

ALASKA LEGISLATURE SPECIAL COMMITTEE/SUBJECT FILE 8672
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92

Salt pond Artemia for Vietnam shrimp

By Ir. Arjo Rothuis, Institute of Agricultural Engineering (IMAG),

SHRIMP and prawns are among the most valuable exports of Vietnam. Production is estimated to be around 7000 metric tons a year and this is expected to increase to 10,000 tons by 1990.

But until now this has depended on the natural productivity of the coastal region.

In extensive culture systems, the yield varies between 200 and 600 kg per hectare a year.

The culture of shrimp is concentrated in the Plain of Ca Mau in Southern Vietnam, where climatic and biological conditions are very suitable. However, further maricultural expansion in this region is constrained by a scarcity of wild-caught post-larvae, foods and insufficient knowledge of modern aquaculture methods.

Since *Artemia* is regarded as the basic food organism for many fish and crustacean larvae, the availability of sufficient amounts of cysts and biomass is crucial. Although the production of *Artemia* cysts increased to 200 metric tons in 1985, prices of high quality cysts still vary between US\$30-60 a kilo.

But Vietnam — like many other developing countries — has no possibilities for large-scale importation of these cysts. Therefore production in local solar salt-works seems to be the only solution.

Habitat

During the dry season, conditions in the salt evaporation ponds can provide a suitable habitat for *Artemia*. Integration of *Artemia* culture and salt production even results in a better quality (cleaner) salt.

Since 1983, the University of Can Tho under the supervision of Professor Nguyen Kim Quang, has been carrying preliminary introduction experiments in the salt farms of Bac Lieu and Vinh Chau.

The promising results led to a cooperation project between the University of Can Tho and the Dutch

Committee for Science and Technology for Vietnam together with Jaap Brands from the Institute of Agricultural Engineering in Wageningen. He and Gert-Jan de Graaf selected materials worth US\$35,000 to be taken to Vietnam.

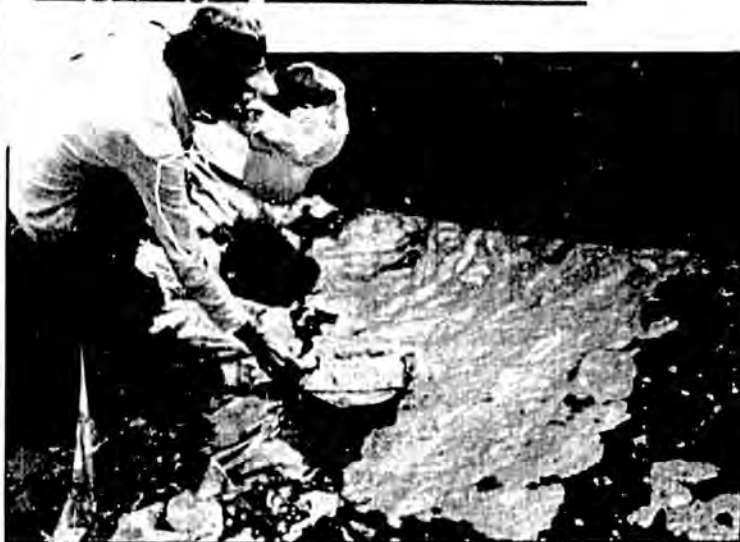
In December 1985, the laboratory in Can Tho was equipped with these materials for cyst processing, canning and quality analysis. At the salt farm of Vinh Chau, a simple field laboratory constructed from bamboo and coconut leaves was equipped with materials for cyst hatching and harvest, water quality plankton and *Artemia* analysis. The electricity for this laboratory was provided by a 600 W wind generator. In three *Artemia* ponds, scientific research concentrated on salinity management, fertilisation method and introduction density.

Besides the work on *Artemia*, a *Macrobrachium rosenbergii* laboratory (including recirculation systems for larvae culture) was also built. There, research on optimal use of *Artemia* nauplii, formulation of artificial foods and new husbandry techniques was performed. During eight months, the whole programme was supervised daily by the writer.

At the salt farm of Vinh Chau, from February to July a total of 15 kg dry weight of cysts were produced. The production rate of the best pond was 8.4 kg/ha/month.

With a hatching efficiency (number of nauplii/g cysts) of about 230,000 and an average hatching synchrony (time between ten and ninety per cent hatching) of six hours, the cysts produced were of good quality. Their

Wageningen, The Netherlands.



Collecting cysts of *Artemia salina* in experimental ponds in Vinh Chau.

nutritive value was also excellent.

Analysis at the *Artemia* Reference Centre in Ghent, Belgium, showed a highly polyunsaturated fatty acid content of 14.6 per cent.

Results

Other interesting results are:

- The optimal introduction density with a San Francisco Bay strain (*Artemia* Systems, Ghent, Belgium) is 20-30 nauplii/l.

- Fertilisation of the *Artemia* pond with organic or inorganic fertiliser at high salinities (over 100 ppt) does not induce an algae bloom. The bad food condition will then result in a poor growth rate and a decreasing fecundity (number of eggs/female).

- Besides the quantity of the algae, quality is also of crucial importance. Mass development of filamentous algae causes a poor growth or even mortality of *Artemia* nauplii soon after introduction. This can be prevented by deepening the pond (0.6 m) and fertilisation at low salinities.

- The use of special fertilisation ponds for "flow-through" *Artemia* culture can also prevent these problems. Here plankton-rich water from the low saline fertilisation ponds flows (by gravity or pumping) through moderate and high saline *Artemia* ponds and finally to the salt crystallisation ponds.

- The culture of *Artemia* is not restricted to the dry season. It was observed that even in the rainy season at a low salinity (85 ppt) cysts were produced. Wind and wave action caused a dispersion of *Artemia* over the nearby salt and evaporation ponds, resulting in a biomass production of about 2.5 tons.

The biomass was used in nursery ponds stocked with a mixed population of wild-caught shrimp post-larvae.

Another part of the *Artemia* biomass was processed

and incorporated in a pelleted food for *Macrobrachium rosenbergii*.

The produced cysts were also used in the *Macrobrachium* hatchery. Introduction of the clear water larval rearing technique indicates a

production potential of about 30 post-larvae/l. And this was without the use of any chemicals for disinfection and/or disease treatment.

Results of the work are very encouraging. Also,

With its long coastline Vietnam offers substantial growth prospects for the development of shrimp and marine fish culture. The work described here is being carried out in the far south of the country.

through the cooperation of the University of Can Tho and the provincial authorities of Hau Giang, costs have been kept low.

Vietnam — with a coastline of 3000 km — has about 150,000 ha of land available for coastal aquaculture. It is believed that in the near future the results of our project can contribute to an increase in the production of farmed fish and shrimp in this country.

The Dutch Committee for Science and Technology and the University of Can Tho have, therefore, agreed on a close cooperation in the coming years, which will be coordinated by Jaap Brands.

● Further information on the project can be obtained from Mr Brands at IMAG, P.O. Box 43, 6700 AA Wageningen, The Netherlands.

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Introducing *Macrobrachium* culture on a laboratory scale at the University of Can Tho.

World-wide service from Norway



Dr. Ole Vahl, Noraqua's director of science and technology.

WITH its now considerable experience in aquaculture, Norway is marketing much more than high-quality salmon and trout. Norwegian manufacturers of farm hardware are finding world-wide outlets for their products. And, increasingly, Norwegian experience and expertise is being sought and used in projects that range from a shrimp farm in West Africa to a land based salmon farm in Iceland.

The latter project is one of a number now being undertaken by the Oslo-based company Noraqua as a joint venture partner, finding capital for development, providing technical back-up and drawing in many other ways on its experience in aquaculture.

Noraqua is in one of the three divisions of the large Selmer-Sande group. Two of these divisions engage in general construction contracting and offshore work.

The third is involved in aquaculture, fisheries and biotechnology. In addition to Noraqua, firms in this division include Norfco, which is engaged in the management of international fishery projects; Norbio, in biotechnological research; and the research firm Biotech, whose work includes biotechnical processing, feed processing and disease control.

Another associate company more immediately linked with Noraqua in fish farming is Kvaløys A/S on the island of Maløy which lies between Bergen and Alesund on the Norwegian west coast.

Founded in 1924, Kvaløys was an exporter of Norwegian salmon long before this was a farm product. It processes and markets other popular food fish species, and it is now also a farming company. With its own harvest plus the production of other farm, Kvaløys exports about 2000 metric tons of salmon a year.

This integrated operation also serves as a training centre for people employed in projects which Noraqua is carrying out itself or is

assisting in one or more stages.

The company is organised to participate in an aquaculture venture at any level from initial project evaluation through to the construction of the farm and opening up markets for its fish.

Looking at evaluation, Noraqua says that this and other services can be provided on a consultancy basis for projects in which the company is not involved as an owner or a partner.

Increasingly, however, it is participating in the projects, helping to design them and finding technical solutions where these are needed. It is also experienced in setting up companies and in finding capital to start and operate worthwhile ventures.

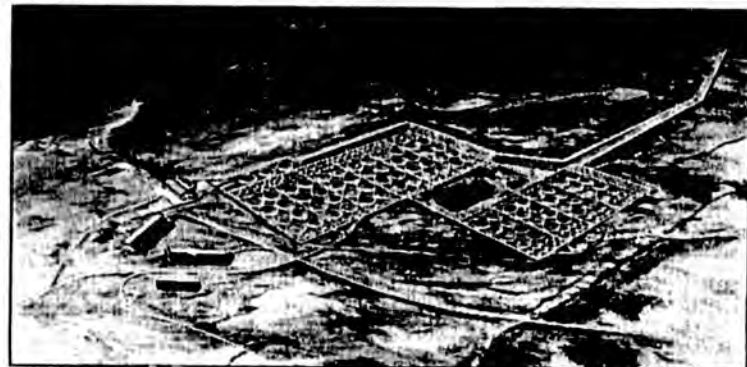
Through its research-based associate companies, it is able to find the most suitable stock, to develop protection against disease and to investigate and

obtain the best feeds for growth.

Opened by Prime Minister Steingrímur Hermannsson in July, the new Islandsfax salmon farm on the Reykjanes Peninsula in south-west Iceland near Keflavik airport is one of the largest of Noraqua's joint venture projects.

