The Future of the Seafood Industry

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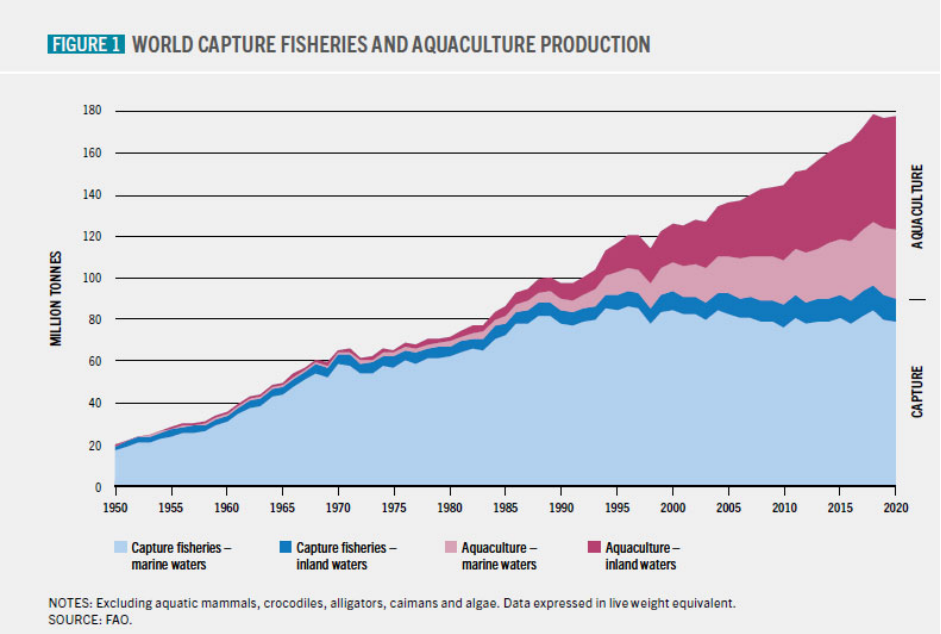
It's a joy to be back together with old friends and to meet new friends at IIFET. And it's an honor to be able to give this presentation. Today I'd like to talk about the long-term future of the seafood industry. I don't have the time and I certainly don't claim the expertise to fully explore this very big and complex topic. My goal is simply to encourage you to think about it—and hopefully suggest answers to some of the many questions thinking about the future raises.

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



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

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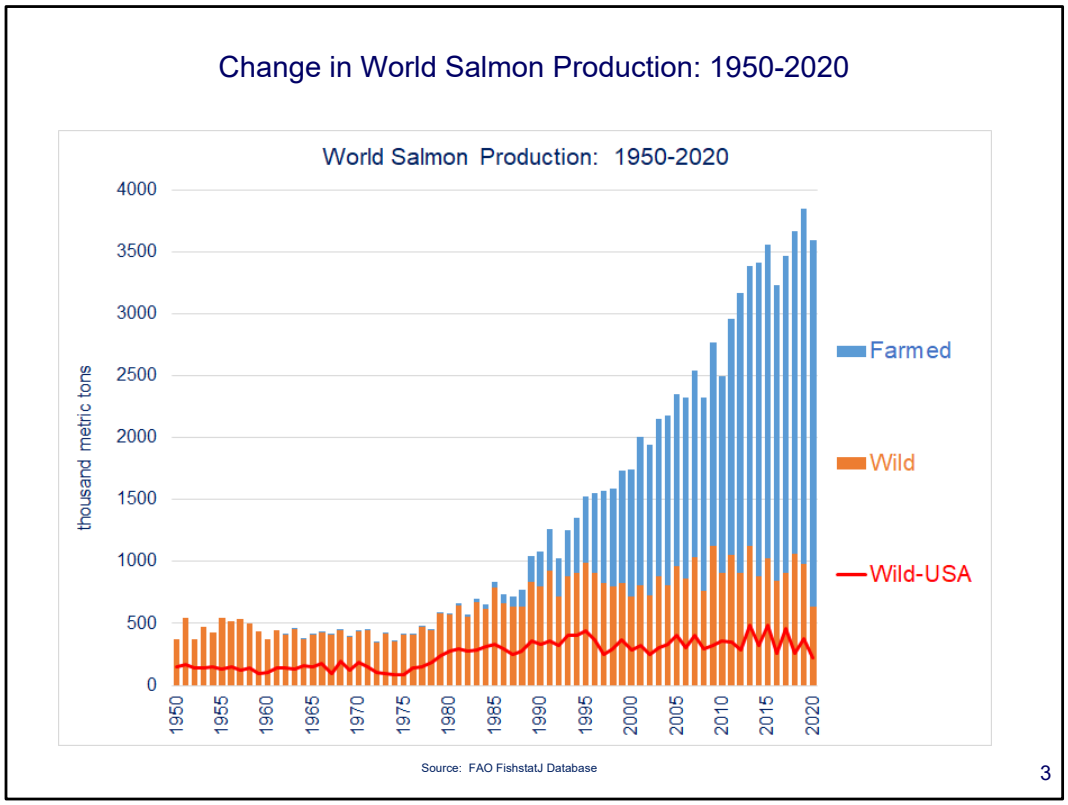
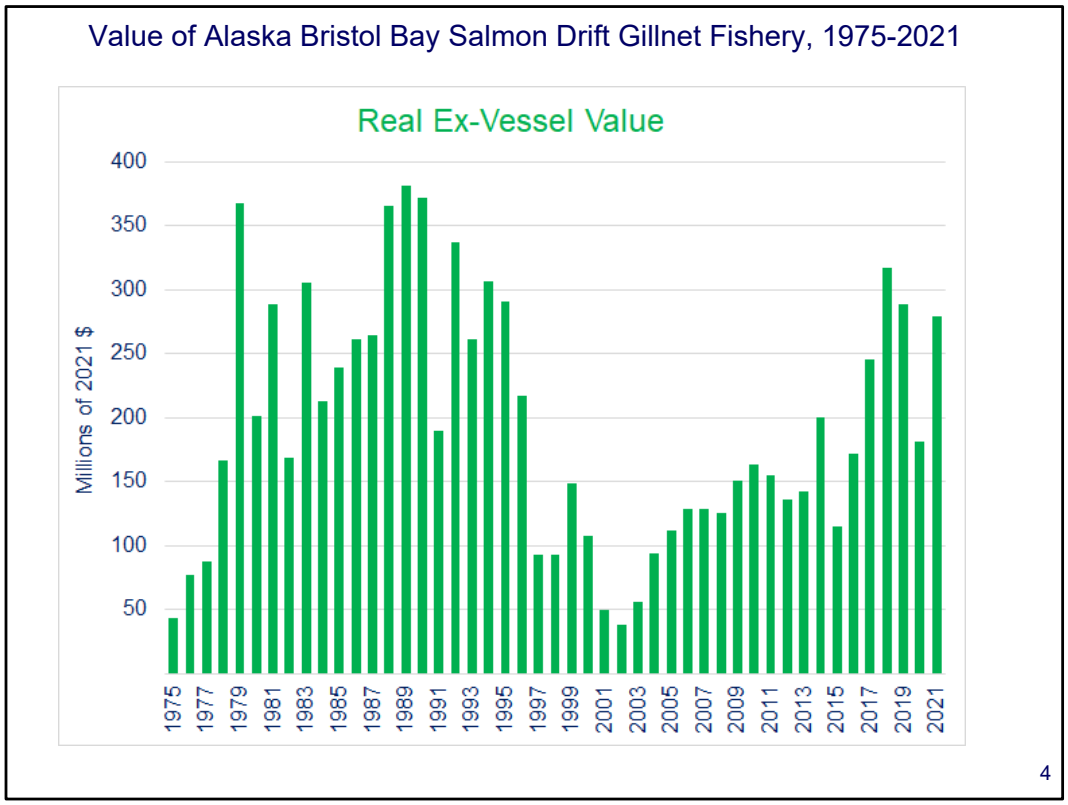
Over the past three decades, the global seafood industry has changed rapidly and profoundly. One of the most dramatic changes has been the growth in aquaculture and in aquaculture's share of global seafood production.



