Ocean noise, prey unprofitability & reactive vessel management in the Salish Sea



Ruth Joy,
Assistant Professor in the
School of Environmental Science
October 29, 2026

Outline

RESEARCH THEMES

1. Unique dialects of killer whales
2. Deep Learning models for processing underwater sound
3. Citizen Scientists & Social Media
4. Improving Stochastic Movement Models (statistics)
5. Forecast systems of whale movement
6. Building the APIs to do this in near-real-time (H.A.L.L.O.)

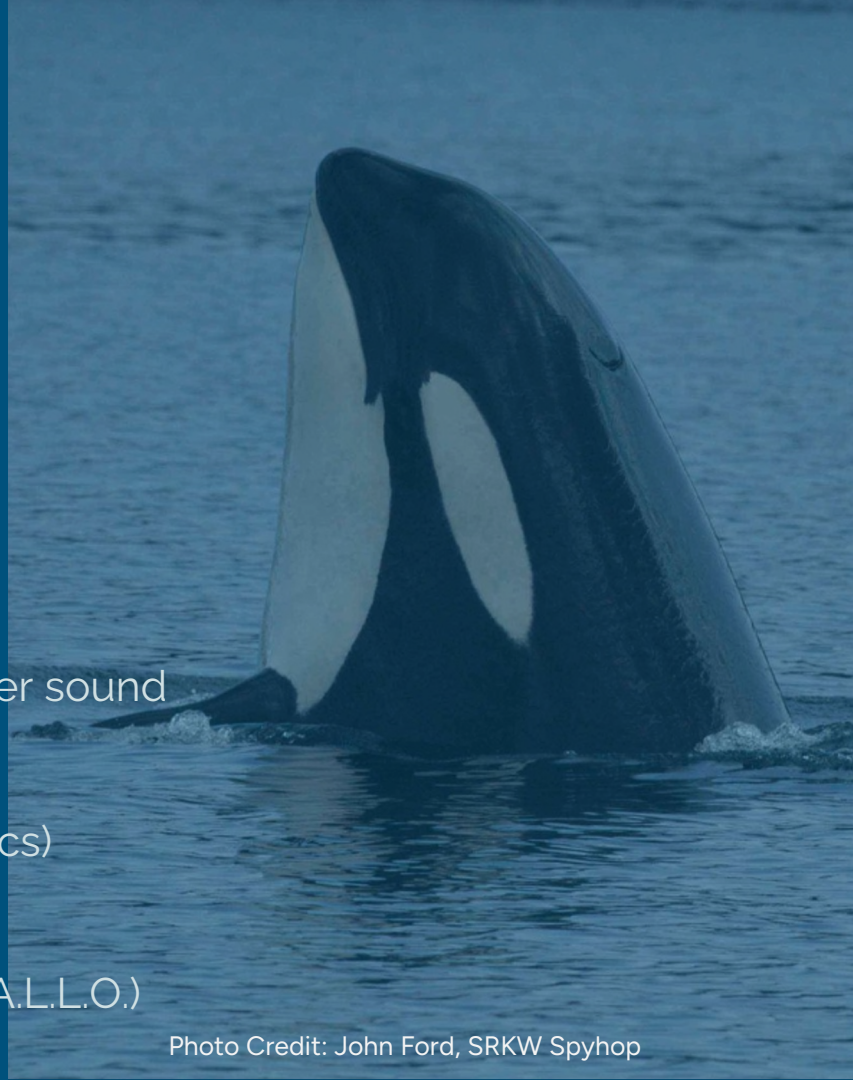


Photo Credit: John Ford, SRKW Spyhop

One species. Different cultures.

Resident Ecotype

Transient (Biggs) Ecotype

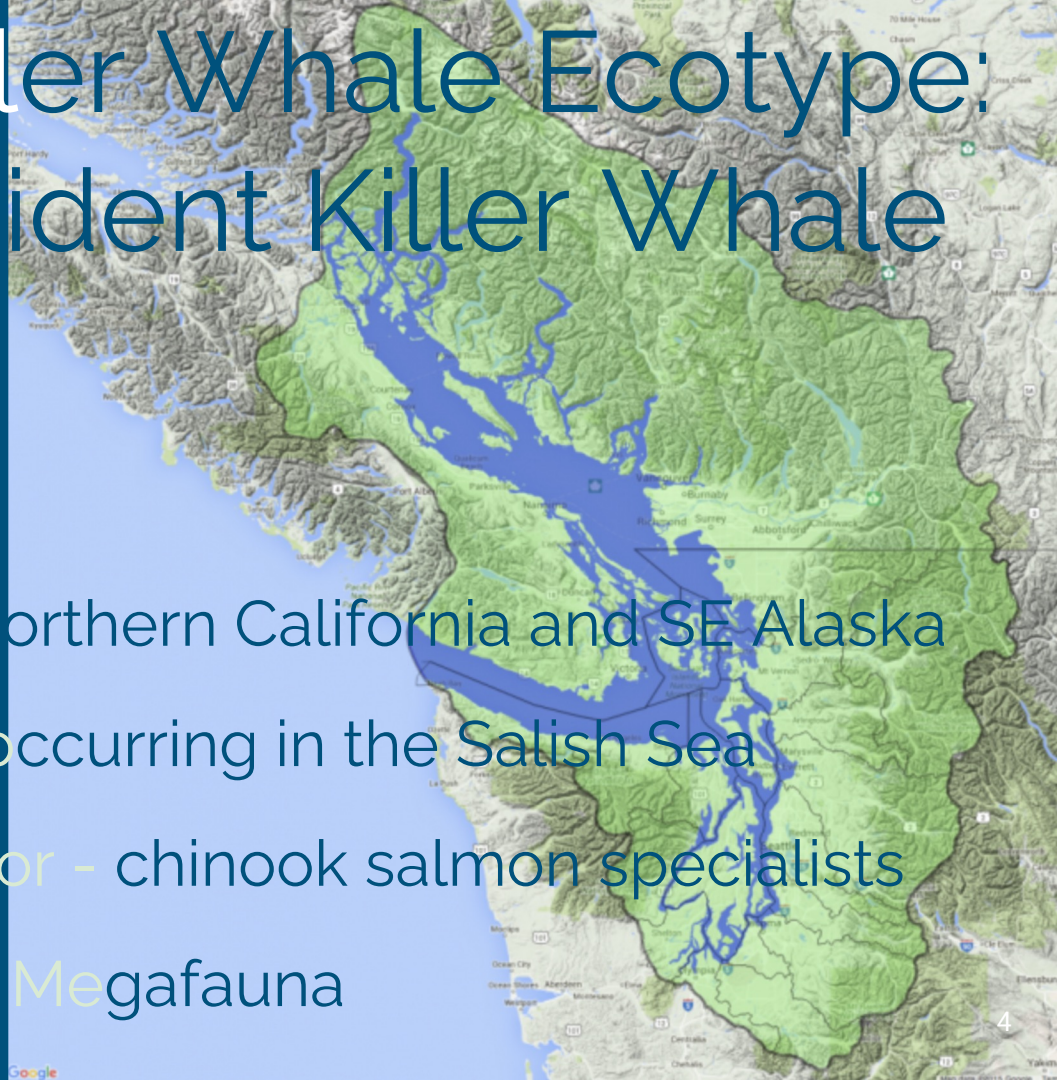
Offshore Ecotype



Killer Whale Clans

Different prey. Unique linguistics.

