Environmental Sensing and Monitoring at the Fundy Ocean Research Center for Energy (FORCE)

by

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(with students & collaborators)

Acadia Tidal Energy Institute

Acadia University

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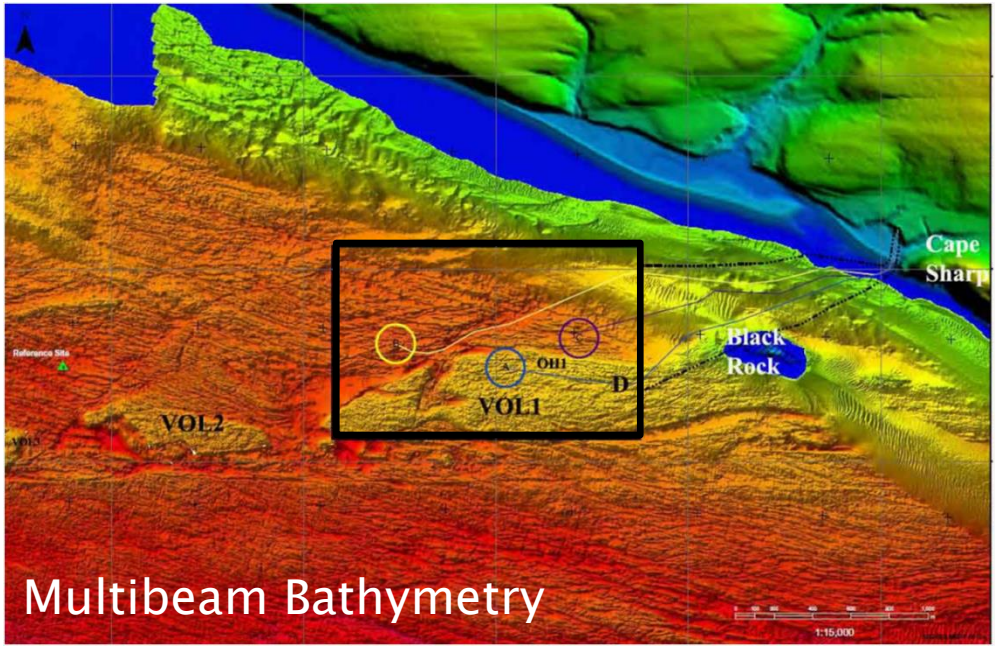
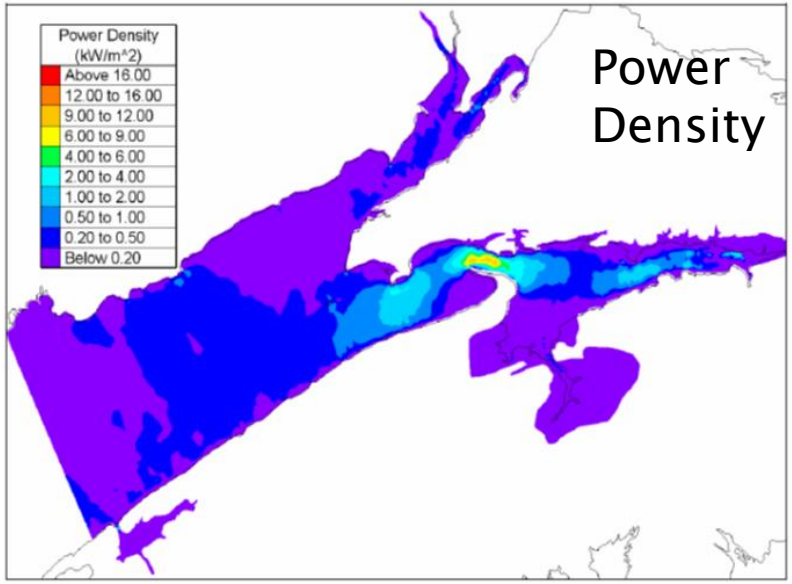
Annex IV Webinar – 27 October 2014

