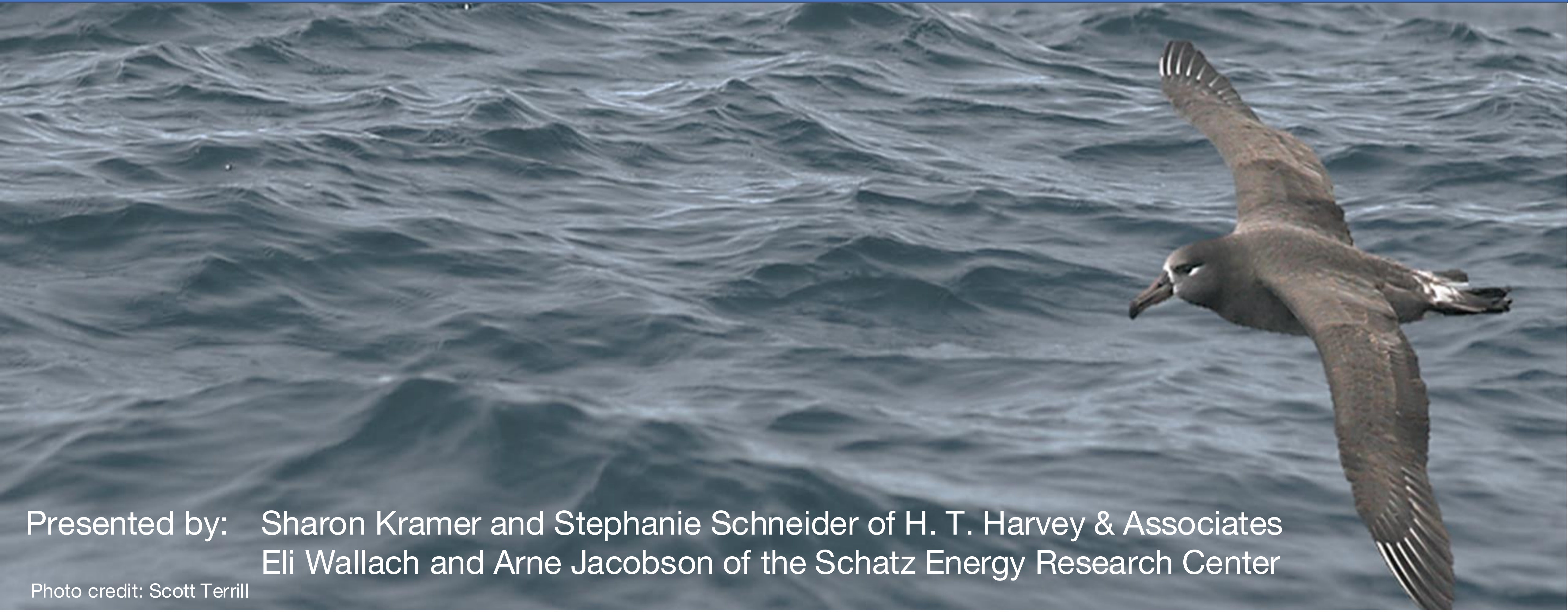
Seabirds in 3D: A New Framework For Assessing Collision Vulnerability With Floating Offshore Wind Developments



Presented by: Sharon Kramer and Stephanie Schneider of H. T. Harvey & Associates
Eli Wallach and Arne Jacobson of the Schatz Energy Research Center

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Seabirds in 3D: A New Framework For Assessing Collision Vulnerability With Floating Offshore Wind Developments

PACIFIC OFFSHORE WIND CONSORTIUM

Webinar Series

Presented by: Sharon Kramer and Stephanie Schneider of H. T. Harvey & Associates
Eli Wallach and Arne Jacobson of the Schatz Energy Research Center

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Pacific Offshore Wind Consortium Core Member Organizations

(shown from north to south)

PMEC
Pacific Marine Energy Center

Oregon State University

Schatz Energy Research Center

Cal Poly Humboldt.

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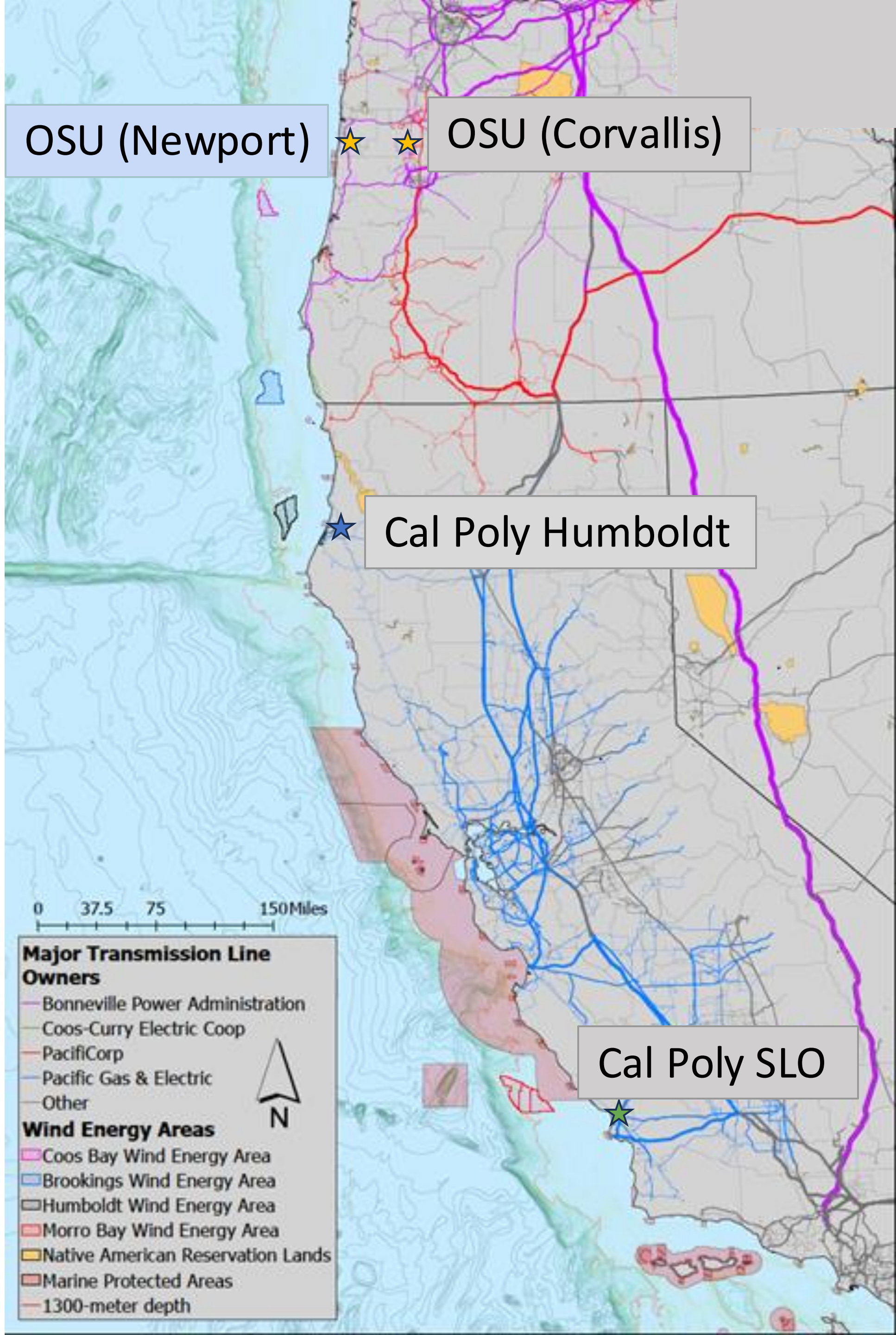

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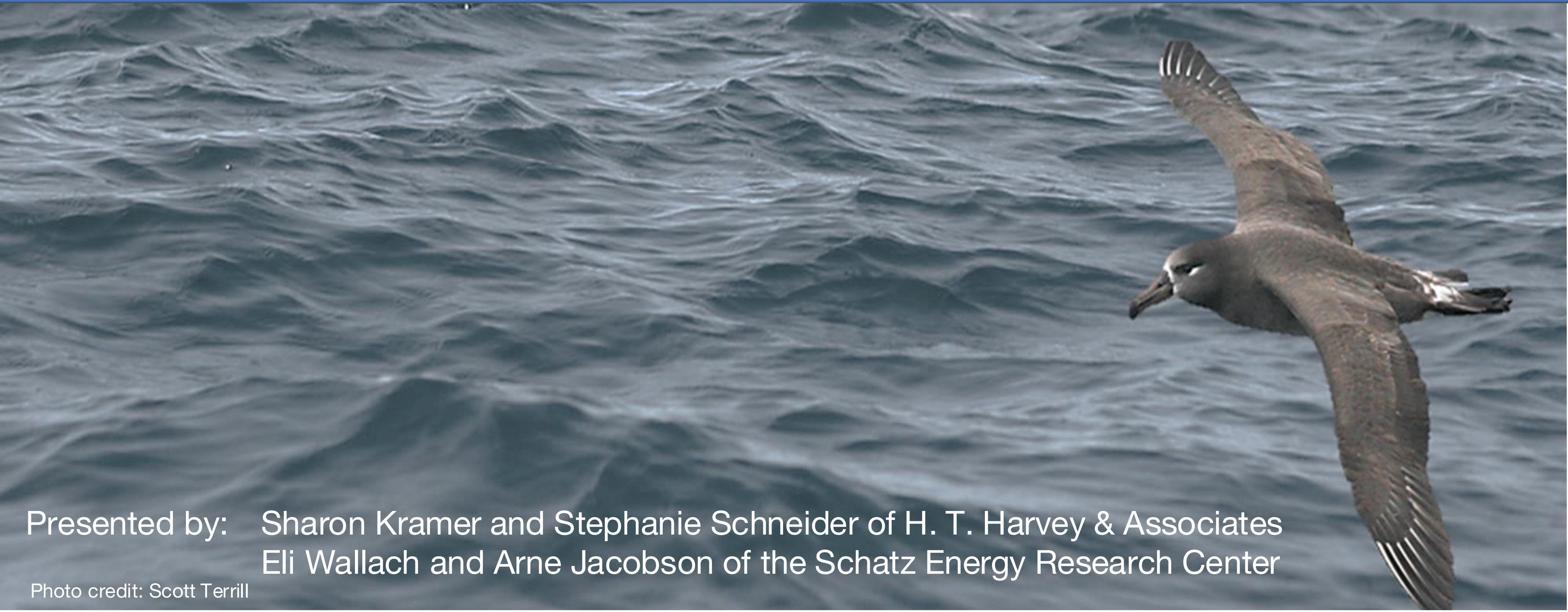

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Agenda

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1. Greeting and Introductions (15 min)
2. Key Takeaways (2.5 min)
3. Overview of the 3D Seabird Project (5 min)
4. 3D Seabird Model (20 min)
5. Power Generation Model (5 min)
6. Trade-offs Between Power Generation and Seabird Vulnerability (20 min)
7. Future Research Priorities (5 min)
8. Conclusions (2.5 min)
9. Panelist Discussion (10 min)
    - Lisa Ballance (Oregon State University)
10. Questions and Answers (35 min)

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Introductions – Project Team

H. T. HARVEY & ASSOCIATES
Ecological Consultants

Kaycee Chang David Stoms	Energy Research and Development Division	California Energy Commission
Arne Jacobson Charles Chamberlin Eli Wallach	Director Co-Director Research Engineer	Schatz Energy Research Center @ Cal Poly Humboldt
Scott Terrill Sharon Kramer David Ainley Stephanie Schneider Sophie Bernstein Sadie Trush	Senior Avian Ecologist; Principal Senior Marine Ecologist; Principal Senior Avian Ecologist Avian and Quantitative Ecologist Marine Ecologist Ecologist, Spatial Modeler	H. T. Harvey & Associates
Glenn Ford Janet Casey	Principal Scientist Scientist	R. G. Ford Consulting Company
Jarrod Santora	Research Fish Biologist, Division Fisheries and Ecosystem Oceanography Team	NOAA's Southwest Fisheries Science Center
Lisa Ballance	Director, Marine Mammal Institute Professor, Fisheries & Wildlife	Oregon State University

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Acknowledgements

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Project Sponsor

CALIFORNIA ENERGY COMMISSION

Technical Advisory Committee Members (current and past)

Dan Barton	Dept. of Wildlife Chair and Associate Professor	Cal Poly Humboldt
Garry George	Director, Clean Energy Initiative	National Audubon Society
Mike Optis	Researcher	National Renewable Energy Laboratory (formerly)
David Pereksta	Avian Biologist	Bureau of Ocean Energy Management
Chris Potter	Senior Environmental Specialist	CA Department of Fish and Wildlife (formerly)
Kaus Raghukumar	Oceanographer	Integral Consulting Inc.
Mark Severy	Research Engineer	Pacific Northwest National Laboratory
Tyler Studds	Development – Offshore Wind	Ocean Winds
Yi-Hui Wang	Offshore Energy Postdoc	California Polytechnic State University (formerly)
Brita Woeck	Lead Environmental & Permitting Specialist	Ørsted

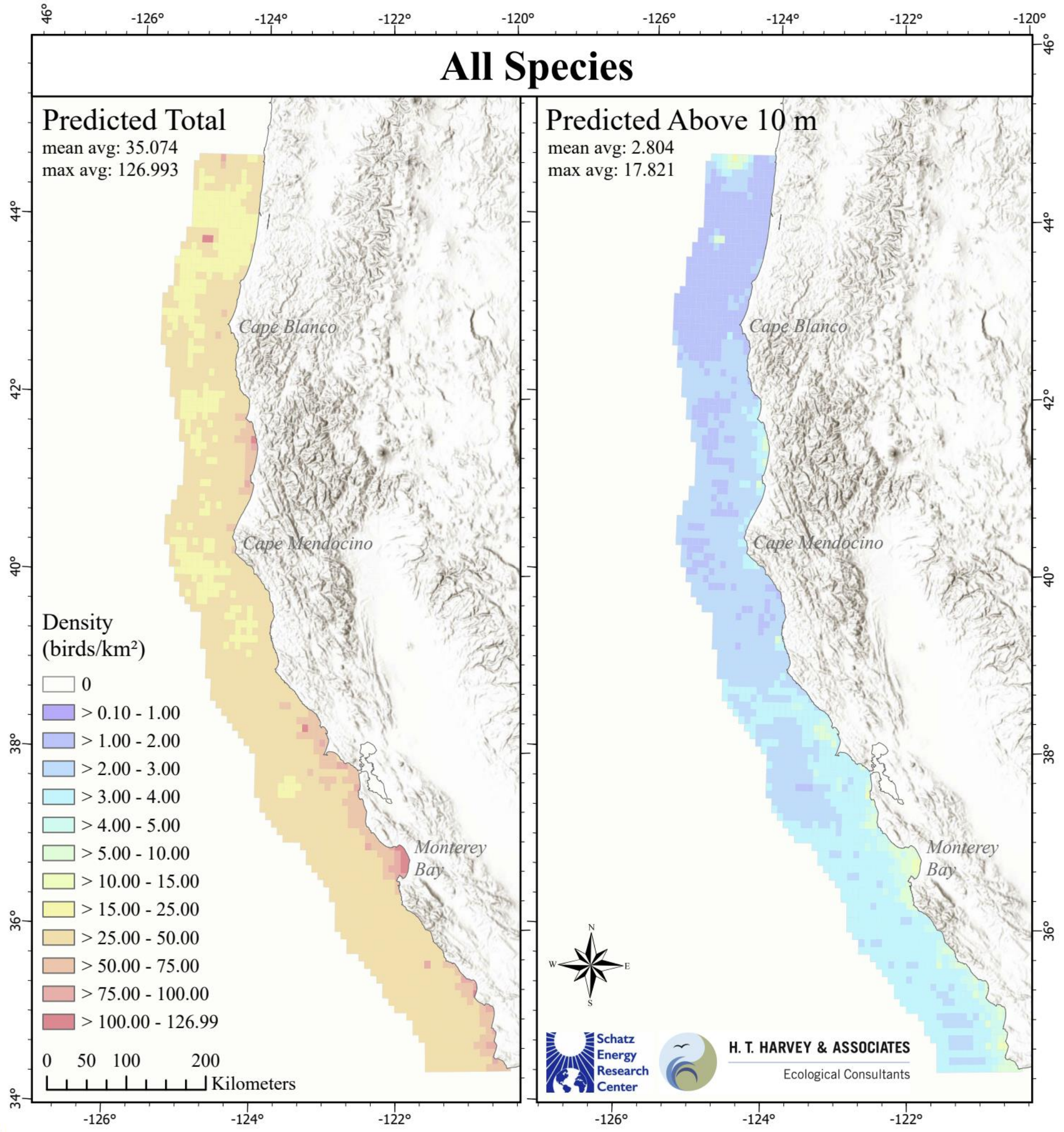
Key Takeaways

Seabirds and Offshore Wind

- Number of birds considered vulnerable to collision is much greater than the expected collision rates. In this analysis, vulnerability is measured in density of birds present above 10 m
- Seabirds off CA exhibit diverse flight styles - only some species are likely to fly above 10 m
- The most prevalent birds above 10 m are gulls, as they are abundant and have a propensity to fly above 10 m (in a range of wind conditions)
- Seabird community composition and density differs in nearshore versus offshore waters

Analysis of Tradeoffs

- Our multi-objective optimization analysis suggests that areas offshore from Cape Mendocino and northern CA into southern Oregon are favorable for renewable energy generation while also having relatively low bird density.



Overview of the 3D Seabird Project

Overview - The Issue

Offshore wind facilities pose risk to seabirds

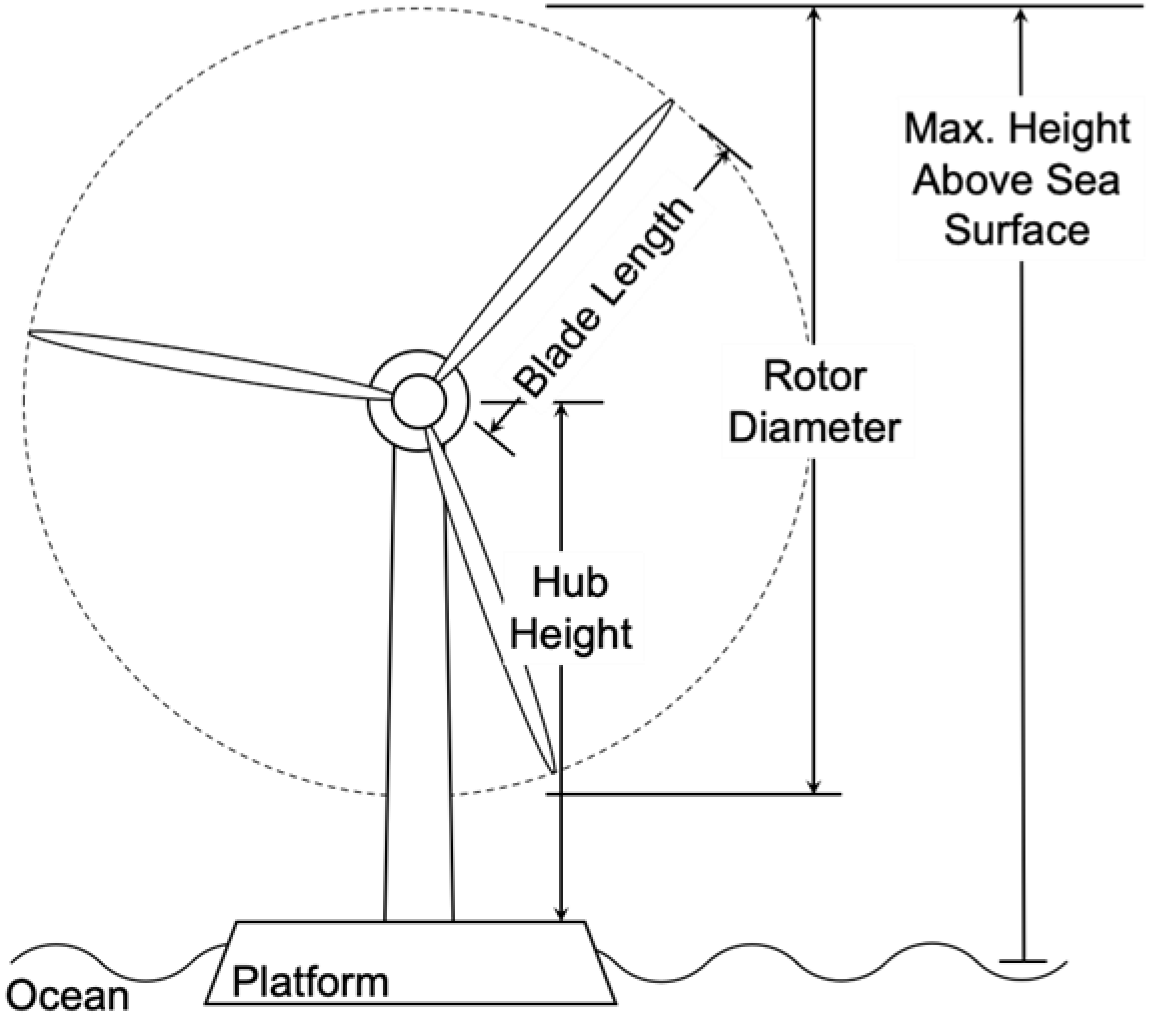
- Displacement versus collision

Existing 2D seabird models can identify hotspots of seabird activity

Estimating collision vulnerability requires better understanding of 3D use

- 2D models do not delineate presence of seabirds at different flight heights

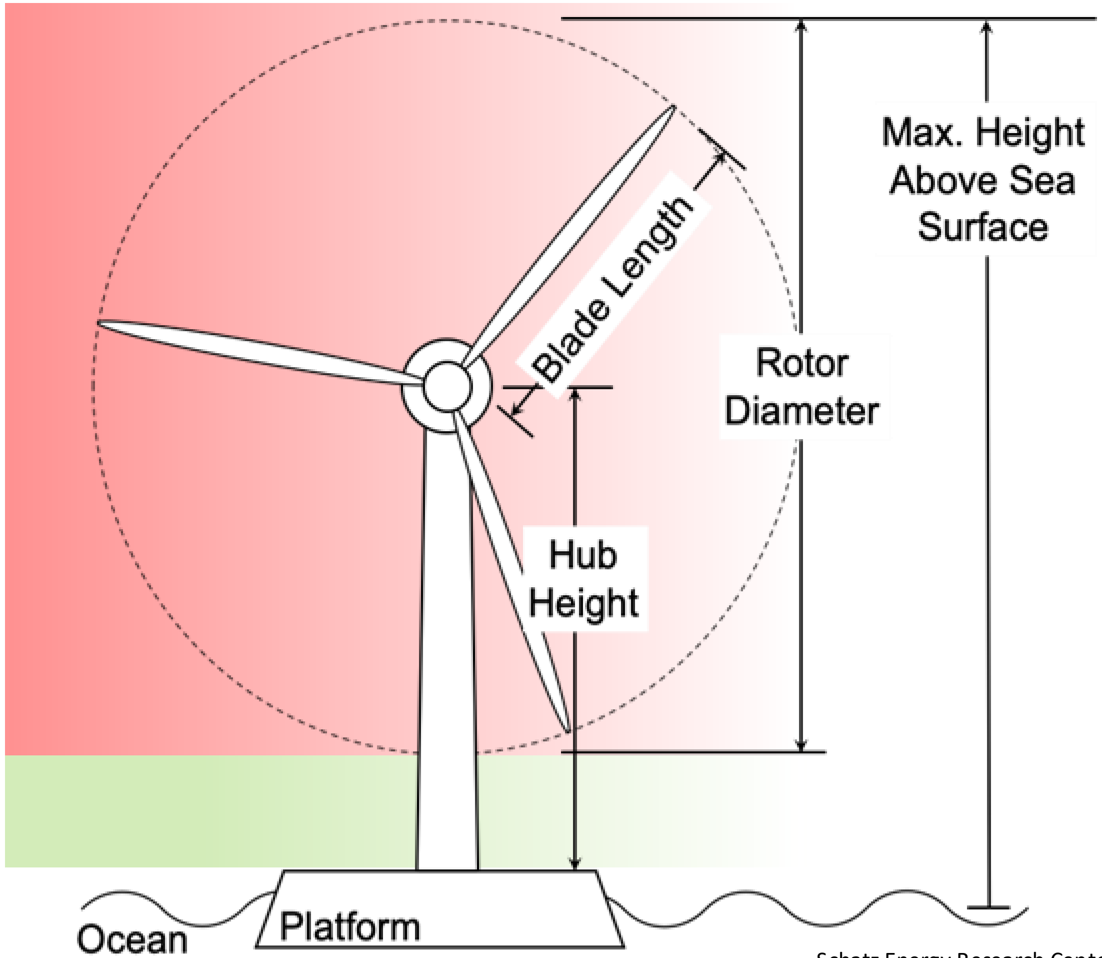
Flight height patterns vary by species and wind speed



Goals and Objectives

This project set out to:

- Develop a three-dimensional seabird distribution model for California
- Evaluate the relative vulnerability of seabirds in offshore wind development regions for different locations
- Compare tradeoffs between seabird vulnerability and power generation



