ENVIRONMENTAL MONITORING, REGULATORY NEEDS & SCIENTIFIC CAPABILITIES: A FACILITATED DISCUSSION BETWEEN SCIENTISTS, REGULATORS AND INDUSTRY WOLFVILLE NOVA SCOTIA NOVEMBER 1ST 2014 10AM – 4PM

A one-day workshop was held in Wolfville Nova Scotia, bringing together regulators, marine energy researchers, and industry representatives, to determine what data are needed and what data can realistically be collected, to assist with siting and permitting (consenting), as well as with effects monitoring, of marine energy devices. The agenda is below.

The workshop was co-sponsored by the IEA Ocean Energy System's Annex IV, the Acadia Tidal Energy Institute, and Nova Scotia Energy.

Premise for the Workshop

Regulators in all nations need to assure that the deployment and operation of wave and tidal devices do not cause unacceptable harm to the marine environment and the animals that live there, particularly fish and marine mammals.

The marine energy industry is young and concerns have been raised about the level of uncertainty around the large number of potential interactions that might occur:

- interaction of marine animals with rotating tidal turbine blades;
- disruption of marine mammal and other animals' communication and navigation due to underwater noise generated by wave and tidal devices;
- biological disruption of animals from electromagnetic fields from power cables;
- harm to marine animals from chemicals released from tidal and wave systems;
- entrapment of large marine animals in mooring lines or power cables;
- changes in benthic habitats due to foundations and anchors; and
- effects of removing energy from ecosystems on sediment transport, water quality and circulation

There has been numerous research, numerical modeling, and field monitoring studies that examine some of these effects in both Europe and North America that help bound our understanding of the scale of potential impacts. It is also clear that some of these potential effects (such as interaction of marine animals) must be examined for a single device, while other interactions (such as effects of energy removal) will only be measured once larger arrays are in the water.

There are many potential interactions that have been documented for other industries, and the level of risk has posed by them has been evaluated (e.g., effects of anchors; chemical coatings for biofouling and corrosion; etc.). While these risks may also occur with marine energy devices, our level of understanding of these interactions is transferable and does not warrant new and expensive monitoring instruments and techniques for marine energy devices.

New technologies and device components developed for marine energy create potential new interactions with animals and habitats for which there are no data; these interactions provide the greatest concerns and risk for regulatory approval. In addition, baseline data on site characterization and use by animals is limited for sites where wave and tidal development is desirable. The scientific community is currently focused on adapting instruments and techniques to gather data in high-energy environments, including observations of animals in close proximity to devices.

This workshop discussed some of the highest priority interactions for tidal devices; provided information on how those interactions might be measured; and discussed the challenges faced by both regulators and researchers in gathering the most valuable information to support informed decisions for tidal energy development.

Workshop Presentations

Following introductions and a discussion on the purposes of the workshop, the first two presentations set the stage for discussion of international initiatives and efforts:

Andrea Copping, Pacific Northwest National Laboratory – Annex IV
Annex IV is an initiative of the international collaborative of 21 nations with an interest in pursuing the development of marine energy, including wave and tidal energy. Annex IV focuses on collecting, analyzing and disseminating information on the environmental effects of marine energy. Additional information on the program can be found online at: http://tethys.pnnl.gov/
The workshop presentation can be viewed online at:
http://tethys.pnnl.gov/sites/default/files/Annex-IV-Presentation-Bay-of-Fundy_Copping.pdf

Raeanne Miller, NERC and SAMS – NERC Knowledge Exchange
The Knowledge Exchange is an initiative of the UK's National Environmental Research Council (NERC) with the goal of developing a common language for communication, collaboration, and information exchange between research, industry, and government bodies to support sustainable growth of the marine energy sector. The workshop presentation can be viewed online at:
http://tethys.pnnl.gov/sites/default/files/Annex-IV-Presentation-Bay-of-Fundy_Miller.pdf

Q&A from Raeanne's presentation:
Q. How can we better link up Networks on an international level?
A. Perhaps we could have direct exchange among networks, with representatives belonging to other networks (for example, between FERN and UK steering group, FERN and Annex IV, and vice versa).

