Near real-time acoustic monitoring from gliders

Tackling practical challenges

Katie Kowarski

Webinar hosted by MERIDIAN

Wednesday, January 13, 2021

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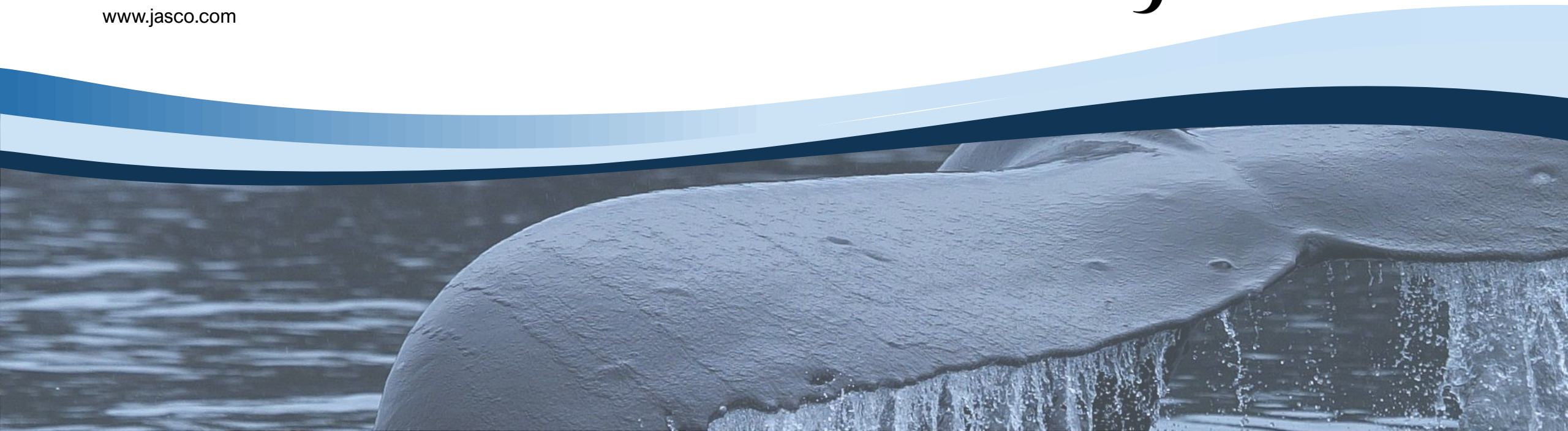
JASCO APPLIED SCIENCES



JASA ARTICLE

Near real-time marine mammal monitoring from gliders: Practical challenges, system development, and management implications

Katie A. Kowarski,[1,a)] Briand J. Gaudet,[1] Arthur J. Cole,[1] Emily E Maxner,[1] Stephen P Turner,[1] S. Bruce Martin,[1,b)] Hansen D. Johnson,[2] and John E. Moloney[1]

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[2]*Department of Oceanography, Dalhousie University, 1355 Oxford Street, Halifax, Nova Scotia, B3H 4R2, Canada*

Why do we need real-time information from gliders?

North Atlantic right whales are dying in Canada. Here's what we know so far

By Rachael D'Amore · Global News
Posted June 27, 2019 1:34 pm · Updated June 27, 2019 5:45 pm

CANADA

Here's why 12 right whales died in Canadian waters — and why more will die if nothing is done

By Kate Allen Science and Technology reporter
Wed., Dec. 27, 2017 | 22 min. read

Collisions with ships, fishing gear entanglement caused right whale deaths: report

Dave Stewart (dave.stewart@theguardian.pe.ca)
Published: Oct 05, 2017 at midnight
Updated: Oct 12, 2017 at 2:41 p.m.

US Navy
MARINE SPECIES MONITORING

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Declaration of 2017 North Atlantic Right Whale Unusual Mortality Event

Posted on August 29, 2017

NOAA Fisheries has declared an Unusual Mortality Event (UME) for North Atlantic right whales throughout their range based on recent elevated strandings along the Atlantic coast, predominantly in the Gulf of St. Lawrence region in Canada. This event began in June 2017 and strandings remain high, with the most recent stranding occurring offshore of Cape Cod, Massachusetts on August 14, 2017.

PAST NEWS

New Publication
Fin whale song patterns shift over time in the Central North Pacific

LMR News: Fall 2020

New publication on beaked whale diving
Extreme diving in mammals: first estimates of behavioural aerobic dive limits in Cuvier's...

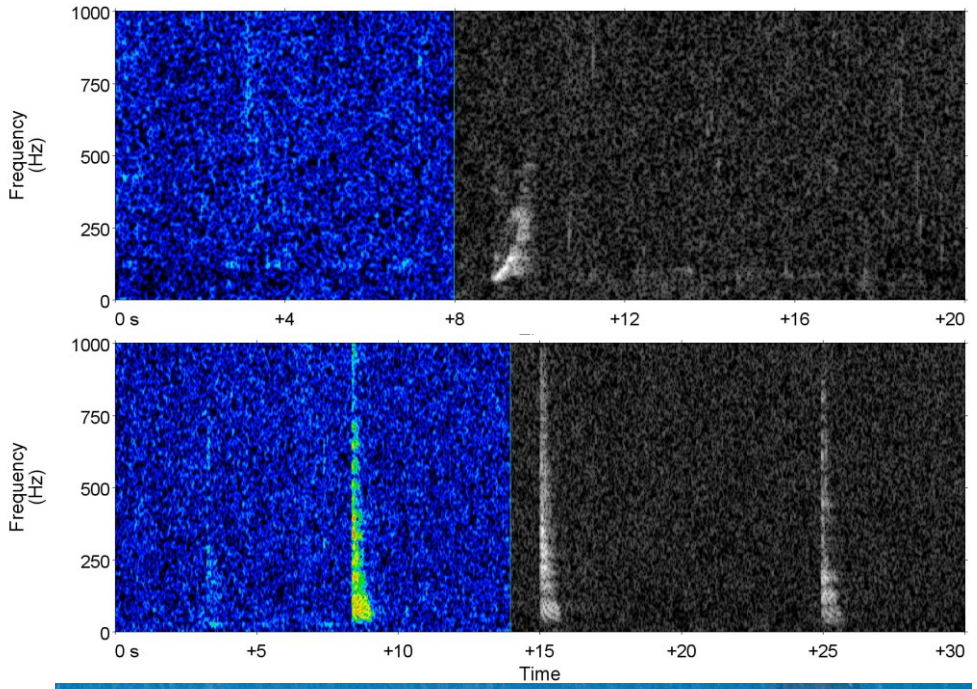
Two percent of the world's North Atlantic right whales have died in the last two months

