Wetlands along the Gila River in Southwestern New Mexico

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Abstract

To examine wetland habitats in southwestern New Mexico, vegetation data were collected during July 2007 from 49 riparian sites along the Gila River. The vegetation data were analyzed using a wetland index based on the wetland affinity of the 476 species found at the sampled sites. Sites that were upstream (from 5,000 to 6,000 feet elevation in the vicinity of the Gila Hot Springs and the Gila Cliff Dwellings National Monument) had significantly ($p < 0.05$) more species per plot (60.7), less bare ground (21% of cover), and fewer plots classified as wetlands (17%) when compared to the group of downstream sites (from 4,000 to 5,000 feet elevation near the towns of Gila, Cliff, and to below Redrock, NM). Correspondingly, downstream sites had fewer species per plot (42.3), more bare ground (41%), and more plots classified as wetlands (56%). These data serve as an important baseline for future ecological studies, including climate change and possible in-stream flow alterations—determining their impact on wetlands, and estimating potential future wetland loss along the Gila River in New Mexico.

Introduction

This study was undertaken to quantify the extent of critical wetland habitat in riparian areas along the Gila River in southwest New Mexico. This project was part of a larger Gila biodiversity study (Kindscher 2008; Kindscher et al. 2008) undertaken to document the presence and abundance of many rare flora and fauna species and their habitats along the upper reaches of the Gila River. That two-year study provided data on the rich floral diversity and distinct vegetation gradient from upstream to downstream (Kindscher 2008; Kindscher et al. 2008).

We analyzed Gila River data collected in the summer of 2007 in relation to *The 1988 National List of Plant Species That Occur in Wetlands* (U.S. Fish and Wildlife Service 2007) to determine the extent to which our plots were occupied by wetland species. Although there are technically three parameters that define wetlands—soils, hydrology, and vegetation (Environmental Laboratory 1987)—we believe that vegetation is an excellent integrator of hydrology and soils in semi-arid and arid environments, because wetland species require both sufficient water and appropriate soils to survive in wetland habitats such as those found along the Gila River. These data provide an essential baseline for assessing the impact of proposed reductions to in-stream flow and for monitoring the effect of potential long-term climatic changes. It is expected that drier periods, or stream-flow reductions, would greatly reduce wetland acreage. In arid regions such as the Gila, where wetlands are uncommon, they provide especially valuable wildlife habitat and serve to slow, retain, and filter water from surface runoff and flooding events. Also, remaining wetland habitats are especially important because it has been estimated that 36% of all wetlands in New Mexico have been lost since the 1780s (Mitsch and Gosselink 1993).

Study Area

Fieldwork took place in Grant, Catron, and Hildalgo counties, New Mexico, from near the towns of Redrock, Gila, and Cliff, upstream to the town of Gila Hot Springs and up the Middle and West forks beyond the Gila Cliff Dwellings National Monument (fig. 1).

Methodology

The methodology for this Gila River riparian study was based on similar large-scale projects that we have conducted in the greater Yellowstone ecosystem (Kindscher et al. 1998; Norris and Farrar 2001; Saveraid et al. 2001; Debinski et al. 1999). A robust methodology was established for this project in the Gila watershed. Forty-nine sites along the Gila River were established with Global Positioning System (GPS) coordinates to permit future resampling to determine long-term trends and facilitate future data analysis to track the status of these species in the event that conservation, restoration, or hydrological changes occur. The study was primarily focused on two geographic categories of sites: upstream sites (higher elevation sites from 5,000 to 6,000 feet, located near the town of Gila Hot Springs and the Gila Cliff Dwellings National Monument), and downstream sites (lower elevation sites from 4,000 to 5,000 feet, located about 40 miles downstream, near the towns of Gila and Cliff, and farther downstream an additional 30 miles, near Redrock, NM; fig. 1). Lands in the

