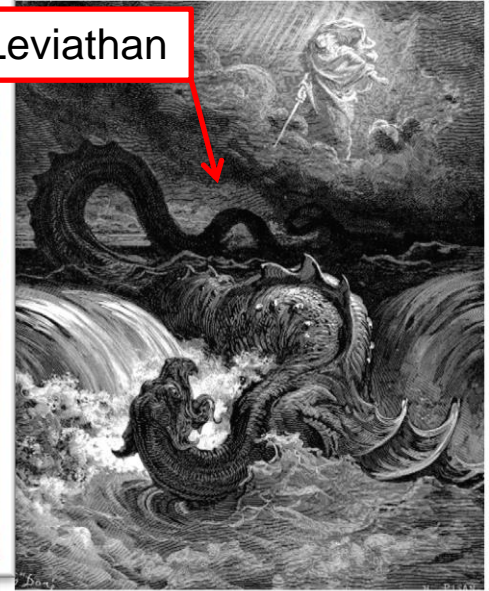
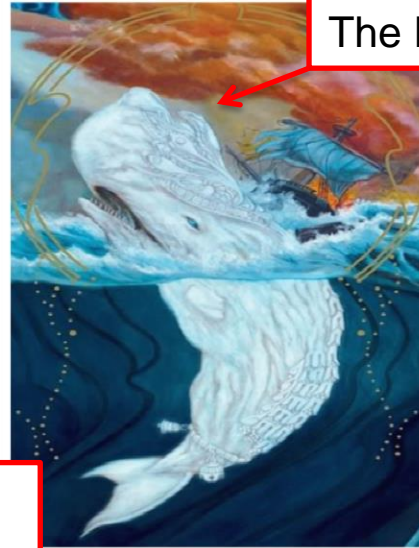
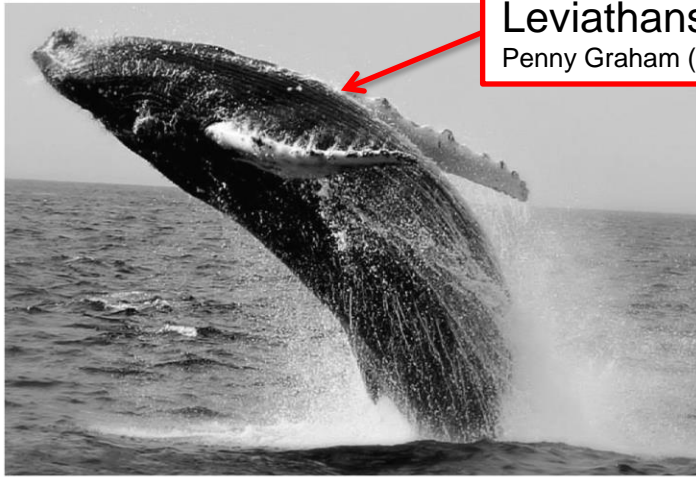


Outer Bay of Fundy Tidal Energy Development: Where the Leviathans Live

Annex IV webinar - October 28, 2014 - Greg Trowse (Fundy Tidal) / Chloe Malinka (SMRU)



Leviathans Photos from Penny Graham (Mariner Cruises)



Fundy Tidal Inc. – Community Tidal Energy Developer

Objectives:

- A) Introduce Fundy Tidal and our sites
- B) Overview of some environmental work done to date
- C) Outline next steps and opportunities to collaborate



Site Introduction – COMFIT / CEDC / CEDIF

Community ownership and control

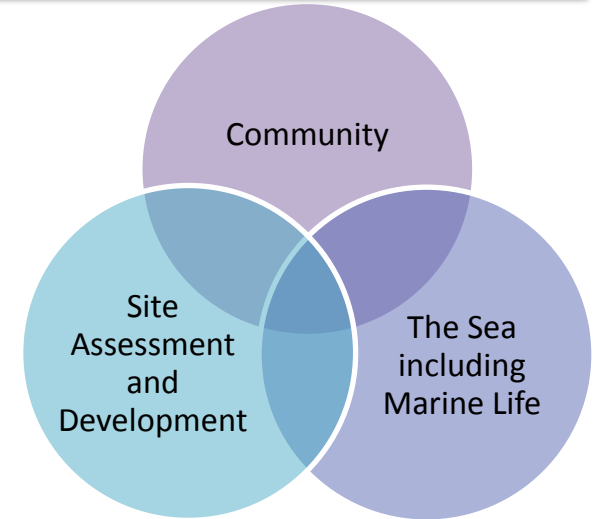
“Small-scale” **Community** Feed-in Tariff (COMFIT) program

Community Economic Development Corporation (CEDC)

Community Economic Development Investment Funds (CEDIF)

<http://www.novascotia.ca/econ/cedif/>

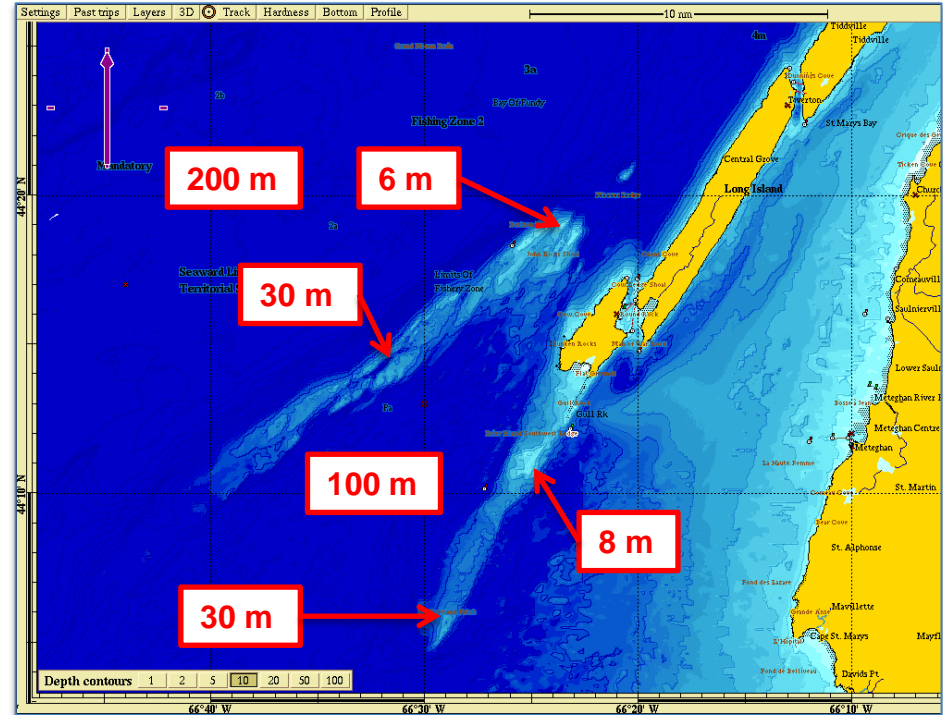
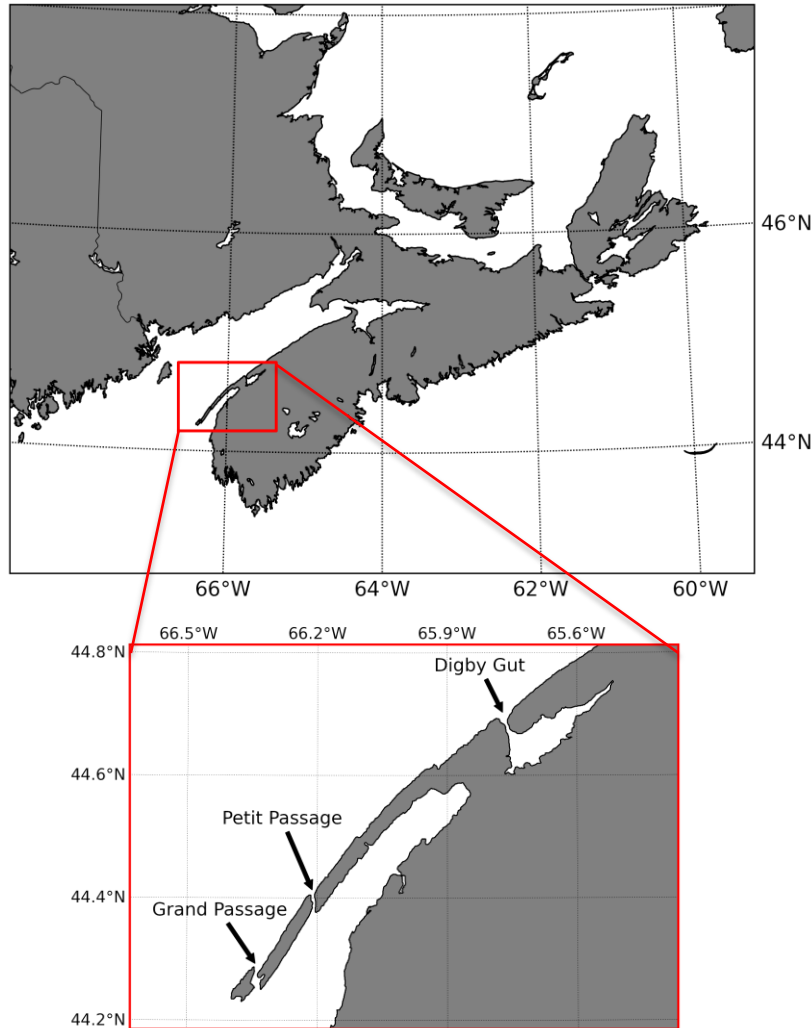
- **\$652/MWh** for a 20 year PPA with Nova Scotia Power
- Individual turbines up to 500 kW (arrays of 500 kW machines OK)
- Distribution connected, **local use** limits **local power production**
- Goal to generate dividends for community shareholders through:
 - a) sale of tidal energy to grid, and
 - b) providing technical consulting services to other projects.



