



Annex IV Environmental Research Webinar Series

Tools and Resources for Environmental Assessments



De-risking the consenting/permitting and operation of MRE development

- ▶ **RADMAPP**– supports making choices for suitable MRE development sites
 - Presented by Duncan Clarke, Head of GIS and Data Management, Aquatera Limited

- ▶ **IMPACT** – identifies potential impacts, provides guidance on how to address impacts in consenting/permitting processes
 - Presented by Ian Hutchison, Director of Operations, Aquatera Limited

- ▶ **Management Measures** – document solutions for managing potential effects, for consent/permit, and operational plans organized by potential impact
 - Dr. Andrea Copping, Senior Research Scientist, Pacific Northwest National Laboratory

De-risking the consenting/permitting and operation of MRE development

- ▶ Resources and Tools that can assist through the consenting/permitting process

- ▶ Audience:
 - Developers, regulators, other stakeholders

- ▶ Purpose and Use:
 - Not prescriptive, but resources to move process forward, support informed discussions

Duncan Clarke

RADMAPP Tool

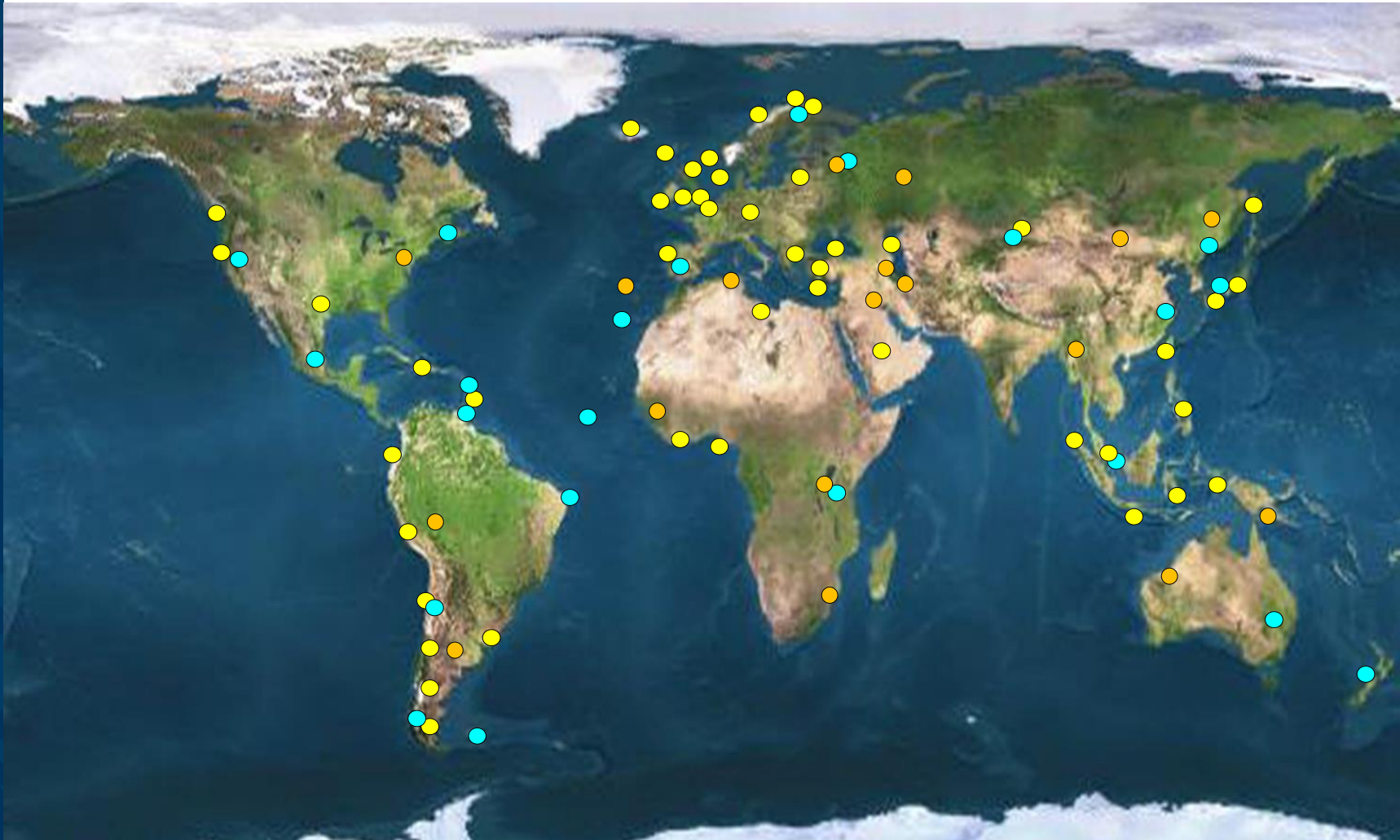


aquatera



Thinking locally acting globally

- Aquatera projects undertaken in 30 countries ●
- We are actively collaborating in many more ●
- Team experience in many other places ●



700+ total projects

400 sustainable energy projects

250 marine energy projects

35 marine energy technologies supported

12 marine array projects

**Aquatera: a world-leading
business in sustainable
development**

Working in **30** countries

Established over **50** island links

20 strategic energy plans

100 onshore wind projects

Over **50** staff & associates

Based in **Orkney**

Formed in **2000**

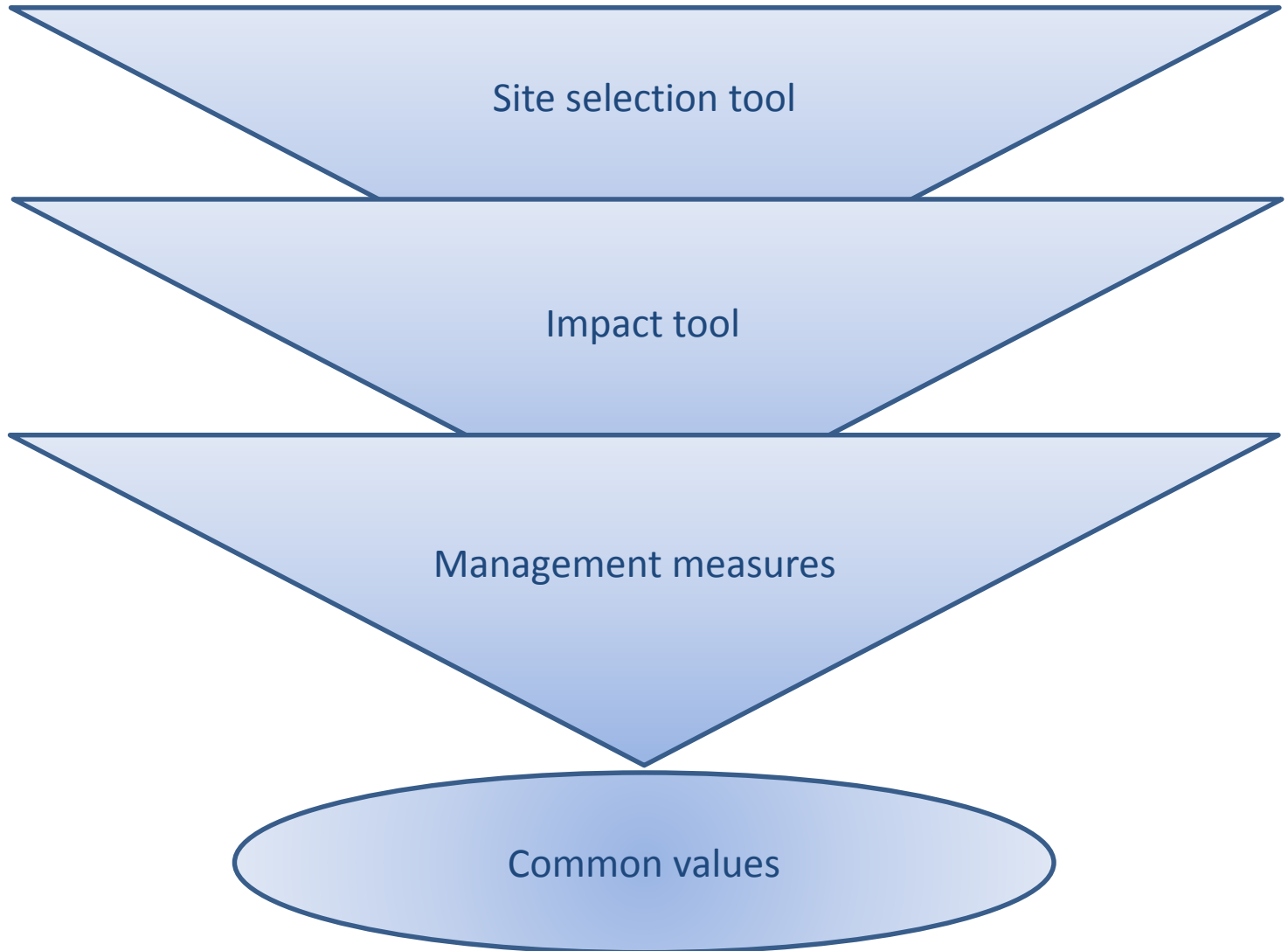
aquatera



Aquatera team



Common values



Need for geospatial analysis

- Picking the right location is key to development success
 - Growing information about ecological sensitivities
 - Increasing awareness of cultural and heritage issues
 - Seas are getting more crowded with multiple uses
 - Pressures to grow the blue economy
 - Need for optimise cost effective solutions



Existing Solutions

- Web-based data viewers
- Consultancy firms

The screenshot displays a web-based map application. The browser address bar shows the URL `marinescotland.atkinsgeospatial.com/nmpi/`. The page header includes the logo for **marinescotland MAPS NMPI**, navigation links for **Login** and **Register**, and a search bar with the placeholder text "Start typing a placename, postcode, c". A Scottish Government logo is also present in the top right corner.

The main map area shows a topographic map of Scotland and parts of Northern Ireland and the United Kingdom. A toolbar at the top of the map contains various icons for navigation and map manipulation. A **Map Scale** panel is visible in the bottom left, showing a scale of 1:6,933,487 and a zoom to scale dropdown menu. A **Layer Control** panel is open on the right side, displaying a list of layers and a legend. The layer control panel includes a search icon and a note: "Click on the [i] for more details in Marine Scotland Information. Drag and drop to set your own ordering of layers (except 'My Information'). Right click to see options." Below the layers list, there are icons for "Base Layers" and a plus sign.

At the bottom of the page, there is a copyright notice: "© Crown copyright and database right (2017). All rights reserved. Ordnance Survey 100024655, OceanWise EK001-20140401. Not to be used for Navigation. All data are covered by Crown Copyright and Privacy and Content Disclaimers Third party copyrights. © OpenStreetMap contributors". The coordinates `-4.383, 58.757 | 4.22-59W, 58.45-24N` are displayed in the bottom right corner.



