Haleakala National Park

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Abstract

The information and statistics presented in this report with geospatial tools will be utilized to scope out optimal areas for the activities proposed in the trip itinerary. This report will identify the ideal places for beginner birdwatchers to attempt to spot the ‘I ‘iwi honeycreeper (*Vestiaria coccinea*) when exploring Haleakala National Park. Cluster analyses were performed to demonstrate where a predominant amount of the declining ‘I ‘iwi roost within the park. However, the resplendent ‘I ‘iwi were not the only native Hawaiian birds analyzed in this project. The Nene (*Branta sandvicensis*), which is Hawaii’s state bird, and Maui Parrotbill (*Pseudonestor xanthophrys*) habitats are also investigated. Watershed analysis on USGS DEMs via hydrological tools found nine different watersheds throughout the park, along with a drainage network which flows in myriad directions depending on the island’s topography. Lastly, interpolation methods were implemented to find the optimal month to visit Haleakala National Park.

Introduction

Haleakala National Park is located along the southeastern face of the island of Maui, which lies within the legendary archipelago known as the Hawaiian Islands. Hawai’i lies 2,400 miles (3,862km) from the nearest continent. The area possesses palpable insight into ancient and modern Hawaiian culture. Therefore, no drinks, food, or gasoline are allowed in the park. Both districts within the park, the Summit and Kīpahulu, are quite remote, so make sure you are prepared for the escapade! Because of the Hawaii’s remoteness, the flora, fauna, and geographic features have evolved into a particularly intriguing ecosystem to many. In 1898, The Republic of Hawai’i was annexed as a territory of the United States. Shortly after this event, in 1916, the Hawai’i National Park was established by Congress, including the Haleakala section (“Timeline”). Since then, the western world’s influence has become quite evident when looking at myriad kinds of empirical studies. For instance, the accretion of anthropological diversity on the Hawaiian Islands increased livestock demand. Urbanization and livestock, particularly pigs, have exponentially increased the occurrence rate and lethality of mosquito-carried malaria, which is currently decimating native Hawaiian bird’s chances at survival (“‘I‘iwi.”).

Problem Statement

Completion of the project resulted in visualization of species distribution of ‘I‘iwi honeycreepers, Nene, and Maui Parrotbills throughout Haleakala, as well as a directional trend and observational hot spots of ‘I‘iwi. A 2D/ 3D linked map is beneficial for gauging the topography and vertical relief throughout Haleakala to aid in navigation during the trip. The project also aimed to delineate watersheds and gain understanding of the drainage patterns and flow direction of the streams in the park. Analyzing interpolated surfaces using inverse distance weighted and kriging methods attempted to help determine which month would be best for visiting the park based on precipitation and max temperature. GIS tools were the most appropriate to analyze these questions and concerns as it allows for spatial statistics that can be mapped. This is extremely helpful for planning an efficient, interesting, and safe trip to a biodiverse place such as a national park.

Methods

Multiple spatial statistics, watershed, terrestrial, and interpolation tools were used to create the map layouts. Inverse Distance Weighting and Kriging tools were utilized to predict surface temperatures over areas without climate data. Spatial statistic tools such as mean center, standard deviational ellipse show where data is located and how it is spread. Average Nearest Neighbor, in addition to mapping cluster tools such as Optimized Hot Spot Analysis and Density Based Clustering aid in determining if data is clustered. Terrestrial tools give a sense of terrain type and slope across an area, while hydrological tools give important details on drainage patterns and watershed delineation.

Table 1: Proposed Maui Trip Itinerary within Haleakalā National Park

Day	**Location**	**Activities**
1	Summit District	Stargazing
2	Summit District	Hiking & pictures
3	Kīpahulu District	Swimming & birdwatching
4+	Hosmer Grove & other archaeological sites	Birdwatching & history

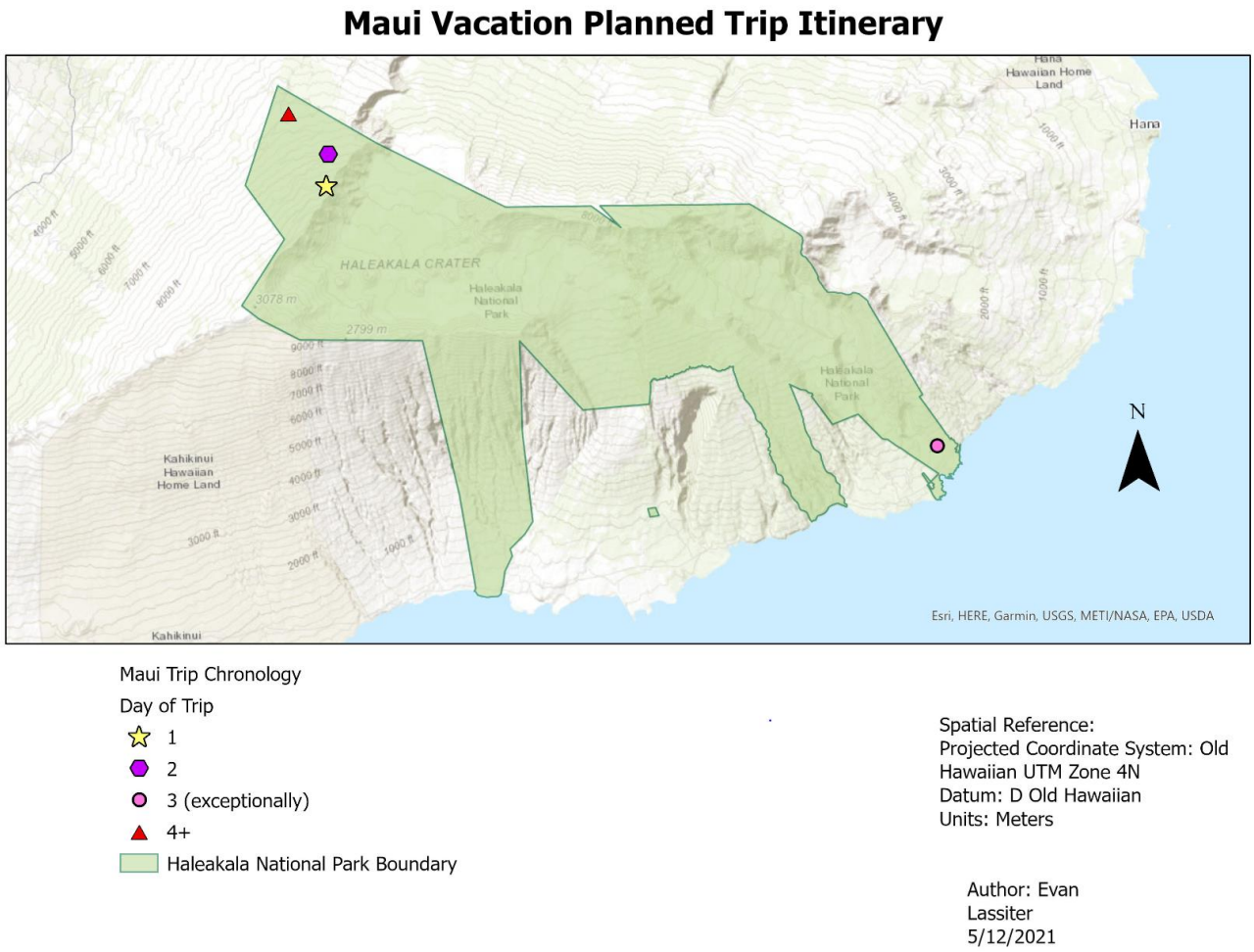


Figure 1: A map displaying the project's chronological itinerary, which flows with the desired activities planned. Day one will be spent stargazing and acclimating to the new environment at Leleiwi Outlook. An attempt to hike up Halemauʻu Trailhead will be undertaken on day two of the escapade. Day three will be the only day spent in the Kīpahulu District, therefore, I must take in all the lush greenery and flowing waters while I can. The last days should be spent revering the rich culture and endangered species of Maui, which are beautifully intertwined in history. Hosmer Grove will be an optimal place for these end-of-trip activities.

Itinerary Limitations

The 'exceptionality' stated in day three of 'Figure 1' represents the point location of which would be travelled to that day if other activities are completely hindered. Day three is mean to be spent swimming and birdwatching in the Kīpahulu District. Therefore, my desired excursions for day three do not follow a set direction or intention. Occasional spontaneity is always good for the soul!