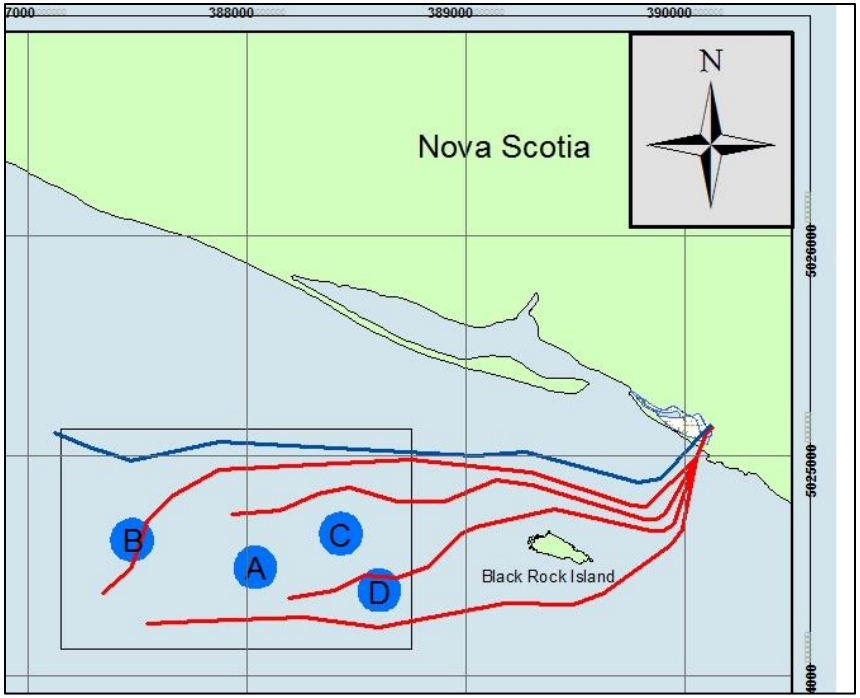
FORCE and Site Features





Video
- cobble / boulder

- Low biodiversity
- Sponge-dominated

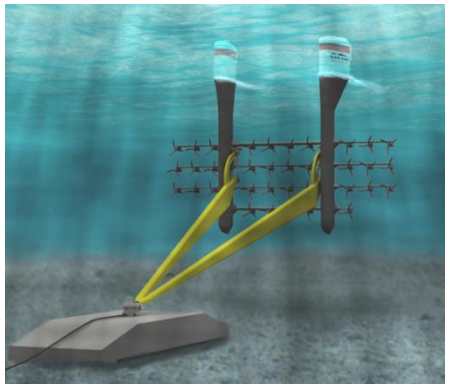


In-Stream Tidal Turbines
FORCE: 2015-2018

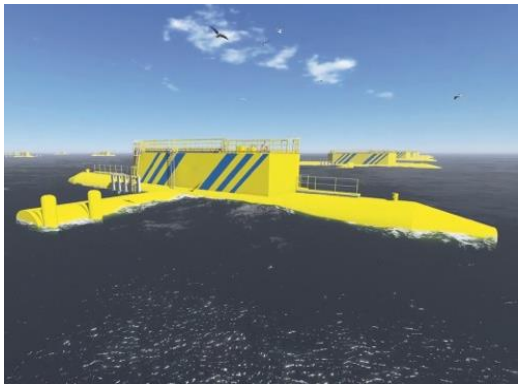
- 4 berths with cables
- Large commercial scale devices
  - Rated 1 MW+ per installation
  - Power for 300-600 homes / unit

OpenHydro

Black Rock Tidal



Minas Energy, Siemens & Bluewater



Atlantis Resources & Lockheed Martin

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Tidal Energy Dev't: Environmental Implications

- Tidal race – up to 6 m/s
- Near and far-field effects?
- Environmental Monitoring Advisory Committee (EMAC)
- Impacts on marine mammals?
- Impacts on fish and lobsters?
  - Transboundary; threatened / endangered
  - Migration corridor

Acoustic Detection of Fish & Lobsters

- Temporal and spatial patterns in the use of Minas Passage / FORCE
- Acoustic tags (Vemco)
  - Fish (286 tags implanted)
  - Lobster (85 tags, carapace)
    - Battery / tag size limits

Species	Status	#Tags
Atlantic sturgeon	Threatened	114
American eel	Threatened	45
Striped bass	**Endangered (BoF)**	**165**
Atlantic salmon	Endangered (iBoF)	62

