MARINE AQUACULTURE ISSUE PAPER

Seafood Demand
Production
Obstacles
Federal and State Actions
Opportunities

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I. Background

Worldwide, landings of capture fisheries have likely peaked (Johnson 2004). At the same time, worldwide freshwater and marine aquaculture production continues to grow to meet increasing seafood demand. Total 2003 worldwide fisheries production amounted to 132.2 million tons (preliminary), and of this 31.7 percent was farm-raised (marine and inland) (FAO, 2005). In comparison, in 1993 17.0 percent of total production was from aquaculture (See Table 1). Many believe that the U.S. can significantly expand its marine aquaculture industry and thus reduce its seafood trade deficit.

The United Nations' Food and Agriculture Organization (FAO 2004) estimates that the status of the oceans' wild fish stocks is as follows:

- **3%** underexploited,
- **21%** moderately exploited and "still offer some scope for further fisheries expansion,"
- **52%** are fully-exploited – that is, "producing catches that are already at or very close to their maximum sustainable production limit,"
- **16%** are overexploited,
- **7%** are depleted, and
- **1%** are recovering from depletion, "meaning they have no room for further expansion **"**

Since 1974, there has been a consistent downward trend in the proportion of world fish stocks offering potential for expansion. This has been coupled with an increase in the proportion of overexploited and depleted stocks -- from about 10 percent in the mid-1970s to close to 25 percent in the early 2000s (FAO 2005). On the West Coast of the U.S., overfished[1] marine species include:

lingcod *(Ophiodon elongates)*	widow rockfish *(Sebastes entomelas*)
cowcod (*Sebastes levis*)	dark blotched rockfish *(Sebastes crameri)*
bocaccio (*Sebastes paucispinis*)	canary rockfish *(Sebastes pinniger)*
Pacific ocean perch *(Sebastes alutus)*	yelloweye rockfish (*Sebastesruberrimus*)

Federal regulations designed to prevent both the targeted harvest and the incidental harvest (bycatch) of these species has resulted in significant cutbacks in commercial and recreational groundfish harvests. Rockfish (e.g., *Sebastes* spp., *Sebastolobus* spp., and *Scorpaena* spp.) landings have decreased from 31,656 metric tons in 1994 to 3,668 metric tons in 2004 (PACFin, 1994, 2004).

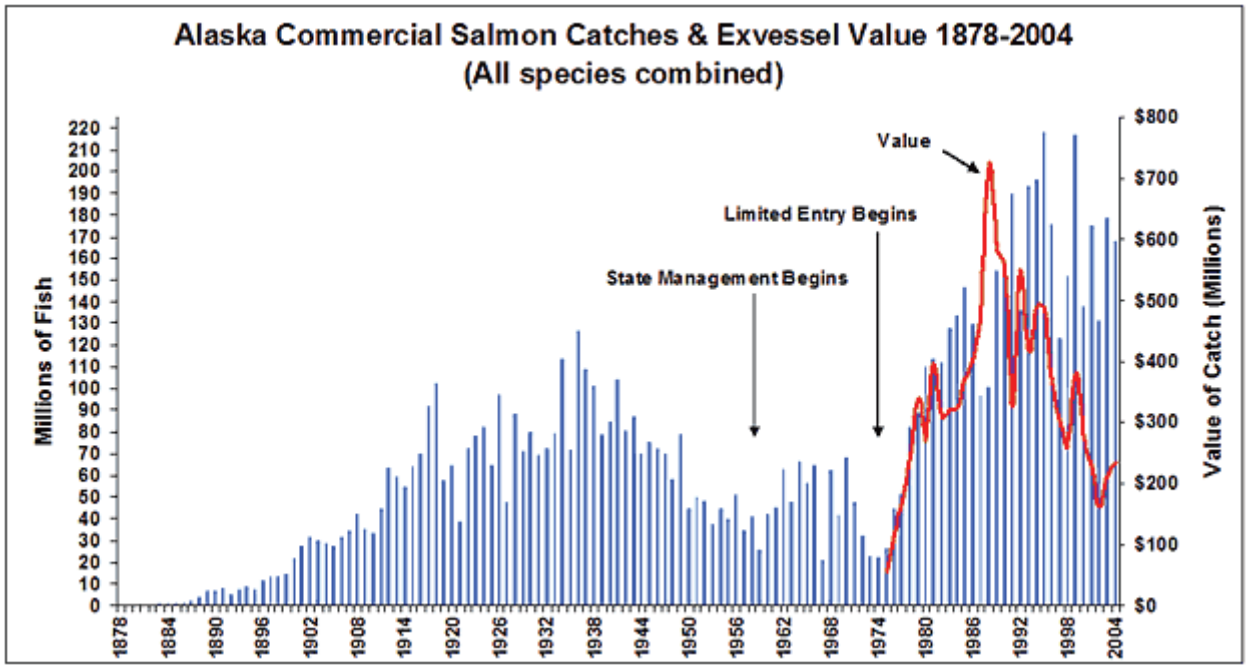
[1] Overfished: Any stock or stock complex whose size is sufficiently small that a change in management practices is required to achieve an appropriate level and rate of rebuilding. The term generally describes any stock or stock complex determined to be below its overfished/rebuilding threshold. The default proxy is generally 25% of its estimated unfished biomass; however, other scientifically valid values are also authorized.

