FROM DIVINING RODS TO RANDOM FORESTS USING PREDICTIVE ANALYTICS TO MAP WETLANDS IN HAWAII

https://aeon.co/essays/why-dowsing-for-water-is-a-test-of-faith-and-of-science

Mari K Reeves (USFWS) and Adonia Henry (Pacific Birds)

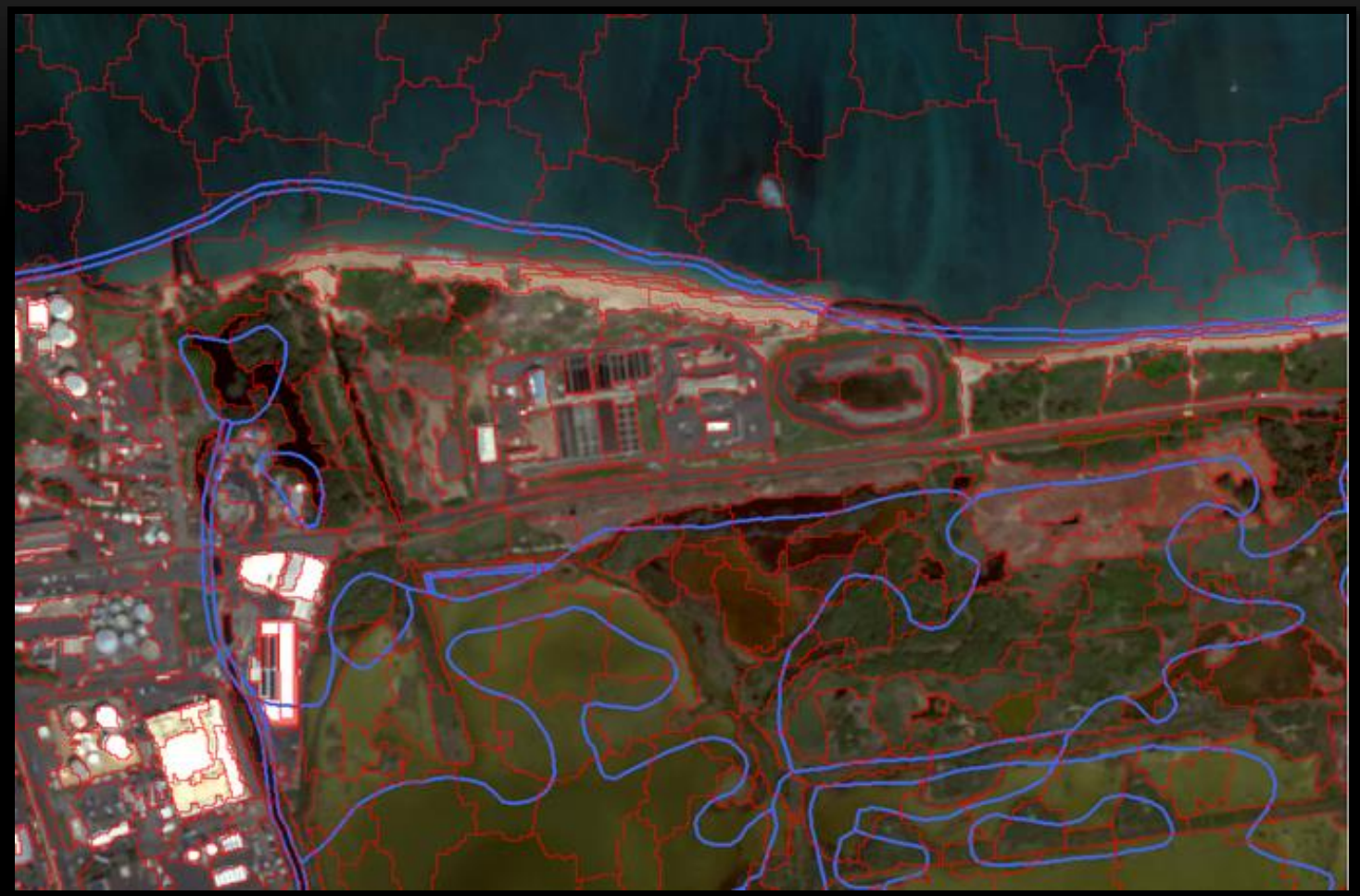
WETLANDS IN HAWAII

- Statewide wetland loss at 15%, with spatial patterns
  - More loss on Oahu (65%)
  - More loss in coastal areas (44%)
  - Less loss at higher elevations (3%)
    - van Rees and Reed, 2014

WHY MAP?

http://legacy.lib.utexas.edu/maps/topo/250k/txu-pclmaps-topo-us-maui-1961.jpg

IMPROVED IMAGERY AND TECHNOLOGY



NATIONAL WETLANDS INVENTORY

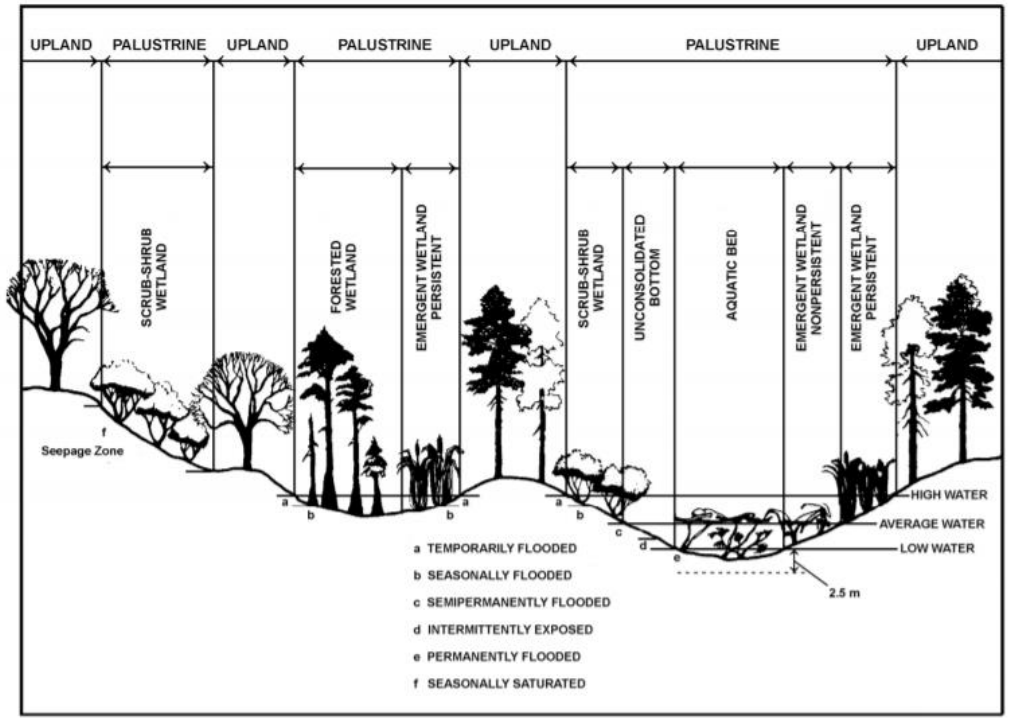
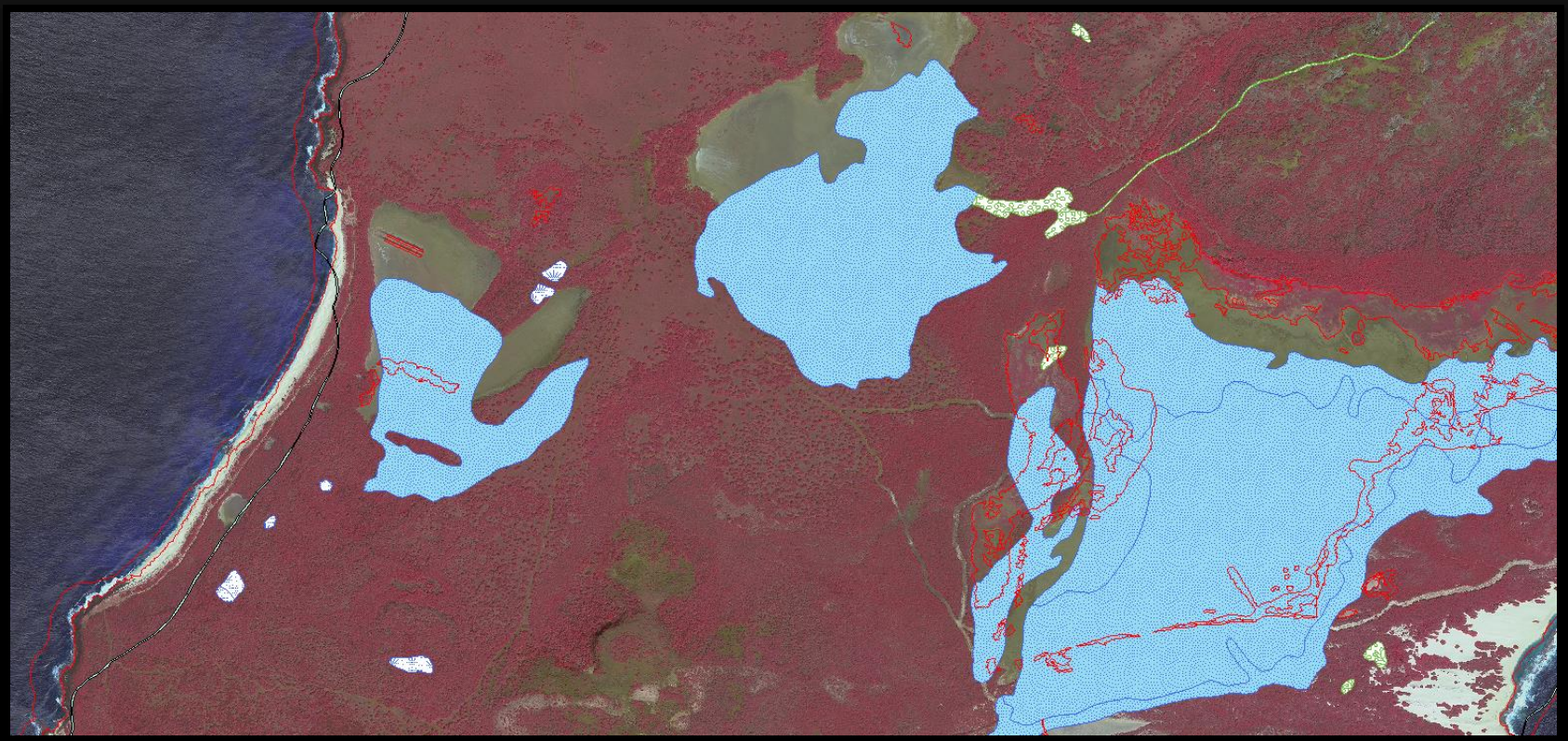


Figure 6. Distinguishing features and examples of habitats in the Palustrine System.

