The Future of the Seafood Industry

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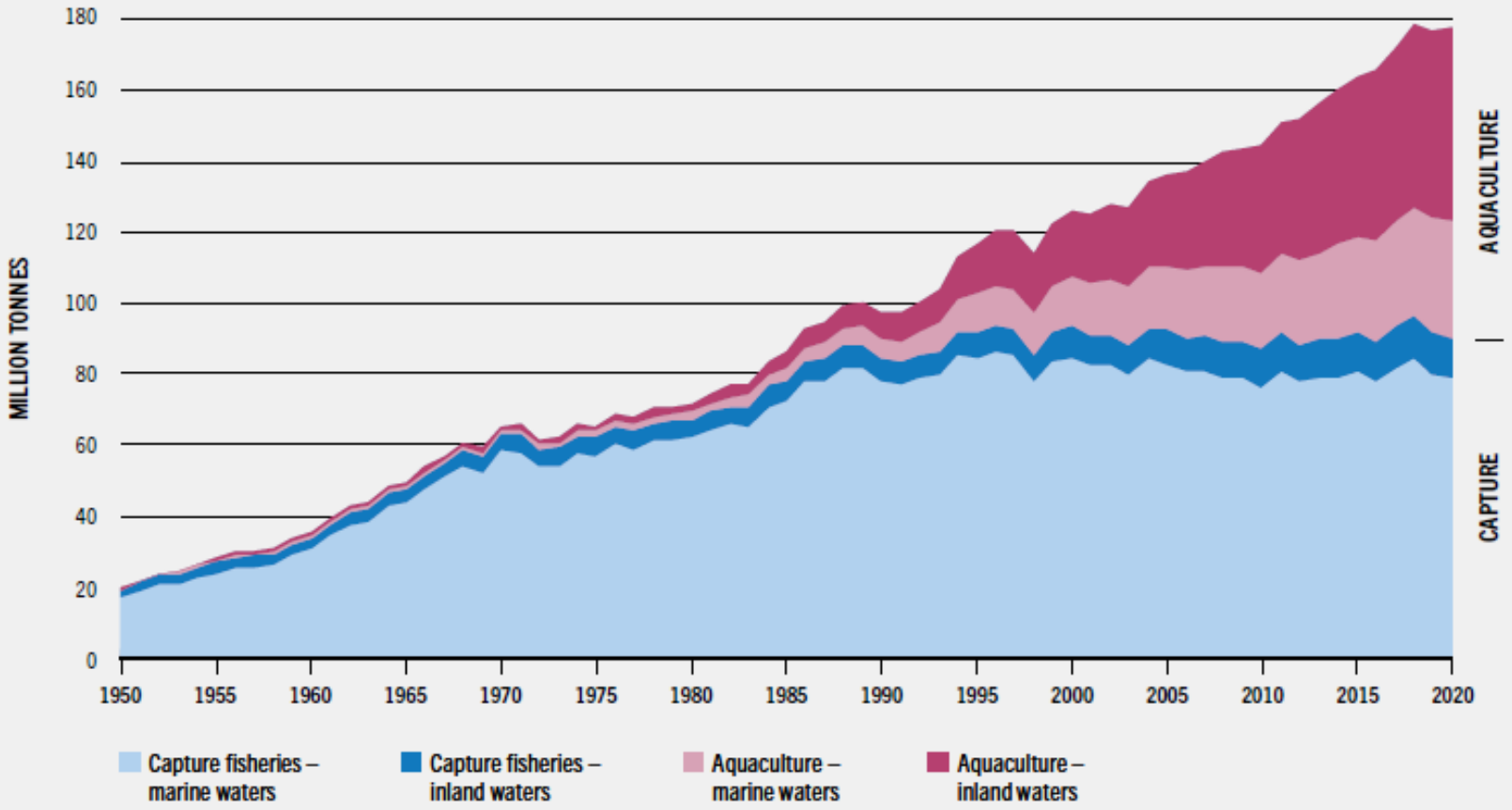
Prepared for
IIFET 2022
Vigo, Spain
July 20, 2022

Over the past three decades, the global seafood industry has changed rapidly and profoundly.

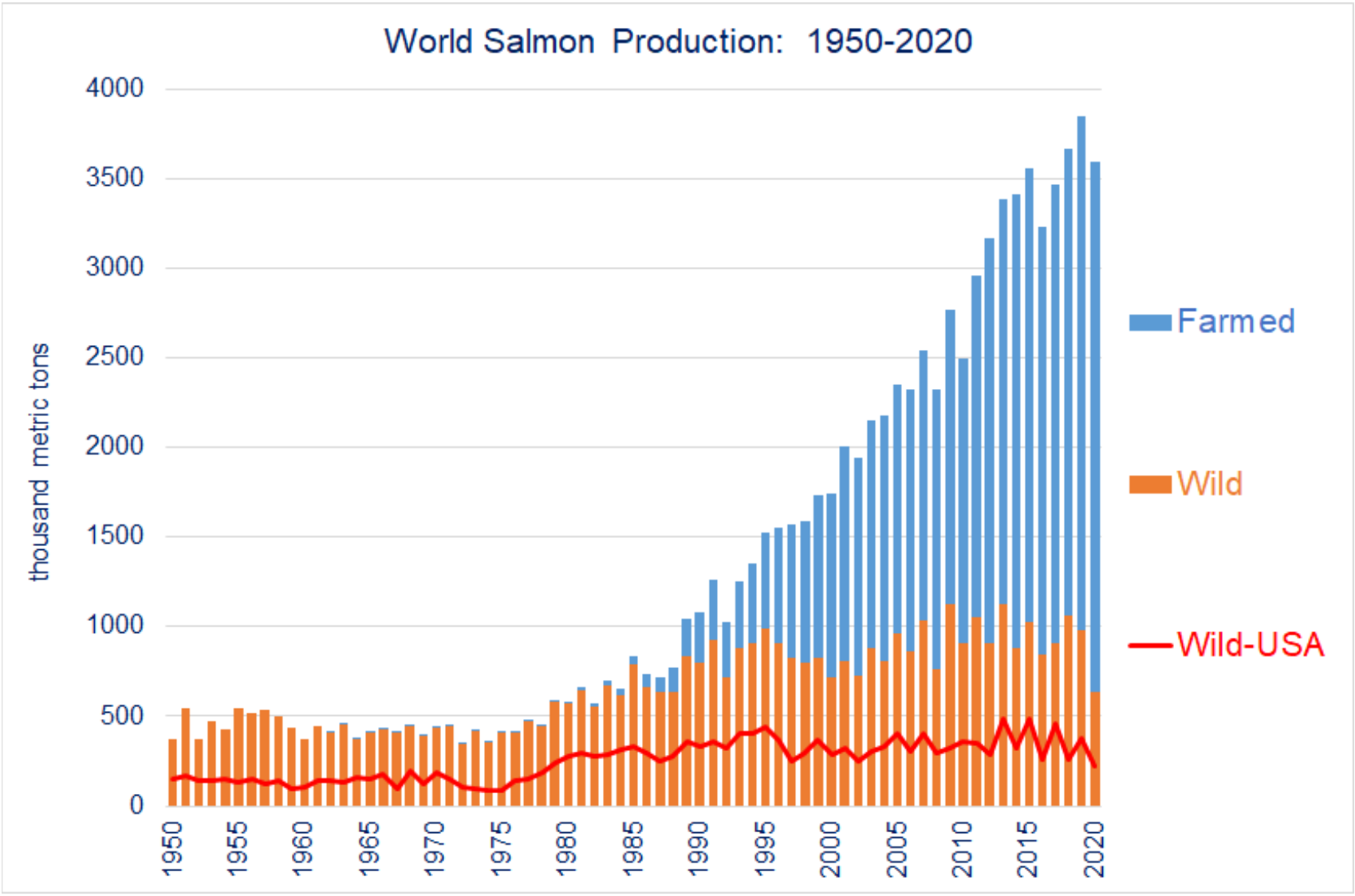
FIGURE 1 WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION



NOTES: Excluding aquatic mammals, crocodiles, alligators, caimans and algae. Data expressed in live weight equivalent.
SOURCE: FAO.