Endangered Killer Whale Ecotype: Southern Resident Killer Whale



Southern: Ranges from Northern California and SE Alaska

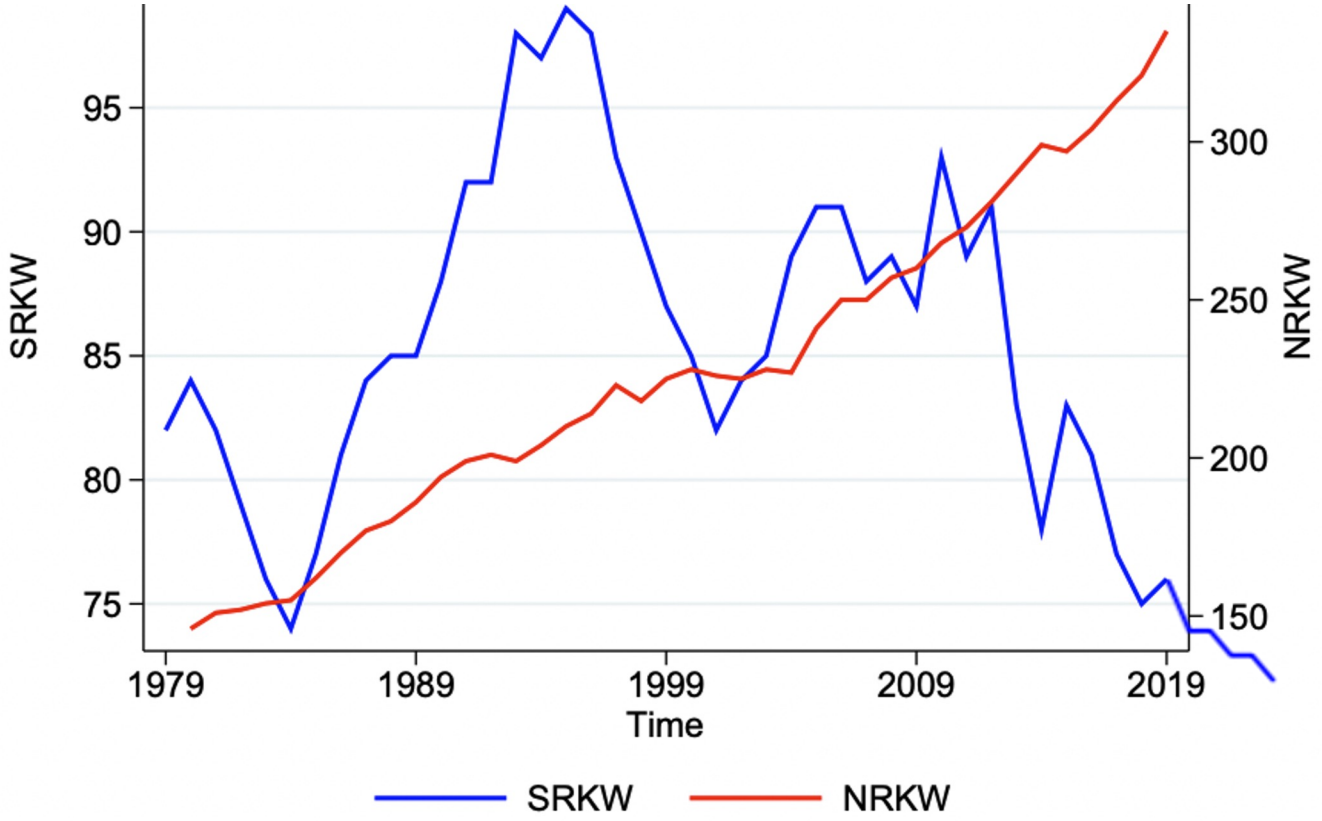
Resident: Historically re-occurring in the Salish Sea

Killer: Apex predator - chinook salmon specialists

Whale: Charismatic Megafauna

25% SRKW population decline in 25 years

In 28 years, underwater noise in the Salish Sea increased by 50%



From Taylor and Mayer 2023

Bioenergetics of SRKW & noise

The impacts of underwater noise on SRKW energy intake:

Males miss, females forego.

