Five Economic Considerations in Thinking About United States Offshore Aquaculture

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This presentation will be posted online at:
www.iser.uaa.alaska.edu/iser/people/knapp

My Background for Talking About Aquaculture

- I've spent many years studying markets for wild fisheries
- It is impossible to understand seafood markets without understanding what is happening in aquaculture
- I have tried to learn as much as I can about aquaculture
- I have visited aquaculture operations in Canada, Norway, Chile, Iceland and Japan

Why am I here?

- I was invited by NMFS
- I am speaking for myself.
- I am not representing
  - NMFS
  - the State of Alaska
  - aquaculture proponents
  - wild fisheries
- I am not trying to argue for or against offshore aquaculture.
- My goal is to discuss some of the <u>economic</u> issues relevant to the debates going on in the United States over offshore aquaculture.

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.

There are many different types of aquaculture. My focus in this presentation is on offshore aquaculture.

Major Types of Aquaculture				***Example***	***Who has major regulatory authority?***
Freshwater				Idaho trout Mississippi catfish	State
Marine (Salt-Water)	Shellfish			Washington oysters	State
	Finfish	Ranching		Alaska salmon hatcheries	State
		Net-Pen	Inshore	Maine salmon farms	State
			Offshore	Hawaii offshore moi farms	State or Federal (EEZ)

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

- Alaska has legitimate concerns about offshore aquaculture.
- But the United States is not just Alaska, and 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 offshore 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 offshore aquaculture, that doesn't mean no-one else should be allowed to have offshore aquaculture.

OUTLINE

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

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

World experience with offshore aquaculture is currently very limited.
Any answers to these questions are necessarily speculative.
None of these questions have been studied in detail.

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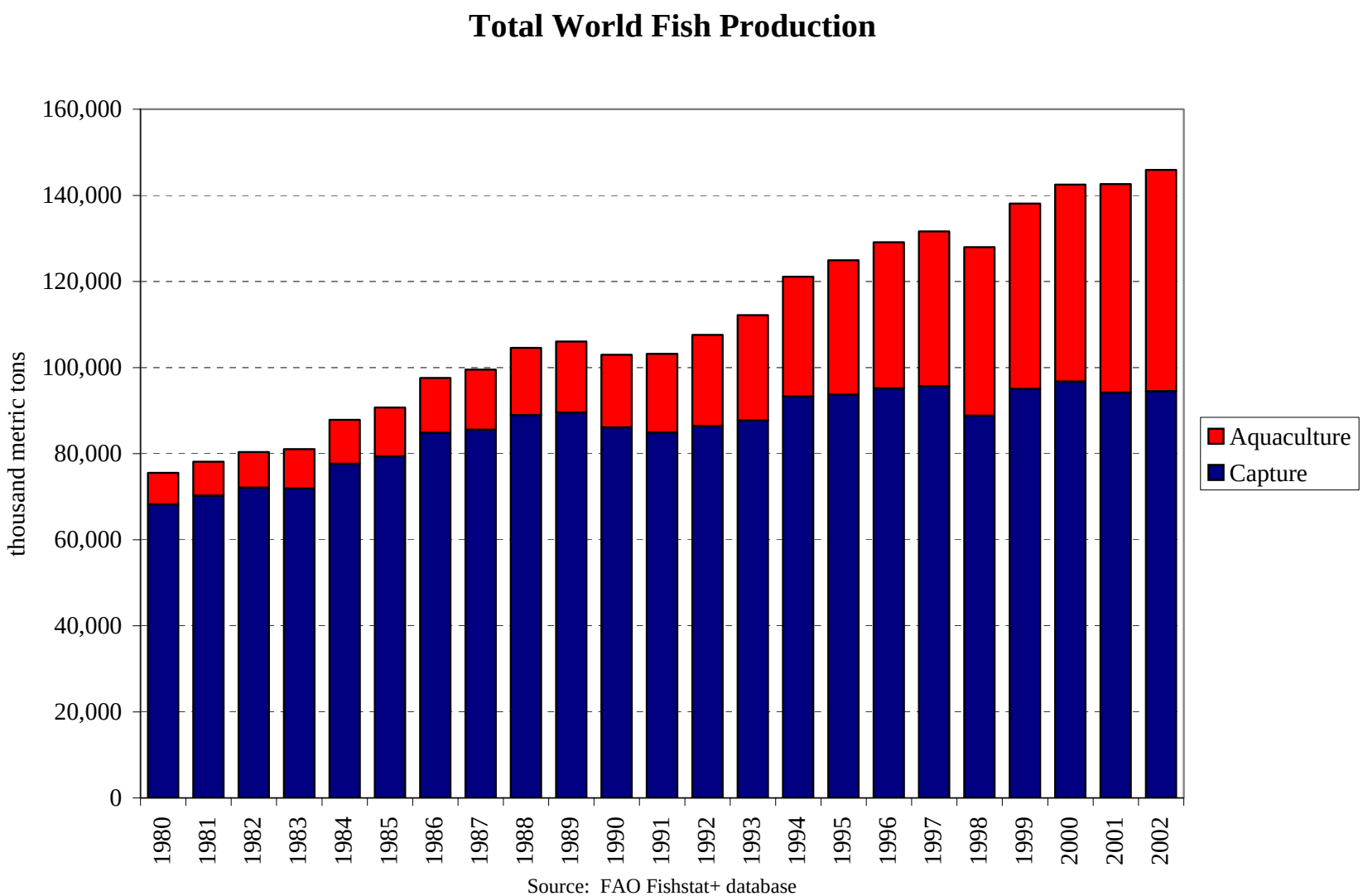
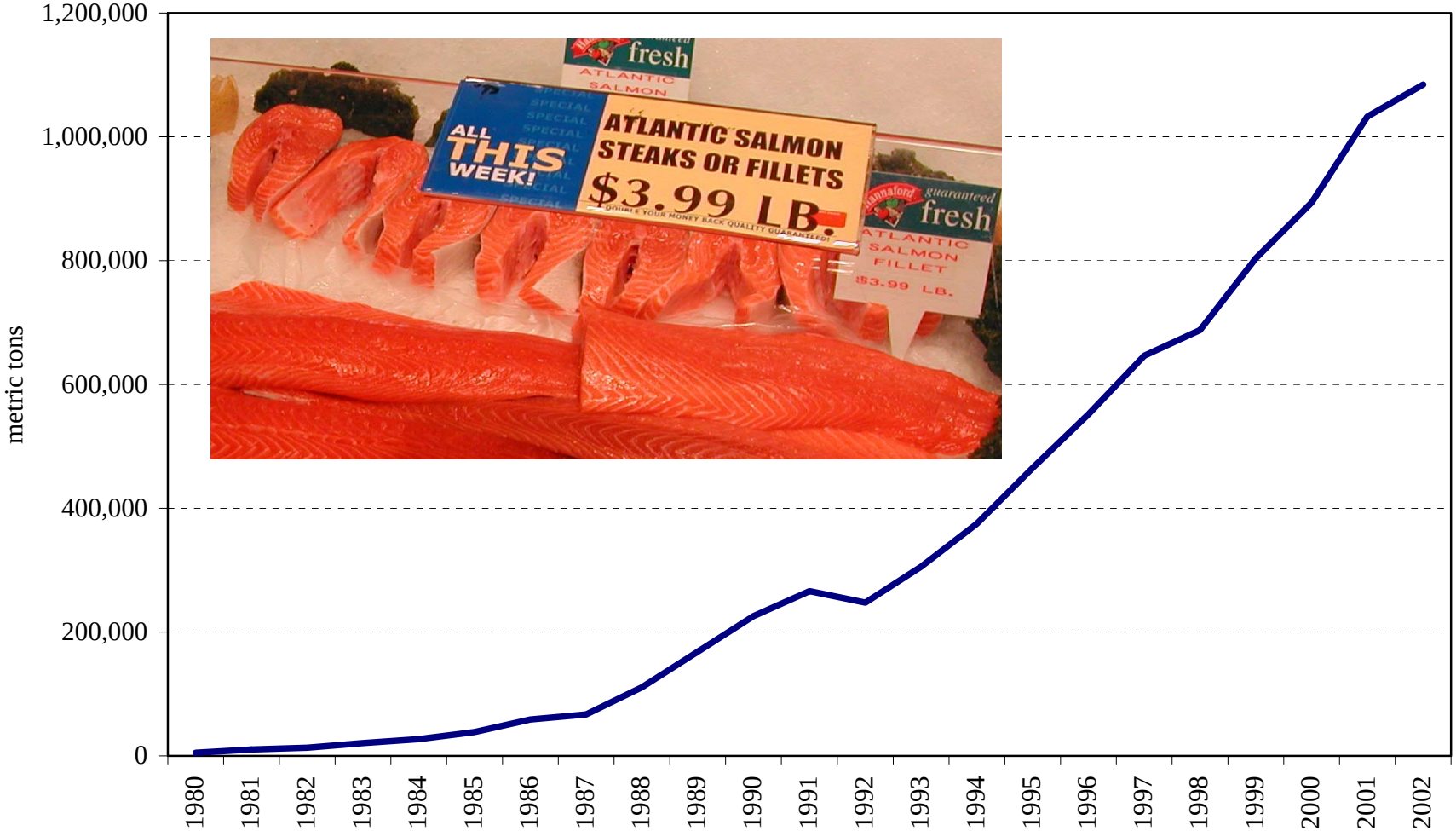
An aquaculture revolution is happening in the world seafood industry. Aquaculture accounts for a large and growing share of world seafood production.