ELSEVIER

Marine Policy
Volume 104, June 2019, Pages 157-162

Mass human-caused mortality spurs federal action to protect endangered North Atlantic right whales in Canada

Kimberley T.A. Davies [a, b], Sean W. Brillant [b, c]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750
500
250
0
0 s
+4
+8
+12
+16
+20
Frequency (Hz)
1000
750
500
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+25
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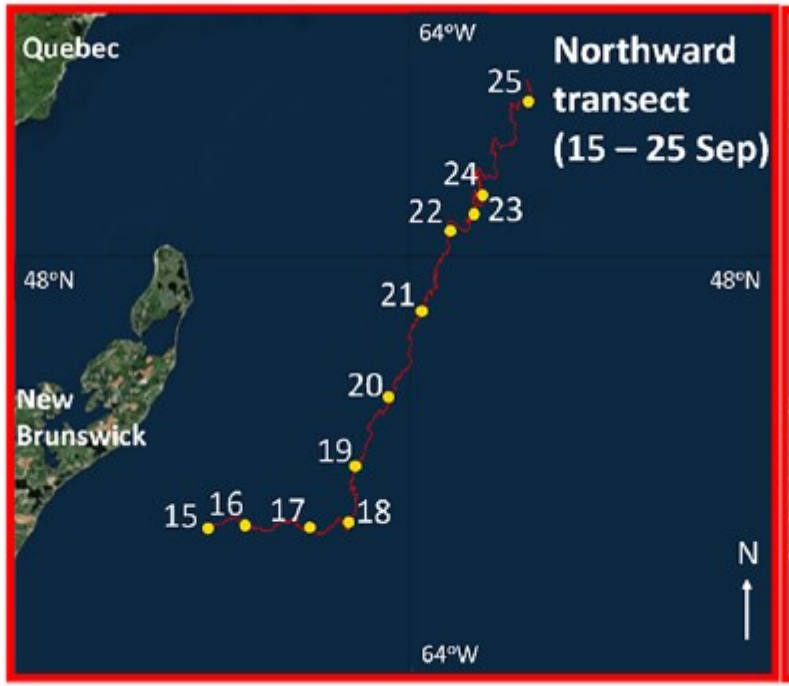
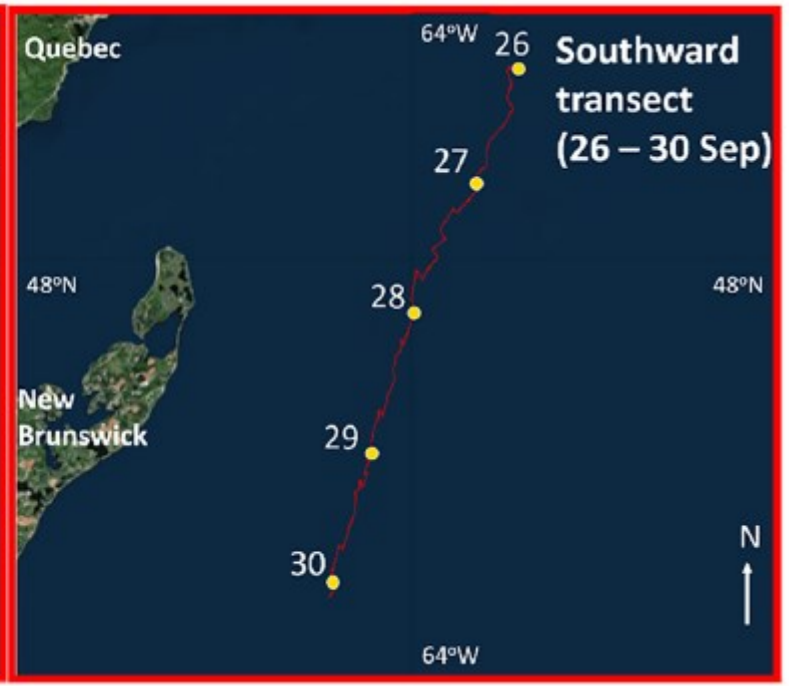
Time


