



SEA Wave: Strategic Environmental Assessment of Wave energy technologies

Deliverable Report D2.1

Knowledge gaps and consenting risks for wave & tidal energy



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Revision

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1 Introduction

This deliverable provides a summary of key knowledge gaps regarding the potential environmental effects of wave and tidal energy development and an overview of consenting risks relevant to the sectors.

This deliverable is informed by a number of key existing resources, such as ORJIP Ocean Energy's Forward Look and OES Annex IV's State of the Science report, which highlight knowledge gaps relevant to the consenting and licensing of marine energy projects.

ORJIP Ocean Energy published the third iteration of its 'Forward Look' document in November 2017¹. This included a prioritised list of strategic research projects to address key issues raised through the Environmental Impact Assessment (EIA)/ Habitats Regulations Appraisal (HRA) processes and set out the purpose, required timing and broad scope of the research projects necessary to meet ORJIP Ocean Energy's overall aim.

The aim of ORJIP Ocean Energy is to ensure that the principal EIA and HRA consenting risks for early array deployments in the wave and tidal sectors are addressed by facilitating a strategic, coordinated and prioritised approach to monitoring and research which is endorsed by industry, regulators and Statutory Nature Conservation Bodies (SNCBs).

This deliverable will update the 'Forward Look' to contribute to the overall objectives of the SEA Wave Project which are to:

- Undertake a comprehensive review of all existing data collected for the sector;
- To address long term environmental concerns around the development of the marine renewable industry's emerging technology.

The aim of this deliverable is to present an up to date, validated and prioritised summary of the knowledge gaps and consenting risks for wave and tidal energy projects.

The objectives of this deliverable are to:

- Issue a Call for Evidence to the SEA Wave Partners, SEA Wave Steering Group and ORJIP Ocean Energy Network;
- Use the responses to the Call for Evidence to ensure the knowledge gaps and consenting risks are up to date.

The overall impact of this Work Package will be:

- A consensus on the priority knowledge gaps and consenting issues upon which coordinated strategic data collection and research efforts should focus on in the SEA Wave project and across the sector, ensuring improved efficiencies in the allocation of resources and distribution of effort.

¹ <http://www.orjip.org.uk/sites/default/files/ORJIP%20Ocean%20Energy%20Forward%20Look%203%20FINAL.pdf>



- An established European Network of stakeholders and end users engaged in better understanding the potential impacts of wave developments and improving the consenting process.
- Refinement of the consenting processes for ocean energy deployments, helping to reduce costs and the time spent in achieving consent.
- Environmental monitoring strategies designed to address the key consenting risks of wave energy projects that will be implemented during the project.

In compiling the list of key consenting issues and risks for the wave and tidal sector, a comprehensive review of the industry's and academia's understanding regarding the potential environmental impacts associated with marine energy has been undertaken in line with the objectives of ORJIP Ocean Energy and SEA Wave.

Ongoing work in environmental monitoring has been reviewed to explore if any identified knowledge gaps are actively being addressed, in order to prevent the duplication of work.

This deliverable within WP2 will improve understanding of where research should be focused and prioritised. It includes a summary of the current understanding regarding the potential environmental impacts, uncertainties and consenting risks currently facing the ocean energy industry. This includes a gap analysis to assess where research effort should be focussed to address the knowledge gaps and uncertainties that exist for consenting and licensing. Prioritisation is to be given to knowledge gaps providing an industry framework for overcoming current uncertainties. Identified knowledge gaps have been validated with regulators, developers and researchers and other stakeholders through the project Steering Group in addition to the project partners and the ORJIP OE Network.

1.1 Structure of this report

This report is structured as follows:

- **Chapter 2:** Methodology for compiling the information in this report
- **Chapter 3:** List of key consenting issues and risks
- **Chapter 4:** List of recently completed, currently underway and planned research on consenting issues and risks
- **Chapter 5:** Conclusions and next steps
- **Chapter 6:** Appendices
 - **Appendix A:** Call for Evidence template
 - **Appendix B:** Issues/risks no longer considered to be key strategic consenting issues



2 Methodology

In order to complete this deliverable, a Call for Evidence was issued to stakeholders within the wave and tidal energy industry. The aim of the call for evidence was to inform the process and to ensure that the most up-to-date information was available to the team. The Call for Evidence is provided in Appendix A:

These responses were then used to update the information within previous versions of the ORJIP OE Forward Look to build this report. This proved to be an effective mechanism for ensuring that the project outputs were fully informed and that the best and most up to date information was available to the team.

The Call for Evidence was issued to the SEA Wave partners, the SEA Wave Steering Group and the ORJIP Ocean Energy Network. The SEA Wave consortium has representatives from the UK, Ireland, Belgium, Finland, Portugal and Sweden, and the ORJIP OE Network has been built over the lifetime of the ORJIP Ocean Energy Programme and consists of 55 active organisations from 26 countries and stretches across Europe, North America, South America, Asia and Australia.

Stakeholders within these groups include regulators, Statutory Nature Conservation Bodies (SNCBs), technology developers, test sites, academics, researchers, consultants, Non-Governmental Organisations (NGOs) and funding bodies.



Figure 1. Geographic spread of the stakeholders that were consulted with as part of the Call for Evidence



The list of consenting issues and risks for wave and tidal currently presented in the previous version of the Forward Look was reviewed and updated following analysis of the responses to the Call for Evidence.

Within the context of this project and the study objectives, the following criteria were used to identify the key EIA/HRA issues:

- **Project type – is the issue relevant to wave projects, tidal current projects, or both?** Issues relevant to all/a number of wave/tidal technology or project types were identified as key issues.
- **Strategic relevance – can and should the issue be addressed at a strategic level?** Issues that should be addressed at a project/site specific level were **not** considered as key issues.
- **Project scale – is the issue relevant to demonstration scale or commercial scale projects?** At this stage, issues relevant to demonstration scale arrays were identified as key issues. It was considered that some issues likely to be relevant at commercial scale only can be tackled in the longer term and are therefore not priorities in the immediate/near-term. However, issues considered to be only relevant at commercial scale that were identified as high priorities by the wave and tidal energy sectors and for which strategic research at demonstration scale would inform commercial scale EIA/HRA, were also identified as key issues during this process.
- **Regulatory issues – is the issue a current concern for regulators and advisors that developers are required to address within project EIA/HRA?** Issues facing developers due to current regulatory concerns (including identified and perceived risks) that can be addressed through coordinated strategic research were identified as key issues.

From the longlist of key EIA/HRA issues, a total of 25 issues were identified as ‘key strategic consenting issues’ currently facing the wave and tidal current industries.

A summary of each of these issues including which industry they are relevant to is presented in **Error! Reference source not found..** A summary of those issues no longer considered to be ‘key strategic consenting issues’ are presented in **Error! Reference source not found..**

Recently completed, underway and planned research relevant to the key consenting risks identified is summarised in Section 3.



3 List of key consenting issues and risks for wave and tidal current energy

Topic	EIA/HRA issue and knowledge gap(s)	Relevant to wave or tidal current or both?	Strategically relevant?	Commercial or demonstration scale?	Key issue in previous Forward Look report?	Current key strategic consenting issue?
Ecological environment						
1. Collision risk	1.1 The nature of any potential interactions between marine mammals and basking sharks and tidal turbines is uncertain	Tidal current	Yes, relevant to all tidal projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
1. Collision risk	1.2 The nature of any potential interactions between diving birds and tidal turbines is uncertain	Tidal current	Yes, relevant to all tidal projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
1. Collision risk	1.3 The nature of any potential interactions between fish and tidal turbines is uncertain	Tidal current	Yes, relevant to all tidal projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
1. Collision risk	1.4 There is uncertainty as to the possible physical consequences of potential collision events for marine mammals, diving birds, fish and tidal turbines	Tidal current	Yes, relevant to all tidal projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
1. Collision risk	1.5 Further development of suitable instrumentation and methodologies for reducing collision risk, monitoring wildlife behaviour around devices and arrays and for detection of any collision events is required	Tidal current	Yes, relevant to all tidal projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
2. Underwater noise	2.1 Lack of available acoustic data from operational devices and arrays	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
2. Underwater noise	2.2 Knowledge regarding the possible effects of underwater noise from the construction and operation of arrays on marine mammals is incomplete	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
3. Electromagnetic fields (EMF)	3.1 Further data and information regarding the possible effects of EMF from	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.



