

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILE 8672
1905 SCOMM 75: MARICULTURE (FISH FARMING), 1987-1990

22



CNL8821

COUNCIL

PAPER CNL(88)21

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
Utilization Research Division
2725 Montlake Boulevard East
Seattle, Washington 98112

December 3, 1986

Dr. John Pitts, D.V.M.
Aquaculture Coordinator
Department of Agriculture
406 General Administration Building AX-41
Olympia, Washington 98504-0641

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."

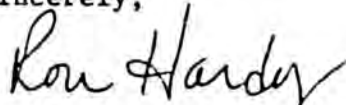
Each of these 4 statements is based on an assumption and each of them can be challenged by the data contained in a large number of published papers. Statement 1 - we have fed as low as 0.8 pounds of a practical diet per pound of gain, while with semi-purified diets we have gotten values down to 0.6. 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

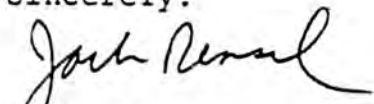
November 1, 1986

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.

literature cited

- Cannon, G.A. (editor). 1978. Circulation in the Straits of Juan de Fuca. NOAA Technical Report ERL 399-PMEL 29. Boulder, CO.
- Ebbesmeyer, C.C. et al. 1979. Dynamics of Port Angeles Harbor and approaches. EPA 600/7-79-252. Evans-Hamilton Inc. Seattle, WA for MESA Project, Washington D.C.
- Herlinveaux, R.H. 1954. Tidal Currents in the Straits of Juan de Fuca. Journal of the Fisheries Research Board of Canada, 11 (6) 799-815.
- Holbrook, J.R., R.D. Muech, D.G. Kachel and C. Wright. 1980. Circulation in the strait of Juan de Fuca. NOAA Technical Report ERL 412-PMEL 33. Boulder, CO.
- Parker, B.B. 1977. Tidal hydrodynamics in the Strait of Juan de Fuca-Strait and the Strait of Georgia. National Oceanic and Atmospheric Administration Technical Report NOS 69.

- Pease, B. 1977. The effect of organic enrichment from a salmon mariculture facility on the water quality and benthic community of Henderson Inlet, Washington. Dissertation, University of Washington, Seattle, WA.
- Stockner, J.G. D.D. Cliff, and K.R.S. Shortreed. 1979. Phytoplankton ecology of the Strait of Georgia. British Columbia. Journal Fisheries Research Board of Canada. 36: 657-666.
- Waldichuck, M. 1957. Physical oceanography of the Strait of Georgia, B.C. Journal of the Fisheries Research Board of Canada 14(3): 321-486.
- Weston, D. 1986. The environmental effects of floating aquaculture in Puget Sound. School of Oceanography, University of Washington. Prepared under contract to the Washington Departments of Ecology and Fisheries. Olympia, WA.

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 fluid and cursive, with a large initial "R" and "S".

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.

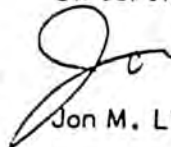
In summary, Dr. Whitely's presentation, in my opinion, is characterized by:

- 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 100

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 THE 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, BLOOD AND ORGANS TO AVOID A POSSIBLE 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 HOFFI 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 NEGUVON IN SPECIAL TREATMENT COMPARTMENTS. INVESTIGATIONS ARE NOW CARRIED OUT FOR A POSSIBLE REGISTRATION OF NUVAN, ANOTHER PHOSPHORINSECTICIDE PREPARATION SINCE THIS DRUG SEEM TO BE MORE EFFECTIVE AT A LOWER DOSE AND LOWER COSTS THAN NEGUVON. 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 HYDROGEN SULPHIDE (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
Project Team Leader



Etolin Island Area
Mariculture Pilot Project

CHAPTER 3

Site Suitability

Page 31 - CHARACTERISTICS OF THE STUDY AREA

- 31 - Topography
- 32 - Climate
- 32 - Hydrology
- 33 - Oceanography and Estuarine Processes
- 34 - Bottom sediments and Sedimentary Processes
- 34 - Currents and Tides
- 34 - Wave Action
- 34 - Circulation Patterns
- 35 - Temperature, Salinity, and Oxygen Patterns
- 35 - Tidal Flushing
- 36 - Patterns of Phytoplankton Productivity and Nutrient Dynamics
- 37 - Carrying Capacity

38 - RESOURCE USE/INVENTORY

- 38 - Timber and Timber Harvest
- 38 - Minerals and Soils
- 38 - Private and State Lands
- 38 - Visual Resources
- 38 - Cultural, Historical and Archaeological Resources
- 38 - Transportation Systems
- 39 - Anchorages
- 39 - Watersheds and Fisheries
- 39 - Wildlife
- 40 - Fish and Wildlife Harvest
- 42 - Recreation