NOAA


Photo by Jude Van Der Meer

Gulf of St Lawrence Trial 2018



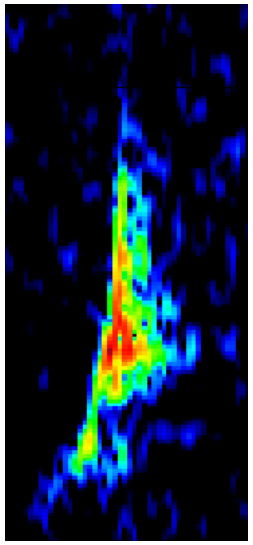


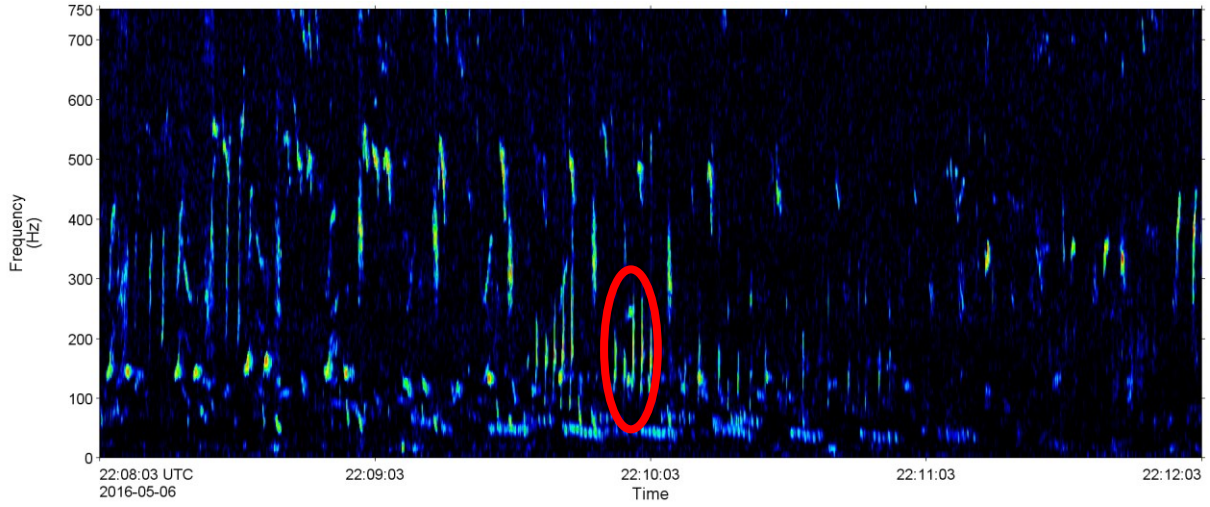
Challenges ➡ **Solutions** ➡ **Future work needed**

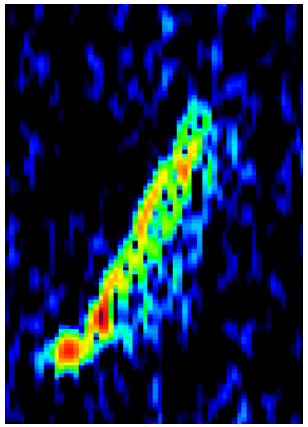
Challenges for analyzing acoustic data for marine mammal occurrence

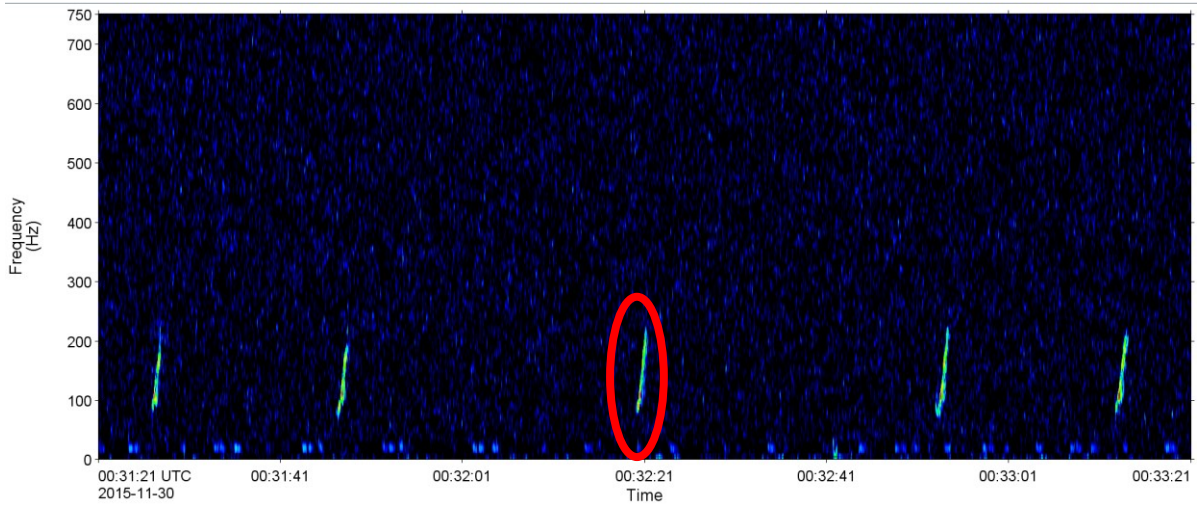
Challenge	Post-retrieval analysis	Near real-time glider analysis
Species with overlapping acoustic repertoires	✓	✓
Differentiating signals of interest from anthropogenic sounds		
Interpreting faint/masked signals		
Developing effective automated systems to support analysis		
Power and storage constraints		
Self noise		
Limited recorder-to-shore transmission budget		
Computational capacity		
No real-time access to raw acoustic data		

Challenge: Species with overlapping acoustic repertoires









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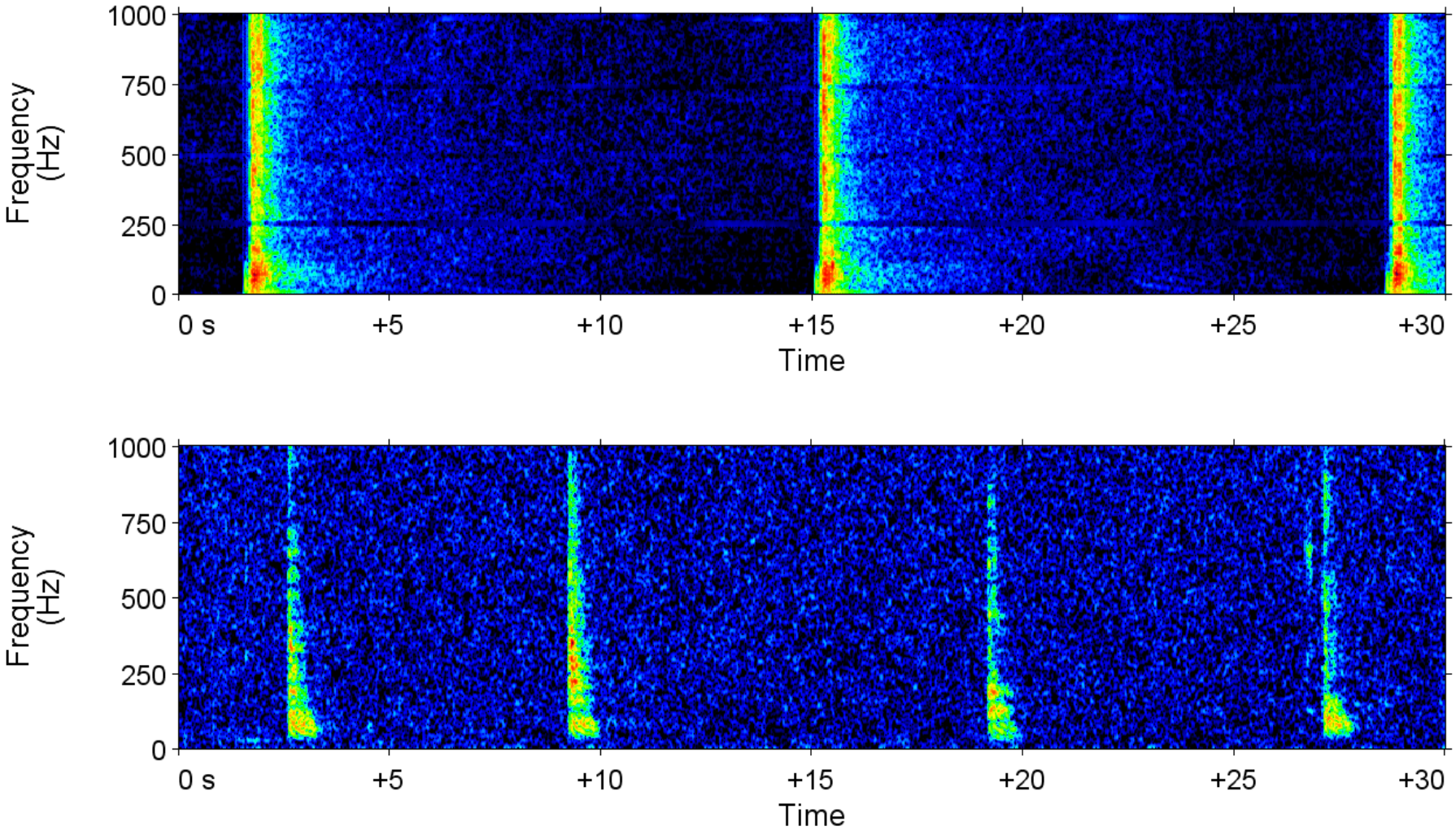
Challenge: Differentiating signals of from anthropogenic sounds



