Scotland as a case study for how benefits of marine ecosystem services may contribute to the commercial fishing industry

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Highlights

- The Scottish fishing industry depends upon a healthy flow of ecosystem services
- Factors affecting ecosystem services for fishing are varied and challenging
- Conservation and fisheries management must consider secondary benefits to fisheries
- Part of Scotland's pledge to the UN SDGs can be met by better fisheries management
- Fisheries should be considered in the context of several of the SDGs

Abstract

In July 2015, Scotland became one of the first countries to sign up to the UN Sustainable Development Goals (SDGs) which, unlike their forerunner the Millennium Development Goals, are not restricted to developing nations. Their respective targets should drive policy decisions for Scottish fisheries, in keeping with the universal intent of the new goals. This paper explores the relevance of SDG 14 to the Scottish fishing industry, noting that there are a number of linkages with other goals and targets that should be considered within management frameworks. Scottish fishing has a long history, but the size of the inshore fleet has seen decline in recent decades, particularly of small-scale fishers in rural communities. Available literature was reviewed and a survey of active Scottish fishers conducted to explore the current availability and equality of distribution of benefits from ecosystem services to Scottish fisheries, and the factors that affect them. The findings suggest that benefits may not currently be equally distributed across Scottish fisheries; this is largely sector dependent and driven by market forces, but also relates to gaps in current management and monitoring systems. Furthermore, the potential benefits to fisheries of marine protected areas (MPAs) established for conservation purposes are not adequately assessed as part of their design, which may result in less support from fisheries stakeholders and reduce the benefit to ecosystem services. It concludes with some recommendations for consideration by decision-makers to improve how fishing businesses and communities could benefit more from ecosystem services whilst operating within environmental limits.

Keywords

Ecosystem services; fisheries; Scotland; poverty alleviation; Sustainable Development Goals; marine protected areas.

1. Introduction

1.1 Scottish Fisheries and the Sustainable Development Goals

Historically Scotland is a fishing nation, but has experienced variable declines in both fish stocks and the active fishing fleet over the last fifty years (Greenstreet *et al.* 2006; Thurstan *et al.* 2010; Heath and Spiers, 2011; Baxter *et al.* 2011). Such declines in employment, landings and catch value are likely to be a result of a number of factors, including environmental change (due to increasing anthropogenic activities, such as overfishing and habitat damage from certain types of fishing gear – Hall-Spencer and Moore, 2000; Kaiser *et al.*, 2000 and climate change) and increasing industry regulation. These declines will have knock-on effects throughout the supply chain (Baxter *et al.*, 2011). Nonetheless, Scotland still has one of the largest commercial fishing industries in Europe, and Scottish vessels land more than two-thirds of the total landings for the UK, with Shetland fisheries contributing up to 15% of the UK total landings alone (Napier, 2014). The Scottish Government estimates that commercial inshore fishing (within 12 nautical miles of the territorial baseline) contributes approximately £90 million per year to the Scottish economy (Marine Scotland, 2015). Commercial fishing remains a traditional and important cultural aspect of many coastal communities, supporting employment opportunities directly through fishing and indirectly through support services, such as processing and transport. The Scottish fishing industry is considered one of the global forerunners in terms of some of its management strategies (Carter, 2014).

In July 2015, Scotland became one of the first countries to sign up to the United Nation's Sustainable Development Goals[1] (SDGs), which, unlike their forerunner, the Millennium Development Goals, are not restricted to developing nations. The UN Sustainable Development Goal 14 '*Conserve and sustainably use the oceans, seas and marine resources for sustainable development'* stipulates a number of targets which are underpinned by the strong application of the ecosystem approach and the principles of sustainable development in the marine environment. This includes Target 14.5 requiring States to conserve 10% of coastal and marine areas by 2020. A number of these targets specify fisheries as one of the industries that should be focused upon by member states to improve management for environmental protection and provide opportunities for smaller-scale subsistence fisheries. Whilst Target 14.9 (see Table 1) is particularly relevant to the small island developing states referred to in 14.7, it should arguably also apply to some of the remaining fishery-dependent coastal communities in Scotland (and indeed similar communities in other developed nations).

Currently, different fishing sectors are subject to varying levels of regulation in Scotland. Mobile-gear fisheries are broadly the most highly regulated in terms of technical measures, spatial management and license restrictions. Static-gear fisheries (such as creeling and set nets) have some limited spatial

[1] http://news.scotland.gov.uk/News/Leading-the-way-in-tackling-inequality-1b49.aspx

management, notably specific prohibitions within Marine Protected Areas (MPAs) for the protection and recovery of highly sensitive features, although some technical measures do apply more broadly. The increasing regulation of fisheries and a greater necessity for ecological conservation of marine habitats and species are perceived to be further reducing opportunities for commercial fishing in Scotland (Baxter *et al.* 2011; Hadjimichael *et al.,* 2013). Many fishers fear increasing regulation is resulting in the decline of historic fishing communities and there is some evidence to support this claim in areas that are experiencing loss of fishing-related employment and outward migration of younger generations (Marine Scotland, 2009). Impacts of changing regulations will vary across the industry and between different sectors; the effects of spatial restrictions or changes in quota are more likely to be felt within smaller-scale businesses and communities where lower fishing capacity will mean profits are lower than for larger vessels or businesses (Carter, 2008; Jentoft and Knoll, 2014). A number of the SDGs place a responsibility on signatories to ensure that the management of industry delivers direct and indirect environmental and socio-economic benefits; SDG 14 is the most directly relevant to fishing, but there are synergies with SDGs 8, 9, 12, 13 and 16 (see Table 1). Such cross-linkages must be considered by policy makers to support a holistic approach to the delivery of the SDGs and to ensure maximum benefit to all.

