Status Norway – with focus on R&D

Randi Nygaard Grøntvedt
Researcher
National Veterinary Institute

Veterinærinstituttet
National Veterinary Institute

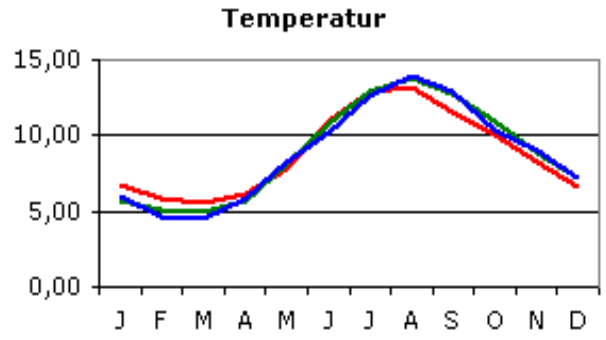
Global supply of Atlantic salmon (tons)

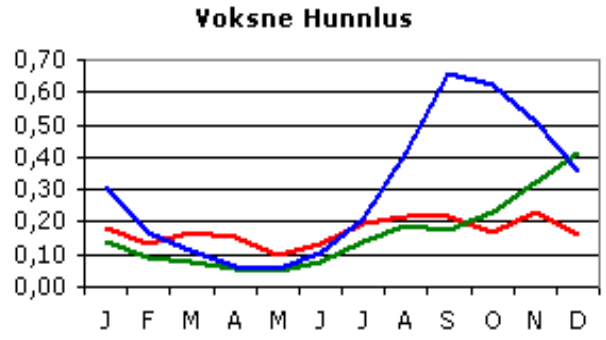
		2007	2008		2009E	
Atlantic Salmon	Norway	750 000	755 000	1 %	845 600	12 %
	Chile	351 000	398 000	13 %	159 200	-60 %
	Scotland	135 000	137 000	1 %	143 850	5 %
	Ireland	12 800	12 000	-6 %	12 000	0 %
	The Faros	20 100	35 000	74 %	49 000	40 %
	Iceland	1 742	1 000	-43 %	1 000	0 %
	Canada	110 669	119 000	8 %	130 900	10 %
	USA	10 000	10 000	0 %	10 000	0 %
	Australia	24 000	26 000	8 %	27 300	5 %
	SUM	1 415 311	1 493 000	5 %	1 378 850	-8 %

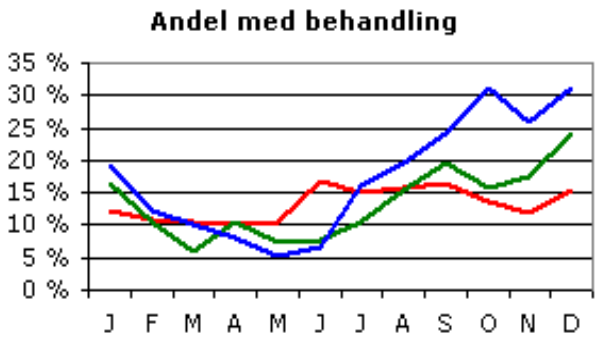
Chemotherapeutants available in Norway

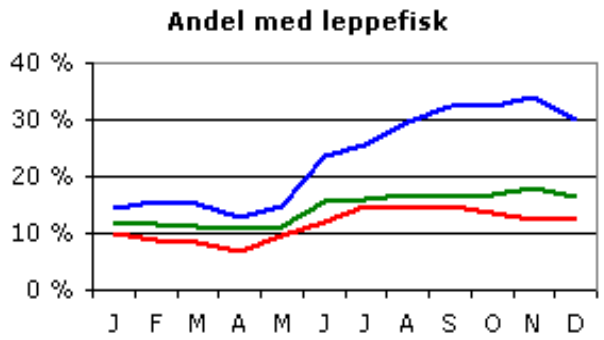
- For use in topical treatments:
  - Pyrethroids
    - deltametrin (Alphamax®)
    - cypermetrin (Betamax)
  - Organophosphorus compound
    - Azamethiphos (Salmonsan)
  - Hydrogen peroxide
- For use as oral treatments:
  - Avermectin (Slice)
  - Chitin inhibitors (Diflubenzuron, Teflubenzuron)

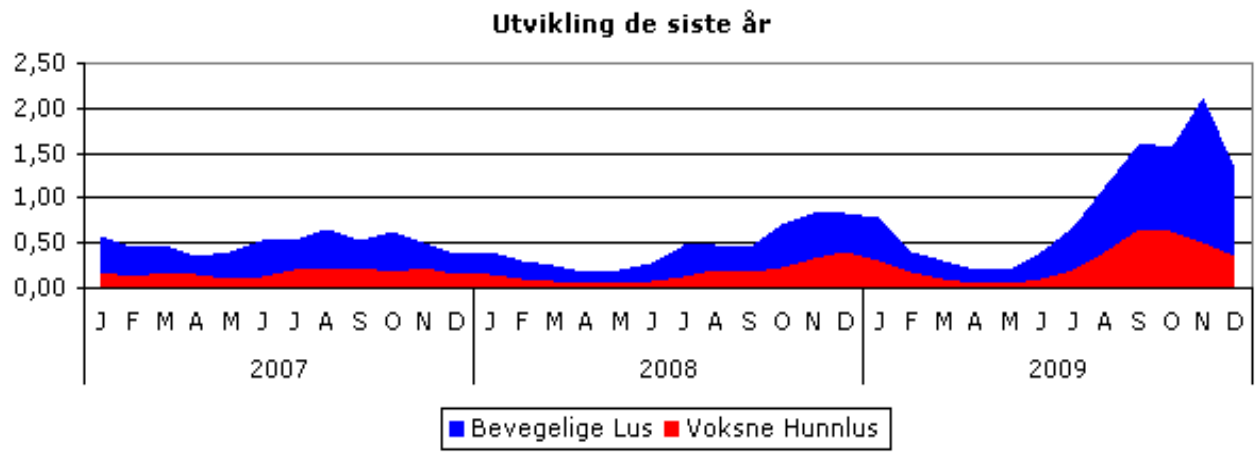
Norge











Forklaring

Her kan du se utviklingen av lusebestanden de siste tre årene.

Velg landsdel i menyen til venstre.

