it would happen, but no one really wanted to believe it. On the west coast, where prices have been hovering at or below production levels for most of the summer, reality has struck home with a vengeance. The need for cash flow has caused many farmers to sell a lot of small pre-market fish for ridiculously low prices - 90¢ a pound was one figure this writer heard mentioned earlier this summer.

Since May we have heard of at least four west coast farms that have been put into receivership, another two that have been sold at fire sale prices and at least a dozen more which are in desperate need of working capital. Everyone else is holding on, praying for higher prices in the fall.

One of the big ones that went into receivership is the Fremstad Group which has four farms, a hatchery and processing plant in the vicinity of Campbell River. It's being handled by the accounting firm of Coopers

and Lybrand which was looking for a buyer as we went to press in August.

Triangel Resources near Tofino on the west coast of Vancouver Island found itself in trouble earlier this spring and was taken over by General Sea Harvest, an affiliate of the Finnish conglomerate, Cultor Ltd. (formerly Finnish Sugar Co.), the parent company of Ewos Canada. General Sea and B.C. Packers were also looking at the assets of Ross Passage Salmon Farm, another west coast operation which found itself in trouble earlier this spring.

One other company that is known to be in receivership is Seagrow Industries Inc. (400 tonne capacity) with two sites in Jervis Inlet. The receiver, Coopers and Lybrand, was still looking for a buyer as we went to press.

There were also some amalgamations before the current shake-up began. For instance, within the last year Five Fishes (Sechelt) and Nordic Ventures (Quadra Island) were purchased by B.C. Packers, the large west coast fishing company-cum-processor owned by Westons. Apparently B.C. Packers is on the lookout for other expansion prospects, but doesn't plan to walk into a situation unless all the biological criteria, etc. are just right.

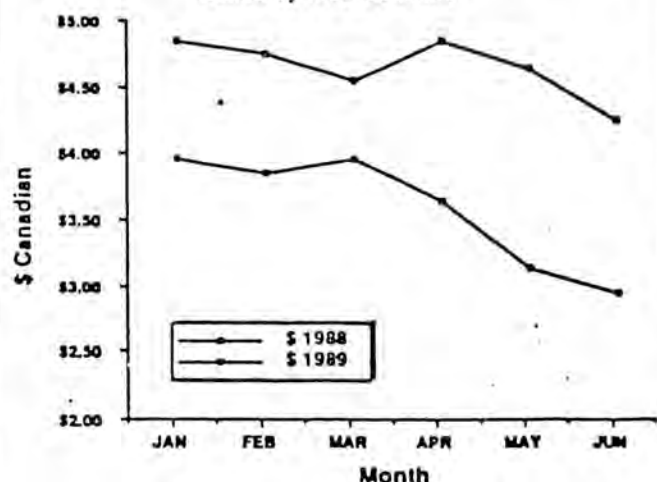
As a general comment, it can be said that the farms with some of the worst financial problems are in the Sechelt area. This is where the goldrush started in 1984

and it is the area that received a lot of the initial debt financing from Norway. Now the Norwegian financing has all but dried up and few investors are prepared to put additional

salmon farms at about \$250 million. And this does not include an additional investment of at least \$50 million in the supply and services sector (cages, feed, nets, etc.). Of this total in-

Fresh B.C. Salmon Prices 4-6 lbs.

Sales by first receivers



The graph above tells the story. The top line shows prices for B.C. farmed salmon (4-6 lbs.) during the first six months of 1988, while the lower line shows prices for the first six months of 1989. Prices are FOB Vancouver (Source BCSFA).

money into the farms because of their current debt structure. Adding to their woes are the growing conditions which many in the industry agree are not as good as those north of Campbell River or on the west coast of Vancouver Island. Indeed, some of the salmon farm sites may end up in the hands of oyster growers who are already lining up for a chance at leases that will probably turn out to be better for shellfish than salmon.

\$250 million investment

A recent estimate puts the total investment in B.C.

vestment, at least \$85 million has come in through Norwegian banks, much of which is now exposed to major losses, according to a recent report in a Norwegian newspaper.

Even for the smaller farms, those with debt in the neighbourhood of \$2-3 million, the debt servicing costs of 15-18% will skim off between \$300,000 and \$400,000 a year. That's a lot of fish, and a lot of debt relative to inventory, assets and equity, particularly in an industry that has yet to establish a solid production base.

>>>>

Problems for suppliers
Although the depressed prices are toughest on the farmers, the suppliers behind the scenes are also hit hard. Scantech Resources of Sechart folded in July after becoming one of B.C.'s major suppliers of fish farm equipment in just four years. President Clark Hamilton says that he lost everything in the failure but is still a strong believer in the future of the industry in British Columbia.

Another supplier which was hard hit was Powell River Net Loft which ceased doing any further work for the fish farming industry in June. The suppliers that are the most exposed are the companies which specialize solely in fish farming equipment and services for the B.C. market. They don't have the flexibility of companies that serve other industries or those that have national distribution.

What went wrong
It's small consolation that salmon farmers around the world are facing the same problems of overproduction and falling prices. Indeed, both the Scots and

a continued shakeout in the Norwegian smolt producing sector.
In British Columbia the problems seem even worse. Excessive debt financing, high jacking rates and high

producers who already arrived late in the world growth curve of farmed salmon production.
Glutted markets

As if this weren't enough, world markets are currently glutted with high inventories of frozen Pacifics, a legacy of an oversupply last year and ample reserves of fresh and frozen farmed Atlantics on world markets this year. Farmed Atlantics now take preference in most European and some North American markets, areas that were once dominated by wild Pacifics. Consequently, the price for both farmed and wild Pacifics has seen a dramatic fall since last December with farm gate prices for farmed chinook (6-9 lb.) dropping more than \$1.50 per pound to \$2.50 and lower for a while early this summer. (New Brunswick Atlantics (6-9 lb.) were wholesaling for about \$1.25 more per

"At the end of the day salmon farming will end up like other producing sectors with only the low-cost producers surviving."

Norwegians are taking a serious beating in Europe where production continues to grow at about 50% per year while demand is at about 25%. In Norway the Fish Farmers Sales Organization (FOS) has recommended holding the number of smolts going into the sea at about 50 million this season. This is to reduce production and maintain prices in the years ahead. One of the consequences, however, will be

mortalities from algal blooms and BKD have continued to chip away at profit margins. B.C. growers have also had to cope with a relatively new and untried culture species, chinook. It doesn't have the 20 year track record of the Atlantic species which the Norwegians and Scots have been able to use to their advantage on both the production and marketing sides. It's taken extra time and money for west coast

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pound than B.C. chinooks of the same size mid-summer, while Norwegian Atlantics were about 50¢/lb less than the New Brunswick product.).

The depressed market conditions came at a particularly awkward time for B.C. growers. The 60 or so companies that started operations within the last four years are at a stage of maximum investment, everything's out on the line, but as yet they haven't had a good chance to make any major earnings and reduce their debt. And now, with salmon prices the way they are, you can be sure that any fish under 4 pounds is being sold below the break-even point.

The worst part is that there aren't any major miracles expected in the near future. Though there should be a modest price rise when the wild-catch season ends this fall, a significant jump in farm gate

World's shrimp producers face same problems

Shrimp producers in southeast Asia are facing the same slide in prices that hit salmon farmers this year. According to a recent article in *Aquaculture Digest* (July 25, 1989) the pond-side price for giant tiger shrimp fell from \$8.50 to \$4.40 per kilo in Taiwan last spring and only recovered slightly during the summer. Taiwanese production costs are about \$5.00 per kilo.

Once again the main culprit is a hyper-active production sector trying to sell product into already-glutted markets. According to *Aquaculture Digest* the winners in the shrimp game are likely to be the low-cost producers in China and Indonesia while the losers are going to be the high-cost, intensive shrimp farmers of Taiwan, the Philippines, Thailand and the rest of the world. Commercial shrimp fishermen will also have problems remaining competitive in the years ahead, the article adds.

prices is not likely since the ever-increasing supply of farmed product from Norway, Scotland, Chile and Ireland is flooding markets in Europe and Japan, and making serious inroads into adjacent turf in the United States. It's a classic case of supply and demand

theory in action and will only be stabilized by market expansion, strong promotional efforts, more efficient production techniques and well organized selling.

Who will survive?

The farms in the best position are those with the

least debt, highest efficiency and deepest pockets, all linked to an efficient means of selling their product. The big integrated national and multinational companies are in a strong position. They can benefit from profits in several segments of the production, processing and distribution chain.

But there is also a future for independent farms if they can maintain a low cost of production. To do so they must run a lean operation, maximizing growth rates, while keeping feed wastage and equipment purchases to the minimum. They will want to have the least expenses possible and get the best prices they can for their product by pursuing niche markets.

Production costs are hard to pin down, but estimates run between \$2.50 and \$3.50 a pound farm gate depending on the site and

... Please turn to page 48

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W. C. SHAKE-OUT

Continued from page 23

what costs are included. This means that in mid August, with farm gate prices hovering at about \$3.00 per pound, B.C. farmers could make a modest profit if they were operating on the lean side or could be losing up to 50¢ a pound if they were on the high side. Unfortunately, for many of them there was no choice but to sell chinook and coho that were starting to mature. A couple of farmers were seriously looking into the possibility of establishing U-catch'em pens catering to wealthy U.S. yachtsmen.

Key to success

One of the most important keys to success in the years ahead will be management. As aquaculture consultant Ted Needham pointed out in a recent issue of UK-based *Fish Farmer* magazine "... every farmer has to find out what his rearing costs really are. ... he can only do this if he works to proper budgets with monthly cash flows projected over two years and updated at least quarterly. All forecasts of fish growth should be based on what has been achieved to date

rather than on some hoped-for improvements." Needham's advice is as sound here in Canada as it is in Scotland. The margin for sloppy record keeping slipped away sometime last winter.

What is the outlook?

Is there any light at the end of the tunnel? Depends on who you talk to, but with another 50,000 tonnes projected to come onto world markets next year (275,000 tonnes total) there's not much hope that prices will again reach 1988 levels.

Who are the consumers?

Who's going to eat all this fine, fresh fish? The European market is nearing saturation and what's left will probably go to Scottish and Norwegian producers. The Japanese market is still available but it takes work to penetrate and, once again, the canny Norwegians are already in there, picking up what the Japanese can't produce for themselves (domestic farmed salmon production for Japan is estimated at about 25,000 tonnes of coho this year). The most accessible market left is our big, convenient neighbor to the south and there's still lots of opportunity there

if the Canadians will make a serious effort to go after it. Marketing and distribution are pivotal. It will take a concentrated, cooperative effort on the part of all Canadian producers of both wild and farmed fish.

At the end of the day salmon farming will end up like other producing sectors with only the truly low-cost producers surviving. They will sell their fish in a well disciplined market where demand will determine the production that is planned and financed. But at this point not even a prophet could say how long the restructuring will take and who the survivors will be. Ω

FRANK SIMON

Continued from page 42

The intense competition in the salmon business doesn't worry Simon either. "There is always room for a producer who's doing things right," he says. "We want to differentiate ourselves on the basis of quality. We believe that if we do everything right, we'll have a prominent position in the market." Ω

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MIX AND MIS-MATCH

Genetic pollution is the most invidious consequence of the escape of farmed salmon, argues Richard Douthwaite, who fears that the mating of farmed with wild fish may eventually eliminate our native stocks

On 9 February 1988 a storm of unusual ferocity hit the west coast of Ireland and swept across the country, leaving a trail of destruction in its wake. In Clew Bay on the Atlantic coast winds were so severe that farmers went down to the beaches the next day with their tractors and collected large quantities of dead fish. It was no surprise that two salmon cages moored in the bay broke up, releasing more than 30,000 fish into the open sea.

It is not always the weather which is to blame for fish farm escapes. One moonless night a few months before the storm, two men in a rowing boat cut the nets of 12 salmon cages moored in Mulroy Bay in Donegal. Almost 10,000 fish, worth £100,000, got away and the farm recaptured less than a quarter of them. The raiders' motive was to catch the escapees in their drift nets and then sell them.

Only recently has concern been expressed about the effects that these escapees might have on wild

salmon stocks. Perhaps the matter should have been addressed earlier. The first Scottish attempts to rear salmon in cages were made in the late 1960s and it was as long ago as 1981 that Scotland's output of farmed salmon exceeded its wild catch, with Ireland reaching that position about four years later.

Today the problem is so large it cannot be ignored. Scottish farmed output is expected to be 54,000 tonnes in 1991, about fifty times the size of the wild catch, and Ireland hopes to produce 15,000 tonnes that year. There is so much salmon in cages at sea that if only two or three per cent break free in any year, they will substantially outnumber the native stock.

Escapes would not matter if the freed fish were genetically identical to those born in the rivers up which they swim. However, this is rarely the case. The salmon in each river – even sometimes in the carrier streams – are unique strains which have evolved in the ten thousand

years since the ice sheets retreated. In most cases escapees will not be of that strain. There are 400 distinct stocks of wild salmon in Scotland, according to a report produced last year by the Scottish Wildlife and Country Link. It also states that wild salmon transferred from one river to another perform less well and have harmful effects on the native stock.

Farmed fish are increasingly being bred, like pigs and cattle, for characteristics which suit life in captivity rather than in the wild. Consequently, if escapees enter a river and mate with wild fish, they will pass on genes which tend towards placid behaviour, late sexual development and more rapid growth. Cross-bred young are therefore less likely than pure-bred natives to survive in the sea and return to the river as adults.

Even if farmed fish turn up in a river but mate with each other rather than with the wild fish, the effects are still adverse. They will

Genetic pollution is not the only threat which fish farming poses to the survival of wild salmon. Disease organisms and parasites multiply rapidly in the confined conditions of a salmon cage and from there they can easily migrate to affect other fish. It is for this reason that salmon farmers become wary if another farm establishes cages within a few miles of their own, which is why whole rivers in Scotland are allocated to one firm.

Now it appears in farmed salmon an every year Pancreas disease an Ireland in 1984

after occurring first in Scotland in 1976. Seventeen of the 21 farms in Ireland now have it and output is consequently down by 25 per cent because of deaths or stunted growth.

The most worrying disease appeared only last year, in Norway: Salmon Anaemia Syndrome kills 80-90 per cent of young fish. Again, its cause is completely unknown.

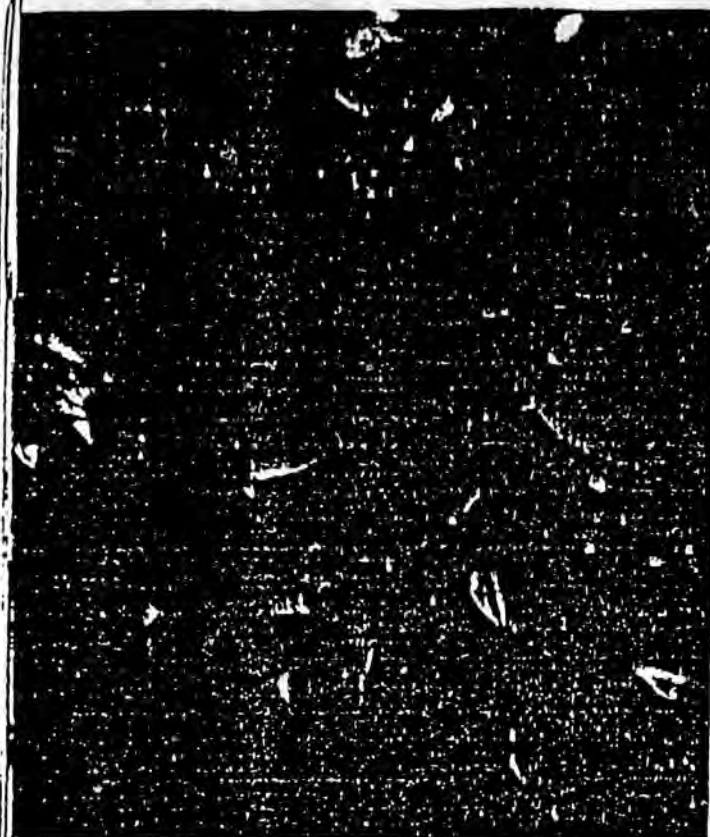
In spite of the threat that diseases present both to their own and to the wild stock, some fish farms are their own worst enemy. In Scotland dead diseased salmon are

known to have been dumped at sea rather than incinerated on land, spreading pathogens far and wide.

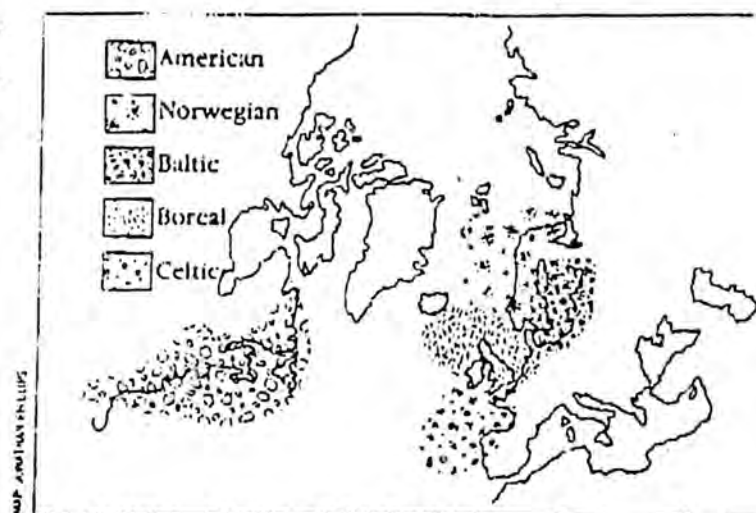
There are also two dangerous parasites. One is a tape worm which uses the edible mussel as an intermediate host, then moves on to affect wild fish. The worm weakens wild salmon, rather than killing them directly, lessening their ability to return up turbulent rivers to their spawning grounds and also making them more vulnerable to disease.

The second parasite is a flatworm, *Gyrodactylus salaris*, which has completely wiped out stocks of

wild salmon in 28 rivers in Norway. It was accidentally introduced when farmed fish were imported from infected hatcheries and put out into freshwater cages. The pest attacks parr – young salmon which have not yet developed the physical features that allow them to live in the sea. It is the most serious threat to Atlantic salmon in Norway today, says Rear Admiral D.J. Mackenzie, director of the Atlantic Salmon Trust, Pitlochry. The only cure so far is a drastic one – to poison any remaining salmon in the river and then restock with uninfected fish.



Previous page: grilse from the Spey.
 Above: fish jostle for food in the confinement of the cages. Right: distribution of the main races of Atlantic salmon



Although fishermen have known for hundreds of years that salmon stocks differ from river to river, scientists have only confirmed this belief within the last 20 years. Using a technique called electrophoresis they can analyse the proteins with which each fish is made up with great precision.

The first finding revealed by this technique was that there are five main races of Atlantic salmon, four of which share a common feeding ground off western Greenland. The Baltic salmon is the exception, feeding as an adult in the sea which gives it its name.

The second finding was that salmon vary genetically to a surprising extent from river to river, even within the same race. Dr Tom Cross, now of

compete with the natives for spawning areas and their young will compete for food. As a result, fewer native fry may survive to set off for the sea as smolts and consequently fewer adult natives will return after a year or more to complete the reproductive cycle. (A young salmon passes through fry, parr, smolt and grilse stages before becoming a mature adult.)

The situation is so serious that regular escapes from farms could eventually wipe out all native salmon. Research in Norway, where salmon have been farmed for much longer than in Scotland or Ireland, shows that in some rivers up to two-thirds of the fish are already of the farmed variety. 'If genetic pollution continues at its present rate, the hereditary variations of some of the river species will be halved within seven years,' says Professor Harald Skjervold whose research findings in this field all point to this alarming conclusion.

Any experienced salmon fisherman will confirm that salmon stocks vary from river to river.

'Some are early rivers where large salmon enter in the spring,' says leading salmon geneticist Professor Noel Wilkins of University College, Galway. 'Other rivers have significant runs only in late summer, when the returning fish are smaller and younger. Some rivers are noted for the fine shape of their fish, others are not.'

Andrew Young, who managed the fisheries of the Duke of Sutherland more than 130 years ago, knew why this was: 'Each river has its own peculiar race of fish,' he wrote. 'We have now shown that salmon undoubtedly return to the river where they have spawned and where they belong to the race of fish that inhabit that particular river.' Professor Wilkins agrees: 'Salmon return to their own river with amazing accuracy and mating occurs predominantly between individuals who were born in the same river system.'

It is this inbreeding which has allowed the different strains to develop. In some rivers a higher proportion of fish come back after two or more winters at sea than after one year as grilse. Thus, if all the smolt are killed by disease or pollution one year, others are left to return to the river the following year to spawn, giving a chance for numbers to recover.

Fish farmers are deliberately trying to eliminate this characteristic: what they want are fish with a low grilse rate, because it is more profitable to produce bigger fish which spend two winters in the sea than smaller fish which spend one. Norwegian salmon fit this bill and consequently their eggs have been widely used in Scottish and Irish hatcheries instead of the native strains. Farms also want their hatched fish to be ready to go to sea after one year in fresh water - it is obviously uneconomical to keep them in freshwater cages for an extra season. But again, in the wild, a stock in which some fish go to sea after one year and some after two has a better chance of surviving than one which does not.

Then there is the question of homing. Tagging experiments have shown that a higher proportion of wild fish return to their native rivers from the sea than do hatchery-bred fish released as fry into streams other than those from which their parents came. However, if any introduced fish which do return are caught and mated, their young will show a better return rate, which will

University College, Cork, examined fish from the Bandon and Munster Blackwater rivers in the south of Ireland and found significant differences in their liver enzymes even though they were both of the Celtic race and the river mouths only 80 miles apart. Dr Cross repeated his tests with Boreal fish from the Moy and Carrowiskey in north-west Ireland and found the Carrowiskey fish very different again.

The differences that exist between salmon from different rivers, says Dr Cross, 'are due to the small population sizes and the fact that they have been apart for 5,000 years. How important the differences are to survival, we cannot say. I think we ought at least to keep the different races apart.'

• Contrary to claims by B.C. salmon farmers that salmon egg transfers pose little threat to wild stocks, an Atlantic salmon advisory body has advised extreme caution to avoid disease and genetic problems.

Report sees genetic threat

"None of the benefits of transfer of young Atlantic salmon and salmon eggs into Canadian waters outweigh the threats to native stocks," says a top body of Canadian fisheries scientists.

Fish farmers, the B.C. government and the federal fisheries department have allowed major imports of Atlantic salmon to Pacific waters, claiming they pose a minimal threat to wild stocks. The imports are scheduled to end in 1989.

But a review of egg imports by the Canadian Atlantic Fisheries Scientific Advisory Committee in 1986 warned that "there are unpredictable genetic risks associated with transferring European salmon stocks to North America and the potential benefits to Canadian aquaculture interests may be low."

CAFSAC is a top scientific advisory group which provides background information for Canadian representatives on international bodies studying conservation of Atlantic salmon.

Its conclusions go a long way to support the call issued by the UFAWU in May demanding a halt on any movement of salmon eggs and smolts, particularly Atlantics, until protection of wild stocks can be assured.

The CAFSAC scientists concluded that most of the benefits of imports accrued to the aquaculture industry because "it could allow the industry to expand as quickly as possible (and) it could be cheaper than purchasing local seedstocks."

In the long run, they said, it would "encourage the multinational nature of the aquaculture industry by allowing surplus seedstock in one country to be moved to another country."

But the imports carry the risk of disease, they warned, pointing to the Norwegian experience with the parasite *Gyrodactylus salaris*.

"Although the Canadian Fish

Health Protection Regulations are considered among the best fish disease control mechanisms in the world," they wrote, "they are not infallible, a fact which, along with the large number of potential pathogenic organisms that are not considered under the Canadian regulations, makes the likelihood of an unwanted pathogen or strain of pathogen entering the country with fish from a certified (disease-free) source a very real possibility."

The CAFSAC report is part of a longer study by the North Atlantic Salmon Conservation Organization, a Scotland-based body supported by Atlantic salmon-producing nations.

B.C. salmon farmers have been enraged by UFAWU calls for controls to avert genetic pollution of wild stocks by farmed fish, claiming such pollution is unknown or unlikely to occur.

But NASCO warns that importation of European Atlantics to Atlantic Canada "provide risks of undesirable impacts on North American Atlantic salmon stocks."

"There are new disease or strains of diseases which may be introduced, also hybridization with North American stocks could result in loss of genetic diversity and reduced productivity."

NASCO concluded there is "an urgent need to develop new techniques to study the effects of hybridization, e.g. potential impacts of genetic impoverishment resulting from 'domesticated' or genetically engineered Atlantic salmon stocks (cultured salmon) spawning with wild stocks and hybridization of different strains of wild stock."

NASCO recommends that until definitive measures are in place to protect the genetic integrity of wild stocks, aquaculture projects should:

• use stocks originating as closely as possible to the project area,

• use sterile fish,

• establish "river preserves where no transfers or hatchery stocks is allowed in order to maintain the genetic integrity of some wild stocks; and

• manage stocks to ensure they are not reduced below a minimum size.

The Fisherman 7-15-88

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Algae, disease, low prices hammer B.C. salmon farmers

British Columbia's fish farming industry, wracked by collapsing prices, disease, algae blooms and bankruptcies, is facing a major corporate shakedown.

Despite continued assurances by industry leaders that all is well, signs of trouble include:

- ★ a rash of receiverships affecting about 12 farms and three companies;
- ★ devastating algae blooms throughout the Strait of Georgia which have wiped out some farms and crippled others;

★ industry agreement that the Sunshine Coast, the scene of a salmon farming goldrush only three years ago, may see an exodus of operations to colder, algae-free waters; and

★ continued low prices which are driving down wild salmon prices and forcing more producers to the wall.

The most visible problem has been the algae blooms, which sweep in on hot, calm days and suffocate salmon in their pens within hours. Persistent low levels of algae are believed to contribute to stress and disease.

Losses to various diseases continues to be high on many B.C. farms, according to industry publications.

According to the *Sechelt Press*, a plankton bloom during the Labor Day weekend wiped out five farms, severely damaged five others and destroyed 300 tons of salmon worth about \$2 million. The regional dump, which was to be closed to farm waste Oct. 20, was opened especially to handle the emergency.

Farms in Agamemnon Channel took the brunt of the assault, but the entire

region was affected. Local fishermen heard radio chatter from farmers seeking some place to dispose of the sudden large volumes of dead fish.

Professor Larry Albright of Simon Fraser University told a public meeting on the impact of fish farms later that month that the entire Strait of Georgia is so infested with the algae that farms will be removed from the area completely.

Meanwhile, prices continue to drop, heading below \$1 a pound according to some market reports. The break-even point is estimated to be around \$2.25 to \$2.50 a pound level.

The crunch of falling prices, provoked in part by aggressive marketing by Norwegian producers, is hitting farms hard in many areas.

Coopers and Lybrand, receiver for three firms put into receivership by secured creditors, reports continued financial problems for farms in the Campbell River area.

Eric van Soeren, receiver for North American Salmon Corp., operator of six sites around Quadra Island, and Sea

Grow, with operations at Nelson Island, said Sept. 19 that new buyers had not been found.

But both firms were thrown into receivership by Norwegian banks seeking to slow their losses on loans to B.C. producers. Now van Soeren is seeking a buyer for Atwood Bay farm near Desolation Sound and expects a busy fall with other troubled firms. He would not disclose who is buying the farm.

As a result of the chaos, the normally boosterish industry is shying away from an optimistic DFO analysis of the industry which predicts production could hit 80,000 to 100,000 metric tons by the year 2000.

Product of 50,000 tons is very realistic, the Price Waterhouse report claims. But industry spokesmen believe that disease and other problems will keep them in the low-growth range of about 20,000 tons until the turn of the century.

(Ed: The above article was reprinted with permission from *The Fisherman*, Geoff Meggs, Editor)

Fish farmer sues foreigners

A Washington state fish farmer and his corporation have sued in U.S. District Court alleging that foreign national interests have attempted to monopolize the commercial fish farming industry in his state. Lee A. Holley III of Lopez Island in northern Puget Sound alleges in his suit that foreign business interests, primarily

Norwegian, operated through American national fronts to destroy competition in the industry, remove local control and violate antitrust laws.

Holley, owner of Northern Nights Fish Farms Inc., is suing several Norwegian corporations that have either sole or partial ownership of farms in Puget Sound. Also named in the suit are state officials and other individuals who allegedly contributed to illegal activity. Holley charges that large financial contributions were made to state political campaigns by the foreign interests, which, he says, also assisted in defeating a moratorium proposed against new businesses in San Juan County, where Holley lives.

Comments from the Norwegian companies and state officials were being withheld pending litigation, according to several reached by telephone.

— Brad Matsen

The Fishermen January 25, 1989

Fish farm drug hits wild stock

Fishermen harvesting shellfish off Scotland say a chemical used by salmon farmers is killing marine life.

Scientists at Aberdeen University have linked the chemical with increasing numbers of wild salmon going blind.

The controversy has erupted over Nuvan 500, which farmers use to control pests. Its byproduct, dichlorvos, is listed by the 1987 North Sea Conference as one of 26 most dangerous chemicals in waterways.

The debate highlights the severe problems salmon farming disease treatment can pose for

the marine environment and other marine life.

According to the *London Observer*, in a report on its wire service Jan. 11, scientists at Norway's Institute of Marine Research in Bergen have found the chemical could be damaging sensitive lobster and crab larvae around the farms. Mussels and oysters also absorb the chemical.

Nuvan is strictly controlled on land, but salmon farmers have easy access because they are not subject to the same regulations.

Fishermen and environmentalists are demanding a ban on Nuvan, but farmers say they will

be decimated by sea lice if Nuvan is taken from their arsenal. They favour voluntary controls.

Nuvan is not registered for use in Canada, meaning it is unavailable. Valery Brooks, of the B.C. Salmon Farmers Association, said sea lice are not a problem in this province, but a special session on lice is scheduled for an aquaculture conference in Dartmouth next month.

Scientists there have concluded that sea lice threaten the viability of salmon farming in Atlantic waters and 90 percent of farms must use treatments to control the parasite.

Puget Sound anglers hooking Atlantic salmon

by Brad O'Connor
Times staff reporter



Steve Loop caused quite a stir in June when he showed up at Seacrest Boathouse in West Seattle with a 5½-pound Atlantic salmon he'd caught while fishing for blackmouth near the Southworth Ferry landing.

Atlantics are not supposed to be swimming around Puget Sound and it was only the second Dave Nelson, Seacrest manager, had seen in his 17

years at the boathouse.

Atlantics — 1 million or more of them — are in the Sound, but all are supposed to be confined to net pens where they are reared by private growers for markets mostly in the south, the East Coast and California.

Loops' Atlantic was an escapee.

Since June, Nelson has weighed about a dozen others, all caught on hook and line, which is remarkable. While Atlantics provide some of the world's greatest freshwater sports fishing, they rarely are caught on sports gear in salt water.

"Ponder this," said Nelson, "if we've seen a dozen here, there must be many, many more swimming around out there."

He's correct. There are more.

Will Sandoval, biologist for the Muckleshoot Tribe, said his tribal fishermen have told of netting several Atlantics during summer and fall salmon seasons.

"Some told of catching three or four a day," he said.

Three that Sandoval checked during a state and tribal test fishery for sockeye in July were approaching sexual maturity.

"What concerns me is that they may have been looking for somewhere to spawn. Even if they can't spawn successfully, there's a risk they could be carrying some exotic disease."

Decades ago, attempts were made to establish spawning runs of Atlantics in Washington and British Columbia. All failed and the belief among some fisheries scientists is that further attempts to establish Atlantic runs on the West Coast also would fail.

In fact, most fisheries managers nowadays shudder at the thought of Atlantics spawning in any West Coast stream — not only because of the risk of disease, but because of increased competition for food and space with native trout and salmon.

Reports of Atlantic catches are funneled to Lee Hoines, a Department of Fisheries biologist at Olympia. Of the 203 reported to him last year, most were caught by commercial fishermen in the Bellingham area and around the San Juans.

However, two were caught in fresh water,

on the Nooksack River and another in July in Cedar Creek, a tributary of the Nisqually.

What if they did spawn successfully?

"My assumption is that they can't. I can't say that absolutely is the case, but I hope they don't," said Tim Flint, another WDF biologist.

De Yonge was right on fish-farm perils

By Arthur H. Whiteley, John W. Brookbank and Annamaria K. Johnstone

In his article (P-I Op-Ed, March 29), State Land Commissioner Brian Boyle took severe exception to John de Yonge's March 5 Focus Section article on fish farms.

We believe that de Yonge's pithy comments were right on target.

Boyle argues against relating fish-farm pollutants to untreated human sewage. In terms of organic sludge whose combustion consumes dissolved oxygen from the water, and loading of the water with various nitrogen compounds and phosphate which act as fertilizers, the two pollutants are essentially alike.

The question of dilution of these discharges is relevant.

Metro's West Point Wastewater Treatment Plant dumps its soluble discharge into the main channel of Puget Sound at considerable depth, permitting dispersion. Fish-pen wastes are deposited on the site as feed pellets and feces, which settle as sediment and dissolved components that enter the water column. The sites are channels or embayments with restricted water flow, not rivers, with a one-way flow that flushes things away. Tides flow and ebb and currents in bays create eddies, leading to retention and accumulation of the pen wastes.

Metro sewage must undergo treatment, at substantial and justified expense to our citizens who create this waste. Discharge is monitored by a permit, mandated by federal Clean Water Act. The fish pen solid waste enters the bay raw, untreated, without disinfection — and free to the fish farmer. Washington's pens have avoided the federal discharge permits, although the Sierra Club Legal Defense Fund threatens the state with legal action if this requirement is not enforced.

real, just as it has been in Norway.

Boyle's understanding of the *Gyrodactylus salaris* issue in Norway is at variance with reports from Dag Dolmen of the Directorate for Nature Management in Trondheim. This trematode parasite has been introduced into Norway, according to Dolmen's analysis, "through stocking with salmon parr from infected hatcheries/fish farms." Johnson and Jensen report that total salmon catches in infested Norwegian rivers (1970 to 1984) dropped to 16 percent of levels in uninfested rivers. These were mostly wild fish, which have been nearly decimated by a parasite spread through "hatchery/fish farm" stockings. The smolts that are stocked in salt water fish farms are reared as fry in fresh water hatcheries.

In November, Svein Mehli, head of the division of the Directorate for Nature Management concerned with protection of wild salmon in Norway, testified for Skagit County before the State Shorelines Hearing Board. Mehli reported the escape into Norway waters of thousands of pen-reared salmon carrying furunculosis, the appearance of bacterial kidney disease in farmed stock, the presence of redmouth disease in 300 salmon pens — a disease previously unknown in Norway — and of his concern about "other diseases knocking at the door." Given these facts, we disagree with Boyle's position that "environmental arguments against fish farms are essentially specious."

Boyle objected to de Yonge's extrapolation of the targeted 100 fish pens to the sewage equivalent of Seattle's sewage outfall — as "scientifically absurd." But Boyle can find a graph on pages 133 and 134 of the draft Programmatic Environmental Impact Statement to which he referred that shows that 100 pens will load Puget Sound with biological oxygen demand (organic sludge) 150 percent higher than that of the West Point plant, and add an amount of dissolved nitrogen to the embayments equal to that from this sewage plant. We think de Yonge stated things correctly.

In Norway, which has much smaller farms than are permitted here, pens are moved every couple of years, to try to mitigate environmental problems. Moreover, they are located closer to the open water at the mouth of fjords. In some regions, alternate fjords are kept free of pens to create security zones between sites.

Atlantic salmon can become diseased in their pens and they do escape. This year commercial fishermen have recorded many Atlantics caught along with native salmon south of San Juan Island and between Bellingham and Point Roberts. Escaped Atlantics have been picked up in the Nooksack, Skagit and Nisqually rivers. These are adult fish, apparently ready to breed. We feel that there remains a possibility that they will breed, that they will become established and that they will compete on the breeding grounds with native salmonids — how successfully neither we nor Boyle knows yet. The presence of potentially diseased pen escapees among breeding natives poses a danger that in our opinions is

Boyle must be well aware of the current concern about appearance of viral hemorrhagic septicemia (VHS) in resident salmonids and doubtless has seen the U.S. Fish and Wildlife Service summary of March 3, 1989, which reports that this virus is confirmed in yearling coho and steelhead trout and fall chinook salmon fry from the Makah hatchery. We assume that he is aware of the opinion from the U. S. Fish and Wildlife Service that the logical, though not proven, avenue for entry of this new disease is via Atlantic net-pen culture. If these are proved to be "specious arguments," then we can drop them.

Is it fair for "the working stiffs" on the gillnet boats, purse seiners and reef boats — white and Indian alike — to be crowded off their fishing grounds, or worse, to have their resource diminished? Should clam growers, who have husbanded their rich resource for three generations, be forced to contend with pollution from a fish pen?

In order to generate new jobs and revenue, a wiser course for our state would be to accept the mitigation measure in the draft EIS — to culture salmon in tank farms. These should be on privately owned land with effluent monitored and regulated by permit and then discharged into deep water. In this way the negative impacts of floating mariculture — navigation hazards, storm-caused breakup of pens, dissemination of disease, release of untreated wastes, difficulties with antibiotics and impairment of aesthetics — would be eliminated. Lastly land-based fin-fish culture would place the costs of this industry on those who profit from it.

■ Dr. Arthur H. Whiteley is professor emeritus of zoology at the University of Washington; Dr. John W. Brookbank is professor emeritus of microbiology and cell biology at the University of Florida; Dr. Annamaria K. Johnstone is a marine microbiologist. Soapbox columns are contributed by readers.

Donna Pliner

Additives to the Environment of Net-Pen Reared Fish
Pacific Marine Fisheries Commission 42nd Annual Meeting
Seattle, Washington, October 16-18, 1989

PHD Arthur H. Whiteley and Annamarie Johnstone

We have been asked to address our remarks to the matter of additives to the environment of net-pen reared fish. In this particular forum, we assume the emphasis should be on additives that may have an impact on humans when these fish come to market, rather than the impact on the plant and animal communities in the natural environment, though these are not wholly separable.

By its very nature, net-pen rearing of salmon requires the use of numerous chemicals, sometimes in large amounts, some used in the fresh water hatcheries to produce the fry and smolts, some used in the grow-out period in the marine pens, and others used during processing of the fish for the market. Partial lists are shown in Table 1, compiled from Austin and Austin, 1987, from a 1988 report for the Nature Conservancy Council by the University of Stirling, and from other sources.

The lists include chemicals used in salmon and in other forms of fish culture, both in this country and in foreign countries. Inasmuch as farmed fish are imported from some of these other countries, inclusion of these chemicals in the lists may be relevant to the matter of seafood surveillance in the United States marketplace.

Chemotherapeutics. The most relevant additives for present purposes are antibiotics and therapeutants used to control bacterial diseases. Because of stress, disease may cause losses of 30-40%, sometimes higher. Diseases in salmon farms include *Vibrio anguillarum* (vibriosis), *Aeromonas salmonicida* (furunculosis), *Aeromonas hydrophila* (hemorrhagic septicemia), *Yersenia ruckeri* (red mouth), *Vibrio salmonicida* (Hitra disease), *Renibacterium salmonarum* (bacterial kidney disease). To combat these diseases, medicated food containing antibiotics is supplied. In Washington, the FDA approved antibiotics and therapeutants are oxytetracycline (OTC), Romet 30 (sulfadimethoxine and orhomprim) and sulfamerazine. In addition, Tribissen (sulfadiazine and trimethoprim) is used in Norway and Scotland, and in British Columbia erythromycin is used to control BKD. In Japanese fish culture a wide variety of antibiotics has been used, but has recently restricted the use of chemotherapeutics in cultured fish (Aoki, 1988, pers. comm).

In the US, Norway, BC and Scotland, doses of drugs are as indicated in Table 1B. It is anecdotal, however, that additional amounts of antibiotics are used by farmers, who may mix the drugs with feed and binders. Control of use of antibiotics in Norway and Scotland is regulated by veterinarians, and this is supposed to be the case in R.C. In the British Isles it is apparently easy to find legal loopholes to permit other antibiotics and doses to be used (Austin and Austin, 1987). In Washington fish farmers are supposed to notify the Department of Fisheries if they use antibiotics, but veterinarian supervision is not required. Generally approval exists for only therapeutic use of these

drugs. Nonetheless they often are used prophylactically inasmuch as sick fish may not take the medicated food.

There appears to be no medical or public health supervision or regulation here, or in the other fish farming countries, on the use of antibiotics and chemotherapeutics other than the requirement of FDA approval of the three drugs and their dosages. There appears to be no monitoring by agencies of the use of these drugs or their persistence in marketed fish.

The amounts of drugs used are enormous. In Norway last year, 48 metric tons (105,000 lbs) of OTC alone were used - more than in animal husbandry and human health uses combined (Mehli, 1988, pers. comm. and press accounts). This figure has grown from 13,691 lbs in 1984 (Midtlying, 1985). The 1984 figure for Tribissen, nitrofurazolidon and sulfamerazine is 30,204 lbs (Midtlying, 1985). Comparable figures for British Columbia and Washington are not at hand. Assuming the dosages cited earlier for the 13 Washington pens, calculation leads to a first approximation of about one ton of OTC, a figure similar to that given by a Washington fish pen operator (Dr. A. Bill, 1989, pers. comm.).

The relevant issue here is "Do these uses affect man?" Consumers clearly would be exposed to residual antibiotics in the fish meat. Because of the potential for these residues producing a serious problem in public health, Japan has recently restricted the use of chemotherapeutics, and does not allow cultured fish to move to market if residual drugs can be detected in fish meat (Aoki, 1988, pers. comm.). The potential for adverse effects has been emphasized by Austin (1988, conference in Vancouver, B.C.; Austin and Austin, 1987). The current regulations for control of such residues are based on admittedly minimal research. The FDA requires a 21 day withdrawal period after the last medicated feeding of OTC and 42 days for Romet 30 before slaughtering for the market. In B.C. the withdrawal period is 42 days, and in Norway 61 days. Very few data exist for measurement of persistence of these drugs in fish flesh after feeding. McCracken et al (1976) measured the presence of trimethoprim in trout muscle 77 days after medication; Salte and Liestøl (1983) calculated that the withholding period for trout receiving OTC should be 100 days at winter temperatures, and for Romet 30 they recommended withdrawal periods of 60 days, above 10°C. All authors emphasize that temperature is a seriously complicating factor - residues of Romet 30 persisted for several months in fish at colder temperatures, leading Salte and Liestøl to recommend using the component drugs only in summer. Clearly these limited data do not support the FDA regulation of 21 days. New, more refined measurements of drug residues in salmon coming to market clearly are needed - a recurrent theme of the Austins. Some of these measurements are being made now at the University of British Columbia by McErlane et al. (1989), and Grondel et al. (1987) have published a pharmacokinetic analysis of OTC distribution in carp. In the absence of more detailed studies, humans ingesting farmed salmon may be receiving subtherapeutic doses of antibiotics. One would like to see regulations established for testing the product, by agencies, as it comes to market to ensure the absence of detectable residues. Methods used should be such as those approved by the National Committee for Clinical Laboratory Standards

used by the Clinical Laboratories, Laboratory Medicine, University Hospital, University of Washington.

The issue extends beyond the limits of the penned salmon. Much of the antibiotic fed escapes into the fluid environment and, notably, into the sediments that accumulate beneath the pens (Jacobsen and Berglund, 1988), where it may be exposed to native fish, shellfish, and other indigenous species, thus providing another avenue to humans who may catch and consume these forms.

The medical consequences of the mis-administration of antibiotics are numerous, and are well discussed in such modern treatises as Goodman and Gilman (1985) and Kucers and Bennett (1987). A number of them are antigenic and elicit immunological hypersensitivity responses; some have toxic effects in various tissues varying with the physiological and health state of the person; some particularly should be avoided during pregnancy; tetracyclines lead to discoloration of infants' teeth and may interfere with bone growth; some, notably the tetracyclines, may lead to the development of superinfections by resistant strains of bacteria; they may interfere with the normal immune response; and the breakdown products of antibiotics, including OTC, can be toxic particularly in individuals with compromised livers. Basically, it is poor medical practice to ingest unneeded antibiotics or deteriorating antibiotics.

Another cluster of problems associated with use and misuse of antibiotics is the generation of strains of pathogenic bacteria that have resistance to the drugs. Such strains have now appeared in essentially all fish culture communities that have been adequately tested. Mostly the resistance factors are carried on R plasmids, which also usually are found to carry resistance determinants for 1 to 8 additional antibiotics, thus showing multiple drug resistance. In high proportions, these R plasmids are transferable to other bacteria, and thus drug-resistance may be disseminated to other ecosystems. Studies at the Centers for Disease Control have shown that outbreaks of salmonellosis could be traced to drug-resistant *Salmonella* derived through the foodchain back to land farms associated with agricultural antimicrobial use (Cohen and Tauxe, 1986). It is prudent to evaluate the possibility for a similar generation of R plasmids in fish farms and their dissemination to human populations in the marketplace. When drug-sensitive populations of pathogens are replaced by drug-resistant populations, then treatment of the affected fish becomes ineffective, and, if the R plasmids are in human pathogens, treatment of patients would be adversely affected. Particularly, it is a general principle that medically important antibiotics, including oxytetracycline, the sulfas and erythromycin, should be restricted in their nonmedical uses to minimize R plasmid selection and transmission.

When antimicrobials are used in fish farms near commercial or recreational shellfish beds, there is the further potential for drug-resistant organisms to be concentrated by the shellfish, through filtration, and thus enter human populations.

Food additives. The dry pellets, fed to the penned fish in the marine environment, contain fish meal, grains, fish oils and carbohydrates, supplemented by minerals and vitamins as indicated in Table 2. While these additives have no direct human import, it is reported that planktonic blooms of

the ichthyotoxic dinoflagellate, *Gyrodinium aureolum*, were enhanced by the biotin in fish farm wastes (Turner et al., 1984). These blooms cause mortalities to cultured fish, and, unfortunately, to wild fish as well (Bellock et al., 1985).

Pigment is added to the feed to produce a colored flesh in farmed salmon, inasmuch as the color of wild salmon flesh is derived from natural food organisms. In Great Britain, the carotenoid canthaxanthin, an analog of astaxanthin common in natural food organisms, is used in the form of carophyll red. It is stated in a report from the University of Stirling that this use is banned in the US because of possible carcinogenic properties of canthaxanthin (NCC Report, 1988). To date a petition for its use has not been submitted to the FDA (FDA, Seattle Office, 1989). A petition is presently under consideration for use of astaxanthin as a colorant. A main local supplier adds canthaxanthin as a colorant. There clearly are gray areas here where research and regulation is sorely needed.

Many wild fish are rich in omega 3, polyunsaturated fatty acids. A higher ratio of omega 3/omega 6 fatty acids is believed favorable for maintaining low cholesterol levels in humans. Cultured fish and other sea foods, because of their artificial diets, may have low levels of omega 3 fatty acids, and thus unfavorable ratios of omega 3/omega 6 (Suzuki et al., 1986; Chanmugam et al., 1986). Consequently, individuals eating farmed salmon in the expectation of gaining this supplement will typically be erring, unless the farmer has specifically added it as a dietary supplement and indicated this in marketing. The dry pellets supplied locally generally do not have omega 3 acids added as a supplement (Moore-Clark Co., 1989, pers. comm.) because these are contained in the fish oils of the fish meal used.

Moist pellets, which are more commonly fed during the hatchery phases of salmon farming, are derived from fish meal that is pasteurized, combined with additives, and frozen. However, moist pellets used in some fish farms in Puget Sound contained *Salmonella* spp. (Draft PEIS, WDF, p. 116, 1989). Moist pellets used in British Columbia have been found to contain *Salmonella* (Kelly, 1988, pers. comm.; Babink, 1988, pers. comm.). In these cases it is unclear whether the pathogens had survived the pasteurization, or had appeared subsequently. These pathogens can persist for a period of time in marine waters, are harbored by fish in polluted waters, without harm to them (Buttiaux, 1963). Marine shellfish can concentrate *Salmonella* and transmit them to humans. There is, therefore, a potential for fish culture to join animal husbandry as a mode for affecting humans in the manner described by Cohen and Tauxe (1986).

Hormones. At this time, hormones are being used in B.C., experimentally and perhaps to an extent in actual culture, to control the sex, size and behavior of penned salmon, both *Oncorhynchus* spp. and *Salmo salar*. Gonadotropin, gonadotropin releasing factor and analogs, and antiestrogens have been used in adult females to modify spawning. Androgens and estrogens are used to cause feminization, and, in combination with other techniques, to produce triploid and tetraploid stocks for production of sterile salmon. A review is provided by Donaldson (1986).

In general, these treatments are used on egg-producing females or on eggs and sperm, and the likelihood of carry-over of hormones to adult, marketable fish is tiny. Anabolic steroids including methyl testosterone,

thyroid hormones, somatotropins, certain pituitary hormones can be used to accelerate growth in juveniles and the timing of smoltification (Donaldson, 1986). If these hormones, or androgens and estrogens, were used for growth acceleration or other effects on near-harvest adults, then there would be cause for concern to human consumers.

Pesticides. A remarkable list of agents are or have been used in salmon culture. Examples are: formalin, malachite green, acriflavin, Nuvan, Neguvon, Chloramine T, MS222, copper sulfate, tributyltin, diquat, in addition to the chemotherapeutics. Some are used in Scotland and Norway which apparently are not used, or not permitted, in the U.S. and B.C. Lists are incorporated into Table 1 of this presentation.

Treatment of salmon lice (*Lepeophtherius salmonis*). These copepod ectoparasites pose a severe problem for adult penned fish in Scotland and Norway. In Europe, organophosphate pesticides (Nuvan^R (dichlorvos; Scotland) and Neguvon^R (trichlorfon which forms dichlorvos; Norway) are primarily used. Fish are treated by immersion in a concentration of 1 ppm for 1 hr, as needed. In 1984 39,600 lbs of Neguvon were used in Norway (Midtlyng, 1985). They are inhibitors of acetylcholinesterase activity in the cholinergic nervous system. These agents not only kill fish lice, but other crustacea in the environment as well, including commercially important species such as crabs, lobsters and mussels (Egidius and Moster, 1987), and they cause potentially serious problems to the treated fish (Davies and McKie, 1987; NCC Report, 1988). These agents are restricted by the EPA in the U.S. (Seattle EPA Office, 1989). In Washington, the carbamate Sevin^R (carbaryl) has been suggested for use for treatment of salmon lice, and it is used in oyster culture for controlling ghost shrimp. Sevin, also, is an inhibitor of acetylcholinesterase. Sevin has recently been restricted in parts of the United States, and its discharge is regulated by an NPDES permit. BRAVO (chlorothalonil), a fungicide has been suggested for and used recently on fishpen nets, a use banned by EPA because it is a class B carcinogen (EPA, Seattle, 1989).

Disinfectants and Antifoulants. Formalin and malachite green have been used for control of ectoparasites and fungi, usually in the fresh water phases of farming. Malachite green, a potential teratogen (NCC Report, 1988), is now banned. MS-222 is used under certain conditions for anaesthesia, but with a 21-day withdrawal period for clearance from tissues. Hatchery ponds are sterilized with chlorine.

To prevent fouling of nets by growth of algae and encrusting invertebrates, fish farmers have treated nets and pen structures with the antifouling agent, tributyltin (TBT). This substance, at exceedingly low concentrations, has a variety of adverse effects on marine invertebrates and perhaps on vertebrates (Bailey, D.S., 1987). When, in 1987, farmed salmon appeared in the Seattle markets carrying substantial amounts of TBT in their flesh, the state enacted a law prohibiting this use and partially eliminating it from use on boats. A similar law exists in the national statutes, in Great Britain and other parts of Europe. Despite this ban, a Canadian Governmental memorandum on August 11, 1988, titled "Private Salmon Hatcheries and Netpen Facilities, Some Serious Concerns" indicates that 25% of BC pens are still treated with unregistered boat hull paints, sometimes including TBT, which liberate

large quantities of particulate paint into the water, sometimes onto oyster beds, thus creating potential hazards for two kinds of aquacultured products.

If antifoulant is used on nets now, usually it is copper-based. Copper and other heavy metals are highly toxic to many marine invertebrates. Standards for permissible amounts of copper in farmed fish flesh appear to be lacking.

Summary. There are a number of chemicals and additives used in net pen culture now that have the potential for adverse human impact. Often these are used at the discretion only of the user, and with little or no external monitoring. There appears to be little or no input into this regulation by public health agencies.

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Table 1
Chemicals Used in Net Pen Culture of Fish
(From Austin and Austin, 1986; The Nature Conservancy
Report, Scotland, 1988; and other sources)

Chemotherapeutics

Oxytetracycline	Streptomycin
Romet 30 ^R (sulfadimethoxine and orthomeprim)	Sulfisoxazole
Sulfamerazine	Kanamycin
Tribrissen ^R (trimethoprim)	Fumequine
Erythromycin	Chloramphenicol
Penicillin G	Chloramine T
Oxolinic acid	Acriflavin
Minocycline	Acetic acid
Clindamycin	Formalin
Kitasamycin	Malachite green
Rifampicin	Iodine
Hyamine 3500	Iodophor
Copper sulfate	Benzalkonium
	Nitrofurantoin

Pesticides

Dichlorvos (Nuvan^R, an organophosphate)
Trichlorfon (Neguvon^R, an organophosphate)
Carbaryl (Sevin, a carbamate; used in oyster culture)
Diquat

Antifoulants and Disinfectants

Tributyl tin - now banned
Copper paint
Bitumen
Chlorine
Chlorothalonil

Anaesthetics

MS-222 (tricaine methane-sulfonate)
Benzocaine
Carbon dioxide

Food additives

Colorants-canthaxanthin
Minerals
Vitamins
Omega 3 fatty acids

Table 1B
Doses of Antimicrobials Commonly Used in Salmon Net-pen
Culture

Antimicrobial	Dose, mg/kg of fish/day	Days of Treatment
Oxytetracycline	75	10
Romet 30	50	5
Sulfamerazine	220	14
Tribrissen	30	10
Erythromycin	10-25, or unspecified	4-21

These regimens are repeated 2 or 3 times a year

Table 2
Mineral and Vitamin Food Additives
in Salmon Pellets

(Data from Nature Conservancy Council Report 1988, and
Moore-Clark Analysis)

Minerals

- Calcium phosphate
- Magnesium sulfate
- Sodium Chloride
- Potassium chloride
- Iron sulfate
- Zinc sulfate
- Copper sulfate
- Manganese sulfate
- Cobalt sulfate
- Chromium chloride
- Ethylenediamine dihydroiodide
- Selenium

Vitamins

- Thiamine hydrochloride
- Riboflavin
- Calcium pantothenate
- Niacin
- Pyridoxine hydrochloride
- Biotin
- Folic acid
- Cyanocobalamin
- Inositol
- Ascorbic acid
- Choline chorlide
- Menadione
- alpha tocopherol acetate
- p-aminobenzoic acid
- Retinol acetate
- Vitamin A
- Vitamin B12
- Vitamn D3
- BHA-BHT, antioxidant

HOUSE BILL No. 432 (Resources)

WHAT WE KNOW

- Fishing is the second largest industry in terms of dollars, and **the largest** in terms of employment, in Alaska.
- The wild stocks of Alaska salmon are **healthy** - in numerical strength and because they are virtually disease free.

WHY IS THIS SO ?

- **Because many years ago the people of the Alaska made a commitment.** We said to the federal government and to the exploitive outside interests: "let us control our own destiny and we will be responsible stewards of our natural resources". Some could argue that we haven't always lived up to that commitment as it relates to other natural resources, but I think we've done a pretty good job with our fisheries.
- For it's part, the State of Alaska has **invested** millions and millions of dollars in capital investment for docks, harbors, grids, processing sites; not to mention the numerous loans made to capitalize the fleet. We've appropriated millions more in operating budget funds for fisheries management, enhancement, enforcement, inspection, and a variety of other programs all designed to keep this industry healthy and prosperous. As best we could, **we have honored our commitment.**
- In 1972, the people of Alaska passed a constitutional amendment which paved the way for the limited entry system. There was too much gear in the water - our stocks were endangered and the viability of the industry was in question. Limited Entry was enacted not only to protect the stocks but to allow the Alaskan fisherman to continue making a living. This was not a decision made lightly. Everyone knew that limitation meant that some would not be able to freely participate in the industry; but they made the hard choice. **The people of Alaska honored their commitment to keep the industry healthy.**
- Hand in hand with the Limited Entry program was increased attention to fisheries rehabilitation and enhancement. The State invested considerable amounts in hatcheries and other enhancement programs. The Alaskan fishermen formed aquaculture associations

and taxed themselves to help keep the enhancement effort strong. In the past several years, the responsibility of operating a number of state hatcheries has been turned over to the aquaculture associations, thereby easing the need for state funding of those hatcheries. Remember, hatchery fish come to maturity in the wild and are harvested by all user groups - sport, commercial, and subsistence. **The fishermen who tax themselves and try to keep costs down and returns strong at these hatcheries are honoring their commitment to healthy fisheries.**

- Because we all have kept the commitment we made over thirty years ago, we have a strong, healthy fishing industry, and at the pinnacle of that industry is the wild Alaska salmon; in the opinion of many, the finest seafood in the world.

NOW, IF WE KNOW THIS, WHY WOULD WE WANT TO DO ANYTHING THAT MIGHT JEOPARDIZE THE INDUSTRY WE HAVE ALL FOUGHT SO HARD TO KEEP HEALTHY?

- Some risks associated with fish farming:
 - The health of the wild stocks. I'm not going to print the laundry list of diseases to which farmed fish are susceptible because they seem to be finding previously undiscovered ones every day. Fish kept in captivity until maturity experience much more stress than do wild fish, and this heightened stress makes them susceptible to disease. If diseased fish should escape into the wild, there is a distinct possibility that the disease they carry could be transmitted to the wild stocks with which they mingle. The migration of disease through the wild stocks could be devastating.
 - The reputation for quality that Alaska salmon now possess. In order to control all these diseases, fish farmers must mix large amounts of chemicals into the food pellets given to the captive fish. There is growing concern that these chemicals could make their way into the human food chain. (See "Additives to the Environment of Net-Pen Reared Fish" by zoologist Arther H. Whiteley, included in your bill packet.) Even if these concerns are eventually dealt with through strict regulations, the perception that farmed fish are unhealthy could be detrimental to the marketing of our wild salmon. We all remember the botulism "scare" of the early 1980's and how one or two bad cans of salmon damaged the entire industry.
 - Pressure on a budget built with dwindling revenue. No one seems to know how much the State of Alaska will need to spend should we become involved with fish farming. Licensing, monitoring, enforcement, and siting concerns will all have to be addressed through the State

operating budget. (Not to mention the potential need for State loans or other "bail-out" measures that would have been looked at down the road. The economic disaster that British Columbia fish farmers recently faced gives some indication of what could be in store for us.) Given that many of our constituents, and a number of the members of this body, believe that we are presently underfunding the agencies that manage and protect our fisheries, I am not ready to gamble millions of State dollars on fish farming.

• Market control. Fish farming evolved in Norway because of that country's concern about its wild stocks of Atlantic Salmon and its fishermen. Norway then instituted its own "limited entry" system: fishermen became fish farmers and the government was able to control "supply" as the demand for fish in the European markets fluctuated. At first Norway did well, capitalizing on the sudden drop in demand for Alaska salmon following the botulism scare of the early 1980's.

Today, however, Norway is faced with a number of growing problems. The market is glutted with farmed fish and prices have dropped. Their own high government officials have now acknowledged that the spread of disease from farmed fish threatens what's left of their wild stocks with extinction. Last Spring the government of Norway was under siege to fund 100 new fish disease specialists and 150 fish veterinarians. They are now paying the price for what they allowed to happen to their own fisheries.

The light at the end of the tunnel for Norway is the exportation of fish farming technology and as much control as they can exert over the world supply and demand of salmon. We all know where the investment dollars will come from for fish farming in Alaska, and who will pay 10¢ on the dollar when the so-called "Mom & Pop" fish farms can't make it and have to sell out. Take a look at which country's corporations started taking over the British Columbia fish farms that went into receivership this past year. It is interesting to note that a fish farmer in the state of Washington has filed suit in U.S. District Court claiming that foreign national interests have attempted to monopolize the industry in his state; that Norwegian concerns operating through American "fronts" have conspired to destroy competition, remove local control, and violate antitrust laws.

• In conclusion, the Norwegian-type farmed fish may have captured a large share of the world market in the short term, but I am convinced that, in the long term, the wild fish - the quality fish - harvested by the Alaskan fisherman will be the winner. We should not risk our dwindling State dollars, and our reputation for a quality product, on a capital intensive, foreign dominated industry that has brought collapsing prices, environmental problems, and questionable genetic practices in its wake.

GENERAL CONCERNS WITH 'UPLAND' FISH FARMS:

1. Groundwater contamination.

Fish diseases are commonly transmitted through water sources. Contaminated water discharged from an upland farm could seep into the water table or surrounding streams.

2. Broodstock.

Broodstock ownership, genetic mutations and alterations of broodstock by private business could threaten common property ownership of fisheries. The source of broodstock for these farms is a major concern because it would have to come from either: (a) hatcheries within the state (which you cannot presume will have the excess eggs or smolt to sell), or (b) sources from outside the state. Importation of broodstock from outside is extremely hazardous in terms of not knowing exactly what you getting. The Finfish Farming Task Force recommended that the importation of salmon broodstock and the private ownership of broodstock be banned.

