Food and Agriculture Organization of the United Nations

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Stakeholder Consultation on Progressive Management Pathway (PMP) to Improve Aquaculture Biosecurity

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Sustainability is required in three dimensions in any sustainable industry

1. Economic
2. Environmental
3. Society

- For all industries expected profitability is necessary to get started and to continue operation
- Lack of environmental sustainability is mostly acting slower, and will normally not be tested before expected short-run economic sustainability has been demonstrated
- Societal sustainability is harder to relate to and normally kicks in when one are doing something unusual or new that may challenge what is acceptable

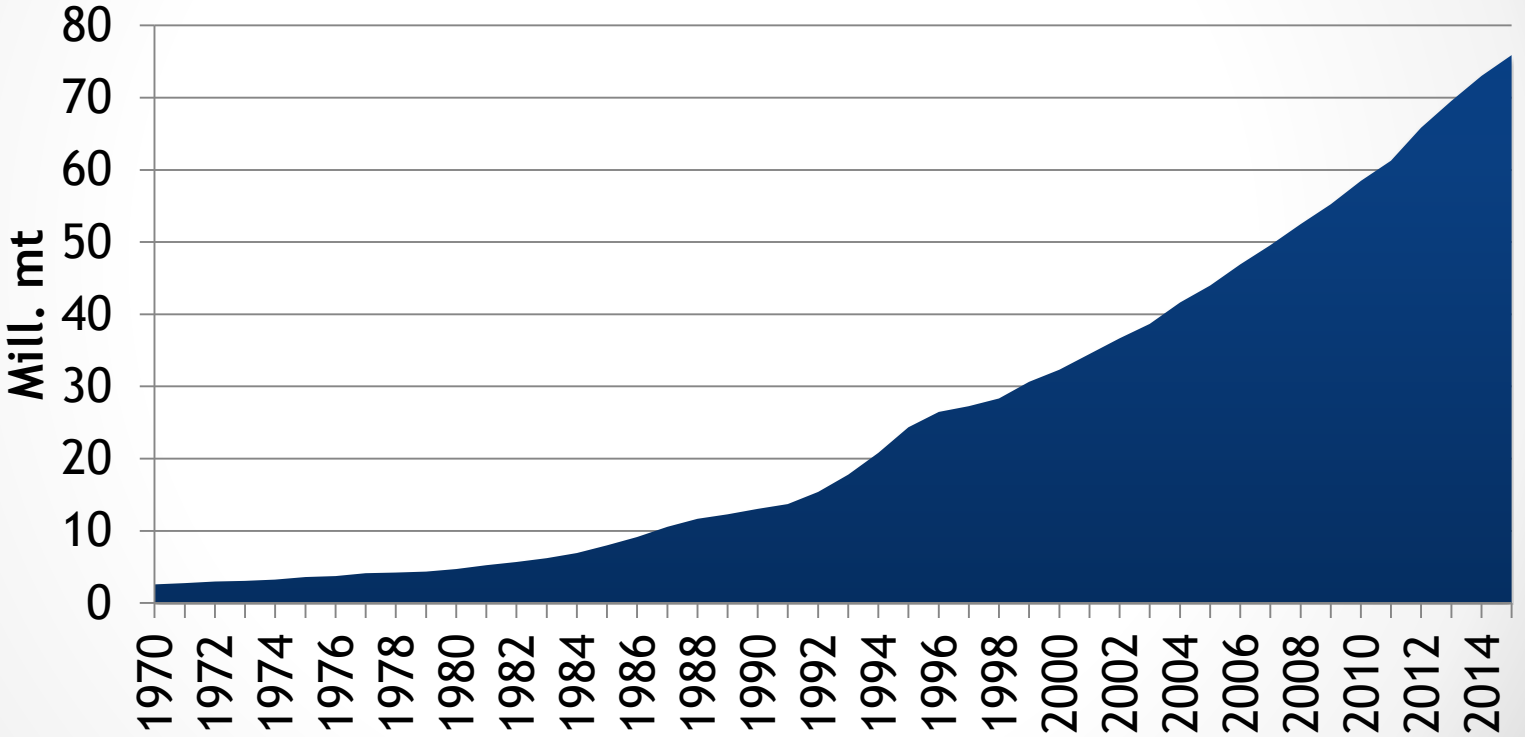
Disease is a part of any biological production process

- If one cannot handle the disease, an industry will not be sustainable
  - The many outbreaks in aquaculture is a sign of immaturity
- Diseases impacts all three pillars of sustainability

- For diseases one can ”handle”, prevention and treatment costs will be a part of a company’s operation costs, and it becomes a part of the governance system pertaining to that industry
  - Disease is just a form of risk, making costs related to disease risk handling costs

- As for all other input factors, the optimal effort is the level where the marginal value of the effort equals the marginal cost
  - As in all biological production, this optimal level of disease is virtually never zero

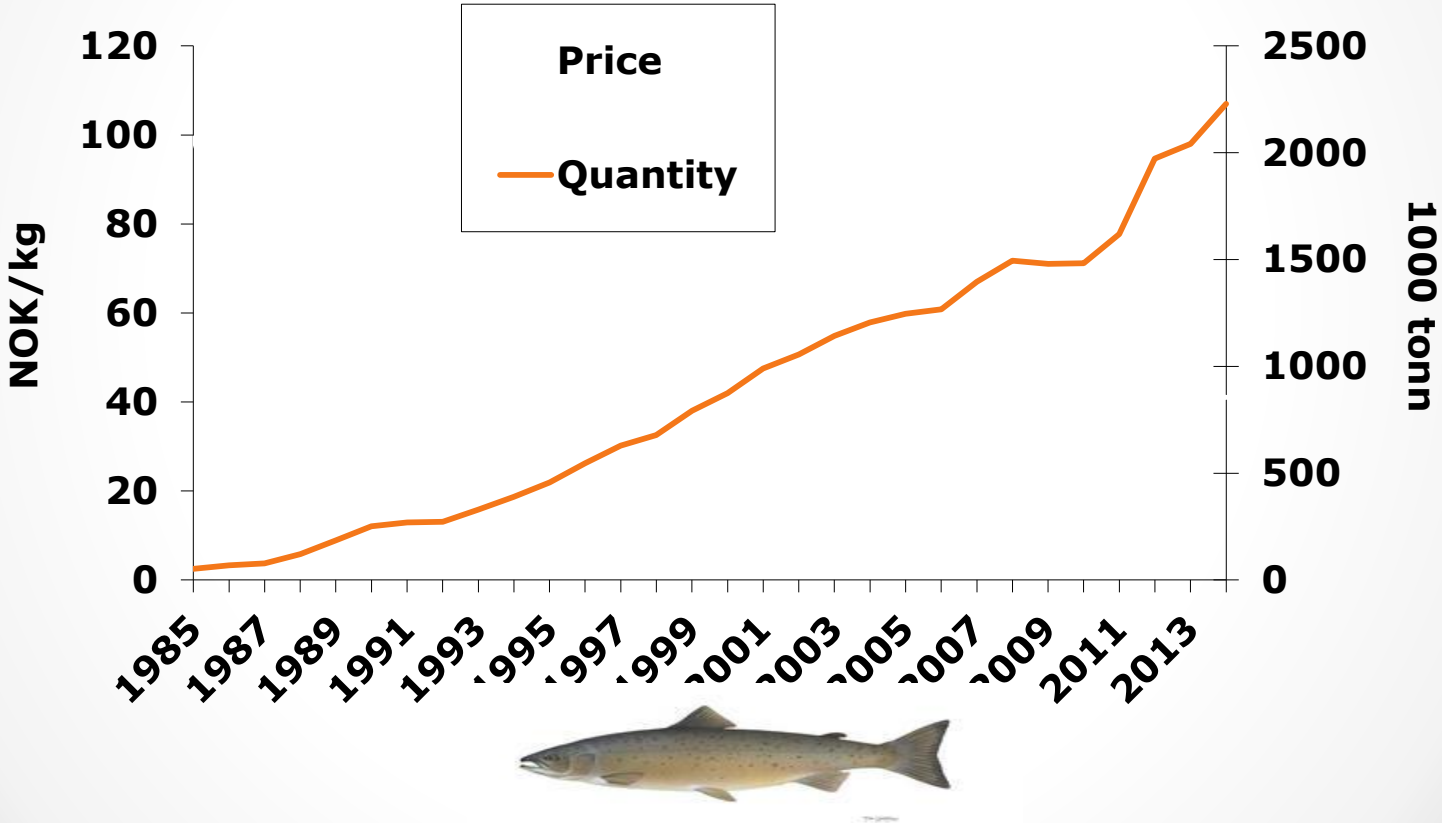
Aquaculture is a global success story
Global production 1970-2015