Minas Passage / FORCE Receiver Lines

2011

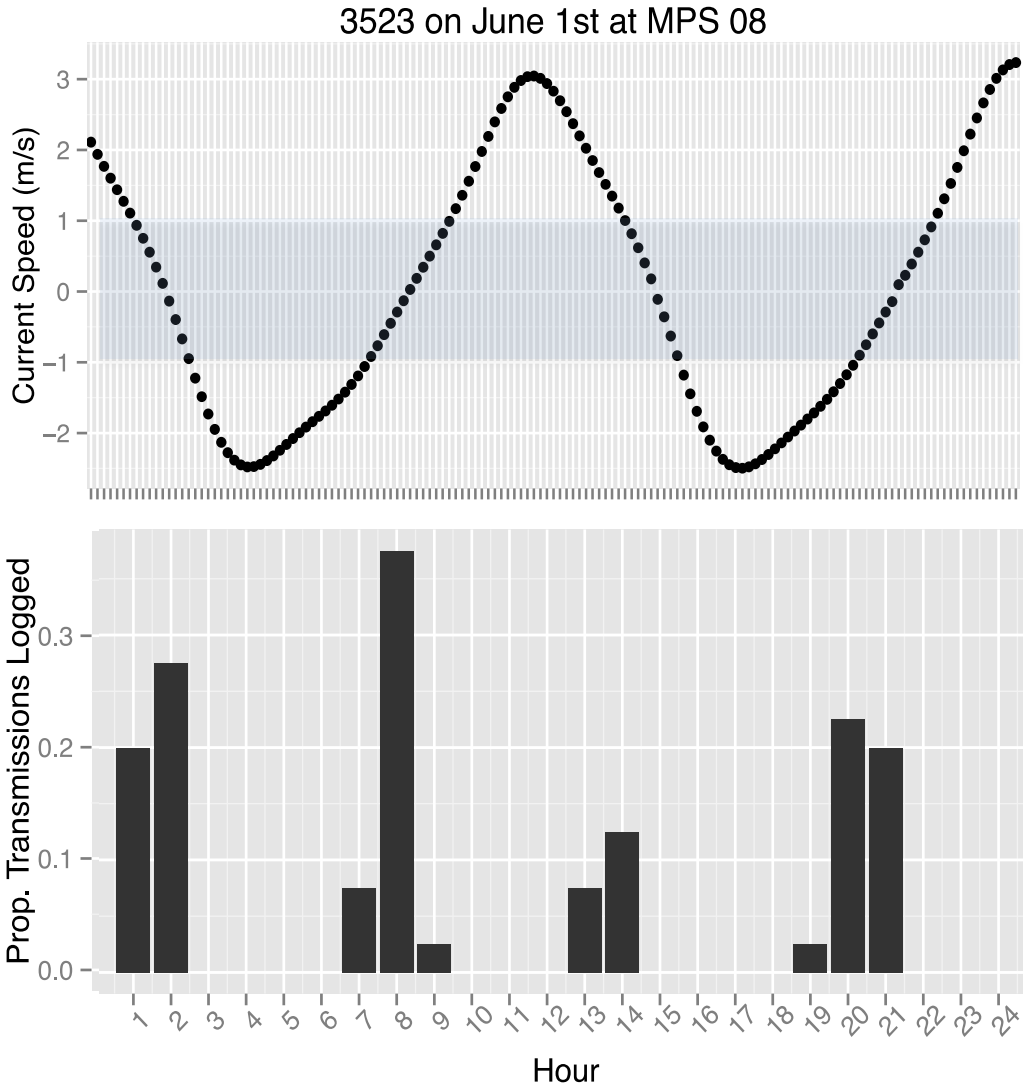
2012 / 2013

Listening gates

OCEAN TRACKING NETWORK
Headquartered at Dalhousie University

300-400 m between units

Current Speed & Range Test Tag Detection

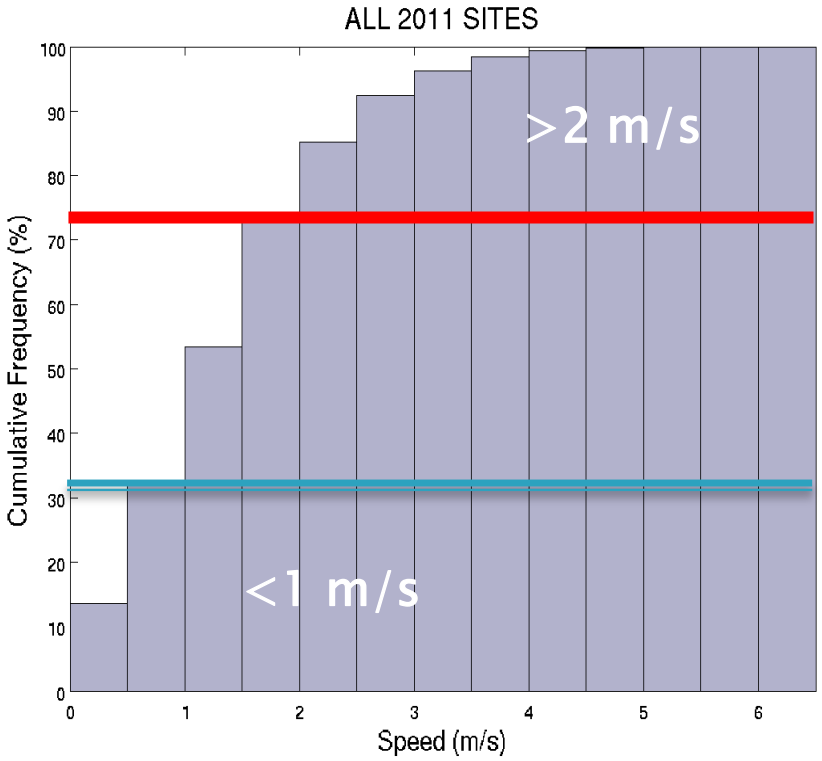


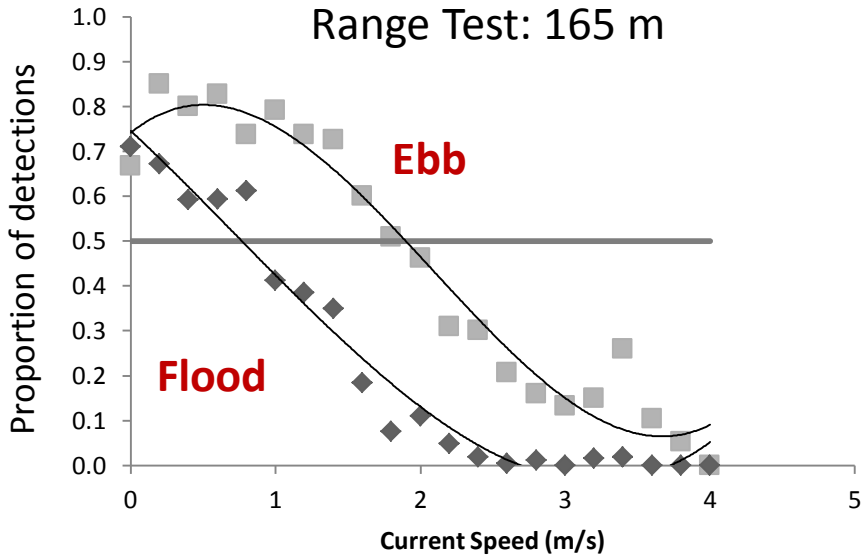
Flood

Slack Water → 1 m/s

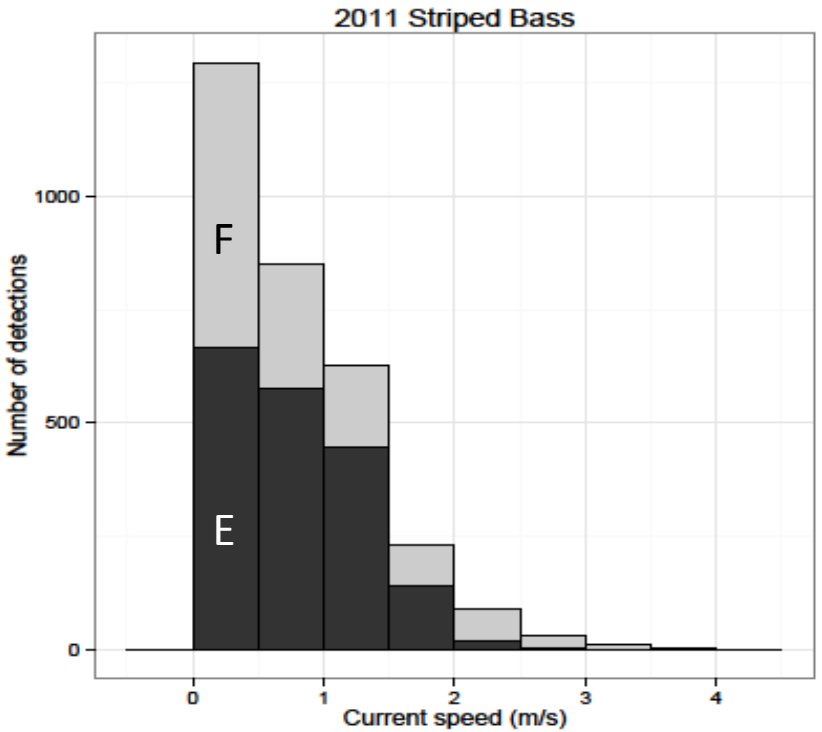
Ebb

Detections ~40% of the time and not during peaks flows





- Depth-ave speeds are often >2 m/s
- Receiver detection efficiency ↓ as current speed ↑
  - Ebb > flood
- Low fish detections at high flows reflects detection efficiency
  - Can't assume fish not present