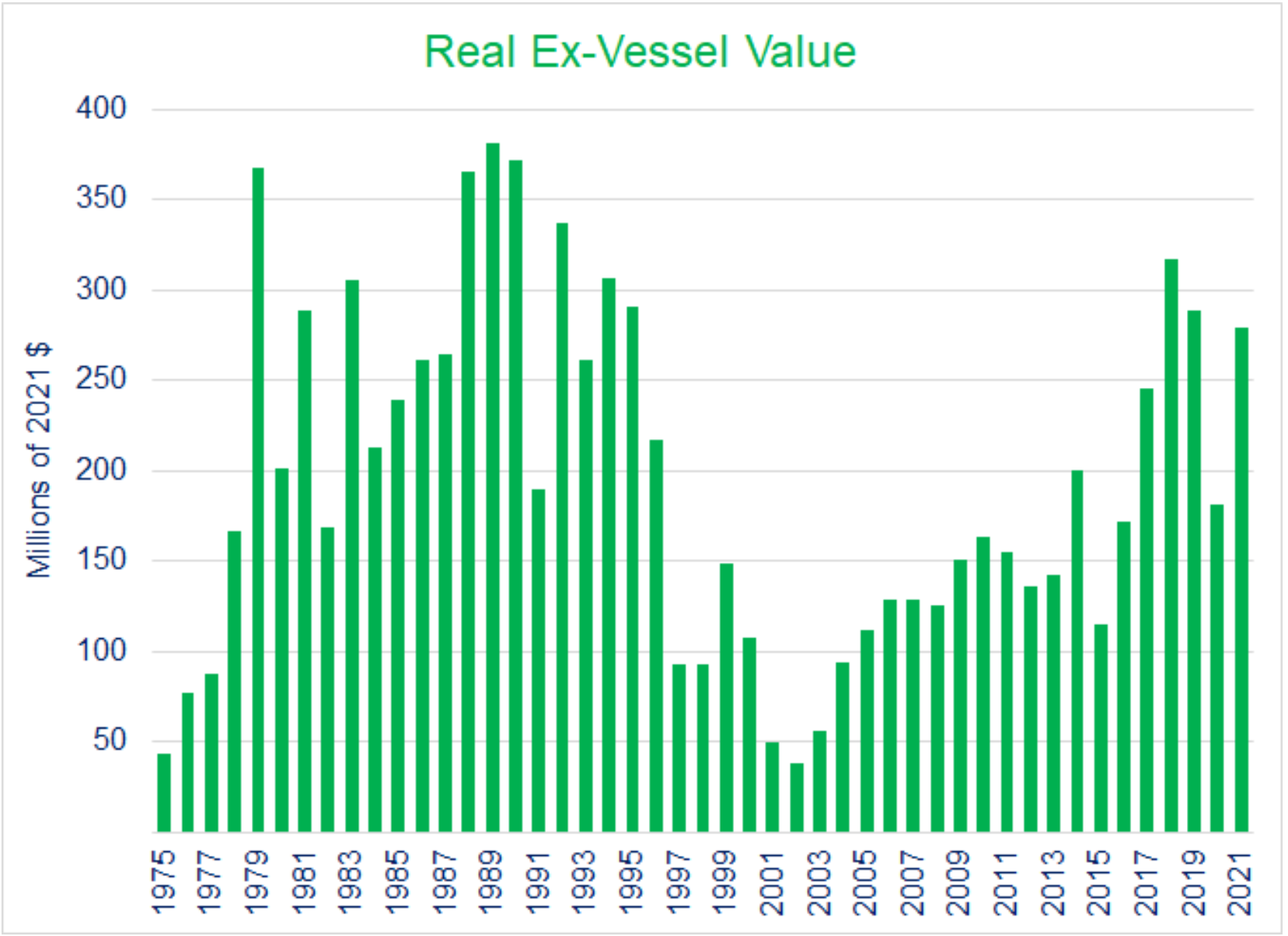
Source: FAO, *The State of World Fisheries and Aquaculture 2022*

Change in World Salmon Production: 1950-2020



Source: FAO FishstatJ Database

Value of Alaska Bristol Bay Salmon Drift Gillnet Fishery, 1975-2021



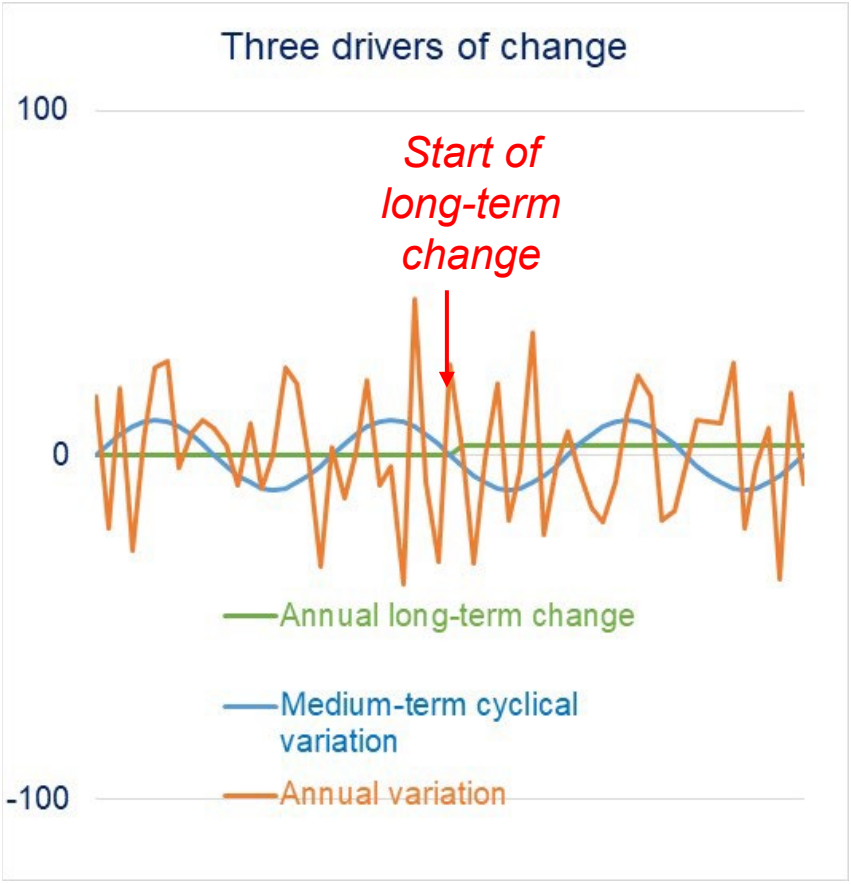
We should expect continued rapid and profound change in the global seafood industry.

1. How should we think about long-term change?
2. What factors will drive change?

1. How should we think about long-term change?

Recognize that drivers of change work on different time scales.

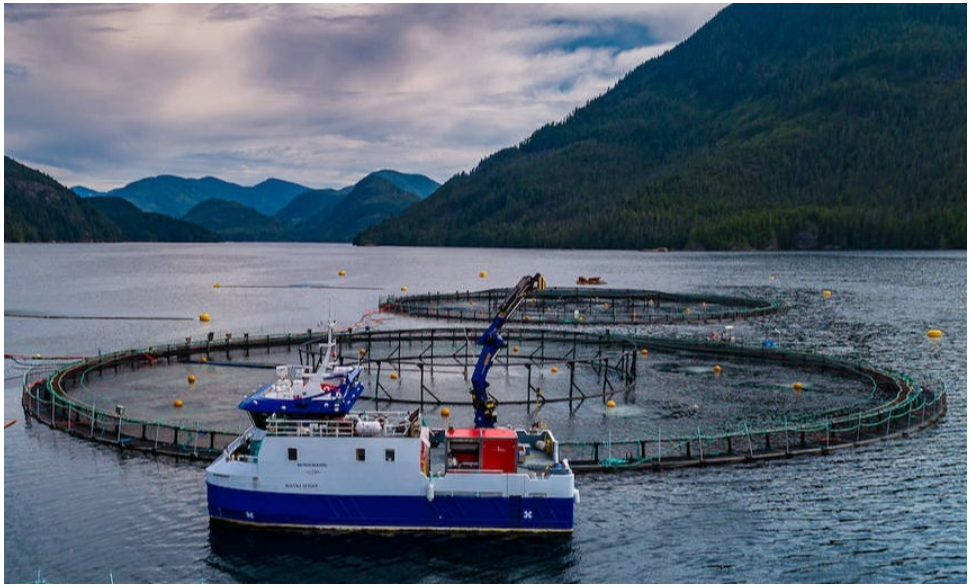
The significance of long-term drivers of future change may be difficult to observe or estimate.



Recognize both the power of and limits to modeling.

