Data Transferability Framework

Prepared for Workshop at ICOE

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Background

As the marine renewable energy (MRE) industry progresses in US and international waters, the increasing demand for data and information about how MRE technologies (wave and tidal devices) may interact with the marine environment continues. Our understanding of the potential environmental effects of MRE development is slowly increasing, informed by monitoring data collected around devices in several nations and a growing body of research studies. Information derived from monitoring and research is published in scientific journals and technical reports, which may not be readily accessible or available to regulators and other stakeholders.

Regulators in all jurisdictions must satisfy legal and regulatory mandates in order to grant permission to deploy and operate MRE devices. Inherent in these laws and regulations is a concept of balancing risk to the environment and human uses of public resources against economic development and human well-being. Research efforts related to the potential effects of MRE development are focused on this concept of risk, and the interactions between devices and the environment most likely to cause harm, or those for which the greatest uncertainty exists, are garnering the most attention (Copping et al. 2016). The components of risk—probability of occurrence and consequence of occurrence—are fundamental to the process by which regulators evaluate project compliance with environmental statutes. The concept of risk also provides an excellent context for discussing research outcomes and assisting regulators in learning more about potential effects.

The MRE industry is struggling with the high costs of baseline assessments and post-installation monitoring, as well as long timelines for obtaining permits, which lead to uncertainty and risk related to project financing. Regulators require assessment and monitoring information to allow them to carry out the necessary analyses to describe, permit, and manage the environmental risks associated with new MRE technologies and new uses of ocean space. One way to reduce risks to the industry and the environment, and to allow for acceleration of this new form of low carbon energy, could be the ability to transfer learning, analyses, and data sets from one country to another, among projects, and across jurisdictional boundaries.

As the MRE industry matures, the ability to readily transfer research and monitoring results, data, study designs, data collection methods, and best practices from project to project will lead to cost reductions for baseline environmental studies and post-installation monitoring. Regulators and stakeholders currently lack access to synthesized and contextualized data emerging from early-stage projects and there are no mechanisms by which to apply data and information across geographically distinct projects. This leads to each individual project bearing the full burden of information requirements on a site-by-site basis. In addition, data are collected around early-stage MRE devices using many different methods, instruments, and measurement scales. If similar parameters and accessible methods of collection were used for baseline and post-installation monitoring data around all early-stage devices, the results would be more readily comparable. This comparability would lead to a decrease in scientific uncertainty and support a common understanding of the risk of MRE devices to the marine environment. This in turn would facilitate more efficient and shorter permitting processes, which would decrease financial risk for MRE project development.

There continues to be high costs and long timelines for consenting/permitting marine renewable energy (MRE) devices. The ability to learn from early projects to inform consenting/permitting processes can help to lower costs and requirements for extensive data collection, and subsequently move deployment of wave and tidal devices forward.

The concept of “data transferability” and “collection consistency” will be examined at the workshop to enable efficent and effective consenting/permitting.

Data Transferability Framework

From examining data transferability literature and interacting with regulators, a framework has been developed to help guide the process of transferring data generated in one location for regulatory use in another location. Under Annex IV, the framework for data transferability has been developed that brings together datasets in an organized fashion, compares the applicability of each data set for use in other locations, and guides the process for data transfer. This framework consists of:

- a method for describing the environment and evaluating the comparability of data sets (MRE project archetypes);
- a series of steps to describe the applicability of the framework to MRE technologies; and
- a method for describing the application of a data set from one site to another to support regulator processes.

The framework proposed here can be used to aid the transfer of data between projects, develop a common understanding of data types and parameters to determine and address potential effects, engage regulators to test the framework, create a set of best practices for collection consistency, and set limits and considerations for how best practices can be applied to assist with effective and efficient siting, permitting, post-installation monitoring, and mitigation.

Following this document, considerations for applying the framework is proposed in a second document *Best Management Practices for Data Transferability and Collection Consistency for MRE*.

Key Interactions

The framework address the five most common concerns for consenting/permitting MRE devices in the Annex IV countries. ther interactions could be added to the framework in the future if there were cause to question their potential risk to the marine environment. The five key environmental interactions, or stressors, that have been identified for the framework are thought to likely cause the greatest risk to the marine environment, largely due to uncertainty and a paucity of data with which to inform models of interactions and to provide confidence in permitting/consenting decisions (Copping et al. 2016):

