Sale of farmed fish 1992-2016
Tonnes and value

*) Preliminary figures

*) Preliminary figures
Approx: 1300 company level licenses and 1200 site level licenses
We produce 15 millions meals of salmon every day on an area compared to this small island Andøya
The legal framework and control authorities
How we regulate the aquaculture industry in Norway

Some examples of legal framework:

• The Aquaculture Act
• The Food Act
• The Animal welfare Act
• The Pollution Control Act
• The Water Ressource Act (land based aquaculture which uses freshwater)

Regulations governing the allocation of aquaculture licenses and sites.
Environmental requirements – authorities

- Fish escape
  Inspection, monitoring

- Pollution
  Monitoring
  Chemicals, waste

- Sea lice
  (medicines)

Directorate of fishery
Norwegian Environment Agency

Norwegian Food Safety Authority
Environmental regulation according to The Pollution Control Act

- All fish farms must have a discharge permit
- The County governor is the regulatory authority. They process the applications for a discharge permit and supervise the aquaculture industry.
- Topics that are typically covered by the permit are limitations in biomass, emissions of chemicals and fish feed, noise, smell etc.
- Environmental monitoring are required according to a Norwegian Standard
- Emissions of delousing water from well boats are not included in the permit (such emissions from well boats to spawning areas and shrimp fields were forbidden in 2016).
Pollution and discharges
Risk for unacceptable effects on vulnerable habitats and stocks

Carrying capacity: *the maximum quantity of fish that can be farmed at a site without the environmental impacts exceeding agreed tolerance limits.*

Photo: Institute of Marine Research
Discharges -organic loading

Figur: Nigel Keely, Havforskningsinstituttet
Dissolved nutrients
- local effects

• Nitrogen and phosphate
  – Dilutes quickly, difficult to measure
  – Minor pulses can occur near pens

• Minor risk at local effects in tidal zone
  – 18 farms and 16 reference stations where measured in Hardangerfjord
  – Only small local effects at farms closer than 50 m from tidal zone
Dissolved nutrients
- regional effects

Risk
• An increase in dissolved nutrients may lead to eutrophication
  – Eutrophication = 50 % increase of phytoplankton biomass compared to natural conditions
  – May lead to increased oxygen consumption

Low risk with today's production volume....
... However, may be problematic in some areas. E.g. Shallow semi closed recipients, sill fjords etc.
Marine life – our common responsibility

Figure: Nigel Keely, Institute of marine research
The MOM-system
Monitoring-Ongrowing fish farms-Modeling:

The obligatory program for monitoring the environmental impact of marine fish farming on the seabed beneath and around the fish farm is described in the standard NS 9410:2016 “Environmental monitoring of benthic impact from marine fish farms”.

The monitoring program in the standard consists of tree types of investigations,

• Preliminary investigation
• B- investigations (local impact zone)
• C-investigations (intermediate impact zone)
Different zones of impact

Local impact zone

Intermediate impact zone

Recipient

Marine life – our common responsibility

www.fiskeridir.no
Relationship between benthic fauna, oxygen and sediment

- Rusty brownish color shows “oxidized” sediment.
- Grey/black shows anoxic and “reduced” sediment.
- Scale 1-4 in accordance with NS-9410:2016

Relationship between benthic fauna, oxygen and sediment

- Rusty brownish color shows “oxidized” sediment.
- Grey/black shows anoxic and “reduced” sediment
- Scale 1-5 in accordance with Veileder 02:2013, and European water framework directive.

Zones of impact and survey stations - B- and C-surveys
Zones of impact and survey stations - B- and C-surveys

- Reference station
- Primary direction of current
- Intermediate zone C-survey
- Local Zone B-survey
- Deep area
- Recipient

- C1
- C2
- C3
- C4
What do the surveys tell us?
Local impact zone – B-surveys

The results from the surveys local impact zone show that the environmental status is good and stable.

From 2012 to 2016 an average of more than 90% of the facilities were classified as “good” or “very good”!

