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ATLANTIC SALMON
A White Paper

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Purpose

The Alaska Department of Fish and Game has produced this White Paper on the status and possible effects of Atlantic salmon farming on the Pacific Coast in response to questions raised by ADF&G biologists and the public following the capture of Atlantic salmon in Alaskan waters. The paper documents the presence of Atlantic salmon in Alaskan waters and reviews the possible consequences. The paper also presents the opinions and recommendations of ADF&G with respect to the continued farming of Atlantic salmon on the Pacific Coast.

I. Background

In Alaska wild salmon are abundant and are a key component in ocean and coastal ecosystems. Salmon are a renewable resource worth millions of dollars to the commercial, sport, personal use, and subsistence fishing economies. Historically the enormous number of wild salmon played an important role in defining the entire Pacific Northwest and Alaska's unique character and economy. However, many of the great runs of Pacific salmon, particularly in the southern portions of their range, are now depressed and well below historical levels due to dams, urbanization, and deforestation. Some are depleted to the point of being listed by the National Marine Fisheries Service as threatened or endangered species. Today, the farming of Atlantic salmon by other states and nations poses a new and perhaps more devastating threat to the survival and abundance of wild Pacific salmon.

As these runs of salmon declined, the resulting increase in the price of wild salmon as well as technological improvements made salmon farming feasible. The farming of Pacific salmon began in the Pacific Northwest in the 1970s. At the same time, Alaska considered allowing the farming of finfish; however, by 1990, it concluded that the dangers were too great to the wild system that Alaska currently depends upon. The farming of finfish in Alaska was banned in 1990 to protect wild stocks from the danger of disease and pollution as well as the possibility of escaped farm fish displacing or breeding with wild fish.

[1] Revised from February 24, 1999 and October 12, 2001 versions.

In the late 1980s salmon farms in British Columbia and Washington State began to import Atlantic salmon from eastern Canada and Europe. Farmed Atlantic salmon are raised to market size (or to maturity for broodstock) in floating saltwater net pens. Tens of thousands of these exotics of all life stages are regularly liberated into the North Pacific Ocean. Release occurs both through accidents as well as the deliberate release of small or slow-growing fish. Norwegian studies show escaped Atlantic salmon can depress wild Atlantic salmon production in streams. Further studies in British Columbia show that Atlantic salmon can spawn successfully in the wild and that juvenile Atlantic salmon can compete successfully against steelhead.

The annual release of tens of thousands of Atlantic salmon into the Pacific Coast ecosystem amounts to biological pollution of the ocean and poses an enormous threat to wild Pacific salmon. Introductions of non-native species have frequently resulted in unexpected and often catastrophic consequences from habitat destruction, diseases or parasites, hybridization, reproductive proliferation, and predation and competition. Sexually mature Atlantic salmon are now commonly found in both fresh and salt water throughout the Pacific Northwest and Alaska. In 1998 juvenile Atlantic salmon were found in British Columbia's Tsitika River; otolith analysis confirmed that these fish resulted from successful inriver spawning by escaped farm parents.

II. Range and Life History of Pacific and Atlantic Salmon

There are 6 species of native *Oncorhynchus*, commonly referred to as Pacific salmon: chinook, coho, sockeye, chum, and pink salmon in North America and cherry salmon in Asia. Historically, Pacific salmon spawned in almost every accessible stream, lake, and major river in an arc across the North Pacific from northern California to Japan and Russia's Kamchatka Peninsula. Eggs are laid in the gravel where they hatch and the young develop. After leaving the gravel some species of Pacific salmon go directly to the sea while others first spend a year or two in fresh water. Pacific salmon spend from one to five years at sea before returning to spawn and die. Some stocks of Pacific salmon are currently returning at a fraction of their former abundance, particularly in the southern portion of their range, whereas in northern British Columbia and Southeast Alaska, many salmon stocks have recently had record returns.

The life cycle and preferred spawning and rearing habitat of Atlantic salmon are similar to that of steelhead. Both spawn in medium to large rivers from fall through spring. Both spend up to three years in streams and rivers before migrating to the sea where they spend up to three more years before returning to spawn. Unlike other Pacific salmon, both Atlantic salmon and steelhead may survive spawning, return to the sea, and subsequently return to spawn again. As juveniles in freshwater both species stake out and defend territories in streams and rivers and feed aggressively on fish and insects.

