Cromarty Firth Sea the Value Workshop 2

Wednesday 15 November 2023 | 10:00-15:00 | National Hotel, Dingwall

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The *Sea the Value* project aims to understand the different values communities hold towards their local marine environment, the diverse benefits it provides, and how nature-based solutions can support and integrate with community development. The project is focussing on two case studies in the UK, the Cromarty Firth in Scotland, and the Solent on the south coast of England. The project outputs will be used to inform wider management and planning of marine biodiversity across the UK.

The University of Aberdeen and the Moray Firth Coastal Partnership facilitated a second workshop with the Cromarty Firth community, with the aim of reviewing the outputs from the first participatory mapping workshop held in Dingwall (22 June 2023) and to investigate trade-offs under two future scenarios in the Cromarty Firth. The second workshop was again held at the National Hotel in Dingwall and was attended by 17 stakeholders representing a range of organisations (see Table 1). A full list of participants and their contact details is provided in Annex 1.

Table 1: Workshop attendees organisations (*organisation also represented at Workshop 1)**.**

Organisations	
NatureScot*	Black Isle Partnership*
Local Residents*	Highland Council*
Environmental Consultant*	RSPB*
University of Aberdeen Lighthouse Station*	Moray Ocean Community*
Landowner*	Port of Cromarty Firth*
SAMS Enterprise*	Mossy Earth / Moray Ocean Community*

Welcome, Introduction and Reviews 10:00-11:00

Tavis Potts (University of Aberdeen) welcomed the attendees and thanked them for attending the event (Image 1). Tavis introduced the Sea the Value project team (see Table 2 below), the Sea The Value project and outlined the aims and objectives of the workshop. All slides presented on the day are included in Annex 2.

Image 1: Tavis Potts introducing participants to the Sea the Value project.

Table 2: The Project Team.

Name	Organisation	Role
Prof Tavis Potts	Aberdeen University	Project Principal Investigator, Facilitator
Dr Daryl Burdon	Daryl Burdon Ltd	Facilitator
Dr Andy van der Schatte Olivier	University of Portsmouth	Facilitator
Dr Jeremy Anbleyth-Evans	Aberdeen University	GIS Mapping, Note-taker
Dr Kate Gormley	Aberdeen University	GIS Mapping, Note-taker
Vicky Paxton	Moray Firth Coastal Partnership	Engagement, Note-taker

Activity 1: Review of Features Mapping

The first activity was to review the features maps which were produced during the features mapping exercises in Workshop 1. The three hand-drawn maps of features in the inner, middle and outer Cromarty Firth, produced by the participants in Workshop 1, have been digitised, combined and standardised into one features map for the Cromarty Firth. Each table was provided with an A1 print out of the features map (see Figure 1) and were asked to comment on: (1) the features categories as per the legend; and (2) the location and extent of each feature.

The stakeholders were given 20 minutes to complete this task. Notes were taken from each table and the map will be revised accordingly following stakeholder feedback. Once completed, the map will be shared with all of the workshop attendees and the wider community for use within their organisations.

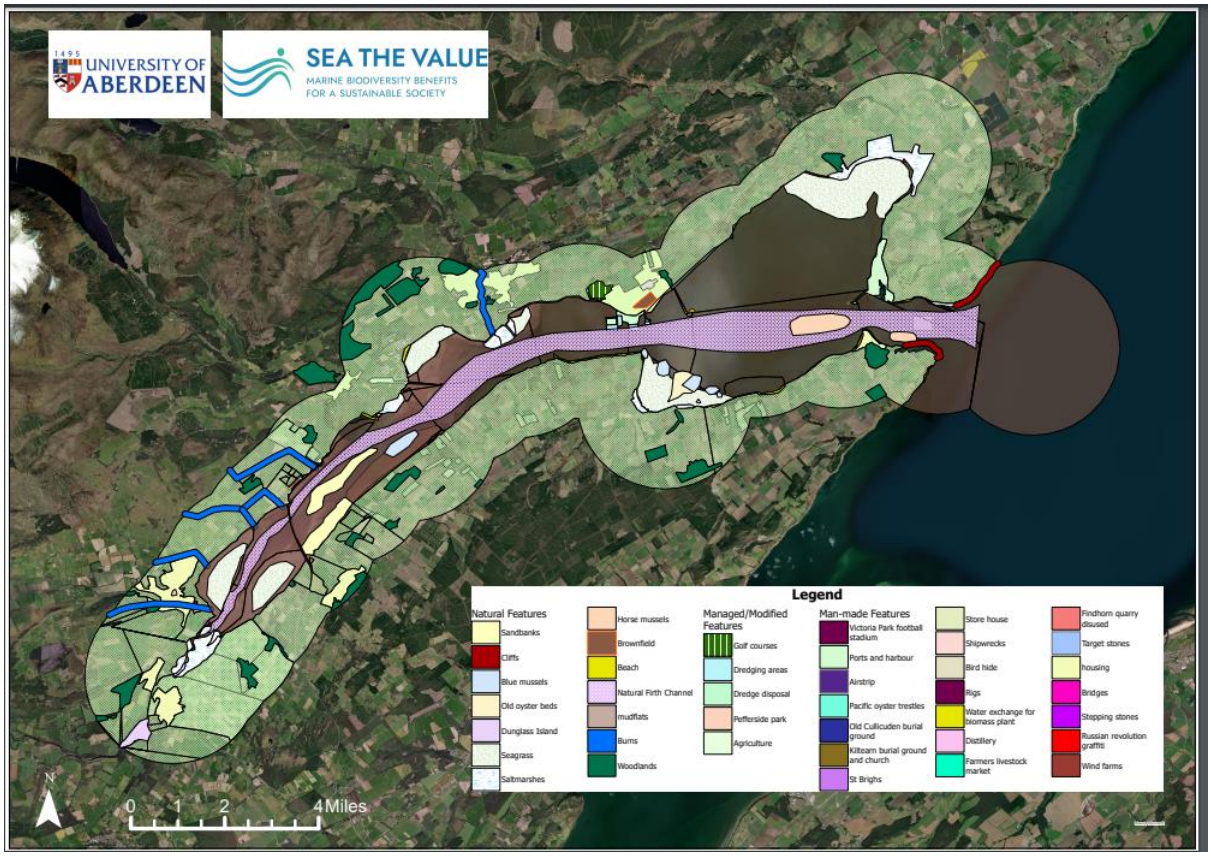


Figure 1: Digitised map of features produced from the hand-drawn maps in Workshop 1.

Activity 2 – Review of Features vs Benefits Matrix

The second activity asked the workshop participants to review the relationships between the features and their associated benefits, as identified in Workshop 1. In order to facilitate this activity, the features and benefits were presented in a matrix format and the participants were asked to review and edit the matrix. There was only 30 minutes allocated to this activity and therefore the overall matrix was split across the three tables, with each table reviewing a sub-set of the natural, modified/managed and man-made features. The combined results of the activity are presented in Figures 2-4 – green shaded cells represent the relationships identified in Workshop 1, a cross represents a missing relationship identified in Workshop 2 and a yellow cell represents an incorrect relationship which was identified in Workshop 1 but which needs to be removed from the matrix. The results from this activity will be used to update the GIS files and will be incorporated into the mapping outputs of the project. This assessment demonstrates that the participants identified some features, e.g. saltmarsh as delivering a broad range of benefits (18 in total), whereas other features were assessed to deliver a narrower range of benefits, such as brownfield sites (8 in total) (Figure 2).

	Societal Benefits (SB)											Abiotic Benefits (AB)				Economic Benefits (EB)			Other Benefits (OB)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	SB1	SB6	SB7	SB8	SB9	SB10	SB11	SB12	SB13	SB14	SB15	AB1	AB2	AB3	AB4	EB1	EB2	EB3	OB1	OB2	OB3
	Food (wild, farmed) / Drink	Healthy climate (Carbon Sequestration)	Prevention of coastal erosion	Sea defence	Waste burial / removal / neutralisation	Tourism / Nature Watching	Spiritual and cultural well-being	Aesthetic benefits	Education, research	Physical health benefits	Psychological health benefits	Wind energy	Water resources (quality and quantity)	Archaeology / Geology / Geomorphology	Transport	Place to live	Place to work	Industry	Habitat / species biodiversity	Intrinsic value	Functioning ecosystems
Natural Features	13 & 13a	12 & 18	19	20	3 & 21	22	23 & 37	24	25	26	27	28	4 & 31	32	40	34	35	33	36	36a	5
Beach		X	X	X	X			X	X		X		X	X			X	X	X	X	X
Seagrasses			X				X				X		X				X			X	X
Mudflats							X	X		X			X	X			X	X		X	X
Saltmarshes	X			X			X	X	X	X	X		X	X			X	X		X	X
Blue mussels		X	X	X		X	X		X		X		X	X			X	X	X	X	X
Sandbanks				X			X	X	X		X				X		X			X	X
Natural Firth channel									X	X	X						X			X	X
Dunglass Island							X	X	X	X	X			X			X	X		X	X
Burns	X				X	X	X	X	X	X	X			X			X			X	X
Woodland											X		X	X			X	X		X	
Old oyster beds	X					X	X		X										X	X	
Horsemussels		X			X		X		X				X							X	
Cliffs			X	X		X	X	X	X	X	X			X			X	X	X	X	
Brownfield						X	X		X					X		X			X	X	X

KEY

Original relationships identified in WS1

X New relationships identified in WS2

X Original relationships identified in WS1 which need to be deleted

Figure 2: Edited Natural Features vs Benefit matrix for the Cromarty Firth.

	Societal Benefits (SB)											Abiotic Benefits (AB)				Economic Benefits (EB)			Other Benefits (OB)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	SB1	SB6	SB7	SB8	SB9	SB10	SB11	SB12	SB13	SB14	SB15	AB1	AB2	AB3	AB4	EB1	EB2	EB3	OB1	OB2	OB3
	Food (wild, farmed) / Drink	Healthy climate (Carbon Sequestration)	Prevention of coastal erosion	Sea defence	Waste burial / removal / neutralisation	Tourism / Nature Watching	Spiritual and cultural well-being	Aesthetic benefits	Education, research	Physical health benefits	Psychological health benefits	Wind energy	Water resources (quality and quantity)	Archaeology / Geology / Geomorphology	Transport	Place to live	Place to work	Industry	Habitat / species biodiversity	Intrinsic value	Functioning ecosystems
Modified / Managed Features	SB1	SB6	SB7	SB8	SB9	SB10	SB11	SB12	SB13	SB14	SB15	AB1	AB2	AB3	AB4	EB1	EB2	EB3	OB1	OB2	OB3
Pefferside park		X				X	X	X	X	X	X			X			X	X	X	X	X
Dredging zone															X		X	X			
Golf Courses			X	X		X	X	X	X	X	X						X	X		X	X
Dredge disposal													X		X		X	X			
Agriculture		X			X	X	X		X	X	X	X	X	X		X	X	X	X		X

KEY

Original relationships identified in WS1

X New relationships identified in WS2

X Original relationships identified in WS1 which need to be deleted

Figure 3: Edited Modified / Managed Features vs Benefit matrix for the Cromarty Firth.

	Societal Benefits (SB)											Abiotic Benefits (AB)				Economic Benefits (EB)			Other Benefits (OB)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	SB1	SB6	SB7	SB8	SB9	SB10	SB11	SB12	SB13	SB14	SB15	AB1	AB2	AB3	AB4	EB1	EB2	EB3	OB1	OB2	OB3
	Food (wild, farmed) / Drink	Healthy climate (Carbon Sequestration)	Prevention of coastal erosion	Sea defence	Waste burial / removal / neutralisation	Tourism / Nature Watching	Spiritual and cultural well-being	Aesthetic benefits	Education, research	Physical health benefits	Psychological health benefits	Wind energy	Water resources (quality and quantity)	Archaeology / Geology / Geomorphology	Transport	Place to live	Place to work	Industry	Habitat / species biodiversity	Intrinsic value	Functioning ecosystems
Man-made Features	SB1	SB6	SB7	SB8	SB9	SB10	SB11	SB12	SB13	SB14	SB15	AB1	AB2	AB3	AB4	EB1	EB2	EB3	OB1	OB2	OB3
Russian revolution graffiti carved in trees							X	X													
Stepping stones across saltmarsh						X		X													
Football stadium Victoria Park							X														
Bridges						X		X													
Housing								X													
Target stones																					
Findhorn quarry (Disused)																					
Airstrip																					
Farmer's livestock market	X					X															
Distillery						X															
Harbour / Dock / Piers / Marina / Jetty / Cruise Liners / Lifeboats / Ferry	X			X			X														
Heat exchange point for woodchip plant		X			X																
Rigs																					
Bird hide						X	X														
Shipwreck						X		X	X					X					X	X	X
Store house						X											X	X		X	
Pacific oyster trestles																					
Old Cullicuden burial ground						X	X	X	X		X			X			X		X	X	X
Kiltearn burial ground and church						X	X	X	X		X			X			X		X	X	X
St Brighs																X				X	
Wind Farms		X							X			X					X	X			

KEY

Original relationships identified in WS1

X New relationships identified in WS2

X Original relationships identified in WS1 which need to be deleted

Figure 4: Edited Man-made Features vs Benefit matrix for the Cromarty Firth.

