

# Risk Evaluation of Norwegian Aquaculture and the new “Traffic light system”

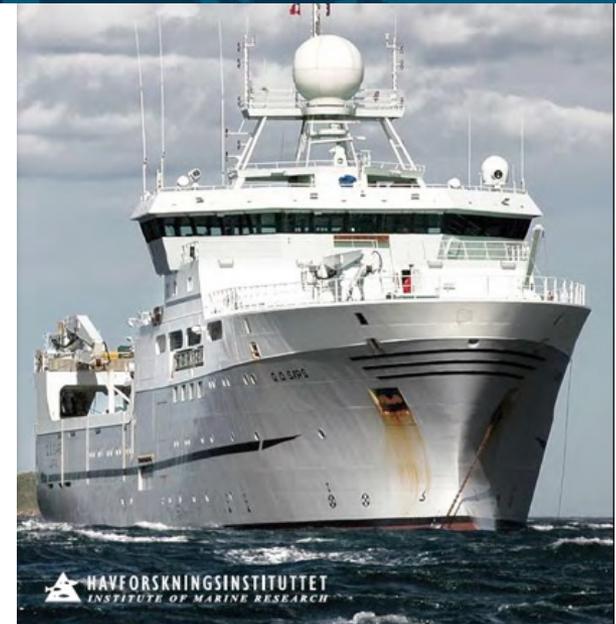
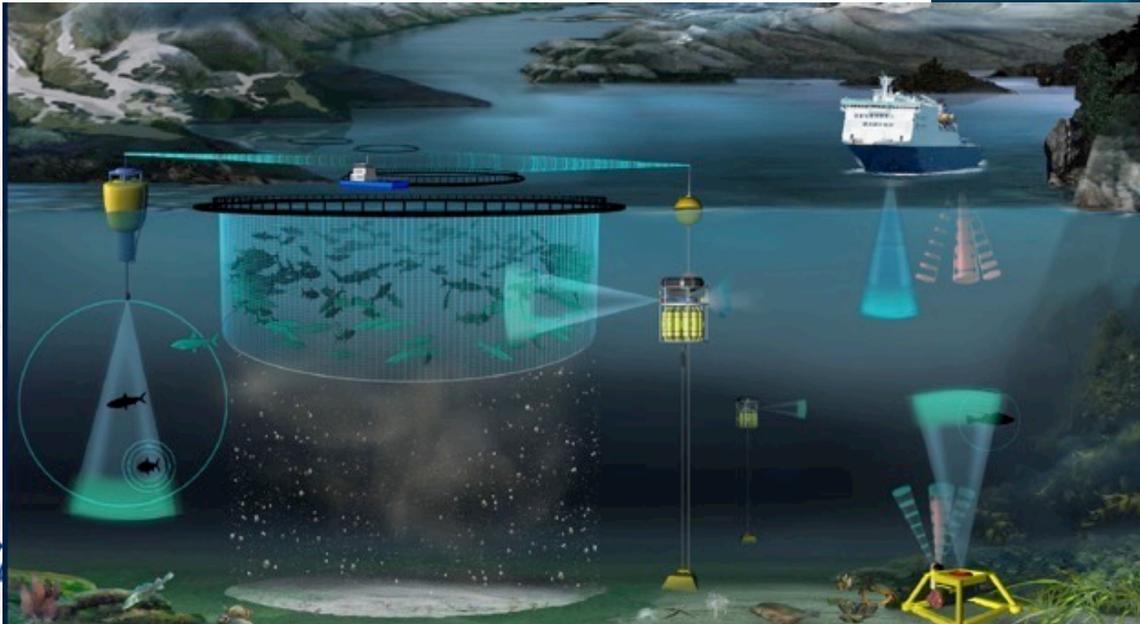
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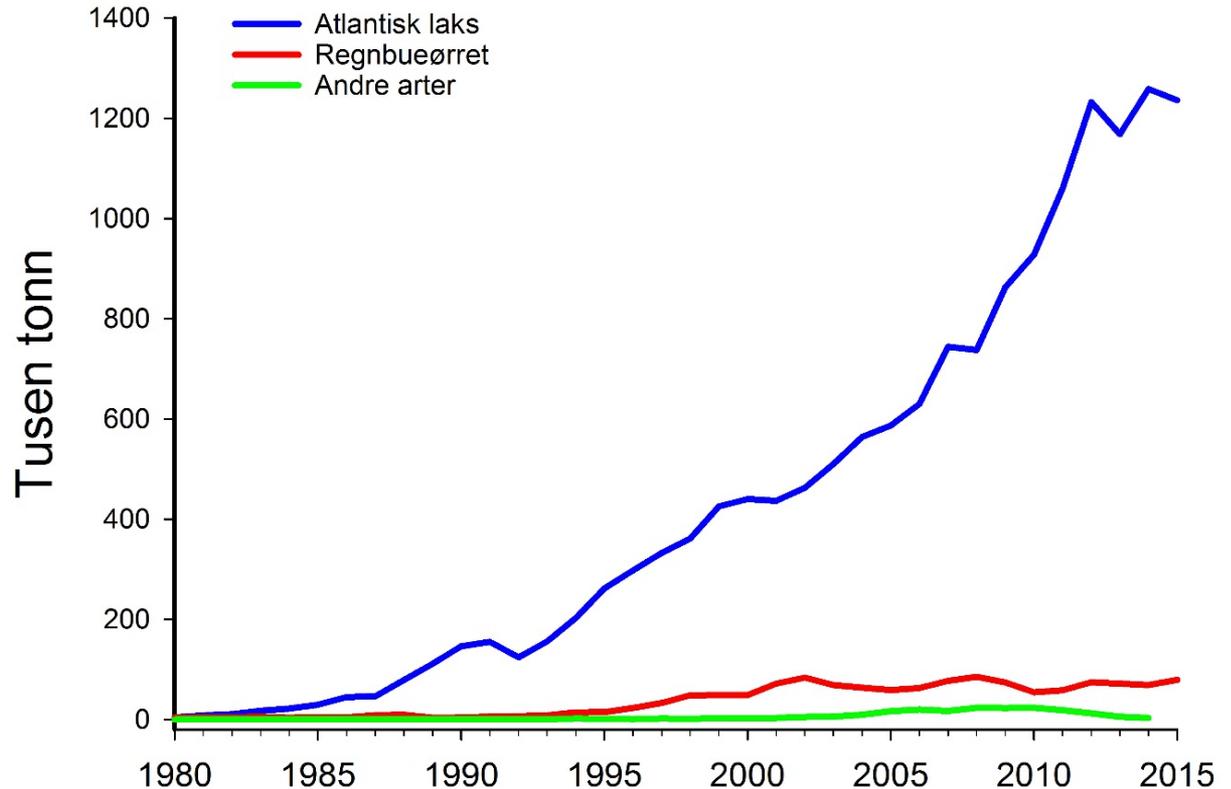
# Institute of Marine Research

