The Solway Estuary:
a socio-cultural evaluation of a coastal energy landscape.

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Ethical statement

This research has been conducted in accordance with the ethical guidelines of the respective author's institution. The research is original having not been previously published and is the result of the authors' intellectual thought.

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Executive Summary

Seascapes have long been valued by society for many reasons. The introduction of offshore wind farming places a new component in to the seascape structure adding to the ways in which seascapes can be valued. However, the associated physical and experiential change may cause conflict with established socio-cultural, ecological and economic values and perceptions of value. In this report we show that, with respect to the Robin Rigg wind turbine array, issues of climate change and renewable energy technologies residents of the Solway estuary express a pragmatic approach to offshore wind provision.

- Individual expressions of socio-cultural, ecological and economic value reflect connections and dependence, tangible and intangible, between the physical and ecological form of the seascape and the daily activities of coastal communities.
- Connection in this sense is not only place specific but also acknowledges society as a reflexive and purposeful component of a dynamic natural world.
- Change is considered a constant in this dynamic world view. However, participants' views are characterised by thoughts of fairness, where both the costs and benefits associated with actions needed to address climate change are shared equally by society as a whole.

Understanding these relationships requires an approach designed to draw out individual, community, environmental, visual, physical and spiritual dimensions of connections built around place. The explicit inclusion of individual narratives, across a wide range of stakeholders, captures the bond that develops between society and the natural world from a living-in-place perspective and gives voice to expressions of self that articulate;

- environmental connections,
- community connections,
- functional connections, and
- personal connections.

Contents

1. Introduction

This report presents the results of an exploratory review of the relationships between marine-based wind farms, the fishing industry and the coastal community in a case study of Kirkcudbright, South-West Scotland, and the Robin Rigg wind turbine array. A challenge for rural sustainable development is to enable small and relatively isolated communities to remain socially and economically viable by exploiting economic opportunities (Hanley & Nevin, 1999). What does this mean for communities in the Solway estuary with high levels of deprivation, including fuel poverty? Will further wind farm development benefit these communities or might it lead to further deprivation through loss of livelihoods dependent on fishing and tourism?

Large scale renewable energy is the cornerstone of UK government's plans to meet its international commitments to the Kyoto protocol, and contribute to the European Union Renewables Directive. The EU has committed to provide 20% of its energy consumption from renewable sources by 2020. At a national level the UK's legally binding target requires that 15% of energy supply must be delivered from renewable sources by 2020 (Department for Energy and Climate Change, 2011). Meeting this target may require the UK to deliver 40% of its electricity generation from renewable sources by the 2020 deadline, dependent upon the scale of contributions made by the heat and transport sectors. The Scottish Government has further committed for renewable energies to generate the equivalent of 100% gross annual electricity consumption by 2020 (Scottish Government, 2011). As a consequence the use of large scale wind turbine energy technologies is increasing in the UK.

Increasing use of renewable wind technology is not without controversy (Devine-Wright & Howes, 2010; Evans et al., 2011; Devine-Wright, 2011), in the UK this has resulted in a move away from terrestrial wind farms towards marine installations. Within the wind energy sector marine-based wind is expected to become a significant contributor in meeting the UK and Scottish Government targets. If the UK Governments predictions of a 15 to 20GW supply of energy from marine-based wind technologies by 2020 are to be realised, this will require a tenfold increase in capacity, based on 2011 levels of 1.8GW (Greenacre et al., 2010).

Yet given this potential for a continued large scale expansion of marine-based wind the social, environmental, and economic impacts to the existing social and ecological resources and activities within the surrounding areas are still not widely understood (Inger et al., 2009; Gee & Burkhard, 2010). Whilst there is some evidence that marine renewable technologies in general are more readily accepted by the public (Devine-Wright, 2011), there are still significant concerns regarding offshore wind farms. For example, Firestone & Kempton (2007) identified that the *'overwhelming majority of the population expects negative impacts'*, these perceptions cover a wide range of socio-economic and environmental concerns. Licht-Eggert et al. (2008) describe a considerable drop in institutional and stakeholder support for offshore wind farms in coastal communities when compared to regional and national levels.

2. Background

The spatial effects of wind farm construction inevitably lead to physical changes of the marine environment over a range of spatial scales. Previous reviews have characterised the associated consequences of these changes as potentially both advantageous and disadvantageous. Specifically focus becomes placed on issues of composition and structure, place identity and dependence, proximity and displacement associated with the perceptual and physical consequences of spatial change. Socio-economic issues include cultural and aesthetic values, shaped by sense of place, place attachment and identity, and the on-shore and offshore economic activities of coastal communities that include fishing and tourism industries (Devine-Wright & Howes, 2010; Gee & Burkhard, 2010; Firestone & Kempton, 2007; Mackinson et al., 2006; Scottish Government, 2008; Lilley et al., 2010).

Environmental issues are principally described around the creation of *de-facto* marine protected areas through the exclusion of fishing activity and the introduction of hard substrates in areas characterised by soft sediments (Petersen & Malm, 2006; Ashley et al., 2014; Börger et al., 2014). Focus is placed on the creation of artificial reef systems within areas of fishing exclusion with the potential for enhancing biodiversity levels, leading to consequent 'spillover' improvements in catch potential outside of these protected zones (Inger et al., 2009; Wilson et al., 2010; Hooper & Austen, 2014; Vandendriessche et al., 2014). However, access to any beneficial fisheries effects due to 'spillover' may be further complicated by the combination of fishing activity displacement and gear-specific usage conflict (Campbell et al., 2014).

In the UK, coastal communities have a long and sustained tradition of artisanal and commercial fisheries. These communities understand the importance of the socio-cultural, ecological and economic values associated with their links to the marine environment (Mackinson et al., 2006). This shared history has established long standing connections between coastal seafaring communities, adjacent terrestrial communities and the marine ecosystem. Biophysical and perceptual change in the marine environment will have an impact on and consequences for the communities that live in and depend upon this

environment, but how communities respond to these changes will also have reciprocal impacts on the marine environment (Cheng et al., 2003; Ian Perry & Ommer, 2010). The multi-faceted, interconnected and interdependent nature of socio-cultural, ecological and economic values characterise an integrated coastal lifescape.