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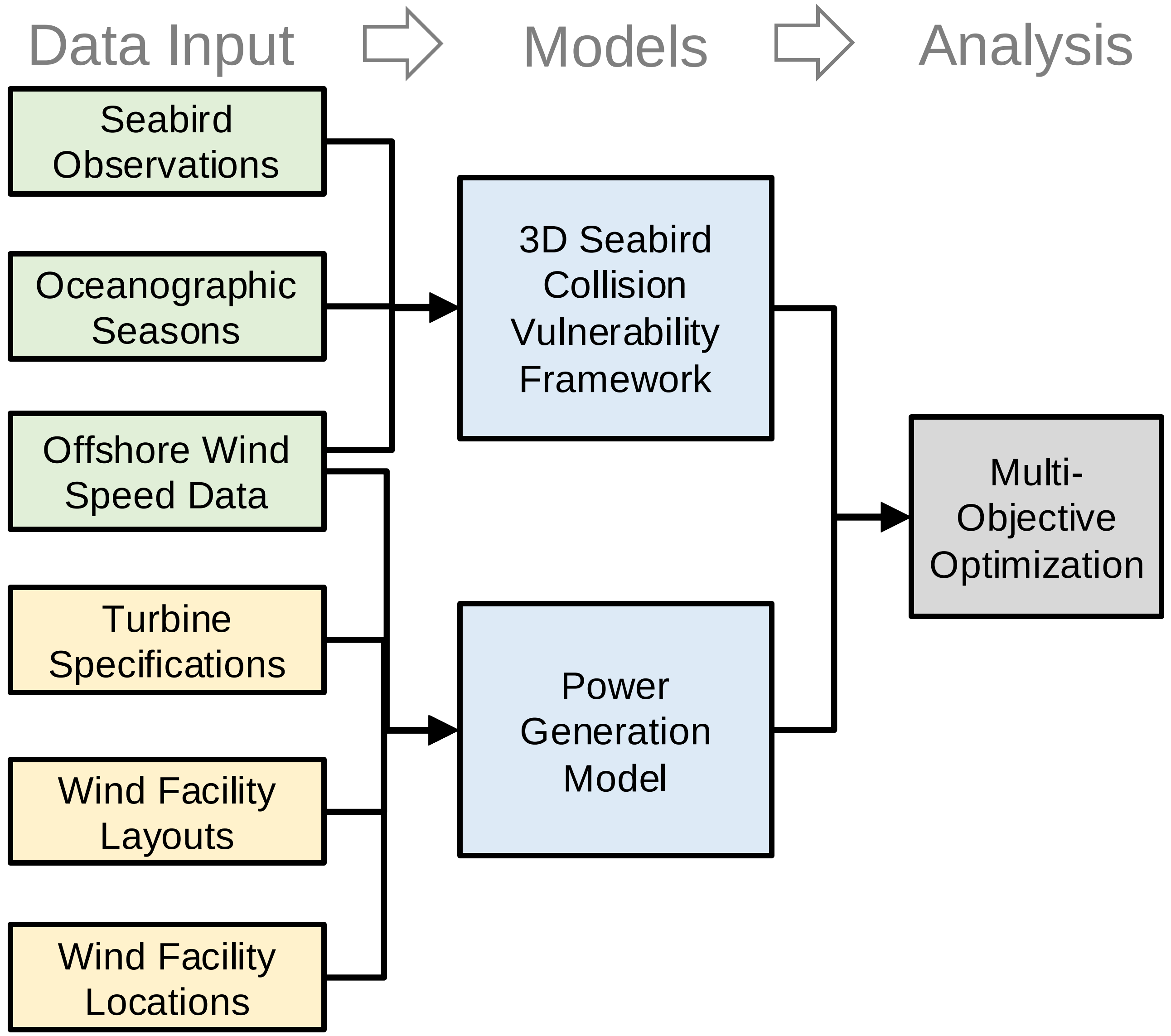
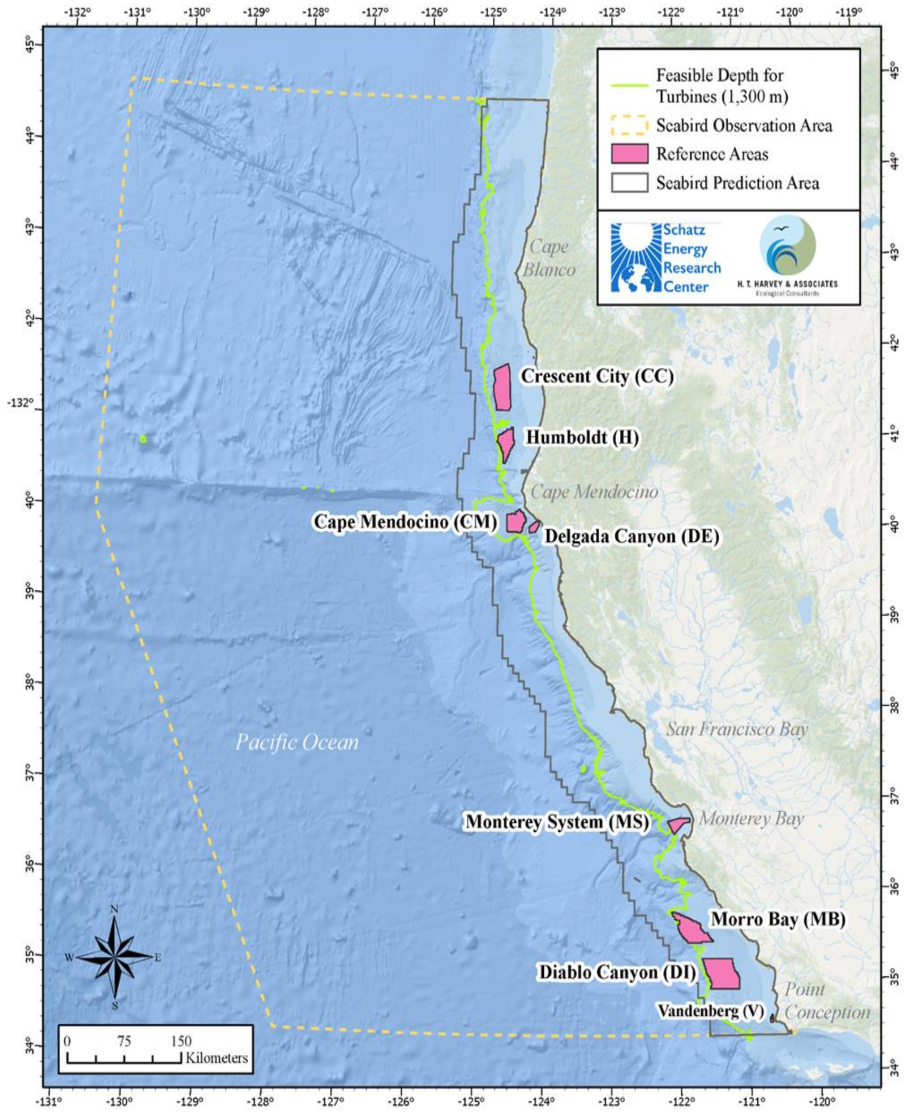
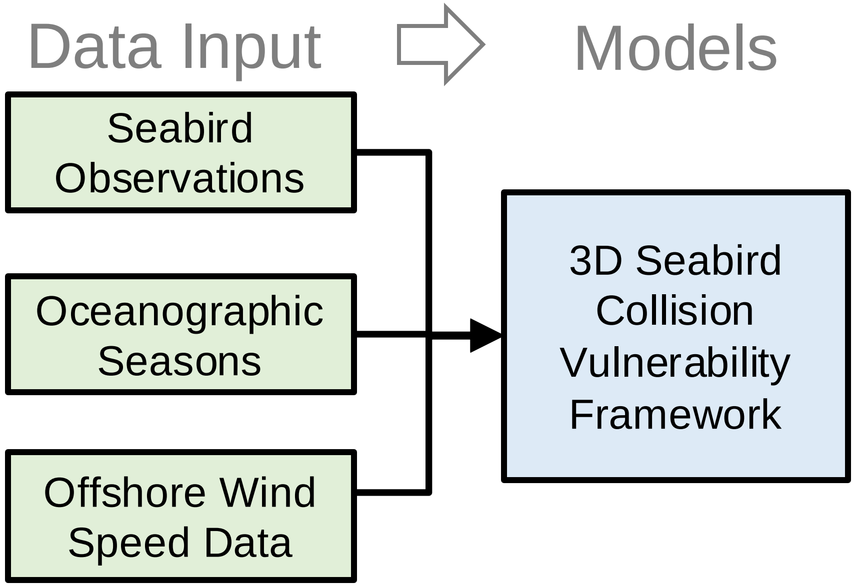
Project Overview





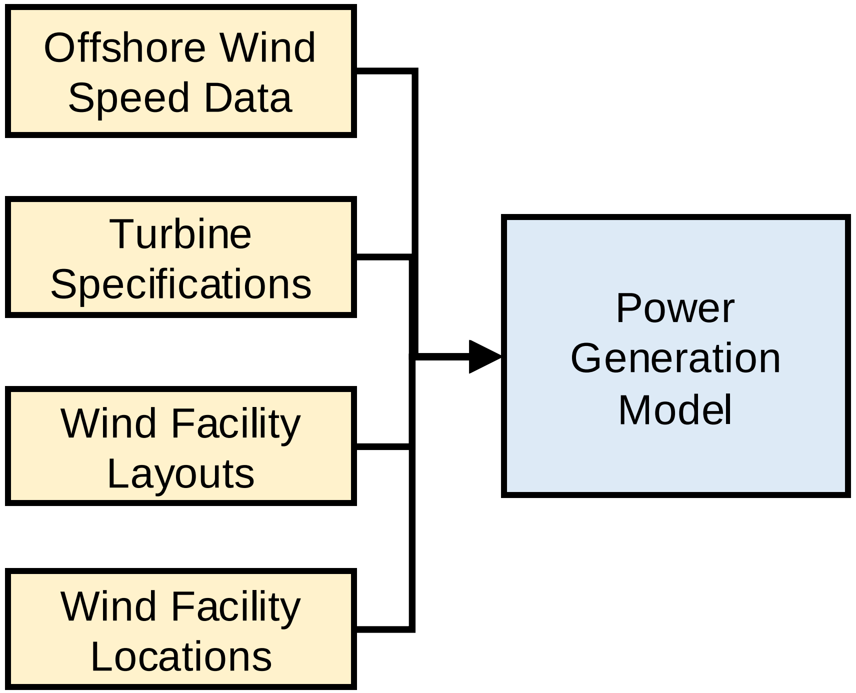
Project Overview – 3D Seabird Model



- Based on observational data from aircraft and vessels spanning 1980 to 2016
- Based on long term oceanographic conditions (seasonal definitions)
- Probability of seabirds flying above 10 m is estimated via logistic regression based on flight group and windspeed
- 2D seabird density estimated using an inverse distance weighted (IDW) algorithm
- Combines regressions predicting flight height and spatial interpolation algorithms predicting abundance in 2D
- Uses modeled wind speed data (NREL CA-20 & Northwest Pacific; Windtoolkit databases)

Project Overview – Power Generation Model

Data Input ⇨ Models



Based on:

- Modeled wind speed data
  (NREL CA-20 & Northwest Pacific; Windtoolkit databases)
- NREL 12 & 15 MW reference turbines

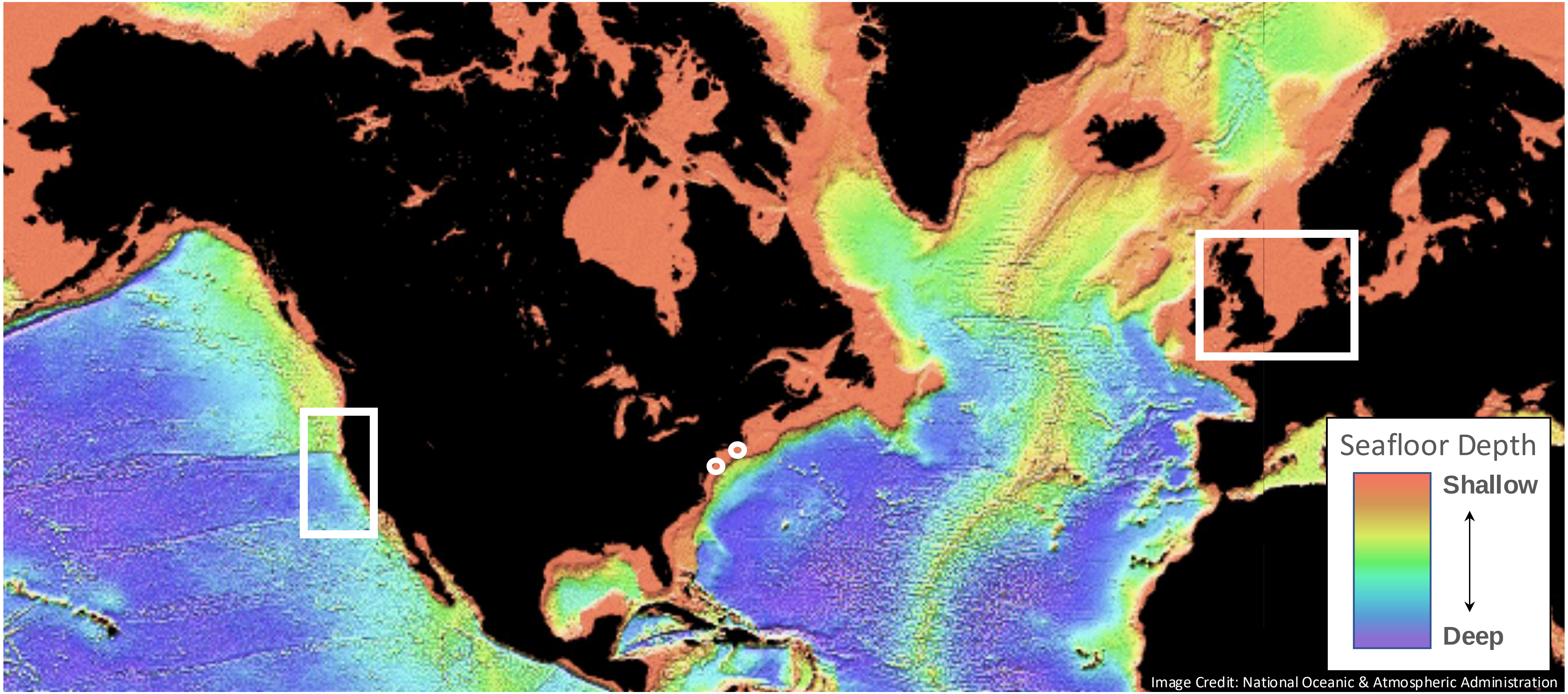
Goal: Simulate a variety of wind facility scenarios

Approach: Simulations modeling

- Uses an Eddy Viscosity model as implemented by SAM (System Advisor Model) to estimate wake losses

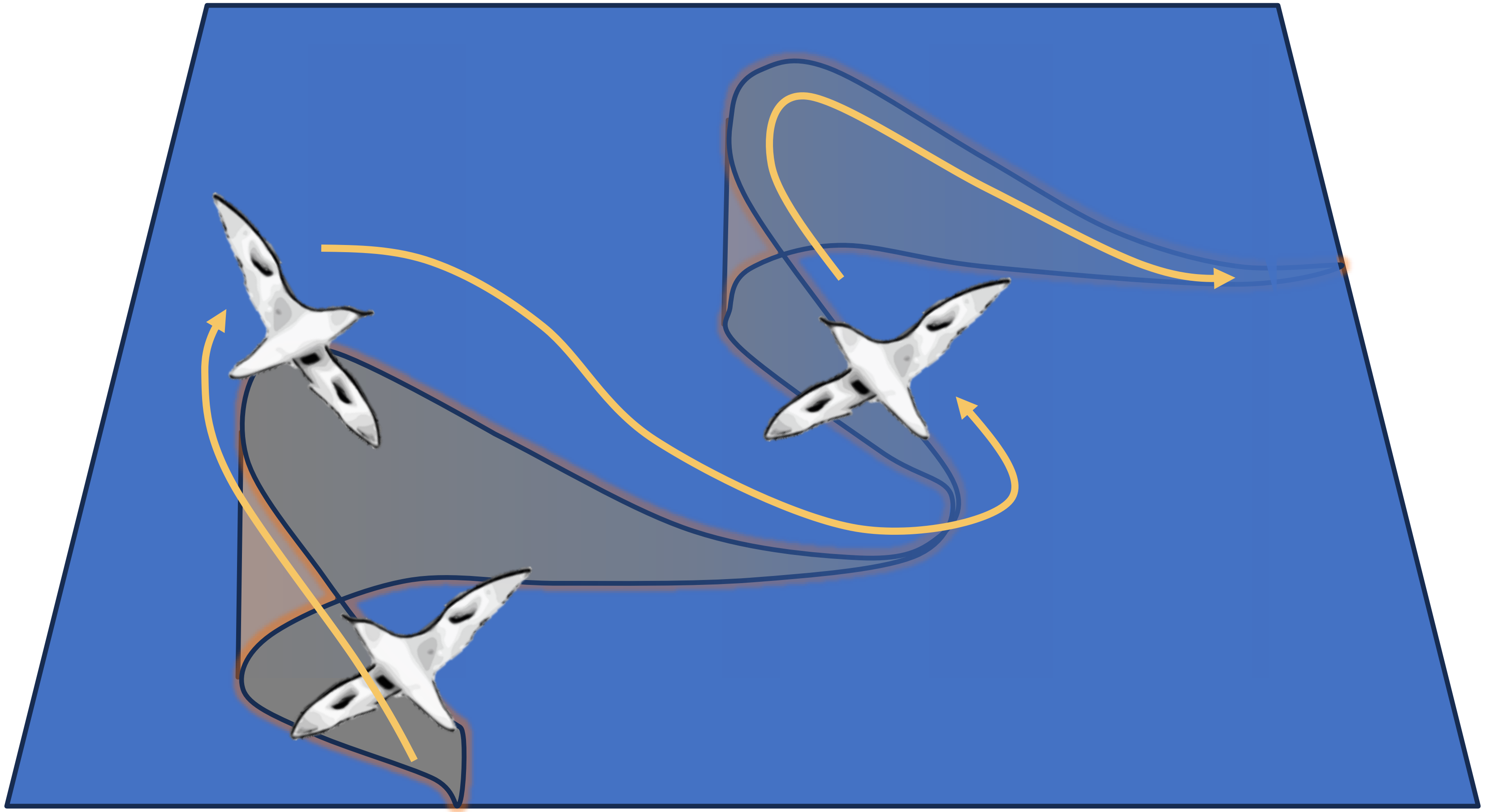
3D Seabird Model

Offshore Wind and Seabirds in the Pacific



Offshore Wind and Seabirds in the Pacific

Unlike areas developed for Offshore Wind in Europe and eastern USA, the California Current avifauna contains many dynamic soaring species (albatross, petrels, shearwaters)



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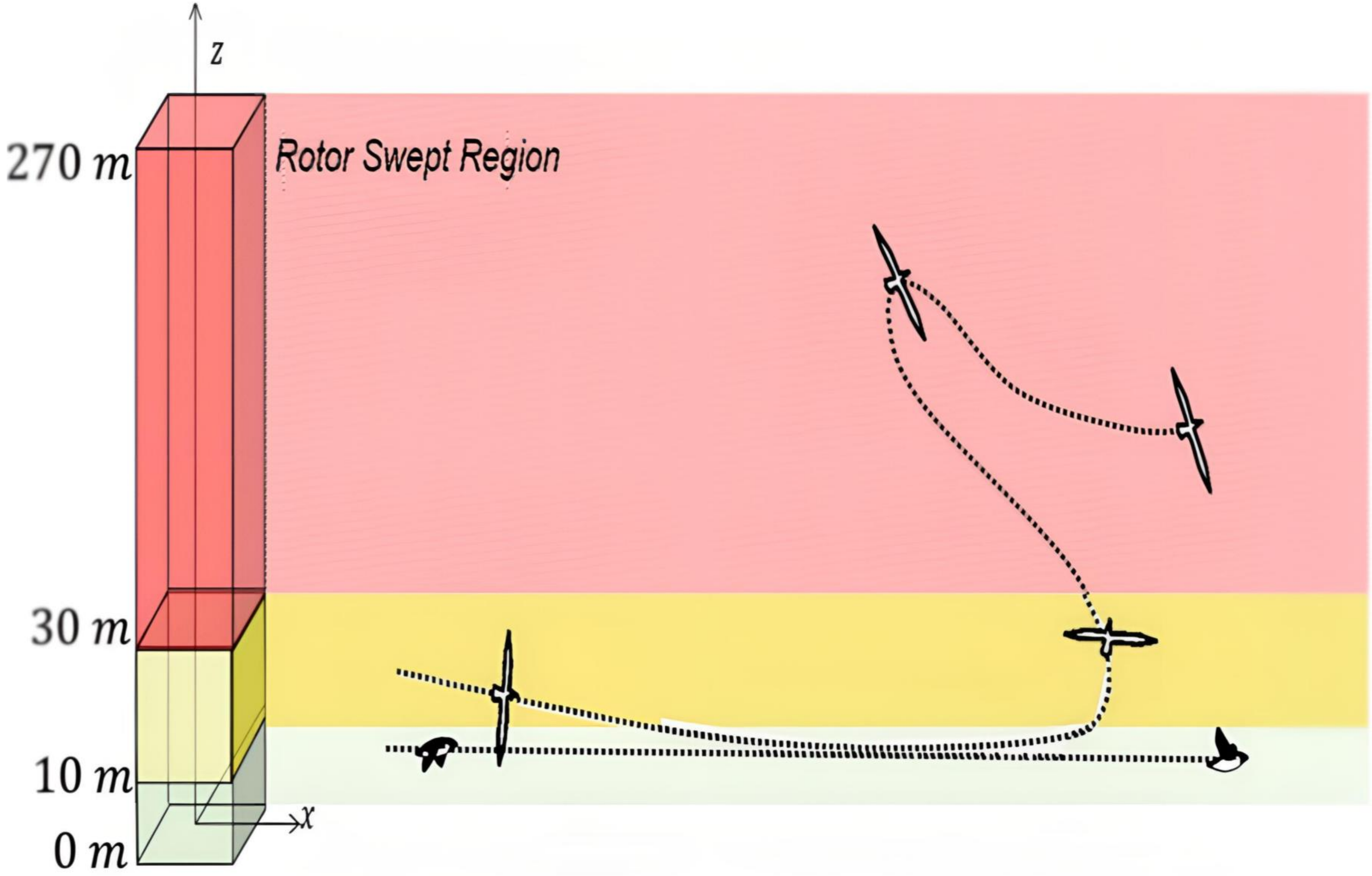
Offshore Wind and Seabirds in the Pacific



Collision Vulnerability is distinct from "Collision Risk"

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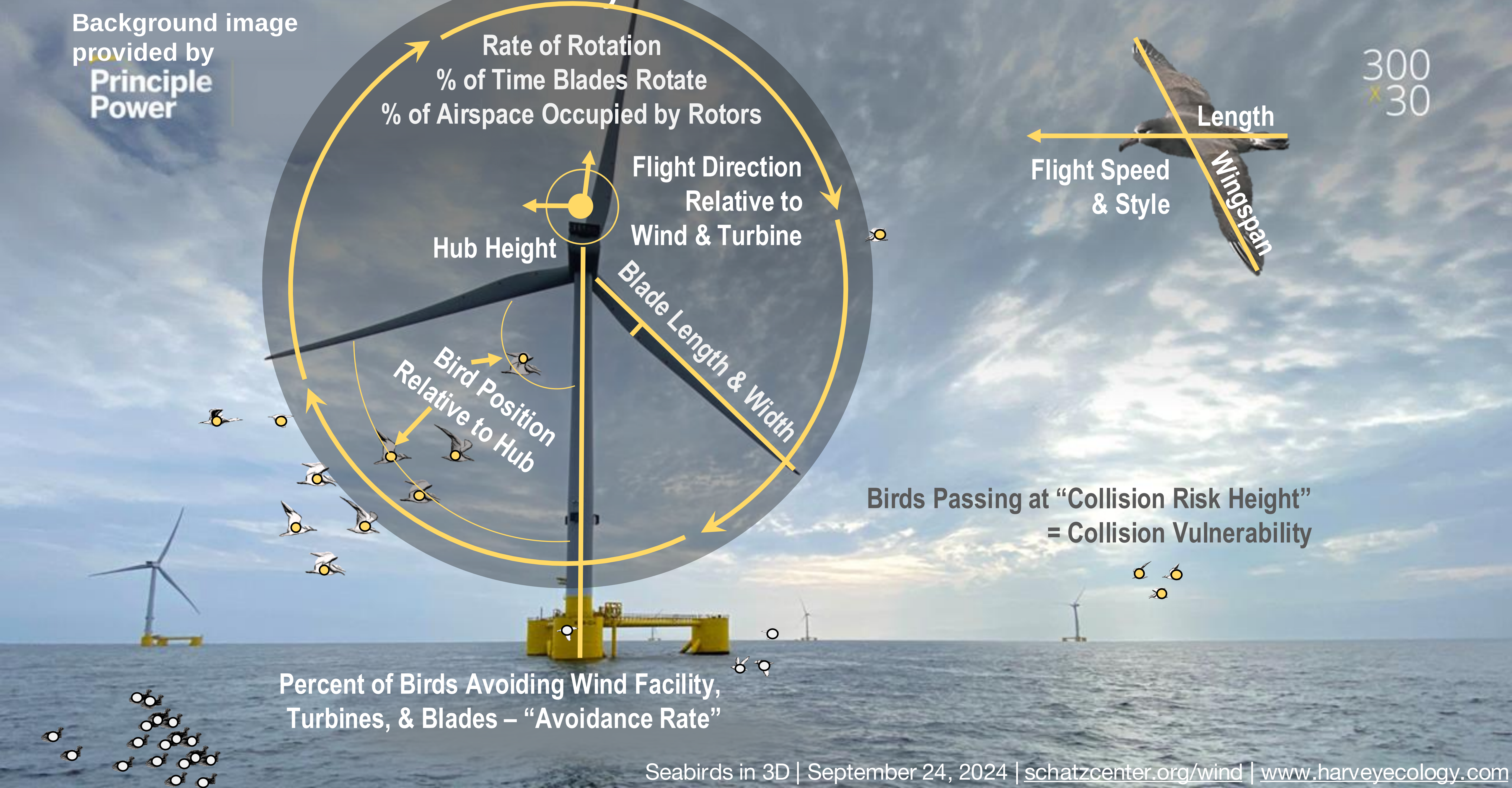
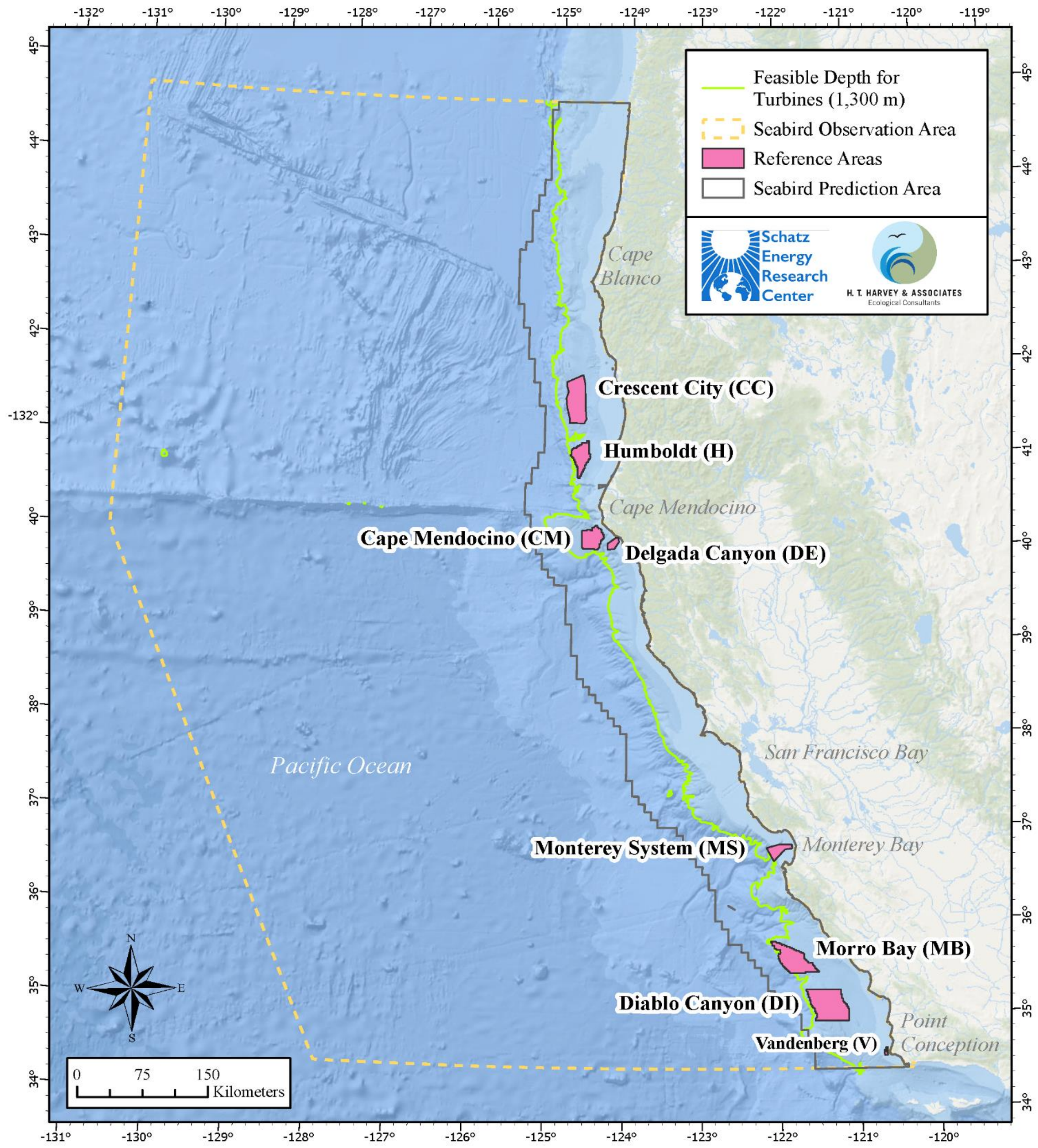