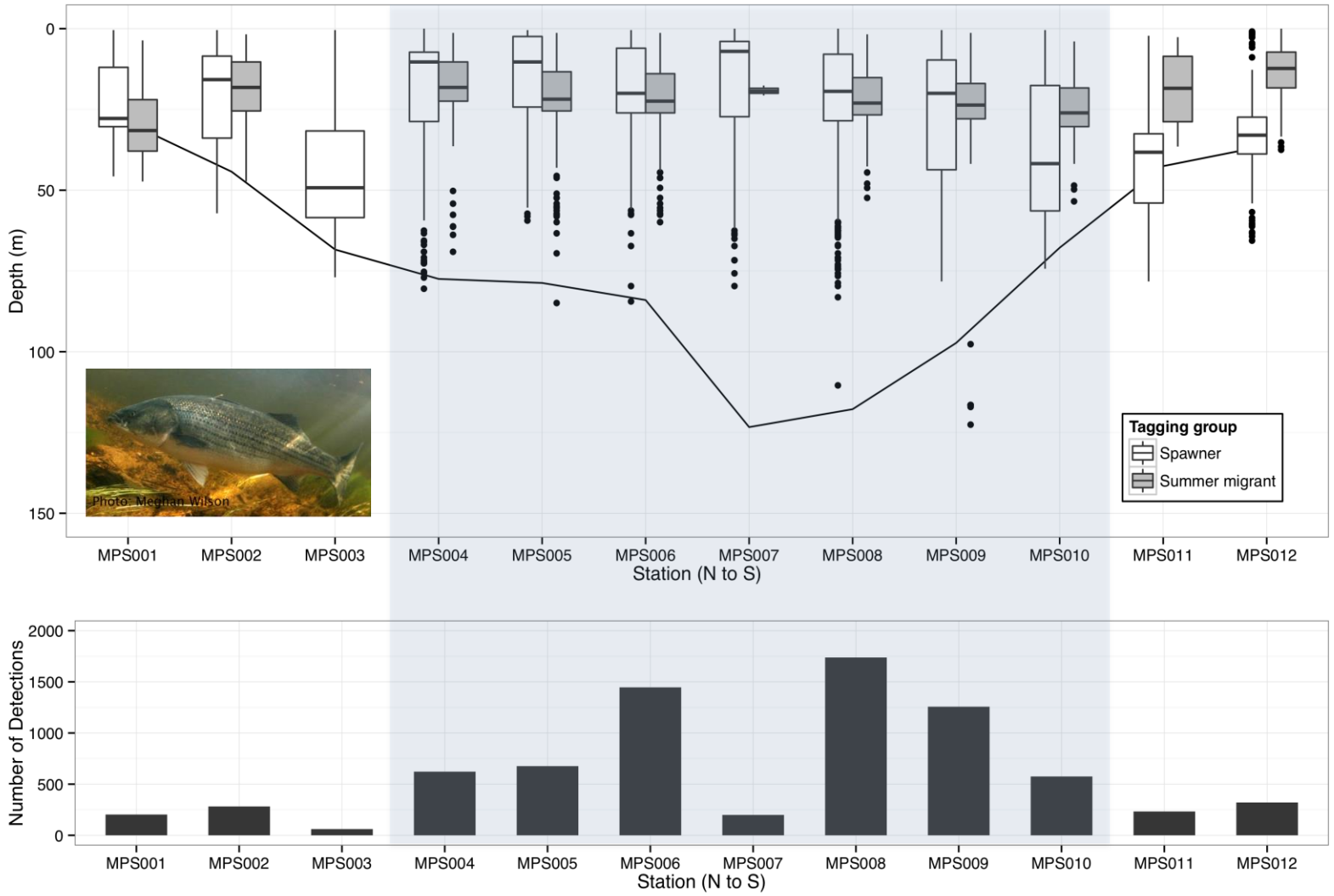
Credit: Jeremy Broome

Summary of fish use of Minas Passage

Species	Duration	Max travel speed	Multiple passes	Depth preference
Atlantic salmon (post smolts)	late May – mid June 2-3 weeks	2-3 m/s Ebb	Few	ND: 0-10 m?
American eel	mid Sept – mid Nov 8 weeks	3.0 m/s Ebb / Night	Few	5-30 m
Atlantic sturgeon	Spring – fall, mostly during migration	3.2 m/s	Some	15-35 m
Striped bass	**Near year-round!!**	**3.9 m/s**	**Common**	**15-35 m**

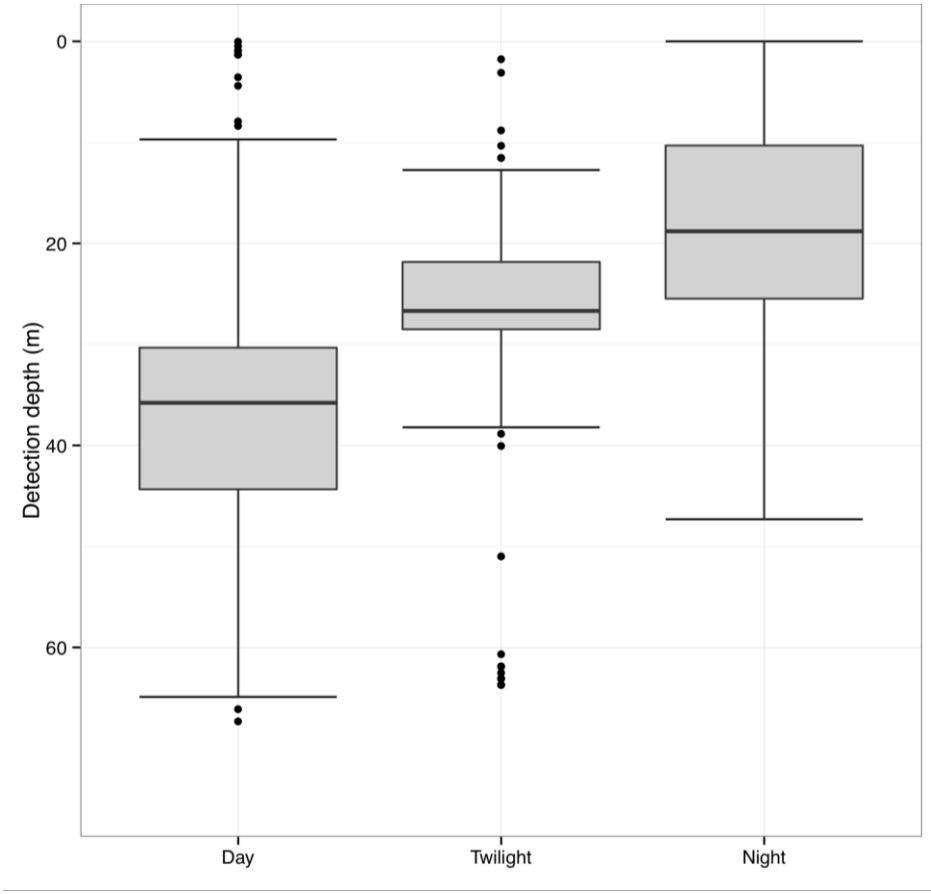
Source: Redden et al. 2014

Striped bass tag detections & depths (2011 – 2013)