- National governmental institute under the *Ministry of Trade, Industry and Fisheries*
- More than 700 employed
- Budget > 1 billion NOK/yr
- **Research and Advice** on marine living resources, environment and aquaculture



# Aquaculture production in Norway

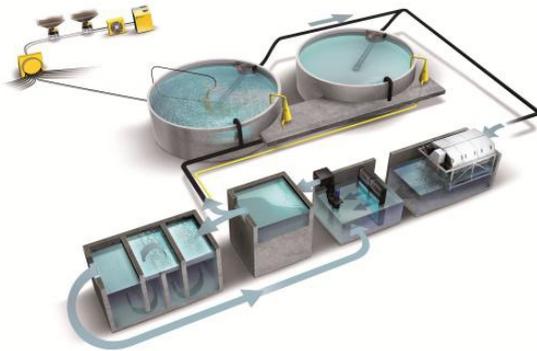
- Atlantic salmon production in 2014; 1.29 mill tons
- > 300 mill salmon individuals transferred to sea cages every year
- Around 600 sites in use at any time along the Norwegian coast.
- Most of the production in large sea cages



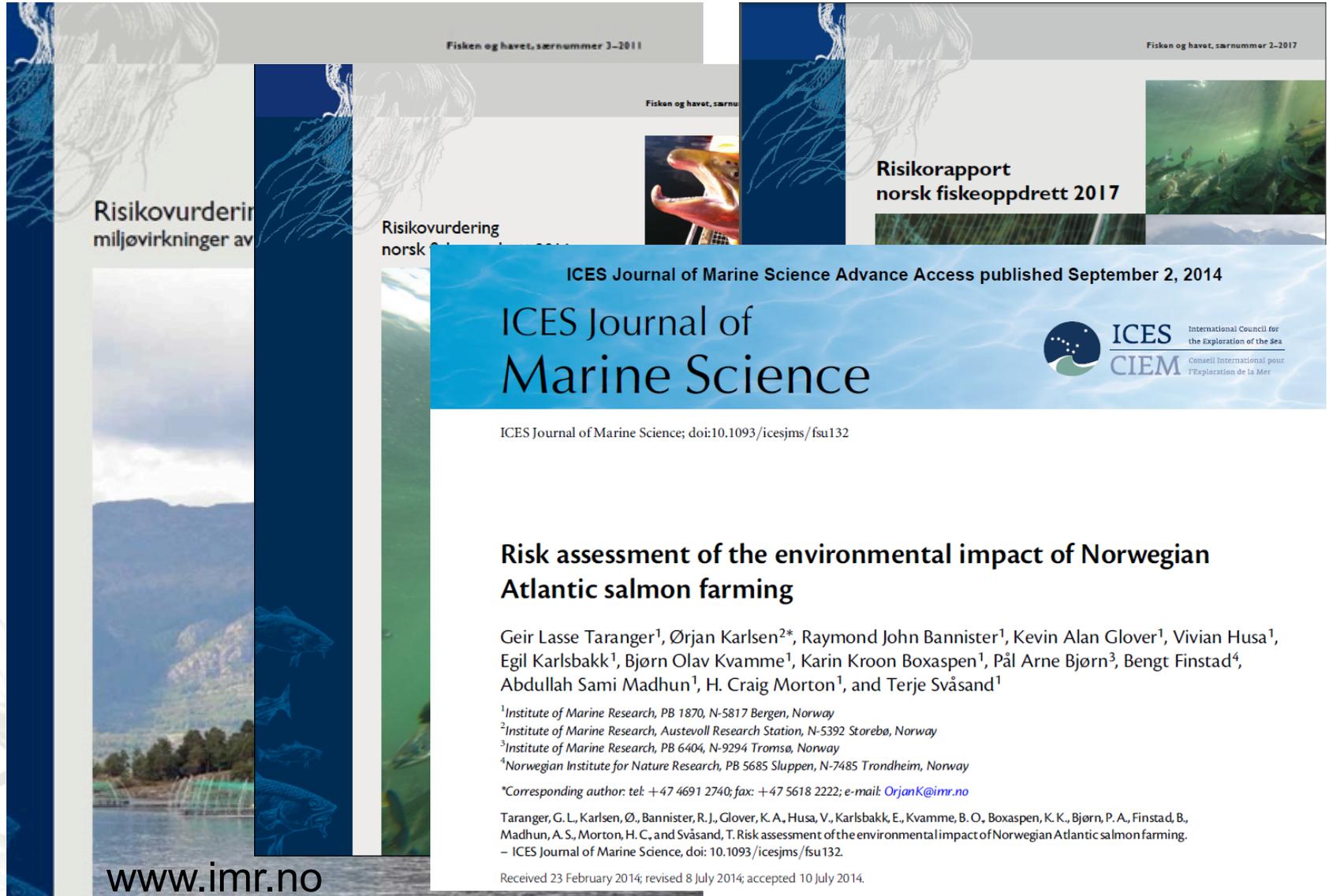
# Salmon farming in Norway

Smolt in FW  
from egg to  
100g in FW  
tanks

100g to harvest 5 kg in  
open sea cages in fjords  
and coastal areas



# IMR; Yearly risk assessment of environmental impact since 2011



The image is a collage of various reports and journal covers. On the left, there are two vertical panels. The top one is titled 'Risikovurdering miljøvirkninger av' and the bottom one shows a landscape with mountains and water. In the center, there are several overlapping report covers. One is titled 'Fisken og havet, særnummer 3-2011', another 'Fisken og havet, særnummer 2-2017', and a third 'Risikorapport norsk fiskeoppdrett 2017'. The largest, central element is the cover of the 'ICES Journal of Marine Science', published September 2, 2014. The journal cover features the title in large black letters, the ICES logo, and the text 'ICES Journal of Marine Science; doi:10.1093/icesjms/fsu132'. Below the journal cover, the title of the article 'Risk assessment of the environmental impact of Norwegian Atlantic salmon farming' is displayed in bold. The authors' names and their affiliations are listed below the title. At the bottom left, there is a small logo of a fish and a triangle, and the website address 'www.imr.no'. At the bottom right, there is a small text block with the authors' names and the journal information.