Innovations leading to productivity growth is the main driver for increased aquaculture production

- The same story as for salmon can be told for most other successful species (Kumar and Engle, 2016)
- The innovations may be different for various species, but they lead to better control with the produciton process
- In principle, the same control with the production process that has enabled systematic R&D to create innovation can be used to address disease challenges
  - In practice to what extent this happens is to a large extent determined by the governance system

Global salmon production and Norwegian export price and production cost 1985-2014 (2014=1)



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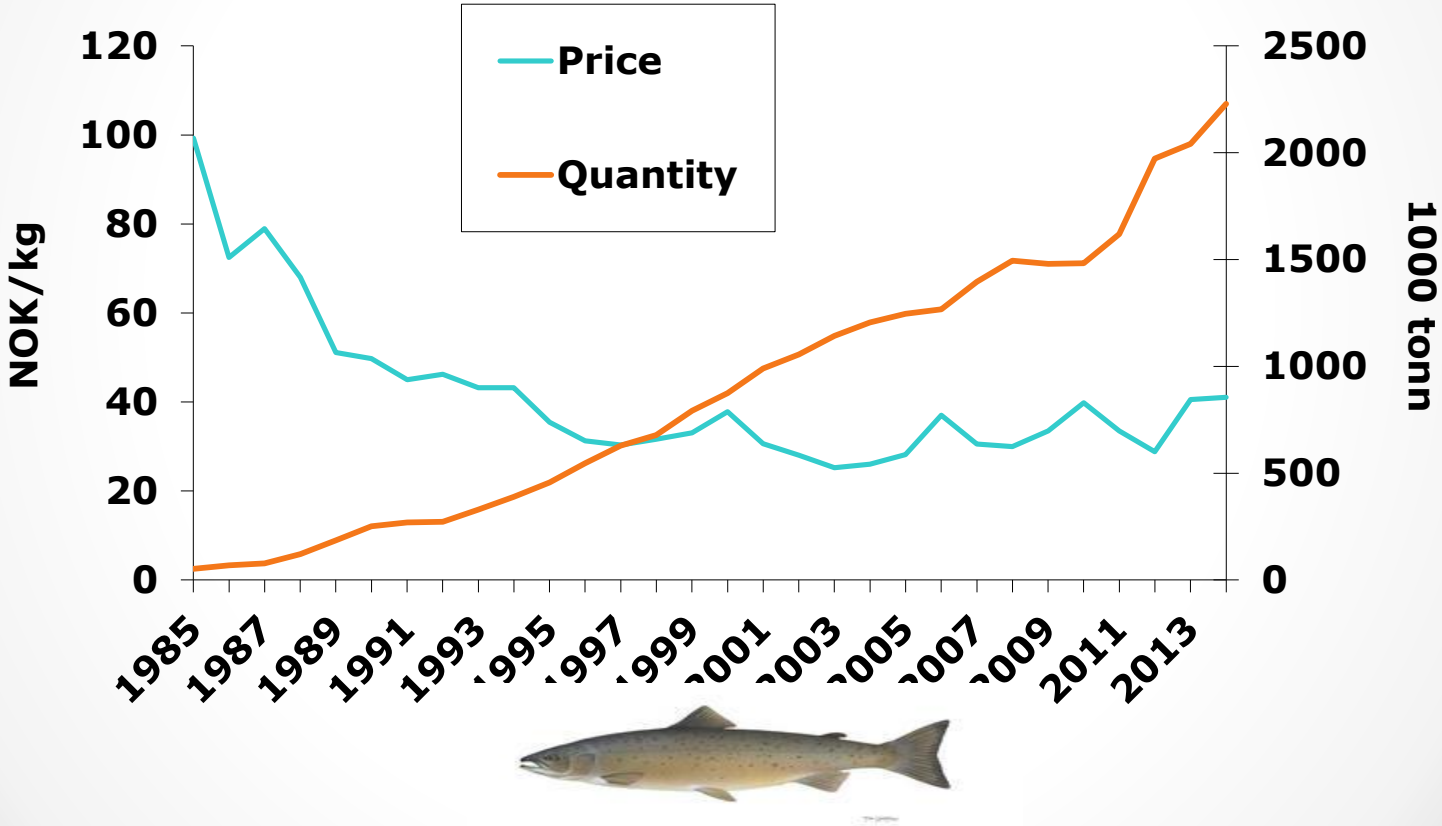

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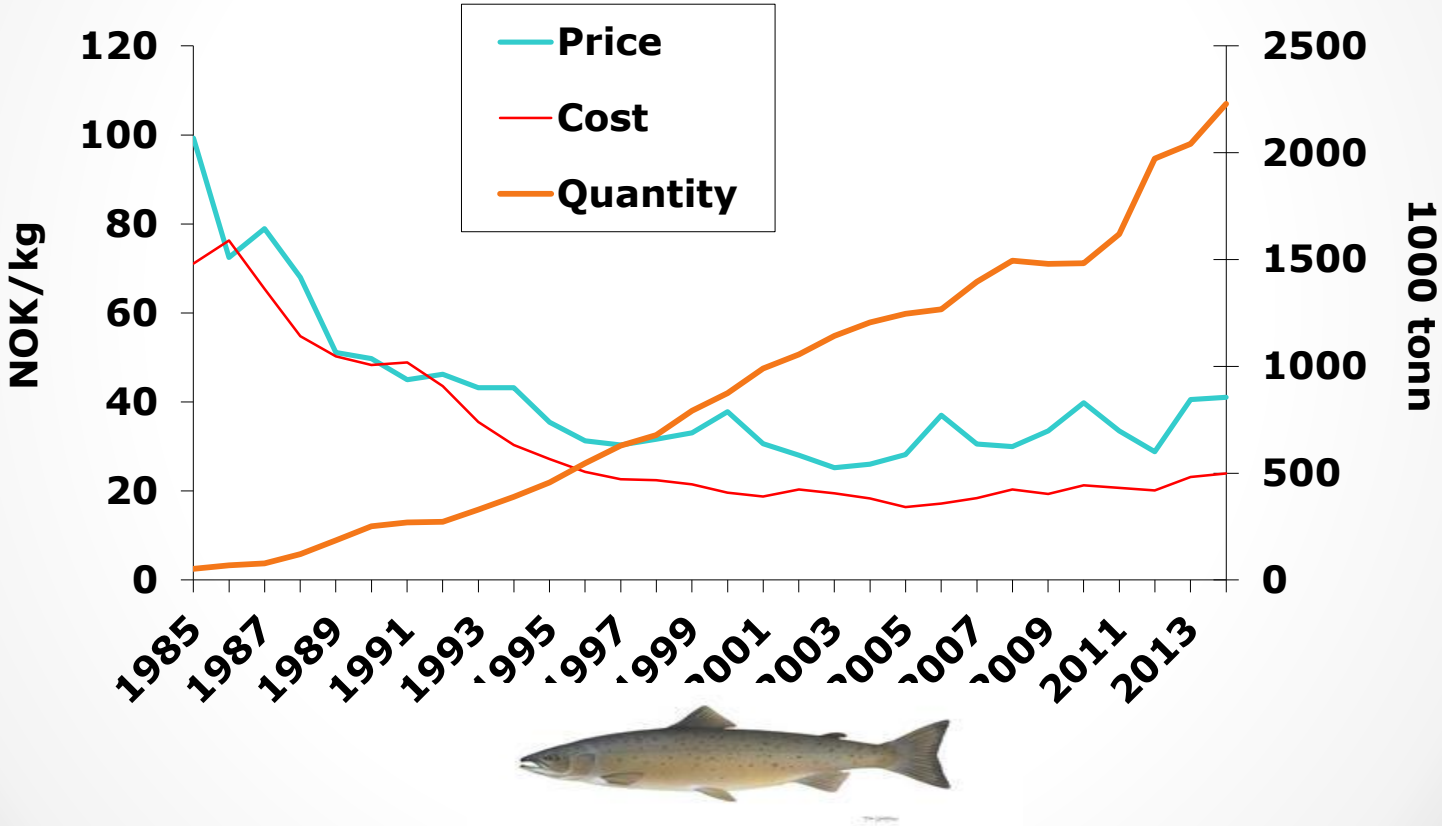
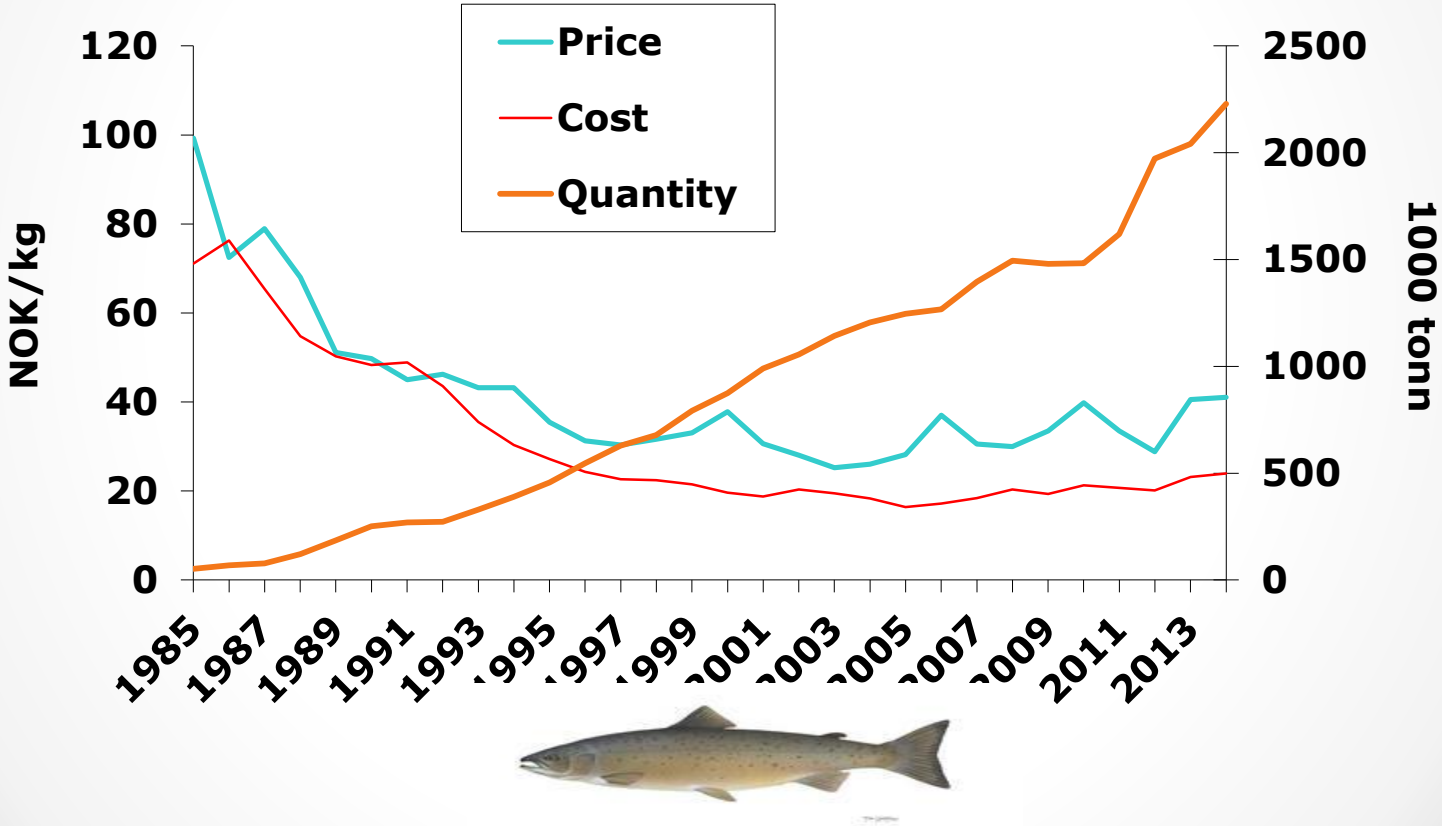