Tennessen et al. 2024

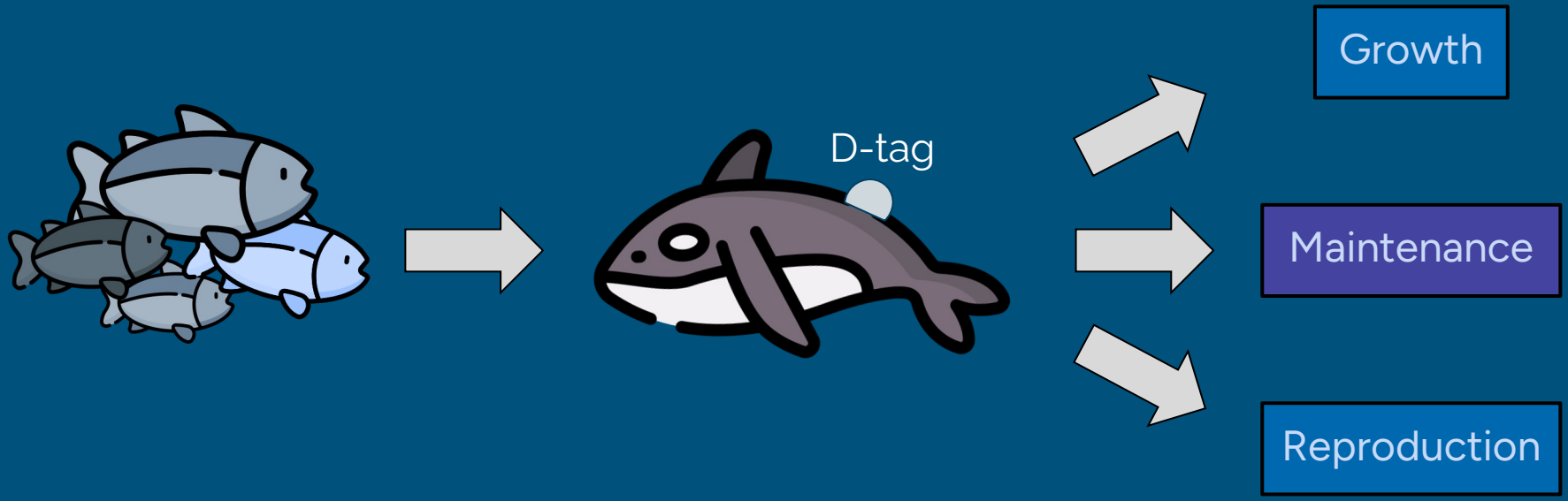


MSc Student
Janine McNeilly

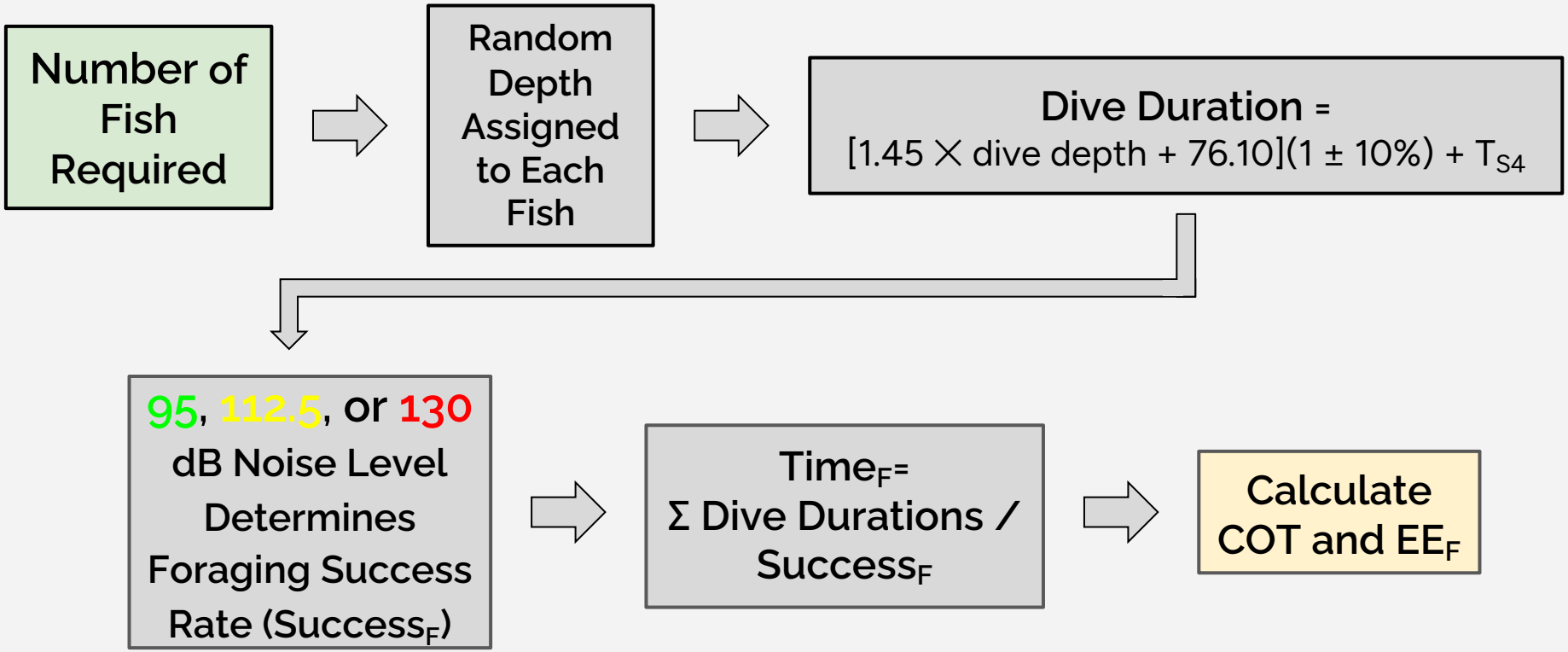
In Review: Conservation Physiology

J Pod in the Pender VRZ on 2025/10/23.
Photo taken by MSc student Janine McNeilly

A Basic Bioenergetics Model



Energy Expended While Foraging



In noisy environments, males miss & females forego

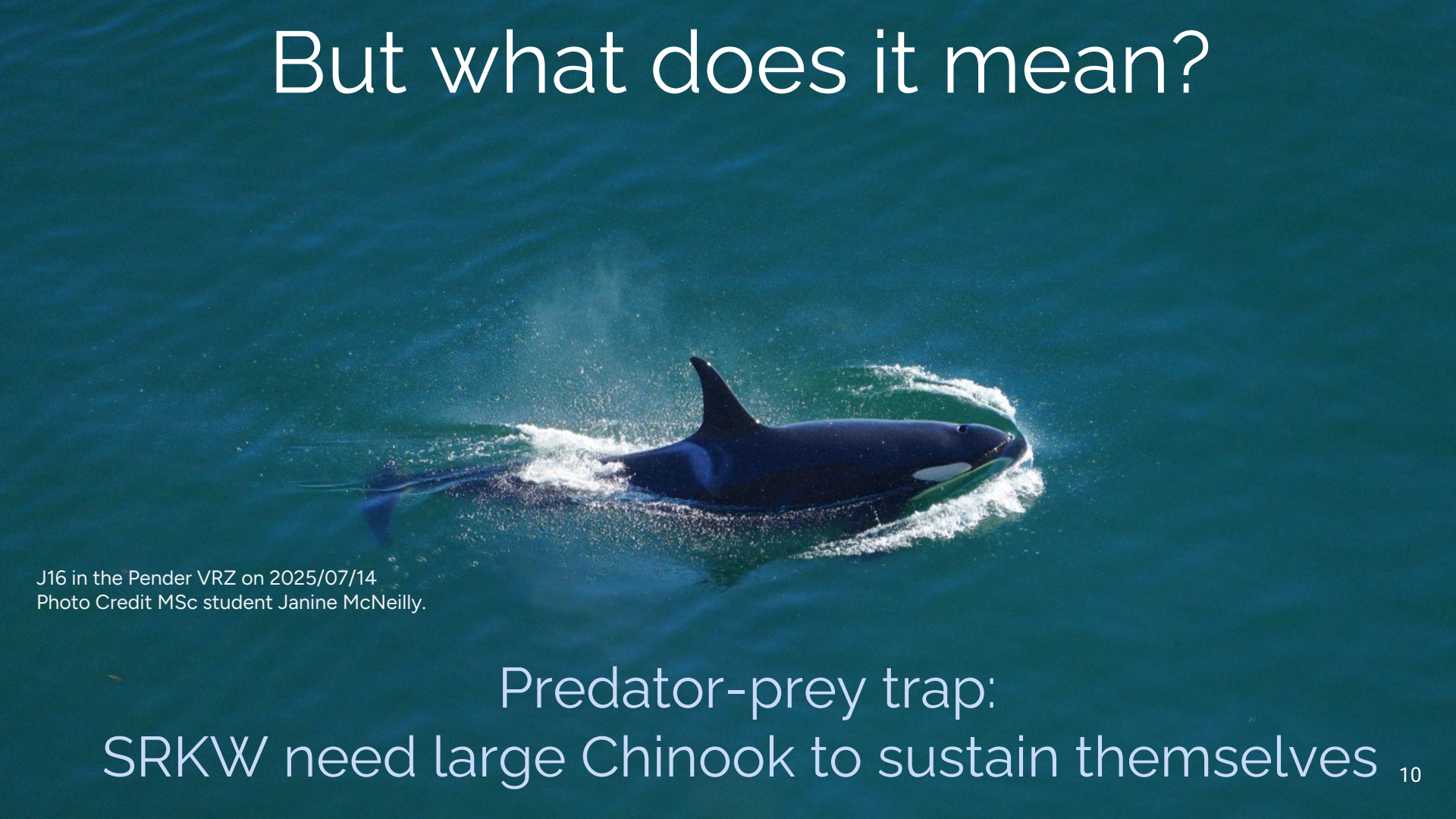


(Tennessen et al. 2024)

Auditory masking:

Whales have difficulty receiving information about where food is, and they spend more time & energy searching for fish, and find fewer.

But what does it mean?



J16 in the Pender VRZ on 2025/07/14
Photo Credit MSc student Janine McNeilly.

Predator-prey trap:
SRKW need large Chinook to sustain themselves

Calculating noise exposure levels

95 dB | 112.5 dB | 130 dB





Marine biologist Lauren Laturnus is watching vessel traffic in the Salish Sea, from East Point on Saturna Island, B.C. Her work is part of a multi-year Simon Fraser University pilot project called the Human and Algorithms Listening for Orcas (HALLO) project. (Dillon Hodgin/CBC, Scot Northern)



