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Priority Areas for Breeding Birds within the Planning Area of the Desert Renewable Energy Conservation Plan

Christine A. Howell, PhD and Samuel D. Veloz, PhD

PRBO Conservation Science
3820 Cypress Dr., #11
Petaluma, CA 94954

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Data availability

To check for updates on this report or to acquire the GIS raster output from the species richness and two Zonation analyses (with and without weighting) visit http://data.prbo.org/apps/drecp/. The distribution models for many of the species in this report, including current and future distributions, as well as the projections for current and future climate and vegetation in California can be found at the following website (http://data.prbo.org/cadc/tools/ccweb2/).

Contact information
Sam Veloz
sveloz@prbo.org
707-781-2555 ext. 308

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Executive Summary

We conducted a landscape prioritization analysis within the Desert Renewable Energy Conservation Plan (DRECP) planning area to identify areas of high and low value to a suite of 66 breeding birds which included "sensitive" species (i.e., threatened, endangered, or Bird Species of Special Concern) and more common species that collectively represent a range of ecological attributes. The DRECP planning area provides important habitat for birds, providing over 50% of the breeding range within California for at least 20 bird species.

Using output from species distribution models as the inputs for a conservation prioritization analysis, we determined which areas in the DRECP planning area constitute the top 10% of the landscape in terms of their importance to the breeding bird community. These high value areas occurred throughout the DRECP planning area with a high percentage occurring in the Colorado Desert, Northern and South Eastern Mojave Desert, and the Sonoran Desert. On average, U.S. Fish and Wildlife Service lands in the DRECP planning area contain the highest priority areas of any other landowner. We did not find much of a difference in the overlap between priority rankings and different categories of protected areas except that managed open space lands, such as the majority of Bureau of Land Management Lands in the study region, had the lowest conservation value. The relatively high conservation value of unprotected lands, e.g. local and county jurisdictions, in the DRECP study area indicates that there are opportunities to acquire or place conservation easements on unprotected lands as part of renewable energy project mitigation. In general, high priority areas should be avoided for solar siting and should be incorporated into mitigation or land protection opportunities to benefit birds.

We determined which areas in the DRECP planning area constitute the lowest 10% of the landscape in terms of their importance to breeding birds. These low priority areas should be considered first for siting solar and other renewable energy installations to minimize impacts on breeding birds as the loss of these areas would result in the smallest decreases in suitable habitat for all of the species we considered. Low priority areas for birds included parts of the Mojave Desert (Central, South Eastern, and South Central). Comparing our prioritization results among all of the Renewable Energy Action Team study areas, the Barstow and West Mojave study areas would have the least impact on breeding birds in the DRECP planning area.

Our landscape prioritization results varied when we gave greater weight to sensitive species than to non-sensitive species, indicating that limiting analyses to sensitive bird species is not adequate to capture the breeding bird priority areas in the DRECP planning area. Additionally, species richness was a poor predictor of the Zonation prioritization, suggesting that conservation decisions should not be based on species richness alone. We recommend priority be given to areas of overlap between the weighted and non-weighted Zonation results when determining which areas would be more suitable for renewable energy development.

Our results provide a data-rich and scientifically defensible means to determine high and low priority areas for breeding birds. However, we recommend that these results be used in concert with similar analyses that include other taxa, natural communities, and ecosystem services.

Further, even low priority areas for birds contained a relatively high degree of avian species richness suggesting they are providing worthwhile habitat for birds. In these cases, we recommend site-specific surveys to assess their value prior to development.

Our approach provides an important example of a rigorous priority-setting conservation planning exercise within the DRECP planning boundary (or in other settings) that could be extended to incorporate additional stakeholder data or information.

We provide our modeling results to the public in the form of GIS layers so that our analyses may be used in conservation decision making within the DRECP planning area. To check for updates on this report or to acquire the GIS raster output from the species richness and two Zonation analyses (with and without weighting) visit data.prbo.org/apps/drecp/.

Introduction

Unprecedented efforts are underway to establish new solar energy projects in the desert regions of California. Federal and state natural resource agencies in California are preparing a landscape-level conservation plan in order to expedite the siting and development of renewable energy facilities across California's deserts. A Renewable Energy Action Team (REAT) was formed consisting of the California Energy Commission, California Department of Fish and Game, Bureau of Land Management, and the U.S. Fish and Wildlife Service to oversee the implementation of the Desert Renewable Energy Conservation Plan (DRECP). The DRECP is a Natural Community Conservation Plan (NCCP), which has the goal of providing for effective protection and conservation of desert ecosystems while allowing for the appropriate development of renewable energy projects within the planning area (Figure 1). It aims to provide long-term endangered species permit assurances to renewable energy developers, a process for conservation funding to implement the DRECP, and a basis for one or more Habitat Conservation Plans under the Federal Endangered Species Act.

The DRECP has 11 planning goals[1] within its planning area, however the three goals most relevant to this report are to: 1) provide for the long-term conservation and management of covered[2] species within the DRECP planning area; 2) further identify the most appropriate locations within the DRECP planning area for the development of utility-scale renewable energy projects, taking into account potential impacts to threatened and endangered species and sensitive natural communities; and 3) provide a comprehensive means to coordinate and standardize mitigation and compensation requirements for covered activities within the planning area.

The overarching goal of this report is to provide the DRECP process and stakeholders, including renewable energy developers and advocates with information relating to the three DRECP planning goals listed above. There is an urgent need for this information. The DRECP convened a panel of Independent Science Advisors to provide independent scientific input for the DRECP. The State of California's Natural Community Conservation Planning (NCCP) Act mandates that a process be established for obtaining independent scientific analysis and input, to assist in meeting scientifically sound principles for the conservation and management of

[1] http://www.drecp.org/about/index.html
[2] Which species constitute the final list of 'covered species' has not been determined.

species proposed to be covered by each Natural Community Conservation Plan. One of the major recommendations of the ISA report (ISA 2010; p vi) was to "*use appropriate spatially explicit, dynamic, probabilistic maps and models to address information gaps to the degree feasible*."

Figure 1. The DRECP planning area boundary is shown in yellow.

To help better inform the DRECP decision making process with regard to the three DRECP goals, we created spatially explicit statistical models of the current distributions of desert breeding birds and we used these models to prioritize areas within the DRECP area based on their importance to these birds. The results of the prioritization exercise can be used in solar siting decisions (e.g., to select sites for development that are less important to birds) and in mitigation decisions (e.g., to select mitigation sites that are most beneficial to birds). In addition, our approach serves as an example of a rigorous and scientifically defensible modeling approach that can be applied to address data gap issues for other wildlife. We hope that this will result in a stronger scientific foundation for the DRECP with regard to wildlife and reduced renewable energy impacts on desert wildlife and their habitats.

METHODS

Modeling approach

Our statistical modeling approach for the DRECP area builds on our previous peer-reviewed efforts to model the current and future projected distributions of California bird species (Stralberg et al. 2009, Wiens et al. 2009). Species-distribution modeling involves using species point locality data, coupled with information on climate and vegetation, to develop correlative species distribution models (SDMs) that project the potential distribution of a species. For our modeling approach, we use bird point locality data from a variety of sources (see below) in conjunction with the maximum entropy distribution-modeling algorithm (Maxent 3.2.1; Phillips and Dudik 2008) to project current bird distributions at an 800 x 800 m pixel resolution across all of California. We later clipped the SDM output to the spatial extent of the DRECP area (Figure 1). We used the Maxent algorithm because many of our records were "presence-only" data that only recorded whether a species was present, but not whether it was absent. Maxent has excellent predictive performance for presence-only modeling (Elith et al. 2006).

Selection of bird species

For this analysis we initially included breeding birds within the planning area that are listed as threatened or endangered under the U.S. Endangered Species Act and the State of California Endangered Species Act (referred to as "sensitive species" throughout the text), species listed as Bird Species of Special Concern (BSSC; Shuford and Gardali 2008), and focal species designated by Partners in Flight[3] that are representative of major habitat types (Chase and Geupel 2005) occurring within the planning area (e.g., desert, scrub, oak, sagebrush, and riparian habitats). We also selected the 40 most frequently detected bird species out of approximately 80,000 individual detections of desert birds observed by PRBO scientists in California deserts in the past decade. We excluded the Brown-headed Cowbird (*Molothrus ater*) because it is in an obligate brood parasite that has a negative effect on some landbirds, and we excluded the Common Raven (*Corvus corax*) because it is often associated with anthropogenic development. For these reasons we did not include these two species in our modeling exercise, although they were among the most frequently observed species. We also excluded species for which we did not have enough data points to create a species distribution model (see next section).

[3] http://www.partnersinflight.org/default.htm

We restricted our analyses to the breeding season, when habitat associations of the species are most clear (i.e., birds are present within breeding territories). Breeding-season records were filtered using breeding-season range maps (Zeiner et al. 1990, Shuford and Gardali 2008) to ensure that migratory records were not included in the models; hence, only species that breed within the DRECP boundary were included.

We used point locality occurrence records obtained from (1) PRBO Conservation Science (PRBO) and partners for 1993–2007 (http://www.prbo.org/cadc/); (2) USDA Forest Service Pacific Southwest Research Station Redwood Sciences Laboratory (RSL) and Klamath Bird Observatory (KBO) for 1992–2006; (3) the North American Breeding Bird Survey (BBS) for 1997–2006; (4) California Natural Diversity Database (CNDDB); and (5) Cornell Laboratory of Ornithology eBird database downloaded from the Avian Knowledge Network (http://www.avianknowledge.net) where locational accuracy was known within a 5-km radius.

We were able to model the breeding distributions of 66 species (Appendix 1). Because of data limitations there were some sensitive species that we were unable to model within the DRECP area (Appendix 2). These include sensitive species where we did not have enough point locality data, as well as species that occur in the DRECP during the non-breeding season (and hence were beyond the scope of our modeling efforts as we modeled breeding distributions).

