



Workshop on Environmental Monitoring and Mitigation around Deployed Marine Energy Devices

Andrea Copping
Pacific Northwest National Laboratory
& OES-Environmental

Ian Hutchison
Aquatera Ltd.
& ORJIP Ocean Energy



Workshop Agenda

Start Time	Agenda Topic
16:30	Introductions, Purpose of the workshop
16:45	Examples of environmental monitoring and mitigation around projects
17:30	Best practices in monitoring
18:00	Role of research in supporting monitoring programs, potential for funding
18:20	Next steps
18:30	Adjourn

Questions we will address today:

- What drives specific monitoring data collection and analysis needs around a deployed device?
- What information can help focus these monitoring efforts?
- Are there other types of information that might be needed?
- How can we deliver this information for good of the sector?



Examples of Environmental Monitoring and Mitigation around Projects

- SMEC, Canada
- CalWave, US
- Voith, Scotland
- Meygen, Scotland
- Morlais, Wales

Grand Passage Sustainable Marine Energy (Canada) Ltd.

Developer: Sustainable Marine

Regulator: Fisheries and
Oceans Canada (DFO)

Location: Grand Passage,
Nova Scotia

Generating capacity: 0.42 MW

Consent status: consent was
awarded in 2018, renewed in
2020, 2022

Sustainable Marine projects and facilities in Nova Scotia

FORCE



Grand Passage



Parrsboro

Digby

Dartmouth



- Sustainable Marine Canada HQ
- Logistical hub for NS projects
- Outfitting of platform control units



Grand Passage Sustainable Marine Energy (Canada) Ltd.

Mitigation Measures

- **Collision risk**
 - Daylight only operation; and
 - Shutdown if Schedule 1 Species at Risk is seen within 100m
- **Underwater noise**
 - no mitigation measures specified
- **Benthic impacts**
 - no mitigation measures specified
- **Other notable mitigation measures**
 - no mitigation measures specified

Grand Passage Sustainable Marine Energy (Canada) Ltd.

Monitoring measures

- **Collision risk**
 - Collection and analysis of underwater video data to observe fish, seabirds, sea turtles, and marine mammals in the near field of the turbine
 - Collection and analysis of acoustic data to monitor vocalizing marine life
 - (Voluntary) half-hourly marine animal observation
- **Underwater noise**
 - Collection and analysis of acoustic data to monitor marine noise
- **Benthic impacts**
 - None
- **Other notable monitoring measures**
 - None



Grand Passage Sustainable Marine Energy (Canada) Ltd.

Reporting requirements:

- **Collision risk**
 - Quarterly underwater video and hydrophone data analysis and reporting issued to DFO
- **Underwater noise**
 - Quarterly hydrophone data analysis and reporting issued to DFO
- **Benthic impacts**
 - none
- **Other notable reporting requirements**
 - none





Grand Passage Sustainable Marine Energy (Canada) Ltd.

Observations:

- **Mitigation and monitoring measures; what worked well what didn't go to plan?**
 - Underwater cameras functioned as expected; water clarity is variable
 - Hydrophone allowed assessment of device noise and detection of vocalizing mammals
- **Preparing the EMMP and agreeing mitigation and monitoring measures; key challenges and lessons learned:**
 - Proponent proposes plan; some back-and-forth; decision-making somewhat opaque
- **How mitigation and monitoring activities were funded; private, public, both?**
 - Private initially; some current activities part of research funded by Canadian government