I watched some of the implications of that change in my career studying the Alaska salmon industry, as salmon farming grew from a very small industry to dominating world salmon production.



Competition from farmed salmon first led to a drastic drop in prices and value of Alaska salmon and later a rebound in prices and value as salmon farmers vastly expanded world demand for salmon. But at the start of my career I never imagined the turbulent changes the industry would face.

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?

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I believe that over the next thirty years--during the careers of the younger people attending this meeting--we should expect similar or even more rapid and dramatic change in the global seafood industry, including the parts of the industry any of us may study. Today I'd like to offer some suggestions about how we should think about long-term change, and some of the factors likely to drive change.

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

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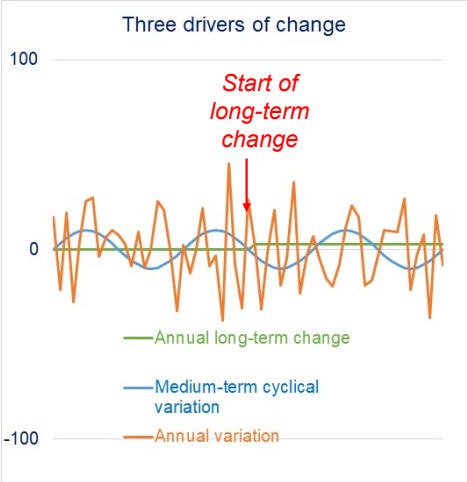
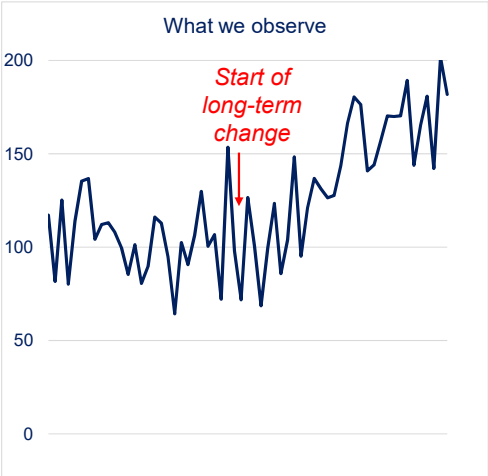
How should we think about long-term change?

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.





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We should recognize that drivers of change work on different times scales. The most important drivers of future change may work gradually and be difficult to observe or estimate initially amidst the variation caused by short-term factors.

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

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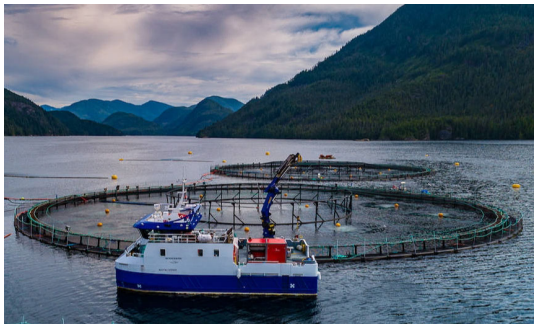
We should recognize both the power of and the limits to modeling the long-run future. Modeling forces us to think rigorously, but what we can learn from modeling the global food system is limited by complexity, lack of data, our uncertainty about key assumptions driving our models, and structural changes. Sometimes we can learn as much from simple theory and from watching, listening, and thinking.

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

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We have to think about both fisheries and aquaculture. Even if you are mostly interested in questions specific to wild fisheries or specific to aquaculture, you can't ignore the many ways they affect each other, not only through market competition but also through market development, infrastructure, technology and politics.

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.

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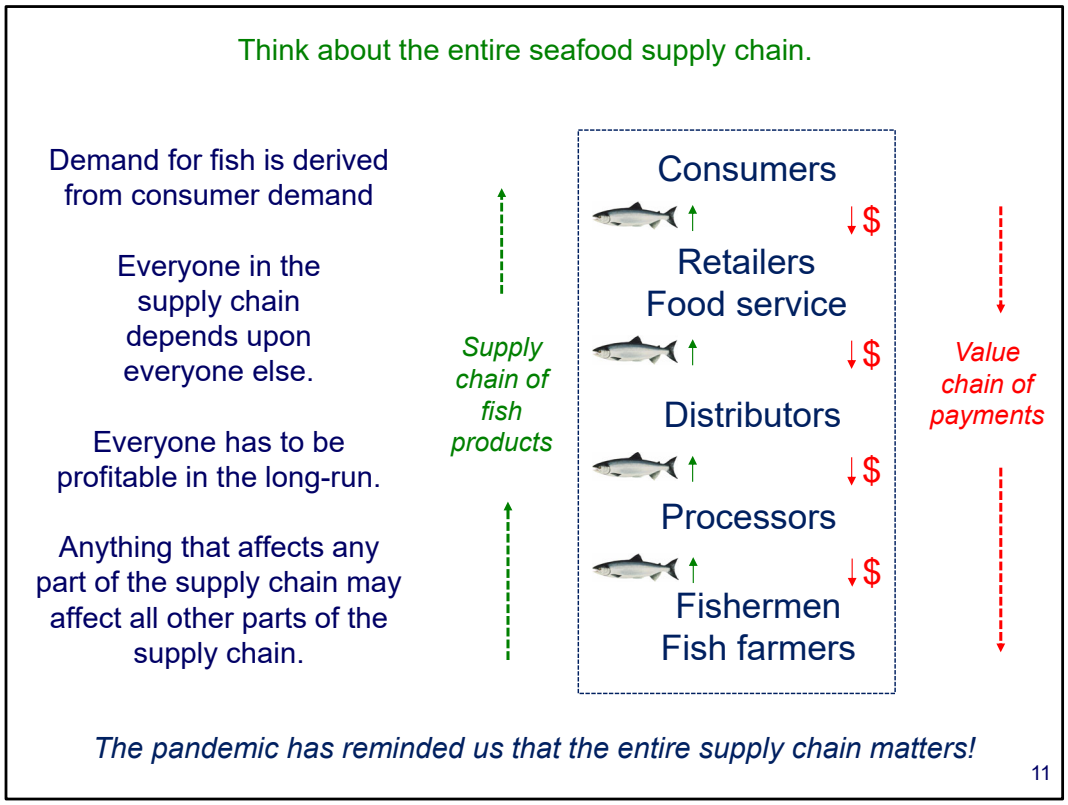
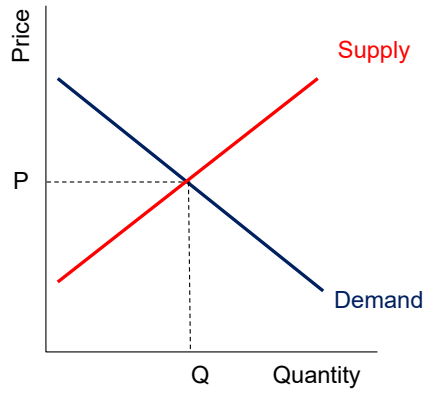
We should think critically about differences between wild fisheries and aquaculture—which will drive differences in how they change in the future. Aquaculture has far more control over fish production than wild fisheries, and only aquaculture has potential to grow. Government has different roles in managing wild fisheries and aquaculture. The histories of wild fisheries and aquaculture are very different. Because wild fisheries are much older, they have stronger cultural traditions, more dependent communities, and in general are less receptive to innovation. Where they are important and established, they may have more political power.



