



Sustainable (biological) control of sea lice in Norwegian Atlantic salmon farms: a system dynamics approach

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Why sea lice is a problem?

- Norway is a leading global producer of farmed Atlantic salmon, producing nearly 50% of global production (Hamza, Rich and Wheat (forthcoming, 2014)).
- It is estimated to cost the salmon industry between 0.5 – 2 billion NOK each year.
- The Norwegian Research Council spent nearly 50 million NOK on sea lice research between 2010 – 2013.

A need for an integrated model (further expansion)

- There is a need to develop a more integrated approach to the epidemiology and economics of disease that better represents and captures existing feedback mechanisms that can influence the success of disease control interventions and their cost-effectiveness

Goal

- We motivate a generic framework that can be used more broadly in analyzing the impacts of alternative aquatic disease control strategies.
- We then provide some illustrative results of applying this model in the context of sea lice (*Lepeophtheirus salmonis*) control strategies in the farmed salmon industry in Norway as a proof-of-concept.
- **Introduction of biological control of sea lice to the original model.**

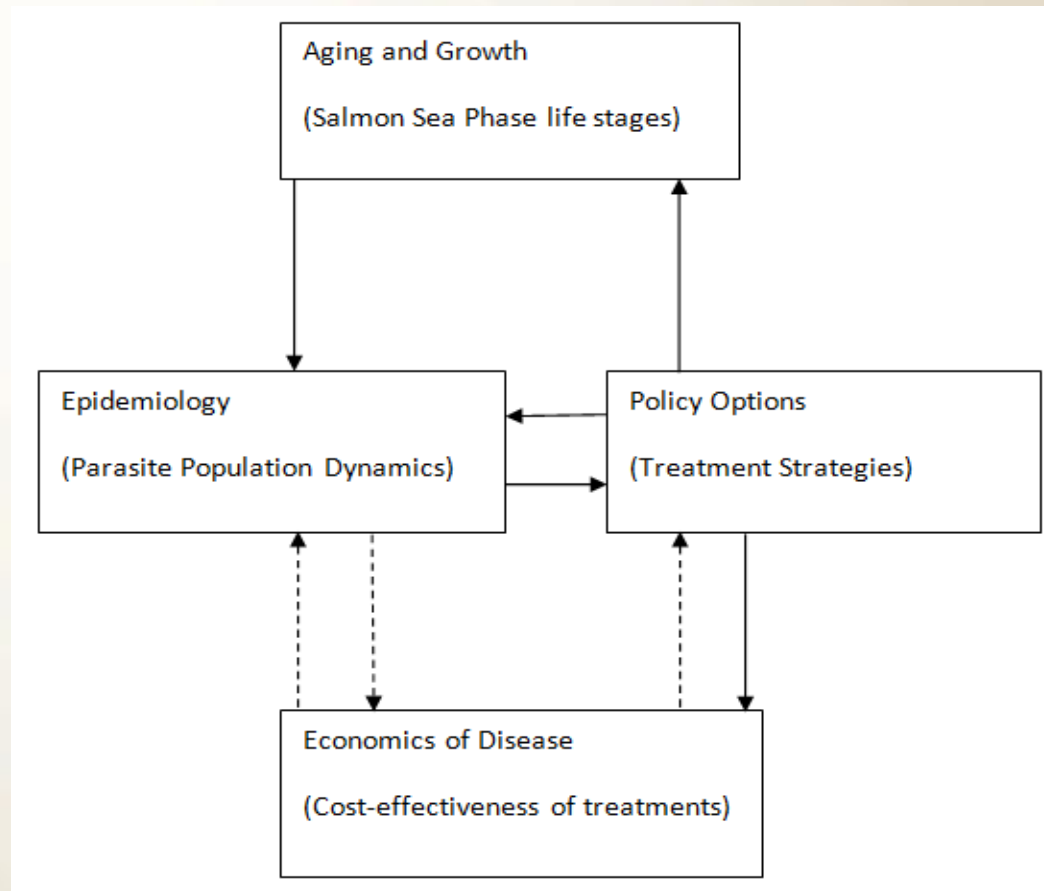
Research questions

Can sea wrasse provide a more effective control of sea lice in Norwegian salmon farms?

A. How much does it cost?

B. Is wrasse treatment more effective in terms of lice control and costs than chemical treatments (in-feed and bath)?

Overview of Model Structure



Expansion

- In this project, we expand the work of Hamza, Rich, and Wheat (forthcoming, 2014) to model the impact of biological control on sea lice on salmon farms.
- We also add value to the modeling work done on the effectiveness of sea wrasse to control sea lice by Groner, Cox, Gettinby, and Revie (2013).