Table 2: List of spatial data used to create information products for Haleakala National Park

Data Name	Data Source	File Type	Coordinate System	Why you need it
National Parks	https://blackboard.stonybrook.edu/bbcswebdav/pid-5929967-dt-content-rid-51540709_1/xid-51540709_1	Zip file	Old Hawaiian UTM Zone 4N	To accurately represent the Haleakala National Park boundary
USGS DEM n21w15	http://nationalmap.gov/viewer.html	GeoTIFF	Old Hawaiian UTM Zone 4N	Elevation data
Roads – Maui County	https://geoportal.hawaii.gov/datasets/roads-maui-county?geometry=-156.338%2C20.627%2C-156.011%2C20.740	Downloaded shapefile	Old Hawaiian UTM Zone 4N	To accurately represent the main roads on the island
Nene	https://doi.org/10.15468/dl.fr3npu	CSV	Old Hawaiian UTM Zone 4N	For the species' recorded sightings
Nene area	https://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22679929A112386209.en	File Geodatabase Feature Class	Old Hawaiian UTM Zone 4N	For inferences on the species' habitat
'I'iwi	https://doi.org/10.15468/dl.byj23w	CSV	Old Hawaiian UTM Zone 4N	For the species' recorded sightings
'I'iwi area	https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T22720844A179228794.en	File Geodatabase Feature Class	Old Hawaiian UTM Zone 4N	For inferences on the species' habitat
Maui Parrotbill	https://doi.org/10.15468/dl.qv7g2u	CSV	Old Hawaiian UTM Zone 4N	For the species' recorded sightings
Maui Parrotbill area	https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22720753A94681687.en	File Geodatabase Feature Class	Old Hawaiian UTM Zone 4N	For inferences on the species' habitat
US States (Generalized)	https://www.arcgis.com/sharing/rest/content/items/99fd6	File Geodatabase Feature Class	Old Hawaiian UTM Zone 4N	For inset map

	7933e754a1181cc755146be21ca/info/metadata/metadata.xml?format=default&output=html			

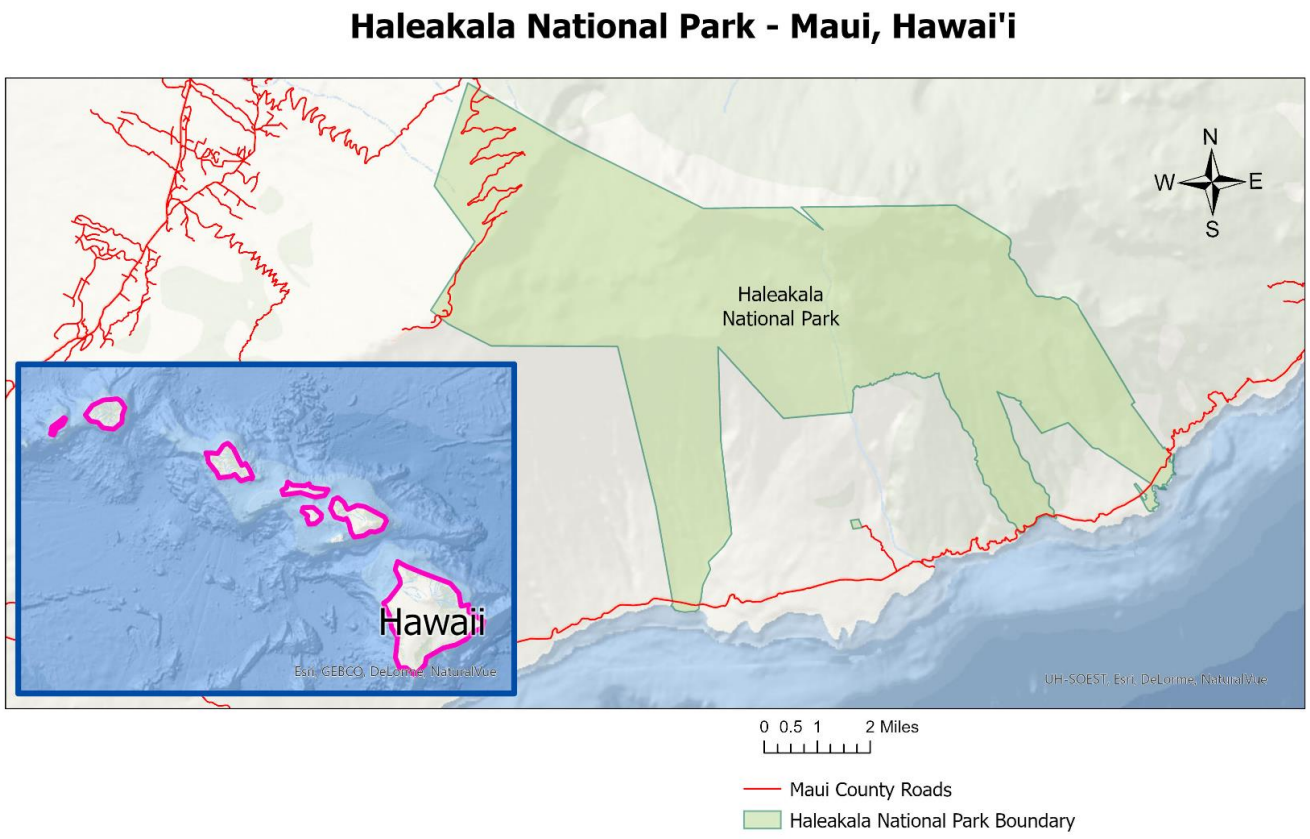


Figure 2a: A site map of the study area(s) of this project, which lie within the Haleakala National Park Boundary. Along with an inset map of the infamous archipelago: Hawaii.

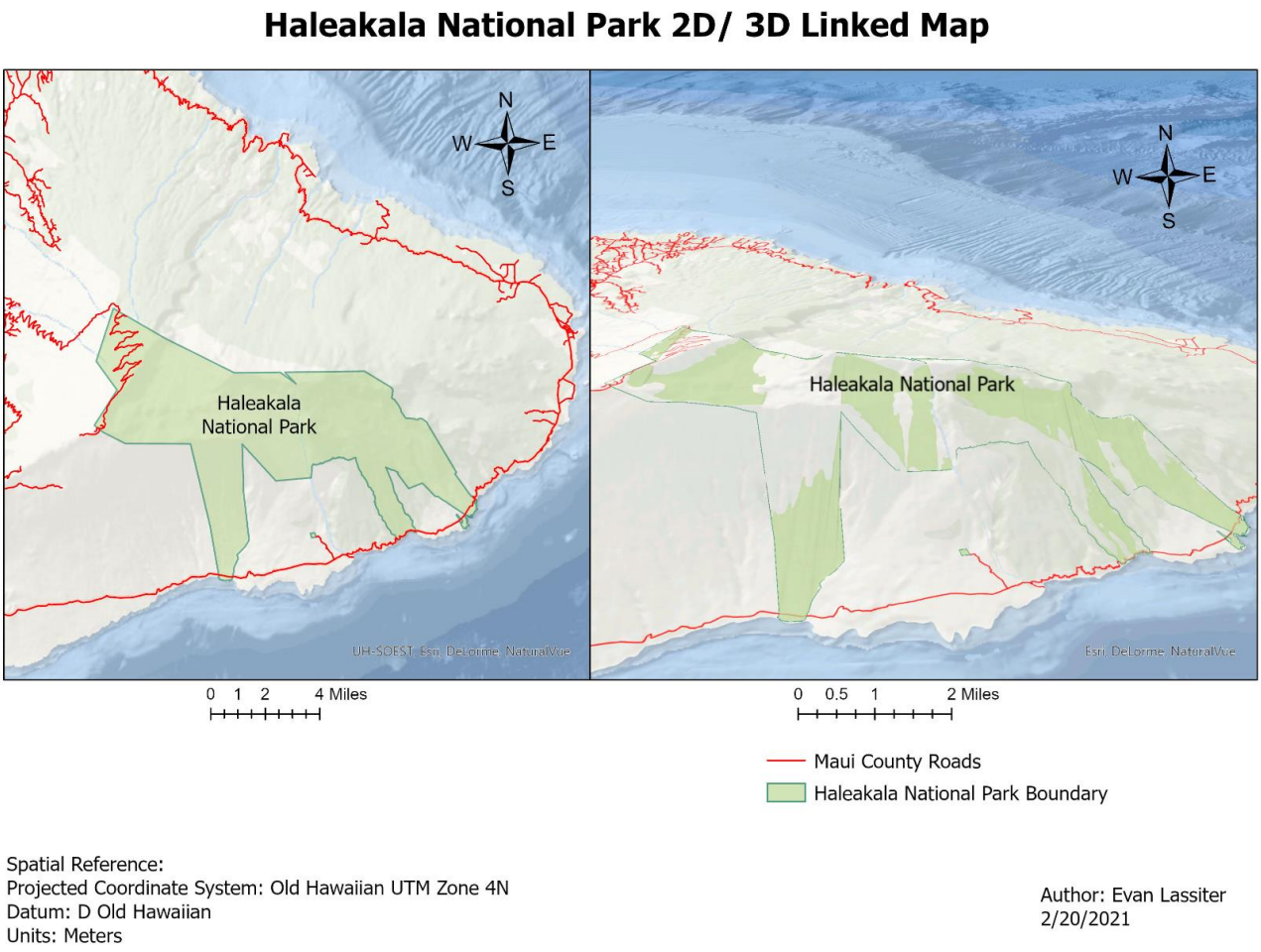


Figure 2b: A 2D/ 3D linked map layout, which depicts the vertical relief of Haleakala National Park on the right.