Table 1: Total Inland and Marine Worldwide Fisheries Production (Capture and Aquaculture) in Million Metric Tons 1993 – 2003 (FAO 2004).

Year	Total Capture	Total Aquaculture	Total World Fisheries	Percent Aquaculture of Total
1993	86.6	17.8	**104.4**	**17.0%**
1994	91.7	20.8	**112.5**	**18.5**
1995	92.0	24.4	**116.4**	**21.0**
1996	93.5	26.7	**120.2**	**22.2**
1997	94.2	28.6	**122.8**	**23.3**
1998	87.7	30.6	**118.3**	**25.9**
1999	93.8	33.4	**127.2**	**26.2**
2000	95.5	35.5	**131.0**	**27.1**
2001	92.9	37.8	**130.7**	**28.9**
2002	93.2	39.8	**133.0**	**29.3**
2003	90.3	41.9	**132.2**	**31.7**

The growth of the farmed Atlantic salmon industry in the past 20 years has severely impacted the West Coast salmon industry by driving down prices and shifting market share. Alaska's share of the world salmon market fell from 40 percent in 1980 to 20 percent in 2000 (Knapp 2003). The price of commercially caught Chinook salmon in Alaska fell from $2.69 a pound in 1988 to $1.30 in 2002; and the exvessel value for all commercially caught salmon species fell from a high of $782 million in 1988 to about $163 million in 2002 (ADFG 2005). Please refer to **Figure 1** for Alaska commercial salmon catch and value information, and **Table 2** for farmed salmon statistics.

Figure 1: Alaska Commercial Salmon Catch and Exvessel Value (ADFG 2005).



II. Seafood Demand

By 2020, the world's population is expected to grow from the current 6.5 billion to about 8 billion people. This larger market will increase sales opportunities for the seafood industry and it is likely that aquaculture products will be needed to meet much of the increased seafood demand. For example:

Worldwide in 2015: World fish consumption is expected to rise 35 percent over current levels (FAO 2005).

U.S. in 2020: It is likely that 1.5 to 4 million tons of additional seafood supply will be required to satisfy new demand (Johnson 2004).

Worldwide in 2020: Global per capita seafood consumption could reach 17.1 kg or a total increase of 32 million metric tons (round weight) (IFPRI 2003).

III. U.S. Seafood Trade Deficit and Aquaculture Production

In 2003, the total U.S. export value of edible and non-edible fishery products was $12.0 billion—an increase of $294 million compared with 2002. The total import value of edible and non-edible fishery products in 2003 was $21.3 billion—an increase of $1.6 billion compared with 2002 (NOAA, 2004). Therefore, the U.S. has a seafood trade deficit of over $9 billion dollars. Most of the deficit value is attributable to shrimp, which in 2004 was 34 percent of total imported products (Johnson 2004).

In 2002, the U.S. produced 4.4 percent (quantity) of the world's aquaculture production (FAO,

2004) that was valued at nearly $1.1 billion (Johnson 2004). Most of the U.S. aquaculture production was the channel catfish (*Ictalurus punctatus*).

Table 2: U.S., British Columbia and Worldwide Farmed Salmon Statistics

1)	Forecasted future value of British Columbia aquaculture (Graham, 2003)	$1 billion
2)	BC salmon aquaculture contribution to provincial gross domestic product in 2000 (BCSFA no date)	$310 million (U.S.)
3)	British Columbia value of salmon aquaculture exports to U.S. in 2001 (% to U.S. of all exports) (Lanteigne 2002)	$407 million (96 percent)
4)	Canada percent share of world farmed salmon production (Johnson 2004)	7 percent
5)	Norway percent share of world farmed salmon production (ibid)	39 percent
6)	Chile percent share of world farmed salmon production (*ibid*.)	33 percent
7)	Percentage of BC farm salmon exports sold to U.S. (BCSFA no date)	89 percent
8)	Alaska share of world salmon production (Knapp 2003)	1980: 40 percent 2000: 20 percent
9)	Percent of world salmon production supplied by farmed salmon in 2003 (Johnson 2004)	73 percent
10)	U.S. Atlantic salmon imports in 2004 (quantity/value) (Harvey 2005)	394 million lbs/$871 million, a 5 percent decrease in quantity and value from 2003.
11)	The U.S. share of the world market for farmed salmon production in 2003 (Johnson 2004)	1.2 percent
12)	Estimated total economic value of the Atlantic salmon net pen industry in Washington State in 1999 (Amos and Appleby 1999)	$40 million