3. Water appropriation.

Upland farms will use an enormous amount of water. A 200 ton production capacity farm requires 50 cubic feet of water per second, an amount equal to the amount of water the city of Eugene, Oregon uses. The debate over House Bill 210 demonstrated the controversy which exists relative to the appropriation of water in this state.

4. State budget.

Upland farms will still need to be licensed, inspected and monitored for compliance with state laws and regulations. This will take money away from other programs the resource agencies are having a difficult time administering now. Sonja Corazza, the co-chair of the United Fishermen of Alaska's Mariculture Committee testified in House Resources that Southeast shellfish farmers told her that some lease sites had not been checked in three years. DNR didn't have the personnel or the funds to adequately monitor all the sites.

TWO EXAMPLES OF PROBLEMS WITH "UPLAND" FISH FARMS:

1. The Finfish Farming Task Force toured an upland farm in Washington State that is owned by Dan Swecker and a subsidiary of Sealaska Corporation. The farm grows pan-sized coho salmon.

The majority of the facility consists of above-ground swimming pools where the salmon are raised. The water is supplied from several wells. The farm also has a number of small, man-made ponds where the adult brood stock is kept.

Members of the task force noticed that a couple of the ponds were dry and abandoned, and asked why. The answer was that the adult fish in those ponds had passed a pathogen down into the water table and that the pathogen had then travelled back into the wells and had been introduced into the swimming pools containing the juvenile fish. This caused an unexpected, but devastating, outbreak of disease among the population.

It took them quite a while to discover the source of the infection, and the solution was to move the earthen ponds as far away as possible and drain them into an adjacent swamp.

2. The deaths of 100,000 cohos in a river in Washington State have been linked to the seepage of water discharged from a nearby landlocked fish farm, as reported in the Seattle P-I, November 1, 1989.

COMMENTS ON 3-26-90 DRAFT CS FOR SB195
PRO-FISH FARMING BILL

What the bill allows:

Marine and uplands rearing of Arctic char, Dolly Varden, steelhead, rainbow trout, sablefish, and sheefish.

Uplands rearing of Pacific Salmon in both fresh and salt water.

Concerns:

Sets up enormously time and money consuming responsibilities for the Dept. of Fish and Game. Where will the funding come from? Will we cut programs that support and manage common property fisheries which bring huge benefits and tax revenues to the people of the state in order to fund support for a few private businesses?

Directs Dept. and University to spend time and money on research for fish farming. What research will have to be stopped to do this?

Rearing of salmon and other species is allowed in "upland locations." It does not limit this to TANKS alone. Upland ponds increase the danger of groundwater contamination and less positive control of wastes, chemicals, and used water.

Allows non-salmon species to be farmed anywhere, including in marine net pens. There are environmental risks involved with that, including water contamination (ground water, streams, and ocean water) and genetic intermingling with wild stocks, siting conflicts with the many other shoreline user groups, and a host of other netpen problems that are not exclusively related to salmon.

Broodstock acquisition. Allowing fish farming and setting up mechanism to get eggs either from "surplus" hatchery eggs or from wild stocks implies a "forever" obligation on the part of the state to ensure a source of eggs for this new industry.

Who determines if eggs are surplus? Surplus to what? Do we circumvent the intended purpose of the state and PNP hatchery systems which was to produce the maximum possible number of fish for the common property resource. What if they can make more "cost recovery" money by selling eggs to farms than sticking to their original goals?

And for species not currently available in established hatcheries, will we be forced to take eggs from wild stock at the expense of sport, subsistence, and commercial fisheries,

and the health of natural runs? If there is a huge investment in the fishfarming industry, the Department and Board of Fish will be under tremendous pressure to keep the industry supplied with enough broodstock. A new, and competing "user" group will have been established for broodstock.

Will fishermen, who directly and indirectly have paid to build the hatcheries, and rebuild and conserve the natural fish stocks of this state, be forced to inadvertently fund the broodstock sources for the fish farming industry which could so easily destroy the very resources and markets upon which they depend?

Fish and Game is made responsible for standards for waste water treatment - the expertise for that sort of thing is in DEC.

Water rights, "in-stream flow" issues are not addressed. Farms will require large amounts of water. Where will their right to the water fit in with rights of municipalities, homeowners, miners, etc?

What are the penalties for violations of fishfarm regulations? Besides a fine for a violation of water discharge regs or regs regarding disposal of diseased fish, does the state have any recourse if streams and wild stocks are irreparably harmed by a fish farmer's actions?

Pathology services. Bill allows for certification of private pathology labs to service farms. It would be very expensive for state to provide all those services but is it safe to leave it to private industry? If the lab is private for-profit, and thus is working FOR the fish farmer, will they be strict in their reporting of results? Would they want to shut down their own client? How much will it cost the state to properly monitor those private labs?

The Seattle Times 2/28/89

WASHINGTON'S LARGEST NEWSPAPER ■ COPYRIGHT 1989 SEATTLE TIMES COMPANY

'An emergency disease'

Lethal virus may have infected wild salmon and trout, biologists say

by Jack Broom
Times staff reporter

A potentially lethal fish virus that prompted biologists to destroy 3.8 million fish and eggs in two Washington hatcheries last week may also have infected wild salmon and trout and could spread like a plague, experts say.

"This is classed as an emergency disease. It's not to be taken lightly," said Jerry Grover, an associate manager in the U.S. Fish and Wildlife Service's regional office in Portland.

Thousands of wild salmon, trout and other species will be gathered in the next few weeks from areas around the two hatcheries where the virus was recently detected.

Biologists fear that viral hemorrhagic septicemia (VHS), never before seen in North

STEELHEAD RUN SUFFERS

■ An early count of fish at the locks is "terrible." Northwest, B 5.

America, may have the potential to spread rapidly in Northwest hatcheries, net pens and fish populations in open waters.

"Right now there's about a 50-50 chance" that the virus has infected fish in the wild, said Ray Brunson, a fish pathologist for the Fish and Wildlife Service.

The virus, known as VHS, is not regarded as dangerous to humans, even if people eat fish that have been infected.

Biologists say VHS may be far more dangerous to steelhead, a form of trout, than to salmon, but the extent of the danger to both species is not yet known.

In Europe, where VHS has been detected previously, coho salmon have been observed to carry the virus and suffer no ill effects, said Larry Peck, head of salmon-culture operations for the state Department of Fisheries. But Peck said that is no

Please see **FISH** on A 6

Virus called 'emergency'

FISH

continued from Page 1

guarantee that Pacific salmon would survive the infection.

In recent laboratory tests on trout here, about 70 percent died after being injected with large doses of the virus.

The presence of VHS was discovered in routine tests at the state's Glenwood Springs Hatchery on Orcas Island and the federally run Makah National Fish Hatchery on the Olympic Peninsula.

Although the virus itself had not killed any fish at those facilities, all fish and eggs at both hatcheries were intentionally killed to prevent its spread. Workers killed the fish by adding chlorine to the water or by turning off the fresh-water supply, causing the fish to die from lack of oxygen.

Yesterday, workers were still killing the last of the fish and putting them into trenches to be buried.

The next step is to determine whether fish outside the hatcheries have the infection.

"We're setting up a very aggressive sampling schedule," Peck said.

He said crews will use nets, lines, traps and electric-shock devices to gather fish from streams and open water near the two hatcheries.

After the fish are caught, it will take two weeks to test them for the virus.

Peck would not speculate on the chance that the virus is now in wild fish, but he said it's possible that salmon returning from the ocean brought the virus into the two hatcheries.

No one knows how the virus got to this country, Peck said. If

anyone had a guess at this point, he said, "it would be just speculation."

Opponents of net-pen salmon raising believe, however, that the importation of Atlantic salmon eggs to the state is the most likely cause.

"It could have come over as infected Atlantic salmon eggs, and Pacific salmon could have picked it up from them. I think that's the most probable cause," said L. Joe Miller, president of the Marine Environmental Consortium.

Miller said his organization will ask at a public hearing tomorrow for a moratorium on new net-pen permits until the cause and extent of the disease are known.

It is impossible to determine how much damage the virus could do to fish populations here because so little is known about its effects, particularly on salmon.

In Europe, where the virus has been detected mainly in trout, it was responsible for killing 80 percent to 90 percent of the trout in a certain confined area, Grover said.

The ability of the disease to spread quickly among fish poses great concern to commercial operators raising salmon in net pens.

"We're cooperating with the state Department of Fisheries in its investigation," said Haavard Rabben, general manager of Global Aqua USA, which raises Atlantic salmon in floating net pens in Puget Sound.

Eggs and fry used by Global Aqua are routinely tested for many diseases and have never tested positive for VHS, Rabben said. But he said if the virus is in wild fish in Puget Sound, it could spread to his fish.

Brunson said the fish kill hurt the morale of hatchery workers. "They've invested a lot of their effort and their heart in trying to rear fish, and then we call them and tell them to kill them," he said.

The number of fish destroyed last week represented only about 1 percent of the fish raised in state, federal and tribal hatcheries in Washington state, but there is deep concern over whether the

disease will be found elsewhere.

"It was discovered in routine sampling at Glenwood Springs, and we know we've transferred fish in and out of that facility to and from other hatcheries," said Tony Floor, state fisheries spokesman.

But Peck said no eggs or fish were transferred out of the Glenwood Springs hatchery last year because egg samples from returning adult fish showed that some type of virus was present. "We knew we had some type of problem. We didn't know what it was, but we red-flagged that facility," he said.

Peck said it is too early to gauge the extent of the threat to the state's 30 major salmon hatcheries, but he said additional tests are being done at each site.

More than 327 million fish were released last year from state, tribal and cooperative hatcheries. The smaller federal fisheries program released 60 million fish last year in Washington, Oregon and Idaho.

Grover said the fish destroyed at the Makah hatchery represented "a substantial portion of our total production" in the Northwest. He said fish raised on the Olympic Peninsula are considered particularly valuable because they are close to the ocean and usually have a good survival rate when released.

CANADA'S

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Alaska Department of Fish & Game

NEWS

FOR IMMEDIATE RELEASE

March 1, 1989

ALASKA CONCERNED ABOUT NEW FINFISH VIRUS

Juneau...Fishery pathologists in the Fisheries Rehabilitation, Enhancement, and Development (FRED) Division of the Alaska Department of Fish and Game (ADF&G) are very concerned about the discovery in the State of Washington of Viral Hemorrhagic Septicemia (VHS), a fish virus that has not occurred before in North America.

Recently, a VHS virus was identified in spawning coho and chinook salmon in two hatcheries in the State of Washington: the Glenwood Springs Hatchery on Orcas Island and the Makah Hatchery operated by the U.S. Fish and Wildlife Service near Neah Bay. All fish in these hatcheries were destroyed, and the facilities have been quarantined in order to prevent the spread of this virus.

VHS, first discovered in 1938 in Europe, causes disease primarily in rainbow trout in both fresh and salt water. Other fish shown to be susceptible include Atlantic salmon, brook trout, golden trout, rainbow trout-coho salmon hybrids, and goldfish. Transmission is by contact with other infected fish or contaminated waters. VHS has not been detected in North America despite extensive disease monitoring. VHS is capable of causing severe mortalities in older, larger fish, while Infectious Hematopoietic Necrosis Virus (IHNV), indigenous to wild Alaskan sockeye salmon, typically kills fry and juveniles. As with other viral diseases, there is no treatment for VHS except prevention.

Dr. Ted Meyers, Principal Pathologist for the FRED Division, has found no evidence of VHS disease in Alaskan

salmon stocks. According to Dr. Robert Burkett, Chief of Technology and Development for the FRED Division of ADF&G, Alaska maintains the best possible protection against invasion of exotic fish diseases because it prohibits the importation of any finfish into the state. "The most important thing was done ten years ago when regulations were established prohibiting import of finfish," Burkett says.

Dr. Meyers has been in contact with investigators performing the VHS identification and survey work at the Sand Point U.S. Fish and Wildlife Service Fish Pathology Laboratory in Seattle. Dr. Meyers will be travelling to the Seattle Laboratory to monitor the progress of the investigations and to determine the extent of the VHS problem in Washington and the Pacific Northwest. FRED Division pathologists will continue to monitor Alaskan salmonid stocks for IHNV using procedures that would detect other viruses as well, including VHS.

As a result of the potential risk to Alaskan stocks, the Commissioner of ADF&G, Don Collinsworth, is calling for the immediate formation of a Pacific Coastal Task Force composed of state and provincial representatives from Alaska, Washington, Oregon, Idaho, California, and British Columbia, with appropriate representatives from state, federal, tribal, and private industry, to investigate the risk of spreading VHS from infected hatcheries in Washington State and to develop effective control methods to contain this disease.

* * * * *

FISH FARMING IN ALASKA:
GAMBLING WITH RESOURCES AT PUBLIC EXPENSE

BY
SENATOR DICK ELIASON

Alaska should move now to ban commercial finfish farming in the state. Development of a fish farming industry could jeopardize our natural resources, our sport and subsistence fisheries, and our billion-dollar commercial fishing industry.

Stewardship of common property resources is one of the most challenging responsibilities with which Alaska's government is charged. Our state Constitution (Art.VIII, Sec.2) provides, "The legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State...for the maximum benefit of its people." As a member of the legislature for nineteen years I can assure you that implementing this policy so that everyone is happy is an impossible task, but it is nonetheless essential to strive for the greatest common good.

The mandate to manage natural resources for the public good is, in itself, ample reason for the legislature to ban fish farming. Even fish farm advocates agree that risks to wild stocks can be minimized but not eliminated, and that the current economic potential for fishfarming is bleak. How can we justify spending public funds to help establish an industry which could bring catastrophe to natural resources and to the state's largest private sector employer?

The small group of individuals pushing for fish farming in Alaska is quick to point out that many countries around the globe are ardently pursuing mariculture, and that Alaska should jump on the bandwagon. Does any one of these other countries boast natural fishery resources on a par with

Alaska's? On the contrary. In most cases, they've either never had significant natural stocks or their fisheries have been decimated by poor management. These countries have little to lose by experimenting with fish farming.

The development of the world's finfish farming industry has been marked by an initial period of very rapid growth, and more recently by severe economic woes including many bankruptcies and the dumping of large quantities of farmed fish on the market at a loss. Farm operations have been established long enough in many places for us to see that the industry is plagued by problems Alaska does not have now, and does not want.

Critical areas of concern include water quality, siting, and hazards to natural stocks. The degradation of water quality seems impossible for fish farms to avoid. According to a state report done in Washington, one typical fish farm using net-pens produces pollutants "equivalent to untreated sewage from approximately 10,000 persons." Pollutants are also laced with hormones and antibiotics given to the fish; these are believed to pose a serious threat to the public health by producing antibiotic-resistant bacteria in the human food chain. Over time, in a single site, tons of oxygen-demanding waste are produced. Complaints about pollution from salmon farms are cropping up in Ireland, Norway and Canada. Fish farms contributed to the pollution which likely was a key factor in the frightening killer-algae-bloom which destroyed all marine life in its path when it swept

through the North Sea in 1988. Maintaining the quality of the marine environment along our coasts is something in which most Alaskans have a stake.

The location of fish farms has sparked bitter public debate in places like Puget Sound. Even in Alaska a limited number of sites possess the features desirable for fish farms: accessibility, protection from heavy wave action, good flushing action, availability of a fresh water source, a good distance from anadromous fish streams, and so on. Many of these same attributes are desired for other uses: shellfish farms, hatcheries, recreation, boat moorage, residential development, etc. Conflict over siting is inevitable.

Perhaps the most unsettling of the potential dangers of fish farming center around the problems of fish disease, accidental escapement, and genetic intermingling.

These are serious concerns even in Norway, where mariculture is "state of the art" and fish farmers have access to extensive subsidized technical expertise. Fish escaping from pens pose a threat even if the renegade fish are free of disease. Renegade salmon may compete for space in a river inhabited by natural stocks, and inbreeding can weaken the qualities which suit a fish to life in the wild (such as the ability to migrate).

In Norway the escapement of large numbers of fish infected with a deadly disease has threatened wild stocks. Fish biologists there have concluded that disease in farms can lead to higher rates of infection in the vicinity of the net

pens, even if the disease itself already exists in natural stocks. When an exotic disease breaks out in a river inhabited by natural stocks, the entire river must be poisoned to eradicate it; this has happened in the U.S. and in Norway.

Recently the deadly VHS disease erupted again at a hatchery in Washington, and was also detected in wild salmon. The source of VHS is a mystery. But the fact that it never appeared in the U.S. until shortly after the establishment of fish farming, and that two of the three hatchery outbreaks of the disease in Washington have occurred within ten miles of major salmon farms, seems to lead to an apparent connection.

Those advocating fish farming in Alaska claim that all these risks can be minimized with the proper controls, siting guidelines and, of course, adequate funding. Indeed, to allow ANY fish farming, funding would be required for a whole new layer of bureaucracy spanning four departments (DEC, DNR, Fish and Game, and Public Safety), including lab space, state fish pathologists, biologists, and protection officers as well as office personnel.

But no amount of regulation can be effective if enforcement can't be guaranteed -- a costly and virtually impossible task when fish farms would be located in remote places and monitored sporadically. For example how can we prevent a farmer in some isolated bay from releasing diseased fish into the wild to save the huge expense of proper disposal? (Such actions are alleged to be taking place in Norway).

More than 70,000 people are employed seasonally in Alaska's seafood industry. They depend on the state to manage fisheries resources for a sustained yield. An average of only 3 people are needed to run the average fish farm. Fish farming has been touted as a fine "Mom & Pop" operation, a family business -- well, maybe if you're a member of the Rockefeller family, because it takes about \$1,000,000 to get started and it's a minimum of two years before you can expect any return on your investment! Financing for ventures in Alaska would likely come from out of state and foreign investors, so even if the industry were able to reap a profit, much of it would not benefit Alaskans. A much better "Mom & Pop" operation is shellfish farming, which has the legislature's full support (and mine), and which is now developing in various parts of Alaska.

Economic diversification and development deserve our support, but it should not be blind support of "anything at any cost." Potential benefits must always be weighed against potential harm. I concur that within human limitations, damage can be minimized in fish farming, but I doubt that adequate adherence to protective measures can be achieved, and I can't see a reason to take any risks when potential benefits are so minuscule.

We can best serve Alaska by responsibly managing our fisheries resources according to sustained yield principles, maximizing returns by controlled harvest and through enhancement efforts, continuing to support the "Americanizing"

and "Alaskanizing" of our fisheries, increasing incentives for shore-based processing, strengthening our marketing and quality assurance/education efforts, and by overall efforts to maintain a healthy marine environment.

The legislature recently received the final recommendations of the Finfish Farming Task Force appointed by Governor Cowper. The report confirms that the potential negative impacts of fish farming on natural stocks cannot to be eliminated, and does not present any evidence that Alaska stands to gain enough to justify taking the risks involved. The report recommends that the legislature act this session to resolve this issue.

To this end I have introduced Senate Bill 397, which would ban commercial finfish farming in Alaska. The current moratorium on fish farming will expire this July, unless action is taken. I hope that the members of the public will make their views known to their elected representatives in Juneau so that the legislature can resolve this issue once and for all.

Mary made call
on 2-14-90

Spoke with Dr. Ross Antipa, Chief of Staff of the Washington State Senate Committee on Environment and Natural Resources.

(Has PhD in fisheries biology and has done considerable research on fish disease. Now Committee staff in Senate. Olympia, phone number 206-786-7413)

So far no one has proven that the recent outbreaks of the deadly VHS fish disease in Washington are caused by the fish farming industry, but timing and other evidence certainly indicate the connection.

Last year over 500 Atlantic salmon were sold on commercial fish tickets. This is proof that large numbers of fish are escaping from fish farms and are entering the fisheries.

Many of the stocks used by Washington hatcheries and fish farms are imported from Europe. The eggs must be certified which should guarantee that they are disease-free. But certification is done by statistical sampling which leaves room for a large margin of error.

VHS virus first appeared last year at two hatcheries. This year it appeared at one more. Two of these three occurrences were within 10 miles of major Atlantic salmon farms. VHS has now shown up in wild salmon, so there are at least four areas with the virus. It has shown up in both coho and chinook. In Europe it has killed off huge numbers of wild trout.

Dr. Antipa notes that as soon as any fish farming is allowed, the farmers become a real political force, contributing to campaigns, lobbying, forming coalitions with other groups, working for changes in the regulations which restrict them, and so on. He said that has certainly been the experience in Washington and British Columbia.

PACIFIC FISHERIES
LEGISLATIVE TASK FORCE

Salmon Net Pen Aquaculture - Remarks of L. Joe Miller
FEB 7, 1987

My name is L. Joe Miller, I live on Whidbey Island. Our waterfront property is far removed from the areas zoned for salmon net pen culture.

I chair a large organization on South Whidbey known as Save Our Shores and I also chair The Marine Environment Consortium, a coalition of concerned groups throughout Puget Sound. My professional background is in local government as a city manager in Bellevue Washington and Rochester New York.

I will confine my remarks to the issues of land use, impact upon the human environment, and my recommendations for the sharing of responsibilities between state and local authorities.

The concern of our members centers principally on water quality, property values, noise, lighting, odor, view obstruction, adequacy of regulation, financial impacts on local governments, the physical mass and appearance of structures, access and shore facilities and the preemption of traditional marine uses, such as sports fishing, commercial fishing, water sports, recreational boating, commercial boating (safe harbors and limitation on operating speeds).

We urge a careful analysis of the economic issues including: (1) how many jobs will result from this industry and how many existing jobs might be lost; (2) is there any validity to the balance of payments claims; (3) are there any successful financial net pen operations in this state; (4) what is the risk of price manipulation and destabilization of the fishing industry; (5) how much revenue is this industry liable to produce and how will it be distributed within our society.

If a salmon pen were located in tanks on dry land it would be regarded as industrial in nature and would never be allowed in a residential district. At best it might be described as a feed lot. In fact, it is not farming at all but is simply a feed lot for fish, with all attendant problems.

Under our law such an operation would be exempt from local zoning restrictions only if the facility were operated by the state itself. That exemption would not extend to the states lessees. The same rules apply to the submerged lands along our shores.

The films we have seen of fish pens in Norway and Scotland appear to be well removed from established residential areas. We think this a good idea and should be an essential element of siting criteria in this country.

I suggest that a basic issue is: If we are to have net pens, how should the program be administered? More specifically, what are the respective roles of state and local governments?

Clearly, the missions and expertise of the various state agencies suggest their responsibility in the areas of marine biology, public health, water quality and marketing. You will note that the Washington State interim guidelines are limited to these areas and, I believe, appropriately so.

On the other hand, local governments are better able to know and understand the impacts on the owners and users of adjacent properties, and the traditional users of the aquatic areas in question. This is commonly known as land use planning and administration, the traditional and proper province of cities and counties. Land use uniquely requires the intimate involvement and participation of affected neighbors.

The state can't perform this role effectively because their departments are not easily accessible, their personnel can't know the local issues and conditions, local concerns are not within their missions or imperatives, and indeed, there is strong potential for conflict between state and local goals and objectives. Finally, land use issues are not within the technical capacity of the state agencies involved. Fisheries and agriculture experts are not experienced land use planners.

These local issues are profoundly important to the people in the local communities and you can be sure that those people will be involved in this process somewhere, somehow. The economical and expeditious place for this to happen is in the local land use process, not in the state legislatures or the courts.

I believe that we are beginning to sort out the appropriate state and local roles in the State of Washington. Heretofore, counties have been too passive because they perceived that they were powerless. They are beginning to realize that they do indeed have substantial jurisdiction in these local issues that I have described. Also, the state authorities appear to be recognizing that this is a shared program. It would be useful, and indeed, essential, to develop some formal clarification and definition of the respective roles if we are to move toward a workable environment.

If net pens are to operate here at all, the industry, the neighborhoods, and the state and local governments are going to have to establish a better atmosphere of trust and role sharing. I doubt that much will happen in net pen aquaculture in this state until the present relationships are substantially improved.

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

Pacific Fisheries Legislative Task Force, State Capitol, Olympia,
Feb. 7, 1987

Dr. Arthur H. Whiteley, Professor, Department of Zoology,
University of Washington

I intend in these few minutes to comment on one aspect only of pen rearing of salmon - the relationship to pathogenic bacteria and other agents of disease.

The growth of bacterial populations in a natural environment is limited by the availability of nutrients. In a typical, natural marine environment the bacterial populations are relatively sparse. Given appropriate nutrients, either in the form of dissolved materials or sediments, the opportunity for growth in these populations will be much enhanced. It is generally agreed that salmon pen culture contributes substantially to the eutrophication of the environment of the pen - both in terms of soluble and finely suspended material, and in terms of larger particles that form heavy sediments on the bottom. In this way, the pens enrich the local environment for bacterial growth. Those bacteria already present in the water and substratum can increase. Any brought in with the introduced fish can increase as well. A variety of diseases can thereby be fostered by the pens. Some of these are of bacterial origin, some are viral, and some are due to organisms such as fish lice, parasitic worms, etc. The enhancement of the bacteria by nutritional enrichment works to the disadvantage of the penned fish. They are already stressed by the conditions in which they grow. They are therefore susceptible to bacterial invasion. Notably *Vibrio anguillarum* and *Renibacterium salmonarum* infect the penned fish and often kill them, and other vibrios and aeromonads are of major importance as salmon pathogens. *Vibrio anguillarum* produces disease in penned salmon in this State and in British Columbia. It also is ubiquitous in Norwegian waters, and is responsible for many of their fish farm diseases. With the advent of intensive fish farming in Norway, a new disease, the "hitra" disease, has appeared and now is responsible for 80% of the disease problems in the Norwegian fish farms. Its cause is uncertain, but vibrio species occur in connection with the disease

outbreaks (Håstein, 1986).

A significant question is whether these infections affect wild fish. Weston (1986) concludes that the evidence argues against such transmission. Others point out the difficulty of making such a determination because of the mobility of the wild fish and other complexities associated with working in a submerged, marine environment (Trust, 1986; Johnson, 1989; Staley, pers. com.). It takes only a few minutes exposure for a fish - penned or wild - to become infected. Often the route of transmission is through the gills. The infected fish often die, but if they survive, they frequently become carriers of the pathogenic organism. Both viruses and bacteria can be shed through the feces of the fish, thus spreading the focus of contamination in the natural environment. Moreover, in certain cases (*Renibacterium*) the bacteria can be passed from a female to her eggs, where it associates with the yolk, and transmits the disease to her offspring (Trust, 1986). It is too early to conclude that there is no transmission from a pen to the general environment and to the wild fish there. On the contrary, it is the opinion of microbial ecologists that an infected fish pen would in all likelihood serve as a focus for the infection of fish in the environment, and from them for the transmission of disease to their offspring (Staley, pers. com.).

In addition to pathogenic bacteria, the stressed salmon can serve as a focus for a number of serious viruses. These, too, may enter their host through the gills, and can be transmitted to other fish and to next generations (Trust, 1986). It is expected that they will be locally enhanced by the concentrations of wastes associated with fish pens (Staley, pers. com.), and this enhancement poses problems for the penned fish, and for wild fish as well. The danger that such viruses can be transmitted to wild fish is recognized by laws that prevent introduction of salmonids from the Columbia River system, which is infected by viruses, into any other river system in this State.

These pathogens and related ones that will multiply in the accumulated fish wastes, can serve as a reservoir of infection of marine invertebrate organisms as well. This, too, is a difficult field of inquiry because of the nature of the environment and the mobility of some of the organisms, and most information is derived from study of captive invertebrates. It is believed,

however, that animals living in degraded environments (which I assume would include under-pen locales) can be seriously disabled by such bacteria. Bacteria that degrade chitin, including *Vibrio*, *Beneckea* and *Pseudomonas*, cause shell disease in a host of crustacea, including spiny lobsters, tanner crabs, king crabs, various shrimp, and others of economic importance (Johnson, 1983). The species of *Vibrio* bacteria that infect crabs and shrimp include those associated with salmon pens or are present in local waters: *V. anguillarum*, *V. parahaemolyticus*, *V. alginolyticus*. (Johnson, 1983). Laboratory experience indicates that animals kept in clean sea water are difficult to infect, but those in the presence of sewage sludge developed shell disease. In addition to causing shell diseases, bacteria invade shrimp, crabs and other crustacea and cause internal infections. Again, the total relation of these infections to stress, to polluted environments, to salmon pen sewage is not resolved (Johnson, 1983), but we believe this relationship needs analysis in relation to establishing fish pens in the vicinity of shrimp and crab populations.

There is a well documented literature demonstrating that molluscan embryos and larvae - some of commercial significance - are subject to serious infection by these same species of vibrio bacteria. Abalone embryos and Pacific oyster (*Crassostrea gigas*) embryos and veliger larvae in hatcheries suffer serious mortalities from vibriosis (Sparks, 1985; Jeffries, 1984; Tubiash and Elston, 1984). It would be prudent to determine carefully the potential damage that may be caused by juxtaposing salmon pens to oyster and abalone culture facilities, and to native bivalve beds.

It would be of interest, also, to determine if vibriosis similarly affects these same kinds of molluscan larvae and embryos in the natural plankton, thereby affecting natural populations. Beyond that, it is important to know if populations of these *Vibrio* species or other pathogens, enhanced by sewage or fish pen wastes, infect other forms of invertebrate larvae or adults. I am thinking of the sponges, sea urchins, starfish and the host of other invertebrates which, though not of direct commercial value, are absolutely fundamental to the ecosystems of these water and to their productivity. Their impairment would sound the death knell for these waters.

Some of these bacteria are pathogenic to man as well. Knowledge of the genus *Vibrio* is expanding rapidly. This genus, which includes *V. cholerae*, includes species that typically live in marine locales (Kelly et al., 1982). *V. anguillarum* appears not to infect humans. However, *V. vulnificus* and *V. parahaemolyticus* do infect humans. *V. vulnificus*, a recently recognized species, is a deadly pathogen that is carried in sea water. It is readily filtered and concentrated from sea water by oysters and clams and it is easily transmitted to humans when these bivalves are eaten. The results are often fatal. Other than through ingestion, humans can contract the disease through simple contact of sea water with open wounds or mucosal tissues. It is predominately a warm water organism, which suggests that our waters may be safe from it, but virulent strains of this species have been found in Oregon associated with fish, crabs and clams and in Japan associated with eels (Tison and Kelly, 1986; Kelly and McCormick, 1981; Tison and Kelly, 1984; Blake, Weaver and Hollis, 1980). A preliminary search for this species in the San Juan Islands has not revealed it, but its presence in warmer bays there, and in the Canadian Gulf Islands, or elsewhere in the Sound cannot yet be discounted (Kelly, pers. com.). *V. parahaemolyticus* is, by contrast, commonly found around the San Juan Islands and doubtless is ubiquitous here (Kelly, pers. com.). It causes acute gastroenteritis in humans (Tison and Kelly, 1984; Blake, Weaver and Hollis 1980). This form of gastroenteritis appears to be transmitted exclusively through food, usually seafood (Blake, Weaver and Hollis, 1980). It can be a very significant infectious agent: in Japan, over a 10 year span, 24% of reported cases of food poisoning were attributed to this bacterium.

V. parahaemolyticus, thus, is present here, is a known pathogen of humans, and is transmitted through filter feeders such as clams and oysters. *V. vulnificus* is found nearby, and with further searching may be found in the Sound and Gulf. Simple contact with infected sea water will lead to serious infection. The former species, and probably the latter as well, thrives in heavy, enriched sediments such as sewage sludge. It can also be expected to grow in salmon pen sludge (Staley, pers. com.; Kelly, pers. com.).

It has been argued by associates of the salmon pen aquaculture industry that human diseases associated with these vibrios have been rarely found in the Puget Sound region, and therefore no danger is posed by them. Thus fish pen aquaculture is justified. It is good that the base line now, before salmon pens are well established, is essentially zero. The water is relatively clean, now, and the populations of these pathogens are within tolerable limits, using customary screening methods for detecting these pathogens. But a further complication is introduced by a recent paper (Grimes, et al, 1986). They find that when such pathogens as I have been discussing are introduced into marine waters, they rather quickly lose their identity as measured by conventional culture methods. They enter into dormancy, but remain viable though not culturable by traditional methods. Failure to find them using these methods could lead to overlooking a substantial, but cryptic source of serious pathogens in the environment.

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.

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- The main obstacles to increased consumption in the United States derive from limitations of supply. Fish are primarily caught and supplied from the open seas. Not only does the catch itself fluctuate from year-to year (season to season), but the U.S. is heavily dependent on foreign suppliers. In recent years, imports have accounted for at least 60% of domestic consumption. In 1985, the figure was 64.4%. Our 60% import level reflects the superior organization and equipment of foreign fishing industries, their high commitment to quality, and the fact that some foreign countries developed new, high value products that the U.S. has not yet managed (or attempted) to emulate.

- Numerous opportunities present themselves for expansion in the seafood industry. Moreover, for many important species, that demand appears to be strong enough to offset the higher prices that will follow limited supply.

- Since it is unlikely that domestic supply can meet the increased demand, imports will continue to make up the difference.

- It is clear that aquaculture holds great potential for establishing a steady supply of high quality seafood. Aquatic animals thus reared can be harvested at the optimum time and processed immediately (Seafood Processing & Distribution by Resource Dev. Inc., report 715, Nov. 1986).

Ocean Harvest Static for 20 Years

- The annual harvest world-wide of fishery products from our oceans has remained static for the past 20 years, yet world population has passed 5 billion and is expected to double in 35 years. (August 5, 1986 presentation to National Conference of State Legislators, Dr. James Avault, fishery biologist La. St. Univ.).

\$4.5 billion in Seafood Deficit in 1985

The United States imported \$4.5 billion in seafood in 1985. Fish is our largest food import (Sci. of Food and Agriculture, Nov. 1985).

EXAMPLES

-\$48.2 million in fish analog (surimi) from Japan alone in 1985

-\$1.2 billion in wild caught and cultured shrimp in 1985

-\$80 million in farmed salmon in 1985, primarily for Norway, Canada, Scotland, Ireland, Denmark, Chile and New Zealand (see worldwide Pen Reared Salmon attached)

Percapita Fish Consumption Rising Rapidly

U.S. annual percapita consumption of commercial fish and shellfish has risen from 12.3 pounds in 1982 to 14.5 pounds in 1985. (Washington Seafood Marketing Study, Dec. 1986).

If we are to reach consumption of 20 pounds percapita by 1990, an additional 1.5 billion pounds of seafood are needed to satisfy demand. (Seafood Bus., Jan/Feb 1987).

Prepared by John Pitts, DVM, Washington State Department of Agriculture, January 1987

Norway

- 1973 production = 170 tons, 1985 = 27,000 tons, est. 1986 - 40,000 tons.
- "Imports of fresh salmon from Norway totaled 15.8 million pounds Jan-Oct '86, compared with 11.2 million pounds during the same period in 1985" (Seafood Bus., January '87), refers to U.S. imports only.
- Wholesale value of fresh Atlantic Salmon exceeded \$4.00 per pound during the '86 period.
- In 1985, Norway produced 78% of all farmed Atlantic Salmon. In 1985 71.8% of all fresh salmon entering the U.S. originated in Norway, valued in excess of \$60 million.

Scotland

- Farmed production increased from 600 tons in 1980 to 7,000 tons in 1985, and 8,000 tons in 1986. Planned production for 1987 - 14,000 tons.
- Scotland is the second leading exporter of Atlantic Salmon to U.S., \$4 million value in 1985.

Major Producers of Pacific Salmon (25% of the farmed salmon)

Japan

- Currently the largest producer, primarily farmed Coho.
- 1985, 6,900 tons were produced for domestic consumption.

United States

- Washington State production of pan-sized Coho was 1,685 tons (3,369,000 pounds) in 1985, with a wholesale value exceeding \$10 million.
- Production was primarily by one company, on approx. 8 surface acres of marine water.

Canada

- Industry established in British Columbia, New Brunswick and Nova Scotia.
- The 70 currently operating farms in B.C. represent investment of \$75 million, employs 375 directly, and spend \$50 million/yr. on services and supplies.
- B.C. plans to produce 30,000 metric tons of salmon by 1990, primarily for U.S. export market.

Chile

- Exported 0.3 million pounds Coho to U.S., Jan-Oct 85, and 1.4 million pounds during same period 1986.
- Total production in 1986 was 800% over 1985.
- "We imported more Chilean cultured Coho in 1986 than were caught by Oregon fishermen", (Dr. J. Lannan, O.S.U. fishery biologist.)

The United States imported \$80 million in farmed salmon in 1985. The 1986 figures are not yet available, but will be much higher. The U.S. Market for farmed salmon is estimated to be worth \$130 million by 1990.

Finland:
1983 - 372 jobs at 103 farms
1984 - 515 jobs at 129 farms
1985 - 721 jobs at 194 farms

Support industries such as fish processing, net making, feed production, cage construction, etc., create a multiplier of 1.5 to 2.0 for upland employment. (source: Highlands and Islands Development Assoc., 1986).

Norway: 1984 - 2,000 jobs at 500 farms
1986 - 2,700 jobs at 700 farms
1987 - 150 new farms permitted (Ministry of Fishery, Norway, pers. comm., Oct. 1986).

Total jobs related to Norwegian salmon industry expected to go from 4,000 in '84 to 12,000 in '90. (Water Farming Jour., Nov. '86).

Canada: December, 1986 - 75 farms in British Columbia
23 farms in Bay of Fundy

Average employment is 5.5 jobs/farm - 539 jobs total. Upland support not included.

Puget Sound: January, 1987

Domsea, Manchester, employs an average of 140 people at 3 farms and 2 hatcheries, and their processing plants. 1985 Coho production was 3,369,000 pounds with an estimated wholesale value of \$10,107,000.

Sea Farms, Pt. Angeles, 13 jobs at 2 acre farm (will add 6 more in 87-88 as they expand), 2 jobs at Hadlock site, and 5.5 jobs at Rochester hatchery. Additional seasonal employment during harvest and summer. 1987 production est. = 500,000 lbs.

ScanAm Farms, Cypress Island, 11 full time plus seasonal employ. 50,000 pound production '86, est. 700,00 lbs. in 1987.

Prepared by John Pitts, DVM, Washington State Dept. of Agriculture, Jan. 1987

SPECIES	POUNDS GROWN	PRICE/LB. EX-VESSEL	VALUE EX-VESSEL	PRICE/LB. WHOLESALE	VALUE WHOLESALE
HARDSHELL CLAMS					
BUTTER	18,231	\$0.27	\$4,911	\$0.50	\$9,116
NATIVE LITTLENECK	534,417	\$0.52	\$277,523	\$1.10	\$587,859
MANILA	2,847,558	\$0.53	\$1,500,094	\$1.25	\$3,559,448
SOFTSHELL	405,256	\$0.38	\$155,497	\$1.00	\$405,256
OYSTERS					
OLYMPIA	2,447	\$21.47	\$52,526	\$21.47	\$52,537
PACIFIC	6,020,000	\$1.07	\$6,437,788	\$2.51	\$15,110,200
KUMAMOTO	36,661	\$9.19	\$336,757	\$9.19	\$336,915
EUROPEAN (O. EDULIS)	1,219	\$16.92	\$20,623	\$16.72	\$20,382
MUSSELS	264,000	0.53	140,844	\$1.10	\$290,400
TROUT (RAINBOW, CUTTHROAT)					
EGGS	75,000			\$28.00	\$2,100,000
JUVENILES (LIVE)	12,600			\$25.00	\$315,000
PAN-SIZED	552,000	\$1.60	\$883,200	\$2.00	\$1,104,000
SALMON (COHO)					
EGGS	420			\$120.00	\$50,400
JUVENILES (LIVE)	1,000			\$64.00	\$64,000
PAN-SIZED	3,369,000	\$1.36	\$4,581,840	\$3.00	\$10,107,000
TOTAL	14,139,809		\$14,391,602		\$34,112,511

NOTES:

1) Whole weight is reported for all species except oysters. Oysters are reported as pounds of shucked meat. A gallon of oyster meat weighs about 8.75 pounds and a pound of meat is equivalent to around 5 pounds whole weight (in the shell). If oysters were reported in whole weight like everything else, their total production would be around 30 million pounds and total aquaculture production would be around 38 million.

2) "Ex-vessel" values are those reported to the department. These are consistently below market value. Consequently, I have included a best guess wholesale value (value of finished product including processing, packaging and shipping in most cases). I consider wholesale value to be the best estimate of actual value for the industry and the most consistent.

3) Washington is a major producer of eggs and juveniles for stocking trout farms. These are sold live and are consequently reported as final product (harvested fish) elsewhere.

RECEIVED

JUL 4 1985

PLANNING

DEPT.

NATIONAL AQUACULTURE IMPROVEMENT ACT OF 1985

Food Security Act of 1985
Title 17 -- Related and Miscellaneous Matters
Subtitle D. National Aquaculture Improvement Act of 1985

An Act

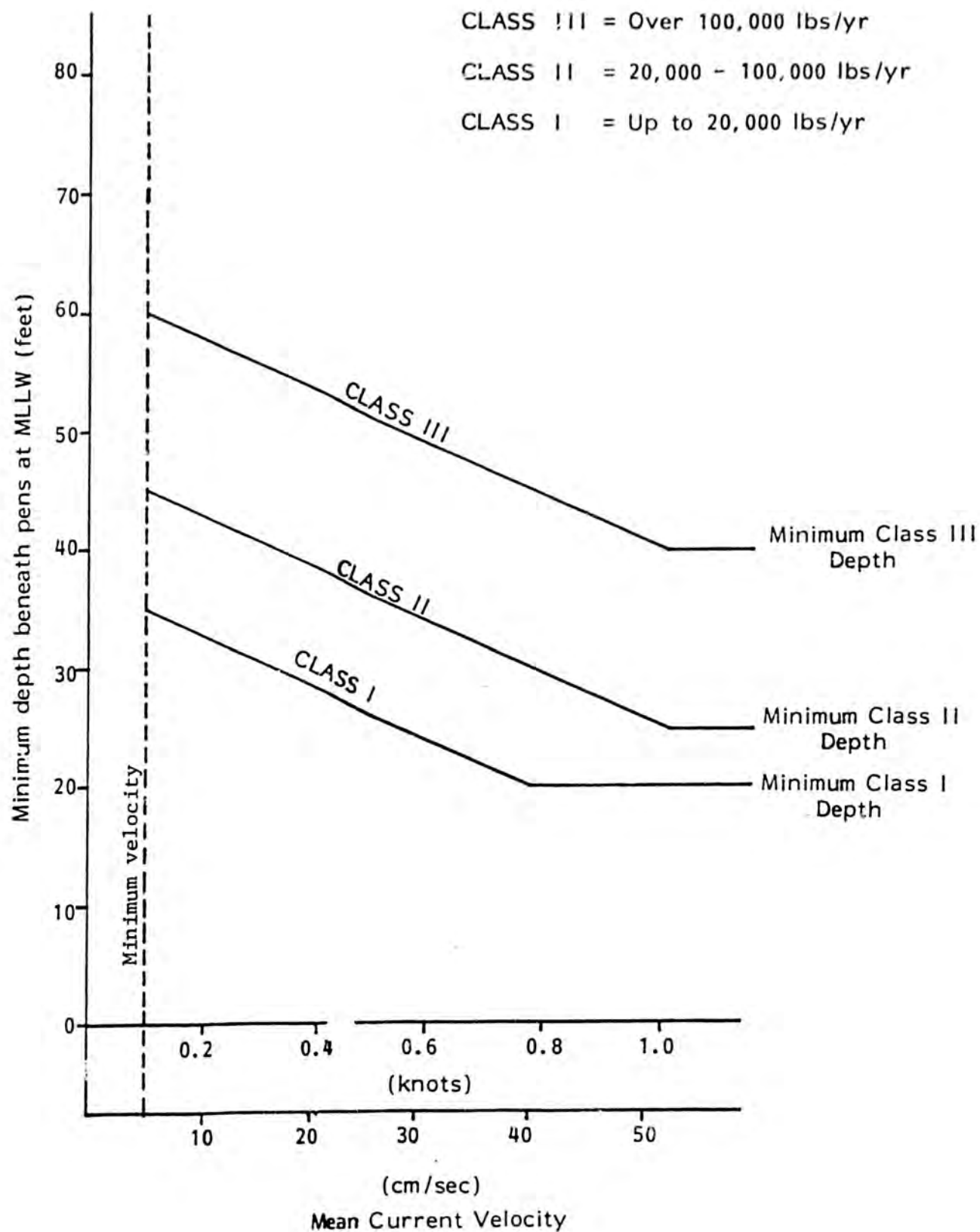
To provide for the development of aquaculture in the United States, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Aquaculture Improvement Act of 1985".

FINDINGS, PURPOSE, AND POLICY

SEC. 2. (a) FINDINGS--Congress finds the following:

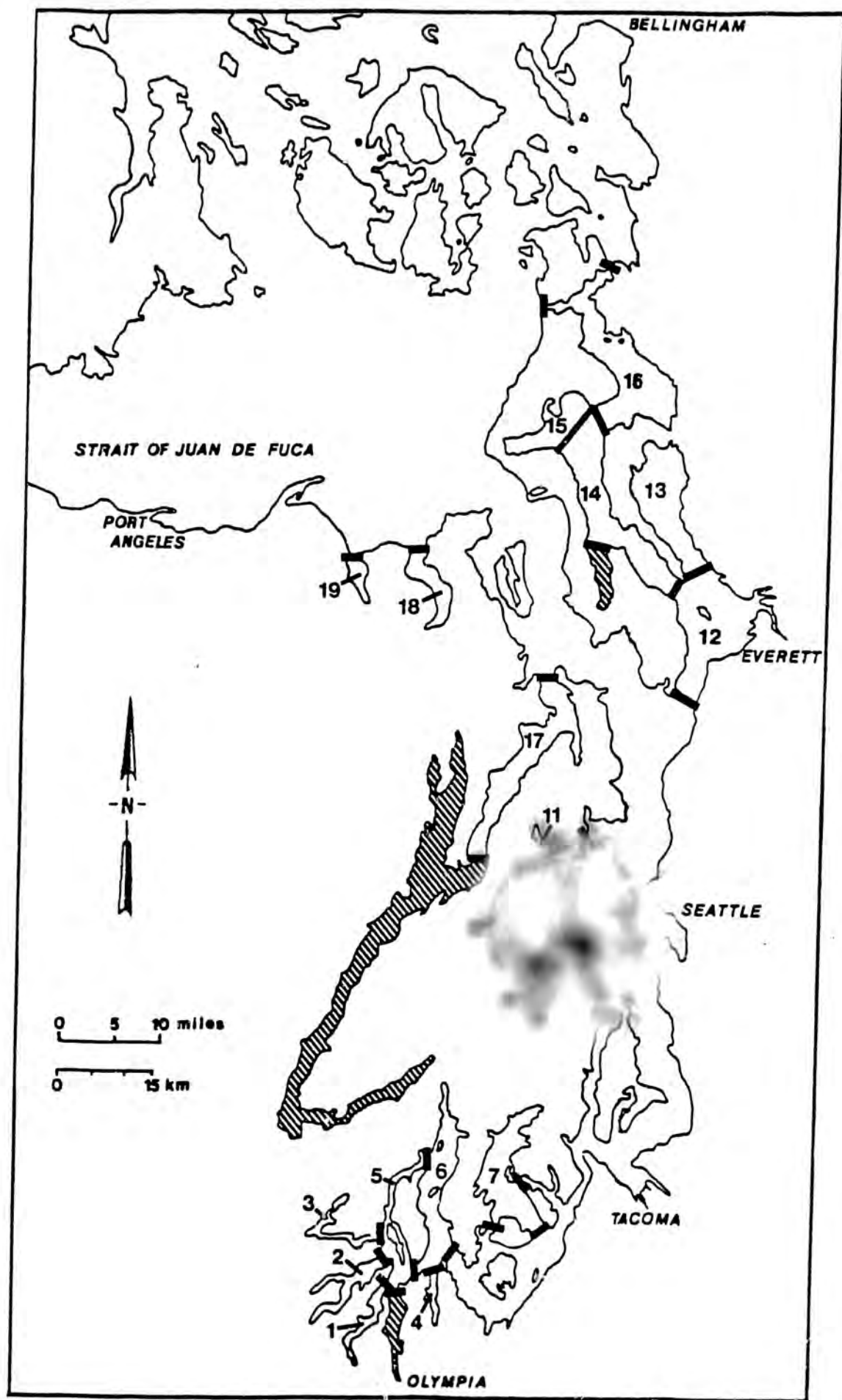
- (1) The harvest of certain species of fish and shellfish exceeds levels of optimum sustainable yield, thereby making it more difficult to meet the increasing demand for aquatic food
- (2) To satisfy the domestic market for aquatic food, the United States imports more than 50 per centum of its fish and shellfish, but this dependence on imports adversely affects the national balance of payments and contributes to the uncertainty of supplies.
- (3) Although aquaculture currently contributes approximately 13 per centum of world seafood production, less than 6 per centum of current United States seafood production results from aquaculture. Domestic aquacultural production, therefore, has the potential for significant growth.
- (4) Aquacultural production of aquatic plants can provide sources of food, industrial materials, pharmaceuticals, and energy, and can assist in the control and abatement of pollution.
- (5) The rehabilitation and enhancement of fish and shellfish resources are desirable applications of aquacultural technology.
- (6) The principal responsibility for the development of aquaculture in the United States must rest with the private sector.
- (7) Despite its potential, the development of aquaculture in the United States has been inhibited by many scientific, economic, legal, and production factors, such as inadequate credit, diffused legal jurisdiction, the lack of management information, lack of supportive Government policies, and the lack of reliable supplies of seed stock.
- (8) Many areas of the United States are suitable for aquaculture, but are subject to land-use or water-use management policies that do not adequately consider the potential for aquaculture and may inhibit the development of aquaculture.



MINIMUM DEPTH AND CURRENT VELOCITY FOR NET-PEN SITING

WATER QUALITY CONSIDERATIONS IN NET-PEN CULTURE

- **Dissolved oxygen**
 - Reduced through respiration and decomposition of organic matter
- **Nutrients**
 - Toxicity
 - Stimulation of phytoplankton growth
- **Mitigation strategies**
 - Avoid areas with existing chronic water quality problems
 - Avoid areas with poor flushing
 - Avoid a high density of pens in a small area



OTHER INTERIM GUIDELINES

- 150 to 300 ft from habitats of special significance
- 1500 ft from critical bird and mammal habitats
- Unpelletized wet feed should not be used
- Predator control measures must comply with federal and state regulations
- Tributyltin should not be used as an antifouling agent
- Only FDA licensed antibiotics should be used. They should be used on a short term basis and not administered prophylactically over extended periods.
- Transfer and importation of fish in accordance with state and federal regulations
- An operations plan must be prepared including project description, and anticipated operational practices.
- A site characterization survey should be done before permit approval
- Annual monitoring should be performed at all Class II and III facilities



ALASKA MARINE RESOURCE QUARTERLY

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UNIVERSITY OF ALASKA

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COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF ALASKA FAIRBANKS, USDA AND SEA GRANT COOPERATING



Shellfish Mariculture

by
Michael Kaill
Mariculture Coordinator
FRED Division
Alaska Department of Fish and Game

Introduction

Alaska has the potential to enter a new resource industry - shellfish mariculture. Although oyster farming has been with us for some time, its growth has been hampered by lack of infrastructure. Culture of other species of shellfish, though unproved in Alaska, has been demonstrated in Japan, Canada, and the Pacific Northwest as well as other places. Recent action by the Alaska legislature has begun to clear away some of the obstacles keeping Alaska from realizing its potential.

Environmentally, Alaska is well suited to shellfish mariculture. However, there are some challenges that must be addressed.

Bourne and Brett (1984) suggest that:

"Several criteria must be considered when deciding if an animal is suitable for culture; three of the most important are an inexpensive and plentiful source of juvenile (seed), a rapid growth rate (or reasonably so), and a high price for the product."

Added to this are the technical as well as social factors involved in site selection for a sea farm in Alaska's tidewaters.

Permitting and Permit Activity

Legislation has been passed to authorize the collection of spat for bivalve shellfish farming. In order to meet the intent of this legislation, the Alaska Department of Fish and Game (ADF&G) has undertaken the following tasks:

1. Created a permit system for commercial collection of spat (juvenile shellfish) to be used as seed for bivalve shellfish farming. At this time there are three commercial scallop spat fishermen.
2. Revised the Fish Transport Permit (FTP) so that it will be appropriate for the shellfish program. The purpose of the FTP is to protect natural and enhanced stocks against disease problems and unwanted mixing of gene pools.
3. Proposed new regulations for the shellfish mariculture program. At the time of this

writing, these regulations are under public review.

4. Prepared a unified application system for a shellfish farm. One of the problems expressed by the public is the heavy load placed on applicants as they deal with the many agencies involved in permitting. ADF&G, working cooperatively with other agencies, has produced a single application form for ADF&G, Department of Environmental Conservation (DEC), Department of Natural Resources (DNR), and the Governor's Division of Governmental Coordination (DGC). DGC will receive the application form from the applicant and coordinate review. The unified application form is now in the final stages of review.
5. Began to develop information on key issues in anticipation of the 1987-88 legislative session. This effort is being coordinated by ADF&G and involves DEC, DNR, Department of Labor, and the Commercial Fisheries Entry Commission (CFEC). CFEC is involved not from the point of view of limited entry, but of commercial fishery licensing. This information packet will include discussion papers on important issues, an analysis of management systems in other states and countries, and an analysis of selected policy options.

Permit Activity: The Department of Environmental Conservation has issued or is in the process of issuing certification for about 50 shellfish farming operations. Of that number, about ten oyster and mussel operations are producing product for the market. Main centers of production at this time are Halibut Cove Lagoon (in Kachemak Bay) and the Wrangell/Petersburg area. There are several operators in Kodiak, Ketchikan, and parts of Prince William Sound that are seriously working toward producing products in marketable quantities.

Promising Aspects of Mariculture in Alaska

Market: In order for a cultured product to be successful, it should command a high and stable price and be in high demand. For the species holding best promise for mariculture in Alaska (oyster, scallop, and mussel) the situation is encouraging - particularly since the American public is turning to seafood as one way to increase quality of life and health.

Sites for Sea Farms: One of Alaska's great advantages over the "lower 48" for mariculture is its extensive and highly complex shore line. Pollution (including the recent problems with "visual" pollution) seems to be a major obstacle to the continued development of mariculture elsewhere in the Pacific Northwest. Alaska's low pollution levels, together with the many protected coves and bays found in much of the state, show a real advantage in this area. Low population densities suggest that this will not be a problem for some time.

It is important to note that sea farm siting requires careful coordination, not only with areas of environment and alternative uses (subsistence, scenic esthetic, commercial anchorage, and others).

Stability: A successful mariculture would use one of Alaska's strong resources to augment sometimes problematical oil revenues. The "boom-or-bust" nature of Alaska's industries is frequently mentioned. Sea farming has the potential to create a steady economic benefit to the state.

Benefits to Rural Alaska: Since mariculture operations require remote siting and a fair amount of year-round labor, it is expected that coastal rural Alaska will receive a large share of any economic benefits coming to the state through mariculture.

Growth Potential: Mariculture is a growing industry. Even in countries where it is a major force, sea farms are a relatively recent development. There is good potential for increases in profit margin, ease of operating the farms, safety to the plants and animals being farmed, and for reduction of negative visual and environmental effects. Areas of promise are: advances in equipment technology (feeding, cleaning of cages, flotation systems, handling of product) and technical advances in biological areas (genetic engineering, inexpensive seed production from hatcheries, new species/polyculture development).

Working in coordination with the commercial fishing industry, innovative combinations of mariculture and commercial fishing can be developed. For example, one of the most profitable aspects of mariculture involves seeding some selected sections of the ocean floor with small scallop. Subsections of

Shellfish Mariculture *continued*

that area are then harvested by commercial fishermen, a plan similar to crop rotation.

Problems and Challenges

PSP: Bivalve shellfish are filter feeders and, as such, are capable of concentrating the toxin from several species of free-swimming microscopic organisms. The result can be Paralytic Shellfish Poisoning (PSP). The problems with this are primarily associated with human health, expense, loss of shelf life, and logistical problems involved with testing to make sure that a particular shipment of product does not have PSP toxin above tolerance levels.

One of the advantages of scallop culture is that the traditional product form (shucked adductor muscle) does not have appreciable amounts of toxin and can be marketed with a minimum of testing for PSP.

One need of the industry is for more efficient PSP testing, particularly for southeast Alaska.

Siting: Remote site locations maybe necessary to get good water quality and to get away from conflict-prone high-use areas. However, the remote sites have problems from the point of view of getting and supporting workers on site, getting the products to market, and general logistics (maintenance service, supplies, etc.). Site selection must consider trade-offs between these factors.

Seed Supply: A basic need for any farm is an inexpensive and reliable seed supply. Shortage of seed is one of the reasons that shellfish mariculture in Alaska has not grown more quickly. Options are to purchase from a hatchery or capture from wild sources.

A joint ADF&G/OFCF project now under way in Kodiak is testing feasibility of capturing weathervane scallop spat using spat collectors developed by the Japanese scallop farmers. OFCF (Overseas Fisheries Cooperation Foundation) is a quasi-government Japanese foundation funding projects whose objective is to promote international goodwill. Other similar but smaller-scale projects are under way in various parts of the state.

Economics: The profit margin for a shellfish farmer may be narrow. To operate a successful business, the farmer must have a good financial plan, including an understanding of the critical economic parts of the farming operation. Examples are minimizing equipment cost, controlling logistic problems, getting best use of labor, and effective marketing.

Disease and Genetics Issues: These issues are not cause for serious concern as long as proper safeguards and programs are in place (inspections, lab support, etc.). In general (providing that there is no introduction of exotic stocks), any disease threats from indigenous stocks can be dealt with using existing policy and procedure. Review and policy adjustments are ongoing, as the resource agencies accommodate these new programs.



Mike Kaill examining kelp near Kodiak Island.

A Quick Look at Alaska Mariculture by Species

Scallop: here are several species of scallop in Alaska. Scallop of interest to mariculturists are: the weathervane (*Patinopecten caurinus*), the purple-hinge rock scallop *Crassodoma (Hinnites) gigantea*, and two or more species collectively called "bay scallop" (genus *Chlamys*). Of these, the large, commercial weathervane is of great interest. A close relative is the basis of the rich scallop culture in Japan. The weathervane has a high demand in the U.S., commanding a consistently high price based on product from the trawl fishery. The purple hinge is not commercially taken, since it is sparsely (though widely) distributed. If a hatchery program for seed could be initiated, this species, with growth and product quality close to the weathervane, could show much promise.

However, the bay scallop complex, composed of smaller, slower growing scallops, might be marginal for culture.

Oyster: There is currently a "half-shell" oyster industry in Alaska. Many of the farms are in the Wrangell-Petersburg area, though new interest is appearing in the Ketchikan area, Prince William Sound, and Kodiak. The Alaska-produced product (Japanese oyster, *Crassostrea gigas*) is of high quality. One of the reasons for this is that the oyster is on the edge of its range, and seldom comes into reproductive condition in Alaskan waters. Energy that would go into gonadal tissue is devoted to flesh, creating a plump, yet relatively fast growing oyster. Seed is provided by producers in Washington and Canada, which is a problem because of expense and logistics. The Japanese oyster is presently the only authorized mariculture Alaska import.

Mussel: Although not a common seafood item in Alaska, the blue mussel (*Mytilus edulis*) is a highly prized delicacy in Europe. There is an increasing appreciation for this species in Alaska, particularly when diners realize that the cultured mussel is far superior to the one taken from the beach. Culturing blue mussel has the advantage of readily available seed (dense concentration of spat settlement in some areas) and an 11-month growing season, compared to 2 to 3 years in other species.

Other Species: Other species of shellfish are candidates for culture in Alaska, but are not nearly as strong as the species mentioned above. These include surf clam, razor clam, as well as species not yet authorized by the legislature such as sea urchin, shrimp, and crab.