Development of the marine environment as an energy landscape needs to consider the interconnected nature of seascapes as complex social-ecological systems (Berkes & Folke, 1998). However, the ecological components of marine systems are usually studied independently of the societal components (Ian Perry & Ommer, 2010) despite knowledge of how the interconnected and interdependent relationships between natural resource, ecosystem goods and services and human well-being are considered crucial for sustaining human activities (Balmford et al., 2008; Ian Perry et al., 2010). Current methods employed to assess the impacts of renewable energy development, which inform the sustainability policy-decision making debate, fail to fully take account of the complex nature of ecological, socio-cultural, and economic value interactions (Symes & Phillipson, 2009; Ian Perry et al., 2010; de Groot et al., 2014). Research on these relationships is a key driver within the context of environmental sustainability and natural resource management agendas.

3. Study Area

3.1 Robin Rigg Wind Turbine Array

The Robin Rigg wind turbine array, the first commercial offshore wind farm in Scottish waters, is situated in the Solway estuary, mid-way between the Galloway coast, South-West Scotland, and the Cumbrian coast, North-West England (Fig 1). The centre of the turbine array is approximately 11 km from the Dumfries and Galloway coastline and 13.5 km from the Cumbrian coastline. With a generation capacity of 180MW the Robin Rigg wind farm is the largest in Scotland, consisting of 60, 125 m high, V-90 3MW Vestas turbines (E.ON, 2014). Each turbine is supported on a monopile foundation which typically extends 30 to 40 m into the sea bed, in shallow waters of between 4-13 m deep (4C Offshore, 2014).

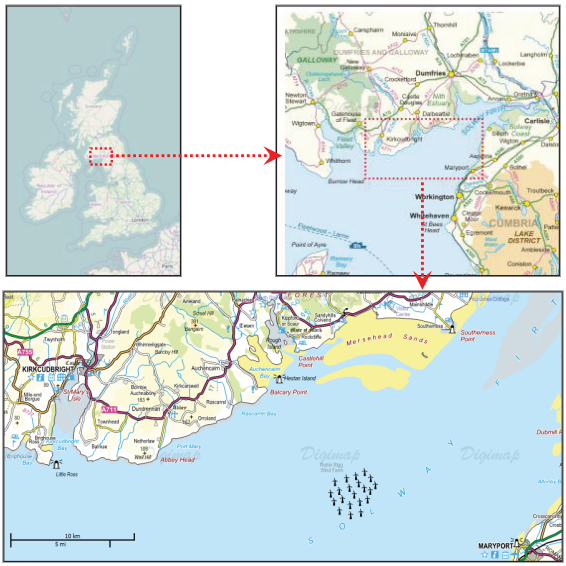

Figure 1 Location of Kirkcudbright and the Robin Rigg wind turbine array in the Solway estuary, South-West Scotland (Map images. © Crown Copyright and Database Right 2015. Ordnance Survey (Digimap Licence)).

Construction began in September 2007, turbine installation was completed in Aug 2009, and the first power generation was in September the same year, with the site fully commissioned in Apr 2010 (4C Offshore, 2014). Total project value

for the development, manufacture, construction and installation phases was £381 million, of which 37% was won by UK companies, but only 0.2% of the total contract value was received by the Dumfries & Galloway region (BVG Associates, 2011). Whilst the turbines sit within the Scottish side of the Solway estuary both the onshore grid connection and the Management & Operations base are situated in Cumbria, England (BVG Associates, 2011). The electricity currently generated by Robin Rigg has brought about a consequent reduction of 257,000 tonnes of CO2 emissions per year (4C Offshore, 2014).

Recent results of the statutory marine environmental monitoring found no significant or lasting impacts on birds, mammals and benthic fauna during the construction and post construction phases (Natural Power, 2014). The impact of wind farms on tourism in the Dumfries & Galloway region has been valued as a decrease in tourist related expenditure into the regional economy of 1.72%, or £6.17 million per year (Scottish Government, 2008). Whilst this study did not differentiate between attitudes to land-based and marine-based installations, the vast majority, 93-99%, of visitors suggest that the experience of seeing a wind farm would not have any effect on future visits to the area (Scottish Government, 2008).

Robin Rigg is located in an area traditionally associated with fishing industries, and related local industry such as oyster farming and cockling. Plans to build further off shore wind farms in the Solway estuary are at the consultation stage, and are opposed by the local coastal communities:

- *'Tourism, farming and fishing are regarded as the most important economic activities we have in this area..... and concern expressed about the effects of renewables development on the tourism and fishing industries in particular'* (Marine Scotland, 2014).
- *'The proposed additional wind farm adjacent to Robin Rigg is considerably larger than the existing site and would without doubt drastically affect tourism in the area recognised nationally and internationally for its outstanding scenery'* (BBC News, 2013).
- *'Community benefit is seen as a key issue and should be maximised as far as possible.....if the Robin Rigg extension is to proceed, the cable should*

come into the Scottish side and economic benefits should go to Scottish Communities' (Marine Scotland, 2014).

3.2 Kirkcudbright, Dumfries and Galloway, SW Scotland

Kirkcudbright sits within the the Dumfries and Galloway fisheries area of the Solway estuary, the fishing industry within Dumfries and Galloway is dominated by the shellfish fisheries (Dumfries & Galloway FLAG, Undated). Marine Scotland (2013) statistics for 2012 show a total Scottish shellfish catch of 69,000 tonnes; scallop landings account for 20 per cent of the value and 25 per cent of the volume of all Scottish shellfish landings. Kirkcudbright harbour handled more than 6,000 tonnes representing a value of over £3,000,000, making the harbour the largest for scallop catch landings in the UK (Cappell et al., 2013). Shellfish fisheries contribute over 95% of the harbour's total catch value with scallop (*Pecten maximus*) and queen scallop (*Aequipecten opercularis*) the most financially important species accounting for over 80% of the annual catch values, lobster accounts for 10-15% of the annual catch values (Dumfries & Galloway FLAG, Undated). Other important fisheries include the static gear fishery for crab and whelk.