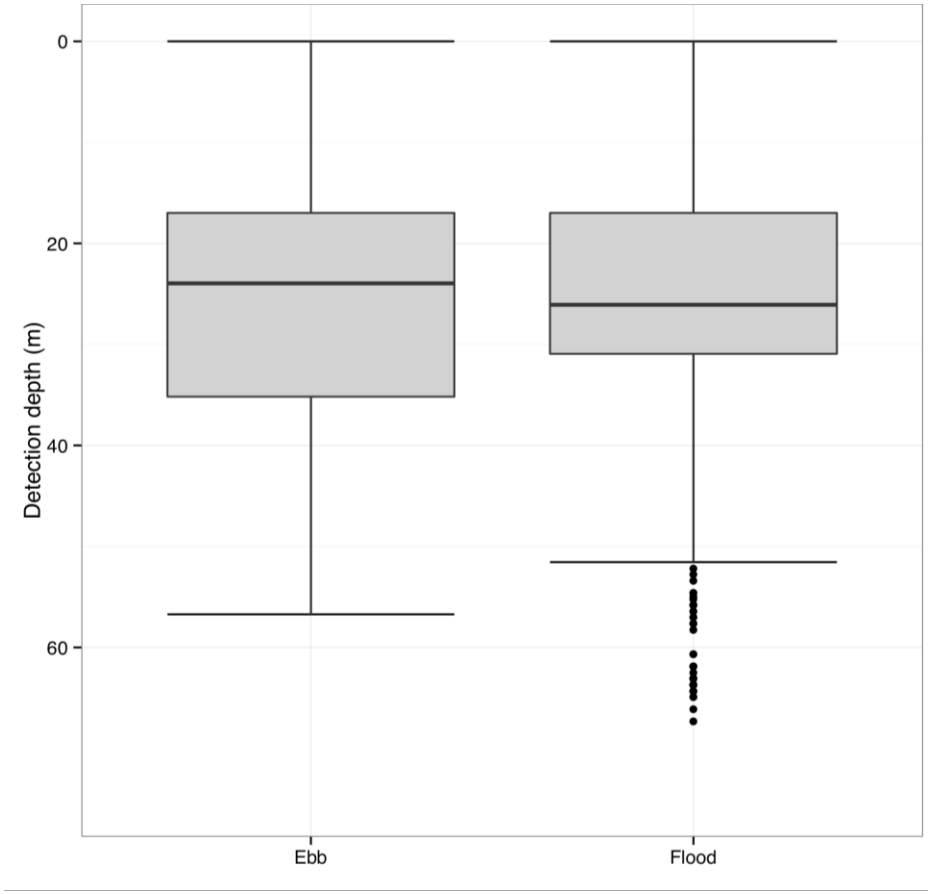


Striped bass - detection depths at FORCE

Day Night

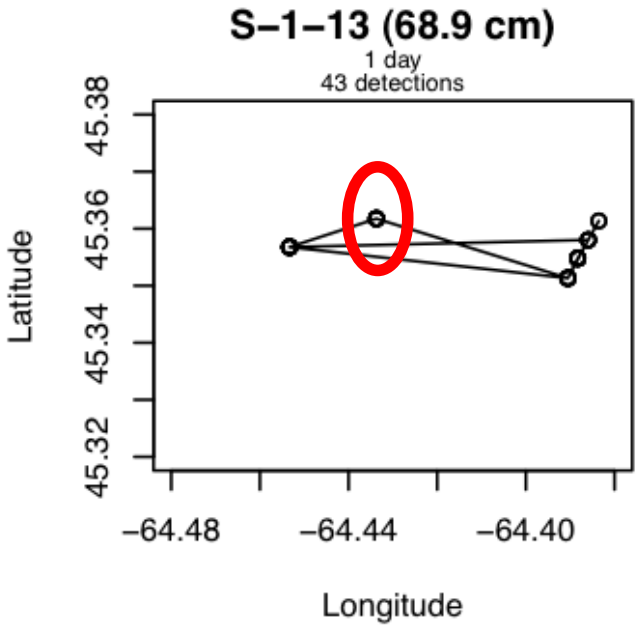


Ebb Flood

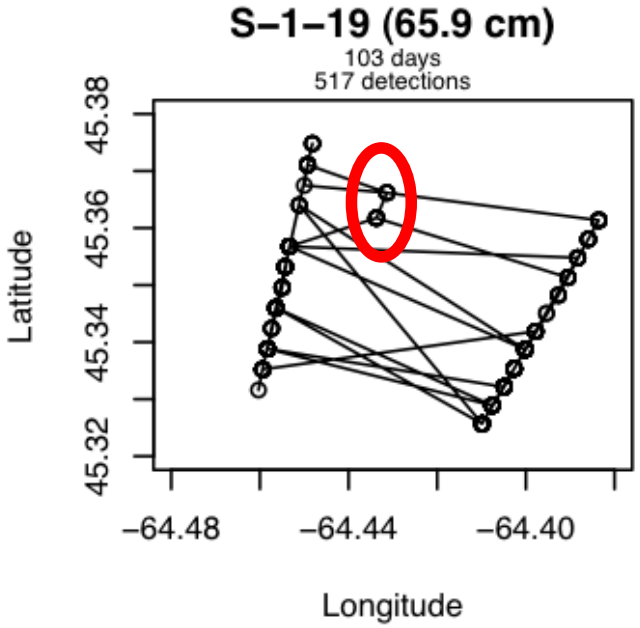


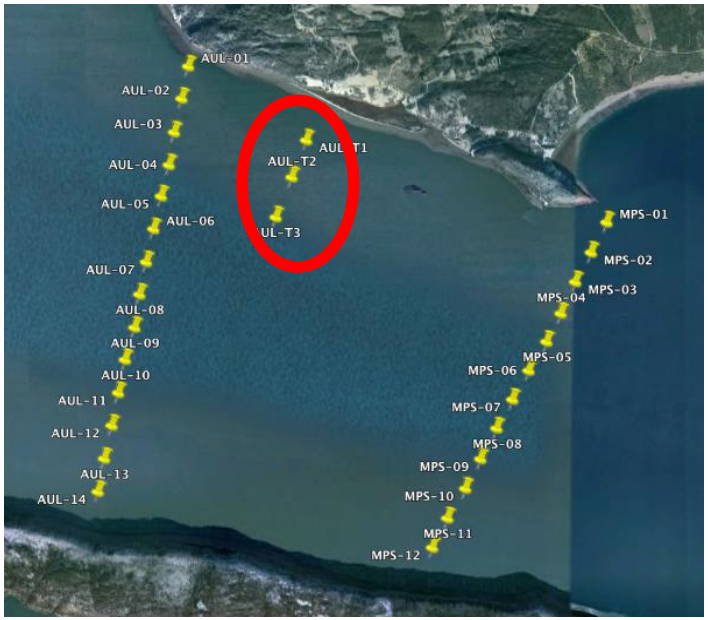
More than a migratory route!

