Supporting **I**mplementation of **M**aritime Spatial Planning in the **Celt**ic Seas

Component: 1.2 Support for Member States' Implementation of Maritime Spatial Planning

Sub-component: 1.2.1 Spatial Demands and Scenarios for Maritime Sectors and Marine Conservation

Deliverable: D3c Overview Report on the Current State and Potential Future Spatial Requirements of Key Maritime Activities

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Coordinator	Stephen Jay
Authors	**Lynne McGowan, Stephen Jay, Sue Kidd**
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Table of Contents

Figures

Tables

Boxes

List of Acronyms

AFB	Agence Française pour la Biodiversité
AIS	Automatic Identification System
CBD	Convention on Biological Diversity
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
COM	Communication
DAERA	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)
DEFRA	Department of Environment Food and Rural Affairs (England)
DCCAE	Department of Communications, Climate Action and Environment (Ireland)
DG-MARE	Directorate-General for Maritime Affairs and Fisheries
DIRM-NAMO	Direction Interrégionale de la Mer Nord Atlantique Manche Ouest
EC	European Commission
EIA	Environmental Impact Assessment
EMFF	European Maritime and Fisheries Fund
EU	European Union
GDP	Gross Domestic Product
GES	Good Environmental Status
GVA	Gross Value Added
HOOW	Harnessing Our Ocean Wealth (Ireland)
IAS	Invasive Alien Species
IMO	International Maritime Organization
IMP	Integrated Maritime Policy
MMO	Marine Management Organisation
MPA	Marine Protected Area
MSP	Maritime/Marine Spatial Planning
MSFD	Marine Strategy Framework Directive
MS	Member State
NAMO	North Atlantic and Western Channel
NGO	Non-Governmental Organisation
OREDP	Offshore Renewable Energy Development Plan (Ireland)
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
SA	Sustainability Appraisal
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SNML	National Strategy for the Sea and Coastline (France)

SPA	Special Protection Area
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UK	United Kingdom
WNMP	Welsh National Marine Plan

The SIMCelt Project

SIMCelt - Supporting Implementation of Maritime Spatial Planning in the Celtic Seas is a two-year €1.8 million project co-financed by DG MARE and focussed on promoting the development of transnational cooperation to support the implementation of Directive 2014/89/EU in the Celtic Seas. Led by University College Cork, the project consortium comprises both planners and researchers from seven partner institutes representing a mix of governmental authorities and academic institutes from Ireland, France and the UK. This consortium is particularly interested in developing meaningful cooperation between neighbouring Member States to support implementation of spatially coherent plans across transboundary zones of the Celtic Seas, building on previous work and leveraging new opportunities to identify and share best practice on technical, scientific and social aspects of transboundary maritime spatial planning (MSP).

This report brings together research work that has been undertaken on the development of scenarios for MSP, including the results of a scenarios workshop, and presents the main findings of this in relation to future spatial demands in the Celtic Seas.

1. Introduction

1.1 Context

This report provides an overview of work undertaken as part of SIMCelt component C.1.2.1, *Future Spatial Demands and Scenarios for Maritime Sectors and Marine Conservation*. The specific objective of this component is:

To investigate current and potential future spatial demands of key maritime sectors, with reference to cross-border issues.

To achieve this objective, research has involved:

- An analysis of existing spatial constraints, demands and expectations for growth of key sectors
- Considering information that appears critical to informing decisions in relation to future demands, e.g. economic and social evaluations
- Stakeholder input from government representatives, sector representatives and other interested parties

These activities have been led by the University of Liverpool in addition to this, further research undertaken by Agence Française pour la Biodiversité (AFB) has analysed activities for establishing Marine Protected Areas (MPAs) in Member States waters. This has helped to identify designated, planned and potential protected sites that may influence the location of future maritime activities in other sectors.

In addition to this report, outputs associated with Component C.1.2.1 include five Sector Briefing Notes that cover the key maritime sectors the project has focused on. These are:

- Aquaculture
- Cables and Pipelines
- Offshore Wind Energy
- Ports and Shipping
- Wave and Tidal Energy

These Briefing Notes provide information on the current status and trends of each sector within the Celtic Seas, associated marine planning policies and the drivers of change that may affect how each sector develops in the future. In addition, a separate Comparative Analysis of National Strategies for Marine Conservation in the Celtic Seas Region (de Magalhaes et al, 2017) has been undertaken by Agence Française pour la Biodiversité (AFB, French Biodiversity Agency). This provides insights into the governance of Marine Protected Areas (of numerous types) at international, European and national levels and identifies key similarities and differences between management approaches, recognising that different types of protected area can prohibit human activity, but also through an ecosystem-based approach allow for certain types of activity within limits. This, in turn, helps to demonstrate where countries can cooperate to develop coherent and integrated environmental protection within the Celtic Seas.

1.2 Structure of Report

This report is divided into five chapters. **Chapter 1** considers what is meant by scenarios and explores their use in both terrestrial planning and marine management (including MSP) in order to draw out key lessons from existing experience of scenario building studies and understand the individual steps that may be required in building scenarios. **Chapter 2** then applies these lessons to the development of a scenario building methodology for use within the SIMCelt project. Here the overall approach to developing scenarios is described in detail, with reference to earlier work undertaken in the writing of the maritime sector Briefing Notes, and plans for how these scenarios will be used.

Chapter 3 details how the scenarios were tested by stakeholders in a workshop held in September 2017 and presents the outputs of discussions held on the day. Three central questions were put to stakeholders to determine how the spatial footprint of key maritime sectors would change up to 2050 and the implications this would have for transnational cooperation on MSP. By looking first at sectoral ambitions, then potential interactions with other sectors, it has been possible to identify key future issues for MSP and transnational working.

Chapter 4 analyses the outputs of the workshop to draw some conclusions about the changing spatial demands in the Celtic Seas that MSP may have to manage. In doing so, it analyses some of the key sectoral changes and potential interactions that may become more critical to MSP. How planning authorities may work collaboratively to resolve the issues related to future spatial demands is discussed, with stakeholder recommendations from the scenarios workshop forming the basis for this analysis.

Finally, **Chapter 5** of the report reflects on the scenario building process as a tool for generating stakeholder debate and evidence gathering to support the MSP process. The report also makes recommendations to planning authorities regarding the management of changing spatial patterns of development and how transnational approaches can contribute to more ecosystem-based, integrated MSP.

2. The Use of Scenarios in Spatial Planning

2.1 Introduction: The Purpose of Scenarios

Critical to any forward-looking spatial plan is the setting of goals and an understanding of the baseline conditions, drivers of change and future trends that will shape new spatial development. However, to determine what the most desirable future for any given place might look like several tools for decision making can be used, including the development of visions, strategies, forecasts, road maps, action plans and scenarios.

- A *vision,* or spatial vision, as used within the planning process refers to an expression about desired future outcomes of a planning process, may be created collectively and encompass a single goal or series of goals (Shipley and Newkirk, 1999).

- A *strategy* describes in broad terms a method or plan of action designed to achieve a goal or aim. The European Commission's Communication on Developing a Maritime Strategy for the Atlantic Ocean Area (COM(2011) 782 final) outlines a range of actions to promote territorial cohesion and the overriding objective of creating sustainable jobs and growth, for example through regional clustering of maritime industries with educational establishments.

- *Forecasts* are predictions or estimates of the future state of a given variable over a period of time, for example weather conditions or financial trends. Forecasts are usually based on an understanding of the current state and underlying assumptions about how the variable is likely to change.

- *Road maps* are plans or strategies with an intended goal, for example the Department of Housing, Planning and Local Government in Ireland's "Towards a Marine Spatial Plan for Ireland – a roadmap for the development of Ireland's first marine spatial plan" (Department of Housing, Planning and Local Government, 2017) sets out the four stages of work that are needed to develop Ireland's first Marine Spatial Plan. The Roadmap itself constitutes a first stage in this process.

- *Action plans* contain more detailed actions needed to reach particular goals, which may or not follow each other in sequence. Action plans may also accompany broader strategies, for example the European Commission's Action Plan for a Maritime Strategy in the Atlantic area (the Atlantic Action Plan, COM(2013) 279 final) sets the priorities for research and investment that will be needed to drive the ambitions of the Atlantic Strategy forward.

Whilst all these tools are relevant for MSP, the focus of this work is on the use of scenarios to understand future spatial demands for maritime space. The use of scenarios as part of planning processes has its origins in military strategy and business planning (Lindgren and Bandhold, 2009:38), and whilst there is no single definition of a scenario, one useful definition from the Intergovernmental Panel on Climate Change (2008) states:

> *"A scenario is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold."*

Therefore, any process that examines a scenario or scenarios involves first of all the creation of alternative images of the future and then evaluating this scenario or scenarios against some kind of goal or set of values. In doing so, the purpose of using scenarios is inextricably linked to the question of *what is it we want to know about the future?* At a general level, van Hoof at al. (2014) posit that scenarios 'can contribute to policy decision making by identifying and anticipating developments (desirable and undesirable) and information gaps and inconsistencies' that help to focus attention on causal processes and decision points that can be used in making better strategies.

At a more specific level, scenarios can cover a range of questions about the future based on elements such as their theme, process and content. Several authors (for example, Ducot and Lubben (1980), Duncan and Wack (1994) and Van Notten et al. (2003)) have attempted to define typologies of scenarios based on these criteria and others. However, for the purpose of this research, the typology created by Borjeson (2006) has been used to determine types of scenario, which are outlined in the next section.

2.2 Types of Scenario

Borjeson (2006) provides a simple distinction between scenario types based on principal questions a user may want to pose about the future. This uses three questions:

- What will happen?
- What can happen?
- How can a specific target be reached?

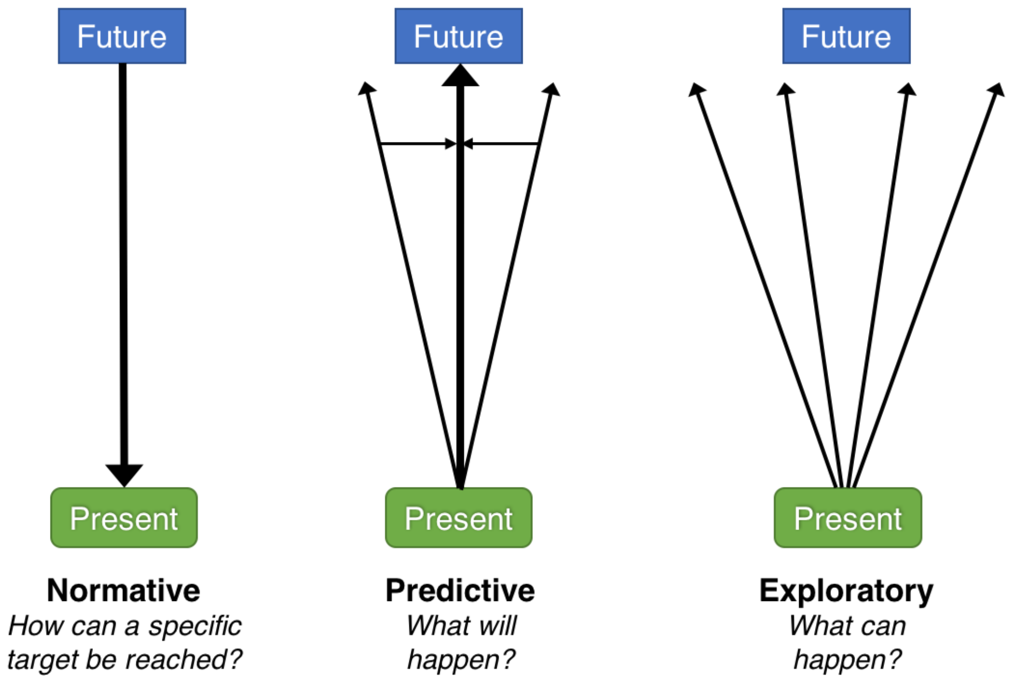
Normative scenarios address the question of *how can a specific target be reached?* Normative scenarios are most frequently used when a desired end state is known, and the user wants to determine how that state can be reached by working backwards. Back casting in this way can help to identify incremental steps that should be taken to achieve the desired goal, and also identify the factors that may prevent achievement of the end goal.

Predictive scenarios can be used to answer the question of *what will happen?* In this case, information about the past and present is projected forward to a specific point to see what the situation might be. In other words, forecasting is used to determine change. For example, predictions of coastal erosion around the UK coast have been used to develop Shoreline Management Plans that respond to potential risks over 20, 50 and 100-year periods.

The last type, **exploratory** scenarios consider '*what can happen?'* given a set of plausible futures. They are often used to understand developments over a longer time horizon or more strategic issues (Borjeson et al, 2006:727). Examples of this type of scenario include those used for the Rising Waters project, which aimed to strengthen the preparedness and adaptive capacity of communities within the Hudson River watershed in the face of climate change (see Roberts, 2014). Here four scenarios (Procrastination Blues, Stagflation Rules, Nature be Damned! and Give Rivers Room!) were used to determine the consequences of different paths of action and the likelihood that different response options would be taken up under each scenario.

The pathways explored by each of the three types of scenario can be summarised as shown in Figure 1 below. Visualising scenarios in this way, normative scenarios may be seen as 'inward bound' as they work backwards to see how a desired future might grow from the present. In contrast, predictive and exploratory scenarios might be described as 'outward bound' as they extrapolate trends into the future or ask *what if?* or *what can happen?* questions to arrive at a range of possibilities.

Figure 1: Types of scenario



Source: Quist (2014)

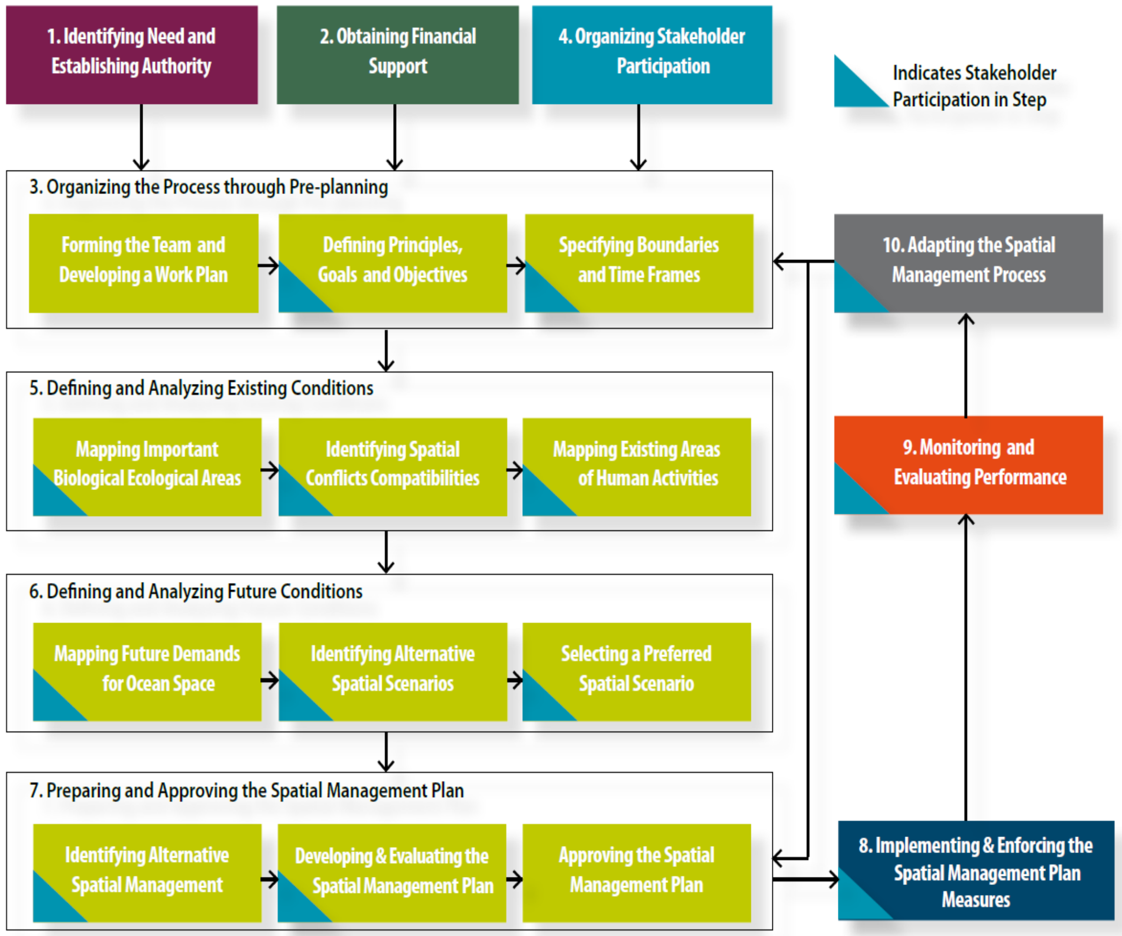
Whilst the typology of scenarios used here is illustrated with reference to ways of generating different images of the future that may be either quantitative (as may be the case with a predictive scenario) or qualitative (in the case of exploratory scenarios), there are instances when different types can be used in conjunction with each other, for example in the Water Scenarios for Europe and for Neighbouring Countries (SCENES) project, exploratory scenarios for freshwater management were first developed to provide a specific 'end point' that set a socio-economic and institutional context for water management, and then used a backcasting (normative) method to identify interim objectives, policy actions and strategies to achieve this vision (see Kok et al, 2011).

In the following section, examples of how scenarios have been used for different aspects of marine management (including MSP) are considered. These show not only the contexts in which scenarios may help decision making but also the range of techniques used to build different scenarios and the characteristics an effective scenarios exercise should incorporate to maximise their usefulness in planning processes.

2.3 The Use of Scenarios in Maritime Spatial Planning and Management

The use of scenarios to assist in planning can also be applied through the MSP process. Under the UNESCO Guide for MSP (Ehler and Douvere, 2009), identifying alternative spatial scenarios is an essential part of Step 6, Defining and Analyzing Future Conditions (as shown in Figure 2 below).

Figure 2: A Step-by Step Approach to MSP



Source: Ehler and Douvere (2009)

As part of the plan making process, Step 5 – Defining and Analyzing Existing Conditions should provide a baseline analysis of the current social, economic and environmental characteristics of the plan area. In considering future conditions, the next step is essentially asking the question “Where do we want to be?”. To inform this, key outputs from this step ought to include:

- A *trend scenario*, or a predictive scenario outlining what the plan area may look like if there are no new planning interventions (this is commonly referred to as the ‘Business as usual' scenario). This involves defining a timeframe or limit for how far ahead any potential changes to sea uses should be considered, for example 10, 20 years and so on. Historical trends may be projected forward, and potential new activities should be incorporated to determine spatial and temporal requirements for the use of marine space. Forecasting changes to spatial demands at this point and visualising changes using GIS maps may help to identify conflicts and compatibilities in marine use.

- *Alternative spatial scenarios*. These may be more exploratory scenarios demonstrating how human activities in the plan area may look under different sets of goals and objectives. The Guide cites the example of scenario development for the Belgian part of the North Sea, where six scenarios were developed based on the weighting given to sets of objectives and goals under the themes of Ecology and Biodiversity, Economy and Society and Culture in association with a set of decision rules. Whilst an exact methodology for generating alternative scenarios (or the number of scenarios) is specified, the Guide does emphasis the need for decision making rules or criteria for developing scenarios. By developing alternatives, it should be possible to see:
    - Where there is a concentration of activities,
    - Areas that may need special protection
    - Relationships between different areas and networks

- A *preferred scenario*, that provides a normative basis for identifying and selecting management options that will feature in the marine plan. In this final phase, a decision should be made about the preferred scenario, based on the goals and objectives that are prioritised for the plan area. However, the viability of preferred options does not just rest on the achievement of objectives, but also a range of decision criteria such as public acceptance, cost of implementing management measures, environmental, social, economic and cumulative impacts.

By selecting a preferred scenario for development of the marine area, it is then possible to answer the question of "How do we get there?". At this stage, policies and measures that guide development for the marine plan area should be elaborated.

<u>Scenarios and the MSP Directive</u>

The MSP Directive is less prescriptive than the UNESCO Step-by Step approach in terms of how potential future uses of the sea and maritime activities are considered in the overall decision-making process for maritime spatial plans. The Directive states that when establishing MSP, "Member States shall have due regard to the particularities of the marine regions, relevant *existing and future activities and uses* and their impacts on the environment, as well as to natural resources, and shall also take into account land-sea interactions" (Art 4(5)).

In addition to this, plans should "identify the spatial and temporal distribution of relevant existing and future activities and uses in their marine waters" (Art. 8) to support the sustainable development and growth of the maritime sector. In doing so, Member States should take into consideration relevant interactions of activities and uses, such as aquaculture areas, fishing areas, installations and infrastructures for energy, transport routes etc.

Whilst the use of scenarios or choosing between alternative approaches is not explicitly mentioned in the Directive, the need to take into account future uses and activities across a range of sectors should provide for the consideration of alternative options. Furthermore, where maritime spatial plans are likely to have significant effects on the environment, they are subject to Directive 2001/42/EC[1] on the assessment of the effects of certain plans and programmes on the environment (the SEA Directive). The SEA Directive requires that in thinking about policy responses, "…reasonable alternatives taking into account the objectives and geographical scope of the plan…" should be considered, thereby ensuring plan-making authorities explore differing futures in some way. Consequently, this should be presented as part of a broader justification for the policies and measures eventually selected within a maritime spatial plan.

Where there are sites designated under the Birds and/or Habitats Directives, the plan may also be subject to an Appropriate Assessment as specified in Article 6 of the Habitats Directive (92/43/EEC). This requires that where a plan or project may have a significant effect on the integrity of a designated site, an Appropriate Assessment should be carried out. Where there are found to be adverse impacts, an assessment of mitigation options or alternative solutions must be carried out to establish whether these would avoid or have a lesser effect on the Site. In doing so, Appropriate Assessment must make predictions about the future state of designated sites under different conditions or actions.

As MSP has developed at an uneven pace amongst the administrations of the SIMCelt project, there is limited experience in the use of scenarios as part of wider plan making processes. The following section draws these experiences together to provide examples of what has been achieved to date.

[1] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (OJ L 197, 21.7.2001, p. 30-37).

<u>England</u>

Within the English marine planning process, there are key stages where future uses of the sea are considered. In the initial plan preparation phase, publication of a Statement of Public Participation (SPP) is followed by 'identifying issues' and 'gathering evidence' (See Figure 3 below). In these two stages the Marine Management Organisation (MMO) in conjunction with stakeholders gathers information about the plan area to provide robust evidence for future decision making. Issues, as defined by the MMO, are an *opportunity or challenge to the marine plan area, that is likely to drive change, or be affected by change over the 20 years the marine plans cover. Issues must also be something that can be addressed, at least in part, by marine planning*. These issues are split between two categories – those that are common to each plan area, for example ensuring navigational safety, and those that are plan area specific, for example transport of nuclear waste by ship near sensitive sites.

Figure 3: The marine plan making cycle in England

Source: Marine Management Organisation (n.d.)

The issues and evidence are summarised in an Analytical Report, before they are used in the development of a vision and objectives for the plan area.

In the 'options development' stage, the MMO considers different ways of achieving the plan objectives and vision, to make sure that the choices made and their implications have been considered. This stage includes a Sustainability Appraisal (incorporating the requirements of the SEA Directive), to assess how a marine plan may affect economic, social and environmental sustainability. In addition, a Habitats Regulations Assessment (UK equivalent to Appropriate Assessment) may take place. Options in the Sustainability Appraisal are compared to a "Business as usual" or predictive scenario, which considers how the marine area might develop in the absence of a maritime spatial plan.

Scenarios are again incorporated into the 'plan policy development' stage of plan making. For the North West, North East, South East and South West plan areas the MMO has commissioned research to review of past trends and current drivers and develop future projections for selected industry sectors that are active in these Plan areas (MMO, 2017). This work has been undertaken by ABPmer, and consists of:

- Evidence gathering: spatial distribution, intensity and economic value of each sector over the past 10-20 years
- PESTLE (Political, Economic, Social, Technological, Legal and Environmental) analysis to identify key changes that could affect the sectors in future
- Development of projections of potential change of scale and location for the sectors in each Plan area over 6 and 20-year time frames using three different scenarios

The scenarios used in this exercise were developed as part of the Celtic Seas Partnership's Future Trends project (described in Chapter 2.4), and consisted of a Business as Usual scenario, Nature @ Work (maximising ecosystem services) and Local Stewardship (local decision making and differentiation). Changes in activity for each sector have been mapped and plotted according to the most appropriate unit of activity (e.g. MW of energy generated, GVA, freight tonnage). Potential trade-offs between sectors and the environment have also been identified for consideration in each of the marine plan areas.

France

In France, following the publication of the National Strategy for the Sea and Coastline (SNML) in May 2017 and in support of Law No. 2016-816 of 20 June 2016 for the blue economy, the North Atlantic-Western Channel Façade is piloting the implementation and monitoring of strategic planning for maritime space and coastal areas through the Façade Strategic Document (*document stratégique de façade*, DSF). A guide to the process by which the DSF will be produced was published by the Ministry of Environment, Energy and the Sea (Ministère de l'Environnement, de l'Énergie et de la Mer, 2017). In the first stage of producing the DSF, the existing conditions of the façade and emerging issues and risks will be identified. This will be followed by the definition of a Vision to 2030, priority objectives for the façade and the selection of indicators to measure progress against the objectives.

In defining the Vision for 2030, a scenarios method will be adopted as it is recognised that the process of developing the DSF is similar to that of a foresight exercise using the scenario method. This is because it builds in different socio-economic, institutional and environmental factors to develop contrasting pathways and visions and enables different points of view and actors to be brought together for collective reflection. However, the guide leaves individual facades scope to develop their own approaches depending on the level of detail required and the number of scenarios and other key variables (Ibid, p21).

2.4 Other Approaches to Scenario Building for Marine Management

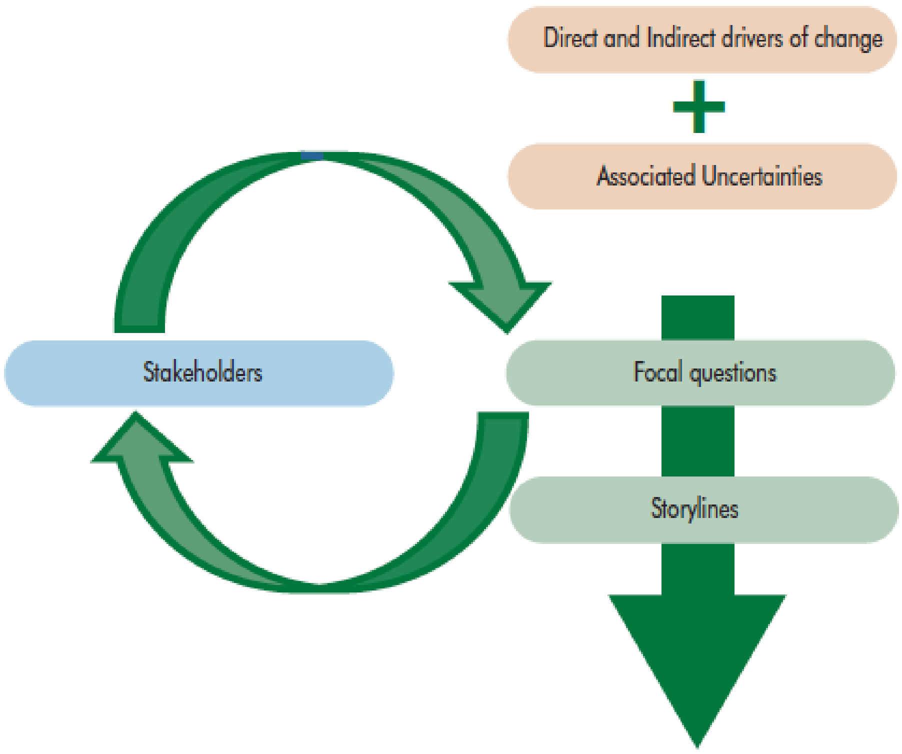
In this section, examples of scenarios work related to the marine environment are reviewed to inform the development of an approach to be used in the SIMCelt project. These examples cover a broad range of processes and policy areas related to marine and coastal planning and demonstrate how different techniques can assist decision making.

UK National Ecosystem Assessment

Context
Following on from the Millennium Ecosystem Assessment of 2005, the House of Commons Environmental Audit recommended that a similar exercise be undertaken for the UK to identify ecosystem service degradation and ensure effective responses were put in place. The UK National Ecosystem Assessment (NEA) was prepared between 2009 and 2011, and involved government, academic, NGO and private sector institutions. For the NEA, predictive scenarios were created to explore how emerging driving forces might combine to create different socio-political and economic conditions in the future and describe different ways the world might look in 2060, and in turn, how this would affect ecosystem services and human wellbeing.