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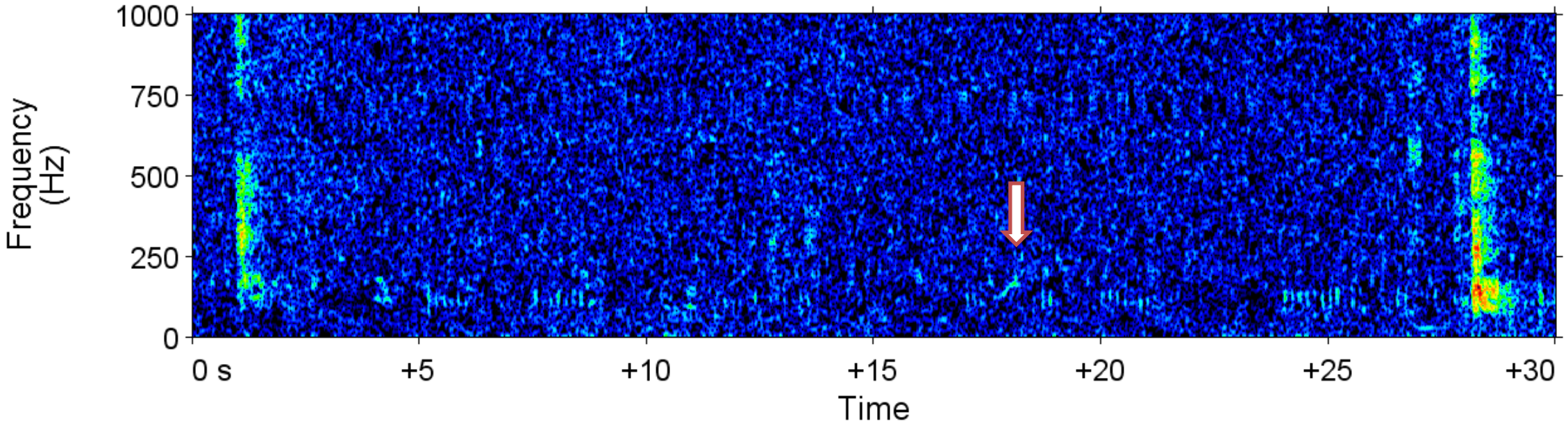
Challenge: Interpreting faint/masked signals