The Kirkcudbright fleet of scallop fishers and associated operations comprises of up to 14 boats each employing 4 to 8 crew members, boat repairers, two scallop gear manufactures and the scallop processing plants (Dumfries & Galloway FLAG, Undated). A large proportion of the Kirkcudbright scallop fishing fleet has close links with or is owned by key local processors (Cappell et al., 2013). The importance of the shellfish industry to local employment was further enhanced by European Fisheries Fund monies contributing to capital investment of more than £2,000,000 for shellfish processing operations in 2010 and 2011 (Marine Scotland, 2012a; Marine Scotland, 2012b).

4. Materials and methods

In this report we make use of fisheries related statistics and individual interview data to characterise the lifescape within which relationships between marine-based wind farms, the fishing industry and the coastal community are described.

4.1 Fisheries Data

This report uses the geographical divisions defined by the International Council for the Exploration of the Seas (ICES) to assign fisheries statistics, as provided by Marine Scotland Fisheries Statistics, to describe fisheries related data for the area within which the Robin Rigg wind turbine array is situated. For the purpose of data analysis this area corresponds with ICES rectangle 38E6. Landings into the Kirkcudbright harbour will be taken from a wider area but will also include those from the ICES rectangle in which 'Robin Rigg' is situated.

4.2 Interview Data

Interviews were undertaken with participants whose lives and livelihoods are dependent upon the Solway estuary. Interviewee selection was directed by day-to-day activities and family histories that describe connection with the fishing and tourist industries that operate along the Scottish Solway coast. One to one interview data expressed personal views regarding physical, perceptual and experiential change associated with the physical presence of the Robin Rigg wind turbine array. Participants were selected to describe a range of individual relationships with the Solway estuary through the activities of employment and livelihoods (Table 1). Categorisation of activities are based on the following; fishing – activities directly and indirectly related to the fishing industry based on the north Solway coast; tourism – provision of holiday accommodation and touristic activities along the north Solway coast; recreation – business involved in the provision of amenities for daily recreational activities in the north Solway estuary and along the coast; public – employed by local government; private – private enterprise owned and operated by local residents.

Table 1 Overview of interviewee day-to-day relationships with the Solway estuary and coast.

	Activity/Business/Organisation				
Participant	Fishing	Tourism	Recreation	Public	Private
001	X			X	X
002	X			X	
003		X	X		X
004	X				X
005			X		X

To maintain continuity of subject matter, a series of open questions followed a pre-set format. However, in providing answers the participants were free to explore their own relationships with the question content building a personal narrative. Subject matter covered landscape composition and aesthetics, employment, fishing and touristic activity, general attitudes to renewable energy and the potential for expansion of Robin Rigg. Individual expressions of place connectedness and emotional bonding were described through perceptions of place identity, place dependence, sense of place and sense of loss.

4.3 Analysis

4.3.1 Fisheries Data

Marine Scotland Fisheries Statistics are used to describe two distinct periods; pre-wind turbines, 2001 – 2007 and post-wind turbines, 2008 – 2013. Fishing effort, employment and landings (volume and value) data are described for the 2001 – 2013 period. Landings data informs the description of species caught, high volume and high value species. Mann-Whitney U-tests explored difference between patterns of landings, fishing effort, and employment data associated with the two described time periods.

4.3.2 Interview Data

Broad thematic grouping of the interview data describes socio-cultural value based on personal expressions of the physical, perceptual and experiential relationships associated with the physical presence of Robin Rigg. Qualitative details from participant narratives are used to characterise socio-cultural relationships from a living in place perspective. These interview data are presented within the discussion providing support for and/or counter point to

selected elements taken from the literature and the quantitative fisheries related component of this study. This approach brings together difference in the scale of observation were the objective, quantitative data selects a narrow, specific focus whilst the subjective, qualitative personal narratives present a wider spatial and temporal view of relationships on the Solway estuary.

5. Results

5.1 Fisheries Data

Fisheries data for the period 2001 – 2013 demonstrate the dominance of shellfish landings from the 'Robin Rigg' ICES rectangle (Fig 2). Shellfish volume and value data describe catch species (Tables 2 & 3). High volume and value species are indicated as contributing at least 25% to total landing volume and value in any one year. Brown shrimp, cockles, mussels, nephrops and whelks are described as high landing volume and value species. Fishing effort and employment data for the study period, 2001 – 2013, are presented in tables 4 and 5. Catch volume and value data, by species, informs price per tonne descriptions, primary catch species are categorised based on a monetary metric; high value>£2k tonne^{-1}, mid value £1k - 2k tonne^{-1}, and low value<£1k tonne^{-1}.

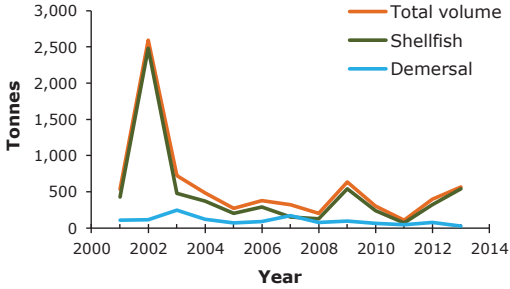

Figure 2 Landings volume 2001 – 2013 for the 'Robin Rigg' ICES rectangle 38E6.

The top 5 species by total landings volume and value are categorised as: high value species – nephrops, brown shrimp; mid value species – cockles; low value species – whelks, mussels. Other categorised species, calculated from landings data, include: high value species – lobster; mid value species – scallops; low value species – queen scallops (Fig 3). Mann-Whitney U-tests for difference between pre wind turbines, 2001-2007, and post wind turbines, 2008-2013, identified significant differences across shellfish landings, fishing effort and employment data (Tables 6 & 7).