Risikovurdering miljøvirkninger av

Fisken og havet, særnummer 3-2011

Fisken og havet, særnummer 2-2017

Risikorapport norsk fiskeoppdrett 2017

ICES Journal of Marine Science Advance Access published September 2, 2014

ICES Journal of Marine Science

ICES International Council for the Exploration of the Sea  
CIEM Conseil International pour l'Exploration de la Mer

ICES Journal of Marine Science; doi:10.1093/icesjms/fsu132

## Risk assessment of the environmental impact of Norwegian Atlantic salmon farming

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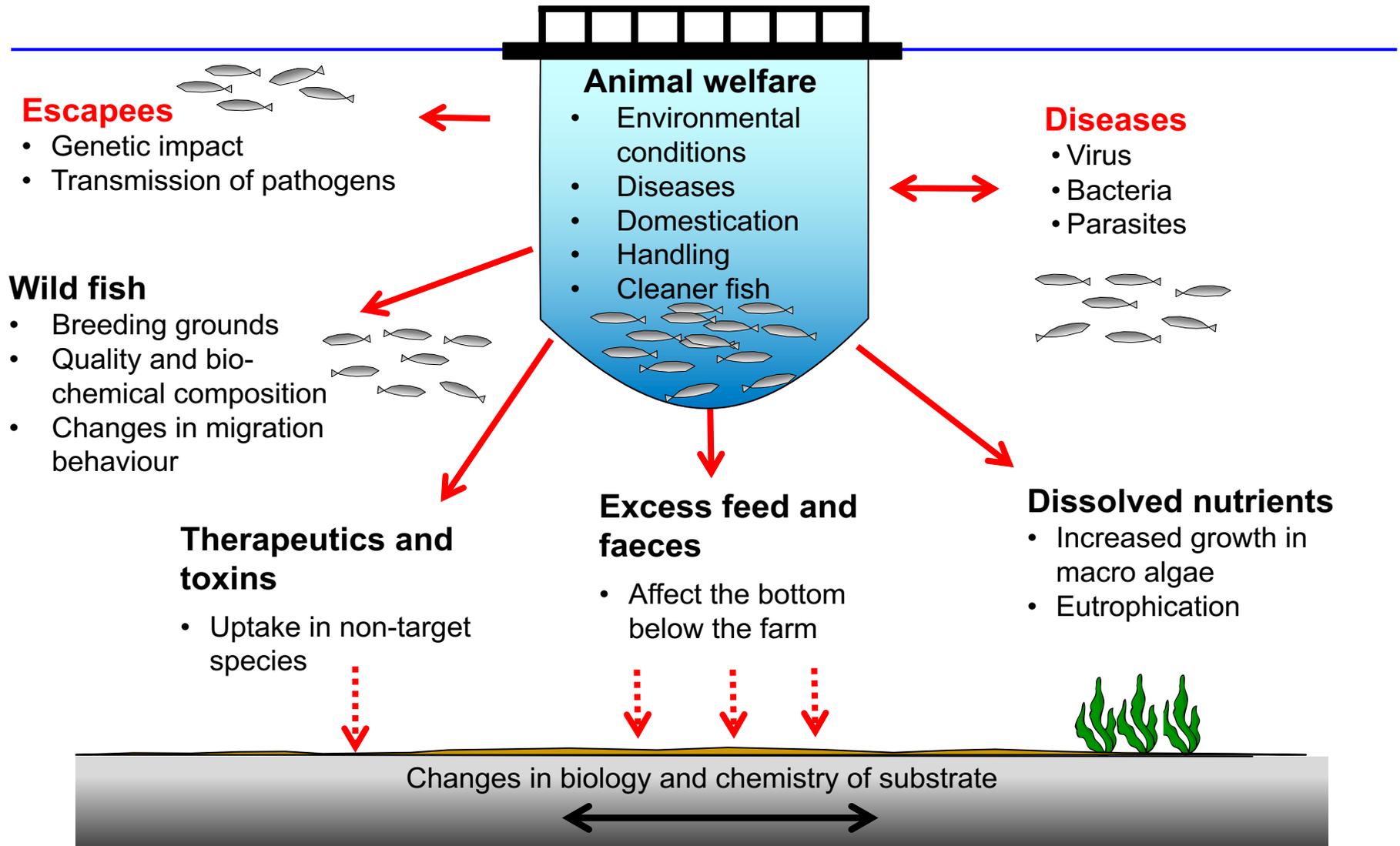
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Taranger, G. L., Karlsen, Ø., Bannister, R. J., Glover, K. A., Husa, V., Karlsbakk, E., Kvamme, B. O., Boxaspen, K. K., Bjørn, P. A., Finstad, B., Madhun, A. S., Morton, H. C., and Svåsand, T. Risk assessment of the environmental impact of Norwegian Atlantic salmon farming. – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu132.

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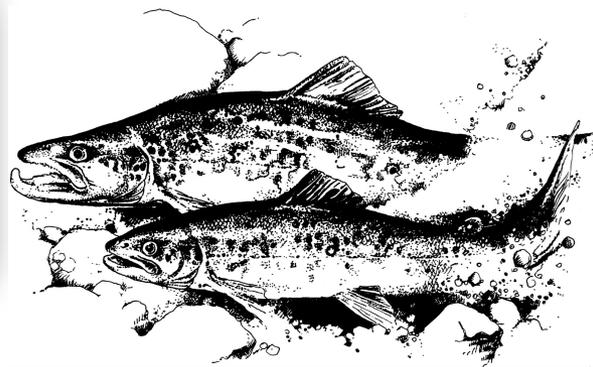
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# Hazards – Open cage aquaculture



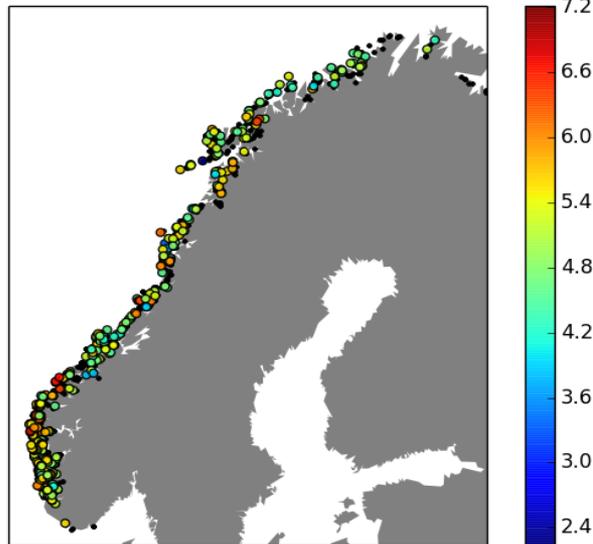
# Current main risk factors

- Impact of **salmon lice** on wild salmonids; especially sea trout is at risk – extensive monitoring and modelling – heavily regulated – large costs in treatment
- Genetic introgression of escaped farmed salmon – extensive monitoring and studies – mandatory mitigation in place
- Use of therapeutics against salmon lice - effects not well known
- Impact of other diseases on wild salmonids – monitoring in place - so far little evidence
- Organic load – mandatory monitoring near farms - considered to be under control so far
- Nutrients – not considered limiting so far – some monitoring in place
- Interactions with coastal fisheries – not well studied