	transmission cables on fish would improve confidence in EIA and HRA					
4. Displacement	4.1 Potential displacement of essential activities of marine mammals, basking sharks and birds	Both	Yes, relevant to all projects	Commercial - this issue was identified as a high priority during the Draft Report consultation process.	Yes	This remains a key strategic consenting issue.
5. General	5.1 Further strategic baseline data (distribution, abundance, seasonality, etc.) for marine mammals and basking sharks is required to better understand use of potential development areas	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue
5. General	5.2 Further strategic baseline data (distribution, abundance, seasonality, etc.) for birds is required to better understand use of potential development areas	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue
5. General	5.3 Further strategic baseline data (distribution, abundance, seasonality, etc.) for fish is required to better understand use of potential development areas	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue
5. General	5.4 An agreed approach to undertaking site characterisation and baseline surveys for marine mammals and birds to inform EIA and HRA is required	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
5. General	5.5 Further data of mobile species populations (particularly qualifying species of Natura sites and EPS) for use in population modelling would improve confidence in EIA/HRA	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
5. General	5.6 Better understanding of population level impacts and methods to assess the significance of population level impacts would improve confidence in EIA/HRA	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
Human environment						



6. Impacts on commercial fisheries	6.1 There is a lack of standardised approach to assessing the availability of alternative fishing grounds (outside development areas) and their ability to sustain existing /displaced commercial fishing levels	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
7. Impacts on shipping and navigation	7.1 Difficulties with assessing and mitigating the potential cumulative impacts on shipping and navigation due to uncertainty around risks that may arise from a number of projects	Both	Yes, relevant to all projects	Demonstration and commercial	Yes	This remains a key strategic consenting issue.
8. Social and economic impacts on local communities	8.1 Difficulty with identifying, assessing, mitigating and managing potential cumulative social and economic impacts from marine energy developments and changes to existing maritime activity	Both	Yes, relevant to all projects	Commercial scale and 'clusters' of demonstration scale projects	Yes	This remains a key strategic consenting issue.
Physical environment						
9. Impacts on physical processes	9.1 Development of hydrographic models to predict the effects of changes in water flow and energy removal caused by (a) the physical presence of the device in the water (b) the removal of energy and secondary effects of changes in water flow and energy removal	Both	Yes, relevant to all projects	Commercial but valuable research could be undertaken around demonstration array projects	Yes	This remains a key strategic consenting issue.
9. Impacts on physical processes	9.2 Validation of hydrographic models to help predict the effects of changes in water flow and energy removal at commercial scale	Both	Yes, relevant to all projects	Commercial but valuable research could be undertaken around demonstration array projects	Yes	This remains a key strategic consenting issue.
Regulatory						
10. Regulatory processes	10.1 Methods/processes are required to help manage perceived and identified environmental risks that may arise from wave and tidal developments to ensure that project level requirements are proportionate	Both	Yes, relevant to all projects	Demonstration and commercial	N/A	This remains a key strategic consenting issue.



10. Regulatory processes	10.2 Methods/processes are required to predict and measure potential cumulative impacts around clusters of lease areas and other industries	Both	Yes, relevant to all projects	Demonstration and commercial	N/A	This remains a key strategic consenting issue.
10. Regulatory processes	10.3 Agreement is required on the approach to applying a design envelope approach to consenting wave and tidal arrays	Both	Yes, relevant to all projects	Demonstration and commercial	N/A	This remains a key strategic consenting issue.
10. Regulatory processes	10.4 Agreement is required on the approach to developing Project Environmental Monitoring Programmes and incorporating adaptive management strategies ² , for commercial scale wave and tidal arrays	Both	Yes, relevant to all projects	Demonstration and commercial	N/A	This remains a key strategic consenting issue.
10. Regulatory processes	10.5 Further guidance is required as to how best to consider decommissioning in the consenting process.	Both	Yes, relevant to all projects	Demonstration and commercial	N/A	This remains a key strategic consenting issue.

Table 1: List of key strategic consenting issues and risks – wave and tidal current

² Bunnefeld, N., Redpath, S. & Irvine, J. 2015. A review of approaches to adaptive management. Scottish Natural Heritage Commissioned Report No. 795. <https://www.nature.scot/sites/default/files/2017-07/Publication%202015%20-%20SNH%20Commissioned%20Report%20795%20-%20A%20review%20of%20approaches%20to%20adaptive%20management.pdf>



4 Overview of existing research

In order to further investigate the knowledge gaps and consenting risks that have been identified, the next section of this deliverable will summarise the past, ongoing and planned research that is being undertaken to reduce uncertainty around the consenting risks and knowledge gaps identified in Section 3.

4.1 All consenting risks

Project status	Project details
Relevant projects recently completed	<ul style="list-style-type: none"> OES Annex IV (including the Tethys database, webinars, expert forums and State of the Science Report led by the Pacific Northwest National Laboratory) SEACAMS database for sharing and disseminating findings from SEACAMS2 marine energy research programme http://www.seacams.ac.uk/ Marine Energy Wales Welsh Offshore Energy Research Database (WOERD). See http://www.marineenergywales.co.uk/developers/research/mep-research-evaluation/

Table 2: Consenting risks identified

4.2 Collision Risk

The table below lists recently completed and planned research relevant to collision risk (relevant to tidal energy only)

Project status	Project details	Relevant consenting risks
Relevant projects recently completed	<ul style="list-style-type: none"> Deployment of EMEC Integrated Monitoring POD at EMEC's Fall of Warness tidal test site as part of InStream project. 	1.1, 1.4, 1.5
	<ul style="list-style-type: none"> A review of collision risk monitoring undertaken to date is included in the OES Annex IV 2016 State of the Science Report. Available here 	1.1, 1.4
	<ul style="list-style-type: none"> An Individual Based Model (IBM) software system for marine mammals has been developed at Swansea University and is to be released "open source" in 2016-17. It is to be tested against historic data collected at Ramsey Sound. Paper available here and in Proceedings of EWTEC 2017 (http://www.ewtec.org/proceedings/). Model available on request from Thomas Lake t.lake@swansea.ac.uk 	1.1, 1.2, 1.3, 1.4, 5.6
	<ul style="list-style-type: none"> Assessment of strike of adult killer whales by an OpenHydro Tidal Turbine (PNNL), Available here 	1.1, 1.4
	<ul style="list-style-type: none"> Loneragan, ML, Sparling, CE. & McConnell, BJ. (In review). Behavioural changes among harbour seals (<i>Phoca vitulina</i>) around an operational tidal turbine. Submitted to International Journal of Marine Science. 	1.1, 1.4
	<ul style="list-style-type: none"> Macaulay, J., Gordon, J., Coram, A., Northridge, S. (2015) Quantifying porpoise depth distributions and underwater behaviour in tidal rapids areas Sea Mammal Research Unit, University of St Andrews, Report to Scottish Government, no. MR 7.1.1., St Andrews, 12pp. 	1.1
	<ul style="list-style-type: none"> Macaulay, J., Malinka C., Coram, A., Gordon J. & Northridge, S. (2015). The density and behaviour of marine mammals in tidal rapids. Sea Mammal Research Unit, University of St Andrews, Report to Scottish Government, no. MR 7.1.2., St Andrews, 53pp 	1.1



