PRIORITIZING FOREST RESTORATION BASED ON LATE-SERAL HABITAT CONNECTIVITY

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ABSTRACT

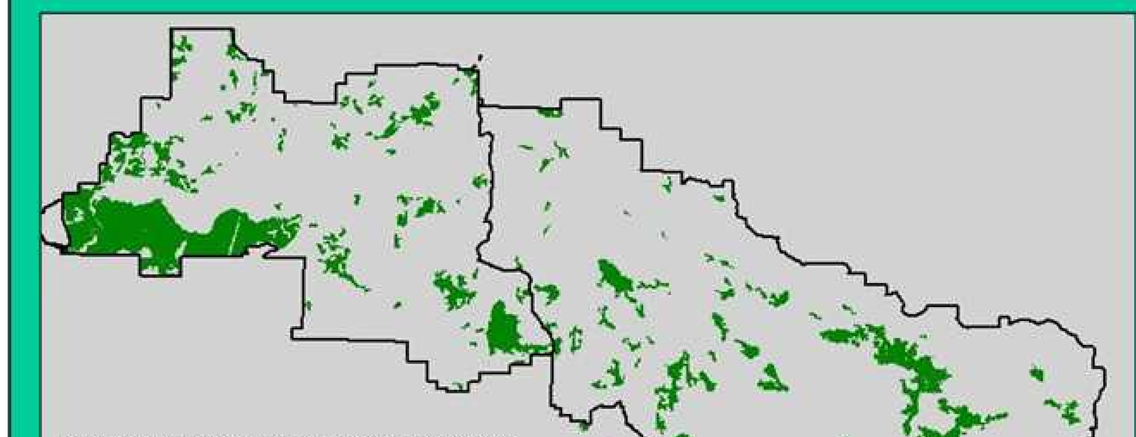
The 50-year Habitat Conservation Plan for the 90,546-acre (36,643-hectare) Cedar River Municipal Watershed (CRMW) in western Washington, USA, requires restorative thinning on a portion of the 71,000 acres of early-seral forest to facilitate the creation of late-seral forest characteristics. I developed a technique for prioritizing the location of restoration projects based on the connectivity of late-seral forest habitat as it develops over the planning period. Initially, forested areas likely to ecologically benefit from thinning were identified on a watershed landscape derived from tree inventory and airborne sensor data. Forest growth was then simulated to the end of the planning period for alternative landscape scenarios based on thinning and not thinning these targeted areas. Habitat connectivity was assessed on these alternative landscapes by simulating the dispersal of late-seral forest dependent wildlife species using the Program to Assist in Tracking Critical Habitat (PATCH). Comparison of the relative successful dispersal activity between landscapes indicated where thinning will provide the greatest benefit to late-seral forest habitat connectivity.

Step 1. Target forest characteristics that would likely benefit ecologically from thinning.

Forest Characteristics	Target
tree density*	>200 trees/acre
canopy closure*	>70%
tree diameter*	5-21" dbh
tree age*	30-90 years
site class*	III or IV
slope*	<30%
elevation*	<4,500' asl