# Salmon lice - current main risk

- Infections with the crustacean parasite **salmon lice** on wild salmonids; one of the main problems since the late 90s
- Salmon farming has increased the **number of hosts** in coastal waters dramatically
- Evidence indicate that 0.3 lice/g fish is lethal for salmon post-smolts in nature

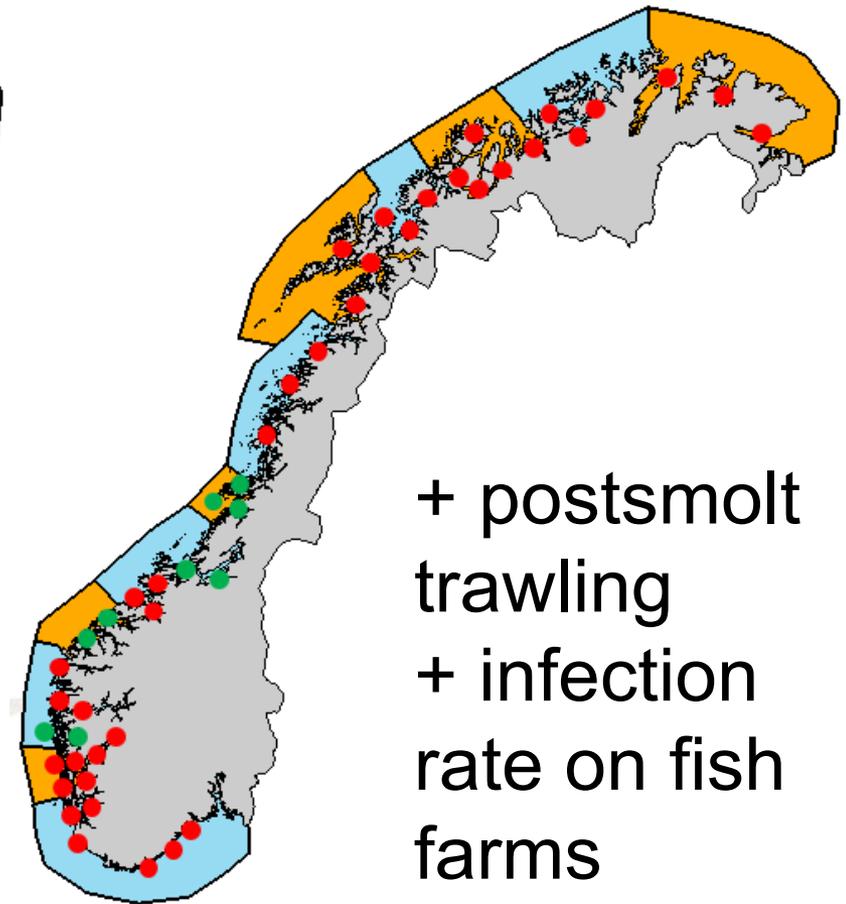
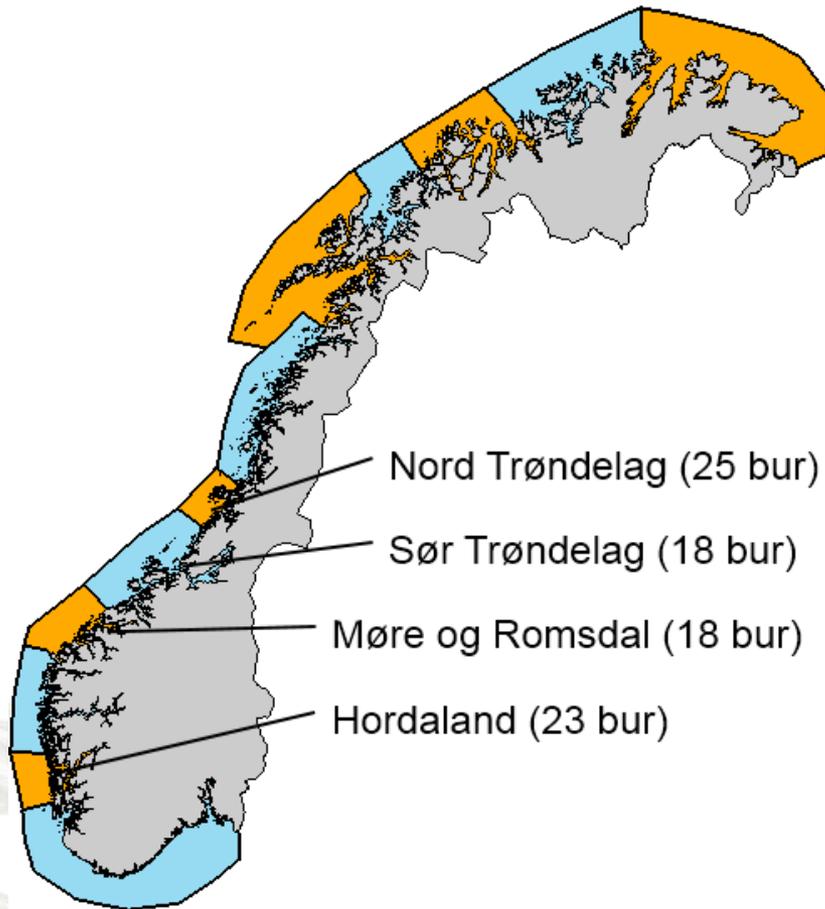