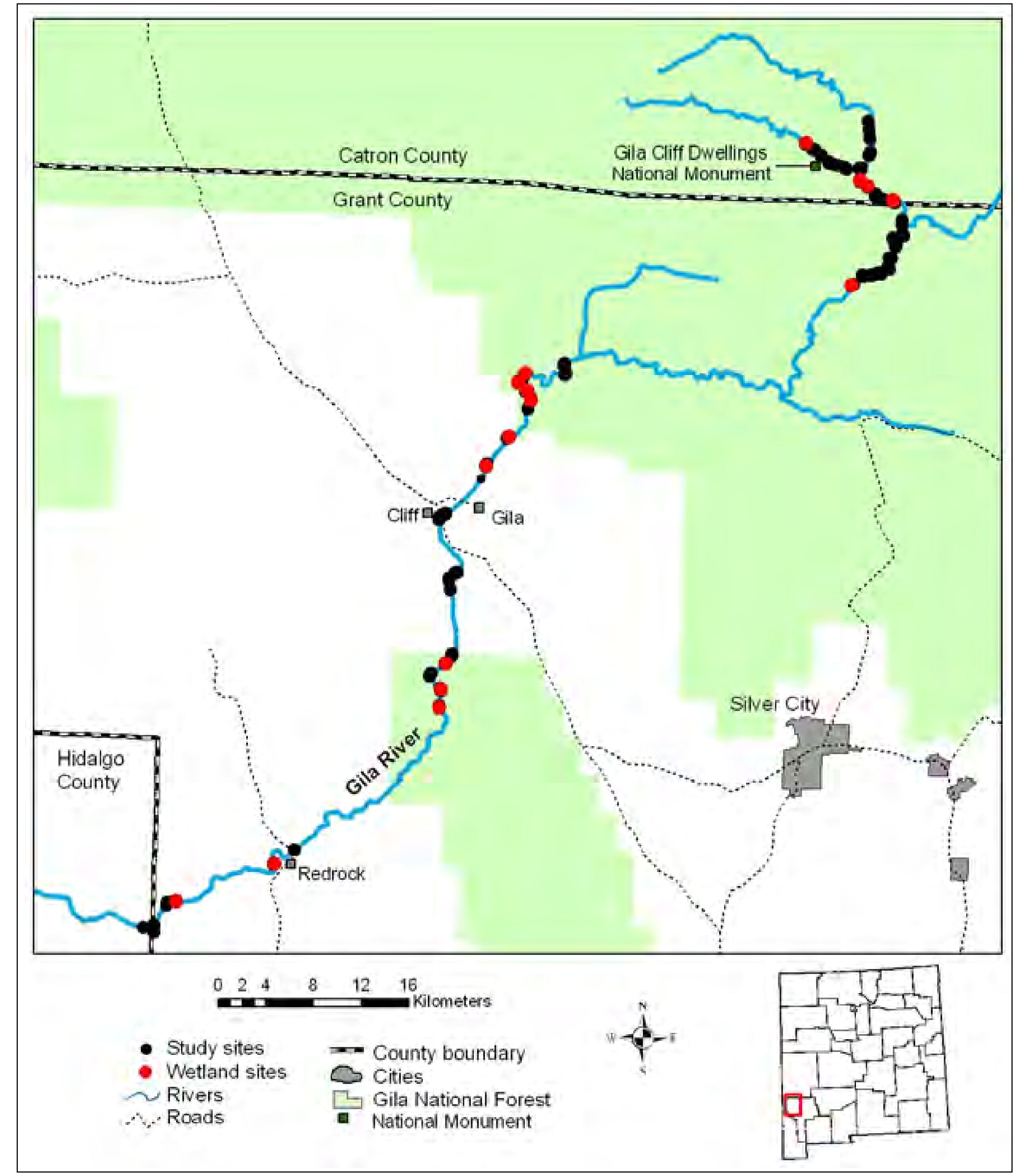

Fig. 1. Study sites along the Gila River riparian area. Each site had three 0.1 ha vegetation plots whose data were averaged.