Study Area



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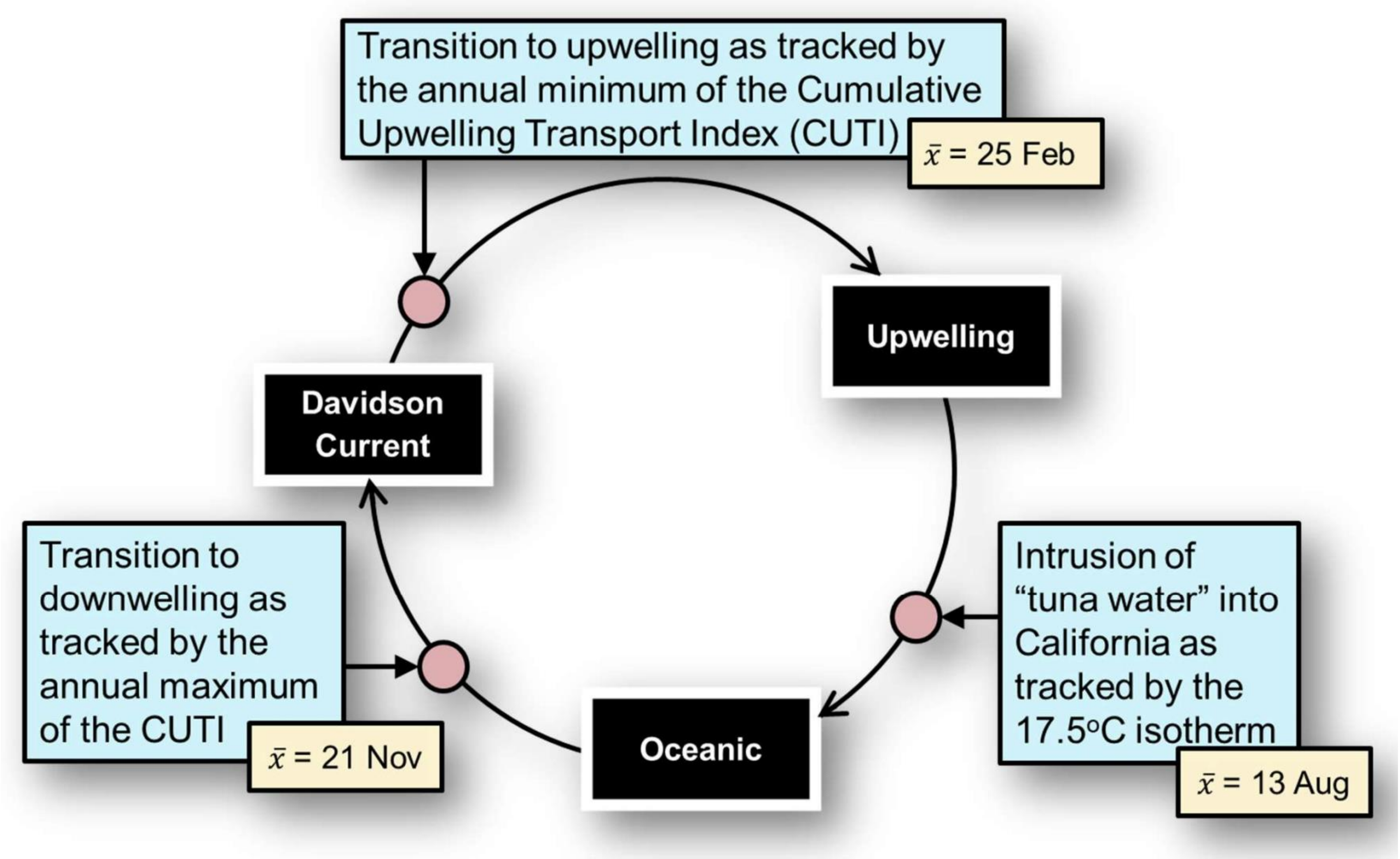
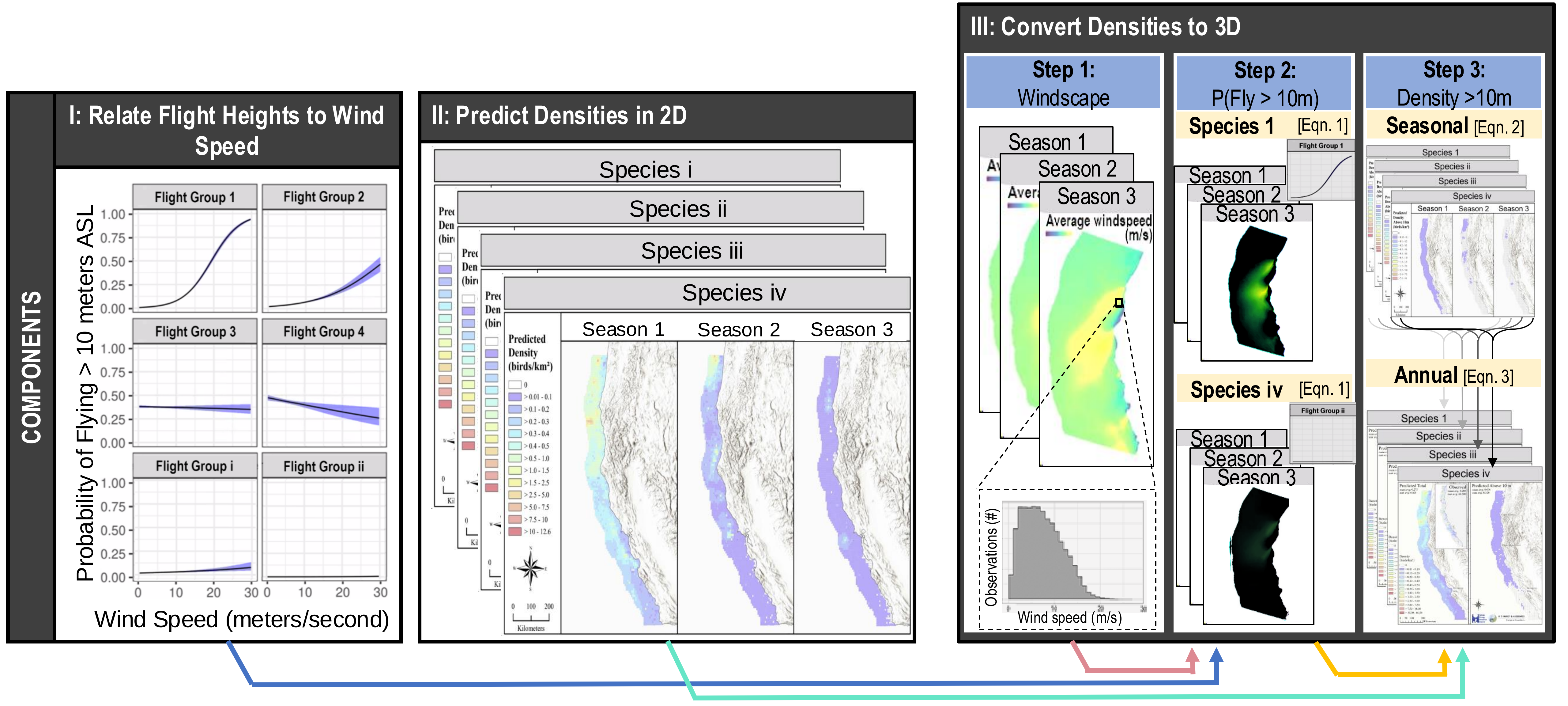
Seabird Seasons

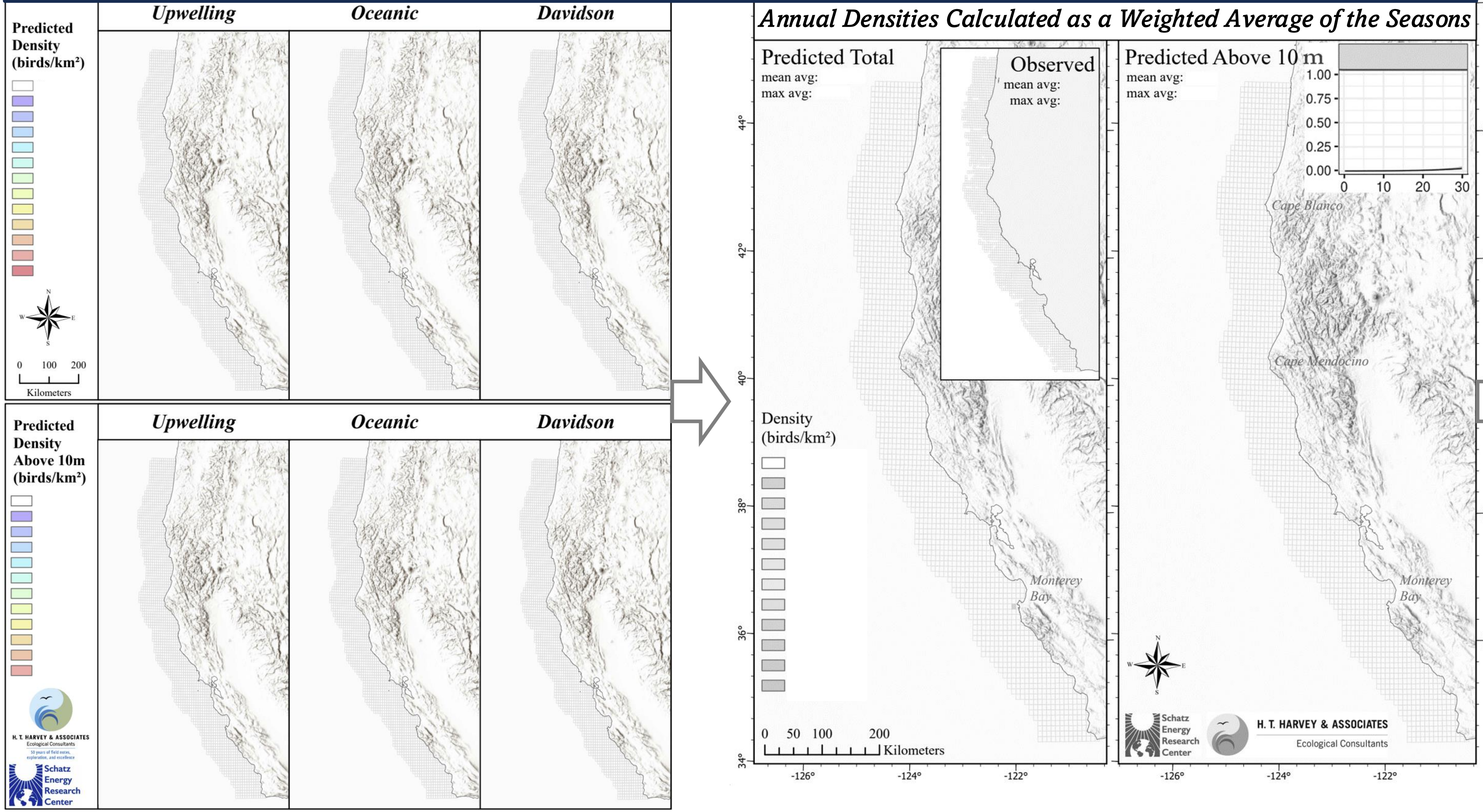


3D Seabird Model Framework



Final Output: Density Predictions Overall and > 10 m

Prediction Format for Single Species



FINAL OUTPUT

Aggregate Density Predictions ($birds/km^2$) for All Birds included in Framework

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Supporting Data

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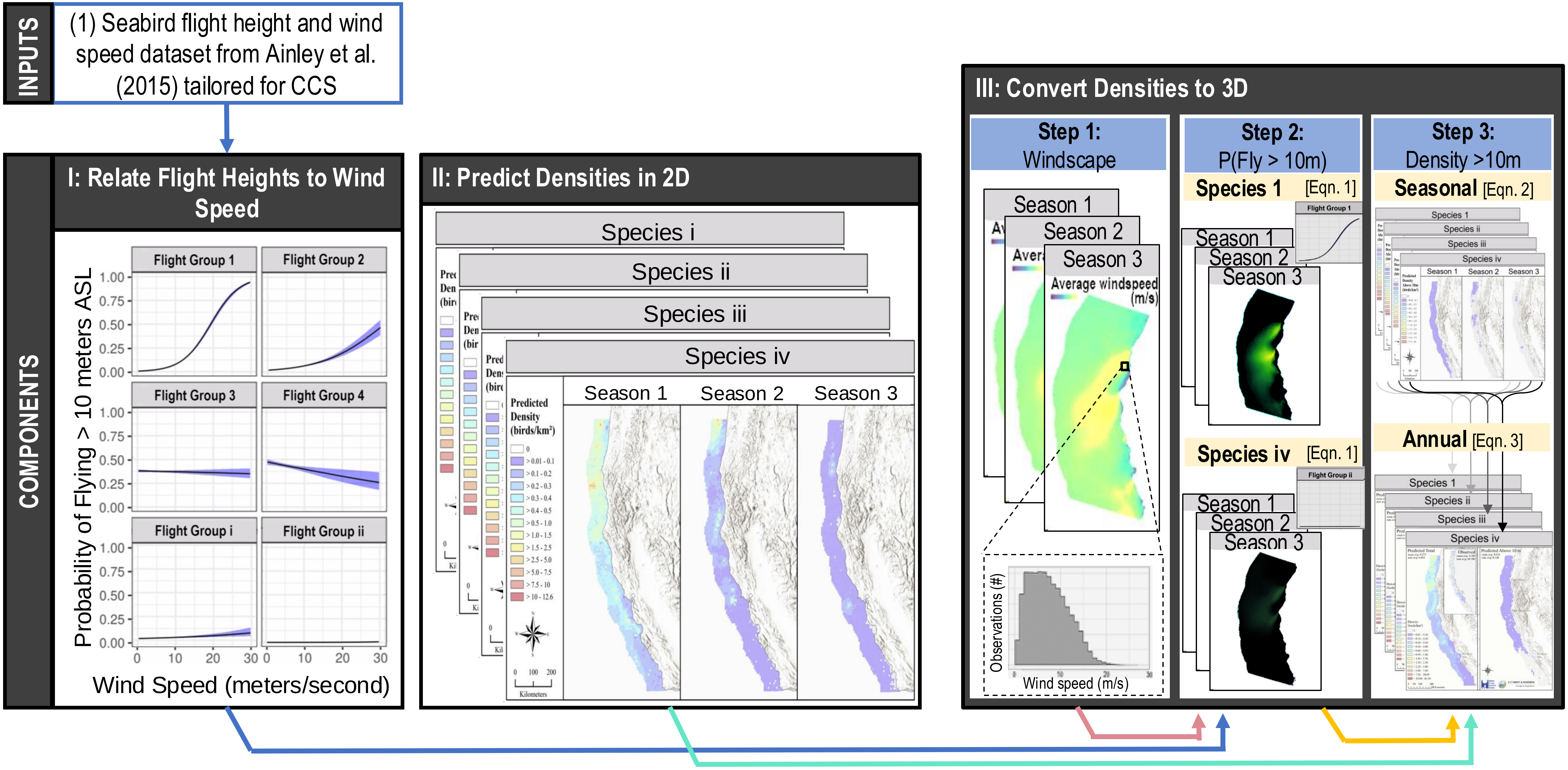
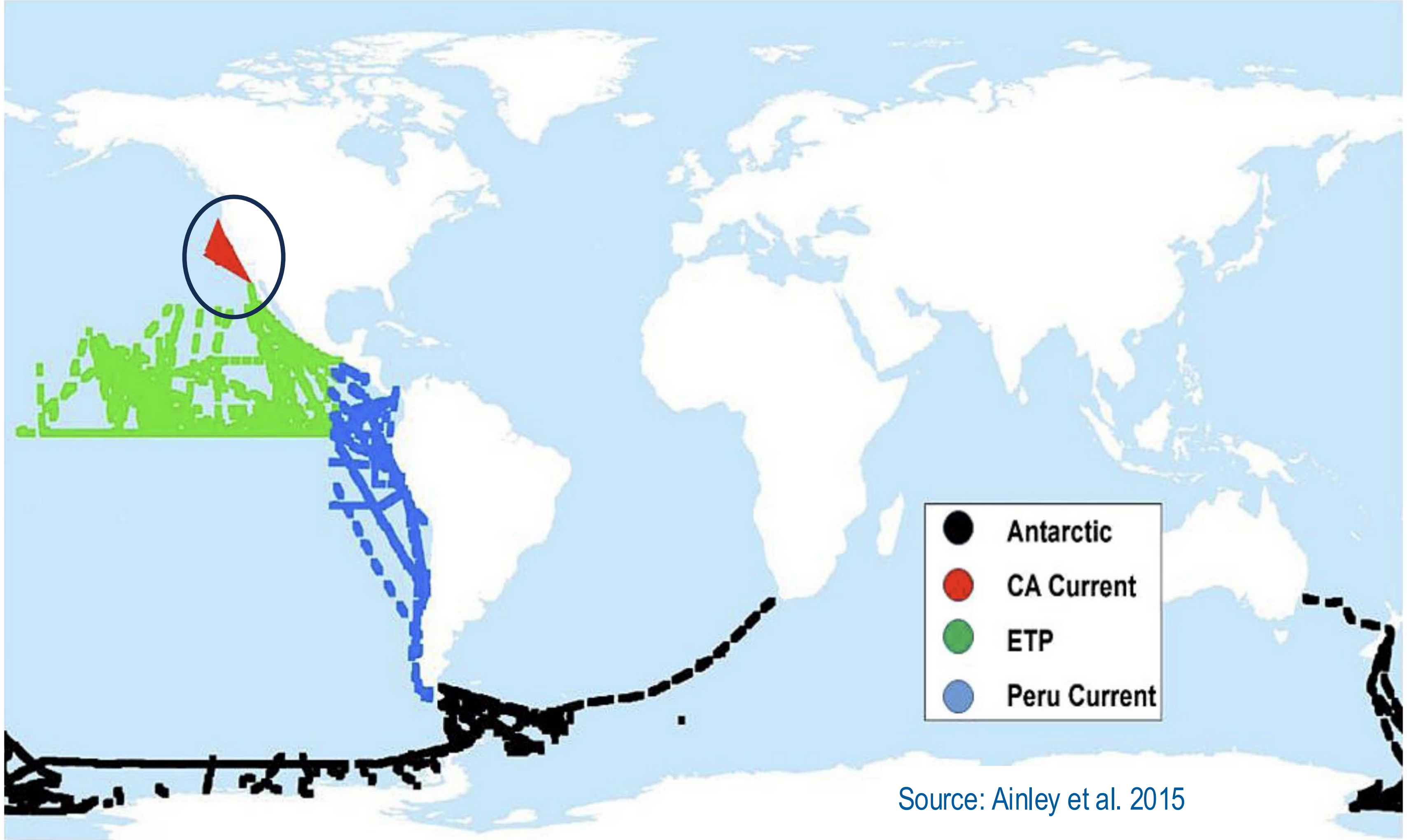


Extensive Seabird Surveys for Flight Height & Wind Speed Relationships

Component I: Flight Height & Wind Speed



Vessel based surveys

- 87 cruises (1976-2006)
- Spanned much of the Pacific Basin

Sample Sizes

- 131,354 sightings
- 271 species

These extensive data, which included observations of bird species from outside the region, were tailored to focus on species known to occur in the California Current System

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Supporting Data

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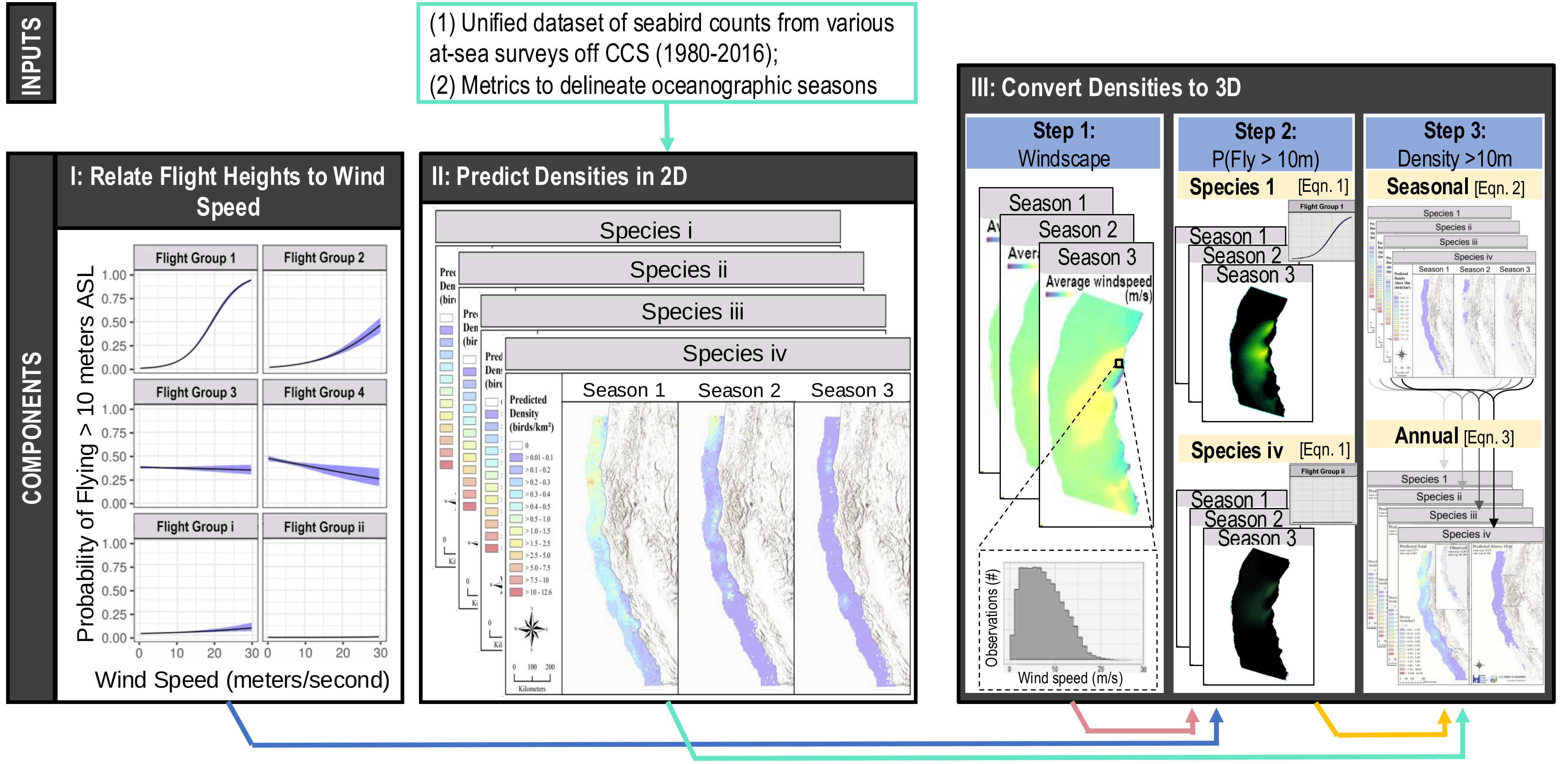
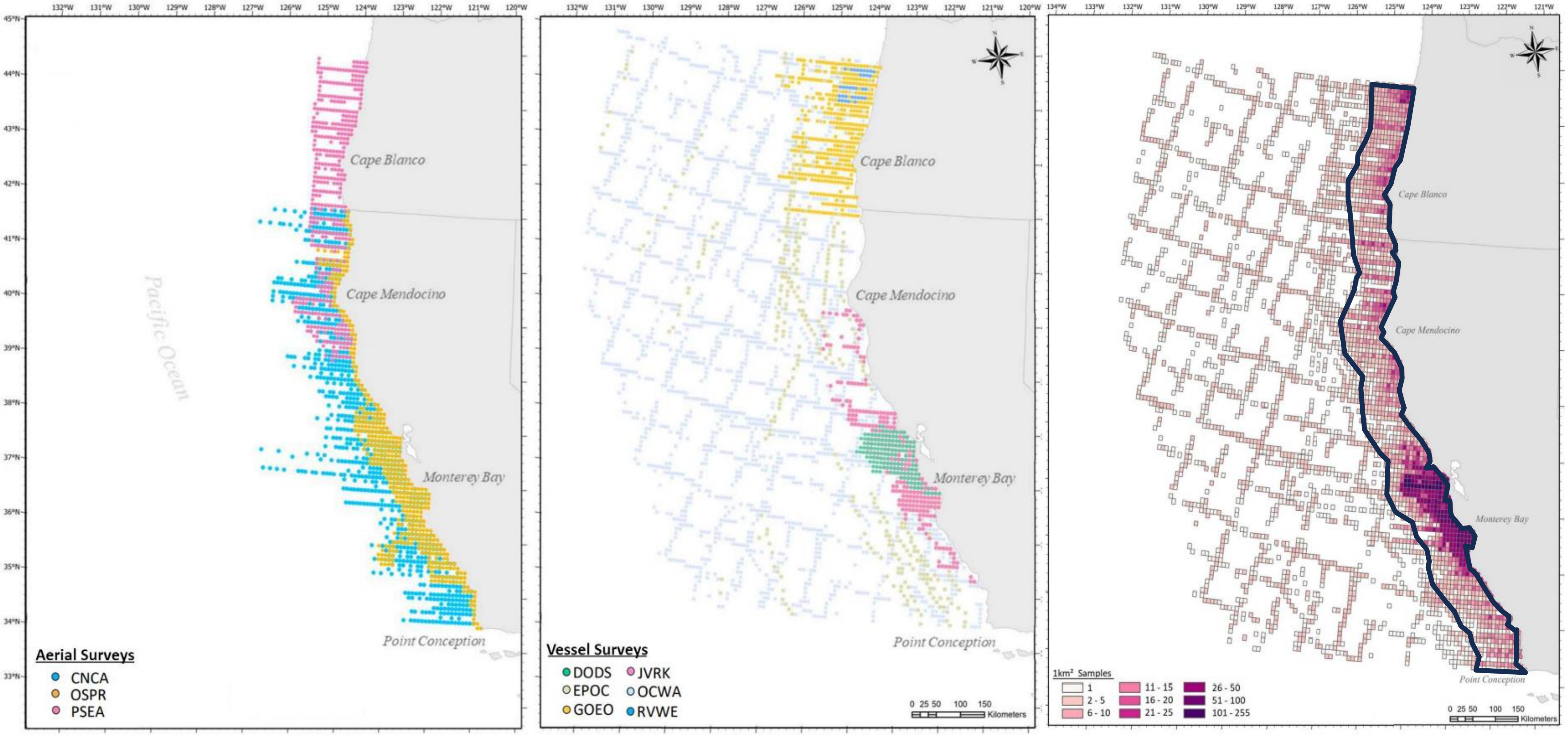
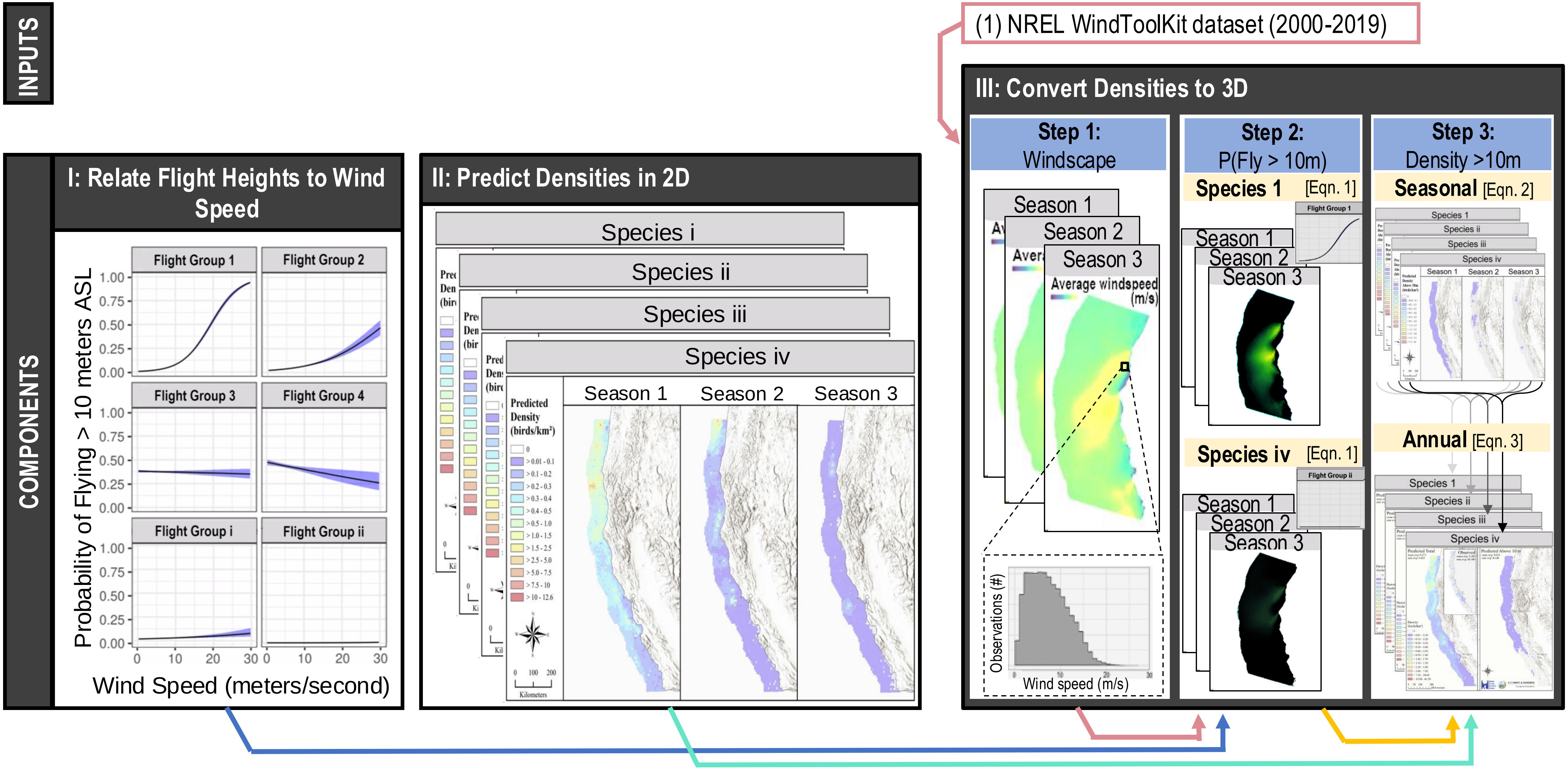