IV. U.S., Canadian and International Projects of Note

In the U.S., experimental aquaculture projects are located off the coasts of New Hampshire (haddock, cod, summer flounder (*Paralichthys dentatus)*, and halibut), Hawaii (Pacific threadfin, *Polydactylus sexfilis*), and Mississippi (red drum, *Sciaenops ocellatus*). Also in Hawaii, the culture of Kahala *(Serioli dumerili)* or Kona Kampache, a fish in the Amberjack family, has just begun off the Island of Hawaii. In March 2005, Neptune Industries, a Florida hybrid striped bass (*Morone spp.)* producer, and farmed shrimp producer Sweetwater Shrimp Inc., signed a letter of intent to pursue barramundi culture (*Lates calcarifer)* (Business Wire 2005). However, it does not appear that this will be a marine net pen project. The Harbor Branch Oceanographic Institution in Florida is refining the breeding and larval rearing practices for the Florida

pompano (*Trachinotus carolinus*) and black sea bass (*Centropristis striata)* for year-round production of fingerlings for farmers. Other marine species cultured in the U.S. include hybrid striped based (*Morone spp*.) and mutton snapper (*Lutjanus analis*).

Worldwide, cobia *(Rachycentron canadum)* farming has expanded to Puerto Rico, Vietnam, China, and Taiwan; with another venture being built in Belize, and one being considered in the Gulf of Mexico.

Worldwide, the culture of haddock, cod, and hake grew from 169 metric tons in 2000 to 1,445 tons in 2002 – a 192.4 percent growth rate (FAO 2004). Haddock (*Melanogrammus aeglefinsus),* Atlantic halibut (*Hippoglossus hippoglossus),* and cod (*Gadus morhua*) culture, on a smaller scale, is ongoing in Atlantic Canada (Newfoundland). Norway, the leader of farmed Atlantic halibut, produced over 400 metric tons in 2002 out of a worldwide production of 1,500 metric tons (Rust 2003). It also produced 8 million Atlantic cod juveniles in 2004 from 17 different producers (Solsletten 2005). In the United Kingdom (U.K.), Shetland Johnson Seaforms plans to convert a salmon farm to an Atlantic cod farm, and plans a three-fold increase in production over the next five years to 18,000 tons by 2010 (Bevington 2005). The European farmed cod industry is expected to boom in the next five years (Mitrovich 2005).

Bluefin tuna (*Thunnus spp*) culture has now spread to 18 countries including Mexico, Australia, Spain, Italy, Croatia, Tunisia, Portugal, Malta, Greece, Cyprus, and Morocco. Annual production of all tuna species is now projected to be 40,000 metric tons (Sylvia 2005). Bluefin tuna and amberjack (*Seriola dumerilii*) have both been recently spawned in captivity in Malta and Spain respectively, and it is hoped that this will lead to less of a dependence on wild stocks. (Galea 2005).

Limited sablefish (*Anoplopoma fimbria*) culture has started in British Columbia. As of May 2005, only one sablefish farm, Sablefish Farms Ltd., was in operation (DiPietro 2005). The goal of the company is to raise 2 million fingerlings within five years. Thirty-seven sablefish sites have been approved around Vancouver Island, while a hatchery is scaling up production on Salt Spring Island to provide juvenile sablefish for the proposed B.C. industry. Fishing and environmental groups have raised concerns about this operation.

Similar to the impact of Atlantic salmon on wild capture prices, the emergence of the before mentioned marine species may affect the price of wild-capture fish (e.g. cod). Additionally, freshwater cultured species, such as tilapia (*Tilapia spp.*), have increased its U.S. market share significantly in the past 10 years. Between 1995 and 2003 imports of tilapia, primarily from China, rose from 50 million to 381 million pounds (Johnson 2004).

V. Opportunities

The live capture and growth of traditionally wild capture fish is not a new idea. Lobster "pounds" are holding areas in which lobstermen keep their catch to avoid glutting the lobster market and driving down the price per pound. In New England, most lobsters are harvested in the fall, when their shells are hard and the weather has not yet turned too harsh for fishing. Lobstermen generally begin filling the pounds in October and have emptied them by April. The

pounds themselves are dammed-off inshore areas, often up to two acres large and a few feet deep. Aerators are used to ensure good water quality and incoming and outgoing tides assure nearly complete water exchanges. The lobsters are fed a feed similar to the bait used to catch them (Cohen 2003).

Holding and feeding wild caught fish (e.g., halibut) in shore-based net pens has been experimented with in British Columbia[2]. Similar to pounded lobster, the fish are then sold when market conditions are more favorable (Mauriks 2003). As mentioned earlier, tuna capture and fattening of tuna is also an expanding industry.

Captive Breeding – Marine Net Pen

As more is learned about marine finfish aquaculture technologies, opportunities could arise for recovering overfished and depleted fish stocks. The idea is similar to the captive broodstock programs that have been utilized to assist in the recovery of West Coast salmonid stocks listed for protection under the Endangered Species Act. At the NOAA's Manchester Research Station in Puget Sound, achievements include the successful spawning and propagation of over-fished species such as lingcod and some rockfish species.