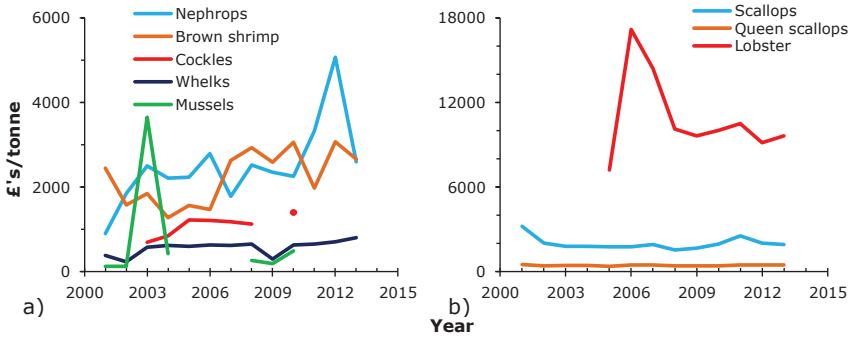

Figure 3 a) Top 5 landings by total volume and value; high value species (>£2k tonne $^{-1}$) nephrops, shrimp; mid value species (£1k - 2k tonne $^{-1}$) cockles; low value species (<£1k tonne $^{-1}$) whelks, mussels. b) Other caught species £'s tonne^{-1} calculated from landings data; high value species – lobster; mid value species – scallops; low value species – queen scallops

Pre-and post- wind turbine periods are characterised by general patterns across landings, fishing effort and employment data. An increase in landing volumes for high and mid value species is suggested through the pre-wind turbine period which changes to one of increasing volumes for the low value species in the post-wind turbine period. Brown shrimp, a high value species, is described by declining volumes over both periods.

Whilst total effort and trawl effort are characterised by decreasing values in both pre and post wind turbine periods, levels of disclosive fishing effort indicate an increasing trend over the post-wind turbine period. Employment data describe an increasing trend for the D&G based fisheries industry, which is set against a decreasing trend for employment in the Scottish fishing industry, the general D&G labour force, and the general Scottish labour force in fishing regions.

Table 2 Shellfish landings volume (tonnes) 2001 – 2013; data taken from the Marine Scotland Fisheries Statistics. High volume species contribute ≥25% (highlighted yellow) to total landing volume in any one year.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Brown Shrimps	62.3	41.6	51.1	16.6	31.3	8.8	11.6	38.9	3.3	6.6	17.0	0.4	3.8
Cockles			37.9	27.4	34.9	77.8	32.7	4.1		49.7			
Crabs (C.P.Mixed Sexes)						2.2	4.6	4.8	0.1	0.04	1.1		
Crabs - Velvet (Swim)							0.03	0.02					
Cuttlefish								0.002	0.001				
Lobster					0.0	0.9	2.9	2.1	0.2	0.6	1.3	0.1	0.0
Manilla clam										3.7	0.2		
Mussels	300.0	2360.0	262.7	110.2				18.4	83.0	13.6	20.4	0.3	
Nephrops (Norway Lobster)	24.4	6.0	10.4	14.3	6.6	6.2	30.3	9.1	3.8	20.3	52.0	8.3	2.4
Queen Scallops	13.0	50.6	18.7	58.1	1.4	3.1	0.2	7.4	9.0	0.9	0.3	21.6	15.0
Scallops	0.0	14.3	3.6	30.0	18.4	0.7	7.9	11.3	0.6	1.3	2.9	6.6	0.9
Spider Crabs						0.02							
Squid									0.1				0.01
Whelks	25.9	0.01	84.4	111.0	7.4	0.2	9.7	3.8	0.01	3.2	4.6	62.7	77.8

Table 3 Shellfish landings value (£'s) 2001 – 2013; data taken from the Marine Scotland Fisheries Statistics. High value species contribute ≥25% (highlighted yellow) to total landing value in any one year.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Brown Shrimps	152,382	65,714	94,310	21,282	98,215	37,134	45,718	143,933	46,830	48,073	22,228	3,665	55,314
Cockles			26,395	23,248	85,937	272,622	57,943	5,823		166,251			
Crabs (C.P.Mixed Sexes)						23,525	13,000	19,566	532	76	629		
Crabs - Velvet (Swim)							51	129					
Cuttlefish								4	2				
Lobster					12	45,681	63,262	26,596	9,464	14,646	9,377	2,814	1,235
Manilla clam										1,782	312		
Mussels	38,700	304,440	958,160	47,098				6,100	86,365	15,989	5,060	322	
Nephrops (Norway Lobster)	22,032	11,091	25,971	31,577	29,687	49,872	80,921	29,101	47,946	108,910	114,423	134,712	34,014
Queen Scallops	6,552	20,860	8,149	25,942	992	4,131	134	3,738	19,636	865	96	32,325	38,702
Scallops	58	28,838	6,426	53,915	65,298	3,651	22,924	22,234	5,242	6,018	4,928	42,793	9,920
Spider Crabs						27							
Squid									1,033				120
Whelks	10,009	2	48,529	68,192	8,926	416	9,029	3,134	17	4,863	2,004	141,178	336,381

Table 4 Fishing effort data 2001 – 2013 for ICES rectangle 38E6; data taken from the Marine Scotland Fisheries Statistics. Notes on effort data; fishing effort is a measure of the fishing activity of vessels including the time spent travelling to fishing grounds as well as the time spent fishing; effort data covers voyages by UK over 10 metre vessels only; disclosive days represent those days in which less than five over 10 metre vessels undertook fishing activity.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Annual Total Days	630.0	342.4	847.3	544.4	670.0	504.7	417.1	498.4	409.1	311.0	277.3	351.4	461.4
Trawls Days	568.2	275.4	687.9	388.1	570.1	338.4	332.1	473.0	346.4	264.2	267.8	250.0	275.3
Gear type disclosive days	61.8	67.0	159.5	156.3	38.2	2.2	38.5	4.0	62.6	46.8	9.5	77.2	165.5

Table 5 Size of labour force in Dumfries & Galloway and Scottish fishing districts 2000 – 2013; fishermen and general employment, data taken from the Marine Scotland Fisheries Statistics.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total D&G employed in fishing	292	253	99	79	190	195	212	163	171	194	162	233	225	273
Total D&G labour force (1,000)	65	62	62	75	69	66	70	70	70	70	68	63	63.5	65
Fishing based employment in fishing districts	6,902	6,637	5,795	5,276	5,275	5,155	5,205	5,424	5,448	5,409	5,218	4,996	4,747	4,992
Scottish labour force in fishing districts (1,000)	1,437	1,459	1,164	1,165	1,177	1,158	1,189	1,238	1,244	1,231	1,218	1,246	1,256	1,204

Table 6 Results of Mann-Whitney U-tests to describe difference in volume of landings, fishing effort and employment between pre-wind turbines (2000-2007) and post-wind turbines (2008–2013) periods. Yellow highlighted values identify statistically significant difference.