study area are owned and managed by the federal government (Gila National Forest, Gila Cliff Dwellings National Monument, and the Bureau of Land Management), the State of New Mexico, The Nature Conservancy, and private property owners. All sites were selected within naturally vegetated riparian areas (cropland was excluded in downstream locations) and were separated by at least one half mile to ensure independence. Some sites were located over three miles and 1,000 feet lower than trailheads. Due to inaccessibility of sites even farther from trailheads along the river, several stretches of river have no plot sampling. This also explains the 20-mile gap in the Gila Wilderness that separates the group of upstream sites from downstream sites.

The vegetation of each site was characterized by three 18m-radius (0.1 ha) circular plots, with plot centers located at 100m intervals, and was sampled for all overstory and understory plant species. Cover values were determined for all plant species, and voucher specimens were collected and deposited in the Dale A. Zimmerman Herbarium (SNM) at Western New Mexico University and the Ronald L. McGregor Herbarium (KAN) at the University of Kansas. Although grazing has historically impacted Gila River riparian habitat, there is currently no grazing on Gila National Forest–owned sites, and grazing was observed to be moderate at the few privately owned downstream study sites where grazing occurred.

All data were collected on a fieldwork form, entered into an Excel spreadsheet, and summarized by species and plots. Sites were also divided into upstream and downstream locations. All species names are from the New Mexico checklist at the Range Science Herbarium at New Mexico State University (Allred 2007). Statistical analysis using unpaired t-tests (in SPSS version 16.0) were conducted to compare upstream versus downstream locations for species richness per plot and for wetland species categories.

All plant species found in the Gila River riparian plots were assigned one of five wetland values as defined in the 1987 *Wetlands Delineation Manual* (Environmental Laboratory 1987) and listed in the *National List of Plant Species That Occur in Wetlands* (Reed 1988):

(1) obligate wetland plants (OBL) occur almost always (estimated probability > 99%) in wetlands, but occasionally are found in non-wetlands (estimated probability < 1%);

(2) facultative wetland plants (FACW) usually occur in wetlands (estimated probability 67% to 99%), but occasionally are found in non-wetlands (estimated probability 1% to 33%);

(3) facultative plants (FAC) share an equal likelihood (estimated probability 33% to 67%) of occurring in either wetlands or non-wetlands;

(4) facultative upland plants (FACU) usually occur in non-wetlands (estimated probability 67% to 99%), but occasionally are found in wetlands (estimated probability 1% to < 33%); and

(5) obligate upland plants (UPL) occur almost always (estimated probability > 99%) in non-wetlands.

These categories were used to calculate average wetland values where OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5. Average wetland values are calculated using a weighted average of each species' standardized percent cover. Standardized percent cover is obtained by converting all plot totals to 100% (as many plots had overlapping canopy layers and totals greater than 100%). Individual species' cover values were therefore adjusted proportionally so that their totals equaled 100% per plot. Each standardized species cover is multiplied by its assigned wetland category number given above. The sum of these values for all species in a plot is the average wetland value. If the average calculated wetland value is less than 3.00, then the area supports hydrophytic (wetland) vegetation. This process is an expansion of the FAC-neutral test found in the Corps of Engineers *Wetlands Delineation Manual* (Environmental Laboratory 1987). Our modification of the FAC-neutral test uses the more accurate cover of all species present in an area, while the original test is usually applied to dominant species only.