This is a hatchery making use of the warmed water from thermal springs in the area and then on-growing the fish in tanks ashore where they are protected

Noraqua helps develop farm projects from Iceland to Tasmania



This drawing shows how the big land-based salmon farm of Islandsfax will look when it is completed.



The hatchery building at Islandsfax.

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Trial harvest of rainbow trout in Tasmania.

Above: Noraqua floating hatchery on a hydro-electric dam in north-eastern Portugal. The first on-growing cages can be seen on the right.

Left: Trial harvest of rainbow trout in Tasmania.

Right: Experience gained by Noraqua on the Kvaløys farms on Maløy on the west coast of Norway is applied to the company's project around the world.



against the cold temperatures of the Icelandic winter. Described briefly by features editor Tom Wray in *FFI* in July, the Islandsfax farm was started by the Samband cooperative organisation and Noraqua and was set up with financial help from the Nordic Investment Bank.

Hatchery

Although eventual production could rise as high as 5000 tons a year, the initial scheme is more modest. The hatchery unit is designed to produce about 750,000 smolts a year. From the incubators, the young fish are raised through fingerling to smolt stage in freshwater tanks. From these, they will be transferred to the large on-growing tanks which are made of reinforced concrete.

Noraqua designed and engineered this farm which should be harvesting about 750 tons of salmon in 1988.

Speaking to *FFI* recently, Dr. Ola Vahl, director of science and technology in Noraqua, described some of the company's other substantial projects in Portugal, Australia, Chile and the United States.

A graduate in science from the University of Bergen, Dr. Vahl joined the company in 1985, having spent some 18 years in various research and development projects. These included work in the development of scallop farming and processing.

"Our operating company in Portugal," he told *FFI*, "is setting up a hatchery and cage project to raise large rainbow trout in the freshwater of a hydro-electric dam."

This farm is sited in the north-east of the country and the design had to allow for the dam's changes in

water level. The solution for the Quinta do Salmao farm was a hatchery building that floats with the cage system.

Noraqua has been working on the project since 1985. It is expected to attain a production of 300 tons in 1988; the company will also supply and service other trout farms in the area.

When Noraqua became involved in a salmonid venture in Tasmania, one of the problems faced by the company was the Australian prohibition on the importation of eggs or live fish. But there is a stock of land-locked salmon in New South Wales and the eggs from these fish are being used.

Salmon Enterprises of Tasmania (Saltas) is a joint venture company with the government of Tasmania holding 51 per cent. Local interests in the state hold 30 per cent and Noraqua has a 19 per cent share.

"This is a smolt producing and research company," said Dr. Vahl, adding that Noraqua would be providing technical support. Under the agreement setting up the operation, it has an option, for the first ten years, to buy 40 per cent of the smolt output.

Million smolts

Hatchery production was expected to begin with 160,000 smolts in November, rising to one million smolts by 1989.

A salmon on-growing company, has been formed by Noraqua. Through an associate company called Norlax, it also has a 50 per cent share in Nortas, which plans to grow about 350 tons of rainbow trout a year in seawater. The other 50 per cent of Nortas is held by local investors.

Another Noraqua operation in the Southern Hemisphere is in Chile. There

Norlax Chile is importing Atlantic salmon eggs from Norway through Noraqua's own quarantine depot set up for the export of trout as well as salmon eggs.

Chilean Salmon (Chisal) is working south of Puerto Montt where a hatchery should be producing about one million smolts a year by 1990.

"The hatchery site is in a remote area in the south," said Dr. Vahl. "It was selected because it is alongside a very good and rather unique river."

Volcano

The hatchery is at the foot of a volcano. The river flows from a lake along the side of this volcano and the water is not only clean but is warmed to a steady year-round temperature of 8-9 deg.C.

"This presents exciting opportunities for fish farming," said Dr. Vahl.

Another Noraqua joint venture project has taken the company away from salmonids, to the dorado or dolphin fish of warm sea waters. Laboratory and hatchery work on this fish began in Bermuda. A hatchery is being set up in Florida, USA, and there are also plans to develop farming in Hawaii where the dolphin fish is a popular delicacy known as mahi mahi.

"We have been looking for a suitable site in Hawaii," said Dr. Vahl.

One way of farming the fish would be to use floating raceway technology developed at the Kvaløys farms in Norway. But another technical possibility for Hawaii could be a land based seawater system.

Further information about Noraqua and its activities and services can be obtained from Noraqua A/S, Box 5101, Majorstua, N-0301 Oslo 3, Norway.

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ABOVE: Even with the help of a net, harvesting the large active fish can be dangerous. Watch your ears!

RIGHT: Another view of the pond farming operation in Iran. Farm workers bring in a net load of carps. The shore of the Caspian Sea is one area where the pond culture of various carps is now well developed.



LAKE FARM CAGES WILL BOOST

IRAN'S FISH SUPPLY

IRAN, like other Middle East countries, has no tradition of fish farming. There are some large ponds on the shore of the Caspian Sea, where common, silver and grass carps — as well as sturgeon — are bred and raised to stocking size. There are also some trout farms near the capital Teheran, and in Shiraz in the south of the country.

Fish is very popular in Iran, and at the Iranian New Year in March no family would do without a fish on the table.

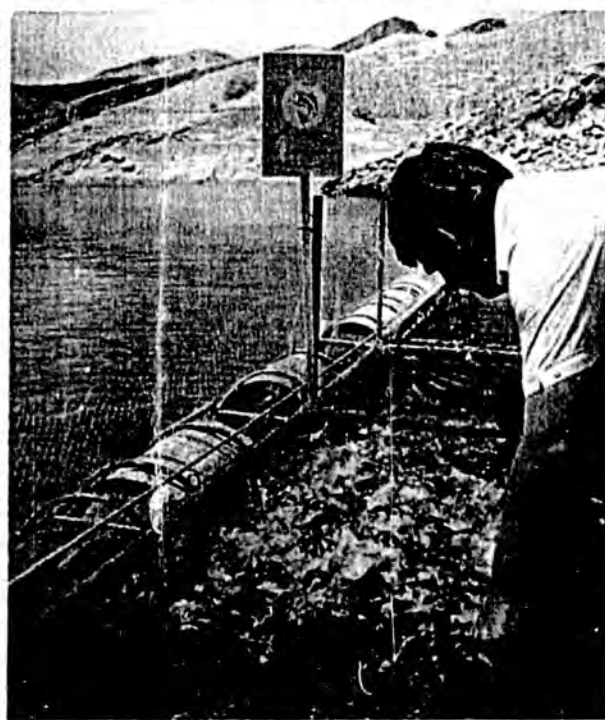
Ten years ago the Agriculture Department of the University of Ahwaz in the province of Khuzestan, north of the Persian Gulf, installed its first fish pond. Positive results led to the erection of a modern breeding station which nowadays has a water area of 500 hectares.

The two to ten hectare ponds permit intensive production. Some ponds are reserved for holding broodstock and young fish.

Pond water supply is taken from a channel of the Karun irrigation system, and each pond can be drained. Last year a modern warm water hatchery was erected for the controlled breeding of carp and other herbivores. Yearly production capacity of the plant is now 1000 tons.

Dr. Esmail Heydarpur of Ahwaz University is the "father of fish breeding" in southern Iran. Dr. Heydarpur studied agriculture in West Germany with special instruction in fish breeding. He wants to accelerate the development of fish farming in Iran to provide the population with protein through the consumption of economically-priced fish such as the carp.

Dr. Heydarpur therefore started a new project financed by Karun Agro Industries. Earlier pilot tests with small, self-constructed net-cages in



Dr. Heydarpur with the first harvest from the pilot net cage installation in Iran's Lake Dez.

**Report
by:
Gerhard
Moller**

the Dez storage lake near the town of Dezful in western Iran proved that the lake offered ideal conditions for growing common carp (*Cyprinus carpio*).

The lake has a water area of about 5000 hectares and a depth of 150 metres. Surface water temperature from June

until September is 30 deg. C, while from October to May it is over 10 deg. C.

In 1984, the West German consultant Dr. Christian Proske of the Inter-Fish company was entrusted with the delivery and construction of a large net cage plant in the

lake. Work was completed early in the summer of 1986.

For the project, a huge cage complex with a net capacity of 11,000 cubic metres was chosen. The net depth of eight metres makes it possible at high temperatures for the fish to seek the cooler waters at the bottom of the cage.

Some nine cages with a diameter of 42 metres each are anchored over water 100 metres deep. Impairment of the water quality by intensive stocking of fish in the cages is said to be out of the question. A strong water flow through the lake — on average 200 cubic metres a second — would, it is claimed, allow the yearly production of 5000 tons of fish without damaging the environment.

The Inter-Fish net cage plant has a capacity of 700 to 1000 tons of carp a year. These figures will increase when local personnel become familiar with the operation of the farm. Fingerlings of 30-50 grams are delivered from the pond hatchery station.

Besides the large net cage installation, a huge amount of equipment had to be bought for the efficient functioning of the Lake Dez cage farm.

For the project, Inter-Fish delivered, among other things, a 60-ton catamaran-type work raft powered by two 35 hp outboard engines. The raft has a large working surface for setting out and harvesting the fish. A one-ton crane powered by a generator set is also fitted, and the raft is able to carry a truck.

Inter-Fish also delivered three outboard-powered workboats and a raft capable of transporting three tons of feed per load. Other equipment included a Mercedes-Benz cool truck, a fingerling transporter and trailer and a Unimog work truck.

Each of the net cages supplied by Inter-Fish consists of 16 parts and has a circumference of 144 metres. Six anchors weighting five tons each and fabricated in Iran each secure three cages. The water surface level of Lake Dez can vary up to 40 metres, and during storms waves two metres high can be generated.