Extensive Seabird Surveys off California for 2D Density Predictions

Component II: 2D Density Predictions



Supporting Data



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Extensive Wind Data off California

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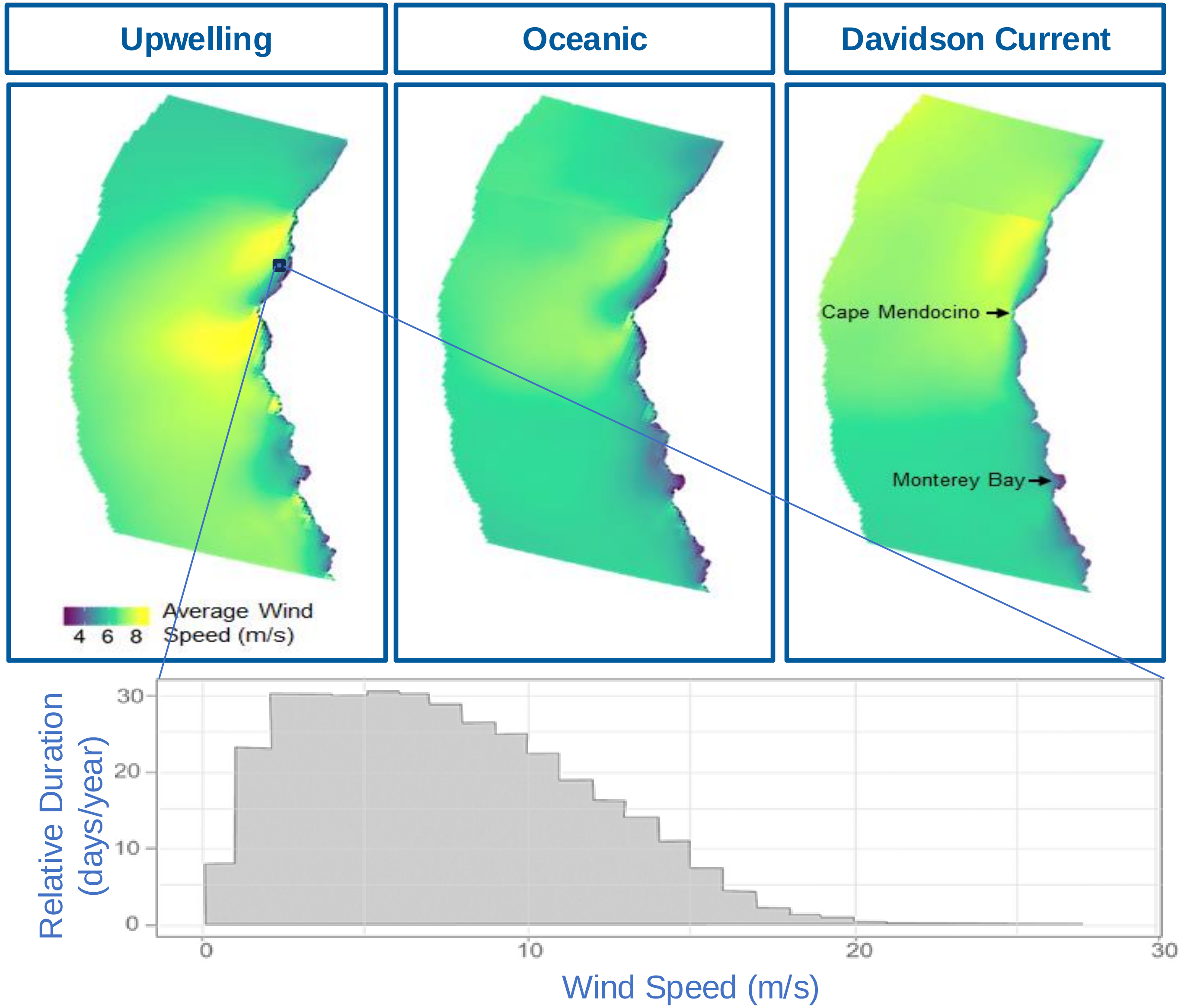
Component III: Convert 2D to 3D, Step 1: Windscape



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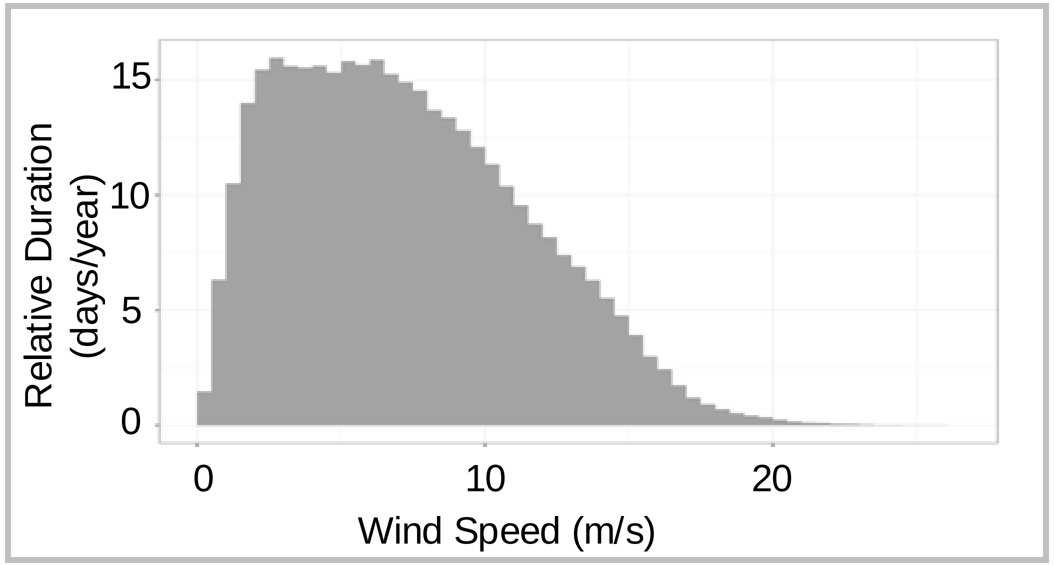
Seabirds in 3D: Flight Height

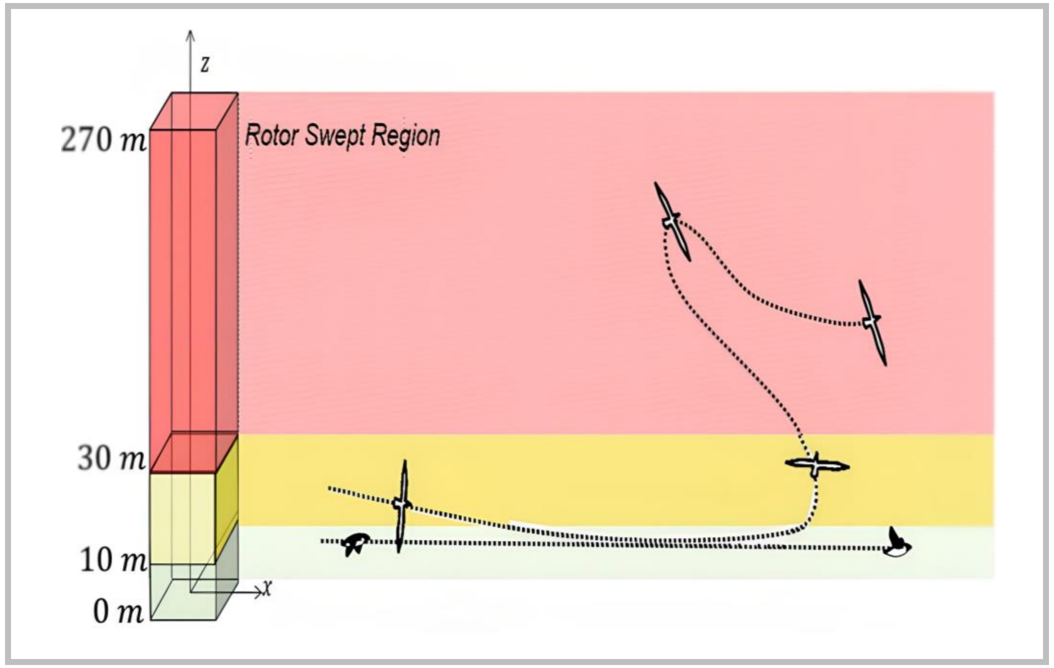
Extensive study on flight behavior

- Full spectrum of wind speeds
- Tailored to represent seabirds present in the California Current

Seabird flight height data were binned

- **Categories:** On water, 0-3 m, 3-10 m, >10 m
- **Relevance to Rotor Swept Zone (RSZ):** 10 m is a conservative proxy for the lower extent of the RSZ @ 30 m ASL
- **Approach:** Logistic regression
- **Outcome:** Probability of birds flying >10 m across full spectrum of winds (0 to 30 m/s)





Seabirds in 3D: Species Included

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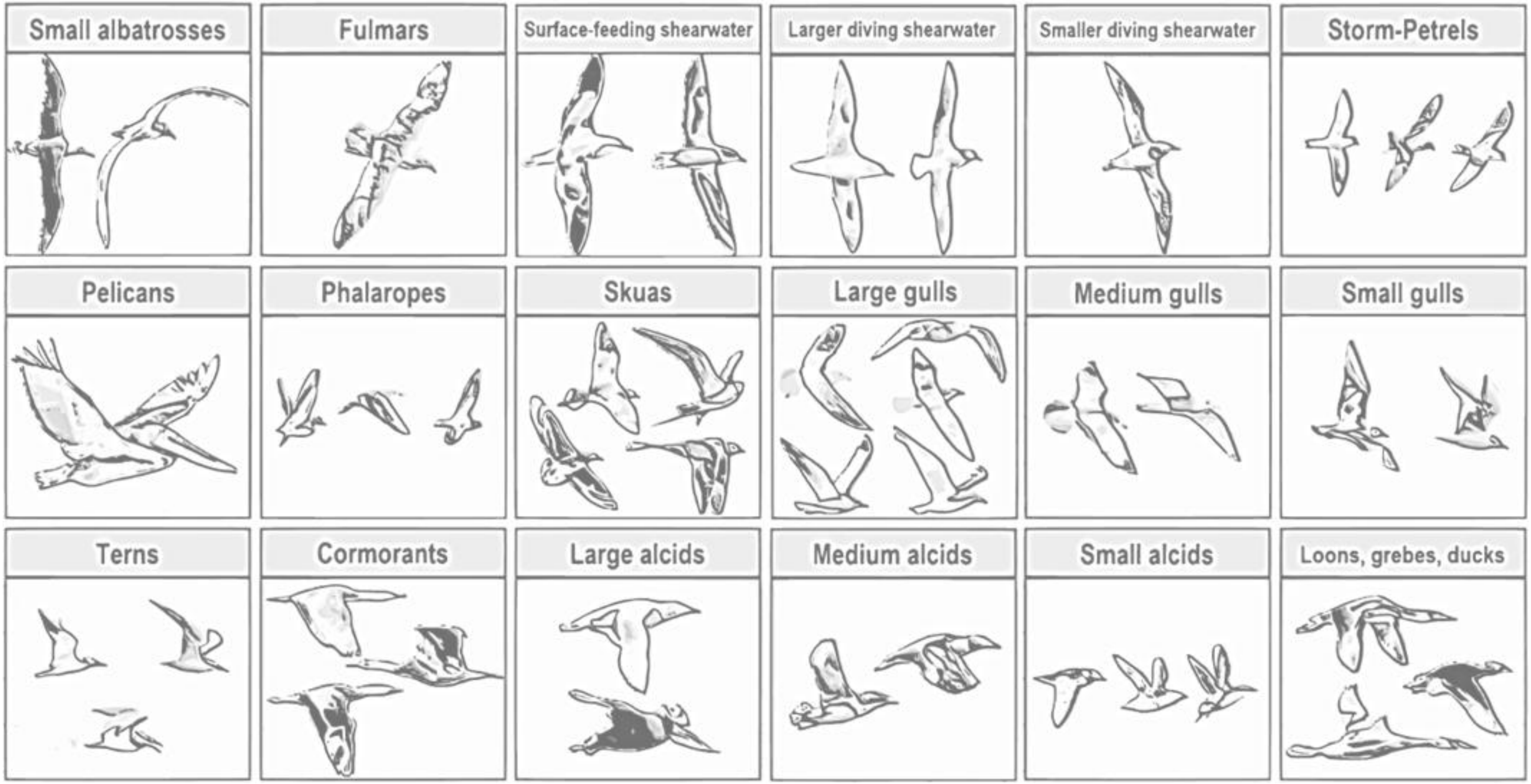
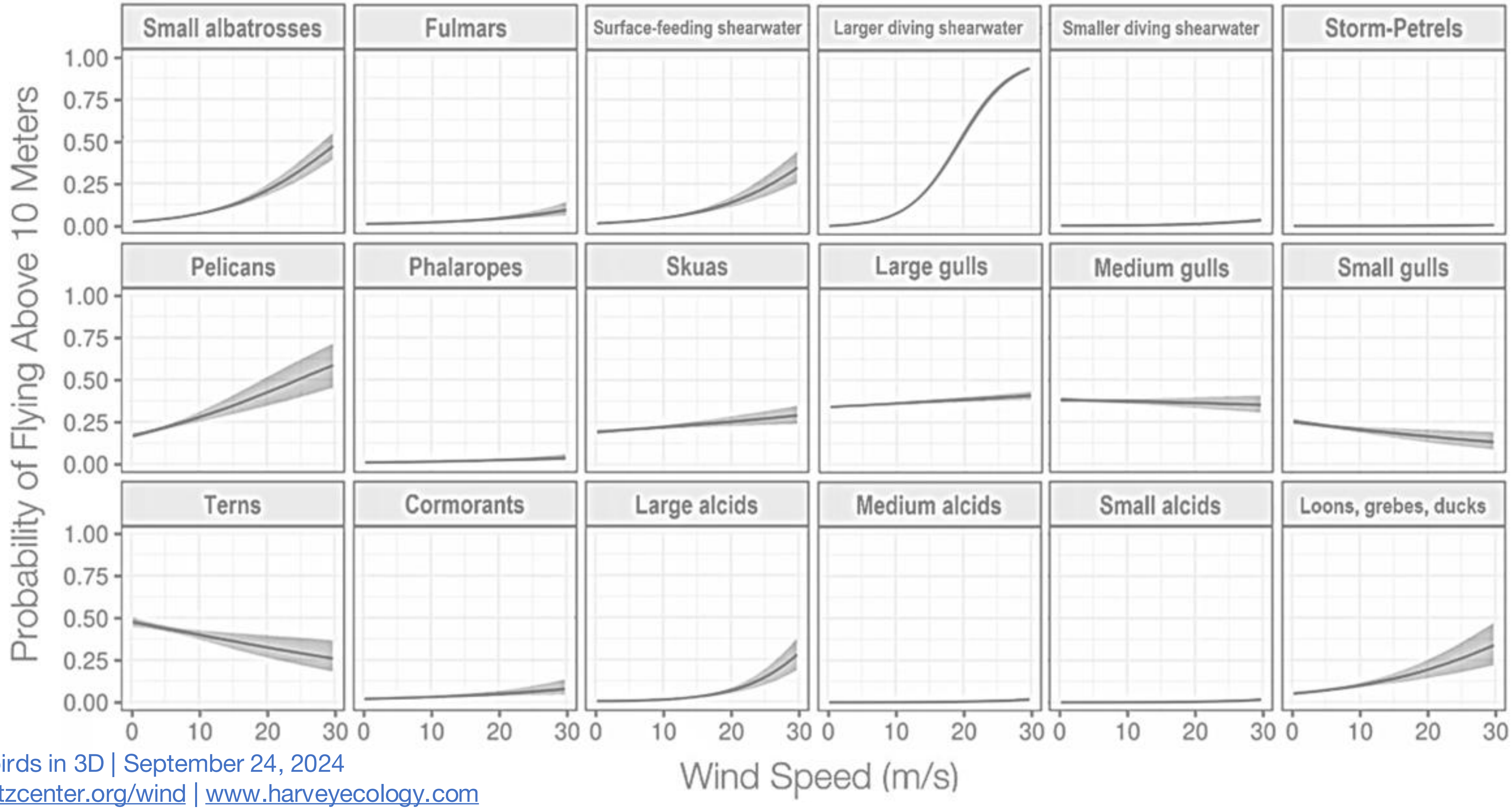
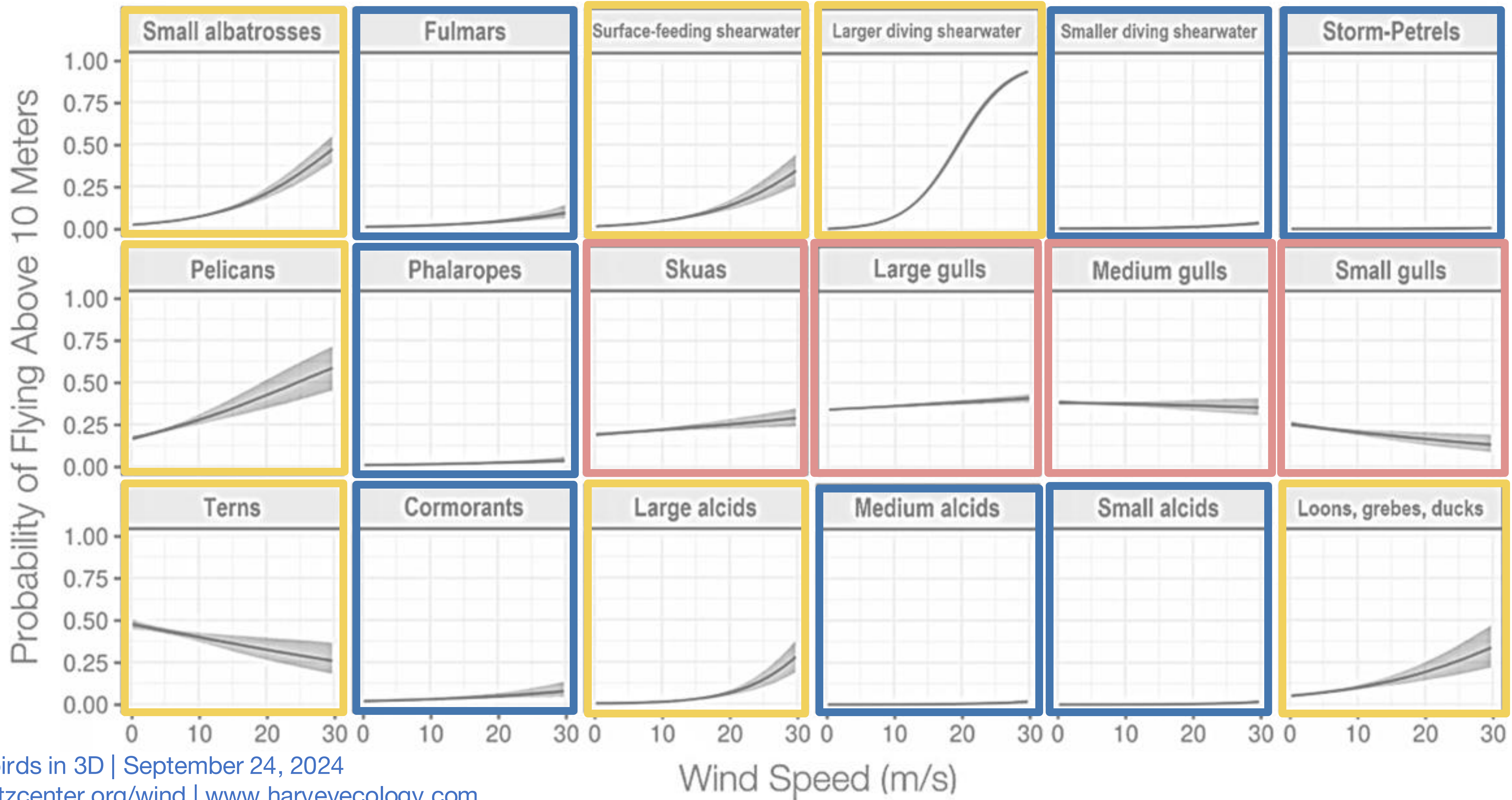


NOTE: Bird images are not to scale

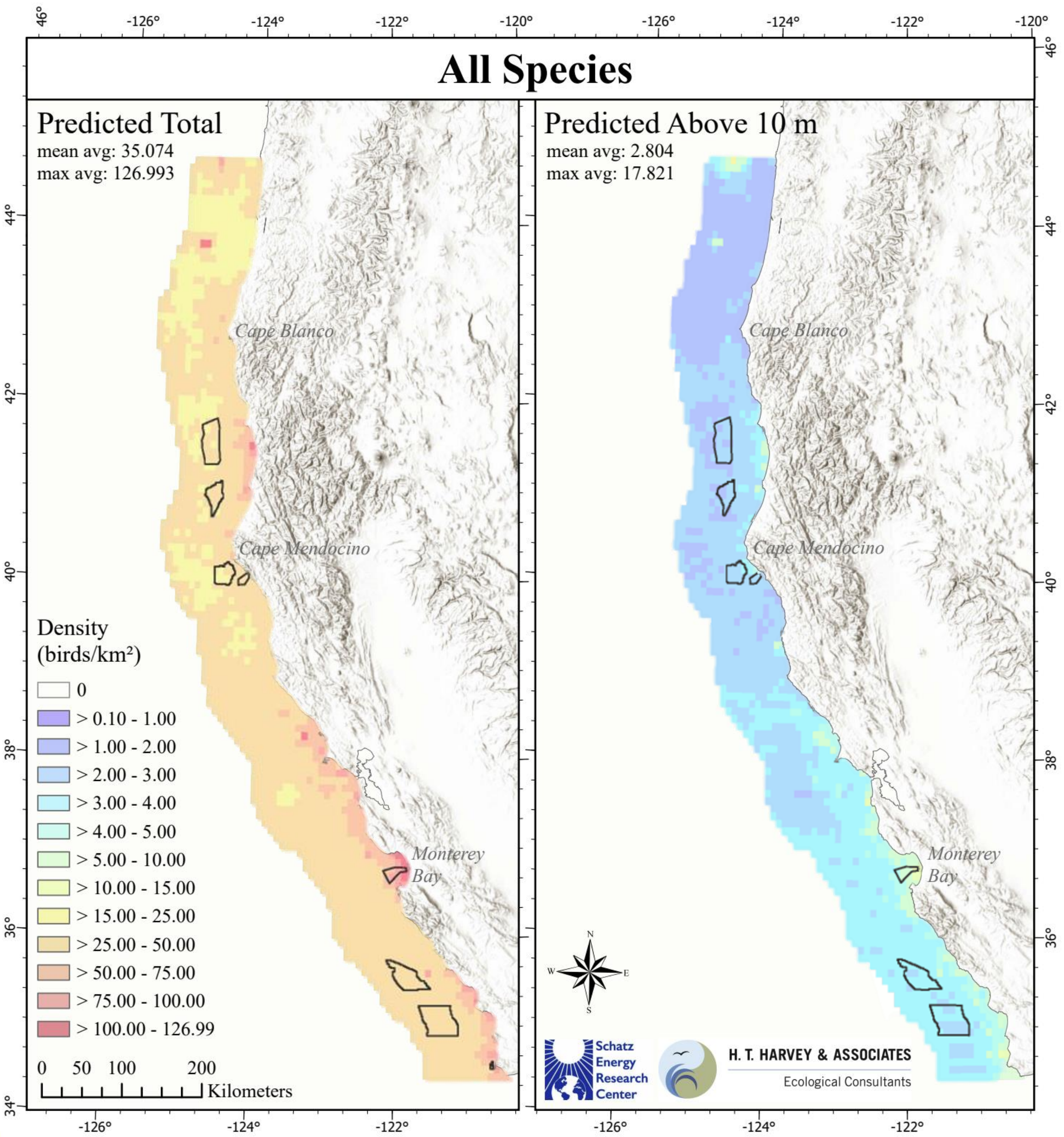
Seabirds in 3D: Wind Speed and Flight Height