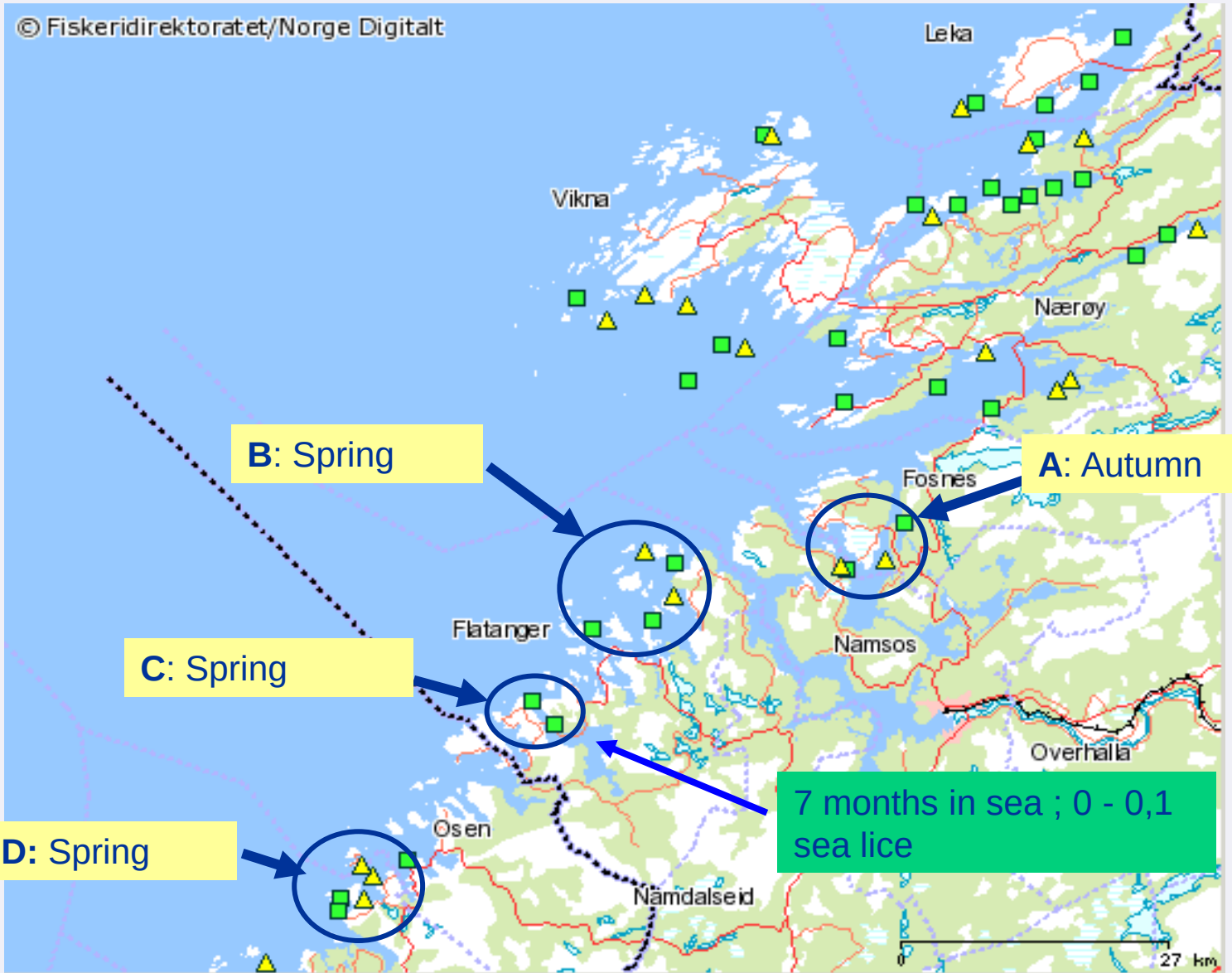
- 2007
- 2008
- 2009

National Veterinary Institute, Norway

Varieties of tools for louse control – a need for more knowledge

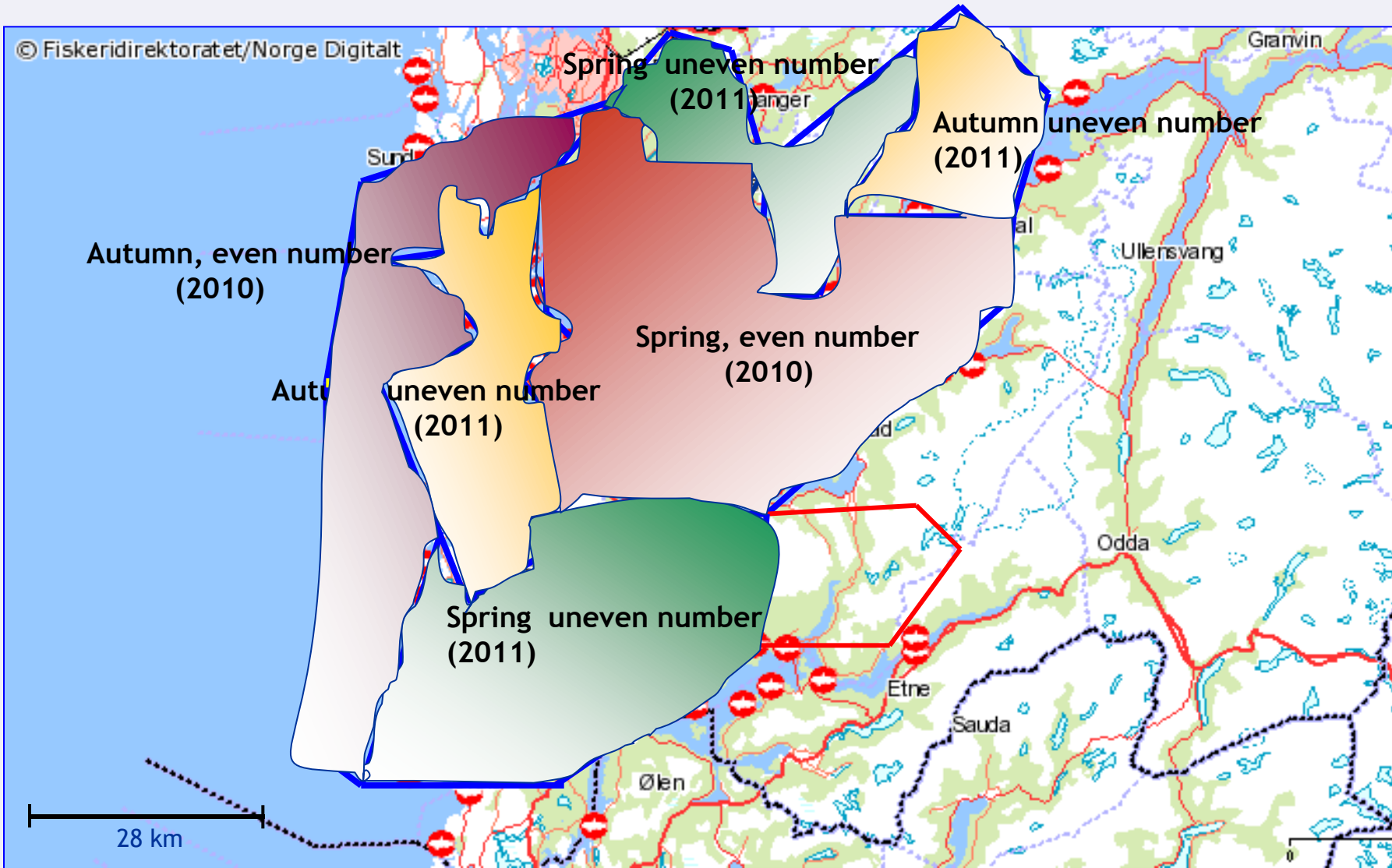
1. Preventive measures
   - Ring-fence areas
     - Synchronised production cycle of 1-year class of fish
     - Fallowing
   - Vaccines
   - Breeding
   - Health feed
   - Other measurements
2. Biological control
   - use of cleaner fish, wrasse
   - Future coming biological control measurements?
3. Monitoring and surveillance
   - Counting, sensitivity testing, population development
4. Use of chemotherapeutants
5. Surveillance of wild salmonids