Aquaculture researchers in Norway are experimenting on ways to increase the survivability of hatchery raised cod to enhance depleted North Sea stocks. (Fiorillo 2005).

VI. Obstacles to Aquaculture Growth in the U.S.

One factor hampering U.S. aquaculture growth is the availability of high-quality near shore sites. The primary rationale for moving operations offshore is that, theoretically, there is a greater availability of appropriate sites that potentially have fewer user conflicts and environmental impacts than sites located in coastal waters closer to shore (Cicin-Sain *et al.* 2001). If there is to be significant aquaculture development in the U.S., it will most likely occur in the EEZ. Public policy issues that have not been addressed for aquaculture in the EEZ include conveyance of property rights in public waters, minimization of user conflicts, and ensuring that government policy objectives (e.g., environmental regulations) are not jeopardized (Cicin-Sain et al. 2001).

Several entities, including state agencies, particularly the Alaska Department of Fish and Game; fishing groups (e.g., Alaska Trollers Association, Pacific Coast Federation of Fishermen's Associations, United Fishermen of Alaska); and environmental groups (Institute for Agriculture and Trade Policy, Natural Resources Defense Council) have adamantly opposed marine fish farming. Concerns regarding Atlantic salmon impacts (and other species) on wild stocks include disease transfer, pollution from net pen facilities, and ecological impacts from escaped salmon. There is also the concern about economic harm to local fishing communities from "subsidized" salmon farms (Grader *et al.* 2003). For a more detailed description of environmental concerns about fish farming please, refer to the *Environmental Impacts of Marine Aquaculture* (Phillips

[2] On the West Coast (including Canada), the growth of markets for live finfish began in the late 1980s for species including cabezon (*Scorpaenichthys marmoratus)*, gopher rockfish (*Sebastes carnatus*) china rockfish (*Sebastes nebulosus*) and lingcod (*Ophiodon elongatus*). Holding and feeding for extended lengths of time after capture does not appear to occur at this time.

2005).

Funding for NOAA, the lead agency for marine aquaculture in the U.S., may be another constraint to expansion of fish farming into the EEZ. While there are increases requested for FY 2006 and again in 2007, significant increases in the NOAA marine aquaculture budget may not be realized until FY 2008. If offshore aquaculture legislation is passed in the next year, NOAA could be hard pressed to fulfill its expanded role with its current funding levels.

VII. U.S. Federal Actions

At the Federal level, notable aquaculture policy actions have included:

U.S. Department of Commerce Aquaculture Policy (1999): The objectives of the policy include:

- Increase the value of domestic aquaculture production from the present $900 million annually to $5 billion, which will help offset the $6 billion annual U.S. trade deficit in seafood.
- Increase the number of jobs in aquaculture from the present estimate of 180,000 to 600,000.
- Develop aquaculture technologies and methods both to improve production and safeguard the environment, emphasizing where possible those technologies that employ pollution prevention rather than pollution control techniques.
- Develop a code of conduct for responsible aquaculture by the year 2002 and have 100 percent compliance with the code in Federal waters.
- Double the value of non-food products and services produced by aquaculture in order to increase industry diversification.
- Enhance depleted wild fish stocks through aquaculture, thereby increasing the value of both commercial and recreational landings and improving the health of our aquatic resources.
- Increase exports of U.S. aquaculture goods and services from the present value of $500 million annually to $2.5 billion.

National Marine Fisheries Service (NMFS) Draft Code of Conduct for Responsible Aquaculture in the U. S. Exclusive Economic Zone (EEZ) (2002): The purpose of the code is to provide general guidance for siting and operation of aquaculture facilities in the EEZ seaward of coastal state boundaries and authorities.

The Rationale for a New Initiative in Marine Aquaculture (2002): The Initiative's recommendations are as follows:

- NMFS should commit publicly to strengthening its rational development of marine aquaculture in the nation's coastal and offshore waters and immediately implement specific administrative actions, which can be done without additional legislative authority.

- NMFS should enhance its capabilities to advancing aquaculture technologies with a focus on production systems for new species and new practices, for rebuilding overexploited stocks and endangered marine species, and improving environmental technologies and practices.

- NMFS should move to stimulate domestic production of U.S. aquaculture products in support of the Aquaculture Policy.

U.S. Commission on Ocean Policy[3]: The "Ocean's Act of 2000" established the U.S. Commission on Ocean Policy to make recommendations for a coordinated and comprehensive national ocean policy to promote, among other things, protection of the marine environment; the need for consistent regulations and management of ocean activities; and investment designed to promote national energy and food security. The final report of the Commission was released in 2004. The Commission's recommendations regarding aquaculture can be found below:

- Congress should amend the National Aquaculture Act to designate NOAA as the lead Federal agency for marine aquaculture; create an Office of Sustainable Marine Aquaculture in NOAA; and designate the Secretary of Commerce as a permanent co-chair of the Joint Subcommittee on Aquaculture, along with the Secretary of Agriculture. The NOAA should use this authority to design and implement national policies to promote environmentally and economically sustainable marine aquaculture.

