Accelerating Aquaculture Production

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Sustainability Challenges

- During the last 20 years, challenges have emerged as aquaculture has grown rapidly around the world
- Can we accelerate production, but avoid these pitfalls?
- Challenges
  - Environmental
  - Social
  - Food Safety
  - Animal Welfare
  - Traceability

Mangrove Habitat

Resource Limitations

- Water
- Land
- Energy
- Feed
- Labor

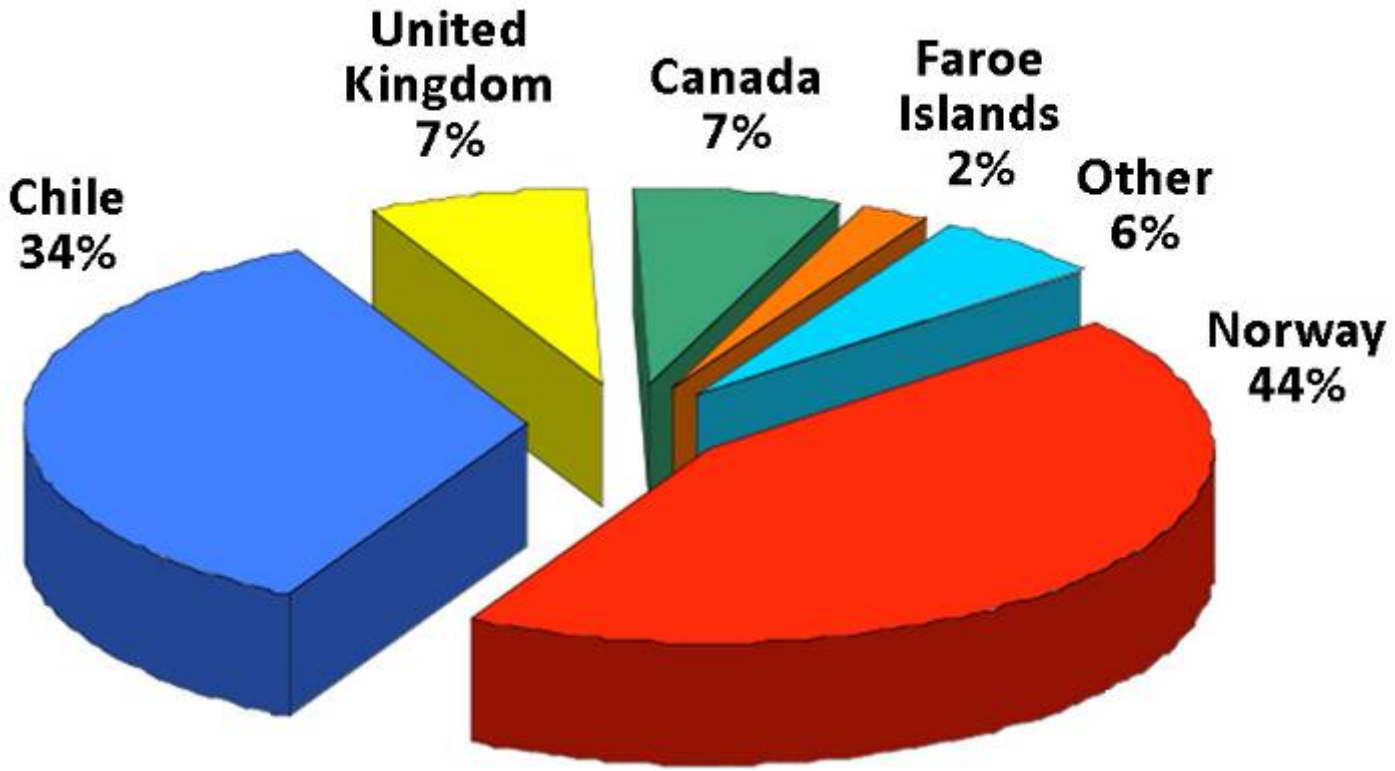
Water

- Freshwater is becoming scarce and precious
- FAO calculated an index for efficiency of use of freshwater for aquaculture
  - Tons of production per cubic kilometer of annual precipitation minus annual evapotranspiration
  - China produced 1,777 t/km^3/y
  - Korea produces 317 t/km^3/yr
  - Global average is only 200 t/km^3/yr

