Economic Perspectives on United States Marine Aquaculture

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Marine Aquaculture Task Force
Anchorage, Alaska
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About myself

- Ph.D. in Economics from Yale University (1981)
- Worked at University of Alaska Anchorage Institute of Social and Economic Research since 1981
- Undertaken wide variety of research about Alaska economy, Alaska fisheries management, and Alaska fisheries markets
- Continuously engaged in research on salmon markets and the salmon industry since 1991
- Visited aquaculture and hatchery operations in Canada, Norway, Chile, Iceland, Japan and Russia
- Read extensively about aquaculture but have not engaged in detailed analysis of aquaculture economic issues (except for market effects)
- Will participate in a NMFS-funded study of economics of offshore marine aquaculture which is just getting underway
- Representing myself
- Not representing University of Alaska, State of Alaska, Alaska salmon fishermen, NMFS, or aquaculture industry!

What I think about aquaculture

Aquaculture is an emotional issue in Alaska. Many Alaskans think the answer to any kind of aquaculture is "Just say no."

I think we need to learn more and think more in developing aquaculture policy for the United States—and for Alaska.

I think we should think carefully about the opportunities offered by aquaculture and whether there are ways we can responsibly take advantage of them.

I think the issue is not whether to choose wild fisheries or aquaculture, but rather how we can responsibly achieve the potential benefits of both wild fisheries and aquaculture.

Note: Except where otherwise specified, all photographs in this presentation are by Gunnar Knapp.

Marine aquaculture is not just—or even mainly--about Alaska or salmon farming.

- Alaska has legitimate concerns about marine aquaculture.
- But the United States is not just Alaska.
- The U.S. EEZ is not just the EEZ off Alaska.
- It is reasonable and appropriate for the federal government to be discussing offshore aquaculture and whether and how to allow or encourage it in U.S. federal waters.
- Other states' interests and attitudes with respect to aquaculture are not necessarily the same as those of Alaska.
- It is reasonable or appropriate for Alaskans to want a major role in any decisions affecting waters off Alaska.
- If Alaskans don't want aquaculture—inshore or offshore-- that shouldn't necessarily dictate what happens off other states.

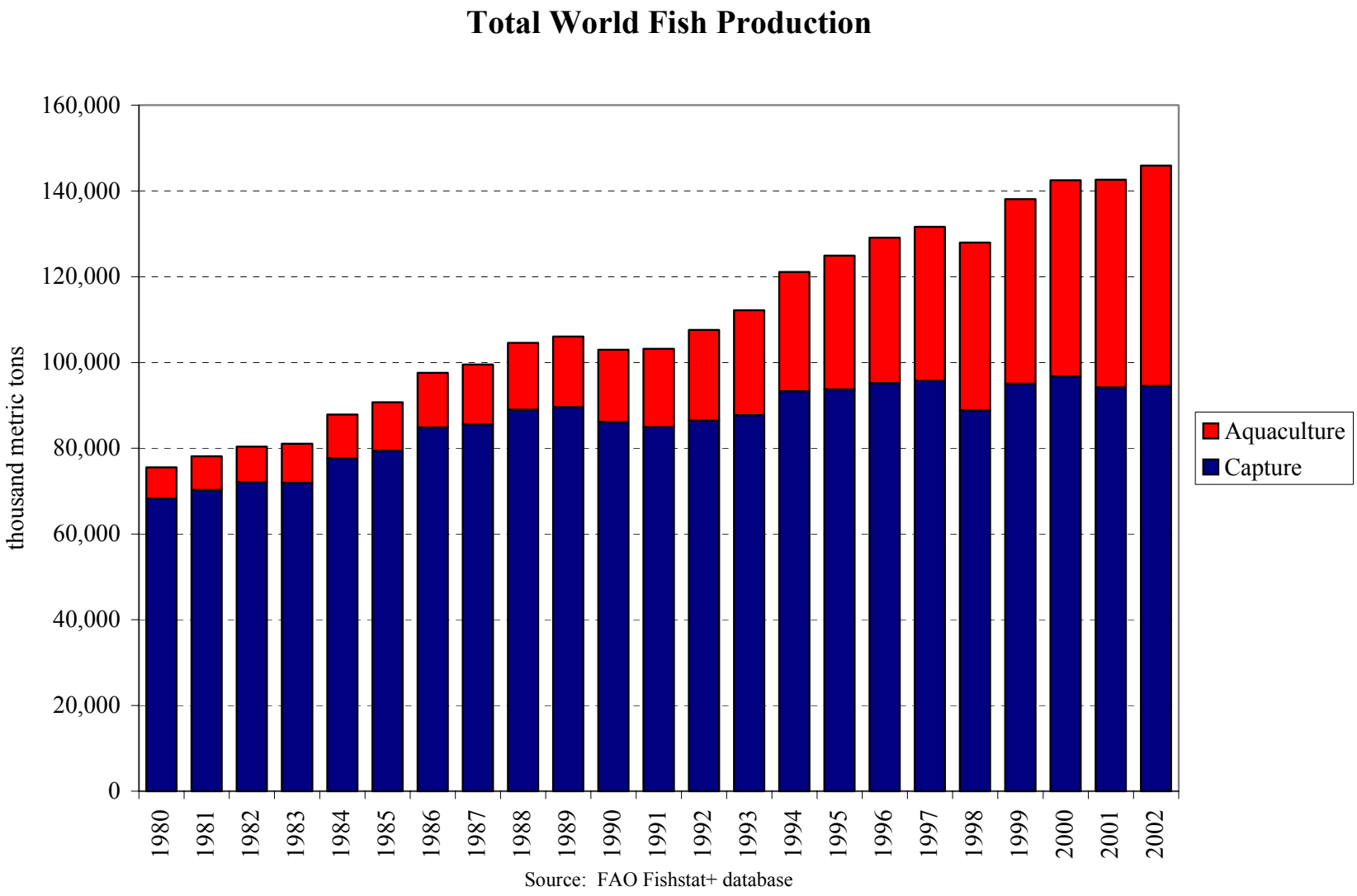
Outline

- PART I: Implications of aquaculture for wild fisheries: The case of Alaska wild salmon *[25 minutes]*
- PART II: Five economic considerations in thinking about U.S. marine aquaculture *[20 minutes]*
- PART III: The fish feed issue in the aquaculture debate: An economic perspective *[5 minutes]*
- PART IV: United States marine aquaculture: Three questions *[5 minutes]*
- PART V: How to keep marine aquaculture from happening *[1 minute]*

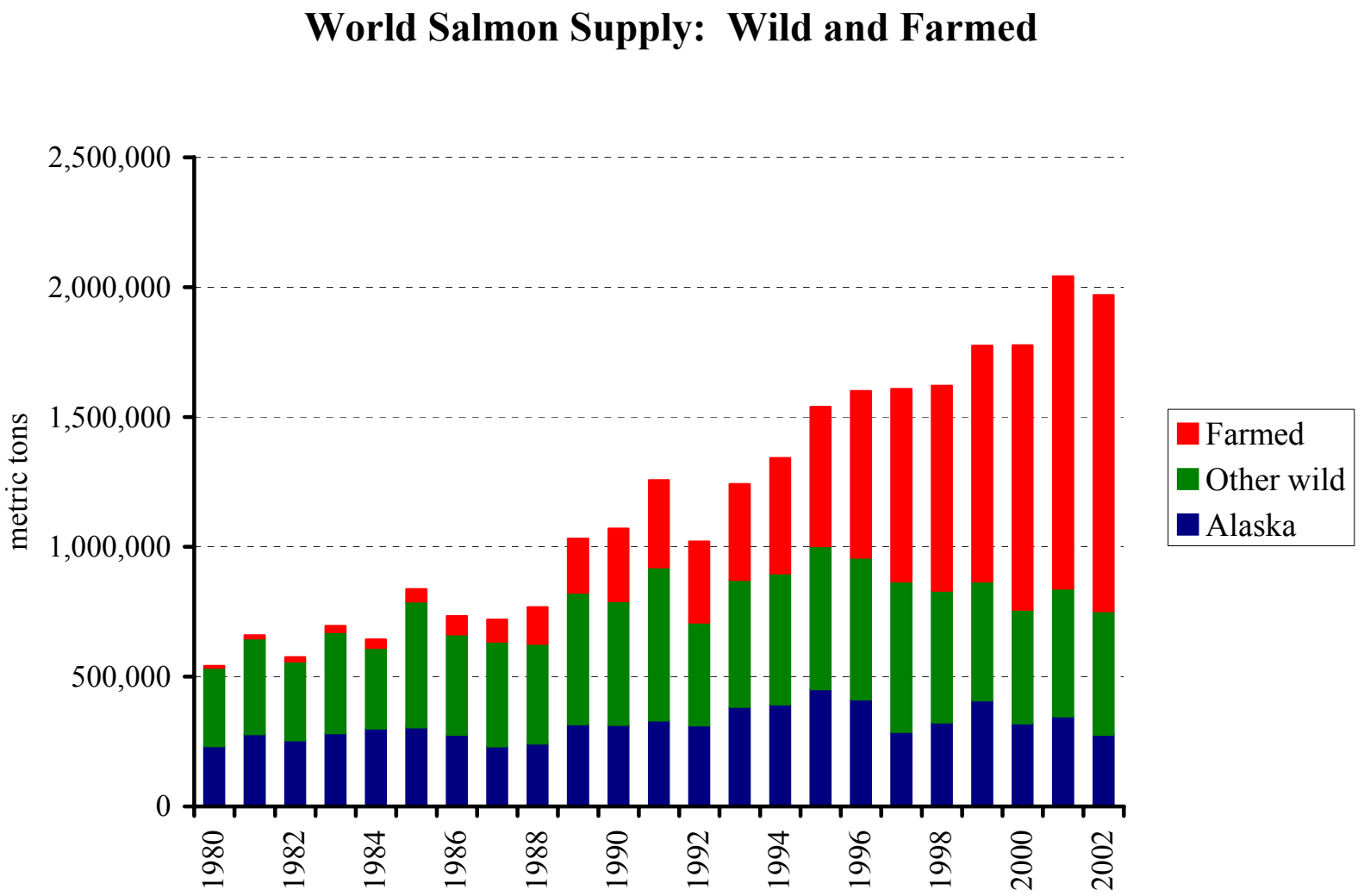
PART I

Implications of Aquaculture for Wild Fisheries: The Case of Alaska Wild Salmon

An aquaculture revolution is happening in the world seafood industry. Aquaculture accounts for a large and growing share of world seafood production.



Salmon is one of the species for which the growth in aquaculture production has been most dramatic. Since 1980, farmed salmon has increased from 2% of world salmon supply to 60% of world salmon supply. Alaska wild salmon has fallen from more than 40% to less than 20% of world supply.



How will the growth of aquaculture affect wild fisheries?

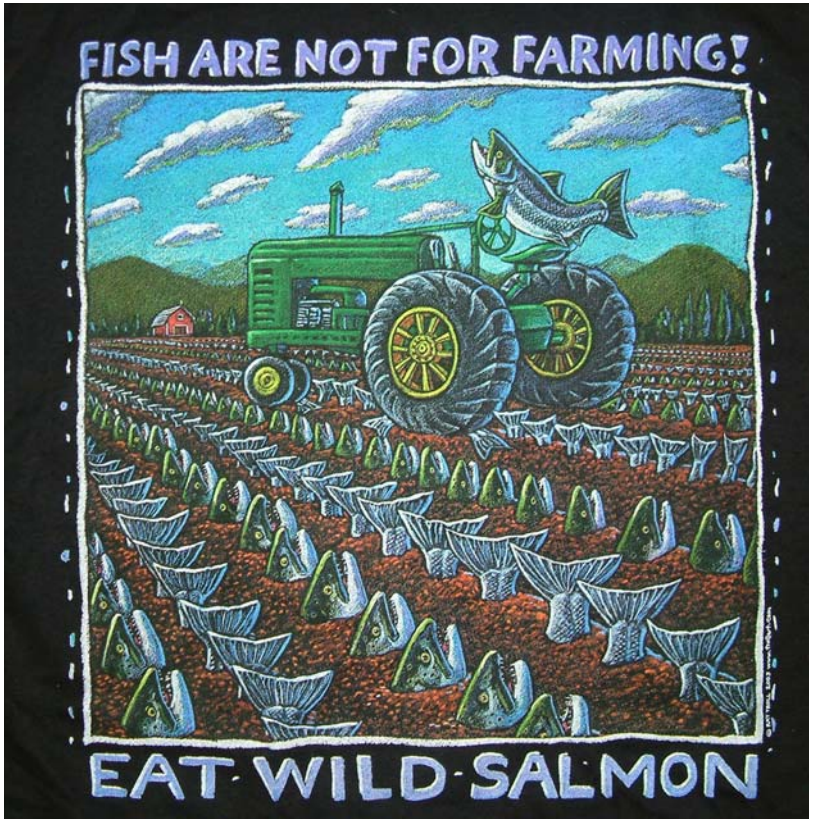
The effects of salmon farming on the Alaska wild salmon industry provides insights into this question.

How has salmon farming affected the Alaska wild salmon industry?

POPULAR / GREEN / ALASKAN PERSPECTIVE:

Unfairly subsidized and inferior farmed salmon harmed the environment and wild stocks in producing nations, and flooded world markets, depressing wild salmon prices and significantly harming Alaska fishermen and fishing communities.

POPULAR / GREEN /ALASKAN PERSPECTIVE . . .



T-shirt by Alaska artist Ray Troll

How has salmon farming affected the Alaska wild salmon industry?

AN ECONOMIC PERSPECTIVE:

Salmon farming exposed a natural monopoly to competition, benefiting consumers by expanding availability, lowering prices, spurring innovation and market development, and leading to a more efficient wild salmon industry more focused on meeting market demands.

1. The Alaska salmon industry is very diverse. Beware of generalizations about the salmon industry or how it has been affected by salmon farming.

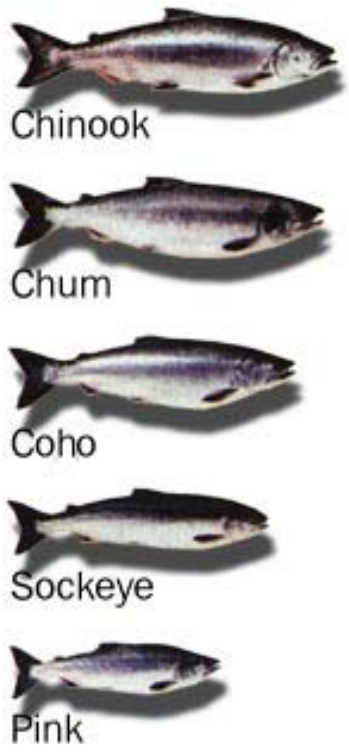
Beware of generalizations about:

"salmon"
"salmon prices"
"salmon markets
"salmon consumers"
"the salmon industry"
"effects of salmon farming on the wild salmon industry"

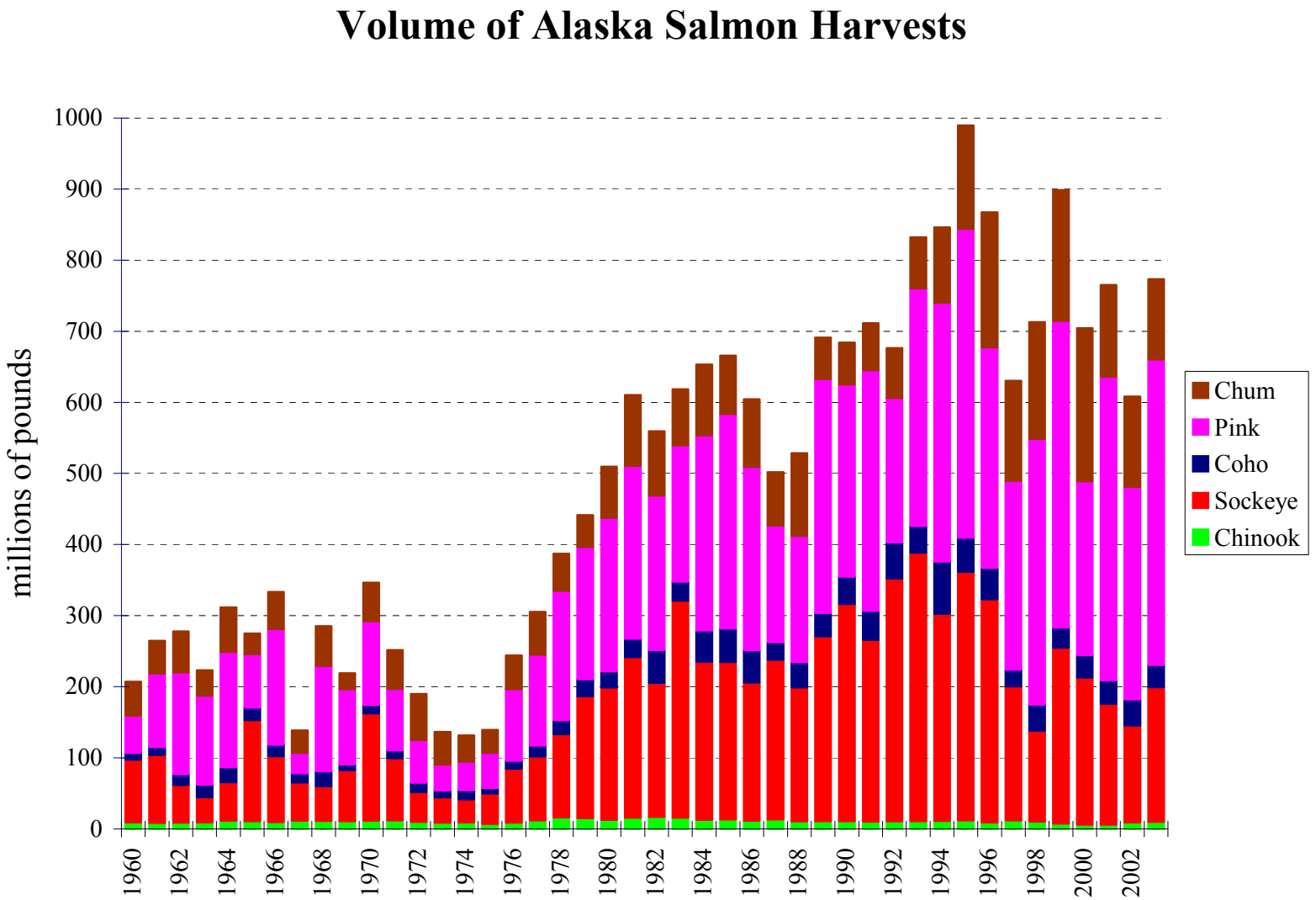
Five salmon species are harvested in Alaska:
sockeye, pink, chum, coho and chinook.

Different species vary widely in size, fat content and other characteristics which affect taste and suitability for different product forms.

Species	Also called	Average weight (Alaska, 2004)
Chinook	King	15.9
Chum	Keta, Dog	7.9
Coho	Silver	7.2
Sockeye	Red	5.8
Pink	Humpy	3.6



Harvests trends and volumes vary widely between species. Sockeye, pink and chum harvests are much larger than coho and chinook harvests.

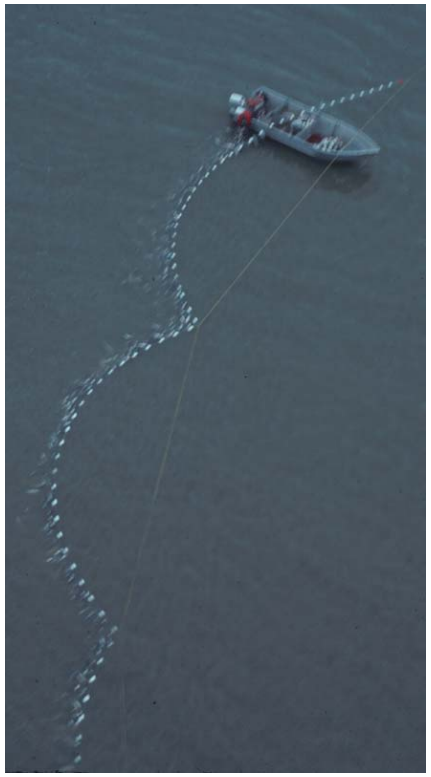


Salmon are harvested in Alaska using four major types of gear. There are important differences between gear types in catch volumes, costs, species harvested, and fish handling.

Seine

Drift gill net

Set gill net



Troll

Troll fishing picture source: Downloaded February 3, 2005 from www.primeseafood.com/ salmon.html. Picture originally courtesy of Seafood Producers Cooperative.

Alaska salmon are harvested in 27 different limited entry fisheries. These fisheries differ widely in value, number of permit holders, average earnings and average permit value.