- Collision risk: The potential for marine animals to collide with tidal or river turbine blades, resulting in injury or death is a primary concern for consenting turbines. There is a high degree of uncertainty around the probability or consequence of collision, especially for populations afforded special protection (Copping et al. 2016).
- Underwater noise: The potential for the acoustic output from wave or tidal devices to mask the ability of marine mammals and fish communication and navigation remains uncertain, as does the protential to cause physical harm or to alter animal behavior (Clark et at. 2009; DOE 2009; Gotz et al. 2009; Wilson et al. 2007). Noise from installation, particularly pile driving may cause short-term harm; this risk is focused on the longer term operational sound of devices.
- Electromagnetic fields (EMF): EMFs emitted from power export cables and energized portions of MRE devices are thought to perhaps affect EMF-sensitive species by interrupting their orientation, navigation, and hunting. Cables have been deployed in the ocean for many decades, but uncertainty remains around the effects of cables associated with MRE devices (Copping et al. 2016)
- Changes in habitat: Placement of MRE devices in the marine environment may alter or eliminate surrounding habitat, which can impact the behavior of marine organisms. Habitat changes are well-studied in the marine environment from other industries and the small footprint of MRE devices are unlikely to affect animals or habitats differently than those from other industries, however regulators and stakeholders continue to express concern (Copping et al. 2016)
- Changes in physical systems: MRE devices may alter natural water flows and remove energy from physical systems, which could result in changes in sediment transport, water quality, and other effects on farfield habitats (Polayge et al. 2011). While there is a lack of field data to validate models, modeling results indicate impacts from single devices are too small to be measured, but should be revisited once large arrays of MRE devices are deployed (Copping et al. 2016; DOE 2009).

MRE Project Archetypes

The viability of transferring data or learning from early or existing projects to inform future projects was gleaned from literature in several fields. The most promising transferability methodology and framework that might be applied to MRE permitting follows that of Václavík et al. (2016), determined for research around sustainable land management. The authors' concept of defining a project "archetype" based on a variety of indicators can be applied to other place-based studies, including MRE studies. By adopting the concept of an "MRE project archetype" (MREPA), a combination of stressors, site conditions, MRE technologies, and receptors can be applied to help describe MRE projects. The comparability between archetypes at the location of origin of a dataset (such as from early projects) and the location to which data will be transferred (future projects) can be evaluated, forming the basis of the framework.

Each project MREPA is defined by four variables: stressors (or key interactions), site conditions, MRE technology types, and receptor groups. A series of matrices have been developed for each of the five key stressors that can be applied to an MRE project at the origin site and at the target site. From each matrix, an MREPA can be identified for a particular project or set of data that might be useful for transfer. For example, the MREPA matrix for collision risk indicates 22 possible MREPAs based on the project site conditions, MRE technology types, and receptors (Table 1). Defining the project MREPA is the first step in determining the ability to transfer data between projects, as discussed in the following section. The matices for five key stressors are shown in the Appendix.

Table 1. Marine Renewable Energy Project Archetype (MREPA) Matrix for Collision Risk.

Site Condition [(a)]	Technology	Receptors
Shallow and Narrow Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
		Diving Birds
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds
Shallow and Wide Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
		Diving Birds
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds
Deep and Wide Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds
Deep and Narrow Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds

(a) Shallow channels are defined as having a depth less than 40 m. Deep channels are defined as having a depth greater than 40 m. Narrow channels are defined as having a width of less than 2 km. Wide channels are defined as having a width greater than 2 km.

Applying the framework

The purpose of applying the data transferability framework is to classify projects by archetype to enable discovery of existing datasets that are comparable, in order to inform the potential risks of future projects. Once comparable datasets have been discovered and reviewed, there is a strong potential that trends and conclusions about specific interactions and risks from the existing datasets can inform future projects, resulting in a decrease in need for site specific data collection, and more efficient permitting/consenting.

To apply the framework the following *Guidelines for Transferability* have been laid out:

1. Characterize the MREPA of the future project by examining the stressors, site conditions, MRE technology types, and receptors. Figure 1 provides an example of characterizing a project for collision risk for marine mammals.

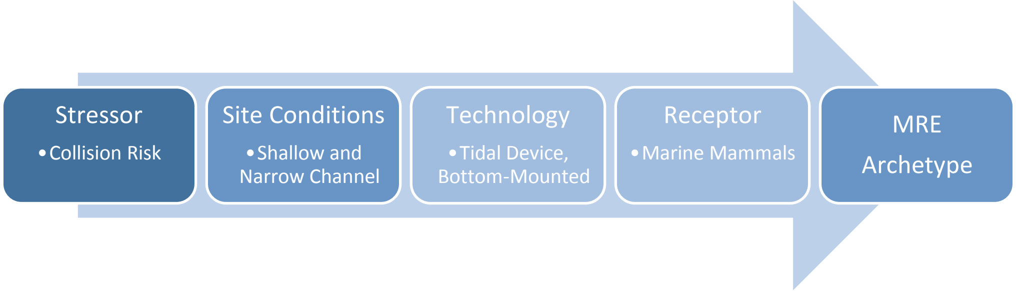

Figure 1.Example of an MREPA for a project site of origin.