45 - ENVIRONMENTAL IMPACTS

- 46 - Guidelines
- 46 - Factors Influencing Magnitude of Impact
- 47 - Size of Operation
- 47 - Need for Upland Facilities

53 - ENVIRONMENTAL IMPACTS, WATER QUALITY

- 53 - Potential Water Quality Impacts
- 54 - Potential Water Quality Conflicts With Other Users

55 - ENVIRONMENTAL IMPACTS, FISH AND WILDLIFE

- 55 - Potential Impacts of Specific Techniques
- 55 - Anchored Floating Facilities (Rafts and Longlines)
- 56 - Sedimentation
- 56 - Alteration of Phytoplankton
- 57 - Effects on Benthic Communities
- 58 - Suspension From Poles
- 59 - Intertidal and Submerged Structures
- 59 - Bottom Culture
- 60 - Intertidal Handling
- 61 - Fertilization

61 - POTENTIAL IMPACTS COMMON TO ALL FACILITIES

- 61 - Introduction of Exotics
- 62 - Disease Transmission
- 62 - Disease and Parasite Control
- 63 - Predator Control Techniques and Disturbance
- 65 - Fouling Control Techniques
- 66 - Disposal of Wastes

67 - CONFLICTS WITH OTHER COASTAL USERS

- 67 - Land Management Issues
- 67 - Mariculture Development Land Use Needs
- 68 - Displacement of Public Use
- 68 - Recreation
- 69 - Anchorages
- 69 - Fish and Wildlife Harvest
- 70 - Conflicts With Other Commercial Uses of Tidelands and Submerged Lands
- 70 - Commercial Fishing
- 70 - Commercial Recreation
- 71 - Logging
- 71 - Mining
- 72 - Urban Development
- 72 - Residential Development
- 72 - Historic or Archeological Sites
- 72 - Land Speculation
- 73 - Impacts on Adjacent Owners
- 73 - Upland Access
- 73 - U.S. Forest Service As Upland Managers
- 74 - Cumulative Effects of Expanding Tideland Use
- 74 - Summary

75 - DEVELOPMENT

- 75 - Costs of Production
- 75 - Start - Up Costs
- 75 - Labor
- 76 - Paralytic Shellfish Poisoning (PSP) Costs and Concerns
- 77 - Transportation
- 77 - Marketing

79 - GUIDELINES AND MITIGATING MEASURES

- 79 - Relative Measures of Suitability
- 79 - Guidelines for Siting Shellfish and Sea Vegetable Mariculture Facilities and Mitigating Impacts
- 80 - Siting Guidelines
- 82 - Project Design Guidelines
- 84 - Operational Guidelines



Etolin Island Area

Mariculture Pilot Project

CHAPTER 4

Project Review and Permitting

Page 87 - INTRODUCTION

88 - Siting and Design Phase

88 - Alaska Coastal Management Program Project Review Process

- 88 - Coastal Project Questionnaire and Preapplication Services
- 91 - Consolidated Shellfish Farm Application
- 91 - Project Schedule
- 91 - Conflict Resolution
- 92 - Public Notice Systems
- 93 - Issuance of State Agency Permits

95 - Approvals Routinely Required For Siting and Mariculture Projects

- 95 - Land Management Approvals
- 95 - New Process
- 96 - Tideland Permits
- 96 - Leases
- 96 - Other DNR Approvals
- 96 - U.S. Forest Service Land Use Permits (Special Use Permits)
- 97 - NEPA Processes

97 - Other Mariculture Project Regulatory Approvals Routinely Needed

- 97 - Department of Environmental Conservation Approvals
 - 98 - 401 Certification
 - 99 - Wastewater Discharge and Solid Waste Permits, System Plan Reviews
- 100 - Department of Fish and Game Approvals
 - 100 - Shellfish Farm Permit
 - 100 - Title 16 Permits
- 100 - U.S. Army Corps of Engineers Approvals
 - 101 - Section 10 and Section 404 Permits

102 - STOCKING PHASE

- 102 - Fish Transport Permit
- 102 - Aquatic Stock Acquisition Permit

105 - CONSOLIDATED SHELLFISH FARM APPLICATION EVALUATION

- 106 - Comments
- 107 - Summary
- 107 - Annual Reports

103 - PRODUCT DISTRIBUTION PHASE

- 103 - National Shellfish Sanitation Program
 - 103 - Procedures to be followed by the State
 - 104 - Procedures to be followed by the Food and Drug Administration
 - 104 - Procedures to be followed by the Industry
 - 104 - The NSSP Manual of Operation
- 104 - Site Certification and Development
- 105 - Product Certification Prior to Marketing

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

Wan
High

Hi
need
from
mega-
pan a
opera
spher

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.

