Title
Perspectives in Conservation Biology in Southern California: I. Current Extinction Rates and Causes

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Publication Date
2001-07-12

Perspectives in Conservation Biology in Southern California
I. Current Extinction Rates and Causes

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July 12, 2001

The state of California houses some of the highest levels of species richness in the world. The California floristic province is considered one of the 18 global biodiversity hot-spots (Wilson 1992). More than one quarter of all plant species found north of Mexico are native to California and about half of these are found only in California. Further, it is estimated that there may be as much as 700 endemic[1] species in the Southern California area and several entire endemic families of invertebrates, vertebrates, and Anniellidae (legless lizards) (Scott, T.A.[2], personal communication). Based simply on the numbers of species in California, many are likely at risk to becoming threatened, endangered, or extinct.

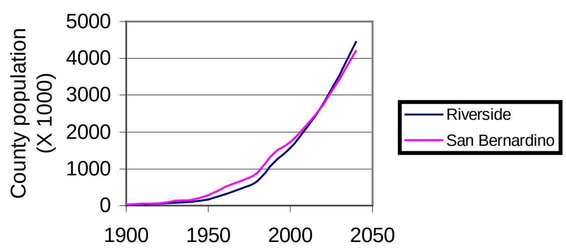

Figure 1. Human population changes and projections in Riverside and San Bernardino Counties.

California remains also among the fastest growing states. The human population has been growing rapidly since the gold rush of the 1850's and, at the decadal time scale, shows no signs of slowing down. The 1998 data from the California Department of Finance suggests the state population of 29.9 million in 1990 will nearly double to 58.7 million by 2040. In Riverside and San Bernardino counties alone, the population is expected to increase by 3.5 to 4-fold (Fig 1).

Given the unique biological richness and human population pressures in California, the rate of species extinctions in the state may serve as a useful indicator of where species conservation is headed in the rest of the continental U.S. To evaluate this, we examined the rate of animal extinctions in California using data compiled by the California Department of Fish and Game (Wildlife and Habitat Data Analysis Branch), and the rate at which plant and animal species in California were listed as threatened or endangered (using U.S. Fish and Wildlife Service data). Understanding these trends and the underlying causes will help us begin to put extinction and policy into perspective.

The high number of endemic species with small and restricted distributions in California means that species extinctions will likely be more severe in this state before the rest of the continental U.S. For example, as a result of the reduced number of year-round flowing streams in Southern California, most native freshwater fish are now extinct, rare or endangered (Swift et al. 1993). To estimate the rate of animal species extinctions in California, we plotted the cumulative number of extinct animal species against time (Fig 2) using a database compiled by the California State Fish and Game. The data set covers the last 200 years, but it is possible that Native Americans had an

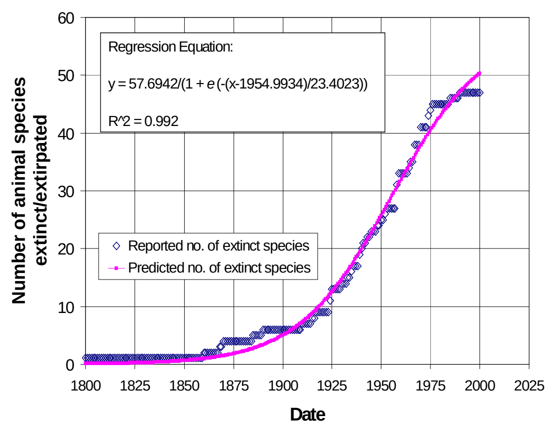

Figure 2. Rate of animal species extinctions in California over the past 200 years.

[1] Populations native and restricted to a specific region - Not naturally occurring outside a particular region.
[2] Scott, T.A., University of California, Riverside, Department of Earth Sciences.

impact on native species prior to that period. Out of the 54 species listed as extinct[3], only sixteen have populations surviving outside the state, (i.e., they have been extirpated from California). We included these extirpated species in this exercise, because the loss of genetic diversity when local and regional populations become extinct may pose a threat to long-term population viability.

Using a curve fit approach we found that the best equation ($y = 57.6942/(1 + e(-(x-1954.9934)/23.4023)))$, to describe the extinction data was not linear but sigmoidal, with an s-shaped curve (Fig. 2). The R^2 value (the square of the correlation coefficient), is a statistical measure of how well the line fits the data. For this equation, the R^2 value (0.994), indicates that the curve depicts the current and projected rate of animal extinction with a high degree of certainty. In addition, the curve indicates that the rate of species extinctions grew exponentially between the years 1925 and 1975 (approximately one species every 1.4 years), and showed a decrease after that period, (approximately one species every 10 years). This suggests that changes in habitat and species management practices, and/or increased public awareness during the 1970's and 1980's, may have had a positive impact towards the preservation of more species. The Endangered Species Act (passed in 1973) may be a contributing factor.