We need to think not just about fisheries and aquaculture, but about the entire seafood supply chain. The demand for fish is derived from consumer demand, and everyone in the supply chain between the fish producers and the consumer depends on 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.

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We need to think about both supply and demand and how they may change in the long run. What matters for any industry, and what will matter for the seafood industry, is not just what it can produce but also what it can sell.

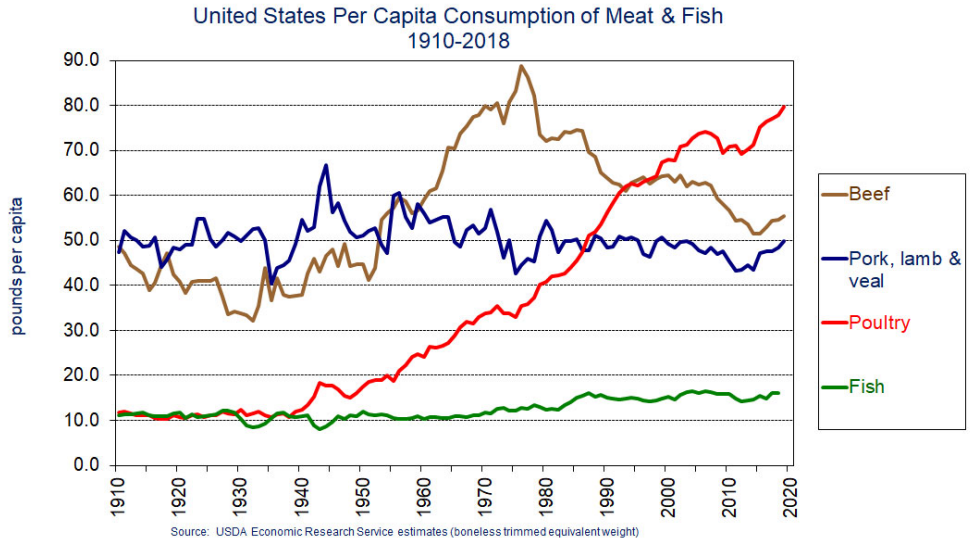
Think about not just fish but also other foods

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.

We need to think about the future of not just fish but also of other foods. Over the long-run, all of these products will compete with each other for both 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.



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We should 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. Why did American poultry consumption rise so dramatically from the 1940s onward? Could American consumption of fish rise in a similar way 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

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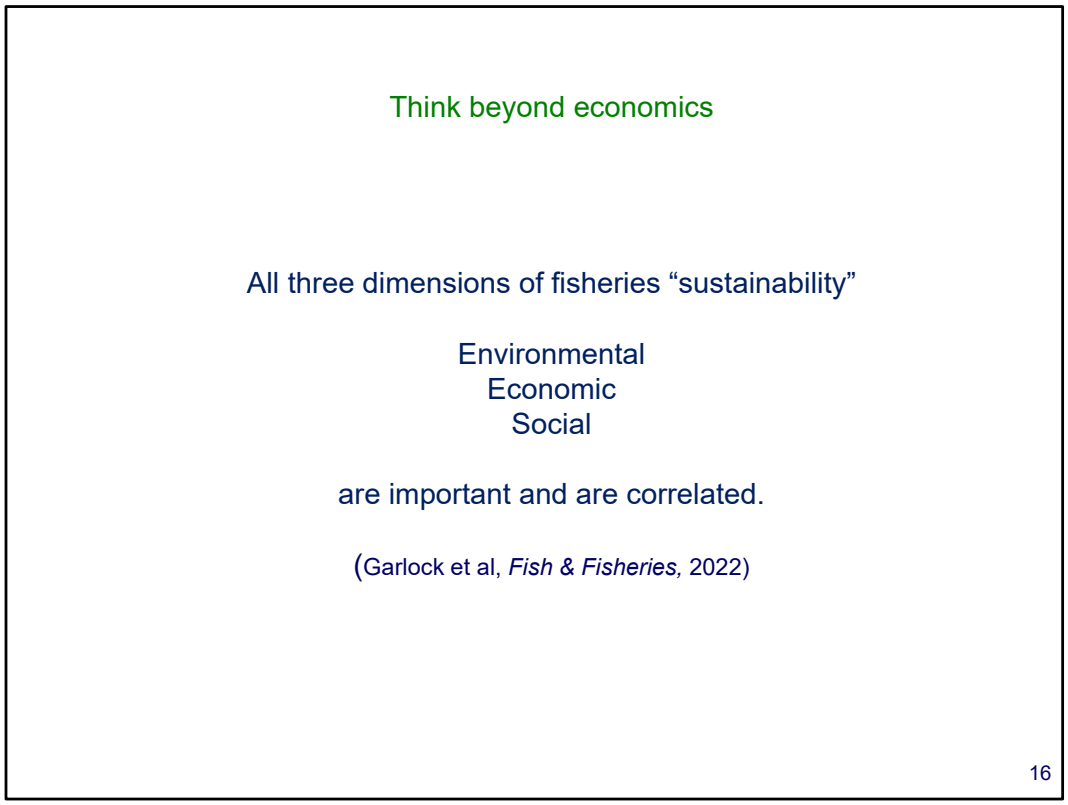
We need to think globally. For any wild fishery and any type of aquaculture, the potential competition is increasingly global—and the potential markets are increasingly global. To see this I only need to look at the smoked farmed salmon for sale in my local Alaska supermarket—from New Zealand, Scotland and Norway.



We need to think beyond economics. Economics can’t explain all the factors that will drive the future of seafood—such as the political resistance to some forms of fisheries management or to some kinds of aquaculture. As Jon Sutinen reminded us yesterday, we can learn from history, and other disciplines such as psychology and sociology.

And economic outcomes are not the only outcomes that matter. All three dimensions of fisheries “sustainability” are both important and correlated—environmental sustainability, economic sustainability, and socially sustainability. Fisheries can’t be economically sustainable unless they are environmentally sustainable. Although we might debate this, my guess is that ultimately fisheries can’t be socially sustainable unless they are economically sustainable. But economically sustainable fisheries may not be politically sustainable unless they are socially sustainable.

