Using Convolutional Neural Networks and Aerial Imagery to Monitor Seals at Point Reyes National Seashore

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Motivation: Why Change Monitoring at Point Reyes National Seashore?

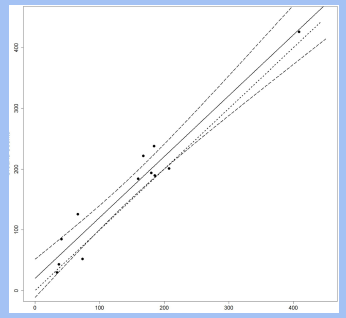
- Consistent and long-term monitoring allows informed decision making about the protection of elephant seals and harbor seals
- Occupy new beaches and areas like cliff sides that present difficulties and dangers for on-the-ground monitoring
- Elephant seal *(Mirounga angustirostris),* 4,000+
- Harbor seal *(Phoca vitulina),* 6,000+

In the future, the proposed method could

1. **dramatically decrease the amount of time, energy, and resources expended in monitoring these populations**
2. **increase the accuracy of counts**
3. **protect the safety of the surveyors**

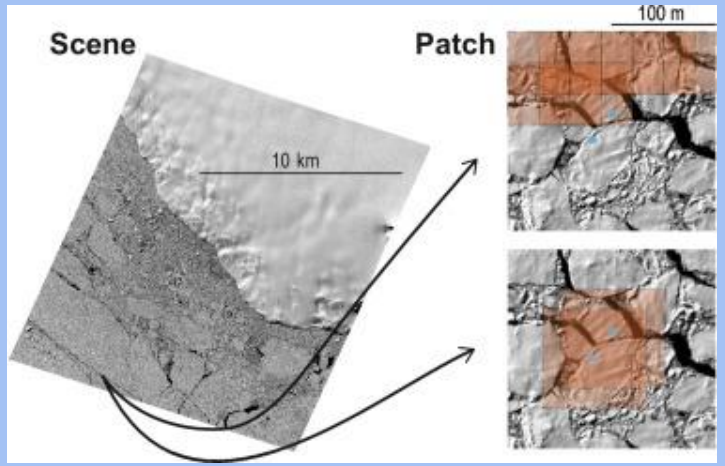
Image Credit: Marjorie Cox, National Park Service

Previous Work Using Remote Imagery

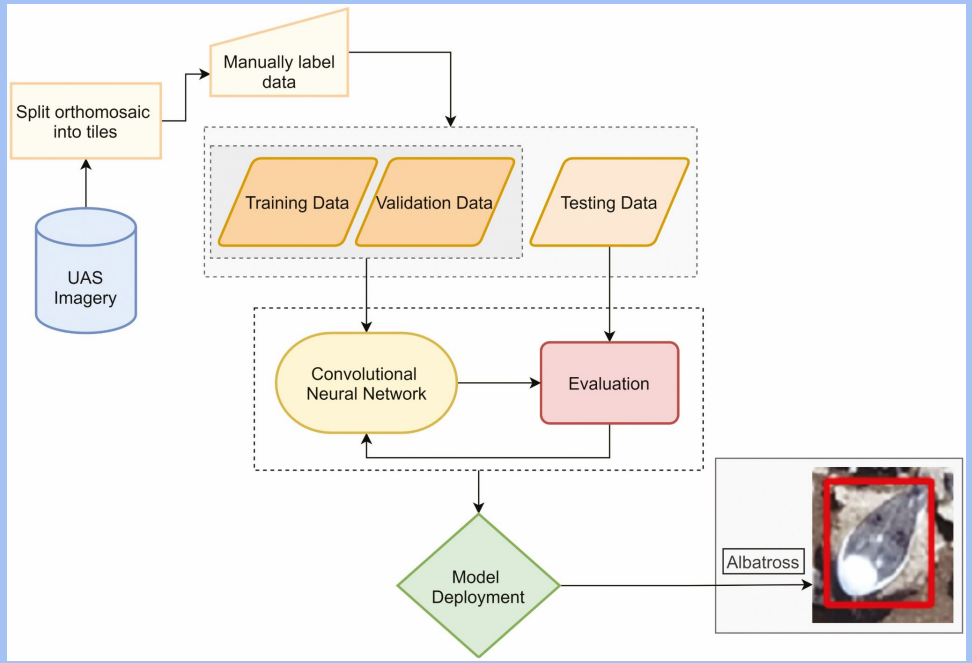


Satellites, the All-Seeing Eyes in the Sky: Counting Elephant Seals from Space (McMahon et al., 2014)

