

Emerging Dominance of Aquaculture: The Future of the Seafood Market and Fisheries Management

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Key Themes

- Aquaculture will dominate the seafood market – esp. international trade
- Winners will control costs and manage for markets
- Fisheries managed more like ‘aquaculture’
--- win
- Aquaculture sectors managed more like fisheries (US marine aquaculture) --- lose

Seafood Sector

- Extremely Complex and Diverse
 - 100s of species, many technologies, many areas
- Highly International
- Bureaucratic Regulatory Environment
- Fragmented
- Wasteful
- Marketing is Not Advanced
- Highly Misunderstood by Consumers including Chefs
- Volatile – in Prices and Quantities

Simple Realities



**Inefficient Fisheries Management and/or Unmet Demands
are the Stimuli for Aquaculture and Innovation**

Simple Realities

People whose lives depend on the harvest of seafood want:

- Better control of cost
- Minimize environmental/exogenous shocks
- Better control fish stock and growth rates
- Manage to meet the market demand
- Sustainable profits

CONTROL

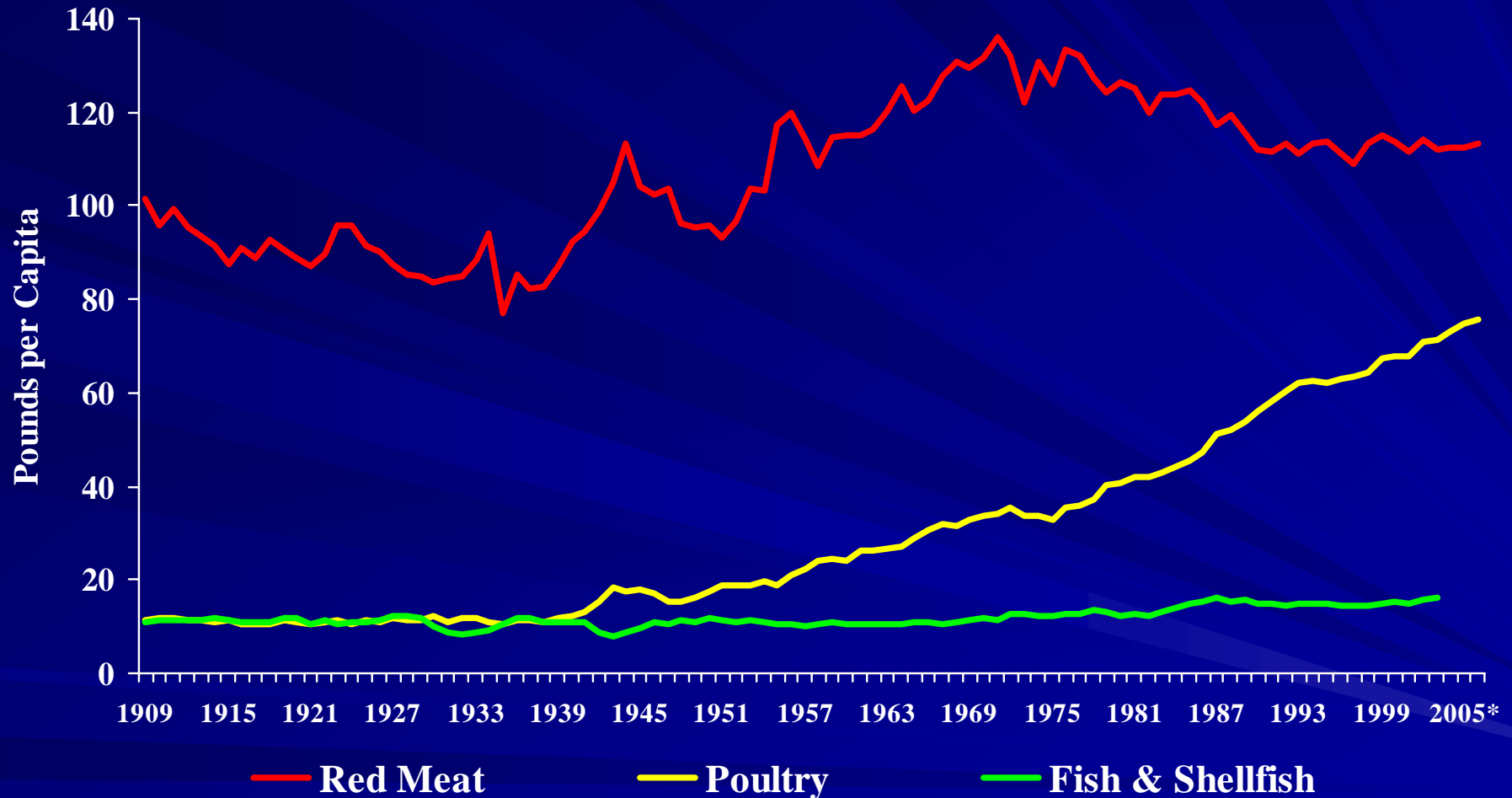
of production and marketing through
Ownership, Information and Technology

If the Future will be Dominated by Aquaculture

What does it mean for the future of the
seafood sector?

What does it mean for the future of
fisheries/aquaculture management?

U.S. Per Capita Consumption of Red Meat, Poultry, and Fish and Shellfish, 1909-2006



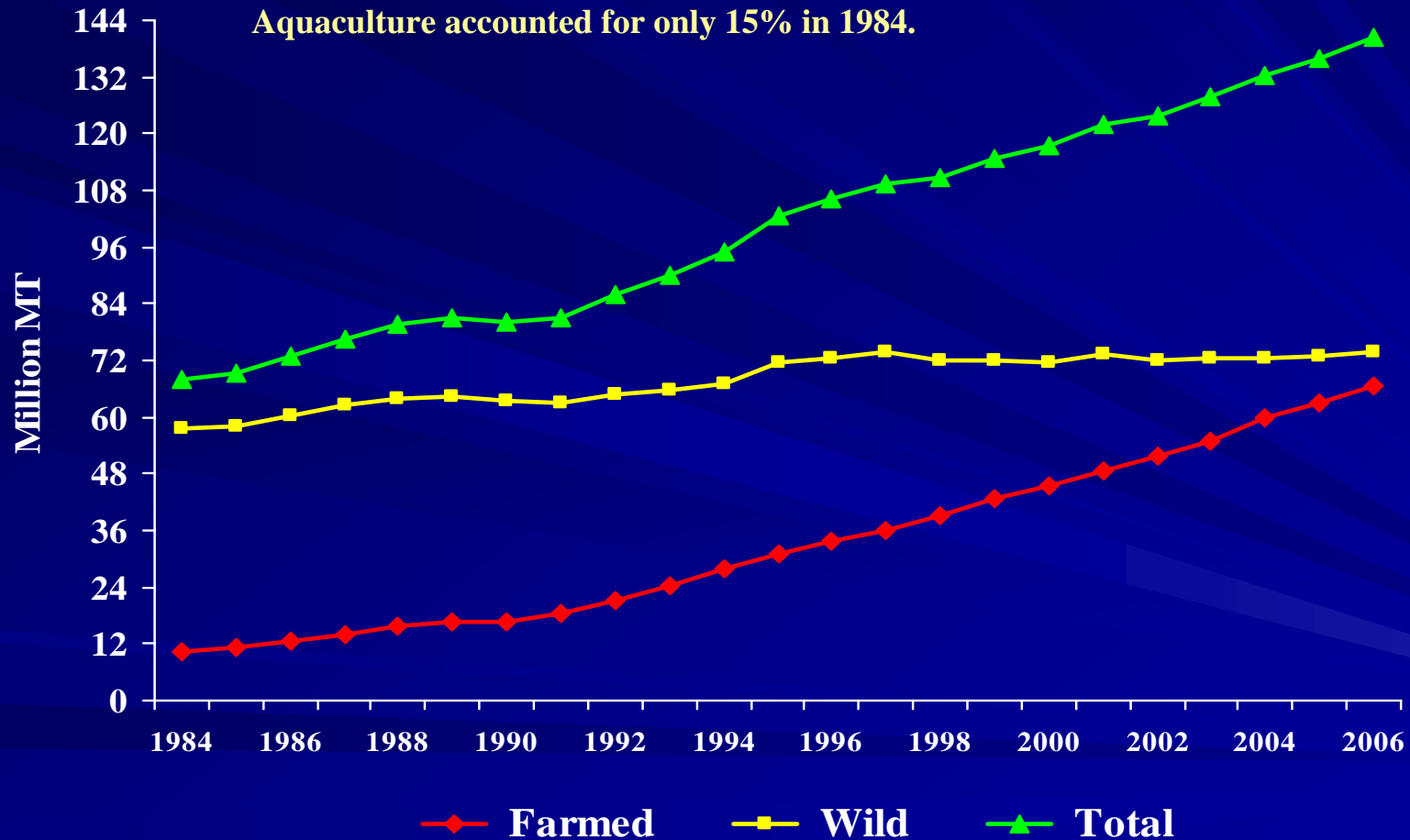
Source: USDA/Economic Research Service.

*2004-2006 Red Meat and Poultry data are forecasts.

Approximate World Production of “Food” Fish and Seaweeds

Aquaculture accounted for 47% of world food fish production in 2006.

Aquaculture accounted for only 15% in 1984.



Source: FISHSTAT (2008).

To develop expectations about the future of the seafood sector, we must consider aquaculture and fisheries interact?

In the ecosystem?

In the market ?

Aquaculture and Fisheries: Ecosystem

- Use of wild fish for inputs
- Disease transmission and related interactions
- Intentional releases or unintentional escapes
- Use or enhancement of habitat

The growth of aquaculture influences fisheries through its use of wild fish as inputs

- Feed
 - Small pelagics for fishmeal and fish oil
- Wild-Based Aquaculture
 - Tuna
 - Post-larval shrimp
 - Eel
 - Grouper
 - Mussel
- Broodstock
 - Salmon (in past)
 - Shrimp (mostly in past)

A Note on “The Feed Issue”

Using fish to feed fish is “unsustainable” (ex. salmon, shrimp farming)

- Growth of aquaculture farming will exhaust the fishmeal and fish oil supply and cause overfishing
 - This is a fisheries management/governance problem
 - not an aquaculture problem

Reality

- The majority of fishmeal is used by poultry and pigs
- Increasing relative price of fishmeal & fish oil
 - Provides economic incentives for innovation
 - Improving feed conversion ratios, new feed formulations/substitutes, new species

Aquaculture and Disease

Example:

- Parasite, *B. ostreae*, was introduced (probably) into France in oysters imported from California which originated from the NMFS Aquaculture Lab in CT

