Aquaculture possibilities for Europe – can we learn from the Norwegian Atlantic salmon story?

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New Frontiers For Blue Growth

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Norwegian fish farming

• Norway is the world’s largest producer of Atlantic salmon (Salmo salar); “steady” increase in production during the last 35 yrs;
  – > 1.2 million metric tonnes salmon produced in 2014
• Rainbow trout (O. mykiss, pacific salmon species imported to Europe) farming is the 2nd largest production; ca 70,000 tons pr year
• Considerable efforts in R&D to develop other species for aquaculture e.g. Atlantic cod and Atlantic halibut; production is still at low levels due to disease, production & market issues

How is the salmonid farming conducted?

• Broodstock, eggs and fry/juveniles reared in freshwater systems (mainly flow-through tanks)
• Transfer to sea (as smolt) at around 100g
• Around 300 million smolt transferred to sea cages each year to around 600-1000 coastal sites
• On-growth in seawater from 100g to ca 5kg (harvest)

Modern Salmon farm in western Norway

160 m circumference, 40m deep; > 100,000 fish/cage feeding “dry” feed using compressed air - monitored by video

Photo; R.W. Schulz

Key features with open sea cage farming

• Efficient in terms of production, water exchange and fish handling
• Close contact with environment; impacted by environment and impacts on environment
• Dependent on site/exposure, water currents and other environmental factors
• High risk and high efficiency!
• Can open sea farming continue to grow - and also be extended to new fish species?
• What changes are needed?

Previous challenges and solutions

• Organic overloading; solved by; siting/new cage technology – movement from sheltered and shallow areas to more exposed sites, improved feed formulation & feeding technology – mandatory monitoring established
• Bacterial diseases; controlled by vaccines and other prophylactic measures
• Viral diseases; partially controlled by vaccines, selective breeding (QTL assisted), zoning, stamping out
Current main challenges

- **Salmon lice**: mainly environmental problem for wild fish (even at low numbers in farms)
- **Viral diseases**: fish welfare, production losses and potential transfer to wild fish
- **Escapees**: genetic impact on wild populations
- **Use of chemical treatments/drugs** (mainly against salmon lice): resistance development, potential environmental impact, fish welfare...

Salmon lice

- Why is this parasite a problem for wild fish?
- Salmon farming has increased the number of hosts in Norwegian coastal waters dramatically
- Around 400 million salmon and rainbow trout in sea cage farms at the coast each year - compared to 400,000 wild salmon returning from the ocean
- salmonids get osmotic problems at > 0.1 lice/g fish weight
- > 0.3 lice/g fish weight: high risk of mortality in wild salmon smolts

Viral diseases

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* around 600 marine sites in operation at any time

High number of outbreaks in farms;
- High viral infection rates found in some escaped farmed salmon (also in rivers)
- (but) No or low detection of virus in wild salmon and sea trout (so far)

Current status of salmon farming and management in Norway

- Further expansion of salmon farming is delayed due to environmental impacts
  - Exceptions; licenses (farms) with low environmental impact (salmon lice and escapees)
- New system for environmentally dependent growth/decline decided in Norwegian parliament in spring 2015; mainly based on salmon lice as indicator for regional environmental sustainability
- How will the regional assessment be conducted (under development)?
- Solutions; A range of (non-chemical) measures are taken into use/being developed to reduce the impact (of salmon lice)

How to assess regional environmental sustainability?

- Monitor lice on wild-caught salmonids
- Modeling distribution of salmon lice from farms
- Monitor lice infections on salmon farms and in test systems
- Estimated regional status; basis for sustainability assessment

New production technologies and regimes for on-growing

- **Land-based** recirculation systems for seawater on-growth (either for large post-smolts or until harvest)
- **Closed sea cages** (water pumped from deeper water; more control of water quality and parasite load)
- **Semi-submerged** sea cages (avoid parasites and other hazards in surface water)
- **Offshore** cages (may allow larger production but is also risky)
Lessons learned in Norway

• Basic biological understanding of salmon and pathogen biology (incl. genomics) essential for the development (e.g. fish health)
• Production is environmentally (and fish health/welfare) challenging – strong governance needed
• Environmental and fish health/welfare regulations drive innovation and implementation of new solutions – that also may be utilized for other species/areas

Thank you for the attention!

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