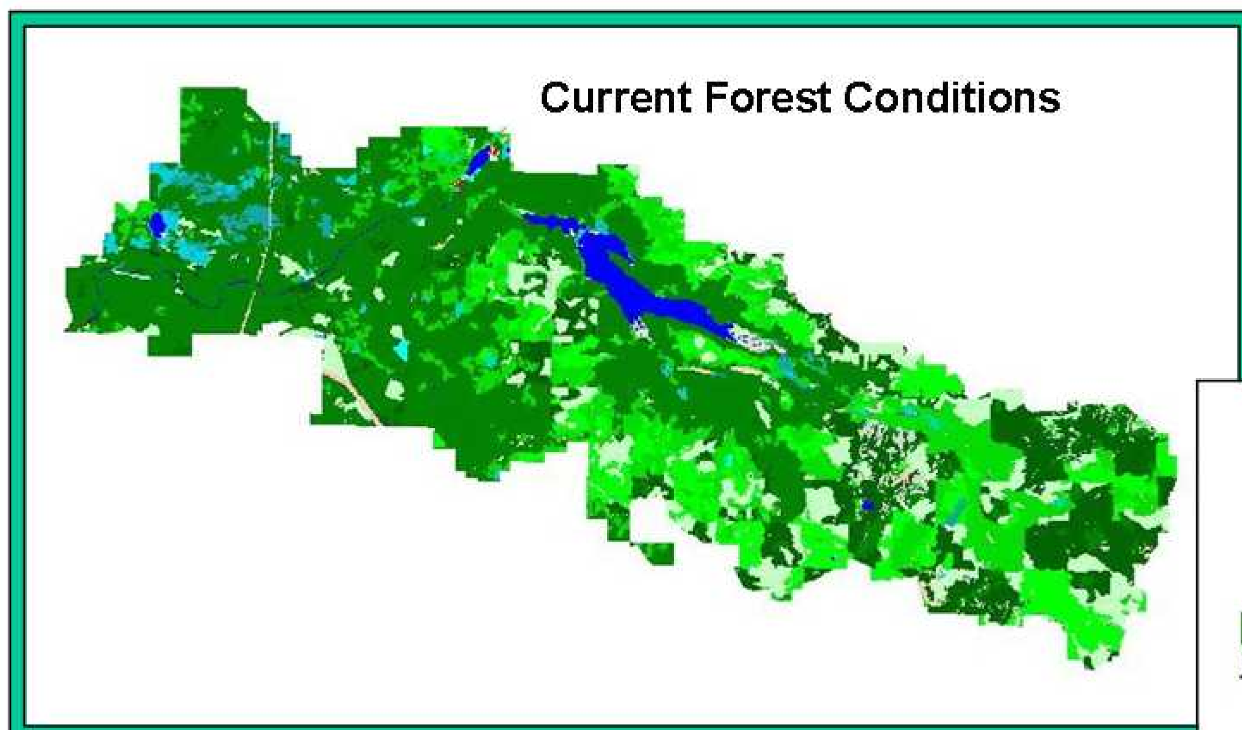
*spatial data representation in CRMW

Step 2. Spatially locate forest stands with targeted forest characteristics.