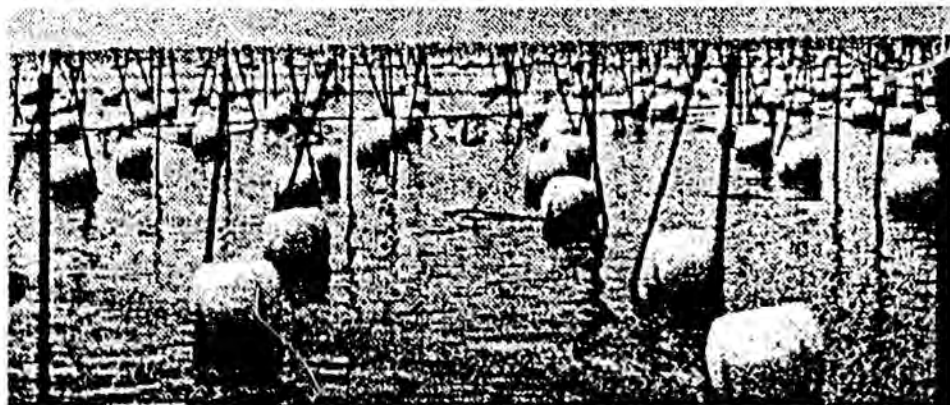
Smith said his firm soon will relocate to a remote section of the

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

Table of Contents

Acknowledgments	v
Abstract.	vii
1.0 INTRODUCTION	3
2.0 FLOATING MARICULTURE IN PUGET SOUND	
2.1 Salmon net-pen culture.	7
2.2 Shellfish culture	12
3.0 POTENTIAL ENVIRONMENTAL EFFECTS	
3.1 Water circulation	17
3.2 Water quality	22
3.3 Phytoplankton	39
3.4 Sedimentation	48
3.5 Benthic macrofauna.	64
3.6 Fish and megafauna.	74
3.7 Introduction of exotic species.	78
3.8 Diseases.	85
3.9 Genetic effects	91
3.10 Toxicants	96
4.0 MODELING OF ENVIRONMENTAL EFFECTS	
4.1 Introduction.	101
4.2 Water quality modeling.	101
4.3 Sedimentation modeling.	106
5.0 ENVIRONMENTAL REGULATION OF MARICULTURE	
5.1 Introduction.	115
5.2 State regulations	116
5.3 Regulations of other countries.	118
6.0 RECOMMENDATIONS.	127
LITERATURE CITED.	131

Acknowledgments

The following persons provided information included in this report or reviewed earlier drafts. I thank them for their assistance and cooperation.

Hans Ackefors - University of Stockholm, Stockholm, Sweden
John Baross - University of Washington, Seattle, Washington
Ed Black - Ministry of the Environment, Victoria, British Columbia
Paul Blake - Center for Disease Control, Atlanta, Georgia
Bruce Burrow - Municipality of Metropolitan Seattle, Seattle, Washington
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
Nicolas Gonzalez - Spanish Institute of Oceanography, La Coruna, Spain
Lee Harrell - National Marine Fisheries Service, Manchester, Washington
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
Bill Hershberger - University of Washington, Seattle, Washington
Bill James - Washington Department of Fisheries, Olympia, Washington
Bob James - Washington Department of Ecology, Olympia, Washington
Peter Jeffards - Penn Cove Mussels, Penn Cove, Washington
Bruce Kay - Environmental Protection Service, Vancouver, British Columbia
Michael Kyte - Ardea Enterprises, Lynnwood, Washington
Jon Lindbergh - North Bend, Washington
John Liston - University of Washington, Seattle, Washington
Lars-Ove Loo - Institute of Marine Research, Lysekil, Sweden
Conrad Mahnken - National Marine Fisheries Service, Manchester, Washington
Bob Matsuda - Municipality of Metropolitan Seattle, Seattle, Washington
Asha Mahtre - Department of Public Utilities, Olympia, Washington
Louis Mottet - Friday Harbor, Washington
Madelon Mottet - Friday Harbor, Washington
Charles Nolan - Seattle-King County Health Department, Seattle, Washington
Arthur Nowell - University of Washington, Seattle, Washington
Bruce Pease - Washington Department of Fisheries, Point Whitney, Washington
Deborah Penry - University of Washington, Seattle, Washington
Mary Jane Perry - University of Washington, Seattle, Washington
Tommy Petersen - Faroese Sea Breeding Commission, Faroe Islands
Gil Potter - Washington Dept. of Social and Health Serv., Olympia, Washington
Bob Saunders - Washington Department of Ecology, Olympia, Washington
Knut Senstad - Sea Farm of Norway, Bergen, Norway
Lynn Singleton - Washington Department of Ecology, Olympia, Washington
Emil Smith - California Department of Fish and Game, Sacramento, California
James Staley - University of Washington, Seattle, Washington
Richard Strickland - Thalassaco Science Communications, Seattle, Washington
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
ough a
dis-
served
well-
remely

