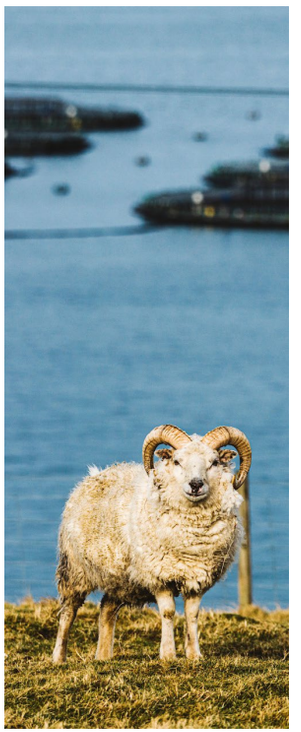
Hydrodynamic modelling to support salmon aquaculture

Scottish Sea Farms

Tom Adams

DHI MIKE Symposium, Coventry

13th June 2023



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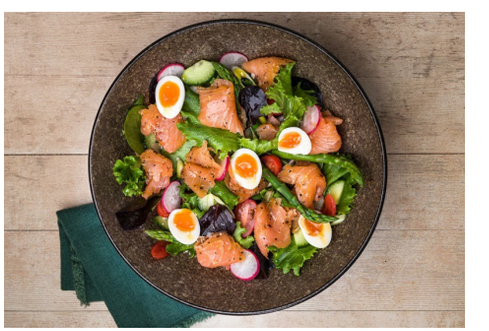
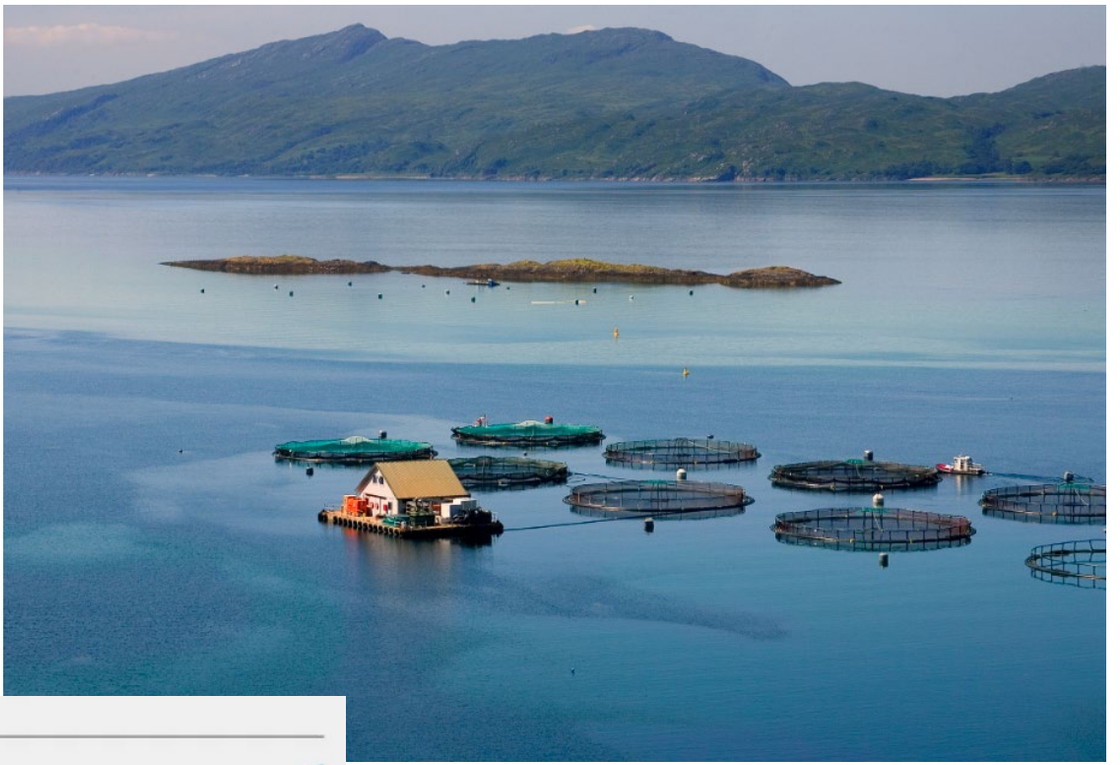
- Introduction and motivation
- Models
- Site scoping
- Environmental interactions
- Regulatory requirement
- Summary



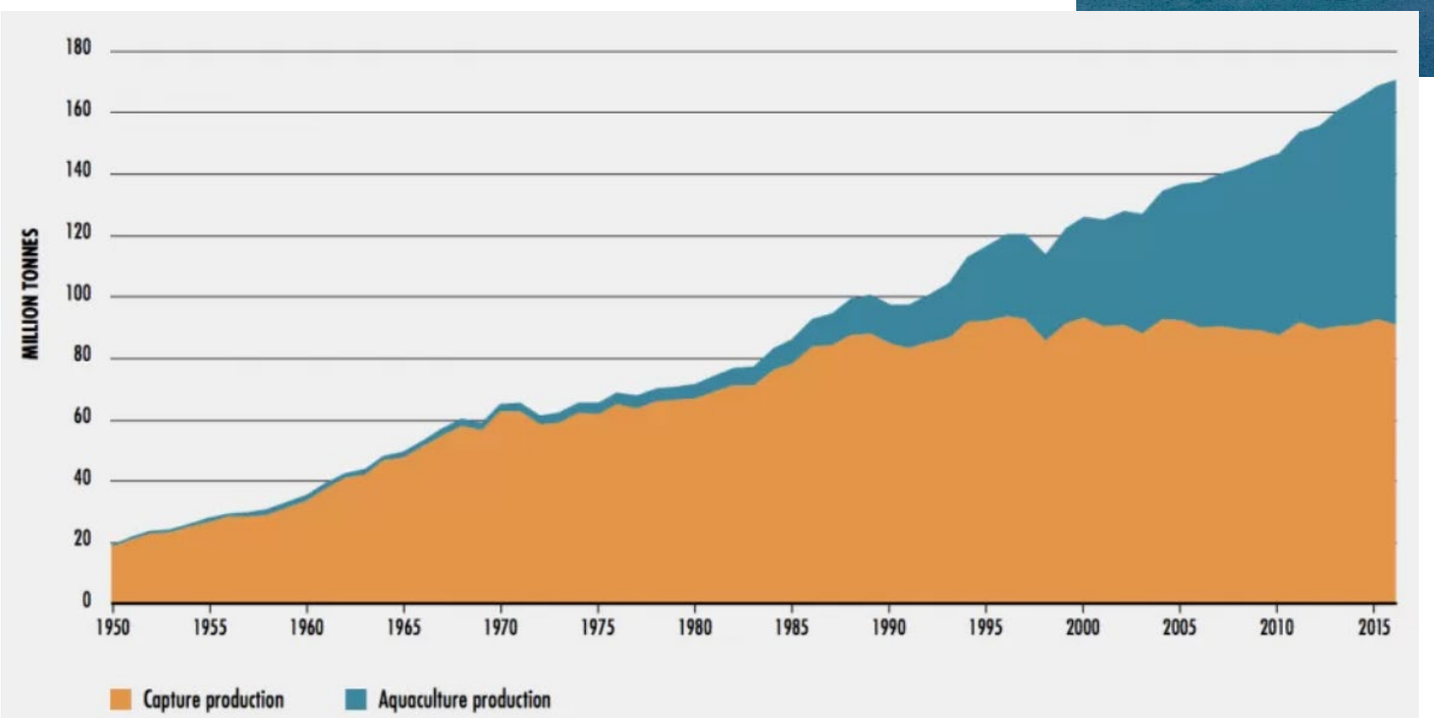
Aquaculture

“The rearing of aquatic animals or the cultivation of aquatic plants for food”

