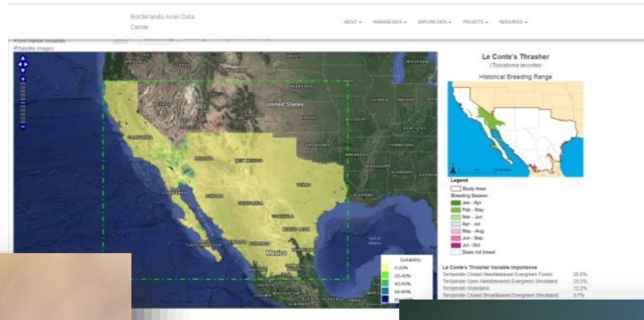
Developing tools for detecting climate change impacts on birds and their habitats in the desert southwest



Report to the US Fish and Wildlife Service

October 31, 2017

Sam Veloz, Dennis Jongsomjit, Leo Salas, Nathan Elliott, Geoffrey Geupel, Grant Ballard.

Conservation science for a healthy planet

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Point Blue Conservation Science

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Acknowledgements

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Point Blue Conservation Science 10/31/2017

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Introduction

The overall goal of this project was to provide information that will be used by managers for identifying climate change impacts and high priority monitoring locations, define adaptation opportunities, and improve capacity for making conservation decisions for wildlife populations and habitats using birds as indicators.

Assessing the vulnerability of species or ecosystems to climate change and formulating appropriate management responses requires predictions of the exposure and sensitivity of the species or ecosystems to projected changes. However, the uncertainty associated with predicting these future impacts of climate change implies that we cannot rely on models alone, but must also integrate information from other sources (i.e., monitoring data; Dawson, et al. 2011). We therefore developed a foundation for monitoring environmental change in the US Fish and Wildlife Service Region 2 and Northern Mexico by identifying where and what to monitor in order to evaluate climate-change impacts.

Climate change will not have the same effects in all locations – some areas will change quickly (hotspots) and others will change slowly (refugia). Identifying both types of areas and monitoring the rate at which they are changing is important, as is identifying areas for which projections are uncertain and increasing sampling effort accordingly. Extending models we have already developed for California (Figure 1), we have identified the locations throughout Northern Mexico and USFWS Region 2 where we predict the greatest changes in climate, habitats, and bird communities.

During a workshop with experts in Natural Protected Area (NPA) management, bird monitoring and climate change in Mexico, we used places identified by our analyses to define priority bird species, sites, and regions and to help to develop a coordinated bird monitoring strategy with respect to climate change in the project area, including deserts and NPAs in Mexico.

We built a bilingual web portal where users can view predicted distributional changes in bird, habitat, and climate under future climate conditions, readily updateable with new data as they become available. We also provided training on the use of the final products via multiple webinars.

Methods

Climate Data

We used contemporary climate data from the WorldClim Climate Dataset, version 1.4 (Hijmans *et al*., 2005). This dataset has a spatial resolution of approximately 1km and covered the entirety of the study area, both spatially and temporally. We used future climate projections from Conservation International's Downscaled Future Climate Scenarios dataset (Conservation International, 2009; Tabor and Williams, 2010). Downscaled, this dataset had a spatial resolution of 2.5 arc-minutes (approximately 4 km across the SJV region).

The future projections were taken from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model dataset which was used for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. We chose to use climate layers from the more pessimistic A2 emissions scenario to better capture the potential changes in climate. We used data from five general circulation climate models:

- Bjerknes Centre for Climate Research, Norway, BCM2.0 Model (Sorteberg *et al*., 2005)
- CSIRO Atmospheric Research, Australia, Mk3.5 Model (Gordon *et al*., 2010)
- Institute for Numerical Mathematics, Russia, INMCM3.0 Model (Dymnikov *et al*., 2004)
- CCSR/NIES/FRCGC, Japan, MIROC3.2, medium resolution (K-1 Model Developers, 2004)
- National Center for Atmospheric Research, CCSM3.0 (Collins *et al*., 2006)

We used multivariate analyses to collapse the many variables that go into climate-change models into climate gradients that we then used to calculate the projected change in overall climate for each ~1km grid cell within Mexico and parts of the SJV region within the United States. We measured this change by calculating the standardized Euclidean distance between current and future climate. This metric allows the magnitude of climate change to be analyzed with respect to historical interannual variability for each climate variable and/or the spatial heterogeneity of each climate variable within the area of interest (Williams et al. 2007). Standardizing climate change in this way allowed multiple climate variables with different units to be combined into a single index, but more importantly, it placed the magnitude of projected change in the perspective of what species have had to tolerate over recent history or in terms of what distance they would have to move to keep pace with changing climate. We used this data from these climate models to calculate a series of bioclimatic variables which were then used in our vegetation and bird models.

Bird Data

Point Blue developed a set of data standards that was sent to potential data providers along with a request to share data for our project. Through outreach provided by Sonoran Joint Venture partners, we brought in datasets from eight different projects in California, Arizona and Mexico. To fill in the gaps in areas in which standardized monitoring data were unavailable, we acquired over 100,000 avian observation records made by citizen scientists through eBird (Sullivan *et al.,* 2009).