Introductory Presentations 11:00-11:30

Two introductory presentations were given in this session: Daryl Burdon (Daryl Burdon Ltd.) presented an introduction to the matrix approach and future scenarios assessments; and Steph Elliott (RSPB) provided an introduction to the Nigg Bay coastal realignment. The slides from these presentations are included in Annex 2.

The Matrix Approach and Future Scenarios (Daryl Burdon)

The Matrix Approach[1] is a structured assessment of the relative importance of marine features (habitats and species) in delivering ecosystem services and societal benefits and is based on literature review and expert opinion. Outputs from the Matrix Approach, shown as radar plots (see for example Figure 6 below), are a valuable tool to support trade-off assessments as the benefits provided under different scenarios can be assessed.

Scenarios assessments can be used to investigate whether policy measures are robust and to aid future planning and management. It is recognised that scenarios are best created through a collaborative process that takes into account the necessary expertise across disciplines and knowledge. Scenarios assessments provide a valuable tool to enable thinking about the future the dynamics of the Cromarty Firth and to explore how changes in the ecosystem can impact society. Scenarios must be plausible and credible requiring local knowledge gained through stakeholder engagement. Future scenarios in the Cromarty Firth were used to identify where natural capital is changing in response to natural or anthropogenic drivers and assessed the loss or gain in the delivery of benefits and the potential impact on stakeholders. The scenarios assessments undertaken with the Cromarty Firth workshop will compare the delivery of benefits under contrasting future scenarios against the case of 'Business as Usual'.

Following extensive engagement with local communities around the Cromarty Firth, it was agreed that the scenarios to be investigated within this workshop relate to managed realignment and Native oyster restoration. Both of these future scenarios are currently being discussed in relation to the Cromarty Firth, although no specific plans have been submitted to date.

The Nigg Bay Coastal Realignment (Steph Elliott, RSPB)

Steph provided an excellent insight into the history, development and construction of the Nigg Bay coastal realignment site. With the use of a range of images (see Annex 2), Steph demonstrated some of the key aspects and challenges which arose during the construction of the coastal realignment site. Steph concluded the presentation by outlining the reasons why the coastal realignment was undertaken: Climate change adaptation (restore previous and mitigate future saltmarsh loss; demonstration of technique; "future-proof" reserve for wintering birds) and additional benefits (high tide flood storage; reduce sea wall maintenance costs; blue carbon).

[1] Potts, T., Burdon, D., Jackson, E., Atkins, J.P., Saunders, J., Hastings, E. & Langmead, O., 2014. Do marine protected areas deliver flows of ecosystem services to support human welfare? *Marine Policy*, 44, pp. 139–148. https://doi.org/10.1016/j.marpol.2013.08.011

Scenario 1: Managed Realignment 11:30-12:30

Introduction

Nature-based solutions use the power of nature, and the services and benefits nature provides, to help tackle major challenges such as delivering Net Zero and enabling us to adapt to the impacts of climate change[2]. Managed realignment, whereby existing sea walls are breached to allow tidal inundation on to terrestrial land, can be seen as a triple-win solution[3], as the intervention has the potential to mitigate against some impacts of climate change (by providing a natural form of sea defence and erosion prevention), results in an increase in saltmarsh, which sequesters carbon (a blue carbon habitat), and provides additional habitat for juvenile fish and invertebrates species and functional waterbird assemblages[4]; which in turn provides recreational opportunities for society. Managed realignment is therefore a cost-effective technique to deal with the consequences of sea level rise when compared to installation and maintenance of hard engineering solutions. However, it is recognised that to gain these benefits, other benefits may be lost as a result of the change in land-use. Future scenario assessments allow us to identify potential gains and losses and to identify which stakeholders may be impacted under such interventions.

Managed realignment has already taken place in the Cromarty Firth, with the RSPB having undertaken coastal realignment within Nigg Bay, which resulted in the creation of an additional 25 ha of saltmarsh habitat (Image 2).

Image 2: Aerial image of the Nigg Bay Coastal Realignment Site (source: Steph Elliott's presentation).

[2] https://www.gov.scot/publications/scottish-biodiversity-strategy-2045-tackling-nature-emergency-scotland-2/documents/
[3] https://doi.org/10.1016/j.marpolbul.2005.09.012
[4] https://doi.org/10.1016/j.ecss.2007.04.028

Although the primary focus of this intervention was to restore habitat for waterbirds, the saltmarsh created wider biodiversity benefits as well as a range of other benefits for society including sea defence as a result of wave attenuation, coastal adaptation to sea level rise, and carbon sequestration.

This first scenario, *proposes that an additional series of managed realignment sites could be created in the Cromarty Firth to achieve the multiple benefits* listed above. Proposing a series of managed realignment sites, rather than just an individual site, would be in-keeping with the recent Scottish Biodiversity Strategy[1] which states "*Protected areas will be larger, better connected and in good condition*" (pp. 30) recognising that "*Nature Networks across our landscapes will underpin the resilience and health of species and habitats*" (pp. 31).

One of the primary focusses of the Sea The Value project, is on carbon sequestration within coastal systems. Carbon sequestration can be defined as the "*net capture of carbon dioxide by coastal and marine biota*"[5]. Saltmarsh is a very good habitat for sequestering carbon (see Figure 5), and it is reported within the literature that sequestration rates range from 0.86-2.1 tC/ha/yr. A range of sequestration values is reported, as the exact rate depends on the condition of the saltmarsh and the environmental conditions within individual sites. It must also be remembered that other habitats within the Cromarty Firth (e.g. seagrass, intertidal and subtidal sediments) also provide a carbon sequestration function, however our focus in this scenario is on saltmarsh only.

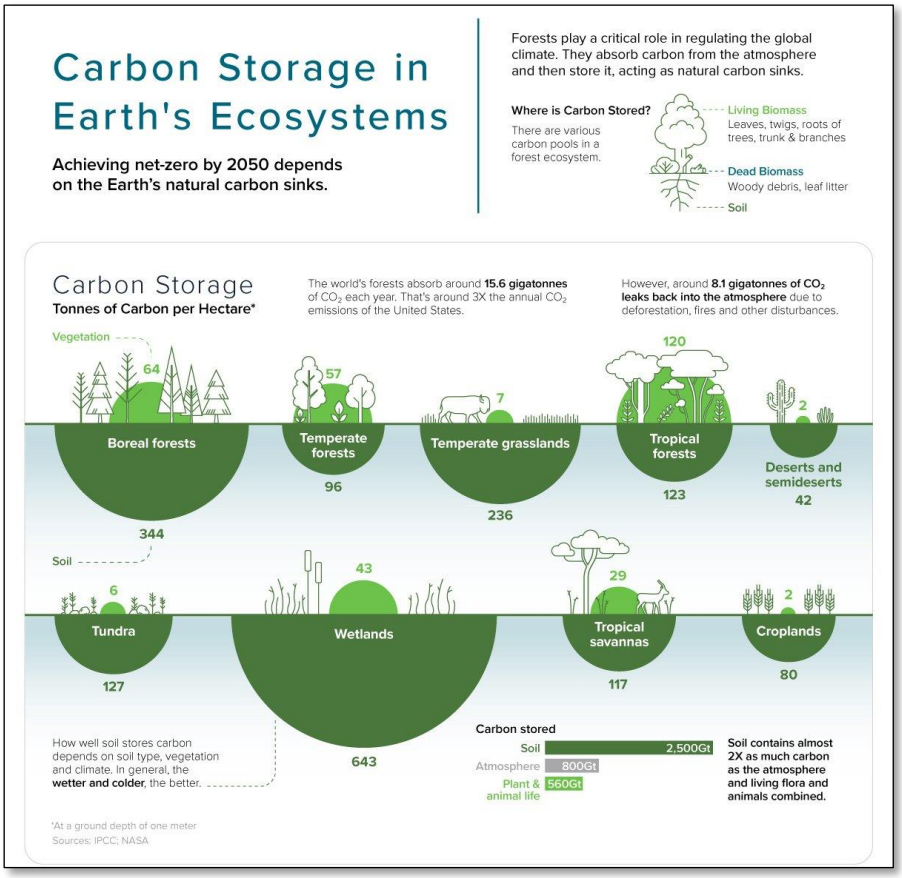


Figure 5: Carbon storage in Earth's ecosystems[6].

[5] https://doi.org/10.1007/978-3-319-17214-9

[6] https://www.visualcapitalist.com/sp/visualizing-carbon-storage-in-earths-ecosystems/

For the purposes of this scenario, *we are proposing that an additional 130 ha of saltmarsh could be created within a series of managed realignment sites around the Firth* – this would increase saltmarsh extent in the Cromarty Firth by approximately 30% based on the extents mapped in Workshop 1. This could result in 104-273 tC/yr being sequestered, in addition to providing a wide range of other benefits for society which we will also explore within this scenario. This scenario will look at the trade-offs in societal benefits with a change in land-use. No site-specific locations have been identified, and therefore for the purposes of this exercise we will assume that there will be a land-use change from agricultural land to coastal saltmarsh, although it is fully recognised that managed realignment may be undertaken on terrestrial land which is currently used for other purposes.

It must be strongly emphasised here that this is a hypothetical future scenario, and there are no formal plans to undertake such interventions. Any replacement of land, as part of any future managed realignment project, would only be considered with the full consultation and participation of landowners underpinned by due process. These scenarios are for demonstration purposes only.

To aid trade-off discussions, outputs from the Matrix Approach[7] can be used to assess the relative importance of the different features in delivering societal benefits. The radar plots have been amended to reflect the range of benefits identified by stakeholders in Workshop 1. The concentric circles in the radar plots reflect the relative importance (inner = low, middle = moderate, outer = high) of that feature delivering the benefit based on literature review and expert opinion. In the case of this first scenario, we are interested in trade-offs between the benefits delivered by agricultural land versus saltmarsh.

Methodology

The assessment was undertaken in three groups, each containing 5 or 6 participants. The change in benefit provision was assessed using a 5-point Likert scale (-2 = large decrease; -1 = small decrease; 0 = no change; +1 = small increase; +2 = large increase; ? = unknown) and was captured using a pre-produced template on each table (Figure 6). An additional template was also provided in case participants wished to assess the impacts on Tourism/Nature Watching (general) in further detail (Figure 7). The assessment included: a change in benefits under the future scenario; a description of why this change may occur; the confidence in their decision; and a description of which stakeholders may be affected. Workshop participants used the relationships between features and benefits, as illustrated using the Matrix Approach (Figure 8) to support their trade-off discussions.