40

NONNATIVE OYSTERS IN THE CHESAPEAKE BAY

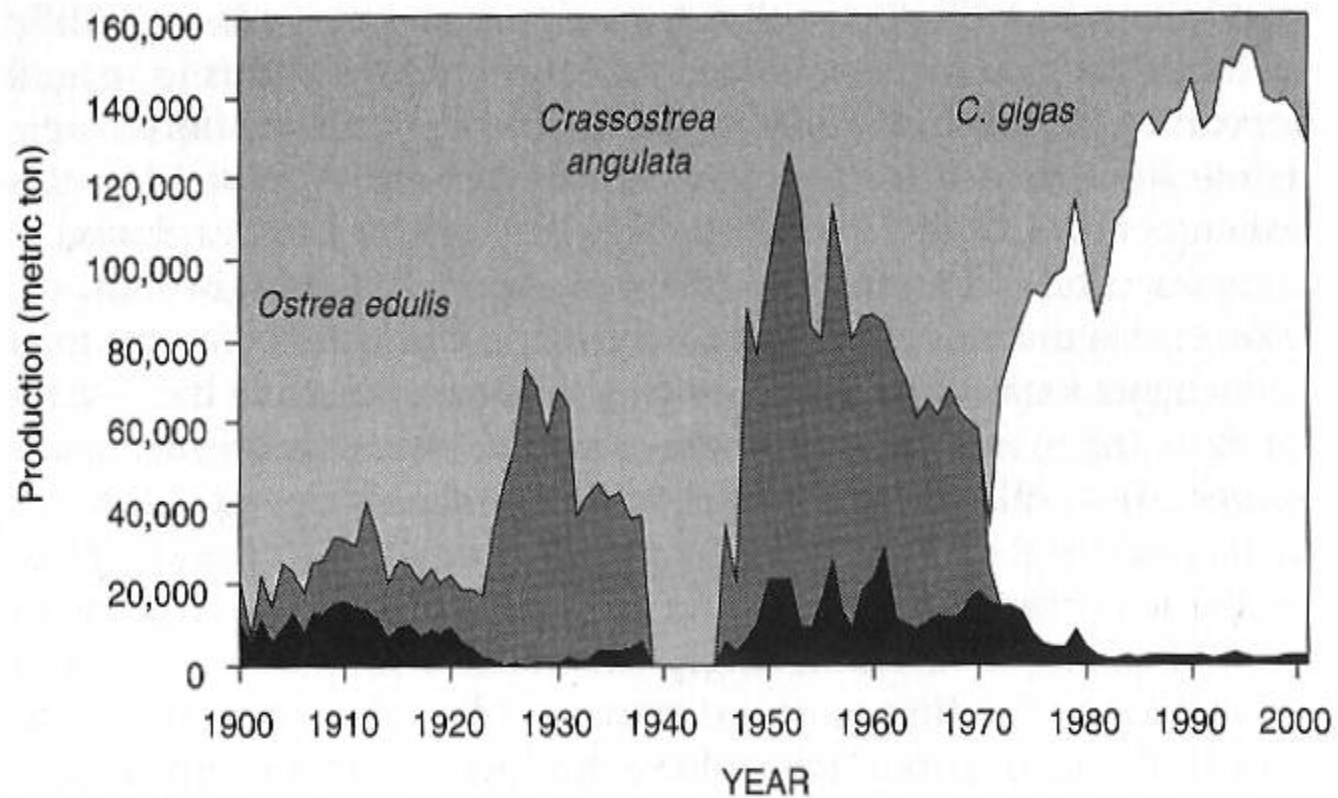


FIGURE 3.2 French oyster landings
SOURCE: Modified from Goulletquer and Héral (1997).

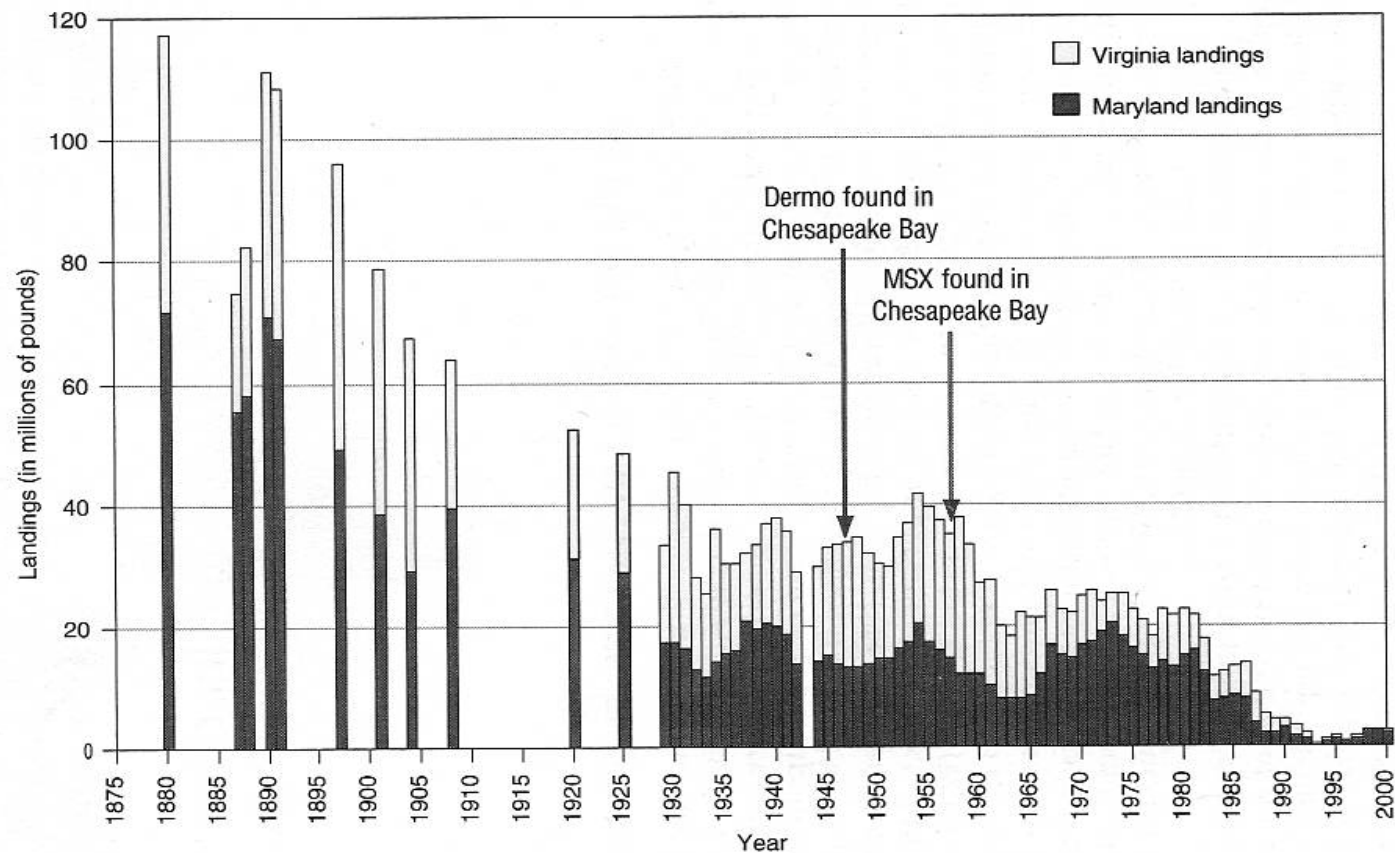


FIGURE 2.1 History of commercial oyster landings in the Chesapeake Bay.

SOURCES: Data from Chesapeake Bay Program, <http://www.chesapeakebay.net/data/historicaldb/livingresourcesmain.htm>; National Marine Fisheries Service, http://www.st.nmfs.gov/st1/commercial/landings/annual_landings.html

Chesapeake Bay Oyster “Fishery” Management Options

- Replenish/Restore oyster habitat = Aquaculture
- Oyster sanctuaries (fallow fields) = Aquaculture
- Introduce disease resistant native oysters = Aquaculture
- Introduce triploid native oysters that grow fast enough to harvest before they get disease = Aquaculture
- Introduce triploid Asian *C. ariakensis* oysters = Aquaculture
- Introduce diploid Asian *C. ariakensis* oysters = Aquaculture

Traditional Fisheries Management is Largely Irrelevant!

Introduction of a Nonnative Species

May become invasive but it may help save or create an industry

Introduction of **Asian Oyster** in France and West Coast US – saved/created an industry

Introduction of **White Shrimp** from S. America to Asia – reduced cost

Introduction of **Salmon** to Chile, Australia and New Zealand – created an industry

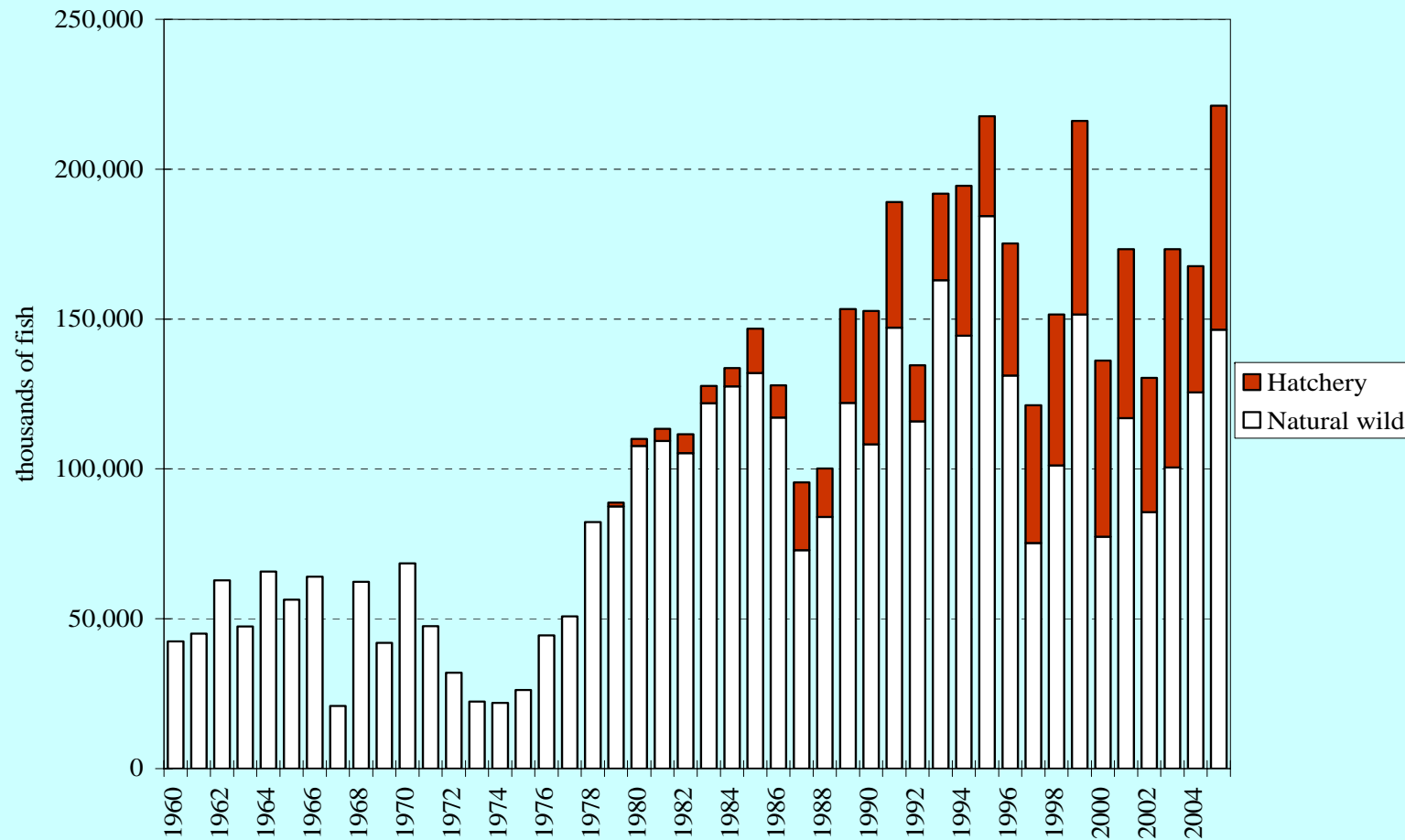
Introduction of **Channel Catfish** from the US to China – created an industry

Introduction of **Tilapia** from Africa to Everywhere – created industries/became invasive some places

Aquaculture (Hatchery)-Based Fisheries

- Can result in increased harvest - so fishermen like it, but.....
- It is inefficient
- In some cases it has resulted in large production of lower-valued species (ex. AK chum and pink; Japan chum; Russia pink and chum)
- Problems with genetic diversity and integrity of wild stocks

Alaska Commercial Salmon Catches Since 1960: Natural Wild Salmon and Hatchery Salmon

