CLIMATE CHANGE: ASSESSING LANDSCAPE VULNERABILITY

Pacific Northwest Research Station

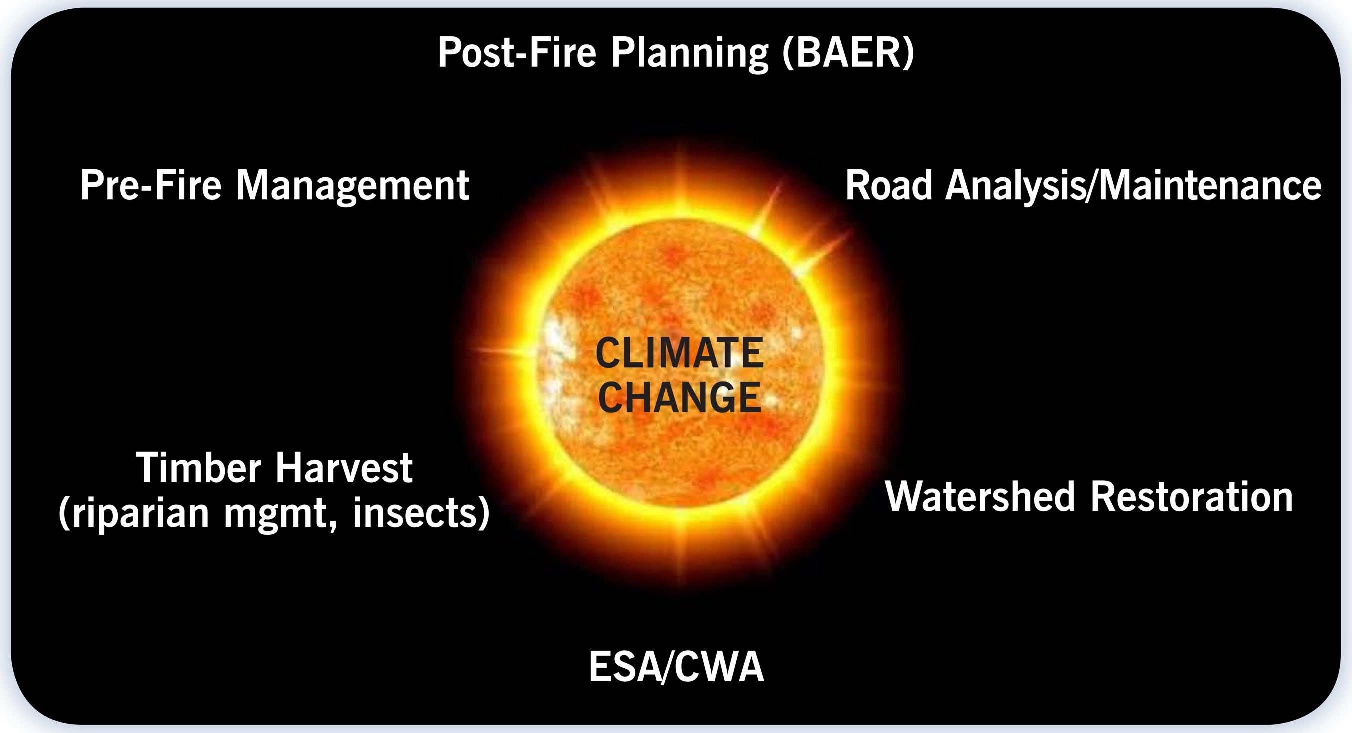
Earth Systems Institute

NetMap

Community Digital Watersheds & Shared Analysis Tools (www.netmaptools.org)