Methods Used
The scenarios developed for the NEA were created by first identifying the scope and focal questions of the exercise with user and research communities and undertaking an analysis of existing scenario studies at the global, European and British scale to see if they contained any useful aspects related to a) the process of scenario building, and b) information that could help inform underlying assumptions in the NEA scenarios (see Figure 4). Storylines for the NEA scenarios were developed using a morphological analysis. This involved creating a matrix that lists direct and indirect drivers of change (e.g. climate change, economic growth) against different trends (e.g. low/high population growth, land use change). Different storylines were then constructed by linking cells horizontally in the matrix, each strand forming a distinct scenario based on understandings of how drivers might be associated or causally connected (Haines-Young et al, 2011:1206). What was essential was that each storyline was plausible and had an internal consistency or logic to the way that it was assembled from different variables.

Figure 4: The role of stakeholders and focal questions in building the UK NEA scenarios



Source: Haines-Young et al (2011)

Outputs

For the purposes of the NEA six scenarios were developed – these included:

- *Green and Pleasant Land* – a preservationist attitude arises because the UK can afford to look after its own backyard without diminishing the ever-increasing standards of living
- *Nature @ Work* – promotion of ecosystem services and multifunctional landscapes are seen as key for maintaining quality of life
- *Local Stewardship* – societies strive to maintain a sustainable focus on life within their immediate surroundings
- *Go with the Flow* – a future based on current ideals and targets
- *National Security* – climate change and increasing energy prices force nations to attempt greater self-sufficiency and efficiency in core industries
- *World Markets* – high economic growth and a focus on removing barriers to trade

Application

The scenarios produced by the original NEA have been used to demonstrate changes to overall ecosystem service provision, both by broad habitat types and overall categories of ecosystem service (regulating, provisioning, cultural). In the first instance, a condition score has been assigned to each habitat based on overall service output and weighted for area of habitat expected to be present in 2060. Coastal margins and marine are two of the habitats included in this analysis. The results of this exercise are also broken down to sub national/devolved administration level for England, Scotland and Wales to highlight projected change in habitat stock under the six scenarios.

Strengths of Approach

- Scope and purpose of the scenarios clearly defined in conjunction with stakeholders and potential users of results
- Provides a set of scenarios that can (and have been) used in other scenario building exercises (e.g. Celtic Seas Partnership's Future Trends work)
- Quantification of outcomes (i.e. changes in habitat coverage and ecosystem service provision) provides a firm foundation to support decision making

Weaknesses

- Scenarios don't fully account for changes in the marine environment (as at the time of the NEA the methodology for this was not fully developed)
- Geographical scope - only considers implications of scenarios for mainland UK and not international transboundary effects
- Uses a highly technical and resource-intensive approach

UK NEA Follow-On Phase

Context

The NEA Follow-On phase (2012-2014) aimed to build upon the knowledge base created by the UK NEA to make it relevant to decision and policy making at different spatial scales across the UK, further people's understanding of the economic and social value of nature, develop tools and products to operationalise the ecosystem approach and to support the inclusion of natural capital in the UK's National Accounts (UK National Ecosystem Assessment, 2014).

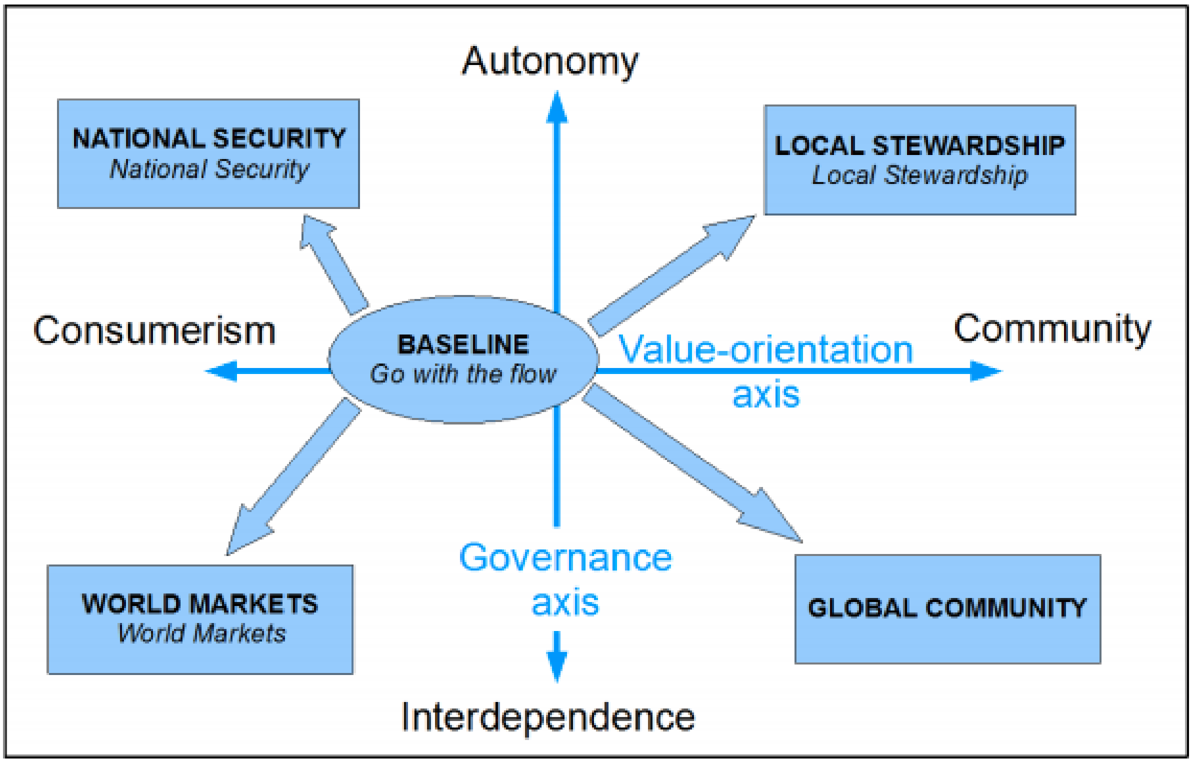
Methods Used

In the NEA Follow-On, a specific set of coastal and marine ecosystem services were defined for use in this scenarios exercise, which was a more exploratory approach than the NEA itself. In a workshop held in 2013, experts were asked to assess how these ecosystem services would change up to 2060 under different macroeconomic and climate change conditions, as well as socio-economic or environmental shocks. Five different scenarios were used, with experts first asked to consider changes to ecosystem services under a baseline (go with the flow scenario). The next day participants examined ecosystem services change under the remaining four scenarios. The effects on ecosystem services were scored according to positive or negative outcomes using a Likert-type scale across three UK regions.

Outputs

Besides the definition of a specific set of coastal and marine ecosystem services in NEA Follow-On, four of the original NEA scenarios (*National Security, Local Stewardship, World Markets* and *Go with the Flow (Baseline)*) were used, however a fifth scenario (Global Community, shown in Figure 5 below) was developed by experts, reflecting wider international factors and influence of globalised maritime governance.

Figure 5: Scenarios used in the UK NEA Follow-On



Source: Turner et al (2014)

Application

The use of a scenarios approach in the NEA Follow-On helped to demonstrate the impacts of different socio-political contexts on existing coastal and marine ecosystem services, with the results of the exercise showing that the 'global community' scenario yielded the greatest positive benefit to ecosystem services whilst 'world markets' had the greatest negative effect. This enabled participants to suggest changes to current and near-future management practices that would improve the sustainability of ecosystem services without requiring substantial changes in societal organisation (Turner et al, 2014:62). Subsequently, methods to quantify existing ecosystem services (goods and benefits) and measure change are elaborated, and gaps in current valuation methods for particular ecosystem services (e.g. coastal defence) were identified.

Strengths of Approach

- Expert driven and participatory
- Builds on existing scenario work

- Clearly defined scope (in terms of looking at impacts on ecosystem services)

Weaknesses

- Geographical scope - UK only – though allowance for external drivers is demonstrated in the 'global community' scenario
- Changes in resource use/spatial footprint are implicit in the scenarios rather than explicit

CEFAS – Alternative Futures for Marine Ecosystems (AFMEC)

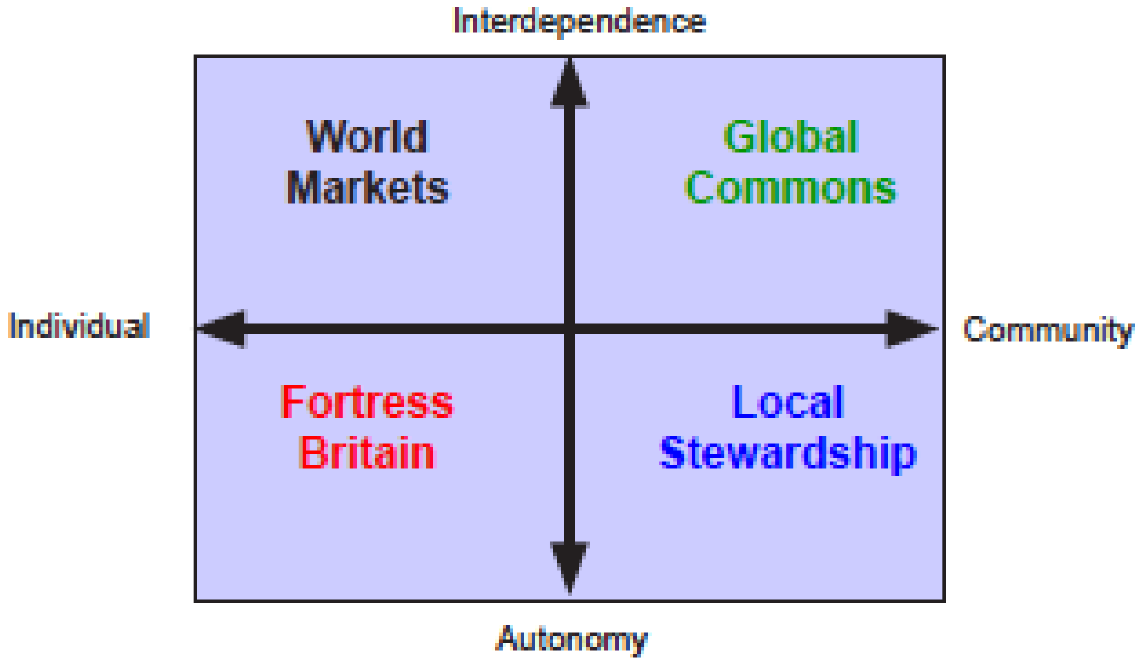
Context

This study, undertaken in 2004, presents a set of four scenarios for marine ecosystems that were intended for the UK's Department for Environment, Food and Rural Affairs (Defra) and other stakeholders to use in strategic planning. The scenarios were designed to cover a period of 20-30 years and were complementary to other UK government funded futures research initiatives undertaken at the time, including *Charting Progress: An Integrated Assessment of the State of UK Seas* (Defra, 2005).

Methods Used

AFMEC synthesises scenarios work undertaken both in the UK and internationally that has a cross-cutting approach to activities in the marine environment. By identifying common elements of these scenarios, (for example, the Millennium Ecosystem Assessment and the Intergovernmental Panel on Climate Change) a four-quadrant, two axes *'possibility space'* was developed to help define a new set of scenarios. Under this approach, the two driving forces considered the most likely to instigate change were determined to be societal values (from individual to community) and distribution of power (autonomy to interdependence). In conjunction with a set of key parameters including GDP growth, demographic change, land use and water consumption, temperature and sea level rise, energy consumption and others, four scenarios were developed that correspond to the quadrants of the possibility space (see Figure 6). The scenarios are both exploratory and predictive in nature, as they attempt to quantify changes, but also provide a more qualitative description of what this might mean for society and the marine environment.

Figure 6: The scenarios framework (possibility space) developed for the AFMEC report



Source: Pinnegar et al (2006)

<u>Outputs</u>
The report presents four scenarios – World Markets, Global Commons, Fortress Britain and Local Stewardship, with a description of the conditions present under each one. To demonstrate use of the scenarios, they have been applied to a range of activity domains determined by stakeholders including climate and hydrography, fisheries, tourism and leisure, ports and shipping, oil and gas and aggregates. For each scenario potential trends and environmental impacts are demonstrated – for example in the ports and shipping sector, the World Markets scenario is characterised by the greatest growth in shipping activity, and therefore poses greatest risk pollution, whereas under the global commons scenario shipping growth is coupled with tighter environmental regulation to reduce risk of pollution.

<u>Application</u>
The report concludes with a discussion about how the scenarios may be used, noting that they are aimed at a wide audience including government departments, offshore operators, conservationists and more. Two types of use are identified – first, using the scenarios as a starting point to generate discussion, for qualitative explorations of trends in a participative setting. Secondly, they may be used as a framework in more rigorous scientific studies, where quantitative data, modelling techniques and expert opinion may be utilised, for example in analysing climate change impacts.

<u>Strengths of Approach</u>
- Has a strong basis in tried and tested examples of previous scenario development work
- Developed in conjunction with expert stakeholders
- Uses quantitative data to underpin scenario 'storylines'
- Creates four easily identifiable and substantially differentiated scenarios for use
- Can be applied across a range of projects

Weaknesses

- Changes in resource use/spatial footprint are implicit in the scenarios rather than explicit
- Does not allow for differing trends across regions or administrations

Dessine-Moi un système Mer-terre **(Draw me a land-sea system)**

Context

The Dessine-moi project was funded through the French Ministry of the Environment and ran from 2013-2014. The project considered the problem of how modes of governance related to 'land', 'sea' and 'coast' reflected different temporal and spatial approaches and perspectives on the relationship between human activities and ecosystems. As a consequence, governance processes developed independently of each other may hinder the effective development of shared visions and strategies for the land-sea interface and the implementation of policy. Dessine-moi therefore sought to understand the diversity of representations of the land-sea system and its boundaries. It then used foresight techniques to determine how representations of the land-sea system would change in the future, demonstrating tools and intervention strategies that may help to understand biases and move towards a more convergent view of the land-sea system.

Methods Used

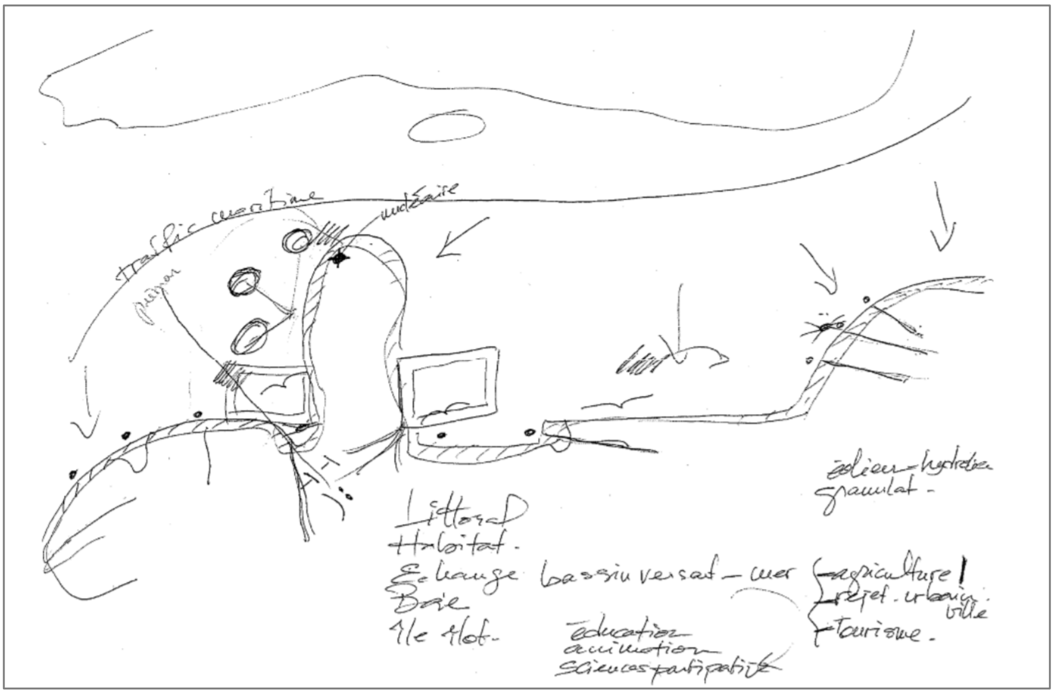
The approach adopted by the Dessine-moi project was tested with actors from the Eastern Channel-North Sea façade. Stages of the process included:

- Interviews with actors (from inside and outside the region) to understand their conception of the land-sea system
- Prospective interviews – examining how conceptions of the land-sea system might change in the future
- Reflective exercise with participants – considering trends and critical uncertainties at the land-sea interface and using morphological analysis to develop three exploratory scenarios (rapid Blue Growth and regional specialisation, a 'Blue Door' with competing regions on either side of the Channel and 'Channelling together', with greater cooperation and an ecosystem approach)
- A second workshop where the scenarios were discussed in order to identify a preferred scenario
- Follow-up interviews with participants and a final analysis of outputs

Outputs

An important part of the Dessine-moi process was the development of 'mental maps', free association of ideas and 'issue cards' indicating different representations of the project area. These were used in interviews. Figure 7 below provides an example of a mental map. In addition to this, key findings of the project have been outlined and used to develop a set of recommendations about the process of developing shared visions and the use of foresight techniques to guide this approach.

Figure 7: Dessine-moi project: a 'Mental Map' of the Channel Area



Source: DIRM-MENM (2014)

<u>Application</u>

The experiences of participants and operational lessons learned from the Dessine-moi project have been developed into a document that highlights the use of foresight in the context of developing shared strategies and supports the work of agents involved in the management and planning of the land-sea area, in particular state organisations, local authorities and public bodies (see Kervarec, Michel and Trouillet, 2015).

<u>Strengths of Approach</u>

- Recognition that divergence of views may not be overcome
- Emphasises the importance of understanding the process, indicators developed and how they should be mobilised following the participatory exercise

<u>Weaknesses</u>

- Geographical scope – considered French side of the Channel only
- Participatory, but only with a limited group of people

Celtic Seas Partnership – Future Trends

Context

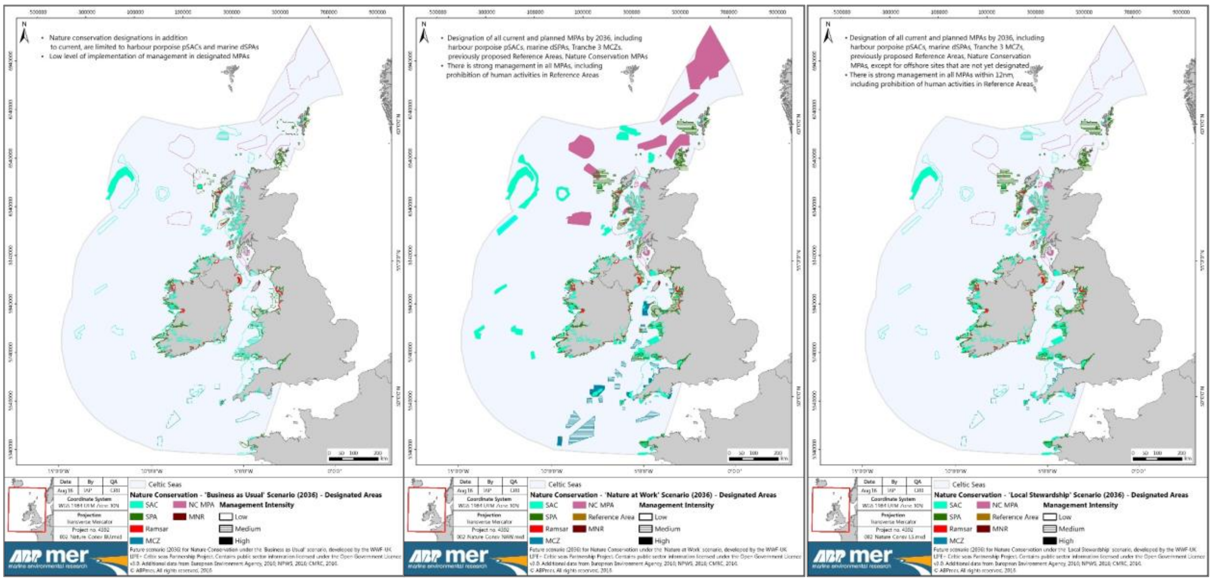
The LIFE+ funded Celtic Seas Partnership (CSP) focused on stakeholder engagement in implementation of the Marine Strategy Framework Directive. One action of this project examined future trends in the Celtic Seas marine region, with reference to what this means for the achievement of Good Environmental Status (GES) and the need for an integrated, ecosystem-based approach to marine management. The period considered was approximately 20 years from 2016. CSP's Future Trends work covered ten sectors (shipping, ports, nature conservation, offshore wind, oil and gas, coastal defence, nature conservation, fisheries, aquaculture, tidal energy, aggregates and tourism and recreation).

Methods Used

The Future Trends work was undertaken in five main phases, combining both exploratory and predictive approaches

1. *Testing of draft scenarios* in stakeholder workshops to understand how they might impact on the achievement of GES.
2. A *baseline analysis* of the current state of play and drivers for change in the Celtic Seas region (political, economic, environmental) was undertaken for the ten sectors. Reports for each sector were shared with thematic experts for fact checking and further comment.
3. *Mapping of spatial impacts* was undertaken for each sector under the three different scenarios. These maps were created by projecting forward trends for each sector and incorporating knowledge on drivers of change (see Figure 8 below).
4. *Responses to maps* were collated from thematic experts concerning their plausibility, implications for development of each sectors and any potential opportunities/conflicts they see arising from this development pattern.
5. The *final analysis and conclusions* drew together impacts of each scenario across a range of variables, including sectoral interactions, economic and social impacts and impacts on the environment (ecosystem services and descriptors of GES).

Figure 8: Designation of MPAs under different scenarios



Source: ABPmer and ICF International (2016b)

<u>Outputs</u>

Three scenarios were developed for the Future Trends work - a *Business as Usual* scenario, alongside two scenarios adapted from the UK National Ecosystem Assessment – *Nature @ Work* and *Local Stewardship.* A full description of the baseline information and underlying assumptions for each scenario have been made available on an interactive website which features maps, a series of reports detailing methodology, baseline, scenarios, their analysis and a final summary report.

<u>Application</u>

Besides providing material to inform recommendations from the Celtic Seas Partnership on the need for transnational working to tackle common environmental problems and reduce conflicts between sea users, scenarios developed for the Future Trends work have been taken up by the Marine Management Organisation for use in developing plans for NW, NE, SW and SE plan areas (see Marine Management Organisation, 2016).

<u>Strengths of Approach</u>

- Participatory, many stakeholders from around Celtic Seas have had an opportunity for input.
- Builds on some already tested scenarios (from UK National Ecosystem Assessment)
- Covers a broad range of sectors
- Consideration of issues on sector by sector basis (with GIS maps) allows for recognition of potential trade-offs that need to be made between sectors

<u>Weaknesses</u>

- Design of stakeholder engagement led to widening of possibilities (many ideal scenarios) rather than narrowing down and achieving consensus around a limited set of ideas. These were difficult to integrate into an 'ideal' scenario.

- Incomplete and old data used to produce some maps does not reveal true extent of spatial impacts

Cooperation in Fisheries, Aquaculture and Seafood Processing (COFASP) Project

Context
The Cooperation in Fisheries, Aquaculture and Seafood Processing (COFASP) project was an EU 7th Framework Programme project that ran from 2013 to 2017 and used foresight methodology to determine the research agenda for the next 15 years+ related to fisheries, aquaculture and seafood processing. To do this, foresight techniques were used to develop four "New World" scenarios, depicting how the fisheries and aquaculture sectors may evolve. These scenarios were used to identify trends, research questions and strategies for organising research and funding.

Methods Used
The foresight process followed five key steps:

1. *Defining the system including the problem, boundaries, and horizon of the system and subsystems*. This can include identifying elements outside the system that actors have no control over, e.g. consumer demand.
2. *Identification of key variables (drivers) and building different hypotheses for the future for each driver*. For each sub-system, indicators that show evolution of the subsystem, understanding of its evolution (trends in the last 10/20 years) and hypotheses about the future were considered.
3. *Creation micro scenarios for each subsystem* by assembling drivers and hypotheses. This process involves taking a hypothesis for each driver in a sub-system and linking them together in a logical and plausible storyline as illustrated in Figure 9 below (referred to as morphological analysis – see UK NEA, JRC (2008)).

Figure 9: Assembly of micro-scenarios in a subsystem

DRIVER	HYP 1	HYP 2	HYP 3	Micro-Scenario
Driver 1	Hyp A	Hyp B	Hyp C	1
Driver 2	Hyp i	Hyp ii	Hyp iii	
Driver 3	Hyp X	Hyp Y	Hyp Z	2
Etc.				

4. *Outlining possible future macro scenarios* by assembling the micro scenarios. This process is similar to assembling macro scenarios. For each sub-system, macro-scenarios were linked together to create scenarios for the system as a whole.
5. *Identification of uncertainties, challenges and opportunities*. Once the global scenarios were developed, they were the subject of discussion and analysis by stakeholders. In the case of the COFASP project, this meant identifying the research questions and opportunities to support future developments in fisheries, aquaculture and seafood processing.

Outputs

Through three stakeholder workshops, four 'New World' scenarios were defined: 'It's not EU, it's me…' (economic crisis, lack of cooperation and high competition for marine resources), 'Fortress Europe… not so splendid isolation' (closed borders, no single market and increasing exploitation of marine resources), 'The moral high ground' (well organised and controlled fisheries, greater public awareness and civil society engagement, recognition of ecosystem services) and 'EUtopia' (economic recovery, increasing demand for fish and seafood products with traditional species declining and greater public awareness of the marine environment). These scenarios were then used to define key research challenges relating to marine science in general, the environment, fisheries, aquaculture, seafood processing, value chains, governance and the organisation of research funding.

Application

The scenarios were used to define key research challenges relating to marine science in general, the environment, fisheries, aquaculture, seafood processing, value chains, governance and the organisation of research funding. This has fed into the development of a Strategic Research Agenda for European fisheries to become more efficient, selective and less destructive of habitats, leading to higher and more sustainable yields[2].

Strengths of Approach

- Definition of system and boundaries enables clarity over which elements or variables will be built into the overall process and should provide justification of what has been excluded
- Provides a systematic approach to defining variables (drivers) and external forces that may affect future development in the system
- Is participatory and includes expert judgement

Weaknesses

- Only uses one system in example – for transnational cooperation on MSP several systems (sectors/countries) may need to be considered separately
- Development of micro-scenarios using several permutations of numerous variables within each subsystem may be time consuming
- An imaginative "leap" from micro- to macro- scenarios is required

[2] http://cordis.europa.eu/result/rcn/200152_en.html

Valuing Ecosystem Services in the Western Channel (VALMER) Project

Context

VALMER was an eleven partner, €4.7 million project co-funded by the INTERREG IV A Channel programme, which aimed to examine how improved marine ecosystem services assessment could support effective and informed marine management and planning. The project ran from September 2012 to March 2015. VALMER project used scenario building processes to engage stakeholders in the management of six case study sites within the Western Channel between England and France. In each of the case studies, scenarios were combined with ecosystem service assessment methods to assist in site management decisions. Different scenario building techniques including exploratory and predictive scenarios were used across the six case study sites. This variation in approaches demonstrated the flexibility of scenarios to be interpreted and discussed by stakeholders in ways that they feel most comfortable with.

