Evaluating Habitat Suitability and Connectivity for a Small Carnivore, Pacific Marten, in a Patchy Fire-Prone Landscape

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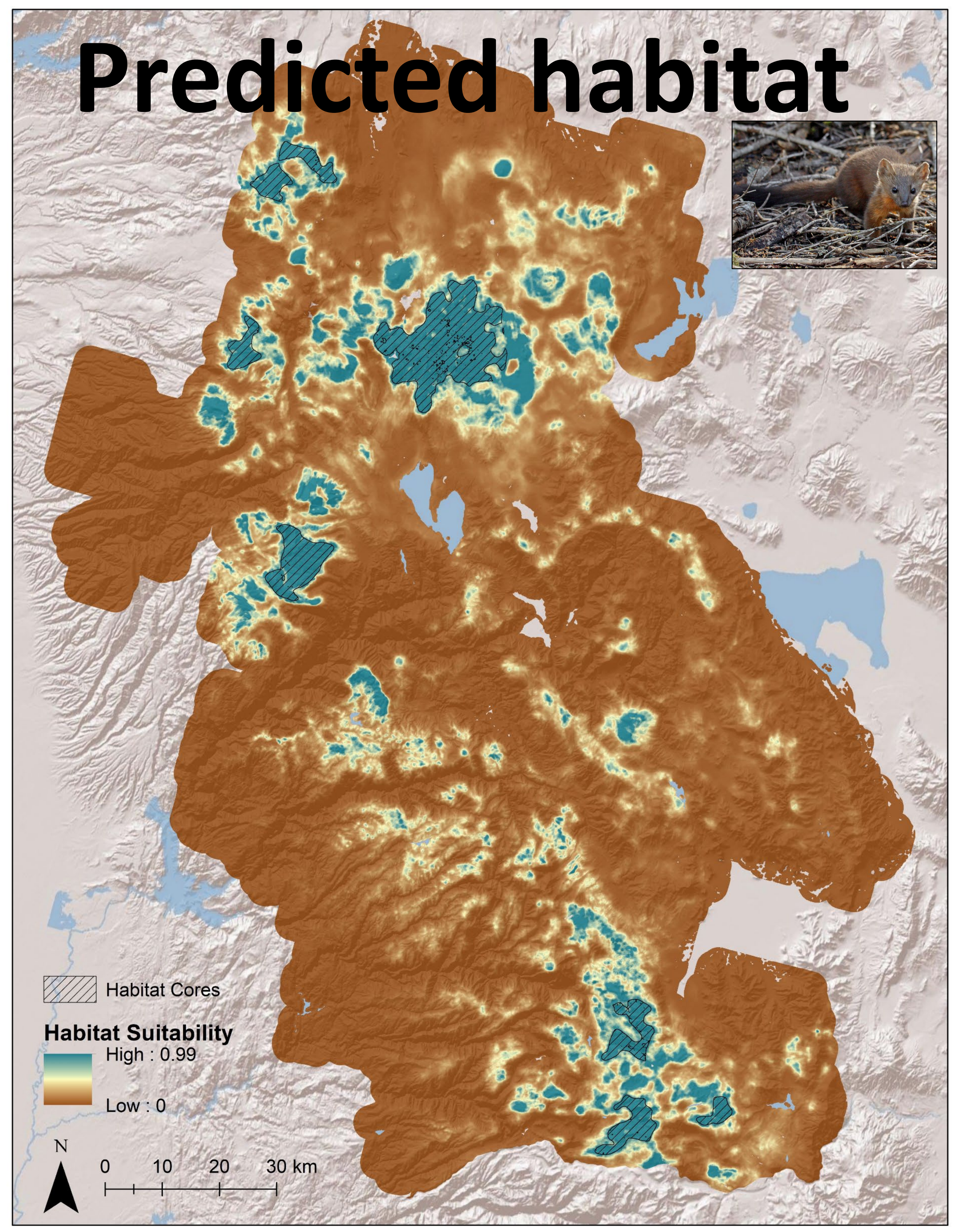

Figure 1. We used a MaxEnt approach[1,2] to model marten habitat suitability in northeastern California. Our point dataset included 12,393 marten locations (32 individuals; 2010-2018) thinned at 1-km and a random sample of 10,000 background points. We scale-optimized abiotic and biotic predictor variables, fit 9 models, and evaluated model performance via lowest AIC_c values.