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<tr>
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<tbody>
<tr>
<td>1 – Very good</td>
<td>72,0 %</td>
<td>70,7 %</td>
<td>73,7 %</td>
<td>73,2 %</td>
<td>77,9 %</td>
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<tr>
<td>2 – Good</td>
<td>19,7 %</td>
<td>22,2 %</td>
<td>19,7 %</td>
<td>18,7 %</td>
<td>17,3 %</td>
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<tr>
<td>3 – Poor</td>
<td>7,0 %</td>
<td>6,3 %</td>
<td>6,0 %</td>
<td>7,2 %</td>
<td>4,4 %</td>
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<tr>
<td>4 – Very poor</td>
<td>1,3 %</td>
<td>0,8 %</td>
<td>0,6 %</td>
<td>0,9 %</td>
<td>0,4 %</td>
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<tr>
<td></td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
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</tbody>
</table>

Figure 1: Number of reported B-surveys
Impact of organic load in the local impact zone – MOM-B investigations 2016

Data are given as percentage of sites with its ecological condition:

1 low organic loading;
2 moderate organic loading;
3 high organic loading (maximum allowed loading);
4 overloading of the site
Benthic fauna diversity in the intermediate zone – C-survey

Stasjonsverdi (nEQR) C2
2015 og 2016
Examples on regional monitoring programs:

- Blue Planet AS – Regional monitoring in aquaculture intensive recipients.
  - Rogaland
  - Hordaland
  - Nordland

_BQE in accordance with WFD guidelines._
Areas of risk
- aquaculture production

• Farms located in recipients with limited water exchange
  – E.g., Sill fjords

• Low oxygen value
  – Potential threat for marine species in the recipient

• Change of benthic community from its reference values
  – Lower diversity
  – Increase in opportunistic and tolerant species.
Sørfjorden
Prod. 128 tonn/km² 2015-2016

Oksygeninnhold (ml/l) i indre basseng i Sørfjorden

Graf: Fylkesmannen i Hordaland, Data: UNI Research, Blue Planet og Rådgivende Biologer
Malnesfjorden
Prod. 66 tonn/km2 2015-2016
4 sites and 1 slaughtery

- Undersøkelser i 2014
  - Oksygen bunnvann var god
  - Bunnfauna var dårlig i resipienten

- Fettsyre analyse av sediment i dypområder
  - Viste ingen forhøyde verdier
  - Ikke sedimentering fra anleggene til dypområdet (?)

- Pålegg om månedlig overvåking av oksygen i bunnvann
Malnesfjorden
Prod. 66 tonn/km² 2015-2016
4 sites and 1 slaughtery

  - Oxygen each September for 8 years
  - Benthic fauna diversity low, but showing signs of recovery.

- Monthly oxygen measurements shows late stirring of bottom water
Knowledge needed
- Vulnerable habitats, hard bottom, sill fjords

New project 2017-2021 AKVAKYST (HI)

- Effects on special habitats – coral reefs, eelgrass, etc.
- Effects on coastal benthic habitat – coastal prawns, lobster, crayfish etc.
- Effects of lice treatment water on corals and sponges

New project 2017-2019 SUSTAIN-AKVA (HI)
Focus on hard bottom community in northern Norway and effects on soft bottom corals.
Knowledge-based management
Revision of benthic fauna indices

• Collaboration between Directorate of Fisheries and Environment agency.

• Researchers from Universities, IMR, NIVA, and research companies.

• Norway had only one set of threshold values for benthic fauna BQE.
Revision of benthic fauna indices

<table>
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<th>Indeks</th>
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<th>Dårlig</th>
<th>Svært dårlig</th>
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<td>0,49 - 0,31</td>
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<td>H'</td>
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<td>3,0 - 1,9</td>
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<td>25 - 17</td>
<td>17 - 10</td>
<td>10 - 5</td>
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<td>IS₁₀₁₂</td>
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<td>7,5 - 6,2</td>
<td>6,2 - 4,5</td>
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<td>25 - 20</td>
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<td>15 - 10</td>
<td>10 - 0</td>
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Marine life – our common responsibility

DIRECTORATE OF FISHERIES

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Regioner
- Barentshavet (B)
- Norskehavet Nord (G)
- Norskehavet Sør (H)
- Nordsjøen Nord (M)
- Nordsjøen Sør (N)
- Skagerak (S)

Vanntyper (kyst):
1. Åpen eksponert kyst
2. Moderat eksponert kyst
3. Beskyttet kyst/fjord
4. Ferskvannspåvirket beskyttet fjord*
5. Sterilt ferskvannspåvirket beskyttet fjord
6. Naturlig oksygenfattig fjord
7. Strømfiske sand
8. Søregne vannforekomster

* Flåten ikke i Skagerak, da hele området er ferskvannspåvirket.
Figur 4 Beregnede gjennomsnittlige naturtilstandssverdier basert på alle data (metode 1). Blå linje viser tidligere oppgitte referanseverdier (Veileder 01:2009). Foråret søyle til venstre viser klasiifiseringen slik den er definert i dag (Veileder 02:2013). Type 1/2/3 og 4/5 er definert i Figur 3, Kapittel 3.1.3
- Thresholds values proposed for 5 different water types and geographical areas
• The proposed changes will be implemented in to the national WFD guidelines.