Globally, aquaculture has seen a steady increase in production over last 4 decades



https://scotphoto.com/product/lismore-fish-farm-cages/

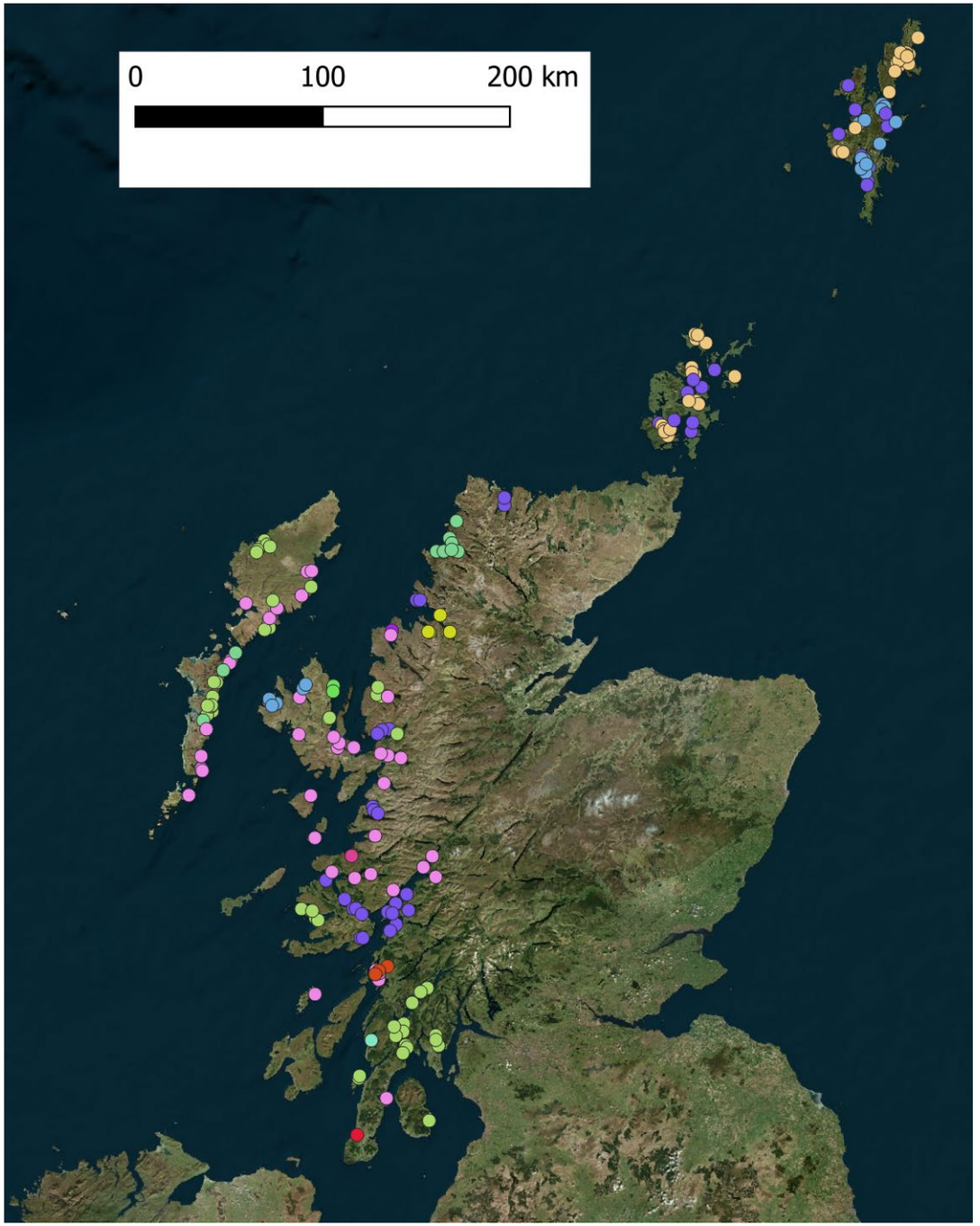


https://ocean.si.edu/conservation/fishing/fao-state-world-fisheries-and-aquaculture-production

Aquaculture

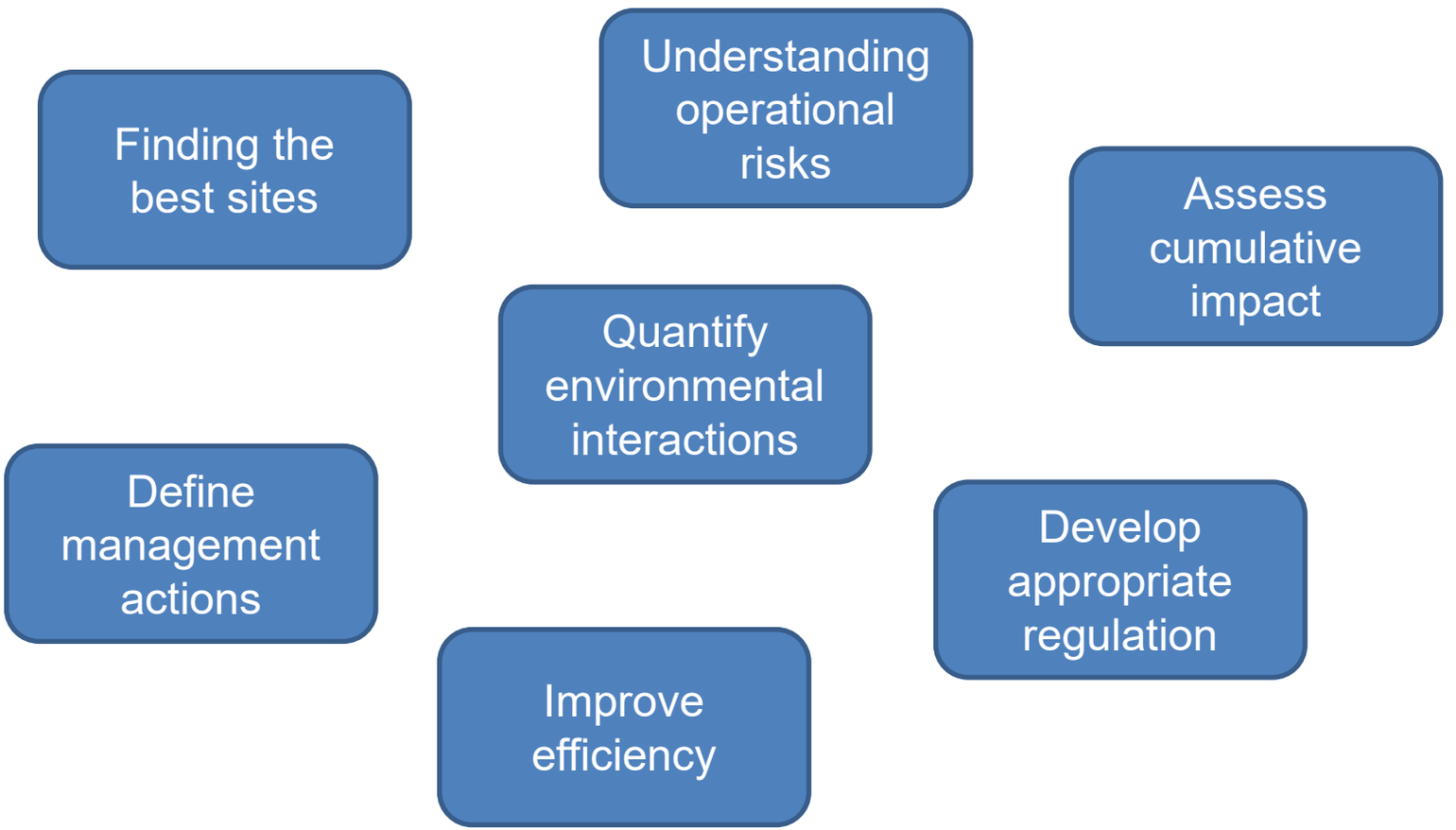
Atlantic Salmon is one of Scotland's key exports, and was the UK's biggest food export in 2022

Salmon production is around 95% of the total value of Scottish aquaculture production (£578 m in 2022)



Motivation

For effective management and operation, it has become increasingly important to have a clear picture of environmental conditions, both close to sites and more broadly in coastal waters.