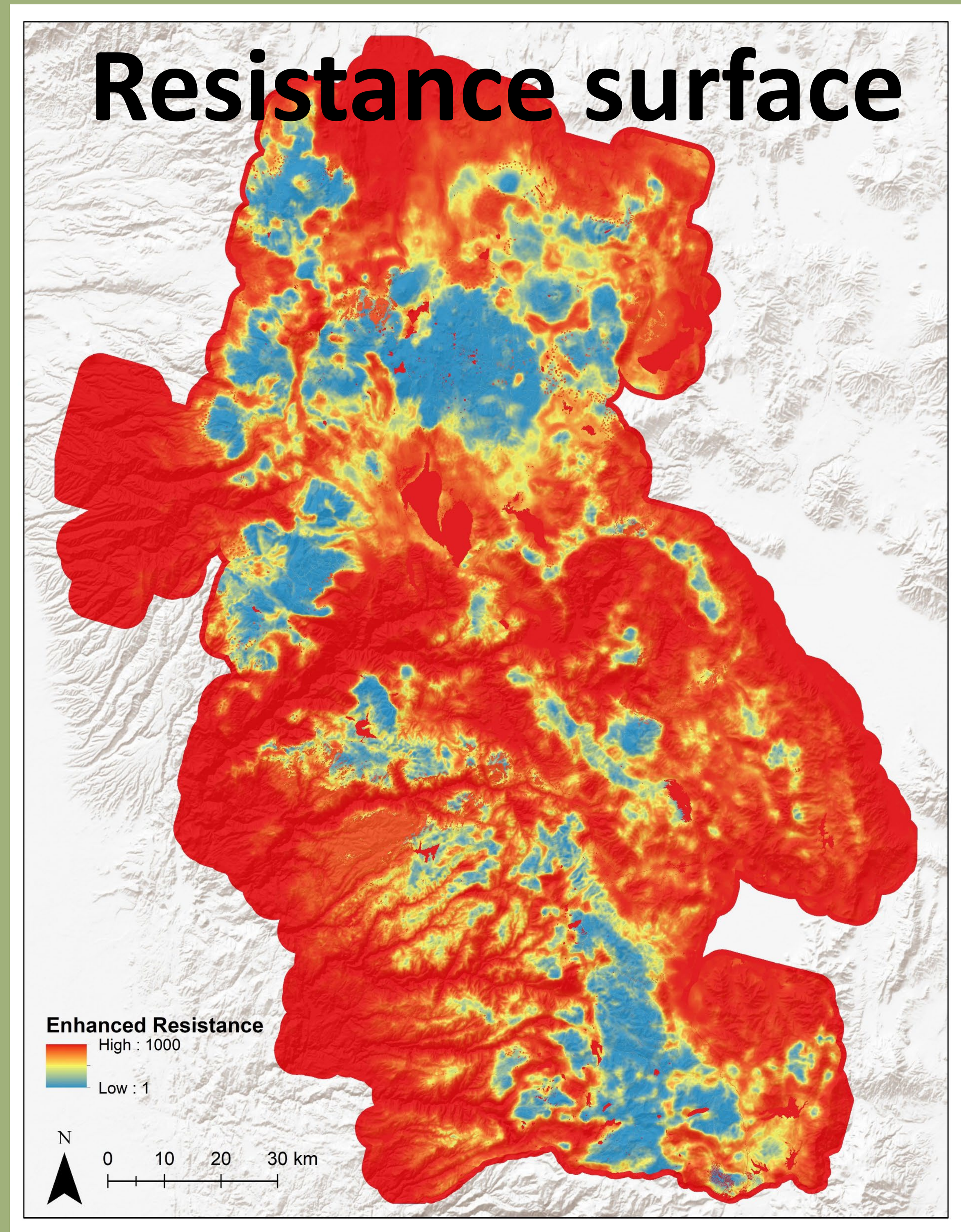

Figure 2. Our habitat suitability model provided the foundation for the resistance surface of our connectivity model. We transformed suitability values with a negative exponential function[3] and rescaled values (1-1000) to accentuate resistance discrimination[4]. We modified the resistance surface to include movement costs not represented by suitability (e.g., open water)[5].