In our study, we planned to calculate the wetland status of each plot based on the wetland values of all species found in each plot. The *National List of Plant Species That Occur in Wetlands* (Reed 1988) is comprised of plants found in wetlands, but because our study encompasses a riparian area along an environmental gradient, over 100 species we observed were not on this list. The majority of these unlisted species do not occur in wetlands and are correctly considered upland (UPL) species. Although the *National List* is fairly comprehensive, some wetland species have also not been given a listing (NI for not included). For example, mountain figwort (*Scrophularia montana*), streamside bur-cucumber (*Sicyos ampelophyllus*), and mountain nettle (*Urtica gracilenta*), which are found in riparian areas and could be considered wetland species, are not included on the list. Unlisted species occurred infrequently in the plots and only two of the unlisted species averaged more than 1% per plot—see tables 1 and 2. Three species, stinging nettle (*Urtica dioca*), tamarisk (*Tamarix ramosissima*), and rabbitbrush (*Ericameria nauseosa*), which we frequently found in the riparian area, are perhaps questionably listed as upland species on the *National List*. For the purpose of our study, all species not assigned a wetland value on the *National List* are assigned no values and are neutral in the calculations.

Results

For the 49 sites (147 plots) along the river, a total of 476 plant species were recorded. The riparian area contains forests dominated by cottonwood (*Populus* spp.) and willow (*Salix* spp.) species in both upstream and downstream plots (tables 1 and 2). In addition, there are open areas of grasslands, savanna, and sand and gravel bars.

Significant differences ($p < 0.05$) were found between upstream and downstream locations for bare ground and dominant species cover (see table 3). Upstream areas had significantly more species (60.7 per plot) compared to downstream sites (only 42.3 species per plot). Upstream sites had significantly less bare ground, occupying only 20.9% of the plots compared to downstream sites with 30.1 % (table 3). Vegetation differences were illustrated by the upstream plots having significantly greater facultative wetland, facultative, facultative upland, and upland species cover per plot (table 3). More importantly, upstream plots had significantly higher average wetland index values (3.62) compared to downstream plots (3.00). Plot values below 3.00 indicate that the plots are dominated by wetland species. Over 45% of downstream sites could be considered wetlands while only 20% of upstream plots had wetland-dominant vegetation. Although upstream sites had significantly greater species richness and total vegetative cover, wetland species account for a much greater

Table 1. Upstream plot summary showing species with greatest cover and wetland status for plots sampled along the Gila River in July 2007. Average species cover from 75 plots at 25 sites, located from 3 miles below the Grapevine Campground at the forks of the Gila (the junction of the East and West forks) upstream to along the Middle and West forks above the Gila Cliff Dwellings National Monument. All plots were at an elevation between 5,000 and 6,000 feet.

Species	Common Name	Wetland Category	Avg. % Cover
Populus angustifolia	narrow-leaf cottonwood	FACW	13.23%
Artemisia carruthii	Carruth's sagewort	UPL	12.39%
Ericameria nauseosa	rabbitbrush	UPL	11.58%
Salix irrorata	blue-stem willow	FACW+	9.85%
Alnus oblongifolia	Arizona alder	FACW+	6.64%
Acer negundo	boxelder	FACW-	4.73%
Platanus wrightii	Arizona sycamore	FACW-	3.67%
Populus fremontii	Fremont's cottonwood	FACW	3.42%
Populus acuminata	lance-leaf cottonwood	FACW	3.11%
Vitis arizonica	canyon grape	FAC	2.76%
Bromus carinatus	California brome	UPL	2.35%
Pinus ponderosa	ponderosa pine	FACU	1.97%
Juniperus monosperma	one-seed juniper	UPL	1.85%
Bouteloua gracilis	blue grama	UPL	1.78%
Juniperus scopulorum	Rocky Mountain juniper	UPL	1.55%
Parthenocissus vitacea	thicket creeper	FACW-	1.48%
Sporobolus cryptandrus	sand dropseed	FACU-	1.29%
Bouteloua curtipendula	sideoats grama	UPL	1.27%
Brickellia floribunda	Chihuahuan brickellbush	UPL	1.17%

Table 2. Downstream plot summary showing the species with the greatest cover and wetland status for plots sampled along the Gila River in July 2007. Average species cover summed from 72 plots at 24 sites, located from the Turkey Creek confluence north of Cliff, NM, to below Redrock, NM. All plots were between 4,000 and 5,000 feet in elevation. The symbol * designates a non-native species. "NI" in the Wetland Category column indicates that this species was not included in the wetland species list (Reed 1998).

