

Ciénega San Bernardino - Wetland Restoration

ACTIVE

By [Western Geographic Science Center](#)

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Overview

Desert marshes and wetlands, or “*ciénegas*”, are extremely biodiverse habitats imperiled by anthropogenic demands for water and changing climates. Given their widespread loss and increased recognition as important wildlife habitat, remarkably little is known about restoration techniques.

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The U.S. Fish and Wildlife Service established the [San Bernardino National Wildlife Refuge](#) (SBNWR) in 1972. Cattle were removed and undesired woody plants were treated. Desired woody plants were planted and gabions were installed to reduce erosion and stabilize arroyos. The first gabion constructed on the SBNWR was in 1984, with nineteen to follow. In 2000, the [Cuenca Los Ojos](#) (CLO) Foundation acquired the Ciénega San Bernardino and other properties downstream of the SBNWR in Sonora, Mexico and restoration began immediately. Construction of gabions on CLO began in 2001 and continues today. By 2013, 46 loose-rock wire gabions and one check dam were built on CLO.

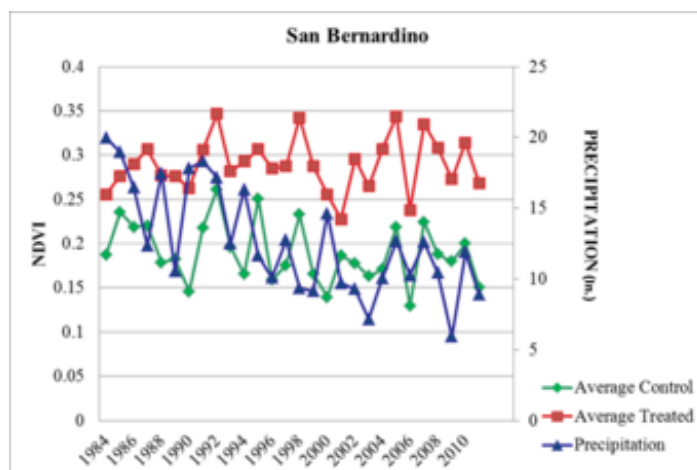
In this study, we examined the effects of gabions (wire baskets filled with rocks used as dams) on vegetation in the Ciénega San Bernardino, in the Arizona, Sonora portion of the US-Mexico border, using a remote-sensing analysis coupled with field data. The Normalized Difference Vegetation Index (NDVI), used here as a proxy for plant biomass, is compared at gabion and control sites over a 27-year period during the driest months (May/June).

Generalized linear models (GLM) were used to estimate the effects of precipitation and the presence or absence of gabions when NDVI changes were detected. Area where gabions were located demonstrated a maintained greenness, with some increase; areas without demonstrate a decline in vegetation density—associated with the precipitation trend (drought; Fig. 1).

Over this period, green-up occurred at most sites where there were gabions and at few of the control sites where gabions had not been constructed. When we statistically controlled for differences among sites in source area, stream order, elevation, and interannual winter rainfall, as well as comparing before and after the initiation of gabion construction, NDVI values increased around gabions and did not change or were negative where there were no gabions. NDVI at gabion sites does not respond prior to gabion construction but NDVI at gabion sites demonstrates a strong response to precipitation after the gabions are built (Fig. 2).

Field data from 2000 to 2012 of plant cover, species richness, and species composition suggest all these measured increased and corroborate the NDVI findings. The response of vegetation to gabions demonstrated here over a 10-year period suggests that long-term restoration of a mature *ciénega* is possible. This research documents the positive influence of gabions when sites are targeted for stream restoration and the potential to ameliorate drought conditions for a desert *ciénega* (Norman et al 2014).

For more information about the study sites and restoration done, go to: [San Bernardino Wildlife Refuge](#) and the [Cuenca Los Ojos Foundation](#) websites.



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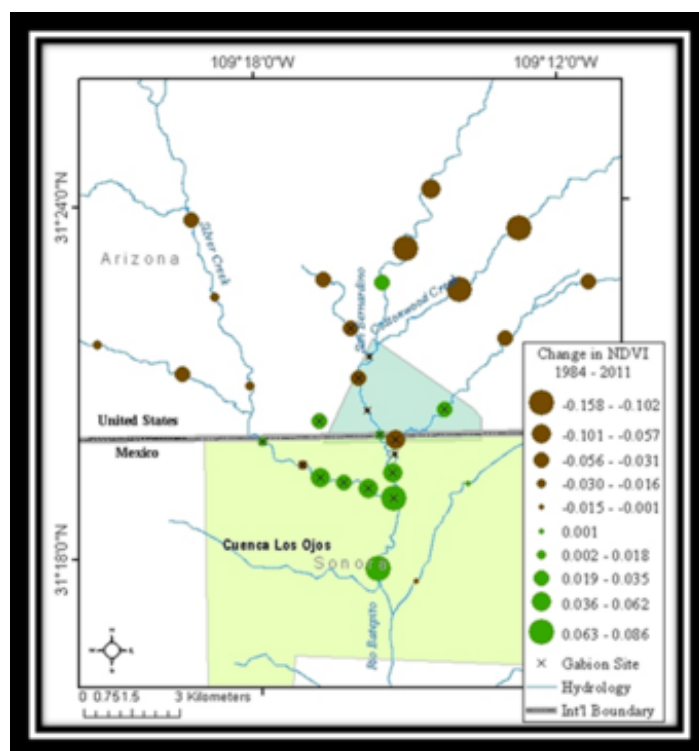
Figure 1. Average NDVI plotted over time in San Bernardino at treated and control sites, in relationship to annual precipitation.(Public domain.)

to desert marsh restoration in the Mexican Highlands. *Ecological Engineering*, 70C, 241–254. <https://doi.org/10.1016/j.ecoleng.2014.05.012>

Wilson, N. R., & Norman, L. M. (2018). Analysis of vegetation recovery surrounding a restored wetland using the normalized difference infrared index (NDII) and normalized difference vegetation index (NDVI). *International Journal of Remote Sensing*, 39(10), 3243–3274. <https://doi.org/10.1080/01431161.2018.1437297>

Publications

Norman, L. M., Villarreal, M. L., Pulliam, H. R., Minckley, R., Gass, L., Tolle, C., & Coe, M. (2014). Remote sensing analysis of riparian vegetation response



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Figure 2. Map depicting areas in the San Bernardino Wildlife Refuge and Cuenca los Ojos, where gabions have been installed (marked with X) and other control sites, with levels of increasing or decreasing vegetation signatures portrayed by green or brown circles, depending.(Public domain.)

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