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Salmon Ocean Ranching in Alaska

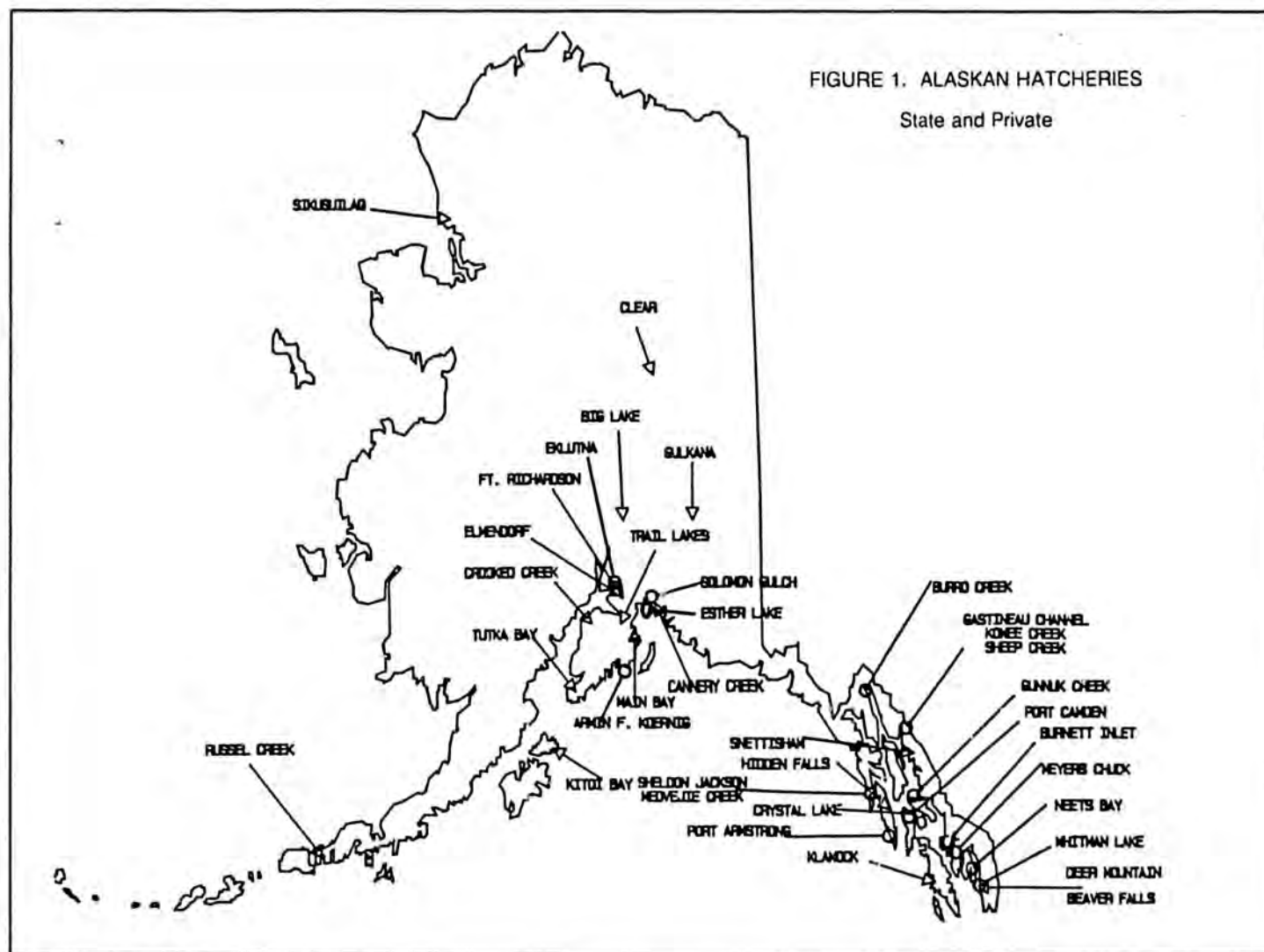
by
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 Director
 FRED Division
 Alaska Department of Fish and Game

Introduction

The largest and most successful form of aquaculture in Alaska is salmon ocean ranching. It was created out of need by the state legislature in the early 1970s when natural salmon runs were depleted statewide. Enabling legislation in 1971 began with a public program and expanded in 1974 to statutes allowing for a private nonprofit sector. Ocean ranching of salmon is an established technology over 100 years old which takes advantage of the fact that salmon "home" or return unerringly to their location of release.

The source of initial production comes from freshwater hatcheries which control the environment such that roughly eight times the survival is achieved over their natural counterparts. This is true because a constant, reliable source of water is applied during the egg to juvenile salmon release phase, as contrasted to natural production which can be severely limited based upon lack of water flow, natural streambed dynamics, and freezing temperature regimes. Depending upon the species' life history strategy, the salmon are released into the marine environment as fry for chum or pink salmon, or as smolts for chinook or coho salmon, or into a freshwater lake as sockeye salmon fry. It is this unique, instinctual migratory behavior of leaving freshwater as juveniles, growing and initiating maturation in the marine environment with the return back to freshwater to spawn that

distinguishes Pacific salmon and sea run trout like steelhead and makes them so economically valuable. This life style is called anadromy and its survival value is obvious in that the richness of ocean pastures can be exploited by what was originally a freshwater fish. Moreover, the fact that salmon specifically return or "home" to their location of release causes aquaculturists to have some control over their migration as if they were on a chemical leash. That the leash is chemical has been determined by many laboratory and field experiments which all prove that anadromous salmon and trout have an uncanny sense of olfaction, or they smell their way home. In the course of going home, these fishes are caught in the commercial, sport, subsistence, and personal-use fisheries and contribute substantially to the social and economic lives of urban and rural Alaskans.



Ocean Ranching *continued*

Present Status

There are currently 19 public hatcheries run by the Alaska Department of Fish and Game (ADF&G), Fisheries Rehabilitation, Enhancement and Development (FRED) Division, and 25 private nonprofit permits with 18 operational hatcheries practicing the technology of salmon ocean ranching throughout Alaska. The scope of the program is bold and worldwide in perspective (Fig. 1). These hatcheries took 1.338 billion salmon eggs last year, plus over 10 million trout eggs (Fig. 2). The Alaskan salmon ocean ranching program is the largest in North America, approximately one-half the size of Japan's and roughly equal to Russian programs. Sockeye salmon production alone is the largest in the world with over 100 million eggs taken. These phenomenal records were achieved from inception in the early 1970s to the present, a relatively short 17 years. As yet, preliminary data suggests that the returns in 1987 from both the public and private nonprofit program account for roughly 18 percent of the total salmon harvest statewide. When the data for Alaskan hatchery returns in 1987 is graphed, it shows that most of the returns to date are from pink salmon, followed by chum and sockeye salmon (Fig. 3). The reason pink salmon ocean ranching has been so successful relates to their 2-year life cycle and the fact that they are economical to raise.

Aside from the biological successes, salmon ocean ranching has had a profound impact on the economic and social structure of Alaskan communities. One study conducted in 1984 predicts that the statewide program will generate net benefits over costs of \$90 million to the Alaskan economy for just the commercial fishery portion of the program. A more recent study to quantify the economic impacts of the ocean ranching program utilizes an impact model developed by the Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage. This model determined that the economic contribution of ocean ranching to resident personal income was \$75 million and over 2,000 resident jobs from fish dollars directly earned in the fishing industry, or by indirect or induced spending in other sectors of the community.

Since these programs produce significant numbers of fish for the sport fishery as well, both economic studies have underestimated the total economic impact. Because values

FIGURE 2. ALASKAN HATCHERY EGG TAKES 1987

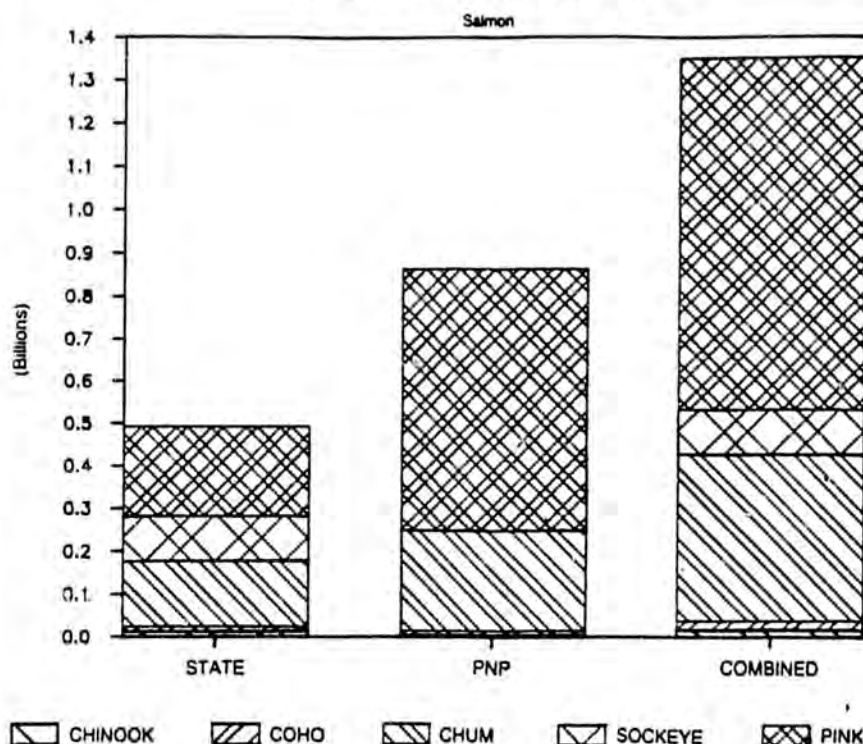
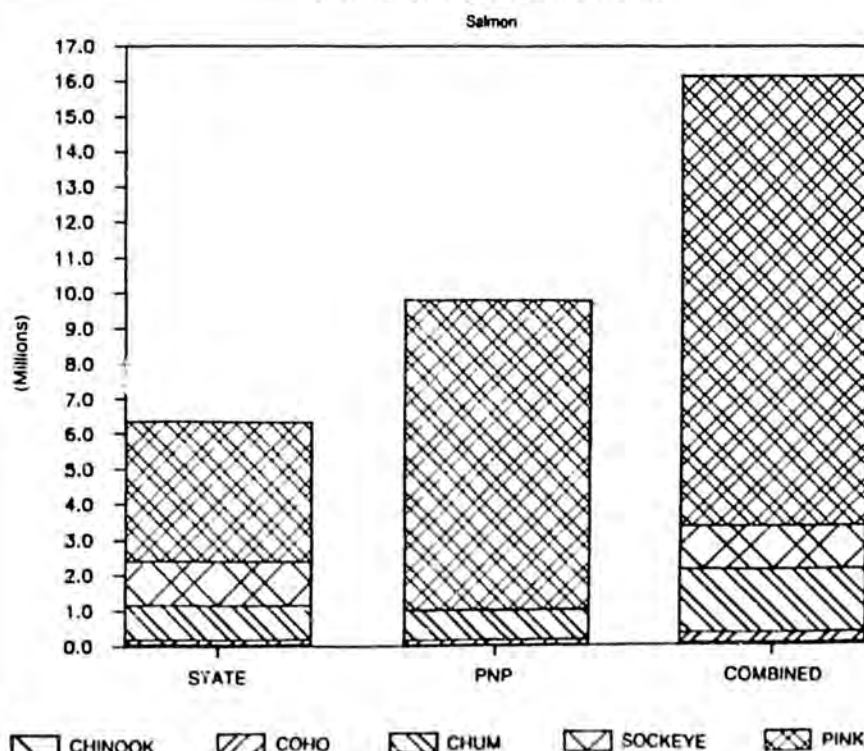


FIGURE 3. ALASKAN HATCHERY RETURNS 1987



Ocean Ranching *continued*

have not been generated for the recreational value, it has been difficult to compute the economic benefit in total to date; when this is done, an even greater economic impact than presently projected will result.

An insight into the scope of the salmon ocean ranching program in the immediate future can be seen in the projected adult return and revenue from the 1988 egg take. Given the generation times of the salmon species involved, this can be two years or 1990 for pink salmon and six years or 1994 for chinook salmon. The projected adult common property fishery harvest of salmon from both state and private nonprofit programs represent roughly 34 million fish and \$76 million in gross revenue (Figs. 4 and 5).

In addition to anadromous salmon and steelhead trout, the public enhancement program (the ADF&G/FRED program) produces substantial numbers of landlocked or resident species, such as rainbow trout, Arctic grayling, Arctic char, sheefish and, most recently, lake trout. The culturing and future production potential of these species is encouraging based upon sport fishermen demand from both resident and tourist sectors.

Salmon ocean ranching in Alaska is an unparalleled biological and economic success and has achieved a world-class status after only ten years of adult returns. On this basis, the full potential of the present program has not been reached yet based upon the capacity of the production systems. It is this production potential in terms of continuing salmon supply that will provide the foundation for Alaska's world market salmon share and help to strengthen the salmon industry against future salmon harvest fluctuations.

FIGURE 4 ALASKA STATE AND PNP HATCHERY PROGRAMS

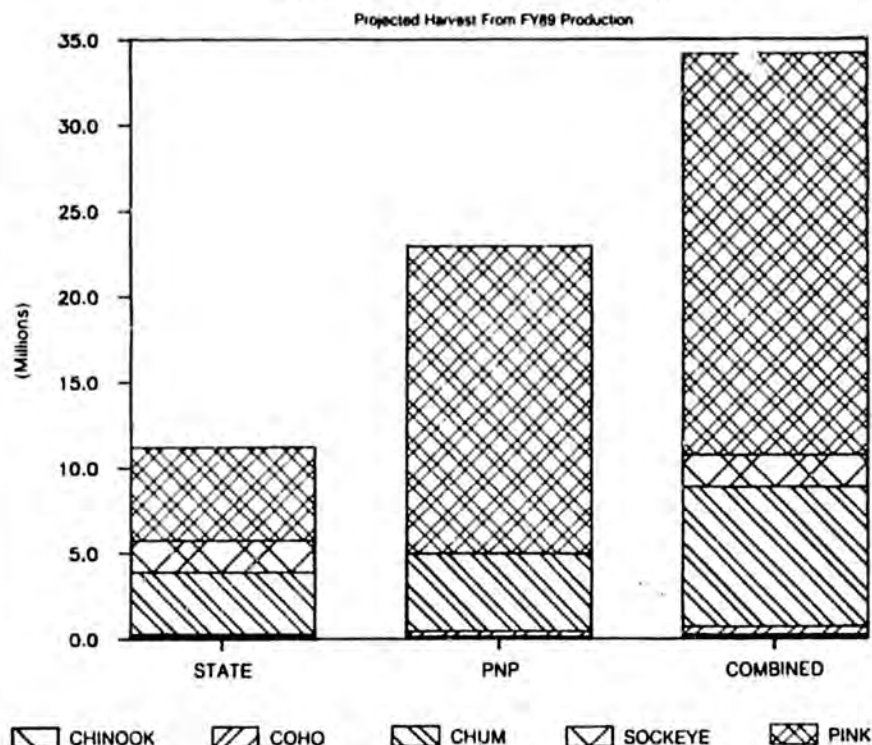
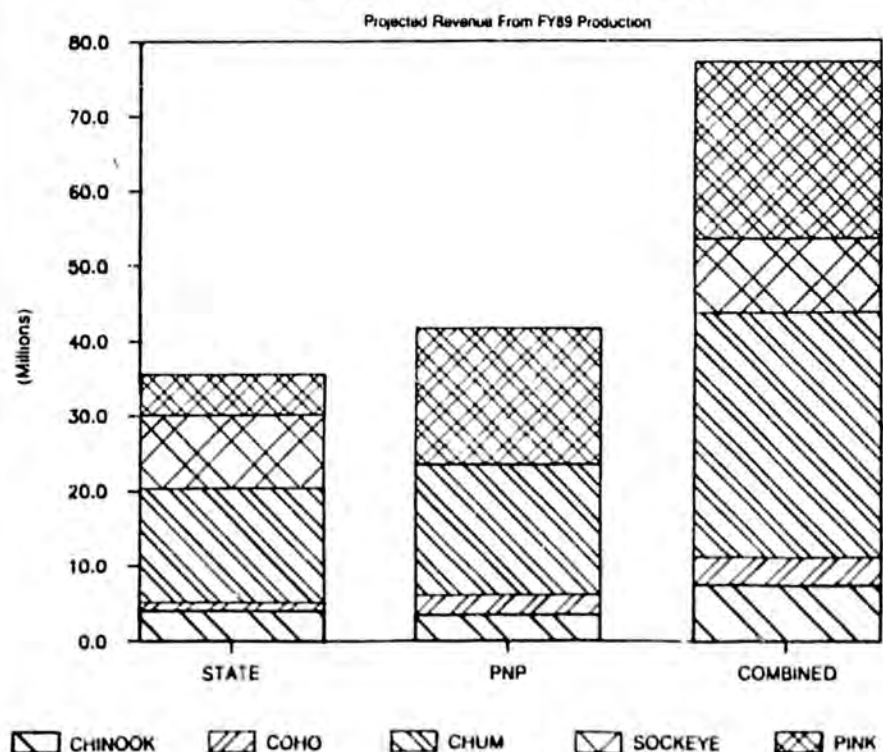


FIGURE 5 ALASKA STATE AND PNP HATCHERY PROGRAMS



Economics of Salmon Farming

by
Brad Pierce
Legislative Analyst
House of Representatives
Research Agency

The recent debate in the Alaska State Legislature over aquatic farming legislation (HB 108 and SB 106) has been highly emotional and often lacking in basic factual information. The most controversial subject has been whether to allow finfish and, more specifically, salmon farming in Alaska. Conflicting testimony has been offered before legislative committees concerning the feasibility of salmon farming in the state and its potential economic effects on the existing commercial fishing industry. Offered below is some basic economic information on salmon farming and estimates of impacts I have gleaned from a variety of sources in the course of studying this subject for the legislature during the past year.

The worldwide development of salmon farming to date, beginning in Norway in the early 1970s, has largely been a phenomenon of small to medium-sized companies. This has been primarily the result of an 8,000 m³ (cubic meter) pen size limitation in Norway, which was designed to encourage family businesses. As a social policy, the volume limitation has been successful in maximizing employment and improving the economies of coastal communities. However, it has also been a major contributor to disease problems in the Norwegian salmon farming industry as it encourages farmers to overstock pens to maximize returns on their investment. Farmers in Norway routinely produce 200 mt of Atlantic salmon annually within these volume constraints. Farms in New Brunswick or Nova Scotia with a comparable production capacity would typically have 2-3 times this net pen volume and far fewer disease problems caused by stress from overcrowding.

There are substantial economies of scale in salmon farming, though these tend to be tempered by the risk of disease outbreaks in very large single-site operations. To avoid domestic volume constraints, the effects of exchange rate fluctuations, and to reduce shipping costs to primary markets in the U.S., many successful Norwegian aquaculture firms have invested heavily in the burgeoning British Columbia salmon farming industry. About 40 percent of the investment capital in the B.C. salmon farming industry has come from

Norwegian sources, although many other sources of capital (including the Vancouver Stock Exchange) have been used. Aquaculture is now the fastest growing industry in B.C. The result has been an evolving corporate farm type structure (as opposed to small family farms in Norway) to the Canadian industry as smaller operators have acquired investment capital and have purchased others or expanded their operations to multiple sites.

A recent survey of B.C. salmon farms (November 25, 1987) by the Ministry of Agriculture and Fisheries listed 113 operational farms and 38 sites which were licensed but not operational. Average farm volume has increased from 6,767 m³ in 1986 to 20,821 m³ in 1987, while total B.C. farm volume has increased from 466,895 m³ to 2,123,739 m³. Likewise, the average farm holding capacity increased from 53.5 mt in 1986 to 166.6 mt in 1987, and total holding capacity grew from

3,717 mt to 16,990 mt. According to the Ministry of Environment, there are 38 commercial fish hatcheries with a combined capacity of 65 million eggs, although due to limited egg supplies, actual production is less than half of capacity.

Estimates of stock on hand in B.C. farms by species are as follows (in mt):

Chinook	2,768
Coho	1,214
Atlantics	81
Rainbow trout	194
Total	4,257

The cost structure of a typical B.C. salmon farm (Table 1) is presented in terms of the break even cost per pound of operations. Generally, it takes at least 6 quarters between the time smolts are put in a pen until the first harvests begin and the farmer can realize some cash flow. By the time full production is

TABLE 1. COST STRUCTURE OF A 110 mt B.C. SALMON FARM*
 (in U.S. Dollars)

Capital Costs		Total Initial Financial Requirement	
Buildings	\$ 22,500	Capital Costs	\$ 157,500
Cages & Nets	75,000	Operating Capital	262,500
Equipment	38,250		
Infrastructure	21,750		
Total	\$ 157,500	Total	\$ 420,000
Operating Expenses		Annual Costs	Cost per lb. Salmon
Smolts		\$ 26,925	\$ 0.12
Feed		150,626	0.67
Disease Control		2,640	0.01
Harvesting		20,024	0.09
Fuel & Supplies		18,000	0.08
Labor		22,500	0.10
Maintenance		4,875	0.02
Management Salaries		26,250	0.12
Communications		6,000	0.03
Insurance		6,000	0.03
Lease Fees		750	0.00
Professional Fees		6,000	0.03
Mortality Insurance		22,500	0.10
Miscellaneous		3,000	0.01
Depreciation		14,813	0.07
Term Loan Interest		9,286	0.04
Operating Loan Interest		1,738	0.01
Total Annual Expenses		\$ 341,926	\$ 1.52

*Source: Canada-British Columbia Subsidiary Agreement on Small Business Incentives.

Economics *continued*

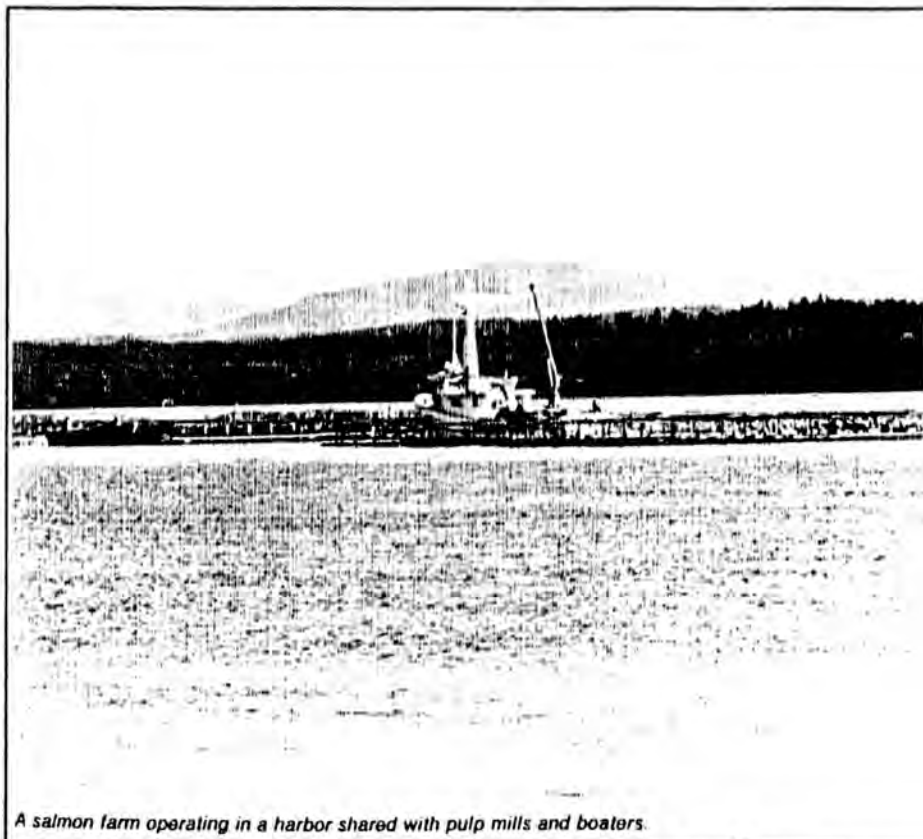
achieved (usually by the third year of operation) the average grower probably has a total investment of \$1 million (U.S.) in the operation. For 4-6 lb. fish, B.C. growers have been receiving farmside prices of \$2.30-\$2.65/lb. producing margins of 50-75 percent (larger fish command higher prices and produce greater margins). Production costs and mortality rates are expected to come down considerably in the near future through greater use of domesticated broodstock and improved husbandry techniques. These factors are likely to increase profitability even as increasing supplies of farmed fish in the marketplace tend to lower product prices.

The focus of the B.C. industry is turning from southern inside waters northward, to outside regions with more oceanic conditions. Colder water temperatures in northern B.C. produce slower growth rates, but these are more than compensated for in decreased mortalities (due to disease episodes and plankton blooms) compared to those experienced by southern B.C. farmers.

Currently the B.C. industry directly employs 544 persons - 318 full-time farm employees, 137 part-time workers, and 89 office employees. Salmon farming employees are not highly paid. The average annual wage assumed in another recent B.C. survey was \$18,000 - similar to wages paid in the seafood processing industry. The major difference is that salmon farming provides year-round employment to local residents, while the seafood processing industry tends to employ large numbers of seasonal nonresident workers. One has only to peruse a copy of the "Canadian Aquaculture Buyer's Guide" to realize that the industry is developing a substantial support sector with local businesses supplying smolts, net pens, feed, consulting and diagnostic services, processing, shipping, and marketing.

The Economic Impact of Salmon Farming in Alaska

During the past year, several attempts have been made to forecast the economic impact of a salmon farming industry (or varying scales of production) in Alaska with widely differing results. Given the fact that growing conditions in Alaska are very similar to those in northern B.C. and the cost structure of the Canadian industry cited previously, there is little doubt



A salmon farm operating in a harbor shared with pulp mills and boaters.

that salmon farming is economically feasible in the state. Even with marginally higher production and shipping costs, farmers in Alaska should be able to become competitive and realize reasonable profit margins.

A salmon farming industry in Alaska is likely to have purchasing and sales patterns that are similar to the existing fishing industry. For example, purchases of equipment are likely to be made outside the state, while basic supplies such as smolts and feed are more likely to be purchased locally. Alaska will have a smaller support sector than B.C. because the economy is much less mature. The most prudent approach to calculating economic impacts appears to be to assume an effect that is comparable (in proportional terms) to the existing commercial fishing industry. An additional consideration is that much of the capital investment for salmon farming is likely to come from outside the state as it has in B.C. (and as it has in the Alaska commercial fishing industry as well). This means that a certain amount of gross revenues will go to pay debt service and returns to outside investors, which will tend to offset the higher resident wage impact cited previously.

With these caveats in mind, my best guess is that a 10,000 mt Alaska salmon farming industry would produce 600 direct full-time jobs, a payroll of \$9.9 million and gross sales of about \$66 million. Note that a 10,000 mt industry is likely to be several years in the future, although a 4,000 mt industry could be realized within 4 years of the passage of enabling legislation. Purchases of feed from local processors (estimated at \$23 million) and eggs/smolt from public and private hatchery operators (about \$9.6 million) would also ripple through the state economy.

Presently, we do not have a feed plant in Alaska capable of supplying dry feed at economical prices. However, there are surimi plants in the Aleutians that produce fish meal byproducts (currently sold to Taiwan eel farmers) that could easily convert to supply fish feed at prices that are competitive with feed costs in other salmon farming countries. Surplus salmon eggs from Alaska's ocean ranching program are readily available. In 1986, Alaska's public and private nonprofit hatcheries had 4.6 million chinook and 23.2 million coho eggs that could not be used for enhancement projects under current genetic

Economics *continued*

regulations. These surplus egg supplies vary from year to year, but are expected to remain at substantial levels into the foreseeable future.

Even though there is little evidence of direct price competition between wild and farmed salmon in the existing economic data, there is little doubt that farmed production is rapidly gaining a dominant share of growing premium markets worldwide, while wild production is declining in market influence. About 97 percent of the harvest of premium species in Alaska is marketed in frozen form and only three percent fresh, while almost all farmed salmon is marketed in fresh product form. There is a fundamental consumer preference for fresh fish that is likely to increase in the future as greater volumes of farmed salmon become available. Thus, the market impact of worldwide salmon farming production will occur regardless of whether or not a salmon farming industry exists in Alaska.

Various attempts have been made to model the future market impacts of farmed salmon production on the existing commercial fishing industry, with little success. Salmon markets are extremely volatile and do not lend themselves readily to mathematical modeling techniques. Recently both the supply of, and demand for, fresh farmed salmon have exploded. Seafood markets in general have been very strong worldwide. Farmed salmon is a relatively new phenomenon in the marketplace. In a sense, salmon farmers have created their own markets by offering a high quality product year-round. With such a short market history to trend from and only a vague idea of the potential market size, economists have a difficult time forecasting the market impacts of farmed salmon production with confidence. However, these recent attempts at estimating market impacts are useful in illustrating the relative impact of worldwide farmed salmon production on the existing fishing industry in Alaska compared to a proposed local salmon farming industry.

We know that demand for salmon products in general is price elastic, i.e., a one percent increase in supply results in a less than one percent decrease in price. Estimates vary widely on the degree of price elasticity. A recent University of Alaska study applied the existing range of elasticity estimates for salmon products to the value of the Alaska commercial salmon harvest, assuming a 100,000 mt

increase in worldwide annual farmed salmon production by 1990. Several simulations were run varying the structure of a salmon farming industry (small vs. large farms) and the substitution effects of farmed for wild species. The worst case scenario forecast a \$36.4 million annual loss in gross revenues to Alaska commercial salmon fishermen, while the best case estimated a \$5.1 million loss.

Using this methodology, the potential market loss attributable to a 10,000 mt Alaska salmon farming industry would range between \$2.4 million (worst case) and \$0.4 million (best case). If we think of these market impacts in proportional terms and relate them to the 1987 Alaska salmon harvest value (estimated at \$458 million), worldwide farmed salmon production could potentially cause an 8 percent decrease in revenues by 1990. By comparison, production from an Alaska salmon farming industry could decrease commercial

fishermen's gross revenues by an additional one-half of one percent.

In conclusion, salmon farming is feasible in Alaska and development would offer substantial economic benefits to the state with minimal incremental impact on the existing commercial fishing industry. Aside from the immediate economic benefits, salmon farming would offer significant spinoff effects as the technology of broodstock development could be applied to the present ocean ranching system. Recently developed diploid techniques, which produce all female fry, seem particularly promising. Husbandry practices developed by farmers could also be applied to other species. Indications are that B.C. growers are 2-4 years away from the commercial farming of black cod, which offers another very large market potential. I hope this information contributes some perspective and clarity to the ongoing debate.



Transferring smolt (from hatchery location) to a salmon farm

Salmon Farming: Gambling with Alaska's Wild Stocks?

by
Alaska Trollers Association

The fishing industry feels the value of shellfish and vegetable culture to the state and local communities outweighs the associated costs. It is these forms of mariculture which will fit into the Alaskan style of life, and economy, with few negative impacts on our existing socioeconomic structure. On the other hand, we strongly oppose the implementation of salmon farming in Alaska. Our opposition rests not on the concern over a single issue, but rather the cumulative effect this proposed industry will have on the state's economy, the fishermen of this state, and our entire industry.

To begin, let's take the issue of what agency in the state government will be charged with the responsibility of regulating this proposed industry and the implications on the protection of our wild stocks. We should first consider that Alaska produces 90 percent of all salmon landings in the United States or 43 percent of the world's landings from wild, natural runs of salmon. While the spread of disease from penned to wild salmon may be of a low order of probability, the potential for major damage to the wild stocks does exist. Therefore, any discussion of this new industry must focus on the regulatory climate which will protect our massive investment, an investment, by the way, which has produced one of the world's most successful ocean ranching programs.

Currently the stringent regulatory safeguards on wild stocks is adequate. Still we are worried that regulations like strictly forbidding the importation of non-indigenous or exotic species of fish, a primary safeguard in our present system, may fall by the wayside because the development of the proposed industry is perceived as more important than the possible effects to the gene pool and disease on our wild stocks. For instance, in Norway this safeguard was circumvented in 1986 with the importation of Scottish smolts. In sidestepping the normal caution of nonimportation, the Norwegians introduced a new disease form into their waters which quickly spread and caused massive mortality to their inventory of fish. Just how much havoc this outbreak caused is hard to determine since there seems to be reluctance on the part of the Norwegians to let the rest of the world know what happened. Closer to home we have

seen British Columbia transfer Atlantic salmon to the Pacific coast. The threat this transfer represents to wild stocks, particularly steelhead, remains to be seen.

We are also worried about the possible effects to wild stocks from escaped pen-reared fish. It has become apparent that these fish do escape no matter how stringent the protections are. For 25 years Norway has been in the farming business and just this spring they discovered that 10 percent of the fish in their streams weren't from wild stocks after all, but instead were escaped farmed fish.

It is interesting to note that the promoters of pen-reared salmon are even now seeking to circumvent prudent regulatory controls. The proposed bills allowing mariculture in the state place the authority for management of the proposed industry under the Department of Commerce and Economic Development instead of the Department of Fish and Game which has the mandated safeguards needed to protect our wild stocks. Our concern with the placement of management is certainly not a reflection of the promoters purported position of wanting strict regulation and safeguards, but a reflection that the management of this prospective industry would be given to an agency with little experience in the biological and technical basis needed to protect our wild stocks and current industry.

Actions and incidences such as the introduction of exotics raise the question of how a private, for-profit industry will impact our wild runs of salmon and whether the profit motive will cause the industry to try to evade prudent regulatory safeguards in the interest of short-term profits.

The cumulative negative effect of salmon farming is again typified when one asks the question of where the resources will come from to manage this prospective industry. Herein lies one of our major concerns with the mariculture industry. Proponents suggest that their industry will take little from the existing system but as most of us know there are no free lunches out there; you just can't get something for nothing as the fish farm promoters suggest. There will have to be government programs created or expanded to regulate fish farming practices and these regulatory programs will cost money and state resources. It is a safe bet that the money and

resources won't come from an increasing state budget and we know the new operations won't be paying taxes until they start showing a profit, which will be many years down the road.

As you may know, state agency funding is determined by using one of two criteria, either through what is called formula funding or discretionary funding. Formulas are used to determine funding levels for such agencies and programs as the Department of Education and municipal revenue-sharing. The monies left over after formula funding are termed discretionary funds. Discretionary funds are what currently run agencies like the Department of Fish and Game and the Department of Natural Resources; these funds are determined by our policy makers every year at budget time. To many, a fish is a fish; therefore, it is a safe bet that the funds to run this proposed industry will come out of the current fish management programs. These are the same programs that are producing such a high rate of return to our state's economy, the same programs that are already being cut to the bone because of revenue shortfalls.

The question then is what happens when an agency such as the Department of Fish and Game sees budget reductions; it affects their ability to make accurate resource management decisions. Because of the lack of information on which to base sound management decisions, there is the tendency to manage the resource conservatively. This may appear good for the state, and is how any prudent manager would respond, but when one considers that a portion of the resource has been wasted when it could have been harvested, it becomes a loss to the fishermen and our economy. For example, a recent analysis done for the Bristol Bay fishery indicated that for each additional \$86,000 put into the management program, management error decreased by one percent. In this fishery one percent represents a direct loss to fishermen of \$2.76 million. In this instance if the funds had been available to reduce management error by the required one percent the economy would have seen at least a 3,000 percent return on investment. We might also point out that this doesn't include losses to other segments of our economy in which these dollars would have circulated if the resource had been optimally managed.

Salmon farming has become one of the most controversial subjects within the fishing industry this year. The following articles explain two opposing viewpoints on the issue.

If, by chance, mariculture management funds don't come out of fishery management funds, they'll come out of things like hatchery funding. This would be the ultimate irony - because if salmon farms get hatchery money, then fishermen will have to make up any deficits with more assessment taxes to themselves in order to keep these hatcheries open. In this case, fishermen would be financing the fish farm industry, an industry they don't want in the first place and in fact would be in direct competition with them.



A fisherman picks wild salmon out of his gillnet on the Copper River flats.

Along with the guise of strict regulation and limited use of the states decreasing management resources, proponents of pen rearing like to say that their industry will provide a boost to our state and local economies. It should be pointed out that our current fishing industry already employs approximately 50,000 people directly, this does not include employment in associated support industries in all segments of our economy. We don't feel that salmon farming can even come close to the positive impacts the current industry has on our state, and in fact the economic impact this proposed industry will have is the transfer of jobs and wealth from an established segment of the economy to a new, smaller group who may not even be Alaskan residents. Although proponents are selling the concept that the farms will be owned and run by local residents and be typical of small business like your local fisherman, or grocer, the real world depicts a different reality. Small, locally-owned operations won't have a

chance. Because of the startup and operating costs involved, mom and pop type Alaskan operations may be able to get their food in the door, but it is doubtful that they could stay afloat if hit with a disease outbreak or a downturn in the industry which all experts project in the next 3-5 years. In fact we would submit that if fish farming were to come to Alaska we would see the industry dominated by a few wealthy individuals and multinational corporations predominantly from Norway. As with any other industry, as it progresses through its life cycle more technology is required in order for businesses in that industry to remain profitable. Technology usually means a more capital intensive industry with fewer employees. This type of industry is certainly not what most of our local community members can afford or are being promised.

At a seminar in Seattle, John Spence from Hardy Seafoods, a thriving mariculture company in British Columbia, told the audience that "mom and pop operations were just a dream." He said these small operations are being bought up by larger organizations and that by 1990 the industry in B.C. would be controlled by 20 or so large companies.

In the October issue of B.C. Business, an article titled "The Norwegian Connection" states that since Canadian banks aren't willing to advance funds for mariculture development, Norwegian financial offers are eagerly accepted, and the Norwegians are now estimated to control 60 percent of the industry in British Columbia. These financing packages also contain clauses which require the farmer to buy building facilities and supplies from Norwegian suppliers. The article goes on to state that should reality fail to live up to projected goals, the Norwegians could call in their mortgages and end up owning the industry in B.C. outright.

As mentioned above the isolated issues are bad enough but cumulatively they increase the damaging effects to our existing industry. In no other way is this point exemplified more than the issue of competition between product forms.

Proponents profess first, that their product will not compete with our wild-caught product for a share of the world market. Second, that even if Alaskan pen-reared salmon did compete with our wild product this competition would be such a small increment that it wouldn't make that much difference, and finally, that world seafood consumption is

increasing. Our response to their first claim is we must realize that there is only one market for fish products in the world; fish of all kinds compete on this market. Since the volume of pen-reared salmon projected by 1990 will triple, salmon farm producers will look to new markets and product forms to keep pace with production. In order to remain profitable, they will have to try to take traditional markets away from our wild-caught product. For instance, farmers in Alaska will attempt to target markets like Japan which currently consumes 84 percent of our frozen salmon each year.

Secondly, as the supply of all fish products increases, the price paid by the consumer will decline. As with all products, price is directly related to available supply. Since Alaskan pen-reared salmon will compete in the world market, as any product, the increases in production will have a direct effect on the current price of the product and certainly an effect on ex-vessel prices.

Finally, with regard to the fact that worldwide seafood consumption is on the increase, it must be borne in mind that we are primarily concerned with the consumption of salmon and not of seafood in general. The market for salmon is a much more limited demographic market and even though it will share in the general increase in consumption the increase won't be to the extent that mariculture proponents would lead us to believe.

Pen-reared salmon production will cost the fishing industry through lost management, fisheries enhancement, and possible harmful effects on our wild stocks. It is ironic that not only would we pay for production through losses to our existing industry, but that product which we inadvertently help produce will further cut into the existing economy by competing with our wild product in the world markets.

Mariculture proponents are fond of saying that we have a right to fail. We, the fishermen say yes, but not at our expense. We have in Alaska the last great wild salmon runs in the world, these runs are the second largest revenue generators in this state and are proving to be Alaska's true Permanent Fund. Pen-reared salmon compete with this resource and dilute the value of our already massive investment. No one can say for certain that no harm will come to our wild stock from pen-reared fish. It just doesn't make good economic sense to gamble with our industry's future knowing what the stakes are.

Salmon Farming: Bright Star for Alaska's Future?

by
Rodger Painter
Executive Director
Alaska Mariculture Association

Few issues in recent memory have stirred a stronger debate in the seafood industry than proposals to remove the legal roadblocks to development of salmon farming in Alaska.

The Alaska Mariculture Association believes fishermen should not feel threatened by Alaska salmon farms.

A host of arguments have been raised against salmon farming, but the strongest objections involve concerns about the impacts on markets and threat of disease spreading from farmed stocks to wild populations.

Market Impacts

Nothing in the debate over mariculture has been more elusive than a common vision of the marketplace.

Opponents of salmon farming in Alaska contend the new production will add to an impending glut of world salmon markets and help drive down dockside prices. Advocates dispute this monolithic vision of the marketplace, saying that markets for cultured and wild products are discrete and there is little overlap. This means Alaska farmed salmon will compete directly against foreign imports, not traditional markets for wild salmon.

One group of researchers from the University of Alaska (UA) surveyed U.S. seafood buyers and concluded worldwide production of farmed salmon appears to have had a relatively minor impact on domestic demand for Alaska salmon. UA economists also completed a study showing Alaska salmon farms should have a negligible effect on salmon markets, but worldwide production could result in a significant lowering of price.

These conclusions have been bolstered by the record value of this year's salmon catch. According to preliminary figures, Alaska salmon fishermen were paid in 1986 a record \$461 million for 90 million fish, the smallest harvest of the decade. This is in sharp contrast to the 1985 record of 147 million salmon worth \$389 million.

These price increases come at a time when the overall imports of farmed salmon into the U.S. continue to increase, despite a drop in Norwegian production.

U.S. Consumption and Market Trends

Virtually all marketing experts agree the hottest seafood market is the United States. National Marine Fisheries Service (NMFS) statistics show the per capita consumption of seafood rose from 12.9 pounds (finished weight) in 1981 to 14.7 pounds last year. While a 1.8 pound gain doesn't sound like much, the increase means Americans ate 582 million pounds more seafood in 1986 than they did only five years earlier. That represents a 20 percent growth in market volume.

In the past, U.S. consumption of salmon increased slowly from .1 pound per capita in 1970 to .4 pound per capita in 1980. Increased supplies from Alaska and Norway then boosted that figure up sharply to .8 pound in 1985, but a drop in landings in 1986 pushed that figure back down to .5 pound, according to Pacific Fishing magazine.

Some analysts say consumption of salmon probably would not have fallen and overall seafood consumption would have been much higher if more seafood was available.

Domestic fisheries landings appear to have leveled off, and foreign producers seem to be the primary beneficiaries of improved seafood markets. Fishermen are earning more for smaller catches, but the primary effect of the laws of supply and demand has been to push up seafood import's alarming rates: imports of edible fish and shellfish increased by \$1.8 billion or 58.6 percent over the five-year period. These forces have resulted in a U.S. seafood trade deficit of \$3.5 billion in 1986, a 79.6 percent increase in five years.

The people who sell most of Alaska's salmon production appear to agree that Alaska's involvement in salmon farming does not pose problems for sales of wild salmon. Processing company officials testifying before the Alaska legislature or quoted in the industry and general news media generally voice concern about the growth of salmon farming worldwide, but discount the impact of Alaska's participation.

Ward Cove's President Alec Brindle says: "The Norwegians with their fish have nearly taken the U.S. market over. It's affecting our markets, but at the same time our market is growing. It's a question of whether or not the market can grow to accept the increased capacity. Frankly, I don't see how Alaska can stand still while the market passes it by."

Important to consider when debating the market impact of Alaska salmon farms is the fact that some major Alaska seafood companies already are purchasing farmed salmon to satisfy consumer demand. Supermarket ads and restaurant menus in Anchorage show Norwegian salmon has even achieved substantial penetration of in-state markets. These are the fish that would be displaced by salmon farms in Alaska.

A Fairbanks resident interested in farming cohos recently observed that the only salmon available most of the year in the Interior city is imported from Norway. "How would commercial fishermen be hurt if I try to displace it from seafood counters?"



Nets are stretched over fish pens to keep birds out.

Disease Threat Differs Little from Hatchery Operations

An irony of the current debate over salmon farming is that the salmon industry is beginning to tout the virtues of Alaska's "wild" product. While this may have an appealing ring with consumers, the new tag doesn't jibe with the increasing percentage of the catch accounted for by fish released from private and state hatcheries.

The aquaculture component of Alaska's salmon production is becoming significant. In fact, state biologists estimate about 70 percent of Prince William Sound's record 25.6 million pink catch this year came from area hatcheries. Just what percentage of the

statewide harvest will come from enhanced stocks is unclear, but it should be significant and is likely to get larger in coming years.

More than 1 billion eggs were taken by Alaska's public and private hatcheries during 1986 and that number is increasing.

These massive numbers of eggs are taken to hatcheries and handled in ways identical to salmon farming facilities, except the juvenile fish are released to intermingle with wild stocks, often after short-term stays in salt water net pens. Farmers simply hold the fish in net pens to adult size.

These similarities are critical because private and state hatcheries have a very good track record in dealing with disease, and there have been no indications of infections spreading to wild stocks. One of the strongest objections many fishermen have to salmon farming is the potential risk of spreading disease from pen-reared fish to the wild and enhanced salmon runs.

While no person would argue salmon farming poses no risk to wild stocks, most scientists agree the disease threat of pen rearing differs little from ocean ranching.

Brian Allee, former president of Alaska's most successful private hatchery system and Director of Alaska Department of Fish and Game (ADF&G) Division of Fisheries Rehabilitation, Enhancement and Development (FRED), told a House Resources Committee:

"The Alaska Department of Fish and Game feels that a fish farm and a PNP (private non-profit) hatchery are functionally similar in terms of the biological concerns. And since all PNP hatcheries require permits, by way of consistency, so should all fish farms. Based on this assumption, the statewide disease and genetics policy should be applied to the fish farm permit, in order to reduce the risk of damage to the wild stocks of salmon, which are a common property resource. Both policies have been well developed and implementation of these policies will serve as more than sufficient control."

The most comprehensive U.S. scientific study of the effects of mariculture conducted to date (The Environmental Effects of Floating Mariculture in Puget Sound, by Dr. Donald Weston, for the University of Washington) downplayed the potential disease threat of salmon farming:

"While fish held in culture are likely to show more frequent appearance of disease than wild fish, disease does not appear to be transmitted to the wild populations. The bacterial diseases of salmonids in mariculture are not transmissible to humans... Increased bacterial abundance in sediments beneath a mariculture facility is quite probable, but it has not been demonstrated that this increased abundance is of any significance in terms of human health."

Control of disease is one of the challenges inherent in aquaculture and other forms of animal husbandry. The concerns voiced now by opponents of salmon farming are very similar to statements by some fishermen when Alaska's salmon ranching program was being debated in the legislature during the 1970s.

The success of Alaska in dealing with disease problems and the resulting strong support of fishermen testify to the ability of salmon culturists to effectively deal with disease.

Alaska has one of the world's best salmon aquaculture disease management programs, but even the best procedures do not completely erase the threat of disease. Many fishermen will recall serious outbreaks of disease in Alaska hatcheries which led state managers to destroy diseased brood stock and, in some cases, start all over again. But, these problems have been overcome and these same hatcheries are unqualified success stories with no apparent effect on wild stocks.

Salmon farmers also are likely to have reoccurring disease problems, but are showing the industry can respond quickly to those challenges. The large losses of Norwegian farmed stocks to the Hitra disease this year provides a prime example. The National Marine Fisheries Service reports that a new vaccine for Hitra already is being used by Norwegian farmers and the smolt surviving the outbreaks have built a resistance to the disease and are in high demand.

Some critics have questioned whether disease management practices such as the use of antibiotics would affect other marine organisms or lead to the development of disease-resistant strains of bacteria. Most scientists discount these theories, saying the levels of antibiotic usage will be so low that it won't be measurable in the marine environment and, even if it was, the selective

build-up of disease-resistant organisms is highly improbable.

The effect of salmon farming upon water quality is another issue raised frequently. The experience of two of the largest and longest operating salmon farming facilities in the U.S., as described by Bill Waknitz of the National Marine Fisheries Service, is:

"Domsea Farms has a very large facility in Clam Bay, Washington, near the town of Manchester. This facility is not only 5.4 times larger than the Norwegian size limit, but is thought to be the largest single salmon farm in the world, and it has been in continuous operation for almost 15 years. This facility is located 300 yards from the end of a pier owned by the United States Environmental Protection Agency (EPA). Attached to the end of this pier is the National Marine Fisheries Service net pen research complex. This is the largest net pen research system in the U.S. seawater intake for the EPA Region 10 Water Quality Laboratory is located at the end of this pier, 20 feet from the NMFS facility and 300 yards from Domsea Farms. The water drawn through this intake is used by EPA as the clean reference water against which samples of suspected polluted marine water are compared, through a variety of laboratory tests... If the water quality in Clam Bay were adversely affected by the presence of the giant Domsea facility and the NMFS complex, EPA would take remedial action."

Tests on the Domsea farm by the EPA reveal that sediments under the net pen complex are only two inches deep and extend no further than 100 feet from the pens. The EPA compared the effect of the farm on the sea floor with that of a dock.

This information does not suggest that the concerns of mariculture critics should be dismissed. To the contrary, these scientific findings point out that the biological and environmental problems posed by mariculture are manageable if proper siting and culturing practices are followed.

Alaska's ocean ranching program has encountered only minimal problems because of a conservative approach. These policies should be imposed upon mariculture operations in Alaska to ensure we continue to enjoy the benefits of the state's most important natural resources - its abundant fisheries resources.

Environmental Effects of Mariculture

by
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Regional Supervisor
Alaska Department of Fish and Game

The evaluation of floating mariculture facilities in Alaska is needed to determine if there are any environmental effects resulting from these operations. There have, however, been studies of mariculture facilities in Washington's Puget Sound. From that, insights into potential environmental effects from floating mariculture can be gained.

Based upon Puget Sound studies, Weston (1986) suggests floating mariculture operations may result in one or more of the following potential environmental effects: (1) accumulation of organic-rich sediments beneath the facility, (2) changes in water circulation, and (3) changes in water quality. In addition, predation problems can arise if not properly addressed in the operation of the facility.

Probably the most common environmental effect associated with floating mariculture is accumulation of organic-rich sediments in the form of wastes, uneaten food, and shell debris on the benthic substrate below the facility. Møller (1976) found that the magnitude of pollution (feed loss and excrement) from a Norwegian fish farm using fresh or wet feed can reach 60 percent of the total amount of food used. Such deposition can result in physical and chemical changes in the natural bottom sediment (Milne, 1979). Included in these changes are increased oxygen consumption within the sediment and increased concentrations of total volatile solids, total organic carbon, sulfides, nitrogenous compounds and phosphates (Weston, 1986). Although Weston (1986) reported that organic-rich sediments occurred around most culture facilities reviewed, the depth of the accumulations depended upon the water depth and current velocities. In general, he found that accumulation of sediments can be expected beneath any culture facility located in less than 15 meters of water. Accumulation of such sediments and the resultant oxygen depletion in the interstitial water can have effects upon the infaunal invertebrate community. Loss of species that are intolerant of organic enrichment (such as echinoderms, crustaceans, and molluscs) often occurs (Weston, 1986). In addition, impacts to bottom vegetation such as eelgrass beds can be expected if facilities are sited over such areas.

Conversely, such mobile species as fish and crabs can be attracted to culture facilities. Romero et al. (1982) reported that the highest densities of crabs in Ria de Arousa, on the northwest coast of Spain, were associated with mussel culture rafts. Pease (1977) found crab and fish species more abundant under culture facilities in Puget Sound than in control sites, and Beveridge (1984) mentions high densities of wild rainbow trout observed around Scottish fish rearing facilities. Increased numbers of crabs and fish under and around culture facilities are probably a result of abundant food supply and possibly cover opportunity.



A farm worker hand feeds penned salmon.

Any anchored floating facility can be expected to somewhat alter water circulation in its immediate vicinity, and floating mariculture operations are no exception. Milne (1979) reported that studies done on Japanese floating fish farms showed reduced currents within the pens as compared to the surrounding water. The effects of these circulation changes are generally minimal but can result in increased sedimentation below the facility when water velocities are reduced and any suspended material is dropped (Beveridge, 1984).

Changes in water chemistry can also result from mariculture operations. These changes are usually an increase in ammonia concentrations and decrease in dissolved oxygen (Beveridge, 1984; Weston, 1986).

Normally these changes do not cause a problem unless the facilities are sited in areas of extremely restricted flushing or in areas of intense mariculture operations which is beyond what would be expected in Alaskan locations.

Proper siting of facilities can usually address the effects discussed above. Floating mariculture facilities should be located in well flushed locations with water depths adequate to prevent grounding at all tidal stages. Sensitive marine habitats such as eelgrass beds or the mouths of anadromous fish streams should also be avoided.

Predation is a common problem with mariculture operations throughout the world. The list of predators includes all types of fish or shellfish-eating mammals, fish and birds (Lindberg, 1976; Milne, 1979; Beveridge, 1984). Usually precautions such as installation of screening or netting will significantly reduce losses. However, if large numbers of predators are present, predator control can become a problem. Given the undeveloped state of most potential mariculture sites in Alaska, predation might be expected from such important mammalian species as mink, marten, otters, seals or sea lions. To reduce potential predation problems, especially from seals and sea lions, care should be taken to avoid known concentration areas such as haulout locations.

Currently, there are no formal guidelines or siting criteria intended to minimize environmental effects for mariculture facilities in Alaska. Instead, each application is evaluated on a site-specific basis through the state's interagency review process for projects in the coastal zone. During reviews, the Departments of Fish and Game, Environmental Conservation and Natural Resources, among others, evaluate all aspects of the proposal, including potential environmental effects.

To improve this process, an interagency team is developing criteria for identifying sites where mariculture facilities would be most suitably located. Included in the criteria will be consideration of competing uses, the physical and ecological requirements of mariculture sites, and human-use patterns. It is hoped that guidelines can be established which will provide potential mariculture operations with sites that have the necessary physical and biological attributes, but which

Criteria for Establishing Salmon Farms



Environmental Effects

continued

cause minimal social and environmental conflicts.

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by

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The prospect of pen-rearing salmon in Alaska has become one of the hottest topics in the state. From fish camps, to city hall, to the legislature, the topic of whether or not to allow salmon pen-rearing is causing a heated debate.

The market success of the Norwegian salmon farming industry and the growth worldwide in fish farming generally have spurred interest in pen-rearing salmon in Alaska. During the 1987 session of the Alaska State Legislature, bills were introduced to legalize salmon pen-rearing. Senate Bill 106 and House Bill 108 would "encourage the establishment and growth of an aquatic farming industry" in Alaska. The bills would establish a permit system which would be administered by the Department of Commerce and Economic Development for aquatic farms and private-for-profit hatcheries.

In response to this action in the legislature, Governor Cowper directed the Fisheries Cabinet to review the mariculture issue and prepare a recommendation to him. The cabinet prepared for the governor a set of criteria for judging any authorizing legislation. The governor approved these criteria, and they were presented to the legislature.

The governor's position stated that mariculture may provide substantial economic benefits to our coastal communities and help diversify and stabilize our economy if it is developed in an orderly fashion which provides the maximum benefit to Alaskans. The governor emphasized that we must ensure protection for our fisheries resources, other resource users and the environment.

The governor then set out eight points which he felt legislation must satisfy to meet these goals. These are:

1. **The mariculture industry must benefit Alaskans.**

The mariculture industry must be developed in a manner which does not result in unfair competition with existing fisheries or cause undue economic

displacement in our coastal communities. Legislation should, to the extent possible under the law, provide for local hire at mariculture facilities and give preferential access to mariculture permits and mariculture related tidelands leases to Alaskans.

2. **The mariculture industry must pay for itself and the state should get a fair return for the use of state resources.**

Legislation should contain provisions for recovering administrative and other state costs associated with managing the industry. The legislation should also ensure that the state gets a fair return for the use of tidelands and other resources.

3. **The development of the mariculture industry in Alaska should be done in an orderly fashion which encourages a stable, dependable industry.**

Legislation should provide general criteria which will lead to the development of a regulatory program which discourages speculation on permits and tidelands leases, encourages sound financial planning, and provides for a diverse industry ranging from "Mom and Pop" ventures to larger corporate operations.

4. **The mariculture industry must meet all state and federal requirements for human health, product quality and sanitation.**

Legislation should ensure that mariculture facilities meet all state and federal requirements for human health, safety, and sanitation. Legislation should also require that mariculture products meet or exceed all state and federal product quality and human health standards, and provide the means to ensure that state regulators can protect human health and product quality.

5. **Mariculture activities must be managed to ensure protection of the biological integrity of natural plant and animal stocks.**

Legislation must address the issues of pathological and genetic protections for natural sea vegetable and fish stocks.

Criteria *continued*

6. **Mariculture activities must be managed in a manner which ensures adequate environmental safeguards and habitat protection.**

Legislation must ensure that mariculture facilities are sited, designed and operated to protect air and water quality, to provide for proper disposal of wastes, and to minimize adverse effects to important fish and wildlife habitat.

7. **Mariculture facilities must be sited to minimize land-use conflicts, maintain navigation and ensure access to upland areas.**

Legislation should provide guidance for siting facilities to minimize conflicts with other tidelands users, reducing visual and aesthetic impacts, maintaining navigation and ensuring access across state tidelands.

8. **Broodstock acquisition for mariculture purposes should be carefully regulated, especially for species subject to limited entry fisheries.**

Legislation should contain provisions limiting the acquisition of broodstock for species subject to limited entry fisheries. Legislation should grant the Department of Fish and Game the authority to regulate the acquisition, transport, and propagation of mariculture broodstock, and provide the Board of Fisheries the ability to resolve allocation decisions regarding broodstock acquisition if necessary.

Last March, the House Resources Committee held extensive hearings on House Bill 108. As expected, the bill generated considerable controversy statewide with proponents arguing that mariculture represented a significant new economic opportunity for Alaskans; and opponents expressing concerns over the potential effects on wild fish stocks, restrictions on traditional uses of our coastal areas, and a loss of income from existing commercial fisheries.

Late in the session it became apparent that authorizing legislation was not going to pass. All parties became concerned that the questionable legal status of pen-rearing salmon could lead to speculation on tidelands sites and a "gold rush" mentality similar to the

situation which developed in British Columbia. The resulting confusion and inevitable litigation would not be to anyone's advantage, so a carefully crafted moratorium bill was introduced and passed in the waning hours of the session. This bill (Senate Bill 297) placed a moratorium which expires July 1, 1988, on issuing permits for most finfish farming. It also authorized shellfish farming and limited finfish farming in fresh water.

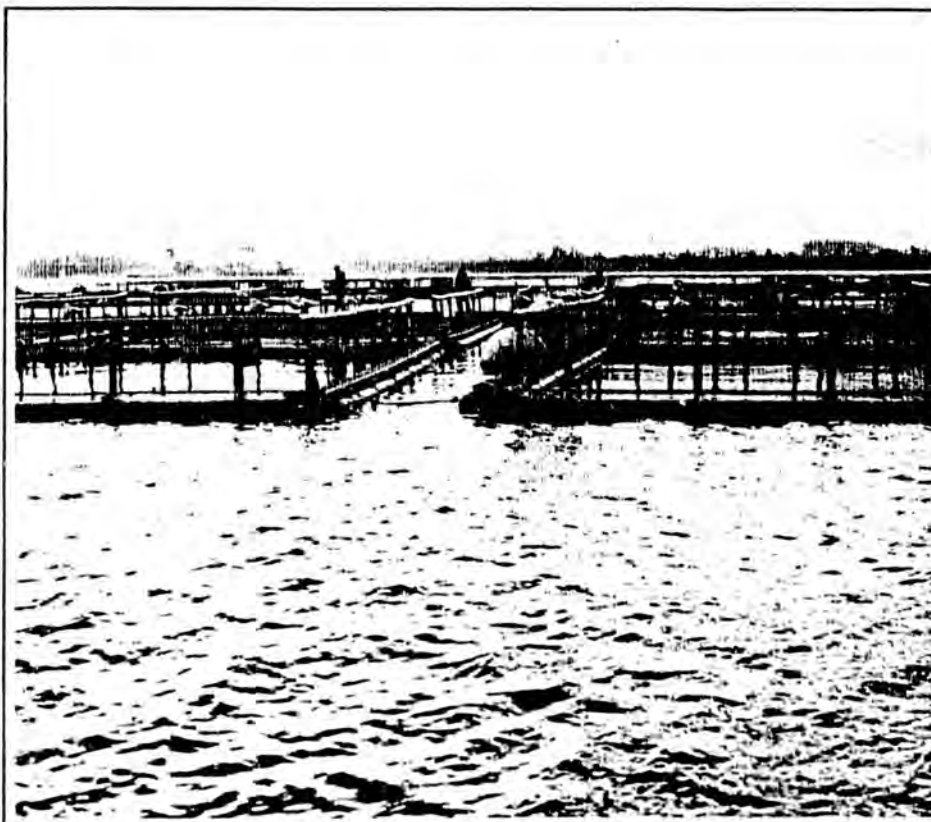
At the close of last session, the legislature established an informal workgroup to continue working on the mariculture issue. This group included Senators Eliason, Duncan, and Zharoff and Representatives Herrmann, Ellis, and Pearce. The administration has continued to work on this issue under the auspices of the Fisheries Cabinet.

In May, following the end of the legislative session, the Fisheries Cabinet identified two major tasks to be performed over the interim. First, the cabinet agreed that a consistent and uniform permitting program for shellfish mariculture needed to be developed and implemented. Second, the issues identified

during last session needed to be addressed in a systematic fashion.

Given these two tasks, the agencies set about to develop a shellfish permitting program. This has involved developing a new shellfish farm permit from the Department of Fish and Game and streamlining existing permitting procedures under the Alaska Coastal Management Program. This will result in a package where the prospective farmer will be able to secure most state permits through one application instead of going to numerous agencies.

At this time, the administration is working on a number of fronts on the broader issue of finfish mariculture. The resource agencies have gone through an extensive process to identify the key outstanding issues which remain to be resolved. Research is being conducted to see how these issues are addressed in other parts of the world, most notably British Columbia, Washington, California, and Maine. These areas were chosen because they offer a range of management systems and have social, economic and biological characteristics similar to Alaska.



Washington state salmon pens anchor in a nonresidential area.

Selecting a Site for a Salmon Farm

by
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Salmon farming, an endeavor that began in the Pacific Northwest, has become one of the fastest growing industries in neighboring British Columbia, as well as in a number of other countries located in higher latitudes on both sides of the equator. To be successful, however, experience suggests much more is required than just tossing a dart at a map. A site meeting a number of different criteria is required. Requirements of husbandry for the species and species life stage must be met. The physical characteristics of a good site fall within a somewhat narrow range. For the firm to be successful factors involving social, political, regulatory and transportation criteria must be met as well. This article will discuss the physical and biological requirements of siting salmon farms.

