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SIMULATING THE IMPACT OF POLICY CHANGES IN ICELANDIC LUMPSUCKER FISHERY

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ABSTRACT

In the fishing year 2012 a new regulation was enforced in the Icelandic lumpsucker fishery which made it obligatory for fishermen to land everything they catch. Before 2012 the common practice involved cutting the fish belly open on-board, removing the roe sac and then discarding the flesh as it has had little commercial value. A bio-economic model of the lumpsucker fishery was constructed and simulated for the next 25 years with the aim of assessing the impact of this non-discard policy on the profitability margin of the fishery and the number of jobs within the fishery. A system dynamics approach was applied; a causal loop diagram was developed describing how variables affect one another followed by model implementation in Stella.

1 INTRODUCTION

The aim of the research is to assess the impact of a non-discard policy. In order to do so, a model of the Icelandic lumpsucker fishery was constructed and simulated for 20 years and a comparison on the two policies was done in terms of the following indicators:

1. The profitability margin of the fishery: $(R(q,p) - C(E,q))/R(q,p)$
   where R is the yearly revenue from the fisheries, and C the cost of the fishery.
2. Number of man-years in the fishery

2 THE MODEL

The lumpsucker model is based on several different functions; a biological function describing biomass growth, a harvest function, cost and revenue functions and a price function.

2.1 Natural biomass growth function

Very limited biological data can be found on the female lumpsucker stock. As a consequence, a simple standard bio-economic biomass model is applied. It accounts for no age structure and the population dynamics are described with a logistic function:

$$G(x) = r \cdot x_{lump} \cdot \left(1 - \frac{x_{lump}}{K}\right) = \alpha \cdot x_{lump} - \beta \cdot x_{lump}{}^2$$

where x_{lump} is the stock size of female lumpsucker, K is the carrying capacity and r the intrinsic growth rate of the stock.

2.2 Economic functions

The cost is assumed to be described by the function: $C(e,q)=fc*E+vc*R(q,p)$, where fc is fixed costs, E, is effort, vc is variable cost and $R(q,p)$ is the revenue. Under a non-discard management scheme a new cost function, $C(e,q)=fc*E+vc*R(q,p)+w*q_{lump}$, also accounts for processing cost in land.

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The most valuable part of the lumpsucker are the roes. The lumpfish itself is however worth a lot less. The revenue function before 2012 was assumed to have the following form:

$$R(q,p)=P(q,t)\bullet Y(e,x)=p_{roe}\bullet q_{roe}\bullet=p_{roe}\bullet\eta\bullet q_{lump}$$

where p_{roe} is price of roe, p_{roe} is the amount of roes harvested, η is the ratio of roes and q_{lump} is the lumpfish harvest. A more representative revenue function after the legislation changed in 2012 would be:

$$R(q,p)=p_{roe}\cdot\eta\cdot q_{lump}+p_{lump}\cdot(1-\eta)\cdot q_{lump}=q_{lump}\cdot\left[\eta\cdot(p_{roe}-p_{lump})+p_{lump}\right]$$

where p_{lump} is price of the lumpsucker.

Monthly price data from Statistics Iceland were modelled with an AR(1) process:

$$p(t)=\mu+a\cdot(p(t-1)-\mu)+e_t$$

where μ is the mean price, and e_t is the error term.

3 A CAUSAL LOOP DIAGRAM, VALIDATION AND SIMULATION

A causal loop diagram (CLD) of the fishery was constructed alongside the process of formulating the model functions. Developing a CLD proved helpful for understanding relationships between factors in the fishery and providing important insights. For instance that effort is highly dependent on price of roes, meaning that some fishermen choose not to use their fishing permits given that the price for roes during a particular fishing season is not good enough. Once all relevant parameters had been estimated, the model was implemented in Stella™ and validated with historical data. For instance, the harvest function was validated with effort data during the last 10 years and the effort function was validated by feeding the model with historical price data.

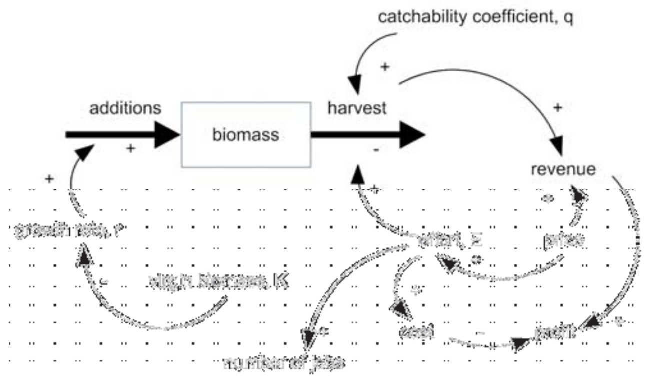

Figure 1: A CLD of the lumpsucker fishery.

4 CONCLUSIONS

The main results from the simulations were that under a non-discard policy, the profitability of the fishery decreased by approximately 30% while the number of jobs increased by half. The system dynamics approach proved useful for this case as it allowed for holistic modeling of the fishery. With the model in place, a further study on how sensitive any chosen indicators may be to model parameters could easily be carried out. An example of that might be the sensitiveness of the profitability of the fishery in regards to currency changes.

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