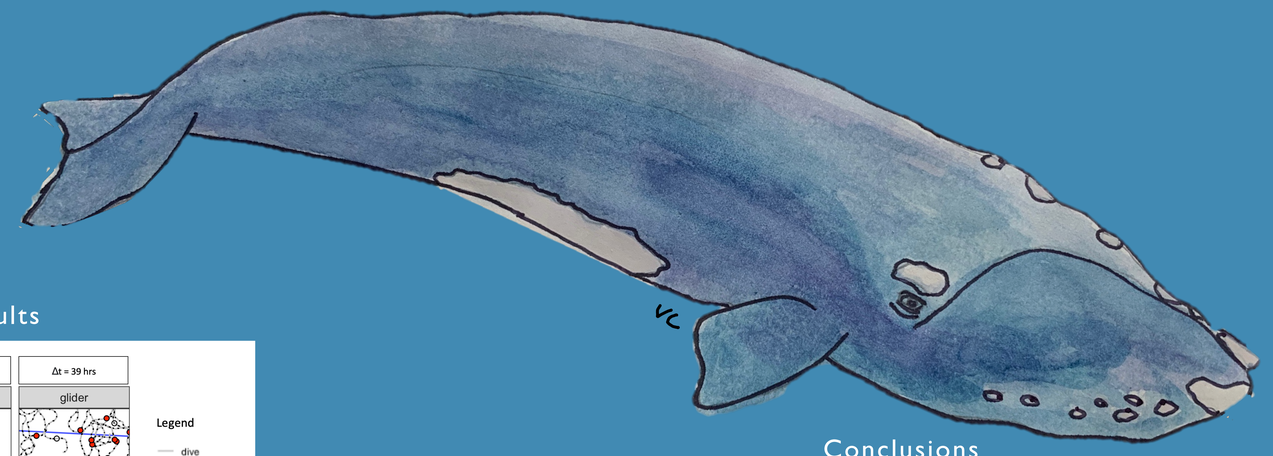
Comparing visual and acoustic surveys for the dynamic management of North Atlantic right whales (*Eubalaena glacialis*) in Canada

Valentina Ceballos
Valentina.Ceballos@dal.ca
Supervised by:
Christopher Taggart & Hansen Johnson,
Oceanography Department, Dalhousie University



Introduction

- Critically endangered **North Atlantic right whales** face acute risks from fishing gear entanglement and vessel strikes and chronic risk related to climate change.
- Fisheries and Oceans Canada (DFO) and Transport Canada (TC) attempt to reduce these risks through dynamic fisheries closures and vessel speed-reductions following right whale detections.
- Visual and acoustic detections are used interchangeably despite notable differences.
- Due to inherent field biases, a model is the best way to compare these two surveys.

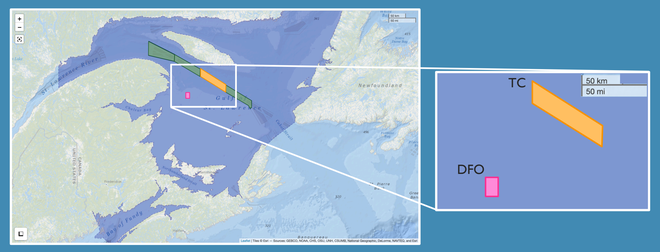


Figure 1 Gulf of Saint Lawrence with dynamic DFO fishing (blue) and TC transit (green) areas on the left; examples of individual survey zones on the right (Source:WhaleMap)

Goals

1) Develop a simulation to compare visual and acoustic survey platforms
2) Apply the simulation to inform more effective right whale monitoring strategies

Methods

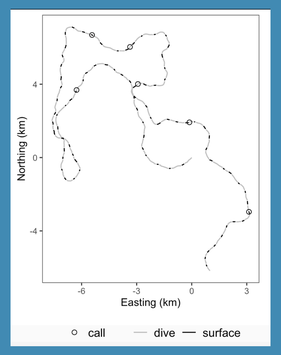


Figure 2 Simulated whale swimming and calling

- Expand existing whale movement model[1]
- Add whale diving[2] and calling behaviour[3]
  Average dive time = 12 min +/- 3 min;
  Average surface time = 5 min +/- 1 min
  Average call rate = 0.25 upcalls/whale/hour +/- 0.500 upcalls/whale/hour
- Create DFO and TC survey areas
- Create platform transits that cross the survey areas
  planes = 51m/s, ~100 knots
  vessels = 4m/s, ~8 knots
  glider = 0.1m/s, ~0.2 knots
- Add detection capabilities[1, 4]
- Combine and run multiple times in a Monte Carlo approach

