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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

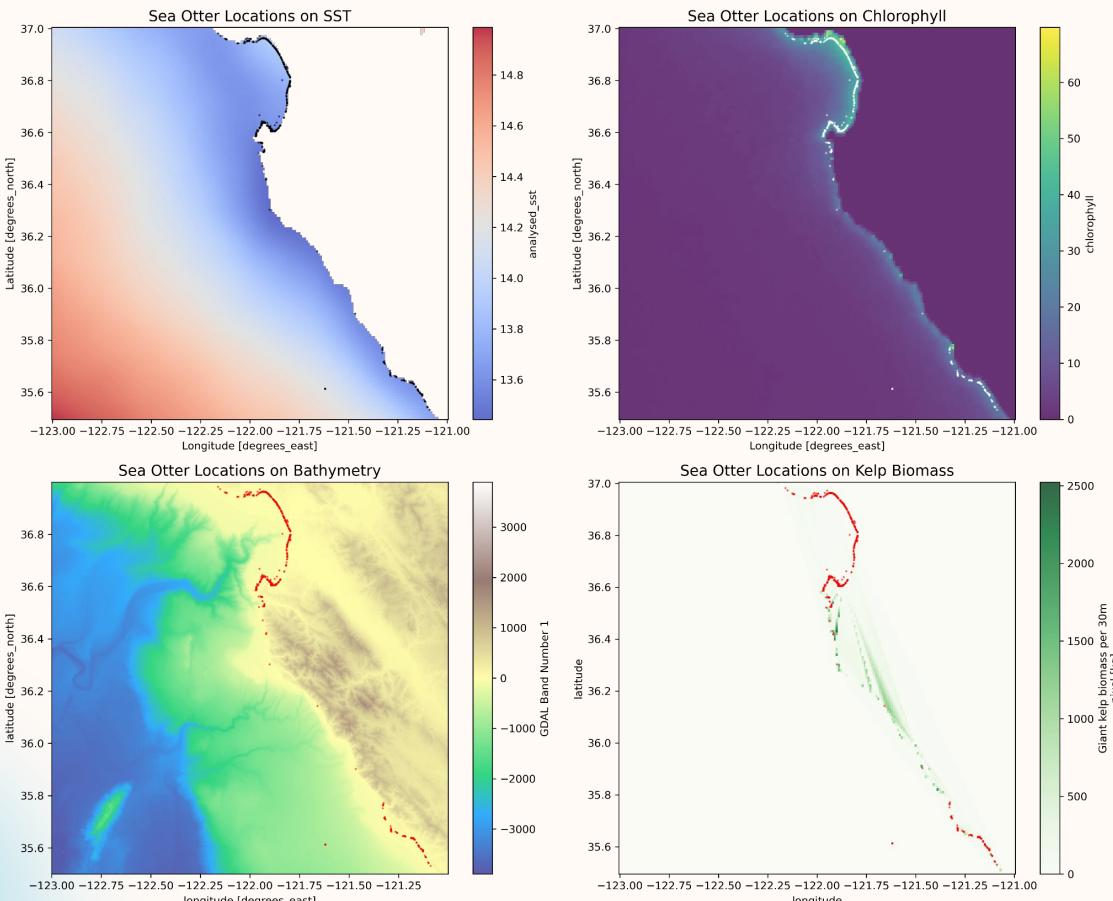


# Integrated Satellite & Biological Data

Study Area: Central California Coast

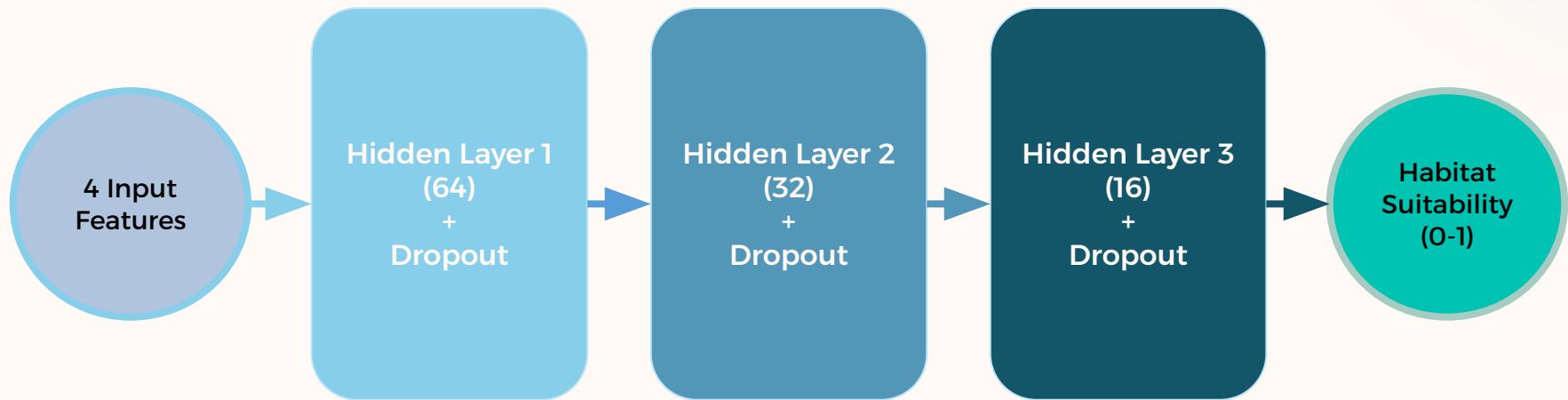