- The NOAA's new Office of Sustainable Marine Aquaculture should be responsible for developing a comprehensive, environmentally-sound permitting, leasing, and regulatory program for marine aquaculture.

- The U.S. should work with FAO to encourage and facilitate worldwide adherence to the aquaculture provisions of the Code of Conduct for Responsible Fisheries[4].

VIII. Legislation

The National Aquaculture Act: In 1980, Congress passed the National Aquaculture Act. The

[3] The Congressionally mandated U. S. Commission on Ocean Policy is separate from the privately funded Pew Oceans Commission. The Pew report (2003) includes a section on aquaculture recommending a moratorium on the expansion of marine finfish farms until standards for ecologically sustainable practices are set and implemented. To see the report, "America's Living Oceans: Charting a Course for Sea Change", go to http://www.pewtrusts.org/.

[4] Adopted in 1995 by the FAO, the nonbinding Code of Conduct for Responsible Fisheries provides "a necessary framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment." Go to http://www.fao.org/fi/default.asp to see the code.

Act declared a national aquaculture policy which called for establishing and implementing a national aquaculture development plan. It also encouraged aquaculture activities and programs in both the public and private sectors of the economy. The Act established a coordinating group, the Joint Subcommittee on Aquaculture (JSA), chaired by the U.S. Department of Agriculture (USDA). The JSA has been responsible for developing the National Aquaculture Development Plan, which identifies the relative roles of the Departments of Agriculture, Interior, and Commerce, and establishes a strategy for the development of an aquaculture industry in the United States.

Natural Stock Conservation Act of 2005: In April 2005, Senator Murkowski (R-Alaska) introduced the Natural Stock Conservation Act (S. 796). This bill would prohibit the development of aquaculture in the EEZ until Congress acts to ensure that every Federal agency involved consults with the governor of each state located within a 200-mile radius of the aquaculture facility, if approved by the regional fishery management council, and conducts analyses related to:

- disease control,
- structural engineering,
- pollution,
- biological and genetic impacts,
- access and transportation,
- food safety, and
- social and economic impacts of such facility on other marine activities, including commercial and recreational fishing.

National Offshore Aquaculture Act of 2005: In June 2005, Senators Stevens (R-AK) and Inouye (D-HI) introduced the long awaited National Offshore Aquaculture Act **(S. 1195).** For a NOAA fact sheet on the bill see **Appendix 1**. The bill authorizes the Secretary of Commerce to establish and implement a regulatory system for offshore aquaculture in the U.S. EEZ. According to NOAA, this bill would:

- Authorize the Secretary of Commerce to issue offshore aquaculture permits and to establish environmental requirements where existing requirements under current law are inadequate.
- Exempt permitted offshore aquaculture from legal definitions of fishing that restrict size, season and harvest methods.
- Authorize the establishment of a research and development program in support of offshore aquaculture.
- Require the Secretary of Commerce to work with other Federal agencies to develop and implement a streamlined and coordinated permitting process for aquaculture in the EEZ.

National Oceans Protection Act of 2005 (S. 1224): Introduced in June 2005 by Senators Boxer (D-CA) and Lautenberg (D-NJ), this bill has numerous sections on fisheries management, oceans research, marine mammals, and aquatic nuisance species. S. 1224 also contains a section on marine aquaculture which specifically refers to adhering to National Environmental Policy Act

requirements prior to aquaculture development (i.e., leasing). The bill, under its "Requirement For Regulations" section, also states:

> The Administrator of the National Oceanic and Atmospheric Administration may not lease a coastal, estuarine, or offshore area for aquaculture or issue a permit for aquaculture until the Administrator promulgates national standards and regulations that protect native stocks and prevent disease transmission, transmission of parasites, genetic dilution of wild stocks, introduction of invasive species, and impairment of habitat and water quality.

IX. Regional, State and Other Policy Actions

Pacific States Marine Fisheries Commission: At its 57th annual meeting in 2004 in Seattle Washington, the PSMFC passed the following position statement on aquaculture by unanimous vote:

> The PSMFC supports NOAA Fisheries continuing its existing fisheries regulatory, research and management responsibilities, but urges the agency to re-evaluate its role regarding the promotion and subsidy of aquaculture.
>
> - The Commission recommends a strong precautionary approach toward marine aquaculture to avoid premature incentives and investments that could result in serious environmental and economic consequences in communities that have traditionally relied on native stocks.
>
> - Regardless of what direction the aquaculture initiative takes, local stakeholders, regional councils and state agencies should have significant and meaningful input into decisions related to the siting of aquaculture facilities and their operation and other significant issues associated with aquaculture.

