gwerth mewn gwahaniaeth
delivering on distinction

Morlais Demonstration Zone

Additional Information to Support Morlais Habitats Regulations Assessment (migratory fish)

Document Title: Additional Information to Support Morlais Habitats Regulations Assessment (migratory fish)			
Morlais Document No. MOR-MSP-DOC-003 File No.: MMC351	Status: FINAL	Version No: F1	Date: 16/10/2020

MarineSpace

Making Sense of the Marine Environment ™

Additional Information to Support Morlais Habitats Regulations Assessment (migratory fish)

Document Ref: J/2/16/16	Originator: D Kirby
Date: 16/10/2015	Circulation: Open

Additional Information to Support Morlais Habitats Regulations Assessment

Prepared by:

MarineSpace Ltd

MarineSpace
Making Sense of the Marine Environment™

MarineSpace Ltd
Ocean Village Innovation Centre
Ocean Way
Southampton
SO14 3JZ

Date	Originator	Version	Action	Signature
14/10/2020	D Kirby	0.1	Internal Draft	
14/10/2020	J Lewis	1.0	Director Sign-off / External Document	
16/10/2020	O Humphrey	1.1	Internal Draft - Addressing Client / Regulator Comments	
16/10/2020	J Lewis	2.0	Director Sign-off / External Document	
			Choose an item.	
			Choose an item.	
			Choose an item.	
			Choose an item.	
			Choose an item.	
			Choose an item.	

Contents

List of Figures

No table of figures entries found.

List of Tables

This document forms an addendum to the Information to Support Habitats Regulations Assessment [Document MOR/RHDHC/DOC/0067] previously submitted by Menter Mon.

Natural Resources Wales (NRW) maintain a view that the Morlais Project way cause adverse effects to migratory fish species listed in Annex II of the Habitats Directive of designated sites in north Wales, particularly the Atlantic salmon of the Afon Gwyrfai a Llyn Cwellyn SAC. NRW have advised, therefore, that they are not currently able to reach a conclusion on Adverse Effect on Site Integrity (AEOSI) based on the information presented.

The purpose of this document is to present additional information on Stage 2 (Assessment) of the shadow Habitats Regulations Assessment for Morlais, in relation to migratory fish. An update to Stage 1 (Screening) in relation to Annex II migratory fish species is also provided for context and to demonstrate why additional Stage 2 information is being presented.

1. Stage 1

1.1. Migratory Fish

1.1.1. Introduction

It was identified in the Morlais HRA Scoping Document that the potential impacts on fish that may arise from the activities at Morlais Demonstration Zone (MDZ):

- Effects of electromagnetic fields;
- Effects of underwater noise;
- Barriers to migration routes;
- Collision risk with devices;
- Effects of habitat loss; and
- Indirect effects such as changes to habitat or availability/distribution of prey species.

Table 1-1[1] was compiled to illustrate the potential impact pathways that might arise as a result of different phases of the project. The categories of operations were taken from the Regulation 33 advice for the Severn Estuary/Môr Hafren SAC and supplemented with project-specific operations that may be missing from the published advice package.

Where there is no potential for a particular impact pathway to arise from the project, these have automatically been screened out of assessment and are greyed out.

Where there is a potential for the impact pathway to arise only in the case of a direct spatial overlap between the MDZ and the European site, which is not possible, these were screened out of assessment and recorded as N in **Table 1-1** (N = no pathway).

[1] Table Numberings relate to the original "Information to Support Habitats Regulations Assessment" (Document MOR/RHDHC/DOC/0067) previously submitted by Menter Mon.

Table 1-1 Summary of Impact Pathways for the Morlais Development Zone

Categories of operations which may cause deterioration or disturbance		Does phase lead to such a category of operations?		
		Construction	**Operation**	**Decommissioning**
Physical Loss	Removal/substratum loss	N	N	N
	Smothering	N	N	N
Physical Damage	Changes in suspended sediment	Y – migration route only	Y – migration route only	Y – migration route only
	Desiccation & changes in emergence regime			
	Changes in water flow rate	N	N	N
	Changes in wave exposure	N	N	N
	Abrasion/physical disturbance (of habitats)	N	N	N
	Changes in grazing management			
Non-physical disturbance	Noise and visual presence	Y – migration route only	Y – migration route only	Y – migration route only
Toxic contamination	Introduction of synthetic compounds			
	Introduction of non-synthetic compounds[1]			
	Introduction of radionuclides			
Non-toxic contamination	Changes in nutrient loading			
	Changes in thermal regime		N	
	Changes in turbidity (light penetration)	Y – migration route only	Y – migration route only	Y – migration route only
	Changes in salinity		N	
	Changes in oxygenation			
Biological disturbance	Introduction of microbial pathogens			
	Introduction of non-native species	N		N
	Selective extraction of species			
Additional mechanisms	Collision risk		Y	
	Effects of electromagnetic field		Y	
	Non-selective extraction of species		Y	

[1] Introduction of non-synthetic compounds such as oil is considered a force majeure i.e. an unforeseeable catastrophic event. It is considered that the likelihood of occurrence is negligible, therefore it has not been considered as part of the assessment.