Physical Requirements

The physical/environmental characteristics of waters surrounding ice-free coastal Alaska are determined largely by the source, the massive Japanese or Kuroshio Current that moves easterly across the Pacific Ocean, dividing at approximately the border of the State of Washington and the Province of British Columbia. Those waters being the natural habitat of Pacific salmon, they quite satisfactorily meet the requirements of temperature, salinity, and oxygen for salmonids during their juvenile to nearly mature life stages. Waters which emanate from the open ocean appear to be associated with some of the most successful farms. Some important exceptions, however, have been noted in Puget Sound - particularly during the chaetoserous bloom of October/November, 1987. Local conditions that alter the basic physical and chemical parameter of open ocean waters typically do so in an inimical manner, particularly in Alaska. Fortunately most of the waters of Alaska that are adjacent to the Gulf of Alaska may well be suitable for salmon farming. The gulf is, after all, the main rearing area of Pacific salmon of both North American and Asian origin.

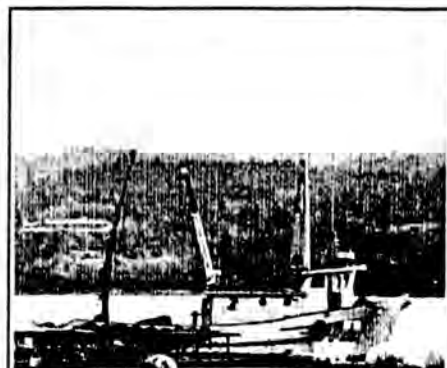
Physical/Environmental Influences: The optimum temperature for salmonids (salmon and trout) is 38-60°F; salinity 22-30 ppt; oxygen levels should be above 7 mg/l. Certain

local land forms and characteristics can create localized conditions that fall beyond these ranges, so are to be avoided by the would-be salmon farmer. Areas with extensive freshwater inputs, particularly that of glacial origin; bays, sounds or other relatively enclosed areas with shallow sills barring access routes to deep water; extensive tidal flats; very high current velocities; insufficient water depth; and areas subject to industrial or organic pollution are the main problem spots.

Freshwater influences: Salmonids are referred to as being anadromous. That is, they typically mature, reproduce, incubate their eggs and spend their first days, months or even years in fresh water, and then migrate to salt water for their main growth. Once capable of osmoregulating (physiologically adjusting their blood sodium and chloride ion content) in saltwater (during this life stage salmonids are called "smolts"), they migrate downstream into saltwater. King, coho, and chum salmon and steelhead trout oftentimes spend days or months in areas of intermediate salinity such as estuaries or moving back and forth between oceanic waters and river mouths. Consequently, the upper reaches of narrow arms, with extensive freshwater inputs may be highly satisfactory to the rearing of fry (the free swimming life stage after absorption of the yoke sac and before smoltification), and to smolts and shortly thereafter. Low salinities are thought to assist with the transitional phase incurred during and just after smoltification by assisting with keeping blood salinities normal, between 10 and 12 ppt. Experience indicates, however, that areas of low salinities, <5-10 ppt particularly if salinities change with depth, tides, or weather, can cause problems during the later grow-out phase. Once salmon have adapted to sea water they appear to prefer salt concentrations to remain consistently high. Areas that have wide salinity changes (greater than 5 ppt within a period of less than a day) should be avoided, as should sites with extensive freshwater lenses (>2-4 ft), especially during the summer months.

Glacial waters are often quite cold (<36°F), and highly turbid, which can irritate a fish's delicate gill membranes. Generally, glacial water should be avoided for those reasons. There may be, however, an occasional exception. If a site offers many other advantages and is some distance from the source, or the source is of low volume even during periods of high runoff, and the glacial

water is very shallow (<1-2 ft) and inexpensive power is available, deep water might be upwelled satisfactorily. Some sort of solid material skirt or shroud that encircles the pens and runs from above the water line to below the glacial runoff (which offer other advantages such as keeping floating debris or oil away from the fish) would be helpful. Careful temperature and salinity measurements over the course of a year or more during a variety of weather conditions, however, should be made before a site with glacial influence should be chosen.



Seafoods of Norway salmon farm operating in Port Angeles, Washington, harbor.

Enclosed areas: A satisfactory site should have water that is exchanged often. Bays, sounds, or arms that have a sill or shallow area (depth of less than that found at the pen site) between the site and open water should be avoided. Nutrients from metabolic waste products and uneaten feed can stimulate algae growth in an enclosed area. After the algae dies and sinks, bacteria and fungi consume cell walls and contents. The respiration of the decomposing organisms can deplete oxygen. High winds can then bring the oxygen deficient water to the surface. At best, fish grow poorly and are much more susceptible to disease in low (<5 mg/l) oxygen water. At worst (<2 mg/l) they all die.

The most desirable location for a cabin, float plane or boat moorage may not be the best place for a salmon farm.

Tide Flats: Large tidal flats can cause wide temperature changes. Waters can become too warm (>65°F) in summer and too cold (<38°F) in winter for good growth. Extensive tide flats typically are found near the mouths of

Selecting a Site *continued*



large rivers which carry heavy sediments. The strong fresh water influence can be harmful, as was mentioned previously.

High current velocities: With the high tidal range found in coastal Alaska there are probably no open areas with insufficient current velocities. Norway, for example has a tidal range of about 10 ft. Too high of current speeds are much more likely. At water flows above 5 mph (7 ft per second) it becomes difficult to keep nets from billowing up and forming pockets. Fish do not appear to grow as well or remain healthy in net pens that routinely deform sufficiently to trap them in pockets. While very heavy (1,000 lb) anchors can be used to secure the corners of net pens, much heavier webbing and support ropes must be used to avoid tearing of the net fabric and consequent loss of fish. Anchoring the pen complex becomes much more difficult and consequently expensive in high currents.

Water depth: Adequate water depth assists in spreading wastes and uneaten feed over a large enough area to prevent buildup. Minimum water depth should be 60 ft at the lowest tide on the shallow side of the pen complex - unless special accommodations (such as rearing species that typically use just the upper portion of the water column such as steelhead/rainbow trout) are made. In essence, the deeper the better. An ideal site would have 90 ft or greater depth right next to shore. Stiff legs (rigid attachments between shore and the pens) could then be used to anchor the complex.

Weather Protection: While cages are built that will sustain near-open ocean conditions caring for fish during extended periods of heavy waves is difficult and can be hazardous to operators and workers. Shelter from storm winds and waves is highly desirable. Moderate waves (2-4 ft) can be smoothed by the use of a log boom. Log booms must be properly constructed, however. More damage can be done by a loose log than by the waves that have turned it into a battering ram. Due to the complex manner that storms often move in, picking a site with less than one-half mile of open water in all directions is advisable. Adequate shelter from the prevailing storm winds and waves may require open water distances of less than that.

Biological Requirements

There are several important biological requirements in siting a prospective salmon

farm: The presence or freedom from harmful algae blooms, certain marine plants, predators, and large numbers of other salmonids can spell the difference between success and failure of a farm.

Algae: There are at least two species of phytoplankton that are harmful to salmonids. *Chaetoceros convolutus* is a diatom that has long setae (spikes) with hooks on the ends that can form long chains. They can block and damage gills. The initial response of fish is to feed poorly or not at all. After gill damage occurs troubled fish will be at the surface with their heads pointed up current, next to the netpen edge. Gills become coated with mucus, can have a mottled appearance, and bleed easily. If examined under a microscope the gills appear inflamed as the diatom causes a reaction not unlike that of an insect bite on a human. Dead fish, particularly small ones, often are found with their mouths stretched wide open.

Blooms occur most often in the fall under conditions of little wind and sunny weather, although spring blooms do occur. Water clarity is not a useful guide as even very low concentrations of *Chaetoceros* can cause problems (>5 cells per milliliter). Rainbow trout and Atlantic salmon appear to suffer the worst with neutered coho salmon following. Smaller individuals of the same species may have higher mortalities than do larger ones. This algae is known to occur and to have adversely affected fish in Southeast Alaska and in Prince William Sound.

Heterosigma akashiwo caused extensive mortalities of farmed salmon in certain areas of southern British Columbia during late June of 1986. Thought to occur in heaviest concentrations near the interface of nutrient-laden rivers and salt water, it may produce a mucous-like substance that is toxic to fish. Rainbow trout are the most susceptible species; larger individuals of a given species appear to be troubled more than smaller ones. Its occurrence in Alaska is unknown to the author.

Kelp Beds: Locating a farm near large kelp beds should be avoided. Kelp beds can experience large seasonal die-offs and create huge volumes of drifting materials that can foul nets or in extreme cases cause damage to pens. Herring spawn on kelp also. Eggs can foul nets to the point of blocking water flows.

Predators: Seals and sea lions can wreak havoc with salmon, their natural prey. Farms should have heavy guard nets surrounding pens and placed far enough away so that tidal currents do not cause the nets to touch. Locating a farm near haulouts is to be avoided.

Other salmonids: Large populations of salmon nearby can bring diseases and predators. Consequently, farms should be located some distance away from streams with large spawning populations of salmon.

Other Criteria

This article has been a brief discussion of some of the factors to be considered in siting a salmon farm. There are additional criteria, some rather abstract, to be used before a final choice is made. Social and political considerations of neighbors should not be overlooked. It is quite difficult to argue with the contention that salmon farms change the vista of waterfront property. Proximity to people, goods, services, and transportation figure in importance to costs and chances of success. Lastly, and perhaps the most important, is the site and its location must be suited to the personalities, capabilities, and desires of the operator(s) and his or her staff.

A Cautionary Note: It must be emphasized that selecting an optimum location for salmon farming is, as yet, very much more an art than a science. The vagaries of weather can cause severe problems to salmon farmers. While our pool of knowledge of the cultural requirements of salmon and trout is quite extensive, there is a lack of knowledge about specific weather conditions and the resultant physical and biological oceanographic effects. Cells of low oxygen waters are the principal physical concerns, and the ecology, and distribution of blooms of at least two species of single-celled algae that can cause harm to salmonids are of very high biological importance. It must be emphasized that due to our lack of knowledge about the above mentioned physical and biological oceanographic concerns, even by closely following the guidelines contained in this article and others of a similar nature, success in farming salmon may be elusive. One thing is well known - failure is very expensive.

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Dolly Garza

Dear Reader:

The Marine Advisory Program is pleased to send you the fourth edition of the Alaska Marine Resource Quarterly. We hope you find it full of useful research and technology information as it applies to the fishing industry and other marine resource use groups.

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January 12, 1990

Senator/Representative
State of Alaska
Juneau, Alaska 99801

Dear Madam or Sir:

During this past summer, evidence began coming out of Norway that all was not well on the salmon farms. Visitors returning from Norway reported reading in local newspapers reports of widespread disease in farm fish and pollution in the fjords. Some of these diseases are known but there are some new ones that no one has seen before. The nature of these new diseases is unknown even to scientists.

My board of directors directed me to go and see first hand. My trip included interviews with journalists, scientists at the Institute of Marine Research at Bergen, a visit to a local salmon farm, and discussion with local townsfolk.

The Institute of Marine Research is the only scientific institute in the world that is looking into the disease and genetic effects of farmed salmon on wild stocks of salmon. There is a concern among scientists, whom I spoke to, that the Norwegian government may not continue to fund these programs in the future.

The local populace is in an uproar over what is happening on the local salmon farms.

I learned that many farmers, when faced with the need to destroy diseased fish, simply release them into the fjord where they can spread disease to wild stocks. Likewise, I have heard reports of Canadian farmers releasing contaminated farm fish in Vancouver, B.C..

Faced with the tragedy of economic disaster, it is understandable that a farmer would take this low-cost

way out. The cost of enforcing such clandestine activity, especially in remote areas of Alaska, would be very high.

I have taken the liberty of providing you with translations of several articles from local Norwegian newspapers which show the extent and the seriousness of a problem that "does not exist." Proponents of salmon farming have neglected to report on this critical issue.

We have to keep in mind that, while Norway has some 100,000 of wild stock salmon, Alaska is blessed with stocks in excess of 100 million salmon.

After personally seeing what is happening in Norway and listening to the public outcry, I can only hope that you conclude with me that the risks are too great for Alaska to entertain salmon farming.

Sincerely yours,

Reidar Solberg
President
AIFMA Coop

INTRODUCTION

The Board of Directors of the Alaska Independent Fisherman's Marketing Association, "AIFMA", in December of 1989 directed me to go to Norway and look into the effects of farm raised salmon on wild stocks of salmon. The areas of concern were disease and genetic intermingling. Where I received my information was at the Institute of Marine Research in Bergen, the Bergen Tidende newspaper, a fish farm on the island of Austrovul, and a number of local people through out western Norway.

My hope, after looking at the situation in Norway, is that we will hold off introducing fish farming in Alaska because of the threat of spreading disease to the hundreds of millions of wild stock salmon and the threat of spawning interruption by escaped or released farm raised salmon. The possibility also exists that diseased farm fish, or fish with heavy doses of antibiotics could effect the market conditions of natural salmon which have been handled and presented with so much care over the years.

A very unnerving bit of information, I learned, is that when faced with the need to destroy diseased salmon, many farmers simply release them into the fjord where they can mingle with the wild stocks of salmon. I have heard of this happening on farms on Vancouver Island, B.C. Diseased farm salmon were released at the direction of the British Columbia Fisheries Department.

SUMMARY

At this point in time the Institute of Marine Research in Bergen is the only one that is doing studies to determine what affect the farm raised salmon will have on wild stock of salmon.

we must remeber that Norway has only 100,000 wild stock spawners, where as we have returns as high as 60 million to Bristol Bay alone. If you tally up the return of salmon to all other Alaska fishing areas, and the river systems in Canada the potential loss would be devastating both ecologically and financially.

In Norway, the intent of the fish farms was to generate income for families in the island communities. There are a number of bankruptcies occurring at this time, even though the farms have be heavily subsidized by the Norwegian government. The interesting thing is that the control of smolt is in the hands of big busniness. The three major players in the smolt production is British Petroleum, Sea Farms (a multi-national corporation), and Mowi (this is Norsk Hydro, one of Norway's largest corporations).

In talking with the Norwegian scientist, their feeling is that fish farming has gone much faster then the scientific community has progressed in this area. There are 700 farms in Norway that can produce 250 tons of fish per year per farm. The question then arises, where is the food for the fish farms going to come from? Do we take the pollock, herring, and other fish with their high protein content and grind it up into a fish meal to feed salmon when we have starvation throughout the world.

Looking at possible risk of our wild stocks of salmon, whether it be through disease or through genetic destruction, allowing the onslaught of fish farms on the Pacific Coast is much to great of a risk. The statement made by a prominent Norwegian scientist, that in ten years there has been a destruction of ten thousand years of salmon genetics.

I come from the commercial fishing community and I think about the amount of damage one case of botulism in Belgium did to the market of salmon world wide, I have a real concern about the medications going into farm raised salmon. The amount of dollars generated by the commercial salmon fishery is much to great to risk loosing because of the efferts of certian special interest groups. Whether these groups be Weyerhauser Corporation in the state of Washington, B.C. Hydro with their push for dams on the Frazier River in Canada, or any group that would want to begin fish farming in Alaska, we cannot risk the value of wild stocks of salmon.

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My meeting at the took place on the morning of November 30, with Magne Kalhovde also attending. Snorre Tilseth, the director of the fishery, was unable to attend. Brit Hjeltne was very helpful by giving us a tour of the facilities. She then gave us a run-down of the diseases affecting fish farms.

Farm fish diseases;

- (1)- Vibriosis (Vibrio bacteria)
Bacteria disease affecting salmon as well as trout
In farm fish as well as wild stocks
Detected as early as 1918
Virus is in the water, is much harder on farm fish due to the close environment which causes "stress."
- (2)- Hitra (Cold water vibriosis)
Seen in fish farms since 1977
Mostly in winter months
- (3)- Furunkulosis
Problem began on trout farms
The disease begins with blistering, then moves into the blood stream
Norway's problem began with fish brought in from Scotland in 1985
In 1988 the disease showed up in two other river systems in. No answer to where it came from.
- (4)- Salmon lice
A real problem for farm fish
Treatment is Nuvan (Neguvon insecticide that has an impact on crab, clams, etc.)
- (5)- Gyroactylus Salaris
Fresh water parasite
Appeared in farms in late 70's to early 80's
Created a huge problem
The thinking is that it came from Sweden due to movement of smolt from one river to another.
- (6)- BKD
First seen in Norway in 1980
- (7)- Infectious Anemia of Salmon (IAS)- was called (SAS)
New disease that appeared in 1984
They think it's a virus but aren't sure
To this point it has not appeared in wild stocks of salmon

(1) Furunkulose in two fish farms.

Even if the fish has got the infection it is still all right as food. That is as long as the fish is not ill and the illness has left no visible tracks, such as outward bleeding, sores, etc.

(2) Illness to live with. Furunkulose

It doesn't have to be a catastrophe for Norwegian fish farming. We already know how to live with Viberiose. We try not to "stress" the fish when the temperature in the water is high. Although the bacteria is in the water, it does not affect the fish as good food. To rid the water of Furukulose is impossible..

(3) Yersinia Ruckeri

The bacteria yersinia ruckeri is found in Norwegian fish farming. The bacteria was unknown in Norway until a few years ago.. The illness is very infectious and can affect the fish if it is being "stressed" for example, under transportation. It can live both in sea water and in fresh water.

(4) Salmon Anemi Syndrom (SAS)

The veterinary institution thinks that SAS comes from a virus. The illness was first detected in 1984.. Six fish farms had to slaughter all their fish and begin all over again when they had SAS in their fish farms. SAS is a blood illness, the blood gets thin and it then affects the liver. At this time we don't know if the illness is contagious through roe, but it's contagious from fish to fish.

(5) Infectious Salmon Anemi

The feared illness salmon anemi has attacked fish farms in west Norway county of Hordaland. (Bergen is in Hordaland.) Infectious salmon anemi is so far only affecting Norway. The illness has a high rate of death. The salmon anemi has not entailed as big losses as the "Hitra disease" but the problem with salmon anemi is that we don't know what causes the infection. We don't have any drugs to attack the infection and it will take a long time to find a vaccine. The fish farms that get hit by the infection, all the fish must be slaughtered as soon as possible. We can not see that it spreads through roe, but we know that it spreads through the sea.

(6) Unknown fish illness

An unknown fish illness is ravaging at Stord. Over the whole bottom of a lake on Stord there have been found dead fish. The dead fish is being attacked by a fungus. It is not known if the fungus is the real reason for the dying of the fish.

(7) Hitra disease vaccine

Hitra disease vaccine is too expensive. Experiments this year with the "hitra disease" vaccine look very good so far. It may be necessary to us the vaccine on the same fish later. The problem is that the vaccine is very expensive, over \$100 for a liter.

(8) Bakteriell Nyresykdom

A fish farm had to slaughter all their fish fry because it was infected by the illness "bakteriell nyresykdom". This caused big losses for the owners with no money for compensation. This will probably mean that other fish farms with the illness will try to hide it instead of slaughtering the infected fish.

(9) Gyrodactylus Salaris (salmon parasite)

Gyrodactylus Salaris (GS) is caught by wild fish in many of the rivers from fish farms which are dealing with rainbow trout. It will be a lot more difficult to get permission to have a rainbow trout farm.

(10) Furunculose

It's been found that Furunculose can begin in rivers as well as in the sea. It can act in four different ways.

1. High rate of death.. Interior bleeding and swelling of the spleen.
2. Not as high rate of death, outside sores visible.
3. Wrong color of the intestine of the fish.
4. No rate of death. The disease can begin in high water temperature.

(11) New illnesses

More new fish illnesses crop up. We know hardly nothing about these new illnesses. We think it has to do with viruses. As an unknown, we don't have any drugs against the viruses. The question is, how can new illnesses break out all of a sudden. Some of the illnesses can come from the fact that there are too many fish in the fish farms, and that the farms are giving too much medication. The other problem with medicine is that it can effect the export of the fish. The USA may say that they don't want to import any fish which has been given antibiotics.

(12) Bacterium Kidney Disease

This disease develops slowly and breaks out on fish as late as half a year later. It can be wounds in the fish meat and smoked fish can get a bit of a wrong color..

(13) Selling unslaughtered fish

Make it illegal to sell fish unslaughtered. The reason is that there may be a parasite in the fish. The parasite lives in the intestine of the fish. The parasite is not dangerous for human consumption.

(14) Gyrodactylus Salaris

Drammen watercourse has been hit by the freshwater parasite Gyrodactylus. It will cost millions to save the salmon stocks in the Drammen river.

(15) Furunculose

Tons of fish die. The only thing we can do is to work for better environments and hope that the researchers will find an effective vaccine.

(16) Gyrodactylus

32 rivers have parasites on the fish now (Feb. 24, 1989). To get rid of the infection we have to put poison in the rivers to kill all the fish so that the infection will dissipate and a new salmon stock can be brought in to the rivers.

(17) Gyrodactylus Salaris

The parasite hangs on small salmon in the rivers. As the parasite eats on the salmon it creates a sore on the skin which brings fungus, virus, bacteria into the salmon and kills it. The parasite doesn't have eggs, but gives birth to another parasite which is half formed with another, so the multiplication is fast.

(18) Virus from USA

A fish farm in North Trondelag has got a new virus that has not been found in Norway before. The virus is known on the Pacific Coast of the USA. The virus gives anemi to the fish.

(19) Furunkulose

Salmon that escape from fish farms bring infections to other areas. Escaped salmon which has been infected by furunkulose is on it's way up the river system. It is proven that fish which have escaped have brought furunkulose to another fish farm.

(20) Furunkulose

To try and restict the Furunkulose, management has said that it is illegal to transport fish for one area to another.

(21) Vaccination

The vaccination of all the fish in the fish farms is out of the question at this time.

(22) Furunkulose

All fish with Furunkulose is to be slaughtered. Fish farmers are doing all they can to stop the infection of and spreading of Furunkulose. Now they are slaughtering all their fish that have Furunkulose.

(23) Hitra disease

The return of Hitra disease after the winter of 1988 is taking place. Fish farmers along the west coast are cheering because of good growth of the fish, good temperatures in the sea, and not to much disease.

(24) Hitra disease

We have now developed an effective vaccine against "Hitra disease". It gives 95% protection to the fish. That means that the "Hitra disease" is on it's way to being wiped out. (April 1988)

PROTECTION ZONES FOR SALMONS - A CONCEPT FOR THE
PRESERVATION OF GENETIC DIVERSITY OF WILD SALMONS
AND REDUCTION OF THE SPREADING OF DISEASES BETWEEN
DOMESTIC AND WILD SALMONS

by

Senior Engineer Bjørn Lindgren, LENKA,
The Ministry of Environment, Norway.

BACKGROUND

Norway has some 500 local populations of wild salmon, each having its particular spawning river. During thousands of years these populations have developed local, genetic, distinct characteristics as regards size, growing speed, behaviour and ecological adaption.

These local populations constitutes a vast genetic recourse, which we, in the line of the recommendations of the Brundtland commission, believe we are responsible to protect and manage as intact as possible as a resource for the coming generations.

From the Nature Conservation part of view, the protection of genetic diversity is an aim in itself. From the aquacultural industry's point of view, the genetic variations found in wild salmon populations constitutes the biological basis for the future sustainable development of salmon

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farming, with particular importance for breeding programmes.

There is therefore a general agreement among the authorities in Norway that the wild salmon populations should be kept healthy and strong, an agreement also of course shared by those who have a commercial or recreational interest in wild salmon fishing.

Let me also for the background mention that the different salmon populations over the years have been severely affected, by acid rain, water course regulations, parasites and overfishing both in the rivers and in the seas.

IMPACT ON WILD SALMON POPULATIONS FROM AQUACULTURE.

During the last years there has been a growing concern in Norway on what effects the growing fish farming industry will cause for the wild salmon populations.

Two main points have come into focus:

1. The breeding programmes have resulted in a domestic salmon, which are genetically significantly different from wild salmons. Surveys in 1987 in 54 rivers in the southern part of Norway shows that out of 615 caught salmons, 83, that is 13%, were escaped salmons from fish farms. The actual figure is probably however much higher. The catches were organized through the Norwegian gene bank project. Catching was done by local co-workers, who were instructed to drop all salmons which could be identified as domestic salmons in the first hand. The 83 salmons in this figure are thus the remaining domestic salmons identified by the experts of the project after the sorting out done in the first hand by local co-

workers.

Because of figures like there is a growing fear that continuous interbreeding between escapees and wild fish will cause a considerable reduction of the natural genetic diversity in salmon populations.

The most alarming and pessimistic prognoses by one the leading experts in Norway on genetics, professor Harald Skjærvold at the Norwegian Agricultural University, anticipates that we may have 50% reduction of the natural genetic variety in the course of a periode of 7 to 10 years. I must add, however, that there are different points of view among norwegian genetic experts, mostly because of uncertainty as regards the spawning success of escapees in competition with the wild salmons.

2. The two-way spreading of diseases between wild fish and fish farms is another problem. The general picture in Norway is that the different fish diseases mainly cause problems for the farms, not the wild populations. The diseases exist in nature and is part of the ecological balance broadly speaking.

As an example of this, the second best salmon river in Norway, the Numedals-lågen was infected by furunculosis in the seventies. But during all the years furunculosis where found in Numedals-lågen it did not have any significant effects on the magnitude of the catches.

But there is one important exeption in this picture, the Gyrodactyllus Salaris, a parasite which now has spread to 30 Norwegian rivers causing death to young salmons in their first three living years in the fresh water periode. The parasite has virtually wiped out the salmon populations in many of those 30 rivers. We believe

that the reasons for these dramatic effects is that the parasite is introduced to norwegian watercourses (it is native to Sweeden and the Baltic sea). Norwegian salmon populations has no "ecological defence" against it. The Gyrodactylus Salaris is spread mainly through the distribution of salmon fry and waters from infected hatcheries.

Let me also add that there is a considerable concern in Norway on the long-term effects of the growing pressure of fish-diseases on the environment. The alarming growth in use of antibiotics is one question of particular importance. To day the use of antibiotics in agriculture extends the use in agriculture and human medicine, put together.

A research programmed was therefore startet in 1987 to strengthen the knowledge on long term effects of the use of antibiotics.

THE PROTECTION ZONE CONCEPT.

The concept which was put on the agenda of Lenka by the Ministeries of the Environment and the Fisheries was to see if one could hope to reduce genetic mixing and the two-way spreading of diseases by establishing zones in the fiord areas outside the outlets of the most important salmon rivers where fish farming should be restricted or not allowed at all.

To have a thorough discussion and evaluation of the zone concept, Lenka arranged a meeting in February 1988. Most of the norwegian experts in the field of genetics, fish diseases, and the ecology and behaviour of salmons were participating.

The recommendations from the meeting were in short:

1. The zone concept should be elaborated in detail for a sample of the genetically most important salmon populations by an expert group.
2. Because of the uncertainty on whether the zones will prove to be an efficient measure, zones should be established for a temporary periode of 5 years. After 5 years there should be a evaluation of the effects of the zones.
3. A research programme covering both genetic effects, veterinary research, and the development of more escape proof farming plants should be established for the same periode to support the following evaluation of the zone concept.

As a follow up of the meeting, Lenka established two fast working groups, one expert group which should work out a detailed proposal for zones, and a group which should work out the frames of a research programme.

The expert group proposed 51 zones covering 125 rivers, which were considered of special genetic importance.

The sampling of the 125 rivers were done according to the following criteria:

- one should have sample of rivers along all the coastline of Norway, so that conditions following gradients like north-south, inner fiords/ outer coastal areas, temperature and salinity which are believed to be important for the ecological adaption and genetic diversity were included.
- one should include all rivers where the local populations has special features which represent extreme deviation from the "normal".

as regards morphology, behavior, growing speed and ecological adaption.

- one should include rivers with populations with big numbers of individuals, which generally are more resistant against genetic pollution than populations with a fewer individuals.

The detailed designing of the zones followed three main criteria:

- The zones stretches roughly out 20 km from the outlet of the river. Studies indicates that there are a considerable larger procentage of escaped domestic salmons in rivers if salmon farms are located within a range of 20 km from the outlet, than in rivers where farms are located further out. The critera however was to a great part adjusted by topography and local conditions. In fact zones varies from very great ones in the long fjords to rather small ones round the outlet of rivers.
- Between the zone border and the outlet of the river there are other rivers on both sides of the fjord, which in this connection are believed to function as "buffer" rivers. The idea is that escaped domestic salmon in the spawning periode will tend to go up in these rivers before they reach the river one is trying to protect.
- The borders of zones for rivers infected by Gyrodactylus Salaris are drawn roughly where the salinity during the spring flood is 15- 18 pro mille. Experiments show that Gyrodactylus Salaris survives only 15 minutes in waters where the salinity is higher than 15 pro mille. If salmon farms are located in waters with a salinity higher than this, one should be fairly safe that the farms will not turn out to be

breeding places for this particular parasite.

The research group recommended a programme covering the following aspects:

- A monitoring programme covering a sample of rivers where zones are established, compared by rivers with no zones.
- The impact on genetic diversity from escaped domestic salmon.
- The development of genetic dominant markers to be used in pilot experiments to study the genetic effects on populations of wild fish through generations.
- The studies of the behaviour of escaped domestic salmon, particularly on the question of their spawning success.
- The development of escape proof technology in fish farming plants.
- The development of improved technology for disinfection of waste water from production and slaughtering units.
- Veterinary research, with particular emphasis on the pattern of two-way spreading of diseases between fish farming plants and wild populations.

The research activities are recommended to be implemented within an annual financial framework of 5 million N kr, and within a period of 6 years. A follow-up programme was recommended at the end of the 6 years-period, particularly with a view to the genetic consequences.

PUBLIC HEARING OF THE PROPOSAL

The proposals of the expert group were sent on a public hearing by The Ministry of Environment, and The Ministry of the Fisheries, late June. The time schedule is that the final decision on whether to establish protection zones or not will be made by the two ministries in course of 1988.

As for Norway, the concept of protection zones is a new strategy in the field of the protection of marine genetic resources. The protection zones is an effort to protect genetic resources in situ, and is regarded as a supplement to the salmon gene bank project, which has been going on for a few years. The monitoring part of the research-programme is carried out by the gene-bank-project.

Whether the zones will prove to be an effective measure against genetic pollution and the spreading of fish diseases remains to be seen. However faced with the challenge of preserving genetic diversity in a time where more and more marine species are being commercially cultivated and farmed and more and more of the coastal zone areas are being occupied for mariculture we think the zone concept is well worth to be tried out and evaluated. The doubts on the real effects of the zones is in our opinion an argument for their establishment on a temporary basis, not against it.

If the zones should turn out to have no significant effects, we will simply terminate the project at the end of the 5 year period. But if they should prove to contribute to the preservation of genetic diversity, it would be a big failure not to establish them now, given the possible speed of the reduction of genetic diversity that I mentioned earlier.

Juneau Empire 11-14-90

Virus infects pond-raised shrimp

THE ASSOCIATED PRESS

CHARLESTON, S.C. A deformity-causing virus in imported pond-raised shrimp has been found to infect three species of South Carolina shrimp under laboratory conditions.

The experimental transmission of the virus from Pacific white shrimp to native Atlantic shrimp species raises the question of whether the same thing could happen in the wild, state biologist Susan Harris said.

Stunted growth, reduced survival, aimless sinking and swimming and wrinkled or crinkled antennae are among the symptoms of Runt Deformity Syndrome, which is caused by the virus. Up to 60 percent of the Pacific white shrimp sampled at the Waddell Mariculture Center showed signs of the syndrome, Harris said.

The virus can be passed in fecal

matter and effluent from shrimp ponds and has a relatively long residence time in the environment, perhaps years, Harris found.

Harris has recommended disinfection of pond bottoms, tanks and effluent, and that all affected animals should be destroyed or cooked. The virus won't hurt humans, she said.

"I recognize the enormity of this. It will definitely adversely impact the fledgling industry. Unfortunately for the (shrimp) farmers, they represent (or should) a relatively small proportion of the population and economy of the state. Our first responsibility should be to protect the public resources of the state," Harris wrote in a memo to the state Marine

Resources Division.

The Waddell Mariculture Center is now sterilizing its shrimp mariculture facilities.

Others are not concerned about the findings. Paul Sandifer, director of the state marine division said experts told him not to worry because problems can be controlled by preventing shrimp from escaping from ponds. The wildlife department has proposed rules requiring shrimp farmers to take extra precautions to prevent shrimp from escaping.

Pacific white shrimp are imported from hatcheries to raise in South Carolina ponds. The shrimp grow faster and larger and are more profitable than their Atlantic cousins.

Juneau Empire 11-14-90

Pollution threatens commercial shellfish beaches in Washington

THE ASSOCIATED PRESS

TACOMA, Wash. — More than a third of Washington's 80,000 acres of shellfish habitat are so polluted that some kind of harvest restrictions are required to protect public health, ecology officials said.

Closure of commercial shellfish beds is especially frustrating because the demand for oysters, clams and scallops from Puget Sound is high, largely due to pollution in East Coast shellfish beds.

"It's ironic that the same contamination processes are now at work in Puget Sound," said Tim Determan, a state Department of Ecology shellfish specialist. He was among the participants in a state shellfish conference last week.

According to a new survey by the state Departments of Ecology and Health, 36 percent of the state's shellfish beds are so tainted by water pollution that harvest is restricted or prohibited.

The survey also says 40 percent of Washington's recreational beaches, where residents dig for clams and other shellfish, are seriously threatened by pollution and may have to be closed for harvest.

Programs to eliminate pollutants at the source are falling behind the rapid population growth near Puget Sound, and contaminated bays and estuaries are not getting any cleaner, conference participants said.

"I think there will definitely be more shellfish beds closed in the next 10 years unless we can be more successful in protection," said Bob Saunders, head of the Ecology Department's Shellfish Protection Unit.

"We're losing areas rapidly," added Bill Taylor, a fourth-generation clam and oyster grower from the South Sound area.

Shellfish populations around urban and industrial areas such as Commencement Bay and Budd Inlet

were choked out decades ago. The new pollution problems are cropping up in more rural parts of the sound, including Burley Lagoon near Purdy, Minter Bay on the Key Peninsula, and several bays in the South Sound.

The pollution is coming from leaking septic tanks, small sewer systems and farm manure, officials said.

"The frustrating part is that it's really not all that complex and it is possible to fix it," Saunders said.

The Puget Sound Water Quality Authority and several other agencies have been working for more than five years to stop the flow of sewage in several watersheds. They have persuaded farmers to fence streams to keep livestock out and have stepped up inspection of septic tanks.

John Dohrmann of the water quality authority said it takes a long time to repair the damage caused by decades of human activity.



News Release

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FISH KILL REPORT RELEASED

OLYMPIA--The August fish kill in the Black and Chehalis rivers was caused by pollution not natural environmental conditions, according to a report released today by the Department of Ecology.

"Although water quality in the Black and Chehalis rivers was not ideal for salmon, trout and whitefish in early August, this fish kill was not caused by the ambient river conditions," said Ecology Director Chris Gregoire. "However, on and after the afternoon of August 8, the day the fish kill was reported to Ecology, our investigators were not able to find physical evidence of pollutants actively entering the Black River."

Gregoire said the investigation is continuing and Ecology is taking action to tighten pollution requirements for fish farms and other wastewater dischargers located on the Black River.

"We are not closing the book on this case, nor are we saying that enforcement actions won't be taken at a later date. The report we are issuing today summarizes the results of the investigation to date and actions we feel are necessary to prevent future problems."

Gregoire said Ecology, the departments of Fisheries and Wildlife, and the Chehalis Tribe conducted one of the most exhaustive investigations ever of a fish kill in Washington.

Gregoire said it appears that something toxic entered the Black River about August 6 nine miles upstream from the confluence of the Black and Chehalis rivers. Ecology was notified and responded to the incident on August 8.

"Although our spill responders were on the scene shortly after being notified on August 8, they failed to take water samples that day," Gregoire said. "However, water samples collected by Fisheries and private citizens were analyzed by Ecology."

Gregoire said the agency should have also notified the Chehalis Tribe of the fish kill. "This was a unique event because a second fish kill occurred downstream several days after the initial kill. From now on, we will put out a widespread warning during all fish kill incidents."

Gregoire said Ecology learned a lot from the incident and the experience will be used to improve response should there be future fish kills of this kind.

During the investigation, Ecology inspected four fish-farms, several dairies, a blueberry farm, a turf farm and several businesses that handle chemicals. Several tips about possible illegal dumping of chemicals into the river were also investigated.

"Numerous samples of water, sediments and fish were collected by Ecology and analyzed for literally hundreds of pollutants," Gregoire said.

Eleven people who reported stinging eyes while swimming in the river on August 7 and 8 were also interviewed.

According to the report, all fish in a nine-mile stretch of the Black River were assumed to be killed.

Fisheries estimates show that 320 adult chinook salmon, 100,000 coho salmon fingerlings, 16,500 cutthroat trout, 118,000 forage fish (sculpins, dace, shiners, suckers and lampreys), 320 mountain whitefish, and 3 adult steelhead trout were killed.

The report concluded that facilities along the river need to have their wastewater discharge permits upgraded.

The Global Aqua facility is receiving special attention because it is the largest fish-rearing facility on the Black River and is located where the fish kill began.

The report also identified several corrective actions that are needed. Among the actions underway or being considered are:

- o a short-term cooperative water quality monitoring study by Ecology and the Chehalis Tribe;
- o an immediate increase in inspections of water pollution sources in the greater Chehalis River watershed to get a better idea of what pollutants are getting into the water and to ensure that facilities have the required permits;
- o an assessment of whether an intensive Ecology water quality study is needed in the Black River; and
- o an assessment of whether an ambient water quality monitoring station on the Black River should be established by Ecology.

Ecology has also been working for the past year on a new general permit for fish-rearing facilities. Ecology is drafting the permit with the help of governmental agencies, environmental organizations, the aquaculture industry and the public.

--over--

Gregoire said the incident highlighted the need for investigators to receive notification of fish kills and spills as soon as possible.

"It is essential that people call Ecology immediately when they see a spill occur or if they observe an unusual number of dead fish."

Suit Likely Over Salmon Pens

The emerging industry of salmon farming poses many potential dangers to the marine environment, including pollution from unconsumed antibiotic and hormone-laced feed, fish feces, and fish carcasses; the spread of disease from crowded pens; and genetic imbalances due to the escape of exotic salmon species into surrounding waters. Despite our repeated requests that it require Clean Water Act discharge permits for salmon pens, the State of Washington has issued draft regulations that purport to exempt such facilities from these permits. Therefore, staff attorney Stephan Volker has served the state and the Environmental Protection Agency with a 60-day notice of our intent to sue to enforce this requirement of the Clean Water Act.

Algae Bloom!

(The Blob that Killed the North Sea)

by Buck Jenkins

April in the Northern Hemisphere heralds the spring thaw, and thoughts turn longingly towards May, when new life springs forth with vigor. For Norwegians, there will be a certain nervousness as their "Day of Days," Syttende Mai, draws near—especially for those who live on the southern coasts or who make their living from fish farming. They wait to see if the disaster of 1988 will recur—a drama with the flavor of an early Japanese flick that would have a title something like "The Blob that Ate New York," only this blob sucked life from the North Sea, destroying everything in its path.

The spring of 1988 was an unusually warm and sunny one in Scandinavia—a phenomenon that brings with it a sense of well-being. On May 9 at a fish farm in the Gullmarfjord on the west coast of Sweden, abnormal behavior among the caged rainbow trout was observed. By May 11, most of these fish were dead.

On May 14, the same abnormal behavior was noticed by fish farmers at Hamborgsund and Arendal. Mortality among wild fish was also reported along the west coast of Sweden. By May 17, fish farms along the south coast of Norway as far west as Lindesnes had lost most of their fish. On May 23-24, a "massive fish kill" occurred at four Atlantic salmon farms in the Flekkefjord area.

The Norwegian scientific community began a major campaign to determine the cause of these deaths

Last May, Scandinavian fish farmers noticed abnormal behavior by their fish. Several days later they were dead. This was the first clue anyone had of the deadly blob that was threatening all marine life in the North Sea.

among caged and wild fish. A tide of algae measuring six miles wide and 30 meters deep was monitored. It was identified as *Chrysochromulina Polylepis*, a single-celled organism releasing a hitherto unknown toxin. Where the algae concentration reached its peak, most marine life perished. The tide was being pushed by wind and currents westward along Norway's coast.

Fish farms near Gothenburg, Sweden, were towed into the nearby river and the affected fish recovered within two hours. The Norwegian Fish Farmers Association took its cue from the Swedes and mounted a massive towing operation. Every conceivable sort of sea-going vessel was used, including tugs, ferries and supply ships.

Coast Guard and research vessels, with aircraft and satellite aid, monitored the algae front. As the tide advanced, they advised fish farmers when to tow the huge fish pens, measuring 100 meter across, into the inner fjords. In two weeks, 120 fish pens were moved to safety.

Odd Ustad, spokesman for the Norwegian Fish Farmers Association, called the rescue operation "the largest of its kind in the world" and pronounced it "a great success."

Although the farmed fish escaped, other marine life did not. The seabirds' hatching season was at its height, and there were heavy losses of birds along the south coast. The Purple Snail has virtually disappeared from some affected areas, and no one knows yet whether this disappearance is temporary or permanent.

As far as is known, most wild fish escaped because they were able to swim away from the algae tide—or bloom. However, fish that were biologically programmed to remain in certain areas (such as cod fingerlings which instinctively hide in shallow, rock-sheltered areas) were nearly decimated. Similarly, animals living on soft or sandy sea bottoms could escape the toxin by burrowing, whereas animals living on hard sea bottoms and unable to move quickly, such as the Purple Snail, would be killed in great numbers.

By June 15, the invasion of the killer algae was over, but the work of analyzing and diagnosing the significance of this potential disaster had just begun. Clearly many people would do much complicated scientific work and many experts would make pronouncements. What was the cause of the bloom? Was Norwe-

future emergencies? In November 1988 I traveled to Norway to learn what was being done to throw light on these and other significant questions. As might have been predicted, there were wildly divergent views.

En route to Oslo, I thumbed through *Scanorama*, the in-flight magazine for SAS. One article jumped out at me: "Dawn of Doomsday." The article covered more than the disastrous bloom of *Chrysochromulina polylepis*. It also discussed other major eruptions in the biological life of the Baltic and North Seas: the recent death of seals from a virus resembling the distemper-virus; the invasion of other seals into the vacated territory; massive increases of starfish along the Norwegian coast, etc. The author of "Doomsday" (Tony Samstag, a free lance journalist living in Oslo) spoke of definite links between these biological oddities and the contemporary increase of pollutants into the North and Baltic Seas from human, agricultural and industrial waste.

At the opposite end of the spectrum was a short interview I conducted by telephone with Odd Ustad, public relations manager of the Norwegian Fish Farmers Sales Organization located in Trondheim. Ustad stated categorically that the recent algae bloom was "no problem" for the Norwegian fishing industry. He pointed out that the loss of 500 tons was only .06 percent of the total production of farmed fish in Norway. While this loss was catastrophic to the individual farmers involved (fewer than 10), insurance helped to cover the loss to some extent.

Ustad went on to describe the entire algae bloom situation as a tempest in a teapot. "After all," he continued, "algae blooms are common all over the world. British Columbia, Chile and Scotland experienced similar algae invasions in 1988." He also said that algae blooms are so common in Japan that Japanese fish farmers routinely relocate their fish farms in summer—he felt that some such relocation system would have to become part of Norwegian fish farming in the future.

was now ready to interview scientists. My first interview was with Dr. Bjarne Underdal, professor of the Department of Food Hygiene at the Norwegian College of Veterinary Medicine. Dr. Underdal agreed with Odd Ustad that algae blooms are quite common in nature—he even said that there is a Biblical reference to "red tide," which could very well have been an algae bloom.

Underdal explained how algae blooms occur. Algae are forms of single-celled plants which live by

Algae blooms are common all over the world. British Columbia, Chile, Japan and Scotland experienced similar algae invasions in 1988. Even the Biblical reference to a "red tide" in Exodus may well have been an algae bloom.

consuming the fragments of waste produced by sea creatures. Algae usually exist in off-shore environments where upwelling currents stir up sea bottoms, bringing massive amounts of fragments of dead bodies and waste products of sea animals to the surface.

Very often in nature the presence of a plentiful food supply triggers a rapid reproduction (which in the case of the algae is cell division); thus a "bloom" or efflorescence of algae can result. Conditions for such a bloom were especially favorable in the spring of 1988 because the sun shone a great deal more than normal.

One of the mysteries surrounding the "*Chrysochromulina* disaster" concerned the exact process by which the algae destroyed marine organisms. One report I had read before coming to Norway asserted that the algae clogged the gills of fish, suffocating them. Another report said that the algae bloom harbored a virus or bacteria which attacked the fish and other organisms, producing a fatal disease. Dr. Underdal, who was personally in-

of death of the marine organisms, was eminently qualified to isolate the real cause—a toxin produced by the heavily concentrated algae.

The experiments established that for some unknown reason the *Chrysochromulina polylepis* algae were producing a deadly toxin which attacked three groups of cells in fish and other marine organisms, destroying their ability to perform necessary body functions and killing toxified victims rather quickly. Dr. Underdal said that the toxin simultaneously damaged cells responsible for digestion, the production of hemoglobin, and the regulation of salt in the body. (These salt-regulating glands are located in the gills, a fact which might have led to the appearance of organisms being choked to death.)

Dr. Underdal (as well as Odd Ustad) wanted one point specifically stressed. In no way does the toxin produced by *Chrysochromulina* become stored in the flesh of the organism; thus the meat of farmed salmon and trout which were towed away from the algae bloom was in no way affected.

Even though the process by which this algae bloom killed fish and other organisms had been isolated (although as of this writing the exact chemical structure of the toxin was still a matter of conjecture), I still needed a lot more information. For this, I turned to Bjørn R. Braaten, research manager for Aquaculture at NIVA (the Norwegian Institute for Water Research). Braaten had some opinions about the significance of last summer's "algae disaster."

Like other scientists I interviewed, he stressed that algae blooms (and occasionally toxic ones) have been around a long time and are a routine part of nature's overall process, which is often marked by large seasonal variations—what some people might refer to as "disasters," such as the periodic collapse of entire species for brief periods of time.

Without the existence of fish farming along the Norwegian coast, the existence of an ecological disaster could have gone undetected. The death of 500 tons of farmed fish was a sure indication of the presence of an environmental problem in the region. In the past, even the massive



death of many marine organisms in the region might have been chalked up to unknown sources. Although Ustad had pronounced the algae bloom "not a major problem" for the fish farming industry, Braaten observed that the toxin produced by *Chrysochromulina polylepis* had disastrous effects on many other organisms.

Still, Braaten expressed concern over a couple of salient points concerning this spring's outburst of *Chrysochromulina polylepis*. Although this particular species of algae has been known to scientists since 1960, this spring's bloom was the first known example of this particular algae producing toxin. Braaten said that algae are toxic and non-toxic at different times, and the reason for this difference is not understood. He offered the theory that possibly the algae were being disturbed by some environmental irritant and produced the toxin in self-defense.

A second point which he discussed was that the very size and duration of the bloom argued for the presence of an immense concentra-

tion of nutrients. These nutrients had to contain large amounts of nitrogen and phosphorus, which are supplied by run-off from the land. In recent years, these elements have greatly increased because of pollution of the North Sea, the Skagerrak, the Kattegat and the Baltic Sea by human waste and fertilizer contained in the run-offs. However, Braaten said, it was difficult for a scientist to draw an unqualifiedly positive correlation between increased pollution of the sea and this spring's large algae bloom.

Unqualified correlation or not, the algae bloom has made many people increasingly aware of the complexities of the ecological process and the dangers of upsetting it with more and more pollution. Fish farms themselves, because of their tremendous concentration of fish in small areas, may be contributing to the pollution problem. One Oslo source who wishes to remain unidentified said some government officials were considering refusing permits to new fish farms, and oth-

The one-celled algae *C. polylepis* extended its toxic tentacles into the North Sea areas known as Kattegat and Skagerrak last summer. The dates on the map shows the movement of the algae tide.

continued on page 33.



Fish farms like the one pictured above were towed to the safety of fjords to escape the algae tide. Photo by Robert Paulson.

ers were suggesting it might be wise to reduce the number of fish farms (presently 700).

Europe, too, is beginning to act. Recently there was a conference in Brussels with the title, "EEC Workshop of Eutrophication and Algal Blooms in the North Sea Coastal Zones, the Baltic and Adjacent Areas." At the 1987 North Sea conference in London, the countries surrounding the North Sea pledged to halve their 1985 levels of environmental toxins and nutrient discharges by 1995. Norway pledged to do this by 1992. Fortunately or unfortunately, Norwegian discharges make up only 3 percent of the total. This demonstrates the necessity of international cooperation in solving the pollution problem.

Another positive result of the algae bloom was the announcement by Norsk Hydro, the world's largest producer of complex fertiliz-

ers, that it would begin trials of a phosphate-free fertilizer. It is also developing a low-phosphate fertilizer.

Norway, with the most to lose if pollution isn't stopped, is again leading the way and setting the standard. In a recent Norwegian opinion poll, more than 97 percent of those questioned said that they would like to see their government focus more on environmental measures, and 85 percent were willing to pay what this would cost.

The Norwegian Council for Scientific and Industrial Research (NTNF) is already intensifying research into sea and fjord pollution with the aim of developing technology which can be used for environmental surveillance of the sea and fjords.

With this resolve, perhaps the spectre of "the blob that ate the coast of Norway" can be kept at bay. □



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MUTUAL IMPACT OF WILD AND CULTURED ATLANTIC SALMON IN NORWAY

By

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ABSTRACT

The development and current status of the fish farming industry, enhancement and sea ranching of salmon in Norway are briefly described, and an account is given of the natural salmon river populations in different parts of the country.

Record of cultured salmon in the open sea, coastal waters and rivers are briefly reviewed, and so are also migration studies on liberated farmed salmon. Diseases common to wild and cultured populations are described and discussed in relation to mutual impact.

The current situation is discussed in relation to actual and potential effects on natural gene pools and spreading of disease agents. Initiatives to protect natural gene pools are discussed, and experiments to gain additional knowledge of the genetic resources are outlined.

INTRODUCTION

Farming of Atlantic salmon in Norway commenced around 1970, and since then the production has increased steadily. In 1987 the annual production amounted to 47.417 metric tons, and the predictions for 1988 are around 75.000 tons. The production takes place along larger parts of the coast, but is low in southeastern parts and in the northernmost county Finnmark.

Wild Atlantic salmon is found in rivers all along Norway, and despite damage of stocks in southern Norway due to acid precipitation and in mid- and northern Norway due to the parasitic monogenean fluke Gyrodactylus salaris, the total reported catch of salmon has varied between 1050 and 2147 metric tons over the last 27 years. The annual variation in the production of the different rivers is considerable. All rivers seem to have their own stock with specific life histories and productive traits. Investigations of the population structure of Norwegian salmon using gene markers have been conducted by Ståhl and Hindar (1987).

Atlantic salmon has been released in Norwegian rivers for many years to enhance local stocks. They have mostly been released as unfed fry (10-15 millions a year), but also as underyearlings or smolt. Smolts (4-500 000 a year) are released primarily to compensate for damages to recruitment caused by river regulations (Hansen *et al.* 1987). Most fish released are from local stocks (Ståhl & Hindar 1988). Ocean ranching has so far been carried out on an experimental basis only, although the results have been most encouraging (Hansen and Jonsson 1988).

It is a reasonable assumption that the fish farming industry in Norway will continue to increase, and we therefore need to take good care of our several hundred local populations of wild salmon. Moreover the possibilities to augment the stock enhancement work and to develop ocean ranching of salmon should be assessed.

Many questions have been raised about the impact of the growing fish farming industry on the natural salmon populations. This concern has mainly been focused on two aspects; the transfer of disease from farmed to wild fish and the danger of eradicating salmon gene pools by

breaking down isolation mechanisms between stocks, and decreased fitness of the wild salmon due to introduction of nonindigenous gene or gene combinations. Transfer of diseases from wild to farmed fish is also a matter of concern, and for the fish farming industry strong and healthy wild populations with a high degree of genetic variation is a good insurance if the cultured populations should be subject to massive disease infections or unexpected genetic alterations.

The aim of the present case study is to give an overview of the relationship between wild and cultured salmon in Norway, including initiatives to protect the natural gene pools. The greater part of the study is based on published papers and reports, and in addition some discussion on validity of concern is included.

DESCRIPTION OF THE SITUATION

Recent development in farming and ocean ranching of Atlantic salmon has led to an increased proportion of reared fish in nature. Based on fin morphology and scale analysis the proportion of reared fish (ranching and farm escapees) has increased from about 10% in 1986 to about 20% in 1988 in commercial fisheries in Norwegian home waters (Hansen *et al.* 1987a, Lund and Hansen 1988, Lund *et al.* in prep.). If not caught in the fisheries, the adult salmon enter rivers to spawn (Hansen *et al.* 1987b). Using direct observations of body morphology, brood stock surveys in rivers in southern Norway in 1987 revealed that 23 (43%) out of 54 rivers examined contained reared salmon (Gausen 1988). In total of 615 salmon examined 83 (13%) were determined to be of reared origin.

These escaped fish spawn in the streams. For instance, in the small river Imsa there is an annual run of between 100 and 200 mature rainbow trout which have escaped from fish farms. They spawn and they leave the river system as kelts (Jonsson and Hansen, in prep.). The number of viable offspring is extremely low. Because Atlantic salmon is a species native to Norway it is likely that reared salmon can yield viable offspring in nature. However, the reproduction success of reared salmon in nature is still unknown (Ståhl and Hindar 1988).

Experimental releases of farmed Atlantic salmon show that there is a

seasonal variation in survival. Survival of escaped salmon during their first sea year is much higher for those escaping in spring than for those escaping during the rest of the year (Hansen & Jonsson 1986, 1989). Adults escaping during summer seem to enter rivers at random and behave like homeless fish (Hansen et al. 1987b). When escaping from sea cages at the smolt stage the fish return to the same area from which they escaped and enter rivers in this area to spawn (Hansen et al. 1989).

Reared salmon might affect natural populations in several ways. For example the fluke Gyrodactylus salaris is at present spread to 32 rivers by stocking fish from infected hatcheries. This parasite attacks salmon parr and causes heavy mortality. In 1984 the estimated loss of salmon to Norway was around 250-500 tonnes (Johansen & Jensen 1986), and now the damage is still higher as the fish in more rivers have been infested by the fluke. Salmon smolts are still imported to Norwegian fish farms from other countries, which imposes a continuous risk of importing disease and parasites to which Norwegian salmon stocks are not adapted.

Extinction of local, indigenous fish stocks and erosion of genetic resources are subjects of growing concern to salmon management in Norway. The primary causes of excess salmon mortality in the present century are acid precipitation (Hesthagen & Mejdell-Larsen 1987), and the parasite Gyrodactylus salaris (Johnson & Jensen 1986, 1988). Effects of escapees from salmon farms on natural stocks also is a matter of concern among biologists. For these reasons the Directorate of Nature Management has established a gene bank for salmon based on deep frozen sperm. In 1986 and 1987 sperm collected from a number of salmon rivers throughout the whole country were stored (Gausen 1986 and pers comm.). In total sperm from 69 stocks are by now stored in the sperm bank.

DISEASES

Of the interaction problems between wild and farmed salmonids, diseases is possibly the largest and most serious one. Disease in fresh water farmed fish has been known for considerable time. Sea water farming started more recently, and it was believed that

conditions in seawater would be much better, with cleaner water and less disease problems.

Very little was known about diseases and parasites in free-living marine fishes when the fish farming industry started, and still there are immense gaps of knowledge. It has also appeared that diseases expected to occur only in fresh water, thrive very well in seawater.

The case of the salmon lice, Lepeophtheirus salmonis, is maybe the one giving the best illustration of an interaction between wild and farmed fish. This parasite was well known, it was described by Krøyer as early as in 1838. It is a copepod with a life cycle of 10 stages, 3 pelagic stages and 7 attached to or living on the host. It is found circumpolarly in the northern hemisphere and is host specific for salmonids; the lice disappears from the fish in fresh water within a short time. When and where the free-living fish is infected is not known. The chance for a pelagic-living larvae to encounter its specific host in the open sea, does not seem very large. When wild salmon still were abundant in the rivers, the saying of experienced fishermen was that a high density of lice on the upward migrating fish, was indicative of a good salmon run. Only once, in Canada in 1940, lessions and death probably due to salmon lice were reported (White 1940). Actually, it should have been foreseen that salmon lice could become a potential problem in salmon farming. Under the intensive conditions found in farms, it is no longer a problem for the pelagic larvae to find their spesific host and complete their life cycle producing new larvae easily finding new hosts and so on. It soon became evident that the lice, if present in large numbers, were harmful to salmon. They live on mucus, skin and blood and in the most advanced cases fish are seen with large open lessions especially in the head region. Even if wild-living salmonids arround fish farms have been observed carrying large numbers of lice (Djupvik, pers. com.) lessions or mortality in such fish are not reported.

We still know little about diseases in free-living marine fish, clearly it is among the farmed fish we really encounter the problems. The largest problems are seen in connection with bacterial infections. Vibriosis due to the bacterium Vibrio anguillarum is probably the most well known of such diseases. Vibriosis was one of the economically

most important diseases in marine fish farming, but can now be controlled efficiently through vaccination. Vibriosis is known from a large amount of freeliving marine fish, but epidemics are rarely seen. Along the Norwegian west coast local outbreaks of vibriosis in young saithe are found annually, reaching epidemics proportions in certain years (Egidius et al. 1983). Experiments have shown (Egidius and Andersen 1978) that there is some host specificity amongst V. anguillarum strains isolated from for example rainbow trout and saithe, and more recent investigations have shown that there at least at the DNA level is a slight difference between strains from different hosts (Wiik et al., in press). Mass mortality due to vibriosis is reported in homeward migrating salmonids when entering the rivers, but it does not seem to occur very frequently. Coldwater vibriosis due to V. salmonicida has not yet been reported in wild salmon.

Furunculosis due to the bacterium Aeromonas salmonicida var. salmonicida is another of the important bacterial diseases that must be considered. Furunculosis is endemic in the wild salmonid populations in Scotland, Ireland and Canada, but free-living affected fish are not frequently seen. In fish farms on the other hand the disease can be disastrous and in general of great economic importance. With furunculosis it seems clear that the free-living fish is the reservoir for the disease in farmed fish. In farmed fish the disease outbreaks seem linked with fish density in tanks and cages and other stress inducing factors.

The bacterium Yersinia ruckeri is a newcomer in European fish farms. Even if the disease was believed to be a fresh water one, it has spread to salmon farms all along the Norwegian coast. Possible effects on free-living salmonids are not known. Although the bacterium has been isolated from marine scavenger fish like saithe around affected sea cages, it is not known if the saithe just harbours the bacterium for a short time or if it can be pathogenic also for this and other marine species.

Bacterial kidney disease (BKD) due to Renibacterium salmoninarum is probably the most dreaded of the salmonid diseases mainly because its development is slow and because the diagnostics is difficult and time consuming. BKD was first thought to be purely a disease of farmed

fish, but with improved diagnostic methods the bacterium was also found in wild stocks though its impact there is unknown. We most probably have the same situation as with furunculosis: that the infection reservoir is in the wild stocks, but the disease problems break out under farming conditions. The disease in farms can lead to higher infection rates of wild stocks in the vicinity.

Of fungal disease agents Ichthyophonus hoferi is common and often harmful in several species of marine fish. It has been found in farmed salmon, but until now without showing much effect.

Of parasites the monogenean fluke Gyrodactylus salaris has done great harm in Norwegian salmonid rivers. The fluke is believed to have been imported with smolts for farming from Sweden to Norway in the early seventies. This fluke is now spread to about 30 salmon rivers, many of which are nearly emptied of Atlantic salmon. In the fish farming industry Gyrodactylus is no problem. Infected fish are easily treated and the parasite disappears when the smolts are put into sea water. This is the only disease mentioned here where apparently wild stocks are the losers.

Examples have been given of disease interactions between free living and farmed salmonids, mostly to our knowledge in the disfavour of the farmed fish. Our general knowledge on disease in free living marine populations including salmonids, is still far too restricted, but there clearly is reason for great consideration and carefullness in movements of fish from different regions.

GENETIC VARIATION AND GENETIC STRUCTURE OF SALMON IN NORWAY

Population structure of salmon in Norway

Ståhl and Hindar (1988) have made a comprehensive monograph of the Norwegian salmon stocks with reference to the population structure, number of spawners (population size) and differences within and between wild and farmed salmon stocks. From studies on biochemical genetics they concluded that the natural salmon is divided into genetically distinct populations; sometimes more than one within the

same river system. Farmed salmon (commercial stocks for intensive farming and culture aimed stocks) is not a homogeneous group and it is not possible to distinguish between wild and cultured salmon on the individual level by use of biochemical gene markers.

Potential genetic impact

Skjervold (1988) gave an overview of the types of genetic impact the fish farming could have on natural salmon stocks. In spite of the difficulties in estimating the numbers of escapees from fish farms, and of the magnitude of their contribution to the recruitment of salmon, evidently a great potentiality exists of significant gene transfer risk from farmed salmon to occasional rivers.

The farmed salmon has been subjected to intensive selection for improvement of productive traits, especially improved growth rate and late maturation. Genetic selection is performed systematically through a large scale program on improvement for fish farming conducted by the Fish Farmers Association and the Fish Farmers Sales Organization in Norway. In addition most egg producers make phenotypic selection of broodstock, and probably also seminatural selection as an adaptation to life under farming condition (domestication) has taken place for 4-5 generations. The genotypes of the farmed fish may differ in several respects from the genotype of the population from which they originated several generations ago. It is difficult to predict how this change will affect their adaptation with respect to survival in the natural environment, but escapees which reproduce in rivers chosen by random will always decrease the differentiations between the wild salmon populations.