EVSC MSc Student
Neil Saxvik

with Straitwatch

BISC MSc Student
Lauren Laturnus

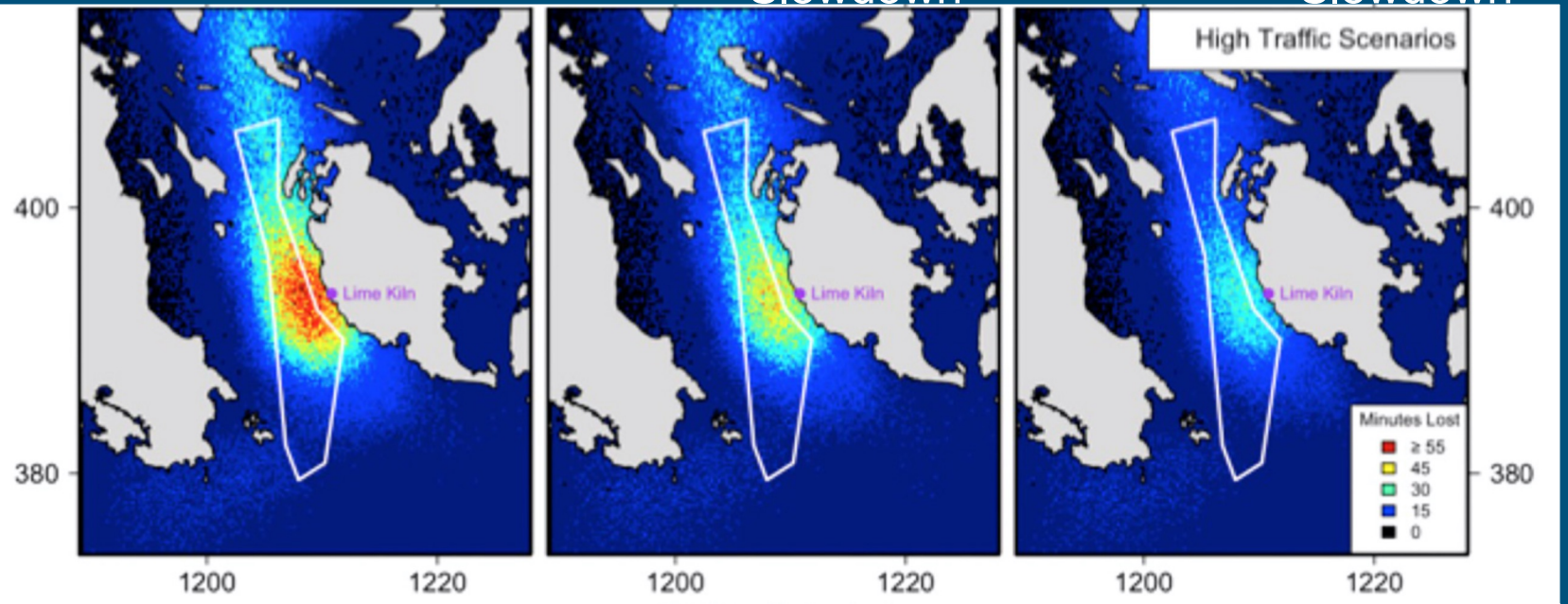
at East Point

Management: Reduce noise exposure

Baseline Speed

28% less lost foraging time
Volunteer
Slowdown

40% less lost foraging time
Compulsory
Slowdown



Joy et al. 2018



Outline of Steps to Building an Operational Forecasting System for whale movement

Near real-time Observations (finding whales)

Stochastic Movement Model

Observation Model Synthesis

Operational Forecast System

Forecasting System because it takes 2+ hr to slow a huge cruise ship or commercial ship down!

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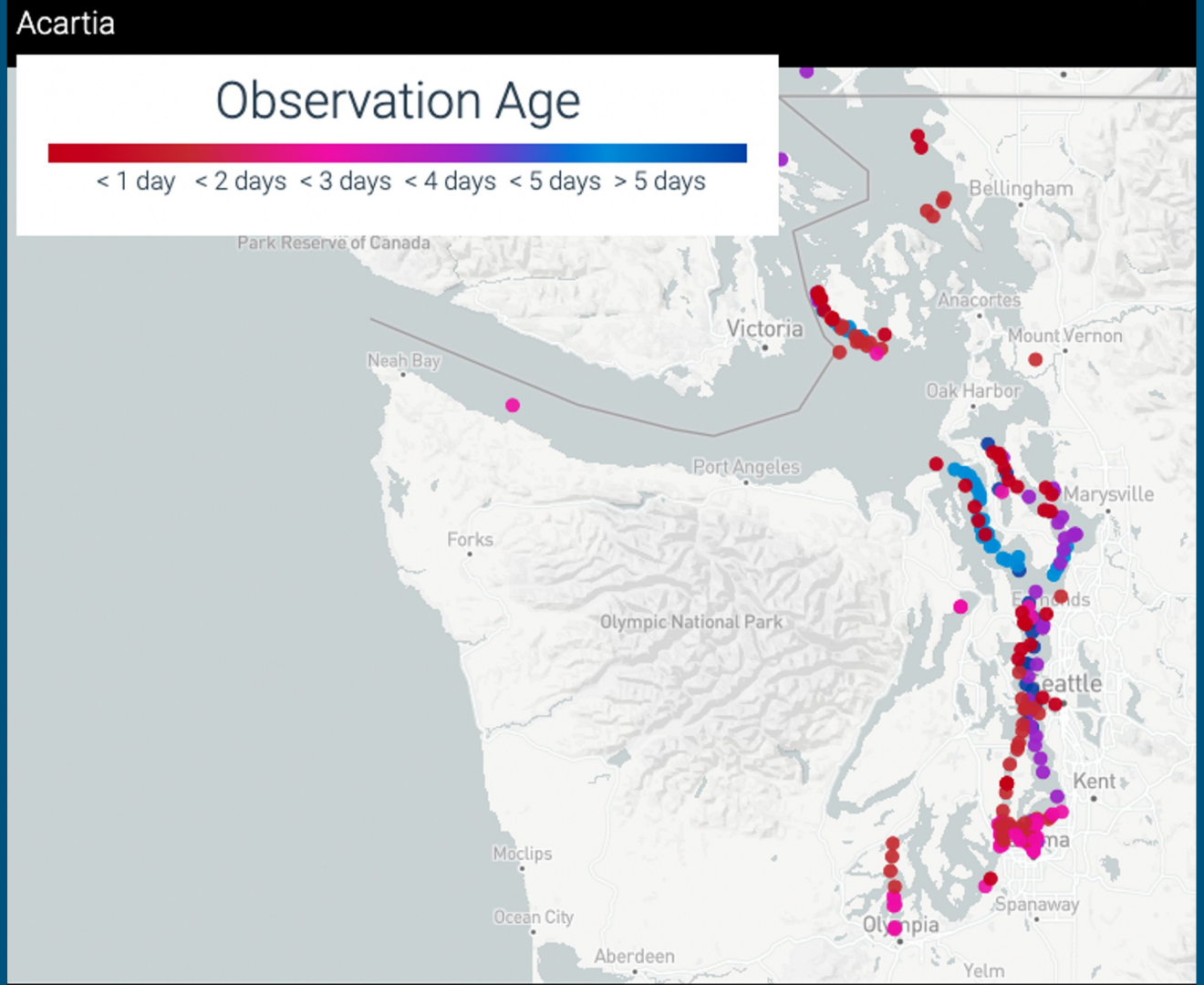
Near real-time Observations*** (finding whales)

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***When tagging these whales is not allowed!