- Modeling forces us to think rigorously
- But there are limits to what we can model
  - Complexity
  - Lack of data
  - Uncertainty of key assumptions
  - Structural change
- Sometimes we can learn as much from
  - Watching and listening
  - Simple theory

Think about both fisheries and aquaculture.



- Fisheries and aquaculture are both important
  - As sources of fish and food
  - Economically and socially
- Both affect the other
  - Market competition
  - Market development
  - Infrastructure
  - Technology
  - Politically

Think critically about differences between wild fisheries and aquaculture.

	Wild fisheries	Aquaculture
Control over fish production	**Far less**	**Far more**
Potential to grow	**Low or none**	**High**
Government role in management	**Catches and allocation of common property fish**	**Use of the marine environment**
History	**Older** *Stronger cultural traditions* *More dependent communities* *Less receptive to innovation* *More political power?*	**Newer** *Weaker cultural traditions* *Fewer dependent communities* *More receptive to innovation* *Less political power?*

These differences will drive differences in future change between wild fisheries and aquaculture.

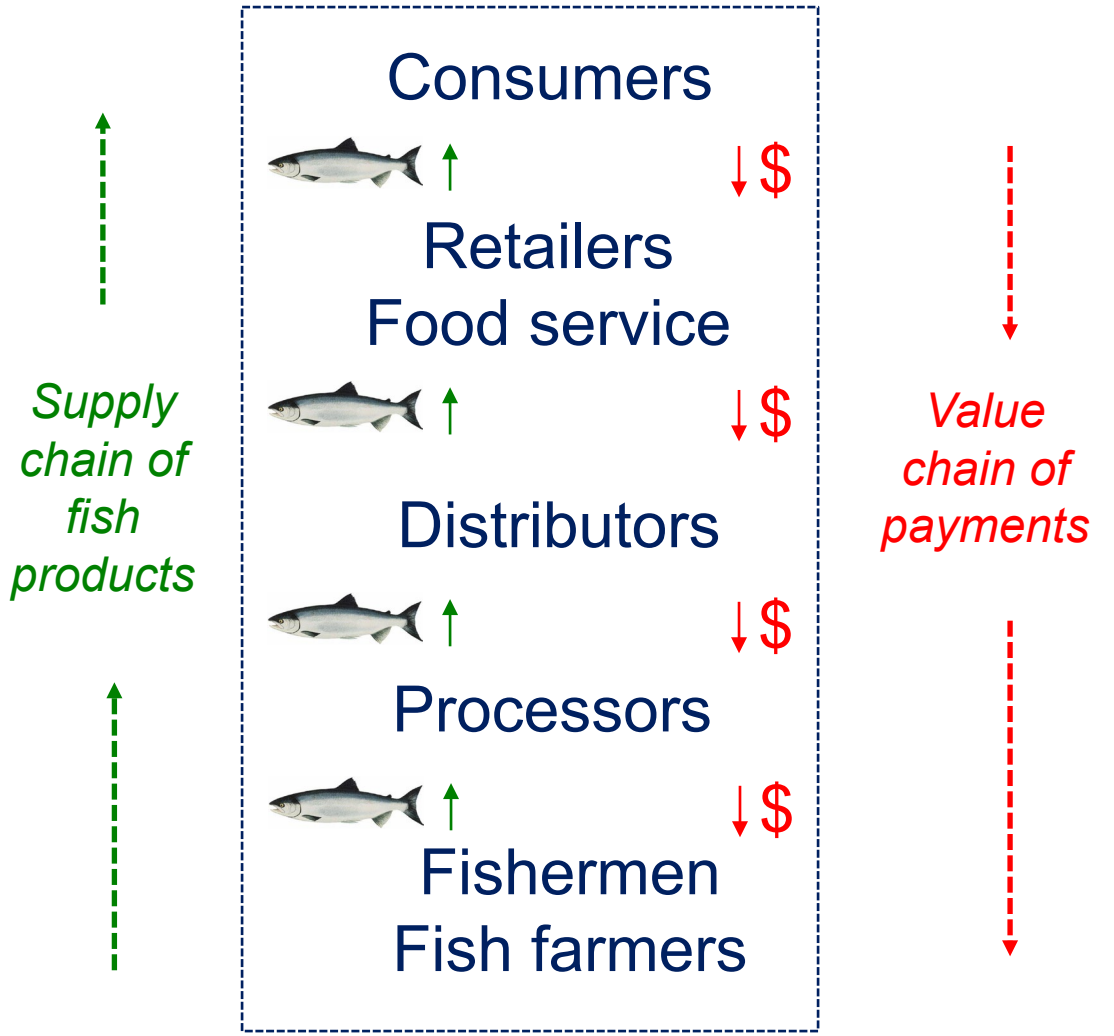
Think about the entire seafood supply chain.

Demand for fish is derived from consumer demand

Everyone in the supply chain depends upon everyone else.

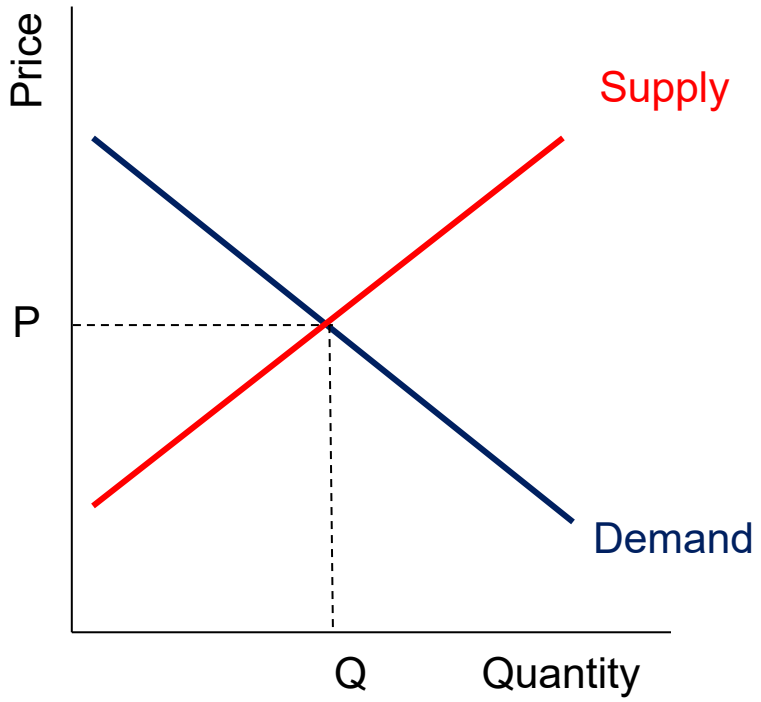
Everyone has to be profitable in the long-run.

Anything that affects any part of the supply chain may affect all other parts of the supply chain.



The pandemic has reminded us that the entire supply chain matters!