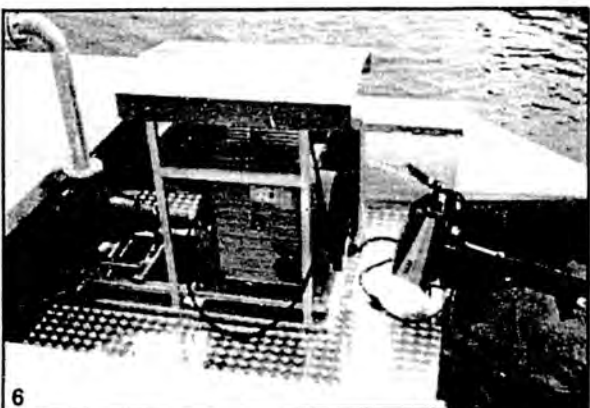
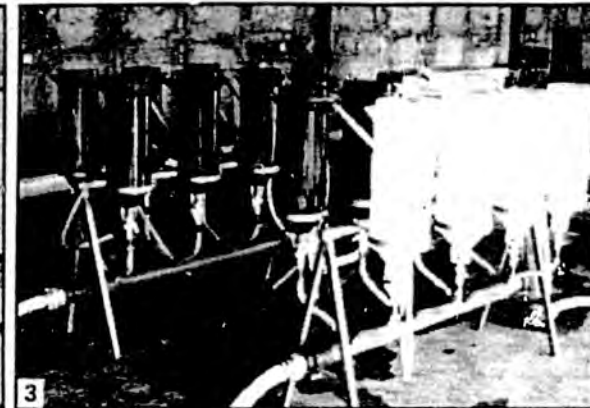
For harvesting, the content of a cage a separate net is spread into the cage, hauled in and the fish is put into boxes aboard the raft. Each 500 kg batch of boxes is loaded by crane onto the truck standing on the raft.

After landing of the raft ashore, the fish is trucked to cold store. Next morning the cool trucks transport it on ice the 1000 km or so to Teheran. Nearly all fish from the lake will be marketed in this way, and will be with the consumer no later than three days after harvesting.

Lake Dez fish farm has 30 employees. Fish feed is presently brought from Teheran, but a feed mill as well as a cold storage depot and large ice machine are planned for the farm site.

Karun Agro Industries is also owner of the net cage farm, and has so far invested about five million Deutschmarks. It is said that investors will see a return on their money within two or three years, and the excellent quality and eating qualities of Lake Dez carp will ensure a strong demand well into the future.

1. The huge net cages were assembled by three German specialists assisted by Iranian college students. 2. Mounting the nets to the new cages. 3. A group of Zuger glasses in the firm's own hatchery. 4. The nine net cages floating in Lake Dez. 5. This Mercedes truck is used to transport the carp fingerlings. 6. One of the three smaller work rafts. 7. The famous 'Dez carp' is very popular and not only in the Dez region of Iran. 8. The one-ton crane being erected on the large work raft.



ALLIGATORS COME BACK

THE AMERICAN alligator was once classified as an endangered species in its native haunts in the southern USA.

Now, however, it is once again thriving in states such as Louisiana where there is an abundance of natural swamp and marsh habitat.

This did not happen by accident. Conservation and restoration programmes organised and directed by the Louisiana Department of Wildlife and Fisheries (LDWF) did two things.

First, they generated enough wild alligators for the state to initiate a 30-day trapping season each year in September-October. Since 1972, 150,000 alligators have been harvested statewide. Last year, in addition to hides, 136 metric tons of meat was sold.

Second, they gave rise to an aquaculture industry in Louisiana which is expected to grow enormously from its present nucleus of 13 licensed farms over the next decade.

Vital part

The LDWF considers cultured alligators to be a vital part of its conservation and restoration programmes.

It has sponsored research since 1964 at its coastal Rockefeller Wildlife Refuge, led by biologists Ted Joanen and Larry McNease, which has perfected farming techniques employed throughout the South. It has also provided hatching year alligators from state-owned lands to qualifying farmers until they can generate broodstock capable of making each farm self-sustaining.

According to Mr. Joanen, the 13 licensed farms will soon become independent of the programme and LDWF

Louisiana perfects culture, reports Dr. Jay V. Huner



A four-metre long alligator waits for its food, while a handler at the farm talks to visitors.

will start supplying stock to 20 or more qualifying applicants who wish to start their own operations.

Larger

Broodstock, wild or domestic, is not available but some prospective farmers are buying larger domestic animals to grow-on for broodstock.

LDWF biologists have developed techniques which use environmental culture

Initial stocking rates for 15 cm hatchlings is five per sq. m which is reduced to two at the end of the first growing year.

Food of choice is ground (first year) or chopped (second to third years) carcasses of nutria (*Myocaster coypus*) with a vitamin/mineral supplement.

Nutria is readily available during the winter trapping season at \$0.18-0.22 per kg and is stored for year-round use. A less satisfactory food is ground trawl by-catch (fish) from the state's marine shrimp fishery.

Growth

At the end of the third growing season, alligators average 1.5 m (1.2-1.6 m range) and weigh 21 kg (15-30 kg range). This growth requires about 105 kg of food with 64 kg being consumed between the second and third years.

This is considered an economically viable proportion as hides average about \$66 per kg and the flesh averages about \$4 per kg. Rising temperatures to 31 deg. C can shorten the growing period to 12-18 months. But, it is still not clear if it is economical to raise alligators at such elevated temperatures.

Under current economic conditions, cultivated alligators need to be harvested after three years because third year food conversion rates decline greatly and stocking densities decrease beyond any cost benefit ratio. Prospective brood-

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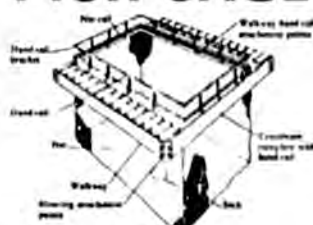
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Broodstock on a Louisiana farm.

stock is cultivated in open systems at ambient temperatures and there is essentially no growth from October through early March.

Cultured alligators first mature at an age of six years compared to 9-10 years for wild animals (2+ m for both) but do not become successful spawners until they reach nine (cultured) or 13 (wild) years of age.

Relatively large pens (0.8 ha) are needed to simulate natural habitat and permit stocking of 17.5-22.5 adults per ha (sex ratio one male to 2-4 females).

Fertility

Females make mound-like nests of natural vegetation and lay an average of 40 eggs that are 85 per cent fertile with a 70-75 per cent hatch rate.

Broodstock must be fed nutria carcasses or some equivalent food if it is to produce viable offspring consistently.

Eggs are removed from nests before day eight and incubated in nests made with natural nesting materials in environmental chambers. Best temperature is 31-31.7 deg. C. Nesting material must have a high moisture content to facilitate microbial breakdown of the egg shell so that young can hatch successfully. Moisture

levels must be about 90 per cent during the incubation period of four to five weeks.

Currently, it appears that annual farm production of 200-1000 alligators is required for partial or sole source income levels. Some farmers also open their farms to the public at a nominal charge to supplement their incomes.

Louisiana farmers are now producing 3000 skins and 18 tons of meat a year. This will, according to LDWF biologist Joanen, increase dramatically in five to ten years as more farms begin production.

He notes that current production of farmed and wild-harvested alligators, mostly from Louisiana and Florida, provides less than ten per cent of the international demand for alligator products. He sees little competition from more temperate areas because of the costs of maintaining heated systems and generating broodstock at ambient temperatures. Food is cheaper too.

Advantages

Wild harvest of alligators is not expected to fluctuate much. Farmers have several advantages in competition with producers of wild animals. First, hides are superior; second, the cultured animals have larger hides per unit of length; and



Young alligators wait for their frozen food to thaw.



Yearling alligators inside a holding chamber which is heated during cool weather.

third, cultured animals may be slaughtered at any time.

Thus, aquaculturists in Louisiana are confident that alligator aquaculture will be a major industry within a short time.

● Further information about alligator aquaculture and availability of alligator products may be obtained from Ted Joanen, Louisiana Department of Wildlife and Fisheries, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70643, USA.



In addition to the farm production, about 15,000 wild alligators are taken each year in Louisiana.



Considerable skill is required to make sure that the alligator hide (worth about \$46 a metre) is not damaged during skinning.

Hatchery sell-off for Canadians

CANADA'S federal government is planning to sell off ten salmon hatchery operations in the Maritime provinces.

It is prepared to sell to provincial governments or private enterprise.

But the plan has already run into opposition in the provinces. New Brunswick's Fisheries Minister Jim Tucker criticised his federal counterpart Tom Siddon, saying that provincial governments do not have the money to buy the hatcheries.

"The hatcheries should continue to have federal involvement," said Mr. Tucker. He suggested a joint agreement involving both levels of government, saying that federal officials were needed because of their expertise in salmon enhancement.

Meanwhile the private fish farmers, of which around 20 are based in New Brunswick, have greeted the plan with much more enthusiasm. The market for salmon is currently buoyant and they see the sale as an opportunity to take advantage of this.

Scottish feeds mill opened

NEARLY 200 fish farms throughout the Scottish Highlands and Islands stand to benefit from the opening of BP Nutrition's specialist production mill for feeds at Invergordon.

The ceremony was performed on November 24 by John MacKay, Minister for Education, Agriculture and Fisheries at the Scottish Office.

The £34 million project comprises a modern fish feed mill which will supply expanded and pelleted salmon feeds throughout Scotland, Northern England and Ireland.

BP's two other fish feed plants are in Lancashire, where the emphasis is on fry

feed and pelleted trout food, and Witham in Essex, which supplies expanded trout feed to the farms of Southern England.

The new mill at Invergordon is fully computerised and automated.

Intentionally sited on a green field location at the Inverbreakie Industrial Estate, the most modern purpose-built fish feed mill in Europe will benefit both wheat farmers and fish meal producers.

Crops are used in the production of salmon feed and 60 per cent of the raw material is fish meal from wild caught fish, much of which is landed by the Scottish fleet.

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Meeting looks at oyster quality

MUSSEL fisherman and oyster growers from the Teign Estuary in South Devon, England, met officials recently to discuss shellfish production and better quality.

The gathering at Forde House, headquarters of the Teignbridge Council, was attended by representatives of the Ministry of Agriculture, Fisheries & Food, DHSS, District Council Environmental Health Officers, the Shellfish Association of Great Britain and South West Water.

Bernard Young, Teignbridge Chief Environmental Health Officer, said the main purpose of the meeting with local fishermen was to look at ways of improving the quality of oysters.

The Teign Estuary is one of the most important Pacific oyster growing areas in the country and production is steadily increasing as demand for this type of oyster expands.