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

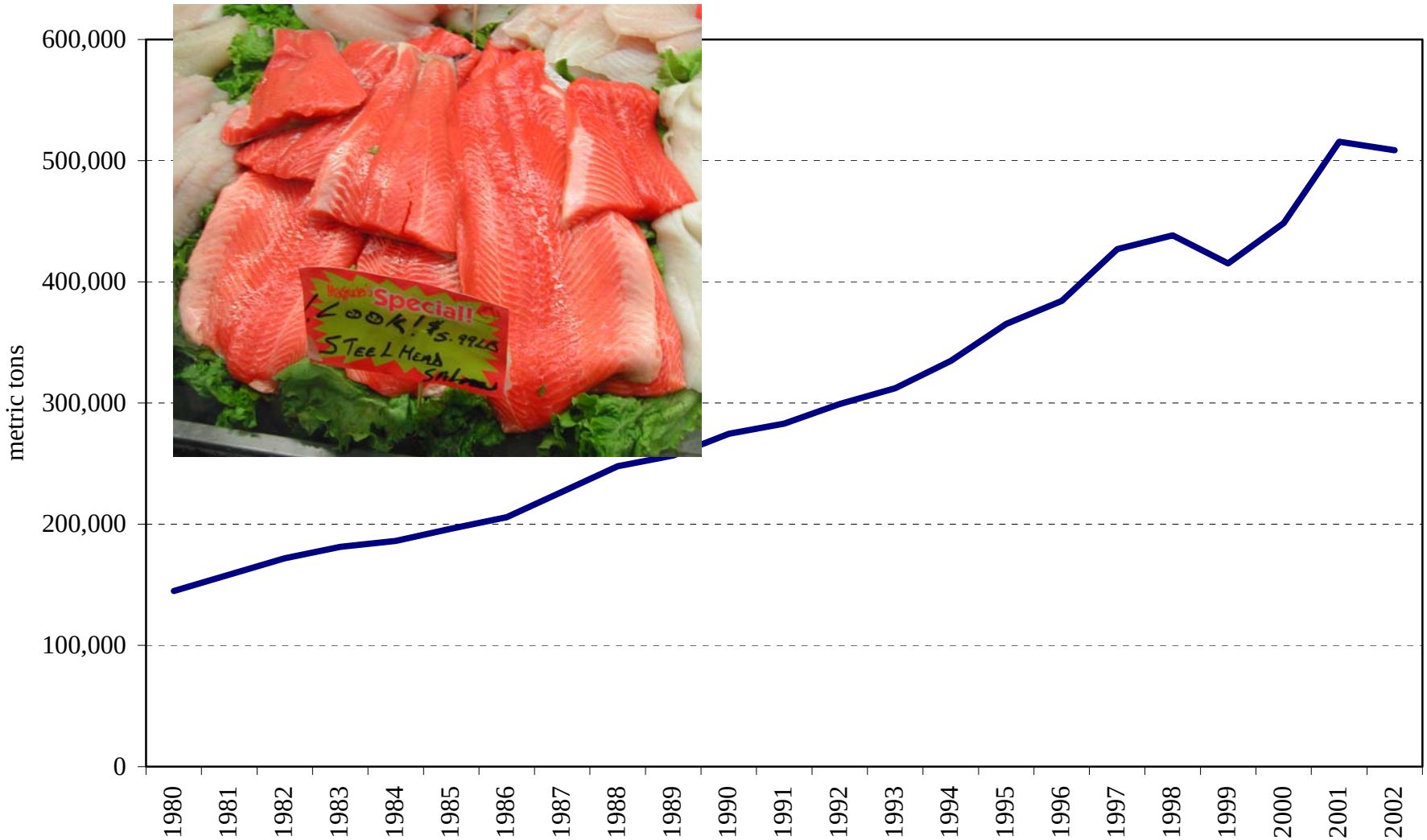
World Aquaculture Production, 1980-2002: Atlantic Salmon



