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Examining IKONOS as a Data Source for Locating Desert Wetlands in the Southwestern U.S.

The USGS is coordinating a national research effort to address concerns of amphibian population declines. A national survey of amphibians is underway to determine the status of species across the U.S. Amphibians are most evident during their breeding season, when they congregate in wetlands. In the deserts of the Southwest, locating potential breeding habitat is challenging, as wetlands are rare and typically small, and the presence of water is highly ephemeral.

Can potential breeding habitats be located using remotely sensed data and, if so, what type of data are needed?

ARMI
Amphibian Research and Monitoring Initiative

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Wetland Clues

A variety of features in the desert provide useful clues for locating areas where surface water may linger long enough to support amphibian reproduction:

- Local concentrations of herbaceous vegetation and vigorous woody vegetation
- Convergence of animal tracks from large mammals
- Presence of stocktanks and other human structures
- Co-occurrence of certain geomorphological features and landscape settings

Note cracking of soil where rainfall pooled. This is a potential amphibian breeding site.

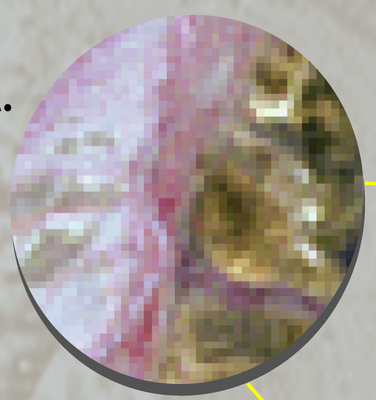
A road partially dams up this wash and causes a pool to form during the summer rainy season.

Potential Sources of Data for Locating Wetlands

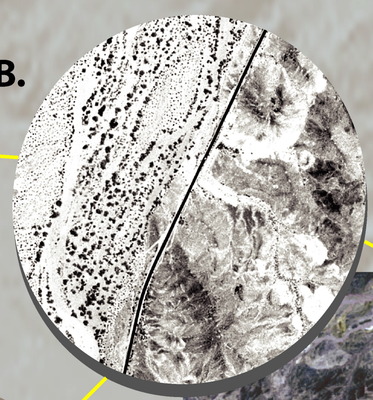
Landsat Thematic Mapper (TM) data are inexpensive, and the USGS has an extensive and ever-growing data archive. The spectral resolution of these data are helpful for distinguishing differences in vegetation vigor in arid settings, but the spatial resolution (30 m) can be too coarse for detecting the types of clues that signal desert wetlands.

Digital orthophoto quadrangles offer information at a much higher spatial resolution (approx. 1 m), and are also archived by the USGS. When these data are available as color-infrared imagery, they provide an excellent source of information for locating potential wetlands. Unfortunately, the data are sometimes only available as black/white imagery, as in the portion of the country shown here.

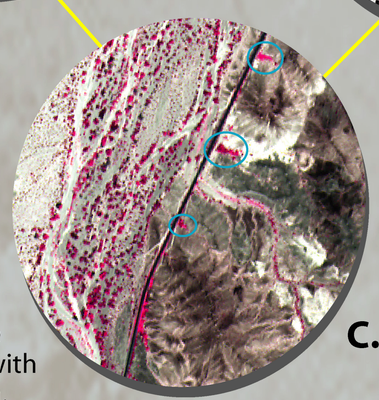
IKONOS data have less spectral information than TM, but more than digital orthophotos. IKONOS data also offer relatively high spatial resolution (4 m multispectral, 1 m panchromatic). These data are proprietary and expensive. Additionally, since the sensor is relatively young, the data archive is much less extensive compared with TM and digital orthophoto imagery archives.



A.



B.



C.