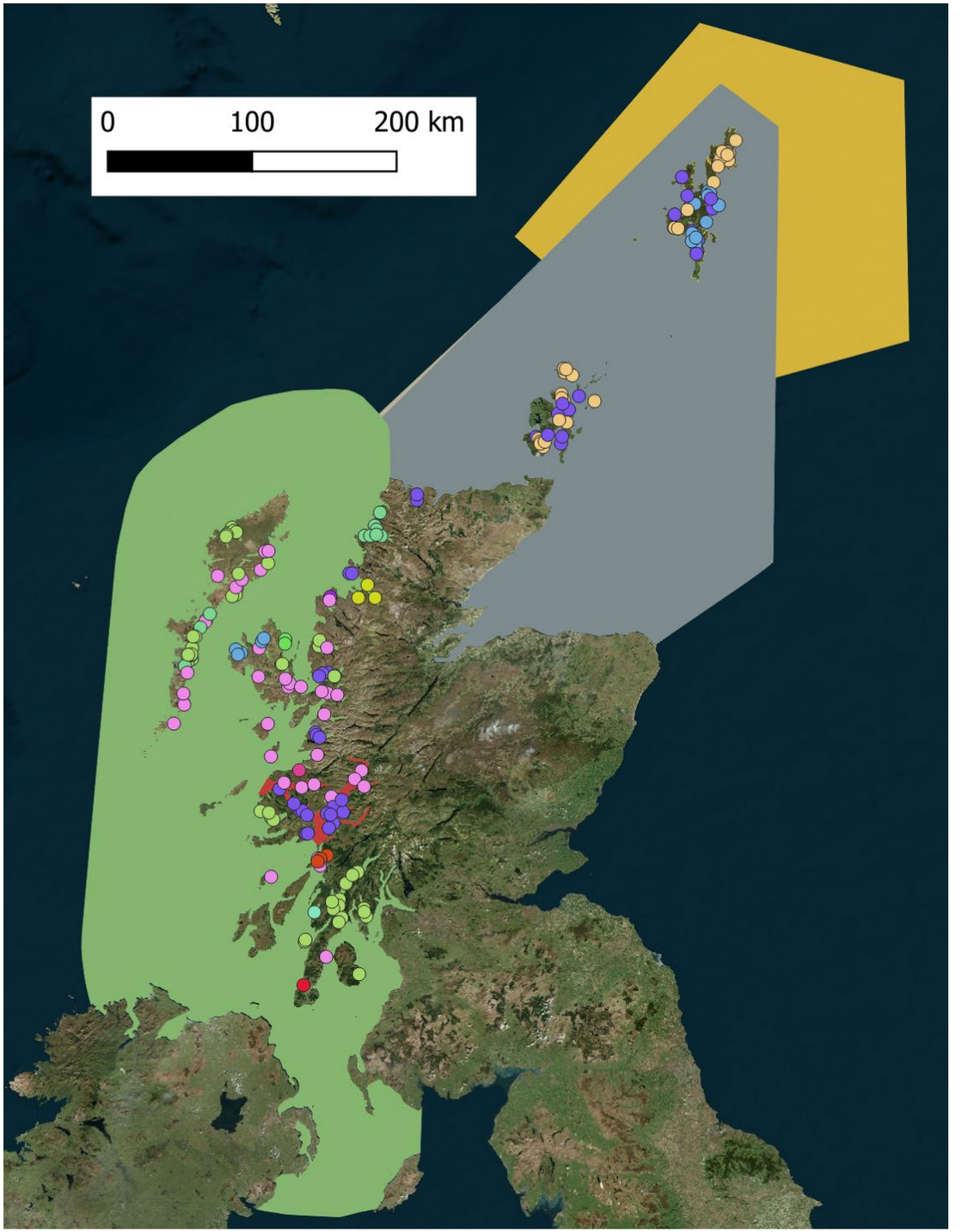
Models

Range of models at different scales and resolution – dependent on application

Model domains in map all have MIKE implementations
(except WeStCOMS FVCOM green domain)

Mixture of 2D/3D models

Basic PT used for most work
(minor dabble with AD/EcoLab)

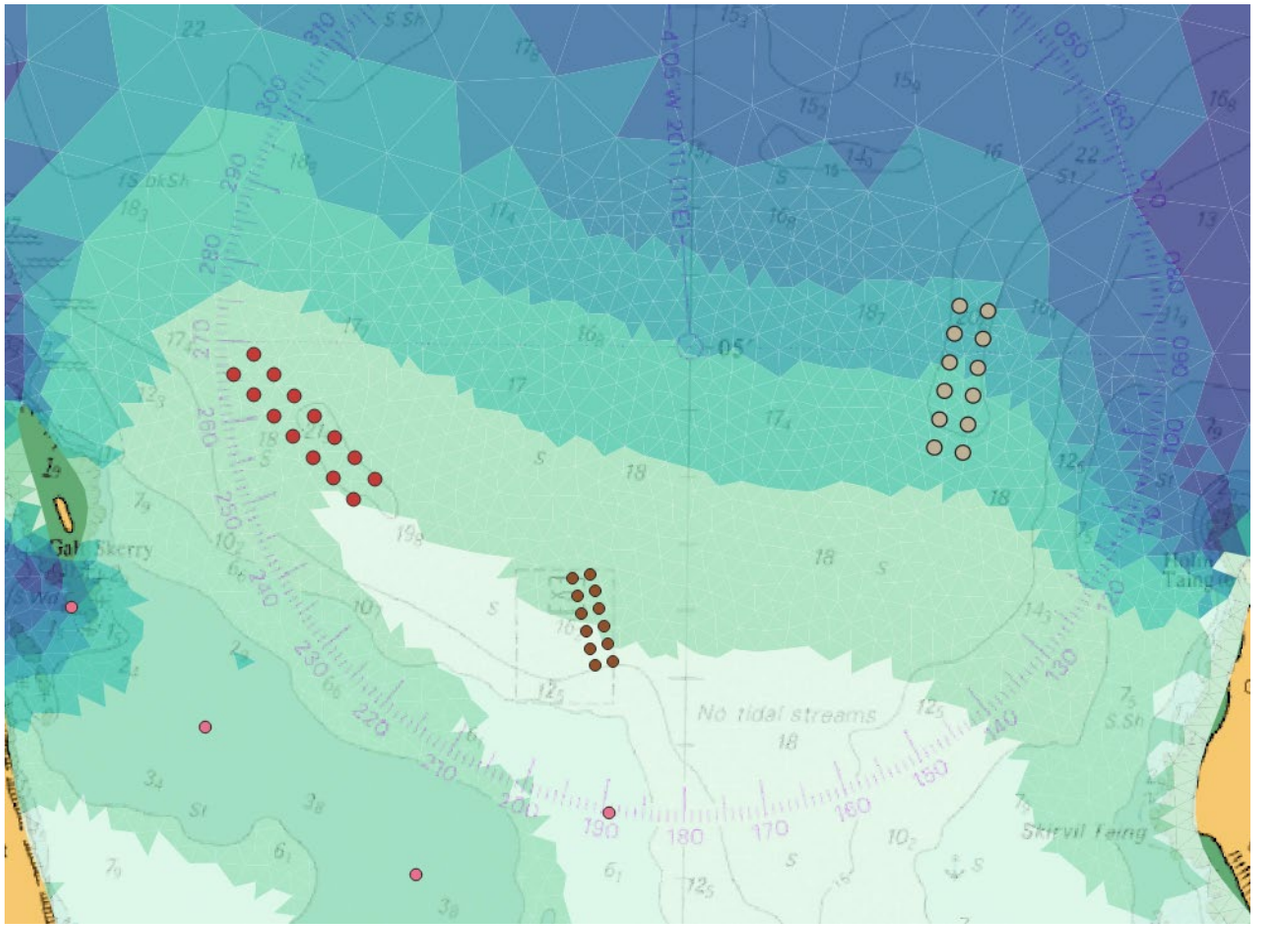


Scoping

Suitable conditions governed by:

- Current speed
- Depth
- Wave exposure

Model statistics and combining with other data sources a key part of investigations



Environmental interactions

The local environment influences conditions on a farm. But a farm also influences the local environment, and can interact with other farms.

