Rainwater Basin 2012 Wetland Vegetation Map. 2015.

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Overview

The Rainwater Basin (RWB) wetland complex in Nebraska historically contained more than 11,000 individual wetlands. Knowing the vegetation present in the wetlands can aid conservation efforts and decision making, so we created a vegetation map covering all historical RWB wetlands based on vegetation communities present in 2012. The objective of this article is to detail the process for creating the 2012 RWB wetland vegetation map and general results of the map.

Methods

Imagery Processing. We acquired three 2012 aerial imagery sets covering the RWB, including spring (1–15 March) color infrared, mid-summer (July) true color, and late-summer (1–10 August) color infrared imagery. Spring and late-summer color infrared aerial photographs were collected by Cornerstone Mapping (Lincoln, Nebraska). We color-balanced, orthorectified, and mosaicked the images into counties. The mid-summer imagery was processed and supplied by the Farm Service Agency.

Wetland Segmentation. We used eCognition Developer 8 (Trimble Germany GmbH, Munich, Germany) to segment all historical RWB wetlands. This program uses image object orientated processing to aggregate pixels that have similar color and texture. The resulting image object polygons generally contain similar vegetation communities. To conduct the segmentation, we loaded all three imagery sets and a shapefile of all historical RWB wetlands. Using chessboard and multiresolution image object segmentations, all RWB wetlands were segmented into vegetation communities. Polygons were then assigned a unique polygon identifier.

Field Vegetation Surveys. We collected field vegetation data at 12,594 points on RWB wetlands, spread across Wetlands Reserve Program sites, other long-term private easements, state Wildlife Management Areas, and federal Waterfowl Production Areas. Surveys were conducted between 27 August and 9 November, 2012. At each point, we placed a 1-m^2 sampling frame and recorded all vegetation cover types and associated percentage ranges within the frame. Vegetation cover types were a predetermined list of 37 species and groups of species chosen based on their commonness and importance to wetland management. Percentage ranges included 0–5%, 6–25%, 26–50%, 51–75%, 76–95%, 96–100%.

Field Data Management. Using a combination of Microsoft Access 2007 and Excel 2007 (Microsoft Corporation, Redmond, Washington), we converted the raw data into a usable format. We first converted percentage ranges to their midpoint (e.g., 5–25% became 15%). Next, we summed the midpoints for all cover types at a point and divided each midpoint by the sum so each point would be equally weighted in analysis.

Shapefiles of the field survey points and segmented wetlands were loaded into ArcMap 10 (ESRI, Redlands, California). Using a spatial join, we added the unique polygon identifiers to the survey points shapefile. In Access and Excel, we used the field data, including unique polygon identifiers, to determine the map class each polygon represented. The map classes were an aggregation of the 37 vegetation cover types and included Bare Soil/Mudflat, Cattail, Grass, Moist-Soil Species, Reed Canarygrass, River Bulrush, Water, Wet Meadow Species, and Woody Species. We conducted a series of queries to determine the dominant map class of each unique polygon identifier.

Assigning Training and Testing Data. We then specified surveyed polygons as training or testing data. Training polygons were used to teach eCognition the imagery pixel characteristics of each map class. Testing polygons were used to assess the accuracy of the final vegetation map. Polygons that were the most dominated (~ 70–100%) by a map class were chosen for training data while polygons with approximately 50–70% were chosen for testing data. Polygons with ≤50% dominance were used as neither training nor testing data.

Classification of Vegetation Communities. Wetland segments were classified in two sets: interior and exterior wetlands. The interior portion of the RWB region (90.2% of the RWB wetland area) contained all three image sets. However, the remaining, exterior region only had mid-summer imagery and so had to be classified separately.

Interior wetlands were classified in eCognition, where we loaded all the imagery and interior wetlands shapefile. We conducted a chessboard segmentation to load the wetland segments, assign class tool to assign training polygons their appropriate class, and the classified image objects to samples tool to set the training polygons as samples. A supervised classification was conducted, which assigned a map class to every polygon based on the following training data characteristics: the mean pixel value of each of our nine imagery bands, standard deviation of each band, maximum difference between imagery bands, and brightness within each polygon. Classification was repeated for the exterior wetlands using the same methods, except using only the mid-summer imagery.

Classified polygons were exported from eCognition and loaded in ArcMap. We added a field in the shapefile and populated it with the appropriate map class. The classified polygons, training data, aerial imagery, and Light Detection and Ranging (LiDAR) elevation data were loaded into ArcMap and used to manually verify that every polygon was logically classified. The map class “Agriculture” was also created and assigned to all cultivated polygons based on aerial imagery. After the second verification, we saved the testing data polygons as a separate shapefile for the accuracy assessment. All field surveyed polygons were then reassigned their appropriate class.

Incorporation of Irrigation Reuse Pits. To incorporate irrigation reuse pits into the vegetation map, we used a shapefile containing all irrigation reuse pits in the RWB region (RWBJV 2012). We then performed an identity overlay with the vegetation map as the input and the irrigation reuse pits shapefile as the identity feature. A field was created and populated with whether polygons overlapped an irrigation reuse pit or not.