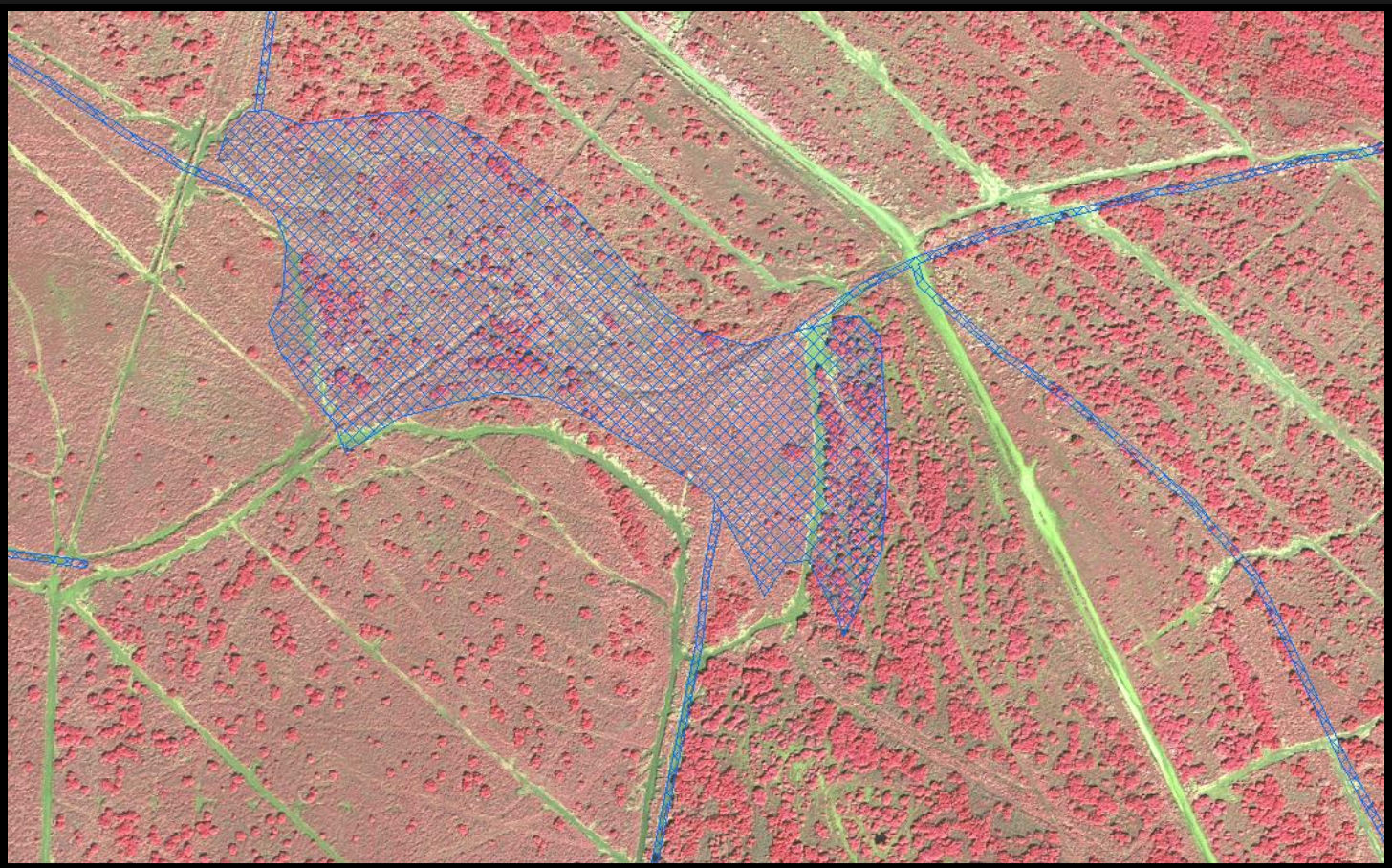
Limits. The Palustrine System is bounded by upland or by any of the other four Systems.

https://www.fws.gov/wetlands/documents/Classification-of-Wetlands-and-Deepwater-Habitats-of-the-United-States-2013.pdf