CalWave, California

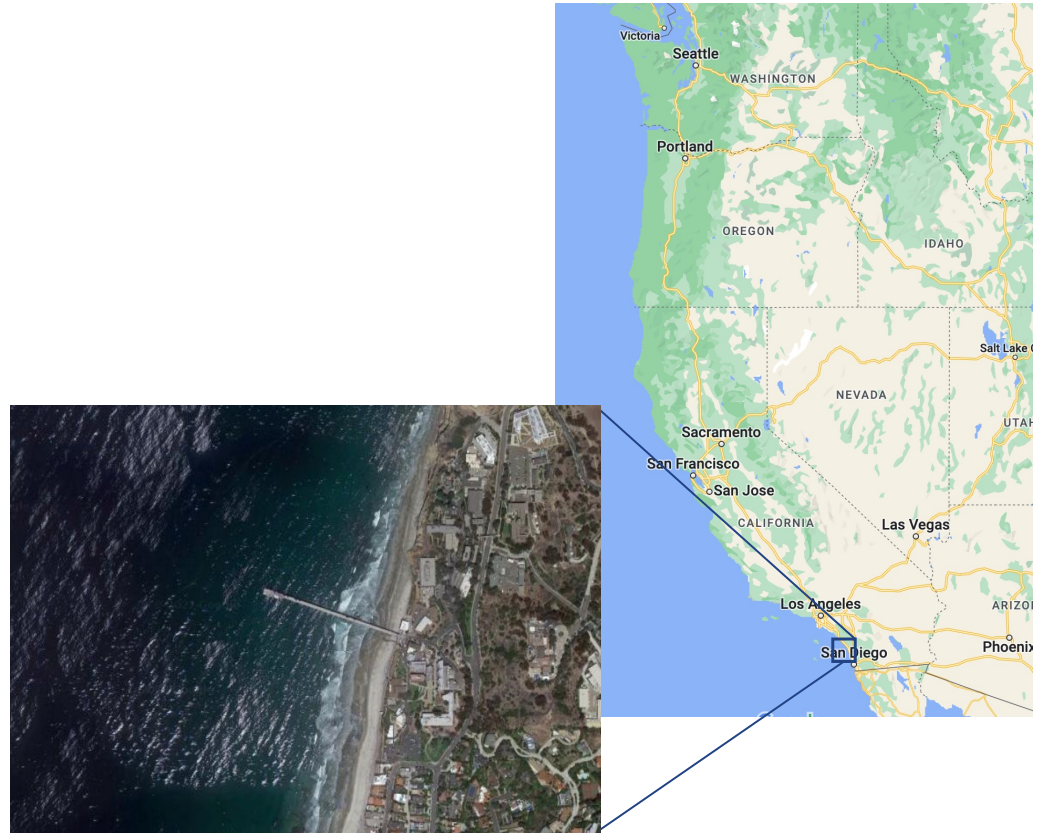
Developer: CalWave

Regulators: California Department of Fish and Wildlife (DFW), California Water Boards, National Marine Fisheries Service (NMFS), US Army Corps of Engineers (USACE), US Coast Guard Private Aids to Navigation (PATON)

Location: La Jolla, California

Generating capacity: 15 kW

Consent status: consented and reporting complete



CalWave, California

	Mitigation Measures	Monitoring Measures	Reporting Requirements
Collision Risk	Device motion relative to surrounding wave environment	External onboard camera continuously observing moving components	Any unanticipated impact on ESA-listed species would have required reporting
Underwater Noise	Machinery located inside pressure hull	Drifting (days) and fixed (months) hydrophones	Any unanticipated impact on protected species would have required reporting
Benthic Impacts	Consideration in anchoring selection	360-degree video camera (days)	Observations of any unanticipated changes from baseline
Other Notables	Taut mooring lines (minimizing entanglement risk) Vessel operations at test site deemed higher risk to marine life than deployed WEC itself	On-device video camera (all duration) Appropriately trained MMOs on board vessels; 500m distance from whales and 100m distance from marine mammals & sea turtles	Marine mammal observations and any unanticipated changes from baseline study Reporting of any suspected entanglement to NMFS would have been required

CalWave, California

Observations:

- **Mitigation and monitoring measures; what worked well what didn't go to plan?**
 - All monitoring efforts worked well. After around 8-months of continuous operation, the onboard external camera started to experience lens fogging and some vision obscuring from bio-growth. Gradual degradation of image quality/usefulness continued between months 8 and 10 of deployment.
- **Agreeing mitigation and monitoring measures; key challenges and lessons learned:**
 - Due to the motion of the WEC being aligned with wave action, marine life appeared to move in unison with the WEC. No impacts were observed
 - Moving parts were largely self-cleaning as long they were exercised periodically
- **How mitigation and monitoring activities were funded; private, public, both?**
 - Public (US DOE funding) + Private (cost share)