Species	Common Name	Wetland Category	Avg. % Cover
Populus fremontii	Fremont's cottonwood	FACW	17.56%
Salix gooddingii	Goodding's willow	OBL	8.64%
Baccharis salicifolia	mule's fat	FACW	5.29%
Salix exigua	sandbar willow	OBL	3.76%
Platanus wrightii	Arizona sycamore	FACW	3.17%
*Salsola tragus**	Russian-thistle	FACU	3.01%
*Melilotus albus**	white sweet-clover	FACU	1.96%
Aristida ternipes	Hook threeawn	UPL	1.63%
Ericameria nauseosa	rabbitbrush	UPL	1.52%
Sporobolus contractus	spike dropseed	UPL	1.47%
Acer negundo	boxelder	FACW	1.40%
Chenopodium neomexicanum	New Mexico goosefoot	NI	1.26%
Artemisia carruthii	Carruth's sagewort	UPL	1.20%
*Kochia scoparia**	Mexican fireweed	FAC	1.15%
Ambrosia monogyra	burrobush	NI	1.13%
Conyza canadensis	horseweed	FACU	1.03%
Sporobolus cryptandrus	sand dropseed	FACU	1.01%
Heterotheca subaxillaris	camphorweed	UPL	0.83%
Chenopodium berlandieri	pitseed goosefoot	UPL	0.78%
*Cynodon dactylon**	Bermudagrass	FACU	0.72%

Table 3. Comparisons of bare ground, wetland groups of plants, and number of species between upstream and downstream Gila River riparian sites using 2007 plot data.

Category	Upper Gila Cover	Lower Gila Cover	T-test statistics
Bare ground	20.9%	40.8%	t = 4.6, df = 128, p < 0.001
Upland Species	26.2%	15.0%	t = −9.6, df = 139, p < 0.001
Facultative Upland Species	7.3%	5.8%	t = −4.3, df = 143, p < 0.001
Facultative Species	7.1%	3.7%	t = −8.2, df = 140, p < 0.001
Facultative Wetland Species	8.5%	7.0%	t = −2.4, df = 145, p = 0.016
Obligate Wetland Species	1.8%	2.8%	t = −1.4, df = 95, p = 0.141
Number of species	60.7	42.3	t = −8.3, df = 143, p < 0.001

proportion of total cover among downstream sites, which results in much higher percentage of downstream sites classified as wetlands.

Discussion

The Gila River in southwest New Mexico is still an unregulated river, and the riparian corridor is dominated by stands of native species. Although there are some patches of exotic species such as white sweet clover (*Melilotus alba*) and bermuda grass (*Cynodon dactylon*), the cover is overwhelmingly dominated by native species characteristic of undegraded riparian habitat.

One rare plant, Mimbres figwort (*Scrophularia macrantha* Greene ex Stiefelhagen), was found along both West Fork and Middle Fork sites of the Gila. This plant is not federally listed, but it is a species of concern for the U.S. Fish and Wildlife Service and the State of New Mexico and is a sensitive species on U.S. Forest Service lands (New Mexico Rare Plant Technical Council 1999). The Mimbres figwort was identified in moist and sheltered locations along both forks of the Gila River, and these populations represent a range extension as it had not been found before in Catron County or along the Gila River.