But about five years ago — because of sewage pollution — Teignbridge Council made an order that all shellfish grown in the Teign must be purified and also relaid in a cleaner part of the estuary for four weeks before sale.

This practice has substantially reduced the number of public health outbreaks and at the recent meeting Devon fishermen and shellfish merchants agreed to continue to relay oysters in cleaner waters during the winter period.

After years of research on catfish ... Dutch team turns to eel culture

A DUTCH university's fish culture and inland fisheries teaching and research team set up in 1975 has gone on to win an international reputation for the quality of its work.

And it has recently begun to act as an important catalyst in the development of intensive fish culture in the Netherlands.

The team works within Wageningen Agricultural University's Department of Fish Culture and Inland Fisheries. Starting with a part-time staff member of just one — Professor E. A. Huismans — the Department now has a full-time team of about 20 scientists and other specialists.

It is staffed by experts in a number of aquaculture and fisheries fields. These include fish reproduction physiology; fish nutrition, feeds and feeding; fish health care and fish diseases; fish husbandry technology; and fisheries biology and management.

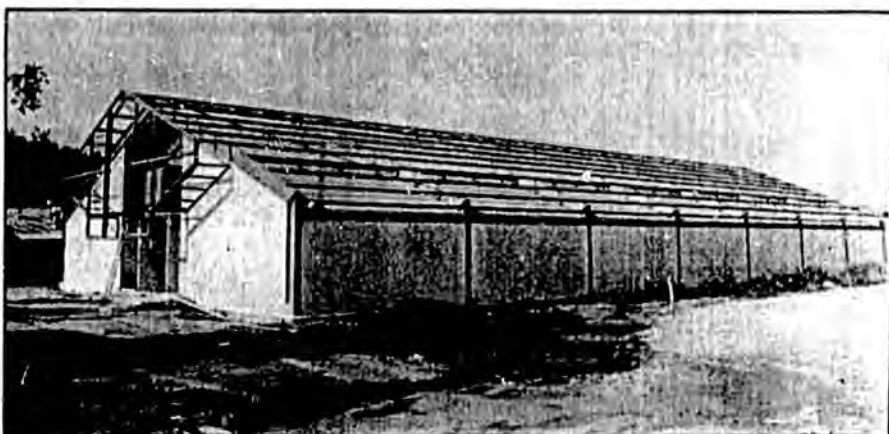
Since it was founded, the Department has produced many MSc. and PhD. graduates, and has been involved in several fish culture and fisheries projects in tropical countries.

The Wageningen team is probably internationally best known for its work on the African catfish (*Clarias gariepinus*). The team's years of dedication and research on this spectacular looking fish have played a major part in bringing its culture to commercial fruition both in Africa and, surprisingly, in Holland itself.

The African catfish is now cultured in ponds in a number of countries such as the Ivory Coast, Cameroon and the Central African Republic.

In the Netherlands this fish is grown in recirculation systems at high densities.

The Department started its applied research work on the African catfish in 1977. With the National Fish Culture Station in Bangui in the Central African Republic, FAO, the University of



This new three million guilders laboratory at Wageningen will be used to carry out research on a number of fish species including eels. It features an advanced recirculated water system.



Ing. E. H. Eding, one of several of the Department's researchers working on African catfish.

Utrecht and Israel's Kinneret Limnological Laboratory, it developed a new culture technology applicable in developing countries.

Results of this research, ultimately aimed at improving the nutritional status and

income-generating capacity of developing countries, have recently been published in the *Practical Manual for the Culture of the African Catfish* (reviewed in *FFI* in September).

Steroids

Hormonal control of reproduction in African catfish has been an important research area investigated by the Wageningen team. Researchers are currently looking into the role of steroid conjugates in stimulating reproduction to further enhance the culture of this fish.

This project is concentrating on the formation of gonadal steroid conjugates and the role of these water-soluble steroids in the regulation of egg maturation,

ovulation and spawning. The results may lead to the production of pharmaceutical products for fish culture.

Other research has shown that cold shocking of eggs is a successful method to introduce triploidy in African catfish. The exact time at which the cold shock should be applied is two to four minutes post-fertilisation.

Much of the interest for induced triploidy in fish culture is based on the assumption that triploids would be sterile and may show better growth than diploids at least after the time of sexual maturation of diploids.

Experiments at Wageningen have shown that, after gutting, more product remained in triploids than in diploids. The researchers recommend that decisions in favour of triploid culture of the African catfish should

therefore be based more on expected advantages concerning body composition and gutted weight than on an expected increase in growth rate. Growth rate was not significantly affected by triploidy.

Fish health

Research in fish health and fish diseases by the Department of Fish Culture and Inland Fisheries at the Agricultural University of Wageningen is assuming greater importance as the number of fish farms in the Netherlands increases. Production systems used are very intensive and run high risks of sudden outbreaks of diseases.

It is therefore very important to be able to assess the level of fish health. Such

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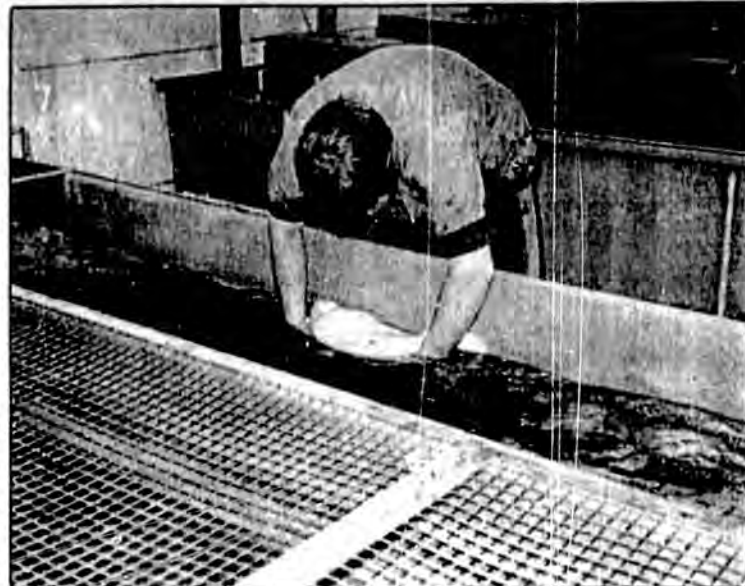
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One of the African catfish broodfish at the Wageningen research laboratory.



Inspecting a carp in the broodfish unit.



PhD. student Hans Kome leads an experiment on inbred lines of carp.



Mr. M.A.M. Machiels is developing a computer model to calculate fish growth from biochemical information.

assessment could enable supplementary management measures to be applied in time to prevent disease-induced economic losses.

Present research in this area focuses on checking out the validity of certain haematological parameters (leucocytes, plasma proteins) as a useful feature of fish health. This is being carried out on a number of species-specific diseases including the nervous syndrome of carp, the ruptured intestine syndrome of catfish and the summer mortality of marine cultured rainbow trout.

Until recently, the bulk of Wageningen's research work has centred on the African catfish and carp. But with the imminent opening of the Department's impressive new three million guilders laboratory, Dutch investigations into the culture of the European eel are set to move into top gear.

Interest

There is now tremendous interest in the intensive culture of eels in northern Europe, and the Wageningen team is eager to probe the

secrets of this poorly understood fish, which has still to reproduce and ongrow fully in captivity.

Two of the things the Dutch researchers will be looking into are how to influence sex differentiation in eels, and how to artificially induce ovulation in the reproduction cycle.

In the Department's new 740 square metre laboratory on the Wageningen campus, research will be carried out not only on eels but also on the African catfish, Indonesian catfish and carp.

A recirculation system will provide gas-heated water at the various temperatures required to a series of 1000 litre capacity rectangular tanks and smaller aquaria. There are no windows in the laboratory, the artificial lighting intensity in each room being individually controlled to provide the photoperiod required.

Wageningen University offers various opportunities for training foreign workers in aspects of aquaculture. These opportunities have largely arisen from the needs of development co-operation and from the long-standing association between experts

and institutes in the Netherlands and certain tropical and sub-tropical areas.

As courses are given in English, participants are required to have a good command of this language. A certificate of proficiency may be stipulated.

The Wageningen Agricultural University in October 1986 started a Master of Science course in animal production and aquaculture, designed for graduates from developing countries. Applicants are selected on the basis of their academic record and on the results of an entrance examination. The course lasts two years.

The MSc. programme includes a series of basic modules covering design and analysis of experiments, data

processing, nutritional physiology, farm economics, microbiology, principles of animal production, animal physiology immunology, and endocrinology and reproduction.

Then, those students specialising in aquaculture rather than animal production, will go on to study the principles of fish production, fish health control and fish technology, fish feeds, aquacultural engineering, problem solving and so on. Students must submit and successfully defend a thesis.

An important aspect of the University's training for Dutch students is that they have to spend a total of five to six months on practical work. This is more often than not given abroad.

The Department of Fish Culture and Inland Fisheries itself is also involved in projects abroad. As well as its work with the African catfish in the Central African Republic, it has been engaged in a grass carp project in Egypt, is now helping to upgrade fishery education in Indonesia, and has accepted a research upgrading assignment in Costa Rica.

● Further information from The Agricultural University, Department of Fish Culture and Inland Fisheries, Zodiac Building, Marijkeweg 40, POB 338, 6700 AH Wageningen, The Netherlands.

Over: Holland looks to intensive fish culture

Indian prawn hatchery

AS PART of its overall strategy for developing brackish water prawn farming, India's Marine Products Export Development Authority (MPEDA) has entered into a technical cooperation agreement with the firm France Aquaculture.

The firm is setting up a hatchery for the supply of tiger prawn (*Penaeus monodon*).

This hatchery will be based at Godalpur in Orissa on the east coast. It will have a production capacity of 25 million larvae a year and is expected to boost prawn farming in the state, which is seen to have great potential.

The hatchery is scheduled to be commissioned by the end of 1987.

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Pakistan shrimp

WORK is nearing completion on the construction of a pilot shrimp culture project at Bhora Bari Taluka, in Pakistan's Thatta district. Building began in 1982, and the cost should come to 28 million rupees.

