Sustainable Marine Aquacultue

Chris Carter

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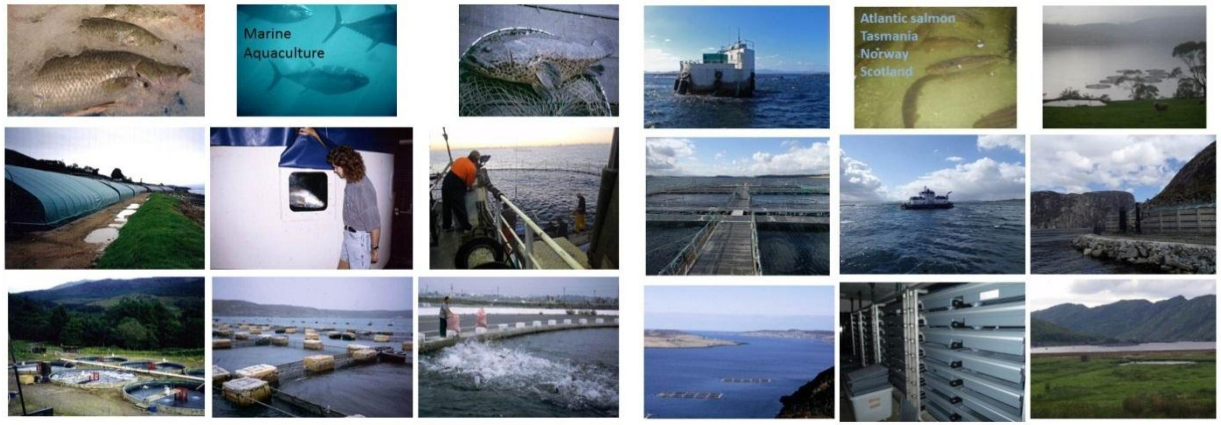
Sustainable Marine Aquaculture

Ecosystem Approach to Aquaculture (EAA)
Food and Agriculture Organisation of the United Nations,

Since 2005
"An ecosystem approach to aquaculture (EAA) strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties of biotic, abiotic and human components of ecosystems including their interactions, flows and processes and applying an integrated approach within ecologically and operationally meaningful boundaries."

"This aquaculture evolution will be a modern, twenty-first century, knowledge-based process to pioneer the development of sustainable, ecologically integrated aquaculture systems that have positive impacts on both natural and social ecosystems" Barry Costa-Pierce, 2002.

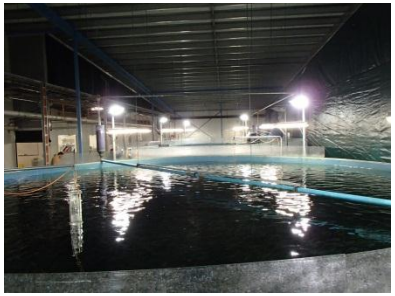
Thompson et al. A whole of ecosystem assessment of environmental issues for aquaculture.



Plan

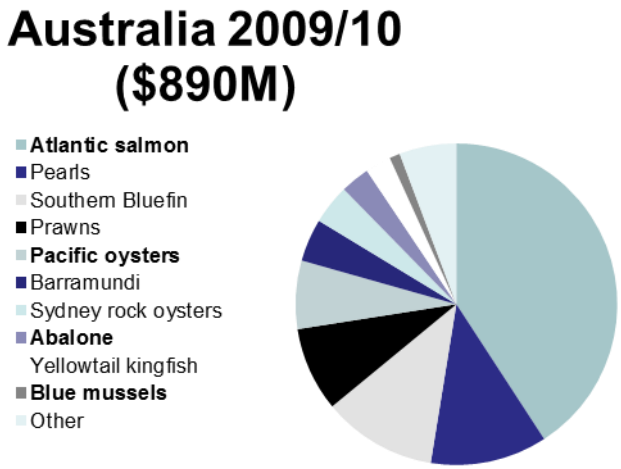
- Sustainable marine aquaculture
- Global context of Australian and Tasmanian aquaculture
  - Importance of Atlantic salmon
- Atlantic salmon
  - Expansion, Challenges, Research and Development Solutions
- Futures for Tasmania