Methods Used

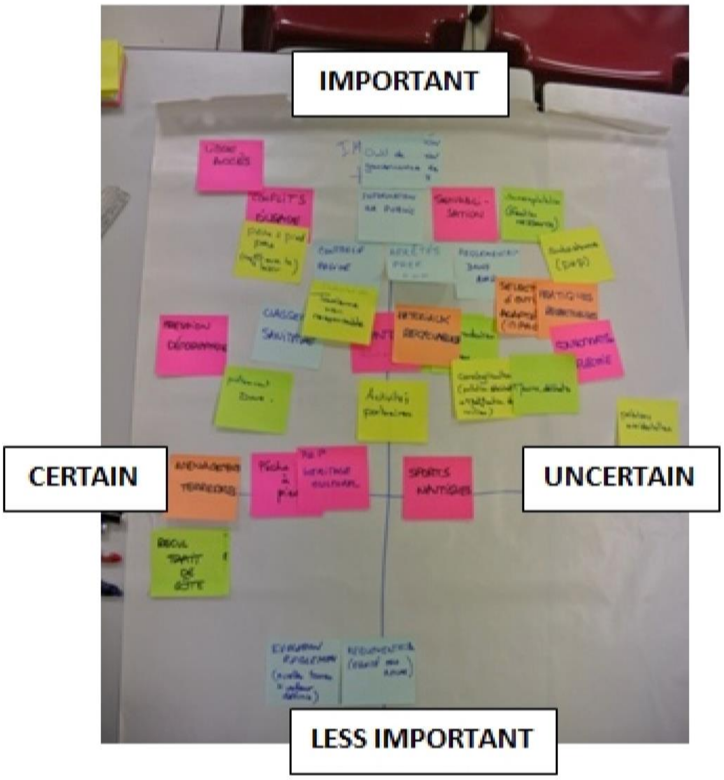
In each of the case studies, scenarios were combined with ecosystem service (ES) assessment methods to assist in site management decisions. Different scenario building approaches were used across the six case study sites, reflecting stakeholder choice and demonstrating the flexibility of scenarios to be interpreted and discussed in ways that stakeholders feel most comfortable with. The case study methods included:

- Habitat mapping and determination of ecosystem services provided
- Bayesian Belief Networks and socio-ecological modelling of pressures and effects on ES
- GIS mapping of sites and ES provided
- Assessment of cultural ES through online and face-to-face surveys
- PESTLE analysis and sorting of elements according to their importance and probability of occurrence to determine risks and opportunities (see Figure 10 below)
- Numerical modelling and multi-criteria analysis
- SWOT analysis of management scenarios
- Use of *Regnier's Abacus* to determine consensus on the desirability and feasibility of scenarios

Outputs

For each of the six case study areas, a set of bespoke scenarios were generated (except in the Poole Harbour case study where questionnaires asked participants about how changes to the environment would affect their willingness to continue using the site). In addition, illustrative maps and analysis of stakeholder inputs provided information to underpin management decisions at each site.

Figure 10: VALMER Golfe Normand-Breton case study: distribution of key elements following PESTLE analysis



Source: Herry and Winder, 2015

<u>Application</u>

Each of the case studies was connected to site management decisions – for example, in the Plymouth Sound to Fowey case study, ESA and scenario building were used to support the environmental actions of the Cornwall Maritime Strategy. In the Marine Natural Park of Iroise Sea, scenarios for the adaptive strategies for management of kelp forests were developed to support sustainable management of kelp forests.

<u>Strengths of Approach</u>

- Highly participatory in terms of defining the scope of each exercise (ecosystem services to be considered) and decision making related to scenario outcomes
- Multiple sectors considered
- High degree of quantitative information used to support the definition of baselines and implications of each scenario
- Use of maps to visualise potential implications of each scenario

<u>Weaknesses</u>

- Examples only work on smaller scales where there is relatively complete data coverage

- No transboundary (international) examples to highlight differing planning processes and priorities

2.5 Key Elements of Scenario Building

Based on both the general scenarios literature and examples from practice, the following elements in Box 1 have been identified as being critical to developing robust scenarios for use in planning exercises.

Box 1: Key elements of scenario building techniques

Participatory: Scenarios should be created with stakeholder input, either in the creation of the initial narrative, defining focus/scope or in checking plausibility and potential outcomes (*Herry and Winder, 2015)*
Time frame: this may vary depending on the nature of driving forces – should be at least five years where change happens quickly, but up to 50 years where change may be more slow or uncertain. Typically at least 10 years *(Pinnegar et al, 2006:16)*
Plausibility: whilst scenarios are not intended to be accurate forecasts of a future state, they should be constructed in such a way that people working with them can see the scenarios as possible futures
Internal consistency: the building blocks (or drivers) that are used to create each scenario should be joined together in an explainable and logical manner (*Haines-Young et al, 2011, and van Hoof et al, 2014)*
Plurality: 2-4 scenarios are considered to be the optimal number for exploring a range of potential futures.
Resonance: the scenarios produced should have sufficiently distinct narratives for users to understand the varying conditions and drivers to be considered. They should tell a story that is convincing and remarkable. Dramatic or extreme scenarios, or memorable names to describe the scenarios are useful in this instance *(JRC 2008)*

3. Developing Scenarios for SIMCelt

3.1 Methodology

The overall methodology for developing scenarios has followed three key stages. First, to gather data about current and future uses of the Celtic Seas marine region, a set of sectoral Maritime Activity Briefing Notes have been developed. Secondly, the existing policies, drivers for change within different sectors and issues for MSP identified in the Briefing Notes were used as the basis for developing scenarios that were tested in a workshop. Finally, the results of the scenarios workshop were analysed to understand the implications of future maritime developments for MSP and transboundary cooperation.

<u>Briefing Notes</u>

The Maritime Sector Briefing Notes that have been developed consider the current spatial patterns of development for a limited number of key maritime sectors. It was decided to focus on a smaller number of sectors due to the time limited nature of the project and to examine each one in more depth.

The final selection of sectors to be included in the Briefing Notes was based upon two main criteria:

- That the sector has a distinct transnational dimension, in terms of movement across transnational space or fixed patterns of spatial development (or structures) that span national borders; or
- The sector is known to have growing spatial demands. i.e. is an expanding sector that must be taken into account in the development of maritime spatial plans

In addition to these criteria, efforts were also made to align the sectors chosen with some of those to be featured in other sub-components of the SIMCelt project relating to ecosystem services (undertaken by DAERA) and cumulative effects (undertaken by the Marine Institute). These were discussed in a meeting at the University of Liverpool in January 2017.

The sectors chosen for inclusion in the Briefing Notes were:

- Cables and Pipelines
- Ports and Shipping
- Offshore Wind Energy
- Wave and Tidal Energy
- Aquaculture

The Briefing Notes were prepared between January 2017 and February 2018. A first iteration of the Briefing Notes was circulated amongst SIMCelt project team members from May to June 2017 in order to gain initial feedback. The draft papers were then circulated amongst a wider audience of stakeholders from government departments and agencies, industry and private sector organisations, NGOs and academics to obtain further views on content.

The Briefing Notes were structured in the following way:

1. Current distribution of activity – including maps, graphs and other pertinent information relative to the performance of the sector in each of the administrations within the project area
2. International and EU policies governing the development of the sector and key actors/agencies with responsibilities pertinent to the current and future spatial distribution of that sector
3. An analysis of the key national MSP and sectoral policies and responsible agencies for each sector
4. A section on Interactions with Other Sectors and the Environment, which explores the compatibility of the sector with other marine activities and its potential impacts on the environment, both positive and negative
5. Drivers for change – covering the key technological, political, economic and other drivers that may affect future spatial development of the sector
6. Key MSP and Transboundary issues – considering existing and future issues for the sector that should be taken into account in the marine planning process

The key drivers and transboundary issues identified for each sector are summarised in Boxes 2 and 3.

Box 2: Drivers for Change in Key Maritime Sectors

Aquaculture

- More efficient licensing processes to enable faster establishment of aquaculture sites
- Continued financial support from the European Union and other institutions to deliver new operations or help established businesses adapt to new markets and technologies
- Increasing consumer demand for high quality seafood products
- Potential impacts of climate change on aquaculture, including changes to the general conditions under which aquaculture species grow
- Development of integrated multi-trophic aquaculture (IMTA), or polyculture
- Development of Multi-Use Platforms (MUPS)
- Increasing use of GM (genetically modified) species (as fish food or final product)
- Changes to cost of energy used in aquaculture production

Cables and Pipelines

- The development of new offshore wind farms and wave/tidal energy devices will necessitate development of new grid connections
- The development of smart grids may provide additional opportunities for cable networks
- Development of gas storage or carbon capture and storage facilities in former offshore hydrocarbon fields may require the construction of new pipelines or a change of use in existing pipelines

Offshore Wind Energy

- Potential increase in exporting offshore wind energy to neighbouring countries
- Changes to national or EU renewable energy targets
- A downturn in the economic climate could affect banks or other investor's willingness to finance large scale projects
- Reduction or removal of incentives for renewable energy could make offshore wind energy less economically viable
- Increasing size and generation capacity of wind turbines
- Continued investment in Research and Development to develop more new technologies
- Deployment of floating wind turbines will enable generation at greater depths and further out to sea

Box 2 continued

Ports and Shipping
• Emissions Control Areas requiring ships to use low sulphur content fuels • Opening of Arctic sea routes and new shipping lanes to access polar routes • Need to remain competitive with other European and extra-EU ports • Increase in ship size to achieve economies of scale in transport costs • Prevailing economic conditions and implications for global trade • EU 'Blue Belt' initiative contributing to further reduction of customs formalities for shipping • Increasing efficiency of ships through use of Liquefied Natural Gas (LNG) as a fuel, particularly for short sea shipping routes • Development of E-navigation systems, leading to improved navigational safety • Port infrastructure needs to keep pace with increasing container ship sizes to maintain competitiveness (e.g. dredging deeper channels, load/unload facilities) • Flexibility of port facilities to support diversification • Development of specialist shipbuilding services with other European and extra-EU ports
Wave and Tidal Energy
• EU/national policies continuing to drive increased energy production from renewables (2030 and 2050 targets) • Public perception of tidal and wave energy, including tidal impoundments and their potential environmental impacts may be a barrier to development • Increasing fossil fuel prices may increase the attractiveness of marine renewables as an alternative • Continued investment in research and development (R&D) and capital financing for upscaling from pilot to commercial deployment is essential • Developing grid capacity to support commercial scale marine energy generation • Development of onshore infrastructure (e.g. port facilities) to support maintenance and construction of devices
Cross-Sectoral
• Competition between users, e.g. offshore wind and fisheries, ports and conservation • Potential for co-location of aquaculture and offshore renewable energy installations • Development of autonomous vessels (large and small) for monitoring, moving goods

Box 3: MSP and Transboundary Issues for Key Maritime Sectors

Aquaculture

- As aquaculture grows, more space will need to be allocated to sites that are suitable for aquaculture production. This may lead to conflict with other users
- Moving sites and associated acitivites further offshore (e.g. more boating to reach cages, installation of partially submerged equipment) may also lead to conflicts
- Ensuring biosecurity of aquaculture species in situ and during movement of species

Cables and Pipelines

- Delays to the development of a single European market for energy may have an impact upon the financing of infrastructure projects such as offshore grids
- Pipelines and cables that cross jurisdictional boundaries require individual licensing/consenting procedures for each jurisdiction, which is a time-consuming process and a barrier to development
- Repurposing of pipelines (e.g. for carbon capture and storage) may require new impact assessment/consenting processes to be put in place

Offshore Wind Energy

- Development of turbines suitable for deeper waters; these turbines could be sited in areas close to marine borders
- Need for new connecting infrastructure to link offshore wind farms to land
- Cumulative impacts arising from the development of several wind farms in a relatively small area may have a transboundary nature
- Proposed new interconnections including Isle of Man wind farm to mainland UK and North Seas offshore grid electricity interconnection linking Scotland, the Republic of Ireland and Northern Ireland
- With regards to navigational safety, a harmonised approach to the marking of offshore wind farms (and other offshore structures) will be required to ensure navigational safety

Box 3 continued

Ports and Shipping
• Competition between Celtic Seas ports to attract the same business, e.g. Irish Sea ports and trans-Atlantic trade • Changes to international shipping routes as new ports or additional port capacity becomes available • The importance of top-level governance structures and recommendations for dealing with particular issues, such as the International Maritime Organization to achieve a level playing field in the maritime sector • Understanding by the ports and shipping sectors of the needs and requirements of other marine sectors such as aquaculture and offshore renewable energy – this requires greater stakeholder engagement across sectors • Data availability and harmonisation for the creation of plans is important when dealing with different jurisdictions, for example AIS data provided by different countries
Wave and Tidal Energy
• The main impacts of wave and tidal devices are likely to relate to competition with other maritime users for space. In particular, issues of navigational safety around proposed wave and tidal energy installations need to be taken into account • Depending upon location, electricity infrastructure for bringing power ashore from wave and tidal devices may cross marine borders, therefore requiring consent from different national jurisdictions • Planning for connection to appropriate onshore infrastructure (e.g. transformer stations and grid connections) will require effective integration between MSP and terrestrial planning systems • Tidal range developments are likely to have impacts on tidal processes across a large area, potentially regional sea scale. Impact assessments for proposed developments must therefore consider effects at an appropriate scale that includes transboundary areas and cumulative effects
Cross-Sectoral
• Cross-border cabling may be required for some wind farms that are close to land within other jurisdictions • Interaction between new offshore energy installations (e.g. floating wind turbines) and shipping lanes.

3.2 The SIMCelt Scenarios

Following on from production of the draft Sector Briefing Notes, the information contained within the notes, feedback from stakeholders and material from other reports were used as the basis for developing a set of maritime scenarios. These scenarios were to be used for prompting discussion about future development of different sectors within the Celtic Seas and what this might mean for MSP and transnational cooperation.

With regard to previous examples of scenario development (as discussed in Chapter 2.3 and 2.4), it was decided that the scenarios for SIMCelt should be developed using the four quadrant or 'possibility space' approach with two main variables used to construct the horizontal and vertical axis respectively. In line with the criteria used to determine which sectors should be featured in the Briefing Notes, it was decided that the focus of the scenarios should be on:

1. Understanding the changing spatial demands (footprint) of maritime sectors; and
2. Their implications for transnational cooperation on MSP.

These two dimensions or characteristics of future sectoral activities were then used as the basis for the two axes in a possibility space. Along the horizontal axis, changing spatial footprint is measured. Along the vertical axis, degree of cooperation between administrations is considered. The labelling of each axis and definition of terms are described below.

<u>Footprint: Spatial Diffusion vs. Efficiency (Horizontal axis)</u>

The degree to which maritime activities use space or resources within and across plan areas in the Celtic Seas marine region and how this may change over time is a central concern for MSP. Given the different stages of economic growth that can be attributed to different maritime sectors, some activities can be expected to expand in terms of spatial distribution (e.g. the development of new offshore wind farms) and/or resource use (e.g. more intensive aquaculture). Conversely, other maritime sectors could be expected to decrease their spatial footprint (e.g. when oil and gas fields are exhausted and rigs are decommissioned).

In previous scenario exercises, axes that plot environmental concerns or green approaches against economic development may be seen as a proxy for changing spatial footprint – with green approaches denoting a more sustainable or gradual pattern of development whilst economically driven aspirations representing maximum resource exploitation and use of space. For example, in the United Nations Environment Programme's Global Outlook for 2002-03, the Market First and Security First scenarios are largely driven by economic growth or, 'consumerism'. This is considered the opposite to the Sustainability First and Policy First scenarios which support stronger regulatory roles for institutions and more equitable, or 'community' approaches (UNEP, 2002), (Pinnegar et al, 2006). However, given changes in modern technology and the drive to decarbonise the economy, many new marine sectors are founded on the basis that they provide more sustainable or greener alternatives to older methods, for example electricity generation from offshore wind and wave energy rather than coal and gas. In addition, many older sectors are recognising the need for less environmentally harmful ways of operation, e.g. cleaner, safer ship design and the recognition of multiple benefits to society from particular types of development serve to demonstrate that the 'economy versus environment' approach is less valid as the forces shaping development grow increasingly complex.

Therefore, for this scenarios exercise, a new approach that seeks to understand patterns of spatial development in different terms has been devised. Based on the idea that MSP seeks to manage conflict and compatibilities and promote the coexistence of relevant activities and uses, the concept of spatial diffusion or spatial efficiency will be used to determine the changing spatial footprint of present and future activities.

In this case, **spatial diffusion** is used to describe a situation where different marine users or sectors:

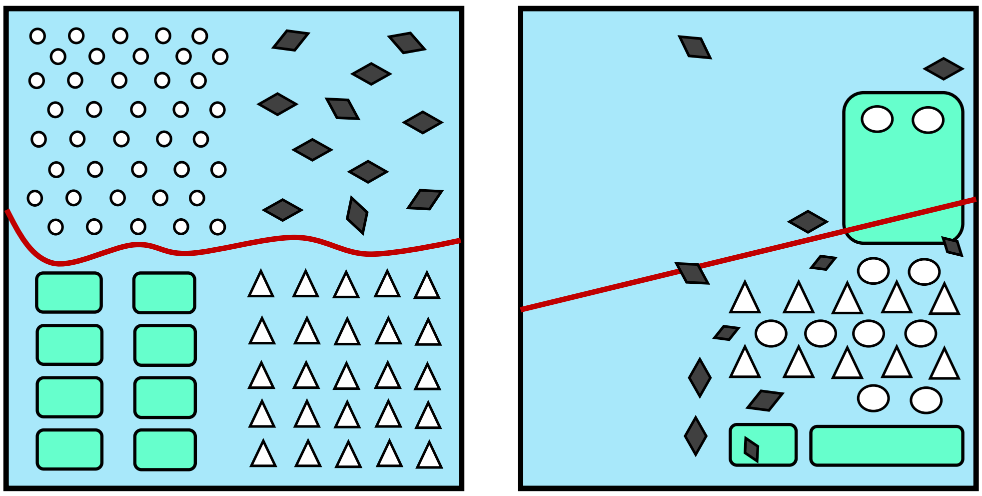
- Take up the maximum amount of marine space that is available to them;
- Use that space exclusively (i.e. do not coexist or co-locate with other marine users); and
- Use marine resources both expansively and at their most intensively to maximise exploitation of the marine resource available to them.

Spatial efficiency, on the other hand, occurs when:

- Take up a smaller amount of marine space;
- Use the same space – coexisting or co-locating with other compatible activities;
- Use limited resources, or use marine resources in a more sustainable manner.

These concepts are illustrated in Figure 11 below. To the left, spatial diffusion is shown at its most extreme, with four 'blocks' of different uses occupying the maximum amount of space that is available to them and a line, which could represent an undersea cable or pipeline intersecting the space. Each activity occurs in a distinct place and there is no overlap between different types of use.

Figure 11: Illustrating spatial diffusion (L) versus spatial efficiency (R)



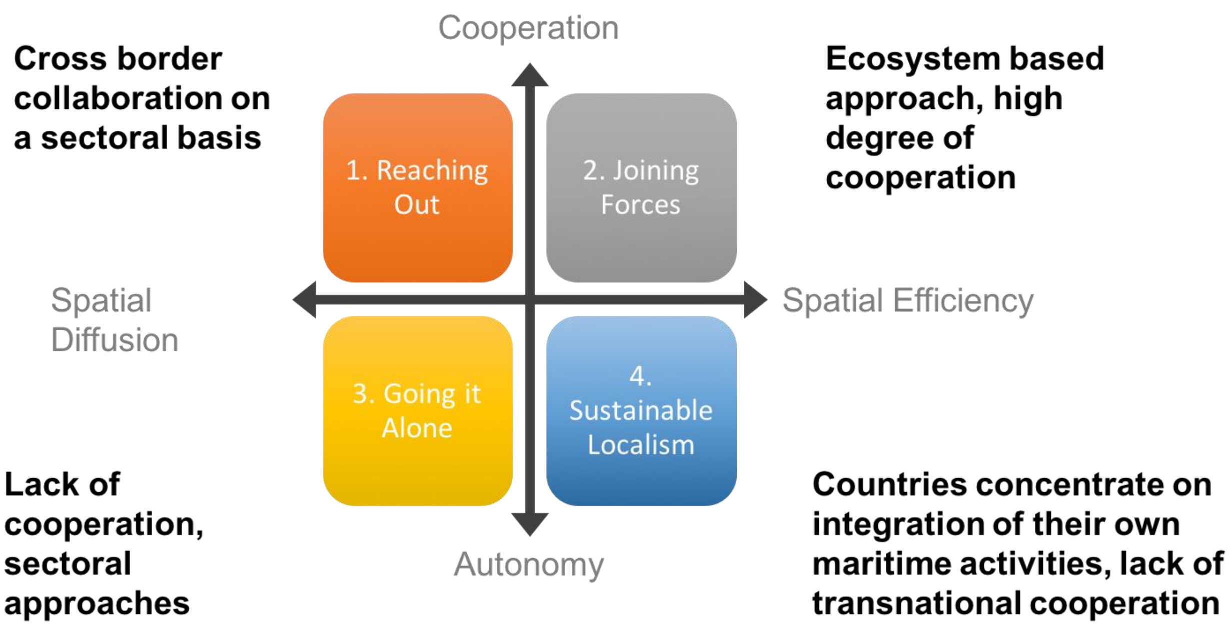
On the right, a more spatially efficient pattern of use is shown. Here the totality of marine uses takes up a much smaller area, with some activities sharing the same space or working in close coexistence, for example where cables and pipelines at depth do not interfere with activities that take place on the water surface.

Cooperation: Autonomy vs. Cooperation (Vertical axis)

The vertical axis within the possibility space attempts to measure the degree of cooperation that takes place between planning authorities on MSP. At the bottom end of the scale, **autonomy** refers to minimal levels of cooperation between authorities (at national or international scales) and the maintenance of 'hard' boundaries around a given entity's maritime space. At the opposite end of the vertical axis, **cooperation** refers to strong relationships between planning authorities that span national borders, more permeable boundaries (whilst respecting national sovereignty) and a recognition of shared responsibility for maritime regions. This may manifest itself in the development of regional cooperation, new models of governance, ecosystem-based management or more integrated forms of planning (see van Tatenhove, 2013)

The possibility space developed for SIMCelt is shown in Figure 12 below. Full descriptions for each scenario are included in Box 5.

Figure 12: The SIMCelt Possibility Space



Drivers and their Impacts

Having defined the two key dimensions of the possibility space, the next step was to 'flesh out' the storylines related to each possible scenario. To do this:

1. The drivers and key issues for MSP identified within each of the Briefing Notes were collated in a table for each sector,
2. Further columns were added to the table for spatial efficiency, increasing cooperation and justification,

3. For each driver or planning issue, a decision was made by the Liverpool project team on whether it would lead to increasing or decreasing spatial efficiency or increasing/decreasing levels of cooperation between planning authorities. The results of this were recorded using a scale that ranged from decreasing through neutral to high increase in the table (see the example given in Box 4 below),
4. The justification for each choice was added in the final column, and then
5. Where the resultant impact for each driver/issue was judged to be other than neutral, this driver/issue was then mapped onto the possibility space (numbers underlined in Box 4 denote drivers that have been selected for mapping).

Box 4: Example of determining cooperation and spatial footprint impacts

	OFFSHORE WIND	Spatial Efficiency	Cooperation	Justification
1	Existing proposals for wind farms are built	-/=	=/+	Will take up more marine space. Consultation required on SEA/EIAs and possible interconnectors
2	Renewable energy Directive targets for 2020 and Energy Strategy 2030 targets	-/=	=/+	Targets driving development of new offshore structures. May be cooperation between countries on export of renewables
3	Scotland: 100% of electricity from renewables by 2020	=	=	Depends on type of renewables. National target so does not necessarily require cooperation with others
4	UK: GHG emissions reduced by 80% by 2050	-/=	+	

	PORTS AND SHIPPING	Spatial Efficiency	Cooperation	Justification
5	Reduction of CO_2 emissions and pollution by shipping	=	+	Enforcement may require cooperation between authorities
6	Continued work to enhance the competitiveness of the EU shipping sector by increasing short sea shipping and improving port infrastructures and services	=/-	=	Increased maritime traffic and port activity.
7	Innovation in shipbuilding to improve the environmental performance of ships	=	=	Spatial impacts limited to minimising environmental effects.
8	Continued development of the TEN-T network	=/+	++	Concentration of shipping traffic through key routes to enable accessibility of all regions

Key			
++	High increase	=	Neutral
+	Some increase	-/=	Neutral – tending to decrease
=/+	Neutral-tending to increase	-	Decreasing

Mapping Impacts on to the Possibility Space

Having identified the likely impacts on sectoral drivers and planning issues across all the sectors in the Briefing Notes and drawing on drivers identified from the comparative study of Marine Protected Areas, these have been mapped on to the possibility space in order to create storylines for each scenario.

To do this:

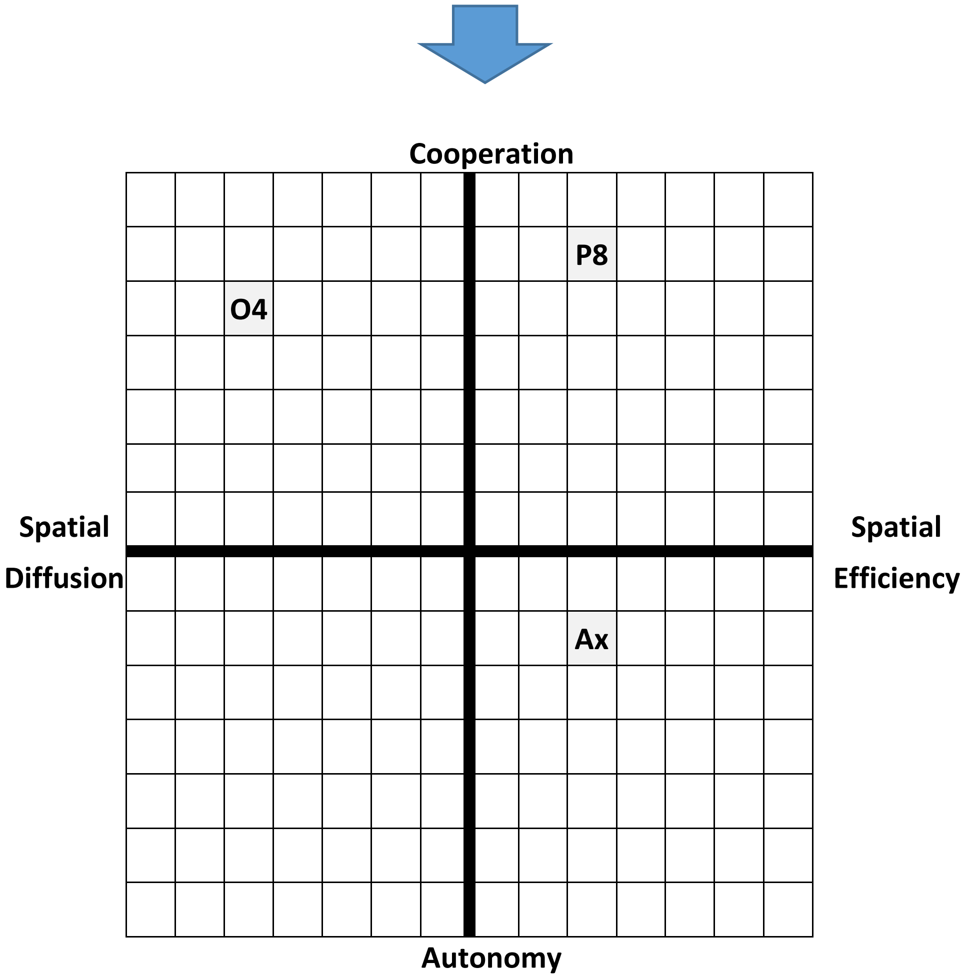
1. Each driver/issue in the tables was numbered (e.g.O1, O2 for offshore wind, C1,C2 etc. for conservation and so on)
2. The possibility space was further divided up into 7x7 grid squares for each quadrant
3. Based on the likely impacts of each driver/issue in the table, a decision was made about where this would fit within the possibility space. As a guide, where spatial efficiency was seen to be increasing, the marker would fall into either scenarios 2 or 4 (the right-hand side of the matrix), or if it was decreasing in scenario 1 or 3 (the left-hand side of the space). Level of cooperation was then considered – if this was seen to be increasing then the marker would fall in the top half of the space (scenarios 1 or 2), and if decreasing in the bottom half (scenarios 3 and 4).

Following this logic, it was possible to locate each driver or issue within a single quadrant of the possibility space. Then depending on the degree to which spatial efficiency or levels of cooperation were likely to change, the marker was assigned to an individual grid square within that quadrant.

4. Where there was a high or very high increase/decrease in spatial efficiency, the marker was first placed closer to the (right/left) ends of the horizontal axis. For moderate or low changes in spatial efficiency the marker was placed closer to the centre of the horizontal axis.
5. Then, where a high increase/decrease in cooperation was expected, the marker was moved up or down in line with the vertical axis towards the top or bottom of the space. For moderate or low changes in level of cooperation, the marker was moved only slightly up or down in line with the vertical axis.
6. This process was repeated with each driver until they had all been placed somewhere within the possibility space. Multiple markers were allowed in each grid square if this was the most appropriate placing for them.
7. A final check was then made to ensure that there was consistency in the way the markers had been placed on the grid – for example where a driver for the aquaculture sector might be co-location with tidal lagoons, it was important to check that any drivers for the tidal energy sector related to co-location of aquaculture were treated in a similar way (i.e. markers placed in the same grid square, unless there was a clear reason for differentiating between the two).
8. The drivers in each quadrant were then assembled into a storyline with illustrative examples of how different sectors may develop up to the year 2050. Each scenario was given a title that conveys its main characteristics.

