

# Bioacoustics and Machine Learning as Key Tools in Conservation

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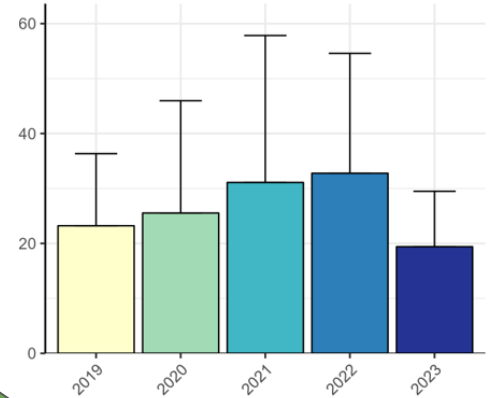
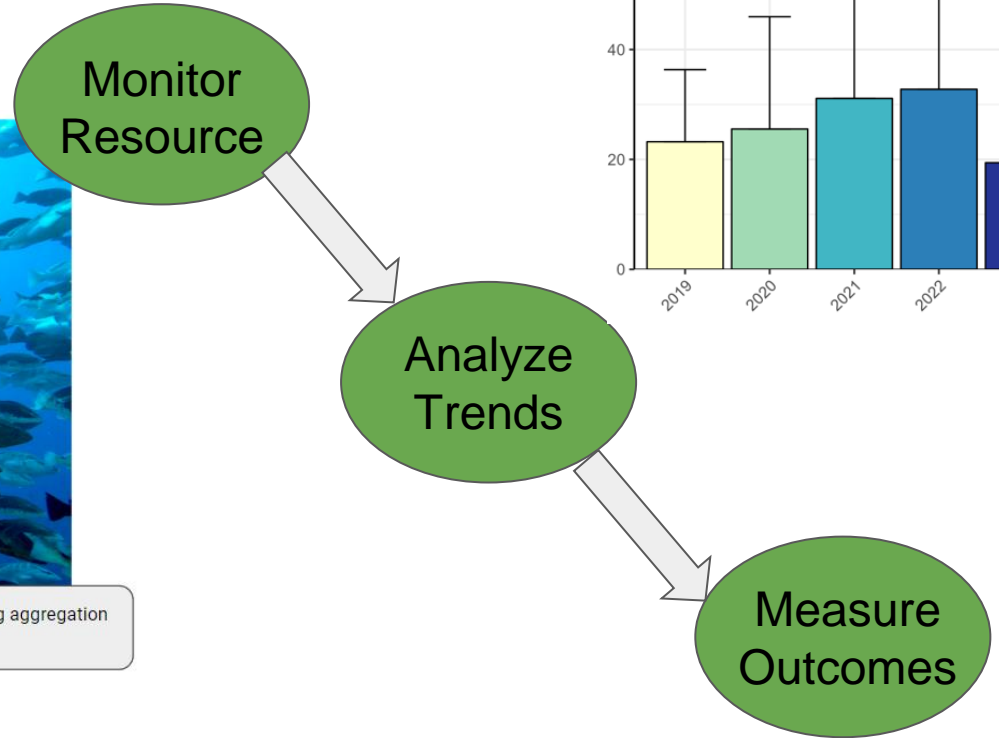
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# Evidence-based conservation needs **monitoring**



# Advantages of automated wildlife surveys

- Cost effective
- Less invasive
- Repeatable
- Archivable
- Scalable (space/time)
- **Statistical power!**



# Primary Monitoring Services

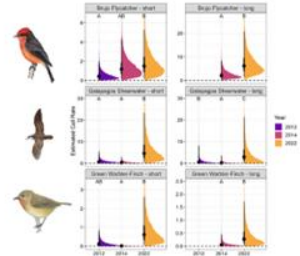
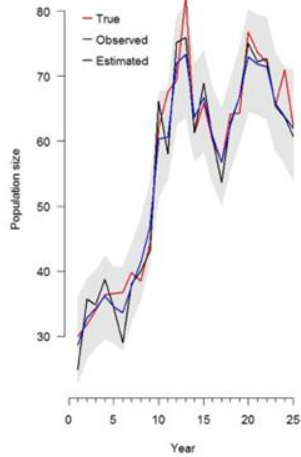
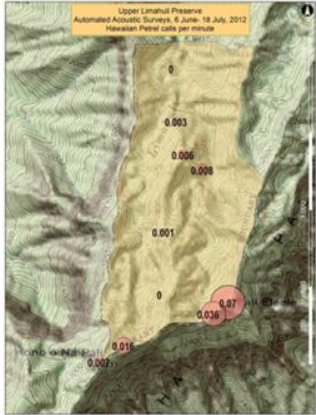
## Endangered Species Recovery

