Renewable Energy and the West Mojave

How Can Large-Scale Renewable Energy Development Affect Species Movement and Gene Flow?




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California has mandated that one-third of its electricity come from renewable sources by 2020, much of which will likely come from large-scale renewable energy. The purpose of this project was to examine the effects of such large-scale renewable energy development on connectivity in the West Mojave.

WHAT IS CONNECTIVITY?

Connectivity refers to the degree to which organisms can move among habitat patches and populations. Individuals must be able to move between patches to meet their resource needs, while populations must be connected to allow for dispersion, gene flow, and re-colonization.

LARGE-SCALE RENEWABLE ENERGY DEVELOPMENT IN THE WEST MOJAVE

The largely undeveloped but ecologically rich West Mojave (See Figure 1) has become the focus of California's renewable energy planning. Energy providers have submitted project applications that would collectively cover more than one million acres of the region (BLM 2009). Poorly planned development could contribute to habitat loss and fragmentation, barriers to species movement and gene flow. Although project permitting and regional planning evaluate basic environmental impacts of such projects, rarely do they consider impacts on connectivity.

To study the effects of large-scale renewable energy on connectivity, we modeled the present and three future scenarios: future baseline with climate change and urban development up to 2050, a "low" renewable energy development scenario (See Figure 2), and a "high" renewable energy development scenario (See Figure 3).

MODELING SPECIES MOVEMENT AND GENE FLOW

We focused our connectivity analysis on two flagship species of the West Mojave: the desert tortoise (*Gopherus agassizii*) and the bighorn sheep (*Ovis Canadensis nelsoni*). Our modeling was conducted with a program called Circuitscape, which uses circuit theory to predict connectivity by connecting populations through a landscape of varying conductance. The results highlight potential pathways that desert tortoises or bighorn sheep might take to travel between populations and critical habitat areas (See Figures 4 and 5). The results also indicate that without proper planning, the cumulative development of large-scale renewable energy projects throughout the West Mojave could have a negative effect on species' connectivity.