- Protected Near Shore Sites are Scarce
- Open Ocean Technology is Still Evolving

The Chilean Salmon Case

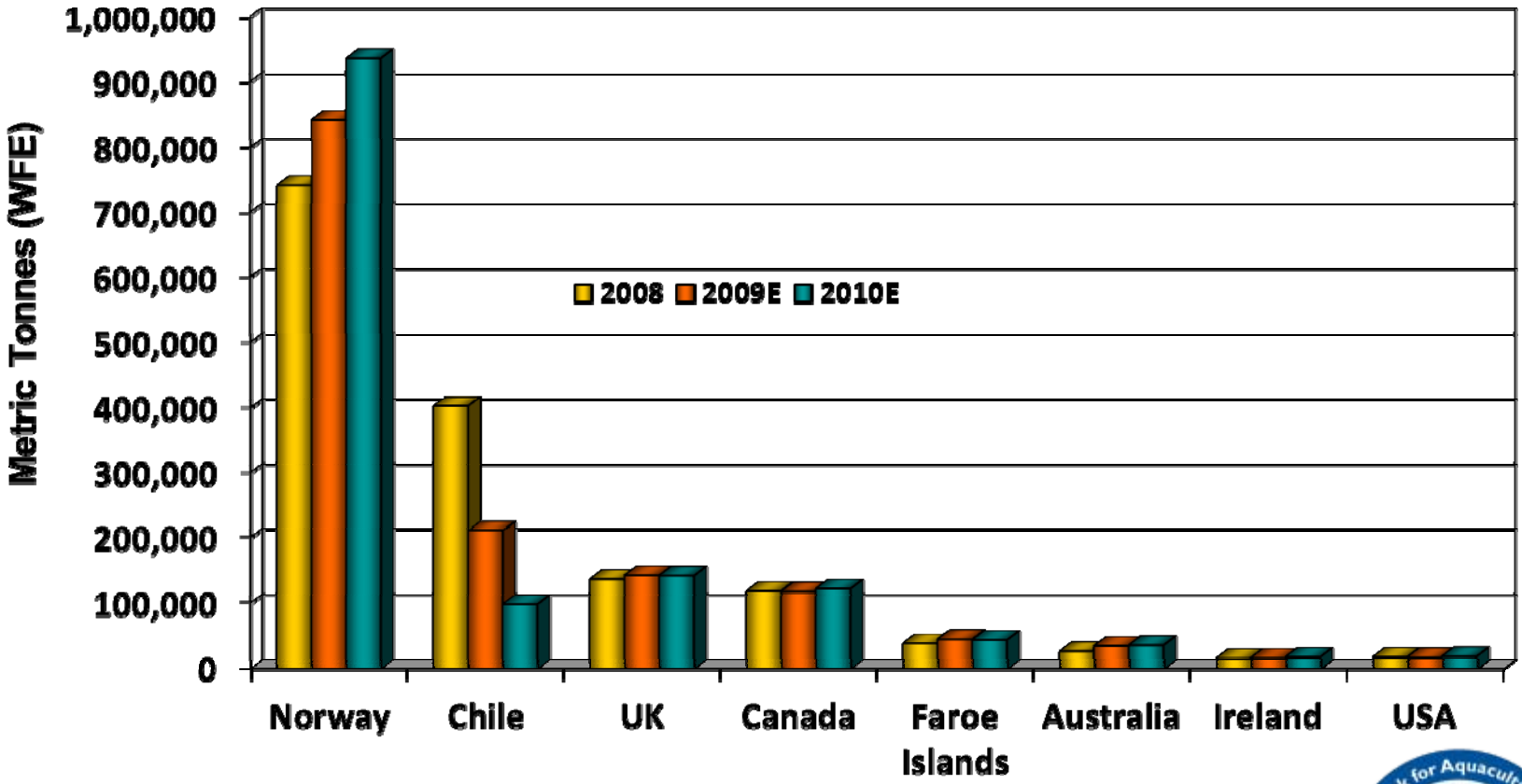
World Salmon Production in 2008



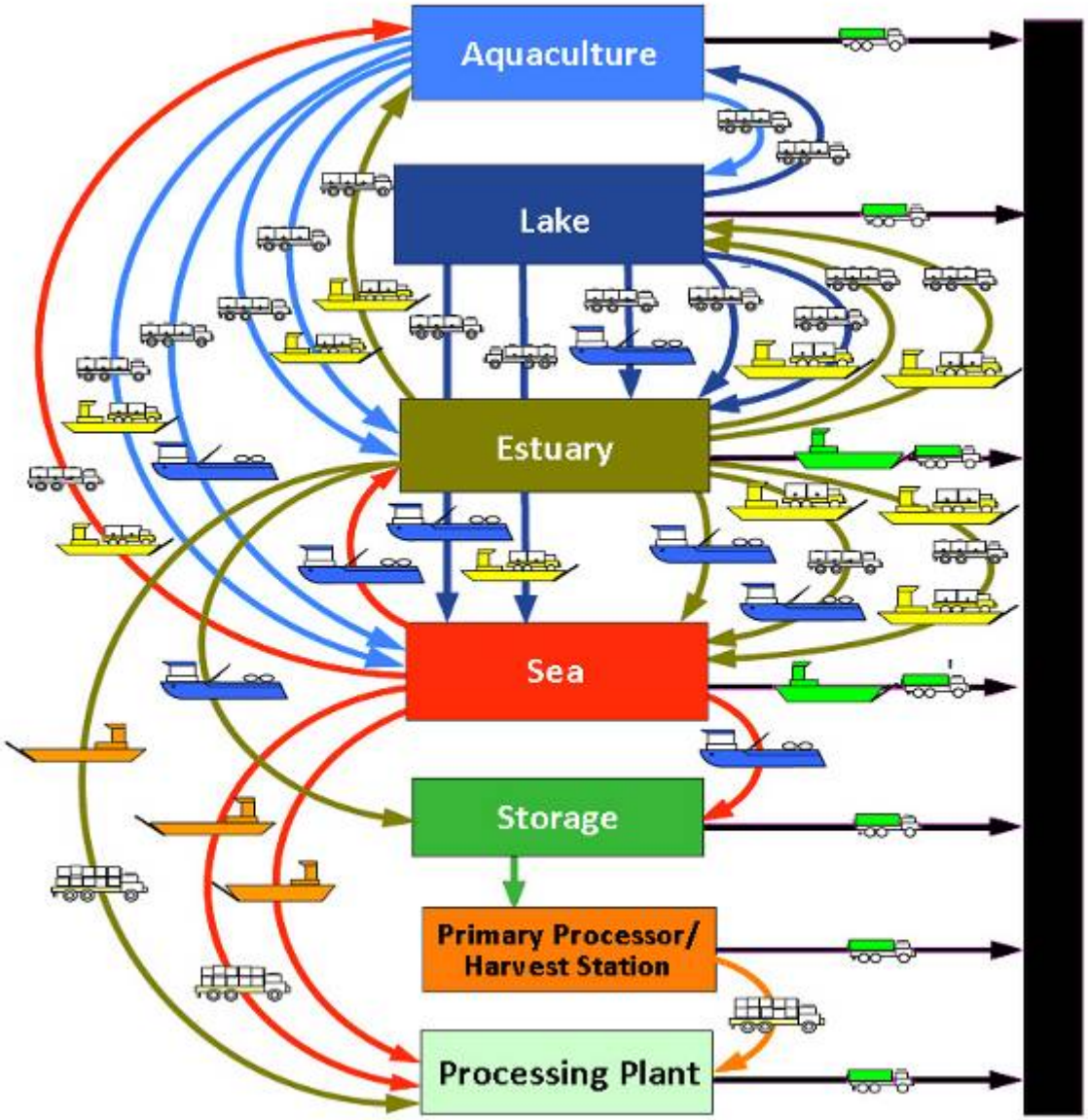
Outbreak of Infectious Salmon Anemia (ISA) in Chile in 2008

- Biosecurity was weak
  - Imported infected eggs from Norway
  - Cage sites too close together
  - Stocking densities too high
- Industry was too excited about growth, and got a little sloppy.