Seabirds in 3D: Wind Speed and Flight Height



Seabirds in 3D: All Modeled Bird Species



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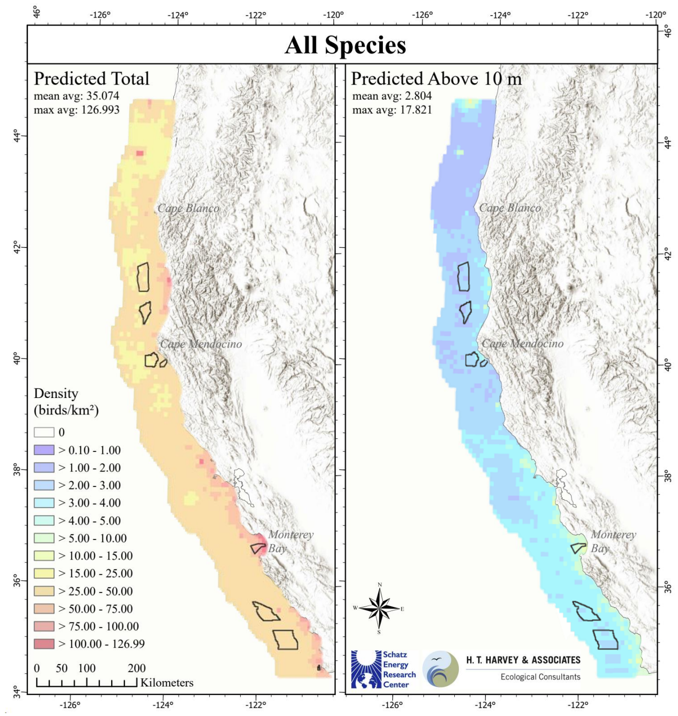
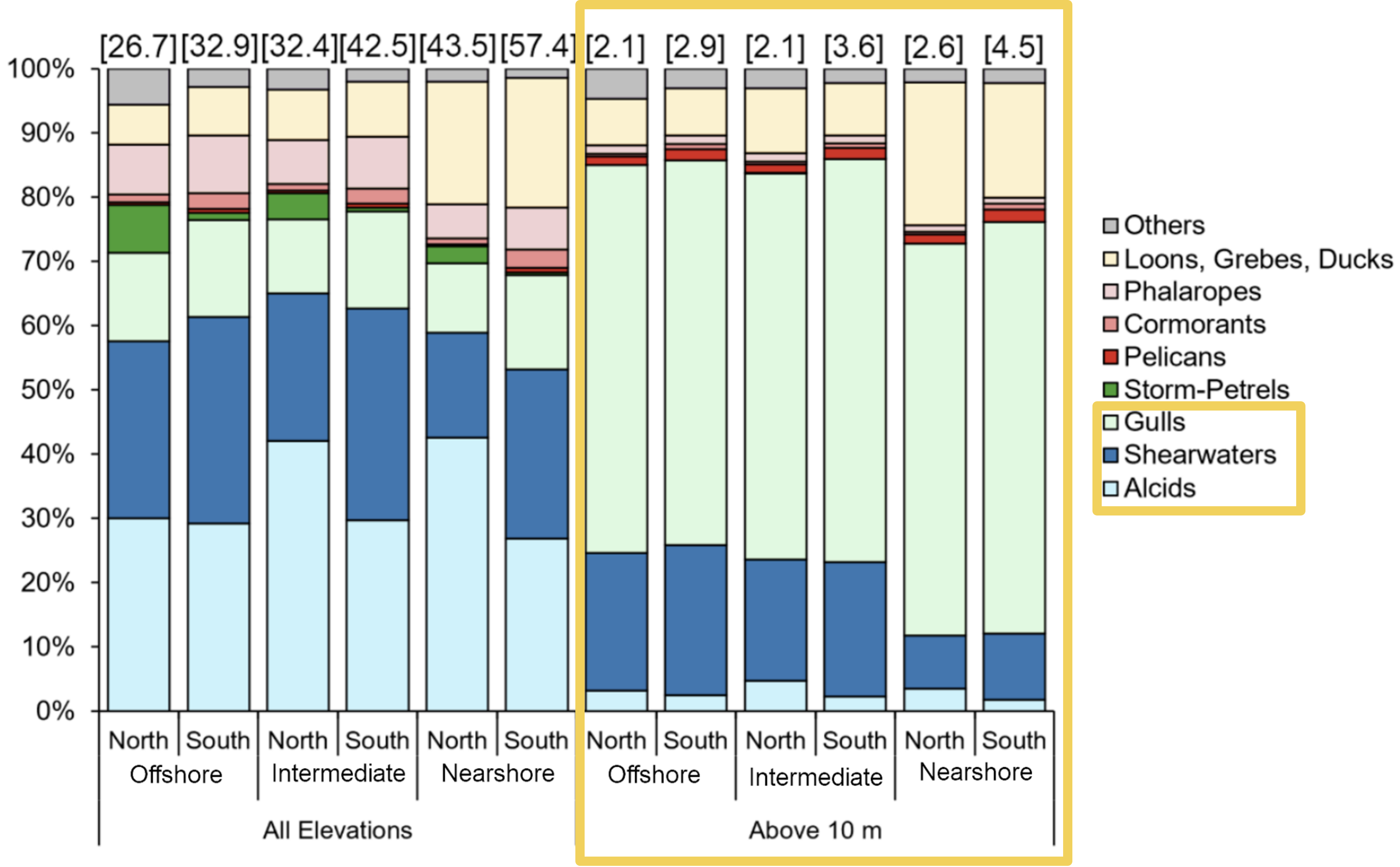
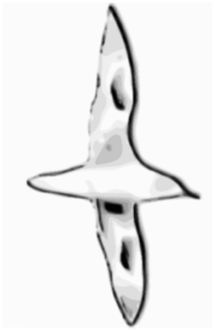
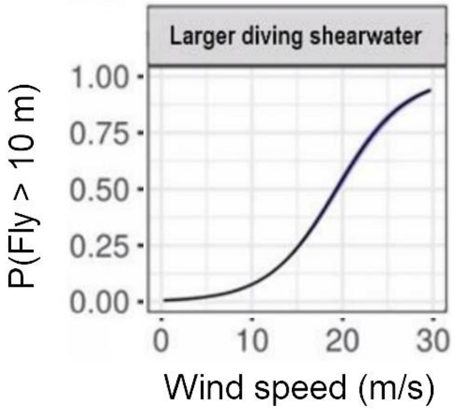


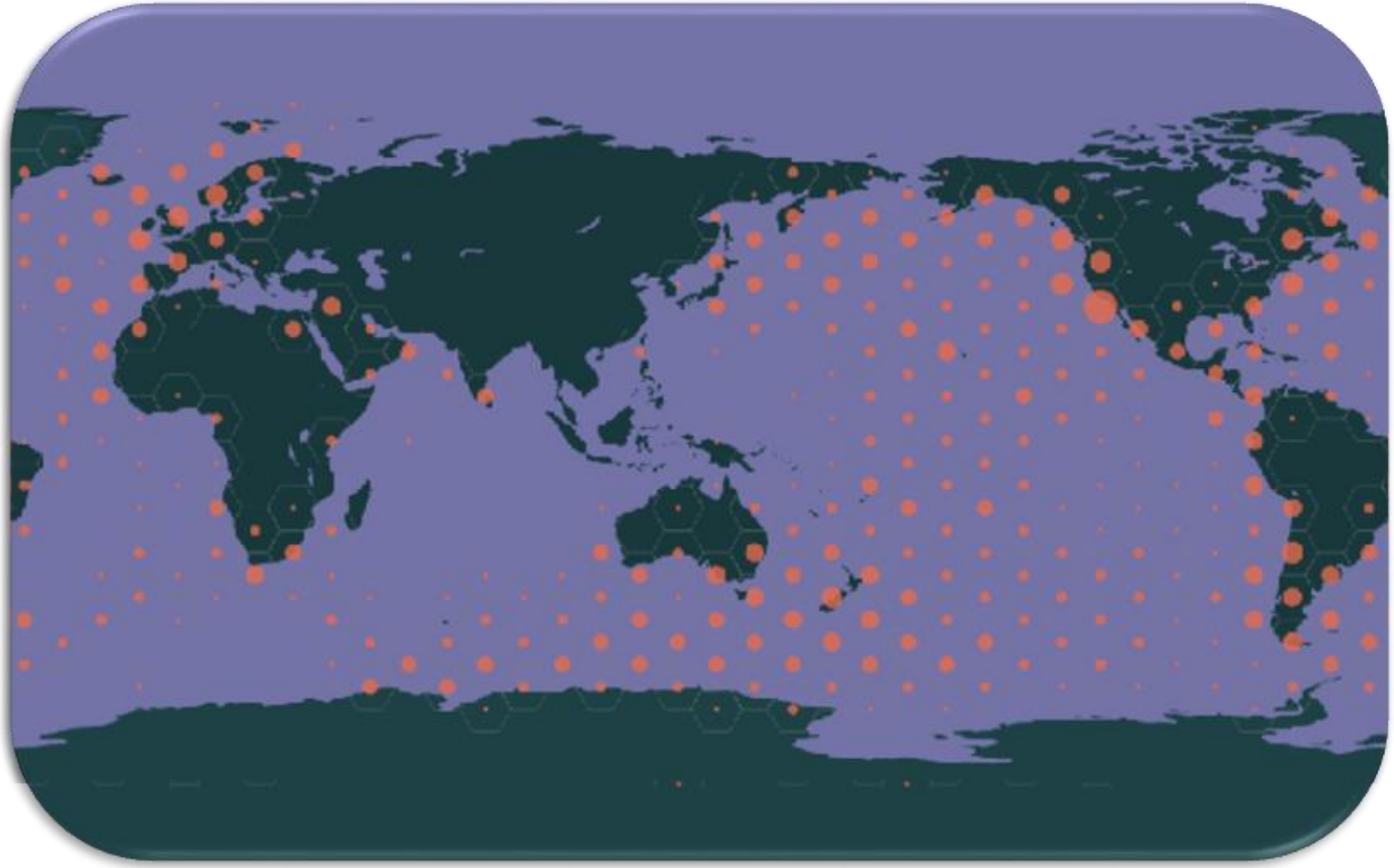


Seabirds in 3D: Sooty Shearwater

Only Sooty Shearwater:

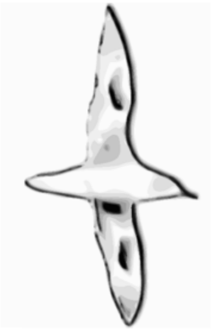


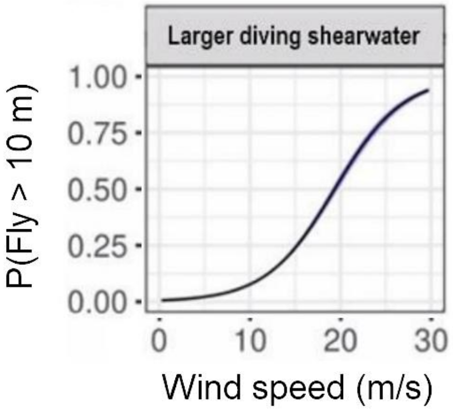




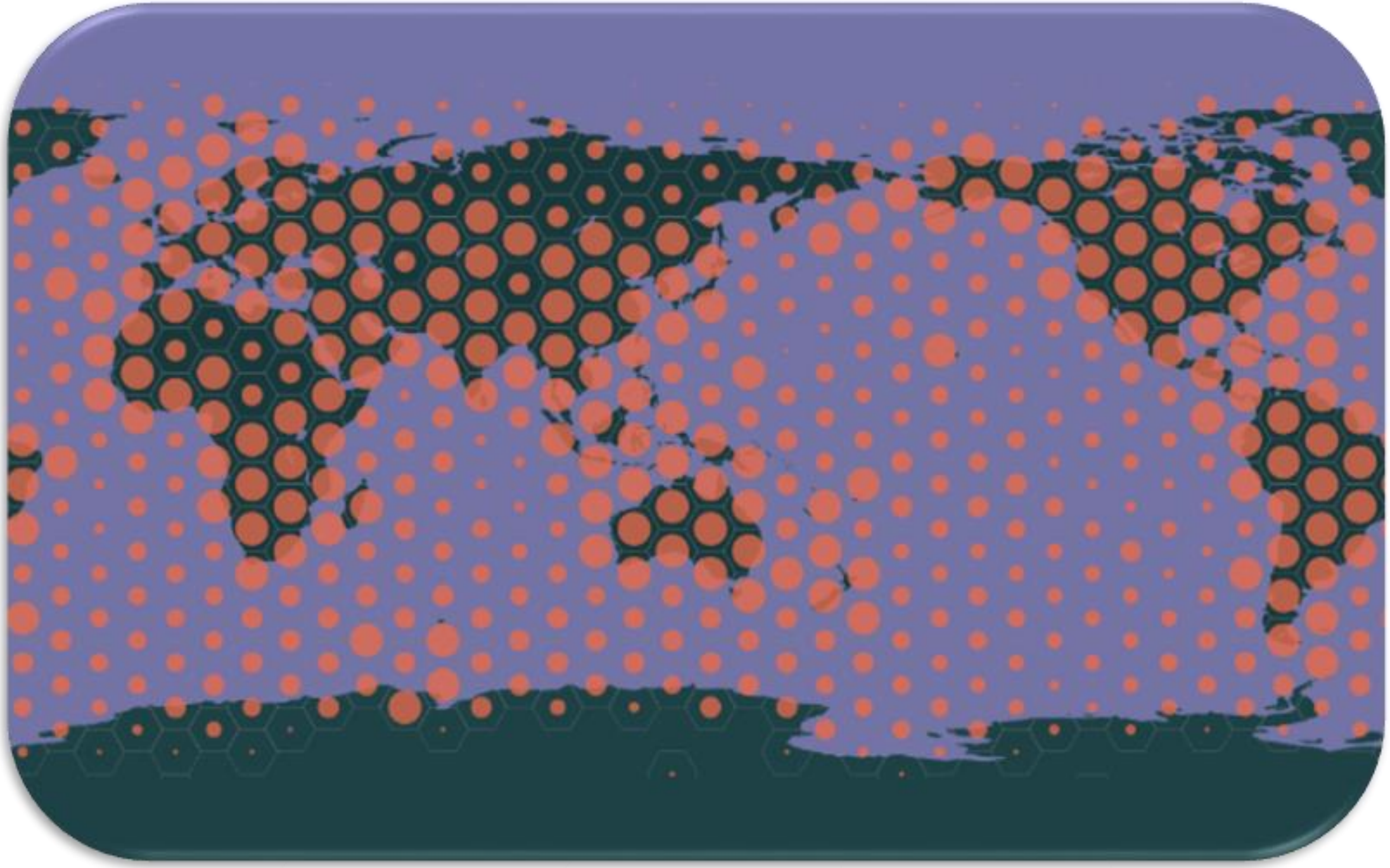
(Map generated using Open Street Maps and Global Biodiversity Information Facility, September 2024)

Seabirds in 3D: Sooty Shearwater





All bird detections in the database:



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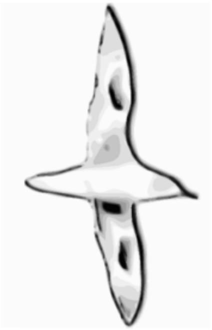


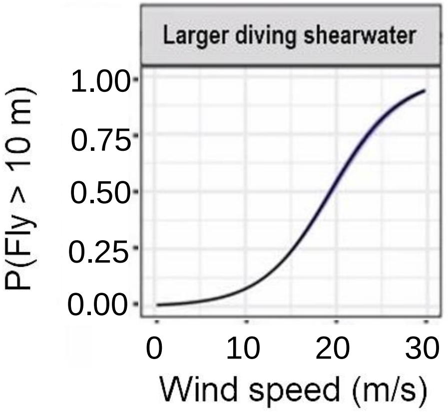
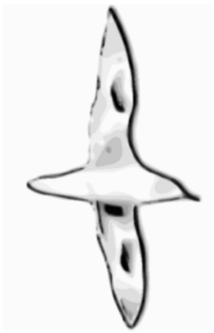
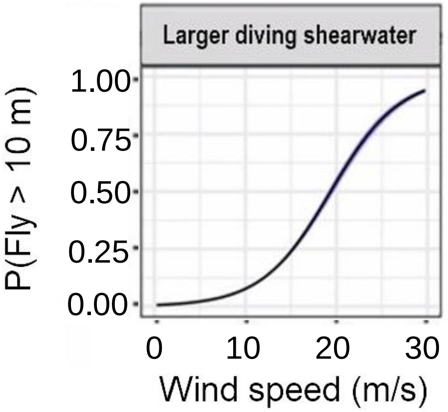
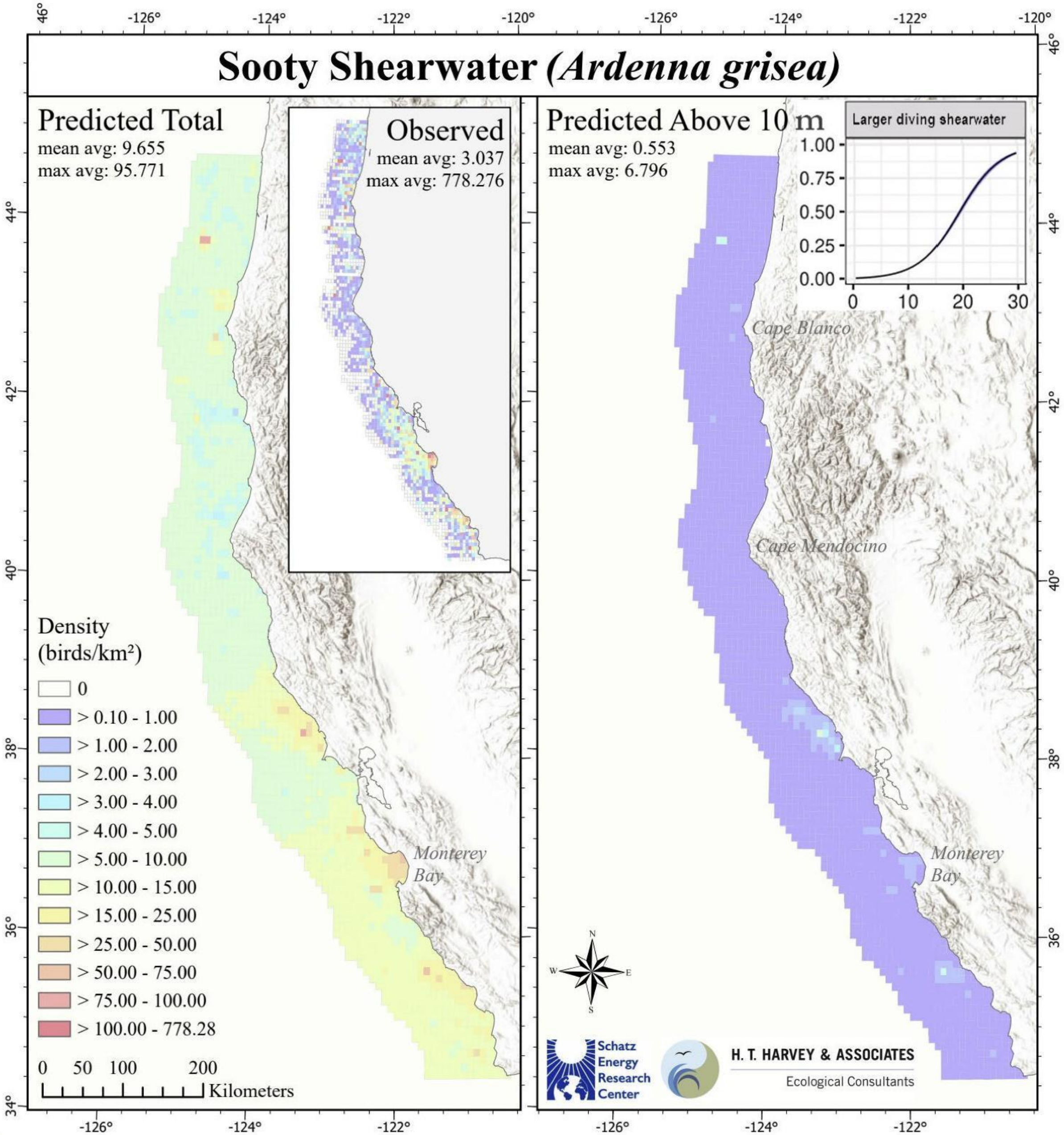


Photo credit: Linda Terrill; Location: Capitola, CA; Date: September 2024

Seabirds in 3D: Sooty Shearwater







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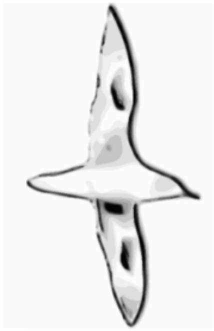
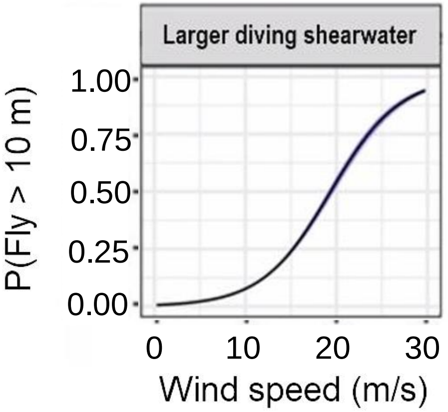
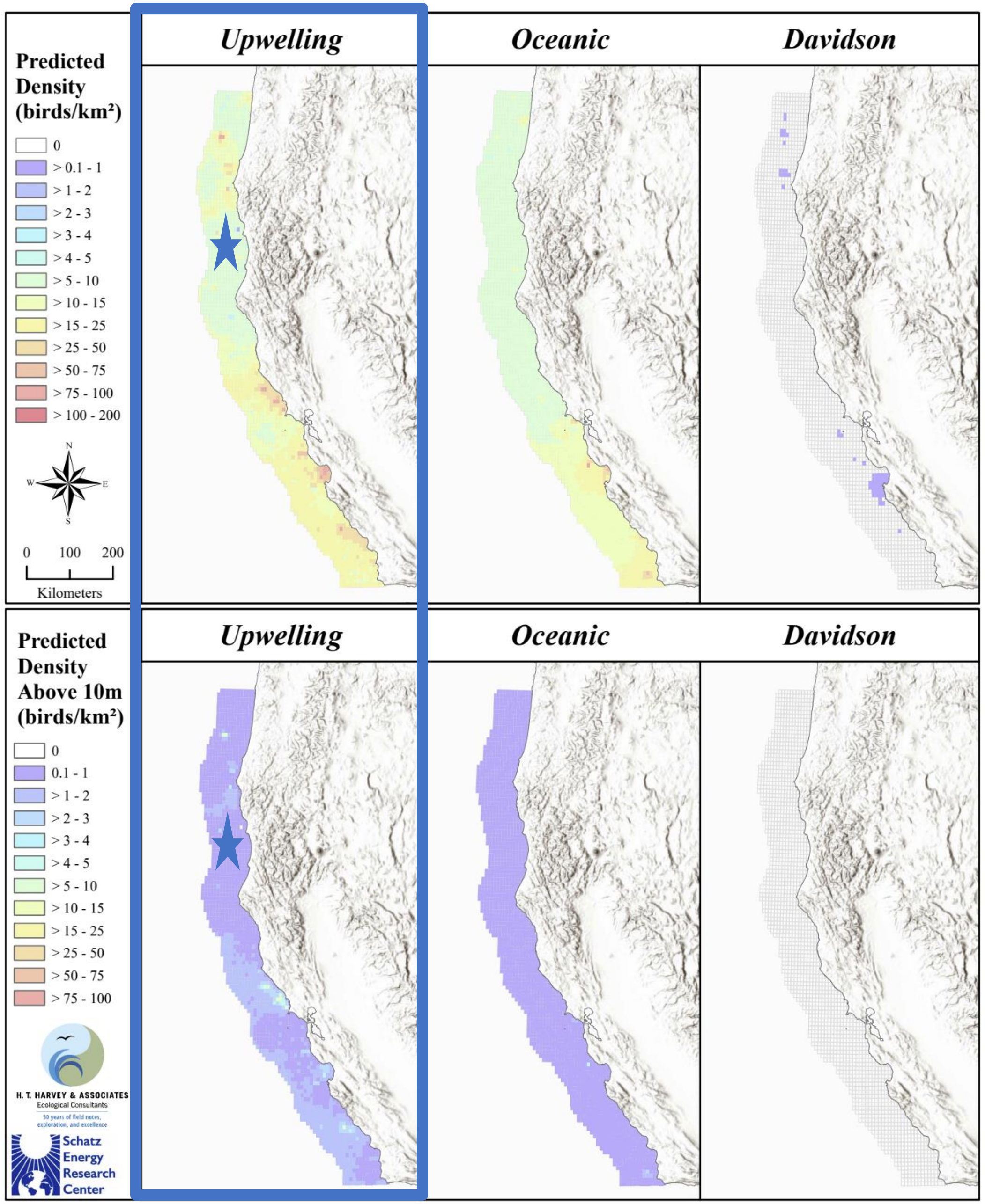
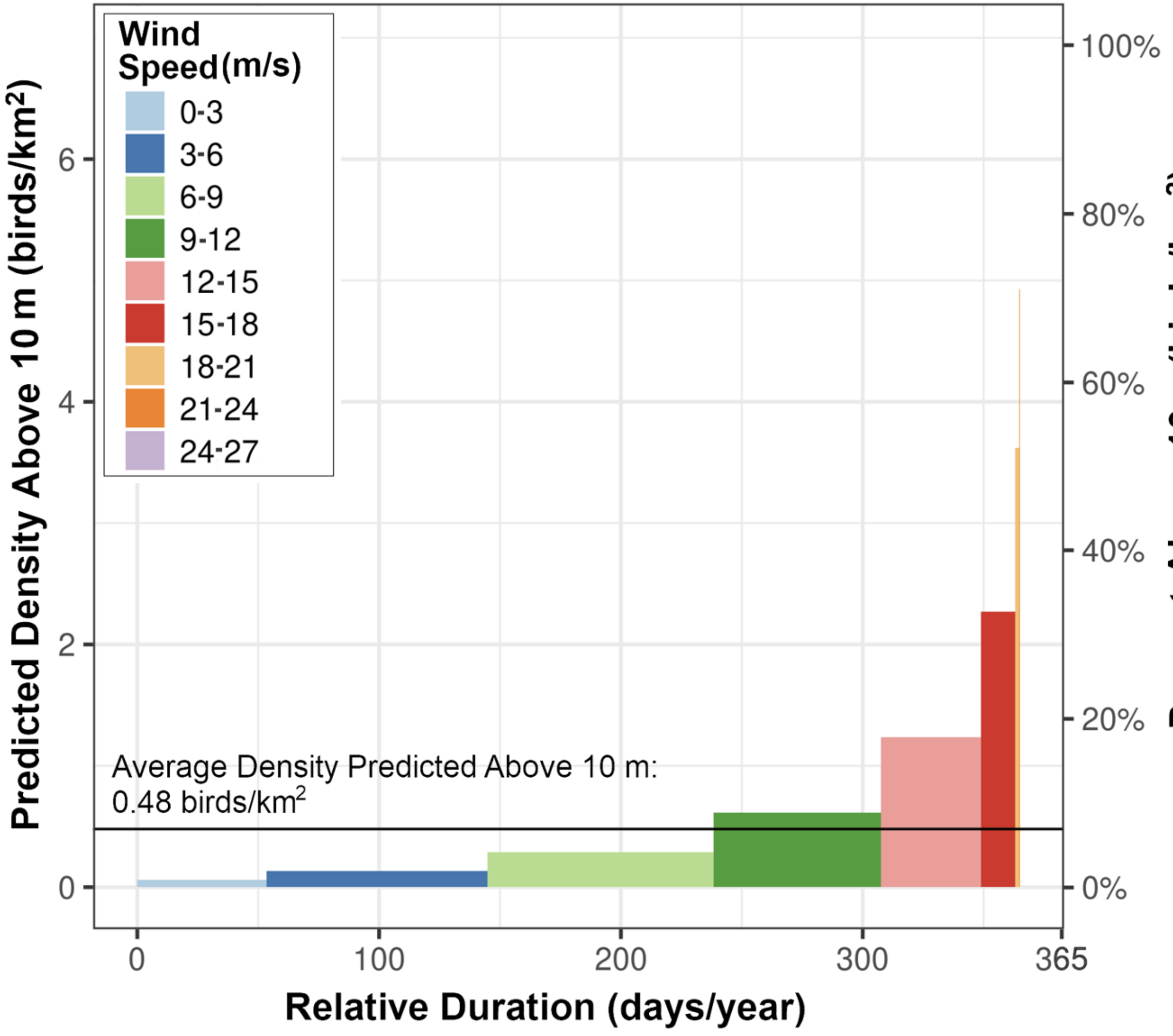
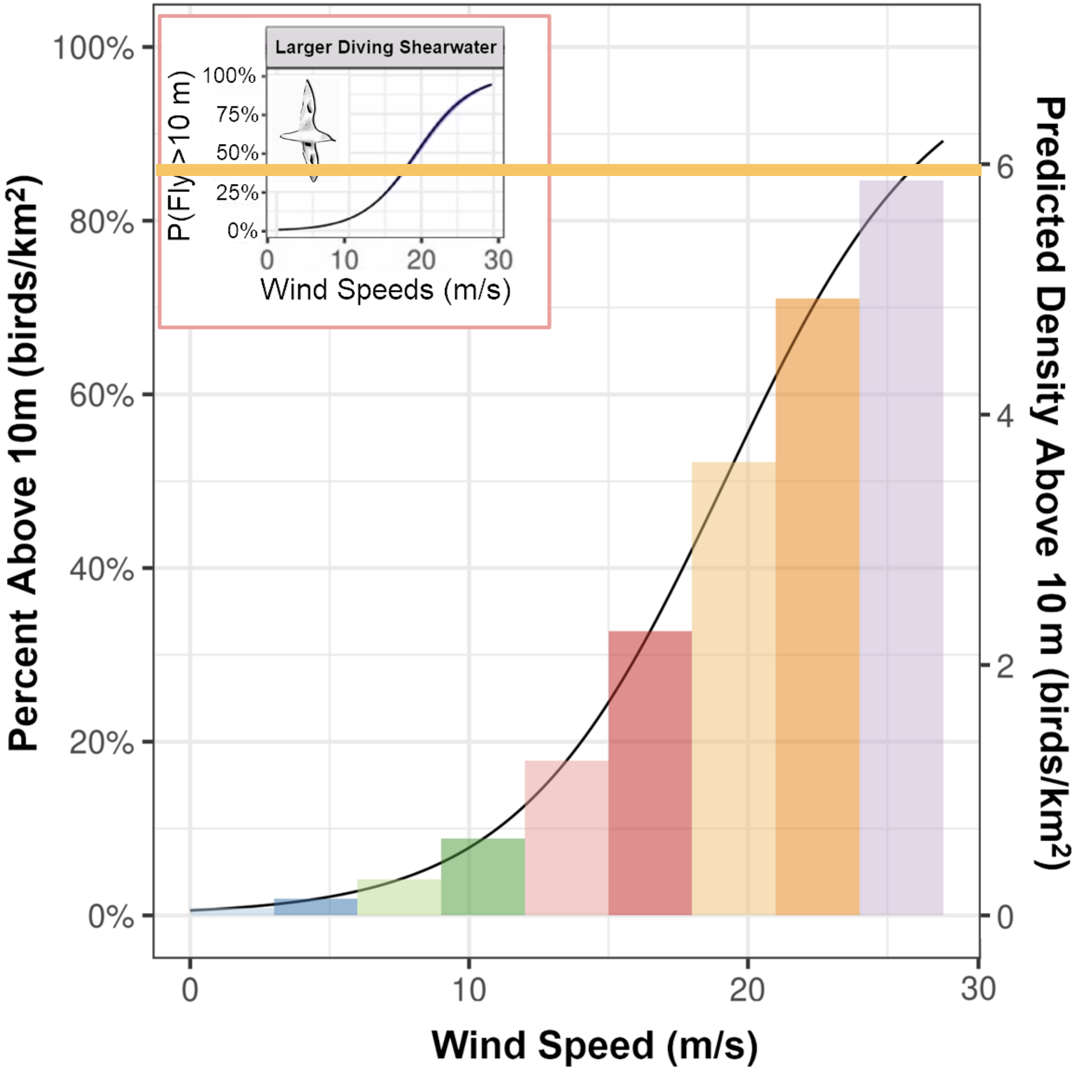