Diseases threatened the industry's existence in the early years, and they still impact prices



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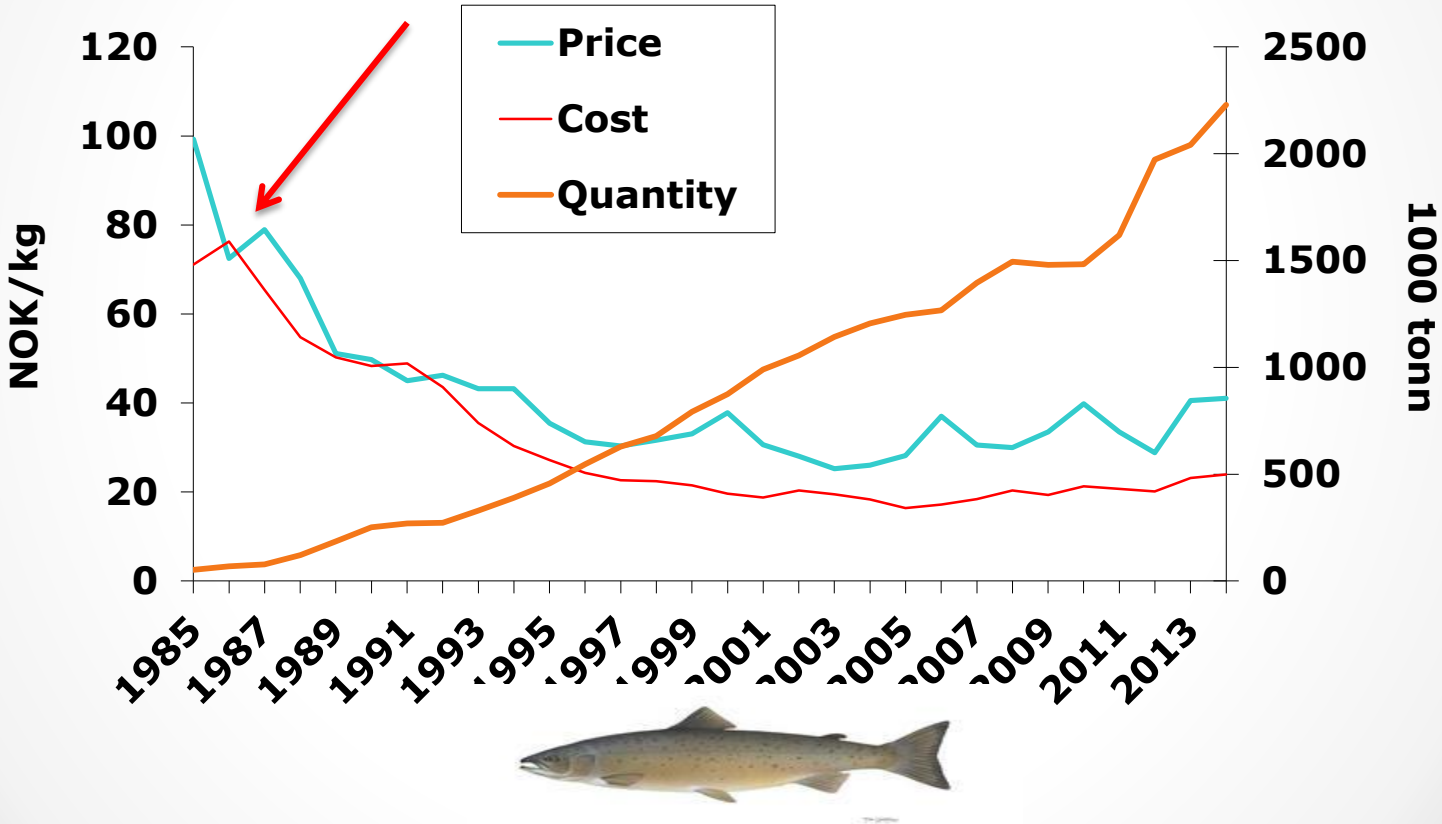

