Climate Change Vulnerability Assessments for Terrestrial and Freshwater Vertebrates in the Mediterranean Coast Network of National Parks

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"We cannot solve our problems with the same thinking we used when we created them."

-Albert Einstein (14 March 1879 - 18 April 1955)

Abstract

To preserve biodiversity in the 21st century we must understand how changes in the physical environment will differentially alter species fitness. In an effort to aid the National Park Service in protecting the native fauna of the Mediterranean Coast Network, we examined 68 randomly selected species distributed across five taxonomic groups. The species we studied match the proportions that correspond with the ecological communities of the Santa Monica Mountains National Recreation Area, Channel Islands National Park, and Cabrillo National Monument. Using NatureServe's Climate Change Vulnerability Index—which incorporates modeled future temperature and moisture change and species life history data—we scored each species' vulnerability to climate change. Native species were more vulnerable to climate change (t-test; $p < .01$), with 30% of natives scoring from Moderately Vulnerable (MV) to Extremely Vulnerable (EV), and all non-natives being either Increase Likely (IL) or Presumed Stable (PS). Taxonomically, we found that amphibians and fish are more at risk than birds, reptiles, and mammals, with 100% of the former species scoring between MV and EV. Animals currently listed as federally endangered or threatened are more vulnerable than unlisted species (Mann-Whitney test; $p < .001$), as are animals on the Channel Islands in comparison to the other two parks. While initially attempting to include plants and invertebrates in our study, available information about their life histories from web resources, peer-reviewed literature, and expert correspondence was insufficient to complete any assessments. The factors that most affect species' sensitivity and exposure to climate change in our study are dispersal abilities, sea level rise, and confinement by anthropogenic and natural barriers, which together account for 75% of vulnerability score variability (multivariate regression; $R^2 = .75$; $p << .001$). These findings emphasize the importance of habitat corridors, which would allow migrating animals to track moving climate envelopes, and influences park managers to consider the controversial strategy of assisted migration. Additionally, further research on the life histories of plants and invertebrates, which comprise the bulk of ecosystem biomass, is needed to effectively protect the species of the Mediterranean Coast Network from climate change.

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1 Introduction

Although anthropogenic greenhouse gas emissions will alter climate on a global scale, changes to ecosystems will depend on the magnitude and direction of regional climate change (Klausmeyer & Shaw, 2009). In the past, comparisons of ecosystem stability across the world's biomes have allowed scientists to rank Earth's most vulnerable regions, thereby identifying conservation targets on a global scale (Myers *et al.*, 2000; Sala, 2000). Likewise, vulnerability at the species level is of major concern to park managers. By pairing the downscaled general circulation models with analysis of species' physiological climate niches and historical exposure to climate variability, we can possibly identify which populations will experience fitness declines in the future and focus our conservation efforts on these species. Vulnerability indices are useful tools for dealing with hypothesized changes to species fitness because they utilize both information on simulated climate changes and information on life histories; helping to determine which species are vulnerable and to which key factors. In so doing, they can aid and inform conservation action, and draw public attention to the importance of understanding climate change.

Using the NatureServe Climate Change Vulnerability Index (CCVI), we categorized the vulnerability of species to climate change among three parks in the Mediterranean Coast Network (MEDN) for the National Park Service (NPS). We scored 68 randomly selected species distributed across five taxonomic groups in proportions that match the ecological communities of the MEDN to understand the patterns of species vulnerability by taxonomic group, park, nativity, and conservation status in the park system. Our study will aid the NPS in creating an appropriate conservation plan in light of current and future climate change by providing a broad picture of species vulnerability within their park area.

We will introduce the background for our study through a literature review that provides a theoretical understanding of how climate change can affect the ecology of California's Mediterranean biome. This includes: 1) a background on our study site, the MEDN; 2) an understanding of the effects of climate change on ecosystems, biogeochemical cycles, and fire regimes; and 3) an introduction to the CCVI. Our research questions and methodology stem from an understanding of these topics and are followed by our results and a discussion of their implications for park managers.

2 Literature Review

2.1 Mediterranean Biome

Biomes, or bioclimatic zones, are appropriate divisions used to organize and classify the natural world (Paulson, 2005). Each zone is characterized by its particular climate and type of vegetation. As defined by the NPS, the Mediterranean biome consists of five generally small areas around the world, distributed between approximately 30°–40° north and south latitude, and is characterized by cool, wet winters and warm, dry summers (NPS, 2009). The areas also experience a cold offshore ocean current, which helps to moderate annual average temperatures. These coastal conditions make the Mediterranean biome a desirable human habitat, which adds the stresses of urbanization and habitat fragmentation on wildlife, making it a conservation priority (Cox & Underwood, 2011).

2.1.1 Mediterranean Coast Inventory and Monitoring Network

In order to monitor and preserve natural resources the U.S. National Parks Service has a system of organized parks throughout the country. The parks are divided into 32 Inventory and Monitoring Networks (I&M). The Mediterranean Coast Inventory and Monitoring Network (MEDN) specifically, is located in Southern California and is composed of three sections: Cabrillo National Monument, Channel Islands National Park, and Santa Monica Mountains National Recreation Area (Figure 1). While not expansive in area, these three units represent some of the best examples of a Mediterranean biome and are home to a rich biodiversity; more than 1,000 plant species provide an important habitat for nearly 500 mammal, bird, reptile, and amphibian species (NPS, 2009). They are also some of the only protected areas of their kind, which is ever important with the occurring shifts in climate and continuous population growth in the area. The following are descriptions of each park.

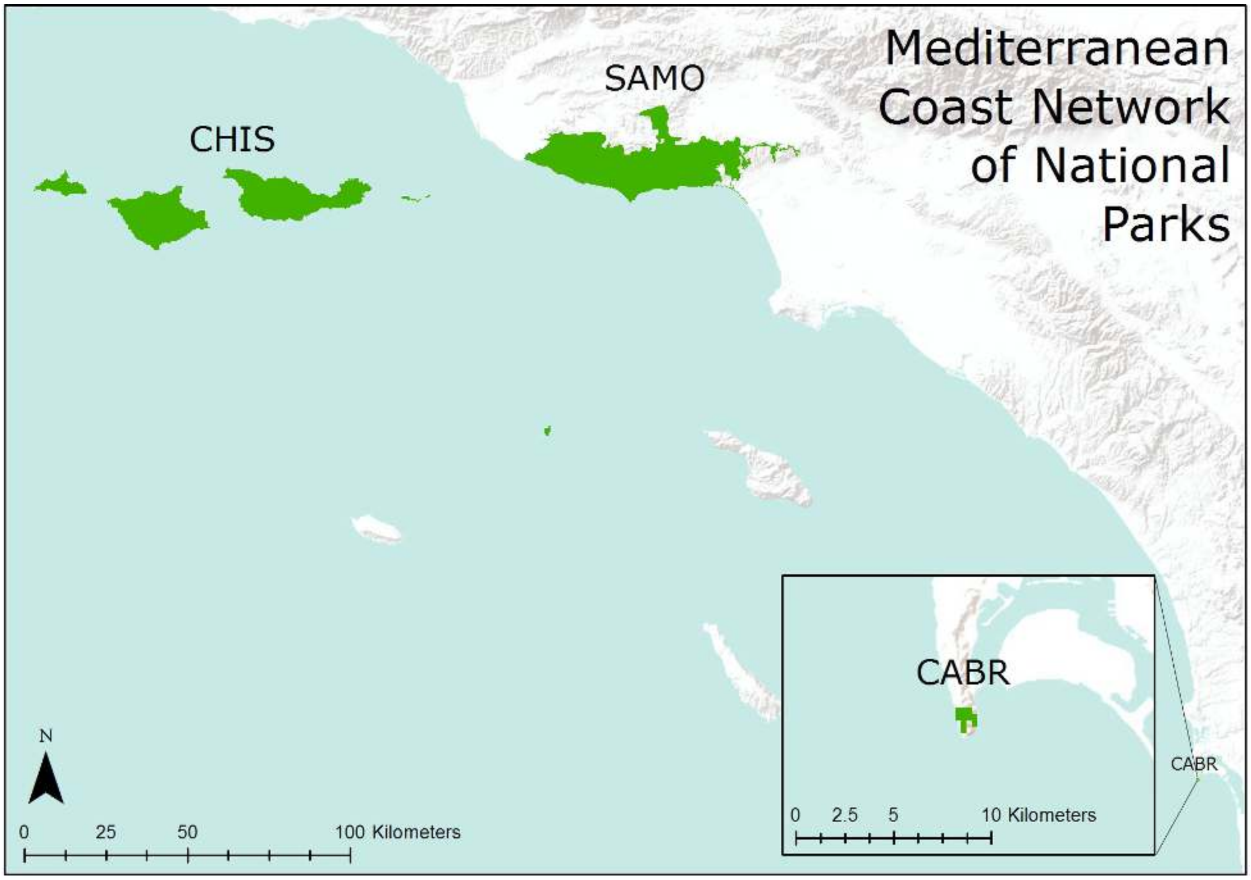

Figure 1. Mediterranean Coast Network of National Parks. The marine area of the CHIS is not included in this map.

2.1.1.1 Cabrillo National Monument

Located on the Point Loma peninsula in San Diego, Cabrillo National Monument (CABR) is the southernmost park of the MEDN. It is isolated from other natural land by the Pacific Ocean and surrounding development, making it an island of rare habitats within a highly developed landscape. Aside from the 60 acres of actual monument, the area also administers 128 acres of marine intertidal zones and co-manages the 640 acre Point Loma Ecological Reserve with the U.S. Navy. Many species on the peninsula have already been recognized as endangered by the California Department of Fish and Game Natural Resource Diversity Database, including the maritime succulent scrub, coastal sage scrub, and maritime chaparral. The southwestern end of the park contains one of the richest and most biologically diverse tide pool areas remaining in San Diego County; and just beyond the park lays the Point Loma kelp beds. Collectively, this region of the Mediterranean Network contains over 1000 species of organisms, 80 of them considered to be sensitive to anthropogenic stressors. This is an important area to consider when evaluating coastal ecosystems and such factors as sea level rise, warming oceans, and coastal erosion (NPS, 2009).

2.1.1.2 Channel Islands National Park

Channel Islands National Park (CHIS) currently encompasses roughly 250,000 acres of water and land in an island chain just off the southern coast of California. The park chain is made up of Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara– all which host outstanding and unique natural resources and genetic diversity. So exceptional, in fact, that the U.S. Congress declared the waters surrounding the park islands a national Marine Sanctuary. In 1991, the National Parks Service declared the park one of the original prototype Long-term Ecological Monitoring sites. (NPS, 2009)

2.1.1.3 Santa Monica Mountains National Recreation Area

Of all 3 sections, the Santa Monica Mountains National Recreation Area (SAMO) is by far the most diverse in terms of land acreage and ownership. The area extends over 150,000 acres, roughly half of which is currently protected through federal, state, and local park agency ownership. While the other half remains privately owned, much of it is still underdeveloped, but development is expanding. The diverse communities of vegetation in the SAMO provide home for 50 species of mammals, nearly 400 bird species, and over 35 reptile and amphibian species (NPS, 2009).

2.1.1.4 Inventory and Monitoring

The purpose of the MEDN is to create inventories of its species and natural features so that park managers can better understand both the features that exist in their parks and any significant changes in natural systems. Despite the bulk of present information, these inventories alone are not enough to monitor the growing effects of climate change on species.

2.2 The Effects of Predicted Climate Change on Ecosystems

Both the magnitude of climate change and the ability of species to adapt will vary geographically (IPCC, 2007; Deutsch *et al*., 2009). The resilience of individual species to a changing habitat is inextricably linked to the larger scale vulnerability of a biome's biodiversity to climate change. Studies comparing biome level vulnerability to anthropogenic stressors, including climate change, have found Mediterranean climate ecosystems to be some of the most susceptible on Earth to future environmental change (Sala, 2000). The following section addresses the predicted effects of climate change to the Mediterranean biome of California.

2.2.1 Modeled Effects of Climate Driven Changes to Fire Regimes

Modeled changes to fire regimes depend on the direction of precipitation change in California, which in turn depends on which GCM is used to assess climate change. For example, Lenihan *et al.* (2003) use two different GCMs in a study that models fire frequency in California. The medium sensitivity Hadley CM2 model that predicts a warmer future climate also foresees increased precipitation compared to the low sensitivity Parallel Climate model that predicts slightly less warming and net decreases in precipitation through time. The wetter Hadley CM2 scenario exhibits increased variability in fire frequency and increased fire intensity when burnings do occur compared to the historical record. Increased annual precipitation promotes the growth of woody plants that can out-compete grasses when soil water levels are high. An amplified abundance of woody plants means that during relatively dry years there is a large supply of fuel when fires occur. Fires that occur during the relatively dry years of the wet scenario are greatly intensified compared to the fires of the dry climate as well as compared to the fires during the historical record because of the larger fuel supply. Conversely, in the drier scenario, grasses increased in abundance relative to woody plants, allowing for more frequent and consistent burnings but of less intensity compared to the wetter scenario. This study reveals the sensitivity of local ecologies to the direction of future climate change. In doing so, it defines the range of possible future fire regimes in California, but does not specify a "most likely scenario", which may be necessary to for immediate action by conservationists.

2.2.2 Modeled Effects of Precipitation and Temperature to Net Primary Productivity

Lenihan *et al.* (2003) also demonstrate how future precipitation scenarios alter the net primary productivity of California's wild lands. In their study, increased temperatures lead to increased net primary productivity (NPP) under both the PCM and Hadley CM2 model scenarios. The direction of precipitation change plays a role in determining the magnitude of the increase in NPP, with the drier scenario showing less of an increase for California. The wetter scenario allows the increased abundance of woody plants and ultimately bolsters NPP over both the historical period and the drier scenario. While the amplified NPP predicted by either climate scenario may seem beneficial, increases in productivity ultimately stem from increases in the abundance of certain vegetation types. Therefore increased productivity in the model is associated with decreases in biodiversity for California. To buffer ecosystems against such vegetation changes, future conservation programs may necessitate active native plant removal from regions in California where such plants did not previously exist.

2.2.3 Modeled Effects of Elevated Carbon Dioxide Concentrations on NPP, Vegetation Biomass and Streamflow

Not only do different precipitation scenarios lead to varied trends in fire regimes and net primary productivity, different carbon dioxide concentrations under diverse emissions scenarios lead to different NPP and biomass predictions. In a modeling study of a chaparral ecosystem in southern California, NPP and biomass are shown to inversely decrease as a function of temperature in opposition to the overall increase in NPP modeled for all of California by Lenihan *et al.* (Tague *et al.*, 2009). Such decreases in NPP are offset in scenarios with higher carbon dioxide concentrations. This is because at higher CO_2 concentrations, efficiency in water use by plants increases such that decreases in biomass and NPP caused by higher temperatures are negligible. Although, at the highest concentrations of CO_2 that the study uses, the temperature projection increase is so great that even these CO_2 buffering effects also become negligible.

The effects of changes to NPP and biomass on summer streamflow rates are assessed within this study as well. Scenarios with high concentrations of CO_2, biomass and NPP increase show increases in the frequency of low streamflow years. The scenarios in which temperature effects outweigh CO_2, such as in the lowest CO_2 concentration scenario, show decreases in the low flow years with potential consequences for downstream erosion rates. The multitude of varying scenarios in biomass and NPP changes with respect to CO_2 emissions and modeled temperature changes highlight the effects that different GCMs and emissions scenarios have on regional climate and ecological studies.

2.2.4 Modeled Effects of Climate Driven Changes to Vegetation Distribution

Uncertainty in the direction of climate change in California leads to opposing predictions in future vegetation distributions by bioclimatic models. Loarie *et al*. (2008), using the Hadley CM3 and PCM models with varying emissions scenarios, show that California's flora will tend to shift either towards higher elevations or northwards depending on a plant's location in

California and on the climate model used. The patterns of species movement they present in their research are variable between emissions scenarios and models, with the only consistent trend being the ultimate break up of California's ecosystems as species migrate to newly favorable locations. If studies such as this one are to successfully provide information on the direction of species movement, they too should use ensemble averages of GCMs to ascertain the most likely direction of species migration.

Likewise, Hayhoe *et al*. (2004) do not find coherent trends in vegetation distribution change forced by precipitation changes among their models and emissions scenarios because their models predict opposite directional trends. In contrast, they do provide evidence that the vegetation distribution changes forced by temperature changes are coherent across all emissions scenarios and models. Such confident projections may stem from the fact that all emission scenarios and model types project the same direction of temperature change.

2.2.5 Modeled Effects of Exacerbation Regarding Species Invasions

Species invasions are one of the greatest threats to biodiversity that climate change could possibly exacerbate. Although climate change may intensify the spread of non-native species, observational evidence of this statement is still largely a vacant area of exploration (Sandel & Dangremond, 2011). It is beneficial to look at traits of natives versus exotic species and combine them with climate change predictions to determine whether natives or exotics will be favored in a new climate regime. Methodology would include species distribution, trait information, climate data, human influence index, and spatial analysis (Sandel & Dangremond, 2011). When studying the effects of invasive species on ecosystems, disturbance regimes must be taken into consideration to better understand how disturbance promotes invasions by strengthening the ability to out compete natives (Gritti *et al.*, 2006).

2.3 Nature Serve's Climate Change Vulnerability Index

The literature on climate change's effects to California's Mediterranean biome provides a range of possible outcomes of environmental change from an ecosystem perspective, without specifically addressing changes to individual species fitness. Vulnerability assessments can fill this gap in our knowledge by ranking future fitness changes to species on multiple spatial scales, from a habitat to a whole biome.

2.3.1 Vulnerability Factors

NatureServe, a non-profit conservation organization, recommends their Climate Change Vulnerability Index (CCVI) for ranking species vulnerabilities. The CCVI is an algorithm for calculating species vulnerabilities that takes into consideration a number of biological and environmental factors by incorporating information from geographic information systems (GIS) and climate modeling. It calculates the potential effects of climate change on biota by focusing on two factors: exposure and sensitivity (Schlesinger *et al*., 2011). The CCVI is broken up into four sections (A–D) as follows: A) Exposure to Local Climate Change, B) Indirect Exposure to Climate Change, C) Sensitivity, and D) Documented or Modeled Response to Climate Change.

Exposure, Sections A and B, examine direct and indirect exposure to climate change, respectively. This includes model projections of temperature and a moisture metric in Section A; and 1) exposure to sea level rise, 2) distribution relative to natural and anthropogenic barriers, and 3) the impact of land use changes resulting from human responses to climate change, in Section B. The NatureServe organization recommends use of ClimateWizard data for temperature and the Hamon AET:PET (actual evapotranspiration to potential evapotranspiration) moisture metric (Hamon 1961) for future temperature and moisture projections (Young *et al.*, 2011).

Sensitivity, Section C, considers intrinsic characteristics of the species being assessed as they apply to climate change. It consists of: 1) dispersal and movement, 2) predicted sensitivity to temperature and moisture changes, 3) restriction to uncommon geological features or derivatives, 4) reliance on interspecific interactions, 5) genetic factors, and 6) phenological response to changing seasonal temperature and precipitation dynamics (Young *et al.*, 2011). Section D is an optional section that considers any completed simulations of the future for the species of interest (Young *et al.*, 2011).

2.3.2 Scoring

Within the sections above, species are evaluated based on the vulnerability contributions of up to twenty-four different factors that receive the following possible scores: Greatly Increase, Increase, Somewhat Increase, Neutral, Somewhat Decrease, Decrease, or Unknown (Young *et al.*, 2011); although, the full range of scores is not always offered for each factor. Sections B–D are where the greatest amount of subjectivity comes into play. Because many of these scores are assigned through individual research and knowledge of the assessor, scores may vary among different assessors. The species is also assigned both a global and state-level rank. Globally they can receive a G1 through G5, GX, or GH rank. G1 ranked species are the most endangered and closest to extinction, GX species are presumed extinct, and GH species are missing or possibly extinct. At the state-level, the same ranking system is applied (Mehlman, 2004; Young *et al*., 2011). Final vulnerability scores for each species are a combination of exposure and sensitivity scores and are translated into six categories of vulnerability: Extremely Vulnerable, Highly Vulnerable, Moderately Vulnerable, Not Vulnerable/Presumed Stable, Not Vulnerable/Increase Likely, and Insufficient Evidence.

The index provides an uncertainty score based on the amount of information used as an input. If data is sparse for a particular species, the vulnerability score will have a lower confidence. This confidence score allows conservationists, project planners and scientists to understand which species have sufficient data that lend information to providing a more reliable score, and which species need more background data. The CCVI does not take into account population and range size or demographic components because these are examined in the NatureServe conservation status assessments. Overlap between these two assessments aims to be reduced in order to use both scores in conjunction with one another.

The move to use vulnerability index scores to inform conservation species is a relatively recent venture for researchers (Williams *et al.*, 2008). Though the CCVI is a newly developed method and may not provide a definite answer to how populations will respond to changing climates, it establishes an initial approach to protecting biodiversity. To aid informed conservation practices by the NPS and preservation of Mediterranean biodiversity, we will compare the relative vulnerabilities of species to climate change within the MEDN and attempt to answer the following research questions:

3 Research Questions

3.1 How vulnerable is the biota of the Mediterranean Coast Network to Climate Change?

1) How do projected future temperature and moisture changes compare among the parks?
2) What are the vulnerabilities of species within each park?
3) What are the relative vulnerabilities of natives, non-native, threatened and endangered species?

4) What are the relative vulnerabilities of taxonomic groups?
5) Which CCVI factors drive vulnerability scores?
6) For how many species and for which taxonomic groups is there not enough information to assess vulnerability?

4 Methodology

The CCVI is not a strictly quantitative tool, so an effort was made to otherwise maximize objectivity. To achieve this, each species was scored twice in a double blind manner. We randomly selected 68 species distributed across five taxonomic groups in proportions that match the ecological communities of the MEDN to estimate patterns of species vulnerability in the park system.

4.1 Species Lists

We obtained species lists for the three parks in the MEDN from www.mednscience.org, www.nature.nps.gov/biology/endageredspecies/speciesdatabase/cfm (for threatened or endangered species), and from MEDN researchers. The lists were modified by the addition, but mostly the removal, of species. For example, marine organisms are excluded from our lists because the CCVI currently does not account for oceanic responses to climate change, such as acidification. The other major removal was plants because there was not enough natural history information to complete their assessments. Although we acquired an invertebrate list for CABR, natural history information for this taxonomic group was insufficient as well. Freshwater fish are not included in CABR or CHIS because distinguishing them from marine fish was not feasible, given the enormity of marine fish occupying these two parks, and time and energy constraints. All modifications to the original MEDN species lists are recorded in the "Notes" section of each park's "____ModifiedSpeciesList_Vertebrates.xls" file. After the lists were finalized, the total amount of species had gone from 862 (CABR) + 1480 (CHIS) + 1682 (SAMO) = 4024 to 204 (CABR) + 97 (CHIS) + 346 (SAMO) = 647.

4.2 Stratification Scheme

Every taxonomic group for which there are data is included in the study to facilitate within park comparisons of these taxonomic groups. Unlike earlier vulnerability studies that use the CCVI and intentionally selected species thought to be vulnerable to climate change, we used a stratified random sampling scheme for species selection (Figure 2) (Schlesinger et al. 2011). Doing so allowed us to draw vulnerability conclusions that are not restricted to the species assessed, but extend to their nativity, conservation, taxonomic groups, and parks. A stratified random sampling scheme also ensures no species selection bias that may unrealistically portray the vulnerability of a given park or of the park network as a whole, such as by assessing only vulnerable species.