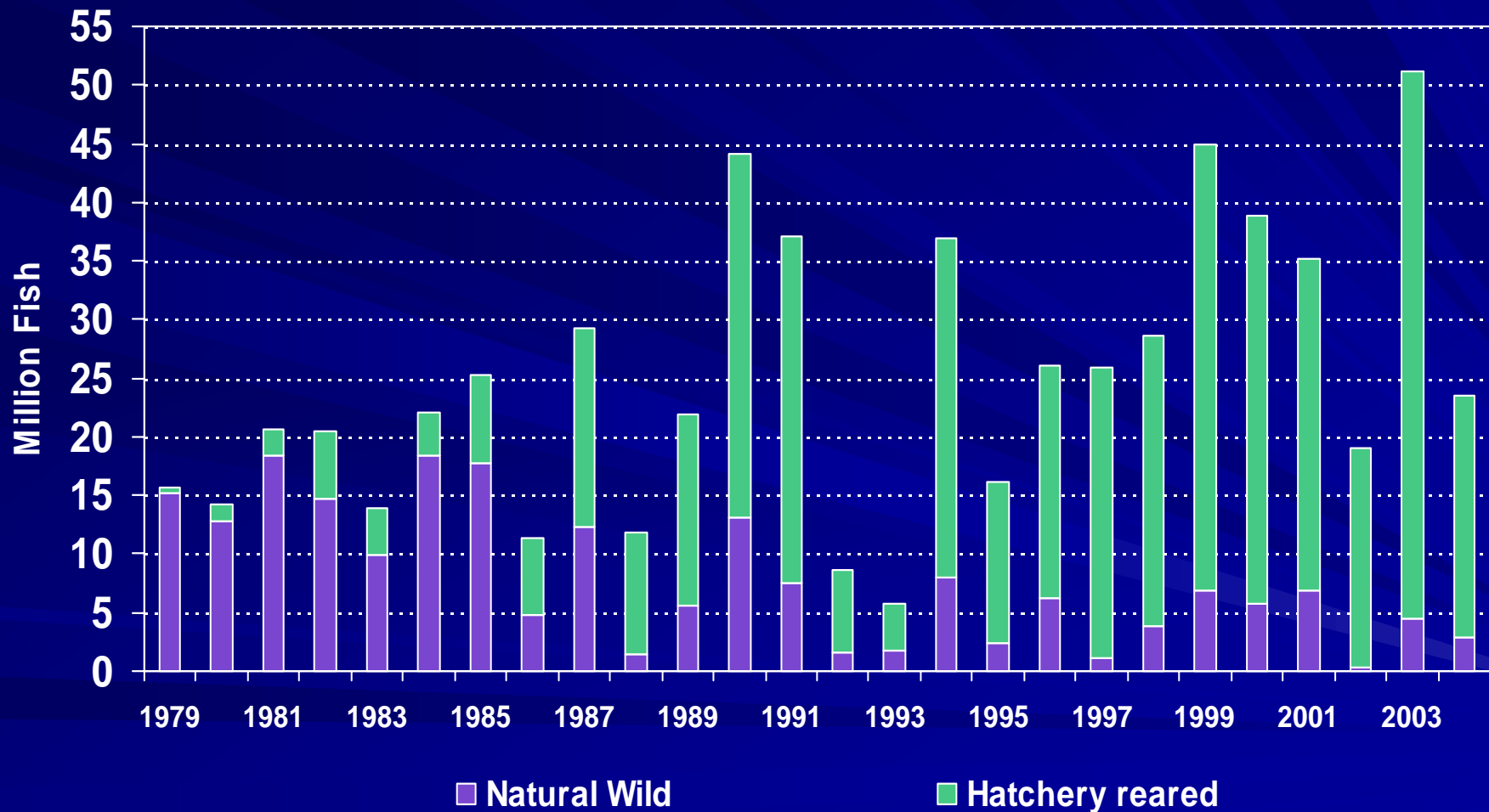


Source: Data for 1960-1978: ADF&G Catch Data; Data for 1979-2005:
ADF&G Hatchery Data

Aquaculture (Hatchery)-Based Fisheries: Integrity of wild stocks

- Hatchery fish do not face the same selective pressure as wild stocks
- Hatchery releases can displace wild stocks and compete for food and habitat

Historical Hatchery Contribution to Total Commercial Harvest of Pink Salmon Prince William Sound, Alaska



Source: Prince William Sound Annual Management Reports, ADF&G (2007, 2006).

Aquaculture and Habitat

Negative for wild fish stocks

- Shrimp farms in the estuary - mangrove
- Excessive finfish cage culture and pollution

Positive for wild fish stocks

- Oyster reef building
- Rotational Management of Scallops (like forestry) – creates marine protected areas (fallow fields)

Aquaculture and fisheries interact in the ecosystem.

Aquaculture is a fisheries management option.

Very little economic research has been done to evaluate the interactions.

Aquaculture and Fisheries: International Trade and the Market

Aquaculture has had a Tremendous Influence on Fisheries through International Trade and the Market

- Increased supply has influenced prices
 - Influenced effort in some fisheries (ex. salmon)
- Changed consumer behavior and developed new markets (ex. catfish)
- Accelerated globalization (ex. shrimp, tilapia, salmon)
 - Reaction more trade barriers
- Increased concentration and vertical integration (ex. salmon)
- New product forms and improved quality and consistency (ex. tilapia, salmon)
- Forward thinking and market driven (ex. salmon, oysters)
- Improved stability and reduce uncertainty (ex. salmon)

Growing Market Share and Product Innovation

- Consistently Available
- Consistent Quality
- Stable or Declining Cost
- Meet Consumer Demands

US Seafood Consumption is Concentrating in Fewer Species

Edible kg per Capita

1987				2006				% change
71%	1	Tuna	1.59	90%	Shrimp	2.00	+92	
	2	Shrimp	1.04		Tuna	1.32	-17	
	3	Cod	0.76		Salmon	0.92	+359	
	4	AK Pollock	0.40		AK Pollock	0.74	+86	
	5	Flatfish	0.33		Tilapia	0.45	N/A	
	6	Clams	0.30		Catfish	0.44	+63	
	7	Catfish	0.27		Crab	0.30	+101	
	8	Salmon	0.20		Cod	0.23	-70	
	9	Crab	0.15		Clams	0.20	-33	
	10	Scallops	0.15		Scallops	0.14	-8	
	Other	2.16		Other	0.75	-65		
	Total	7.35		Total	7.48	+2		

Source: NFI (2008).

U.S. Retail Sales, 1994 vs. 2007

Source: *Seafood Business*

Best Sellers (Seafood Case)

	1994	2007
1	Shrimp	Shrimp
2	Salmon	Salmon
3	Pollock, Cod, Haddock	Crab
4	Catfish	Tilapia
5	Flounder	Catfish

Sources: Perkins, C. (1994) and Robinson, P. (2008)

Large Retailer and Chain Restaurant Demands have:

- Encouraged vertical and horizontal integration
- Stimulated globalization
- Encouraging various certification programs – Sustainability and Safety
 - Farmed Salmon
 - Wild Salmon
 - Shrimp
 - Alaska Pollock

Note on Selling Sustainability and Health to US Consumers

- Sustainability and Safety are essentially required esp. now that companies like WalMart and Darden Restaurants are involved
- Healthfulness is important but secondary to the US consumer – We are Fat!
- Priorities for the Bulk of Real Consumers (not Green Peace members, Gourmets, pregnant mothers or movie stars)
 - Convenience
 - Taste
 - Price
 - Perceived Value