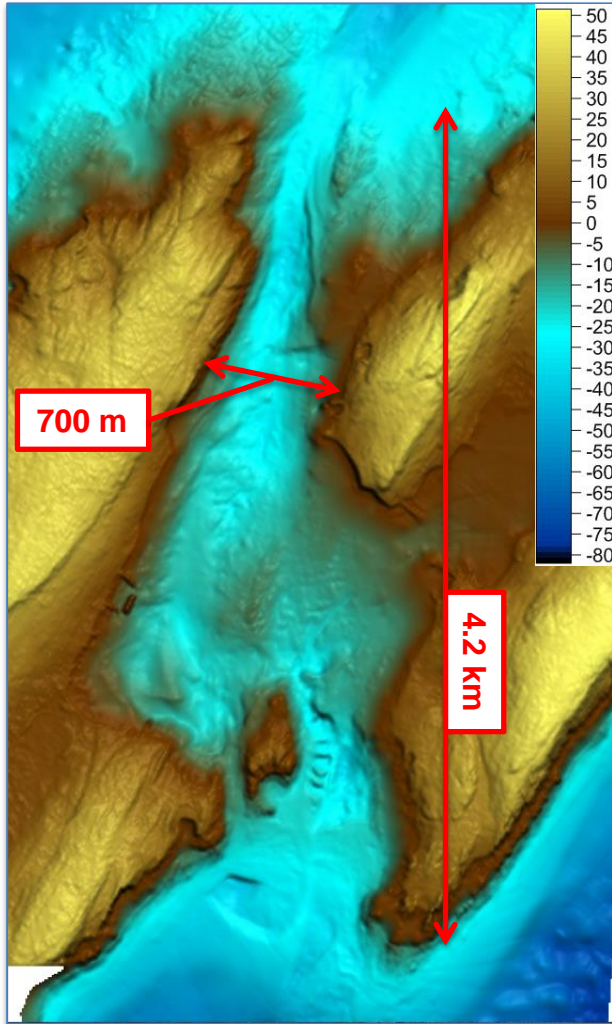
You never know what can grow!

Site Introduction – Locations

- 3 tidal energy sites located in SW Nova Scotia
- Grand Passage adjacent to productive feeding ground for several species of marine mammals, including “Charismatic Megafauna” a.k.a. in the sea “Leviathans”

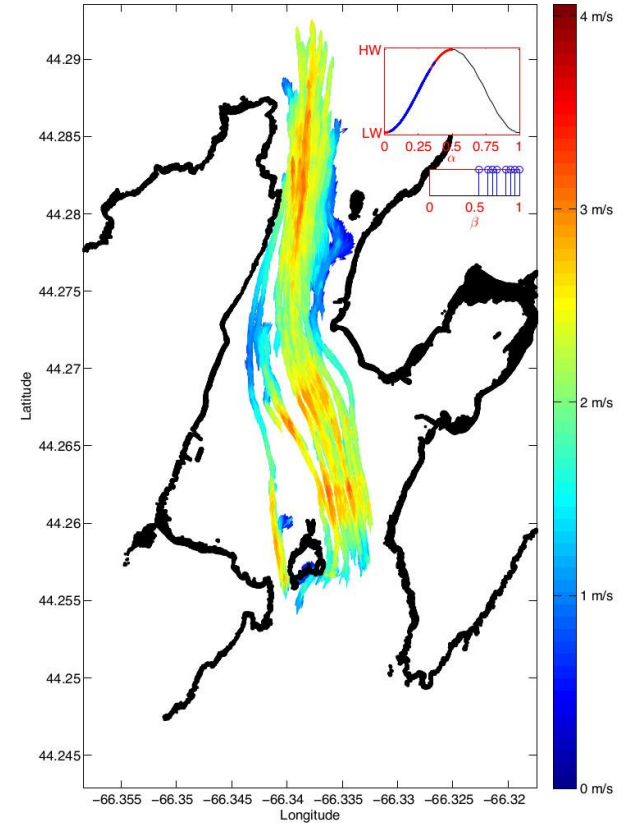
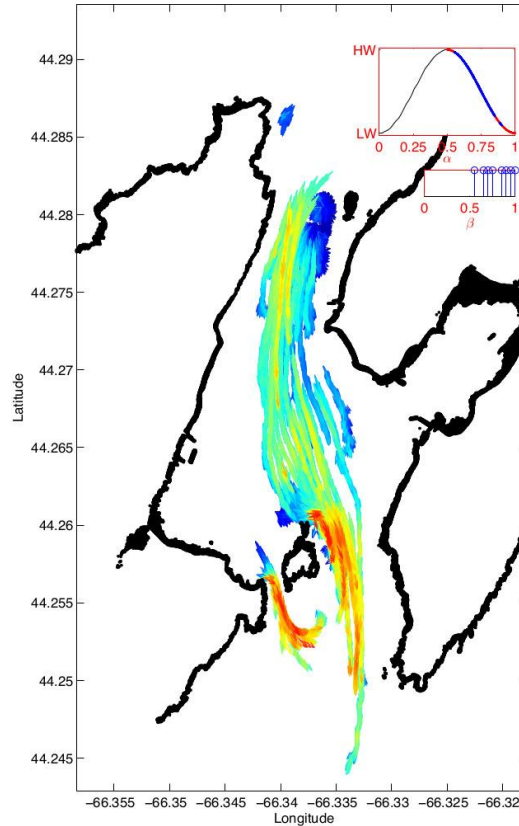
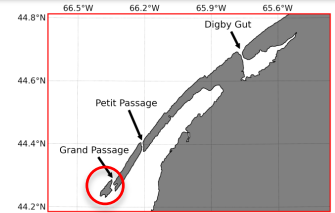


Site Introduction – Flow and Bathymetry (Grand Passage 500 kW)