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

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

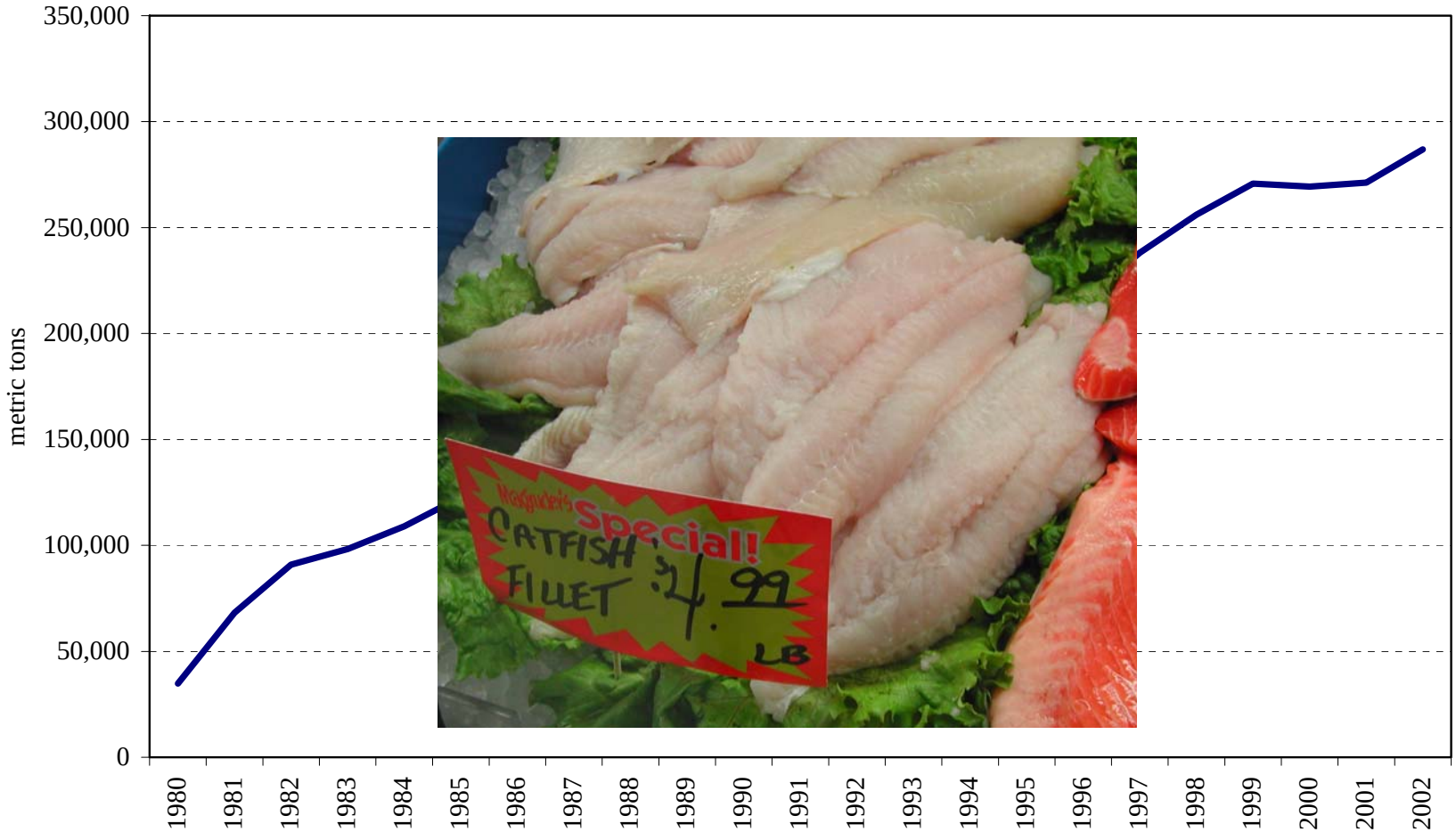
World Aquaculture Production, 1980-2002: Rainbow Trout



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

Catfish . . .

World Aquaculture Production, 1980-2002: Channel Catfish



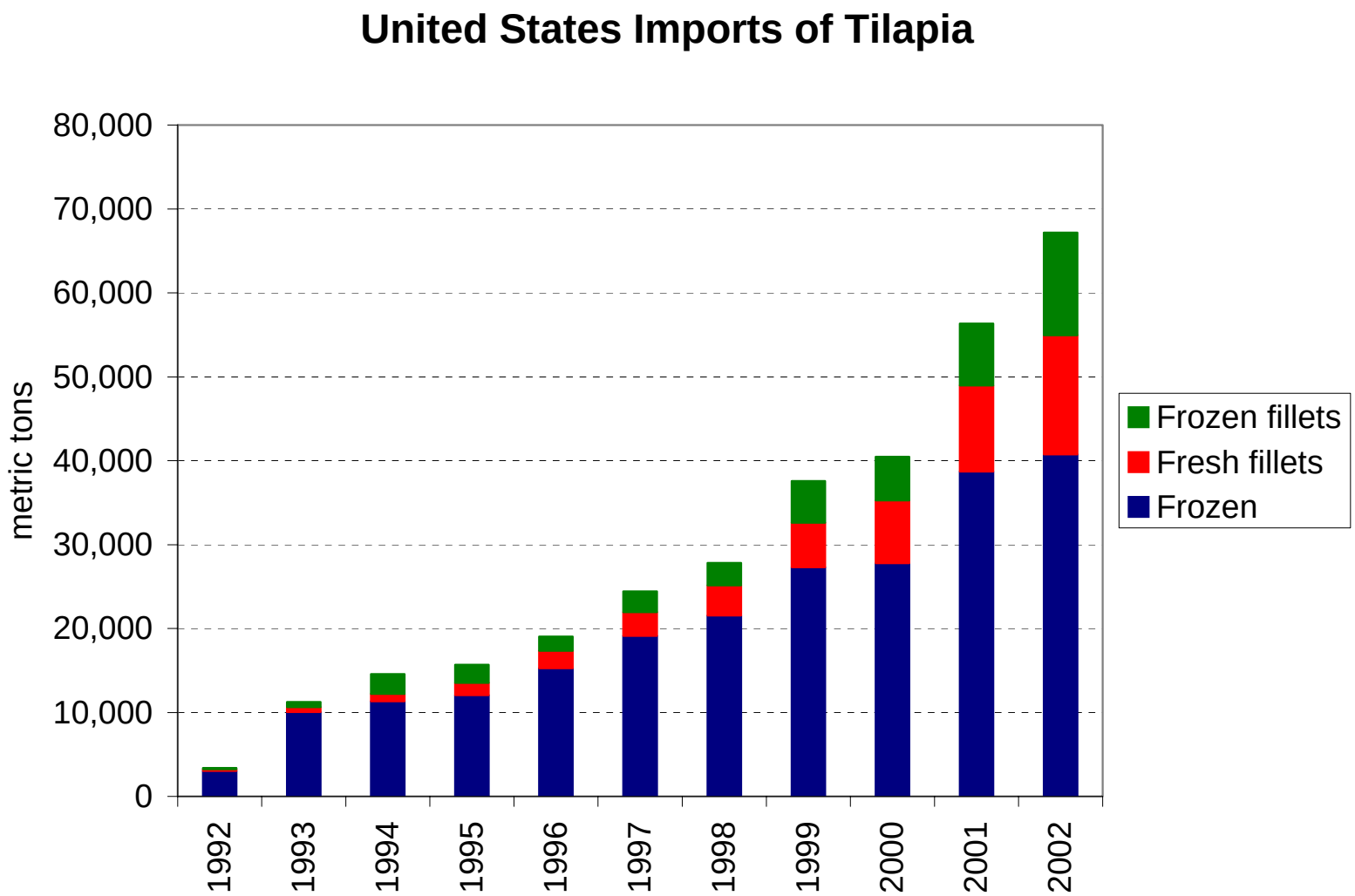
Source: FAO Fishstat Plus database. Note: Graph excludes reported Chinese production.