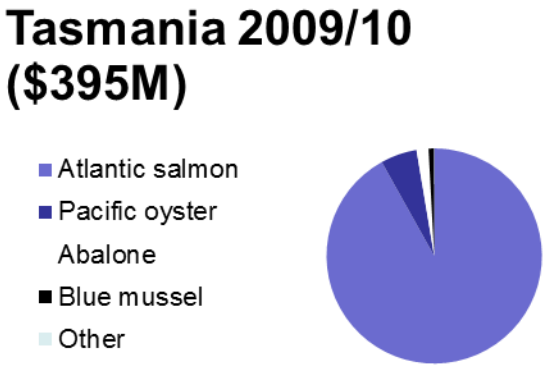




Australia & Tasmania

- Australian Aquaculture production 73000 tonnes worth A$890M.
- Marine aquaculture = Australian aquaculture (>95% of production, >95% of value).
- Tasmania is the #1 aquaculture state (49% of production, 44% of value).
- Atlantic salmon is the #1 aquaculture species (42% of production, 41% of value).





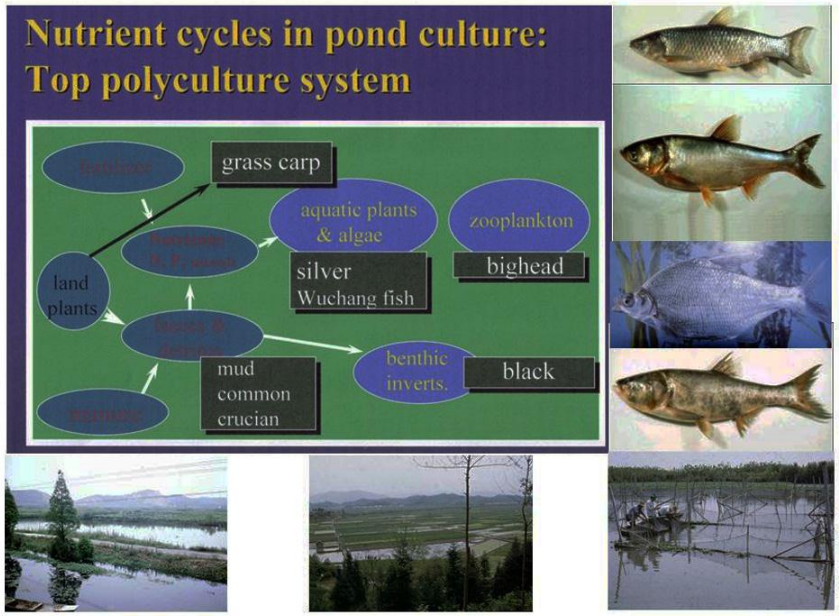
[Austasia Aquaculture, Trade Directory Dec 2012]

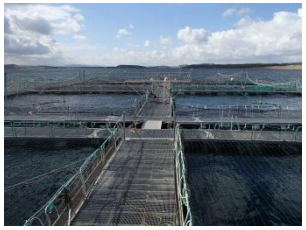
Global Aquaculture

Ranked by production (% 2010)

[Total of all = US$34.8B]