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Bath treatments

100 m – 5 km
0 – 100 hr

Aqua Pharma. https://www.fishfarmingexpert.com/aqua-pharma-innovate-uk-institute-of-aquaculture/lice-treatment-project-praised-for-outstanding-collaboration/1256513

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Deposition of feed/faeces

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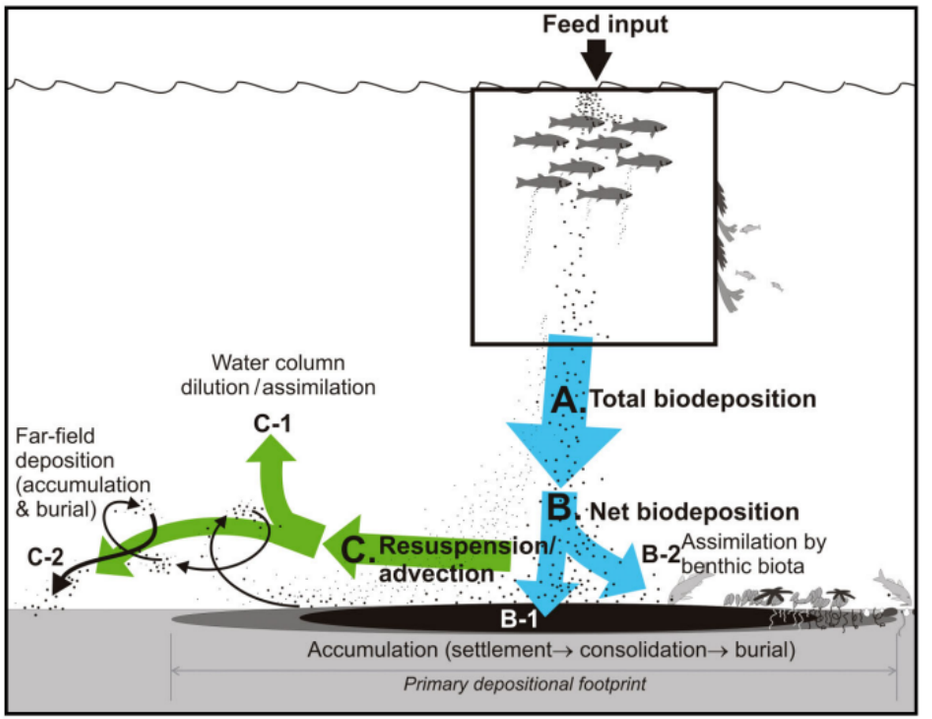

Keeley et al. 2013. https://www.int-res.com/articles/aei2013/3/q003p275.pdf

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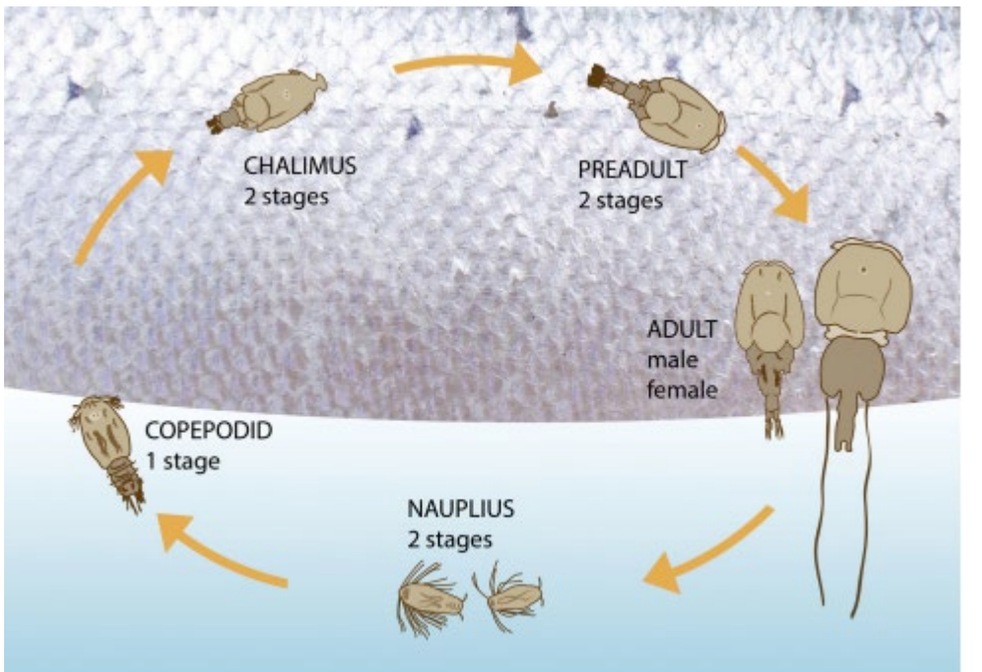
Sea lice

Up to 100 km
Weeks - year



https://upload.wikimedia.org/wikipedia/commons/f/fa/Salmon_louse_life_cycle.png

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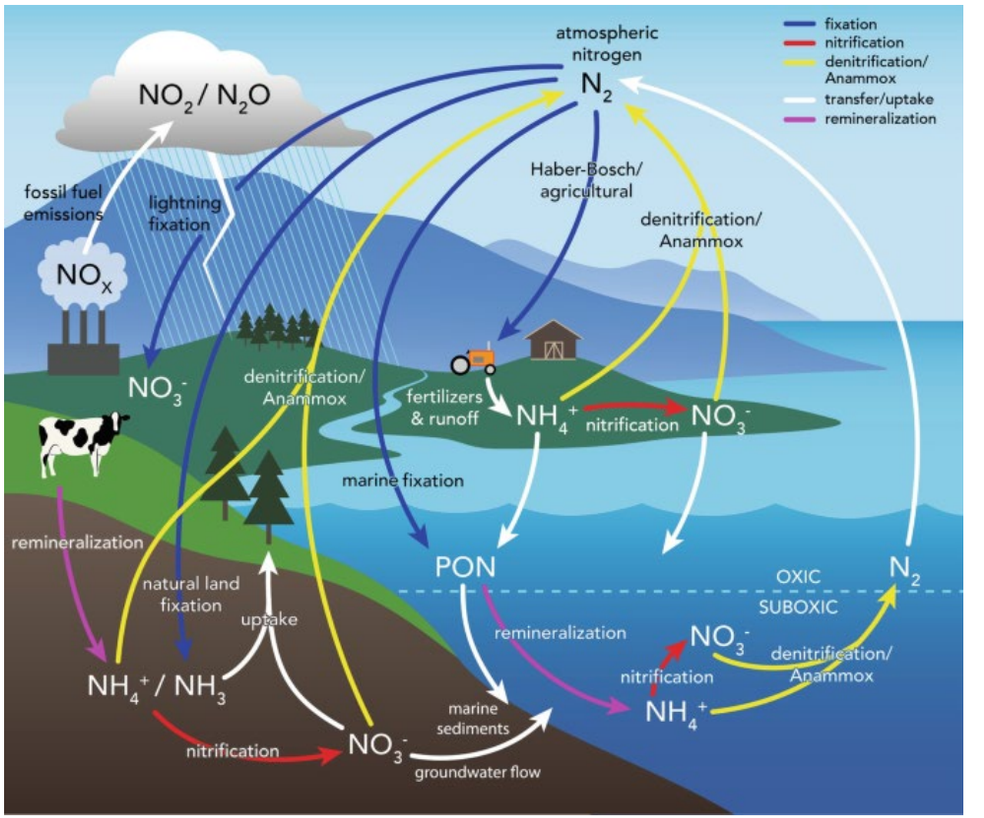
Up to 100 km
Weeks - year