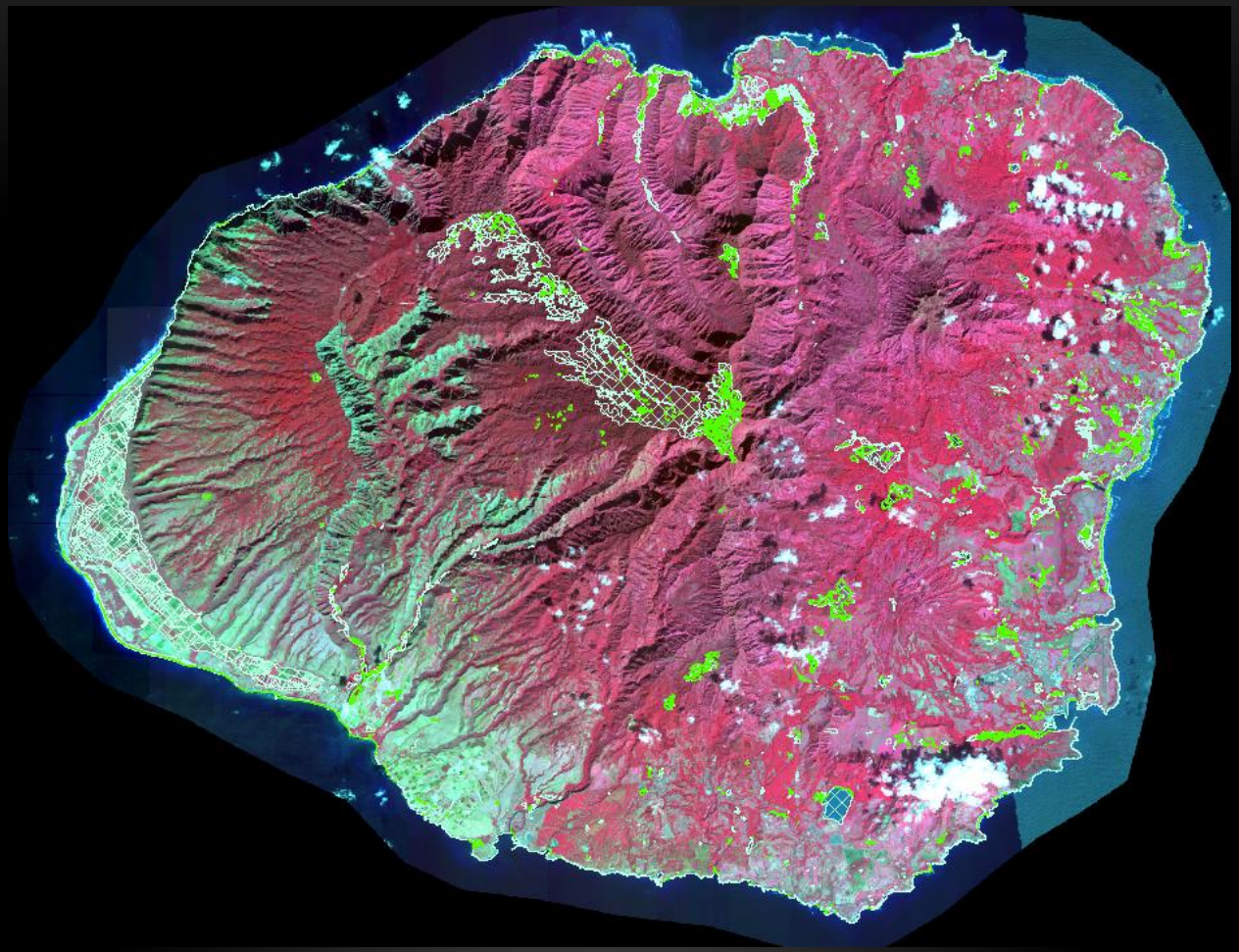
NWI AND CCAP LAYERS IN NIIHAU



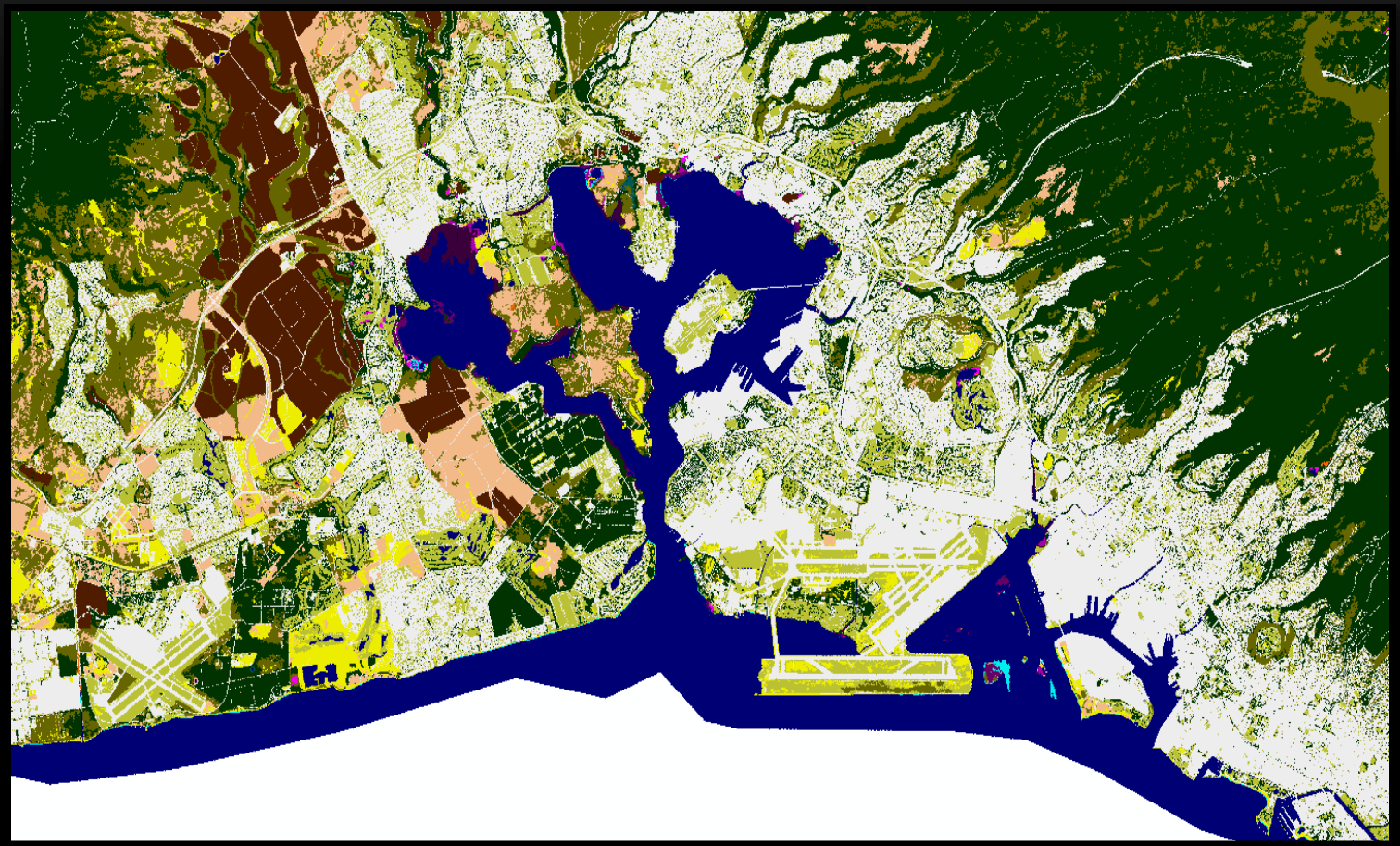
LAND USE AND LAND COVER CHANGE



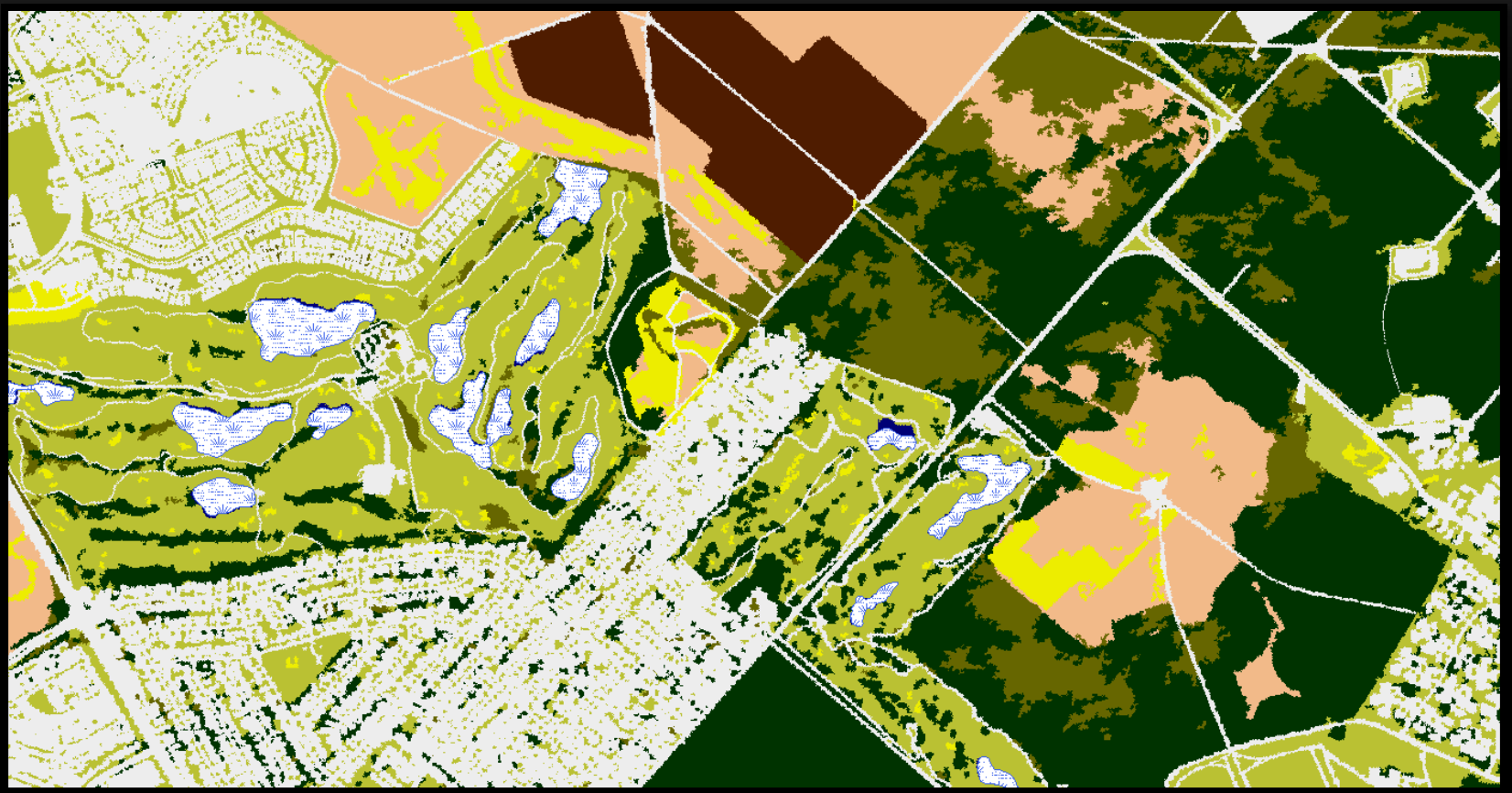
KAUAI AND OAHU NWI IS MORE CURRENT



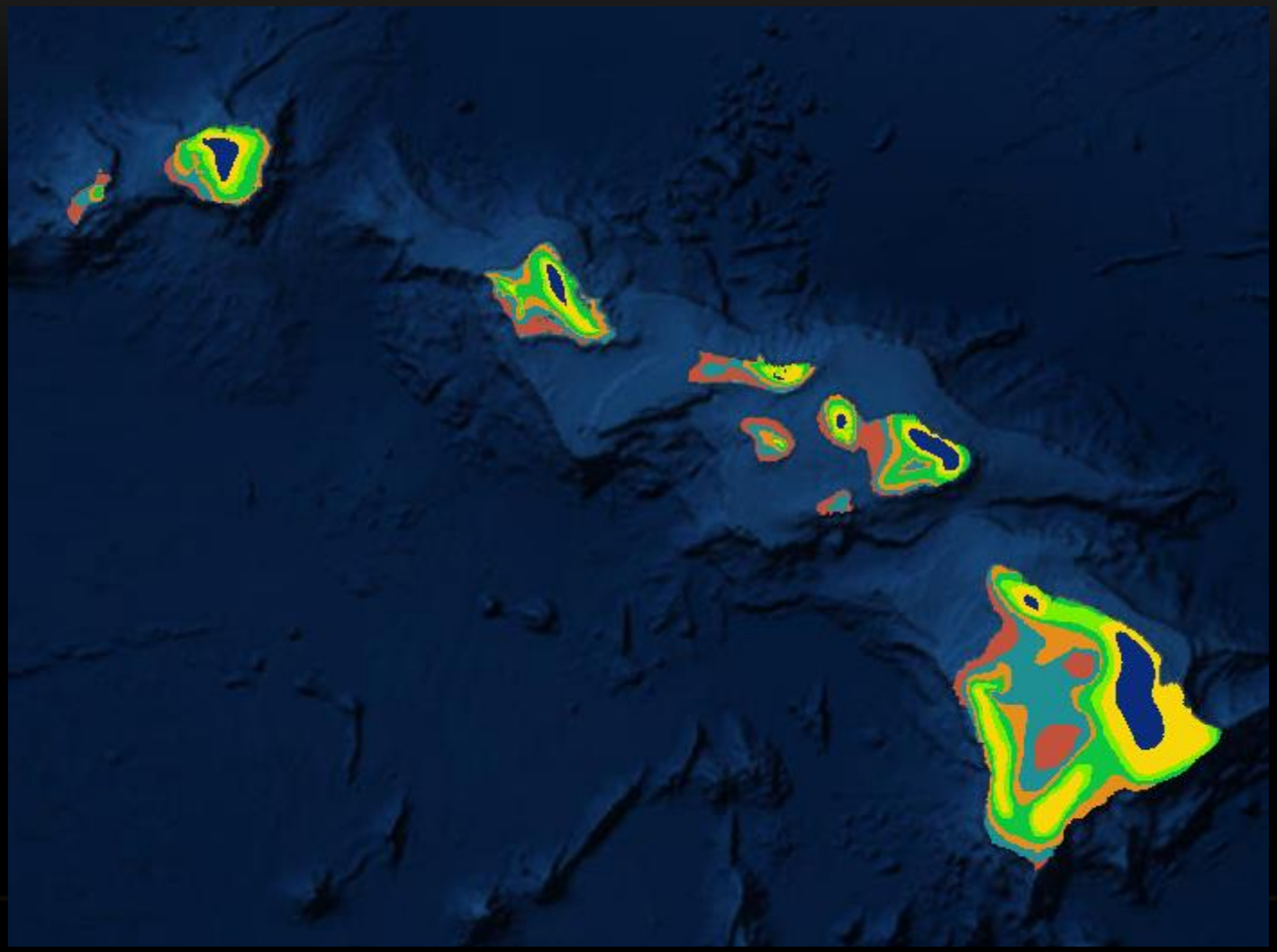
NOAA CCAP LAYERS



NOAA CCAP LAYERS

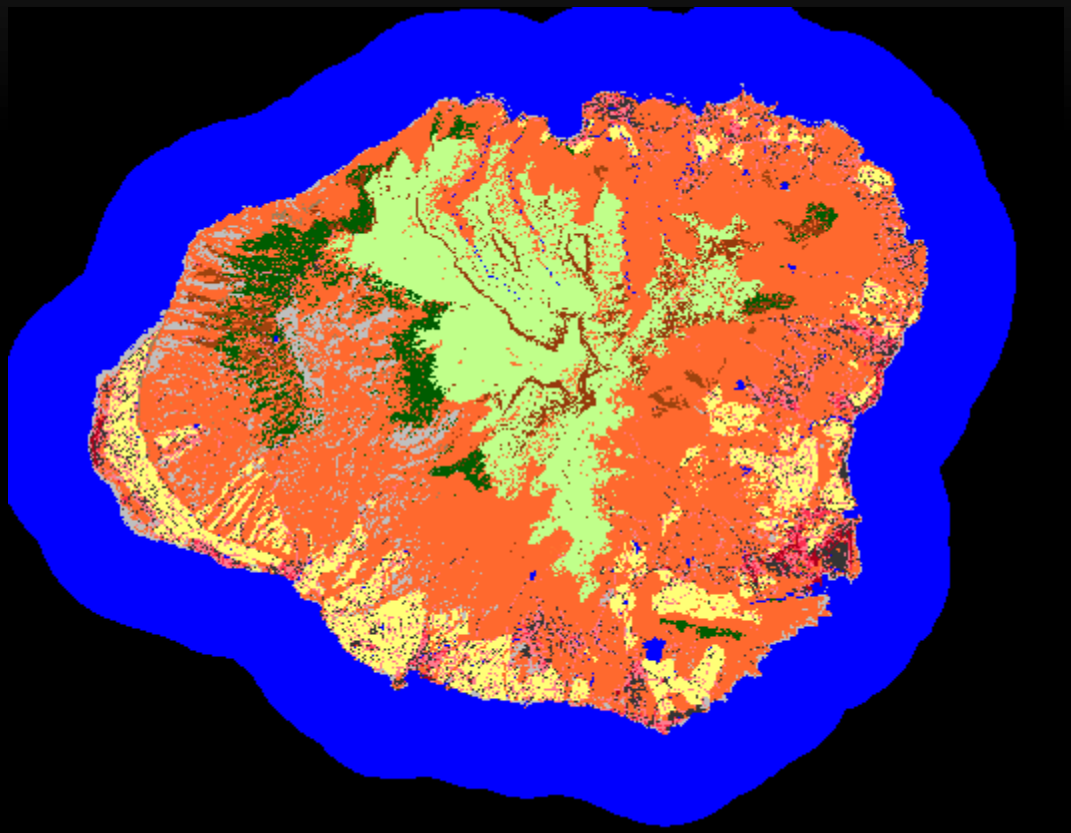


OTHER LAYERS – CLIMATE BASED MOISTURE



https://pubs.usgs.gov/of/2012/1192/