1 day



103 days



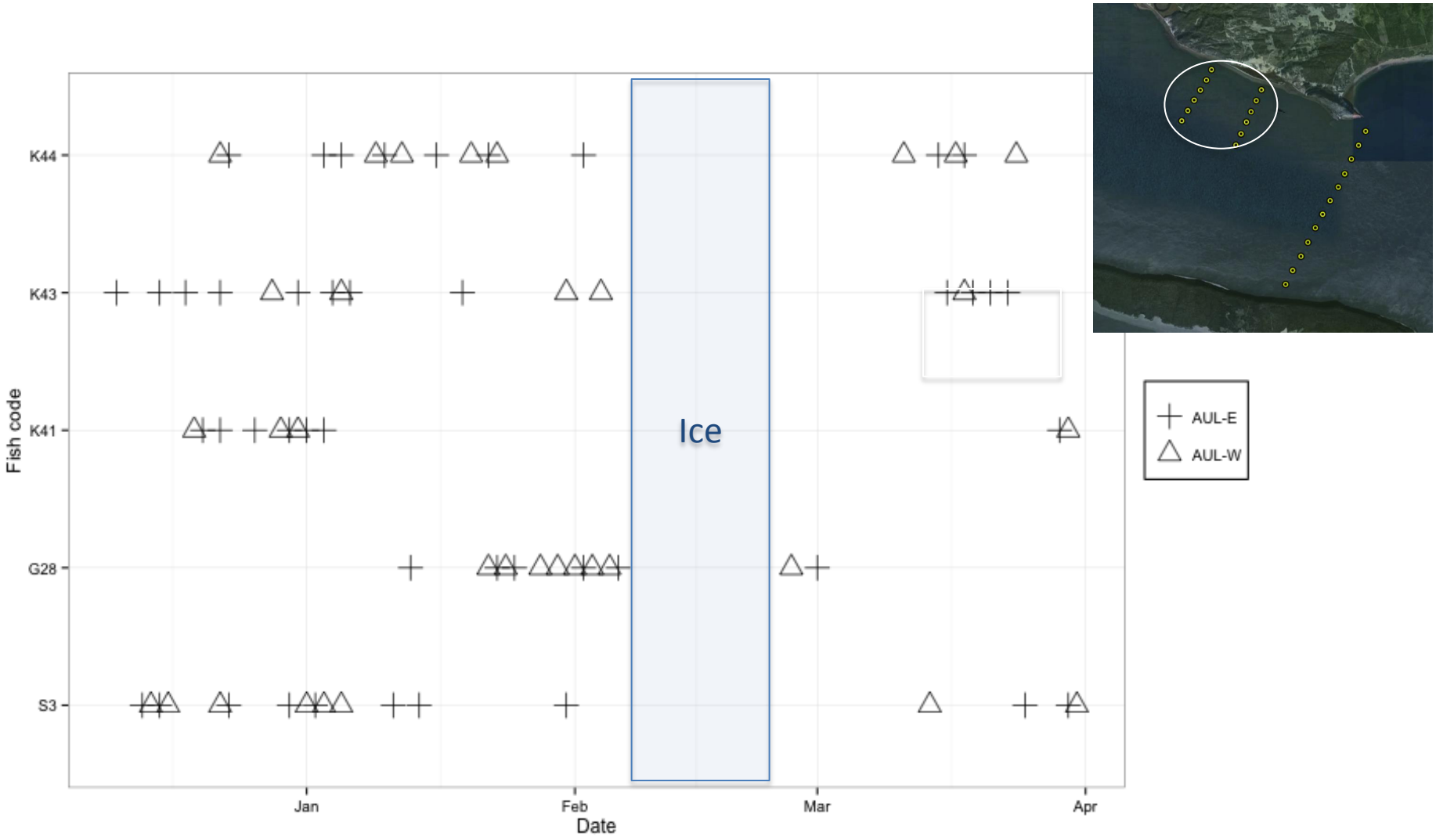


Frequent the FORCE site – <u>potentially</u> at risk

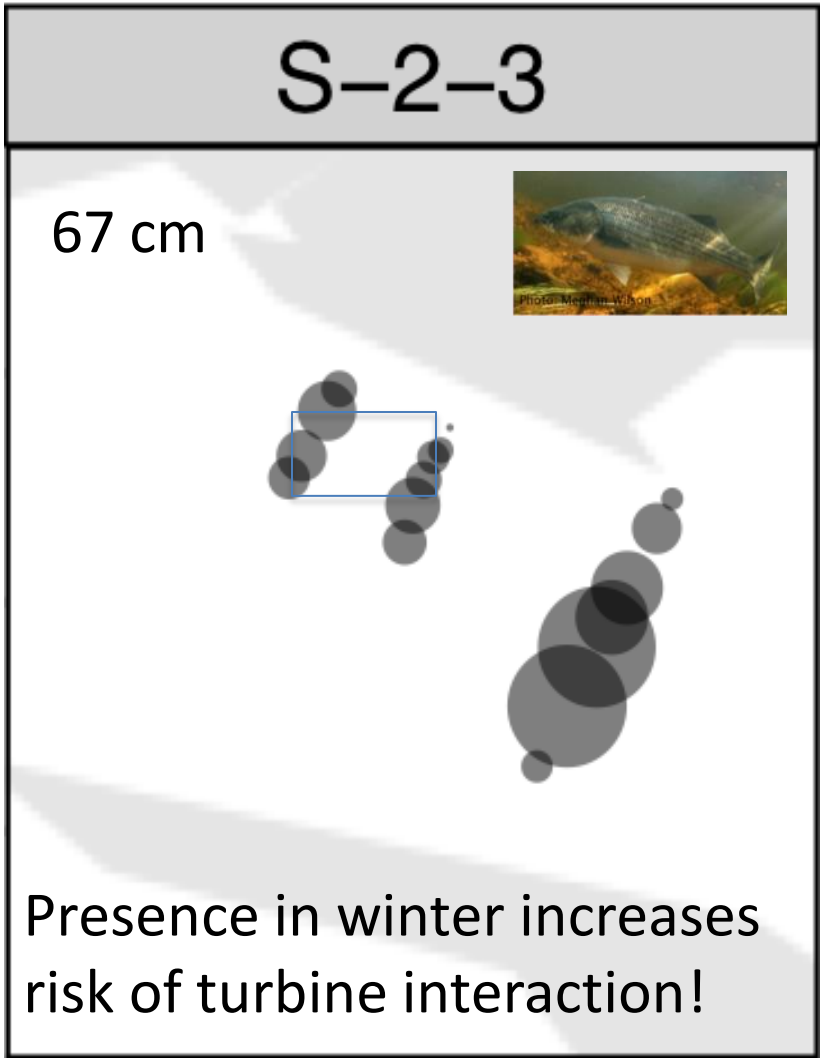
Tagging studies cannot address avoidance behaviour!