6-700 sites in operation;  
scale indicate lice production  
pr site



# Salmon lice surveillance

- Smolt cages – test fjords
- Traps and gil nets



+ postsmolt  
trawling  
+ infection  
rate on fish  
farms



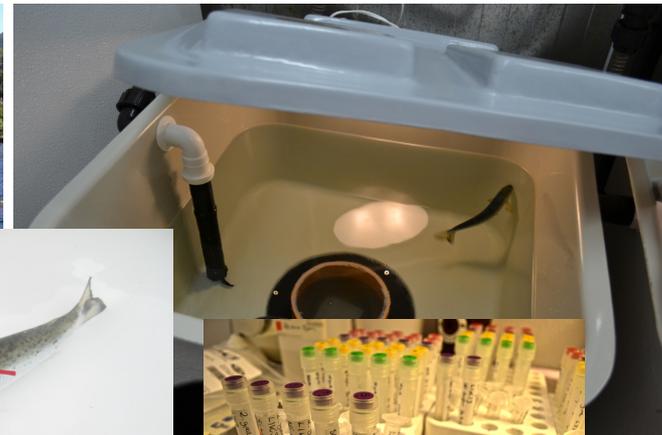
# From individual wild fish observations to estimates of population-wise effects

Salmon lice counts on wild salmonids

- Traps
- Gill nets
- Trawl

Physiol. effects on individual fish studied in lab

Assumed population/ area-wise effects and risk assessment



## Risk assessment – A. salmon smolts 2010–2016

Risk assessment based on monitoring of sea trout captured in traps and gill nets in May and June as well as trawling of emigrating post-smolt

Estimated mortality from salmon lice*	%
Low	< 10
Moderate	10-30
High	>30

\*criteria proposed by Taranger et al. 2012 and endorsed by the Norwegian parliament in 2015

Risk for sea lice related mortality in wild Atlantic salmon 2010-2016

Fylke	Fjord	Sted	2010	2011	2012	2013	2014	2015	2016
Aust-Agder	Sandnesfjord	Sandnesfjord	0	0	0		0	0	0
		Kilsfjorden							0
Rogaland	Ryfylke	Hellvik	0	0	0	0	0		
		Vikedal <sup>*2012</sup>		36	20				9
		Indre Årdal					0		
		Ytre Årdal					4	2	52
		Nedstrand				3	8		42
Hordaland	Hardanger	Forsand		0	0				
		Granvin	0	0					
		Ålvik		54	51	0	2		4
		Strandebarm							74
		Rosendal	0	69	53	13	1	44	36
		Etne	0	0	16	1		7	13
		Indre Etne					3		
		Ytre Etne					11		
		Ålfjorden							76
		Bjørnafjorden	Samnangerfjord						
Nordhordland	Lindås	Lindås						44	
		Masfjorden						20	52
		Herdlafjorden							65
Sogn og Fjordane	Sognefjorden	Balestrand	0	0	2	0			
		Vik				0	0		
		Bjordal					5		
		Brekke / Dingja	0	35	23	0	40	58	
		Sohund						54	32
		Sorbøvågen							100
		Maurstadvika							38
Møre og Romsdal	Romsdal	Eresfjord	0	0	0				
		Sandnesbukta				22			
		Isfjord/Måndalen	0	0	0	0	37	1	
		Bolsøy <sup>*2010-2012</sup>	2	10	22	15	98		
		Vatnefjorden				0	93	8	35
		Frønfjorden				7	42		18
		Storfjord	0	0	37				
Sør-Trøndelag	Trondheimsfjord	Sykkylven	0	0	0				15
		Ørsta	0	5	9			1	50
		Stordalsvika						41	27
		Sjøholt							55
		Skatval <sup>*2010</sup>	6	0	2	0	1		
		Agdenes	0	90	94	0	13	8	42
		Hitra	0	5	0	0	0		
Asserøy							5		
Nord-Trøndelag	Namsen	Tøtdal/Namsenfj.	0	0	0	0	0	0	4
		Sitter <sup>*2010-2011</sup>	32	24	71	15		67	14
		Vikna			7	98			
		Vikna sør					83		78
		Vikna nord				82		85	

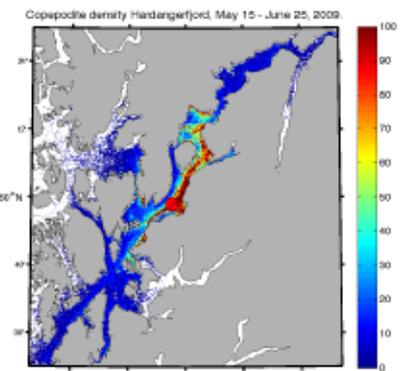
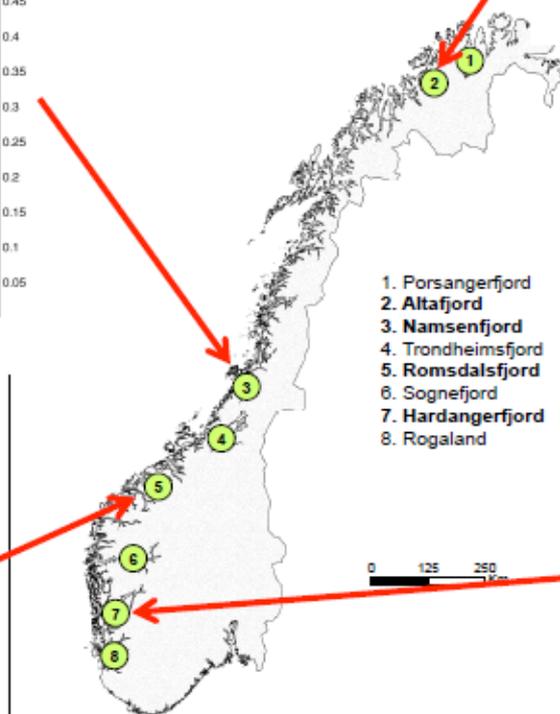
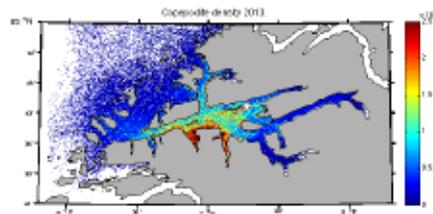
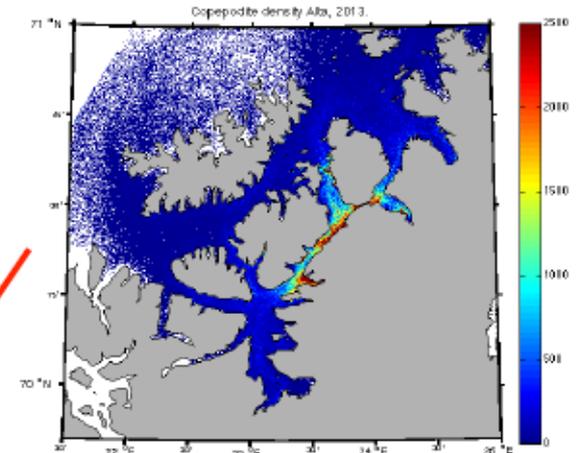
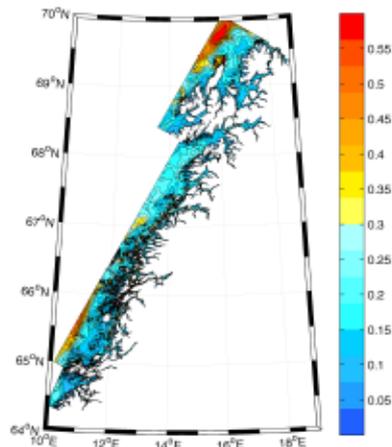
\*Har grunnet lavt antall smolt brukt all fisken fanget. Agdenes 2015 endret til risiko uke 22.