<ul style="list-style-type: none"> Marine Scotland/SNH - Refining Estimates of Collision Risk for Harbour Seals and Tidal Turbines (Band, Sparling, Thompson, Onoufriou, San Martin & West, 2016. Refining Estimates of Collision Risk for Harbour Seals and Tidal Turbines. Scottish Marine and Freshwater Science, Volume 7, Number 17. Available here 	1.1, 1.2, 1.3, 1.4, 5.6
<ul style="list-style-type: none"> MeyGen Knowledge Transfer Partnership (KTP) with University of Aberdeen (February 2015 – January 2017) Dr Beth Scott and Benjamin Williamson KTP Associate 	1.1, 1.4, 1.5
<ul style="list-style-type: none"> Monitoring undertaken around tidal turbines including those deployed at EMEC, ORPC (USA), OpenHydro (Canada), Verdant Power (USA), MeyGen (Inner Sound, Scotland) 	1.1, 1.4
<ul style="list-style-type: none"> MS led project with SNH Contribution: Fine-scale harbour seal at-sea usage mapping around Orkney and the North coast of Scotland Scottish Marine and Freshwater Science Report Vol 7 No 27 Esther L. Jones, Sophie Smout, Clint Blight, Carol Sparling and Bernie McConnell. Available here 	1.1, 1.4
<ul style="list-style-type: none"> Nekton Interaction Monitoring System (NIMS) (ended in 2016) (Dr John Horne, University of Washington). In cooperation with PNNL, develop and test algorithms for real-time detection of biomass properties and individual target trajectories. Available here 	1.1, 1.4, 1.5
<ul style="list-style-type: none"> ORE Catapult Tidal Turbine Collision Detection - A review of the state-of-the-art sensors and imaging systems for detecting mammal collisions. Available here 	1.1, 1.4, 1.5
<ul style="list-style-type: none"> ORJIP Review of Acoustic Deterrent Devices and Marine Mammal Mitigation for Offshore Wind Farms (SMRU Marine and Xodus) Phase 2 (stage 1 and stage 2): Exploring the possibility of using ADDs as a 'replacement' for MMO/PAM mitigation. Although the focus of the work has been on offshore wind, some of the principles may apply to ocean energy 	1.1, 1.4, 1.5
<ul style="list-style-type: none"> Passive acoustic methods for fine-scale tracking of harbour porpoises in tidal rapids (MacAulay, J. D. J., Gordon, J. C. D., Gillespie, D. M., Malinka, C. E. & Northridge, S. P. Feb 2017 In : Journal of the Acoustical Society of America. 141, 2, p. 1120-1132) 	1.1, 1.4, 1.5
<ul style="list-style-type: none"> PNNL harbour porpoise study on consequence of collision with MCT (Wood, J.; Joy, R.; Sparling, C. (2016). Harbour Seal - Tidal Turbine Collision Risk Models. An Assessment of Sensitivities.) Report by SMRU Consulting. pp 57. 	1.1, 1.4
<ul style="list-style-type: none"> SMRU work investigating the physical consequences of potential blade strikes on marine mammals (Loneragan, M. & Thompson, D. (2015) Collision risk and impact Study: Examination of models for estimating the risk of collisions between seals and tidal turbines. Sea Mammal Research Unit, University of St Andrews, Report to Scottish Government, no. MR 7.2.2, St Andrews, 15pp) 	1.1, 1.4
<ul style="list-style-type: none"> SMRU/NERC/MREKE funded project to develop self-contained buoy tracking system (report due soon) 	1.1, 1.4, 1.5
<ul style="list-style-type: none"> SNH has published guidance on Collision Risk Assessment of Marine Wildlife with Tidal Turbines. This is a review of the three approaches most commonly used to date for underwater collision risk assessment (Band CRM, SRSL Encounter Rate Modelling (ERM) and RPS Exposure Time Modelling for Birds (ETM). Scottish Natural Heritage (2016) 'Assessing collision risk between underwater turbines and marine wildlife'. SNH guidance note. Available here 	1.1, 1.2, 1.3, 1.4, 5.6
<ul style="list-style-type: none"> Study by SAMS assessing the usage of tidal streams by harbour porpoise. Riding the Tide: Use of a moving tidal stream habitat by harbour porpoises (Benjamins, S., 2016). 	1.1, 1.4



	<ul style="list-style-type: none"> University of Washington's Intelligent Adaptable Monitoring Package (Iamp), January 2015 to June 2017 (Dr Brian Polagye). Development and field deployment of cabled and autonomous integrated monitoring packages for marine renewable energy. 	1.1, 1.4, 1.5
	<ul style="list-style-type: none"> Williamson, B.; Fraser, S.; Blondel, P.; Bell, P.; Waggitt, J.; Scott, B. (2017). Multisensor Acoustic Tracking of Fish and Seabird Behavior around Tidal Turbine Structures in Scotland. IEEE Journal of Oceanic Engineering, In Press (99), 1-18. 	1.1, 1.4, 1.5
	<ul style="list-style-type: none"> Advanced Laboratory and Field Arrays Lab Collaboration Projects (ALFA-LCP), Task 10.4, 11/18 – 12/21, John Horne (jhorne@uw.edu) – no dedicated website or reports. Project recently underway and in initial phases. 	1.1, 1.2, 1.3, 1.4, 5.6
	<ul style="list-style-type: none"> Advanced Telemetry and Bio-logging for Investigating Grey Seal Interactions with Marine Renewable Energy Installations, January 2016 to January 2019 (PhD – University of Swansea KESS programme/NRW). Supervised by Dr Tom Stringell (NRW) and Dr James Bull, Dr Luca Borger and Prof Rory Wilson (University of Swansea). This project will use cutting-edge telemetry and bio-logging devices to quantify and understand interactions between grey seals and potential MRE installations. 	1.1, 1.4
Relevant projects currently planned or underway	<ul style="list-style-type: none"> Investigating cetacean response to an operating power kite. SEACAMS2 project SC2-RD-B11. Data collection summer 2019. Project end: Jul 2020. In collaboration with Minesto. http://www.seacams.ac.uk/seacams2/. 	1.1, 1.4
	<ul style="list-style-type: none"> Investigating spatio-temporal distribution and tidal occupancy of harbour porpoise (<i>Phocoena phocoena</i>) in the west Anglesey tidal stream demonstration zone. Project start- May 2017, end- Jul 2019. In collaboration with Menter Mon. http://www.seacams.ac.uk/seacams2/. 	1.1, 1.4
	<ul style="list-style-type: none"> Marine Scotland/ SNH: Scottish Government Demonstration Strategy Phase 2 - Trialling methods for tracking the fine-scale underwater movements of marine mammals. This is the package of in-situ monitoring equipment being deployed around the MeyGen turbines in Inner Sound, via Scottish Government's demonstration strategy (and complementing MeyGen's own in-situ monitoring suite, delivered by Aberdeen University). Phase 1 report available here 	1.1, 1.4, 1.5
	<ul style="list-style-type: none"> Monitoring at MeyGen - Scottish Government Demonstration Strategy – Phase 2 Monitoring around the first devices deployed at MeyGen and MeyGen KTP with University of Aberdeen. 	1.1, 1.4
	<ul style="list-style-type: none"> SEACAMS2 Assessing the impact of the experimental DeltaStream tidal energy unit in Ramsey Sound (Pembrokeshire) on grey seals movements and energy expenditure. Seals will be tagged to monitor and reproduce 3D movements, behaviour and energy expenditure, using novel high-tech GPS-enabled 'Daily Diary' bio-logging devices developed by Swansea University. 	1.1, 1.4
	<ul style="list-style-type: none"> SEACAMS2 project SC2-RD-B36 - Behaviour of fish schools during operation of a tidal energy converter kite in the Holyhead Deep. http://www.seacams.ac.uk/seacams2/ , project started September 2018 – July 2019, 	1.1, 1.2, 1.3, 1.4, 2.2, 4.1
	<ul style="list-style-type: none"> SMRU Consulting (funded by OESEA) study on harbour porpoise PAM data gathered by TEL within Ramsey Sound. 	1.1, 1.4, 1.5
	<ul style="list-style-type: none"> SEACAMS2 Project studying harbour porpoise surface behaviour in tidal currents. Project start- July 2018, end- Jul 2019. In collaboration with Menter Mon. http://www.seacams.ac.uk/seacams2/. 	1.1, 1.4



	<ul style="list-style-type: none"> Third-generation Adaptable Monitoring Package – January 2017 – December 2019. EWTEC paper submitted. Contact: Brian Polagye, University of Washington bpolagye@uw.edu. Publication and thesis forthcoming in 2019. 	1.1, 1.4, 1.5
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Table 3: Completed and planned research in relation to collision risk

4.3 Underwater noise

The table below lists recently completed and planned research relevant to underwater noise

