

# Fine-scale change detection using unmanned aircraft systems (UAS) to inform reproductive biology in nesting birds



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## Introduction

Obtaining reliable reproductive population estimates is crucial for effective management and conservation of wildlife species. Anaho Island National Wildlife Refuge (NWR), located in Pyramid Lake, Nevada, hosts one of the largest breeding colonies of American white pelicans (*Pelecanus erythrorhynchos*) in the West and is also a regular breeding ground for double-crested cormorants (*Phalacrocorax auritus*), California gulls (*Larus californicus*), Caspian terns (*Hydroprogne caspia*), and great blue herons (*Ardea herodias*). In May 2015, U.S. Fish and Wildlife Service staff from the Stillwater National Wildlife Refuge Complex collaborated with the U.S. Geological Survey National Unmanned Aircraft Systems Project Office, the Pyramid Lake Paiute Tribe and researchers from Humboldt State University to conduct a series of unmanned flights over nesting bird colonies at Anaho Island NWR to evaluate the utility of unmanned aircraft systems (UAS) for informing reproductive biology.

## Methods

### Mission

- **Location:** May 2015, Anaho Island National Wildlife Refuge, Nevada
- **Targets:** American white pelican, double-crested cormorant, California gull, Caspian tern, great blue heron
- **UAS:** Raven RQ-11A (USGS owned and operated)
- **Flights:** 3 flights on 2 consecutive days.

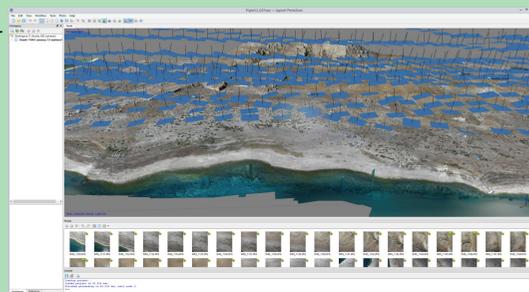


Raven RQ-11A UAS (photo courtesy of USGS)

- Preprogrammed transects at 400 and 300 foot AGL. 12 ground control points placed before nesting season and surveying using real time kinematics (RTK)
- **Ground Counts:** On-island legacy ground counts conducted simultaneously with flights

### Image Processing

- Orthophotos of entire nesting area created using Agisoft Photoscan (Agisoft L.L.C.)
- American white pelican features extracted with Feature Analyst (Overwatch Systems) extension in ArcMap 10.2 (ESRI 2013)



Agisoft Photoscan processing Anaho Island NWR data

### Analysis

- Nearest Neighbor analysis conducted with Geospatial Modelling Environment (GME) (Beyer 2013) and Program R (R Core Team 2015)

## References

- Agisoft L.L.C. 2015. Agisoft Photoscan (Version 1.1.6)
- ESRI. 2013 ArcGIS Desktop (Version 10.2). Redlands, CA: Environmental Systems Research Institute
- Overwatch Systems. 2015. Feature Analyst (Version 5.1).
- Beyer, Hawthorn L. 2013. Geospatial Modelling Environment (Version 0.7. 3.0). URL: <http://www.spatial ecology.com/gme>
- R Core Team. 2015. R: A language and environment for statistical computing (Version 3.2.2). R Foundation for Statistical Computing, Vienna, Austria.