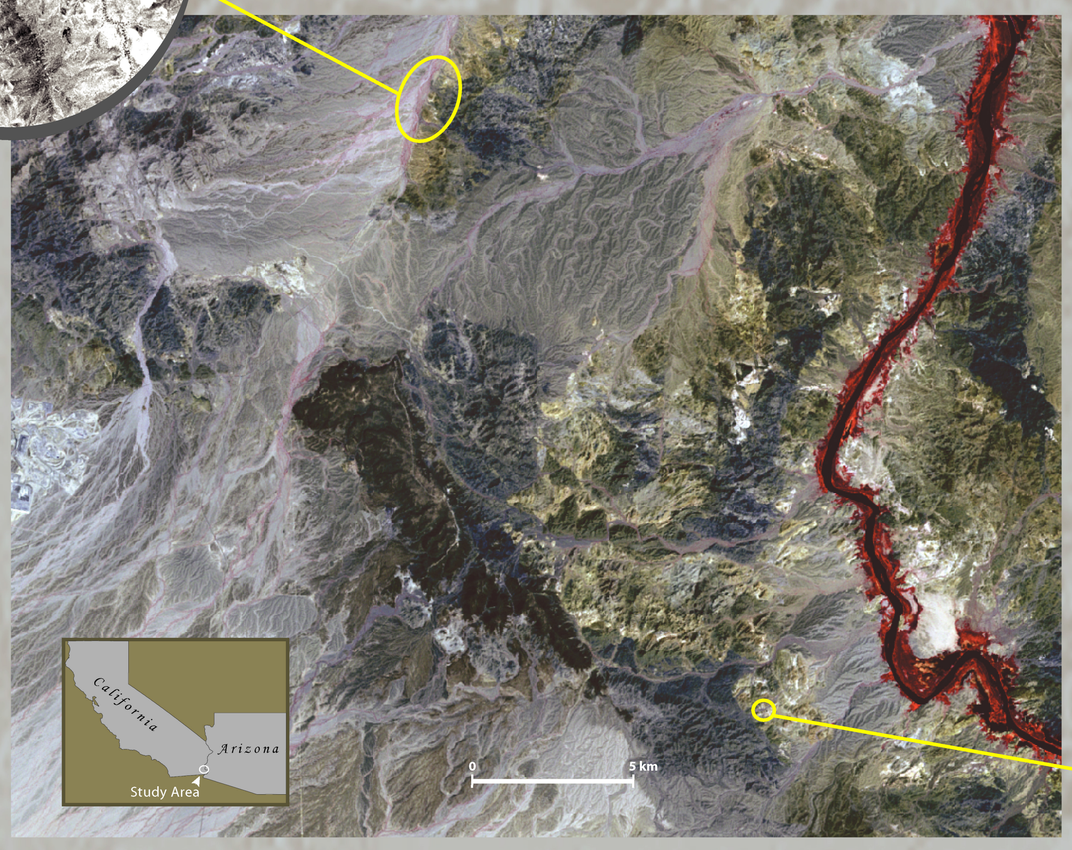
Example 1

Roads may act as impoundments for water draining off hillslopes. Such sites have been used by frogs and toads for breeding following thunderstorms. Impounded areas are typically associated with more lush vegetation.

A. The spectral characteristics of TM data can distinguish differences in vegetation vigor, but neither the road nor the impounded sites are large enough to be represented by TM's 30-meter pixel resolution

B. Digital orthophoto quadrangles offer excellent spatial resolution (approximately 1 meter), but only black/white imagery was available for this area, and the desired vegetation characteristics are not discernable.

C. The IKONOS imagery offers good spatial resolution and adequate spectral resolution to distinguish the wetland sites, which appear as intense red pixels near the road (see areas circled in blue above).



This Landsat TM image shows the study area for this data source comparison. The Colorado River is on the eastern side, along a portion of the California/Arizona border. The image is depicted in a color-infrared scheme, where vegetation is red and the remaining colors primarily represent different types of exposed rock and sediments.

Example 2

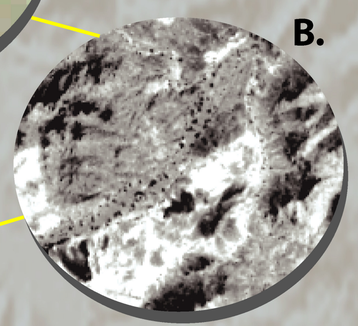
Water from rainstorm runoff fills depressions along drainage courses, providing a week or two of important wetland breeding habitat for amphibians. These sites generally support herbaceous vegetation and more species of woody vegetation than the surrounding area.

A. Riparian vegetation should appear as red tones in this TM imagery, but because the drainage course is very narrow, the signature of the vegetation is mixed with the signature of the background sediments in the 30 m pixels, appearing purple in the image.

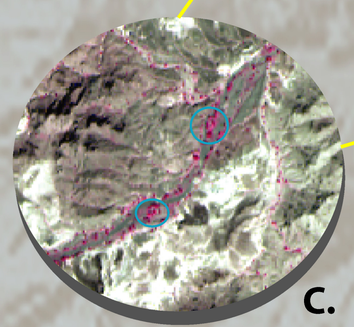
B. Woody riparian vegetation is evident as black "dots" along the drainage course in this black/white orthophoto image, but there is no indication of any areas with local concentrations of vegetation.

C. The vegetation signature in this IKONOS image reveals two areas (circled in blue below) that offer prolonged moisture. Field surveys have shown that these types of areas offer amphibian breeding habitat.

A.



B.



C.

Conclusion

IKONOS data clearly provided the best alternative among the three data sources examined for locating potential desert wetland habitat. The TM data lacked the necessary spatial resolution, and the black/white digital orthophoto imagery was completely uninformative for this application.

BUT: While IKONOS data are very promising for areas where high spatial resolution, multispectral information is needed, our experiences with new data acquisition were troublesome. The requirements to place orders at least three months in advance and allow for a month-long acquisition window were much too restrictive, given annual and seasonal variations in vegetation phenology and hydrologic characteristics. Additionally, data were not delivered until 6 months following acquisition; by then, project personnel were no longer available to interpret the data. The combination of high data cost, high risk associated with targeting an appropriate acquisition date, and lengthy post-acquisition lag time for data delivery have kept us from continuing to pursue IKONOS data as an information source for our applications.