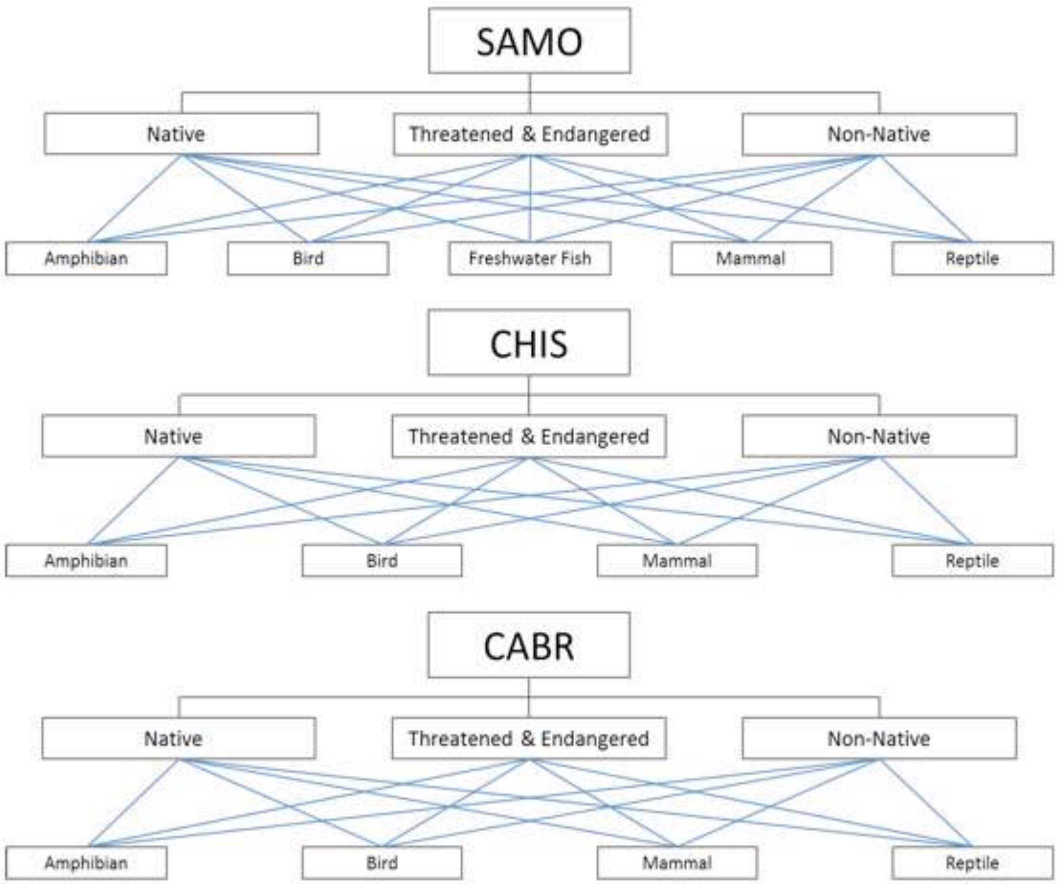

Figure 2. Schematic diagram of species selection. The 68 species were divided by three stratification levels for species selection: 1) by park, 2) nativity status and conservation status, and 3) taxonomic group. The number of species selected for assessment within each category depends on the proportion of species within that category in the MEDN. Species were selected randomly from within each stratification category. Native groupings include species listed as threatened and endangered. SAMO is the Santa Monica National Recreation Area; CHIS is the Channel Islands National Park; CABR is the Cabrillo National Monument.

To select species for assessment from our modified list of 647 species, we initially divided them by park into three lists. Park lists were further broken into three sub-classifications: i) native, ii) non-native and iii) threatened or endangered (included in native sub-classification).

Each of these three sub-classifications was divided into the taxonomic groups present in each of the parks (Figure 2).

Within the taxonomic group tier, we assigned each species a number and then randomly sorted the numbers using www.Random.org. The number of species chosen from each park, nativity, conservation status, and taxonomic group for assessment depended on the proportion of species within each stratification category on the modified species lists. For example, of the total number of species from the whole park system, 53% are from SAMO, 32% are from CABR, and 15% are from CHIS. Therefore, of the species we assessed, ~53% are from SAMO, ~32% from CABR, and ~15% from CHIS.

The proportions of species we assessed only roughly match the proportions of our stratification scheme because we rounded up from any fraction below zero, so that at least one species was assessed for every taxonomic group within the third tier of stratification if a species existed. We rounded to an integer number of species by standard rounding rules for all other stratification categories. Initially starting with 52 species for assessment, special taxonomic group rounding increased our species number to 68. Therefore, with seven assessors each doing about two assessments per week for ten weeks, we conducted 136 assessments.

4.3 Quality Control

We performed trial assessments of the Blanding's turtle, *Emydoidea blandingii*, which was previously assessed by Walk *et al*. in a 2011 study that used the CCVI. This gave us a chance to compare our results to published work. From our seven assessment scores, five resulted in "moderately vulnerable", one was "highly vulnerable", and one was "extremely vulnerable"; while Walk *et al*. (2011) determined that the Blanding's turtle was "presumed stable". To control for this inter-assessor subjectivity, each species in our study was scored separately by two researchers. The entire group together would reassess any species that resulted in a pair of vulnerability scores that were more than one score apart (this assumes that each score is equally spaced along the spectrum of vulnerabilities). Data were collected on how many scores disagreed and by how much. This procedure eliminates some uncertainty in determining the climate change vulnerabilities of species.

Efforts were made to ensure that each person would assess a nearly equal amount of species within each park, taxonomic group, nativity group, threatened or endangered species and overall in order to reduce assessor biases within these categories (Table 1). Furthermore, each possible assessor pair combination was chosen a nearly equal number of times (

Table 2). This arrangement eliminates some uncertainty in determining the climate change vulnerabilities of species.

Table 1. Allocation among assessors of species assessments within stratification categories. A number in “[ ]” is the number of assessments within a given category. The target percentage of assessments for each assessor within a given category is 14.3% because there are 7 assessors.

	Brett	Justin	Karen	Kirstie	Misa	Natalie	Shotaro		mean		SD	
Total Assessments [136]	20 (14.7%)	19 (14.0%)	19 (14.0%)	19 (14.0%)	20 (14.7%)	19 (14.0%)	20 (14.7%)		19.4		0.53	mean
SAMO [70]	10 (14.3%)	10 (14.3%)	10 (14.3%)	10 (14.3%)	10 (14.3%)	10 (14.3%)	10 (14.3%)		10		0.0	
CHIS [26]	4 (15.4%)	4 (15.4%)	3 (11.5%)	3 (11.5%)	4 (15.4%)	4 (15.4%)	4 (15.4%)		3.7		0.49	
CABR [40]	6 (15.0%)	5 (12.5%)	6 (15.0%)	6 (15.0%)	6 (15.0%)	5 (12.5%)	6 (15.0%)		5.7		0.49	
Native [120]	17 (14.2%)	14 (11.7%)	16 (13.3%)	19 (15.8%)	19 (15.8%)	17 (14.2%)	18 (15.0%)		17.1		1.8	
Non-Native [16]	3 (18.8%)	5 (31.3%)	3 (18.8%)	0 (0.0%)	1 (6.3%)	2 (12.5%)	2 (12.5%)		2.3	(14.3%)	1.6	
Threat./Endanger [14]	3 (21.4%)	2 (14.3%)	2 (14.3%)	4 (28.6%)	1 (7.1%)	1 (7.1%)	1 (7.1%)		2		1.2	0.80
Amphibian [10]	2 (20.0%)	1 (10.0%)	2 (20.0%)	2 (20.0%)	1 (10.0%)	0 (0.0%)	2 (20.0%)		1.4		0.79	
Bird [90]	13 (14.4%)	13 (14.4%)	11 (12.2%)	12 (13.3%)	14 (15.6%)	14 (15.6%)	13 (14.4%)		12.9		1.1	
Fish [6]	1 (16.7%)	1 (16.7%)	1 (16.7%)	1 (16.7%)	0 (0.0%)	1 (16.7%)	1 (16.7%)		0.86		0.38	
Mammal [18]	2 (11.1%)	2 (11.1%)	3 (16.7%)	2 (11.1%)	4 (22.2%)	2 (11.1%)	3 (16.7%)		2.6		0.79	
Reptile [12]	2 (16.7%)	2 (16.7%)	2 (16.7%)	2 (16.7%)	1 (8.3%)	2 (16.7%)	1 (8.3%)		1.7		0.49	

Table 2. Assessor pair frequencies.

	Brett	Justin	Karen	Kirstie	Misa	Natalie	Shotaro
Brett	0	3	4	3	3	4	3
Justin	3	0	4	3	3	2	4
Karen	4	4	0	2	3	3	3
Kirstie	3	3	2	0	4	4	3
Misa	3	3	3	4	0	4	3
Natalie	4	2	3	4	4	0	3
Shotaro	3	4	3	3	3	3	0
mean	3.3	3.2	3.2	3.2	3.3	3.2	3.3
	3.2						
SD	0.1						

Although the CCVI itself calculates a vulnerability confidence score for each species based on input parameters, differences between assessment results for the same species, if any, provided additional confidence information.

4.4 Lacking Information

The CCVI's Section B requires that at least 3 of the 4 parameters are filled to calculate a vulnerability score, and Section C requires this for 10 of the 16 parameters. Species for which these data were lacking were replaced by the next species in the randomly ordered list. Replaced species were recorded to aid in the analysis of which taxonomic, nativity, and park groups we know most and least about.

4.5 Assessments

This study relies heavily on the NatureServe CCVI for which instruction is provided in the Guidelines for Using the NatureServe Climate Change Vulnerability Index document, from here on referred to as the "Guidelines". The following explanation of this study's assessment procedure is intended to be an abbreviated version of the Guidelines. For the purpose of providing insight to and instilling confidence in our reasoning, it is accompanied by an example assessment of *Rana draytonii*, the California red-legged frog.

4.5.1 Preliminary Information

Preliminary information is input before filling in Sections A–D. This includes: the geographic area assessed, species scientific and common names, major taxonomic group, relation of species' range to assessment area, assessor, G and S ranks, and whether the species is a cave or groundwater aquatic system obligate. G (Global) and S (State) ranks are NatureServe conservation status ranks that do not consider climate change, but do account for crucial determinants of species vulnerability, such as population size, that the CCVI tool does not. Thus, NatureServe recommends using the CCVI results and G and S ranks in concert to inform management decisions (Young *et al*., 2011). The ranks are listed for a species within its respective "Conservation Status" section of the NatureServe Explorer database, which is freely accessible to the public online at http://natureserve.org/explorer, suggested by NS, and was the first resource we used for information before accessing peer-reviewed literature, books, other websites, and available experts. The specific sources were recorded in the "Assessment Notes" box for each assessment.

For the example assessment, the inputs—in the same order as above—include: SAMO, *Rana draytonii*, California red-legged frog, amphibian, east/west edge of range, Shotaro, G2G3 and S2S3, and the obligate field is left blank. Ranks of 2 and 3 out of 5 mean that *R. draytonii* is imperiled to vulnerable according to NatureServe.

4.5.2 Section A: Exposure to Local Climate Change

For SAMO and CABR, we relied on ClimateWizard (http://www.climatewizard.org/) for most of the downscaled climate data (e.g. future temperature change, and past temperature and precipitation), which is recommended by NatureServe. Future percent Hamon AET:PET moisture change data were downloaded from NatureServe (http://natureserve.org/). The settings we selected to obtain the projected annual average temperature change compared to the 1961–1990 baseline average are as follows: the 16 GCMs ensemble average climate model (median value for each cell), A1B (medium) emissions scenario, and mid-century (2050) time period (Table 3). This data is available for use in ArcMap at a 12 km resolution (Figure 3, Figure 4). Past climate data were average annual temperature and precipitation for the time period of 1951–2006 at 4 km resolution. To fulfill the requirements of this section, a map of projected temperature or Hamon AET:PET and one of a given species' range were overlaid. Next, the percentages of the species' range within the assessment area that fall into NatureServe designated temperature or AET:PET ranges are calculated. Most species included the entire area of a given park, so climate data only needed to be collected and calculated once. The values for both climate variables must be determined for the CCVI to assess vulnerability.

Projections of warming in the SAMO are moderate to low (from < 3.9 to ~5.5 degrees F) in relation to the scale range of the CCVI (Figure 3). Figure 4 shows that all of the SAMO is to experience percent moisture change of about -3% to -5%. This data is at the lower end of predictions for the United States, according to the nationwide map from the inset of Figure 4Figure 4.

For CHIS, future temperature and moisture maps were not available from ClimateWizard, so we improvised by downloading downscaled past and future temperature and actual evapotranspiration (AET) data from http://regclim.coas.oregonstate.edu/index.html, a collaboration website between the United States Geological Survey (USGS) and Oregon State University (OSU). We averaged the climate data from three general circulation models: MPI ECHAM5, USGS GENMOM, and GFDL CM2.0. The future climate projections (2040–2069 time-mean) are modeled under the A2 (high) emissions scenario (IPCC, 2007) at 15 km resolution and compared to the 1968–1990 time-mean of the models (Table 3). In spite of the higher emissions scenario, CHIS was projected to experience less temperature increase (~1.5-2°F) than SAMO and CABR (Figure 3, CHIS). Potential evapotranspiration (PET) data were not available for download so we used simulated monthly future and past temperature (from the USGS and OSU) and day length (from the United States Naval Observatory) in the Hamon equation for calculating PET (Hamon, 1960). Percent change in AET:PET was calculated by subtracting past AET:PET from future AET:PET and then dividing by the past AET:PET, for each grid cell (Figure 4, CHIS) (Hamon, 1960). Some parts of the islands are projected to experience greater drying than the mainland (e.g. most of Anacapa), while other regions are projected to experience less net drying by 2050 (e.g. the northern parts of all islands). The moisture projections were highly variable with parts of the islands modeled to experience <2.8% AET:PET deficits and others >11.9% (Figure 4, CHIS). Although, some of this variation can probably be attributed to grid cells that were dominated by water, and therefore, inaccurately represented future moisture change on the small proportions of land that also occupied these grid cells.

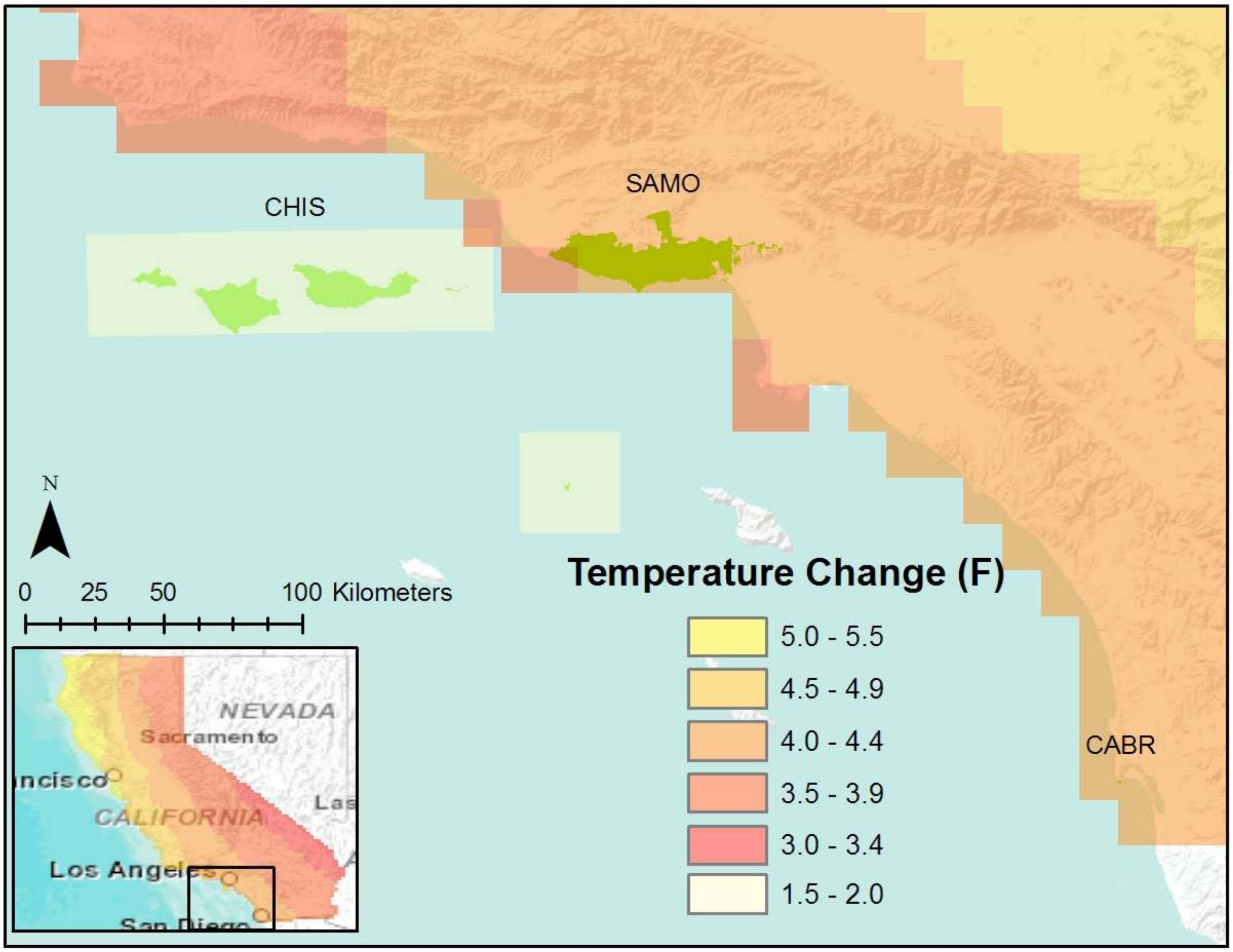

Figure 3. Map of Future temperature change from the 1970s to the 2050s. Temperature change is calculated from model output of future temperature (2040-2069 time mean) minus past temperature (1961-1990 time mean) for the ensemble average of 16 IPCC models under the A1B (medium) emissions scenario. Temperature change for the CHIS is calculated by averaging simulated future temperature (2040-2069 time mean) minus simulated past temperature (1968-1990 time mean) under the A1 (high) emissions scenario for MPI ECHAM5, USGS GENMOM, and GFDL CM2.0.

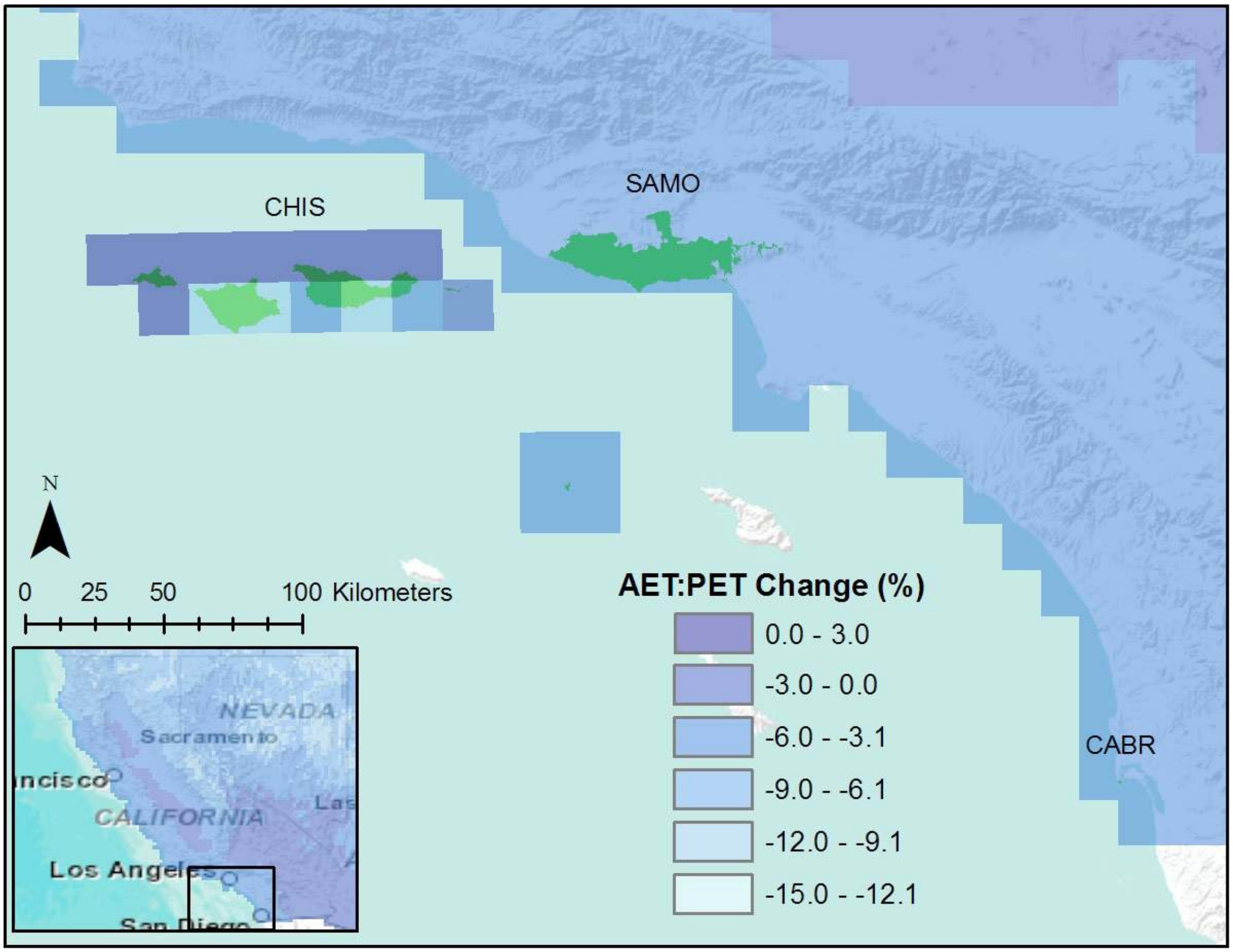

Figure 4. Map of percent change in AET:PET from the 1970s to the 2050s. AET:PET changes for each grid cell are normalized to their 1950 decadal mean. AET:PET change is calculated from model output of future AET:PET (2040-2069 time mean) minus past AET:PET (1961-1990 time mean) and divided by past AET:PET for the ensemble average of 16 IPCC models under the A1B (medium) emissions scenario and using the equation for Hamon PET (Hamon, 1960). The A1 (high) emissions scenario and MPI ECHAM5, USGS GENMOM, and GFDL CM2.0 were used for the CHIS.

Table 3. Climate models, Emissions Scenarios, and Time Periods used in the CCVI.

	Future Settings				
Park(s)	*GCMs*	*Emissions Scenario*	*Resolution*	*Future Time Period*	*Past Time Period*
SAMO & CABR	ensemble average of 16 from IPCC AR4	A1B (medium)	12 km	2040-2069	1961-1990
CHIS	MPI ECHAM5, USGS GENMOM, and GFDL CM2.0	A2 (high)	15 km	2040-2069	1968-1990

4.5.3 Section B: Indirect Exposure to Climate Change

Three subsections determine indirect exposure to climate change: exposure to sea level rise, distribution relative to natural and anthropogenic barriers, and predicted impact of land use changes resulting from human responses to climate change. The Guidelines suggest the use of an interactive map provided by the University of Arizona's Department of Geosciences (UADG) that simulates inundation due to rising sea level (http://www.geo.arizona.edu/dgesl/research/other/climate_change_and_sea_level/mapping_slr/). Additionally, conclusions of Adams and Inman (2009) about storm surge and wave induced cliff erosion were taken into account. To score species restriction to natural and anthropogenic barriers, we reviewed species mobility information and additional maps. For instance, identifying a large distance between freshwater bodies means increased vulnerability for fish, but less so for ducks. Likewise, non-volant animals rate as more vulnerable than birds to roadways, an anthropogenic barrier. Actions to mitigate climate change may contribute to the vulnerability of a species, which would be the consequence if a new solar farm was built on previously undisturbed wildland.

It is obvious from viewing the UADG map that if sea level rises by 1 meter, SAMO will experience less than 10% inundation. The potential losses from storm surges and wave erosion were not thought to be significant either; therefore, *Rana draytonii* is marked as "neutral" for this factor. NatureServe Explorer notes the identification by the United States Fish and Wildlife Service of water bodies within 2 km of each other and connected by 150 meters wide corridors as suitable minimum quality habitat for *R. draytonii*. Viewing the topographic base map provided by the Environmental Systems Research Institute (http://www.arcgis.com/home/webmap/viewer.html?webmap) in ArcMap reveals possible corridors to hills (e.g. Simi Hills) and mountain ranges (e.g. Santa Susana Mountains) north of SAMO. Yet, *R. draytonii* is marked as "somewhat increase" for the natural barriers factor because these possible corridors are not thought to be abundant. The vast majority of urban development will hinder—if not completely prevent—migration by *R. draytonii*, so due to the considerable urbanization around the SAMO, "greatly increase" is marked for the anthropogenic barriers factor. No climate change mitigation projects such as alternative energy infrastructure would appear to negatively or positively affect *R. draytonii* in the SAMO and its potential future range, so it is marked as "neutral" for the climate change influenced intentional land use change factor.