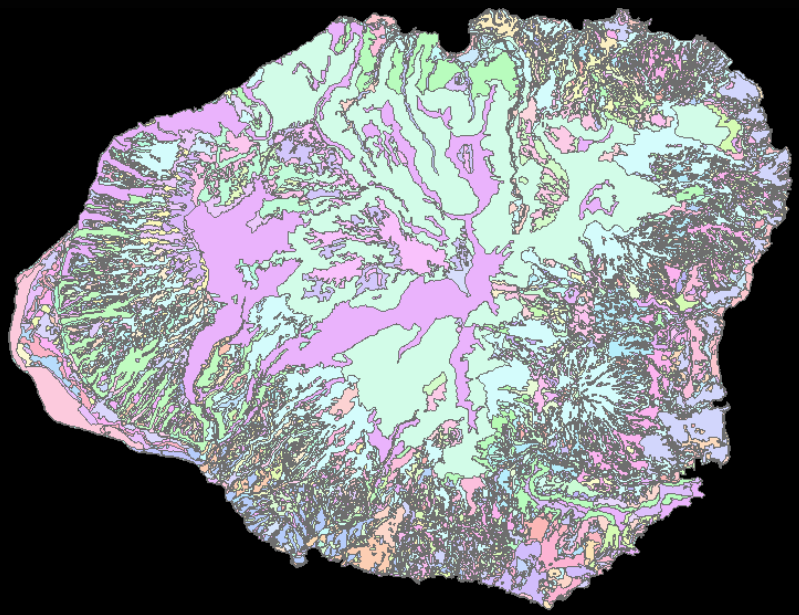
OTHER LAYERS – LANDFIRE VEGETATION TYPE



https://www.landfire.gov/

OTHER LAYERS – SOILS AND GEOLOGY

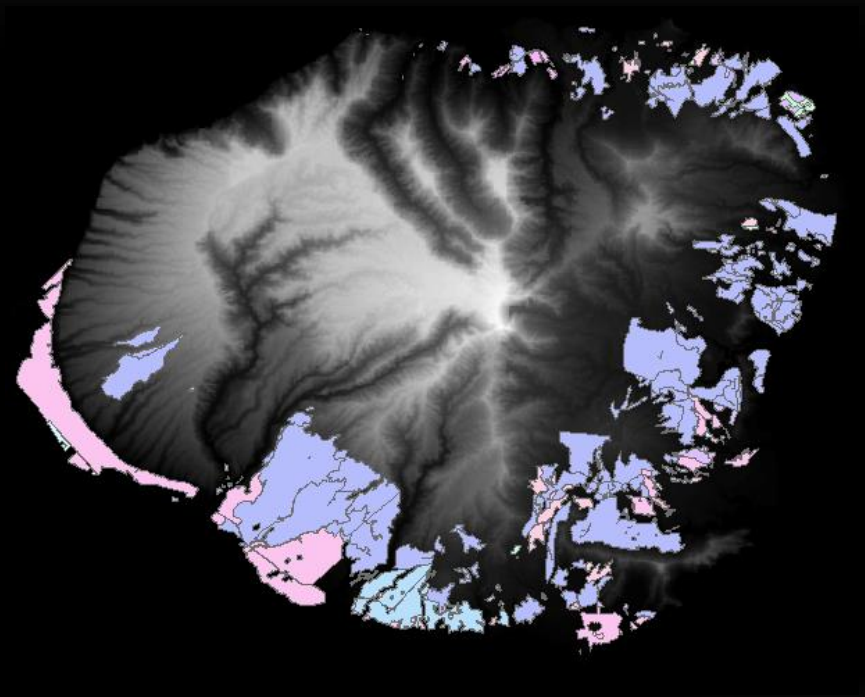
- Soils



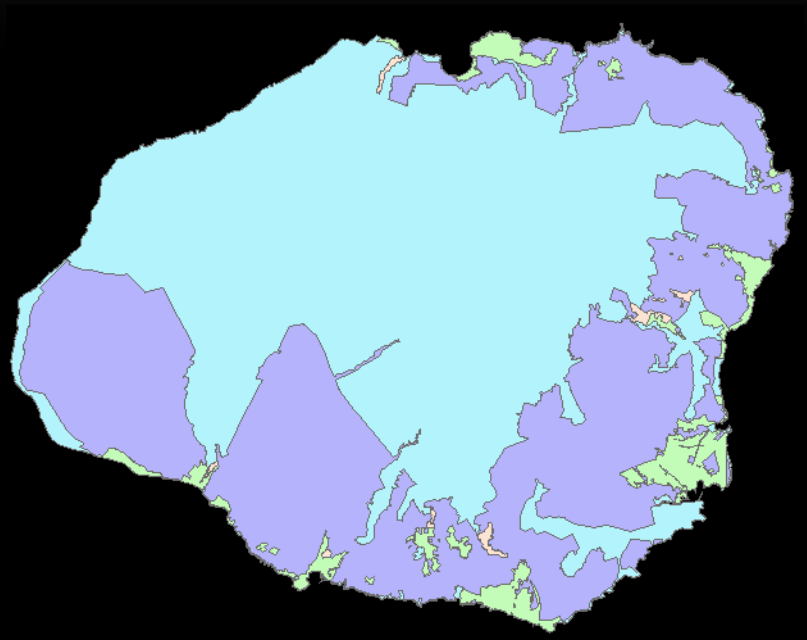
- Geology

OTHER LAYERS – AGRICULTURE AND LAND USE

- Agriculture

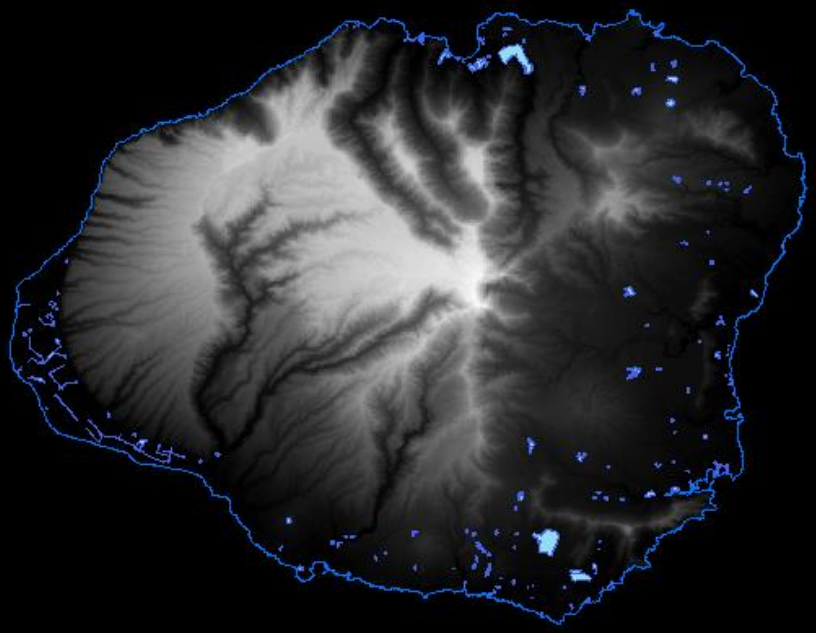


- Land Use Districts

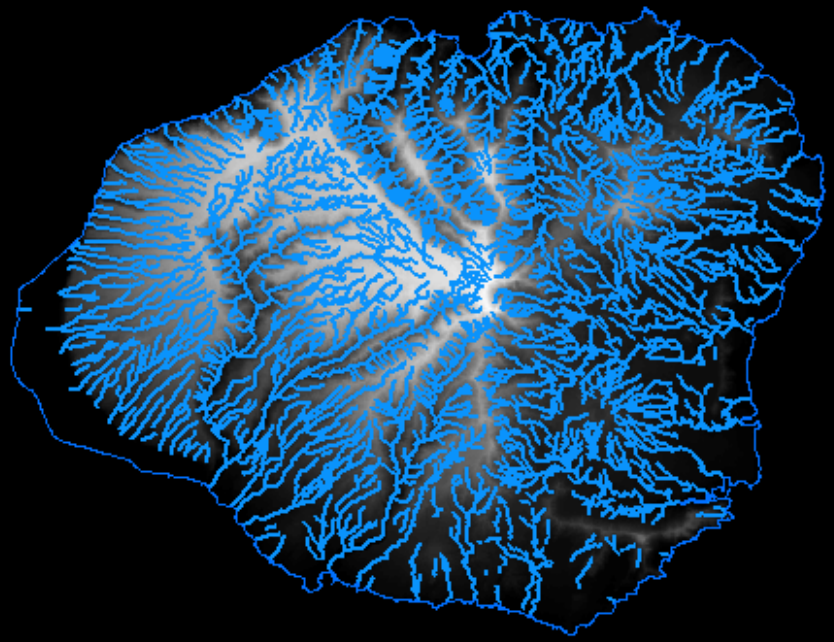


OTHER LAYERS – WATERBIRDS AND STREAMS