Nutrients

Up to 10 km
Weeks - year

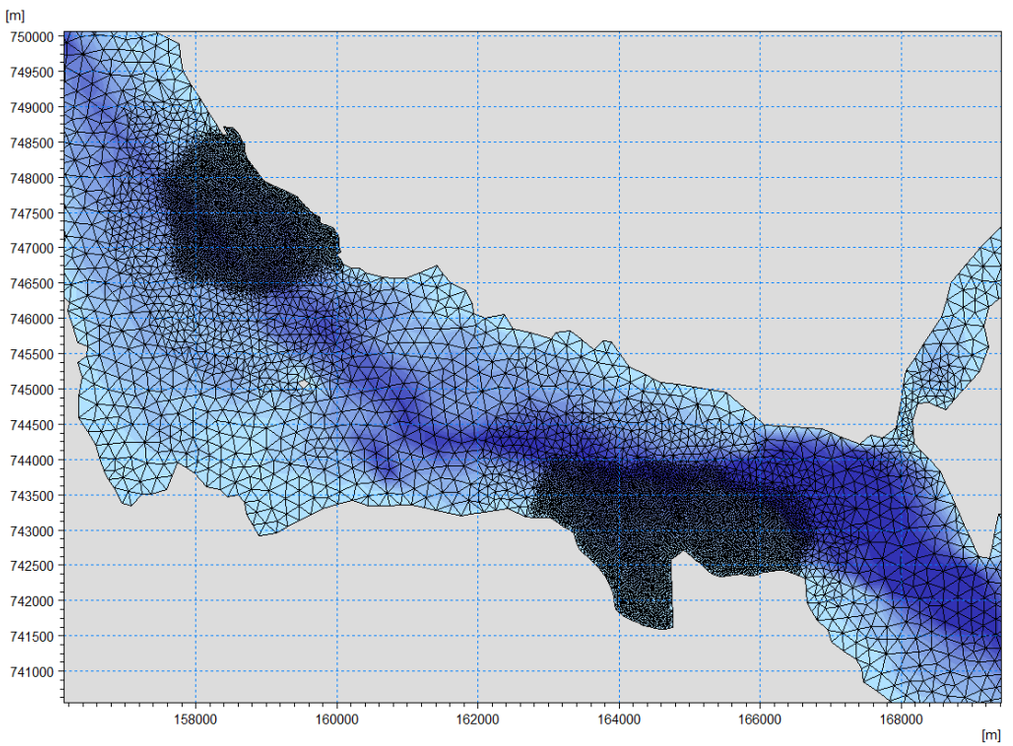


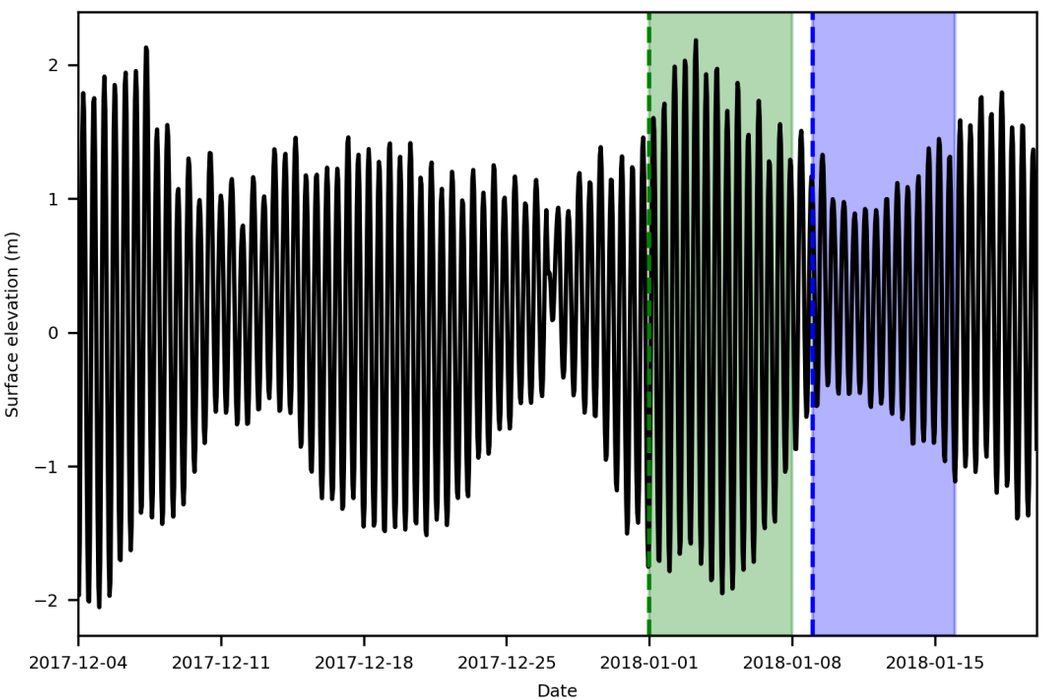
https://link.springer.com/chapter/10.1007/978-3-030-67746-6_1

Bath treatments

Quantity regulated site-by-site

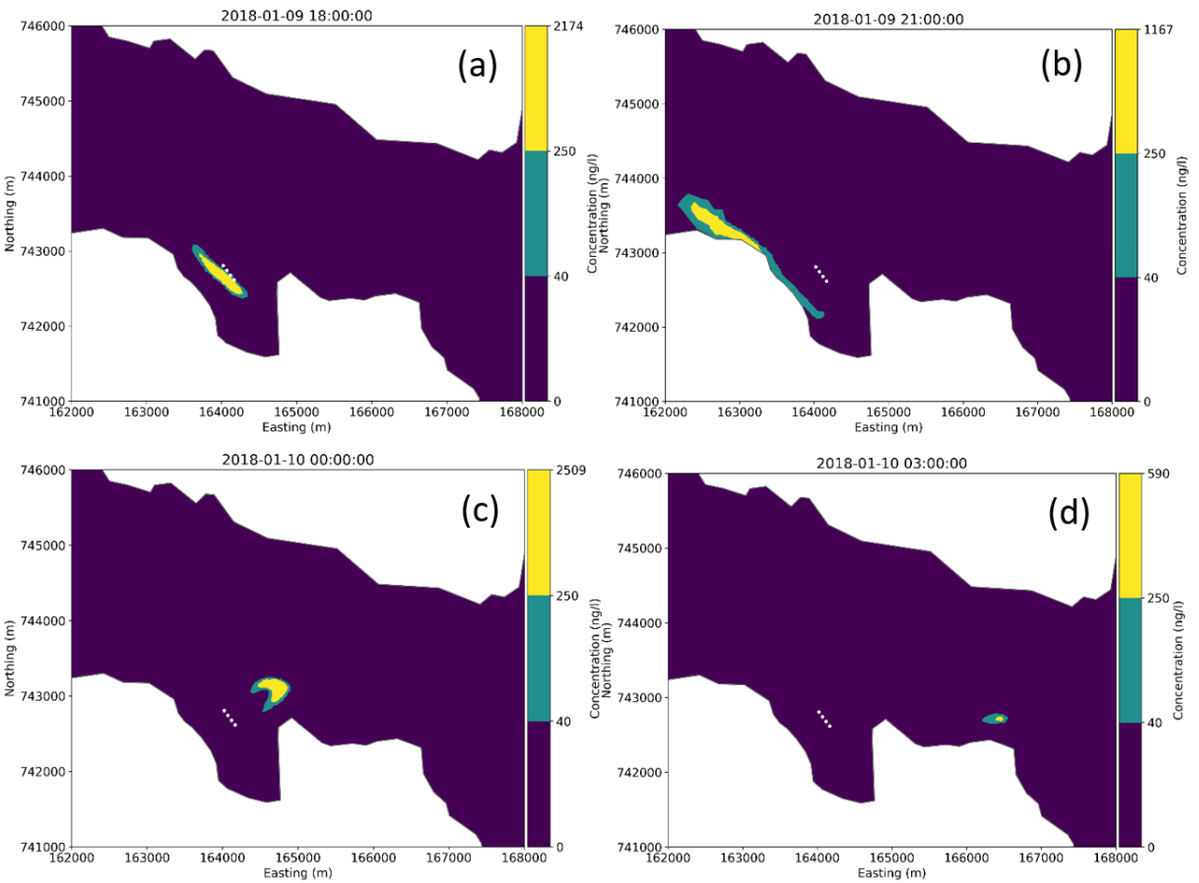
Historically based on simplistic calculation; now marine models are used