[7] https://doi.org/10.1016/j.marpol.2013.08.011

Scenario 1 Managed Realignment **Facilitator Initials**_____ **Table Number**_____

Key: ++ large increase in delivery; + small increase in delivery; 0 = no change; - small decrease in delivery; -- large decrease in delivery; ? = unknown

	Benefits	Change in Benefits ++, +, 0, -, --, ?	Explanation of change	Confidence H, M, L	Stakeholders Impacted
1	Food (wild, farmed) / Drink				
2	Healthy climate (Carbon sequestration)				
3	Prevention of coastal erosion				
4	Sea defence				
5	Waste burial / removal / neutralisation				
6	Tourism / Nature watching (general)				
7	Spiritual and cultural well-being				
8	Aesthetic benefits				
9	Education, Research				
10	Physical health benefits				
11	Psychological health benefits				
12	Wind energy				
13	Water resources (quality and quantity)				
14	Archaeology / Geology / Geomorphology				
15	Transport				
16	Place to live				
17	Place to work				
18	Industry				
19	Habitat / species biodiversity				
20	Intrinsic value				
21	Functioning ecosystems				

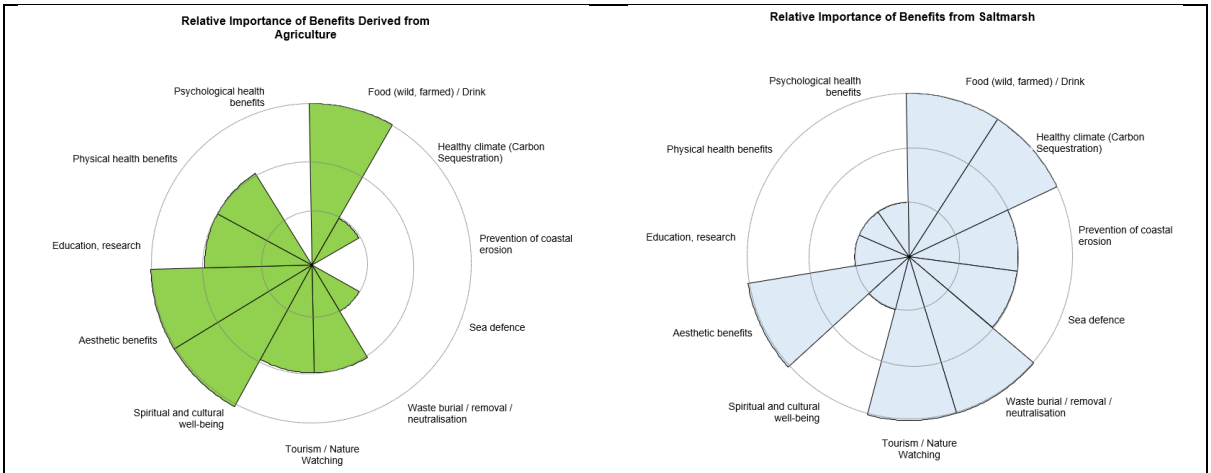
Figure 6: Template used to capture trade-off assessment scores.

Scenario 1 – Managed Realignment (continued) **Facilitator Initials**_____ **Table Number**_____

Key: ++ large increase in delivery; + small increase in delivery; 0 = no change; - small decrease in delivery; -- large decrease in delivery; ? = unknown

	Benefits	Change in Benefits ++, +, 0, -, --, ?	Explanation of change	Confidence H, M, L	Stakeholders Impacted
6a	Tourism and nature watching (bird watching)				
6b	Tourism and nature watching (rowing / kayaking / paddleboarding)				
6c	Tourism and nature watching (cruising / boat trips)				
6d	Tourism and nature watching (recreational fishing)				
6e	Tourism and nature watching (sailing / windsurfing)				
6f	Tourism and nature watching (swimming)				
6g	Tourism and nature watching (wildfowling)				
6h	Tourism and nature watching (cycling)				
6i	Tourism and nature watching (cruise ships)				

Figure 7: Template used to capture trade-off assessment scores specifically with respect to Tourism and Nature Watching.



Business As Usual Scenario: Relative importance of agricultural land in delivering societal benefits.

Scenario 1 - Managed Realignment: Relative importance of saltmarsh in delivering societal benefits.

Figure 8: Radar plots illustrating the outputs from the matrix approach for agricultural land (Business as usual) and the development of saltmarsh through managed realignment (future scenario).

Results

The scores for the change in each benefit were analysed with the mean results across the three tables of participants, and the spread of data, presented in Figure 9. The shaded cells and black dots represent the mean score, whilst the dashed line represents the variation in scores across the three tables of participants. The shading reflects the type of benefit which is being assessed in each row: yellow = provisioning societal benefit; purple = regulating societal benefit; green = cultural societal benefit; red = abiotic benefit; orange = economic benefit; and blue = other benefit.

Under the managed realignment scenario, there was agreement across all three tables that there would be a small reduction in food production, given the land-use change from agricultural land to saltmarsh habitat (Figure 9). It was felt that any agricultural land used for managed realignment would not be the highest grade of agricultural land and therefore it was agreed that it would be a small change (-1) in this benefit.

The stakeholders identified that there would be significant increases in a number of regulating benefits, given the role of saltmarsh in sequestering carbon (+2), prevention of coastal erosion (+2), sea defence (+2) and bioremediation of waste (+1) (Figure 9). Positive increases in these regulating benefits were consistent across the three tables however there was some debate as to whether they were large (+2) or small (+1) increases in these benefits, represented by the dashed arrows in Figure 9. A similar trend was also identified for the cultural benefits with large increases (+2) identified for tourism/nature watching, spiritual and cultural well-being and education/research; although it is recognised that there was not agreement across all three tables particularly in relation to spiritual and cultural well-being and education/research. Participants identified a small increase (+1) in

psychological health benefits under the managed realignment scenario, but felt that there would be no change in physical health benefits.

With regard to the abiotic benefits (AB1-AB4), a large positive increase (+2) in water resources (quality and quantity) was identified across the three table of participants, and a small increase (+1) in transport under the managed realignment scenario (Figure 9). This scenario would have no impact on wind energy (0), and the impact on archaeology / geology / geomorphology was unknown with no consensus across the three tables of the direction and magnitude of change. Looking at the economic benefits (EB1-EB3), the general consensus across the three tables was that there would not be any significant change in any of the benefits, although some tables identified a small positive change (+1) for a place to live and place to work and small negative change (-1) for industry. Overall, the participants identified large positive increases in the other benefits, including habitat/species biodiversity (OB1), intrinsic value (OB2) and functioning ecosystems (OB3); although it is noted that one table identified a potential small negative change (-1) in habitat/species biodiversity and one table identified no change for intrinsic value and functioning ecosystems.

When focussing specifically on the breakdown of tourism/nature watching categories (Figure 10), potential large positive increases were identified for bird watching (SB10a) and wildfowling (SB10g), two activities which are closely associated with saltmarsh habitat. Smaller positive increases were identified for rowing/ kayaking / paddleboarding (SB10b), recreational fishing (SB10d) and swimming (SB10f) with improvements in water quality being cited as the reason for these potential increases. No changes were identified with the other tourism / nature watching categories (SB10c, SB10e, SB10h, SB10i).

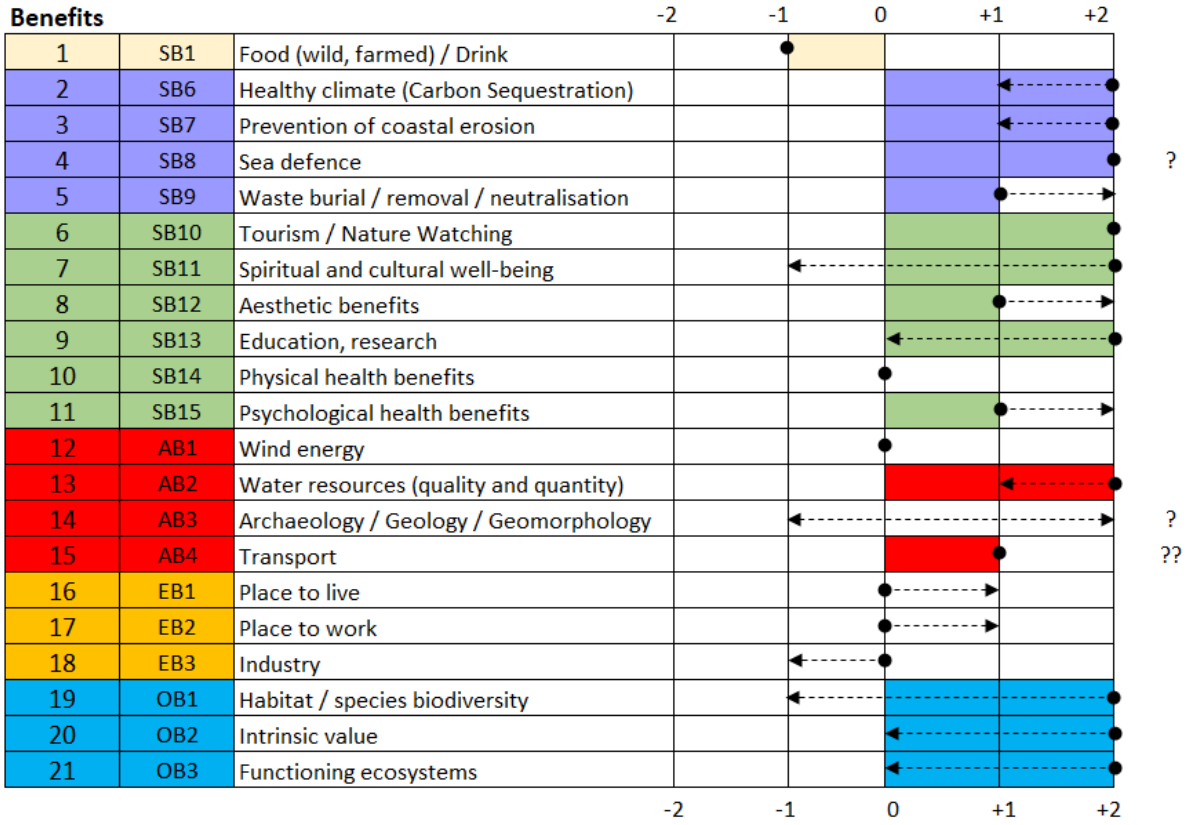


Figure 9: Output from the trade-off assessment for the 'Managed Realignment' scenario (combined results from 3 tables of 5 or 6 stakeholders). The shaded bars with black dot represent the combined

change from the 'Business as Usual' scenario (represented as 0), with the variance of responses across the three tables represented by the dashed line. A question mark reflects where scores were unknown by one (?), two (??) or three (???) tables.

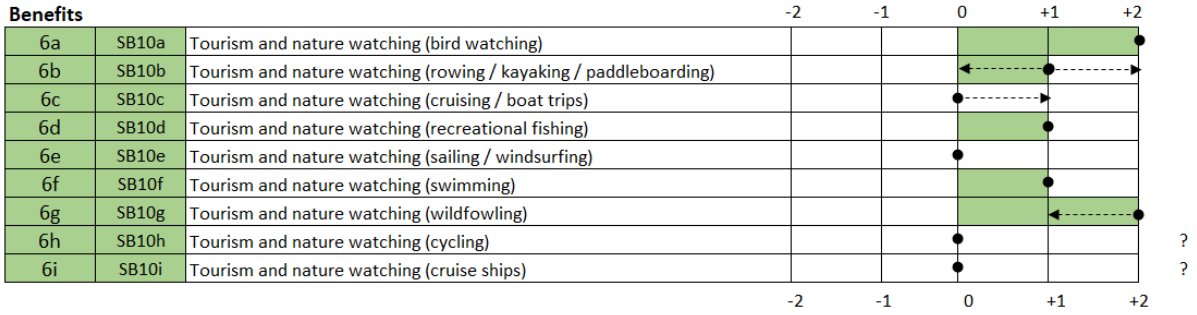


Figure 10: Outputs from the trade-off assessment for the 'Managed Realignment' scenario focussing on tourism / nature watching activities (combined results from 3 tables of 5 or 6 stakeholders). The shaded bars with black dot represent the combined change from the 'Business as Usual' scenario (represented as 0), with the variance of responses across the three tables represented by the dashed line). A question mark reflects where scores were unknown by one (?), two (??) or three (???) tables.

Scenario 2: Native Oyster Restoration 13:15-14:30

To start this session, Dr Andy van der Schatte Olivier (Portsmouth University) provided an introduction to Native oyster restoration. His presentation covered how oyster reefs are classified, experiences of oyster restoration projects in the Solent, and the benefits provided by shellfish reef ecosystems. The slides from the presentation are provided in Annex 2.

Introduction

One of the two focusses of the Sea The Value project is on bioremediation of waste. Bioremediation of waste can be defined as the "*The presence of coastal and marine biota which have the potential to remove anthropogenic contaminants and organic inputs*"[8]. Bioremediation is undertaken by a range of features (habitats and species) in the Cromarty Firth, such as Horse mussels (*Modiolus modiolus*), European blue mussels (*Mytilus edulis*) and other filter feeding bivalves. Our focus in this scenario is solely on the restoration of Native oysters in the Cromarty Firth. Historically, the Cromarty Firth has had Native oyster beds present (61 ha of old oyster beds were identified and mapped by stakeholders during the participatory mapping in the Cromarty Firth – see Figure 1 above), and therefore the Firth is considered to be a suitable area for the re-introduction of the species.

