force | Fundy Ocean Research Centre for Energy

Project Update 2019

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HIGHLIGHTS 2019

New Technology On Deck

The Bay of Fundy is witnessing a surge of new technologies after the demise of the OpenHydro device in July 2018.

In February 2019, **Sustainable Marine Energy (SME)** announced successful energy generation from its 280-kilowatt floating platform PLAT-I in Grand Passage. In June, SME announced conclusion of phase 1 of platform testing, including no evidence of marine life in contact with the platform. In July, the Province announced it had issued a license for a 1.26MW SME tidal array at FORCE.

SME's PLAT-I platform installed in Grand Passage, NS

In June 2019, **DP Energy** announced the hiring of Sarah Thomas as new project manager for a nine-megawatt tidal energy system at FORCE (recently awarded $29.8 million from the Government of Canada's *Emerging Renewable Power Program*. The project includes six Andritz Hydro Mk1 1.5MW seabed mounted tidal turbines. In July 2019, DP announced the successful deployment of ADCPs at berth E with support from Nova Scotia companies Seaforth Geosurveys and Huntley's Sub Aqua Construction.

In addition, **Jupiter Hydro** and **Big Moon Power** have received permits to begin new device testing near the FORCE site. **Nova Innovation** has a project under consideration by the Province; other players are expected to announce additional projects in the near future.

As well, the Province has indicated it plans to release a tender for a new developer at FORCE; this tender will include the removal of the OpenHydro turbine from the FORCE site.

Force Science Program Wins Respect On World Stage

FORCE Science Director Dr. Dan Hasselman has been invited to be Canada's lead expert in the "State of the Science Report 2020" – the leading research report related to the marine renewable energy sector. Dr. Hasselman will collaborate with co-authors to produce an analysis of environmental monitoring approaches and technologies. A draft of the report will be released at the International Conference on Ocean Energy (ICOE) in May 2020 in Washington D.C.

This builds on FORCE's pioneering sensor research from three underwater platforms, as well as ongoing environmental monitoring work that represents more than 2,700 'C-POD' marine mammal monitoring days, over 400 hours of hydroacoustic fish surveys, bi-weekly shoreline observations, 50 observational seabird surveys, as well as lobster surveys, drifting marine sound surveys and additional sound monitoring.

SECTOR OVERVIEW

Marine Renewable Energy (MRE)

Marine renewable energy has been harnessed for centuries – powering mills, transporting nutrient-rich sediment, moving vessels, supporting marine life migration, even terrifying surfers – but only recently has it been understood as a vast untapped reserve of power. Seventy-one per cent of the Earth's surface is composed of moving water, all containing energy that can be converted to electricity.

MRE can:

- Provide clean, sustainable electricity
- Contribute to action on climate change
- Spur industrial growth by capitalizing on skills and assets already present in other sectors
- Create a game-changing opportunity for remote communities

Theoretical estimates for global MRE potential indicate resources exceeding 100,000 terawatt hours (TWh) of electricity, equal to the power needs of over 8 billion Canadian households – more than the current power demands of the entire planet.

Canada continues to deepen its exploration of marine renewable energy (MRE) as a potential solution to clean energy, greenhouse gas emission (GHG) reduction, and economic growth targets.

Given the country's natural resource assets as well as existing expertise in the marine sector, ocean waves, wind, tides, salinity, temperature differences and river currents can all contribute to Canada's clean energy bottom line. Canada has an estimated 35,700 megawatts (MW) of tidal energy potential, enough clean power to displace over 113 million tonnes of CO2 (equal to removing over 24 million cars off the road). Adding wave and river, the potential climbs to 340 gigawatts, enough energy to power every home in Canada five times over. The country's offshore wind energy potential is still being mapped, but projected to be larger still.

The opportunity includes both large-scale transmission projects and small, distributed community generation. Over 300 companies have already found work in the Bay of Fundy's emerging tidal stream sector. A total of 251 remote Canadian communities rely on their own fossil fuel plants; 176 of them are fuelled by imported diesel. Canada is now demonstrating marine renewable technologies that offer remote communities a solution that can be cost competitive, avoid emissions, and create jobs.