Think about both supply and demand
and how they may change in the long run



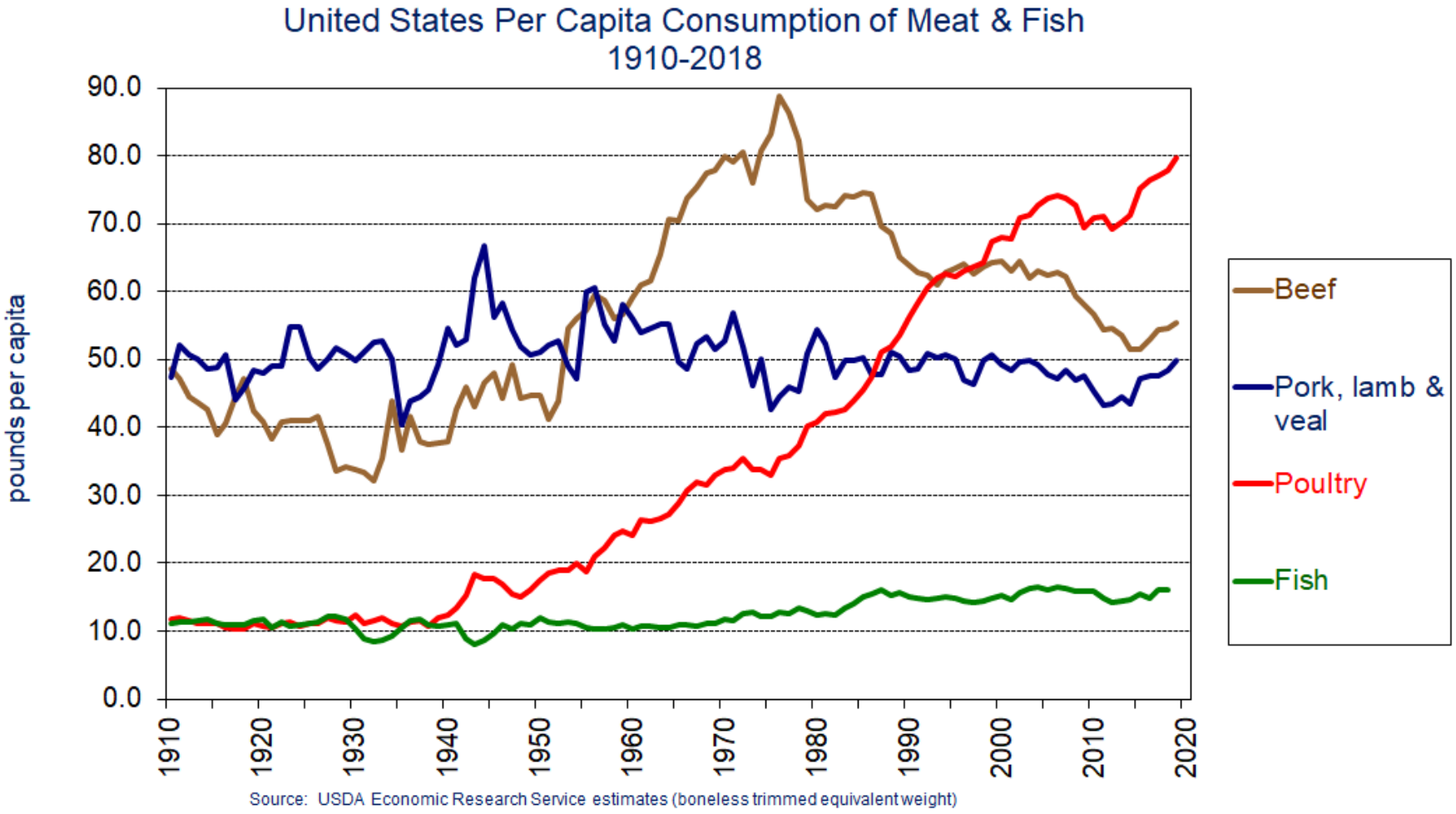
What will matter for the seafood industry is not just what it can produce but also what it can sell.

Think about not just fish but also other foods

All of these products will compete for production inputs and consumers' food spending.

All of their future production costs and market demand will affect future production and prices for all of them.

Think about how and why consumption of meat, poultry and fish changed in the past and how and why it might change in the future.



Think globally

Potential competition is increasingly global
Potential markets are increasingly global

Smoked salmon for sale in an Alaska supermarket

New Zealand

Scotland

Norway

Think beyond economics

All three dimensions of fisheries “sustainability”

Environmental
Economic
Social

are important and are correlated.

(Garlock et al, *Fish & Fisheries,* 2022)

2. What factors will drive change?

ECONOMICS
POLITICS
ENVIRONMENT
INNOVATION
MARKETING

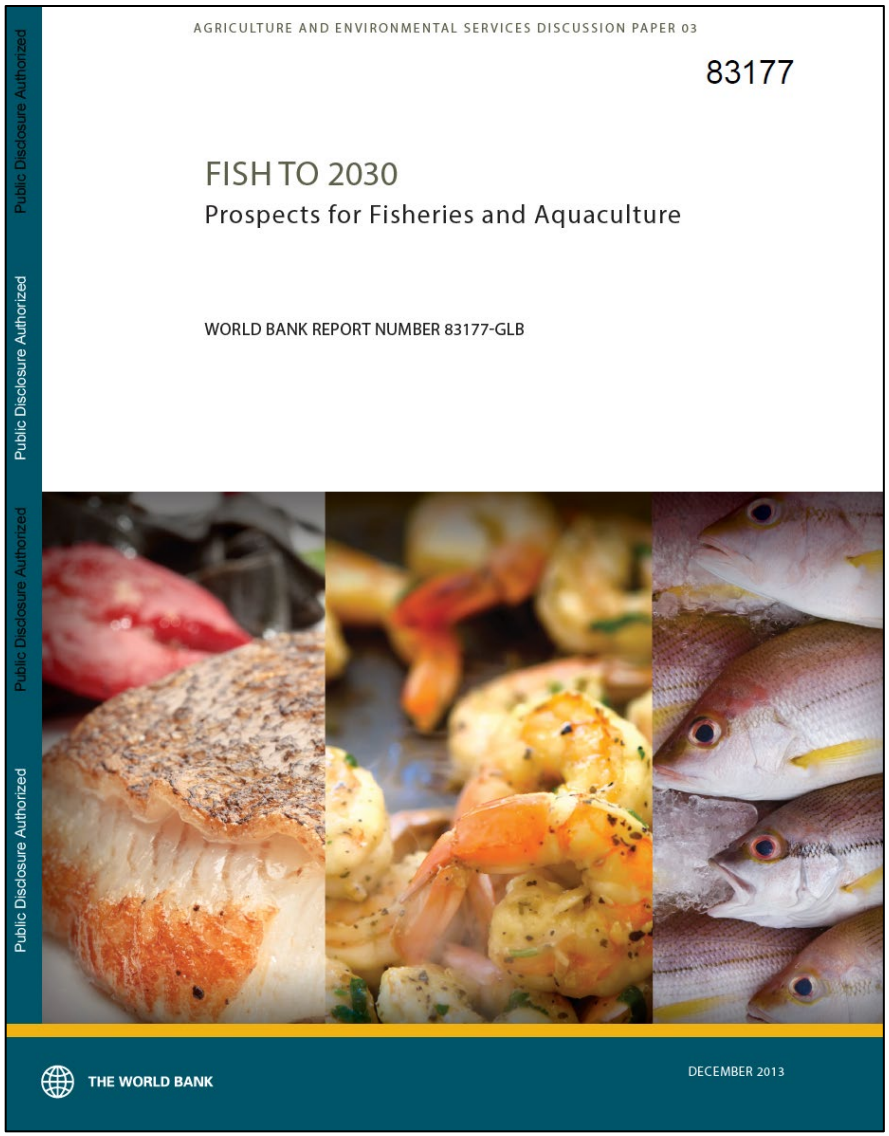
ECONOMICS

Changes in the global economy and regional economies

Likely long-term implications of economic drivers

- Growing global population and income will increase global food demand and production

- Regional differences in population and income growth will shift:
  - *Where* seafood and other foods are consumed
  - *Which* seafoods and other foods are consumed



Fish to 2030 Projections

- Aquaculture will produce about 2/3 of food fish
- China will consume nearly 40% of all seafood
- Production of tilapia, shrimp will more than double
- Aquaculture will more than double in India, Latina America, and SE Asia
- Per Capita consumption of fish in Sub-Sahara Africa will decline

POLITICS

Government policies not specifically focused on the seafood industry which affect the seafood industry

Policy area	Examples of effects on seafood industry
Trade	Import & export tariffs, quotas, & bans Country-of-origin labeling regulations
Immigration	Immigrant labor supply Guest-worker labor supply
Labor	Minimum wages Work-place safety regulations
Food	Food safety regulations Food labeling regulations
Infrastructure	Transportation costs Energy costs Port facilities Broadband availability
Environment	Water quality regulation Processing waste discharge regulations Energy subsidies & taxes

National governance is critically important for fisheries (Garlock et al, 2022)

- National governance conditions explain substantial variation for all three pillars of sustainability: environmental, economic, and social

- Sustainability is a challenge for countries with weak rule of law or corruption

- Conservation relies critically on a well-functioning central government that
  - supports the legal basis for addressing overfishing
  - upholds rule of law
  - Respects local control of access

- The state of national economies largely influences the ability of local economies to prosper

Garlock, T., Anderson, J. L., Asche, F.,Smith, M. D., Camp, E., Chu, J., Lorenzen, K., & Vannuccini, S. (2022). Global insights on managing fishery systems for the three pillars of sustainability. *Fish and Fisheries,* 00, 1-11. https://doi.org/10.1111/faf.12660

ENVIRONMENT

Long-run environmental change including effects of climate change

- Including changes in ocean conditions . . .
  - Temperatures
  - Currents
  - Acidification

- Potentially dramatically affecting:
  - Distribution and abundance of wild fishery stocks
  - Growing conditions for marine aquaculture
  - Growing conditions for land-based aquaculture

- Potentially dramatically affecting
  - Global food production
  - Global food markets

Aquaculture is relatively less vulnerable
to long-term environmental change than wild fisheries.