Something's still missing

- Data viewers don't provide analysis
- Analysis tools don't give you spatial data
- Viewers and tools are often location and/or sector specific
- There is a lack of transparency over the processes and data used
- Limited online availability
- Expensive licensing systems
- Limited updating
- Lack of ability to integrate own data



Need for a tool

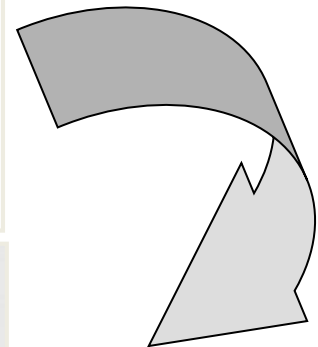
- Multiple interested parties
- Lack of integrated data
- Lack of integrated knowledge
- Difficulty visualising issues spatially
- Geospatial issues at regional, site wide and location by location issues can determine the viability and acceptability of renewable energy projects
- Need a tool to help screen siting options and support development of prospective sites
- Tool needs to front end load decision making, build on established knowledge and understanding, allow for learning through experience, reduce costs and risks, deliver good solutions



Strategic planning tool – the RADMAPP approach

- Takes account of technical, economic, environmental, cultural, social and infrastructure issues
- The distribution of the various factors identified in the weighting analysis was entered into a GIS
- The various scores are applied to the areas, line and points representing the various features
- Maps are prepared showing the distribution of suitability for the different strategic options, project locations and/or activities

Example outputs for grid infrastructure



Landfalls



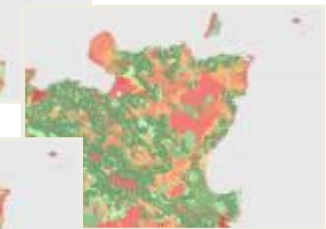
Switching station



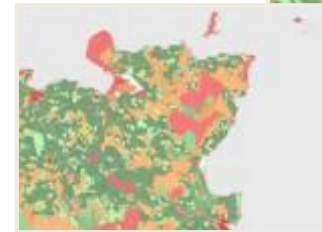
Converter station



Buried cables



Overhead lines



Key issues to consider in site selection

- Resources
- Technical feasibility
- Planning constraints
- Costs and revenue
- Infrastructure



All together, 141 planning permissions in total of various sizes for these designated areas, and 10,000,000 m³ of water will be available in the region of the proposed water supply system.

It is intended to provide water to the central and southern parts of the island, which will provide a high level of water security. The water supply system will be designed to provide water to the central and southern parts of the island, which will provide a high level of water security. The water supply system will be designed to provide water to the central and southern parts of the island, which will provide a high level of water security.

Area	Water supply (m ³ /day)	Publicly funded (m ³ /day)	Private investment (m ³ /day)
Central	1	100	1,000
South	2	20	200
Overall	3	120	1,200

Area	Water supply (m ³ /day)	Publicly funded (m ³ /day)
Central	1	100
South	2	20
Overall	3	120



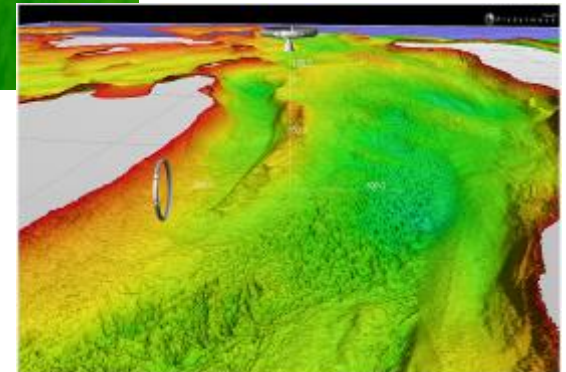
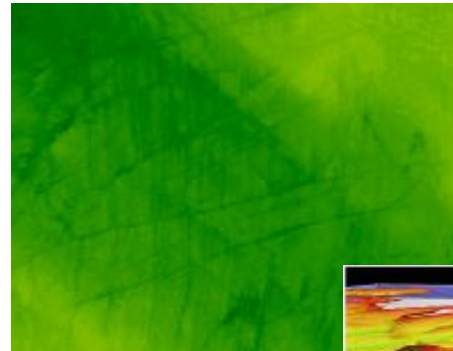
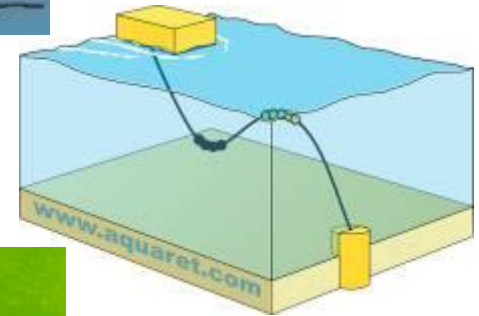
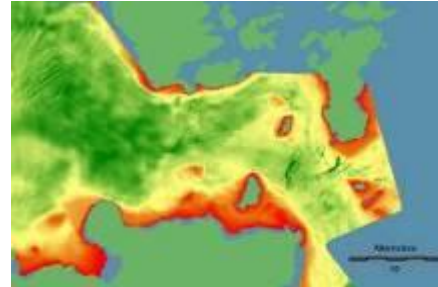
Energy resources

- Data sources
 - Satellite data
 - Buoy/ADCP data
 - Radar data
 - Modelled data
- Resource patterns
 - Typical conditions
 - Seasonality
 - Extreme conditions
- Energy shadows from other developers



Technical feasibility

- Water depth
- Foundation/mooring
- Energy attenuation
- Seabed type
 - Sediment type/depth
 - Bedrock
 - Morphology
- Current velocity
 - Tidal streams



Costs and revenue

Costs

- Technology development
- Permitting
- Capital
- Installation
- Operating
- Decommissioning

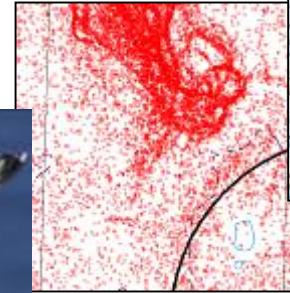
Revenue

- Selling technology
- Selling know-how
- Selling energy
- Selling or renting out site permits
- Sharing costs



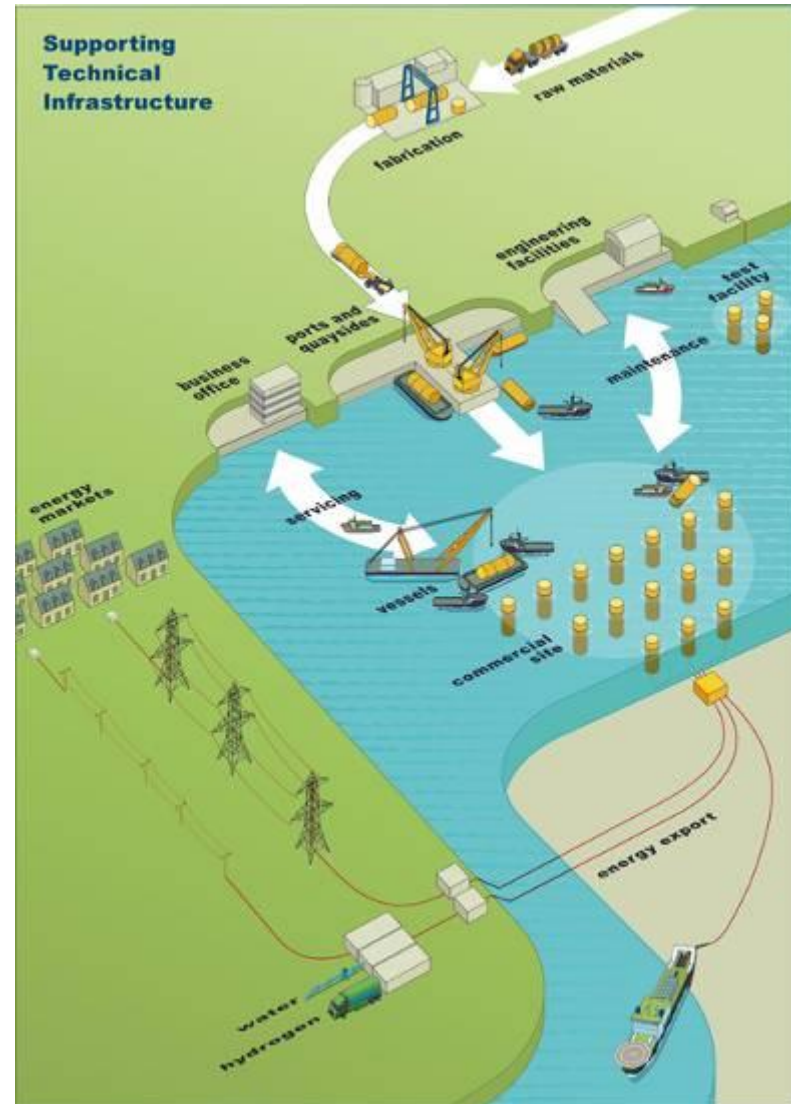
Planning constraints

- Shipping
- Fishing
- Seabirds
- Sea mammals
- Seabed communities
- Conservation areas



Infrastructure

- Supply chain
 - Materials
 - People
 - Communities
- Manufacture and fabrication
- Assembly and loadout
- Specialist vessels and workboats
- Offshore connections
 - Subsea cables
 - Connection platforms
- Substations or energy conversion
- Onward energy transport
 - Grid
 - Other



Approach to the site selection aspects of the tool

Sensitivities

Each sensitivity is mapped and categorised in relation to established objectives

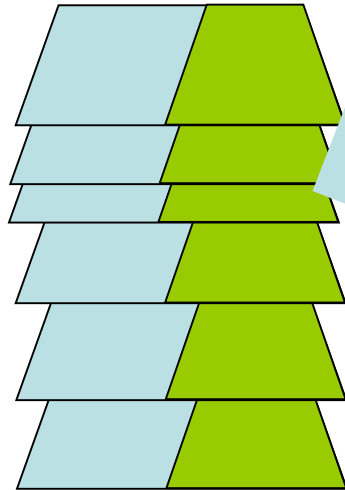
Energy

Technical feasibility

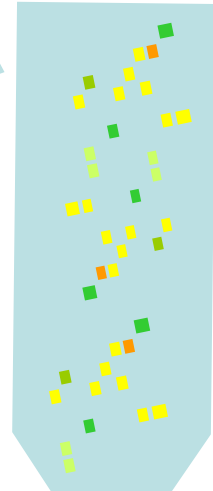
Costs and revenues

Planning constraints

Infrastructure



Possible interactions are identified, relevant to each sensitivity

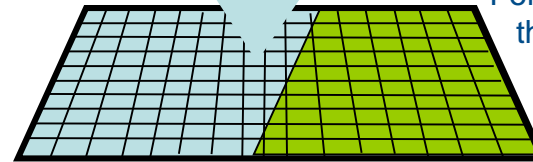
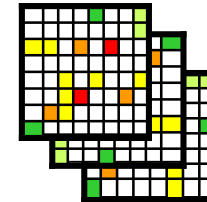


Activities

Devices

Supporting technology

Associated operations



For each grid square based upon the level of sensitivity and the relevant impact vectors development potential is established