To better understand if this slower animal extinction rate after 1975 indicates that animal species populations have stabilized or if it is only a temporary reprieve, we plotted the cumulative number of species listed as federally threatened or endangered in California against time (Fig 3). To construct this graph we evaluated the threatened and endangered species dataset from the U.S. Fish and Wildlife website <http://endangered.fws.gov/>. As with the species extinction data, we used a curve fit approach to describe the data distribution. For the animal species listings we found that a linear equation ($y = -4880.627 + 2.483x$) with an R^2 of 0.95 best described the data. For the plant data we found that a logarithmic equation ($\log y = -111.776 + .057x$), with an R^2 of 0.94, best described the data. Currently, California contains the greatest number of endangered plants (178) and the greatest number of endangered birds (14) of any region of the continental U.S. (U.S. Fish and Wildlife website, <http://endangered.fws.gov/>).

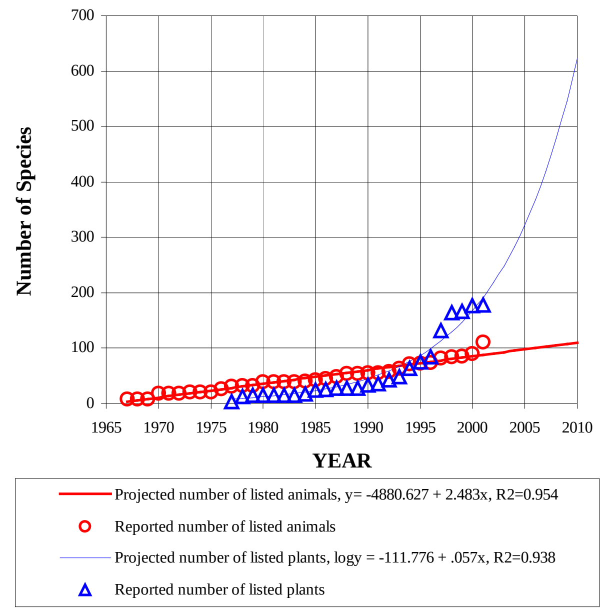

Figure 3. Reported and projected number of threatened and endangered plants and animal species in California.

Figure 3 indicates that the rate of animal listings between 1985 and 1995 was approximately one species every 122 days. During the same time period, the rate of plant listings was approximately one species every 72 days. Since 1995, the overall rate of animal listings has remained roughly constant. In contrast, the overall rate of plant listings has doubled since 1995. Now, approximately one new plant species is listed every 38 days. If the trends depicted in the graph continue, the number of endangered and threatened plant and animal species will increase with time, with listings of plant species occurring at a much faster rate than for animals. The animal listing information also indicates that the current slowing down trend in the rate of animal extinctions (Fig 2), depicted in the s-shaped curve, may be just a temporary situation. It is yet to be determined if animal extinction rates in California are truly on the decline.

To understand some of the causes underlying the animal extinction graph (Fig 2), we summarized the causes cited by the California State Department of Fish and Game. For some species, reasons for extinction were not cited. For others, multiple reasons were given. The two most frequent reasons cited for species extinctions were habitat conversion and urban development. Each of these was cited 11 times

[3] Only 47 of the actual number of extinct species (54) were included in Figure 2, as the date of extinction was not available for all species.

(Table 1). The third most common cause was categorized as human induced hydrologic change. This reason was cited 10 times and included draining, dredging, flooding and flood control. Taken together, these three reasons make up more than half of the causes cited for California animal extinctions.

Table 1. Reasons cited as causes of animal extinctions in California.

Habitat Conversion to Agriculture and Grazing	11
Development and Urbanization	11
Hydrological Changes (flood control, dredging other)	10
Exotic Species Introductions	8
Mining (sand and gold)	8
Pesticides and Pollution	4
Over Exploitation (hunting and collecting)	4
Deliberate Hunting to Extinction	1

From the animal extinction graph (Fig 2), it appears that at least in the short term (the next 5 to 10 years), the number of animal species becoming extinct in California may stabilize. However, given the projected increase in the rate of species listings, and the projected increase in the human population within the next 40 years (along with the accompanying habitat conversions), the longer-term prospects for preventing species extinctions may not be as optimistic. Currently the state is relying more heavily on habitat conservation plans (HCPs), and in particular multi-species habitat conservation plans (MSHCPs), in conservation efforts and land use planning. These landscape level, multi-species plans may prove to be essential for the conservation of species, especially if the numbers of potential listings exceed the management abilities of the various enforcement agencies. Moreover, with the current pace of population growth, there will be little undeveloped habitat available to add into future MSHCPs. Thus, decisions made now as MSHCPs are written, will affect not only species that are currently listed as threatened and endangered, but also species that will be listed in the future. We urge all parties involved in Habitat Conservation Planning and MSHCP processes to reflect on the responsibility they posses and legacy they will leave.

Acknowledgments:

A special thank you to Darlene McGriff, California Dept. of Fish & Game, who provided clarification on the status of species extinctions in California. We also wish to thank University of California Jennifer Lansing for her assistance with the data analyses, undergraduate student Kathleen Fleming for her invaluable literature reviews for the manuscript, and graduate student Amy E. Lindahl, and undergraduate student Edward D. Abad for their helpful comments.

Citations:

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Swift, C., C. Haglund, R. Thomas, M. Ruiz and R.N. Fisher. 1993. The status and distribution of the freshwater fishes of southern California. Bulletin of the Southern California Academy of Sciences 92(3): 101-167.

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