Environmental data

Current climate data were based on 30-year (1971-2000) monthly climate normals interpolated at an 800 x 800 m grid resolution by the PRISM group (Daly et al. 1994). From the monthly temperature and precipitation grids, we produced 19 standard bioclimatic variables (Nix 1986; www.worldclim.org/bioclim.htm), but reduced these to 8 variables by removing complex variables that were derived using both temperature and precipitation, and then removing highly correlated variables ($r > 0.90$). Predictor variables selected for modeling were: (1) annual mean temperature, calculated as the 12-month average of mean monthly temperature; (2) mean diurnal temperature range, calculated from the 12-month average of the difference between mean maximum and mean minimum temperature for each month; (3) isothermality, calculated as the ratio of mean diurnal temperature range to the annual temperature range (maximum temperature of the warmest month - minimum temperature of the coldest month); (4) temperature seasonality, calculated as the 12-month standard deviation of mean monthly temperature; (5) mean temperature of warmest quarter, calculated as the average temperature of the warmest 3-month period; (6) annual precipitation, the 12-month total of mean monthly precipitation; (7) precipitation seasonality, calculated as the 12-month coefficient of variation of mean monthly precipitation; and (8) precipitation of driest quarter, calculated as the average precipitation for the driest 3 month period. We also included a categorical variable for land cover based on modeled vegetation (see below). However, since we did not explicitly model riparian vegetation we also included a stream index as a covariate which served as a surrogate for riparian habitat. The stream index was calculated by measuring the inverse distance to the nearest stream at each grid cell.

Vegetation data

To improve the capacity of the SDMs to project changes in habitat relevant to birds, we included vegetation distribution as an input to the models (see Stralberg et al. 2009, Wiens et al. 2009). We created a vegetation model that included 12 broad vegetation classes and their observed relations with climate, solar radiation, soil, and topography based on the California Gap Analysis vegetation layer (Davis et al. 1998). The 12 classes were aggregated from the California Wildlife Habitat Relationship types (Mayer and Laudenslayer 1988) and included:

(1)) Annual Grassland, Perennial Grassland
(2) Blue Oak Woodland , Blue Oak-Foothill Pine
(3) Desert Scrub, Alkali Desert Scrub, Desert Succulent Shrub
(4) Eastside Pine, Juniper, Piñon-Juniper
(5) Mixed Chaparral, Chamise-Redshank Chaparral, Coastal Scrub
(6) Montane Hardwood-Conifer, Douglas Fir
(7) Montane Hardwood, Coastal Oak Woodland
(8) Ponderosa Pine, Klamath Mixed Conifer
(9) Redwood, Closed-Cone Pine Cypress
(10) Red Fir, Lodgepole Pine, Subalpine Conifer
(11) Sagebrush, Bitterbrush, Low Sage; and
(12) Sierran Mixed Conifer, White Fir, Jeffrey Pine.

We excluded developed and agricultural categories from our vegetation model, as well as aquatic, wetland, riparian, and non-vegetated categories that were thought to be driven more by proximity to water sources or were not directly climate-associated. From a 10 x 10 km grid of points across the state, we removed those grid points that fell in an excluded vegetation type and used the resulting sample (n = 9,752 grid points) to develop vegetation-classification models using the Random Forest algorithm (Breiman 2001), which has consistently performed well in predicting the distributions of individual species (Lawler et al. 2006, Prasad et al. 2006). We used the Random Forest package for R (R Development Core Team 2007), building 500 classification trees with three randomly sampled candidate variables evaluated at each split. Classification trees are nonparametric, hierarchical models that consist of a set of decision rules on the predictor variables, which recursively partition the data based on binary splits. The Random Forest algorithm was designed to produce accurate predictions that do not over fit the data (Breiman 2001). It develops multiple feasible models, which are then averaged to produce a more robust prediction.

Model performance

The performance of the SDMs was tested using the area under the curve (AUC) of receiver operating characteristic (ROC) plots, which test the ability of the model to discriminate between true presence locations of a bird against all other locations that were sampled (Phillips et al., 2006). An AUC score of 1 indicates perfect discrimination and a score of 0.5 indicates discrimination no better than random. In general, AUC scores between 0.7 and 0.8 are considered fair to good. AUC scores above 0.9 are considered excellent (Swets 1988). For each species a cross-validated mean AUC was calculated. The occurrence points were divided into 10 equal-sized groups and 10 successive models were run using nine of the groups and predictions were made to the one withheld group to calculate a predictive AUC. A final cross-validated mean AUC was calculated from the AUC from all 10 models. We only included threatened, endangered, or BSSC species if AUC > 0.80.

Creating presence/absence maps

The SDM output consists of maps of an index of habitat suitability for a species within each of the 800 x 800 m pixels, where the index value ranges from zero to one and where one equals high suitability. We created presence/absence maps from the SDM output in order to produce a species richness map that aggregated results for all 66 species. We applied a threshold to the suitability index map for each species in order to convert the index into a map showing presence and absence (e.g., if the suitability index was greater than the threshold value, then the species was considered to be present). There are different methods of applying thresholds, including many options available through the Maxent program. We selected a threshold method that minimizes the omission error for training occurrences. For each species, the chosen threshold was the minimum predicted suitability index value that would include all of the locations where a species was observed to be present (Pearson et al., 2007). This method is not as conservative as other threshold approaches and may slightly overestimate a species range, but we wanted to err on the side of including all potential areas that a given species might use. We also used these maps to determine the percent of a species range in California that fell within the DRECP boundary (see Appendix 1). These range calculations are approximations based on our threshold SDMs calculated at an 800 m resolution, and they only include the California portion of a bird's breeding range (many of the breeding ranges extend into Arizona, Nevada, or other states) but they are useful for comparing richness maps with priority setting analyses.

Priority setting analysis

We used the conservation planning software Zonation 2.0 (Moilanen 2007) to prioritize areas within the DRECP boundary for birds. Zonation iteratively removes pixels from the landscape, at each step minimizing the loss of habitat to all species under consideration based on their marginal value (see below). It creates a hierarchical ranking of conservation priorities in the landscape, rather than using a target-based planning reserve selection design where the outcomes are either in the reserve or out (e.g. finding a minimum area for representation of all species as in Marxan).

Here we use the core area Zonation removal rule where at each iteration of cell removal; the algorithm minimizes the loss of the species with the smallest proportion of its distribution remaining thereby retaining core areas for all species (Moilanen 2007). During each iteration, the algorithm determines the proportion of each species' distribution that would be lost by removing each remaining pixel in the landscape. The pixel chosen for removal results in the smallest loss for the species with the smallest proportion of its total distribution remaining, thereby conserving the core areas for all species across the landscape. The algorithm proceeds until all pixels have been removed from the landscape. The pixels which are removed last are considered as the highest conservation value. Zonation produces an output map which shows the order of cell removal, cells with low values were removed first and are considered as lower conservation priorities, cells with high values were removed last and will have the greatest conservation impact if they are lost from the conservation network.

We used the SDM outputs for the 66 bird species as inputs in the Zonation exercise. We conducted two Zonation analyses. In the first analysis, all species were weighted equally. In the second analysis, we weighted species according to their BSSC rankings and their status on federal and state endangered species lists. Species received a weight of 1 if they did not have any special status. Weights of 3, 4 and 5 were used for BSSC priority species 3, 2, and 1 respectively. A weight of 8 was given to species that are listed as threatened or endangered on

Federal or State endangered species lists. A weight of 10 was used for species that are listed as threatened or endangered on both Federal and State endangered species lists.

Study area

The boundary of the DRECP has changed over the past two years with various portions added or subtracted along the western edge. We used the boundary delineation as of June 2011 (as determined by DRECP Stakeholder groups) in our analyses. In order to better summarize and visualize our results we further divided the DRECP into subsections because the DRECP encompasses a wide range of ecoregions, including parts of the Sierra Nevada, as well as the Colorado, Sonoran, and Mojave deserts (Figure 2). We used the ecological sections determined by Miles et al. (1998) to calculate the number and percent cover of each ecological section that fell within the DRECP. These included the following five ecological sections: Sierra Nevada (2.2%), Southern California Mountains and Valleys (1.3%), Colorado Desert (10.7%), Sonoran Desert (13.5%), and the Mojave Desert (58.9%). Because such a large percent of the DRECP is Mojave Desert (58.9%), we further broke the Mojave into seven subareas (Owens Valley, Northern, Central, West, Eastern, South Central, and South Eastern Mojave; Figure 2). We based the boundaries of these subareas on aggregations of ecological subsections presented in Miles et al. (1998). Collectively, we refer to the seven Mojave subareas and the remaining four ecological sections as "subregions." We summarized our analysis results by these 11 subregions throughout the text.

We obtained geographic information system (GIS) polygons[4] characterizing the land ownership and protected area status based on categories developed by the DRECP[5]. 16 classes of land ownership have been identified in the DRECP region (Figure 2b). The federal government owns and manages 74% of the study region with management distributed among seven agencies; the National Park Service (16.9%), the U.S. Department of Agriculture Forest Service (0.1%), Bureau of Land Management (44%), U.S. Department of Defense (13%), U.S. Bureau of Reclamation (0.3%), U.S. Fish and Wildlife Service (<0.1%). California state agencies manage 3.2% of the study area; CA State Lands Commission (1.7%), CA Department of Parks and Recreation (1.3%), CA Department of Fish and Game (0.2%), University of CA (<0.1%), Santa Monica Mountains Conservancy (<0.1%). Other entities manage the remaining 22.4% of

[4] Data were downloaded from http://www.mojavedata.gov/mdep.html
[5] Draft DRECP Framework Conservation Strategy Report, http://www.drecp.org/documents/strategy/index.php