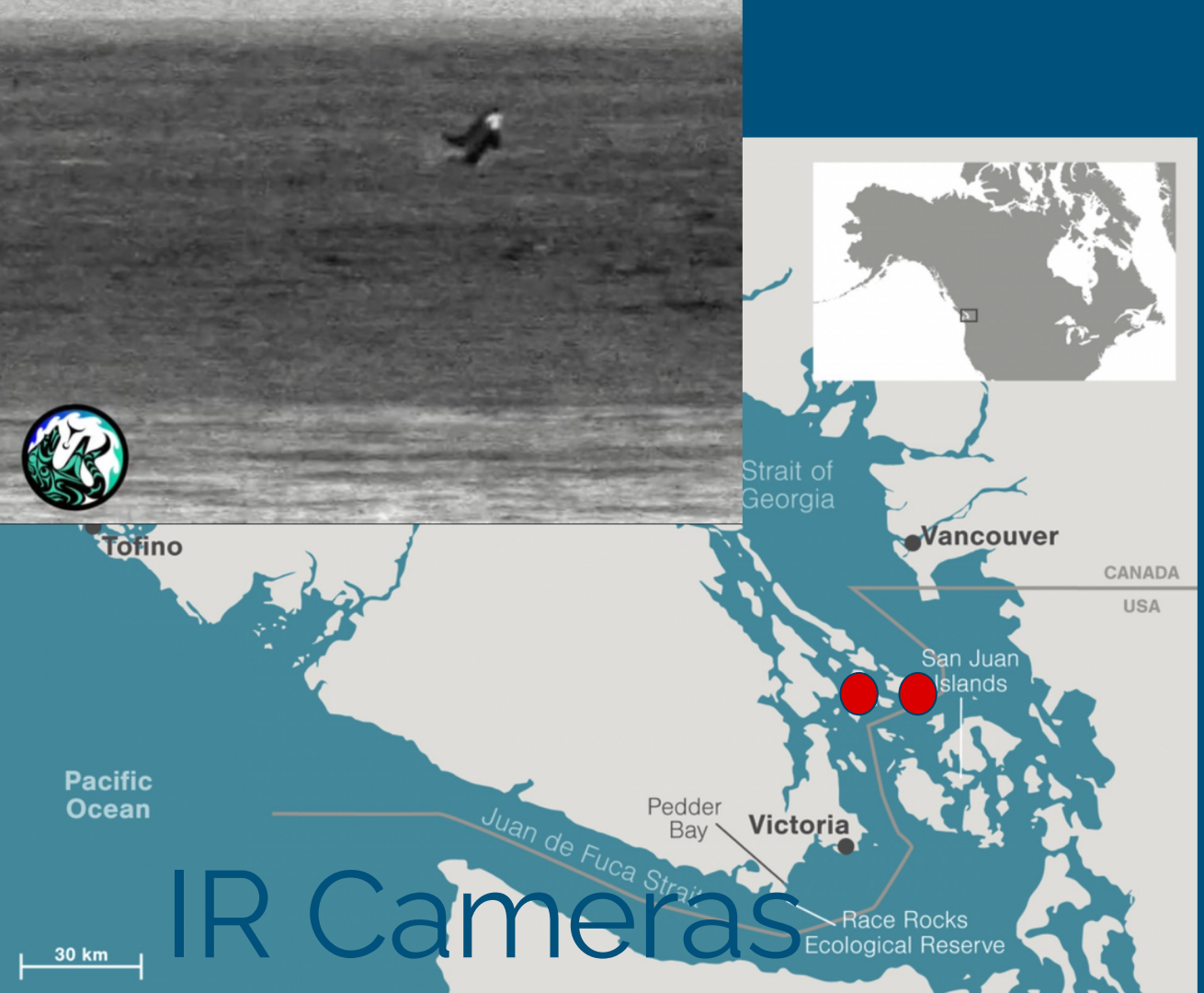


New Data Sources

Building bots to scrape social media from community science posts

New Data Sources

CNN-based models from real-time Infrared cameras along shipping routes



IR Cameras



How to find more whales?

Listen Underwater!

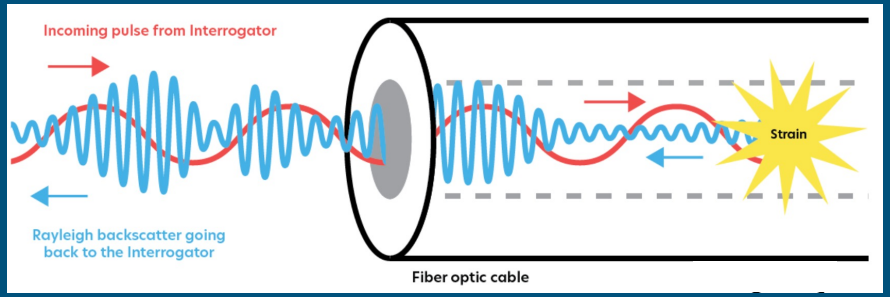
Hydrophones collect real-time '*observation*' data

Hydrophone deployed at Salmon Bank, off San Juan Island
Photo credit: Jason Wood, SMRU Consulting Ltd



Digital Acoustic Sensing on the VENUS data fibres

Interrogator detects & localizes sound sources

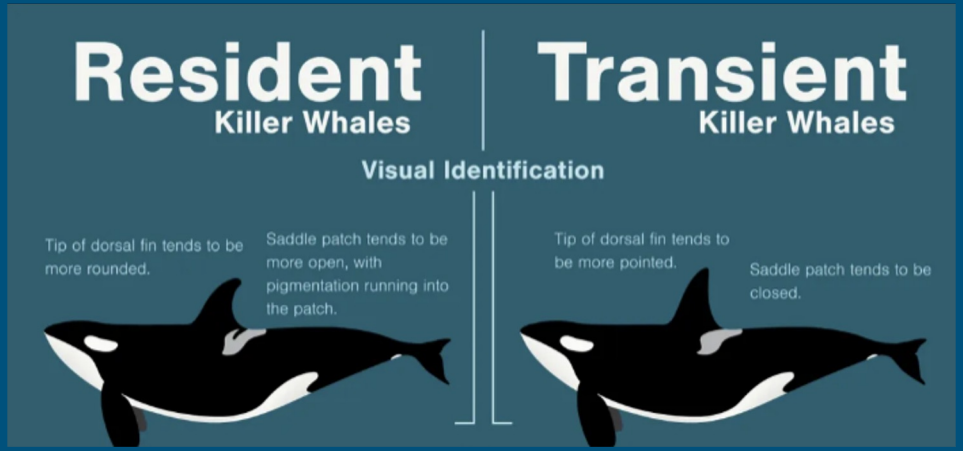


*Starting with humpback whales



Data collection,
call annotation,
model training and testing
to detect
Southern Resident killer whales

Harnessing Deep Learning (CNNs) to detect and classify different dialects of killer whales (at different hydrophones)



Southern Residents
West Coast Transients,
White-sided Dolphins &
Humpback Whales,
Propeller noises,....

nature > scientific data > data descriptors > article

Data Descriptor | Open access | Published: 03 July 2025

A Public Dataset of Annotated Orcinus orca Acoustic Signals for Detection and Ecotype Classification

K. J. Palmer, Emma Cummings, Michael G. Dowd, Kait Frasier, Fabio Frazao, Alex Harris, April Houweling, Jasper Kanes, Oliver S. Kirsebom, Holger Klinck, Holly LeBlond, Lauren Laturnus, Craig Matkin, Olivia Murphy, Hannah Myers, Dan Olsen, Caitlin O'Neill, Bruno Padovese, James Pilkington, Lucy Quayle, Amalis Riera Vuibert, Krista Trounce, Svein Vagle, Scott Veirs, Val Veirs, Jen Wladichuk, Jason Wood, Tina Yack, Harald Yurk & Ruth Joy

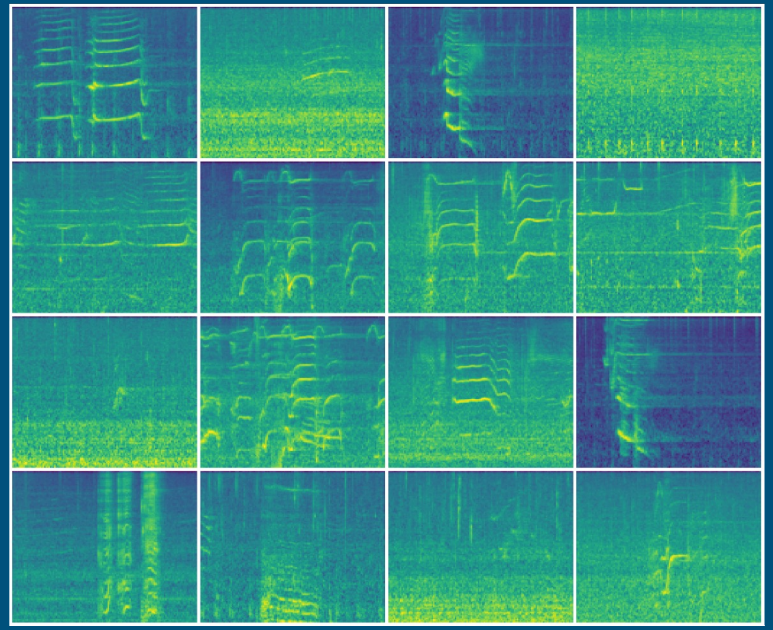
Former Postdoc
Kait Palmer



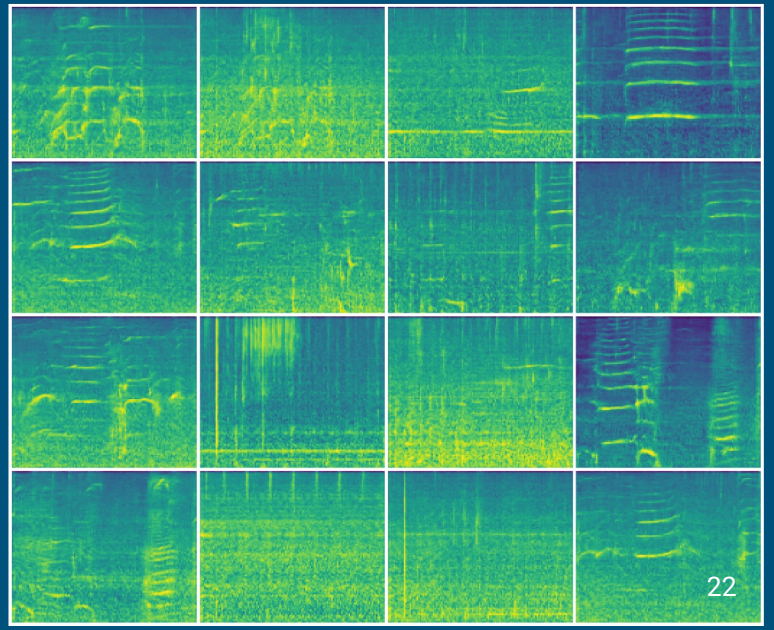
Published: Nature Scientific Data

Data Augmentation (generative A.I.) methods for overcoming data sparcity, training models and transferring to new locations using synthetically generated annotations

Original Pulsed calls



Synthetically Generated



Bruno Padovese
PostDoc Fellow

Published.