For our modelling, we acquired and used a large quantity of avian observation records for the study region aggregated specifically for this project. All of the data below will potentially be federated and included in the Borderlands Avian Data Center Node depending on data owner permissions. These observations break out as follow:

Datasets used for modeling:

- Audubon California
- Arizona Game and Fish Department
- Breeding Bird Survey data across the region
- Carlsbad Caverns NP
- Chihuahuan Desert Network Parks Low Elevation
- National Commission of Natural Protected Areas (http://www.conanp.gob.mx/)
- AVESMX (http://avesmx.conabio.gob.mx/)
- Cornell Lab of Ornithology, eBird
- Dept. of Defense/Los Alamos
- Aaron Flesch – University of Montana
- Guadalupe Mountains NP
- Rocky Mountain Bird Observatory
- National Park Service
- USFWS National Wildlife Refuges

Other data acquired during the project

- Alamos Wildlands Alliance
- Bureau of Land Management
- New Mexico State University
- Pronatura Noroeste
- Steve Russell & Gale Monson
- Tucson Audubon Society
- University of Arizona
- US Fish & Wildlife Service
- US Forest Service

After consulting with local experts and identifying which species we had sufficient observations to model, we settled on a list of 67 species to model (Appendix A).

Other Data

For vegetation data, we used the Global Land Cover 2000 dataset for North America from USGS (Latifovic *et al*., 2004). This dataset was derived from the VEGETATION instrument aboard the SPOT-4 satellite. Land cover was classified into 29 coarse categories of vegetation and land use type at a resolution of approximately 900m over the entire study area.

Soil data came from the Harmonized World Soil Database, which was created by the Food and Agriculture Organization of the United Nations (Fischer *et al*., 2008). We resampled the data to match the land cover data's resolution of 900m.

Elevation data came from the USGS Shuttle Radar Topography Mission (http://dds.cr.usgs.gov/srtm/). We used this digital elevation model to calculate the slope, aspect, and insolation for each pixel in the study area at a resolution of 900m. Calculations were performed with the Slope, Aspect, and Area Solar Radiation tools, respectively, in ArcGIS 9.3.

Vegetation Models

We used boosted regression trees to model the current and future distribution of vegetation with climate, soil, and geophysical variables as input. Climate data consisted of bioclimatic variables derived from the sources described above. Additional variables included slope, solar radiation, and distance to stream. We modelled each of the 29 vegetation classes in Global Land Cover 2000 dataset for both present and future climates using boosted regression trees to identify the most probable cover type by pixel.

Bird Models

We ran bird habitat suitability models with the program Maxent v3.3.3k (Phillips *et al.*, 2006) using climate and vegetation type as inputs. We acquired bird presence locations from sources listed above throughout our area of interest. We then filtered locations for spatial and temporal accuracy. Climate variables included total precipitation, mean temperature, and temperature range for species specific breeding windows in time (e.g. March through June).

We then mapped current and future distributions of each species to identify which species are most sensitive to future climate change. We also produced maps highlighting future changes in bird species richness and bird community composition. We calculated community ecology indices to quantify the change in bird communities relative to the projected magnitude of climate change.

Results

Map the Magnitude of Climate Change

The climate models we used all project warmer temperatures in but vary in the direction and magnitude in changes in precipitation (Figure 1). However, climate is multivariate

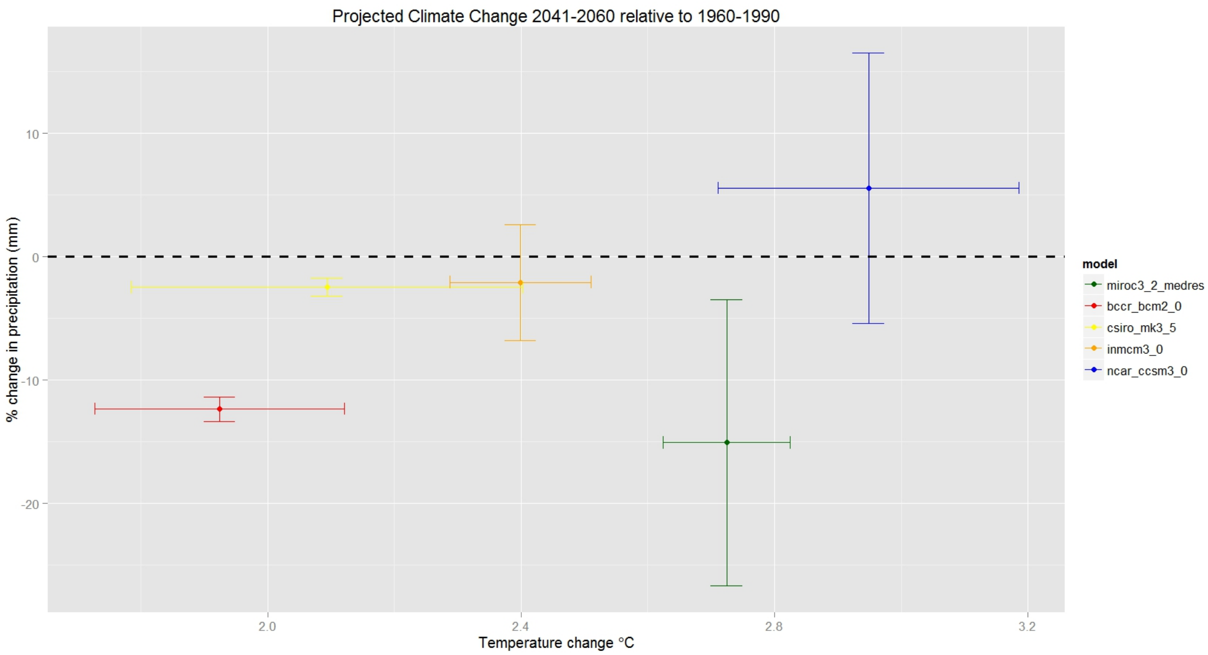

Figure 1. Changes from historic (1960 – 1990) and modeled future (2041 – 2060) mean annual temperature and mean annual precipitation across the study region from five future climate models.