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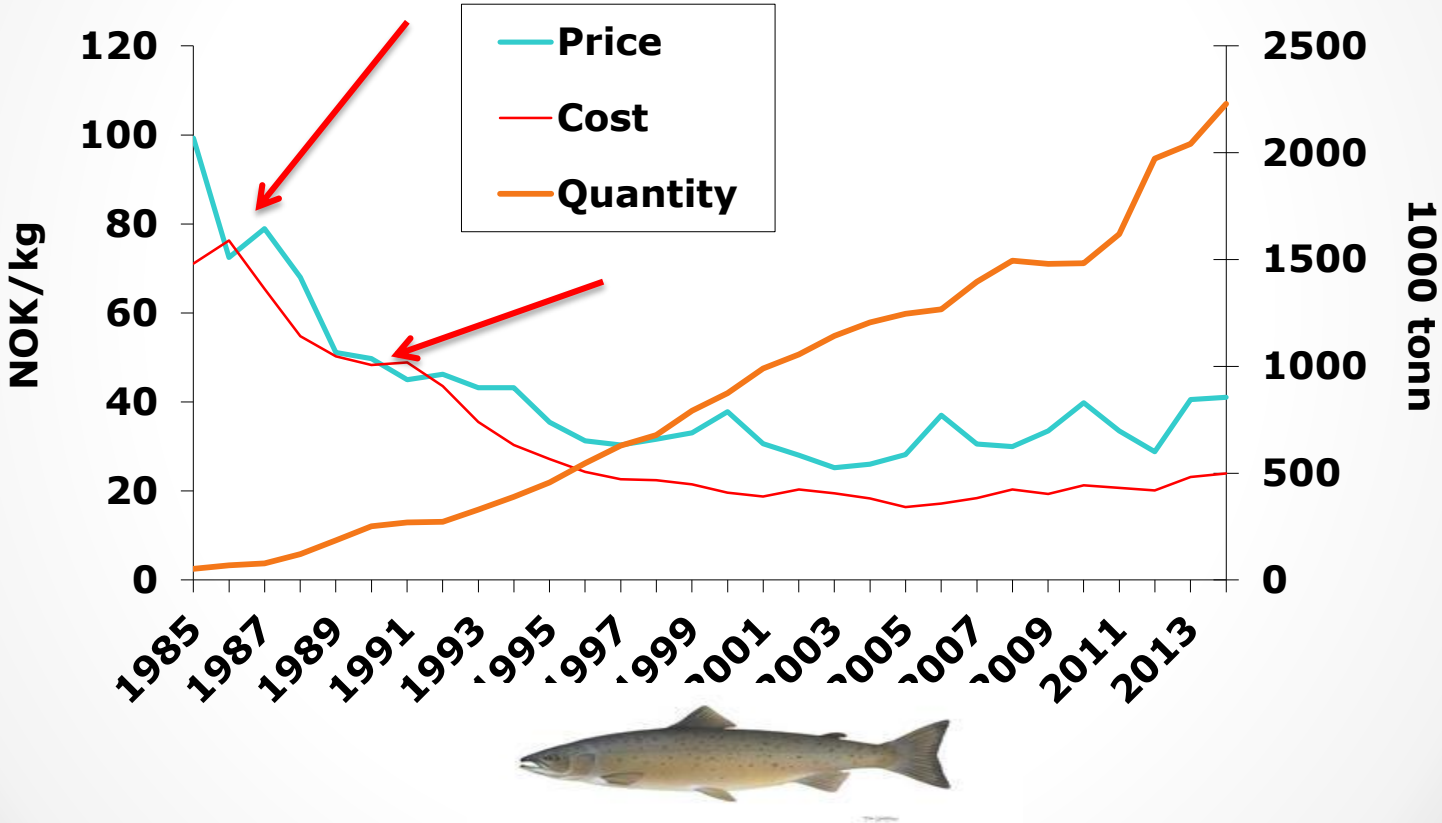

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