The impact pathways that have not been screened out in **Table 1-1** have been carried forward and assessed for LSE against the migratory fish features of European sites screened into assessment.

It should be noted that both Annex II species of lamprey: sea lamprey *Petromyzon marinus*; and river lamprey *Lampetra fluviatilis* have been screened out of impact pathways arising from underwater noise. Research presented in the Moray West Offshore Wind Farm HRA screening report indicates that sea lamprey respond to sound at frequencies of between 20 Hz and 100 Hz.

However, they do not possess a swim bladder and are less sensitive to sound than fish that do possess a swim bladder (Moray Offshore Windfarm (West) Ltd, 2017). Both species are considered not sensitive to the effects of underwater sound emissions for this shadow HRA and are screened out of assessment.

In the case of SACs for Annex II migratory fish, they are listed in **Table 1-2** in order of increasing distance from the MDZ.

1.1.2. Designated sites

1.1.2.1. Screening Overview

Table 1-2 presents the LSE assessment of the proposed scheme on the designated features of the designated sites for migratory fish. There are no LSE predicted on the qualifying species of any of the designated sites, which are therefore screened out of further assessment.

Table 1-2 Summary of LSE for Afon Gwyrfai a Llyn Cwellyn SAC

Name of site	Distance to project (between nearest extent of MDZ and outer extent of site) (km)	European site features	Impact pathways during construction (C), operation (O) and decommissioning (D). (✓ = potential for LSE; X = no potential for LSE; a, b, c, d, e, f = relevant explanatory text)																	
			Disturb. Of migratory routes by u/water noise.			Changes in water quality of migratory routes			Changes in prey availability of migratory routes			Barrier to migration routes			Collision with devices			EMF		
			C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Afon Gwyrfai a Llyn Cwellyn SAC	31	Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Afon Eden - Cors Goch Trawsfynydd SAC	65	Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Dee and Bala Lake/ Afon Dyfrdwy a Llyn Tegid SAC	77	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Dee Estuary/ Aber Dyfrdwy SAC	86	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Cardigan Bay/ Bae Ceredigion SAC	97	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Wye/ Afon Gwy SAC	114	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	

Name of site	Distance to project (between nearest extent of MDZ and outer extent of site) (km)	European site features	Impact pathways during construction (C), operation (O) and decommissioning (D). (✓ = potential for LSE; X = no potential for LSE; a, b, c, d, e, f = relevant explanatory text)																	
			Disturb. Of migratory routes by u/water noise.			Changes in water quality of migratory routes			Changes in prey availability of migratory routes			Barrier to migration routes			Collision with devices			EMF		
			C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
River Wye/ Afon Gwy SAC	114	River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Twaite shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Afon Teifi/ River Teifi SAC	121	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Allis shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Twaite shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Afonydd Cleddau/ Cleddau Rivers SAC	143	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Pembrokeshire Marine/ Sir Benfro Forol SAC	149	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Allis shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	

Name of site	Distance to project (between nearest extent of MDZ and outer extent of site) (km)	European site features	Impact pathways during construction (C), operation (O) and decommissioning (D). (✓ = potential for LSE; X = no potential for LSE; a, b, c, d, e, f = relevant explanatory text)																	
			Disturb. Of migratory routes by u/water noise.			Changes in water quality of migratory routes			Changes in prey availability of migratory routes			Barrier to migration routes			Collision with devices			EMF		
			C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Pembrokeshire Marine/ Sir Benfro Forol SAC	149	Twaite shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Ehen SAC	151	Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Afon Tywi/ River Tywi SAC	153	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Allis shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Twaite shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Usk SAC	155	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Twaite shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Derwent and Bassenthwaite Lake SAC	160	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Derwent and	160	River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	

Name of site	Distance to project (between nearest extent of MDZ and outer extent of site) (km)	European site features	Impact pathways during construction (C), operation (O) and decommissioning (D). (✓ = potential for LSE; X = no potential for LSE; a, b, c, d, e, f = relevant explanatory text)																	
			Disturb. Of migratory routes by u/water noise.			Changes in water quality of migratory routes			Changes in prey availability of migratory routes			Barrier to migration routes			Collision with devices			EMF		
			C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Bassenthwaite Lake SAC		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Carmarthen Bay and Estuaries/ Bae Caerfyrddin ac Aberoedd SAC	162	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Allis shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Twaite shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Bladnoch SAC	167	Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Eden SAC	175	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Solway Firth SAC	178	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Severn Estuary/Môr Hafren SAC	222	Sea lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
	222	River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	

Name of site	Distance to project (between nearest extent of MDZ and outer extent of site) (km)	European site features	Impact pathways during construction (C), operation (O) and decommissioning (D). (✓ = potential for LSE; X = no potential for LSE; a, b, c, d, e, f = relevant explanatory text)																	
			Disturb. Of migratory routes by u/water noise.			Changes in water quality of migratory routes			Changes in prey availability of migratory routes			Barrier to migration routes			Collision with devices			EMF		
			C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
		Twaite shad	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
River Camel SAC	289	Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
Endrick Water SAC	302	River lamprey				Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	
		Atlantic salmon	Xa	Xa	Xa	Xb	Xb	Xb	Xc	Xc	Xc		Xd			✓e			Xf	

1. Explanatory Text

Table 1-2 (a)

Sensitivity to underwater noise is dependent upon the specific hearing abilities of the species. The potential effects are:

- Lethal effects and physical injury;
- Auditory injury (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)); and
- Behavioural response.