	Mann-Whitney U	Z	*p* value
Total landings	14.00	-1.000	0.317
Shellfish landings	17.00	-0.571	0.568
Brown Shrimps	7.00	-2.000	0.046
Nephrops (Norway Lobster)	18.00	-0.429	0.668
Cockles	4.00	-0.387	0.699
Whelks	16.50	-0.644	0.520
Mussels	0.00	-2.449	0.014
Lobster	8.00	-0.258	0.796
Scallops	14.00	-1.000	0.317
Queen Scallops	17.00	-0.571	0.568
Annual Total Days	6.00	-2.143	0.032
Trawls Days	7.00	-2.000	0.046
Gear type disclosive days	21.00	0.000	1.000
D&G fishers/D&G labour force	19.00	-0.645	0.519
Scottish fishers/Scottish labour force	3.00	-2.723	0.006
D&G labour force/Scottish labour force	17.00	-0.904	0.366
D&G fishers/Scottish fishers	15.00	-1.162	0.245

Table 7 Median values of statistically significant variables

	2001-2007	2008-2013
Volume of brown shrimp (tonne)	46.35	6.57
Volume of mussels (tonne)	281.30	18.37
Annual fishing effort (days)	544.40	380.20
Annual trawl effort (days)	388.10	271.60
Scottish fishers in Scottish labour force of fishery regions (%)	45.29	43.32

6. Discussion

In this section of the report interview data in the form of personal narratives are introduced. These data are set in the context of a lifescape permeated by fishery activities characterised in section 6.1. The combination of personal narrative and fisheries data help characterise socio-cultural, environmental, and economic relationships associated with the Robin Rigg wind turbine array, the coastal community around Kirkcudbright and its associated fishing industry.

6.1 Environmental Connection

Personal narratives describe the clear connections to change felt through difference in the physical composition of the Solway estuary seascape. Initially a visual perception to change is described, a realisation of the physical change in landscape which appears to diminish with distance.

> '*There is a visual change* [negative] *from some parts of the coast. We* [Brighouse Bay] *are fairly far out and not effected by it* [Robin Rigg] *as much as if it were closer* [Robin Rigg]*' (R003)*

> '*We* [Isle of Whithorn] *are situated at the extremes of any visual impact' (R001)*

An appreciation of experiential change in estuary structure and function, due to the physical presence of Robin Rigg, is described by suggestions of sandbank movements and fishing restriction with the potential for an impact on fishing opportunities.

> *'Robin Rigg being there has altered the structure and characteristics of the sandbanks in the estuary. For forty years prior to it* [Robin Rigg] *being here the estuary was steady, now it is changed. The depth of water* [around the sandbanks where Robin Rigg is situated] *used to be shallow, a drying sandbank, but now it is much deeper. We now have sandbanks that weren't here.....since the construction* [of wind turbines] *there has been movement of the sandbanks which will have displaced benthic communities'....." (R004)*

> *'Yes there has been change, there were skate* [fishing] *grounds there* [Robin Rigg] *they are not used any more' (R002)*

> '*There used to be a skate fishery on the Robin Rigg banks and shrimps in the gullies alongside the sandbanks' (R004)*

> ' *.....people on the other side* [England] *blame it* [Robin Rigg] *for silting up Silloth harbour' (R005)*

Expressing an awareness of the interconnected and interdependent nature of environment and fishery related activity respondents acknowledge the consequent potential for ecological change.

> *'Any disturbance from the construction phase will be offset by the fact that fish are not taken there now' (R002)*

> *'I don't know what the marine effect will be. I presume there would be some change because they* [fishermen] *can not get access to it [*Robin Rigg*]' (R003)*

> *'I think it has not had too much of a negative effect on fish but shellfish is different. Cockles need a certain type of sediment to live, not hard, sharp sand they need more of a muddy, watery sand. Now the cockle beds are covered in a hard sand crust in many places. It is the same type of sand that used to be on the Robin Rigg sandbanks. I can not say for sure that building the turbines has resulted in the sandbanks moving but I think it has' (R004)*

> *'There will be a negative impact on the seabed and water quality from the construction phase. The exclusion of fishing removes the 'farming effect' where mobile gear churns up feed sources in the same way ploughing land turns the ground over. The loss of this may have a negative impact for species' (R001)*

6.2 Community Connection

Secondary data related to levels of fishing activity for the 'Robin Rigg' ICES rectangle reveals difference between the pre-wind turbine period, 2001-2007, and the post-wind turbine period, 2008-2013. Both the total fishing effort and number of trawl days show a reduced number of fishing-based days during the post-wind turbine period. The suggested reduction in fishing activity, within the 'Robin Rigg' ICES rectangle, is further supported by an increasing trend in fishing days described by a disclosive nature, days where fewer than five vessels are operating. Whilst total catch and shellfish volumes did not exhibit significant difference between the two described periods, changes in catch trends for shellfish species add detail to an altered pattern of fishers activity which may be associated with the construction and operational periods of the Robin Rigg wind turbine array, when compared with the pre-wind turbine period. Landings and effort data describe a pattern of cessation, reduction or displacement of fishing effort with consequent changes to species catch volumes.

Difference in catch pattern is described statistically by reduced volumes of brown shrimp. These data suggest a relationship between reduced trawl effort and decreasing volumes of brown shrimp caught, which ultimately leads to thoughts of cause. In a 2012 North West Inshore Fisheries and Conservation Authority report (NWIFCA, 2012) catches of brown shrimp in the English side of the Solway estuary were anecdotally described as '*abysmal*'. Solway shrimp fishers, based on the English coast, blamed changes in weather with long periods of heavy rainfall adversely affecting the salinity of water in the shallow areas were shrimp are usually caught (NWIFCA, 2012). Reactions to the potential for change to the shellfish fisheries on the Scottish side of the estuary further reflect this wider, whole system view of the Solway where not only the influence of Robin Rigg may be felt but also recognising the Solway as a constituent of much larger regional and national systems.