4.5.4 Section C: Sensitivity

In this section, each factor pertains to the species' intrinsic abilities, so environmental influences should not be considered. For example, factor 1 is concerned with the capacity of a species to disperse and move, irrespective of barriers because they are accounted for in section B. The California red-legged frog is a non-migrant locally and over long distances according to NatureServe Explorer, but because it can move up to 2 km it earns a "neutral" rating for the dispersal and movement factor.

Temperature and precipitation variability tolerance is rated in subsection C2; along with dependence on a disturbance regime that may change with the climate; and snow, ice, etc. habitats. The CCVI bases temperature variability on the cells with the largest average differences between annual high and low temperatures, and constitute more than 10% of the assessment area. Precipitation variability is defined as the difference between the average annual minimum and maximum cell values within the species' assessment area. Additionally, the preference for cold and/or moist environments is considered in rating climate variability tolerance.

Rana draytonii is noted by NatureServe Explorer to be inactive in cold temperatures, but it certainly depends on the coolest habitat in SAMO, which will likely decrease in extent because of climate change. This dependence and associated loss is consistent with a rating of "greatly increase" as it is defined in the Guidelines for the physiological thermal niche of a species. Also, the historical temperature variation of this assessment area is between 47.1–57°F, resulting in a "somewhat increase" contribution to vulnerability. *R. draytonii*'s hydrological niche is comparably specific, being between 11–20 inches of precipitation variation, and therefore, it "somewhat increases" vulnerability to potential precipitation changes. In consideration of *R. draytonii*'s hydrological niche, its vulnerability is best described by this factor's definitions of "increase" and "greatly increase" because our climate projection data indicate net drying that would be detrimental to such an aquatically dependent species. For dependence on a disturbance regime that may change, *R. draytonii* is marked as "unknown" because it is unclear how fires, floods, and landslides influence its vulnerability and whether they will increase or decrease in frequency with climate change. This species does not depend on freezing habitats so it is marked as "neutral" for this factor.

Subsection C3 relates to the reliance of a species on uncommon geological features such as soil and water pH, therefore, from range map inferences and no information about this frog species' geological specificity, *Rana draytonii* rates "neutral" for this factor.

The interspecific interactions subsection C4 accounts for dietary versatility and dependence on other species for habitat generation, propagule dispersal, and a factor of choice. It is assumed that lack of information about *Rana draytonii* does not mean oversight, so it is rated "neutral" for habitat generation dependence. The vulnerability contribution from the dietary versatility factor is "neutral" because of *R. draytonii*'s taste for a variety of invertebrates and small vertebrates. It does not rank as "somewhat decrease" because it does not eat plants as an adult. *R. draytonii* does not depend on other species for propagule dispersal, and therefore, is marked as "neutral" for this factor. No other species interaction is apparent so this factor is marked "unknown" by default. The decisions to select "neutral" versus "unknown" in this subsection exemplify the CCVI's reliance on assessor judgment.

The opportunity to account for genetic factors is given in subsection C5, where either measured genetic variation or the occurrence of recent bottlenecks may be credited with a vulnerability contribution. The former is not expected to be common, while that of recent bottlenecks is more likely because it is traditionally easier to observe. Although genetic research of *Rana aurora* and *Rana draytonii* distinguished them as separate species, variability within a species was not assessed by Shaffer *et al*. (2004). From occurrence counts shared via the Global Biodiversity Information Facility website (www.gbif.org), *R. draytonii* qualifies for the most severe vulnerability rank of "increase" for this factor. With the understanding that occurrence data do not necessarily reflect actual population sizes, "neutral" is also selected.

Lastly for section C, phenological response to climate change can be searched for in the USA National Phenology Network database (http://www.usanpn.org/). Yet, no information was found for *Rana draytonii*, so the vulnerability contribution of this factor must remain "unknown". Overall for Section C, 11 of 16 factors were scored, satisfying the information quantity requirements of the CCVI.

4.5.5 Section D: Documented and Modeled Response to Climate Change

This final section is optional and not expected to play much of a role in our assessments, given the newness of assessing species vulnerability to climate change. Accordingly, no previous studies involving *Rana draytonii* and climate change vulnerability were found. We are aware of a few peer-reviewed papers, such as Gardali *et al.*'s (2012) and Loarie *et al.*'s (2008) that studied climate change effects on California wildlife, but unfortunately their conclusions do not neatly fit into the CCVI parameters. In the rare event that data were available, they were included.

Rana draytonii, the threatened California red-legged frog, is "highly vulnerable" with "moderate" confidence according to this assessment. Without regard to the weight of each factor, the largest increases to vulnerability came from anthropogenic barriers, the lack of experience with and the suspected low tolerance for direct temperature and moisture variation, and a possible bottleneck. The caveats are that this is the result of one vulnerability assessment tool and one assessor. As was discussed above, in order to reduce subjectivity in this study, two assessors were assigned to each species within a given park. The vulnerability resulting from the second independent assessment of *R. draytonii* is "highly vulnerable" with "very high" confidence.

5 <u>Results</u>

Assessors agreed on vulnerability scores for 76% of species, while the remainder scored no further than one vulnerability apart; no species had to be assessed by the group as a whole. Using the CCVI scores, we compared the vulnerabilities within each tier of the stratification scheme to determine the most vulnerable parks, taxonomic groups, nativity statuses, and conservation statuses.

Table 4. Overall vulnerability score equivalents.

Extremely Vulnerable (EV)	3
HV-EV	2.5
Highly Vulnerable (HV)	2
MV-HV	1.5
Moderately Vulnerable (MV)	1
PS-MV	0.5
Presumed Stable (PS)	0
IL-PS	-0.5
Increase in Range Likely (IL)	-1

To be able to quantitatively analyze differences between stratification groups, final and factor vulnerability scores were assigned integer values (Table 4, Table 5). In doing so, we assumed that the distances between all vulnerability scores are equal. To determine which factors had the greatest influence on the final vulnerability scores within our assessment we ran linear regressions between each factor and final vulnerability scores. The dispersal and movement, sea level rise, anthropogenic barriers, and natural barriers scores are the four factors that individually explain the largest percentage of variability in the final scores, and are the only ones that explain more than 20% of the final score variability (Figure 5). The dispersal score, for example, has the highest R^2 of any factor and explains 45% of the variation in the final scores (Figure 5A). The slope of the anthropogenic barrier score regression is the greatest among these four factors, indicating that slight changes in its value had the largest effect on the overall scores (Figure 5C).

Table 5. Factor vulnerability score equivalents.

Greatly Increase (GI)	5
GI-I	4.5
Increase (I)	4
I-SI	3.5
Somewhat Increase (SI)	3
SI-N	2.5
Neutral (N)	2
N-SD	1.5
Somewhat Decrease (SD)	1
SD-D	0.5
Decrease (D)	0

A B C D

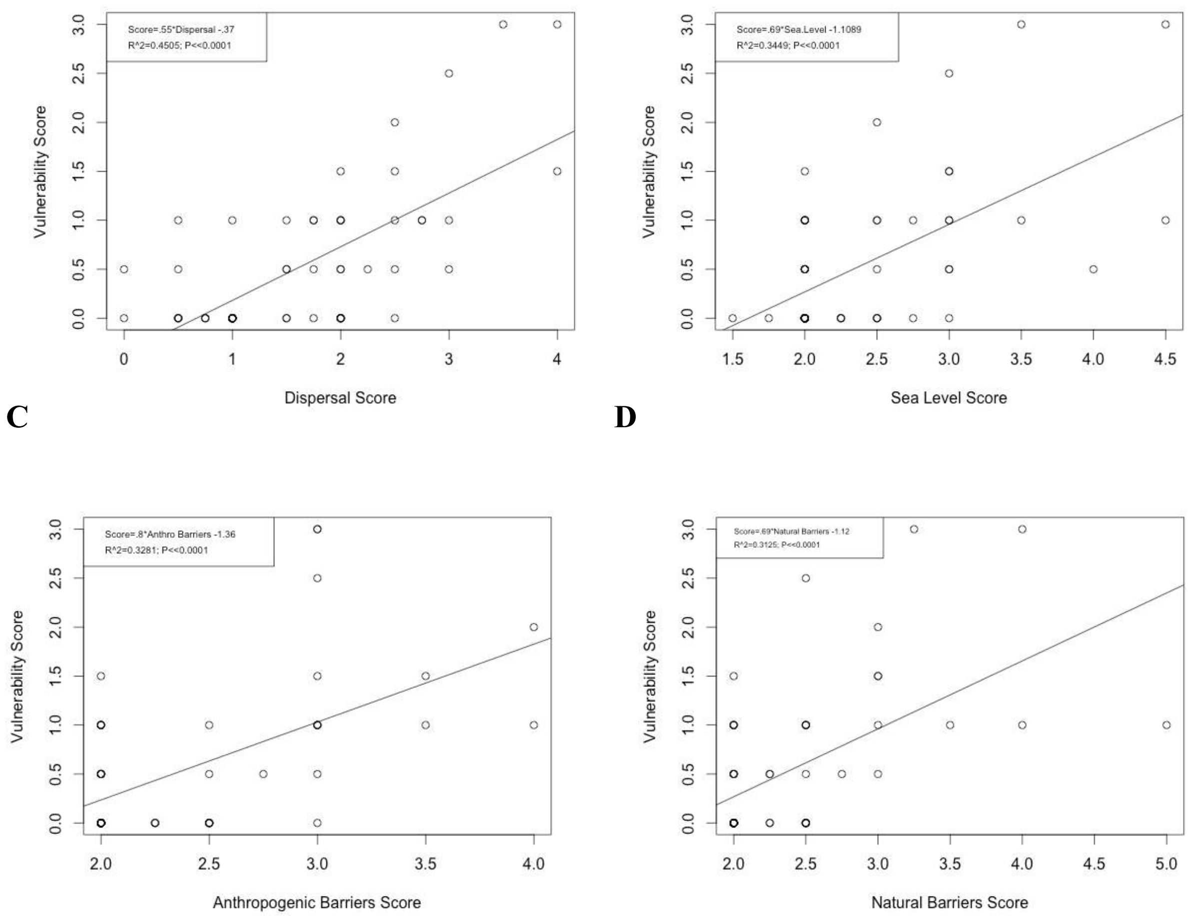

Figure 5. Linear regressions between overall vulnerability scores and the four factors with the highest R^2 values: Dispersal (A), Sea Level (B), Anthropogenic Barriers (C) and Natural Barriers (D) (all p-values <<.0001). Differences in the range of applicable values for each factor in the index lead to differences in the range of x-axis values between plots.

A multivariate regression that combines these four factors explains 75% of the variability in the final vulnerability scores ($R^2 = .75$, $p << .0001$):

$$\text{Final Score} = \text{Dispersal} + \text{Sea Level} + \text{Natural} + \text{Anthropogenic Barriers} \quad (1)$$

5.1 Park Vulnerabilities

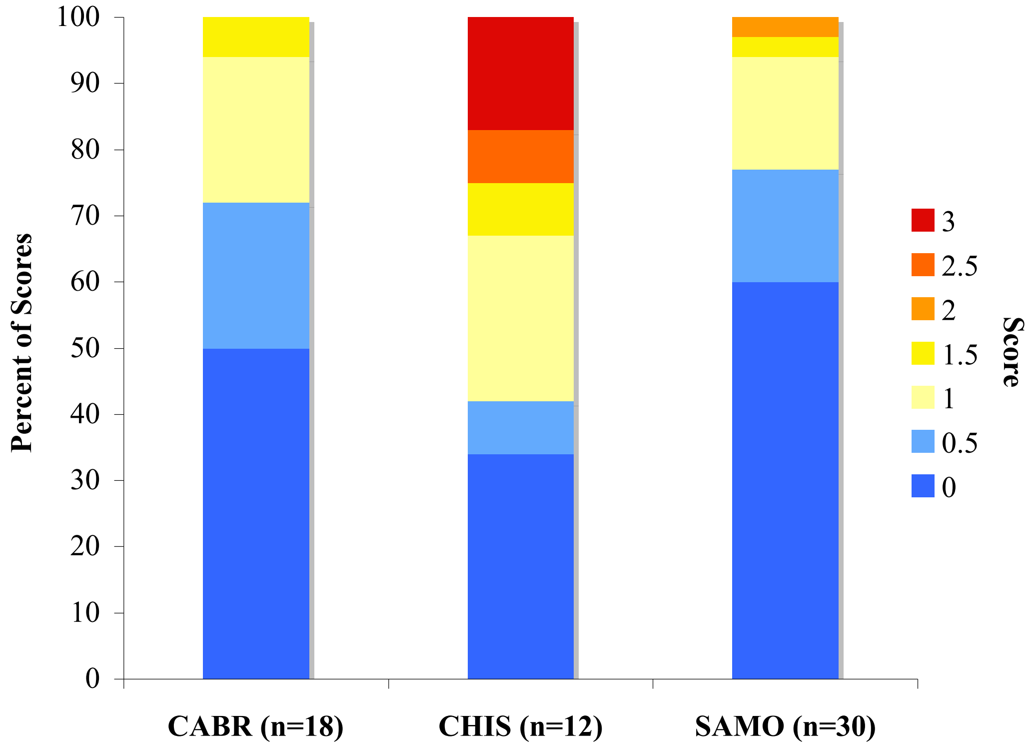

Figure 6. Percent distribution of overall vulnerability scores within the parks. Each score is the average of two assessments for one species. Only native species are included. Cool colors represent MV-PS and PS species. Warm colors represent EV through MV species. See Table 4 for the vulnerability score equivalents of the numeric values listed at the right in this figure.

The mean vulnerability scores for the three parks are 0.4 (SD = 0.4), 1.1 (SD = 1.2), and 0.4 (SD = 0.5) for the CABR, CHIS, and SAMO, respectively. The percentage of PS vulnerability scores is greatest in the SAMO (63%), followed by CABR (55%) and CHIS (46%) (Figure 6). The percentage of EV scores is greatest in the CHIS (15%), while both SAMO and CABR have 0% EV scores. Within the SAMO, scores range from HV through PS, so no species received scores of EV-HV or EV. The percentage of species that received a score of MV-PS is 17% in the SAMO. The MV scores account for 14% of the species, while HV-MV and HV scores each comprise 3% of the species in the SAMO. In the CABR, scores range from HV-MV through PS. No species received scores of EV, EV-HV, or HV in this park. 20% of species scored MV-PS or MV in the CABR. The remaining 5% of the CABR is made up of species that received a score of HV-MV. In the CHIS, scores range from EV through PS, but the scores of MV-PS and HV both account for 0% of the species. The percentage of species with MV scores is 23%, followed by 8% of the species receiving HV-MV scores in the CHIS. Another 8% is composed of species receiving EV-HV scores, with the remaining 15% of the CHIS species receiving EV scores.

5.2 Nativity Vulnerabilities

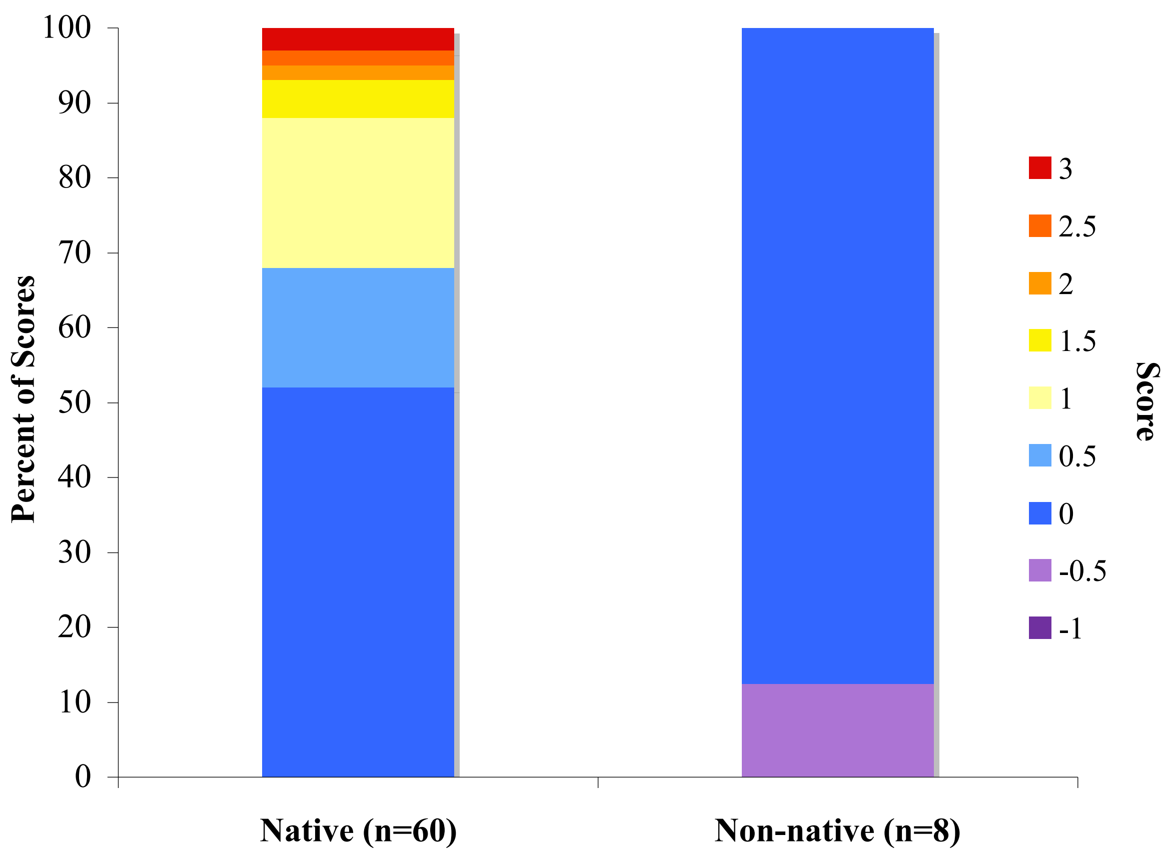

Figure 7. Percent distribution of overall vulnerability scores by nativity. Each score is the average of two assessments for one species. Cool colors represent MV-PS through IL species and warm colors EV through MV vulnerable species. See Table 4 for the vulnerability score equivalents of the numeric values listed at the right in this figure.

Native species vulnerabilities ranged from PS through EV, while all non-natives were either PS or IL (Figure 7). Most natives scored PS (52%) and the second highest percentage of native species scored MV (20%). The percentage of natives with scores of MV-PS is 16%, while HV-MV is 5%, HV or EV-HV is 2%, and EV is 3%. The averaged native vulnerability score (0.53; SD = 0.74) is significantly different from the non-native average (-0.06; SD = 0.2) (t-test; $p < .01$).

5.3 Conservation Status Vulnerabilities

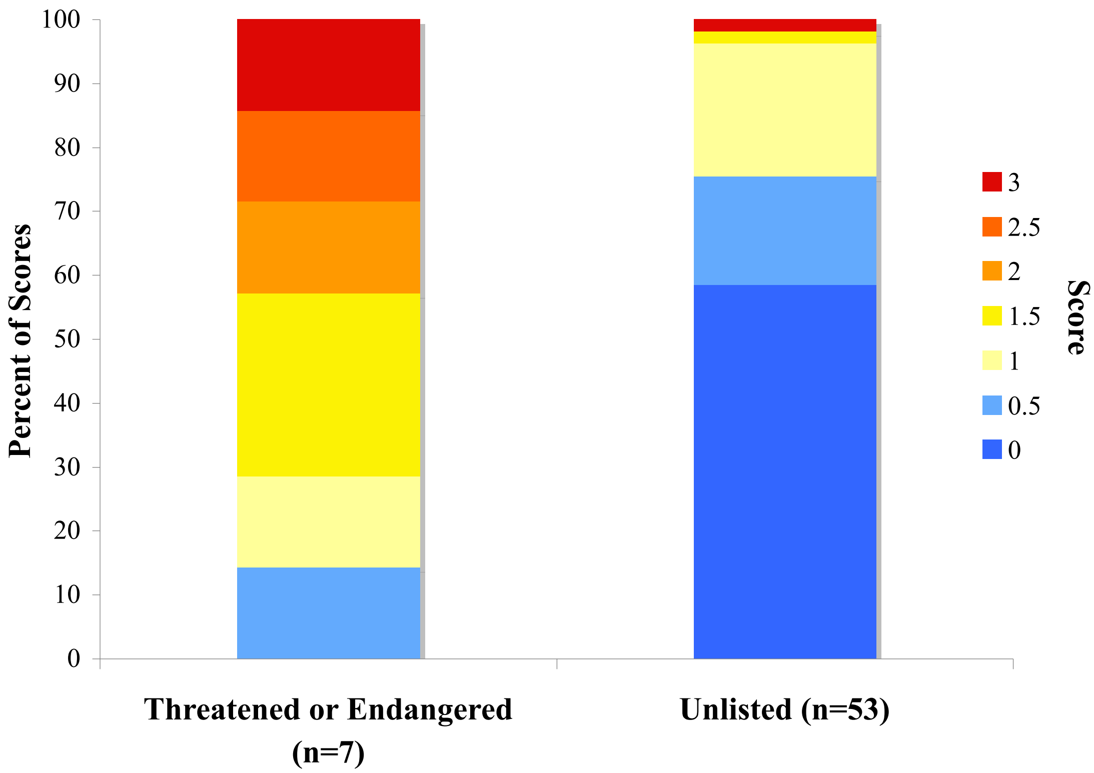

Figure 8. Percent distribution within conservation status groups of overall vulnerability scores for natives. Each score is the average of two assessments for one species. Cool colors represent MV-PS and PS species. Warm colors represent EV through MV species. See Table 4 for the vulnerability score equivalents of the numeric values listed at the right in this figure.

The majority of unlisted native species is PS (59%), where as no threatened or endangered species are PS (Figure 8). 76% of unlisted species are either PS or MV-PS. EV, EV-HV, HV, MV, and MV-PS scores each comprise 14.3% of the listed species, while 28.6% is comprised of HV-MV scores. Within the unlisted species MV scores are greater than 10 times more common than HV-MV and EV scores individually. Out of 7 possible vulnerability scores, listed species cover 6 of them, compared to the 5 vulnerability scores covered by the 53 unlisted species. The unlisted vulnerability scores (from EV through PS) range wider than listed scores (from EV through MV-PS). Threatened and endangered (mean = 1.7; SD = 0.9) were significantly more vulnerable than unlisted species (mean = 0.4; SD = 0.6) (Mann-Whitney test; $p < .001$).

5.4 Taxonomic Vulnerabilities

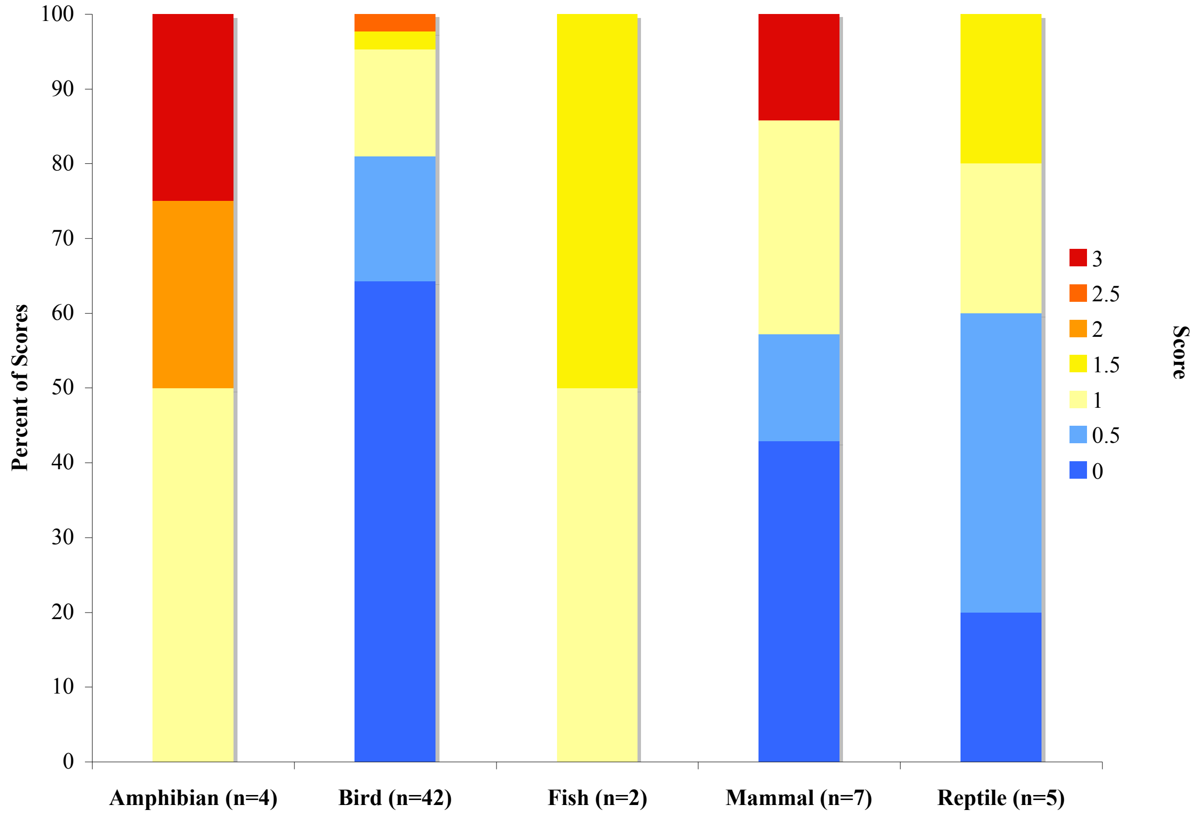

Figure 9. Percent distribution of overall vulnerability scores for natives by taxonomic group. Each score is the average of two assessments for one species. Cool colors represent MV-PS through IL species and warm colors represent EV through MV species. See Table 4 for the vulnerability score equivalents of the numeric values listed at the right in this figure.