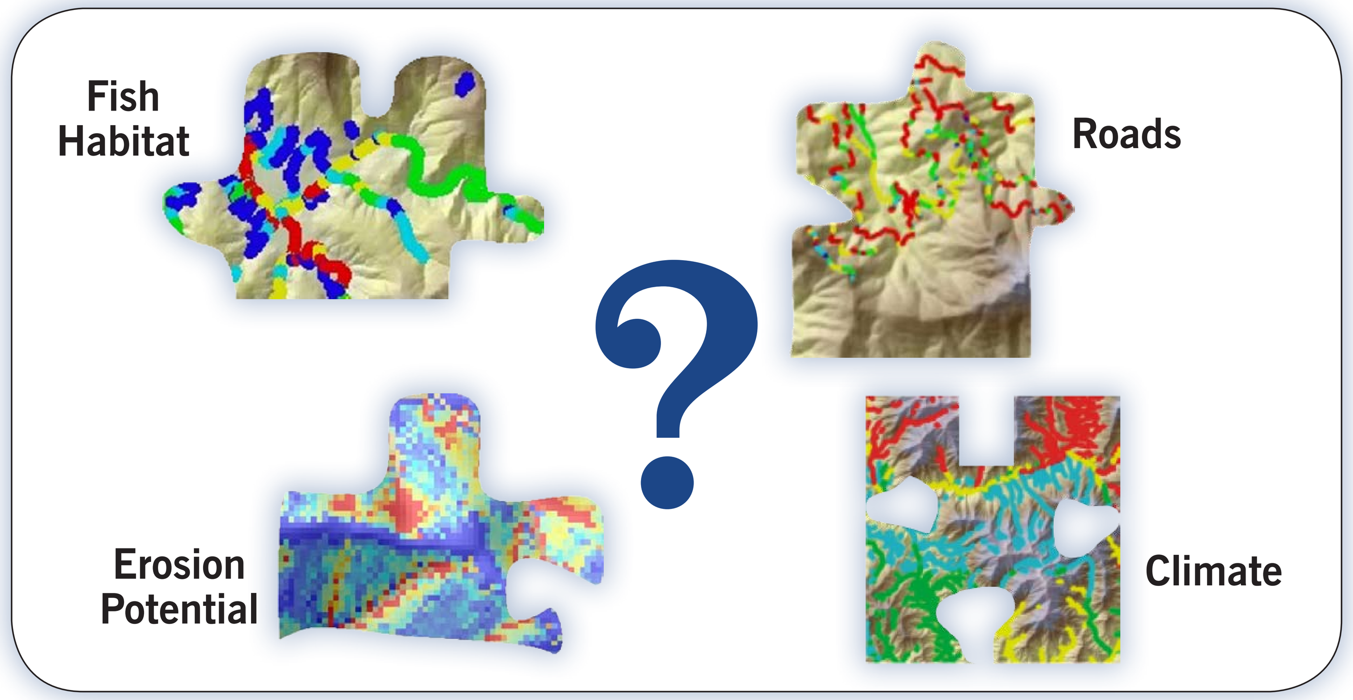
Climate Change: Linking with Other Priorities

Climate change impacts can be considered on their own (impacts of warmer stream temperatures on sensitive fish species) or climate change can be considered in context of other, ongoing management priorities.



Analysis Approaches

There are options: (1) Cause and effects models can be used to assess singular responses (air or water temperature predictions) or (2) Analysts can use a flexible and exploratory assessment to consider how the pieces of the watershed puzzle fit together.



Climate Change and Road Concerns

In this illustrative example in the Boise watershed in Idaho, we perform a 'landscape vulnerability' assessment in the context of climate change: a higher chance of winter flooding can pose a risk to the road system & aquatic habitats.