Different scenarios can be considered by applying different impact factors




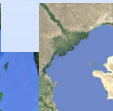



Example scoring for generic tidal and wave devices

Category	Definition of categories for each parameter	Units	Weighting for tidal development	Weighting for wave development
Land/ Sea	Land	Y/N	0	0
	Sea	Y/N	1	1
Spring Tide	<0.5	m/s	0	1
	0.5 to 1	m/s	0.05	0.8
	1 to 1.5	m/s	0.1	0.5
	1.5 to 2	m/s	0.5	0.1
	2 to 3	m/s	1	0
	>=3	m/s	1	0
Neap Tide	<0.5	m/s	N/A	N/A
	0.5 to 1	m/s	N/A	N/A
	1 to 1.5	m/s	N/A	N/A
	>=1.5	m/s	N/A	N/A
Tidal flows and eddies from satellite and aerial photography	Eddy	Y/N	0	N/A
	Turbulent flow	Y/N	0.3	N/A
	Lamina jet flow	Y/N	1	N/A
	Eddy/flow boundary	Y/N	0	N/A
Breakers	Breakers	Y/N	0.1	0.7
Overfalls	Overfalls	Y/N	0.2	0.2
Tide rips	Yes	Y/N	0.8	0.1
Eddies	Yes	Y/N	0.2	0.5
Wave Height	<0.5	m	0.9	0
	0.5 to 1	m	0.8	0.1
	1 to 1.5	m	0.7	0.3
	1.5 to 2	m	0.6	0.4
	2 to 2.5	m	0.5	0.5
	2.5 to 3	m	0.4	0.6
	3 to 3.5	m	0.3	0.8
	>=3.5	m	0.2	1
Observed wave exposure	Very sheltered	Y/N	1	N/A
	Sheltered	Y/N	0.8	N/A
	Moderately exposed	Y/N	0.5	N/A
	Exposed	Y/N	0.2	N/A
	Severely exposed	Y/N	0.1	N/A



Strategic planning studies

Areas of work	80s	1990s	2000s								2010s						
			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
<i>Sector road-mapping</i>																	
<i>Strategic assessments</i>		 															
<i>Spatial plans</i>																	
<i>Resource assessments</i>																	
<i>Technology foresight</i>																	
<i>Community development</i>																	
<i>Supply chain capacity building</i>																	

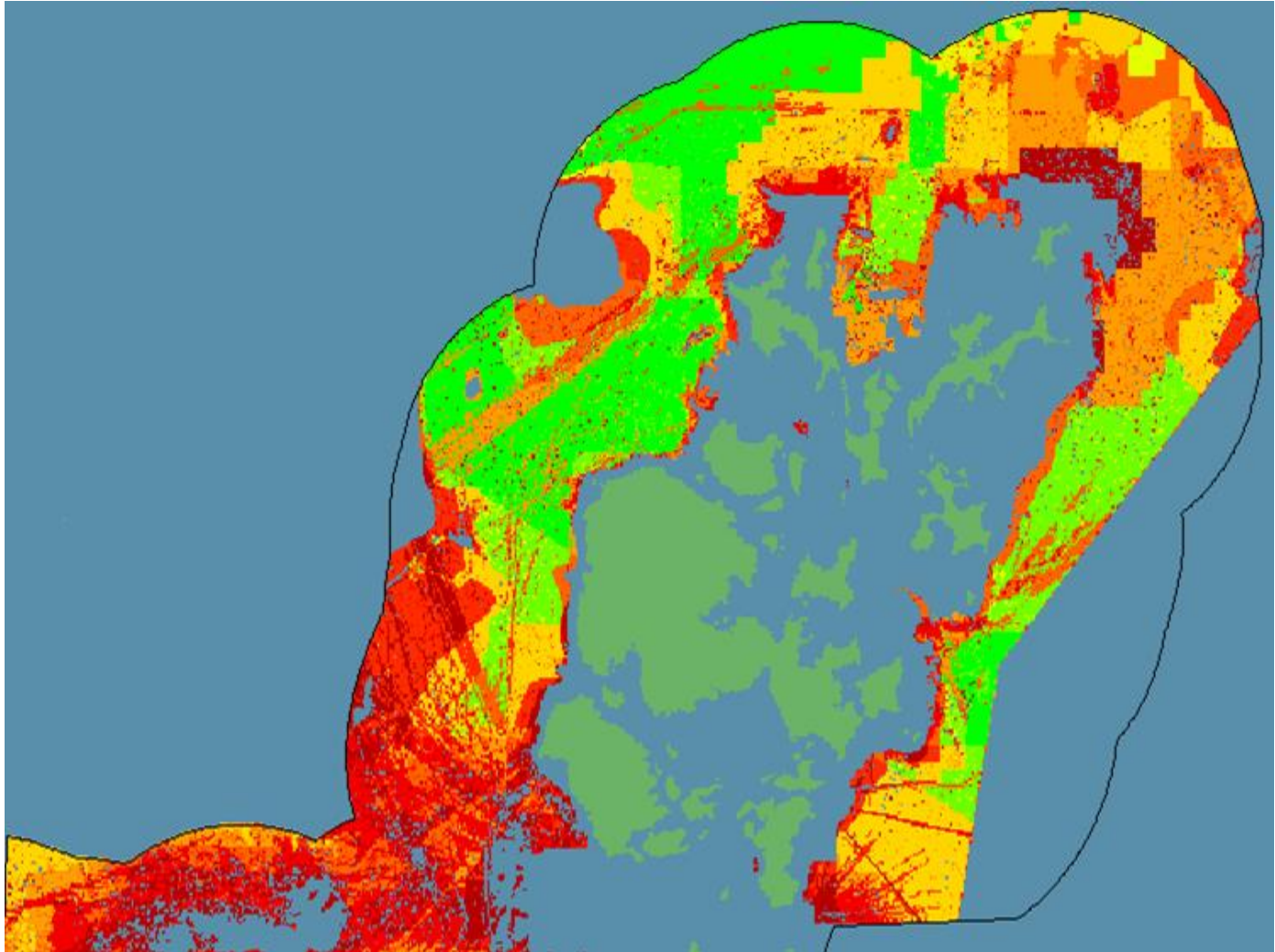
Renewables
- strategic plans, spatial plans, strategic assessment, market assessment

Oil & gas, marine technology
- strategic plans, spatial plans, technology development pathways, market assessment

Renewables
- Regional & national renewables road mapping, resource assessment, community development, sector capacity building



Example results of site selection



Future possibilities

- Expand methodology to other development types
- Use logic to answer of spatially sensitive questions
- Develop bolt on tools
 - Links to impact tool
 - 3D models
- Produce an all round tool that allows full control over decision making process



AquaPixel Tool

- Array Placement and Optimisation
- Levelised Cost of Energy Calculations (LCOE)
- Time series evaluation of the energy resource
- Automated report production



Conclusions

- Provision of a tool that simplifies site selection
- Complete suite of information relating to a tidal development
- Baseline outputs are robust and transparent
- Allowance of user to tweak elements and add their own data
- Ability to link outputs with other spatial mapping systems
- Results underpin other tools in the system





aquatera

Ian Hutchison

Ian.Hutchison@aquatera.co.uk

Duncan Clarke

Duncan.Clarke@aquatera.co.uk

Ian Hutchison

IMPACT Assessment Tool

Potential Impacts of Marine Energy Development on
Scotland's Marine Ecological Environment



aquatera



Project drivers and background

The Scottish Government set a target to cut emissions by 42 per cent by 2020 whilst recognising the need to ensure the protection of Scotland's important biodiversity.

Government commissioned project:

- *Review of the potential impact of wave and tidal energy on Scotland's marine ecological environment*

Aquatera applied its existing logic framework which identifies and assesses potential impacts between a wide range of activities and environmental sensitivities to bring added value to the project and provide a framework upon which the IMPACT Tool is based.



Project aim

- To evaluate the potential impacts of wave and tidal renewable energy devices on Scotland's marine and coastal wildlife and habitats
- Identify, prioritise and help address the potential **key issues** surrounding the development of marine energy



Project Team

- Aquatera
- Sea Mammal Research Unit (SMRU) Ltd
- European Marine Energy Centre (EMEC)
- Scottish Association for Marine Science (SAMS)
- International Centre for Island Technology, Heriot-Watt University (ICIT)
- Aberdeen University
- Environmental Research Institute (ERI)
- Robert Gordon University (RGU)



Key Objectives

- Identify the key technical elements associated with marine renewable energy development
- Identify marine species and habitats which are potentially vulnerable to the development of marine energy in Scotland
- Identify potential key interactions and priority marine ecological issues arising from the development of marine energy in Scotland
- Provide recommendations for addressing these key issues in the consenting process



Project Steering Group

- Marine Scotland
- Scottish Natural Heritage
- The Crown Estate



Project outputs

- Comprehensive database of potential interactions
- Assessment of potential interactions and an agreed list of 'key issues'
- Guidance for considering key issues in the consenting process
- Online tool to provide direct access to the outputs of the study in an easily searchable and accessible format



Project outputs

- Comprehensive database of potential interactions
- Assessment of potential interactions and an agreed list of 'key issues'
- Guidance for considering key issues in the consenting process
- Online tool to provide direct access to the outputs of the study in an easily searchable and accessible format



IMPACT assessment tool

Can be accessed online at:

<http://www.gov.scot/Topics/marine/Licensing/marine/tool>






Allows users to:

- Identify the potential key environmental impacts associated with wave and tidal energy developments
- Access guidelines and recommendations for how best to assess, monitor and manage these impacts.



Using IMPACT

Home | About | Topics | News | Publications | Consultations | Text size: [A](#) [A](#) [A](#)

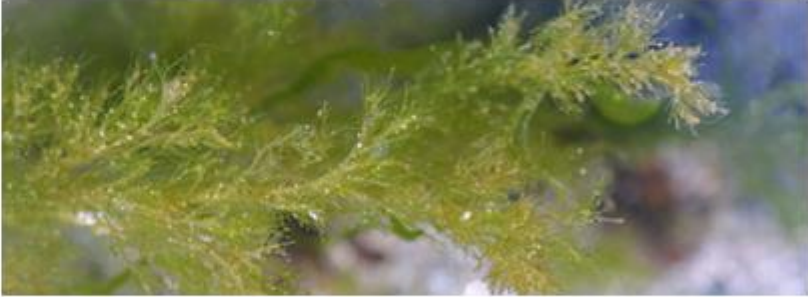
You are here: | Topics | Marine and Fisheries | Licensing | Marine Licensing | Impact Assessment Tool |     

- Marine and Fisheries
 - Licensing
 - Marine Licensing
 - Apply Now
 - Guidance
 - Fees
 - Current Marine Renewable Energy Projects
 - Current Construction, Cable and NRIP Projects
 - Licensing Information
 - Impact Assessment Tool**
 - Supporting or Objecting to Applications
 - Frequently Asked Questions
 - Contact

Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment

[Introduction](#) | [Impact Assessment Tool](#) | [Assessment And Monitoring Guidance](#)

[Introduction](#)
[Contact Us](#)



Welcome to IMPACT

IMPACT is an online tool that has been produced by Aquatera on behalf of the Scottish Government as one of the outputs from the commissioned study – [A Review of the Potential Impacts of Wave and Tidal Energy Development on Scotland's Marine Ecological Environment \(Aquatera, 2012\)](#).

IMPACT provides direct access to the outputs of this study in an easily searchable and accessible format. This allows users to identify the potential key environmental impacts



Using IMPACT

The screenshot shows the IMPACT website interface. At the top, there is a navigation bar with links for Home, About, Topics, News, Publications, and Consultations. A text size selector is on the right. Below this is a breadcrumb trail: You are here: Topics | Marine and Fisheries | Licensing | Marine Licensing | Impact Assessment Tool. Social media icons for Facebook, Twitter, LinkedIn, and Google+ are also present.