Figure 13: Example of populating the 'Possibility Space' to create storylines

Driver/ Issue		Spatial Efficiency	Cooperation
O4	UK: GHG emissions reduced by 80% by 2050	-/=	+
P8	Continued development of the TEN-T network	=/+	++
AX	Development of niche market aquaculture products for local markets	=/+	-



A complete set of tables showing how impacts on cooperation and spatial footprint have been considered are included in Appendix 1.

Box 5: The four SIMCelt scenarios

1. Reaching Out

Key features: Cross border collaboration on a sectoral basis

International and national climate change targets and pollution controls are key drivers of change.

These lead to countries making greater efforts to deploy **marine renewables** in coastal areas and further offshore. More areas are zoned for the primary purpose of renewable energy growth both in coastal areas and further out to sea, creating competition for space between energy interests and other sea users such as aquaculture and shipping and increasing cumulative impacts. Transnational energy infrastructure is put in place to support the distribution of green energy.

Sharing of **information** within sectors is seen as a way to increase coordination, e.g. E-navigation, maritime service portfolios and development of the Common Information Sharing Environment for shipping.

Within the **shipping** sector international agreements on pollution are also key drivers of change, with more Emission Control Areas being designated and a much greater number of ships using LNG fuels. The seasonal opening of Arctic sea routes takes place but is dependent on high levels of international cooperation to maintain safety and security. Motorways of the Sea continue to develop along key routes and into more remote areas to connect with Arctic routes and growing renewable energy zones.

Ambitions for **aquaculture** production remain high across Celtic Seas countries as consumer demand for aquaculture product increases. As aquaculture moves further offshore this creates greater competition with other sea users. Climate change impacts such as increases in sea water temperature and increasing storminess also make large-scale production more challenging.

Increased sharing of data regarding **MPA** designations and collaboration on environmental monitoring takes place, e.g. using satellite data and autonomous vehicles to monitor marine habitats and species movements.

Box 5 continued

2. Joining Forces

Key features: Ecosystem based approach, high degree of governmental cooperation

This scenario affords the highest level of protection to the **marine environment**, with regards to international requirements such as CBD and MSFD. Countries cooperate on decisions about new MPAs, including some in international waters. At the national level, there is greater clarity and direction in the way that MPAs are designated and managed.

Tight environmental constraints mean that countries think more strategically about the location of maritime activities and there is a strong drive towards **colocation** of marine renewables with activities such as coastal defences, tourism, fisheries and aquaculture.

International **shipping** activity continues to increase, with larger ships being used to take advantage of economies of scale. In EU Member State waters, reduced customs formalities increase the efficiency and volume of goods moved through ports. Upgrades to port facilities and connectivity to ports hinterlands are implemented to take advantage of both international and local shipping movements. In areas where multiple marine users are active, protection of navigational safety is considered a priority.

Aquaculture growth is managed through the allocation of space in maritime spatial plans. Continued financial support from the EU and other institutions helps to deliver new operations that use innovate methods such as multi-use platforms shared with offshore wave energy and monitoring stations.

As well as developing colocation with aquaculture, fisheries and environmental monitoring, **renewable energy** continues to grow in two main areas. **Offshore wind** energy moves further out to sea, as technology for deeper waters (including floating platforms) becomes more viable both technologically and financially. A limited number of **tidal lagoons** are built, primarily for energy generation, but also supporting new leisure and tourism activities.

Box 5 continued

3. Going It Alone

Key features: Minimal cooperation, expanding sectoral approaches

Under this scenario, countries work independently to pursue their own **Blue Growth** targets, expanding and maximising exploitation of their maritime resources across marine territories. Coordination and cooperation on MSP is minimal. Competition within maritime sectors becomes fiercer, leading to distinct winners and losers, for example bigger **ports** using economies of scale and their connectivity to capture more shipping trade compared to smaller ports.

Efforts to protect the **marine environment** are limited as countries seek greater levels of economic exploitation, e.g. using waters more intensively for aquaculture, fishing and producing energy.

In terms of **aquaculture**, increasing demand for farmed products and the need to combat impacts of climate change such as increased seawater temperatures lead to the use of genetically modified alternatives to fishmeal, and GM species that grow faster.

To ensure security of energy supplies, existing sources of hydrocarbons continue to be extracted whilst new sources are explored. **Offshore wind, wave and tidal energy** continue to expand, with devices deployed in coastal waters and further offshore. Large tidal lagoons and barrages are built where these do not interfere with key navigational routes, resulting in some loss of habitats.

Box 5 Continued

4. Sustainable Localism

Key features: Countries concentrate on developing their own maritime activities but there is a lack of transnational cooperation.

Under this scenario economic growth in traditional industries is slow but there is accelerated growth in green and high-tech sectors. Smart **specialisation** within the maritime sector helps regions to develop unique strengths and capacities. New technologies also help to integrate different sectors using the same space as shared platforms monitoring systems and less polluting ways of doing things are found.

Conservation and environmental objectives focus on the reinforcement of existing management and regulation measures. Where new MPAs are considered for designation, there is a strong emphasis on additional socioeconomic benefits that can be provided through designation.

To use space more effectively, the **aquaculture** sector adopts a polyculture approach and multi-trophic species. High quality, niche aquaculture products with greater added value and traceability throughout supply chains are developed for local markets.

Diversification occurs within the **port** sector due to the slow growth of international trade, for example specialised shipbuilding services and innovations in logistics through greater use of IT and real-time tracking. Facilities servicing the offshore energy industries are adopted by some ports to compensate for the decrease in international cargos. In other ports, **short sea shipping** experiences a modest increase for specialised cargos such as liquid bulk.

Wave and tidal energy is increasingly favoured over offshore wind as technologies improve and both small and large-scale projects become more financially viable. Tidal lagoons are built in locations for the dual purposes of energy generation and protecting areas vulnerable to flood risk.

4. Celtic Seas 2050: Scenarios Workshop

4.1 Overview of the Workshop

To test the four scenarios and ascertain stakeholder views on future issues for MSP in transboundary areas, a workshop was held at the University of Liverpool in London Campus on Tuesday 19th September 2017. A full agenda for the day is included in Appendix 2

Stakeholders were invited from across maritime sectors in the Celtic Seas administrations and planning authorities. Participants on the day included consultants, researchers, ecologists, planners, representatives from the energy, fisheries and shipping sectors.

At this workshop, participants were split into four thematic groups that most closely matched their interests and the sectors under consideration. These were:

- Aquaculture
- Conservation
- Energy (offshore wind, wave and tidal)
- Ports and Shipping

Following presentations from invited guest speakers, workshop participants contributed to three interactive sessions that explored the SIMCelt scenarios.

Sectoral Ambitions
In the first session, participants discussed the four scenarios and then considered what they might mean for their thematic group. The scenario possibility space was used to help determine where each sector would be in terms of its spatial footprint and level of transnational cooperation on MSP.

Sectoral Interactions
In this session participants were given the opportunity to consider other sectors' ambitions for 2050 and what this might mean for their own sector in terms of potential competition for space or new synergies that might arise.

Promoting Cross-Border Cooperation
In this final session, each table took two of the issues identified in the previous session for further discussion and development of ideas to help resolve the problem. In their groups, participants were asked to describe the problem and identify whether this had a transnational dimension. A pro forma was used to guide participants through ways to resolve the problem.

4.2 Presenting the Scenarios

At the beginning of Activity 1, participants were given time to read through the four scenarios before thinking about how the scenarios might apply for the sector they had been allocated. This enabled them to consider the internal consistency of the scenarios and to reflect on the terms ‘spatial diffusion’ and ‘spatial efficiency’. This enabled some general feedback on the scenarios to be collated. In the main, the two axes presented were understood, however in discussions on the tables some comments were made with regards to the plausibility of the scenarios and terminology. These included:

- Concerns (related to scenarios 3, *Going it Alone* and 4, *Sustainable Localism*) that Brexit would mean the UK no longer cooperates with other countries. However, it was also noted that following Brexit negotiations, irrespective of the outcome, that the impacts will have dissipated and cooperation between the UK and EU will have stabilised again.
- The headings and scenarios don’t match – drivers and targets are international level, but implementation is at local level.
- It should also be remembered that by 2050 all European countries will have their own maritime spatial plans that will guide development.

In addition, some participants noted that it would be useful to define the starting point (current position) on the axis to give people a sense of where the sectors currently are compared to where they could be in the future.

4.3 Sectoral Ambitions

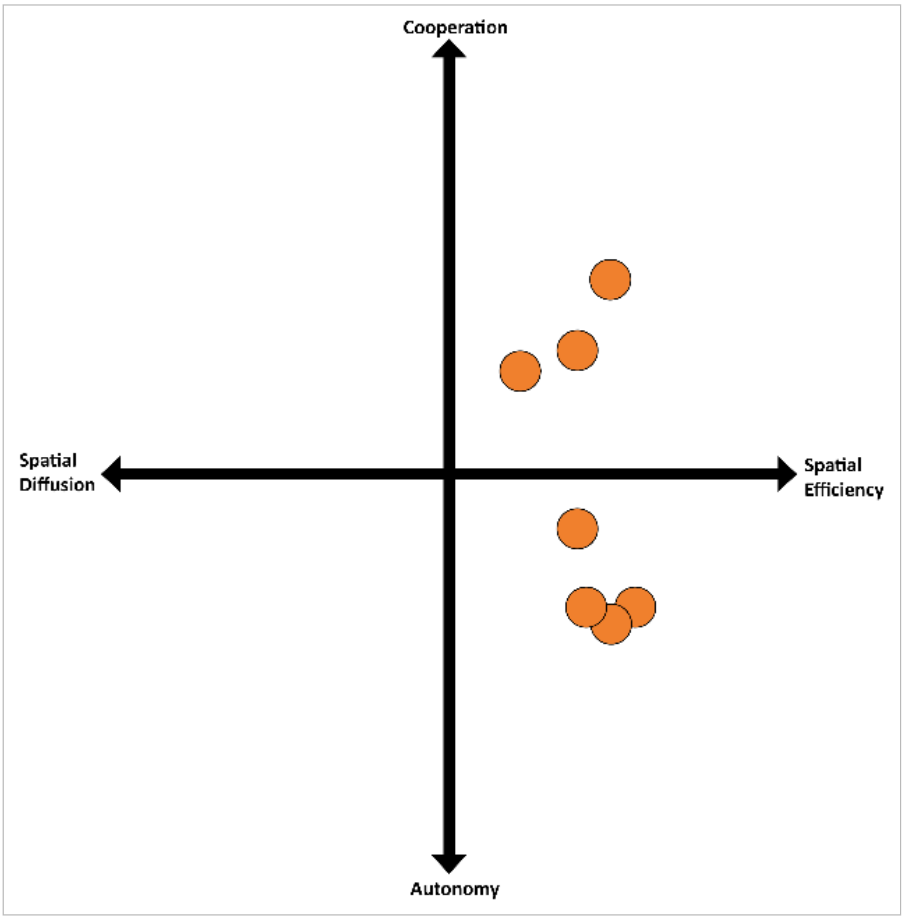
In the first session, participants were asked to familiarise themselves with the four scenarios and to give their views on which of the scenarios seemed most plausible or most desirable for their thematic group. They were then asked to think about where their sector would be by the year 2050 in terms of the degree of transboundary collaboration that might take place and whether the sector would increase its spatial efficiency. This information was recorded by placing coloured stickers onto the possibility space to show the sector’s position by 2050. The groups were not asked to agree on one common position, allowing for variation between countries and sub-sets of each sector, for example freight shipping and recreational boating. Participants were also asked to provide comments on their choice using Post-It notes.

Aquaculture

For the aquaculture sector, participants’ expectations of where the sector would be by the year 2050 are shown in Figure 14. This clearly shows a move towards greater spatial efficiency within the sector – driven by inshore developments and competition for space with other sectors. Other factors influencing efficiency included:

- MSP being in place and providing greater clarity to the sector
- The scale of aquaculture operations, with smaller scale operations to co-locate with other sectors
- It was noted that it would be desirable to move into areas [offshore] that are not used very much, but the ability to do this is limited by technology, climate and conditions.

Figure 14: Aquaculture



With regards to cooperation, participants did not agree on the level of transnational cooperation that would be undertaken by 2050. Differences related to the following:

- Where levels of cooperation are low, this represents the current situation being expected to continue to 2050
- Where participants expected levels of transnational cooperation to be higher, this was due to either cooperation with other sectors (to facilitate co-location), or localised developments in cross-border areas requiring joint working.

Conservation

Within the conservation sector, views on the future of marine protection showed a similar pattern of divergence to that of the aquaculture group, with a move towards increased spatial efficiency – though this time with greater variation in the level of efficiency that would be achieved - and differing views on the level of transnational cooperation as shown in Figure 15 below.

Spatial efficiency within the conservation sector was felt to be increased by the following factors:

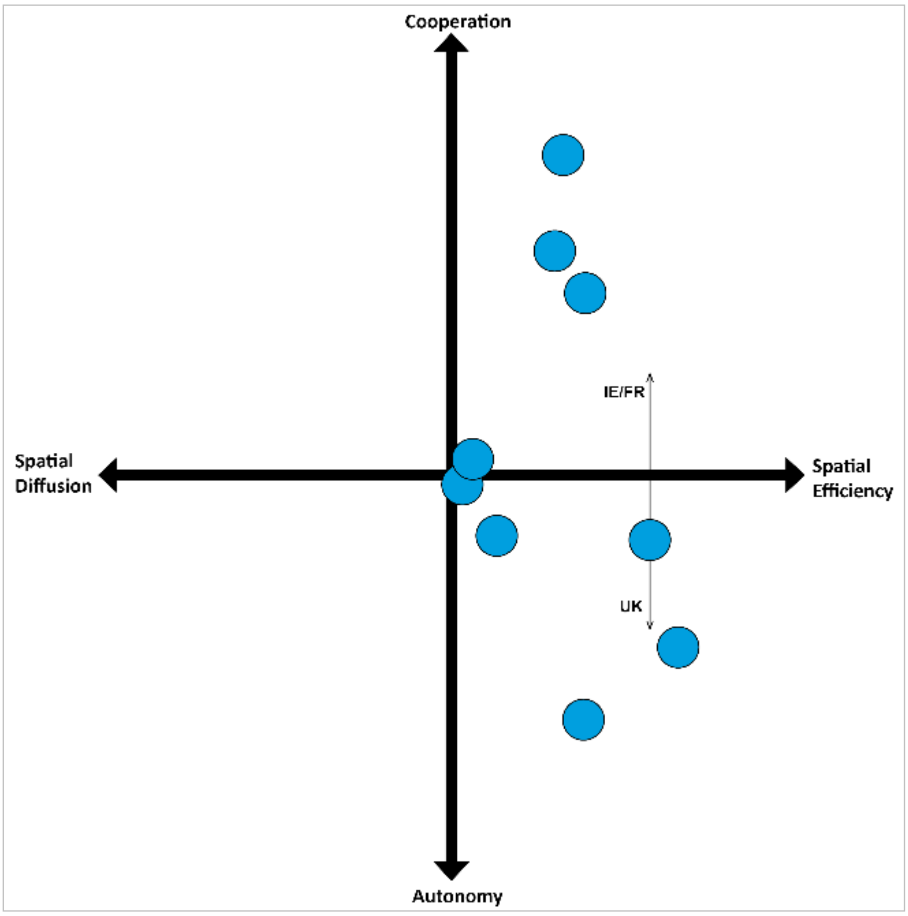
- Use of SEA/EIA for developments and adherence to a plan-led approach

- Maintenance of existing regulation for MPAs and ongoing activities to allocate new MPAs. Tighter environmental constraints, as described under the *Joining Forces* scenario would not happen.
- Some colocation or permitted activities within designated areas will develop, however this will be on an ad-hoc basis rather than government led.

Despite this, some concerns remained about the overall effectiveness of MPA governance and regulation. These included:

- For the UK in particular, implementation of environmental legislation will receive less attention in favour of pursuing economic development
- Management goals for MPAs not being achieved
- Enforcement of MPA management measures weakening and changes in accountability for MPA management
- Conflicting policy in other sectors leading to less protection for the environment
- The perceived lack of an ecosystem level approach to conservation and the need for conservation to be put at the forefront of decision making activities

Figure 15: Conservation



Where there was divergence in the level of cooperation expected by participants, views were to some extent shaped by the ongoing discussions over the UK's exit from the European Union, being viewed from both positive (increased cooperation) and negative angles (decreasing cooperation). Some participants noted that for the UK only levels of cooperation may decrease, whilst for Ireland and France as they will remain Member States of the EU their level of transnational cooperation would increase.

In instances where levels of cooperation were anticipated to increase, it was noted that:

- Efforts in respect of data collection may continue through research institutions but not government or industry
- Cooperation may relate to the protection of species that are transnational in character
- Other regional sea mechanisms such as OSPAR and NGOs could continue to drive cooperation on conservation issues
- For the UK, cooperation with third countries (non-Member States) may become more prevalent

A final consideration in the development of conservation related to policy divergence between Celtic Seas administration in relation to the incorporation of social wellbeing factors into decision making. In Wales the Well-being of Future Generations (Wales) Act 2015 is promoting greater consideration of wellbeing and socio-economic criteria in conservation decisions, however it is unclear whether this approach will be taken up other UK administrations, France and Ireland.

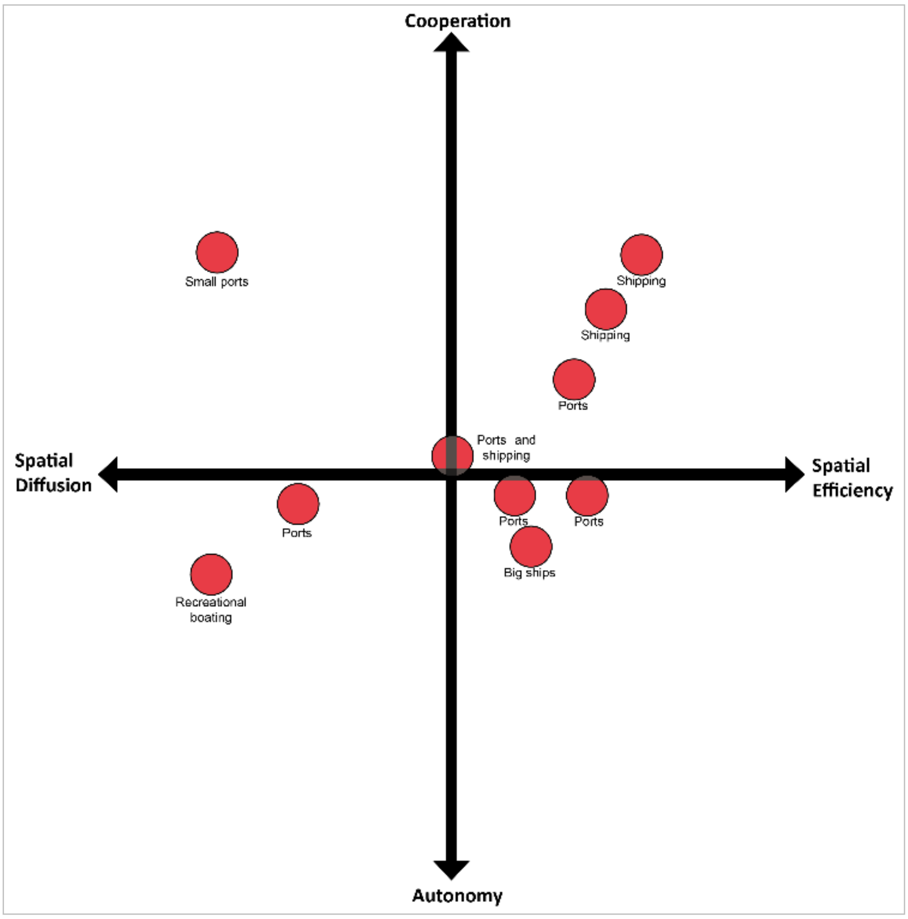
Ports and Shipping

Within the ports and shipping group, participants differentiated between sub-sectors when thinking of how the picture might look in 2050 and this is reflected in the more uneven pattern of possibilities shown in Figure 16 which encompasses recreational boating, small and larger ports and shipping in terms of large container ships.

In terms of (container) shipping, this was seen to be increasing in its spatial efficiency, though there were differing views on the degree of future cooperation. Within this sub-sector, the increasing size of ships and developing 'Motorways of the Sea' combined with the need to ensure navigational safety were seen as key factors for increasing spatial efficiency. The UK's departure from the EU was seen as a neutral factor in terms of changing shipping routes as either international (non-EU) shipping would be more attracted to UK ports or goods might enter the UK via short sea routes from Europe. In addition, the potential for the Celtic Seas to benefit from opening of Arctic routes (as outlined in the *Reaching Out* scenario) was seen to have little effect on overall spatial patterns as the northernmost parts of the Celtic Seas lack the infrastructure to take advantage of the opportunities this may bring, apart from a limited increase in shipping traffic due to transhipment.

With regards to cooperation, competition for trade was seen as the main reason for low levels or a tendency towards autonomy. In contrast international regulation of shipping through the IMO and increasing levels of digitalisation to aid navigational safety, autonomous vessels and ship operations more generally could increase the level of cooperation as this would require the same standards and procedures to be adopted.

Figure 16: Ports and Shipping



For ports, participants felt that the trend for this sector was one of lower levels of cooperation and spatial efficiency relative to the shipping sector. Like within the shipping sector, the dominance of market forces shapes both the level of cooperation (with many ports competing against each other for the same trade) and spatial requirements for port operations.

It was noted that in France, small to medium sized ports are managed by local authorities and have greater autonomy and serve national rather than international market forces. It was also noted that smaller ports may have greater capacity to innovate in relation to marine renewables in terms of maintenance/servicing industries and new technology. An exception to the trend of relatively low levels of cooperation and spatial efficiency within the smaller ports sector was highlighted in relation to fisheries – as the fisheries sector consolidates, some smaller ports that have previously supported fishing and are experiencing a decline may turn to different activities, whilst remaining fishing ports and related services will become more concentrated, achieving a higher degree of spatial efficiency.

Finally, within the ports and shipping sector, some though was given to the sub-sector of recreational boating. The trend for this sub-sector was to remain a spatially diffuse (as it already is) and with potential for further fragmentation as the deployment of offshore wind and other marine renewables may deter leisure craft from some areas. Although transnational cooperation in this sub-sector was regarded as also remaining low, the example of the English Channel's network of leisure ports, *Marina 2020*, developed through the

Interreg 4a funded CAMIS project[3] was cited as an example of how regional cooperation might be achieved.

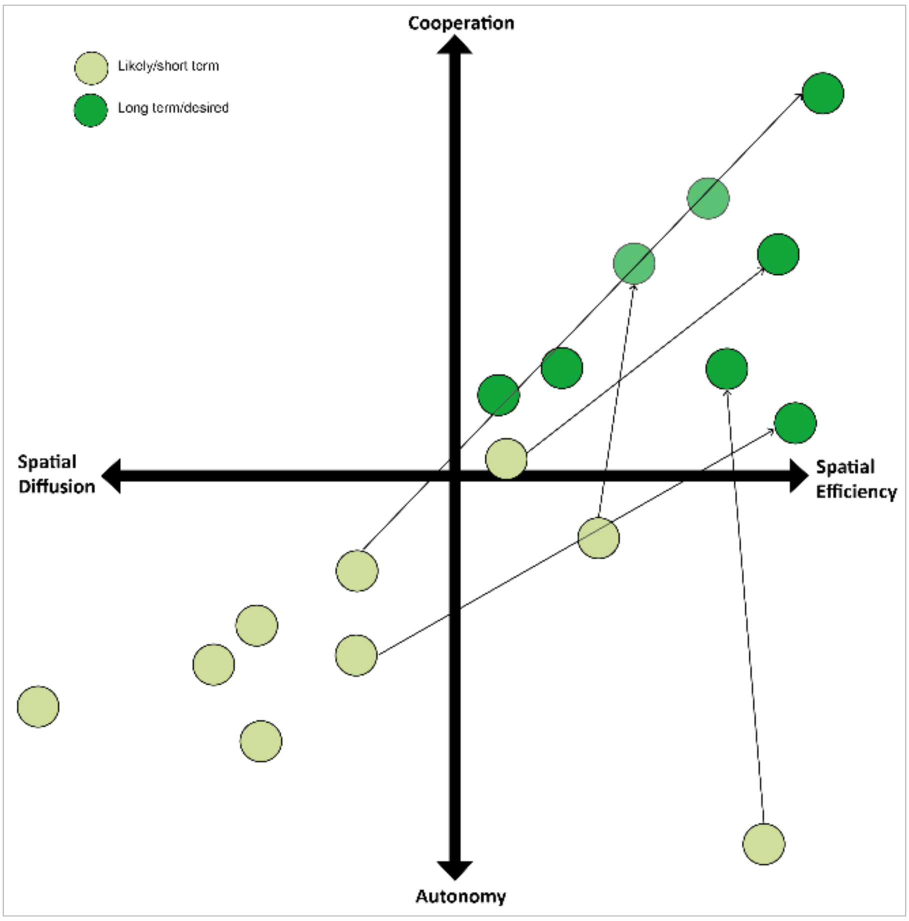
Wind, Wave and Tidal Energy

For the wind and wave energy group, a different approach was taken to use of the possibility space. For these sectors, both short term (near future) and longer-term developments were considered, with participants indicating more specific trajectories of change within the sector.

For wave energy (Figure 17), participants largely agreed that wave energy would move from a position of spatial diffusion and relatively low levels of cooperation in the short term to a more cooperative, spatially efficient pattern of development. In the short-term perspective, levels of cooperation were viewed as being low for the following reasons:

- Wave and tidal energy is still developer-led rather than planning-led
- Cooperation at this stage is limited to research and environmental monitoring
- The wave and tidal energy sector has not yet fully engaged with other marine users to understand their needs

Figure 17: Wave Energy



[3] Channel Arc Manche Integrated Strategy (CAMIS). https://camis.arcmanche.eu/outputs/maritimeclusters.html

The shift from the short term/near future position of the sector to the long term represents quite a dramatic shift and reveals high aspirations for wave and tidal energy. Reasons given for improved spatial efficiency included:

- Future development of more strategic approaches to planning for wave and tidal energy that are currently lacking
- The ability of tidal lagoons to offer multiple benefits and support other uses, e.g. public access, recreation, space for aquaculture
- Wave and tidal projects may be more locally responsive to stakeholders
- Wave energy may remain small scale, driven by devolved/regional government. This may lead to efficiency by default as support from local communities is needed.

In terms of cooperation, participants cited the following for increased levels:

- There is a strong public desire for MSP to secure wider sustainability and public benefits, so cooperation will be desirable from a societal point of view
- (With respect to tidal lagoons) projects can only be successful if there is local community support and buy-in due to multiple benefits at the local level. More cooperation from local stakeholders is therefore needed for tidal projects (in contrast to offshore wind which is more top-down). It was noted that in Ireland, if objectives in the Offshore Renewable Energy Development Plan (OREDP) are achieved there will be greater cooperation between developers and planners, supporting sustainable development of the wave and tidal sector.
- Some participants felt that cooperation in the wave and tidal sector may be limited to sharing of data and that cross-border cooperation would still be minimal.