Nedwell et al. (2008) discuss injury and fatality from underwater transient pressure waves related to both the peak pressure, and the duration that the peak pressure acts upon the body of the fish. In terms of a peak pressure level exposure it is indicated that:

- Lethal effects occur at incident peak underwater sound levels of ≥260 dB re 1µPa @ 1 m;
- There is increasing likelihood of death or severe injury leading to death in a short time at incident peak underwater sound levels of ≥240 dB re 1µPa @ 1 m; and
- Direct physical injury to gas-containing structures and auditory organs may occur, particularly from repeat exposures at incident peak underwater sound levels of ≥220 dB re 1µPa @ 1 m.

Atlantic salmon can detect and respond to underwater sound emissions. They are classified as hearing generalists, unable to hear high frequencies but are able to hear low frequency sound and infrasound (SSE, 2011). Nedwell *et al.* (2008) postulate that Atlantic salmon is most sensitive to underwater sound at a frequency of 160 Hz, where the threshold Sound Pressure Level is 95 dB re 1 µPa @ 1 m. Based on these data, underwater noise might cause tissue damage to the auditory system (PTS) of the salmon following 1 hour exposure at a level of 215 dB re 1 µPa @ 1 m. Hearing impairment (TTS) might occur following exposure at a level of 195 dB re 1 µPa @ 1 m (for a period of 1 hour).

Atlantic salmon have a dBht *Salmo salar* metric of 90dBht (SSE, 2011). This is postulated as the threshold for significant avoidance reaction, meaning virtually all individuals will take avoidance action when exposed to that sound level.

Allis and twaite shad are clupeids (herring family). Clupeids are known as underwater sound emission sensitive species as they are classified as hearing specialists. Clupeids have a greater hearing range than most fish and being able to detect ultrasound (up to 180 kHz) (Popper *et al.*, 2004). In the absence of shad-specific sonograms those of Atlantic herring have been used.

Doksætera *et al.* (2009) demonstrated that transmissions of 1–2kHz nor 6–7kHz6 have any significant negative influence on Atlantic herring on the received sound pressure level tested (127–197 and 139–209 dB139–209 dB re 1µPa @ 1 m, respectively). Military sonars of such frequencies and source levels were determined to have no adverse effects in areas of overwintering Atlantic herring including not substantially affecting their behaviour.

Construction and Decommissioning

The worst-case scenario for underwater sound and pressure emissions during the project will arise during the construction phase (and therefore, by extension, also assumed as likely to occur during the

decommissioning phase). Sound emissions will be associated with the drilling/drill-drive-drill sub-activity during installation.

Nedwell *et al.* (2003) assessed the noise from rock socket drilling, comprising drilling into hard rock that may be considered comparable to the operations that may occur as part of construction of MDZ. Drill noise was predominantly low in frequency, with a strong fundamental component at 125 Hz and harmonics up to 1 kHz. Drill noise therefore falls within the frequency ranges produced by shipping noise (<1 kHz). The drill noise could be detected above background levels up to 7 km from the source. Unfortunately, the source level could not be determined from the data.

MeyGen (2012) reviewed published noise level records of drilling in order to inform their assessment for tidal turbine development. McCauley (1998) measured drilling from an oil drilling rig and indicated that broadband source levels were around 144 dB re 1 µPa @ 1 m. Analysis of the drilling noise showed that dominant tones were produced in the 31 Hz and 62 Hz 1/3 octave bands. Nedwell *et al.* (2010) reported that noise levels produced during foundation socket drilling were 178 dB re 1 µPa @ 1 m. These measurements were taken in an area of sandstone bedrock, not dissimilar to the MDZ. MeyGen (2012) reported that it was uncertain which of these two noise level measurements would be more representative of the noise levels produced during construction of the tidal device due to the overall lack of data on noise measurements.

PTEC (2014) modelled the underwater noise levels of drilling operations in support of a tidal energy project. Noise propagation modelling was undertaken for a series of scenarios of drilling operations, for which the worst-case scenario was a 4 m diameter pile and a 333 kW drill power. It was determined that the maximum noise level modelled (160 dB re 1 µPa) was detectable at a maximum range of 18 m from the source. This noise level is considerably lower (35 dB) than the threshold which can result in disturbance (TTS) to Atlantic salmon. Unfortunately, the source level could not be determined from the data. It is not known at what distance the threshold noise levels for impact would be reached. However, it can be inferred that noise levels which could lead to disturbance levels would only occur in the immediate vicinity (i.e. <18 m) of drilling operations.

In line with the precautionary principle the worst-case scenario for noise production has been used to inform the screening exercise. The worst-case noise levels are below the threshold for onset of TTS in the most sensitive Annex II migratory fish species; therefore, even at 1 m from the drilling noise source, the noise levels will be below the threshold for detection by the individual.