Gulf of Mexico Fishery Management Council: In January 2004, the Gulf Council released a scoping document entitled "To Provide for Regulation of Offshore Marine Aquaculture of Selected Fish." Following this, in September 2004 the Gulf Council and NOAA Fisheries stated their intention to prepare a draft supplemental environmental impact study in support of the amendment. It is currently unknown when further action will be taken on this issue.

California:

- In 2003, California passed a bill (SB 245) banning aquaculture of salmon, exotic (non-native) and transgenic (genetically-engineered) fish in state waters, including the ocean from 0 to 3 miles offshore.
- In 2004 Hubbs Sea World Research Institute, based in San Diego, California, announced plans to set up a fish and shellfish farm in the Pacific Ocean on a decommissioned oil platform[5], 10 miles off Ventura County, California. We are

[5] Relatedly, in 2003, in the 108th Congress, Representative David Vitter (R-Louisiana) introduced legislation (HR

unaware of significant progress on this proposed project as of August 2005.

Washington: In 2002, the Washington Fish and Wildlife Commission adopted rules **(Chapter 220-76 WAC Aquaculture)** governing marine finfish aquaculture. The rules require that fish growers develop a fish escape prevention plan, report escapes, and attempt to recapture escapees. The rules also address aquaculture facility inspection authority and establish an Atlantic salmon watch program.

Alaska: Alaska banned fish farming in state waters in 1990.

Louisiana: In early 2005, a specially commissioned task force created by the Louisiana Legislature came out in support of offshore aquaculture using former oil and gas platforms in the Gulf of Mexico. Some excerpts from the report are below:

- It is practical to consider that the use of existing Gulf of Mexico production platforms could prove beneficial in expediting the development of a mariculture industry in Louisiana.
- Production platform liability costs to mariculture enterprises may be reduced by sharing those costs jointly with other potential platform users such as liquefied natural gas storage and wind energy ventures. A Louisiana production platform mariculture policy should encourage the opportunity for such arrangements to exist.

Pew/Woods Hole Marine Aquaculture Task Force: In June 2005 the Pew Charitable Trusts and Woods Hole Oceanographic Institution announced the establishment of a Marine Aquaculture Task Force, a privately funded initiative which will be comprised of "leaders from the worlds of science, industry, conservation and government—to develop national aquaculture standards to guide future development of our oceans." According to its sponsors, to address aquaculture's risks and benefits, the members of the Marine Aquaculture Task Force will be guided by the principle that marine aquaculture must be conducted in a way that does not harm fish and wildlife and the ecosystems on which they depend.

X. Discussion

It has been suggested that in marketing fresh seafood, pen-reared and wild capture Atlantic cod could complement each other by providing year round market stability in Europe (Williksen 2005). According British Marine Finfish Association (BMFA no date), in the U.K., the development of a successful and sustainable marine fish farming industry for species such as whitefish (e.g. cod, haddock and halibut) offers a valuable additional supply source for the seafood processing industry, hit hard in recent years by dwindling quotas; and it is unlikely that farmed product will compete with wild-caught whitefish, but instead will complement fleet landings.

2654) to amend the Outer Continental Shelf Lands Act to direct the Secretary of the Interior to issue regulations under which the Secretary may authorize use of a decommissioned offshore oil and gas platform for culture of marine organisms, an artificial reef, or scientific research, and for other purposes. This bill was never moved.

The thought that wild and farmed salmon could complement each other is probably not realistic because of the large volumes of cheaper and consistently produced farmed salmon. However, "organic" farmed salmon[6] and wild capture salmon may complement each other in the premium market as consumers look for an "environmentally friendly" product. Or will they compete?

In a reversal of a 15 year declining trend, Alaska salmon revenues began rising in 2003 due to higher prices and larger harvests. The price and demand for wild salmon have gone up partly because of negative press regarding farmed salmon (e.g. PCB contamination), thus creating a niche market (Wilhelm 2005). The West Coast wild salmon industry will need to continue the trend of increasing quality and product differentiation if they are to expand their market share[7] (Babcock and Weninger 2004). To that end, the Alaska Seafood Marketing Institute now has website links to 114 companies offering direct seafood sales to individuals. These companies (including fishing vessels) market wild caught salmon with product descriptions such as: "superior product", "minimally handled", "among the purest fish found anywhere", and "better than organic - it's wild".

How will marine (and freshwater) aquaculture impact west coast commercial fisheries such as lingcod and rockfish? Tilapia sales are likely taking market share away from commercially caught West Coast marine whitefish. The forecasted expansion of farmed Atlantic cod could pose yet another challenge to the West Coast commercial fisheries market share. For all West Coast capture fisheries, product quality, consumer preference and willingness to pay premium prices for wild caught fish will likely be vital to their survival in light of ever increasing aquacultural competition. Also, the rebuilding of West Coast overfished stocks will be critical to the survival of an already decimated commercial groundfishery.

[6] Organic foods are the fastest growing foods in agriculture and production is expected to increase 240 fold by 2030 (NOAWG 2005). Efforts to market organically (e.g., "environmentally friendly") farmed salmon are expanding. The designation of organic to wild salmon stocks is also being pursued.

