Prioritizing Restoration on the Irvine Ranch Natural Landmark

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Introduction

The Irvine Ranch contains some of the best remaining native ecosystems of Southern California. Over 46,000 acres have been permanently protected—nearly 40,000 of which have been designated a Natural Landmark by both the US Department of Interior and U.S. State Parks. Although these wildlands are fully protected, they are under significant short-term and long-term ecological stress from multiple sources. The mosaic of sage scrub, chaparral, native perennial grasslands, oak- woodlands, and riparian habitats has experienced degradation from agriculture, invasive grazing, woodland clearance, development, invasive species, and low-impact fires over the last 150 years. Many other protected wildlands in the region are in a similar state. The process of ecological restoration can increase habitat value and resiliency to disturbance events and also protect intact habitat from invasion by non-native species. However, funding available for restoration is limited. Through integrating a return on investment approach to restoration planning, conservation organizations can make better use of the limited funds and human resources.

Existing prioritization approaches

• Weighted ranking systems
  - Rank sustainability, transparency, and incorporation of cost, and ranking criteria is often not well defined
• Cost-effectiveness analysis
  - Ignored spatial dependencies and temporal dynamics
• Few examples utilizing systematic conservation planning principles and tools

Challenge

• Develop a restoration prioritization approach that is meaningful at multiple ecological scales and is spatially and temporally explicit
• Develop a restoration schedule, that provides the greatest ecological benefit given a fixed budget
• Integrate the factors in systematic conservation planning which have not been incorporated into date such as time delays, feedback between investments, a potential high likelihood that the restoration may not succeed, and spatial dependencies between existing habitat and the sites that are to be restored

Goal

Our goal is to identify the combination of restoration sites and activities across the Irvine Ranch landscapes, and the schedule for their implementation, that will provide the greatest and most resilient improvement in habitat coverage for a fixed budget.

Method

Our approach is spatially and temporally explicit and accounts for the cost of restoration, likelihood of restoration success, the probability of drought and a major catastrophic fire event, the benefit of spatial connectivity, and the relative contribution of restoring a given site towards enhancing the ecological resilience of the broader ecosystem. Our objective is to maximize the restoration of habitat and to achieve management goals given a fixed budget constraint.

Identified candidate restoration sites

• 823 degraded areas identified on the basis of desired habitat type (based on remnant vegetation), degradation state, slope and aspect
  - Highly degraded 0–15% native species coverage
  - Partially degraded 16–30% native species coverage
  - Total area identified is 1,359 HA
• Minimum size of candidate restoration sites is 0.5 HA
• 923 sites merge to 108 restoration clusters within the same sub-watershed to assist with implementation logistics
• Sites were selected for restoration on a restoration cluster level

Factors considered in prioritization

• Cost of restoration: site preparation, plant materials, seeding/planting, management and maintenance, slope, aspect
• Likelihood of success (risky habitat type, degradation, slope, aspect and perimeter shared with degraded vegetation)
• Ecological events: fire and drought
• Benefit of restoration: restored area, historic non-sensitive animals and plants, contributions to improving ecological resilience (fire risk zones, climate change corridors and connectivity corridors)

Constraints

• Final annual budget: $700,000; $14 million over 20 years, which accounts for failures
• Logical constraints: 80 HA per year

Sensitivity Analysis

We performed sensitivity analysis on the following factors to identify the sources of uncertainty that have the greatest impact on the outcome and on our decisions:

• Whether or not fire and drought probabilities are included
• Removing the effects of a preference towards roads in the benefit function (high fire risk zones)
• Different benefit weights to restoring polygons of different degradation states
• Preferences for the restoration of particular habitat types

Optimal solution

Compares three heuristics to a near optimal solution:

• Random
• Static approach that maximizes benefit of likelihood of success
• Dynamic heuristic that maximizes the speed at which the system is restored

Outcome

• Over the 20-year time period, not all sites are restored, emphasizing the need for prioritization. With the 80HA per year constraint, around 200 sites aren’t restored at the end of 20 years.
• On average, sites are chosen ~1.6 times for restoration. The likelihood of success (LoS) is ~0.6 because of the LoS average LoS with the impact of drought and fire.
• The total probability of success is therefore (0.75^8 *0.05^12)/(1-1/12) which equates to approximately 0.6.
• Total number of polygons attempted are 1,004 (lower at the cluster site level). Total number successful polygons within 20 Years are 687. Total area restored is 962 HA.

Model Evaluation

We also compare the different possible matrices for evaluating the outcomes of a restoration plan and measuring the robustness of model based on:

• Average score
  - Use average score of all sites within each restoration cluster as the utility of that restoration cluster.
  - Use highest score of all sites within each restoration cluster as the utility of that restoration cluster.

Summary

Our prioritization algorithms account for the likelihood of restoration success, the probability of a major catastrophic fire event, the benefit of spatial connectivity, and the relative contribution of restoring a given site towards enhancing the ecological resilience of the broader ecosystem. These factors represent key considerations when planning for restoration, although data on ecological aspects can be challenging to collect, particularly information on the cost and likelihood of success.

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For further information

Please contact Morgan Smith. Email: msmith@irconservancy.org. More information about Irvine Ranch Conservancy can be obtained at www.irconservancy.org.