- Waterbird Survey Locations

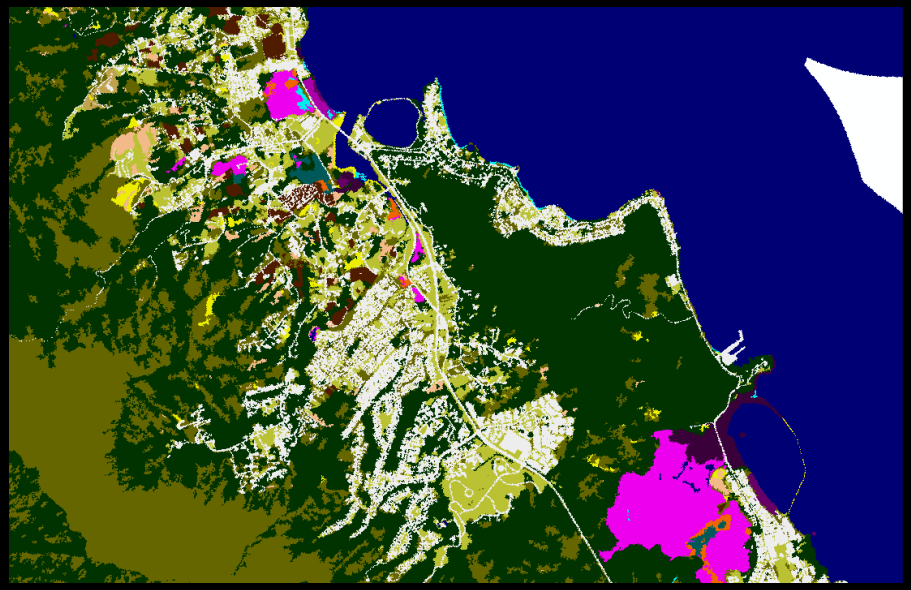


- State Department of Aquatic Resources, Streams

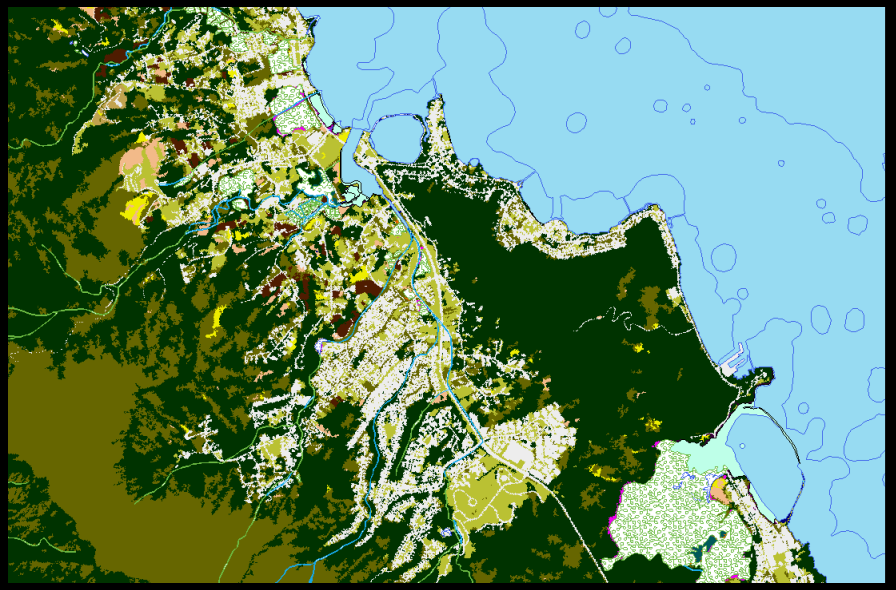


BOTH CCAP AND NWI HAVE WETLAND INFORMATION…

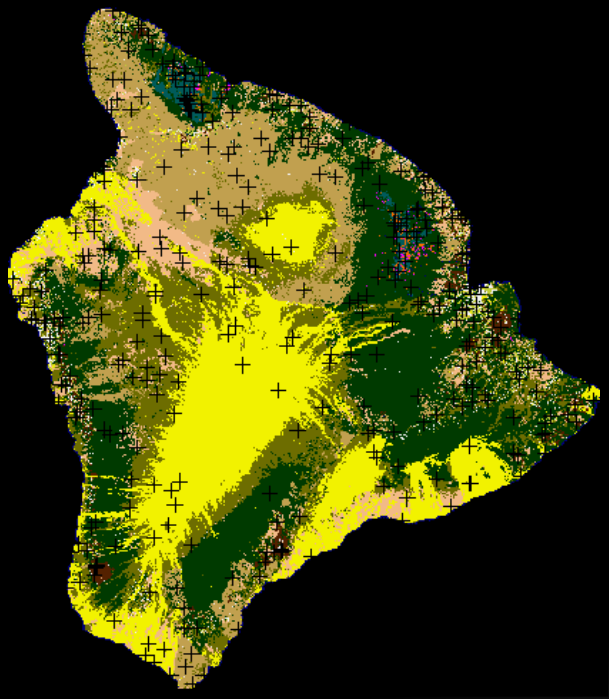
- NOAA CCAP



- USFWS NWI

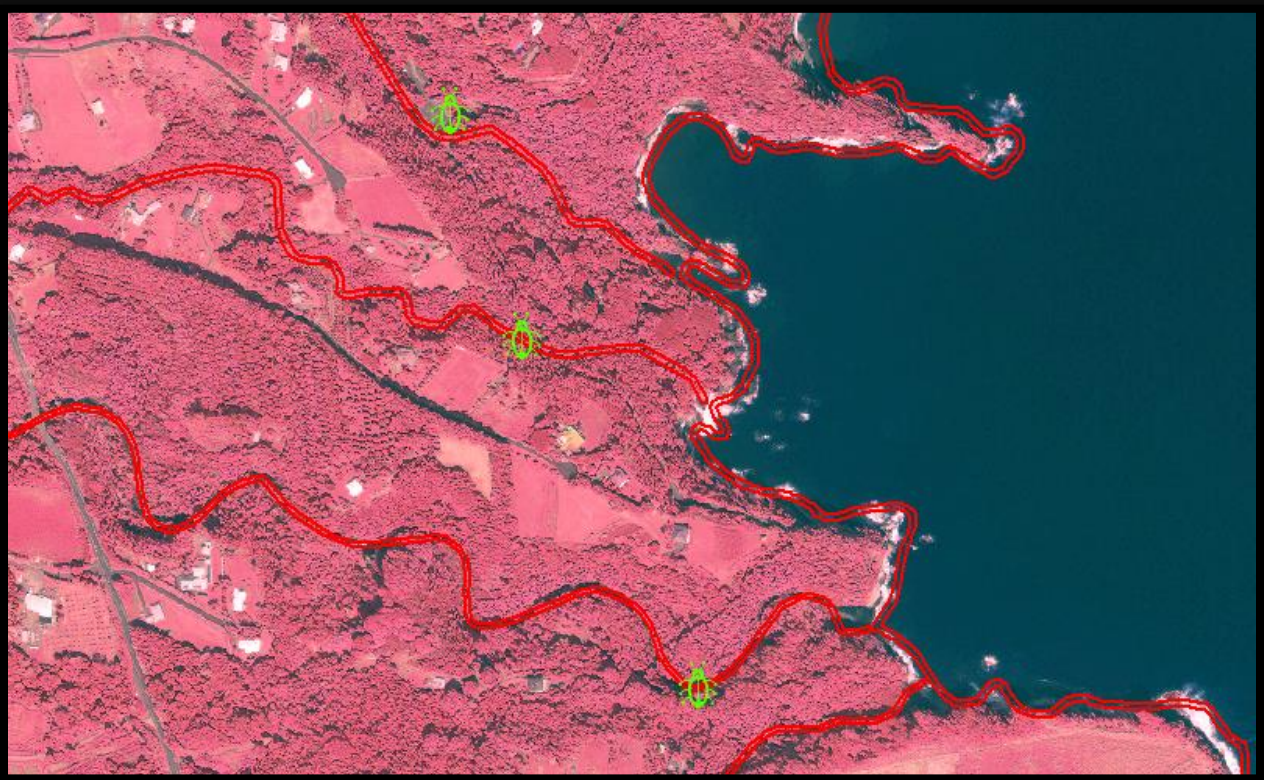


TRAINING DATA SET



- In a random, stratified design, we picked **WET** and **DRY** and threw **everything** else out.

