

Ana Sy-Quia
Machine Learning II
Spring 2025

Neural Nets & Kelp Forests: Mapping Sea Otter Habitat Suitability 🦦



A Conservation Crisis

California Sea Otters:

- 99% population collapse from fur trade hunting
- Keystone species critical for kelp forest ecosystems

Challenge: Where are the best environmental conditions for sea otter recovery?

Opportunity: Satellite data enables large-scale habitat monitoring

Objective: Build ML model to predict sea otter habitat suitability using satellite oceanographic data



Integrated Satellite & Biological Data

Study Area: Central California Coast

Time Period: 2002–Present

01



GBIF Otter Sightings → Target 'presence' (0/1)

02



Sea Surface Temperature (JPL MUR ~1km)

03



Chlorophyll-a (MODIS ~1.4km)

04

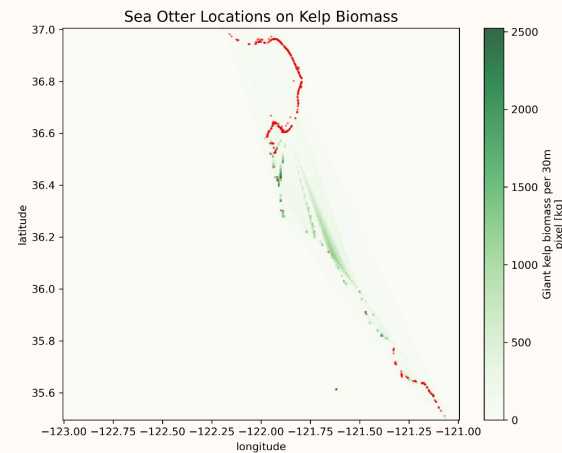
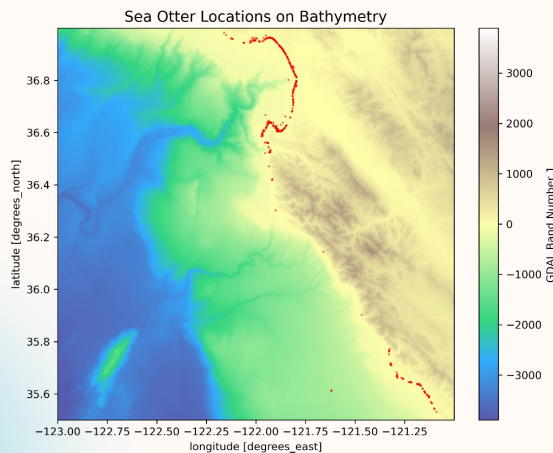
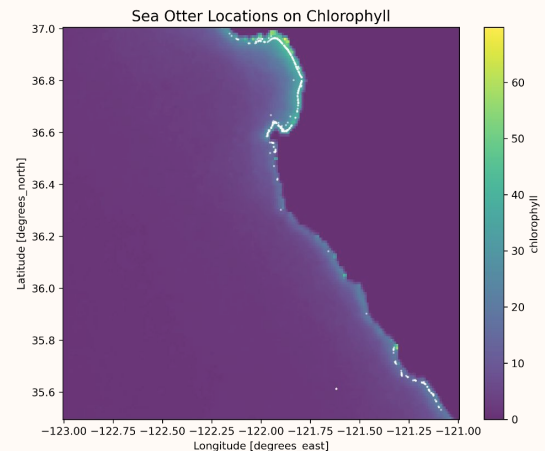
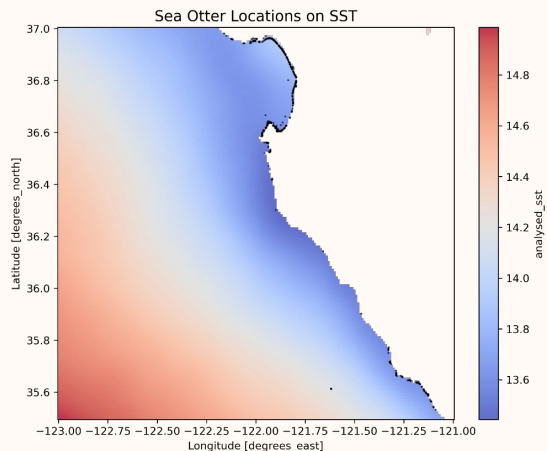


Bathymetry (NOAA ~30m)