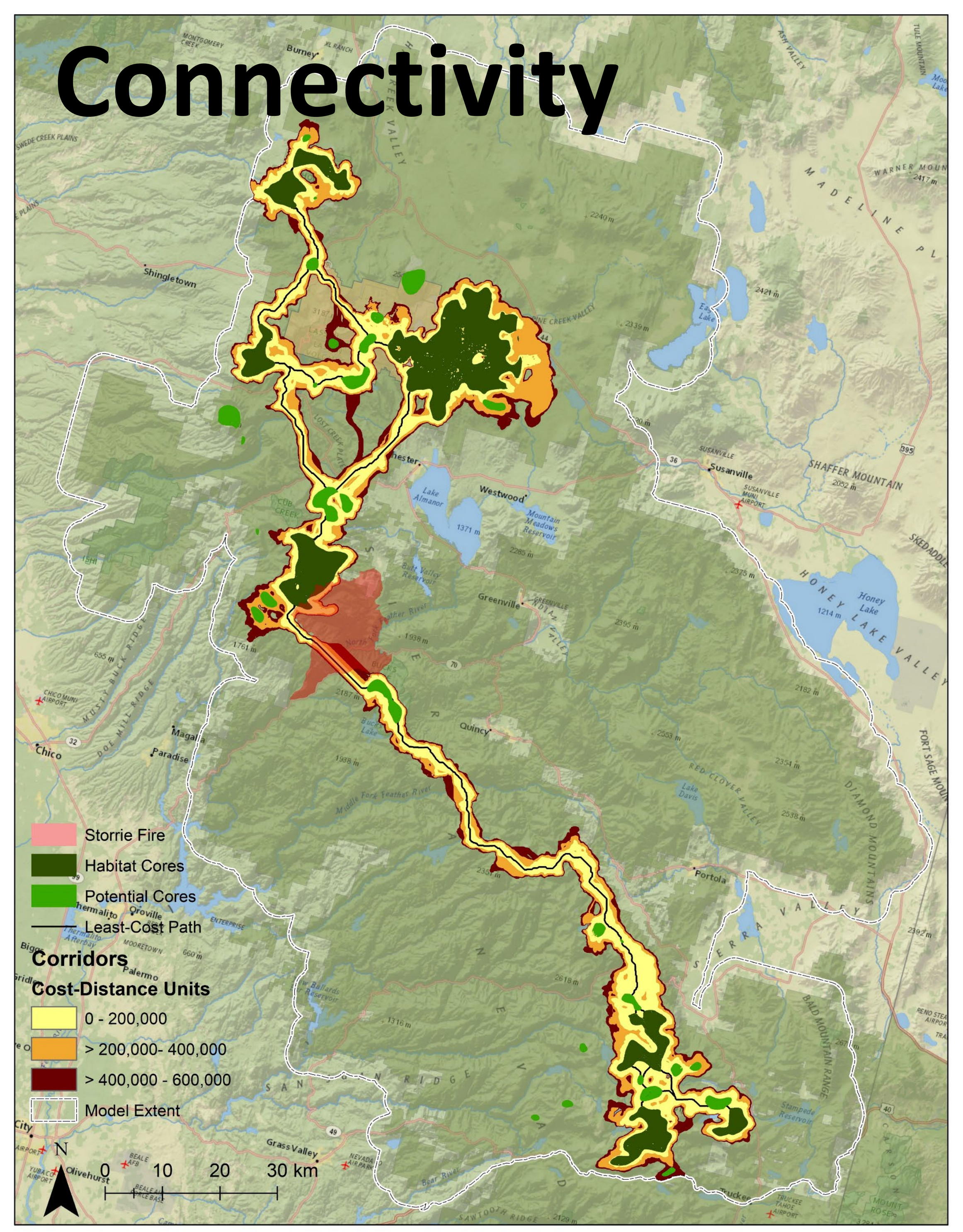

Figure 3. We incorporated habitat cores with our resistance surface to delineate potential marten movement corridors. We modeled least cost path corridors (i.e., predicted least resistance) using Linkage Mapper version 2.0[4]. Corridors had a minimum width of 600,000 cost distance units (approximately 0.7 km width) as determined by expert opinion and previous analyses[5].