The mean vulnerability scores for each taxonomic group are 1.8 (SD = 1.0), 0.3 (SD = 0.5), 1.3 (SD = 0.4), 0.8 (SD = 1.1), 0.7 (SD = 0.6) for amphibians, birds, fishes, mammals, and reptiles, respectively. Together, PS and MV-PS scores comprise the majority of the birds, mammals, and reptiles (Figure 9). The percentage of PS vulnerability scores is highest (64%) within the birds and lowest (0%) within the amphibians and fishes. 43% of mammals are PS as are 20% of reptiles. The percentage of EV through MV species is highest (100%) within the amphibians and fishes, and lowest (19%) within the birds. 43% of mammals and 40% of reptiles were scored EV through MV. EV through MV-PS scores constitute the majority of all taxonomic groups with the exception of birds. Of the warm colors within each taxonomic group, MV scores are equally or more frequent than the remaining scores combined. Within fishes 50% are MV and 50% are HV-MV. Within amphibians 50% are MV, 25% are HV, and 25% are EV.

Birds have the largest variety of scores including: PS, MV-PS, MV, MV-HV, and HV. Mammal vulnerability scores have the widest range, from PS through EV.

6 Discussion

Of comparable significance to any conclusion of this study, the ecology and life history characteristics for vascular plants and invertebrates were not accessible enough to complete a full vulnerability assessment or were inexistent for some species. This was very unfortunate, because these taxa are found at the base of all food chains, and thereby play a prominent role in the life histories of each of the species that we assessed. It is evident that this information is crucial to better pinpointing trends that are causing vulnerability.

Statistically significant vulnerability differences between some of the stratification categories (e.g. native birds and amphibians) were found in the results of our study. The combination of the 4-main-factors—dispersal and movement capability, sea level rise, and dispersal inhibition by anthropogenic and natural barriers—explains a large portion ($R^2 = .75$; $p << .0001$) of the variability in the overall scores. Differences in vulnerability scores between parks, nativity, conservation statuses, and taxonomic groups are likely caused by differences in the values of the 4-main-factors. We used the averaged values of these 4-main-factors to understand the differences among vulnerability scores of stratification groups. In doing so, we assume that they each have equal weight in determining overall vulnerability, which is a rough approximation.

6.1 Parks

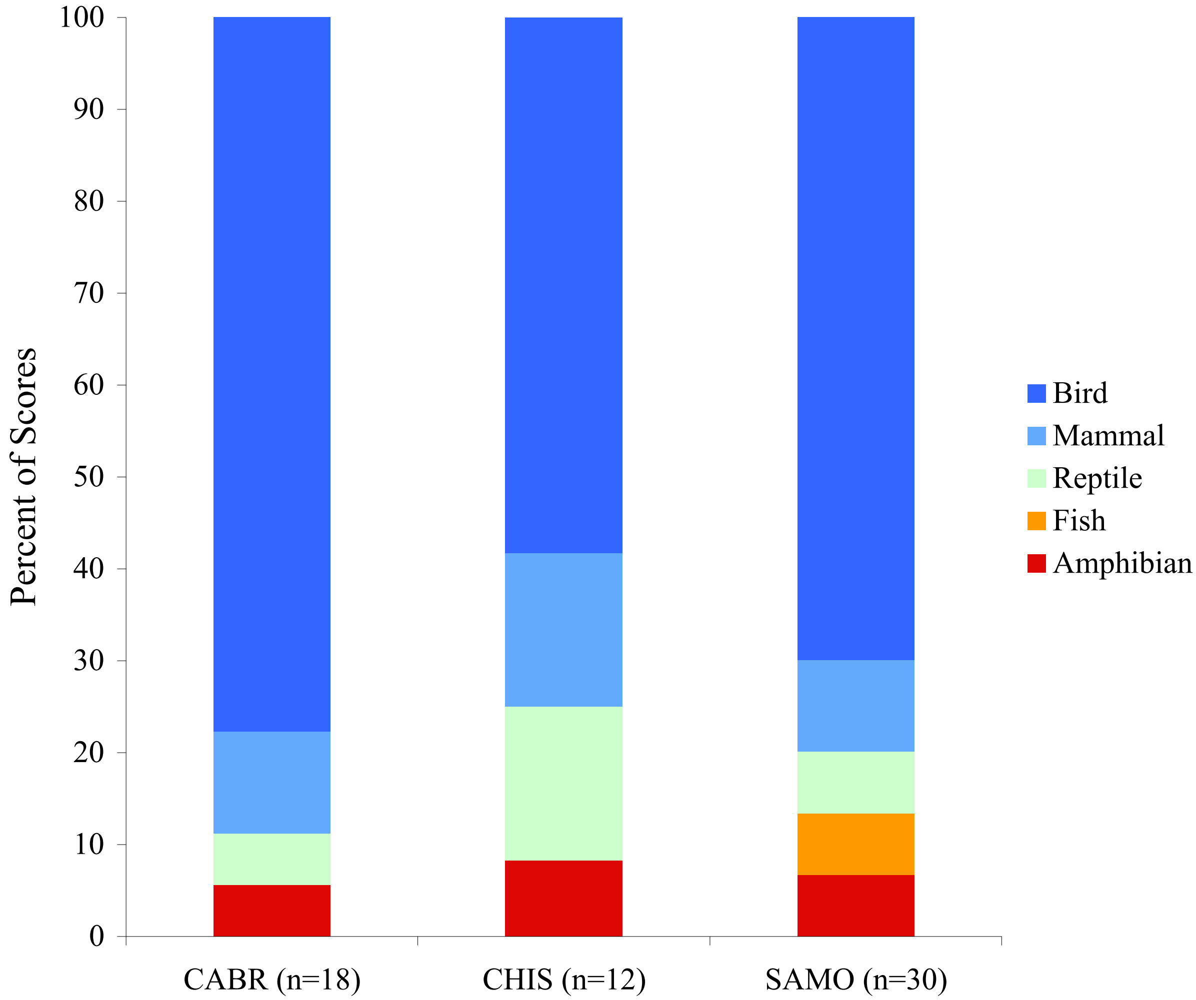

Figure 10. Percent distribution of native species assessed by taxonomic group within each park. The SAMO is the only park with fishes. Both the CABR and CHIS include 1 amphibian, while the SAMO includes 2.

Differences in the percentage of vulnerability scores among parks are probably not due to differences in the percentages of taxonomic groups within each park. Fishes and amphibians comprise approximately 13% of the species within SAMO, 6% of CABR (amphibians only) and 8% of species on the CHIS (amphibians only) (Figure 10). Since fishes and amphibians have the lowest percentage of PS scores and the SAMO has the highest percentage of fishes and amphibians, we would expect that if taxonomic vulnerability explains park vulnerability, the SAMO would have the lowest percentage of PS species. Instead, the opposite is true, the CHIS has the lowest percentage of PS and the highest percentage of MV and greater species, while the SAMO has the highest percentage of PS species (Figure 6). When fishes and amphibians plus threatened and endangered species are considered, we see that the CHIS (33%) has a larger percentage of these assessments than the SAMO (17%) and CABR (10%). The special rounding rules that we followed disproportionately supplemented the CHIS with threatened and endangered species assessments, and likely explain much of the increased overall vulnerability of this park. Yet, the proportion of threatened and endangered species is largest in the actual CHIS, therefore, their higher vulnerability compared to the other parks should not be ignored.

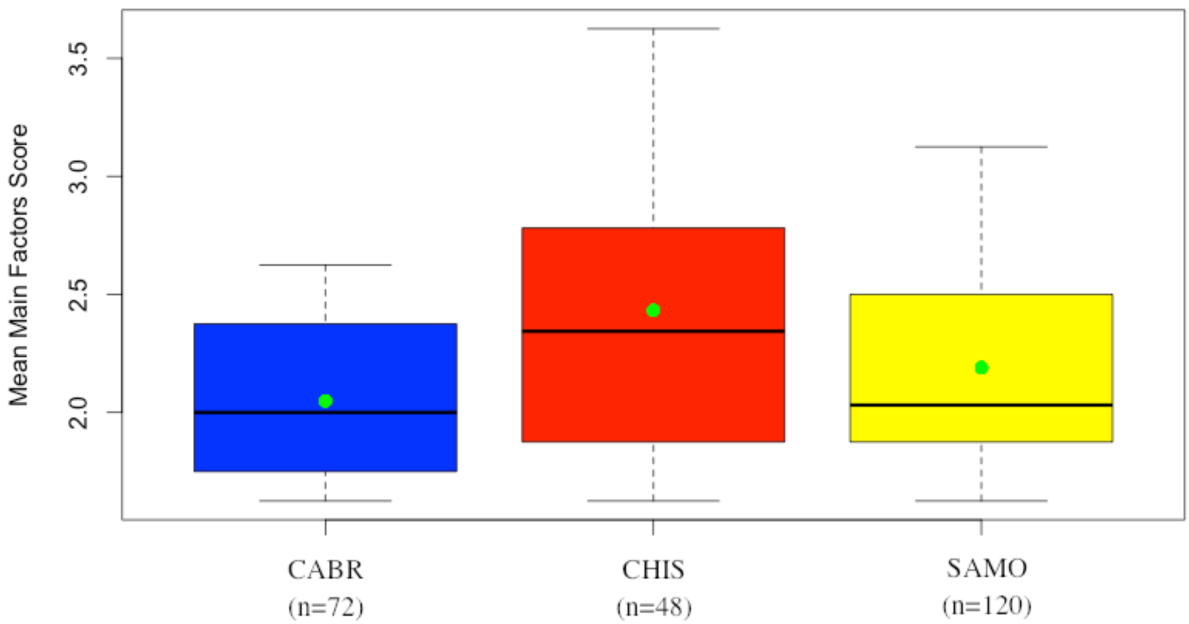

Figure 11. Mean of the 4-main-factors' vulnerability contributions within the parks. The contributions for each park are as follows: CABR-2.0, CHIS-2.4, and SAMO-2.2. See above for the identification of the 4-main-factors. See Table 5 for the vulnerability contribution equivalents of the numerical values on the y-axis. Boxplots show mean score (green dot), median (black horizontal line), interquartile range (IQR) (length of box), quartile 1/3 -/+ 1.5 x IQR or extreme value (plot whiskers), and outliers (white dots).

Park vulnerability may in part be explained by differences between the mean of the 4-main-factors scores (Figure 11). The CHIS received the highest mean vulnerability contribution from the 4-main-factors (mean = 2.4; SD = 0.65), followed by SAMO (mean = 2.2; SD = 0.44) and lastly, CABR (mean = 2; SD = 0.34). Differences in the vulnerability of species among parks may also be caused by differences in the climate models and emissions scenarios used to assess future temperature or moisture change in each park (Table 3), but this influence has not been quantified. Since the CHIS has the highest proportion of vulnerable species, but is projected to experience the lowest amount of future temperature increase, differences between climate models and emissions scenarios probably did not play a large role.

6.2 Nativities

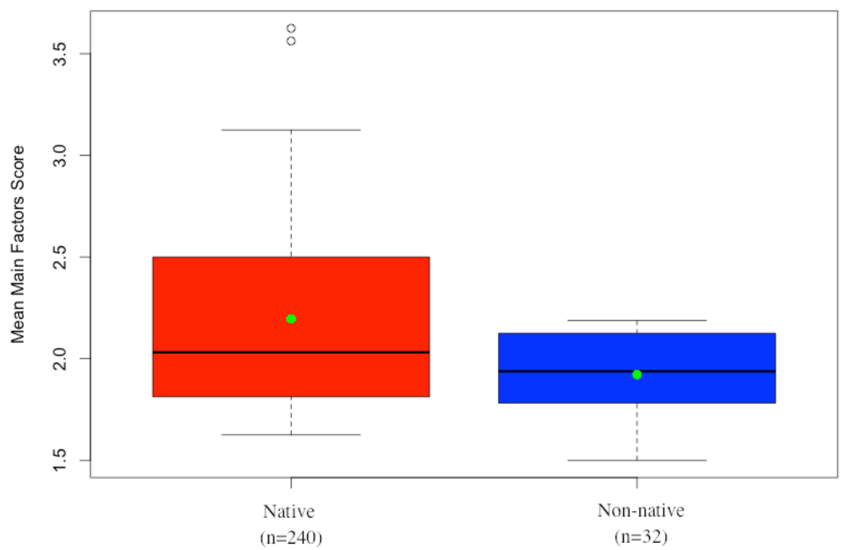

Figure 12. Mean 4-main-factors score by nativity (t-test; $p < .05$). Sample sizes (n) are the results of each species having 4 main factors. See above for the identification of the 4-main-factors. See Table 5 for the vulnerability contribution equivalents of the numerical values on the y-axis. Boxplots show mean score (green dot), median (black horizontal line), interquartile range (IQR) (length of box), quartile 1/3 -/+ 1.5 x IQR or extreme value (plot whiskers), and outliers (white dots).

Natives received a statistically significant higher mean vulnerability contribution (mean = 2.2; SD = 0.48) from the 4-main-factors than non-natives (mean = 1.9; SD = 0.23) (t-test; $p < .05$), which could possibly explain the differences in their final vulnerability scores (Figure 12). This discrepancy in overall vulnerability scores cannot be explained by the proportion of amphibians, fish, and threatened and endangered species within natives versus non-natives because they are 18% and 25%, respectively. Part of the advantage for non-native species is their ability to tolerate and even flourish in disturbed sites, so extensive urban development and degraded natural habitat that surround the MEDN parks, negatively affect these species less than they do natives. Therefore, the 4-main-factors would contribute less vulnerability to non-natives than to natives, and this likely explains most of the statistically significant difference between nativity groups in mean overall vulnerability scores.

6.3 Conservation Statuses

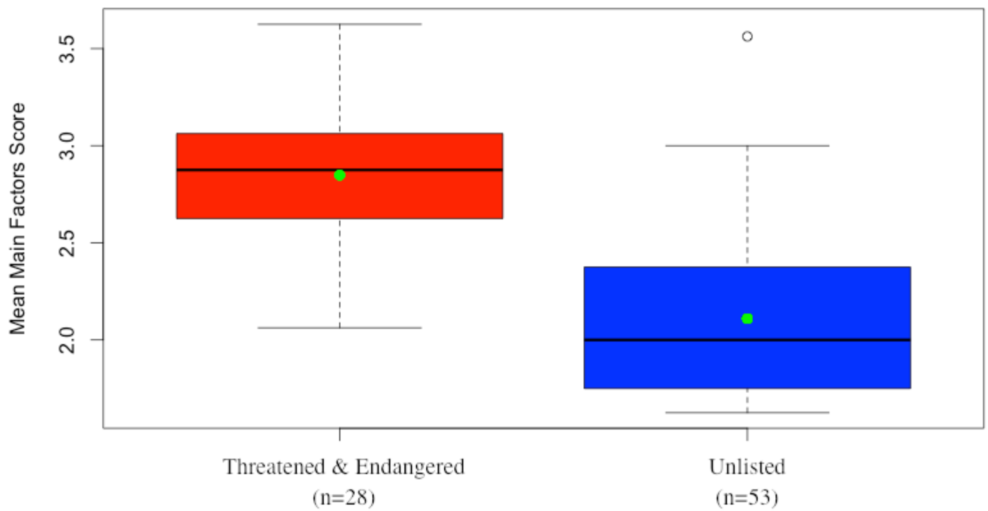

Figure 13. Mean of the 4-main-factors' vulnerability contributions within conservation status groups (t-test; p < .01). The contributions for both conservation status groups are as follows: threatened & endangered-2.8 and unlisted-2.1. See above for the identification of the 4-main-factors. See Table 5 for the vulnerability contribution equivalents of the numerical values on the y-axis. Boxplots show mean score (green dot), median (black horizontal line), interquartile range (IQR) (length of box), quartile 1/3 -/+ 1.5 x IQR or extreme value (plot whiskers), and outliers (white dots).

Listed species received a higher mean vulnerability contribution (mean = 2.8; SD = 0.5) from the 4-main-factors than unlisted (mean = 2.1; SD = 0.4) (t-test; p < .01), which could possibly explain the differences in their final vulnerability scores (Figure 13). Amphibians and fishes make-up 29% of threatened and endangered species compared to 8% of non-listed native species. As you will see below in the discussion of taxonomic groups, amphibians and fishes have the two highest 4-main-factors means. Additionally, the CHIS and its associated higher mean 4-main-factors vulnerability contribution, is disproportionately represented within threatened and endangered species. These characteristics of the listed species probably cause much of their higher 4-main-factors mean, and therefore, their overall vulnerability score.

6.4 Taxonomic Groups

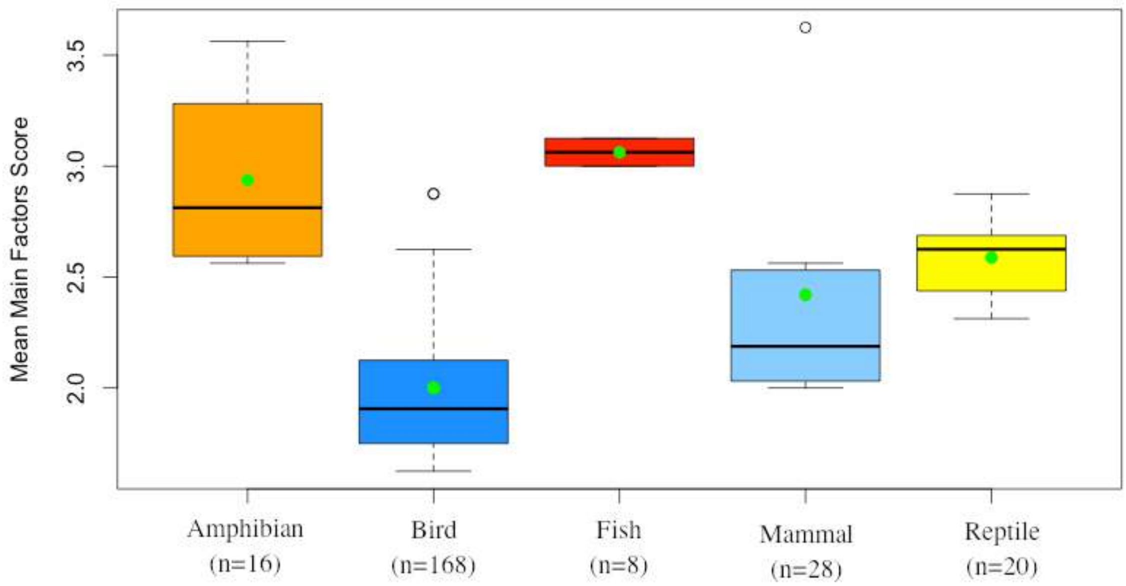

Figure 14. Mean 4-main-factors scores by taxonomic group**.** The 4-main-factors score for birds is significantly lower than other taxonomic groups (Tukey-Kramer Honest Significant Difference Test; $p < .05$). See above for the identification of the 4-main-factors. See Table 5 for the vulnerability contribution equivalents of the numerical values on the y-axis. Boxplots show mean score (green dot), median (black horizontal line), interquartile range (IQR) (box), quartile 1/3 -/+ 1.5 x IQR or most extreme value (plot whiskers), and outliers (white dots).

Taxonomic differences in the mean 4-main-factors scores, to some degree, explain differences in the final vulnerability scores (Figure 14). Fishes (mean = 1.3; SD = 0.4) received the highest mean vulnerability contribution from the 4-main-factors, while birds received the lowest (mean = 0.3; SD = 0.5) (Tukey-Kramer Honest Significant Difference Test; $p < .05$), and amphibians received the second highest. 3 of the 4-main-factors relate to the probability of successful climate change induced migration, so birds are least affected because of their ability to fly. To further highlight this point, with the exception of birds, all terrestrial and freshwater taxonomic groups in the CHIS have little chance of successfully alluding climate change by relocating to the mainland. Additionally, the reliance of amphibians and fishes on wet habitats in a Mediterranean climate, not only limits their ability to cope with projected drying conditions, it exacerbates the difficulty of tracking changing climate envelopes. Other than fishes and amphibians trading places, the 4-main-factors means reflect the overall vulnerability scores of the taxonomic groups.

Differences in vulnerability scores between categories are influenced by the remaining CCVI factors, but the extent is assumed to be negligible. Although not completely accurate, the 4-main-factors are treated as though they have equal weights. The climate change vulnerabilities of native amphibians and fishes that were found in this study may be accurate, but because of small sample sizes (n = 4 and n = 2, respectively), assessments of more species within these taxonomic groups would add confidence. Also, it would be interesting to see the results without the inclusion of species that are consequences of special rounding rules, so that more accurate extrapolations to the overall vulnerabilities of the various stratification categories can be made. We recommend further study of the influences that these caveats have on the results of our study and the implications for the MEDN.

The results indicate that birds have the lowest vulnerability to climate change of all taxonomic groups. 80% of birds have an indication of stability in response to climate change. With their high movement capabilities, sea level rise and barriers may not as negatively impact bird species in the MEDN. Birds have larger ranges relative to other taxonomic groups, so their dispersal capability may not be as adversely affected by habitat loss due to climate change. Both anthropogenic and natural barriers do not pose a threat to these species. The birds that did receive a score that indicates vulnerability to climate change are those already listed as endangered or threatened. The Western Snowy Plover (EV-HV), Coastal California Gnatcatcher (HV-MV), and California Least Tern (MV-PS) are the assessed birds that are listed and scored as vulnerable.

Similar vulnerability studies have been completed, and are used for comparison with our own findings (Byers and Norris, 2011; Schlesinger *et al.,* 2011). The main difference between these two studies and ours is that we randomly selected species to assess, while the New York and West Virginia studies hand selected species that had global and state rankings. Also, the fact that New York and West Virginia are located on the east coast of the United States and have very little to no coastal lands compared to California (and especially the three parks that we focused on) had an influence on some of the differences between our results. Although they looked at species on the east coast of the United States versus west coast we find that there are much more similarities between our results than there are differences.

The most promising similarities that we found between our study and theirs pertained to the degree of vulnerability among taxonomic groups, as well as the most influential factors that were used to calculate these vulnerabilities. All studies agreed that fish and amphibian species were most vulnerable to climate change, while avian and mammal species were least vulnerable. Again, it appears that fishes and amphibians have a harder time dealing with changing moisture levels and have a harder time dispersing and relocating, while this is the opposite case for birds and many mammals.

Of the twenty-four risk factors that were looked at with each assessment, four stood out in our study that correlated most with higher overall vulnerability scores. These were a species response to sea level rise, their movement and dispersal abilities, and lastly, the effects of anthropogenic and natural barriers to dispersal. Unanimously, our three climate change vulnerability studies agreed that a species' movement and dispersal abilities, anthropogenic barriers to dispersal, and natural barriers to dispersal were three of the top factors correlating to higher species vulnerability. Although both of these other studies actually incorporated plants and invertebrates in their assessments, they agreed that it was the hardest information to obtain. They both found correlation between vulnerability and the two factors genetic variation and modeled responses, but again this information was only available for a very small selection of species.