Project status	Project details	Relevant consenting risks
Relevant projects recently completed	<ul style="list-style-type: none"> EMEC project which looked at monitoring of noise across the different projects at their sites and what was learnt/what worked well (Presented at EWTEC 2015) 	2.1, 2.2
	<ul style="list-style-type: none"> EMEC’s regulator’s guide to underwater noise funded by NERC Available here 	
	<ul style="list-style-type: none"> Loughborough/EMEC Knowledge Transfer Partnership. 	
	<ul style="list-style-type: none"> SAMS/Loughborough project to investigate the effects of flow speed on noise propagation – DECC funded 	2.1, 2.2
Relevant projects currently planned or underway	<ul style="list-style-type: none"> TCE and MS guidance on underwater noise. Available here 	2.1, 2.2
	<ul style="list-style-type: none"> Acoustic measurements of wave energy converters operating at the US Navy’s Wave Energy Test Site, Ongoing – Indefinite end date, Brian Polagye (bpolagye@uw.edu) – acoustic characterization of Fred. Olsen Lifesaver published in 2017 EWTEC proceedings, internal progress reports to University of Hawaii. Received levels are relatively low amplitude and difficult to differentiate from ambient noise at distances > 100 m. 	2.1, 2.2
	<ul style="list-style-type: none"> Acoustic Monitoring of Wave Energy Converters (Dr Brian Polagye University of Washington). Ongoing acoustic monitoring and methods development for wave energy converters at the US Navy Wave Energy Test Site (Hawaii, US) in conjunction with University of Hawaii and Sea Engineering. Deployment of bottom mounted, mid-water, and drifting instrumentation packages. 	2.1, 2.2
	<ul style="list-style-type: none"> Approval of international consensus standard (IEC TC114 62600-40) for acoustic measurements of wave, current, and ocean thermal energy conversion systems. Publication by IEC expected by June 2019, Brian Polagye (bpolagye@uw.edu) – Convener. 	2.1, 2.2
	<ul style="list-style-type: none"> INVESTIGATING CETACEAN RESPONSE TO AN OPERATING POWER KITE. SEACAMS2 project SC2-RD-B11. Data collection summer 2019. Project end: Jul 2020. Gemma Veneruso, Bangor University g.veneruso@bangor.ac.uk. In collaboration with Minesto. http://www.seacams.ac.uk/seacams2/. 	2.1, 2.2
	<ul style="list-style-type: none"> Observations of sound from Northwest Energy Innovations (NWEI) Azura and Fred Olsen Lifesaver at the US Navy Wave Energy Test Site in Hawaii (January 2015 – ongoing) and will include additional WECs). EWTEC paper submitted. Conference presentation in June 2017 at ASA. Brian Polagye 	2.1, 2.2
	<ul style="list-style-type: none"> Device acoustic characterisation at EMEC’s test sites under the H2020 FloTEC, Ocean_2G and InToTidal. 	
	<ul style="list-style-type: none"> SEA Wave, www.seawave-emff.eu, Dr Matthew Witt / Dr Anthony Bicknell (University of Exeter) 	2.1, 2.2



This project has been co-funded by the European Maritime and Fisheries Fund (EMFF) of the European Union



	<ul style="list-style-type: none"> ○ Ambient soundscape and fisheries biomass assessments using passive and active acoustic around single and multi-device site ○ Effects of single and multi-device site on soundscape or time ● Influence of device(s) on amount and/or distribution of fish biomass 	
	<ul style="list-style-type: none"> ● SEACAMS2 project SC2-RD-B36 - Behaviour of fish schools during operation of a tidal energy converter kite in the Holyhead Deep. http://www.seacams.ac.uk/seacams2/ , project started September 2018 – July 2019, Dr Timothy Whitton, Bangor University, t.whitton@bangor.ac.uk 	1.1, 1.2, 1.3, 1.4, 2.2, 4.1

Table 4: Completed and planned research in relation to underwater noise



4.4 Displacement

The table below lists recently completed and planned research relevant to displacement

Project status	Project details	Relevant consenting risks
Relevant projects recently completed	<ul style="list-style-type: none"> EMEC Wildlife Data Analysis Project (Long, C. 2017. Analysis of the possible displacement of bird and marine mammal species related to the installation and operation of marine energy conversion systems. Scottish Natural Heritage Commissioned Report No. 947.) 	4.1
	<ul style="list-style-type: none"> Joint SNCB Interim Displacement Advice Note. Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments (January 2017). Though focused on offshore windfarms, many of the principles will be equally applicable to wave and tide. Available here 	4.1
	<ul style="list-style-type: none"> Marine Scotland – Sensitivity of metrics derived from Population Viability Analysis (PVA) Cook, A.S.C.P. & Robinson, R.A. 2016. Testing sensitivity of metrics of seabird population response to offshore wind farm effects. JNCC Report No. 553. JNCC, Peterborough. 	4.1
	<ul style="list-style-type: none"> Marine Scotland. A Protocol for Implementing the Interim Population Consequences of Disturbance (PCoD) approach: Quantifying and Assessing the Effects of UK Offshore Renewable Energy Developments on Marine Mammal Populations. Harwood, J., King, S., Schick, R., Donovan, C. & Booth, C. (2014) A Protocol for Implementing the Interim Population Consequences of Disturbance Model (PCOD) Approach: Quantifying and Assessing the Effects of UK Offshore Renewable Energy Developments on Marine Mammal Populations. Report No SMRUL-TCE-2013-014. Scottish Marine and Freshwater Science, 5(2). 	4.1
Relevant projects currently planned or underway	<ul style="list-style-type: none"> Investigating cetacean response to an operating power kite. SEACAMS2 project SC2-RD-B11. Data collection summer 2019. Project end: Jul 2020. Gemma Veneruso, Bangor University g.veneruso@bangor.ac.uk. In collaboration with Minesto. http://www.seacams.ac.uk/seacams2/. 	1.1, 1.2, 1.3, 1.4, 2.2, 4.1
	<ul style="list-style-type: none"> Project proposed by NRW to the Defra Impacts Evidence Group in March 2019 for funding. Awaiting outcome. "Improving understanding of the potential effects and consequences of displacement of marine mammals by wave and tidal stream arrays and development of a suitable assessment framework" 	4.1
	<ul style="list-style-type: none"> SMRU Consulting PCOD+ project (2016-2019). One of the five key tasks is to explore how marine mammal monitoring programmes can be tailored to assessing the population level effects of disturbance and critically, identify how early warning signals can be detected. This study will identify which potential type of data could be collected using existing and novel technologies and are most suitable for inclusion in a monitoring programme. Available here 	4.1
	<ul style="list-style-type: none"> Underway - SEACAMS2 project SC2-RD-B36 - Behaviour of fish schools during operation of a tidal energy converter kite in the Holyhead Deep. http://www.seacams.ac.uk/seacams2/ , project started September 2018 – July 2019, Dr Timothy Whitton, Bangor University, t.whitton@bangor.ac.uk 	1.1, 1.2, 1.3, 1.4, 2.2, 4.1

Table 5: Completed and planned research in relation to displacement



4.5 General

The table below lists recently completed and planned research relevant to general consenting risks.