Identification of Cropped Wetlands. Cultivated areas that pond water annually or every few years can provide important migratory bird habitat. We created the map class "Cropped Wetland" and assigned it to all cultivated polygons that ponded water ≥25% of the time. Ponding frequency was determined based on Annual Habitat Survey (AHS) data. The AHS assessments, which map the RWB wetland areas of ponded water, wetland vegetation, and historical nonfunctional wetland, were conducted in 2004 and annually from 2006–2012. The individual years of AHS data were used to determine the percentage of years that areas ponded water.

We exported all of the Agriculture polygons from the vegetation map and all of the remaining wetland vegetation as two separate shapefiles. We performed an identity overlay with the Agriculture polygons as the input and the ponded ≥25% of the time shapefile as the identity feature. In the output, we selected all polygons that pond ≥25% of the time and changed the map class to Cropped Wetland. We then merged the Agriculture and Cropped Wetland shapefile with the shapefile of the other wetland vegetation to recombine the vegetation map.

Topology Maintenance. First, we repaired geometry to delete polygons with null geometry. We then created a topology with the rule polygons must not overlap and corrected all errors. Polygons were dissolved based on the Vegetation and Pit fields.

Accuracy Assessment. We calculated the overall, producer, and user accuracies of the vegetation map based on the previously saved shapefiles of testing polygons that included each polygon's area, field-verified class, and twice verified vegetation map class. The accuracy of non-surveyed natural vegetation (i.e., all map classes except Agriculture and Cropped Wetland) polygons was calculated as the area of correctly classified polygons for all classes divided by the total testing polygon area. The accuracy of all surveyed polygons was assumed to be 100%. The surveyed property accuracy and overall accuracy were calculated as Accuracy = (%Surveyed area × %Surveyed accuracy) + (%Non-surveyed area × %Non-surveyed accuracy).

Producer accuracy represents the probability a testing area was correctly classified and was calculated as the area correctly assigned to a class divided by the field-verified area of the class. User accuracy represents the probability classification correctly denoted field conditions and was calculated as the area correctly assigned to a class divided by the total area of that class in the vegetation map.

Results and Discussion

Vegetation Map. The final vegetation map contained 45,777 individual polygons covering 79,575 ha (Figure 1). The Agriculture map class covered 77% of the historical wetland area (Table 1). The prevalence of agriculture can be attributed to the historical modifications of RWB wetlands to facilitate cropping. Among the natural vegetation types, Moist-Soil Species was the most common due to habitat managers employing techniques to promote these species and privately-owned wetlands often being integrated into farm operations, the disturbance from which promotes moist-soil species. The least common map class was Water because of region-wide drought conditions in 2012 and the ephemeral nature of RWB wetlands.

Accuracy Assessment. Non-surveyed natural vegetation polygons were 62.9% accurate. When combined with the 100% accuracy of surveyed polygons, natural vegetation accuracy was 84.5% on surveyed properties, 62.9% on non-surveyed properties, and 75.0% for the overall map.

Reed canarygrass had the highest producer accuracy, while Bare Soil/Mudflat had the lowest. The lower producer accuracy of Bare Soil/Mudflat was due to it being difficult to distinguish when its dominance was near 50%. Water and Woody Species map classes had the highest user accuracies because they were easily distinguishable when >75% dominant. User accuracy was lowest for River Bulrush and Reed Canarygrass.

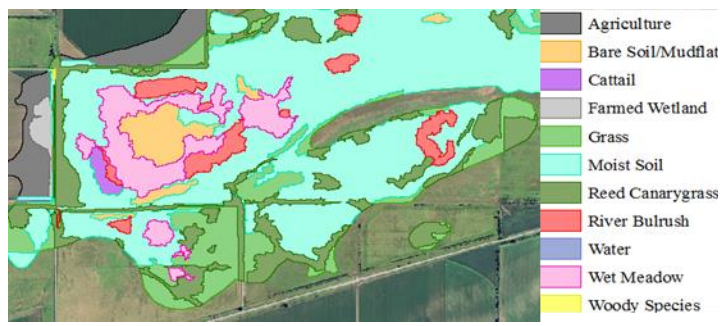

Figure 1. Wetlands in Clay County, Nebraska, representing a portion of the 2012 Rainwater Basin vegetation map, with mid-summer imagery.

Table 1. Area of each map class in the final vegetation map of wetlands in the Rainwater Basin. Also included are the percentage of the area of the entire map each map class covers and percentage of the area of natural vegetation (i.e., not Agriculture or Cropped Wetland) each of the non-cultivated classes covers.

Class	Area (ha)	% Entire Map	% Natural Veg.
Moist-Soil Spp.	7,059.1	8.9	39.5
Wet Mead. Spp.	1,305.5	1.6	7.3
B. Soil/Mudflat	686.8	0.9	3.8
Water	468.5	0.6	2.6
Cattail	488.9	0.6	2.7
R. Canarygrass	2,650.5	3.3	14.8
River Bulrush	678.5	0.9	3.8
Grass	3,974.2	5.0	22.2
Woody Species	575.9	0.7	3.2
Crop. Wetland	709.8	0.9	---
Agriculture	60,977.3	76.6	---

Literature Cited

RWBJV. 2012. Scoring criteria and ranking for Wildlife Habitat Incentive Program, Rainwater Basin Public Wetland Watershed Special Initiative. RWBJV, Grand Island, Nebraska, USA.