# Test areas for modeling in 2013-2015

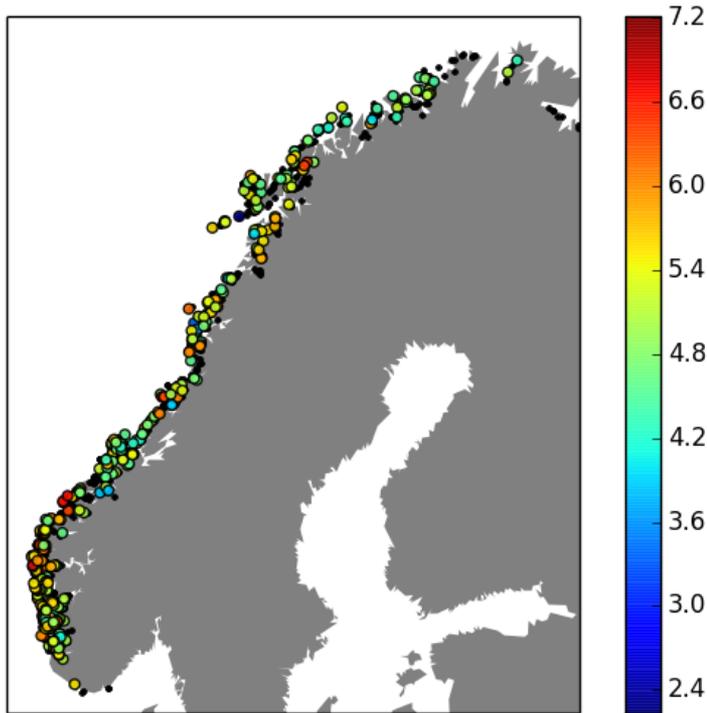
## The IMR current model system

On-going activity is nationwide.

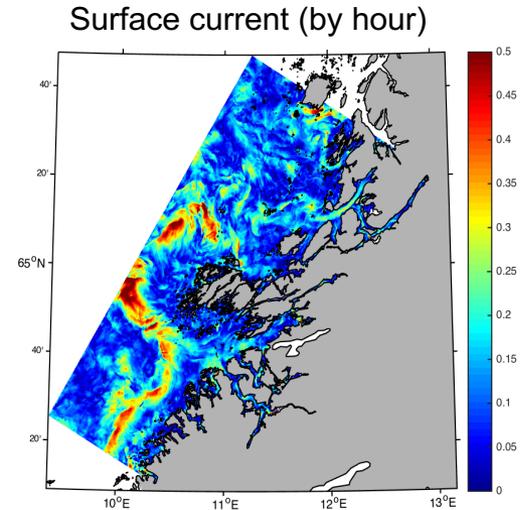


# Modelling salmon lice

Based on release of salmon lice from all farms, temperature, current and salmon lice behaviour

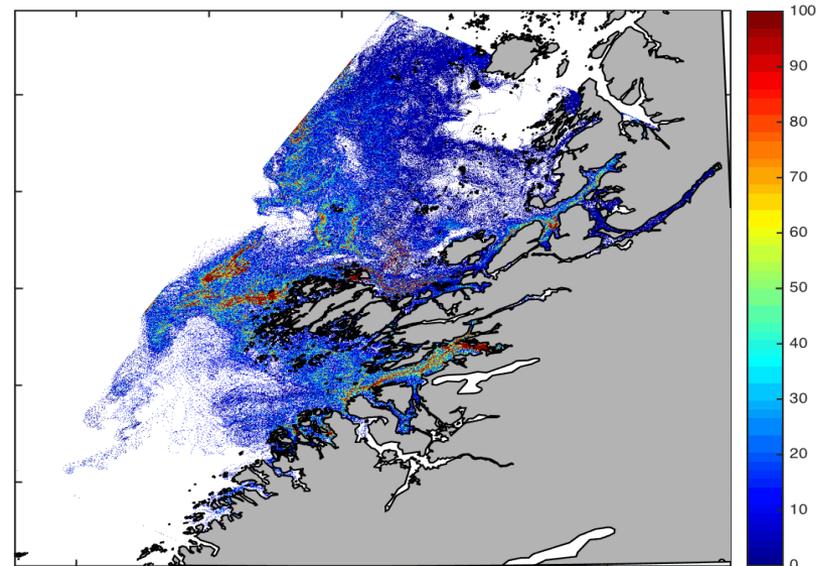


6-700 sites in operation;  
scale indicate lice production  
pr site



Fjord model, 160m resolution

Copepodits/m<sup>2</sup> (day by day)



# The “traffic light” for sustainable aquaculture development



- Defining environmental goals and thresholds for impacts
- Divide the coast into 13 regions for assessment of *regional environmental sustainability*
- Salmon lice effects on wild salmonids currently the only parameter
- Farmed salmon production capacity in the region will be adjusted to “regional carrying capacity”

Parliament white paper (2015)