Carol Sparling, Sea Mammal Research Unit – Marine Mammals, Tidal Energy and Collision Risk: A UK Perspective

There are many different tidal projects in various stages of consenting in the UK. Each is required to provide insight into potential collision risk for marine mammals, mostly driven by EU Directives. Each developer must show that the project will not create risk for marine mammals, yet there is a very high degree of uncertainty about the interaction. The presentation discussed the development of a marine mammal collision model and the various inputs to the model from field demonstrations of tidal turbines, mitigation measures for tidal turbines, and monitoring gear used to observe the interactions using active and passive acoustics. The workshop presentation can be viewed online at: http://tethys.pnnl.gov/sites/default/files/Annex-IV-Presentation-Bay-of-Fundy_Sparling.pdf

Q&A from Carol's presentation:

Q. Is there research being done into deterrence of animals from tidal turbines?
A. There is no research funding in the UK until it is shown that marine mammals are definitely negatively impacted.
A. A project has been done on the US west coast, using sound to deter migrating gray whales from wave devices, but in the US when you start deterring with sound you may run into regulatory issues of harassment of marine mammals. Work is also underway in the UK to develop active acoustic devices that would be less bothersome to cetaceans.

Q. If you start mitigation too early, how can you make the regulatory process work? The example is SeaGen, where shutdown has lead to a missed opportunity to learn how the marine mammals interact with the turbine.
A. We need to use adaptive management and choose sites carefully to reduce risk of impacts. Then have the right monitoring plan in place to monitor potential high priority risks.

Q. What happens when we go towards multiple turbines?
A. It is essential that we learn about risks from single device and demonstration array deployments, allowing us to develop monitoring and adaptive management plans for larger projects. The concern is that larger arrays might have population effects where the population begins to avoid an entire area, and we will have to have monitoring in place to detect this.

Anna Redden, Acadia University - Tracking the Movements of Large At-Risk Species at a Turbine Test Site

The Bay of Fundy has the highest tides in the world. Data are being collected on fish and other marine animals living in and around a tidal test site under development in the Bay of Fundy. The very strong tidal currents and large tidal prism present challenges to observing and predicting movements of these animals, in order to predict their risk of collision with tidal turbines for the test site and for commercial buildout. This presentation shows a series of tools and methods for providing information on the resident and migratory species. The workshop presentation can be viewed online at: http://tethys.pnnl.gov/sites/default/files/Annex-IV-Presentation-Bay-of-Fundy_Redden.pdf

Q&A from Anna's presentation:
Q. Because of the limitations in this very fast environment, will we be able to see changes in fish behavior once turbines are installed?
A. We will need other types of sensors, or combinations of sensors to get close enough to the turbine to do this. Fish are smaller and harder to detect than marine mammals, which makes this challenging.

Gayle Zydlewski, University of Maine - Effects Monitoring of Fish at/near an ORPC Turbine
Regulators want to understand the potential risk to fish from tidal turbines, which involves understanding not only potential collision but other close encounters, including evasion by fish in close quarters to the turbine. This presentation shows results of monitoring around a tidal turbine in coastal Maine, including the proportion of fish of different size classes who interrupt their swimming to turn back from the turbine, those that pass through the turbine, those that spend time in the wake of the turbine, and those that avoid the turbine from a greater distance. Also shown are studies of the make up of fish that might be in the vicinity of the turbine. The workshop presentation can be viewed online at:
http://tethys.pnnl.gov/sites/default/files/Annex-IV-Presentation-Bay-of-Fundy_Gayle.pdf

Q&A from Gayle's presentation:
Q. What proportion of the 48% of the fish that passed through the turbine survived?
A. We had two acoustic cameras, one before and one after the turbine and therefore they were unable to identify individual fish exiting the turbine. Not being able to see actual contact with the turbine is a data gap. However we can see that the fish reorient after they pass through the turbine.

Q. Does use of the active acoustics affect the behavior of the animals?
A - Marine mammals have been known to avoid active acoustics, however the Didson cameras we use emit high frequencies, generally outside the hearing range of most, but not all, marine mammals. There is no evidence that fish are responding to the acoustics.

Q. Do you see trends based on fish size?
A - Most of the fish we studied were 10 cm or less. It is possible that larger fish (and they are present in the system) are avoiding the turbine at a further distance, but we can't be sure.