The main content area features a large banner with the IMPACT logo and the title "Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment". Below the banner are three main sections: "Introduction" (highlighted with a red circle), "Impact Assessment Tool", and "Assessment And Monitoring Guidance".

On the left side, there is a vertical navigation menu under "Marine and Fisheries" with sub-sections for Licensing, Marine Licensing, and Impact Assessment Tool. The "Impact Assessment Tool" sub-section is expanded, showing links for "Introduction" and "Contact Us".

The "Introduction" page content includes a photograph of green seaweed and the following text:

Welcome to IMPACT

IMPACT is an online tool that has been produced by Aquatera on behalf of the Scottish Government as one of the outputs from the commissioned study – [A Review of the Potential Impacts of Wave and Tidal Energy Development on Scotland's Marine Ecological Environment \(Aquatera, 2012\)](#).

IMPACT provides direct access to the outputs of this study in an easily searchable and accessible format. This allows users to identify the potential key environmental impacts



Using IMPACT

The screenshot shows the IMPACT website interface. At the top, there is a navigation bar with links for Home, About, Topics, News, Publications, and Consultations. A text size selector is on the right. Below this is a breadcrumb trail: You are here: Topics | Marine and Fisheries | Licensing | Marine Licensing | Impact Assessment Tool. Social media icons for Facebook, Twitter, LinkedIn, and Google+ are also present.

A left-hand navigation menu is titled 'Marine and Fisheries' and includes sub-sections for Licensing and Marine Licensing. Under Marine Licensing, there are links for Apply Now, Guidance, Fees, Current Marine Renewable Energy Projects, Current Construction, Cable and NRIP Projects, Licensing Information, Impact Assessment Tool, Supporting or Objecting to Applications, Frequently Asked Questions, and Contact.

The main content area features a header image with the IMPACT logo and the title 'Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment'. Below the header are three main sections: 'Introduction' (highlighted with a red circle), 'Impact Assessment Tool' (highlighted with a red circle), and 'Assessment And Monitoring Guidance'. A sub-menu on the left of the main content area lists 'Introduction' and 'Contact Us'.

Below the 'Impact Assessment Tool' section, there is a photograph of green seaweed. The text below the photo reads: 'Welcome to IMPACT' followed by a paragraph: 'IMPACT is an online tool that has been produced by Aquatera on behalf of the Scottish Government as one of the outputs from the commissioned study – [A Review of the Potential Impacts of Wave and Tidal Energy Development on Scotland's Marine Ecological Environment \(Aquatera, 2012\)](#).' Below this, it states: 'IMPACT provides direct access to the outputs of this study in an easily searchable and accessible format. This allows users to identify the potential key environmental impacts...



Using IMPACT

Home | About | Topics | News | Publications | Consultations | Text size: [A](#) [A](#) [A](#)

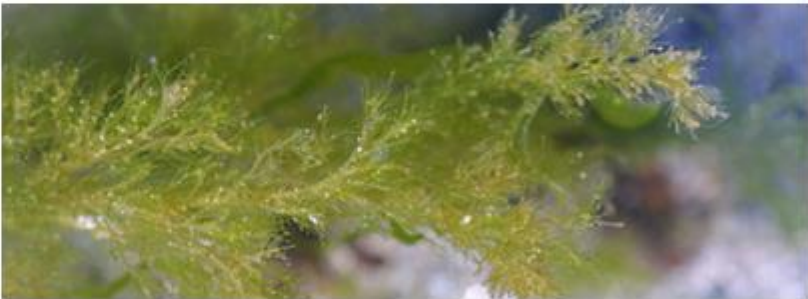
You are here: | Topics | Marine and Fisheries | Licensing | Marine Licensing | Impact Assessment Tool |

- Marine and Fisheries
 - Licensing
 - Marine Licensing
 - Apply Now
 - Guidance
 - Fees
 - Current Marine Renewable Energy Projects
 - Current Construction, Cable and NRIP Projects
 - Licensing Information
 - Impact Assessment Tool**
 - Supporting or Objecting to Applications
 - Frequently Asked Questions
 - Contact

Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment

- Introduction**
- Impact Assessment Tool**
- Assessment And Monitoring Guidance**

Introduction
Contact Us



Welcome to IMPACT

IMPACT is an online tool that has been produced by Aquatera on behalf of the Scottish Government as one of the outputs from the commissioned study – [A Review of the Potential Impacts of Wave and Tidal Energy Development on Scotland's Marine Ecological Environment \(Aquatera, 2012\)](#).

IMPACT provides direct access to the outputs of this study in an easily searchable and accessible format. This allows users to identify the potential key environmental impacts



Using IMPACT

Home | About | Topics | News | Publications | Consultations | Text size: [A](#) [A](#) [A](#)

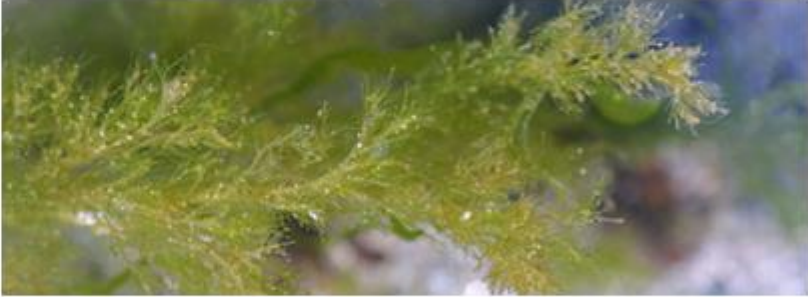
You are here: | Topics | Marine and Fisheries | Licensing | Marine Licensing | Impact Assessment Tool |

- Marine and Fisheries
 - Licensing
 - Marine Licensing
 - Apply Now
 - Guidance
 - Fees
 - Current Marine Renewable Energy Projects
 - Current Construction, Cable and NRIP Projects
 - Licensing Information
 - Impact Assessment Tool**
 - Supporting or Objecting to Applications
 - Frequently Asked Questions
 - Contact

Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment

[Introduction](#) | **[Impact Assessment Tool](#)** | [Assessment And Monitoring Guidance](#)

[Introduction](#)
[Contact Us](#)



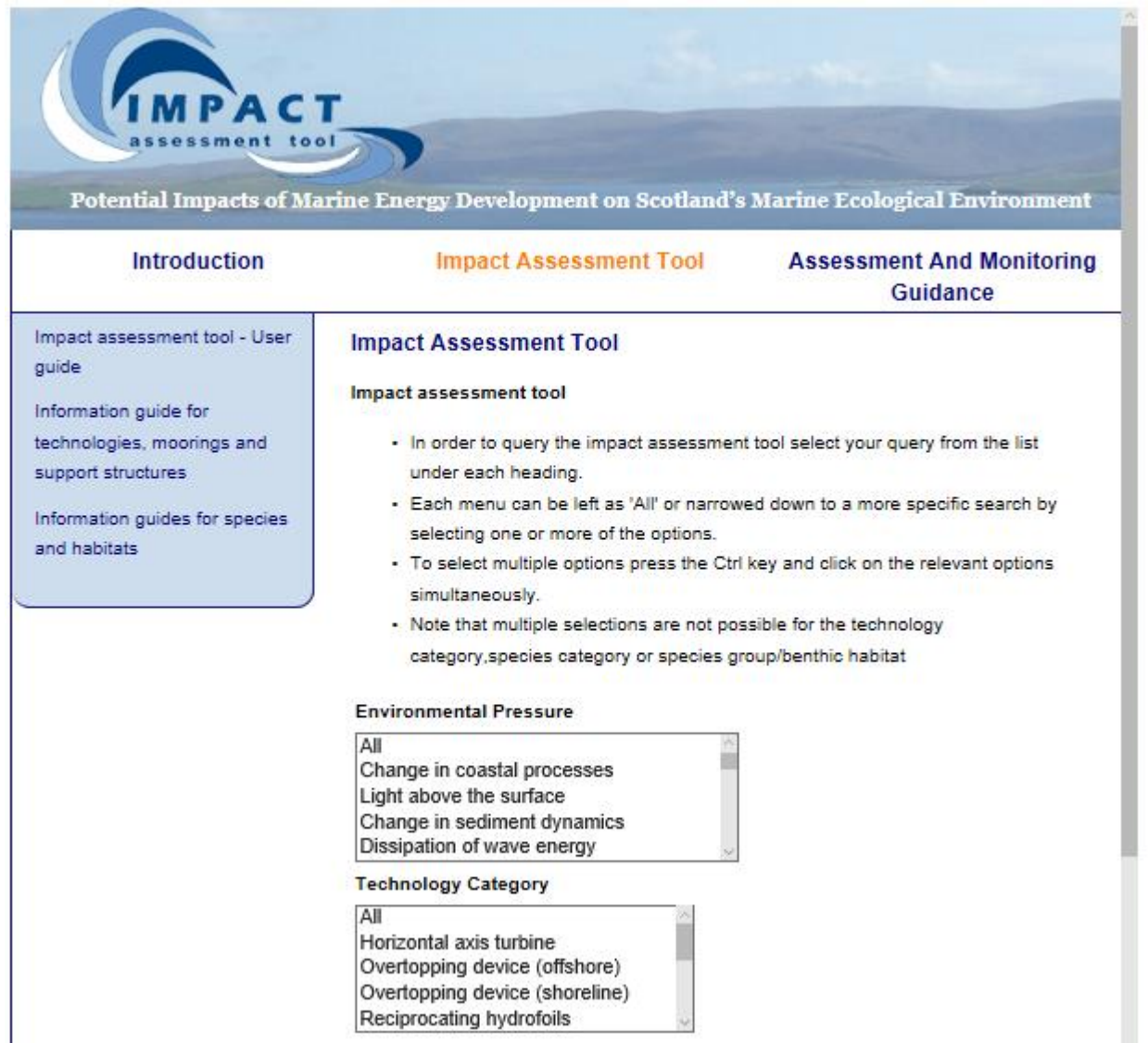
Welcome to IMPACT

IMPACT is an online tool that has been produced by Aquatera on behalf of the Scottish Government as one of the outputs from the commissioned study – [A Review of the Potential Impacts of Wave and Tidal Energy Development on Scotland's Marine Ecological Environment \(Aquatera, 2012\)](#).

IMPACT provides direct access to the outputs of this study in an easily searchable and accessible format. This allows users to identify the potential key environmental impacts



Querying the database



The screenshot shows the IMPACT assessment tool website. At the top, there is a logo for 'IMPACT assessment tool' and a title: 'Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment'. Below the title are three navigation tabs: 'Introduction', 'Impact Assessment Tool' (which is highlighted in orange), and 'Assessment And Monitoring Guidance'. On the left side, there is a sidebar with three links: 'Impact assessment tool - User guide', 'Information guide for technologies, moorings and support structures', and 'Information guides for species and habitats'. The main content area is titled 'Impact Assessment Tool' and contains a sub-section 'Impact assessment tool' with a bulleted list of instructions. Below the list are two dropdown menus: 'Environmental Pressure' and 'Technology Category'. The 'Environmental Pressure' dropdown is currently set to 'All' and lists 'Change in coastal processes', 'Light above the surface', 'Change in sediment dynamics', and 'Dissipation of wave energy'. The 'Technology Category' dropdown is also set to 'All' and lists 'Horizontal axis turbine', 'Overtopping device (offshore)', 'Overtopping device (shoreline)', and 'Reciprocating hydrofoils'.