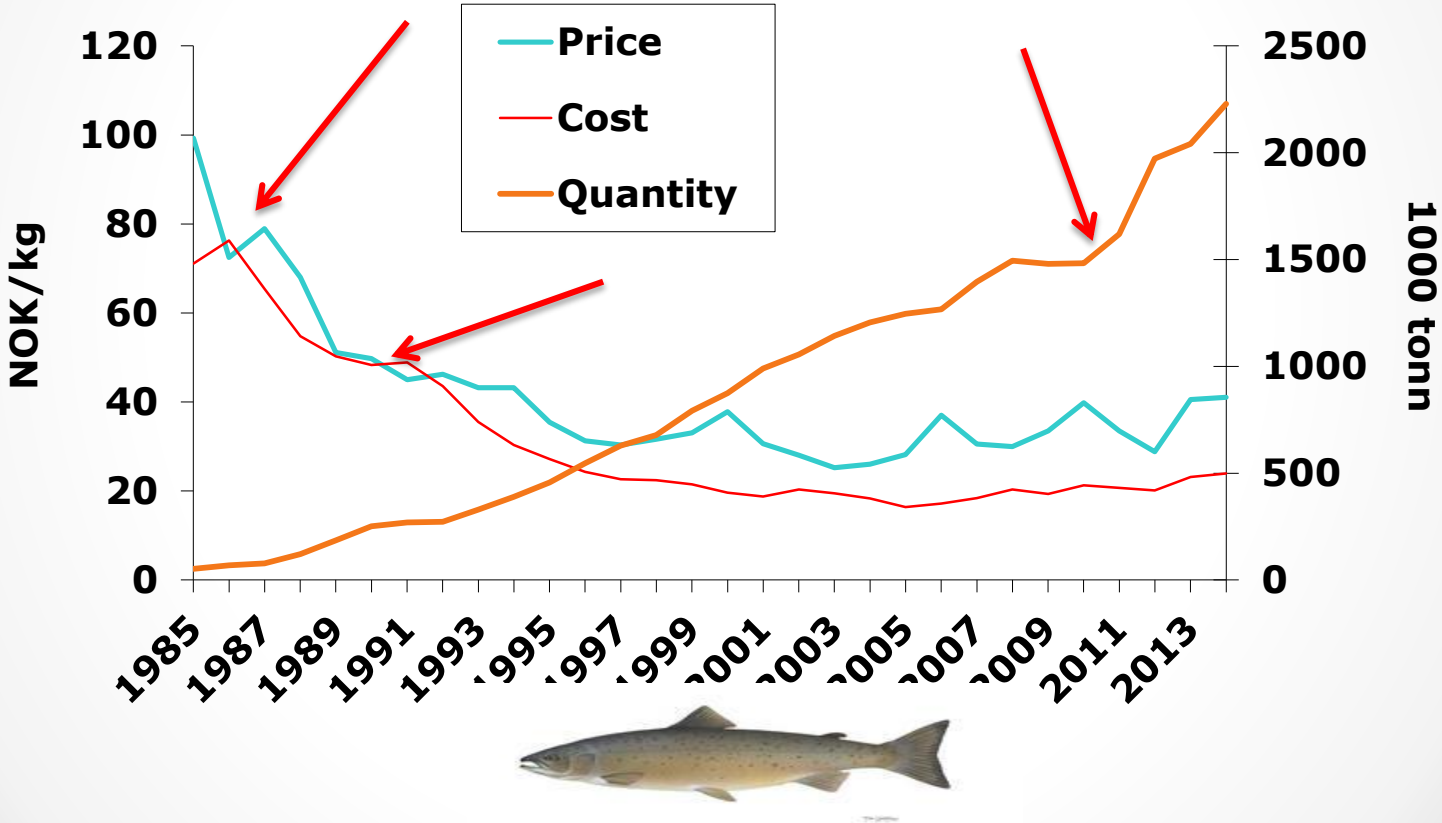
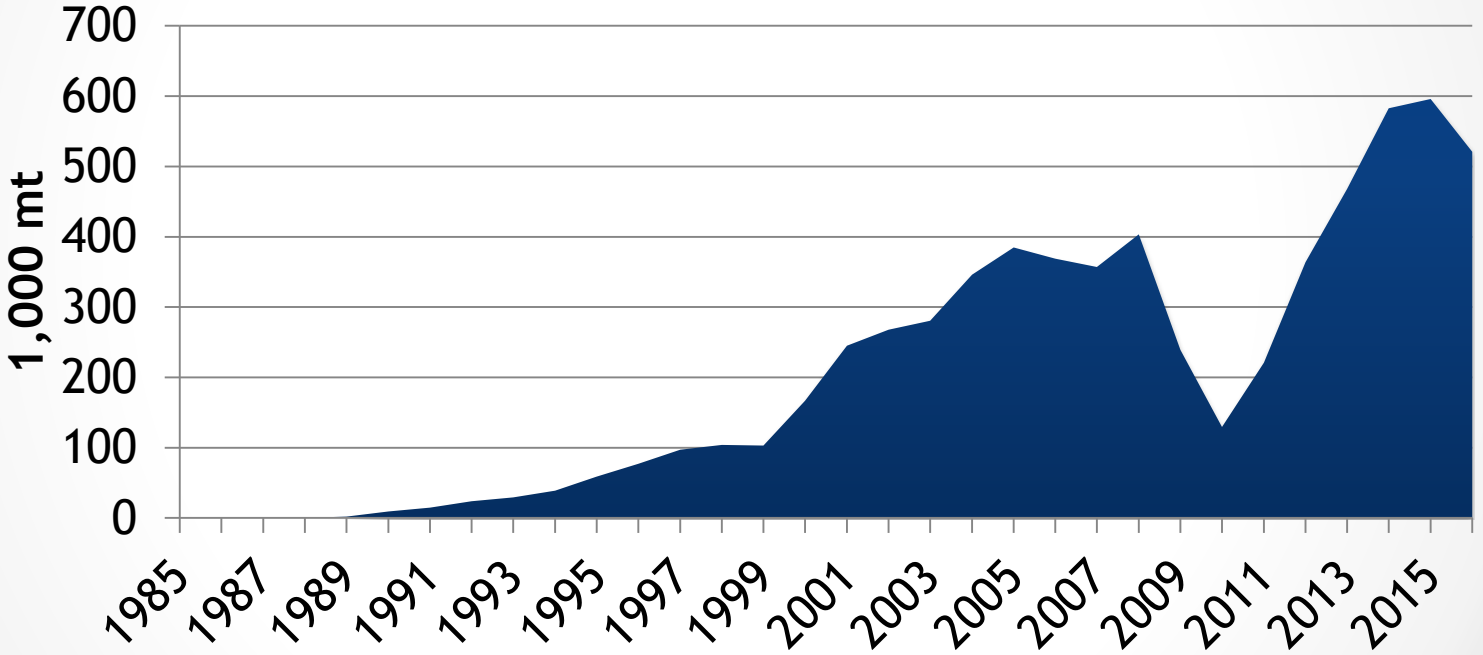
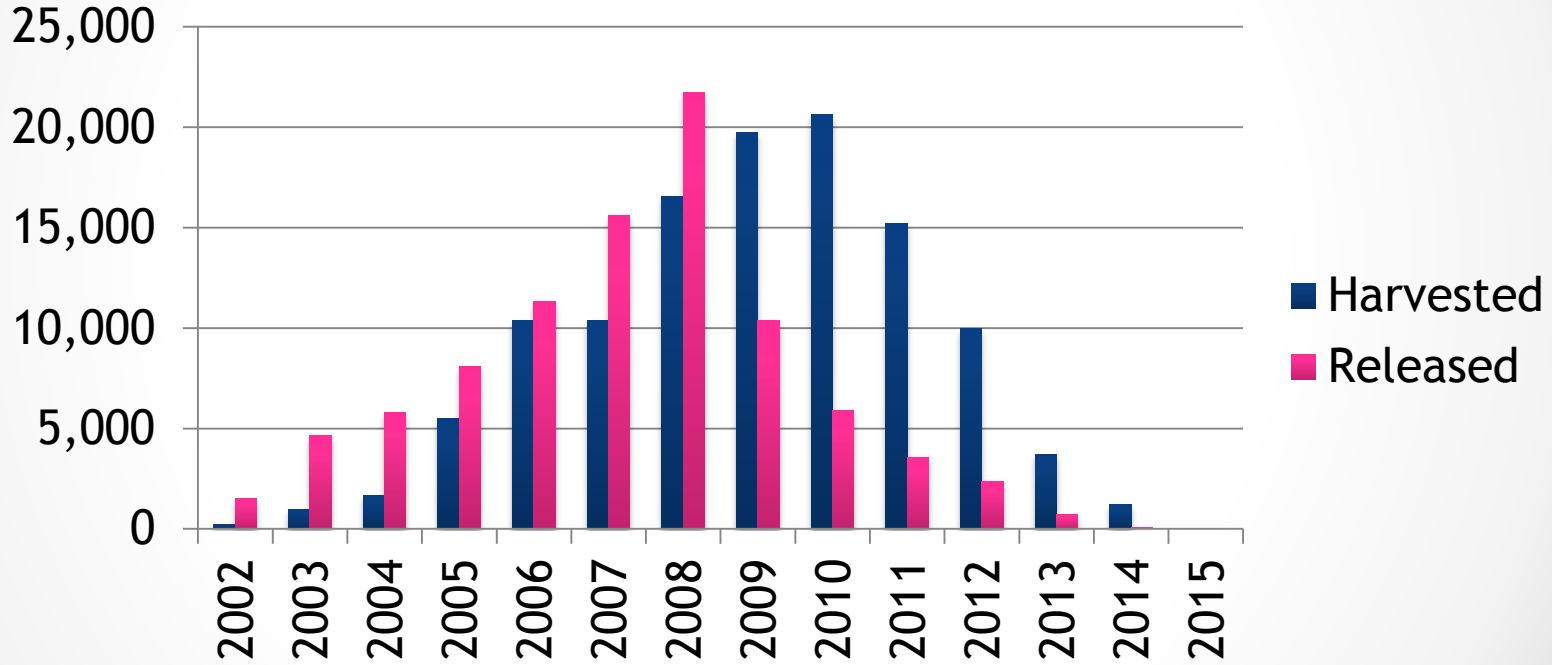