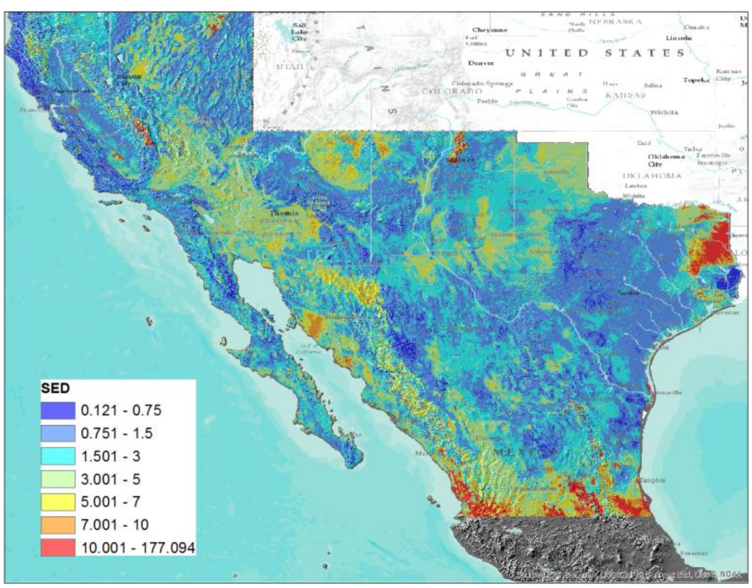

Figure 2. The standardized Euclidean distance between historic climate (1960 - 1990) and modeled future climate (2041 - 2060) for April – July.

and includes many variables from different seasons. Therefore providing a single index of climate change that includes a range of variables and seasons enables the ability to map and understand where on the landscape we expect to see the greatest changes in climate (Figure 2).

We used multivariate analyses to collapse the many variables that go into climate-change models into climate gradients that were used to calculate the projected change in overall climate for each

~1km grid cell within Mexico and parts of the SJV region within the United States. We produced maps indicating the magnitude of multivariate climate change using the standardized Euclidean distance (SED). This metric allows the magnitude of climate change to be analyzed with respect to historical interannual variability for each climate variable. Standardizing climate change in this way allows multiple climate variables with different units to be combined into a single index, but more importantly, it places the magnitude of projected change in the perspective of what species have had to tolerate over recent history. These maps will be used to identify areas likely to experience the greatest changes in overall climate and areas that are projected to be refuges of relatively stable climate. As part of the development of climate change adaptation strategies, the maps can be used to assess the exposure of species to climate change. We produced maps of the mean SED across the five GCMs used in this study to illustrate the variation in the magnitude of climate change within the Sonoran Joint Venture Region (Figure 1). We also show the uncertainty in the magnitude of climate change by mapping the standard deviation in SED values from the five GCMs.

Map the Change in Vegetation

The first step to modeling bird distributions was to model the distribution of vegetation in relation to current climate and other physical variables. We then projected these models unto future climate conditions to examine where the distribution of vegetation is projected to change in the future. To illustrate changes in vegetation, we calculated the Bray-Curtis distance between predicted current and future vegetation communities. High Bray-Curtis distance values indicate locations where large changes in vegetation community composition are projected by the models. We show the mean Bray-Curtis distance between the vegetation habitat suitability projections from the five GCMs to illustrate gradients of vegetation change across the study region (Figure 2). There are areas of overlap between high (and low) climate change (Figure 2) and vegetation change (Figure 3) but there are also areas where the two don't completely overlap.

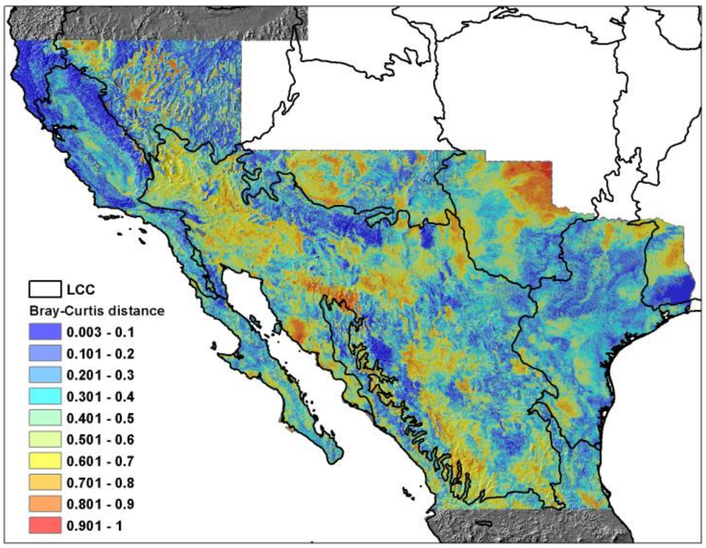

Figure 3. Mean vegetation community turnover (upper panel) based on five GCMs for 2050.

Map Future Bird Distributions

Because many of the birds we are modeling vary in the timing of their breeding season depending on where they breed, we felt that we needed to allow for changes in both the timing and location of potential breeding habitat in our models. We therefore created current and future climate surfaces for each four-month quarter starting in February and continuing until July (i.e, quarter 1 = Jan, Feb, Mar, Apr, quarter 2 = Feb, Mar, Apr, May, etc.). We produced models of the suitability of breeding environmental conditions for each quarter for both current and future climate conditions. Results show changes in environmental suitability between quarters within current conditions (Figure 4) and in the future (Figure 5). Results also indicate that we should expect both the timing and location of breeding habitat to change for some bird species in the Sonoran Joint Venture region with future climate change. The models show where environmental conditions will be suitable for breeding but not whether the species will be able to alter the timing of their breeding to match optimal conditions. Please visit the web portal (https://data.pointblue.org/partners/borderlands/explore-data/pluma-map/) to view species distribution maps for all species.