Farmed Atlantic Salmon
Production

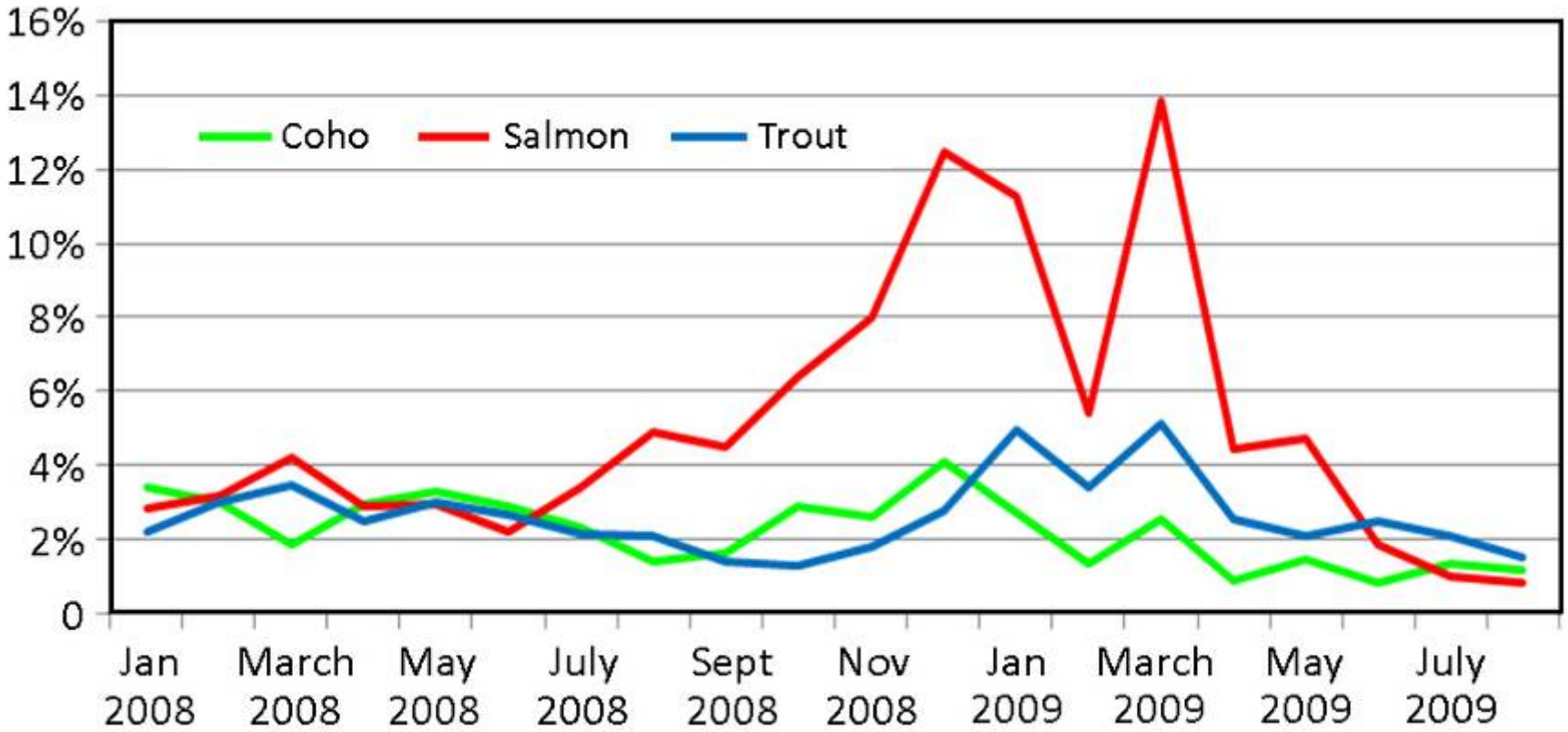


Source: Kontali



Movement of goods and materials helps the dispersion of disease agents.