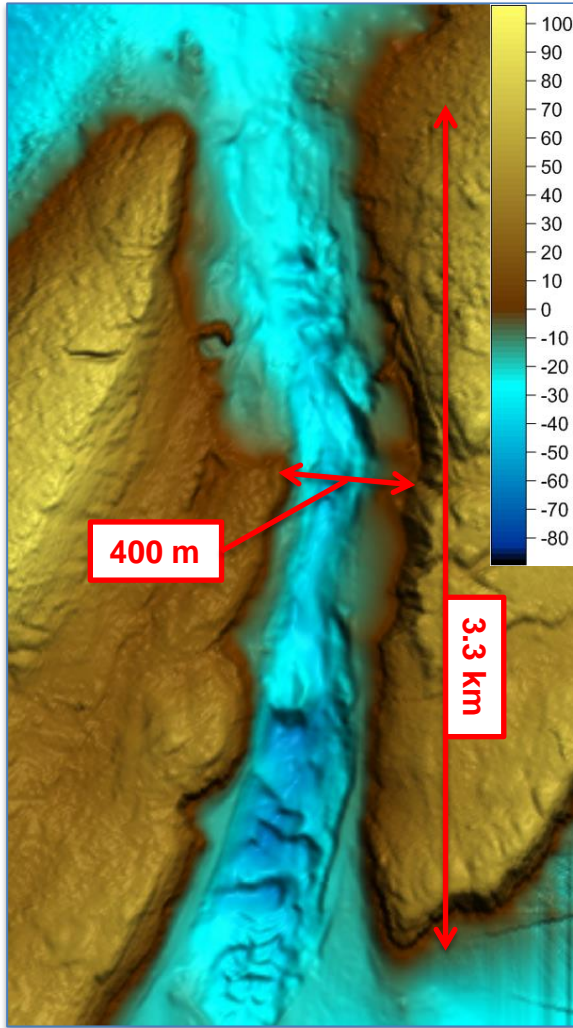


Turbine Berths

- 10 to 30m deep
- Max flow \approx 3 to 3.5 m/s

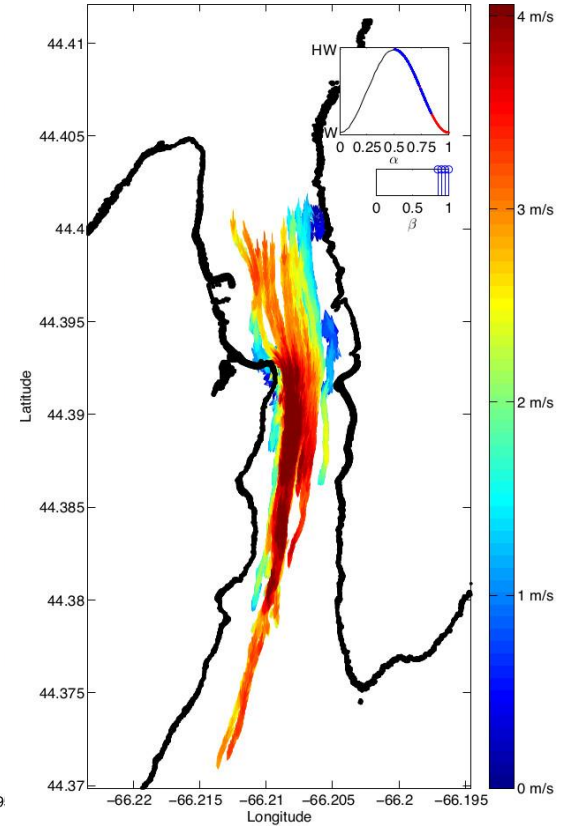
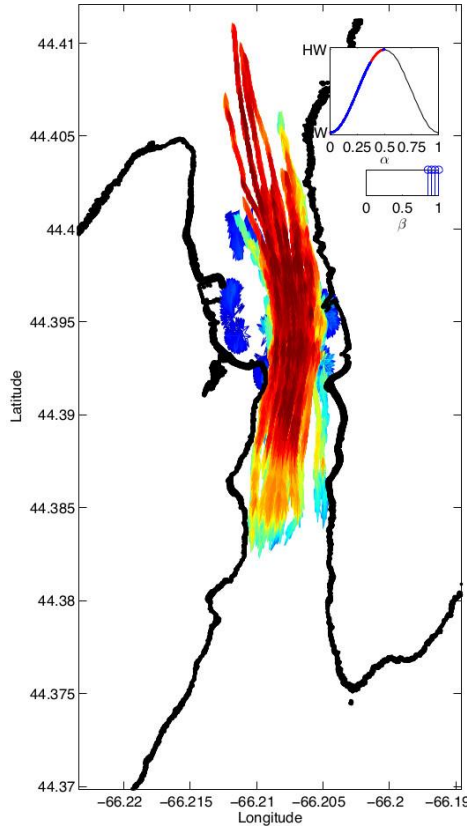
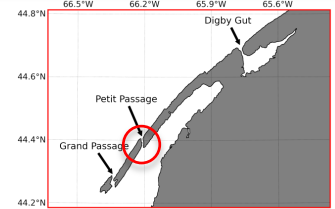


Site Introduction – Flow and Bathymetry (Petit Passage 500 kW)

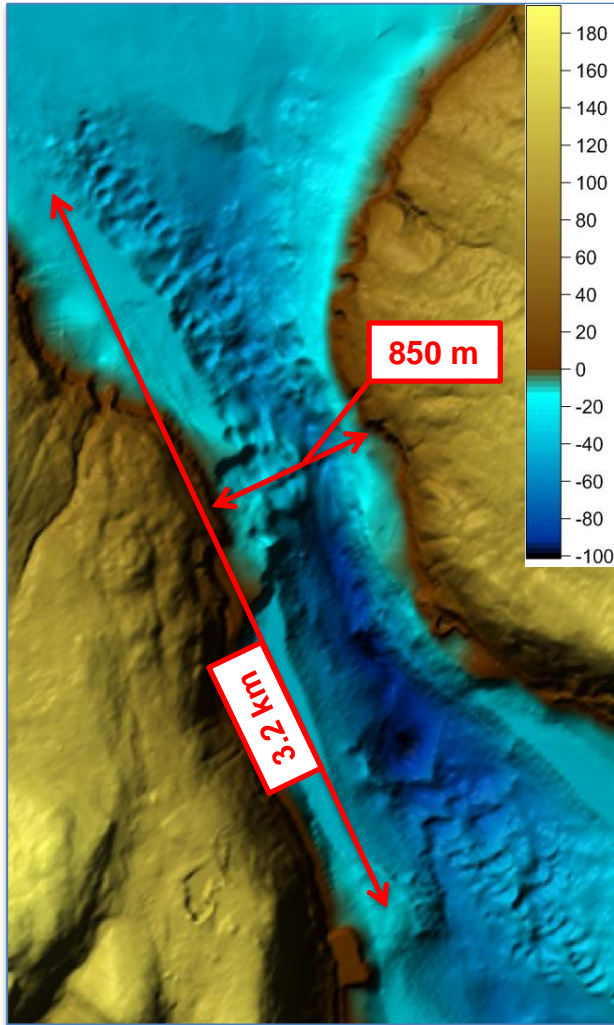


Turbine Berths

- 20 to 50m deep
- Max flow \approx 4 to 4.5 m/s

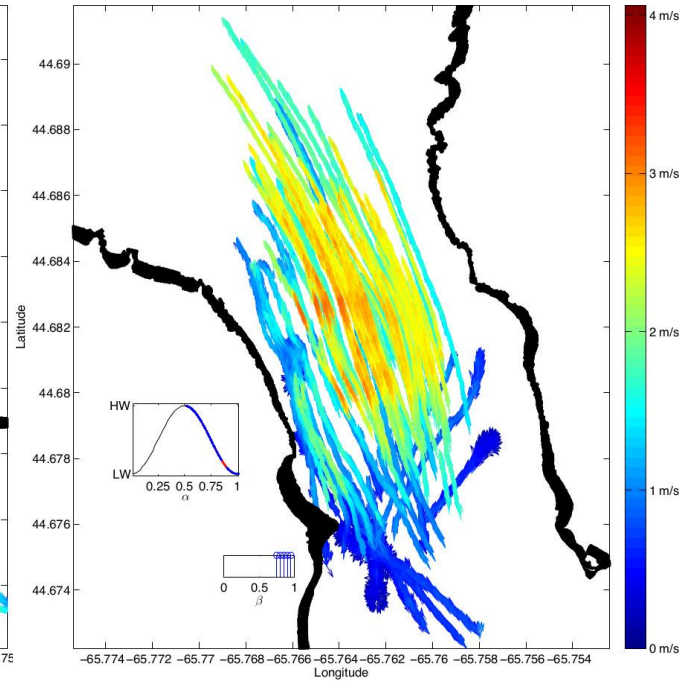
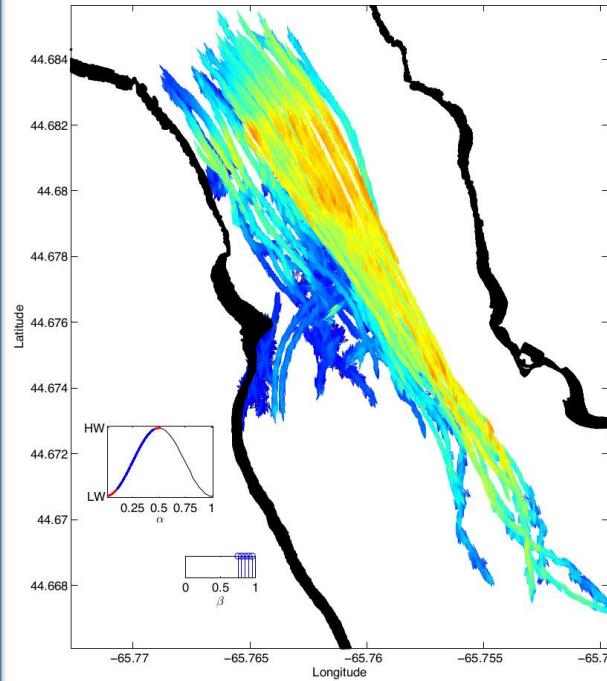
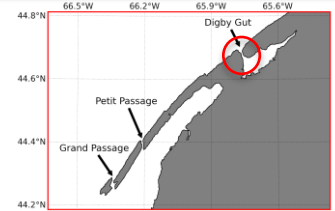