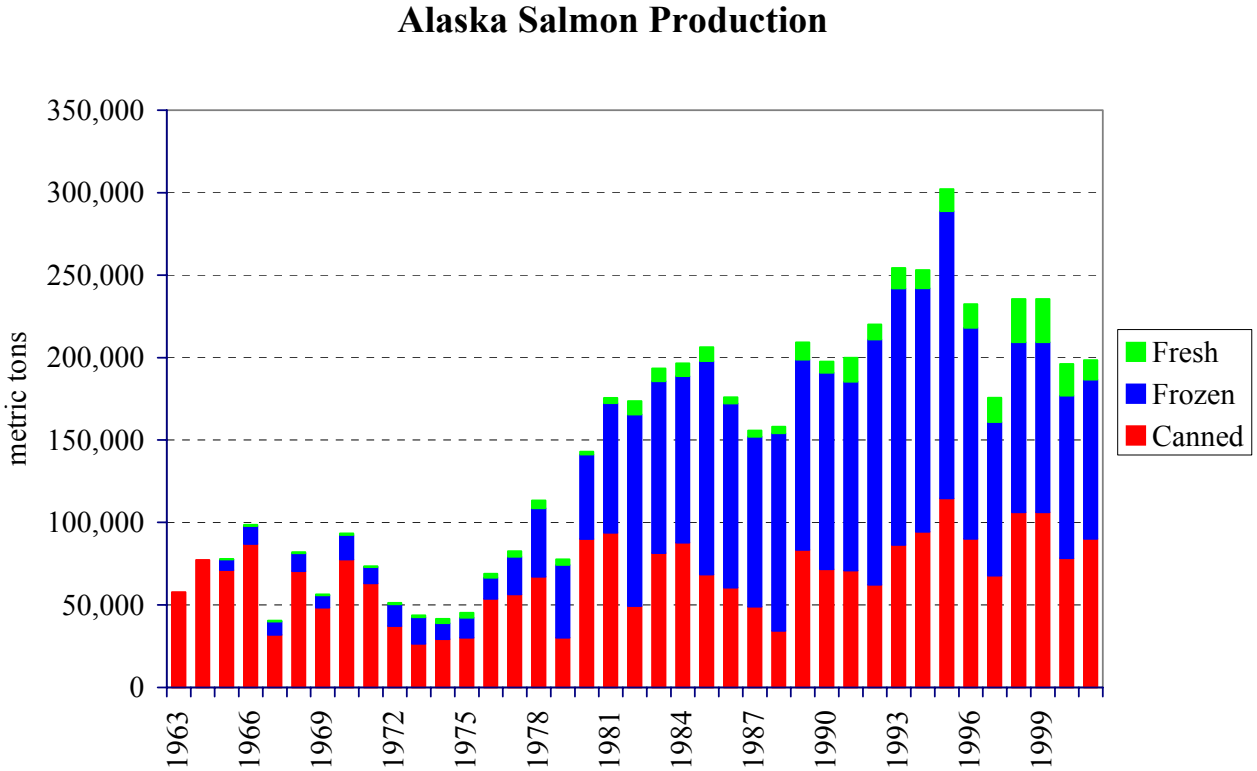
Overview of Selected Alaska Salmon Fisheries, 2000

Area	Gear	Gross earnings ($millions)	Total permits	Resident permits	Resident share of permits	Share of permits fished	Average earnings per permit fished ($ 000)	Average permit value ($ 000)
Bristol Bay	Drift gill net	65.5	1,896	916	48%	96%	35.9	80.5
Southeast	Purse seine	28.8	416	189	45%	86%	80.8	39.3
PWS	Drift gill net	22.2	541	393	73%	97%	42.3	59.3
PWS	Purse seine	19.2	268	197	74%	49%	147.8	22.0
Chignik	Purse seine	12.3	99	75	76%	100%	124.4	200.0
Cook Inlet	Drift gill net	4.2	577	384	67%	89%	8.3	32.3
Kuskokwim	Gill net	1.2	823	815	99%	76%	1.9	6.5
Lower Yukon	Gill net	0.7	704	694	99%	80%	1.3	12.1
Other 19 fisheries		91.5	6,432	5,193	81%	62%	23.0	
Total		245.7	11,756	8,856	75%	73%	895.8	1103.1

Source: Commercial Fisheries Entry Commission, Basic Information Tables.

The Alaska salmon industry is much more than fishing. Tendering and processing are integral parts of the industry.

Alaska wild salmon are processed into four major primary products: canned salmon, frozen salmon, fresh salmon, and salmon roe.



Products and markets differ significantly for different species.

The canned share is greatest for pink and sockeye salmon

Fresh production is greatest for chinook, coho and chum salmon.

Alaska Salmon Production, by Product and Species, 1999-2003

	Canned	Frozen	Fresh
Pink	74%	22%	4%
Sockeye	34%	61%	6%
Coho	11%	76%	14%
Chum	8%	76%	15%
Chinook	2%	66%	32%

Note: Omits other products, which account for less than 1% of production for all species

For all species except pink salmon, the largest share is sold frozen.

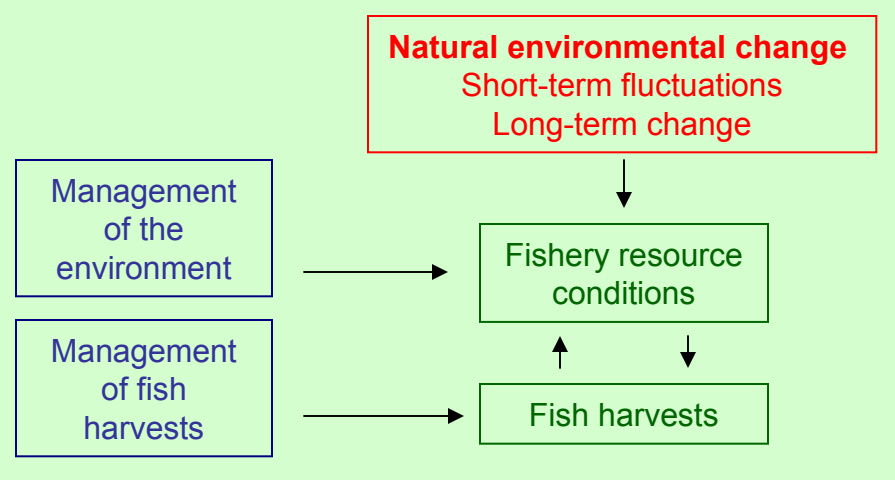
Beware of generalizations about the salmon industry or how it has been affected by salmon farming . . .

- Anything that I tell you about the effects of salmon farming on the Alaska wild salmon industry
  - Does not apply to all salmon species, gear groups, fisheries, products or markets
  - Will probably NOT apply to some salmon species, gear groups, fisheries, products or markets

- Anything anyone else tells you about the effects of salmon farming on the Alaska wild salmon industry
  - Probably does not apply to all salmon species, gear groups, fisheries, products or markets
  - Will probably NOT apply to some salmon species, gear groups, fisheries, products or markets

2. Wild fisheries are complex natural, economic and political systems. Aquaculture may have many different direct and indirect effects in the short-run and long-run.

A wild fishery is partly a natural system
driven by and affecting fishery resource conditions.

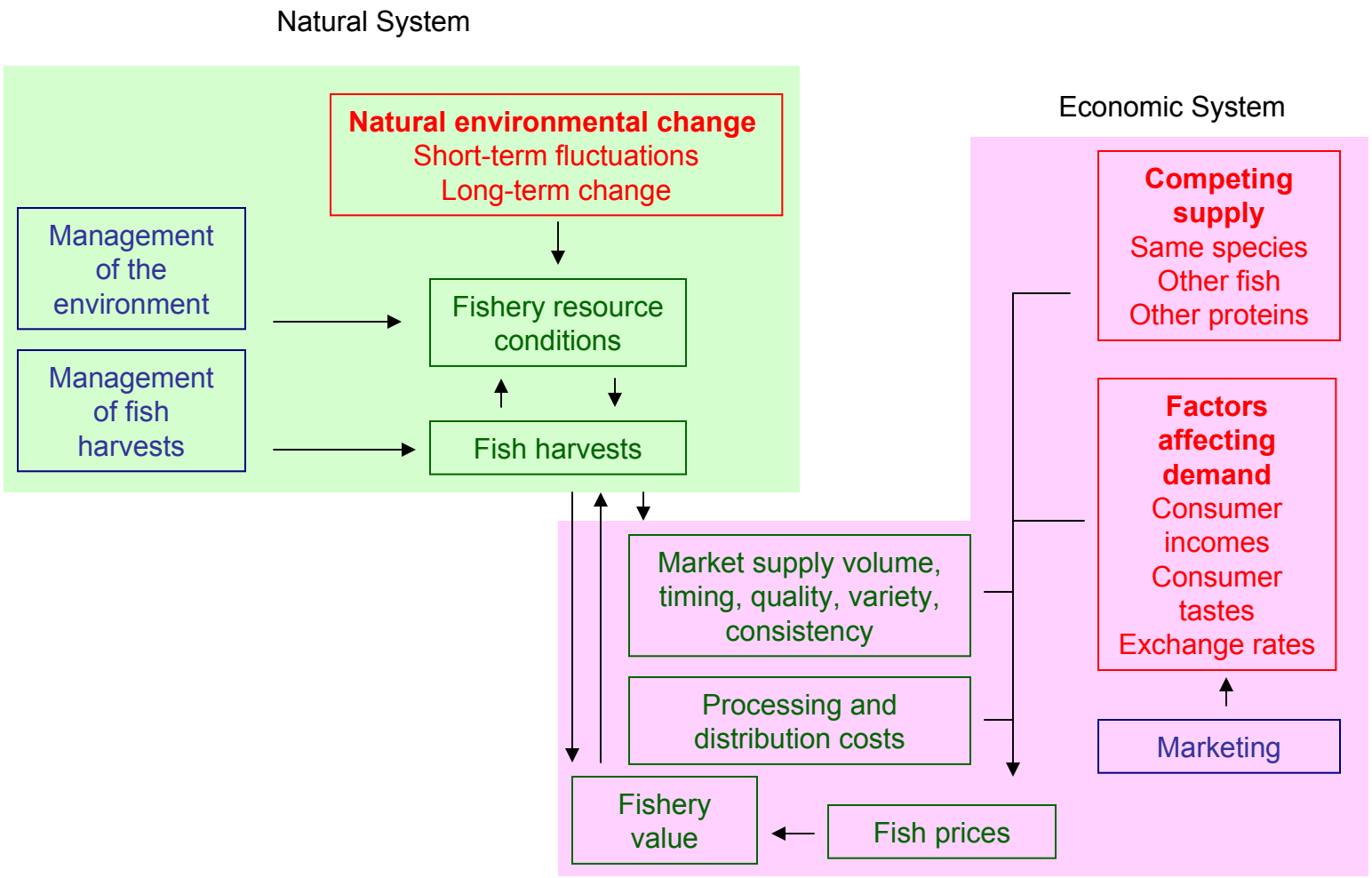


Variables endogenous to the system are shown in green

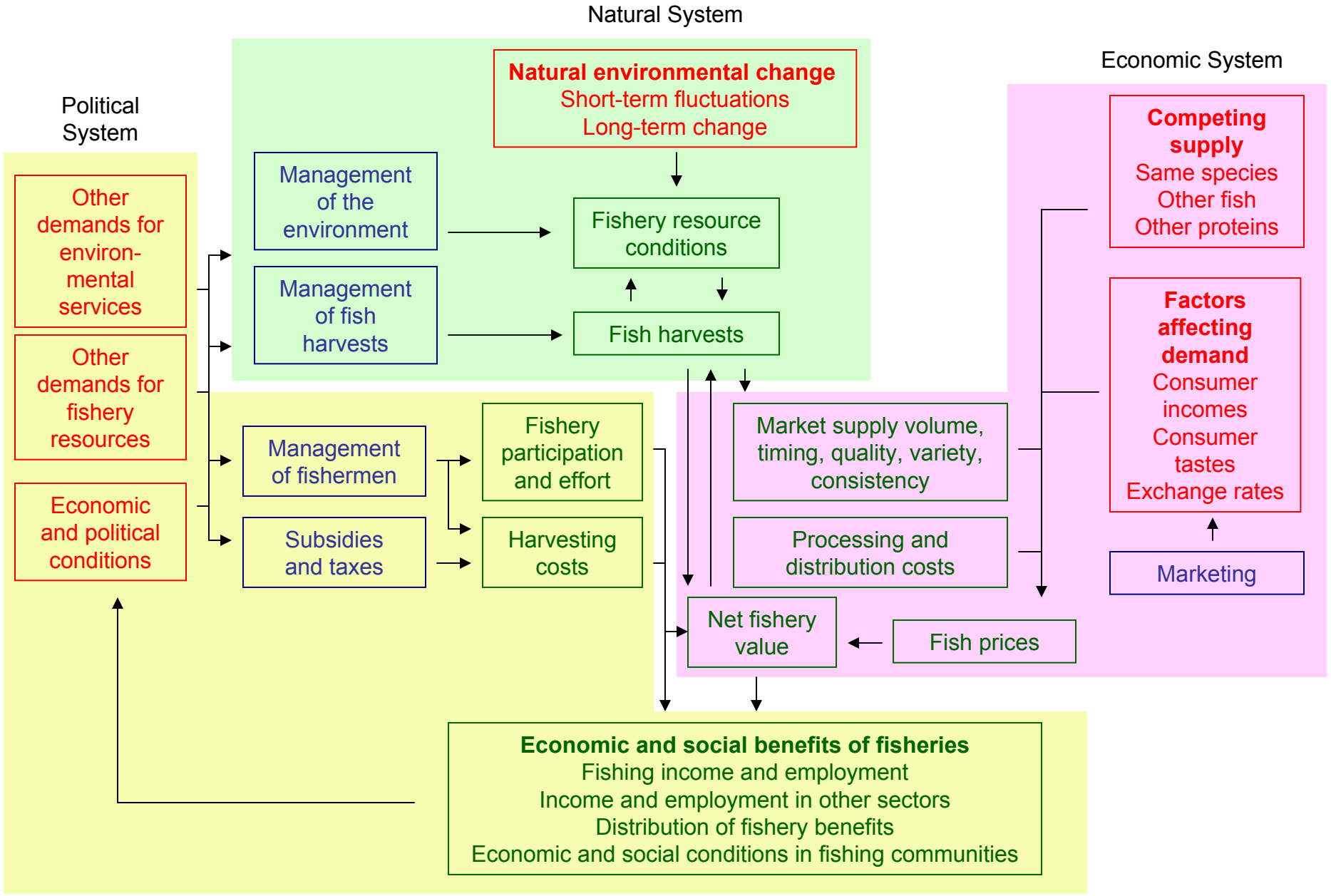
Variables exogenous to the system are shown in red

Policy variables are shown in blue

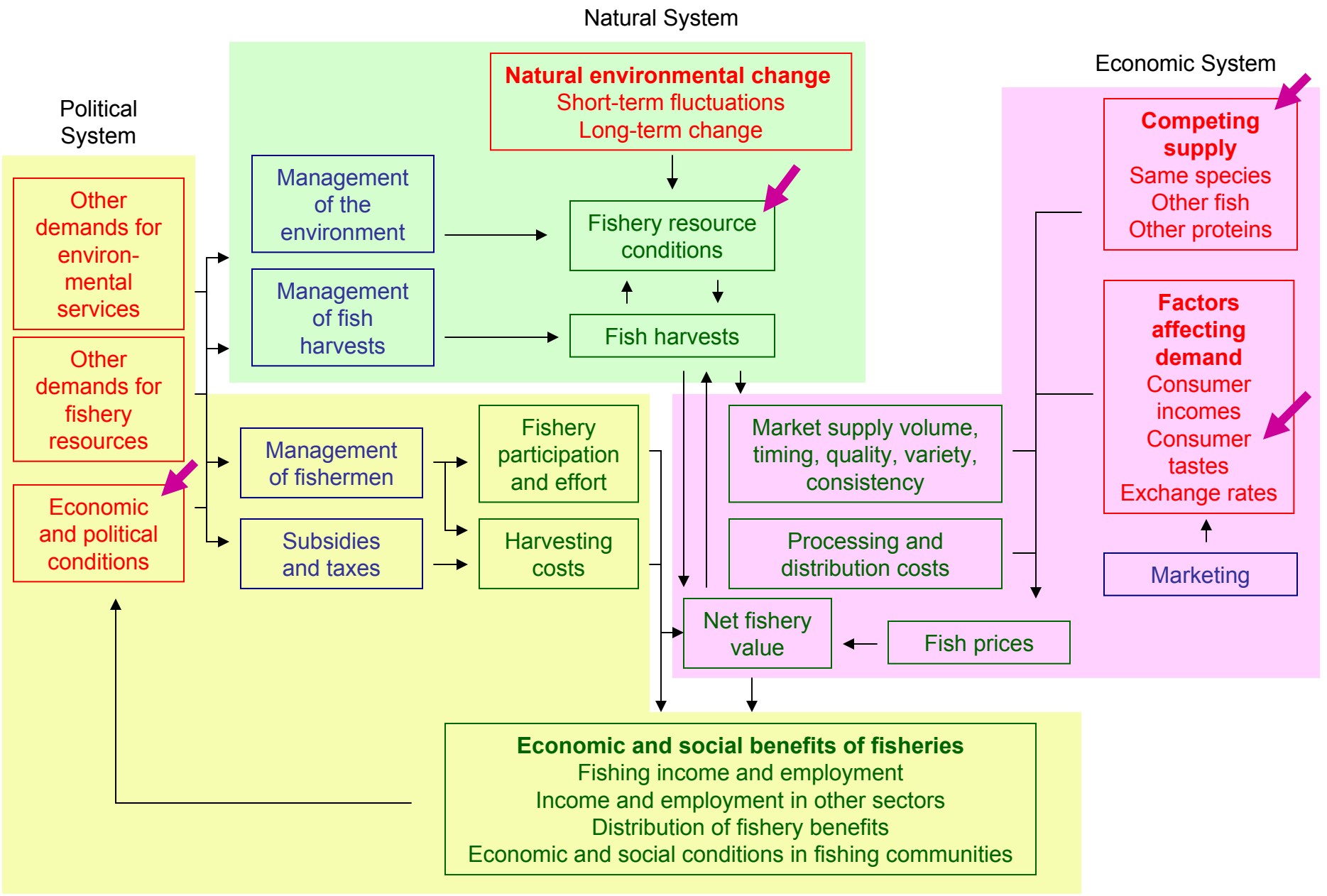
A wild fishery is partly an economic system
driven by and affecting fish prices and value.



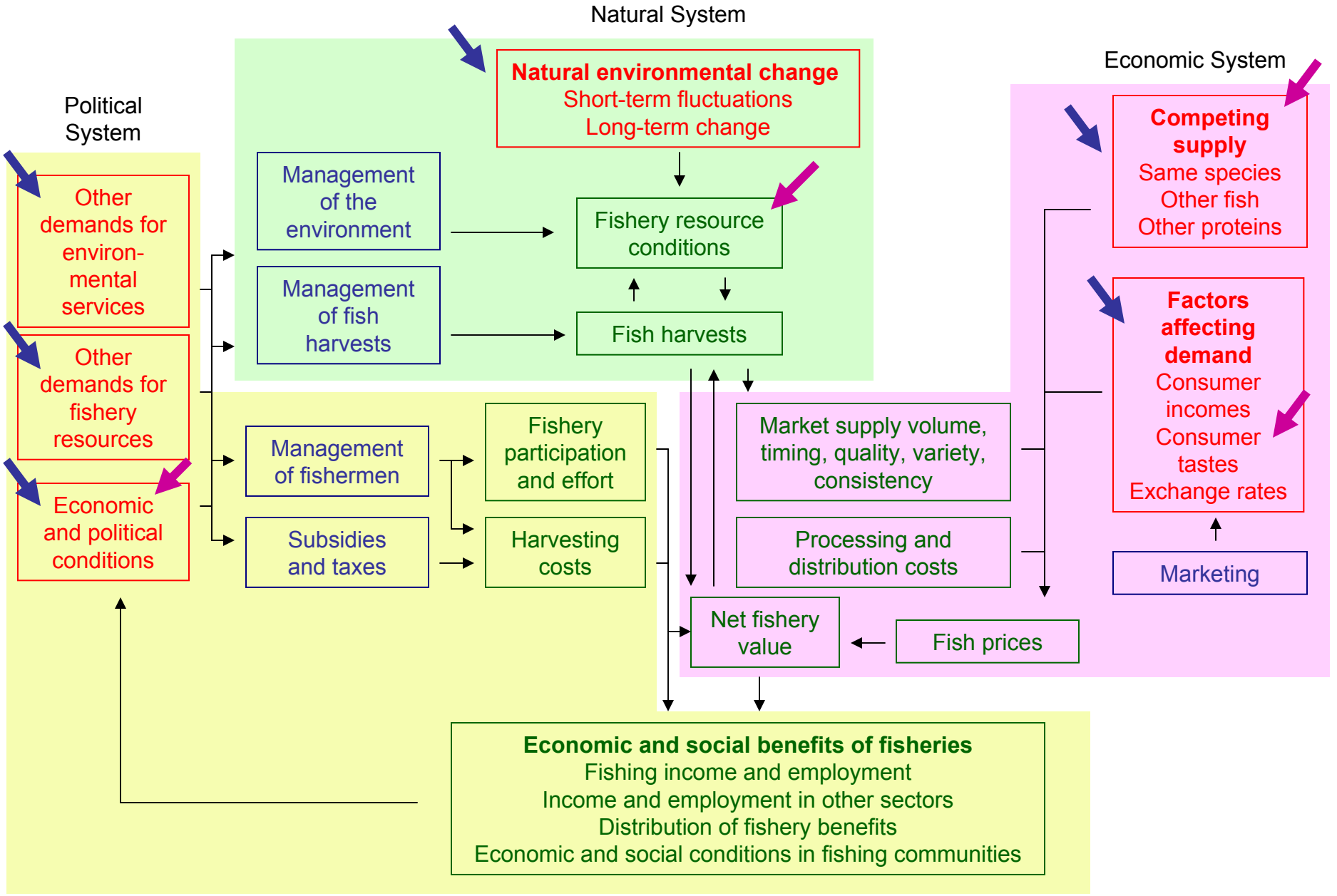
A wild fishery is partly a political system driven by and affecting how management choices are made and how costs and benefits of fisheries are distributed.