. . . and Tilapia.

World Aquaculture Production, 1980-2002: Nile Tilapia

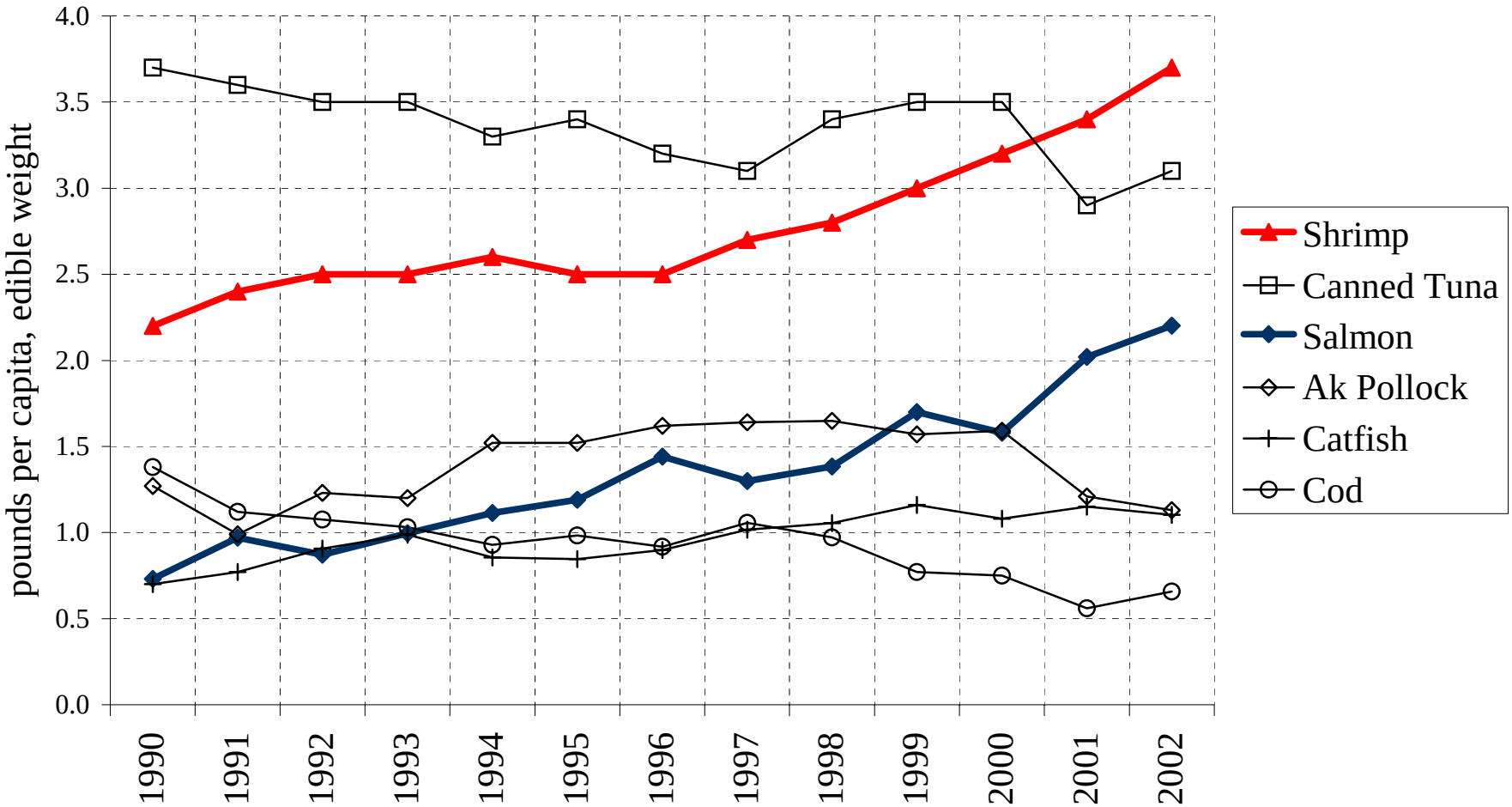
Source: FAO Fishstat Plus database. Note: Graph excludes reported Chinese production.

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.