Average Monthly Mortality



Salmon Farming in Chile

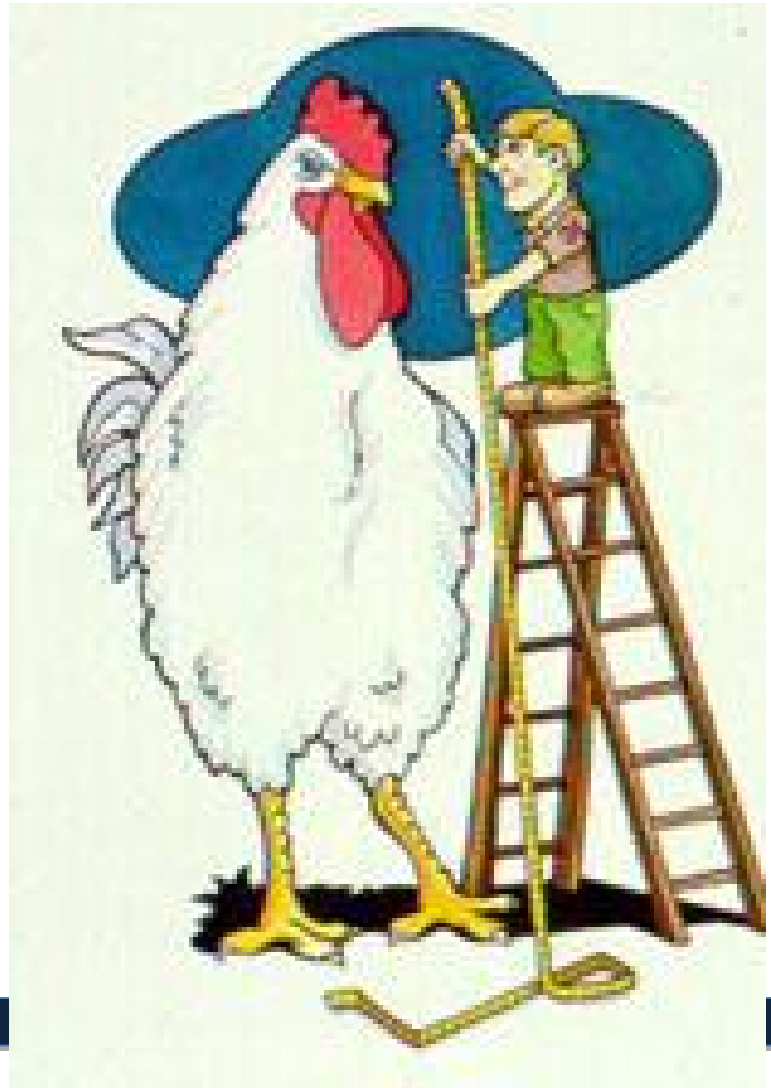
The Shrimp Farming Case

Shrimp Farming History Characterized by Disease

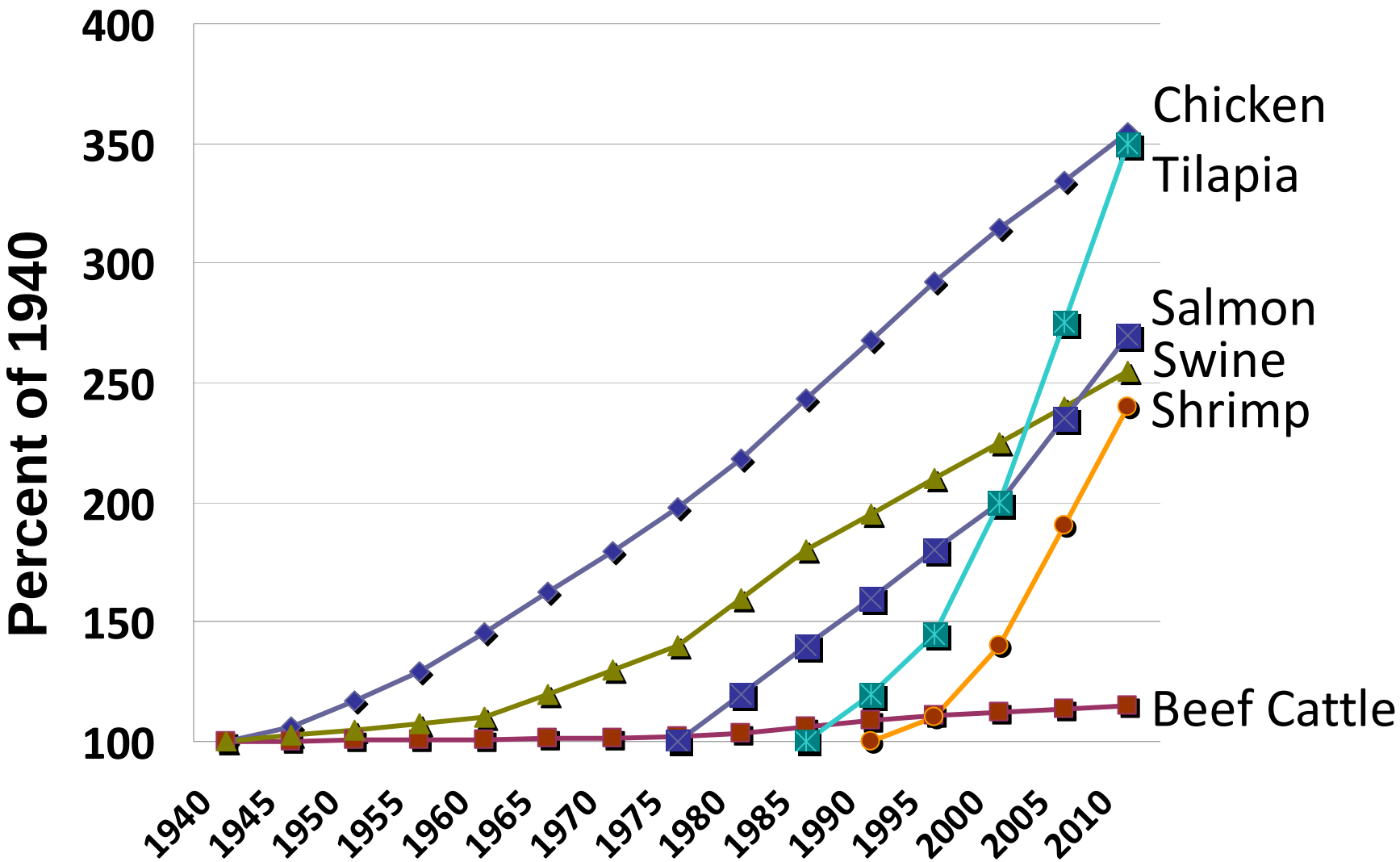
Year	Countries	Disease	Impact
1982	Ecuador	BP	Mortality in hatchery
1988	Taiwan	YHV	80,000 to 25,000 mt
1992	China	WSSV	220,000 to 50,000 mt
1994	Ecuador, Mexico	TSV	TSV resistant stylirostris sent to Brunei (2000)
2002	Thailand, Indonesia	MSGV	Reduced profitability
2004 2006	Brazil, Indonesia	IMNV	Reduced profitability
2006	Belize, Mexico,	PvNv	Reduced profitability

Specific Pathogen Free *Penaeus vannamei* developed and bred for performance

SPF stocks enable more efficient selective breeding



Relative Genetic Gain in Growth Rate



Aquabounty GMO Salmon

Size comparison of an AquAdvantage® Salmon (background) vs. a non-transgenic Atlantic salmon sibling (foreground) of the same age

Technology is Changing the Business

- More sustainable
  - Greatly reduced mangrove destruction and effluents
- More consistent
  - Less vulnerable to epidemic diseases
  - High margin (30-50%) and high volatility are giving way to lower margins (10-20%), higher volume, and better quality.
- More cost effective
  - Cost of feed and postlarvae declining
  - Genetic improvement expected to yield 10-15% increase in growth rate per year

The Lesson

- To improve profitability, it is important to stay abreast of the latest technology
  - Identification of new diseases
  - SPF genetically improved monodon
  - Intensive ponds with minimal water exchange
  - Probiotics and bioflocs

Bioflocs and Probiotics

CHANGING PARADIGMS IN SHRIMP FARMING:
V. ESTABLISHMENT OF HETEROTROPHIC BACTERIAL COMMUNITIES