Credit: Freya Keyser

Winter 2012-2013 - FORCE receiver detections



Winter presence / Water temps @ 0-3°C



- 35% of tagged fish detected
- Detections: >80% of winter days

S-2-3

3/14/2013

3/25/2013

3/26/2013

3/30/2013

3/31/2013

Tracking Lobster Movements

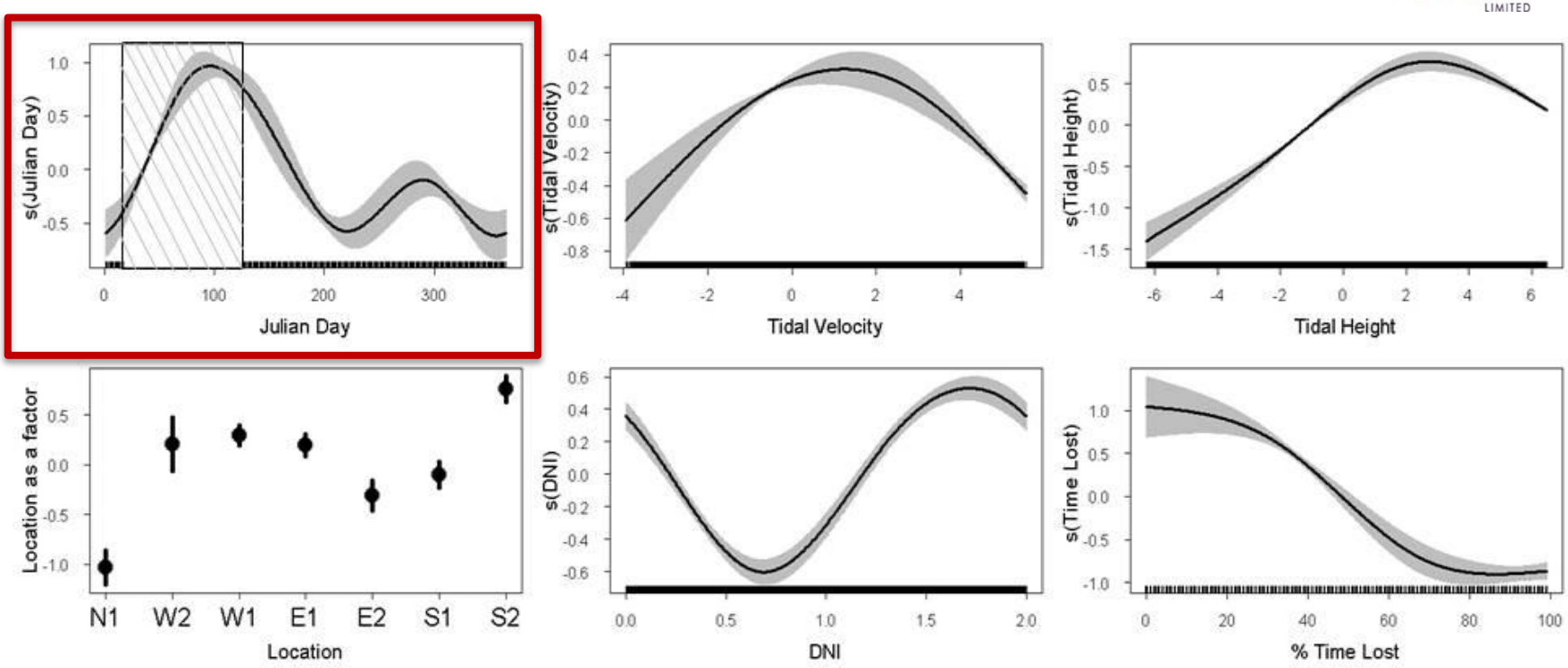
Credit: Kaycee Morrison

- Confirmed migration through FORCE
- Also suggested some overwintering
- Complementary studies
  - Lobster habitat mapping
  - Fisher interviews

Baseline Studies: Harbour Porpoise Detection / Presence

- Hydrophone detection of harbour porpoise click trains
- Seasonal peaks related to prey (herring) abundance
- Detection limitations due to
  1. Ambient noise
     - Flood >> Ebb
     - Spring >> Neap Tides
     - Site effects
  2. Pseudo (flow) noise