## Ecosystem Health

## Measuring Outcomes

## Quantify Impacts

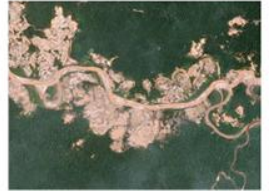
## Detecting Emerging Threats



**Biodiversity**



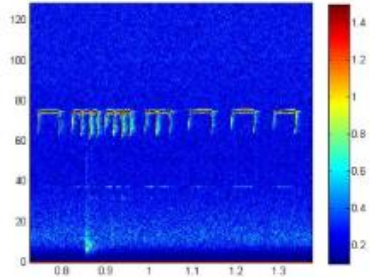
**Biocultural**



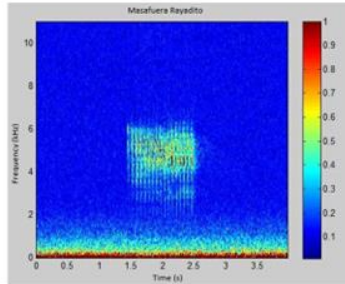


# Rare species detection

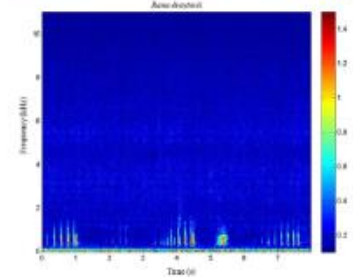
Lamotte's Roundleaf Bat



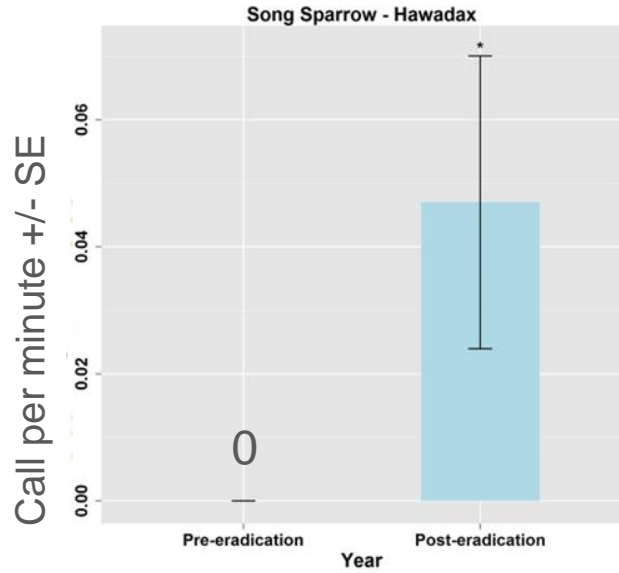
Masafuera Rayadito



CA Red-legged Frog



# Conservation outcomes



# Quantifying impacts



# The need for Deep Learning

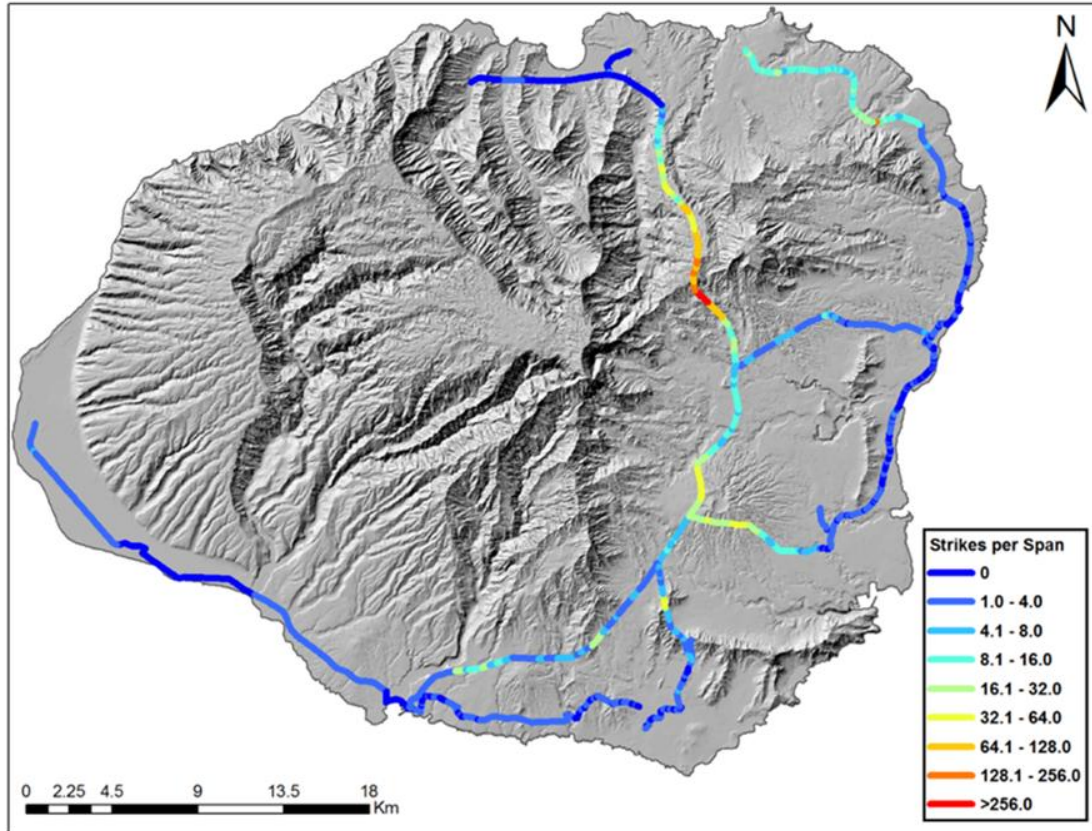
Year	Project	SM	Hours	GB	Channels
2012	UMP	6	652	103.51	1
2013	UMP	8	6,656	1,056.71	1
2014	UMP	55	71,560	11,360.87	1
2015	UMP	55	75,555	11,995.11	1
2016	UMP	65	78,560	24,944.37	2
2017	UMP	70	83,852	26,624.69	2
		<b>TOTAL</b>	<b>316,183.00</b>	<b>75,981.74</b>	

36 years of data  
**~4 hours of signal!**

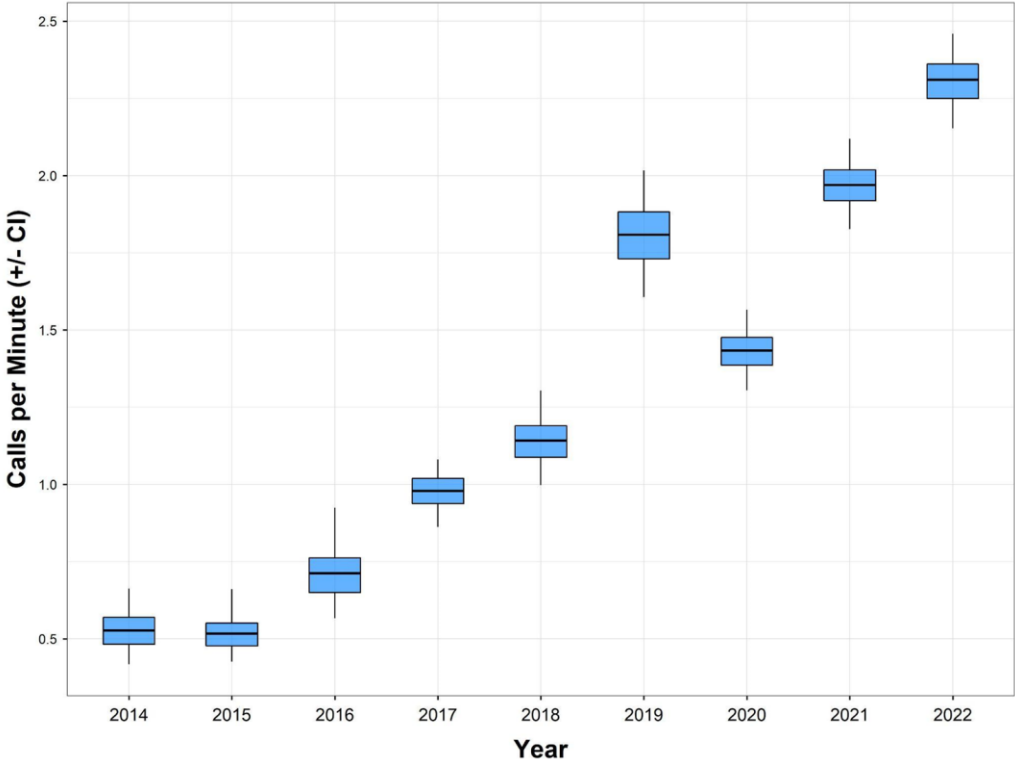


# Quantify impacts - Modeling collision risk

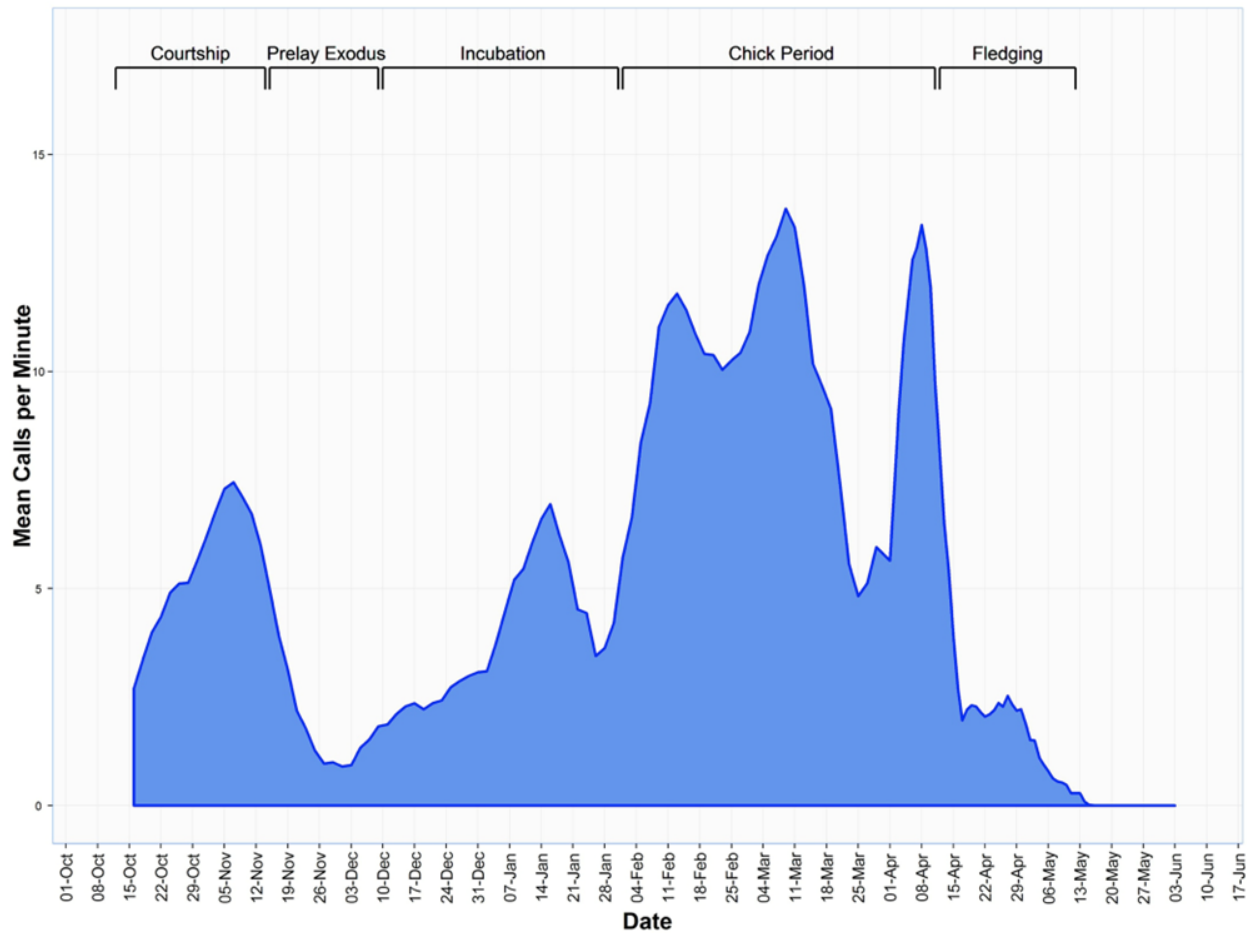
Analysis by Travers et al.