1.2 Ecosystem services and Scottish fisheries

Ecosystem services are defined as '*the benefits obtained by humans from the environment'* (Millennium Ecosystem Assessment, 2005) and as such are a key consideration for the management of Scottish fisheries, underpinning fishing profitability and sustainability. Currently, approximately 51% of the global population live and work in coastal areas (within 200km of the ocean – Kummu *et al.*, 2016), accounting for 61% of the global total Gross National Product (GNP), and global *per capita* consumption of fish is increasing (Agardy et al. 2005; UNEP, 2006). Ecosystem services relating to and supporting commercial fishing have been well defined in previous literature, including the direct provisioning service of food security, regulating services such as carbon storage, or supporting services that healthy, well-functioning seabed habitats provide as fish and shellfish spawning and nursery grounds, and 'cultural services' including employment and tourism (Hein *et al.,* 2006; Barbier *et al.*, 2011; and see Figure 1). However, there has been little focus on measuring the socio-economic benefits of such services (*e.g.* food and income) specifically for Scotland other than for their direct economic contribution to the country. It is not clear how the different fishing sectors benefit from ecosystem services and what the implications of change or the unfair distribution of benefits are for smaller or poorer communities. Furthermore, following SDG target 14.5, a better understanding of how MPAs and other spatial conservation measures deliver ecosystem services relevant to fisheries is needed, particularly the socioeconomic effects from spatial measures and the contribution of these measures to safeguarding sustainable fishing opportunities and addressing any perceived and real inequalities.

Figure 1 goes here

In this study we examine the interaction of ecosystem services and the Scottish fishing industry and consider how the new global SDGs apply to Scottish fisheries. We explore the synergies and key linkages between relevant SDGs and highlight where policy makers should work together to co-deliver Scotland's commitments to the SDGs. We also seek to ascertain whether current governance systems are likely to be sufficient to support smaller-scale fishing businesses and communities and contribute to poverty alleviation. Finally, we offer some recommendations based on the study's findings. Table 1 summarises all of the SDGs that were considered and referenced in this study as being of direct or indirect relevance to the Scottish fishing industry and its interactions with ecosystem services, and will be referred to throughout the paper.

Table 1 goes here

2. Methodology

This study is comprised of two parts: a literature review on ecosystem services relating to fisheries in Scotland and a survey of Scottish fishers' perceptions regarding the value of ecosystem services to fisheries and how those benefits are distributed in Scotland.

The literature review considered:

- How fisheries and ecosystem services are framed in the literature
- Current regulations and approaches for the delivery of ecosystem services as they apply to fisheries in Scotland
- Linking socio-economic benefits to Scottish fisheries and the drivers behind them (*e.g.* regulation, quota, markets);

A survey of fishers' perspectives on the benefits of ecosystem services was conducted through the online survey tool *Survey Monkey*. Snowballing methodology (Biernacki and Waldorf, 1981) was used to disseminate the survey using 12 direct contacts (fishers), targeted social media and circulation via fisheries industry representatives. The survey was open between 31st March and 16th May, receiving 10 responses and some additional unstructured e-mail feedback.

The survey comprised 10 questions (see Appendix 1), designed to gauge the type of fishing practice undertaken, determine the importance of fishing to the respondent and their community and how they perceive the importance of various ecosystem services to them and their businesses. It also included

questions to investigate how fishers perceive benefits are distributed across the industry and the equity of those benefits.

3. Results

3.1 Literature review

3.1.1 Relationship between Fisheries and Ecosystem Services

Due to their economic importance and the greater availability of data in comparison with other marine ecosystem services, fisheries in relation to a provisioning service are the most analysed (Liquete et al. 2013). Ecosystem services terminology around fisheries is complex; food provision from wild-capture fisheries is categorised under provisioning ecosystem services, yet there is often little differentiation between indicators of the service, ecosystem function or ecosystem benefit (Hattam et al. 2015). Hattam et al (2015) uses the following example: the amount (tonnes) of fish landed for consumption is an indicator of benefit and not the service provided, as landings do not reflect the full potential of the ecosystem to provide the service, being influenced by externalities in fisheries management (quotas, fishing selectivity etc). Therefore, multiple indicators are needed, for the service (e.g. fish populations) and the benefit (e.g. landings) (Hattam et al. 2015) if we are to accurately examine and quantify the flow of socio-economic benefits of ecosystem services and the Scottish fishing industry. However, the difficulty in assessing ecosystem condition and hence capacity of the ecosystem to provide services is a common problem throughout the literature, hence the reliance on proxy indicators such as fishery statistics (Maes et al. 2016).

