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Environmental and socio-political shocks to the seafood sector: What does this mean for resilience? Lessons from two UK case studies, 1945–2016

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ABSTRACT

Fisheries products are globally traded commodities, which have led to varying degrees of social and economic dependency for producing regions. These dependencies become more evident at times of major demand or supply shocks. Resilience to such shocks is intertwined with, and rooted in, the intra-sectoral structure and governance frameworks. This work analyses two large-scale, capital-intensive and export-oriented seafood sectors: Atlantic salmon and North-east Atlantic mackerel, responded to the environmental, economic and geopolitical shocks accompanying their development, from a UK perspective. Intra-firm controls are identified as elements, which have delivered resilience and strength in these two sectors. This work highlights the central, yet different role of the UK government in increasing their resilience and underlying producing regions. Our work contributes to the broader context of regional development and changing global food demand identifying both domestic and external threats to sustainability. Our approach aims to expand the debate around seafood production from 'food security' to a transdisciplinary analysis, which incorporates wider economic, social, and ecological sustainability aspects.

1. Introduction

Fisheries products have become globally traded commodities which has led to increasing degrees of export dependency for producing regions [11,61,83]. Such dependency generates several social and economic risks which become accentuated at times of challenge to supply or demand [12,27,58]. The complexities inherent in the relations of exploitation and commodification [12] are also influenced by extra-sectoral factors, such as natural ecological shifts in productivity and politically-influenced free-trade agreements. Jennings et al. [58] suggested that sectoral-based analyses for fisheries often overlook important elements such as links with environmental changes, human health and fish welfare. Recognising this transdisciplinary complexity, the present work examines how two export-orientated sectors of major significance to the UK, farmed Atlantic salmon (an aquaculture product) and North-east Atlantic mackerel (a capture fishery) have responded to ecological, environmental and socio-political shocks, and how they have maintained their microeconomic (i.e. sectoral) and macroeconomic (regional) viability.

The seafood industry is mediated by complex relationships within and across national boundaries [58]. Producing regions, such as Scotland, may be part of a larger nation-state (in this case the United Kingdom) whilst engaging with wider trading partnerships, such as the European Economic Area [74]. Although individual companies compete for market share, they may also collaborate for mutual benefit [44], e.g. on product labelling, trading of fishing quotas or production standards [93]. Furthermore, because of the limited scope for further expansion of most capture fisheries, aquaculture has been identified as a "focus area" with significant scope for further expansion, giving the seafood industry a dual nature, composed of fisheries and aquaculture.

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In this multidisciplinary examination of these two seafood sectors, this work applies both a sectoral and a regional (UK) perspective. As the UK is currently a member of the EU, both these sectors have to abide by both national and EU-level policies, the latter regulated through the Common Fisheries Policy (CFP) [28]. The North-east Atlantic (NEA) mackerel and salmon farming sectors were chosen for this study based on their importance to UK seafood production: NEA mackerel is consistently the most landed species by Scottish vessels, accounting on average for 28% of landings by weight and 18% of landings by value [89]; Atlantic salmon is the most important reared fish in the UK, accounting for nearly 99% of the total UK aquaculture production by weight in 2012 [70], and the most sold, imported and exported seafood product by value [90]. The specific objectives of this study were to investigate: *1)* how these two sectors have responded to environmental, economic and geopolitical shocks which accompanied and influenced their development; *2)* to identify how structural differences or similarities between these two sectors have influenced their ability to respond to these shocks; *3)* to examine whether the degree of consolidation within these two sectors has conferred economic resilience and how such resilience may influence their future development. Consolidation is here defined as the aggregation at production level of multiple firms through *Concentration and Centralization, foreign direct investment (FDI), and Association* as defined by Havice and Campling [44]. Resilience is here defined and understood within the conceptualization proposed by Brand and Jax [9] of 'ecological-economic' resilience, and following the definition of Perrings [75]. More generally, the term resilience can be traced to the post-classical, 'engineering-analogue' meaning [48] introduced by Holling [47] (C[13]. Therefore, in this work the term 'resilience' describes the ability of a sector to adapt to exogenous shocks. However, as it will be argued in the conclusions, this work also identifies a trend of rising exposure to shocks linked to the expansion of these two sectors.