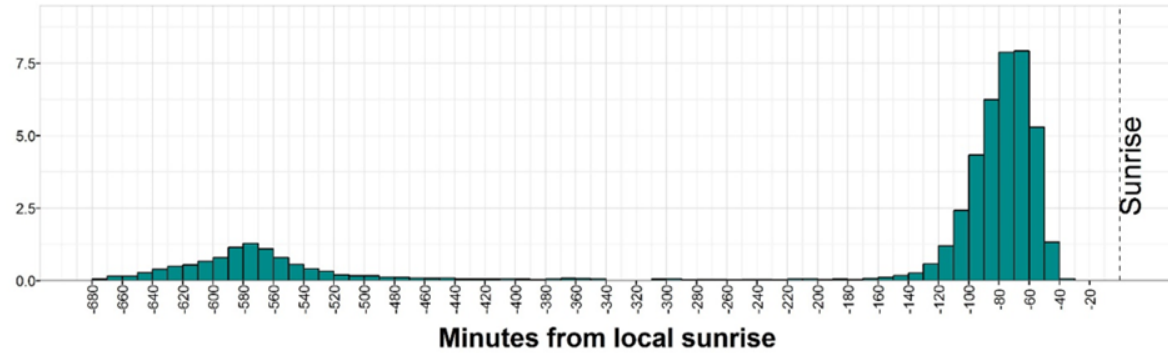
# Hawaiian Petrel Calls per Minute at Upper Limahuli Preserve



