Spring 2024 Project Summary

Jefferson County Ecological Conservation

Quantifying the Effects of Hydrologic Restoration in the Camas National Wildlife Refuge and Mud Lake Wildlife Management Area

Project Team

Project Team:
Cassidy Bromka (Project Lead)
Rosemary D'Andrea
Matthew Stewart
Kevin Jo

Science Advisor:
Keith Weber (Idaho State University)

Fellows
Jane Zugarek (California - JPL)
Michael Pazmino (California - JPL)

Team Contact: Cassidy Bromka, cassidy.bromka@du.edu
Partner Contact (USWFS): Andrea Kristof, andrea_kristof@fws.gov
Partner Contact (IDFG): Brett Panting, brett.panting@idfg.idaho.gov

Project Overview

Project Synopsis:
Wetlands in the Mud Lake Wildlife Management Area and Camas National Wildlife Refuge have experienced declines in surface water throughout the past 40+ years. To increase the surface water encompassed by the wetlands, the U.S. Fish and Wildlife Service and the Idaho Department of Fish and Game have ongoing restoration projects. In our study, we utilized NASA Earth observations to quantify wetland restoration efforts by determining wetland extent and change in 2016 and 2020, predicting wetland extent in 2060, and creating repeatable methods to guide future monitoring and decision making.

Abstract:
Wetlands in the Camas National Wildlife Refuge and Mud Lake Wildlife Management Area, a rare landscape feature in the Intermountain West, are crucial for migratory birds along the Pacific Flyway, yet these wetlands have experienced a noticeable decline in extent and inundation over the last 40+ years. Partners at the U.S. Fish and Wildlife Service and Idaho Department of Fish and Game have ongoing restoration efforts that are yet to be quantified. To assist these partners, we used NASA Earth observations to quantify change in wetland extent and determine if the restoration projects met the intended impact. The QA_PIXEL band from Landsat 5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) was used to identify water. Landsat 8 OLI imagery was also used for classifying landcover in ArcGIS Pro for 2016 and 2020 and to forecast landcover in 2060 using TerrSet's Land Change Modeler. We also compared lidar data from 2011 and 2019 to detect changes in vegetation height, ground elevation, and surface water levels, and Sentinel-2 Multispectral Instrument (MSI) imagery to detect changes in vegetation health. Classification results indicated overall accuracies over 84% and Kappa indices above 0.80, well surpassing random classification performance. From 2016 to 2020 our classifications showed an 825 acre increase in wetland extent, and our forecasted 2060 model showed a 2795 acre decrease. Combining our partners' knowledge of the area with our analyses, we created a remote sensing workflow to enhance future monitoring and decision-making. This

study demonstrated the feasibility of NASA Earth observations in quantifying wetlands, informing restoration projects, and supporting avian conservation.

Key Terms:
Landsat 5 TM, Landsat 8 OLI, Sentinel-2 MSI, lidar, remote sensing, wetland classification, wetland restoration, TerrSet Land Change Modeler

Application Area: Ecological Conservation
Study Location: Camas National Wildlife Refuge, ID, and Mud Lake Wildlife Management Area, ID
Study Period: October 2011 to May 2023, Forecasting to 2060
Seasonal: 2016 and 2020 (April to May and August to September)

Community Concerns:

- Recent loss of persistent surface water in the Camas National Wildlife Refuge and Mud Lake Wildlife Management Area areas is a concern because these wetlands are essential to nesting waterfowl and are a critical stop for migratory birds along the Pacific Flyway.
- These wetlands also perform ecosystem services including improving water quality, carbon sequestration, and the management areas provide recreation for the public.
- The project partners have conducted past restoration projects, but they needed repeatable methods to evaluate their efforts and guide future management decisions.

Project Objectives:

- Analyze changes in the elevation, surface water level and vegetation with lidar data
- Classify 2016 and 2020 landcover to determine wetland extent
- Forecast wetland extent to 2060
- Develop repeatable methods for future monitoring and restoration evaluation

Partner Overview

Partner Organization(s):

Organization(s)	Contact (Name, Position/Title)	Partner Type	Sector
U.S. Fish and Wildlife (USFWS)	Andrea Kristof, Wildlife Biologist	End User	Federal Government
Idaho Department of Fish and Game (IDFG)	Brett Panting, Regional Wildlife Biologist	End User	State Government

Decision-Making Practices & Policies:
The decision-making practices of our partners in relation to wetland management and restoration are rooted in traditional approaches, including in-person surveys and field observations to track changes in wetland extent. These methods, while effective in certain contexts, can be resource-intensive and might not capture the full scope of environmental changes. To complement these efforts, our partners have also begun to utilize remote sensing techniques, offering a broader perspective of ecological changes over time. However, the application of such technologies is still emerging in their operational frameworks. The management of wetland areas, especially in relation to restoration projects funded by substantial budgets of $10 million for USFWS and $850,000 for IDFG, is further complicated by legal and regulatory frameworks. These include water rights issues that involve negotiations with local and irrigation companies, imposing restrictions on the amount of water that can be allocated for wetland restoration.

