Genetic Connectivity among Coastal Cactus Wren Populations

in San Diego County

Overview and Objectives

The coastal Cactus Wren is a fragmentation-sensitive resident species in southern California requiring thickets of cholla or prickly pear cactus for nesting. Limited naturally by the patchy distribution of this habitat, Cactus Wren populations have become further fragmented in recent decades by urbanization, habitat degradation, and stochastic events such as wildfire. As a result, Cactus Wren populations have been diminished in size and distribution, and occur largely as islands in a matrix of generally unsuitable habitat.

Among the possible consequences of fragmentation on Cactus Wren viability is genetic isolation, which could lead to loss of genetic variability and ability to adapt to changing environments. Although Cactus Wrens, like other birds, are mobile and can presumably fly long distances between patches, nothing is known about actual connectivity among populations in southern California. Juvenile dispersal, whereby young birds leave their natal territories and establish breeding territories of their own, is the key process by which genetic connectivity is achieved, yet this stage of the life history of birds is probably the most poorly understood.

The goal of this study is to evaluate the degree of genetic connectivity among coastal Cactus Wren populations in San Diego County, coordinating with a similar effort in Orange County led by Dr. Kris Preston of the Nature Reserve of Orange County (NROC). Specifically, the objectives are to:

1. Develop a minimum of 10 polymorphic microsatellite loci that amplify DNA from coastal Cactus Wrens and genotype samples.
2. Collect blood samples from Cactus Wren populations throughout San Diego County, and individually color band Cactus Wren nestlings for a future investigation of juvenile dispersal (Objective 4).
3. Use microsatellite markers to evaluate within- and among- population genetic variability, including both San Diego and Orange County populations.
4. Prepare a Data Summary of genetic study results
5. Conduct follow-up surveys to resight color banded wrens and evaluate dispersal patterns and behavior.

Task 1: Develop 10-20 variable polymorphic microsatellite loci specific to coastal Cactus Wrens.

Schedule: February 2011(or upon USGS receipt of funds – September 2011)

Microsatellites are highly variable nuclear gene regions that are commonly used in conservation genetics to discern genetic structure at a population scale. Using state-of-the-art 454 sequencing technologies, we will develop a microsatellite enriched genomic library for the coastal Cactus Wren. The resulting dataset should contain at least 100 microsatellite loci that can be amplified in the coastal Cactus Wren. From these we will select 10-20 polymorphic loci for further genotyping. Testing will be performed on a subset of blood samples from 1-2 individuals per collecting site that are obtained in collecting efforts in San Diego and Orange Counties (see below).

Once loci are selected and sample collection completed, we will extract DNA from collected blood samples using standard DNA extraction techniques. These will then be genotyped for the selected microsatellite markers. Genotyping will be performed on an ABI 3730 genetic analyzer.

Note that completion of this task as outlined above relies on 50% matching funds pending final approval from NROC. Should these funds not be available, this task will be re-scoped or re-budgeted.

Deliverables

- List of variable loci, primer sequences and optimized amplification conditions.

Task 2: Collect blood samples from Cactus Wren populations throughout San Diego County, and individually color band Cactus Wren nestlings for a future investigation of juvenile dispersal.

Schedule: mid-March – late May 2011

We propose to collect DNA samples from nestlings in 80 Cactus Wren nests from throughout the species' range in San Diego County, including San Pasqual Valley, Lake Hodges, and Otay Valley, as well as other small sites. We will coordinate closely with the Cactus Wren survey team conducting county-wide surveys in 2011 and identify sampling locations based on their findings of bird locations, abundance, and nesting status. Once nests are located, field investigators will visit them every 7 days to determine status and establish a date for banding/DNA sampling. We will

band nestlings at 6-7 days of age with a unique combination of color bands, and will collect a small drop of blood by clipping the toe nail.

Deliverables

- List of cactus wrens sampled for DNA and color banded, including age, location, and nest/territory ID.

Task 3: Use microsatellite markers to evaluate within- and among- population genetic variability.

Schedule: October 2011 (or upon USGS receipt of Year 2 funds- July 2012)

We will use a number of standardized techniques to describe genetic relationships among individuals and collection sites. To evaluate spatial structure, we will use Bayesian assignment methods to assign individuals to contemporary gene pool clusters based on their genotypes and spatial locations. In addition, we will use analyses of molecular variance (AMOVA) to test the significance of genetic divergence among and within each collection site. To test for evidence of inbreeding or loss of genetic diversity, we will compute estimates of heterozygosity, allelic richness, inbreeding coefficient and effective population size at each sample site. Finally, we will apply a landscape genetic approach to evaluate pairwise genetic distance measures among collection locations to the geographic distance among sampling locations. We will calculate geographic distance in two ways: 1) straight Euclidean distance among sampling locations, and least-cost-path distances through suitable habitat (as mapped by FWS). In this framework, we will also evaluate the potential genetic effects of hypothesized barriers to dispersal such as large highways and urban development.

Task 4: Prepare Data Summary

Schedule: August 2012 – September 2012

A data summary report will be prepared by Dr. Vandergast and her staff that disseminates the results of the genetic analyses performed in Task 3.

Deliverables

- The data summary will include an outline of the goals and objectives of the project, a description of the field and laboratory methods used to collect and analyze samples, a description of the statistical methods employed to analyze

the genetic data, and a discussion of the results including applicability to future management and monitoring.

Task 5 and Task 6 are planned but not yet contracted

Task 5: Conduct follow-up surveys to resight color banded wrens and evaluate dispersal patterns and behavior.

Schedule: October 2011 – April 2012

We will resight banded birds at our banding sites at the end of the breeding season in 2011 and in early 2012, when young birds disperse from their natal territories. Ideally, this effort would be coupled with a larger range-wide survey such as that scheduled for 2011 to maximize the potential for detecting dispersing, color banded wrens. We will record location, and describe the habitat occupied by each banded bird re-located, as well as information on its nesting status. This information will be interpreted within the context of the findings of the genetics analysis, and will be used to guide recommendations regarding management of physical corridors to connect Cactus Wren patches.

Deliverables

- Dr. Kus will prepare a summary of the number and locations of banded Cactus Wrens resighted during the winter and spring of 2011-2012, including an assessment of distances moved relative to original banding locations..

Task 6: Prepare Detailed Scientific Publication

Schedule: August 2012 – December 2012

The genetics and field principal investigators will jointly prepare a manuscript for publication that details and jointly interprets the findings of the genetic analysis and re-sighting work completed in Year 2 of the project.

Deliverables

- One publication will be directed at resource managers and be prepared in a format acceptable to a peer-reviewed journal.