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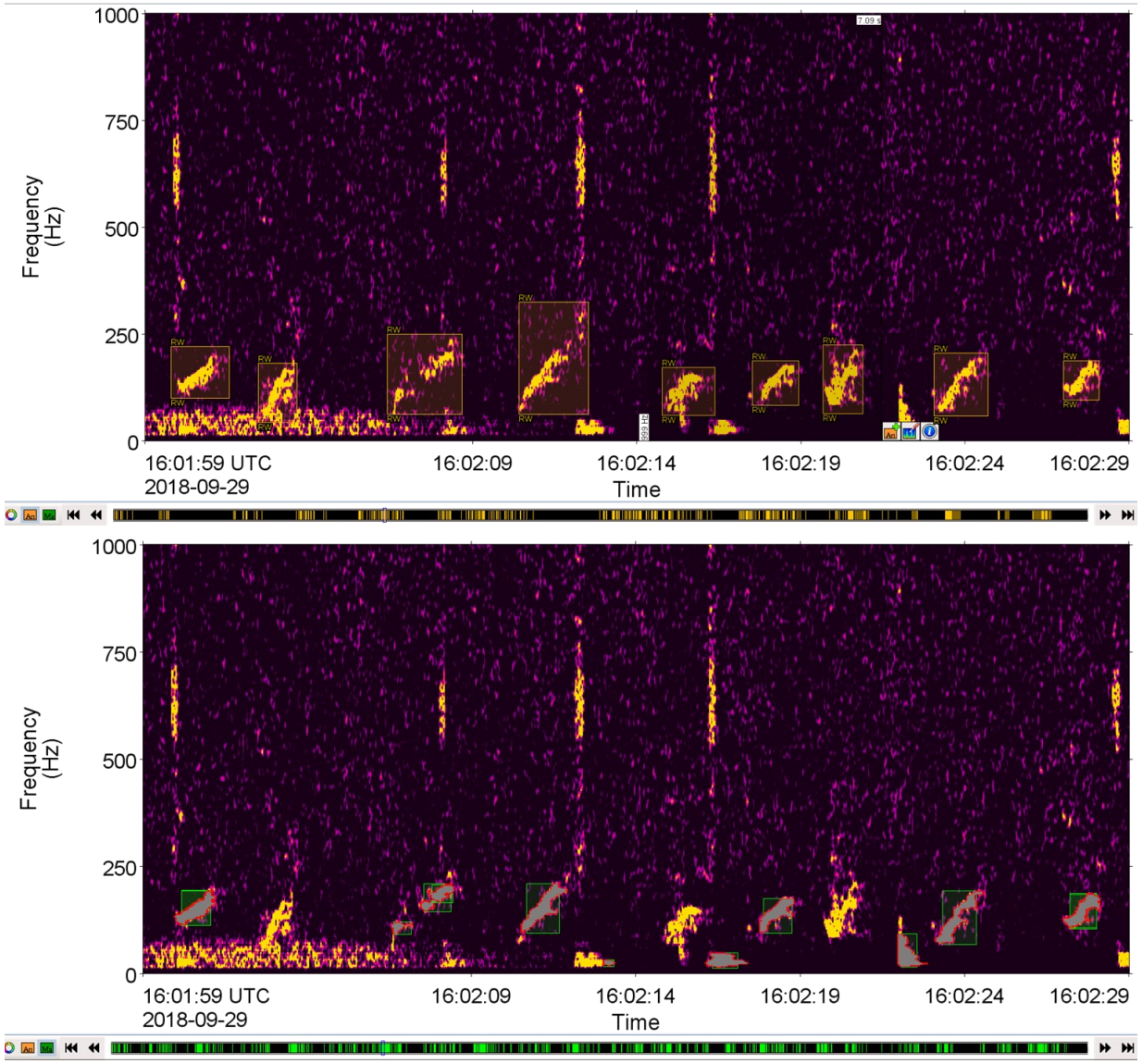
Challenge: Developing effective automated systems to support analysis



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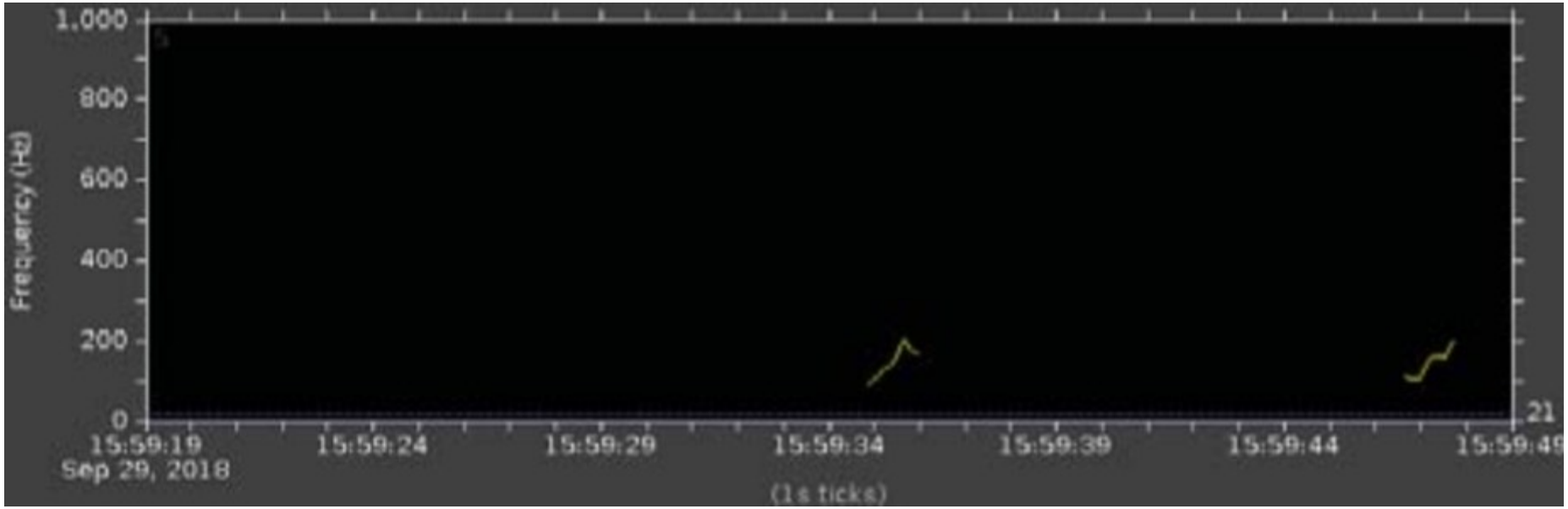
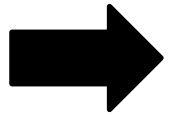
Computational capacity		✓
No real-time access to raw acoustic data		✓

Challenge: Limited bandwidth → no real-time raw acoustic data



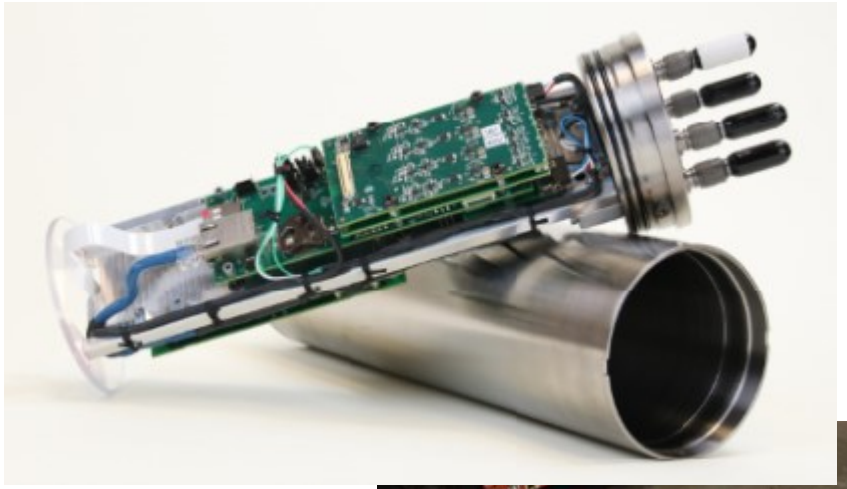
Challenges for analyzing acoustic data for marine mammal occurrence