Specific types of farming in specific regions may be
vulnerable to environmental change.

But aquaculture can respond by
changing locations, production methods and species.

Wild fisheries have always experienced fluctuations in abundance driven by annual and longer-term variation in ocean conditions.

But climate change could potentially dramatically affect wild fishery resources beyond the range of historical variation.

- Changing geographical distribution of fishery resources
- Changing species composition of fishery resources

We are beginning to see significant impacts of climate change on some fisheries.

Into the ice: A crab boat's quest for snow crab in a Bering Sea upended by climate change

This year, the snow crab harvest dropped nearly 90%.

Stocks collapsed in the aftermath of two warm years, 2018-19, when the annual winter ice pack shrank, and the cold pools that offer crab protection from cod and other predators were drastically reduced.

The warming has been linked by scientists to climate change driven by the release of greenhouse gases by fossil fuel combustion and other human activities.

Source: Bernton (2022)

The longer-term implications of climate change for wild fisheries are very difficult to predict.

But we should think about how they might affect us and how we could prepare and adapt.

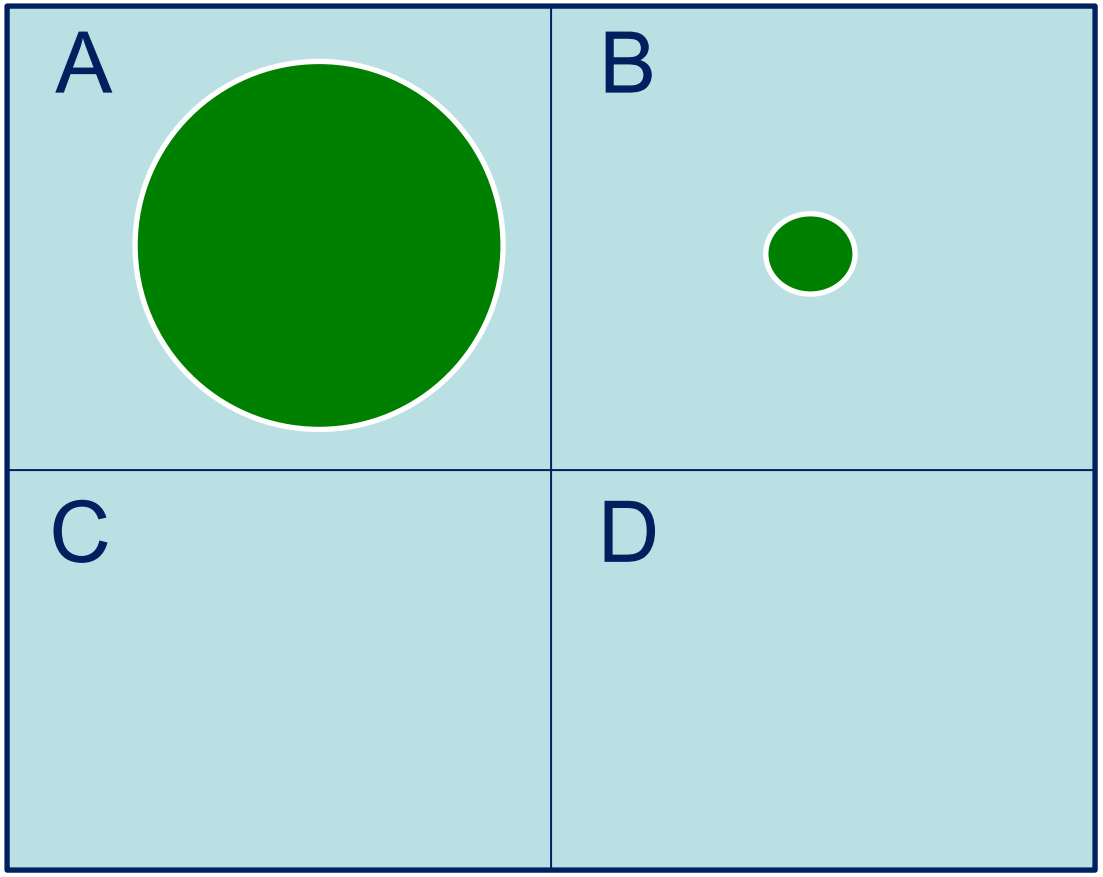
Emerging questions for wild fisheries management:

- If we expect significant potential change in the geographic distribution and species composition of fish stocks

- How can we better prepare for:
  - Economic and social adjustment to declining stocks
  - Sustainable management of new stocks
  - Efficient utilization of new stocks
  - “Fair” allocation of new stocks

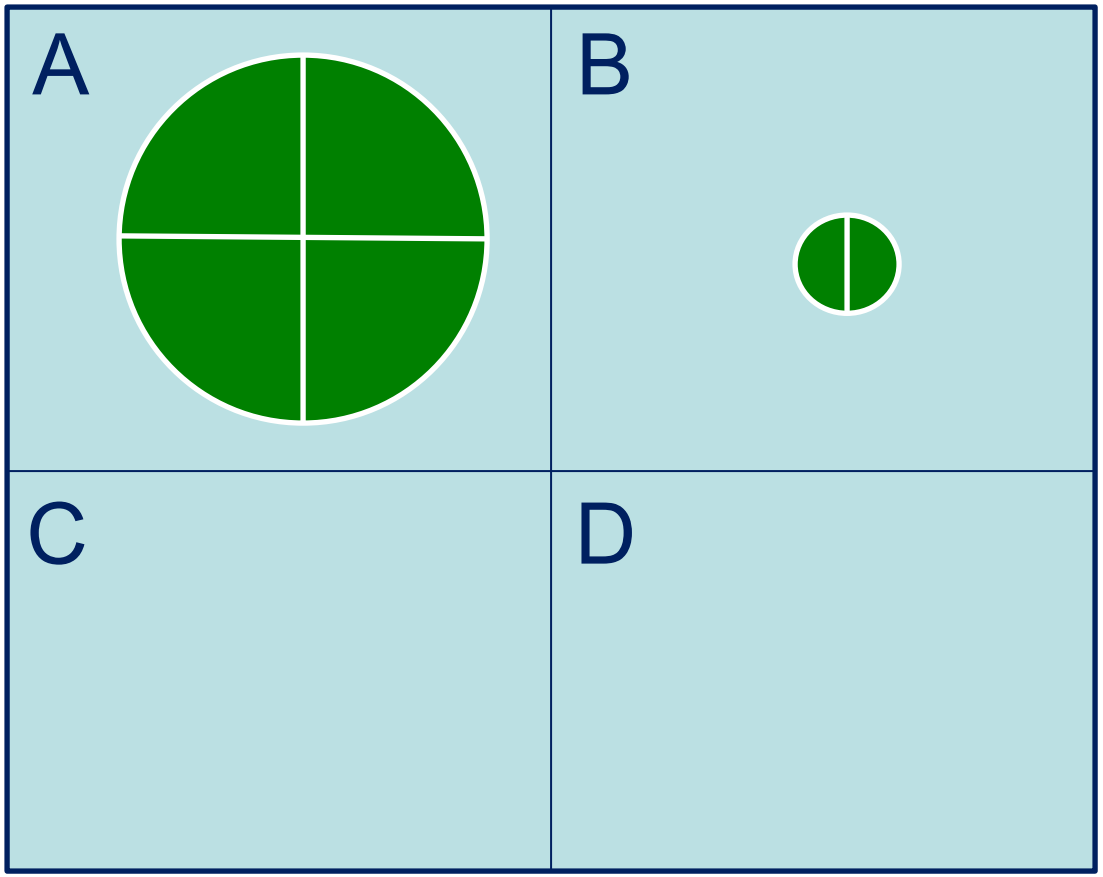
Suppose historically we had an open-access TAC fishery for stocks of greenfish in areas A & B

The fishery was "sustainable" but rents were dissipated.



Suppose we then implemented IFQ management for stocks of greenfish in areas A & B

The fishery became not only “sustainable” but also generated rents.

