

Diversity Patterns in the Terrestrial Avifauna of the Salton Sea¹

Mark B. Mendelsohn,² William I. Boarman,² and Robert N. Fisher²

Abstract

We performed bird point counts monthly March-June 2001 and bi-monthly August 2001-February 2002 across a sampling grid of 35 points along the west edge of Salton Sea. We found that landbird species diversity (both in numbers of species, and numbers per species) was dependent on proximity to the sea. Diversity was at a maximum nearest the shore, and was significantly lower farther from the shore. Creosote bush (*Larrea tridentata*) and alkali goldenbush (*Isocoma acradenia*) are the co-dominant plants on the study site, and vary widely in their horizontal and vertical structure. After measuring vegetation cover within the study site, we concluded that avian diversity patterns were caused by these differences in vegetation structure, which also corresponded to proximity to the water's edge. In light of the prevalent debates on potential restrictions of water inflow to the Salton Basin, there is concern that the ecology of the landbirds using this land-shore interface, not to mention the millions of waterbirds and other organisms using the region, may be severely impacted (Shuford et al. 2002).

Introduction

The Salton Sea is a large, saline lake in the counties of Imperial and Riverside, in the Colorado Desert of southeastern California, created in 1905 by flooding of water accidentally diverted from the Colorado River (Redlands Institute 2002). It has become a critical habitat for aquatic and terrestrial fauna alike, especially migrating and wintering birds. More than 400 bird species have been recorded at the Salton Sea, of which about 100 species have established breeding populations (Patten et al. 2003). In the Salton Basin, within desert creosote scrub habitat atop an extensive alkali sink, vertebrate and invertebrate life forms have made homes of this unique and seemingly inhospitable landscape.

However, due to salinity levels approaching toxic concentrations in this biologically and recreationally significant body of water (Shuford et al. 2002), one phase of a multi-dimensional effort to restore the Salton Sea is based on desalinization. Enhanced Evaporation Systems (referred to as "salt blowers"; *fig. 1*) located near the shore are in the testing stage to see if desired results are temporally and financially feasible. As part of a large-scale ecological study designed to monitor the effects of possible particulate deposition from the salt blowers, we gathered baseline count and local distribution data on avian diversity near the southwestern shore of the sea (*fig. 1*). Please see Mendelsohn et al. (2003) for a more detailed manuscript on the research presented here and Redlands Institute (2002) for general information and references therein for research involvements at the Salton Sea.

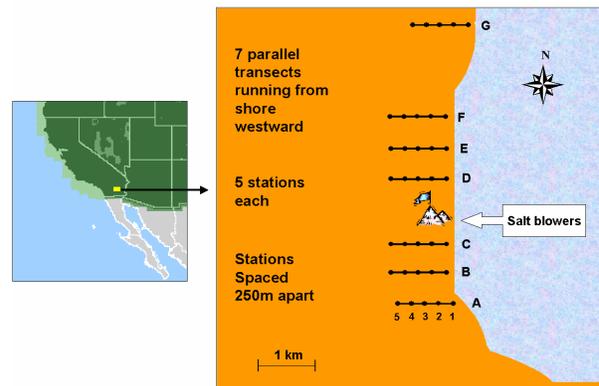


Figure 1— Study design at site located along the southwestern edge of the Salton Sea in southeastern California. Note: transect G is spaced 2 km (vs. 0.8 km distance between other transects) away from the nearest transect because it was intended to serve as a control in the original study plan where the purpose was to study the effect of possible salt deposition on terrestrial fauna.

Currently, challenging issues of the use and fate of this resource are being tossed around between farmers, policy-makers, water district boards, environmental agencies and many other stakeholders. For nearly a century, rivers have fed nutrient-filled water into the sea. At present, talks of redirecting this river water to coastal Southern California for human use are at the forefront. Ecologists and non-scientists alike suggest that this reduction in source water could have direct and far-reaching effects on the Salton Sea ecosystem

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²U.S. Geological Survey, Western Ecological Research Center, 5745 Kearny Villa Rd., Suite M, San Diego, CA 92123. E-mail: mmendelsohn@usgs.gov.

(D. Barnum, pers. comm.) and surrounding developed areas.

Methods

Our study site lies almost completely within the U.S. Navy's former Salton Sea Test Base, near the southwestern corner of the Salton Sea. The vegetation on this site of extensive alkali sink constitutes primarily Sonoran desert creosote scrub (Redlands Institute 2002). A sampling grid was established along the west edge of the sea with seven transects running perpendicular to the sea and five running parallel to it (*fig. 1*). The five parallel transects were placed across the gradient of distance from the sea edge at 250-m intervals beginning approximately 100 m from the water's edge. Six of the perpendicular transects were placed at 800-m intervals from north to south. A seventh was placed approximately 2 km north of the others. Data were collected at each of the 35 points where the transects intersected.