Offshore Wind

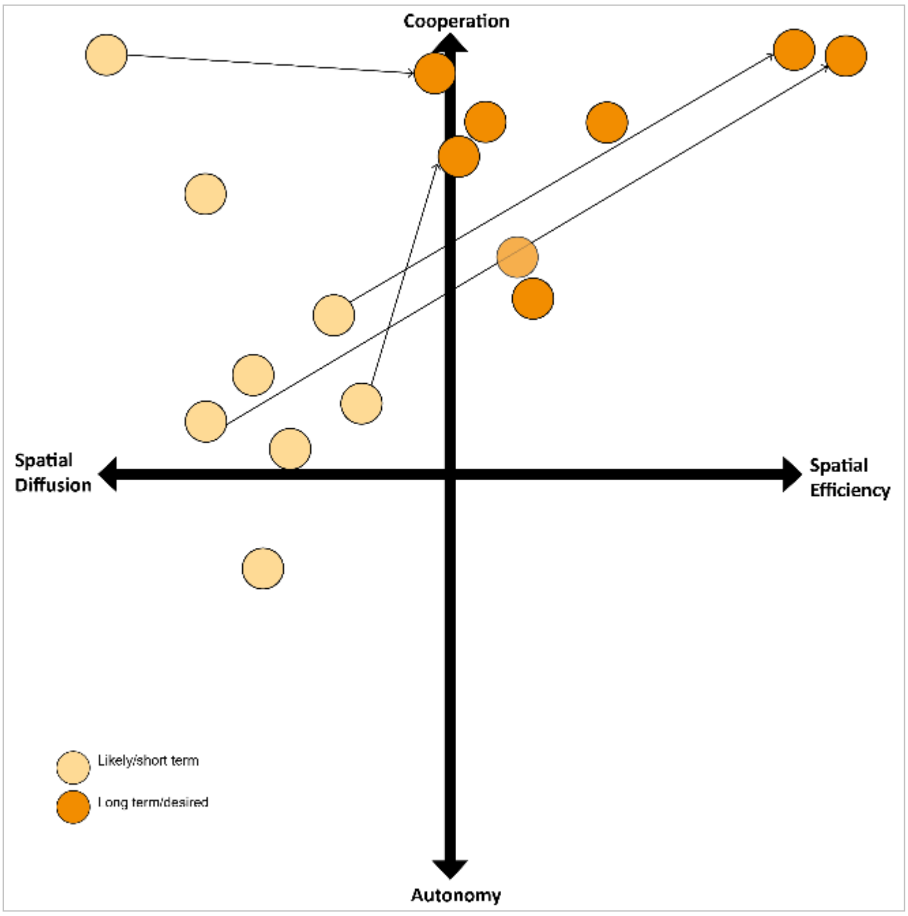
For offshore wind (Figure 18), participants found this sector to already have a medium to high levels of cooperation in place as developers are looking to a more strategic, Europe-wide approach for the offshore wind sector and this is reflected in cooperation amongst developers rather than in relation to MSP. Patterns of development in the sector are more spatially diffuse. This is in part due to levels of maturity in the industry in different administrations (as some places such as England and Scotland do already have wind farms whilst Northern Ireland has none).

Over the longer term, participants envisaged that levels of cooperation would further increase to a high degree and that spatial efficiency would improve, although there were variations in the degree to which efficiency would be gained. Reasons for improvement in spatial efficiency given by participants included:

- Increasing embeddedness of offshore wind within MSP
- Greater consideration of social and ecological impacts of wind farms, supporting better coexistence/colocation with other uses
- Potential for supergrids to influence location

It was noted however, that offshore wind farms do require a certain amount of their ‘own’ space due to navigational and other safety issues (potential damage to cables) that may continue to restrict opportunities for colocation. In addition, as further areas are released for licensing of offshore wind farms this will inevitably lead to further spatial diffusion as more of the marine area is taken up by wind farm developments.

Figure 18: Offshore Wind Energy



Higher levels of cooperation in offshore wind development were thought to be driven by:

- Bigger scale of windfarms and the international nature of consortia/project developers, particularly with respect to large-scale arrays in deeper waters
- Further embeddedness within MSP: there is already cooperation on technical aspects of wind farm development but not so much on planning
- An energy supergrid might drive cooperation, but there are many practical issues surrounding grid connection that may act as a barrier

Summary

In considering sectoral ambitions, there is a general trend across all sectors to move towards a more spatially efficient type of development that supports co-existence or colocation with other sectors. This is particularly so for wind, wave and tidal energy where participants saw the greatest opportunities for co-location with other sectors. For ports and shipping, this picture was slightly different, mainly due to the variations in size of the different sub-sectors considered by participants such as recreational boating and much larger freight services where the nature of the activity and the actors involved are already incredibly different. Overall, participants recognised the positive nature of the same direction of travel across all the sectors, as this demonstrates a desire for more sustainable patterns of development.

With regards to cooperation, the possibility spaces provide a more mixed picture of whether levels of cooperation on MSP would increase.

- In the offshore wind, wave and tidal energy sectors there is a strong, clear message that cooperation will increase, as these sectors are continuing to grow and will need to influence future maritime spatial plans to ensure that appropriate locations for energy installations are delineated and potential for conflicts with other development are minimised.
- For ports and shipping, again the variation within subsectors provided for a more mixed situation. However, despite the economic dominance of large ports and the protection offered to crucial shipping lanes, opportunities for the ports and shipping sector to become more engaged in cooperation due to the digitisation of trade and navigation might help to improve the broader picture for this sector.
- Within the aquaculture sector, some participants felt that already low levels of cooperation would continue to exist into the future.
- In the conservation sector, scepticism related to Brexit and the UK's continuation to adhere to EU conservation objectives were seen as a major reason for decreasing cooperation. But, cooperation on marine science/data collection and the existence of other regional seas governance mechanisms might help to push increased cooperation.

In the following section, participants' views regarding future sectoral interactions are explored.

4.4 Sectoral Interactions

During the break the possibility spaces for each sector were photocopied and distributed to the other tables so participants could see where other participants thought their sector would be along the possibility space by 2050. Having considered possible changes in each of the other sectors, participants were asked what this would mean for their own sector. Key questions put to the participants included:

- Are there likely to be more spatial conflicts?
- Are these different activities compatible and able to function in the same space?

Facilitators for each group took notes of the discussion, which are presented in Table 1. At the end of this session the facilitators for each group fed back the key issues that had been identified with respect to cross-sectoral working.

The key points identified from the discussion included:

- There are limited conflicts between the aquaculture and conservation sectors, those arising could be managed through a more proactive approach to consultation and agreement.
- Aquaculture and conservation have a mutual interest in maintaining good water quality.
- The colocation of aquaculture and offshore energy was identified as a key opportunity, however some big questions remain about the possibility of colocation as aquaculture areas may not be suitable for energy installations (and vice versa). Similarly, it was noted that the case for economic viability and societal benefits has not been made so developers may be unwilling to take risks.
- Offshore aquaculture (moving further out to sea) might be seen as a constraint by other sectors.
- Wave energy appears to offer the greatest opportunities for co-design that can incorporate wider community benefits.
- Colocation between ports and aquaculture is unlikely to take place, but ports may benefit from the spatial management of aquaculture as they can influence location to protect navigational safety.
- Energy development is likely to have further negative impacts on conservation, e.g. underwater noise impacts from construction or decommissioning, seabed disturbance due to cabling and cumulative impacts. Floating platforms may lessen some of these risks.
- Port expansion may be constrained by existing conservation designations, e.g. SPAs and SACs.
- Ports and Shipping legislation can be a driver for conservation and environmental improvements, e.g. Ballast Water Convention, Port Reception Facilities Directive.
- Ports may be more likely to enter trade-offs with conservation, e.g. Bristol port where conservation projects and mitigation measures are needed.
- Shipping lanes are unlikely to change to accommodate new energy developments.
- Ports may need to evolve in order to keep pace with logistical demands from larger wave, tidal energy and offshore wind developments.
- An increase in long haul shipping may increase the risk of invasive alien species and other biosecurity risks.

Table 1: Key sectoral interactions

	Conservation	Energy	Ports and Shipping
Group: Aquaculture	• Limited conflicts which we think can be managed quite well, e.g. via licensing process and better co-location of activities • Mutual interest in water quality • Cumulative impacts of aquaculture biggest threat to conservation • Unknown impact of climate change? • Increase in collaboration from industry • Don't see how co-operation with aquaculture will affect conservation. • In Ireland, certain licences were being approved without any EIA, which posed a potential threat to conservation. Compensation then needed to be provided to remedy this situation. • By 2050 licensing will be much better. • Broadly same scenario as aquaculture • Spatial efficiency but a wider range of cooperation/autonomy, tending towards cooperation • Compatible/complimentary with aquaculture – in many cases – but depend on location/activity/objectives • Approach is the key – work/talk/agreement driven • Opportunity to take on board/be influenced by NGO environment • Opportunity to promote green credentials, promote green tourism • Depends on species, type of tourism, location, societal pressure	• Aquaculture seems opportunistic and without a requirement for integration. • If high tech developments took place in the high seas the picture might move more to the left-hand side, although this depends on the level of integration in MSP which would increase efficiency • Co-location sounds good in theory, but it takes two industries to come together that may not be too interested in doing so. Co-location sounds attractive to planners, but is it to industry? • Practicalities remain a stumbling block: there are design issues, issues related to accessibility and safety, and interference with each other's operations. There is also an issue related to economic risks: e.g. aquaculture may compromise the (economically more valuable) operation of offshore wind farms. • Commercial viability is the key driver in both sectors, so anything that makes operations more expensive is likely to be precluded. So risk assessment is important: what are the costs and benefits to either sector? • Spatial overlap may be an issue: Offshore wind sites are not necessarily where aquaculture would take place. Co-location may also depend on the total available potential sites (or lack of alternatives – e.g. in the case of tidal range energy). So, opportunities and constraints models and mapping of potential locations for all sectors would be helpful. • Repowering nearshore may preclude other industries but also offer opportunities for co-design. A main stumbling block is that offshore wind would not benefit from co-design in the same way that aquaculture would, but would be landed with higher costs (problem of over-engineering). • Wave energy offers greater possibilities for co-design as initiatives are smaller scale and more local and need to produce multiple benefits to draw community support. There may be community benefits to co-location even if there are no economic benefits. • The business case for offshore aquaculture still needs to be made. • Floating wind farms would also see aquaculture as a constraint. • A key question is who will push co-location and what societal benefits are expected: What will it take to get the offshore wind sector to take on a higher level of risk? Can MSP really impose this on developers?	• Colocation in commercial scale activity will be a challenge – other sectors favoured, e.g. tourism • Spatial management of aquaculture good for ports sector – they can influence location • Benefit – diversification of smaller ports

Table 1 continued

	Conservation	Energy	Aquaculture
Group: Ports and Shipping	• Increased long haul shipping increases risk of IAS/biosecurity breaches – effect on local ecosystems • Tradeoffs may increase with ports conducting conservation projects, e.g. Bristol • Ports and shipping legislation can be a driver for conservation, e.g. Ballast Water Convention, Port Reception Facilities Directive, noise regulations. But there will be an increase in underwater noise • Increases in long haul shaping could increase the risk of IAS and biosecurity risks. Ports legislation could help with this issue.	• A complex map due to a complex industry! • Shipping routes are taken as a given framework and hard constraint that is unlikely to change (all agree) • Safety and economic efficiency aspects are the key drivers for the shipping sector; thus, they have a strong incentive to stick to the shortest possible routes • New trade routes might open up as a result of Brexit • More modular ship-building may be able to support ports (see Northern Ireland shipping strategy) • Ports also need to evolve with larger wave and tidal energy and offshore wind logistics • Efficient shipping and port development need equally efficient infrastructure on land	• Broad range of possibilities • Opportunities: smart ports, integration with other sectors e.g. energy, shared facilities, co-location, feed in/fish out • Negatives: more ports > bigger boats – issues around navigation/location of wind farms or services (feed barge moorings) • Too dependent? What if port/harbour facilities become unavailable

Table 1 continued

	Aquaculture	Conservation
Group: Energy	• Very broad • In 2050 cooperation/spatial efficiency quarter • Depends on location • Small pilots • Moves further offshore – less conflict, but increased technology and infrastructure challenges • High energy further offshore, harnessing that is key • [Moving offshore will] free up space for aquaculture, also provide opportunities for colocation	• Underwater noise impact from construction • Decommissioning noise impacts species e.g. harbour porpoise • Increase in cabling/networks • Cumulative impacts • Transboundary cooperation between countries – potential benefit to conservation • Floating platforms would enhance conservation • By 2050 we may have realised some of the long-term impacts of projects taking place now. Conversely we may be seeing the early stages of other industry • Lack of cooperation from wave and tidal with other industries is a risk to conservation

	Aquaculture	Ports and Shipping
Group: Conservation	• Broadly same scenario as aquaculture • Spatial efficiency but a wider range of cooperation/autonomy, tending towards cooperation • Compatible/complimentary with aquaculture – in many cases – but depend on location/activity/objectives • Approach is the key – work/talk/agreement driven • Opportunity to take on board/be influenced by NGO environment • Opportunity to promote green credentials, promote green tourism • Depends on species, type of tourism, location, societal pressure	• Similar pattern of dots to aquaculture and shipping • Existing ports constrained by SACs/SPAs • Potential for ecological engineering?

4.5 Promoting Transnational Working

Following the discussions of sectoral interactions, the two top issues from each table were identified by facilitators for elaboration of problems and possible solutions. The issues identified were:

1. Biosecurity and shipping
2. Conservation and offshore wind
3. Colocation of aquaculture and conservation areas
4. Colocation of aquaculture and offshore wind
5. Transnational energy grids and storage facilities
6. Colocation of aquaculture and ocean renewable energy (further offshore)
7. Port diversification
8. Designation of new shipping lanes

Participants then began to consider these issues in more detail and think of ways they could be addressed by planning authorities. For each issue, discussion was guided using a pro forma for participants at each table to complete. This helped to identify the transnational nature of the issue, possible solutions and the resources or mechanisms that would need to be put into place in order to improve the existing situation.

The following Boxes (6-13) show the completed pro forma for the issues listed above.

Box 6: Actions on Biosecurity and Shipping

Table: Conservation

<table>
<tr><td colspan="2">What is the issue? Does it have a transnational dimension?
Biosecurity and shipping</td></tr>
<tr><td colspan="2">Can this be resolved by MSP processes or policies? If so how?
• Consolidate existing biosecurity policies and legislation e.g. through a policy or requirement for a biosecurity action plan
• MSP implementation guidance can provide advice on which sectors and type of activity need which measures
• Good awareness of IAS helped by advancement of MSP
• Marine planning evidence portals can help identify risk areas/routes</td></tr>
<tr><td colspan="2">What type of intervention is required?
✓ Further research
☐ New legislation
✓ More engagement with certain sectors
✓ Other (Specify)
Ballast Water Convention, WFD, MSFD

Promote citizen science as a monitoring tool</td></tr>
<tr><td>Who needs to be involved?
✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies</td><td>✓ General Public – citizen science – identification of invasive species
✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
✓ International Governance Organisations, e.g. United Nations - IMO
☐ Other (Specify)</td></tr>
</table>

Box 7: Actions on Conservation and Offshore Wind

Table: Conservation

What is the issue? Does it have a transnational dimension?

Conservation and offshore wind

Can this be resolved by MSP processes or policies? If so how?

- *DESIGNATE ZONES for offshore wind that are de facto no take zones as a conservation benefit.*
- *MSP policies can drive licensing conditions to minimise risk and impacts on other sea users.*
- *MSP is a driver for data collection and sharing, identify opportunities and risks.*
- *MSP policies can enhance environment and look favourably on co-location. May also look more favourably on floating platforms, less intrusive*
- *If approved, OSPAR can inform marine licensing conditions*

What type of intervention is required?

✓ Further research – *OSPAR guidelines re decommissioning*
☐ New legislation – *floating platforms*
✓ More engagement with certain sectors
☐ Other (Specify) – *Ecosystem services*

Offshore interconnected network

Seascape

Who needs to be involved?

✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
✓ General Public

✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
✓ International Governance Organisations, e.g. United Nations *IMO*
✓ Other (Specify) – *Specific working group*

Box 8: Actions on Co-location of Aquaculture and Conservation

Table: Aquaculture

What is the issue? Does it have a transnational dimension? *Co-location of aquaculture and conservation* *(Yes, it has a transnational dimension – cumulative impacts)*	
Can this be resolved by MSP processes or policies? If so how? *MSP can assist/is starting to assist with* • *SEA/EIA* • *Depends on where and what conservation objectives are* • *Depends on the detail of the plan* • *Identify cumulative impacts* • *Mitigation strategies*	
What type of intervention is required? ✓ Further research ✓ New legislation / *guidance* ☐ More engagement with certain sectors ✓ Other (Specify) – *look at MUSES project*	
Who needs to be involved? ✓ MSP Authorities ✓ Other Government Departments ✓ Specific Sectors ✓ NGOs ✓ Sector Representative Bodies ✓ Specific Companies ✓ General Public	✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions ✓ International Governance Organisations, e.g. United Nations ☐ Other (Specify)

Box 9: Actions on Co-location of Aquaculture and Offshore Wind Energy

Table: Aquaculture

<table>
<tr><td colspan="2">What is the issue? Does it have a transnational dimension?
Colocation of aquaculture and offshore wind</td></tr>
<tr><td colspan="2">Can this be resolved by MSP processes or policies? If so how?
No, but:
• Identify areas of shared interest, conflict, overlap
• Facilitate
• Done by sectoral intervention – incentives, logistics
• Sustainable development/blue growth
• Wind alone – transnational potentially, but aquaculture alone is not</td></tr>
<tr><td colspan="2">What type of intervention is required?
✓ Further research – case studies
☐ New legislation
✓ More engagement with certain sectors
✓ Other (Specify) – projects/pilots
• Technology
• Conditions – physical
• Different types of aquaculture
MUSES project doing some of this</td></tr>
<tr><td>Who needs to be involved?
✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
✓ General Public</td><td>✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
☐ International Governance Organisations, e.g. United Nations
☐ Other (Specify)</td></tr>
</table>

Box 10: Actions on Transnational Energy Grids

Table: Energy

<table>
<tr><td colspan="2">What is the issue? Does it have a transnational dimension?
A transnational grid and storage facilities – (interconnectors) – integrated in wider energy systems
- Political issue (e.g. Ireland)
- Lack of incentives
- Electricity cost as a driver/disincentive</td></tr>
<tr><td colspan="2">Can this be resolved by MSP processes or policies? If so how?

Practical issues (e.g. transfer stations), but opportunity to think strategically

MSP to include aspirational goals for energy</td></tr>
<tr><td colspan="2">What type of intervention is required?
☐ Further research
✓ New legislation – UK legislation does not encourage cooperation
☐ More engagement with certain sectors
✓ Other (Specify) – Platform for exchange: government, developers/industry, planners

Promote storage – related research and show benefits for developers</td></tr>
<tr><td>Who needs to be involved?
☐ MSP Authorities
✓ Other Government Departments
☐ Specific Sectors
☐ NGOs
☐ Sector Representative Bodies
✓ Specific Companies
☐ General Public</td><td>☐ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
☐ International Governance Organisations, e.g. United Nations
✓ Other (Specify) R&D</td></tr>
</table>

Box 11: Actions on Co-location of Aquaculture with Tidal Energy

Table: Energy

What is the issue? Does it have a transnational dimension?

Co-location aquaculture/offshore renewables – use tidal lagoons to prove the concept of spatial pressure > aquaculture inshore drives the move offshore

Can this be resolved by MSP processes or policies? If so how?

- *Needs more engagement with actors in the industry*
- *Needs government policy*
- *Focus on social licence/benefits*
- *Identify suitable areas and use safeguarding policy*

What type of intervention is required?

✓ Further research – *proving commercial viability of offshore aquaculture*
☐ New legislation
✓ More engagement with certain sectors
✓ Other (Specify)
Aquaculture strategy
"A voice for the industry"
More trials/better trials and business case (plus risk assessment)

Who needs to be involved?

✓ MSP Authorities
☐ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
☐ General Public

☐ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
☐ International Governance Organisations, e.g. United Nations
☐ Other (Specify)

Box 12: Actions on Port Diversification

Table: Ports and Shipping

What is the issue? Does it have a transnational dimension?

Ports realising opportunities for diversification related to Blue Growth

- *Both small and large ports*
- *Engaging ports in planning for other sectors*
- *Some port/shipping activities are more transnational than others, e.g. renewable energy*

Can this be resolved by MSP processes or policies? If so how?

- *Need to present a transnational picture of opportunities available to the ports sector*
- *Proactive stakeholder engagement – building into review of first cycle of marine plans*

What type of intervention is required?

✓ Further research – *of cost/benefits, financial mechanisms and supply chains*
☐ New legislation
✓ More engagement with certain sectors
☐ Other (Specify)

Who needs to be involved?	
✓ MSP Authorities ✓ Other Government Departments ✓ Specific Sectors ✓ NGOs ✓ Sector Representative Bodies ✓ Specific Companies ✓ General Public	☐ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions ☐ International Governance Organisations, e.g. United Nations ✓ Other (Specify) – *financial mechanisms, maritime clusters*

Box 13: Actions on Shipping Lanes

Table: Ports and Shipping

What is the issue? Does it have a transnational dimension? *[MSP authorities] designating shipping lanes of national significance that exclude other activities/users* - *By 2050 autonomous ships or high-speed passenger vessels might need separate lanes* - *Transnational as it involves UNCLOS and freedom for international shipping to navigate*	
Can this be resolved by MSP processes or policies? If so how? *Could be designated by planning authorities or the IMO*	
What type of intervention is required? ✓ Further research – *technical studies, e.g. Short Sea Shipping in the Irish Sea – establishment of network* ✓ New legislation – *established processes could be further developed* ☐ More engagement with certain sectors ☐ Other (Specify)	
Who needs to be involved? ✓ MSP Authorities ✓ Other Government Departments ✓ Specific Sectors ✓ NGOs ✓ Sector Representative Bodies ✓ Specific Companies ☐ General Public	✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions ✓ International Governance Organisations, e.g. United Nations ✓ Other (Specify) - *IMO*

5. Conclusions

This Chapter presents an analysis of the research that has been undertaken in the SIMCelt project in relation to the use of scenarios as a tool for understanding future spatial demands on maritime space and potential cross-border issues. For more detailed information relating to the individual sectors considered as part of the scenarios work, please also refer to the Maritime Sector Briefing Notes and AFB's *Comparative analysis of national strategies for marine conservation in the Celtic Sea Region* report (de Magalhaes *et al*, 2017).

5.1 Future Spatial Demands

In terms of future spatial demands, all of the sectors examined in the Briefing Notes and scenarios exercise are expected to grow, however with regards to the possibilities of more spatially efficient forms of development the following trends can be discerned:

- The aquaculture sector is likely to achieve some spatial efficiency through greater attention in maritime spatial plans and new techniques such as multi-trophic systems; however ambitions for colocation with other sectors are unlikely to be realised on a large scale.
- Cabling will increase with the development of new offshore renewable energy, with a limited number of new cross-border interconnectors coming into service.
- Conservation activities (i.e. designation of MPAs) is expected to continue, but a greater challenge for this sector will be ensuring that management objectives are met.
- Ports and shipping, as critical supports to global economic activity, will remain a primary focus for MSP in terms of protecting lanes and navigational safety and port hinterlands to facilitate expansion and diversification. Diversification of ports may lead to some spatial efficiencies and cooperation with other sectors that rely on port facilities and infrastructure, such as offshore wind energy.
- Offshore wind will continue to have a growing spatial footprint, particularly in French waters where many proposed schemes are in development and will soon become operational. Some spatial efficiency may be achieved through technological improvements to the generation capacity of wind turbines.
- Wave and tidal energy will develop a much greater spatial footprint as pilot activities are scaled up to commercial scale and new locations for deployment are found. Spatial efficiencies may be found through co-design and consultation with local communities to bring benefits such as enhancing leisure and tourism facilities.

In addition to the sectoral trends outlined above, a number of key issues emerged that were not explored fully in either the Briefing Notes or the scenarios workshop, but that may present opportunities or risks. Here we differentiate between those issues that must be dealt with more immediately, i.e. those already being tackled to some degree by planning authorities through policies or programmes of measures, and issues that are only just on the horizon of current thinking but may present a challenge to MSP in the longer term.

In the **short term**, the following issues that have been identified are already of concern in MSP, but require further action:

- *Invasive Alien Species* – whilst progress is being made on this issue in relation to measures supporting the implementation of the Marine Strategy Framework Directive, the development of MSP can help to raise awareness of this problem further. Interactive mapping and evidence portals related to MSP can help to identify areas that may be at risk, e.g. shipping lanes and recreational boating areas.
- *Port diversification* – this is particularly important for small fishing ports that may lose business as landings and processing may be consolidated into existing large fishing ports. The growth of ocean energy and offshore wind also provides opportunities for ports in proximity to where renewables are deployed to provide construction and maintenance facilities, if sufficient space exists on land.

In the **longer term**, the following may need to be given greater consideration in future marine plans:

- *Carbon Capture and Storage (CCS)* facilities – these have not been explored in the Briefing Notes, however further research in this field could lead to greater calls for subsea storage and the repurposing of gas pipelines to support decarbonisation.
- *Energy Grids* – whilst there are no offshore energy grids operational in the Celtic Seas, initiatives such as the ISLES II project and the continued development of offshore renewable energy can drive the development of schemes that enable the distribution of energy to and from multiple sites and across jurisdictions.
- *Unmanned Autonomous Vessels* – the manufacture and use of autonomous vessels is currently being tested in ports outside the SIMCelt area, but while this technology is still far from becoming mainstream questions are already being asked of their safety in regards of non-navigational accidents such as fire (see Wróbel et al., 2017) or ability to communicate during ship-to-shore situations[4]

5.2 Reflections on the Use of the SIMCelt Scenarios

This report started with a definition of a scenario, which states that:

> *"A scenario is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold."*

This definition has provided a context in which the purpose and use of scenarios in (maritime) spatial planning could be explored, starting with an examination of the different types of scenario that may be used in the process of developing forward-looking plans. These three types – normative, predictive and exploratory – represent different ways of creating images of the future. Such images can then be used to anticipate future changes

[4] https://fairplay.ihs.com/safety-regulation/article/4294866/rotterdam-port-voices-autonomous-ship-concerns

and focus attention on the decisions that should be made or strategies that can help ensure more desirable outcomes.

The examples of scenario building from existing MSP processes and recent marine related projects highlighted in this report, and indeed the work undertaken to develop an exploratory set of scenarios for the SIMCelt project have shown that all three types of scenario have a place in the MSP process. This is most evident in the examples provided by the UNESCO step-by-step approach to MSP and the Future Trends work within the Celtic Seas Partnership. Both examples show how developing a predictive (business as usual) scenario and then testing more exploratory or alternative scenarios can help to evaluate all the possible consequences of different development pathways. In the case of the UNESCO approach, this also leads to the final step of defining a normative vision of the future and determining the most appropriate strategy or actions to achieve that vision.

Whilst it is not within the scope of the SIMCelt project to determine a future vision for the Celtic Seas, the MSP Directive requires that plans should take into account future uses across a range of sectors and consider alternative options. Therefore it is implicit that the maritime spatial plans developed across the Celtic Seas region, whether at national or regional level, use scenarios as part of the wider planning process. Whilst there is still limited experience in the development and use of scenarios for MSP, this report provides principles and examples that can support developing practices.

Notwithstanding the major findings of the scenario building exercise undertaken within this project, a number of lessons have been learned about the process of building scenarios and using them to inform plan making processes.

The use of a four-quadrant, or 'possibility space' has mirrored the approach to developing scenarios used in other exercises, such as those undertaken in the Millennium Ecosystem Assessment and the AFMEC project (Pinnegar et al, 2009). However, a critical difference in this exercise has been in regards to the choice of the two variables used to construct the horizontal and vertical axes, namely autonomy/cooperation and spatial diffusion/efficiency. The use of these two axes as a framework, together with the scenario pen pictures, provided for a very broad range of possibilities in terms of the spatial footprint of future maritime activities and cooperation between planning authorities to be represented. However, in testing the scenarios with participants, their feedback on the way the scenarios had been presented has provided points for reflection and learning:

- With regards to the overall 'image' presented by the individual scenarios, the drivers and targets considered are focused at a national or international level. However the reality is that implementation of maritime spatial planning will occur on a more regional basis (for example, through English marine plan areas and Scottish regional marine plan partnerships). This link through from high level aspirations to what potentially may be the case on the ground needs to be more clearly reflected in the pen pictures and in the way that participants are asked to think about the position of their sector in 2050.

- Related to this, the definition of a baseline position for each sector on the possibility space is an important part of demonstrating the geographic specificities of development for each sector on the space. By allowing participants to define a ‘current’ position for their sector, based on activity in a specific region rather than a general picture of the sector as a whole, it might be possible to tease out a more realistic picture of how the spatial footprint of maritime activities is likely to change in different plan regions and think about sectoral interactions, trade-offs and cross border implications in a more discerning way.

- The scenarios as set out, may not provide an accurate picture of the future but they have a value in terms of promoting debate about the direction maritime spatial plans might take. This can allow for more creativity and opportunities for learning about the potential of MSP to facilitate particular outcomes.

5.3 Recommendations

Drawing on the information set out in the Briefing Notes, and the results of the scenarios workshop, a set of recommendations has been developed based around the use of scenarios as a tool to help maritime spatial planning, spatial footprint of maritime activities, cooperation (between sectors and at a transnational level) and future issues for MSP.

<u>The Use of Scenarios for MSP</u>

Scenario exercises should be developed in line with the principles set out in Box 1
The principles set out in Box 1 are drawn from a range of sources and have all played a role in the development of the scenarios building exercise used in the SIMCelt project. The participatory element in particular has both helped to draw in a range of expertise in defining the drivers that were first outlined in the Briefing Notes and provide further insights in testing the potential outcomes related to each scenario in a workshop setting. It should be noted, however that it is important to plan for participation in scenario building in a way that is resource efficient in terms of the amount of time and effort participants are expected to devote to different elements of the scenarios work. This could also apply to wider engagement processes in MSP where stakeholder input is essential but must be designed to enable those with limited resources (and opportunities) to take part in some way.