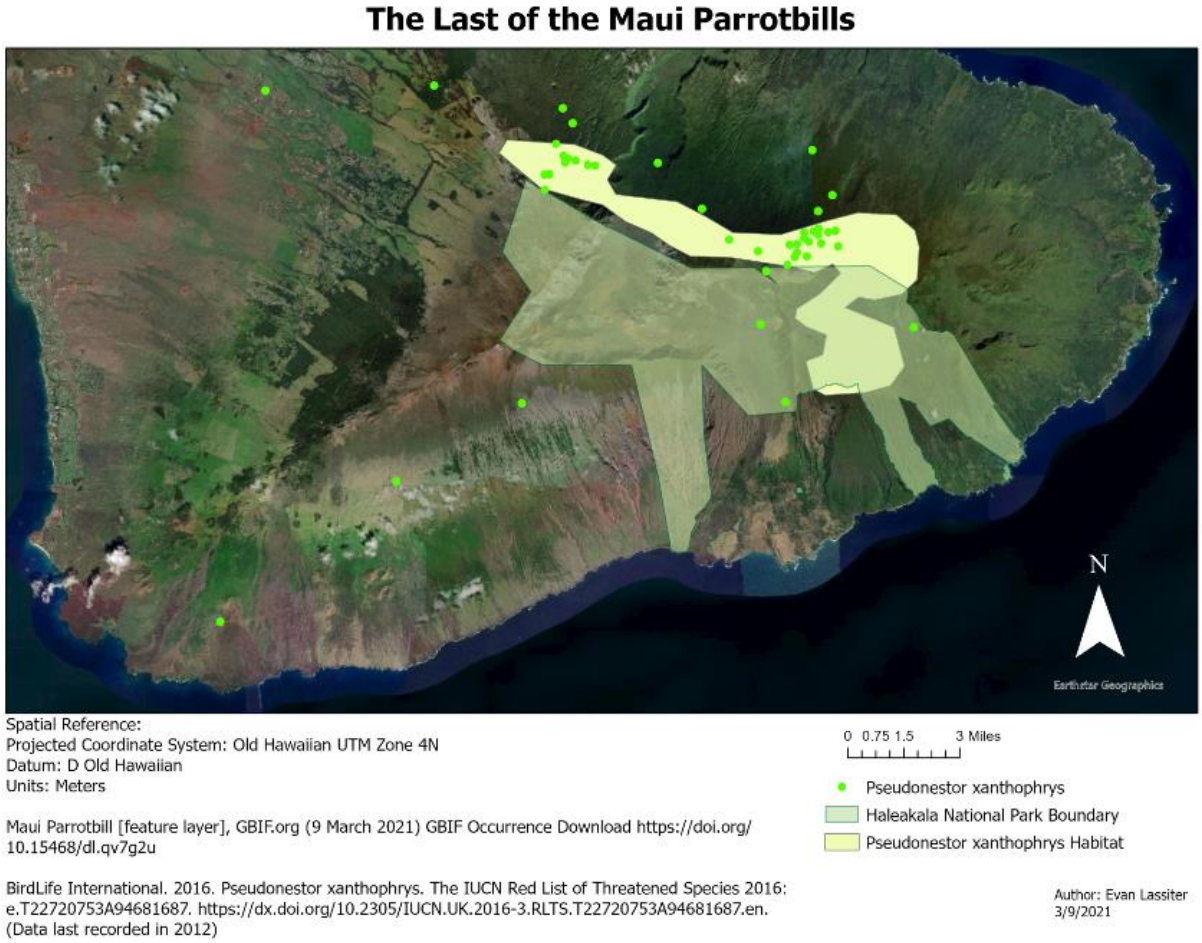


Figure 3: A map displaying GBIF observational data of the last sightings of the ever-declining Maui Parrotbill. An IUCN polygon layer representing the Parrotbill's considered habitat range is seen superimposed below the Haleakala Park Boundary. Neither of the data layers are clipped to Haleakala National Park because their current state is so dire that boundary-dependent analysis would provide maladaptive inferences and deductions.

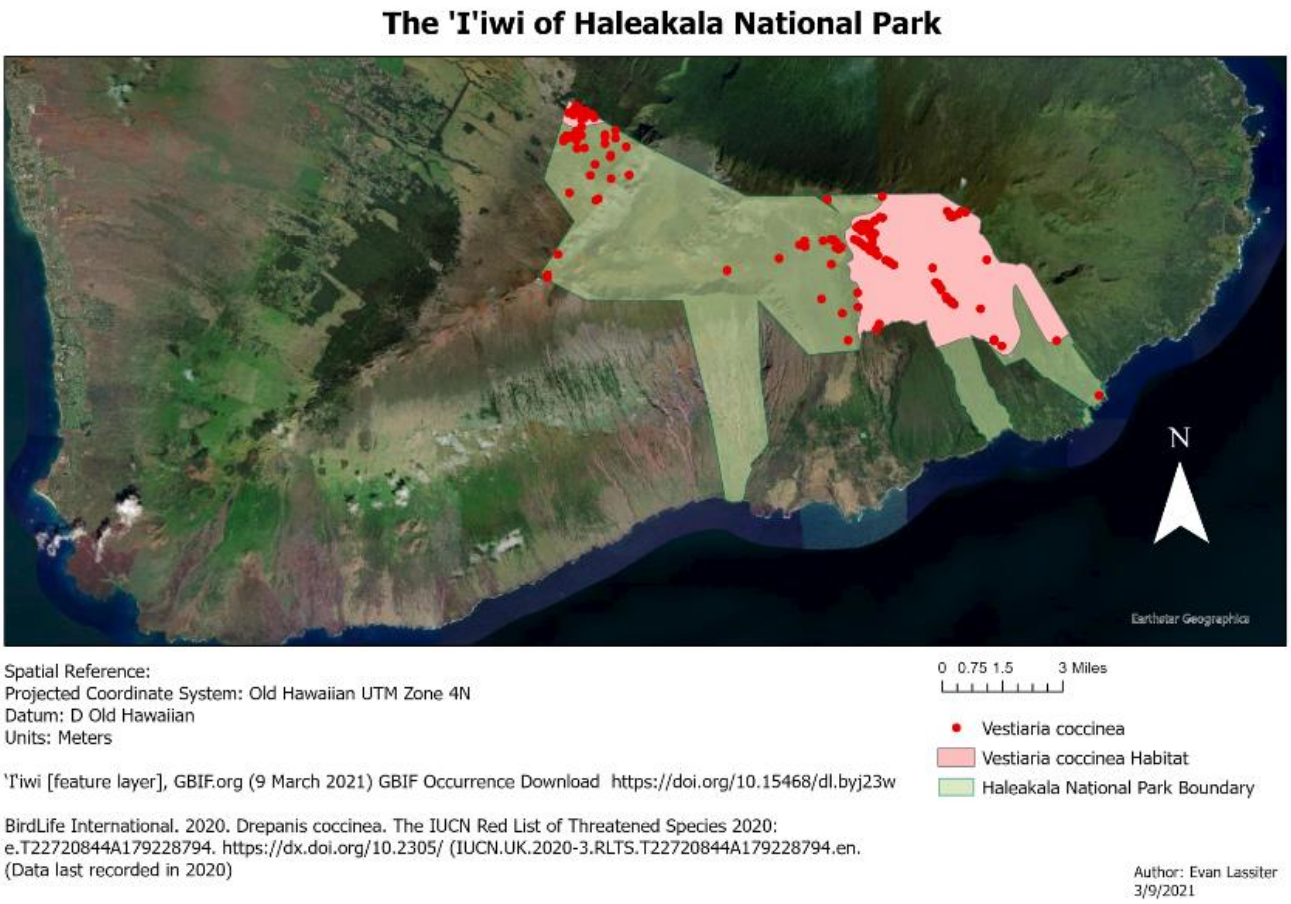


Figure 4: A general map presenting the recorded geographic sightings, via GBIF observational data, of the notorious native Hawaiian bird; The ‘I‘iwi honeycreeper. The pink polygons represent IUCN habitat ranges. Both data layers are clipped to the Haleakala National Park boundary because the vacation, and further analyses of the species will be considering the honeycreepers within the protected area. Likely due to the ‘I‘iwi’s deep roots in Hawaiian royal culture, the records of data have been accumulated for over the past 190 years!