# Implementing the “traffic light system”

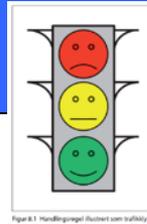
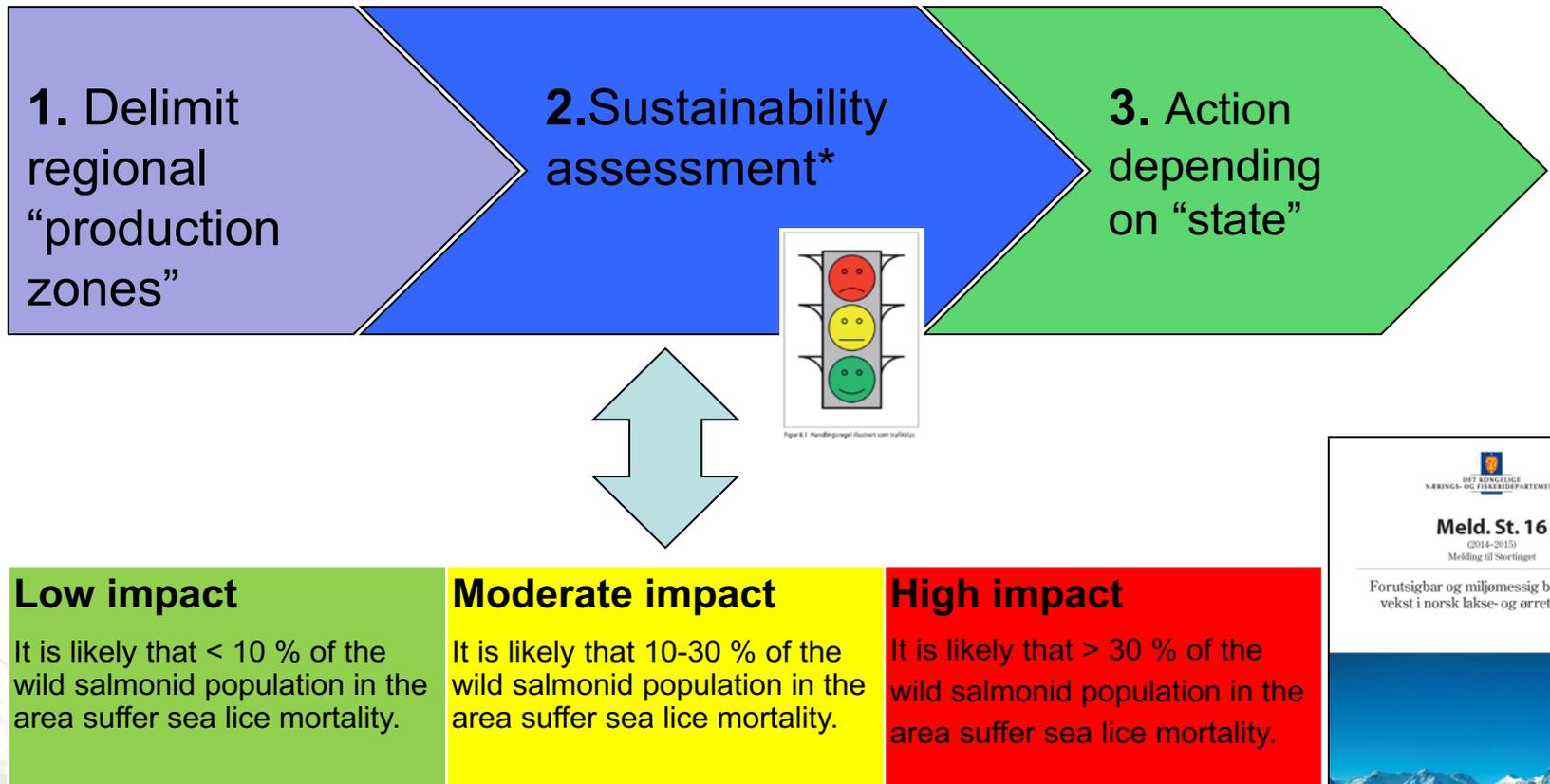
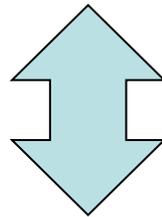


Figure 8.1. Handlingregel (dukkert som trafikklys)



## Low impact

It is likely that < 10 % of the wild salmonid population in the area suffer sea lice mortality.

## Moderate impact

It is likely that 10-30 % of the wild salmonid population in the area suffer sea lice mortality.

## High impact

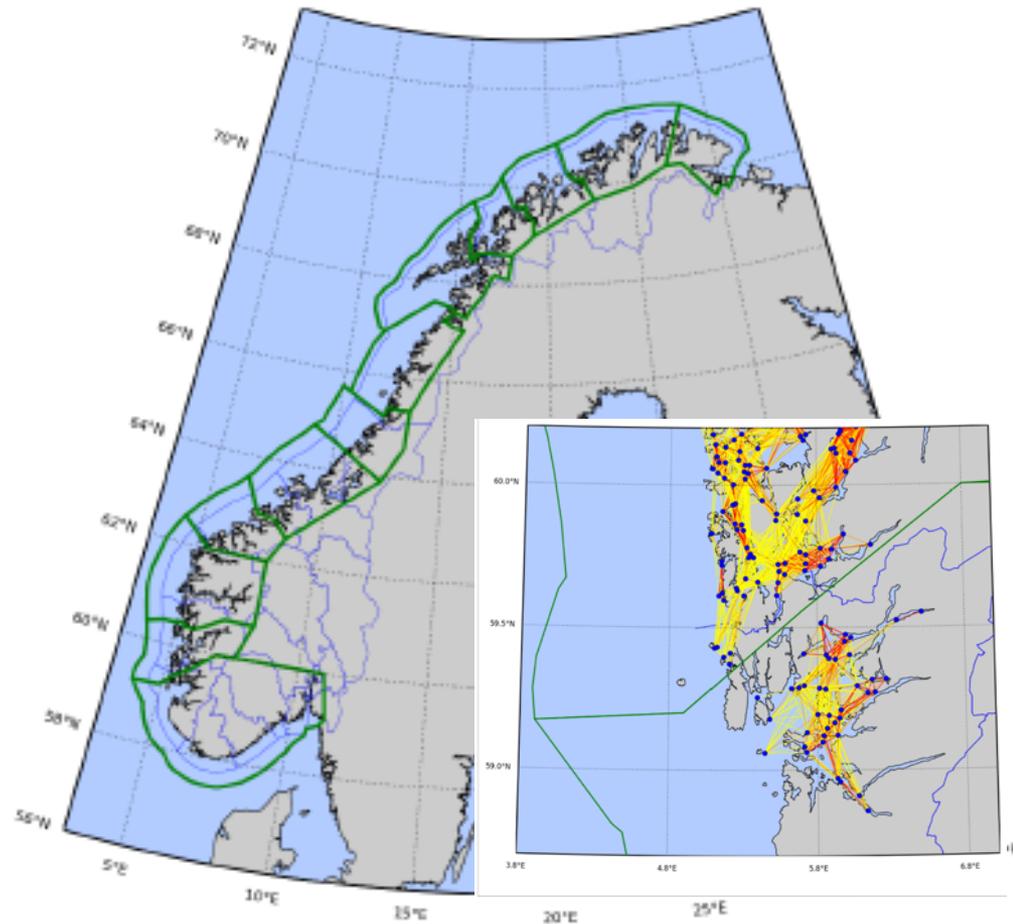
It is likely that > 30 % of the wild salmonid population in the area suffer sea lice mortality.