Site Introduction – Flow and Bathymetry (Digby Gut 1.95 MW)



Turbine Berths

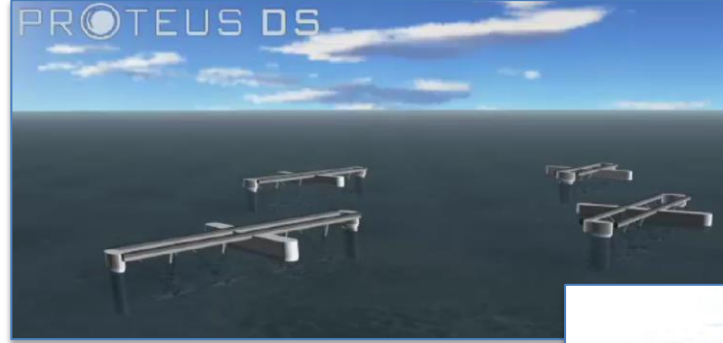
- 10 to 30m deep
- Max flow \approx 3 to 3.5 m/s



Site Introduction – Turbines

Digby Gut

- Develop with Tocardo (Netherlands)
- 1.95 MW in 2 phases (2015 / 2016)
- Prelim. design, 12 to 16 turbines
 - 3 or 4 floating platforms



Grand Passage

- MOU with Clean Current (BC, Canada)
- 500 kW in 2 phases (2015 / 2016)
- Prelim. design, 4 x 125 kW turbines
 - 1 or 2 platforms



Petit Passage

- MOU with Nautricity (Scotland)
- 500 kW in 1 phase (2016)
- Prelim. design, 1 or 2 turbines
 - similar to mid-water column system tested at EMEC



Site Introduction – Fundy Tidal Field Office and Whale Tour Boats

A) Field office located in Freeport

- “Small-scale” cabled observing system (500m cable to ADCP bottom pod, flow, waves, temperature, and pressure)
- Cabled passive acoustic monitoring (PAM) test with OceanSonics “icListen”

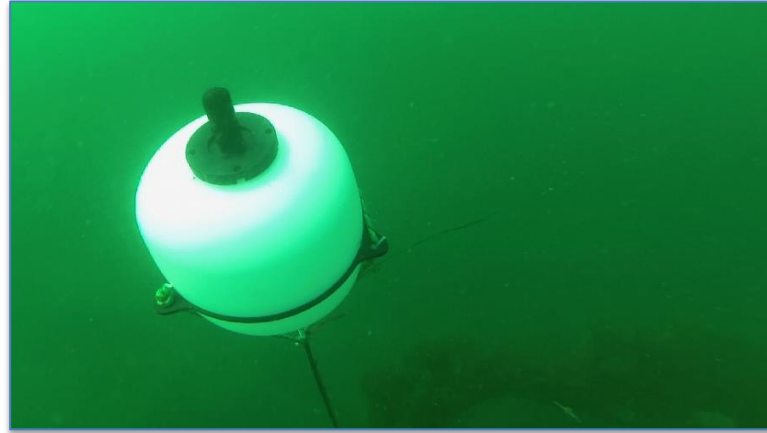


B) Whale tour vessels of opportunity for equipment testing (video, hydrophones, imaging sonars)



Environment – Overview

Look and Listen approach to environmental monitoring



2014 focus is baseline environmental monitoring

- a) assess initial conditions prior to turbine deployment
 - marine life and noise
- b) test methods and sensors for use around turbine(s) in 2015 / 2016

Objective:

- Help develop a real-time marine life monitoring system
- Using acoustics, video, and marine observers to assess potential near and mid-field interactions between turbines and marine life

Environment – Look and Listen (Marine Observers 1 of 4)

Bay of Fundy Marine Life Observation Program, includes:

- public ("citizen scientists"),
- local whale tour operators, and
- dedicated trained observers (part-time local jobs)

2 day marine observer training conducted by Dr. Moira Brown

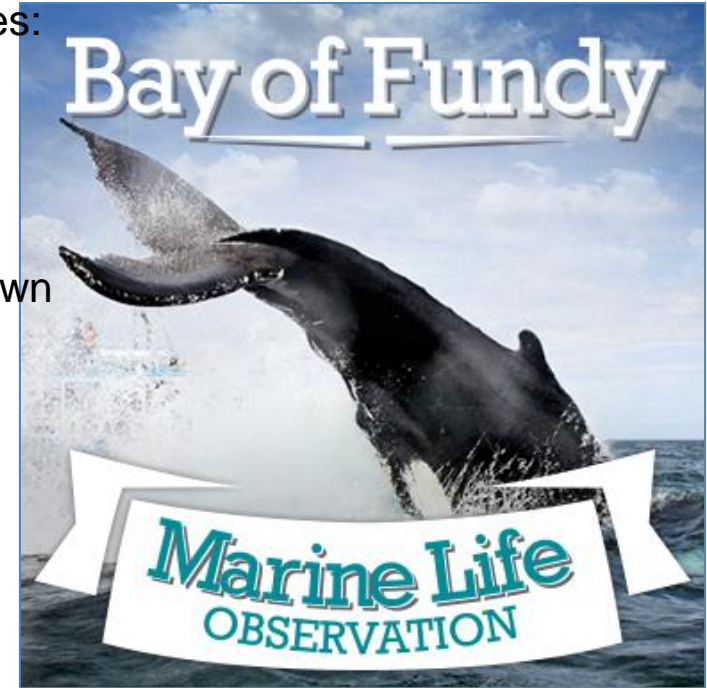
Data collection using 2 free smart phone applications

A) Whale Alert 2 – opportunistic data (public use)

B) Spotter Pro – effort based surveys

- **Trained observers (whale tour operators and dedicated observers)**

Opportunistic data also contributed through social media



Compare data from whale tours to observations collected in the passages

Environment – Look and Listen (Marine Observers 2 of 4)