2. What factors will drive change?

ECONOMICS
POLITICS
ENVIRONMENT
INNOVATION
MARKETING

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What factors may drive future long-term change in the seafood industry? I'd like to discuss five factors which I think may be particularly important, which I call "economics," "politics," "environment," "innovation," and "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

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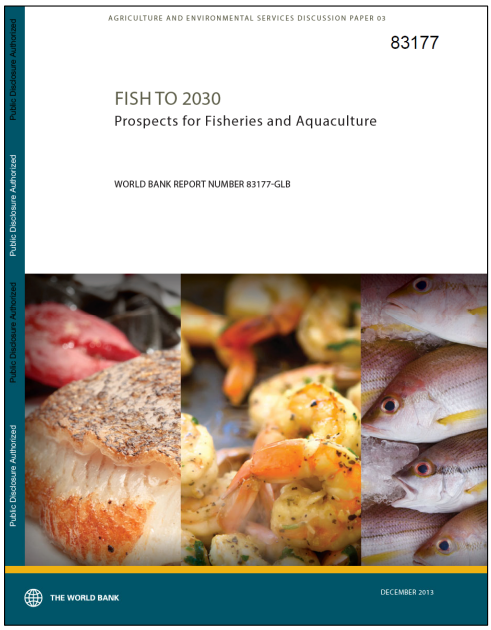
I use the term "economics" to refer to changes in the global economy and regional economies which may affect all industries including the seafood industry and the broader food industry. Among the important long-term economic drivers will be growing global populations and income, which will increase global food demand and production—including seafood demand and production. Regional differences in population and income growth will shift both where seafood and other foods are consumed, and 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

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This 2013 World Bank study projected changes in fisheries and aquaculture to 2030 based on a model of world food production and consumption with multiple producing regions, multiple species group, and relationships between fish meal and meat and aquaculture markets. The model results were fundamentally driven by assumptions about population and income growth rate, price elasticities of demand, and other parameters. What I find particularly interesting and important in the projections is that while projected future growth in aquaculture is dramatic, the projected trends are not uniform across species, producing regions or consuming regions. Put simply, the future of seafood is not the same for all regions or all species.

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

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I use the term “politics” to refer to government policies not specifically focused on the seafood industry but which affect the seafood industry. There is a wide range of these policies. Among the most obviously important are trade policies. Clearly the future of the seafood industry will be significantly affected by whether past trends toward freer trade and globalization continue or are reversed. But other policies may be important as well. For example, in many developed countries, immigration and guest-worker policies affect labor supply and costs for the seafood processing industry.

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

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However, in much of the world the most important way in which "politics" may affect the future of the seafood industry is not through specific government policies, but by whether there is a well-functioning government which enables a well-functioning economy. National governance is critically important for the environmental, economic and social sustainability of fisheries. Neither fisheries, aquaculture nor any kind of industry can reach its full potential if a country is corrupt, if bribery is a major cost of business, if property rights are not protected, or if laws are not enforced.

Jon Sutinen reminded us yesterday of the importance and challenges of enforcement. The best fishery management plans and laws and regulations are useless if governments can't implement and enforce them and build and maintain confidence that they can do so.

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

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I use the term "environment" to refer to long-run environmental change, including effects of climate change. The experts tell us that climate change could bring dramatic changes in ocean conditions, including temperatures, currents and acidification. These changes could potentially dramatically affect the distribution and abundance of wild fishery stocks, growing conditions for marine aquaculture, and growing conditions for land-based aquaculture. In turn, they could potentially dramatically affect global food production and 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.

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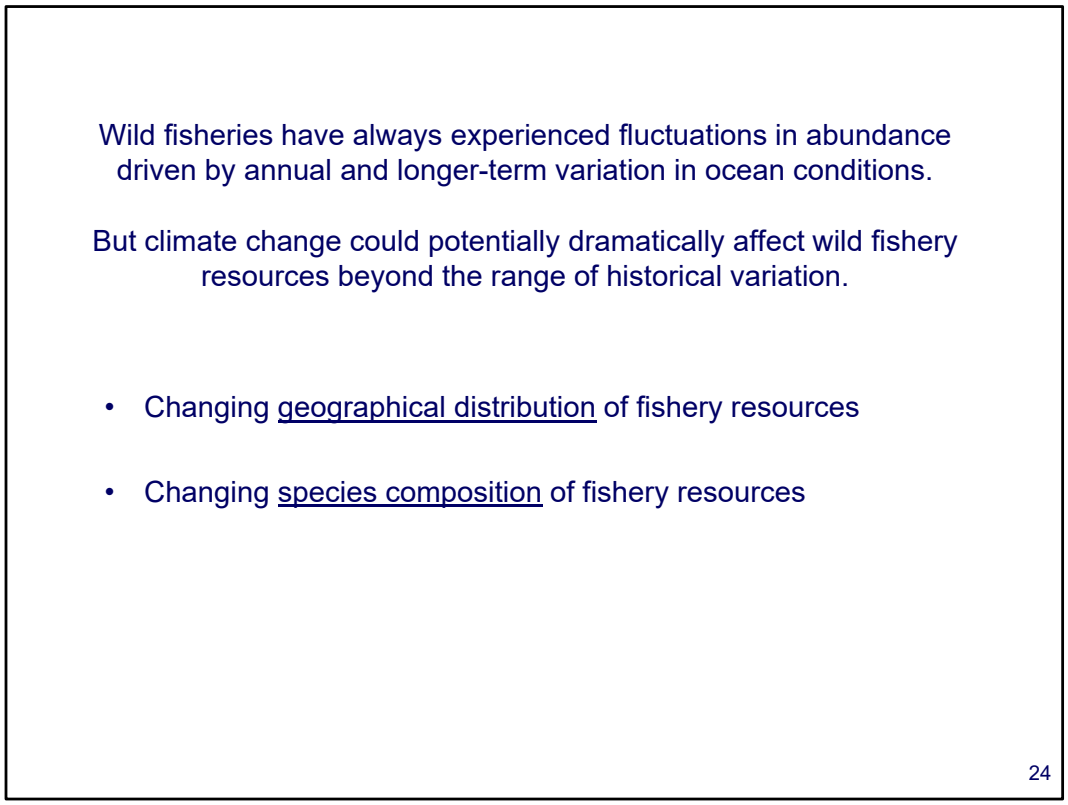
Aquaculture is relatively less vulnerable to long-term environmental change than wild fisheries. Specific types of farming in specific regions may be vulnerable to environmental change, such as the red tides that have occurred with warmer waters and killed fish in pens in some areas. But aquaculture can respond to these kinds of challenges by changing geographic 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 both the geographical distribution of fishery resources as well as the 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)

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We are beginning to see significant impacts of climate change on some wild fisheries, such as the 90% drop in crab harvests in a major Alaska fishery described in this Seattle Times article.

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.

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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

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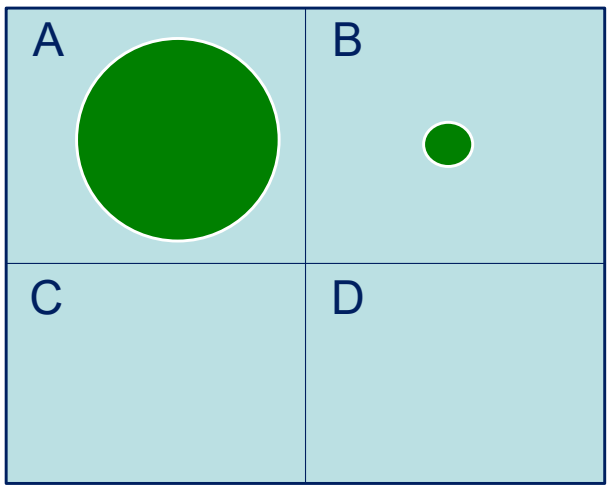
The potential effects of climate change on wild fishery stocks leads to new kinds of questions for wild fisheries management. Here is a question I find particularly interesting. If we expect significant potential change in the geographic distribution and species composition of fish stocks, how can we manage fisheries to better prepare for economic and social adjustment to declining stocks, sustainable management of new stocks, efficient utilization of new stocks, and "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.



