Training and International Collaboration for Environmental Monitoring of Tidal Energy Devices

SUMMARY REPORT

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TABLE OF CONTENTS

INTRODUCTION

The effects of tidal energy devices on fish are generally unknown, largely due to a lack of devices installed worldwide. However, these potential effects are of high concern to fishers, regulators, the scientific community, and other stakeholders. With the deployment of the Cape Sharp Tidal tidal energy device at the Fundy Ocean Research Centre for Energy (FORCE) test facility in Minas Passage in 2016, we have the opportunity to study fish interactions with this device. The information gained from single devices, such as this, is needed to inform predictions of the effects of device arrays on fish from the individual to population level.

Given the difficulty of observing fish in the highly energetic environments targeted for tidal energy development, and the multiple spatial and temporal scales at which fish and other animals may interact with and be affected by tidal energy devices, best practices for collecting and processing data have yet to be formed. There is a need for demonstrating the utility of different types of technology for documenting fish interactions with tidal energy devices on a variety of scales, including the nearfield, where blade strike is concerning to regulators and members of the public. These data must be collected over large spans of time to capture the high variability in fish presence and behavior in such energetic and dynamic environments, and methods for automatically processing data are essential for handling this data flow. Collaboration between biologists using this information and the engineers and programmers who create the equipment and data processing methods will result in the development of much-needed tools suited to this task.

Collaboration across multiple research groups and organizations is also increasingly important for this newly forming industry, which has begun to take root across the globe but faces similar uncertainty regarding environmental effects at every location. Different technologies and approaches have been applied by several research groups around the world to better understand how animals interact with tidal energy devices. As tidal energy deployments begin to scale up, it is essential for us to begin tying together our findings from different locations, aligning our future efforts, and establishing best practices for monitoring device effects. A concerted effort to compare and contrast sites and develop a standard approach to effects monitoring will maximize the use of the limited resources available for such work and broaden the impact of the individual projects involved.

TRIP DETAILS & BACKGROUND INFORMATION

The purpose of my 10-day trip to Aberdeen, Scotland, was two-fold. The first goal was to meet with Dr. Pauline Jepp, the lead software engineer at Tritech, Ltd. Tritech manufactures the Gemini multibeam sonar, which has been employed by Cape Sharp Tidal to observe animal movements in the nearfield of their device at the FORCE site. Dr. Jepp developed the software to automatically detect and track marine mammals in the vicinity of another tidal energy device deployed in Strangford Lough, UK, and she is currently working to adapt her methods to apply to fish. By meeting in Aberdeen, she aimed to show me how the program currently works and what its abilities and limitations may be. My goal was to share with her what information would be most useful to biologists charged with evaluating fish interactions with turbines, and to discuss

how she may incorporate this into her software. Dr. Jepp and I met on the 12th and 13th of December. The 12th included a visit to St. Andrews, where we met with researchers at the Sea Mammal Research Unit (SMRU) who will be using the same Gemini data to assess marine mammal interactions with the Cape Sharp Tidal turbine, and with whom I will be collaborating as we test Dr. Jepp's software and provide feedback to her. On the 13th, I spent the day with Dr. Jepp at Tritech headquarters, where we went over her software, my past research, and what we may each do in the future to improve and apply the Gemini software.

The second goal of my trip to Aberdeen was to meet with the research group at the University of Aberdeen led by Dr. Beth Scott. Dr. Scott's group is one of the few in the world that have been working on monitoring fish near tidal energy devices in the field, and they have developed a novel remotely-deployed, bottom-mounted platform which integrates several types of sonars to gather data on fish, marine mammals, and diving birds [1]. They have also made progress in processing these data, automatically separating echoes of interest from environmental noise [2]. I had met with this group during my PhD work at the University of Maine to discuss our approaches to studying the effects of tidal energy devices on fish and potential collaborations. During my recent trip to Aberdeen, we aimed to solidify our collaboration goals and draft a research project. This international collaboration will not only involve Acadia University (Dr. Anna Redden and myself; examples of work by Dr. Redden and her team in [3-6]) and the University of Aberdeen (Dr. Scott and her research group [1,2]), but also the University of Maine, where my graduate advisor, Dr. Gayle Zydlewski, continues to gather data at the tidal energy site in Maine [7-11] and at the FORCE site, and the University of Washington, where Dr. John Horne and his research group have been developing approaches to monitoring population-level effects of tidal energy development [12-15]. Dr. Horne was also in Aberdeen, so I also met with him during my visit. Dr. Zydlewski attended our meetings remotely from Maine. We met on December 8th, 9th, and 14th, with time between spent compiling our ideas and researching potential funding opportunities.