Combining Flight Height relations and 2-D Density





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Seabirds in 3D: 9 Species of Gulls

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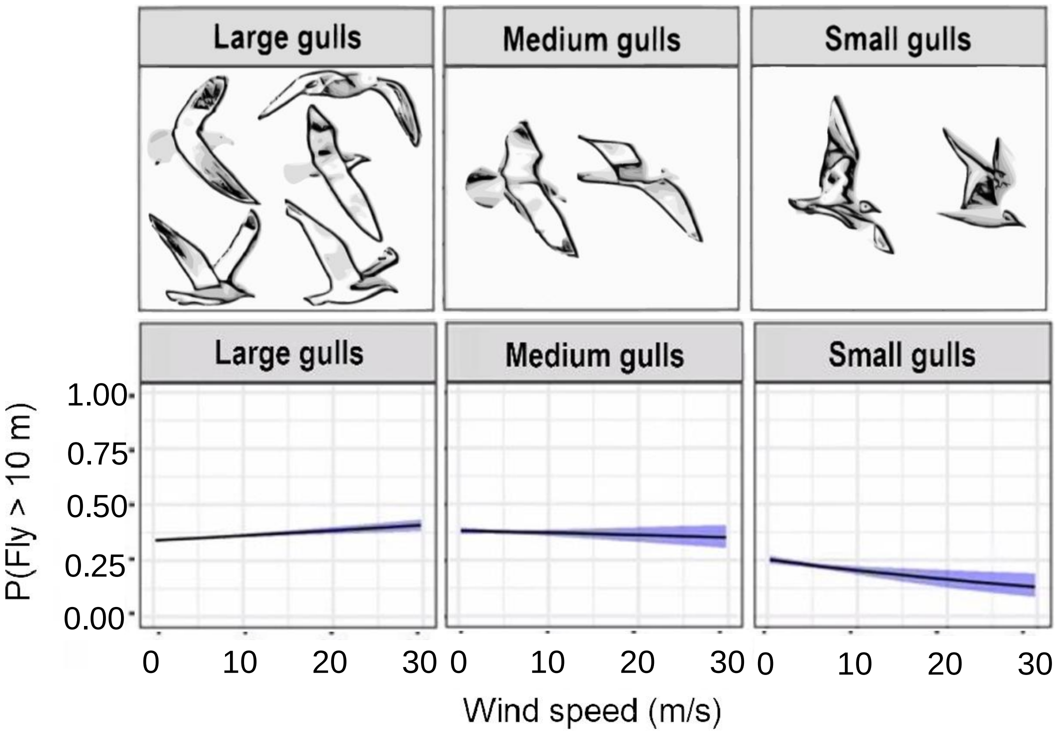
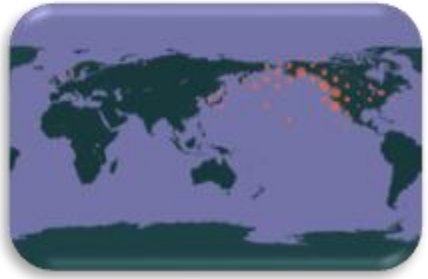


California Gull

Western Gull

Herring Gull

Glaucous-winged Gull



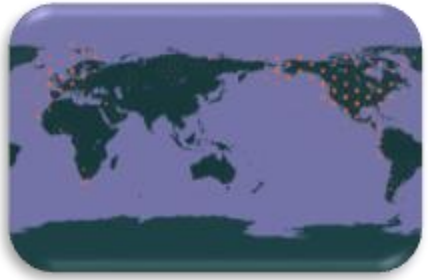
Heermann's Gull

Short-billed Gull

Black-legged Kittiwake

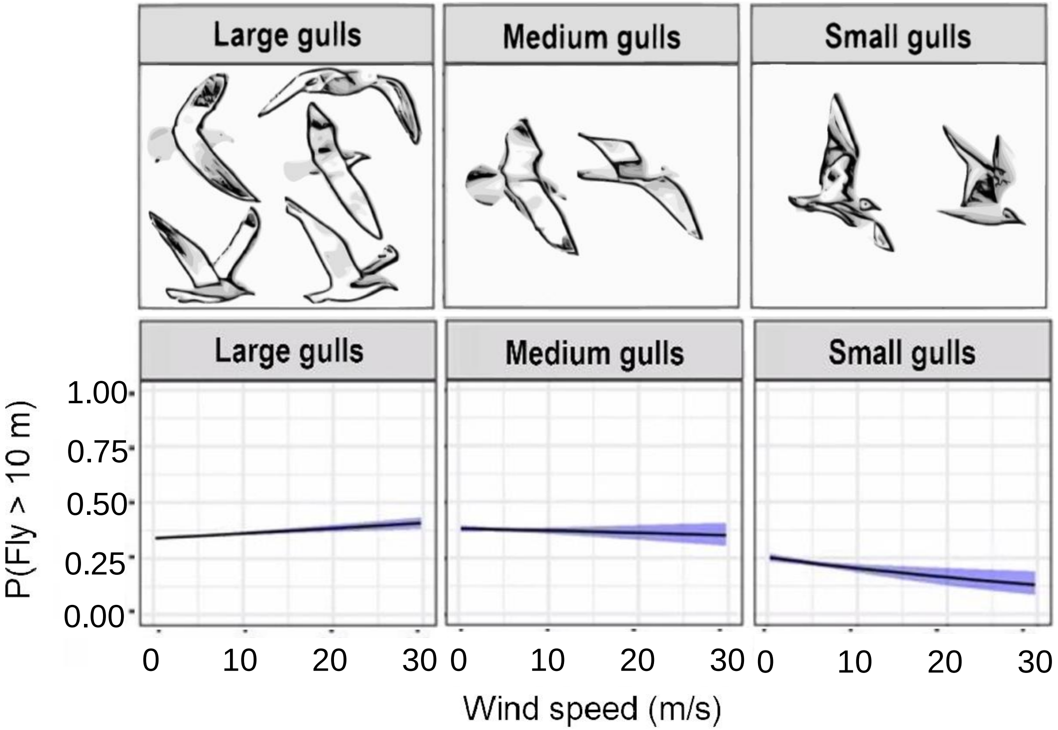
Bonaparte's Gull

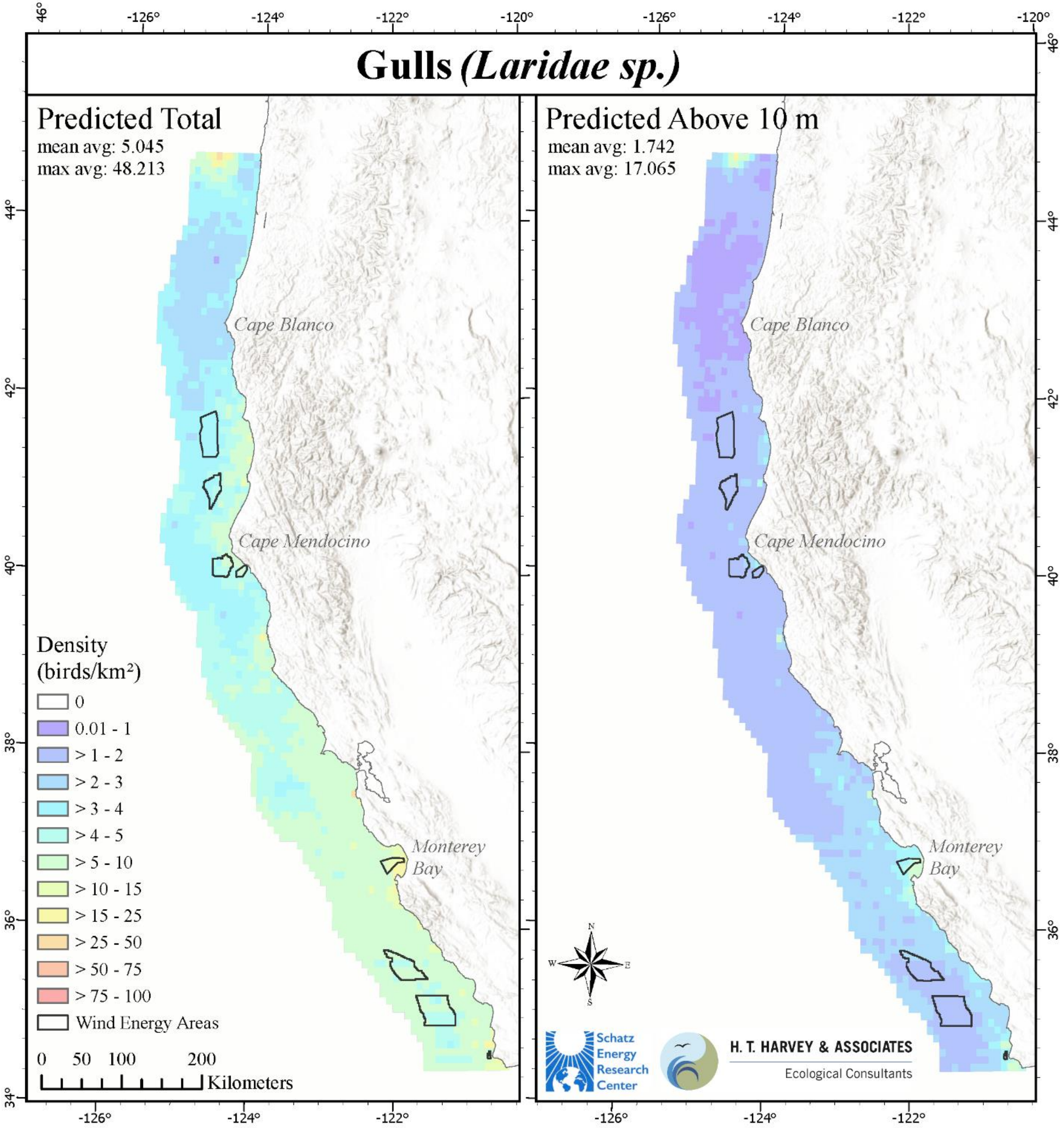
Sabine's Gull



(Maps Generated using Open Street Maps and Global Biodiversity Information Facility, September 2024)

Seabirds in 3D: 9 Species of Gulls





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Seabirds in 3D: Murrelets

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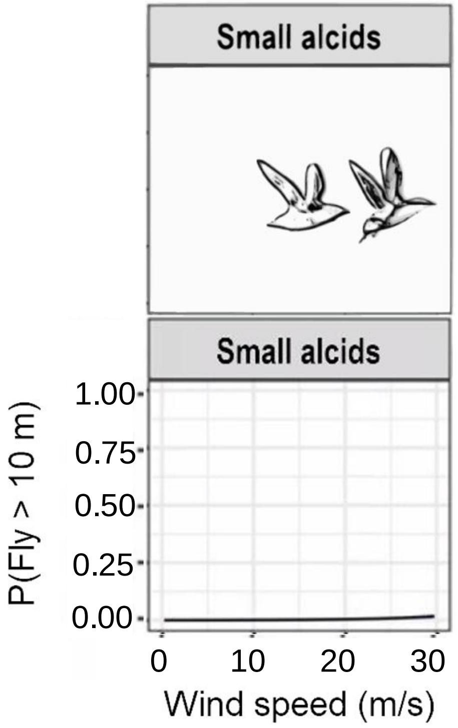


Marbled Murrelet

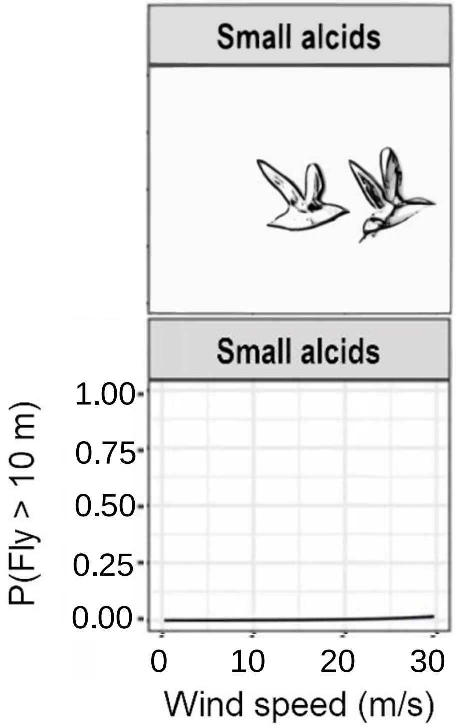
Scripps's Murrelet

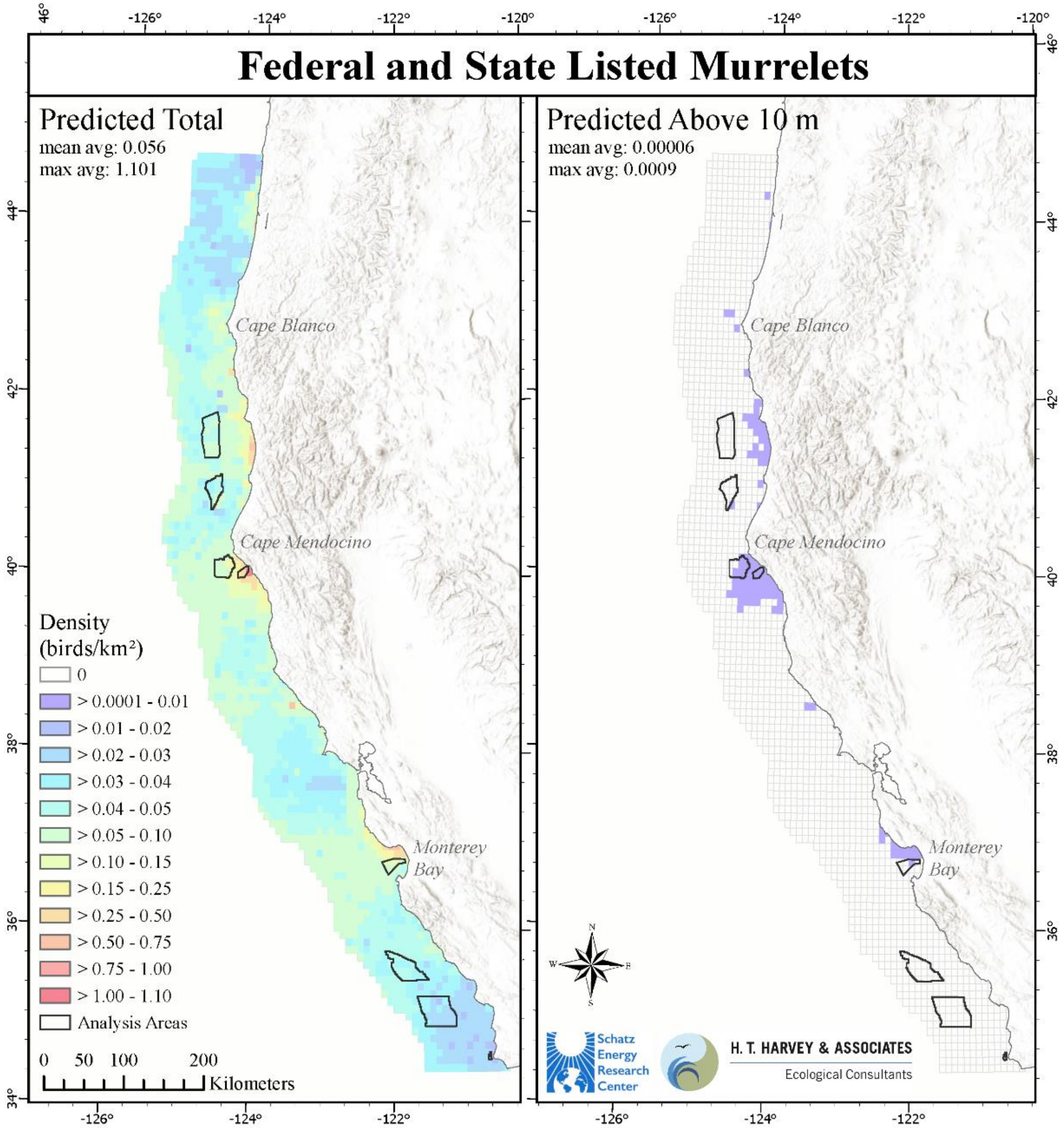
Guadalupe Murrelet

Craveri's Murrelet

(Maps Generated using Open Street Maps and Global Biodiversity Information Facility, September 2024)

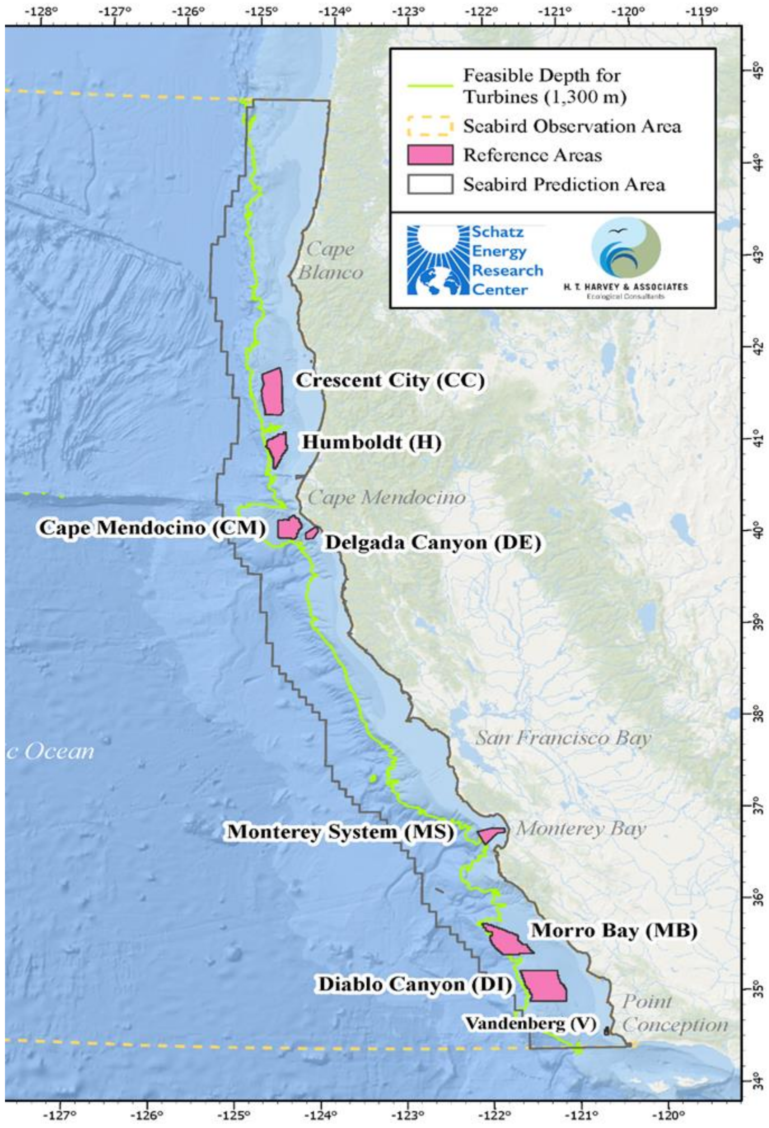
Seabirds in 3D: Murrelets





Power Generation Model

Power Generation Scenarios



Reference Areas

- BOEM Wind Energy Areas (WEAs): Humboldt, Morro Bay, & Diablo Canyon (former call area)
- Notional Areas for Potential Wind Development: Crescent City (POET) & Cape Mendocino
- Proposed Wind Demonstration Project Areas in California State Waters: CADEMO Project @ Vandenburg
- Seabird Hot Spots: Delgada Canyon & Monterey Canyon System (OSW development unlikely)
- Full Coast Analysis considering a single turbine

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Wind Facility Power Generation

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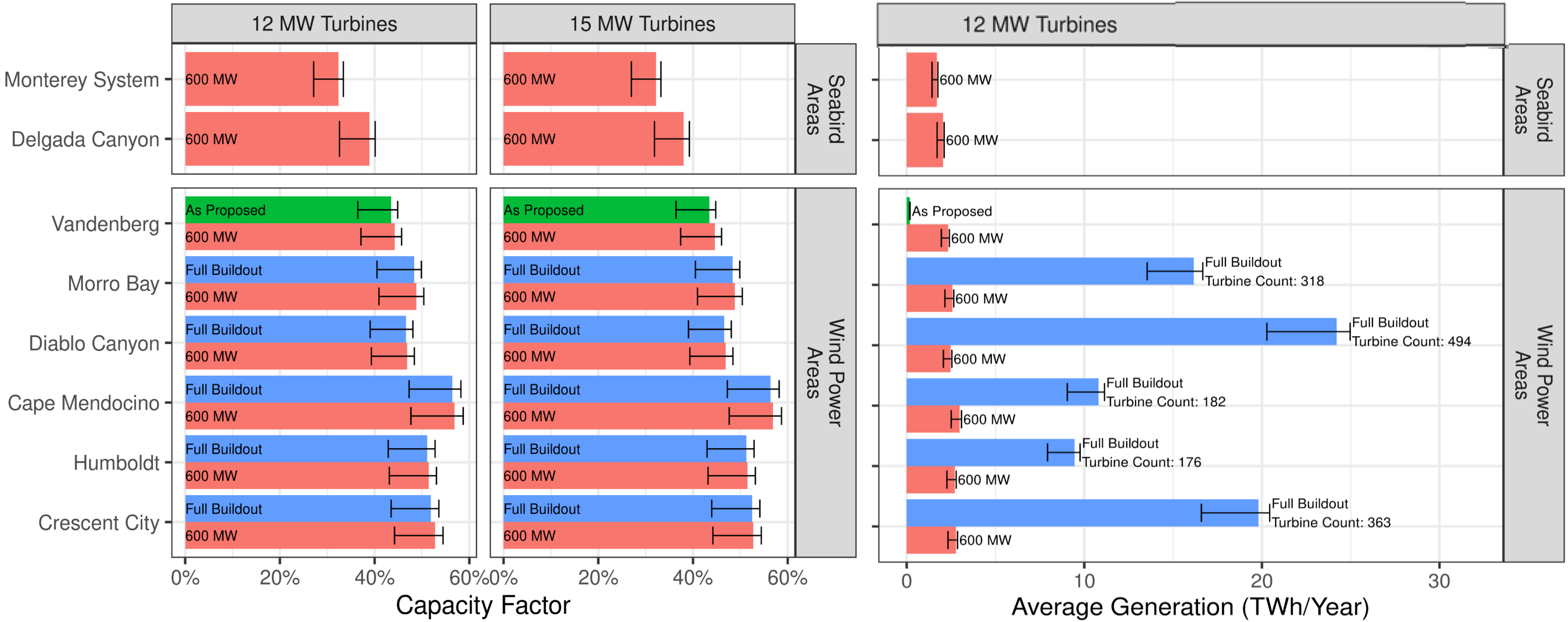
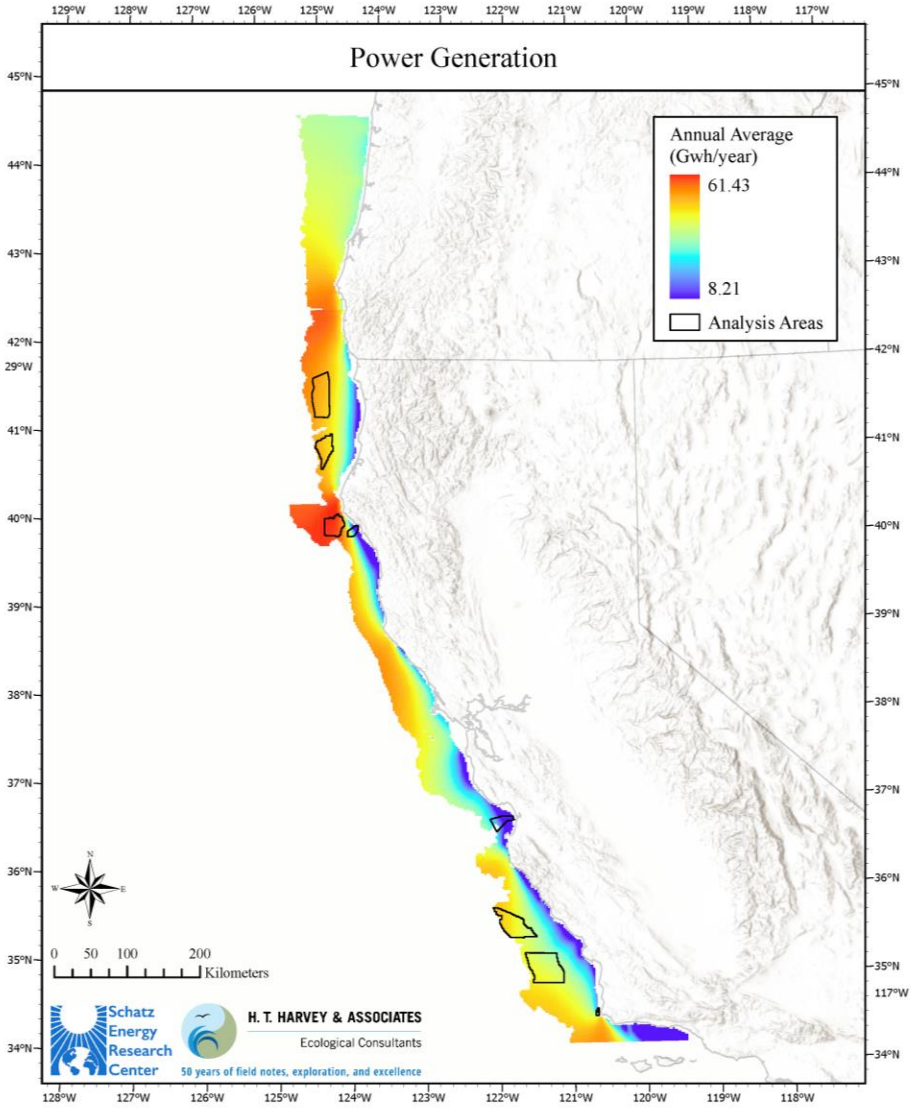