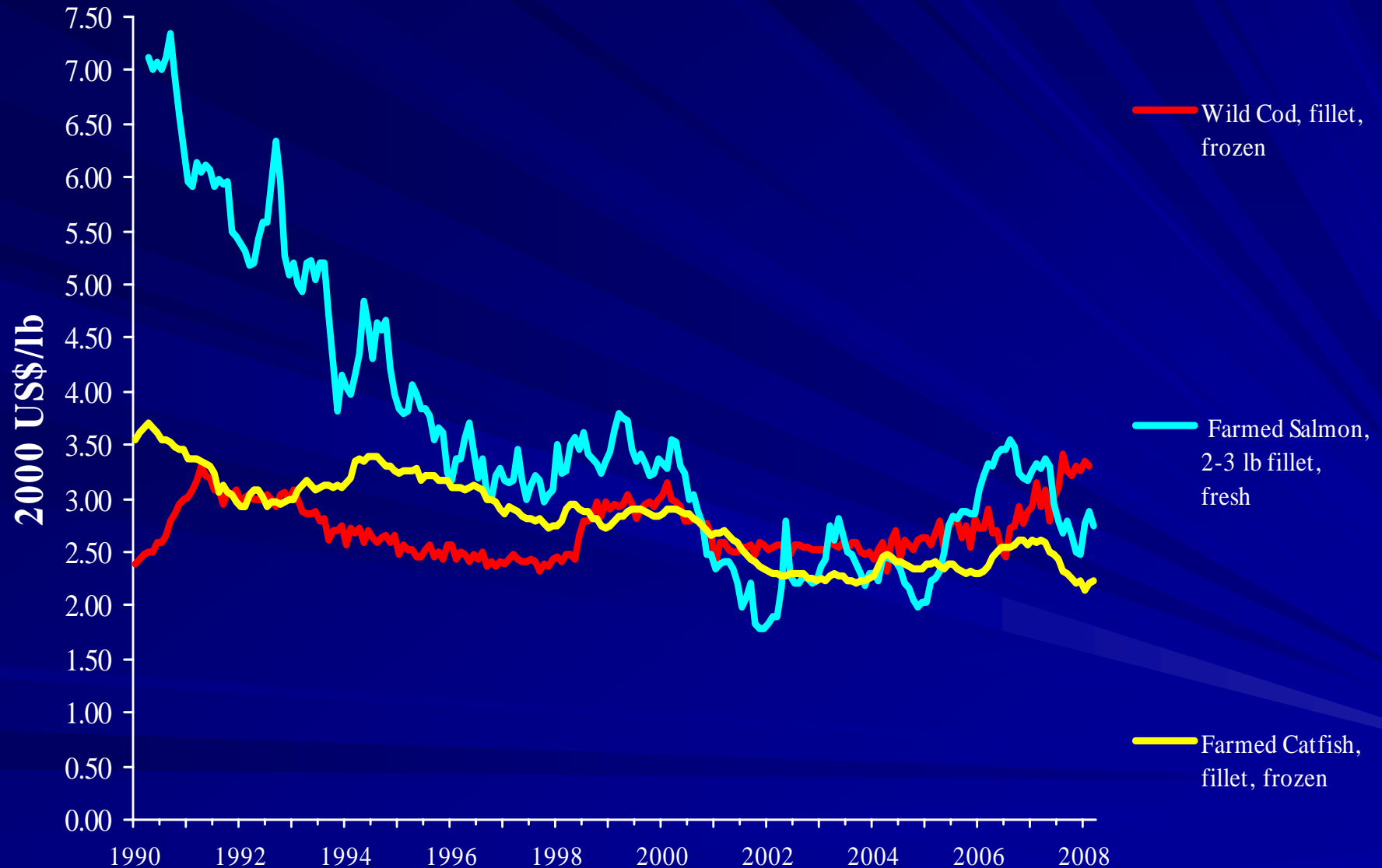


Photo: Jingjie Chu



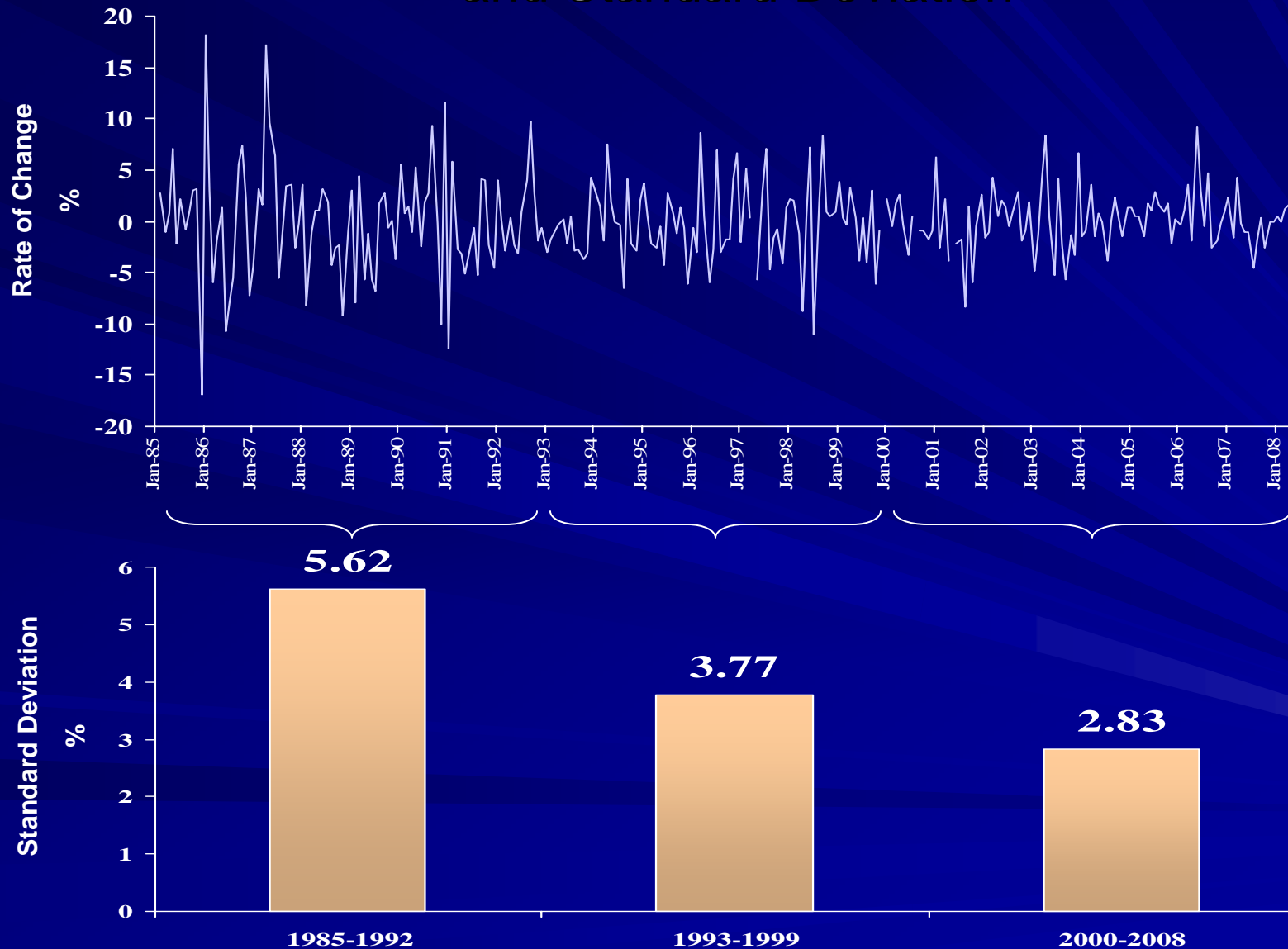
Photo: Jingjie Chu

Real Price Trends of Seafood



Sources: USDA, 1990-2008; Urner-Barry Publications, 1990- 2008; USDC/NMFS, 1990-2008.

US Fresh Atlantic Dressed Imports – Price Monthly Percentage Rate of Change and Standard Deviation



Cost Share: Aquaculture vs. Fishery

Item	Aquaculture	Fishery
Labor	4-10%	25-45%
Maintenance	2-4%	9-23%
Fuel	1-4%	4-11%
Fingerlings	2-15%	—
Feed	40-60%	—

Cost Factors Influencing Competitiveness

Aquaculture

- Biotechnology
- Disease Management
- Feed Cost/ Quality
- Consolidation/
Restructuring
- Farm Management
- Regulations

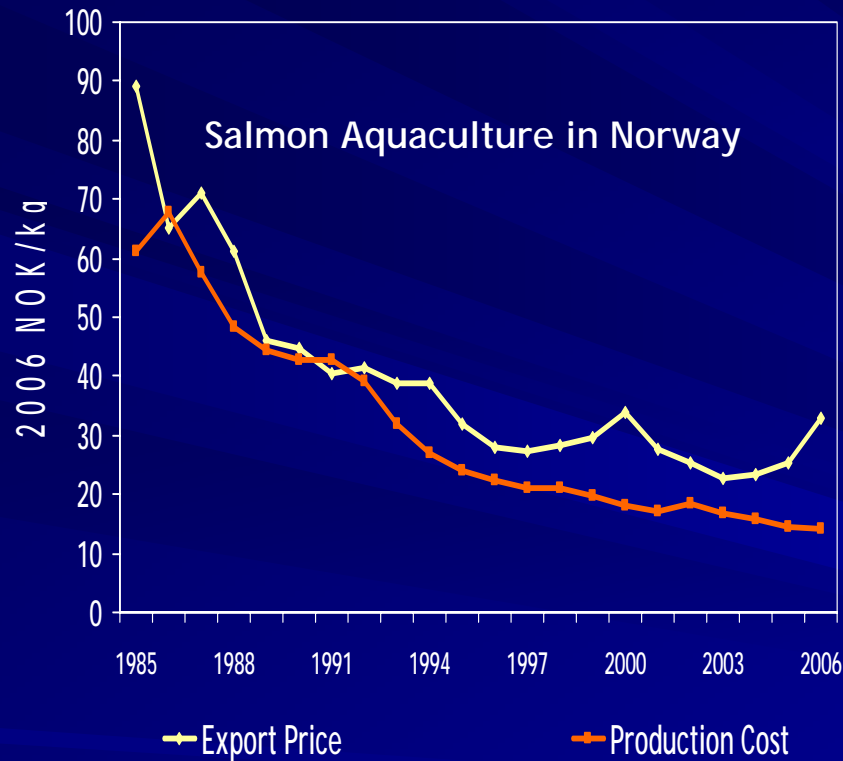
Fishery

- Fisheries Governance
- Fish Stock
- Environment
- Crew-share
Arrangements
- Maintenance/Repair

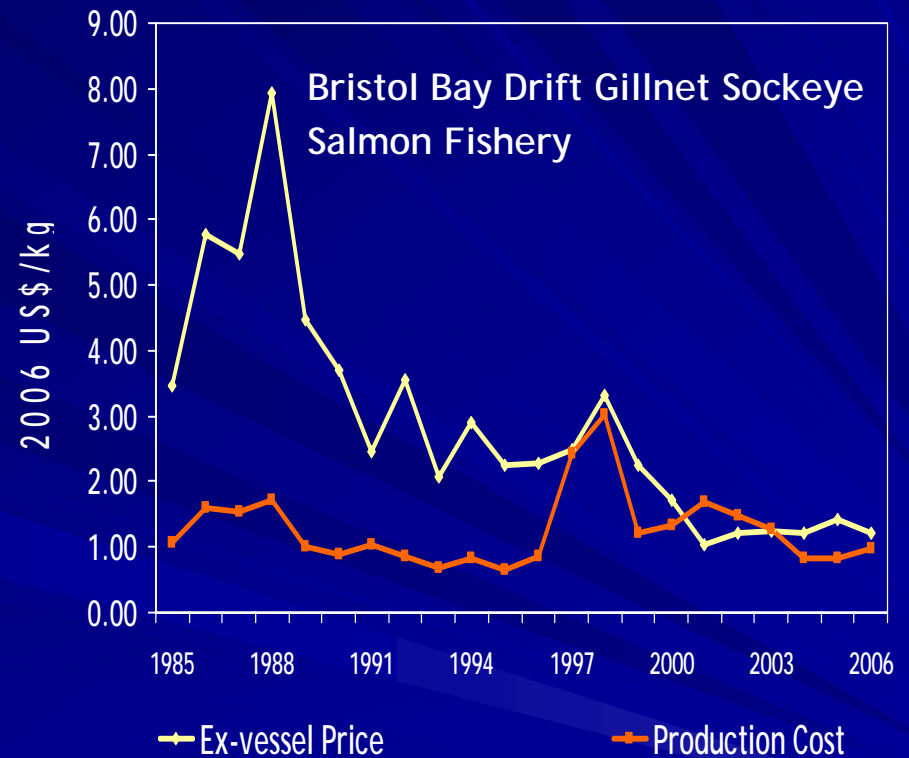
“Technical Progress has been Futile”

Rolf Willmann, FAO, Loss in Resource Rents Session,
IIFET 2008

Production Cost: Salmon Aquaculture vs. Capture Fisheries



Sources: Norwegian Directorate of Fisheries (2005); Guttormsen (2007).



Sources: ADF&G (2007); Valderrama (2008).

Norway: Salmon Farming



Photos: J.L. Anderson

Wild Salmon Fishery

MSC Certified
Sustainable Alaska
Sockeye Fishery

*Alaska's Bristol Bay drift gillnet salmon
fishery -2005.
(Photograph by Bart Eaton, Source:
Gunnar Knapp)*