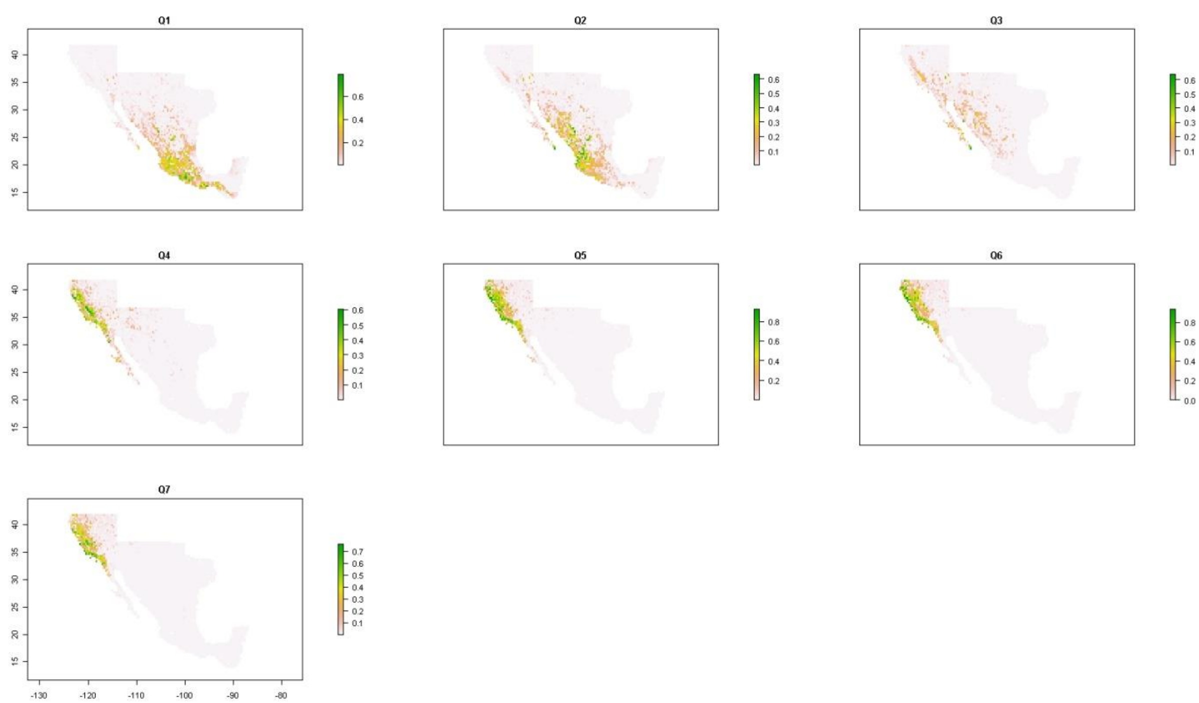

Figure 4. Environmental suitability for breeding habitat of California Towhee for seven periods (Q 1-7) based on current climate conditions.

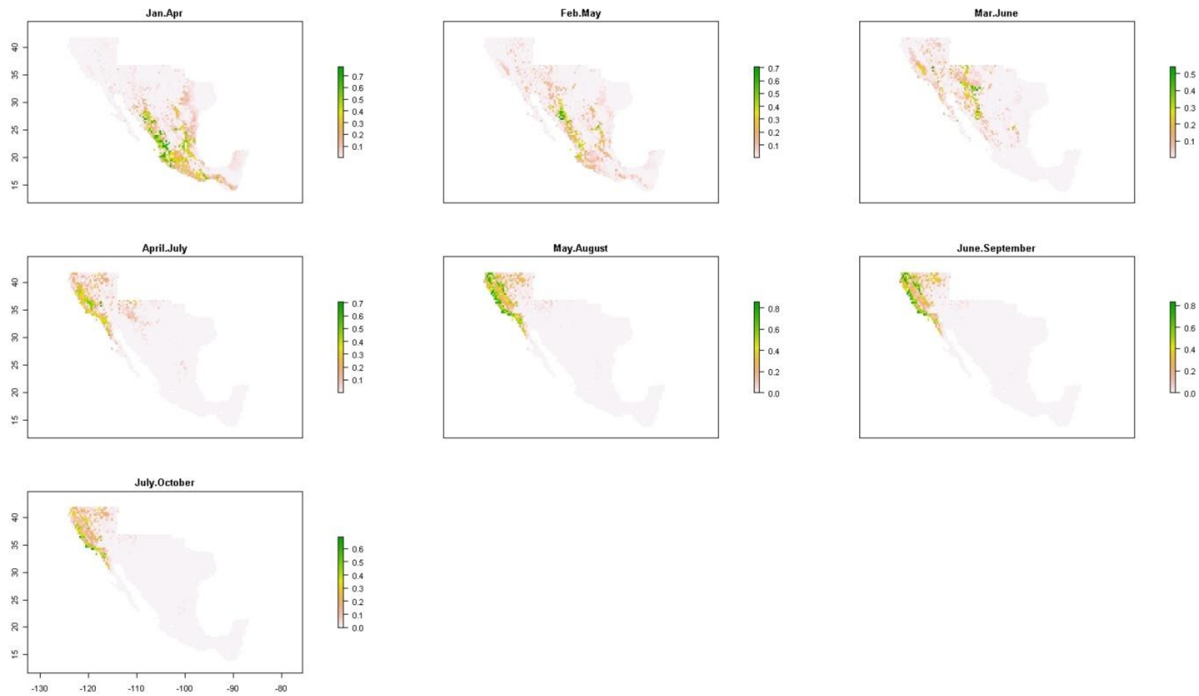

Figure 5. Environmental suitability for breeding habitat of California Towhee for seven periods (Q1-7) based on future climate conditions.