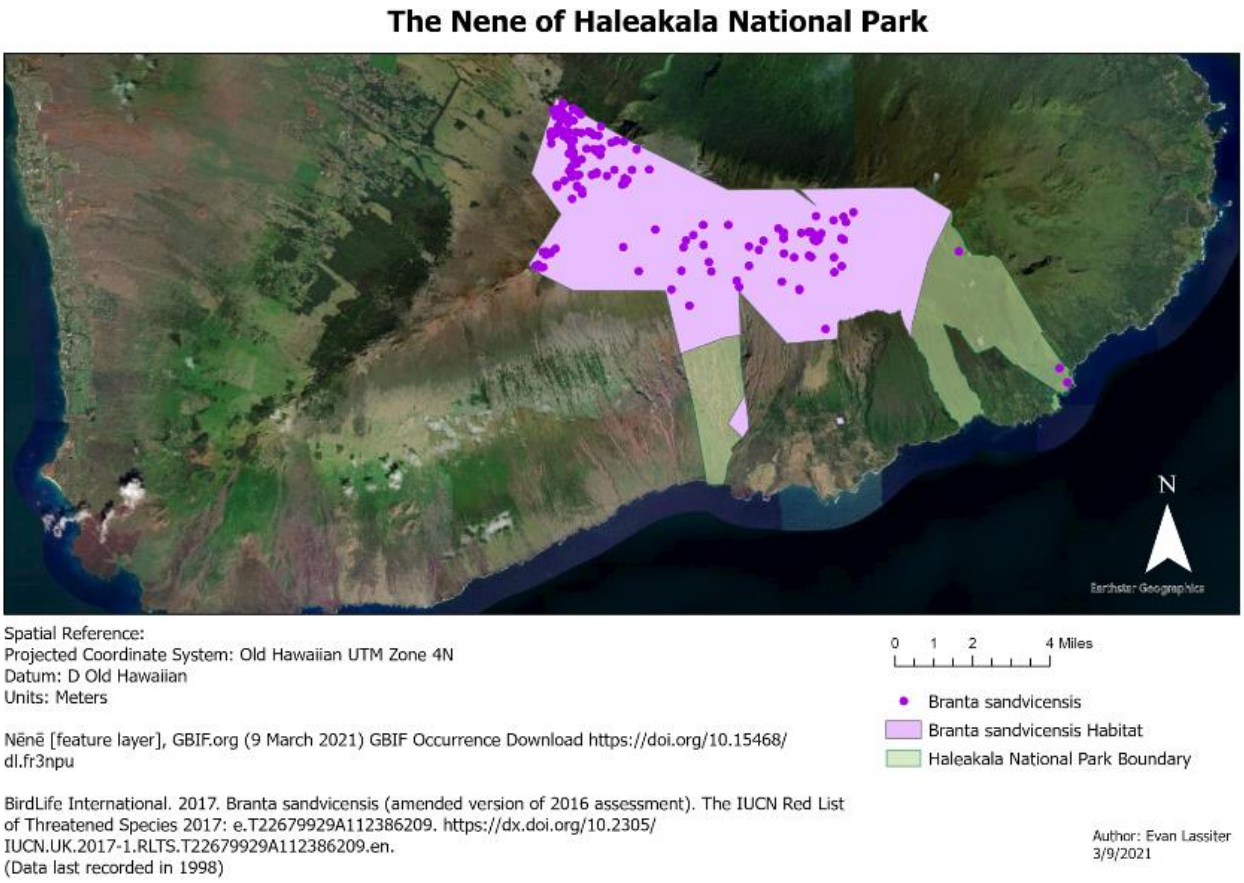


Figure 5: A map illustrating where the Nene goose can likely be spotted when traversing through Haleakala National Park.

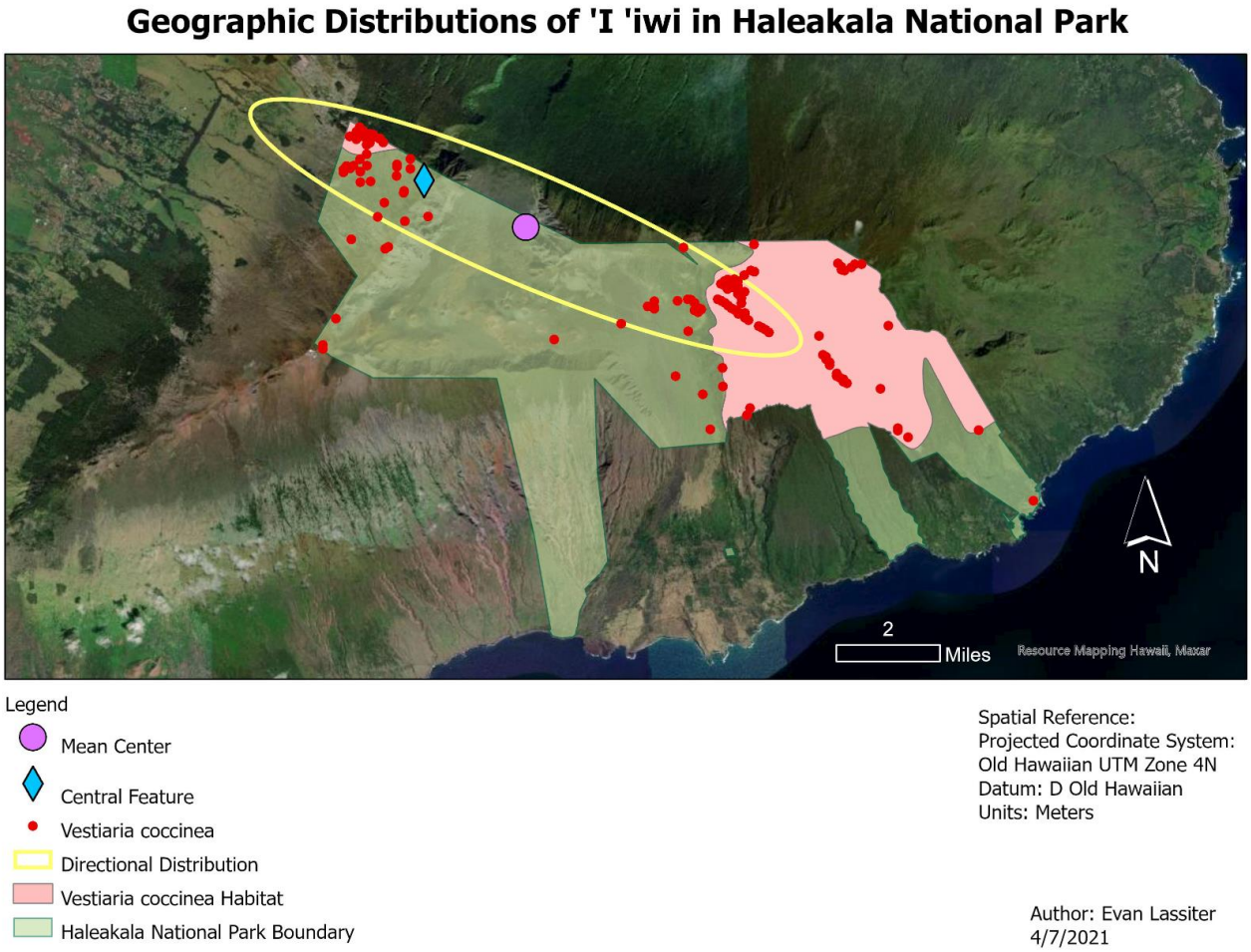
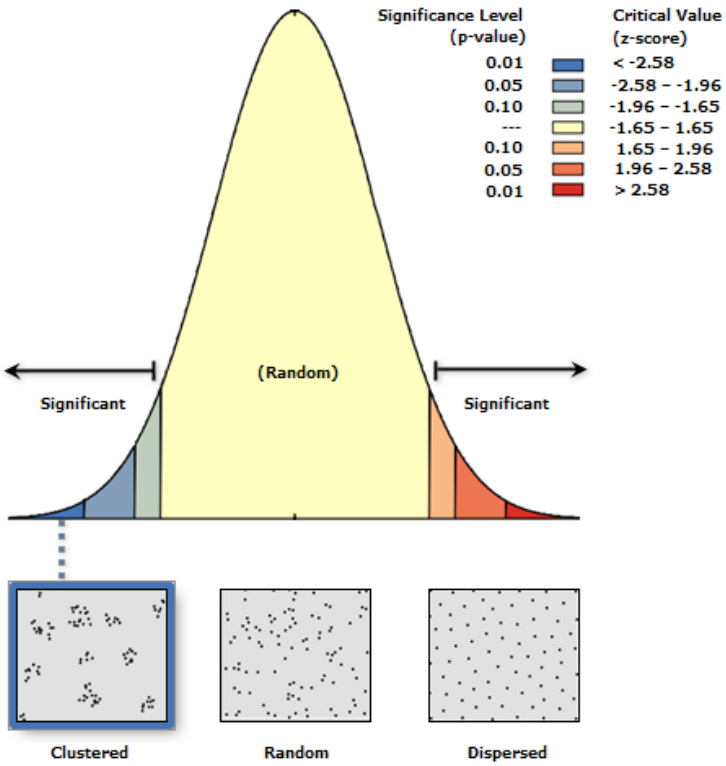


Figure 6: This map builds on the ‘I‘iwi (*Vestiaria coccinea)* distribution map mentioned earlier (Figure 4). I created this map to determine whether the map is fit for clustering analysis, which helps me determine the best places to spot ‘I‘iwi within the park. The Mean Center of the distribution is indicated by the purple circle near the northern border of the park. The Central Feature depicts the point most accessible from all the other ‘I ‘iwi sightings, and notably, is placed in a location slightly northwest of the Mean Center. This makes sense given that the densest cluster lies in that direction, away from the Mean Center feature. The Directional Distribution Ellipse (one standart deviation) reveals the trend in ‘I ‘iwi occurences in the dataset, which in this case the the Haleakala National Park boundary.