Voith Hydro, Orkney

Developer: Voith Hydro

Regulator: Marine Scotland

Location: EMEC tidal test area, Fall of Warness, Orkney

Generating capacity: 1 MW

Consent status: consenting completed in 2013 and reporting complete

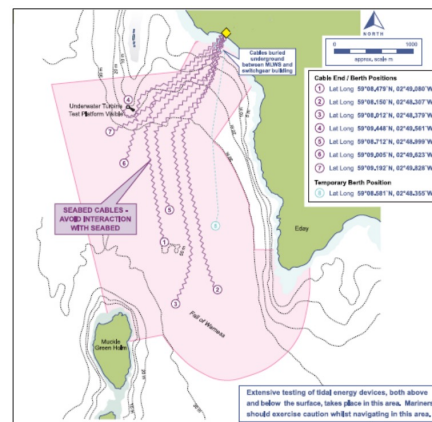
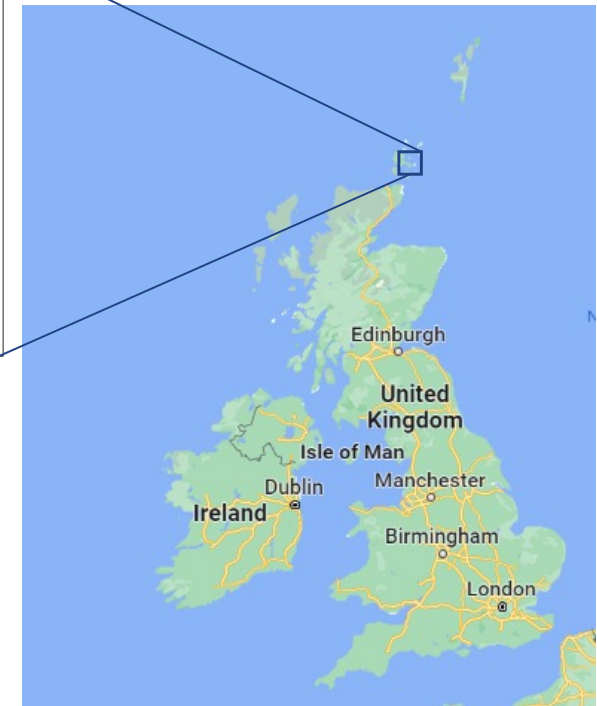


Figure 2: EMEC Fall of Warness tidal test site infrastructure



Voith Hydro, Orkney

	Mitigation Measures	Monitoring Measures	Reporting Requirements
Collision Risk	Turbine soft starts during commissioning Minimize turbine standstill	Underwater video monitoring to investigate near field behavior	Soft start 'log' (6 months)
Underwater Noise	Drilling soft start MMO during drilling (mitigation zone)	Acoustic monitoring: <ul style="list-style-type: none"> - Drilling - Vessel thrusters - Above deck activities 	MMO report and acoustic monitoring report (8 weeks)
Benthic Impacts	Pre-construction ROV survey	Post-construction ROV survey	Pre-construction report (prior to installation) Post-installation ROV report and 'as built plan' (28 days)
Other Notables	Vessel management plan agreed to reduce disturbance at seal haul outs	Seal haul out monitoring during installation activities	Environmental monitoring report (12 months)



Voith Hydro, Orkney

Observations:

- **Mitigation and monitoring measures; what worked well what didn't go to plan?**
 - Agreed not to undertake acoustic monitoring of vessel operations or drilling operations for future work
 - Agreed not to implement 'soft starts' during drilling or turbine operations during future deployments
 - Cameras worked well initially but 2/3 lenses became fouled quite quickly
- **Preparing the EMMP and agreeing mitigation and monitoring measures; key challenges and lessons learned:**
 - Iterative process with the regulator and statutory advisors
 - Aided by existing consents at the site and agreement that the activities were at an established test site
 - Strong policy support for tidal energy development at the time
 - Clear distinction made between monitoring and supplementary research
 - EMMP agreed for project in two phases; monopile installation and device operation
- **How mitigation and monitoring activities were funded; private, public, both?**
 - All activities funded by developer, vessel acoustic monitoring done by EMEC & Heriot Watt University