Full Coast Analysis

Results for a single 12 MW turbine in each of the 2x2km grid cells

- Estimated wind generation values for sites as deep as 1300 m
- Capacity factors are slightly higher than for actual windfarms as wake losses are not considered
- The generation potential is generally better further offshore
- Best wind resource is available offshore of Cape Mendocino and Southern Oregon



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Tradeoffs Between Power Generation and Seabird Vulnerability

Pareto Analysis - Introduction

Why Pareto Analysis

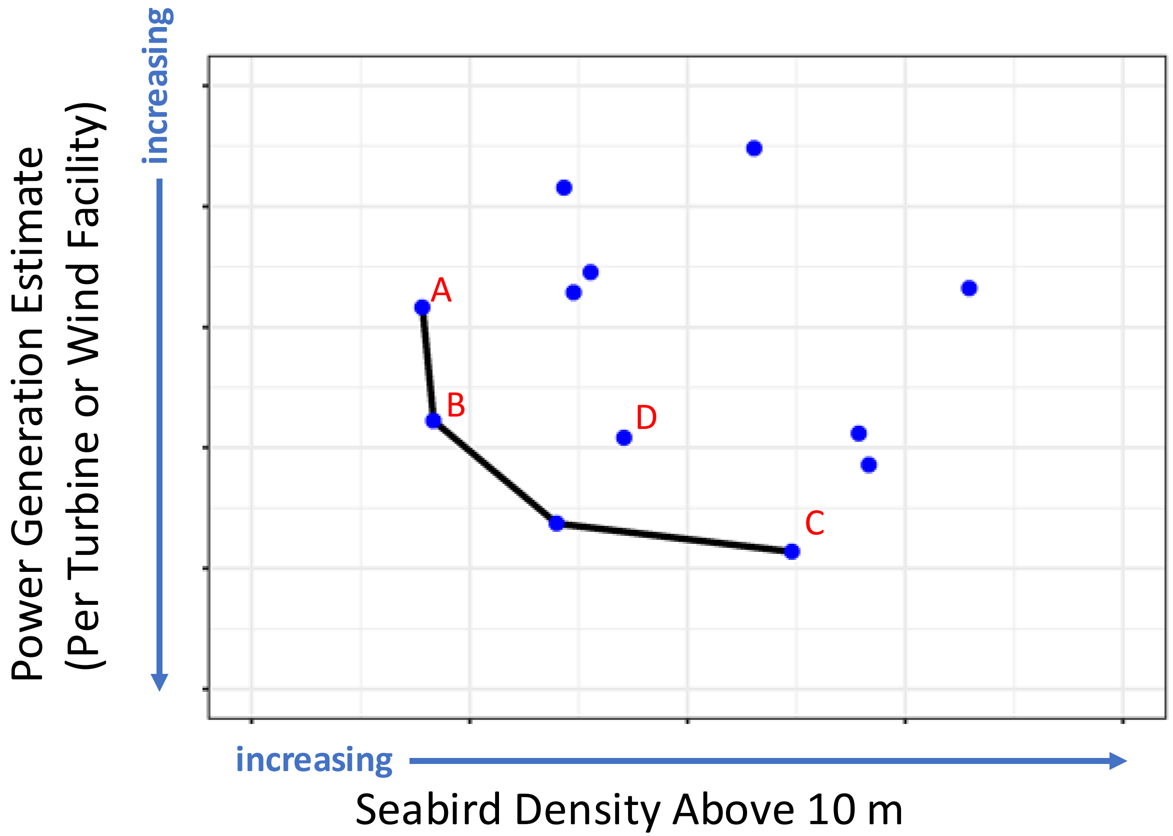
- Commonly used for multi-objective decision making
- Enables comparison of marginal benefit between alternatives
- Does not require assigning weights to each objective

Pareto Analysis Framing

- Typical to maximize or minimize both objectives
- The metrics used are (i) inverse annual energy generation and (ii) seabird density above 10 m

Conceptual Example of Pareto Analysis

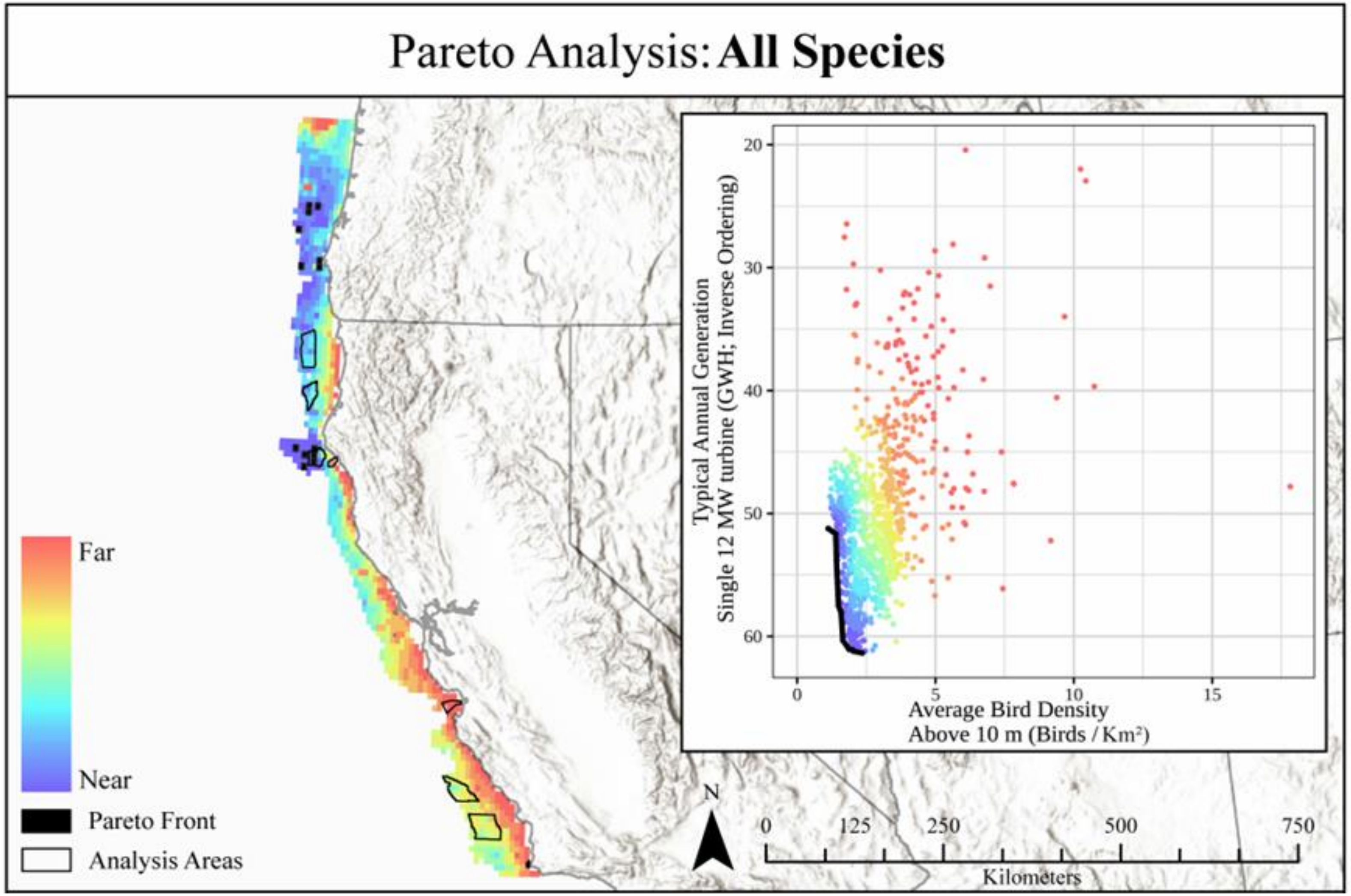
- Pareto Efficient alternatives shown with a black line – the Pareto front
- Alternatives to the left have lowest seabird vulnerability
- Alternatives to the bottom have the highest wind energy generation



Pareto Curve Results - All Species

- Each point represents a grid cell with a single 12 MW turbine
- Dark (purple) areas on the map indicate alternatives near to the Pareto front
- Lighter (red) areas indicate alternatives far from the Pareto front

- Areas far from shore and to the North in our study area show the best performance.
- Areas off Cape Mendocino have the best generation potential, while areas off the Oregon coast show the lowest prevalence of seabirds.



Pareto Curve Results - Sooty Shearwater

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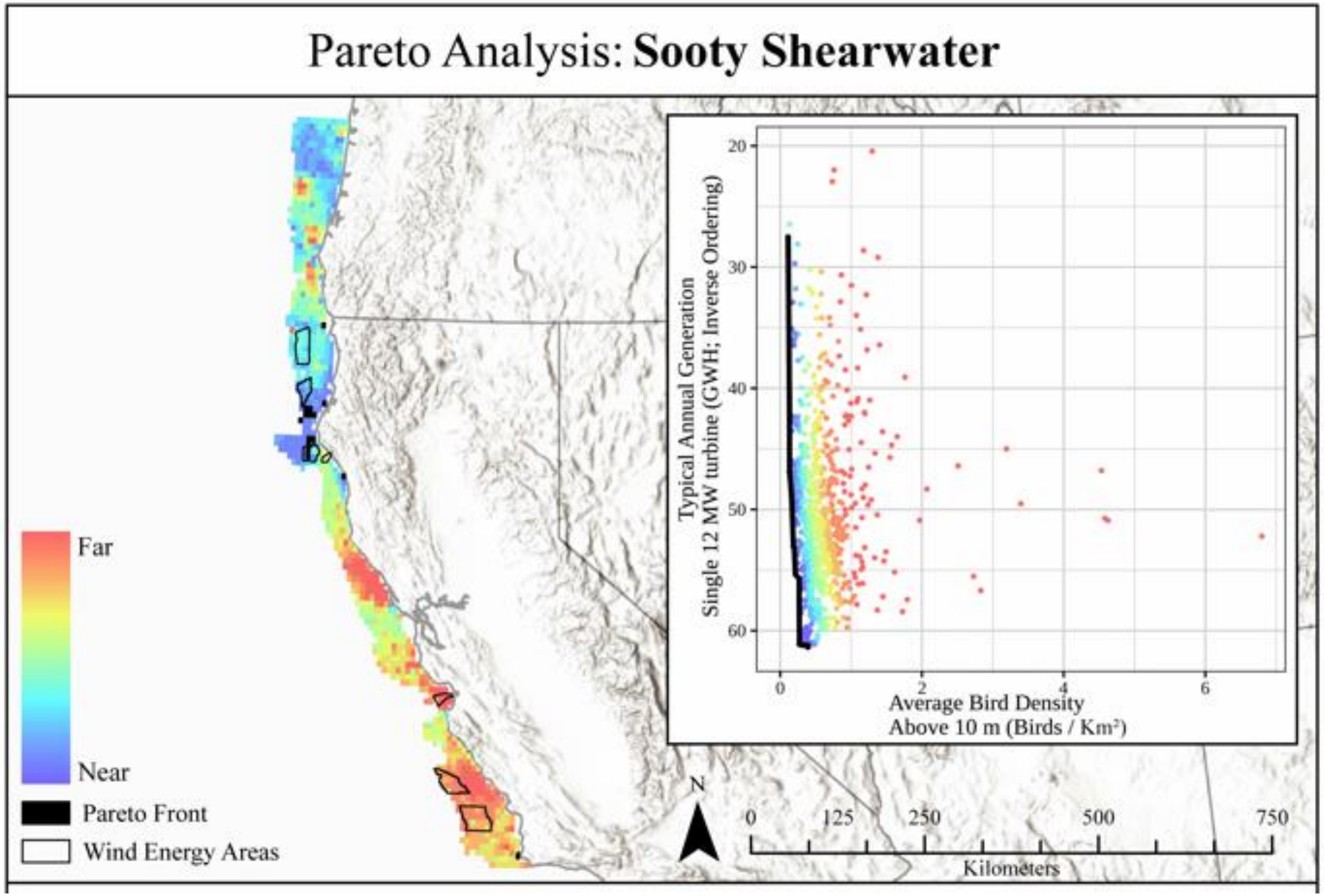
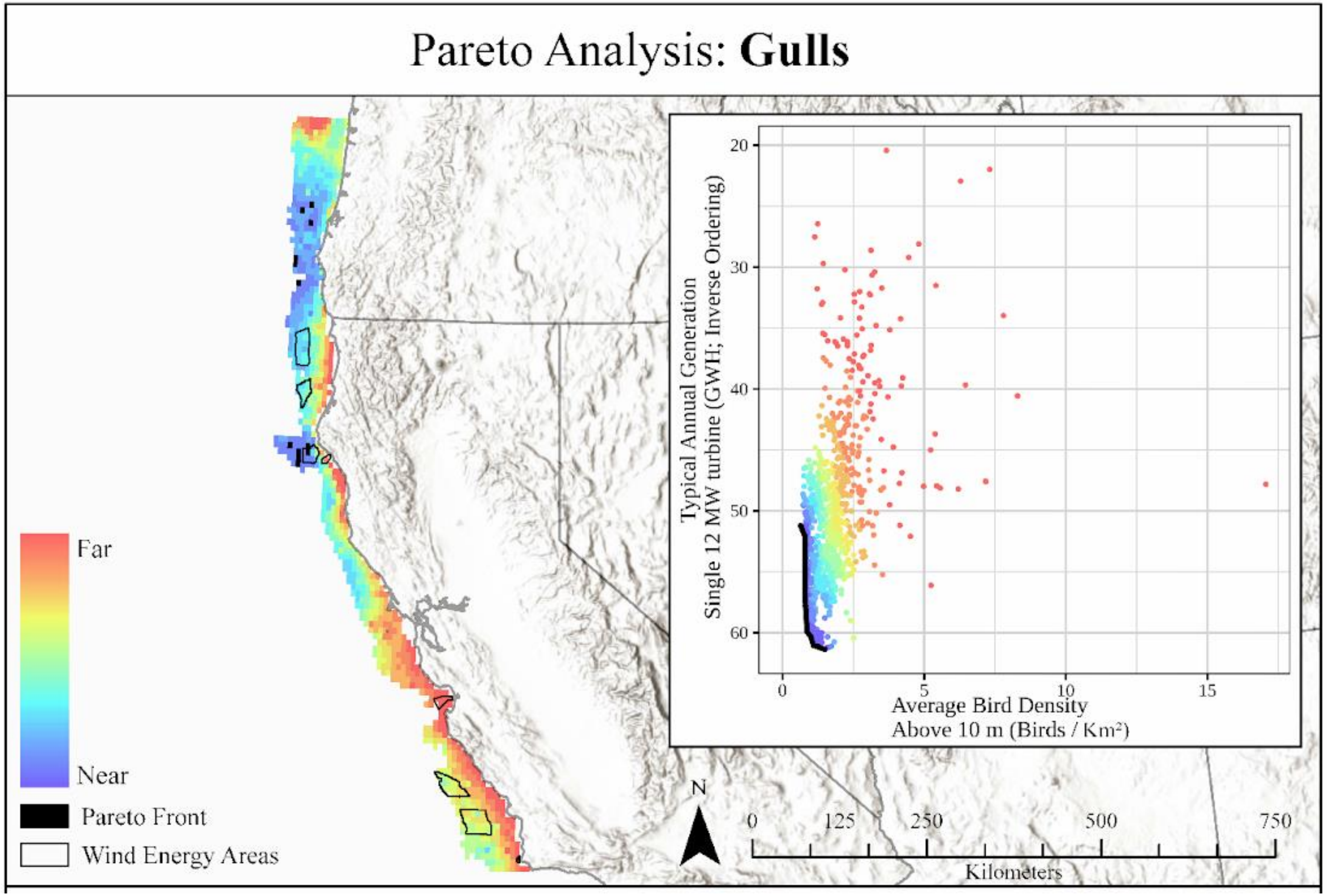
- Sooty Shearwaters are of greater concern given their dynamic soaring flight-style
- These birds only achieve RSZ-heights in uncommon wind conditions (e.g., > 20 m/s for 50% probablity of being > 10 m)
- This leads to low average density estimates above 10 m (<7 birds per km^2)
- These birds are more likely to fly offshore, with relativity dense populations predicted offshore primarily in southern regions



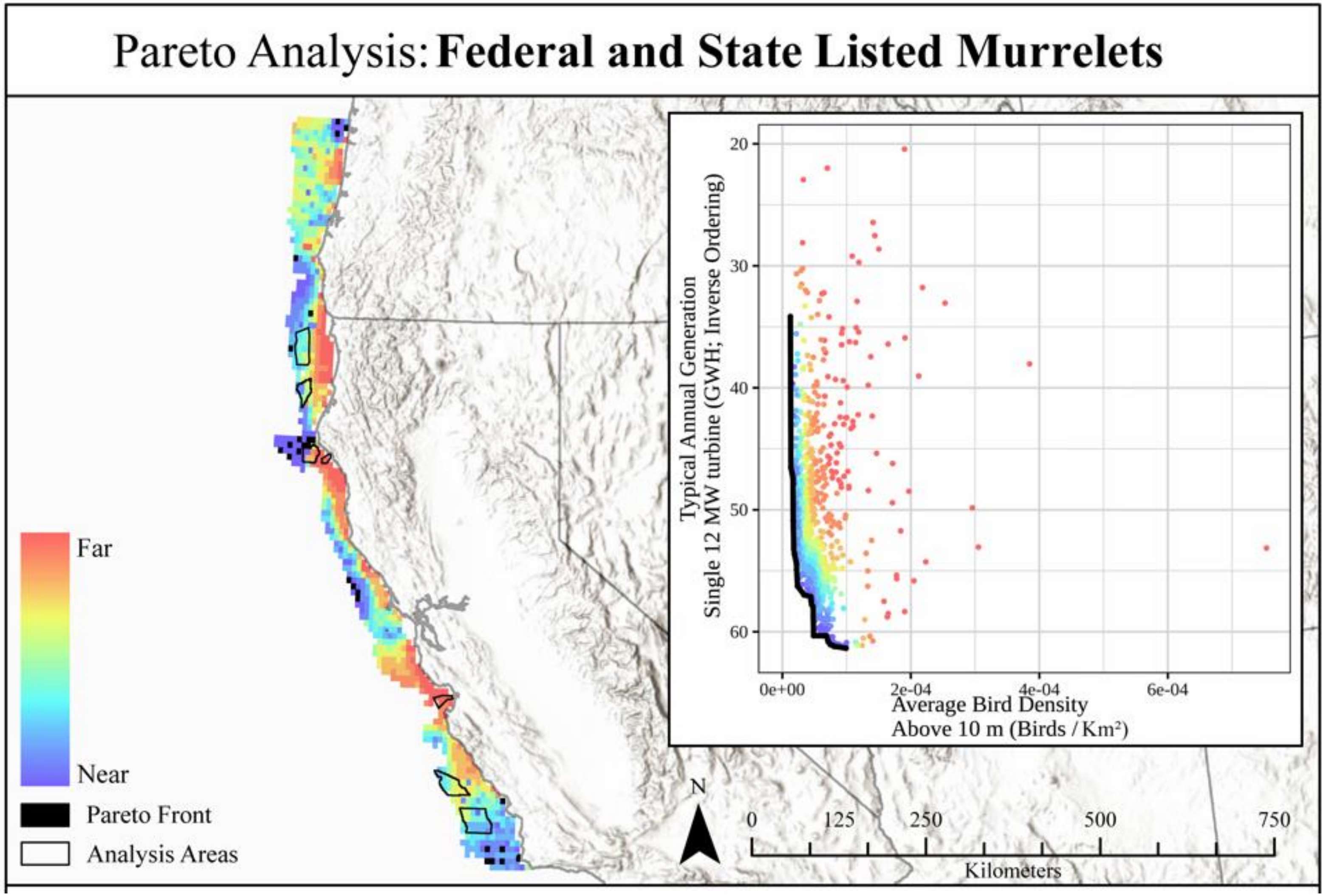
Pareto Curve Results - Gulls

- Gulls make up much of the total vulnerability of all bird species, thanks to their propensity to fly above 10 m in a range of wind conditions
- Our estimates show above 50% of seabirds present over 10 m are gulls
- Gulls tend to concentrate more closely to shore and in the warmer waters in the south of the study area



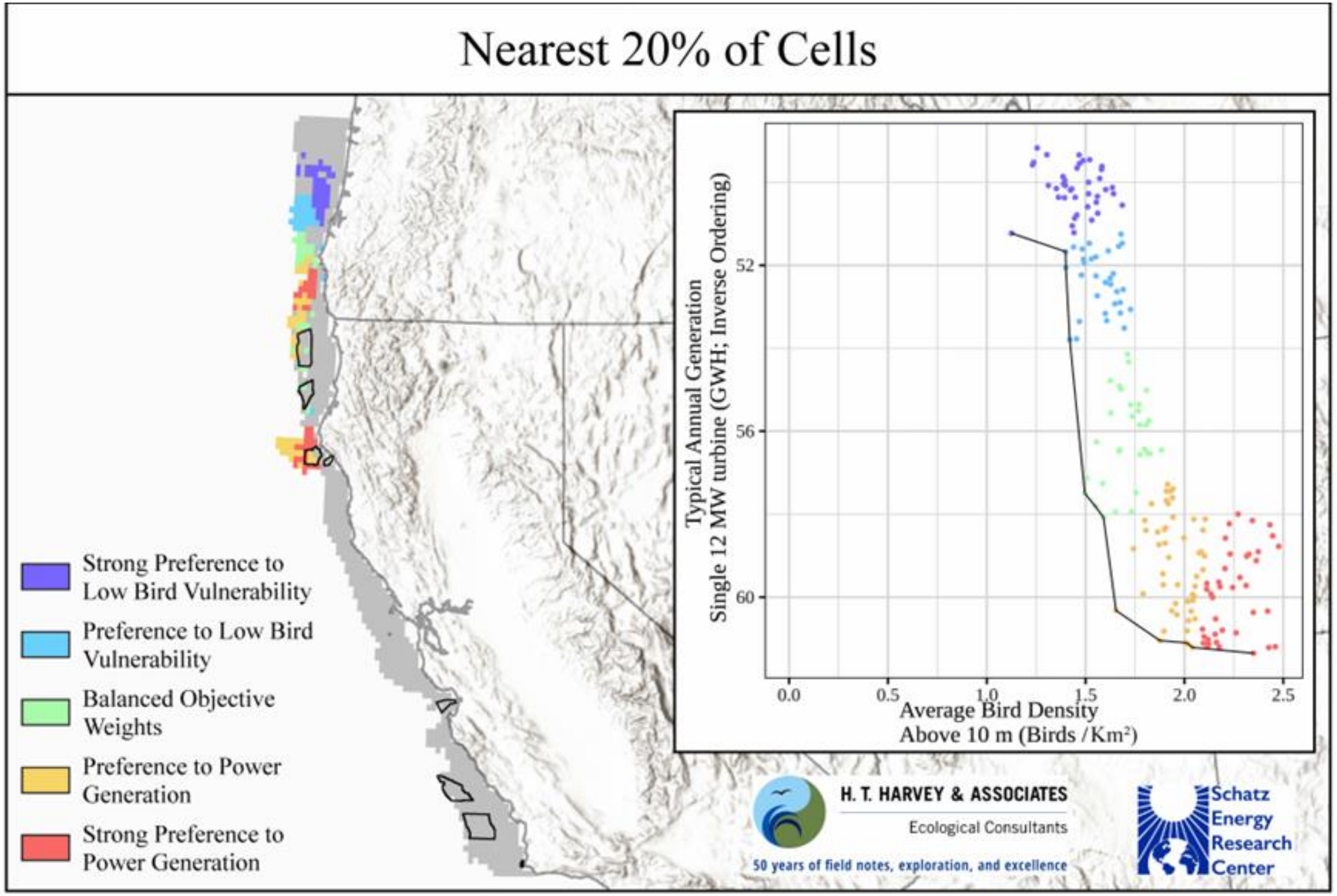
Pareto Curve Results – Federal & State Listed Murrelets

- Murrelets have low propensity to enter RSZs and generally remain nearshore
- Our estimates show above a very small percent of seabirds present over 10 m murrelets
- Max density estimates are less than 0.001 birds per km^2
- Southern extent has the lowest vulnerability