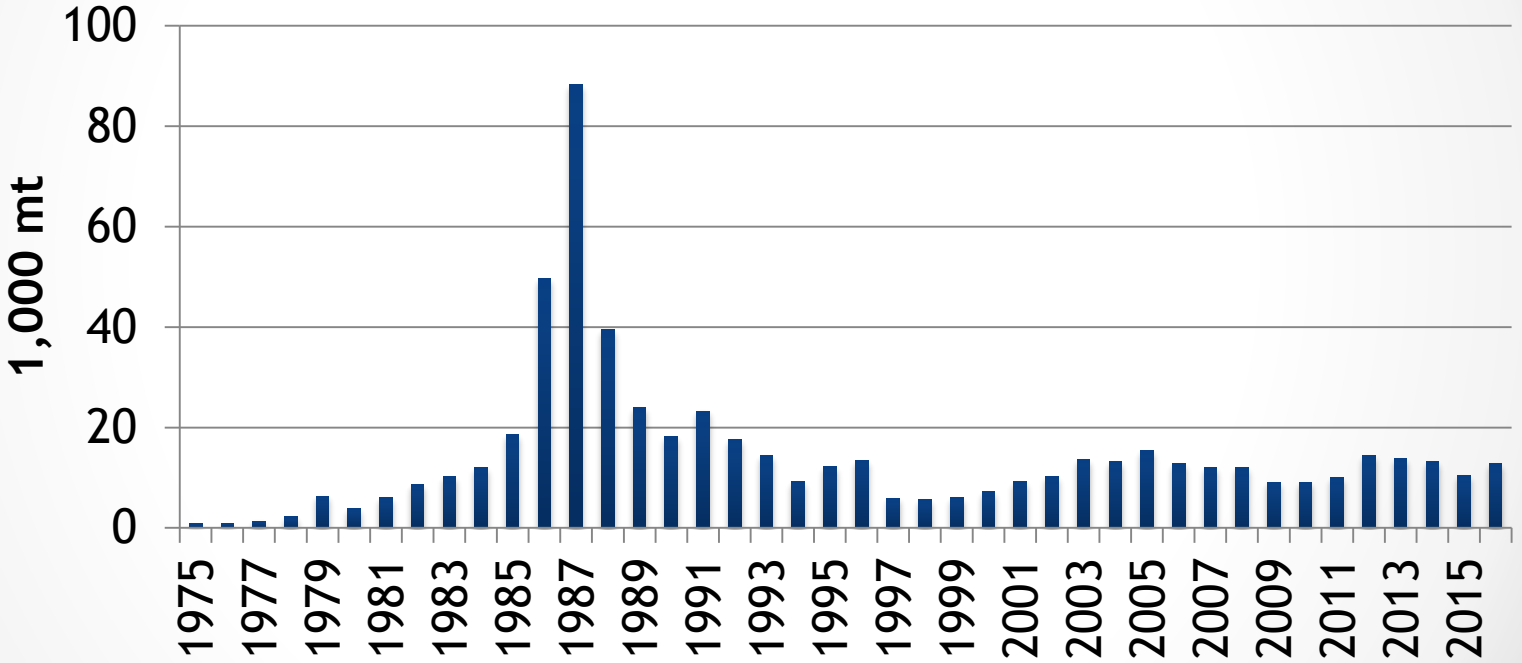
Chilean production of Atlantic salmon



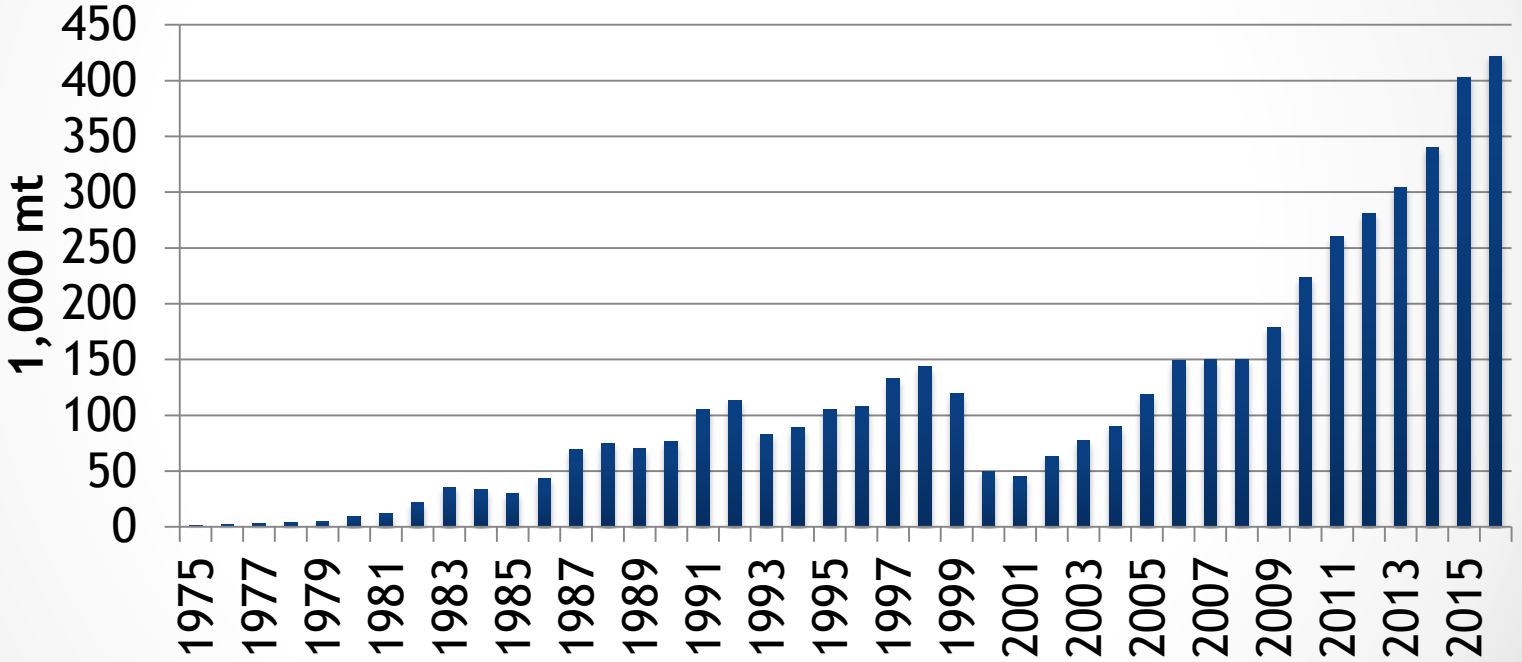
The story of cod aquaculture in Norway



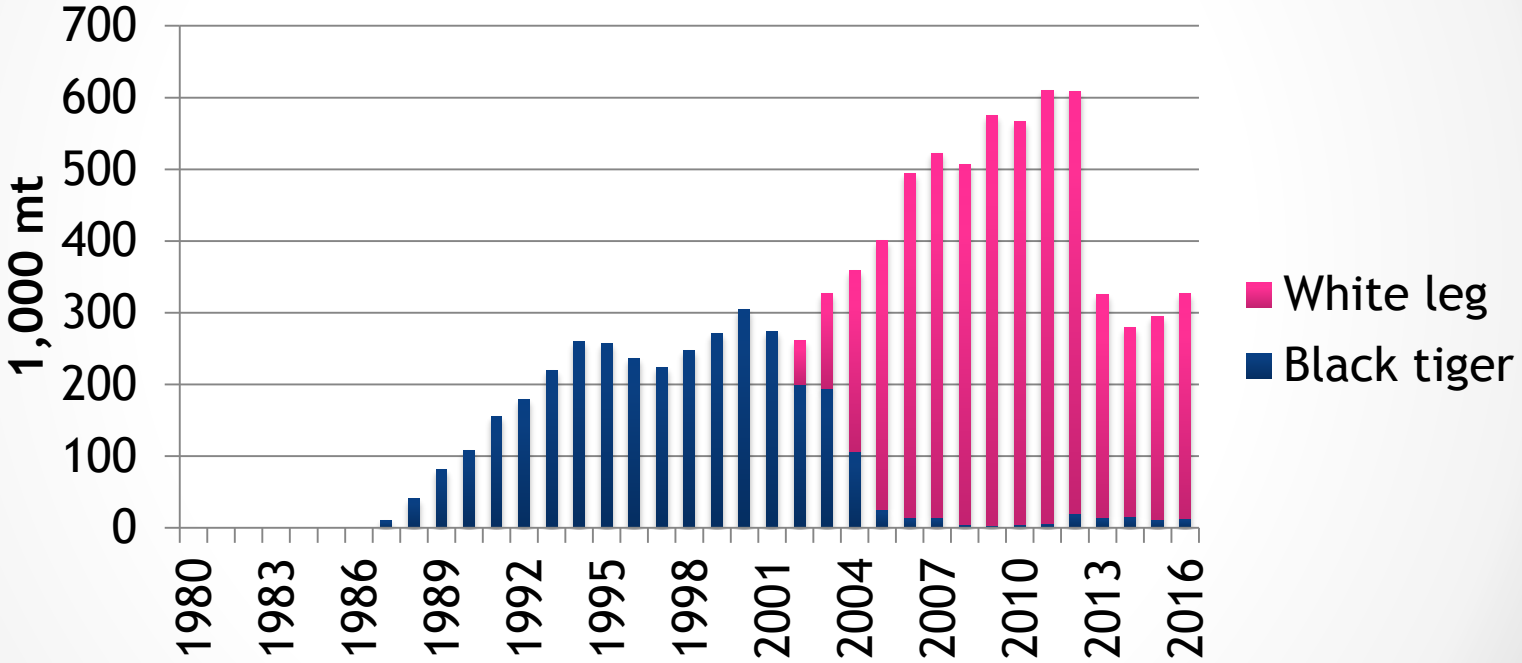
Disease, togeter with poor governance threatens sustainability - Shrimp production, Taiwan



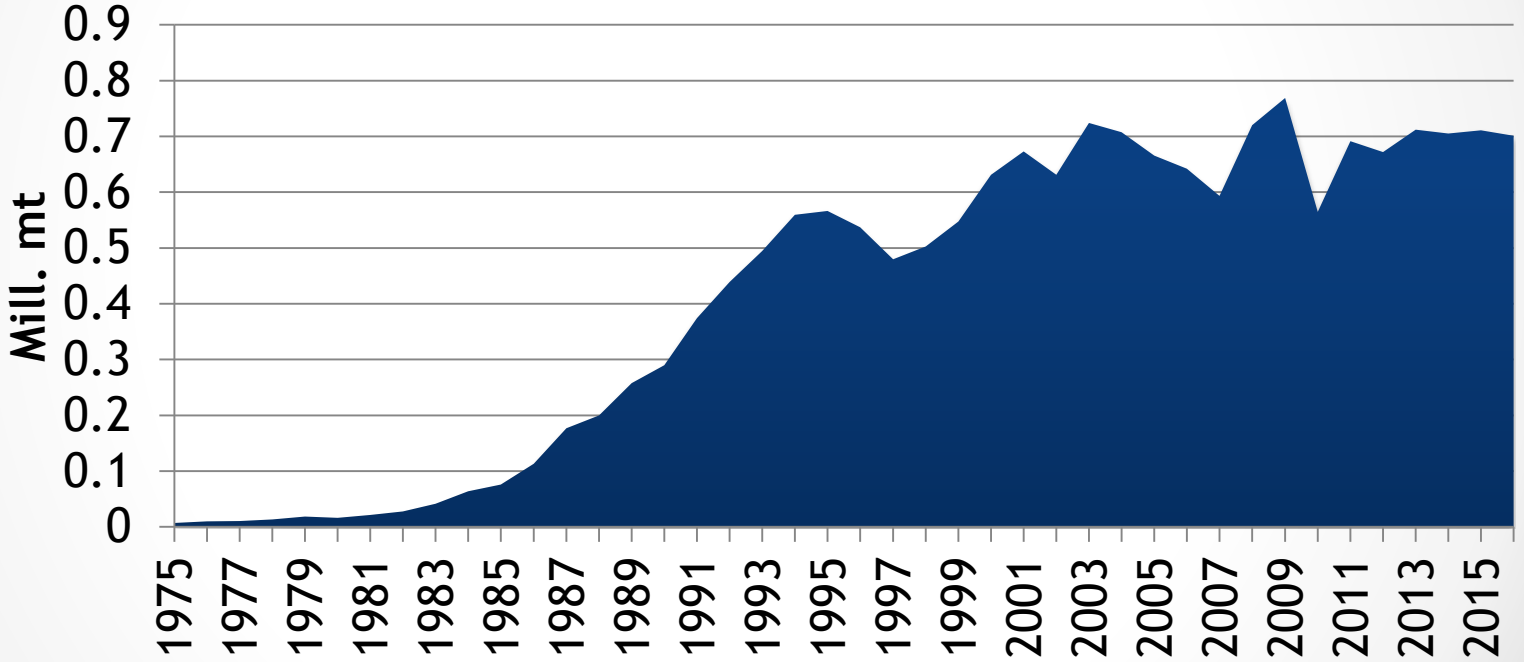
If one learn to handle the disease in time, an industry can rebound – Shrimp production in Equador