IMPACT
assessment tool

Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment

Introduction **Impact Assessment Tool** Assessment And Monitoring Guidance

Impact assessment tool - User guide

Information guide for technologies, moorings and support structures

Information guides for species and habitats

Impact Assessment Tool

Impact assessment tool

- In order to query the impact assessment tool select your query from the list under each heading.
- Each menu can be left as 'All' or narrowed down to a more specific search by selecting one or more of the options.
- To select multiple options press the Ctrl key and click on the relevant options simultaneously.
- Note that multiple selections are not possible for the technology category, species category or species group/benthic habitat

Environmental Pressure

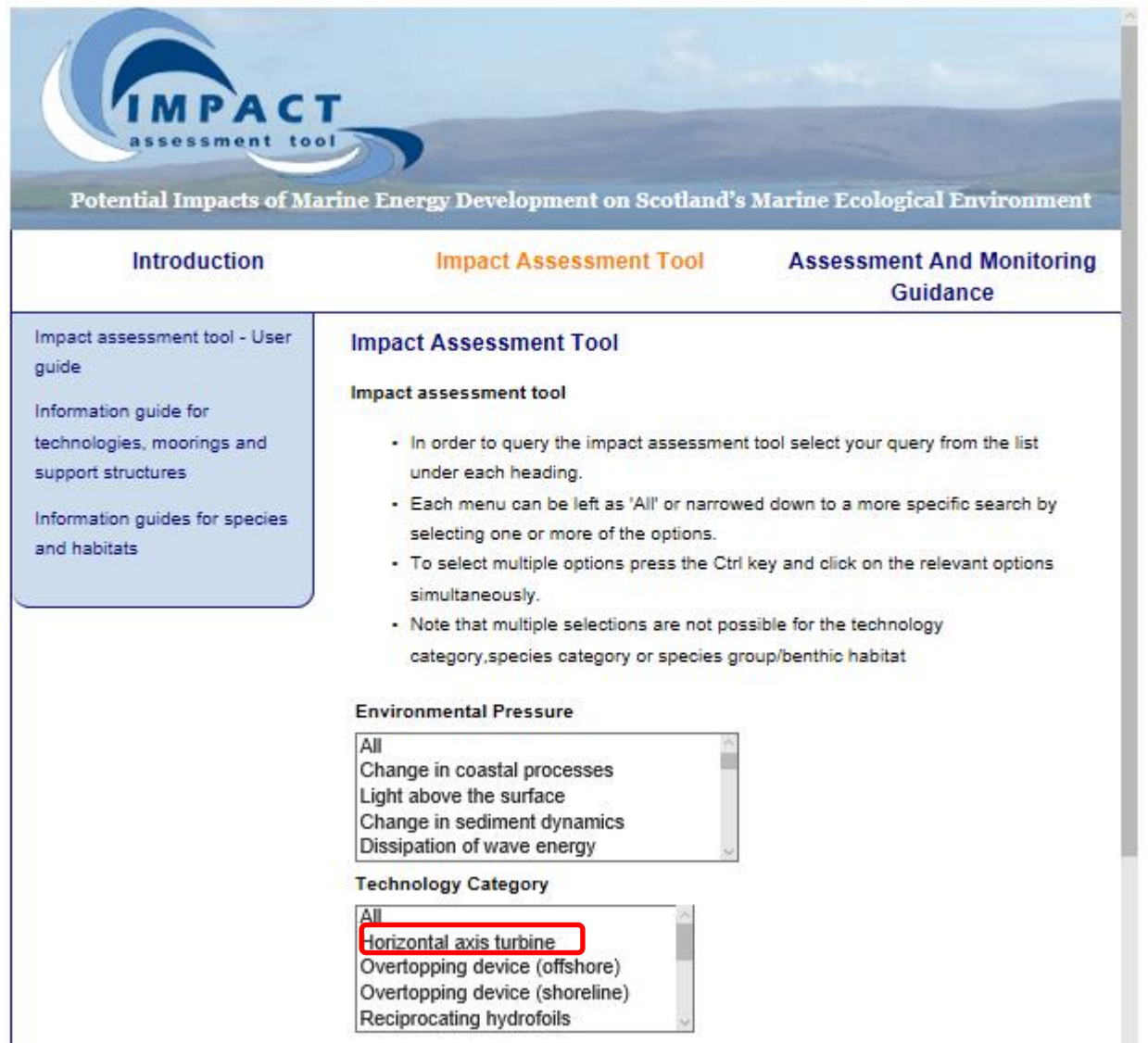
All
Change in coastal processes
Light above the surface
Change in sediment dynamics
Dissipation of wave energy

Technology Category

All
Horizontal axis turbine
Overtopping device (offshore)
Overtopping device (shoreline)
Reciprocating hydrofoils



Querying the database



The screenshot shows the IMPACT assessment tool website. At the top, there is a logo for 'IMPACT assessment tool' and a title: 'Potential Impacts of Marine Energy Development on Scotland's Marine Ecological Environment'. Below this, there are three navigation tabs: 'Introduction', 'Impact Assessment Tool' (which is highlighted in orange), and 'Assessment And Monitoring Guidance'. On the left side, there is a sidebar with three links: 'Impact assessment tool - User guide', 'Information guide for technologies, moorings and support structures', and 'Information guides for species and habitats'. The main content area is titled 'Impact Assessment Tool' and contains a sub-heading 'Impact assessment tool' followed by a list of instructions:

- In order to query the impact assessment tool select your query from the list under each heading.
- Each menu can be left as 'All' or narrowed down to a more specific search by selecting one or more of the options.
- To select multiple options press the Ctrl key and click on the relevant options simultaneously.
- Note that multiple selections are not possible for the technology category, species category or species group/benthic habitat

Below the list, there are two dropdown menus. The first is labeled 'Environmental Pressure' and has the following options: 'All', 'Change in coastal processes', 'Light above the surface', 'Change in sediment dynamics', and 'Dissipation of wave energy'. The second is labeled 'Technology Category' and has the following options: 'All', 'horizontal axis turbine' (which is highlighted with a red box), 'Overtopping device (offshore)', 'Overtopping device (shoreline)', and 'Reciprocating hydrofoils'.



Outputs

Impact assessment tool - User guide

Information guide for technologies, moorings and support structures

Information guides for species and habitats

Results Breakdown

[Back to Impact Assessment Tool](#)

The following table shows the potential key issues which are relevant for this query. For each key issue there are three outputs:

- **Summary Assessment Results** - provides a matrix which summarises the judgements made in the assessment between a species & device type for each relevant environmental pressure
- **Detailed Assessment Results** - provides a table of the judgements made in the assessment between a species & device type for each environmental pressure/key issue (*note that only those interactions which were judged to be key issues are included here - for a full output, including those not identified as key issues click on the 'Detailed assessment results' button at the bottom of this page*)
- **Assessment and Monitoring Guidance** - provides a pdf of the guidance relevant to each key issue

For a full output of the results for this query click on the buttons at the bottom of the page.

Pressure	Key Issue			
Direct abrasion	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance
Loss of habitat	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance



Outputs

Impact assessment tool - User guide

Information guide for technologies, moorings and support structures

Information guides for species and habitats

Results Breakdown

[Back to Impact Assessment Tool](#)

The following table shows the potential key issues which are relevant for this query. For each key issue there are three outputs:

- **Summary Assessment Results** - provides a matrix which summarises the judgements made in the assessment between a species & device type for each relevant environmental pressure
- **Detailed Assessment Results** - provides a table of the judgements made in the assessment between a species & device type for each environmental pressure/key issue (*note that only those interactions which were judged to be key issues are included here - for a full output, including those not identified as key issues click on the 'Detailed assessment results' button at the bottom of this page*)
- **Assessment and Monitoring Guidance** - provides a pdf of the guidance relevant to each key issue

For a full output of the results for this query click on the buttons at the bottom of the page.

Pressure	Key Issue			
Direct abrasion	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance
Loss of habitat	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance



Summary assessment results

Direct abrasion

[Go Back](#)

Key: [show/hide](#)

Score	Explanation
1	Potentially significant at a 10MW scale
0	Assessed as not significant at a 10MW scale
NA	Not Applicable
Unknown	Unknown whether this will be significant at a 10 MW scale
-	This combination not assessed for this environmental pressure. Screened out in initial assessments. See Main report for details.

Search Criteria:

Environmental Pressure: Direct abrasion Technology Category: Horizontal axis turbine Mooring or Support Structure: All Species Category: All Species Group: All Individual Species: All

Category	Common Name (or species considered in Benthic Habitat)	Species Group or Habitat	Latin Name	Technology & Moorings and Support structures			
				Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Horizontal axis turbine & Rock anchors and mooring lines
Fish and Shellfish	Small-spotted Catshark (Lesser spotted Dogfish)	Demersal Finfish	Scyliorhinus canicula	0	0	-	0
Fish and Shellfish	Cuckoo Ray	Demersal Finfish	Leucoraja naevus	0	0	-	0
Fish and Shellfish	Spotted Ray	Demersal Finfish	Raja montagui	0	0	-	0
Fish and Shellfish	Thornback Ray (Roker)	Demersal Finfish	Raja clavata	0	0	-	0
Fish and Shellfish	Common Skate (Blue Skate)	Demersal Finfish	Dipturus batis	0	0	-	0
Fish and Shellfish	Atlantic Herring	Pelagic Finfish	Clupea harengus	0	0	-	0
Fish and Shellfish	Angler Fish (Monkfish)	Demersal Finfish	Lophius piscatorius	0	0	-	0
Fish and Shellfish	Norway Lobster	Shellfish	Nephrops norvegicus	0	0	-	0
Fish and Shellfish	Common Lobster (European Lobster)	Shellfish	Homarus gammarus	0	0	-	0
Fish and Shellfish	Edible Crab (Brown Crab)	Shellfish	Cancer pagurus	0	0	-	0
Fish and Shellfish	Velvet Swimming Crab (Velvet Crab)	Shellfish	Necora puber	0	0	-	0
Fish and Shellfish			Coriniae				



Summary assessment results

Direct abrasion

[Go Back](#)

Key: [show](#)/[hide](#)

Score	Explanation
1	Potentially significant at a 10MW scale
0	Assessed as not significant at a 10MW scale
NA	Not Applicable
Unknown	Unknown whether this will be significant at a 10 MW scale
-	This combination not assessed for this environmental pressure. Screened out in initial assessments. See Main report for details.