The MRE sector continues to show promise as a contributor to our low-carbon economy, with the global installed capacity doubling from 2016 to 2017. And through this period of growth, Canada has emerged as a global leader. Over the past decade, the Canadian MRE sector has established supportive policy, made key investments in technology demonstration infrastructure and technical and environmental research, and spurred activity by connecting a steadily growing supply chain of Canadian businesses. As a result, Canada is often recognized for its strategic approach, slowly building the experience, knowledge, and innovation necessary to advance the Canadian sector.

Challenges remain: the sector has not yet converged on a single design solution for energy capture or mooring, and working with new technologies in marine environments is still pioneering work.

Canada's MRE sector faces many of the same challenges the global sector faces: lack of market, challenges attracting finance, knowledge and technology gaps, and depending on location, insufficient infrastructure.

Tackling these challenges requires sustained effort in key areas, including:

- establishing policies to support long-term activity
- accelerating innovation
- sustaining and growing a supply chain, and
- growing the technical and environmental knowledge base

PROGRESS IN 2019

Facilitating the Demonstration of Technology

Operations:

FORCE continues to administer the Marine Access Permit (MAP) procedures for all marine operations at the FORCE Site. The process has governed over 100 marine operations varying in size from multi-week operations with various vessels and generator deployments and recoveries to single vessel small operations lasting only a couple of hours. At any given time, there can be over a dozen subsea assets being managed by the MAP process, all with significant subsea footprints involving complicated ground-tackle and anchors. Each new operation is scrutinized to ensure there are no ill-effects due to simultaneous operations. The MAP procedures have successfully managed various marine incidents including the interaction of an anchor and mooring line with Cable A.

FORCE also partnered with Operational Excellence Consulting Inc. (Halifax, NS) this past year to document lessons learned from various marine operations over the last few years. The report, Lessons Learned: Marine Operations in the Minas Passage (2019), documents operational constraints, information to address commonly-encountered situations, and learnings to-date in an effort to help support and de-risk future projects at the FORCE test site. This work was funded by the OERA. The webinar is available here: https://oera.ca/outreach/oera-webinar-series/force-site-marine-operations-lessons-learned

Cape Sharp Tidal:

The CST turbine remains at berth D – connected but non-functioning. In March 2019, the NS Department of Energy and Mines revoked CST's license at FORCE. This invalidated the feed-in tariff, cancelled CSTV's sub-lease at FORCE, and necessitated the removal of the device.

FORCE has taken over monitoring of the turbine: this involves monthly "checks" to confirm the rotor remained stationary during the most powerful monthly tide, using data delivered to shore from instruments onboard the turbine, and reported to regulators. FORCE is likely to play a role in a removal process, but it remains unclear when and how.

In August 2019, FORCE submitted a statement of claim naming Cape Sharp Tidal Venture Ltd., OpenHydro Technology Limited, OpenHydro Technology Canada Ltd. and Naval Energies as defendents. This claim relates to CST interaction with Cable A during their marine operations at FORCE in 2016/2017; the claim is essentially a protective action that preserves FORCE's ability to seek damages arising from the interaction in the future. The potential long term affects from the interaction of the anchor and Cable A cannot be fully known from recent tests and surveys.

DP Energy:

In September 2018, NRCAN announced $29.8 million to FORCE berth holder Haligonia Tidal Energy Ltd. from the Emerging Renewable Power Program for a nine-megawatt tidal energy system at FORCE, combining both floating and submerged turbines. The project incorporates five Andritz Hydro Mk1 1.5MW sea-bed mounted tidal turbines, and a single Scotrenewables Tidal Power SR2-2000 floating turbine. The project is intended to demonstrate tidal stream's capability to extract energy in both shallow and deep water. In June 2019, DP Energy announced the hire of Sarah Thomas as new project manager for their tidal project in NS. In July 2019, DP announced the successful

deployment of ADCPs at berth E with support from Seaforth Geosurveys of Dartmouth, Huntley's Sub Aqua Construction of Kentville, and Applied Renewables Research of Northern Ireland. ADCP were scheduled for retrieval in Aug, with analysis in September.