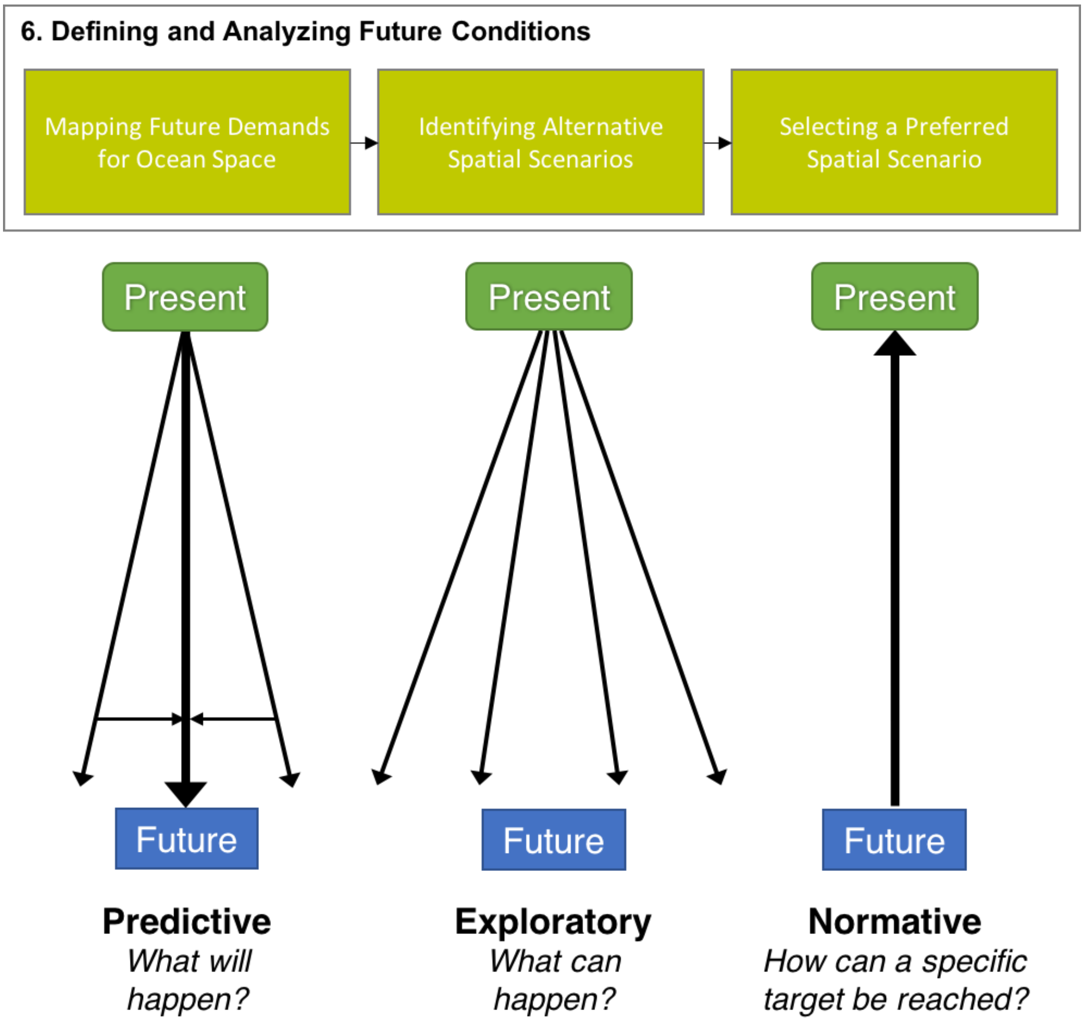
Box 1: Key elements of scenario building techniques

Participatory: Scenarios should be created with stakeholder input, either in the creation of the initial narrative, defining focus/scope or in checking plausibility and potential outcomes (*Herry and Winder, 2015)*
Time frame: this may vary depending on the nature of driving forces – should be at least five years where change happens quickly, but up to 50 years where change may be more slow or uncertain. Typically at least 10 years *(Pinnegar et al, 2006:16)*
Plausibility: whilst scenarios are not intended to be accurate forecasts of a future state, they should be constructed in such a way that people working with them can see the scenarios as possible futures
Internal consistency: the building blocks (or drivers) that are used to create each scenario should be joined together in an explainable and logical manner (*Haines-Young et al, 2011, and van Hoof et al, 2014)*
Plurality: 2-4 scenarios are considered to be the optimal number for exploring a range of potential futures.
Resonance: the scenarios produced should have sufficiently distinct narratives for users to understand the varying conditions and drivers to be considered. They should tell a story that is convincing and remarkable. Dramatic or extreme scenarios, or memorable names to describe the scenarios are useful in this instance *(JRC 2008)*

Scenarios should be used as a key tool in MSP for informing policy development

The three types of scenario (predictive, exploratory and normative) that were introduced in Chapter 2 of this report can all be considered valid approaches to understanding future demands for marine space and management issues. This is shown in the way that the UNESCO Step-by-Step approach combines all three to first predict future needs, think about what might happen under different alternatives and then develops a normative vision of what the future should be, as is demonstrated in Figure 19 below. This maps the three broad types of scenario onto the three stages of defining and analysing future conditions set out in the IOC-UNESCO guide (Ehler and Douvere, 2009).

Figure 19: Mapping of Scenario Approaches onto the MSP Process



Source: Based on Ehler and Douvere (2009) and Quist (2014)

These techniques fit along a spectrum from the more quantitative (predictive) to qualitative (normative), but even predictive scenarios involve some element of judgement that introduces amore qualitative aspect to them. Within a planning process therefore, the user does not need to be limited to choosing one ‘type’ of scenario but may call upon different approaches at different points, or could use combinations of approaches, e.g. predictive-exploratory. The main value of scenarios is that they provide a focus for a more qualitative, creative and forward-looking debate about the direction of a plan

Develop sectoral trajectories as part of scenario building

The UNESCO Step-by-Step approach to MSP (Ehler and Douvere, 2009) highlights the importance of establishing a business as usual or *trend scenario* to determine future spatial requirements of existing (and new) maritime activity. This predictive approach can help to identify current development trends in different sectors and their likelihood to keep pace with policy ambitions and prompt analysis of why particular trends are occurring. Projections could also act as the starting point for developing other, more exploratory scenarios, for example questioning what might happen if targets are not met/exceeded.

Use scenarios to understand the aspirations of maritime sectors
The first activity of the scenarios workshop (sectoral ambitions) provided clear examples of the direction of travel in certain sectors (e.g. offshore wind, aquaculture) in terms of increasing their spatial efficiency or increasing levels of cooperation (e.g. wave and tidal energy). These aspirations, as shown on the possibility space provide a useful visualisation that can be easily understood by others. Use of the possibility space also offers the opportunity to gain a more nuanced understanding of stakeholder aspirations and realities of what is happening or may happen in individual sectors than can be expressed through policy documents.

Working Towards Greater Cooperation

'Spatial efficiency' should be used as a key concept in considering uses of maritime space
Spatial efficiency has been used in the SIMCelt scenarios work to reflect maritime activities that take up a smaller amount of space and resources than they potentially could, where coexistence or co-location takes place, in contrast to diffuse activities that take up maximum space and resources, excluding others. This takes planning ideas beyond the idea of integrated policy and characterises how more sustainable spatial management of maritime activities could be achieved. The aspirations of participants in the scenarios workshop, across all the sectors considered (with a few minor exceptions), to move towards a more spatially efficient type of development in the future shows that this concept is broadly understood and favoured.

Further research should be undertaken to understand the viability of co-location
Whilst the workshop has shown that there is a great desire to move towards a more spatially efficient type of maritime planning which includes greater co-location, particularly of energy installations and aquaculture, the reality of making this happen is incredibly complex. As yet there are no large-scale examples in the Celtic Seas of economically viable, co-located activities, such as offshore wind and aquaculture as was called for in the third set of workshop activities. There are many risk factors and barriers (technical, safety, financial) that must first be explored and resolved through demonstration and pilot projects (such as the Horizon 2020 funded MUSES project) before developers will be convinced of the benefits to co-location. In addition, whilst the policy environment for maritime spatial planning is generally supportive of co-location and coexistence of multiple sectors, there are no clear incentives or methods of compulsion for this type of spatial arrangement to take place. Therefore, more proactive efforts by developers in conjunction with research institutes are likely to be the most appropriate way to drive the ambition for co-location of activities forward.

APPENDICES

Appendix 1: Developing the SIMCelt Scenarios

A.1.1. Mapping of Drivers

This section provides a complete overview of all the drivers and issues that were used in developing narratives for the SIMCelt scenarios. Each driver or issue in the table comes from the corresponding Sectoral Briefing Note and has been judged in terms of increasing/decreasing spatial efficiency and cooperation by members of the University of Liverpool project team. Work for Table x (Conservation) has been undertaken by the Agence française pour la biodiversité (AFB) project team.

Table 2: Spatial Efficiency and Cooperation Impacts Related to Aquaculture

No.	SECTOR Aquaculture	Spatial Efficiency	Cooperation	Justification
1a	Simplifying administrative procedures.	=	+	CFP requirement, may require learning from other MS.
1b	More efficient licensing processes to enable faster establishment of aquaculture sites	-	=	Indicates increasing demand for space
2	Securing sustainable development and growth of aquaculture through coordinated spatial planning	+	(+)	Allows further integration of aquaculture into planning processes; increases opportunities to identify spatial requirements and potential synergies with other activities
3	Enhancing the competitiveness of EU aquaculture	=	=	Product innovation does not necessarily imply changes in spatial demands or increased cooperation
4	Promoting a level playing field for EU operators by exploiting their competitive advantages	=	=	Depends on what those advantages are – quality of product, traceability will not increase spatial footprint per se. Some aspects e.g. labelling might require cooperation
5	overcoming the challenge of lack of space – by either moving further offshore…	=	=/+	May increase overall footprint of aquaculture. Requires further investment in infrastructure and technology, plus there is an increased risk associated with operating in more exposed conditions. Moving sites further offshore and activities associated with this (e.g. more boating to reach cages, installation of partially equipment) may lead to conflicts with different users requiring greater stakeholder engagement and cooperation

6	… or, in future, sharing infrastructure with other sectors such as wind energy	**++**	**+**	Will optimise use of space but dependent on technologies and sectors working together
7	Improving skills and education, enabling firms to specialise, innovate and adapt to new technologies	**=**	**=**	New technologies/adaptation could lead to spatial efficiencies in some cases but this is highly dependent on type of aquaculture/species
8	National ambitions to increase aquaculture production	**-**	**+**	Will require some expansion of sites, increased stakeholder engagement
9	NI: maximise the opportunities presented by the harvesting of seaweed WALES: Development of macroalgae (seaweed) if demand for it *Future developments in blue biotechnology, with seaweed and algae being important contributors to new pharmaceutical and cosmetic products*	**-**	**=**	Will increase spatial demands, particularly in coastal zones where there is competition for space Some algae products have relatively small footprint
10	Scotland: diversification of farmed species	**=/-**	**=**	Diverse species may have different spatial requirements (i.e. cannot be farmed together)
11a 11b	Contribution to security of food supplies Increasing consumer demand for high quality seafood products	**=/-** **=/-**	**=** **=**	Will require more space (but not as much as agriculture). Some cooperation on identification of sites/operation required. Cumulative impacts of increasing number of sites.
12	Increasing demand for fishmeal to support the farming of larger fish species requires more intensive fishing and use of smaller fish species.	**-**	**=**	
13	Farming of certain species reduces pressure on wild populations	**=/-**	**=/+**	May require development of permanent structures, requires engagement in planning process
14	Potential for marine tourism opportunities and increasing public knowledge of sustainable seafood, e.g. seafood festivals and organised tours of mussel and salmon farms	**=/+**	**=/+**	May increase demands on coastal tourism infrastructure
15	Restocking of certain species may provide a boost to recreational angling	**=**	**=**	Likely to be small scale, limited need/opportunities for cross-border cooperation
16	Demographic changes and out-migration of younger people from coastal communities may threaten the continuity of aquaculture production in some places	**=**	**=/+**	More likely to decrease spatial demand. Cooperation needed if this trend is to be reversed
17	Continued financial support from the European Union and other institutions will help to deliver new operations or help established businesses adapt to new markets and technologies	**+**	**=**	Will increase demand for aquaculture space. New operations/markets may develop from local specificities. Cross-border cooperation may be limited to learning from best practices

18	Improvement of water quality through successful implementation of the Water Framework Directive and Marine Strategy Framework Directive to support production of the highest quality shellfish (Agri-Food Strategy Board, 2013)	=	+	Improving water quality could increase number of site suitable for aquaculture use. Implementation of WFD and MSFD require transboundary cooperation
19	The Draft Welsh National Marine Plan identifies potential impacts of climate change on aquaculture, including changes to the general conditions under which aquaculture species grow, such as seawater temperature, plus changes in rainfall and run-off leading to increased turbidity and nutrient loading	=	+	May require changes in location but not necessarily affecting amount of space required Cooperation on climate change adaptation/mitigation will be required
20	Threats to aquaculture species such as disease, parasites and algal blooms	=/-	=/+	Will require careful consideration of location to avoid potential impacts. Might require cooperation to ensure biosecurity
21	Development of integrated multi-trophic aquaculture (IMTA), or polyculture, where different species such as shellfish, seaweed and fish are cultivated together to enable the recycling of nutrients through the food chain	+	=	Positive impacts in terms of spatial efficiency. May not require transboundary cooperation
22	Development of Multi-Use Platforms (MUPS) that allow co-location of aquaculture and offshore energy generation	+	=/+	Stakeholder engagement across sectors and boundaries needed to understand potential impacts
23	As aquaculture grows, this may lead to conflict with other coastal users and potentially also zones for conservation such as Natura 2000 sites, SPAs and SACs.	=	+	Depends on type of designation and whether this permits aquaculture use to take place inside protected area. Stakeholder engagement/consultation required
24	Ensuring biosecurity of aquaculture species in situ and during movement of species from sites such as hatcheries and cages will continue to be an important feature of aquaculture regulation	=	+	No additional spatial requirements, but where there is an increase in aquaculture activity this will require cooperation on biosecurity

Table 3: Spatial Efficiency and Cooperation Impacts Related to Cables and Pipelines

SECTOR **Cables and Pipelines**		**Spatial Efficiency**	**Cooperation**	**Justification**
1	Implementation of Projects of Common Interest (PCIs)	+	+	Development of shared infrastructure. Will require cooperation across sectors and on MSP
2	Development of interconnectors (not already PCIs)	+	+	Development of shared infrastructure. Will require cooperation across sectors and on MSP
3	Increased interoperability of (gas) transmission systems	+	+	Can lead to use/development of shared infrastructure
4	Enhancement of cross border (gas) transmission	=	+	Does not imply new infrastructure needed. Political cooperation necessary
5	Increasing competition for space where pipes make landfall	=	=	Requires integration between terrestrial/marine plans but not necessarily transnational
6	Development of additional wind farms	-	=	Increasing space required for wind farms. Need for cooperation depends on location
7	Development of wave and tidal energy devices	-	=	Increasing space requirements. Need for cooperation depends on location
8	Roll-out of smart energy grids	+	+	Development of shared infrastructure. Will require cooperation across sectors and on MSP
9	Repurposing of pipelines for gas storage or CCS	+	=/+	No additional spatial requirements. Need for cooperation depends on location
10	Construction of new pipelines for gas storage/CCS	-	=	Increasing space requirements. Need for cooperation depends on location
11	Development of single European market for energy	+	+	Dependent on new infrastructure needed. Political cooperation necessary

Table 4: Spatial Efficiency and Cooperation Impacts Related to Conservation/MPAs

No	Marine Protected Areas	Spatial Efficiency	Cooperation	Notes/justification
1	MPA network designation and management fostered by an increasing influence of international initiatives/requirements	+	++	Strengthening international or European conservation initiatives/requirements (OSPAR convention, N2K and MSFD directives...)
	Designation			
2	More transboundary cooperation and information regarding the national designation	+	++	Examples: Following CBD recommendations, retroplanning was used on both sides of the Channel. This move on the calendar level allowed for more visibility and informal exchanges between technical teams British approach takes foreign views into account when creating MCZ In France, a transboundary consultation procedure could be conducted if a PN/PNM project close to another country was to be submitted to an environmental evaluation. In general, EIA/SEA must be offered to consultation to bordering countries.
	Sustainable Development			
3	MPAs are more taken into account in national Integrated Maritime Policy	++	-/+	MPAs taken into account in sectorial or global marine plans. This would increase the spatial efficiency between marine conservation and sustainable development. If IMP is coordinated between countries, this driver would foster cooperation level too.
4	Develop more MPAs which have a role of planning or take into account socioeconomic considerations.	++	+	- French Nature Park ou Nature Marine Park can be considered local MSP tools - MCZ take socioeconomic considerations into account These categories can favour economic development (potentially more effective planning and licensing in UK waters)
	Management			

5	More articulation of the MPAs management at the scale of the national networks	++	+	Allows to tackle issues where it's needed the most
6	More adaptive management	++	+	Allows to adjust objectives and regulation in the MPAs if need.
7	More participation of the public	+	+	Increases cooperation for UK MPAs.
8	More transboundary cooperation for MPA management	+	++	Transboundary cooperation for coordination of objectives, regulations, means, communication, monitoring… Example of transnational cooperations between 2 neighboring MPA through an European Grouping of Territorial Cooperation in the Mediterranean (between Corsica FR and Sardinia IT) Could be impulsed by Ospar or through the setting up of collaboration groups. Can be an alignment of management plans or the setting of common conservation objectives. Can be through the creation of networks of managers, as was attempted during the MAIA project or done by MEDPAN in the Mediterranean Sea...
9	More cooperation in international waters	+	++	High seas MPAs in the framework of OSPAR.
10	Reinforcement of management and regulation to reach objectives	+/-	=	Increasing of the thresholds for the appropriate Assessments Focus on Strong Protection Zones More regulation measures to comply with targets. (Spatial efficiency = + if more careful in allowing projects so probably more efficient or - so it might be stricter and therefore have less projects allowed)

Table 5: Spatial Efficiency and Cooperation Impacts Related to Offshore Wind Energy

	SECTOR **Offshore Wind**	**Spatial Efficiency**	**Cooperation**	**Justification**
1	Existing proposals for wind farms are built	-/=	=/+	Will take up more marine space. Consultation required on SEA/EIAs and possible interconnectors
2	Renewable energy Directive targets for 2020 and Energy Strategy 2030 targets	-/=	=/+	Targets driving development of new offshore structures. May be cooperation between countries on export of renewables
3	Scotland: 100% of electricity from renewables by 2020	=	=	Depends on type of renewables. National target so does not necessarily require cooperation with others
4	UK: ghg emissions reduced by 80% by 2050	-/=	+	
5	Changes to national/international renewable energy targets	=	+	More stringent targets will push up demand for offshore energy installations
6	Increase in value of contracts for difference (cfd)/incentives	-	=	Likely to make construction of wind farms more viable if investment can be returned. Increasing subisidies in one country (e.g. Ireland) may increase possibility of generating energy for export
7	Decrease in value of cfd/subsidies	=	=	Likely to slow down development of offshore wind
8	Development of wind farms in deeper waters	=	+	Depends if development is instead of, or in conjunction with construction of wind farms close to coast. Deep water developments closer to neighbouring country borders may require a greater level of stakeholder engagement/consultation
9	Requirements for land based infrastructure to support transmission of offshore wind energy from remote areas into national grid	=	=/+	No impact on use of marine space.
10	Continued co-financing of projects by MS to enable energy production from Third Countries	=/+	=/+	Could increase number of wind farms or displace activity to areas beyond project boundaries. Becoming more significant in light of Brexit
11	(IE) Development of offshore wind energy for export through cooperation mechanisms such as BIC, NSCOGI	-	+	Could significantly increase number of wind farms in Irish waters
12	Developing supply chains for offshore wind energy	=/+	=	No real impact on use of marine space
13	Environmental monitoring to assist mitigation	=	=/+	Cooperation may be required for mitigation if there are significant cross-border impacts
14	Ensuring appropriate port facilities to support offshore wind	=	=	Availability of existing infrastructure could influence location of new wind farms.
15	Increasing tourism activity linked to wind farms e.g. tours, information centres	+	=	Opportunities for colocation of activity. Will occur at local level so not necessarily promoting transnational cooperation
16	Colocation with aquaculture	+	=/+	Depends on readiness of technology

17	De facto use of wind farms as 'closed' areas, assisting repopulation of certain species	-	=	Could be beneficial in the longer term. Cooperation across sectors may be required if fishing activity displaced
18	Negative public perception of wind farms due to changes in seascape, visual amenity	-/=	=	May prevent construction of wind farms in some areas, especially coastal.
19	Competition with other marine renewables to operate in same space	=	=/+	Need for greater cooperation in border areas.
20	Competition for space with:			
a	Aggregates	-	=/+	
b	Oil and gas	-	=/+	
c	Cables and pipelines	=	=	Need for greater cooperation in border areas.
d	Conservation areas	=	+	
e	Shipping lanes	-	=	
21	Development of floating turbines	-	=	Potential for more dispersed development in deeper waters.
22	Use of floating turbines as multi-use platforms for aquaculture, monitoring,	+	=/+	Co-location of activities. Possibly in collaboration with neighbouring administrations.
23	Downturn in economic climate affecting bank's willingness to invest in large scale projects	=	=	Slowing down of development.
24	Increasing size and generation capacity of wind turbines	+	-/=	Possibility to concentrate higher output in smaller areas.
25	Continued investment in R&D	=	-/=	Trend towards higher output in smaller areas, though also into deeper waters. May be backed by national policies.
26	Turbines in deeper waters, close to marine borders	-	=/+	Potential for more dispersed development. More likely to require cross-border collaboration.
27	Increasing need for cross-border infrastructure to support individual wind farms	-	+	Wider-ranging infrastructure (grid development) requiring cross-border cooperation.
28	Cumulative impacts of several wind farms in small space – particularly with cross-border dimension	-/=	+	Could lead to more separation between wind farms, with more cross-border neotiation
29	New international energy grids	-	+	Wider-ranging infrastructure (grid development) requiring cross-border cooperation.
30	Navigational safety and harmonised approaches to marking of hazards – international organisations playing a lead role	=	+	No significant spatial demands, but international standards developing.

Table 6: Spatial Efficiency and Cooperation Impacts Related to Ports and Shipping

	SECTOR Ports and Shipping	Spatial Efficiency	Cooperation	Justification
1	International Convention for the Control and Management of Ships' Ballast Water and Sediments coming into force in September 2017	=	+	Enforcement may require cooperation between authorities
2	introduction of Emission Control Areas (ECAs)	=	+	As above
3 3	a single European maritime transport space without barriers EU 'Blue Belt' initiative contributing to further reduction of customs formalities for shipping	=/+	+	Will help to increase intra-EU traffic, requires common framework for governance
4a 4b	European network for maritime surveillance integration of maritime surveillance through the Common Information Sharing Environment.	=	+	May assist in developing evidence base and identifying transnational issues. Contribution to environmental monitoring and governance CISE promotes common standards for shipping information > more efficient movement of goods
5	reduction of CO_2 emissions and pollution by shipping	=	+	Enforcement may require cooperation between authorities
6	Continued work to enhance the competitiveness of the EU shipping sector by increasing short sea shipping and improving port infrastructures and services (diversification)	=/+	=/+	Increased maritime traffic and port activity.
7	Innovation in shipbuilding to improve the environmental performance of ships	=	=	Spatial impacts limited to minimising environmental effects.
8	Continued development of the TEN-T network	=/+	++	Concentration of shipping traffic through key routes to enable accessibility of all regions
9	Continued development of Motorways of the Sea	=/+	++	As above
10	cooperation between ports	=	+	May encourage specialisation/complementarity
11	upgrades of infrastructure to improve connectivity with ports' hinterlands	=/+	=	Could increase competitiveness of ports and therefore traffic. Requires consideration of land-sea interactions
12	Promotion of short sea shipping routes	=	=	Could increase traffic or decrease volume of larger ships on some routes. Requires transnational cooperation between port operators/shipping companies
13	Developing niche markets by investing in marine sports, marinas and nautical leisure activities and cruise port facilities	=	=	Could increase competition for space if numerous activities developed in close proximity

14	Developing skills related to the maritime sector	=	=	No spatial impacts
15	(Scotland) maintenance of lifeline ferry routes and their integration within passenger transport networks	=	=	Need to maintain existing patterns (though these are reviewed periodically). No
16	Protection of navigational safety	=	+	Important that there is cooperation on international routes and in cross-border zones of activity
17	Prevention of developments that could restrict access to ports	=	=	Depends on nature of development
18	Expansion of cruise reception facilities	-/=	=/+	Will lead to increase in shipping traffic in some areas.
19	Innovation in logistics and supply chains	=	=	May require some transnational cooperation; however competition between ports may prevent this
20	Opening up of Arctic sea routes due to receding polar ice such as the North East and North West Passages	-	+	Will make certain Celtic Seas routes and ports busier.
21	Increase in ship size to achieve economies of scale in transport costs	=/+	=	May reduce vessel traffic along certain routes but cause congestion on others
22	economic downturn	-	=	Will reduce traffic. Countries more likely to pursue individual goals for growth
23	Increasing efficiency of ships through use of Liquified Natural Gas (LNG) as a fuel, particularly for short sea shipping routes (Ecorys, 2012:54)	=	=	No overall spatial impacts
24	Development of E-navigation systems, leading to improved navigational safety	=	=	No overall spatial impacts
25	Ability of port infrastructure to keep pace with increasing container ship sizes (e.g. dredging deeper channels, load/unload facilities)	=	=	May increase competition between ports and displace some traffic
26	Competition between ports to attract the same business, e.g. Irish Sea ports and trans-Atlantic trade	-	=	May increase choke points. Increased competition means less cooperation
27	Changes to international shipping routes as new ports or additional port capacity becomes available	=	=	Depends on location. Cooperation on TSS may be required
28	Interaction between new offshore energy installations (e.g. floating wind turbines) and shipping lanes.	=/+	+	Cooperation on navigational safety/international routes required
29	Wind farms built in deeper waters	=	+	may be closer to maritime borders and therefore will require a greater level of cross-border consultation. Planning for more navigational safety is required.
30	Specialised shipbuilding and repair services	=/+	+	May assist in attracting new trade to ports
31	Development of autonomous vessels	-/=	+	May require separate lanes/infrastructure. Cooperation required to ensure navigational safety

Table 7: Spatial Efficiency and Cooperation Impacts Related to Wave and Tidal Energy