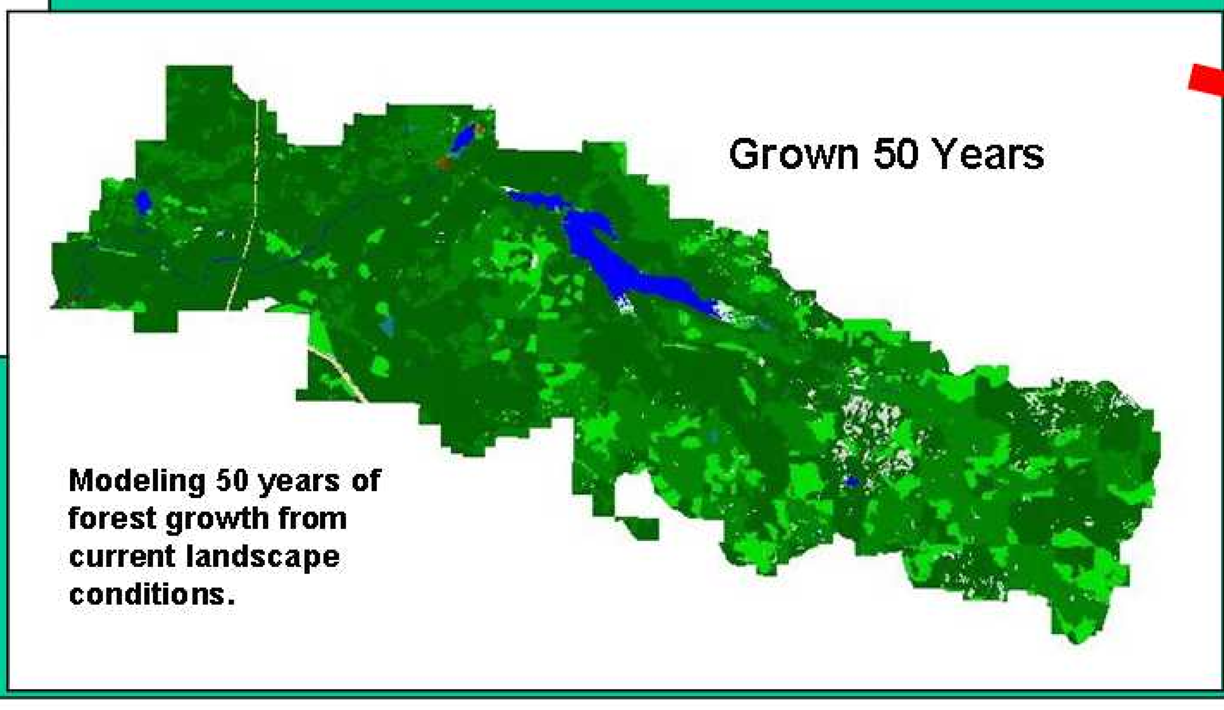


The forested area in the CRMW that is targeted for restoration, based on remotely sensed data classified with timber cruise information, is 10,875 acres.

Step 3. Create "base landscape" by simulating forest growth over the planning period.



Darker green represents older forest.



Modeling 50 years of forest growth from current landscape conditions.

Step 4. Create "alternative landscape(s)" based on potential effects of thinning in targeted stands.

Represents alternative landscape condition in 50 years, following thinning in the near term.

Darker green represents older forest.

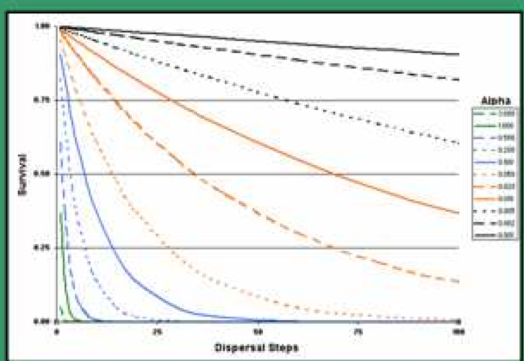
Step 5. Simulate dispersal of late-seral forest dependent wildlife species in both landscapes.

http://www.epa.gov/wed/pages/models/patch/patchmain.htm

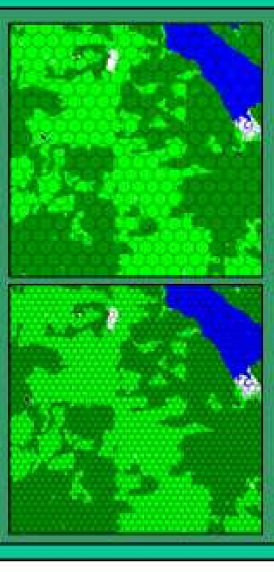
The PATCH model simulates wildlife dispersal based on:

1) the distribution of habitats on a landscape (see previous forest maps),
2) the affinity of wildlife species for habitats,
3) home range size (smaller home ranges mean bigger potential populations),
4) mortality during dispersal (⇧ mortality with ⇧ distance), and
5) dispersal turning probabilities (⇧ probability when in proximity to habitat).

2) The habitats delineated on the landscape maps are relatively weighted within PATCH based on the specified affinity of a targeted wildlife species. In this case, the habitat is weighted for an idealized late-seral forest dependent species.



4) Dispersal survival, based on a specified constant (alpha), is simulated by an exponential decay as dispersal distance increases.



3) Home ranges are simulated within PATCH as a matrix of hexagons. Species with smaller home ranges (e.g., the lower image at left) will have larger potential populations given equal habitat requirements. PATCH allows for varying home range sizes by "borrowing" suitable habitat from adjacent unoccupied home ranges, based on specified limitations.

5) The probability of turning during dispersal is simulated within PATCH by specifying an appropriate balance between randomness and the influence of surrounding habitat. The upper image of successful dispersal activity at left (the darker the red, the more activity) shows a population which has zero probability of turning once it sets out on a trajectory. The lower image shows such a high probability of turning that individuals of the population are unable to leave good breeding habitat, even when there are no vacant suitable home ranges. The middle image strikes a balance between the two, allowing turning probabilities that are influenced by the proximity of suitable habitat, but provide for dispersal through less than optimal habitat.