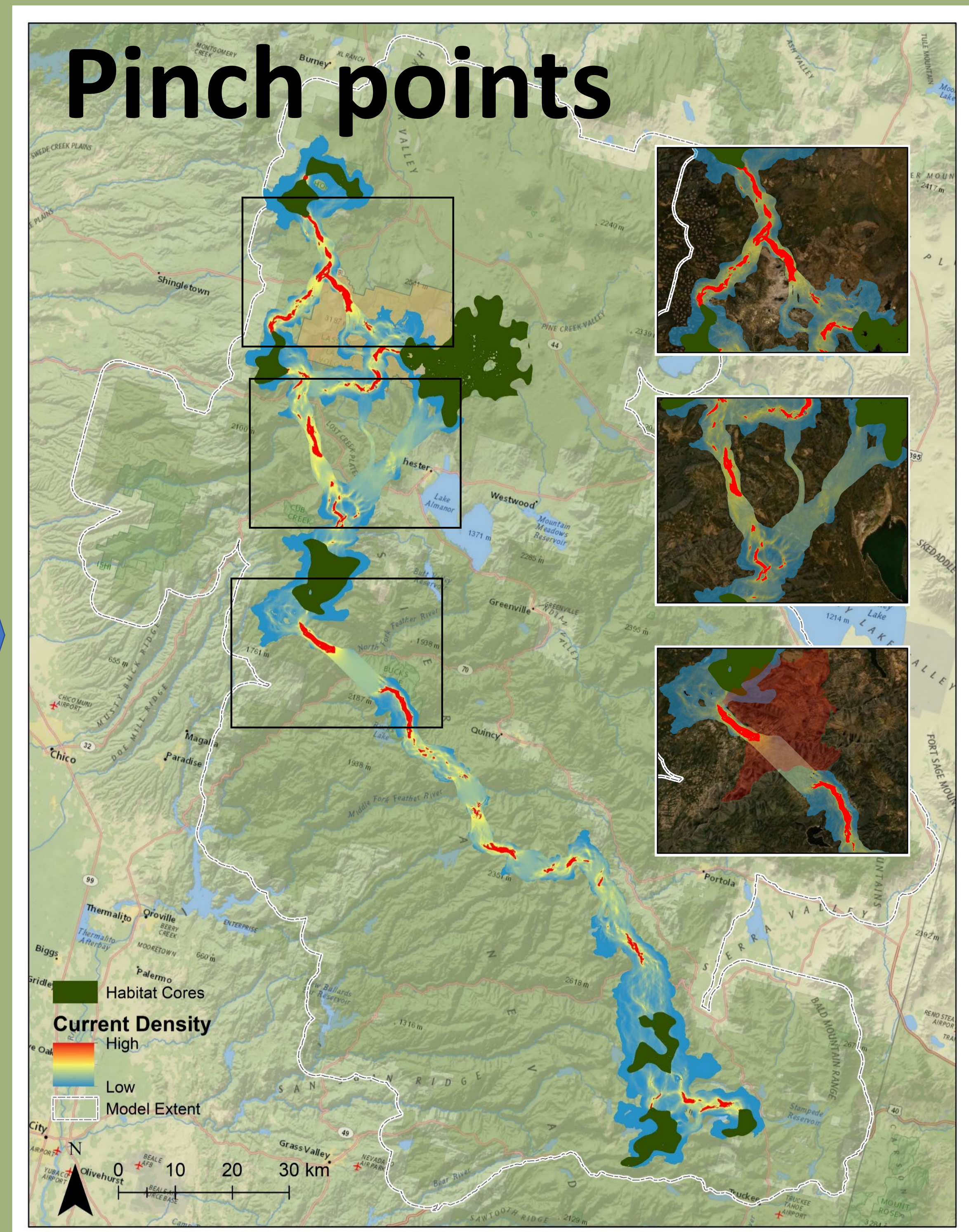

Figure 4. Pinchpoints are areas where movement may be funneled that can be prioritized for protection, restoration, or enhancement[6]. We used the Pinchpoint Mapper tool via Circuitscape software[7] to identify narrow corridor sections. We constrained, then reclassified density outputs to include areas with density values greater or equal to the mean plus 2 standard deviations[8].

PROJECT SUMMARY

We used a robust data set to inform marten habitat suitability. Our top model had 3 variables representing 94% of permutation importance at varying scales:

Predictor (Scale)	Permutation Importance
Elevation (30-m)	47.4
Mean Biomass (990-m)	27.2
Mean Slope (990-m)	19.5
Mean Tree Density (270-m)	4.8
StDev of Canopy Cover (990-m)	1.2

We identified 8 core areas (mean area = 66.2 km^2; range 15-260 km^2; Figure 1).