SME:

In February 2019, SME announced successful energy generation from its 280-kilowatt floating platform PLAT-I in Grand Passage. In May, SME announced a fishing boat had struck the PLAT-I, with non-significant damage to the platform. In June, SME announced conclusion of phase 1 of platform testing, including no evidence of marine life in contact with the platform. In July, the Province announced it had issued a licence for a 1.26MW SME tidal array at FORCE.

PLAT-I platform testing.

Research and Development

FORCE advances research through its growing stable of science personnel and onshore and offshore assets.

Dr. Dan Hasselman and Dr. Joel Culina, two leading experts in fish monitoring and hydrodynamics, together with FORCE's team of ocean field technologists, are able to deliver a sector-leading science program in partnership with universities and other research entities.

FORCE's onshore assets include a meteorological station, video cameras, an X-band radar system, and tide gauge. Offshore assets include modular subsea platforms for both autonomous and cabled data collection and a suite of instrumentation for a variety of research purposes.

Research priorities are based on consultation with regulators, other Fundy users, academics, and industry; each project is aimed at reducing risk. Projects include:

- *The Vectron*: the world's first stand-alone instrument to remotely measure turbulence in the mid-water column in high resolution. Vectron analysis will help tidal energy companies to better design devices, plan marine operations, and characterize the tidal energy resource.
- *Cabled Platform*: delivering real-time monitoring data from near-turbine locations using a variety of sensors (like the Tritech Gemini imaging sonar) to detect marine life in the vicinity of operating turbines. This platform may prove to be an essential piece of monitoring equipment

- *Hydroacoustics Platform:* comparing bottom-mounted fish profiling data collection to downward facing fish profiling data from vessel transects, this may determine both the most effective way to monitoring fish long term in tidal energy sites.
- monitoring of the sea state and vessel activity.

The Pathway Program

The Pathway Program is a multi-year collaborative effort between FORCE and OERA to identify an effective and regulator approved monitoring solution for the tidal energy industry in Nova Scotia.

The Pathway Program involves several phases, including:

i) Global capability Assessment
ii) Advancing Data Processing and Analytics, and
iii) Technology Validation.

The first phase of this program is a Global Capability Assessment that involves a comprehensive literature review about the use of different classes of environmental monitoring technologies (i.e., PAM, imaging sonars, echosounders) for monitoring tidal energy devices around the world. Subject matter experts have been commissioned to provide reports on these instrument classes, and FORCE has received final reports for PAM and imaging sonars.

Other projects underway include:

• *Continued ADCP deployments and data collection* to better understand the resource at the FORCE Site, and to characterize wake effects of turbines

• *A focused effort to characterize the wake from Black Rock* as RADAR has identified significant turbulence about the relatively large geological mass

• *MRE GIS:* display and communicate large and complex data sets

• *Tide gauge recovery and repair.* The FORCE tide gauge began experiencing issues with data collection in April 2019; inspection revealed a leak in the data/power cable. The cable was replaced, re-terminated, and tested before re-deployment on June 6, 2019.

Environmental Monitoring

Since 2009, FORCE has provided baseline environmental studies, environmental effects monitoring, and applied research.

For tidal stream to move to large-scale development, the public and regulators must be satisfied that any development activity is safe, sustainable and viable.

FORCE's environmental effects monitoring program (EEMP) is designed to better understand the natural environment of the Minas Passage and the potential effects of turbines as related to fish, seabirds, marine mammals, lobster, marine noise, benthic habitat and other variables. All documents are available online: fundyforce.ca/document-collection

To date, international research studies of tidal stream devices have been encouraging: findings indicate that fish and marine mammals generally avoid turbines. But this must be proven conclusively. Robust research and monitoring programs will be critical to retiring risk and uncertainty.