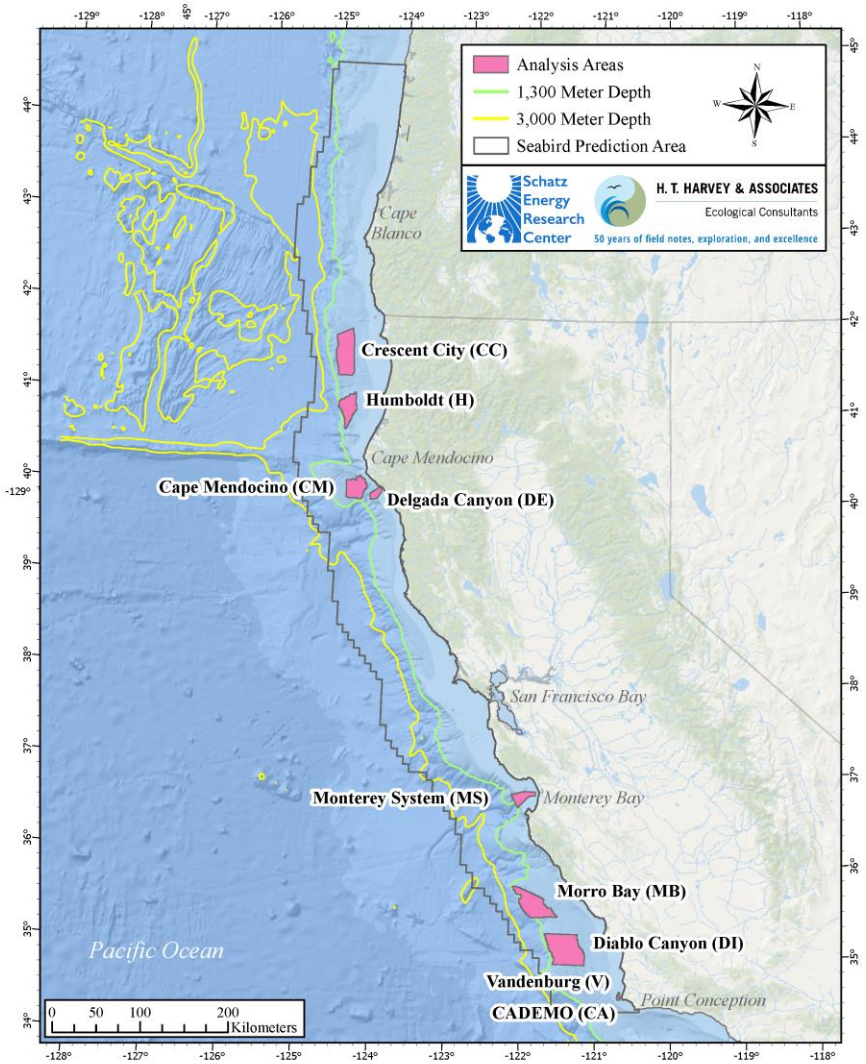


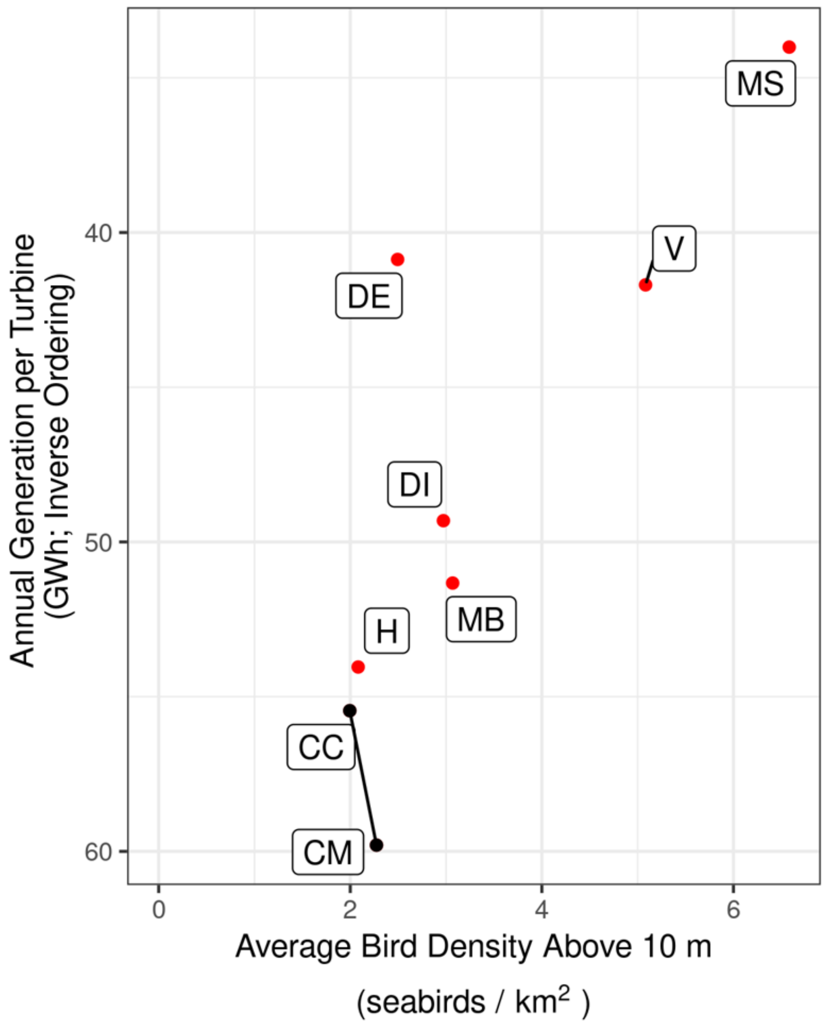
Pareto Curve Results
Simple Grouping – All birds

- Zoom in on the 20% of alternatives nearest Pareto front
- Grouped and colored to show which metric is favored
- The shape of the Pareto curve suggests picking an alternative which falls near the "knee" of the plot
- Alternatives near the knee (yellow) have near to maximum performance in both metrics. These areas are off Cape Mendocino and offshore of the California-Oregon boarder

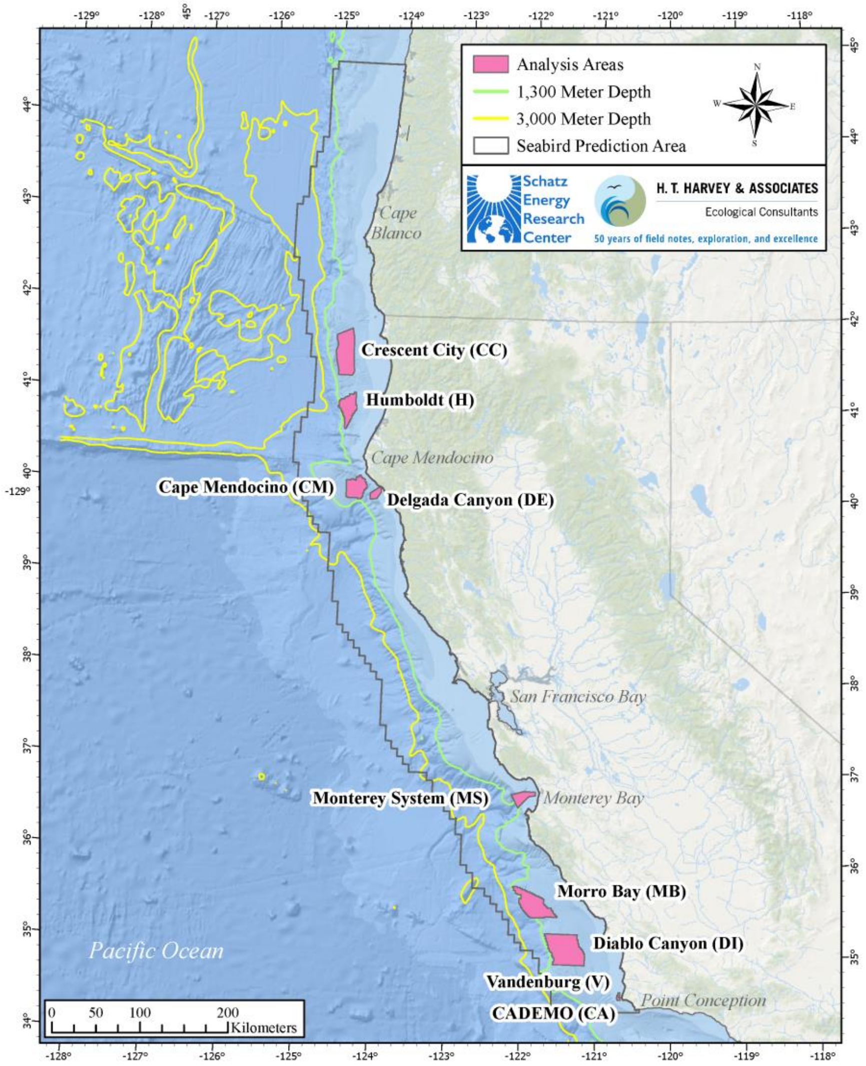


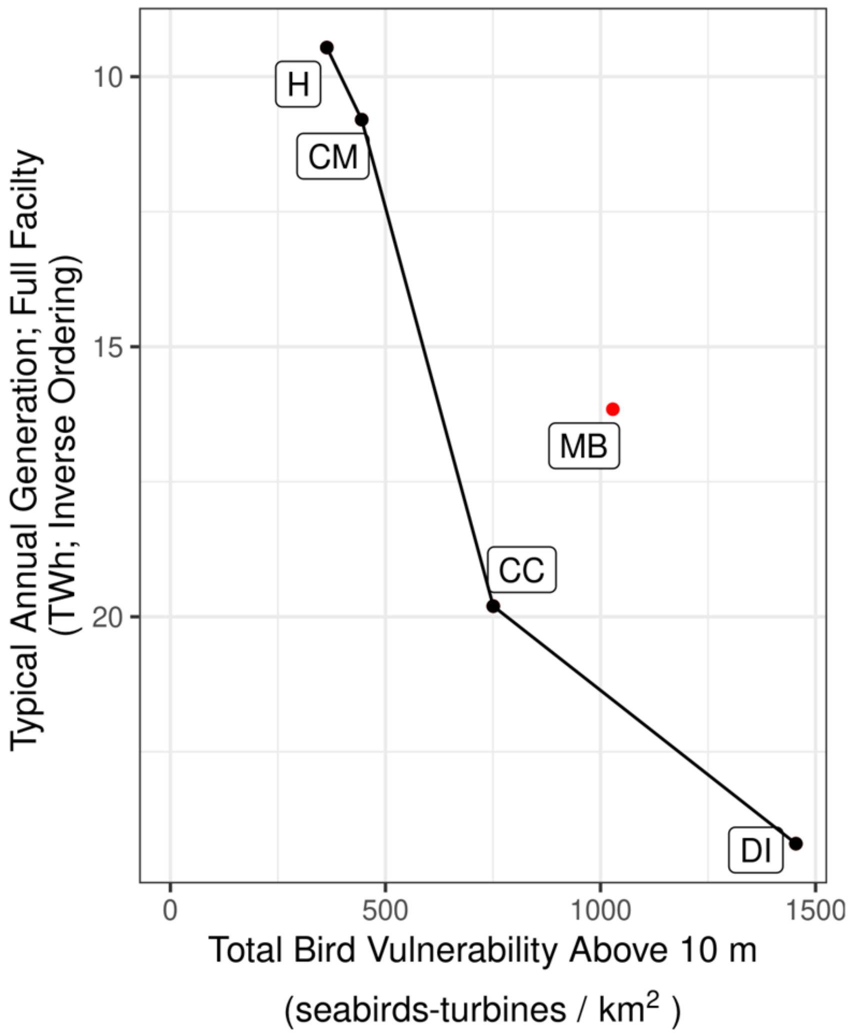
Pareto Analysis of Wind Facility Scenarios: Per Turbine





Pareto Analysis of Wind Facility Scenarios: Full Facility





Future Research Priorities

Future Research Priorities

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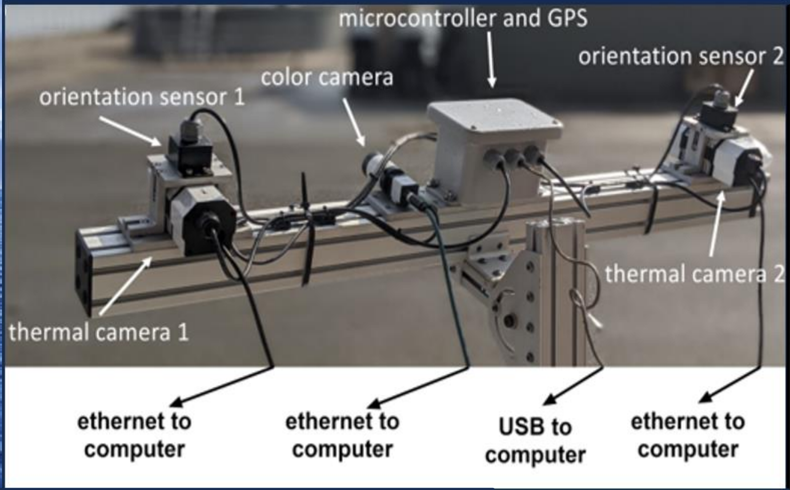
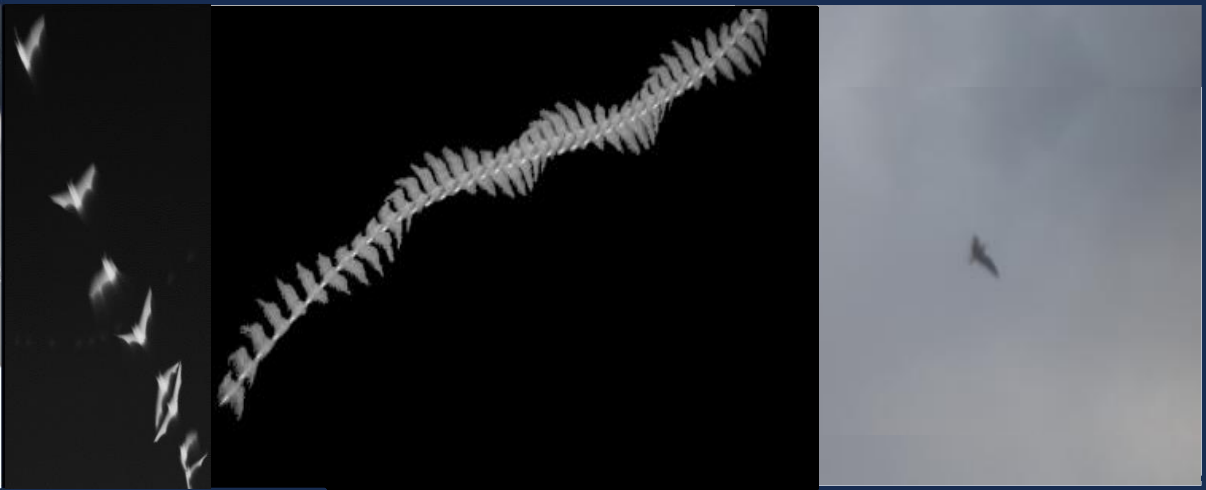
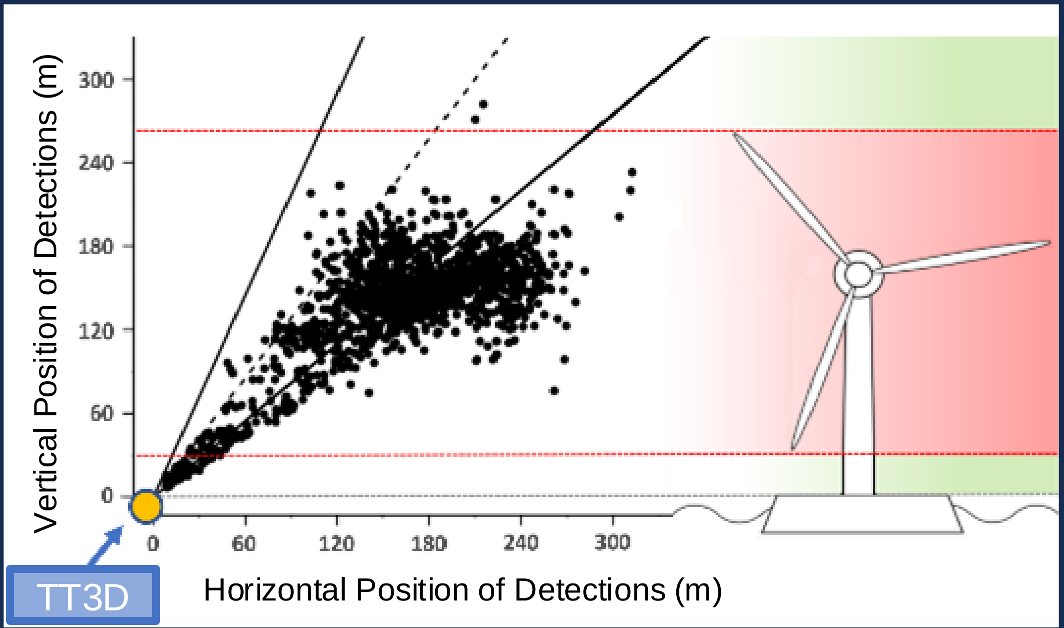
TT3D Offshore Prototype



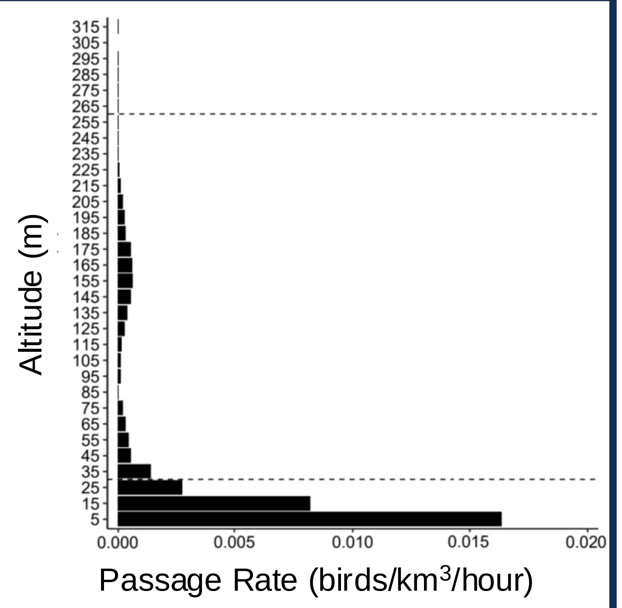
TT3D Thermal & Optical Imagery



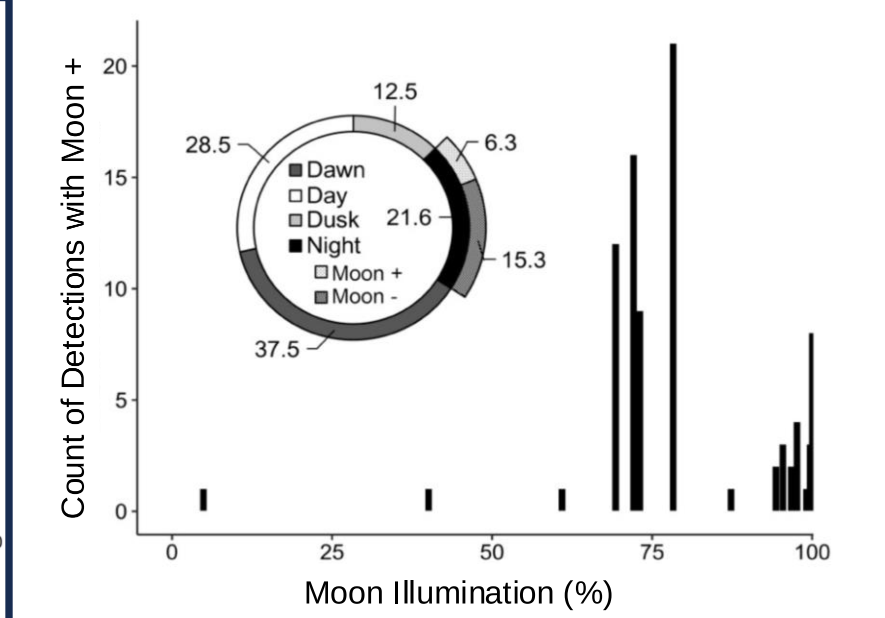
TT3D Field of View alongside a 230-m diameter OSW turbine



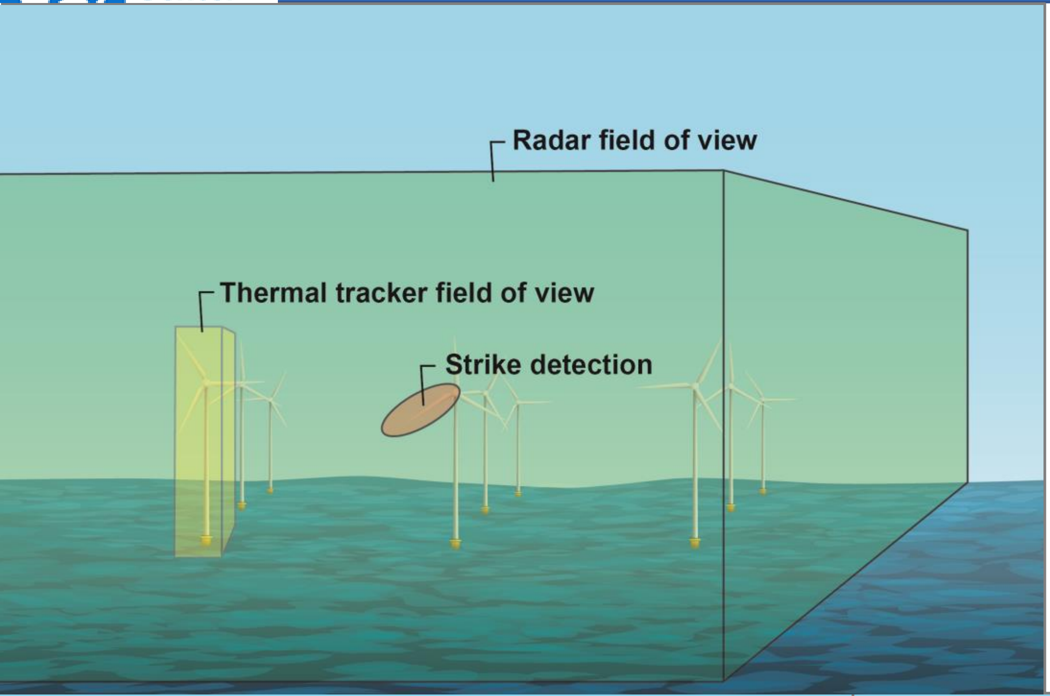
Volumetric Passage Rate



Detections & Ambient Light



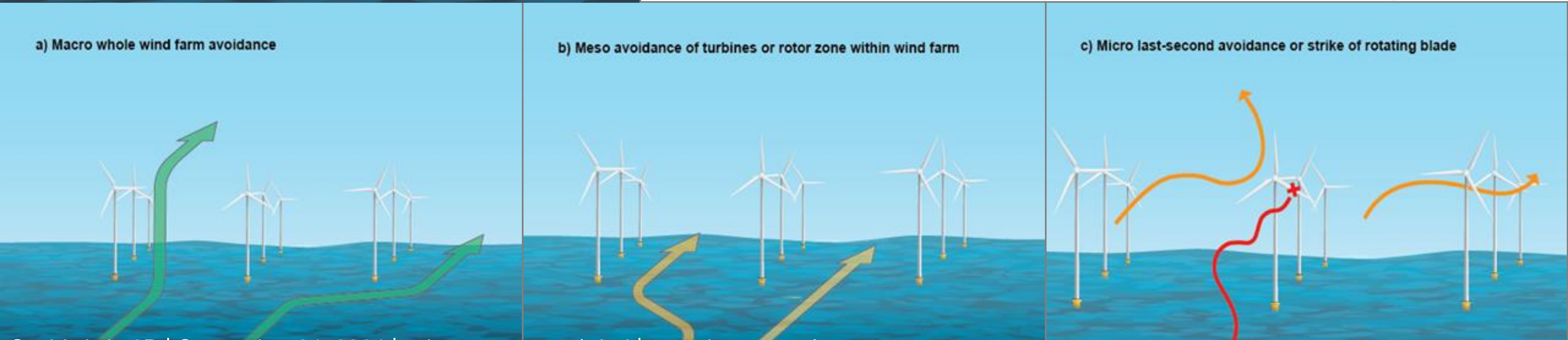
Future Research Priorities



Integrated, Real-Time, Multi-Scale System for Monitoring Seabird Interactions with Floating Offshore Wind Technologies

- Develop and test technology capable of gathering data needed to generate collision risk models

integral INSIGHT FOR AN EVOLVING WORLD



Conclusions

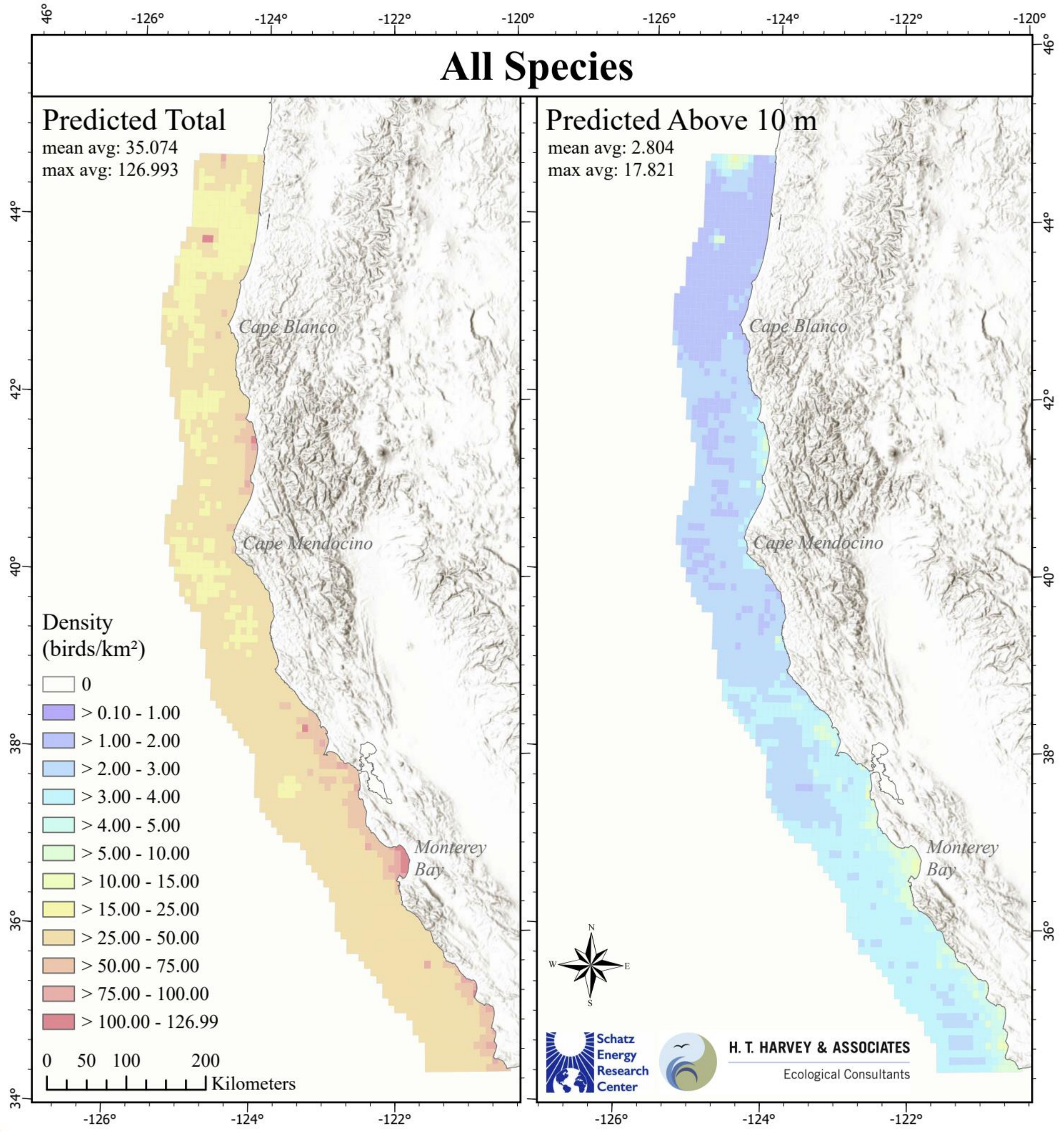
Key Takeaways

Seabirds and Offshore Wind

- Number of birds considered vulnerable to collision is much greater than the expected collision rates. In this analysis, vulnerability is measured in density of birds present above 10 m
- Seabirds off CA exhibit diverse flight styles - only some species are likely to fly above 10 m
- The most prevalent birds above 10 m are gulls, as they are abundant and have a propensity to fly above 10 m (in a range of wind conditions)
- Seabird community composition and density differs in nearshore versus offshore waters

Analysis of Tradeoffs

- Our multi-objective optimization analysis suggests that areas from Cape Mendocino and northern CA into southern Oregon would be favorable for both renewable energy generation and relatively low bird density



Panelist Discussion

Lisa Ballance (Oregon State University)

Question and Answer

If you're interested in receiving updates on our newly released reports and upcoming events, please email us at windstudies@schatzcenter.org and ecoinfo@harveyecology.com

Additional Resources Cited

- NOAA Seafloor Topography Map Version 4.0
  - Smith & Sandwell 1996 (http://www.ngdc.noaa.gov/mgg/image/global_topo_large.gif)
- Dynamic Soaring Publications
  - Richardson et al. 2018 (DOI: https://doi.org/10.1098/rsnr.2018.0024)
  - Kempton et al. 2022 (DOI: DOI: 10.1126/sciadv.abo0200)
- Seabird Flight Height & Wind Speed Publication
  - Ainley et al. 2015 (Marine Ornithology 43: 25–36)
- ThermalTracker-3D Publications
  - Matzner et al. 2020 (DOI: https://doi.org/10.1016/j.ecoinf.2020.101069)
  - Schneider et al. 2024 (DOI: https://doi.org/10.3389/fmars.2024.1346758)
- SEABIRD: System for Environmental Assessment of Bird/Bat Interactions with Real-Time Detection Presentation
  - Chang et al. 2024 (DOI: https://doi.org/10.4043/35220-MS)