MeyGen, Pentland Firth

Developer: Atlantis Resources

Regulator: Marine Scotland

Location: Inner Sound, Pentland Firth, Scotland

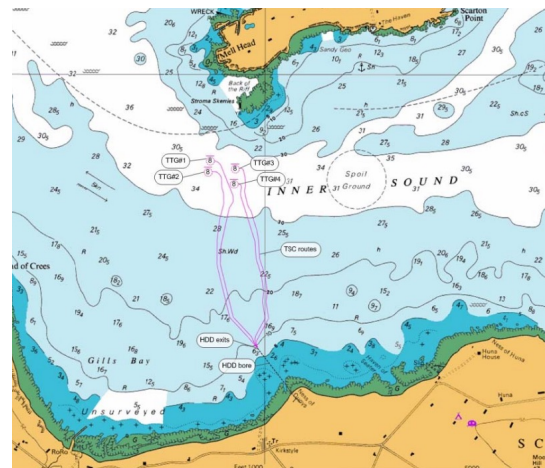
Generating capacity:

Phase 1 – 6 MW installed to date

Phase 2 – additional 80 MW

Phase 3 – total 398 MW

Consent status: consent granted for up to 86 MW generating capacity, conditional on staged deployment



MeyGen, Pentland Firth

	Mitigation Measures	Monitoring Measures	Reporting Requirements
Collision Risk	None	Survey, Deploy, Monitor Strategy, Marine Mammal Monitoring Programme, Seal Tagging, Shoreline monitoring, Active Acoustics	EMMP
Underwater Noise	None	Operational noise monitoring	EMMP
Benthic Impacts	Minimize footprint of foundation piles, minimize cable voltage to reduce EMF, increase length of drilled cables	Habitat monitoring, dispersion of drill cuttings during HDD	EMMP
Other Notables		Passive Acoustic Monitoring	PEMP



MeyGen, Pentland Firth

Observations:

- **Mitigation and monitoring measures; what worked well what didn't go to plan?**
 - Provided significant evidence of avoidance behaviour by harbour porpoise
 - New monitoring platform recently installed with St Andrews University
- **Preparing the EMMP and agreeing mitigation and monitoring measures; key challenges and lessons learned:**
 - EMMP (or PEMP) agreed in consultation with a project steering group, consisting of the developer, regulator, advisors and the research/monitoring teams
 - Project was instrumental in demonstrating the 'survey, deploy and monitor' approach
 - Key challenge in mapping out how data collected during phase 1 could be used in scaling up the project (consents and monitoring plan design)
- **How mitigation and monitoring activities were funded; private, public, both?**
 - Combination of private, public and research funding (significant resources the Scottish Demonstrator Project to support collision risk research)