Aquaculture may affect wild fisheries directly in many ways--with many complex indirect effects.



3. Many factors other than salmon farming are also driving change in the wild salmon industry.



Other factors which have contributed to the decline in wild salmon prices include:

- Large Alaska wild salmon harvests
- Increased competition from Russian wild salmon
- Stagnation of the Japanese economy

Farmed salmon has not directly affected prices for canned salmon or salmon roe.

Globalization is transforming seafood production, processing, distribution, and retailing.

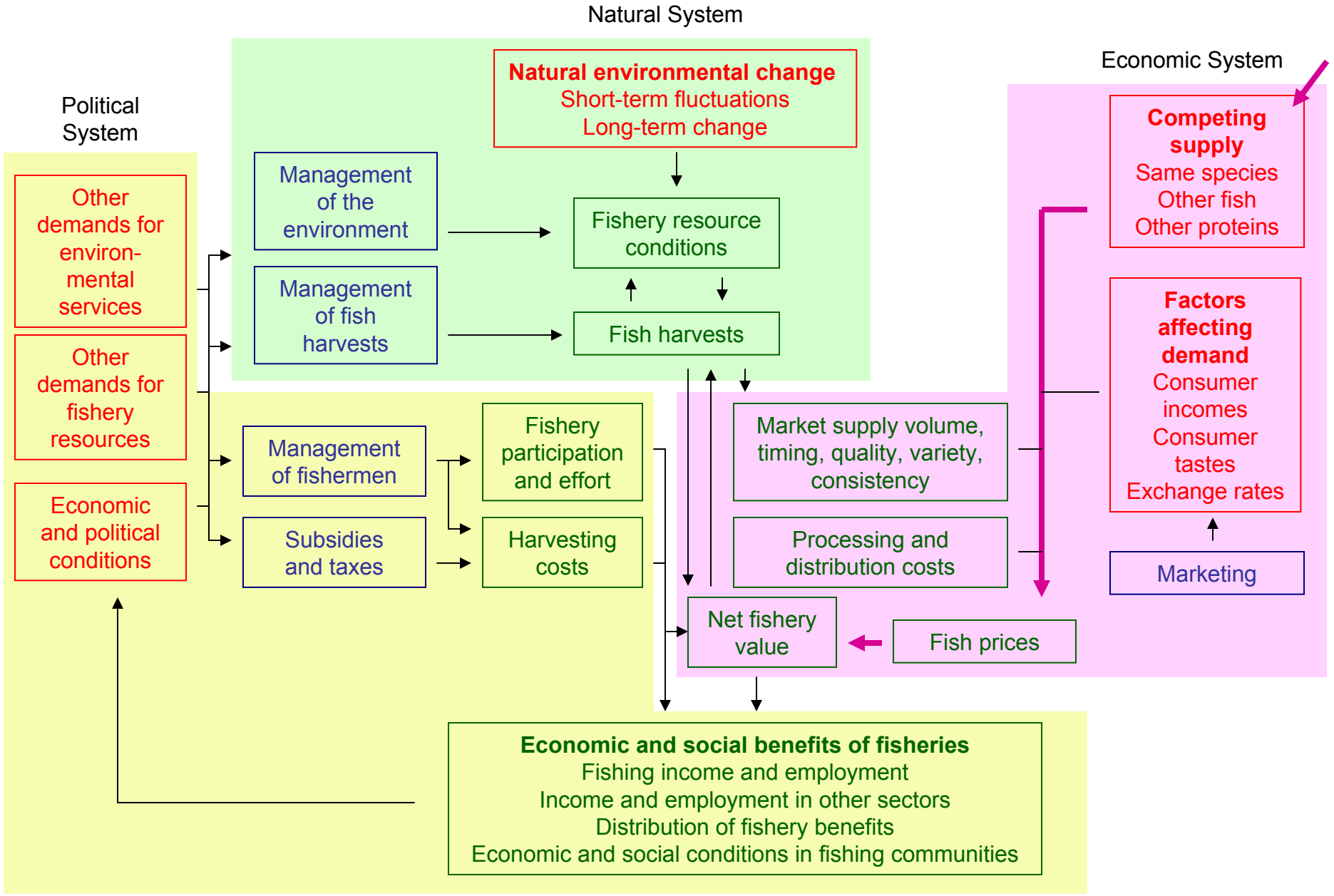
- Increasing consolidation and market power in the retail and food service industries
- Restructuring of seafood distribution networks
- Rapid expansion of seafood trade
- Shift in labor-intensive seafood processing to countries with low labor costs
- Increasing pressure on seafood suppliers to improve quality and lower costs
- International standards for food handling and safety
- Demand for new product forms

For seafood producers, globalization means:
more competition from other suppliers around the world
more demands from buyers which add to producers' costs

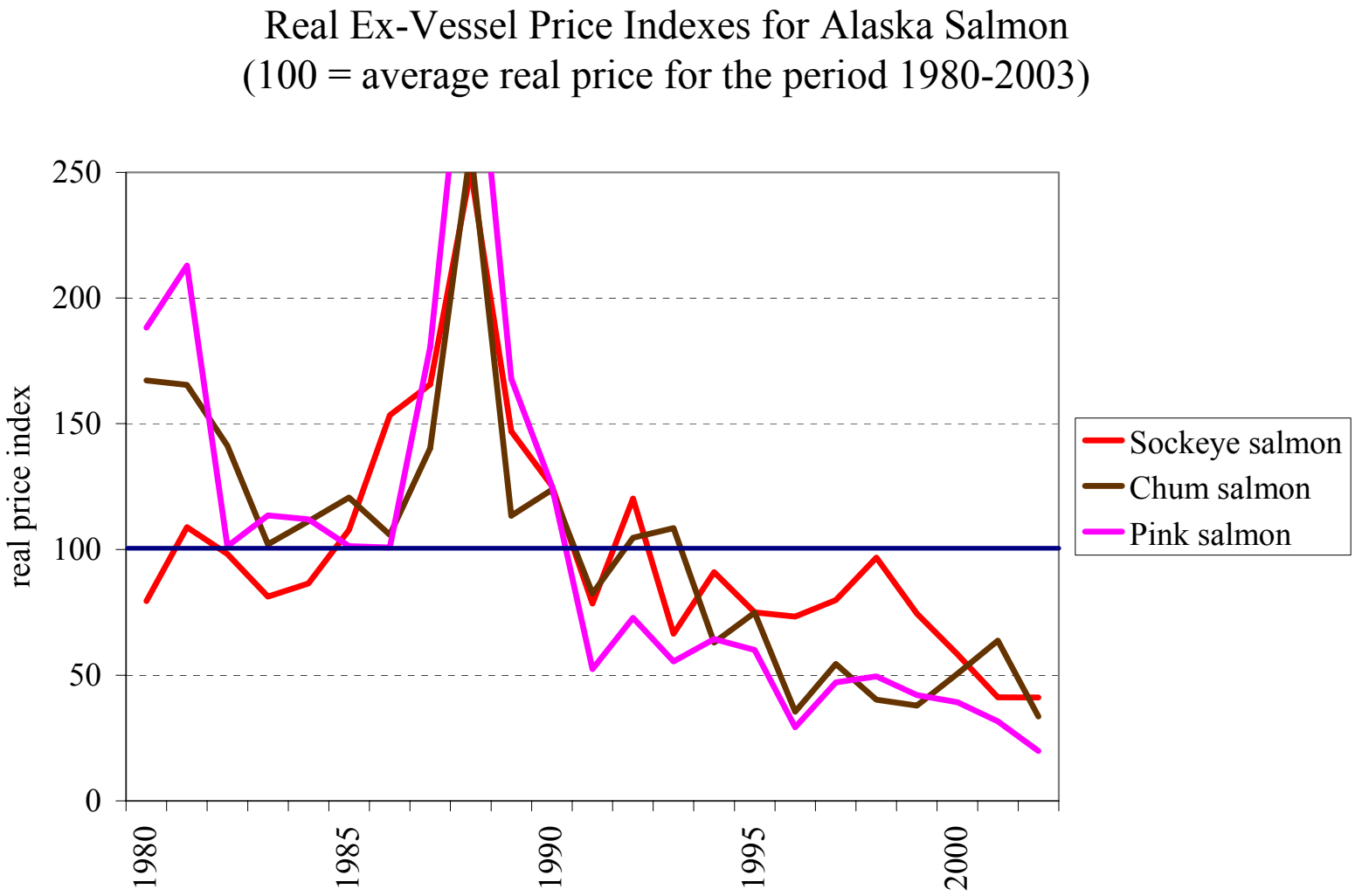
Buyers in the increasingly consolidated retail and food service industries want products which:

- Are of consistent quality
- Can be supplied consistently, reliably and in large volumes
- Are viewed by consumers as safe, convenient and attractive
- Are traceable through the entire chain of production and distribution
- Can be supplied at stable and competitive prices

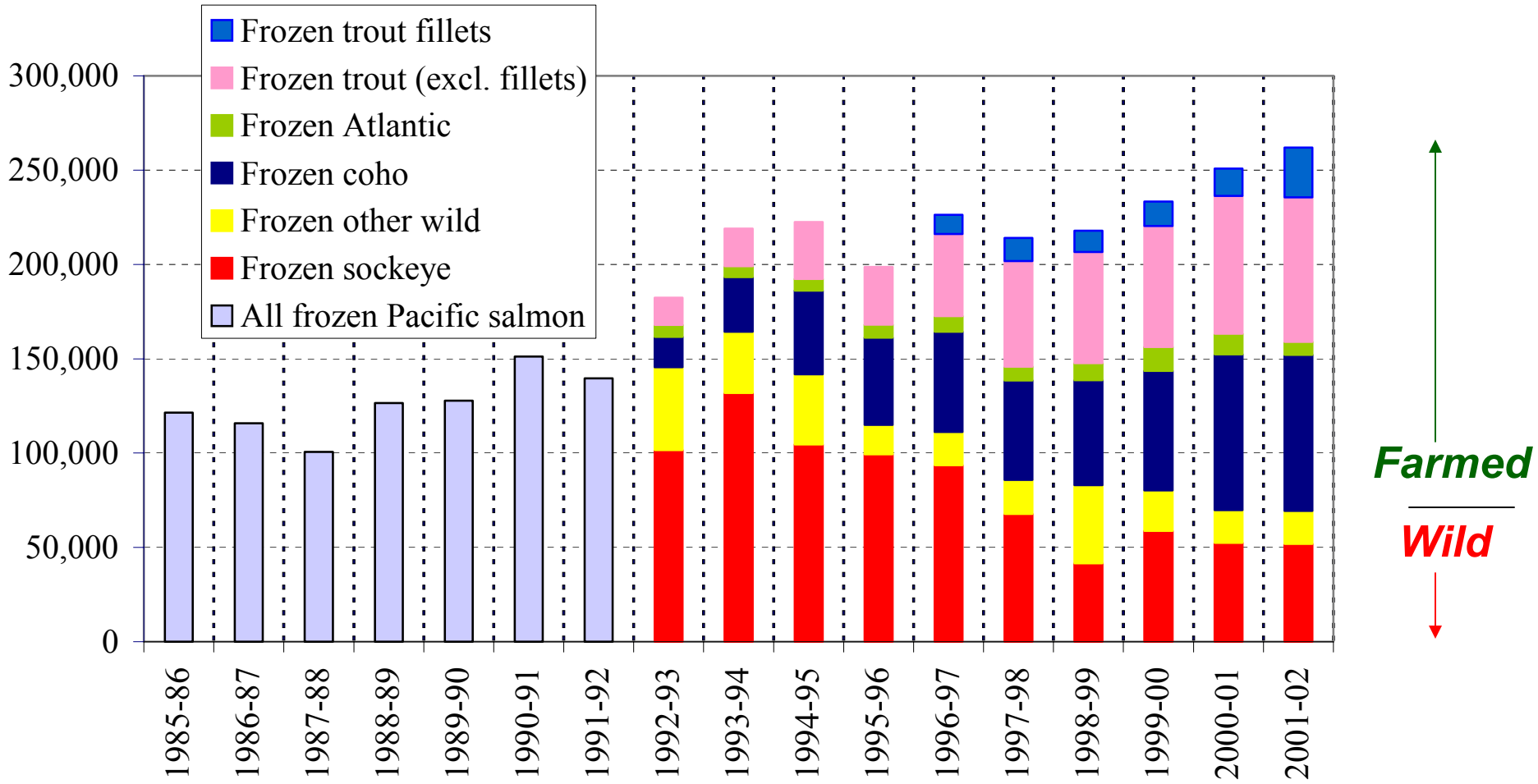
4. Salmon farming exposed wild salmon's natural monopoly to competition, expanding supply and driving down prices.



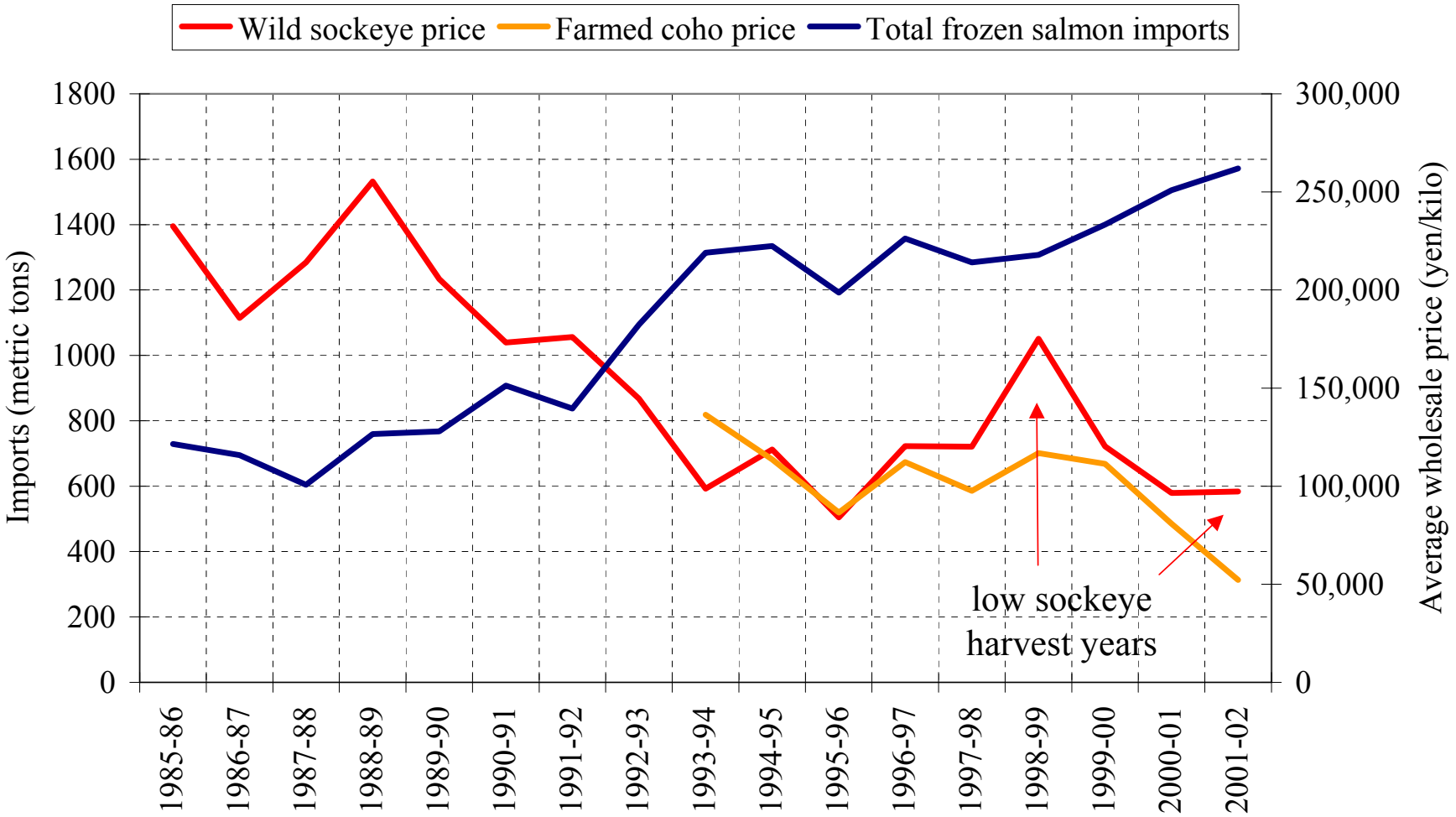
Competition from farmed salmon was the most important cause of a dramatic decline in Alaska wild salmon prices since the late 1980s.



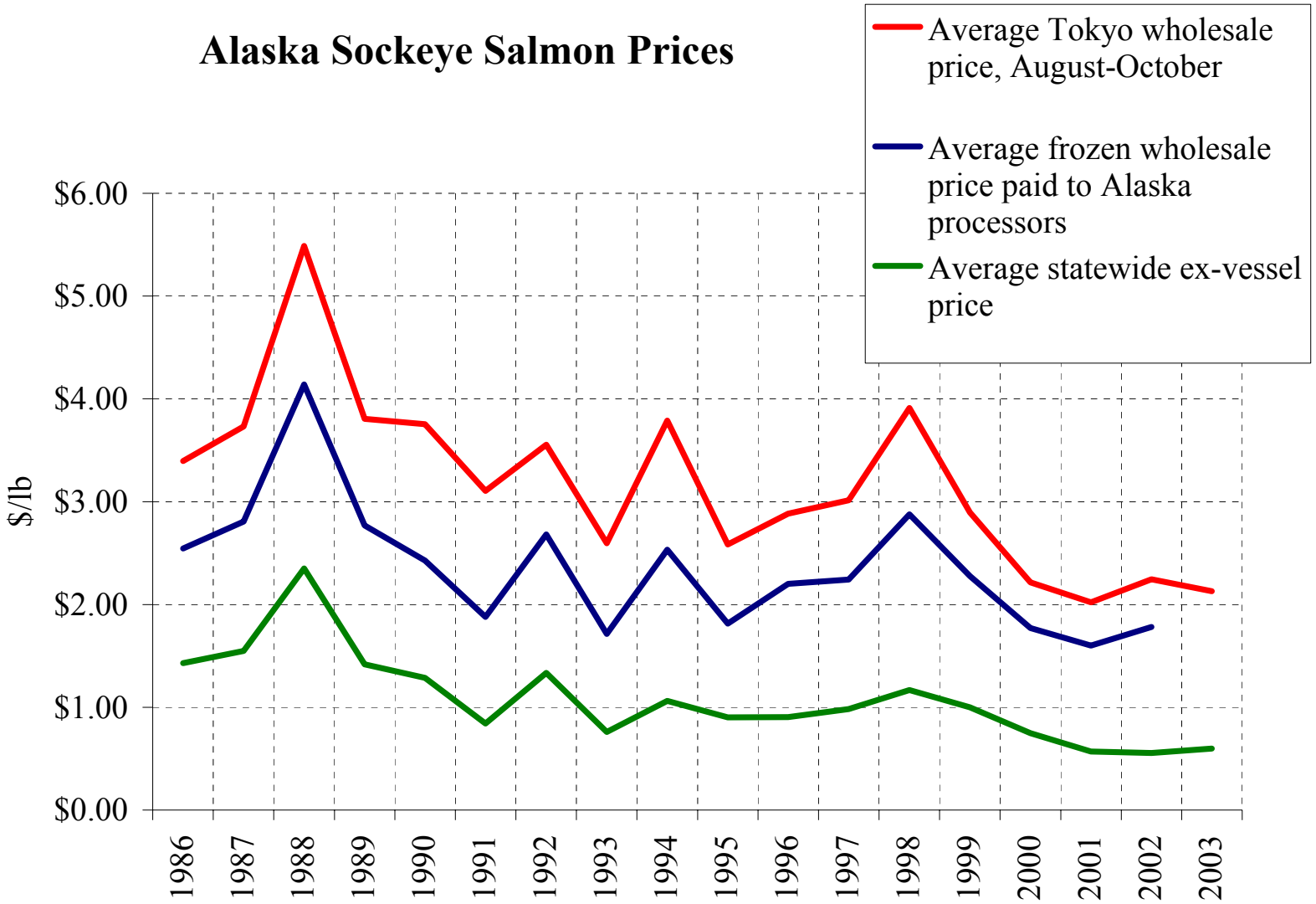
In just ten years farmed salmon replaced wild sockeye as the dominant product in the Japanese frozen salmon market.