Project status	Project details	Relevant consenting risks
Relevant projects recently completed	<ul style="list-style-type: none"> A displacement model for foraging seabirds has been developed for offshore wind farms. A similar model could be developed for W&T projects – Marine Scotland, 2016. Available here 	5.6
	<ul style="list-style-type: none"> Acceptable thresholds of change: how much is too much? A review of population assessment on marine mammals. SMRU Consulting report for NRW. Due to complete July 2017. Lead contact Tom Stringell tom.stringell@naturalresourceswales.gov.uk 	5.6
	<ul style="list-style-type: none"> An Individual Based Model (IBM) software system for marine mammals has been developed at Swansea University and is to be released “open source” in 2016-17. It is to be tested against historic data collected at Ramsey Sound. Paper available at Available here and in Proceedings of EWTEC 2017 (http://www.ewtec.org/proceedings/). Model available on request from Thomas Lake t.lake@swansea.ac.uk 	1.1, 1.2, 1.3, 1.4, 5.6
	<ul style="list-style-type: none"> Critical knowledge gaps: estimating potential maximum cumulative anthropogenic mortality limits of key marine mammal species to inform management (Mackay, A., 2016). This research was carried out in Australia, but lessons learnt may be relevant in a UK and European context. Available here 	5.6
	<ul style="list-style-type: none"> EcoWATT 2050 EPSRC (2014-2017) Impacts of Very Large Scale Arrays and their Regulation. EcoWatt2050 seeks to provide the underpinning science for the strategic policy development and planning being undertaken by the regulatory authorities for marine renewable energy. 	5.6
	<ul style="list-style-type: none"> Marine Scotland Fine-scale harbour seal at-sea usage mapping around Orkney and the North coast of Scotland (Scottish Marine and Freshwater Science Report Vol 7 No 27 Esther L. Jones, Sophie Smout, Clint Blight, Carol Sparling and Bernie McConnell. Available here) 	5.6
	<ul style="list-style-type: none"> Marine Scotland. A Protocol for Implementing the Interim Population Consequences of Disturbance (PCoD) approach: Quantifying and Assessing the Effects of UK Offshore Renewable Energy Developments on Marine Mammal Populations. Harwood, J., King, S., Schick, R., Donovan, C. & Booth, C. (2014) A Protocol for Implementing the Interim Population Consequences of Disturbance Model (PCOD) Approach: Quantifying and Assessing the Effects of UK Offshore Renewable Energy Developments on Marine Mammal Populations. Report No SMRUL-TCE-2013-014. Scottish Marine and Freshwater Science, 5(2). 	5.6
	<ul style="list-style-type: none"> Marine Scotland/SNH have completed the project Refining Estimates of Collision Risk for Harbour Seals and Tidal Turbines (Band, Sparling, Thompson, Onoufriou, San Martin & West, 2016. Refining Estimates of Collision Risk for Harbour Seals and Tidal Turbines. Scottish Marine and Freshwater Science, Volume 7, Number 17. Available here) 	1.1, 1.2, 1.3, 1.4, 5.6
	<ul style="list-style-type: none"> NRW Guidance to inform marine mammal site characterisation requirements at wave and tidal stream energy sites in Wales (Sparling C, Smith K, Benjamins S, Wilson B, Gordon J, Stringell T, Morris C, Hastie G, Thompson D & Pomeroy P 2015: Guidance to inform marine mammal site characterisation requirements at wave and tidal stream energy sites in Wales NRW Evidence Report Series Report No: 82, 87pp, Natural Resources Wales, Bangor. NRW commissioned report carried out by SMRU Consulting. This project developed a framework for assessing risk to marine mammals from wave and tidal stream developments and provides 	5.4



	<p>guidance on how to tailor surveys to provide better information for impact assessments. Marine Scotland's Survey, Deploy & Monitor Policy was reviewed and version 2 was published in April 2016. Available here</p>	
	<ul style="list-style-type: none"> NRW managed project with APEM through the Defra Impact Group: Review of methodologies to assess loss of early life stages of fish from entrapment in MPAs. Due for publication in April 2019. This project will also make recommendations for survey requirements and post validation studies for each of the methodologies. While the main driver for the project is entrapment losses from cooling water intakes, it may be of relevance to marine renewable energy. When published, APEM are looking at setting up a webinar to present findings to industry and regulators. 	5.6, 5.4, 10.1, 10.4
	<ul style="list-style-type: none"> RICORE Project has now been completed. (Work package 4 – Pre-consent survey optimisation). This work package is concerned with: Identification of current requirements; identification of commonalities; survey guidance; cost reduction opportunities; and socio-economic engagement. The results can be found here 	5.4
	<ul style="list-style-type: none"> Scientific advice on matters related to the management of seal populations – briefing paper to Special Committee on Seals (SMRU, 2016). Available here 	5.6
	<ul style="list-style-type: none"> SNH has published guidance on Collision Risk Assessment of Marine Wildlife with Tidal Turbines. This is a review of the three approaches most commonly used to date for underwater collision risk assessment (Band CRM, SRSL Encounter Rate Modelling (ERM) and RPS Exposure Time Modelling for Birds (ETM). Scottish Natural Heritage (2016) 'Assessing collision risk between underwater turbines and marine wildlife'. SNH guidance note. Available here 	1.1, 1.2, 1.3, 1.4, 5.6
	<ul style="list-style-type: none"> JNCC study; Guide to population models used in marine mammal impact assessment. Available here 	5.6
	<ul style="list-style-type: none"> A survey and monitoring framework for marine birds at tidal lagoon energy projects in Wales. NRW commissioned report, carried out by WWT Consulting. To be completed by April 2016. Project management: NRW (Patrick Lindley, Marine Ornithologist). The aim of this project is to produce a framework to enable a consistent approach to the gathering of data to inform consenting and monitoring for tidal lagoon developments. The framework will aid development of NRW's advice on future environmental assessments for proposed tidal energy projects in Wales. Although the focus of the work is tidal lagoon projects, some of the principles are likely to also be relevant for wave and tidal current projects. 	5.4
	<ul style="list-style-type: none"> Advanced Laboratory and Field Arrays Lab Collaboration Projects (ALFA-LCP), Task 10.4, 11/18 – 12/21, John Horne (jhorne@uw.edu) – no dedicated website or reports. Project recently underway and in initial phases 	1.1, 1.2, 1.3, 1.4, 5.6
	<ul style="list-style-type: none"> Sheehan EV, Cartwright AY, Witt MJ, Attrill MJ, Vural M, Holmes LA (2018). Development of epibenthic assemblages on artificial habitat associated with marine renewable infrastructure. ICES Journal of Marine Science, fsy151. Available here 	
	<ul style="list-style-type: none"> Wilding TA, Gill AB, Boon A, Sheehan EV, Dauvin JC, Pezy JP, O'Beirn F, Janas U, Rostin L, De Mesel I (2017). Turning off the DRIP ('Data-rich, information-poor')—rationalising monitoring with a focus on marine renewable energy developments and the benthos. Renewable and Sustainable Energy Reviews 74: 848-859. Available here 	
Relevant projects currently	<ul style="list-style-type: none"> CEFOW, http://www.emec.org.uk/about-us/wave-clients/wello-oy/cefow-clean-energy-from-ocean-waves/ 2016-2020, Dr Matthew Witt (University of Exeter) & Dr Emma Sheehan (University of Plymouth) 	5.4



planned or underway	<ul style="list-style-type: none"> Guide to Population Models used in Marine Mammal Impact Assessment. Available here 	5.6
	<ul style="list-style-type: none"> JNCC leading work to look into producing guidance for marine mammal management units. Lead contact Sonia Mendes JNCC Sonia.Mendes@jncc.gov.uk 	5.5
	<ul style="list-style-type: none"> Joint NRW project with NE on development of sonar camera for surveying <i>Sabellaria</i> reef in the Severn Estuary - developing non-invasive tools for accurate detection of biogenic reefs in low visibility highly dynamic environments. Lead contact Maria Alvarez, Natural England maria.alvarez@naturalengland.org.uk 	5.4
	<ul style="list-style-type: none"> MacArthur Green, Glasgow - Tracking guillemots and razorbills. Initial deployment of the tags is planned for the summer of 2017 with recoveries carried out a year later. This should mean maps of migration routes from different colonies would be available in late 2018. 	5.5
	<ul style="list-style-type: none"> Marine mammal survey work off North Anglesey: Bangor University undertaking double platform boat-based transect surveys of combined Morlais and Minesto project area to assess methods for calculating absolute density and provide estimates for use in EIA. 	5.4
	<ul style="list-style-type: none"> Marine Scotland/SNH - Development of a Power Analysis Tool. The aim of this study is to design a software package that can be used by non-specialists to aid design of monitoring studies that have sufficient power for use in assessing impacts. 	5.4
	<ul style="list-style-type: none"> NERC-funded VertlBase (April 2016 – March 2018) - Supporting evidence-based decision-making on marine vertebrate interactions with wave and tidal energy technologies. Lead Research Organisation: Cranfield University 	5.4
	<ul style="list-style-type: none"> NRW are developing a position statement on the use of Marine Mammal Management Units (MMMU) in Welsh waters. We consider the appropriate scale for assessing marine mammal connectivity to be the MMMU. This is due for publication in summer 2019. 	5.5
	<ul style="list-style-type: none"> Marine Scotland/ SNH: Scottish Government Demonstration Strategy Phase 2 - Monitoring around the first devices deployed at MeyGen. Phase 1 now complete: Trialling methods for tracking the fine-scale underwater movements of marine mammals. This is the package of in-situ monitoring equipment deployed around the MeyGen turbines in Inner Sound, Phase 1 report. Available here 	1.1, 1.2, 1.3, 1.4, 5.6
	<ul style="list-style-type: none"> POP Individuals to Populations: The potential effects of large tidal arrays on mobile marine populations. This research will be at the forefront of detailed individual-to-population modelling and add accurate functional response relationships between changes in energy/time use in individuals so as to be able to assess the relative risks of significant changes at population levels due to the addition of large scale renewable developments. 	5.6
	<ul style="list-style-type: none"> SEACAMS2 Review of current data requirements for assessing risks from a MRE development to marine mammals in Wales. The study will explore the consenting process for previous projects (where available) to assess to what extent baseline data collection requirements have been met and whether using existing datasets could fulfil the current regulatory requirements. 	5.4
	<ul style="list-style-type: none"> SEAWave, http://www.emec.org.uk/research/international-projects/sea-wave-strategic-environmental-assessment-of-wave-energy-technologies/, 11/2018-11/2021, Dr Matthew Witt (University of Exeter) & Dr Emma Sheehan (University of Plymouth) <ul style="list-style-type: none"> Overlapping projects using multi-method ecological site characterisation for assessment of single and multi-device effects Method, power and device impact assessments 	5.4
<ul style="list-style-type: none"> SMRU Consulting and the University of St Andrews - Improving understanding of bottlenose dolphin movements along the east coast of Scotland (2017 – 2019). 	5.5	