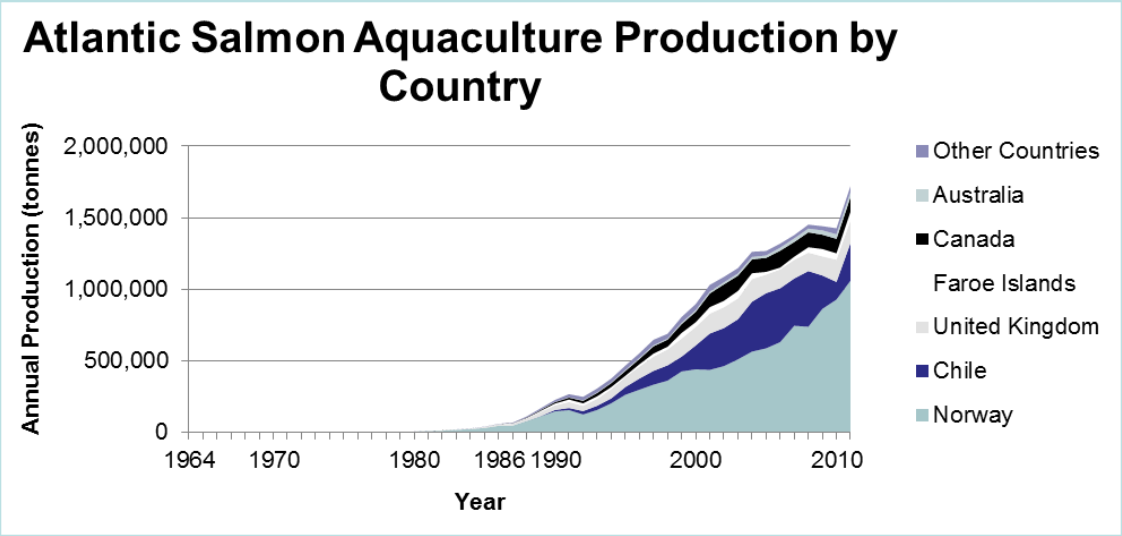
1. Grass carp (7.2%) [$5.5B]
2. Silver carp (6.9%) [$5.4B]
3. Catla (6.5%) [$7.2B]
4. Clam (6.2%) [$3.4B]
5. Common carp (5.8%) [$4.6B]
6. White prawn (4.5%) [$11B]
7. Bighead carp (4.3%) [$3.3]
8. Tilapia (4.2%) [$4.0B]
9. Crucian carp (3.7%) [$2.4B]
10. Atlantic salmon (2.4%) [$7.8B]



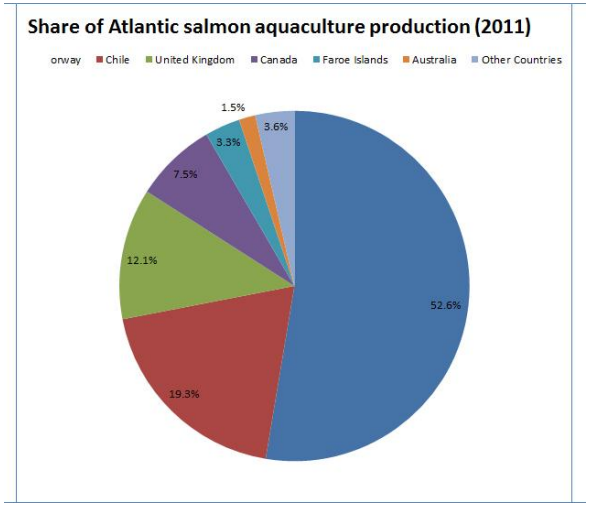


[FAO 2013, FIGIS Fisheries Statistics – Aquaculture]

Global trends in Atlantic salmon aquaculture



[FAO 2013, FIGIS Fisheries Statistics – Aquaculture]



Atlantic salmon farming in Tasmania is an exceptional commercial success

Atlantic salmon from Tasmania

- 1-2% of global production, ranked 6th in world.
- Australian domestic market takes 85-90% of production.
- Production has increased by 40% in last 5 years, relative increase ranked 1st in world.

Growth of salmon farming in Tasmania

Double production to 85000 tonnes by 2030. Be a $1 Billion industry.

Current Australian domestic consumption less than 1 meal per person per month.

FAO challenges
Land (and water) availability
Finance and investment
Social impacts
Biosecurity and fish health
Energy-effective
Cost-effective
Effective feeds

Challenges and R&D Solutions

- Environment
- Selective breeding program (SBP)
  - Health and welfare
  - Climate change effects on growth and production
  - Product quality
- ➢ Feeds
  - How much fish oil and fishmeal
- Training
  - High School through to PhD

Environment

Define Ecosystem Processes and Interactions

What Do We Do

- Characterise condition/ ecosystem interactions
- Develop & support modelling
- Develop & review monitoring

Why Is This Important

- *Address concerns → stakeholder confidence*
- *Reassurance (sustainability / understanding)*
- *Provide operational boundaries, performance evaluation and indicators → planning & development*