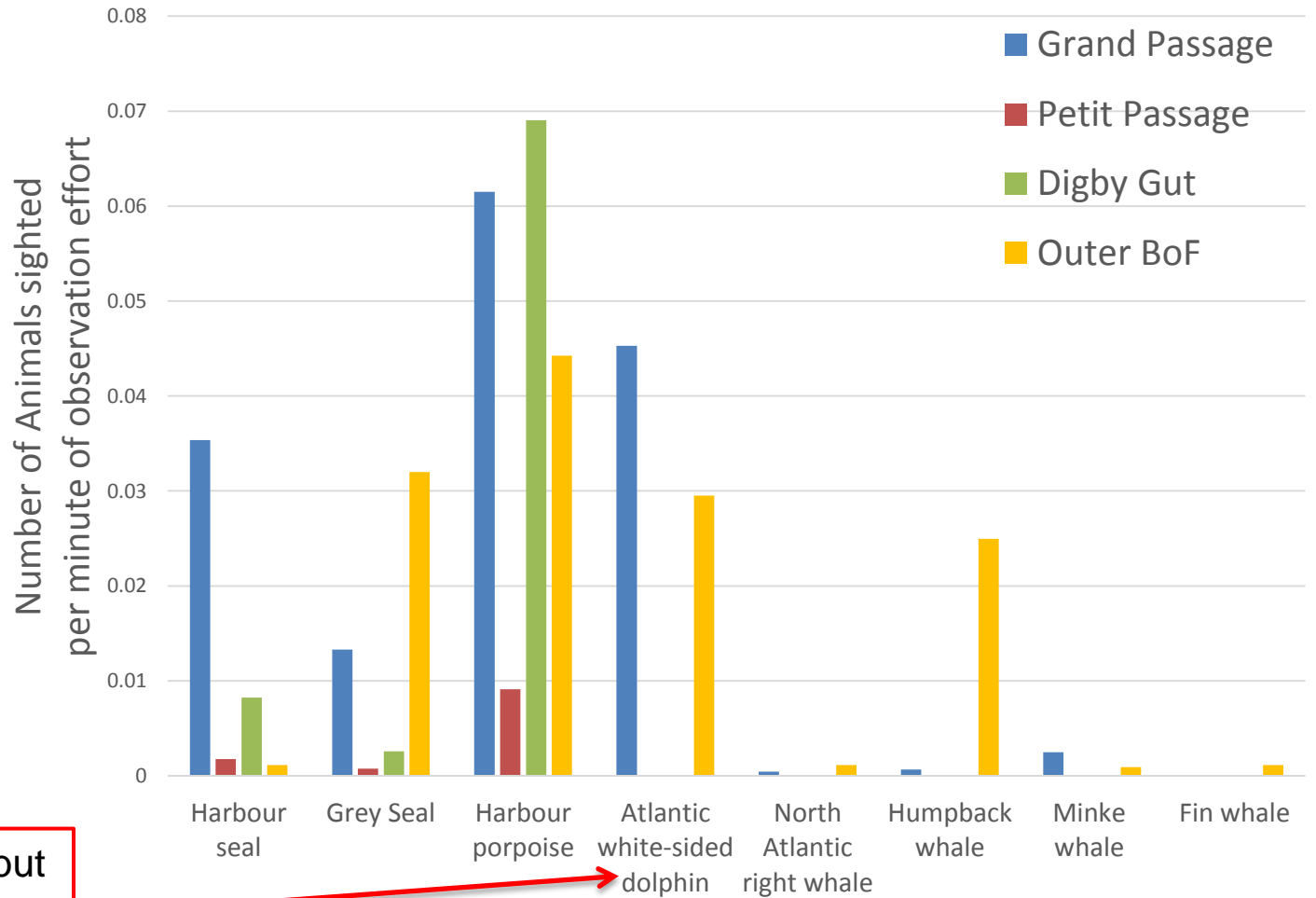
Over 246 hours of dedicated observation (Jun 13 – Oct 19, 2014) over 79 observation periods, representing nearly 9,500 individual marine mammals, fish, and birds sighted in the 3 passages and outer BoF!

- 1,541 individual marine mammals (8 species)
 - Harbour seal, grey seal, harbour porpoise, Atlantic white-sided dolphin, North Atlantic right whale, minke whale, fin whale, humpback whale
- 8 fish (sharks and tuna) (4 species)
 - Porbeagle, thresher, basking, bluefin tuna
- 7,937 individual birds (48 species)



Environment – Look and Listen (Marine Observers 3 of 4)

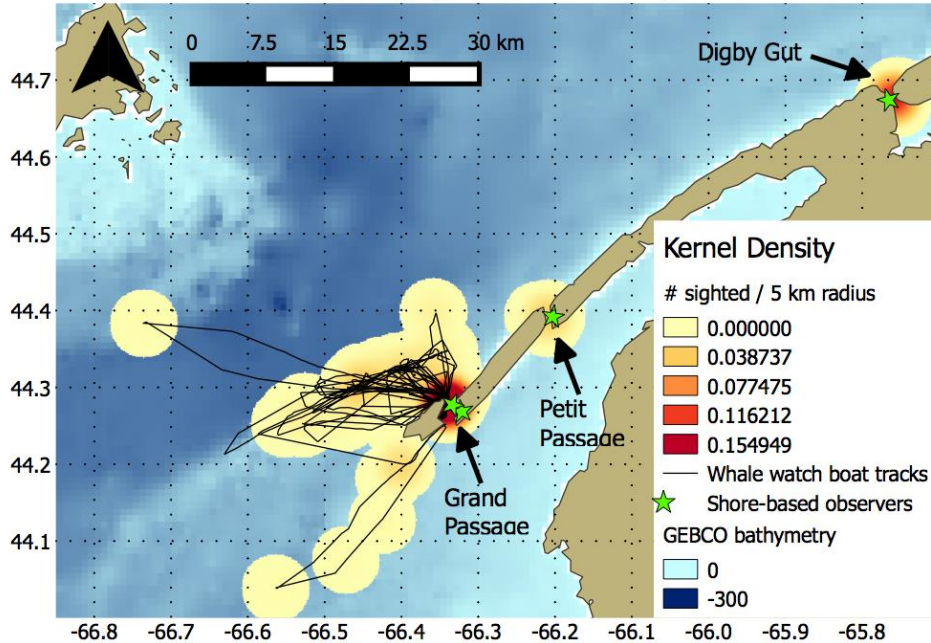
Example of marine mammal species sighting rates (Jun. - Oct. 14)



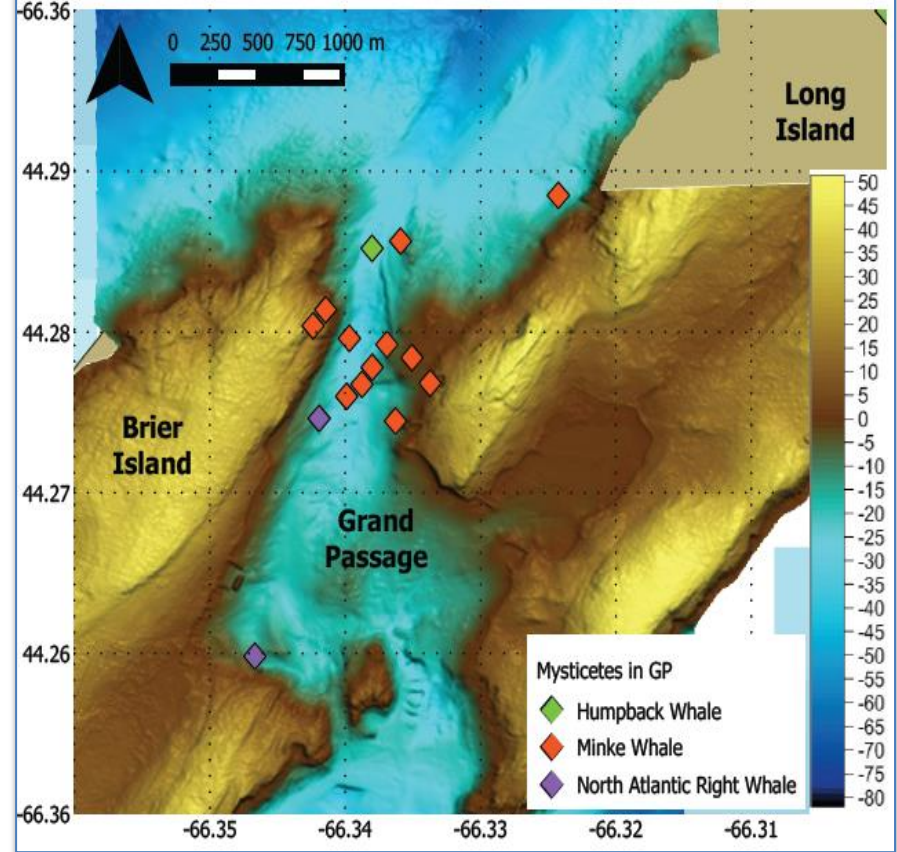
Few events, but large groups

Environment – Look and Listen (Marine Observers 4 of 4)

Harbour porpoise (*Phocoena phocoena*) heat map from sightings uploaded via the app (Jun 16 - Oct 19 2014).



