Using Color-infrared Photography and GIS to Quantify Cattail Coverage in Wetlands

H. Jeffrey Homan, Linda B. Penry, and George M. Linz
USDA, Wildlife Services, National Wildlife Research Center, Bismarck, ND

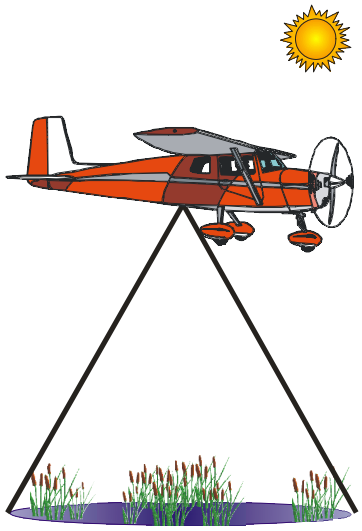
Introduction

Analyzing changes in habitat features at very large scales requires digital images with both high spatial and spectral resolutions. As part of an experiment to reduce blackbird (Icterinae) damage to sunflower, we used large-scale color-infrared photography to monitor regrowth of herbicide-treated cattail (Typha spp.) in wetlands used by roosting blackbirds. In this presentation we describe the methods used to collect, convert, interpret, and analyze high resolution images.

Methods

Data Collection: We used a SLR 35-mm camera loaded with Kodak Ektachrome® Professional Infrared EIR film. The photographs were shot through a 24-mm lens. A Wratten #12 filter and haze filter were attached to the lens to counteract blue light effects and improve clarity. Film speed was set manually at EI 100, the recommended speed for the AR-5 developing process used for infrared accuracy. Shutter speed and aperture settings were 1/500 sec and F-5.6, respectively.

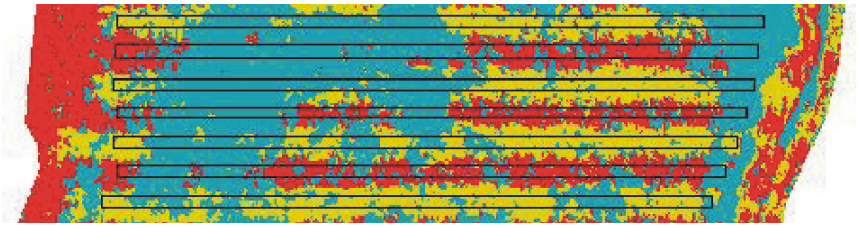
We aerially photographed the wetlands at 460-610 m above ground level. All photographs were taken vertically through a 38-cm diameter port in the floor of the plane's fuselage. To reduce distortion and shadowing of the ground features, photographs were taken nearly perpendicular to the wetlands on cloudless days from 1100 to 1400 h CT.



Data Conversion: The developed images were scanned at 2100 pixels per inch (ppi) with a Polaroid® Sprint Scan 35 Plus. The scans were converted to Tagged Image Format files. File size was ~16 MB.

Data Interpretation: We used ArcView® 3.2a software with the Image Analysis extension to categorize pixels into four habitat features through a supervised classification. Ground truthing was used to determine the different habitats observed in the scanned images. Living cattail was red, dead cattail was white or pale gray, open water was black, and floating vegetation was fluorescent blue.

Data Analyses: Annual changes in proportions of living cattail, dead cattail, open water, and floating vegetation were tracked from 1999-2002. A pixel-based coordinate system was used to coregister raster images of wetlands across years. Changes in the proportions of categorized features were tracked through time by summarizing pixel counts between subplots in the wetlands.

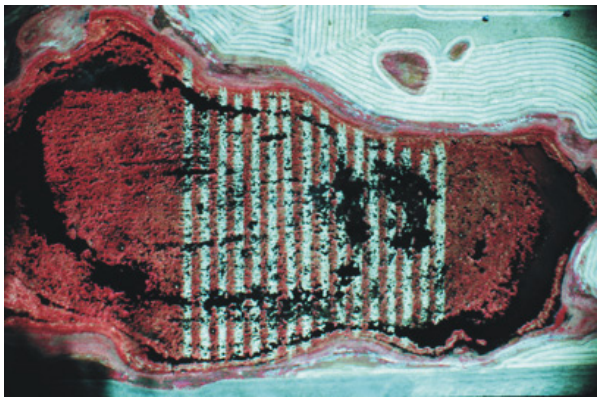


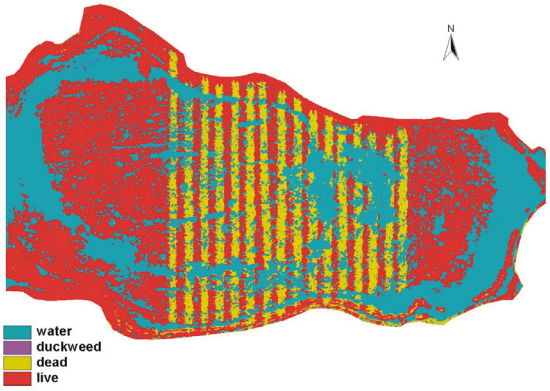
Magnified view of wetland subplots.