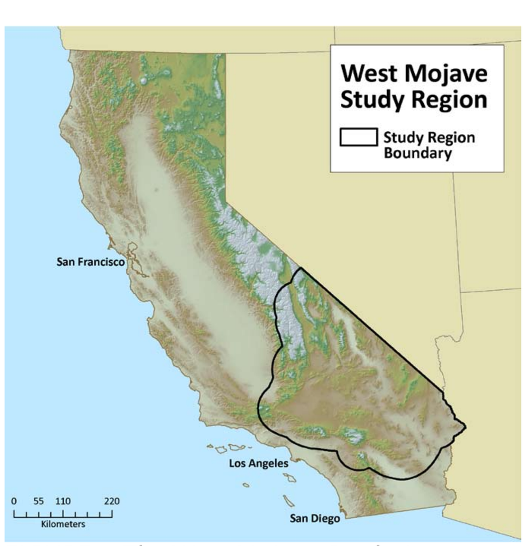


FIGURE 1. The West Mojave Study Area

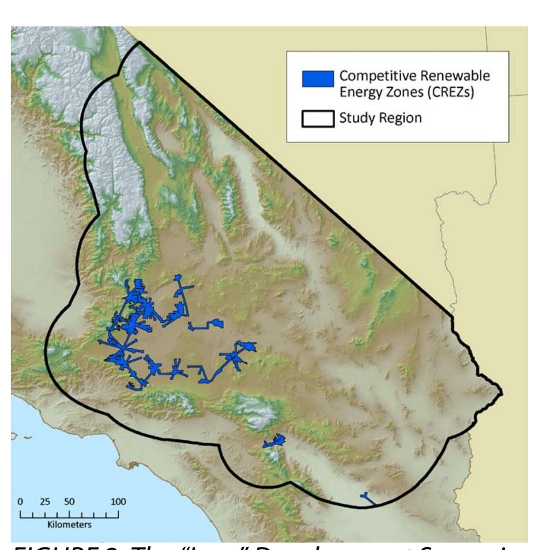


FIGURE 2. The "Low" Development Scenario

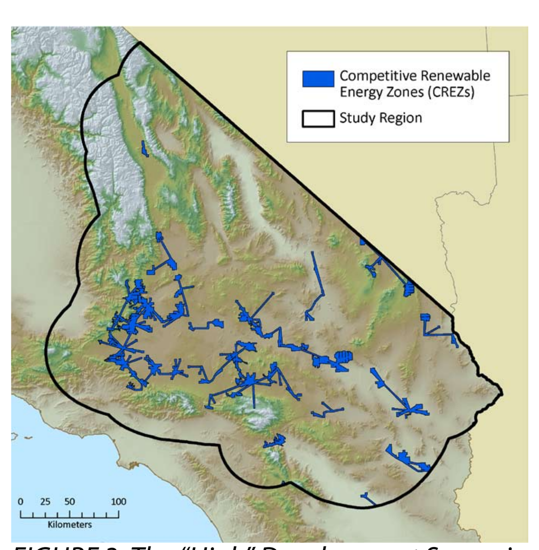


FIGURE 3. The "High" Development Scenario

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 transmission and renewable energy planning processes.
- Reconsider the location, size, or configuration of projects that impact connectivity within or between important habitat areas.
- Mitigate impacts to connectivity by siting on previously disturbed land, clustering development, minimizing fencing, or considering translocation.
- Examine effects to metapopulations of concern to avoid impacting important populations that act as sources.

BOTH

- 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 specifically 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

DESERT TORTOISE

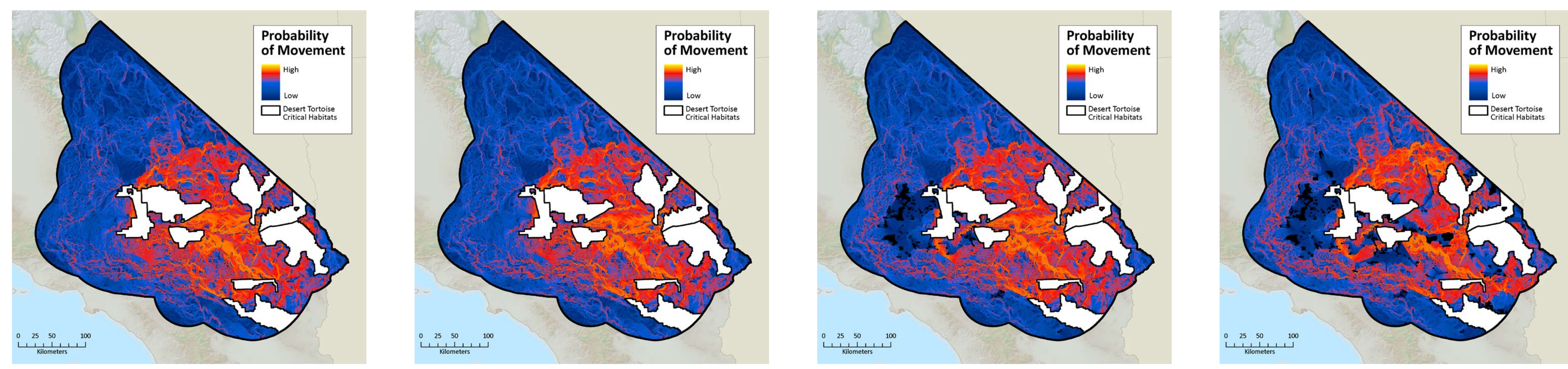


FIGURE 4. (a)Present Scenario (b) Future Baseline Scenario (c) Future Low Scenario (d) Future High Scenario

Although the historic habitat of desert tortoise was relatively continuous in the West Mojave (Hagerty 2008), it is becoming more fragmented in the face of increased development and urbanization. There is a slight shift in desert tortoise movement patterns between critical habitats from the **Present** to **Future Baseline Scenarios** (see Figure 4), due mostly to climate change. In the **Low Scenario**, renewable energy development has relatively little impact on the connectivity of the desert tortoise because most developments occur to the west of the critical habitats and thus do not significantly block tortoise movement. However, a number of project developments overlap with the western critical habitats, possibly compounding habitat loss issues. Many of the projects in the **High Scenario** are planned for areas important for tortoise connectivity and within desert tortoise critical habitats. Projects surrounding critical habitats impede tortoise movement to and from those habitats