Given the z-score of -22.729223, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Average Nearest Neighbor Summary

Observed Mean Distance:	109.8242 Meters
Expected Mean Distance:	380.4067 Meters
Nearest Neighbor Ratio:	0.288702
z-score:	-22.729223
p-value:	0.000000

Dataset Information

Input Feature Class:	Vestiaria coccinea
Distance Method:	EUCLIDEAN
Study Area:	161495558.881977
Selection Set:	False

Figure 7: The report above demonstrates the results of running the Average Nearest Neighbor tool on the dataset of ‘I ‘iwi. The report found a low z-score of -22.729223 and a p-value of 0. This indicates that there is a less than one percent chance of this pattern occuring due to random chance. Both values also lie within the bluest part of the normal cure, which further support this degree of certainty at the 99% confidence level.

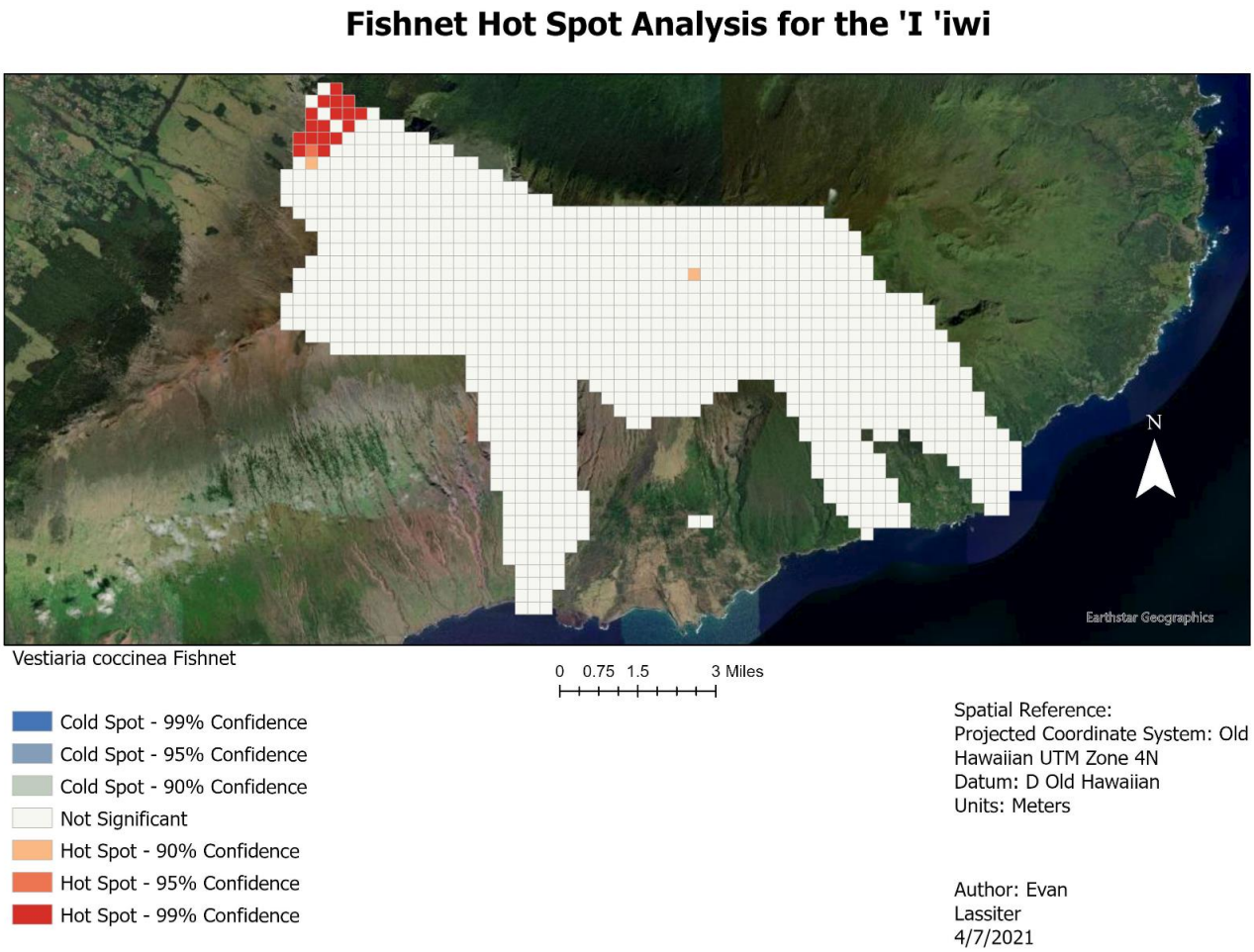


Figure 8: A map illustrating where the ‘I‘iwi honeycreepers predominantly live throughout a statistically calculated fishnet grid.

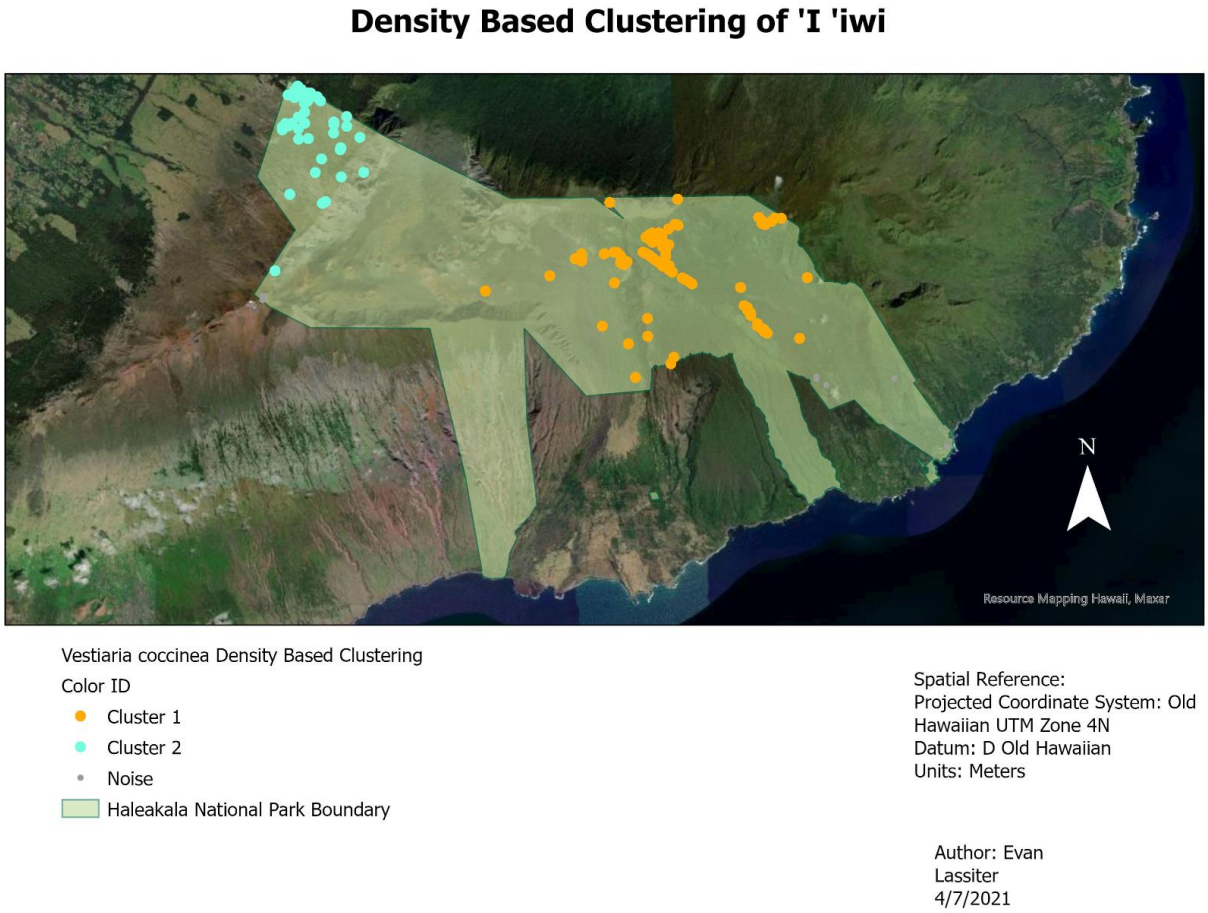


Figure 9: A map demonstrating the two clusters of ‘I‘iwi within Haleakala National Park.