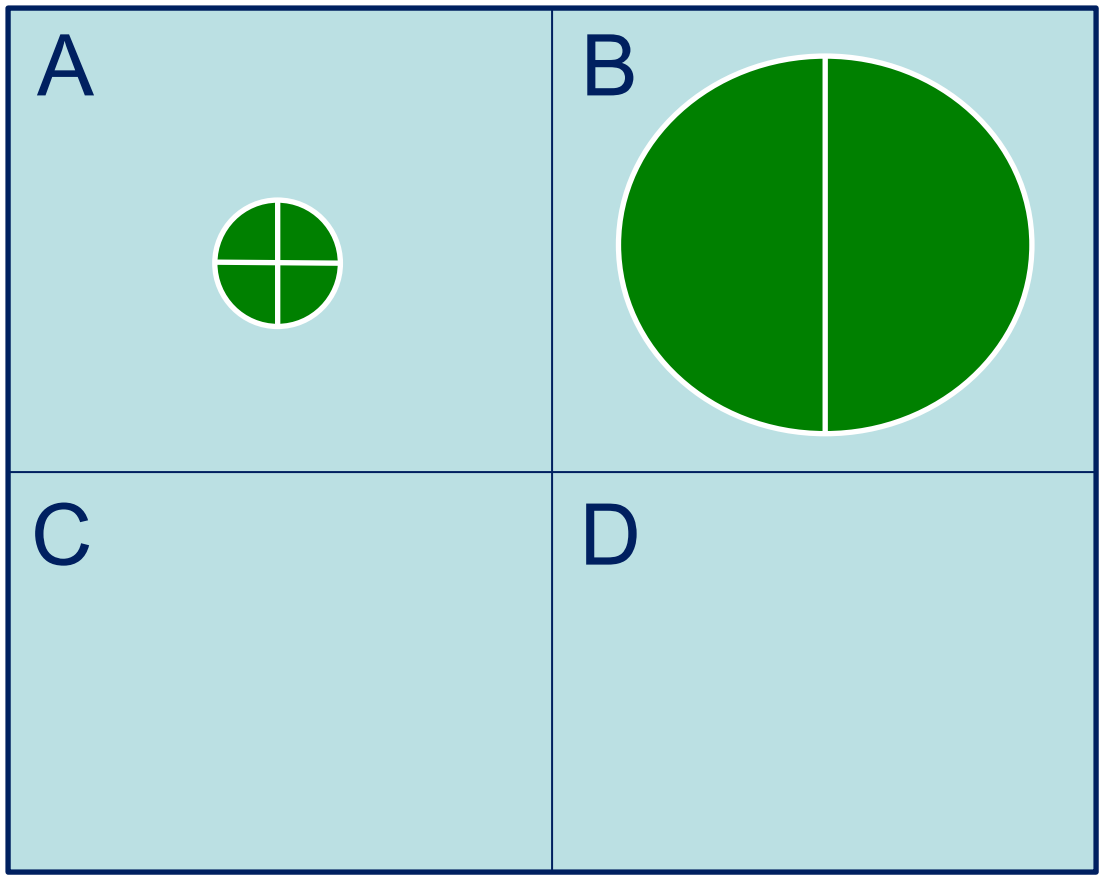


Suppose stocks of greenfish shift spatially from area A to area B

If we adjust TAC's the fishery remains "sustainable."

The fishery also continues to generate rents—though there are "winners and losers."

Quota share holders in A can hedge against change by acquiring shares in B.



Potential effects of climate change:

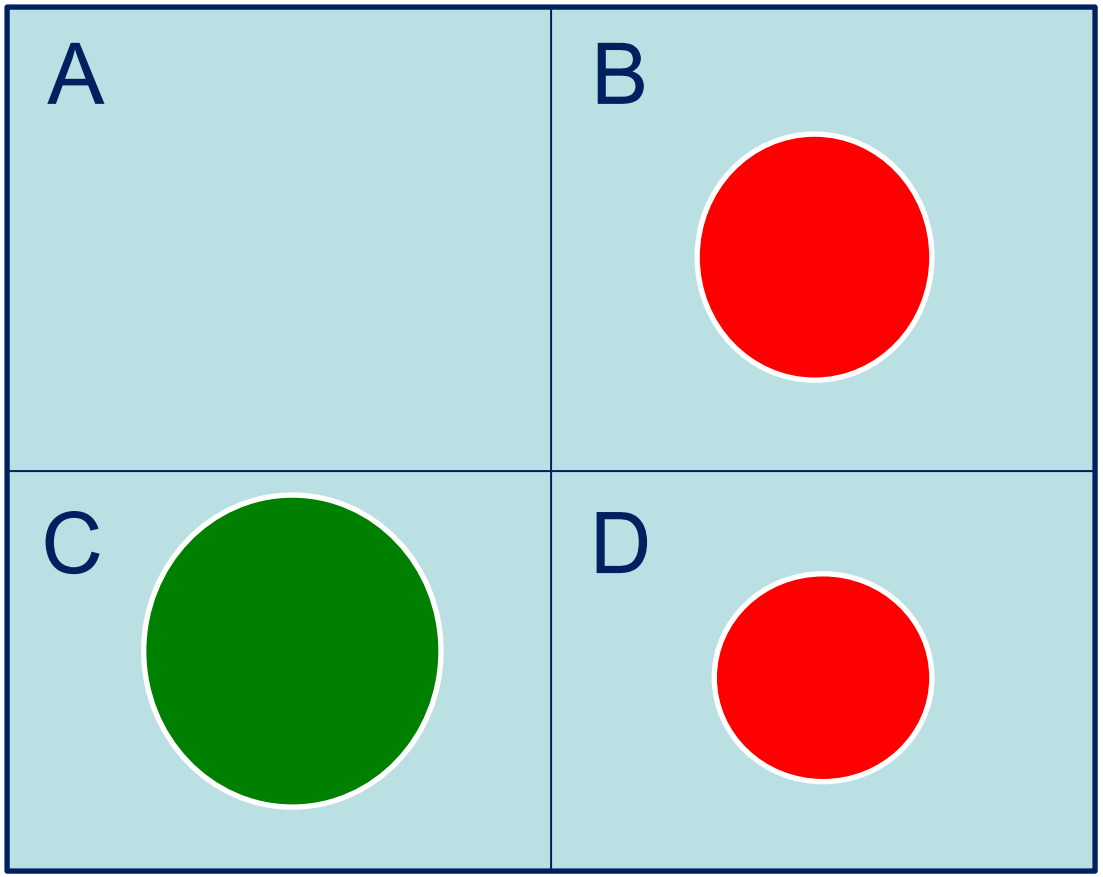
Suppose all fish disappear from area A,
greenfish shift to area C, and
stocks of redfish appear in areas B and D.

Unless we prepare for change, we will have:

No fishing rights

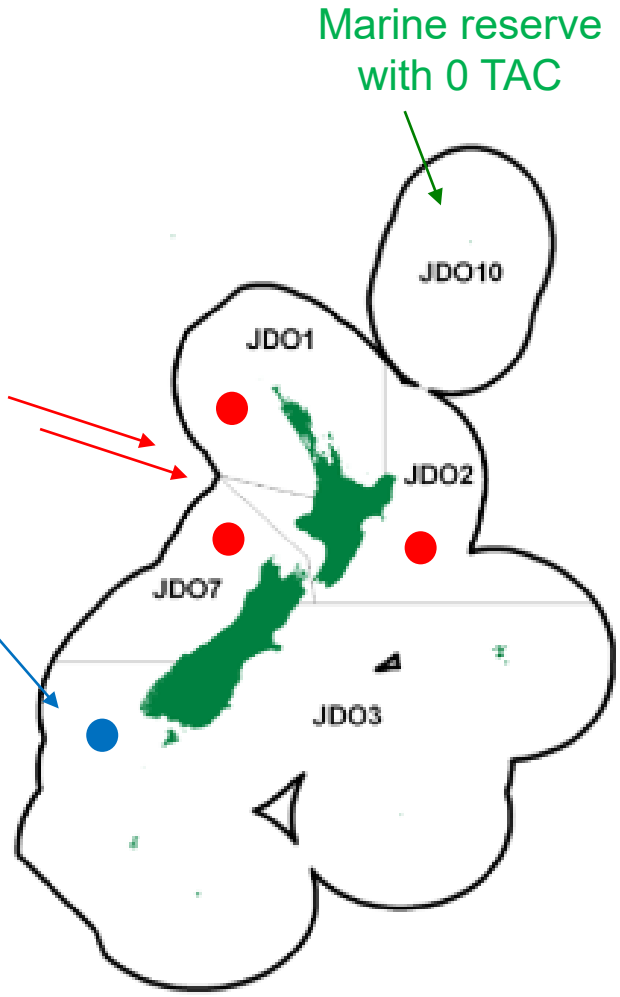
No mechanism for efficient utilization of stocks

Potential rent dissipation from race for quota shares for redfish



New Zealand management system for John Dory

- The system defines stocks for the entire area around New Zealand, even if catches are minor or zero
- Currently almost all catches are in areas 1, 2 and 7
- Currently quotas and catches in area 3 are very small.
- If stocks shifted south to area 3 the TACC would increase for quota owners
- If a new fish stock is created by law:
  - 20% of the quota will go to Maori
  - 80% of the quota will go to the government
  - The government would likely auction the quota



New Zealand has already determined who would get the rents from any new stocks in NZ waters—
but not what would happen if stocks move to international waters

INNOVATION

Innovation in the supply chains for seafood and other foods

affecting:

- How foods can be harvested, farmed, processed, packaged, transported & sold

- Costs, prices, and margins throughout supply chains

Technological innovation is transforming the global economy.