There is only one species of Atlantic salmon. Historically Atlantic salmon spawned in streams flowing into the North Atlantic from Portugal to Connecticut. Young Atlantic salmon spend one to three years in fresh water, migrate to the sea where they spend up to three years and then return as adults to spawn. Atlantic salmon are now extinct in southern Europe and greatly diminished in numbers in the northern portion of their range. In their native range, wild Atlantic

salmon are prized sport fish because they grow to 70 pounds, are considered highly aggressive and territorial, and readily take flies, lures and bait.

The initial decline in Atlantic salmon stocks was due to overfishing and habitat destruction as human populations grew and spread into formerly remote portions of Europe, Scandinavia and North America. Domesticated farm stocks of Atlantic salmon in Scandinavia have escaped and spread disease and parasites to many of the remaining wild stocks. Farm-raised Atlantic salmon have also hybridized with wild stocks, thereby reducing the wild stock's ability to survive in the wild. Norwegian studies show escaped Atlantic salmon can depress wild Atlantic salmon production in streams. Further studies in British Columbia show that Atlantic salmon can spawn successfully in the wild and that juvenile Atlantic salmon can compete successfully against steelhead.

III. Salmon Farming

Salmon farms raise fish to maturity in floating net pens from which they are harvested and sold. Farmed salmon are also transported in live-tank vessels to central locations where they are held until needed and then killed and shipped fresh. Unlike traditional hatcheries where the fish are released to grow in the sea, farmed fish are supposed to spend their entire life in captivity. Captive Atlantic salmon are farmed in areas where they occur naturally as well as in areas far outside of their natural range in marine environments and protected bays as far away as Chile.

Farming of Atlantic salmon, along with coho, chinook, and steelhead salmon, began on the Pacific Coast in the early 1970s. Originally coho salmon and then chinook salmon were the major species raised, but beginning in the late 1980s, Atlantic salmon were introduced and have become the most common farmed species. Atlantic salmon have been selectively bred to do well in captivity, take approximately 30 months to grow to market size, and have a wide range of time over which they may spawn so that maturing fish can be ready for market almost year-round. Currently in British Columbia, 11 private hatcheries and two freshwater rearing lakes support over 90 operational farms. Each of these farms has 10 to 30 marine net pens where the adults grow until ready for market. Farms are located along the outer coast of Vancouver Island and in the Strait of Georgia as far north as Bella Bella.

On January 31, 2002, the Province of British Columbia lifted a moratorium on establishing new fish farms. This is a serious concern to Alaska as it appears that the fish farming industry will focus on establishing new sites much closer to the U.S./Canada border. It is expected that any fish escaping from these sites would move north into Alaskan waters further exacerbating the current problem.

IV. Accidental Escapements, Deliberate Releases, and Recoveries of Farmed Atlantic Salmon

Storms, tides, marine mammals, or accidents sometimes damage a farm's floating net pens and result in the accidental escapement of thousands of farm fish of all life stages. In addition, escapements of small numbers of fish, which are difficult to detect or quantify, are common.

Reporting of escapes, observations of escaped farm fish in fresh and salt water, and estimations of subsequent recoveries vary by time and region. Deliberate release of "non-performing" fish (estimated at 3–5% of production) totals hundreds of thousands of fish annually and this number is neither precisely known nor reported. Deliberate releases are referred to as "leakage" and occur when the smaller fish simply swim away when large mesh nets are substituted for the smaller mesh nets in which the fish are initially contained.

British Columbia Releases and Recoveries

In 1991 Canada initiated an Atlantic Salmon Watch Program to track accidental escapements and recoveries of escaped fish. Prior to this, escapements of farm salmon were not documented. Under this program we know that from 1991 to 2001, 396,522 escapes have been reported from British Columbia. Reporting is not required in Washington State, but from 1996 through 1998, three large-scale escapes totaling 595,000 fish were reported in the news media.