The origin of the salmon used for fish farming is important. Ståhl (1987) has shown that especially the Baltic salmon differs in genetic composition from the salmon in the north-east Atlantic, and east-Atlantic salmon differs in several aspects from the west-Atlantic stocks. As far as we know there has been no import of west-Atlantic live salmon to Norway (except for scientific purpose), but for several years we have had importations of smolts from Iceland, Scotland and especially from Sweden and Finland (Baltic salmon).

Gjedrem and Aulstad (1974) observed that a strain of Baltic salmon showed much lower resistance to vibrio disease than the Norwegian strains, indicating that genetically differences in resistance to certain diseases exist between geographically distant groups. Escapement of fish with other adaptations to diseases and parasites in the environment will represent a risk for transferring such disease agents to natural population. Thus newly established or potential hybride populations may be eradicated due to spontaneous or accidental disease outbreaks.

Hybridization, hybride vigor and short term adaptation

Crossbreedings of natural and escaped salmon in the rivers are expected to cause increased heterozygosity, which may lead to hybrid vigor for some traits. Hybride vigor most often is found for traits with low heritability (Skjervold 1988), and survival traits have low heritabilities as far as they have been studied (Gjerde 1986). Thus, hybridizing with natural salmon in a river may give the impression of very well adapted fish; an adaptation which may oust nonhybride natural salmon, but last only for the first generation. Altukhov (1981) described a similar case with chum salmon where liberation of non-indigenous fish resulted in very low production both of the introduced fish and of the indigenous fish in the same river.

Genetic drift, reduced genetic variability and low numbers of spawners

Low numbers of spawners (effective population size) will always increase genetic drift, decrease heterozygosity and consequently increase the risk of loss of genes. A number of 100 specimens of each sex is recommended by Allendorf and Ryman (1987) but in several cases of artificial reproduction for enhancement work and intensive fish farming, the spawning populations are considerably less than recommended based on theoretical considerations. However, judged from the results of Ståhl and Hindar (1988) the heterozygosity is higher in artificial than in most natural populations, and the genetic variability within populations is not reduced due to culture activities. This may be due to the fact that cultured populations usually represent different natural populations and contain more genetic variation than any single population. Therefore the risk of

reducing the fitness of salmon through reduced genetic variability does not seem to be serious for the moment, although it should be kept in mind by monitoring both cultured and natural populations through several generations.

In conclusion the escapement of farmed salmon, and liberation of non-indigenous salmon for enhancement work represents a risk of decreasing the genetic variability between populations, possibly also reducing the long time fitness by first generation hybrid vigor in adaptive traits through hybridization between indigenous and non-indigenous fish. For the moment, however, loss of genetic variability through low numbers of broodstock for culture purpose does not seem to represent a risk.

INITIATIVES

To avoid impact of cultured salmon on wild stocks a series of initiatives have been taken or are being planned in Norway. These initiatives are listed below with a statement of the status of each of them.

Technical improvement

In addition to representing a risk for wild salmon, salmon escaping from fish farms always represent a loss for the fish farmer. Improvement of technical facilities to prevent escapement therefore is an immediate initiative to prevent contact between wild and cultured salmon. Usually, the security of a fish farming facility is a compromise between the chance of loss and the cost of investment. Landbased facilities are more safe than ordinary net pens, and closed or semiclosed pens are also an alternative. For the moment, landbased facilities for marine culture are not much used in Norway, but closed or semiclosed systems are under development. No specific demand is required for fish farming devices, but it has been proposed to establish protective areas for salmon where no farming activities will be allowed unless they are secured with respect to escapement. Within the zones technical improvements may prevent contact between natural and farmed salmon.

Gene banks (sperm banks)

Salmon from Gyrodactylus-treated streams are taken care of by artificial breeding and liberation, partly also in intensive culture (Ståhl and Hindar 1988). A sampling program for deep-freezing of sperm is undertaken (Gausen 1986). In 1986 sperm from 48 strains were preserved, while in 1987 the sperm bank increased to contain sperms from 69 populations. By using such sperms, populations which have been eradicated may at least partly be reconstructed. By use of androgenetic techniques more complete natural populations may be reconstructed from sperm banks (Scheerer et al. 1986).

Restriction on transfer of live material

For many years there has been a lack of smolts for the fish farming industry in Norway, as the smolt production did not increase as fast as the development of food fish production. For this reason, some imports have been legislated, in some cases with disastrous results concerning cultured salmon (i.e. import of furunculosis from Scotland) and natural populations (possible import of Gyrodactylus salaris from Baltic countries). In 1988 there was a surplus of smolts in Norway. This situation is expected to persist, and there is no longer any reason for import of live salmon, although even this year (1988) there has been an import of salmon eggs from Iceland. Transport of live material within the country probably also has contributed to the spread of Gyrodactylus. This seems to be a problem especially in cases where salmon farms are situated in fresh water systems also supporting anadromous salmonids, or in brackish water with a salinity lower than 14 to 18 o/oo. For this reason restrictions of transfer within Norway are also proposed, but not yet decided upon.

Use of indigenous fish for enhancement work

Enhancement has been conducted for several years by releasing offspring from occasional salmon of unknown origin, also farmed fish. To protect the between strain variation, in principle now only endemic fish are allowed to be used for enhancement of natural stocks. Only when such fish is unavailable, non-indigenous fish are allowed used.

Areas protected from fish farming

Hatcheries for commercial production of smolts for intensive fish farming are usually not located in or close to rivers with anadromous salmonid populations. However, some existing hatcheries are located close to rivers with sea-run fish, and inland in Norway plants for rainbow trout productions (mostly small) are sometimes located in lakes draining to salmon rivers. Such fish farms have probably spread Gyrodactylus salaris. Hereafter no new installation for intensive production or for enhancement work for other than indigenous populations, will be allowed in rivers supporting anadromous populations.

To protect larger areas, a plan has been formulated for time restricted protective areas for wild salmonids. This plan is now subjected to consideration by involved official agencies and private organizations, and the fate of the proposal is yet uncertain. The aim of the proposal is to protect larger areas and secure references for observation of gene introgression and spread of disease agencies. To prevent further spread of Gyrodactylus salaris no new culture activities will be allowed where this parasite has been found. This include the river drainage and a defined area usually within about 20 km of the river mouths. Usually, rivers having a mean annual catch of more than 500 kgs anadromous salmonids will be protected. A few larger fjord areas (Sognefjorden, Trondheimsfjorden) are also proposed to be held free from new aquaculture installations. Such protective areas are proposed for five years as it is desirable to gain experience about the effect of such restrains before long-lasting decisions are made. If escapement free facilities are constructed, limited farming activities may be allowed, and existing farms within the areas will be allowed to continue.

MONITORING AND RESEARCH

The establishment and increase of the intensive fish farming industry represent a new and possibly serious threat to the natural populations of Atlantic salmon in Norway as well as in several other countries. From a management point of view actions are taken or will be taken to

conserve the natural population in coexistence with the developing fish farming industry, and possible commercial sea ranching activities. A first approximation to such management is to monitor the changes that really take place, and then to develop new methods for interaction studies. Further studies on quantities of escaped reared salmon in coastal areas and in the rivers, studies on infection sources for disease agents, occurrence of disease agents in natural populations and development of methods for defence against parasites (i.e. Gyrodactylus) in natural environment are required. Reconstruction of eradicated (or strongly decreased) natural populations from live gene banks or sperm banks by androgenesis is another area of research and development. Concerning genetic impact, the discussion is often loose and concentrates more on potential impact than on actual facts. To base this discussion on observed or experimental data will be a great challenge for scientific activities in the near future. Further studies on genetic differentiation of natural populations is important. To study hybridization and gene introgression, use of gene markers is a promising method. For other species (cod, brown trout) broodstocks homozygous for specific gene markers (biochemical or morphological) are developed (Skaala *et al.* 1988). No suitable markers are yet found for salmon, but this will be further investigated for application in field studies on interaction between populations. If such studies are difficult or impossible to perform with salmon, they will be performed with brown trout as a model species.

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COUNCIL

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POTENTIAL IMPACTS OF SALMON FARMING ON WILD STOCKS

POTENTIAL IMPACTS OF SALMON FARMING ON WILD STOCKS

1. INTRODUCTION

- 1.1 The Atlantic salmon has colonised roughly its present distribution range since the last glaciation some 10,000 years ago. Representatives of the salmonid group of fish have been found in fossils dating back 5 million years. For the first time in the evolutionary history of the salmon man has made a sudden intervention to artificially propagate domesticated, selectively bred Atlantic salmon on a large and rapidly expanded scale. The advent of this salmon farming industry is an exciting and valuable development. It may even exert some degree of protective influence, at least economically, on the wild stocks. Nevertheless, this new industry could pose new threats to the wild stocks and such concerns have been expressed by a number of national and international organisations.
- 1.2 This paper, which should be read in conjunction with the detailed review attached (Annex 1) is prepared in accordance with the decision of the Council at its Fourth Annual Meeting. It presents a summary of the potential threats, the activities of other organisations and suggests possible action by the Council of NASCO.

2. POSSIBLE INTERACTIONS BETWEEN FARMED AND WILD FISH

Production of farmed fish

- 2.1 Salmon aquaculture is not new. The first commercial salmon hatchery was established on the Rhine in 1852 and by the turn of the century hatcheries had been established in almost every salmon producing country. The recent large scale expansion of salmon farming is, however, unprecedented. The industry has expanded from a production of 10 tonnes in 1970 to a production by eight countries of over 65,000 tonnes in 1987. There are estimates of a production of between 90,000 and 259,000 tonnes by 1990. This may be seen in relation to a wild salmon catch averaging under 10,000 tonnes over the last twenty years (Fig. 1). The attached review, examines the occurrence and behaviour of farmed fish in the wild (Section 2), the possible genetic interactions (Section 3), diseases and parasites (Section 4), the introduction of non-indigenous salmonids (Section 5), economic interaction (Section 6), and the impact upon the aquatic environment (Section 7).

Occurrence of farmed fish in the wild

- 2.2 Farmed salmon may occur in the wild as a result of accidental release (escape) or deliberate release. There is direct evidence that salmon farm escapees are caught in the Faroese long line fishery. It has been estimated that on average 15% of the fish held in fish farm cages escape accidentally. If this percentage is applied to the 1987 harvested production, up to 10,000 tonnes of farmed fish may have escaped to the wild. Recent reports from Norway suggest that up to 13% of the fish ascending rivers in southern Norway may be of farmed origin. In addition to escapees, unwanted parr may be deliberately released into the wild by salmon farmers or given to fishery managers for stocking.

Genetics

- 2.3 The Atlantic salmon is being domesticated by the salmon farming industry; farmed fish have been selected for traits favourable for rearing in captivity, e.g. tameness, growth rate and late maturity. Hatchery production produces marked reductions in genetic variabilities. On the other hand it has been estimated that 2,000 distinct stocks of wild Atlantic salmon exist in Europe and North America. Clear genetic differences can be demonstrated between European, North American and Baltic salmon and studies within these groups have demonstrated genetic differences between and in some cases within river systems. These studies are supported by strong circumstantial evidence of physiological differences which are heritable. Several studies conclude that Atlantic salmon rivers should all be regarded as having genetically separate populations. The adaptive significance of these genetic differences has been demonstrated. The genetic variability in a wild salmon population enables adaptation to differing environmental conditions and therefore assists its long term survival.
- 2.4 In view of the risk of hybridisation posed by the large number of farmed fish in the wild there have been warnings of the need for the formulation of a strategy on how best to conserve the genetic resources that are still available. There has been one recorded instance of the risks of such introductions. The transfer of 350 million chum salmon eggs (from the Kalininka to the Naiba River in the Soviet Union) took place and twenty years later the run of salmon into the Naiba River was virtually extinct. This is an important example because Atlantic salmon show more genetic variability than Pacific salmon.

Introductions, diseases and parasites

- 2.5 The rapidly expanding aquaculture industry has led to an associated increase in the number and severity of diseases of farmed fish and such disease problems have led to growing concern about the possibility of the introduction and transfer of diseases from farm stocks to wild fish. The possible dangers to wild fish from introduced diseases and parasites have been highlighted by the problem of Gyrodactylus salaris, a monogenean fluke introduced to Norway with imported hatchery stock. The parasite now occurs in more than 28 watercourses and annual losses of salmon are already estimated to be 250-500 tonnes. The ICES ad hoc Study Group on Environmental Impact of Mariculture believed that the importation of exotic species or disease organisms is the greatest environmental risk associated with mariculture because the consequences may be widespread and irreversible. Concern has recently been expressed in the North American Commission of NASCO about the growing interest in the use of rainbow trout in sea-cages along the eastern seaboard of North America. The rainbow trout has the potential to pose a severe ecological threat to Atlantic salmon management.

Environment

- 2.6 The rapid growth of the salmon farming industry has led to an increased awareness that there may be considerable impacts on the aquatic environment, both in freshwater and marine conditions. The most significant characteristics of fish farm wastes as they affect water quality are nitrogen and phosphorous compounds, oxygen consumption, suspended solids and a range of therapeutic and prophylactic chemicals. Although the industry has posed only localised environmental problems to date its continued development, given anticipated growth, is likely to cause greater

problems. Furthermore, there is concern that the behaviour of wild fish may be modified by the presence of cages.

3. ACTIVITIES OF OTHER ORGANISATIONS

- 3.1 The subject of inter-relationships between farmed and wild salmon was considered by the ANACAT Fish Committee at its 1987 meeting. The papers presented dealt mainly with the methods of distinguishing farmed and wild salmon, the occurrence of farmed salmon in the wild and possible impacts. It is intended that this topic could be considered further as part of a mini-symposium on spawning variability in 1989. ICES has established a Working Group on the Environmental Impacts of Mariculture which will meet for the first time in 1988 to consider, among other things criteria for site selection which will minimise the environmental impacts of mariculture.
- 3.2 Several Working Groups concerned with Introductions and Transfers have been established including those of ICES, EIFAC and the North American Commission of NASCO. ICES and EIFAC have prepared Codes of Practice concerning introductions and transfers. Some countries have not endorsed either code of practice while in some other countries the codes are only applied to the import of non-indigenous species. The NAC Working Group has produced a series of recommendations, which apply specifically to salmonids in Canada and the USA and which recognise the potential for adverse genetic effects, in addition to diseases and other ecological interactions, resulting from introductions and transfers. These recommendations included the prohibition of transfers of eastern hemisphere and Icelandic Atlantic salmon, and the use of alternate sources of stocks for both enhancement and aquaculture until appropriate protocols could be developed. Such protocols are now being drawn up by Health and Genetics sub-groups. The NAC group also prepared a computer-based inventory of salmonid introductions and transfers.
- 3.3 The Norwegian authorities have responded to the threats to the genetic resources of their salmon by establishing a sperm bank. Sperm banks have also been established to supply the salmon farming industry with disease free milt and research is currently underway into the feasibility of cryopreserving salmon eggs and embryos.
- 3.4 Commercial trials in the UK of the performance of all female, triploid salmon are now being undertaken. These fish are sterile and therefore avoid the problem to the farmer of maturation in the sea cages. This development, if adopted by the industry, could have favourable implications with regard to possible genetic effects of fish farm escapees. However, further research into the behaviour of these fish in the wild may be required.
- 3.5 In Norway and British Columbia regulations requiring a minimum distance between net-pen facilities and major salmon spawning streams, i.e. aquaculture-free zones, have been introduced.

POSSIBLE ACTION BY THE COUNCIL

- 4.1 NASCO holds the international responsibility for conservation of salmon stocks. There is clearly a need for further research into the effects of the new aquaculture industry on these stocks. Areas of research which have been highlighted include further development of methods of stock identification; assessment of the number of farmed salmon escaping, their migration pattern and whether or not they breed; and the effects of hybridisation between wild and farmed fish if this occurs. The Council might like to consider how such research might be stimulated.
- 4.2 The North American Commission of NASCO established a Bilateral Scientific Working Group in 1986. Their Report has been published separately as Annex 13 to NAC(87)20. It includes recommended actions to be taken to reduce potential risks. The NAC group also developed an inventory of salmonid introductions and transfers. The Council may wish to consider if such actions should be recommended to the North East Atlantic Commission. As with the NAC Group this Commission might well liaise with the ICES Working Group on Introductions and Transfers.
- 4.3 The Council might like to consider whether an internationally agreed Code of Practice to protect wild stocks might be developed. Such a code could consider recommendations on, for example, aquaculture-free zones, the use of local broodstock, the disposal of surplus stock from aquaculture, the possible use of all female triploid stocks etc. A review of the main elements which might form the basis for a code could be carried out by the Council as part of its role in the conservation of salmon stocks under the Convention.
- 4.4 The Council might wish to consider in further detail the mechanics, costs and benefits of establishment of gene banks. In addition to established techniques for cryopreservation of sperm, research is underway in the UK and in other countries on cryopreservation of salmonid ova and embryos. A review of the state of these techniques and other methods of preserving genetic resources could be considered at the Sixth Annual Meeting.
- 4.5 The Council may wish to consider in more detail any evidence on the environmental effects of sea cages on wild stocks and review the evidence for diseases being transmitted from farmed to wild.
- 4.6 The Council may wish to see a review of the legislation relating to the interactions described in this paper as taken from the Laws, Regulations and Programmes Database which now exists.

5. SUMMARY

- 5.1 The attached review requested by the Council examines in some detail the possible interactions between wild and farmed salmon. It concludes that the growth of aquaculture has produced new potential threats to the Atlantic salmon. Some of these are known to be serious but the effects of others are not known. These potential threats include loss of genetic variability, to introduction and transfer of diseases and parasites and changes in the aquatic environment. A number of organisations are studying the evidence for some of these interactions. The Council of NASCO may wish to consider which action it should take. Some options are listed above.

Secretary
Edinburgh
18 May 1988

Refutations of
Dr. Whitely's argu-
ments solicited
by John P.H.S., Dept
of Ag, WA



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Northwest and Alaska Fisheries Center
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December 3, 1986

Dr. John Pitts, D.V.M.
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406 General Administration Building AX-41
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Dear John:

Thank you for your letter of October 7, 1986, asking for comments on the presentation given by Dr. Arthur Whitely to the Puget Sound Alliance on the effects of salmon farming on Puget Sound. Dr. Whitely has made several factual errors in his testimony, has attempted to link marine net-pen farming with human disease, and has presented information on potential pollution from uneaten fish feed and fish excretory products without pointing out the assumptions upon which his calculations are based. I will limit my comments to those areas which my background in fish biochemistry and nutrition research and my practical experience qualify me as an expert.

Fish farms are designed to operate at a profit, and it is in the best interest of fish farmers to manage their farms in such a way that the quality of the rearing environment is maintained at high levels. Fish farmers do not locate net-pens such that there is 0 feet beneath them, as Dr. Whitely states on page 2. Nor are they so careless as to allow 20% of the feed they use to pass through the pens as waste to collect on the bottom and decay, as stated by Dr. Whitely on p. 3-4. Dr. Whitely implies that the decision to limit salmon farms in Norway to 8000 M³ is a biological decision because bigger farms pollute the environment. In fact, the decision to limit the size of fish farms in Norway is a political or social decision designed to limit the numbers of large corporate fish farmers and encourage small family businesses. Dr. Whitely also states on page 3 that the main reason that Norwegian salmon farmers want to develop salmon farms in Puget Sound is that there is no limit in Washington on the size of salmon farms. Actually, the main reason for the interest of the Norwegian investors is that North American farms are closer to North American markets. To remain competitive in North American markets, the Norwegians must eliminate the \$0.75 to \$1.00 per pound charge for shipping fresh fish from Norway by air freight.

Dr. Whitely makes several misleading statements and factual errors regarding the potential contribution of marine net-pen culture to disease. On page 8 he states that the presence of fish pens in certain bays in Japan destroyed oyster aquaculture for years and was harmful to all invertebrates. This is certainly not the case in Washington or British Columbia where many salmon farmers make extra money by growing mussels on ropes suspended from their net-pens. Anyone who has ever seen a salmon



farm knows that one of the main problems with net fouling is the presence of invertebrate on the nets. Dr. Whitely also implies that red tide, which causes paralytic shellfish toxin to accumulate in clams, oysters, and mussels, is somehow connected to salmon farming. Since red tide has occurred from Alaska to Washington for at least as long as history has been recorded, the presence or absence of salmon pens would seem to be irrelevant. Dr. Whitely's most serious factual error concerns Vibrio vulnificus, a human pathogen found in uncooked shellfish. Dr. Whitely implies that the presence of Vibrio vulnificus is somehow related to Vibrio anguillarum, a fish pathogen first isolated from herring which does not cause disease in humans. Dr. Whitely's assertion that several genera of bacteria - Aeromonas and Vibrio - are concentrated around marine net-pens has never appeared in the scientific literature and is irrelevant as far as the potential for human disease is concerned. According to Dr. Marleen Wekell, Seafood Specialist for the Food and Drug Administration, there has been only one documented human death in the United States caused by Vibrio vulnificus, and this was caused by eating uncooked shellfish. This condition apparently affects only those people with liver disease and is completely treatable with antibiotics. Dr. Whitely's assertion that "people are dead" conflicts with the records of the FDA and the CDC. Dr. Whitely states that incidents of gastroenteritis on the East Coast are clearly relatable to pollution from marine fish farms, despite the fact that, with the exception of Eastport, Maine, there are no fish farms on the East Coast. Dr. Whitely mentions the amount of oxytetracycline used by Norwegian fish farmers and by extrapolation predicts how much will be used in Puget Sound on 280 acres of fish farms. He does not mention that the regulations governing the use of antibiotics in the United States are very different from those in Norway, making his predicted value completely inaccurate. In the United States, salmon farmers might at most use medicated feed for several weeks out of the year.

Let me now turn to Dr. Whitely's statements on fish food and fish excretions (p 3-4). There are several key assumptions made in Dr. Whitely's argument. They are:

- (1) "It takes two pounds of feed to make one pound of salmon."
- (2) "20% passes through the pens as waste and falls to the bottom and is distributed to the sea."
- (3) "30% of the consumed carbon and 10% of the consumed nitrogen will end up as feces and fall through the pen as feces."
- (4) "About 65% of the nitrogen that is consumed will be excreted."

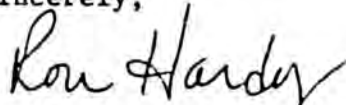
Each of these 4 statements is based on an assumption and each of them can be challenged by the data contained in a large number of published papers. Statement 1 - we have fed as low as 0.8 pounds of a practical diet per pound of gain, while with semi-purified diets we have gotten values down to 0.6. Statement 2 - I would guess that less than 5% is uneaten at worst. What is uneaten by the salmon is eaten at once by perch and other fish that live just outside the nets. Statement 3 - what ends up in the feces depends upon what ingredients were used in the diet. We have made some diets that exceed 90% dry matter digestibility and 97% protein digestibility. That would change Dr. Whitely's numbers for carbon and nitrogen to less than 10% and less than 3%, respectively. Also fish

feces are very liquid compared to that of terrestrial animals (85-90% compared to 60-65%) so the feces dissolve or disintegrate very rapidly after excretion. Statement 4 - the amount of consumed nitrogen excreted depends again on the diet formulation - it is not a set amount. The goal of fish nutritionists is to formulate a diet in which the amino acid balance is just what the fish needs to grow and no more. As diet formulations improve, the proportion of consumed nitrogen excreted, which now is 40-50%, will decrease.

What all this adds up to is that the quantities of nitrogen excretion and dry matter pollution that Dr. Whitely calculates would result from fish farms are overstated. It might be possible to approach the numbers he uses by deliberately formulating an unbalanced diet containing poorly digested and unpalatable ingredients, by using inappropriate feed pellet sizes, and by feeding the fish at a rate much higher than they can eat. A fish farmer following these practices would not be in business for long. Dr. Whitely's evocative statement in which he equates the pollution generated by a 5-acre fish farm to 5,000 to 10,000 people defecating and urinating in Griffin Bay may be an attention grabber but it is a meaningless statement. Fish excrete ammonia rather than urea like humans. Ammonia is very soluble in water and is converted almost instantaneously to nitrites and then to nitrates by ubiquitous marine bacteria. Nitrates are food for marine plants. As mentioned earlier, salmon feces contain a higher water content than the feces of terrestrial animals and, since salmon do not have a active microflora in the gut, in contrast to humans, the feces do not contain high levels of bacteria. Most of the undigestible materials in fish feces are complex carbohydrates and fiber of plant origin, which are rapidly decomposed by marine bacteria. Domsea Farms, Ind., which has had net-pens in the same location for over 10 years, has no accumulation of material beneath the nets, according to the divers I know.

In conclusion, there are doubtlessly other comments that could be made regarding Dr. Whitely's testimony but those I have mentioned cover the areas in which my expertise lies. I hope you find these comments useful and if documentation is required on anything I have covered I will be glad to provide it.

Sincerely,



Ronald W. Hardy, Ph.D.
Supervisory Research Chemist

MILNER - RENSEL ASSOCIATES
NATURAL RESOURCE CONSULTANTS

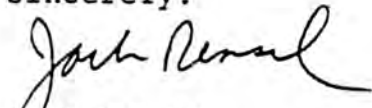
November 1, 1986

Dr. John Pitts
Dept. of Agriculture
406 General Administration Bldg.
Olympia, WA
98504

Dear John:

Enclosed are a few comments on Dr. Whitley's presentation.
I hope they will be of some use to you. I actually enjoyed
doing the review as it sharpens my skills to do this sort of
critique.

Sincerely:



Jack Rensel
Fisheries Scientist

Review of Dr. Arthur Whitely's Sept. 6, 1986 presentation to the Puget Sound Alliance as transcribed and sent to us by the Dept. of Agriculture.

page 2. 3rd paragraph. Density of fish is more typically measured in terms of weight of fish per unit volume of water area, not in terms of number of fish per unit volume. Puget Sound coho farms rear fish at 0.25 to 0.50 lbs/cu ft for delayed release facilities and 0.25 to about 1.5 lbs. per cubic foot for commercial pan size operations. It has been attempted at rates up to 4.0 lbs. per cu. ft. but I doubt if that is widely practiced. Rearing of fish to larger size such as adult sized coho or Atlantic salmon may involve higher densities as the fish exceed the 1 lb size. Many of the Atlantic salmon farms that we have planned are using about 1 lbs. per cu. ft. as a maximum density. Others have used as little as 0.4 lbs. per cu. ft. in their planning to error on the conservative side or to satisfy insurance company requirements. (lbs/cu.ft. to kg./cu m factor is 16.02)

page 3. paragraph 2. There is no printed evidence of the alleged Norwegian concern for environmental protection in regulating the size of their net-pen operations. The only citation we have seen (Edwards 1978) specifically states that the volume limitation was imposed to spread the benefits of aquaculture as much as possible among the people of Norway. The Weston report addresses this topic through personal communications with knowledgeable people and arrived at the same result.

same paragraph. the proposed net-pens of Sea Farm of Norway net-pens are two sets of pens, each 100 by 590 feet. This amounts to 2.71 acres, not 5 acres as Dr. Whitely asserts.

page 3. 3rd paragraph. Dr. Whitely states that it takes 2 pounds of feed to produce 1 pound of fish. It has been my experience that it is fairly easy to obtain a 1.5 to 1 conversion ratio, although it varies with the species, size and purpose of rearing (delayed release, pan size or full size).

page 4. 2nd paragraph. Dr. Whitely states that the nitrogen loading from the particular net-pen facility under discussion will be "... a little lower and the biological oxygen demand is higher than the LOTT wastewater treatment facility treatment plant". In reality, Dr. Weston's report indicates that total nitrogen loading is only 1/4 as high as the LOTT plant (in percentage form, 23.1%). The net-pen facility was expected to produce 34% more BOD than the LOTT treatment plant.

same paragraph. The figures for acreage of proposed net-pens are erroneous and misleading. The discussion should be about leased area (bottom area including anchorage and buffer area) as well as encumbered area (the actual surface area occupied by the floats and net-pens). This is the official terminology as adopted by the DNR.

Using the October 2, 1986 published DNR statistics provided to us by Mr. Steve Tilley the following is provide as a summary of ongoing and proposed salmon net-pen activity. There are presently 7 commercial fish farms operated by 4 organizations in Puget Sound. Five of the operations rear Pacific salmon and two are devoted to Atlantic salmon. There are two farms under construction, one for Pacifics (a release facility) and one for captive culture of Atlantics. There are a number of existing large and small net-pen facilities operated by tribes and sport groups in cooperation with the Department of Fisheries for the delayed release of Pacific salmon. Additionally, there are 22 sites in various stages of permitting with the majority (17) designed for rearing of Atlantic salmon.

The average "leased area to encumbered area ratio" of all proposed and existing salmon farms is 5 to 1 (mean value 0.2, SD = 0.194). There is a total of 347.25 acres of leased area associated with the proposed and existing net-pens (excluding the few herring holding pens). The DNR lists encumbered area for only 14 of the existing or proposed facilities. Therefore, we must apply the ratio mentioned above to the total number of acres we arrive at a fair estimate of the total encumbered surface area from all proposed and existing net-pens. This amounts to 69.5 acres for all proposed and existing facilities (not 280 acres as suggested by Dr. Whitely).

The average size of all proposed and existing facilities is 10.2 acres of leased land or 2.04 acres of encumbered surface area. These figures are biased by a number of fairly large proposals in Island County that may never be implemented due to continual delays and problems associated with that area.

Given the correction of Dr. Whitely's data basis and the understanding that acreage based production schemes are a broad approximation at best, we may proceed with the analysis. 69.5 total encumbered acres divided by 2.71 acres for the average facility discussed by Weston (1986) yields a factor of 25.65 (not 56). Multiplying the nitrogen production figure in Weston's table 4 by this factor yields 3,847.5 lbs. per day versus 6,400 lbs. day for the Renton treatment plant. There were no figures available for total nitrogen production from the West Point site so it is a mystery how Dr. Whitely arrived at his stated conclusion

comparing nitrogen production from net-pens to that particular treatment facility.

The BOD figures are 19,237 lbs. per day for all existing and proposed net-pen sites versus 38,000 lbs. for the METRO West Point site. There are several obvious flaws in this type of comparison, for example: it compares a single point outfall to 34 separate sites scattered throughout Puget Sound. The comparison assumes that the nutrient loading of all net-pens would be the same as the example facility. In fact the average would be significantly less due to the number of delayed release and pan-sized cono farms that produce less amount of product per unit area of net-pens compared to the Atlantic salmon farms. Additionally, there is little comparison in the nature of net-pen wastes compared to municipal discharges due to the lack of heavy metals, organic contaminants (PAHs) and other trace toxics. Dispersion of freshwater borne treatment plant wastes, discharged from pipes and diffusers bear little resemblance to the pattern of discharge from net-pen facilities.

In summary of this section, Dr. Whitely has stated that the nutrient loading and BOD effect of all the existing and proposed net-pens would be "almost the same" as the discharge from the West Point facility. It is impossible to see how he arrived at that conclusion from the given nitrogen data. The evidence points to likely orders of magnitude less nitrogen production from all the proposed and existing net-pens. The BOD data shows that the net-pens would produce about 1/2 of the METRO West Point discharge.

page 5. paragraph 3. The discussion of circulation in Puget Sound entirely ignores the vast body of data that demonstrates a net inflow at depth and a net outflow of the surface waters in the Strait of Juan de Fuca (see the discussion below). It is true that circulation is limited in distal areas of Puget Sound such as southern Puget Sound and to a lesser extent in the main basin of Puget Sound (PSWQA 1986) but the evidence is clear for the straits and San Juan Island areas. These areas are subject to the classic estuarine flow situation mentioned above.

Dr. Whitely asserts that higher levels of phosphates in the area of the San Juan Islands versus the open ocean is a measure of the lack of exchange in Puget Sound. This discussion ignores two obvious sources of the nutrients that influence the San Juans Islands and the straits. 1) The Fraser River Plume continually supplies nutrient rich fresh waters to the subject area (Stockner et al. 1979). Thus, in spite of a net outflow of water due to the estuarine effect (see below), there is little diminishment of nutrient level.

2) The San Juan channels are subject to extreme turbulence of flow and upwelling of bottom waters rich in nutrients. This ocean origin bottom water that provides another significant source of nutrient to surface waters in the area. Neither of these effects is a significant effect in the open ocean. Dr. Whitley's argument is totally unfounded and shows a regrettable lack of understanding of the hydrodynamics of circulation in the subject area.

Back up documentation:

Herlinveaux (1954) studied a cross section of the straits to assess tidal current strength and direction at depths to 540 feet. He found that the ebb tide was strongest and longer at the surface (from 0 to 210' deep), while the flood was stronger at greater depths. Herlinveaux and Tully (1961) further explored this phenomena and showed that freshwater input from riverine sources could account for the net-outflow at the surface. It has been estimated that approximately 80% of the total freshwater outflow in the straits is contributed by the Fraser River (Waldichuck 1957). Freshwater from this source and other British Columbian and Puget Sound rivers is partly mixed with more saline ocean water by the time it reaches the eastern straits. Tidal mixing in the San Juan Islands, adjacent channels and Admiralty Inlet accelerates the mixing of the surface freshwater layers in the eastern straits (Cannon et al. 1978). In this area it forms a brackish, surface water zone that sets seaward. "else freshwater would accumulate within the system". Seaward flow may be temporarily interrupted or reversed by intense storms passing through from the Pacific Ocean. The reversals may force oceanic surface waters as far east as Widbey Island. However, the "net flow" of mid channel surface waters (to about 50 m deep) is to the west while deeper waters have a net flow to the east (Ebbesmeyer 1979, net flow is the movement of water summed over flood and ebb tides).

Page 6. 10th line from the bottom. It would be highly unlikely that all or even most of the larger particulate matter released from a net-pen would fall "straight down" as asserted in this section. In reality, the accumulation beneath net-pen farms that have been in place for long periods such as the Domsea Farm facility in Clam Bay show surprising little accumulation of sediment beneath the pens, and none beyond a short (100') distance. The discussion about the impacted bottom causing passing, wild fish to become sick and have damaged gills is totally unfounded and rather ludicrous. Pease (1977) presents the worst case analysis of possible impacts and found increased numbers of fish beneath the pens with no observed mortalities or disabled fish.

Dr. Whitley further makes the mistake of equating conditions in the fjords of Norway with the circulation in Puget Sound. It is generally true and cited by Weston (1986) that the circulation in Norwegian fjords is greatly reduced compared to most of Puget Sound.

page 8. 1st paragraph. There are no known forms of "persistent toxicity" that remains for years after aquaculture facilities are removed. Perhaps Dr. Whitley is referring to build ups of organic carbon and nutrients that may cause hydrogen sulfide gas release from areas that have been grossly polluted from any source that includes nutrient discharge. See page 42 of Weston (1986) that explains why the Japanese phytoplankton situation does not apply to Puget Sound.

Page 8. 2nd paragraph. Aeromonas salmonicida is the causative agent of furunculosis, an important disease of salmon and trout, is generally thought to be a freshwater based bacteria. I have had experience with fish that showed signs of this bacteria after transfer to saltwater, but it was likely contracted prior to entry. I have had discussions with Dr. Harrell concerning our lack of knowledge concerning the transfer of this and other diseases in salt water.

John, I will leave the disease issues to you and other experts in this field, and to the results in Don's published report.

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UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

*Office of the Director
School of Fisheries, WH-10*

29 October 1986

Mr. John L. Pitts
Aquaculture Coordinator
Washington Department of Agriculture
406 General Administration Bldg. AX-41
Olympia, Washington 98504-0641

Dear Mr. Pitts:

I have read a copy of the transcript of the presentation by Arthur Whitely of 6 September 1986 which was circulated among aquaculture experts by you on 7 October 1986. My background is largely in channel catfish and tilapia culture in the southern United States, but I have become intensely interested in the net pen situation since assuming my present position and hope to take an active role in the research which undoubtedly will be forthcoming on net pen culture and its environmental impacts.

With respect to the testimony, there are certainly some cogent facts brought out by Dr. Whitely, as well as some legitimate concerns. The part-truths and innuendo, along with the obvious (admitted) bias on his part colors the testimony. Oversimplifications are made in the area of food conversion (the 2:1 ratio of food:fish is too high for an average), and in equating human sewage with fecal and ammonia production by fish on any kind of an equivalent (e.g., pound-for-pound) basis. There may be few data available for fish, but from what I have seen in other parts of the country, loading rates used by sanitary engineers when designing sewage treatment systems have little or no relationship to fish waste; typically the loading by fish is significantly less than that for equivalent amounts of sewage.

Putting aside the appeals to emotion, comparisons with activities in Japan which are not parallel to what would ever be considered as appropriate in Puget Sound, and distortions as to such things as how much antibiotic might be used (fish farmers only use antibiotics when problems occur; they avoid routine use), there are legitimate concerns, most of which are researchable. The problem has been, and may continue to be, a source of funds for examining these problems. Certainly, we need more information on the impacts of waste on the sedimentary environment and on the water column. We also need to evaluate potential impacts on the surrounding environment resulting from the use of antibiotics in net pens, and we need to find ways of properly siting net pens to ensure good circulation and limit environmental impacts. Polyculture of sessile organisms outside of net pens as a means of cycling waste products into other harvestable tissue, resituation of net pens on some type of fixed or variable schedule, vaccination of fish against diseases for which we now must use antibiotics, selective breeding for disease resistance, and many other subjects applicable to some of the concerns raised relative to net pens should all receive our attention.

Mr. John L. Pitts
October 29, 1986
Page 2

The Western Regional Aquaculture Consortium (WRAC) centered at the University of Washington, and recently approved by the U.S. Congress, will provide a stable source of funding for aquaculture projects in the Pacific Northwest. One would assume that at least some attention, and resources, will be aimed at the net pen problem, so that answers can be obtained to the questions being raised. Armed with those answers, intelligent decisions can be made. The University of Washington and the other universities which make up the consortium, plus other universities, colleges, state agencies and federal agencies with roles to play in aquaculture, will all have their opportunity to interact with the WRAC under our current plan. Funding will be available for high quality, **objective** studies involving various aspects of aquaculture.

My position, and the one I want projected by researchers in the School of Fisheries, is that we are objective researchers interested in addressing researchable problems and providing information to decision makers. As professionals we are neither advocates nor detractors of aquaculture. Our personal views should not cloud our objectivity, and we must remain neutral as scientists so our data are not biased. I feel that our researchers can bridge the gap between the opponents of aquaculture and the industry. Also, we can make contributions to research in areas where there is little or no controversy.

I hope these thoughts are of some use and would be pleased to discuss these and other matters with you at any time.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Robert R. Stickney". The signature is stylized with a large, sweeping initial "R" and a long, horizontal flourish extending to the right.

Robert R. Stickney, Director
School of Fisheries

cc: Kenneth K. Chew

DRAFT

JON M. LINDBERGH
44811 S.E. 166 STREET
NORTH BEND, WASHINGTON 98045, USA
PHONE (206) 398-4896 • TELEX 152558 SEA

November 3, 1986

Dr. John L. Pitts, Aquaculture Coordinator
Department of Agriculture
406 General Administration Building, AX-41
Olympia, Washington 98504-0641

Dear John:

I would like to submit the following comments on the transcript of a presentation made by Dr. Arthur Whitely on September 6, 1986 to the Puget Sound Alliance.

Pg. 2, line 3. The statement that (pen rearing of fish) is "rapidly gaining ground" is questionable. From 1970 through 1982, about seven commercial salmon pen culture sites were established in the Puget Sound area. This included four Domsea Farms sites, the Aquasea Farms site at Lopez Island, the Mariculture Northwest site in the Hood Canal, and the Squaxin Island site. Subsequent to 1982, three additional sites have been established, three were discontinued, and permits for 22 sites have been applied for. Data on sites existing and applied for is given in the attached compilation from DNR.

This rate of development is very low compared to the rate of development in Norway, Scotland, Japan, British Columbia and Chile. In Norway and British Columbia, the development is an order of magnitude higher.

Pg. 2, line 7. Fish pen rearing is not new in Puget Sound. Domsea Farms Inc., a producer of pan sized salmon, began operations in 1970. The company has three sites within one mile in Rich Passage between Manchester and Bainbridge Island. In the past five years, production has been about 3,000,000 pounds annually from these three sites. At the Manchester site alone 1,500,000 pounds were produced annually, which is between two and three times the projected production in the Sea Farm of Norway site in Griffin Bay.

The United States EPA has a major laboratory adjacent to Domsea's Manchester site. EPA and NMFS personnel have studied the environmental efforts of Domsea's fish pen culture activities and have found no significant adverse effects beyond the area directly beneath the pens.

Pg. 2, line 43. Whitely is apparently referring to fish density of 83 Kg/M^3 . Such density is more than five times the maximum density used or proposed by Puget Sound fish growers. Some growers plan to operate at eight Kg/M^3 .

Pg. 3, line 4. Whitely appears to be implying that esthetics are not a major consideration amongst his concerns. I think esthetics are his primary concern and most other issues are raised because they are more defensible on a legal level.

Pg. 3, lines 6-11. The facilities referred to do not need to be on the shoreline.

Pg. 3, lines 20-22. J would continue to maintain that the Norwegian salmon farm restriction of 8000 M³ accepted for primarily sociological, not ecological reasons. The effect of restricting culture volume is to encourage higher density (ref. Whitely pg. 2, line 43). Higher density in the same space would lead to the threat of a higher intensity of pollutants. Furthermore, Norway does not significantly restrict siting as it related to depth or current, which affect waste accumulation even more than production volume.

Higher culture densities would appear to subvert the social intent of the 8000 M³ restriction. My hunch is that the Norwegian regulatory agencies are amenable to higher production per farm but are reluctant to make political waves by changing the law. Allowing higher densities accomplishes the same objective through the back door.

Pg. 3, lines 26-28. No one is suggesting that aquaculture be allowed on the scale it exists in some Japanese bays.

Pg. 3, lines 30-31. The primary reason Norwegians are interested in establishing salmon farms in the U.S. and Canada is that the region offers the largest potential market and fish raised here will not incur an airfreight cost of \$0.75 - \$1.00 per pound. Norwegian exports to the U.S. will be jeopardized when U.S., Canadian, and Chilean production becomes substantial. (Chilean production costs are so low that they can probably absorb the airfreight and still remain competitive.)

Pg. 3, lines 34-37. Whitely has used several different terms to describe fish pen facility size, which give confusing inferences when used to compare Norwegian and Puget Sound facilities. The best term to describe the size of such facilities is annual fish production, which is closely related to the amount of metabolic waste products released. Let us assume we are using fish pens in both cases with dimensions 40 feet by 40 feet by 17 feet deep (about 12 M by 12 M by 5 M), with maximum fish density of one pound per cubic foot (16 Kg/M³). Let us also assume that about 70% of the pens are used for harvest fish with the rest being used for per brood and in maintenance.

Given these dimensions and fish loadings, the Griffin Bay facility would have an area of 2.06 acres and the Norwegian facility about 0.42 acres (considering pen space only). The Griffin Bay facility, then, would use just under five times the area of the Norwegian facility not over fifteen times as much as implied by Whitely.

It is further worth noting that the projected fish production of the Griffin Bay facility is only 65% of that in the above model and the actual production in many Norwegian facilities is much higher. If one uses the fish density used by Whitely on pg. 2, line 43, the Norwegian facility would be larger than the Griffin Bay facility in terms of annual production.

Pg. 4, line 9. Gowan et al gives a figure of 20% feed fed as wastage. In my opinion, this is excessively high. Weston gives lower figures in his current report. Feed is the highest cost item encountered in the culture of pen reared salmon, hence it is strongly to the financial advantage of pen operators to maintain good feed efficiency.

Pg. 4, lines 17-21. Whitely takes the position that the only effect of rearing fish in Washington State is the waste left behind. It would make as much sense to claim that wheat grown in the state would only benefit the state if it were eaten here and building Boeing aircraft would benefit the state only if the aircraft were operated here. Some comments and figures related to the economic effects of salmon aquaculture are given in write-ups by John Forster and myself which were sent to you.

Pg. 4, line 22-48. Suggest requesting comments by Don Weston on this issue.

The figure of "280 acres of pens" used by Whitely introducing the same confusion which is discussed above under Pg. 3, lines 34-39. It is also much larger than actually applied for unless one includes the scope of anchor spreads. (See enclosed DNR information.)

Weston's report provides information on nutrient loads from existing sewer plants and several rivers. Data from the Fraser should be added, as it strongly impacts the San Juan County and Skagit County area.

A discussion of the difference between sewage and fish culture waste would be worthwhile.

Pg. 5, lines 36-47. Need discussion on the water flow characteristics of Puget Sound. In general, ocean water flows in along the bottom and Sound water mixed with river discharge flows out towards the ocean on the surface. This flow pattern provides significant circulation, not simply a back and forth pattern as suggested by Whitely.

Pg. 6, lines 1-6. I suspect that the phosphate referred to in the San Juans comes from a continuous input by the Fraser River (and perhaps from Vancouver), not a static supply of phosphate drifting back and forth through the Islands.

Pg. 6, lines 7-38. This section is difficult to comment on precisely without access to Whitely's diagrams. However, he appears to be comparing fish culture pollution in restricted bays in Norway which have limited flushing with anticipated pollution in Griffin Bay which has very strong flushing. Whitely's conclusions would appear to be highly exaggerated.

Actual examinations of Clam Bay, where flushing is relatively similar and fish production is much higher than projected production in Griffin Bay, show a completely different and less threatening picture.

Pg. 6, lines 38-47 and Pg. 7, lines 1-35. Whitely has again taken an extreme case and put it forward as an average situation. In Washington, we have the examples of the Aquasea Farms facility in Lopez Island and the Domsea Farms facility in Clam Bay near Manchester. At Aquasea Farms the facility was installed in shallow water with very low circulation. Sediment built up rapidly and there were serious effects to the fish in the pens (it is noteworthy there were no reports of adverse effects beyond the pens themselves). In contrast, at the Domsea Farms facility in Clam Bay only about two inches of sediment has built up directly under the pens and no sediment is visible beyond 100 feet from the pens. The thickness of sediment has been reported by NMFS to have stabilized at approximately two inches in the last several years. None of the catastrophic effects predicted by Whitely and experienced at Aquasea Farms have occurred after 17 years of Domsea operations.

Domsea annual production at Clam Bay is about five times that of Aquasea's peak year and almost three times projected production levels at Griffin Bay. There is more than sufficient information available to allow growers to understand the differences between the Aquasea and Domsea facilities and to avoid the selection of another Aquasea situation.

Pg. 6, lines 46-49 and Pg. 7, lines 1-3. If this happens to the fish in the cages, the grower will quickly go out of business, as Aquasea Farms did.

Pg. 6, lines 48-49. NMFS reports that wild fish around the Domsea facilities have increased in number and show no evidence of stress or disease.

Pg. 7, lines 24-27. The effects of large scale fish pen production are neither new nor unknown. Domsea has been in operation since 1970 and environmental effects have been studied by the EPA and NMFS over the past several years.

Pg. 7, lines 29-39. The Norwegian farms referred to by Whitely in this section are sited in inappropriate locations as Aquasea Farms was in an inappropriate location. As discussed under Pg. 6, lines 7-38, the growers and associated regulatory agencies have more than sufficient understanding of sediment buildup to avoid such locations.

Pg. 7, lines 40-45 and Pg. 7, lines 1-5. The Japanese have instituted very intensive aquaculture development along many sections of their coasts. No one is proposing aquaculture development to anywhere near the Japanese level in Washington State.

Pg. 8, lines 4-5. Weston refers to a number of instances where the bottom below fish pens reverted to normal in a relatively short period of time. This is in contrast to the long reversion period needed for the bottom under log storage areas.

Pg. 8, lines 5-16. Weston discusses the red tide issue in his report.

Pg. 8, lines 17-47 and Pg. 9, lines 1-3. You and Don Weston were quite effective in refuting Dr. John Brookbank's claims regarding the vibrio issue during the hearing in Coupeville on September 13. Dr. John Liston's letter stated his opinion that vibrios associated with fish pen culture do not pose a threat to public health.

Pg. 9, lines 5-16. It is my understanding that the use of oxytetracycline and other antibiotics are used far more extensively in agriculture than in aquaculture. Some comparisons might be appropriate.

Pg. 9, lines 27-45. Domsea Farms and the NMFS have been medicating fish against vibrio in Clam Bay near Manchester since 1970. The preponderant antibiotic has been oxytetracycline. The actual production volume of fish in Clam Bay has been higher than proposed production in any other area in the state and medication has at times been relatively high. NMFS and Domsea pathologists check for vibrio resistance and report they have found none after 17 years. In other words, after 17 years of medication against vibrio with oxytetracycline to a concentrated biomass of fish higher than can be expected in any other proposed area (I don't anticipate any new 160 pen complexes), the resistance problem raised by Whitely and Brookbank has not occurred. Further information can be obtained from Dr. Lee Harrell, NMFS at phone (206) 842-7181.

Draft

Pg. 10, lines 13. A rather presumptuous statement.

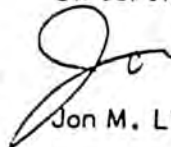
In summary, Dr. Whitely's presentation, in my opinion, is characterized by:

- Extreme examples he claims are representative of average situations.
- Intermixing acreage, culture volume, and production volume so as to arrive at misleading statistics.
- Attempts to compare unrelated disease pathogen problems with fish pen culture.
- Invalid statements.
- High levels of "scare" tactics.

His objective appears to be not a conservative, ~~but~~ reasoned approach to the development of the aquaculture industry, but an attempt to block it. His requested moratorium would impose serious financial uncertainty on groups applying for aquaculture permits. Investors would look elsewhere and aquaculture would be diverted to other states and foreign countries. Small local groups would simply go out of business. Once salmon aquaculture becomes firmly established in other areas, these areas will tend to dominate the market place and it will be increasingly difficult for operators to establish here. Such a situation would fit with Dr. Whitely's unstated objective, but would it be of advantage to the State of Washington?

Please feel free to call if I can be of assistance on this issue.

Sincerely,



Jon M. Lindbergh

JML/dd
Encls.

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

*College of Ocean and Fishery Sciences
Institute for Food Science and Technology, HF-10*

June 13, 1986

Ms. Leslie Aickin
320 Meadow Road
Port Townsend, Washington 98368

Dear Ms. Aickin,

Your letter asking questions concerning the potential of increased human risk from Vibrio parahaemolyticus and V. vulnificus due to salmon pen culture has been passed to me by Dr. Hershberger. I have previously corresponded with Dr. Whitely about the possible effects of fish aquaculture on Vibrio populations and he was perhaps using some of my comments in his Lopez Island presentation.

V. parahaemolyticus and V. vulnificus are known to occur in the Puget Sound region usually associated with shellfish. However, they are not common organisms and are rarely found in large numbers. This is important since evidence suggests large numbers are necessary to cause human infection. Both these species grow significantly only at water temperatures above about 15°C (59°F) and prefer temperatures above 20°C (68°F). The cold waters of Puget Sound rarely achieve the 20's except in shallow inshore bays or sheltered areas. This is probably why we find the organisms associated with shellfish which grow in such waters.

The occurrence of disease due to these organisms is quite unusual in this region. We have had a few limited outbreaks of a mild diarrhea due to V. parahaemolyticus here and in British Columbia but I am not aware of any cases due to V. vulnificus in our area. This organism can cause a very serious infection which can be fatal but it is somewhat rare and, as noted by Dr. Hershberger, the disease only occurs in people with compromised liver function.

In my opinion it is quite likely that there would be an increase in the number of Vibrios in an area where fish farming takes place. However, the Vibrios most likely to increase are the common low temperature species which have a very low capacity (if any) for causing human disease. Thus I am skeptical that fish farming would present an enhancement of human hazard.

Nevertheless, I recommended to Dr. Whitely that it would be prudent to run periodic tests in adjacent sensitive areas of the occurrence of particular types of Vibrios (so called "mesophilic Vibrios") to ensure that there is no increase in their occurrence

-continued-

Ms. Leslie Aickin
June 13, 1986
Page 2

or numbers. I am still of that opinion since it is always better to be safe than sorry.

Realistically, the risk to human health due to Vibrios associated with fish farming seems slight and is not sufficient of itself to justify preventing the installation of such systems.

Sincerely,

J. Liston (ek)

J. Liston
Professor and Director
Institute for Food Science & Technology

cc: Dr. Hershberger

JL:ek

University of Washington
School of Fisheries

19 Oct 86

John L. Pitts
Aquaculture Coordinator
406 General Administration Bldg., AX-41
Olympia, WA 98504-0641

Dear Mr. Pitts,

This letter is in response to a request that you issued 7 October 86, for expert comment on Dr. Whitely's testimony of 6 September 86. I am the University of Washington's shellfish hatchery manager, working directly under Ken Chew. Our hatchery is located at Manchester, WA, and exists as a cooperative arrangement with National Marine Fisheries Service (NMFS). We are in close proximity to both the NMFS salmon net pen system and Domsea Farms.

In spite of Dr. Whitley's reputation as a scientist, I found the transcript of his testimony distinctly lacking scientific objectivity and filled with statements which were blatantly emotionalistic, subjective, and unsubstantiated. Given at a public hearing, these statements seemed to constitute nothing short of an invitation to hysteria.

He did, however, raise some legitimate concerns: what is the carrying capacity of Puget Sound with regard to aquaculture of various types? And what are possible biotic interactions between various species undergoing intensive culture. It is to this second topic that I would like to address my remarks. On page 7 of the transcript, Dr. Whitely made reference to the detriment of oyster culture as a purported result of fish pen culture. I have managed the U of W shellfish hatchery for 10 years. A shellfish hatchery deals with embryonic and larval forms. These forms are particularly sensitive to changes in water quality. As a matter of fact, embryonic forms of oysters are often used for water quality bioassays. When I first began at the Manchester site, I wanted to be assured that the water quality at this location would be acceptable for operation of a shellfish hatchery, so I conducted several bioassays, comparing the survival and growth of oyster larvae in lots of water from Manchester and from Hood Canal. (Hood Canal is the one area where Pacific oysters

reproduce naturally.) There was no significant significant difference in the results of those bioassays. In the ten years that I have conducted experiments at Manchester, I have observed nothing extraordinarily detrimental in cultures of oyster, scallop and mussel larvae. All of this work has been conducted in water taken directly from Clam Bay. The intake of the pump is within 20 feet of a NMFS salmon pen, and within 1/4 mile of Domsea's pen system.

Post larval oyster growth rate at Manchester is not rapid. But it is about what might be expected for the ambient temperatures which occur there. Because of the summer temperatures ($<15^{\circ}\text{C}$) and the nutrient level at Manchester, it has proven to be an excellent location for reconditioning oysters which have been used for early spring spawning brood stock. For the past two years, Coast Oyster Company has participated in joint experiments with the University of Washington exploring just this potential. The results have been overwhelmingly positive. We expect to report these results at the next meeting of the Pacific Coast Oyster Growers Association.

Thus, rapid rematuration of gonads of adult oysters, and good survival and growth of larval bivalves of several species, both occur in close proximity to salmon pens. These successes should tend to discredit claims that pen rearing is, in itself, detrimental to shellfish culture.

Sincerely,



Hal Beattie

PO Box 248

Manchester, WA 98353-0248

Red title
- UHS IPN Disease
- Enc. Lin. 107 of 108

6/2 1986 N.H. & J. G. Erickson
Vancouver B.C.,

1

DISEASES, POLLUTION AND QUALITY CONTROL
BY
PROFESSOR TORE HÅSTEIN
HEAD, DEPARTMENT OF FISH DISEASES, NATIONAL VETERINARY INSTITUTE
OSLO, NORWAY

FROM THE TIME MAN BEGAN TO DOMESTICATE THE FISH BY KEEPING LARGE NUMBER OF FISH ON A LIMITED AREA IN CAGES, PONDS OR RACEWAYS, FISH DISEASES CHANGED FROM BEING AN INTERESTING PHENOMENON TO BECOMING AN IMPORTANT PROBLEM. THE FIELD OF FISH PATHOLOGY HAS THUS BECOME MORE AND MORE IMPORTANT OVER THE LAST DECADE IN CONNECTION WITH THE GROWTH OF THE FISH FARMING INDUSTRY IN NORWAY.

THIS GROWTH HAS GIVEN RISE TO AN URGENT NEED FOR DIAGNOSTIC SERVICES, DISEASE PREVENTION AND CONTROL AS WELL AS FOR RESEARCH INTO DIFFERENT ASPECTS OF DISEASE PROBLEMS, POLLUTION AND BIOTECHNOLOGY TO ASSIST THE FISH FARMERS TO KEEP A HEALTHY FISH POPULATION.

WHEN DISCUSSING DISEASE IT IS NECESSARY TO STRESS THAT LEGISLATION IS AN IMPORTANT TOOL TO COMBAT FISH DISEASES BECAUSE LEGISLATION MAKE IT POSSIBLE TO RESTRICT MOVEMENTS OF FISH WHEN IT IS SUSPECTED THAT THEY MAY CARRY DISEASES TO WHICH THE ACT APPLIES.

IN NORWAY THE DISEASES OF FISH ACT WAS PASSED 4TH. DECEMBER 1968 AND CAME INTO FORCE IN 1969. THE DISEASES TO BE INCLUDED IN THIS ACT ARE ASSIGNED IN A ROYAL DECREE AND SINCE THE ACT IS AN ENABLING ACT, THE LIST OF DISEASES MAY BE CHANGED. I.E. IF NEW SERIOUS FISH DISEASES ARE DESCRIBED, THEY MAY EASILY BE INCLUDED ON THE LIST OF NOTIFIABLE DISEASES.

THIS LEGISLATION, HOWEVER, COVERS ONLY FRESHWATER SPECIES INCLUDING ANADROMOUS AND CATADROMOUS FISH SPECIES. AS SEVERAL SPECIES OF MARINE ORIGIN ARE OF INTEREST IN THE FISH FARMING INDUSTRY SUCH AS TURBOT, HALIBUT, COD, CYSTERS, MUSSELS ETC. WORK IS NOW UNDERTAKEN TO UPDATE THE FISH DISEASE LEGISLATION IN NORWAY IN ORDER TO MEET THE NEW REQUIREMENTS FOR DISEASE CONTROL IN THOSE SPECIES. THE NEW LEGISLATION WILL THUS COVER ALL AQUATIC ORGANISMS.

THE FISH DISEASE LEGISLATION IN NORWAY TODAY ARE ENFORCED BY MINISTRY OF AGRICULTURE, DIVISION OF VETERINARY SERVICES, WHILE MINISTRY OF FISHERIES ARE RESPONSIBLE FOR ALL OTHER ASPECTS OF THE FISH FARMING INDUSTRY.

THE NEED FOR VETERINARY SERVICE IN THE FISH FARMING INDUSTRY HAS LONG BEEN RECOGNIZED AND THE FISH FARMERS HAVE SOMETIMES COMPLAINED ABOUT THE LACK OF VETERINARY SERVICE AND HEALTH OF FISH IN THE FIELD DUE TO THE DIFFICULTIES IN SENDING MATERIAL FOR AUTOPSY AND DIAGNOSTIC WORK TO THE MAIN VETERINARY LABORATORIES.

IN RECENT YEARS THIS SERVICE HAS, HOWEVER, BEEN IMPROVED. THE MONITORING OF THE HEALTH CONTROL SYSTEM WHICH INVOLVES A CLOSE LIASON BETWEEN FISH FARMERS, LOCAL VETERINARIANS, LOCAL VETERINARY LABORATORIES AND THE DEPARTMENT OF FISH DISEASES, NATIONAL VETERINARY INSTITUTE.

IN THE LAST YEAR A MORE CLOSE COOPERATION BETWEEN THE NORWEGIAN FISH FARMERS ASSOCIATION AND THE NORWEGIAN VETERINARY ASSOCIATION HAS BEEN ESTABLISHED. THIS INVOLVE AMONG OTHERS THAT THE FISH FARMS HAVING AN AGREEMENT WITH THE LOCAL VETERINARIAN SHALL BE INSPECTED 4 TIMES A YEAR AND THAT THESE INSPECTIONS COVER CERTAIN BASIC REGISTRATIONS AS TO THE MANAGEMENT AND THE CONDITIONS ON THE FARMS. THE FISH FARMERS ORGANIZATIONS HAS ESTABLISHED A FUND TO COVER THE TRAVELLING EXPENSES FOR SUCH INSPECTIONS, WHEN THE TRAVELLING DISTANCE EXCEED 15 KILOMETRES ONE WAY. THE AGREEMENT BETWEEN THE FISH FARMERS AND THE LOCAL VETERINARIANS ALSO INVOLVE REPORTING OF UNEXPECTED MORTALITIES AND "ABNORMALITIES", EXAMINATION OF FISH EITHER ON SPOT OR BY SENDING IT TO A DIAGNOSTIC LABORATORY FOR FURTHER ATTENTION TO ENABLE THE PRESCRIPTION OF CHEMOTHERAPEUTIC AGENTS OR ANTIBIOTICS FOR THERAPEUTIC USE IF NECESSARY.

THE CLOSE COOPERATION BETWEEN THE FIELD VETERINARIANS AND THE LABORATORIES AS WELL AS THE ROUTINE INSPECTIONS IN THE FARMS, HAVE GIVEN US A FAIRLY GOOD POSSIBILITY TO OVERVIEW THE DISEASE SITUATION THROUGHOUT THE COUNTRY.

ALTHOUGH THE SITUATION IN GENERAL TERMS ARE GOOD, THERE ARE, HOWEVER SOME DISEASE PROBLEMS THAT NEED INCREASING ATTENTION IN ACCORDANCE WITH THE INCREASING VOLUME AND INCREASED INTENSITY OF THE FISH FARMING INDUSTRY.