Anglesey Marine Energy: Morlais

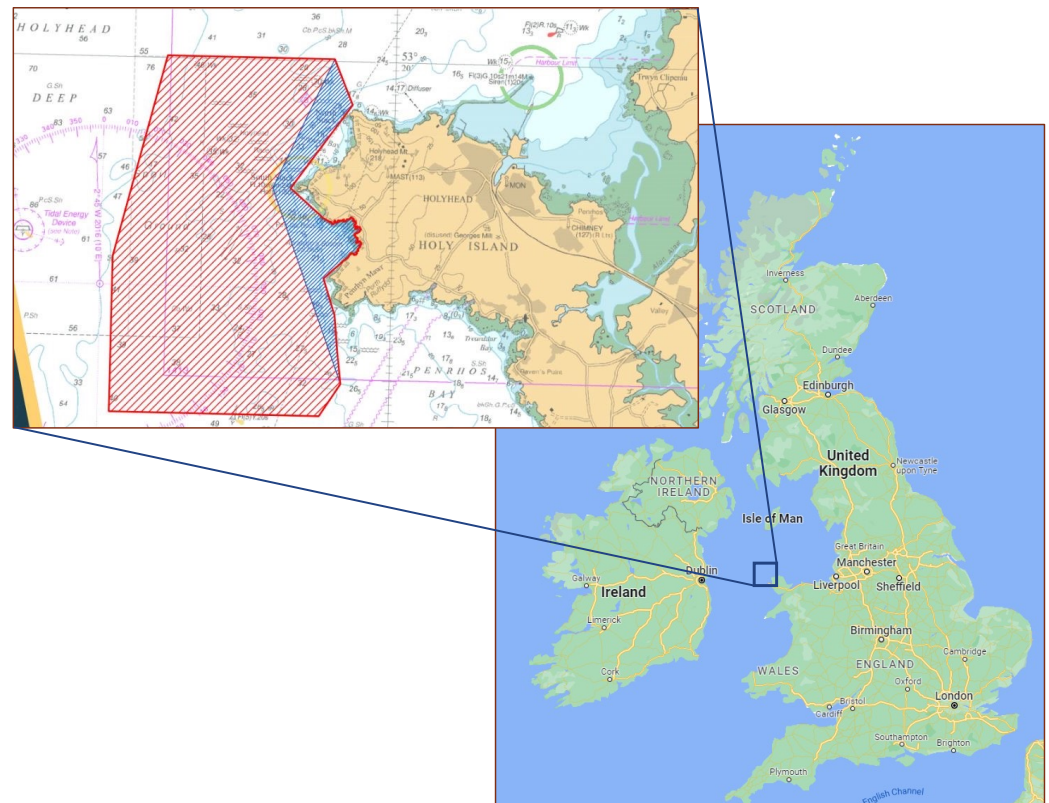
Developer: Menter Môn (not for profit, 3rd sector)

Regulator: Natural Resources Wales

Location: 35 km² area of seabed off the coast of Holy Island, Anglesey (within the West Anglesey Demonstration Zone (WADZ))

Generating capacity: 240 MW

Consent status: consent was awarded in December 2021.



Anglesey Marine Energy: Morlais

	Mitigation Measures	Monitoring Measures	Reporting Requirements
Collision Risk	ADDs, Visual deterrents	PAM, Active Sonar, Surface/UW Cameras, VP survey, colony counts	TBC. EEMP in development
Underwater Noise	MMMP	Noise quantification & spatial distribution	TBC. EEMP in development
Benthic Impacts	Precon surveys/micrositing	None	None
Other Notables	TBC in EEMP	TBC in EEMP	TBC



Anglesey Marine Energy: Morlais

Observations:

- **Mitigation and monitoring measures; what worked well what didn't go to plan?**
 - n/a – project in pre-development
- **Preparing the EMMP and agreeing mitigation and monitoring measures; key challenges and lessons learned:**
 - Work in progress! Outline EMMP agreed during the consenting process, Advisory Group established and a detailed EMMP for Phase 1 is being developed.
 - Priority questions and indicators agreed with the Advisory Group
 - Baseline data and other technical work programmes are underway
- **How mitigation and monitoring activities were funded; private, public, both?**
 - Morlais has secured funding from WEFO to support the design of the EMMP (including baseline data collection, equipment trials etc), which has allowed the engagement of an extensive team of experts to support the design work.



Best Practices

- What drives specific monitoring data collection and analysis needs around a deployed device?
 1. Based on the marine animals/habitats at risk, based on what the developer and regulator agrees upon
 2. Existing knowledge
 3. Specific interactions:
 - For tidal/river/ocean current only: potential risk or collision or close encounter
 - Underwater noise from the operational device
 - Electromagnetic fields from the power export cable
 - Changes in benthic habitats, changes in pelagic habitats
 - Whatever your regulator determines (!)



Best Practices

- What information can help focus these monitoring efforts?
 - Collision risk: ongoing monitoring. Research on instruments needed, models to be refined and validated.
 - Underwater noise: collected for WECs and turbines, using IEC TC114 standards, perhaps using US regulatory action levels for marine mammals and fish.
 - EMF: emissions from cables and devices related to the amount of power carried by the cable and the configuration of the cable. Appears to be of little concern.
 - Changes in benthic and pelagic habitats: can be understood from other offshore industries. Siting is important.