# Rich season-long data

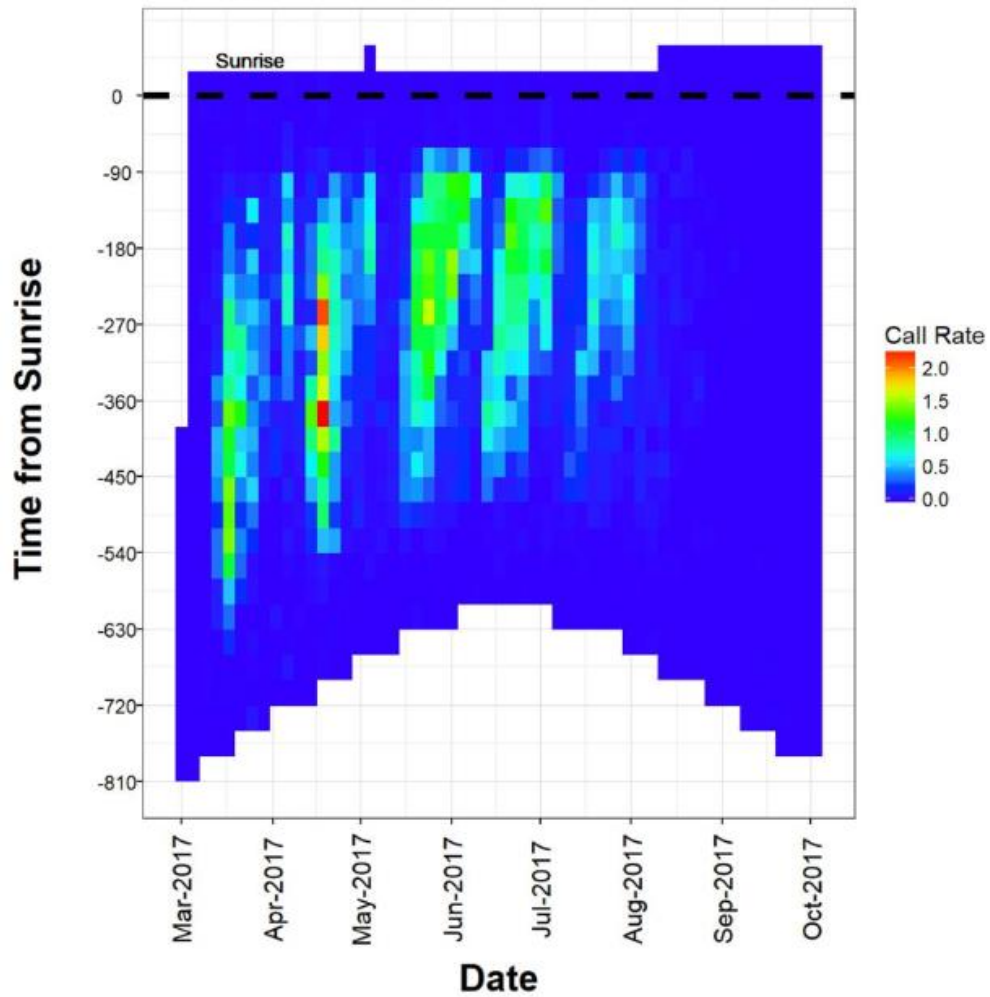


# Daily activity patterns



Acoustic activity by minute from sunrise

# Ashy Storm-petrel - Phenology





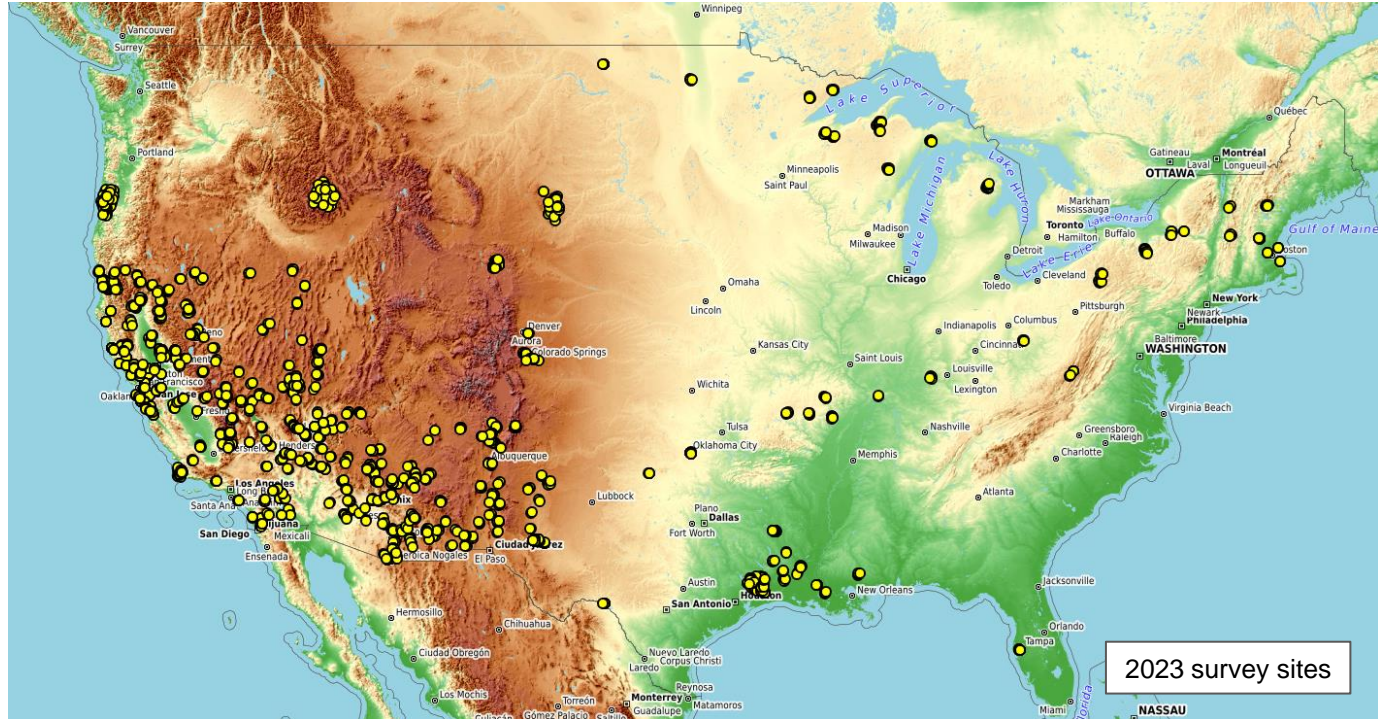
# Continental Scale Monitoring

# NABat

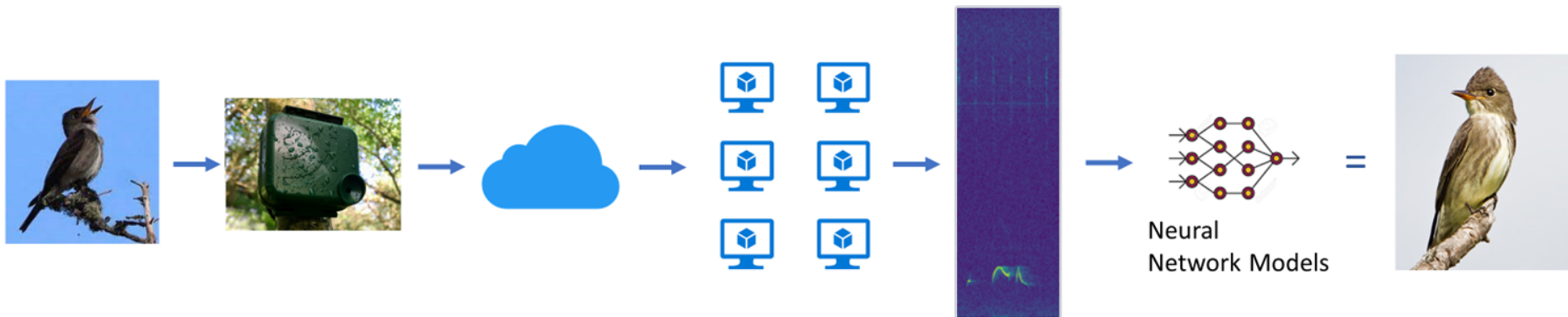


# NORTH AMERICAN BAT MONITORING PROGRAM

- **1,598** Locations
- **10** sensor types
- **21,812,939** files
- **26 TB** of data