Assessment associated with installation for the MeyGen project (MeyGen, 2012), which assessed the use of foundation socket drilling into the seabed to install pin-piled tripods, determined no likely significant effects on fish species.

MeyGen (2012) indicated that there was one available measurement for operational noise produced by a tidal turbine, that of a 300 kW horizontal axis turbine in the Bristol Channel, which was modelled to produce a source level of 165.7 dB re 1 µPa @ 1m. Following the application of an uplift factor, MeyGen (2012) determined that source level for a 1 MW and 2.4 MW would be 171 dB re 1 µPa @ 1m and 177 dB re 1 µPa @ 1m, respectively.

Using these measurements, MeyGen (2012) found that, under a worst-case deployment scenario of 36 x 2.4 MW turbine, operational noise from turbines would not cause mortality or injury and a behavioural reaction of strong avoidance would occur at 18 m and mild avoidance at 68 m (for the most sensitive hearing specialists such as herring).

Operation

Studies such as Frid *et al.* (2012), state that operational noise of tidal energy convertors is unlikely to be ecologically significant.

There is very little information on the operational noise produced by tidal devices. However, the information available has informed a number of preceding EIA studies, including the recently consented PTEC project. The results from the noise modelling conducted for the PTEC project (2014) and MeyGen (Kongsberg, 2012) have been applied to this project. Information from the Technical Note produced by Subacoustech (2019) for this project is also used.

Subacoustech (2019) reviewed the noise outputs of a suite of tidal devices. It was reported that predicted source noise levels ranged from 145 to 175 dB re 1 uPa @ 1 m. The corresponding frequency range was rarely reported. One turbine design with the most information available, OpenHydro, has a predicted source noise level of 152 dB SPL_{RMS}, with the majority of the energy centred on the 125 Hz 1/3 octave frequency band. This low frequency noise is within the typical frequency range of the predominant component of ambient noise (Subacoustech, 2019) as well as fish hearing ability (e.g. salmon; Harding *et al.,* 2016). The noise emitted from OpenHydro was reported to reach background noise levels within 1-1.5 km from the source.

Four underwater noise monitoring stations were installed in the MDZ by SEACAMS (University of Bangor) to record background noise and assess variation on a daily and tidal cycle basis (Subacoustech, 2019). Underwater noise measurements were taken over periods of 15-30 days in 2016, 2017 and 2018. Analysis of the records revealed that noise levels were highly consistent between sites and years; all were between 89 dB to 107 dB SPL_{RMS} re 1 µPa. As expected there was variation in the noise levels with the position of the tide, and when marine traffic was present.

PTEC (2014) modelled the propagation of operational noise of a tidal turbine of maximum rotor diameter of 24 m. They reported that a level of 160 dB re 1 µPa would be reached at a maximum of 6 m from the turbine. Note that this is smaller than the maximum rotor size potentially proposed for the Project, 27 m, however, the scale of potential effect on fish species associated with the noise of tidal turbines from PTEC and MeyGen shows range to be limited to the low 10s of metres at greatest, and this is expected for other tidal turbines of a similar scale.

For the MeyGen project, the behavioural impact ranges of fish were modelled for the operational noise predicted to be emitted from a 1 MW and 2.4 MW turbine. Operational noise was predicted to be up to 177 dB SPL_{RMS} for a 2.4 MW turbine, with peak energy content below 100 Hz but also significant peaks in the 1,500 Hz and 5,000 Hz bands (Subacoustech, 2019).

The findings of MeyGen (2012) and PTEC (2014) show that any impacts of underwater noise from construction and operation will be limited to the area immediately surrounding the device and is unlikely to extend beyond the boundaries of the MDZ. The worst-case scenario of complete avoidance of the MDZ due to underwater noise is not considered to have an ecologically significant effect on the migratory routes of Annex II migratory fish as the area is very small in comparison to the total available habitat for migration and so can be avoided at minimal cost to the individual, particularly as there are no natal rivers inshore of the MDZ. Therefore, the pressure pathway from noise during the construction and operation phase of the project is not considered significant.

No LSE will arise from disturbance of the designated Annex II migratory fish populations using migratory routes in association with underwater noise.

Table 1-2 (b)

There may be a localised decrease in water quality associated with potential increases in suspended sediment concentrations/increase in turbidity arising from resuspension of sediments.

Resuspension may arise from excavation of seabed material and dumping *in situ* for the emplacement of structures (construction and decommissioning phase). However, as the site comprises mostly rock, no significant amounts of sediment are expected to be resuspended.

Sediment plumes are not expected to be generated during the project at any phase.

Resuspension due to changes in the hydrodynamic regime around the structures (operational phase) is anticipated to be extremely localised and contained to the site only. Therefore, the exposure pathway for any small increases in turbidity at certain restricted times are not likely to result in any significant effects with any migratory fish features of SACs assessed. This is especially the case when considering the context of the migratory 'space' associated with the Irish Sea and the Southwest Approaches.

No LSE will arise from changes in water quality of migratory routes for the designated Annex II migratory fish populations associated with any SACs.