Escaped Atlantic salmon caught by commercial fishermen in British Columbia can be sold and thus commercial recoveries are documented on fish tickets. The Atlantic salmon catch limit in the British Columbia sport fishery is 20 fish per day. In 2000, the most recent year for which complete records are available, a record 7,833 adult Atlantic salmon were recovered from marine sport, research, and commercial fisheries in British Columbia. Freshwater recoveries of Atlantic salmon are common; in 2000, 131 adults and 12 juveniles were recovered from 18 British Columbia rivers and streams.

Alaskan Recoveries

Salmon farming of any species is not permitted in Alaska. Farmed Atlantic salmon escape and migrate north where they are caught in Alaska fisheries. The Alaska Department of Fish and Game solicits the return of recovered Atlantic salmon from the commercial fisheries and the public through the use of news releases, Division of Sport Fish information booklets, posters at processing plants and launch ramps, and a website. The first recovery of an Atlantic salmon in Southeast Alaska occurred in 1991, and since then almost 600 Alaskan recoveries have been documented by the Alaska Department of Fish and Game and the National Marine Fisheries Service. Commercially caught Atlantic salmon are not sold in Alaska and thus are not recorded on fish tickets. Some recoveries occur during random sampling of commercial landings, but other fish are recognized by fishermen and turned in to sampling crews or to Alaska Department of Fish and Game offices. Untold numbers go unrecognized. If they are recognized many are discarded or kept for personal use by fishermen who do not have ready access to a department representative and know that Atlantic salmon cannot be sold.

Based on the increasing number of recoveries, researchers estimate that the total number of Atlantic salmon annually in Southeast Alaskan waters has increased in recent years from several hundred to a few thousand. While the great majority of recoveries occur around Ketchikan and Petersburg, a few Atlantic salmon are caught farther north. In recent years Atlantic salmon have been recovered in Lynn Canal north of Juneau, in Icy Strait, in Prince William Sound, and in the

Aleutian Islands. In 1997 the National Marine Fisheries Service documented an Atlantic salmon recovery in the Bering Sea trawl fishery, and there are anecdotal reports of several other recoveries in this area. Recoveries in Alaska rose to a high of approximately 161 in 1998 with approximately 35 recovered in 2001. The first documented freshwater recovery of an Atlantic salmon in Alaska also occurred in 1998 when a sport fisherman caught one in Ward Creek just north of Ketchikan. The fisherman reported that a second Atlantic salmon was paired with the one he caught, but a subsequent foot survey by the Department of Fish and Game did not locate this second Atlantic salmon, although other fishermen contacted during the survey had also seen the pair. In 2000 and 2001, additional Atlantic salmon were captured in fresh water in the Yakutat area.

Using an analysis similar to that used for determining coded wire tag contributions, the Alaska Department of Fish and Game estimates that in recent years an average of 700 have been caught, representing about 3,000 present annually in Alaskan waters.

V. Economics of Salmon Farming

Historically, salmon farming has been subject to "boom or bust" cycles triggered by complex factors common to many farming enterprises (supply and demand, high prices bringing inexperienced operators, etc.). In the mid 1980s approximately 150 farms operated in British Columbia but a lack of experience and problems associated with poor siting of the net pens resulted in failure of about half.

About 90 operational marine salmon farms in British Columbia currently produce about 38,000 metric tons of Atlantic salmon annually. This is equivalent to almost 12 million 7-pound coho salmon (the record Southeast Alaska all-gear coho catch is 5.7 million fish). In 1999, the last year for which full records were available, British Columbia salmon farmers reported producing 49,100 metric tons (49 million pounds) of farmed Atlantic and Pacific salmon worth over $250 million Canadian dollars. Atlantic salmon accounted for 81% of farm production, whereas chinook salmon made up 16% and coho salmon 3%. In 1995 the industry claimed to support almost 2,100 full-time equivalent positions earning $63 million dollars in wages and benefits with 92% of the jobs located in small communities outside Vancouver and Victoria. Many of the jobs are year-round, and 90% of the supplies and services are purchased from 250 local companies. About 77% of the harvest is exported, making farmed salmon British Columbia's largest agricultural export. In 1999 in British Columbia, the pounds of farmed salmon marketed were nearly three times that of wild salmon. At the same time, wild salmon only brought the commercial fisheries, pound for pound, one-quarter of what the farmers receive for their crop.