Within the literature, the framing of ecosystem services and fisheries is two-fold: fisheries are discussed as a provisioning service, but are also widely covered in relation to their impacts on the delivery of ecosystem services. Particularly, fisheries are highlighted as an example of decreasing natural capital and negative impact on the functioning of ecosystems through intensive fishing depleting populations (Barot, 2017; Murawski et al. 2000; Hutchings 2000). The decreased capacity of marine environments to replenish biomass and thus provisioning (and other) services is linked to overfishing and other anthropogenic activities (including pollution and climate change) (Barot et al. 2017). Changes in global climate are expected to pose the greatest long-term threat to marine ecosystems (IPCC, 2007/2014), and are identified as one of two significant pressures on the Scottish marine area which are widespread (Baxter *et al.,* 2011), alongside fishing, which impacts on the seabed and species. The cumulative and synergistic effects of overfishing and climate change in the context of continued ecosystem services delivery is understudied. However, it is apparent that the projected impacts of climate change on fisheries and aquaculture are generally negative on a global scale (Holmyard, 2014). Climate change impacts including: temperature changes, sea level rise and ocean acidification may directly and indirectly impact the productivity of marine fishes (Harley *et al.,* 2006; Munday *et al.,* 2008; Barange

et al., 2014) and are likely to influence the flow of ecosystem services, the stability of fisheries provision and the derived benefits of ecosystem services to fisheries. Through SDG 13, States are required to urgently address and mitigate climate change impacts which may require a greater understanding of the interaction between climate change, ecosystem services and fisheries.

Further consideration of other ecosystem services in relation to fisheries is needed. For example, there has been limited but growing research on the trade-offs between marine ecosystem services whereby maximising the benefits from one ecosystem service (e.g. fisheries) may be at the expense of another (e.g. carbon storage) (Martin et al. 2016). To elaborate, reducing fisheries exploitation could rebuild carbon stores in apex predators and fish stocks (carbon storage benefits) and also form larger steady state stocks (Martin et al. 2016). Yet, by ignoring both trade-offs between marine ecosystem services and potential negative externalities (e.g. biodiversity loss and climate change), maximising often short-term economic gain at the expense of longer-term economic returns has caused widespread ecosystem degradation (Martin et al. 2016; Pope et al. 2016). Ultimately, degraded ecosystems and decreased biodiversity can result in a reduction or loss of a valuable ecosystem services (Pope et al. 2016). Overall, a more holistic framework is needed to evaluate the interaction between ecosystem services delivery, benefit flow and fisheries (Hattam et al. 2015; Piet 2017).

3.1.2 Spatial protection measures and ecosystem service flows

Managing fisheries is complex due to the multiple objectives encompassing economic, ecological and social goals (Halpern et al. 2013) that can result in trade-offs; where an improvement in one objective may be at the detriment of another (Jacobsen et al. 2016). A more holistic framework of ecosystem-based management and ecosystem services is proposed as a way of dealing with the resultant trade-offs between objectives (Shelton et al. 2014). Fundamentally the ultimate goal of fisheries management should be to balance the different objectives with a healthy resilient ecosystem at its heart (Martin et al. 2016). Ecosystem-based management (EBM) combined with an ecosystem services framework could provide a clearer understanding of the impacts on ecosystem services (and flow of benefits), identify trade-offs and manage anthropogenic activities accordingly (Martin et al. 2016; Hattam et al. 2015).

Scotland's MPA Network was implemented to fulfil international commitments towards marine conservation and deliver the UK and Scottish Government's commitment to delivering a '*clean, healthy, safe, productive and biologically diverse marine and coastal environment that meets the long term needs of people and nature*' (Scottish Government 2010; Hopkins et al. 2016). The MPA network will be crucial in enabling Scotland to meet the SDGs, primarily SDG 14 for States to conserve a proportion (at least 10%) of the natural environment (see Target 14.5, Table 1). However, the network

could potentially secure flows of socio-economic benefits from ecosystem services to fisheries if effectively designed and managed (Potts et al. 2014).

Scottish MPAs are principally designed as conservation tools to '*protect marine biodiversity and ecosystems to ensure that the natural environment, and the diversity of industries which depend upon it, is safeguarded for the future*' (Turner and Schaafsma, 2015) using a feature-based approach for site selection (Hopkins et al. 2016). Whilst the feature-based approach has received some criticism with regards to maintaining ecosystem function across the network, maintaining site integrity with habitats and species that MPAs are designed to protect in good ecological condition, can have positive effects on ecosystem services delivery (Potts et al. 2014). Highlighting the ecosystem services that derive from MPAs allows for the identification of services that can be enhanced or supported by MPA processes (Fletcher et al., 2011). For example, the South Arran MPA in the Firth of Clyde, designated for nationally important biodiversity features (including maerl beds and seagrass beds) provides important spawning grounds for herring and cod (Ellis *et al.*, 2012). Similarly, sub-tidal sandbanks within the Moray Firth SAC provide spawning grounds and nursery areas for sandeels and many commercially exploited juvenile fish (Potts et al., 2014).