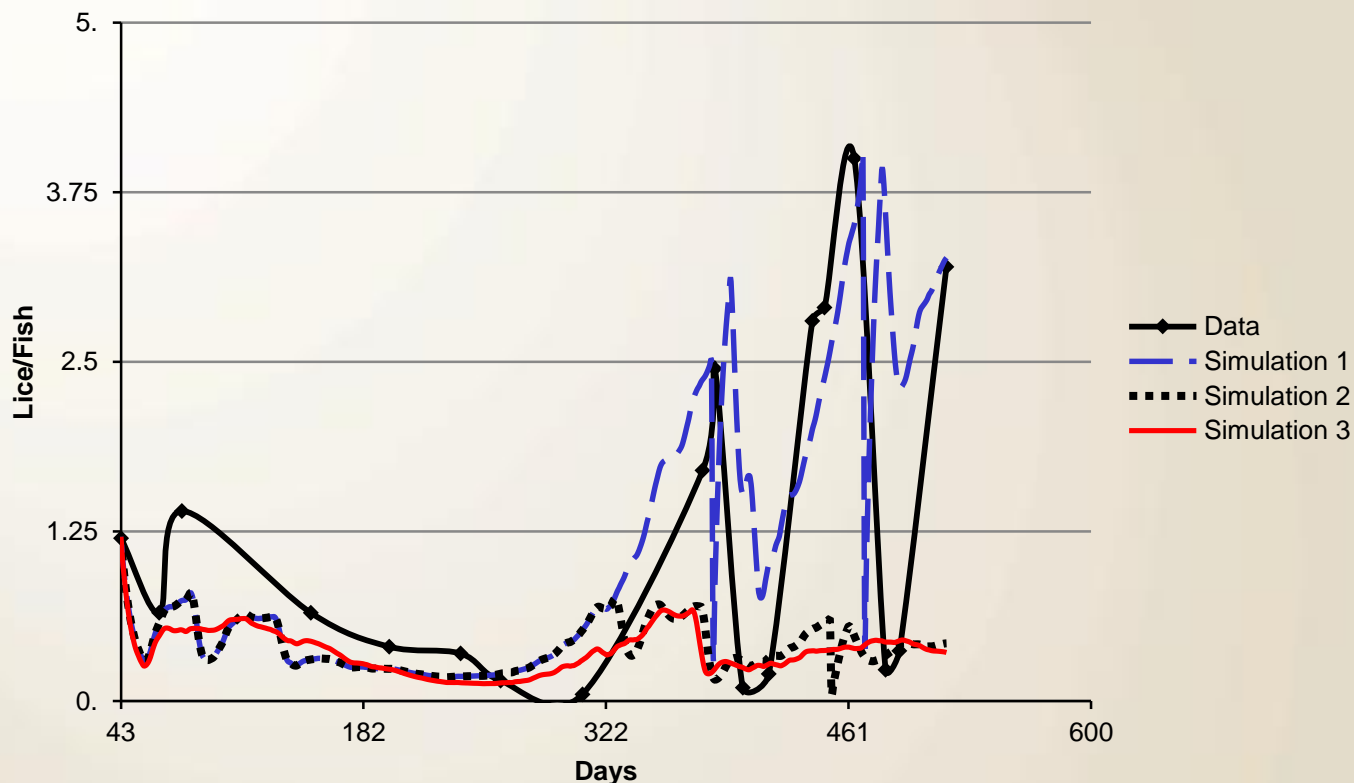
Simulation scenarios

Simulation 1: Baseline		Simulation 2		Simulation 3	
Day	Treatment	Day	Treatment	Day	Treatment
78	In-feed	78	In-feed	1	Sea wrasse (the whole production cycle)
126	In-feed	126	In-feed	365	In-feed
377	Bath	320	In-feed		
397	In-feed	370	In-feed		
464	Bath	444	Bath		
464	Bath	444	Bath		

Groner, Cox, Gettinby and Revie (2013)