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.

able
ound.
nkton
ould
some
these
on by
e. A
high-
thern
tain

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.

solid
ces,
ner-
epo-
in-
and
sul-
ects
are
ment
cil-
pon
be

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.

ted with
s placed
he steps
e placed
g eval-

ronment
ronment
hat the
rulent,
e that
ociated
ised by
assoc-
re are
e does

ssable
rganic
growth
ed in
issue
e has
ments
emon-
human

e is
stage
the
pac-
pes.
the

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

670 - 999 Canada Place
B.C. International Commercial
Arbitration Centre
Vancouver, B.C. V6C 2E2
Telephone (604) 684-2821

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.

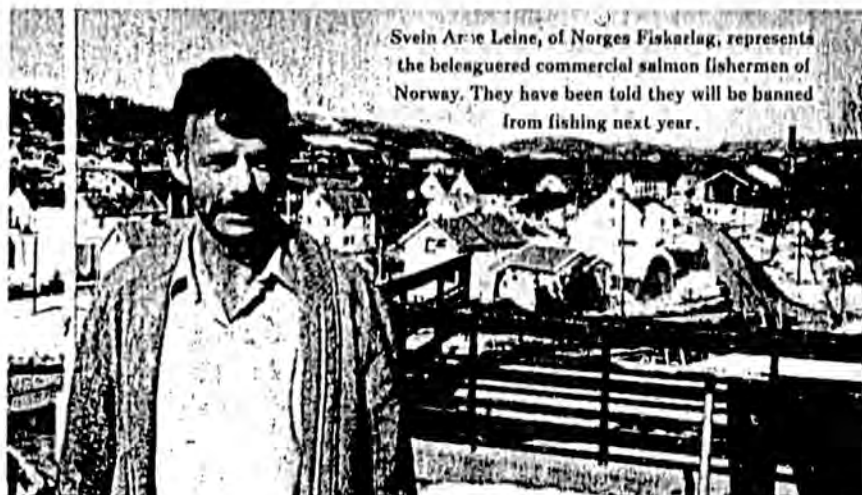
A measure of the difference between Canada and Norway is the fact that Norges Fiskarlag and the Fish Farmers Association requested that the Canadians meet them together.

"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 fishermen 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

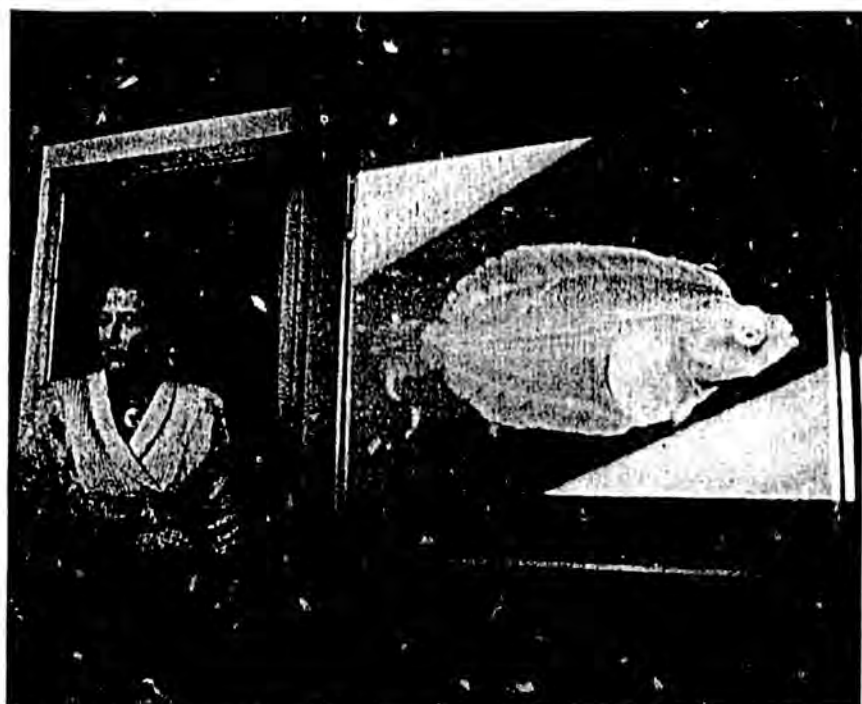


Norwegian scientists have been combatting an outbreak of furunculosis in wild salmon which was introduced to the system from hatchery trout. Infected smolts imported to Norwegian farms near Bergen in 1985 caused a

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 Kyrksæterøra.

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.	