In Scotland, there are few protected areas with long-term monitoring data, yet some initial analyses suggest MPAs could deliver ecosystem services flows to areas outside designation. Howarth *et al.* (2015) note evidence of "spillover" (McClanahan and Mangi, 2000) in the area surrounding the north Lamlash Bay no-take zone and there is also anecdotal evidence for spillover from non-nature conservation fisheries exclusion zones, such as the British Underwater Test and Evaluation Centre site off the northwest coast of Scotland (Pickering, 2003). However, there is little recorded evidence or analysis that commercial fisheries are substantially benefitting from this ecosystem services flow either through "ecological" or "fisheries" spillover (Di Lorenzo et al. 2016), or that this is translated into socioeconomic benefits for local fishing businesses.

Anecdotal evidence from mobile-gear fishers with fishing grounds adjacent to the "Windsock" fisheries cod recovery closure in the North Sea (mobile gear excluded indicates that fishers may be benefitting from cod spillover: Pers. Comm., Anon; Jaworski and Penny, 2009) by "fishing the line". This suggests some fisheries regulations within Scotland may be maintaining ecosystem services benefit flow, yet this and other regulations are not yet quantified for success in these terms. Fisheries closures (and other designations that prohibit fishing activity) can also have negative ecosystem effects in the displacement of fishing activity to adjacent open areas; if there is a subsequent damaging increase in fishing effort, the socio-economic benefits from ecosystem services will not be realised, resulting in substantially reduced recruitment, preventing significant spillover (Sladek-Nowlis & Roberts, 1999; Quinn *et al.*,

1993; Hilborn *et al.*, 2004). Complementary management measures will therefore be required to reduce the impact of vessels displaced from a protected area and concentrated into the surrounding grounds. This relates directly to SDG Target 14.4 and is discussed in more detail in Kenny *et al.* (2017) in this special issue.

Within Scotland, guidelines for incorporating ecosystem services in to the designation of MPAs exist yet there is little evidence to date suggesting that sites have been designated explicitly on the basis of their contribution to ecosystem services (Potts et al., 2014). Furthermore, management measures within MPA sites were designed to address feature-based threats and, though they also knowingly afford protection to non-designated priority marine features, they do not necessarily take an ecosystem-based approach. To ensure management measures secure the flow of ecosystem services, more research is needed into the impacts of activities on ecosystem services provision. At present data on identifying and evaluating ecosystem services flows is incomplete (Potts et al., 2014). A comprehensive dataset of ecosystem services and socio-economic benefits within Scotland would facilitate the designation of MPAs in relation to ecosystem services and development of adequate management measures to maximize potential socio-economic benefits to society. Additionally, monitoring the flow of regulating, provisioning and cultural services and benefits from MPA sites, and the influence of site management on ecosystem services delivery will be important for delivering SDG 14.

3.1.3 Socio-economic benefits of ecosystem services to Scottish fisheries

Employment and financial income as a socio-economic benefit of marine ecosystem services are key considerations for commercial fisheries, particularly for small-scale (<12m vessels, generally using static gears) fishers who have limited livelihood alternatives (Brookfield *et al.*, 2005; Worm *et al.*, 2009). In 2013, commercial fishing represented 0.2% of employment opportunities within the Scottish labour force, with 4,796 fishermen employed on Scottish vessels. According to Scottish Government statistics, the number of fishermen employed in the Scottish fishing industry has fallen by 29% since 1970, a decrease of 48% in regular employment, 47% in irregular and 80% in recreational crofters. It is possible that this decrease in numbers is related to a reduced fleet capacity as well as increased efficiency (Scottish Government, 2014). The data also demonstrates that the size of the Scottish fishing fleet has decreased in the past 50 years, reaching the lowest recorded number of active fishing vessels (2,020) at the end of 2013. Coupled with the decline in fishing employment and fleet size, the total quantity of fish landed by Scottish registered vessels in 2015 was 439,900 tonnes, representing a decrease of 15% since 2014, with a value of £437 million, a decrease of 15% in nominal terms (Scottish Government, 2015).

While subsidies are available from the European Union (EU) to support Member States' fisheries (without which, EU fisheries would run at a 4.6% loss), these have been found to be ecologically harmful, leading to over-capacity in the fleet, a potential loss in biodiversity and ultimately further disadvantaging both fisheries and the ecosystem (Heymans *et al.,* 2011). In this connection, it is important to note SDG 14.6 on the prohibition of certain types of subsidies that contribute to over-capacity and overfishing (see Mohammed *et al.,* (2017) in the current special issue). Heymans *et al.* (2011) suggest that while a removal of subsidies would see a short-term loss in landings and income, and potentially employment, it would lead to greater long-term ecological stability and an increase in profitability for fisheries. However, the question remains: in such a scenario, would the Scottish fishing fleet be able to survive the initial loss to reap future benefits? This may be an academic argument following the recent UK vote to leave the EU, as access to such funding over the coming years may be uncertain.

