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GROUP PROJECT BRIEF

Cumulative Impacts of Large-scale Renewable Energy Development in the West Mojave

Effects on habitat quality, physical movement of species, and gene flow

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ON THE WEB AT HTTP://WWW.BREN.UCSB.EDU/~WESTMOJAVE SPRING 2009

INTRODUCTION

Climate change is one of the top environmental challenges of our time. To combat climate change and its associated risks, the United States is looking to renewable energy as a viable alternative to fossil fuel energy sources. To slow our contribution to climate change, California's Governor has issued an executive order requiring one-third of statewide electricity production to come from renewable sources by 2020. To fulfill these unprecedented goals, developers are looking beyond distributed generation and small-scale plants to large-scale wind and solar developments. With its large, windy, open expanses, perpetually sunny days, and general lack of development, the West Mojave has quickly become the focus of in-state renewable energy planning. However, renewable energy development its own ecological consequences

GOAL

Examine the cumulative effects on habitat fragmentation, species movement and gene flow in the West Mojave, given specific scenarios of large scale renewable energy development.

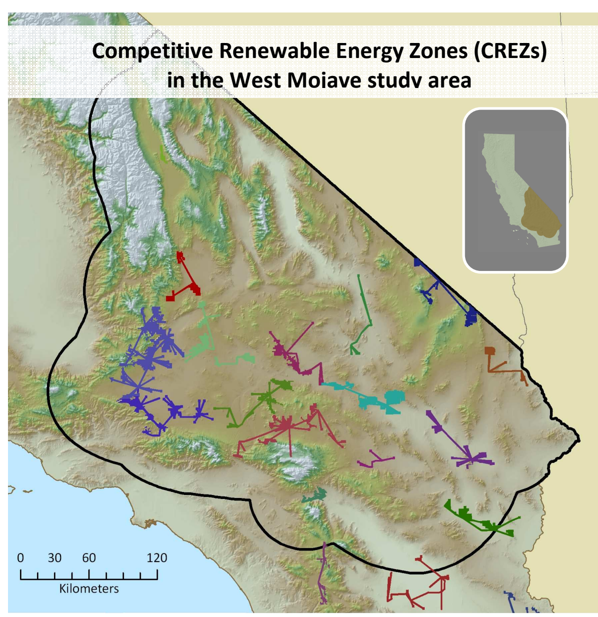
PROJECT SIGNIFICANCE

The purpose of this project is to examine the cumulative effects on habitat fragmentation, species movement and gene flow in the West Mojave, given specific scenarios of large scale renewable energy development in the region. As we turn to large-scale solar and wind farms to satisfy our growing need for renewable energy, we must consider the impacts these projects can have to the immediate landscape and to ecological processes. The West Mojave contains some of the most pristine areas in California, and is home to more than 20 endangered or threatened species,[1] as well as several flagship species, including the desert tortoise (*Gopherus agassizii*) and the bighorn sheep (*Ovis Canadensis nelsoni*). Although individual project permitting and regional conservation planning efforts evaluate certain aspects of the environmental impacts of such projects, rarely do these avenues evaluate the cumulative impacts of a network of multiple projects.

ESTABLISHING DEVELOPMENT SCENARIOS

This project calculated that California is expected to demand an additional 50,000 to 286,000 GWh of renewable energy in 2050. To meet this demand, providers have submitted numerous applications to planning and land management agencies to build solar and wind projects in the West Mojave region.[2] Together, these applications would cover more than one million acres in the region.

Because it is difficult to predict exactly how many large-scale renewable energy developments will actually be built in the West Mojave, we began by establishing the minimum and maximum expected renewable energy demand in 2050. To predict where these projects may be built, we based our analysis on information from the California Energy Commission's Renewable Energy Transmission Initiative (RETI). Their purpose is to determine where transmission lines must be built to reach large-scale renewable energy developments. In doing so, RETI identified over 2,150 potential, proposed, or planned energy projects throughout the state of California and grouped them into Competitive Renewable Energy Zones (CREZs).



Each CREZ can contain wind, solar, and geothermal projects, and there are 18 CREZs that exist either partially or wholly within the West Mojave study region. To satisfy the low predicted demand, the analysis assumed that six of the CREZs within the West Mojave – those which RETI identified as the most economically and environmentally viable – would be built. To satisfy the high predicted demand, the analysis assumed all eighteen zones within the study region would be developed.

In order to isolate the effects of renewable energy versus other development and change that will occur by 2050, all of the modeling done in this analysis was conducted on four scenarios.