Satellite Counts



SealNet: A fully-automated pack-ice seal detection pipeline for sub-meter satellite imagery (Gonçalves and Lynch, 2020)

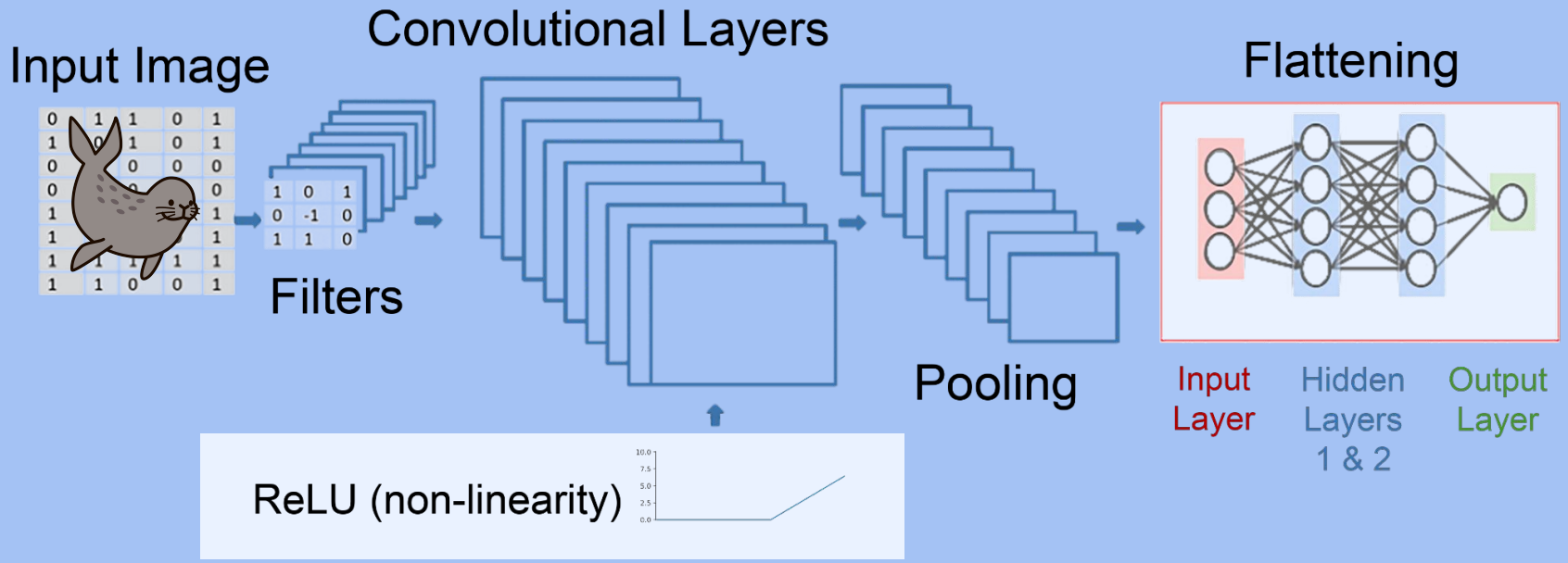


Drones and deep learning produce accurate and efficient monitoring of large-scale seabird colonies (Hayes et al., 2021)

Modeling: How is a Convolutional Neural Network (CNN) useful?

- Build model in R using TensorFlow and Keras packages
- 80-10-10 training-validation-testing split

Image from "Convolutional Neural Network: Feature Map and Filter Visualization," Towards Data Science



Data

Images gathered from Google Earth and Maxar's Global Enhanced Geoint Delivery catalogs

Labeled animals using VGG image annotation tool

Image Credit: National Park Service

Harbor Seals

Image Credit: National Park Service

Count data from NPS since 1997

Breeding Season (March, April, May)

- “pup” and “adult”

Molting Season (June, July)

- “adult”