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Benthic-Pelagic Interactions in Macquarie Harbour

Objectives

- Quantify nutrient fluxes at local/ regional scales
- Calibrate environmental model
- Identify potential indicators of key ecosystem processes

Parameters Measured

- **Water column:**
  - temp/salinity/DO
  - bottom water nutrients
- **Sediment: Water**
  - Nutrient fluxes
- **Sediments:**
  - Macrofauna
  - O2 microprofiles
  - Acid Volatile Sulphides (AVS)
  - Particle Size
  - C:N content
  - Microbial diversity & abund. (genetics)
  - Fatty acid signatures

Characterising Conditions/ Model Calibration

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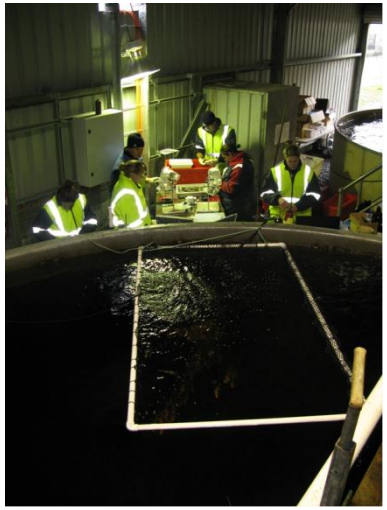
[Dr Catriona Macleod, IMAS, Aquaculture-Environment]

SBP-selective breeding program
SALTAS & CSIRO



Selecting for

- **Resistance to AGD (amoebic gill disease)**
- **Greater weight at harvest**
- **Lower early maturation**
- Current fillet fat levels*
- Current fillet colour (astaxanthin)*

* currently at correct levels

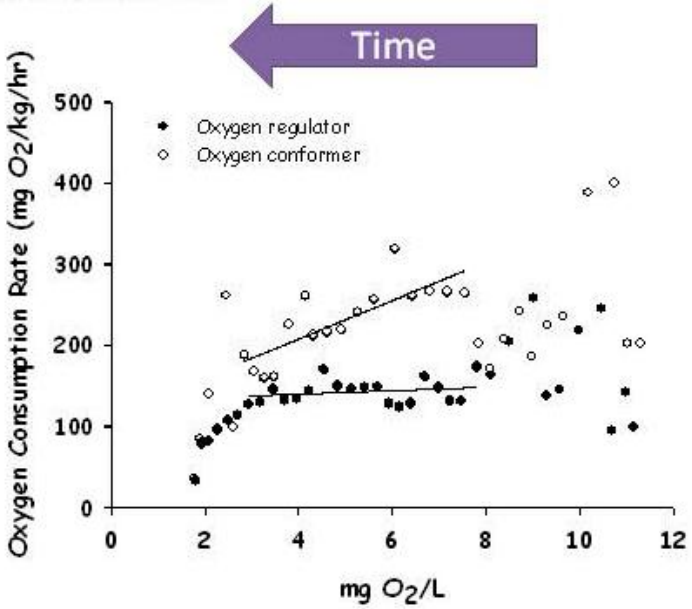
Salmon hatched in 2013 will
- **grow 18% faster** than an unselected salmon,
- **go 21% longer** without being treated for AGD,
- be **3% less likely** to mature early.

[Dr Brad Evans, Geneticist, SALTAS]

Super salmon and climate change effects

- Increasing water temperature and decreasing dissolved oxygen
- Unexpected result – some salmon regulate oxygen consumption under decreasing dissolved oxygen.
- This ability makes them more robust and able to recover more quickly.