- The **Present** Scenario reflects current vegetation types, present urban development, roads, and other infrastructure such as dams and aqueducts.
- The **Future Baseline** Scenario reflects the features of the Present Scenario, but also incorporates additional urban development projected to 2050, and a simple climate change model of a 2°C temperature rise.
- The **Low Renewable Energy Development** Scenario ("Low Scenario") reflects the Future Baseline Scenario with the addition of six CREZs in the western reaches of the study area.
- The **High Renewable Energy Development** Scenario ("High Scenario") reflects the Future Baseline Scenario with the addition of all eighteen CREZs throughout the study area.

CONNECTIVITY ANALYSIS

A connectivity analysis is useful to quantify how large-scale renewable energy development and associated infrastructure may cause barriers to species movement and gene flow. Generally, connectivity refers to the degree to which a landscape allows for the flow of organisms among habitat patches and populations, and it is imperative for both species survival and biodiversity. Individuals must be able to move between habitat patches to meet their resource needs, while populations must be connected to allow for dispersal, gene flow, and re-colonization [3] ; when populations are isolated, they become susceptible to inbreeding depression and are less able to adapt to varying environmental conditions like climate change [4] This analysis employed a software program called Circuitscape to conduct a connectivity analysis for the desert tortoise and the desert bighorn sheep. Circuitscape uses circuit theory to predict connectivity by connecting populations to each other through the landscape, which acts as a circuit of varying conductance. The results highlight potential pathways between populations and critical habitat areas given the conductance of the surrounding habitat.

DESERT TORTOISES are found in the Mojave and are widely distributed in a variety of desert habitats, especially creosote scrub.[5] Habitat fragmentation and barriers to movement can severely limit desert tortoise populations.[6] Although their historic habitat was relatively continuous in the West Mojave,[7] it is becoming more fragmented in the face of increased development and urbanization. Highways are specifically problematic due to the increased likelihood of fatal incidents with motor vehicles.[8] In fact, highways can depress desert tortoise population density as far as 400m away.[9]

This analysis modeled connectivity between eight designated desert tortoise critical habitats (See Figures 1-2). Many of the CREZs in the High Renewable Energy Development Scenario are planned for areas important for tortoise connectivity and within desert tortoise critical habitats. Scattered CREZs surrounding critical habitats decreased tortoise movement to and from those habitats (from orange to blue).

DESERT BIGHORN SHEEP exist in the West Mojave, desert as 69 small, distinct populations, each of which depends on migrants from other populations to maintain genetic diversity. Thus, bighorn sheep exist as a meta-population, and the individual populations and the habitat connecting them are highly important. Should one population become isolated or decline, every population is at a greater risk of extinction. This analysis modeled connectivity between all 69 sheep populations, and conducted a more detailed analysis on a subset of 8 populations. The analysis indicates that proposed future large-scale renewable energy development, especially in the High Scenario, decreased movement from high (in yellow) to low (in blue), such as the pathways between the southwest and northeast Mojave desert.

CONNECTIVITY MAP OUTPUTS

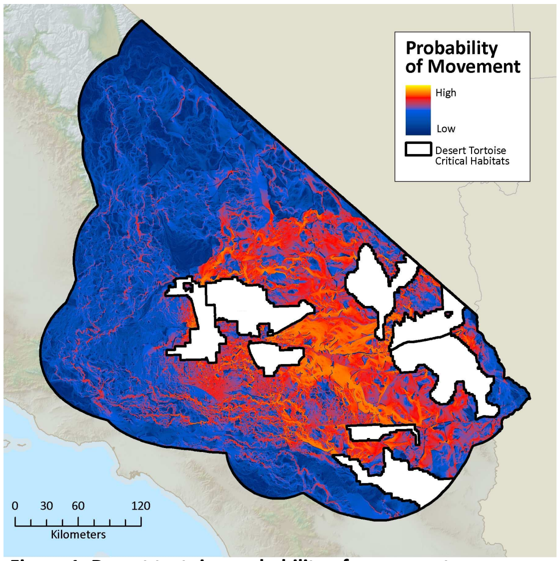


Figure 1. Desert tortoise probability of movement (present scenario)

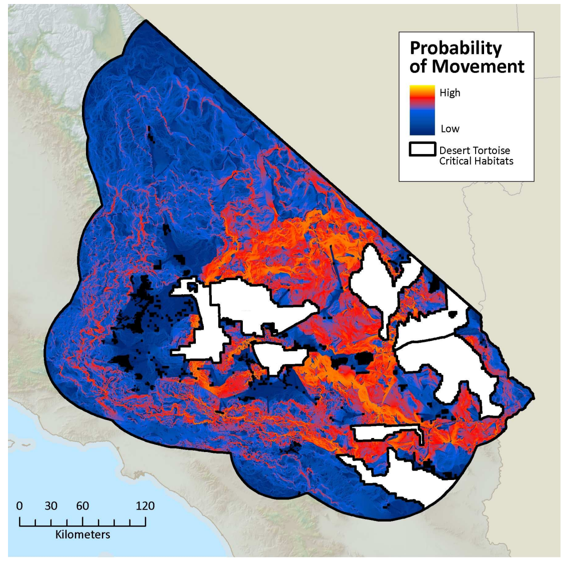


Figure 2. Desert tortoise probability of movement (High Scenario)