Step 1: Define Vulnerable Habitats

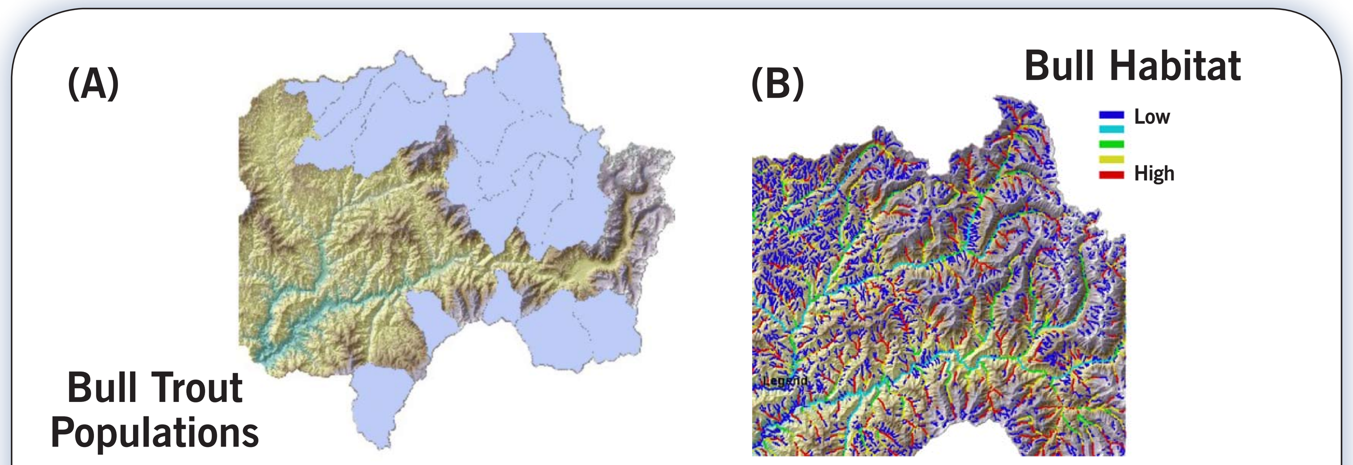


Fig. 1 (A) In the North and Middle Forks of the Boise River, areas of Bull trout populations have been identified at the subbasin scale. (B) A provisional Bull trout intrinsic potential model is constructed using indices of channel gradient, valley morphology and tributary confluences.

Step 2: Examine Downscaled GCM Predictions

One of the climate change predictions made by the Climate Impact Group (UW) is the difference between the ratio of snowmelt runoff to total runoff between historical and the future (2080 in this example).

Large increases in the ratio of snowmelt runoff to total runoff stem from a lowering of the snowpack in winter.

In certain areas, this implies lower stream flows in the summer and a higher chance of winter flooding (rain on snow) in the winter (Fig. 2). Areas containing vulnerable roads may be at higher risk to winter floods (and streams with lower summer flow may present a risk to fisheries).

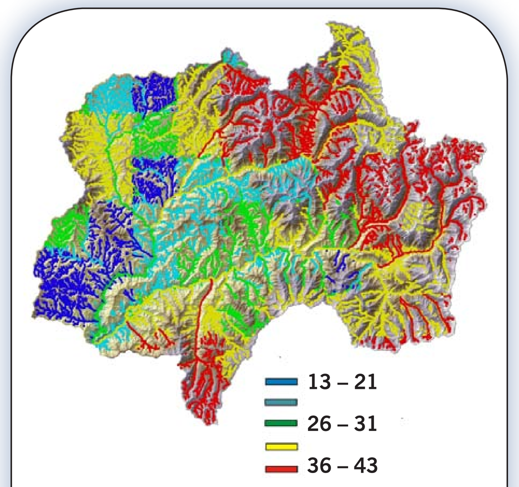


Fig. 2. Ratio of snowmelt runoff to total runoff, in percent (2080-historical)