An example on ring-fence areas in use



National Veterinary Institute, Norway

Suggested ring-fenced areas in another part of the country



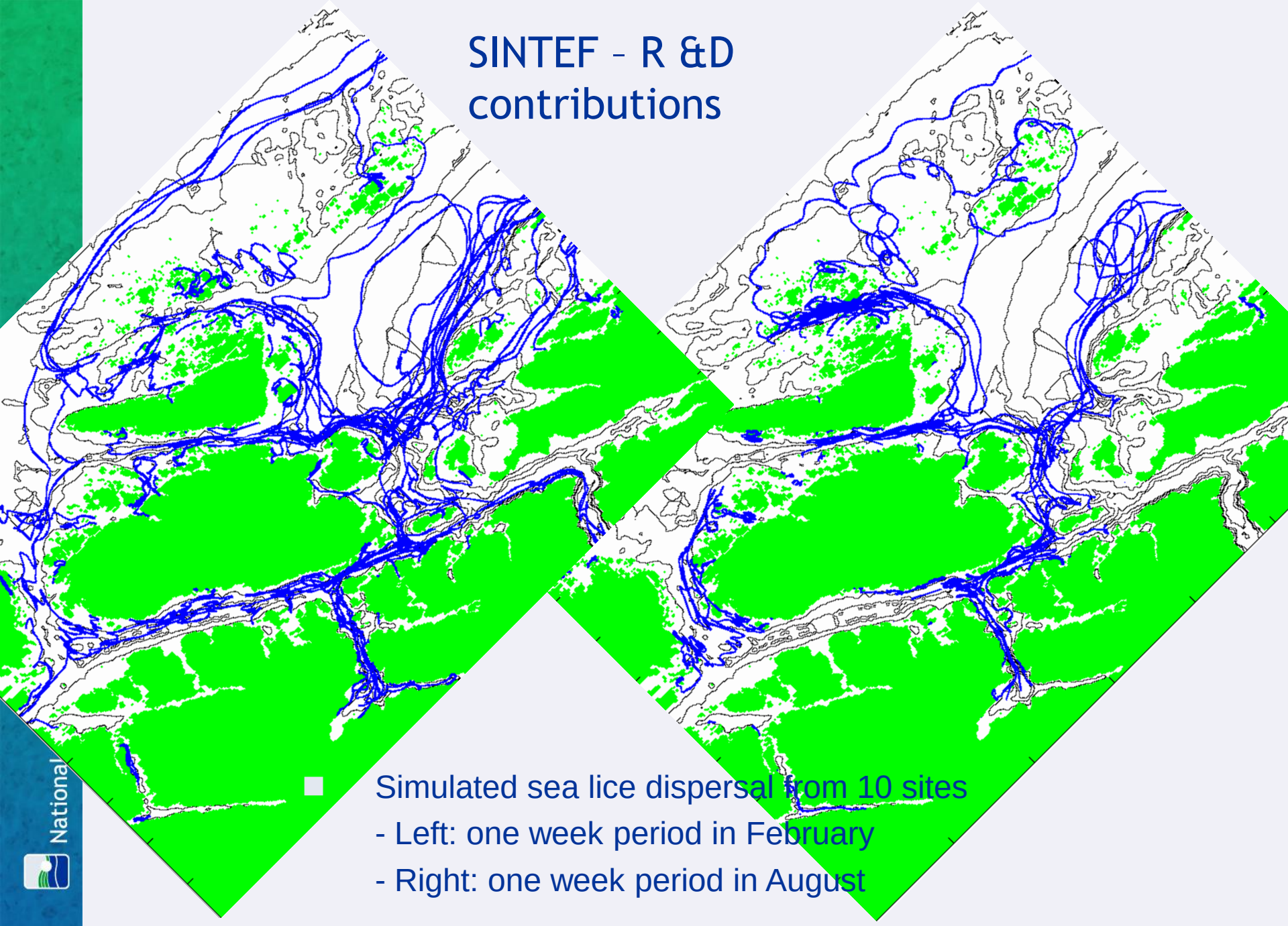
National Veterinary Institute, Norway

Ongoing R&D projects related to structural measurements

- **PrevenT (Salmon Louse – Prevention and treatment)**
  - Establishment of a salmon lice population dynamics model for use in:
    - web accessible dynamic maps in real-time as well as in forecasts.
    - Identification of areas, or farm sites, with elevated likelihood of resistant lice indicated by low treatment effects
    - Simulation of effects of control measures implemented in coastal areas, such as fallowing or synchronized treatments or vaccines
    - Testing predictions on the dispersion of salmon lice
    - Identify areas of poor understanding of salmon lice population processes and the needs of data gathering.