The station will consist of 12 experimental ponds of 3.2 acres each, eight demonstration/commercial ponds of 12.5 acres, four nursery ponds, a field laboratory, facilities for shrimp processing and feed storage, offices and staff accommodation.

The first crop will be raised from March to June next year, with plans for another from July to December. The production target is 40 kg an acre, totalling 40 tons a year.

Also in the Thatta district, an aquaculture training institute has been set up near Chilya. This will run three month courses for up to 40 trainees at a time.

Holland looks to intensive fish culture



Johan Verreth, chairman of the Netherlands Society for Aquaculture.

UNTIL a few years ago, the main fish species cultivated in the Netherlands were the roach, pike-perch, carp, pike and rainbow trout.

Only the rainbow was grown for the table market, the other species being cultured for restocking Holland's extensive network of ponds, lakes, streams and canals.

In 1985, about 100 tons of rainbow trout was produced by Dutch farmers. Most of the fish is grown in traditional ponds, and one or two people have also recently started to grow them in net cages at the edge of the sea.

But according to Johan Verreth, chairman of the Netherlands Society for

Aquaculture and a researcher with Wageningen University's Department of Fish Culture and Inland Fisheries, climatic conditions in Holland are not really favourable for growing trout.

"Our summers are too warm and our winters too cold," he explained. That is why the seawater cage culture of trout in the Netherlands is facing a number of disease problems. The pond farms are also facing problems with water quality.

The rapidly growing interest in the Netherlands in the intensive warm water culture in recirculated systems of the African catfish (*Clarias gariepinus*) and the European eel stems largely from the pioneering work done by Wageningen University's Department of Fish Culture and Inland Fisheries.

Because the catfish can tolerate low oxygen levels in the water, it has been found very suitable for culture not only in African ponds but also in intensive recirculation systems in Holland.

Stocking densities used by Dutch farmers are said to range from 350 to 400 kg of fish per cubic metre, and at Wageningen University African catfish have even been grown at 500 kg per cu. m.

The Dutch catfish farming industry seems to be dividing itself into a few specialist producers of fingerlings and a larger number of ongrowers. Many of the latter are pig or poultry farmers seeking diversification because of EEC and national restrictions on their traditional farming activities.

KNOWN more for the cultivation of mussels and cockles than for fin fish farming, the Netherlands nevertheless has a small but growing fish farming industry producing for the table market chiefly rainbow trout, African catfish and eels. To find out more

about these developments, FFI features editor Tom Wray went recently to Holland to talk to JOHAN VERRETH, chairman of the Netherlands Society for Aquaculture, and WOUT DEKKER, a member of the R&D group of Trouw & Co. BV International.



A rainbow trout cage farm in Geedereede harbour south-west of Rotterdam.

Trouw's Wout Dekker estimates the Netherlands' total production of African catfish in 1985 to be somewhere between 60 and 80 tons. This year production could jump to 150 tons, and for 1987 a figure of 400 tons has been forecast.

Challenge

But though it had been proved that the African catfish can be grown very easily in Northern Europe, it is a completely new species to most Europeans and presents a tough marketing challenge.

No beauty in the round, the African catfish is however said to yield excellent filets and makes very good eating when smoked. The smoked product has a flavour somewhere between that of mackerel and eel.

But production of African catfish in Holland is increas-

ing too fast and the market is currently oversupplied, said Johan Verreth.

According to a report from the Dutch Agricultural Economics Institute, farms already constructed by 1985 were capable of producing 500 tons a year, and with new investments made this year annual production capacity could have jumped to 1500 tons.

Starting out with small fish of 2.3 mg, Dutch growers can rear African catfish to a market size of 6-700 g in seven to eight months. Feed conversion is said to be close to 1:1, and the production of 50 tons of fish requires about two to three hours of work a day.

According to Wout Dekker, it is not possible to discuss a realistic cost price for the fish because it depends on the size of the farm and the fine tuning of the production system. But in only

three years the African catfish has become a luxury item sold mostly to the restaurant trade, though some fish has been sold through the Paris wholesale market.

"We estimate that prices should be between 9 and 12 guilders a kilo," said Mr Dekker, who is also on the board of the Netherlands Society for Aquaculture. "But after a couple of years it could drop to 6-7 guilders as systems are fine-tuned."

Question

The Dutch success in growing African catfish in warm water recirculated systems posed the question of whether or not that success could be translated to other, more difficult, species such as eels, for which there is a huge unsatisfied market.

That some people think so can be seen from the flurry



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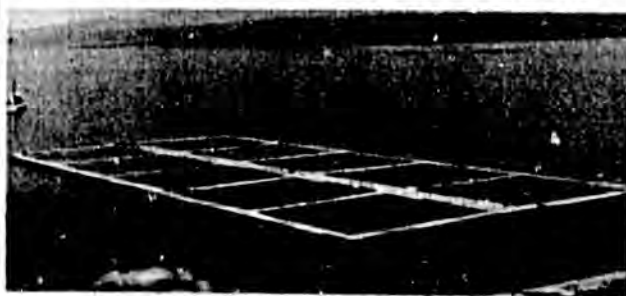
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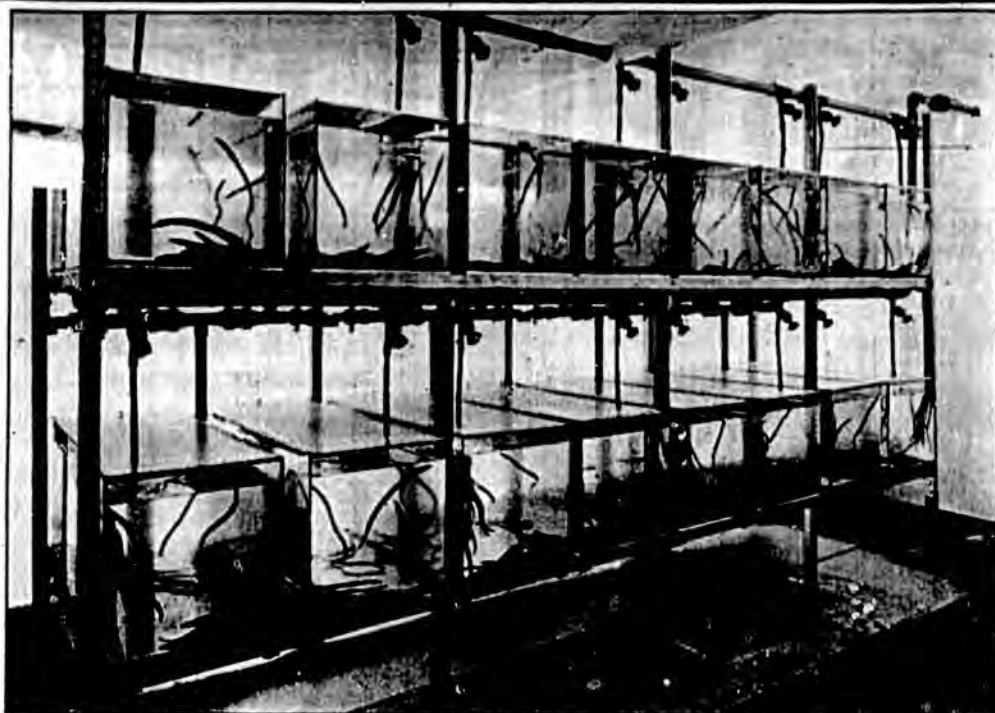


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Eels at Trouw International's rebuilt test farm near Putten east of Amsterdam.

of activity now taking place in Holland. Johan Verreth told *FFI* that a number of huge eel farm projects are in the planning and construction stages with annual production capacities of up to 800 tons.

Biggest Dutch eel farm to be established so far is Texvis BV, a 6000 sq. m operation based on 84 rectangular basins in which it is aimed to produce some 300 tons of eels a year by 1988.

Located on the island of Texel, the most southerly of the West Frisian islands opposite the town of Den Helder, the Texvis plant was set up in January of this year by Dr. E. W. Liewes, a former employee of Trouw International. The eels are being grown in recirculated seawater.

According to Johan Verreth, it is unclear whether or not the eel farms based on recirculation systems are going to be commercially viable in the long run. There is no marketing problem but the rearing technology in recirculation has not "crystallised" and there are some technical problems to solve.

Supply

The major problem for eel growers over the next few years will be the supply of glass eels or elvers. That is why Wageningen University's Department of Fish Culture and Inland Fisheries has started work to try and reproduce eels in captivity. The day that hatchery-reared juveniles can be produced

for growing-on in holding facilities will signal a major step forward in eel culture.

A key feature of Holland's aquaculture is its close relationship with education, research and development. The "know-why" of the research institutes, most of which are in Wageningen, is transformed into "know-how" by experimental stations and development centres all over the country and transferred to the farmer through the extension services.

Johan Verreth and his colleagues hope such a system can be developed for Holland's emerging fish farming industry. Wageningen University's Department of Fish Culture and Inland Fisheries has clearly got

much to contribute, as also has Trouw which has over 25 years experience in aquaculture.

Trouw has recently rebuilt its test farm where feeding trials are carried out on various coldwater and warmwater fish.

At a more practical level, a number of Dutch agricultural colleges and high schools are beginning to offer courses in fish culture. Initiatives are also being taken to provide an efficient fish health care service and to develop a quality control programme.



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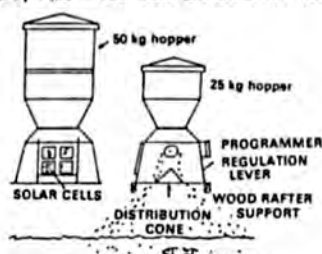
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Sri Lanka link to Stirling

BRITAIN'S Overseas Development Administration (ODA) has set up a six-year formal link for research and training between the Institute of Aquaculture at the University of Stirling in Scotland and the Faculty of Science of Ruhuna University in Sri Lanka.

The link will fund training of staff from Ruhuna in fisheries and aquaculture, collaborative research programmes, and curriculum development for the new fisheries and aquaculture courses being established at Ruhuna.

The Institute of Aquacul-

ture at Stirling is an international institute with students from 22 countries. It undertakes research projects in Africa, South-east Asia and South America, as well as Britain and Europe.

It has had training and research involvement with

Sri Lanka for ten years. Staff from Stirling have also run specialist training programmes and regional training courses in Colombo in conjunction with the British Council on several occasions.