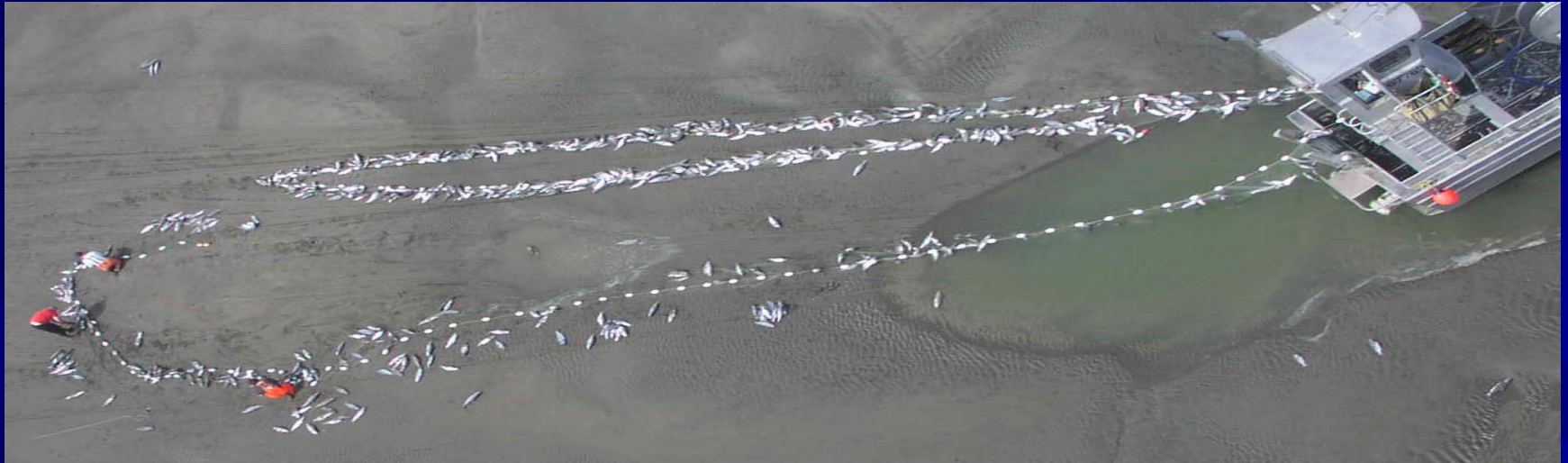


Norway: Salmon Processing



Photos: J.L. Anderson

Alaska Salmon Handling

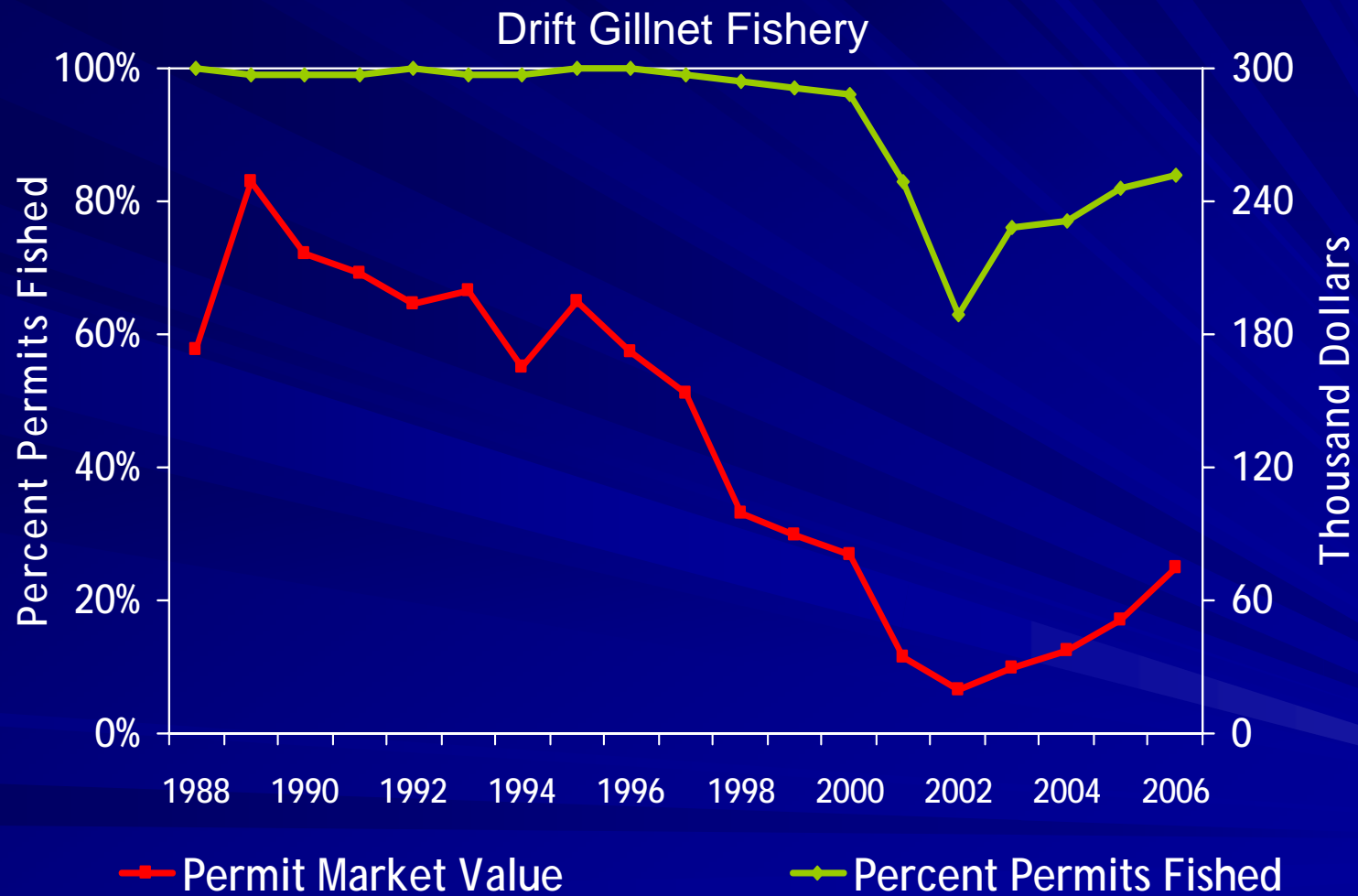


*Sockeye salmon in a
Bristol Bay gillnet
at low tide —Source
G. Knapp*



*Internal bruises in a wild
chum salmon fillet -Source
G. Knapp*

Permit Market Value and Percent of Permits Fished in the Bristol Bay Sockeye Fishery



Source: CFEC (2007).

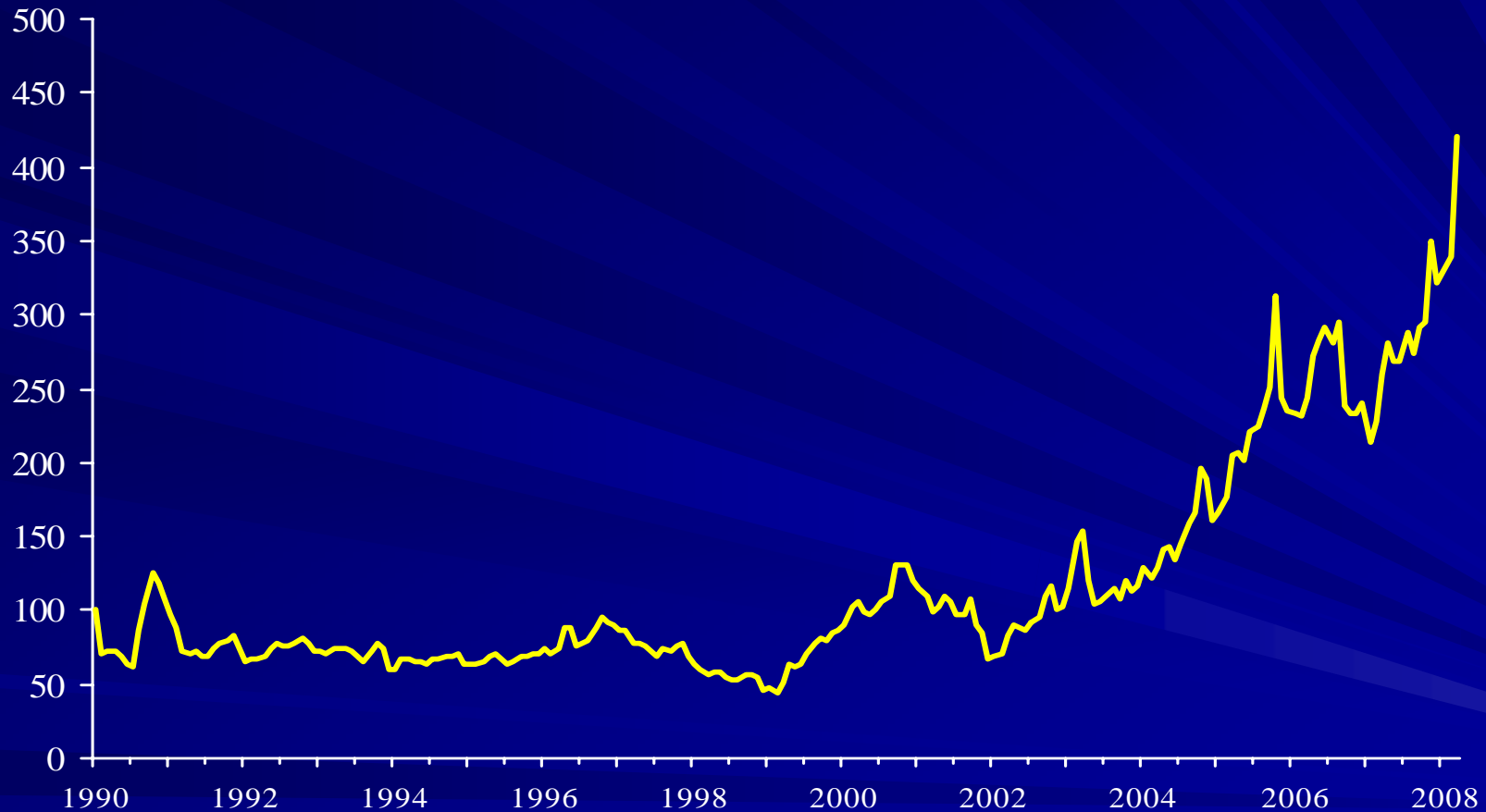
- Competition with farmed salmon has increased efficiency through reduction of effort
 - Bristol Bay Salmon, Alaska

- Competition with farmed salmon has increased efficiency through attempts to restructure the fleet
 - Chignik Salmon Coop., Alaska

The Aquaculture Sector Creates New Markets

- Salmon Farmers created new markets in southern US
- Farmed Salmon created new markets premium wild salmon
- New Products – Pin-Bone-Out Salmon Fillet
- New markets are all being developed by aquaculturists: ex. sturgeon, barramundi, tilapia, basa, oysters, cobia, mussels and many other species

Diesel Fuel: Producer Price Index 1990 = 100



Source: U.S. Bureau of Labor Statistics (2008).

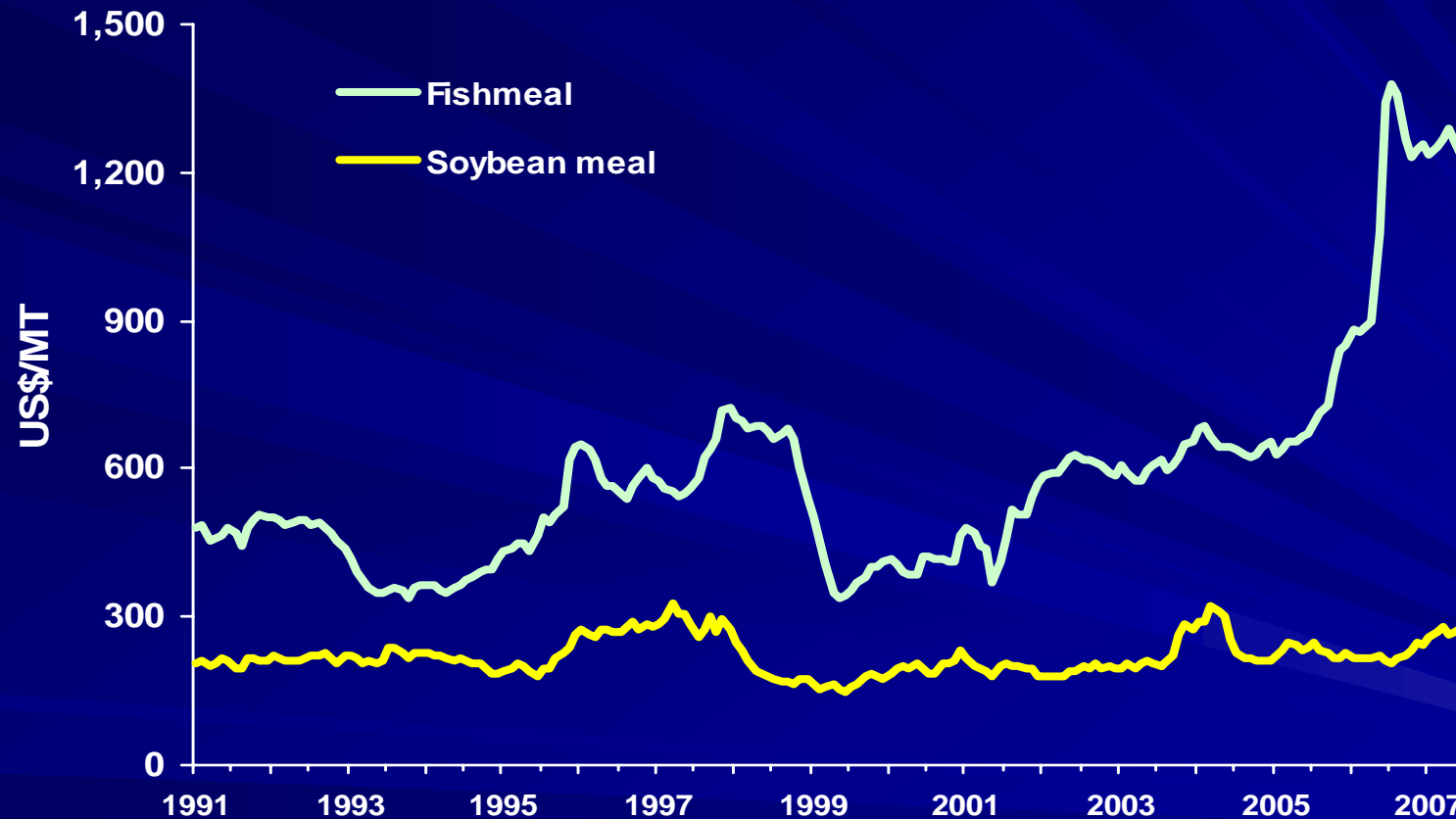
Implications of Rising Fuel Cost

Stronger competitive position of farmed fish
and shellfish

over:

Wild-caught seafood

Fishmeal and Soybean Prices



Fishmeal: 64/65%, any origin, wholesale, CIF Hamburg.

Soybean meal: 44%, any origin, CIF Rotterdam/Hamburg.

Source: Oil World / GLOBEFISH (2007).