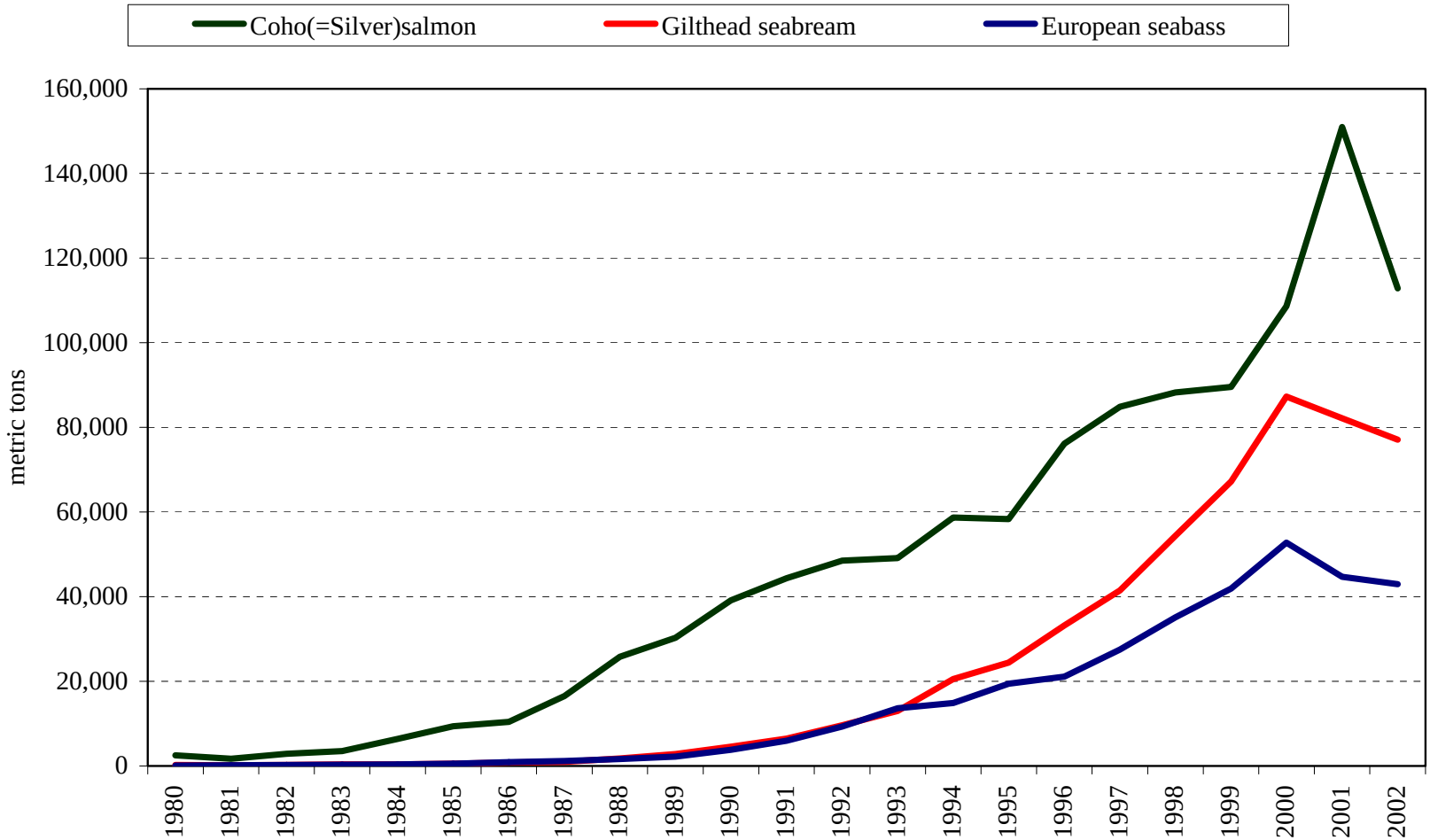
Estimated United States Per Capita Fish Consumption: Top Six Species (edible weight)



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.

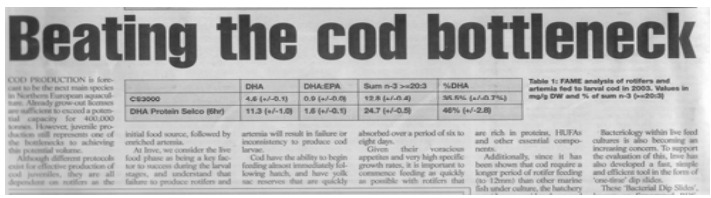
"The present farm set-up allows for the production of approximately two tonnes of caviar a year, as well as 75 tonnes of sturgeon for production of smoked fillets or bullets," manager Rene Rennerwood tells *FFI*. Bullets are sturgeon with head, tail, fins and scutes removed.

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 foreseen to be the next main species in Northern European aquaculture. Already grow-out licences 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 rearing, 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 appetite 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.

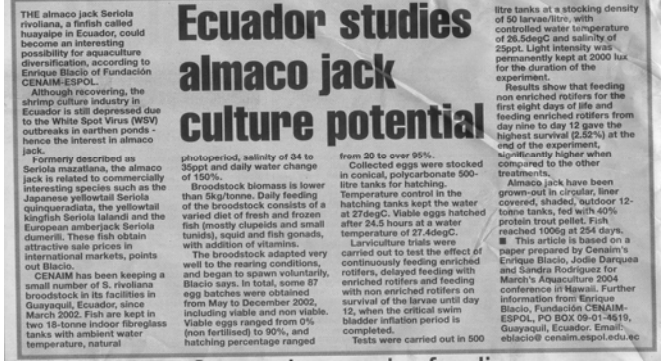
Additionally, since it has been shown that cod require a longer period of rotifer feeding (to 12mm) than other marine fish under culture, the hatchery

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

These 'Bacterial Dip Slides'

	DHA	DHA:EPA	Sum n-3 >=20:3	%DHA
CS3000	4.6 (+/-0.1)	0.9 (+/-0.0)	12.8 (+/-0.4)	36.5% (+/-0.3%)
DHA Protein Selco (Ehr)	11.3 (+/-1.0)	1.6 (+/-0.1)	24.7 (+/-0.5)	46% (+/-2.8)

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)



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 09-01-4519, 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 Riccrca e Didattica in aquaculture and mariculture at Camerino University at San Benedetto del Trunto, 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 0.3kg, 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 natural diet, mainly over

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 farm area of the site. It is

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 skillfish, *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.

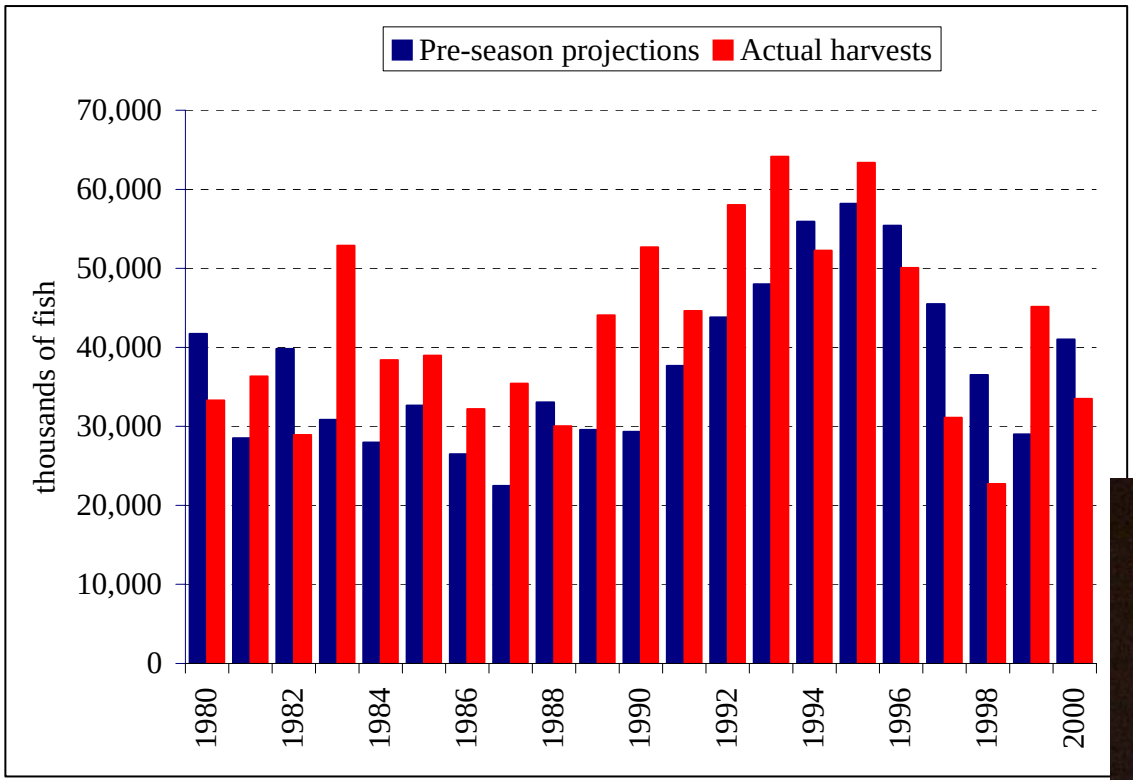
Fresh tilapia for sale at Swanson's Store, Bethel, Alaska, April 2002

