A small parasite making big waves?

Industry Consolidation and Collaboration under Spatial-Dynamic Externalities

Nøstbakken, Abbot, Morency-Lavoie
Drivers of mergers and acquisition (M&A)

- Economies of scale
- Transport
- Innovation
- Regulations

+ Spatial externalities: internalize by buying neighbors
Drivers of mergers and acquisition (M&A)

Hypothesis: Parasites and pathogens may have an intra-industry impact

1. Driver of merger and acquisition (M&A)
2. Increasing cooperation (samdrift)

Are sea lice contributing to M&A?
Number of Firms accounting for 80% of Total Production

Source: Marine Harvest
The Single Biggest Challenge of the Industry

*Sea lice as a density-dependent constraint to salmonid farming* (Jasen et al., 2012)

→ **Surging treatment costs: x5 since 2011**

Treatments (about 20% of production costs, 6 NOK/kg):
- Biological: wrasse (cleaner fish)
- Medicine: in-feed pellet (oral)
- Chemical: bath delousing (hydrogen peroxide)
- Mechanical: freshwater at 35°C
The Single Biggest Challenge of the Industry

**Biological Impacts:**
- Direct Costs: Treatment
  - Industry-wide costs 5bn NOK\(^1\)
  - Lower bound: 10% of export value
- Indirect Costs: higher mortality, slower growth, higher feed conversion ratio, decrease in quality...

**Institutional Impacts:** through environmental regulations
- Mandatory treatment, fallowing
- Spatial impacts: geographical diversification

\[\text{Effects of firms’ scale}\]

\(^1\)Nofima (2015)
Density-Dependence

- 974 licences (780 tonnes)
- Troms/Finnmark (945 tonnes)
- Locations: 3 to 6 licences
- Max Allowed Biomass: 2,340-4,680t
- 2015: 1,303,346 tonnes
- One location = all wild population!

<table>
<thead>
<tr>
<th>Counties</th>
<th>Biomass/km^2</th>
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<tbody>
<tr>
<td>Finnmark</td>
<td>2.5</td>
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<tr>
<td>Troms</td>
<td>9.4</td>
</tr>
<tr>
<td>Nordland</td>
<td>8.2</td>
</tr>
<tr>
<td>Nord-Trøndelag</td>
<td>15.2</td>
</tr>
<tr>
<td>Sør-Trøndelag</td>
<td>15.5</td>
</tr>
<tr>
<td>Møre og Romsdal</td>
<td>19.1</td>
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<td>Sogn og Fjordane</td>
<td>17.6</td>
</tr>
<tr>
<td>Hordaland</td>
<td>42.9</td>
</tr>
<tr>
<td>Rogaland</td>
<td>22.9</td>
</tr>
<tr>
<td>Vest Adger</td>
<td>13.9</td>
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</table>

Source: Sintef (2011)
Location-Specific

Idiosyncratic levels of lice and patterns of dispersion

Source: Institute of Marine Research
Location-Specific
Idiosyncratic levels of lice and patterns of dispersion

Source: Institute of Marine Research
Identification Strategy
Proximity versus Connectivity
Empirical Model

Proximity (distance) and connectivity (lice spread)

Simple case:
Two firms (j,i) with one location each

$Z_{ji}$ : Probability of firm j buying firm i
$X_i$ : Farm i characteristics
$W_{ij}$ : Connection matrix from farm i to farm j

$$Z_{ji} = \phi(\alpha_0 + \beta_1 X_i + \beta_2 Dist + \beta_3 W_{ij} + \beta_4 Dist \ast W_{ij} + \mu)$$
Subsample: Hardanger Fjord

- Important producing region
  - 15.2% of all licences
  - > 12% of farm locations in Norway
  - 9% of all Norwegian allowed biomass capacity
- High risks of lice
- Well monitored by researchers and biologists
Preliminary Results and the Way Forward

- Lice Connectivity (W)
- Distance (Dist)
  - + Explore different measures of proximity (from edges, by roads)
- + Diversification of Production Zones
Future Work

Step 2. Apply to Sagfjord and compare regions
Step 3. Extend to all locations in Norway
Step 4. Analyze formal and informal cooperation networks
Spatial externalities can be drivers of M&A

Include spatial patterns of spread and connectivity

Preliminary results suggest lice impact acquisitions

→ Undersea creatures may create waves on land and in boardrooms
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Consolidation and Collaboration under Spatial-Dynamic Externalities

Félix Morency-Lavoie
felix.morency-lavoie@nhh.no

Norwegian School of Economics
Bergen, Norway
Innovation: Shielding from Lice

- Open-ocean facility
- Fully-enclosed pens
- "Snorkel" barrier
- Tarpaulin shielding skirt
- Laser
- Subsea pens
- Land-based facilities
## Data: Sources

<table>
<thead>
<tr>
<th>Layers</th>
<th>Dataset</th>
<th>Source</th>
<th>Period</th>
<th>Granularity</th>
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<tr>
<td>Economic</td>
<td>Financial data, sales, costs</td>
<td>Fiskeridirektoratet</td>
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<td>Firms</td>
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<td>Merger history</td>
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<td>Lice count by maturity stages</td>
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<td>Biomass, mortality, withdrawals</td>
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<td>Physical</td>
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<td>(Ocean) Connection matrix</td>
<td>IMR</td>
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<td>Lok_NR</td>
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</table>

Other complementary industry information:

- [BarentsWatch.no](http://BarentsWatch.no), [Lusedata.no](http://Lusedata.no)
- [Norwegian Seafood Council](http://Norwegian Seafood Council), [Statistics Norway](http://Statistics Norway), [Directorate of Fisheries](http://Directorate of Fisheries)
A Brief History of Norwegian Aquaculture

Salmon vs Cod: First-Hand Real Prices (2016 Nok/kg)

Source: Statistics Norway and Noregs offisielle statistikk
Source: Directorate of Fisheries
"(Sea lice) is a divine intervention to drive salmon upriver into freshwater to wash off the burden of the lice, all to man’s benefit." - Fishermen from ca. 1700 (Berland and Margolis, 1983)

- Natural occurring parasite
- Developed resistance to treatments
- Density dependence
- Constraint to growth of the industry