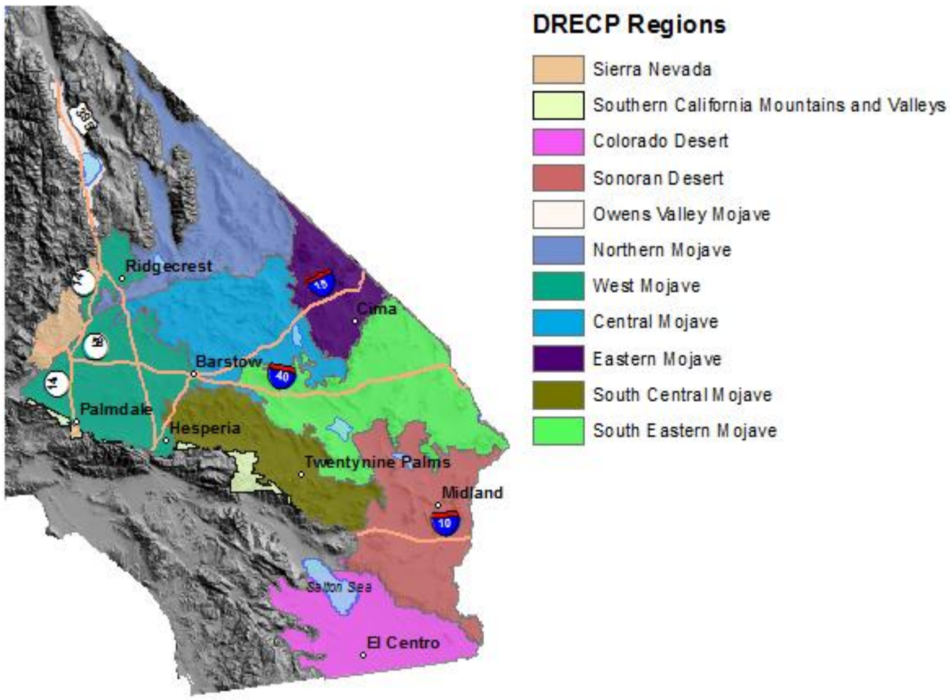
the planning area; Tribal lands (0.6%), Non-Profit/NGO (0.1%), Local jurisdictions (<0.1%), Private Lands (20.2%) and Municipal (1.4%).

Four categories of protected areas have been developed for the DRECP which take into account land ownership, designated land use and land management[6]. Type 1 areas are managed conservation lands which are protected in perpetuity; management primarily addresses ecological protection. Examples of Type 1 lands include federal or state wilderness areas. Type 2 areas are managed conservation or open space lands not protected in perpetuity; the main difference with Type 1 lands is that protection is not permanently designated. Examples of Type 2 lands include National Parks and monuments and public and private nature reserves. Type 3 areas are managed open space lands that do not have permanent protection and where ecological protection and management is one of several land uses but not the primary purpose of management. The majority of lands in the DRECP planning area are Type 3 lands; examples include most of the BLM lands and military installations. Type 4 lands are unprotected lands where there is no permanent designated protection and ecological protection and management are not an intended purpose. Examples of Type 4 lands include local jurisdictions, tribal lands and land managed by the CA State Lands Commission.

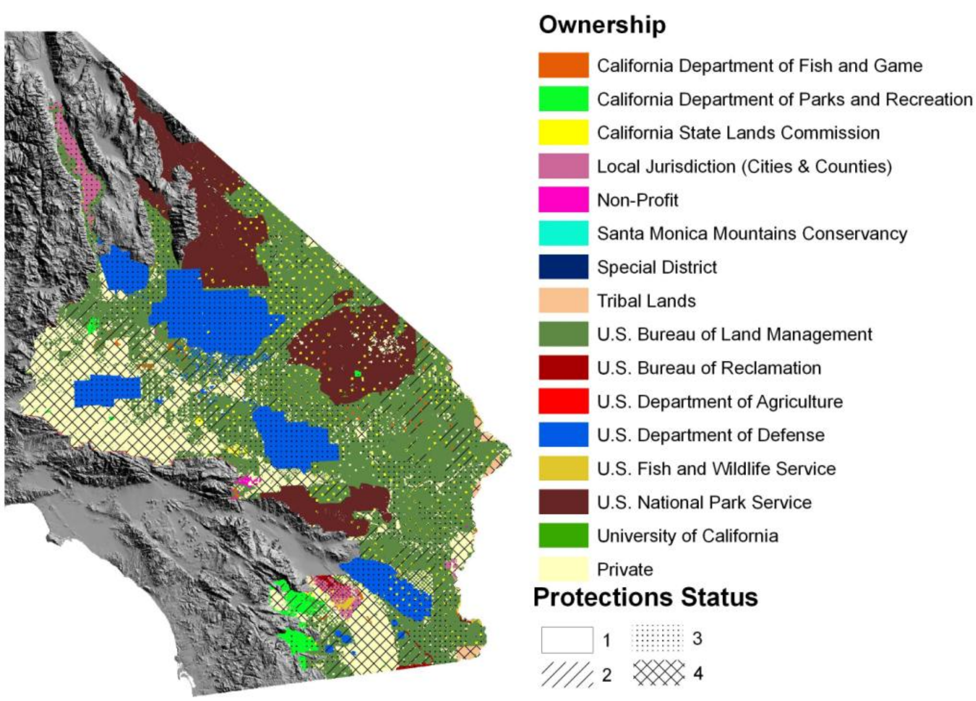
[6] See Draft DRECP Framework Conservation Strategy Report for more details, http://www.drecp.org/documents/strategy/index.php

Figure 2. DRECP subregions (a) and maps of landowners and protection status (b) used in this report with major roads and cities shown for reference.

(a)



(b)



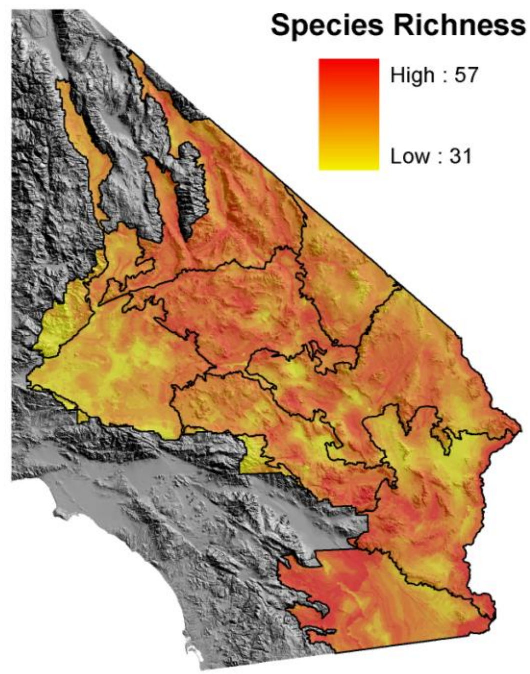
RESULTS

Species distribution models

All of the distribution models had fair to excellent AUC scores. There were 13 species with AUC values from 0.705 to 0.795 (Appendix 1) which is considered fair to good. All remaining models had AUC values greater than 0.80 indicating good to excellent model performance.

The distribution models for many of these species, including current and future distributions, as well as the projections for current and future climate and vegetation in California can be found at the following website (http://data.prbo.org/cadc/tools/ccweb2/).

Figure 3. Bird species richness for 66 desert associated species within the DRECP.



Species richness

We created species occurrence maps by establishing a threshold for a species presence or absence in each pixel and then combined all the individual species maps to determine species richness. Species richness as predicted by the SDMs varied across the DRECP (Figure 3). Richness ranged from a low of 31 species per pixel to a high of 57 species per pixel. There was no location in which all 66 were predicted to occur in the same geographic location. The highest levels of species richness occur in the Colorado Desert, Central Mojave, and Northern Mojave (Table 1). The Sierra Nevada and Southern California Mountains and Valleys had the lowest species richness; these two areas also had the greatest variation in richness likely because we selected desert associated species and these two areas lack substantial desert habitat. The greatest variance in richness within one of the desert areas occurred in the Sonoran Desert where richness was particularly high along the Salton Sea (northern edge of the Colorado Desert). In the Sonoran Desert, maximum richness equaled the highest richness values found in other locations within the DRECP.

Table 1. Mean avian species richness, standard deviation of richness, minimum richness, and maximum richness within the DRECP subregions. Subregions are listed from highest to lowest mean richness.

Subregion	mean	Std	min	max
Colorado Desert	50.62	2.89	43	57
Central Mojave	50.55	1.83	43	56
Northern Mojave	50.20	1.83	43	57
South Eastern Mojave	49.20	2.31	41	57
South Central Mojave	49.01	2.39	41	56
Sonoran Desert	48.96	3.24	41	57
Eastern Mojave	48.76	1.72	39	54
Owens Valley Mojave	47.69	1.10	42	52
West Mojave	47.04	2.44	35	56
Sierra Nevada	43.65	3.72	31	51
Southern California Mtns & Valleys	43.49	3.82	33	51

We also used the species occurrence maps to calculate the percent of a species breeding range within California that fell within the DRECP boundary (Appendix 1; summarized in Table 2). For a handful of species almost their entire California breeding range falls within the DRECP (Table 2; Appendix 1). The Gila Woodpecker (see Appendix 1 for scientific names) had over 99% of its range within the DRECP boundary and 20 species have over 50% of their breeding range within the DRECP. The two species we considered with the smallest portion of their California breeding range within the DRECP were the Blue-gray Gnatcatcher (12.68%; an oak woodland habitat focal species) and the Black-chinned Sparrow (18.41%; a scrub habitat focal species).