05

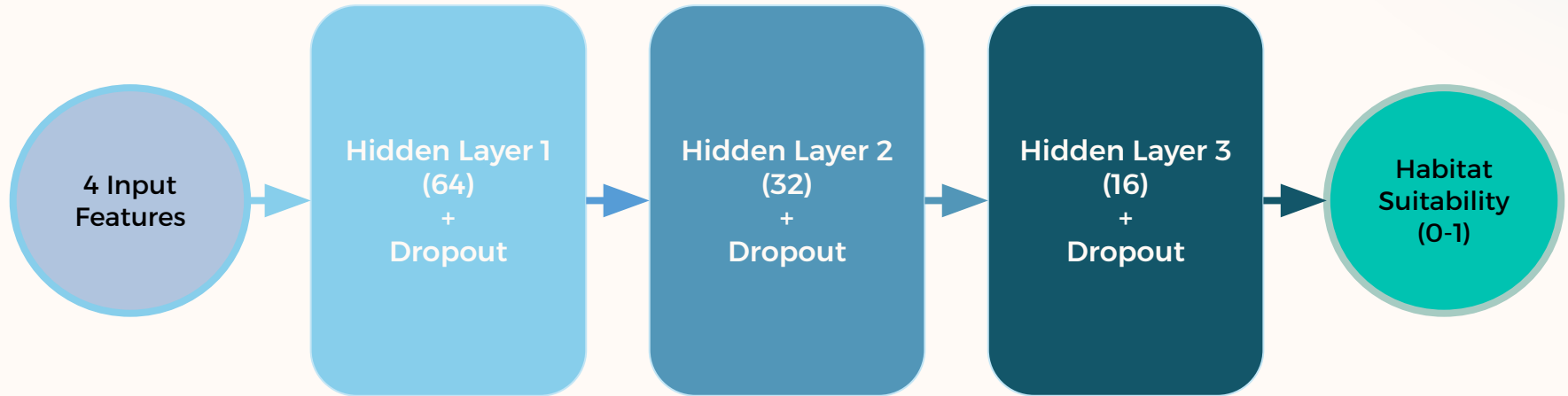


Kelp (Landsat ~30m)



Neural Network Approach

Captures complex environmental relationships



** Regularization included L2 + progressive dropout + early stopping + learning rate scheduling*

Strong Predictive Performance

99.3% Recall

94.7% Accuracy

98.5% ROC-AUC

** Used a 0.3 threshold to maximize recall for conservation applications*

Key Habit Drivers

Chlorophyll drives habitat quality

- Higher productivity = more prey = better habitat
- Generally positive effect with higher values

Depth sets physical limits

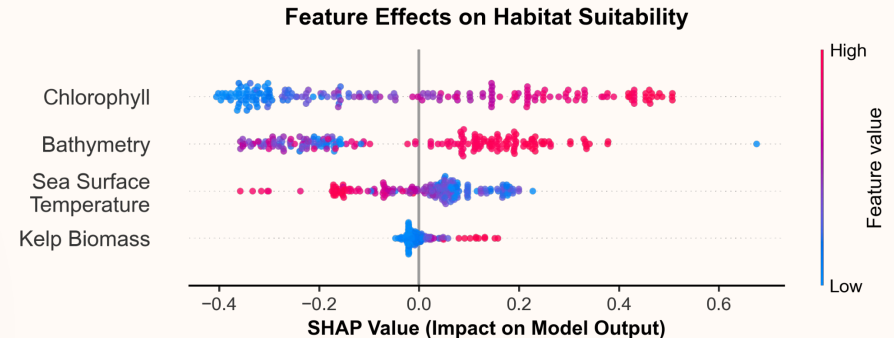
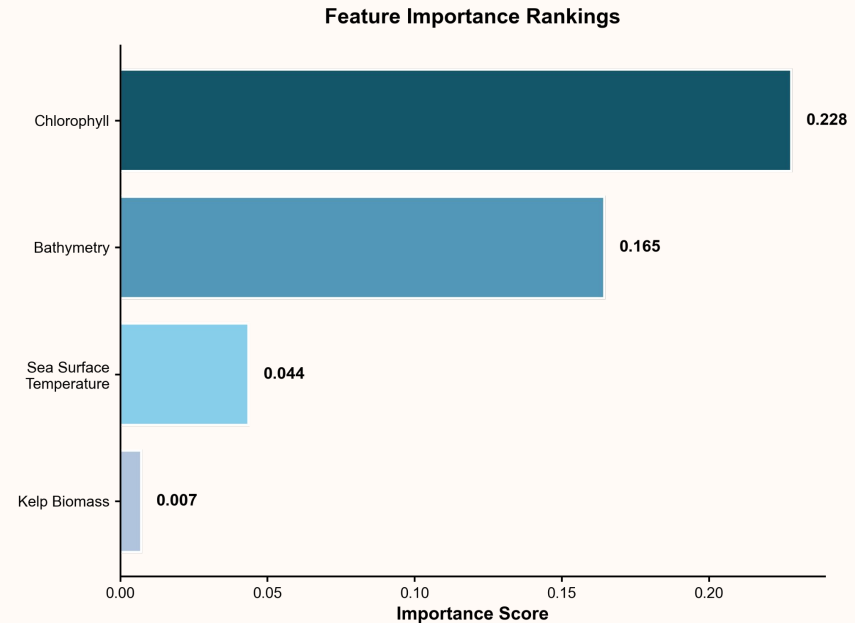
- Otters have optimal diving ranges
- Not all depths are accessible or productive