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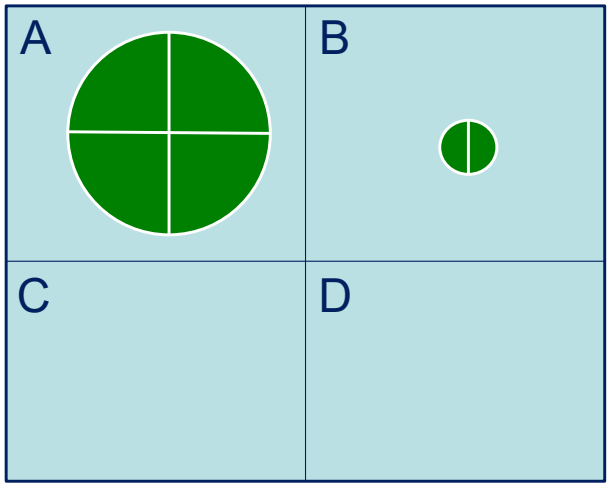
Let me give a simple illustration of how climate change raises new questions for fisheries management. Suppose historically we had an open-access TAC fishery for stocks of greenfish in areas A & B. Because harvests were limited, the fishery was environmentally "sustainable," but as economists we would have been concerned that that the 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.



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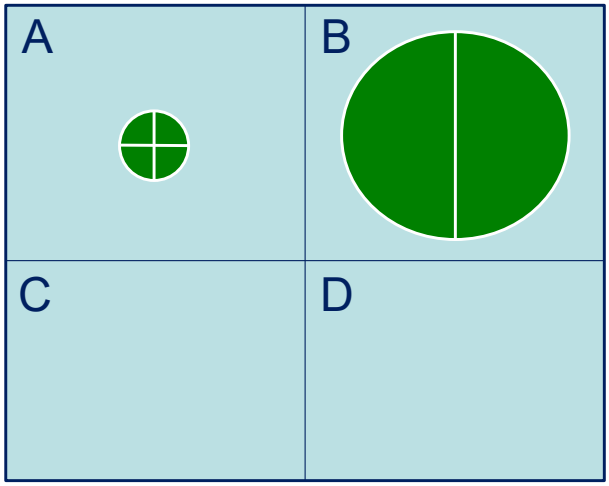
Suppose then that the managers, at our suggestion, implemented IFQ management for stocks of greenfish in areas A & B, with four equal quota shares in Area A and two equal quota share for the smaller stock in Area B. We would have congratulated ourselves that the fishery now became not only "sustainable" 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.



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Suppose next that the stocks of greenfish shifted eastward from Area A to Area B. We would have had to adjust the total quotas, but both fisheries would remain sustainable. They would also both continue to generate rents. There would of course be winners (the quota holders in Area B) and losers (the quota holders in Area A). We might reason that the quota share holders in area A could have hedged against the risk of this stock change by acquiring shares in Area B.

Potential effects of climate change:

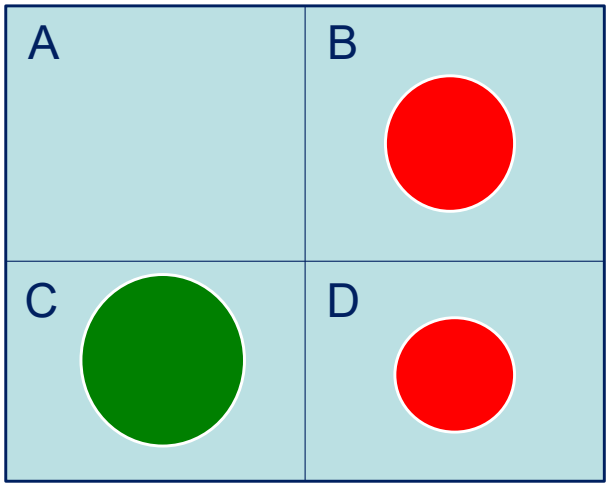
Suppose all fish disappear from area A,
greenfish shift to area C, and
stocks of redfish appear in areas B and D.

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



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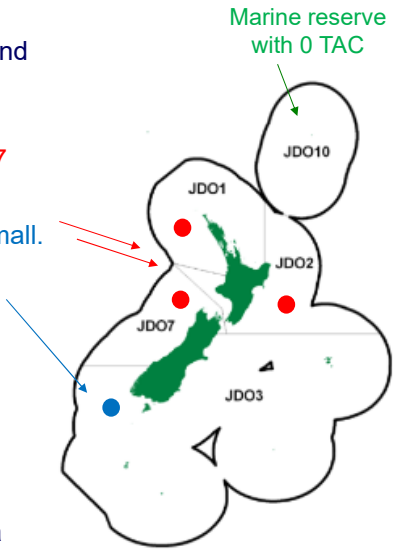
Now we come to the new challenges for management posed by the potential for climate change to dramatically change both the geographic location and species composition of fish stocks. Suppose, because of climate change, all fish disappear from area A, all greenfish shift to area C, and new stocks of redfish appear in areas B and D. We might, fairly quickly, develop TACs for the new stocks, although we might be uncertain about what might be sustainable harvests given rapid change in the resources. But unless we have prepared for this change, we will now have no fishing rights and no mechanism for efficient utilization of any of our fish stocks. And we face the risk of increased rent dissipation if fishermen race for anticipated future quota shares for greenfish in Area C, and for redfish.

This illustration suggests to me that we should think about the potential for this kind of situation to arise in all of the waters for which we aspire to manage fisheries—both national and international. The question is not just how well our current management is working under the range of resource conditions we are familiar with. It's also how well it would work if resource conditions were to change dramatically, and what we could do in advance—before we know how conditions might change—to make it work better.

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

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The New Zealand management system for John Dory provides an example of how we might deal with the challenge in the previous illustration. New Zealand defines stocks for all species for the entire area around New Zealand, even if catches are minor or zero. Currently almost all John Dory catches are in areas 1, 2 and 7 in the north. Quotas and catches in area 3 in the south are very small. If stocks shifted south to area 3 the total allowable catch would increase. If a new fish stock is created, by law 20% of the quota will go to Maori and 80% of the quota will go to the government which would likely auction it. So New Zealand has already determined who would get the rents from any new stocks in New Zealand waters. But what remains unresolved is what would happen if stocks were to move into 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

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I use the term “innovation” to refer to innovation anywhere in the supply chains for seafood and other foods, potentially affecting how foods can be harvested, farmed, processed, packaged, transported & sold to consumers, as well as 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."