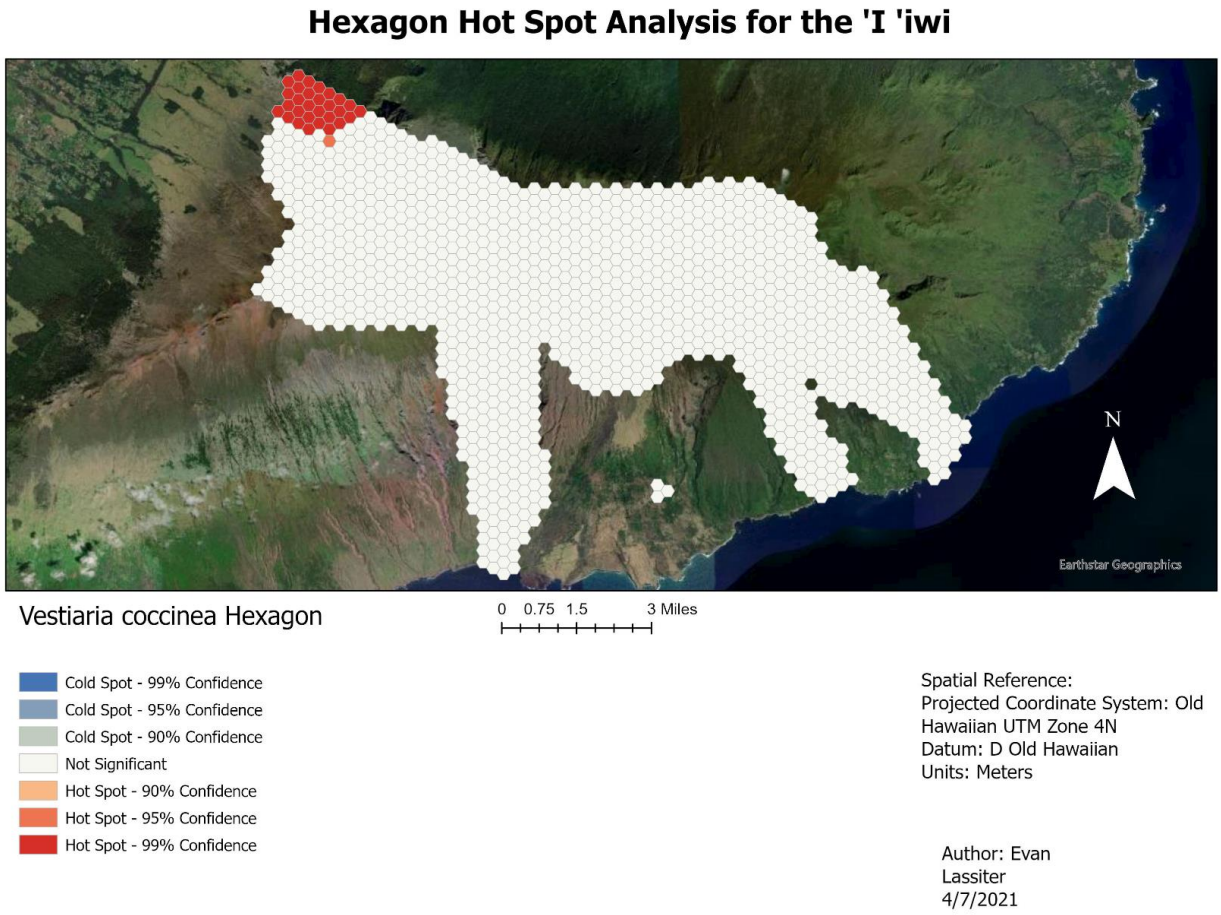


Figure 10: A map illustrating where the ‘I‘iwi honeycreepers predominantly live throughout a statistically calculated hexagonal grid.

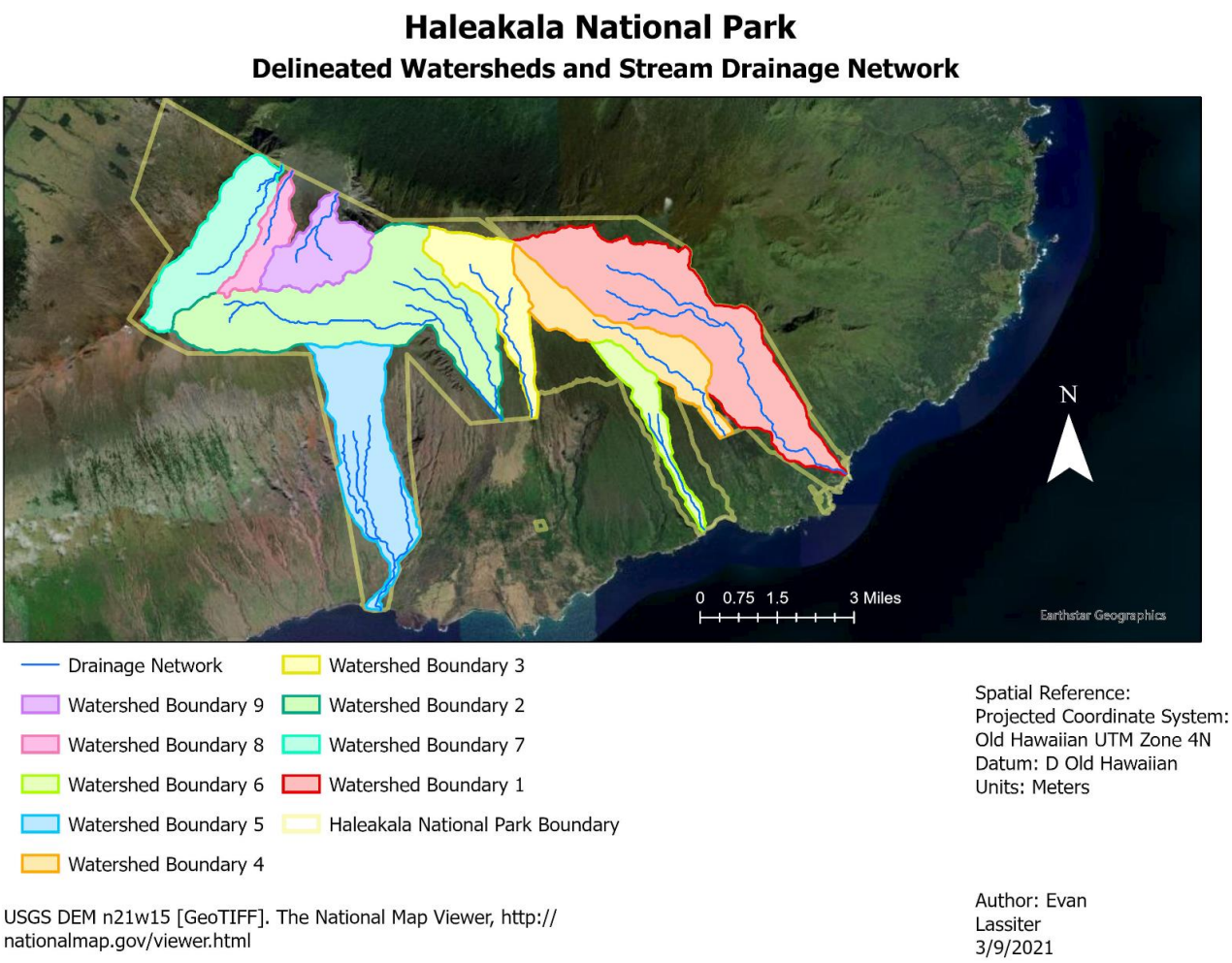


Figure 11: A map of the nine watersheds found within Haleakala National Park with a stream drainage network of flowing streams (in blue) superimposed over the watersheds.