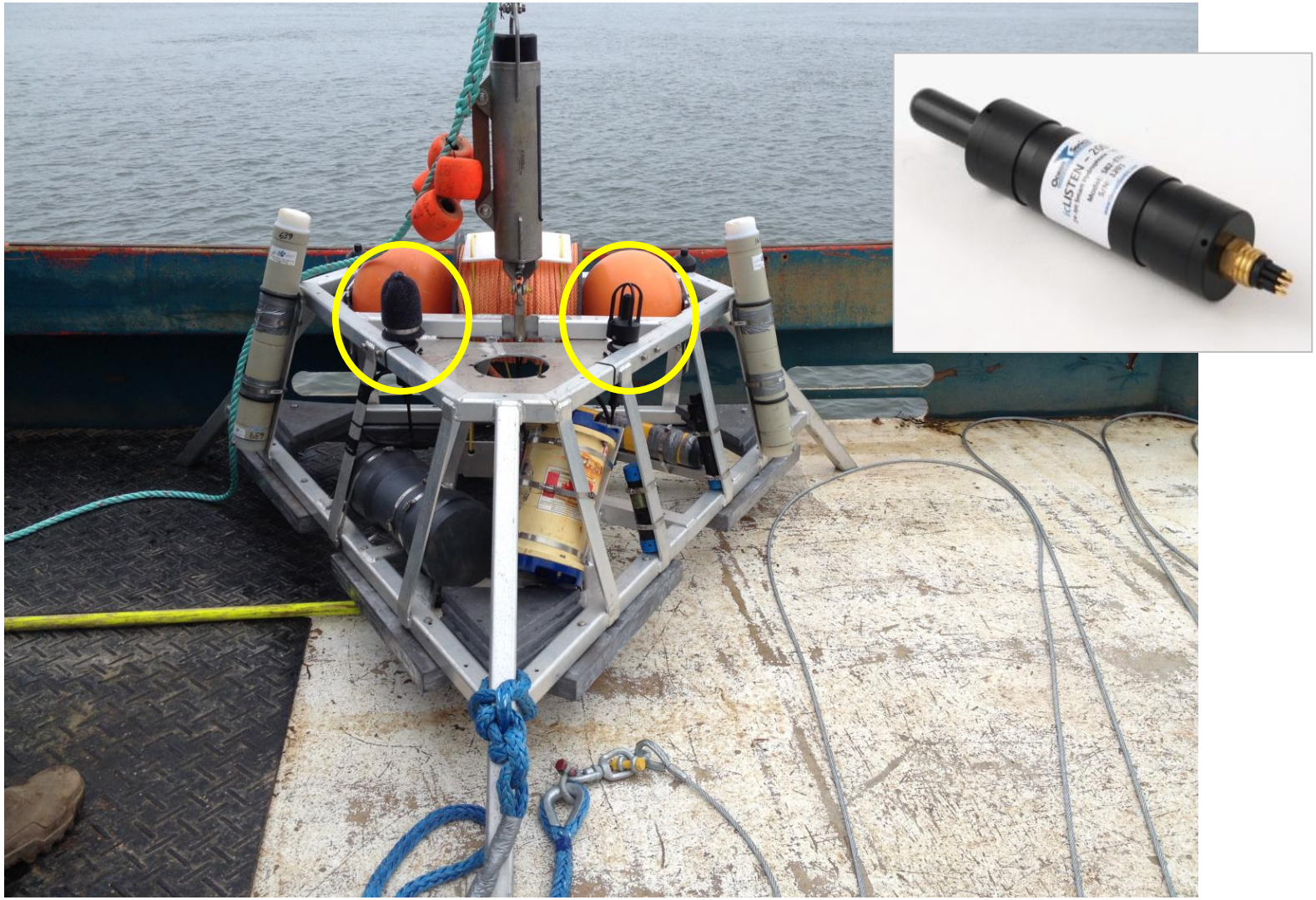
Data Trends - GAM/GEE Model



Source: Wood et al. 2013

- Temporal and tidal influences most important

Hydrophone Performance Testing: June 2014



Ocean Sonics

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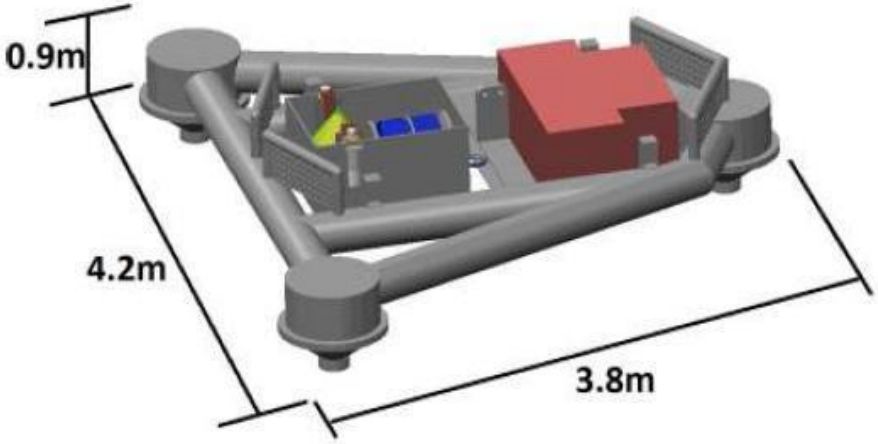
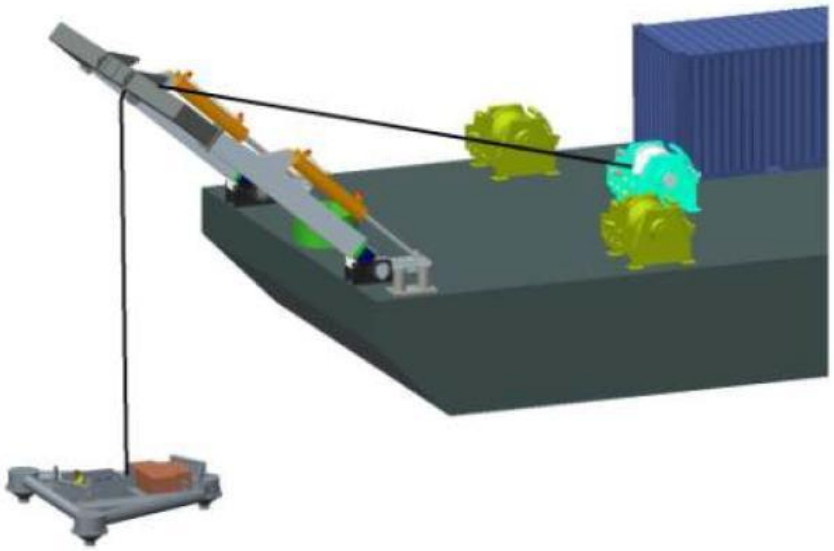
FORCE Sensor Platforms

- Sensors on cabled and non-cabled platforms
  - Acoustic (passive & active)
  - Optical
- Vectron project
  - Turbulence (Lead: Dalhousie Univ)
- Real-time data collection
- Testing of sensor compatibility
  - Turbine applications
  - Environmental monitoring
- Collaboration potential!!





Conclusions & next steps

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- Poor detection efficiency at high current speeds
  - But partial datasets reveal movement patterns
- Migratory species vary in their use of tidal races!
- “Playground” for Bay of Fundy striped bass (at risk population)
  - Year-round presence including winter; SST range: 0-3°C
  - If “sluggish” at temps below 6°C, may have elevated risk of collision
- Next steps:
  - Model encounter and collision probabilities
  - FAST sensor platform / marine animal detection
  - Sensor advances → OERA / UK TSB funding opportunity

http://www.oera.ca/news/requests-for-proposals-funding/current-opportunities/

Acknowledgements

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- Duncan Bates et al
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- Darren Porter, Tony Lewis and crews

OERA Offshore Energy Research Association of Nova Scotia

Ocean Sonics

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OS Open Seas Instrumentation Inc.

OCEAN TRACKING NETWORK Headquartered at Dalhousie University

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