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One of the reasons I began trying to think about the long-term future of seafood, and what might drive it, was that I was so struck by an article by Tom Friedman in the New York Times about how technological innovation is transforming the global economy. Focusing on innovation in computing technology, he wrote that "we're moving into a world where computers and algorithms can do ever more to analyze, optimize, prophesize, customize, digitize and automatize. As an example for "prophesize" he suggested that technology will be able to tell you when your elevator will break or what your customer is likely to buy. He concluded that *"any company that doesn't deploy all six elements will struggle, and this is changing every job and industry."*

I was really struck by that conclusion. It got me wondering to what extent the seafood industry was deploying all of these six elements, and whether there were ways to do so, and if so how they might change the industry, and whether it was true that it would struggle if it didn't apply all six elements. So I began to try to think about innovation in the seafood industry.

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

Feeding salmon at the same Chilean farm:

1990s

2000s

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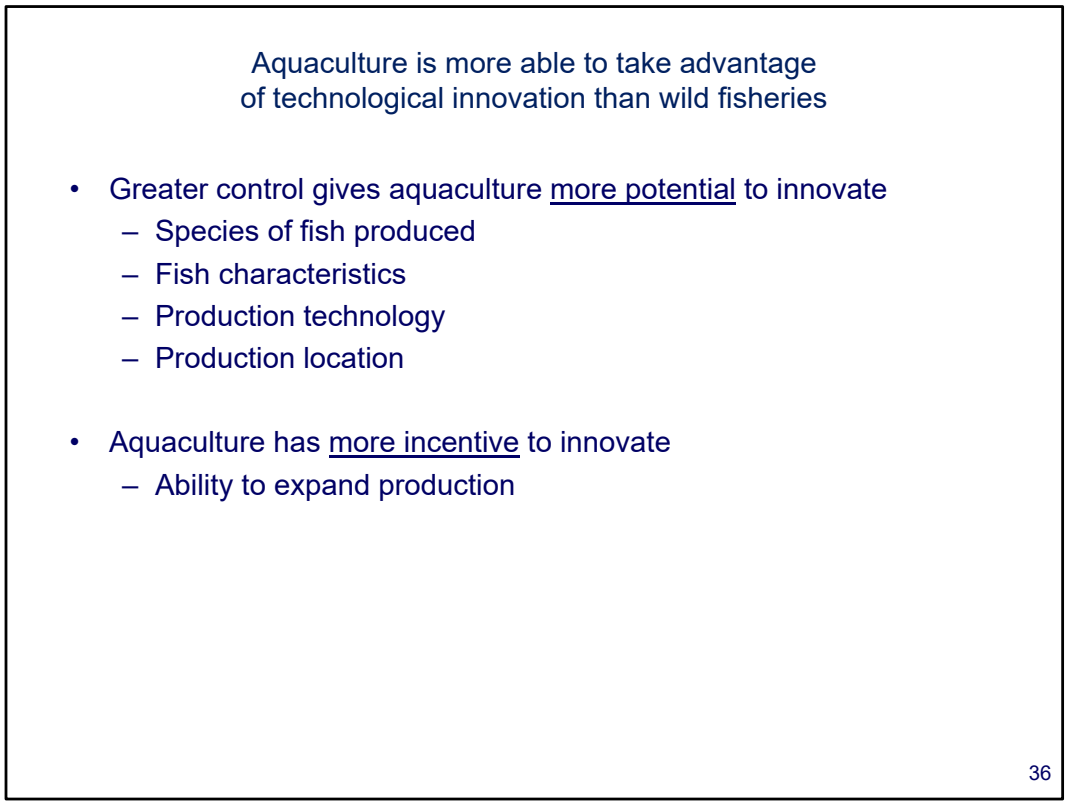
I reflected that I've seen dramatic innovation over my career—but mostly in aquaculture. I reflected how the workers at the first salmon farm I ever visited, in Chile, were feeding salmon by hand, and how amazed I had been when I returned to visit that same farm about 15 years later, to find an automated feed system which pumped to the net pens through hoses from a single feed storage barge, and underwater cameras monitoring how much of the feed the fish were eating, and turning off the flow of feed when the fish began to lose interest in eating.



The reason that I've observed so much more innovation in aquaculture than in wild fisheries is that aquaculture is far more able to take advantage of technological innovation than wild fisheries—because aquaculture has so much greater control of production Greater control gives aquaculture more potential to innovate—in the species of fish produced, the fish characteristics, the production technology (such as whether to produce in inshore farms, offshore farms, or land-based facilities), and the production location (such as near to end markets, or in countries which encourage aquaculture). In addition, aquaculture has far more incentive to innovate because of its ability to expand production to reap more benefits from innovation.

Rapid innovation is occurring in every part of aquaculture

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

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So rapid innovation is occurring in every part of aquaculture: species, genetics, feeding, disease management, production environment, harvesting, and geographic location—to name just a few.

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.

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Some kinds of aquaculture innovation get most of the public attention, such as impressive new technologies for offshore farming and land-based farming—even though progress with these technologies seems to be slower than originally hyped. But I think it's other kinds of innovation, far less visible to or appreciated by most of the public—which are most important in steadily transforming aquaculture.

For example a recent industry report which described a machine for monitoring fish behavior in pens which *"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 in the system can provide an alert to the fish farm."* That struck me as exactly the kind of computing technology innovation which Tom Friedman had written was transforming the global economy, and which every industry would need to deploy.

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

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What drives innovation in aquaculture? First and foremost are problems to be solved. Innovations happen when and because they are needed—not before. It doesn't pay to invest in developing technologies you don't need yet. Critics often point to potential future problems that no one knows how to address. History suggests that very often—though not always—when there's a need, a way will be found.

A second extremely important driver is continuous learning from experience. The more we do anything, the better we tend to get at it, as we keep experimenting. Land-based farming has a huge head start—thousands of years—in learning from experience. There is tremendous opportunity for aquaculture to learn a lot more from a few more decades of experience. Aquaculture benefits from significant investment in both basic and applied research, with financing from aquaculture producers, the feed industry, venture capital, and governments. And aquaculture adopts new 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

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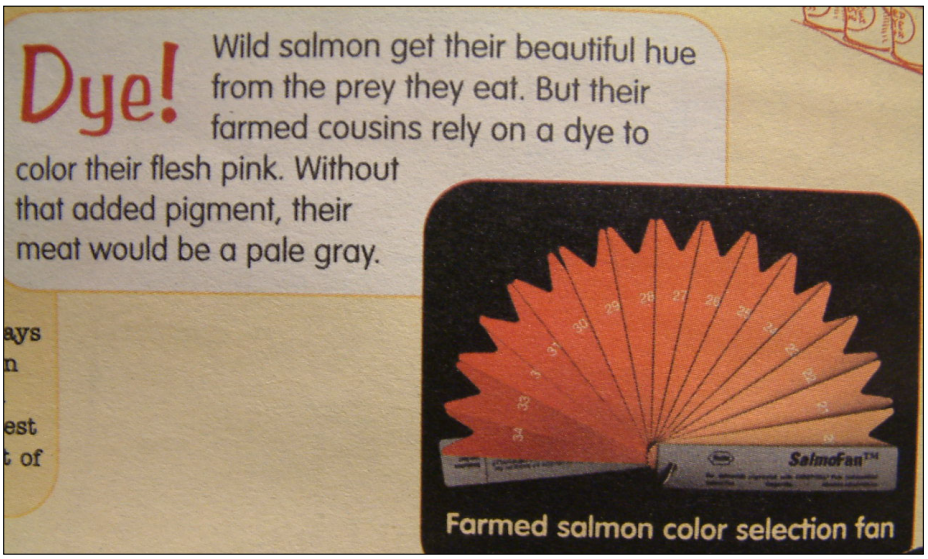
Of course, not all innovations succeed. The biggest investments tend to get the most hype—because they need to attract investors. Many highly publicized innovations in farming new species or farming in new ways have met unanticipated problems and have not been profitable. Technology advances—but progress is bumpy.