Policies designed to limit fishing activity to ensure the sustainability of fish stocks may overlook the cultural services fishers derive from fishing. Williams (2008) found fishing to be at the heart of social organisation and identity in the fishing communities of Northeast Scotland, with long lines of fishing families passing down enterprises from father to son. Studies elsewhere also show that in many communities fishing goes beyond economic livelihood, providing social capital, knowledge systems, a sense of place and cultural identity (Jacob *et al.,* 2001; van Ginkel, 2001; Brookfield *et al.,* 2005; Urquhart and Acott, 2014), while the physical objects associated with fishing (i.e. buildings, boats, harbours) also contribute to 'place character' for community cohesion and attraction for tourism (Urquhart and Acott, 2014). These non-material benefits that fishers derive from ecosystems are difficult to value economically, often leaving them hidden as market externalities despite their importance to fisher communities (Chan *et al.,* 2012).

3.2 Survey of Scottish fishers

A total of 10 active Scottish fishers submitted responses to the survey and some additional informal written feedback was also received. Due to the limited number of respondents, some of whom did not answer all the questions, the outcomes of this survey are presented here as a pilot study, highlighting some of the relevant qualitative results. The survey questions are detailed in Appendix 1.

Table 2 summarises the sector, broad geographic remit and family history within the industry of the respondents. No other personal information was solicited in order to ensure anonymity amongst industry members and an ethical approach to the research.

Table 2 goes here

For question 1, the fisheries sectors were defined as follows:

- Mobile demersal gear: bottom-towed fishing gear, including dredges and trawls
- Mobile pelagic gear: non-bottom-towed fishing gear, including pelagic trawl or seine netting
- Static gear: non-towed methods, including baited pots or creels, set nets, rod and line fishing
- Hand-gathering: collecting fish and shellfish by hand, including digging (*e.g.* cockles), diving (*e.g.* scallops)

There were no respondents from the mobile pelagic gear sector. The majority of the respondents stated that they fish within inshore waters (<12 nautical miles). The respondents' family history of fishing varied, with 4 being fifth generation fishers or more, contrasting with 3 being first generation fishers.

Question 4 asked how respondents perceived fishing opportunities had changed in the last 20 years. Of the nine respondents to this question, one felt that opportunities had increased, seven felt they had decreased and one felt they were much the same. The respondent who suggested that fishing opportunities had increased in the last 20 years listed themselves as a static gear fisher working inshore waters. However, those who have experienced a decline in fishing opportunities were predominantly mobile-gear fishers. The respondent who reported no change in fishing opportunities was a hand-gatherer.

For question 5, 'Please indicate the role of commercial fishing in your community', respondents provided approximate numbers for the following categories:

- Approximate number of direct jobs (*e.g.* active fishers)
- Approximate number of indirect jobs (*e.g.* transport, fish processors, vessel engineers)
- Approximate number of opportunities to sell locally caught fish to the community (*e.g.* regular fish market, restaurants, fish and chip shops).

Responses suggest that a number of domestic marketing opportunities are directly connected to the community in which seafood is landed. Furthermore, they indicate that non-direct fisheries roles (*e.g.* processors) provide a greater source of employment than direct fishing. However, opportunities to market locally landed commercial seafood species appear to be limited.

The next questions sought to identify how fishers perceive the importance of ecosystem services to their businesses or sector and how the socio-economic benefits of these are distributed. Seven key ecosystem services were selected for the purpose of this study, which were divided into two categories:

- Socio-economic:
    - Eating fish I catch as part of my diet
    - Financial income
    - Just being at sea or participating in fishing
    - My physical health and my well-being (mental health) when fishing
- Ecological:
    - The condition of seabed habitats (*e.g.* as spawning/nursery areas for fish and shellfish)
    - The abundance of other species (*e.g.* plankton, predators)
    - Changes in sea conditions (*e.g.* currents, temperature)

Respondents were asked to rank the ecosystem services on a scale of 1–4 (for the socio-economic) and 1–3 (for the ecological), where 1 is the ecosystem services they consider most important to them in that category.

These questions were answered by only six of the respondents, of which for question 6, 'financial income' was ranked highest, followed by 'just being at sea…' and 'physical health…', with 'eating fish as part of my diet' ranked lowest. For question 7, respondents ranked 'the condition of seabed habitats' above 'the abundance of other species' with 'changes in sea conditions' ranked as the lowest supporting (environmental) ecosystem service.

The next two questions (7 and 8) explored the respondents' perceptions on how economic benefits of fishing are distributed individually, locally, nationally (UK) and internationally, and the results of this will be discussed in relation to Scottish Government statistics on the contribution of fishing to the Scottish economy. A total of seven fishers responded to these questions, which asked respondents to select the estimated percentage of how economic benefits of fisheries are distributed at each of these four different levels in terms of a) distribution of seafood as food, and b) financial income from fishing (fishers, processors, distributors, etc.), respectively.