Native oysters naturally live in shallow, subtidal coastal and estuarine habitats, in areas dominated by mixed sediments[9]. Native oysters filter algae and organic matter from the water column, which form their food source, and in doing so can significantly improve surrounding water quality by decreasing the turbidity. Native oysters also have the ability to remove excess nutrients from water, particularly nitrogen, which at high levels can be detrimental to the environment by promoting harmful algal blooms, depleting oxygen and fish death. For example, it is reported that one adult oyster can filter more than 200 litres of water in a single day[10]. In addition, Native oysters also provide a range of other ecosystem services and societal benefits which will be explored in this scenario, such as providing a 3-dimensional structure which can support higher biodiversity than surrounding sediments, a protected nursery ground for fish and other invertebrates, and in the longer term the potential to develop into a sustainable fishery providing both provisioning (food) and cultural benefits.

The aim of Native oyster restoration is to establish a self-sustaining reef, but the critical mass required to achieve this continues to be subject to debate and will ultimately depend on site characteristics such as hydrodynamics and seabed structure. At present community-led plans to re-introduce Native oysters into the Cromarty Firth are at an early stage with some initial baseline ROV and intertidal surveys underway. To provide an indication of the size and extent of potential Native oyster restoration projects, the DEEP project in the neighbouring Dornoch Firth, aims to establish a self-sustaining reef of 4 million oysters covering an area of 40 ha, replicating the numbers which would have existed in the Dornoch Firth before the species was wiped out in the 1900s[11]. However, it must be emphasised that environmental conditions within the Dornoch and Cromarty Firths differ, and therefore these figures are just indicative of what may be required to form a self-sustaining reef in the Cromarty Firth.

This scenario therefore proposes that Native oysters would be re-introduced into the Cromarty Firth, which would turn areas of subtidal mixed sediment (the 'Business As Usual' scenario) into a self-sustaining 3-dimensional Native oyster bed. It is recognised that this would take a number of years to

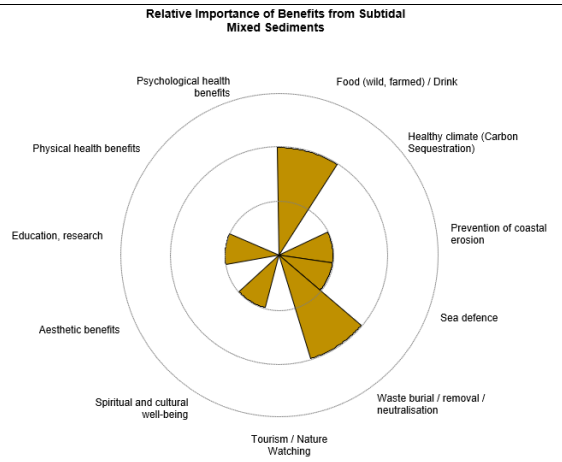
[8] https://doi.org/10.1007/978-3-319-17214-9
[9] https://nativeoysternetwork.org/
[10] https://nativeoysternetwork.org/
[11] https://nativeoysternetwork.org/portfolio/deep/

develop (10+) however success from similar projects has demonstrated that it may be feasible in the Cromarty Firth given that historically Native oysters were present within the system.

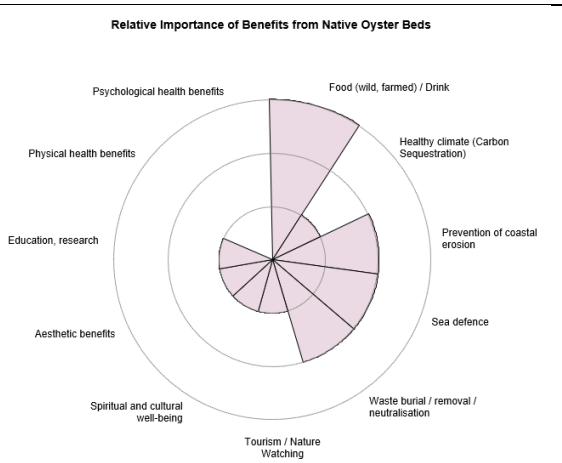
It must be strongly emphasised here that this is a hypothetical future scenario, and there are no formal plans to undertake this restoration work. It is also assumed that all relevant Habitats Regulation and environmental assessments and permissions would be followed for any intervention. These scenarios are for demonstration purposes only.

Methodology

The same methodology was employed for Scenario 2 as described for Scenario 1 above, with results being captured across three tables using pre-prepared templates (see Figures 6 & 7 above). Workshop participants used the relationships between features and benefits, as illustrated using the Matrix Approach (Figure 11) to support their trade-off discussions.



Business As Usual Scenario: Relative importance of subtidal mixed sediments in delivering societal benefits.



Scenario 2 - Native Oyster Restoration: Relative importance of Native oyster reefs in delivering societal benefits.

Figure 11: Radar plots illustrating the outputs from the matrix approach for subtidal mixed sediments (Business as usual) and the development of Native oyster beds (future scenario).

Results

Under the Native oyster restoration scenario, the participants identified a large positive increase (+2) in the food provisioning benefit, although it is noted that 1 table identified a small positive change (+1) in this benefit reflected by the dashed arrow in Figure 12. Given the aim of this scenario was to develop a self-sustaining Native oyster reef then this could potentially result in a commercial fishery, thus an increase in food production for human consumption would be expected. With respect to the regulating services, small positive increases (+1) were expected for carbon sequestration (SB6), prevention of coastal erosion (SB7) and sea defence (SB8) although some participants felt that these benefits may show a large positive increase (+2) reflected by the dashed arrow. Small positive increases in a range of cultural benefits were identified, including tourism / nature watching (SB10),

spiritual and cultural well-being (SB11), aesthetic benefits (SB12) and psychological health benefits (SB15), with a large positive increase (+2) identified for education / research (SB13) associated with the scenario.

With respect to the abiotic benefits, a large positive increase (+2) in water resources (AB2) was identified by all tables, hence there is no variability arrow associated with that benefit. Given that bioremediation of waste is one of the key benefits from the restoration of Native oyster reefs then this will likely have influenced the score here in relation to water quality; this benefit is closely linked to waste burial / removal / neutralisation (SB9) identified above which also scored a strong positive increase (+2) by each table. There was no agreed change in any of the other abiotic benefits, although a small increase (+1) in archaeology / geology / geomorphology (AB2) and a small decrease (-1) in transport (AB4) were identified by one table.

There was consensus across all three tables that there would be a small positive increase (+1) in places to work (EB2) and industry (EB3) as a result of Native oyster restoration activities including establishing local industries to supply juveniles. It was deemed that this scenario would have no impact on places to live (EB1). With regard to the 'Other Benefits', in general strong positive increases (+2) were identified for habitat / species biodiversity (OB1) given that Native oyster reefs provide habitat for a range of species, for intrinsic value (OB2) and functioning ecosystems (OB3). There was some discussion between the tables as to whether these latter two benefits were a small or large positive increase, as reflected by the dashed arrows in Figure 12.

With respect to Tourism / Nature watching, the analysis identified a small positive increase (+1) in bird watching (SB10a), recreational fishing (SB10d) and swimming (SB10f) (Figure 13). It is likely that these changes were identified given the role of Native oyster reefs in providing habitat for a wide range of marine organisms, thus supporting local bird and fish populations, and also due to improvements in water quality which would have a positive effect on swimming within the vicinity of the Native oyster reef. No impacts on other tourism / nature watching categories were identified. It must be noted that the analysis presented in Figure 13 is based on the results from two tables only, as the third table did not undertake this part of the exercise.

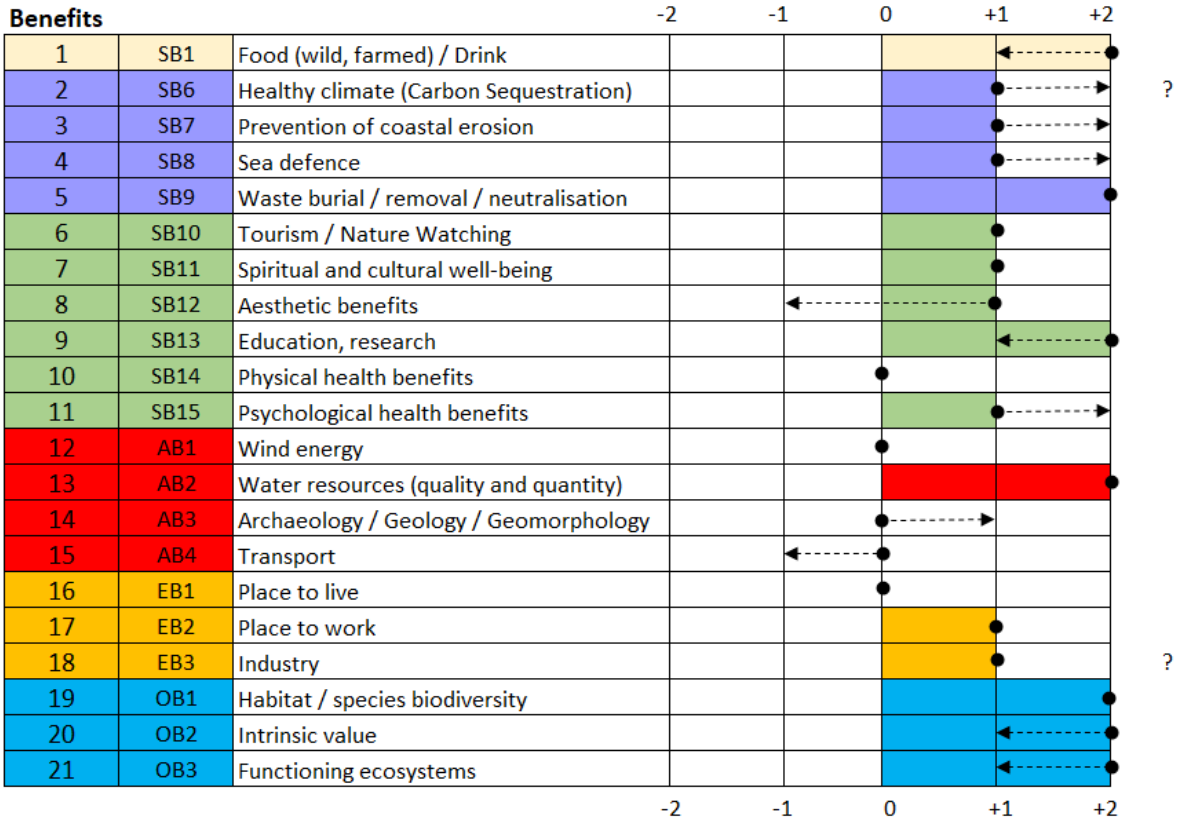


Figure 12: Output from the trade-off assessment for the 'Native Oyster Restoration' scenario (combined results from 3 tables of 5 or 6 stakeholders). The shaded bars with black dot represent the combined change from the 'Business as Usual' scenario (represented as 0), with the variance of responses across the three tables represented by the dashed line. A question mark reflects where scores were unknown by one (?), two (??) or three (???) tables.

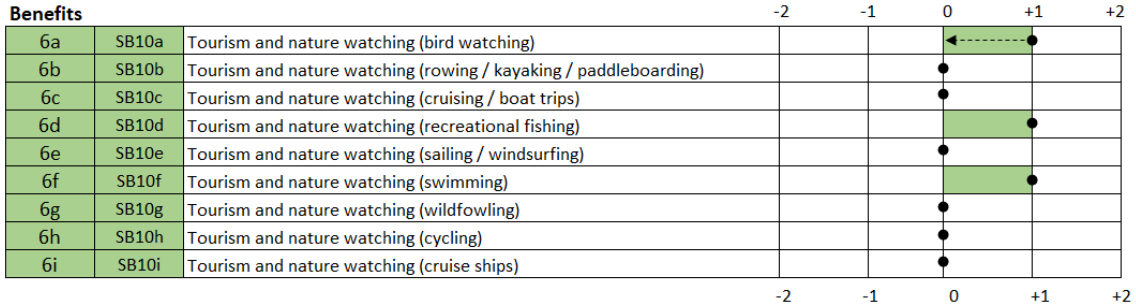


Figure 13: Outputs from the trade-off assessment for the 'Native Oyster Restoration' scenario focussing on tourism / nature watching activities (combined results from 2 tables of 5 or 6 stakeholders). The shaded bars with black dot represent the combined change from the 'Business as Usual' scenario (represented as 0), with the variance of responses across the three tables represented by the dashed line). A question mark reflects where scores were unknown by one (?), two (??) or three (???) tables.