Challenge
Developing effective automated systems to support human analysis
Power and storage constraints
Computational capacity



JASCO's
OceanObserver

JASCO's **OceanObserver**



- Java
- Linux operating system
- Integrated with glider mission computer
  - ➢ Can run 11+ automated detectors (8 distinct FFT configurations)
  - ➢ Can record continuously at 512 and 16 kHz continuously
- Storage: four 512 GB SD cards
- 2-3W power (estimated to achieve 100 d mission)

Challenges for analyzing acoustic data for marine mammal occurrence

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Provide enough context for confident species detection

Identify and prioritize important acoustic events

Near real-time detection of baleen whales

Stage 1: Automated detector development

- 11 (6 species-specific; 5 general)
- Contour-following PAMlab algorithm

Near real-time detection of baleen whales

Stage 1: Automated detector development

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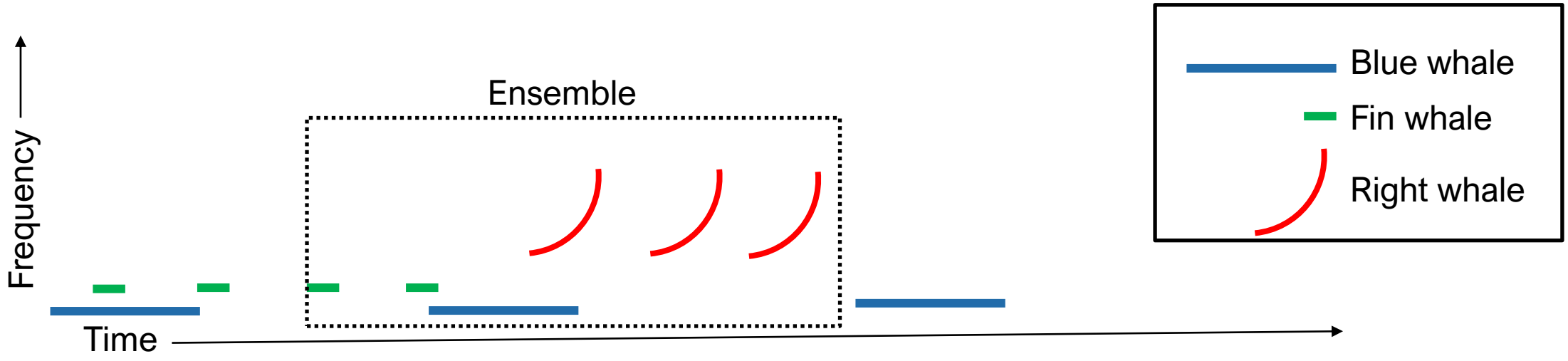
Stage 2: Candidate detection prioritization and data transfer

- Each detection assigned priority ranking
- Sliding window finds ensemble with highest-ranked score



Near real-time detection of baleen whales

Stage 1: Automated detector development

- 11 (6 species-specific; 5 general)→analysis protocol
- Contour-following PAMlab algorithm

Stage 2: Candidate detection prioritization and data transfer

- Each detection assigned priority ranking
- Sliding window finds ensemble with highest-ranked score
- Ensembles sent to glider computer until transmission budget maxed
- When glider surfaces ensembles sent to shore (in order of ranking)