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



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Many years ago at an industry trade show I picked up a so-called “SalmoFan” which illustrates the flesh colors salmon farmers could get from different feeds—allowing them to grow fish to meet the color preferences of different geographic markets. Later I found this used an illustration in a brochure put out by salmon farming opponents. To them it showed 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.

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I believe that salmon farming critics miss the real lesson of the SalmonFan, which is that 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

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There is also significant potential for innovation in wild fisheries, both in harvesting and in management. For example, we can imagine innovation in fish finding, stock targeting, gear selectivity, vessel design and energy efficiency. For management we can imagine innovation in enforcement, catch reporting, stock assessment and 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

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However, without sustainable and rights-based management, the potential benefits from innovation in harvesting may be dissipated by over-fishing and overcapitalization. I still recall how strongly I was struck by a statement Jim Anderson quoted in his memorable keynote address at the IIFET meetings in Vietnam in 2008 that in many of the world's fisheries "technical progress has been futile." What a contrast between the implications of technical progress in these fisheries compared with most industries!

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

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However, even if wild fisheries management is sustainable and rights-based, it may still significantly and insidiously hamper technological innovation by restricting how fishing may be done. For example, restrictions on the kinds of gear or vessels harvesters may use may hamper innovation in gear or vessels.

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.

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In Alaska's Bristol Bay, wild salmon are harvested in gillnets. The salmon are bruised as they are caught in and removed from gillnets—which lowers their value. *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. More than 40 years ago, Alaska's limited entry legislation created transferable limited entry permits for fisheries defined by gear types—and salmon harvesting technologies haven't changed significantly since then.

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

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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. So 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.

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We can't predict—or maybe even imagine—the long-term changes technological innovation may bring to the seafood industry. Perhaps some day we could see self-driving smart fishing gear, or integrated algae-based open ocean aquaculture, or fully-automated seafood processing and distribution.

There could be potentially enormous new opportunities for supply chains able to adopt new technologies. And there could be potentially enormous new challenges for supply chains unable to adopt new technologies utilized by their competitors.

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

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The final factor affecting the future of seafood that I want to discuss is “marketing,” which I define as efforts to grow demand for seafood and other foods. Marketing will be 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

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I'd like to give four examples of potential strategies for growing demand for a fish species. We can see all of these strategies in the seafood industry particularly among aquaculture producers. One strategy is to build your brand: to change consumer preferences so that consumers substitute your fish for other foods. Painting wild salmon on the sides of airplanes is one of the many ways the Alaska Seafood Marketing Institute has tried to influence consumers to prefer wild Alaska salmon.

Many people think of marketing as being entirely this strategy—convincing consumers to prefer your fish. But it's not the strategy which has driven most of the dramatic growth in global demand for salmon and other farmed fish.

Strategy for growing demand . . .
Sell your fish in more places so more consumers can buy them

Norwegian salmon for sale in Dubai

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Another strategy is to sell your fish in more places so more consumers can buy them. This strategy has been tremendously important for the salmon industry in growing global demand for salmon. Formerly salmon simply weren't available in most countries, in most kinds of food stores, and in most kinds of restaurants. The limited production of wild salmon fisheries was mostly sold in relatively few countries and relatively few kinds of stores and restaurants. Now farmed salmon is widely sold in countries all over the world and all kinds of stores and restaurants—making it much easier for consumers to buy. And one of the most important interactions between farmed and wild salmon is that by introducing salmon to new consumers all over the world, salmon farmers also greatly expanded markets for wild salmon.

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

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Another very important strategy for growing demand is to sell your fish in more product forms to meet more consumer demands for food attributes such as variety, ease of preparation, and suitability for different kinds of meals. The farmed salmon industry has engaged in continuous innovation of new product forms which are now widely available. And this has also benefited the wild salmon industry, which has begun to produce many of these same product forms.

Strategy for growing demand . . .

Sell your fish combined with other foods that consumers demand

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A fourth strategy which we have begun to see relatively recently is to sell your fish combined with other foods that consumers demand. In this way demand for your fish grows as demand for the other foods grows, and prices of the consumer product are less subject to fluctuations in the price of your fish. When Kraft markets Philadelphia Cream Cheese, it is helping to grow demand for salmon.

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

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We can learn a lot about how the seafood industry is marketing fish, and what this might mean for the future of the seafood industry, if we simply observe how fish and other foods are being sold—both where we live and as we travel. I seem to have thousands of pictures I've taken of fish products in stores around the world, but I keep being surprised by what I see. I want to show you a few pictures of what I saw in my local Safeway supermarket in Alaska last week, and speculate on what they might suggest about seafood marketing and future seafood demand.

I was amazed to find that the store was selling identically packaged and priced products of these three kinds of fish—farmed tilapia, wild cod, and wild salmon. To me, this suggests that the seafood company—Morey's—buys all of these species of fish, and is trying to convey the message to consumers that the products are all of similar quality and are all good options. If I'm familiar with salmon and have never tried cod or tilapia, seeing these products displayed like this might encourage me to do so.

Certainly this strategy has worked with my wife, who keeps bringing home new kinds of fish for me to try, which generally surprise me with how good they taste. And she keeps challenging me to guess what species I'm eating—which I often can't. Of course, this may have a lot to do with the sauces on the fish, which can help almost any kind of fish taste good.

If this is the strategy we are observing in this picture, it suggests to me that it may greatly increase total demand for seafood over time, as more consumers become more familiar with different kinds of fish. But it will also make different kinds of fish closer substitutes, selling for similar prices, and may help lower cost species more than higher cost species. The tilapia farmer may benefit more than the wild salmon fisherman.

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

Identically-priced meat & fish products

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I was even more surprised to find—at the meat counter—that the store was offering so-called “multi-meal deals—your choice of any four packages of beef, chicken, pork or seafood” for a single price. To me, this conveyed a similar message that all of these products are good options and that the wild pacific cod product on the lower left and the so-called “snow legs crab flavored seafood with surimi” on the right are good options of similar quality to the beef, chicken and pork products displayed around them. To me this suggests that the store is trying to encourage consumers to try, and become familiar with, not only the meat products that they sell but also the seafood products that they sell and would like to sell more of. This kind of strategy, which I’m guessing I’ll see more of in the future, might tend to expand demand for seafood over time.

We face potential competition from new kinds of foods

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I wasn't as surprised to find so-called "impossible burger patties"—made from plants. I had tried them once and thought they were pretty good. And just the previous evening, at dinner with my daughter and her friends, I had heard them talking about impossible burgers and how much they liked them. So I wondered about whether this kind of plant-based meat might ever become a significant substitute for and competitor of seafood.