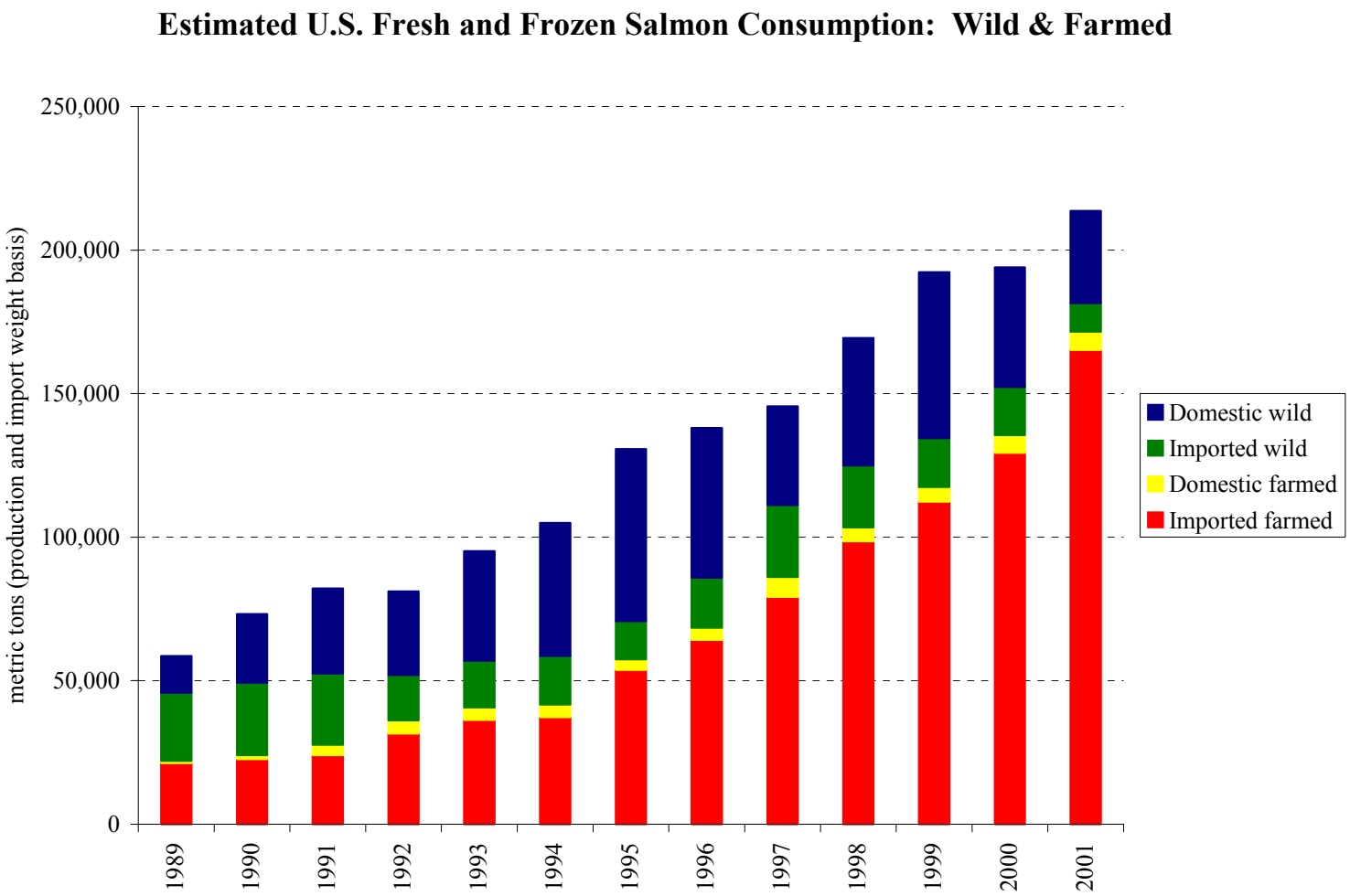
As total supply increased, Japanese wholesale prices for both farmed salmon and sockeye salmon fell dramatically.



As Japanese wholesale prices declined, prices paid to Alaska processors and fishermen declined.



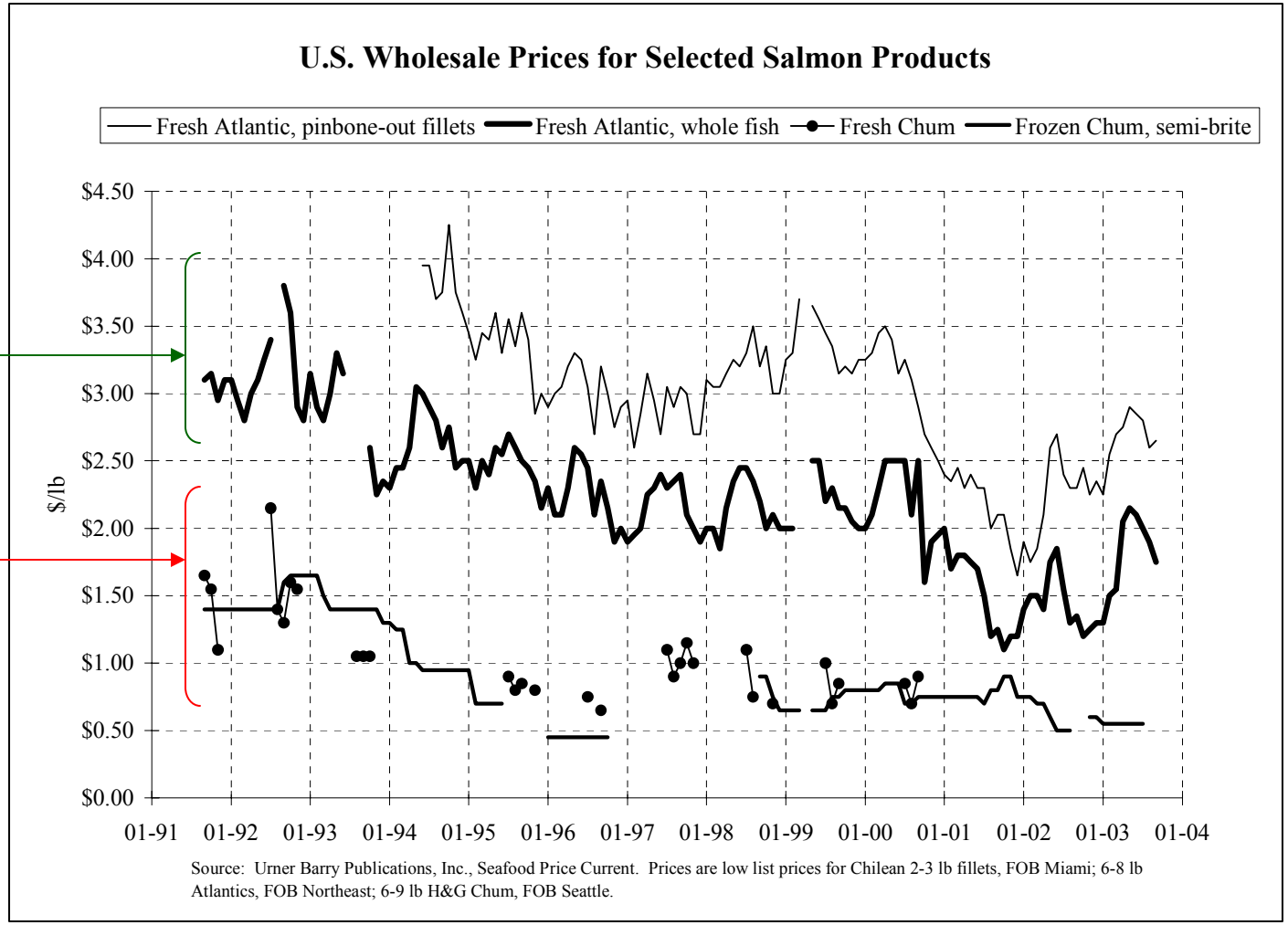
U.S. imports of fresh farmed salmon have grown very rapidly.



As total supply has expanded dramatically, United States wholesale prices of both farmed and wild salmon have fallen.

Fresh farmed salmon, fillets and whole fish

Fresh and frozen wild chum salmon



The decline in sockeye salmon prices happened because of competition between farmed salmon and Alaska wild salmon in international markets.

- It was caused by Japanese imports of Chilean farmed coho and Chilean and Norwegian farmed trout.
- It was caused by farmed production in a foreign country which was exported to another foreign country.
- Banning fish farming in Alaska didn't keep it from happening.
- Banning imports of farmed salmon wouldn't have kept it from happening
- In an increasingly globalized economy, wild fisheries are affected by aquaculture, wherever it is happening.

5. Wild salmon faces significant inherent challenges in competing with farmed salmon.

POPULAR / GREEN /ALASKAN PERSPECTIVE:
Farmed salmon is an inferior product.

Chefs around the country rate wild salmon far superior to farmed. "To be perfectly honest, it [farmed salmon] is crap," says Executive Chef Daniel Long of Bon

Dye! Wild salmon get their beautiful hue from the prey they eat. But their farmed cousins rely on a dye to color their flesh pink. Without that added pigment, their meat would be a pale gray.

Farmed salmon color selection fan

AN ECONOMIC PERSPECTIVE:

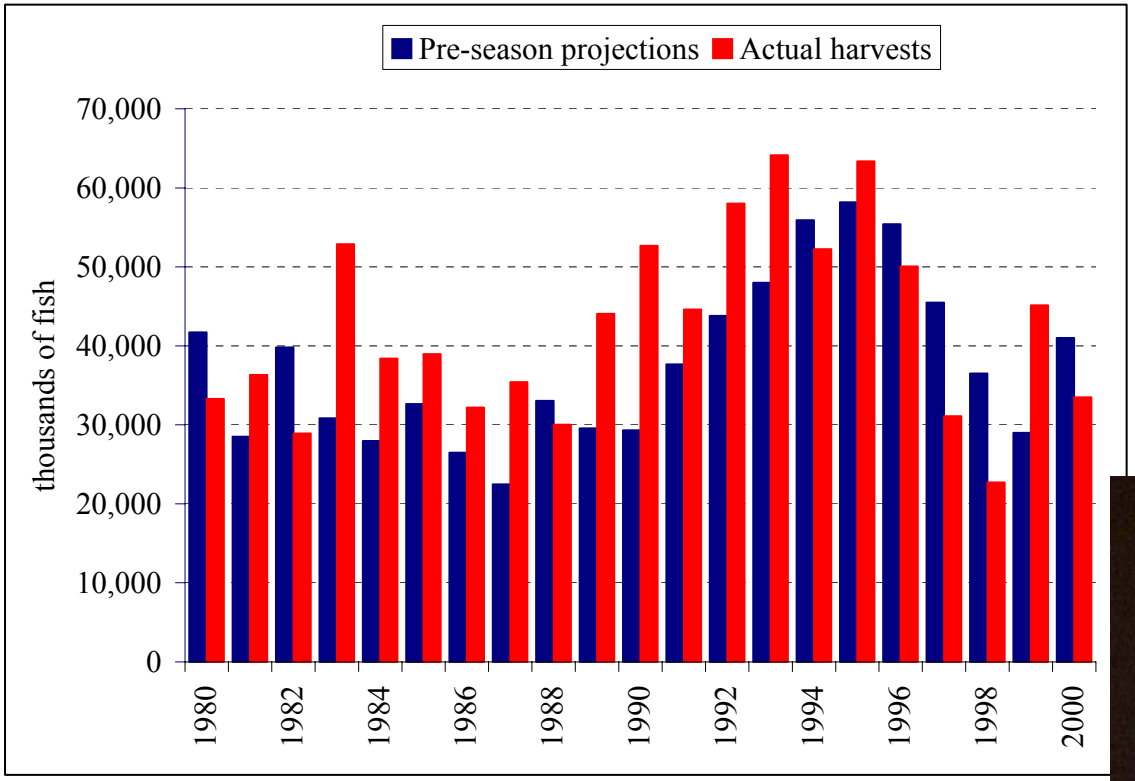
Understanding how wild and farmed fish compete requires looking at the entire systems for producing, processing, distributing and marketing wild and farmed fish, including:

- relative costs and risks at all levels in the distribution chain
- all the attributes that matter to buyers

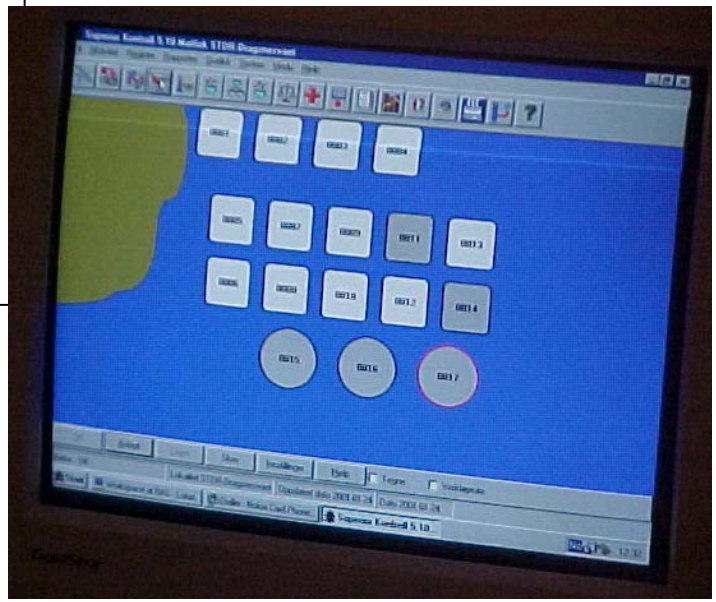
Farmed salmon has many inherent advantages over wild salmon with respect to costs, risks, and ability to meet market demands.

These advantages derive from the greater control of farmers over all stages of production and distribution.

Inconsistent and unpredictable supply makes it much more difficult for wild salmon producers than for farmed salmon producers to meet buyers' supply needs and to plan for marketing.



Actual Alaska sockeye salmon harvests typically differ from pre-season projections by 30%.

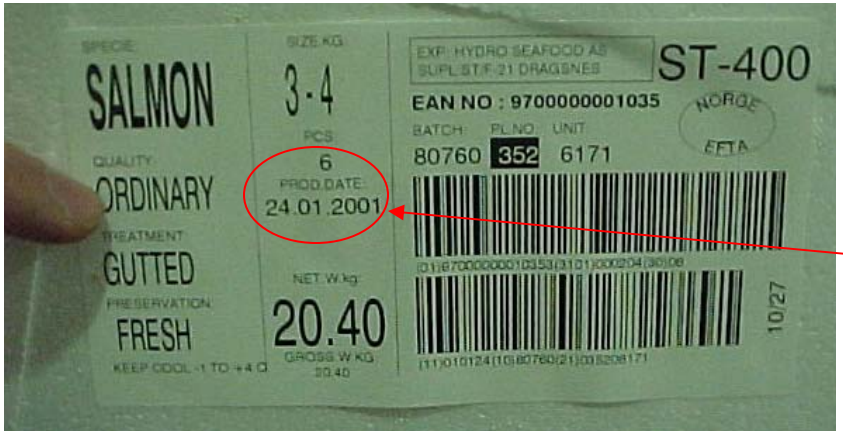


This computer at a Norwegian salmon farm can tell the producer exactly how many fish of what size are in each pen (and in the pens of all the farms owned by this company on three continents)

The seasonality of wild salmon fisheries increases production costs relative to farmed salmon, and makes it relatively more difficult to market wild salmon.

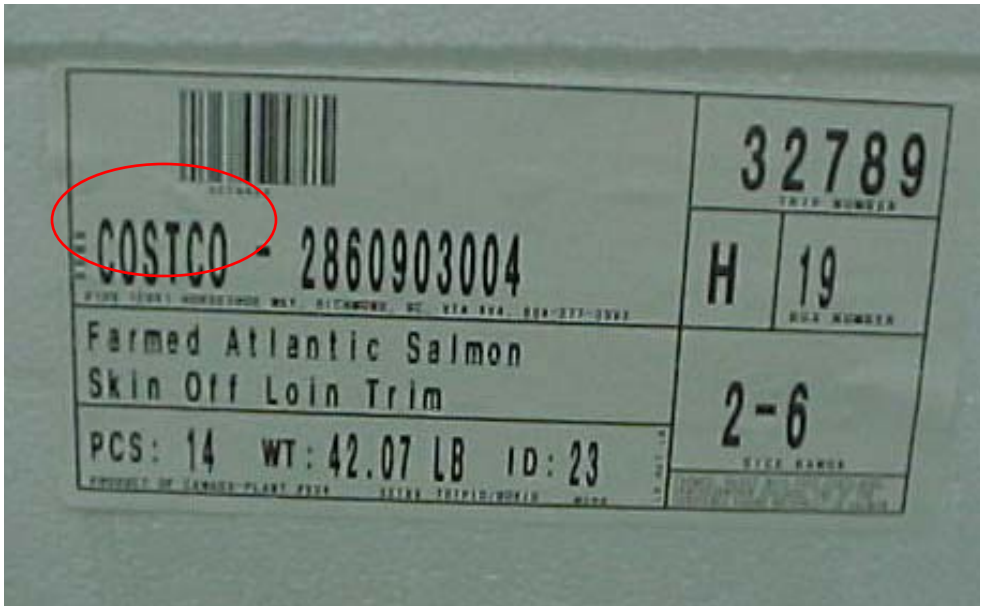
The fact that many Alaska fishing boats and processing plants are idle for much of the year is a huge cost disadvantage.

Because it processes farmed salmon year round, this relatively small British Columbia facility processes as much salmon as the largest Alaska facilities.



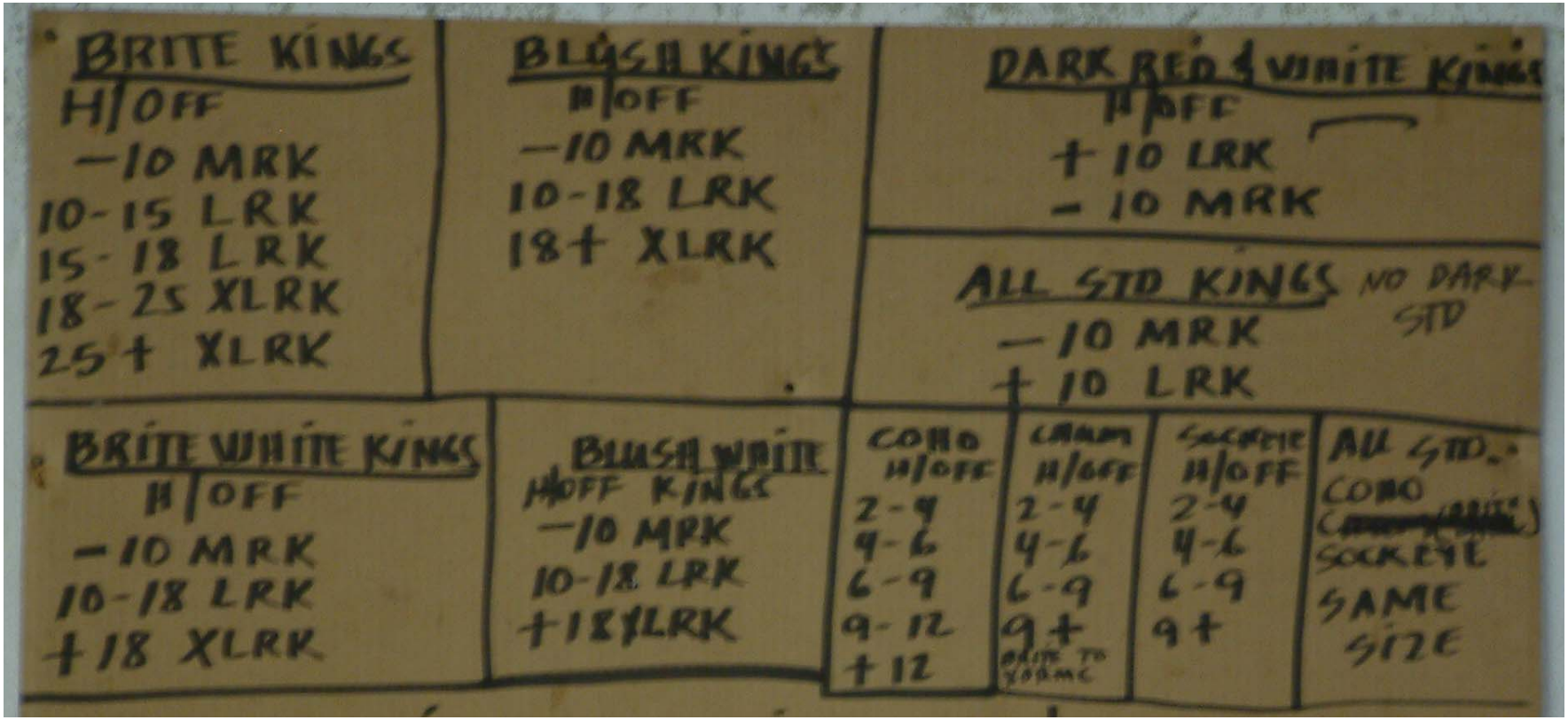
Norwegian salmon processed in winter

Very large harvests in short time periods makes canning the only practical option in some wild salmon fisheries.