Table 1-2 (c)

The project may potentially indirectly affect prey availability in the area through a variety of mechanisms including, but not limited to, removal/loss of habitat supporting prey species, increased turbidity, underwater sound emissions, and changes in hydrodynamics.

The MDZ is not known to be a key feeding ground for any of the Annex II migratory fish species at any of their life stages. Nonetheless, it cannot be ruled out that some species may opportunistically feed in the area as they pass through.

Assessments associated with MeyGen determined that no significant effects would result concerning habitat supporting prey species or prey species themselves. The project EIA of fish ecology and populations relevant to the MDZ also indicate no LSE is expected to occur. Habitat loss at the seabed and increases in turbidity are not determined to be significant, nor are effects of underwater emissions, associated with construction or operation of the tidal energy convertors.

The MDZ represents a very small portion of the overall area transited by migratory fish in the context of the total available habitat space of the Irish Sea and Southwest Approaches. The results from MeyGen (2012) and PTEC (2014) demonstrate that the area within which there would be an impact of underwater noise would not exceed the boundary of the MDZ. Nedwell *et al.* (2003) demonstrated that drilling noise may be detectable above background noise at a distance of up to 7 km. Although larger than the boundary of the MDZ, the potential zone of impact from noise around the MDZ is also not a significant proportion of the total habitat available. As such, it can be assessed that no LSE will arise on any designated Annex II migratory fish population features of SACs as a result of effect of changes in prey species.

Table 1-2 (d)

The physical structures of the MDZ, including the tidal energy convertors and seabed foundations may pose a barrier to the migratory route of Annex II fish populations.

The physical structures of the MDZ will be contained within the consent area, delineated by the red line boundary. The potential distribution of infrastructure and convertors within the MDZ is unlikely to present a complete barrier to the passage of migrating fish. However, the maximum additional distance that would be added to a migration (if any individual had to go around the edge of the consent area instead of along the coast) would be approximately 25 km.

The MDZ will be unlikely to form a barrier to any key migration routes that are unavoidable. There are no SACs designated inshore of the MDZ.

The MDZ represents a very small portion of the overall area passed through by migratory fish in the context of the Irish Sea and the Southwest Approaches. As such, it can be assessed that no LSE will arise on any migratory fish features of SACs as a result of physical barrier to migration.

Table 1-2 (e)

Due to the limited data available on routes followed by migratory fish species, there is a high level of uncertainty with regards to potential exposure of these species to tidal energy devices. Uncertainty regarding the potential collision risk is the result of from limited understanding of the ability of these animals for long range avoidance, i.e. the potential of the fish to detect the operational noise of the device, and their ability for close-range evasion, i.e. - the potential of the fish to visually detect the device. **Given this uncertainty, LSEs upon designated Annex II migratory fish populations for collision risk cannot be excluded without further analysis. Therefore, further information/assessment is presented below to inform Stage 2 of the HRA process. All SAC's identified in Stage 1 (Screening) with migratory fish qualifying features are included in Stage (Assessment) due to the uncertainty about the origin/destination (in terms of SACs) of migratory fish that may pass through the MDZ.**

Table 1-2 (f)

EMF emissions can arise in the immediate area around cables that would be used as part of the MDZ project. Assessments of EMF have indicated that electrical fields reach background levels at a distance of 20 m (Frid *et al.*, 2012).

There is generally a lack of understanding on the potential impacts of EMF on marine species. EMF can have a disorientating effect on migratory fish species as they use electromagnetic fields for navigation purposes, though the extent to which this is used is species-specific. EMF could therefore result in exclusion of use of the zone or cause loss of the individual from the population.

As stated before, the MDZ represents a very small part of the total habitat available to migratory fish throughout the Irish Sea. Exclusion from the area, or loss of the individuals that use the area, is unlikely to result in a likely significant effect on the population of designated Annex II migratory fish species of a SAC in relation to EMF.

2. Stage 2 Assessment

2.1. Migratory Fish

The following assessment is broken down into 2 steps:

- Identification of conservation objectives for each of the designated sites screened into Stage 2 assessment; and

- Assessment of impact pathways n.b. a single assessment will be provided for all designated sites.

2.1.1. Conservation Objectives

2.1.1.1. Afon Gwyrfai a Llyn Cwellyn SAC (31 km from MDZ)

A single species from this SAC, Atlantic Salmon, is considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:

- The population of the feature in the SAC is stable or increasing over the long term;
- The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. Natural factors such as waterfalls may limit the natural range of individual species. Existing artificial influences on natural range that cause an adverse effect on site integrity, such as physical barriers to migration, will be assessed; and
- The Gwyrfai will continue to be a sufficiently large habitat to maintain the feature's population in the SAC on a long-term basis.

2.1.1.2. Afon Eden - Cors Goch Trawsfynydd SAC (65 km from MDZ)

A single species from this SAC, Atlantic Salmon, is considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:

- The Atlantic salmon population must be viable throughout its distribution in the river and maintaining itself on a long-term basis.
- There will be no contraction of the number or age range of the salmon population.
- There will be sufficient habitat to support a viable population.
- All factors affecting the achievement of these conditions are under control.