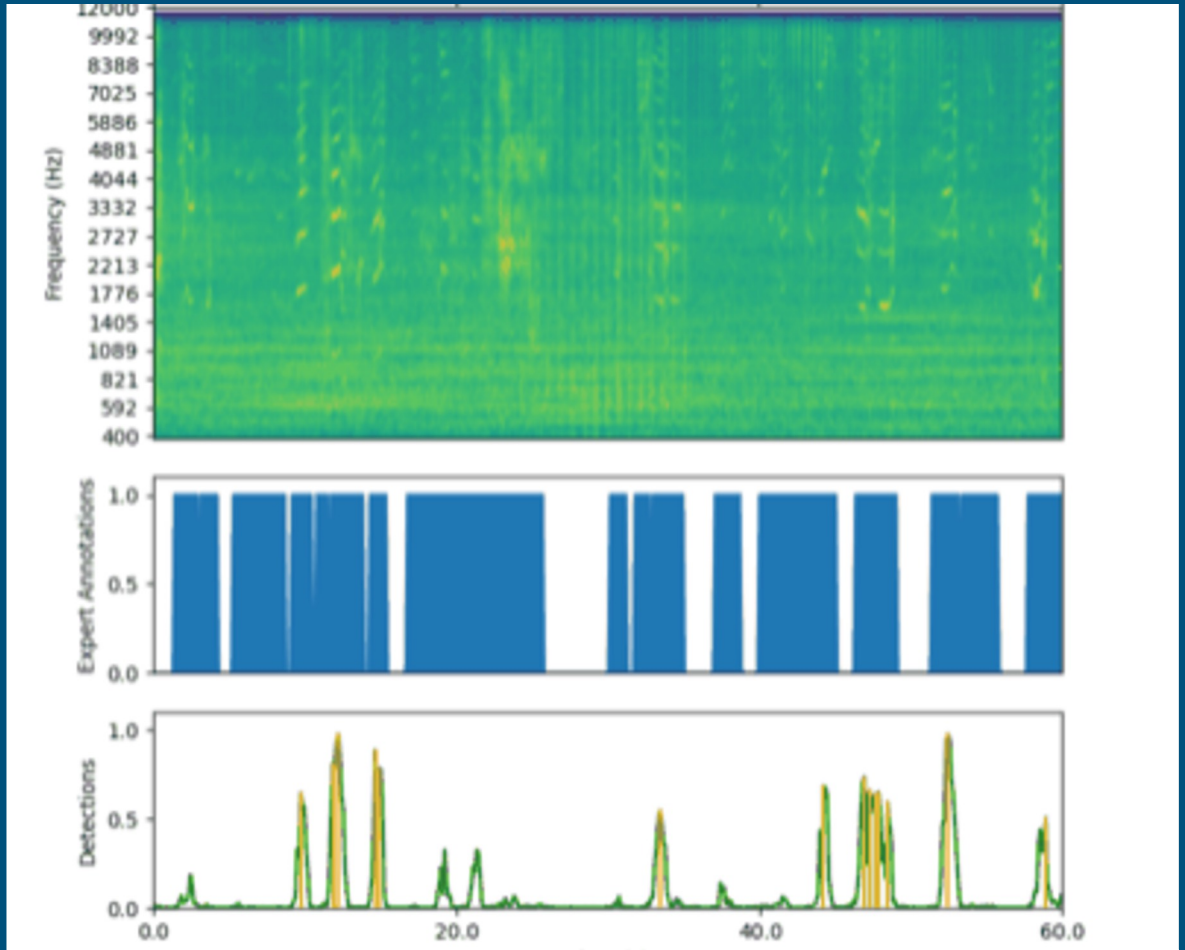


PhD student
Fabio Frazao



Deep Learning: Sequence Networks (RNNs)

Uses a sequence deep learning model to include acoustic context in a killer whale detector



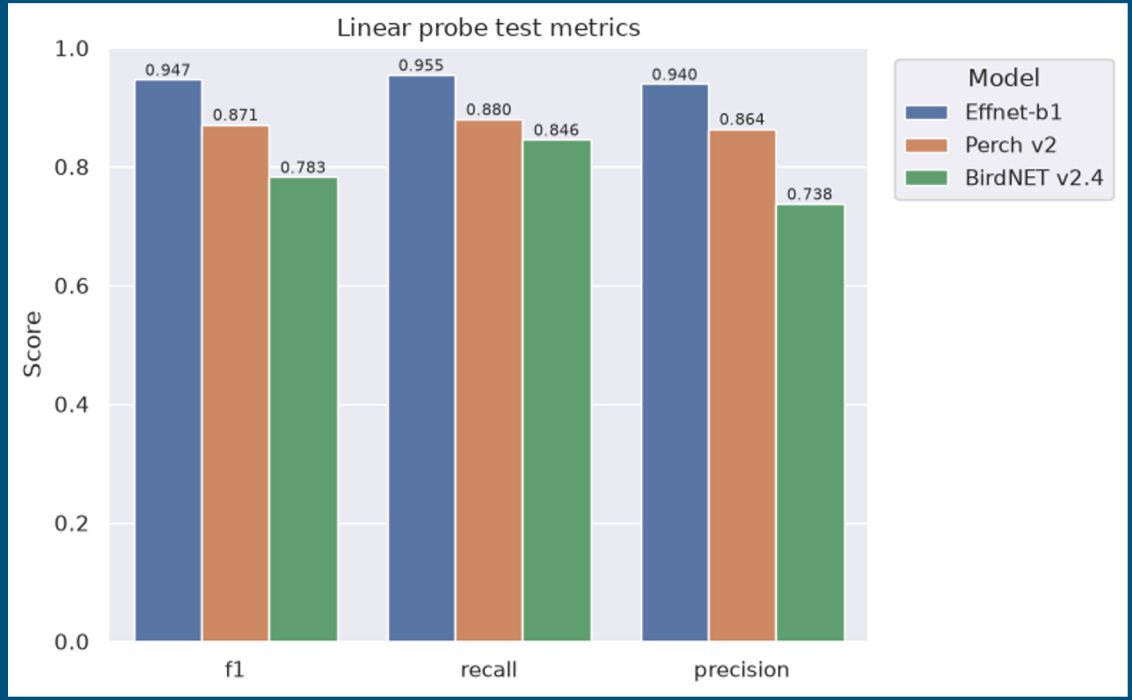
1 minute recording
Input to detector

Human Annotations
(Pulsed Calls)

Output of detector

Fully Supervised Outperforms Foundation Models

- The fully supervised Efficientnet-b1 model outperforms both Perch and Birdnet
- Self-supervised learning





Noah Barrett
PhD student
Computer Science

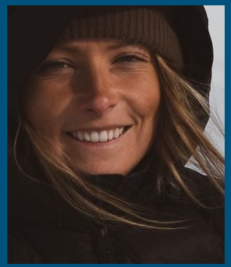
Instead of focusing on pulsed calls, what about looking at echolocation clicks?

Machine Learning Approaches for Automated Classification of Southern Resident Killer Whale Echolocation Clicks in the Salish Sea: Lasso Regression or Ensemble Tree-Based Methods?