We can summarize the suitability maps by region and season to examine whether the models project that spatial and temporal patterns of suitability change over time. For example, we do not project a change in the seasonality of habitat suitability of California Towhee in the Sonoran and Mojave Desert region. However, three of the five models do project a decline in breeding habitat suitability across all time periods from historic conditions while project increases (Figure 6).

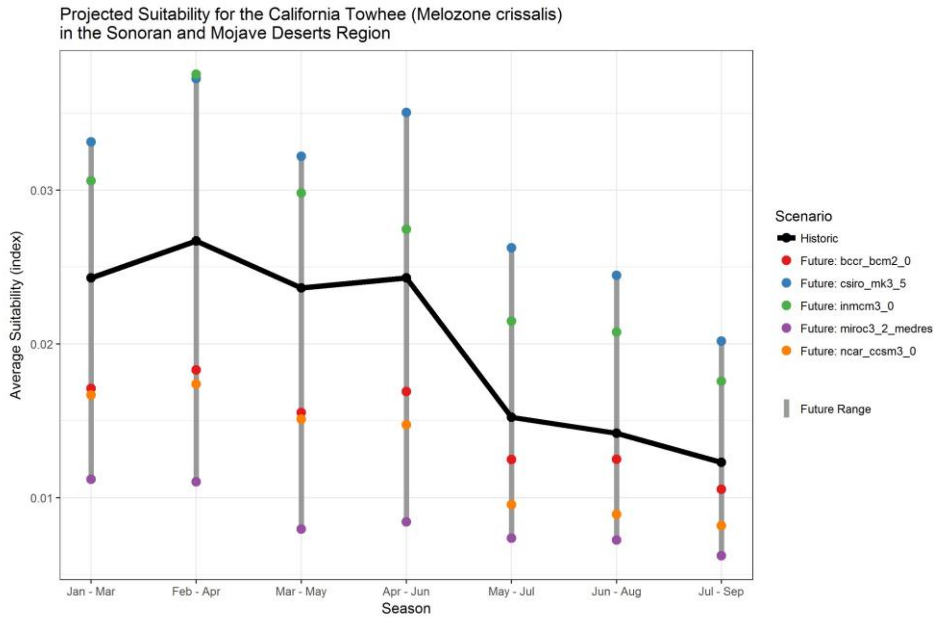

Figure 6. Mean environmental suitability of breeding habitat for California Towhee within the Sonoran and Mojave Bird Conservation Region for historic and future climate conditions. Environmental suitability is higher earlier in the year given future climate conditions.

Bird community changes

We used the bird habitat suitability models to estimate changes in both species richness (Figure 7) and community turnover (Figure 8) for every time period and future climate model. These maps are not available on the website currently but can be made available upon request.