2.1.1.3. River Dee and Bala Lake/ Afon Dyfrdwy a Llyn Tegid SAC (77 km from MDZ)

Three species from this SAC, Atlantic Salmon, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The SAC feature populations will be stable or increasing over the long term.
- The natural range of the features in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future.

- There will be no reduction in the area or quality of habitat for the feature populations in the SAC on a long-term basis.
- All known, controllable factors, affecting the achievement of these conditions are under control (many factors may be unknown or beyond human control).

2.1.1.4. Dee Estuary/ Aber Dyfrdwy SAC (86 km from MDZ)

Three species from this SAC, Atlantic Salmon, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- Undertake a programme to investigate, control and reduce invasive species.
- Investigate the impacts of current discharges from historic waste sites and the general state of diffuse pollution within the Estuary.
- Investigate the impacts of commercial fisheries.
- Investigate cumulative, in-combination and off-site effects to inform future decision making on planning applications.
- Natural Resources Wales to review consents in the light of new evidence.
- Investigate the impacts of reduced freshwater inputs flushing through the Estuary.

2.1.1.5. Cardigan Bay/ Bae Ceredigion SAC (97 km from MDZ)

Two species from this SAC, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for both of these species:

- The presence, abundance, condition and diversity of typical species is such that habitat quality is not degraded.
- The population is maintaining itself on a long-term basis as a viable component of its natural habitat.
- The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.
- The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing.

2.1.1.6. River Wye/ Afon Gwy SAC (114 km from MDZ)

Four species from this SAC, Atlantic salmon, twaite shad, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The population of the feature in the SAC is stable or increasing over the long term.
- The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms.

- There is, and will probably continue to be, a sufficiently large habitat to maintain the feature's population in the SAC on a long-term basis.

2.1.1.7. Afon Teifi/River Teifi SAC (121 km from MDZ)

Five species from this SAC, Atlantic salmon, twaite shad, allis shad, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The population of the feature in the SAC is stable or increasing over the long term.
- The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions e.g. food supply. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. Natural factors such as waterfalls may limit the natural range of individual species. Existing artificial influences on natural range that cause an adverse effect on site integrity, such as physical barriers to migration.
- There is, and will continue to be, a sufficiently large habitat to maintain the feature's population in the SAC on a long-term basis.

2.1.1.8. Afonydd Cleddau/Cleddau Rivers SAC (143 km from MDZ)

Two species from this SAC, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for both of these species:

- The population of the feature in the SAC must be stable or increasing over the long term.
- The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions e.g. food supply. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future.
- Passage of the feature through the SAC is not to be hindered by artificial barriers such as weirs.
- The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the habitat requirements of the features. The close proximity of different habitats facilitates movement of fish to new preferred habitats with age.

2.1.1.9. Pembrokeshire Marine/ Sir Benfro Forol SAC (149 km from MDZ)

Four species from this SAC, twaite shad, allis shad, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The presence, abundance, condition and diversity of typical species is such that habitat quality is not degraded.
- The population is maintaining itself on a long-term basis as a viable component of its natural habitat.
- The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.
- The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing.

2.1.1.10. River Ehen SAC (151 km from MDZ)

A single species from this SAC, Atlantic Salmon, is considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:

- Maintain or restore the extent and distribution of the habitats of qualifying species.
- Maintain or restore the structure and function of the habitats of qualifying species.
- Maintain or restore the supporting processes on which the habitats of qualifying species rely.
- Maintain or restore the populations of qualifying species.
- Maintain or restore the distribution of qualifying species within the site

2.1.1.11. Afon Tywi/ River Tywi SAC (153 km from MDZ)

Four species from this SAC, twaite shad, allis shad, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The population of the feature in the SAC is stable or increasing over the long term.
- The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions e.g. food supply. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. Natural factors such as waterfalls may limit the natural range of individual species. Existing artificial influences on natural range that cause an adverse effect on site integrity, such as physical barriers to migration, will be assessed.

- There is, and will probably continue to be, a sufficiently large habitat to maintain the feature's population in the SAC on a long-term basis.

2.1.1.12. River Usk SAC (155 km from MDZ)

Four species from this SAC, twaite shad, Atlantic salmon, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The population of the feature in the SAC is stable or increasing over the long term.
- The natural range of the feature in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in terms of near-natural hydrological and geomorphological processes and forms, e.g. suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions, e.g. food supply.
- Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future. Natural factors such as waterfalls may limit the natural range of individual species. Existing artificial influences on natural range that cause an adverse effect on site integrity, such as physical barriers to migration, will be assessed.
- There is, and will probably continue to be, a sufficiently large habitat to maintain the feature's population in the SAC on a long-term basis.

2.1.1.13. River Derwent and Bassenthwaite Lake SAC (160 km from MDZ)

Three species from this SAC, Atlantic salmon, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- Maintain or restore the structure and function (including typical species) of qualifying natural habitats.
- Maintain or restore the structure and function of the habitats of qualifying species.
- Maintain or restore the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
- Maintain or restore the populations of qualifying species.
- Maintain or restore the distribution of qualifying species within the site.