Best Practices

- Are there other types of information that might be needed?
 - Changes in sedimentation patterns or water circulation
 - Displacement of migratory patterns or movements of marine animals
 - Research can best address these and other issues at array scale



Best Practices

- How can we deliver this information for the good of the sector?
 - Agree on priority information needed
 - Consensus around strategic research
 - How we can deliver this research

Best Practices

	Sensor	Energy Environment	Data Products	Receptor
Collision Risk	Multi or single frequency sonar	Tidal, riverine	Mean biomass as a function of depth, tidal state, time of day; abundance of species; fish tracks	Fish, marine mammals
	Acoustic and video cameras	Tidal, riverine	Number of animals over unit time in sampled volume	Fish, marine mammals
	Hydrophone/click detector	Tidal, riverine	Presence/absence of vocalizing marine mammals and automated click detector	Marine mammals and some fish
	Acoustic doppler current profiler	Tidal, riverine	Tidal velocity data for correlation with biological data	Auxiliary data
Underwater Noise	Hydrophone	Wave, tidal, riverine	Sound pressure data, spectral levels, RMS sound pressure	Marine mammals and some fish
	Acoustic doppler current profiler	Tidal, riverine	Current data and wave data	Informs acoustic environment
	Anemometer	Wave, tidal, riverine	Wind speed/direction	Informs acoustic environment
	Conductivity, Temperature, Depth (CTD)	Wave, tidal, riverine	Sound speed data	Acoustic environment
Changes in Habitat	Sediment sampler	Wave, tidal, riverine	Sediment size, infauna diversity/abundance, organic/pollutant content	Sediment, infauna
	Remotely operated vehicle	Wave, tidal	Sediment composition, epifauna/pelagic diversity/abundance along transects	Sediment, epifauna, demersal
	Drop-down camera	Wave, tidal, riverine	Sediment composition, epifauna diversity/abundance in quadrats	Sediment, epifauna
	360-degree camera	Wave, tidal	Epifauna/pelagic diversity/abundance on/around foundations and anchors	Epifauna, demersal
Electromagnetic Fields	Towed magnetometer	Wave, tidal, riverine	Spatially interpolated 2D scalar magnetic field – cables and devices	Invertebrates, some fish
	Fixed station magnetometer	Wave, tidal, riverine	Time-varying scalar magnetic field strength – devices	Invertebrates, some fish
	Electric field sensor	Wave, tidal, riverine	Time-varying electric field strength – devices	Invertebrates, some fish



Research to Support Consenting, Successful Projects

- Focus on information gaps based on regulator needs
 - Focus on interactions with greatest uncertainty
 - Consider monitoring for scale of project (single device versus arrays)
 - Consider regional requirements (such as European Directives)
-
- Global Research Fund



Notable Processes

- Risk retirement, data transferability, guidance documents (add URLs)
- Management measures (aka mitigation)
- ORJIP Information notes (Wales)
- Upcoming:
 - Case Studies (examples) of applying data transferability to risk retirement
 - Regulator workshops – December 6th
 - ✓ 3:00pm UTC: <https://pnnl.zoomgov.com/meeting/register/vJltdumvrz4pGL5Ca7AoTfjoi223eZhYf9s>
 - ✓ 12:00am UTC: <https://pnnl.zoomgov.com/meeting/register/vJltd6uqzwtHIES-jzs3fW4gU8FJx7Ssrg>
 - Workshop for developers (?)
 - Critical evidence gaps, summary of ORJIP Forward Look

Next Steps

- Global Research Fund note
- Update critical evidence needs for global context
- Prepare guidance note around the development of monitoring and mitigation plans
- Include guidance into 2024 State of Science
- Enhanced collaboration and exchange between monitoring and research teams



Survey

Please fill out our short survey!





Thank you!

Andrea Copping
andrea.copping@pnnl.gov

Ian Hutchison
ian.hutchison@aquatera.co.uk