Discussion, Feedback and Next Steps 14:30-15:00

The final session of the day provided an open platform for discussion of the Sea the Value workshops and their outputs. A number of participants identified mapping outputs which would be useful for their respective organisations. The project team assured participants that all outputs from the workshops will be freely available for all participants and the wider Cromarty Firth community, and that we will work with individual organisations over the coming months to ensure that the outputs are fit for purpose and in a variety of formats. Tavis also stated that it is also his intention is to provide the mapping outputs for all schools and libraries in the Cromarty Firth area so that the outputs can be used widely within the community.

All participants were asked to complete a feedback form at the end of the workshop, with the results summarised in Annex 3. There was clear interest in the scenarios assessments with the majority of participants identifying the scenarios exercises as 'very useful' or 'extremely useful' and all participants stated that they wished to be invited to future workshops in the Cromarty Firth.

The third and final workshop in this Sea the Value series will focus on mapping the beneficiaries in the Cromarty Firth and will take place in March 2024. The date and venue for the third workshop will be circulated in January 2024.

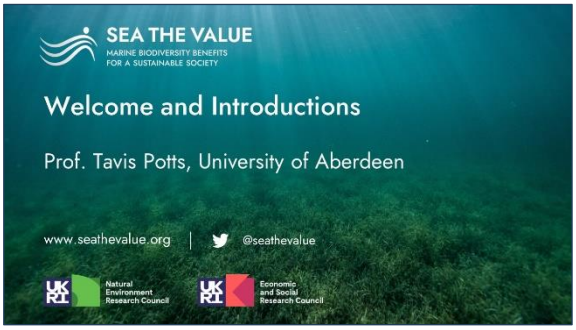
Acknowledgements

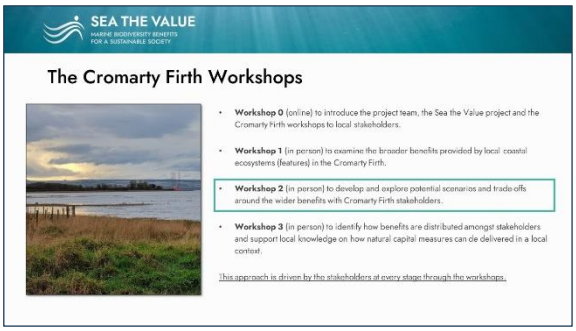
The Sea The Value Project Team wishes to thank all of the attendees for their enthusiasm and valuable inputs to the workshop. The project team also wish to thank UKRI for funding the project and Vicki Paxton from the Moray Firth Coastal Partnership for her assistance in organising the workshop.

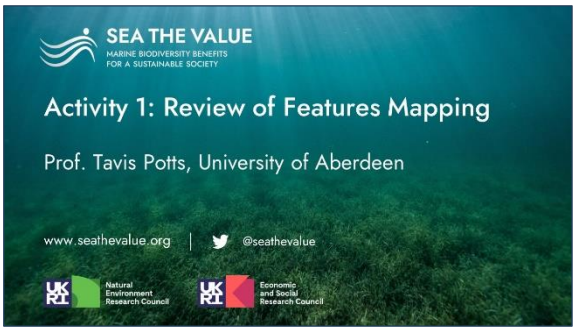
Annex 1: Workshop Participants

Name	Organisation
Ben Leyshon	NatureScot
Caroline Vawdry	Local Resident
Catriona Mallows	Local Resident
Duncan Macrae	Consultant
Francis Williams	Moray Ocean Community
Hannah Swanson	University of Aberdeen Lighthouse Station
Hector Munro	Landowner
Iain Gatward	SAMS Enterprise
Isla MacLeod	Mossy Earth / Moray Ocean Community
Julien Paren	Black Isle Partnership
Mike Kendal	Local resident / marine ecologist
Rebecca Hewitt	University of Aberdeen Lighthouse Station
Scott Dalgarno	Highland Council
Steph Elliott	RSPB
Terri Sawyer	Moray Ocean Community
Fiona Richardson	Highland Council
Alex Johnson	Port of Cromarty Firth

Annex 2: Workshop Presentations







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Refined List of Features

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Activity 1: Review of Feature Mappings

- Each table has A1 map of features and A3 map of polygons.
- Spend 5 minutes familiarising yourself with the map.
- Comment on Features Categories.
- Comment on the Extent of each feature.
- Write all comments on the A1 map.
- 20 minutes for Activity 1 (finish at 10:30).

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Activity 2: Review of Features vs Benefits

Dr Daryl Burdon, Daryl Burdon Ltd.

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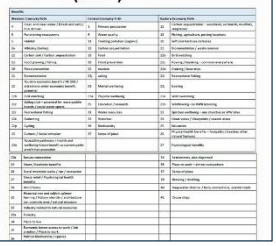
Identification and Mapping of Benefits (WS1)

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Features vs Benefits Matrix (WS1)

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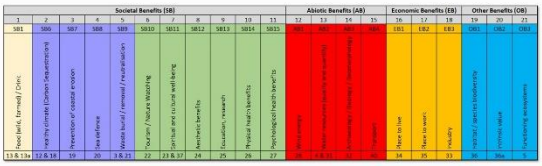
Refined List of Benefits



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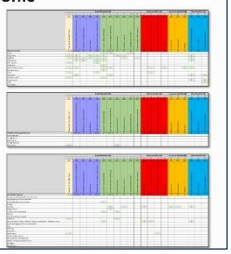
Activity 2: Review of Features vs Benefits

- Each table has part of the Features vs Benefits Matrix.
- Spend 5 minutes familiarising yourself with the matrix.
- Sense check each cell: Green = Benefit from that Feature.
- Facilitator to use an X if cell colour needs to change.
- If time allows comment on Modified/Managed & Man-made Features.
- 30 minutes for Activity 2 (finish at 11:00).



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The Matrix Approach and Future Scenarios

Dr Daryl Burdon, Daryl Burdon Ltd.

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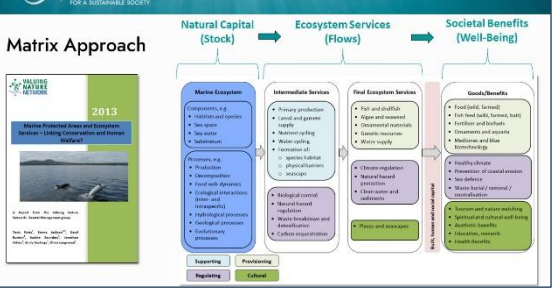
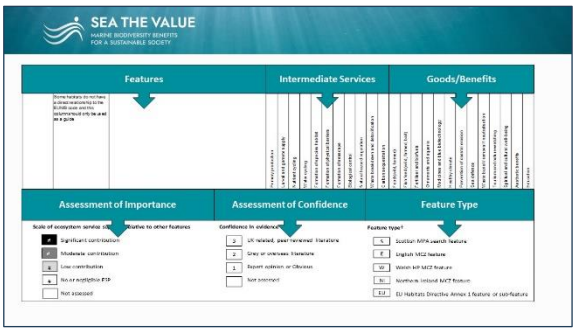
Matrix Approach

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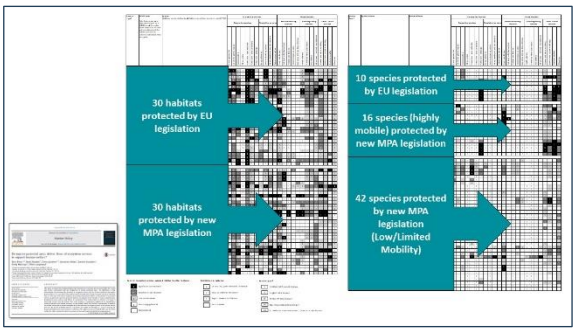
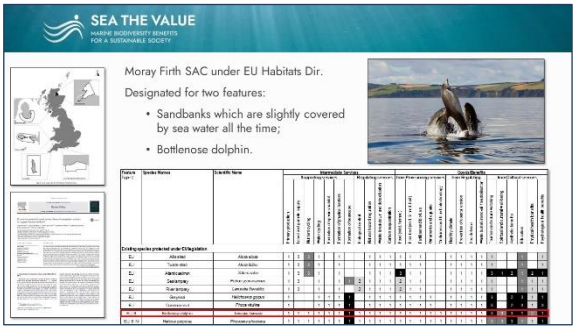
Features
Intermediate Services
Goods/Benefits
Assessment of Importance
Assessment of Confidence
Feature Type


30 habitats protected by EU legislation
30 habitats protected by new MPA legislation
10 species protected by EU legislation
16 species (highly mobile) protected by new MPA legislation
42 species protected by new MPA legislation (Low/Limited Mobility)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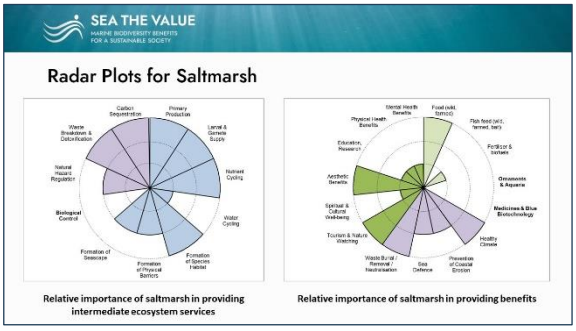
Moray Firth SAC under EU Habitats Dir.
Designated for two features:
• Sandbanks which are slightly covered by sea water all the time;
• Bottlenose dolphin.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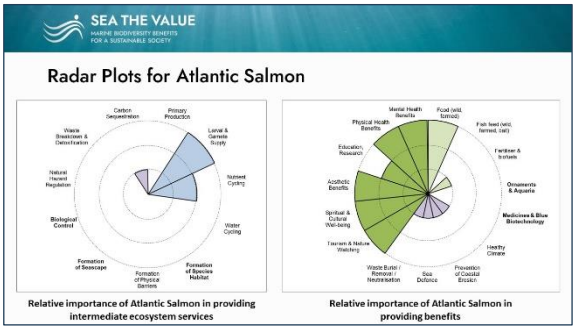
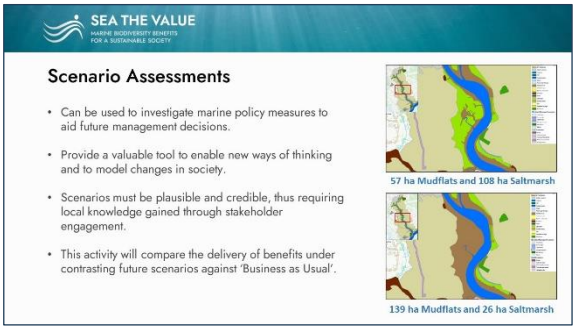
Radar Plots for Saltmarsh
Relative importance of saltmarsh in providing intermediate ecosystem services
Relative importance of saltmarsh in providing benefits