Because it can choose when to process fish, this BC farmed salmon processor doesn't process salmon until it already has a buyer. The fish are processed to that buyer's specifications.

Wide variation in sizes and quality increases costs of processing and marketing wild salmon.



Grades at a southeast Alaska processing plant

6. Competition with farmed salmon has revealed significant "self-inflicted" problems in the wild salmon industry.

Significant quality problems in many fisheries resulting from practices at many different stages of fishing, tendering and processing

Bruises in a Yukon River chum salmon fillet

Significant quality problems . . .

Bruising as fish are caught in and removed from gillnets

Fishermen focused on catching fish fast rather than handling them well

Lack of careful handling during tendering, and long delivery times between when fish are caught and when they are processed

Photographs by Bart Eaton

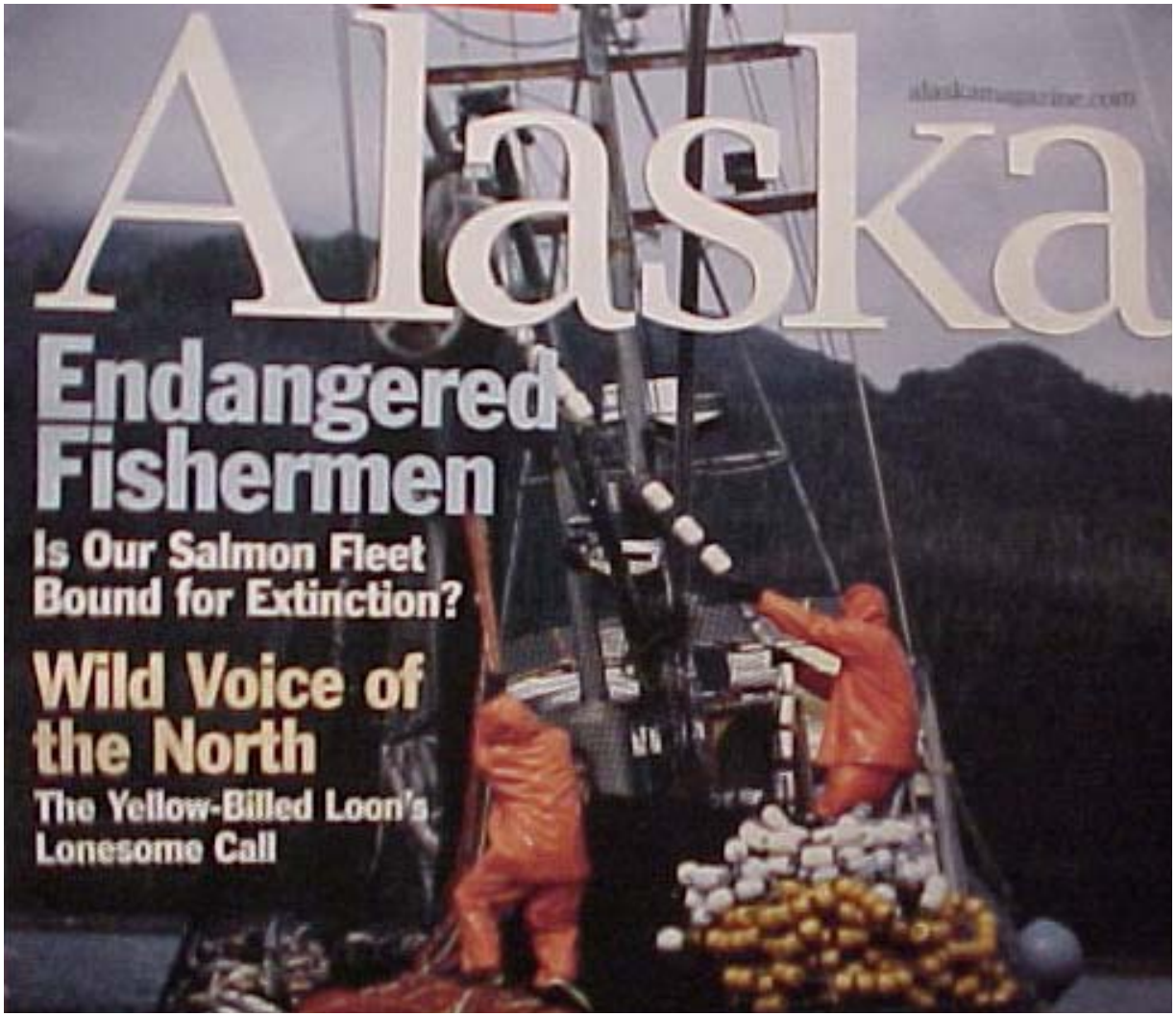
Far more boats than are needed to harvest the fish in some fisheries—leading to a "race for fish" which adds to costs and hampers quality

Photographs by Bart Eaton

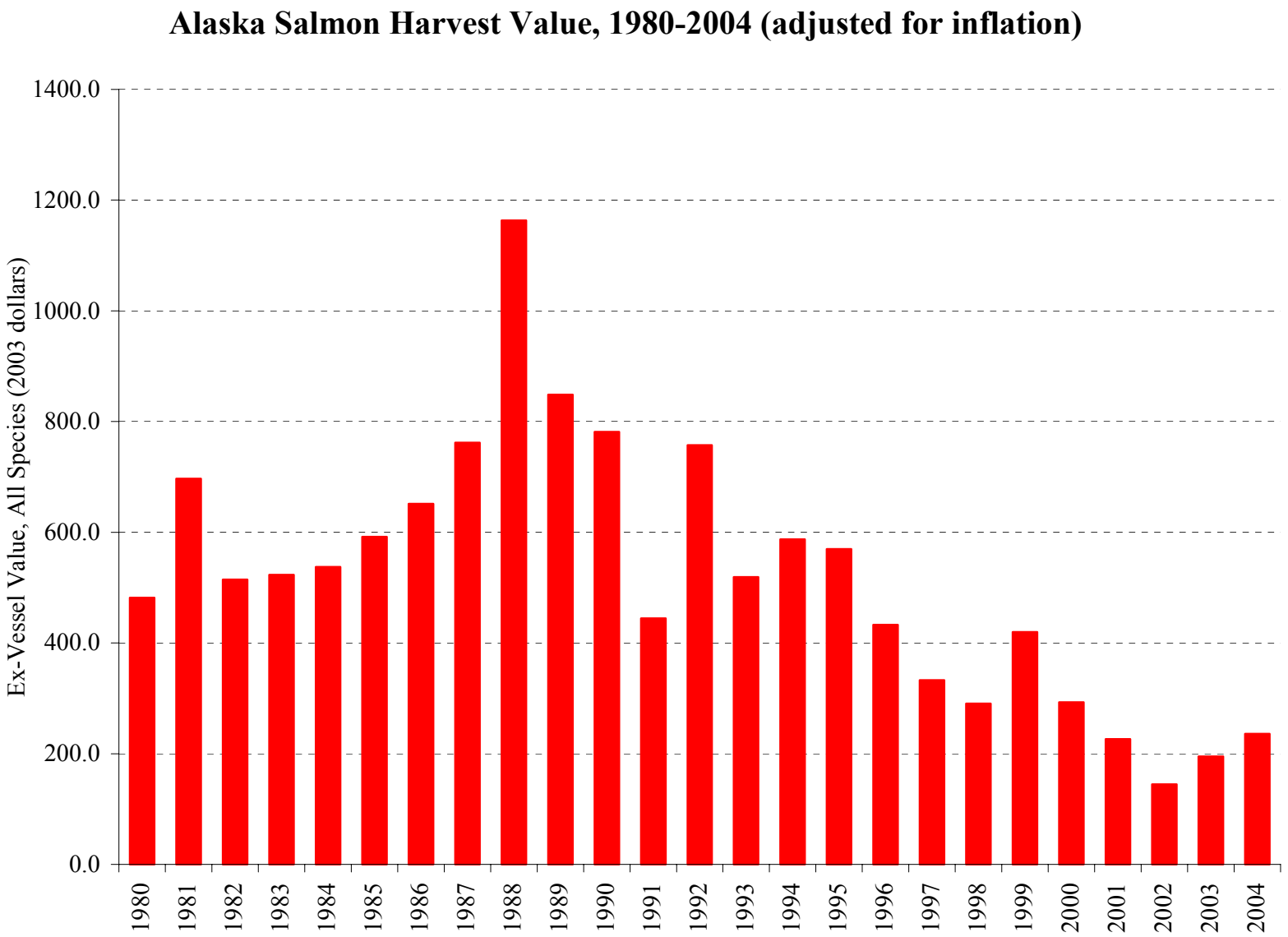
7. Economic pressures caused in part by salmon farming have contributed to changes to address “self-inflicted challenges” and which make the salmon industry more economically viable.

- Reduction in costs and increased efficiency as fishermen and processors exited the industry
- Significant improvements in quality
- Increased attention to marketing
- New product development
- Political pressures for fishery management changes and restructuring
  - Chignik Co-op
  - Southeast seine fishery buyout
  - Board of Fishery restructuring workgroup

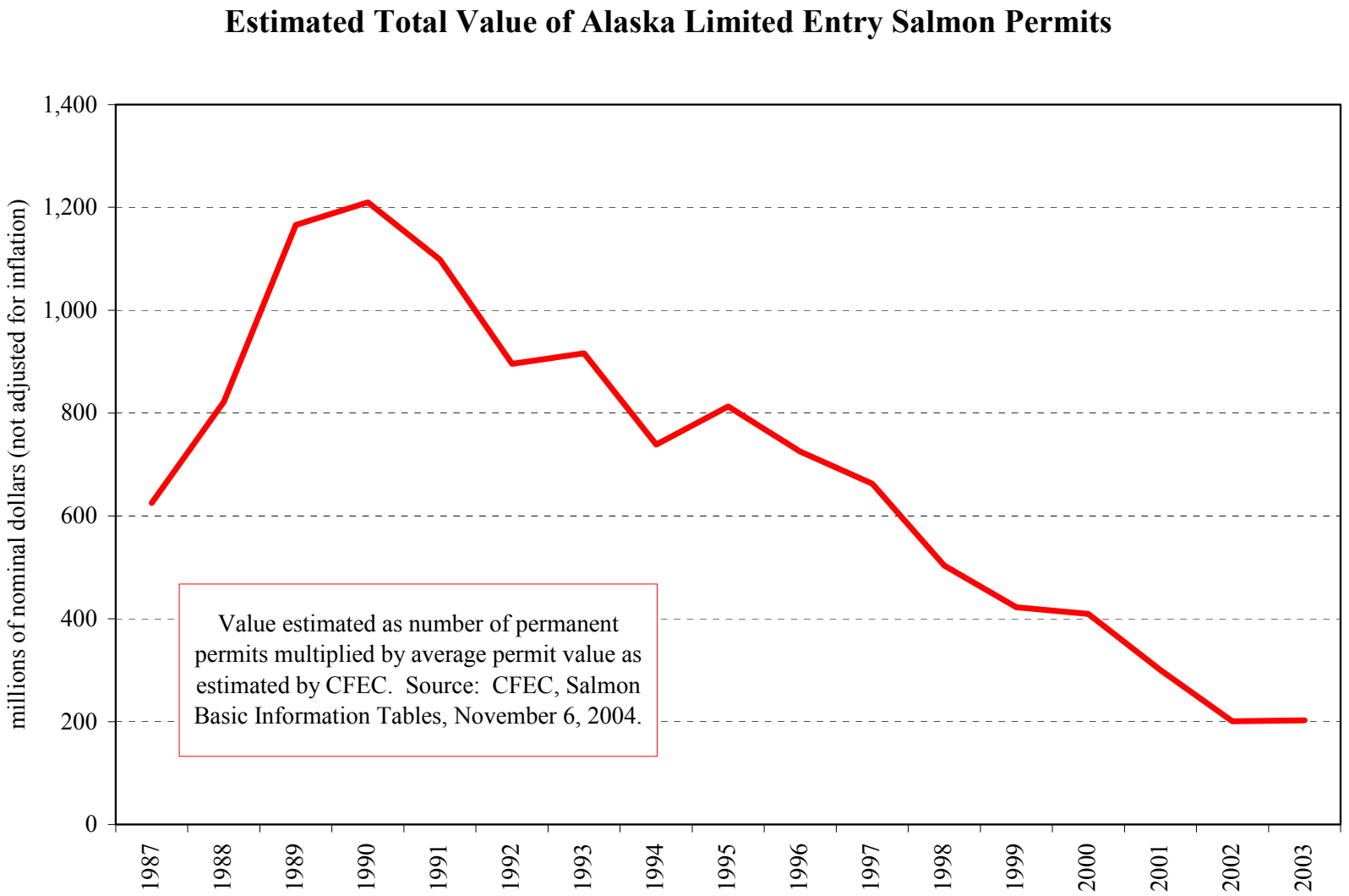
8. The economic changes caused in part by salmon farming have been painful and difficult for the wild salmon industry, fishermen and communities.



Since the 1980s, the value of Alaska's salmon harvests has fallen by more than half.



Alaska fishermen have been hurt not only by the decline in catch value but also by a drastic decline in the value of salmon limited entry permits.



The number of Alaskan permit holders fishing for salmon has declined by 40%.

Participation of Alaska Permit Holders in Alaska Salmon Fisheries: 1988 and 2002

Gear type	1988	2002	Decline	Percent decline
Purse seine	867	437	430	49.6%
Drift net	2286	1606	680	29.7%
Power troll	685	559	126	18.4%
Set net & hand troll	4128	2236	1892	45.8%
Other	145	12	133	91.7%
Total	**8111**	**4850**	**3261**	**40.2%**

Source: Neil Gilbertsen, "Residency and the Alaska Fisheries," *Alaska Economic Trends, December 2004.*

The decline in the salmon industry has affected fishermen's status and feelings of self-worth.

"People used to be proud to be a gill netter. People now ask you what you do, and you don't want to tell them. They ask you why you are an idiot."

Source: Interviews with Cook Inlet salmon fishermen conducted by the University of Alaska Anchorage Institute of Social and Economic Research, 2003.

The decline in the salmon industry has had numerous other economic, social and political effects.

- Consolidation in the processing industry
- Declining tax base in rural communities
- Declining populations in fishing communities
- Social stresses: alcohol abuse and family abuse
- Declining political influence of the salmon industry
- Pressures for reallocation from commercial fisheries to other user groups

9. The effects of salmon farming on the wild salmon industry have not all been negative. Farmed salmon has greatly expanded the market and created new market opportunities for wild salmon.

- Salmon farming has made salmon much more widely available
- The salmon farming industry has developed new products.
- Salmon farming has created new fish consumers
- Some of those new consumers have discovered wild salmon seeking
  - Better taste
  - Wildness
  - A healthier product
  - A more socially and environmentally responsible product
- The growth of salmon faming is creating growing niche market opportunities for high-quality wild salmon.

Over the past two years, growing demand for high quality wild salmon has been reflected in higher prices for chinook, coho and sockeye salmon.

In 2004 and 2005, prices paid to fishermen were up sharply in high-quality fisheries such as the Copper River fishery and Southeast Alaska troll fisheries.

May 2004

COPPER RIVER SALMON ARE BACK

Commercial fishermen net record prices for kings and reds

Consumers also can expect to pay more for flavorful fish

By T.C. MITCHELL
Anchorage Daily News

Salmon eaters, brace yourselves.

After 12 hours of fishing Monday, the Copper River Delta commercial fleet was rewarded with the best king and red salmon prices they've ever seen.

Fishermen got $6.25 a pound for kings they delivered to tenders, and a dime more for fish delivered straight to the processors, said Mark Irving, a Cordova fisherman who participated in the season opener. He said the reds brought $4.25.

Last year's prices at this time were reported at $2.85 per pound for reds and $5 for kings. What fishermen get for their fish helps determine what people pay in markets and restaurants.

Bill Gilbert, manager of NorQuest Seafoods, a salmon buyer in Cordova, said the opening prices this year are historic — and reflect an improving Lower 48 economy.

"They've never been this high," he said.

Persistent promotion of Copper River salmon in recent years is pay-

See Back Page, **COPPER RIVER**

■ **SALMON:** 12-page section devoted to Alaskans' favorite fish, including marketing, dining, art and the salmon's cycle of life.
Life & Salmon, D-1

ERIK HILL / Anchorage Daily News
Levi Adams positions a fresh Copper River king salmon fillet in the display case at New Sagaya.

The problems faced by the wild salmon industry have not gone away.

- Not all wild salmon species are well-suited for niche markets.
- As the supply of wild salmon to niche markets expands, prices paid by these markets will decline.
- Wild salmon will continue to face inherent challenges associated with providing consistent supply of large volumes to large buyers.

10. Farmed salmon has benefited consumers by lowering prices, expanding supply, developing new products, and improving quality of both farmed and wild salmon.

- Since the development of salmon farming, both farmed and wild salmon have become:
  - Cheaper
  - Available much more consistently over the year
  - Available in far more stores and restaurants
  - Available over a far larger geographic region
  - Available in more product forms
  - Higher quality

POPULAR / GREEN / ALASKAN PERSPECTIVE:
Competition from salmon farming has hurt fishermen

ECONOMIC PERSPECTIVE:
Competition from salmon farming has helped consumers

11. Salmon farming has had no apparent direct effects on Alaska wild salmon resources. Salmon farming could have indirect effects on wild salmon resources which might be positive or negative.

- Salmon farming is banned in Alaska.
- The ban was passed in 1989 due to concerns about:
  - potential harm to wild fish stocks
  - potential economic competition
- Small numbers of Atlantic salmon which have escaped from British Columbia salmon farms are being caught in Alaska waters
  - The State and fishermen are concerned that escaped Atlantic salmon could colonize Alaska streams or bring disease, harming wild salmon stocks
  - Some studies suggest that it would be difficult for Atlantic salmon to become established—given the failure of numerous attempts to introduce Atlantic salmon on the west coast over the past century.

In theory, aquaculture could indirectly benefit wild fishery resources by lowering their economic value—thus reducing pressure for over-exploitation.

- But the more well-managed a fishery is, the less the potential to reduce “over-exploitation”
  - Lower prices have not led to lower catches in most Alaska salmon fisheries
  - Where lower prices have led to lower catches, this has occurred mostly in years of large runs—when lowering catches is of least benefit to the resource

In theory, aquaculture could indirectly harm wild fishery resources by lowering their economic value—thus reducing political commitment to their protection. This may be happening in Alaska:

- Reduced funding for fisheries management.
- Reduced political commitment for protection of salmon habitat
  - Shift of salmon habitat protection responsibilities from Alaska Department of Fish and Game to Alaska Department of Natural Resources.
  - Proposed reduction in water quality standards for mining operations
  - New proposals for oil drilling in Bristol Bay
  - New proposals for large-scale gold mining in Bristol Bay drainage

12. The experience of Alaska wild salmon suggests that anyone interested in wild fisheries should pay close attention to what is happening in aquaculture. No wild fishery market—especially for higher valued species—should be taken for granted.

Aquaculture is not going to go way. The challenges to wild fisheries posed by aquaculture will increase over time. Aquaculture will continue to grow rapidly because it can meet market demands for predictable, year-round and growing supply of high-quality seafood.

Fresh tilapia for sale at Swanson's Store, Bethel, Alaska, April 2002

Implications of Aquaculture for Wild Fisheries: The Case of Alaska Wild Salmon
CONCLUSIONS

1. The Alaska salmon industry is very diverse. Beware of generalizations about the salmon industry or how it has been affected by salmon farming.
2. Wild fisheries are complex natural, economic and political systems. Aquaculture may have many different direct and indirect effects in the short-run and long-run.
3. Many factors other than salmon farming are also driving change in the wild salmon industry.
4. Salmon farming exposed wild salmon's natural monopoly to competition, expanding supply and driving down prices.
5. Wild salmon faces significant inherent challenges in competing with farmed salmon.
6. Competition with farmed salmon has revealed significant "self-inflicted" problems in the wild salmon industry.
7. Economic pressures caused in part by salmon farming have contributed to changes to address "self-inflicted challenges" and which make the salmon industry more economically viable.
8. The economic changes caused in part by salmon farming have been painful and difficult for the wild salmon industry, fishermen and communities.
9. The effects of salmon farming on the wild salmon industry are not all negative. Farmed salmon has greatly expanded the market and created new market opportunities for wild salmon.
10. Farmed salmon has benefited consumers by lowering prices, expanding supply, developing new products, and improving quality of both farmed and wild salmon.
11. Salmon farming has had no apparent direct effects on Alaska wild salmon resources. Salmon farming could have indirect effects on wild salmon resources which might be positive or negative.
12. The experience of Alaska wild salmon suggests that anyone interested in wild fisheries should pay close attention to what is happening in aquaculture. No wild fishery market—especially for higher valued species—should be taken for granted.