Brian Polagye, University of Washington - Integrated Instrumentation for Monitoring at High Flow Sites
Environmental studies at the small projects (pilot or demonstration size) are expensive in relation to the overall project, and it is difficult to extrapolate to large commercial projects. The interactions of greatest importance for early projects are potential for collision of animals with devices, changes in distribution of animals and use of their habitats, and effects of sound from the devices on animals. This presentation demonstrates some of the challenges of measuring these interactions around devices, and some of the solutions under development, including dealing with very large datasets through an integrated instrumentation package. The workshop presentation can be viewed online at:
http://tethys.pnnl.gov/sites/default/files/Annex-IV-Presentation-Bay-of-Fundy_Polagye.pdf

Nathan Johnson, Ocean Renewable Power Corporation (ORPC) - Keys to Industry Advancement: Environmental Monitoring & Adaptive Management

ORPC has deployed two tidal turbines in Cobscook Bay in coastal Maine – one mounted on a barge and one bottom-mounted. Environmental information gained with the barge-mounted turbine allowed the company to develop a monitoring program and adaptive management scheme with the regulatory agencies. A variation on the tidal turbine was deployed in an Alaskan river, that has provided additional information that support monitoring and adaptive management programs. This presentation describes the monitoring and adaptive management advances made. The workshop presentation can be viewed online at:
http://tethys.pnnl.gov/sites/default/files/Annex-IV-Presentation-Bay-of-Fundy_Johnson.pdf

Q&A from Nathan's presentation:

Q. Did the lights on the river turbine monitoring platform attract the fish?

A. A third party designed the monitoring for the RiverGen, and we are unclear on the impact of the lights. However, the fish are probably moving too fast in the river to react to lights and approach the platform.

Key Discussions and Outcomes from Workshop Discussions

The following notes reflect the discussions that took place among the workshop participants; no overall consensus on these statements was sought. Although individuals are not named in the notes, the statements recorded here are a collection of individual thoughts and interactive discussion.

Regulatory Needs and Transferability of Information between Projects

The group discussed the need to decrease uncertainty for permitting/consenting, and how the transfer of information between projects might be enhanced.

- Marine mammals and fish are of the greatest concern, depending on the location. Often both groups are very important. The potentially adverse outcome of a single strike of a marine mammal (which could result in serious injury or death) may be very important to the population in sensitive locations with vulnerable populations. In some locations, many fish may be lost before the risk becomes unacceptable, depending on the jurisdiction and the specific risk from devices, as well as the health of the resident animal populations.
- In order to better understand the potential for collision between marine animals and tidal turbines, as well as the potential adverse outcomes, observations are needed of interactions between marine animals and turbines, using acoustics and/or optical instruments. These observations should help delineate the potential for marine animals to be attracted to, to avoid, to evade (at close quarters), or to be struck by a turbine blade.
- Particular species must be chosen for monitoring, based on the specifics of the tidal devices being tested (which parts of the system might affect which species), as well as by the health of the population, the potential risks associated with the proposed development and political considerations.

- Information is most transferable between/among different turbines deployed in the same location/body of water, while transferability of information between/among different environments is harder for regulators to accept. This is based on the different physical environment, different species, species behavior, and other factors.
- Baseline data collection, like that being collected at FORCE, is very important. Several European tidal projects are faced with trying to understand post-installation monitoring without having an adequate baseline against which they can be compared.
- Monitoring must be proportional to the potential risks that may arise from a proposed development.
- More attention will need to be paid to farfield monitoring as we move to arrays.

Baseline Data for Development vs. Fundamental Science, Investing in Renewable Energy

The group discussed the importance of and difference between the collection of baseline or fundamental data and data specific to the development of a tidal project.

- The group felt that national interests (i.e., governments) should be responsible for collection of broad baseline data for coastal and estuarine areas; this call for government funding of baseline data collection is further justified as the data can be relevant to a wide range of activities and industries, not just marine energy
- Equally important is the need for governments to support the collection of fundamental scientific data to understand interactions of the marine environment with tidal turbines; these research investments can help to better focus and perhaps decrease the necessary expenditures for long-term monitoring programs.
- Baseline data that is specific to a tidal project should be the financial responsibility of the project developer.
- A necessary component of developing this industry is the need to develop and test tools and monitoring techniques for effective sampling and analysis. This development is still in the realm of research and should also be the purview of governments, working with instrument and software developers who stand to gain a whole new set of industrial clients.
- Baseline data, for the area (government responsibility) and for the site (developer responsibility), are essential to evaluate risk. Permits or licenses can be issued based on baseline data, while a monitoring plan is needed to ensure that the risks are monitored.
- As renewable ocean energy is still a very young industry, it is appropriate that national (and other levels of government) invest in its development. Society benefits from public funding of research, as a higher level of understanding and objectivity can be required.
- We need to keep in mind that there are ancillary sources of information that are very important, such as knowledge from fishermen, offshore wind developers, and the oil and gas industry.