	<ul style="list-style-type: none"> SMRU Consulting PCOD+ project (2016-2019). One of the five key tasks is to explore how marine mammal monitoring programmes can be tailored to assessing the population level effects of disturbance and critically, identify how early warning signals can be detected. This study will identify which potential type of data could be collected using existing and novel technologies and are most suitable for inclusion in a monitoring programme. Available here 	5.6
	<ul style="list-style-type: none"> The River Dee Trust, Aberdeenshire, and Marine Scotland Science - Salmon and sea trout tracking array. The aim is to determine the migration routes of salmon and sea trout by tracking the movement of these fish from the rivers Dee, Don and Ythan for Vattenfall's European Offshore Wind Deployment Centre (EOWDC). Tagging will commence in 2018. 	5.5

Table 6: completed and planned research in relation to consenting risks

4.6 Shipping and Navigation

The table below lists recently completed and planned research relevant to shipping and navigation

Project status	Project details	Relevant consenting risks
Relevant projects recently completed	<ul style="list-style-type: none"> NOREL Guidance on Under Keel Clearance 	7.1
	<ul style="list-style-type: none"> Strategic Area Navigation Appraisal (SANAP) for the Pentland Firth and Orkney Waters Strategic Area (Anatec) 	7.1

Table 7: Completed and planned research in relation to shipping and navigation

4.7 Socio-economics

The table below lists recently completed and planned research relevant to socio-economics

Project status	Project details	Relevant consenting risks
Relevant projects recently completed	<ul style="list-style-type: none"> Human Dimensions of Tidal Energy. A case study comparison of attitudes towards current energy development in urban (Washington, US) and rural (Alaska, US) communities. Dreyer, S.; Polis, H.; Jenkins, L. (2017). Changing Tides: Acceptability, Support, and Perceptions of Tidal Energy in the United States. Energy Research & Social Science, 29, 72-83. 	8.1
	<ul style="list-style-type: none"> Marine Energy Pembrokeshire (2015) Marine Energy in Wales Investment, Jobs, Supply Chain. Available here 	8.1
	<ul style="list-style-type: none"> Marine Scotland and Sciencewise-ERC - Community engagement: assessing the social impacts of marine renewables. A two-way conversation with the people of Scotland on the Social Impact of offshore renewables. Presentation available here. 	8.1
	<ul style="list-style-type: none"> Development of guidance for undertaking economic impact assessment – Marine Scotland 	
	<ul style="list-style-type: none"> MS Community benefits report –Local Energy Scotland – Scottish Government Good Practice Principles for Community Benefits from Offshore Renewable Energy Developments. Available here 	8.1
	<ul style="list-style-type: none"> New Economics Foundation (2017) A socio-economics benefits assessment of the Celtic Seas Partnership. Available here 	8.1



	<ul style="list-style-type: none"> Research priorities for assessing potential impacts of emerging marine renewable energy technologies: Insights from developments in Wales (UK) (R.C. Roche, et al., Research priorities for assessing potential impacts of emerging marine renewable energy technologies: Insights from developments in Wales (UK), Renewable Energy (2016), Available here 	8.1
	<ul style="list-style-type: none"> The Crown Estate (2012) A Socio-economic Methodology and Baseline for Pentland Firth and Orkney Waters Wave and Tidal Developments. Available here 	8.1
Relevant projects currently planned or underway	<ul style="list-style-type: none"> Oxford Brookes University – (June 2017 – October 2019) - The socio-economic impact of offshore wind on the human environment. The project will analyse the socio-economic effects of Vattenfall's EOWDC from the construction stage through to becoming fully operational to help better understand how offshore wind developments can be maximised to benefit the region and local communities. Although the focus of the work is on offshore wind, some of the principles might apply to ocean energy. 	8.1

Table 8: Completed and planned research in relation to socio-economics

4.8 Regulatory

The table below lists recently completed and planned research relevant to regulatory consenting risks and issues

Project status	Project details	Relevant consenting risks
Relevant projects recently completed	<ul style="list-style-type: none"> Adaptive Management Plans for MCT (Strangford Lough), Anglesey Skerries and Swansea Bay Tidal Lagoon 	10.4
	<ul style="list-style-type: none"> All marine licences which have required a PEMP as a consent condition (see marine licence info available here) 	10.4
	<ul style="list-style-type: none"> Assessing Environmental Effects (WREN) Adaptive Management White Paper (Hanna, L., 2016) 	10.4
	<ul style="list-style-type: none"> Defining project envelopes for marine energy projects: Review and Tidal energy test facility and marine mammal case study. Available here. NRW and SMRU, February 2019. Contacts Kate Smith (now Nova Innovation), Kat Route-Stephens (NRW) and Carol Sparling (SMRU) 	10.3, 10.5
	<ul style="list-style-type: none"> The Crown Estate Development Zone workshops. Available here 	
	<ul style="list-style-type: none"> EMEC Fall of Warness Environmental Appraisal – Guidance on PEMP Development 	10.4
	<ul style="list-style-type: none"> Findings of UK Demo Zone workshop held in Cardiff in July 2015 by The Crown Estate, Scottish Natural Heritage, Natural Resources Wales, Natural England and Welsh Government. 	10.3, 10.5
	<ul style="list-style-type: none"> Horizon 2020 RiCORE Work package 3 – Survey, Deploy and Monitor. This work package concerns the feasibility of a rollout of the Survey Deploy and Monitor approach to consenting across the EU as well as other forms of risk-based and adaptive management. See http://ricore-project.eu 	10.1
	<ul style="list-style-type: none"> MeyGen Knowledge Transfer Partnership (KTP) with University of Aberdeen (February 2015 – January 2017) Dr Beth Scott and Benjamin Williamson KTP Associate 	
	<ul style="list-style-type: none"> NRW advice to Welsh Government on marine plan opportunities to guide the sustainable use of Welsh sea: tidal stream energy case study. Report was shared in Q3 2017, details possible mechanisms for delivering a more proportionate, risk-based approach to consenting. 	10.1
<ul style="list-style-type: none"> NRW Guidance to inform marine mammal site characterisation requirements at wave and tidal stream energy sites in Wales (July 2015). Available here. NRW commissioned report carried out 	10.1	



