Economic impacts of ocean acidification on shellfish fisheries and aquaculture in the United Kingdom

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Summary

Ocean acidification (OA) may pose a serious threat to commercial fisheries in Europe, especially those reliant upon vulnerable shellfish species. No economic assessment of the effects of OA on shellfish production has previously been attempted in the UK, although calcifying shellfish species generated more than 50% (£302 million) of total marine fisheries revenue in 2012 (figure 1), and a further £33 million of revenue was associated with shellfish aquaculture. Applying the Net Present Value (NPV) approach, a partial equilibrium (PE) model and a computable general equilibrium (GE) model, we estimated both direct losses and wider economy consequences of OA impacts on shellfish production up to 2100 at 2010 prices.

The findings suggest that: (i) the potential economic losses by 2100 to shellfish fisheries and shellfish aquaculture under a ‘high emission’ scenario could be around £954 million when the NPV approach is applied. (ii) Under a PE analysis, the potential losses would be five times higher, as income changes over the period are also considered. (iii) Losses would be especially high in Wales and Northern Ireland (in relative terms) where shellfish fisheries and aquaculture are particularly important, but absolute losses would be highest in Scotland.

Materials and Methods

For the estimation of the potential harvest losses of molluscs due to OA, the NPV approach (Cooley and Doney 2009), and a partial-equilibrium (PE) analysis (Narita et al. 2012) were applied. In addition a simplified computable general equilibrium (GE) framework was adopted and offered insights into how the loss of shellfish production, might indirectly affect macroeconomic elements such as output, income, and employment. A number of different future scenarios were tested including: low emissions (IPCC SRES B1 -380ppm); high Emissions IPCC A1F1 (750ppm); low sensitivity of shellfish and high sensitivity of shellfish (based on Gazeau et al. 2007). Discounting rate was set at 3.5%, as is used by the UK Treasury
Results & Discussion

The potential annual losses in UK mollusc and crustacean production (fisheries and aquaculture combined) were estimated to span between £1.4 million (assuming a low emissions scenario and low sensitivity) and £9.1 million (assuming a high emissions scenario and high sensitivity) according to the NPV approach. The cumulative potential losses were estimated at £ 127 - £ 816 million during 2010-2100, although impacts are likely to be unevenly spread across UK regions. In cumulative terms, the biggest absolute losses with regard to fisheries would be in Scotland (£61.8 – 396.1 million) although relative losses would be higher in Northern Ireland (heavily dependent on *Nephrops*) and Wales (heavily dependent on scallops and whelks). With regard to aquaculture production, the biggest absolute losses would again be in Scotland (£2.2 – 14.6 million) but would also be substantial in both Northern Ireland and Wales (£2.1 – 13.5 million and £1.7 – 10.7 million respectively). Under a PE analysis, the potential losses would be five times higher, as income changes over the period were also considered, as were assumed changes in market demand. Estimates projected using the PE framework encompass a range from £14.5 to £21.5 million for annual shellfish revenue losses.

A GE model was used in this study to illustrate economy-wide systematic feedbacks i.e., macroeconomic consequences and welfare loss as a result of OA. Overall, the reduction in fisheries revenue resulted in negative impacts on GDP and in other sectors. The analysis suggested a negative knock-on impact in manufacturing and services, as well as a negative impact on employment. On the other hand a positive impact on tax revenue and government expenditure indicates that a reduction in fisheries could yield a marginal positive impact to government accounts. A reduction in UK fisheries as a result of OA would also have negative impact on both domestic and rest-of-the-world (RoW) trade balance. The UK is a net importer of shellfish, and especially prawns.

Addressing the problem of ocean acidification with the aim of preserving commercially valuable shellfish resources will require regional, national and international solutions to be sought, including a reduction in atmospheric CO₂ emissions (mitigation) and possibly a shift in focus to species that are less vulnerable to OA effects (adaptation). Further research is urgently needed in order to ‘scale up’ from laboratory experiments, where commercial species are exposed to elevated CO₂ or low pH to figure out what sensitivities might mean for populations in the wild and hence for regional economies (Le Quesne & Pinnegar 2012).

This work was supported by the UK Department for Environment, Food and Rural Affairs (Defra) through contract C6012 PLACID (Placing Ocean Acidification in a wider Fisheries Context).

References