Lobster monitoring

A baseline catchability study was completed at the FORCE site in October - November 2017, while no turbine was deployed. This study provides baseline catchability rates in

the absence of a turbine and builds upon previous lobster research at the FORCE site. The next lobster catchability study is contingent on the presence of a turbine operating at the site, which is needed to fully evaluate the effects of in-stream tidal turbines on lobster catchability rates.

Fish monitoring

FORCE contracted the University of Maine to analyze fish-monitoring data using a downward facing hydro-acoustic echosounder. UMaine has experience conducting similar monitoring programs for a tidal energy project in Cobscook Bay, Maine. The goal of this program is to describe and quantify fish distributional changes that reflect behavioural responses to the presence of a deployed turbine.

Results to date have shown that the density of fish at turbine height was highly variable across tidal stage, time of year, and location within the FORCE site. Preliminary findings suggest no significant effect of the turbine on the density of fish in the mid-field of the turbine or on fish vertical distributions, but more data collection during additional turbine deployments is needed evaluate impacts to fish.

A report outlining these preliminary findings can be found in FORCE's 2017 annual report, located at: www.fundyforce.ca/document-collection

Like the lobster program, the fish monitoring program requires the presence of an operational turbine at the FORCE site in 2018 for testing its effects. Further, a non-operational turbine may bias baseline data collection. FORCE was planning to conduct fish surveys during known periods of peak migration in 2019 – notably, in spring to capture migration periods of alewife, Atlantic herring, striped bass, Atlantic sturgeon, American shad, Atlantic mackerel, and rainbow smelt (Baker et al., 2014; Stokesbury et al.,2016) and also in late fall in consideration of outward migration of Atlantic herring, blueback herring, and alewife (Townsend et al., 1989). These data collection efforts were contingent on operational status of the turbine.

In the interim, FORCE, in cooperation with Echoview Software (Tasmania, Australia) and the University of Maine, has been focusing efforts on data processing and analysis of fish survey data as well as in support of a comparative analysis with data collected from a bottom-mounted FAST system. FORCE staff completed the Echoview software training course in Q2 2019 to build the skillset of processing hydroacoustic data. Presently, FORCE staff are undertaking data processing to enable the University of Maine and Echoview staff to complete data analysis and reporting and to improve the efficiency data processing.

Marine mammal monitoring

In 2018/19, FORCE continued to conduct two main activities aimed at testing the EA prediction that project activities are not likely to cause significant adverse residual effects on marine mammals within the FORCE test site (AECOM, 2009). These activities have been ongoing on a regular basis since 2016.

Passive Acoustic Monitoring (PAM)

FORCE contracted the Sea Mammal Research Unit Consulting (Canada) to complete data analysis relating to the deployment of click recorders' known as C-PODs. The goal of this program is to detect changes in the distribution of the harbour porpoise in relation to operational in-stream turbines.

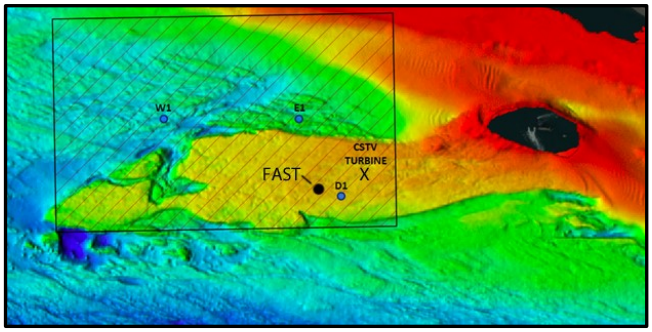
Since 2011 to early 2018, more than 4,695 'C-POD days' have been completed in the Minas Passage. Over the study period, it was

found that harbour porpoise use and movement varies over long (i.e., seasonal peaks and lunar cycles) and short (i.e., nocturnal preference and tide stage) timescales. The analysis completed by Sea Mammal Research Unit (Canada), showed some evidence to suggest marine mammal exclusion within the near-field of CSTV turbine when it was operational (November 2016 – June 2017) (Joy et al., 2018). The results of the analysis also indicated that the C-PODs in closest proximity to the turbine (230 m and 210 m distance) had shown decreases in detections whereas there is no evidence of mid-field avoidance with a turbine present and operating. The latest findings also showed a decrease in detections during turbine installation activities which is consistent with previous findings (Joy et al., 2017), but will require additional data collected in relation to an operating turbine to allow for a full assessment of the EA predictions.