	<p>by SMRU Consulting. This project developed a framework for assessing risk to marine mammals from wave and tidal stream developments and provides guidance on how to tailor surveys to provide better information for impact assessments.</p>	
	<ul style="list-style-type: none"> NRW managed project with APEM through the Defra Impact Group: Review of methodologies to assess loss of early life stages of fish from entrapment in MPAs. Due for publication in April 2019. This project will also make recommendations for survey requirements and post validation studies for each of the methodologies. While the main driver for the project is entrapment losses from cooling water intakes, it may be of relevance to marine renewable energy. When published, APEM are looking at setting up a webinar to present findings to industry and regulators. 	5.6, 5.4, 10.1, 10.4
	<ul style="list-style-type: none"> NSIPs process – development of Evidence Plans 	
	<ul style="list-style-type: none"> OpenHydro Snohomish PUD Adaptive Management Plan 	
	<ul style="list-style-type: none"> Project by NRW3 - Developing principles and approaches to defining Project Design Envelopes for marine projects, using marine mammals and the Morlais north Anglesey tidal energy demonstration zone as a case study. This project will use marine mammals and the West Anglesey Demonstration Zone as a case study to explore the environmental issues, challenges and opportunities associated with defining flexible project design envelopes for multi-technology marine energy test sites and demonstration zones, with a view to further developing the good practice approaches and principles identified at the UK demo zone workshop held in Cardiff in July 2015. Due to finish by the end of the financial year 2016/2017. Results will be presented in two reports; one principles document for open dissemination and another with more detailed info on Morlais and proposed activities (used to identify the principles). This will be shared once Morlais consent application is in the public domain. 	10.3, 10.5
	<ul style="list-style-type: none"> Scottish Government – Review of the potential impacts of wave and tidal energy developments on Scotland’s marine ecological environment 	10.1
	<ul style="list-style-type: none"> TEL DeltaStream CMAMP and supporting work. 	10.4
	<ul style="list-style-type: none"> Towards an integrated approach to marine benthic monitoring (Frojan, C., 2016). 	10.4
	<ul style="list-style-type: none"> NERC-funded VertlBase (April 2016 – March 2018) - Supporting evidence-based decision-making on marine vertebrate interactions with wave and tidal energy technologies. Lead Research Organisation: Cranfield University. 	10.1
	<ul style="list-style-type: none"> SOWFIA Project: The overall goal of the SOWFIA project is to provide recommendations for European-wide streamlining of IA and approval processes, thereby helping to remove legal, environmental and socio-economic barriers to the development of offshore power generation from waves. Available here 	
Relevant projects currently planned or underway	<ul style="list-style-type: none"> SEA Wave WP 5. This work package has been developed to provide strategic guidance and recommendations based on critical analysis and best practice advice. This WP will provide recommendations on how key impact pathways and potential effects should be considered when undertaking EIAs and Habitat Risk Assessments for various types and scales of wave developments. 	
	<ul style="list-style-type: none"> WESE Project (http://wese-project.eu/) aims to overcome non-technological barriers of wave energy. These non-technological barriers include uncertainty around potential environmental impacts and the associated consenting challenges. 	

³ Supported by Project Steering Group composed of Morlais, SEACAMS, NRW Operations, NRW Licensing



Table 9: Completed and planned research in relation to regulatory consenting risks and issues

5 Conclusions and Next Steps

A number of high priority consenting issues and risks have been identified through wide-ranging consultation with the SEA Wave partners, the SEA Wave Steering Group and the ORJIP Ocean Energy Network. This work built on previous efforts during which a broad consensus was reached between industry, regulators, stakeholders and the wider research community. All of these high priority consenting risks and issues presented in Section 3 will require further research through future strategic and project level monitoring and research to reduce uncertainty

The SEA Wave project will actively work to ensure progress in these high priority research areas through the following tasks:

- Wide distribution of this deliverable through the Communication and Dissemination Plan of SEA Wave. This will include dissemination throughout the ORJIP Network.
- Active input from this deliverable to the four Environmental Monitoring Strategies (EMSs) that will be completed as part of work package 2
- Active engagement with SEA Wave partners in the development of the EMSs to ensure uptake of the priorities as set out in this document
- Active engagement with network of researchers who have been identified in this deliverable as undertaking research in order to validate the EMSs before implementation

At this time, SEA Wave would like to actively encourage stakeholders to express their interest in any of the high priority strategic research projects identified. Any updates regarding recently completed, ongoing or planned research relevant to these research topics would be most welcome by the team at any time. Please use the contact details provided below.



This project has been co-funded by the European Maritime and Fisheries Fund (EMFF) of the European Union



Appendix A: ORJIP Ocean Energy & SEA Wave: Call for Evidence 4 – March 2019



This project has been co-funded by the European Maritime and Fisheries Fund (EMFF) of the European Union. The contents of this document reflect only the (author's view. EASME is not responsible for any use that may be made of the information it contains.





Introduction

The third ORJIP Ocean Energy Forward Look was issued in November 2017 (see: [Forward Look](#)). This included a prioritised list of strategic research projects to address key EIA/HRA issues and set out the purpose, required timing and broad scope of the research projects necessary to meet ORJIP Ocean Energy’s overall aim.

The Forward Look is currently being updated and will be re-issued in April 2019 as part of ORJIP Ocean Energy’s work with the SEA Wave Project to address long term environmental concerns around the development of the marine renewable industry’s emerging technology. To inform this process and to ensure that the most up-to-date information is included for each of the priority research projects, ORJIP Ocean Energy participants are kindly requested to input into this process by completing this form.

For each of the high priority research projects please provide the following information in the table below:

- Details of any updates regarding work recently completed, currently underway or confirmed that meet the objectives of the high priority strategic research project(s) as set out in the Forward Look; and
- Suggestions for any additional potential research projects (candidate projects) that would help to meet the objectives of the high priority strategic research project(s) as set out in the Forward Look.

Topic	High priority strategic research project
A. Collision risk	A.1 Near-field monitoring of marine mammals around operational tidal turbines and first arrays to inform collision risk assessment
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • <i>etc.</i> • <i>etc.</i>
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • <i>etc.</i> • <i>etc.</i>
	A.2 Further research to help understand the possible likelihood, probability and consequence of collision with tidal turbines for marine mammals
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • <i>etc.</i> • <i>etc.</i>
Suggestions for potential research	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i>



projects (candidate projects)	<ul style="list-style-type: none"> • etc.
	A.3 Further development of instrumentation and methodologies for detecting potential collision events around tidal turbines and arrays
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
	A.4 Further development of collision risk models for marine mammals, fish and birds to inform EIA/HRA
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
B. Underwater noise	B.1 Establishment of an acoustic ‘evidence base’ for operational devices and arrays
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
	B.2 Development of noise propagation models to further reduce uncertainty regarding the potential impacts of commercial scale arrays
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
	B.3 Gather acoustic data around single operational machines
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i>



projects (candidate projects)	<ul style="list-style-type: none"> • etc.
C. Displacement	C.1 Development of an agreed approach to assessing the potential effects and consequences of displacement from wave and tidal arrays
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
D. Socio-economics	D.1 Further studies and research to understand the potential social and economic opportunities and impacts from the development of marine energy projects in rural communities
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
E. General	E.1 Monitoring around operational tidal turbines and first arrays to gather information on the behaviour of diving birds, marine mammals, basking shark and migratory fish around operating tidal turbines
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
	E.2 Development of mitigation measures for identified and potential impacts of wave and tidal developments
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • etc.
	E.3 Further development of instrumentation and methodologies for monitoring wildlife behaviour around tidal turbines and arrays
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • etc.



	<ul style="list-style-type: none"> • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	E.4 Further research to improve understanding of the potential population level effects of protected mobile species from commercial scale wave and tidal current projects
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	E.5 Review and dissemination of findings of environmental monitoring studies
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	E.6 Establish appropriate and proportionate objectives and methodologies for site characterisation surveys to inform EIA/HRA
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
F. Regulatory issues	F.1 Review of PBR approach to regulation including consideration of alternatives
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	F.2 Development of methods/processes for identifying and managing environmental risks associated with wave and tidal energy developments within the consenting process
Research projects recently completed,	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)



currently underway or confirmed	<ul style="list-style-type: none"> • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	F.3 Development and agreement of methods/processes for implementing a design envelope approach to consenting wave and tidal arrays.
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	F.4 Development and agreement of methods/processes for developing Project Environmental Management Plans, incorporating mitigation measures and adaptive management strategies, for demonstration and commercial scale wave and tidal arrays.
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	F.5 An agreed approach to undertaking any HRA with regards to proposed SACs for harbour porpoise is required
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.
	F.6 Methods are required for determining connectivity of mobile qualifying species from protected sites with development areas
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S) • etc. • etc.
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S) • etc.