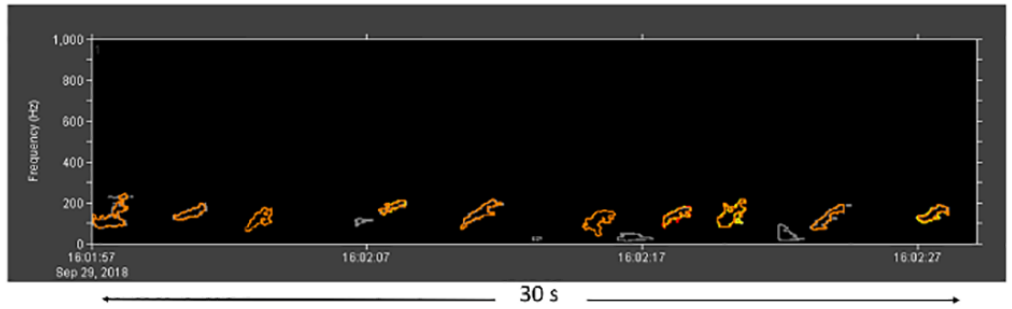
Stage 3: Manual validation

- Ensembles→ Teledyne Webb→ Database → Emailed to analyst

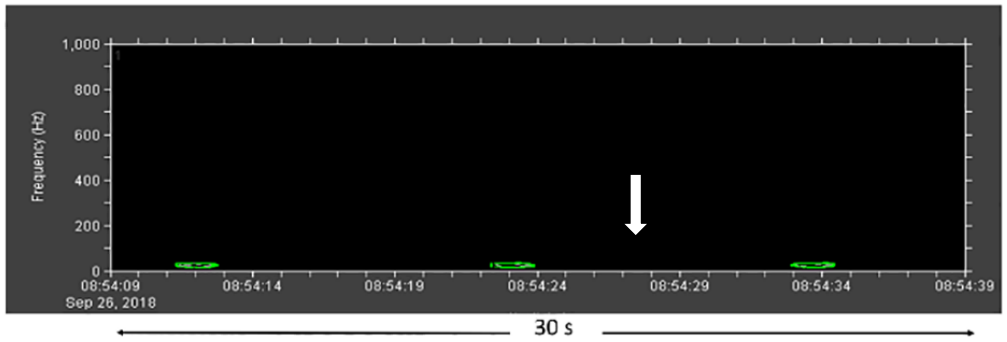
Contour emails

Right whale 1 | Right whale 3 | Fin whale
Right whale 2 | Blue whale | General

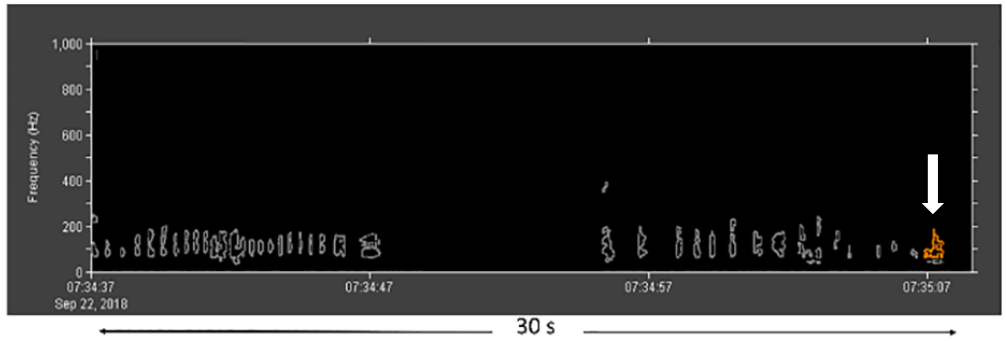
Right whale
Frequency (Hz)



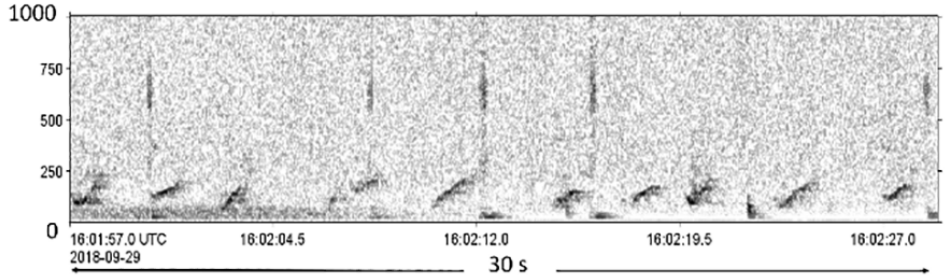
Fin whale
Frequency (Hz)

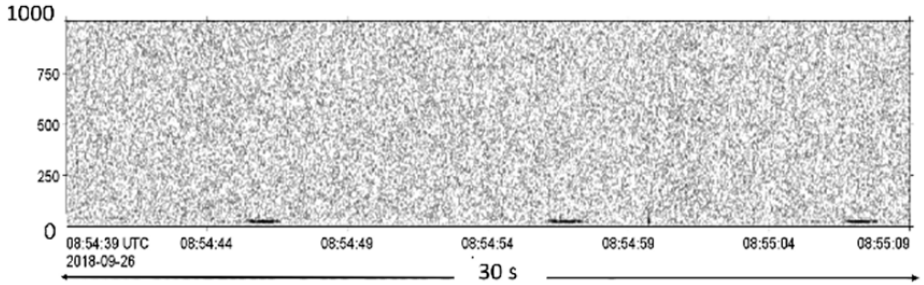


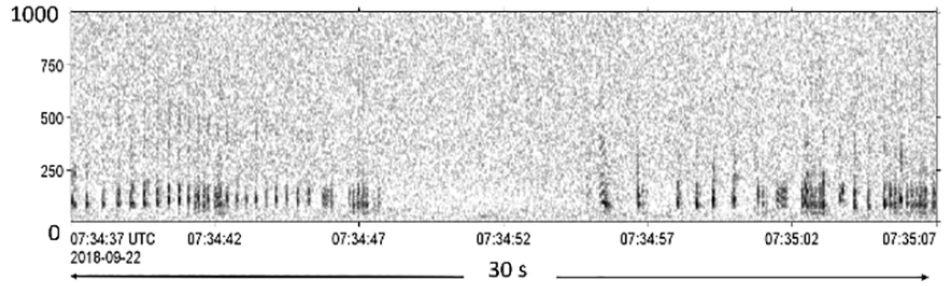
Minke whale
Frequency (Hz)



Spectrograms



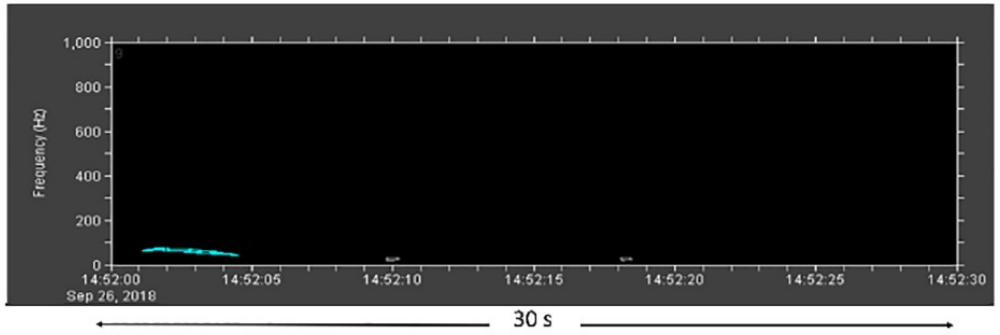




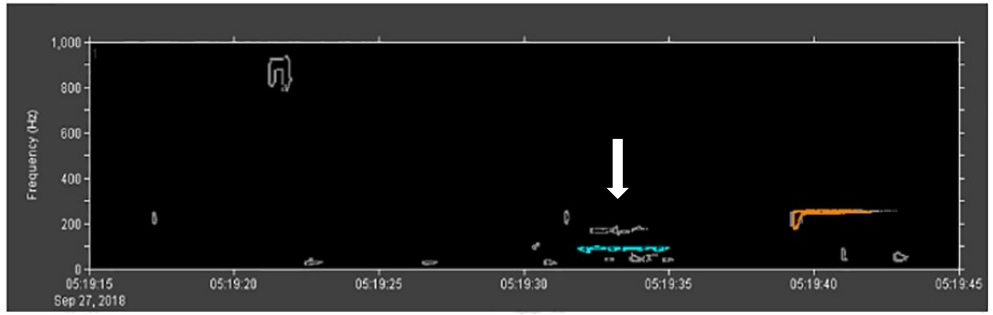
Contour emails

Right whale 1
Right whale 2
Right whale 3
Blue whale
Fin whale
General

Blue whale
Frequency (Hz)



Glider
Frequency (Hz)