\*using regional salmon lice index



# Production zones and regional sustainability assessment

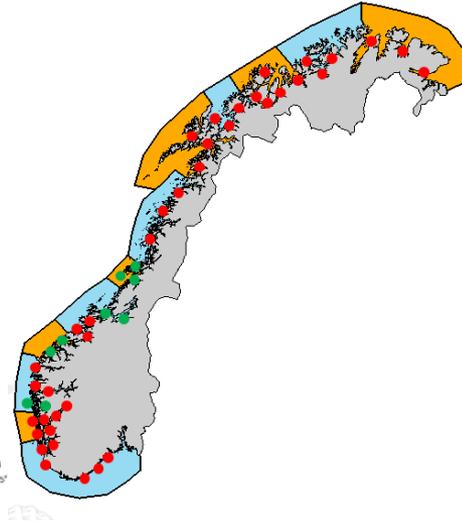
- 13 zones; Based on water currents, lice dispersal and sites
- High connectivity within zones – minimum transfer between
- Impact of salmon lice on wild salmonids will be scored for each zone
- Salmon industry growth depend on the environmental status in each zone



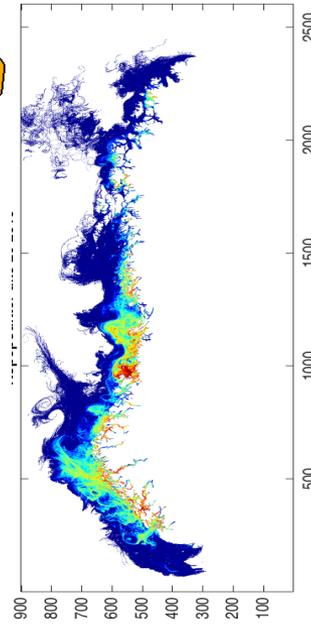
# New system in operation from 2018 – regulating the growth of salmon farming



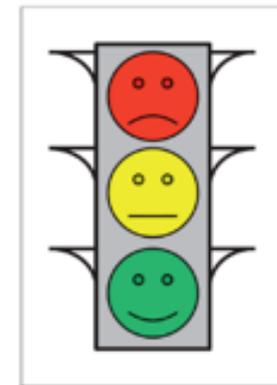
Production zones



Wild fish observations



Models

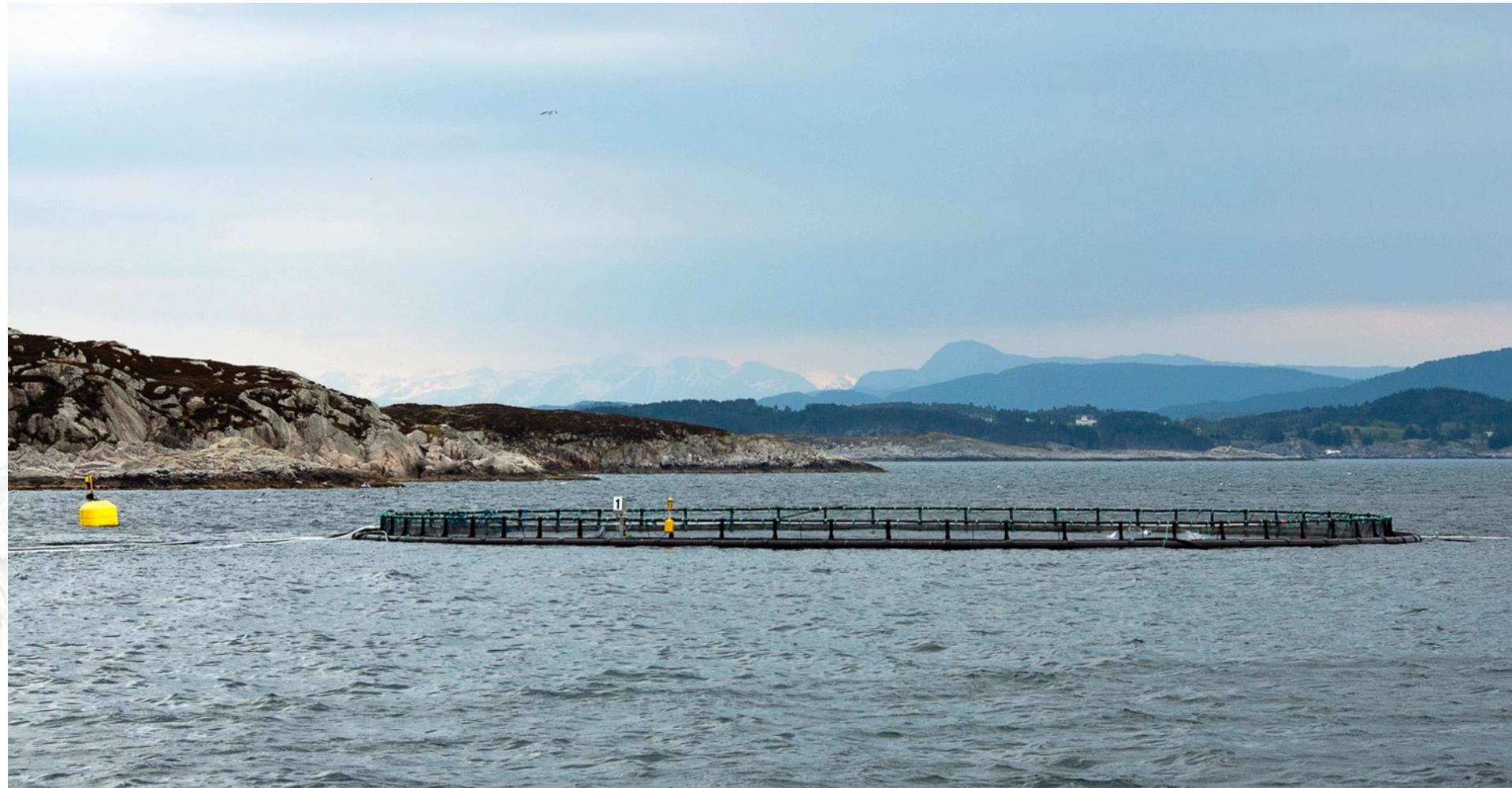


Figur 8.1 Handlingsregel illustrert som trafikkllys

Assessment and capacity regulation



# Thank you for the attention!



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Photo: R.W. Schulz