Search Criteria:

Environmental Pressure: Direct abrasion Technology Category: Horizontal axis turbine Mooring or Support Structure: All Species Category: All Species Group: All Individual Species: All

Category	Common Name (or species considered in Benthic Habitat)	Species Group or Habitat	Latin Name	Technology & Moorings and Support structures			
				Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Horizontal axis turbine & Rock anchors and mooring lines
Fish and Shellfish	Small-spotted Catshark (Lesser spotted Dogfish)	Demersal Finfish	Scyliorhinus canicula	0	0	-	0
Fish and Shellfish	Cuckoo Ray	Demersal Finfish	Leucoraja naevus	0	0	-	0
Fish and Shellfish	Spotted Ray	Demersal Finfish	Raja montagui	0	0	-	0
Fish and Shellfish	Thornback Ray (Roker)	Demersal Finfish	Raja clavata	0	0	-	0
Fish and Shellfish	Common Skate (Blue Skate)	Demersal Finfish	Dipturus batis	0	0	-	0
Fish and Shellfish	Atlantic Herring	Pelagic Finfish	Clupea harengus	0	0	-	0
Fish and Shellfish	Angler Fish (Monkfish)	Demersal Finfish	Lophius piscatorius	0	0	-	0
Fish and Shellfish	Norway Lobster	Shellfish	Nephrops norvegicus	0	0	-	0
Fish and Shellfish	Common Lobster (European Lobster)	Shellfish	Homarus gammarus	0	0	-	0
Fish and Shellfish	Edible Crab (Brown Crab)	Shellfish	Cancer pagurus	0	0	-	0
Fish and Shellfish	Velvet Swimming Crab (Velvet Crab)	Shellfish	Necora puber	0	0	-	0
Fish and Shellfish			Coriniae				



Summary assessment results

Direct abrasion

[Go Back](#)

Key: [show/hide](#)

Score	Explanation
1	Potentially significant at a 10MW scale
0	Assessed as not significant at a 10MW scale
NA	Not Applicable
Unknown	Unknown whether this will be significant at a 10 MW scale
-	This combination not assessed for this environmental pressure. Screened out in initial assessments. See Main report for details.

Search Criteria:

Environmental Pressure: Direct abrasion Technology Category: Horizontal axis turbine Mooring or Support Structure: All Species Category: All Species Group: All Individual Species: All

Category	Common Name (or species considered in Benthic Habitat)	Species Group or Habitat	Latin Name	Technology & Moorings and Support structures			
				Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Horizontal axis turbine & Rock anchors and mooring lines
Fish and Shellfish	Small-spotted Catshark (Lesser spotted Dogfish)	Demersal Finfish	Scyliorhinus canicula	0	0	-	0
Fish and Shellfish	Cuckoo Ray	Demersal Finfish	Leucoraja naevus	0	0	-	0
Fish and Shellfish	Spotted Ray	Demersal Finfish	Raja montagui	0	0	-	0
Fish and Shellfish	Thornback Ray (Roker)	Demersal Finfish	Raja clavata	0	0	-	0
Fish and Shellfish	Common Skate (Blue Skate)	Demersal Finfish	Dipturus batis	0	0	-	0
Fish and Shellfish	Atlantic Herring	Pelagic Finfish	Clupea harengus	0	0	-	0
Fish and Shellfish	Angler Fish (Monkfish)	Demersal Finfish	Lophius piscatorius	0	0	-	0
Fish and Shellfish	Norway Lobster	Shellfish	Nephrops norvegicus	0	0	-	0
Fish and Shellfish	Common Lobster (European Lobster)	Shellfish	Homarus gammarus	0	0	-	0
Fish and Shellfish	Edible Crab (Brown Crab)	Shellfish	Cancer pagurus	0	0	-	0
Fish and Shellfish	Velvet Swimming Crab (Velvet Crab)	Shellfish	Necora puber	0	0	-	0
Fish and Shellfish			Corinopus				



Detailed assessment results

Impact assessment tool - User guide

Information guide for technologies, moorings and support structures

Information guides for species and habitats

Results Breakdown

[Back to Impact Assessment Tool](#)

The following table shows the potential key issues which are relevant for this query. For each key issue there are three outputs:

- **Summary Assessment Results** - provides a matrix which summarises the judgements made in the assessment between a species & device type for each relevant environmental pressure
- **Detailed Assessment Results** - provides a table of the judgements made in the assessment between a species & device type for each environmental pressure/key issue (*note that only those interactions which were judged to be key issues are included here - for a full output, including those not identified as key issues click on the 'Detailed assessment results' button at the bottom of this page*)
- **Assessment and Monitoring Guidance** - provides a pdf of the guidance relevant to each key issue

For a full output of the results for this query click on the buttons at the bottom of the page.

Pressure	Key Issue			
Direct abrasion	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance
Loss of habitat	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance



Detailed results

Detailed Assessment

[Back to Results](#)

[Refine Results](#)

[Export Results](#)

Key: [show/hide](#)

Score	Explanation
1	Potentially significant at a 10MW scale
0	Assessed as not significant at a 10MW scale
NA	Not Applicable
Unknown	Unknown whether this will be significant at a 10 MW scale
Technology/Mooring vs Impact Mechanisms Score	Explanation
NA	It is not possible for the technology/moorings/support type to give rise to this environmental pressure
Y	The technology/moorings/support type has the potential to give rise to this environmental pressure at 10MW scale of development
N	The technology/moorings/support type does not have the potential to give rise to this environmental pressure at 10MW scale of development
U	At this current time, it is unknown whether the technology/moorings/support structure type has the potential to give rise to this environmental pressure

More details describing the significance score can be found in the main report and the user guide for this tool

Search Criteria:

Environmental Pressure:	Direct abrasion	Technology Category:	Horizontal axis turbine	Mooring or Support Structure:	All	Species Category:	All	Species Group:	All	Individual Species:	All	
Impact Mechanism	Technology Type	Technology Category	Technology vs Impact Mechanisms Score	Mooring Support	Mooring vs Impact Mechanisms Score	Category	Species Group	Common Name	Latin Name	Score	Comment	Key Issues No
											Abrasion is likely to damage or kill these species, which are sessile or sedentary. E. ...	



Assessment and monitoring guidance

Impact assessment tool - User guide

Information guide for technologies, moorings and support structures

Information guides for species and habitats

Results Breakdown

[Back to Impact Assessment Tool](#)

The following table shows the potential key issues which are relevant for this query. For each key issue there are three outputs:

- **Summary Assessment Results** - provides a matrix which summarises the judgements made in the assessment between a species & device type for each relevant environmental pressure
- **Detailed Assessment Results** - provides a table of the judgements made in the assessment between a species & device type for each environmental pressure/key issue (*note that only those interactions which were judged to be key issues are included here - for a full output, including those not identified as key issues click on the 'Detailed assessment results' button at the bottom of this page*)
- **Assessment and Monitoring Guidance** - provides a pdf of the guidance relevant to each key issue

For a full output of the results for this query click on the buttons at the bottom of the page.

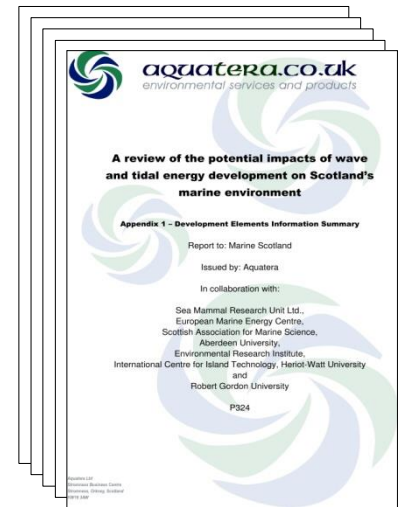
Pressure	Key Issue			
Direct abrasion	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance
Loss of habitat	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed	Summary Assessment Results	Detailed Assessment Results	Assessment and Monitoring Guidance



Assessment and monitoring guidance

Provides the following for each potential impact:

- Preliminary desk based studies required
- Baseline characterisation surveys that should be undertaken
- Further desk studies following baseline characterisation surveys
- Monitoring measures during installation and operation and under what circumstances each measure may be appropriate



Overview

The IMPACT Tool can provide the following:

- List of potential impacts relevant to a particular type of wave or tidal project
- Comprehensive overview of the potential effects of each impact on a large range of species and habitats
- Guidance on how these impacts should be addressed during the consenting process

Concluding points

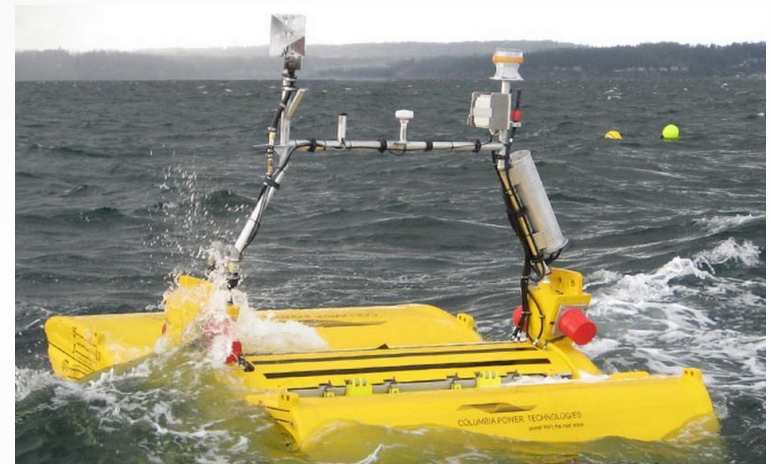
- Demonstration of an impact mapping methodology that could be applied to other geographies, technologies, project types etc
- Applies a risk-based approach to impact assessment which is underpinned by evidence and experience
- Robust and transparent
- Underlying framework allows new evidence and learning to be incorporated, future proofing the Tool

Andrea Copping

Management Measures

Management Measures Tool

- ▶ Document solutions for managing potential effects
- ▶ For use in discussions and process for consent/permit
- ▶ Useful for developer operational plans
- ▶ Tool is organized by potential impact, also by technology type, interaction, etc.



Creating the Management Measures Tool



Pacific Northwest
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

Creating the Management Measures Tool

- ▶ Scanning through applications and licenses in UK and elsewhere for management measures that have been used/suggested.

Creating the Management Measures Tool

- ▶ Scanning through applications and licenses in UK and elsewhere for management measures that have been used/suggested.
- ▶ Consulting with researchers, regulators.

Creating the Management Measures Tool

- ▶ Scanning through applications and licenses in UK and elsewhere for management measures that have been used/suggested.
- ▶ Consulting with researchers, regulators.
- ▶ Collated management measures,

Creating the Management Measures Tool

- ▶ Scanning through applications and licenses in UK and elsewhere for management measures that have been used/suggested.
- ▶ Consulting with researchers, regulators.
- ▶ Collated management measures, parsed by:
 - Technology (wave, tidal, or both)
 - Phase of project (design, installation, operation, decommissioning)
 - Stressor (collision risk, EMF, acoustics, benthic effects, etc.)
 - Receptor (marine mammals, fish, birds, habitat)
 - Management measure
 - Implications of using measure

Creating the Management Measures Tool



Creating the Management Measures Tool

- ▶ Collision risk workshop (February 2016 in Edinburgh around ICOE)
 - Invited researchers, regulators, developers, consultants
 - Plan developed to retire collision risk
 - Need to collate, analyze, and disseminate management measures in use, in licenses, suggested.



Creating the Management Measures Tool

- ▶ Collision risk workshop (February 2016 in Edinburgh around ICOE)
 - Invited researchers, regulators, developers, consultants
 - Plan developed to retire collision risk
 - Need to collate, analyze, and disseminate management measures in use, in licenses, suggested.