Time Period: 2002–Present

- 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

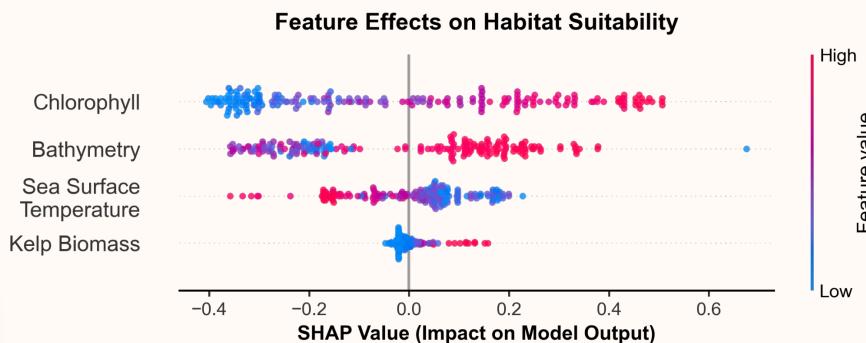
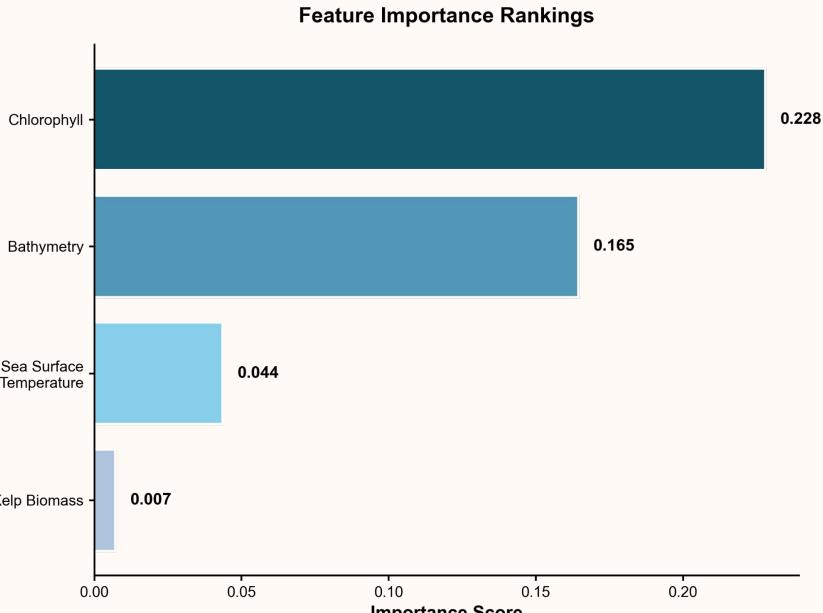
- Otters have optimal diving ranges
- Not all depths are accessible or productive