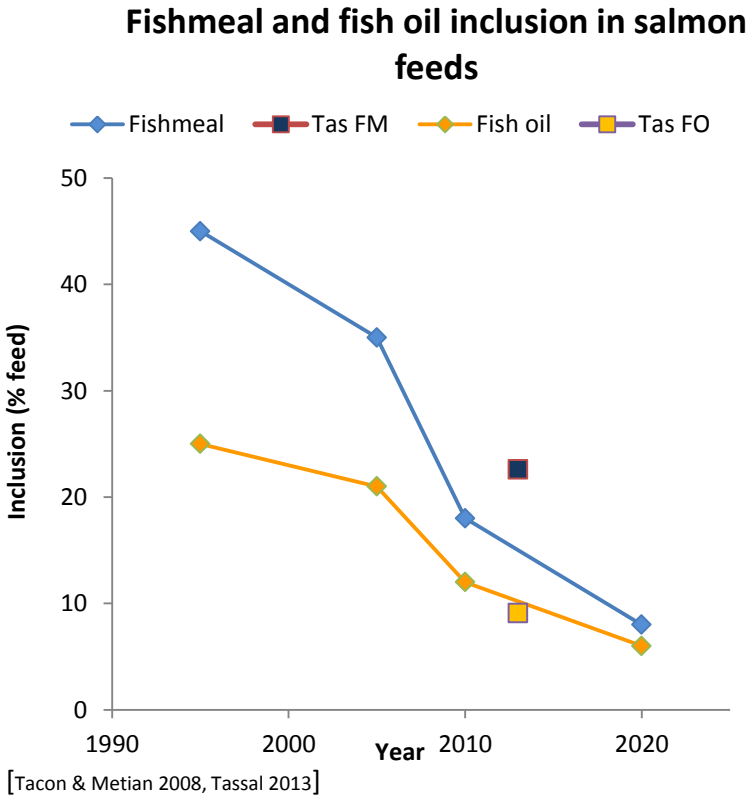
Atlantic salmon parr. Change in oxygen consumption as dissolved oxygen decreases. Pattern for regulator and conformer.



[Katersky et al. 2009]

A short history of salmon feeds

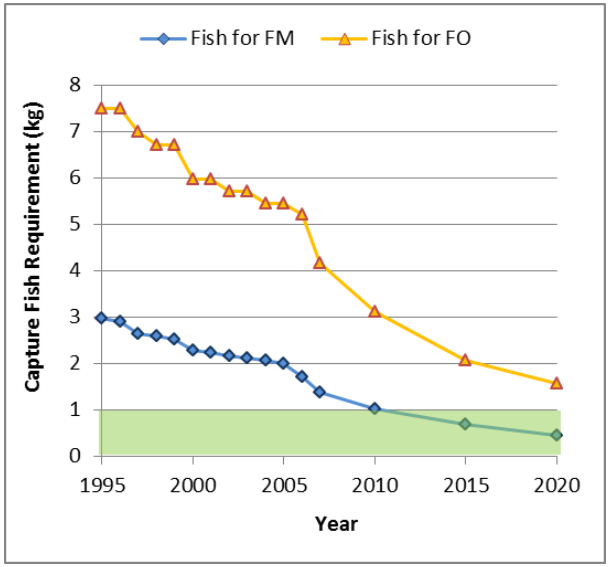
- Reliance on marine capture fisheries for fishmeal and fish oil has decreased.
- Extensive global research effort has made reductions possible.
  - ⇨ advances at a fundamental level
  - ⇨ applied research including industry-lead
- Fishmeal is **not** essential in Atlantic salmon feeds.
- Fish oil
  - small amount is needed to meet essential fatty acid requirements.
  - included to meet consumer demand for omega-3 long chain fatty acids.



[Tacon & Metian 2008, Tassal 2013]

Super salmon & nutrition

[Tacon & Metian 2008]