PART II

Five Economic Considerations in Thinking About U.S. Marine Aquaculture

Five Economic Considerations in Thinking About U.S. Marine Aquaculture
OUTLINE

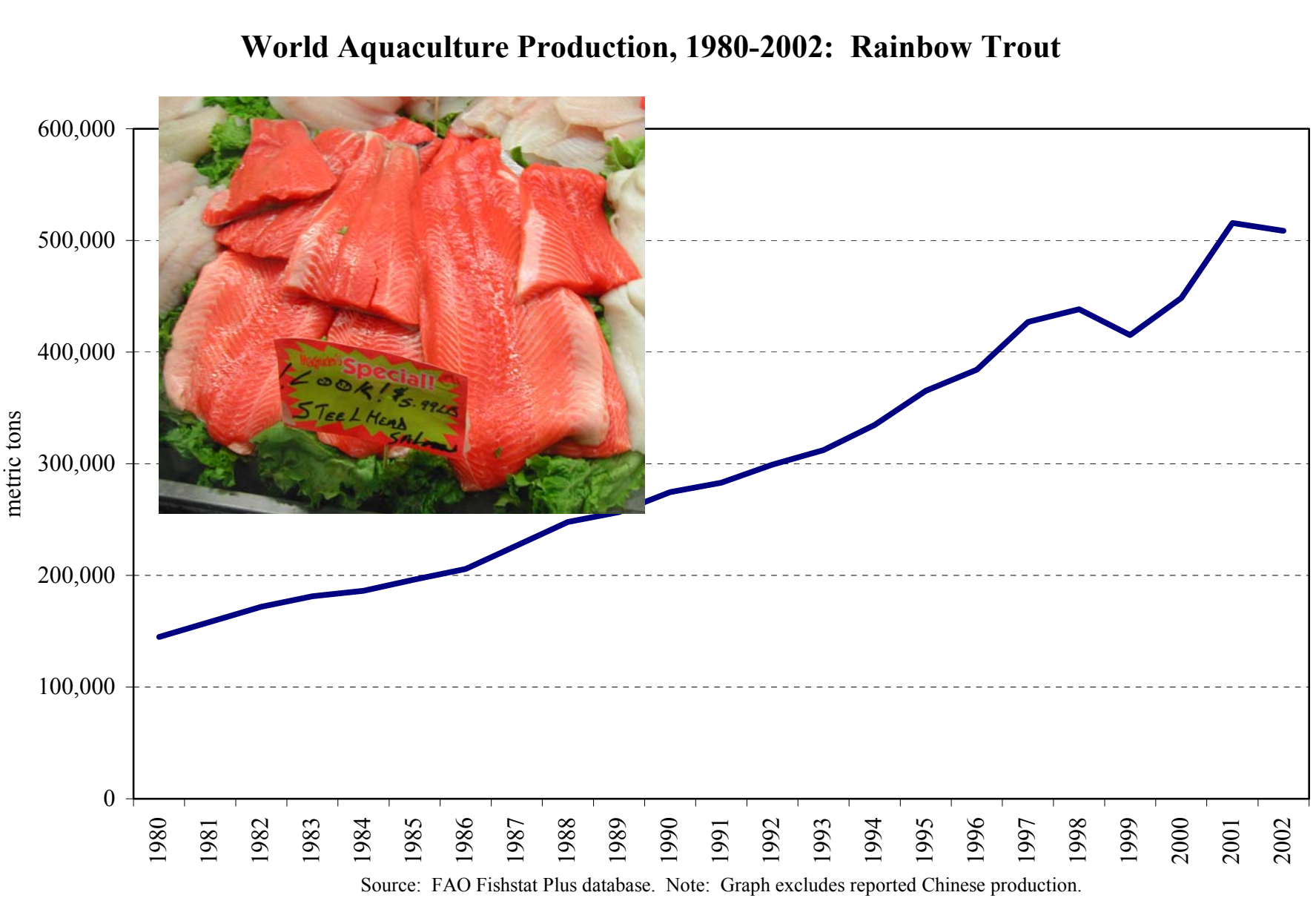
1. What is likely to happen with aquaculture in the rest of the world?
2. What is the economic potential for U.S. marine aquaculture?
3. What are the potential effects of U.S. marine aquaculture on markets and prices for wild fisheries?
4. What are the potential economic benefits of U.S. marine aquaculture?
5. What are the potential economic costs of U.S. marine aquaculture?

Farmed Atlantic salmon is only one of many finfish species for which aquaculture production has grown very rapidly.

World Aquaculture Production, 1980-2002: Atlantic Salmon

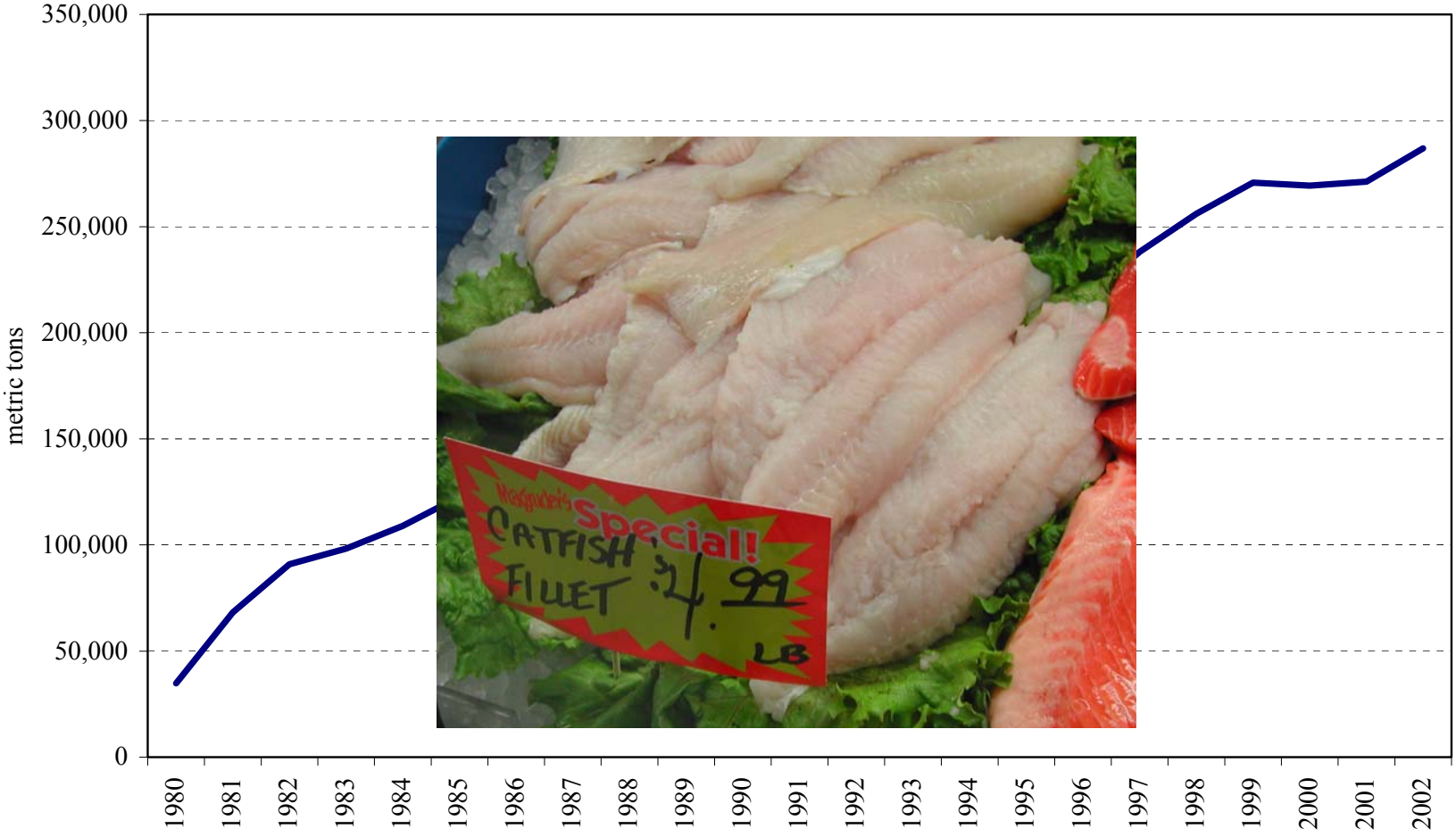
Source: FAO Fishstat Plus database. Note: Graph excludes reported Chinese production.

Other finfish species for which farmed production has grown rapidly include trout . . .



Catfish . . .

World Aquaculture Production, 1980-2002: Channel Catfish



Source: FAO Fishstat Plus database. Note: Graph excludes reported Chinese production.

. . . and Tilapia.

World Aquaculture Production, 1980-2002: Nile Tilapia

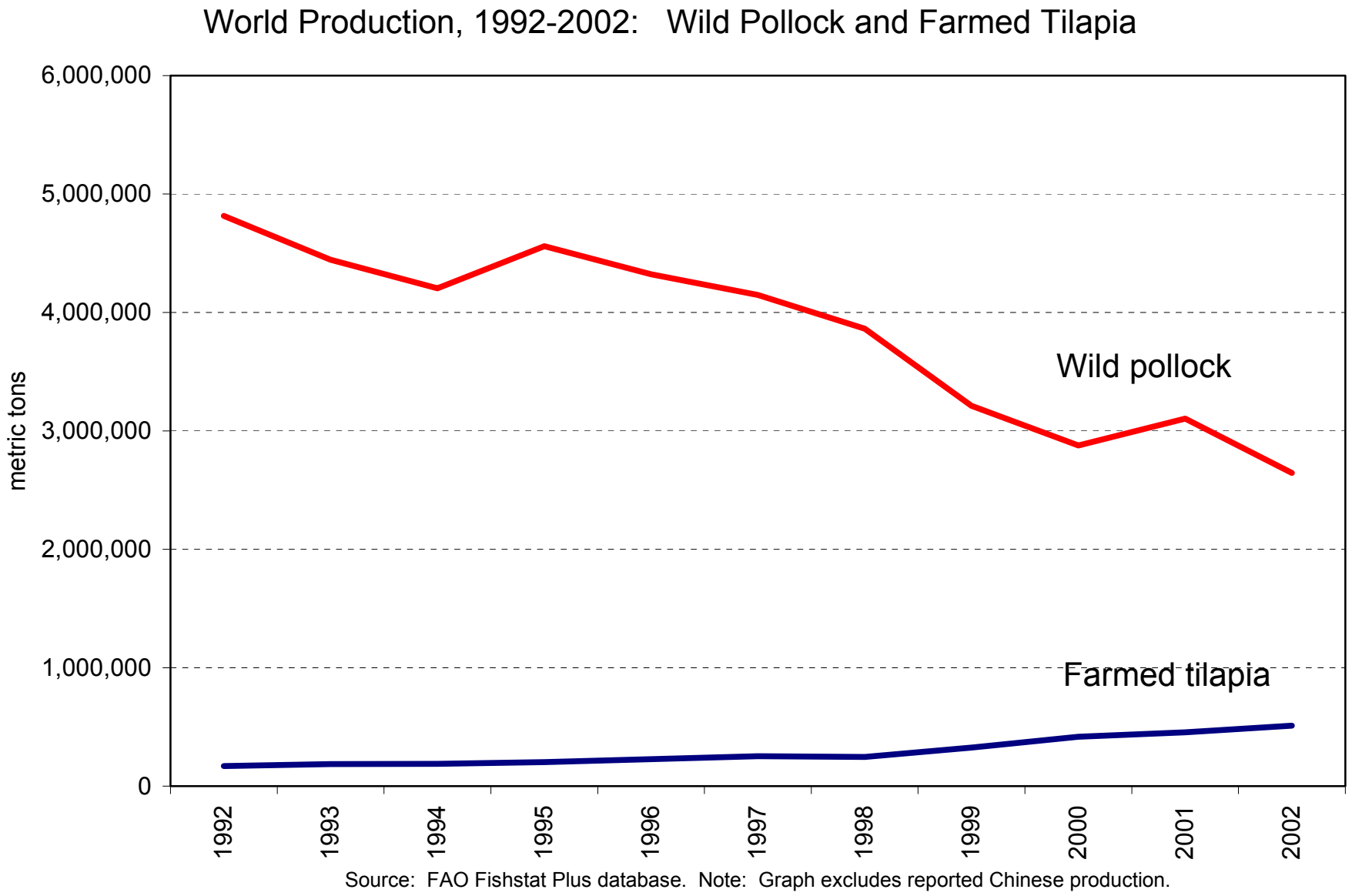
metric tons

600,000
500,000
400,000
300,000
200,000
100,000
0

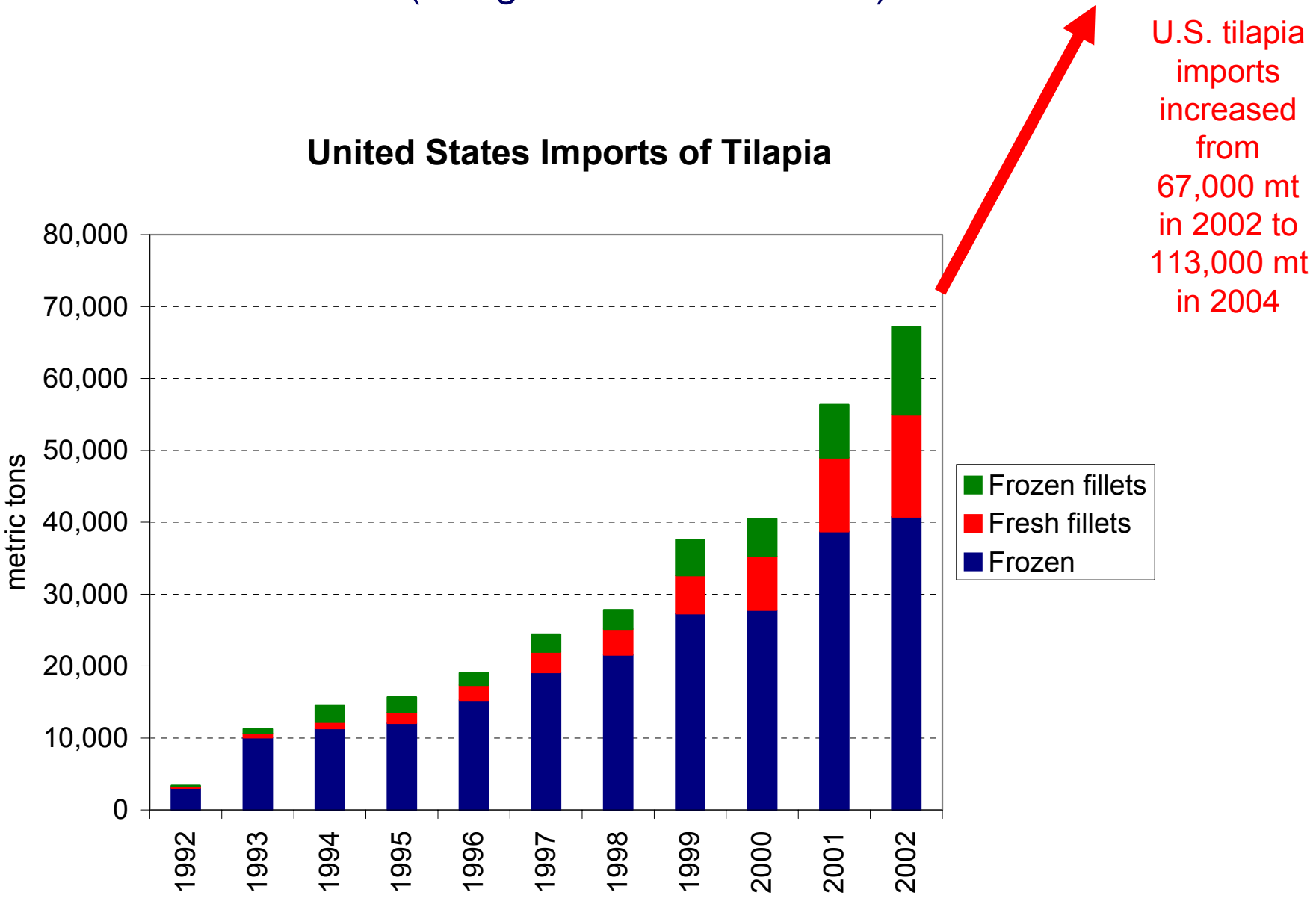
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002

Source: FAO Fishstat Plus database. Note: Graph excludes reported Chinese production.

Alaska pollock producers have expressed concern that they could face competition in whitefish markets from growing production of farmed tilapia.

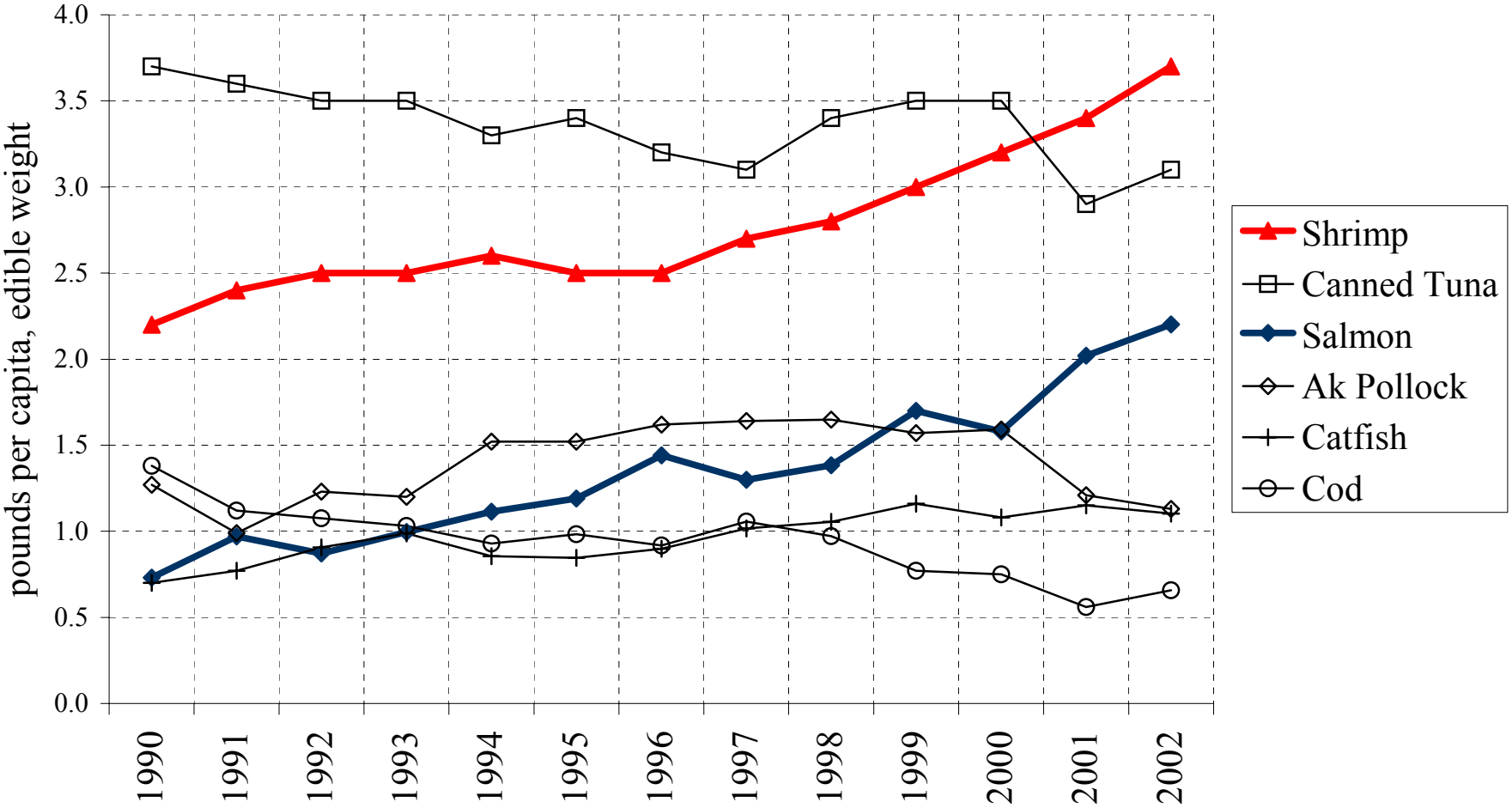


Farmed tilapia is one of the fastest growing U.S. seafood imports (along with farmed salmon).



Farmed shrimp and farmed salmon are the fastest growing components of U.S. seafood consumption and rank first and third in total consumption.