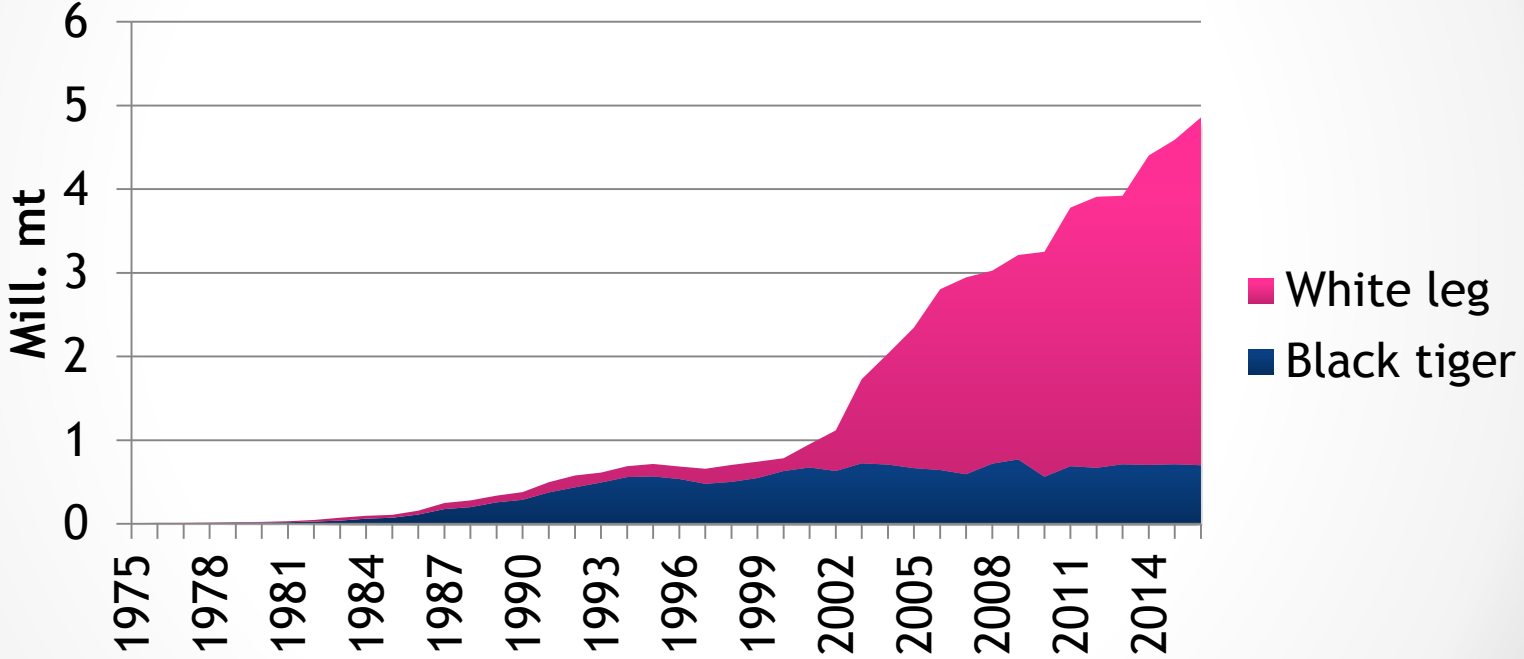
But new suprises may wait around the corner when one have solved one challenge - Shrimp production in Thailand



Global black tiger production



Global farmed shrimp production: One are partly adressing the cahllenges and partly travelling along with them

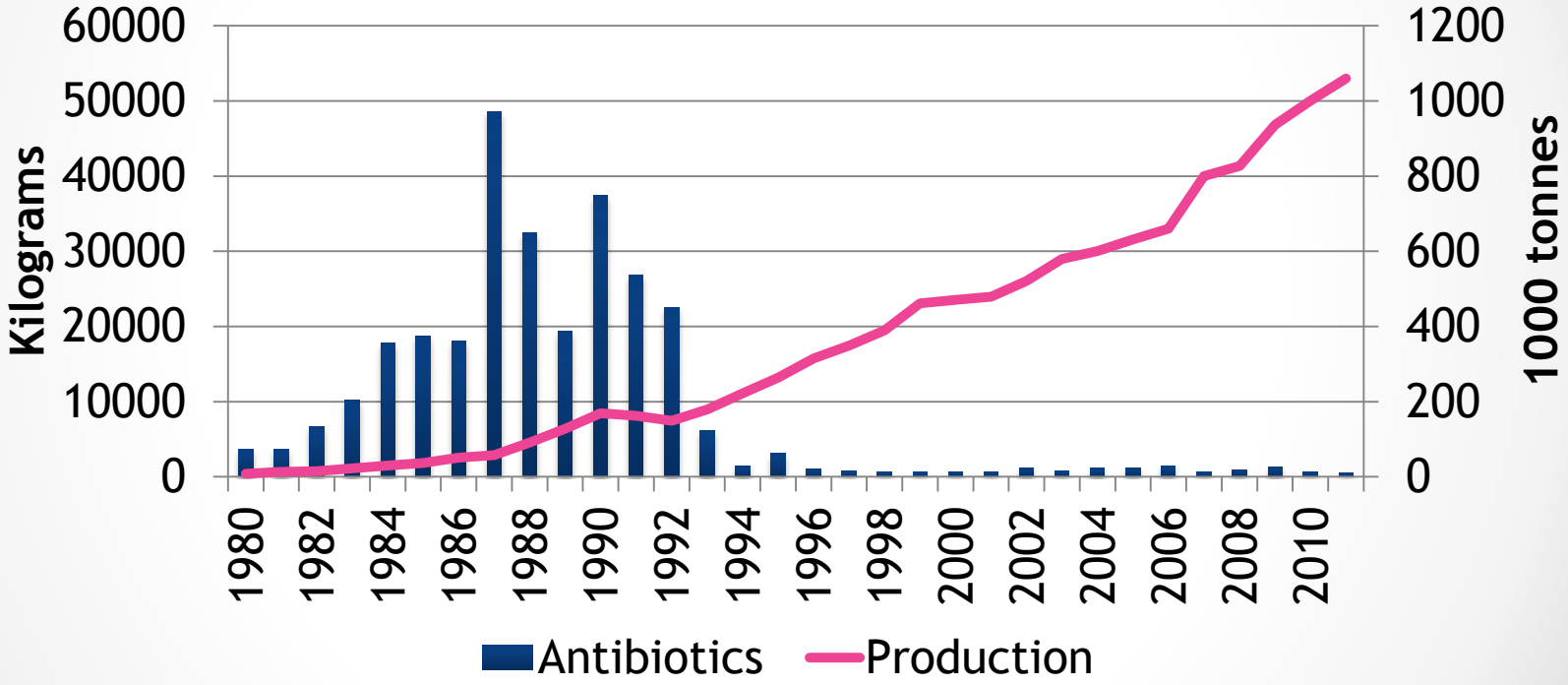


Fish veterinarians are a new disipline

- First veterenary Ph.D. Focising on fish disease was completed in 1969
- Essential for preventing or treating disease
- In 1985, one knew very little about diseases in aquatic reatures
  - Which led to many stupid reponses when disease showed up
  - But also to innovation

