First Steps for Marine Life Impact Assessment of Hydrokinetic Turbines in the Arctic

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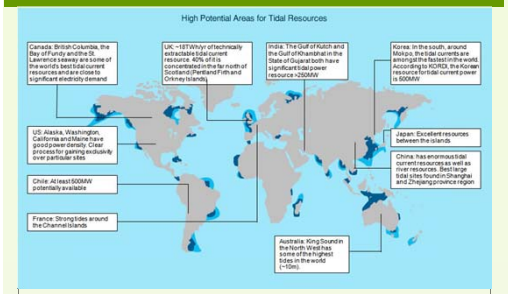
CHTTC Canadian Hydrokinetic Turbine Test Centre

Introduction



- Promising market for hydrokinetic energy in the world in next 50 years
  - ✓ 240 GW ($550 billion investment) by 2050 [1]
- Significant potential for hydrokinetic generation in north America
  - ✓ 2 GW ($2 billion/year) in Canada by 2030 [2]

Canada's Estimated Marine Energy Resources [2]

Tidal in-stream	6.3 GW
River current	2 GW
Wave	27.5 GW

Technologies [3]

Tidal barrage	abandoned
Kinetic turbine	pilot projects
Wave shoreline	experimental
Wave near shore	experimental
Wave offshore	pilot projects
Ocean Thermal	experimental
Salinity Gradient	laboratory

CHTTC Canadian Hydrokinetic Turbine Test Centre

- The centre is located on the Winnipeg River in the community of Seven Sisters, 120 km north east of Winnipeg.
- The objective of the CHTTC is to create a national hydrokinetic test location that allows Canadian companies to test turbine systems.
- CHTTC team provides consulting, measurement and engineering services.

Velocity (m/s)	Depth (m)	Width (m)
2.2-2.5 m/s	11-13 m	50-60 m

Environmental Concerns

- There are concerns surrounding the potential for adverse interactions between hydrokinetic turbines and aquatic biota, including fish and marine mammals.
- Investigation of marine mammal-turbine interactions is particularly challenging, because laboratory studies are not feasible for these organisms.
- Marine mammal fauna are critically endangered in the locations where hydrokinetic energy projects have been proposed e.g.:
  - ✓ Killer whale (*Orcinus orca*), Admiralty Inlet, Washington
  - ✓ Beluga whale (*Delphinapterus leucas)*, Cook Inlet, Alaska

Case Study Site

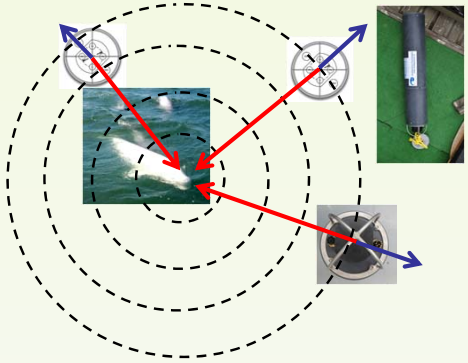
Churchill River Estuary

- Unlike Cook Inlet, Alaska, and eastern Hudson Bay and Ungava Bay in northern Quebec, the local beluga population inhabiting in the Churchill River estuary is secure.
- Prudent management and protection of this population can accommodate investigation of interactions with hydrokinetic turbines.
- This unique research opportunity will yield information relevant to permitting of a hydrokinetic project in the Churchill River estuary.
- Churchill can be reached by train and by air at reasonable costs compared to other northern communities.
- The tidal velocities exceed 5 knots which are not exceptional compared to other site but it meet minimum requirements for a hydrokinetic site.

Phase 1

Tracking Beluga Whales Using Hydrophone

- The main idea is to deploy three or four omnidirectional hydrophones in the Churchill River estuary to track beluga whales activities in vicinity of hydrokinetic turbines.
- To evaluate the practicality of this idea in collaboration with two Dartmouth based companies, Geospectrum Technologies Inc. and Akoostix Sound Research and Design, the phase 1 of the project kicked off using one GuardBuoy hydrophone manufactured by Geospectrum and programed by Akoostix.

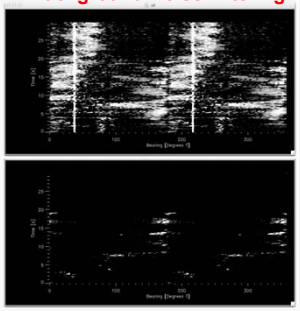


Setup and Testing

- Data collection conducted in four days, late August, and in each day 3 to 4 hours amount of sound recorded.
- Two differentiating pressure channels recorded sound waves at 48 kHz sampling frequency each.
- Based on the time delay between channels for a specific sound, the angle of the sound source with respect to hydrophone is identified.
- In this measurement the exact location of the sound source is not located since only one hydrophone has been deployed.

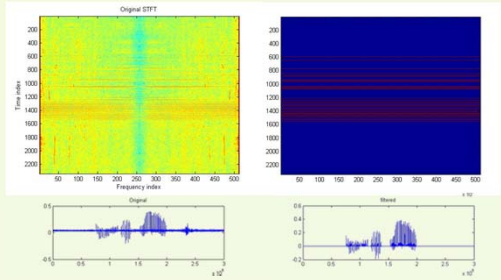
Preliminary Results

Background Noise Filtering

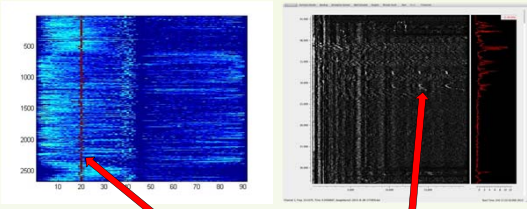


Preliminary Results

Click and Vocal Separation



Bearing Detection



Boat Engine Bearing Beluga Vocal

Conclusion

- **An Omnidirectional hydrophone deployed in Churchill River Estuary and collected beluga whales vocal and clicks.**
- **Background noises were filtered out from the rest of the results.**
- **A filter developed to separate vocals from clicks.**
- **Preliminary results are promising since we are able to clearly identify direction of the sound.**
- **For future work we advice to use a higher frequency band hydrophone, up to 150 kHz, to capture the whole spectrum of clicks.**
- **Clicks are more frequent than vocals but it is more difficult to distinguish between clicks from two different sources.**

References

[1]. Carbon Trust, "Marine Green Worth Paper," 2011.
[2]. "Canada's Marrne Renewable Energy Technology Roadmap," 2011.
[3]. Peter Fraenkel, "Briefing on Tidal Turbines, Pat 1: Resources and Environmental Issues," 2012

Funding Source

NSERC Engage