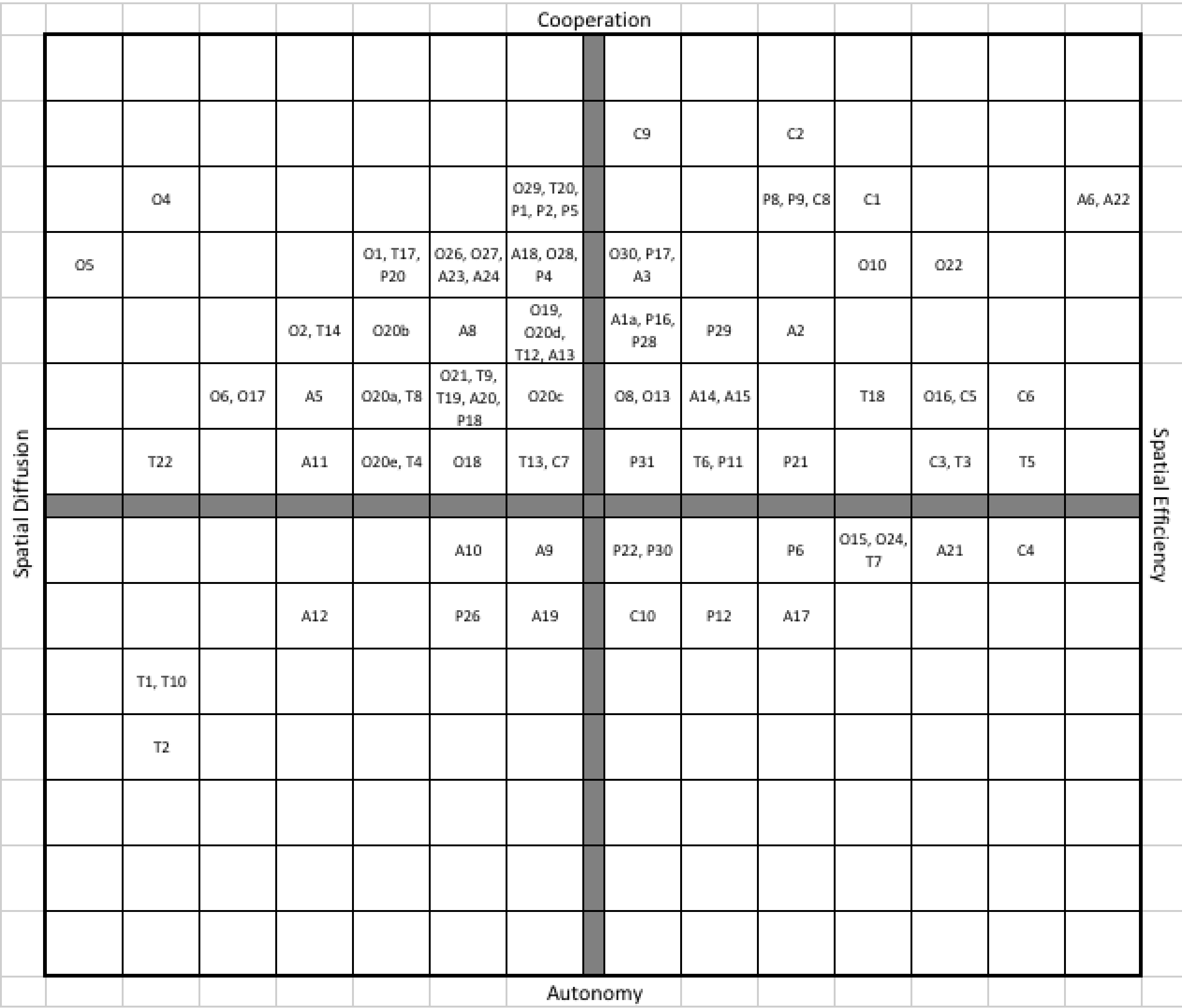
	SECTOR **Wave and Tidal Energy**	**Spatial Efficiency**	**Cooperation**	**Justification**
1	Renewable Energy Directive Targets; Decarbonisation by 2050	-	-	Likely to be more dispersed development, with Member States pursuing own targets
2	Contribution to security of energy supply	-	-	Likely to be more dispersed development, with countries pursuing own energy security
3	potential for aquaculture to take place within lagoons	+	=	Co-location, on relatively small scale
4	Tidal devices - Competition for space with aquaculture (cages moored to sea bed)	-/=	=	Possible displacement of aquaculture
5	provision of additional sites for coastal tourism and recreation (e.g. windsurfing in tidal lagoons)	+	=	Possible local synergies
6	Construction of lagoons will boost demand for aggregates	=/+	=	Increased aggregates extraction, possibly close to lagoon construction
7	Tidal lagoons may help to reduce coastal flood risk, depending on location and design	=/+	=	Possible local synergies
8	Negative interactions with shipping – retention of water may close off certain routes and ports that rely on high tides for shipping movements	-	=/+	Rerouting of shipping (longer routes), needing some cross-border negotiation
9	Competition with other renewables such as offshore wind	-	=/+	Possible displacement of other renewables, needing some cross-border negotiation
10	European/national policies continuing to drive increased energy production from renewables (2030 and 2050 targets)	-	-	Likely to be more dispersed development, with nations pursuing own targets
11	Public perception of tidal and wave energy, including tidal impoundments and their potential environmental impacts may be a barrier to development	=	=	Could lead to more development in less scenic, urbanised areas
12	Lack of knowledge concerning length of consenting process for large scale wave and tidal energy projects: experience and lessons learned from consented projects could be used to inform development processes and speed up decision making	=	=/+	Possible cross-border learning
13	Increasing fossil fuel prices may increase the attractiveness of marine renewables as an alternative form of energy	-	-	Driver for wider, dispersed development, with nations meeting own energy needs
14	Continued investment in R&D and capital financing for upscaling from pilot to commercial deployment is essential.	-	=/+	Larger-scale development, with transnational project development

15	The attractiveness of subsidies for wave/tidal energy production, e.g. Feed-in Tariffs and Contracts for Difference will increase the financial viability of generation from these sources	**-**	**=/+**	Larger-scale development, with transnational project development
16	Real unit cost of developing wave and tidal energy not yet fully understood for wave and tidal projects. Evidence gathered from the commercial deployment of early projects will help to determine true costs and the level of financial support required to enable further development of the sector (Renewable UK, 2013)	**=**	**=**	Uncertain financial future
17	Developing grid capacity to support commercial scale marine energy generation, which may take place in remote coastal areas that are not well services by electricity grids	**-**	**+**	Possible long-distance, cross-border grid connections
18	Development of onshore infrastructure (e.g. port facilities) to support maintenance and construction of devices	**=/+**	**=**	Likely to be localised, near to devices
19	The main impacts of wave and tidal devices are likely to relate to competition with other maritime users for space. In particular, issues of navigational safety around proposed wave and tidal energy installations need to be taken into account	**-**	**=/+**	Likely to displace other activities, possibly requiring cross-border agreements
20	Depending upon location, electricity infrastructure for bringing power ashore from wave and tidal devices may cross marine borders, therefore requiring consent from different national jurisdictions	**-**	**+**	Possible long-distance, cross-border grid connections
21	Planning for connection to appropriate onshore infrastructure (e.g. transformer stations and grid connections) will require effective integration between MSP and terrestrial planning systems	**=**	**+**	Land connections localised, but requiring inter-authority (land-sea) working, possibly cross-border
22	Tidal range developments are likely to have impacts on tidal processes across a large area, potentially regional sea scale.	**-**	**=**	Large-scale dispersed development, with cross-border implications

A.1.2. Mapping Drivers onto the Possibility Space

Figure x below shows how the individual drivers and issues considered in the Sectoral Briefing Notes have been mapped onto the possibility space based on their likelihood of increasing spatial efficiency and cooperation.

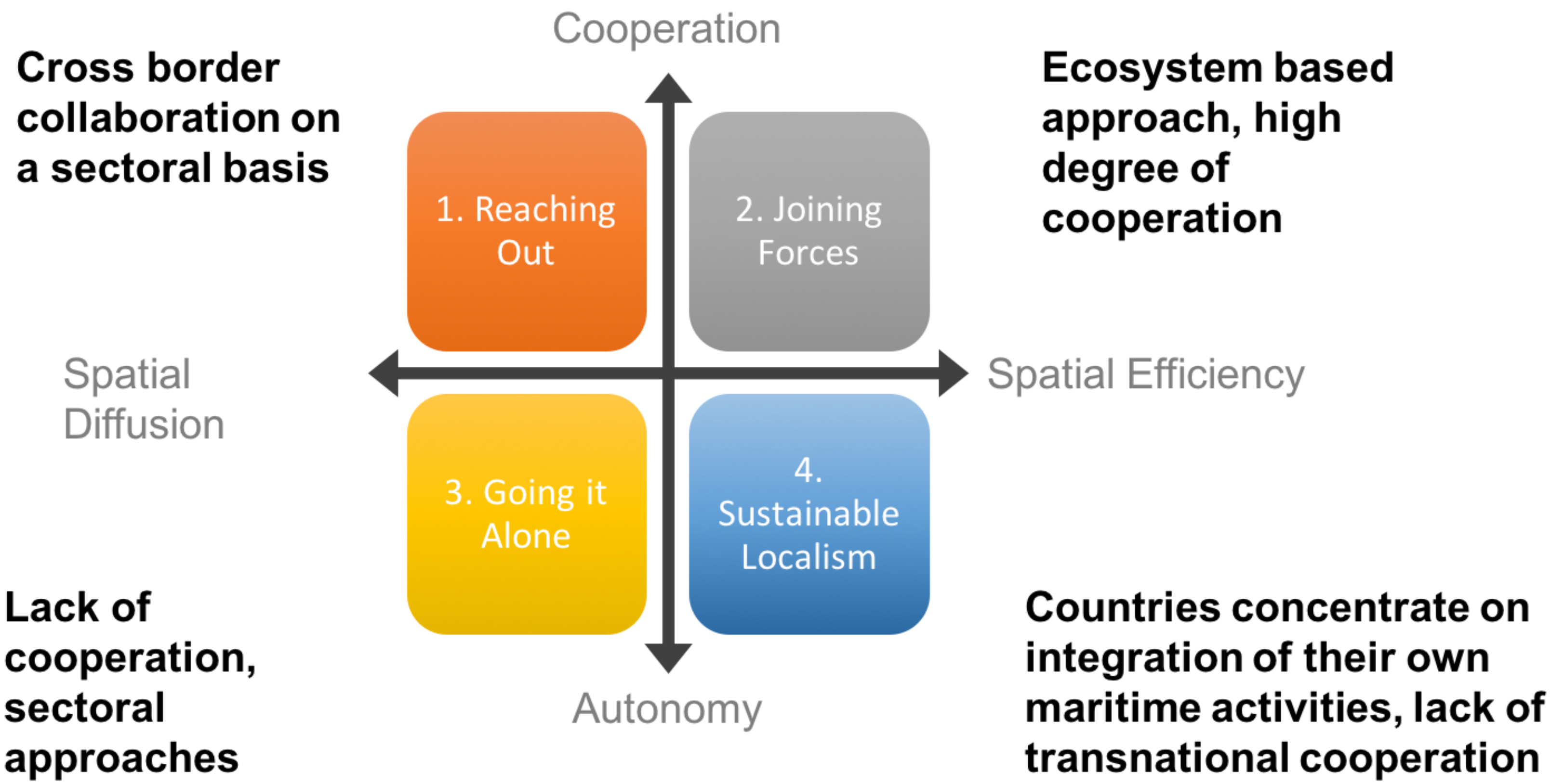
Figure 20: Mapping individual drivers onto the possibility space



Key

A$_n$ = Aquaculture
C$_n$ = Conservation
O$_n$ = Offshore Wind Energy
P$_n$ = Ports and Shipping
T$_n$ = Wave and Tidal Energy
n *refers to the numbers listed in Tables 2-7.*

A.1.3. Developing the SIMCelt Possibility Space



A.1.4. The SIMCelt Scenarios

The full text of the scenarios developed for SIMCelt are as follows:

1. Reaching Out

Key features: Cross border collaboration on a sectoral basis

International and national climate change targets and pollution controls are key drivers of change.

These lead to countries making greater efforts to deploy **marine renewables** in coastal areas and further offshore. More areas are zoned for the primary purpose of renewable energy growth both in coastal areas and further out to sea, creating competition for space between energy interests and other sea users such as aquaculture and shipping and increasing cumulative impacts. Transnational energy infrastructure is put in place to support the distribution of green energy.

Sharing of **information** within sectors is seen as a way to increase coordination, e.g. E-navigation, maritime service portfolios and development of the Common Information Sharing Environment for shipping.

Within the **shipping** sector international agreements on pollution are also key drivers of change, with more Emission Control Areas being designated and a much greater number of ships using LNG fuels. The seasonal opening of Arctic sea routes takes place but is dependent on high levels of international cooperation to maintain safety and security. Motorways of the Sea continue to develop along key routes and into more remote areas to connect with Arctic routes and growing renewable energy zones.

Ambitions for **aquaculture** production remain high across Celtic Seas countries as consumer demand for aquaculture product increases. As aquaculture moves further offshore this creates greater competition with other sea users. Climate change impacts such as increases in sea water temperature and increasing storminess also make large-scale production more challenging.

Increased sharing of data regarding **MPA** designations and collaboration on environmental monitoring takes place, e.g. using satellite data and autonomous vehicles to monitor marine habitats and species movements.

2. Joining Forces

Key features: Ecosystem based approach, high degree of governmental cooperation

This scenario affords the highest level of protection to the **marine environment**, with regards to international requirements such as CBD and MSFD. Countries cooperate on decisions about new MPAs, including some in international waters. At the national level, there is greater clarity and direction in the way that MPAs are designated and managed.

Tight environmental constraints mean that countries think more strategically about the location of maritime activities and there is a strong drive towards **colocation** of marine renewables with activities such as coastal defences, tourism, fisheries and aquaculture.

International **shipping** activity continues to increase, with larger ships being used to take advantage of economies of scale. In EU Member State waters, reduced customs formalities increase the efficiency and volume of goods moved through ports. Upgrades to port facilities and connectivity to ports hinterlands are implemented to take advantage of both international and local shipping movements. In areas where multiple marine users are active, protection of navigational safety is considered a priority.

Aquaculture growth is managed through the allocation of space in maritime spatial plans. Continued financial support from the EU and other institutions helps to deliver new operations that use innovate methods such as multi-use platforms shared with offshore wave energy and monitoring stations.

As well as developing colocation with aquaculture, fisheries and environmental monitoring, **renewable energy** continues to grow in two main areas. **Offshore wind** energy moves further out to sea, as technology for deeper waters (including floating platforms) becomes more viable both technologically and financially. A limited number of **tidal lagoons** are built, primarily for energy generation, but also supporting new leisure and tourism activities.

3. Going It Alone

Key features: Minimal cooperation, expanding sectoral approaches

Under this scenario, countries work independently to pursue their own **Blue Growth** targets, expanding and maximising exploitation of their maritime resources across marine territories. Coordination and cooperation on MSP is minimal. Competition within maritime sectors becomes fiercer, leading to distinct winners and losers, for example bigger **ports** using economies of scale and their connectivity to capture more shipping trade compared to smaller ports.

Efforts to protect the **marine environment** are limited as countries seek greater levels of economic exploitation, e.g. using waters more intensively for aquaculture, fishing and producing energy.

In terms of **aquaculture**, increasing demand for farmed products and the need to combat impacts of climate change such as increased seawater temperatures lead to the use of genetically modified alternatives to fishmeal, and GM species that grow faster.

To ensure security of energy supplies, existing sources of hydrocarbons continue to be extracted whilst new sources are explored. **Offshore wind, wave and tidal energy** continue to expand, with devices deployed in coastal waters and further offshore. Large tidal lagoons and barrages are built where these do not interfere with key navigational routes, resulting in some loss of habitats.

4. Sustainable Localism

Key features: Countries concentrate on developing their own maritime activities but there is a lack of transnational cooperation.

Under this scenario economic growth in traditional industries is slow but there is accelerated growth in green and high-tech sectors. Smart **specialisation** within the maritime sector helps regions to develop unique strengths and capacities. New technologies also help to integrate different sectors using the same space as shared platforms monitoring systems and less polluting ways of doing things are found.

Conservation and environmental objectives focus on the reinforcement of existing management and regulation measures. Where new MPAs are considered for designation, there is a strong emphasis on additional socioeconomic benefits that can be provided through designation.

To use space more effectively, the **aquaculture** sector adopts a polyculture approach and multi-trophic species. High quality, niche aquaculture products with greater added value and traceability throughout supply chains are developed for local markets.

Diversification occurs within the **port** sector due to the slow growth of international trade, for example specialised shipbuilding services and innovations in logistics through greater use of IT and real-time tracking. Facilities servicing the offshore energy industries are adopted by some ports to compensate for the decrease in international cargos. In other ports, **short sea shipping** experiences a modest increase for specialised cargos such as liquid bulk.

Wave and tidal energy is increasingly favoured over offshore wind as technologies improve and both small and large-scale projects become more financially viable. Tidal lagoons are built in locations for the dual purposes of energy generation and protecting areas vulnerable to flood risk.

Appendix 2: The Scenarios Workshop

A.2.1 Scenarios Workshop Agenda

Celtic Seas 2050:
Developing Scenarios for the Celtic Seas Workshop

Tuesday 19th September

The University of Liverpool in London, 33 Finsbury Square, EC2A 1AG

Agenda

9.15 Arrival, sign in

9.30 Welcome to the day; introduction to SIMCelt project and day's activities
Stephen Jay, University of Liverpool

09.45 Presentations from invited speakers
- *Alena Petrikovicova, DG MARE – the MSP Directive and Blue Growth*
- *Stephen Hull, ABPmer –Thinking about the Future: Examples from the Celtic Seas Partnership and Marine Planning in England*
- *Ivana Lukic, European MSP Platform – Methodology for developing MSP relevant visions*

10.45 Presentation of scenarios work to date and introduction to Activity 1
Lynne McGowan, University of Liverpool

11.00 Break

11.15 Activity 1: Where are we going? Sectoral ambitions
Stakeholders in groups discuss 4 potential scenarios and try to locate where particular sectors might be by 2050

12.25 Lunch

13.10 Activity 2: Where are we going? Sectoral interactions
In mixed groups stakeholders discuss how sectors will interact with other sea users given a specified trajectory to 2050

14.15 Break

14.50 Activity 3: Promoting cross-border cooperation
Potential issues and conflicts identified in Activity 2 will be divided between tables and discussed, with particular reference to:
- Cross-border or transnational impacts,
- Planning responses and
- Opportunities for cooperation

15.50 Report back/group discussion and summary
Sue Kidd, University of Liverpool

16.30 Close of day

www.simcelt.eu

A.2.2 Participant List

Celtic Seas 2050: Developing Scenarios for the Celtic Seas Workshop

Tuesday 19th September, University of Liverpool in London, Finsbury Square

Surname	**First Name**	**Organisation**
Bartoli	Stella	CCP Research Foundation
Billingham	*Charlotte*	*University of Liverpool*
de Boer	Femke	Scottish Whitefish Producers Association
Ehler	Charles	IOC-UNESCO
Fartaoui	*Michael*	*Agence française pour la biodiversité*
Fernandez Lopez	Javier	Ecorys Spain
Finke	Gunnar	MARISMA Project
Gee	Kira	Helmholtz Zentrum Geesthacht
Haddon	*Paul*	*Marine Scotland*
Henocque	Yves	IFREMER
Hopkins	*Charlotte*	*University of Liverpool*
Howell	Dickon	Howell Marine
Hull	Stephen	ABPmer
Hunt	Julia	Defra
Jay	*Stephen*	*University of Liverpool*
Jones	Hannah	University of Liverpool
Judd	Adrian	CEFAS
Kelly	Rosie	The Crown Estate
Kidd	*Sue*	*University of Liverpool*
Kreiner	Anja	MARISMA Project
Lukic	Ivana	S.Pro
Marjoram	Sarah	Thomson Ecology
Mausolf	Elisabeth	MARISMA Project
McGowan	*Lynne*	*University of Liverpool*
McGrath	Clodagh	DP Energy
McKinley	Emma	Cardiff University
Mendas	Zrinka	University of the Highlands and Islands
Murray	Lee	Natural Resources Wales
Nic Aonghusa	*Caitriona*	*Marine Institute*
O'Hagan	*Anne Marie*	*MaREI, University College Cork*
Petrikovicova	Alena	DG MARE
Rooney	*Aoibheann*	*DAERA NI*
Salthouse	*Caroline*	*North West Coastal Forum*
Taylor	Lucy	Severn Estuary Partnership
Thomas	Sara	DONG Energy

Italics denote project team member

Appendix 3: Workshop Outputs

A.3.1. Sectoral Ambitions (Activity 1)

<u>Table: Aquaculture</u>

- Inshore developments – competition for space requires cooperation.
- By 2050 – more clarity – MSP

- Headings and scenarios don't match – drivers and targets are international level, implementation local. Separate out the sectors to fit the scenarios?
    - Scale
    - Different areas
    - What does transboundary mean?
- Desirable to move into areas that aren't used very much – but limited by technology, climate, conditions

- Very scale dependent
- Influence of other sectors

- Smaller scale, inshore – cooperate with other sectors (co-locate)

- Lack of transnational cooperation – will continue from present to 2050
- Similar level of spatial efficiency
- Localised cooperation across borders

Figure 21: Possibility Space for Aquaculture completed by workshop participants

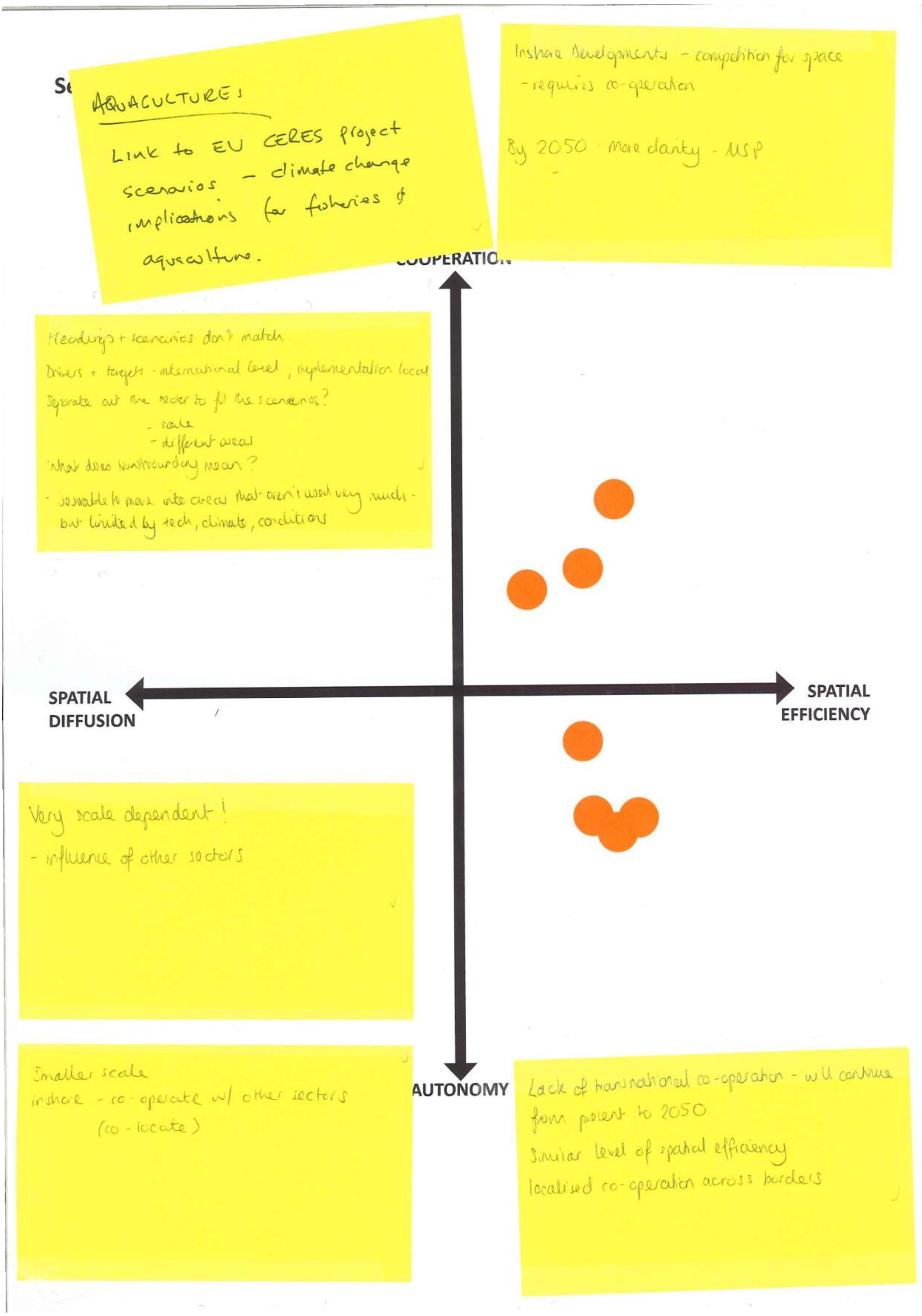


Table: Conservation

With reference to scenarios 3 and 4 which represent possible post Brexit scenarios:
- Concerned with the implication that Brexit means Britain will no longer talk to other countries
- Why would Brexit necessarily mean that we wouldn't still try and protect the environment?

General comments:
- In 2050 we should remember all countries will have marine plans and also that whilst UK will not be in the EU, IE and FR will.
- Scenarios are designed to make people think. The best scenarios are often extremes designed to make you think of the spatial implications. This is what the Gaufre Project did. For example, in a purely economic focused scenario you don't care about the location of spawning grounds.
  - It would be useful to define the starting point (0) on the axis. Is this where we are or where we are?
- Cooperation is not always beneficial. Whether or not co-operation is beneficial to the environment can depend on who are the most accomplished negotiators and on existing regulation.
- Co-operation doesn't necessarily mean that everyone has to do the same thing.
  - Could OSPAR perhaps facilitate cooperation between FR, IE & UK post Brexit? Only if MSP WG introduced
  - DEFRA is keen to strengthen the OSPAR link
  - In UK terms I think even with Brexit, conservation is one sector where cross-border cooperation will continue regardless, driven by NGOs and facilitated by OSPAR etc. Existing relationships built in the Celtic Seas will facilitate this. Danger that despite cooperation the environment will suffer through conflicting policy in other sectors

- There is controversy regarding whether the MPA network in the UK can deliver
- NI are aware of the controversy in England and have taken this into consideration when developing their own plans and making them achievable by backing them up with science.
- Conservation needs more than just MPA's

Where will the sectors be in 2050?
- Sharing of data will be more likely. Existing management techniques will continue after Brexit.
- Can see existing management continuing but goals not being achieved.
- Was confused by the term 'spatial diffusion'

  - Only path to marine conservation on an ecosystem level
  - Marine conservation should be primary criterion in locating new activities
  - Cooperation will be used to protect 'transboundary species'. Protection evaluated at the biogeographical level
  - There will be spatial efficiency because all activities will be submitted to SEA/IEA and engaged within the framework of a plan. However, too much competition between economic activities and marine conservation

- Existing regulation remains
- Enforcement weakens of MPA management and accountability changes
- Good data sharing between areas
- No appetite for strategic overview of data collection in marine area
  - Cooperation will increase – Brexit fallout/implications will have levelled past 15/20 years and this will restart
- Improved colocation but not a strategic approach to decisions by government
  - Well-being divergence, e.g. Welsh Future Generations Act vs. France/Ireland – unsure of their goals moving forward with respect to well-being/socio-economic development factors. Interesting to see how this evolves moving forwards

- There won't be tighter environmental constraints; ongoing allocating activities
- More emphasis on public values and wellbeing feeding into conservation decisions. (Driven by Welsh legislation in the UK perhaps?)
  - Conservation objectives will remain, but perhaps with limited activity/enforcement
  - Ongoing data sharing improvements between certain organisations – HEIs, RIs, but possibly not at government level and industry level
- Lack of effective management/implementation of MPAs
- Impact of Brexit will have dissipated, and cooperation between EU and UK will have stabilised again
- UK may have developed stronger links outside Europe?