C-PODs: Ocean technologist Tyler Boucher, along with crew, haul a SUBS package containing a C-POD aboard during recovery.

The C-PODs were deployed on December 6, 2018 and recovered on March 29, 2019. Following inspection and data-recovery, maintenance activities included replacement of CPOD batteries, replacement of acoustic release batteries, refurbishment of one SUBS package, and the fabrication and installment of mounts for the MetOcean Telematics (Dartmouth, NS) beacons. The C-PODs were re-deployed on April 3, 2019, and are currently collecting data.

The delay for the re-deployment was caused by the amount of maintenance required during this turn around as well as the vessel availability for the operation. The vessels normally used for this operation were both away on location for other jobs. It took a special weather window for a vessel to return to the area, and also have time for the deployment.



Map: FORCE test site with approximate locations for C-PODs deployed on SUBS packages (W1, E1, D1), and the planned location for deployment of the FAST platform mounted with PAM devices (•).

In 2019 FORCE also received an F-POD from Chelonia Limited (makers of the C-PODs; Cornwall, UK), which it will deploy at the FORCE site. This instrument is being included in FORCE's comparative PAM study outlined in its 2019 EEMP plan. This study aims to understand the relative performance of multiple PAM devices (i.e., C-POD, F-POD, SoundTrap, icListenHF, and AMAR-G4) across the range of tidal flows experienced at the FORCE site. The first phase Aquatron testing has been completed and confirms that each device can detect synthetic click trains emitted by an icTalk used to mimic harbour porpoise vocalizations. FORCE is now preparing to deploy the devices on a FAST platform at the FORCE site to commence the field trial component of this study.

Observation Program
FORCE's marine mammal observation program in 2019 includes observations made during bi-weekly shoreline surveys, stationary observations at the FORCE Visitor Centre, and marine-based observations during marine operations. All observations and sightings are recorded, along with weather data, tide state, and other environmental data. Any marine mammal observations are shared with SMRU Consulting to support validation efforts of PAM activities.

In recent months a number of FORCE staff received training to operate an Unmanned Aerial Vehicle (UAV), and are in the process of developing a study design to assess the relative utility of UAV-based versus walking-based observational surveys in summer 2019.

FORCE also hosts a public reporting tool that allows members of the public to report observations of marine life: mmo.fundyforce.ca

Seabird monitoring

FORCE's goal with seabird monitoring is to understand whether a turbine causes displacement of surface-visible seabirds and marine mammals from habitual waters, and to identify changes in behaviour. This work is led by Envirosphere Consultants (Windsor, NS).

Over the last several years, FORCE and Envirosphere have collected observational data from the deck of the FORCE Visitor Centre, documenting bird species presence, behaviour, and seasonality throughout the FORCE site. Overall, these surveys have documented the distribution, abundance, and seasonality of water-associated birds in the Minas Passage, but there has been limited opportunity to determine potential effects and test the EA predictions given the short time period with an operational turbine at FORCE.
FORCE has begun a collaboration with Envirosphere and Dr. Phil Taylor at Acadia University (Wolfville, NS) to synthesize previous observation-based seabird baseline datasets (2017-2018) and to integrate this information with data from radar-based monitoring (Walker and Taylor, 2018).

Radar based monitoring, based on an X-band radar located at the FORCE Visitor Centre has typically been used for flow characterization, but can be used to monitor bird movements throughout and around the FORCE test site. This integrated work will help to quantify the risk for seabirds in relation to operating tidal energy turbines at the FORCE site and will examine the potential of statistical models to improve the precision and certainty in detecting impacts to seabirds. This work will advance the ability to describe seabird abundance, species composition, spatial and temporal distribution, and seasonality.