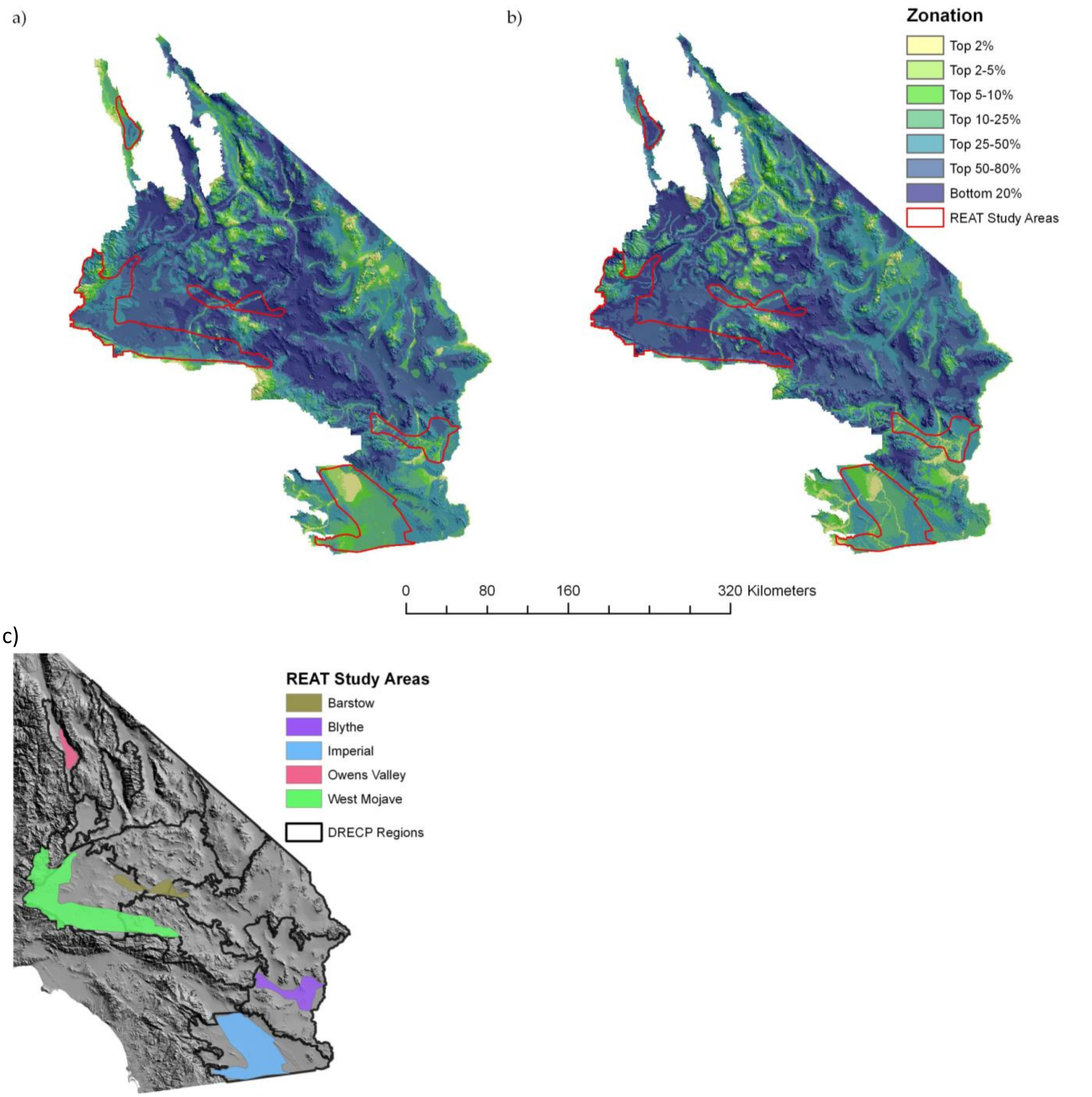
Table 2. Summary of the percent of a species range within the DRECP boundary for the 66 species included in our analyses.

Percent of range in DRECP	Number of species
0-10	0
>10-20	2
>20-30	25
>30-40	13
>40-50	6
>50-60	4
>60-70	8
>70-80	1
>80-90	6
>90-100	1

Priority setting analysis

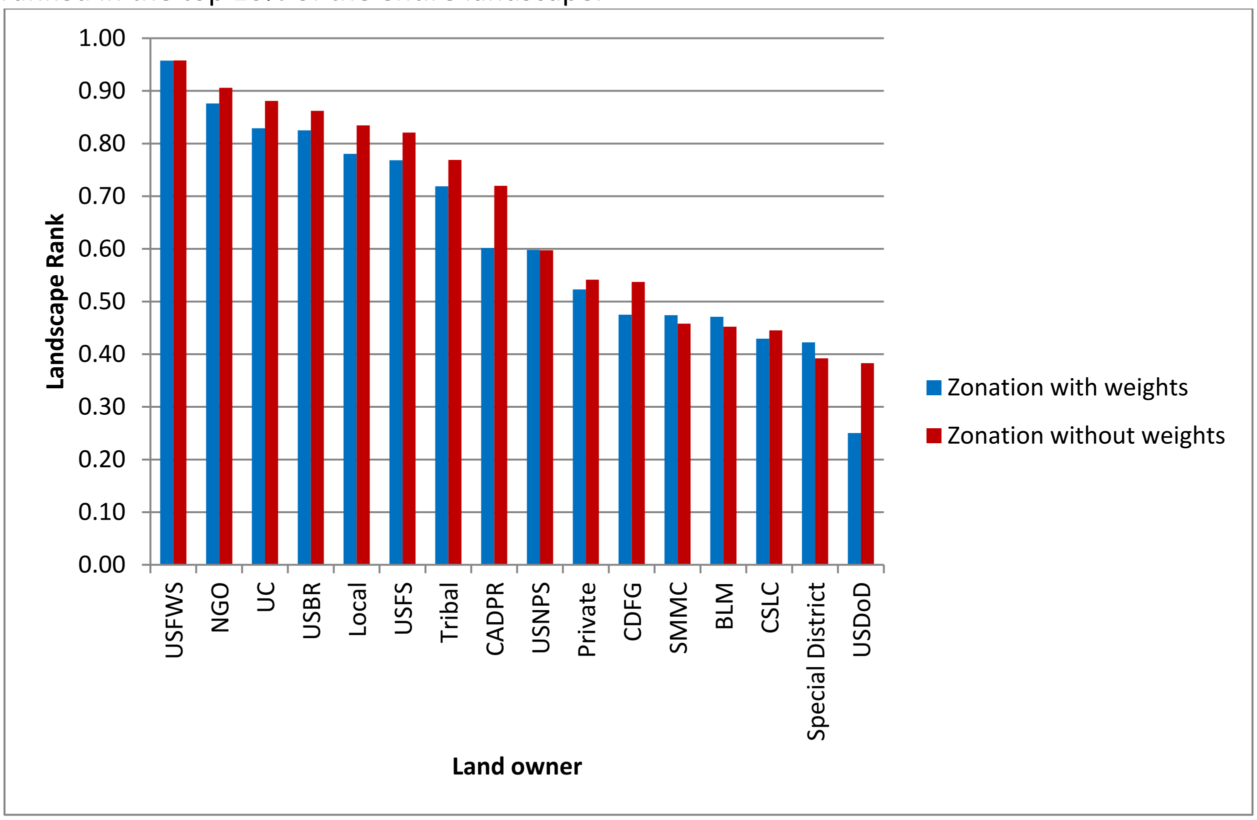
The Zonation analysis indicates the priority areas in the landscape in order to conserve the 66 bird species. The priority areas determined by the Zonation analysis varied when species were not weighted (Figure 4a) versus weighted by their classification as threatened, endangered, or a bird species of special concern (Figure 4b). For example, the Owens Valley Mojave subregion contains areas ranked as the top 10% of the landscape when species are not weighted (Figure 4a). However, when species are weighted this area falls into the bottom 50% of the landscape in terms of priority areas for birds (Figure 4b). By overlaying the Renewable Energy Action Team study areas, we can identify priority conservation areas within each study area where developments should be avoided (Figure 4c).

Figure 4. Zonation results for analysis a) without species weighting and b) with species weighting showing the areas that are most important to birds in the landscape (e.g. the top 2% of the landscape for birds). The DRECP Renewable Energy Action Team (REAT) study areas are shown with labels for reference c).



We summarized the mean Zonation rankings by broad classes of landownership. Lands owned by the United States Fish and Wildlife Service (USFWS) have the highest ranked areas in both the weighted and un-weighted Zonation analysis with an average value of USFWS lands in the top 10% of the DRECP region (Figure 5). The lowest priority areas for desert bird species were found on United States Department of Defense Lands (Figure 5). We found that privately owned lands are generally ranked to have lower conservation value.

Figure 5. The mean values of Zonation rankings summarized by land ownership are shown for the Zonation analyses with and without weighting. Land ownership was summarized for United States Fish and Wildlife Service (USFWS), United States Bureau of Reclamation (USBR), California Department of Parks and Recreation (CDPR), Tribal, University of California (UC), non-governmental organizations (NGO), United States Department of Agriculture (USDA), United States National Park Service (USNPS), county or city owned (Local), California Department of Fish and Game (CDFG), Santa Monica Mountain Conservancy (SMMC), Bureau of Land Management (BLM), privately owned, California State Lands Commission (CASLC), Special Districts and the United States Department of Defense (USDoD). Higher values are considered to have higher conservation priority, i.e. a value of 0.9 means that the area is ranked in the top 10% of the entire landscape.

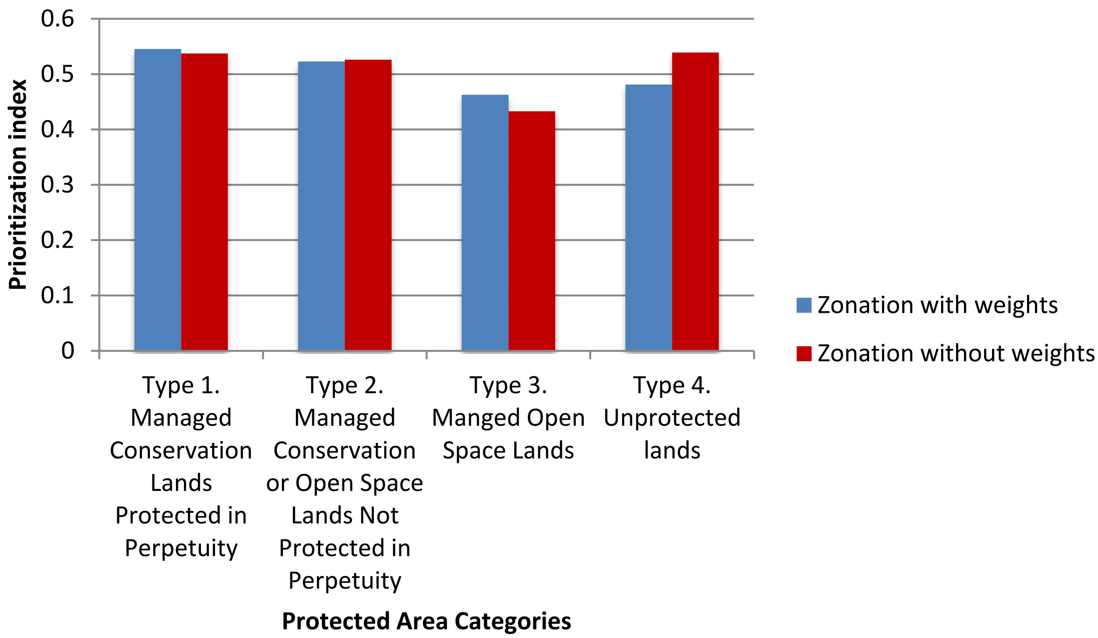


We summarized the Zonation rankings by DRECP protected area categories (Figure 2b, DRECP 2011[7]) by creating a prioritization index which was calculated by taking an area weighted sum of all rankings with each category of protected areas. We found that Type 3 protected areas (managed open space lands) contained the lowest prioritization index among the protected area categories (Figure 6). We also found little difference between the

[7] Draft DRECP Framework Conservation Strategy Report, http://www.drecp.org/documents/strategy/index.php

prioritization index values for the Type 1, 2 and 4 protected area categories, except for the Zonation analysis with weights where unprotected lands had lower values than Type 1 or Type 2 categories (Figure 6). These results indicate that there are conservation opportunities in unprotected areas which are of equal value to areas within protected areas.