Disease challenges can be solved

Antibiotics use in Norwegian aquaculture



But governance is neccessary

- With easy transfer of disease in the water body, good governance is necessary for prevention
- If your treatment does not impact the health status of your fish very much, you do not treat

Disease costs in a surviving industry are manageable: Several categories

- The economics of fish disease is basically the same as in agriculture
- Prevention costs
  - Is a fixed cost, that is present when there are no disease but which makes any industry susceptible to disease more profitable over time
- Disease costs
  - Treatment, reduced growth, increased mortality and poorer capacity utilization
  - But there also savings like reduced feed cost
- And when computing the cost of disease, it has nothing to do with the turnover of an industry
- It is lower profits or margins due to either higher cost or forgone revenue
  - When profits are negative over a cycle, the company is bankrupt, and if all companies are bankrupt, the industry disappear

The economic effect of disease: A simplified model (Abolofia et al, 2017)

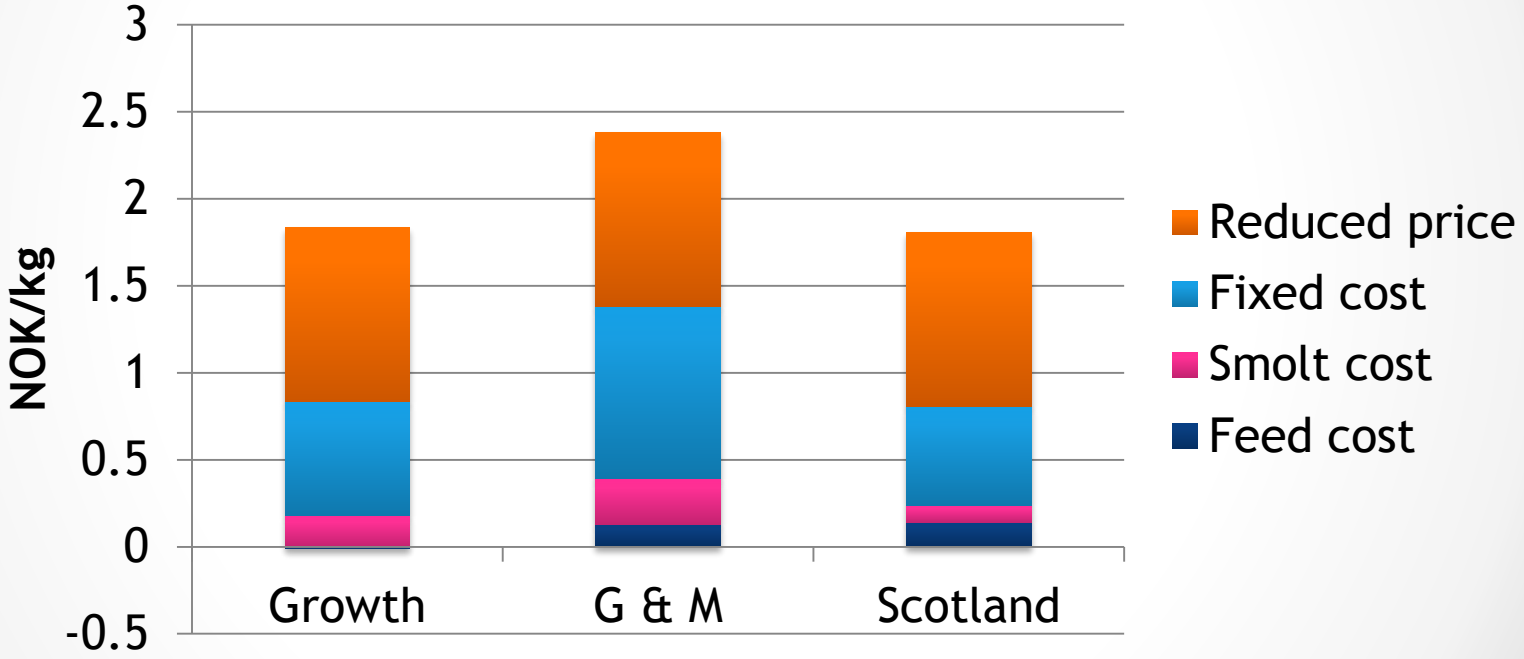
$$\Pi(T) =$$

$$\underbrace{P \cdot \left(B_0 + \int_0^T \dot{B}(t; L_t) \cdot ds \right) \cdot e^{-rT}}_{\text{harvest revenue}}$$

$$\underbrace{- C_f \int_0^T FCR \cdot \dot{B}(t; L_t) \cdot e^{-rt} ds}_{\text{feed cost}}$$

$$\underbrace{- C_r \sum_{n=1}^{N} e^{-rT_n}}_{\text{treatment cost}}$$

Loss relatively to salmon vaccinated against PD per/kg



The cost of not vaccinating

- Is substantial, ranging from 1.50 NOK/kg to 2.50 NOK/kg depending on assumptions in my simulations
  - Ranges from 7.50 NOK/kg to 12.50 NOK/kg for a 5 kg fish
  - But this can also be used to buy and feed more smolt if the regulator allows it

- The cost is split between higher costs in all categories due to poorer fish performance, and reduced revenue/price due to lower size and poorer quality

Socio-economics

- Our knowledge about the socio-economic impacts of aquaculture is quite limited, and the effects of disease is even more limited
- We know that aquaculture primarily is a developing country industry, with developing countries making up more than 90% of the production
  - Asia dominates, partly because of an early start (both Africa and South America has faster growth rates after the turn of the century)
- What we know indicate that aquaculture to a large extent is another crop, and we can therefore deduce quite a bit given what we know
-

The impact of aquaculture

- We know that it create jobs, but have little data on how much
  - It also cause social disruption as all economic growth
- Strong disease outbreaks provides an indication of how much by showing displacement
  - The ISA outbreak in Chile is estimated to have made between 10,000 and 30,000 people lose their jobs

Food security

- Is a controversial subject, since it not obvious what it is
- I think it is that people have access to the food and nutrition they need either because they produce it or because they have the income to buy it (Smith et al, 2010)
  - Food sovereignty is just damaging
- There are many see aquaculture as food for the rich (Bevridge et al, 2013; Troell et al, 2014), but it is increasingly becoming clear that it is highly important also for the poor in most countries with high production (Belton et al, 2018)
  - It is less traded than wild fish and much cheaper

Yields

- From aqriculture we know that yields for any crop varies a lot
- Governance is the most important element, of which disease risk is an important part
- As a consequence, a number of high productivity technologies are not used in poorer countries

As for economic effects, foregone production is the most important effect of disease

- The largest challenge is the aquaculture production that is not occurring at all
- The second largest problem is the lower yields because of poorer breeding, feed etc. as well as more disease
- This leads to less nutrition, less jobs and less economic development, and given what we know about the importance of fish in nutrition, poorer public health

Challenges

- As in all development work, build capacity!
- But the capacity must be adapted to local needs
- Somewhat paradoxically, the increasing dominance of a few species is most likely a blessing, since it means that more research is conducted that is useful for everyone
- But it is still a challenge to disseminate it, and particular to farmers in the settings with weakest governance, which also tend to be the poorest and with least capacity

Concluding remarks

- Disease costs are substantial in aquaculture
  - Would be interesting to compare with other types of animal production
  - Timeline in prevention and treatment approaches would also be interesting
- In salmon aquaculture, with the exception of lice, most focus is on prevention, which is a sign of a maturing industry
  - But room for much innovation and improvement in prevention techniques and governance
- Somewhat speculative, my impression is that although explicit disease costs has increased, also for this category actual cost is coming down as losses due to foregone growth and poor capacity utilization is being reduced
  - Fish is growing faster and are harvested larger than ever before

Concluding remarks

- We have learned a lot about aquatic diseases in recent decades
  - Our ability to prevent and treat has never been better
  - But it do depend on governance as much as on disease specific knowledge
- And there is a long way to go

- Disease will remain an economic and societal challenge, and how one handle it will be one of several critical success factors for any aquaculture producer

- Aquaculture has been the world´s fastest growing food production technology for four decades. The benefits are large enough that this is likely to continue, but the limited knowledge associated with a new technology has made it risky, with disease as an important component

- A large part of the blue revolution is due to transfer of knowledge from agriculture. This need to happen also in relation to disease and handling of other risk factors