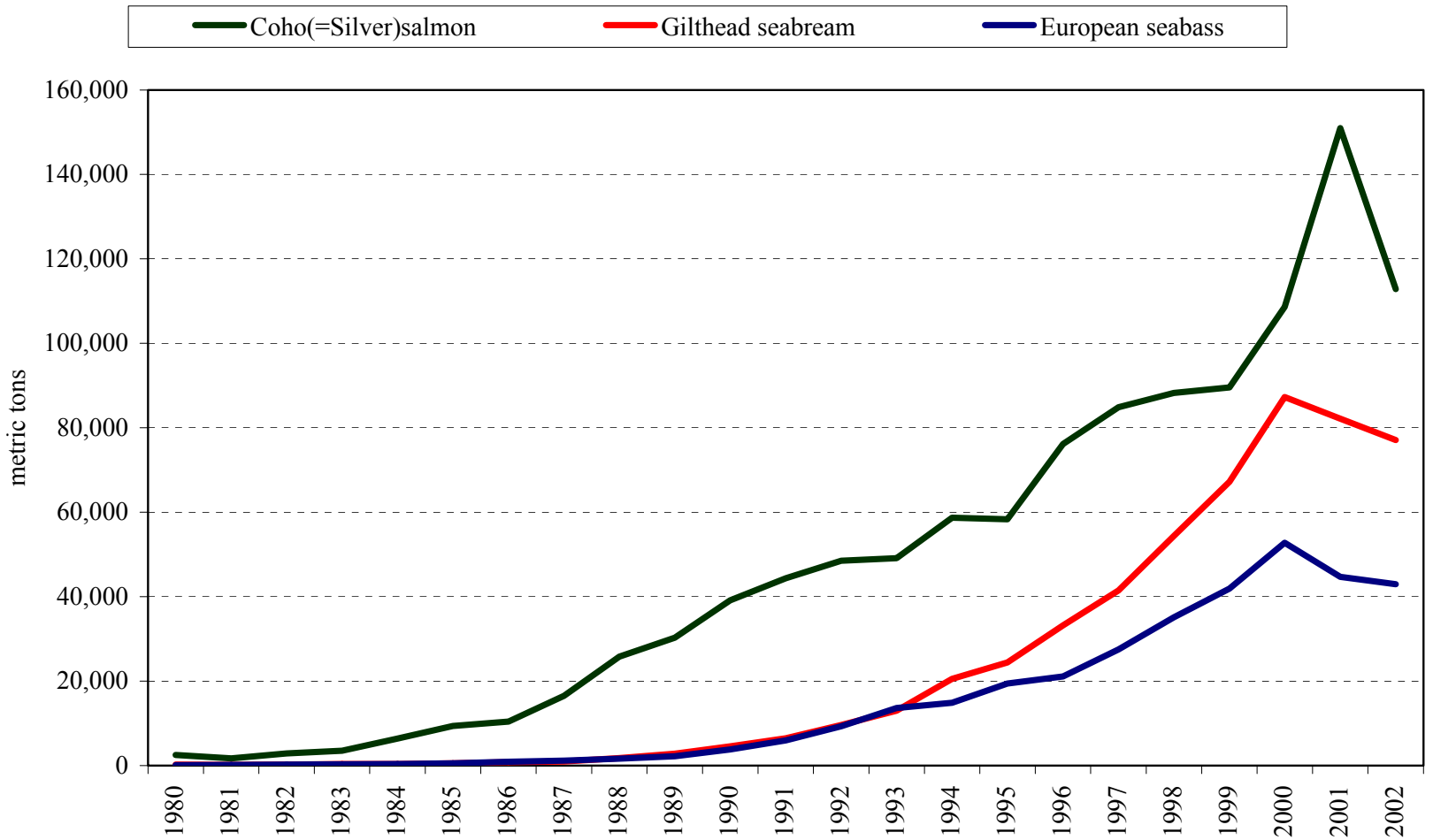
Estimated United States Per Capita Fish Consumption: Top Six Species (edible weight)



Source: National Fisheries Institute Estimates.

This is not to suggest that all kinds of aquaculture inevitably succeed. For some farmed species, growth in supply has outstripped market demand, causing prices to fall and production to decline.

World Aquaculture Production, 1980-2002: Coho salmon, Seabream, Seabass



Source: FAO Fishstat Plus database. Note: Graph excludes reported Chinese production.

Nevertheless, articles in the aquaculture trade press convey a sense of a dynamic international industry with rapid innovation and expansion occurring for many species in many countries . . .

Fish Farming International February 2004 WATER QUALITY & RECIRCULATION 13

Future looks bright for sturgeon system

ROKAVIAR INC, a sturgeon farm established in 1998 in South Florida, is well on the way to producing caviar as well as sturgeon meat for the US market.

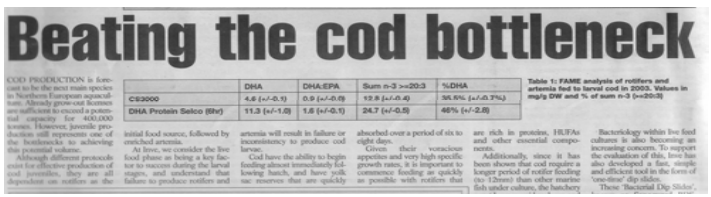
"The present farm set-up allows for the production of approximately two tonnes of caviar a year, as well as 75 tonnes of sturgeon for production of smoked fillets or bullets," manager Reise Rennemeiwaal tells *FFI*. Bullets are sturgeon with head, tail, fins and scutes removed.

Florida environmental regulations only allow for use of small amounts of well water and have strict demands regarding farm effluents. Therefore the farm, in Homestead, Florida, is set up as an intensive production unit using recirculation technology.

The sturgeon are grown in above-ground tanks, volumes varying from 1cu m in the nursery to 125cu m in the grow-out facility. Water treatment components include drum filters for solids removal, submerged and trickling biofilters, ozone generators and oxy cones and paddlewheels for gas exchange.

Rokaviar started with production of the hester, a hybrid between beluga (*Huso huso*) and sterlet (*Acipenser ruthenus*). But unreliable fingerling supply forced the selection of different species. Currently the focus is on the Siberian sturgeon (*A. baeri*) and the Russian sturgeon or osetra (*A. gueldenstaedti*).

Top left: Rokaviar's new generation Russian sturgeon (*A.gueldenstaedti*). Above: Rokaviar's old farm (left) and the expansion the company did last year



Beating the cod bottleneck

COD PRODUCTION is forecast to be the next species in Northern European aquaculture. Already grow-out licenses are sufficient to exceed a potential capacity for 400,000 tonnes. However, juvenile production still represents one of the bottlenecks to achieving this potential volume.

Although different protocols exist for effective production of cod juveniles, they are all dependent on rotifers as the initial food source, followed by enriched artemia.

At live, we consider the live food phase as being a key factor to success during the larval stages, and understand that failure to produce rotifers and artemia will result in failure or inconsistency to produce cod larvae.

Cod have the ability to begin feeding almost immediately following hatch, and have yolk sac reserves that are quickly absorbed over a period of six to eight days.

Given their voracious appetites and very high specific growth rates, it is important to commence feeding as quickly as possible with rotifers that are rich in proteins, HUFAs and other essential components.

Additionally, since it has been shown that cod require a longer period of rotifer feeding (to 12mm) than other marine fish under culture, the hatchery

Bacteriology within live feed cultures is also becoming an increasing concern. To support the evaluation of this, Inve has also developed a fast, simple and efficient tool in the form of 'one-time' dip slides.

These 'Bacterial Dip Slides'.

Table 1: FAME analysis of rotifers and artemia fed to larval cod in 2003. Values in mg/g DW and % of sum n-3 (=>20:3)

	DHA	DHA/EPA	Sum n-3 >=20:3	%DHA
C@3000	4.6 (+/-0.1)	0.9 (+/-0.0)	12.8 (+/-0.4)	36.5% (+/-0.7%)
DHA Protein Selco (Btr)	11.3 (+/-1.0)	1.6 (+/-0.1)	24.7 (+/-0.5)	46% (+/-2.8)

Fish Farming International June 2004

Ecuador studies almaco jack culture potential

THE almaco jack Seriola rivoliana, a finfish called huayaipe in Ecuador, could become an interesting possibility for aquaculture diversification, according to Enrique Blacio of Fundación CENAIM-ESPOL.

Although recovering, the shrimp culture industry in Ecuador is still depressed due to the White Spot Virus (WSV) outbreaks in earthen ponds - hence the interest in almaco jack.

Formerly described as Seriola mazatlana, the almaco jack is related to commercially interesting species such as the Japanese yellowtail Seriola quinqueradiata, the yellowtail kingfish Seriola lalandi and the European amberjack Seriola dumerili. These fish obtain attractive sale prices in international markets, points out Blacio.

CENAIM has been keeping a small number of S. rivoliana broodstock in its facilities in Guayaquil, Ecuador, since March 2002. Fish are kept in two 18-tonne indoor fibreglass tanks with ambient water temperature, natural photoperiod, salinity of 34 to 35ppt and daily water change of 150%.

Broodstock biomass is lower than 5kg/tonne. Daily feeding of the broodstock consists of a varied diet of fresh and frozen fish (mostly clupeids and small tunids), squid and fish gonads, with addition of vitamins.

The broodstock adapted very well to the rearing conditions, and began to spawn voluntarily, Blacio says. In total, some 87 egg batches were obtained from May to December 2002, including viable and non viable. Viable eggs ranged from 0% (non fertilised) to 90%, and hatching percentage ranged from 20 to over 95%.

Collected eggs were stocked in conical, polycarbonate 500-litre tanks for hatching. Temperature control in the hatching tanks kept the water at 27degC. Viable eggs hatched after 24.5 hours at a water temperature of 27.4degC.

Larviculture trials were carried out to test the effect of continuously feeding enriched rotifers, delayed feeding with enriched rotifers and feeding with non enriched rotifers on survival of the larvae until day 12, when the critical swim bladder inflation period is completed.

Tests were carried out in 500 litre tanks at a stocking density of 50 larvae/litre, with controlled water temperature of 26.5degC and salinity of 25ppt. Light intensity was permanently kept at 2000 lux for the duration of the experiment.

Results show that feeding non enriched rotifers for the first eight days of life and feeding enriched rotifers from day nine to day 12 gave the highest survival (2.52%) at the end of the experiment, significantly higher when compared to the other treatments.

Almaco jack have been grown-out in circular, liner covered, shaded, outdoor 12-tonne tanks, fed with 40% protein trout pellet. Fish reached 1006g at 254 days.

■ This article is based on a paper prepared by Cenaim's Enrique Blacio, Jodie Darquea and Sandra Rodriguez for March's Aquaculture 2004 conference in Hawaii. Further information from Enrique Blacio, Fundación CENAIM-ESPOL, PO BOX 09-01-4610, Guayaquil, Ecuador. Email: eblacio@ cenaim.espol.edu.ec

Fish Farming International May 2004

Italians looking into tub gurnard farming

WITH THE increasing production of seabass and seabream in recent years, and the resulting decrease in prices causing problems for many Mediterranean farms, researchers in Italy have been investigating the possibility of diversifying into production of other valuable species – mainly sparids such as red seabream and shi drum.

But a group led by Professor Paolo Melotti, director of the Centro Universitario di Ricerca e Didattica in aquaculture and mariculture at Camerino University at San Benedetto del Tronto, have chosen to look at a triglid, the tub gurnard (*Trigla lucerna*).

Well known and in demand from consumers in Italy, where it commands a high price, especially for fish over 0.5kg, tub gurnard can reach a maximum length of 75cm, and lives at depths of 10-150m.

Research began on tub gurnard in 1997 when specimens were first collected from the wild, fished from the central Adriatic and along the Croatian coast, in order to create a broodstock and develop techniques for controlled reproduction.

Initially there were mortalities of around 80% among the captured fish due to the sudden variation in pressure.

The 14 specimens that survived were initially fed on a

Tub gurnard can reach a length of 75cm, and lives at depths of 10 to 150m

Fish Farming International February 2004

Big plans for striped bass

BLUE Heron Aqua Farms operates a hybrid striped bass farm bordering Everglades National Park, near Florida City, Florida, and has ambitious plans to boost production up to 2700 tonnes a year.

A subsidiary of the publicly held Florida corporation Neptune Aquaculture Inc, Blue Heron maintains a 209 million litres/day water usage permit and a 20 year lease from South Florida Water Management District.

Cherch started in the aquaculture business about eight years ago when he met Ernest Papadoyianis, Blue Heron's president and CEO.

"Ernie has over 20 years experience as an entrepreneur, executive and developer in the aquaculture industry," Cherch tells *FFI*. "My background is one of businesses.

"You have too many people in aquaculture that fly by the seat of their pants. If they knew the fundamentals and followed them they'd do a lot better."

Blue Heron's farm manager is Michael Jouveit, from South Africa, where he was involved in farming catfish and other species.

Following the completion of its US$1.17 million private offering in December 2002, the company completed renovations to the north

A juvenile hybrid striped bass

Fish Farming International May 2004 GLASGOW SHOW/COLDWATER MARI

BC spearheads sablefish studies

RESEARCHERS in British Columbia, Canada, are working with private companies towards the development of large scale commercial breeding of a new coldwater marine species – sablefish (*Anoplopoma fimbria*). **BERNADETTE TOURNAY** reports.

Sometimes sold as black cod in the USA, although not a member of the cod family (its closest relatives are the skilfish, *Erilepis zonifer*), sablefish occurs in the wild in the north Pacific, from northern Japan around the coast of Asia and North America, and south as far as California.

Market analysis done on behalf of the British Columbia Ministry of Agriculture and Fisheries estimates a demand of 2-16,000 tonnes by 2021 valued at $22-114 million.

Research into rearing sablefish began at the Pacific Biological Station of Fisheries and Oceans at Nanaimo in the 1960s by the late Dr William Kennedy, who showed that the species adapted to captivity and could be on-grown to market size.

But work stopped in the early 1970s when it was found there were problems ensuring an annual supply of wild juveniles.

Research started again in the mid-1980s to overcome this problem by developing techniques for hatcheries to induce spawning of sablefish

Sablefish harvested from a commercial operation in British Columbia

Why is the aquaculture revolution happening?

Farmed Chilean coho salmon, Daiei supermarket, Tokyo, Japan, July 2004

Aquaculture is growing rapidly because it can meet market demands for predictable, year-round and growing supply of high-quality seafood.

Fresh tilapia for sale at Swanson's Store, Bethel, Alaska, April 2002

Photograph by Gunnar Knapp

Aquaculture has significant competitive advantages over wild fisheries in supplying world seafood markets in an increasingly globalized economy.

- Production is predictable.
- Production is year round.
- Production can increase.
- Production can be located close to infrastructure.

We may think that:

Wild fish taste better.
Wild fish are healthier.
Wild fish are more environmentally responsible.

But tasting better, being healthier, and being environmentally responsible are not what drives the ability to compete successfully in the global food industry.

Think about what most Americans eat.

Aquaculture faces significant challenges

- Availability of feed—particularly for carnivorous species such as salmon
- Disease control
- Environmental effects
  - Pollution
  - Effects on wild stocks
- Unstable markets, bankruptcies and consolidation
- Consumer resistance
- Political challenges
  - Unfavorable regulatory environment

These challenges will limit particular kinds of aquaculture in particular places.

But there are no obvious limits to growth in total world aquaculture production.

- Feed
  - Fish farmers can substitute vegetable-based feeds for fish-based feeds. This is already happening for salmon.
  - Many aquaculture species, such as catfish and tilapia, are grown almost entirely on vegetable-based feeds.
- Environmental Effects
  - Environmental effects can be reduced through regulation and changes in techniques and locations
- Market Acceptance
  - Rapid growth in consumption proves that buyers and consumers will accept farmed products

There is very significant potential for growth in aquaculture production.

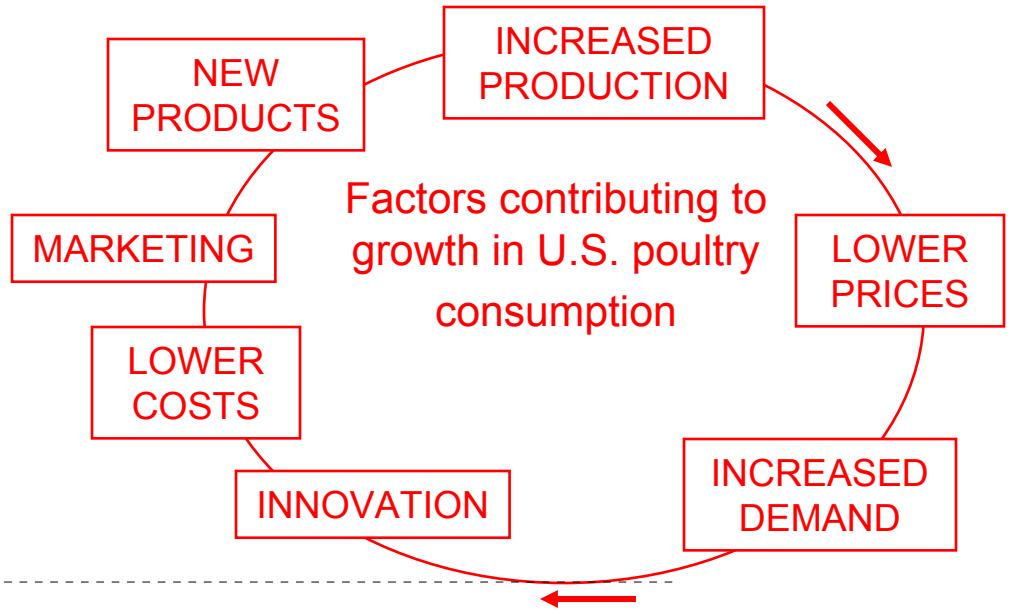
- The global aquaculture industry has very significant resources to invest in research, production and marketing
- Technological innovation is occurring rapidly.
- Once technological hurdles are overcome, farming of new species can expand at a very rapid rate.

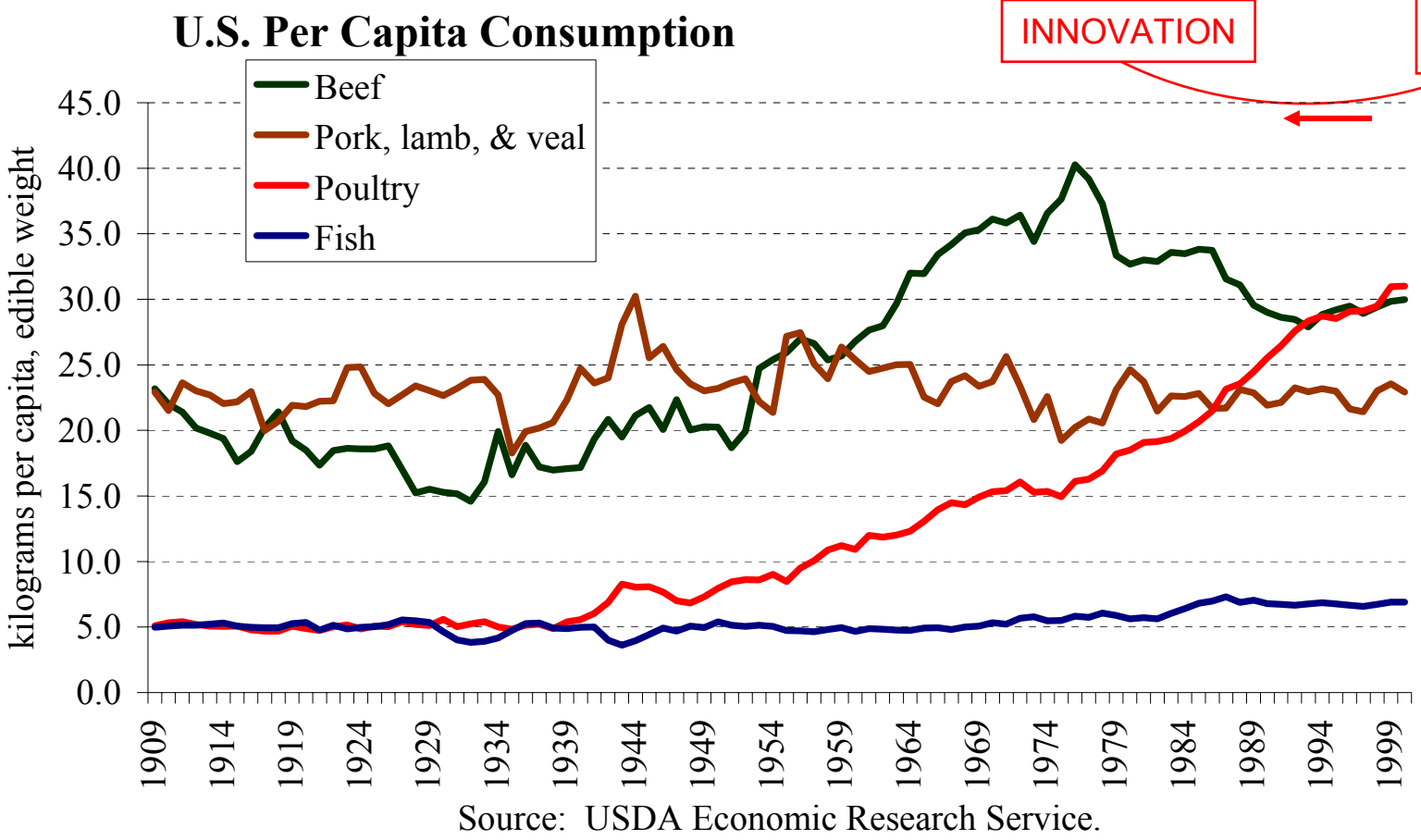
The past isn't necessarily a guide to the future.