[7] The extent to which price premiums for high-quality wild salmon can emerge in consumer markets is not fully known. Anecdotal evidence suggests that consumers could be willing to pay more for Alaskan wild salmon, although it appears that considerable effort will be required to develop a reputation for delivering a consistently high-quality product before these premiums can be realized (Babcock and Weninger 2004).

X. REFERENCES

1. Amos, Kevin and Andrew Appleby. 1999. Atlantic Salmon in Washington State: A Fish Management Perspective. Washington Department of Fish and Wildlife, 600 Capitol Way, North Olympia, Washington 98501.

2. ADFG (Alaska Department of Fish and Game, Division of Commercial Fisheries). 2005. Salmon Exvessel (Price Per Pound) by Area and Species. Juneau, Alaska. http://www.cf.adfg.state.ak.us/geninfo/finfish/salmon/salmhome.php

3. Babcock, Bruce and Quinn Weninger. 2004. Can quality revitalize the Alaskan salmon industry? Working Paper 04-WP 359. Center for Agricultural and Rural Development. Iowa State University Ames, Iowa. www.card.iastate.edu

4. Bevington, Pete. 2005. Salmon site switches to cod. Fish Farming International. 32 (3).

5. BCSFA (British Columbia Salmon Farmers Association). No date. Salmon aquaculture in BC Today. Campbell River, BC.

6. BMFA (British Marine Finfish Association). No date. Marine fish offers huge economic opportunity. Midlothian, United Kingdom. \http://www.bmfa.uk.com/news/economic_op htm.

7. Business Wire. 2005. Neptune Industries look at barra JV in Florida. April 3, 2005. San Francisco, CA.

8. Cohen, Andrea. 2003. Digging for Answers in Lobster Pounds. *Two if by Sea.* Winter Spring, 2003. MIT and WHOI Sea Grant Programs.

9. Cutland, Laura. 2003. Atlantic Canada ramps up haddock and halibut farming. November 3, 2003. Intrafish Media The Wave. FAO. 2005.

10. State of World Fisheries and Aquaculture 2004. Rome, Italy

11. Fiorillo, John. 2005. Raising well-behaved cod. The Wave 6/1/2005 *The Wave,* IntraFish Media. John Fiorillo, Editor Seattle Washington.

12. Galea, Chris. 2005. Captive amberjack broodstock successfully fertilized (07/16/2005). GROWfish, Gippsland Aquaculture Industry Network. Traralgon Victoria Australia. http://www.growfish.com.au/default.asp.

13. Government of British Columbia. 2002. News Release #02-01. January 31, 2002. Ministry of Agriculture, Food and Fisheries. Victoria, British Columbia.

14. Grader Zeke, Benjamin Natasha, and Glen Spain. 2003. *Fishermen's News.* May, 2003.

15. Graham Bud. 2003. Assist. Dep. Min., B.C. Ministry of Ag., Food & Fish. Conference on Marine Aquaculture: Effects on the West Coast and Alaska Commercial Fishing Industry. November 17-19, 2003 Seattle, Washington.

16. Johnson, Howard. 2004. 2004 Annual Report of the United States Seafood Industry. Twelfth Edition. H.M. Johnson and Associates. 104 pp.

17. DiPietro, Dan. Commercial sablefish catchers say report shows need to slow down with farms (5/10/2005). *The Wave,* IntraFish Media. John Fiorillo, Editor - Seattle, Washington.

18. International Food Policy Research Institute (IFRPRI), Fish as Food. Projections to 2020, Meeting Global Demand. 2003. Washington D.C.

19. Knapp Gunnar. 2003. Univ. of AK, Fairbanks Conference on Marine Aquaculture: Effects on the West Coast and Alaska Commercial Fishing Industry. November 17-19, 2003 - Seattle, Washington.

20. Lanteigne, Stephen. 2002. Current Status and Potential of the Canadian Aquaculture Industry (Study No. 1). Office of the Commissioner for Aquaculture Development. Ottawa, Canada. 53 pp.

21. Mauriks, Kim. 2003. Conference on Marine Aquaculture: Effects on the West Coast and Alaska Commercial Fishing Industry. November 17-19, 2003 - Seattle, Washington.

22. Mitrovich, Velo. 2005. Cod starts to live up to expectation – finally! *Fish Farming International.* 32 (7):16-21.

23. Nash, C.E. (editor). 2001. The net-pen salmon farming industry in the Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-49, 125 p. NTIS PB2002-100948.

24. NOAA Fisheries, Industry and Trade Program. 2001. Imports and Exports of Fishery Products Annual Summary, 2001.

25. NOAWG (National Organic Aquaculture Working Group). 2005. White Paper May 24, 2005 -Proposed national organic standards for farmed-aquatic animals and plants (aquaculture) with supporting documentation and information. George Lockwood, Richard Nelson, and Gary Jensen, Editors. 81 pp. USDA, Washington DC.