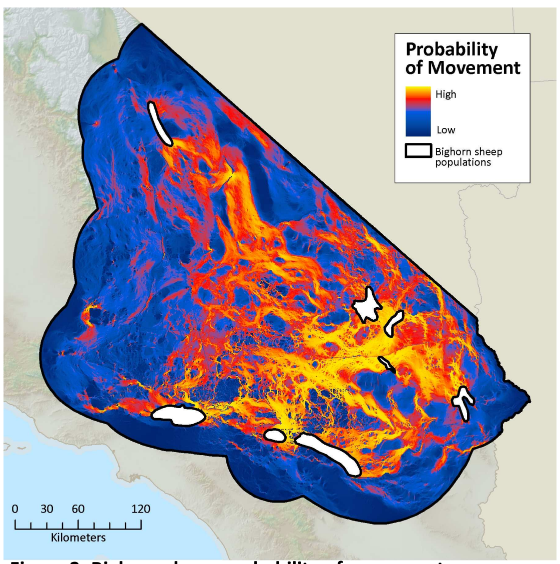


Figure 3. Bighorn sheep probability of movement (Present Scenario)

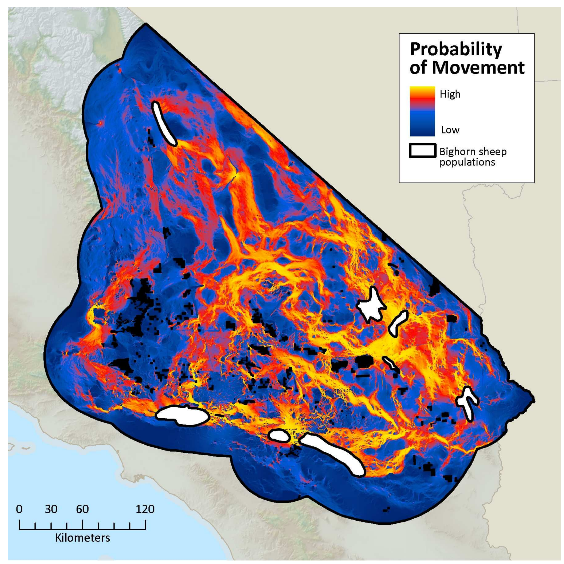


Figure 4. Bighorn sheep probability of movement (High Scenario)

GENE FLOW OF THE DESERT BIGHORN SHEEP

Quantitative outputs from the Circuitscape connectivity model were combined with population genetic data to predict migration rates between bighorn sheep populations. Migration rates between all populations decrease from the Present to all three future scenarios. Specifically, migration rates between the San Gabriel Mountains population, the largest in the region, and populations in the northeast are significantly impacted. In the High Scenario, the migration rates between these populations decrease to near or below one migrant per generation, the adequate gene flow to prevent genetic isolation. Cumulatively, large-scale renewable energy development could significantly impact gene flow between many other sheep populations, decreasing the viability of the entire metapopulation of desert bighorn sheep in the West Mojave.

HABITAT FRAGMENTATION ANALYSIS

This analysis employed a software program called Fragstats to analyzes landscape fragmentation and quantify changes to total desert tortoise critical habitat, bighorn sheep core habitat, and to specific habitats important for species movement across all scenarios. The Fragstats analysis shows that the total core habitat area decreases for all scenarios and for both species. The Fragstats analysis reinforces the fact that renewable energy development can decrease essential habitat.

RECOMMENDATIONS

PLANNERS

- Continue current efforts to coordinate and streamline renewable energy development on a regional scale, and with long-term implications in mind.
- Integrate connectivity analyses into the environmental analyses of the various transmission and renewable energy planning processes.
- Reconsider the location, size, or configuration of projects that impact connectivity within or between important habitat areas.
- If development is inevitable, work to mitigate impacts to connectivity by siting on previously disturbed land, clustering development, minimizing fencing, or considering translocation.
- Specifically examine impacts to metapopulations of concern to avoid impacting important populations that act as sources for dispersers.

PLANNERS AND CONSERVATION ORGANIZATIONS

- Expand these types of analyses to include additional species and scenarios.
- Conduct additional investigations into particularly problematic developments.

CONSERVATION ORGANIZATIONS

- Prioritize the purchase or easement of lands important to connectivity.
- Provide additional technical support and expertise to agencies to conduct connectivity analyses.
- Provide feedback to planning processes and continue to advocate for environmentally responsible land use decisions and intelligent siting.
- Promote greater efficiency and distributed generation to minimize the overall need for large-scale renewable energy developments.

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