SEA THE VALUE
MARINE BIODIVERSITY BENEFITS FOR A SUSTAINABLE SOCIETY
Radar Plots for Atlantic Salmon
Relative importance of Atlantic Salmon in providing intermediate ecosystem services
Relative importance of Atlantic Salmon in providing benefits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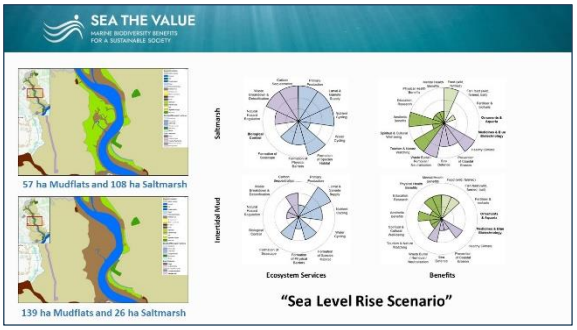
Scenario Assessments
• Can be used to investigate marine policy measures to aid future management decisions.
• Provide a valuable tool to enable new ways of thinking and to model changes in society.
• Scenarios must be plausible and credible, thus requiring local knowledge gained through stakeholder engagement.
• This activity will compare the delivery of benefits under contrasting future scenarios against 'Business as Usual'.
57 ha Mudflats and 108 ha Saltmarsh
139 ha Mudflats and 26 ha Saltmarsh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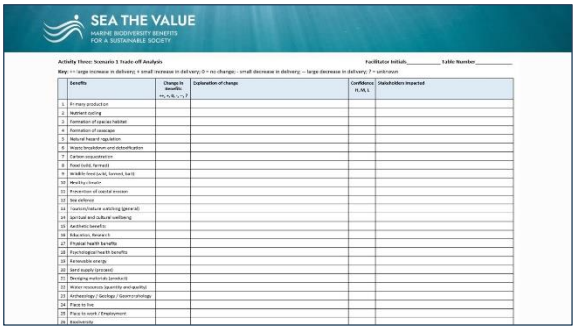
57 ha Mudflats and 108 ha Saltmarsh
139 ha Mudflats and 26 ha Saltmarsh
Saltmarsh
Intertidal Mud
Ecosystem Services
Benefits
"Sea Level Rise Scenario"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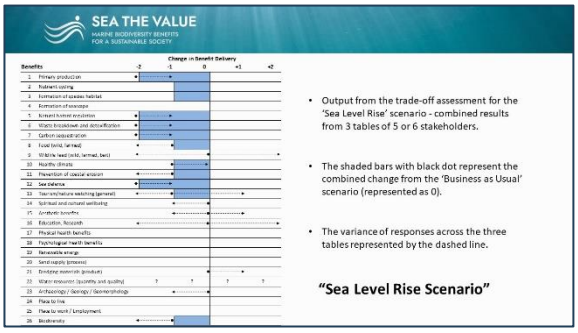
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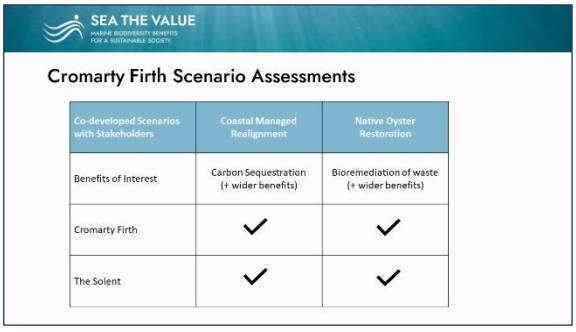
Change in Benefit Delivery
• Output from the trade-off assessment for the 'Sea Level Rise' scenario - combined results from 3 tables of 5 or 6 stakeholders.
• The shaded bars with black dot represent the combined change from the 'Business as Usual' scenario (represented as 0).
• The variance of responses across the three tables represented by the dashed line.
"Sea Level Rise Scenario"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Cromarty Firth Scenario Assessments
Co-developed Scenarios with Stakeholders
Coastal Managed Realignment
Native Oyster Restoration
Benefits of Interest
Carbon Sequestration (+ wider benefits)
Bioremediation of waste (+ wider benefits)
Cromarty Firth
The Solent


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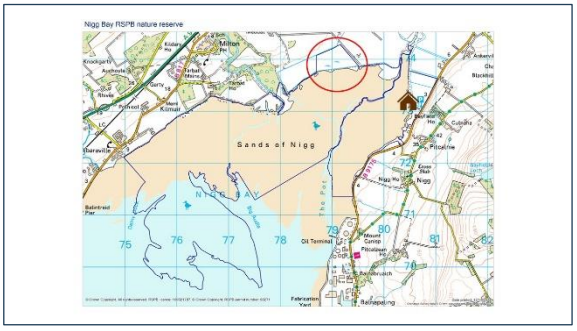
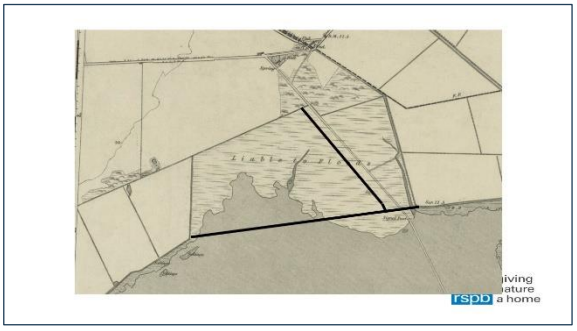
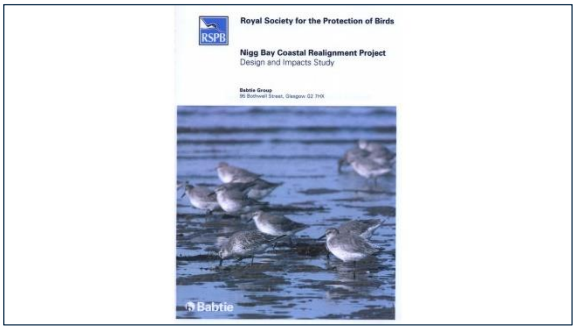
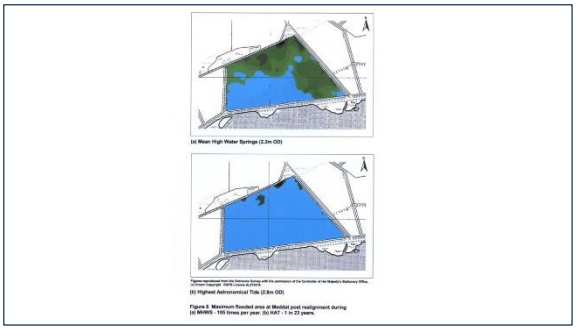
Introduction to the Nigg Bay Coastal Realignment
Steph Elliott, RSPB
www.seathevalue.org
@seathevalue
Natural Environment Research Council
Economic and Social Research Council

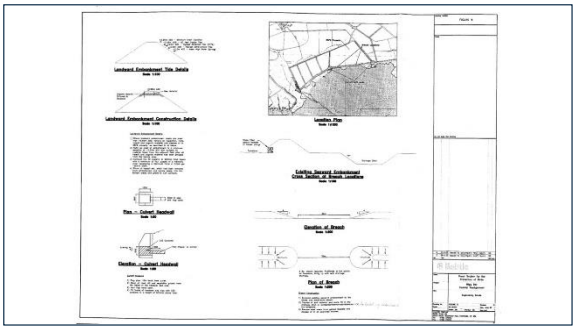

RSPB
SCOTLAND

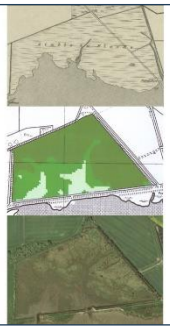

Nigg Bay RSPB nature reserve
Sands of Nigg
Nigg Bay
Oil Terminal
Fabrication Yard
Balintraid Pier


rspb


Royal Society for the Protection of Birds
RSPB
Nigg Bay Coastal Realignment Project
Design and Impacts Study
Babtie Group
Babtie


(a) Mean High Water Springs (3.2m OD)
(b) Highest Astronomical Tide (3.8m OD)


Babtie



Why?

- Climate change adaptation
  - restore previous & mitigate future saltmarsh loss
  - demonstration of technique
  - "future-proof" reserve for wintering birds
- Additional benefits
  - high tide flood storage
  - reduce sea wall maintenance costs
  - (blue carbon)

giving nature a home

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Introduction to Scenario 1: Managed Realignment

Prof. Tavis Potts, University of Aberdeen

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Coastal Managed Realignment

- Managed realignment, is a nature-based intervention whereby existing sea walls are breached to allow tidal inundation on to terrestrial land, resulting in the formation of coastal habitats (mudflats and saltmarsh).
- Managed realignment can be used for flood and erosion management, habitat compensation and/or habitat restoration.
- It can be seen as a triple-win for the environment, society and the economy.
- Managed realignment is, however, a sensitive matter for landowners; their interests must be taken into account and handled with care.

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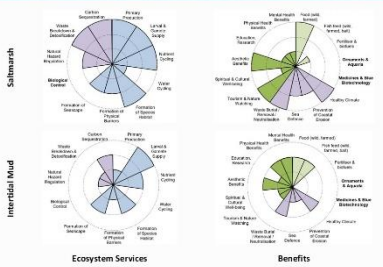

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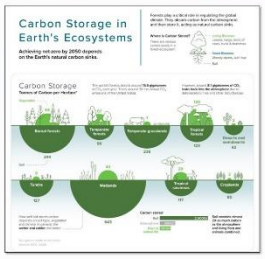
Carbon Sequestration

Marine Features	Carbon Sequestration Rate (tC/ha/yr)	
	Low	High
Saltmarsh (A2.5)	0.86	2.59
Subtidal Sands (A5.2)	0.08	0.56
Subtidal Muds (A5.3)	0.12	0.56
Intertidal Sediments (A2.1, A2.2, A2.3, A2.4)	0.11	0.37
Seagrass beds (A2.6)	0.27	0.27
Shellfish beds (A2.7, A5.4)	0.01	0.09

- One of the primary focusses of the Sea The Value project, is on carbon sequestration within coastal systems.
- Carbon sequestration can be defined as the "*net capture of carbon dioxide by coastal and marine biota*"
- Other habitats within the Cromarty Firth (e.g. seagrass, intertidal and subtidal sediments) also provide a carbon sequestration function.



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Scenario 1: Managed Realignment in the Cromarty Firth

- Scenario 1 proposes that an additional series of managed realignment sites could be created in the Cromarty Firth to achieve the multiple benefits.
- Proposing a series of managed realignment sites, rather than just an individual site, would be in-keeping with the recent Scottish Biodiversity Strategy which states:
  - *"Protected areas will be larger, better connected and in good condition"* (pp. 30)
  - *"Nature Networks across our landscapes will underpin the resilience and health of species and habitats"* (pp. 31).

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Scenario 1: Managed Realignment in the Cromarty Firth

- Scenario 1 proposes that an additional 130 ha of saltmarsh could be created within a series of managed realignment sites around the Cromarty Firth
- This would increase saltmarsh extent in the Cromarty Firth by approximately 30% based on the extent of saltmarsh identified and mapped by the stakeholders in the participatory mapping workshop.
- This could result in 104 - 273 tC/ha/yr being sequestered, in addition to providing a wide range of other benefits for society which we will also explore within this scenario.

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Scenario 1: Managed Realignment in the Cromarty Firth

- This scenario will therefore look at the trade-offs in societal benefits with a change in land-use.
- No site-specific locations have been identified, and therefore for the purposes of this exercise we will assume that there will be a land-use change from agricultural land to coastal saltmarsh
- NOTE: It is recognised that managed realignment may be undertaken on terrestrial land which is currently used for other purposes.

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Scenario 1: Managed Realignment in the Cromarty Firth

- It must be strongly emphasised here that this is a hypothetical future scenario.
- There are no formal plans to undertake such interventions.
- Any replacement of land, as part of any future managed realignment project, would only be considered with the full consultation and willing participation of landowners.
- These scenarios are for demonstration purposes only.

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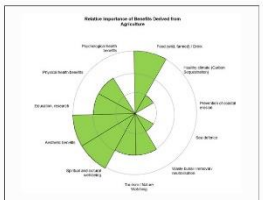
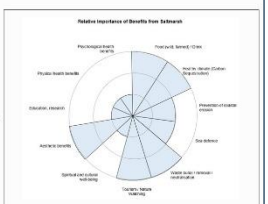
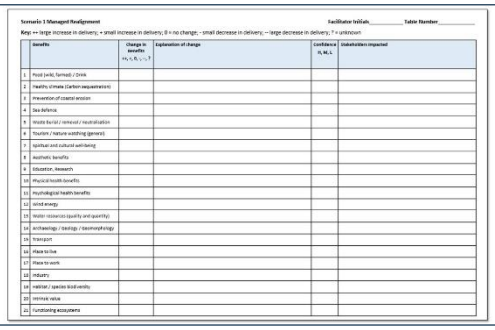
Scenario 1: Trade-off Assessment



Business As Usual Scenario: Relative importance of agricultural land in delivering societal benefits.



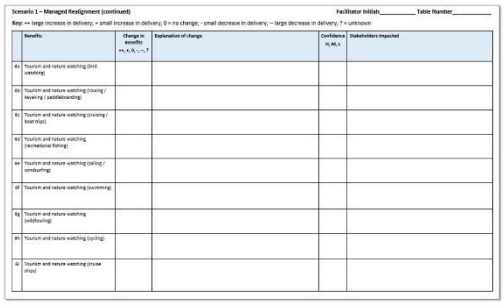
Scenario 1 - Managed Realignment: Relative importance of saltmarsh in delivering societal benefits.