> *'They have not stopped us fishing in the estuary. There used to be a skate fishery on the Robin Rigg banks and shrimps in the gullies alongside the sandbanks. I also think we could operate a razor clam fishery out there but restrictions on mechanical dredging to protect the cockle beds mean we can not fish the razors.*
>
> *The trouble is it is all connected, for instance prices in the Dutch market also had an effect on shrimp fishing here. All of it comes together as one big system with knock-on effects and Robin Rigg is a part of that now' (R004)*

This altered pattern of fishery activity is set against the backdrop of an observed increase in regional fisheries related employment, which itself is not a reflection of national fisheries related employment. The number of people employed in the Scottish fishing industry, as a percentage of the total work force in fishing regions, was significantly lower in the post-wind farm period. Conversely, regional fishery-based employment, during the post-wind turbine period, is characterised by increasing trends. The numbers of D&G fishers represent an increasing proportion of the overall D&G labour force and also overall Scottish fishers employment, at a time when the D&G labour force is declining in size as a proportion of the Scottish labour force in the fishing regions.

Whilst previous studies have identified issues related to displacement of fishing effort and the proximity of wind farm installations, many studies tend to focus

on the potential for benefit from the creation of *de-facto* marine reserves by exclusion and restriction, with the associated possibility for improved fishing performance from a 'spillover' effect (Inger et al., 2009; Wilson et al., 2010; Hooper & Austen, 2014; Vandendriessche et al., 2014). Environmental monitoring programmes that cover the operational phase of wind farms have yet to detect any significant or lasting change in community structure, species abundance or diversity during the first years of operation (Wilson et al., 2010; Degraer et al., 2012; Lindeboom et al., 2011). In this respect environmental monitoring of Robin Rigg has not demonstrated any difference (Natural Power, 2014). The evidence for a beneficial 'spillover' effect has in the main been inferred from previous studies of Marine Protected Areas and has yet to be similarly associated with wind farms (Beukers-Stewart et al., 2005; Wilson et al., 2010; Vandendriessche et al., 2014). Issues such as time, or rather lack of time, for any beneficial affect of fishing exclusion to become apparent, the relatively small area of individual wind farm constructions, and the propensity for natural temporal and spatially variability can influence findings (Berkenhagen et al., 2010; Vandeperre et al., 2011; Natural Power, 2014).

However, potential also exists for an actual or perceived 'displaced activity' influence to be felt across multiple marine and coastal users and objectives (Berkenhagen et al., 2010; Gee & Burkhard, 2010; Lilley et al., 2010; Ramos et al., 2014). Reflection on the potential for social consequences attached to the physical presence of marine-based wind turbines and the consequent displaced fishing activity should also be considered. The significantly lower level of trawl related fishing effort suggests altered patterns of trawl activity; fishing vessels involved in trawling may now be operating within different areas. Displaced fishing effort can potentially lead to gear conflict where the increased competition for space can bring mobile towed gear users into close proximity with the static gear of potters and whelkers (Blyth et al., 2002; Campbell et al., 2014). Displaced fishing effort has been reported to reduce incomes due mainly to increased fuel costs moving to new, often more distant fishing grounds with an associated increase in fishing voyage duration (Mangi et al., 2011). The effects due to displacement are felt more by mobile gear users as they are forced to move, whilst static gear users are more often impacted by increased

levels of gear conflict brought about by the displaced mobile gear users (Blyth et al., 2002; Mangi et al., 2011).

6.3 Functional Connection

Community-based narratives describe a Solway estuary fishery that has not experienced significant change, positive or negative, in relation to the physical presence of Robin Rigg. Experienced through the day-to-day activity of making a living along the Solway estuary, where fishing and tourism represent an important source of employment, the impact of Robin Rigg is characterised as being small. Fishing activity attributed to the north coast fishers, in the main, occurs further west. The creation of a *de-facto* exclusion zone may have removed small amounts of activity related to the skate and shrimp fishery.

> *'The type of fishing that may have been influenced is not carried out here* [Kirkcudbright] *or on the north coast..... The south coast* [English] *shrimp fishers may have felt a greater impact' (R002)*

> *'They* [fishermen] *may have been restricted a little but the Kirkcudbright fishermen fish all around the Scottish and Isle of Man coast' (R003)*

> *'Perhaps you could say the skate fishing has been affected' (R004)*

The exclusion of fishing around the sandbanks on which Robin Rigg is located has not resulted in issues of displacement and gear conflict nor have any of the potential benefits from a 'spillover' effect been observed.

> '[Displacement] *Not here* [Kirkcudbright]*, Whitehaven, Maryport may be – flat fish, plaice, sole'* (R002)

> *'We* [fishermen] *are all in it together. We have a local arrangement that works to avoid this kind of problem* [gear conflict]. *A voluntary code of conduct operates across the estuary. Occasionally there are issues but they are very infrequent' (R001)*

> *'Any effect* [from spillover] *is more likely to have a positive effect on fish, not shellfish, but I'm not sure' (R001)*

> *'There has been no evidence to date* [of spillover effect]. *Have you ever been out there* [Robin Rigg] *it is a very harsh environment' (R002)*

Respondent's sense of change to the tourist industry is one of little or no decrease in the numbers of visitors coming to the north Solway coast. The potential for change to the visitor experience can not be commented upon in this study.

> *'This coast is very dependent on tourism. It* [Robin Rigg] *has not changed visitor numbers, I don't think so, opposite Auchencairn in the 'honey pot' areas it* [Robin Rigg] *may have' (R003)*

> *'My sense is that there is not less people coming to visit the area but the presence of Robin Rigg could have a negative impact on the tourist experience' (R001)*

Expressed in terms of employment, Robin Rigg has been described as 'disappointing' for the area. Whilst a negative influence on regional fisheries based employment does not appear to have been felt by coastal communities, there has not been any local evidence for an increase in employment related to the offshore or on-shore activities of Robin Rigg.