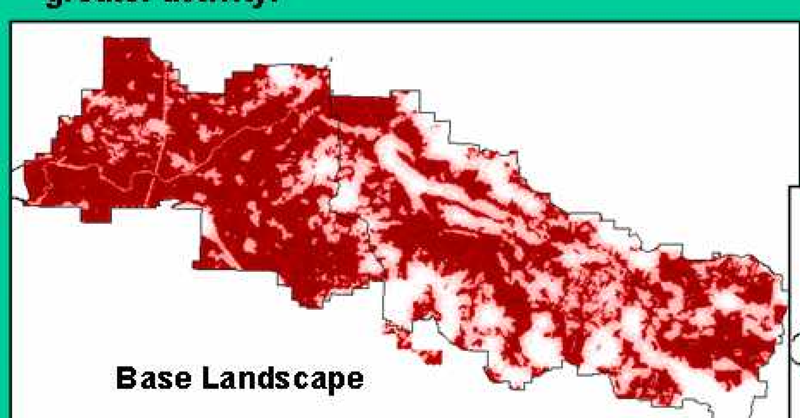
MODEL PARAMETERIZATION

The PATCH model was parameterized based on a hypothetical wildlife species dependent on late-seral forest, and a population that would maximize the number of dispersers on a landscape:

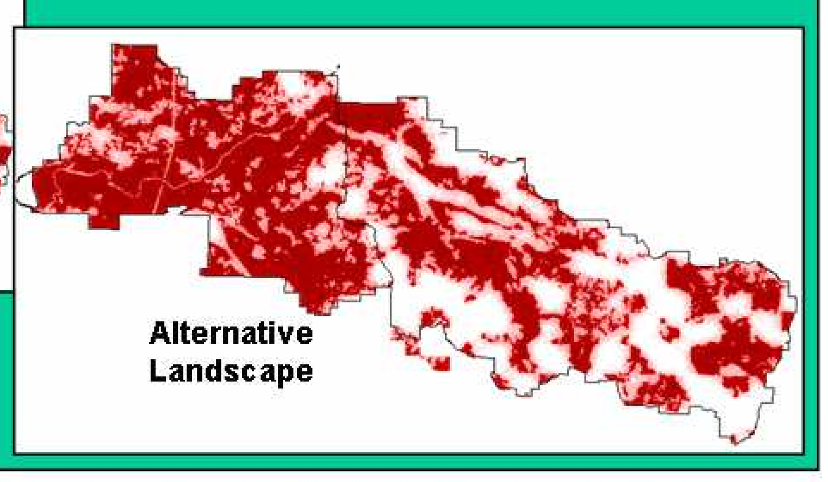
- Habitat distribution (input base and alternative landscape maps)
- Habitat utility weighting (see 2)
- Home range size = 0.44 acres
- Maximum dispersal distance = 1.64 miles = 60 steps = dispersal alpha of 0.05
- Dispersal behavior (e.g., turning probability) = 25-0
- Initial population = 1/2 of available suitable home ranges = 51,525 base, 58,235 alternative
- # of runs = 100 for each landscape

MODEL OUTPUT

The images at left, output from PATCH, indicate the levels of successful dispersal activity on the two landscape scenarios based on specified model parameterization. The darker red show greater activity.