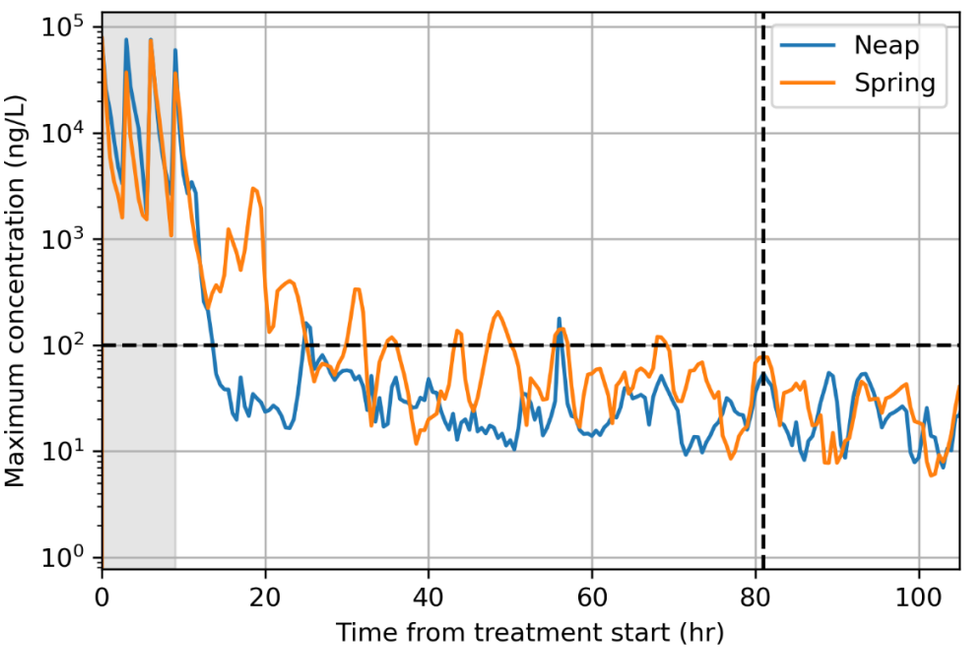


Bath treatments

Fate of individual pen releases



Compliance with Environmental Quality Standards

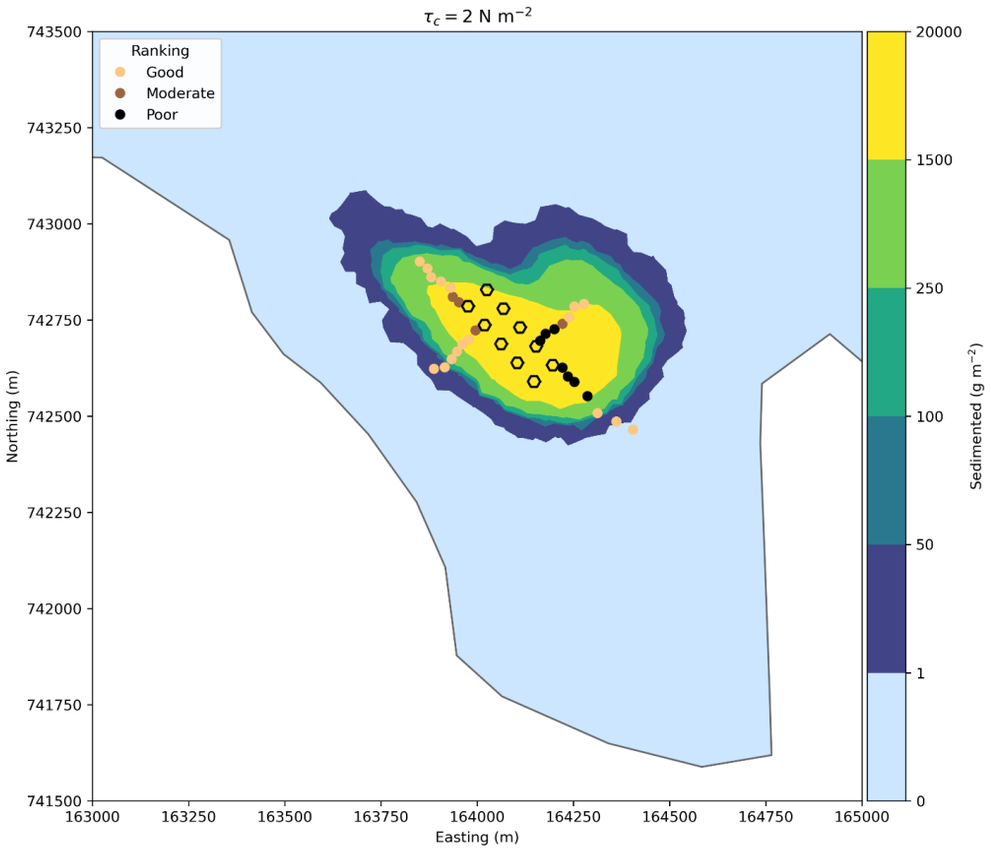


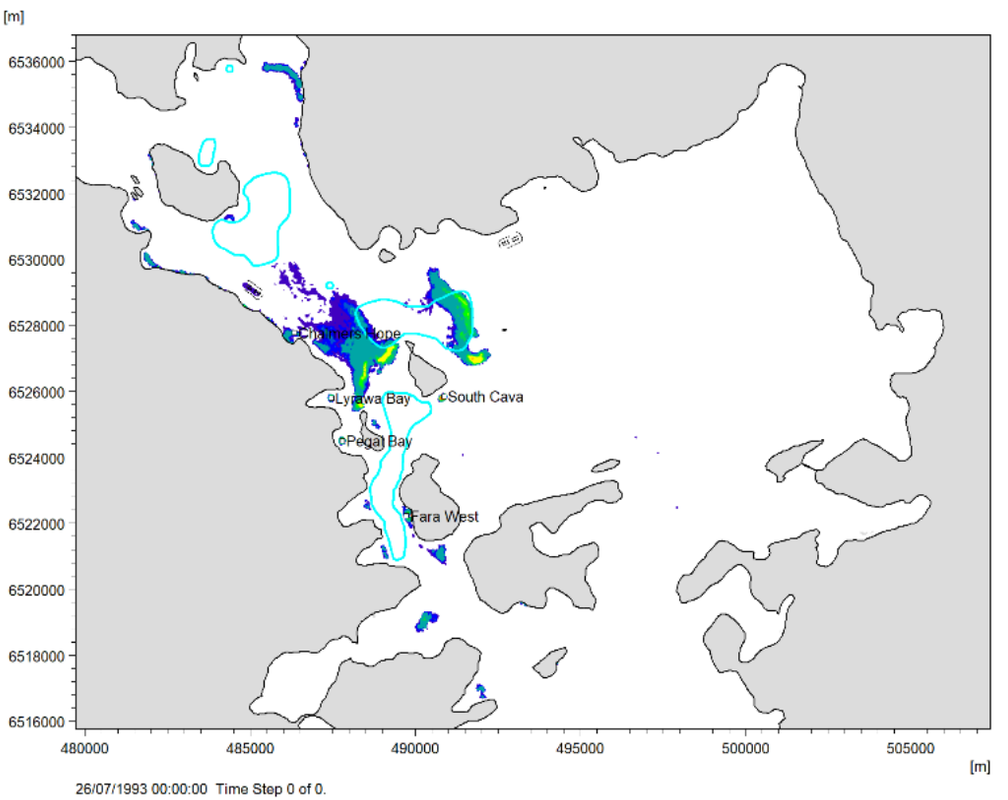
Deposition

Waste feed/faeces => possible enrichment of seabed => change in benthic fauna

Principal determinant of size (permitted maximum biomass) of a farm.
Typically modelled using bespoke software (DEPOMOD)