7 Conclusions & Suggestions

The objective of this project was to identify the vulnerability of a randomly selected group of terrestrial and non-marine species that reside in the three national parks of the Mediterranean Coast Network (MEDN). By determining and understanding the species' vulnerability to climate change through various aspects of their life history, range, and habitat, we can effectively conclude what conservation management steps the National Park Service (NPS) should adopt in order to mitigate these climate change stresses. Taxonomic groups are not equally adapted to respond to climate change; amphibians and freshwater fish might be more susceptible than reptiles, birds, and mammals. Nativity also affects a species' vulnerability disproportionately, with non-native animals being far more presumed stable than natives. Species previously listed as endangered or threatened are inherently more vulnerable than unlisted species. In addition, species susceptibility also varied among the parks, with the Channel Islands National Park containing the most vulnerable animals. The NPS can utilize this information to create a climate change mitigation plan that focuses on specific strategies targeting separate taxonomic groups, prioritizing the elimination of non-natives and invasives from the parks, directing efforts to protect species that are already identified as threatened or endangered, and providing special attention to endemics residing on the CHIS.

Factors such as dispersal and movement, sea level rise, and natural and anthropogenic barriers have the greatest amount of impact on a species' ability to tolerate climate change. Furthermore, the dispersal and barriers factors can be potentially controlled by the NPS management team. For example, management plans can focus on assisted migration strategies such as ensuring that species living in riparian habitats will have access to other riparian areas around the park, although this strategy is not widely popular.

In order to efficiently reduce the effects of climate change throughout the Santa Monica Mountains National Recreation Area, Channel Islands National Park, and Cabrillo National Monument, a large amount of research on plants and invertebrates is required. Plants and invertebrates account for the bulk of the MEDN's biomass and biodiversity. Unfortunately, their vulnerabilities could not be properly assessed due to lack of information regarding them. The NPS can ease the consequences of climate change by furthering their studies on plants and invertebrates in their parks. It is evident that global climate change will continue to alter the biodiversity of animals throughout various ecosystems. Assessing species vulnerability to climate change is a first step to preserving biodiversity in light of climate change.

We suggest a couple of options for future studies of species vulnerability in the MEDN. First, selection of more species for assessment in continuation of our study would provide greater confidence in extrapolating vulnerabilities to park, nativity, conservation status, and taxonomic groups. Second, selection of just a few species (e.g. keystone) for assessment would allow for a more in-depth analysis of specific species vulnerabilities, and therefore, provide more confidence. Our study serves as a useful reference for park managers looking for an approximate understanding of what climate change has in store for the species of the MEDN.

8 Literature Cited

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Williams, S.E., Shoo L.P., Isaac J.L., Hoffmann A.A. & Langham G. (2008) Towards an integrated framework for Assessing the Vulnerability of Species to Climate Change. *PLoS biology*, **6**, 2621-6.

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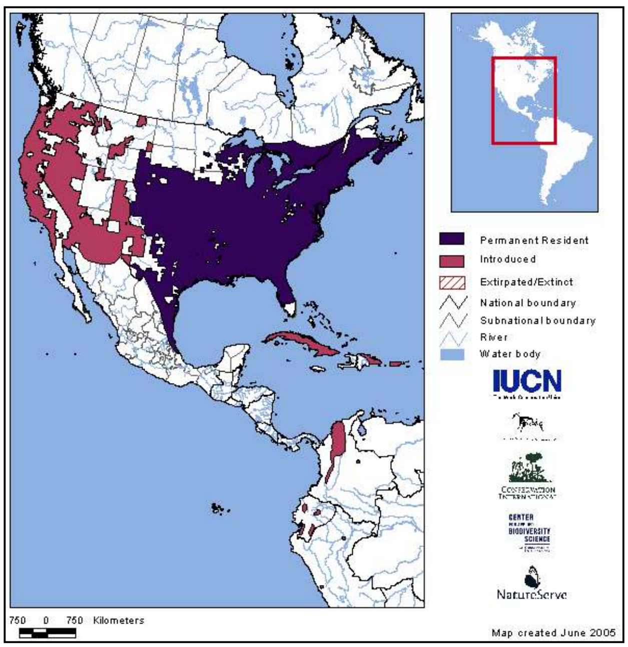
9 Appendices

9.1 Results Database

Available digitally from the authors.

9.2 Species

American Bullfrog (*Lithobates* [=*Rana*] *catesbeiana*)
PRESUMED STABLE



Taxonomic Group: Amphibian

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): .5

Diet Type: Carnivore, Invertivore

Nativity: Non-native

Abundance: Uncommon

Habitat: Forested, Herbaceous, Scrub-shrub Wetland Riparian,

References:

NatureServe (2012) American Bullfrog (*Rana catesbeiana*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from http://www.natureserve.org/explorer.

Anacapa Deer Mouse (*Peromyscus maniculatus anacapae*)
MODERATELY VULNERABLE

Taxonomic Group: Mammal

Park: CHIS

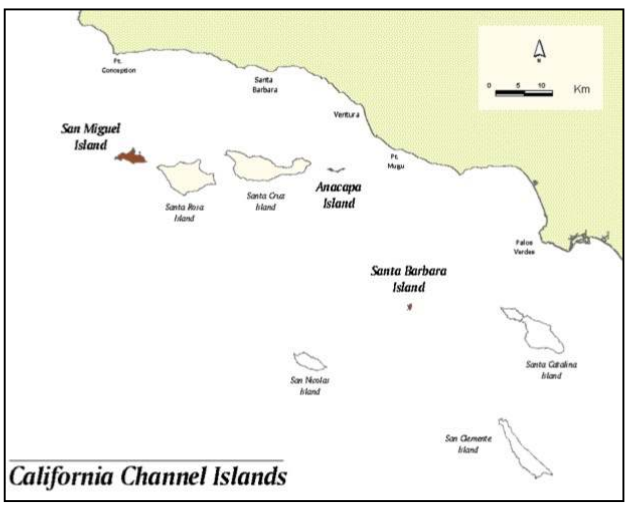
G-Rank: G5T1T2

S-Rank: S1S2

Body Mass (kg): .033

Diet Type: Frugivore, Granivore

Nativity: Native



Abundance: Uncommon

Habitat: Alpine, Cropland, Hedgecrow, Desert, Conifer, Hardwood and Mixed Forest

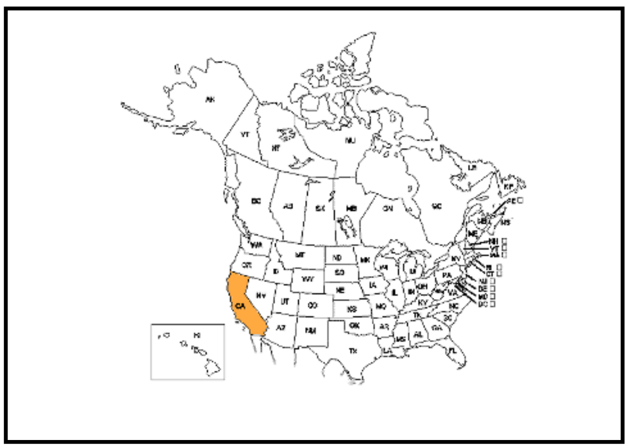
References:

NatureServe (2012) Anacapa Deer Mouse (*Peromyscus maniculatus anacapae*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from http://www.natureserve.org/explorer.

Oliver P., Lacy R., Ashely M., (2000) Conservation and Management of Anacapa Island Deer Mouse. *Conservation Biology*, **14**, 819-832.

Schwemm C., Coonan T., (2001) Status and Ecology of Deer Mice on Anacapa Santa Barbara and Miguel Islands., California. NPS Technical Report.

Arroyo Chub (*Gila orcuttii*)
MODERATELY VULNERABLE



Taxonomic Group: Fish

Park: SAMO

G-Rank: G2

S-Rank: S2

Range Size (sq. km): 2,000-80,000

Body Size (cm): 12

Diet Type: Herbivore, Invertivore

Nativity: Native

Abundance: Unknown

Habitat: Freshwater creeks, rivers, and pools

References:

Gila orcuttii - (Eigenmann and Eigenmann, 1890). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012.

Moyle, Peter B., Yoshiyama, Ronald M., Williams, Jack E., and Wikramanayake, Eric D. (1995) Fish Species of Special Concern in California. *Department of Wildlife & Fisheries Biology*. University of California, Davis

Barn Swallow (*Hirundo rustica*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: S5

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.019

Diet Type: Invertivore

Nativity: Native

Abundance: Common

Habitat: Herbaceous wetland, Aerial, Riparian, Cliff, Cropland/hedgerow, Grassland/herbaceous, Old field, Savanna, Suburban/orchard

References:

Barn Swallow. *California NatureMapping Program*. Accessed on June 8, 2012. Retrieved from http://naturemappingfoundation.org/natmap/ca/facts/birds/barn_swallow.html.

Brown, C.R. & Brown, M.B. (1999) Barn Swallow (Hirundo rustica). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Accessed on June 8, 2012. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/452, doi:10.2173/bna.452.

Hirundo rustica - (Linnaeus, 1758). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Lee, C.A. (1995) More Records of Breeding Barn Swallows in Riverside, California. *Western Birds*, **26**, 155-156.

Belding's Savannah Sparrow (*Passerculus sandwichensis beldingi*)
MODERATELY VULNERABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S3

Range Size (sq. km): 250-20,000

Body Mass (kg): 0.025

Diet Type: Granivore, Invertivore

Nativity: Native

Abundance: Common

Habitat: Salt marshes, herbaceous wetlands

References:

Grenier, J. L. and Greenberg, R. 2004. A Biogeography Pattern in Sparrow Bill Morphology: Parallel Adaptation to Tidal Marshes. *Evolution*, 59(7), 2005, pp. 1588-1595.

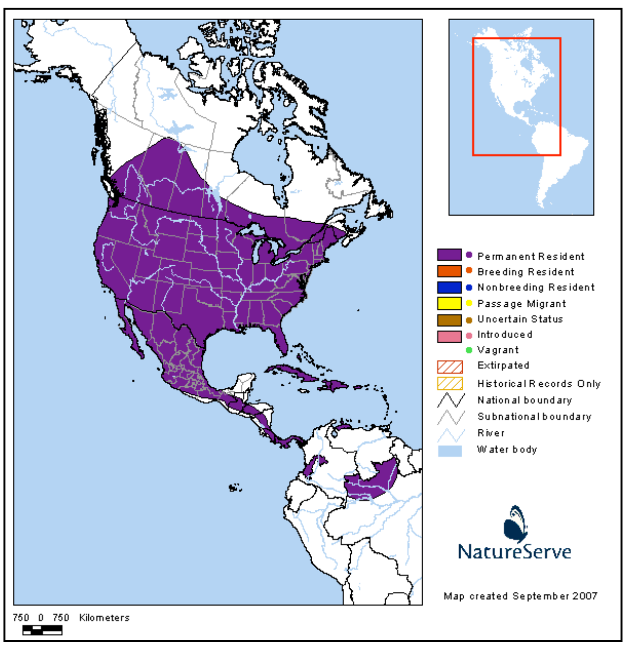
Hoffman, S. M., Konecny, J., and Zembal, R.. 2006. A Survey of the Belding's Savannah Sparrow in California. Department of Fish and Game. Species Conservation and Recovery Program Report No. 2006-03.

Passerculus sandwichensis beldingi – (Ridgway, *1885*). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012.

Powell, A. N. and Collier, C. L. 1998. Reproductive Success of Belding's Savannah Sparrows in a Highly Fragmented Landscape. *The Auk* 115(2):508-513.

Big Brown Bat (*Eptesicus fuscus*)

MODERATELY VULNERABLE-PRESUMED STABLE



Taxonomic Group: Mammal

Park: CABR

G-Rank: G5

S-Rank: S5

Range Size (sq. km): -

Body Mass (kg): 0.018

Diet Type: Invertivore

Nativity: Native

Abundance: Unknown

Habitat: Riparian; desert; forest - conifer, hardwood, mixed; old field; shrubland/chaparral; suburban/orchard; urban/edificarian; woodland - conifer, hardwood, mixed; subterrestrial

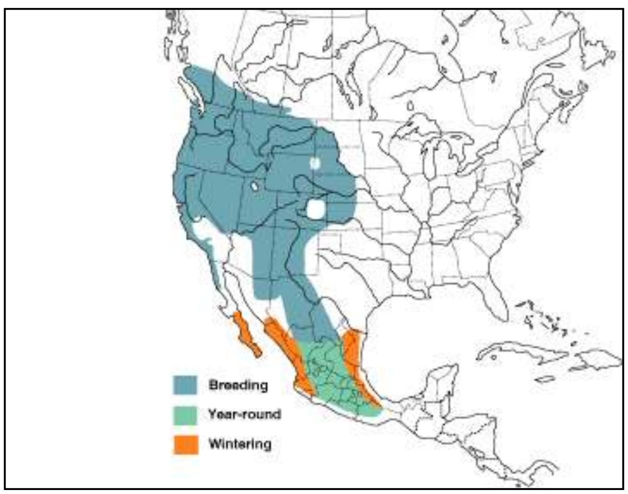
References:

NatureServe (2012) Big Brown Bat (*Eptesicus fuscus*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 16, 2012. Retrieved from http://www.natureserve.org/explorer.

Photo: Thomas H. Kunz

Black-headed Grosbeak (*Pheucticus melanocephalus*)

PRESUMED STABLE-MODERATELY VULNERABLE (CHIS)
PRESUMED STABLE (SAMO)



Taxonomic Group: Bird

Park: CHIS, SAMO

G-Rank: G5

S-Rank: SNRB

Range Size (sq. km): -

Body Mass (kg): 0.047

Diet Type: Frugivore, granivore, invertivore

Nativity: Native

Abundance: Rare (CHIS), common (SAMO)

Habitat: Forested wetland; riparian; forest - conifer, hardwood, mixed; shrubland/chaparral; woodland - conifer, hardwood, mixed

References:

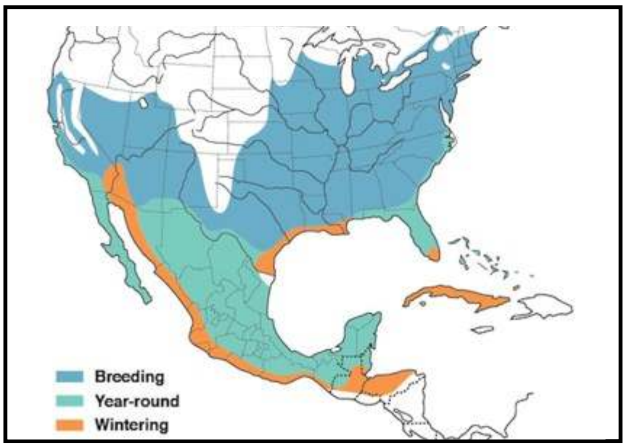
Black-headed Grosbeak. *BirdWeb: Seattle Audubon Society*. Accessed on June 8, 2012. Retrieved from http://birdweb.org/birdweb/bird/black-headed_grosbeak.

Ortega, C. & Hill G. E. (2010). Black-headed Grosbeak (*Pheucticus melanocephalus*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Accessed on June 16, 2012. Retrieved from http://bna.birds.cornell.edu/bna/species/143. doi:10.2173/bna.143.

NatureServe (2012) Black-headed Grosbeak (*Pheucticus melanocephalus*). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Photo: Alan Vernon

Blue-gray Gnatcatcher (*Polioptila caerulea*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: CABR, CHIS

G-Rank: G5

S-Rank: S4

Range Size (sq. km):

Body Mass (kg): 0.006

Diet Type: Inertivore

Nativity: Native

Abundance: Uncommon

Habitat: Riparian, Forest - Conifer, Hardwood, Mixed, Old field, Shrubland/chaparral, Woodland - Conifer, Hardwood, Mixed

References:

Goguen, Christopher B., and Nancy E. Mathews. (1996) Nest Desertion by Blue-gray Gnatcatchers in Association with Brown-headed Cowbird Parasitism. *Animal Behaviour.* **52.3**. 613-619.

Hitch, Alan T., and Paul L. Leberg. (2007). Breeding Distributions of North American Bird Species Moving North as a Result of Climate Change. *Conservation Biology.* **21.2**. 534-539.

Kershner, Eric L. and Walter G. Ellison. 2012. Blue-gray Gnatcatcher (*Polioptila caerulea*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/023 doi:10.2173/bna.23

Bobcat (*Felis rufus*)
MODERATELY VULNERABLE

Taxonomic Group: Mammal

Park: SAMO

G-Rank: G5

S-Rank: S5

Range Size (sq. km): >2,500,000

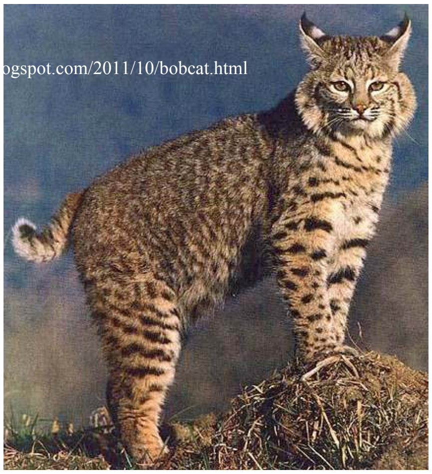
Body Mass (kg): 8.60

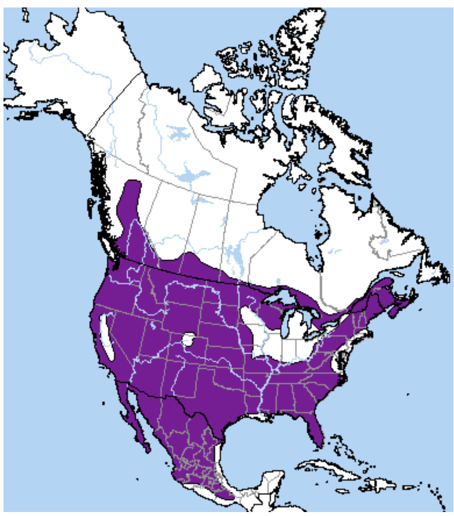
Diet Type: Carnivore

Nativity: Native

Abundance: Unknown

Habitat: Forested Wetland, Riparian, Bare rock, Desert, Forest-Conifer, Hardwood, & Mixed, Shrubland/chaparral





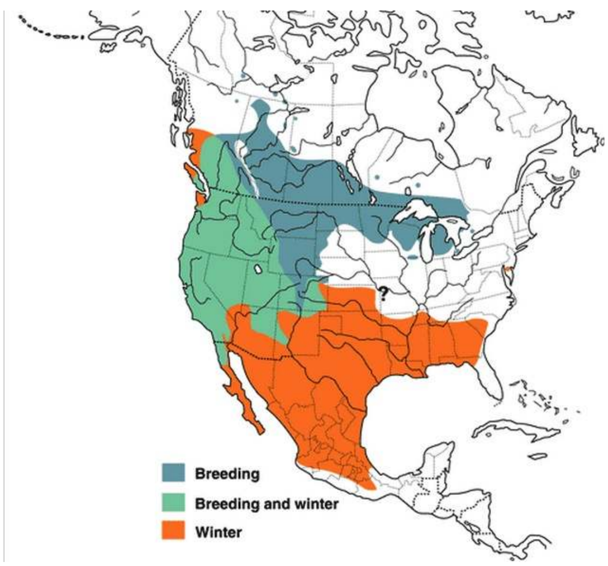
References:

Lynx rufus – (Schreber, 1777). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, April 2012. Retrieved from www.natureserve.org/explorer/.

Riley, S.P.D., Pollinger, J.P., Sauvajot, R.M., York, E.C., Bromley, C., Fuller, T.K. & Wayne, R.K. (2006) A southern California freeway is a physical and social barrier to gene flow in carnivores. *Molecular ecology*, **15**, 1733-41.

Riley, S.P.D., Sauvajot, R.M., Fuller, T.K., York, E.C., Kamradt, D.A., Bromley, C., Wayne, R.K., Monica, S., National, M., Area, R., Hillcrest, W. & Oaks, T. (2003) Effects of Urbanization and Habitat Fragmentation on Bobcats and Coyotes in Southern California. *Conservation Biology*, **17**, 566-576.

Brewer's Blackbird (*Euphagus cyanocephalus*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: SNR

Body Mass (kg): .67kg

Diet Type: Granivore, Invertivore

Nativity: Native

Abundance: Common

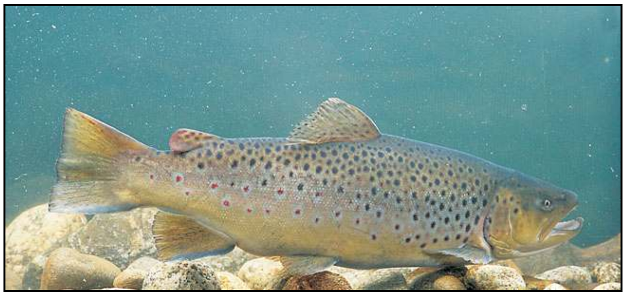
Habitat: Cropland, Hedgerow, Grassland, Sand Dune, Savanna, Shrubland, Chaparral, Suburban, Orchard, Woodland

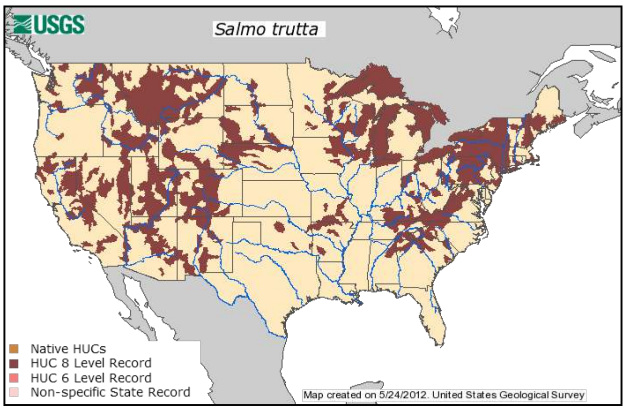
References:

NatureServe (2012) Brewer's Blackbird (*Euphagus Cyanocephalus*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from http://www.natureserve.org/explorer.

Martin, S.G. (2002) Brewer's Blackbird (*Euphagus cyanocephalus*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Retrieved on June 20, 2012 from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/616

Brown Trout (*Salmo trutta*)
PRESUMED STABLE





Taxonomic Group: Fish

Park: SAMO

G-Rank: G5

S-Rank: SNA

Range Size (sq. km): -

Body Mass (kg): -

Diet Type: Invertivore, piscivore

Nativity: Non-native

Abundance: -

Habitat: Deep water, shallow water

References:

California Fish Website. *University of California*. Accessed on April 6, 2012. Retrieved from http://calfish.ucdavis.edu/species.

Fuller, P., Larson, J., Fusaro, A. & Neilson, M. *Salmo trutta*. *USGS Nonindigenous Aquatic Species Database*. Accessed on June 11, 2012. Retrieved from http://nas.er.usgs.gov/queries/FactSheet.

Marine and Great Lakes Invasives Search. *Salmo Trutta*. *National Park Service*. Accessed on April 6, 2012. Retrieved from www.nature.nps.gov/water/marineinvasives/search_static.cfm.

NatureServe (2012) Brown Trout (*Salmo trutta*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on April 6, 2012. Retrieved from www.natureserve.org/explorer.

California Least Tern (*Sterna antillarum browni*)
PRESUMED STABLE – MODERATELY VULNERABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G4

S-Rank: S2S3

Range Size (sq. km): 20,000 – 2,500,000

Body Mass (kg): .03-.045

Diet Type: Invertivore, Piscivore

Nativity: Native

Abundance: Uncommon

Habitat: Riparian, Near Shore, Sand/Dune

References:

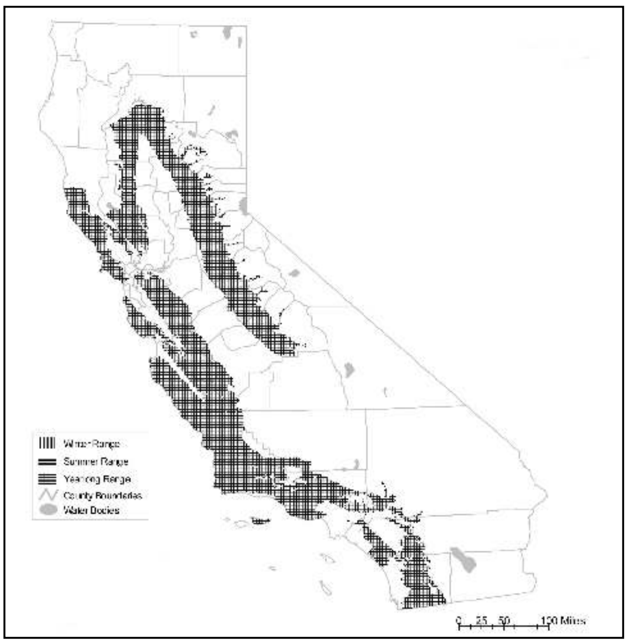
NatureServe (2012) California Least Tern (*Sterna antillarum browni*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from http://www.natureserve.org/explorer

Elam D., Grim M., Bartel J., (2006) California Least Tern 5-yr Review, *U.S. Fish and Wildlife Service.*

California Department of Pesticide Regulation (2012) Accessed on June 20, 2012. Retrieved from http://www.cdpr.ca.gov.