These high production levels of Atlantic salmon are not achieved without impacting the surrounding ecosystems. The profits of salmon farms are subsidized by ecosystem costs and the impacts on wild stocks. As these impacts became obvious, the British Columbia Provincial government commissioned a comprehensive Salmon Aquaculture Review, completed in 1997. Although this report generally supported the industry, it also cited several areas where improvements were desirable, one of which was better containment of net pen fish. The salmon farming industry supports these recommendations and seeks to implement them but claims a

need to expand operations to areas currently off-limits to make the recommended changes affordable.

VI. The Problems

As with any exotic species there are concerns about the effect of Atlantic salmon on native populations of Pacific salmon, including diseases, colonization, interbreeding, predation, habitat destruction, and competition. These concerns are presently heightened given the troubled status of some wild Pacific salmon stocks in the Pacific Northwest and British Columbia. Depressed returns open up an ecological niche for new species in previously balanced and fully utilized habitats. In addition, recent changes in water temperature may also have additional adverse effects such as an increase in diseases and parasites.

In a published paper entitled "Impacts of Introduced Species in the United States," Dr. Daniel Simberloff[2] with the Department of Ecology and Evolutionary Biology at University of Tennessee, pointed out, "That on a general level, introduced species often interact with the destruction and fragmentation of habitat, the other major cause of our national conservation crisis." In addition he noted that of the 632 species listed as endangered under the United States Endangered Species Act, invasive species are feeding on approximately 100 of those listed, and for 424 of the listed species, habitat destruction is the main threat. He also notes that disease and competition from introduced species are also threats to endangered species.

In a lecture on introduced species at the University of Michigan (http://www.sprl.umich.edu/GCL/notes2/introspp.html), it was noted that, "Of the greater than 1,000 freshwater fish in the U.S., Canada and Mexico known in recent history, 3% have gone extinct in the past 100 years, and another 26% are at risk of extinction. Reasons for their decline are: habitat destruction 73%; introduced species 68%; pollution 38%; hybridization 38% and over harvesting only 15%."[3]

The cataclysmic effects of the 1959 Nile perch introduction to Africa's Lake Victoria include: mass extinctions, loss of biodiversity, water and air pollution and health and economic problems. A task force of fish biologists summed it up nicely in a 1985 report stating: "Never before has man in a single ill-advised step placed so many vertebrate species simultaneously at risk of extinction and also, in doing so, threatened a food resource and traditional way of life of riparian dwellers."

Granted, not all introduced species become invasive with such horrific histories. However, it's important to note that invasive species are implicated in the decline of 42 percent of the species listed in the Endangered Species Act.[4] And the cost of these invasive species is staggering.

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[2] Simberloff, D. 1996. Impacts of Introduced Species in the United States. Consequences Vol 2, No 2, Saginaw Valley State University. University Center, MI 48710.
[3] Lecture: "Introduction To Global Change II," Professor Tim Killeen and graduate student instructor Bridget Fahey, University of Michigan's Global Change Program, 1997.
[4] Flack and Benton. 1998. Invasive Species and Wetland Biodiversity. National Wetlands Newsletter Vol. 20, No. 30:7.

Economic damages and control of non-indigenous animals, plants and microbes cost the U.S. $138 billion a year, according to a January 1999 Cornell University ecologist's report.[5]

The history of ecological menace, resulting economic disasters of invasion, and eradicating or recovering from the invasion of introduced species has prompted many countries and individual U.S. states to enact regulations banning entry of certain types non-native species.

Colonization of Atlantic Salmon

Atlantic salmon escaped from net pens are not only common in salt water but are now found with increasing frequency in rivers and streams in British Columbia and Washington State. Many of these fish are sexually mature. Multiple successful spawning events in British Columbia's Tsitika River, Adam and Eve River, and Amor de Cosmos Creek have now been documented, and there is no reason why Atlantic salmon should not be able to reproduce elsewhere. Consistent with increasing annual marine recoveries of Atlantic salmon, freshwater recoveries near Yakutat in Alaska occurred in both 2000 and 2001. There are literally thousands of remote salmon streams in Southeast Alaska. Almost all are surveyed for escapements from the air making detection of Atlantic salmon incursions difficult.