Figure 6. Conservation prioritization index summarized by protected area categories used in the desert renewable energy conservation plan. The prioritization index is an area weighted sum of the Zonation landscape rankings within all polygons of a protected area category. Higher values mean higher conservation value per unit area.



We also used the area weighted prioritization index to summarize the Zonation rankings by the proposed DRECP Renewable Energy Action Team (REAT) study area polygons. We found that the Imperial study area has the highest area weighted sum for the Zonation analysis with weights and without (Table 3, Figure 9) signifying that renewable energy projects in this study area could have a significant negative effect on the conservation of birds. The Barstow and West Mojave study areas have the lowest Zonation rankings based on the area weighted index which indicates that these study areas would have the least conflict between the conservation of birds and renewable energy projects. We found the greatest difference in rankings between the Zonation analyses with weights and without in the Owens Valley study area suggesting that effects of renewable energy projects in this area may have a greater impact on non-special status species.

Table 3. The area weighted sum of Zonation rankings within Renewable Energy Action Team study areas. Individual study areas were ranked from lowest area weighted sum to highest. Higher values indicate study areas with containing a greater amount of priority conservation areas per unit area.

	No weighting		Weighting	
REAT Study Area	Sum/Count	Rank	Sum/count	Rank
Barstow	0.25	1	0.42	3
West Mojave	0.49	2	0.29	1
Blythe	0.65	3	0.74	4
Owens Valley	0.71	4	0.33	2
Imperial	0.84	5	0.81	5

High priority areas for birds

We quantified where priority areas occurred by DRECP subregion using (1) the top 5% of the landscape, (2) the next 5% of the landscape (top 5-10%), and (3) both of these areas combined (overall top 10%) using both Zonation runs (with and without weighting; Table 4, Figure 7). In each of these cases there is a fixed amount of priority area that represents a certain top percent of the landscape (e.g., the top 10% of the landscape is equal to 90,938 km^2) and we wanted to know which subregions held the greatest amount of these priority areas. In all three cases, the Colorado Desert had the greatest percentage of priority areas followed by the Northern Mojave (regardless of weighting). These two subregions held 36.8% (no weighting) to 48.1% (weighting) of the priority areas that included the top 5% of the landscape; 41.3% (no weighting) to 45.8% (weighting) of the priority areas that included the top 5-10% of the landscape; and 39.0% (no weighting) to 47.0% (weighting) of the priority areas that included the cumulative top 10% of the landscape.

The next most important subregions for containing priority areas were the Sonoran Desert, South Eastern Mojave, and Central Mojave. These three subregions held 31.7% (no weighting) to 41.9% (weighting) of the priority areas that included the top 5% of the landscape; 31.2% (no weighting) to 38.8% (weighting) of the priority areas that included the top 5-10% of the landscape; and 31.4% (no weighting) to 40.3% (weighting) of the priority areas that included the cumulative top 10% of the landscape.

We examined which subregions in the landscape were most affected, in terms of the percent of priority areas they held by the weighting scheme we employed (Table 4). For the cumulative top 10% of the landscape, the weighting scheme caused the greatest change on whether priorities areas fell within the Central Mojave (9.2% increase due to weighting), Owens Valley (6.7% decrease), South Eastern Mojave (6.5% decrease), or the Sonoran Desert (6.2% increase). This suggests that there are more sensitive species in the Central Mojave and Sonoran Desert (relative to non-sensitive species); similarly there are fewer sensitive species in the Owens Valley and South Eastern Mojave (relative to non-sensitive species).

Figure 7. Location of high priority areas from Zonation for the top 5% and top 6-10% of the landscape within the DRECP for a) non-weighted and b) weighted analyses.

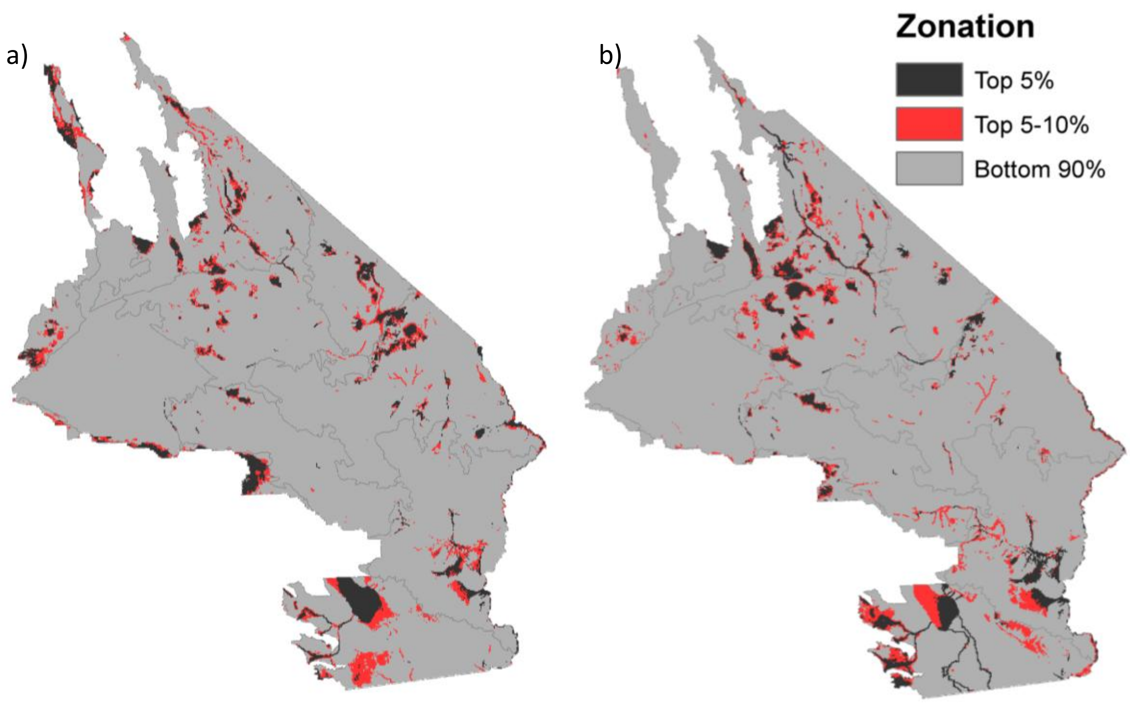


Table 4. The percent of high priority areas falling within each subregion and the corresponding importance ranking where priority areas were determined without species weighting and with species weighting. Change indicates the difference between weighting and non-weighting scenarios; rank change is based on the absolute value of change. Priority areas were determined for a) the top 5% of the landscape, b) the top 5-10%, and c) the cumulative top 10% (both a) and b) combined).

a) Top 0-5% of landscape

	No weighting		Weighting		Change	
Subregion	%	rank	%	rank	%	rank
Sierra Nevada	3.6%	9	0.7%	10	-2.8%	9
So. Calif. Mtns & Valleys	8.1%	5	2.4%	7	-5.7%	6
Colorado Desert	21.6%	1	25.5%	1	4.0%	8
Sonoran Desert	10.4%	4	18.1%	3	7.7%	3
Owens Valley Mojave	6.9%	7	0.0%	11	-6.9%	5
Northern Mojave	15.2%	2	22.6%	2	7.4%	4
West Mojave	3.5%	10	0.9%	9	-2.6%	10
Central Mojave	6.1%	8	16.7%	4	10.6%	1
Eastern Mojave	7.3%	6	2.1%	8	-5.2%	7
South Central Mojave	2.2%	11	3.8%	6	1.6%	11
South Eastern Mojave	15.1%	3	7.1%	5	-8.0%	2

b) Top 5-10% of landscape

	No weighting		Weighting		Change	
Subregion	%	rank	%	rank	%	rank
Sierra Nevada	5.0%	8	3.2%	7	-1.8%	8
So. Calif. Mtns & Valleys	4.1%	9	2.4%	8	-1.8%	9
Colorado Desert	24.0%	1	27.6%	1	3.5%	7
Sonoran Desert	10.6%	4	15.4%	4	4.8%	5
Owens Valley Mojave	6.9%	7	0.4%	11	-6.5%	2
Northern Mojave	17.3%	2	18.3%	2	1.0%	10
West Mojave	2.7%	10	1.8%	10	-0.9%	11
Central Mojave	8.5%	5	16.3%	3	7.8%	1
Eastern Mojave	7.0%	6	2.1%	9	-5.0%	4
South Central Mojave	1.7%	11	5.6%	6	3.9%	6
South Eastern Mojave	12.1%	3	7.1%	5	-5.0%	3

c) Top 0-10% of landscape

	No weighting		Weighting		Change	
Subregion	%	rank	%	rank	%	rank
Sierra Nevada	4.3%	9	2.0%	9	-2.3%	10
So. Calif. Mtns & Valleys	6.1%	8	2.4%	7	-3.7%	8
Colorado Desert	22.8%	1	26.5%	1	3.7%	7
Sonoran Desert	10.5%	4	16.7%	3	6.2%	4
Owens Valley Mojave	6.9%	7	0.2%	11	-6.7%	2
Northern Mojave	16.2%	2	20.4%	2	4.2%	6
West Mojave	3.1%	10	1.4%	10	-1.7%	11
Central Mojave	7.3%	5	16.5%	4	9.2%	1
Eastern Mojave	7.2%	6	2.1%	8	-5.1%	5
South Central Mojave	2.0%	11	4.7%	6	2.7%	9
South Eastern Mojave	13.6%	3	7.1%	5	-6.5%	3

Low priority areas for birds

We determined the least important areas in the landscape for the suite of birds using (1) the bottom 2% of the landscape, (2) the bottom 2-5% of the landscape, and (3) the bottom 5-10% of the landscape (Figure 8a & b) for both Zonation runs (with and without weighting). We then combined the outputs from the bottom 10% of the non-weighted and weighted outputs to determine the overlap. The overlap indicates areas that are considered the bottom lowest 10% of the landscape by both weighting scenarios (Figure 8c). There was a total of 2,516 km^2 in the overlap, of which >70% occurred in the following subregions: Central Mojave, South Eastern Mojave, and South Central Mojave (Table 5). There was no overlap in the following subregions: Sierra Nevada, Southern California Mountains and Valleys, Colorado Desert, and Owens Valley Mojave.