INCORPORATING T&E SPECIES

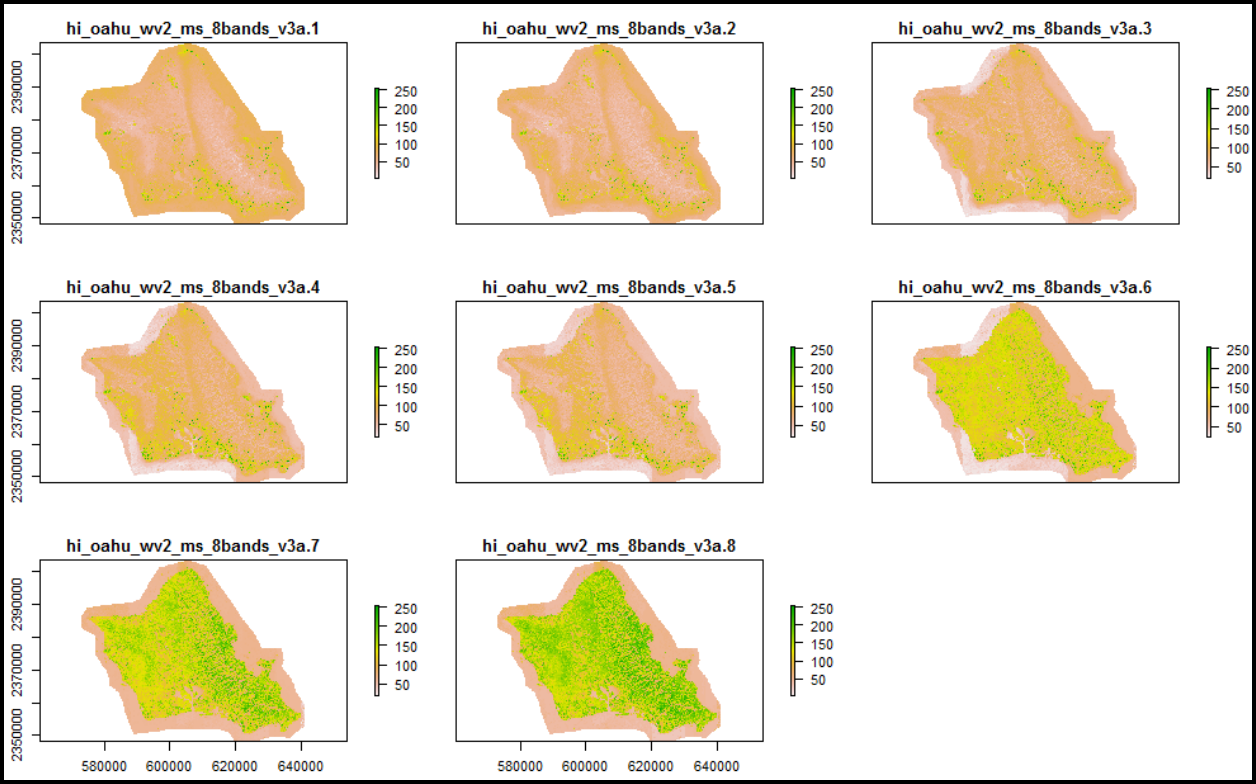


ONLY OPEN WATER WETLANDS

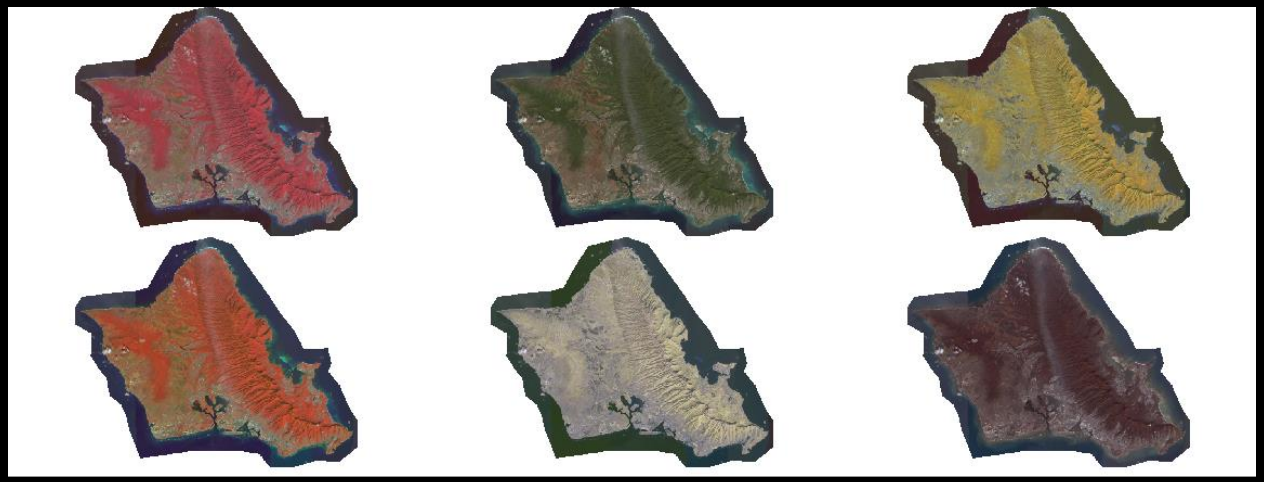
TRAINING DATA FOR JAMES CAMPBELL NWR

SATELLITE IMAGERY

MULTISPECTRAL IMAGERY

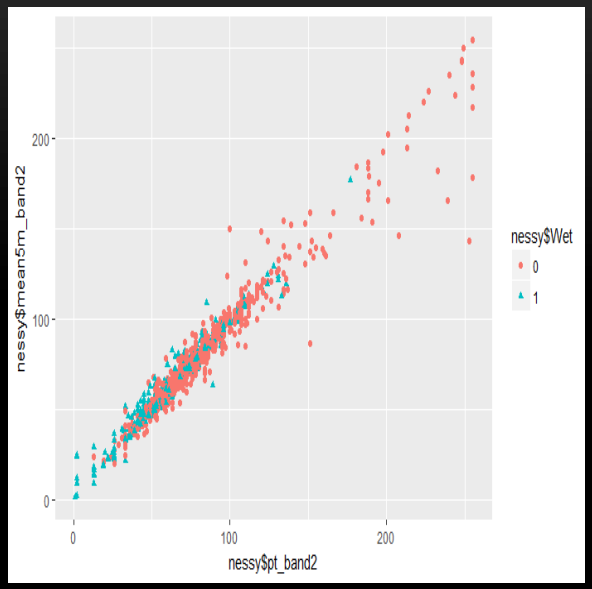


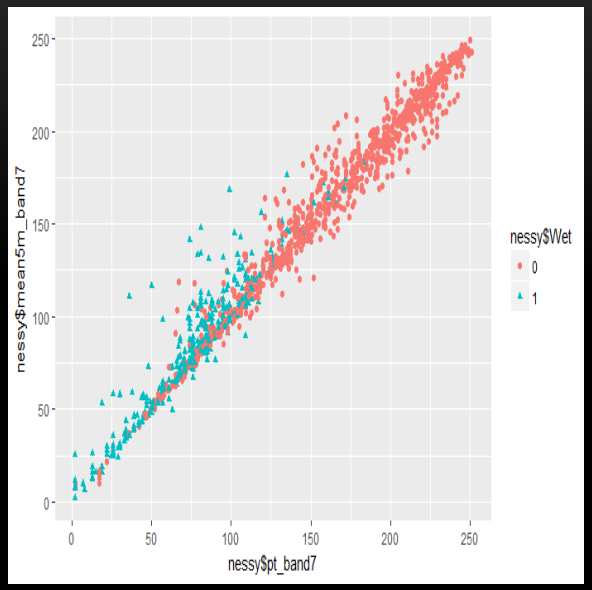
WE ONLY SEE THREE BANDS AT ONCE, BUT THE SATELLITE SEES MORE… AND SO DOES THE MODEL

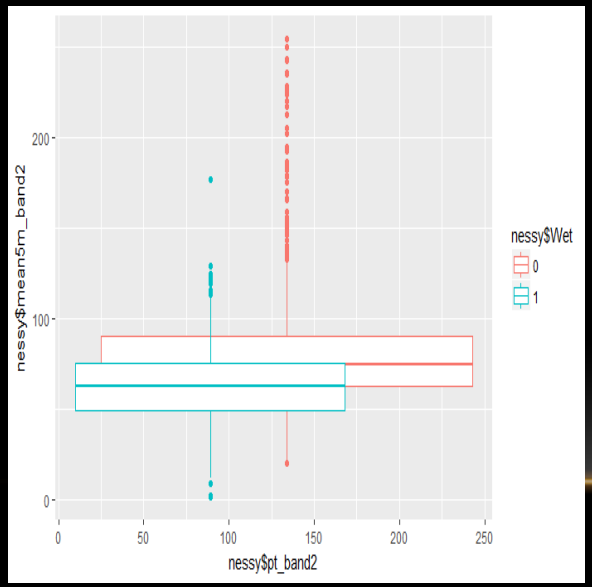


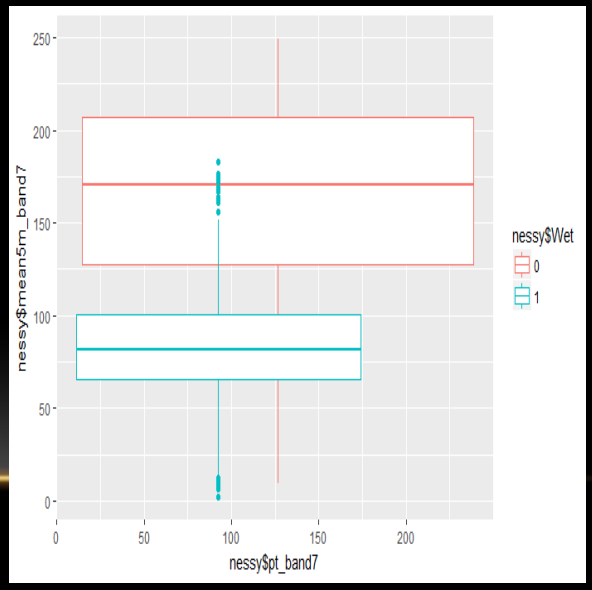
WHICH BANDS TO USE?

BAND 2 VS BAND 7



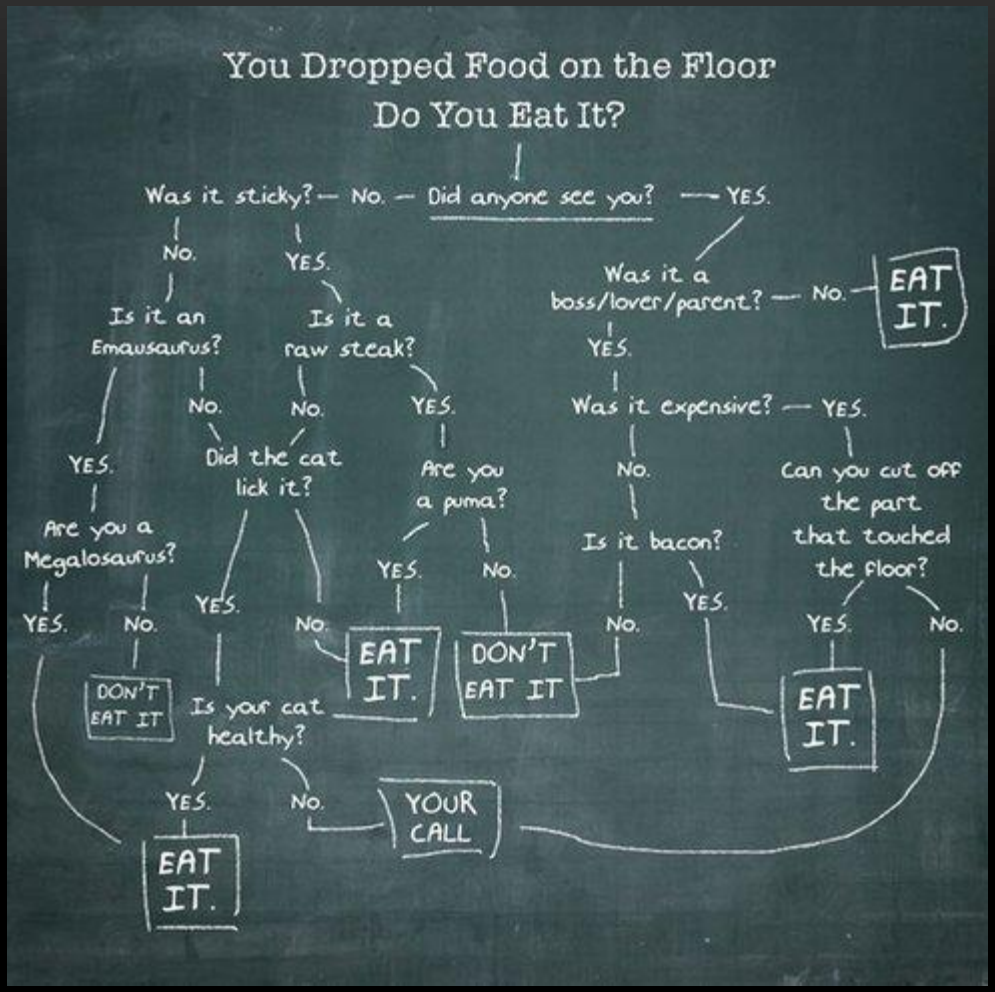






MACHINE LEARNING HELPS US UNDERSTAND AND PREDICT

- Classification algorithms randomize the variables and split the data
  - Over and over and over again.
- In supervised classification, the analyst also classifies and splits the data
  - Training and Testing Datasets (75%/25%)
  - 10-fold cross validation