G. Shipping and navigation	G.1 Development of agreed methods/processes for assessing, mitigating and managing potential impacts on shipping and navigation
Research projects recently completed, currently underway or confirmed	<ul style="list-style-type: none"> • <i>INSERT NAME OF PROJECT, LINK TO WEBSITE OR PUBLISHED REPORTS, START DATE, END DATE AND CONTACT(S)</i> • <i>etc.</i> • <i>etc.</i>
Suggestions for potential research projects (candidate projects)	<ul style="list-style-type: none"> • <i>INSERT PROJECT TITLE/OUTLINE, POSSIBLE LEAD AND FUNDING SOURCE(S)</i> • <i>etc.</i>

Please list any suggested changes to the list of high priority projects. Are there any research projects that should no longer be considered a priority or are there any additional priority strategic research projects that should be included? Please provide details below:

Please provide details of any datasets that you are aware of that could be made available for further research and analysis.

- *NAME OF DATASET; TYPE OF DATA AVAILABLE (e.g. WILDLIFE MONITORING DATA VISUAL OBSERVATIONS, VIDEO DATA, ACOUSTIC DATA, ETC. AND WHETHER IT'S BASELINE OR MONITORING DATA); PROJECT DETAILS INCLUDING NAME, LOCATION AND DATE; NAMED CONTACT AND ANY LINKS TO DATA; ETC.*



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Any other comments/suggestions regarding the Forward Look?



Appendix B: Issues/risks no longer considered to be key strategic consenting issues – wave and tidal current

Topic	EIA/HRA issue	Relevant to wave or tidal current?	Strategically relevant?	Commercial or demonstration scale?	Iteration of F.L that issue was demoted	Current key strategic consenting issue?
Human environment						
Impacts on seascape	Lack of regional and local coastal landscape character assessments and objective assessment criteria to inform Seascape, Landscape and Visual Impact Assessment	Both	Yes, relevant to all projects	Demonstration and commercial	Version 3	Not considered to be a key strategic consenting issue as this issue is not relevant to all projects.
Impacts on seascape	Lack of understanding regarding the economic value of seascape and any change in this as a result of renewable activities	Both	Yes, relevant to all projects	Demonstration and commercial	Version 3	Not considered to be a key strategic consenting issue as this issue is not relevant to all projects.
Regulatory						
Regulatory processes	There is uncertainty as to how proposed Special Areas of Conservation for harbour porpoise will be considered with regards to consented sites and future applications	Both	Yes, relevant to all projects	Demonstration and commercial	Version 3	This issue has now been addressed
Ecological environment						
Underwater noise	Agreed approaches for measuring ambient noise in high energy environments are required	Both	Yes, relevant to all projects	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue. This has been addressed by work undertaken e.g. by The National Physical Laboratory (NPL). It is now important that the guidance produced is adopted by regulators and statutory advisors and implemented by developers and researchers.
Underwater noise	Agreed approaches for measuring noise from operational devices and construction activities are required	Both	Yes, relevant to all projects	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue. This has been addressed by work undertaken e.g. by NPL. It is now important that the guidance produced is adopted by regulators



						and statutory advisors and implemented by developers and researchers.
Underwater noise	Knowledge regarding the possible effects of underwater noise from the construction and operation of arrays on diving birds is incomplete	Both	Yes, relevant to all projects	Demonstration and commercial	Version 2	This is not considered to be a key strategic consenting issue (assuming that piling is not used).
Underwater noise	Knowledge regarding the possible effects of underwater noise from the construction and operation of arrays on fish is incomplete	Both	Yes, relevant to all projects	Demonstration and commercial	Version 2	This is not considered to be a key strategic consenting issue (assuming that piling is not used).
Entanglement	Concern within the regulatory and advisory bodies that mooring lines pose an entanglement risk to marine mammals and large fish	Both	No, project specific	Demonstration and commercial	Version 2	An SNH commissioned review of the potential for megafauna entanglement risk from marine energy developments concluded that moorings associated with marine renewable energy devices are unlikely to pose a major threat to cetaceans due to the size and mass of the moorings however there is a greater risk for large baleen whales due to their size and foraging habitats. ⁴ This is no longer considered to be key strategic consenting issue.
Seal injuries from vessel propellers	Lack of understanding around the possible cause of death to seals with 'corkscrew' injuries	Both	Yes, relevant to all projects	Demonstration and commercial	Version 2	There is strong evidence that predatory behaviour by grey seals, rather than ship propeller injuries, is likely to be the main cause of spiral seal deaths. ⁵ This evidence does not completely eliminate ship propellers, but it is now less likely they are a key factor. This is no longer considered to be a key strategic consenting issue specific to the wave and tidal sectors.

⁴ http://www.snh.org.uk/pdfs/publications/commissioned_reports/791.pdf

⁵ <http://www.smru.st-and.ac.uk/documents/2173.pdf>



Reef effects	Potential for positive effects such as use of development sites as feeding and nursery areas for fish and use of structures as fish aggregation devices	Both	Yes, relevant to all projects	Commercial	Version 2	Not considered to be a key strategic consenting issue.
Reef effects	Indirect effects on predators including potential for increased foraging opportunities	Both	Yes, relevant to all projects	Commercial	Version 2	Not considered to be a key strategic consenting issue.
Introduction of non-native invasive species	An agreed approach is required in the use of guidance for MNNS to inform the development of Project Environmental Management Plans	Both	Yes, relevant to all projects	Commercial	Version 2	Not considered to be a key strategic consenting issue.
Entrapment	Potential risk of entrapment of marine mammals and basking sharks from machines and associated moorings or support structures	Both	No, technology specific	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue.
Barrier to movement	It is uncertain whether developments will cause a barrier to movement for marine mammals and basking sharks	Both	No, site/project specific	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue.
Barrier to movement	It is uncertain whether developments will cause a barrier to movement for migratory fish	Both	No, site/project specific	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue.
Impacts on benthic communities	Direct loss of habitat and near field effects (e.g. scour, deposition) on protected or sensitive sub-littoral seabed communities	Both	No, site/project specific	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue.
Impacts on benthic communities	The potential wider or secondary effects on protected or sensitive sub-littoral seabed communities due to installation and operation of machines and associated moorings or support structures is poorly understood	Both	No, site/project specific	Commercial	Version 2	Not considered to be a key strategic consenting issue.
Ecological effects due to changes in hydrographic properties	Effects on predator-prey capture rates due to changes in hydrodynamic properties as a result of presence and operation of machines	Both	Yes, relevant to all projects	Commercial	Version 2	Not considered to be a key strategic consenting issue.



Ecological effects due to changes in hydrographic properties	Effects on ecosystem functioning due to changes in hydrodynamic properties as a result of presence and operation of machines	Both	Yes, relevant to all projects	Commercial	Version 2	Not considered to be a key strategic consenting issue.
Human environment						
Impacts on commercial fisheries	Further baseline inshore fisheries activity data to inform CIA (Cumulative Impact Assessment)	Both	No, site/project specific	Demonstration and commercial	Version 2	This is not considered to be a key strategic consenting issue. Data is required at a project/site level to inform site selection and EIA.
Impacts on commercial fisheries	Lack of standard measures for mitigating potential impacts on commercial fisheries	Both	No, site/project specific	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue. Any mitigation measures would be entirely site and project specific.
Impacts on commercial fisheries	Lack of a standardised approach and guidance, specific to the sector, on effective engagement with the commercial fishing industry and local stakeholders	Both	Yes, relevant to all projects	Demonstration and commercial	Version 2	Not considered to be a key strategic consenting issue. This is a site and project specific issue. There is sufficient existing guidance i.e. FLOWW.
Impacts on shipping and navigation	Further baseline data to inform cumulative aspects of Marine Navigational Impact Assessments	Both	No, site/project specific	Demonstration and commercial	Version 2	This issue is considered to be site/project/regionally specific and not a key strategic consenting issue.
Impacts on tourism and recreation	Difficult to predict and assess potential impacts on tourism and recreation	Both	Yes, relevant to all projects	Commercial	Version 2	Not considered to be a key strategic consenting issue.
Carbon footprint	A standard approach for accurately calculating the full life cycle carbon footprint for wave and tidal arrays is required	Both	Yes, relevant to all projects	Commercial	Version 2	Not considered to be a key strategic consenting issue.
Physical environment						
Impacts on physical processes	Lack of baseline field data to inform hydrographic models	Both	No, site/project specific	Commercial	Version 2	Not considered to be a key strategic consenting issue.

Table A1: List of consenting issues/risks no longer considered to be key strategic consenting issues - wave and tidal current



SEA Wave



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