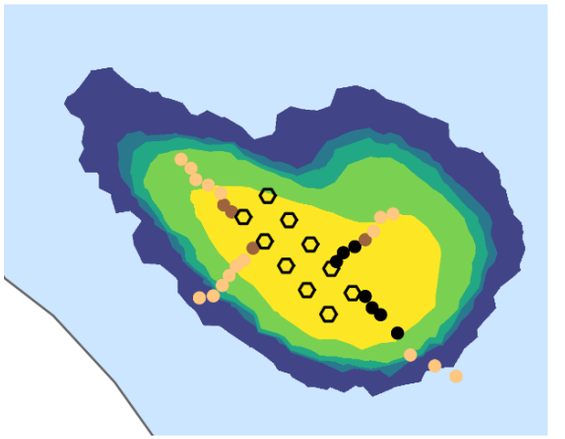
Supported by marine modelling for cumulative assessment

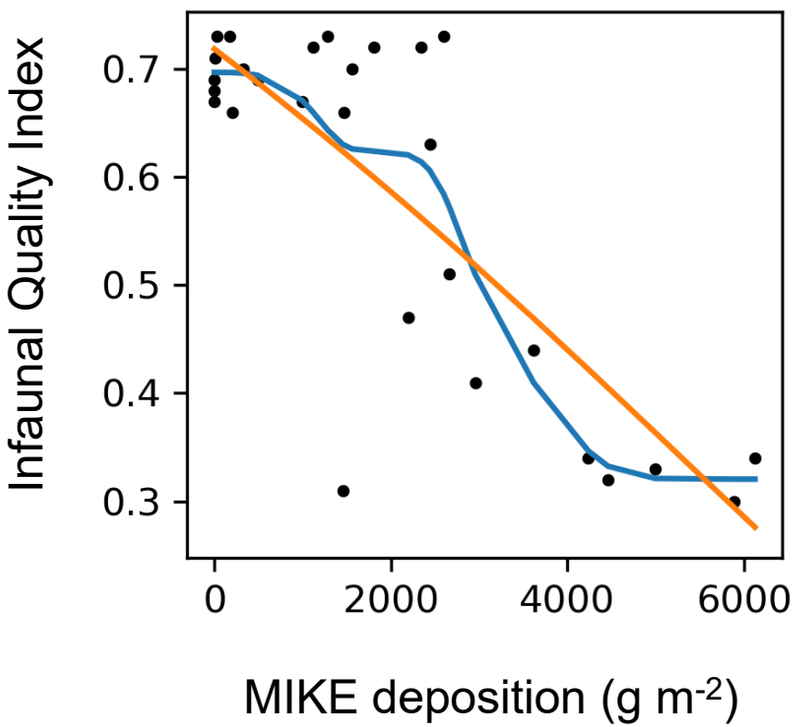


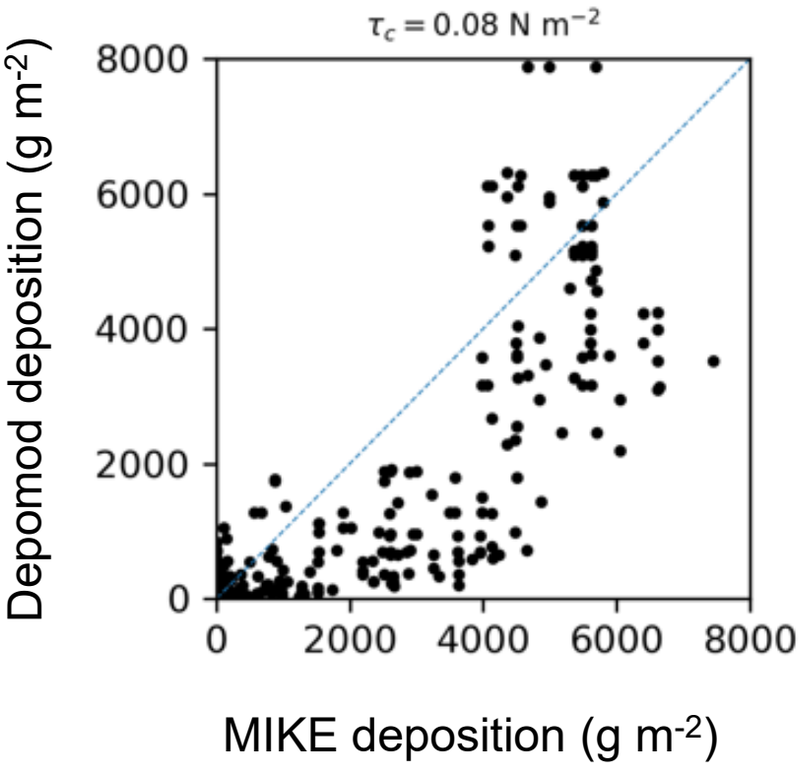


Deposition

Increase in efforts to validate predictions







Sea lice

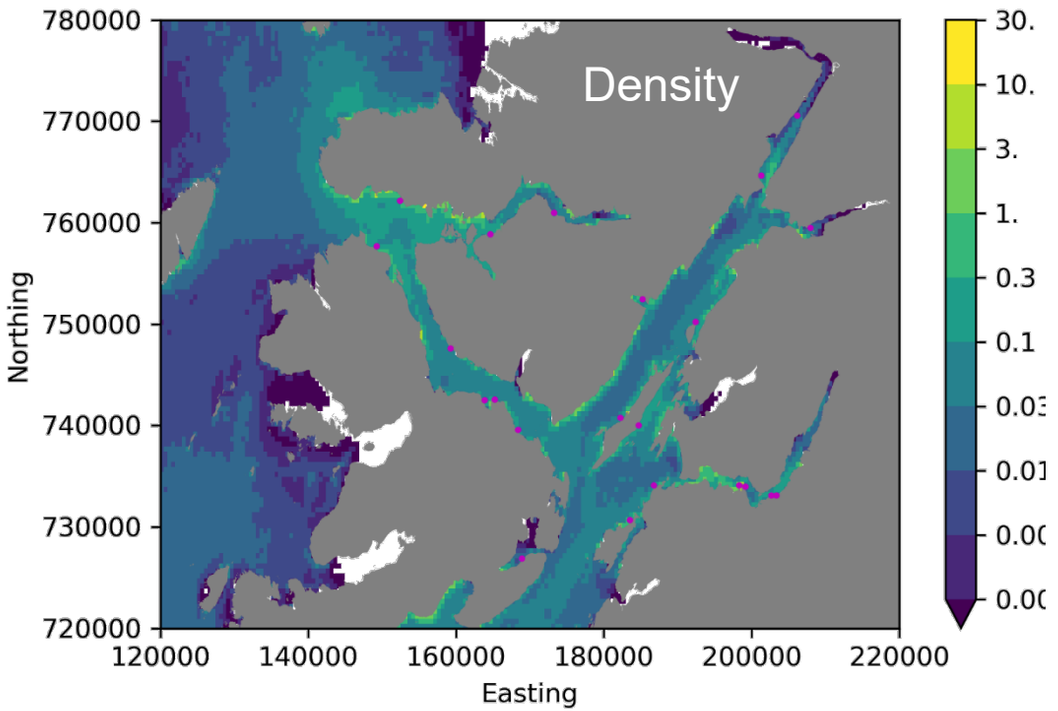
Parasites which infest fish, and can cause detriment