- Collaboration between National Veterinary Institute, Institute of Marine Research, Norwegian Institute of Nature Research and Norwegian computer center
- international cooperation

SINTEF – R &D contributions



- Simulated sea lice dispersal from 10 sites
- Left: one week period in February
- Right: one week period in August

Vaccines

- PrevenT, vaccine part

1. Tissue specific transcription in adult *L. salmonis* measured by microarray (UoB/IMR/NVI)
2. Signal mediation in the digestive canal (IMR)
3. Molecular characterisation of blood-digestion (UoB)
4. Identification of immune-inhibiting molecules, (NVI)
5. Clinical test of vaccine candidates (IMR/UoB/NVI)

- Focus on developing molecular and biological tools to identify and evaluate vaccine targets
- Adult female main research focus
  - knowledge of digestion processes and the link to reproduction

Large scale RNAi-based screening to identify vaccine candidates

	Activity	Time
1	Test >500 candidates with RNAi (~3%)	3 years
2	Evaluation of effects/localisation inn the lice/antigenisity etc	Continues
3	Vaccine antigen candidates	Continues
4	30 – 50 test vaccines	3-5 years
5	1-5 good vaccine candidates	Ca. 3 years

Shown that number of lice/fish can be reduced by vaccination

Breeding (Nofima Marin)

- Towards selection for increased resistance to the salmon louse in Atlantic salmon (FHF: 2007-2012)
  - genetic variation in resistance against *L. salmonis*
  - genetic correlation between resistance to the salmon lice and other economic important production traits
  - search for biomarkers and develop predictors of increased resistance to sea lice that can be used for selection
  - investigate if the counting of the number of lice per fish can be automated using digital image analysis
    - for use on anaesthetized fish in the field

Other biological control measurements to come? Looking for the sea lice secrets!

- PrevenT, vaccine part
  - Identify intestinal “achilles heels” targetable by other strategies than vaccines?
- RNAi technologi
  - Inhibit vital protein production in the sea louse, reduction in off spring?
- Sequencing and interpretation of the sea louse genome
  - Marine Harvest, IMR, FHF and UoB
- Interaction between fish and salmon louse: a transcriptomic study (FHF 2010)
  - To use multiple gene expression profiling for identification of genes that determine infectivity of salmon louse and resistance to the parasite in salmon

Other development projects in the "preventive" category:

- Filtering systems in well boats and at slaughter facilities
- Mechanical removal of sea lice?
- Underwater feeding system?
- Closed farming systems?
- Other ideas?
  - LET US KNOW!

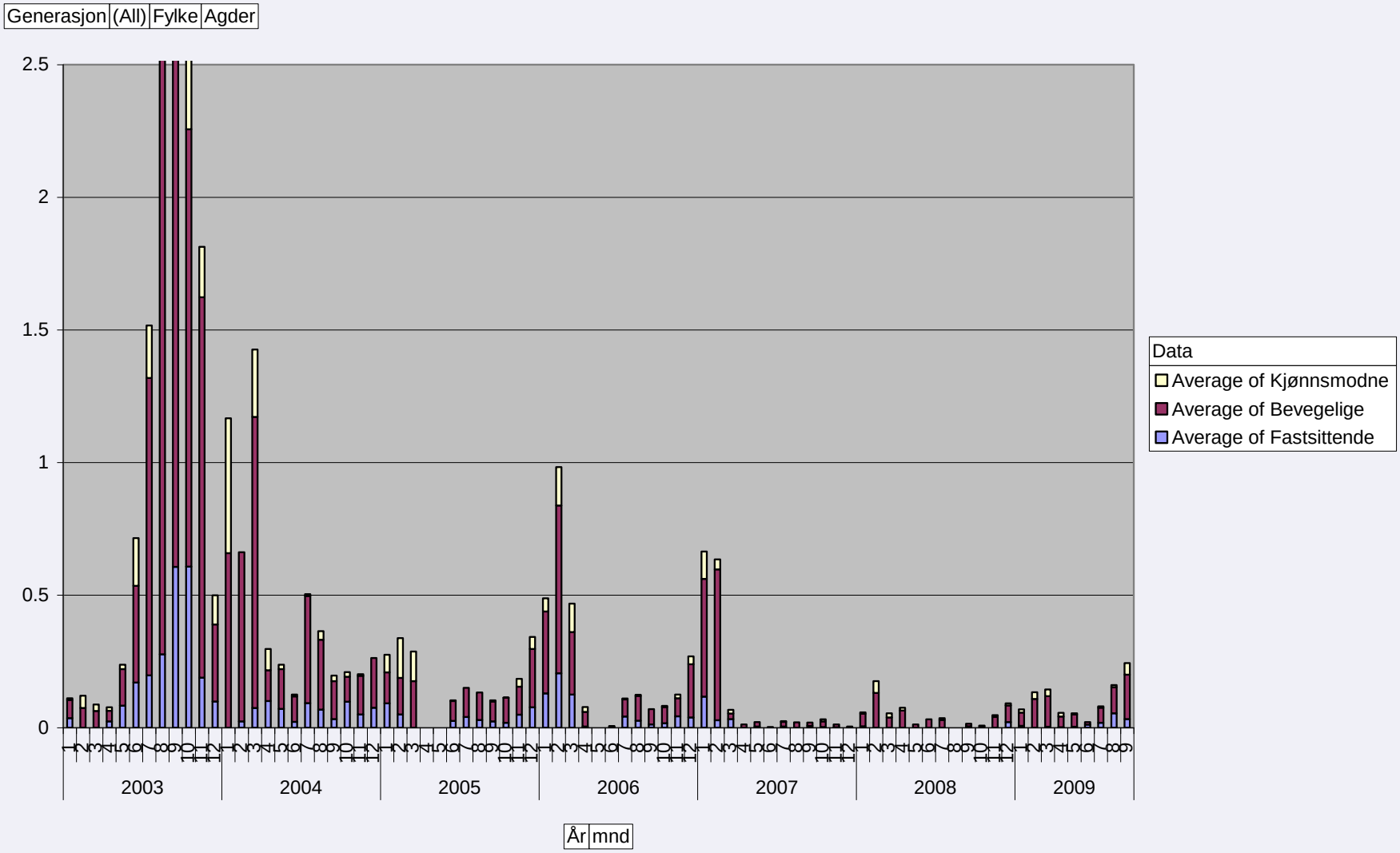
Effects? Feasibility? Needs for further development?