Sound monitoring

In late 2018, FORCE convened a working group of experts in passive acoustic monitoring (PAM) data collection and analyses from local academic institutions, industry partners, and other stakeholders. The purpose of the workshop was to discuss the challenges and operational limitations inherent with using PAM technologies for marine mammal and sound monitoring in high-flow environments like the FORCE test site and to identify potential solutions to improve environmental effects monitoring capabilities for operational in-stream tidal energy turbines in the future. The workshop sought to address questions from regulators regarding the integration or corroboration of results from multiple PAM technologies deployed in and around the FORCE test site.

The workshop also explored potential future projects to support further environmental monitoring using PAM technologies with the end goal of lending confidence to environmental effects monitoring technologies and approaches used in support of tidal energy devices.

Building on this workshop, FORCE is undertaking an assessment of the relative performance of PAM technologies in partnership with Dalhousie University's Oceanography Department (Halifax, NS) and industry partners GeoSpectrum Technologies (Dartmouth, NS), Ocean Sonics (Truro, NS), and JASCO Applied Sciences (Dartmouth, NS). This integrated comparative analysis looks at near-field sound data collected by hydrophones (i.e., underwater sound recorders):

- on the CSTV turbine, collecting data since September 4, 2018 (three icListen hydrophones);
- two icListen hydrophones mounted on a Fundy Advanced Sensor Technology (FAST) platform deployed approximately 35 m from the turbine from September 5 – 21, 2018;
- an AMAR (Autonomous Multichannel Acoustic Recorder) deployed approximately 100 m from the turbine from June 29 – November 19, 2018.

In addition, an acoustic Doppler current profiler mounted on the CSTV turbine has collected current data since September 4, 2018. This data will be used to understand how ambient sound varies with the tidal flow conditions. This work will continue to characterize ambient sound levels as a function of current speed and tidal cycle and then evaluate the performance of each sensor with respect to ambient sound and compare the results of each system and its configuration. This comparative analysis will provide valuable information about future marine sound monitoring technologies and protocols while building on previous acoustics analysis at the FORCE site.

Other activities

Independent of EEM programs, FORCE also conducts and supports additional research efforts, including FAST and the Pathway Program mentioned above, as well as fish tagging efforts and wetlands monitoring.

Fish Tracking

To enhance fish monitoring and to expand its data collection capacity, FORCE partnered with the Ocean Tracking Network (OTN) and attached one VEMCO fish tag receiver to each C-POD mooring/SUBS package. These receivers are used to supplement OTN's ongoing data collection program within the Minas Passage and are referred to as 'Buoys of Opportunity.'

Upon retrieval of the C-PODs and receivers, instruments are shared with OTN where data is offloaded prior to redeployment. This effort will support increased knowledge of fish movement within the Minas Passage, which has applicability beyond tidal energy demonstration, as well as complement FORCE's hydroacoustic data collection efforts that do not allow for species identification.

OTN data managers are in the process of acquiring information, including species identification, and sharing this with FORCE. Initial results show that the OTN receivers deployed by FORCE have detected tags from the nine (9) different research projects.

Starting in 2018, FORCE has worked in collaboration with Dr. Mike Stokesbury at Acadia University to install additional VEMCO receivers of a new design on FORCE's C-POD moorings/SUBS packages. These new receivers are expected to be even more effective in picking up acoustic

detections in high flow environments, where tag signals can be obscured by noise. This partnership will contribute additional information regarding movement patterns of Atlantic salmon, sturgeon, striped bass, and alewife in Minas Passage and Basin. This work is sponsored by the OERA, NRCan, NSDEM, the Natural Sciences and Engineering Research Council of Canada (NSERC), and the Canadian Foundation for Innovation (CFI).

Wetlands Monitoring

FORCE is also completing onshore terrestrial monitoring in 2019. This work will be done to verify impact predictions made in relation to its work in the marsh wetlands along Black Rock Beach to install four electrical cables and a data cable. This monitoring work has been ongoing since the installation of the cables in 2014.

Completed by Envirosphere Consultants, this includes periodic walkovers by a biologist and a botany survey in the disturbed area, repeating baseline work done in 2014 and monitoring work completed in 2015 and again in 2016.