# Putting rigorous, efficient, repeatable ML pipes into production



1. Nature happens!

2. Sensors record ambient sounds

3. Sound files copied to cloud

4. Species classification cluster started

5. Spectrograms calculated from sounds

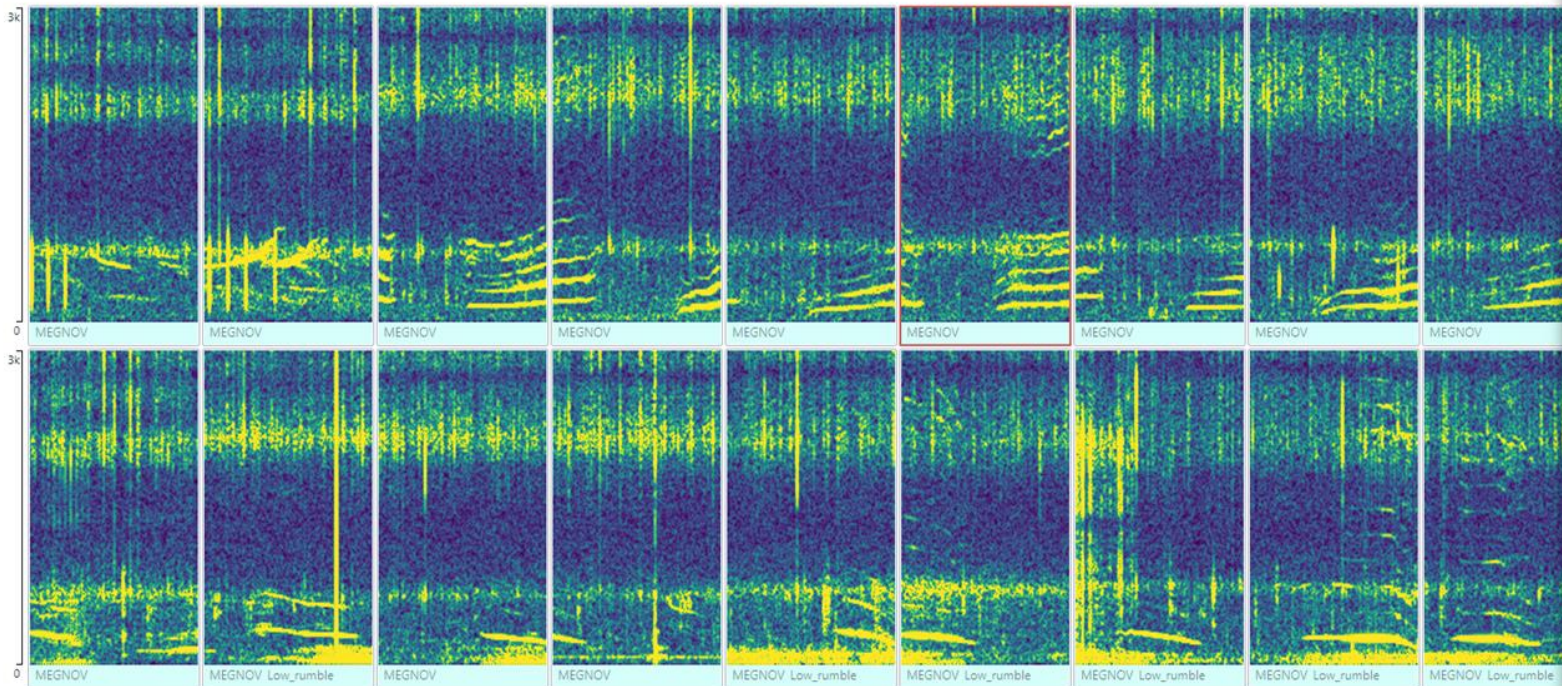
6. Species I.D. predicted

**Olive-sided Flycatcher!**





# Cloud-based Workflows & Web apps

▶ 0:02 / 0:02  20 per page  
on page 1 of 110








## User Config

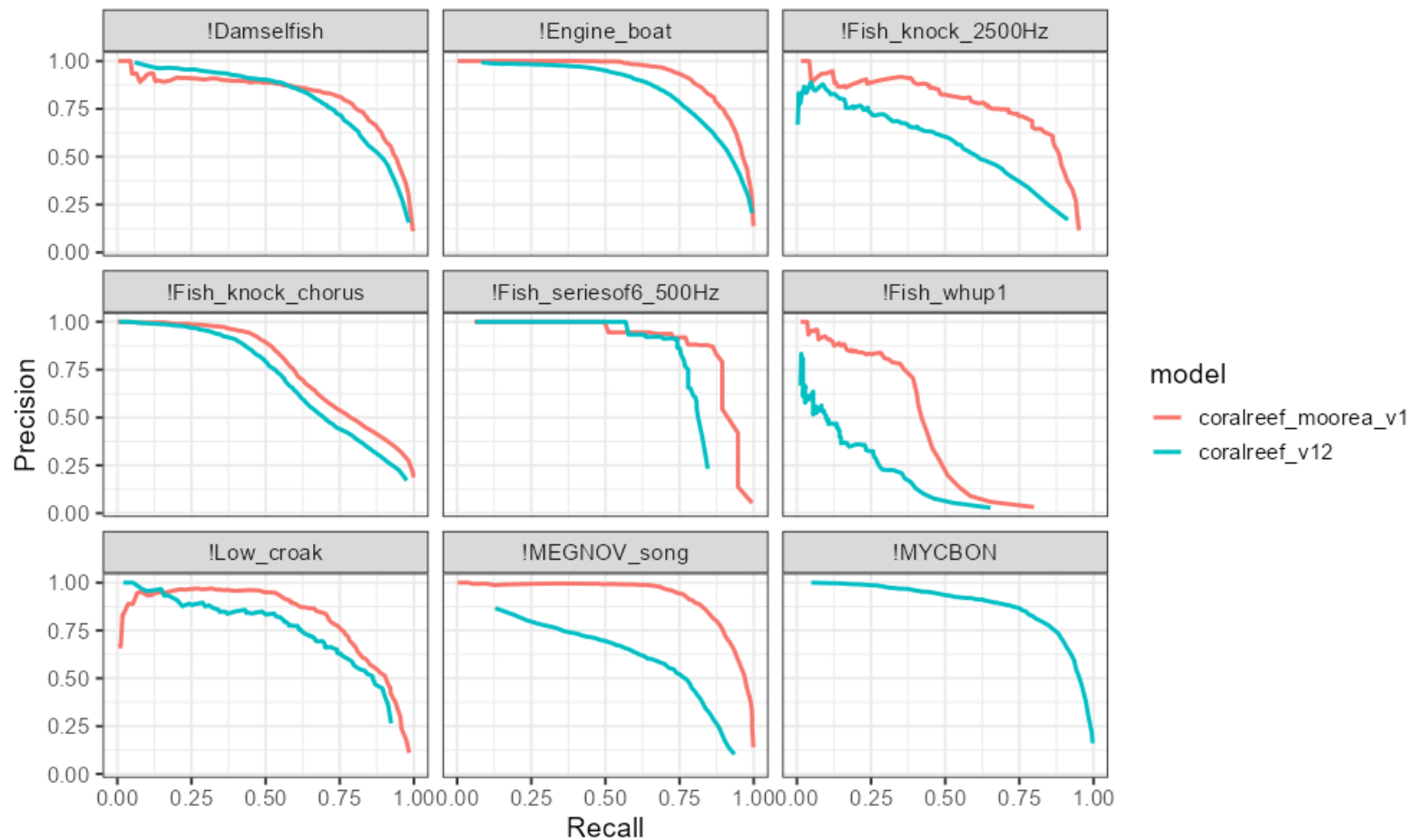
- playback volume:
- playback rate:
- highpass hz :
- lowpass hz :
- padding seconds:
- min freq:
- max freq:
- vmin:
- vmax:
- spec res hz:
- temp res ms:
- clips per row (cols):

UPDATE

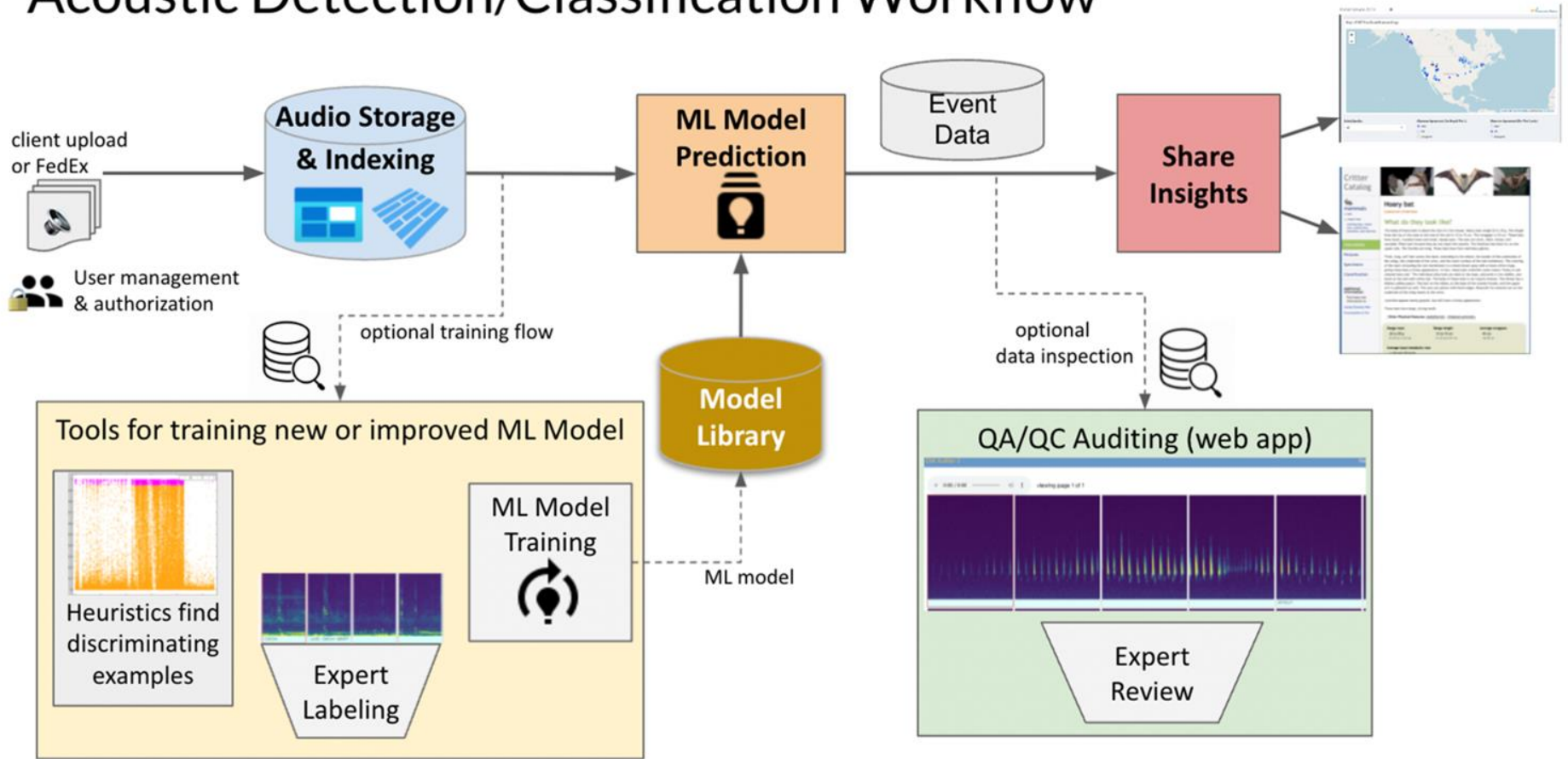
## Label Hotkeys

Label	Hotkey
0	Digit0 
Broadband_buz:	
Cascading_saw	
Cascading_wai:KeyC	
Cascading_wai:	