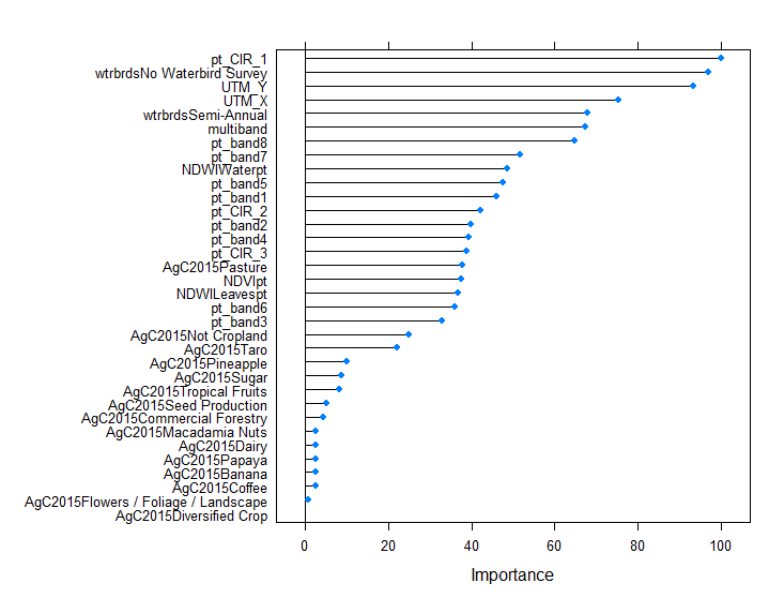


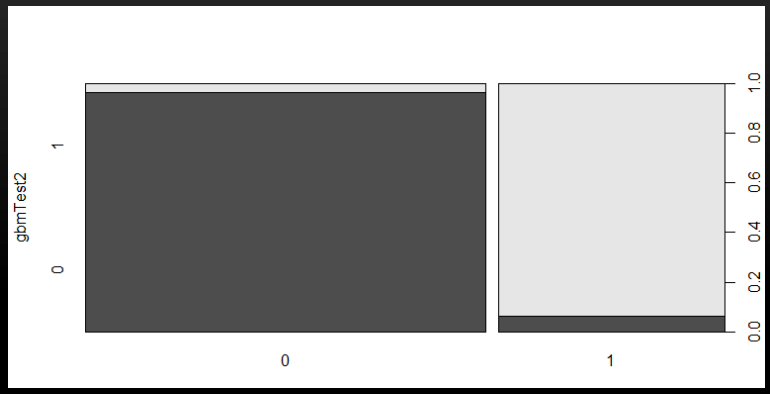
https://laura.makes.org/

LOCH NESS, MESSY NESSY, AND THE KRAKEN

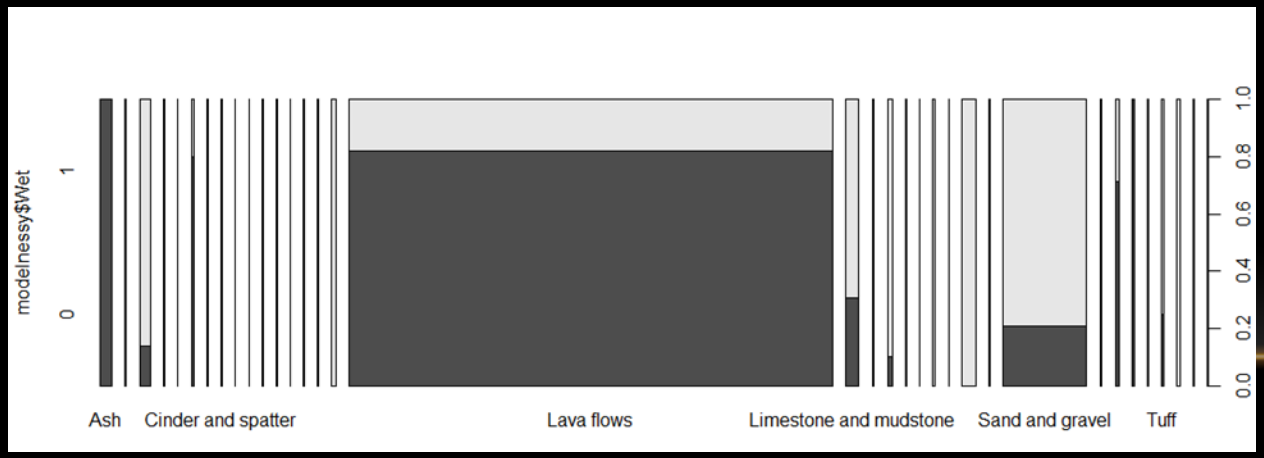
Random Forests
Boosted Regression
Partial Least Squares
Elastic Net Regression

MODEL RESULTS…

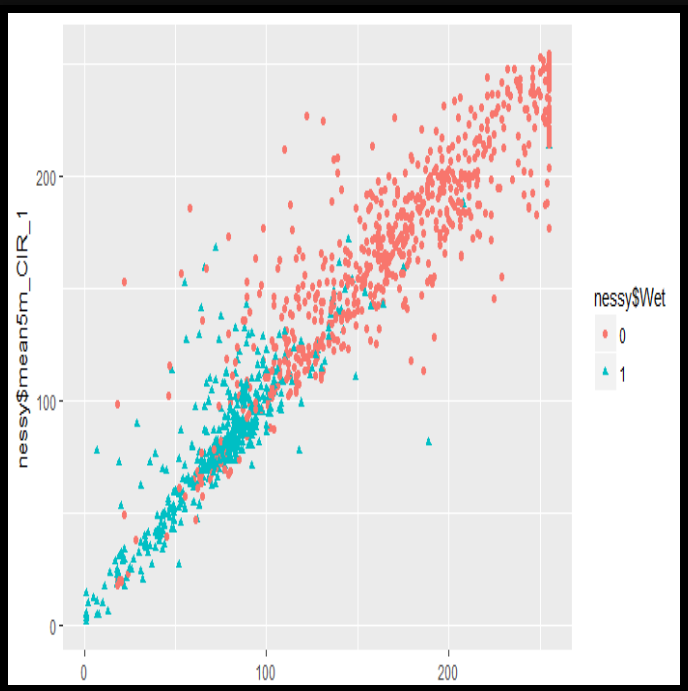


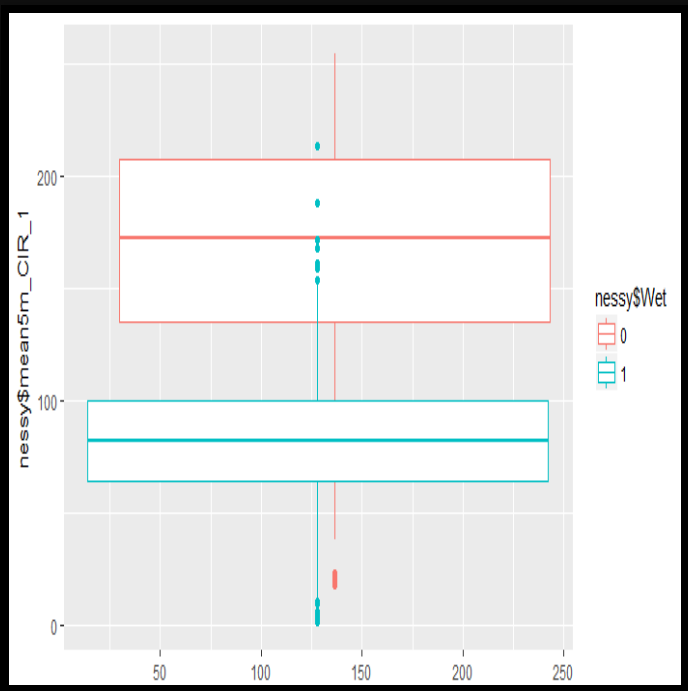


- Which variables are important
- How are they influencing the predictions?
- How well did the model work?

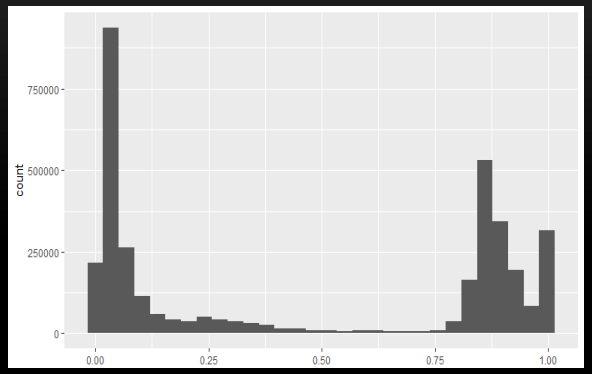


NRCS – TUNED COLOR INFRARED

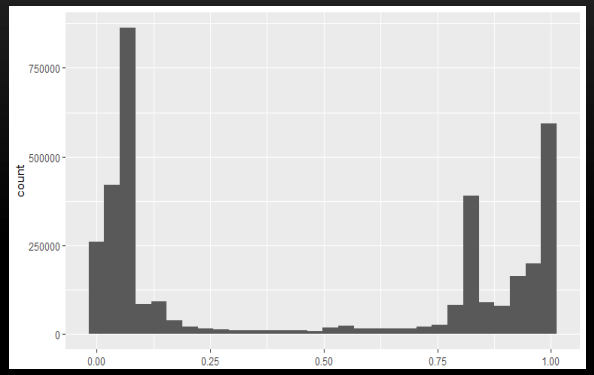




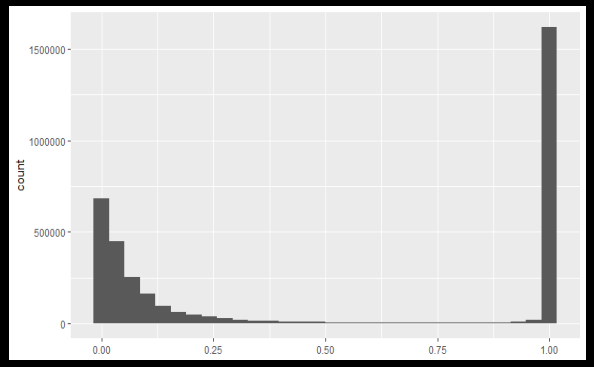
PREDICTIONS!!!!