2. Compare the MREPA of the future project with those of existing projects to determine the similarlity of the MREPAs.

3. Evaluate the transferability potential of information from existing projects to the future project. In order for data transferability to be considered, the two projects *must share the same MREPA*, thereby ensuring that the two locations share the same stressor, site conditions, MRE technology types, and receptors. Next, the degree of transferability should be evaluated by examining the receptor species, specific technology types, wave or tidal resource, and geographical proximity of the projects to one another, with the necessity of matching all features from existing datasets to those of future projects, decreasing with each step (Figure 2).

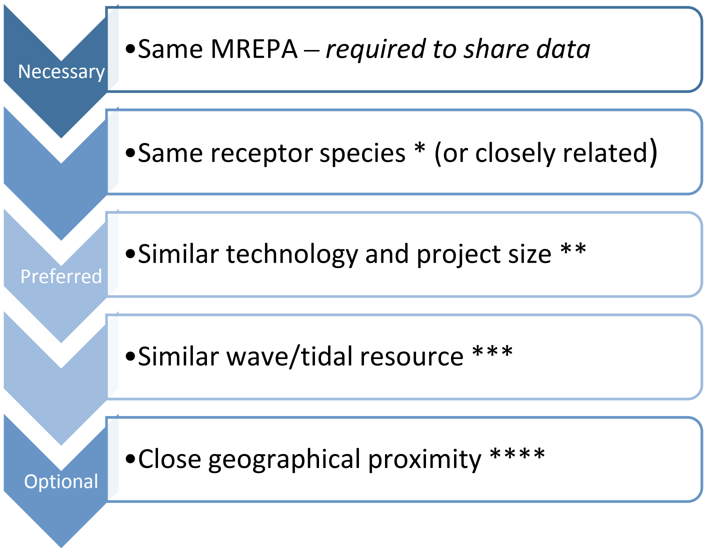

Figure 2. Evaluation Heirarchy for transferability potential of data.

* The same or closely related receptor species is needed; for example, transferring learning among seal species may be appropriate, while little may be learned about effects on a seal species with data related to whale species around an MRE project.

** Similar types of wave devices or tidal devices will produce better learning for future proejcts. For example, it would be best to compare point absorber data from an existing project to a future point absorber project, rather than compare to an oscillating water column device. In addition, data will best be transferred among projects with small numbers of devices, or among arrays.

*** Transferring data between projects with similar wave or tidal energy resources is likely to results in more comparable results. For example, comparing high velocity tidal currents (>3m/s) among projects is preferably to comparing a high velocity tidal current project (>3 m/s) to a lower velocity current (<1.5 m/s) project.

**** The closer that projects are geographically located, the more comparable the data are likely to be.

Data Discovery

As a companion to the framework, a *Monitoring Dataset Matrix* is under development, to classify all existing monitoring datasets by an MREPA, as well as listing key metadata features of each dataset (i.e., data parameters, collection location, collection methods, contact, etc.). Once completed, the *Monitoring Dataset Matrix* will allow a practitioner to discover datasets, based on the MREPA, to evaluate the consistency of information, and therefore the data transferability, between the existing datasets and data that will be collected for future projects.

Use of the Framework

By implementing the data transferability framework, the siting and permitting/consenting processes for installation of single MRE devices and arrays may be shortened and scarce funding resources directed toward interactions that remain most uncertain. The framework is developed to provide a background against which discussions with regulators can proceed to understand the limits of transferability, based on the confidence individual regulators have to accept data and information collected in one location for information analyses of applications for MREs in her/his jurisdiction. The framework will also facilitate initial permitting/consenting discussions between developers and regulators to determine data collection and monitoring efforts needed to license a project and to determine operational monitoring needs.

References

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Appendix

MRE Archetype Matrices

The MRE project archetypes (MREPA) are shown for each stressor, which identify the potential site conditions, MRE technology types, and receptors that can be described for existing MRE projects and for future projects. From each matrix, an MREPA can be identified for a particular project or set of data that might be useful for transfer. Defining the project MREPA is the first step in determining the transferability potential of data from existing projects to future projects.

Collision Risk

The potential for marine animals to collide with tidal or river turbine blades, resulting in injury or death is a primary concern for consenting turbines. There is a high degree of uncertainty around the probability or consequence of collision, especially for populations afforded special protection (Copping et al. 2016). Projects related to collision risk have the potential to be classified as one of 22 possible MREPAs based on the project site conditions, MRE technology types, and receptors (Table 1).

Table 1. Marine Renewable Energy Project Archetype (MREPA) Matrix for Collision Risk.

