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# Comparison of bird community indices for riparian restoration planning and monitoring

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ABSTRACT

The use of a bird community index that characterizes ecosystem integrity is very attractive to conservation planners and habitat managers, particularly in the absence of any single focal species. In riparian areas of the western USA, several attempts at arriving at a community index signifying a functioning riparian bird community have been made previously, mostly resorting to expert opinions or national conservation rankings for species weights. Because extensive local and regional bird monitoring data were available for Nevada, we were able to develop three different indices that were derived empirically, rather than from expert opinion. We formally examined the use of three species weighting schemes in comparison with simple species richness, using different definitions of riparian species assemblage size, for the purpose of predicting community response to changes in vegetation structure from riparian restoration. For the three indices, species were weighted according to the following criteria: (1) the degree of riparian habitat specialization based on regional data, (2) the relative conservation ranking of landbird species, and (3) the degree to which a species is under-represented compared to the regional species pool for riparian areas. To evaluate the usefulness of these indices for habitat restoration planning and monitoring, we modeled them using habitat variables that are expected to respond to riparian restoration efforts, using data from 64 sampling sites in the Walker River Basin in Nevada and California. We found that none of the species-weighting schemes performed any better as an index for evaluating overall habitat condition than using species richness alone as a community index. Based on our findings, the use of a fairly complete list of 30–35 riparian specialists appears to be the best indicator group for predicting the response of bird communities to the restoration of riparian vegetation.



## 1. Introduction

Riparian areas of the semi-arid Intermountain West (USA) are responsible for a large proportion of biological diversity in this region (Knopf et al., 1988; Ohmart, 1994). Their high productivity also makes riparian areas among the most valuable lands for human uses in desert regions, which has resulted in degradation and transformation due to agriculture, water diversion, and channelization (Patten, 1998). As a result of these major impacts to western rivers, much effort and money has been devoted to the goal of restoring historical conditions of river channels and floodplains (Goodwin et al., 1997; Rood et al., 2003), often with the explicit objective of improving wildlife habitat conditions. It is therefore surprising that there has not been more standardized scientific planning and success evaluation made available for guidance in projects that have multiple wildlife objectives (Palmer, 2009).

Restoration planning and monitoring requires some method of site evaluation, and the first step in this process is selecting appropriate environmental indicators (e.g., Carignan and Villard, 2002; Caro, 2010). Despite a great deal of literature on the subject, however, the selection of such indicators is often arbitrary and the indicators themselves are rarely tested (Niemeijer and de Groot, 2008).

The development of biological criteria for site evaluation using faunal communities has become an important approach to riparian monitoring and assessment (Carignan and Villard, 2002), and many different taxa have been used (Hilty and Merenlender, 2000). In general, species assemblages have been found to make better indicators of ecosystem integrity than single species, regardless of the criteria by which these species were selected (Hutto, 1998;

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Niemeijer and de Groot, 2008). This may especially be the case if, as often occurs, there may be no singles species that can serve as an "umbrella" or other surrogate for all wildlife needs (Caro, 2010), and many species of conservation concern may be rare or absent.

Birds have often been proposed as indicators of ecosystem integrity (e.g., Croonquist and Brooks, 1991; Morrison, 1986). Birds are particularly useful for scientific planning and evaluation of riparian restoration projects because most riparian-associated species respond quickly and sensitively to habitat change (Sanders and Edge, 1998). A complete riparian bird assemblage may use riparian areas for nesting, foraging, or migration corridors, and requires a diversity of microhabitats (Saab, 1999), often missing in a landscape that has been simplified by past land uses. Also, well-established and easily replicated survey protocols can monitor a large number of bird species at once (Hutto, 1998; Ralph et al., 1995). However, any indicator set might still be enhanced by the inclusion of other taxa (Caro, 2010).

Past attempts at using bird community data for the purpose of riparian habitat evaluation included approaches using expert opinion about the habitat specializations of bird species (e.g., Rich, 2002; Wiens et al., 2008), historical comparisons of species abundances (e.g., Ammon, 2002), or habitat modeling for individual species that serve as surrogates for larger species groups (e.g., Caro, 2010; Dickson et al., 2009). More quantitative and empirically tested tools are needed (Simaika and Samways, 2009).

Community summary statistics have been criticized for potentially hiding more than they reveal (Lamb et al., 2009), and species richness, in particular, is criticized for treating all species the same (Fleishman et al., 2006). Species differ in conservation concern, in degree of habitat specialization, and in regional habitat occupancy. The objective of this paper is to test whether a bird community index could be developed that responds to habitat restoration more sensitively than species richness alone, by weighting species according to these three criteria.