We identified 10 corridors linking core areas (Figure 3) using Figure 2.
- northern model area: 6 corridors (mean length 27.9 km; range 0.5-40)
- southern model area: 3 corridors (mean length 15.1 km; range 8.8-19)
- corridor between north and south: 118 km length

From these data we conclude: predicted marten habitat in our model region (Lakes Basin [south] to Lassen [north]) was characterized by relatively small cores of high suitability (e.g., capable of supporting small numbers of individuals based on average home range size[9]), separated by relatively long distances (e.g., greater than the typical dispersal distance of a juvenile marten[10]). Patchiness was driven largely by elevation and groups of cores likely ranged from well-connected (shortest distance) to functionally isolated (longest distance; Figure 3, Figure 4).

And once our work was completed, the Dixie Fire happened…

Figure 5. During 2021, much of our modeling area burned in the 963,309 ac Dixie Fire, the largest single-ignition wildfire in contemporary California history.

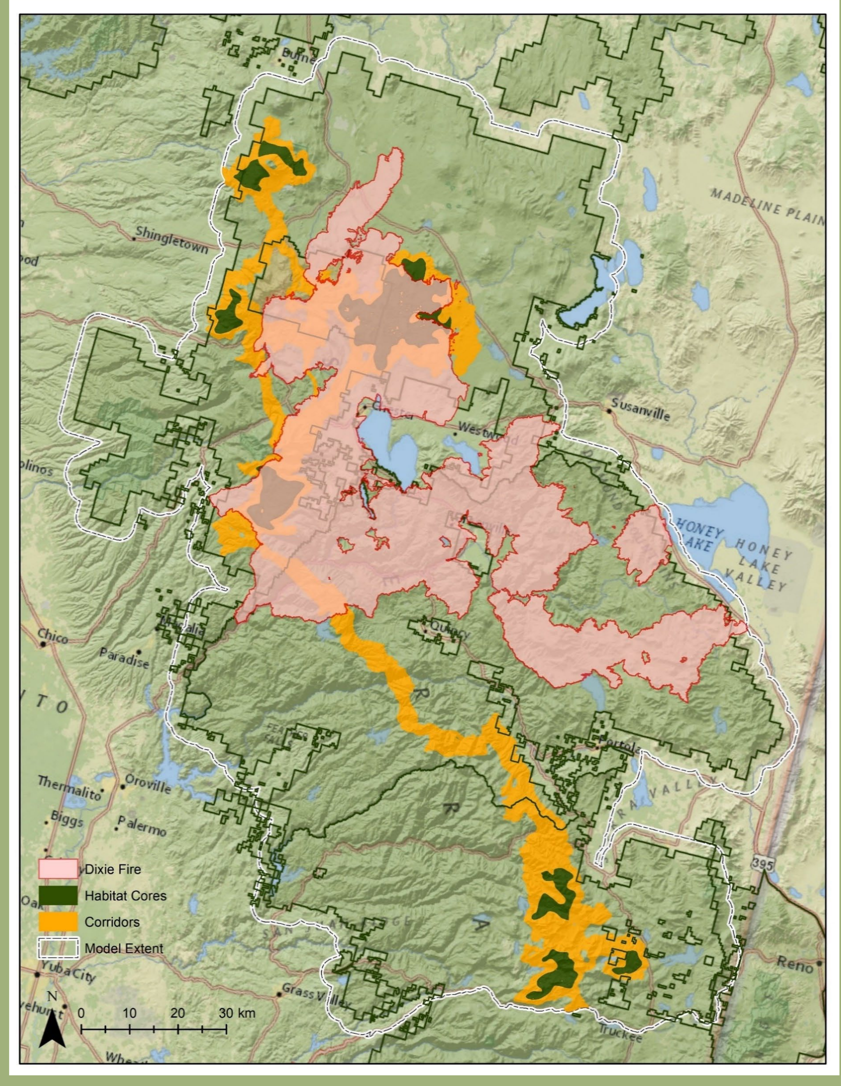

Figure 6. Dixie Fire footprint (pink) overlaid on predicted habitat cores (dark green) and connectivity corridors (yellow). Dotted line shows model extent.