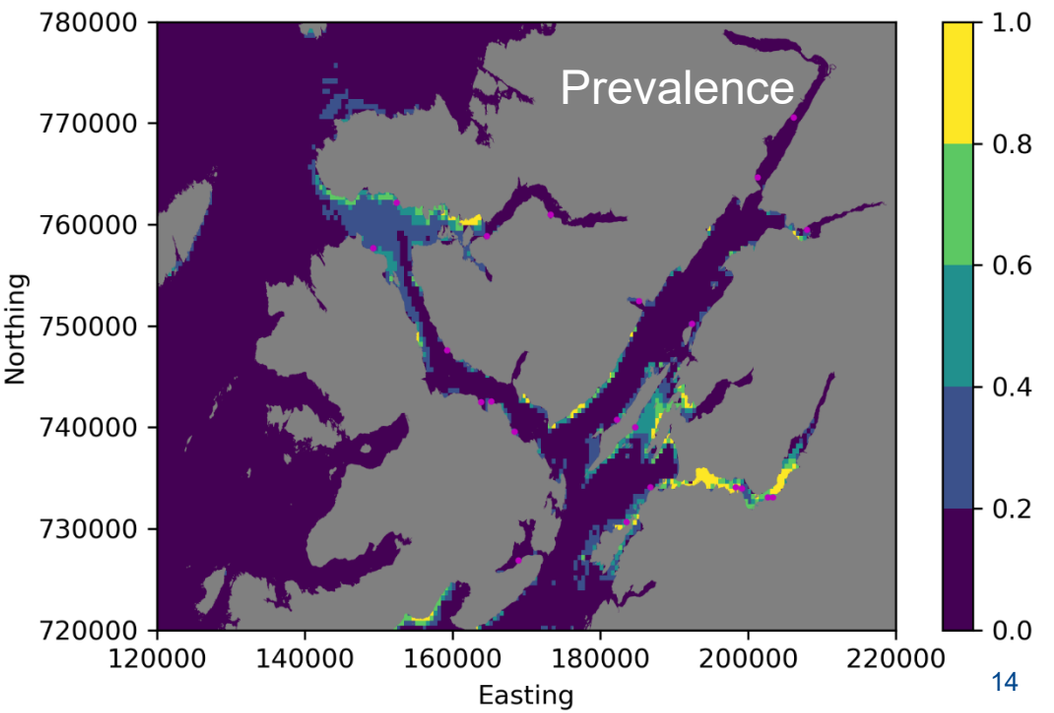
Range of measures in place to assist control

Modelling dispersal of lice an element of Environmental Impact Assessment and Environmental Management Plan

Wild <-> farmed interactions

https://flyfishing-and-flytying.co.uk/





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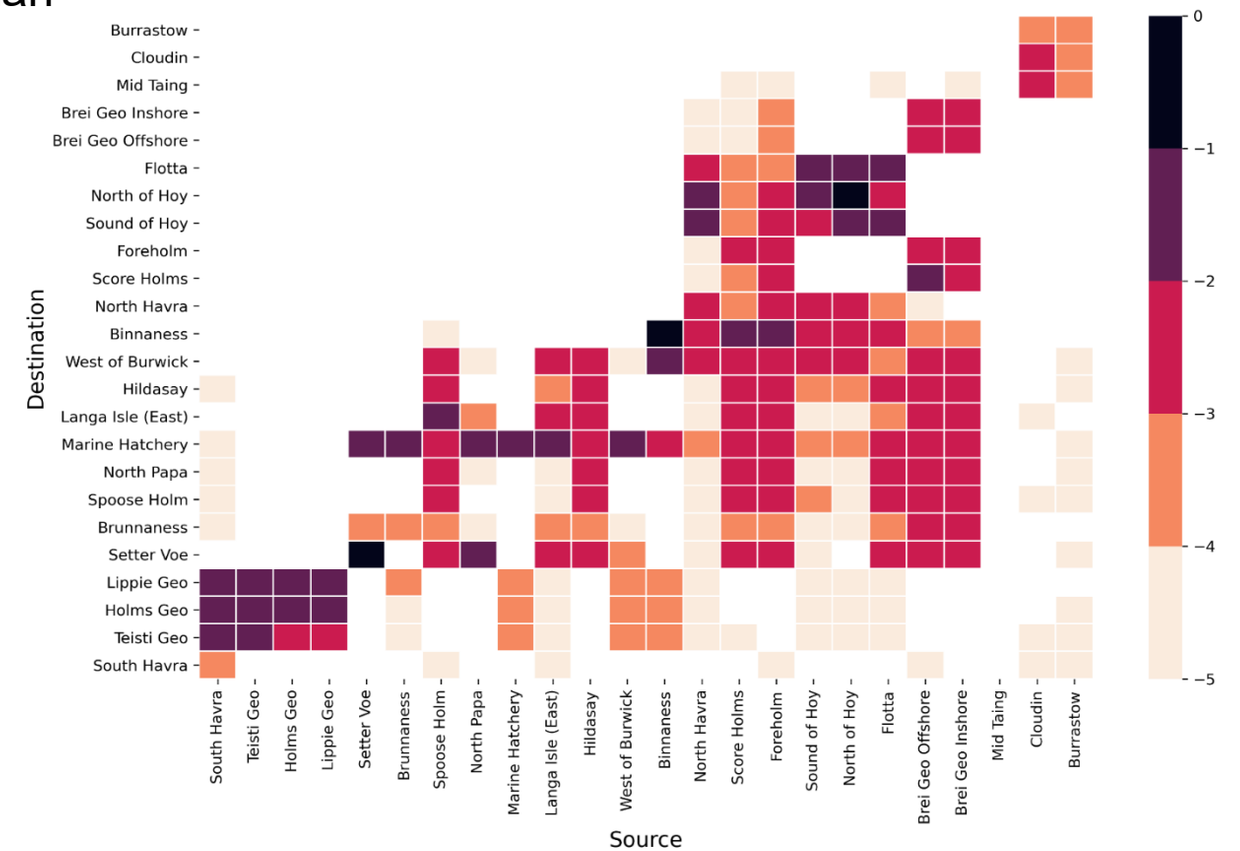

Regulatory requirements

Bath treatments
- During application for new/elevated medicine consent level

Deposition
- During application for change in biomass/new site
- Cumulative modelling for impact on Priority Marine Features

Sea lice
- Component of Environmental Impact assessment
- Inform wild salmonid monitoring in Environmental Management Plan
- Sea Lice Risk Framework wild salmonid impacts (under consultation)

Nutrients
- Simple water body calculations part of Environmental Impact Assessment

Summary

- MIKE is one of several modelling tools in use in Scottish aquaculture industry
- Increasing dependence on use of models for novel assessments
- Accepted standard methodology for assessment of some (but not all) interactions
- Use for nutrients uncommon at present
- Achieving a balance between cost/benefit
- MIKEIO toolbox has been invaluable for developing workflows – Thanks!
  - Options to work with particle XML files?
  - Processing external data to MIKE format?
  - Options to configure batch/sensitivity runs?

Thanks for listening!

tom.adams@scottishseafarms.com

https://scottishseafarms.com/app/uploads/2022/06/%C2%A9ScottishSeaFarms-Lober-Rock-pens-and-barge.jpg