The riparian corridor supports a considerable amount of wetland vegetation, especially in the downstream portion of the river where the river channel width and riparian area are greater. Of the downstream sites that we sampled, 45.8% are characterized as wetlands, indicating that much of the riparian area is dominated by wetland vegetation. Upstream there is greater coverage by upland species such as Carruth's sagewort (*Artemisia carruthii*) and rabbitbrush (*Ericameria nauseosa*), but no obligate wetland species of substantive cover. The channel, often deeply incised in shady canyons, with less bare ground, and at higher elevation, appears to be moister, but due to a smaller watershed and stream flow, and a steeper gradient, proportional cover by wetland species is lower (only 20% of sites sampled). The greater total species richness and cover per plot and within each wetland indicator category (except obligate wetland species) found in upstream plots is reflective of greater habitat diversity and moister growing conditions, rather than a greater abundance of actual wetland habitats. Downstream plots are characterized by less total diversity, but much greater cover by obligate wetland species, especially the willows—*Salix gooddingii* and *S. exigua*.

The data collected during this research will be archived for collaborative use and will be valuable for environmental assessments, conservation planning, riparian and wetland restoration, and management of the river's vegetation. Most importantly, these data provide an important baseline for studying wetlands and their coverage related to any proposed water development projects or climate change that may alter the hydrology of the river. Models used to study future changes in hydrology will need to address impacts to wetlands. It is well known that high flow events are essential for establishment of cottonwoods (*Populus* sp.) and other wetland-dependent species (Lytle and Merritt 2004; Shafroth et al. 2002), and therefore alteration of flow regime due to water development projects would threaten the persistence of these wetland types. Predictions of species changes to our data set, coupled with use of the wetland index, could be useful for estimating the impact of future water development proposals on the critical riparian wetland habitat of the Gila River.

Our data are available to other researchers and the public through the author's website, and research collaboration is encouraged: http://www.kbs.ku.edu/people/kindscher.htm