BENEFITS OF TRAVEL

Travelling to Aberdeen to meet with key collaborators in my upcoming research was incredibly helpful. Connecting face-to-face at the outset of any project is invaluable for understanding the people involved and ensuring more successful teamwork in the future. These few days of meetings allowed us all to communicate our objectives efficiently and clearly, and to plan future collaborative work that will meet individual goals efficiently while addressing the broader topic of tidal energy development effects on marine animals.

Aberdeen was an especially useful location because many of my future collaborators were nearby, including Dr. Jepp at Tritech, several researchers at the Sea Mammal Research Unit in St. Andrews, Dr. Scott and her research group (Dr. Benjamin Williamson and Shaun Fraser) at the University of Aberdeen, and Dr. Horne. It is rare that so many of us are in the same location at the same time, making this a particularly productive trip in terms of introductions and planning.

OUTCOMES OF TRAVEL

Meetings at Tritech

Meeting with Dr. Jepp provided me with a clear idea of the current abilities of the Tritech Gemini software and the algorithms she has been developing to automatically detect and track fish in the Gemini dataset from Minas Passage. I was able to give Dr. Jepp more information on the fish behaviors we may expect to see in these strong tidal flows, based on my previous research that used a different multibeam sonar for a similar task. We identified several acoustic target properties that may be useful in separating fish moving with the current from debris doing the same, which Dr. Jepp can integrate into the software. We discussed the role I will play in helping her to assess the software's performance. This will be an iterative process of me applying the software to Gemini data, comparing software outputs to my own manual observations, and providing feedback to Dr. Jepp, with the goal of developing the best possible fish tracking algorithms for tidal energy device assessment.

During our visit to St. Andrews, the SMRU researchers and I were updated on the status of Gemini software and became familiar with each other's research objectives. We laid out approaches for applying Dr. Jepp's software and providing feedback to her to improve it further. We reviewed the original goals of the project, which were primarily related to developing the Gemini's fish and mammal tracking capabilities, and discussed how we might apply the outcome to future environmental monitoring. We made plans to meet remotely after the holidays to discuss specific project deliverables and timelines for each project component.

Meetings at the University of Aberdeen

During my meetings with Dr. Scott and her team, Dr. Horne, and Dr. Zydlewski, it became clear that we were all at a point in our respective work where collaboration was necessary to fill the remaining research gaps. We identified three main research areas that could be addressed through collaboration: assessing fish behavior in relation to their physical environment (e.g., turbulence), using stationary and mobile hydroacoustic surveys at each site to identify possible generalizations for informing effects monitoring, and drawing together existing information to explore potential effects on fish at the population level. Combining information from multiple sites worldwide will allow us to understand which generalizations can be made, which will aid in determining best monitoring practices [15]. We identified potential funding sources for this collaborative effort and planned our next steps for applying to these sources, including drafting a letter of intent which outlines our objectives and general methods we will use.

Additionally, we all felt the need for a focused workshop to prioritize the gaps in our current knowledge of how fish are affected by tidal energy devices, to identify existing data available to us, and to develop a framework for drawing this information together to address the most pressing concerns. The initial workshop is likely to be held in Nova Scotia early this year, with future workshops to follow. These will involve Dr. Scott's team, Dr. Horne, Dr. Zydlewski, and Dr. Redden and other researchers here in Nova Scotia.

SIGNIFICANCE TO NOVA SCOTIA

Nova Scotia is one of the few places in the world with tidal currents strong enough to be harnessed for significant electricity generation. Here, there is also a huge amount of concern on the part of fishermen, regulators, and researchers as to the effects of these devices on fish. We are actively seeking to address these concerns, and teaming up with international scientists working on similar issues enhance our ability to answer important questions. Working with Dr. Jepp, for example, will greatly improve my ability to assess fish interactions with turbines through the iterative software testing and feedback approach we will now be able to implement. Collaboration with Dr. Scott, Dr. Horne, and Dr. Zydlewski will allow us to pool information gathered at multiple tidal energy sites and to combine multiple fields of expertise. This broadens the scope of possible research and will allow us to address more complex questions such as population-level effects. By comparing findings from multiple sites, we can look for generalities and learn if results from one location can be applied to another, or if the research must be repeated. This will lead to developing best practices for monitoring tidal energy sites around the world, including Nova Scotia. The upcoming workshop between key researchers of fish interactions with tidal energy turbines will be an essential first step to prioritizing research goals and planning efficient approaches to data collection and analysis.

ACKNOWLEDGEMENTS

Thank you to my advisor, Dr. Anna Redden, for encouraging me to pursue this trip, in which we accomplished what we hoped, then some. Thank you to Dr. Pauline Jepp for taking the time to meet with me at bring me to St. Andrews, and for her continuous efforts to expand on the abilities of the Gemini sonar software to aid our research. Thanks also to Dr. Beth Scott and her team (Dr. Benjamin Williamson and Shaun Fraser), Dr. John Horne, and Dr. Gayle Zydlewski for setting aside time to discuss a new collaboration. Finally, thank you to OERA for making this trip possible.

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