26. PacFIN, 1994, 2004. Pacific Fishery Management Council Groundfish Management Team Reports. Pacific States Marine Fisheries Commission. Portland, Oregon.

27. Phillips, Stephen. 2005. The Environmental Impacts of Marine Aquaculture. Pacific States Marine Fisheries Portland. Portland, Oregon. 23 pp.

28. Rust, Mike. 2003. Conference on Marine Aquaculture: Effects on the West Coast and Alaska Commercial Fishing Industry. November 17-19, 2003 Seattle, Washington.

29. Solsletten, Vegard. 2005. Slow and Steady for Farmed Cod. *IntraFish.* 3(2): 28.

30. Sylvia, Paula. 2005. Current Status Of Bluefin Tuna Farming In North America World Aquaculture 2005, - Meeting Abstract 493. Hubbs-SeaWorld Research Institute 2595 Ingraham Street San Diego, California 92109 USA.

31. U.S. Commission on Ocean Policy. 2004. An Ocean Blueprint for the 21st Century. Final Report. Washington, DC, 2004 ISBN#0–9759462–0–X.

32. Waknitz, F.W., T.J. Tynan, C.E. Nash, R.N. Iwamoto, and L.G. Rutter. 2002. Review of potential impacts of Atlantic salmon culture on Puget Sound chinook salmon and Hood Canal summer-run chum salmon evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-53, 83 p.

33. Wilhelm, Steve. 2005. Salmon sales surge on demand for upscale fish (May 30, 2005). *Puget Sound Business Journal*. Seattle, WA. http://sanfrancisco.bizjournals.com/seattle/services/

34. Williksen, Trond. 2005. Talk given at the conference the "Role of aquaculture in meeting global seafood demand". June 20, 2005. Seattle, Washington. (Sponsored by NOAA Fisheries).

Appendix 1: Summary of the National Offshore Aquaculture Act - S. 1195 (Source: NOAA Aquaculture Program June 7, 2005).

Purpose: To provide the necessary authority to the Secretary of Commerce for the establishment and implementation of a regulatory system for aquaculture in Federal waters, also known as the U.S. Exclusive Economic Zone (EEZ).

What the Bill Would Do:

- Authorize the Secretary of Commerce to issue offshore aquaculture permits and to establish environmental requirements where existing requirements under current law are inadequate.
- Exempt permitted offshore aquaculture from legal definitions of fishing that restrict size, season and harvest methods.
- Authorize the establishment of a research and development program in support of offshore aquaculture.
- Require the Secretary of Commerce to work with other Federal agencies to develop and implement a streamlined and coordinated permitting process for aquaculture in the EEZ.
- Authorize to be appropriated "such sums as may be necessary" to carry out this Act
- Provide for enforcement of the Act.

Major Features of the Proposed Regulatory Framework for Offshore Aquaculture Permits

Aquaculture operations would require two permits: a site permit for a particular area of the EEZ and an operating permit for specific species and systems to be placed on the site.

- The Secretary of Commerce would be authorized to set fees and establish permit terms and conditions.
- Applicants would be able to submit applications for both permits for review at the same time.
- Permits would be transferable.
- Eligibility for permits would include foreign entities provided they have an agent in the U.S. and agree to be subject to U.S law.
- Once all permit requirements are met, the Secretary of Commerce would be required to render a decision within 120 days, or provide written notification to the applicant with an explanation and timeline for decision.

The Secretary of Commerce would be required to consult with Federal agencies, Fishery Management Councils, states, and tribes before issuing a permit.

- Permit actions for sites located on leases or easements under the Outer Continental

Shelf Lands Act (OCSLA), or within 1 mile of an OSCLA-permitted facility, would require concurrence from the Secretary of the Interior.

- The Secretary of the Interior would be authorized to impose additional requirements for aquaculture on OCSLA sites.

Most site permits would be for 10 years, renewable in 5-year increments.

- Permits for demonstration projects and for sites requiring Department of the Interior concurrence may differ.

Environmental Requirements

Permit decisions would be based on criteria that take into account environmental requirements and compatibility with other uses

- Environmental requirements would include those already in existence under current law, plus additional requirements that may be developed by the Secretary of Commerce in consultation with other Federal agencies.
- Environmental requirements would address risks to and impacts on wild fish stocks, marine ecosystems, water quality, habitat, marine life, and other features of the environment.

Implementation of the Act would require compliance with the *Coastal Zone Management Act* and, to the extent practicable; the Secretary of Commerce would ensure that offshore aquaculture does not interfere with fisheries conservation and management.

The Secretary of Commerce would be authorized to collect information to evaluate the suitability of sites for aquaculture, to monitor the effects of aquaculture, and to take appropriate measures to ensure compliance with environmental requirements – including suspending, modifying, or revoking permits.

Permit holders would be required to post bonds or other financial guarantees, and would have to remove structures, gear, and other property and restore the site upon the expiration or termination of a permit.