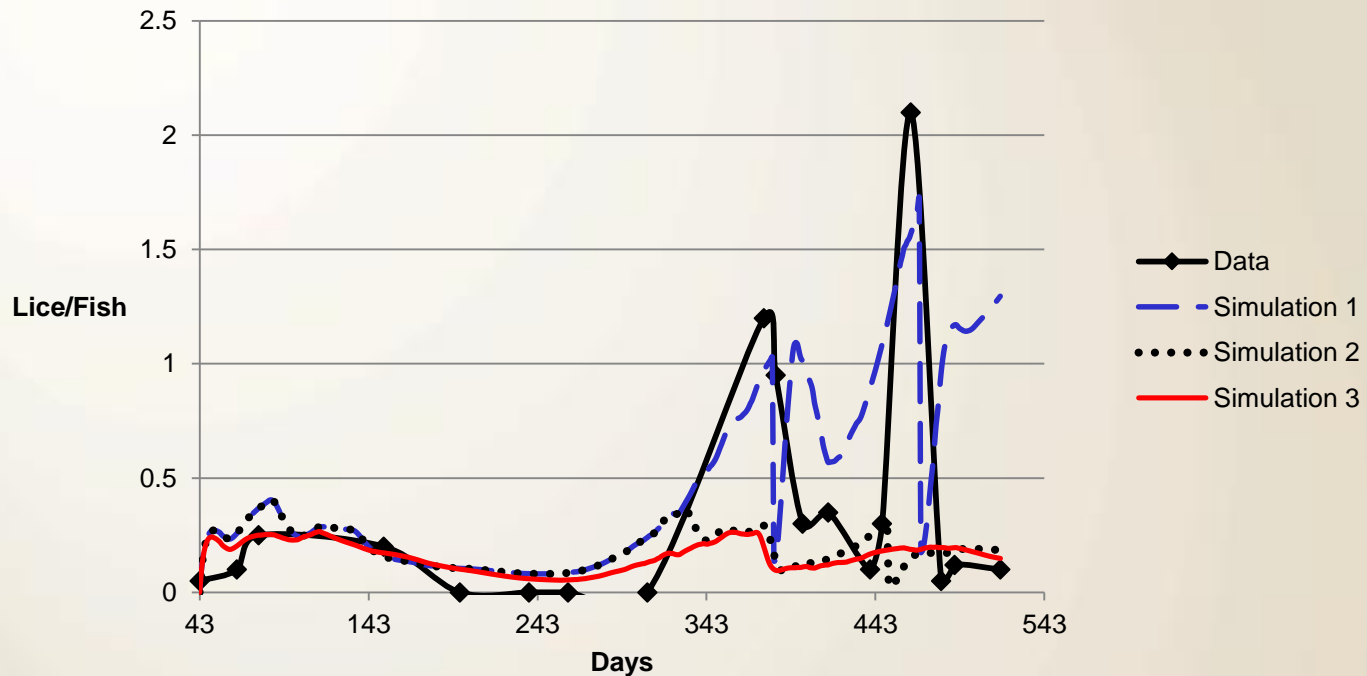
Simulation results

Mobile stage lice

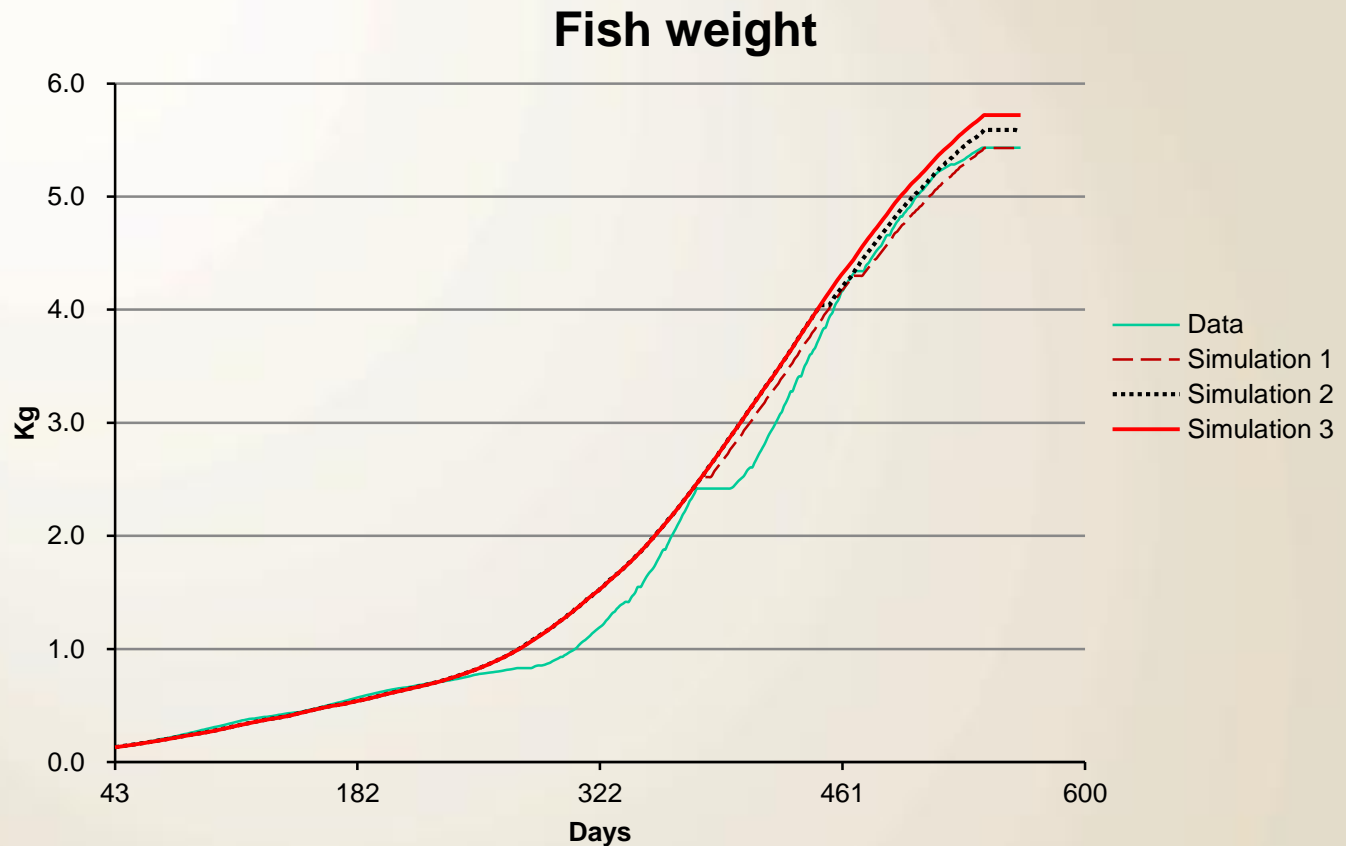


Simulation results

Adult female lice

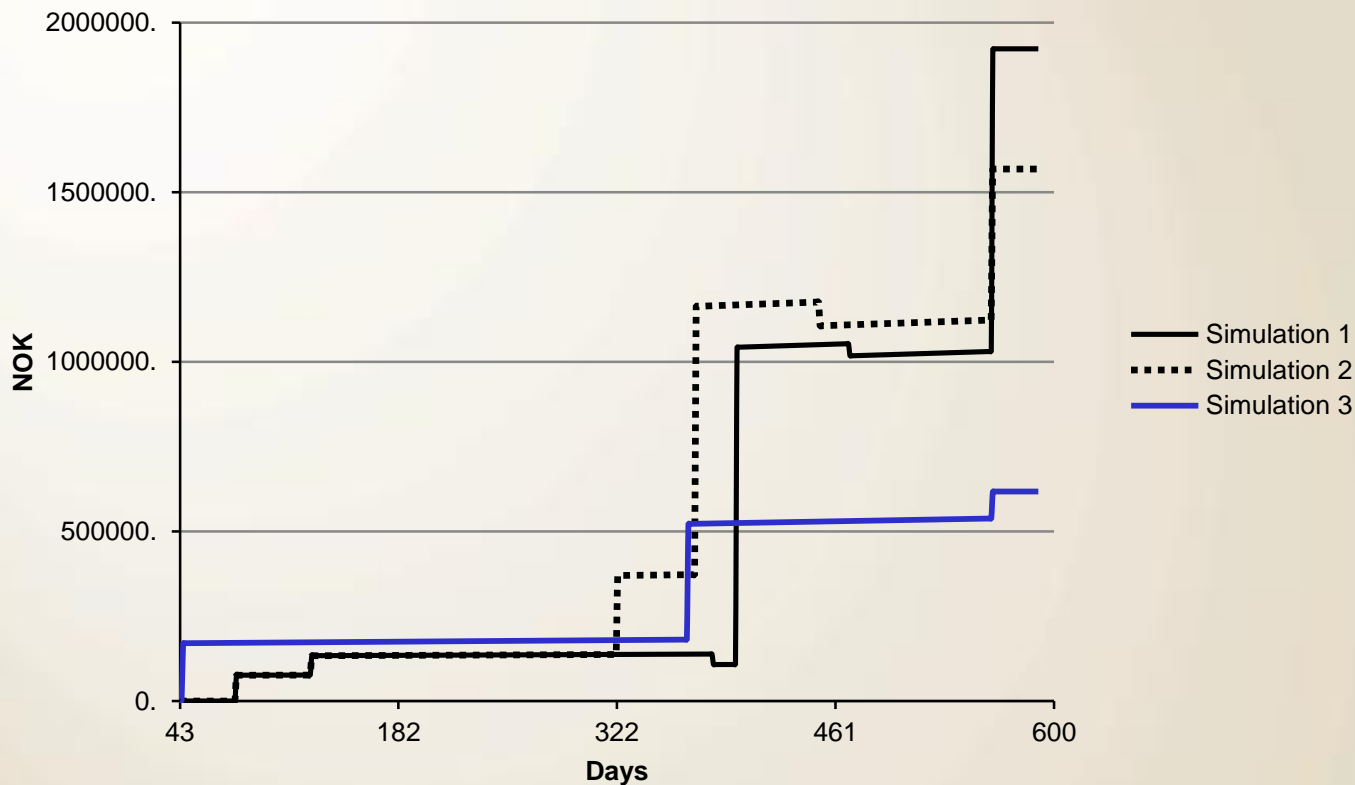


Simulation results



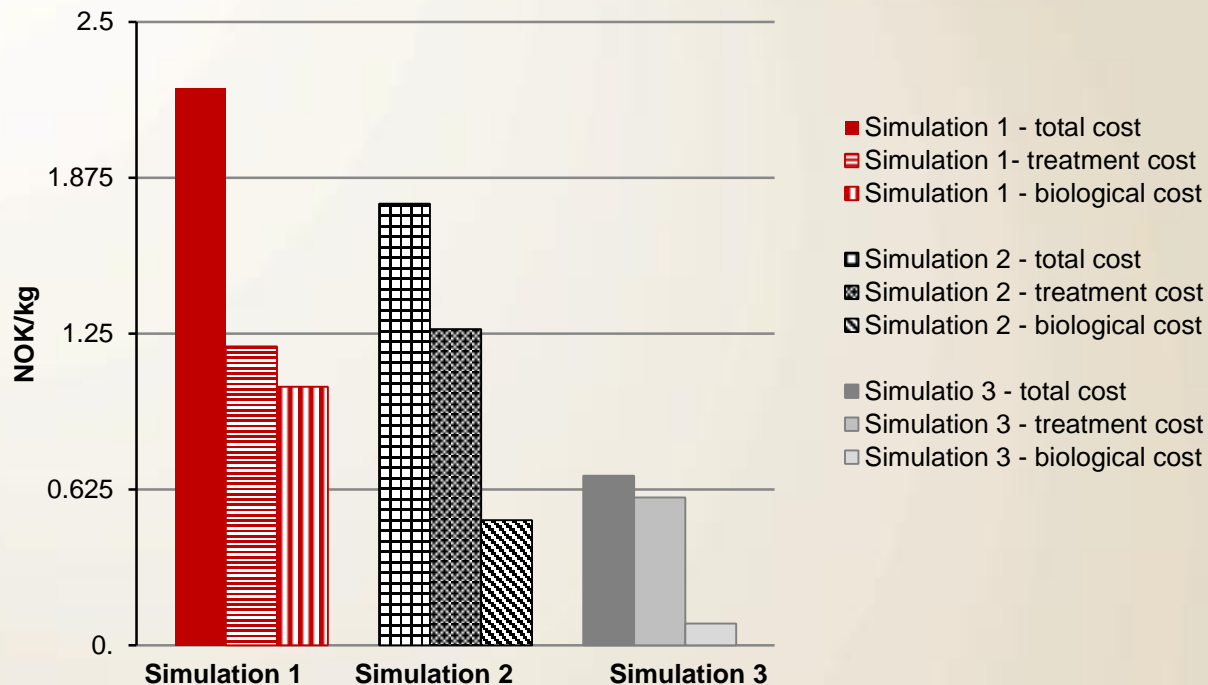
Simulation results

Treatment costs



Simulation results

Treatment costs per kg of fish



Conclusions

- Our previous study showed the timing and type of treatment could make lice control strategies more efficient (Hamza, Rich and Wheat (forthcoming, 2014)).
- The current study shows that biological control of lice is even more efficient in controlling lice in terms of:
 1. Costs
 2. Lice level per fish
 3. Significant reduction of dependency on chemical treatments (80% less use of chemicals) - reduction of environmental externality associated with chemicals

More insights

- **The effectiveness of wrasse to control lice depends on:**
 1. Wrasse to salmon ratio (density)?
 2. Wrasse feeding (eating lice) efficacy?

- **Optimization depends on what to optimize:**
 1. Lowest possible lice level.
 2. 0% use of chemical treatments.
 3. Lowest cost.
 4. Highest lice consumption rate (wrasse feeding optimization).



Thank you

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