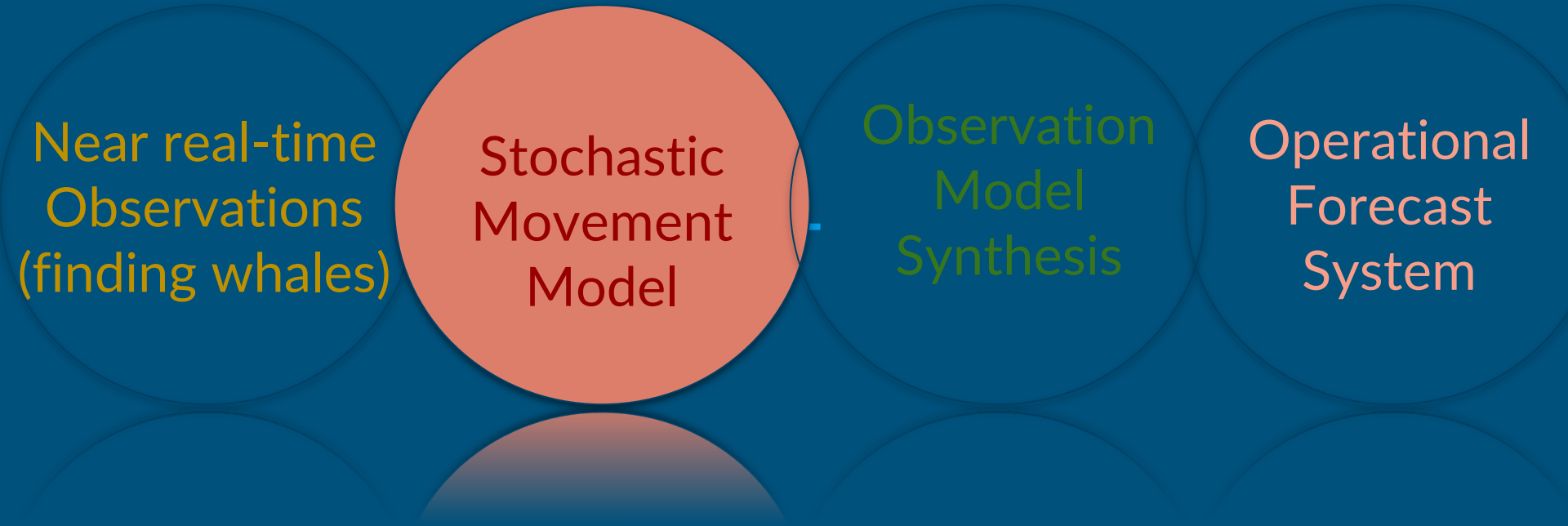
by

April Houweling

April Houweling
MSc student
Paper In Revision in JASA

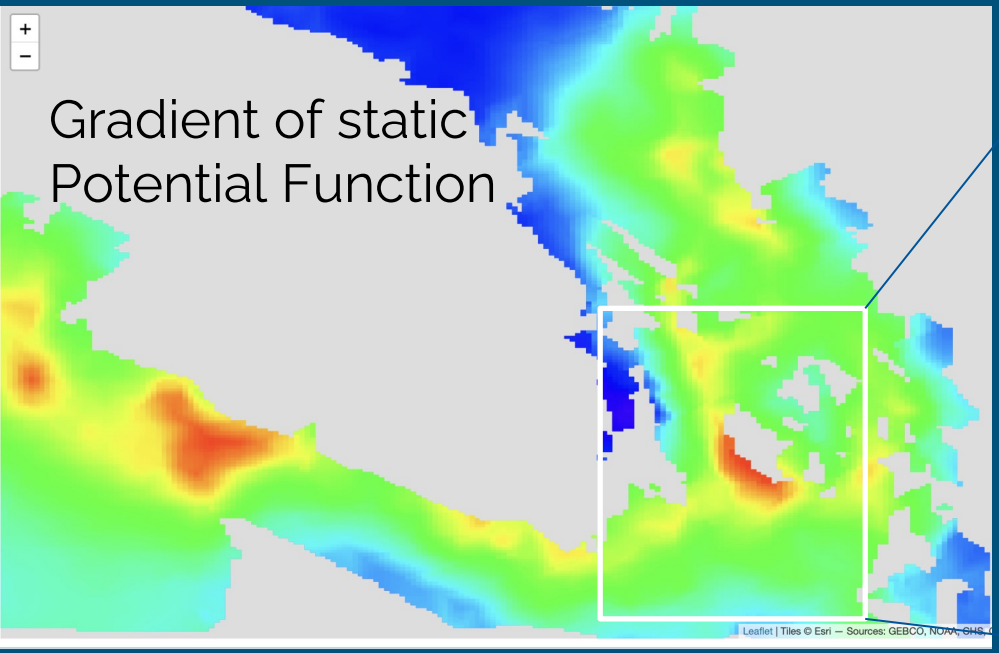


Outline of Steps to Building an Operational Forecasting System for whale movement



REAL-TIME Data ⇒ REAL-Time Forecasting Of SRKW Movement.

MSc Student
Teng-Wei Lin





We formulate CRW models … in cartesian coords

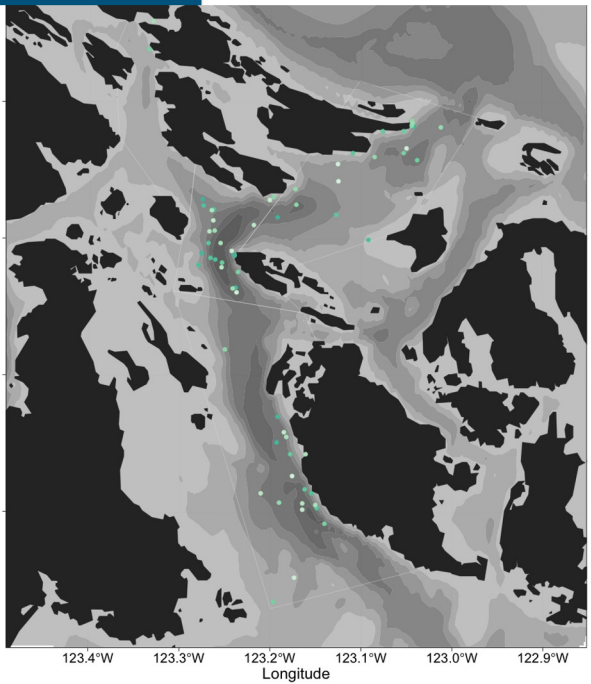
$$v_t = (1 - \alpha_t)\,\mu_t + \alpha_t\, v_{t-\Delta} + w_t$$

Whale

Drift or (Potential Function)

Time Step (Continuous OU)