California Red-legged Frog (*Rana draytonii*)

HIGHLY VULNERABLE



Taxonomic Group: Amphibian

Park: SAMO

G-Rank: G2G3

S-Rank: S2S3

Range Size (sq. km): 20,000-2,500,000

Body Mass (kg): -

Diet Type: Invertivore (adult), herbivore (immature)

Nativity: Native

Abundance: Rare

Habitat: Creek, low gradient, pool, shallow water, herbaceous wetland, riparian

References:

California Wildlife Habitat Relationships System. (2008) California Red-legged Frog, *Rana draytonii* range map and life history. California Department of Fish and Game. Sacramento, California. http://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx. (Accessed: February 15, 2012).

GBIF Data Portal. California Red-legged Frog, *Rana draytonii*. Global Biodiversity Information Facility. http://data.gbif.org. (Accessed: May 17, 2012).

NatureServe (2012) California Red-legged Frog (*Rana draytonii*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on May 21, 2012. Retrieved from http://www.natureserve.org/explorer.

Photo: Dong Lin © California Academy of Sciences.

Cal. Striped Racer (*Masticophis lateralis lateralis*)
PRESUMED STABLE

Taxonomic Group: Reptile

Park: SAMO

G-Rank: G4

S-Rank: SNR

Range Size (sq. km): -

Body Mass (kg): -

Diet Type: Carnivore, Inertivore

Nativity: Native

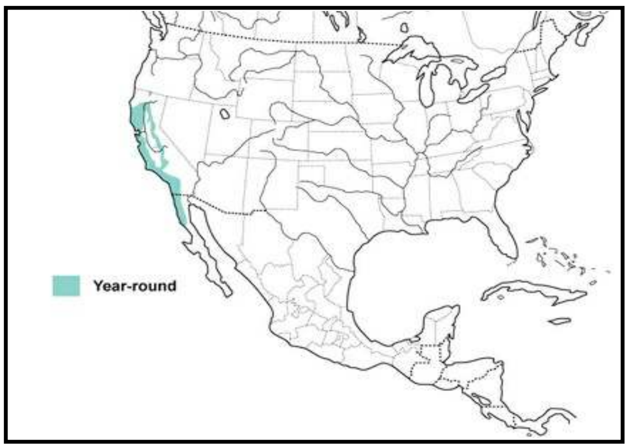
Abundance: Uncommon

Habitat: Riparian, Grassland/herbaceous, Savanna, Shrubland/chaparral, Woodland - Hardwood, Mixed

References:

Hammerson, G. A. (1979) Thermal Ecology of the Striped Racer, *Masticophis lateralis*. *Herpetologists' League.* **35.3**. 267-273.

California Thrasher (*Toxostoma redivivum*)
MODERATELY VULNERABLE – PRESUMED STABLE



Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: S5

Range Size (sq. km): 20,000-2,500,000

Body Mass (kg): 0.084

Diet Type: Frugivore, Granivore, Inertivore

Nativity: Native

Abundance: Common

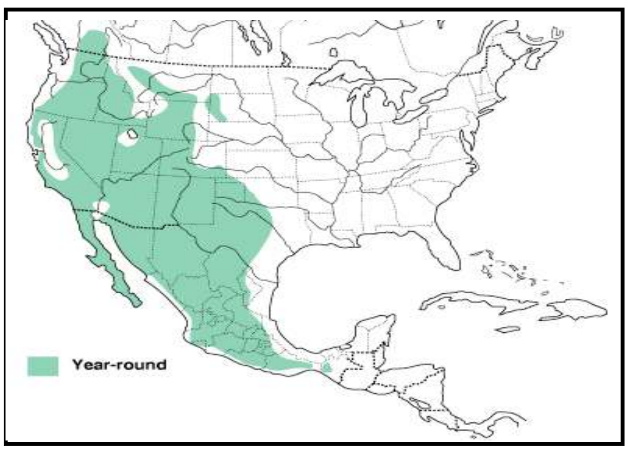
Habitat: Riparian, Shrubland/Chaparral

References:

Cody, Martin L. 2012. California Thrasher (*Toxostoma redivivum*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/323 doi:10.2173/bna.323

Sgariglia, Erik A., and Kevin J. Burns. (2003) Phylogeography of the California Thrasher (*Toxostoma redivivum*) Based on Nested-Clade Analysis of Mitochondrial-DNA Variation. *The Auk.* **120.2**. 346.

Canyon Wren (*Catherpes mexicanus*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: CHIS

G-Rank: G5

S-Rank: S5

Range Size (sq. km):

Body Mass (kg): 0.039

Diet Type: Inertivore

Nativity: Native

Abundance: Occassional

Habitat: Bare rock/talus/scree, Cliff

References:

Jones, Stephanie L. and Joseph Scott Dieni. 1995. Canyon Wren (*Catherpes mexicanus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/197 doi:10.2173/bna.197

Johnston, Heather L. & Ratti, John T. (2002) Distribution of Habitat Selection of Canyon Wrens, Lower Salmon River, Idaho. *The Journal of Wildlife Management*. 66.4, 1104-1111.

Cassin's Kingbird (*Tyrannus vociferans*)

PRESUMED STABLE

Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: S4

Range Size (sq. km):

Body Mass (kg): 0.046

Diet Type: Frugivore, Invertivore

Nativity: Native

Abundance: Common

Habitat: Riparian, Old field, Savanna, Shrubland/chaparral, Woodland-Conifer, Hardwood, Mixed

References:

Tweit, Robert C. and Joan C. Tweit. 2000. Cassin's Kingbird (*Tyrannus vociferans*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/534. doi:10.2173/bna.534

Tyrannus vociferans – (Swainson, 1826). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Retrieved from www.natureserve.org/explorer/.

Taxonomic Group: Bird

Park: CABR

Coastal California Gnatcatcher (*Polioptila californica*)

G-Rank: G4

HIGHLY VULNERABLE-MODERATELY VULNERABLE

S-Rank: S2

Range Size (sq. km): 250-20,000

Body Mass (kg):

Diet Type: Insectivore

Nativity: Native

Abundance: Threatened

Habitat: Riparian, Shrubland/chaparral

References:

Atwood, Jonathan L. and David R. Bontrager. 2001. California Gnatcatcher (*Polioptila californica*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/574. doi:10.2173/bna.574.

Niven, D. K., Butcher, G. S., Bancroft, G. T., Monahan, W. B., & Langham, G. (2009). Birds and Climate Change: Ecological Disruption in Motion. National Audubon Society.

Polioptila californica californica – (Brewster, 1881). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Retrieved from www.natureserve.org/explorer/.

U.S. FIsh and Wildlife Service (2010). Coastal California Gnatcatcher 5-year Review : Summary and Evaluation. *U.S. Fish and Wildlife Service*. 50 pp.

Common Loon (*Gavia immer*)

MODERATELY VULNERABLE-PRESUMED STABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S1

Range Size (sq. km): >2,500,000

Body Mass (kg): 4.134

Diet Type: Piscivore

Nativity: Native

Abundance: Common

Habitat: Wetlands/Riparian/Near Shore

References:

Common Loon. *Bird Web*, Seattle Audubon Society; Retrieved from www.birdweb.org/birdweb/.

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010. Common Loon (*Gavia immer*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313. doi:10.2173/bna.313

Gavia immer – (Brunnich, 1764). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Retrieved from www.natureserve.org/explorer/.

Common Yellowthroat (*Geothlypis trichas*)

PRESUMED STABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S3

Range Size (sq. km): >2,500,000

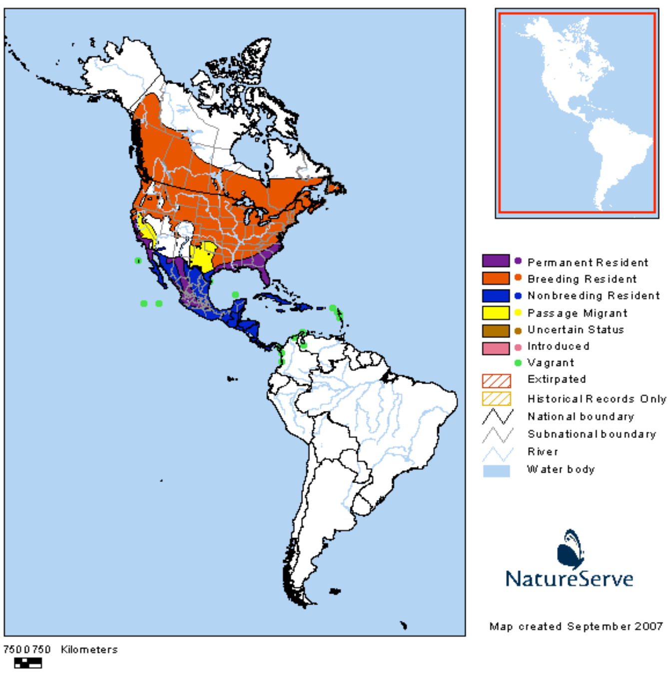
Body Mass (kg): .01

Diet Type: Invertivore

Nativity: Native

Abundance: Common

Habitat: Chaparral, Riparian, Suburban, and Wetland



References:

NatureServe (2012) Common Yellowthroat (*Geothlypis trichas*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from http://www.natureserve.org/explorer.

Dark-eyed Junco (*Junco hyemalis*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): .002

Diet Type: Granivore

Nativity: Native

Abundance: Common

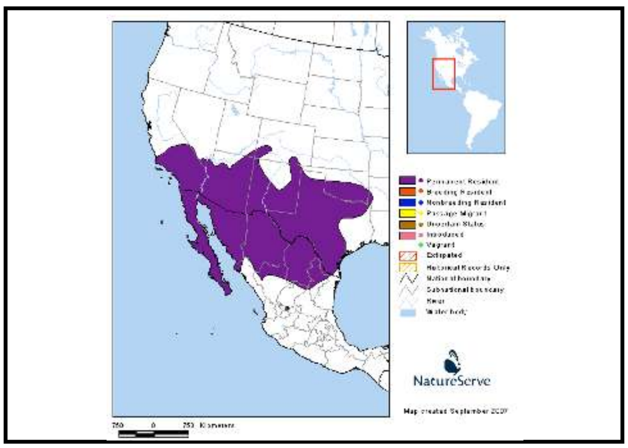
Habitat: Bog/fen, Riparian, forest, savanna, chapparal

References:

Junco hyemalis - (Linnaeus, 1758). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012.

Nolan, Jr., V., E. D. Ketterson, D. A. Cristol, C. M. Rogers, E. D. Clotfelter, R. C. Titus, S. J. Schoech and E. Snajdr. (2002) Dark-eyed Junco (Junco hyemalis), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North AmericaOnline: http://bna.birds.cornell.edu/bna/species/716 doi:10.2173/bna.716.

Desert Shrew (*Notiosorex crawfordi*)
PRESUMED STABLE



Taxonomic Group: Mammal

Park: CABR

G-Rank: G5

S-Rank: S3

Range Size (sq. km):

Body Mass (kg): 0.005

Diet Type: Invertivore

Nativity: Native

Abundance: Abundant

Habitat: Riparian, Desert, Grassland/herbaceous, Shrubland/chaparral, Woodland - Conifer & Hardwood

References:

Chung-MacCoubrey, A., Bateman, H.L. & Finch, D.M. (2009) Captures of Crawford's Gray Shrews (*Notiosorex crawfordi)* Along the Rio Grande in Central New Mexico. *Western North American Naturalist*, **69**, 260–263.

Notiosorex crawfordi::. *Beaver Creek Watershed: Beaver Creek Environmental Atlas*, Accessed on June 8, 2012. Retrieved from http://beavercreek.nau.edu/Animal%20and%20Plant%20pages/Mammals/Notiosorex%20C.htm.

Notiosorex crawfordi – (Coues, 1877). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

European Starling (*Sturnus vulgaris*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: CABR, CHIS

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): -

Body Mass (kg): 0.085

Diet Type: Frugivore, Granivore, Invertivore

Nativity: Non-Native

Abundance: Common

Habitat: Forested Wetland, Herbaceous Wetland, Riparian, Cliff, Cropland/hedgerow, Grassland/herbaceous, Savanna, Shrubland/chaparral, Suburban/orchard, Urban/edificarian, Woodland - Conifer, Hardwood & Mixed

References:

Freeman, S.N., Robinson, R.., Clark, J., Griffin, B.M., Adams, S.Y. (2007) Changing demography and population decline in the Common Starling *Sturnus vulgaris*: a multisite approach to Integrated Population Monitoring. *The British Trust for Ornithology,* **149**, 587–596.

Møller, A.P., Rubolini, D., Lehikoinen, E. (2008) Populations of migratory bird species that did not show a phenological response to climate change are declining. *Proceedings of the National Academy of Sciences,* **105**, 16195–16200.

Robinson, R. A., Baillie, S.R., Crick, H.Q. (2007) Weather-dependent survival: implications of climate change for passerine population processes. *The British Trust for Ornithology,* **149**, 357–364.

Sturnus vulgaris – (Linnaeus, 1758). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Fox Sparrow (*Passerella iliaca*)
MODERATELY VULNERABLE

Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.032

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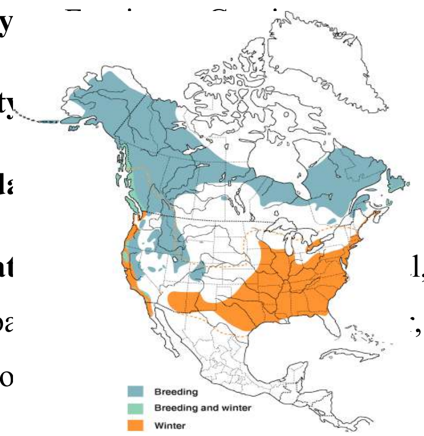


References:

Weckstein, Jason D., Donald E. Kroodsma and Robert C. Faucett. 2002. Fox Sparrow (*Passerellailiaca*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/715 doi:10.2173/bna.715

Zink, Robert M. (1994) The Geography of Mitochondrial DNA Variation, Population Structure, Hybridization, and Species Limits in the Fox Sparrow (*Passerella iliaca*). *Evolution*. **48.1**, (96-111).

Fox Squirrel (*Sciurus niger*)
PRESUMED STABLE

Taxonomic Group: Mammal

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 1.062

Diet Type: Frugivore, Granivore, Herbivore, Invertivore

Nativity: Non-native

Abundance: Uncommon

Habitat: Riparian, Forest - Conifer, Hardwood & Mixed, Savanna, Shrubland/chaparral, Suburban/orchard, Woodland - Conifer, Hardwood & Mixed

References:

King, J.L. (2004) *The Current Distribution of the Introduced Fox Squirrel (*Sciurus niger*) in the Greater Los Angeles Metropolitan Area and Its Behavioral Interaction with the Native Western Gray Squirrel (*Sciurus griseus*)* (ed A Muchlinski). California State University, Los Angeles, Los Angeles, CA.

Sciurus niger – Linnaeus, 1758. *NatureServe Explorer: An Online Encyclopedia of Life*, Version7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Tesky, J.L. (1993) Sciurus niger. In: Fire Effects Information System, [Online]. *U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory* (Producer). Accessed on June 8, 2012. Retrieved from: http://www.fs.fed.us/database/feis/animals/mammal/scni/all.html.

Garden Slender Salamander (*Batrachoseps major major)*

MODERATELY VULNERABLE

Taxonomic Group: Amphibian

Park: SAMO

G-Rank: G4

S-Rank: S4

Range Size (sq. km): 20,000-200,000

Body Mass (kg): 0.016

Diet Type: Invertivore

Nativity: Native

Abundance: Rare

Habitat: Riparian, Forest - Hardwood, Shrubland/chaparral, Woodland - Hardwood

References:

Batrachoseps major major – (Camp, 1915). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Parra-Olea, G., Wake, D., Hammerson, G., Papenfuss, T. (2008) *Batrachoseps major*. In: IUCN 2011. *IUCN Red List of Threatened Species*. Version 2011.2, February 2012. Accessed on June 10, 2012. Retrieved from www.iucnredlist.org/.

Grasshopper Sparrow (*Ammodramus savannarum*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S2

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.017

Diet Type: Granivore, Invertivore

Nativity: Native

Abundance: Rare

Habitat: Grassland/herbaceous, Old field, Savanna

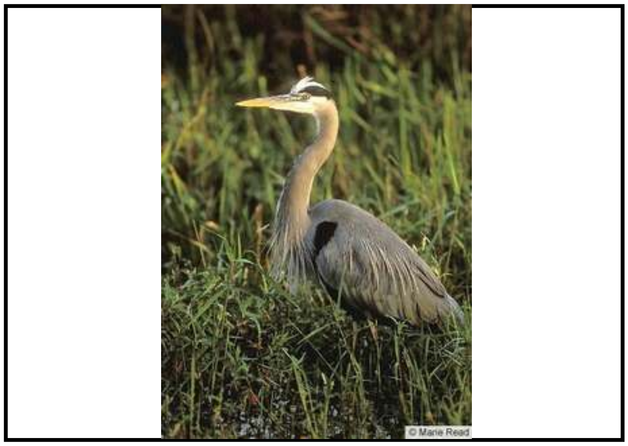
References:

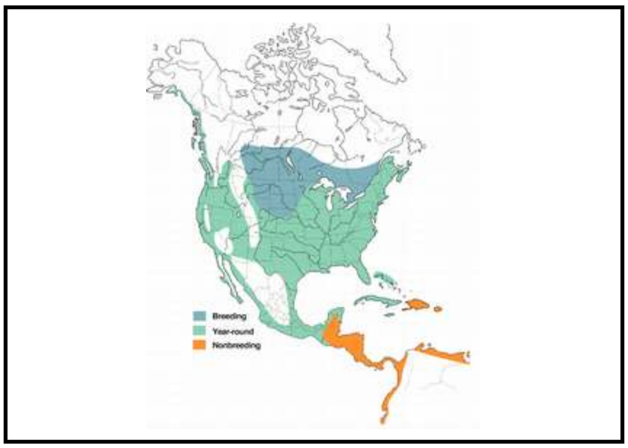
Ammodramus savannarum – (Gmelin, 1789). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Joern, A. (1988) Foraging Behavior and Switching by the Grasshopper Sparrow *Ammodramus savannarum* Searching for Multiple Prey in a Heterogeneous Environment. *The American Midland Naturalist,* **119**, 225-234.

Vickery, P.D. (1996) Grasshopper Sparrow (*Ammodramus savannarum*). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Accessed on June 8, 2012. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/239, doi:10.2173/bna.239.

Great Blue Heron (*Ardea herodias*)
PRESUMED STABLE





Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S4

Range Size (sq. km): >2,500,000

Body Mass (kg): 2.576

Diet Type: Carnivore, Invertivore, Piscivore

Nativity: Native

Abundance: Common

Habitat: Bay/sound, Herbaceous wetland, Lagoon, River mouth/tidal river, Scrub-shrub wetland, Shrubland/chaparral, Tidal flat/shore, Low gradient, Shallow water, Forested wetland, Herbaceous wetland, Riparian, Temporary pool, Forest - Conifer, Hardwood & Mixed, Grassland

References:

Ardea herodias – Linnaeus, 1758. *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Gough, G. Great Blue Heron Ardea herodias: Life History Groupings. *USGS Patuxent Wildlife Research Center*. Accessed on June 8, 2012. Retrieved fromhttp://www.mbr-pwrc.usgs.gov/id/framlst/i1940id.html.

The Great Blue Heron. *National Audubon Society*. Accessed on June 8, 2012. Retrieved from http://web4.audubon.org/bird/boa/ f38_g1g.html.

Vennesland, R.G. (2004) Great Blue Heron: Ardea herodias. *Accounts and Measures for Managing Identified Wildlife*, Accounts V., 1-12.

Vennesland, R.G. & Butler, R.W. (2011) Great Blue Heron (Ardea herodias). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Accessed on June 8, 2012. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/025, doi:10.2173/bna.25.

Great Egret (*Ardea alba*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: S4

Range Size (sq. km): >2,500,000

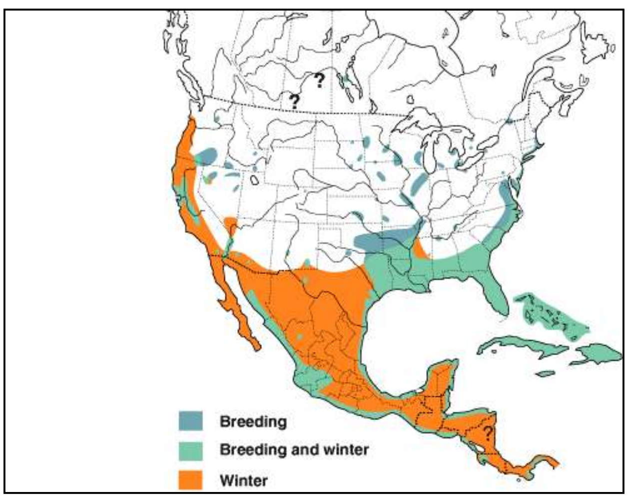
Body Mass (kg): 0.935

Diet Type: Carnivore, invertivore, piscivore

Nativity: Native

Abundance: Common

Habitat: Bay/sound; wetland - herbaceous, scrub-shrub, forested; lagoon; river - mouth, low gradient; tidal flat/shore/river; shallow water; riparian; grassland/herbaceous



References:

Mccrimmon Jr., D.A., Ogden, J.C. & Bancroft, G.T. (2011) Great Egret (*Ardea alba*). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Accessed on June 16, 2012. Retrieved from http://bna.birds.cornell.edu/bna/species/570. doi:10.2173/bna.570.

NatureServe (2012) Great Egret (*Ardea alba*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 16, 2012. Retrieved from http://www.natureserve.org/explorer.