- Just because farming of a species isn't profitable now doesn't mean it won't be in the future
- Just because production of a species isn't significant now doesn't mean it won't be in the future.
- Just because consumers don't eat a fish today doesn't mean they won't in the future.
- Tomorrow's major aquaculture species may not be the same as those of today.

The past was not a guide to the future
for farmed salmon, catfish or tilapia.

Unlike wild fisheries, aquaculture has potential for continuing demand-driven growth. The historical experience of poultry may be a better indicator of the potential for aquaculture than that of wild-caught fish.





Source: USDA Economic Research Service.

What is likely to happen with aquaculture in the rest of the world?

- Growth in world aquaculture production is likely to continue regardless of what happens with United States aquaculture.
- A growing number of species will be farmed in significant volumes.
- Aquaculture production, processing and distribution will continue to change
  - Where fish are farmed
  - What fish are fed
  - What products are produced
  - How fish are distributed
  - What consumers buy and eat

Five Economic Considerations in Thinking About U.S. Marine Aquaculture
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The United States currently accounts for only a small share of world aquaculture production.

United States Share of World Aquaculture Production (Excl. China)

Marine, salmon & trout	0.9%
Marine, other finfish	0.0%
Freshwater finfish	4.8%
Molluscs	5.7%
Crustaceans	3.0%
Other	0.0%
Total	3.4%

Marine finfish production represents only a small part of U.S. aquaculture production.
Current offshore finfish production is only a tiny portion of that.

United States Aquaculture Production, 2002
(thousand metric tons)

Marine, salmon & trout	13
Marine, other finfish	0
Freshwater finfish	331
Molluscs	122
Crustaceans	32
Other	0
Total	497

Source: FAO Fishstat+ database.

Catfish, oysters and clams account for most of U.S. aquaculture production.

If seems likely that the United States could compete successfully with other countries in marine aquaculture production --if it chose to do so.

COMPETITIVE ADVANTAGES

- diverse and favorable water conditions.
- high level of technology.
- well-developed infrastructure.
- skilled labor
- lowest transportation costs to U.S. markets
- very competitive in animal farming industries (chicken, beef, etc.)

COMPETITIVE DISADVANTAGES

- high labor costs
- high values of competing coastal uses
- unfavorable regulatory structure
- less developed infrastructure and higher costs in some regions (Alaska)

The economic potential for offshore aquaculture may be less off Alaska than in other U.S. offshore waters.

COMPETITIVE ADVANTAGES OF ALASKA RELATIVE TO OTHER U.S. OFFSHORE AREAS

- favorable cold-water conditions
- skilled labor
- processing facilities

COMPETITIVE DISADVANTAGES OF ALASKA RELATIVE TO OTHER U.S. OFFSHORE

- less developed infrastructure
- higher labor costs
- higher processing costs
- higher transportation costs to U.S. markets
- more severe weather and ice conditions

U.S. marine aquaculture policy is currently very unfavorable to marine aquaculture development.

- Ambivalent-to-hostile regulatory structure for most other coastal marine aquaculture
  - Lack of clear regulatory structure
  - Opposition by local groups & NGOs
  - Political risk
- Lack of an enabling regulatory structure for offshore (EEZ) marine aquaculture
- Without an enabling regulatory structure offshore marine aquaculture will not develop

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It is absolutely clear that aquaculture can have dramatic impacts on markets for wild fisheries.

- Alaska has directly experienced the effects of farmed salmon on markets for wild salmon.
  - Competition from farmed salmon has been the major (but not the only) factor in the dramatic decline in prices for wild Alaska salmon.
  - The decline in prices has caused significant economic difficulties for Alaska salmon fishermen, processors and fishing communities.
- U.S. wild shrimp producers have experienced similar effects of competition from farmed shrimp.
- Similar effects on prices for other wild fish species are likely if aquaculture production expands for those species
  - A recent study projected that large-scale farmed sablefish production would lead to significantly lower prices for wild sablefish.*

*Dan Huppert and Barbara Best, *Study of Supply Effects on Sablefish Market Price*, University of Washington, June 2004.

The market impacts of aquaculture will occur regardless of the extent of United States offshore aquaculture production.

- Alaska's salmon farming ban did not stop the market impacts of farmed salmon on wild Alaska salmon.
- The fact that United States farmed salmon production (in Maine and Washington) is an almost insignificant part of world production has not stopped the market effects of farmed salmon on wild Alaska salmon.
- The fact that United States farmed shrimp production is an almost insignificant part of world production has not stopped the market effects of farmed shrimp on U.S. wild shrimp producers.
- United States trade policy offers little protection against market impacts of aquaculture on wild fisheries
  - U.S. wild fisheries are heavily dependent on export markets
  - The most significant effects of farmed salmon on markets for Alaska wild salmon occurred in Japan.

Over the longer term, the market implications of aquaculture for wild fisheries are not necessarily all bad.

- Aquaculture—by making more fish more consistently and widely available—expands demand.
- As the number of fish consumers grows, the number of wild fish consumers will grow.
- As aquaculture accounts for a larger and larger share of world fish production, niche market opportunities for wild fisheries--as a special product in limited supply—will grow.
  - This is beginning to happen for high quality wild salmon.

Low prices are bad for fishermen but good for consumers.

- The United States has many more fish consumers than wild fish producers.
- If increased aquaculture production results in lower prices of fish—farmed and wild--many Americans would consider that a good effect.
- Most kinds of food have been getting cheaper. Most of us don't consider that a bad thing or worry about how farmers have been affected.
- Most of us would welcome lower prices of:
  - Gasoline
  - Lumber
  - Tomatoes
  - Airline tickets

  . . . and we wouldn't think very much about how the producers were affected.

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There are a variety of potential economic benefits to the United States and coastal regions from marine aquaculture.

- Jobs and income
  - in fish farming
  - in support activities for fish farming
  - in fish processing
  - in feed production
  - in manufacture of equipment and supplies
- Economic diversification for coastal communities
- Royalties and tax income
- Potential synergies with wild fisheries
  - More efficient utilization of processing facilities
  - More efficient utilization of other infrastructure (ports, roads)
  - Markets for wild fisheries by-products as fish feed

Aquaculture can provide year-round employment in coastal areas.
Salmon farming and processing on a remote island in western Norway —in January

United States companies are leaders in aquaculture technology.

10 INNOVATION

US company Northwest Marine Technology (NMT) plans to have an automated fish vaccination system ready for production by September.

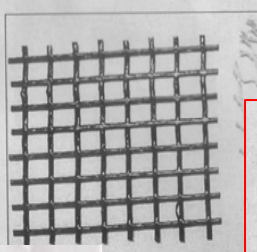
SHOW/COLDWATER MARINE FINFISH Fish Farming International May 2004

Cage 'net' revolution!

US COMPANY Ten Cate Nicolon has introduced what it claims is the first ever containment net designed specifically for aquaculture applications: Aquagrid.

"Traditional nylon and polyester nets used in aquaculture were designed to catch fish, not contain them," says Mark Gunzenhauser, Ten Cate Nicolon's director of strategic markets.

"Aquagrid semi-rigid mesh is the first net created specif-



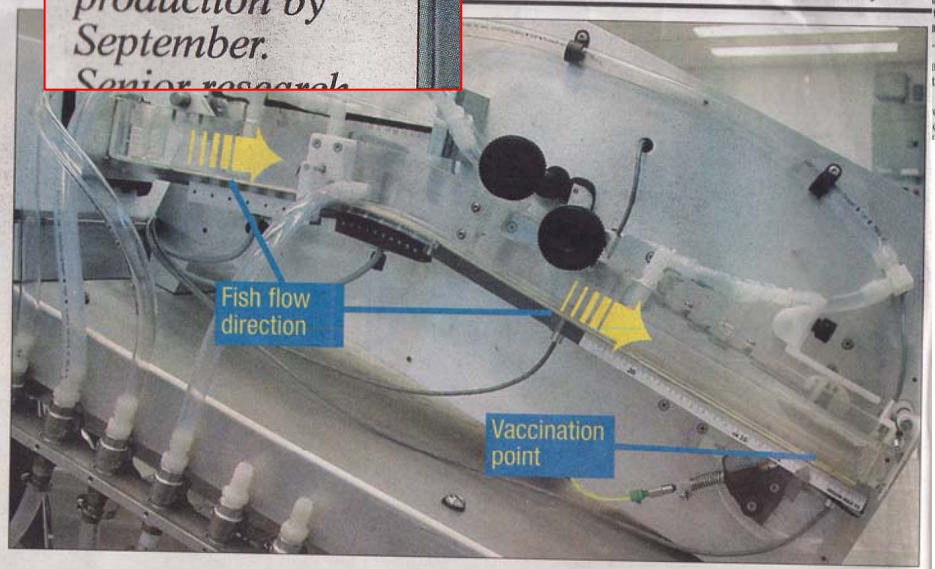
AQUA CULTURE

US COMPANY Ten Cate Nicolon has introduced what it claims is the first ever containment net designed specifically for aquaculture applications: Aquagrid.

10 INNOVATION

Fish Farming International May 2004

US company Northwest Marine Technology (NMT) plans to have an automated fish vaccination system ready for production by September. Senior research scientist Lee Blankenship speaks to **ANTHONY HILDEBRAND** *about his company's innovation*



Automated vaccination!

Potential economic benefits . . . (cont.)

- The scale of potential economic benefits from marine aquaculture depends on the scale of production.
- Direct employment in or supporting marine aquaculture facilities would likely be much smaller than the indirect employment created in processing, distribution, feed supply, equipment manufacture, and other industries.
  - Many of these benefits would not occur locally.
- The extent to which local communities might benefit would depend in part upon the regulatory structure:
  - Local hire requirements
  - Local landing requirements
  - Local taxing authority
- Most wild fishermen would not be likely to benefit directly unless they chose to work in the industry.
- Unlike many kinds of fishing, marine aquaculture is less likely to develop as small, family-owned businesses. It would be a larger-scale, corporate activity.

Five Economic Considerations in Thinking About U.S. Marine Aquaculture
OUTLINE

1. What is likely to happen with aquaculture in the rest of the world?
2. What is the economic potential for U.S. marine aquaculture?
3. What are the potential effects of U.S. marine aquaculture on markets and prices for wild fisheries?
4. What are the potential economic benefits of U.S. marine aquaculture?
5. What are the potential economic costs of U.S. marine aquaculture?

Marine aquaculture has potential environmental costs.

- Potential environmental costs:
  - Pollution
  - Disease
  - Escapes
  - Navigational hazards
  - Aesthetic/visual effects
- Some of the potential environmental costs associated with offshore aquaculture may be less than for inshore aquaculture
  - Less concentration of pollutants because of deeper water and greater water flow through pens
  - Farther from large concentrations of migrating fish (e.g. returning salmon)
  - Reduced aesthetic/visual effects
  - Potentially less of a navigational hazard (depending upon location)

The nature and significance of environmental costs associated with marine aquaculture depends on what is being farmed and how it is farmed and where it is farmed.

- There are significant differences between species which might be farmed in marine aquaculture.
- There are significant differences between different regions of the U.S.
  - in what kinds of wild stocks are present
  - in what other coastal activities are present

The nature and significance of environmental costs associated with marine aquaculture depends on how it is regulated.

- Species which are allowed to be farmed
- Where farms are allowed to be situated
- How farms are allowed to operate

There is no obvious reason why many of the potential environmental costs associated with marine aquaculture could not be addressed through regulation.

It would be impossible to reduce the potential environmental risks of marine aquaculture to zero.

- If we insist on “zero environmental impact” or “zero risk” marine aquaculture will be impossible
- If we insist on “zero environmental impact” or “zero risk”
  - we will be imposing a higher standard than we do for other kinds of food production
  - we will be imposing a higher standard than we do for other uses of the marine environment
    - Wild fisheries
    - Salmon ranching

Marine aquaculture represents competition for wild fisheries.

- Supply from marine aquaculture will compete with wild fisheries in U.S. and foreign markets
  - The extent of competition will depend upon the extent to which the U.S. marine aquaculture production is of species the same as or similar to those caught in U.S. wild fisheries
- Fishermen and regions dependent on wild fisheries for which aquaculture reduces prices will be economically harmed
  - Over time, aquaculture development may help wild fisheries to develop new markets
  - Consumers will benefit from more competition in fish production
- <u>These effects will likely occur regardless of the extent to which the United States develops marine aquaculture.</u>

Marine aquaculture raises important economic, political and philosophical issues about our goals and values.

- How important is the creation of more jobs and income?
- What should be the standard for balancing economic opportunities and their associated potential environmental risks?
- How important is it for the United States to produce its own food rather than to rely on imports?
- Should we promote new economic opportunities which may compete with existing economic activities?
- How should we balance the interests of food consumers (lower prices) with the interests of food producers (higher prices)?
- Should we allow “privatization” of parts of the oceans?
- Who should make these decisions?

PART III

The Fish Feed Issue in the Aquaculture Debate: An Economic Perspective

[Farming carnivorous fish] “increases demand for small low-trophic fish that are finite in supply and critical food for other marine predators.” – Rebecca Goldburg, 9/17/05

IMPLICIT ASSUMPTIONS

- Increased production of carnivorous fish leads to proportional increases in demand for feed fish
- Increasing demand for feed fish necessarily leads to increasing catches of feed fish
- The proper response is to reduce demand for feed fish by slowing or ending farming of carnivorous fish

AN ECONOMIC PERSPECTIVE . . .

- Long before large-scale salmon farming, feed fish stocks were being exploited to make fish meal and fish oil for use in agriculture
- Salmon farming has resulted in substitution of fish meal and fish oil from agricultural uses to use as fish feed.
- Salmon farming has not resulted in large increases in catches of feed fish.

AN ECONOMIC PERSPECTIVE . . .

- Salmon farming uses fish meal and fish oil being in a way that produces MORE value.
- Ending salmon farming would result in fish meal and fish oil being used in a way that produces LESS value.
- Not farming carnivorous fish to reduce demand for fish meal and fish oil is a strategy to reduce the value of major wild fisheries.

AN ECONOMIC PERSPECTIVE . . .

- Growth in carnivorous fish farming will increase demand for feed fish.
- Catches of feed fish depend not just on demand—but also on how feed fish stocks are managed.
- If feed fish stocks are well-managed then increasing demands will not lead to irresponsible catches.
- If feed fish stocks are not well-managed, then what is needed are policies to strengthen management.

AN ECONOMIC PERSPECTIVE . . .

- Increasing the value of fish meal and fish oil has the potential to increase the value of many wild fisheries
  - The greater the value of fish meal and fish oil, the greater the extent to which we will be able to make economic use of large volumes of unutilized “wastes” from processing of wild fish (including wild Alaska salmon)

"Marine aquaculture must thus reduce its use in fish feeds of meal and oil made from wild-caught fish."–Rebecca Goldburg, 9/17/05

IMPLICIT ASSUMPTIONS

- Because potential fish meal and fish oil supplies are limited, we should discourage farming of carnivorous fish.

AN ECONOMIC PERSPECTIVE . . .
If fish meal and fish oil supplies are limited, markets will adjust.

- Through rising prices of fish meal and fish oil, leading to:
  - substitution by farmers of other feeds for fish meal and fish oil
  - farmers switching to production of other species
  - consumers switching to consumption of other species as prices rise

- All of these adjustments have been happening and will continue to happen

PART IV

United States Marine Aquaculture: Three Questions

In any study, the answers you get depend on the questions you ask.

- I have not been able to find a clear statement of the charge to the Marine Aquaculture Task Force (MATF) or what questions you are trying to answer.
- The WHOI News Release about the MATF (June 22, 2005) implies certain questions.
- I would like to suggest three additional questions you should be asking.

From the WHOI News Release about the MATF (June 22, 2005)

"The Pew Charitable Trusts . . . announces the establishment of the Marine Aquaculture Task Force . . ."

- *". . . to develop national aquaculture standards to guide future development of our oceans."*
- *". . . to address aquaculture's risks and benefits."*
- *". . . 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."*

1. What kind of INSTITUTIONS will lead to responsible development of marine aquaculture?

". . . to develop national aquaculture standards to guide future development of our oceans."

The press release implies that you will focus on standards.

- What will be the relative role of standards in developing marine aquaculture, compared with the institutions that interpret and implement those standards?
  - In U.S. federally-managed fisheries, what is the relative role of the national standards in the Magnuson-Stevens Act compared with the institutions (the Fishery Management Councils & NMFS) which interpret and implement those standards?
- In considering standards, what is the capacity of your commission to learn and understand the issues related to the developing good standards?
  - Is the development of standards a technical issue or a political issue?
- To what extent should you be thinking about what kind of institutions would develop good standards rather than what the standards should be?

2. To what extent should standards be local, statewide or national?

". . . to develop national aquaculture standards to guide future development of our oceans."

The press release implies that we need national aquaculture standards.

- Alaska commercial salmon fisheries are not managed under national standards
- Alaska's salmon hatchery program is not subject to national standards.
- Alaska's shellfish aquaculture program is not subject to national standards

Would it be better for Alaska or the nation if they were subject to national standards?

3. What are the benefits of marine aquaculture?

One sentence in your press release mentions benefits.

". . . to address aquaculture's risks and benefits."

The rest of the press release talks mostly about risks and costs—implying that that is where you will focus your attention.

". . . 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."

". . . there are significant environmental and socio-economic concerns associated with its development."

"Before plunging in, we should consider very carefully the effect it will have on marine ecosystems and the people and communities who depend on them." [Chris Mann]

Marine aquaculture has both risks/costs and benefits.

POTENTIAL RISKS / COSTS

- Environmental effects
- Socio-economic effects

POTENTIAL BENEFITS

- Income & jobs
- Diversification of economic activity (locally and nationally)
- Reduced dependency on imports
- Benefits to consumers
- Benefits to wild fisheries

The answers you get depend upon the questions you ask.

How can we minimize environmental and socio-economic risks and costs of marine aquaculture? (a TECHNICAL question)	How can we balance costs and benefits of marine aquaculture? (a TECHNICAL and POLITICAL question)
Don't allow marine aquaculture	Allow marine aquaculture when benefits outweigh risks and costs
Allow marine aquaculture only when all risks are fully understood	Allow marine aquaculture when risks are understood well enough that we can be confident that they are reasonably low
Allow marine aquaculture only if risks are zero	Allow marine aquaculture when risks are low relative to benefits
Allow marine aquaculture only if it has no environmental costs.	Allow marine aquaculture when environmental costs are low relative to benefits
Allow marine aquaculture only if there are no adverse economic and social impacts	Allow marine aquaculture if positive economic and social impacts outweigh negative impacts—and if those adversely impacted are compensated.

These are the questions and answers I usually hear in Alaska about marine aquaculture.

How can we minimize environmental and socio-economic risks and costs of marine aquaculture? (a TECHNICAL question)	How can we balance costs and benefits of marine aquaculture? (a TECHNICAL and POLITICAL question)
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These are the questions and answers I usually hear in Alaska about Alaska's commercial fisheries.

How can we minimize environmental and socio-economic risks and costs of Alaska commercial fisheries? (a TECHNICAL question)	How can we balance costs and benefits of commercial fisheries? (a TECHNICAL and POLITICAL question)
Don't allow commercial fisheries	Allow commercial fisheries when benefits outweigh risks and costs
Allow commercial fisheries only when all risks are fully understood	Allow commercial fisheries when risks are understood well enough that we can be confident that they are reasonably low
Allow commercial fisheries only if risks are zero	Allow commercial fisheries when risks are low relative to benefits
Allow commercial fisheries only if they have no environmental costs.	Allow commercial fisheries when environmental costs are low relative to benefits
Allow commercial fisheries only if there are no adverse economic and social impacts	Allow commercial fisheries if positive economic and social impacts outweigh negative impacts—and if those adversely impacted are compensated.

These are the questions and answers I usually hear in Alaska about Alaska's salmon hatcheries.

How can we minimize environmental and socio-economic risks and costs of Alaska salmon hatcheries? (a TECHNICAL question)	How can we balance costs and benefits of salmon hatcheries? (a TECHNICAL and POLITICAL question)
Don't allow salmon hatcheries	Allow salmon hatcheries when benefits outweigh risks and costs
Allow salmon hatcheries only when all risks are fully understood	Allow salmon hatcheries when risks are understood well enough that we can be confident that they are reasonably low
Allow salmon hatcheries only if risks are zero	Allow salmon hatcheries when risks are low relative to benefits
Allow salmon hatcheries only if they have no environmental costs.	Allow salmon hatcheries when environmental costs are low relative to benefits
Allow salmon hatcheries only if there are no adverse economic and social impacts	Allow salmon hatcheries if positive economic and social impacts outweigh negative impacts—and if those adversely impacted are compensated.

PART V

How to Keep U.S. Marine Aquaculture from Happening

Aquaculture is a business. Marine aquaculture will not happen in the United States unless we create favorable conditions for aquaculture businesses to develop and to compete successfully with other producers.

One way to keep marine aquaculture from happening is to ban it. Other ways include:

- Allow zero environmental risk
- Allow zero economic or social impacts
- Consider only potential risks and costs, and ignore potential benefits.
- Wait until all issues are understood before making any decisions
- Create a costly regulatory approval process with unclear and uncertain guidelines
- Keep changing the rules
- Subject the industry to frequent political and legal challenges