> *'There has been no change, which means no benefit. Employment creation has been zero. Are shellfisheries suffering because of Robin Rigg? Yes, but proving it I don't think I can do that. If you consider the sandbank changes are because of Robin Rigg, then changes in sediment on the banks that have resulted in changes to cockle beds would mean yes' (R004)*

> *'Very little effect, it may have been different if the services came to the north' (R002)*

> *'There has been no change. There is the community fund but it is not big enough to create real employment. Most of that kind of benefit seems to go South' (R005)*

Typically reviews such as this seek to describe relationships using secondary data taken from ICES rectangles which cover an area of 30 nautical miles x 30 nautical miles, whilst statutory environmental monitoring is undertaken at the level of the wind farm and the adjacent area. Each provide equally relevant detail from differing scales covering different perspectives, but importantly when brought together they highlight the linked social and ecologically components of an integrated coastal lifescape. The physical presence of the Robin Rigg wind turbine array has the capacity to influence coastal communities as well as cause ecological change. The consequences of displaced fishers activity and increased cost are also experienced, or perceived, by the on-shore community of the fishing industry, fish merchants and processors (Mangi et al., 2011).

Additionally, on-shore communities are also aware of the structural presence of wind turbines through their visual impact on tourism-based industries, where a negative influence is expressed as a decrease in tourist related expenditure (Scottish Government, 2008).

6.4 Personal Connection

The sections above highlight the connected nature of the Solway estuary lifescape from a community-based socio-economic value perspective supported by an assessment of ecological quality. However other key values are likely to experience perturbation due to the introduction of a new seascape component. Gee and Burkhard (2010) discuss the impacts to cultural ecosystem components from off-shore wind farm construction, advocating the addition of these intangible values to a holistic assessment of seascape communities in the context of offshore wind farm development. This approach reflects the connections and dependence, tangible and intangible, between the fundamental physical and ecological form of the seascape with the associated activities and relationships created between coastal communities and their surroundings. In the connection of self to the specific physical setting of place the nature of change in a dynamic lifescape is recognised.

> *'Rivers and estuaries are changing places, change is a part of this kind of environment..... My feelings have not changed definitely not, categorically not. The estuary is a living place continually utilised by humans and has been like that for many, many years and will change again in the future' (R002)*

> *'Everything is linked with knock on effects' (R001)*

The experienced nature of change is accompanied by a difference based on perspective; change is perceived through both a temporal and spatial lens. Thoughts of distance, in time and space, are used to characterise a personal sense of connection to the dynamic nature of seascape.

> *'The estuary view is not as aesthetically pleasing as it use to be, and the effect is greater the closer you are' (R001)*

> *'Unless you are opposite* [the wind turbines] *then it hasn't* [changed], *but I don't want to walk the estuary seeing them* [wind turbines] *knowing they could be causing damage. I also feel guilty about feeling like that' (R003)*

> *'You can be terribly 'not in my back yard' about them but you have to except some* [because of climate change]. *But they have to be in the right place, they should not interrupt iconic views' (R003)*

> *'My experience of the estuary has not changed. More often people who have moved in to the area for retirement are more vociferous about it* [change of experience]' *(R002)*

Connection in this sense is not only place specific but also represents society as an active participant in a dynamic natural world.

> *'When looking at it* [Robin Rigg] *there is a sadness. Intellectually there is a feeling of 'not in my back yard' but we know that you have to share the pain, share the costs* [emotional] *of moving away from a carbon-based energy future. Every part of society should' (R003)*

> *'The Solway has been and always will be changing and Robin Rigg has not altered* [our] *dependence on it. Change is a part of the seascape' (R002)*

The personal nature of this relationship comes to the fore with respect to additional interest and observation from outside agency.

> *'Are we watched more? Many more groups now seem to have a say on what we do and what we know. There are more people looking. Robin Rigg can be used as a cause by people who know little about this area, fishing and the communities' (R004)*

When participants are asked to reflect on change to the meaning and emotional bonds developed between the Solway estuary and themselves, the nature of relationships built and held over time measured in lives and generations rooted in place are expressed.

> '*Robin Rigg has not changed how I feel about this place* [Brighouse Bay], *my forbears came here in the 1640's' (R003)*

> *'It is just another change in a changing environment. I accept it for what it is and I have a very strong feeling for the estuary, I have lived here all of my life ' (R002)*

A connection that, when approached from the perspective of lives and livelihoods, accepts the dynamic characteristics inherent in thoughts of a relationship described in terms of lifescape. Society in this sense is considered a reflexive and purposeful component of a natural world.

'*I don't think it has* [changed my sense of place], *I'm not upset by them* [wind turbines]. *Would I rather they weren't here? I think we need them if you take climate change seriously. You can see the effects of climate change in the estuary, we are now getting increasing numbers of sea bass. We get a lot up here now, and that can only be because the water is warming' (R004)*

'You can't always tell what will happen, look at the railways. Railways did more harm than these turbines. When the railway came shipping as a way of moving goods in and out of the area stopped and activity at the harbour [Kirkcudbright] *changed because of it. Others benefitted, a thriving mussel trade in Kippford used the railways extensively to get mussels to market. But then when the local railways were closed, in 1965, the mussel trade completely stopped and has never returned' (R002)*

But the physical change, when viewed in the present, can also be expressed by a sense of loss. Personal feelings about specific settings and emotional connections to shared interests capture the connection that develops between society and a natural world from a living-in-place perspective.

'The introduction of something that is not characteristic of the surroundings changes it [sense of place], *they* [wind turbines] *are structures that you would not normally expect to see. The coastal landscape is different; the wind turbines are out of character not a natural thing' (R001)*

'Yes, you miss all the fishermen. There used to be many shrimpers out there [Portling] *and at low tide we'd all come in-shore, have a cup of tea and catch up with each other before everyone went back up the estuary on the in-coming tide' (R004)*

However with respect to climate change, renewable energies and the position of society as an agent of change participants express a pragmatic approach. Views are grounded in an equitable consideration where costs and benefits of the need to address climate change should be shared by society as a whole.