Despite numerous attempts to transplant Atlantic salmon to Washington State and British Columbia in the early 1900s, self-sustaining anadromous populations of Atlantic salmon were not successfully established. From about 1912 through 1927 millions of eggs or juvenile Atlantic salmon were released from hatcheries or planted into lakes and rivers in British Columbia and Washington State. Some systems were only planted once, while in others, millions of Atlantic salmon eggs and juveniles were transplanted at a variety of sites for several years. Even within their native range, few populations of Atlantic salmon have been successfully reintroduced despite considerable effort.

All earlier attempts at introduction involved eggs or juvenile fish rather than the maturing adults now being released. The young Atlantic salmon would have to successfully compete in fresh water, migrate to the sea, and then return to successfully spawn, all the while competing against Pacific salmon, which were much more abundant in Canadian waters at that time. Furthermore, current escaped or released Atlantic salmon are now the offspring of generations of parents raised in the Pacific environment and are competing against greatly reduced runs of Pacific salmon in many systems. While the fish are confined in net pens open to the sea, some acclimatization of these fish to local conditions probably occurs. Farmers select for survival and growth when spawning their fish so that the offspring are better adapted to the local environment, improving the chance that these traits will be passed on to the next generation. While farmed fish are used to being fed pellets, making it difficult for them to capture food in the wild, some adult Atlantic salmon spend almost a year in fresh water in their home range without feeding, so an inability to capture wild food probably would not impede Atlantic salmon from surviving to spawn. When successful spawning occurs, the resulting fry begin life as wild fish, absent any learned hatchery responses, and would probably respond instinctively to their

[5] Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. June 12, 1999. Environmental and Economic Costs Associated with Non-Indigenous Species in the United States. Cornell University. Ithaca, NY.

surroundings. Obviously these fry would not be as well adapted as native species, but with available habitat, reduced competition, and enough chances, it might be possible to establish a self-sustaining population. Now that the presence of wild-hatched Atlantic salmon has been documented in Canadian streams, it only remains for these fish to reproduce in order for a self-sustaining wild population to be established.

Disease

Current British Columbia Atlantic salmon imports are limited to stocks which have been inspected at least four times for known pathogens and which are certified as free of specific pathogens for at least 18 months prior to their importation. The originating facility itself must also be certified as free of specific pathogens for a period of time before fish or fish products bound for export are allowed to be held there. In British Columbia all imports are held under quarantine where mortalities are documented and further disease testing occurs. Fertilized eggs may still be imported, but none have been imported in recent years. However, if the numbers of farms and sites are allowed to grow, we are concerned that importation of additional broodstock from the East Coast would occur, and increase the risk of importing exotic pathogens.

Crowding fish in net pens increases stress, which makes them more susceptible to disease. Therefore, when outbreaks do occur they tend to spread rapidly through the captive population. For this reason many farmed salmon are inoculated against disease agents. There is concern that the unregulated prophylactic use of antibiotics may result in more virulent or antibiotic-resistant fish pathogens. Some diseases have been documented first in farmed salmon, probably because these fish are under relatively intense and continuous observation, and the rapid spread of a communicable disease through a captive and crowded population is very obvious.

Documentation of the transmission of diseases from farmed salmon to wild stocks is difficult given the lack of baseline information regarding the prevalence of disease organisms in wild fish populations. As previously stated, salmon farming in the United States and Canada is highly regulated with continual disease testing and certification requirements. This is especially true for Atlantic salmon farming in the Pacific Northwest. Hence, all pathogens reported in farmed Atlantic salmon have been indigenous to local wild salmonid or marine fish. These pathogens have included infectious hematopoietic necrosis virus (IHNV) and viral hemorrhagic septicemia virus (VHSV). Sea lice of various species and bacterial agents such as *Vibrio anguillarum* (vibriosis) and *Aeromonas salmonicida* (furunculosis) have also been identified. Although these fish pathogens are indigenous, there is always some risk of disseminating different or mutated strains of the same pathogens by farmed salmon. These other strains, perhaps more virulent, could infect new host species.