Biological control by use of wrasse

National Veterinary Institute, Norway

Wrasse, an effective weapon

Data from Marine Harvest



No use of medical treatment in this area for two years!

National Veterinary Institute, Norway

Ongoing R&D project related to wrasse

- Norwegian Research Council (RCN) project
  - Farming, with focus on nutrition and on-groing
  - Practical use of farmed wrasse
  - Collaboration between Marine Harvest, Villa Organic, IMR, NIFES and Nofima Marin
- Industry development
  - several commercial production sites
- Establishment of a knowledge platform
- Feeding systems and technologies for industrial production of wrasse (SINTEF)
- Biofilm and biofouling control – how to make the wrasse work better in cages (SINTEF)

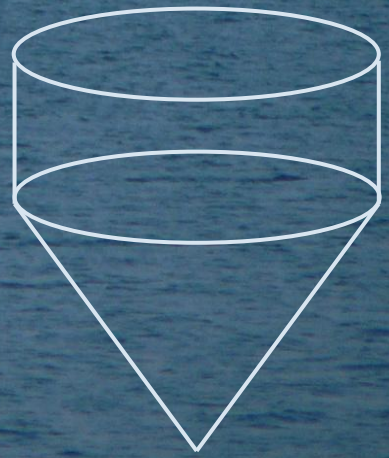
Surveillance and resistance, ongoing R&D projects

- Topilouse (RCN-project 2010-2012)
  - Evaluation of effect after treatment:
    - From abundance to prevalence. An easier and more statistical secure method to evaluate treatment efficiency?
  - NVI, University of Strathclyde, Glasgow; University of Prince Edward Island, Canada
- PrevenT:
  - Mechanisms of drug resistance development
    - Development of simple single-dose bioassays for field use
    - Development of in vitro methods for detection of emerging resistance situations
    - Estimation of parameters for selection pressure after different treatments
  - Norwegian School of Veterinary Science, UoB, VESO and Atlantic Veterinary college, Canada.
- Surveillance program on resistance

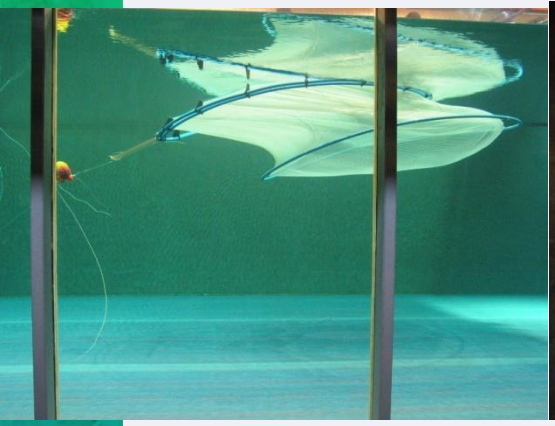
1. Safe use of shield (tarpaulin) around treatment volume during various conditions
2. Efficient dispersion of chemotherapeutants and oxygen into the water volume
3. Adequate management of fish behaviour, environment and security
4. Accurate efficacy evaluations of the treatments