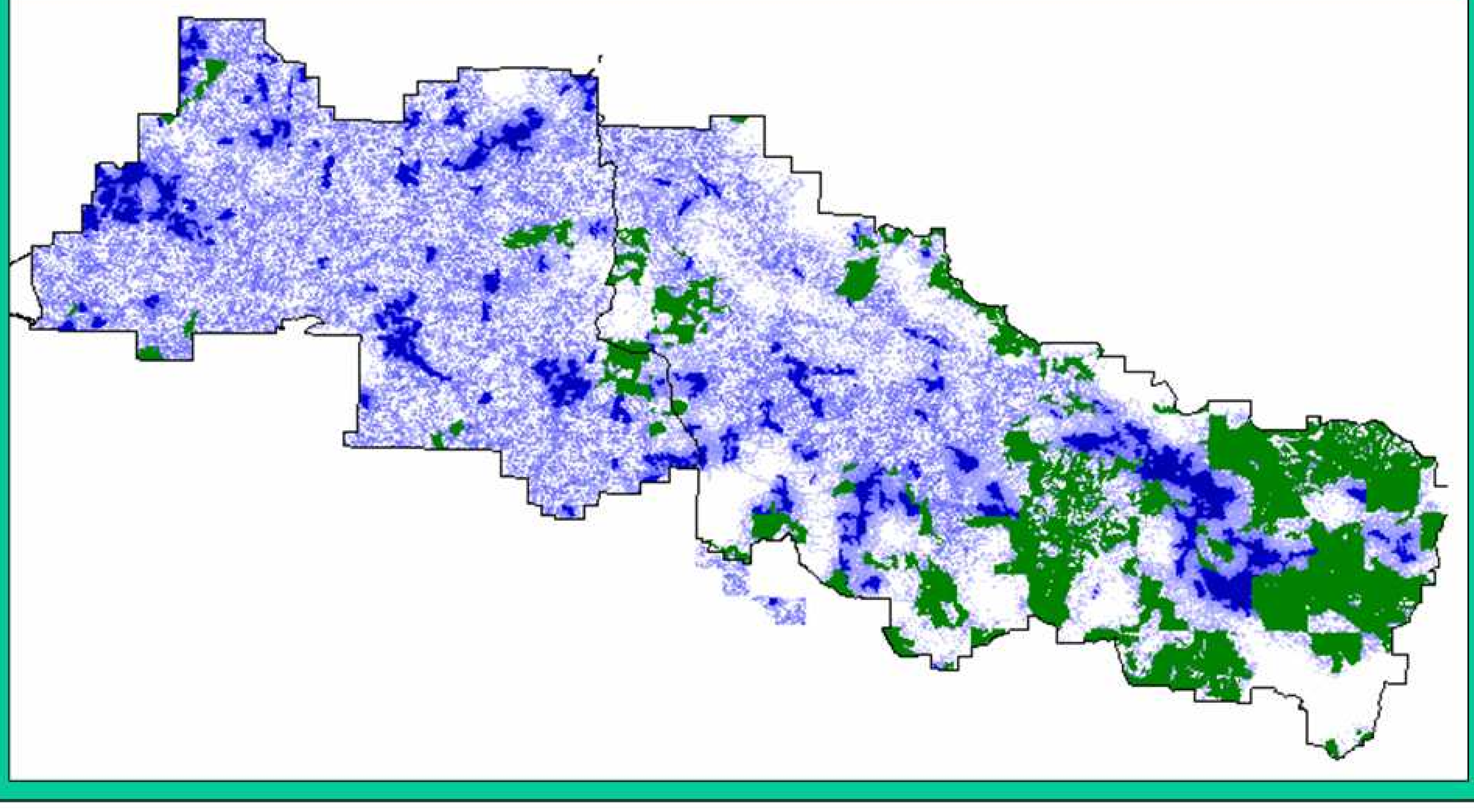
Base Landscape



Alternative Landscape

Step 6. Compare spatially explicit dispersal activity between landscape alternatives to identify areas that most benefit habitat connectivity.

This image indicates the difference between the two images of successful dispersal activity generated from the two landscape scenarios. The darker blue indicates where greater dispersal activity occurs 50 years following the the near-term restoration of targeted forested areas, compared to not conducting the restoration. The greater activity is assumed to be analogous to greater habitat connectivity for this idealized late-seral forest dependent species, and provides a means of prioritizing restoration projects now. The dark green in this image is current old-growth forest.



PLANNED REFINEMENTS

1) Alter targeted forest characteristics to better account for stands that would likely benefit from thinning.

2) Use better base habitat map (e.g., derived from LiDAR) to improve classification accuracy and spatial resolution.

3) Incorporate adjacent lands to better account for migration across boundaries.

4) Utilize better simulation of forest growth (e.g., Forest Vegetation Simulator) to improve estimates of future landscape conditions.

5) Parameterize PATCH using data from individual species to improve habitat connectivity for single species management. Or, conversely, utilize data that represents a suite of wildlife species to generally improve late-seral forest connectivity.