Results

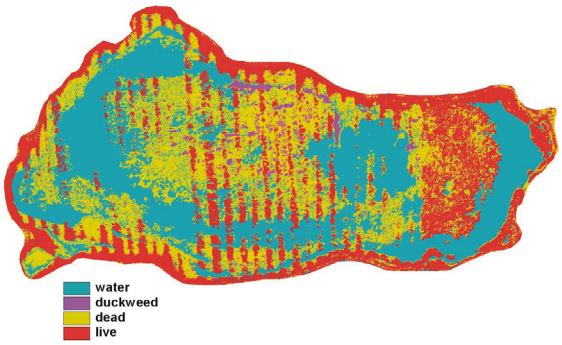
As seen in the images below, the herbicide treatments were applied in a north-south direction alternating with untreated lanes. Over time, the treated cattail decayed, became submerged, and was replaced by open water; whereas, the untreated lanes maintained their structure except for 2001 when high water partially submerged the lanes.

1999

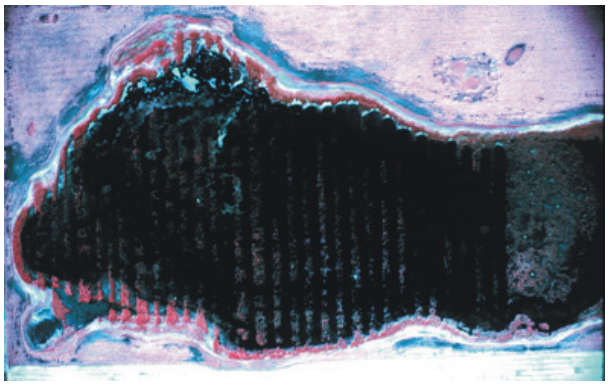


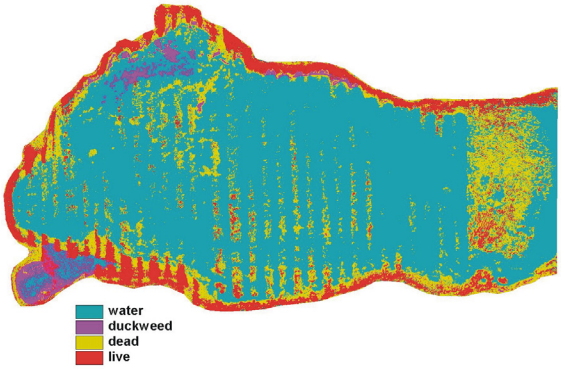


2000

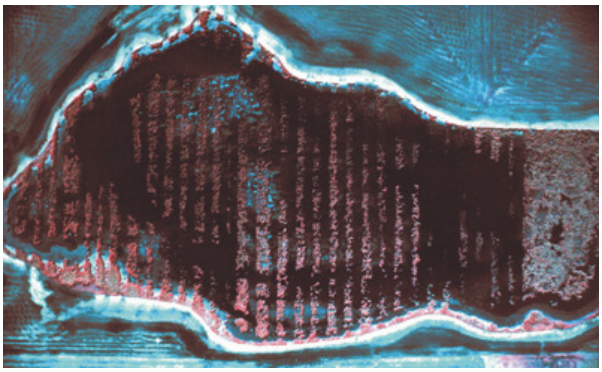


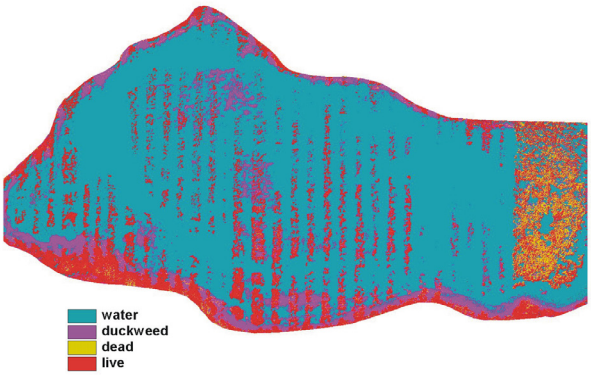
2001





2002





In the tables below are results from one of five wetlands used in the experiment. In this example the herbicide maintained its efficacy across all four years; however, the untreated lanes began to lose some integrity due in part to loss of cattail in the treated lanes.

Changes in percent composition of four habitat features in treated lanes from 1999-2002.

Year	Treated Lanes			
	Live cattail	Dead cattail	Open water	Floating vegetation
1999	1	59	40	0
2000	0	42	54	4
2001	0	6	93	1
2002	2	0	91	7

Changes in percent composition of four habitat features in untreated lanes from 1999-2002.

Year	Untreated Lanes			
	Live cattail	Dead cattail	Open water	Floating vegetation
1999	57	2	41	0
2000	26	30	43	1
2001	5	18	77	1
2002	18	1	73	8

Discussion

Although expensive and difficult to use, color-infrared film provides far better information for defining classes of vegetation than color slide film. High spectral sensitivity is needed at large scales because minor inaccuracies in interpretation have profound impacts on the analysis. In this experiment a ground cell resolution of ~1 m was obtained, which is considered a large scale in GIS analysis.

We have empirical evidence that the images could have been scanned at far less than 2100 ppi. This would have saved on file size without any change in coverages of the habitat features. The resolution of the slide film was in the 4000-5000 ppi range. We consider 2100 ppi an acceptable compromise between file size and ground cell resolution.

By its nature, large-scale photography sacrifices areal coverage for spatial detail. This method can only be applied when working on experiments with relatively small sample sizes. In an average day of flying, we collected 20 images over a 4-hour shooting window; thus, large-scale photography is labor intensive and costly compared to the 15-30 m satellite images (e.g., Landsat) currently used in most GIS analyses. However, several of our techniques to reduce blackbird damage are evaluated at a scale of <100 km^2. At this scale, the methods described above are economically feasible while providing highly detailed data.