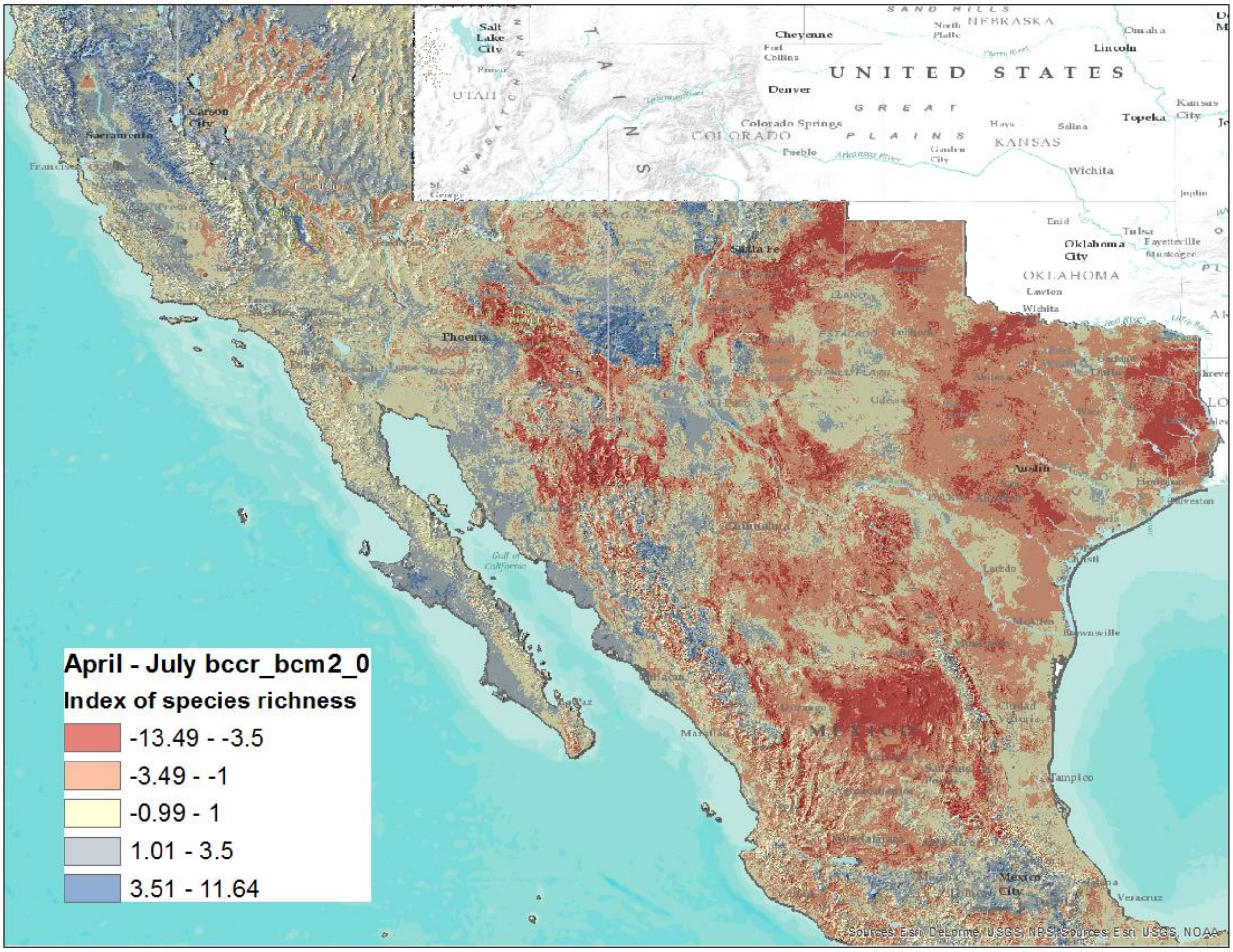

Figure 7. Change in an index of species richness based on the bird habitat suitability models from historic (1950-2000) and projected to future (2039-2050) climate. Blue colors indicate where models project increases in species richness while red areas indicate decreases in species richness.

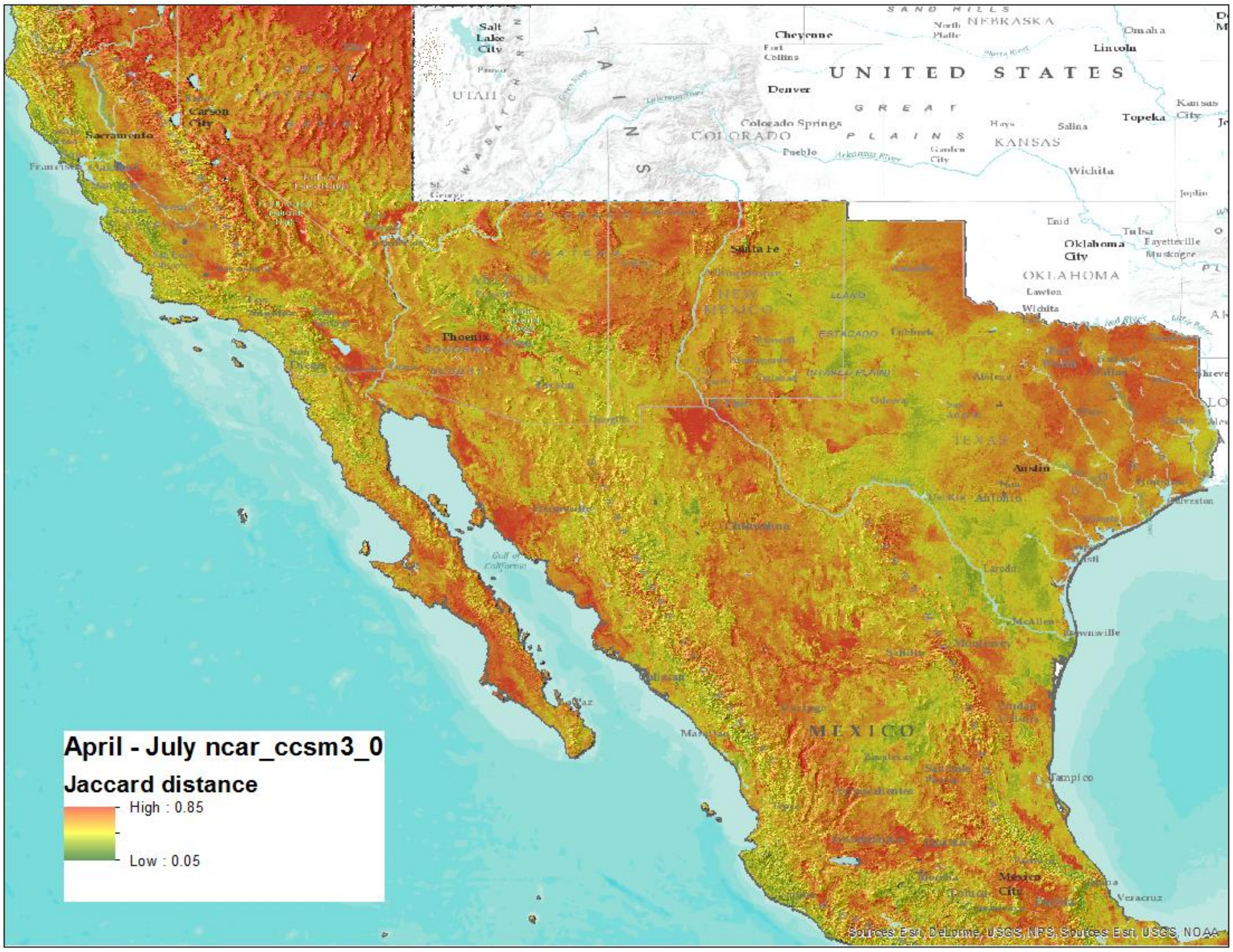

Figure 8. Projected bird community turnover based on the bird habitat suitability models from historic (1950-2000) and projected to future (2039-2050) climate. Red values indicate larger changes in bird community composition between current and future climate conditions.

Presentations

Dr. Sam Veloz presented webinars on the models and demonstrations of the web portal to the Sonoran Joint Venture technical committee and the Desert Landscape Conservation Cooperative. He also gave invited presentations of this work at the North American Ornithological Congress 2012 and at the Ecological Society of America Conference in 2014.

In May 2013 staff from the Sonoran Joint Venture gave a plenary talk at the “Adapting to a Changing Climate in the Sky Island Region” conference, held in Tucson, Arizona. We gave an overview of this project, presented some preliminary results and plans for monitoring, and discussed challenges for working on transborder climate change issues.