THE MAIN DISEASE PROBLEMS IN SALMONID FISH CULTURE IN NORWAY TODAY ARE OF BACTERIAL ORIGIN, ALTHOUGH VIRAL-, PARASITIC-AND NUTRITIONAL-AND ENVIRONMENTAL DISEASES OCCUR.

THE MOST IMPORTANT DISEASES IN NORWAY TODAY HAVE BEEN HEMORRHAGIC SYNDROME (THE SO CALLED "HITRA DISEASE"), VIBRIOSIS (INFECTION WITH VIBRIO ANGUILLARUM), BACTERIAL KIDNEY DISEASE (BKD), FIN ROT, "WINTER ULCERS", SEA WATER COSTIASIS AND SEA LICE (INFESTATION WITH LEPECHTHEICUS SALMONIS). CLASSICAL FURUNCULOSIS CAUSED BY AEROMONAS SALMONICIDA VAR SALMONICIDA WAS HOWEVER INTRODUCED INTO SOME 23 NORWEGIAN FISH FARMS DUE TO IMPORT OF LIVE ATLANTIC SALMON SMOLTS FROM SCOTLAND: A DISEASE THAT HAS NOT OCCURRED SINCE 1969.

FARMS SINCE 1969. FURUNCULOSIS AS WELL AS VIRAL HEMORRHAGIC SEPTICEMIA (VHS)

IN RAINBOW TROUT WAS AT THAT TIME ERADICATED BY A POLICY OF STAMPING OUT COMBINED WITH THOROUGH MECHANICAL CLEANSING AND DISINFECTION OF THE FACILITIES. THE SAME PROCEDURE IS NOW BEING USED AT THE NEW OUTBREAKS OF FURUNCULOSIS, AND ALL FISH IN THE AFFECTED FARMS WILL BE SLAUGHTERED WITHIN 1ST OF JUNE 1984 BY SANITARY SLAUGHTERING PROCEDURES INVOLVING SAMPLING AND DESTRUCTION OF CLEANING WATER, SLICED AND ORGANS TO AVOID A FURTHER SPREAD OF THE INFECTIOUS AGENT.

SUCH SANITARY MEASUREMENTS HAVE ALSO BEEN APPROVED IN CONNECTION WITH OTHER NOTIFIABLE DISEASES HAVE BEEN SOMEWHAT DIFFERENT FROM DISEASE TO DISEASE.

ONE OF THE DISEASES THAT HAVE CREATED THE LARGEST LOSSES IN THE FISH FARMING INDUSTRY IS THE "HITRA DISEASE" WHICH HAS OCCURRED SINCE 1977. ACCORDING TO REPORTS FROM INSURANCE COMPANIES, THE DISEASE CONSTITUTES ABOUT 80% OF THE CLAIMS DUE TO DISEASE PROBLEMS IN THE FISH FARMS. THE DISEASE, DERIVING ITS POPULAR NAME FROM HEAVY OUTBREAKS OF THE DISEASE IN FISH FARMS AT THE ISLANDS HITRA AND FROYA IN 1979, IS CHARACTERIZED BY A HEMMORRHAGIC DIATHESIS WITH NUMEROUS PUNCTATE HEMORRHAGES IN THE SKIN AS WELL AS IN INTERNAL ORGANS. HEMORRHAGES IN THE MUSCLE ARE MORE SELDOM SEEN.

- HISTOLOGICAL INVESTIGATIONS HAVE REVEALED CHANGES IN THE MUSCULATURE SIMILAR TO THOSE FOUND IN SELENIUM / VITAMIN E DEFICIENCY IN OTHER ANIMALS. THE ETIOLOGY OF THE DISEASE HAVE BEEN OBJECT FOR DISCUSSION AS THE WETHER THE VIBRIO SP ISOLATED IN CONNECTION WITH DISEASE OUTBREAKS ARE OF PRIMARY OR SECONDARY CHARACTER. IN ORDER TO ELUCIDATE DIFFERENT ASPECTS OF THE DISEASE, A RESEARCH PROGRAMME "HEALTHY FISH PROJECT" WAS ESTABLISHED WITH ECONOMIC FUNDS FROM THE FISH FARMERS ORGANIZATIONS. WITHIN THIS RESEARCH PROGRAMME, REPRESENTATIVES FROM DIFFERENT RESEARCH INSTITUTIONS MAKE APPROACHES TO THE DISEASE FROM DIFFERENT ANGLES SUCH AS BACTERIOLOGY, IMMUNOLOGY, GENETICS, NUTRITION, POLLUTION AND ENVIRONMENT. DURING THE YEARS THE PROJECT HAS EXISTED, VALUABLE INFORMATION AND RESEARCH RESULTS HAVE BEEN OBTAINED, GIVING A BETTER UNDERSTANDING OF THIS PARTICULAR DISEASE. TREATMENT WITH CHEMOTHERAPEUTICS AND ANTIBIOTICS HAVE BEEN TRIED WITH VARIABLE RESULTS AND AT THE PRESENT TIME VACCINATION EXPERIMENTS IN THE FIELD ARE BEING CARRIED OUT.

VIBRIOSIS HAS ALSO BEEN AN IMPORTANT DISEASE IN NORWEGIAN FISH FARMS OVER THE PAST YEARS AND IT IS STILL WIDE SPREAD IN SEA WATER ENTERPRISES. THE ETIOLOGICAL AGENT, VIBRIO ANGUILLARUM SEEM TO BE UBIQUITOUS IN NORWEGIAN COASTAL WATERS AND THUS OUTBREAKS ARE ALWAYS LIABLE TO OCCUR IN BOTH RAINBOW TROUT AND ATLANTIC SALMON. ESPECIALLY IN THE PERIOD JULY - OCTOBER WITH THE CLASSICAL PATHOLOGICAL SIGNS DESCRIBED IN THE LITERATURE WITH SKIN ULCERATIONS AND SOIL LESIONS IN THE MUSCLE. ALTHOUGH MEDICAL TREATMENT STILL ARE IMPORTANT IN DOMESTIC THE DISEASE IT IS OBVIOUS THAT THE VACCINATION SCHEMES ESTABLISHED IN 1977 SEEM TO BE MORE AND MORE IMPORTANT FROM A PREVENTION POINT OF VIEW. THE USE OF VACCINES AGAINST THE DISEASE IS INCREASING RAPIDLY, BACTERIAL KIDNEY DISEASE (BKD) WAS FIRST REPORTED IN 1960 IN NORWEGIAN FISH FARMS AND IT IS REGISTERED IN HATCHERIES AS WELL AS IN SEA WATER IMPROVEMENTS AS A CHRONIC, RELATIVELY SLOW DEVELOPING DISEASE WITH A CONSTANT ENHANCED MORTALITY. THE DISEASE HAS BEEN CHARACTERIZED BY SKIN ULCERATIONS AS WELL AS NECROTIC FOCI IN LIVER, SPLEEN AND KIDNEY. SOMETIMES WITH ABSCESSE-LIKE AREAS WITH A CREAMY CONSISTENCY ESPECIALLY IN THE KIDNEY.

SOME TIMES EXTENDING INTO THE MUSCULAR TISSUE. SINCE BKD IS A NOTIFIABLE DISEASE RESTRICTIONS ARE IMPOSED ON AFFECTED FARMS WHICH INVOLVE MOVEMENT OF FISH,

—SANTUARY SLAUGHTERING ETC. TWO VIRAL DISEASES HAVE BEEN OBSERVED IN NORWAY IN THE LAST TWO DECADES, NAMELY VIRAL HEMORRHAGIC SEPTICAEMIA (VHS) AND INFECTIOUS PANCREATIC NECROSIS (IPN). VHS HAS HOWEVER AS MENTIONED PREVIOUSLY BEEN ERADICATED BY MEANS OF STAMPING OUT AND HAS THUS NOT BEEN REGISTERED IN NORWAY SINCE 1974. THE INCIDENCE OF IPN HAS HOWEVER BEEN INCREASING IN NORWAY IN RECENT YEARS, BUT IN SPITE OF THE FIRST RECORDING OF THE DISEASE IN 1975, CLASSICAL CLINICAL OUTBREAKS OF THE DISEASE WAS NOT REGISTERED UNTIL 1985 IN A COUPLE OF FISH FARMS HAVING OBTAINED EGGS FROM A SPECIFIC SOURCE. THE MORTALITY IN ONE OF THE FARMS DID HOWEVER, NOT EXCEED 30% IN THE TWO TANKS WITH FISH OF THIS ORIGIN WHILE THE MORTALITY ON OTHER FISH ON THE SAME FARM ONLY WERE APPROXIMATELY 0.5% IN THE SAME PERIOD.

MYCOTIC INFECTIONS HAVE NOT BEEN A MAJOR PROBLEM IN NORWEGIAN FISH FARMS ALTHOUGH ICHTHYOPHONUS HOFFERI INFECTIONS HAVE BEEN OBSERVED IN FARMS USING FEED CONTAINING TRASH FISH. NO ATTEMPTS HAVE BEEN MADE TO TREAT THE DISEASE. MORE RECENTLY INFECTIONS WITH EXOPHTHALA SP HAVE BEEN REGISTERED AND THOUGH IN MOST CASES ONLY REGISTERED IN SINGLE INDIVIDUALS, THE FUNGUS HAS GIVEN SERIOUS PROBLEMS WITH INCREASED MORTALITIES IN ONE HATCHERY. SEVERAL AFFECTED FISH SHOW EXOPHTHALMUS, DISTENDED ABDOMENS AND ABNORMAL SWIMMING BEHAVIOUR. POST MORTEM EXAMINATIONS SHOW ASTITES DUE TO RENAL DYSFUNCTION AND FUNGAL GRANULOMAS, ESPECIALLY IN THE KIDNEYS. AFFECTED SMOLTS RECENTLY TRANSFERRED TO SEAWATER ARE USUALLY ALSO DEHYDRATED

WORK IS CARRIED OUT TO ELUCIDATE THE SOURCE OF INFECTION AND DISSEMINATION AS WELL AS TREATMENT OF THE DISEASE

TWO PARASITIC DISEASES ARE OF SPECIAL IMPORTANCE IN NORWEGIAN FISH FARMS, NAMELY SEA WATER COSTIASIS AND SALMON LICE, ALTHOUGH OTHER PARASITIC CONDITIONS SUCH AS EUROTHIRUM CRASSUM CREATE PROBLEMS FROM TIME TO TIME.

DISEASE PROBLEMS DUE TO LOPHOMYXOBOLA NECTATOR IN MARINE FISH FARMS WERE FIRST RECORDED IN 1981 IN ATLANTIC SALMON SMOLTS. CLINICALLY AFFECTED FISH SHOW IRREGULAR SWIMMING BEHAVIOUR AND GASPING AT THE WATER SURFACE, MORTALITIES BEING AS HIGH AS 40%. THE DISEASE APPEARS AS AN INCREASING PROBLEM 10-12 WEEKS AFTER TRANSFER TO SEA WATER WITH AFFECTED SMOLTS SHOWING REDUCED GROWTH RESULTING IN A COMPLETE CACHECTIC CONDITION. APART FROM THE CACHECTIC CONDITION, ONLY GILL CHANGES HAVE BEEN OBSERVED. WHETHER THE PARASITE HAS FOLLOWED THE FISH FROM FRESHWATER OR IF IT IS A SPECIFIC MARINE VARIETY OF THE NECTATOR IS DIFFICULT TO SAY, BUT RECENT WORK HAVE SHOWN THAT THE PARASITE HAVE BEEN FOUND IN MARINE FISH SPECIES. THE DISEASE HAS USUALLY UNDER FARMING CONDITIONS BEEN TREATED WITH FORMALIN 1:4000. REPEATED TREATMENTS HAVE, HOWEVER, BEEN NECESSARY.

→ THE SALMON LOUSE *LEPEOPHTHEIRUS SALMONIS* IS COMMON IN MOST FISH FARMS IN SEA WATER AND SERIOUS PROBLEMS HAVE BEEN ASSOCIATED WITH IT. THE SALMON LICE CAUSE EXTENSIVE DAMAGE TO THE SKIN, ESPECIALLY IN THE HEAD REGION TO THE EXTENT OF CAUSING EXPOSURE OF THE CRANIAL BONES IF ADEQUATE TREATMENT ARE NOT CARRIED OUT. ALTHOUGH THE FISH MAY LIVE FOR A CONSIDERABLE TIME WITH SUCH LESIONS, THE FISH WILL BE WEAKENED DUE TO LOSS OF BLOOD, OSMOTIC STRESS AND SECONDARY INFECTIONS. THE DISEASE IS USUALLY TREATED WITH THE ORGANOPHOSPHOR INSECTICIDE NEGUVEN IN SPECIAL TREATMENT COMPARTMENTS. INVESTIGATIONS ARE NOW CARRIED OUT FOR A POSSIBLE REGISTRATION OF NEUVAN, ANOTHER PHOSPHORINSECTICIDE PREPARATION SINCE THIS DRUG SEEM TO BE MORE EFFECTIVE AT A LOWER DOSE AND LOWER COSTS THAN NEGUVEN. THOUGH NUTRITIONAL DISEASES SUCH AS LIPOIC LIVER DEGENERATION (LLD), CATARACTS DUE TO ZINC DEFICIENCY AND SPINE MALFORMATIONS DUE TO LACK OF VITAMINE C IN THE FEED USED, SUCH DISEASES ARE OF RELATIVELY LITTLE SIGNIFICANCE FOR THE TIME BEING. WITH THE INCREASED KNOWLEDGE OF THE BASIC NEEDS IN FISH FOR TRACE MINERALS, VITAMINS AND BETTER FEEDING REGIMENTS, SUCH DISEASES WILL PROBABLY IN THE FUTURE BE EVEN LESS IMPORTANT.

ENVIRONMENTAL DISEASES SUCH AS "RED TIDES" OR UNUSUAL FLAGELLATE BLOOMS HAVE BEEN A CURRENT PROBLEM FROM TIME TO TIME. THE OCCURRENCE OF TOXIC ALGAE SEEM TO BE INCREASING AND IT IS MORE OFTEN REGISTERED OF UNNORMAL BLOOMS OF PLANKTONIC ALGAE YEAR ROUND ALONG THE COASTAL AREAS IN WHICH THE FISH FARMS ARE LOCALIZED. THE DINOFLAGELLATE IN MOST CASES HAS BEEN GYRODINIUM AUSTRALUM WHICH HAS CAUSED PATHOLOGICAL CHANGES IN THE GILLS SUCH AS GILL IRRITATION, HEMORRHAGES AND "SLOUGHING" OF THE EPITHELIAL LINING LEAVING THE GILL CAPILLARIES EXPOSED WITH REDUCED ABILITY OF SUFFICIENT OXYGEN UPTAKE. ALSO ALGAE LIKE PHAEOCYSTIS POUCHETTI, EUTREPTIELLA SP AND GYMNODINIUM GALATHEUM MAY CAUSE PROBLEMS IF THE CONCENTRATIONS ARE HIGH ENOUGH. WHETHER THE ALGAL BLOOMS ARE CAUSED BY A PLentiful SUPPLY OF NUTRIENTS (POLLUTION) FROM FISH FARMS OR COMMON IN COASTAL WATERS ARE NOT KNOWN.

IT IS, HOWEVER, BEYOND DOUBT THAT THE WASTE OF FEED AND FISH FECALS UNDERNEATH THE NETCAGES IN FISH FARMS IN SEA WATER ARE LARGER THAN WHAT MAY BE BROKEN DOWN NATURALLY. SEDIMENTATION DO THUS OCCUR IN SUCH FARMS AND WHEN THESE SEDIMENTS ARE BROKEN DOWN, OXYGEN IS USED AND TOXIC SUBSTANCES HARMFUL TO FISH MAY DEVELOP. MOST COMMON IS METHANE GAS "CH₄" AND CARBON DIOXIDE, BUT ALSO HYDROGENSULPHIDE (H₂S). FEEDING INTENSITY, FEED TYPES AND WATER EXCHANGE ARE IMPORTANT FACTORS AS TO THE BUILDING UP OF CODIMENTS UNDERNEATH THE CAGES. LARGE FARMS WITH HIGH FISH DENSITY GIVE A LARGER ON SPOT CONCENTRATIONS THAN SMALL FARMS WITH LESS DENSITY WHICH GIVE SEDIMENTATION OVER A LARGER AREA.

IN ADDITION TO THIS THE ENVIRONMENT MAY ALSO BE AFFECTED BY INCREASED PRIMARY PRODUCTION DUE TO RELEASE OF NUTRITIONAL SALTS. THE PROBLEM MAY BE PREVENTED BY MOVING OF THE NET CAGES TO NEW LOCALISATIONS AND IDEALLY A FISH FARM UNIT SHOULD HAVE ONE LOCALITY WITHOUT FISH TO RESTORE NATURAL CONDITIONS IN THE LOCALITY.

THE FISH AS PRODUCT FOR CONSUMPTION

ACCORDING TO THE REGULATIONS GIVEN, THE NORWEGIAN GOVERNMENTAL QUALITY CONTROL SERVICE FOR FISH AND FISHERY PRODUCTS, DIRECTORATE OF FISHERIES IS RESPONSIBLE FOR THE QUALITY CONTROL OF FISH AS PRODUCT FOR CONSUMPTION WHICH ALSO INCLUDE FARMED FISH. A LOT OF FACTORS ARE OF SIGNIFICANCE FOR THE QUALITY OF FARMED FISH FOR CONSUMPTION. CUE WORDS HERE ARE:

1. PRODUCTION-TECHNICAL FACTORS SUCH AS
 - A) STARVATION OF THE FISH BEFORE SLAUGHTER
 - B) CATCHING/HANDLING IN CONNECTION WITH SLAUGHTER
 - C) SEDATION OF FISH BEFORE SLAUGHTER (ONLY CARBONDIOXICE CO2 OR COOLING TO LOW TEMPERATURES ARE ALLOWED).
 - D) BLEEDING OF THE FISH, WASHING PROCEDURES
 - E) GUTTING
 - F) QUALITY GRADING/SORTING
2. BIOLOGICAL FACTORS SUCH AS
 - A) SEXUAL MATURITY
 - B) MALFORMATION OF THE FISH
 - C) LOOSE MUSCULATURE OF THE FISH
3. DISEASE FACTORS
 - A) INFECTIOUS DISEASES
 - B) PARASITIC DISEASES
 - C) NUTRITIONAL DISEASES
 - D) ENVIRONMENTAL DISEASES

IT WOULD BE TOO MUCH TO GO INTO DETAILS HERE, BUT THE HYGIENIC QUALITY CONTROL IS DIRECTED AGAINST VISIBLY EXTERNAL OR INTERNAL CHANGES MANIFESTED IN THE DIFFERENT DISEASES. AS MENTIONED PREVIOUSLY MEDICAL TREATMENT MAY BE NECESSARY FOR TREATMENT IN CONNECTION WITH CERTAIN INFECTIOUS AND PARASITIC DISEASES. THIS MAY OF COURSE CAUSE HYGIENIC PROBLEMS FROM A CONSUMPTION POINT OF VIEW UNLESS AN ADEQUATE CONTROL SYSTEM EXISTS. IN NORWAY ALL PRESCRIPTIONS FROM THE LOCAL VETERINARIANS ON DRUGS TO BE USED IN FISH FARMS HAS TO BE REPORTED TO THE NORWEGIAN GOVERNMENT QUALITY CONTROL SERVICE FOR FISH AND FISHERY PRODUCTS AND TO NATIONAL VETERINARY INSTITUTE ACCORDING TO A DECREE FROM THE DIVISION OF VETERINARY SERVICES. THE SAME DECREE ALSO GIVES PRESENT AS TO WITHDRAWAL TIME AFTER TREATMENT BASED ON RESEARCHWORK DONE ON FISH BREAKDOWN FOR DIFFERENT DRUGS IN FISH. FOR THE TIME BEING THE WITHDRAWAL TIME WILL BE 40 DAYS WHEN WATER TEMPERATURE IS ABOVE 10°C AND 90 DAYS WHEN WATER TEMPERATURE IS BELOW 10°C.

SPECIFIC DETECTION METHODS HAVE BEEN ESTABLISHED AND WITH CONTROL OF FISH PRIOR TO SLAUGHTERING ACCORDING TO STANDARD EXAMINATION PROCEDURES ARE SUFFICIENT TO KEEP THE FARMED FISH IN NORWAY UP TO A HIGH QUALITY STANDARD FROM A HYGIENIC POINT OF VIEW. IT IS OUR INTENTION TO KEEP IT THAT WAY.

GENERAL COMMENTS ON ARTHUR WHITELEY

Page 2: Use of statistic from experimental pens in Norway is not representative of normal densities. "83 pounds per m^3 that's about 8 fish per cubic meter." We feel that our maximum densities should not exceed 1.0 pounds per $ft.^3$ which is around 35 pounds per m^3 . In addition, this is highly dependable on the size of the fish and usually is less than that figure.

Page 2: In reference to Whitely's example of normal pen size (ie: 40 x 40 x 15 or 20) - We use considerably smaller pen sizes as we feel it gives us more control over the fish. The point is that there are different beliefs and strategies throughout the industry. It cannot all be characterized by one large producer's chosen methods.

Page 3: Assertion that the Norwegian size limit is based on environmental concerns. We have never heard this argument put forth by the Norwegians. They say it was an economic incentive to keep the farms small to encourage local operators and cooperative agreements for management. This was instituted after the development of some large farms which were "grandfathered" in the regulations.

Page 3: "onshore support facilities where food is processed" though common practice in Norway, is rare in Puget Sound. We generally buy manufactured food from elsewhere.

Page 3, 4, others: Several comments made regarding "large corporations", "Norway" doing such and such, "The Norwegian Companies" say this, fish "sold by Norway", ect.

We must clarify the issue regarding who the growers are. I'm aware of 2 Norwegian operators - ScanAm and Sea Farms - which are operating through American subsidiaries. The rest are local operators, investors, growers, ect. This is not a foreign invasion and we should not let it be characterized as such by innuendo.

Page 3: "scale diagram comparing the Norwegian legal limit. . ."
Norway's limit is in terms of volume of nets. Here he is comparing that to a surface area size, which itself is unfounded (5 acres).
Griffin Bay proposal = 4 acres surface area including walkways, and = 2 acres surface area of pens.

Page 3: "2 to 1 conversion ratio" - this can range downward to about 1.2 to 1 conversion depending on diet used. Wet feed will have a higher food conversion ratio, ie: the least efficient.

Due to this difference in conversion, I would question not only Whitely's figure for food required but his figures for excretion. Obviously, the better the conversion, the less will be lost to excretion. Our water samples processed by DOE showed no difference

in nitrates, phosphates and ammonia levels in pens compared to reference levels.

Page 4: "20% (of food) passes through the pens as waste" Careful handfeeding can greatly reduce the portion that is wasted, ie: not eaten. We have less than a 5% loss in the Squaxin operation.

Concept of pollution - Every year there are something like 4 to 5 million adult salmon in our Puget Sound waters. There are, of course, many more juvenile salmon and a myriad of other fish populations. The Sound is teeming with fish which consume and defecate just like cultured fish. It would appear that the net pen generated fish s--t is dwarfed by the natural fish s--t. This issue therefore is not one of introducing some incidious pollution to the water (it is, in fact, just part of a larger natural cycling of nutrients) but rather the fact that as a matter of culturing convenience we have confined a portion of this cycle to a relatively small area. We must put the "pollution" question in perspective.

Page 4: "nitrogen from a 5 acre pen is a little lower". It is actually less than one quarter (See Weston Table 4). This is comparison of total volume; as a concentration based on water volume it is minute, ie: it is not equal to contamination from one such community.

Page 4, bottom and elsewhere: "280 acres of salmon pens" what he is

referring to is an inventory by DNR of bed land leases for aquaculture facilities. The lease area is not an indication of the size of the structures of pens. An examination of this relationship by DNR (Bob Hoyser) revealed that site coverage by structures for a lease area was approximately 22%. This includes nets and walkways (see attached). About 1/3 of that was operational or under construction prior to 1986. Note: there are several herring operations and several raise and release facilities.

Comparison of 280 net acres to Seattle wastewater is unjustified on that basis alone. (Page 5)

A note about BOD comparison - first, every water source even rivers, discharges BOD to Puget Sound, naturally. Second, .1 mg/l BOD (from Weston Table 5) nutrient loading can also be expressed as .1 g/m³. Comparing this to O² production levels of plankton in surface waters (I got a figure of 8 g/m³ from Odom, the godfather of ecology) reveals an order of magnitude difference between demand and production on a daily basis.

Page 6: "very heavy sedimentation under the pens." Was this in reference to the high density Norwegian experiment? Obviously the farmers cannot afford a problem that reflects in the health of the fish. This is a point we really need to push - that fish farming

requires clean water. We would be cutting our own throats to be polluting our growing areas like Whitely describes.

Page 7: "Pollution problems seem to be unavoidable in fish farming" (quoting Norwegians). False! Dependent on site and rearing strategies. Norway characteristically does not have the circulation in its sheltered fiords that we have here. If it is as bad in Norway as Whitely describes it, then why has Norway displaced Pacific Salmon in the U.S. and Europe marketplace? They now lead the world in salmon aquaculture production.

Page 8: Infections, infections, infections - not one case in the history of net pen aquaculture which can be attributed to this type of relationship. We would like to see his documentation.

Red tide, the paralytic shellfish poisoning, is not actually a visible red bloom in the seawater as Dr. Whitely showed a picture of from Japan. Perhaps he was referring to Noctiluca or some other red pigmented algae.

Page 8: "Vibrio vulnificus causes primary septicemia". . . some Vibrio may cause diseases in humans. Eating shellfish may infect some humans. 1/2 the people getting primary septicemia from Vibrio may die - as opposed to 1/2 the people who ate the contaminated shellfish. When dealing with bacteria we must determine not only if

the species is a human pathogen but also whether it is a virulent strain of that particular pathogen. Vibrio is everywhere and human infection is rare. Weston has a good discussion of this.

Page 9: "formaldehyde in the food" Oh? We are not aware of this treatment. Just how many fish died as a direct result of this application?

Page 9: There are no documented cases of wild fish contacting disease from pen fish but there are several cases of the opposite.

Page 9: "Drawn out treatment". This simply does not work and is not employed.

Sen. Eliason

Attached pages
reflect type of
material found in
report - could obtain
entire report from
DNR if desired.



ETOLIN ISLAND AREA

Mariculture Pilot Project



Alaska Department of
**NATURAL
RESOURCES**

1988



Greetings:

We are pleased to present this final report of the Etolin Island Area Mariculture Pilot Project. Major elements of this project are:

1. An examination of biological and environmental issues of aquatic farm siting, and
2. A presentation of current permit and permit review processes required by state and federal agencies for establishing aquatic farms.

Other elements include a brief history of mariculture in Alaska, development issues, an examination of the Consolidated Shellfish Farm Application, project recommendations, and a summary of public comments received. Siting guidelines were developed as a result of environmental and biological investigations. The study is limited to shellfish and sea vegetable mariculture and does not address fin-fish farming issues.

This report is intended to be used primarily by state and federal agencies when processing or reviewing permit applications for aquatic farms. It should also be helpful to active or prospective sea farmers, and other individuals interested in the development of aquatic farming.

Six state and five federal agencies participated in the Etolin Island Area Mariculture Pilot project. Preparation of this report included literature reviews, interagency dialogue and cooperation, and field research in the study area. Public workshops were held in Petersburg and Wrangell, and a thirty day review period of a public review draft of the project provided opportunities for public involvement.

Aquatic farming is a relatively new and expanding use of tidelands in Alaska. Sea farming technology applicable to conditions encountered in Alaskan waters is evolving. State and federal agencies are responding to this new industry by developing permits, leases, review processes, policies and procedures to support development while at the same time providing for protection of all natural resources. This report presents an evaluation of processes currently adopted by industry and governing agencies.

Sincerely,

Andrew W. Pekovich, Acting Regional Manager

By:

Terry W. Rader
Terry W. Rader
Project Team Leader



Etolin Island Area
Mariculture Pilot Project

CHAPTER 3

Site Suitability

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Etolin Island Area

Mariculture Pilot Project

CHAPTER 4

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PCFFA Newsletter (California)

17 February 1989

Page 11

120,000 tons of salmon from Norway's fish farms this year. Worldwide, farm production of salmon is expected to increase as much 30,000 to 50,000 tons over last year.

The Seattle-based newsletter also reports that British Columbia fish farmers, including those producing farmed king salmon, are gearing up a promotion effort in the U.S. to market the 12,500 tons of salmon they expect to produce this year. The B.C. Salmon Farmers Association recently hired the Seattle firm of McKnight & Co. to promote their product at Sea Fare. The promotion campaign included a "lavish" reception, a tour by Maunena Kaseburg, a culinary expert, slick 4-color press kits, t-shirts, and press releases.

While the fish farmers are gearing up their promotion efforts, targeting markets traditionally held by troll-caught wild salmon, there has been little done to promote wild king salmon. The Fisheries Council of B.C. appears to be the only group with an advertising campaign promoting wild salmon.

The decision on the funding of the referendum to establish a California Salmon Council (see FRIDAY, 3 February, green insert) which could promote troll kings, has been sent back to the PCFFA member associations for a decision on raising the money for the referendum. The Commercial Salmon Trollers Advisory Committee has decided not to use salmon stamp monies to fund the referendum, even though they have the statutory authority to do so, feeling it would be an inappropriate use of the program which had been sold to the fleet as a method of restoring salmon populations.

Depending on the decision, and the timing of the decision, a referendum vote could possibly be held prior to 1 May. Further delay, could result in a referendum vote not being taken until after 1 October, delaying (if the referendum is successful) the formation of the Council until next year.

For a copy of the report on the fish farming promotion effort, contact Seafood Trend, 8227 Ashworth Avenue North, Seattle, WA 98103, (206) 523-8830.

→ Pollution, Antibiotic Problems Caused by Fish Farms. According to a recent article in the Irish Skipper, Irish oyster growers are complaining about pollution from nearby salmon farms. Similar complaints have also been coming out of Norway and Canada. In a 16 November 1988 issue of The Fisherman (p.10), it was reported that the Bay of Fundy is now being polluted by salmon farms. Art Mackay, a New Brunswick fish farmer, warned a legislative committee that the salmon farming "industry will experience the same kinds of catastrophes that have been experienced in Norway". He advocated that an environmental impact

"A Chardonnay by another grape isn't".....Phillip Newmark

statement be prepared prior to the granting of any permit for salmon farm operations. Provincial authorities, as well as the federal government in Canada, have, in their apparent zeal to promote salmon farming, not required such impact statements nor closely monitored the impacts the farm operations may be having on the aquatic environment or native salmon stocks, despite being asked to do so by such organizations as the United Fishermen & Allied Workers Union.

In a 13 December issue of The Fisherman (p. 9) it was reported that the deadly salmon disease furunculosis, previously unknown in Norwegian waters, is breaking out in fish farms and threatening wild stocks. In a statement made at a regulatory hearing in Washington state on 14 November, Svein Aage Mehli, head of Norway's Directorate for Nature Management said that 5,000 farmed salmon infected with the disease escaped this summer into Hjørundfjorden near Molde.

Mehli said farmed fish will have a negative impact on wild stocks. "First", he said, "there is a genetic problem and second an environmental problem. If Atlantic salmon (escaping in Pacific waters) have the same requirements as coho or steelhead trout - and we know that salmon escape in great numbers - then you will have competition for space in the rivers". Mehli testified that new zoning regulations now being implemented in Norway will ban farms within 20 kilometers of salmon rivers and close entire fjords to farming where salmon rivers are present.

At the same 14 November hearing before the Washington State Shorelines Hearing Board, reports The Fisherman, Arthur Whiteley, a zoologist with a long-standing interest in microbiology, testified that the widespread use of antibiotics in fish culture poses a serious threat to public health. Whiteley stated that antibiotic use on fish farms will produce antibiotic resistant bacteria in the human food chain.

If these resistant bacteria occur in humans, Whiteley testified, "the diseases caused by that organism could not be medically treated. It would eliminate from the tools of the physician those he would want to control disease".

Whiteley produced scientific studies which showed that "in almost every case resistant bacteria is selected by the use of antibiotics in fish culture". In other words, use of antibiotics to treat bacteria causing fish disease kill all but the bacteria which is resistant to the medication. Studies have proved that this resistance can be transferred from one type of bacteria to another and can create resistance to several types of antibiotic.

"If we don't pay attention today, we are going to end up with a bunch of biotech Superfund sites 10 years from now". .Rebecca Goldberg

Whiteley said this type of transference has been documented in the case of vibrio bacteria which causes disease in fish. In a laboratory, this resistance was transferred to different bacteria which exist in the North Pacific food chain and are pathogenic to humans. "This has not been observed in the wild", stated Whiteley, "but could occur. Experiments indicated the genetic mechanism is in place..... and we can predict it will occur in nature under certain conditions".

The Center for Disease Control in Atlanta has found the same phenomenon in beef and poultry, Whiteley testified, and blame it for a dramatic increase in salmonella. The only solution, he said, is to ban the use of antibiotics in fish culture which are used in human treatment.

According to The Fisherman, in British Columbia, both oxytetracycline and erythromycin are used in fish culture even though they also are used in human medicine. There is no inspection to determine whether or not this transference of resistance is occurring in B.C. or whether fish sold to consumers are free of antibiotics.

In California some steps have been taken to protect against the problems that seem inherent with farm salmon production. Last year the Legislature passed AB 3945 by Assemblyman Dan Hauser (D-Arcata) requiring a study by Fish & Game prior to the importation of any exotic salmon species (e.g., Atlantic salmon) to Del Norte County. This year Assemblyman Gerald Felando (R-San Pedro) has introduced legislation, AB 311, requiring the labeling of fish treated with antibiotics or fed food additives.

Advisory Committee Report. In this issue of FRIDAY (insert) is the copy of the report of the California Advisory Committee on Salmon & Steelhead Trout made to the Legislature at the Fishermen's Forum. It was presented by committee chairman Scott Downie.

California Salmon Permits. The California salmon permit and licenses must be renewed before 1 April without penalty (a late fee of \$100 is assessed between 1-31 April). After 1 May, a salmon permit is lost and cannot be reinstated. This year, when the license and permit is renewed, it is recommended that a copy of the boat registration (CF or federal documentation) be sent to Fish & Game for verification that their records list you as the owner of the vessel. Persons not receiving correspondence from Fish & Game by 15 March, regarding the salmon permit renewal, should contact the Department at (916) 739-3378. Special location sales have been set for 10-11 March in Fort Bragg (Salmon Trollers Marketing Association hall) and Santa Barbara (Coast Guard Auxiliary Building); 17-18 March in Crescent City (Fishermen's Wives Hall), and Morro Bay (Veteran's Memorial Building) from 9:00 am to 5:00 pm daily.

Bill Analysis SB 397/HB432

Background/Legislative Intent

In 1987, the Alaska State Legislature passed SB 297 placing a one year moratorium on finfish farming. The following year HCS SSSB 514 was passed, authorizing the farming of shellfish and aquatic plants, extending the moratorium on finfish farming until July 1, 1990, and establishing the five-member Alaska Finfish Farming Task Force. The shellfish farming program is currently being implemented. HCSSSB 514 also contained a provision for inland farms in closed waters. The Board of Fisheries however, denied a proposal to make surplus coho eggs available to an interior-based applicant proposing to operate a recycle hatchery. In doing so, the Board of Fisheries asserted that public policy questions pertaining to brood stock acquisition and the privatization of a public resource were questions that should be addressed by the legislature, rather than set by precedent by the Board.

Although the task force was authorized in 1988, it was not funded until last spring. The members were appointed by Governor Cowper and began work last July. The task force recently issued its report and recommended that prior to the end of the moratorium on July 1, 1990, the legislature take statutory action to expressly allow or prohibit finfish farming. SB 397 would prohibit finfish farming by not allowing a person "to grow or cultivate finfish in captivity or under positive control for commercial purposes." As drafted, the state and PNP hatcheries would remain unaffected.

Amendments Proposed

On Page 2, lines 1-5, the third finding asserts that serious disease and genetic risks are posed to wild stocks. As the FRED Division has stated on the record, in legislative hearings and to the task force, if a properly managed, regulated, and funded pathology and genetics program were in place, similar to that run by the FRED division for current public and private non profit hatcheries, then commercial farming of finfish would not pose a serious risk to the health and genetic integrity of wild stocks.

Sale of finfish under a scientific or educational permit is not allowed currently. Accordingly on Page 3, Section 2, the department recommends deleting item 3.

With regard to Section 2, item 4, the department recommends extending the sentence. After the word "ponds", insert: "provided these fish are not reared or released into waters of the state."

The latest round in the aquaculture battle

OLYMPIA — For 25 years Washington has been edging slowly into aquaculture, seeking to turn Puget Sound and adjoining saltwater areas into a fish farm, enhancing production of seaweed, mussels, oysters, clams and fish, particularly salmon. It sounds like the perfect economic development: exploiting the state's relatively pure waters to create businesses and jobs. Unlike so many industrial endeavors, aquaculture would seem to demand clean waters, protecting the environment rather than degrading it.



Mike Layton

Commentary

For some fish farmers, the success of Japan, Scandinavia, and other places, the process has been too slow, plagued by bureaucracy and selfish waterfront property owners.

For others, including some scientists and the upland dwellers, it's grown too fast and already is creating problems that will only get worse.

The battle has been fought in many small areas, usually in county courthouses and between neighbors seeking to exploit the potential resources or raising alarms about unsightly oyster rafts and salmon pens.

The focus of the fight now is on the state Shoreline Hearings Board.

The board is reviewing Skagit County's refusal to allow a salmon net pen operation just south of Hope Island, a state park and prime sports salmon area, by a consortium of three Indian tribes called the Skagit System Cooperative.

The tribes propose to install 20 pens

behind log booms enclosing an area 480 feet by 100 feet. There would be three blinking navigation lights and boats hauling 10 to 12 workers back and forth. The pens would produce some 500,000 pounds of salmon a year.

Skagit County long ago designated the area as "natural," meaning no commercial development. The county's brief to the Shorelines Board says the Skagit River estuary is the "least disturbed, and most diverse and biologically productive, of all major estuaries of Puget Sound."

The area is home and nursery to a broad complex of biologically sensitive creatures. Pens, the county says, "would be an unsightly blemish on a currently pristine shoreline, reducing enjoyment of the residents and their property values."

But there is more to it than offending the eyes of people who can afford waterfront homes. It also would conflict with the hundreds of salmon fishermen who delight in the area.

Objections are growing to the idea of concentrating so many fish in one spot. Large amounts of fish waste not only pollute the water, but penned fish also are susceptible to epidemics of diseases and parasites. Finally, there is the matter, still only barely understood by scientists, of "genetic pollution" from inbred hatchery and pen fish mixing with wild salmon.

That fear is enhanced by the importation of Atlantic salmon. They're less stressful and thus survive better in pens, but when they escape and breed with the stronger wild salmon, they degrade the race. They also might bring disease that the native salmon can't resist.

Pen opponents' arguments were bolstered yesterday by testimony before the board from

Svein Mehli, a smiling, boyish-faced biologist who directs Norway's nature management program. He was brought here by Skagit County at the suggestion of Canadian fishermen who are even more alarmed than Skagit's waterfront owners at the prospect of corrupting the blood lines of Fraser River and other salmon.

Salmon farming started in the 1960s in Norway, Mehli said, and was first licensed in 1973.

Now 728 fish farms along the nation's 57,000 miles of coastline will produce 70,000 tons of salmon this year; only 1,600 tons come from wild stocks.

But during the years since that beginning, Norwegians have learned that net pens don't work well in estuaries where parasites dwell in brackish waters. They've found that diseases proliferate in the pens, Mehli said, and they're fearful that "if we go on mixing the populations, we will destroy the natural stocks in the long run."

Salmon smolts (baby fish) imported from Scotland escaped pens in Norwegian waters, carrying diseases with them, Mehli said.

John Woodring, a lawyer for the tribes, cross-examined Mehli and read to him state aquaculture regulations under which Washington quarantines and inspects imported fish.

That's good, Mehli said, "but I would still have concern. Certifying fish are free of one disease is better, but you may not be certifying for diseases you're not aware of."

It probably will be several months before a decision is handed down. But the mere fact of the dispute is another warning that man tinkers with the natural environment at his own peril and at risk to the other creatures with which he shares Earth and its waters.

■ Mike Layton is a P-I columnist in Olympia.

SHAKERS

Landlocked Fish Farm Not so Landlocked?

Could a landlocked fish farm be related to the death of 100,000 coho fingerlings in a nearby river? Though the state Dept. of Ecology in Washington isn't exactly saying so, they have noted two "remarkable observations" that come close. The first is that springs lead from the farm's settling pond into the Black River at a location that "looks like

the hottest spot" of the kill, according to deputy director Steve Hunter.

The second is that the aquaculture facility was doing a "drain down" at the time of the fish kills (last August). Hunter said the fish farm discharges several million gallons of water a day into an unlined drainage ditch and settling pond, and that the pond never fills up. No one has been charged, and the coincidence is still just that.

—*Seattle Post Intelligencer*
Nov. 1, 1989

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Puget Sound Fish Farms Challenged

By KEITH SCHNEIDER

Special to The New York Times

PORT ANGELES, Wash. — Salmon farmers in the Puget Sound region are encountering resistance this summer as they and a group of scientific critics clash over the safety of production practices, including the use of antibiotics.

The dispute, waged in public hearings around the sound, comes as the state's salmon farming industry is emerging from legal and legislative battles that have delayed its growth for two years. Local and state licensing panels are considering proposals that would expand the number of Puget Sound salmon farms to 20 from 13 in the next year.

The expansion here, however, and the prospects for the rest of the United States aquatic farm industry could turn on the ability to answer the critics and satisfy consumers that fish are safe to eat.

In 1969, when the first experiment in salmon farming was started in Puget Sound, aquaculture was seen as an intelligent, ecologically responsible way to raise food. The three million acres of Puget Sound offered deep clean water and many protected coves for raising fish in floating enclosures.

Aquatic farms produced 790 million pounds of fish and other seafood last year, or nearly 10 percent of the 8.1 billion pounds of fish and seafood consumed in the United States, the Federal Department of Agriculture says. But the growth in the \$600 million aquaculture industry is slowing as Americans take a second look at the health attributes of fish.

Consumption Fell in '88

Last year, consumption of fish fell to about 15 pounds a person from 15.4 in 1987, the first decline since 1982. Experts attributed the drop largely to uneasiness about ocean pollution.

But farmers and the South's catfish producers depend more than fish farmers here do on synthetic substances to control disease. Fungus, aquatic weeds and other threats to farm-raised fish thrive more readily in fresh water than in salt water, aquaculture specialists say. But the production practices in the other parts of the industry have not yet come under scrutiny as intense as salmon farmers now face in the well-populated Puget Sound area.

Though evidence is far from being clearly established, some biologists say antibiotics could be absorbed into shellfish and other organisms and make some bacteria resistant to the drugs.

Earlier this year, after a series of hearings by a House Merchant Marine and Fisheries subcommittee, the National Marine Fisheries Service began a study to develop new inspection procedures that would be modeled after existing systems that monitor for antibiotics in poultry, pork and beef. The study is scheduled to be completed in 1990.

of salmon, about equal to Washington's salmon harvest.

Maine's aquatic farms have also not been hampered by the intensity of the political conflicts of the industry in the Pacific Northwest. The northern Maine coast is less developed than the Puget Sound region, and many who live along the Maine coast make their living from the ocean.

"There is a highly vocal group of opponents who have argued for years that Puget Sound should not be developed for aquaculture," said Dr. Forster. "Now they are using the food safety issue as a point of argument."

The use of antibiotics worries some critics.

The real issue has always been aesthetic concerns about what should be the proper use of public waters.

Assurances From State

Since 1986, the State of Washington has set guidelines for establishing and managing fish farms and published a series of reports intended to answer questions and reduce anxieties. The reports provide evidence that fish farms properly situated in deep water with strong currents will not pose an environmental problem and have the potential to generate thousands of new jobs. The state's assurances have begun to persuade more counties and review panels to approve new fish farms.

Yet as the number of approvals increase, the dissent has also grown louder. And now critics are raising the safety of production practices to consumers as an important issue. The critics, led by Dr. Arthur H. Whiteley, a retired marine biologist from the University of Washington, assert that feed medicated with antibiotics is widely used on Washington State's 13 salmon farms to treat bacterial diseases.

Dr. Whiteley said that in some cases meat from fish treated with antibiotics may contain residues of the drugs, an assertion strenuously denied by salmon producers. In other cases, he said, antibiotics may be changing the genetic structure of aquatic bacteria infectious to other fish and to humans.

Critics Are Still Uneasy

It is well established scientifically that antibiotics fed to livestock and poultry cause bacteria to develop resistance to the drugs. The Federal Centers for Disease Control in Atlanta has traced some outbreaks of salmonella food poisoning in the Midwest to medicated cattle.

Three antibiotics are approved by the Food and Drug Administration for use on fish farms. The most commonly used is oxytetracycline. Fish farmers are required to stop using medicated feed weeks before salmon are sent to market, and residues are not present in the meat, said Dr. Forster and other industry executives.

But studies have shown that 90 percent of the antibiotics fed to fish are excreted in the feces. Last year researchers in Norway, the world's largest producer of farmed salmon, found that oxytetracycline persisted in the sediments below fish farms for months. Other studies have determined that aquatic bacteria developed resistance to the drugs.

Of particular concern to health specialists is the possibility that resistance to antibiotics could be transferred from bacteria that cause fish diseases to bacteria that cause illnesses in people. The most important of these is *Vibrio parahaemolyticus*, a bacterial strain known to cause severe digestive discomfort in people who have eaten infected shellfish.

In 1982, Japanese scientists showed that antibiotic resistance could be transferred to *Vibrio parahaemolyticus*, but the experiments were performed in very warm water. Kevin H. Amos, chief fish pathologist with the Washington State Department of Fisheries, said in an interview that *Vibrio parahaemolyticus* does not survive well in the cold waters of Puget Sound.

One of the most prolific of the Puget Sound area aquaculture farms is just on the northern shore of Port Angeles harbor where Sea Farm, Washington built a four-acre salmon farm, one of the country's largest. Two 900-foot-long floating steel platforms are divided into 50-foot squares from which nylon nets are suspended to form pens 20 feet deep. Thousands of Atlantic salmon, a species more docile than the aggressive Pacific species, gleam in the clear, cold water like polished stones. This year, Sea Farm may sell more than 1 million pounds of salmon.

Dr. John Forster, who directs the Sea Farm operation here and is president of the Washington Fish Growers Association, a Seattle-based trade group, has worked for years to ease both technical and political problems. The Atlantic salmon, he said, has proved a delicate species in Pacific waters. Farms lose 40 percent of their fish, most of them when 15-month-old smolts, or young salmon, are transferred from freshwater hatcheries and put into saltwater net pens.

Washington's production problems are enabling Maine's aquatic farms to challenge Washington's for dominance in the domestic industry. The 7-year-old industry in Maine now number 18 to 20 farms, executives say. This year, Maine could produce 5 million pounds

New York Times

The
Fisherman (B.C.)
6-23-89

LETTERS

The Fisherman welcomes letters to the editor. Letters must be signed and should be brief, if possible.

UFAWU stand on fish farms needs to be toughened

In a recent editorial entitled "Can the UFAWU represent salmon farm workers?" (April 21, 1989) union policy was outlined with respect to aquaculture — no ban on fish farming but strict regulations. Your position is reasonable and takes into consideration that workers in this industry require safe working conditions and decent wages.

However, it has now become apparent that salmon farming has become an even bigger problem than most had predicted in terms of mort disposal, industrial plastic garbage, destruction of marine wildlife, water pollution, antibiotics, price wars, fish escape-ment and numerous other problems.

The union's decision to embrace a "regulated" aquaculture industry does not take into account the burden that must be shouldered by the residents of the many communities that have to live with and pay for (through taxation) this new industry.

Our communities have lost funding in other areas, such as recycling, parks development and education as public money and expertise are poured into this industry.

We then must live with the mess created by people who don't care about local concerns and values and think that all you have to do is wave money in people's faces and they will swallow anything.

Both levels of government seem completely disinterested in regulating this industry. The new waste management laws for fish farms are not even worth the paper they are printed on. This industry is, and will continue to be, "self-regulating."

This industry has little respect for existing laws like the Fish and Wildlife Act or the Pest Control Products Act, so there is every possibility that new laws will be ignored as well.

In the wake of falling farm fish prices, many people are asking questions concerning the viability of fish farming. But regardless whether or not fish farming is sustainable or must continue to be subsidized by the public, there is no question the industry will continue to impact negatively on coastal communities.

The use of the biocide Nuvan 500 in Scotland to control sea lice is just one indication of what we can expect to see here if it hasn't already been used.

It is becoming more and more obvious that the economic benefits are confined to the fish farming industry while we must pay the social/economic and environmental costs borne out over the long term. Under these circumstances, phasing out fish farming during the next five years is become a more appealing and realistic alternative. Then we can get on with the real job at hand — rehabilitation and conservation of wild salmon stocks.

We would be pleased to present a slide show documenting industry abuses.

Claire Heffernan,

Citizens for Aquaculture Regulations,
POWELL RIVER

URGENT!

Mark your calendars! Notify your Members!
Turn out in your area!

We have the opportunity on several dates at several locations to provide citizen input in the development of the Marine Sanctuary designation for Northern Puget Sound and the San Juan Islands.

This new sanctuary plan will set aside certain areas as natural, to be protected from industrial and other exploitation, under provisions of the Marine Sanctuary Law passed by Congress last year.

**Thursday, November 8
7 PM**

Board of County Commissioners Meeting Room
Courthouse Annex
350 Court Street
Friday Harbor, WA

**Friday, November 9
10 AM**

Orcas Fire Hall
Eastsound, WA

**Monday, November 13
7 PM**

City Hall Community Center
Sixth Avenue and Q Street
Anacortes, WA

**Tuesday, November 14
7 PM**

Island County Courthouse
7th and Main
Coupeville, WA

**Wednesday Nov. 15
7PM**

John Wayne Marina
Old Blynn Highway
Sequim, WA

**Thursday, Nov. 16
7PM**

City Council Chambers
540 Water Street
Port Townsend, WA

**Friday, Nov. 17
7PM**

NOAA Headquarters
Building, 9 Conference Room A
7600 Sand Point Way N.E.
Seattle, WA 98115

***Just Say No to Drugs -
Don't Eat Penned Raised Salmon!***

M.E.C. NEWS

NUMBER 4 • FALL, 1989

*A Publication of the Marine Environmental Consortium
P.O. 2688*

Friday Harbor, Washington 98250

LEGISLATORS VISIT AQUACULTURE SITES

by

Margaret Johnston

President, Marine Environmental Consortium

Members of the Washington State Legislature's House Fish and Wildlife Committee toured two aquaculture sites October 16th, visiting the salmon pens at Kiket Bay in Skagit County and the mussel growing operation at Penn Cove on Whidbey Island. Representative Harriet Spanel initiated the tour and invited residents in those areas to meet with the committee.

Accompanying the legislators were no fewer than five staff members from interested state agencies and seven aquaculture industry representatives.

MEC was represented by board members Dale Fisher, Dr. Arthur Whiteley, Dr. Anna Marie Johnstone and several others. We were allowed a short 40 minutes to make our concerns about aquaculture siting known to the group.

Last year the House Fish and Wildlife Committee voted our bill, HB 1883, out of committee and may consider other bills on aquaculture when the session begins. In the short time we had we succeeded in letting them know just how strong the opposition to floating aquaculture is in every Puget Sound community where applications for new net pens have been made.

Our 1990 legislative agenda will be discussed at our next meeting where State Representative Harriet Spanel and State Representative Mary Margaret Haugen will be joining us.

If you have suggestions about our legislative initiatives for the 1990 session of the Washington State Legislature, please send them to me or to your MEC Representative.

MEC REPRESENTATIVES MEETING

November 15th

NOAA Headquarters in Seattle,
7600 Sand Point Way N.E., Building
Conference Room, 11 AM.

FRONT LINES: NEWS

FISH FARM IMPLICATED IN CHEHALIS RIVER FISH KILL



Wild salmon found dead in the Chehalis River, August, 1989

Findings of the Washington State Department of Ecology's investigation into the mysterious fish kill on the Chehalis River August 6th were released October 28th, citing pollution from a fish farm as the likely cause.

"The preponderance of evidence is that the fish kill occurred downstream from River Mile 9.2," said DOE deputy director Steve Hunter. That was cited as the starting point for the fish kill, 9.2 miles above where the Black River flows into the Chehalis, just downstream from the point where runoff from a fish farm operated by Global Aqua, Inc. enters the river.

Chemicals had been used to clean tanks at the Global Aqua facility in such a way that they could have concentrated in sufficient strength to kill fish, according to the DOE report. Global Aqua has denied any responsibility for the fish kill.

The Washington Fish Growers Association attacked the state's investigation, saying tests conducted by the aquaculture industry after the fish began to die in the river contra-

dicted that finding. However, the DOE investigation noted the agency had not been able to monitor the industry's tests that were cited as proof the fish farms were not the cause.

Delays on the part of the state in investigating the mysterious fish kill hampered the investigation.

WORLDWIDE GLUT OF FARM SALMON SAVAGES FISH PRICES.

National trade publications and other news sources report a glut of farm salmon, created by substantial production in Chile, Norway, Scotland and Canada, has created a pricing crisis in the Salmon industry.

Industry spokespeople insist the oversupply and price decline is a temporary matter that will be over in a few years. In September, *Seafood Business* reported the aquaculture industry's overstatements and claims

have created widespread distrust. "It's no wonder that seafood buyers and investors are leery and confused."

The Vancouver Sun reported 1989 "will be a brutal year for B.C. salmon farms."

Said the Sun "Prices now barely cover the cost of production." By mid August, four B.C. salmon farm operations were in receivership. An industry consultant quoted by the Sun forecast ten per cent of the B.C. salmon farming companies could go under in the next 12 months.

With demand for seafood dropping in the United States, the industry is now planning aggressive marketing campaigns and to produce more expensive products, such as smoked salmon or sturgeon to remain profitable.

Several salmon aquaculture permits that have been issued have not yet been installed in Puget Sound, including a \$12 million Norwegian financed facility west of Port Angeles on the Lyre River which would have been land based, with fish grown in tanks

MEC'S WHITELEY ADDRESSES PACIFIC STATES FISHERIES COMMISSION

Dr. Arthur Whiteley, University of Washington Professor Emeritus of Marine Biology, was invited to report to the Pacific States Marine Fisheries Commission's 42nd annual meeting in Seattle in October on the additives used in fish farming.

The commission is composed of three representatives from each of the five Pacific Coastal states - California, Alaska, Idaho, Washington and Oregon. Dr. Whiteley said his explanation of the additives and their uses, including substances that artificially color the salmon meat, startled many of the commission members.

The Commission acts as an advisory body to governmental fisheries policy making.

AFLOAT AND ASHORE

State Agencies Press Counties to Support Salmon Net Pen Expansion Plan

Although a number of County Commissioners did not agree there is common ground on net pen aquaculture, the Association of Counties is considering the state's proposal. MEC will monitor the progress of this effort and its impacts on our marine environment.



STATE OF WASHINGTON

October 6, 1989

James A. Metcalf, Executive Director
Washington State Association of Counties
1076 South Franklin
Olympia, WA 98501

Dear Jim:

Thank you for coordinating our gathering on October 3, 1989 with county officials to discuss salmon net pen issues. The session was very productive and promising. This letter is being sent to those in attendance to confirm the matters discussed and to suggest a direction for coordinated action on salmon net pen siting.

Although our discussions were frank and candid, and we understand well the difficult nature of these issues, we were heartened by the encouraging prospect that common ground does exist which may serve as the basis for moving forward to consensus solutions. Specifically there appears to be support for the following general propositions:

1. We ought to clarify state policy on aquaculture and salmon net pens, to clearly define: a) the interests of the State in managing state-owned property and protecting water and aquatic resources; and b) the responsibilities of local governments to exercise land use authority under various state laws, so as to resolve the conflicts that apparently now exist.
2. A properly managed and sited salmon net pen industry can benefit Washington State and local jurisdictions.
3. A state preemptive effort on salmon net pen siting and regulation is an unacceptable option and would only serve to compound an already difficult situation.
4. The state agencies are interested in supporting a net pen industry to be regulated and sited under circumstances that protect water quality and other environmental values. The environmental concerns associated with salmon net pens may be addressed through careful regulation, proper siting, and monitoring.
5. The counties share the state's environmental goals and are vitally interested in maintaining local control over siting decisions. The counties are frustrated by the kind of state review of local decisions that now exists.

Wondering Whatever Happened to the State P.E.I.S. for Salmon Net Pens?

MEC members were among the many individuals who raised serious questions about the adequacy of the state's proposed programmatic environmental impact statement for salmon net pens issued last spring.

Attacked as shallow, incomplete and biased, the P.E.I.S. reportedly has been extensively reworked, and is expected to be released by the first of the year. Stay tuned.

Atlantic Salmon Caught by Puget Sound Anglers

The Seattle Times reported Atlantic Salmon are being caught by sports fishermen in various unlikely locations around Puget Sound, including West Seattle, Bellingham, and two in fresh water streams.

Lee Hoines of the State Dept. of Fisheries is collecting all data on Atlantic Salmon -escapes from fish farms - caught in the state. Muckleshoot tribal biologist Will Sandoval reported fishermen from his tribe have netted a number of Atlantics this year and expressed serious concern that these foreign fish could spread disease or successfully spawn, displacing native salmon.

James A. Metcalf
October 6, 1989
Page 100

6. The state agencies and at least some counties are open to exploring alternatives that may lead to a coordinated state/local approach to salmon net pen siting and regulation. That discussion could include representatives from industry, environment, the tribes, upland landowners and other affected interests.

Although many possible solutions were discussed, the state agencies recommend that we include other affected interests in these discussions before developing specific proposals. Many expressed the need to consider our discussion further and to confer with constituents.

Based upon the foregoing the state agencies recommend that a task force reflecting the interests of the state, the local governments, the tribes, environmentalists, the net pen industry, upland landowners and others be formed as soon as possible for the purpose of tapping the community's expertise in this area and forging a consensus based on the best technical information and consistent with the general principles outlined above. Such a consensus should have the result of providing for a viable salmon net pen industry in Washington State with coordinated state/local regulation and proper environmental safeguards.

We would ask that the various county representatives who attended our meeting last week advise you by October 13, 1989 of their interest in participating in such an effort. If the response is positive, a task force will be formed. Because the legislative session is approaching, time is of the essence. We would appreciate everyone's prompt consideration so that we can get moving on this issue.

We look forward to a constructive and positive coordinated effort.

Sincerely,

Brian Boyle
Commissioner of Public Lands

Joe Blum
Director, Department of Fisheries

Chris Gregoire
Director, Department of Ecology

Alan Pettibone
Director, Department of Agriculture

c Attached List

MEC Grows to 26 Members

It only took a rumor of a salmon pen application to convince some 80 residents of the Eld Inlet area near Olympia to organize and join MEC.

Citizens in other areas have formed action groups and have joined MEC to battle threats to the marine environment. They are - Vashon-Maury Island Citizens, Whiskey Creek Organization on the Olympic Peninsula west of Port Angeles and Colvos Passage Coalition at Gig Harbor.



SEAWEED FIRM "RESTRUCTURED"

American Sea Vegetable, the closely held firm that applied in Skagit County to install the world's largest nori seaweed aquaculture operation is being 'restructured,' according to its president, John Olson.

The original ASV proposal drew national media attention and raised a storm of protest from citizens and environmentalists throughout the northwest from many other parts of the nation when first proposed.

ASV originally sought permits in Burrows Bay and off the northeast shore of Guemes Island for almost 1.7 square miles for its proposed nori cultivation. The Burrows Bay site application was withdrawn and the Guemes proposal eventually reduced to 376 acres in two sections, one on each side of Jack Island, a Nature Conservancy property off the northeast Guemes shore.

ASV operated a "test facility" on the eastern shore of Vashon Island for several years. Aquaculture industry sources indicated the firm's southern Puget Sound operation was not a commercial success.

Mr. Olson was engaged last year by

a Canadian aquaculture firm, Canada West Nori Products, for whom he cultivated nori at Stuart Island that was processed in Victoria.

Canada West president Gordon Smith told MEC that Mr. Olson is no longer associated with his firm. He also stated that his operation is far smaller than the ASV proposal for Washington state, and that he views nori aquaculture as incompatible with settled areas like the ones sought by ASV in Skagit County for nori culture.

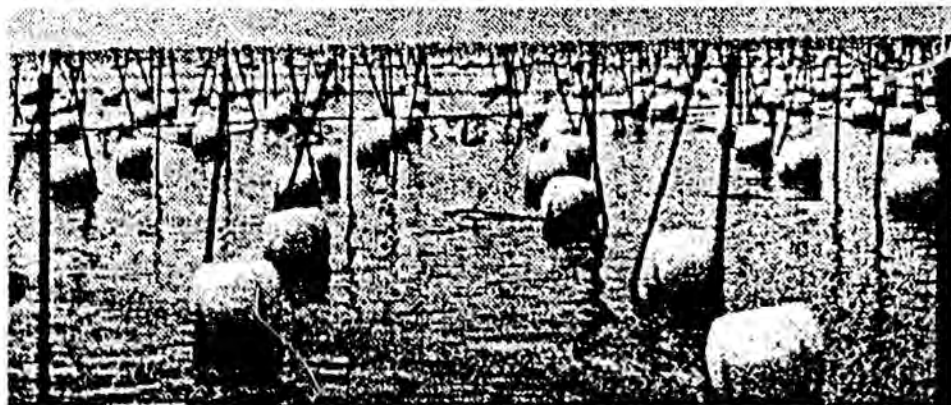
Smith said his firm soon will relocate to a remote section of the

west coast of Vancouver Island to minimize use conflicts.