'Anybody who thinks seriously about climate change has to except something' (R003)

'Nobody can be against it [renewable energy], *it's one of the ways forward. Maybe wind turbines are the wrong way, we should be using the tides. But the technology has to be used in order to try things out, make improvements and move things forward' (R002)*

'It [Robin Rigg] *doesn't bother me but I believe they [*wind turbines*] have economic and technical problems, but as a stepping stone to the next technology they* [wind turbines] *work' (R005)*

'I am very pro wind turbines, it's the best alternative at the moment' (R004)

'*If more benefits* [social and economic] *came north it* [expansion of Robin Rigg] *may be better accepted' (R001)*

'If it goes ahead [Robin Rigg expansion] *money should be set aside to support specific projects such as employing a designated in-shore fisheries officer for the Scottish side of the estuary. I'd like to see more benefits for this side of the estuary, it would be great to get jobs. We get virtually no benefit apart from the small community fund' (R004)*

This view comes with the qualification that there should be a respect for the physical and emotional connections held by the current communities of the Solway estuary.

*'If you are going to put more turbines out there [*in the Solway*] they may as well be there* [Robin Rigg]. *Somewhere else may have more problems, but an extra 50 – 100% might work at Robin Rigg. The fishing community here are very outspoken and they are very vocal about proposals for the Celtic Array and Wigtown Bay but not much is said about this one here* [Robin Rigg]. *I was against the Wigtown Bay proposal it was completely in the wrong place but Robin Rigg may be in the right place. Wigtown Bay would have caused too many problems. We shouldn't stop developing technology because it doesn't work now, we need to use this technology until something better comes along' (R002)*

'I think it would bother them further down [the coast closer to Robin Rigg]. *The trouble is the vocal ones are mostly 'white settlers'. It's not that I mind them* [white settlers] *coming here but they don't want to join in' (R004)*

'More turbines will increase the potential for negative impacts on tourism, but not so much on fishing, Robin Rigg is in an area where not much [fishing] *is going on' (R002)*

7. Conclusion

Coastal communities should be thought of as social systems that are dependent upon marine ecosystems and as such recognised as social-ecological systems. However, current methods employed to assess the impacts of renewable energy development often operate from a single, specific objective perspective and fail to fully reflect the interconnected and interdependent nature of these social-ecological systems (Symes & Phillipson, 2009; Ian Perry et al., 2010; de Groot et al., 2014). In the presentation of secondary fisheries data a specific, narrow characterisation of the changing relationships that may be related to the construction and operation of 'Robin Rigg' is presented. The addition of socio-cultural data places society as a purposeful and aware component of an embedded natural-human world view. Attitudes towards offshore wind farms become a function of trade-offs between values attached to wind farms on the one hand and values held by seascapes on the other (Gee & Burkhard, 2010).

In a study that explored the expected acceptance of offshore wind farming on the West coast of Schleswig-Holstein in Germany, Gee (2010) presented thoughts of a coastal lifescape value, when characterised as an energy landscape, as an aggregated value where human beliefs and beliefs about nature inform attitudes towards wind farms. Values associated with offshore wind farming, when combined with moral convictions around societal issues connected with the need for renewable energy or the fragility of nature, underpin the formation of attitudes (Gee, 2013). Seascapes have been valued by society for a multitude of reasons, the introduction of offshore wind farming now presents a new way in which seascapes can be valued but these values may come in to conflict with other long held values.

In this report the relationships between values associated with offshore wind farms and a shared societal approach to tackling issues of climate change, described by the belief that renewable energies are relevant and important, when combined with a view of the natural world as a dynamic space suggests a key theme in forming favorable attitudes toward offshore wind. Positive attitudes toward offshore wind are still expressed even where nature and the seascape are considered important. However, this study suggests there is a temporal perspective to the experienced nature of change within a dynamic

natural space. Change, when accepted as an integral component of a dynamic lifescape, appears to be placed in the context of, or set against personal experience measured in lives and generations. Viewed through a long lens change is seen as a normal part of natural process, from this perspective no change would appear not normal. Yet the introduction of new, novel, or non-natural structures may contribute to a lessened opportunity to experience the currently perceived naturalness of the Solway estuary. When approached from this perspective does change precipitate a process of trade-off? To what extent do values, attitudes, and expectations regarding the naturalness of landscape and human use of the sea, set within the context of personal experience play a role in re-shaping value beliefs for seascape elements considered as natural, semi-natural or abstract?

8. Recommendations

As an exploratory exercise, based on a relatively small sample size, this report highlights the need for a greater understanding of the multi-dimensional nature of the relationships between society and large scale renewable energy landscapes. Understanding this relationship requires an approach designed to draw out the individual, community, environmental, visual, physical and spiritual dimensions of connections built around place. The collection of individual narratives, across a wide range of stakeholders, should seek to capture those expressions of self, within the context of offshore wind provision, that articulate;

- **environmental connections** where the human part of the natural environment is characterised as an embedded component within a dynamic natural environment;
- **community connections** where physical and emotional bonds are based on shared interests, concerns and histories;
- **functional connections** which describe the degree to which the physical setting supports an intended use dependence;
- **personal connections** for specific physical settings and symbolic connections to place that characterise identity.

In this manner establishing the drivers of [un]-acceptance of offshore wind farms at the level of local residents can inform debate supporting a participatory decision-making process. Failure to include the socio-cultural component of the Solway estuary describes a simplistic seascape structure with little reference to local culture and needs. Solway coastal communities economically and traditionally dependent on fishing activities and tourism, many of which are already economically depressed, may suffer further economic degradation if additional wind farm developments are approved, with clear implications for issues such as the social acceptance of renewable energy projects. Nonetheless, there is evidence that meaningful community participation in energy planning can lead to much greater levels of acceptance (Sorensen et al., 2002; Rogers et al., 2008; Warren & McFadyen, 2010; Rogers et al., 2012). Assessment that fully acknowledges society as a reflexive component of a social-ecological system describes a dynamic environment in which culture and nature occupy the same space, a space where a healthy socio-cultural and ecological system can

support a healthy economic system. Adoption of a holistic approach to the evaluation of new energy landscapes can inform, support and foster movement towards acceptance of a combined sustainable and functional approach to future lifescapes.

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