Scenario 1 Managed Realignment — Facilitator Initials_____ Table Number_____

Key: ++ large increase in delivery; + small increase in delivery; 0 = no change; - small decrease in delivery; -- large decrease in delivery; ? = unknown

	Benefits	Change in benefit (++, +, 0, -, --, ?)	Explanation of change	Confidence (H, M, L	Stakeholders impacted
1	Food (wild, farmed) / Drink				
2	Healthy climate (Carbon sequestration)				
3	Prevention of coastal erosion				
4	Sea defence				
5	Waste burial / removal / neutralisation				
6	Tourism / nature watching (general)				
7	Spiritual and cultural well-being				
8	Aesthetic benefits				
9	Education, Research				
10	Physical health benefits				
11	Psychological health benefits				
12	wind energy				
13	Water resources (quality and quantity)				
14	archaeology / geology / geomorphology				
15	Transport				
16	Place to live				
17	Place to work				
18	Industry				
19	Habitat / species biodiversity				
20	Intrinsic value				
21	Functioning ecosystems				



Scenario 1 – Managed Realignment (continued) — Facilitator Initials_____ Table Number_____

Key: ++ large increase in delivery; + small increase in delivery; 0 = no change; - small decrease in delivery; – large decrease in delivery; ? = unknown

	Benefits	Change in benefits (++, +, 0, -, –, ?)	Explanation of change	Confidence (H, M, L	Stakeholders impacted
6a	Tourism and nature watching (bird watching)				
6b	Tourism and nature watching (rowing / kayaking / paddleboarding)				
6c	Tourism and nature watching (cruising / boat trips)				
6d	Tourism and nature watching (recreational fishing)				
6e	Tourism and nature watching (sailing / windsurfing)				
6f	Tourism and nature watching (swimming)				
6g	Tourism and nature watching (wildfowling)				
6h	Tourism and nature watching (cycling)				
6i	Tourism and nature watching (cruise ships)				

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Activity 3: Trade-off Assessment

- Spend a few mins discussing the scenario and the template.
- The Business As Usual scenario is that the land remains as agricultural land and benefit delivery remains the same.
- The future scenario is a change from agricultural land to saltmarsh.
- For each benefit, assess how the benefit would change under the future scenario (++, +, 0, -, –, ?).
- Facilitators will take notes and assess confidence in the response.
- Finally, think about which stakeholders may be impacted due to the change in benefits.
- You have 45 minutes to complete this activity.

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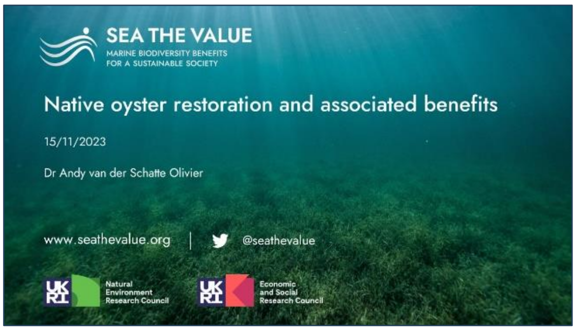
Lunch 12:30-13:15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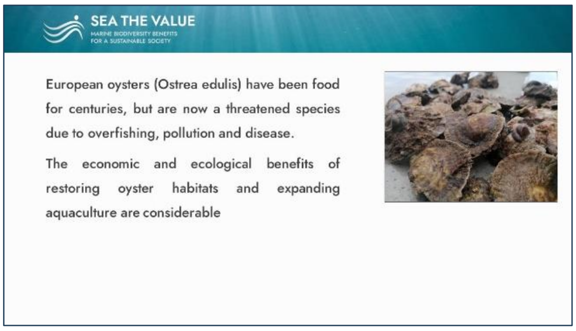
Native oyster restoration and associated benefits
15/11/2023
Dr Andy van der Schatte Olivier
www.seathevalue.org
@seathevalue
Natural Environment Research Council
Economic and Social Research Council


SEA THE VALUE
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FOR A SUSTAINABLE SOCIETY
European oysters (Ostrea edulis) have been food for centuries, but are now a threatened species due to overfishing, pollution and disease.
The economic and ecological benefits of restoring oyster habitats and expanding aquaculture are considerable

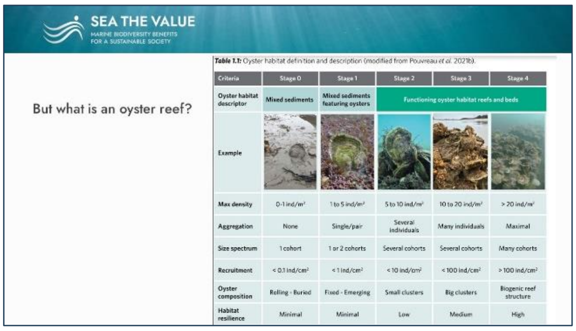
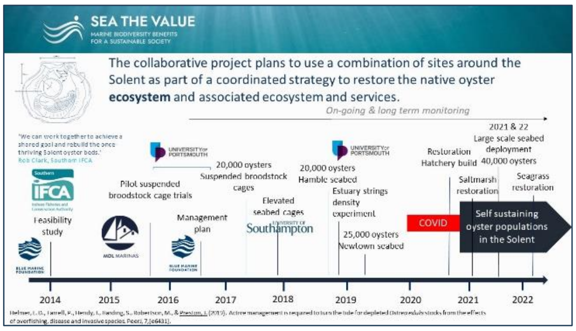


Table 1.1: Oyster habitat definition and description (modified from Pouvreau *et al.* 2021b).

Criteria	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Oyster habitat descriptor	Mixed sediments	Mixed sediments featuring oysters	Functioning oyster habitat reefs and beds		
Example					
Max density	0-1 ind/m²	1 to 5 ind/m²	5 to 10 ind/m²	10 to 20 ind/m²	> 20 ind/m²
Aggregation	None	Single/pair	Several individuals	Many individuals	Maximal
Size spectrum	1 cohort	1 or 2 cohorts	Several cohorts	Several cohorts	Many cohorts
Recruitment	< 0.1 ind/cm²	< 1 ind/cm²	< 10 ind/cm²	< 100 ind/cm²	> 100 ind/cm²
Oyster composition	Rolling - Buried	Fixed - Emerging	Small clusters	Big clusters	Biogenic reef structure
Habitat resilience	Minimal	Minimal	Low	Medium	High


SEA THE VALUE
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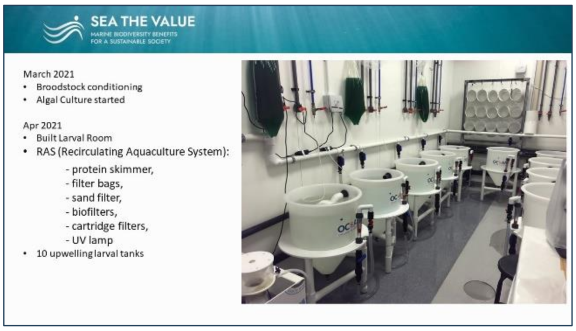
FOR A SUSTAINABLE SOCIETY
The collaborative project plans to use a combination of sites around the Solent as part of a coordinated strategy to restore the native oyster ecosystem and associated ecosystem and services.
On-going & long term monitoring
'We can work together to achieve a shared goal and rebuild the once thriving Solent oyster beds.'
Rob Clark, Southern IFCA
Southern IFCA
Feasibility study
Pilot suspended broodstock cage trials
MDL MARINAS
UNIVERSITY of PORTSMOUTH
20,000 oysters Suspended broodstock cages
Management plan
BLUE MARINE FOUNDATION
Elevated seabed cages
University of Southampton
20,000 oysters Hamble seabed
Estuary strings density experiment
25,000 oysters Newtown seabed
COVID
Restoration Hatchery build
Saltmarsh restoration
2021 & 22 Large scale seabed deployment 40,000 oysters
Seagrass restoration
Self sustaining oyster populations in the Solent
2014
2015
2016
2017
2018
2019
2020
2021
2022
Helmer, L.D., Farrell, P., Hendy, I., Harding, S., Robertson, M., & Preston, J. (2019). Active management is required to turn the tide for depleted Ostrea edulis stocks from the effects of overfishing, disease and invasive species. PeerJ, 7,[e6431].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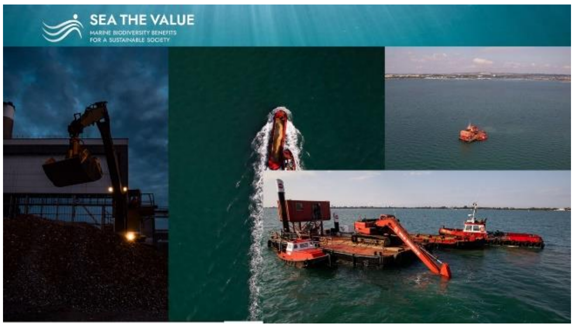
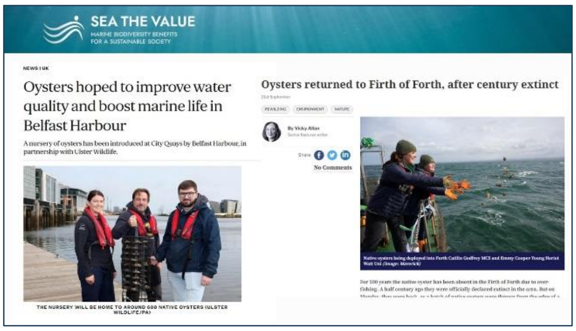
March 2021
• Broodstock conditioning
• Algal Culture started
Apr 2021
• Built Larval Room
• RAS (Recirculating Aquaculture System):
- protein skimmer,
- filter bags,
- sand filter,
- biofilters,
- cartridge filters,
- UV lamp
• 10 upwelling larval tanks

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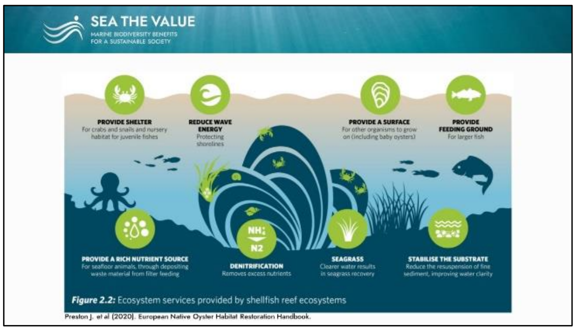
MARINE BIODIVERSITY BENEFITS
FOR A SUSTAINABLE SOCIETY
Oysters hoped to improve water quality and boost marine life in Belfast Harbour
A nursery of oysters has been introduced at City Quays by Belfast Harbour, in partnership with Ulster Wildlife.
THE NURSERY WILL BE HOME TO AROUND 600 NATIVE OYSTERS (ULSTER WILDLIFE/PA)
Oysters returned to Firth of Forth, after century extinct
No Comments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FOR A SUSTAINABLE SOCIETY
PROVIDE SHELTER
For crabs and snails and nursery habitat for juvenile fishes
REDUCE WAVE ENERGY
Protecting shorelines
PROVIDE A SURFACE
For other organisms to grow on (including baby oysters)
PROVIDE FEEDING GROUND
For larger fish
PROVIDE A RICH NUTRIENT SOURCE
For seafloor animals, through depositing waste material from filter feeding
DENITRIFICATION
Removes excess nutrients
SEAGRASS
Clearer water results in seagrass recovery
STABILISE THE SUBSTRATE
Reduce the resuspension of fine sediment, improving water clarity
Figure 2.2: Ecosystem services provided by shellfish reef ecosystems
Preston J. et al (2020). European Native Oyster Habitat Restoration Handbook.

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Thank you

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Introduction to Scenario 2: Native Oyster Restoration

Dr Daryl Burdon, Daryl Burdon Ltd.

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Scenario 2: Native Oyster Restoration in the Cromarty Firth

- Bioremediation of waste can be defined as the "*The presence of coastal and marine biota which have the potential to remove anthropogenic contaminants and organic inputs*".
- Bioremediation is undertaken by a range of features (habitats and species) in the Cromarty Firth, such as Horse mussels (Modiolus modiolus), European blue mussels (Mytilus edulis) and other filter feeding bivalves.
- Our focus in this scenario is solely on the restoration of Native oysters in the Cromarty Firth.
- Historically, the Cromarty Firth has had Native oyster beds present and therefore the Firth is considered to be a suitable area for the re-introduction of the species.