The Institute already maintains a formal link programme with the Agricultural University in Kuala Lumpur and with Songkhla Fisheries Training College in Thailand.

NFU Committee gets a new secretary

ONE of the newcomers to the annual Two Lakes Conference at the Hampshire College of Agriculture in September was Judy Rockcliffe, who has been appointed secretary of the Fish Farming Committee of the National Farmers' Union.

"My mother, being a Londoner, brought me up to favour fish, and lamented the lack of supply through the 1960s and early 1970s," Judy told *FFI*. "So the growth of the fish farming industry, and the greatly increased interest in fish as a food, has been greeted with great pleasure by my family."

Judy has an MA degree in English literature from the University of Manchester.

She first became involved in agricultural politics in 1982 when she joined the NFU to work for the late Peter Jones, then director of the Intensive Livestock Division.

"That was in the days of the whirling disease and preparation for the Diseases of Fish Act," she recalled. "It was also when abstraction licensing, an issue which is still very much with us, was first raising its ugly head."

From Peter, I learnt that, however indirect the link may be, politics affects producer prices, whether it is something which increases costs of production or whether it is an influx of imported fish.

"But, as I see it, the NFU's job is not only to fight against proposals which may damage fish farmers' interests, but also to initiate action which will be of positive benefit to the sector."

"It is important, I believe, for producers to have an input into R&D programmes, for example. Only they know, from a practical on-the-farm basis, what information is really required."

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What price

security?

Asks Michael Ingram

TROUT farming is considered to be a rural activity, forgetting for a moment those enthusiasts who utilise front-line technology with specialised recirculating systems.

In its guise as a peaceful occupation — one with nature itself — fish farming used to be a business which tacitly accepted the occasional loss of stock to the local poacher. Indeed, only a few years ago in my local pub I was regularly taunted by my neighbours with their aside comments such as "one of your fish leapt into my frying pan last night!"

Situated as we are in a quiet out of the way glen, adjacent to the sea, Clearwater Trout Farm used to be protected by a few ancient strands of rusty barbed wire. In fact, this defence used to take such a toll on waders that it was eroded as quickly as possible in most major areas of access to the ponds.

The word "security" rarely entered our vocabulary except as regards the float alarm on the main broodstock pond. Even this was attached to an audible alarm that was so quiet, passing herons used to perch on it before partaking of their daily breakfast.

In time, however, as the farm expanded with the development of the higher technology disease tested all-female and triploid ova, the necessary value of the broodstock requires that more serious thought should be given to both major aspects of security — the control of the

stock and its defence from predators.

The control of the stock (i.e. the use of measures to maintain the *status quo*) was relatively simple to set up.

Originally, a one third home-made float alarm (with the inaudible bleeper) was the sole defence against disaster. In fact, a few days before the purchase of the farm a blockage in the inlet raceway had been the cause of a fish kill which effectively halved the value of the stock (but doubled the expected time sale to achieve commercial viability). The silent alarm can therefore be considered as a totally useless security aid.

Broodstock farming is a specialised business in many ways but its major weakness, with regard to the damage caused by loss of stock, is the time lag to replace such losses. Even more important is the effect on customers who may never receive their eggs.

These eggs are often pre-sold many months in advance, the numbers available determined by the broodstock on the farm. Both the gradual reduction

of stock due to intermittent stealing and the larger losses which can be caused by other, more controllable factors, can result in a damaging shortage of fish at the crucial spawning time.

Easy target

Broodstock are best left alone for much of the year to avoid unnecessary stress. Unlike an on-growing farm, sorting and grading is minimal and opportunities to count the stock are very rare.

By the third year of commercial operation at Clearwater, it was clear that the farm was an easy target for the local thieves (poacher is not a word to use on those people who steal other people's livelihoods) and the

security had to be drastically reduced.

The audible float alarms which had been installed at two or three critical points (in place of the silent tweeter) were the cause of ill-feeling with the only non-farmer whose house overlooked the site. It was apparent that some of the fish took great delight in wellying the float in the dead of night at very unsocial hours!

Purchase of a telephone alarm system removed the nuisance to some extent although the effectiveness was often tempered by an infuriating habit of ringing one up at three in the morning, only to be told that "all systems are normal!"

The computer HAL in the film 2001 has nothing on the

telephone alarms in the Clearwater hatcheries! The only real problem with this form of security alarm is that it is totally dependent on the telephone being replaced on the receiver at the end of the day, and there being no fault on the line.

For example, one of our local residents was being woken at all hours of the night, completely unbeknown to ourselves, by the telephone alarm apparently making its own secret assignments.

But, even at a cost of between £400 - £1000 and coupled with the use of radio-pagers at £35 a quarter, the system still proves its worth time and again; linked as it is to the oxygen electrodes, mains



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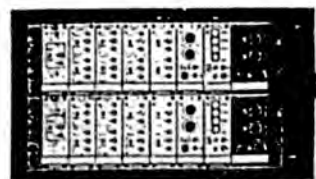


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electricity relays, float alarms and intruder alarms.

With regard to intruders, Clearwater has suffered more than its fair share of unwanted visitors. On the broodstock farm where each fish is valued somewhere between £30 and £100, the removal of any stock is a serious offence as far as we are concerned.

Due to the technological use of powerful lights over the ponds for the photoperiod regime, it was considered that these would be a considerable deterrent — along with a six foot chain-link boundary fence, topped with barbed wire. Unfortunately, modern-day education obviously includes A-levels in fence climbing and after chasing innumerable youngsters across and over the fence it was obvious that even more defence was required.

At an ever spiralling cost, each pond was surrounded

with chicken wire and netting strung across the top. While this netting did not prove a major obstacle in itself, it at least showed if a forcible entry had been made. This is vitally important as the removal of small amounts of fish on a frequent basis can often be more damaging than a 'major removal.'

The chicken wire had the added advantage of making it more difficult for the herons and cormorants to satiate their appetites as they wished. I say "more difficult" because, since the enclosure of the ponds, herons have been observed working their way under the netting (lifting out the staples) and also diving straight down through the overhead netting (six to nine inches square) — and flying straight up again.

Pubs may be open all day on the Isle of Man but such visions have assuredly been



Pond completely netted with artificial light overhead.

noted! Whoever designed a system of two strings around a pond to protect it from herons was either a secret ornithologist subscriber to the Save the Heron Fund or was working with sub-normal, paraplegic birds!

Anyway, apart from such predatory attacks through the netting itself it was considered that, by the summer of 1985, the farm was reasonably well guarded against all but the most determined of thieves. At some point an economic decision has to be made in a business such as fish farming as to how much stock can afford to be "lost" to unknown causes. With a capital investment of some £4000 in fencing, a 24-hour alarm system and variable lights over the ponds, Clearwater was considered to have reached the limit of sensible expenditure on stock protection.

Then, in one night in Sep-

tember 1985, our illusions were rudely shattered. Thieves cut through the chainlink boundary fence, slashed the netting away from one of the ponds and removed about half-a-ton of prime brood fish — one month prior to spawning time!

Prompt announcements over the local radio, contact with all restaurants and hotels and a reward offer of £1000 succeeded in preventing the sale of the fish. But the loss was irreplaceable. A potential one million eggs at a value of £10,000 (as triploids) had been removed from our pre-sold stock.

The solution was clear. High-value stock has to be protected efficiently and effectively and professional methods have to be employed.

On advice from the police (who along with ourselves knew who the perpetrators of the deed had been but



Spawning pond completely netted over. Floats hold airtight for back-up air supply.

were unable to prosecute) and from various security firms, two highly trained guard dogs were purchased — to provide a 24-hour cover.

Similarly, a second chain-link fence topped with an angled barbed wire was erected six feet inside the existing boundary fence around the whole of the farm. Warning signs were placed on all sides of the farm and entry restricted to farm personnel only.

The end product? To the best of our knowledge, no fish have since been stolen from the farm.

One thing is certain. If you have stock of any value, somebody will try and remove it — free of charge. Nobody should consider themselves exempt from this risk and proper provision must be made in budgets for both capital and on-going expenditure on security. The recovery time in fish farming

can be longer than one anticipates.

Today, the fish at Clearwater are safer, but much of the pleasure has been removed from the farming. Even after one had ventured through the double gate at the farm entrance, dipped feet in the disinfectant, and walked gingerly past the baleful glare of the guard dogs (there are now four due to the farm manager discovering a latent love for man-eating hounds), one is still trapped between the confines of chainlink and barbed wire.

As the setting sun silhouettes the barbed wire, red above the sinister black, wolf-like shapes of the guard dogs as they patrol the outer fence, I often dream of owning a quiet rural trout farm in some secluded corner of the countryside, ideally beside the sea — maybe on an island somewhere — where it is safe...? *

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Prawn larvae are born into a hectic world. In the first few days of life the larvae must moult 15 times. A time of great tension.

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In tests in hatcheries around the world, FRIPPAK diets have substantially out-performed all alternatives. They have proved outstanding value for money to hatchery operators by improving larval survival rates, and

enabling optimum growth rates to be achieved. By enabling hatcheries to be a more reliable source of post-larval prawns, FRIPPAK diets are a big marketing plus.

Building on this success, FRIPPAK is now developing new maturation feeds for prawns. In addition, diets are being developed for other sectors of the aquaculture industry including bivalves and fish and considerable success has already been achieved.

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UK firm offers valves and pipes

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A BOOST in profitability is being offered to aquaculture users of imperial PVC fittings and pipe by British PVC specialist Elspa Ltd.

"On offer is the very highest quality metric product range rated 16/20 bar, which gives savings of an average of 50 per cent against established manufacturers," says Elspa.

According to the company, the fittings are used extensively in the European market already — especially in Norway where there is now a heavy demand for this type of product.

Although Elspa's experience is still in its infancy in the aquaculture business, it says it has become increasingly aware of how its range of PVC

valves, pipe and fittings complements the needs of developing fish farmers.

The firm's PVC ball valves are available in both single and double union from 20 mm to 110 mm (1/2 to 4 inches) BSP or plain inch.

Pipes are available in a comprehensive range and are offered at "extremely competitive prices".