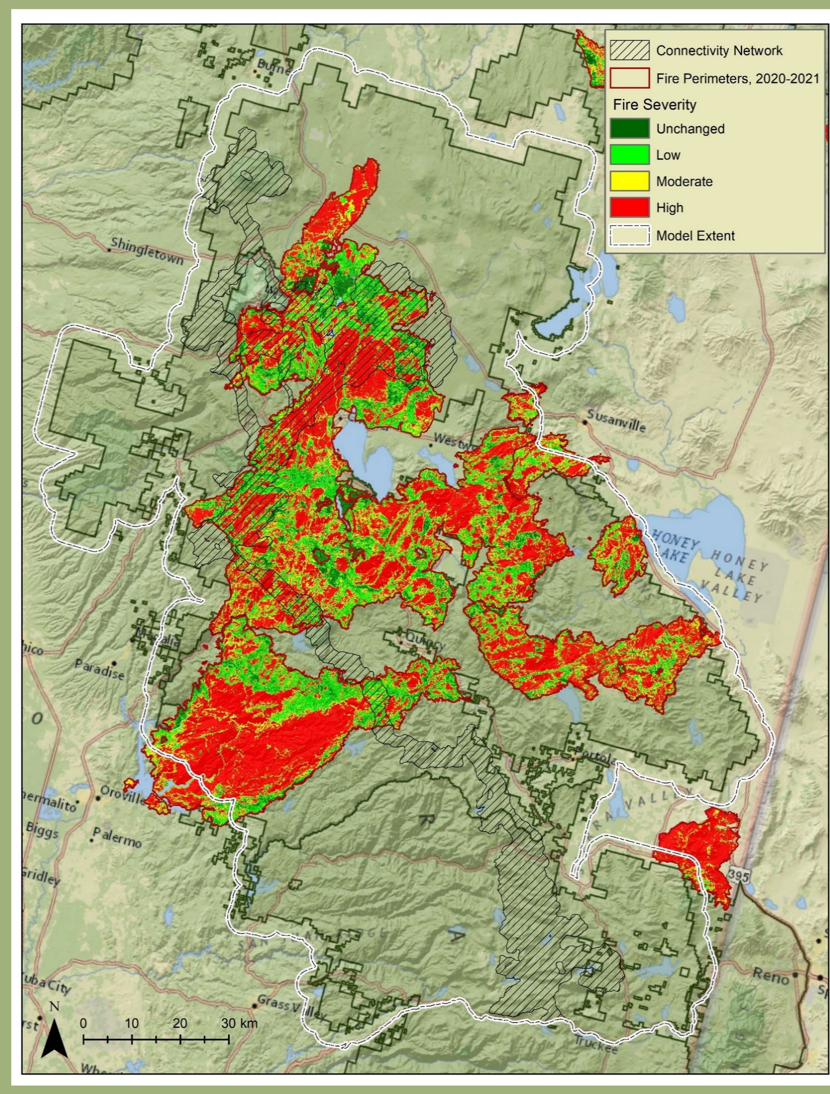

Figure 7. Burn severity within the Dixie Fire. Also includes other fire footprints within the region from the 2020 and 2021 fire seasons (e.g., North Complex).

WHERE DO WE GO FROM HERE?

Within the past two years, the Dixie Fire and other wildfires burned 17.5% of our predicted core/corridor network at high severity and an additional 6.9% at moderate severity (Figure 7).

Responses to wildfire by martens and other carnivore species are often poorly-understood[11,12]. Both the short- and long-term effects of recent fires on marten habitat availability in our modeling region are uncertain.

Given that martens exhibit strong individual- and population-level responses to forest disturbances[13,14,15] (e.g., entirely avoid or modify behavior in altered, degraded, or fragmented habitats), yet are highly-vagile[10,16] (e.g., capable of remarkably long-distance movements for their body size), they offer a compelling study subject in a post-fire landscape that may be increasingly patchy and disconnected.

We suggest land managers and interested entities invest time and funding to:
- Conduct surveys within fire perimeters to describe current marten distributions and future expansions or contractions.
- Identify tangible objectives (e.g., "S.M.A.R.T." goals) to align research and management, perhaps focused on evaluating innovative restoration opportunities over large spatial scales.

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