This paper addresses the use of bird community indicators for conservation planning and monitoring on the Walker River in west-central Nevada, USA, which is currently the focus of watershed-wide restoration planning. Because extensive bird monitoring data were available for Nevada, we were able to develop three different indices based on both local and regional bird data, rather than from expert opinion. The usefulness of each of these indices for riparian restoration planning and monitoring was then evaluated based on how well they are expected to respond to changes in riparian woody vegetation, as modeled using variables derived from LiDAR and other vegetation mapping methods.

## 2. Methods

### 2.1. Study area

The Walker River drains the eastern slopes of the Sierra Nevada in Mono County, CA, and flows in two forks through Douglas, Lyon, and Mineral Counties, Nevada, to its terminal lake, Walker Lake (Otis Bay Ecological Consultants, 2009). The headwaters and higher elevations of the east and west forks are dominated by montane meadow and riparian vegetation such as shrub-willow (*Salix* spp.) and aspen (*Populus tremuloides*), and the lowland areas are dominated by riparian gallery forests (primarily Fremont cottonwood, *Populus fremontii*), agricultural areas, and transitional shrub communities. Much of the historic lowland floodplain has been converted for agricultural uses, but significant sections of riparian shrublands and woodlands are still present. Despite an artificial wetland management area and several reservoirs, floodplain wetlands are relatively rare in the lower elevations (Sharpe et al., 2007), although they were historically more abundant (Dilts et al., 2012).

### 2.2. Bird surveys

Birds were surveyed during the breeding season, over a period of five years (2006–2010). Thirteen transects were randomly placed along accessible sections of the Walker River, primarily in lowland reaches within the cottonwood zone, but with some transitional montane shrub-willow communities. The study area covered about 350 km of river distance, and the elevation range was 1210–1960 m. Each transect had ten survey points spaced at 250 m apart, as near as possible to the river edge.

Survey effort varied among years as new transects were established, with one visit to six transects in 2006, two visits to ten transects in 2007, three visits to 13 transects in 2008, two visits to 13 transects in 2009, and two visits to 12 transects in 2010.

Birds were sampled using standard 10-min point counts (Ralph et al., 1995). The surveys were conducted between May 25 and July 10, between sunrise and 10:00 a.m. in fair weather conditions. For this paper, we included only those birds detected within a 100-m-radius circle from the survey point, excluding fly-over observations, in order to correlate bird detections with local habitat features.

### 2.3. Bird community indices

We developed indices based on the bird community using a two-step process. We first defined the list of riparian species to be considered in the index, and then considered differential weightings of these species using three separate criteria.

#### 2.3.1. Defining the species assemblage and effects of species inclusion

The indicator species that are expected to be most useful for habitat conservation planning are those specialized on the target habitat (Pearson, 1994). We used two alternative methods for ranking the bird species observed on the Walker River according to their degree of specialization on riparian habitats, based on (1) regional data on relative abundance in riparian versus non-riparian habitats and (2) inclusion in riparian nesting guilds. In both cases we excluded all waterbirds (e.g., shorebirds, colonial nesters, and non-passerine marsh birds) from the species list, because our survey method was not designed for them, as well as aerial foragers (e.g., raptors, swallows, swifts, nighthawks), because these could not be tied to local habitat conditions that were subject to restoration. We also excluded non-native species.

For ranking riparian specialization based on relative abundance in riparian compared with non-riparian sites, we used data from 225 transects in the Great Basin region of Nevada, within the same elevation range as the Walker River data (1200–2000 m), collected during the Great Basin Bird Observatory's ten-year Nevada Bird Count program (2002–2011). The program uses a habitat-stratified sampling plan, which categorizes transects according to their dominant habitat types. We compared the mean abundance per point-count survey for each species on the 118 transects from non-riparian habitats versus the 107 riparian- or aspen-dominated transects (aspen is most often riparian-associated in Nevada and supports a riparian bird community). We further filtered the data at the individual point level by using a GIS cover type map, and used only the 980 points from riparian transects that also had riparian habitat within 100 m, and only the 980 points from non-riparian habitats that did not. We used the ratio of the abundances in these two datasets to score the degree of riparian specialization. To select the best threshold for inclusion in the riparian species list, we then used the resulting scores to progressively remove the least specialized species from the list of species used in the indices.

The second method of selecting riparian specialists followed a more traditional guild-based approach often used in the development of bird-based indices (e.g., Bradford et al., 1998; Bryce et al.,