Photograph by Gunnar Knapp

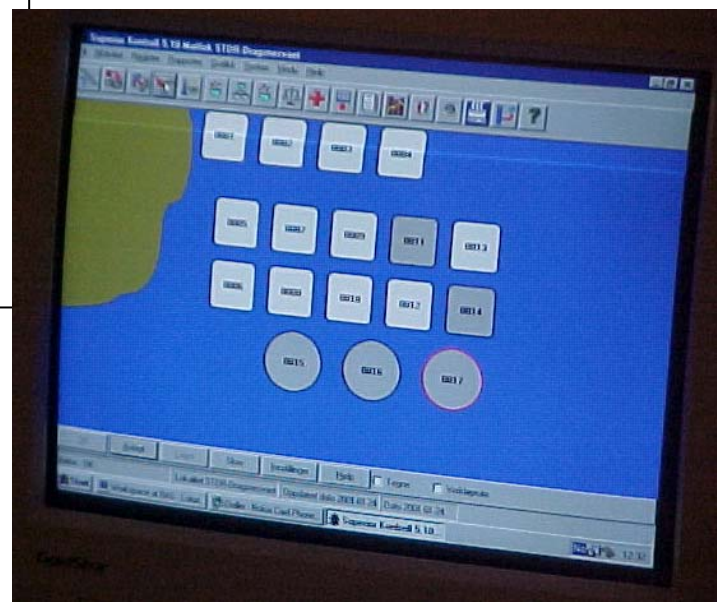
Aquaculture has significant competitive advantages over wild fisheries in supplying world seafood markets in an increasingly globalized economy.

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

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



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



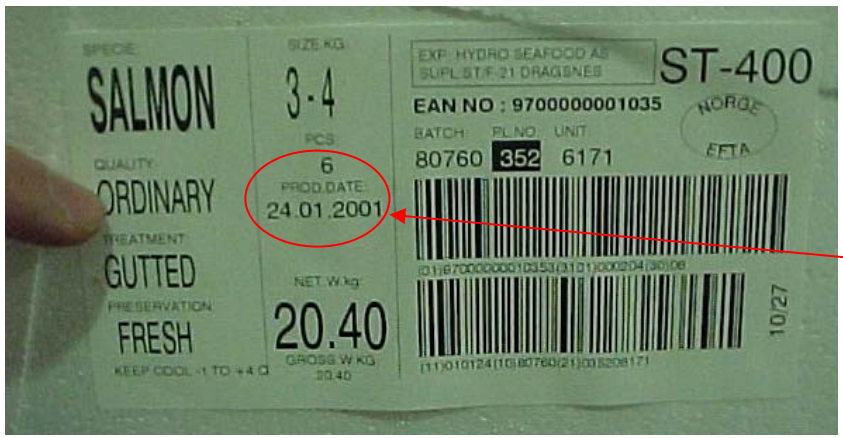
This computer at a Norwegian salmon farm can tell the producer exactly how many fish of what size are in each pen (and in the pens of all the farms owned by this company on three continents)

Year-round production reduces production costs of aquaculture relative to seasonal wild fisheries, and makes it possible for aquaculture to meet buyers' needs year-round.

Farmed Salmon	Wild Salmon
Farmed salmon production can occur year-round.	Most wild salmon can only be harvested during a short summer run.

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.



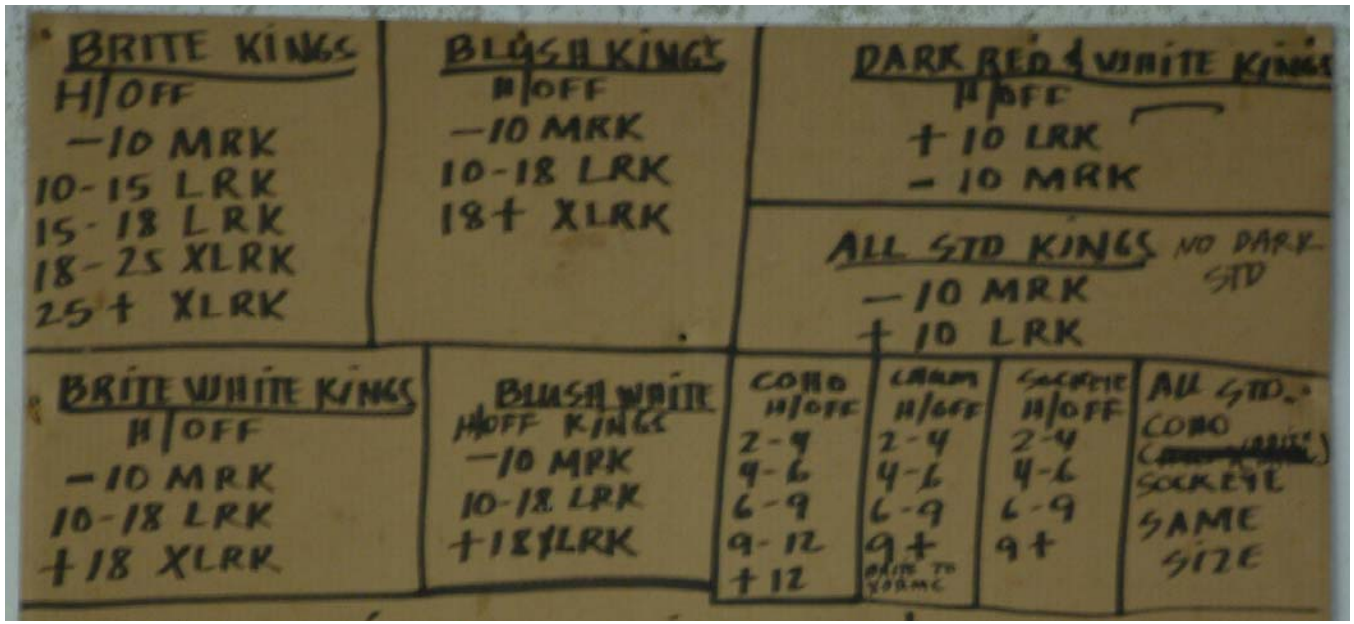
Norwegian salmon processed in winter

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

Ability to control production fish size (and other attributes) allows aquaculture producers to meet buyers' needs and lowers costs.