# ML - Model training, testing, tuning



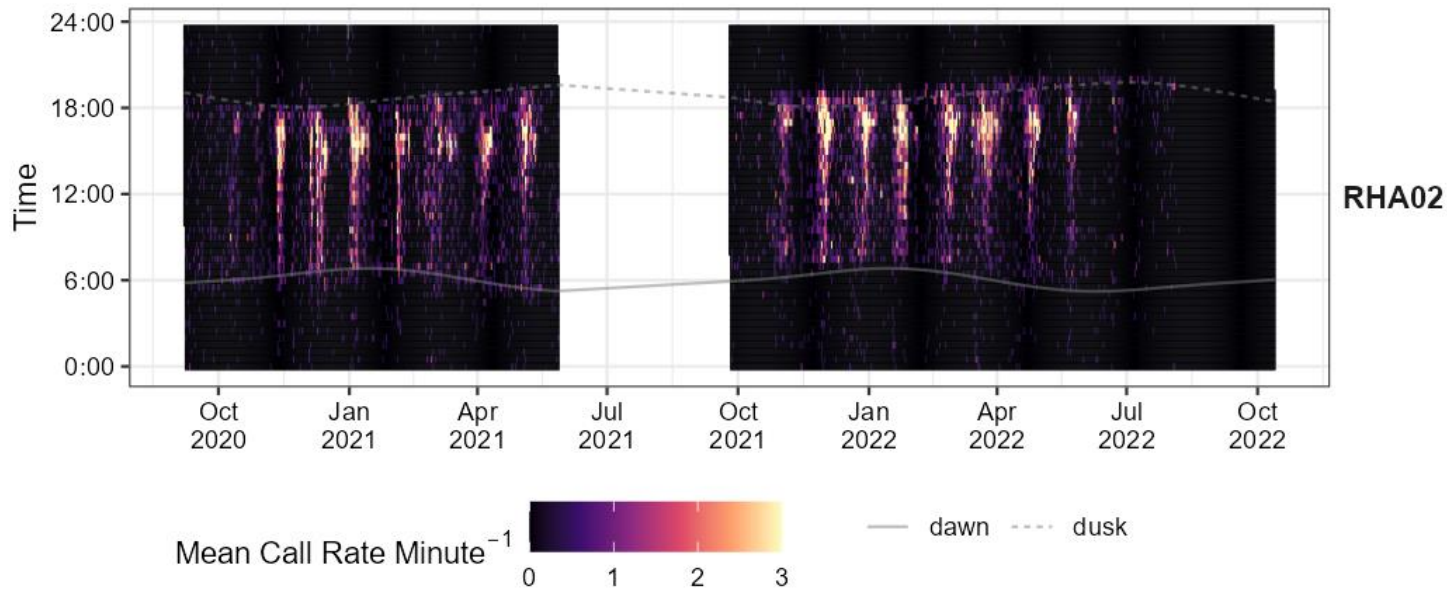
# Acoustic Detection/Classification Workflow





# Marine Soundscapes - starting in 2020

- Created new classification models with data from Florida, Palmyra, and HI
- Our approach leveraged a new google model - “Perch”

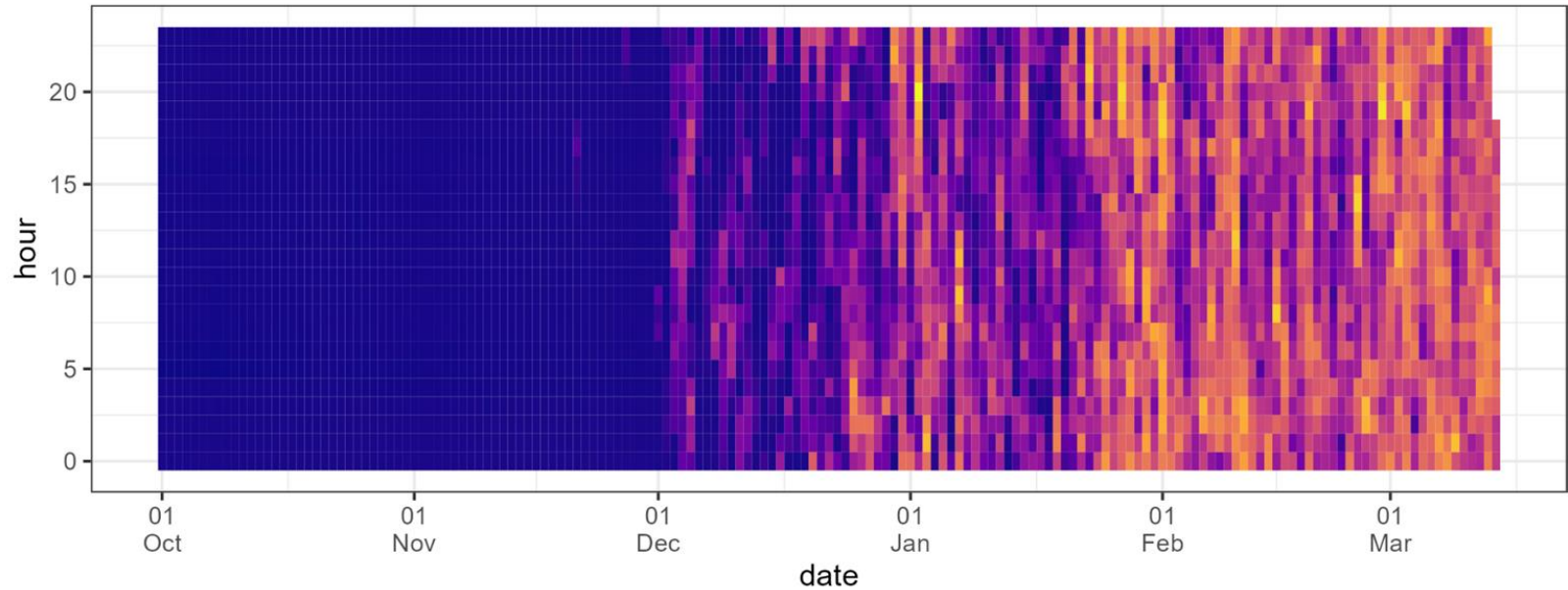


Example raster of grouper vocalizations in the Florida keys throughout the night and season