2.1.1.14. Carmarthen Bay and Estuaries/ Bae Caerfyrddin ac Aberoedd SAC (162 km from MDZ)

Four species from this SAC, twaite shad, allis shad, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The presence, abundance, condition and diversity of typical species is such that habitat quality is not degraded.

- The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.
- The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing.

2.1.1.15. River Bladnoch SAC (167 km from MDZ)

A single species from this SAC, Atlantic salmon, is considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:

- Maintain the population of the species, including range of genetic types, as a viable component of the site.
- Maintain the distribution of the species within site.
- Maintain the distribution and extent of habitats supporting the species.
- Maintain the structure, function and supporting processes of habitats supporting the species.
- No significant disturbance of the species.

2.1.1.16. River Eden SAC (175 km from MDZ)

Three species from this SAC, Atlantic salmon, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- Maintain or restore the extent and distribution of qualifying natural habitats and habitats of qualifying species.
- Maintain or restore the structure and function of the habitats of qualifying species.
- Maintain or restore the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
- Maintain or restore the populations of qualifying species.
- Maintain or restore the distribution of qualifying species within the site.

2.1.1.17. Solway Firth SAC (178 km from MDZ)

Two species from this SAC, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- Maintain the population of the species as a viable component of the site
- Maintain the distribution of the species within the site.
- Maintain the distribution and extent of habitats supporting the species.
- Structure, function and supporting processes of habitats supporting the species.
- No significant disturbance of the species.

2.1.1.18. Severn Estuary/Môr Hafren SAC (222 km from MDZ)

Three species from this SAC, twaite shad, river lamprey and sea lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for each of these species:

- The migratory passage of both adult and juvenile twaite shad, river lamprey and sea lamprey through the Severn Estuary between the Bristol Channel and any of their spawning rivers is not obstructed or impeded by physical barriers, changes in flows, or poor water quality.
- The size of the qualifying species populations in the Severn Estuary and the rivers which drain into it, is at least maintained as is at a level that is sustainable in the long term.
- The abundance of prey species forming the qualifying species' food resource within the estuary, is maintained.
- Toxic contaminants in the water column and sediment are below levels which would pose a risk to the ecological objectives described above.

2.1.1.19. River Camel SAC (289 km from MDZ)

A single species from this SAC, Atlantic salmon, is considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:

- Maintain the extent and distribution of qualifying natural habitats and habitats of qualifying species.
- Maintain the structure and function of the habitats of qualifying species.
- Maintain the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
- Maintain the populations of qualifying species.
- Maintain the distribution of qualifying species within the site.

2.1.1.20. Endrick Water SAC (302 km from MDZ)

Two species from this SAC, Atlantic salmon and river lamprey, are considered by this assessment. The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied for both of these species:

- Population of the qualifying species, including range of genetic types for salmon, as a viable component of the site.
- Distribution of qualifying species within site is maintained in the long term.
- Distribution and extent of habitats supporting the qualifying species is maintained in the long term.
- Structure, function and supporting processes of habitats supporting the qualifying species is maintained in the long term.
- No significant disturbance of the qualifying species.

2.1.2. Assessment of Impact Pathways

Due to the uncertainty over the migratory routes followed by different designated Annex II migratory fish populations, it is not possible to predict the relative likelihood of specific populations interacting with the MDZ development. In view of this, it is deemed appropriate to provide a single combined assessment of collision risk for all of these sites.

2.1.2.1. Collision Risk

For the purposes of this assessment, a worst-case scenario is assumed, with Tidal Energy Convertors (TECs) posing a risk of collision to migratory fish species that occupy the water column and with any interaction resulting in the fatality of the animal involved. It should be noted that this is a highly precautionary assumption that assumes no detection/avoidance of the TECs and also does not take account of the fact that any devices would be installed in an open-water environment where fish passage would not be largely constrained or impeded.

ABPmer (2010) states that the opportunity for fish to engage in long range avoidance is likely to be a function of:

- The source levels of underwater noise associated with tidal devices (particularly during operation);
- Background noise levels (the extent to which device noise levels might be masked by ambient background noise); and
- The particular hearing sensitivities of different species of fish.

The analysis conducted by ABPmer (2010) suggests that hearing sensitive fish (such as clupeids (including shad species)) may be able to detect and avoid individual operational TECs at distances between approximately 120-300 m (depending on the depth of the water). This is even when background noise levels are comparatively high.

It is expected that individual fish will display high capacity for avoidance of TECs. This conclusion is supported by monitoring data from existing tidal energy developments. No instances of fish colliding with turbine blades have been recorded in post-construction monitoring for the tidal array at Bluemull Sound (data informed by automated impact sensors and motion triggered video; Nova International, 2015). Fish were observed to leave the region of the turbines while tidal flow caused the blades to rotate. Similarly, a high level of avoidance behaviour has been observed in fish recorded close to turbine blades within the Roosevelt Island Tidal Energy (RITE) project in New York (Verdant Power, 2020).