- ▶ Called for in UK ORJIP Forward Look



Creating the Management Measures Tool

- ▶ Collision risk workshop (February 2016 in Edinburgh around ICOE)
 - Invited researchers, regulators, developers, consultants
 - Plan developed to retire collision risk
 - Need to collate, analyze, and disseminate management measures in use, in licenses, suggested.

- ▶ Called for in UK ORJIP Forward Look

- ▶ Workshop in Glasgow, May 2017 on MM
 - Draft measures to invited participants ahead of time
 - Discussed by topic area at workshop
 - Iterated with workshop participants, others



Creating the Management Measures Tool

- ▶ Collision risk workshop (February 2016 in Edinburgh around ICOE)
 - Invited researchers, regulators, developers, consultants
 - Plan developed to retire collision risk
 - Need to collate, analyze, and disseminate management measures in use, in licenses, suggested.

- ▶ Called for in UK ORJIP Forward Look

- ▶ Workshop in Glasgow, May 2017 on MM
 - Draft measures to invited participants ahead of time
 - Discussed by topic area at workshop
 - Iterated with workshop participants, others

- ▶ Built online tool



Tethys - <https://tethys.pnnl.gov>

Log In | Register |

TETHYS ABOUT ▾ TETHYS CONTENT ▾ CONNECTIONS ▾ BROADCASTS ▾ HELP ▾

The Annex IV 2016 State of the Science report is available [here](#).

U.S. DEPARTMENT OF ENERGY **OES** OCEAN ENERGY SYSTEMS **ieo wind**
An U.S. Technology Initiative

NEW USER

If you are new to Tethys, start here to learn more

KNOWLEDGE BASE

Access thousands of publications and more, all in a searchable database

NOVEMBER 2017

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Tethys Story
Electromagnetic Field Impacts on Elasmobranch and American Lobster Movement and Migration from Direct Current Cables
At the University of Rhode Island in the United States, a study of electromagnetic field (EMF) impacts on elasmobranchs and lobsters is currently being conducted. The contract is led by the Bureau of Ocean Energy Management and the study aims to assess impacts of direct current (DC) cables on... [Read More](#)

Marine Energy
Generating electricity from the sea

Wind Energy
Generating electricity from wind on land and at sea

Annex IV

WREN

Select MM Tool

Tethys - <https://tethys.pnnl.gov>

Log In | Register |

TETHYS

ABOUT | TETHYS CONTENT | CONNECTIONS | BROADCASTS | HELP

- Search Knowledge Base
- Search Map Viewer
- Events Calendar
- Management Measures Tool

The Annex IV 2016 State of the Science report is available [here](#).

U.S. DEPARTMENT OF ENERGY | OES | OCEAN ENERGY SYSTEMS | ieo wind

NEW USER

If you are new to Tethys, start here to learn more

KNOWLEDGE BASE

Access thousands of publications and more, all in a searchable database

NOVEMBER 2017

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Tethys Story

Electromagnetic Field Impacts on Elasmobranch and American Lobster Movement and Migration from Direct Current Cables

At the University of Rhode Island in the United States, a study of electromagnetic field (EMF) impacts on elasmobranchs and lobsters is currently being conducted. The contract is led by the Bureau of Ocean Energy Management and the study aims to assess impacts of direct current (DC) cables on... [Read More](#)

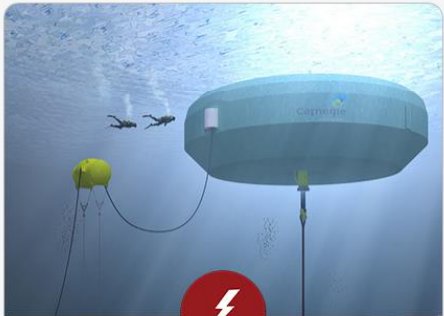
Select MM Tool



Marine Energy
Generating electricity from the sea



Wind Energy
Generating electricity from wind on land and at sea



Annex IV



WREN

Management Measures Tool



Log In

Register

ABOUT ▾ TETHYS CONTENT ▾ CONNECTIONS ▾ BROADCASTS ▾ HELP ▾

[Home](#) » [Tethys Content](#) » Management Measures Tool

Management Measures Tool

Exploring Management Measures that support Deployment of Wave and Tidal Devices

As the MRE industry moves beyond deployment of individual wave and tidal devices towards arrays, there continue to be onerous monitoring requirements placed on developers. Certain risks of MRE devices on the marine environment are not sufficiently well resolved to allow smooth transitions towards a commercial industry. A good example is found in the potential collision of animals with single tidal turbines; the risk of this interaction has not been adequately determined to allay fears of stakeholders and regulators in many jurisdictions.

In consultation with the research and regulatory communities, it was determined that having a set of robust management measures might act as safeguards for marine animals and habitats until such time as definitive monitoring data become available to determine the level of risk from turbines and WECs. At that point, mitigation measures could be dialed back or removed, if warranted.

With the input of the researchers, regulators, and developers at a workshop held May 9th 2017 in Glasgow UK, the following criteria were used to develop the management measures tool shown here:

- Ensure common understanding of all parameters that describe management measures proposed for collision risk, EMF, noise, and benthic disturbance;
- Evaluate each measure for effectiveness in addressing the risk for which it is intended;
- Determine the feasibility and practicality of each measure;
- Facilitate the development of a toolbox of management measures that can be made broadly available, as they are needed
- Consider the use of the tool to guide initial discussions between project proponents and regulators.

The tool can be explored using the following steps:

Filter by Technology Type
Filter by Management Measure Category
Filter by Project Phase
Filter by Stressor
Filter by Receptor

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Wave	Mitigation	Installation	Contamination	Marine Mammals	All receptors	Potential for accidental or unplanned events which could lead to contamination of the marine environment.	Where rock placement is used, ensure clean rock is used.	Reduces/removes risk of contamination from materials.
Wave	Mitigation	Operation & Maintenance	Contamination	Marine Mammals	All receptors	Potential for accidental or unplanned events which could lead to contamination of the marine environment.	Where rock placement is used, ensure clean rock is used.	Reduces/removes risk of contamination from materials.
Wave	Mitigation	Decommissioning	Contamination	Marine Mammals	All receptors	Potential for accidental or unplanned events which could lead to contamination of the marine environment.	Where rock placement is used, ensure clean rock is used.	Reduces/removes risk of contamination from materials.
Tidal	Mitigation	Installation	Contamination	Marine	All receptors	Potential for accidental or unplanned events which could lead to	Where rock placement is used,	Reduces/removes risk of contamination from

Management Measures Tool

Filter by Technology Type:
 Filter by Management Measure Category:
 Filter by Project Phase:
 Filter by Stressor:
 Filter by Receptor:

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Tidal	Compliance	Installation	Contamination	Reptiles	All receptors	Potential for accidental or unplanned events which could lead to contamination of the marine environment.	Management: Establish and implement a Contamination Control Plan / Ship Oil Contamination Emergency Plans (SOPEPs). Compliance with International Maritime Organisation (IMO) and Maritime Coastguard Agency (MCA) codes for the prevention of contamination.	Reduces risk of any contamination event and ensures that contingency plans are in place. Demonstrates compliance with environmental management systems.
Tidal	Monitoring	Operation & Maintenance	Marine Non-Native Species (MNNS)	Marine Mammals	All receptors	Potential for introduction of MNNS which can have an adverse impact on the native species at the site.	Monitoring and reporting of MNNS.	Reduces/removes risk of transfer of non-native species.
Tidal	Mitigation	Decommissioning	Marine Non-Native Species (MNNS)	Habitat	All receptors	Potential for introduction of MNNS which can have an adverse impact on the native species at the site.	Source vessels locally.	Reduce/remove risk of transfer and settlement of non-native species.
Tidal	Mitigation	Installation	Changes in sediment dynamics	Fish	All receptors	Reduced visibility impacting prey detection and obstruction avoidance.	Best practice methodologies to reduce resuspension of sediment during cable burial or device foundation / mooring installation.	n/a
Tidal	Compliance	Decommissioning	Marine Non-Native Species (MNNS)	Birds	All receptors	Potential for introduction of MNNS which can have an adverse impact on the native species at the site.	Adhere to appropriate measures when jettisoning ballast water.	Reduce/remove risk of transfer of non-native species.
Tidal	Mitigation	Operation & Maintenance	Vessel disturbance	Marine Mammals	Marine Mammals	Potential for disturbance from project vessels.	Reduce speed and maintain steady course when animal is sighted.	Reduces potential effects and is a relatively low cost measure.
Tidal	Compliance	Decommissioning	Marine Non-Native Species	Fish	All receptors	Potential for introduction of MNNS which can have an adverse impact on the native species at the site.	Adhere to appropriate measures when jettisoning ballast	Reduce/removes risk of transfer of non-native species

Choose:
-Tidal

Management Measures Tool

Filter by Technology Type:
 Filter by Management Measure Category:
 Filter by Project Phase:
 Filter by Stressor:
 Filter by Receptor:

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install acoustic deterrent devices (ADDs).	This could potentially reduce likelihood of collision with moving blades although the efficacy of ADDs in these environments is unknown. Constant deterring means habituation is likely. This is a simpler system than detect (efficiently) and deter, however would still be expensive to implement. It would also come with an additional noise impact which must also be considered in project assessments.
Tidal	Monitoring	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and shut-down' system using active sonar and other appropriate monitoring equipment.	This could reduce/remove risk of collision with moving blades and enable a route through the consenting process, particularly at high sensitivity locations. However, this could affect power production, is expensive to implement and does not help to reduce scientific uncertainty regarding the risk. The reductions in power production, although small, would bring about uncertainty in the investment process and there are questions around impacts of sonar on sensitive species.
Tidal	Mitigation	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Selective structural and blade coatings i.e. colours to aid detection.	Unknown - it is possible that this will aid detection of subsea structures and help reduce risk. It can be captured in early project design for a small one-off cost, however further research is needed as there is potential for an increased collision risk through 'attraction'.
Tidal	Monitoring	Operation & Maintenance	Collision risk	Fish	Fish	Potential for collision with turbine blades.	Environmental monitoring to detect collision events.	Helps to develop an understanding of avoidance behaviour, nature of interactions and outcome of collision events. However, there are cost implications associated with this level of monitoring.
Tidal	Monitoring	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Environmental monitoring to detect collision events.	Understand avoidance behaviour, nature of interactions and outcome of collision events, however effective monitoring is expensive and requires a lot of data analysis.
Tidal	Monitoring	Operation & Maintenance	Collision risk	Fish	Fish	Potential for collision with turbine blades.	Environmental monitoring to detect collision events.	Helps to develop an understanding of avoidance behaviour, nature of interactions and outcome of collision events. However, there are cost implications associated with this level of monitoring.
Tidal	Monitoring	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Environmental monitoring to detect collision events.	Understand avoidance behaviour, nature of interactions and outcome of collision events, however effective monitoring is expensive and requires a lot of data analysis.
Tidal	Monitoring	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and shut-down' system using active sonar and other appropriate monitoring equipment.	This could reduce/remove risk of collision with moving blades and enable a route through the consenting process, particularly at high sensitivity locations. However, this could affect power production, is expensive to implement and does not help to reduce scientific uncertainty regarding the risk. The reductions in power production, although small, would bring about uncertainty in the investment process and there are questions around impacts of sonar on sensitive species.