Elspa's PVC material consists of closely knit mixtures of quality compounds. With an experienced mixture of these additives, the polymer is converted into sound, durable extrusions and injected mouldings to the highest standard required.

The resulting pipe and fittings have an exceptionally smooth bore and finish, with a high input strength, says the company.

Fittings perhaps constitute the most complete area of Elspa's programme. Not only does it offer the metric and imperial 16 bar, but also a metric 10 bar and "quite uniquely", a 'non-pressure' range (up to 5 bar) with either glue or push fitting joints.

"The economy of this system makes a lot of sense in aquaculture for it gives more than enough quality for a fraction of the cost of a 16 bar fitting," says Elspa.

Information pack from Elspa Ltd., Badsey Fields Lane, Badsey, Evesham, Worcs. WR11 5EX, United Kingdom.

Solar power for Sunfeedy

AS REPORTED briefly in FFI last month, French-made Sunfeedy machines for dispensing dry pellets in fish farms were shown for the first time in an international show at Acquacultura 86 in Verona.

These solar-powered feeders are able to work independently of any other power source. And FNI was told in Verona that they work well even in the cold and cloudy weather of winter.

At present the machines are made only in France and the firm Zigfa International is introducing them to farms around the world. These include farms in Japan where the importing company takes the machines in parts and assembles them locally.

Trout farm

According to Zigfa, the first Sunfeedy machines were tried out in a trout farm in the northern Champagne area in France.

The standard Sunfeedy weighs only eight kg. It works directly from solar energy.

Specially designed for farm ponds and pools, it is said to be easy to install and can be easily moved. From ponds, its use has extended to cages. One recent application is feeding red sea bass in a cage farm in Corsica.

The Teretilex transparent plastic hopper of the standard model holds 25 kg of feed. The small motor is powered by four solar cells.

It can dispense a variety of pellet sizes at feed rates from a few kilos a day to 20 kilos an hour. The machine can be stopped at any time.

The machines can be supplied with larger hoppers of 50 kg capacity.

They are also available in more sophisticated versions fitted with a timing system for programmed feeding.

Further information from Zigfa International, Arcier, 25220 Roche-Lez-Beupre, France. Telex 361597.

Norway firm sets up in BC

T. SKRETTE A/S of Norway has set up a subsidiary company in Vancouver, British Columbia.

Called Aquatess (Canada) Inc., the new company will market the full range of technical equipment supplied by Skretting.

At present, the general manager Alan Osmond, an engineer with wide experience in marketing, is supported by product manager Hermann Hummer-voll from the Skretting organisation.

Sales people are presently being recruited and trained.

It is expected that the organisation will have seven to ten people working within

a year. Staff will include project engineers covering hatcheries and sea cages.

"The aim of Aquatess is to provide high-quality products and a first-class service," says Skretting.

"Based on our wide experience in the fish farming industry and backed by the Skretting organisation, Aquatess should have a flying start."

Aquatess (Canada) has its offices at 890 West Pender Street, Suite 730, Vancouver, British Columbia, Canada V6C 1K5.

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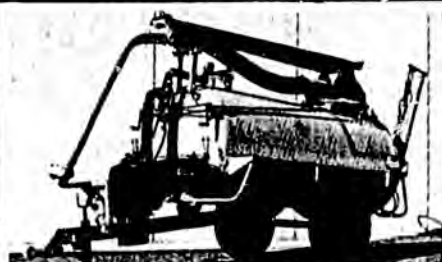
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Shetland farmers dispute rent claim

SALMON farmers in Britain's Shetland Isles say they are determined not to submit to the Crown Estate Commissioners' demand that they pay £50 a ton of fish produced. And, according to Dr. Alistair Goodlad, chief executive of the Shetland Salmon Farmers' Association, there is every possibility that the Commissioners have no right to make the charge anyway.

At the heart of the problem is the question of who owns the seabed around the Shetland and Orkney Isles, where the old Norse system of Udal Law has never been repealed. Under Udal Law, the Crown has no claim to the foreshore, which belongs to the owner of the adjacent land.

"We asked the Crown Estates Commissioners to give us evidence that they are the landlord," Dr. Goodlad told FFI. "They have replied saying that 'The Crown is by prerogative right the owner and, in Scotland, paramount superior of all lands covered by the seas adjoining the coast or by arms of the sea of public navigable rivers and also, with the exception of Shetland and Orkney at least to the extent that the land there has not been feudalised, of the foreshore and land between high and low water mark.'"

The Commissioners claim that there is "a presumption of ownership in favour of the Crown and the burden of proof of title and posses-

sion to the contrary is on a claimant."

They go on to say that the position under Udal Law as affecting foreshore in Shetland and Orkney is well known and understood but there is "no law or practice known to them which suggests that the Commissioners are not entrusted with management on behalf of the Crown of seabed below low water mark around Shetland and Orkney as well as elsewhere in the United Kingdom."

Researching

Some of the best legal brains in Norway are presently researching the status of Udal Law, and this contribution to the argument could be of vital importance not only to Shetland's salmon farmers but to fishermen as well.

Even if it is proved that the Commissioners do have the right to ask for what they call a rent, the amount they are demanding threatens to cripple Shet-

land's emerging salmon farming industry before it can get fully underway, said Dr. Goodlad.

"The way it seems to us is that as long as we were just making a living from the sea that was okay," he said. "But as soon as we start to turn it into a business that can generate profits and help to employ other people on the islands, the Crown wants some of the action."

Nothing

"It's a rip-off. They call it a rent. It's no rent, it's a levy, a tax. A landlord provides a roof over your head

and provides various services. We get absolutely nothing from the Crown Estate Commissioners."

Dr. Goodlad told FFI that the amount Shetland salmon farmers are being asked to pay the Commissioners from January 1987 will jump from £20 a year to £6000-£15,000 a year depending on the amount of fish produced. And with next year's harvest scheduled to reach around 3000 tons this means that some £150,000 a year could be "creamed off" the Shetland salmon farming industry.

"The National Farmers'

Union and the Scottish farmers have largely acquiesced to the Crown Estate Commissioners' demands," he said. "For some of them £50 a ton may not mean very much. But most Shetland salmon farming companies are in the throes of early expansion. They still have heavy debt loads and it will be three or four years before they will have any surplus money with which to do anything."

● FFI features editor Tom Wray visited Shetland recently and his report on fish farming developments there will appear next month.



Alistair Goodlad, salmon farmer and chief executive of the Shetland Salmon Farmers' Association. "The Crown Estate Commissioners want £150,000 a year from us and they are not going to have it," he says.



Salmon harvested from one of the many sea cage farms now established in Britain's Shetland Islands, where the industry is already set to produce some 4500 tons by 1988.

HIDB launches salmon drive

A MAJOR new initiative aimed at maximising the return to the Scottish Highlands and Islands from farmed salmon is being launched by the Highlands and Islands Development Board.

The scheme will link farmers and processors with a range of professional services for salmon product development that could include market research; technical research and development; production development; packaging and design; and marketing. Financial help towards the cost of this professional advice could also be available.

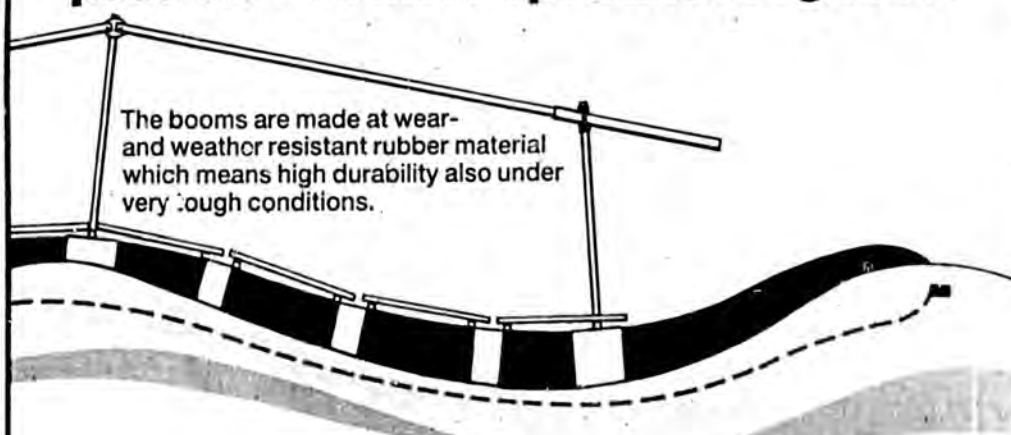
Alastair Alexander, head of product marketing at the HIDB, said: "The salmon industry is one of the fastest growing sectors of the local

economy and it is vital that we ensure that the area derives maximum benefit.

"New product development is one of the keys to the future success of the salmon industry which at present is dominated by fresh and smoked salmon. This scheme, which will act as a 'marriage bureau' between companies and sources of expertise, is designed to encourage the development of new products and ultimately to increase the processing industry in the Highlands and Islands."



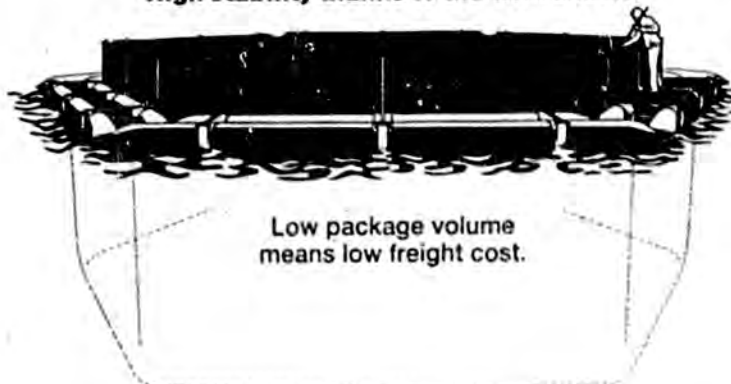
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HOW TO PREVENT PEN-REARED SALMON IN ALASKA

by Chip Thoma

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

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

RESPONSE TO AMA/STURGULEWSKI

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

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

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

ISSUES OF SIMILARITY IN MARICULTURE

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

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

INVESTMENT PATTERNS are similar throughout Europe and the West Coast;

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

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

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

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

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

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

REGULAR TO ALASKA

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

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

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

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

A PROPOSED LOBBY PLAN FOR THE LEGISLATURE

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

RESUME

Theodore P. 'Chip' Thoma

Age: 38

Occupation: Writer, fisherman

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Juneau, Alaska 99801

(907) 463-4935

1916 R Street N.W. #102
Washington, D.C.
(202) 797-9649

EDUCATION

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

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

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

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

MILITARY SERVICE

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

WORK HISTORY

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

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

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

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

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

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

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

1983-84 Public Information Officer, Alaska Division of Elections

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

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

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

suggested title: TO FISH OR FARM ?