Photo: Don DeBold

Green-tailed Towhee (*Pipilo chlorurus*)
PRESUMED STABLE

Taxonomic Group: Bird

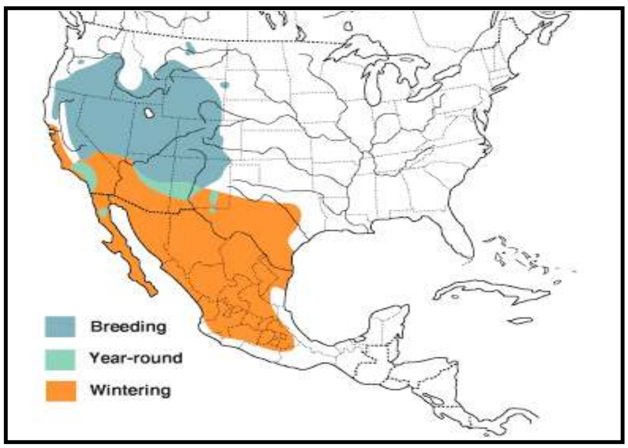
Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km):

Body Mass (kg): 0.026



Diet Type: Frugivore, Herbivore, Inertivore

Nativity: Native

Abundance: Rare

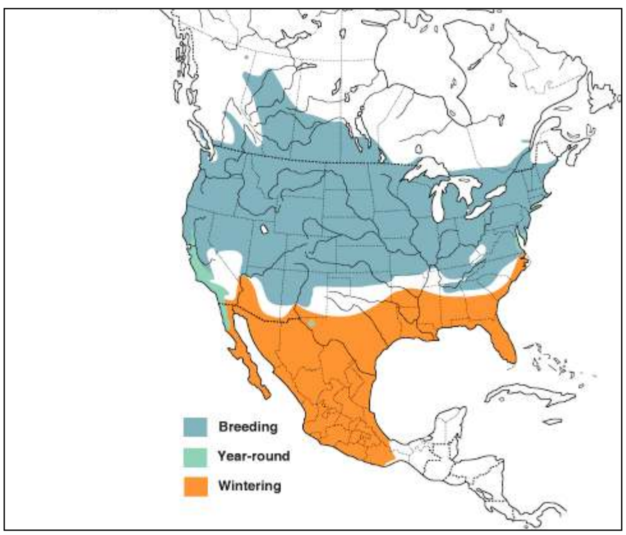
Habitat: Riparian, Shrubland/chaparral

References:

Dobbs, R.C. (2006, March 30). Green-tailed Towhee (*Pipilo chlorurus*): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/greentailedtowhee.pdf

Dobbs, R. C., P. R. Martin and T. E. Martin. 1998. Green-tailed Towhee (*Pipilo chlorurus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/368 doi:10.2173/bna.368

House Wren (*Troglodytes aedon*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S5

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.011

Diet Type: Insectivore

Nativity: Native

Abundance: Abundant

Habitat: Wetland - forested, scrub-shrub; woodland - conifer, hardwood, mixed; riparian; old field; shrubland/chaparral; suburban/orchard

References:

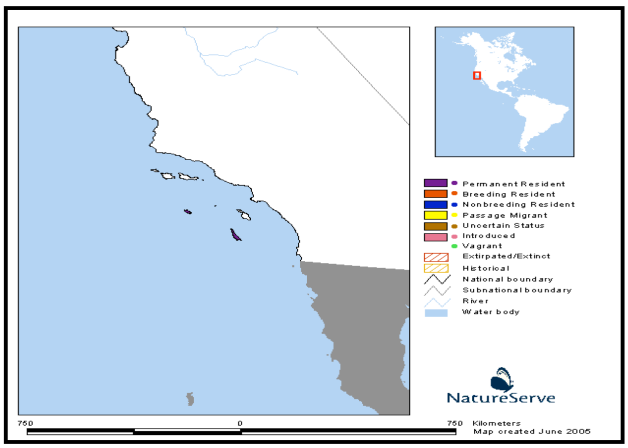
Brumfield, T.R. & Capparella, A.P. (1996) Genetic differentiation and taxonomy in the house wren species group. *The Condor*, **98**, 547-556.

Johnson, L.S. (1998) House wren (*Troglodytes aedon*). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Accessed on May 21, 2012. Retrieved from http://bna.birds.cornell.edu/bna/species/380 doi:10.2173/bna.380

NatureServe (2012) House Wren (*Troglodytes aedon*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on May 21, 2012. Retrieved from http://www.natureserve.org/explorer.

Photo: Dario Sanches

Island Night Lizard (*Xantusia riversiana*)
HIGHLY VULNERABLE – MODERATELY VULNERABLE



Taxonomic Group: Reptile

Park: CHIS

G-Rank: G1

S-Rank: S1

Range Size (sq. km):

Body Mass (kg):

Diet Type: Inertivore

Nativity: Native

Abundance: Rare

Habitat: Bare rock/talus/scree, Cliff, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood

References:

Brattstrom, Bayard H. (1952) The Food of the Nightlizards, Genus Xantusia. *Copeia*. **1952.3**, (168-172).

Fellers, Gary M. & Drost, Chalres A. (1991) Ecology of the Island Night Lizard, *Xantusia riversiana*, on Santa Barbara Island, California. *Herpetological Monographs*. **5**, (28-78).

Least Bittern (*Ixobrychus exilis*)
MODERATELY VULNERABLE

Taxonomic Group: Bird

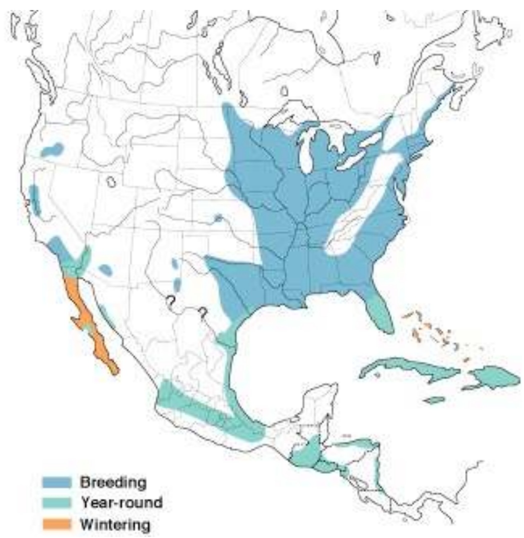
Park: SAMO

G-Rank: G5

S-Rank: S1

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.086



Diet Type: Carnivore, Invertivore, Piscivore

Nativity: Native

Abundance: Occasional

Habitat: Herbaceous wetland, Scrub-shrub wetland, Riparian

References:

COSEWIC. (2009) COSEWIC assessment and update status report on the Least Bittern *Ixobrychus exilis* in Canada. *Committee on the Status of Endangered Wildlife in Canada*. February 2012.

Ixobrychus exilis – (Gmelin, 1789). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Shuford, W.D. and Gardeli T., editors. (2008) Species Accounts, Least Bittern. *Studies of Western Birds,* **1**, 136-142

Marbled Godwit (*Limosa fedoa*)
MODERATELY VULNERABLE

Taxonomic Group: Bird

Park: CABR

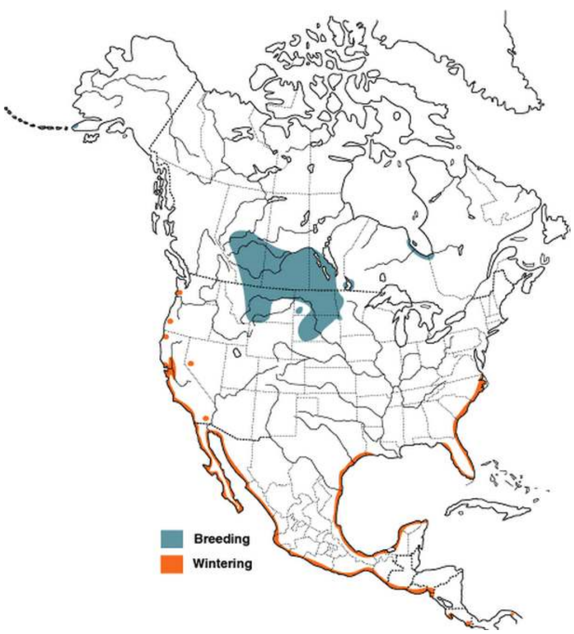
G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): .371

Diet Type: Piscivore, Invertivore



Nativity: Native

Abundance: Uncommon

Habitat: Herbaceous Wetland, Tidal Flat, Shore,

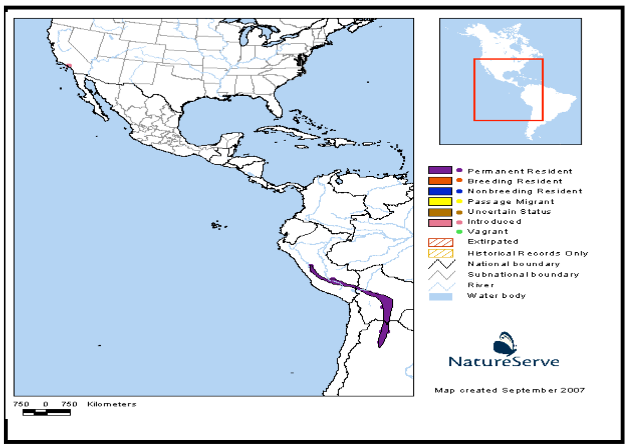
Grassland, Sand Dune, Riparian, Temporary Pool

References:

NatureServe (2012) Marbeled Godwitt (*Limosa Fedoa*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from http://www.natureserve.org/explorer.

Gratto-Trevor, Cheri L. (2000) Marbled Godwit (*Limosa fedoa*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Retrieved on June 20, 2012 from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/492

Mitred parakeet (*Aratinga mitrata*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: SAMO

G-Rank: G3

S-Rank: SNR

Range Size (sq. km): <20,000

Body Mass (kg): 0.026

Diet Type: Carnivore

Nativity: Non-native

Abundance: Uncommon

Habitat: Forest, Woodland

References:

Arndt, T. (2006) A Revision of the *Aratinga mitrata* Complex, with the Description of One New Species, Two New Subspecies and Species-level Status of *Aratinga alticola*. *Journal of Ornithology* **147.1**,73-86.

Mourning Dove (*Zenaida macroura*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

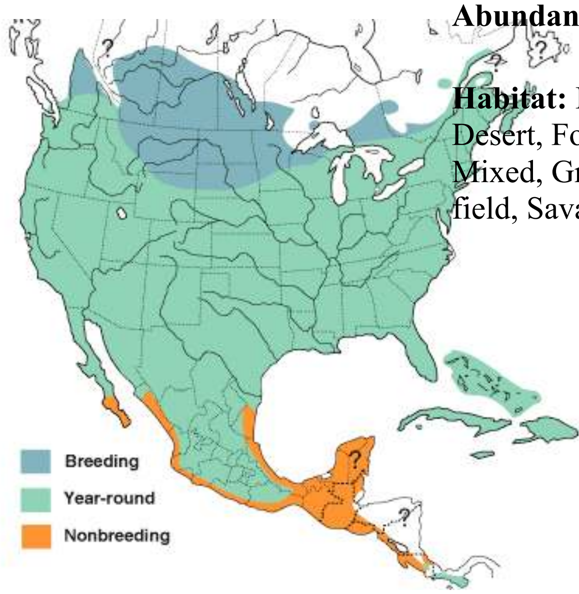
Body Mass (kg): 0.123

Diet Type: Granivore

Nativity: Native

Abundance: Common

Habitat: Riparian, Cropland/hedgerow, Desert, Forest-Conifer, Hardwood, & Mixed, Grassland/herbaceous, Old field, Savanna, Shrubland/chaparral



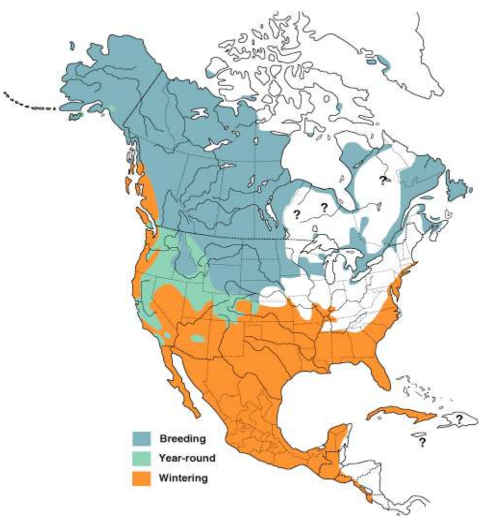
References:

Mourning Dove. *Bird Web*, Seattle Audubon Society; Retrieved from www.birdweb.org/birdweb/.

Otis, David L., John H. Schulz, David Miller, R. E. Mirarchi and T. S. Baskett. 2008. Mourning Dove (*Zenaida macroura*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/117. doi:10.2173/bna.117.

Zenaida macroura – (Linnaeus, 1758). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Retrieved from www.natureserve.org/explorer/.

Northern Pintail (*Anas acuta*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 1.035

Diet Type: Granivore, Invertivore

Nativity: Native

Abundance: Abundant

Habitat: Bay/sound, Herbaceous wetland, Lagoon, River mouth/tidal river, Tidal flat/shore, Low gradient, Shallow water, Riparian, Cropland/hedgerow, Grassland, Tundra

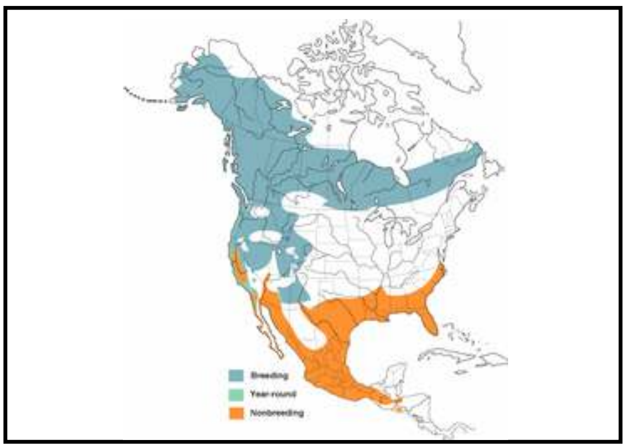
References:

Anas acuta – (Linnaeus, 1758). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 20120. Retrieved from www.natureserve.org/explorer/.

Austin, J.E. and Miller, M.R. (1995) Northern Pintail (Anas acuta). *The Birds of North America Online (A. Poole, Ed.).* Ithaca: Cornell Lab of Ornithology. February 2012. Accessed on June 10, 2012. Retrieved from www.bna.birds.cornell.edu/bna/species/163/.

Tesky, J.L. (1993) Anas acuta. In: Fire Effects Information System [Online]. *U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Science Laboratory.* February 2012. Accessed on June 10, 2012. Retrieved from www.fs.fed.us/database/feis/.

Orange-crowned Warbler (*Vermivora celata*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: SAMO, CHIS

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.009

Diet Type: Frugivore, Invertivore

Nativity: Native

Abundance: Common

Habitat: Riparian, Hardwood, and Mixed Forests, Old field, Shrubland/chaparral, Hardwood and Mixed Woodlands

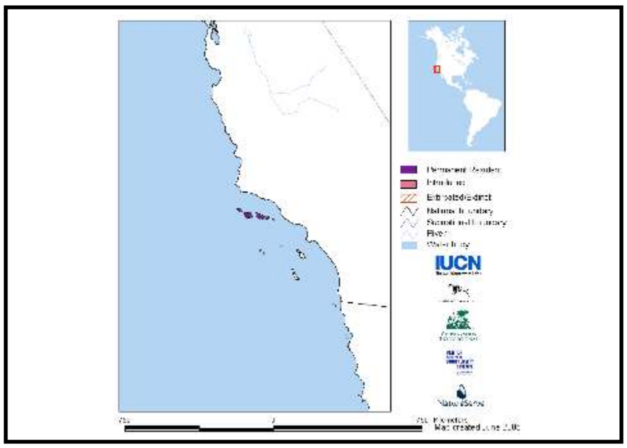
References:

Gilbert, W. M., M. K. Sogge and C. Van Riper III. (2010) Orange-crowned Warbler (*Oreothlypis celata*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/101 doi:10.2173/bna.101.

Laudenslayer, W. F. (2007) Species Notes for Orange-Crowned Warbler: California Wildlife Habitat Relationships (CWHR) System Level II Model Prototype. California Department of Fish and Game.

Oreothlypis celata - (Say, 1823). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012.

Pacific Slender Salamander (*Batrachoseps pacificus*)
EXTREMELY VULNERABLE-MODERATELY VULNERABLE



Taxonomic Group: Amphibian

Park: CABR & CHIS

G-Rank: G4

S-Rank: S2

Range Size (sq. km): 20,000-200,000 (CABR) & 250-1,000 (CHIS)

Body Mass (kg): 0.016

Diet Type: Invertivore

Nativity: Native

Abundance: Common

Habitat: Riparian, Forest - Hardwood, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood

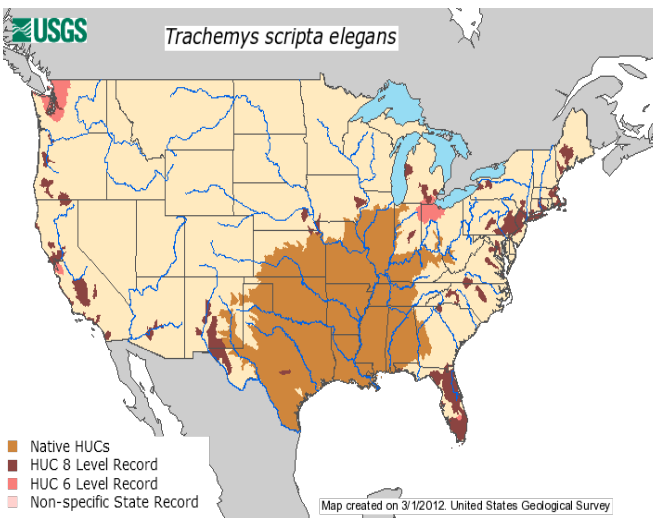
References:

Batrachoseps pacificus – Channel Islands Slender Salamander. *CaliforniaHerps.com: A Guide to the Amphibians and Reptiles of California*. Accessed on June 8, 2012. Retrieved from http://www.californiaherps.com/salamanders/pages/b.pacificus.html.

Batrachoseps pacificus – (Cope, 1865). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Cunningham, J.D. (1960) Aspects of Ecology of the Pacific Slender Salamander, *Batrachoseps pacificus*, in Southern California. *Ecology,* **41**, 88-99.

Red Eared Slider (*Trachemys scripta elegans*)
PRESUMED STABLE



Taxonomic Group: Reptile

Park: SAMO

G-Rank: G5

S-Rank: SNR

Body Mass (kg): .907

Diet Type: Invertivore, Piscivore

Nativity: Non-native

Abundance: Common

Habitat: Wetlands, Riparian

References:

Somma L.A., Foster A., Fuller P., (2012) *Trachemys scripta elegans. USGS Nonindigenous Aquatic Species Database*. Retrieved on June 20, 2012 from http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1261.

Pendelbury P., (2010) *Trachemys scripta elegans. Global Invasive Species Database.* Retrieved on June 20, 2012 from http://www.issg.org/database/species/ecology.asp?si=71&fr=1&sts=sss.

Redhead (*Aythya americana*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 1.100

Diet Type: Herbivore, Invertivore

Nativity: Native

Abundance: Uncommon

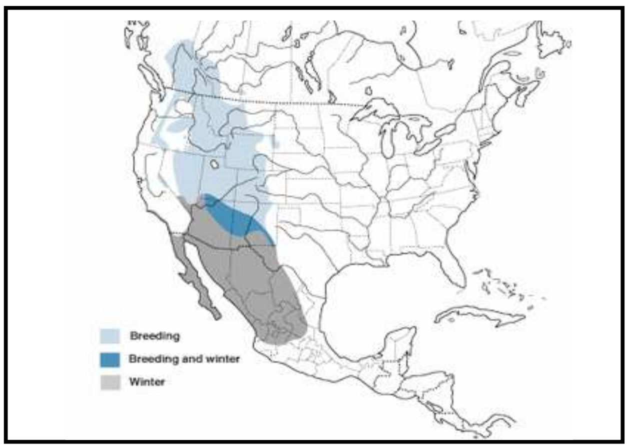
Habitat: Bay/sound, Herbaceous wetland, Lagoon, River mouth/tidal river, Tidal flat/shore, Low gradient, Deep water, Shallow water

References:

Aythya americana – (Eyton 1838). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Woodin, M.C. and Michot T.C. (2002) Redhead (Aythya americana). *The Birds of North America Online (A. Poole, Ed).* Ithaca: Cornell Lab of Ornithology. February 2012. Accessed on June 10, 2012. Retrieved from www.bna.birds.cornell.edu/bna/species/695.

Red-naped Sapsucker (*Sphyrapicus nuchalis*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S3

Range Size (sq. km):

Body Mass (kg): 0.050

Diet Type: Inertivore

Nativity: Native

Abundance: Occasional

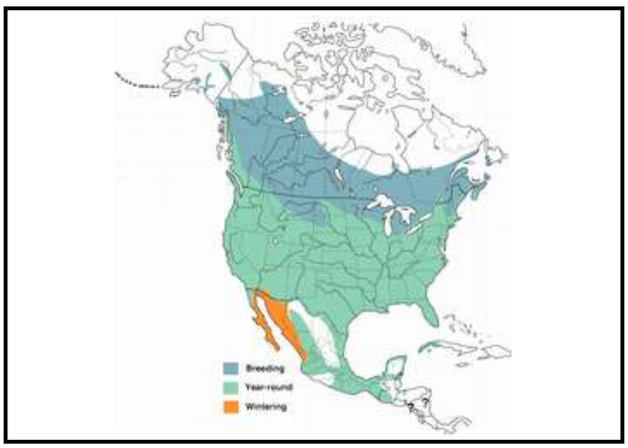
Habitat: Riparian

References:

Daily, G. C. (1993) Double Keystone Bird in a Keystone Species Complex. *Proceedings of the National Academy of Sciences.* **90.2**. 592-594.

Walters, Eric L., Edward H. Miller and Peter E. Lowther. 2002. Red-naped Sapsucker (*Sphyrapicus nuchalis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/663b doi:10.2173/bna.663

Red-winged Blackbird (*Agelaius phoeniceus*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: CABR & SAMO

G-Rank: G5

S-Rank: S5

Range Size (sq. km):

Body Mass (kg): 0.064

Diet Type: Granivore, Invertivore

Nativity: Native

Abundance: Abundant

Habitat: Herbaceous wetland, Forested wetland, Riparian, Scrub-shrub wetland, Cropland/hedgerow, Grassland/herbaceous, Shrubland/chaparral, Suburban/orchard

References:

Agelaius phoeniceus – (Linnaeus, 1766). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Ball, Jr., R.M., Freeman, S., James, F.C., Bermingham, E. & Avise, J.C. (1988) Phylogeographic population structure of Red-winged Blackbirds assessed by mitochondrial DNA. *Proc. Natl. Acad. Sci. USA,* **85**, 1558-1562.

Gavin, T.A., Howard, R.A. & May, B. (1991) Allozyme Variation among Breeding Populations of Red-Winged Blackbirds: The California Conundrum. *The Auk,* **108**, 602-611.

Yasukawa, K. & Searcy, W.A. (1995) Red-winged Blackbird (Agelaius phoeniceus). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Accessed on June 8, 2012. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/184, doi:10.2173/bna.184.

Ringtail (*Bassariscus astutus*)
PRESUMED STABLE

Taxonomic Group: Mammal

Park: SAMO

G-Rank: G5

S-Rank: S3S4

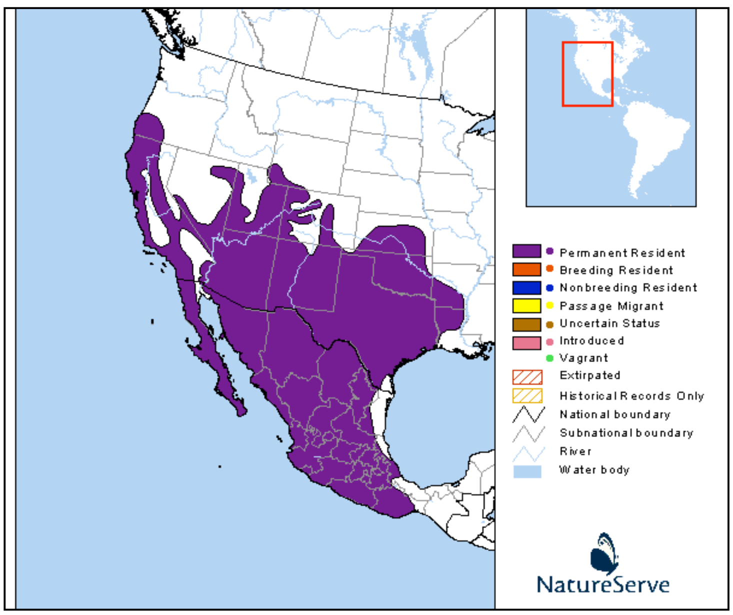
Body Mass (kg): 1.1

Diet Type: Carnivore- Fruigivre

Nativity: Native

Abundance: Rare

Habitat: Desert, Cliff, Chaparral, Woodland, Mixed Temperate Forest and Grassland



References:

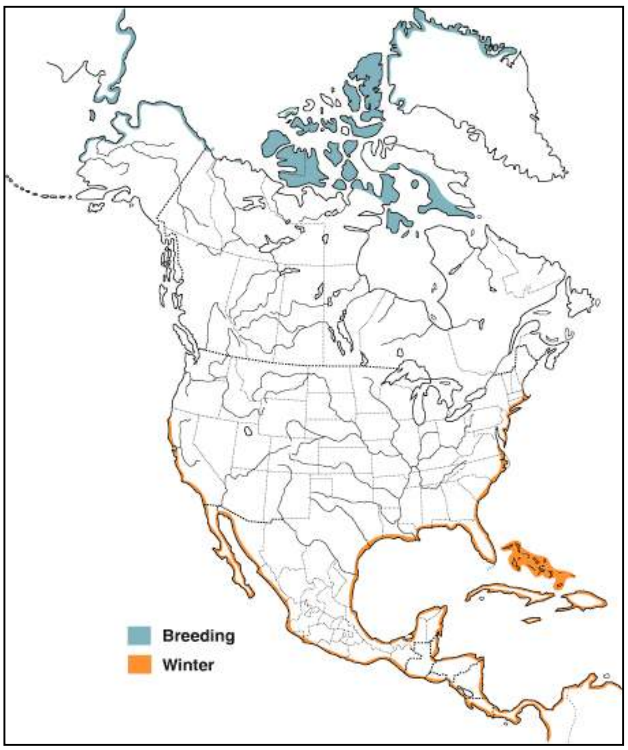
NatureServe (2012) Ringtail (*Bassariscus astutus*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from: http://www.natureserve.org/explorer.