The results from question 8 are quite variable and not obviously conclusive due to the small sample size. The responses are also likely to be dependent on the fishers' sector and size of their business. The responses indicate that the estimated percentage of Scottish seafood intended as food distributed within larger markets (national and international) is higher than local distribution. In terms of the distribution of financial income from fishing, the results indicate that relatively more is retained individually or locally.

The final two questions sought qualitative reflections; firstly, on whether respondents felt the distribution of benefits are fair, to which three answered 'yes' and five answered 'no' (two did not answer), and secondly, how this could be improved. Only two respondents directly answered the latter part of this question:

- *Higher numbers of smaller local boats would benefit the individual fishers and the local community rather than large boats that take more fish but require smaller crews overall and do not spend locally*;
- *More help needed by inshore sector to preserve and improve the ecosystem.*

One respondent suggested a reason as to why benefits are currently not fairly distributed: '*fewer people get an opportunity to benefit from fisheries as the industry consolidated into fewer bigger vessels'*.

Finally, in response to the question, 'Have your fishing opportunities/business improved as a result of existing fisheries management and marine conservation measures?' Three fishers answered 'yes' and five answered 'no' (two did not answer). Respondents' were asked to qualify their answers; of these, five offered comments, but one answer was removed as it named specific people and organisations:

- [*Our local*]* *SAC has benefitted all the local shellfish divers, and we have seen an improvement in the diversity and abundance of other species;*
- *More displaced trawlers equates to more gear conflict;*
- *Fishing in the inshore lochs was devastated when the three-mile limit was removed in 1984. There has been a decline of all species since then. Any management measures to remedy this situation have so far been inadequate;*
- *Our opportunities have improved as a result of the recent (within 10 years) imposition of bans on mobile gear in certain areas. We expect further benefits from MPAs in the future.*

*the name of this SAC was given; however it has been removed for the purpose of this study to ensure respondents' anonymity.

4. Discussion

The UK is currently one of the highest exporters of fish and seafood in Europe and one of the main contributors to fishing-related employment and fish processing in the EU (European Commission, 2015). Scotland's fisheries contribute in the majority to that UK contribution. However, the Scottish fishing industry is declining in size and capacity, and with increasing competition from the expanding aquaculture industry (Natale *et al.*, 2013), there are on-going challenges for both fishers and policy-makers. Regulation and management policies must be developed to ensure environmental sustainability, including stock sustainability of commercially important species, and promote a fair and equitable system for sustainable fisheries businesses. This will not only help to satisfy Scotland's commitment to

SDG 14, but also to a number of other SDGs and their targets, many of which relate to the socio-economic benefits and needs of fishers. In October 2015, the Scottish Government announced proposals for a new Inshore Fisheries Strategy[2], commitment to which was affirmed by the Scottish National Party's manifesto commitment for an updated Inshore Fisheries Bill[3] in their 2016 Holyrood Election manifesto and, crucially, the subsequent inclusion of the commitment in the subsequent 2016-17 Programme for Government after they won.[4] It is essential that this new opportunity for Scotland's inshore fisheries is framed within the SDGs and Scotland's international sustainable development commitments to ensure that the environment and the socio-economic needs of the industry can be appropriately taken into account.

4.1 Contribution of ES benefits to Scottish fishers

Despite the limited responses to the survey, some of the qualitative reflections on the current distribution of ecological and socio-economic benefits are relevant. It is apparent that the demographics of coastal [fishing] communities are highly varied in the role of fishing and the number of associated jobs locally. As well as being a historic industry and a cultural inheritance for some, commercial fishing is also a desirable business prospect for new fishers entering into the industry and/or is an important activity to supplement existing forms of income. Additionally, the responses suggest an imbalance in perceived benefits across the fishing industry, with different sectors benefiting from ecosystem services in different ways. For example, one respondent stated that, '*[Our local] SAC has benefitted all the local shellfish divers, and we have seen an improvement in the diversity and abundance of other species'*. This particular SAC (Special Area of Conservation) is one where certain types of mobile demersal fishing gear are currently restricted. It is likely that local mobile gear fishers were displaced when this restriction was introduced and may not have access to equivalent fishing grounds. The results from the rankings on both the socio-economic and environmental benefits indicate that fishers perceive ecosystem services with a more short-term impact on fishing and fisheries (i.e. direct financial income and the health of seabed habitats) to be of higher relative importance to them and their industry.