Sightings of mysticetes from observers uploaded via the app (June-Oct 2014).



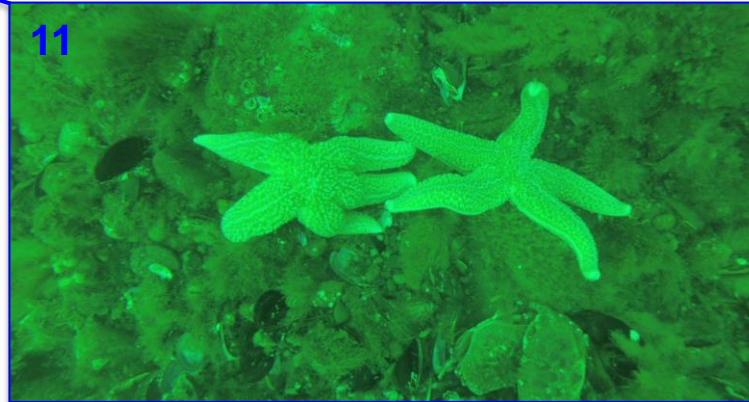
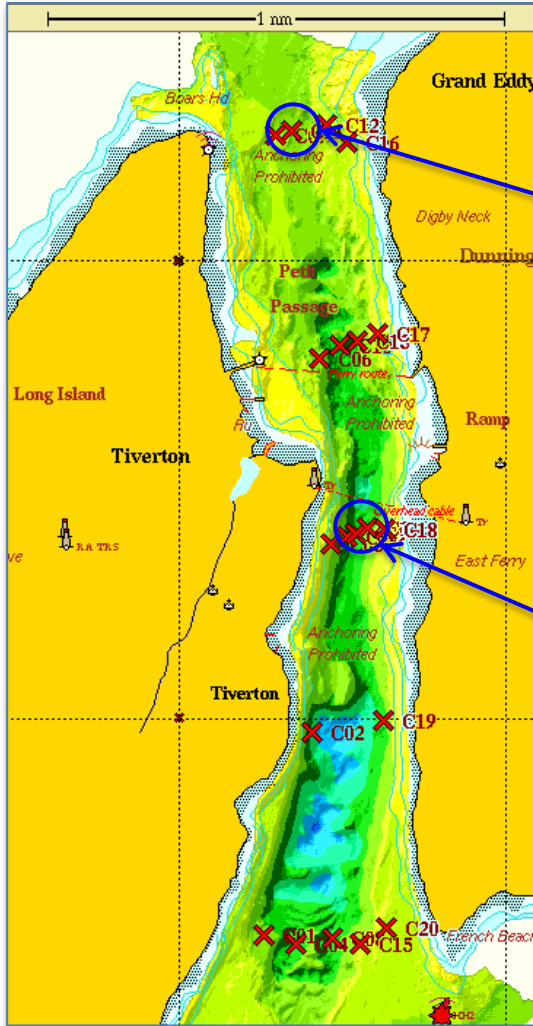
DOWNLOAD THE APP HERE:

<https://itunes.apple.com/us/app/spotter-pro-field-data-capture/id651453350?mt=8>

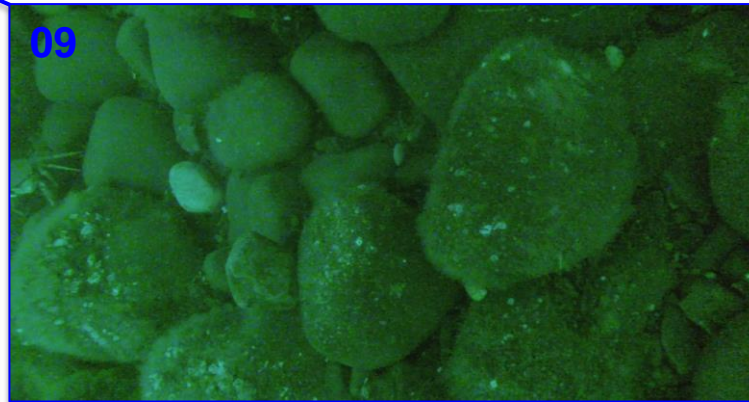
Environment – Look and Listen (Seabed Video – Petit Passage)

Work conducted to assess seabed composition and benthos

Example of broad initial survey



25 – 30m depth
Productive habitat at
north entrance to
passage (starfish,
crabs, mussels, etc.)



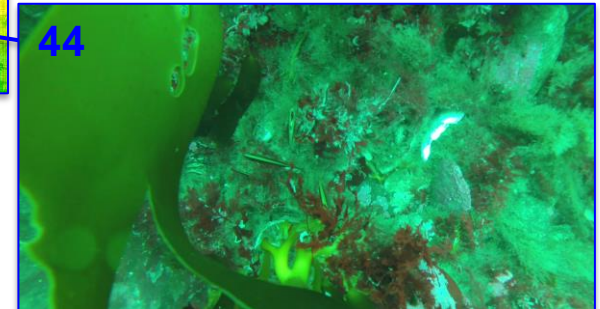
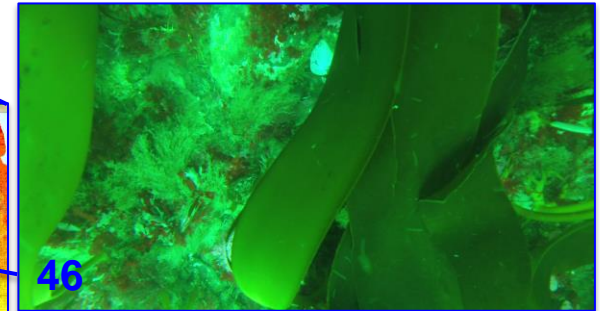
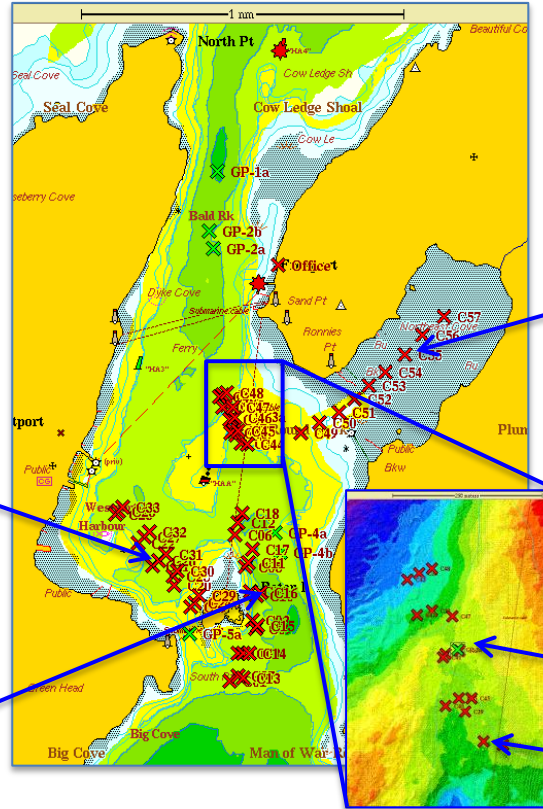
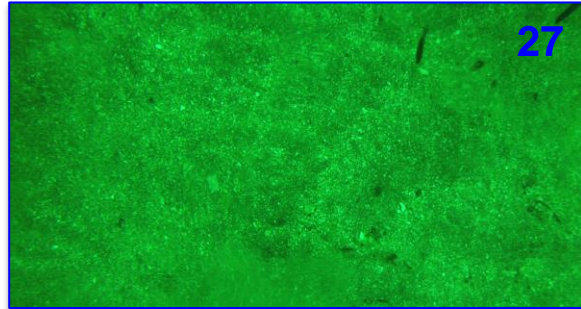
40 – 45m depth
Cobbles and crab at
potential turbine berth
site

Environment – Look and Listen (Seabed Video – Petit Passage)