Earth Observations & End Products Overview

Earth Observations:

Platform & Sensor	Parameter(s)	Use
Landsat 5 TM	QA_Pixel Band water, Spectral Reflectance	Generated spectral indices describing landcover, and predictors for classification modeling of landcover within study area
Landsat 8 OLI	QA_Pixel Band water, Modified Normalized Difference Water Index (NDVI), Normalized Difference Vegetation Index (NDVI), Spectral Reflectance	Generated spectral indices describing landcover, and predictors for classification modeling of landcover within study area
Sentinel-2 MSI	NDVI	Used to calculate NDVI for 2016 – 2023

Ancillary Datasets:

- NOAA Historical Palmer Drought Severity Index – Drought index for analysis of years with similar drought or flood conditions
- LANDFIRE Existing Vegetation Cover – Vegetation dataset map as reference for creating classification sites
- LANDFIRE Existing Vegetation Type – Vegetation dataset map as reference for creating classification sites
- USFWS Camas National Wildlife Refuge Vegetation Inventory, Classification, and Mapping – Vegetation dataset map as reference for creating classification sites
- Dewberry Engineers ID Southern ID_2018_D19 WUID: 300188 lidar dataset – Lidar point cloud data for analyzing change in elevation, change in surface water level, and change in vegetation height
- Watershed Sciences LiDAR Remote Sensing Data Collection: Camas National Wildlife Refuge, Idaho – Preprocessed lidar DEMs and DSMs for analyzing change in elevation, change in surface water level, and change in vegetation height

Models:

- ESRI ArcGIS Pro Forest-based and Boosted Classification (Contact: Keith Weber, Idaho State University) – Classified land cover types based on manually created training points
- IDRISI TerrSet Geospatial Monitoring and Modelling System Land Change Modeler (Contact: Keith Weber, Idaho State University) – Forecasted land cover change to 2060

Software & Coding Languages:

- ArcGIS Pro 3.2 – Training and validation site creation, NDVI and MNDWI calculation, classification modeling, data processing, data visualization, and map creation
- Google Earth Engine – Data Acquisition and Processing, data visualization
- TerrSet – Modeling, data visualization

End Product(s):

End Product(s)	Earth Observations Used	Partner Benefit & Use

Forest-based and Boosted Classification Maps (2016 & 2020)	Landsat 8 OLI	Will help partners understand past changes in wetland extent and whether they correspond with restoration projects intended impacts.
Forecasted Land Change Modeler Map (2060)	Landsat 8 OLI	Will help partners understand where wetlands are predicted to decrease to help target areas for future restoration efforts.
Forecasted Land Change Modeler Map (2023)	Landsat 8 OLI	Will help partners validate the model results by comparing results to a year that has already occurred.
Vegetation Height Change Map	Landsat 5 TM, lidar	Will help partners understand changes in vegetation which can be useful for determining what areas need new vegetation or what areas need vegetation thinning.
Vegetation Health Time Series	Sentinel-2 MSI	Will help partners understand where vegetation is healthy and where it is unhealthy. This is particularly useful for Camas National Wildlife Refuge to help determine which cottonwood trees are dead.

Product Benefit to End User:

Our project marks a notable advancement for end users, enhancing their ability to make informed decisions about wetland management and restoration. By adopting our methodology, partners can establish a more dependable framework for evaluating changes in wetland areas, which will help them to find points of interest for in-person surveys. This approach enables a more judicious allocation of substantial restoration funds, ensuring that resources are used where they are most needed. Our method, which melds corrected elevation data with precise measurements of vegetation height and accurate wetland classifications, forms a robust foundation for ongoing monitoring of wetland dynamics. Moreover, our predictive model for 2060, while based on extrapolations, provides foresight into possible future scenarios, guiding strategic conservation efforts. Addressing previous challenges, such as the reliance on manual creation of training points and the utilization of preprocessed lidar data, our project paves the way for enhanced environmental monitoring and management in wetland conservation strategies.

References

Ashok, A., Rani, H. P., & Jayakumar, K. V. (2021). Monitoring of dynamic wetland changes using NDVI and NDWI based Landsat imagery. *Remote Sensing Applications: Society and Environment*, *23,* 100547. https://doi.org/10.1016/j.rsase.2021.100547

Dahl, T.E. (1990). *Wetland Losses in the United States 1780's to 1980's.* U.S. Department of the Interior, Fish and Wildlife Service. https://www.fws.gov/sites/default/files/documents/Wetlands-Losses-in-the-United-States-1780s-to-1980s.pdf

Herndon, K., Muench, R., Cherrington, E., & Griffin, R. (2020). An Assessment of Surface Water Detection Methods for Water Resource Management in the Nigerien Sahel. *Sensors*, *20*(2), 431. https://doi.org/10.3390/s20020431

Ma, F., Wang, Q., & Zhang, M. (2018). Dynamic changes of wetland resources based on MODIS and Landsat image data fusion. *EURASIP Journal on Image and Video Processing*, *2018*(1), 63. https://doi.org/10.1186/s13640-018-0305-7

Sharma, S. K., & Anjaneyulu, D. (1993). Application of remote sensing and GIS in water resource management. *International Journal of Remote Sensing*, *14*(17), 3209-3220. https://doi.org/10.1080/01431169308904435