Implications of Rising Feed Cost

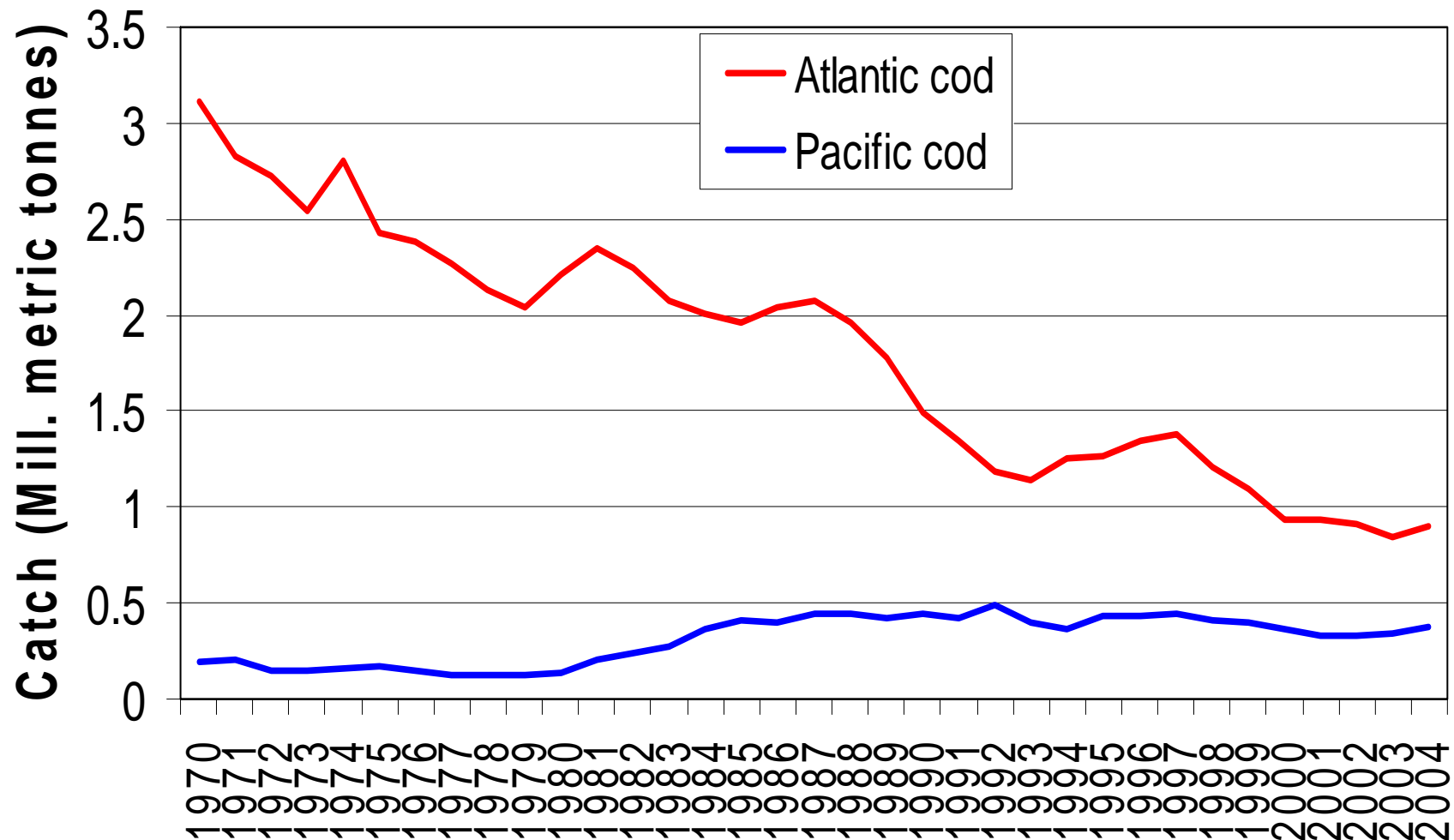
Stronger competitive position of farmed
shellfish (clams, oyster, mussels, scallops)

compared to:

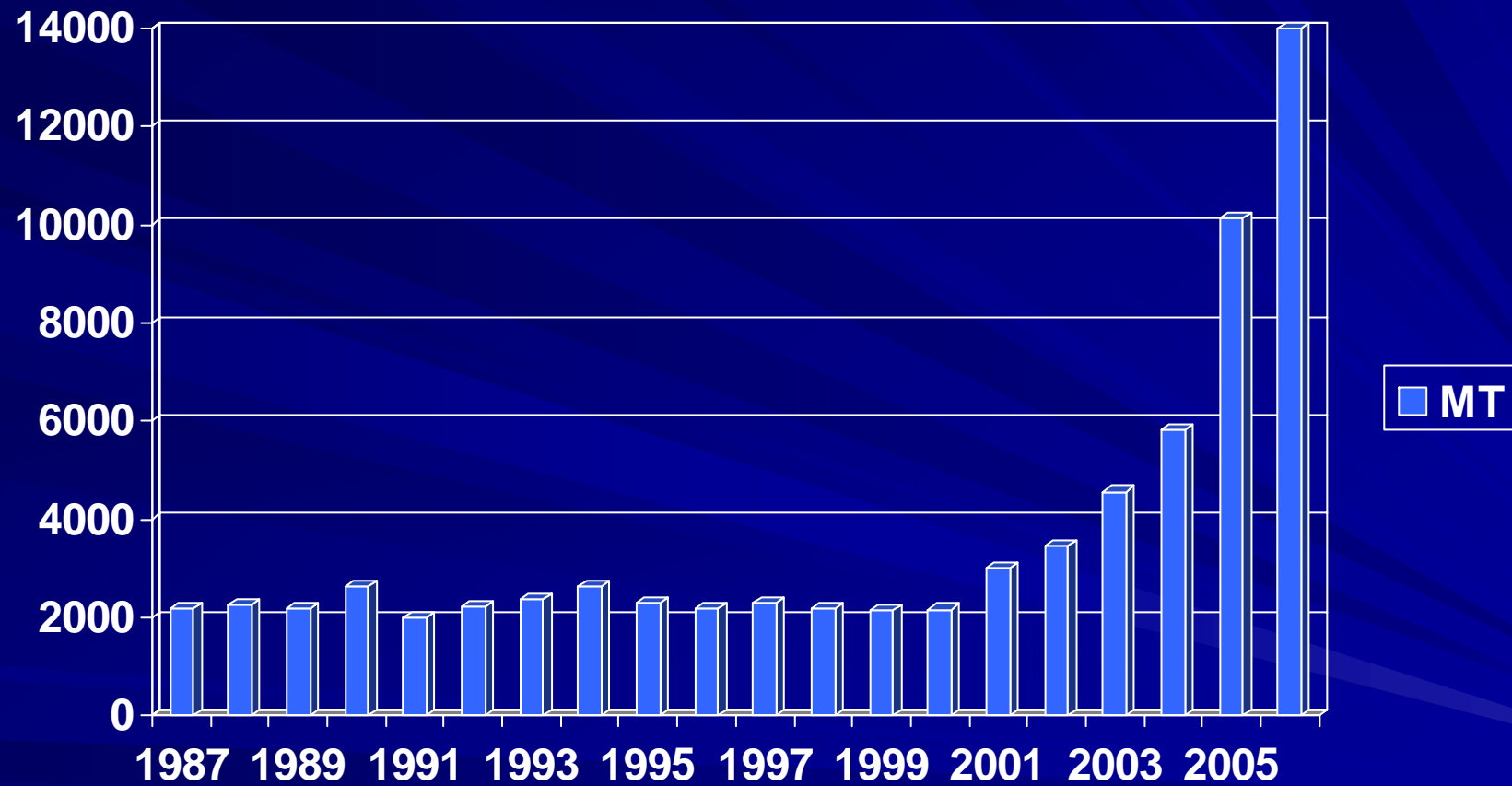
Farmed Finfish and Shrimp

Beef, Pork and Chicken

Global Cod Fisheries – A Stimulus for Aquaculture

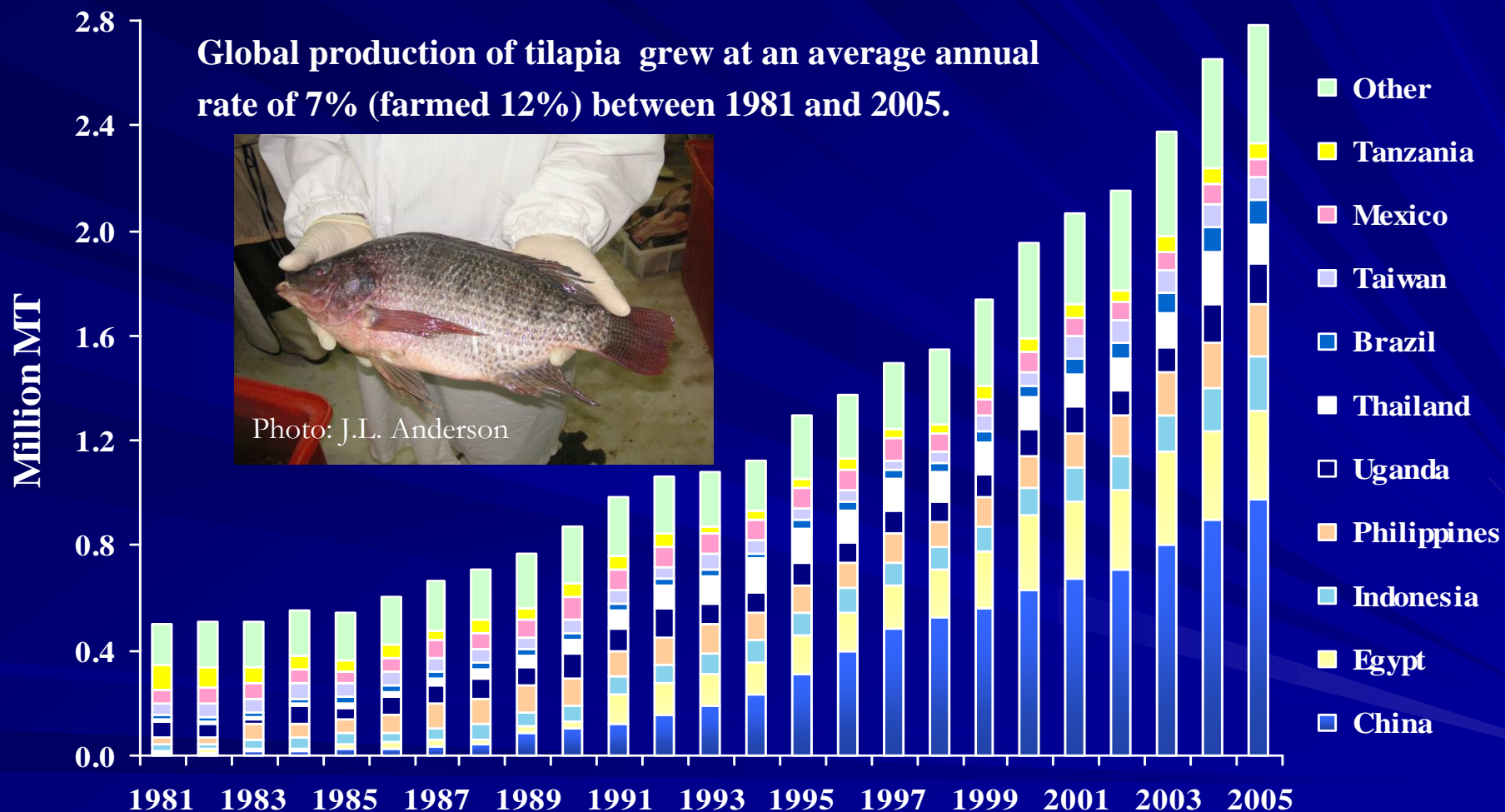


Farmed Atlantic Cod



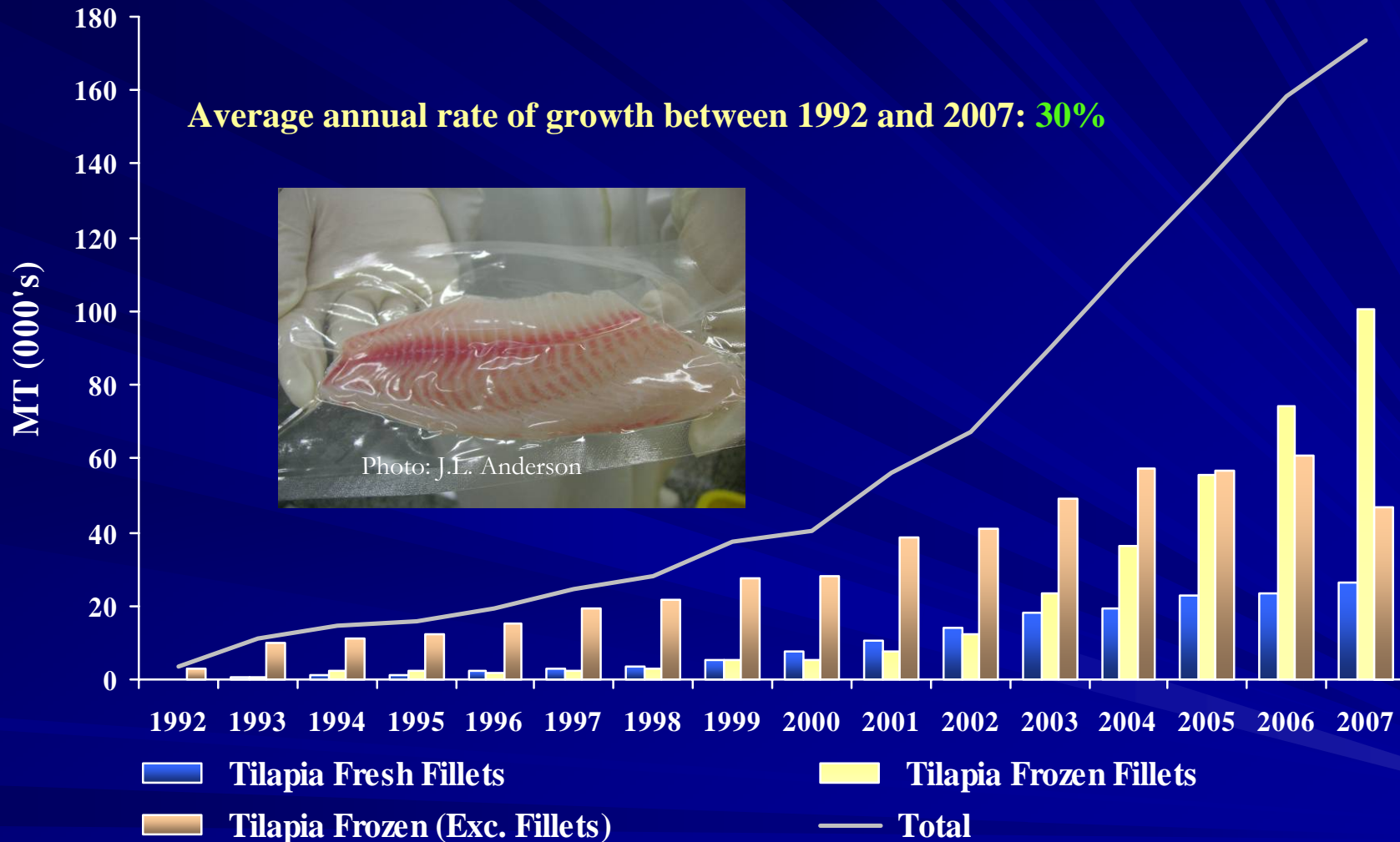
World Tilapia Production

Global production of tilapia grew at an average annual rate of 7% (farmed 12%) between 1981 and 2005.



Source: FISHSTAT (2007).

US Imports of Tilapia



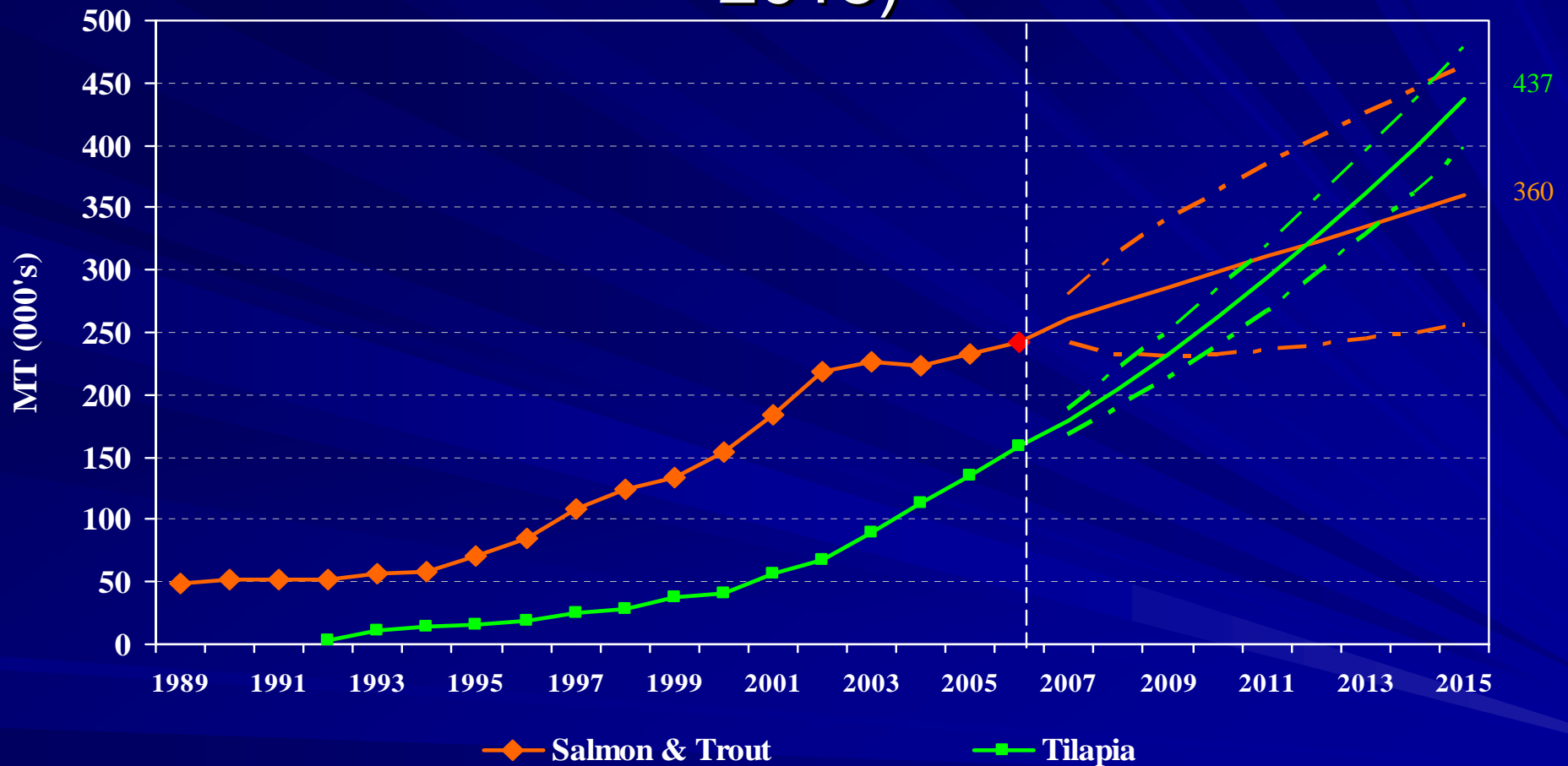
Source: USDC/NMFS (2008).

Tilapia Market

- Very rapid growth
- Competition for flatfish, snapper and other whitefish
- Fillets – Market innovation
- Many environmental NGOs are positive about tilapia
- Increase globalization
- Wal-Mart



U.S. Imports of Salmon vs. Tilapia Actual (1989-2006) and Forecast (2007- 2015)



Source: USDC (2006); Seafood Market Analyst, SeafoodReport.com, U.S. Department of Commerce

Upper and lower bounds represent 95% confidence intervals

Expect Continued Rapid Growth

Rough Est. 2006

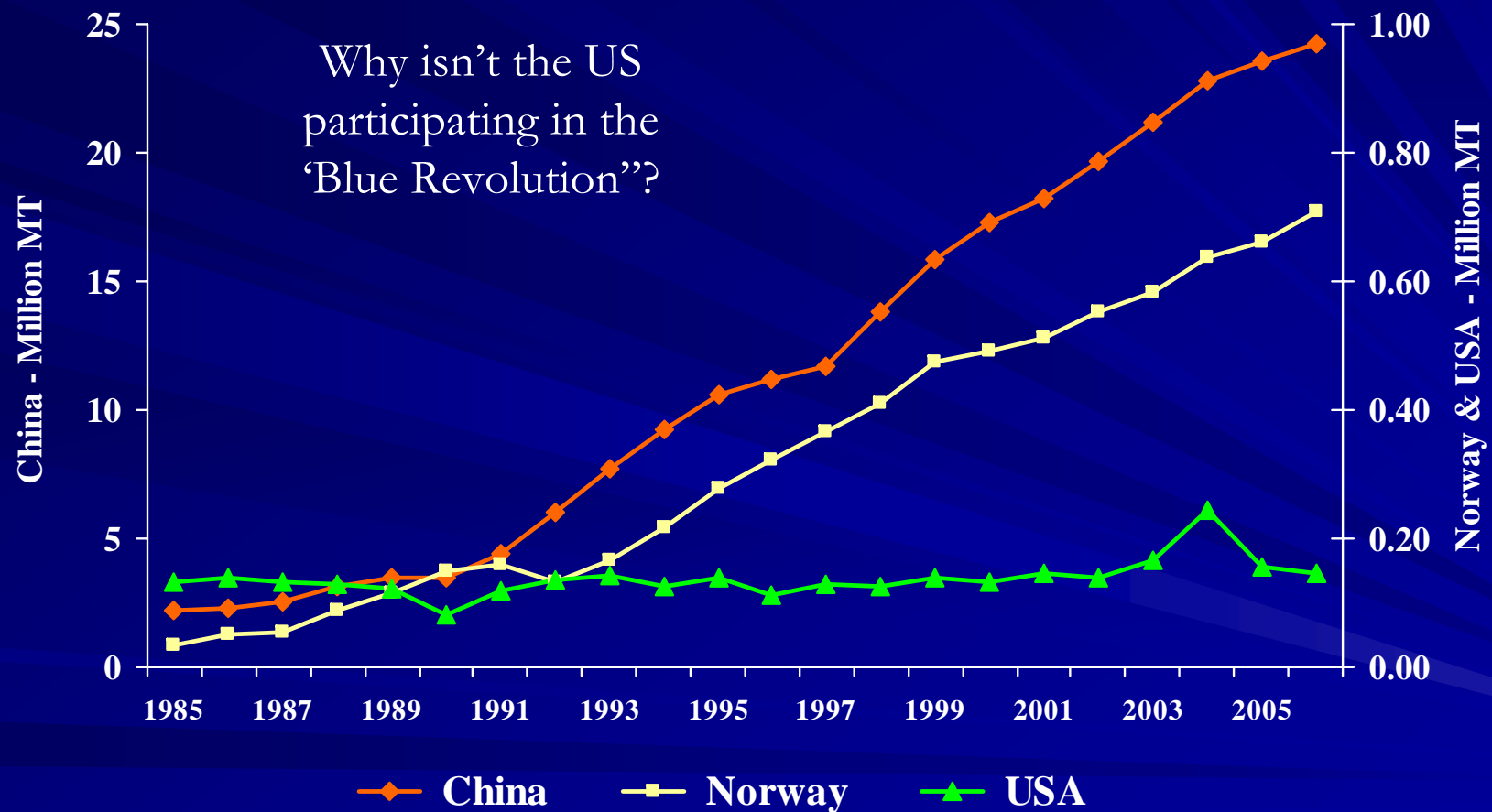
- Tilapia – 2.8 million MT
- Pangasius – over 500,000 MT
- Channel Catfish – over 400,000 MT
- Flatfish – 140,000 MT
- Barramundi – 35,000 MT
- Cod – 15,000 MT
- Cobia - ?

Blue Revolution?

With all this technological change, one might expect countries that think they are adaptive and entrepreneurial - like the US – to be leaders

Maybe Not
Times are Changing

Marine/Coastal Aquaculture Production in China, Norway, and the U.S.



Source: FISHSTAT (2008).

Fisheries Management -

“The integrated process of information gathering, analysis, planning, decision-making, allocation of resources and formulation and enforcement of fishery regulations by which the fishery

management authority **controls** the
present and future behavior of
interested parties in the fisheries,

in order to ensure the continued productivity of the living resources.” (FAO 1999).