Existing monitoring measures are currently inadequate to assess socio-economic benefits of conservation and fisheries management regulations in Scotland. Despite recorded increases in size and abundance of scallops within Lamlash bay NTZ (Howarth *et al.*, 2011, 2015), for example, the

[2] http://www.gov.scot/Resource/0049/00494784.pdf

[3] https://d3n8a8pro7vhmx.cloudfront.net/thesnp/pages/5540/attachments/original/1461753756/SNP_Manifesto2016-accesible.pdf?1461753756

[4] http://www.gov.scot/Resource/0050/00505260.pdf

quantification of 'spillover' of scallops into the surrounding area and consequent socio-economic implications remain understudied. Three of the surveyed fishers felt that their respective fishing opportunities had improved as a result of existing fisheries management and marine conservation measures, while five felt that they had not. However, these eight respondents fish in different areas using different gear, which limit the conclusions that can be drawn from these results. Russ *et al.* (2004) suggests that the success of well-managed MPAs will be reduced if local fishers do not support their implementation, which relies on a full understanding of both potential benefits and losses. Accordingly, monitoring should be extended to include catch data at increasing distances from reserve boundaries to be able to distinguish between 'ecological' and 'fishery' spillover (Di Lorenzo *et al.*, 2016). Similarly, identifying fishing patterns outside the management areas will help to understand whether increases in abundance are the result of recovery or displaced fishing effort (Rakitin and Kramer, 1996), and also allow for an improved understanding of potential gear conflicts as fishers move from protected areas into other fishing grounds.

The results of the survey also indicate an imbalance in terms of benefit sharing from landings and access seafood markets. Current markets and management may be insufficient to support equal benefit sharing across different sectors of the fishing industry. Respondents noted that the majority of food - fish or seafood - was distributed to larger markets, both nationally and internationally. Similarly, the survey suggests fishers perceive a lack of local markets to distribute produce, with respondents noting an average of 4 (maximum 10) opportunities to sell locally caught fish to the community. One comment from this survey referred to the need for more small vessels in place of fewer large vessels currently in operation, to increase benefits to individual fishers and the local community. Tedcastle *et al*. (2016, *in prep.*) reported similar comments from Scottish fishing industry representatives, who suggested that local coastal communities should be the primary beneficiaries of fishing activity and conservation measures. Shortening supply chains may ensure small-scale fishers with limited access to international markets have an opportunity to sell locally and, therefore, more directly. Additionally, increasing and improving opportunities to market Scottish seafood as a tourism attraction (*e.g.* The Seafood Trail[5]) could help to expand local market opportunities. Regulating vessel sizes could also help to support more equal access and distribution of benefits among fishers.

4.2 Scotland's approach to fulfilling fisheries' needs through the SDGs

[5] http://www.theseafoodtrail.com/

While SDG 14 is the most directly relevant to fisheries interests, and the focus of this paper, it is important to consider the wider aims of the SDGs, particularly, how Scotland should take a progressive approach to achieve the SDGs, incorporating all aspects of the fishing industry. Table 3 presents a review of Scotland's current progress in meeting its commitments to SDG 14 through the implementation of international and domestic (UK and Scottish) marine conservation and fisheries legislation. It further highlights what progress is still required and reflects on the potential impact to the fishing industry of meeting these targets.

Table 3 goes here

Scotland already has a number of measures in place, or in development, that will contribute to meeting its commitment to SDG 14 in terms of fisheries, conservation, science and research, and wider collaborations. The progression of Scotland's MPA network supports many of the targets and, indeed, protected area coverage in Scottish waters exceeds the 10% required by target 14.5, though management measures for several sites are outstanding. Scotland's National Marine Plan also offers a framework through which to support an ecosystem approach to managing activities within Scottish waters. In terms of fisheries the Plan includes policies to safeguard fishing opportunities in a development context, but does not offer any fisheries management framework. This should perhaps be reviewed as marine planning must consider cross-sectoral and cumulative impacts (see also Rees *et al.*, (2017) and Diz *et al.*, (2017) in the current special issue).

Table 3 highlights there are wider socio-economic factors that can and should be considered in terms of the SDGs delivering benefits for the Scottish fishing industry, and vice versa, which link directly to the SDG 14 targets. As described in section 3.1.1, SDG 13 (climate action) is of crucial importance to Scottish fisheries, as climate change is one of the major environmental factors that may influence fluctuations in fish stock distribution and availability, shellfish health and critical habitats for key life stages of commercial species (Perry *et al.*, 2005; Hollowed *et al.*, 2013; Secretariat of the CBD, 2014). Climate change impacts may increase uncertainty for fishers, particularly if quotas for other less-affected species may not be easily attainable. However, there is little quantified evidence of the impact on Scottish fishing as some of these impacts are yet to be realised. As species range and abundance are likely to alter with changes in climate, monitoring of commercially important species is required as well as facilitated entry and exit from fisheries to promote more equal benefit sharing as fisheries change (Pinsky and Fogarty, 2012; Shelton, 2014). Reducing overcapacity through subsidy reductions for those

fishing unsustainable stocks, allowing depleted fish stocks to recover, as well as protecting habitats from further degradation are critical in building biological resilience to climate change.

In the face of increasing regulation and changing environmental conditions, some fishers and fishing businesses have consolidated or decommissioned. Marine tourism (e.g. wildlife watching tours) has been suggested as a potential form of diversification for boat-owning fishers facing displacement from fishing grounds or other business issues (Scottish Government, 2015). Not all fishers would choose to pursue alternative employment to fishing for various reasons, *inter alia*, '*not wishing to lose a long-standing family history of fishing or not wishing to undertake opportunities such as tourism, due to its largely seasonal nature in Scotland*' (*Pers. Comm., anon*). However, SDG 14.7 does stipulate that countries should strive for the '*sustainable management of fisheries, aquaculture and tourism*', so a possible diversification of fisheries to other such activities may help to achieve this. Either way, this presents a significant dilemma for decision makers.