Figure 8. Location of low-priority areas in the landscape from Zonation analyses in the DRECP boundary for a) non-weighted analyses (showing bottom 2%, 2-5%, and 5-10% of the landscape), b) weighted analyses (bottom 2%, 2-5%, and 5-10% of the landscape), and c) areas of overlap for weighted and non-weighted analyses. The areas of overlap included the bottom 10% of the landscape (see text).

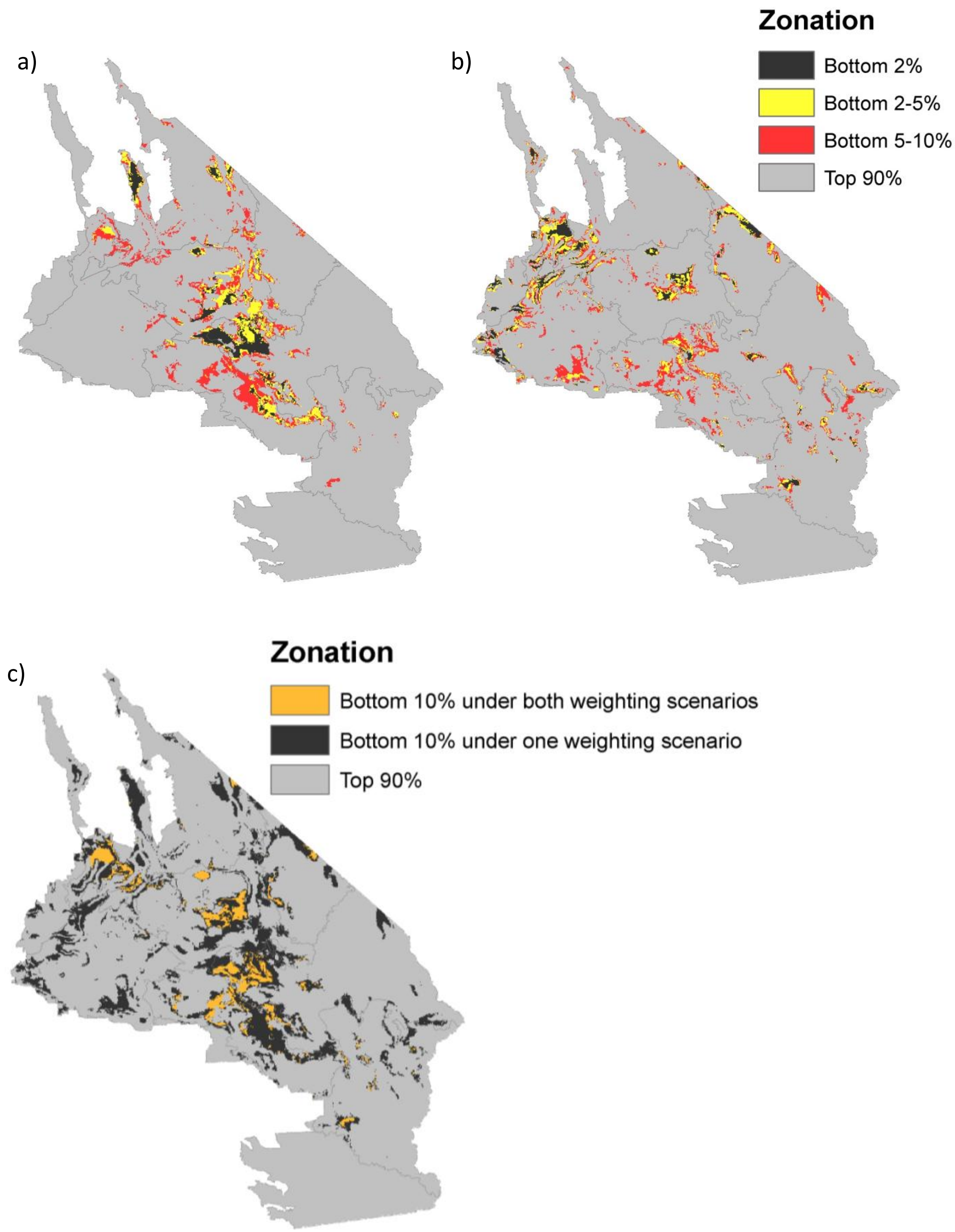
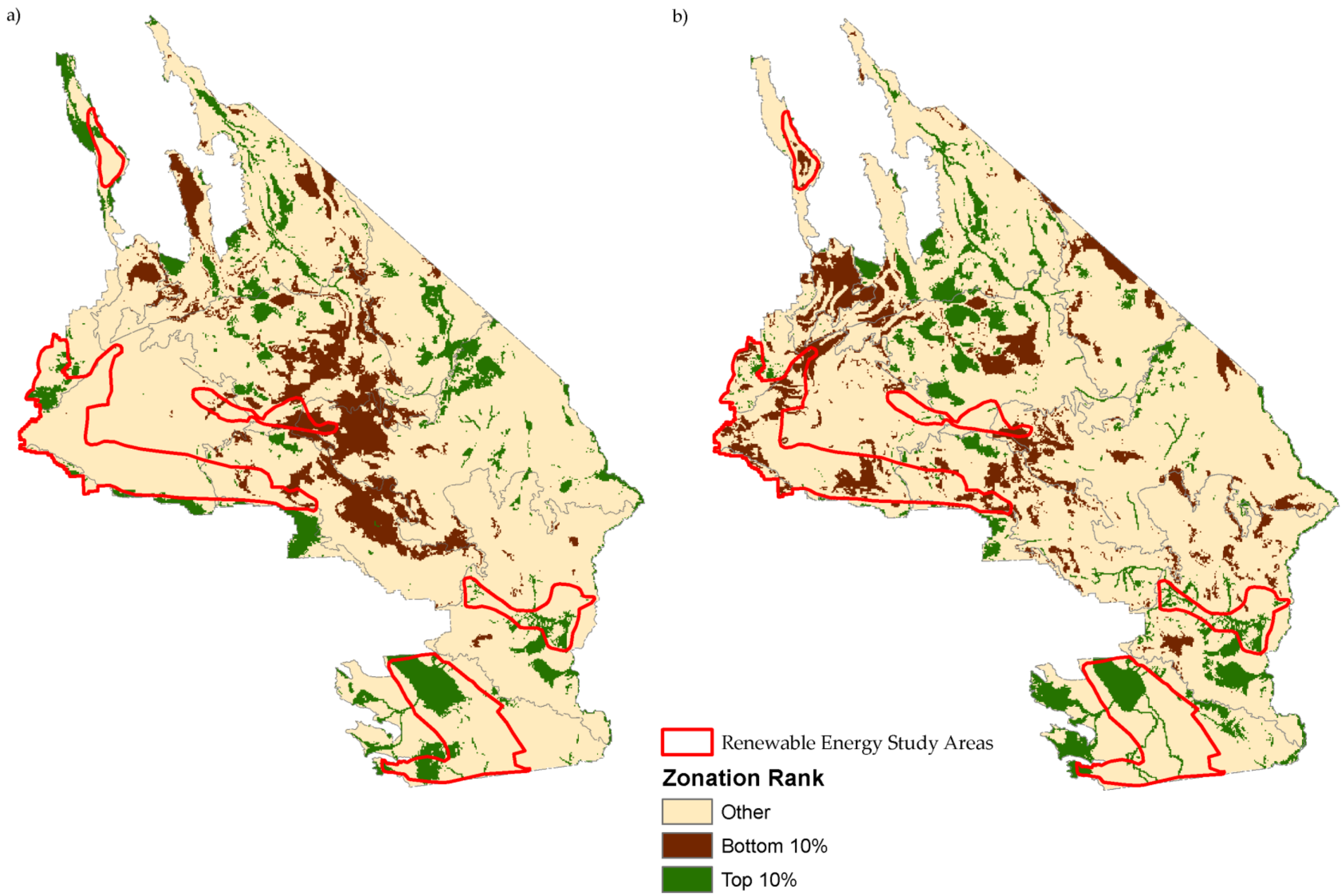


Table 5. The percent of low-priority areas falling within each subregion and their rank.

Subregion	%	Rank
Central Mojave	27.9%	1
South Eastern Mojave	23.5%	2
South Central Mojave	20.5%	3
West Mojave	14.0%	4
Northern Mojave	6.0%	5
Sonoran Desert	4.1%	6
Eastern Mojave	4.0%	7
Sierra Nevada	0%	8
So. Calif Mtns & Valleys	0%	8
Colorado Desert	0%	8
Owens Valley Mojave	0%	8

Figure 9. The top and bottom 10% of the landscape prioritization rankings without species weights (a) and with species weights (b) in relation to the Renewable Energy Action Team study areas.