To-date, this monitoring work has shown the wetland is well-vegetated and has largely recovered from the trenching operations associated with the cable installation.

Awareness and Understanding

Social license for MRE depends on public and regulator confidence that the effects of TISECs on marine life and the environment are understood and acceptable. Most residents of Nova Scotia know little about the project, and while polling indicates that many Nova Scotians support both renewable energy use and tidal stream demonstration, recent media coverage has been extremely mixed: covering deployment, concerns from members of the fishing community, and the collapse of OpenHydro. Representatives from fishers associations, First Nations bands, and some members of the public, while supporting marine renewable energy in principle, have expressed strong concerns about any potential TISEC impacts.

Some of these concerns relate to:

- *Trust in technology:* many fishers believe near-field monitoring programs by berth holders are inadequate
- *Funding:* some opponents have criticized the project as corporate welfare, with big dollars going into unproven technologies, and concern that ownership is primarily foreign
- *Foreign control:* OpenHydro's collapse has made local suppliers very aware of their vulnerability to decisions far outside the region
- *Financial risk:* lobster fishers carry high debt load for license, boat, and equipment, and any potential stressors resulting in change to their catch can have significant implications to their livelihood
- *Displacement:* potential loss of marine space with increased footprint of TISEC areas
- *Species of concern:* many are concerned that turbines may impact species at risk, and/or species important to food, social, and ceremonial fisheries such as American Eel, Striped Bass, Atlantic Salmon
- *Fish migration:* even if collision risk proves to be low, avoidance behaviour could change migratory routes and therefore impact traditional spots

- *Engagement:* a need to broaden outreach to more groups and wider geography

FORCE's environmental monitoring advisory and community liaison committees have representatives from the Nova Scotia Mi'kmaq and fishing communities, and FORCE has had ongoing involvement with lobster fishers who work near the test area. However, there remains a pressing need to take additional measures to engage with groups from around the province, with a focus on fishing and First Nations communities, to understand concerns. FORCE recognizes that there are still many other individuals and communities to connect with. Ultimately, tidal energy needs to co-exist with other users of the marine environment. A new green energy technology also has the potential to connect Fundy communities by protecting marine life from the impacts of climate change – including ocean acidification, erosion, storm surges and population level shifts in the marine ecosystem.

As well, there remains an ongoing need to share information about local content with project developers and opportunities available to Nova Scotia's diverse ocean SME community. In light of OpenHydro's insolvency, there is a need to ensure confidence in the sector's viability and to encourage some SMEs to participate in the sector.

Outreach activities in 2018/2019 focused on six key engagement areas:

- Online brand and reach
- Attendance at conferences and events in the fisheries, renewables, and ocean technology sector
- Engagement with indigenous groups/organizations and individual communities
- Education initiatives, including outreach to children, youth, and educators
- Government relations
- Visitor Centre activities, including outreach to the local community in Parrsboro and Cumberland County

Other Projects

Over the past year, FORCE has explored a number of initiatives to offer its capabilities and gain experience as a service provider to other projects beyond immediate objectives.

Resource Assessment and Turbine Siting:
In 2018, New Energy Corp. (NEC) hired FORCE to provide information for its application for a tidal energy permit in Minas Passage. Central to this information package was a 'macro-siting' of northern Minas Passage, in search of the most suitable locations for its turbine array. Using the Acadia-FORCE numerical model and NEC turbine parameters, maps were generated of key variables, including turbine capacity factor (as a function of the velocity field in northern Minas Passage). Three sites were systematically selected based on scoring criteria, and, through additional consultation with FORCE, NEC settled on a final location and turbine array configuration.

Solar Project:
FORCE applied for and won a bid to install a 30kW solar array at the visitor center through NS Solar Electricity for Community Buildings Program. For this project – still in early planning stages – FORCE will partner with Alternative Resource Energy Authority (a NS municipal-owned corporation) and Cumberland County. In the longer term, when combined with tidal energy, this

project could position FORCE to go off-grid, strengthening the idea of renewable energy diversity as a legitimate rural, remote, and micro-grid solution.