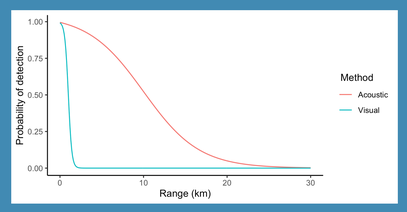


Figure 3 Detection capabilities of the two types of survey platforms

Results

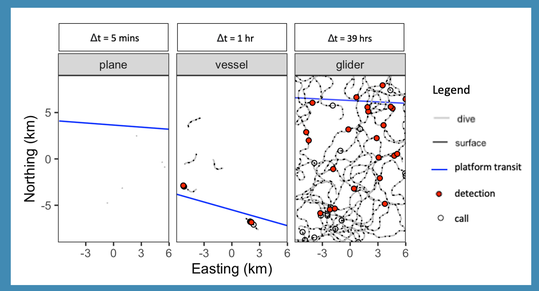


Figure 4 Example of one run of the model in the DFO zone for all three platforms and multiple whales

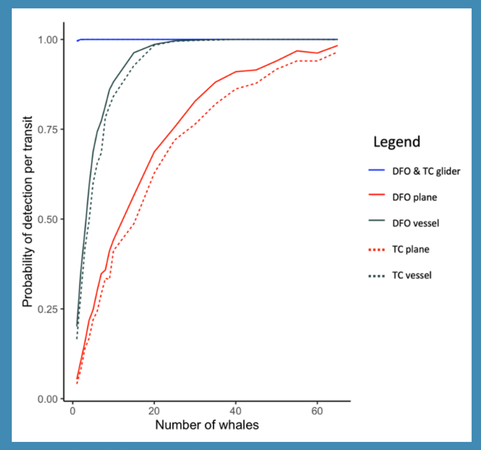


Figure 5 Probability of detecting one whale during one transit based on the number of whales, per platform and zone type

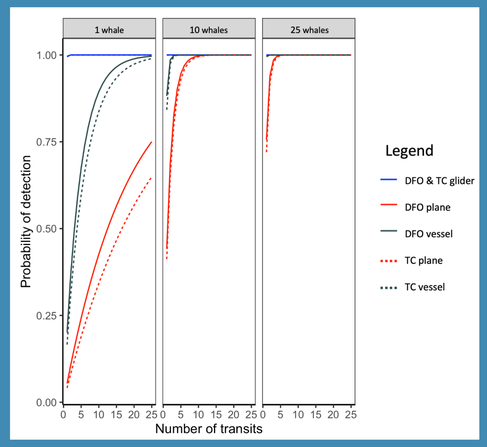


Figure 6 Probability of detecting one whale based on the number of transits, per number of whales (1, 10, and 25), platform, and zone type

- Probability of detection depends on the platform and the number of whales in an area
- Ocean gliders always detect a whale on a single transit, regardless of the number of whales
- Planes require ~20 whales present to detect at least one per transit with 75% confidence (Vessels: ~5 whales)
- Probability of detection also depends on the number of transits performed
- If there is only one whale, planes require ~25 transits to have that same 75% confidence
- Vessels are intermediary in their detection capabilities
- DFO and TC areas are similar

Conclusions

- **Not all survey platform transits are equal**; platform speed, detection capability and number of whales affect the probability of detection.
  For example, plane requires ~20x more whales than gliders to detect at least one with, say ~75% certainty, or >25 transits if only one whale is present.
- **Detection capabilities are explained by the time platforms spend in the survey zone.**

Table 1 Average time spent in each survey zone type by platform

Platform	DFO	TC
Glider	38.8 hours	278.7 hours
Vessel	1.0 hour	6.7 hours
Plane	4.5 minutes	32.7 minutes

- Visual surveys cannot reliably detect single whales, or small groups of whales, with a single transit; despite infrequent whale calling, glider persistence and detection range allows for reliable detection under the same conditions.

What now?
Use this to inform future right whale management: platforms have different pros and cons, using these strategically may improve risk-mitigation efforts – simulation could even include new platforms, like drones and satellites.

References

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