Deal Breakers and Uncertainties

The group discussed some of the challenges of establishing tidal energy as an industry, what occurrences might cause the industry to fail (from an environmental/regulatory point of view), and how critical uncertainties could be addressed.

- It is difficult to permit a new industry while many potential effects are still uncertain. Tidal energy is late to the energy game and is be being held to higher standards than others. For

example, as land-based wind was established, few questions about environmental effects were asked; this is not the case for tidal energy, partly based on issues that have arisen with wind and wildlife interactions.

- It is difficult to slow or stop an industry that is established; in order to support the development of sustainable renewable energy, the regulatory processes need to assist, while assuring that all appropriate questions are asked at the outset.
- There is a perception problem with tidal energy as well: many more marine animals will be hurt by other means (such as: fishing bycatch, Navy sonar, ship strikes) than by tidal, but the newness of the industry and the uncertainties make it scary to many people. In addition, in the UK, marine energy is a regulated industry and therefore subject to preparing Environmental Impact Assessments, while many of the other industries are not.
- It is vital that tidal development is not held up too long, or it will never be established. These companies need to make a profit eventually.
- It is important to remember the overall risk from failure of a tidal turbine or array will never be catastrophic, particularly as compared to an oil spill, which could wipe out an ecosystem. It is also essential that our tolerance or acceptance for risk is proportional in setting up tidal devices. Recent government action in Canada has recognized this by bumping up the trigger for a comprehensive EIA from 5MW to 50MW.
- There needs to be a balance between moving too fast towards tidal energy development and risking something catastrophic of which we are unaware, versus waiting too long, causing companies and investors to walk away, and potentially killing the industry. We need to carry out technology development, research and monitoring technique development, and data gathering concurrently as doing them sequentially will take decades. The companies that are moving ahead will likely reap the rewards, even though being an early adopter is costing the companies a lot of money in environmental and permitting related activities.
- The best way to ensure we move forward, in addition to developing good research and monitoring techniques, is to develop robust models that help us understand the potential interactions and outcomes of animals with devices, and other environmental interactions. These models will all require the collection of validation data from device deployments.
- It is not clear how universal or transferable models of interactions between devices and the marine environment will be from one location to another, particularly as we scale up to commercial array size.

<u>Adaptive Management</u>

Following Nate Johnson's presentation, the group discussed the importance and applicability of adaptive management (AM) in furthering tidal energy development.

- AM is necessary and can be win-win right now. Projects and test centers really cannot be permitted without AM right now, as there are so many uncertainties.
- Certain tidal energy technologies are well suited to AM, as changes in the gear, the operation and the site can be made; other types of devices are much more difficult to re-site. In addition, changes can be made in monitoring programs to better assess interactions of interest. In contrast, AM for hydropower or a mine would not work, as changes in the siting are impossible once established.

- AM poses some concerns for developers seeking project financing, due to uncertainties surrounding future monitoring and mitigation requirements.
- However, from the developer's point of view, there is a huge risk to moving forward with too many turbines in the water at once, so a phased approach is also helpful as a business adaptive management policy.
- AM allows us to try various monitoring techniques and make changes where needed. We do not want to go down a path of measuring *x* for a long time, when we ought to be measuring *y*.
- Having all parties involved from the start is essential for AM to succeed, and ensure that trust and credibility are paramount. Otherwise we run the risk of AM just being a buzzword, and not useful.
- There needs to be commonality among the concepts of AM, perhaps through a framework or checklist, that will include the options available (changes in spacing or siting for future arrays; changes in monitoring schemes and timing; changes in operational characteristics, etc.). However, each AM plan and process will have to be tailored for the site, the species and the technology, and therefore unique to the site.