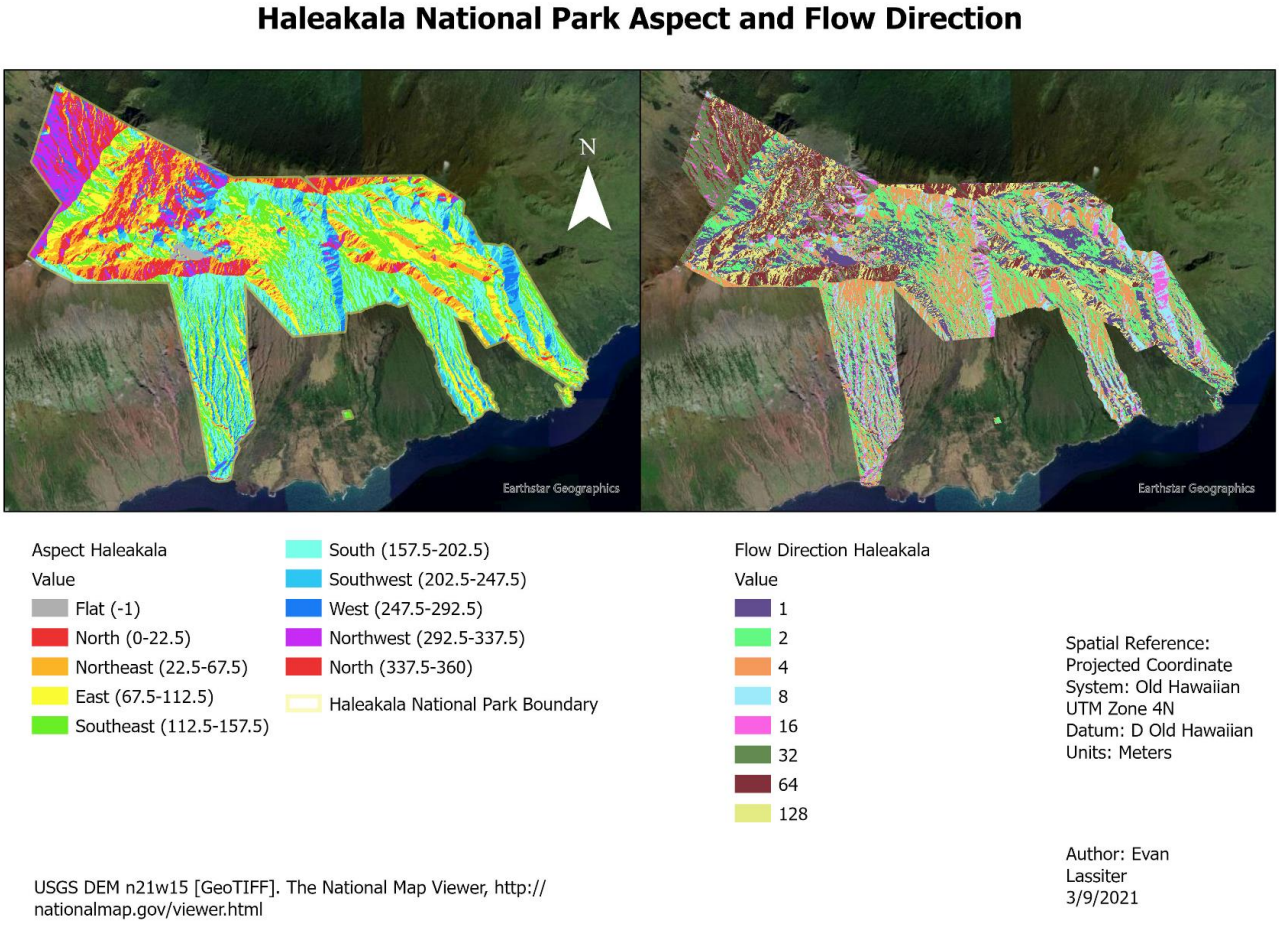


Figure 12: A map illustrating Haleakala's aspect and flow direction. The western side of the map appears to have the largest and most drastic changes in elevation compared to the eastern side of the park. The cell values in the flow direction indicate that downslope movement is mostly eastwards or southwards, which is also represented in the aspect map (left map in frame).

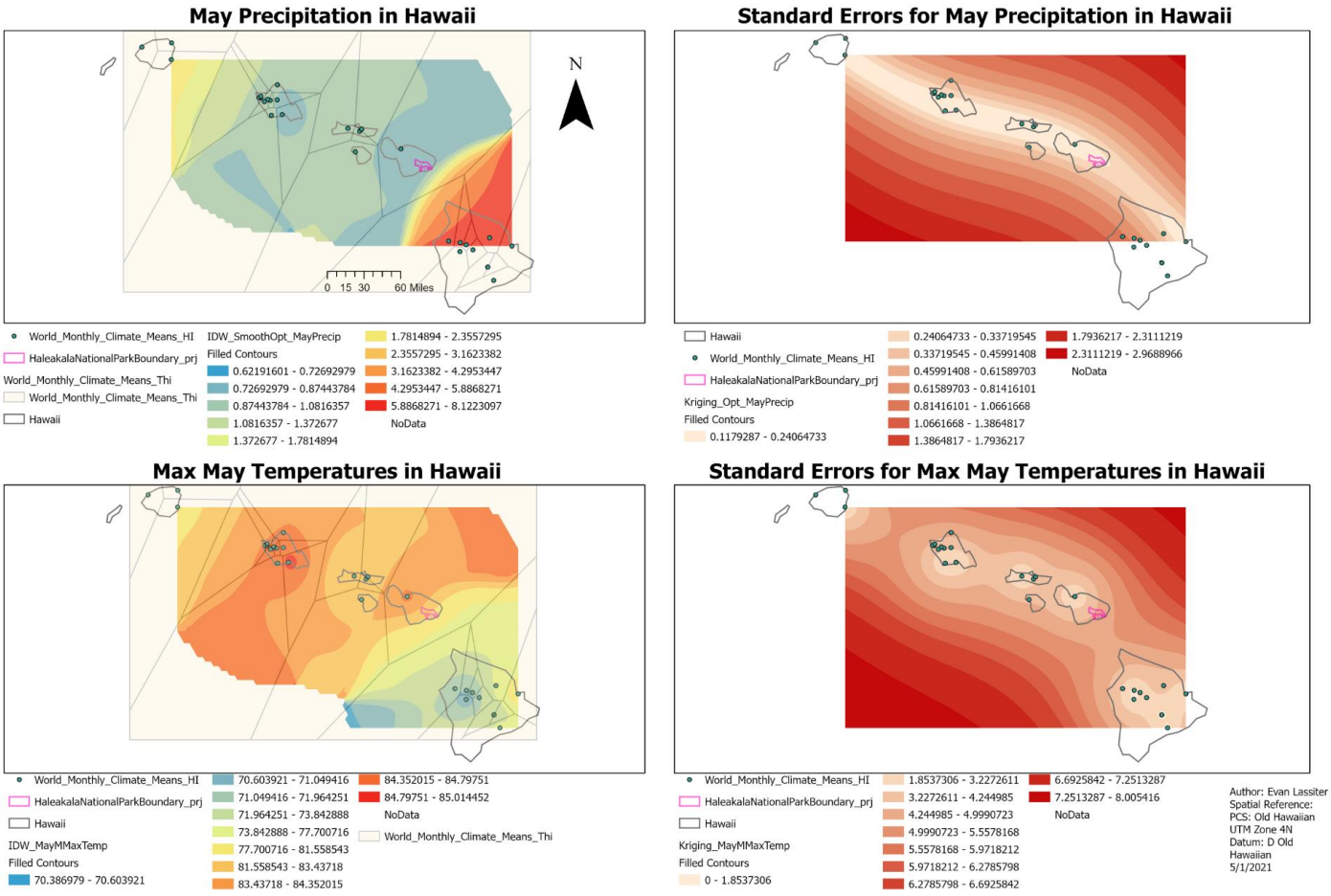


Figure 13: A map layout of the precipitation and max temperature IDW interpolations for the month of May next to their associated standard error maps. Rainfall in May on Maui appears to be very unlikely, which will be great for hiking and wildlife viewing. The precipitation standard error map (top right) further supports the claim that May skies will likely be dry. It would be unlikely to experience a day in Haleakala National Park over eighty-five degrees Fahrenheit in May. Standard errors are most accurate for max temperature at areas outside of the park. However, relatively accurate max temperatures are still depicted.