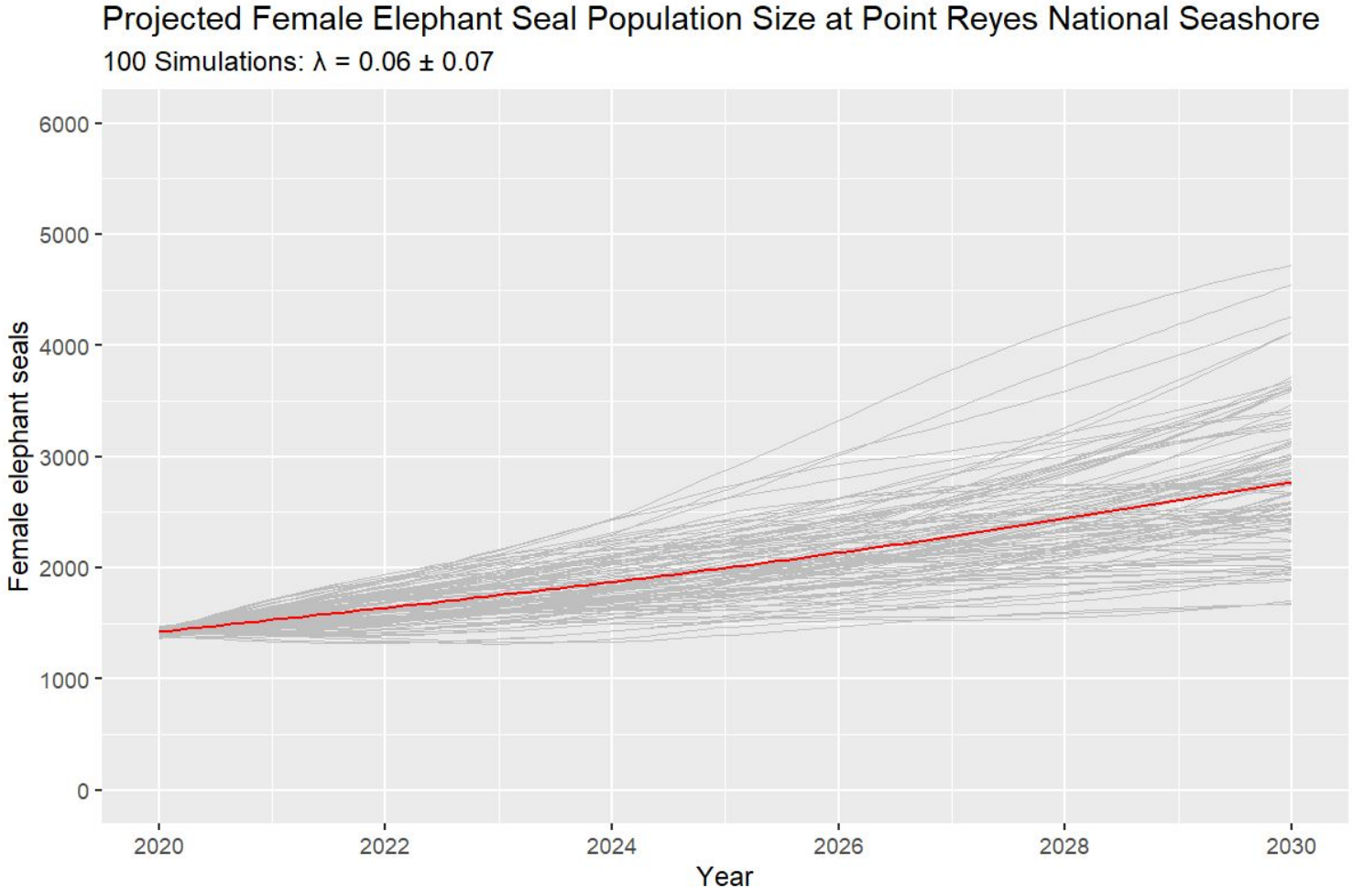
Elephant Seals

Image Credit: National Park Service

Count data from NPS since 1981

Breeding Season (December, January, February, March)

- “pup,” “cow,” and “bull”


Projected Female Elephant Seal Population Size at Point Reyes National Seashore
100 Simulations: λ = 0.06 ± 0.07
Female elephant seals
6000
5000
4000
3000
2000
1000
0
2020
2022
2024
2026
2028
2030
Year

Elephant Seal Labeling Example

Image from Google Earth

dated 2/25/2021

Next Steps

Photo Credit: Marjorie Cox, National Park Service

Expected Outcomes:

- 80% identification accuracy, likely higher
- 50% age classification accuracy
- Comparison with population data from the same year
- Model developed by April

Thank you!

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