Moving Forward

The group discussed the value of gathering for this workshop and whether there was value in staying connected.

- The consensus was that there is value to this kind of discussion and that maintaining and expanding such an international collaboration was essential to solving many of the uncertainties facing the establishment of the tidal industry.
- Once the industry is established we will have more information; right now we need to collaborate to move forward.
  There was consensus around having an online international monitoring group, to meet about every six months.
- Annex IV will take the action of organizing the next online gathering, in May 2015.

Environmental Monitoring, Regulatory Needs & Scientific Capabilities: A Facilitated Discussion between Scientists, Regulators and Industry

Saturday, November 1st 2014 (10:00 am – 4:00 pm)

KC Irving Environmental Science Centre, Acadia University

WORKSHOP AGENDA

10:00	Welcome, introductions and review of the agenda	Anna Redden Andrea Copping
10:10	Annex IV aims and imp of the workshop / relevance of prior webinars / key issues (noise impacts, collision/evasion/attraction, etc)	Andrea Copping
10:20	Knowledge network aims and activities	Raeanne Miller
10:30	Addressing collision risk for marine mammals	Carol Sparling
10:45	Effects monitoring of fish at/near an ORPC turbine	Gayle Zydlewski (web)
11:00	Tracking the movements of large at-risk species at a turbine test site	Anna Redden
11:15	Health break	
11:30	Open discussion regarding challenges in 1. Assessment of animal-device encounter probabilities 2. Detection of collision / evasion / attraction	All
12:30	Lunch / Networking in Garden Room, Irving Centre	
13:30	Environmental sensor options, capabilities in high flow sites, and use of integrated multi-sensor platforms to detect effects / behaviour	Brian Polagye (web)
13:50	Continue open discussion, including regulator requirements for 1. Environmental effects monitoring, sensor applications, filling data gaps and making data accessible. 2. Understanding the transferability of effects monitoring results ○ Between species (fish; marine mammals) ○ Between sites ○ Between MRE technology types ○ Between different scales of development - demo projects vs large commercial operations 3. Evidence of no deleterious effects on marine mammals and fish ○ Is this a reasonable expectation given detection limitations? ○ How much monitoring is enough? ○ How can adaptive management practices be applied? ○ How do we know when we can "retire risk" for a species?	All Nate Johnson (web)
15:30	Next steps 1. Workshop reporting and participant feedback 2. Maintaining open communication via future in person and online meetings and Annex IV Tethys (study results, updates, concerns, technology advances, advice, etc.)	Andrea Copping Anna Redden
15:45	Close of meeting	
16:00	Bus departs for Halifax (Prince George Hotel)	

Environmental Monitoring, Regulatory Needs & Scientific Capabilities:
A Facilitated Discussion between Scientists, Regulators and Industry

List of Participants

Participants	Affiliation	Country	Sector	Note
Andrea Copping	PNNL / Annex IV	USA	Science	
Anna Redden	Acadia	CA	Science	
Anne Marie Belliveau	FORCE	CA	Industry	
Annie Linley	NERC MREKE	UK	Science	via web
Brian Polagye	U Washington	USA	Science	via web
Brian Sanderson	Acadia	CA	Science	
Carol Sparling	SMRU Marine	UK	Science	
Carys Burgess	Emera	CA	Industry	
Craig Chandler	SLR Consulting	CA	Industry	
Donald Humphrey	DFO	CA	Regulator	
Freya Keyser	Acadia	CA	Science	
Gayle Zydlewski	U Maine	USA	Science	via web
Graham Daborn	Acadia	CA	Science	
Greg Trowse	Fundy Tidal Inc	CA	Science	
Ian Hutchison	Aquaterra	UK	Industry	
Jennifer Pinks	Offshore Energy Research Assoc	CA	Funder	
Jocelyn Brown-Saracino	US Dept Energy	USA	Science/Gov't	
Joe Hood	Akoostix	CA	Industry	
Kevin Harnett	OpenHydro	UK	Industry	
Lisa Isaacman	FERN	CA	Science	
Meghan Swanburg	Acadia	CA	Research	
Nate Johnson	ORPC	USA	Industry	via web
Raeanne Miller	NERC MREKE	UK	Science	
Steve Sanford	NS Environment	CA	Regulator	
Xu Wei	Nat'l Ocean Tech Center	China	Science	