Farmed Salmon	Wild Salmon
Farmed salmon is consistent in size and quality.	There is wide variation in the size and quality of individual wild salmon

Grades at a southeast Alaska processing plant



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 carniverous species such as salmon
- Disease control
- Environmental effects
  - Pollution
  - Effects on wild stocks
- Unstable markets, bankruptcies and consolidation
- Political challenges
  - Unfavorable regulatory environment
- Consumer resistance

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.

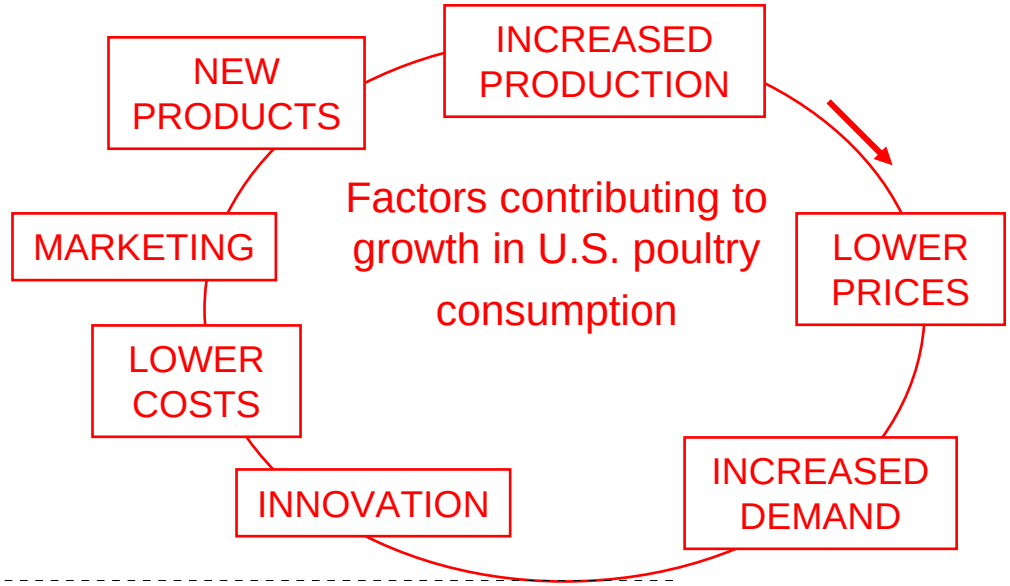
- The global aquaculture industry has very significant resources to invest in research, production and marketing
- Technological innovation is occurring rapidly.
- Once technological hurdles are overcome, farming of new species can expand at a very rapid rate.

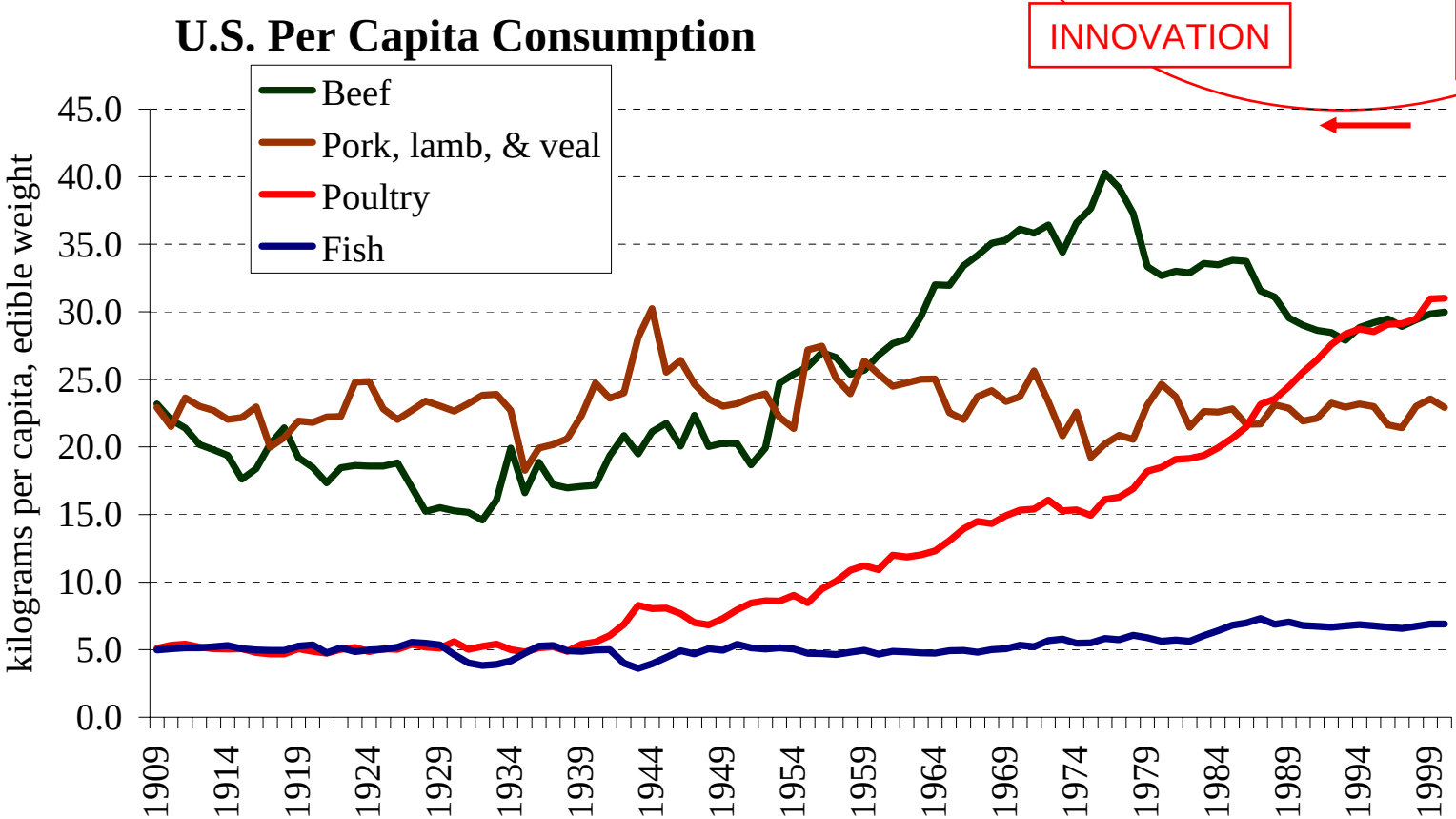
The past isn’t necessarily a guide to the future.