New kinds of foods may compete directly with seafood

Not impossible: plant-based "f'sh"

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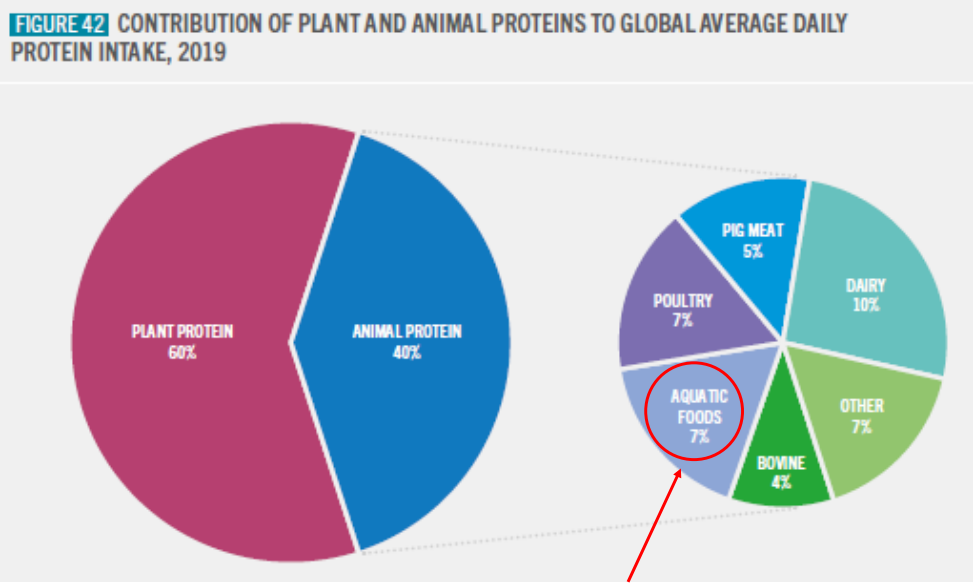
To my astonishment, I then came upon a plant-based product which is clearly trying to just that—compete with and substitute for seafood. If I hadn't needed to work on this presentation and pack for this trip, I would have bought some and brought it home to see what it tasted like. My guess is that with the sauce, it will taste just fine.

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*

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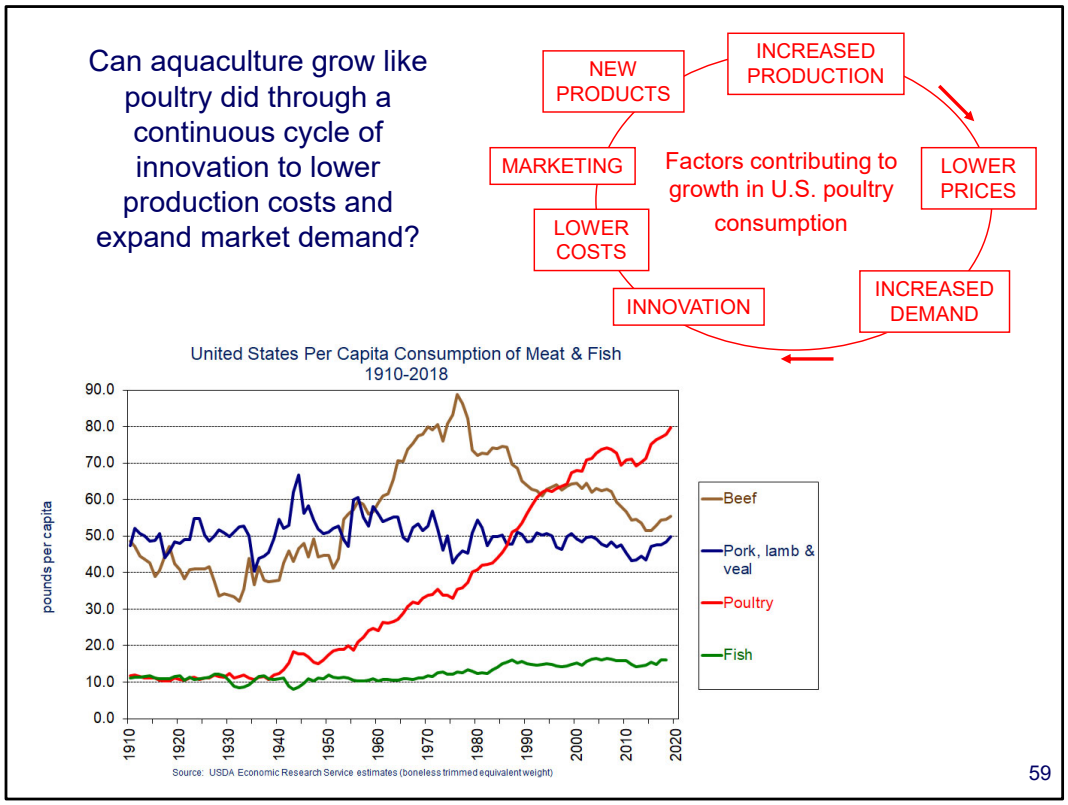
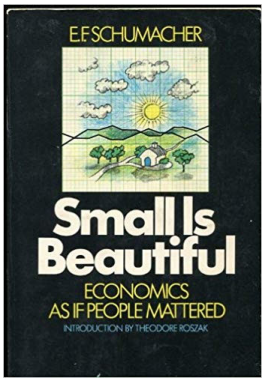
The FAO estimates that seafood accounts for about 18% of global animal protein consumption. If seafood producers can produce fish for competitive prices and market them effectively, there is enormous potential for seafood's share of world protein consumption to grow.



This is what I view as the fundamental question for the future of seafood. Can aquaculture—with its vast potential for innovation—grow in the same way that poultry did in the United States over the past 80 years, through a continuous cycle of innovation to lower production costs and marketing—particularly new product development—to 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



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The future of the seafood industry is a future of new opportunities and new challenges as market opportunities expand while market competition also expands. It is a future of change and risk. Many people deeply believe that "small and local and traditional are beautiful" and advocate for management policies to keep fish production—and particularly wild fisheries—small and local and traditional. For some—ironically, I would suggest, more among wealthier countries—many kinds of aquaculture can't meet this standard.

But like small family farms selling to local markets, it may become increasingly difficult for small family fishing operations selling to local markets to succeed in global seafood markets with larger, integrated and diversified operations. To survive and prosper in a world of change and risk it helps to have deep pockets, to be vertically integrated, to be geographically diversified, and to be innovative.

As in agriculture, there will always be opportunities for small and local and traditional fish producers, and consumers who will support them, and these opportunities may grow in some areas. But in a changed future, just as in farming, small and local and traditional may become less economically or socially feasible and sustainable objectives for fisheries and aquaculture management. The policy tradeoffs may change over time.

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

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In conclusion, I would suggest that in a changed future, the consequences will increase for management policies which ignore how the seafood industry is changing, which slow or prevent adaptation and innovation to respond to new challenges and opportunities, and which treat aquaculture as a threat rather than an opportunity.

I greatly appreciate this opportunity to share these speculations about the future of the seafood industry with you—and I look forward to opportunities during the rest of this meeting, and at future IIFET meetings, to hear your thoughts on these issues, and to learn from your very wide-ranging perspectives and experiences. For me, these opportunities have been the great value of IIFET, along with the lifelong friendships and the feeling of having true colleagues from all over the world. Thank you.