DISCUSSION

High priority areas

Our Zonation analyses rank areas based on their importance to the suite of bird species that we considered within the DRECP planning area. These high priority areas should be avoided when siting new installations or considering other forms of developments. The high priority areas also indicate ideal areas to target as mitigation for future installations. We used the top 10% of the landscape in terms of its importance for birds as our criteria for selecting the high priority areas. The maximum ground disturbance proposed in the DRECP would result in 5% of the study area being impacted. Thus choosing the 10% as our threshold enables a 2:1 mitigation to disturbance ratio for the maximum proposed ground disturbance. However, using Zonation it is also possible to consider other percentages of the landscape when determining priority areas depending on the conservation planning scenario or target (e.g., determining the top 25% of the landscape). The top 10% of the landscape is a fixed amount of area that falls into every subregion that we considered suggesting that there are important areas for birds throughout the DRECP planning area. A high percentage of the high priority areas occur within the Colorado Desert and Northern Mojave; however, every subregion contains high priority areas and hence every subregion is valuable to birds (Table 3).

Effect of species weighting

We considered two weighting schemes in our Zonation analyses. While many priority setting analyses tend to focus on sensitive species because of the associated regulatory compliance, we felt it was important to also include a broader array of species that breed in the habitat, including more common species and focal species. By considering two weighting schemes we were able to determine how the results compared in each subregion when sensitive species had greater weighting and we found that weighting affects which priority areas are selected in every subregion. Our results indicate that, in terms of conservation planning, choosing sensitive species is not adequate to capture the priority areas for the breeding bird community in the DRECP boundary. Similarly, planning that excluded sensitive species would not capture the requirements of the sensitive species.

The weighting analysis also highlights subregions with the greatest disparity between their importance for sensitive species and common species (the subregions that had the biggest percent change between the two Zonation runs; Table 4). It is apparent that some subregions are more important to sensitive species relative to non-sensitive species. For example, a larger percentage of high priority areas fell in the Central Mojave under the weighted scheme than the unweighted schemed suggesting that it is more important for sensitive species than non-sensitive species. The Central Mojave subregion also had the greatest disparity between the two weighting schemes. The Owens Valley and South Eastern Mojave subregions had the opposite pattern with a greater number of priority areas for non-sensitive species.

Low priority areas

Zonation can be also used to identify the low priority areas for the suite of bird species that we considered within the DRECP planning area. These low priority areas should be considered first for siting solar installations to minimize impacts on breeding birds as the loss of these areas would result in the smallest decreases in suitable habitat for all of the species we considered. We examined the bottom 10% of the landscape in term of its importance to birds under both weighting schemes. Similar to the high priority areas, we found that the location of low priority areas varied between the unweighted and weighted model runs (Figure 8a and 8b). We then identified areas that overlapped between the two weighting schemes as these areas are low priority areas under both weighting schemes. The overlap area is approximately 2.8% of the area of the DRECP. The majority (>70%) of the low priority areas occurred in the following subregions: Central Mojave, South Eastern Mojave, and South Central Mojave.

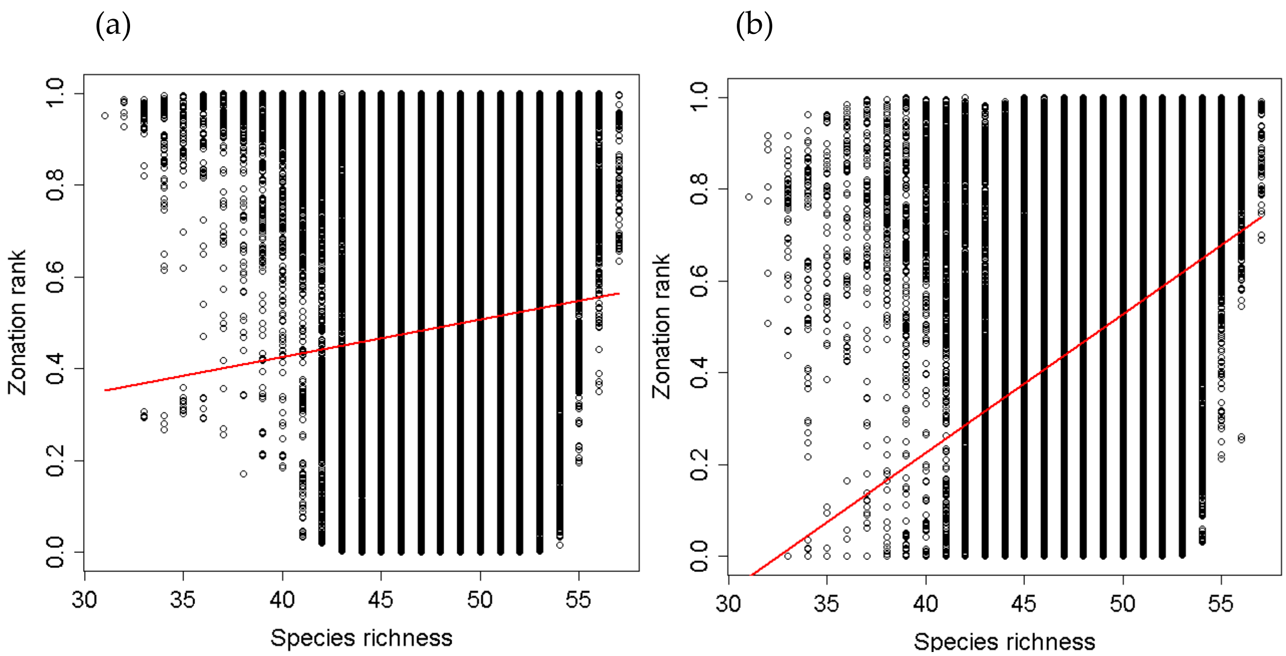
It should be noted that just because a subregion contains low-priority areas does not mean that the entire subregion should be considered low-priority. For example the South Eastern Mojave contained 23.5% of the low priority areas (Table 5) which ranked second among subregions containing low priority areas, but it also ranked third (unweighted) or fifth (weighted) in its importance for high priority areas (based on top 10% of the landscape; Table 4). There were four subregions that did not have any low-priority areas: Sierra Nevada, Southern California Mountains and Valleys, Colorado Desert, and Owens Valley Mojave (Table 5).

Species richness

The Maxent outputs from the species distribution models produce a value between zero and one for each pixel. Higher values indicate that the environmental conditions are more suitable for a bird species. We wanted to create species richness maps in order to compare richness with the Zonation results so we converted the Maxent output into presence/absence maps using a threshold value. The species richness map for the 66 species indicate that richness ranged from 31 to 57 species (Figure 3) which indicates that not all species occur in every location and that there is not one location with all 66 species. The maximum of 57 species in one location (and in multiple subregions) seems a bit high (PRBO expert opinion). The Maxent models project where suitable environmental conditions occur but do not explicitly account for biological processes such as competition that could prevent a species from occupying a site even though environmental conditions are suitable. Additionally, there is currently little scientific guidance on the most appropriate method for choosing a threshold for creating binary maps from the continuous output from presence-only distribution models. It is therefore also possible that a more conservative threshold would have resulted in a lower maximum value of species richness.

One benefit of using Maxent output in the Zonation analysis is that Zonation does not need to convert the continuous Maxent output to a binary grid using a specific threshold and hence uses all possible information. In addition, Zonation considers the entire spatial distribution of all species across the landscape when ranking a pixel. So, although a pixel may have low species richness, it may be ranked highly by Zonation if it contains important habitat for one or a few species. Although we found that species richness was highly correlated with Zonation rankings (Figure 10), basing conservation rankings purely on species richness would exclude important habitat identified by the Zonation analysis, particularly when species weights were not included (Figure 10a).

Figure 10. Linear regression of predictions of species richness vs. Zonation prioritization of breeding bird distributions without using species weights (a) and with species weights (b). The regression in both plots is highly significant (p<0.01) but only explains 1% and 9% of the variation in the scatter plots respectively.



Despite the differences between the results for our species richness maps and Zonation analyses, we still see some noteworthy agreement between them. Both Zonation and the richness maps rank the following subregions in the top five: Colorado Desert, Central Mojave, Northern Mojave, and South Eastern Mojave. Sierra Nevada and Southern California Mountains and Valleys rank in the bottom two for richness and rank 7th-9th in the Zonation (depending on weighting schemes). These latter two subregions occupy relatively small portions of the DRECP and likely lack significant desert habitat. As we were targeting breeding desert bird species in our analyses, it is not surprising that these areas show overall low species richness. It should also be noted that just because an area has low species richness, or a low Zonation rank, does not mean it is not worthwhile habitat for birds. Even the areas with "lowest" richness supported over 30 bird species.

Important considerations

The high and low priority areas that we identified apply only to the 66 breeding bird species that we considered within the geographic area (DRECP boundary) of our analysis. Further analyses are warranted in order to include the non-breeding bird species as well as non-avian taxa. Such analyses will highlight whether an area that is of low importance to birds might be of high importance to other special status species such as the desert tortoise (*Gopherus agassizii*) or other more common species.

There were 11 bird species that we wanted to include in our analyses, but we could not because there was not sufficient data available to produce a reliable species distribution model (Appendix 2). Although Maxent has been shown to have superior predictive power with low sample size compared to other modeling algorithms (Wisz et al. 2008), models with less than 25 records may have poorer predictive accuracy (Hernandez et al. 2006). Moreover, the predictive accuracy of models among different species has been shown to become less consistent as sample size decreases particularly, with sample sizes less than 30 (Hernadez et. al. 2006, Wisz et al. 2008). We generally created species distribution models for species with greater than 30 records. In some cases, we modeled species with fewer records if we found that the modeled range corresponded with the known range map and if the model performance was high.

If sufficient data are not available to create a species distribution model using standard approaches, bootstrapped models utilizing the available data for species with low occurrences could be included in the Zonation analysis while using the uncertainty from the bootstrapped predictions to downweight cells with high uncertainty (Moilanen et al. 2006). Alternately, other approaches could be considered to produce a probability surface for that species based on known associations with habitat associations or some other approach that is thoroughly documented. The probability surface could then be included in the Zonation analyses.