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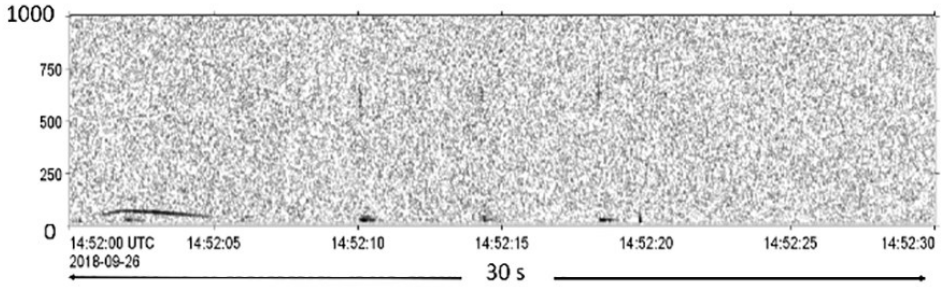

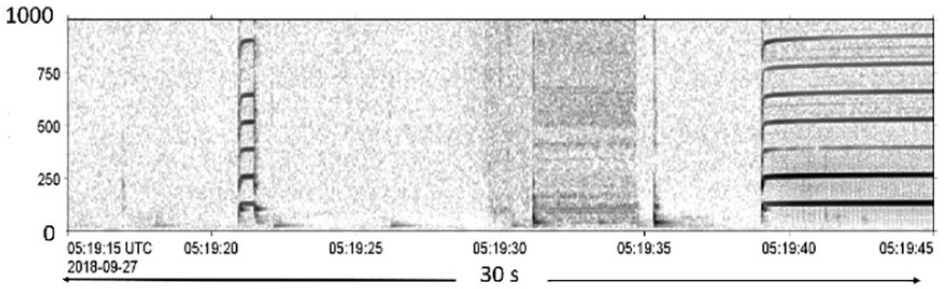

Results

	By email (n = 641)	Hourly (n = 350)	By dive (n = 114)	Daily (n = 16)
Right whale (upcall)				
P	1.00	1.00	1.00	1.00
R	0.76	0.31	0.38	0.62
Fin whale (20 Hz pulse)				
P	1.00	1.00	1.00	1.00
R	0.25	0.15	0.26	0.42
Blue whale (audible downsweep)				
P	1.00	1.00	1.00	1.00
R	0.50	0.20	0.20	0.50
Possible minke whale (pulse train)				
P	0.70	1.00	1.00	1.00
R	0.14	0.06	0.12	0.36

Summary

Challenge
Species with overlapping acoustic repertoires
Differentiating signals of interest from anthropogenic sounds
Interpreting faint/masked signals
Developing effective automated systems to support human analysis
Power and storage constraints
Self noise
Limited recorder-to-shore transmission budget
Computational capacity
No real-time access to raw acoustic data

OceanObserver

Identify and prioritize important acoustic events

Provide enough context for confident species detection

Future work

- Need to increase Recall
  - No acoustic data and limited transmission budget
  - Missed faint signals
- For longer missions, reduced power draw is required
- Can context be captured in the automation itself?

Questions?

OCEAN TRACKING NETWORK

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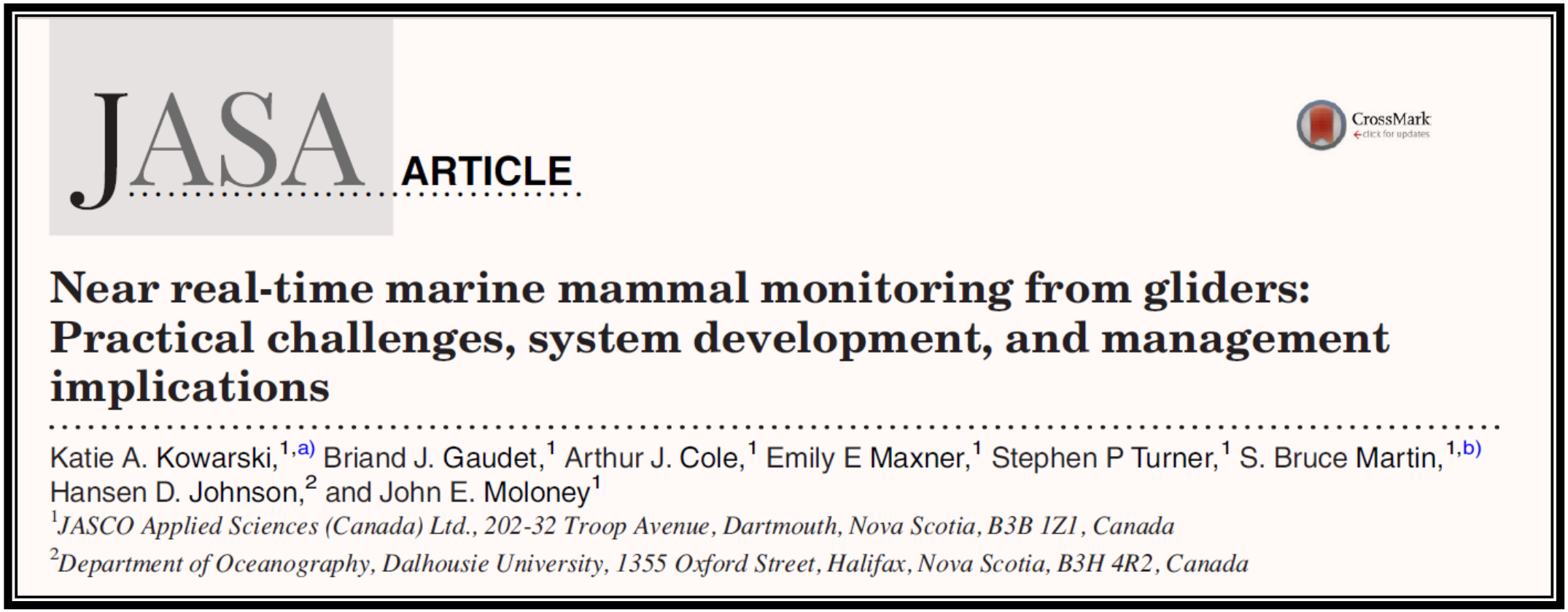

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