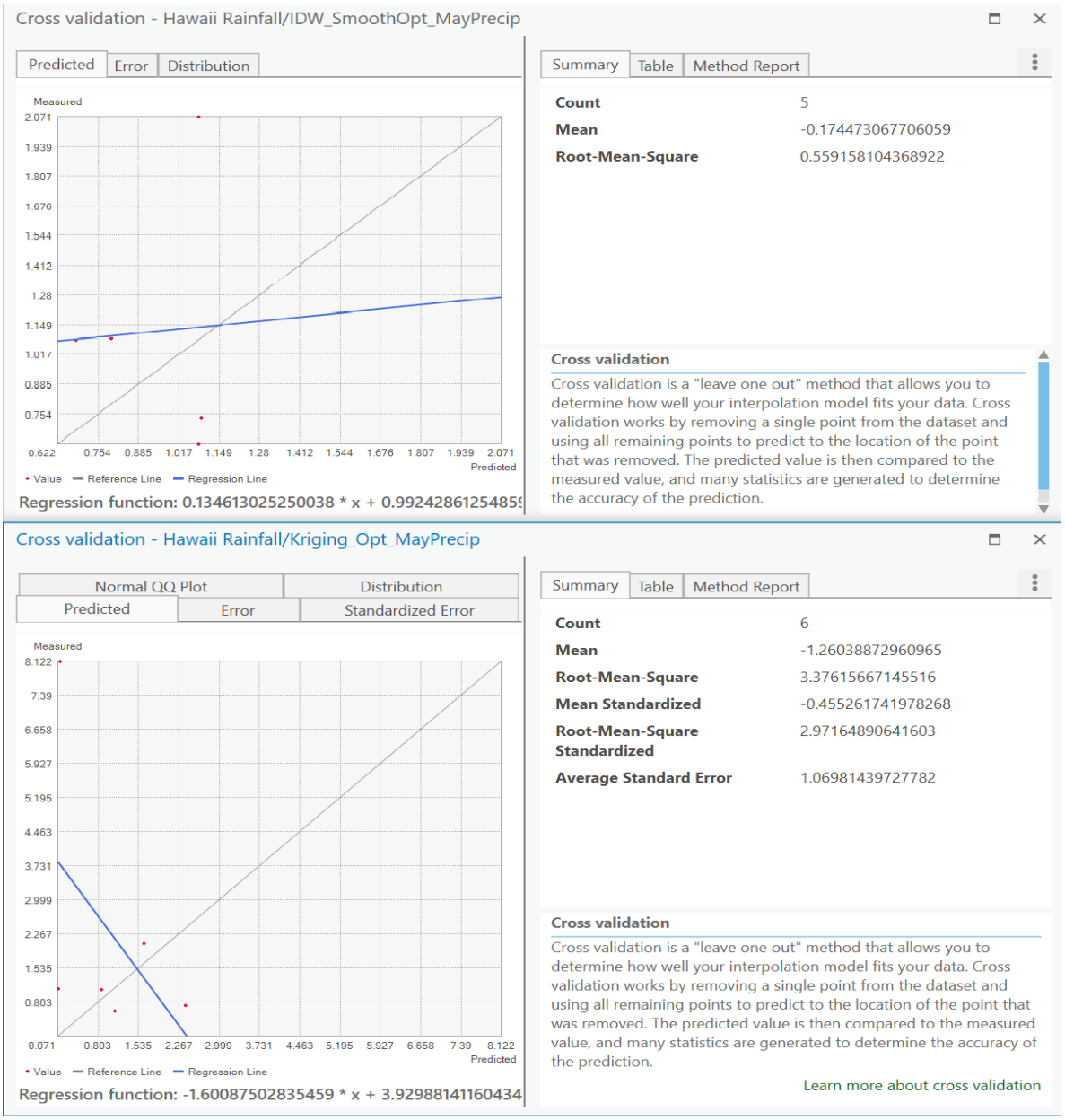


Figure 14: Cross validation of May mean precipitation (in inches) in Hawaii using IDW (top frame) and ordinary kriging (bottom frame). Kriging appears highly unreliable.

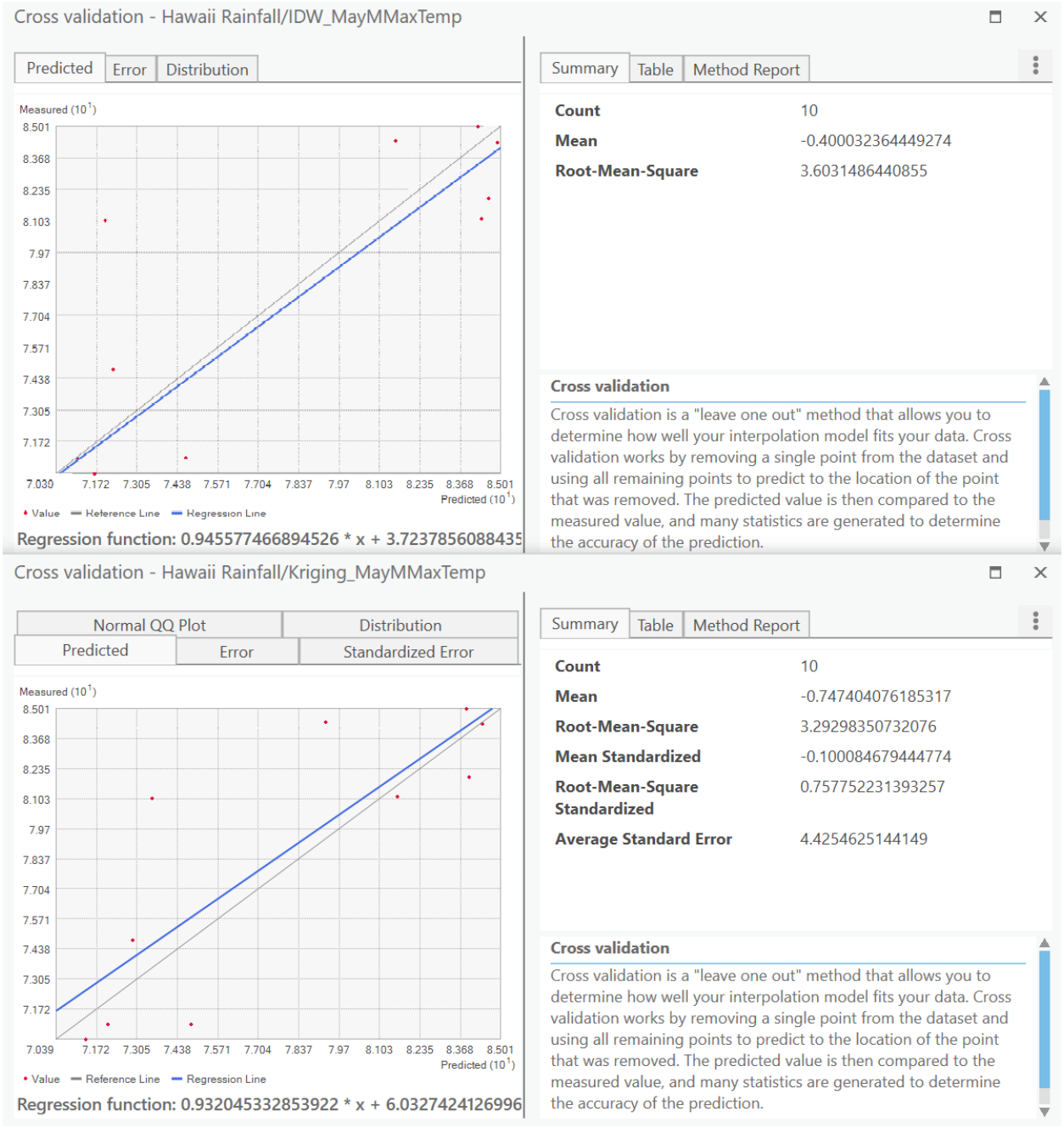


Figure 15: Cross validation of May mean max temperatures (Fahrenheit) in Hawaii using IDW (top frame) and ordinary kriging (bottom frame).

Figure 16: Workflow diagram of the report.

Discussion

Overall, this report presents valid native Hawaiian bird data as a helpful birdwatching aid to anyone visiting Haleakala National Park. The hydrology data is also a helpful aid when traversing through the lush areas of the park. However, the interpolation data of precipitation and max temperatures is highly unreliable. This is likely due to the massive Thiessen polygon that covers the whole island of Maui and a decent amount of ocean. Thiessen polygons are much smaller on some of the other Hawaiian Islands. This is likely due to urbanization, which has higher demand for more accurate weather. This report could be useful to bird ecologists, agricultural biologists, or ethnographic anthropologists because of the diseases addressed that are currently plaguing the beautiful native Hawaiian bird species.

Bibliography

Cover images:

Fox, Catherine Toth. “Return to Haleakalā National Park Starting June 12.” *Hawaii Magazine*, 12 June 2020, www.hawaiimagazine.com/return-to-haleakala-national-park-starting-june-12/.

“Hawaiian 'I'iwi Bird.” *YouTube*, The Nature Conservancy of Hawaii, 6 Apr. 2011, www.youtube.com/watch?v=nZyuqS-Kb7k.

Contextual references:

“‘I‘iwi.” *American Bird Conservancy*, 31 Mar. 2020, abcbirds.org/bird/iiwi/.

“Timeline.” *National Parks Service*, U.S. Department of the Interior, 28 Feb. 2015, www.nps.gov/hale/learn/historyculture/timeline.htm.