Mr. Olson's partner in ASV, John Merrill, PhD., has formed a separate company.

Mr. Olson told MEC that despite the reorganization of his company, the application with Skagit County for a seaweed aquaculture project off Guemes will continue.

As of Nov. 1st, Skagit County's Dept. of Planning and Development has yet to rule whether or not the ASV proposal should be required to prepare a site-specific environmental impact statement for this project.



ASV test farm, Vashon Island, 1987

Ms. Laura Demetron
3.E. Alaska Conservation Co.
P.O. Box 021692
Juneau, Alaska, 99802

Camano Cove Association
Blomquist Beach Association
Camano Homeowners Association
Frenchman's Cove Defense Fund
Griffin Bay Preservation Committee
Hood Canal Environmental Council
Holmes Harbor Preservation Association
Kicker Bay Organization
Oak Bay Coalition
North Discovery Bay Association
Save Discovery Bay
South Point Coalition
Save Our Shores
Saragoga Cove Foundation
Save the San Juan
Guemes Island Property Owners Association
Clean Up South Sound - C.U.S.S.
Lone Rock Defense Fund
Whiskey Creek Organization
Eld Inlet Citizens Against Pollution
Colvos Passage Coalition
Vashon-Maury Island Citizens
ORCA
Yukon Harbor Concerned Citizens
Save Port Susan
Fern Cove Environmental Council

M.E.C.
MARINE
ENVIRONMENTAL
CONSORTIUM
P.O. BOX 2688
FRIDAY HARBOR, WA 98250

*Weston's report
initials*

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

School of Oceanography, WB-10

11 September 1987

Ms. Laura Fleming
Senator Eliason's Office
PO Box V
Juneau, AK 99811

Dear Ms. Fleming:

As you requested I have enclosed a copy of my report on the environmental effects of mariculture. I have requested that the Department of Ecology send you a copy of the interim guidelines which I prepared to evaluate the suitability of a site for culture. You may use these guidelines for general information but I should caution you that it may not be appropriate to blindly apply them to Alaska waters without consideration of local conditions.

You had asked about the possibility that the organic enrichment associated with salmon culture would promote the growth of pathogenic bacteria causing disease in local finfish and shellfish. As I indicated this scenario is highly speculative at the present time. We do not have the information to either prove that a risk exists or totally dismiss the concern, but there is no documented case anywhere in the world of such consequences from mariculture development. The same arguments you are now hearing concerning salmon culture could be raised for any other source of organic enrichment in the marine environment including shellfish culture, fish processing operations and sewage discharges. I would think that there would be particularly close parallels with fish processing. If you have found fish processing operations in Alaska to contribute to disease in local stocks and have developed siting or operational restrictions for the industry to prevent such an occurrence, then I think it would be appropriate to apply comparable guidelines to the mariculture industry. However, it is not justifiable to apply more restrictive policies to the mariculture industry, or for that matter, use disease concerns to prohibit mariculture entirely.

I do not doubt that it is possible to overload a marine system to such an extent that disease in native organisms or other types of environmental degradation become a real possibility. The key to avoiding such conditions is proper farm siting and management. A noteworthy aspect of mariculture is that it is in the interest of the operator to avoid overloading the system. The cultured organisms are themselves dependent on good environmental quality, and any degradation will result in a loss of productivity and a decrease in the profitability of the operation. I believe it is quite appropriate to place siting and operational limitations on mariculture or any other industry to protect local waters, but in my view it is indefensible to argue that the industry should be banned entirely because of potential excesses.

I believe you will find a wealth of information in my report and in the references cited. If I can be of further assistance, please let me know.

Sincerely,

Donald P. Weston

Donald P. Weston, Ph.D.

THE ENVIRONMENTAL EFFECTS OF FLOATING MARICULTURE
IN PUGET SOUND

Donald P. Weston, Ph.D.¹

School of Oceanography, WB-10
University of Washington
Seattle, Washington 98195

Prepared for:

Washington Department of Fisheries
and
Washington Department of Ecology

August, 1986

¹ Current address: Science Applications International Corporation,
13400-B Northup Way, Suite 38, Bellevue, Washington 98005

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Acknowledgments

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Ken Chew - University of Washington, Seattle, Washington
David Damkaer - National Marine Fisheries Service, Seattle, Washington
Frances Dickson - Fisheries and Oceans, Vancouver, British Columbia
Marvyn Eddie - Marine Harvest Limited, Edinburgh, Scotland
Magnus Enell - Swedish Environmental Research Institute, Stockholm, Sweden
Richard Finger - Municipality of Metropolitan Seattle, Seattle, Washington
John Forster - Sea Farm of Norway, Port Angeles, Washington
Kunihiko Fukusho - National Research Inst. of Aquaculture, Nansei, Mie, Japan
John Galat - New Haven Salmon Ranch, New Haven, New Zealand
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Ken Honey - Maine Department of Marine Resources, Augusta, Maine
Eric Hurlburt - Washington Department of Fisheries, Olympia, Washington
Akihiko Hara - National Research Institute of Aquaculture, Nansei, Mie, Japan
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Michael Kyte - Ardea Enterprises, Lynnwood, Washington
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Madelon Mottet - Friday Harbor, Washington
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Jack Rensel - Milner-Rensel Associates, Seattle, Washington
Rutger Rosenberg - Institute of Marine Research, Lysekil, Sweden
Barry Uchida - Municipality of Metropolitan Seattle, Seattle, Washington
Dennis Willows - University of Washington, Friday Harbor, Washington
Ron Zebal - Washington Department of Fisheries, Point Whitney, Washington

ABSTRACT

Mariculture, particularly net-pen culture of salmon and suspended culture of shellfish, has grown rapidly in Puget Sound and the potential exists for this growth to continue. This review attempts to assess the probable magnitude of environmental changes that may result from mariculture operations in Puget Sound. The environmental changes which have been addressed can be summarized in four categories. First, there are some adverse changes which are highly probable for most salmon or suspended shellfish culture operations. These would include the accumulation of organic-rich sediments beneath the culture structure, and the consequent effects on the benthic macrofauna community. Secondly, the potential exists for mariculture effects on water circulation, water quality, phytoplankton productivity and the introduction of exotic species. However, the likelihood of these effects and their potential magnitude is highly dependent upon site-specific conditions or the species cultured. Thirdly, there are several issues for which available data are inadequate for a conclusive determination of significance. These include: 1) the environmental effects of antibiotic usage; 2) alteration of the wild gene pool; 3) the capacity for a mariculture operation to serve as a disease reservoir for the infection of wild organisms; and 4) the proliferation of human pathogens in the vicinity of mariculture sites. These potential effects of mariculture have not yet been demonstrated, and the existence of such effects remains largely speculative. Finally, there is little likelihood that mariculture would adversely affect local abundance of fish and megafauna.

Water circulation - A culture structure placed in the marine environment will reduce current velocity in the surrounding area, particularly in the down-current direction. This reduction in current velocity will impair dilution and dispersal of wastes downstream of the culture operation. However, this effect is not likely to be significant except in cases of intensive culturing in an area with very restricted natural circulation.

Water quality - Cultured organisms and culture practices alter the chemistry of the water passing through the culture structure, most notably increasing ammonia concentrations and decreasing dissolved oxygen concentrations. Greater

changes will occur with salmon net-pen culture than with mussel culture, given the relative production capacities of typical Puget Sound facilities.

The concentrations of nutrients and BOD in the water passing through a mariculture structure are generally very dilute compared to most other discharges to the marine environment. Field studies have typically observed little or no changes in water quality outside the culture structure in well-flushed areas. Adverse effects would be anticipated only in areas of extremely limited flushing or very intensive culturing activity.

Phytoplankton - Floating mariculture is unlikely to have a measurable effect on phytoplankton standing stock or productivity in most of Puget Sound. In the Main Basin of Puget Sound nutrients are not limiting to phytoplankton growth. Thus, additional nutrient input attributable to mariculture should have no effect on productivity. Nutrients may be periodically limiting in some vertically stratified area (e.g., Saratoga Passage), however, in many of these areas the dilution of nutrients which would occur prior to their utilization by phytoplankton would probably make any effect on productivity unmeasurable. A localized and measurable effect on productivity would be expected only in highly stratified and poorly flushed areas (e.g., some embayments of the southern Sound) in which the water passing through a culture structure could maintain its integrity with minimal dilution.

Sedimentation - Floating mariculture generates large amounts of solid wastes in the form of feces and unutilized feed (salmon culture) or feces, pseudofeces and shell debris (shellfish culture). These materials are generally deposited in the immediate vicinity of the culture structure. This deposition results in physical and chemical changes to the natural sediments including decreased redox potential, increased sediment oxygen consumption and increased concentrations of total volatile solids, total organic carbon, sulfides, nitrogenous compounds, and phosphates. While there are profound effects on sediment chemistry, and consequently the sediment biota, these effects are very localized. Visible accumulation of solids and the alteration of sediment chemistry typically extends no more than 30 m from the culture structure.

Accumulation of organic-rich sediments occurred around most culture facilities reviewed. The depth of this accumulation depends for the most part upon water depth and current velocity. In general, accumulation of sediments can be

given
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expected beneath any culture facility when less than 15 m exists between the bottom of the structure and the sea floor. Sediment accumulation is possible at even greater depths, but little data are available since few culture operations have been sited in deeper waters.

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Benthic macroinvertebrates - The accumulation of organic-rich sediments beneath culture facilities and the consequent depletion of oxygen in the pore waters results in changes in the infaunal invertebrate community. Loss of species intolerant of organic enrichment (typically echinoderms, crustaceans and molluscs) often occurs. A few opportunistic species, most frequently polychaetes, attain numerical dominance in the community. In cases of extreme organic enrichment, there may be a total absence of benthic macroinvertebrates. Benthic community changes have been typically observed to be limited to an area within about 30 m of the culture structure. These changes can be expected to persist for the duration of culture activities and for at least several years following their cessation.

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Fish and megafauna - Accumulation of organic material in the vicinity of a mariculture operation may result in the loss of nonmotile megafauna (e.g., geoducks) living in intimate contact with the sediments. However, fish and motile megafauna (e.g., crabs) living on or above the sediment surface are typically found in higher densities around floating mariculture structures than in the surrounding area. The attraction of fish and megafauna to the culture area is probably due to increased availability of food in the form of feed unutilized by the cultured fish, the high abundances of opportunistic macroinvertebrates, and epifaunal organisms living on the culture structure or which fall to the bottom.

Introduction of exotic species - If culture operations require the importation of live material into the state, the potential introduction of exotic species probably represents the greatest environmental threat posed by mariculture. Introduced species may establish self-sustaining wild populations, potentially becoming pests or eliminating native species. While there appears to be little risk of this occurring for those species currently being deliberately introduced for culture in Puget Sound, requests for future introductions should be carefully evaluated in this regard.

Accidental introduction of pests, parasites and diseases associated with imported organisms may also occur. Because of this risk the state has placed many restrictions on the type of organisms which may be imported and the steps which must be taken before live material destined for aquaculture may be placed in state waters. The adequacy of these regulations is currently being evaluated.

Diseases - Some concern has been expressed that the culture environment may serve as a reservoir for those diseases which are present in an environment but demonstrating no clinical symptoms in wild fish. There is a fear that the disease organism may proliferate among the cultured fish, become more virulent, and reinfect the wild stocks. However, there is no evidence to indicate that this scenario has ever occurred. The outbreak of a disease is often associated with some form of stress. In the culture environment, fish may be stressed by overcrowding, undernourishment, poor water quality and physical damage associated with handling and confinement. Thus, while fish held in culture are likely to show more frequent appearance of disease than wild fish, disease does not appear to be transmitted to the wild populations.

The bacterial diseases of salmonids in mariculture are not transmissible to humans. However, some investigators have questioned whether the organic enrichment of bottom sediments caused by mariculture could promote the growth of those species pathogenic to humans. Consumption of shellfish collected in the vicinity could then serve as a route for human infection. This is an issue where available scientific evidence is very meager, but experience to date has failed to show cause for concern. Increased bacterial abundance in sediments beneath a mariculture facility is quite probable, but it has not been demonstrated that this increased abundance is of any significance in terms of human health.

Genetic effects - The issue of the genetic effects of mariculture is largely speculative. Cultured organisms may be at a competitive disadvantage with respect to wild individuals. Thus, if escapes and interbreeding with the wild population occur, there may be some temporary loss of reproductive capacity in the wild population resulting from the production of less fit genotypes. The potential magnitude of this effect is dependent upon the proportion of the breeding population comprised of escaped animals.

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The potential consequences of the interbreeding of escaped and wild organisms, if any at all, are unclear. However, for salmonids at least, the potential magnitude of the problem would seem minimal. For decades fisheries management agencies have routinely been transferring hatchery-reared salmonids between river systems to improve commercial and recreational fisheries. The number of fish which might escape from mariculture is negligible in comparison.

Toxicants - Salmon net-pen culture in Puget Sound requires the occasional usage of antibiotics, most frequently oxytetracycline. The potential environmental effects of this usage are minimized by the high water solubility of the compound, rapid dilution with the surrounding water and the infrequency of its use. Although, there is very little information available, the use of oxytetracycline does not appear to be a major problem at the present level of mariculture development in Puget Sound.

Modeling of Environmental Effects

Mathematical models are not yet available which provide reliable a priori estimates of the effect of mariculture on the receiving water body. As a short-term solution, a model is proposed to predict the changes in dissolved oxygen or metabolite concentration only in that parcel of water which passes directly through a culture structure. Since the model neglects the role of dilution by the surrounding water mass, it does not provide a definitive solution to modeling water quality. However, the model may have applications to site evaluation or the determination of maximum allowable culture intensity in a given area.

Sedimentation models would be valuable in predicting the depth and spatial extent of the accumulation of organic-rich sediments around a culture structure. Analytical models which predict this accumulation based entirely on properties of the settling particles and the moving fluid are beyond the current state-of-the-art. Empirical models are limited by site-specificity, but they represent the only modeling approach of immediate utility. A simple empirical model originally developed for net-pen culture of yellowtail in Japan is described. Given field measurements of particle settling velocity and current regime, the model is able to predict the depth of sediment accumulation as a function of distance from the culture structure.

Environmental Regulation of Mariculture

A review of environmental regulations pertaining to mariculture indicates that the policies of Washington State are generally comparable to those of many of the other states and countries surveyed. In general, the potential environmental consequences of mariculture are assessed on a site-specific and case-by-case basis. Applications for mariculture permits are usually subject to a review process which includes an opportunity for the responsible government agencies to evaluate potential environmental effects. There are typically few, if any, formalized criteria with regards to siting and operation.

Importation of eggs or live animals typically requires a permit from the responsible government agency. The permit will carry with it certain conditions which, depending on the particular state or country, may include restrictions on the country of origin, visual and/or pathological inspections, periods of quarantine, or disinfection requirements. Policies governing importation are tending to become more restrictive, and in several countries there is a total ban on the importation of eggs and/or live animals.

Public Report No. 15

AQUACULTURE
and the Administration of
Coastal Resources in
British Columbia

December 1988

Supposedly this
report highlights
how BC resolved
conflicts relating
to mariculture





OVERVIEW

December, 1988

The dramatic increase in aquaculture activity along the B.C. coast in the past few years has brought with it the promise of greater economic growth and stability for many coastal communities; it has also underlined the potential for conflict among the many legitimate and sometimes competing users of coastal resources. This has resulted in a number of complaints to the Ombudsman's office representing a variety of personal, public and commercial interests, and focusing on concerns such as resource use planning, the tenure granting process, environmental safety and conflict resolution. These concerns have caused the Ombudsman's office to prepare this systems study of the regulation of aquaculture in B.C. This report deals with principles of administrative fairness and not with the technical or political aspects of aquaculture, which are beyond the mandate of this office.

Three levels of government are interested in this development: local government is concerned with zoning and planning, the Federal government with navigable waters and fish spawning grounds, and the Provincial government variously with waste management, economic development, and land and resource allocation. Private interests include those of coastal property owners, aquaculture entrepreneurs, sport fishermen and recreational boaters, the tourist industry, coastal forest company operations, and commercial fishing companies and their unions.

The administrative practices and consensual initiatives discussed in this report are intended to assist resource management while avoiding conflict and litigation. Aquaculture is but one use of coastal resources and the rapid growth of the industry has provided the context for a case study of more general resource management principles. Environmental quality is as important to entrepreneurs investing in a vulnerable stock as to conservationists concerned with a vulnerable wilderness: broad and meaningful participation in long-range planning at once satisfies community and individual interests in protecting property, government concern that decisions are based on complete information, and business dependence on a certain and stable investment climate. Integrated management of abundant but finite coastal resources can put different areas to the appropriate and optimum use of each distinct interest, and revitalized coastal economies will help to finance the preservation and enhancement of other interests.

This report concludes with three major recommendations which address the statutory authority for the administration of aquaculture, the integrated management of coastal resources and activities, and the consensual resolution of related public interest disputes.

Stephen Owen
Ombudsman

B.C. Finfish Aquaculture Inquiry

by B.C. "Gillespie Report"
Govt.

David Gillespie, Chairman

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Dec. 12, 1986

SUMMARY OF REPORT AND RECOMMENDATIONS

1.0 Background and Purpose

- 1.1 The one man Commission of Inquiry was established on November 6, 1986 by the government of British Columbia in response to a moratorium on the issuance of finfish aquaculture tenures imposed by the Honourable Jack J. Kempf, Minister of Forests and Lands.
- 1.2 The Inquiry was charged with preparing a report and recommendations to Government within 30 days on the impact of finfish aquaculture on commercial markets and production facilities, the marine environment and wild fish stocks, and on the activities of other interest groups. It was also required to review government approval and monitoring procedures.

2.0 Process and Response

- 2.1 The Inquiry held public meetings in Parksville, Campbell River, Sechelt and Prince Rupert and held private meetings with government agencies involved in finfish aquaculture. Written submissions were also requested before November 30, 1986. A total of 258 submissions were received in the form of letters, formal briefs and oral presentations from government agencies, commercial fishermen, fish farmers, recreational boaters, native groups, oyster growers, and many other interest groups.
- 2.2 A wide range of issues was discussed as a result of the broad terms of reference for the Inquiry. High expectations were created for the resolution of the these issues.

3.0 The Issues

- 3.1 A number of issues were identified which pervaded the entire range of discussion. These were the extent of government support and control for finfish aquaculture, the moratorium on issuance of land tenure, public knowledge of the industry, and the involvement of native groups within it.
- 3.2 Major marketing issues identified were the impact of the salmon farming industry on prices of wild catch salmon; its impact on market demand and supply; its effect on existing fish processing facilities; its employment impact; and the need for fish marketing strategies and research.

see back

- 3.3 Major environmental issues raised by the Inquiry were disease transfer between fish, genetic alterations, fish predator control, the use of toxicants and pharmaceuticals in finfish aquaculture, the health and safety of farm workers, and the impact of fish farming on water quality and the marine environment.
- 3.4 Agency approval issues addressed during the Inquiry were: the proliferation and abuse of Section 10 licenses; foreign ownership in the industry; inadequate consultation with interest groups; local government involvement in approvals; the length and complexity of the approval system; production plans and diligent use enforcement; and inadequate rental and bond requirements.
- 3.5 Issues involving conflicts of fish farming with other land and resource users were also identified. These were: the need for coastal planning studies; the loss of anchorage and access; impact on local residents; physical obstructions to the fishery and navigation; the size and spacing of fish farms; its effects on the recreation and tourism industry; and the involvement of fishermen in fish farming.
- 4.0 Recommendations to Provincial Government
- 4.1 Continue support for the finfish aquaculture industry.
- 4.2 Develop a provincial aquaculture policy which clarifies provincial direction, agency roles, and the responsibilities of both government and the private sector for the industry.
- 4.3 Establish an aquaculture advisory council from key agencies and interest groups.
- 4.4 Continue to encourage private sector initiatives as the basis for growth and development of the finfish aquaculture industry.
- 4.5 Proceed immediately to establish a master agreement with the federal government respecting approvals, regulation, monitoring and servicing of the finfish aquaculture industry.
- 4.6 Support greater cooperation with local government in promotion, planning and approval of finfish aquaculture.
- 4.7 Affirm and maintain a commitment to the federal-provincial Salmonid Enhancement Program, Phase 2.
- 4.8 Lift the current moratorium on the adjudication of applications for finfish aquaculture sites.
- 4.9 Expand public information programs to provide a broader range of services and information access.

- 4.10 Encourage a formal communication link between the commercial wild fishery and finfish aquaculture associations.
- 4.11 Endorse federal initiatives to increase native involvement in finfish aquaculture development.
- 4.12 Encourage the finfish aquaculture industry to involve native peoples in the industry.
- 4.13 Ensure that current aboriginal land claim negotiations do not influence government policies and procedures respecting issuance of finfish aquaculture tenures.
- 4.14 Recognize native bands as legitimate interest groups in the land referral and tenure process.
- 4.15 Continue to rely upon market forces to dictate farm and wild salmon prices.
- 4.16 Support a strategy for the integrated marketing of B.C. farm and wild salmon products.
- 4.17 Promote use by the aquaculture industry of existing processing plants and infrastructure developed for the wild fishery.
- 4.18 Increase support for research and studies on the potential long-term effects of salmon farming on the marine biological and physical environment.
- 4.19 Establish a mandatory environmental monitoring and data gathering system for each aquaculture site and surrounding area, the results of which should be submitted on a regular basis for review of changes in environmental quality.
- 4.20 End the importation of Atlantic salmon eggs.
- 4.21 Continue the use of a distance guideline to separate fish farms, and apply this guideline to separate fish farms from shellfish aquaculture operations.
- 4.22 Establish, in conjunction with industry, environmental practices for fish farms addressing aesthetic considerations, disposal of dead fish and human waste, predator control, and efficient feeding practices.
- 4.23 Increase research, health inspection and testing activities with respect to the impact of toxicants, hormones and antibiotics used in finfish aquaculture on the environment and the human food chain.
- 4.24 Support (with industry) the development and operation of an aquaculture research centre as a focus for environmental studies, disease research, fish testing and diagnostic services.

- 4.25 Encourage establishment of standards for finfish aquaculture equipment to remove the potential for accumulation of toxicants in farm fish products.
- 4.26 Undertake a review of the occupational environment of finfish aquaculture operations to ensure appropriate regulations for occupational health and safety are in place.
- 4.27 Initiate a program of coastal resource identification studies for use in directing aquaculture applications away from major resource and user conflict areas.
- 4.28 Initiate coastal resource identification studies immediately for the Campbell River-Johnstone Strait, Islands Trust, and Sechelt Inlet areas with direct involvement of all resource user groups in those areas.
- 4.29 Discontinue issuance of aquaculture tenures adjacent to provincial parks and recreation areas.
- 4.30 Encourage local governments to develop or refine local zoning bylaws to address finfish aquaculture operations within their boundaries.
- 4.31 Utilize a minimum distance separation guideline for fish farms in populated coastal areas as a means of reducing impact on upland owners and other resource users.
- 4.32 Encourage the aquaculture industry to institute a program to provide anchorage, access, and emergency assistance to other coastal resource users.
- 4.33 Continue use of the interagency referral system as a primary tool for conflict resolution.
- 4.34 Expand the list of referral groups, increase the time available for response, and establish subsequent notification practices for finfish aquaculture referrals.
- 4.35 Establish an agreement between the provincial Lands agency and federal agencies respecting siting of tenures, information requirements, documentation of concerns, and importance given to referral comments.
- 4.36 Review the provincial lands agency practices involving advertising and notification for prospective finfish aquaculture operations.
- 4.37 Place greater emphasis by the provincial Lands agency on local government input to the finfish aquaculture referral process.
- 4.38 Remove requirements for cost, husbandry, production and harvest strategies from its fish farm production plan.

- 4.39 Establish minimum fish production levels and environmental quality standards for use in measuring diligent use, and increase site monitoring and inspection activities.
- 4.40 Expand production plans for site and improvement locations to include the demarcation of public use and access requirements.
- 4.41 Establish a priority system for the production plan process to accommodate review and approval of significant plan revisions necessitated by disease outbreak, tenure assignments, and other factors influencing tenured operations.
- 4.42 Continue use of Section 10 of the Land Act to authorize investigations for finfish aquaculture.
- 4.43 Require a commitment bond to accompany all finfish aquaculture applications.
- 4.44 Revise rental rates and clean-up bond requirements for finfish aquaculture tenures.
- 4.45 Review and expand the legal tenure documents for finfish aquaculture.
- 4.46 Maintain the present provincial agency approval framework.
- 4.47 Clarify and focus the role of the Ministry of Agriculture and Fisheries as lead provincial agency.
- 5.0 Report Implementation
- 5.1 The report should be reviewed by all provincial government ministries with responsibilities for implementation of its recommendations.
- 5.2 Implementation of recommendations should be done in a coordinated manner and over as short a time period as possible.
- 5.3 Adjustments to the government approval process and the preparation of coastal resource identification studies should be performed over the same time frame.
- 5.4 Finfish site applications filed before October 31, 1986 should be allowed to proceed under existing policies and procedures. Those received after the October 31 moratorium should be subject to new policies, procedures, and resource study restrictions as they fall into place.
- 5.5 The recommendations should be considered for their applications to other forms of commercial aquaculture.



THE REPORT OF THE
SUZUKI FOUNDATION
FACT-FINDING TOUR
ON FISH FARMING
IN NORWAY
APRIL, 1988

JOURNEY to the FUTURE

By
**Geoff
Meggs**



THE FUTURE of the fish farming industry, with its promise of great profit for farmers and grave peril for wild fish resources, is being foretold in three Norwegian laboratories.

In Oslo, veterinarians perform autopsies on farmed salmon, seeking signs of the ever-more prevalent diseases that have battered the industry during the past three years, precipitating multi-million dollar lawsuits and the slaughter of thousands of tonnes of fish.

In another laboratory, in Trondheim, a scientist watches over the frozen sperm of Norway's dwindling wild salmon stocks, gathered here as insurance against farm-borne parasites and genetic pollution which he fears could exterminate the wild stocks forever.

And in a third laboratory, at the Austevoll research station near Bergen, Canadian scientist Karin Pittman peers daily into the gloom of a saltwater-filled silo, watching newly-hatched halibut larvae move like specks of dust through a dim column of light to seek food.

Veteran halibut fisherman Wayne Patterson peers into the holding tank for the world's first farm-raised halibut in Austevoll, Norway. Norway is moving aggressively to farm new species in a research effort aimed at transforming fish production.



Salmon fry, seen here about twice life-size, emerge from their eggs in a hatchery tray.

No licence is granted in Norway where 'it will cause risk of the spread of disease among fish or shellfish'

DISEASE

the struggle to conserve wild stocks and the unflinching drive to smash the biological barriers to fish farming are the recurring themes in Norwegian aquaculture. They are played out against the backdrop of the country's salmon farming miracle, which parlayed surplus eggs from a few hundred depleted Atlantic salmon runs into an industry which employs 5,000 and will produce 70,000 tonnes of fish in 1988.

But as eight British Columbians found on a recent two-week fact-finding tour, the aquaculture breakthrough has not been without cost. We had come to find the answer to a single question: is salmon farming threatening Norway's wild salmon resources?

The answer is yes. We found a country which is fighting farm-borne parasites, disease and genetic pollution to save its wild stocks from extinction. A sign of the desperation: the tiny commercial salmon fishery will be closed forever next year unless Norway's powerful fishermen's organizations can win yet another delay.

We found a country with many similarities to our own, including deep ocean fjords, strong coastal communities and a burning need for economic development.

But we found vast differences as well. Unlike B.C.'s salmon farmers, who have opposed any move to strict regulation, Norway's industry is demanding a freeze on further expansion until stronger measures are in place to assure fish health.

Unlike B.C.'s government, which has insisted that the industry should be regulated only by market forces, Norway's government intervenes directly to control the growth of aquaculture and to direct its development.

Most important of all, we found a country which by our standards has already lost the fight to save the wild salmon. Norway harvests only 11,600 tonnes of wild salmon a year from its 400 streams, a tiny fraction of the 100,000 tonnes taken annually from B.C.'s waters. Nonetheless, Norway's salmon legislation starts from the assumption that protection of the environment and wild stocks must be the top priority.

British Columbia, like Norway, has a salmon farming industry. Unlike Norway, it has a vast wild salmon resource

It was Cameron who had joined several other fishermen in 1986 to protest the issuance of fish farm leases in commercial fishing areas, contrary to government pledges. This protest led to the 1986 moratorium on fish farm licences and a brief commission of inquiry.

But the Gillespie Report, which was produced without testimony from Norwegian experts, ducked the fundamental issues of the environmental impacts of salmon farming.

As rumours and reports of environmental and disease problems trickled in from Norway, Cameron's fellow-fishermen proposed a trip to Norway to settle these questions once and for all.

The UFAWU endorsed the idea and asked the Suzuki Foundation to organize the trip. Union locals raised almost \$10,000 toward the cost of sending five delegates. They included Cameron, troller Dan Clark, of Nanaimo, shoreworker Arnold Nagy, of Prince Rupert, longliner and purse seiner Wayne Patterson, of Vancouver, and union organizer Dennis Brown.

Joining the union group were Will Soltau, a vice-president of the Pacific Trollers Association, and Edith Iglauer Daly, a journalist from Pender Harbour who was on assignment for *The New Yorker*. Soltau is the commercial fishermen's representative on the province's Aquaculture Advisory Committee. As editor of *The Fisherman* and secretary of the foundation, it was my job to organize the tour.

The group left April 11. The questions seemed simple: could disease spread from farmed fish to wild? Is there a danger of genetic pollution of wild stocks by farmed fish? Is pollution from fish farms a threat to the marine environment?

The answers proved fairly easy to find. Issues that are the subject of bitter debate in B.C. are largely settled in Norway, where authorities are drafting ever-more restrictive regulations to safeguard against fish disease.

If B.C.'s salmon farming industry is in its infancy, then Norway's is a teenager, confronting problems of massive growth. Markets may soon be a problem for Norway's fish farmers, but today the main effort centres on disease control. Again and again in the days that followed our arrival in Oslo, we had the uneasy feeling of seeing glimpses of the future.

Patterson holds a preserved sample of the first halibut to be raised from egg to fish at the Austevoll research station. Cod at the station have been trained to answer a dinner bell, eliminating the need for fishermen.



GEOFF MEGGS PHOTO

capable of increasing its production several times over. Yet it is in Norway, not B.C., where government and industry are joining hands to safeguard and husband the source of all the salmon industry's wealth: the wild salmon.

THE B.C.

delegation to Norway was organized by the T. Buck Suzuki Foundation, the environmental organization founded by the UFAWU in 1981. Among the participants was Jim Cameron, a Sunshine Coast gillnetter who had witnessed the explosion of fish farming firsthand.

THE STATISTICAL

story of Norway's explosive fish farm growth, the story brought home by a dozen government and industry groups, is an impressive one. From a modest office building in downtown Oslo, only a few hundred yards from the port and the ancient fortress of Akershus, the Norwegian Royal Ministry of Fisheries manages both traditional fisheries and the aquaculture industry.

Kari Bjorbaek is head of the ministry's aquaculture section. Only 10 years ago, Norwegian farmers were producing only 4,000 tonnes of salmon annually. Today the figure is 12 times that, with harvests expected to reach almost 90,000 tonnes this year and 120,000 by the early 1990s.

Under Bjorbaek's supervision are 611 smolt production plants with a capacity of 183 million smolt per year serving 728 farms with a capacity of five million cubic metres.

The export value of Norway's farmed salmon is more than \$400 million a year. That figure alone convinces Canadian politicians that we need as much farming as possible as soon as we can get it.

But Norway is in no hurry to expand its production. Bjorbaek told us in a morning-long briefing April 14. Although the Norwegian Fish Farmers Association favors a 50 percent increase in farm capacity, to 12,000 cubic metres from 8,000 cubic metres, much of this increase would be used to reduce stocking densities to curb disease.

"Any increase in capacity has not been decided upon yet," Bjorbaek said, "and we have issued no new licences since 1985."

"We are working to improve the quality of farmed fish and to control disease."

In fact, disease control is considered a prerequisite for success in a special report on aquaculture to the Storting, Norway's Parliament.

The existing licensing legislation already requires that no licence be granted where it "will cause risk of the spread of disease among fish or shellfish, will cause risk of pollution (or) has a distinctly unfortunate location in relation to the surrounding environment, lawful traffic or other exploitation of the area."

Now the ministry is proposing even tougher rules on licensing with provisions to tighten disease protection, increase protection for other marine users and to increase participation by women.

Can disease spread from farms to wild stock? The possi-

JOURNEY to the FUTURE



SEAFOOD FROM NORWAY PHOTO

bility will always be there," she replies, "but in the wild stock you can't always notice disease because the fish go to the bottom. We have taken steps to ensure the existence of the wild stock."

Bjorbaek and her staff are optimists. Despite the 1985 outbreak of Hitra disease, a cold water vibriosis or infection which forced the destruction of large numbers of fish, they believe disease can be controlled.

In a recent status report on Norwegian aquaculture, Bjorbaek reported that Norway's "main strategy has been and still is to prevent the spread of communicable diseases through a close monitoring and through strict rules, particularly in relation to hatcheries."

"In spite of this we have had serious outbreaks of various diseases. All our efforts so far have been directed at disease control and only recently have we instituted programs for disease prevention. With the development of new vaccines, we feel confident that we are on our way to tackle these problems."

ACROSS OSLO

in the laboratory of the National Veterinary Institute, director Trygve Poppe is not as confident that disease problems can be resolved.

"Diseases have a very heavy impact on the industry," he says. Norwegian specialists are encountering signs that some diseases are becoming resistant to antibiotics. Each year produces new strains of disease that must be countered.

"As early as 1966 we already had disease imported from Denmark," he told the delegation. "Legislation was passed in 1968 and regulations came in on June 1, 1969. Now we are planning even more comprehensive legislation."

The Veterinary Institute, under the Ministry of Agriculture, is the front line in the war against disease, but also is considered by its critics to be the main chink in Norway's armour.

Although exceedingly conservative, the institute succumbed to industry pressure in 1985 to permit the importation of salmon smolts from Scotland that carried in furunculosis with disastrous effects. About 20 farms had their stocks destroyed without compensation.

Critics contend the institute was lax in allowing the import of eggs from Sweden which some believe carried in the parasite *Gyrodactylus salaris*, a devastating freshwater disease that is crippling wild salmon streams.

Farmers who lost their stock to furunculosis or the control measures are suing the government for 125 million kroner, about \$25 million, in a case that will have tremendous repercussions for the industry.

Today, however, Poppe and his colleagues are more concerned with drafting even tougher regulations on the move-

Despite disease problems, Norwegian salmon farmers are heading for 120,000 tonnes of annual production.

Strict government regulations control use of antibiotics, but farmers are demanding 100 more fish veterinarians before any more farm licences are issued.



GEOFF MEGGS PHOTO

Trygve Poppe, of the national veterinary institute, confirms fish disease moves from wild stock to farmed and vice versa. He wants farmers to breed for disease resistance, not just quick growth.

The tour organized by the T. Buck Suzuki Foundation lasted two weeks and included (left to right) Wayne Patterson, Jim Cameron, of Pender Harbour, journalist Edith Iglauer Daly, of Pender Harbour, union organizer Dennis Brown, shore worker Arnold Nagy, of Prince Rupert, troller Dan Clark, of Nanaimo and troller Will Soltan, of Sointula, also a director of the Pacific Trollers Association.

ment of eggs and fish. On his laboratory slab he has farm samples with distinctive bruised flesh and diseased organs typical of Hitra disease. "The bacteria are humming so loud in there you can almost hear them barking," he remarks.

Control of fish disease is a costly and prolonged process. Furunculosis imported on rainbow trout and transferred to Atlantic salmon in a Norwegian river in the 1960s persisted until 1977. There are worrying signs of other problems.

"BKD is increasing in two Atlantic salmon rivers," Poppe says, "and in one case we have escaped farmed fish."

By B.C. standards, Norway already deploys an army of veterinarians against the disease threat. Sixty veterinarians deal only with fish disease and between 100 and 150 work on fish around the country.

But the salmon farmers association has demanded a freeze on the issuance of further licences until at least 100 more full-time fish health specialists are in the field.

Last year, use of antibiotics rose 170 percent in Norway to 40 tonnes. The increase is disturbing when you consider that use of antibiotics is illegal unless approved by a government veterinarian. Fish may not be moved to market until nine weeks after treatment ends and must again be inspected to confirm the antibiotic is no longer present in the flesh.

"More emphasis should be put into breeding a healthy salmon," Poppe says, "rather than a fast-growing, late-maturing salmon."

"To some extent the salmon farmers have tried to breed for disease resistance but we see every day they have more and more diseases. Obviously, the Atlantic salmon is very vulnerable to disease. We see new diseases coming up all the time."

Are there other solutions? Poppe favours increased capacity on each farm to reduce the density of the stocks, which produces a "fish soup in which it is very easy for disease to spread."

But more drastic are proposals to monitor and regulate the movement of all eggs, smolt and fish. To protect wild salmon streams from genetic and disease threats, large areas of the coast would be declared "security zones" free of farming activity. Finally, Norway would be divided into a number of regions and transfer of live fish from one to the other would be strictly controlled or banned.

It's strong medicine, too strong even for Norway's regulation-minded fish farmers.

TRONDHEIM

situated on a fjord just above the western bulge of Norway's coastline, is the business heart of the Norwegian fishing industry. Here, in a few square blocks, are the offices of Norges Fiskarlag, the country's fishermen's organization, the Norwegian Fish Farmers Association (NFFA), the Norwegian Fish Farmers Sales Organization (NFSO) and a host of other sales organizations for other fish products.

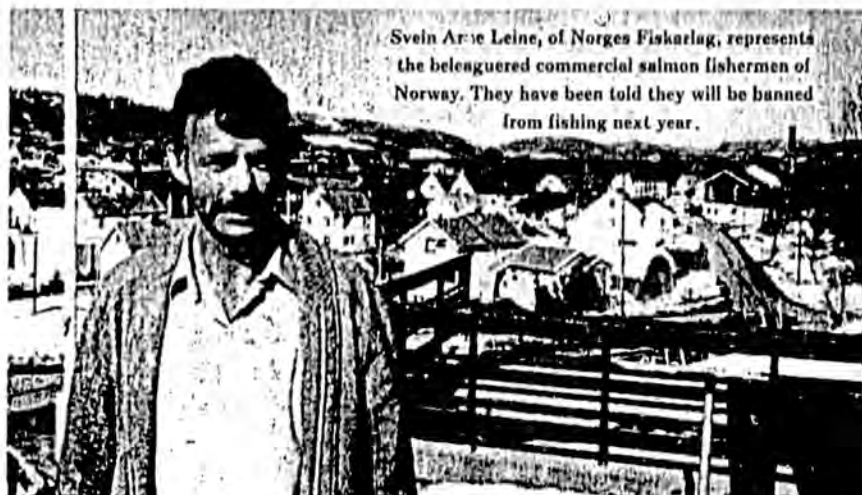
A measure of the difference between Canada and Norway is the fact that Norges Fiskarlag and the Fish Farmers Association requested that the Canadians meet them together.

"We consider them like our little brother," says Torleif Paasche, organizational director of Norges Fiskarlag. At his side is Anne Beriby, secretary of the Norwegian Fish Farmers Association. "Because we have had such a controlled development, we have had a positive relationship," he explains.

Not quite a union, but more than an association, Norges Fiskarlag is backed in its work by national legislation. With more than 19,000 members, it acts on behalf of fishermen coast-wide in 500 local fishermen's associations. Its elected



GEOFF MEGGS PHOTO



Svein Arne Leine, of Norges Fiskarlag, represents the beleaguered commercial salmon fishermen of Norway. They have been told they will be banned from fishing next year.

GEOFF MEGGS PHOTO

Fish farmers support new policies to avoid local conflicts over water use because 'the world wasn't empty when fish farming came.'

board has the sole right to negotiate on behalf of fishermen on economic issues, including fish prices.

Norwegian fishermen are more concerned with allocation issues, pollution from British nuclear power stations and the strength of stocks than with the impact of salmon farming, Paasche says.

The massive cod fishery, for example, produces almost 25 percent of the country's billion-dollar fish landings annually. "A major problem is the balancing between the capability of the fleet and the resources to keep ahead of natural conditions of the fisheries," Paasche says, "how to mix capacity so you don't overfish."

In the case of the salmon fishery, this balance has been fatally disrupted. Proposals to curb commercial fishing and increase regulation of fish farming to protect the depleted wild stocks have united farmers and fishermen in opposition, as well as their common base in coastal communities. This distribution of farms throughout the coast is the result of government licence controls.

Depletion of the salmon must be traced in part to environmental problems like acid rain, Beriby and Paasche agree, as well as the poor husbandry and hatchery practices of river owners, who control salmon streams in Norway.

"The environment department seems to blame fishermen and fish farmers for the problems," says Beriby, "but so many other things could be responsible. They have no evidence except their environmental arguments. We seem to represent something dirty because we are trying to earn money."

Seine fishermen near Trondheim on the island of Hitra — which later gave its name to a salmon disease — pioneered fish farming, Beriby explained, but did not make great strides until they created a sales organization in 1978 to manage their marketing.

The success of the industry "is based on small-scale farms and people willing to share their experience," Beriby explains. "Farming has meant a lot to the coast — at least 5,000 jobs."

At the same time, Beriby says, Norway's "strong laws have been important to success. There are a lot of things we can do and cannot do."

The Fish Farmers Association is opposed to more licences being issued before an even stronger national infrastructure — vets, roads, higher education, research — have been in place. "If they want more licences, they must put in more resources," Beriby says.

The FFA supports local ownership and new policies to avoid conflict with other industries. "The world wasn't empty when fish farming came. We had conflicts with seine pounds and some local conflicts, but we are ensuring now that every community makes its own coastal plan."

Disease is always a concern, she agrees, "but disease is a problem both for wild stock and farmed fish. Diseases exist in wildlife but you don't see it because the fish simply die. Fish farmers are the first who want to get rid of disease."

For this reason they support the minimum 10-kilometre spacing between farms, the requirement for two locations to allow rotation, the regular inspections and the stringent controls on disposal of dead fish.

Vaccination is helping to curb disease, but the real problem, Beriby says, is "education. We need to get results out to fish farmers." Disease outbreaks like furunculosis, she points out, can be traced to imports done under government permit.

Has the relationship always been so friendly? "The need for access to coastal areas has been the most important area of conflict," Paasche says. Where fishermen pond herring or saithe is often where farmers wish to locate.

"The disease question is more troubling in the long run," he adds, "because we are developing a kind of monoculture of the ocean."

Ultimately "the production of wild salmon is so small that

it's not a question of competition between the two," says Paasche. "There will always be some market niches for wild salmon."

Will this attitude change when large-scale production of cod and halibut begins in a few years? It is too early to say.

Beriby has little trouble explaining the merits of salmon farming. She falls silent, however, when it comes to the Norges Fiskarlag demand for a continued gillnet fishery for wild salmon.

This strange friendship between salmon farmers and the commercial fishermen is even more starkly outlined two days later in the tiny coastal community of Kyrksaeterora, where the last of the salmon fishermen live next door to the largest salmon hatchery in the world.

SOUTH OF

Trondheim lies the community of Kyrksaeterora, tucked in the valley at the head of a large fjord. At the town's back is a large freshwater lake which feeds the Harga River, a salmon stream whose water helps run the massive hatchery of the Norwegian Fish Farmers Sales Organization before emptying into the sea.

Further to sea and to the south are the remote fishing villages where most of Norway's remaining salmon fishermen make a precarious living on salmon and other species.

The depletion of Norway's rivers is hard to understand when set next to the huge hatchery, capable of producing 5,000 litres of eggs annually, about twenty percent of the nation's requirements.

As hatchery director Knut Gunnes takes the Canadians through his facility, he emphasizes the role the hatchery plays in genetic improvement of farmed stock.

Launched with donated eggs and then developed into the



GEOFF MEGGS PHOTO

Technicians at the Kyrksaeterora hatchery sort trout from salmon. This enormous hatchery produces broodstock eggs for the fish farming industry. It certifies them disease-free and undertakes selective breeding programs for improved market characteristics as well as disease-resistance.

largest plant of its type in the world, the hatchery allows the farmers to centralize breeding and ensure replacement stock in case of disease losses.

"Our objectives are better growth, feed utilization, later maturing and good disease resistance," Gunnes says. "Disease resistance is the most important goal we see."

Cleanliness is strictly observed in the hatchery. Before eggs are allowed into production, parent fish are examined for any sign of disease. If any is found, the entire stock is slaughtered.

For competitive reasons, the farmers wish to lead the world in selective breeding, seeking fish with better shape and fat content as well as disease resistance. Owned by a company controlled by the sales organization, the hatchery is financed by money taxed from the sale of farmed fish.

So far, growth rates in the farmed fish have been improved by three percent a year, thanks to genetic selection. In outdoor tanks the parent fish of future generations wait their turn. In a nearby seapen operation, other stocks are being grown to maturity.

Domestication of salmon still is several generations away, Gunnes believes, but the latest product is already very tame. Three generations ago, for example, fish could not stand densities greater than eight kilograms per cubic metre for young fish. Now experimental densities of 200 kilograms have been achieved and 20 kilograms is common.

(Lower densities are being used for adult fish to avert disease problems.)

At Gunnes' side is Odd Ustad, public affairs director for the Fish Farmers Sales Organization. At our request, he has invited the local representative of Norges Fiskarlag, Svein Arne Leine, to come to lunch to explain his members' fight to save their remaining wild salmon fishery.

And so Leine, a fisherman himself, sits down in a restaur-

JOURNEY to the FUTURE



GEOFF MEGGS PHOTO

rant overlooking the fjord and the farmers' hatchery to tell how 1,600 Norwegian fishermen are fighting to save their way of life and their communities.

Although always a small fishery, the Norwegian industry gained importance in the 1960s with the development of a gillnet harvest between the baseline and the 12-mile limit. Despite competition from the high seas driftnet fishery and the wealthy sport fishermen working the rivers, the fisherman built their industry in the face of strict regulations and licensing requirements.

But a full 10 years ago, Leine explained, the river owners began campaigning for a halt to the ocean fishery. For centuries, farmers and land owners along river banks have leased fishing rights, often to wealthy foreigners.

As pollution, dams and overfishing drove down catches, they engaged in amateur hatchery work and soon became convinced that they owned all the fish produced by the rivers. They found unlikely allies in the national environment ministry, which saw closure of the commercial fishery as the only sure way to assist the declining stocks.

Although most fishermen harvest salmon only part-time, this income is so crucial "that they may have to stop fishing and find other work if the closure is approved," Leine says. Especially hard-hit are the people on a nearby island, whose community could be wiped out if many are forced to leave.

"Fishermen say pollution is the reason for the decline of the wild salmon," Leine said, "but we are opposed by 200,000 to 300,000 sport fishermen. We are a little group against the rest."

The sport fishermen, often foreigners, are prepared to pay staggering sums to the river owners. Ustad, himself a sport fisherman, had good catches last year on 200 metres he leased for about 600 dollars. For that amount he was allowed to fish both sides of the river on alternate days for June, July and August.

Because the run was good, this year's fee has risen to almost \$18,000. "Common people can't do it," Ustad says. "It's for rich people and people from abroad, who come in by charter planes."

"The closure is simply to provide more fish to rich fishermen on the rivers," says Leine. "Very little is done to stop the driftnet fishery at the Faeroe Islands."

Under the circumstances, Leine has little complaint about salmon farming, although he says his members "are a bit afraid of disease moving from farmed fish to wild fish." Some have lost fishing grounds to farm leases.

"If we manage the pollution and parasite problems properly there is a very positive future for the wild salmon in Norway," Leine says. "But a stop to the commercial fishery now means a stop forever."

The government may offer a compromise, he believes: a freeze on licences and a 10-year phase out of the fishery coupled with complete closures immediately in some areas.

Who are these bureaucrats who have driven farmers and fishermen into a united front? The ministry is called the Directorate for Nature Management, Norway's national agency charged with the protection of wild salmon.

Salmon fry wriggle in a tank at Kyrksaeterora. Fish from about 60 streams have contributed to the gene pool at this hatchery facility. Duplicate government facilities insure the industry against loss of this broodstock to disease or any other calamity.



Norway's long coast, warmed by the Gulf stream, make for ideal farming conditions. Government regulations have forced even distribution of farms around the coast. New regulations will close many inside waters to salmon farms to safeguard wild stocks.

Svein Aage Mehli, head of Norway's Directorate for Nature Management, is responsible for protection of wild salmon stocks from farm-borne parasites and genetic threats. His department is urging the creation of "farm-free" zones and stringent controls on the movement of salmon eggs and smolt.

wild salmon, which Norway treats almost as an endangered species.

Yet it is this small agency which leads the world in researching the impact of salmon farming on natural stocks. Their findings make grim reading.

Svein Aage Mehli, the youthful head of division for salmon, stands guard over about 400 streams, the largest of which produces only about 100 tonnes of salmon a year in the river itself. In many streams the catch is measured in kilograms.

"The catch and spawning population of wild salmon has been relatively stable," Mehli says, "but overall there is a decline in wild stocks."

Part of the reason for the apparent stability is the growing number of farmed fish escaping to nearby streams, which may contribute up to 10 percent of the catch. Undermining the totals is a harvest of up to 600 tonnes annually off the Faeroe Islands, where Denmark operates a drift gillnet fishery that takes between 30 and 40 percent of the total catch of Norwegian stocks.

Mehli's first target in his battle for the salmon is the commercial fishery, which he firmly states will end in 1988. The offshore driftnet fishery, which takes up to 90 percent of some runs, is beyond reach. Sport fishermen will see curbs to the use of gillnets in their sport fishery for mackerel, but otherwise will be left to enjoy themselves.

Also out of reach for the time being is the threat of acid rain. Concentrated in the spring freshet, the acid waters of Norway's mountains "kill very efficiently," Mehli says, when they strike overwintering eggs. Despite a costly program of liming certain rivers, losses of 100 to 200 tonnes annually are blamed on acid rain.

But the greatest threat of all, according to Mehli and his colleagues, is the threat of genetic extermination due to the mixing of stray farmed fish with wild stocks. Genetic straying and farm-borne parasites are ravaging wild salmon streams.

Per Ivar Bergan, executive officer in the directorate, lists four main environmental conflicts between fish farms and wild stocks:

- farms compete for stream water to run their smolt production facilities, reducing areas for spawning in the river, drawing down reservoirs and preventing the migration of anadromous fish;
- diseases and parasites, a big problem for the farmers, can be carried on escaped fish and "spread the diseases to the wild stocks;"
- fish farmers, fearing their stocks will contract diseases from wild fish "have tried to get rid of the wild fish" migrating into their water supply; and
- a lot of fish escape.

"We are very concerned about the genetic effects on the wild stocks of Atlantic salmon and the risk for spreading of new species," Bergan concludes.

Is there evidence of escaped fish actually spawning? "We have no direct evidence production is going down in these streams (due to mixing of farmed and wild fish)," Bergan



GEOFF MEGGS PHOTO

BY CANADIAN

standards, the 130-member directorate, with an annual budget of only \$40 million, is a small institution to handle and entire coastline's environmental problems. Only a fraction of the directorate's research staff handles the management and conservation of



Norway has undertaken the task of 'saving' salmon rivers from farm-borne parasites by stripping them of fish life with pesticide and then restocking with hatchery fish



Gyrodactylus salaris is the scientific name for this one-millimetre long parasite. Only one is required to reproduce and these parasites breed by the thousands, attack juvenile salmon, and kill them. Introduced by river stocking from an infected fish farm, the parasites can only be removed by poisoning the host stock with rotenone.

replies. "But we have no time to wait for evidence. Then it will be too late."

From the viewpoint of the directorate, there is an undeclared war between farmers and the wild stocks. "The farmers are very afraid of wild fish in their intake," Bergen continues. "Some have tried to use so much water that the natural fish can't come up. Some others have used rotenone to get rid of wild fish."

"Some even oppose restocking programs for fear of disease on the wild fish."

Rotenone has been a weapon on the side of the environment department as well. Mehli has undertaken the demoralizing task of "saving" salmon rivers from farm-borne parasites by stripping them of fish life with the pesticide rotenone and then re-introducing hatchery stock.

Less than a millimetre long and common in some Swedish rivers, the parasite *Gyrodactylus salaris* is believed to have entered Norway in a truck carrying salmon smolts. Once established in a Norwegian hatchery, they were distributed throughout the country, in many cases for stocking of rivers.

A recent scientific review of the *Gyrodactylus* story concluded that the most likely explanation for the parasite infestation is that it is "a new parasite to our fauna, which has been introduced through stocking with salmon parr from infected hatcheries/fish farms."

"Evil tongues have said if you are going to design a strategy for spreading disease in Norway, the current system is very effective," Mehli says drily. "If a disease is introduced, we see a rapid spread over the country."

This parasite is particularly mobile. Researchers believe hatchery stocking and movement of escaped farmed fish may be the most likely cause of dispersal, but it could be transported on wet sport fishing equipment or even by birds.

Gyrodactylus was discovered in Norway in 1975, when researchers noticed a sharp decline in the number of smolts in the Lakselva River. A 10-year program of research confirmed the correlation between the presence of the parasite and a single infected hatchery.

"I don't say the parasite causes the infection, but it is reasonable to see a connection," Mehli concludes.

Capable of producing several generations from a single individual, the parasite pierces the skin of the smolt and sucks its blood. Thousands may attack a single fish, killing by infection or dehydration if not from loss of blood. From its first location, the parasite has spread to 30 rivers.

In a single cycle, salmon production may drop from more than 100 tonnes annually to almost nothing. The parasite is blamed for a 300-tonne per year drop in Norway's salmon catches.

Because *Gyrodactylus* survives only on salmon in fresh water, the counterattack must focus on the river. Rotenone has now been used on three of the streams.

"It's a tough treatment," Mehli says, "but this is the only method we have to use to get rid of the parasite." Would it be effective in a river like the Fraser or the Skeena? Mehli shakes his head. "If such a parasite comes to such a river and behaves in the same way, I really can't see any solution for that."



Genetic improvements have allowed greatly increased densities of fish in Norwegian farms, but new regulations will allow larger farms in the hope of encouraging lower densities and fewer outbreaks of disease.

So far the battle against the parasite is budgeted to cost \$2.5 million a year. Pamphlets have been distributed nationally to enlist fishermen's aid in the fight to save the wild stocks. Fish ladders have been closed in an effort to remove the parasite from some streams.

Mehli has developed a 10-year program to control the parasite, but concedes that some streams are too big or too fast to treat with rotenone or any other technique. In these cases, he says, "it's a real tragedy for the wild stocks."

Combating disease on fish farms has been a full-time occupation for regional veterinary officer Arne Kyrkjebø, who is based on Trondheim and works closely with Mehli's team.

It was Kyrkjebø who headed up the two-year struggle against furunculosis on a score of farms in the Trondheim region, using the strong powers of the veterinary laws to force the destruction of entire farm stocks on the suspicion of infection.

The source of the infections was a lag in the production of smolts, Kyrkjebø believes, which produced pressure on the government to allow importation of foreign eggs and smolts. His pointer jumping from one point on the map to another, he rhymes off the diseases present in his region: bacterial kidney disease, furunculosis, whirling disease and more.

Desperate to curb the spread of diseases, the veterinarians are proposing that Norway be divided into zones and movement between these zones banned except under special permit.

Kyrkjebø is particularly concerned "about the sale of fry from hatchery to hatchery. It should be forbidden."

"I am afraid for the wild fish stocks. It is very hard to detect disease in fry and problems are most likely to develop in the smolt."

For Mehli, Kyrkjebø and Bergen, Dagfinn Gausen is developing an insurance policy. A burly biologist, he believes the wild salmon may be destroyed not by disease but by their submersion in a sea of escaped farmed fish. He has undertaken a national salmon sperm bank program to save the wild salmon.

Escaped farmed fish, released by animals, storms or negligence, are spreading throughout Norway's coast. Gausen says flatly that "escapes by salmon from fish farming pens in the seas represent a new and potentially greater threat to natural genetic resources" than *Gyrodactylus* or acid rain.

"The loss of locally-adapted traits or characteristics can eventually exterminate the wild salmon as we know it today." Although 25 of Norway's stocks already are extinct and 15 are very weak, there remain about 400 distinct races of Norwegian Atlantic salmon.

A 1987 B.C. Government brochure on salmon farming made three key statements about salmon farming which the Suzuki Foundation tour proved to be false.

The B.C. government brochure states that "recent studies" showed environmental damage from fish farms was not a concern. In fact, Norwegian experience indicates that feces and other debris from farms completely destroy seabed life directly under pens. This impact may be localized, but can spread under certain conditions. Major research now is beginning in Norway to determine whether the bacteria in these deposits is developing resistance to antibiotics.

The B.C. government brochure states "there is no evidence to indicate that disease is ever transferred from farmed fish to wild stock." This is simply a lie. Since the 1960s,

False reports

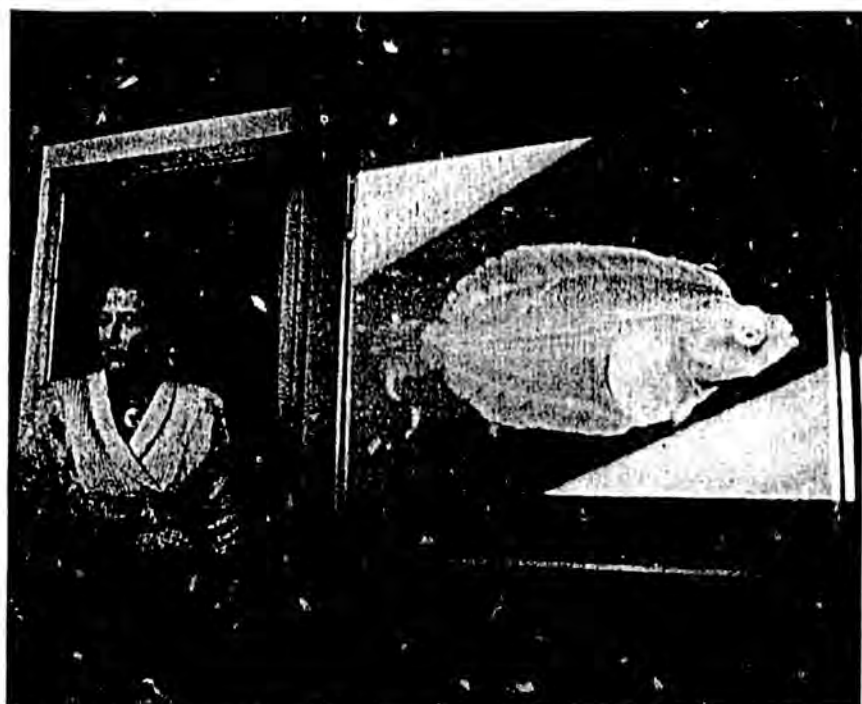


Norwegian scientists have been combatting an outbreak of furunculosis in wild salmon which was introduced to the system from hatchery trout. Infected smolts imported to Norwegian farms near Bergen in 1985 caused a

major disease outbreak which was controlled only after the destruction of thousands of tonnes of farmed salmon. Veterinarians fear the disease may spread in the wild, although there is no evidence of losses as yet. Most seriously, the parasite *Gyrodactylus salaris*, introduced to Norwegian rivers through the stocking of hatcheries and farms, is wiping out wild stocks in a dozen streams.

The B.C. government stated that "escaped farm salmon would rarely interbreed with wild stock, if at all." In fact, escaped farmed fish have been identified in the spawning populations of 28 Norwegian rivers. Spawning out farm fish have been observed. Up to 40 percent of the fish in some rivers is of farm origin. A national salmon sperm bank program has been established to protect remaining wild stocks.

JOURNEY to the FUTURE



GEOFF MEGGS PHOTO

They are under siege. A survey of 54-salmon rivers found farmed salmon in 23 of them, or about 40 percent. The percentage of farmed fish ranged from a low of five percent to a high of 50 percent and averaged 13 percent.

"Nearly every farmed salmon we have encountered is sexually mature," Gausen says. "I believe a great proportion of these salmon are capable of spawning."

Identification of the farmed fish is fairly simple. After a few years in the pens, their dorsal fins and tails are deformed and worn down. By checking the location of fish farms in the regions around the affected rivers, Gausen has concluded the salmon can stray at least 20 kilometres.

Convinced that the survival of the wild salmon is at stake, the directorate has undertaken a third 10-year program, this time to develop a salmon sperm bank.

Failure to act, says Gausen, would mean "destruction of the natural genetic resources which have the greatest value, even for the fish farmers themselves."

"If you destroy that original resource, what can you do if you have problems with the strains you are working with? You can't back up."

In 1986, Gausen began collecting the sperm of endangered salmon runs, freezing it in liquid nitrogen and storing it near Trondheim. Each sample costs about 800 kroner, or almost \$150, "but it's worth it," he says, "because these resources can't be measured in money."

Working from a small truck and changing overalls at every location to avoid spreading disease, he has acquired genetic material from 857 fish representing 69 stocks. Fish farmers hoping for help from Gausen will be disappointed. "This sperm will only be used in saving stocks from extinction," he declares.