Thomas Friedman, *New York Times*, September 27, 2017:

"We're moving into a world where computers and algorithms can

- *analyze* (reveal previously hidden patterns)
- *optimize* (tell a plane which altitude to fly each mile to get the best fuel efficiency)
- *prophesize* (tell you when your elevator will break or what your customer is likely to buy)
- *customize* (tailor any product or service for you alone); and
- *digitize* and *automatize* more and more products and services.

Any company that doesn't deploy all six elements will struggle, and this is changing every job and industry."

I’ve seen dramatic innovation over my career—but mostly in aquaculture

Feeding salmon at the same Chilean farm:

1990s

2000s

Aquaculture is more able to take advantage of technological innovation than wild fisheries

- Greater control gives aquaculture more potential to innovate
  - Species of fish produced
  - Fish characteristics
  - Production technology
  - Production location

- Aquaculture has more incentive to innovate
  - Ability to expand production

Rapid innovation is occurring in every part of aquaculture

- Species
- Genetics
- Feeding
- Disease management
- Production environment
- Harvesting
- Geographic location

This kinds of innovation gets most of the attention

But this kind of innovation is what is steadily transforming aquaculture

"The machine can recognize a pattern at daytime, night time, high tide, low tide, and when there's a deviation from that pattern, even a small change the system can provide an alert to the fish farm.

Drivers of innovation in aquaculture

- Problems to be solved
  - Innovations happen when and because they are needed
  - Not before
- Continuous learning from experience
- Significant investment in
  - Basic research
  - Applied research
- Financing from
  - Aquaculture producers
  - Feed industry
  - Venture capital
  - Governments
- Adaptation of technologies from other industries

Not all innovations succeed.

- The biggest investments get the most hype
- Many highly publicized innovations have
  - Met unanticipated problems
  - Not been profitable
- Technological progress is bumpy

Some salmon farming critics argue that farmed salmon is inferior because it is artificially colored.

Salmon farming critics miss the real lesson of the *SalmoFan*:

Control over production allows aquaculture to respond to market demand in ways that wild fisheries can't even imagine.

There is also significant potential for innovation in wild fisheries

- Harvesting
  - Fish finding
  - Stock targeting
  - Gear selectivity
  - Vessel design
  - Energy efficiency

- Management
  - Enforcement
  - Catch reporting
  - Stock assessment
  - Real-time management

Without sustainable and rights-based management,
the potential benefits from innovation in harvesting may be dissipated.

"Technical Progress has been Futile"

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

Slide from Jim Anderson's keynote presentation, IIFET 2008

https://ir.library.oregonstate.edu/concern/conference_proceedings_or_journals/n870zv89b

Even with sustainable and rights-based management, wild fisheries management may significantly and insidiously hamper technological innovation by restricting how fishing may be done.

Management practice	Types of innovation affected
Gear restrictions	Gear innovation
Vessel restrictions	Vessel innovation Fish utilization innovation
Trip restrictions	Marketing innovations

Bristol Bay wild salmon are harvested in gillnets.
The salmon are bruised as they are caught in and removed from gillnets.

Can't we think of a better way to catch Bristol Bay wild salmon than gillnets?

But Bristol Bay limited entry salmon permits
are specifically defined as gillnet permits.

Alaska salmon harvesting technologies haven't changed since
limited entry legislation established gear types 40+ years ago.

But no one thinks about finding a better way to catch Bristol Bay wild salmon.

If innovation is not allowed:

- There is no return to investment in thinking about innovation
- We never learn what innovations might be possible

We can't predict—or maybe even imagine—
the long-term changes technological innovation may bring.

Self-driving smart fishing gear?
Integrated algae-based open ocean aquaculture?
Fully-automated seafood processing & distribution?

There will be potentially enormous new opportunities for supply chains able to adopt new technologies.

There will be potentially enormous new challenges for supply chains unable to adopt new technologies.

Two years ago, cell-based salmon cost $200,000 per pound to manufacture. Today, it's a fraction of that cost.

MARKETING

Efforts to grow demand for seafood and other foods

Marketing is critical for growth in seafood production.

Without growing demand, growing production
lowers prices until further growth is no longer profitable

Strategy for growing demand . . .

Build your brand: change consumer preferences
so that consumers substitute your fish for other foods

Strategy for growing demand . . .

Sell your fish in more places so more consumers can buy them

Norwegian salmon for sale in Dubai

Strategy for growing demand . . .

Sell your fish in more product forms to meet more consumer demands

Salmon farmers have engaged in continuous innovation of new products

Strategy for growing demand . . .

Sell your fish combined with other foods that consumers demand

We can learn a lot about marketing by visiting an Alaska supermarket

Marketing message: All of these wild and farmed products are good options

Identically priced farmed and wild fish products

Marketing message: All of these meat and seafood products are good options

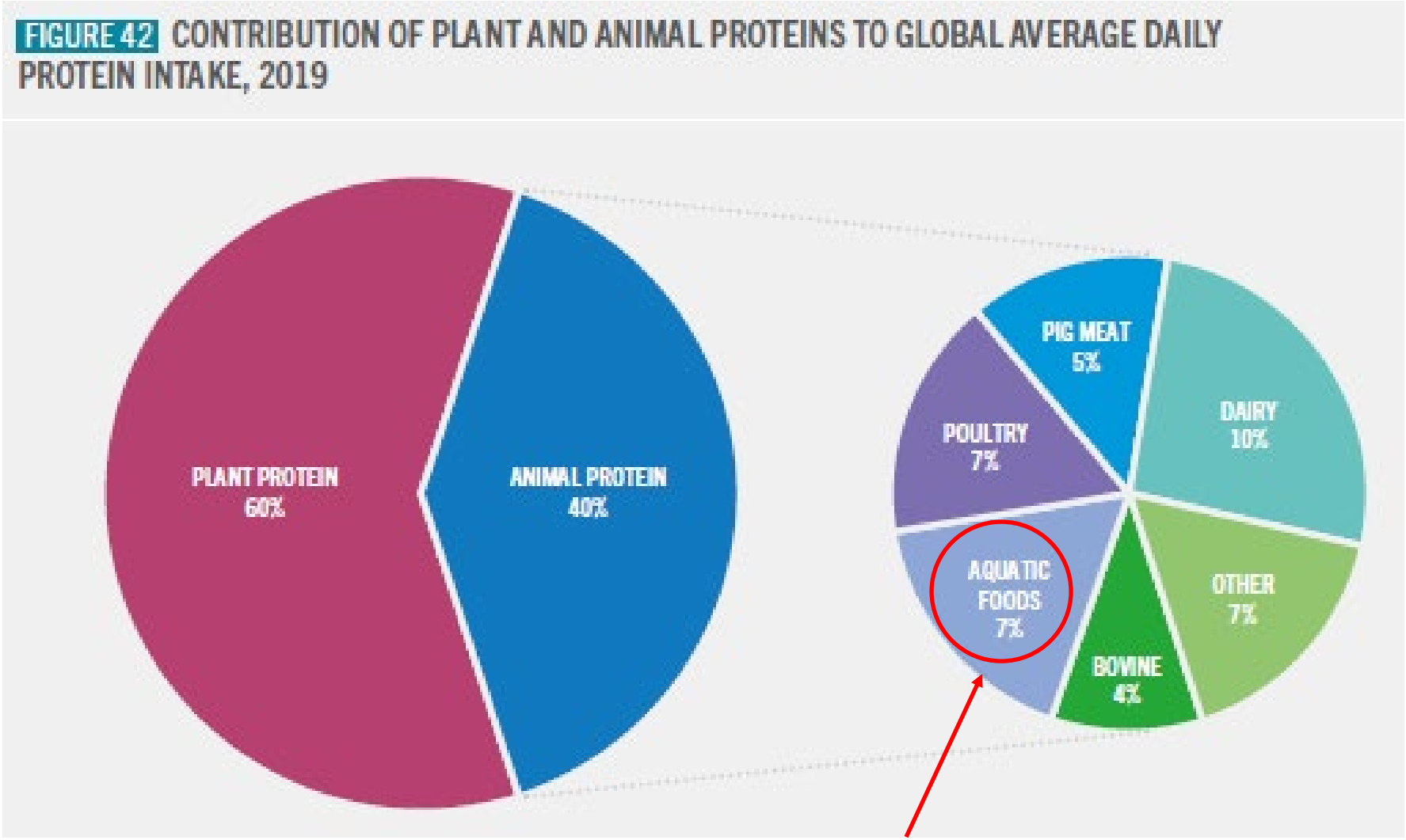
Identically-priced meat & fish products

We face potential competition from new kinds of foods

New kinds of foods may compete directly with seafood

Not impossible: plant-based “f’sh”