Neuwall I.P., Toweill D.E., (1988) *Bassariscus astutus. Mammalian Species Accounts,* **327,** 1-8. Retrieved on June 20, 2012. Retrieved from http://www.science.smith.edu/msi/pdf/i0076-3519-327-01-0001.pdf

Timm R., Reid F., Helgen K., *Bassariscus astutus.*(2008) IUCN Red List of Threatened Species, Version 2012.1. Retrieved on June 20, 2012

Trapp G., Roll M., (2009) Ringtail, *Yolo Natural Heritage Program Species Accounts.* Retrieved on June 20, 2012. Retrieved from: http://www.yoloconservationplan.org/yolo_pdfs/speciesaccounts/mammals/ringtail.pdf

Ruddy Turnstone (*Arenaria interpres*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: SNRN

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.141

Diet Type: Invertivore

Nativity: Native

Abundance: Rare

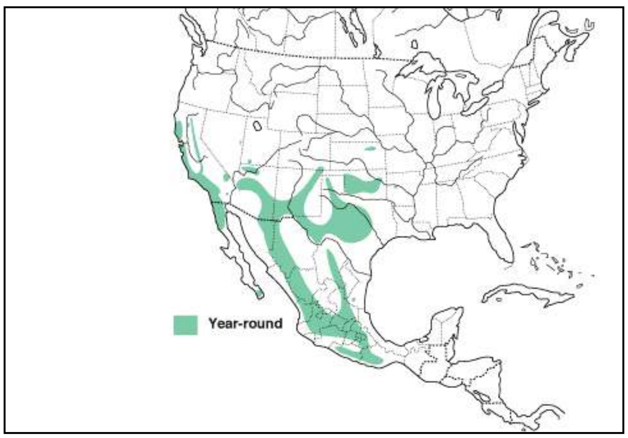
Habitat: Tidal flat/shore, riparian, bare rock/talus/scree, sand/dune, tundra

References:

NatureServe (2012) Ruddy Turnstone (*Arenaria interpres*). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer.

Nettleship, David N. (2000) Ruddy Turnstone (*Arenaria interpres*). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Accessed on June 8, 2012. Retrieved from http://bna.birds.cornell.edu/bna/ species/537. doi:10.2173/bna.537.

Rufous-crowned Sparrow (*Aimophila ruficeps*)
PRESUMED STABLE



Taxonomic Group: Bird

Park: CABR, CHIS

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): 20,000–2,500,000

Body Mass (kg): 0.019

Diet Type: Granivore, invertivore

Nativity: Native

Abundance: Uncommon

Habitat: Shrubland/chaparral, woodland - mixed

References:

Collins, P.W. (1999) Rufous-crowned Sparrow (*Aimophila ruficeps*). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Accessed on June 11, 2012. Retrieved from http://bna.birds.cornell.edu/bna/species/472. doi:10.2173/bna.472.

NatureServe (2012) Rufous-crowned Sparrow (*Aimophila ruficeps*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 11, 2012. Retrieved from www.natureserve.org/explorer.

Thorngate, N. & Parsons, M. (2005) Rufous-crowned Sparrow (*Aimophila ruficeps*). *The Coastal Scrub and Chaparral Bird Conservation Plan: a strategy for protecting and managing coastal scrub and chaparral habitats and associated birds in California*. California Partners in Flight. Retrieved from http://www.prbo.org/calpif/htmldocs/scrub.html.

Photo: Bill Bouton

San Diego Ringneck Snake (*Diadophis punctatus similis*)

PRESUMED STABLE – MODERATELY VULNERABLE

Taxonomic Group: Reptile

Park: CABR

G-Rank: G5

S-Rank: S2

Range Size (sq. km): -

Body Mass (kg): -

Diet Type: Insectivore, Carnivore

Nativity: Native

Abundance: Occasional

Habitat: Wet Meadows, Rocky Hillsides, Gardens, Farmland, Grassland, Chaparral, Mixed Coniferous Forests, Woodland

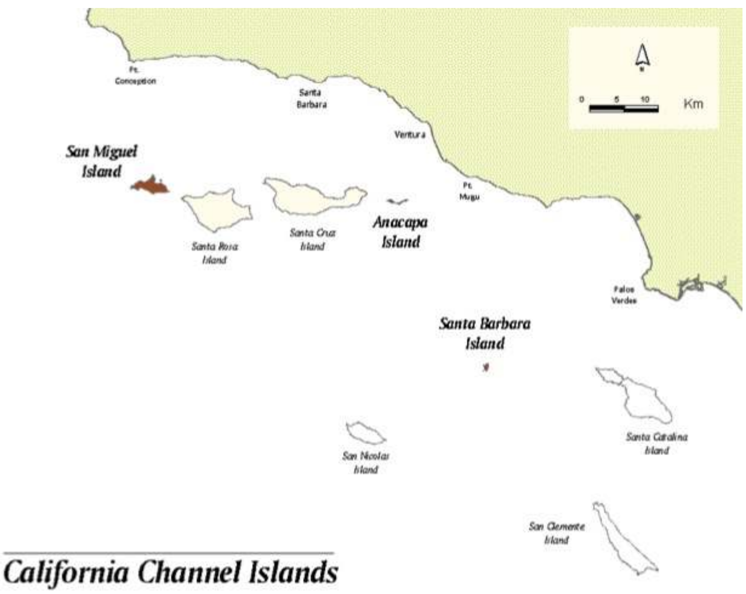
References:

Diadophis punctatus similis – (Blanchard, 1923). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Diadophis punctatus similis - San Diego Ring-necked Snake. *California Herps: A Guide to the Amphibians and Reptiles of California.* February 2012. Accessed on June 10, 2012. Retrieved from www.californiaherps.com/.

Harris, A. S. (2010) Ring-necked Snake - Diadophis punctatus. *Virtual Zoo.* February 2012. Accessed on June 10, 2012. Retrieved from www.virtualzoo.org/.

Santa Cruz Island Gopher Snake (*Pituophis catenifer pumilis*)
MODERATELY VULNERABLE



Taxonomic Group: Reptile

Park: CHIS

G-Rank: G5T1T2

S-Rank: S1

Diet Type: Carnivore

Nativity: Native

Abundance: Uncommon

Habitat: Open Grassland, Dry Streambeds, and Oak and Chaparral Woodlands

References:

NatureServe (2012) Santa Cruz Island Gopher Snake (*Pituophis catenifer pumilis*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on June 20, 2012. Retrieved from http://www.natureserve.org/explorer.

California Herpetology (2012) *Pituophis catenifer pumilis*. Retrieved on June 20, 2012 from http://www.californiaherps.com/snakes/pages/p.c.pumilis.html.

Schwemm C., Coonan T., (2001) Status and Ecology of Deer Mice on Anacapa Santa Barbara and Miguel Islands., California. NPS Technical Report.

Santa Rosa Island Fox (*Urocyon littoralis santarosae*)
HIGHLY TO MODERATELY VULNERABLE

Taxonomic Group: Mammal

Park: CHIS

G-Rank: G1

S-Rank: S1

Range Size (sq. km): 250-20,000

Body Mass (kg): 2.8

Diet Type: Omnivore

Nativity: Native

Abundance: Endangered

Habitat: Temperate forest, temperate grassland, and chaparral

References:

Urocyon littoralis santarosae - (Grinnell and Linsdale, 1930). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012.

Garcelon, D., Wayne, R., and Gonzales, B. (1992) A Serological Survey of the Island Fox (*Urocyon littoralis)* on the Channel Islands, California. *Journal of Wildlife Diseases,* 28(2): 223-229.

Savannah Sparrow (*Passerculus sandwichensis*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: S5

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.025

Diet Type: Granivore, Invertivore

Nativity: Native

Abundance: Uncommon

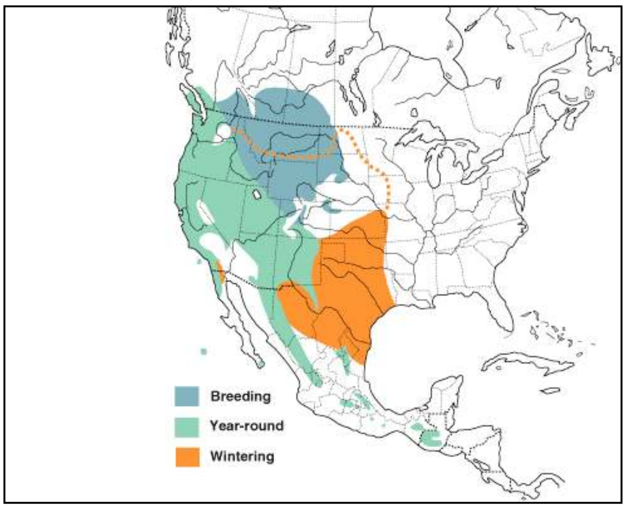
Habitat: Herbaceous wetland, Bog/fen, Riparian, Alpine, Cropland/hedgerow, Grassland/herbaceous, Tundra

References:

Passerculus sandwichensis – (Gmelin, 1789). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Wheelwright, N. T. and Rising, J.D. (2008) Savannah Sparrow (Passerculus sandwichensis). *The Birds of North America Online (A. Poole, Ed.).* Ithaca: Cornell Lab of Ornithology. February 2012. Accessed on June 10, 2012. Retrieved from www.bna.birds.cornell.edu/bna/species/045.

Spotted Towhee (*Pipilo maculatus*)
MODERATELY VULNERABLE to PRESUMED STABLE



Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.042

Diet Type: Frugivore, granivore, invertivore, nectarivore

Nativity: Native

Abundance: Abundant

Habitat: Riparian; shrubland/chaparral; woodland - conifer, hardwood, mixed

References:

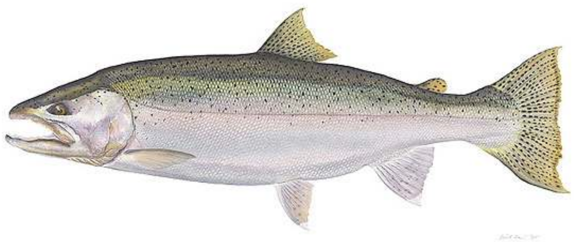
Greenlaw, J.S. (1996) Spotted towhee (*Pipilo maculatus*). *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Accessed on May 21, 20120. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/263 doi:10.2173/bna.263

NatureServe (2012) Spotted Towhee (*Pipilo maculatus*). *NatureServe Explorer: An online encyclopedia of life*, Version 7.1. Accessed on May 21, 2012. Retrieved from http://www.natureserve.org/explorer.

Photo: Walter Siegmund

Steelhead Trout (*Oncorhynchus mykiss*)

MODERATELY VULNERABLE



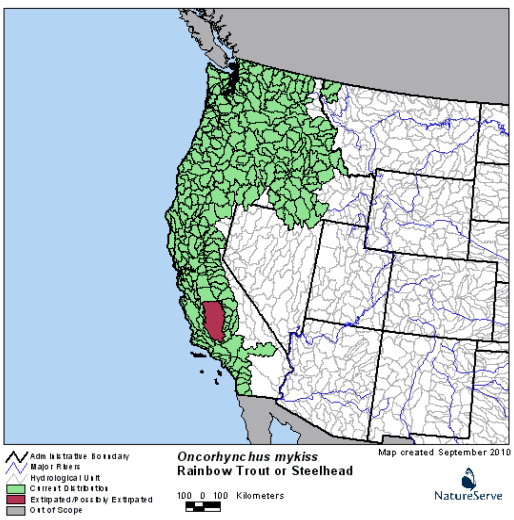
Taxonomic Group: Fish

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000



Body Mass (kg): 0.100

Diet Type: Invertivore, Piscivore

Nativity: Native

Abundance: Rare

Habitat: Near shore, Pelagic, Bay/sound, Lagoon, River mouth/tidal river, Creek, High gradient, Low gradient, Medium River, Moderate gradient, Pool, Riffle, Deep water, Shallow water

References:

Oncorhynchus mykiss – (Walbaum, 1792). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Southern California Steelhead Recovery Plan. *National Marine Fisheries Service.* Office of Protected Resources, Long Beach, California, USA. February 2012.

Striped Skunk (*Mephitis mephitis*)
PRESUMED STABLE

Taxonomic Group: Mammal

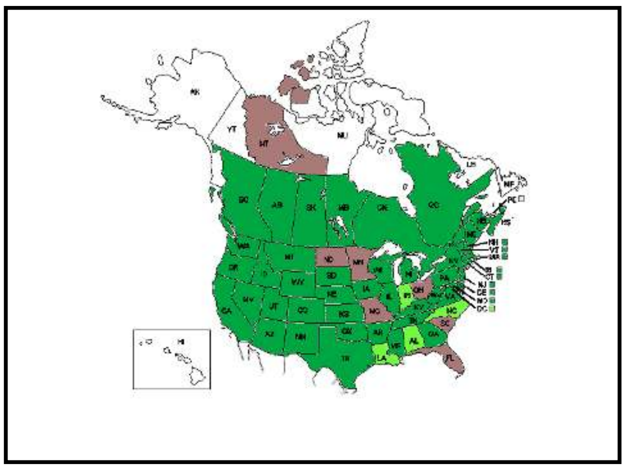
Park: SAMO

G-Rank: G5

S-Rank: S5

Range Size (sq. km): >2,500,000

Body Mass (kg): 6.30



Diet Type: Carnivore, frugivore, invertivore

Nativity: Native

Abundance: Rare

Habitat: Cropland/hedgerow, Desert, Conifer, Harwood, and Mixed Forests, Grassland/herbaceous, Old field, Savanna, Suburban/orchard, Woodland - Conifer, Hardwood, and Mixed Woodlands

References:

Mephitis mephitis - (Schreber, 1776). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012.

Surfbird (*Aphriza virgata*)
MODERATELY VULNERABLE

Taxonomic Group: Bird

Park: CABR

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): 200,000-2,500,000

Body Mass (kg): 0.205

Diet Type: Invertivore

Nativity: Native

Abundance: Uncommon

Habitat: Rocky sea coasts and islands

References:

Aphriza virgata - (Gmelin, 1789). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012.

Senner, Stanley E. and Brian J. Mccaffery. 1997. Surfbird (*Aphriza virgata*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/266 doi:10.2173/bna.266.

Swainson's Thrush (*Catharus ustulatus*)

MODERATELY VULNERABLE

Taxonomic Group: Bird

Park: CHIS

G-Rank: G5

S-Rank: S4

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.031

Diet Type: Frugivore, Invertivore

Nativity: Native

Abundance: Occasional

Habitat: Forested Wetland, Riparian, Bare rock/talus/scree, Desert, Forest-Conifer, Hardwood, & Mixed, Old field, Shrubland/chaparral, Woodland-Conifer, Hardwood, & Mixed

References:

Catharus ustulatus – (Nuttall, 1840). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Retrieved from www.natureserve.org/explorer/.

Mack, Diane Evans and Wang Yong. 2000. Swainson's Thrush (*Catharus ustulatus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/540. doi:10.2173/bna.540.

Swainson's Thrush. *Bird Web*, Seattle Audubon Society; Retrieved from www.birdweb.org/birdweb/.

Thayer's Gull (*Larus thayeri*)

MODERATELY VULNERABLE-PRESUMED STABLED

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 1.093

Diet Type: Invertivore, Piscovore

Nativity: Native

Abundance: Rare

Habitat: Bay/sound, Lagoon, River mouth, Tidal flat/shore, Riparian

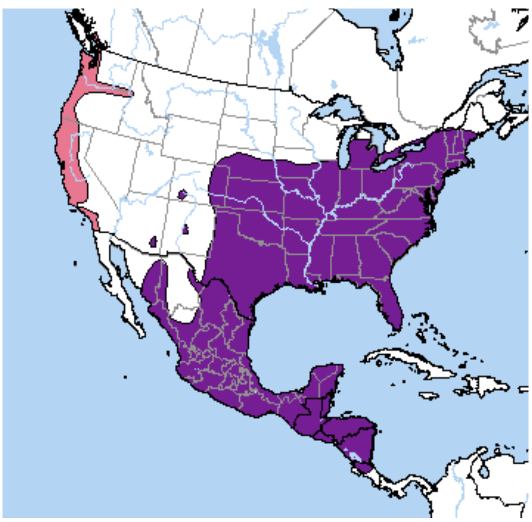
References:

Larus thayeri – (Brooks, 1915). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Retrieved from www.natureserve.org/explorer/.

Snell, Richard R. 2002. Thayer's Gull (*Larus glaucoides*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/699bdoi:10.2173/bna.699

Thayer's Gull. *Bird Web*, Seattle Audubon Society; Retrieved from www.birdweb.org/birdweb/.

Virginia Opossum (*Didelphis virginiana*)
PRESUMED STABLE



Taxonomic Group: Mammal

Park: CABR

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): -

Body Mass (kg): 6.300

Diet Type: Carnivore, Frugivore, Granivore, Herbivore, Invertivore

Nativity: Non-Native

Abundance: Abundant

Habitat: Forested wetland, Herbaceous wetland, Riparian, Cropland/hedgerow, Forest – Hardwood & Mixed, Grassland/herbaceous, Old field, Shrubland/chaparral, Suburban/orchard, Woodland – Hardwood & Mixed

References:

Cuarón, A.D., Emons, L., Helgen, K., Reid, F., Lew, D., Patterson, B., Delgado, C., Solari, S. (2008) Didelphis virginiana. In: IUCN 2011. *IUCN Red List of Threatened Species.* Version 2011.2, February 2012. Accessed on June 10, 2012. Retrieved from www.iucnredlist.org/

Didelphis virginiana – (Kerr, 1792). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012. Accessed on June 10, 2012. Retrieved from www.natureserve.org/explorer/.

Western Gull (*Larus occidentalis*)
PRESUMED STABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: S5

Range Size (sq. km): >2,500,000

Body Mass (kg): 1.011

Diet Type: Carnivore, Invertivore, Piscovore

Nativity: Native

Abundance: Abundant

Habitat: Bay, Lagoon, River

References:

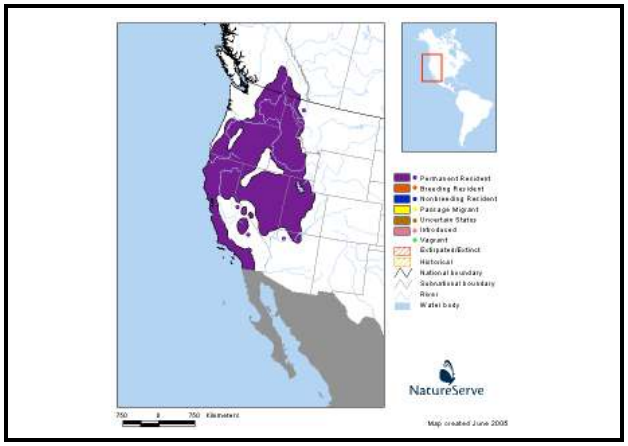
Larus occidentalis – (Audubon, 1839). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, March 2012. Retrieved from www.natureserve.org/explorer/.

Pierotti, Raymond J. and Cynthia A. Annett. 1995. Western Gull (*Larus occidentalis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/174. doi:10.2173/bna.174.

Western Gull. *Bird Web*, Seattle Audubon Society; Retrieved from www.birdweb.org/birdweb/.

Western Skink (*Eumeces skiltonianus skiltonianus*)

MODERATELY VULNERABLE-PRESUMED STABLE



Taxonomic Group: Reptile

Park: SAMO

G-Rank: G5

S-Rank: S5

Range Size (sq. km): 200,000-2,500,000

Body Mass (kg):

Diet Type: Invertivore

Nativity: Native

Abundance: Uncommon

Habitat: Riparian, Forest - Conifer & Mixed, Grassland/herbaceous, Shrubland/chaparral, Woodland - Conifer & Mixed

References:

Plestiodon skiltonianus – Baird and Girard, 1852. *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Accessed on June 8, 2012. Retrieved from www.natureserve.org/explorer/.

Schmitz, A., Mausfeld, P. & Embert, D. (2004) Molecular Studies on the Genus Eumeces Wiegmann, 1834: Phylogenetic Relationships and Taxonomic Implications. *Hamadryad,* **28**, 73-89.

Tanner, W.W. (1943) Notes on the life history of Eumeces skiltonianus skiltonianus. *Great Basin Naturalist*, **4**, 81-88.

Taxonomic Group: Bird

Park: CHIS

G-Rank: G4

S-Rank: S2

Western Snowy Plover (*Charadrius alexandrines nivosus*)

EXTREMELY VULNERABLE-HIGHLY VULNERABLE

Range Size (sq. km):

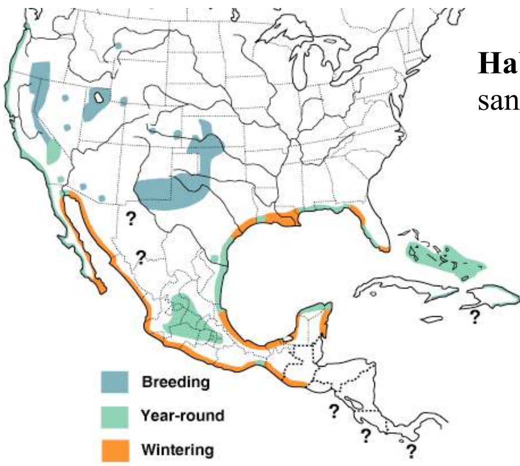
Body Mass (kg):

Diet Type: Invertivore

Nativity: Native

Abundance: Threatened

Habitat: Tidal flat/shore, riparian, sand/dune, beaches, dry mud



*This is the range map for the Snowy Plover

References:

Charadrius nivosus – (Cassin, 1858). *NatureServe Explorer: An Online Encyclopedia of Life*, Version 7.1, February 2012. Retrieved from www.natureserve.org/explorer/.

Lafferty, K. D. (2001). Disturbance to wintering western snowy plovers. *Biological Conservation*, *101*, 315-325.

Page, Gary W., Lynne E. Stenzel, G. W. Page, J. S. Warriner, J. C. Warriner and P. W. Paton. 2009. Snowy Plover (*Charadrius nivosus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/154. doi:10.2173/bna.154.

Pratt, R., Miller, K., Elam, D., & Pisani, I. (2001). Western Snowy Plover Pacific Coast Population Draft Recovery Plan. *U.S. Fish and Wildlife Service*, 492.

Snowy Plover. *Bird Web*, Seattle Audubon Society; Retrieved from www.birdweb.org/birdweb/.

Yellow Warbler (*Dendroica petechia*)

PRESUMED STABLE

Taxonomic Group: Bird

Park: SAMO

G-Rank: G5

S-Rank: SNR

Range Size (sq. km): >2,500,000

Body Mass (kg): 0.010

Diet Type: Invertivore

Nativity: Native

Abundance: Rare

Habitat: Shrubland/chaparral, Suburban/orchard, Woodland - Hardwood

References:

den Haan, H. E., Dufour, K.W., Hobson, K. A., and Mazerolle, D. F. (2005) Effects of large-scale climatic fluctuation on survival and production of young in a Neotropical migrant songbird, the yellow warbler *Dendroica petchia*. *Journal of Avian Biology* 36: 155-163.

Lowther, P. E., C. Celada, N. K. Klein, C. C. Rimmer and D. A. Spector. (1999) Yellow Warbler (*Setophaga petechia*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online:http://bna.birds.cornell.edu/bna/species/454 doi:10.2173/bna.454.

Setophaga petechia - (Linnaeus, 1766). *NatureServe Explorer: An Online Encyclopedia of Life,* Version 7.1, February 2012.

Shuford, W. D., and Gardali, T., editors.(2008) California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. *Studies of Western Birds*. 1:332–339, 2008.