Point Blue and the SJV gave a half-day workshop at the XII CECAM/Congreso Para el Estudio y Conservación de las Aves en México, in San Cristobal de las Casas, Chiapas. Fifteen participants attended the workshop, including Mexican government representatives (CICESE, CONABIO), non-government institution representatives, university students, and professors. The workshop gave an overview of the project purpose and background, provided an introduction to the portal, shared examples from California and elsewhere, and took participants through several interactive examples of ways in which the portal can be used, including use as a decision support tool (http://data.prbo.org/partners/sjv/cecam2013/). We also led a discussion on coordinating and prioritizing bird monitoring with respect to climate change and data and management needs and gathered feedback and suggestions for portal improvements and desired future functionality.

Dr. Leo Salas was invited to be the keynote speaker at the “Tercer Congreso Nacional de Investigación en Cambio Climático” (Third National Congress on Climate Change Research), held in Mazatlán, Sinaloa (http://ola.icmyl.unam.mx/3congreso.htm). Dr. Salas’s talk, entitled ‘Birds Without Borders: climate-smart conservation across international and ecological boundaries,’ focused on why it is important to incorporate climate change in conservation planning and decision-making, how the models for the SJV Climate Change Impacts Tool were developed (see Draft Web Portal below), the results of the models, their use within the tool and their limitations, and how to make decisions despite the unavoidable uncertainty about the future. The last part of the presentation was devoted to developing web-based decision support systems to facilitate learning about ecosystems and promoting adaptive management using data-intensive science, and the new paradigms that this approach entails: transparency, collaboration, and openly sharing data and knowledge across geo-political borders.

The presentation sparked new discussions about a decision support system for monitoring and decision-making on climate change impacts and birds in Mexico and led to increased support for an Avian Knowledge Network node (see http://www.avianknowledge.net/index.php?page=nodes for details) for the desert southwest of the United States and northern Mexico in partnership with the SJV. The presentation also increased interest in using model results for conservation planning in Mexico, and in particular increased interest in data and knowledge sharing with the SJV. A priority for the region should be the development of a decision support system to gather monitoring data, guide hypothesis testing, enhance models on ecosystem impacts and deliver data and information in simple and comprehensible ways to facilitate decision-making.

As part of the SJV Technical Committee meeting in October 2013, we hosted a half-day workshop to introduce the draft web portal with SJV tech committee members. The workshop was very similar to the workshop in Chiapas, covering similar topics, but with fewer interactive activities to accommodate the shorter time slot. Participants gave valuable feedback about coordinating and prioritizing bird monitoring with respect to climate change and data and management needs (which will be the focus of workshops this spring) and we gathered more feedback and suggestions for portal improvements and desired future functionality. Approximately 15 people from SJV partner organizations in the U.S. and Mexico participated in the training.

We presented the draft portal and an overview of project accomplishments at the November 2013 SJV Management Board meeting in Tucson, Arizona. Board members discussed uses for project outcomes and its role in supporting future conservation planning for the SJV and its partners. As a result of feedback from these presentations, workshops, and meetings, we made significant changes to our web portal.

In February of 2015, Dr. Leo Salas and Mr. Dennis Jongsomjit designed and conducted a workshop in Tucson, Arizona, in partnership with the SJV and the Sky Islands Alliance. Biologists from 8 different natural protected areas in northwest Mexico participated in the workshop, along with representatives of the U.S. National Parks Service. The workshop was very successful, with great engagement from attendees. The participants prepared final presentations from conservation planning exercises they performed using the PLuMA tool. The content of the workshop is available here: http://data.prbo.org/partners/sjv/sjvtechcomm/

In April of 2015, Dr. Jennie Duberstein (SJV Coordinator) and Dr. Leo Salas presented the PLuMA tool in the 20th meeting of the Trilateral Committee for Wildlife and Ecosystem Conservation and Management. The “Trilateral” seeks to enhance the cooperation among wildlife management agencies of the three member nations: The U.S., Mexico and Canada. The presentation was well received and elicited numerous inquiries, as it was evident that the PLuMA tool and underlying data and information systems are pivotal resources for planning the conservation of bird species and their habitats across the U.S.-Mexico border.

References

Collins, W.D., Bitz, C.M., Blackmon, M.L., Bonan, G.B., Bretherton, C.S., Carton, J.A., Chang, P., Doney, S.C., Hack, J.J., Henderson, T.B. and Kiehl, J.T., 2006. The community climate system model version 3 (CCSM3). *Journal of Climate*, *19*(11), pp.2122-2143.

Conservation International, 2009. Downscaled Future Climate Scenarios 2.5-minute resolution. Collaborators: Department of Geography, Center of Climatic Research, and Land Tenure Center at the University of Wisconsin. http://futureclimates.conservation.org.

Dawson, T. P., S.T. Jackson, J. I. House, I. C. Prentice, G. M. Mace. 2011. Beyond Predictions: Biodiversity Conservation in a Changing Climate. Science 332: 53-58.

Dymnikov, V.P., Diansky, N.A., Galin, V.Y., Glazunov, A.V., Gritsoun, A.S., Lykossov, V.N. and Volodin, E.M., 2004. Modelling the climate system response to small external forcing. *Russian Journal of Numerical Analysis and Mathematical Modelling rnam*, *19*(2), pp.131-161.

Fischer, G., F. Nachtergaele, S. Prieler, H.T. van Velthuizen, L. Verelst, D. Wiberg, 2008. *Global Agro-ecological Zones Assessment for Agriculture (GAEZ 2008)*. IIASA, Laxenburg, Austria and FAO, Rome, Italy. http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/

Gordon, H., S. O'Farell, M. Collier, M. Dix, L. Rotstayn, E. Kowalczyk, T. Hirst, and I. Watterson. 2010. The CSIRO Mk3.5 Climate Model. CAWCR Technical Report No. 21.

Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. http://www.worldclim.org.