## Results

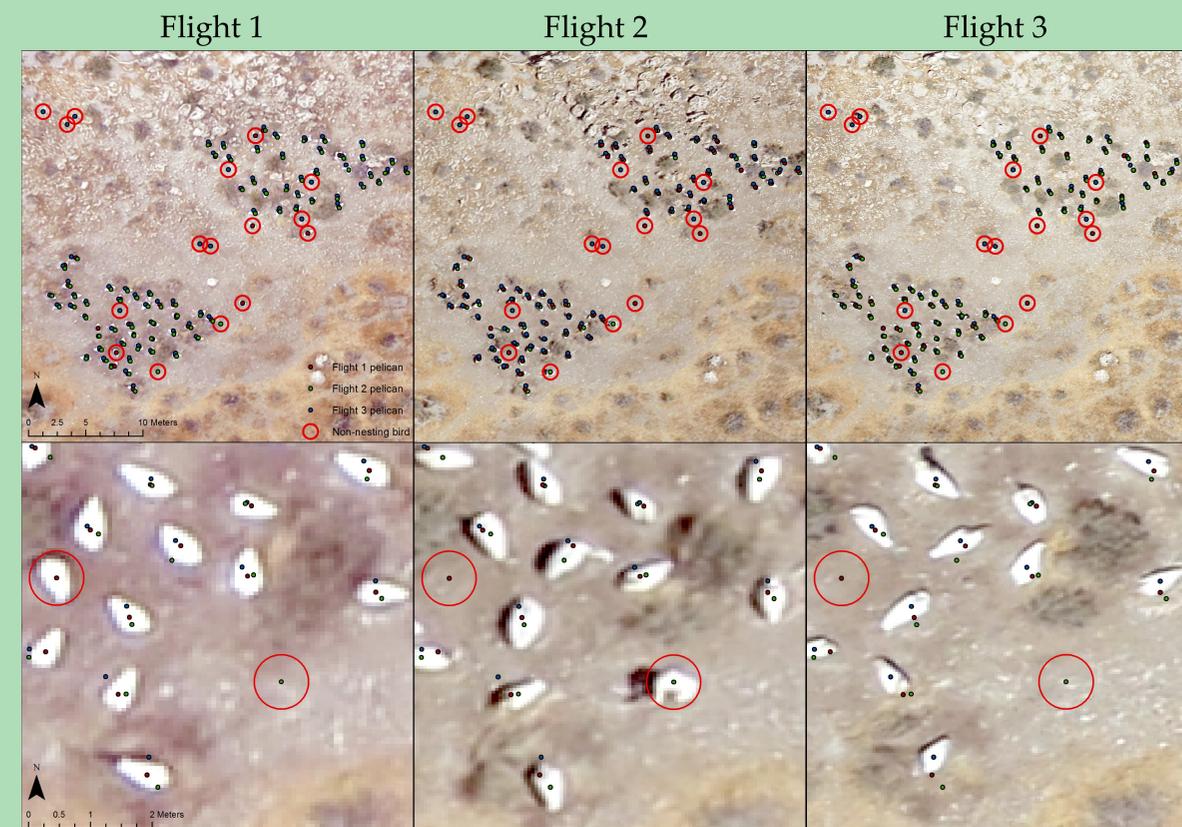


Figure 1. Full extent of pelican Colony B south (top) and a close up of B south (bottom) depicting change through Flight 1, Flight 2, and Flight 3



Figure 2. Ground-based imagery to validate nearest neighbor analysis

Table 1. Use of nearest neighbor results to obtain counts of nesting birds in Colony B south

Flight	Total Birds	Non-nesting Birds Detected	Nesting Birds
Flight 1	79	5	74
Flight 2	76	2	74
Flight 3	83	9	74

- Estimating numbers of nesting American white pelicans is possible using nearest neighbor change detection analysis between multi-temporal image sets
- Imagery must have a high level of spatial accuracy

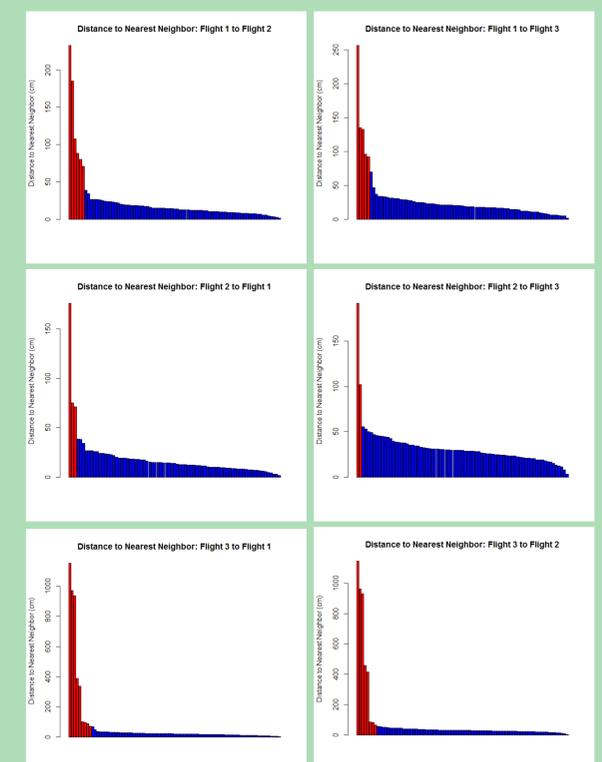


Figure 3. Distance to nearest neighbor in every combination of flights, with red indicating birds were deemed non-nesting and blue indicating nesting birds

## Discussion

- UAS offer the ability to collect data at both high spatial and temporal resolutions, with a relatively low risk of disturbance for American white pelicans, double-crested cormorants, California gulls and great blue herons, and therefore show great promise for monitoring colonial nesting bird colonies.
- A high level of spatial accuracy across multi-temporal images allowed us detect fine scale changes in bird movement that were used to differentiate active nests from loafing and unpaired birds, a critical first step to assessing reproductive success.
- Nearest neighbor analysis of multi-temporal images may provide a rapid way to estimate nesting bird numbers in very large colonies

**Ethics Statement:** All UAS flights were authorized by the Federal Aviation Administration and flown under the operation control of USGS. The utmost care was taken to prevent disturbance and any other safety hazards to wildlife on or near Anaho Island NWR.

## Acknowledgements

Many thanks to the staff at the U.S. Geological Survey National Unmanned Aircraft Systems Project Office for organizing and conducting flights, U.S. Fish and Wildlife Service Stillwater National Wildlife Refuge Complex and Pacific Southwest Region Inventory and Monitoring Initiative for their support, coordination, and funding, the Pyramid Lake Paiute Tribe for their approval and support of the project, and the Bureau of Land Management for assistance with ground control surveys.