In the context of the current diseases occurring in farmed fish in the Pacific Northwest, there is only a low risk that straying Atlantic salmon could bring exotic diseases into Alaska. This is not to say that there would be no risk because certification procedures, regardless of stringency, are not absolute or that this risk would not escalate in the future if a pathogen such as ISA becomes established on the West Coast. Infectious salmon anemia (ISA) is an example of a disease exotic to Alaska and the Pacific Northwest and is caused by an orthomyxovirus. Anecdotal information

on the discovery and spread of ISA virus in eastern Canadian farmed salmon and more recently in Maine is provided below.

Infection and Response: an example

In June of 1996 ISA virus was first detected in the Canadian province of New Brunswick cause insignificant mortality of farmed Atlantic salmon. Eventually, the provincial government shut down 25% of the industry and ordered large numbers of farmed salmon killed in an attempt to halt the spread of the disease. This disease was first detected in Norway's salmon farming industry in 1984. However, recent studies have shown that the New Brunswick virus is genetically different from the European strains and therefore was not imported to North America with fish transports. The virus most likely emerged from a wild marine fish reservoir native to the waters of the Canadian Maritimes.

In New Brunswick, ISAV was initially reported at three Atlantic salmon farm sites in late 1997. The government ordered all fish in pens with infected individuals killed in hopes that this would eradicate the disease. Fish in nearby uninfected pens did not have to be killed. By the time this initial order was implemented 280,000 fish in 33 infected pens on 9 sites had to be killed. Some farmers were reported delaying the killing of uninfected individuals in infected pens claiming that only those actually showing symptoms needed to be sacrificed. Because the fish were killed under government orders farmers also demanded compensation, claiming that only some of the fish were infected and many were not at a harvestable age, resulting in financial losses. The disease was then found in two more bays. A more comprehensive order was issued covering all fish in an infected site rather than just those in infected pens. Some farmers continued to delay killing exposed fish, arguing that prior government-ordered killing was demonstrably not controlling the spread of the disease. By the spring of 1998 the government had ordered 1.3 million exposed or infected fish at 16 sites killed as part of a $10 million buyout package that included fallowing 25% of the industry for 1998–99. But once a virus is introduced into a susceptible population it is almost impossible to eradicate.

In March of 2001 ISAV was confirmed for the first time in the United States at an Atlantic salmon farm in Cobscook Bay, Maine. Since then the virus has caused disease outbreaks at 15 cage sites in the bay where 28 of Maine's 45 finfish leases are located. The USDA has taken charge to halt the spread of the virus by destroying 1.5 million sub-market sized salmon with a requirement to fallow the bay for 60–90 days. Farmers will be compensated for their losses at a sum of $8.3 million a year for two years. Future restocking in 2003 will require a 25% reduction in stocking density and a two year rotation that allows stocking only half of the bay each year. Only one year class of fish will be introduced and harvested within a growing season along with other stringent biosecurity controls.

Interbreeding

The possibility of successful interbreeding between Pacific and Atlantic salmon is apparently small; almost all forced crosses under ideal laboratory conditions failed. Most experts are more

concerned about genetic damage to wild stocks from farm-escaped Pacific salmon. Chinook and coho salmon are also raised in salmon farms, and if continuing escapement and interbreeding with wild stocks occurs over several years, then the potential for genetic damage is high. Genetically altered Pacific salmon developed by Canadian laboratories, while not currently being raised at production levels, also constitutes a significant threat to the genetic fitness of wild stocks.

Competition

In several studies farmed fish of any species have been found to be less "fit" than native wild stocks. Hatchery and farmed fish are typically less able to compete successfully for food, territory, or mates. However, studies have shown that fish released from hatcheries and given the opportunity to set up territories may be able to resist eviction by later-arriving wild competitors. Furthermore, continual deliberate releases or escapements of tens of thousands of Atlantic salmon of all life stages may simply overwhelm local native stocks by force of numbers alone regardless of their "fitness."

Predation

Based on stomach-content analysis the predation on other species by farm-escaped Atlantic salmon is considered to be low. Herring was the most common prey species in recovered Atlantic salmon. No Pacific salmon were found in their stomachs. Most Atlantic salmon recovered in Alaska come from net fisheries, but an increasing number have been caught in recent years in troll and sport fisheries, which suggests these recoveries were trying to feed.