The difference between traditional fisheries management and “aquaculture” management boils down to:

Who is in CONTROL
What is being CONTROLLED

- Traditional fisheries management
 - **Governing institutions CONTROL individual or group behavior** – but not the aquatic organism
- Aquaculture
 - **The individual or group, CONTROLS the production, harvest and marketing of the aquatic organism** - the individual or group receives rights for CONTROL from by the governing institution



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	Typical Fishery Management	“Aquaculturalized” Management
	Regulated Access Management Institutions CONTROL participants	Rights & Responsibility Based Management Institutions transfer CONTROL to participants
Wild ‘Fishery’ Sector	Rent Dissipation, High transaction cost – ex. many fisheries	Positive rents - ex. NZ Fisheries
‘Aquaculture’ Sector	Rent Dissipation, High transaction cost - ex. US Marine Aquaculture	Positive rents - ex. Norway Salmon Farming
Bureaucracy, Police & Non-Government Special Interest	Bureaucracy is large Regulatory costs are very high Special Interests greater influence	Bureaucracy stable or limited Regulatory costs relatively low Special Interests reduced influence

“Aquaculturization” of Fisheries - Taking Control

- Assign Ownership Rights
 - Individual or community fisheries quota
 - Cooperative area management fisheries
- Plant the Field / Breed the Animals:
 - Salmon hatcheries (nearly 40% of AK harvest originates in hatcheries)
 - Oyster/scallop enhancement
- Crop and Forest Rotation
 - Rotational Scallop Fisheries
- Fallow Fields/Range Management
 - Marine Reserves/Sanctuaries
- Land/Habitat Restoration
 - Rebuild Oyster Beds
 - Remove dams
 - Artificial Reefs
- Feed/Fertilize
 - Maine Lobsters get ~ 80% of the feed from bait
 - Capture-Based Aquaculture - Bluefin Tuna farming
- Control Predators/Provide Protection
 - Lobster pots
 - Harvest starfish in oyster beds
- Eliminate Costless Access (Cattle Rustlers)
 - Eliminate unregulated open access

Marine Aquaculture

- **Norway** — Well defined Rights and Responsibilities
- **China** — Late 1970s Rural Reforms and rapid market liberalization — trend toward shifting more responsibility from the government to individuals
- **US** — Moving toward more government oversight in aquaculture
 - Costly, time consuming, fragmented and uncertain regulation
 - Multiple agencies at all levels — local, state and federal
 - Fishery management regulations imposed on aquaculture
 - Don't even have enabling legislation to regulate offshore aquaculture in federal waters !

Note on China



Photo: Jingjie Chu



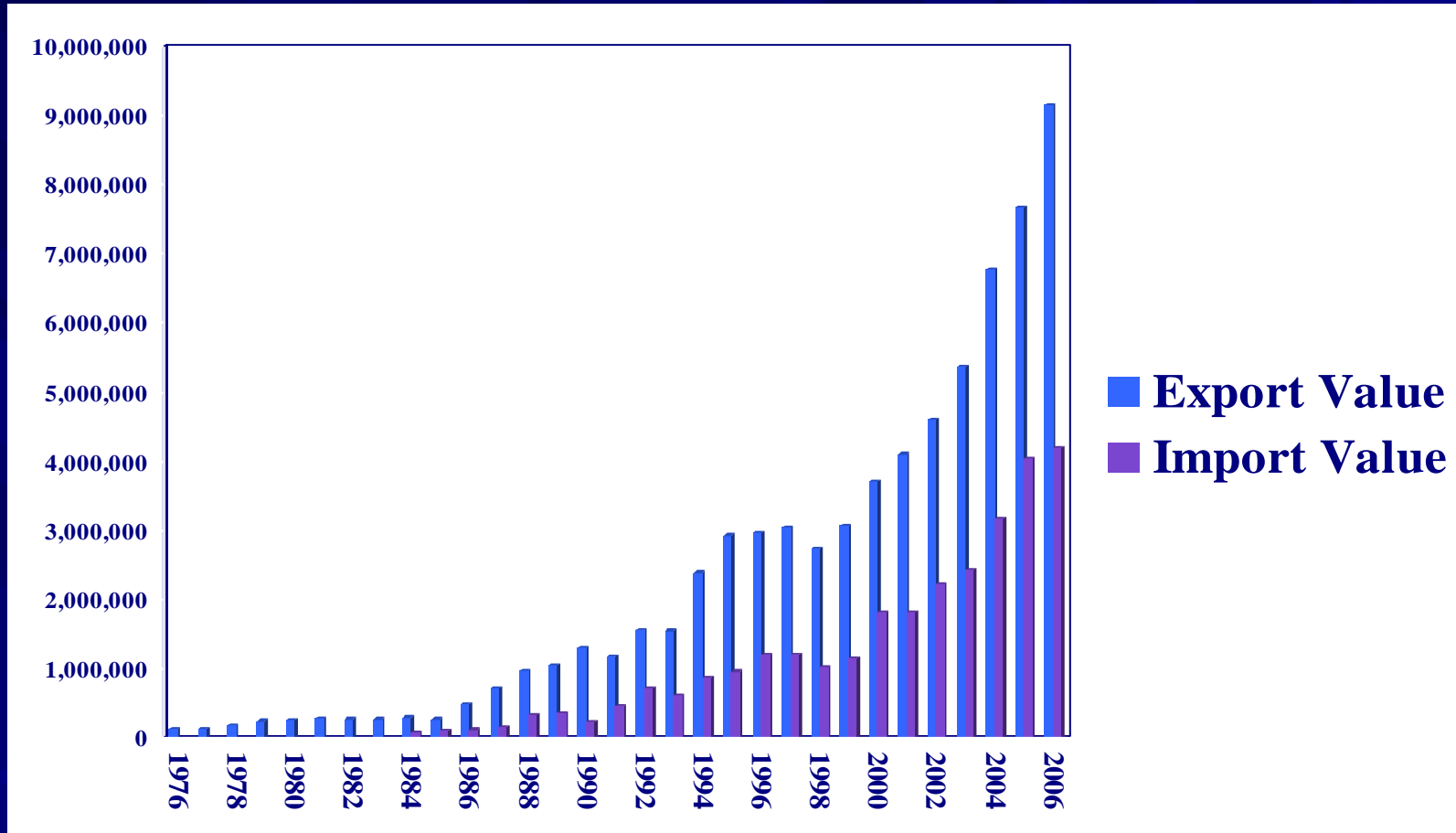
Photo: Jingjie Chu



Photo: J.L. Anderson

China: International Seafood Trade

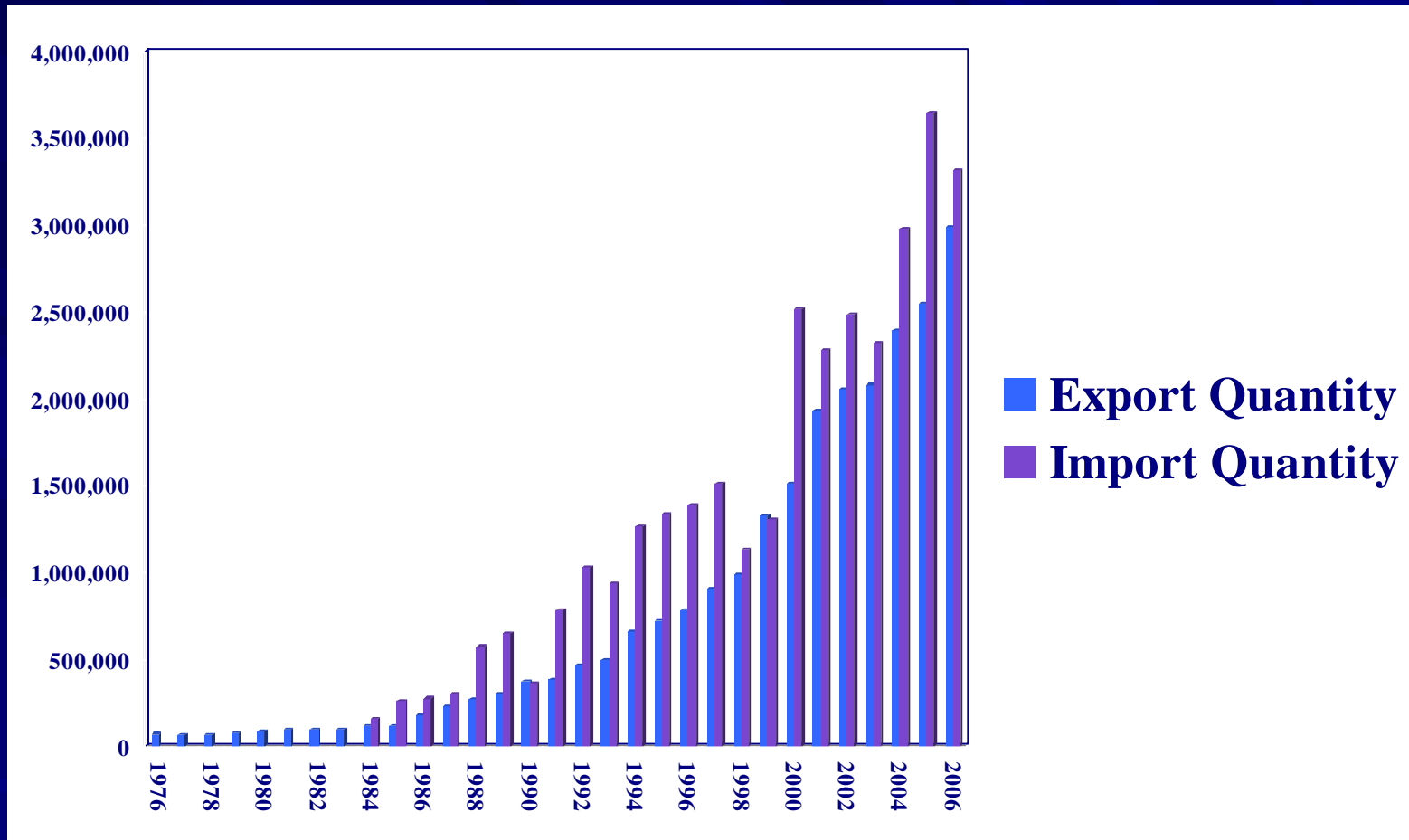
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China: **#1** Seafood Exporter **#6** Seafood Importer

Source: FishStat, FAO 2008

China: International Seafood Trade (MT)



China: **#1** Seafood Exporter **#1** Seafood Importer

Source: FishStat, FAO 2008

US Imports from China: 2007

(Source: NMFS 2008)

- **Breaded Shrimp - #1** (Thailand #2)
- **Squid - #1** (Thailand #2)
- **Scallops - #1** (Canada #2)
- **Tilapia - #1** (Ecuador #2)
- **Alaska Pollock - #1** (South Korea #2)
- **Flatfish Fillets - #1** (Canada #2)
- **Cod Fillets - #1** (Iceland #2)

2006: Total - #1 in Quantity.. #3 in Value (Canada #1)

US Exports to China:2007

(Source: NMFS 2008)

- **Salmon - #1** (Canada #2)
- **Flatfish - #1** (Canada #2)
- **Groundfish - #1** (Germany #2)
- **Frozen - #1** (Japan #2)
- **Total - #1 Quantity: #3 Value**
(Japan #2 Quantity: # 1 Value)

Conclusion

- Aquaculture grows because managed fisheries have failed to meet market demands
- Aquaculture will dominate and lead the seafood industry
- Aquaculture is forcing change in fisheries:
 - Through competition (supply)
 - By developing new technology (hatchery-based fisheries)
 - By example (marketing & quality control)
 - By creating new demand – both for inputs and outputs
- Control of cost and marketing is essential for growth

Conclusion

In the Long Run

All significant commercial Seafood supplies will come from three sources:

- Fish Farms/Aquaculture
 - Aquaculture-Enhanced Fisheries
 - Fisheries that adopt systems of management that are more like “aquaculture” management
 - clearly define rights and responsibilities
 - incorporate principles of husbandry, range management, forestry and farming
 - More market and quality driven
- Fisheries that do not will be marginalized or driven into niches

A photograph of a harbor scene. In the foreground, several fishing boats are docked at a wooden pier. One boat is white with a teal hull, and another is yellow. In the background, numerous salmon pens (cages) are visible in the water, stretching towards a forested hillside. The text "Thank You" is overlaid in the center.

Thank You