Step 3: Calculate Road Density

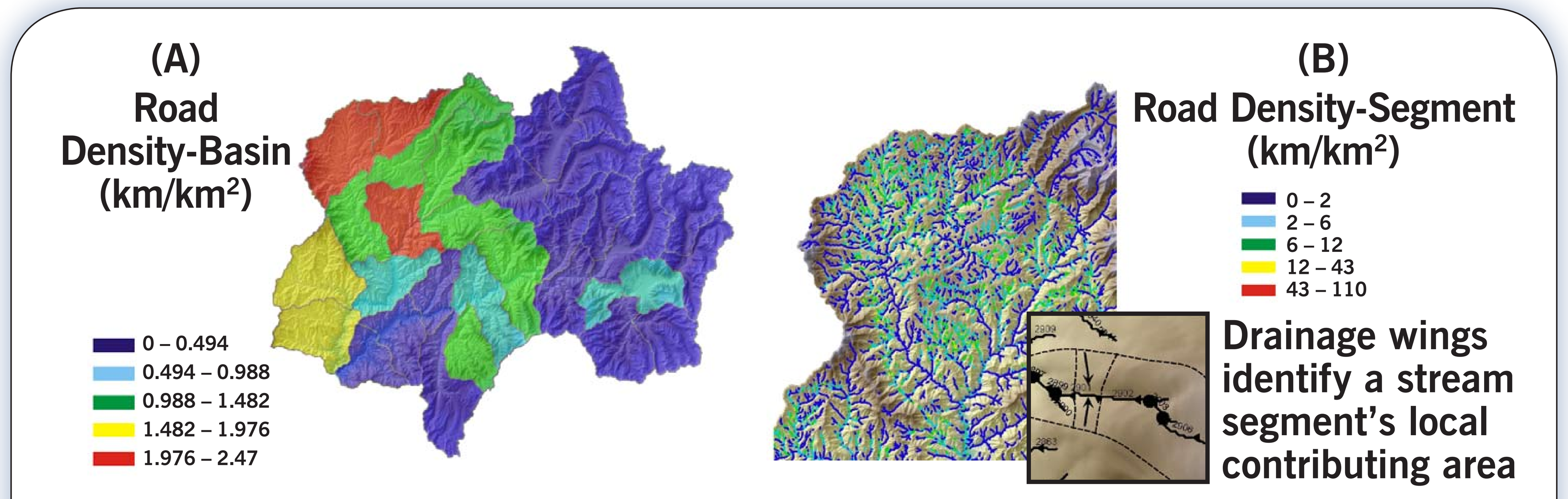


Fig. 3. (A) Road density at the basin scale ranges from 0 to 2.5 km/km2. (B) Road density at the channel segment-drainage wing scale ranges from 0 to more than 100 km/km2, allowing better identification of potential risks.