Wild juvenile Atlantic salmon in their home range are considered highly aggressive, and a self-sustaining wild population in the Pacific would, by definition, actively compete for prime rearing sites and food. Therefore, the greatest threat may occur in fresh water, where the age 1+ fingerlings produced from successful spawnings would prey upon native species that may include pink and chum salmon fry.

VII. Proposed Recommendations: What is Needed and Why

The wild runs of Pacific salmon are far too important and under too much pressure already in British Columbia, Washington State, and much of the Pacific Northwest to jeopardize them further by importing non-native species that are able to escape, compete, and reproduce. We realize that immediate closure of all salmon farms in British Columbia is simply not an option. However, the industry historically has been volatile and failures are common. Therefore, we propose that permits be revoked and farm sites closed when a failure occurs, unless zero-risk programs are adopted. To that end, the State of Alaska recommends the following changes.

Allow only land-based Atlantic salmon farming and storage operations. This can be achieved through a phased approach by allowing only land-based operations to replace failed farms, in

addition to the gradual conversion of other farms. Eliminating failed farms and phasing in land-based operations will reduce or eliminate the risks while minimizing disruption of local economies.

Until land-based operations are phased in, the following changes are proposed to minimize the risks for marine based farming operations:

1. Adopt a "Zero Risk Management" policy in lieu of British Columbia's failed "Managed Risk" policy.
2. Replace the British Columbia Agricultural Ministry as the primary permitting and oversight agency for salmon farms with the B.C. Fisheries Ministry.
3. Stop deliberate release of hundreds of thousands of small "non-performing" Atlantic and Pacific salmon.
4. Provide branding, monitoring, and inventory methods to accurately identify, assess, and control deliberate and accidental releases. Farmed fish must be branded with tags or otolith marks to identify the farm from which the escape occurred, to allow tracking of escapees. Tagging or marking all farmed fish would also allow positive identification of the wild-born offspring of escaped Atlantic farm salmon.
5. Allow only all-females or certified 100% triploid (sterile) Atlantic and Pacific salmon in marine net pens to reduce the risk of feral populations or hybridization.
6. Allow no marine farms north of present locations to minimize risks to Alaskan wild salmon.
7. Immediately cap Atlantic salmon production in existing farms at current levels until phased out within a specified time frame.
8. Provide an absolute prohibition on Atlantic salmon egg and broodstock importation in lieu of the current voluntary program.
9. Negligent escapement of farmed fish should be subject to administrative sanctions (including immediate revocation of permits) and civil action by damaged parties. The farmed salmon industry must understand that continued escapement or deliberate release of thousands of farmed salmon annually will result in further restrictions, including fines, closing farms with poor records, forfeiture of permits, and the eventual closing down of the industry.
10. Any government subsidies should be disclosed and phased out for all nonconforming operations. The industry must immediately comply with all existing regulations, including the currently unenforced regulation that requires containment nets with mesh small enough to contain <u>all</u> the fish. The industry must develop a written plan and timetable for improving inventory control, marking all farmed fish, and implementing effective marine containment for both fish and fish waste.
11. Washington State must implement government oversight of farms and report releases.

Recommendations for all farming operations whether land-based or marine-based:

1. Baseline levels of mortality, disease and parasites must be recorded and available for review. Any abnormal mortality and its suspected cause must be reported immediately. Farmed fish mortality resulting from diseases or parasites must be reported and any diseased

stock immediately removed and disposed of. The use of antibiotics, hormones, and anti-parasite treatments must be documented.

2. Random testing of market-bound fish for pathogens, drugs, or chemical contaminants should be initiated, and the results should be available to the public.
3. Annual surveys should be expanded to discover Atlantic salmon in fresh water. When Atlantic salmon are found in fresh water, industry and government must fund aggressive programs to capture and remove any adults and juveniles. Wherever successful spawning is confirmed, a multiyear intensive effort must be mounted to eradicate the Atlantic salmon. All such remedial actions should be financed by the salmon farming industry.