Circumference 157 m

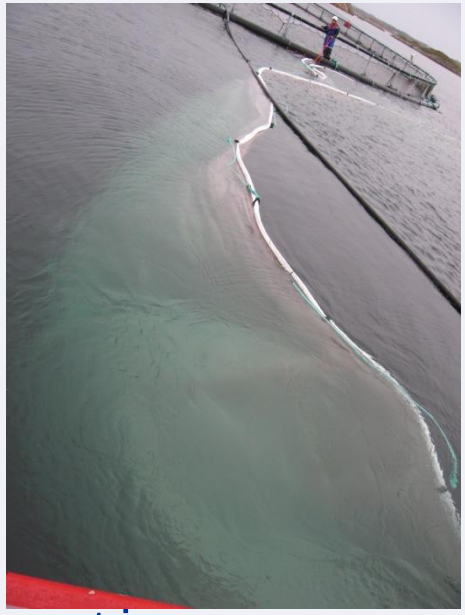
Depth 15-45m



SINTEF – R &D contributions



Technological development of solutions for chemical treatment in cages



Operation of technical solutions for chemical treatment in cages

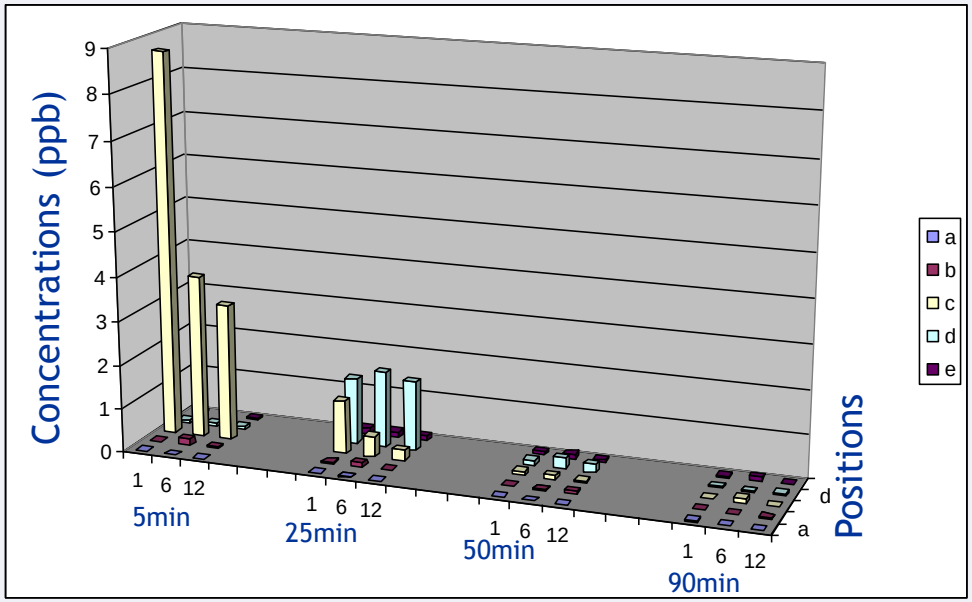
National Veterinary Institute, Norway

Use of medications and optimalization of bath treatment methods

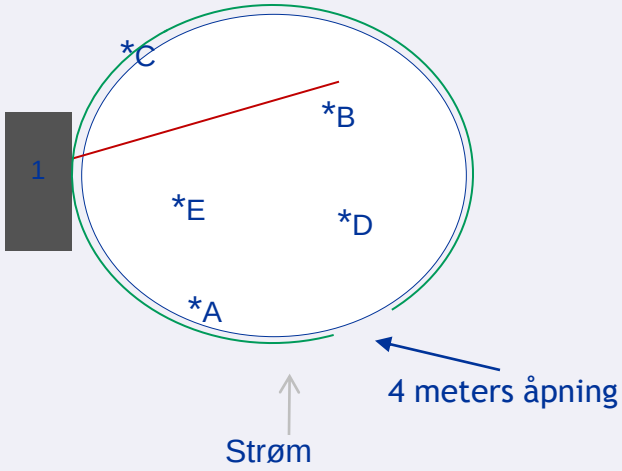
- Topilouse
  - Simulations of bath treatment methods in sea cages
    - Studies on: dispersion, technology, behaviour and oxygen uptake
  - Dispersion and fish behaviour studies in well boats
  - Security
  - Evaluation of effects
- Collaboration between NVI, SINTEF and IMR and many industrial partners

- Other industry development projects:
  - Optimalization of methodology for hydrogen peroxide use in well boats and sea cages
  - Simulation studies in well boat
    - Salmar, SINTEF, Nor consult

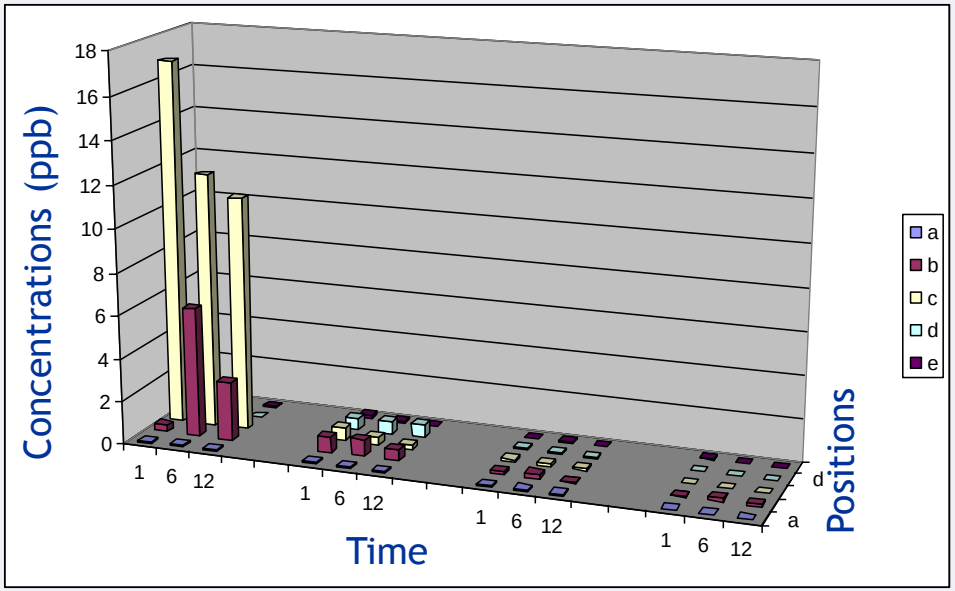
- Testing of new chemicals by using metabolomics (SINTEF)