- 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.

CONCLUSIONS

1. 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

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

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 offshore 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

CONCLUSIONS

2. What is the economic potential for U.S. offshore aquaculture?

- The United States could probably compete successfully with other countries in offshore aquaculture production if it chose to do so.
- The economic potential is probably greatest for
  - higher-valued species
  - production for U.S. market
  - low labor intensity
- The economic potential for <u>offshore</u> aquaculture may be relatively less off Alaska than in other U.S. offshore areas.
- There is no economic potential for U.S. offshore aquaculture without an enabling regulatory structure

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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.

CONCLUSIONS

3. What are the potential effects of U.S. offshore aquaculture on markets and prices for wild fisheries?

- World aquaculture production—onshore, nearshore, and offshore—almost certainly will lower prices for wild fisheries, at least in the short run.
- These market impacts of aquaculture will occur regardless of the extent of United States offshore aquaculture production.
- From a <u>national</u> perspective, many Americans might consider lower fish prices a good thing.

OUTLINE

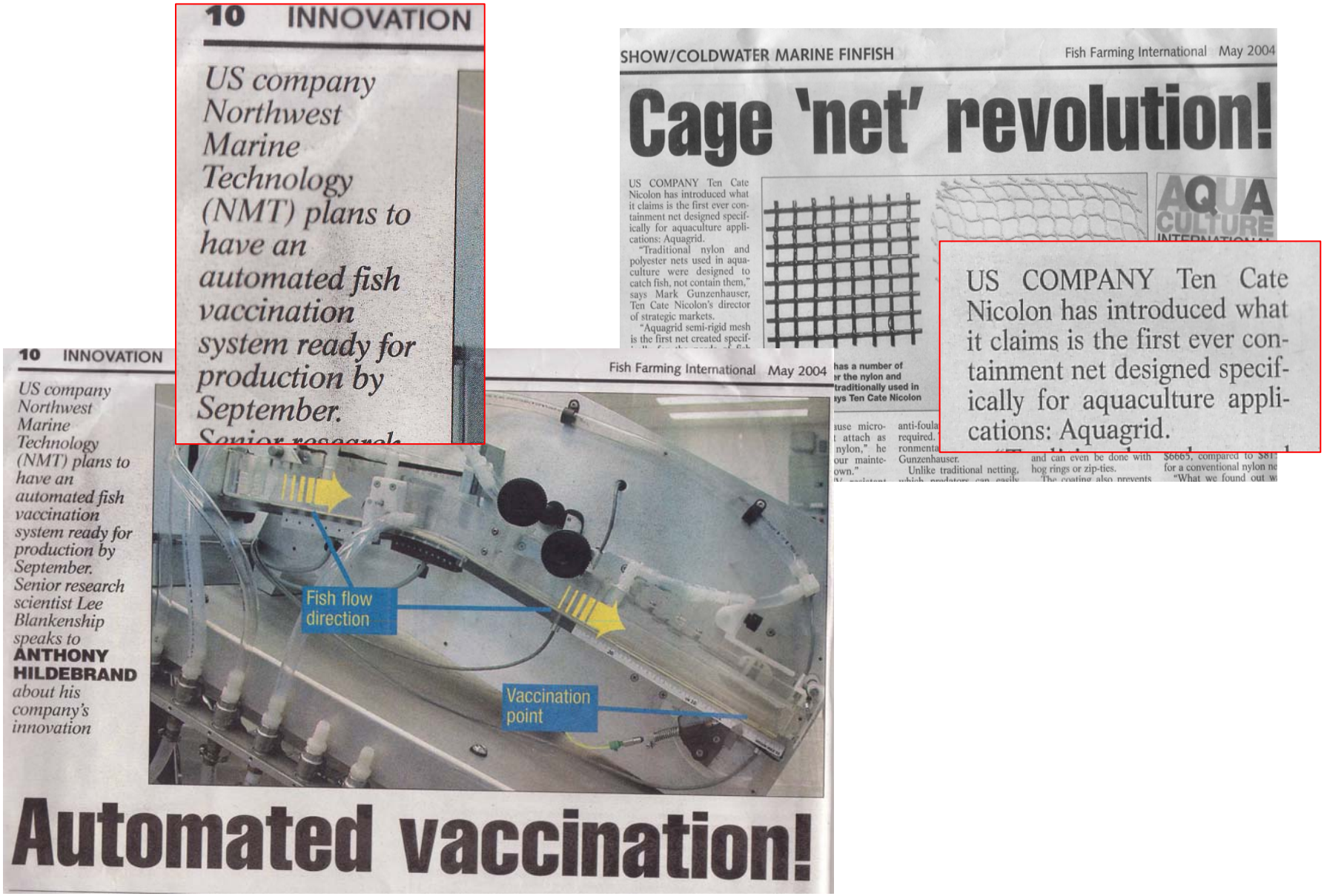
1. What is likely to happen with aquaculture in the rest of the world?
2. What is the economic potential for U.S. offshore aquaculture?
3. What are the potential effects of U.S. offshore aquaculture on markets and prices for wild fisheries?
4. What are the potential economic benefits of U.S. offshore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

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

- Jobs and income
  - in offshore farming
  - in support activities for offshore farming
  - in 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-

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 offshore aquaculture depends on the scale of production.
- Direct employment on or supporting offshore 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, offshore aquaculture is not likely to develop as small, family-owned businesses. It would be a larger-scale, corporate activity.

CONCLUSIONS

4. What are the potential economic benefits of U.S. offshore aquaculture?

- There are a variety of potential economic benefits.
- The scale of potential economic benefits depends on the scale of production.
- Direct employment in offshore aquaculture likely be much smaller than indirect employment in other industries.
- Many of the benefits would occur nationally, not locally.
- The scale of local benefits would depend in part on the regulatory structure.

OUTLINE

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

Offshore 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 offshore 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 offshore 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 offshore 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 offshore aquaculture could not be addressed through regulation.

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

- If we insist on “zero environmental impact” or “zero risk” offshore 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

Offshore aquaculture represents competition for wild fisheries.

- Supply from offshore 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. offshore 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
- These effects will likely occur regardless of the extent to which the United States develops offshore aquaculture

CONCLUSIONS

5. What are the potential economic costs of U.S. offshore aquaculture?

- Offshore aquaculture has potential environmental costs.
  - The nature and significance of environmental costs depends on what is farmed and how it is farmed and where it is farmed.
  - The nature and significance of environmental costs associated with offshore aquaculture depends on how it is regulated.
- Offshore aquaculture represents competition for wild fisheries

Offshore 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?