# Humpback Whale



NWHI

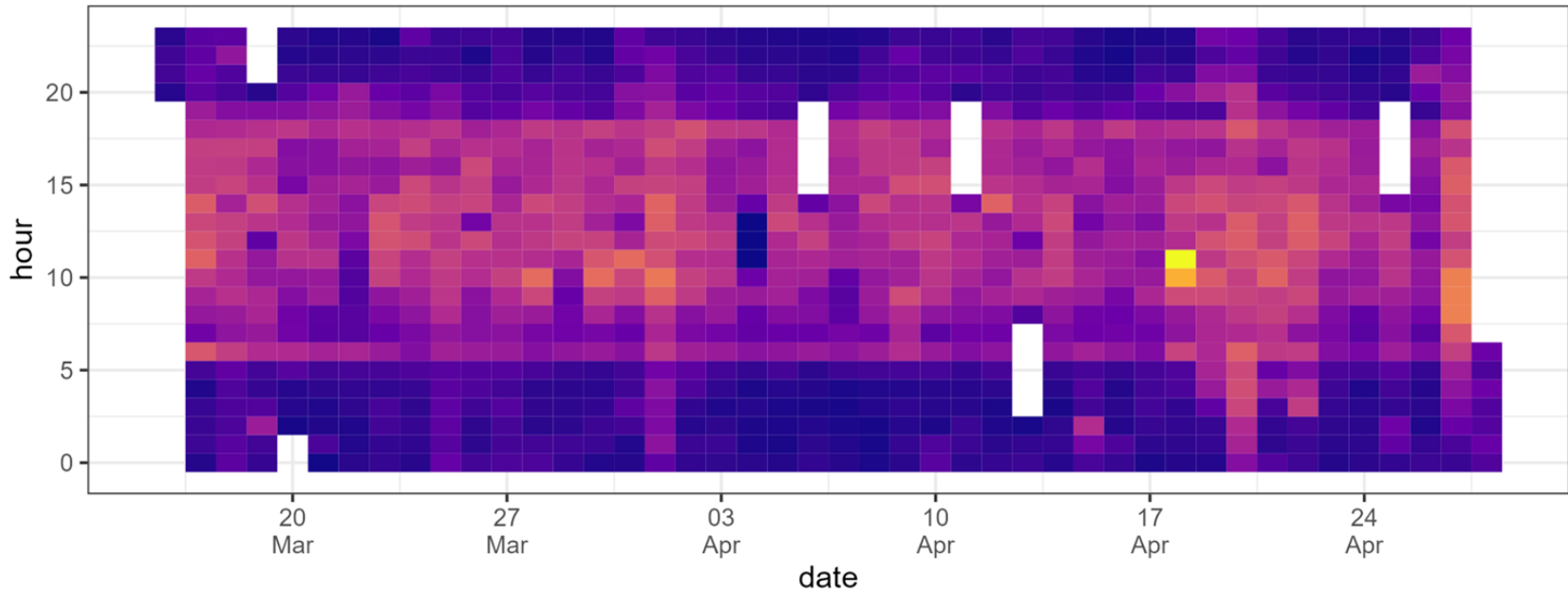


Mean Call Rate Minute<sup>-1</sup>


0 5 10 15

# Engine Activity - Ships and Boats

American Samoa

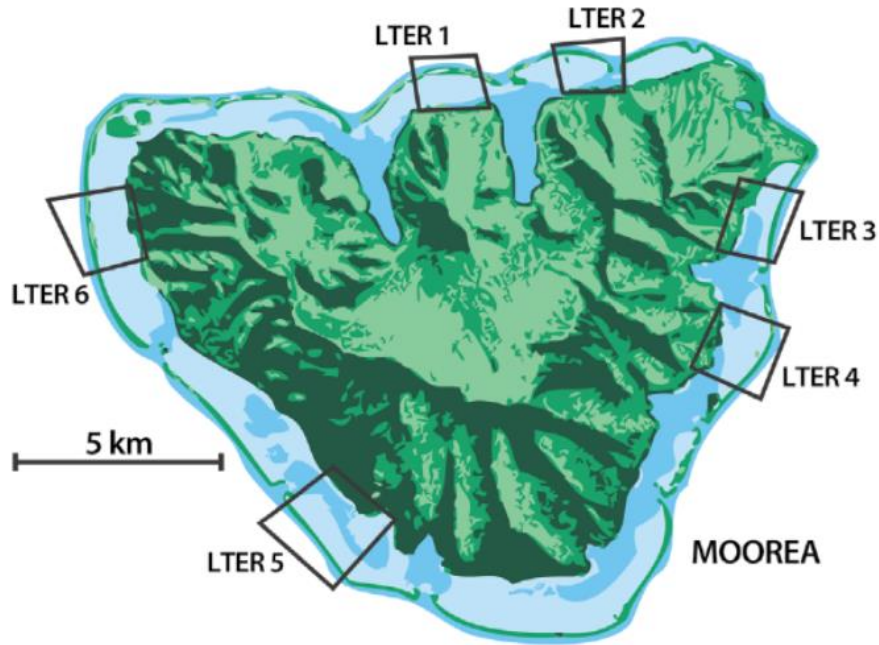


Mean Call Rate Minute<sup>-1</sup>

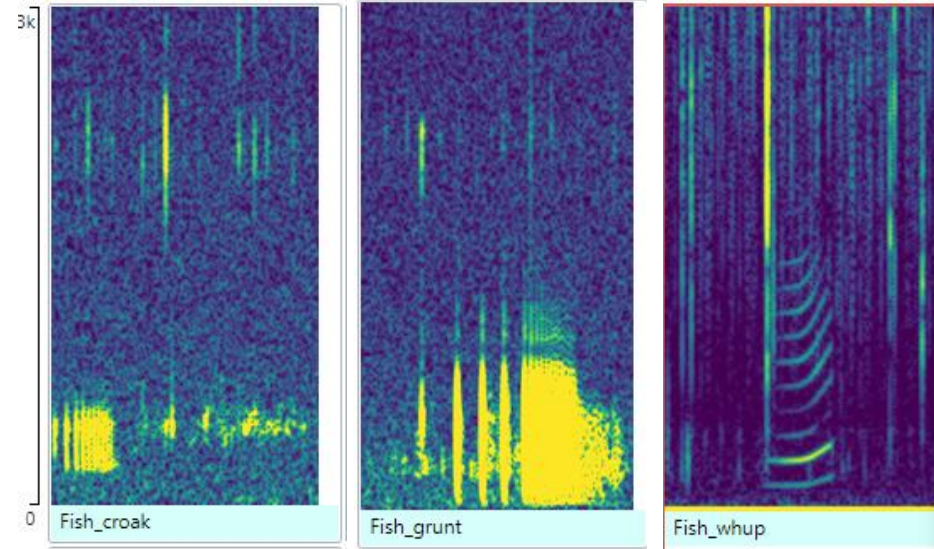


0 5 10 15

# Coral Reef Acoustic Monitoring - Moorea



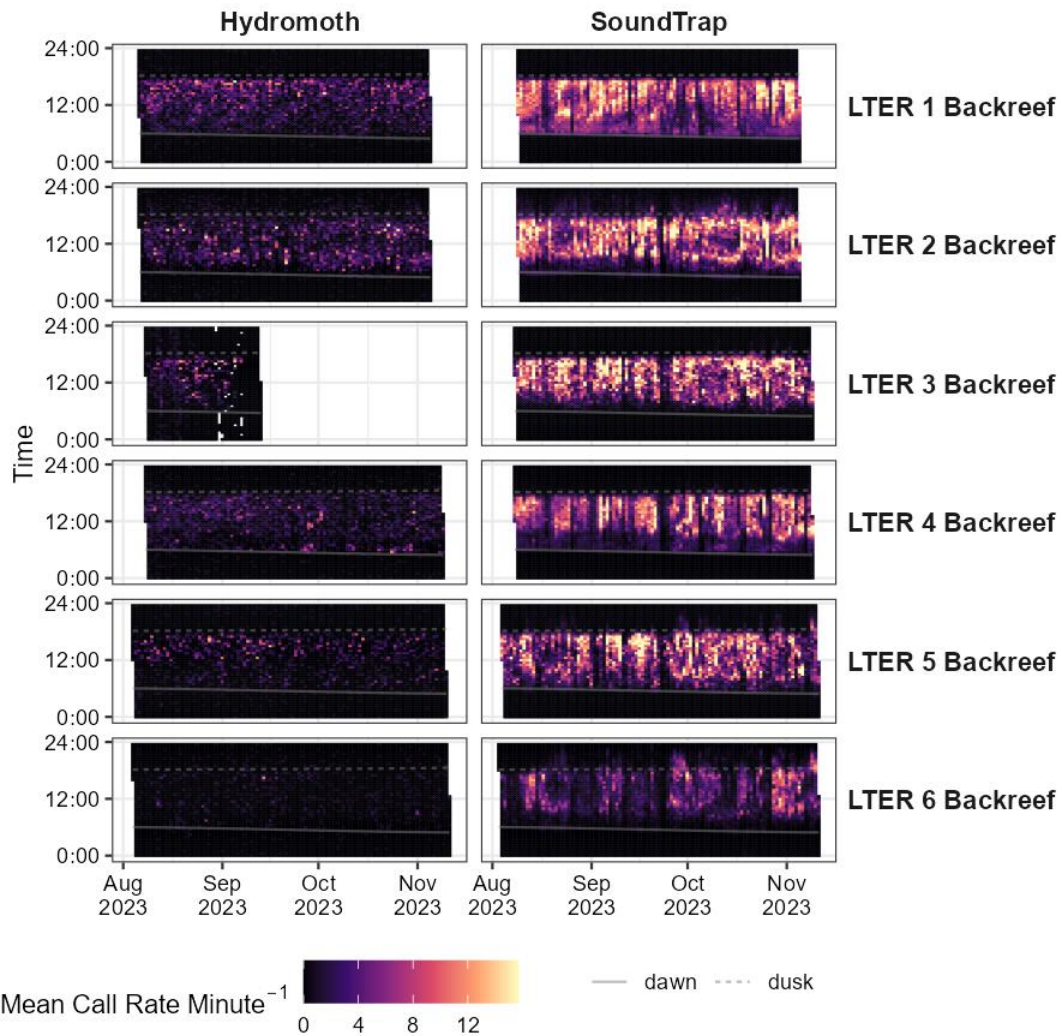
Many Unknown Signals



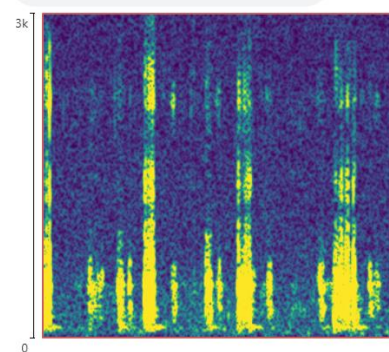




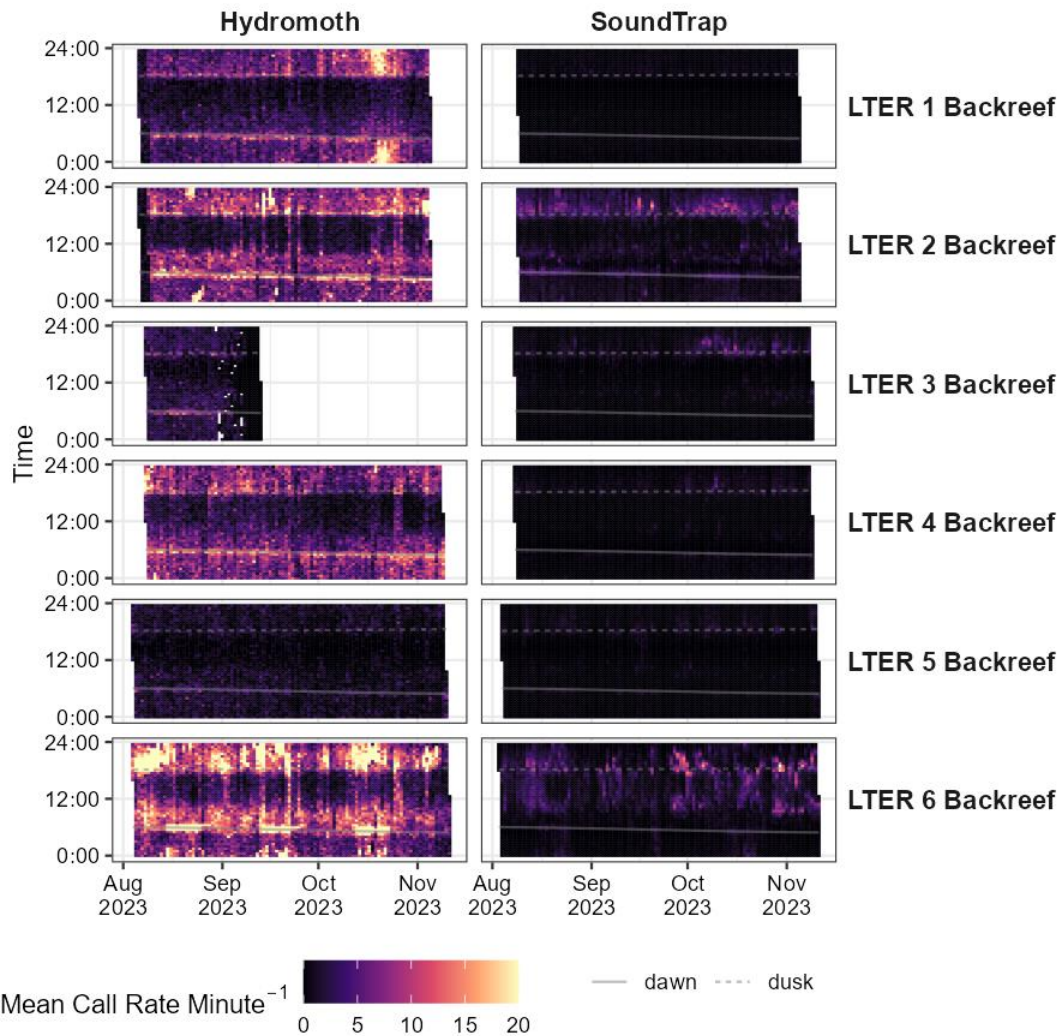




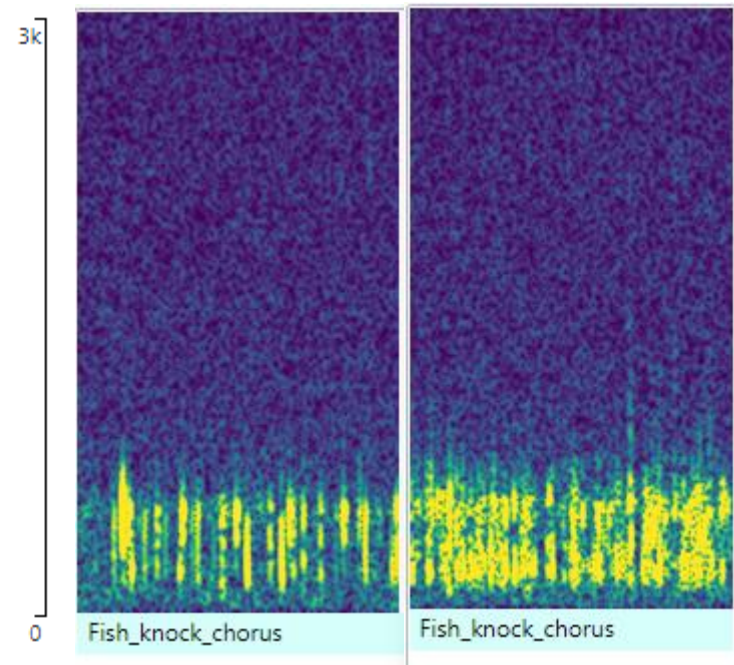
# Parrot Fish grazing



Credit: DJ Mattaar // Shutterstock



# Fish\_knock\_chorus

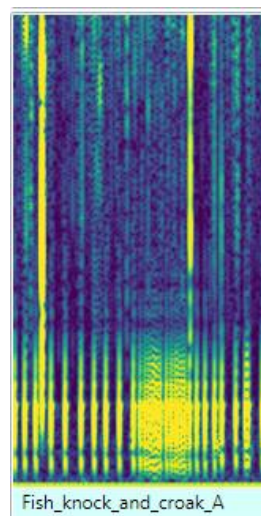
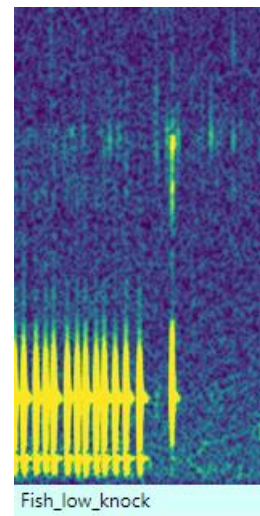
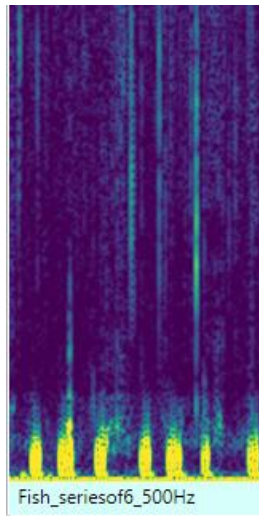


Angel Fish  
MCR LTER. CC  
BY-SA 4.0 -  
Credit: MCR  
LTER. CC BY-  
SA 4.0



# Challenges

- Unknown signal identification
- Naming conventions
- Improving ML models
- Putting things into production
  - Different recorders
  - Different soundscape
  - Different species



# Big Picture

- Data pipeline for marine acoustic recordings
  - Big Data capabilities
  - Repeatable automated workflows
  - Scalable
  - Long term monitoring
- We are excited about opportunities to collaborate!
- Please reach out with any questions!



Damselfish and their coral host (*Pocillopora eydouxi*). MCR LTER - Credit: MCR LTER

Thank You!

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