Future analyses

Future Zonation analyses could be conducted to quantify the biological cost of actual proposed renewable energy projects and their alternatives (Cabeza and Moilanen 2006). Additionally, projected changes in species distributions within the DCREP area due to climate change ought to be considered as part of a more comprehensive Zonation analysis (Caroll et al. 2010).

As indicated in the previous section, it would be highly desirable to consider additional bird species (e.g., wintering birds), as well as non-avian taxa. While we lacked immediate access to such data because our approach built upon our previous modeling work with breeding birds, it is certainly possible to obtain data for additional species from a range of taxa. Future Zonation analyses could include weighting based on a species' sensitivity, as well as based on taxonomic status (e.g., to determine the relative importance of an area for birds versus for mammals). Similarly, future Zonation runs could evaluate the impacts of alternative solar siting and mitigation proposals as well as incorporating the needs of various stakeholders in an iterative process. These types of analyses would be highly beneficial in determining the relative importance of different areas in the landscape to sensitive versus non-sensitive species, as well as among organisms that vary in their sensitivity. These results would be highly desirable in order to make solar siting and mitigation decisions that have the least possible impact on wildlife and to better understand tradeoffs among different siting scenarios.

Conclusion

We conducted a priority setting analysis within the Desert Renewable Energy Conservation Plan (DRECP) planning area to determine areas of high and low value to a suite of 66 breeding birds which included "sensitive" species (i.e., threatened, endangered, or Bird Species of Special Concern) and more common species that collectively represent a range of ecological attributes. Our approach provides an important example of how to rigorously conduct a priority setting conservation planning exercise within the DRECP planning area. The high priority areas we identified should be avoided for solar siting and development. These areas should also be sought out for mitigation or land protection opportunities to benefit birds. The low priority areas that we identified should be considered first for renewable energy development to minimize impacts on breeding birds as the loss of these areas would result in the smallest decreases in suitable habitat for all of the species we considered. The priority setting results varied when we gave greater weight to sensitive species than to non-sensitive species which indicates that limiting analyses to sensitive bird species is not adequate to capture the breeding bird priority areas in the DRECP planning area. We recommend priority be given to areas of overlap between the weighted and non-weighted results. Future analyses should consider the inclusion of the non-breeding range of bird species, as well as non-avian taxa.

Acknowledgments

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Appendix 1. List of bird species included in analysis with common and scientific names. DRECP range refers to the percent of the species range in California that falls within the DRECP planning area. Sensitive status indicates whether the species is federally endangered (FE), federally threatened (FT), state endangered in California (SE), state threatened in California (ST), or a Bird Species of Special Concern in California (BSSC, Shuford and Gardali 2008). Focal species indicates whether the species is considered a focal species within the bird conservation plans for the following habitats: desert, oak, riparian, scrub, and sagebrush (Chase and Geupel 2005; CalPIF 2009). Zonation weight is the weighting value based on their status that was use in the weighted analysis (see text). The number of records is the number of 800-m pixels within California where the species was detected (see text). AUC indicates the area under the receiver operating curve statistic from the species distribution model for that species.

Common Name	Scientific Name	DRECP range	Sensitive status	Focal species	Zonation weight	Number records	AUC
Abert's Towhee	*Pipilo aberti*	92.96			1	86	0.994
Anna's Hummingbird	*Calypte anna*	22.57			1	4662	0.755
Ash-throated Flycatcher	*Myiarchus cinerascens*	22.47		oak, desert	1	3500	0.783
Bell's Vireo	*Vireo bellii*	40.37	FE	riparian	10	213	0.971
Bendire's Thrasher	*Toxostoma bendirei*	73.59	BSSC	desert	3	50	0.991
Bewick's Wren	*Thryomanes bewickii*	20.59			1	3928	0.757
Black Skimmer	*Rynchops niger*	62.37	BSSC		3	55	0.803
Black-chinned Sparrow	*Spizella atrogularis*	18.41		scrub	1	182	0.945
Black-tailed Gnatcatcher	*Polioptila melanura*	38.65		desert	1	378	0.997
Black-throated Sparrow	*Amphispiza bilineata*	51.97		desert	1	702	0.967
Blue Grosbeak	*Passerina caerulea*	28.27		riparian	1	653	0.911
Blue-gray Gnatcatcher	*Polioptila caerulea*	12.68		oak	1	791	0.845
Brown Pelican	*Pelecanus occidentalis*	58.23			1	79	0.972
Brown-crested Flycatcher	*Myiarchus tyrannulus*	37.33			1	14	0.936
Bullock's Oriole	*Icterus bullockii*	22.57			1	3097	0.74
Burrowing Owl	*Athene cunicularia*	28.71	BSSC	desert	4	677	0.919
Cactus Wren	*Campylorhynchus brunneicapillus*	31.88		scrub	1	404	0.96
California Quail	*Callipepla californica*	20.11			1	4485	0.738
Canyon Wren	*Catherpes mexicanus*	20.78			1	262	0.851
Chukar	*Alectoris chukar*	45.30			1	53	0.965
Common	*Columbina*	47.13			1	64	0.985

Common Name	Scientific Name	DRECP range	Sensitive status	Focal species	Zonation weight	Number records	AUC
Ground-Dove	*passerina*						
Common Poorwill	*Phalaenoptilus nuttallii*	22.54			1	216	0.804
Cooper's Hawk	*Accipiter cooperii*	21.52			1	1148	0.81
Costa's Hummingbird	*Calypte costae*	32.15		desert, scrub	1	540	0.923
Crissal Thrasher	*Toxostoma crissale*	91.92	BSSC	desert	3	109	0.988
Gambel's Quail	*Callipepla gambelii*	69.16			1	393	0.978
Gila Woodpecker	*Melanerpes uropygialis*	99.36	SE	desert	8	64	0.996
Golden Eagle	*Aquila chrysaetos*	22.11			1	436	0.763
Gray Flycatcher	*Empidonax wrightii*	37.17		sagebrush	1	313	0.971
Gray Vireo	*Vireo vicinior*	37.73	BSSC	scrub	4	28	0.989
Great Horned Owl	*Bubo virginianus*	23.10			1	834	0.722
Greater Roadrunner	*Geococcyx californianus*	35.83		scrub	1	345	0.922
Great-tailed Grackle	*Quiscalus mexicanus*	91.99			1	196	0.992
Gull-billed Tern	*Sterna nilotica*	80.99	BSSC		3	34	0.997
Hooded Oriole	*Icterus cucullatus*	38.51			1	803	0.92
Horned Lark	*Eremophila alpestris*	23.82			1	1119	0.85
House Finch	*Carpodacus mexicanus*	23.17			1	6446	0.724
Inyo California Towhee	*Pipilo crissalis*	60.48	FT		10	34	0.999
Juniper Titmouse	*Baeolophus griseus*	58.73		sagebrush	1	19	0.97
Ladder-backed Woodpecker	*Picoides scalaris*	62.97		desert	1	250	0.968
Le Conte's Thrasher	*Toxostoma lecontei*	66.58		desert	1	238	0.975
Lesser Goldfinch	*Carduelis psaltria*	22.89			1	4868	0.731
Lesser Nighthawk	*Chordeiles acutipennis*	45.49		scrub	1	217	0.945
Loggerhead Shrike	*Lanius ludovicianus*	46.91	BSSC	sagebrush	4	1097	0.876
Long-eared Owl	*Asio otus*	42.37	BSSC		3	62	0.856
Lucy's Warbler	*Vermivora luciae*	90.87	BSSC	desert	3	77	0.996
Marbled Godwit	*Limosa fedoa*	61.53			1	127	0.985
Mourning Dove	*Zenaida macroura*	23.31			1	6899	0.705
Phainopepla	*Phainopepla nitens*	31.76		desert	1	800	0.903
Pinyon Jay	*Gymnorhinus cyanocephalus*	36.27			1	177	0.975

Common Name	Scientific Name	DRECP range	Sensitive status	Focal species	Zonation weight	Number records	AUC
Prairie Falcon	*Falco mexicanus*	27.58			1	313	0.883
Rock Wren	*Salpinctes obsoletus*	23.23			1	822	0.878
Sage Sparrow	*Amphispiza belli*	22.86		sagebrush, scrub	1	418	0.935
Say's Phoebe	*Sayornis saya*	32.41			1	462	0.937
Scott's Oriole	*Icterus parisorum*	38.09		desert	1	101	0.974
Snowy Plover (interior population)	*Charadrius alexandrinus*	61.11	BSSC		3	96	0.964
Song Sparrow	*Melospiza melodia*	20.39		riparian	1	4709	0.725
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	21.08	FE	riparian	10	37	0.941
Turkey Vulture	*Cathartes aura*	22.83			1	4227	0.725
Verdin	*Auriparus flaviceps*	66.84		desert	1	427	0.978
Western Kingbird	*Tyrannus verticalis*	24.92			1	3229	0.795
Western Yellow-billed Cuckoo	*Coccyzus americanus*	38.65	SE	riparian	8	74	0.855
White-throated Swift	*Aeronautes saxatalis*	23.15			1	1039	0.815
White-winged Dove	*Zenaida asiatica*	50.21			1	286	0.986
Yellow-breasted Chat	*Icteria virens*	23.15	BSSC	riparian	3	947	0.87
Yellow-footed Gull	*Larus livens*	93.33			1	16	0.996

Appendix 2. Species that were not modeled due to data limitations or other factors (see text).

Common Name	Scientific Name
Bald Eagle	*Haliaeetus leucocephalus*
Black Rail (California)	*Laterallus jamaicensis coturniculus*
California Condor	*Gymnogyps californianus*
Clapper Rail (Yuma)	*Rallus longirostris yumanensis*
Elf Owl	*Micrathene whitneyi*
Pectoral Sandpiper	*Calidris melanotos*
Short-eared Owl	*Asio flammeus*
Swainson's Hawk	*Buteo swainsoni*
Vermilion Flycatcher	*Pyrocephalus rubinus*
Wood Stork	*Mycteria americana*
Yellow Warbler (Sonoran)	*Dendroica petechia brewsteri*