The MDZ represents a very small portion of the habitat available to migratory fish throughout the Irish Sea. Data are not available on how closely these fish species ‘hug’ the coast during migration, and therefore it is not possible to predict the likelihood of interaction with the MDZ. Although it is not possible to quantify the portion of each SAC’s population that may use the site, it can be assumed that it would be low enough that any entrainment/removal of individuals would not impact at a population level.

The Applicant maintains that the presence of TECs in the MDZ poses minimal risk of collision to migratory fish species.

However, in recognition of the knowledge gaps identified above, the Applicant commits to undertaking a level of monitoring that is intended to provide supportive evidence of these conclusions.

The Morlais outline EMMP (oEMMP) proposes collection of acoustic imaging data and video footage to assess interactions of marine mammals and seabirds with the TECs. After discussion and agreement with NRW, the Applicant proposes that when video data are analysed for marine mammal and seabird behaviour, the same footage will also be reviewed and analysed to identify if they also contain potential information on behaviour of migratory fish in the visible area around the TEC's. The objectives of this analysis will be to (a) detect any migratory fish in proximity of the TEC devices; (b) describe any observed avoidance behaviour; (c) identify any interactions between turbine blades and migratory fish, and (d) where possible determine the consequence of any collisions, should any occur.

Analysis of the video monitoring data described above for migratory fish, will be in addition to the monitoring of those same data for marine mammal and bird activity. The trigger for analysis will be the proximity of marine mammals or seabirds to the TEC being monitored.

The Applicant commits to make all data collected during monitoring available for use by researchers with the aim of supporting develop this broader understanding of interactions between TECs and migratory fish. Full details of migratory fish monitoring commitments will be included in the oEMMP, which will continue to be updated in agreement with regulators pre-consent, to ensure requirements to address HRA requirements are addressed.

The Applicant also recognises the need to develop a more strategic approach to developing the understanding of potential interactions between migratory fish and tidal energy projects. Work done by Marine Scotland Science[2] is noted and it is proposed that the Applicant works with NRW (and Marine Scotland Science) to investigate how similar strategic-level work could be started in Wales.

The Applicant also notes the recent findings of the OES Environmental State of the Science Report[3] which highlighted that in order to better understand collision risk, advances are required in the following priority areas:

- baseline determination;
- information about individual fish behaviour;
- automated detection of fish collisions;
- correlation of fish behaviour with stimuli (e.g. noise, pressure, velocity, acceleration, and water particle characteristics);
- lethal, sub lethal, and non-contact outcomes of fish collisions with turbines;

[2] Diadromous Evidence Map (2020). Available at: https://www2.gov.scot/Topics/marine/marineenergy/mre/research/diadromous/EvMap

[3] OES Environmental (2020). Available at: https://tethys.pnnl.gov/publications/state-of-the-science-2020.

- effects of marine renewable energy (MRE) arrays on fish; and
- implications of fish collision on populations.

2.1.2.2. Conclusion

Noting that the MDZ is located in open marine waters, with clear sea area for passage of migratory fish to the east and west of the site, it is concluded that in all probability, only a small proportion of any migratory fish will actually potentially interact with any of the TECs proposed to be deployed within the MDZ. It is also assumed, based on monitoring data collated to date from other tidal energy deployments, that most migratory fish that do enter the MDZ will avoid the TEC blades via detection and avoidance behaviour. Therefore, actual collision risk with TEC blades is considered to pose negligible threat to designated Annex II migratory fish populations of the following SACs, and will not pose any risk to the conservation objectives of these sites:

- Afon Gwyrfai a Llyn Cwellyn SAC
- Afon Eden - Cors Goch Trawsfynydd SAC
- River Dee and Bala Lake/ Afon Dyfrdwy a Llyn Tegid SAC
- Dee Estuary/ Aber Dyfrdwy SAC
- Cardigan Bay/ Bae Ceredigion SAC
- River Wye/ Afon Gwy SAC
- Afon Teifi/River Teifi SAC
- Afonydd Cleddau/Cleddau Rivers SAC
- Pembrokeshire Marine/ Sir Benfro Forol SAC
- River Ehen SAC
- Afon Tywi/ River Tywi SAC
- River Usk SAC
- River Derwent and Bassenthwaite Lake SAC
- Carmarthen Bay and Estuaries/ Bae Caerfyrddin ac Aberoedd SAC
- River Bladnoch SAC
- River Eden SAC
- Solway Firth SAC
- Severn Estuary/Môr Hafren SAC
- River Camel SAC
- Endrick Water SAC.

3. References

ABPmer, 2010. Collision of Fish with Wave and Tidal Devices. RPS Group plc on behalf of the Welsh Assembly Government.

Nova International, 2015. Environmental Monitoring and Mitigation Plan Shetland Tidal Array, Bluemull Sound. Available at: https://tethys.pnnl.gov/sites/default/files/publications/NovaInnovation-2015.pdf [Accessed October 2020].

Verdant Power, 2010. Roosevelt Island Tidal Energy Project FERC No. 12611. Final Kinetic Hydropower Application Volume 4 of 4. Available at: https://53b4fc62-dd91-4b62-8bae-942960aeeb07.filesusr.com/ugd/75818c_6e50eba74ca84592a90ce79242435caa.pdf [Accessed October 2020].