Resultater fra DNA tracer metodikk

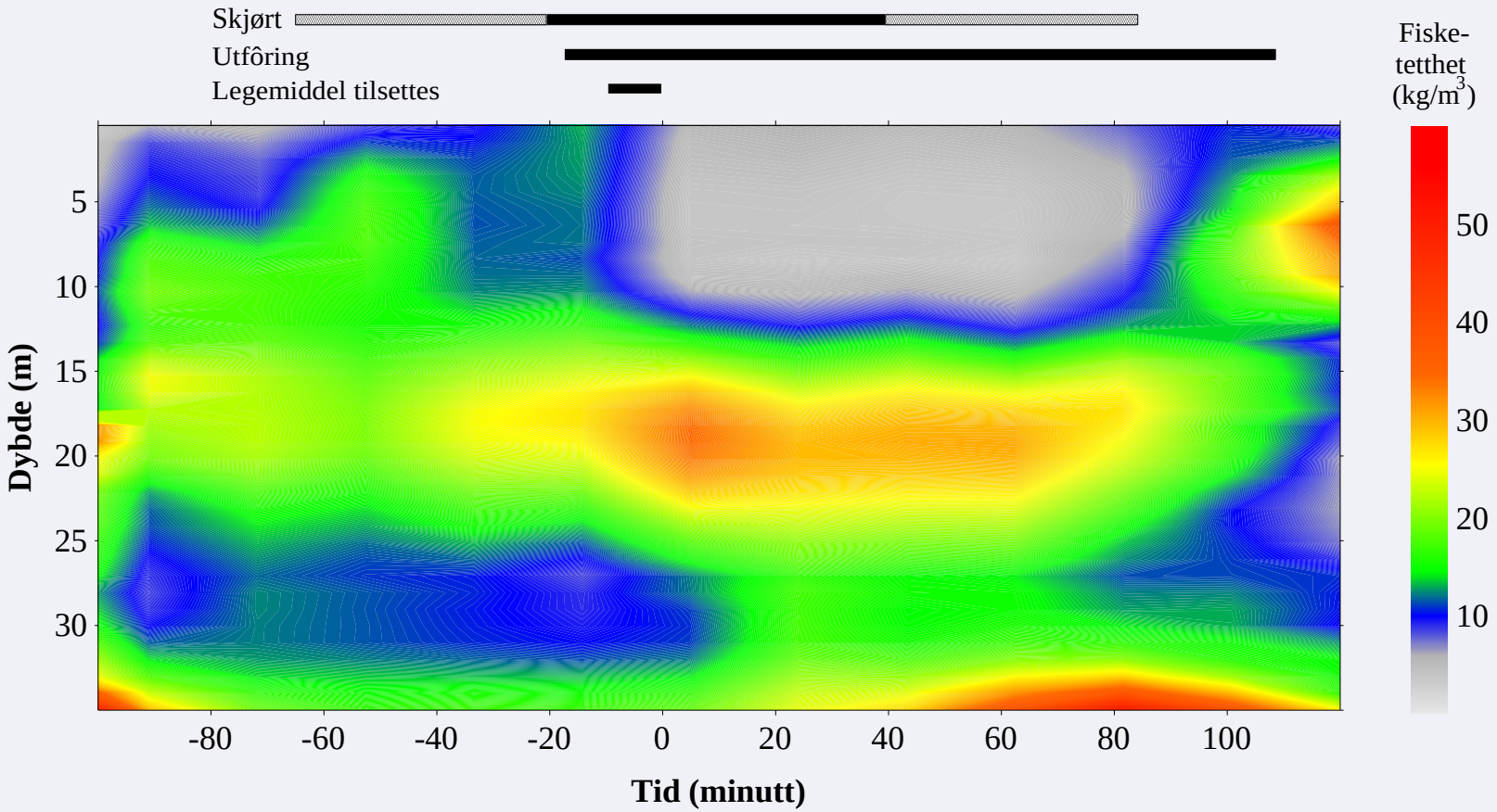


Dybde: 1,6 and 12 m
Tidspunkt: 5, 25, 50 and 90min



Resultater fra direkte metode

Fiske adferd under avlusning, ekko-lodd observasjoner



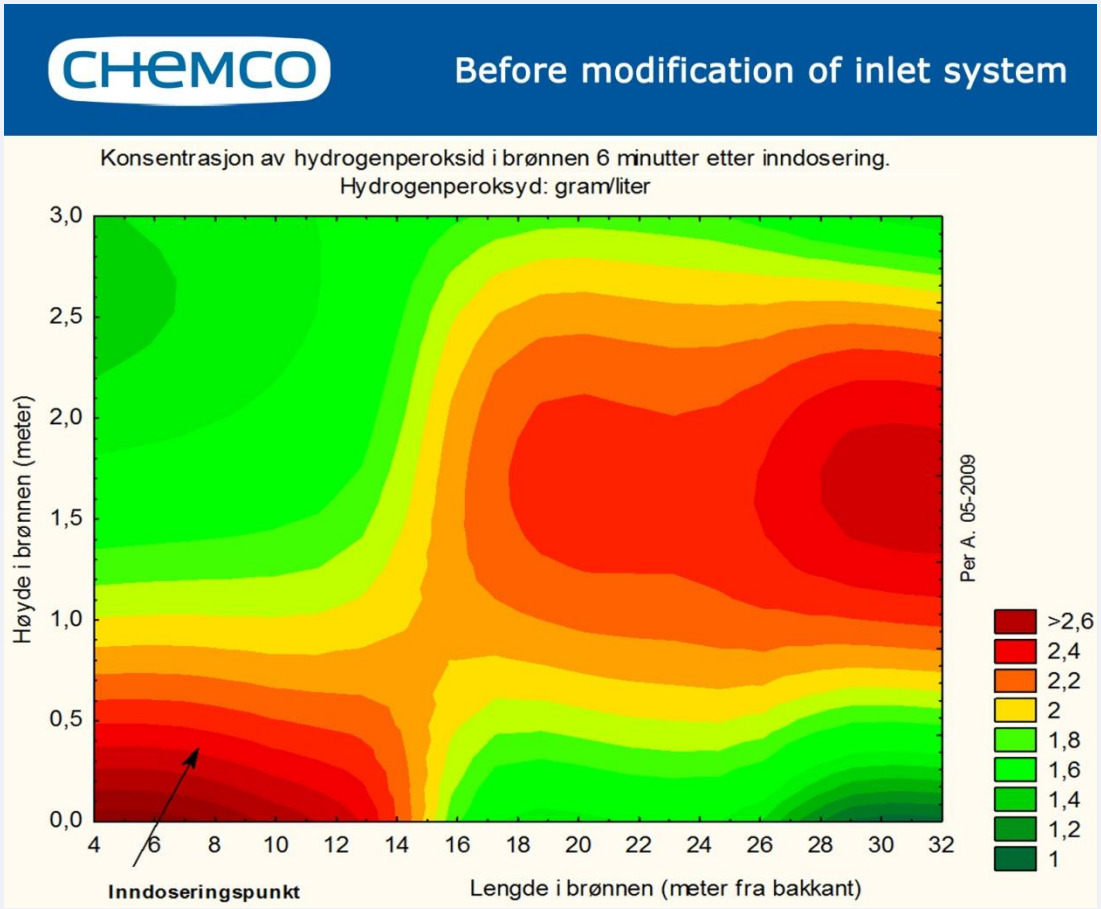
Oppedal og Vigen, 2009

National Veterinary Institute, Norway

HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH

Well boats, hydrogen peroxide as a model system

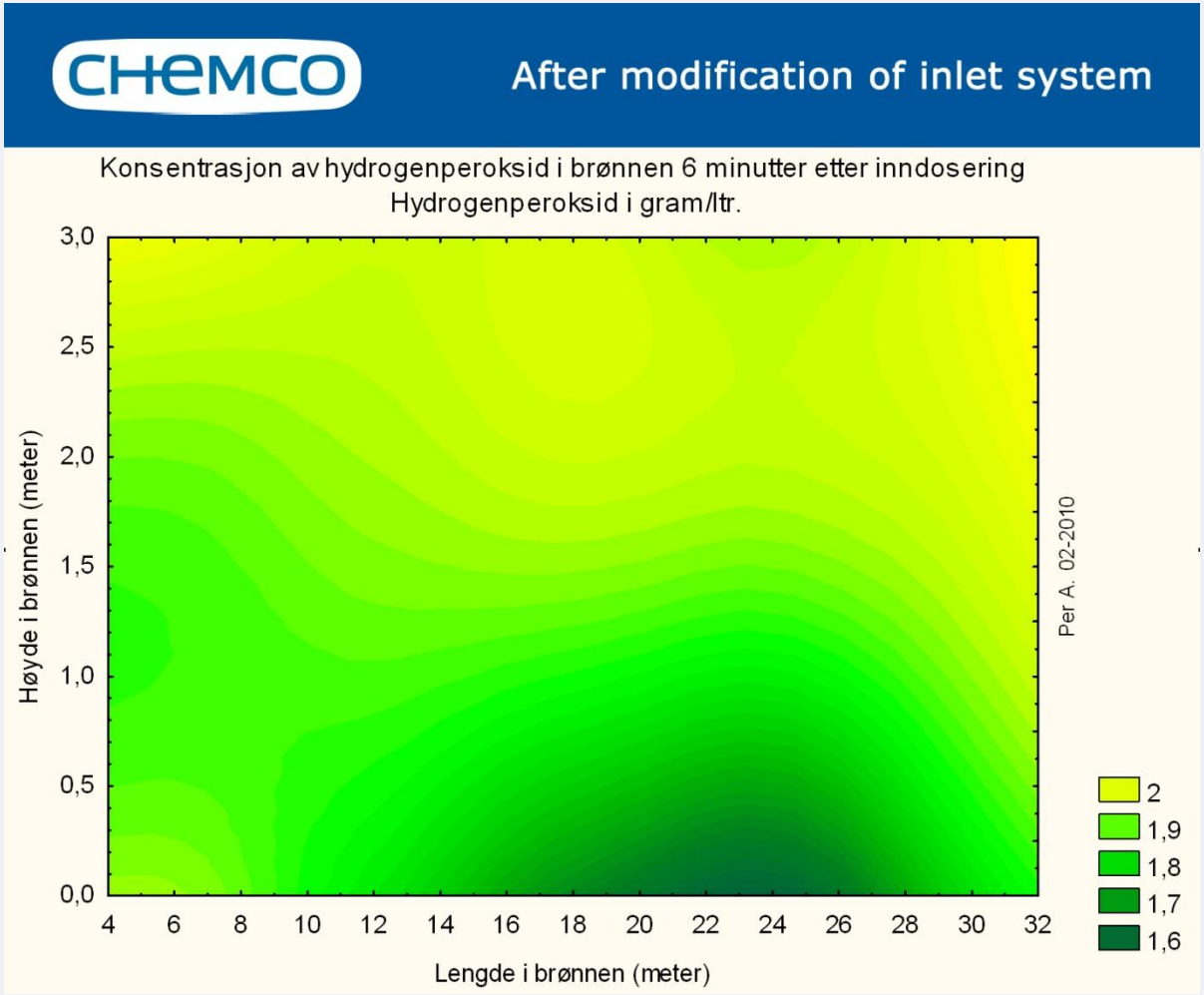
- Picture showing distribution through one channel:



Data from Per Andersen, Marine Consultant

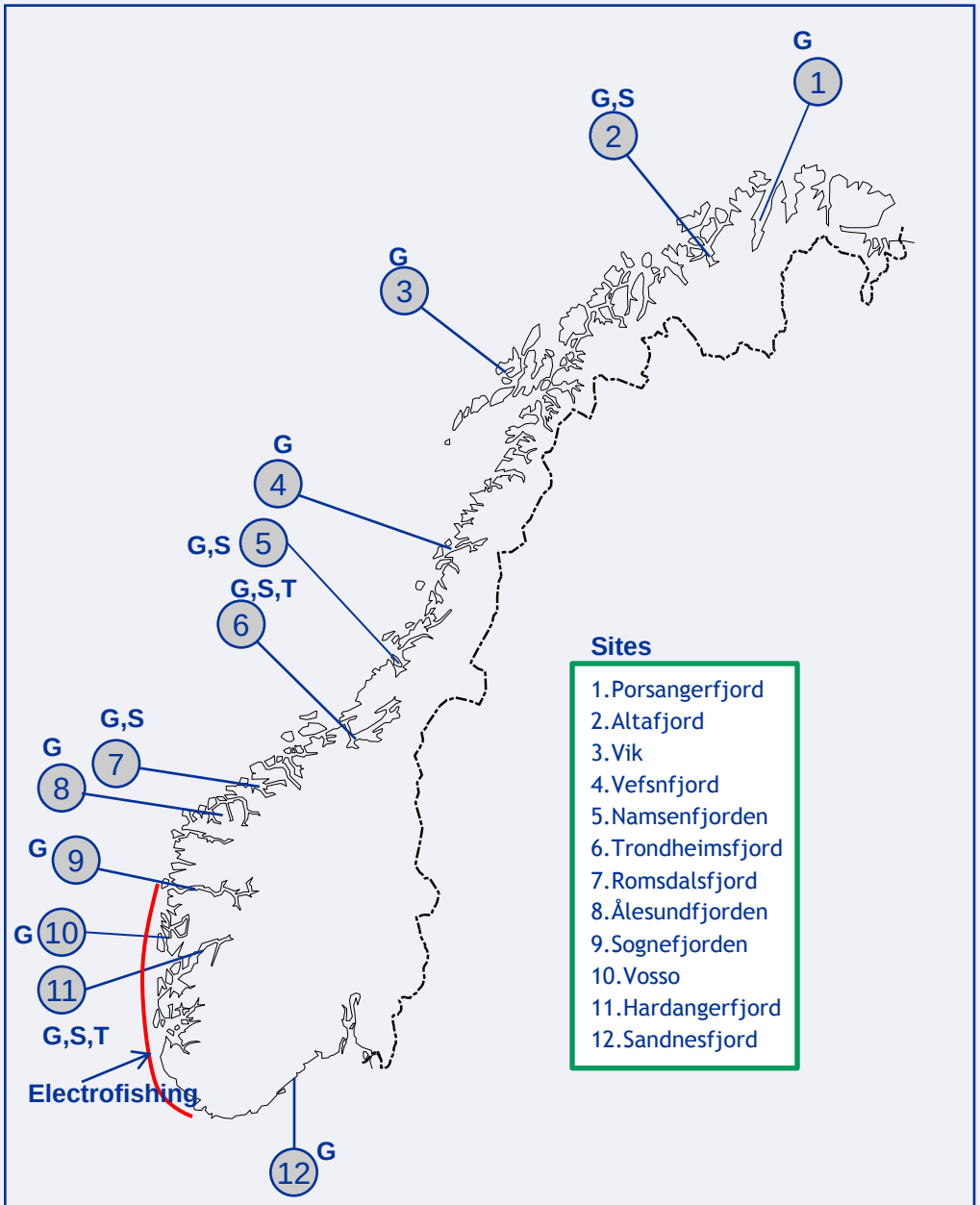
Distribution pattern after modification

- Dosage from top through multi-channels



Data from Per Andersen, Marine Consultant

Sea lice surveillance in Norway, wild salmonids



Methods:
- Gillnetting (G)
- Electrofishing
- Sentinel cages (S)
- Trawling (T)

I this project we have a national monitoring of sea lice levels on wild salmonids along the Norwegian coast (April-September)

The monitoring programme is a collaboration between NINA, IMR, Nofima marin og Rådgivende biologer. Coordinated and led by NINA

National Veterinary Institute, Norway

Photo; Johanne Arff, SINTEF