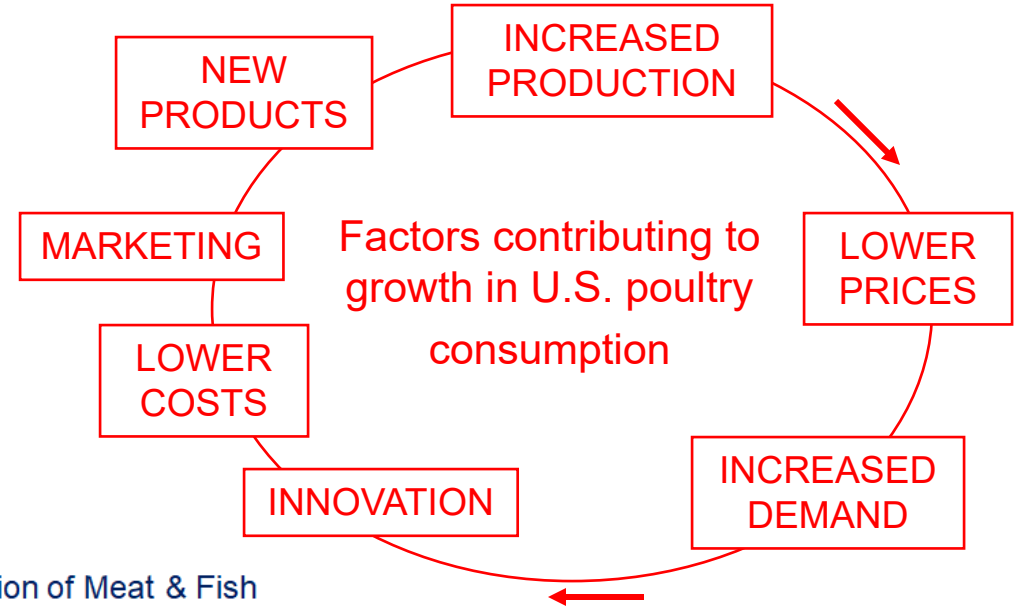
There is enormous potential for seafood's share of world food production to grow

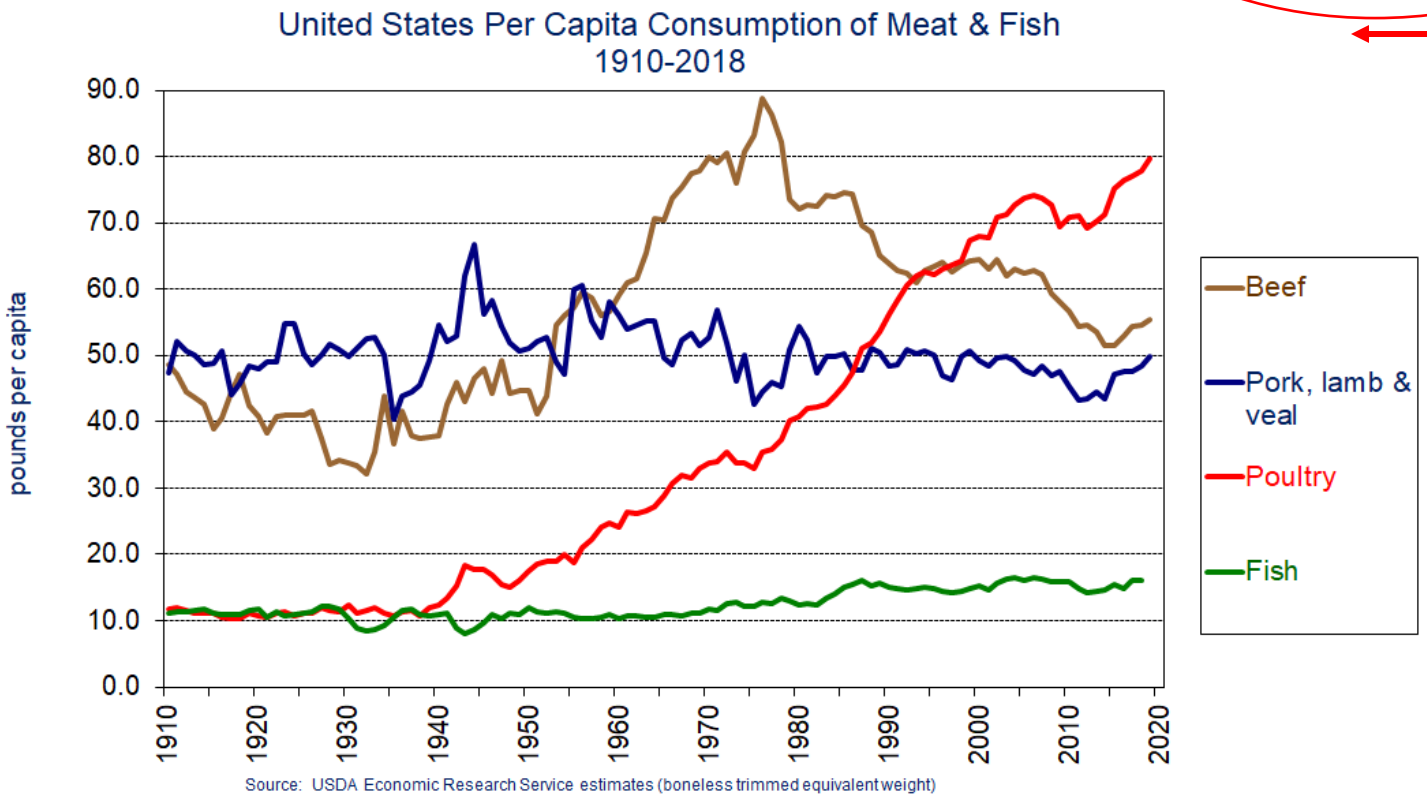


Seafood = 18% of animal protein

Source: FAO, *The State of World Fisheries and Aquaculture 2022*

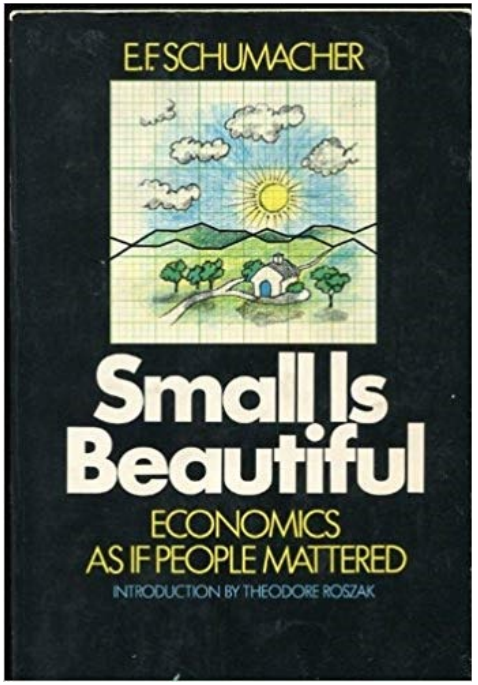
Can aquaculture grow like poultry did through a continuous cycle of innovation to lower production costs and expand market demand?





Policy tradeoffs in fisheries and aquaculture management may change

- "Small and local and traditional are beautiful . . ."
- But in a world of change and risk it helps to:
  - Have deep pockets
  - Be vertically integrated
  - Be geographically diversified
  - Be innovative



In a changed future, the consequences will increase for management policies which

- Ignore how the seafood industry is changing
- Slow or prevent adaptation and innovation to respond to new challenges and opportunities
- Treat aquaculture as a threat rather than an opportunity