SDG 8 (decent work and economic growth), particularly targets 8.2 and 8.9 (Table 1), is highly pertinent to Scotland's fishing industry. Fishing vessels and gear must continue to evolve to improve efficiency and sustainability (Walsh *et al.*, 2002), and financial opportunities for diversifying the industry to more sustainable fishing methods should continue or increase (*e.g.* the European Maritime and Fisheries Fund[6]). Although there is now uncertainty around the future of funding arrangements following the UK vote to leave the EU, these kinds of EU subsidies should arguably continue to provide sustainable opportunities for the fishing fleet to develop and for young people to enter the industry, since there are fears within parts of the fishing industry that it is not an employment option that is attractive to young people (Tedcastle *et al.*, 2016, *in prep.*). Similarly, SDG 9 (industry, innovation and infrastructure), particularly targets 9.3 and 9.5, also link with some of the development needs from SDG 8 for the Scottish fishing industry. This should also include access to markets and the equality of opportunities for sustainable small-scale fishers (in line with SDG 14 indicator 14.B.1).

SDG 12 (responsible consumption and production), particularly targets 12.2, 12.3 and 12.7 (see Table 1), recommends ensuring a reduction in food waste and promoting sustainable practices throughout the supply chain. This is a key area of development for Scottish fisheries, particularly given the challenging requirement of the reformed Common Fisheries Policy (CFP) to phase out discarding practices. One policy aspect not mentioned in any of the feedback from fishers surveyed is the CFP 'landings obligation' and how this might affect their business. The Landings Obligation is currently being introduced to the Scottish fishing industry (and the wider EU) via a phased approach, with all species planned to be at minimal or zero discarding levels by 2019. It is anticipated that this commitment, or

[6] http://ec.europa.eu/fisheries/cfp/emff/index_en.htm

similar, will remain irrespective of future constitutional arrangements with the EU. A number of potential issues have been forecast, particularly for small-scale fishers, who make up the majority of the Scottish inshore fleet, and approximately 80% of the European fleet (Veiga *et al.,* 2016). These potential issues include increased economic cost relating to additional requirements, such as handling and storage of catch that cannot be landed, and lack of quotas (Villasante *et al.,* 2016). Whilst the implications of the Landings Obligation and measures to mitigate impact is the subject of extensive research, the potential issues that have been highlighted indicate a conflict between achieving targets 14.4, 14.7 and 14.9, as current evidence indicates that small-scale fishers are likely to be most affected. SDG 16 (peace, justice and strong institutions), particularly targets 16.6 and 16.7 (Table 1), is relevant to Scottish fisheries in terms of anticipating conflict between sectors and with other sea users or stakeholders by improving our understanding of the benefits *vs.* the impacts of conservation and fisheries management measures. It is important to balance this understanding with the contribution of fishers to society and the economy, and to some extent to the environment, and how they benefit in return.

Related to concerns over the local availability of fresh fish and seafood, SDG 2 (see Table 1) should arguably also include fisheries (and aquaculture), since fresh fish and seafood are a hugely valuable source of protein, vitamins and essential fatty acids, much of which are not available in such significant quantities in any other food type. Indeed, there is a growing evidence base that highlights potentially extensive health benefits of consuming fish (Wall *et al.,* 2010; Hossain, 2011). This is important for developing countries where food security is less reliable, but also for developed countries, including Scotland, where diets do not tend to include an appropriate balance of essential fatty acids (Simopoulos, 2004).

5. Conclusions

The availability of ecosystem services and the distribution of socio-economic benefits are of key consideration in fisheries management and wider management frameworks in order to ensure the promotion and continuation of sustainable fishing opportunities, integrated with the conservation of the marine environment on which they depend. The Scottish Government's three-pillared approach to marine nature conservation is relevant here (Scottish Government, 2011). This study has highlighted that consideration of socio-economic benefits to fisheries within management policies can contribute to the delivery of Scotland's commitment to a number of the SDGs. The following points could be considered in relation to evolving fisheries management policies:

- SDG 14's targets are highly relevant to the needs of Scotland's fishing industry, both in terms of mitigating environmental impacts and ensuring socio-economic sustainability. Particular

attention should be given to meaningfully improving the health of marine ecosystems without significantly affecting fishing activity;

- MPAs and wider fisheries management measures should be designed to enable sustainable fishing businesses to benefit directly from ecological gain (*e.g.* spillover effect, potential future access to areas previously closed for conservation purposes).
- Fisheries managers should facilitate greater investment in local markets, seeking to shorten supply chains, and greater community involvement in the management of the marine area;
- The government's intended new Inshore Fisheries Bill should be framed within and seek to contribute to Scotland's international commitment to the SDGs.

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