Example of focused surveys

Investigating

- a) potential turbine berth site
- b) areas for scientific interest



- Heterogeneous seabed
- Island wake effects
- Large mudflat / intertidal zone

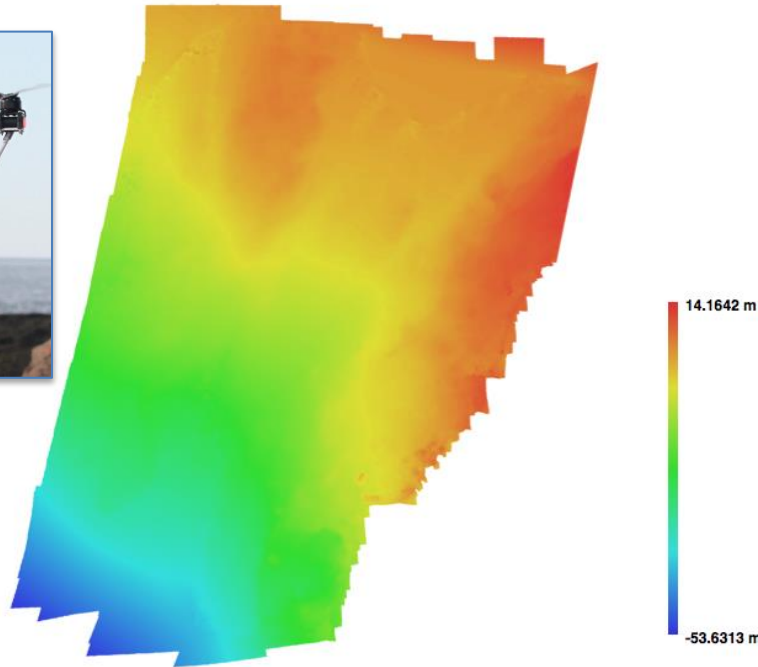
Environment – Look and Listen (UAV/Drone Survey)

Unmanned Aerial Vehicles (UAVs) used to survey the intertidal zone

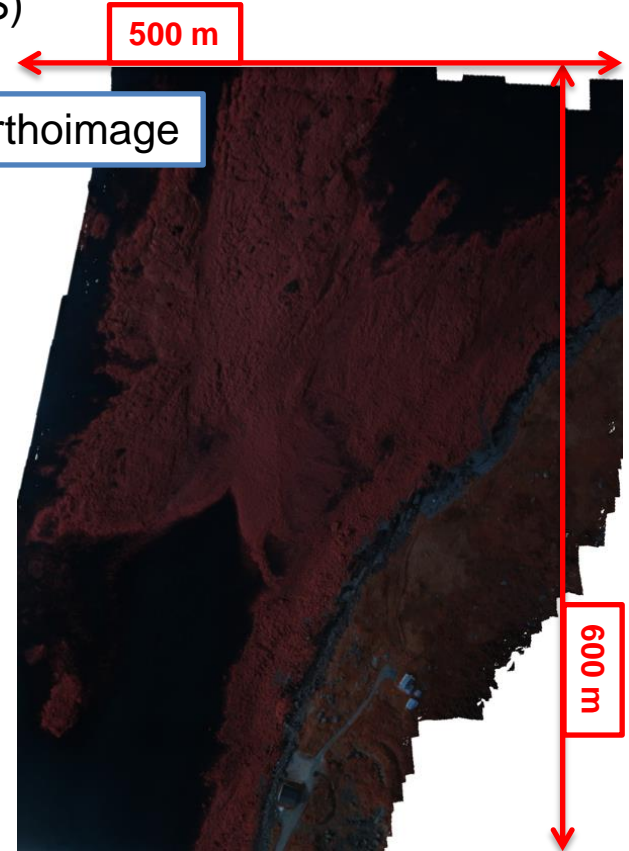
- Useful for models, cable routing, and assessing intertidal benthos
- Collaborating with Scottish Association for Marine Science (SAMS)
- Conducted test in GP with SkySquirrel (Inverness, NS)



Digital Elevation Model



Orthoimage



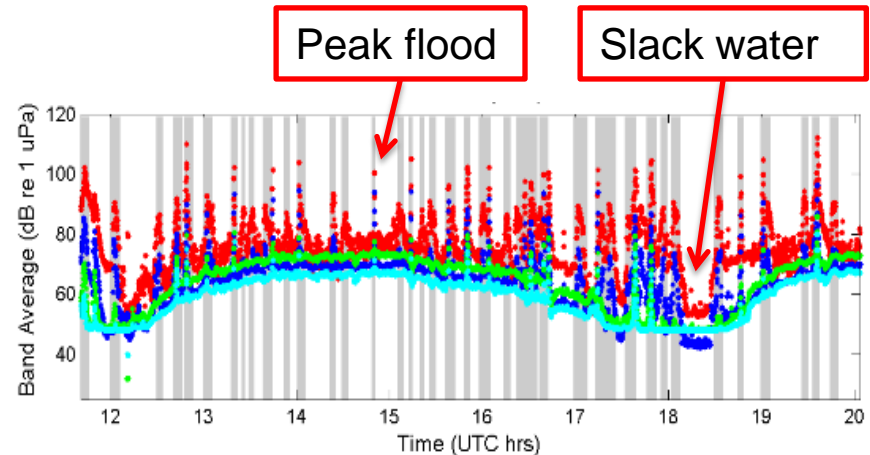
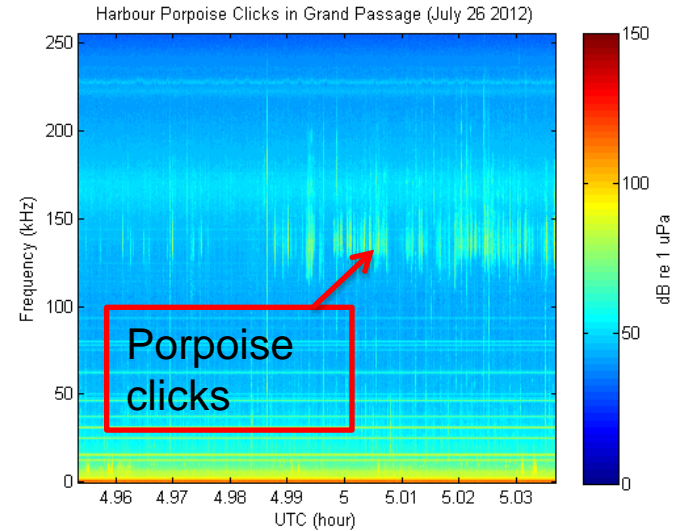
Environment – Look and Listen (PAM with *icListen* – GP 2012)

Initial research project

Estimating acoustic detection ranges over tidal cycle as a partial basis for determining the feasibility of a PAM system for marine mammals [Undergraduate honours project at Dalhousie University (Dr. Alex Hay, Chloe Malinka)]

Challenges:

- Overcoming constraints on detection limits of naturally occurring noise at high-flow sites
- Ambient noise levels increase with current speed
- High background noise levels impact acoustic detection ranges for monitoring marine mammals