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

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

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

To the end of
Paragraph 2

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

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

contact Chip Thoma 463-4935



UNITED FISHERMEN OF ALASKA

MANY OPPOSE FISH FARMING

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

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

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

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

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

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

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

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

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

UFA shares the concerns of ENVIRONMENTAL groups who see **

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

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

Salmon Farming in Alaska: Myths and Facts

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Myth: Salmon farms won't hurt the environment.

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

UFA Framework for Compromise

We support:

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

We strongly oppose:

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

Mariculture -

discussed points of agreement

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

— hatcheries

—

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

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

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

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

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

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

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

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

Authority: AS 16.05.020
AS 16.05.092
AS 16.10.375
AS 16.10.475

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

Article

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

Article 1. Scope of Regulations

Section

1. Application of this chapter

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

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

Article 2. Permit System Established

Section

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(12) evaluation plans.

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

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

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

Authority: AS 16.05.251(a)

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

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

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

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



UNITED FISHERMEN OF ALASKA

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

March 17, 1988

Dear Alaskan:

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

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

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

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

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

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

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

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

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

Kate Graham
Executive Director



UNITED FISHERMEN OF ALASKA

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

MANY OPPOSE FISH FARMING

March 15, 1988

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

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

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

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

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

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

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

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

UFA shares the concerns of ENVIRONMENTAL groups who see

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

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

###

THE NEED TO SAFEGUARD THE GENETIC DIVERSITY OF WILD STOCKS

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

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

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

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

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

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

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

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

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

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

Renegade Norwegian farm salmon polluting wild runs

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Norway:

Wild-salmon endangered by bred-salmon

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

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

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

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

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

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

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

WHY FISH FARMING WORSENS DISEASE RISK

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

• CONFINEMENT

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

• DIET

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

• LACK OF EXERCISE

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

"THE IMPORTANT

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

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

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

Professor Arthur H. Whiteley

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

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

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

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

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

Disease threatens Norway's farms

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

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

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

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

Foundation of Applied Research in Tromsø.

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

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

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

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

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

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

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

Farm fish diseases killing the wild stocks in Norway

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

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

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

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

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

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

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

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

(regulations) anywhere in the world."

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

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

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

"We sent a message to the industry that permission would

be difficult to obtain," he said.

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

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

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



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

DFO says no restrictions on dumping diseased fish

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

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

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

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

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

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

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

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

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

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

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

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

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

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

of inspection of domestic fish sales.

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

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

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

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

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

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

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

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

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

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

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

Salmon 'feedlots' in Northwest



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

By Cheryl Sullivan
Staff writer of The Christian Science Monitor

Port Townsend, Wash.

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

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

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

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

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

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

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

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

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

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

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

New algae bloom hits Gulf salmon farmers

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

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

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

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

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

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

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

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

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

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

Studies find TBT in B.C. farm fish

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

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

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

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

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

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

Atlantic salmon fish kill at Hadlock said not infectious

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

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

Toxic pollutant feared cause of pen-reared salmon deaths

Marine Environment
staff reporter

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

Arthur Kent, a fish pathologist ... a Seattle Marine Research ... at Seattle, said that by ... Oct. 23, he expects to have ... other salmon fish are dying, just like ... a Farm of Norway fish farm ... Hadlock and Indian Island. Since 1986 about 23,000 pen-reared ... salmon in the Hadlock and

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

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

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

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

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

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

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

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

from affected and non-affected fish.

One worry is cancer, said Kent. ... "We haven't seen any cancer ... associated with it, but the types of le- ... sions we see here are found in fish that ... ultimately develop cancer," he said. ... "If the fish survive there's a strong ... possibility they'd develop cancer."

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

That includes the naval installation ... at Indian Island, if hazardous ... materials from that site are found to be ... polluting Port Townsend Bay, he said. ... "We're looking at the Port Town-

send Paper Corporation's mill in the ... possibility," he said. ... Dick Bushmaker, DOE's assistant

superintendent, said that although the Port ... Townsend Paper Corporation has ... —Continued on Page 4-16



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

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

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

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

8 The Fishermen's News - January 1988

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



by Marilyn E. George

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

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

By GEOFF MEGGS

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

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

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

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

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

FISH FARM FIASCO

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

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

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

The moratorium would last for more than two years.

At the seminar, residents also learned that aquaculture is a "highly polluting industry."

FARMERS VS FISHERMEN ON THE SUNSHINE COAST ENVIRONMENT

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

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

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

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

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

But the study now date Agri John Sa morator area.

The fishing and Only Ass ers inf Al

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

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

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



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

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



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



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



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

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

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

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

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

Going for Atlantics In Washington State

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

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

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

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

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

B.C. Salmon Farms Continue to Increase

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

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

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

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

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

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

NORWAY

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

A fish is ecologically running out of turn.

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

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

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

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

The magic word is «Marinet»



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

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

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

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

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

We visited
for salmon
near
two

B.C. salmon farmers learning the pitfalls

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

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

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

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

Algae destroyed fish

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

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

One of the biggest problems



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

Nanaimo salmon tank farm would be illegal in Norway

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

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

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

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

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

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

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

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

Hagen said the proposed tank



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Communities

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

Organizations

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

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

GENETICS

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

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

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

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

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

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

DISEASE

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

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

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

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

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

ENVIRONMENT

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

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

"Mariculture Pollution." *Marine Pollution Bulletin*

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

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

ENVIRONMENT, continued

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

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

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

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

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

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

NUTRITION

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

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

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

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

BRITISH COLUMBIA

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

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

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

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

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

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

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

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

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

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



UNITED FISHERMEN OF ALASKA

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

February 1, 1988

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

Dear Governor Cowper:

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

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

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

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

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

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

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

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

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

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

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

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

Sincerely,

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

Kate Graham
Executive Director

Salmon Farming in Alaska: Myths and Facts

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Myth: Salmon farms won't hurt the environment.

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



Southeast Alaska Conservation Council

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

MARICULTURE

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

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

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

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

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

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

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

ADDITIONAL PROBLEMS WITH FINFISH MARICULTURE

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

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

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

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

Issue paper prepared by Laura Dameron 2/11/88



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907-586-2345

MARICULTURE IN THE 1988 LEGISLATURE

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

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

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

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

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

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

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

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

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

Planning and siting must address the following concerns:

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

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

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

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

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

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

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



Grand Camp
Alaska Native Brotherhood

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

RESOLUTION NO. 27

TITLE: FISH TRAPS ERA

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

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

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

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

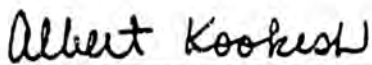
THEREFORE BE IT RESOLVED that the Grand Camp Convention of the Alaska Native Brotherhood and Sisterhood assembled in Haines, Alaska during the week of October 20-25, 1986 vigorously oppose any laws or navigational permits that may be proposed to allow another fish trap to be once again used in Alaskan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

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

ATTEST:

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Biological Interactions of Natural and Enhanced Stocks of Salmon in Alaska

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

Editors

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I.

EXECUTIVE SUMMARY

O. A. Mathisen and G. L. Thomas

Genetic Considerations

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

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

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

Homing and Straying

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

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

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

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

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

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

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

Ocean Carrying Capacity

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

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

Management of Mixed-Stock Fisheries

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

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

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

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

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

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

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

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

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

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

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

Atlantic Salmon

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

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

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

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

Conclusions

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

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

II. INTRODUCTION

The Problem

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

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

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

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

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

Goals and Objectives

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

III. THE PROCESS

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

The workshop was organized into four primary sessions:

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

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

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

IV. RESULTS

A.

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

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

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

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

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

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

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

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

Introduction

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

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

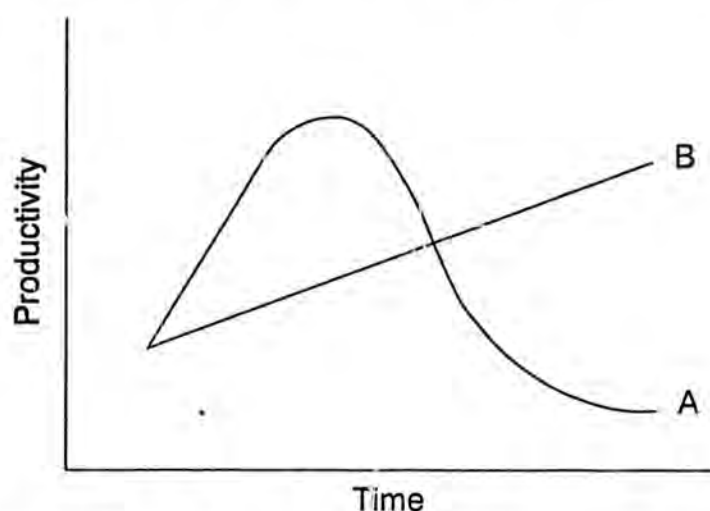


FIGURE 1.—Effects of maximizing immediate increase in productivity without regard to sustainability of the resource. Option A shows likely effect of the single objective of maximizing productivity. Option B shows likely effect of acting to increase productivity while safeguarding genetic resources.

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

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

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

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

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

Interactions of Enhanced and Wild Populations

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

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

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

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

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

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

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

Importance of Genetic Diversity Among and Within Stocks

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

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

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

Hatchery Broodstock Management

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

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

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

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

Recommendations

Therefore, we recommend the following policies and activities.

Policies

1. *Abide by established genetic policy.*

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

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

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

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

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

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

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

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

Activities

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

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

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

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

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

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

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

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

B.
OCEAN CARRYING CAPACITY
R. T. Cooney

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

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

Carrying Capacity Concerns

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

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

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

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

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

Workshop Recommendations

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

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

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

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

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

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

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

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

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

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

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