At each of the 35 points, five-minute counts of individuals of each species of bird seen or heard within a 100-m radius of the count station were recorded, following the methods of Ralph et al. (1993). We did not include as part of the data presented here waterbirds observed on the beach or sea, even if within 100 m of sampling points, nor fly-over observations. Fifteen visits to each station were performed between March 2001 and February 2002, with a sampling period each month during the "spring" (February through June) and every other month in other seasons (i.e., August, October, and December). A variation of a point-intercept vegetation transect (see USDI-NPS 2001 for examples and further references) was performed for each of the 35 nodes to assess cover around each station, to relate to the bird count data.

Systat Version 10 (SPSS Inc. 2000) was used for all statistical analyses. We performed analysis of variance (ANOVA) tests to detect any differences among distances from the shoreline, with respect to total number of birds and total number of species observed. Data from equivalent distances from the shoreline were summed across transects; i.e., transects were treated as the blocking factor, so that values depicted on *figures 2-4* represent the averages across transects. Likewise, vegetation cover was analyzed in the same way. Fisher's Least Significant Difference (LSD) post-hoc tests were used to analyze where the differences among distances, if any, rested. To ease interpretation of *figures 2-5*, we clarify that distance 1 refers to the stations closest to the shoreline, distance 2 is 250 m farther from the shore...until distance 5 which is farthest (just over 1 km) from the sea. Distances 1, 2, 3, 4, and 5 refer to the

respective points across all seven transects, i.e., totaled across all transects.

Total birds

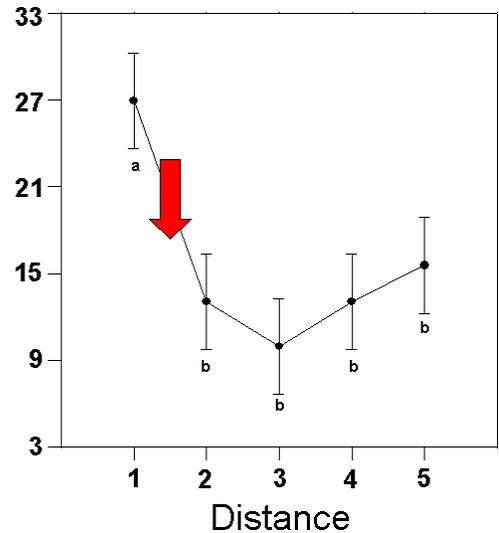


Figure 2— Least squares mean visualization with standard error bars, showing statistically significant differences in individual bird totals between distance 1 and all other distances (group membership from Fisher's LSD signified by the letters "a, b").

Total species

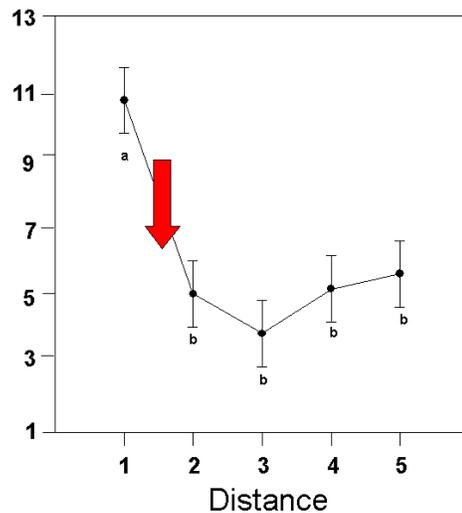


Figure 3— Least squares mean visualization with standard error bars, showing statistically significant differences in total species between distance 1 and all other distances (group membership from Fisher's LSD signified by the letters "a, b").

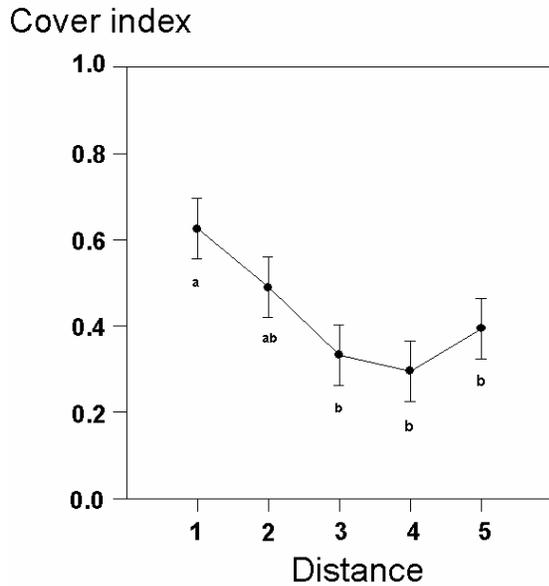


Figure 4— Least squares mean visualization with standard error bars, showing statistically significant differences in vegetation cover between distance 1 and distances 3, 4, and 5; distance 2, however, is not different from 1, nor 3, 4 and 5 (group membership from Fisher's LSD signified by the letters "a, b").