## Temperature fine-tunes suitability

- Regional climate preferences
- Modifies habitat quality locally

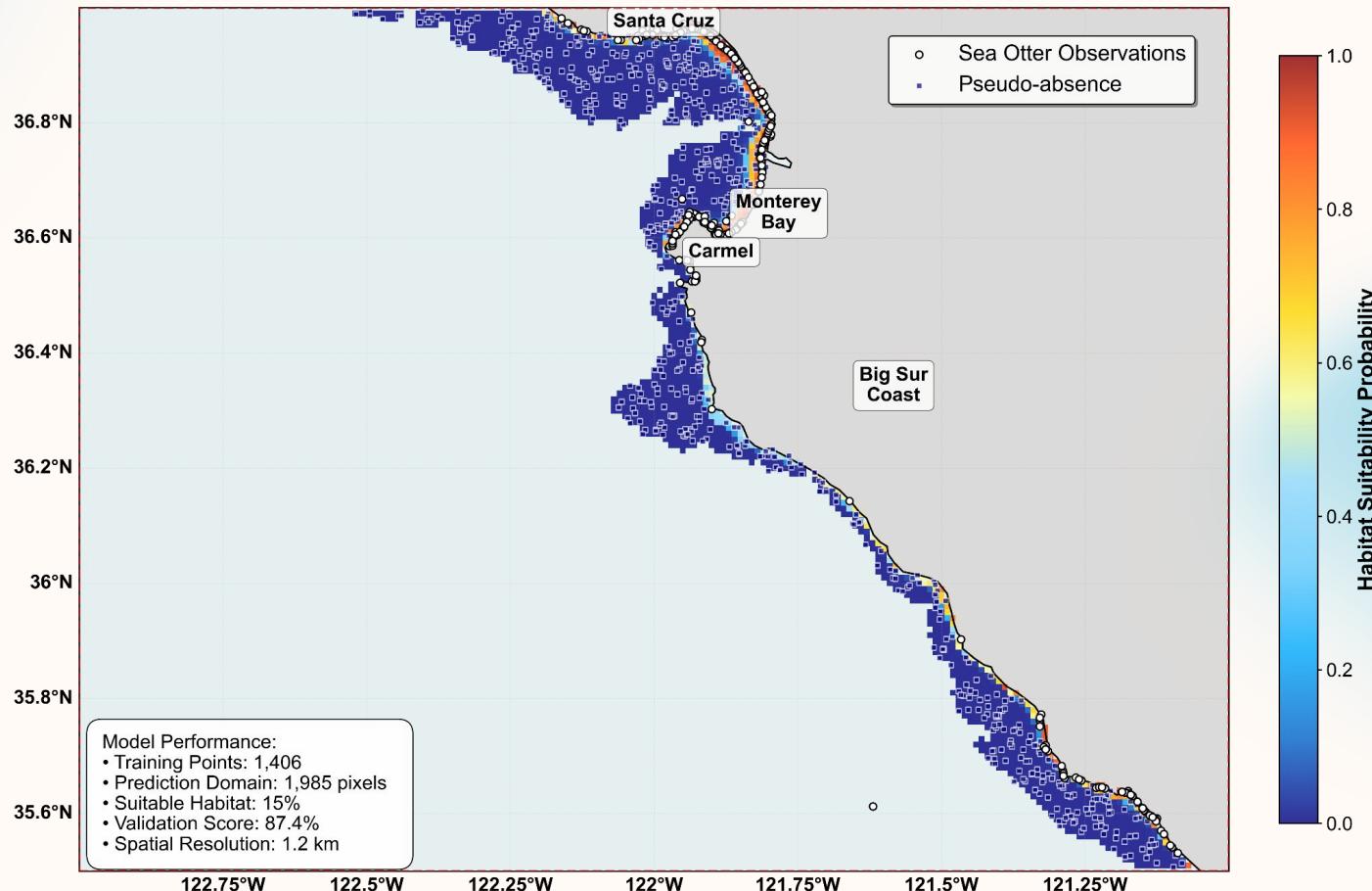
## Kelp Biomass provides marginal gains

- 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!