Proposal for studying the genetic benefits of a wildlife crossing as part of the Western Riverside County Multi-Species Habitat Conservation Plan.

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Introduction

Increasingly fragmented habitats are a common pattern as development and human encroachment expand across the landscape. Fragmentation is particularly extensive in southern California (Seabloom et al. 2002). As native habitat is developed, preserves are designed and maintained amidst urbanized areas in a checkered distribution. These small and often isolated preserves are intended to mitigate the loss of critical habitats, due to development, and are meant for conservation of native flora and fauna. However, due to their size and insularization they may be insufficient to successfully abate a decline in biodiversity and protect the integrity of natural ecosystems (Willis 1974, Forman and Godron 1981).

One concern of fragmented landscapes is that as natural habitats become increasingly fractured, the ability of individual organisms to get from one habitat patch to another simultaneously becomes more difficult and progressively more important. Small preserves are often separated by impenetrable barriers, such as major interstate highways or housing developments, which prevent the exchange of migrants between populations (Reh and Seitz 1990, Gerlach and Musolf 2000, Chruszcz et al. 2003, Keller and Largiadèr 2003). These migration events are important and serve three main functions. First, they serve to supplement unproductive populations demographically, reducing any Allee effect and otherwise reducing the possibility of localized extinction (Brown and Kodric-Brown 1977). Second, when local populations do go extinct, interpatch movements are crucial for reestablishing such populations, an important step in maintaining metapopulation dynamics (Levins 1969, Willis 1974, Hanski 1998). Without migration and replacement, as populations become increasingly fragmented, a cycle of localized extirpation and thus greater isolation of surviving populations leads to increased risk of large scale extinction (Gilpin and Soulé 1986). Third, a degree of genetic movement is important to prevent the pathological effects of inbreeding depression (Franklin 1980) and to maintain variation upon which natural selection can act (Fisher 1930, Edwards 2002). Absence of gene flow among small populations typically results in a loss of genetic diversity by genetic drift (Wright 1931) and demographic bottlenecks. Areas of local extirpation cannot be recolonized and genetic diversity at the species level continues to decrease, reducing the ability to adapt to environmental changes and respond to stochastic processes.

One method to alleviate the detrimental effects of fragmentation is to connect small insular areas through the construction of habitat corridors (Price and Gilpin 1996, Tewksbury et al. 2002). The Western Riverside County MultiSpecies Habitat Conservation Plan (MSHCP) recognizes the need for habitat linkages as being of fundamental importance for the continued survival of the species to which it relates. The ShipleySkinner Reserve, like all of the reserves that are part of the MSHCP, is embedded in a network of major highways, and the number and size of highways is likely to increase in the future as urbanization continues. These highways are likely to preclude movement among habitat patches for a number of species. We propose evaluating the feasibility and effectiveness of providing organisms with a land bridge in order to surmount such barriers. As a model that can likely be generalized to other areas in the MSHCP, we will appraise the potential value of connecting Sycamore Canyon Regional Park with Box Springs Preserve, two areas that have been separated by highways for a number of years.

Given the generality of this problem, our first step is to consider this problem in the context of a clear example where a major freeway bars dispersal of individuals. There are several reasons why a wildlife crossing may be particularly beneficial for Sycamore canyon and Box Springs. Sycamore canyon is, at present, structurally isolated from other habitat patches. The relatively small size of the park is likely to increase the intensity of demographic and genetic stochasticity while the high volume of traffic around its perimeter is likely to prevent interpatch movements that could mitigate such events. The small underground riparian linkage between Box Springs and Sycamore canyon may be insufficient for a number of species to use as an effective transit route between sites. Finally, Sycamore canyon serves as critical habitat for endangered species such as the Stephens Kangaroo Rat.

Goals

We propose studying the general utility of a land bridge, using Sycamore Canyon and Box Springs as an example. Specifically, we will review available literature regarding the effectiveness of wildlife crossings for various taxa, evaluate which organisms in the MSHCP may benefit from such a crossing, and propose a method for evaluating the success/failure of a crossing. These are each addressed below.

1. On a general level, we will conduct a review of current literature to determine how artificial wildlife crossings built elsewhere have been used by various organisms. Specifically, we will investigate:

    (a) how attributes of the structures, such as their location, dimensions, aspects of their construction relevant to the biology of animals, and whether they are above the highway or below it, affect their use by a variety of taxa.

    (b) whether previous studies have addressed whether the ultimate goals of increased population longevity, increased rate of colonization of locally extinct patches, and increased genetic diversity within the total population have been achieved. Emphasis will be placed on crossing structures that exist in habitats similar to that found in southern California and those which specifically target species that are either taxonomically or ecologically similar to the local fauna.

2. On a level more specific to Box Springs, Sycamore Canyon, and the MSHCP as a whole, we intend to investigate the effects of a wildlife crossing on the organisms listed in the plan.

    (a) In order to do this, we will first determine which species listed in the plan could potentially make use of such a linkage. These are most likely to be species with an aversion to open spaces, terrestrial species, animals with a very low dispersal ability, or plants in which pollen and seed movement is limited.

    (b) To determine whether the current riparian linkage is sufficient, we intend to survey, using appropriate techniques, for the presence or absence of an organism in and around the linkage. Such a brief survey may be fruitful, if presence is noted, but may also be inconclusive (if no presence is noted) since seasonal movements outside the duration of the census will remain undetected. We can then compare this riparian zone to an equivalent dryland area, with a similar survey effort, around the site of the proposed land bridge.

(c) We intend to use preexisting data and targeted surveys within both parks to determine which species are likely to benefit from the parks being linked. This would also help identify species that would be good candidates for evaluating the extent to which the highway has already fragmented the local communities.

(d) We will model the potential genetic consequences of a wildlife crossing under a variety of scenarios to estimate the genetic benefits that such a structure could bring both in terms of reducing inbreeding as well as maintaining variation within the population.

(e) We will prepare a report that can be distributed to nonscientists interested in evaluating such land bridges.

3. In the case that such a structure is built, we will propose a method for evaluating whether the bridge is adequately serving its intended function of providing a conduit for individuals. Specifically, we will review current literature to determine the feasibility of using current methods to detect whether organisms are successfully using the bridge to traverse the highway and propose methodology to do this using techniques currently available. This may involve direct monitoring of the bridge itself as well as indirect genetic methods which are able to determine whether gene flow between patches is adequately maintaining genetic diversity. Finally, we will investigate avenues of funding, particularly federal sources, for the construction, maintenance and evaluation of the land bridge.

Budget

Stipend for 3 graduate student researchers for 6 weeks each at 50% with required benefits. Two of the students (LE and SP) may have advanced to candidacy and the third (BW) will not. This breaks down as follows:

$1,678/month x 2 people x 1.5 months = $5,034.00

$1,553/month x 1 person x 1.5 months = $2,329.50

Incidental supplies (printer cartridges, photocopying etc.) = $250

Total = $7,613.50

If either SP or LE or both do not advance to candidacy, the total will be adjusted downward accordingly.

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