This is one side of Norway's multi-million dollar commitment to the wild salmon. The other is the Lenka program, a coastal zone management system now under development which seeks to bring peace to the war over salmon by making protection of wild stocks the cornerstone of fish farm regulation.

LENKA IS

the Norwegian abbreviation for Nation-wide Analysis of the Suitability of the Norwegian Coast for Aquaculture.

Essentially a \$6.5 million coastal zone management program, it unites the ministries of fisheries, labour and environment in a comprehensive planning effort which will give local authorities the power to determine where aquaculture may be located.

The entire coast is being classified according to its suitability for aquaculture. Where shallow water or poor currents could produce pollution problems, farms will be banned.

More important, however, is agreement that fish farms will not be placed into or close to salmon rivers of great value.

To Bergen and his colleagues at the directorate, that

Karin Pittman, a Canadian-born scientist at Austevoll, helped in the breakthrough that saw halibut successfully raised from egg to fish for the first time. The slide records a critical moment: proof that the juvenile halibut has eaten food in its farm environment.



BRITISH HIGH COMMISSION PHOTO

Frozen salmon sperm collected by the British farming industry is for sale worldwide. Similar technology is used by the Norwegians to save wild salmon sperm as insurance against genetic pollution.

means rivers "which give an annual catch of more than 500 kilograms of anadromous salmonids" or any watercourses with "genetically valuable stocks of salmonids."

The result of this decision is the creation of hundreds of "security zones" designed to eliminate farms from inside waters adjacent to salmon streams. Existing farms would be allowed to remain for the time being.

More controversial, but under serious consideration, are proposals to curtail drastically the movement of salmon eggs, smolt or adults from one area to another.

Everyone involved in the Lenka program, including the farmers themselves, have welcomed this new procedure, which will provide even more security for coastal communities and, equally important, the wild salmon.

Along with Lenka, the government is undertaking other initiatives. Research is being stepped up into fish health, particularly "diseases (which) are spread from facility to facility and to wild fish."

"Medicines and chemicals are spread in the environment and may have long-term effects about which we, as yet, know too little," warns the fisheries ministry report to the Storting. "It is therefore very important that research is used to develop new knowledge about what causes diseases and how these can be treated and prevented."

The ministry is proposing an overall plan for development of an even more elaborate infrastructure to "focus especially on strengthening the public administration and improving health and environmental conditions at the facilities."

In short, Norway has made a commitment to a national effort to develop aquaculture in a planned manner, with minimum negative effects on the environment or wild fish. One result of that commitment is the Institute of Marine Research of the Department of Aquaculture located at Austevoll south of Bergen.

AUSTEVOLL

with its brand new labs located on a beautiful fjord south of Bergen, was the last stop on the Suzuki tour, a glimpse of a research facility where Norway hopes to smash the technological barriers to intensive production of all valuable marine fish.

We were guided through the research station by Karin Pittman, a Canadian who looked around the world to see where she could work on the most advanced aquaculture research possible. She decided that Austevoll, where researchers averaging 30 years of age are domesticating salmon, halibut, turbot and cod, was the place.

As a result, she was a member of the team which succeeded in 1986 in raising halibut from egg to adult for the first time.

Last month, she turned on a VCR in her office to show the Suzuki delegation just how far this new technology may go. We watched in silence as the tape showed a Norwegian scientist adjusting the computer which operates the cod-rearing facility at Austevoll.

As the soundtrack played the theme from 2001: A Space Odyssey, the farmed cod raised in a nearby netpen answered a hooter hung from their automated feeder and rushed over for a meal. A trap around the feeder snapped shut and pumped the fish into the tank for vaccination and then back into the pond.

With genetic tagging, the fish could even be released back to the wild, Pittman explained. "This opens the possibility of sea-ranching of cod." With cod trained to answer a dinner bell as faithfully as the family dog, the cod fishery of tomorrow may see computer-fed stocks reporting to the processor's pump when ready for harvest.

Pender Harbour gillnetter John Cameron finally broke the silence as Pittman rewound the tape: "Maybe I'll start banging my head on the side of the boat to attract fish."

Although cod have already gone into limited commercial production, the price remains too low to warrant major expansion in competition with the wild stock fishery.

Wary of competition in salmon markets and anxious to diversify, the Norwegians are moving into other species, Pittman explains. "It's a national effort and we're hoping for a breakthrough here."

Although halibut eggs have been hatched in the lab for decades, no one had succeeded in raising them to adults until 1986. Even then, Pittman says, it took hundreds of thousands of eggs to produce a broodstock that remains under 100 individuals.

The first year only a handful of fish survived. The 1987 crop produced more than 200 adults, but almost more than half fell to an outbreak of vibriosis. This year, however, with on-land facilities and ample egg supply, Pittman hopes to raise 1,000 adults. By 1995, says the ministry of fisheries, production could hit 5,000 tonnes annually.



Setbacks will not be allowed to slow the breakneck pace of commercial production. Cod ranching is on the horizon and, if the legal rights of river owners could be resolved, ocean ranching of salmon would be undertaken tomorrow.

Additional copies of this supplement may be ordered from the T. Buck Suzuki Foundation, 160-111 Victoria Drive, Vancouver Price \$1

Graphic design by Kris Klassen

Slides taken through a microscope trace the life cycle of these first farmed halibut, hatched from wild fish recovered from trawlers' nets.

From tiny, transparent eggs the halibut larvae emerge with huge yolk sacs which sustain them until their first meal of microscopic sea life. By keeping the larvae in a darkened silo of sea water which imitates their natural deepsea environment, the scientists were able to coax the fish to take their first meal.

From there the immature halibut, already exhibiting the basic features of an adult but still completely transparent, quickly develop their distinctive size and color. About four months after hatching, they are two inches long.

Four major Norwegian aquaculture firms, including two with investments in Canada, have already begun commercial attempts to raise cod and halibut. In a new building at Austevoll, Pittman and her colleagues have scaled up the original pilot project into a full-size production facility.

The land-based silos loom 20 feet high in the darkness of the barn. Through small portholes, the tiny larvae can be seen floating like dust in the light of a single dim bulb, waiting for food to come their way.

These larvae are the offspring of wild halibut kept in land-based tanks no larger than a backyard swimming pool. Docile as pet sheep, they readily give eggs as required and rush to the edge to beg for food with gaping mouths when anyone happens by. Will farming them be as simple as it seems?

"This might be the breakthrough year or we might be scratching our heads," Pittman says, "wondering what we did wrong this time."

But if salmon farming is any guide, these setbacks will not be allowed to slow the breakneck pace of commercial production. Cod ranching is on the horizon and, if the legal rights of the river owners could be resolved, ocean ranching of salmon would be undertaken in Norway tomorrow.

In the brave new world of high technology intensive fish production there are no insoluble problems, no absolute technological barriers. There may be no fishermen in this new world and no wild salmon. The choice is ours. •

Fish farm workers slaughter farmed salmon caught in an algae bloom on the Sunshine Coast in 1986. Despite studies indicating many Sunshine Coast farms are located in areas poor for aquaculture, the farms remain.



The UFAWU program

FOLLOWING are the fish farming policy recommendations of the union members on the Suzuki tour as adopted by the General Executive Board in its meeting May 5, 1988:

The basic principle of fisheries development on our coast must be the conservation, enhancement and rehabilitation of wild salmon stocks. Where farms are permitted, they must be strictly regulated. This regulation must be carried out by public agencies with the legislative power and infrastructure to enforce stringent controls for the protection of wild stocks, the environment and the public interest in general.

To this end, we recommend that the union restate its demand for a complete moratorium on the issuance of fish farm licences pending the development of a proper regulatory regime. Licences or permits issued at this time but not used should be withdrawn.

The moratorium must remain in place until:

- 1) both levels of government have completed comprehensive environmental baseline studies coastwide to identify sensitive areas and areas which may be suitable for aquaculture.
- 2) government regulations and infrastructure are in place to protect wild stocks and to regulate aquaculture to at least the Norwegian level.
- 3) completion of a coastal zone management plan to ensure local community involvement in integrated resource management of forest and fishery resources.

The coastal zone management plan will ensure that aquaculture does not proceed unless there is broad public support and areas identified where it could develop with minimum impact on wild stocks and the environment. Such areas would have minimal wild stocks or wild stock potential. Farm broodstock would have to be drawn from local runs to avoid genetic pollution.

These coastal plans would permit locally-based economic development based on improvement of wild stocks or other environmentally-sound initiatives. Where farms are already located in areas where aquaculture should not be permitted, they would be phased out and required to move to aquaculture zones. At the same time, the two levels of government would have to develop an extensive infrastructure of veterinary and inspection services to enforce its regulations. As one delegate said, "the bottom line is the protection of wild stock in its full genetic diversity."

Sounding a warring

WE GOT a very good insight into fish farming and the dangers to our stock in terms of diseases — damage to the environment, the ocean floor, flora and fauna.

The first priority must be to get to the different agencies in B.C. and attempt to convince them that there is a desperate need for an infrastructure which would possibly provide some protection, if they would listen to the experience in Norway.

Another area that's a priority is to get what we have experienced across to the public as much as we can. If we can be successful at that, we may be able to turn this around.

The real top priority is the safety of our wild

stocks. That has to be Number One. **Wayne Patterson, Halibut fisherman and seiner, VANCOUVER**

If our wild salmon and our way of life is to continue, we must pressure the provincial and federal governments into placing strict regulations on the aquaculture industry. With the disease and parasite problems we witnessed in Norway, it would be suicide to allow an unregulated industry such as this to operate in B.C. waters.

In order to stop this stupidity I feel that we must launch a massive campaign and let the people of B.C. know that once again the Socreds and the Tories have deceived us and are willing to sacrifice our industry.

In this effort we must call upon the sport fishermen, city councils, MPs, MLAs and most of all, I feel, the native community must be brought on board. If a parasite such as *Gyrodactylus salaris* were to invade a watershed, it would do serious damage to the stock, if not wipe it out altogether. **Arnold Nagy, Shoreworker, PRINCE RUPERT**

DRAWING from my experience on the Norwegian tour, I believe that the people of B.C. must be made aware that our wild salmon are endangered to the point of possible extinction. Unless strict regulations for salmon farming are put in place immediately, disease, parasites and genetic pollution could weaken our wild stocks and ultimately destroy them entirely.

This may sound extreme, but in Norway wild salmon in many rivers have been wiped out completely.

If such a disaster were to occur on the Skeena or Fraser systems, the results would be devastating environmentally, commercially, recreationally and culturally for the people of B.C.

Dan Clark, Troller, NANAIMO



Fish farm technician adjusts the nets at a broodstock holding farm near Kyrksdalen.

MAJOR ISSUES EXPRESSED

By Sen. Elias's staff on "Gillaspie report" ^{BC's}

PRO AQUATIC FARMING	CON AQUATIC FARMING	INQUIRY RECOMMENDATION
<u>Lack of clear policy on aquatic farming</u> Hindrance to the development of the industry due to the traditional working relationship with the commercial fishery.	<u>Lack of clear policy on aquatic farming</u> Government doesn't support the commercial fishery as hatchery eggs are used to support aquatic farming.	<u>Develop an aquatic farming policy</u> The policy should clarify provincial direction, agency roles, and responsibilities of both government and the private sector. <u>Establish an aquatic farming advisory council</u> The government should establish an advisory council from key agencies and interest groups. <u>Encourage private sector funding</u> Although the government supported marketing, research, egg supply, disease and diagnostic services during initial stages of development, the private sector should fund the industry. <u>Government Coordination</u> Federal, provincial, and local governments should cooperate to regulate the industry. <u>Maintain commitment to enhancement program</u> The provincial government should continue to provide Salmoid Enhancement Program (seems similar to FRED) funding. <u>Lift the current moratorium</u> Information available fails to adequately substantiate maintaining the October 31, 1986, moratorium. The moratorium should be lifted in conjunction with the initiation of the studies and policy changes recommended.
<u>Moratorium</u> Urged the moratorium be lifted immediately to avoid financial losses.	<u>Moratorium</u> Settle land claim issues, conduct environmental impact studies, and review concerns expressed prior to lifting the moratorium.	

PRO AQUATIC FARMING

Lack of public knowledge

Fish farming economic benefits and potential were generally unknown. The public is unaware of the government safeguards for the industry.

Native Involvement

Support for aquatic farming for its potential for generating direct and indirect employment for natives in the small coastal communities of B.C.

Pricing Impact of Farm Salmon

Farm salmon will compete only minimally with wild salmon. The recent price declines are well within the range of normal price fluctuations.

Impact on Market Demand and Supply

The increased availability of salmon is leading to increased consumption.

CON AQUATIC FARMING

Lack of public knowledge

Many government studies regarding marketing and environment impact are not readily available to commercial fishermen.

Native Involvement

Concern about loss of native employment in the commercial fishery and concern on the environmental effects of fish farming in their traditional harvest areas were expressed by the native leaders.

Pricing Impact of Farm Salmon

Concerns were expressed that the influx of farm salmon will cause both farm and wild salmon industries to suffer drastic price declines.

Impact on Market Demand and Supply

The anticipated growth in farm salmon production will lead to market saturation. Production controls should be in place (as in Norway). Farmed salmon should be labeled as such.

Effect on Processing Facilities

If new processing plants are built to process farm salmon, it may aggravate the current over-capitalization of existing plants.

INQUIRY RECOMMENDATION

Communication link should be established

The provincial government should encourage a formal communication between the commercial wild fish and the fish farming industry.

Native Involvement

The federal government should be encouraged to develop programs to assist natives to become involved in aquatic farming. Fish farming in leaders should establish a policy to promote native participation.

Rely upon market forces to dictate prices

B.C. farm salmon should concentrate in specialty markets in the U.S.A. in the major B.C. wild catch product does not compete.

Support a strategy for the integrated marketing of farm and wild salmon products

New markets, new ways of packaging new salmon products should be explored. Government should support this strategy through financial assistance, training missions and technology transfer.

Promote use of existing processing plants

Farm operators should be encouraged to contract between existing processing companies. Government promotion should include review of regulations governing the on-farm processing of salmon, transport of live salmon to plant, inspection/grading of processed salmon.

PRO AQUATIC FARMING

CON AQUATIC FARMING

INQUIRY RECOMMENDATIONS

Impact on Employment

Fish farmers projected large growth in feed plants, plastics and equipment manufacturing construction.

Disease Transference

Some studies indicate the risk of transmission of disease from farm to wild stock is minimal.

Impact on Employment

Currently the commercial fish industry generates many, many jobs. As salmon farming will never generate this level of employment, farming should not be permitted to put the employment health of the salmon fishery in jeopardy.

Disease Transference

Transfer of fish diseases between farms and between farm fish and wild stock was a real concern of many. An immediate ban on egg importation was called for. Farm fish are more susceptible to disease and the diseases will be transmitted to the wild stock.

Genetic Alterations

Concerns were expressed about the possible escapement of farm stock which might interbreed with wild salmon and produce undesirable genetic alterations.

Predator Control

There is insufficient enforcement capability by fish and wildlife officials to stop fish farmers from destroying eagles, herons, seals, otters, and other animals.

Disease Transference

To minimize transfer of diseases between fish farms, 3 kilometres should separate aquatic farms. The provincial government should end the importation of Atlantic salmon eggs.

PRO AQUATIC FARMING

Impact on Water Quality

It is in the farmer's own self-interest to maintain a healthy growing environment for the fish.

Use of Toxicants and Pharmaceuticals

Antibiotics may not be a problem as the substances are water soluble and quickly dilute.

Inadequate Consultation with Interest Groups

Short referral period was necessary to keep processing time delays to a minimum.

CON AQUATIC FARMING

Impact on Water Quality

The following examples of potential damage to water quality were cited:

build up of sediments on the sea bed, increased algae growth, mortality of bottom creatures and plants, and destruction or reduced growth of nearby shellfish beds.

Use of Toxicants and Pharmaceuticals

Studies were cited which implicated the toxicant tributyltin (TBT) as a human health risk, through its concentration in the flesh of farm salmon and shellfish. Lack of manpower reduced the frequency of periodic checks on toxicant levels in farm fish. The use of antibiotics was expressed as a concern.

Inadequate Consultation with Interest Groups

Dissatisfaction with the application referral process was expressed - either because the time available to provide comments was too short (30 days) or because their interests were not included in the process.

INQUIRY RECOMMENDATIONS

Support research on long-term effects of salmon farming

Studies should be performed on the effects of fish farms on shellfish, other bottom dwellers and upon water quality.

Establish a mandatory environmental monitoring system

Monitoring of on and near-site environmental conditions should be required for a permit. The measurement should be regularly submitted for government review. Government needs to establish standards which divide acceptable conditions from unacceptable conditions.

Increased government research, health inspection, and testing activities

Funding for an adequate inspection, testing program should be approved.

Establish standards for finfish aquaculture equipment

The standards should eliminate the use of toxicants which affect human health.

Local Government Involvement

Salmon farmers expressed concern that local government involvement might delay the approval process.

Length and Complexity of Approval System

The high number of agencies involved in the approval system was a source of frustration to many farm operators.

Health and Safety of Farm Workers

Fish farmers stated that concerns are known and the industry has been working on a set of standards.

Local Government Involvement

Local government agencies were concerned that they were given insufficient time in the referral process to consult with an advisory planning group or landowners adjacent to the proposed aquaculture site.

Length and Complexity of Approval System

Provincial regulations and approvals are not tight enough.

Health and Safety of Farm Workers

The lack of safe diving conditions and lack of safety regulations were listed as a concern.

Local governments should redefine zoning bylaws

Approval of aquaculture locations should remain a provincial decision. However, zoning will allow local governments to ensure aquaculture operation are compatible with adjacent uses. The degree to which local government referral comments influence provincial decisions on aquaculture should be clearly identified in government policy.

Continue its use of the interagency referral system

The referral system is important in identifying land use concerns and should be continued. The provincial government should expand its list of referral groups, increase the time available for response (to 60 days) and establish subsequent notification practices for finfish referrals.

Government should adopt regulations for the occupational health and safety of farm workers

The regulations should include requirements for diver training and rescue, personal floatation devices, hand systems, emergency medical services, and proper handling of chemicals and pharmaceuticals.

Site Selection

Established farmers expressed concerns that temporary licenses were being used for financial gain through speculation and as means of tying up sites to prevent competition.

Control of Foreign Investment

Foreign money is needed to offset the reluctance of Canadian financial institutions to provide loans.

Loss of Anchorage and Access

Farm operators spoke of their concerns about boater noise, fuel slicks, and discharge of wastes.

Site Selection

The need for coastal planning studies was stressed often by boaters, commercial fishermen, and government agencies.

Control of Foreign Investment

Individuals argued that foreign control of salmon farming was not in the best interest of B.C. because of the likelihood of export of jobs and profits. Strict controls to prevent foreign corporations from taking over B.C. farms were requested.

Inadequate Rental and Bonding Requirements

The low annual rental charged for fish farms was a concern expressed. It was felt by some that a bond should be posted to allow government to pay for site clean-up in the event of environmental problems.

Loss of Anchorage and Access

Concerns that the coastline would soon be devoid of open anchorages for emergency and recreational use was discussed.

Identification study

The government should initiate a study that will identify sites of high value for other important coastal interest and which should be reserved from aquaculture activities. Speculating within these remaining areas can then be determined on the basis of environmental factors. Fish farms should not be adjacent to provincial parks and recreation areas.

Establish minimum fish production levels

To determine whether land is used productively, the government should set standard levels of fish production. A new rental structure should be established as well as a bond should be required for environmental clean-up.

Offer safe anchorages

The aquaculture industry should be encouraged to institute a program to provide anchorage, access, and emergency assistance to other coastal users.

Upland Owner Impact

The farms benefit communities by adding a tax base.

Effects on Recreational and Tourism Industry

Aquaculture may increase tourisms due to the attraction of touring farms

Involvement of Fishermen in the Farm Industry

Farming will allow fishermen to offset their short income earning period with fish farm equipment.

Upland Owner Impact

Declining property values were due to the imposition of a fish farm along their view frontage.

Effects on Recreational and Tourism Industry

A concern was expressed that the proliferation of fish farms would ultimately erode the tourism industry as related to recreational boating, sports fishing, and commercial fish guiding.

Involvement of Fishermen in the Farm Industry

A large capital outlay is required to start a fish farm. This makes it very difficult to get into the fish farming business

Minimum Distance

The distance between fish farms be determined regarding the potential of the spread of disease and the surrounding property.

Farms offer 'surplus' chinook

Surplus chinook smolts offered to the fisheries department by the B.C. Salmon Farmers Association should be destroyed, says the UFAWU, rather than released in a makeshift enhancement scheme.

At least eight farms offered the smolts for sale earlier this month, suggesting that some kind of technological breakthrough led to survival rates above their forecast.

In fact, the proposal to sell the "surplus" chinook to the Salmonid Enhancement Program is a bid for a bail-out by an industry facing collapsing prices, said the UFAWU May 10.

"Prices for farmed salmon have tumbled a dollar a pound in the past few months," said union spokesman Geoff Meggs. "They simply can't afford to feed these fish and are hoping the taxpayer will bail them out."

Fisheries department spokesman Ted Perry said at least six

million fish were available in farms and hatcheries from Duncan to Powell River. He said DFO would not buy any fish, nor accept donations of fish that were not genetically pure Big Qualicum or Robertson Creek stock.

The fish would be released by DFO into the wild.

At press time, the farmers were insisting on selling the fish, which will starve unless fed by mid-June.

"Release of these fish poses a disease threat to wild stocks and would open the door to private ocean ranching," Meggs said. "Fish farmers have resisted every effort to win appropriate govern-

ment regulations, but they're not shy about asking for government money when times get tight."

Uncontrolled growth of the industry has seen farm fish harvests rise to 6,000 tonnes last year from 387 tonnes in 1986. Prices have crashed from an average annual farm gate value of \$3.17 to \$2.27, according to B.C. provincial statistics.

"Spending on salmonid enhancement has been frozen," Meggs said, "but apparently money may be found for this boondoggle. It's a slap in the face to SEP volunteers who have donated thousands of hours and faced steady funding cuts to even to consider this kind of a scheme."

Consumer group urges farm salmon controls

Both levels of government should step up their regulation of the fish farming industry, says the Consumers' Association of Canada (CAC), to protect the consumer and wild salmon stocks.

In a comprehensive task force report on the industry released April 17, the CAC declares that "a self-regulated industry is not in the consumer's best interest."

Farmed fish is being sold "without specific regulations since pre-existing legislation is being used to govern a new industry," the report says.

In particular, the task force recommends:

- stepped-up provincial government monitoring and regulation of the aquaculture industry;
- public sector testing of fish for market to determine levels of residues;
- monitoring of environmental impacts and prosecution of regulatory violations; and
- consumer labelling to distinguish farmed and wild fish and to report harvest dates.

The report also urges the B.C. Salmon Farmers Association to rejoin the Canadian General Standards Board committees on feed and feed additives to seek ways to reduce residues and contaminants.

The task force expressed concern about colorants, drugs and other medication used in aquaculture "which may remain in the product at the point of consumption."

Antibiotics are a very real problem, the report says, because "long-term consumption of sub-clinical dosages of antibiotics by humans (for example, by consuming antibiotic-containing fish) can lead to the development of resistant strains of bacteria in the body system."

Treatment of infection in humans can be undermined by such doses, the report notes and "there is a potential for allergic reactions by individuals sensitive to antibiotic traces."

(The farm industry has established a Quality Assurance program with spot-checking which it says will control this problem. Fish must be held 42 days after drug treatment before going to market. The provincial government is recommending at least double that time.)

The task force recommends much tighter controls and monitoring of antibiotic use, including certification of farmer staff handling drugs.

The CAC proposes an industry commitment to "produce, catch and process fish without negative impact to the environment."

All types of fish, farmed and wild, should be checked for chemical residues, PCBs and pesticides.

Consumers should insist on protection of wild stocks, the CAC concludes. "A fish farm industry at the expense of the wild stock would, in fact, reduce the choices of fish for the consumer."

LETTERS

The Fisherman welcomes letters to the editor. Letters must be signed and should be brief, if possible.

UFAWU stand on fish farms needs to be toughened

In a recent editorial entitled "Can the UFAWU represent salmon farm workers?" (April 21, 1989) union policy was outlined with respect to aquaculture — no ban on fish farming but strict regulations. Your position is reasonable and takes into consideration that workers in this industry require safe working conditions and decent wages.

However, it has now become apparent that salmon farming has become an even bigger problem than most had predicted in terms of mort disposal, industrial plastic garbage, destruction of marine wildlife, water pollution, antibiotics, price wars, fish escapement and numerous other problems.

The union's decision to embrace a "regulated" aquaculture industry does not take into account the burden that must be shouldered by the residents of the many communities that have to live with and pay for (through taxation) this new industry.

Our communities have lost funding in other areas, such as recycling, parks development and education as public money and expertise are poured into this industry.

We then must live with the mess created by people who don't care about local concerns and values and think that all you have to do is wave money in people's faces and they will swallow anything.

Both levels of government seem completely disinterested in regulating this industry. The new waste management laws for fish farms are not even worth the paper they are printed on. This industry is, and will continue to be, "self-regulating."

This industry has little respect for existing laws like the Fish and Wildlife Act or the Pest Control Products Act, so there is every possibility that new laws will be ignored as well.

In the wake of falling farm fish prices, many people are asking questions concerning the viability of fish farming. But regardless whether or not fish farming is sustainable or must continue to be subsidized by the public, there is no question the industry will continue to impact negatively on coastal communities.

The use of the biocide Nuvan 500 in Scotland to control sea lice is just one indication of what we can expect to see here if it hasn't already been used.

It is becoming more and more obvious that the economic benefits are confined to the fish farming industry while we must pay the social/economic and environmental costs borne out over the long term. Under these circumstances, phasing out fish farming during the next five years is become a more appealing and realistic alternative. Then we can get on with the real job at hand — rehabilitation and conservation of wild salmon stocks.

We would be pleased to present a slide show documenting industry abuses.

Claire Heffernan,

Citizens for Aquaculture Regulations,
POWELL RIVER

The Fisherman
(B.C.)

6/23/89



Cortez Kennedy to anchor Hawks' new defense

SPORTS, Page D1

TRANSLATING THE BODY'S LANGUAGE

Behind those gurgles and rumbles
LIVING, Page C1



Seattle Post-Intelligencer

A HEARST NEWSPAPER

WEDNESDAY MORNING

APRIL 24, 1990

50 CENTS OUTSIDE
SEATTLE METRO AREA 35 C

Salmon pens may take cue from playpens — diapers

By Rob Taylor

Staff Reporter

Washington's infant salmon-farming industry may get the latest in pollution control technology: diapers.

The state Department of Ecology seized on the idea recently as it prepared to issue

water pollution permits for three new net pen operations. But the applicants have been wailing so loudly about the cost and potential problems of the diapers that the department is reconsidering.

At issue is neither the disposable diaper nor the cloth variety. Regulators are talking about requiring a plastic sheet under net

pens to catch feces, food and other wastes. These would be gathered and shipped to a sewage treatment plant.

The system has never been used in U.S. tidal waters before, officials say. And in the face of industry protests, they are trying to determine if they know enough about its practicality to

require it.

In Puget Sound tides, "it would be like putting a sail on these things," complained Terry Wright, a spokesman for the Northwest Indian Fisheries Commission. "It would just blow them away."

"We have grave reservations whether any existing design is

workable," said John Forster, president of Sea Farm Washington Inc. Sea Farm is seeking a permit for net pens at Whiskey Creek, 14 miles west of Port Angeles.

Diapers would be costly, too. Brian Moog, an employee of Swecker Sea Farms, said installing diapers for 42 net pens it

plans off Hartstene Island of Olympia would cost about a million.

The third enterprise seeking a permit is the Jamestown Indian Tribe, which plans an operation in Discovery Bay near Port Townsend.

See **DIAPERS**, Page A4

Diapers: An idea for curbing pollution in the pen

Page 1

The plan to collect and treat wastes stems from a decision last year by the U.S. Environmental Protection Agency, which was under threat of a lawsuit from the Sierra Club Legal Defense Fund to treat fish excrement like factory waste water.

The EPA ruled that net pens need water pollution permits under the Clean Water Act, just as factories do.

The decision requires "best practicable" treatment of all pollution entering U.S. streams and waterways. Washington state law also requires use of "all known available and reasonable" methods of treatment.

After hearing that net pen diapers were used in Europe, state officials suggested last week that they be required in the new permits expected to be issued in about a week.

But yesterday the agency said no decision has been made. And officials sounded as if they were backing off from requiring diapers. At least for now.

"There are a lot of questions about whether this technology is available," said the Department of

Ecology's Chris Haynes, head of the state's water pollution permit program.

"We're not backing down from saying that treatment may be attainable," said Michael Herold, the department's aquaculture permit writer. "But we don't know enough to know what form it will take."

Herold said the agency has also considered a system for vacuuming wastes from under net pens, but is worried that this might harm the environment.

Opponents of net pens have long complained about the wastes and potential for spreading disease. According to Herold, a large net pen would emit as much

sewage as a town of 10,000 to 20,000 people.

Washington's decision would set a national precedent. Maine is considering a net pen permit system, but is waiting to see what Washington does, David Ragsdale of the EPA said.

Ironically, Washington has made diapering of the three proposed operations more difficult. Initially the state planned no treatment for wastes, so it pressed the applicants to put pens in deep water with strong tidal currents to disperse wastes. Now it is backpedaling, and those criteria for siting will have to be reconsidered, said Haynes.

Eventually, permits are ex-

pected to be required for all net pens producing 20,000 pounds of fish a year or using 5,000 pounds of fish food a month, said Wright of the Indian Fisheries Commission.

Herold said that the 13 existing commercial net pens in Washington waters may face a mandate to capture wastes before the three sites that are seeking permits.

The existing pens tend to be in calmer waters better suited to waste gathering. Although they haven't yet been required to get pollution permits, Herold said, "we'll be getting to them."

THE
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50 CENTS OUTSIDE
SEATTLE METRO AREA

from playpens — diap

workable," said John Forster, president of Sea Farm Washington Inc. Sea Farm is seeking a permit for net pens at Whiskey Creek, 14 miles west of Port Angeles.

Diapers would be costly, too. Brian Moog, an employee of Swecker Sea Farms, said installing diapers for 42 net pens

plans off Hartstern of Olympia would cost \$1 million.

The third enterprise is the Jalam Tribe, which plans a permit in Discovery Port Townsend.

draws opposition

By DAVID FOSTER
The Associated Press

RICH PASSAGE, Wash. — The history of salmon-fishing in the stormy North Pacific is filled with tales of brave fishermen riding the wild seas, but its future is being shaped in calmer waters.

Thousands of salmon in this sheltered arm of Puget Sound are captives in sunken pens the size of basketball courts. Crowded fin to fin, they swim endless laps, gobbling feed pellets and being fattened toward the day they'll be scooped up and whisked to market.

Yet while the crenulated coastline and pristine waters that stretch from Washington's Puget Sound to southeastern Alaska might be ideal for fish farming, the political climate is not so welcoming.

In Alaska, where commercial fishermen are a powerful

Please see Back Page, **FISH FARMING**

Anchorage
Daily News

2-20-90

FISH FARMING: Young industry has run into resistance

Continued from Page A-1

lobby, bumper stickers in fishing towns proclaim "Real Fish Don't Eat Pellets," and the legislature is considering a permanent ban on fish farms when a two-year moratorium expires in July.

In Washington state, salmon farmers have the official blessing of the legislature, but that has helped little in the face of challenges from fishermen and environmental groups, which have defeated several proposed farms.

The fish waste produced by a two-acre salmon farm is equivalent to the sewage produced by a town of 5,000 people, claims a Washington citizens group called the Marine Environmental Consortium.

Environmentalists also fear introduced species such as Atlantic salmon — favored because they fetch a higher price and are more docile than Pacific salmon — will corrupt the local gene pool and spread disease. Wealthy owners of shoreside homes, meanwhile, don't want fish farms spoiling their views.

Promoters call fish farming an efficient way to help meet the world's growing appetite for fish. Not only does it provide a year-round supply of fresh salmon to supplement the seasonal wild catch, they say, it also creates jobs free of the hazards of commercial fishing, one of the nation's most dangerous occupations.

They also contend salmon-farming provides an economic incentive to preserve clean water.

"We're the best environmentalists of all, because we're dependent on it," said Jerry Polley, site manager for Global Aqua, the nation's largest salmon farm. "If something's wrong with the water quality, we're going to be the first to complain."

Production of farm-raised salmon, here and abroad, has boomed in five years, flooding markets traditionally held by wild salmon and driving down prices.

"For the first couple of years, as more salmon was around on a year-round basis, the farmed fish seemed to help the wild market," said commercial fisherman Randy Babich. "Now it's a battle at the retail counter."

Fish farming, or aquaculture, is hardly a new concept. For years, farmers have raised oysters in the Northwest, rainbow trout in Idaho and catfish in the Southeast. But techniques have developed more slowly in domesticating salmon, the mainstay of fisheries off Oregon, Washington, British Columbia and Alaska.

For years, it was practiced only by the Norwegians, forced into salmon farming by their declining wild fish populations. But interest has spread quickly since 1985, after Norway refined methods to raise salmon cheaply enough to compete with the wild catch.

In 1983, world production of farm-raised salmon was 23,500 metric tons, just 3 percent of the 670,000-ton wild salmon catch. By last year, farm-raised salmon production had soared to an estimated 202,000 tons, or 30 percent of the relatively constant wild catch.

Norway still leads the pack, producing about 75 percent of the world's farm-raised salmon, but other places, including Scotland, Chile, Canada and Iceland, are catching up.



Daily News file photo

Alaska Department of Fish and Game technician feeds penned salmon at Little Port Walters in southeast Alaska.

The United States, with 50 fish farms in Washington state and Maine, lags far behind, producing 1 percent of the total.

Many of the U.S. salmon farms are run by Norwegian companies, including Global Aqua's four-acre operation in Rich Passage, 10 miles west of Seattle.

Global Aqua's farm is fairly typical: a huge raft anchored offshore holds 40 pens, each lined with a net holding as much as 15 tons of fish, which range from finger-size smolts to fat-bellied salmon 2 feet long.

A half-dozen workers tend the pens from metal walkways, filling automatic feeders and mending nets. At harvest, workers herd fish into one end of the pens, scoop them out with an oversize dipnet and load them onto a boat. The salmon are still kicking when they reach a Seattle processing plant 30 minutes away.

In the three years it takes to raise salmon to harvest, farmers contend with prowling otters, hungry sea lions and diseases that can wipe out whole farms if left unchecked.

Aquaculturists say their operations will never be a major blot on the coastline.

"It would take just 40 acres of farms to produce all of the salmon that was imported into the United States in 1988," said Chris Gibson of Sea Farm Washington in Port Angeles. "The industry does not need a lot of space."

It may need even less space in coming months. Worldwide growth of salmon farming and recent overproduction in Norway have glutted the market with fish. Prices have plunged, and many farms are selling below cost just to keep cash flowing.

In British Columbia, lax regulation and a surge of Norwegian investment capital helped the number of fish farms soar from five to 135 in the past six years. But now many are in trouble. Nineteen have filed for receivership in the past year, and small businesses are being bought out by large investors better able to outlast the lull in prices.

Aquaculture boosters profess confidence in their long-term place in the salmon trade.

Juneau Empire
2-20-90

Japanese buying up Norwegian fish

Surplus of pen-reared fish threatens Alaska's seafood markets in Japan

THE ASSOCIATED PRESS

ANCHORAGE — Norwegian fish farmers are attempting to sell a huge surplus of pen-reared salmon in Japan, long the main market of Alaska seafood processors.

The 88 million pounds of frozen fish could add to an already glutted Japanese salmon market, and drag down prices for this summer's Alaska salmon harvest, according to a U.S. embassy cable from Japan.

More than 80 percent of Alaska's salmon goes to Japan, most of it frozen.

The Norwegians so far have been unable to sell most of their frozen fish, but may cut prices in order to move it, according to the cable released by the U.S. International Trade Administration. If that happens, the Norwegian salmon "will be a threat to U.S. frozen, chum, coho and sockeye salmon," the cable said.

"If they dump it on the market, that would create one hell of a mess," said Roger Dahlke, market-

ing manager for Trident Seafood, a Seattle processor with plants in Bristol Bay and the Aleutians.

Dahlke said Trident is currently trying to sell a lot of Alaska salmon in Japan. But the company is making little headway in a market swamped with both fresh farm-raised fish and frozen fish left over from last season.

As of December, wholesale prices for sockeye salmon had dropped by more than a third from summertime levels, according to Pacific Fishing Magazine. Prices haven't moved much since then, according to industry officials.

Bill Atkinson, publisher of a seafood newsletter that tracks Japanese markets, doubts the Norwegians will be willing to drop their price low enough to compete on the glutted frozen market.

"The Norwegians are not really interested at selling at a loss," Atkinson said. "And the Japanese are not going to accept a high price for them when there are all the other less ex-

pensive fish available."

But one unnamed importer cited in the embassy cable said at least 44 million pounds of the frozen Norwegian fish probably will end up in Japan, knocking down salmon prices just as Alaska's annual harvest begins.

"This scenario, if true, is very critical for U.S. salmon fishermen," embassy officials said. Japanese buyers might import Norwegian salmon in an attempt to force down Alaska salmon prices during pre-season negotiations, the cable said.

"With this type of volume they could start eroding traditional (Alaska) sockeye markets," said Gary Ervin, president of the Kenai Peninsula-based Seafoods From Alaska.

Pen-reared salmon production has been expanding rapidly since the Norwegians pioneered the aquaculture technology in the early 1980s. Salmon farming has been banned in Alaska but is legal in Europe, South America, the South Pacific, Canada and the Pacific Northwest.

Farmers feed the salmon until they reach market size. They offer the fish fresh on a year-round basis. Most Alaska salmon is sold frozen or canned.

Within the past five years, farm-raised salmon have taken over most of the European market, as well as much of the East Coast market, according to a report by the state-funded Alaska Finfish Farming Task Force Force.

Last year Norway produced more than 330 million pounds of salmon, a nearly 60 percent increase from 1988, and farmers have been unable to sell all that fish.

That production, combined with a record Alaska salmon harvest and a strong Japanese chum harvest, created a huge glut on the worldwide market. The amount of unsold fish is estimated by the state finfish task force at more than 200 million pounds. That equals the entire 1989 export of Alaska salmon to Japan.

When Norwegian fish farmers could not sell all their fish, they froze large amounts and began pushing it toward Japanese markets long claimed by Alaska.

"I think the impact of farm-reared salmon on traditional Alaska markets is profound, and simply going to accelerate," said Chuck Becker, Anchorage district director of the U.S. Commerce Department's International Trade Administration.



Filming at sea: Old Harbor fishermen provide talent for new TV ad.

New Alaska seafood ad debuts on national TV

Five Alaska fishermen and the Kodiak Island village of Old Harbor will be making waves in 54 million American homes over the next two months.

The Alaska Seafood Marketing Institute (ASMI) debuted its new 30-second "marine cowboy" commercial promoting Alaska seafood nationwide this week.

The date was less than two weeks after the commercial was filmed in Old Harbor.

"Only fresh or fresh-frozen Alaska seafood can make it into American homes any faster," said Kevin O'Sullivan, ASMI's acting executive director.

The new ASMI commercials feature five Alaska fishermen riding the seas off America's last frontier. In the commercial, the fishermen are shown heading to sea and harvesting Alaska seafood from tumultuous waters.

"The commercial uses a real fishing boat getting knocked around in a real storm off Kodiak Island," O'Sullivan said. "We couldn't chance losing that realism by replacing Alaska fishermen with actors who didn't know what they were supposed to be doing."

The fishermen chosen by the commercial's director have decades of experience in the halibut, salmon, crab, herring and bottomfish harvesting industry. Two generations of Old Harbor's Christiansen family are represented — father Carl who fishes the boat "Sabrina C." and son Ken who fishes the boat "Mischelken C."

Two other fishermen out of Old Harbor, Jose Aguilar and Bill Pulkownik, and one Kodiak fisherman, Matt Shadle, rounded out the on-camera talent for the commercial.

Behind the talent and crew stood the entire community of Old Harbor. The residents of the southern Kodiak Island village rallied around to support the filming and film crew when power was lost for a couple of days, when planes could not get into or out of Old Harbor during a three-day storm and when long distance telephone service to the small community was lost.

Old Harbor's 350 residents put each of the setbacks into perspective. Many of them had survived the tsunami that followed the Good Friday earthquake which swept away most of the village in 1964. The tsunami left only the Orthodox Church and a few houses standing.

When the planes couldn't land with fresh meat and vegetables to feed the film crew, Old Harbor residents donated crab, halibut, deer meat and smoked salmon to keep the crew going.

When electrical power failed before the final scene was shot, an Old Harbor skipper brought his fishing boat around so his generator could provide power to run the television lights.

Women in Old Harbor held traditional banyas so that female production crew members could thaw out by taking steambaths.

For the camera and production crews, the minor inconveniences in town paled in comparison to the talk of filming in the stormy Gulf of Alaska seas.

Weather deteriorated as each day passed. As one of the fishermen described it, the film crew, producers and fishermen ended up in "pretty nautical stuff" including 50 mph winds and waves over the bows and across the decks.

Cameramen tied themselves to the decks while filming and protected cameras with underwater housings.

At one point, the seine boat skipper ordered the fishermen to quit acting and revert to sea duties by chopping away ice in the scuppers and on the deck and deckhouse.

There were 31 people involved in filming the commercial. Out of those, 17 were on Kodiak Island for some portion of the commercial's production. ASMI spent over \$60,000 for talent, lodging, travel, location scouting, production services, equipment and other expenses.

ASMI developed the commercials to promote all Alaska seafood products. The Alaska seafood industry directly contributes one of every 13 jobs in Alaska and one of every eight private sector jobs, the organization says.

The seafood payroll in Alaska in 1983 topped \$1 billion — more than the combined payrolls for the oil and gas, tourism, mining and forest products industries, according to ASMI.

The commercials will be placed on cable television, allowing ASMI to target specific market niches to assure optimum exposure. Stations included are the Arts and Entertainment Network, Cable News Network, The Discovery Channel, The Lifetime Network, Turner Broadcast Network, CBN, TNT and USA.

ALASKA STATE LEGISLATURE · SENATE

SENATOR RICHARD I. ELIASON

LABOR & COMMERCE COMMITTEE, CHAIRMAN

RESOURCES COMMITTEE

RULES COMMITTEE

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SETTLING THE FISH FARMING DEBATE

NOW IS THE TIME TO SAY "NO"

Senator Dick Eliason

After four years of discussion on the subject of mariculture, the time has come for the Legislature to end the debate on fish farming and resolve the matter once and for all.

The grave problems associated with fish farms operating in other states and countries, the testimony of witnesses from Ketchikan to Bristol Bay expressing staunch opposition to the legalization of fish farm operations, and the findings and recommendations contained in the recently released report of the Finfish Farming Task Force have led me to introduce legislation prohibiting commercial finfish farming in Alaska.

Several years ago, when the issue of fish farming was first raised, the Legislature recognized the need to proceed slowly and withhold action until more information could be gathered. We have enacted two consecutive moratoriums on finfish farming and in 1988 called for a non-legislative task force to examine the key issues pertaining to finfish farming in Alaska and providing a well-balanced report to the legislature. The group, which completed its work this month, has done a commendable job of laying out the pertinent facts, noting several possible benefits and some serious risks, and leaves

to the legislature the disposition of the issue. One of the main conclusions in the report is that the legislature should not simply extend the current moratorium on finfish farming (expiring in July), but should instead enact a law either allowing or prohibiting finfish farming.

The legislation I introduced, Senate Bill 397, reflects the concerns addressed in the task force report. In evaluating the costs and benefits of fish farming identified in the report, it seems apparent to me that the serious risks outweigh any potential benefits. These risks include the spread of disease among wild fish by farmed fish, genetic intermingling of wild fish stocks with farmed fish unsuited to survival in the wild, degradation of water quality near finfish farms, and land use conflicts over farm siting. The report acknowledges that these potential threats to Alaska's valuable fishery resources and the environment can never be eliminated if fish farming is permitted. They can only be minimized.

Minimizing the risks would be accomplished largely through state regulation, which would necessitate a substantial expenditure of public funds. I don't believe the public would support such an expenditure when there it is unlikely that a fish farming industry can succeed here, and nobody can guarantee the absolute protection of wild fish stocks upon which commercial fishing, subsistence harvests, recreational fishing, and increasing sportfish-based tourism depend.

Although the proposed ban on finfish farming is necessitated by the legislature's responsibility to protect Alaska's natural resources, I have some additional personal concerns. The proponents of finfish farming speak of "employment" and "economic development." The truth is that fish farms employ very few people, approximately 3 people per farm. Is that worth risking harm to resources which currently support, among other things, Alaska's commercial fishing industry: our largest employer and second only to "Big Oil" in terms of its value to the state in dollars? Furthermore, I am concerned about the fact that most of the private sector investment in any finfish farming industry in Alaska will not be by Alaskans. Even if the industry were to make a profit here, much of it would leave the state.

We are fortunate to have resisted jumping into such a volatile enterprise -- lucky that during our moratoriums we have been able to learn from others' mistakes. We have seen genetics and disease problems cropping up at Norwegian fish farms, water contamination problems in Washington, and some of British Columbia's leading fish farms on the brink of bankruptcy, due in part to a glut of farmed salmon on the world market requiring many to sell below cost.

A couple of other good things emerged from the extended debate stimulated by the proposal of mariculture legislation. The question of shellfish and sea vegetable cultivation was divided from the fish farming issue during the course of legislative work on the issue. This has, in turn, given rise

to a fledgling industry to which Alaska has given both its blessing and the benefit of a comprehensive regulatory process.

Another positive aspect of the long discussion on the issue was the great degree of public participation which was achieved. Public awareness of the implications of launching a fish-farming industry in Alaska led to the expression of concern, and finally staunch opposition from the majority of Alaskans interested in the issue.

In response to all that we have learned, the responsible course of action is for the legislature to now move swiftly in adopting legislation prohibiting finfish farming and thus settling the debate once and for all.

BY SEN. ELIASON, Jones, Kerttula, Zharoff, Duncan, Adams, Binkley, Coghill, Faiks, Fischer, Halford, Kelly, Rodey, Szymanski, Uehling

IN THE SENATE

SENATE BILL NO. 397

IN THE LEGISLATURE OF THE STATE OF ALASKA

SIXTEENTH LEGISLATURE - SECOND SESSION

A BILL

For an Act entitled: "An Act prohibiting finfish farming; and
for an effective date."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

* Section 1. FINDINGS. Based on a legislative examination of the potential effects of allowing finfish farming in the state on the common property resources and on the overall economic well-being of the state; the number of serious concerns associated with finfish farming and the need for study of finfish farming that has caused the legislature to enact two moratoriums on finfish farming and establish a nonlegislative task force to study the issue and to report its findings and recommendations to the legislature; a review of the final report of the Alaska Finfish Farming Task Force which notes several possible benefits and some serious risks of finfish farming; the need for the legislature to take action before the current moratorium on finfish farming expires on July 1, 1990; the recommendation of the task force that the legislature not extend the moratorium, but make a final determination to either allow or prohibit finfish farming; and the testimony and evidence received; the legislature finds that

(1) the state has the healthiest stocks of wild salmon and other wild finfish in the world and benefits from thriving commercial, sport, and subsistence fisheries for these fish and a growing tourism industry related to sport fishing;

(2) the people, economy, and environment of the state are dependent in large measure upon the continued health of the state's wild finfish

resources;

(3) serious risks are posed by commercial finfish farming, including the spread of disease among wild fish by farmed fish, genetic intermingling of wild fish stocks with genetically manipulated farmed fish, degradation of water quality near finfish farms, and land use conflicts over the siting of commercial finfish farms;

(4) the state has invested significantly in marketing efforts to promote Alaskan finfish as wild and natural fish products, and this investment in developing the reputation of Alaskan finfish would be lost by allowing commercially farmed finfish to be produced and marketed from Alaska;

(5) the cost to the state to regulate the commercial finfish farming industry would be high;

(6) few jobs would be generated by a commercial finfish farming industry in the state;

(7) the state is responsible for ensuring the protection and wise use of the renewable natural resources of Alaska and providing a framework for a sound economy;

(8) a long-term decision must be made regarding the future of commercial finfish farming in the state;

(9) avoiding harm to the state's wild finfish, land, and water resources must take precedence over the development of a new speculative and potentially harmful commercial finfish farming industry;

(10) the best interests of the state are served by prohibiting commercial finfish farming.

* Sec. 2. AS 16.40 is amended by adding a new section to read:

Sec. 16.40.210. FINFISH FARMING PROHIBITED. (a) A person may not grow or cultivate finfish in captivity or under positive control for commercial purposes.

(b) This section does not apply to

(1) the fishery rehabilitation, enhancement, or development activities of the department;

(2) nonprofit corporations that hold permits under AS 16.-10.400;

(3) the incidental sale of finfish held for scientific or educational purposes under a permit issued by the department;

(4) rearing and sale of finfish for aquariums or ornamental ponds.

* Sec. 3. This Act takes effect July 1, 1990.

POLLUTION ISN'T A SOUND POLICY

Should corporations use public waters for private profit?

By John de Yonge

P-I Contributor

Consider these things about floating fish farms:

■ A typical net-pen fish farming operation on Puget Sound produces pollutants "equivalent to untreated sewage from approximately 10,000 persons." That's what a state report says. The pollution comes from fish feces, urine and food pellets deposited in the water and on the bottom of the Sound.

■ There are 13 commercial pens now operating over 69 acres of aquatic lands leased from the state. These 13 operations daily deposit to the bottom of Puget Sound nearly six times as much oxygen-demanding fecal matter and other wastes than does Metro's Renton Waste Water Treatment Plant, which serves 430,000 people. Materials that deplete oxygen can radically change or kill off the life forms in an unpolluted environment.

■ Siting 27 more fish farms, now delayed by opposition from upland property holders, environmentalists and county officials, would add a pollution load to Puget Sound equal to that from building four new cities the size of Everett.

■ The "... proper siting of 100 farms would not have significant impact on the aquatic environment." So says the state's just-issued environmental impact statement on floating net pens.

Those 100 fish farms would produce 55 metric tons of oxygen-demanding waste per day. That's 18 more tons a day than Metro's Renton and West Point treatment plants together produce from the sewage of 1 million people.

Analysis

The environmental impact statement was prepared by three private organizations that supply fish-farm companies with paid expert witnesses.

Under Gov. Booth Gardner, state policy is to hush any increase of fish farming in the state's waters and to downplay environmental problems that aquaculture may bring.

The official evangelist is the Department of Agriculture's Dr. John Pitts, veterinarian and former Jefferson County commissioner who appears at meetings and hearings — in one case, as a paid witness for a net-pen applicant — to pooh-pooh environmental objections raised by net-pen opponents.

Opponents are not just those who own shoreline property, who howl against a net pen being erected in their aquatic front yard. They've been fired up by what the state's environmental impact statement confirms: A new, nearby fish farm can give view property a one-time, financial knock.

Opponents include environmentalists like David Ortmann of Friends of the Earth, who says: "Why should we be happy about fish farms that dump tons of fish poop every day into Puget Sound?"

They include commercial fishermen like the Puget Sound Gillnetters, who know something that has largely escaped the notice of sport anglers:

Atlantic salmon, not a salmon but a sea-run trout of the Atlantic seaboard, have escaped by the thousands from net pens here and in British Columbia. The B.C. government booms fish farms with a gusto exceeding even the ta-ra-ra-boom-de-ays from Gardner's men and from Brian Boyle, the separately elected head of the Department of Natural Resources, which manages shore bottoms and other public lands.

What's more, hundreds of thousands of Pacific salmon have also escaped from the pens, especially in British Columbia.

So what does that mean?

The state environmental impact statement points out that escaped exotic fish like the Atlantic salmon "could establish self-sustaining populations and compete with indigenous fish," such as steelhead trout.

That may not be far off.

In the North Puget Sound last year, commercial and sports fishermen caught hundreds, probably thousands, of Atlantic salmon weighing up to 10 pounds.

More dangerous by far is that for the first time ever at least three sexually mature Atlantic salmon showed up miles from the sea in the Nooksack River last year, near Bellingham, and one in the Nisqually, near Olympia. Rumor has a fourth Atlantic netted in the Skagit River at Sedro-Woolley.

What's the worry about four fish, though they may be forerunners of thousands to come?

The environmental impact statement warns that accidental importation of "exotic" fish diseases associated with fish farms in Europe could devastate existing salmon and trout runs in state rivers.

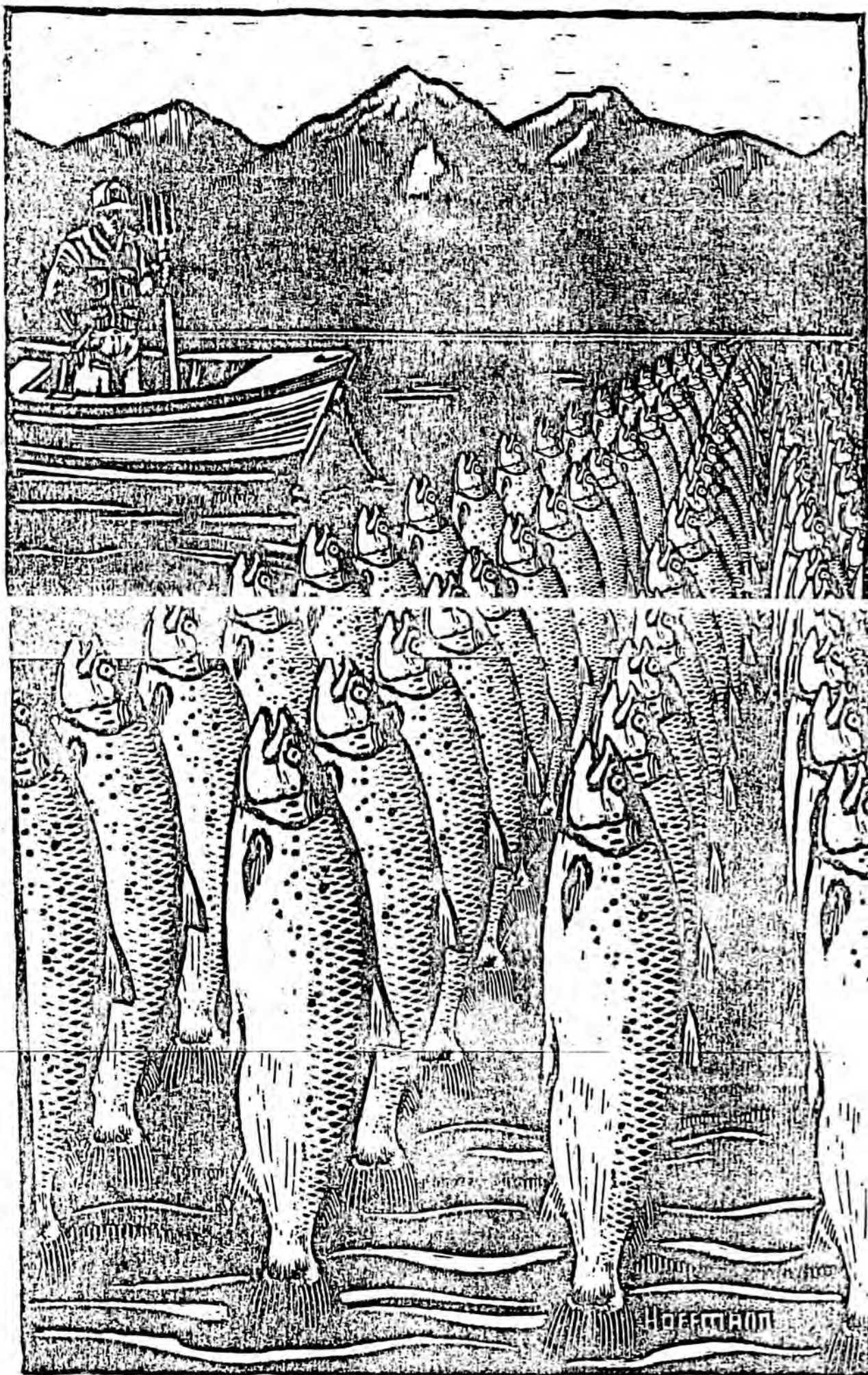
Just in the past two weeks the public has learned that such a disease, viral hemorrhagic septicemia or VHS, has shown up at two hatcheries in state waters. It is the first time ever that VHS has been found in North America.

VHS, state fish-disease experts say, has never been found to occur naturally in Atlantic salmon. They say that the chance that Atlantic salmon in pens here are the source of the disease is "virtually zero." The disease was found in chinook and coho salmon, species raised extensively at federal, state and tribal hatcheries and at commercial net-pen operations.

The impact statement does not dwell on what has happened in Norway, where other diseases associated with that country's extensive net-pen industry have ravaged wild Atlantic salmon runs in 32 rivers. The government was forced to poison some streams, set up a salmon sperm bank to preserve wild genes and consider banning any new net pen within 12 miles of a river mouth, an obvious rule not yet under consideration here.

Nor does the statement dwell on the possibility of migrating wild fish catching indigenous fish diseases from net pens here or of net-pen escapees spreading such diseases into our river systems.

Fish farmers themselves helped call state attention to fecal build-up beneath pens, a build-up that kills clams, oysters and other bottom dwellers and can release poisonous hydrogen sulfide gas, which



DUANE HOFFMANN/P-I

can kill all fish in a pen in minutes.

In 1986 Commissioner of Public Lands Boyle limited new net pens to sites where the water is at least 40 feet deep at low tide, a mile away from other pens and with enough current to flush away food and fecal deposits. He also limited the surface area of new pens to two acres or less.

These requirements ended up in "Recommended Interim Guidelines" written for the departments of Agriculture, Ecology, Natural Resources and Fisheries, which share regulation of the fish-farm industry, with Agriculture and Pitts calling most of the shots.

With no force of law and offered to help county commissioners site pens under state law, the guidelines deliberately do not talk about navigation problems, use conflicts and, most important, esthet-

operations at Port Angeles.

Both pen systems, clean, low in the water, quiet, full of fat, bright Pacific and Atlantic salmon, are barely noticeable in the working harbors that contain them.

But that's quite different than siting a pen in Frenchman's Cove on the west side of Hood Canal, as International Marine Farms Inc. proposes.

Or siting a pen, as Tailfin Inc. proposes, in a main salmon and trout-fishing cove between East Point and Bells Beach on the west side of Whidbey Island, where from her home Margaret Johnston looks out across Saratoga Passage to Camano Island. She heads the Marine Environmental Consortium, made up of 20 citizen organizations that oppose fish and other floating farms.

Katz argues for having the state set standards for

siting and operating net pens, to ensure that the pens do not harm the environment and to give the net-pen operators a clear but flexible regulatory framework to live with. But Katz feels the industry is getting a bad rap from people like Johnston, who, he says, simply don't want a net pen in their aqueous front yard.

"If the two sides could stop feuding and start talking about necessary standards, we could have a safe, considerable industry . . .," he says. "But we're years away from that."

Forster, president of the Washington Fish Growers Association, dismisses esthetic revulsion as the main drive behind the opposition to what he characterizes as a clean, beneficial industry with vast prospects.

"It's more than esthetics. It's an intrusion into a life style that they don't like and they're using environmental problems as a smokescreen . . . Because of that, the debate is dishonest at the moment, terribly dishonest."

Johnston, at a gathering in her home with other members of the Marine Environmental Consortium, characterizes such comments as unworthy.

"The net pen issue raises a fundamental issue of public policy that involves more than us, though the environmental questions are real and cannot be brushed aside by the industry or the state. The big question is: Should the public waters of Washington State be turned over to a few corporations for private profit?"

That's a proper question for us all to ask. It must be answered by political action. Gardner's administration has already answered: Yes.

To me it seems stupid to site more pens in pristine salt and fresh waters (yes, an application is pending in Eastern Washington) until we have better, more extensive scientific information about siting than what the draft environmental impact statement supplies.

Until we know if pens can be sited safely anywhere, we would be blind to commit ourselves to putting major sources of pollution in our unpolluted waterways and in waterways we are trying to clean up.

The tragedy of Norway's rivers demonstrates that.

If the two sides could stop feuding and start talking about necessary standards, we could have a safe, considerable industry.

—Peter Katz,
fish farmer

Commissioners have learned that if they turn down a net-pen proposal, the applicant will seek a full rehearing before the state's Shorelines Hearings Board, with Pitts certain to show up to put the stamp of Gardner's administration on having the permit granted.

Dwain Colby, an Island County commissioner, put the matter thus in a 1987 letter:

"While there may be legitimate reasons for denying a permit to locate a salmon net pen, local government has been placed in the position of being able to say 'yes' to such a proposal but not 'no.'"

Under Gardner, the Department of Ecology has refused to require net pen operators to get pollution-limiting discharge permits under the federal Clean Water Act.

The Sierra Club Legal Defense Fund has announced it will sue the U.S. Environmental Protection Agency if necessary to force EPA to force Ecology to force every net pen operator have such a permit.

The state's draft environmental impact statement declares that the major impacts of net pens can be cured by "proper farm siting to assure dispersion of wastes, flushing of the site and protection of sensitive areas."

It's a view that one can come to easily while talking to such eloquent fish farmers as Peter Katz, a marine architect running the Paradise Bay Co. net farm at Port Townsend, and John Forster, a Ph.D. in aquaculture running Sea Farm Washington's similar