DESERT BIGHORN SHEEP

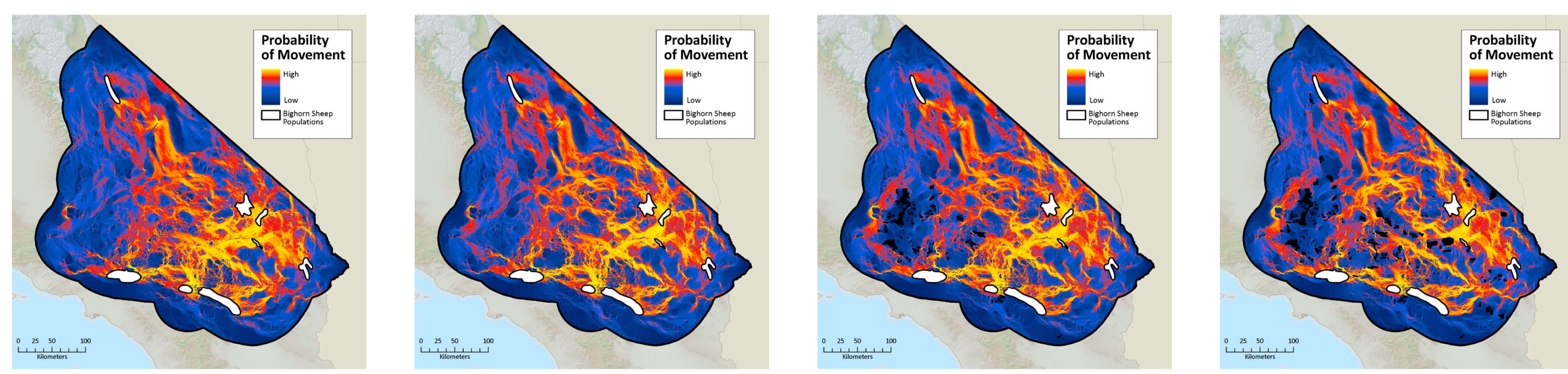


FIGURE 5. (a)Present Scenario (b) Future Baseline Scenario (c) Future Low Scenario (d) Future High Scenario

In the West Mojave, desert bighorn sheep exist as small, distinct populations which depend on migrants from other populations to maintain genetic diversity. Genetic diversity lowers the risk of inbreeding and enhances each population's ability to adapt to changing environmental conditions such as climate change. Bighorn sheep movement patterns between the **Present** and **Future Baseline** scenario for the eight populations modeled are similar (see Figure 5), although many pathways are constrained to higher elevations due to climate change. Proposed future large-scale renewable energy development, especially in the **High Scenario**, obstructs major pathways for movement, such as the pathways between the southwest and northeast Mojave Desert.

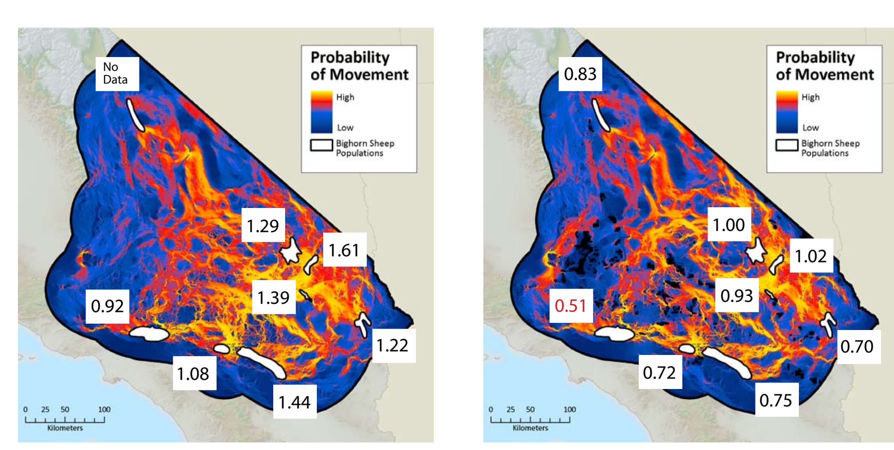
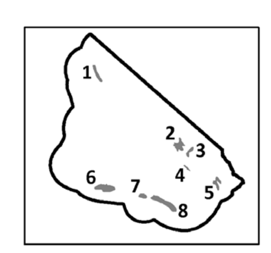


FIG 6. (a) Present Migration Rates (b) Future High Migration Rates



(1) Inyo Mountains;
(2) Old Dad Peak;
(3) Providence Mountains;
(4) Marble Mountains;
(5) Turtle Mountains;
(6) San Gabriel Mountains;
(7) San Gorgonio Mountains;
(8) San Bernardino Mountains.

Gene flow in the Bighorn Sheep

Quantitative outputs from Circuitscape were combined with genetic data to predict migration rates between populations. Migration rates between all populations decrease from the **Present** to all other scenarios. 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** (see Figure 6), the migration rates between these populations decrease to nearly one migrant per generation, the minimum migration rate necessary to maintain adequate gene flow (Mills and Allendorf 1996). Cumulatively, large-scale renewable energy development could significantly impact gene flow between other sheep populations, decreasing the viability of the entire metapopulation of bighorn sheep in the West Mojave.

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