Temperature fine-tunes suitability

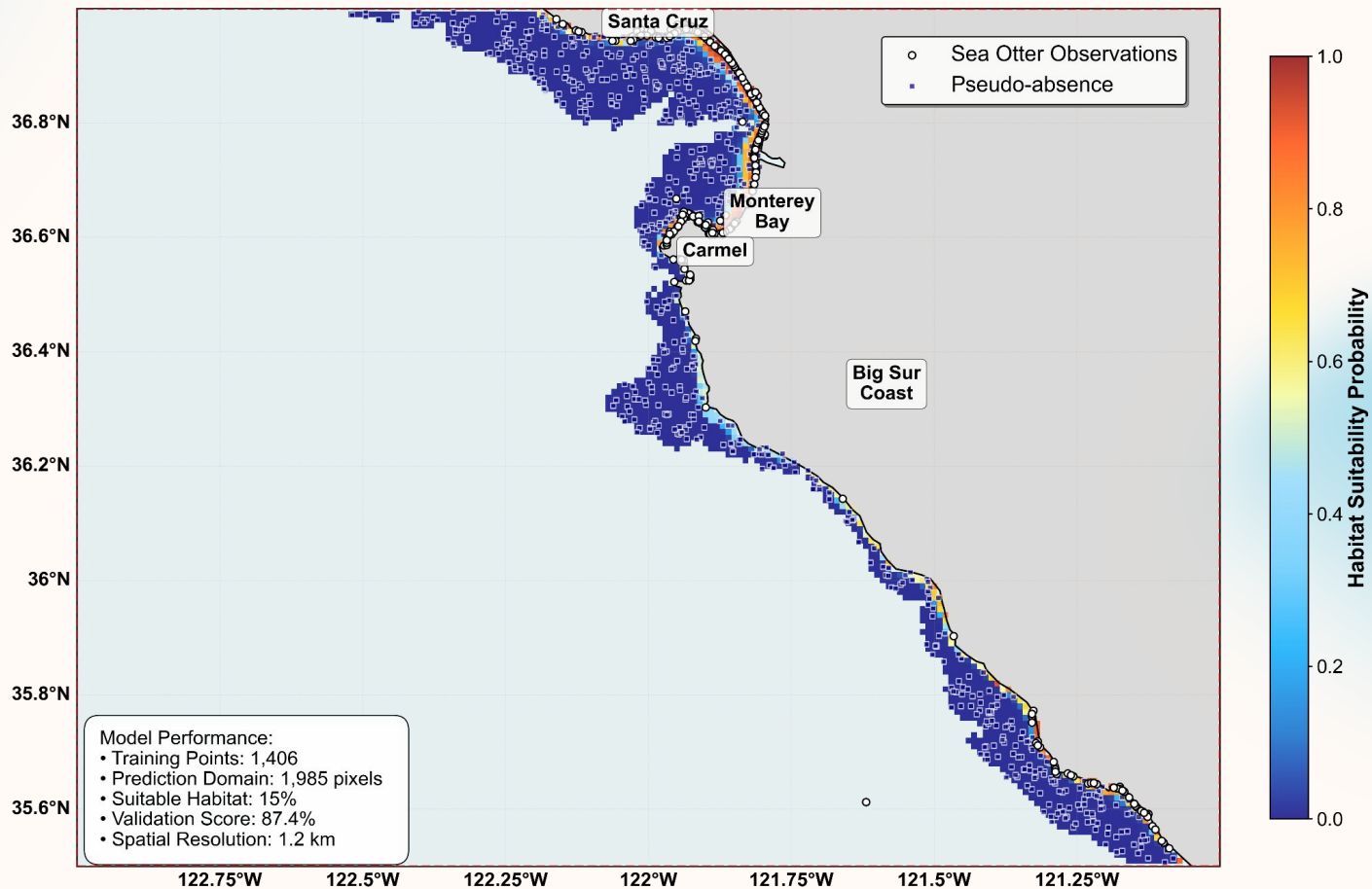
- Regional climate preferences
- Modifies habitat quality locally

Kelp Biomass provides marginal gains

- Small but meaningful contributions
- Helps identify edge habitats



Sea Otter Habitat Suitability Model Central California Coast



Conservation Applications



Habitat Protection – where to focus efforts

Restoration Targets – how to improve degraded areas

Threat Assessment – what to monitor

Management Decisions – practical applications

Immediate Priorities:

- **High-impact protection** of chlorophyll + depth hotspots
- **Climate adaptation** planning
- **Ecosystem approach** using all drivers

Future Directions

Expand Data Integration

Ocean dynamics: Currents, upwelling, wave energy

Biological data: Prey abundance, genetic connectivity

Anthropogenic factors: Pollution, vessel traffic, noise

Enhance Model Capabilities

Temporal dynamics: Seasonal habitat shifts & climate projections

Higher resolution: Sub-kilometer spatial predictions

Multi-species integration: Predator-prey & community interactions





Thanks for protecting our oceans!