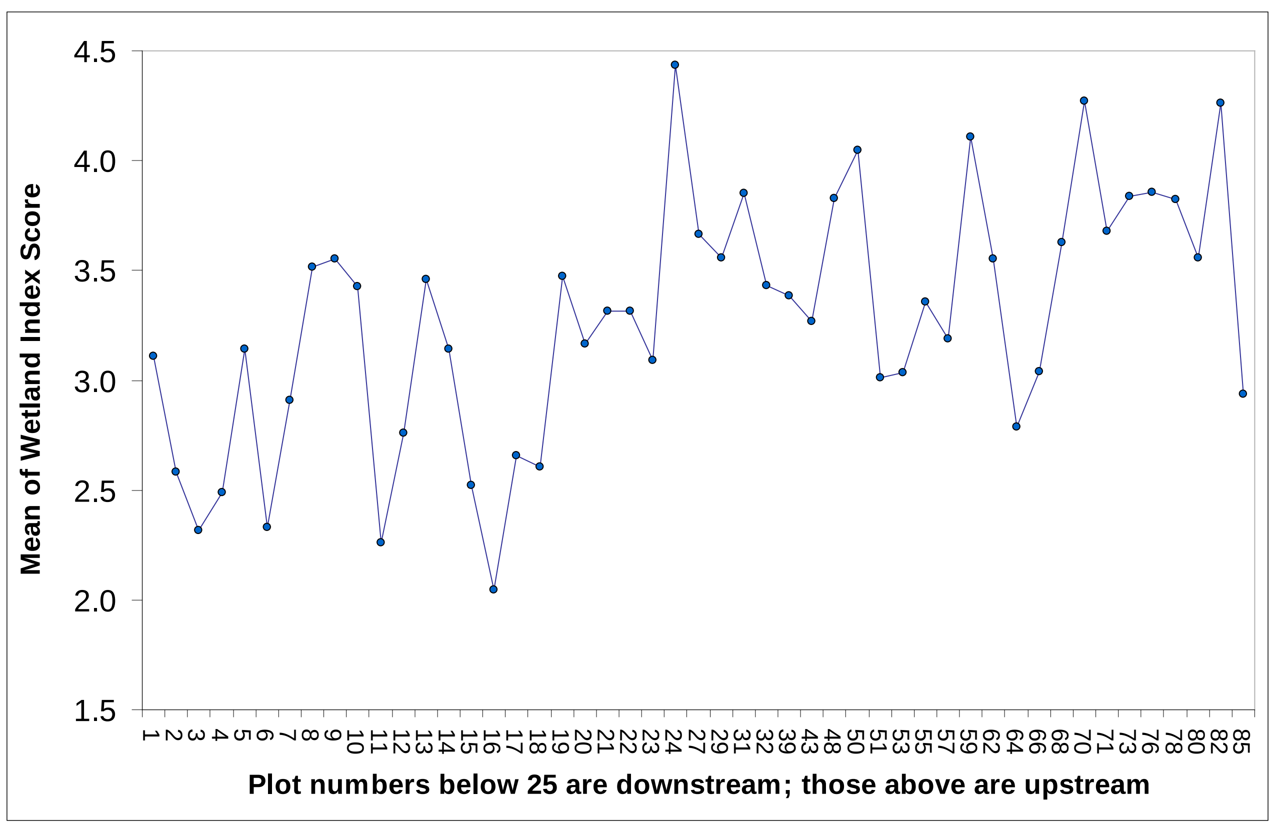

Figure 2. Mean of wetland index score per site (three 0.1 ha plots averaged per site) for riparian plots along the Gila River, showing greater number of sites downstream with vegetation dominated by wetlands (those plots below 3.0).

Acknowledgments

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Literature Cited

Allred, K. 2009. *Flora Neomexicana I: The Vascular Plants of New Mexico—An annotated checklist to the names of vascular plants.* Available from www.lulu.com

Debinski, D., K. Kindscher, and M. E. Jakubauskas. 1999. A remote sensing and GIS-based model of habitats and biodiversity in the greater Yellowstone ecosystem. *International Journal of Remote Sensing* 17:3281–91.

Environmental Laboratory. 1987. *Corps of Engineers wetlands delineation manual.* Technical Report Y-87-1. Vicksburg, MI: U.S. Army Engineer Waterways Experiment Station.

Kindscher, K. 2008. "Vegetation and habitat along the Gila River in southwestern New Mexico," in "Natural history of the Gila: A symposium," special issue 1, *New Mexico Botanist,* 49–53.

Kindscher, K., A. Fraser, M. E. Jakubauskas, and D. Debinski. 1998. Identifying wetland meadows in Grand Teton National Park using remote sensing and average wetland values. *Wetlands Ecology and Management* 5:265–73.

Kindscher, K., R. Jennings, W. Norris, and R. Shook. 2008. Birds, reptiles, amphibians, vascular plants, and habitat in the Gila River riparian zone in southwestern New Mexico. Kansas Biological Survey Open-File Report No. 151, Lawrence, KS.

Lytle, D. A., and D. M. Merritt. 2004. Hydrologic regimes and riparian forests: A structured population model for cottonwood. *Ecology* 85 (9): 2493–2503.

Mitsch, W., and J. Gosselink. 1993. *Wetlands.* NY: Van Nostrand Reinhold.

New Mexico Rare Plant Technical Council. 1999. New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page. http://nmrareplants.unm.edu (Latest update: 14 August 2008).

Norris, W. R., and D. R. Farrar. 2001. A method for the rapid survey and natural quality evaluation of forests in the Central Hardwoods region. *Natural Areas Journal* 21:313–23.

Reed, P. B., Jr. 1988. *National list of plant species that occur in wetlands: National summary.* U.S. Fish Wildl. Serv. Biol. Rep. 88(24). Listing also found at http://plants.usda.gov/

Saveraid, E. H., D. M. Debinski, K. Kindscher, and M. E. Jakubauskas. 2001. A comparison of satellite data and landscape variables in predicting bird species occurrences in the greater Yellowstone ecosystem. *Landscape Ecology* 16 (1): 71–83.

Shafroth, P. B., J. C. Stromberg, and D. T. Patten. 2002. Riparian vegetation response to altered disturbance and stress regimes. *Ecological Applications* 12:107–23.