2. Methods: applying transdisciplinary

A three-day expert workshop was held in August 2015 to collectively analyse data and literature on both sectors and to identify "red flags" linked with changes in production and trade flows. For the purposes of this study, "red flags" were defined as elements which could be susceptible to future abrupt temporary and, or permanent changes (i.e. risks). This approach has been used to identify key risk factors across a wide-range of disciplines e.g. in medical diagnosis [45,69], domestic violence [6], terrorism financing [40] and corporate fraud [100,10]. However, there is currently no specific, well-defined methodology for "red flag analysis" and therefore, in this instance, it was used as part of an expert-led, qualitative approach.

The experts were comprised of seven researchers and two PhD students, in fisheries and aquaculture and included ecologists, biologists, economists and social scientists from a range of research organisations. The workshop was split into two components: data collection and analysis.

2.1. Data collection

Contextual information and production/landings data for each industry was collated and analysed. The workshop participants with a life-sciences background were split into two smaller groups (one focused on salmon, the other on mackerel) based on relevant expertise, and data was collected and written up separately by each group, then fed back to the larger group for analysis. Social scientists worked within both teams, and acted as transdisciplinary links to identify social and economic differences/similarities between the two sectors, based on the published literature reviewed. Information on the history of the development of both industries were obtained through searches of the Aquatic Sciences and Fisheries Abstracts (ASFA, 2016) database spanning 1971–2015. Governmental grey literature was examined when relevant to sectoral and national policies associated with or influencing these industries.

Production data for farmed Atlantic salmon came from the on-line databases [30] (Version 2.12.4; 1950–2013) and Eurostat (www.ec.europa.eu) as well as reports from the Scottish Salmon Producers Organisation (SSPO). Information on market trends was retrieved from FAO Globefish (www.globefish.org). Data on the landings of NEA mackerel were taken from FishStatJ (Version 2.12.4, 1950–2013) and the UK Sea Fisheries Annual Statistics [67]. Trade-flow information came from the Fisheries Commodities Production and Trade dataset (1976–2011). Further contextual information for mackerel was obtained from official stock assessment reports generated by ICES (www.ices.dk) and the UK Sea Fisheries Annual Statistics (MMO, 2015). Information was compiled regarding: international and national actors (i.e. firms operating at the production level and their associations), domestic policies and objectives for industry development, industry characteristics (e.g. composition and size) and markets (both international and domestic). During the collection of contextual information, ecological, social and political shocks which had affected the industries were identified, as well as how the sector had responded.

2.2. Data analysis

During the data analysis component of the workshop, the participants were brought back together into one larger facilitated group to discuss findings, to collectively identify 'red flags' (those elements of the industry which may be affected by shocks to the sector) and to assess, for each 'red flag', whether the regional sector had limited, some or strong resilience to the identified shocks (Table 1). The expert judgements (backed up by information and data collated in the previous component) derived from this part of the workshop were then entered into a traffic light plot.

The analytical process presented here is of interest to multidisciplinary studies. The replicability of this expert-panel approach is, thus, not as immediate as formal quantitative methodologies, and is influenced by the regional focus of the sectors. Qualitative approaches are also difficult to synthetize into single summary metrics but offer an opportunity to better understand the cause-effect relationships of complex, transdisciplinary structures as fisheries production systems.

3. Farmed Atlantic salmon–case study of large-scale aquaculture

Driven by increasing global demand [8] the world-wide output of farmed salmon has grown steadily since the early 1980s, reaching > 2.2 million tonnes in 2013 (a 400-fold increase), with Atlantic salmon accounting for around 91% of the production (Fig. 1).

Aquaculture now provides around 67% of the global production of all salmon specgies (FishStatJ, 2014) with Atlantic salmon farms concentrated in Norway, Chile and the UK (within the UK salmon farming is predominantly based in Scotland). Outside of these countries, production of Atlantic salmon is increasing, but remains relatively low. Although the industry was initially small-scale, the industry is dominated by a few trans-national corporations [4,66]. Appendix D shows in detail the concentration and internationalization of the markets across the largest producing countries. In some instances, for example the UK, value-addition takes place in the country of origin, but the product is often exported fresh or frozen for processing, especially to countries with lower labour costs, such as Poland [16]. Some of these export flows are also influenced by trade-tariffs: e.g., fresh or frozen Norwegian salmon attracts a lower tariff (0%) than the smoked product (15%) when imported into the EU [29]. Salmon farming is thus highly internationalized with actors operating across national boundaries either at the production, trade or both levels (Fig. 2).

The UK is the third largest global producer of farmed salmon at ~180,000 t in 2014 (FishstatJ, 2014). During its expansion in the UK, the industry received substantial investments in research and