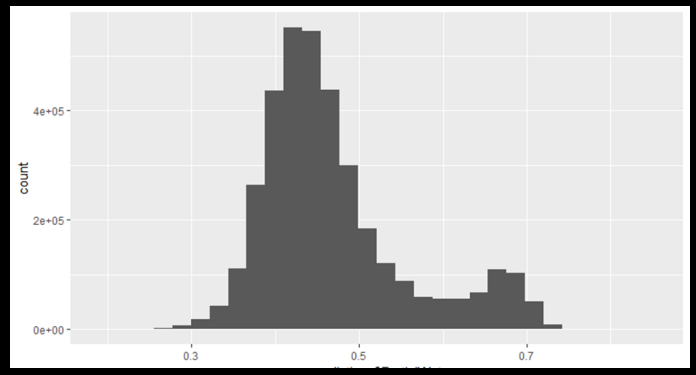
Random Forests (95% Accuracy)



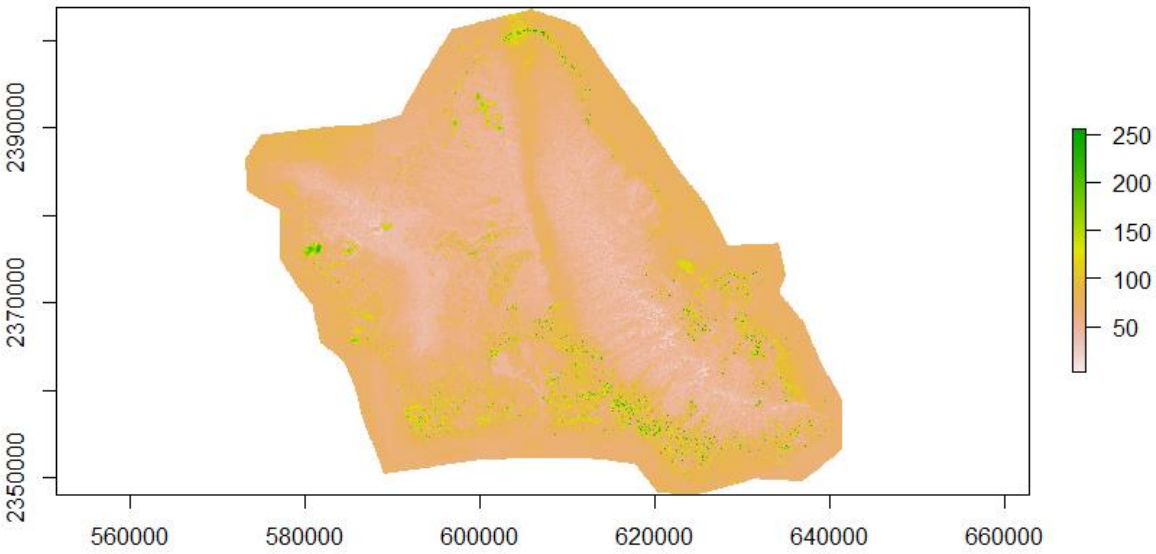
Boosted Regression (93% Accuracy)



Elastic Net Regression (94% Accuracy)



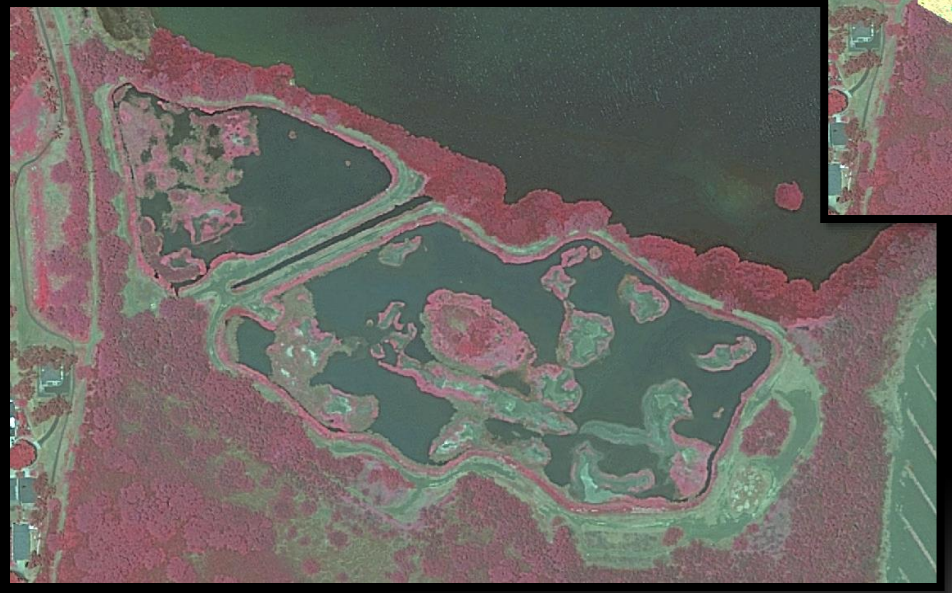
Partial Least Squares Regression (91% Accuracy)

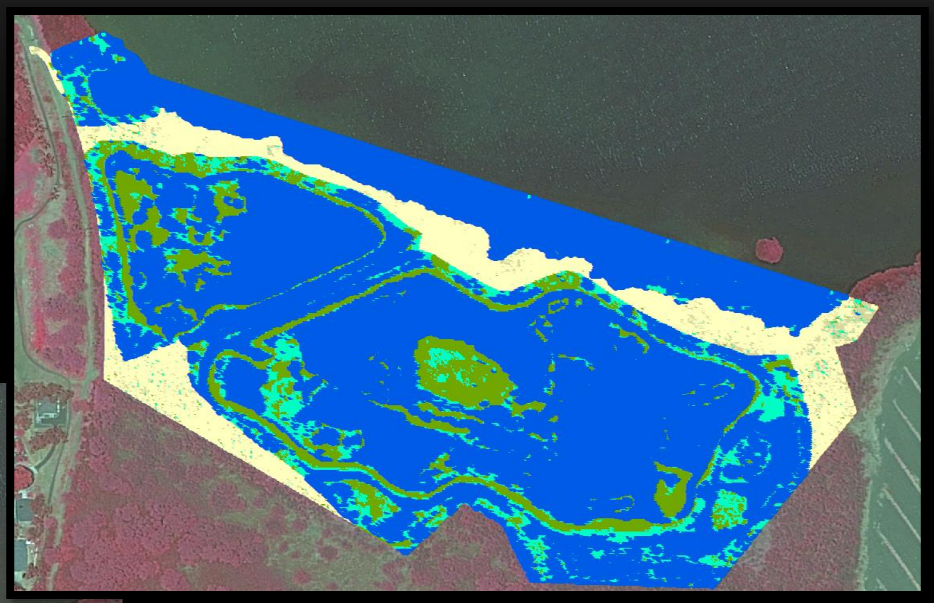



```
> system.time(plot(Oahu8Band))
   user  system elapsed
  10.36    0.69   21.05
```

```
> nrow(Oahu8Band)
[1] 34786
> ncol(Oahu8Band)
[1] 42698
1.48x10⁹ cells
```

PEARL HARBOR NWR



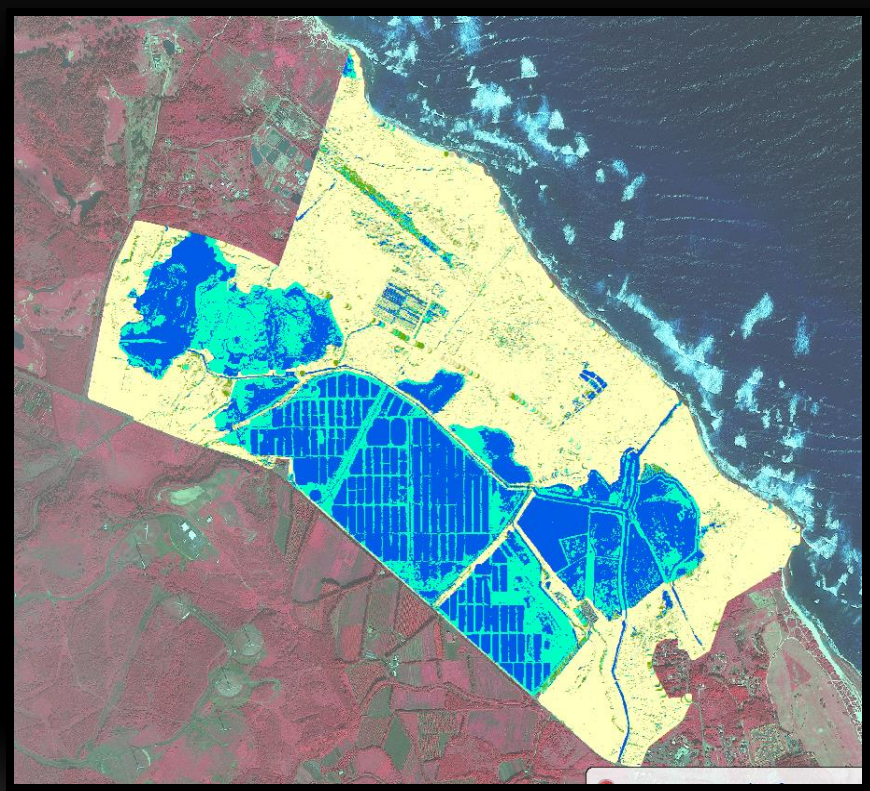


Boosted Regression Probability of Water

- 0--15%
- 16--38%
- 39--69%
- 70--92%
- 93--100%

TRAINING DATA FOR JAMES CAMPBELL NWR

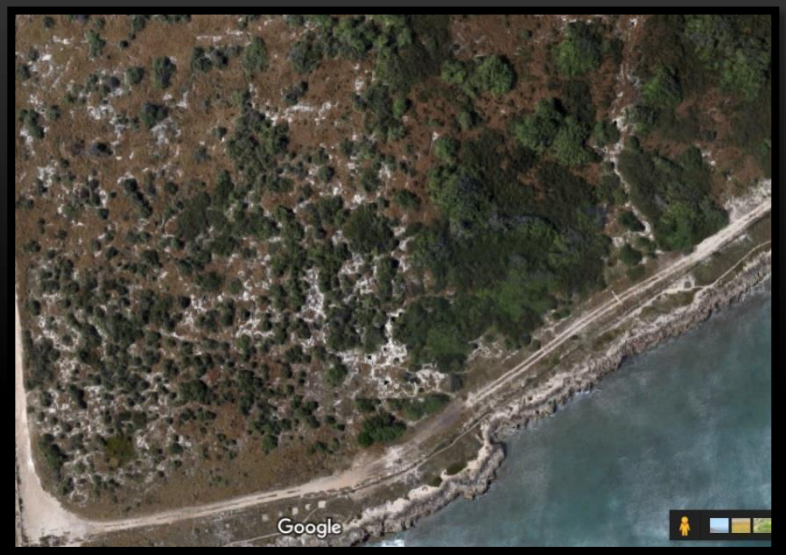
JAMES CAMPBELL NWR



Boosted Regression Probability of Water

- 0--15%
- 16--38%
- 39--69%
- 70--92%
- 93--100%

KALELOA NWR



Boosted Regression Probability of Water

- 0--15%
- 16--38%
- 39--69%
- 70--92%
- 93--100%

EPHEMERAL WETLANDS AND SEASONAL CHANGE

2011-12-27

U.S. FISH & WILDLIFE SERVICE

SATELLITE POSITION MOVEMENT

2017-05-18

ACKNOWLEDGEMENTS

- Pacific Birds, Adonia Henry
- Natural Resource Conservation Service, Tony Kimmet
- National Oceanic and Atmospheric Association, Ross Winans
- USFWS Strategic Habitat Conservation Team: Fred Amidon, Adam Vorsino, Stephen Miller