Site Condition [(a)]	Technology	Receptors
Shallow and Narrow Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
		Diving Birds
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds
Shallow and Wide Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
		Diving Birds
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds
Deep and Wide Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds
Deep and Narrow Channels	Tidal Device, Bottom-Mounted	Marine Mammals
		Fish
	Tidal Device in the Water Column	Marine Mammals
		Fish
		Diving Birds

(a) Shallow channels are defined as having a depth less than 40 m. Deep channels are defined as having a depth greater than 40 m. Narrow channels are defined as having a width of less than 2 km. Wide channels are defined as having a width greater than 2 km.

Underwater Noise

The potential for the acoustic output from wave or tidal devices to mask the ability of marine mammals and fish communication and navigation remains uncertain, as does the protential to cause physical harm or to alter animal behavior (Clark et at. 2009; DOE 2009; Gotz et al. 2009; Wilson et al. 2007). Noise from installation, particularly pile driving may cause short-term harm; this risk is focused on the longer term operational sound of devices. Projects related to underwater noise have the potential to be classified as one of 8 possible MREPAs based on the project site conditions, MRE technology types, and receptors (Table 2).

Table 2. MREPA Matrix for Effects of Underwater Noise.

Site Condition	Technology [(a)]	Receptors
Isolated/Quiet Environment	Tidal Device	Marine Mammals
		Fish
	Wave Device	Marine Mammals
		Fish
Noisy Environment	Tidal Device	Marine Mammals
		Fish
	Wave Device	Marine Mammals
		Fish

(a) Sound levels generally caused by specific portions of each technology: tidal device sound from blade and rotor rotation, as well as power take offs; wave device sound from power take offs. In addition, some lower levels of sound may be generated by mooring systems and interactions between the device and the surface waters, but these sounds were considered to be of less amplitude and unlikely to be of concern for marine mammals (Copping et al. 2016). Isolated/Quite Environments are those with noise measuring less than 80 db. Noisy Environments are those with noise measuring greater than 80 db,

Electromagnetic Fields (EMF)

EMFs emitted from power export cables and energized portions of MRE devices are thought to perhaps affect EMF-sensitive species by interrupting their orientation, navigation, and hunting. Cables have been deployed in the ocean for many decades, but uncertainty remains around the effects of cables associated with MRE devices (Copping et al. 2016). Projects related to EMF have the potential to be classified as one of 10 possible MREPAs based on the project site conditions, MRE technology types, and receptors (Table 3).

Table 3. MREPA Matrix for Effects of EMFs.

Site Condition	Technology	Receptors
Buried Cables	Seafloor Cables	Elasmobranchs
		Mobile /Sedentary Invertebrates
Cables Laid on Seafloor	Seafloor Cables	Elasmobranchs
		Mobile/Sedentary Invertebrates
Shielded Cables	Seafloor Cables	Elasmobranchs
		Mobile/Sedentary Invertebrates
Unshielded Cables	Seafloor Cables	Elasmobranchs
		Mobile/Sedentary Invertebrates
	Draped cables	Elasmobranchs
		Mobile/Sedentary Invertebrates

Habitat Changes

Placement of MRE devices in the marine environment may alter or eliminate surrounding habitat, which can impact the behavior of marine organisms. Habitat changes are well-studied in the marine environment from other industries and the small footprint of MRE devices are unlikely to affect animals or habitats differently than those from other industries, however regulators and stakeholders continue to express concern (Copping et al. 2016). Projects related to habitat changes have the potential to be classified as one of 9 possible MREPAs based on the project site conditions, MRE technology types, and receptors (Table 4).

Table 4. MREPA Matrix for Nearshore Changes to Habitat and Reefing Patterns.

Site Condition	Technology	Receptors
Hard Bottom Habitat	Foundation/Anchors	Benthic Invertebrates
		Demersal Fish
		Shoaling Fish
Soft-Bottom Habitat	Foundation/Anchors	Benthic Invertebrates
		Demersal Fish
		Shoaling Fish
Water Column	Floats/Mooring Lines	Marine Mammals and Sea Turtles
		Demersal Fish
		Shoaling Fish

Physical Systems Changes

Changes in physical systems: MRE devices may alter natural water flows and remove energy from physical systems, which could result in changes in sediment transport, water quality, and other effects on farfield habitats (Polayge et al. 2011). While there is a lack of field data to validate models, modeling results indicate impacts from single devices are too small to be measured, but should be revisited once large arrays of MRE devices are deployed (Copping et al. 2016; DOE 2009). Projects related to physical systems changes have the potential to be classified as one of 4 possible MREPAs based on the project site conditions, MRE technology types, and receptors (Table 5).

Table 5. MREPA Matrix for Changes to Physical Systems and Farfield Habitat Changes.

Site Condition	Technology	Receptors
Enclosed Basin	Tidal Device	Sediment Transport
		Water Quality/Food Web
Open Coast	Wave Device	Sediment Transport
		Water Quality/Food Web