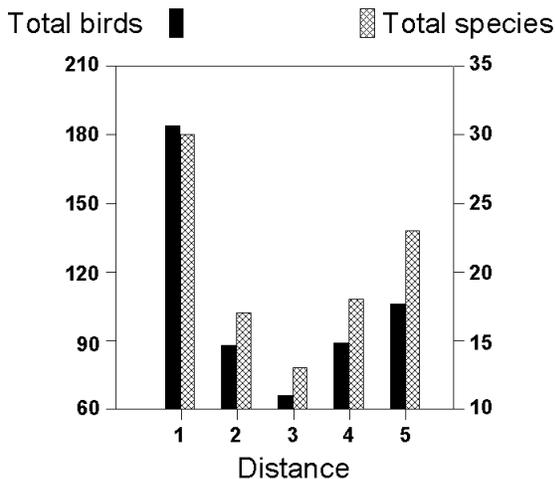


Figure 5— Total numbers of birds and species observed from all stations, showing similar patterns related to distance from the shoreline.

Results

We observed a total of 533 individual landbirds of 44 different species across the whole gradient (i.e., all 5 distances from the shore) and all seven transects (fig. 5). The two most commonly encountered species were the Verdin (*Auriparus flaviceps*) with 70 individual observations, and the Loggerhead Shrike (*Lanius ludovicianus*) with 58 individuals. There was a strong effect of distance from the shoreline on both the total number

of individuals and species observed. Distance 1, which included the seven stations closest to the sea, had 188 individuals, a significantly higher number of individual observations than any of the other four distances (fig. 2; ANOVA: $F_{4,24} = 3.95$, $P = 0.013$). Similarly, the total number of species observed was sensitive to the distance from the shoreline. Distance 1 had 30 species, a significantly higher number than any of the other four distances (fig. 3; ANOVA: $F_{4,24} = 7.62$, $P < 0.001$). The effect of distance from the shoreline on the vegetation cover around each station was not as strong as it was with the two preceding variables. However, the stations at distance 1 had significantly more cover than those at distances 3-5 (fig. 4; ANOVA: $F_{4,24} = 3.59$, $P = 0.020$). The difference between distance 1's vegetation cover and that of distances 2-5 is less drastic (compared to the patterns seen in total birds and total species with respect to distance) because distance 2 appears to be an intermediary, with respect to cover, between distances 1 and 3-5.

Conclusions

Spatial patterns in landbird diversity—a function of the number of species and number of total individuals—appear to be dependent on proximity to the shoreline near the southwest edge of the Salton Sea. Patterns of vegetation cover by the dominant plant species at the site are also related to proximity to the sea's edge. This reflects a probable correlation between the avian diversity and vegetation cover.

Intuitively, any reduction of source water to the Salton Sea, which is quite possible with future management schemes, will lower the sea's surface and have potentially serious effects on the distribution and cover of the surrounding vegetation. This speculation of vegetative change has two lines of reasoning. First, greater vegetation cover at the sea's edge may be dependent on available ground water and other edaphic features that are not found farther from the shore. Second, the sea floor that will be exposed with a reduced sea level is saturated with saline sedimentation, likely unsuitable for the propagation of any plant species except for the most extreme halophytes. Therefore, the areas of greater vegetative cover may be reduced due to loss of water, and may not be replaced in the newly exposed areas immediately next to the water due to altered substrate conditions.

Thus, avian diversity patterns at this critical migratory and wintering region may be affected at the local, if not landscape (the entire shoreline around the sea), level if the sea's inflow is not maintained at current quantities. Therefore, we extend what Shuford et al. (2002) stated regarding waterbird conservation to landbirds as well: any proposed projects which may directly or indirectly

modify the sea should be carefully evaluated and implemented only if they can provide substantial habitat improvements without negatively impacting the suitability of current habitats.

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Literature Cited

- Mendelsohn, M. B., W. I. Boarman, and R. N. Fisher. 2003. **Diversity patterns in the terrestrial avifauna of Salton Sea**. Unpublished draft supplied by the authors.
- Patten, M. A., G. McCaskie, and P. Unitt. 2003. **Birds of the Salton Sea: Status, biogeography, and ecology**. Berkeley, CA: University of California Press; 374 p.
- Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. **Handbook of field methods for monitoring landbirds**. Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41 p.
- Redlands Institute. 2002. **Salton Sea atlas**. Redlands, CA: University of Redlands; 127 p.
- Shuford, W. D., N. Warnock, K. C. Molina, and K. K. Sturm. 2002. **The Salton Sea as critical habitat to migratory and resident waterbirds**. In: Developments in hydrobiology 161, The Salton Sea: Proceedings of the Salton Sea symposium; 2000 January 13-14; Desert Hot Springs, CA. Boston, MA: Kluwer Academic Publishers; 255-274.
- SPSS Inc. **SYSTAT Version 10** [Computer program]. 2000. Available from: 233 S. Wacker Dr., 11th floor, Chicago, IL 60606-6307.
- U.S. Department of the Interior, National Park Service (USDI-NPS). 2001. **Fire monitoring handbook**. Boise, ID: National Interagency Fire Center; 288 p.