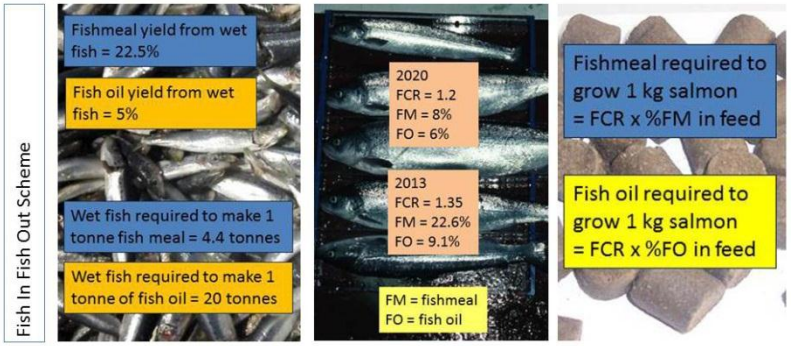
Fish In Fish Out

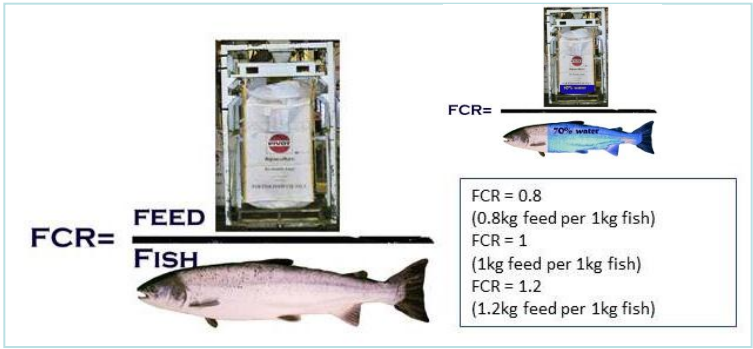
-driven by need for fish oil, not fishmeal

Salmon characteristics

-highly efficient growth and very efficient at:

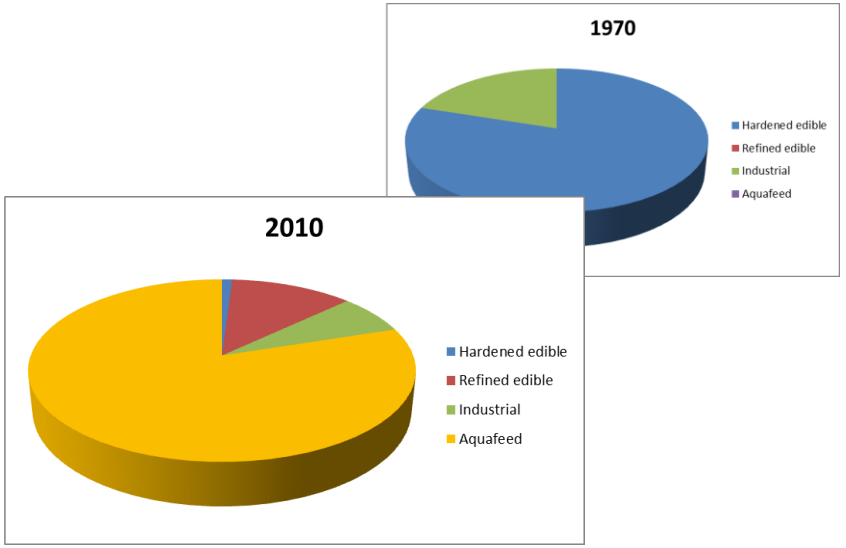
using high oil in feeds,
using vegetable and alternative oils,
reflecting fatty acid profile of feed,
using vegetable and alternative proteins,
retaining protein.





How much fish oil does aquaculture need?

- Sources of fish oil
  - Whole fish from marine capture fisheries (75%)
  - By-products from fish processing (25%)
- Annual global fish oil production
  - ~1 million tonnes pa



Optimise fish oil use

- Increase sources of fish oil
  - **Improve extraction** from whole fish, FM still contains 6-9% oil
  - **Increase** oil by-products from fish processing
  - **Develop** alternative oils: standard vegetable oils, single cell oils, oil blends,
- Manage use of oils
  - Only use at key times in production: broodstock, hatchery and finishing feeds
  - Improve use of Fish Oil Finishing Feeds




Something missing?

- New aquaculture of high value species e.g. spiny lobsters, striped trumpeter
- Aquaculture of
  - filter-feeding shellfish
  - macrophytes (seaweeds)
  - benthic feeding invertebrates
  - Integrated multi-trophic aquaculture (IMTA)
- Innovative technology
- Certification and standards
- Organic aquaculture
- By-products
- Tasmanian strength in
  - Support industries
  - Research
  - Education and training
- …..

Acknowledgements

- Dr Brad Evans, SALTAS
- Dr Catriona Macleod, IMAS
- Dr Adam Main, Tasmanian Salmon Growers Association
- Many colleagues from industry, research and teaching.