K-1 Model Developers. 2004. K-1 coupled model (MIROC) description, K-1 technical report, 1, H. Hasumi and S. Emori (eds.), Center for Climate System Research, University of Tokyo, 34pp.

Latifovic, R., Zhu, Z.L., Cihlar, J., Giri, C. and Olthof, I., 2004. Land cover mapping of North and Central America—global land cover 2000. *Remote sensing of environment*, *89*(1), pp.116-127. http://glcf.umd.edu/data/lc/.

Phillips, S.J., Anderson, R.P. and Schapire, R.E., 2006. Maximum entropy modeling of species geographic distributions. *Ecological modelling*, *190*(3), pp.231-259.

Sorteberg, A., H. Drange, N. G. Kvamstø, I. T Kindem, F. Flatøy, T. Furevik, and M. Bentsen. 2004. Bergen Climate Model (BCM) Version 2.

Sullivan, B.L., C.L. Wood, M.J. Iliff, R.E. Bonney, D. Fink, and S. Kelling. 2009. eBird: a citizen-based bird observation network in the biological sciences. Biological Conservation 142: 2282-2292. http://www.ebird.org.

Tabor, K. and J. W. Williams, 2010. Globally downscaled climate projections for assessing the conservation impacts of climate change. Ecological Applications 20, 554-565.

Williams JW, Jackson ST, Kutzbach JE. 2007. Projected distributions of novel and disappearing climates by 2100AD. Proceedings of the National Academy of Sciences 104:5738-5742.

Appendix A: Species List

Species Code	Common Name	Scientific Name
ABTO	Abert's Towhee	Pipilo aberti
ACWO	Acorn Woodpecker	Melanerpes formicivorus
ATFL	Ash-throated Flycatcher	Myiarchus cinerascens
BCFL	Brown-crested Flycatcher	Myiarchus tyrannulus
BETH	Bendire's Thrasher	Toxostoma bendirei
BEVI	Bell's Vireo	Vireo bellii
BEWR	Bewick's Wren	Thryomanes bewickii
BHNU	Brown-headed Nuthatch	Sitta pusilla
BLPH	Black Phoebe	Sayornis nigricans
BTAH	Broad-tailed Hummingbird	Selasphorus platycercus
BTPI	Band-tailed Pigeon	Patagioenas fasciata
BUSH	Bushtit	Psaltriparus minimus
CACH	Carolina Chickadee	Poecile carolinensis
CACW	Cactus Wren	Campylorhynchus brunneicapillus
CAGN	California Gnatcatcher	Polioptila californica
CALT	California Towhee	Melozone crissalis
CAQU	California Quail	Callipepla californica
CASP	Cassin's Sparrow	Aimophila cassinii
CATH	California Thrasher	Toxostoma redivivum
CBTH	Curve-billed Thrasher	Toxostoma curvirostre
CHRA	Chihuahuan Raven	Corvus cryptoleucus
CRCA	Crested Caracara	Caracara cheriway
CRGU	Crested Guan	Penelope purpurascens

CRTH	Crissal Thrasher	Toxostoma crissale
DICK	Dickcissel	Spiza americana
DUFL	Dusky Flycatcher	Empidonax oberholseri
EAME	Eastern Meadowlark	Sturnella magna
EAWP	Eastern Wood-Pewee	Contopus virens
GAQU	Gambel's Quail	Callipepla gambelii
GFWO	Golden-fronted Woodpecker	Melanerpes aurifrons
GIWO	Gila Woodpecker	Melanerpes uropygialis
GKIS	Great Kiskadee	Pitangus sulphuratus
GRPE	Greater Pewee	Contopus pertinax
HOLA	Horned Lark	Eremophila alpestris
LASP	Lark Sparrow	Chondestes grammacus
LCTH	Le Conte's Thrasher	Toxostoma lecontei
LOSH	Loggerhead Shrike	Lanius ludovicianus
LUWA	Lucy's Warbler	Oreothlypis luciae
MEJA	Mexican Jay	Aphelocoma wollweberi
MOCH	Mountain Chickadee	Poecile gambeli
MOUQ	Mountain Quail	Oreortyx pictus
NOGO	Northern Goshawk	Accipiter gentilis
PABU	Painted Bunting	Passerina ciris
PHAI	Phainopepla	Phainopepla nitens
PROW	Prothonotary Warbler	Protonotaria citrea
RBWO	Red-bellied Woodpecker	Melanerpes carolinus
RCWA	Rufous-capped Warber	Basileuterus rufifrons

SAGS	Sage Sparrow	Amphispiza belli
SBFL	Sulphur-bellied Flycatcher	Myiodynastes luteiventris
SCOR	Scott's Oriole	Icterus parisorum
STFL	Scissor-tailed Flycatcher	Tyrannus forficatus
STJA	Steller's Jay	Cyanocitta stelleri
SUTA	Summer Tanager	Piranga rubra
SWWA	Swainson's Warbler	Limnothlypis swainsonii
TBKI	Thick-billed Kingbird	Tyrannus crassirostris
VABU	Varied Bunting	Passerina versicolor
VCHU	Violet-crowned hummingbird	Amazilia violiceps
VEFL	Vermilion Flycatcher	Pyrocephalus rubinus
VERD	Verdin	Auriparus flaviceps
WBNU	White-breasted Nuthatch	Sitta carolinensis
WETA	Western Tanager	Piranga ludoviciana
WREN	Wrentit	Chamaea fasciata
WSWO	White-striped Woodcreeper	Lepidocolaptes leucogaster
XAHU	Xantus's hummingbird	Basilinna xantusii
YBCU	Yellow-billed Cuckoo	Coccyzus americanus
YEJU	Yellow-eyed junco	Junco phaeonotus
YEWA	Yellow Warbler	Setophaga petechia