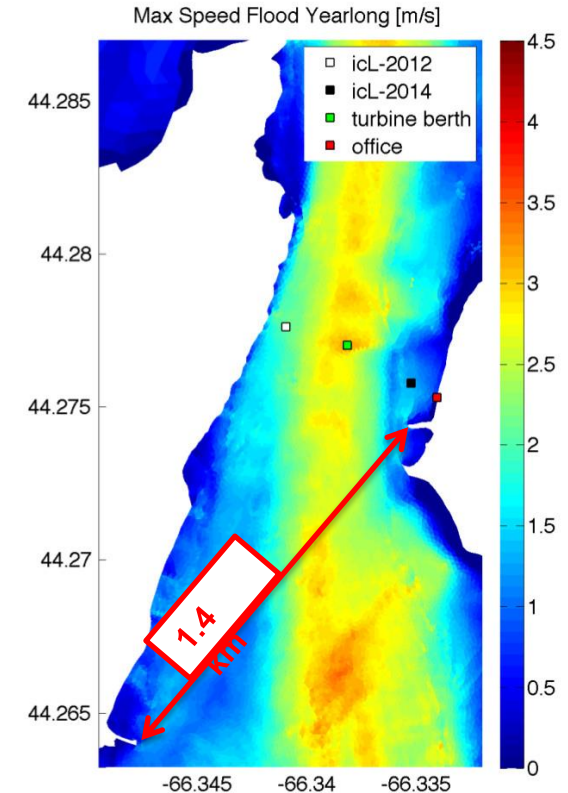
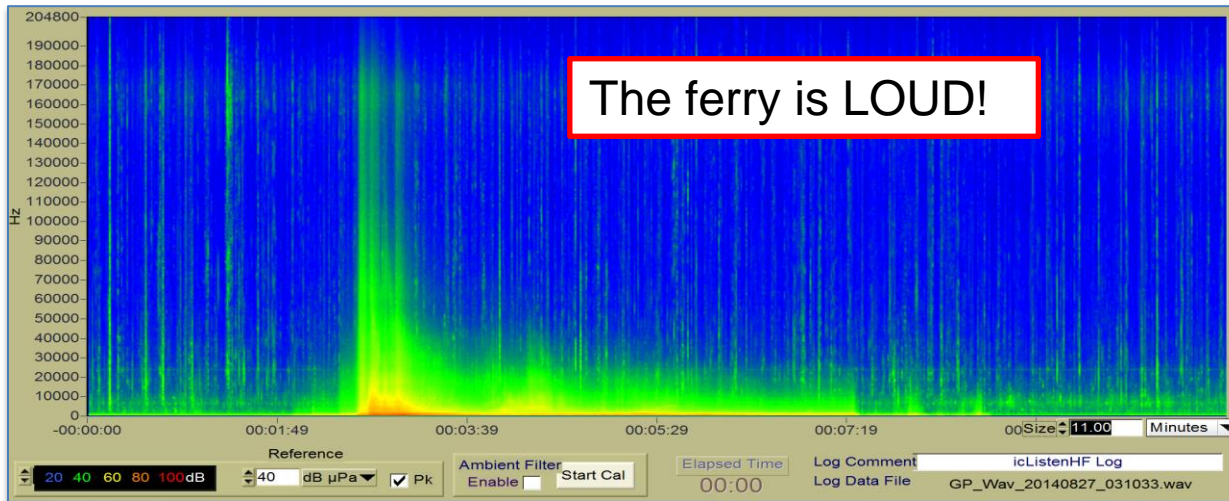


Environment – Look and Listen (PAM with *icListen* – GP 2014)



Short term test with cabled *icListen* HF hydrophone

- deployed at sheltered low flow site adjacent to turbine berth
- continuous data collection, Aug 21 – Aug 28, 2014
- concurrent with dedicated marine observation periods
- 204.8 kHz FFT (7 days, 3 GB)
- 12.8 kHz wav (4 days, 28 GB)
- 204.8 kHz wav (3 days, 192 GB)

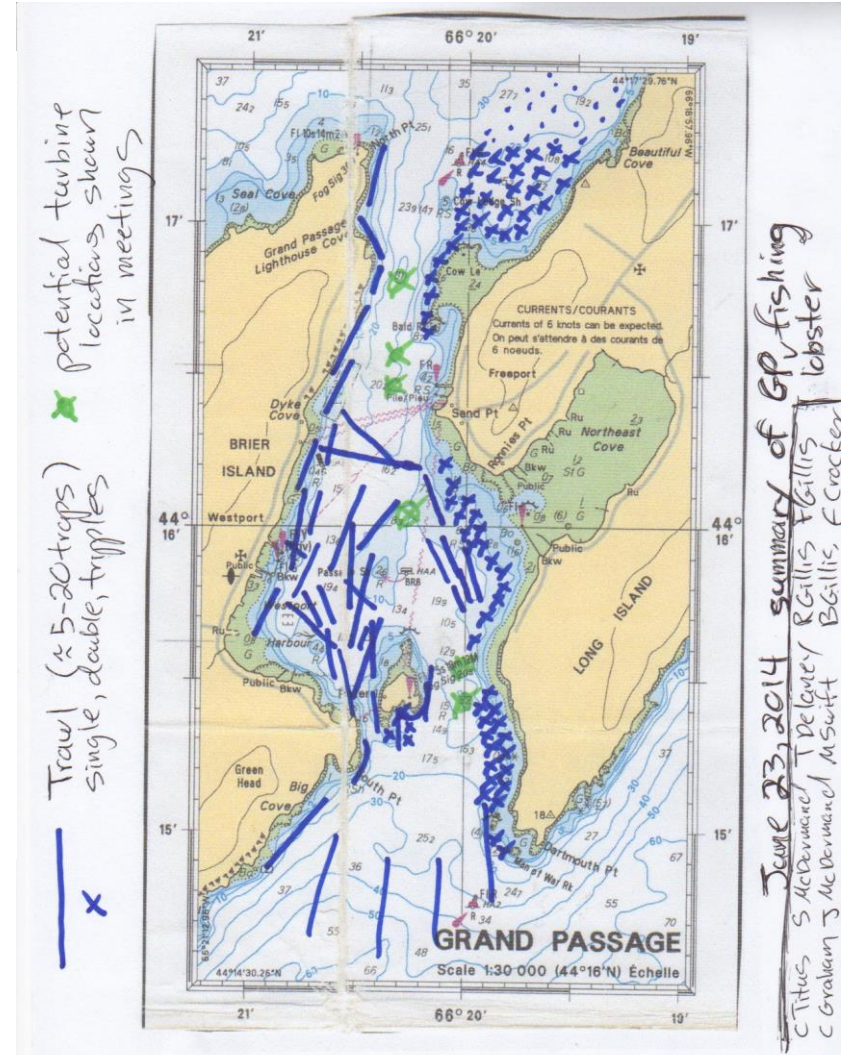


Planning longer term cabled deployment, test software for real-time animal detection and classification

Environment – Look and Listen (Community Engagement)

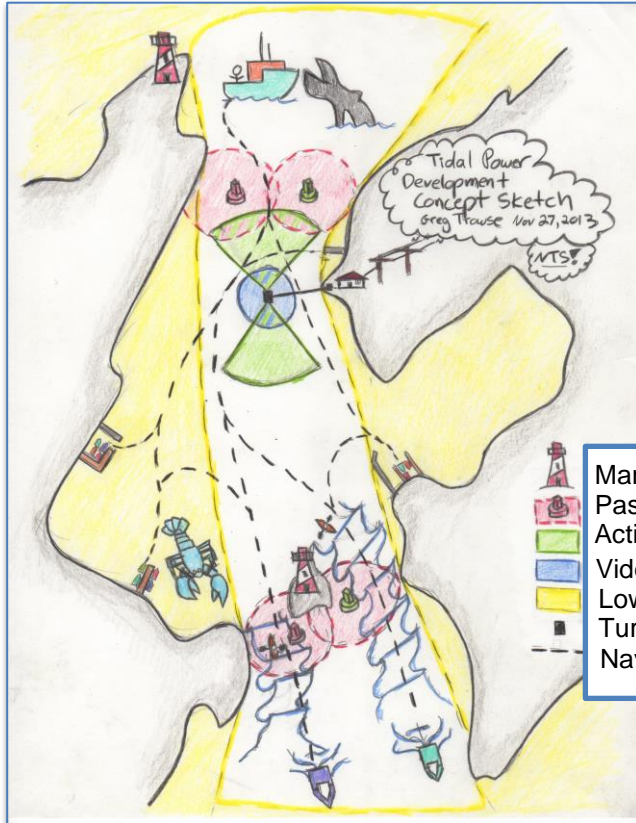
Door to door meetings held with several fishing captains from Freeport and Westport

- Individual discussions and input
 - a) Potential turbine locations
 - b) Valued fishing areas
 - c) Navigation routes
- Generated combined map
- Minimal direct impact on fishing at turbine berth sites
- Cable route and navigation important considerations
- Most Captains not concerned about local traffic, vessels from away could be higher risk
- Community preferred site apparent



Environment – Next Steps

Participate in collaborative work to focus on potential **near and mid-field** interactions between tidal turbines and marine life



- High species diversity and abundance
- Excellent test environment (flow, depth, visibility, infrastructure, community support)
- “Small-scale” projects may help answer questions required before moving to large array developments

- Background noise analysis (existing data)
- Benthic characterization, existing data and and focused surveys (foundations, moorings, cables)
- Fish detection from cabled ADCP data
- PAM real-time animal detection and classification
- PAM sound source localization in high-flow
- Drifting hydrophones
- Testing active acoustics with automated detection