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Scenario 2: Native Oyster Restoration in the Cromarty Firth

- Native oysters naturally live in shallow, subtidal coastal and estuarine habitats, in areas dominated by mixed sediments.
- Native oysters filter algae and organic matter from the water column, which form their food source, and in doing so can significantly improve surrounding water quality by decreasing the turbidity.
- Native oysters also have the ability to remove excess nutrients from water, particularly nitrogen, which at high levels can be detrimental to the environment by promoting harmful algal blooms, depleting oxygen and fish death.

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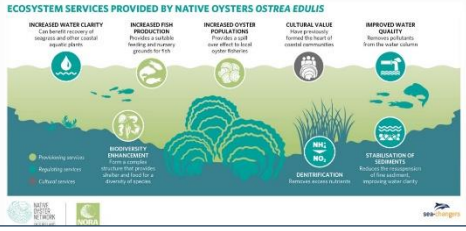
Scenario 2: Native Oyster Restoration in the Cromarty Firth



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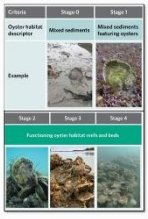
Scenario 2: Native Oyster Restoration in the Cromarty Firth



- The aim is to establish a self-sustaining reef, but the critical mass required to achieve this continues to be subject to debate and will ultimately depend on site characteristics such as hydrodynamics and seabed structure.
- At present community-led plans to re-introduce Native oysters into the Cromarty Firth are at an early stage with some initial baseline ROV and intertidal surveys underway.
- The DEEP project (Dornoch Firth), aims to establish a self-sustaining reef of 4 million oysters covering an area of 40 ha, replicating population numbers in the 1900s.
- However, environmental conditions within the Dornoch and Cromarty Firths differ, and therefore these figures are just indicative.

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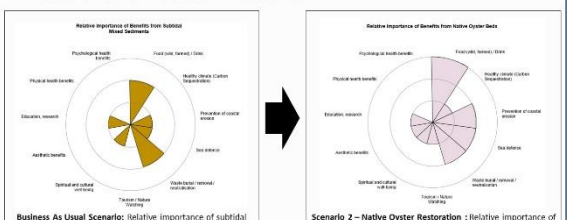
Scenario 2: Trade-off Assessment



Business As Usual Scenario: Relative importance of subtidal mixed sediment in delivering societal benefits.

Scenario 2 – Native Oyster Restoration : Relative importance of Native Oyster Beds in delivering societal benefits.

Scenario 2 - Native Oyster Restoration — Facilitator Initials_____ Table Number_____

Key: ++ large increase in delivery, + small increase in delivery, 0 = no change, - small decrease in delivery, – large decrease in delivery, ? = unknown

	Benefits	Change in benefits ++, +, 0, -, –, ?	Explanation of change	Confidence H, M, L	Stakeholders impacted
1	Food (wild, farmed) / Drink				
2	Healthy climate (carbon sequestration)				
3	Prevention of coastal erosion				
4	Sea defence				
5	Waste burial / removal / neutralisation				
6	Tourism / Nature watching (general)				
7	Spiritual and cultural well-being				
8	Aesthetic benefits				
9	Education, Research				
10	Physical health benefits				
11	Psychological health benefits				
12	Wind energy				
13	Water resources (quality and quantity)				
14	Archaeology / geology / geomorphology				
15	Transport				
16	Place to live				
17	Place to work				
18	Industry				
19	Habitat / species biodiversity				
20	Intrinsic value				
21	Functioning ecosystems				

Scenario 2 - Native Oyster Restoration (continued) — Facilitator Initials_____ Table Number_____

Key: ++ large increase in delivery, + small increase in delivery, 0 = no change, - small decrease in delivery, – large decrease in delivery, ? = unknown

	Benefits	Change in benefits ++, +, 0, -, –, ?	Explanation of change	Confidence H, M, L	Stakeholders impacted
6a	Tourism and nature watching (bird watching)				
6b	Tourism and nature watching (rowing / kayaking / paddleboarding)				
6c	Tourism and nature watching (cruising / boat trips)				
6d	Tourism and nature watching (recreational fishing)				
6e	Tourism and nature watching (sailing / windsurfing)				
6f	Tourism and nature watching (swimming)				
6g	Tourism and nature watching (wildfowling)				
6h	Tourism and nature watching (cycling)				
6i	Tourism and nature watching (cruise ships)				

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Activity 4: Trade-off Assessment

- Spend a few mins discussing the scenario and the template.
- The Business As Usual scenario is that the seabed remains as subtidal mixed sediment and benefit delivery remains the same.
- The future scenario is a change from subtidal mixed sediment to Native oyster beds.
- For each benefit, assess how the benefit would change under the future scenario (++, +, 0, -, –, ?).
- Facilitators will take notes and assess confidence in the response.
- Finally, think about which stakeholders may be impacted due to the change in benefits.
- You have 45 minutes to complete this activity.

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Discussion, Feedback and Next Steps

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Discussion...

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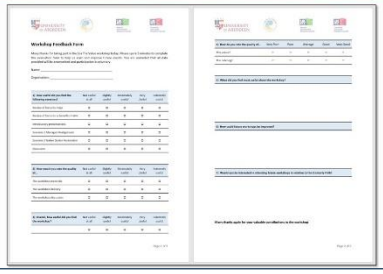
Feedback...



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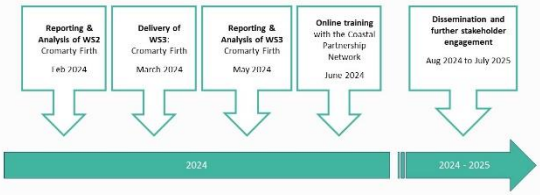
Next Steps...



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Dr Daryl Burdon	darylburdon@gmail.com

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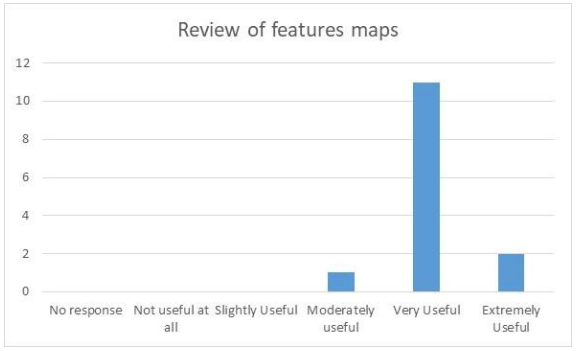
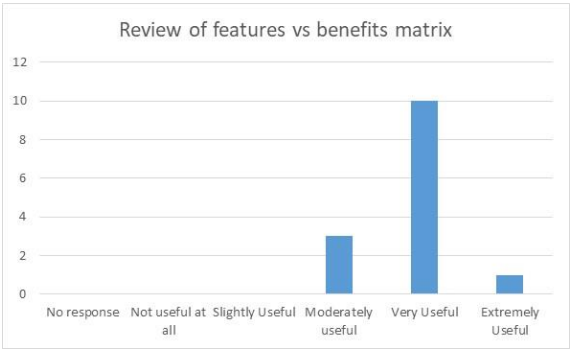
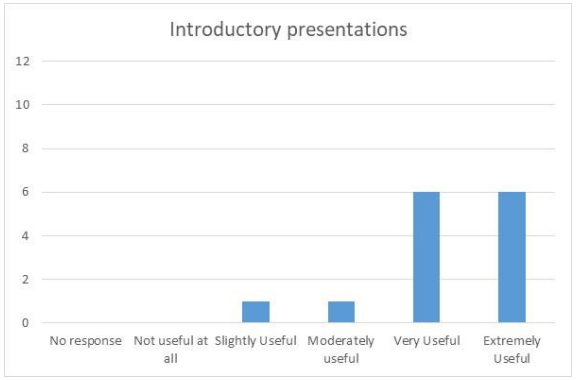
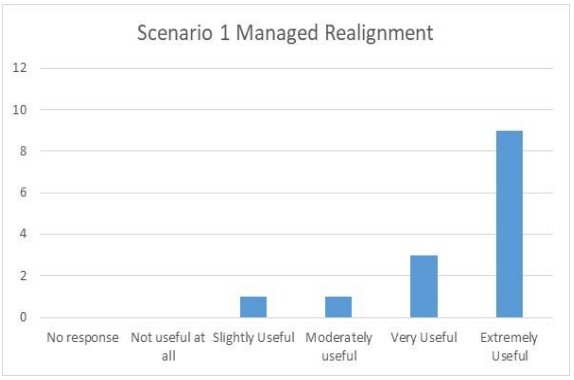
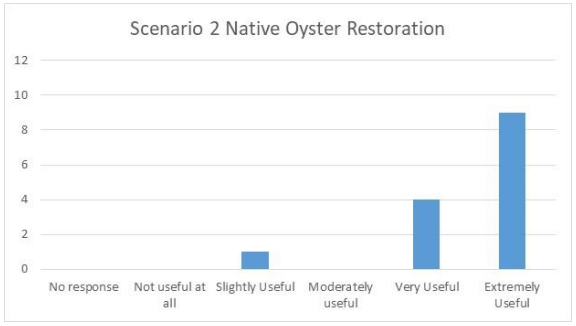
Annex 3: Summary of Workshop Feedback

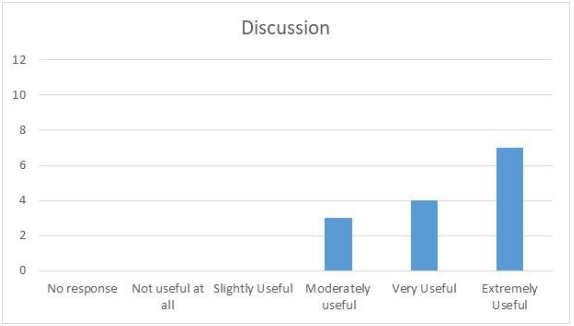


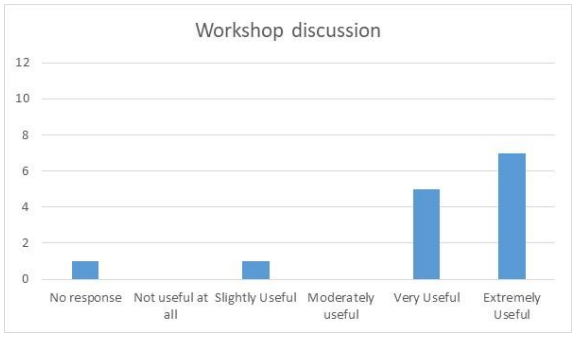


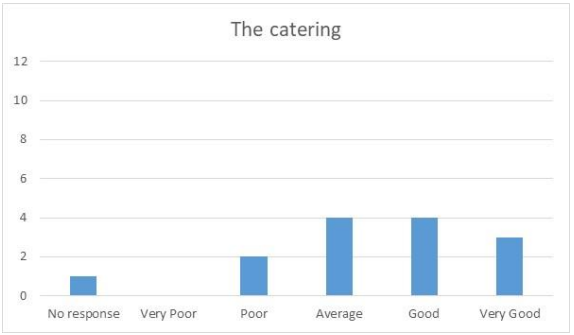












Sample comments on what was most useful about the workshop:

- "*Excellent workshop and opportunity for networking with other stakeholders*."
- "*The hypothetical case studies and spending time working through them was great – a very helpful discussion and good facilitation*."
- "*Learning from different people with different backgrounds*."
- "*Opportunity to be part of a discussion thinking about how I can use the maps with communities as part of our place plan activity*."
- "*Interesting discussions and insight into the topics and scenarios*."
- "*Thinking about different perspectives*."
- "*The most useful thing is bringing people together to talk about the Firth and what could be done and what is being done.*"

Sample comments on how the workshop could be improved in the future:

- "*Maybe more information to read up on in advance of the workshops*."
- "*Maybe evenings/weekends to attract other groups*."
- "*Would be interested to hear views from other landowners around the Firth e.g. farmers*."
- "*Encourage more community members to take part – to balance the conversation – ground scientific discussion in lived experience.*"
- "*A longer lunch to allow for more networking*."