- There is good data sharing through portals across Celtic Seas countries

  - Not necessarily government led. Research led by institutions – change is also led/pushed for by institutions despite government cuts – push for public wellbeing
  - Conservation sites are decided through consultation and so are inclusive and cooperative. BUT management is reactive rather than proactive
  - Activities and developments will be allowed within sites

- Assuming work to support coexistence will continue, political and public support for this will increase.
- France and Ireland will continue to operate within Europe, UK will focus on Commonwealth and global connections – cooperation in the Celtic Seas will suffer
- Environmental legislation will remain. UK will retain this but implementation will receive less attention and environmental statements will suffer as UK seeks to push economic development

  - There is a tension between top down driven ecosystem approach and bottom up approach to manging conservation
  - Geographical considerations, educational targets, infrastructure
  - Conservation overlaps with sectors, depending on the geographical location (proximity to conserved areas)
  - Cooperation should be based on the degree of distance between government and region in question

Figure 22: Possibility space for conservation completed by workshop participants

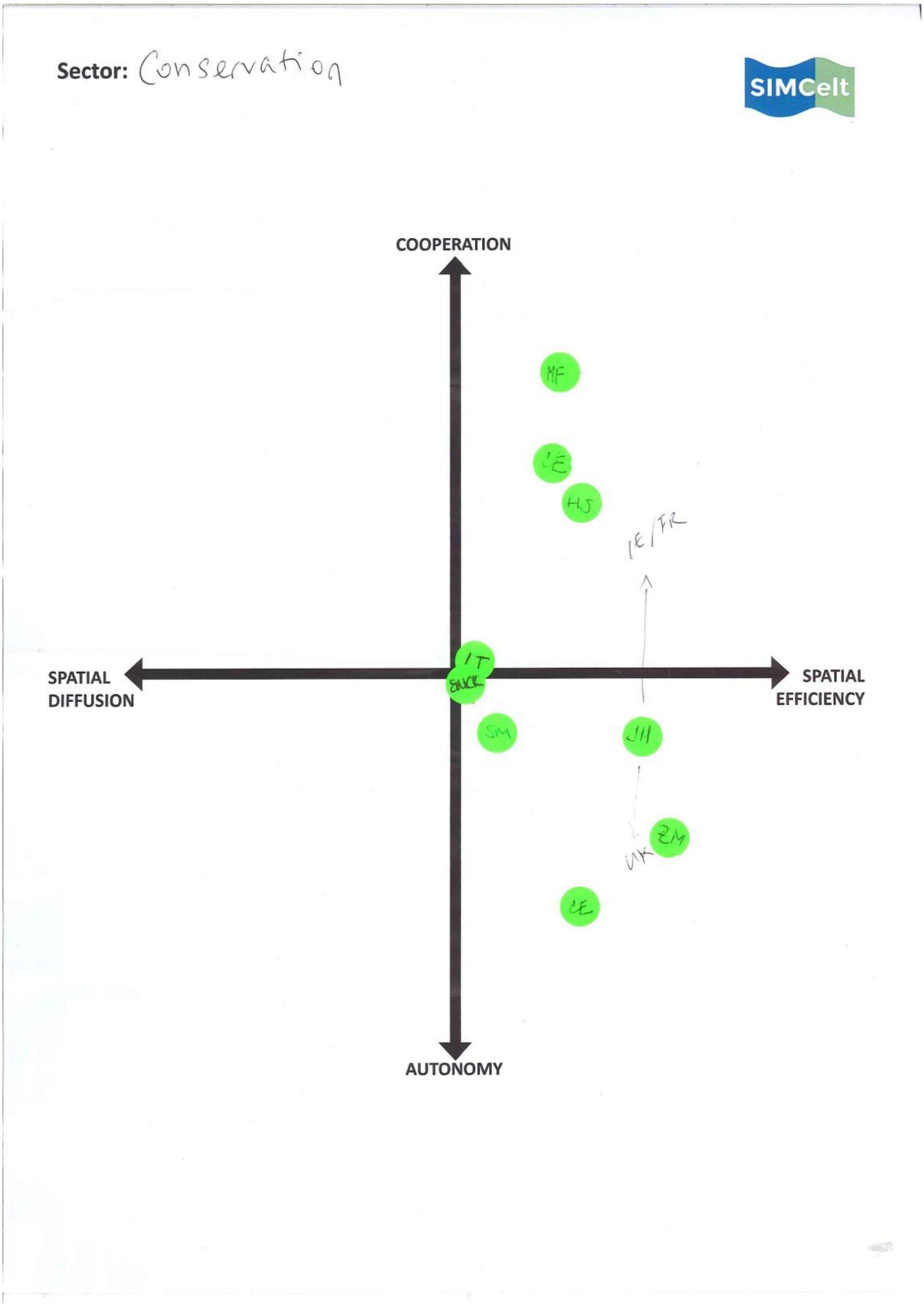


Table: Ports and Shipping

- Scenario 4: mid size/small multi-use ports > autonomy
- Scenario 1: big ship/motorways/safety/security measures increasing > interdependence
- Scenario 2: recreational boats > networking

  - Fishing ports need to have a connection to the land (with industries) > dependency
  - Shipping ports – future is e-navigation/sharing of data – interoperability of systems. Also big competition due to globalisation
  - Ports – basis for infrastructure for new and emerging activities (colocation of activities at sea)
  - Shipping – motorways

- Due to continued globalisation, digitalisation and technological advancements almost all the ships will be autonomous and ports smart.
- Cooperation within and among sectors will be high to meet the increasing demands for food, energy, tourism.
- Ships are also getting larger and running on electricity

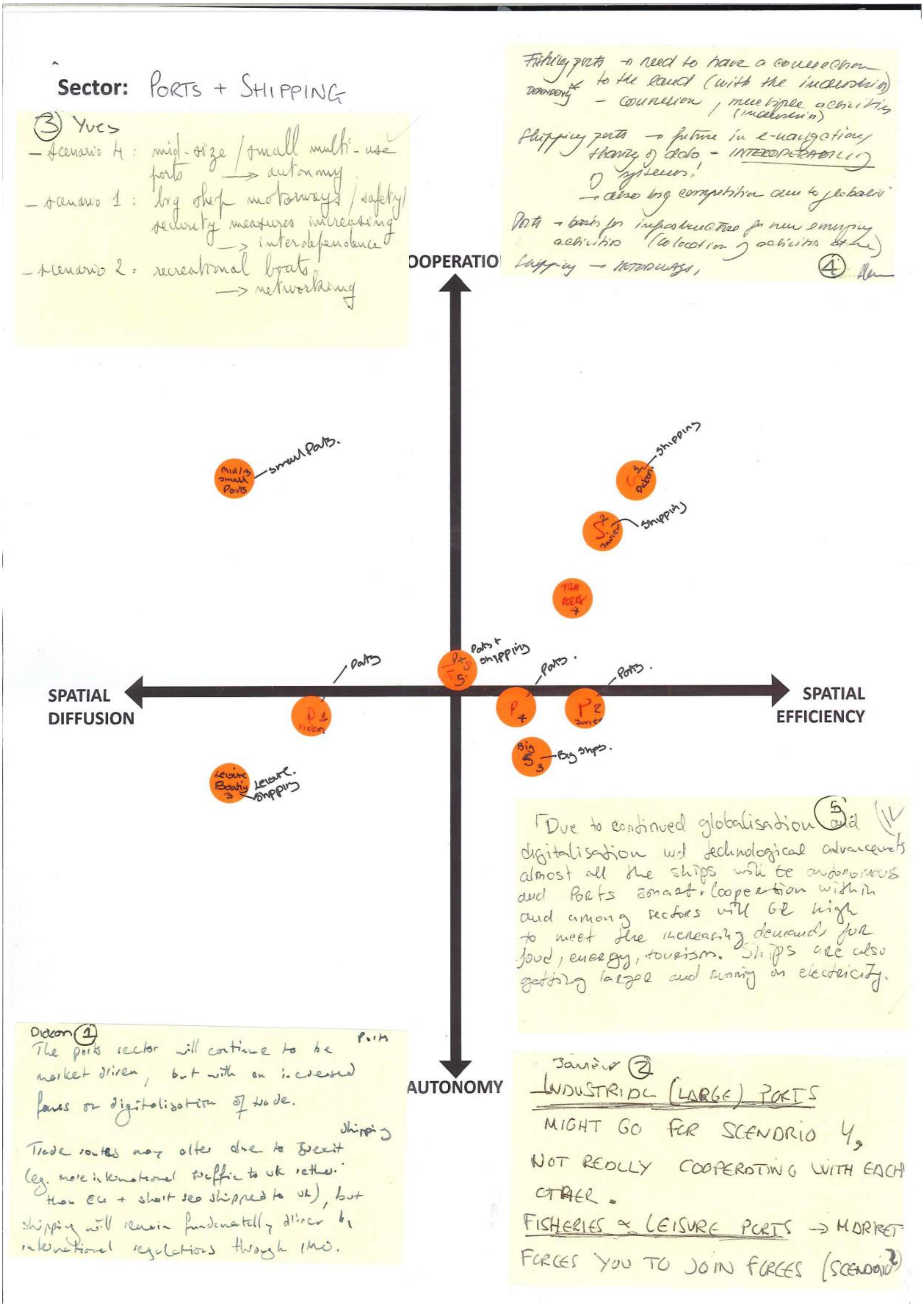
  - The ports sector will continue to be market driven, but with an increased focus on digitalisation of trade
  - Trade routes may not alter due to Brexit (e.g. more international traffic to UK rather than EU and short sea shipped to UK), but shipping will remain fundamentally driven by international regulations through IMO

- Industrial (large) ports might go for scenario 4, not really cooperating with each other
- Fisheries and leisure ports > market forces them to join forces (Scenario 2)

General notes

  - Interactions with renewable energy: by 2050 repowering of wind turbines – ports will need to accommodate new technology, new maintenance/servicing industries. Smaller ports will have greater capacity to innovate
  - Growth of renewables will create problems for recreational boating
  - Lagoons will have direct impact on port access
  - Navigation issues – wind farms not affecting big shipping lanes yet but could they by 2050? Navigation may be digitised so reducing risk
  - UK; shipping, defence, oil and gas will be prioritised
  - Moving offshore – less conflict with ports
  - Other renewable sources by 2050?

Figure 23: Possibility space for ports and shipping completed by workshop participants



<u>Table: Wave and Tidal Energy</u>

General comments on the scenarios:

- Think more broadly than marine energy alone. Marine energy is merely a sub-set of a much larger energy sector
- Spatial efficiency/co-location can be a constraint to the sector in terms of costs and benefits: If a fishing vessel damages an undersea cable, the costs can be greater than the economic gain derived from the fishing effort
  - Traditional industries could be expected to grow more as local communities are interested in promoting them (e.g. artisan fisheries)
- S1 seems likely from a developers perspective and also describes the current situation: Sectors are not cooperating now, and silo thinking is likely to continue (at least for some time)
  - Transboundary cooperation is likely to vary: There may be more cooperation in the environmental sector and less economic cooperation as countries are competing with each other

Discussion of offshore wind

- Temporal aspects of development influence efficiency. ROI in the renewables sector may take a while to achieve
  - Definitions of cooperation are important: Are we talking about individual developers or countries? Developers in the offshore wind sector are already cooperating as all developers are facing similar issues and constraints across Europe
- Round 2 is showing more cooperation amongst developers than Round 1. The future may lie in a more regional approach
  - Developers hold back when bidding for sites, but especially when bidding for finance
- Energy developers are more likely to take a strategic EU-wide approach for offshore wind. This is unlike tidal energy which has a more local approach
- Willingness to cooperate is also related to the maturity of the industry and its level of embeddedness in planning
  - Offshore wind competes with other sectors but needs larger areas offshore. It's likely that more releasing will happen
- A supergrid may act as a driver for cooperation but there are many practical issues surrounding grid connection and seabed connectors
  - Sectoral coordination is already quite good (offshore wind) but this is not integrated in MSP. Cooperation exists on technical aspects but not in planning
- Cooperation depends on drivers that support it – who really wants this enough and is willing to force it?

Discussion of wave/tidal energy

- Offshore wind does need its own space which restricts co-location opportunities. On the other hand, tidal lagoon projects can only be successful if there is local community support and buy-in due to multiple benefits at the local level. More cooperation from local stakeholders is therefore needed for tidal projects, in contrast to offshore wind which is more top-down

- Wave/tidal energy is still autonomous and developer-led rather than planning-led. This might change as the Crown Estate starts to think more strategically. Presently, there is no policy direction regarding tidal range energy; wave energy developments are small-scale and individual

- Small, local and coastal initiatives may actually increase efficiency. Even if this is not planning-led, a more regional municipality-led approach may lead to efficiency by default as support from local communities is needed

Comments on desired developments by 2050:

- Ideal trends depend on perspectives: While developers only care about profits, the public view is that development should be sustainable and that MSP should secure greater public benefit. So cooperation is expected to be desirable from a public point of view.
- Can we always assume that spatial efficiency is a good thing?

- Small scale, start-up, entrepreneurial, devolved/regional government support
- Depends on maturity of technology and scale

- Developer-led rather than plan-led system
- Very limited spatial footprint of wave and tidal currently
- Cooperation limited to research and maybe environmental monitoring

- My experience of the tidal energy industry is a complete lack of interest in engaging with other sectors/understanding others needs for use of that space – I was on the NW Tidal Energy Group and the Mersey Barrage Environment Technical group – they are internally competitive and quite blinkered.

- WIND – decisions based on resource availability
- Cooperation limited to specific aspects
- Limited engagement with other maritime industries

- International cooperation will be difficult at Celtic Seas level. It is more likely to be at developer/individual perspective

- Offshore wind: reaching out – competition for space, cfd's have high value, some sharing of info between sector, developers looking at bigger picture due to European origins
- Wave and tidal: going it alone – increasing cooperation around data but still very limited and minimal cross-border working to expand sector

- Offshore wind farm projects getting larger/multinational, so some degree of cooperation is required. Also push of sea wide/regional energy grids. Also greater consideration of social and ecological impacts of offshore wind farms. But still largely sector-driven targets/interests

- Advanced development of large-scale arrays, into deeper waters, in association with supergrids supporting cross-border energy models

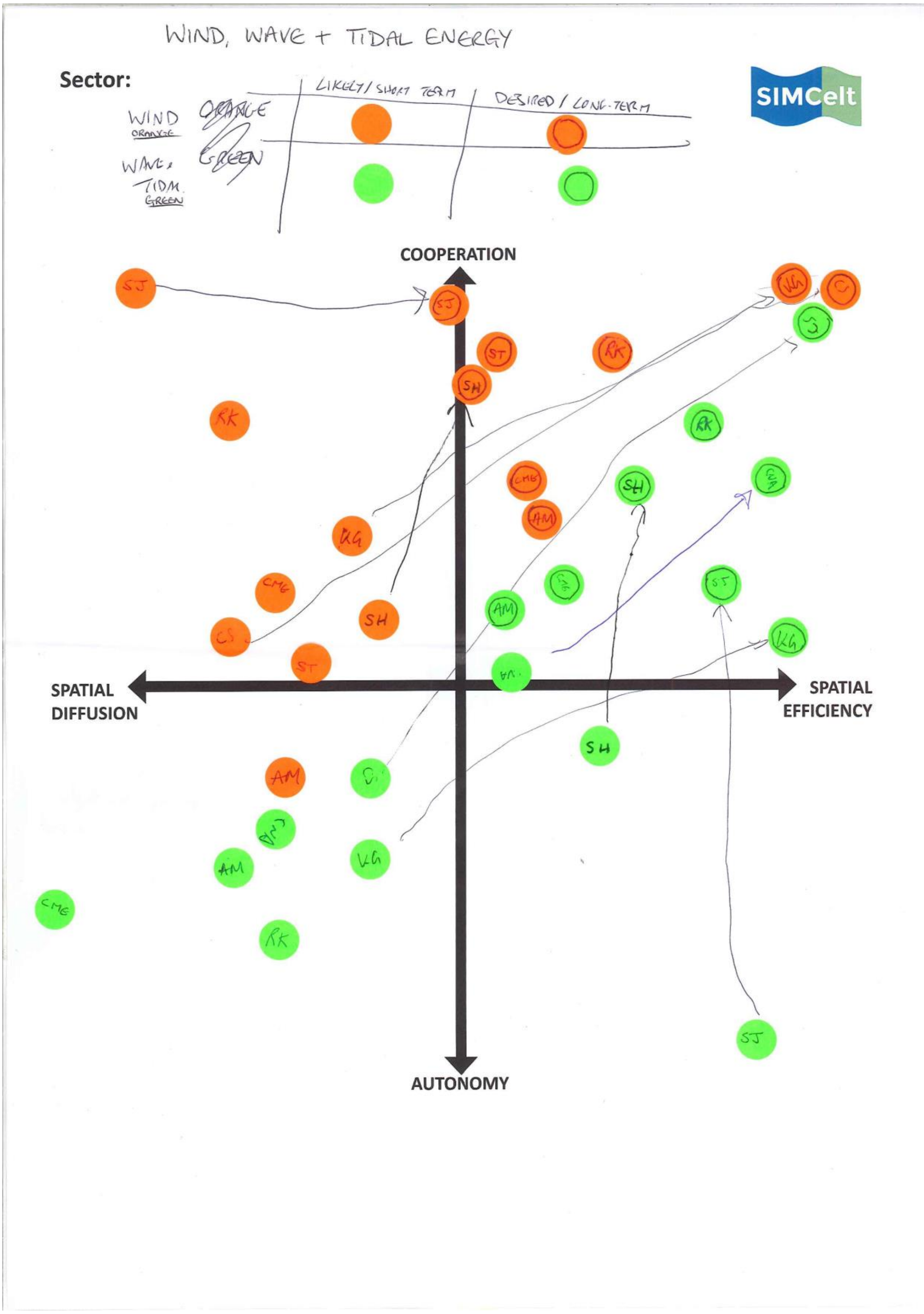
- Wind – some cooperation in planning at national and international level
- offshore wind tends to require more exclusive use of space due to safety (navigation) and interactions (risk to array cables from fishing)
- wave and tidal probably more spatially efficient than wind
- wave and tidal projects more local and responsive to stakeholders
- tidal lagoons offering multiple benefits, e.g. Swansea Bay Tidal Lagoon – public access/recreation/aquaculture

- In Ireland, we have offshore renewable energy development plan, if objectives are achieved we will have cooperation between developers/planners and sustainable development of the wave and tidal sector.

- Economic drivers and government support are key to develop wave and tidal activities.

- Offshore wind is near commercial scale development without government support.

Figure 24: Possibility Space for Energy (Offshore Wind, Wave and Tidal)



A.3.2 Sectoral Interactions (Activity 2)

Conservation Table Views on:
Aquaculture • Limited conflicts which we think can be managed quite well, e.g. via licensing process and better co-location of activities • Mutual interest in water quality • Cumulative impacts of aquaculture biggest threat to conservation • Unknown impact of climate change • Increase in collaboration from industry • JH: Don't see how co-operation with aquaculture will affect conservation. • AR: In Ireland certain licences were being approved without any EIA which posed a potential threat to conservation. Compensation then needed to be provides to remedy this situation. • Ancipates that by 2050 this licencing issue will be much better. Ports and Shipping • Increased long haul shipping increases risk of IAS/biosecurity breaches – effect on local ecosystems • Trade offs may increase with ports conducting conservation projects, e.g. Bristol • Ports and shipping legislation an be a driver for conservation, e.g. Ballast Water Convention, Port Reception Facilities Directive, noise regulations. But there will be an increase in underwater noise • Increases in long haul shaping could increase the risk of IAS and biosecurity risks. Ports legislation could help with this issue. Wind, wave and tidal • Underwater noise impact from construction • Decommissioning noise impacts species e.g. harbour porpoise • Increase in cabling/networks • Cumulative impacts • Transboundary cooperation between countries – potential benefit to conservation • Floating platforms would enhance conservation • By 2050 we may have realised some of the long term impacts of projects taking place now. conversely we may be seeing the early stages of other industry • Lack of cooperation from wave and tidal with other industries is a risk to conservation *Mapping / modelling would be beneficial for industries to identify areas where co-location could exist.*

Aquaculture Table Views on:
Conservation • Broadly same scenario as aquaculture • Spatial efficiency but a wider range of cooperation/autonomy, tending towards cooperation • Compatible/complimentary with aquaculture – in many cases – but depend on location/activity/objectives • Approach is the key – work/talk/agreement driven • Opportunity to take on board/be influenced by NGO environment • Opportunity to promote green credentials, promote green tourism • Depends on species, type of tourism, location, societal pressure Ports and Shipping • Broad range of possibilities • Opportunities: smart ports, integration with other sectors e.g. energy, shared facilities, co-location, feed in/fish out • Negatives: more ports > bigger boats – issues around navigation/location of wind farms or services (feed barge moorings) • Too dependent? What if port/harbour facilities become unavailable Wind and Wave energy • Very broad • In 2050 cooperation/spatial efficiency quarter • Depends on location • Small pilots • Moves further offshore – less conflict, but increased technology and infrastructure challenges • High energy further offshore, harnessing that is key • [Moving offshore will] free up space for aquaculture, also provide opportunities for colocation

Ports and Shipping Table Views on:
Aquaculture • Colocation in commercial scale activity will be a challenge – other sectors favoured, e.g. tourism • Spatial management of aquaculture good for ports sector – they can influence location • Benefit – diversification of smaller ports Conservation • Similar pattern of dots to aquaculture and shipping • Existing ports constrained by SACs/SPAs • Potential for ecological engineering?

Energy Table Views on:
Aquaculture • Aquaculture seems opportunistic and without a requirement for integration. • If high tech developments took place in the high seas the picture might move more to the left hand side, although this depends on the level of integration in MSP which would increase efficiency • Co-location sounds good in theory but it takes two industries to come together that may not be too interested in doing so. Co-location sounds attractive to planners, but is it to industry? (SH) • Practicalities remain a stumbling block: there are design issues, issues related to accessibility and safety, and interference with each other's operations. There is also an issue related to economic risks: e.g. aquaculture may compromise the (economically more valuable) operation of offshore wind farms (ST, CM, SH). • Commercial viability is the key driver in both sectors, so anything that makes operations more expensive is likely to be precluded. So risk assessment is important: what are the costs and benefits to either sector? (ST, SH) • Spatial overlap may be an issue: Offshore wind sites are not necessarily where aquaculture would take place (CS). Co-location may also depend on the total available potential sites (or lack of alternatives – e.g. in the case of tidal range energy). So opportunities and constraints models and mapping of potential locations for all sectors would be helpful (CS). • Repowering nearshore may preclude other industries but also offer opportunities for co-design. A main stumbling block is that offshore wind would not benefit from co-design in the same way that aquaculture would, but would be landed with higher costs (problem of over-engineering). • Wave energy offers greater possibilities for co-design as initiatives are smaller scale and more local and need to produce multiple benefits to draw community support. There may be community benefits to co-location even if there are no economic benefits. • The business case for offshore aquaculture still needs to be made. • Floating wind farms would also see aquaculture as a constraint. • A key question is who will push co-location and what societal benefits are expected: What will it take to get the offshore wind sector to take on a higher level of risk? Can MSP really impose this on developers?

Energy Table Views on:
Ports and shipping • A complex map due to a complex industry! • Shipping routes are taken as a given framework and hard constraint that is unlikely to change (all agree) • Safety and economic efficiency aspects are the key drivers for the shipping sector; thus they have a strong incentive to stick to the shortest possible routes (SH) • New trade routes might open up as a result of Brexit (AMOH) • More modular ship-building may be able to support ports (see Northern Ireland shipping strategy) • Ports also need to evolve with larger wave and tidal energy and offshore wind logistics • Efficient shipping and port development need equally efficient infrastructure on land

A.3.3. Promoting Cross-Border Cooperation (Activity 3)

Issue 1

What is the issue? Does it have a transnational dimension?

Biosecurity and shipping

Can this be resolved by MSP processes or policies? If so how?

- *Consolidate existing biosecurity policies and legislation e.g. through a policy or requirement for a biosecurity action plan*
- *MSP implementation guidance can provide advice on which sectors and type of activity need which measures*
- *Marine planning evidence portals can help identify risk areas/routes*
- *Good awareness of IAS helped by advancement of MSP*

What type of intervention is required?

✓ Further research
☐ New legislation
✓ More engagement with certain sectors
✓ Other (Specify)

Ballast Water Convention, WFD, MSFD

Promote citizen science as a monitoring tool

Who needs to be involved?

✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
✓ General Public – *citizen science – identification of invasive species*
✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
✓ International Governance Organisations, e.g. United Nations - *IMO*
☐ Other (Specify)

Issue 2

What is the issue? Does it have a transnational dimension?

Conservation and offshore wind

Can this be resolved by MSP processes or policies? If so how?

- *DESIGNATE ZONINGS for offshore wind that are de facto no take zones as a conservation benefit.*
- *MSP policies can drive licensing conditions to minimise risk and impact on other sea users.*
- *MSP is a driver for data collection and shoring, identify opportunities and risks.*
- *MSP policies can enhance environment and look favourable on co-location. May also look more favourably on floating platforms, less intrusive*
- *If approved, OSPAR can inform marine licensing conditions*

What type of intervention is required?

✓ Further research – *OSPAR guidelines re decommissioning*
☐ New legislation – *floating platforms*
✓ More engagement with certain sectors
☐ Other (Specify) – *Ecosystem services*

Offshore interconnected network

seascape

Who needs to be involved?

✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
✓ General Public

✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
✓ International Governance Organisations, e.g. United Nations *IMO*
✓ Other (Specify) – Specific working group

Issue 3

What is the issue? Does it have a transnational dimension?

Co-location of aquaculture and conservation
(Yes it has a transnational dimension – cumulative impacts)

Can this be resolved by MSP processes or policies? If so how?

MSP can assist/starting to

- *SEA/EIA*
- *Depends on where and what conservation objectives are*
- *Depends on the detail of the plan*
- *Identify cumulative impacts*
- *Mitigation strategies*

What type of intervention is required?

✓ Further research
✓ New legislation / guidance
☐ More engagement with certain sectors
✓ Other (Specify) – look at MUSES project

Who needs to be involved?

✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
✓ General Public

✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
✓ International Governance Organisations, e.g. United Nations
☐ Other (Specify)

Issue 4

<table>
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What is the issue? Does it have a transnational dimension?

Colocation of aquaculture and offshore wind

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Can this be resolved by MSP processes or policies? If so how?

No, but:

- *Identify areas of shared interest, conflict, overlap*
- *Facilitate*
- *Done by sectoral intervention – incentives, logistics*
- *Sustainable development/blue growth*
- *Wind alone – transnational potentially, but aquaculture alone is not*

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What type of intervention is required?

✓ Further research – *case studies*
☐ New legislation
✓ More engagement with certain sectors
✓ Other (Specify) – *projects/pilots*

- Technology
- Conditions – physical
- Different types of aquaculture

MUSES doing some of this

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Who needs to be involved?

✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
✓ General Public

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✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
☐ International Governance Organisations, e.g. United Nations
☐ Other (Specify)

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Issue 5

What is the issue? Does it have a transnational dimension?	
A transnational grid and storage facilities – (interconnectors) – integrated in wider energy systems - Political issue (e.g. Ireland) - Electricity cost as a driver/disincentive - Lack of incentives	
Can this be resolved by MSP processes or policies? If so how?	
Practical issues (e.g. transfer stations), but opportunity to think strategically MSP to include aspirational goals for energy	
What type of intervention is required?	
☐ Further research ✓ New legislation – UK legislation does not encourage cooperation ☐ More engagement with certain sectors ✓ Other (Specify) – Platform for exchange: government, developers/industry, planners Promote storage – related research and show benefits for developers	
Who needs to be involved? ☐ MSP Authorities ✓ Other Government Departments ☐ Specific Sectors ☐ NGOs ☐ Sector Representative Bodies ✓ Specific Companies ☐ General Public	☐ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions ☐ International Governance Organisations, e.g. United Nations ☐ Other (Specify) *R&D* the Germans

Issue 6

What is the issue? Does it have a transnational dimension?

Co-location aquaculture/offshore renewables – use tidal lagoons to prove the concept of spatial pressure > aquaculture inshore drives the move offshore

Can this be resolved by MSP processes or policies? If so how?

Needs more engagement with actors in the industry
Needs government policy

Focus on social license/benefits

Identify suitable areas and use safeguarding policy

What type of intervention is required?

✓ Further research – proving commercial viability of offshore aquaculture
☐ New legislation
✓ More engagement with certain sectors
✓ Other (Specify)
Aquaculture strategy
"A voice for the industry"
More trials/better trials and business case (plus risk assessment)

Who needs to be involved?

✓ MSP Authorities
☐ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
☐ General Public
Talk to Poland

☐ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
☐ International Governance Organisations, e.g. United Nations
☐ Other (Specify)

Issue 7

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What is the issue? Does it have a transnational dimension?

Ports realising opportunities for diversification related to Blue Growth
- Both small and large ports
- Engaging ports in planning for other sectors
- Some port/shipping activities are more transnational than others, e.g. renewable energy

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Can this be resolved by MSP processes or policies? If so how?

- Need to present a transnational picture of opportunities available to the ports sector
- Proactive stakeholder engagement – building into review of first cycle of marine plans

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What type of intervention is required?
✓ Further research – of cost/benefits, financial mechanisms and supply chains
☐ New legislation
✓ More engagement with certain sectors
☐ Other (Specify)

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Who needs to be involved?
✓ MSP Authorities
✓ Other Government Departments
✓ Specific Sectors
✓ NGOs
✓ Sector Representative Bodies
✓ Specific Companies
✓ General Public

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☐ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions
☐ International Governance Organisations, e.g. United Nations
✓ Other (Specify) – financial mechanisms, maritime clusters

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Issue 8

What is the issue? Does it have a transnational dimension?

[MSP authorities] designating shipping lanes of national significance that exclude other activities/users

- By 2050 autonomous ships or high speed passenger vessels might need separate lanes
- Transnational as it involves UNCLOS and freedom for international shipping to navigate

Can this be resolved by MSP processes or policies? If so how?

Could be designated by planning authorities or the IMO

What type of intervention is required?

✓ Further research – technical studies, e.g. SSS in the Irish Sea – establishment of network
✓ New legislation – established processes could be further developed
☐ More engagement with certain sectors
☐ Other (Specify)

Who needs to be involved?	
✓ MSP Authorities ✓ Other Government Departments ✓ Specific Sectors ✓ NGOs ✓ Sector Representative Bodies ✓ Specific Companies ☐ General Public	✓ Existing Transnational Cooperation Bodies, e.g. OSPAR, Conference of Peripheral Maritime Regions ✓ International Governance Organisations, e.g. United Nations ✓ Other (Specify) - IMO

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