Choose:
-Tidal
-Collision Risk

Management Measures Tool

Filter by Technology Type:
 Filter by Management Measure Category:
 Filter by Project Phase:
 Filter by Stressor:
 Filter by Receptor:

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Tidal	Monitoring	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Environmental monitoring to better understand near-field behaviour and avoidance.	This will help reduce scientific uncertainty, however monitoring can be costly.
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and deter' system using a combination of active sonar and acoustic deterrent device (ADD).	This could reduce likelihood of collision with moving blades although the efficacy of ADDs in these environments is unknown and habituation to ADDs is known to occur in other industries. Could enable a route through the consenting process. This measure is expensive to implement and it is still unknown if deterrent systems will help reduce risk. There are also questions around the effects of ADDs on sensitive species. Their addition adds another noise impact which must also be considered in any project assessments. Would rely on well proven and reliable 'detect and deter' systems. Also, mitigation against collision may prevent discovering whether or not it is a real issue. Further research around ADDs which deter specific groups or species, is underway. This could be useful in deterring specific sensitive species or species groups, at a particular site. For example, University of St Andrews is developing an ADD which deter seals, but which don't effect cetaceans.
Tidal	Mitigation	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Selective structural and blade coatings i.e. colours to aide detection.	Unknown - it is possible that this will aid detection of subsea structures and help reduce risk. It can be captured in early project design for a small one-off cost, however further research is needed as there is potential for an increased collision risk through 'attraction'.
Tidal	Mitigation	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install acoustic deterrent devices (ADDs).	This could potentially reduce likelihood of collision with moving blades although the efficacy of ADDs in these environments is unknown. Constant deterring means habituation is likely. This is a simpler system than detect (efficiently) and deter, however would still be expensive to implement. It would also come with an additional noise impact which must also be considered in project assessments.
Tidal	Mitigation	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and shut-down' system using active sonar and other appropriate	This could reduce/remove risk of collision with moving blades and enable a route through the consenting process, particularly at high sensitivity locations. However, this could affect power production, is expensive to implement and does not help to reduce scientific uncertainty regarding the risk. The reduction in power production, although

Choose:
 -Tidal
 -Collision Risk
 -Marine Mammals

Management Measures Tool

Filter by Technology Type:
 Filter by Management Measure Category:
 Filter by Project Phase:
 Filter by Stressor:
 Filter by Receptor:

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install acoustic deterrent devices (ADDs).	This could potentially reduce likelihood of collision with moving blades although the efficacy of ADDs in these environments is unknown. Constant deterring means habituation is likely. This is a simpler system than detect (efficiently) and deter, however would still be expensive to implement. It would also come with an additional noise impact which must also be considered in project assessments.
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and shut-down' system using active sonar and other appropriate monitoring equipment.	This could reduce/remove risk of collision with moving blades and enable a route through the consenting process, particularly at high sensitivity locations. However, this could affect power production, is expensive to implement and does not help to reduce scientific uncertainty regarding the risk. The reductions in power production, although small, would bring about uncertainty in the investment process and there are questions around impacts of sonar on sensitive species.
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and deter' system using a combination of active sonar and acoustic deterrent device (ADD).	This could reduce likelihood of collision with moving blades although the efficacy of ADDs in these environments is unknown and habituation to ADDs is known to occur in other industries. Could enable a route through the consenting process. This measure is expensive to implement and it is still unknown if deterrent systems will help reduce risk. There are also questions around the effects of ADDs on sensitive species. Their addition adds another noise impact which must also be considered in any project assessments. Would rely on well proven and reliable 'detect and deter' systems. Also, mitigation against collision may prevent discovering whether or not it is a real issue. Further research around ADDs which deter specific groups or species, is underway. This could be useful in deterring specific sensitive species or species groups, at a particular site. For example, University of St Andrews is developing an ADD which deter seals, but which don't effect cetaceans.

Choose:
 -Tidal
 -Collision Risk
 -Marine Mammals
 -Design Feature

[CSV](#)




[New User](#)

If you are new to Tethys, start here to learn more



Name

Email

Comment

Management Measures Tool

Filter by Technology Type:
 Filter by Management Measure Category:
 Filter by Project Phase:
 Filter by Stressor:
 Filter by Receptor:

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install acoustic deterrent devices (ADDs).	This could potentially reduce likelihood of collision with moving blades although the efficacy of ADDs in these environments is unknown. Constant deterring means habituation is likely. This is a simpler system than detect (efficiently) and deter, however would still be expensive to implement. It would also come with an additional noise impact which must also be considered in project assessments.
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and shut-down' system using active sonar and other appropriate monitoring equipment.	This could reduce/remove risk of collision with moving blades and enable a route through the consenting process, particularly at high sensitivity locations. However, this could affect power production, is expensive to implement and does not help to reduce scientific uncertainty regarding the risk. The reductions in power production, although small, would bring about uncertainty in the investment process and there are questions around impacts of sonar on sensitive species.
Tidal	Design feature	Operation & Maintenance	Collision risk	Marine Mammals	Marine Mammals	Potential for collision with turbine blades.	Install a 'detect and deter' system using a combination of active sonar and acoustic deterrent device (ADD).	This could reduce likelihood of collision with moving blades although the efficacy of ADDs in these environments is unknown and habituation to ADDs is known to occur in other industries. Could enable a route through the consenting process. This measure is expensive to implement and it is still unknown if deterrent systems will help reduce risk. There are also questions around the effects of ADDs on sensitive species. Their addition adds another noise impact which must also be considered in any project assessments. Would rely on well proven and reliable 'detect and deter' systems. Also, mitigation against collision may prevent discovering whether or not it is a real issue. Further research around ADDs which deter specific groups or species, is underway. This could be useful in deterring specific sensitive species or species groups, at a particular site. For example, University of St Andrews is developing an ADD which deter seals, but which don't effect cetaceans.

Outcome

Filtered results can be exported to csv at any time.

CSV




[New User](#)

If you are new to Tethys, start here to learn more



Name:

Email:

Comment:

Management Measures Tool

Filter by Technology Type:
 Filter by Management Measure Category:
 Filter by Project Phase:
 Filter by Stressor:
 Filter by Receptor:

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Wave	Design feature	Installation	Loss of habitat	Benthic	Benthic invertebrates	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of devices associated moorings or support structures on the seabed.	Micrositing of offshore infrastructure to avoid sensitive habitats.	This could reduce/remove effects on sensitive habitats and can often be done with little additional costs.
Wave	Design feature	Installation	Loss of habitat	Benthic	Benthic invertebrates	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of devices associated moorings or support structures on the seabed.	Minimize footprint of anchors / foundations.	This could reduce effects on sensitive habitats, however the size of anchors/foundations likely to be that which is suitable for the safe and optimal operation of devices.
Wave	Design feature	Installation	Loss of habitat	Benthic	Benthic invertebrates	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of devices and associated moorings or support structures on the seabed.	Cable protection management measures to ensure that any rock placement that is required will be kept to a minimum to reduce seabed disturbance.	This could reduce effects on sensitive habitats.
Wave	Mitigation	Installation	Loss of habitat	Benthic	Benthic invertebrates	Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of devices and associated moorings or support structures on the seabed.	Use of locally sourced materials, for cable protection, of the same type as the habitat to be disturbed by cable installation.	Minimize impact on biodiversity/ecosystem.

[CSV](#)




[New User](#)

If you are new to Tethys, start here to learn more

[Knowledge Base](#)

Access thousands of publications and more, all in a searchable database



Name

Email

Comment

I agree to the [terms & conditions](#)

Choose:
Wave
Installation
Loss of Seabed Habitat
Effect on Benthic Communities

Management Measures Tool

Filter by Technology Type:
 Filter by Management Measure Category:
 Filter by Project Phase:
 Filter by Stressor:
 Filter by Receptor:

Technology Type	Management Measure Category	Phase of Project	Stressor	Receptor	Specific Receptor	Interaction	Specific Management Measures	Implications of Measure
Wave	Monitoring	Operation & Maintenance	Underwater noise	Fish	Fish	The potential effects from underwater noise generated by wave and tidal energy converters.	Measure noise generated by device(s) during operation to better understand the potential effects on sensitive species.	Measured noise levels can be correlated with threshold values of relevant species to determine impact and need for adaptive management measures. It can be complex and costly to undertake this type of monitoring in high energy environments.
Tidal	Monitoring	Operation & Maintenance	Collision risk	Fish	Fish	Potential for collision with turbine blades.	Environmental monitoring to better understand near-field behaviour and avoidance.	This will help reduce scientific uncertainty, however this type of monitoring can be expensive and there are difficulties associated with storing and analysing the data produced.
Wave	Monitoring	Operation & Maintenance	Entanglement	Fish	Basking shark; Large fish	Potential for marine animals to become entangled in lost fishing gear or other equipment trapped on infrastructure.	Ensure standard notifications of loss of fishing gear in region notified to operators. Reporting of entanglement events.	Good practice for emergency preparedness.
Tidal	Monitoring	Operation & Maintenance	Underwater noise	Fish	Fish	The potential effects from underwater noise generated by wave and tidal energy converters.	Measure noise generated by device(s) during operation to better understand the potential effects on sensitive species.	Measured noise levels can be correlated with threshold values of relevant species to determine impact and need for adaptive management measures. It can be complex and costly to undertake this type of monitoring in high energy environments.
Wave	Monitoring	Operation & Maintenance	Habitat creation	Fish	All receptors	The introduction of infrastructure and artificial substrates will provide habitat and artificial refuges. devices and associated moorings, support structures and export cables.	Monitor near-field behaviours. geophysical survey to identify scour pits, turbidity measurements.	Informs understanding of potential positive impacts from colonisation and use of the project infrastructure which could benefit future project applications. However, there is a cost implication associated with down. Additionally, the associated subsea static monitoring options require O&M which has potential time and cost implications.
Tidal	Monitoring	Operation & Maintenance	Underwater noise	Marine Mammals	Marine Mammals 78	The potential effects from underwater noise generated by wave and tidal energy converters.	Measure noise generated by device(s) during operation to better understand the potential effects on	Measured noise levels can be correlated with threshold values of relevant species to determine impact and need for adaptive management measures, however this can be complex and costly to undertake this type of

Choose:
Wave
O & M
Monitoring
Multiple Stressors
Fish

Management Measures Tool – Summary

- ▶ This tool should help manage potential effects
- ▶ For use in discussions and process for consent/permit
- ▶ Useful for developer operational plans
- ▶ Looking for feedback and use of the tool.





ANNEX IV



Proudly Operated by **Battelle** Since 1965

Questions & Answers

THANK YOU!

- ▶ Recordings of presentations will be posted on *Tethys* at:
<https://tethys.pnnl.gov/environmental-webinars?content=water>
 - Information on previous and upcoming Annex IV webinars
- ▶ Watch for announcements on *Tethys* and your email for the next Annex IV webinar
- ▶ For those of you who are not on the webinar mailing list, visit
<https://tethys.pnnl.gov/tethys-blasts/join>

Andrea Copping (Andrea.Copping@pnnl.gov)

Simon Geerlofs (Simon.Geerlofs@pnnl.gov)

Mikaela Freeman (Mikaela.Freeman@pnnl.gov)

Jonathan Whiting (Jonathan.Whiting@pnnl.gov)

Amy Woodbury (Amy.Woodbury@pnnl.gov)