Stochastic Forcing

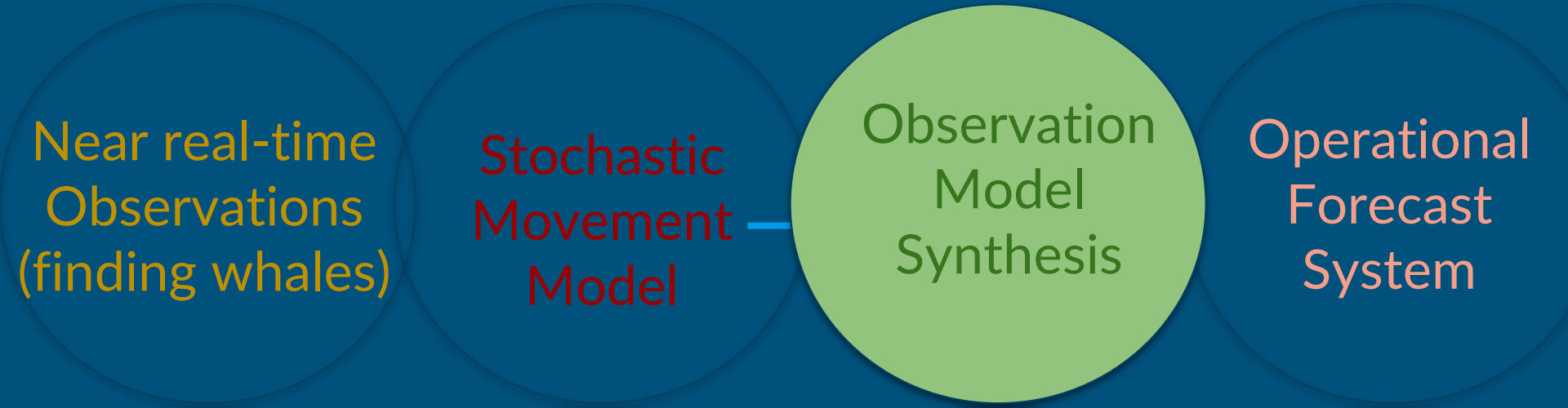


… in polar coords

$$v_t = \alpha_t\, v_{t-\Delta} + w_t$$

Bivariate AR(1) model for velocity & direction

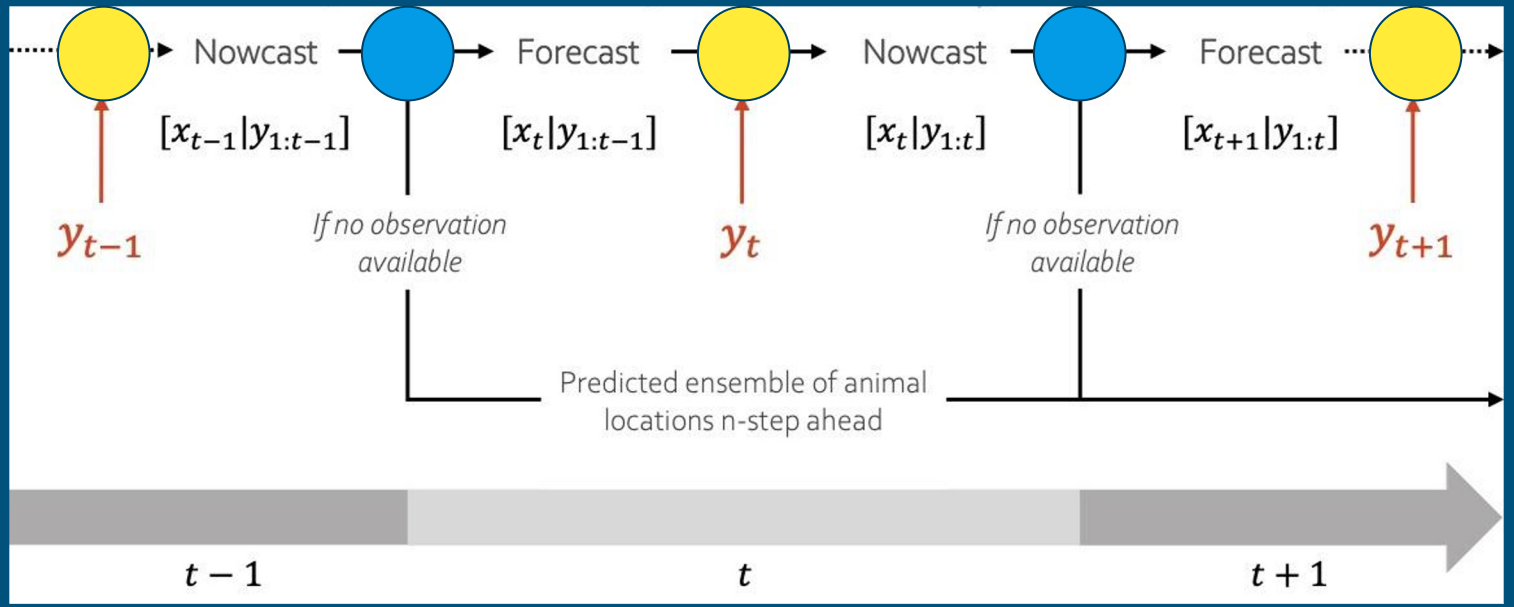
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Synthesis of observations with movement model (state space model)

The State Space Data Assimilation Framework

Short term forecasting using a pMCMC



Outline of Steps to Building an Operational Forecasting System for whale movement

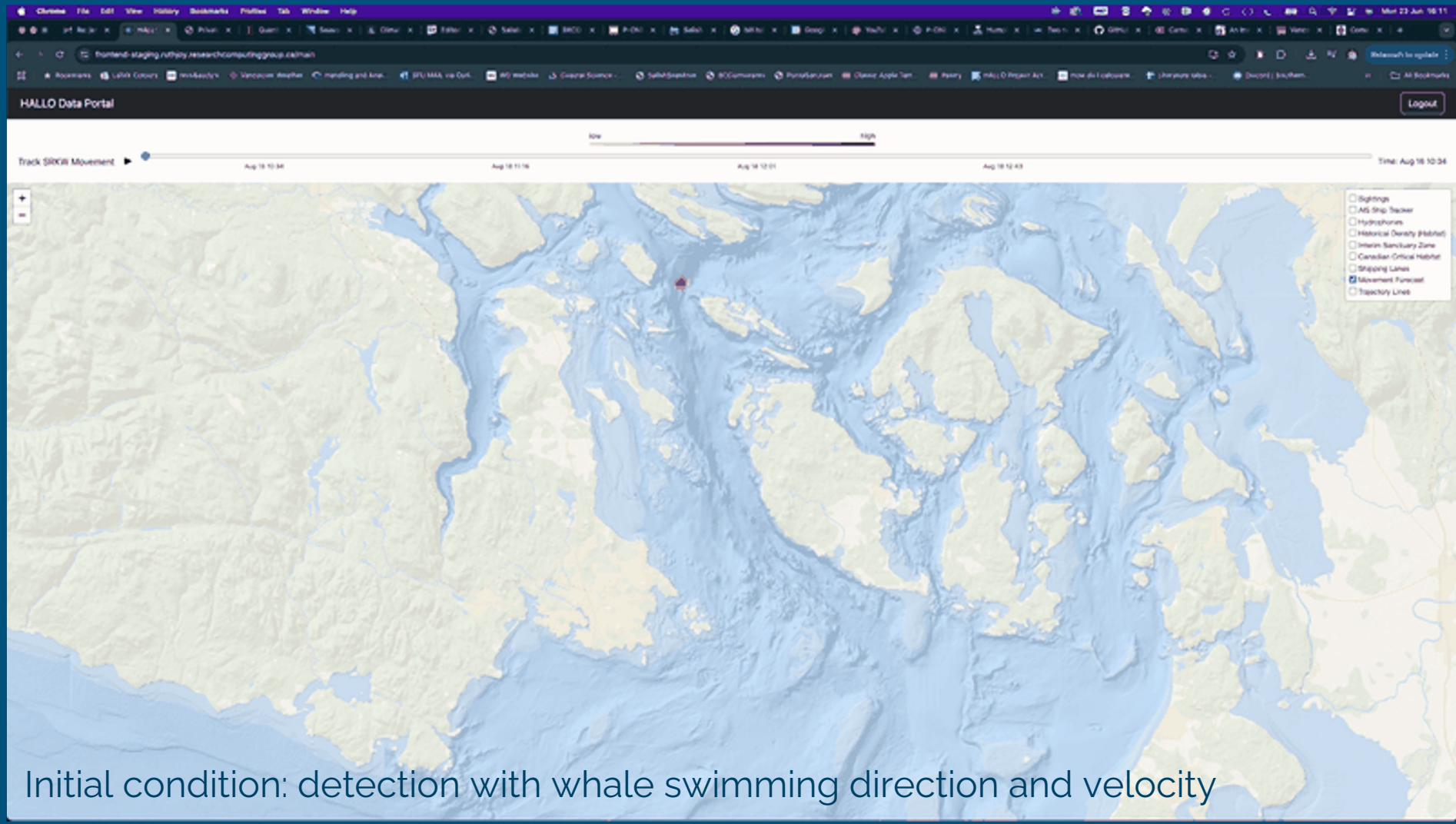
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Initial condition: detection with whale swimming direction and velocity





Thank You to all the f**ORCA**sters!!

Artwork by James P. Johnson (Tlingit)