Step 4: Road Drainage Diversion/Surface Erosion

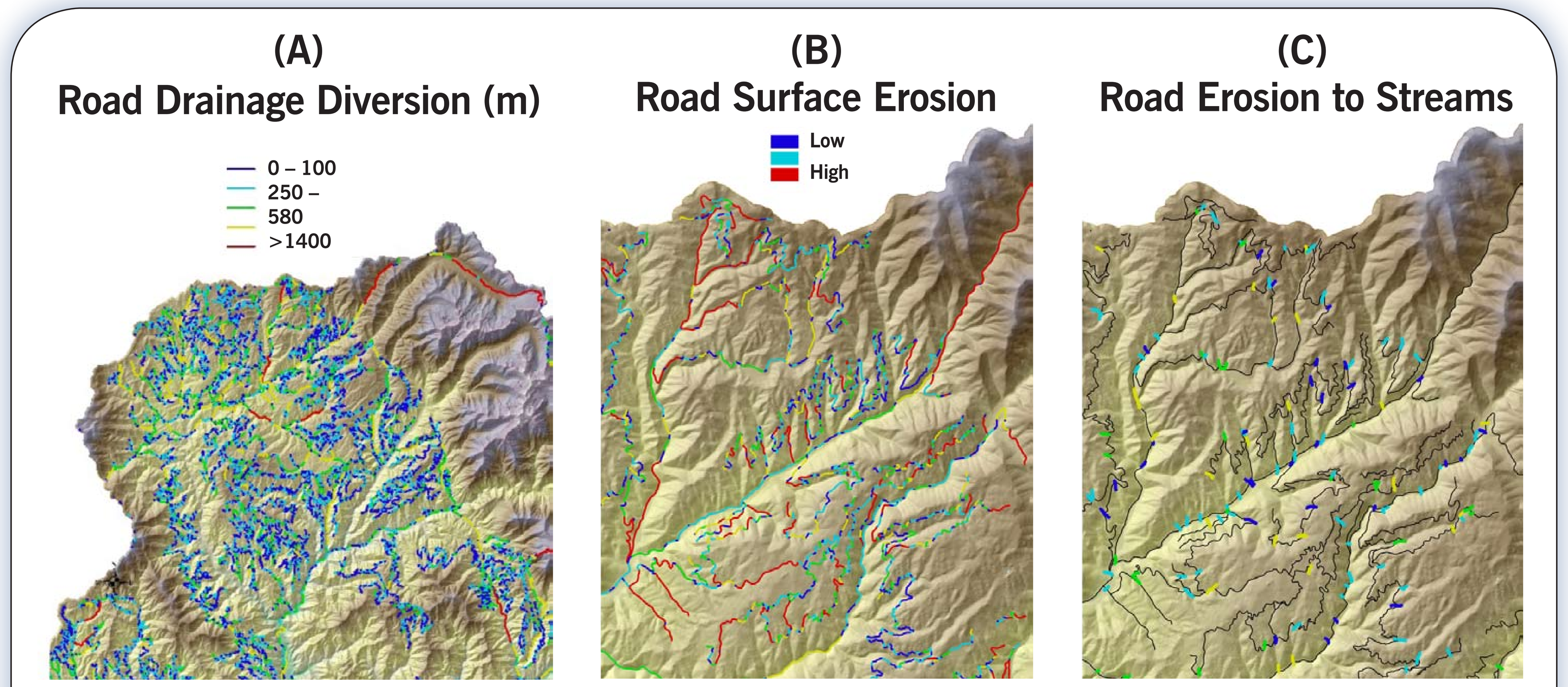


Fig. 4 (A) Road drainage diversion can lead to road washouts, gullies and road surface erosion. (B) Road surface erosion depends on road drainage, road gradient, surfacing & road use (WEPP). (C) Erosion is linked to stream channels to ID potential risk areas.

Step 5: Roads in Floodplains

NetMap's flexible floodplain tool is used to map the inundation area based on a number of bankfull depths above the channel elevation.

The predicted floodplain surface at 3X bankfull depth is shown in Fig. 5.

Roads that cross floodplains are highlighted using the tool. During large winter floods, these areas could contribute to aquatic impacts.

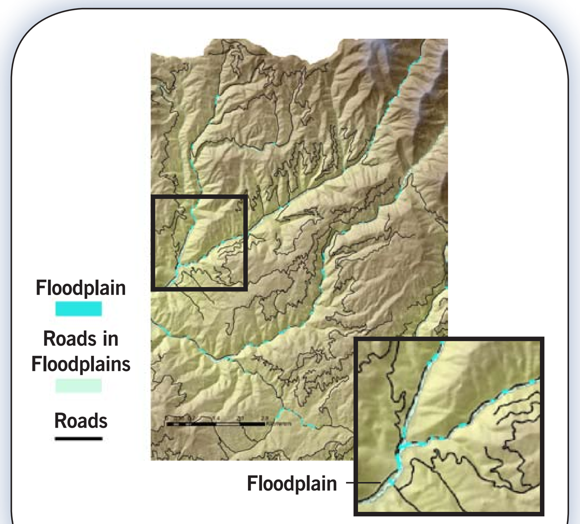


Fig. 5. Predicted Floodplain.

Step 6: Roads Stability

One of NetMap's erosion parameters 'generic erosion potential' (GEP) is based on a topographic index that combines hillslope steepness and curvature, drivers of gully erosion and shallow failures.

In NetMap, road segments (~10 m) are classified according to the GEP index of the underlying hillside (Fig. 6). This provides an approximation of road failure potential, particularly during storms or following fires.

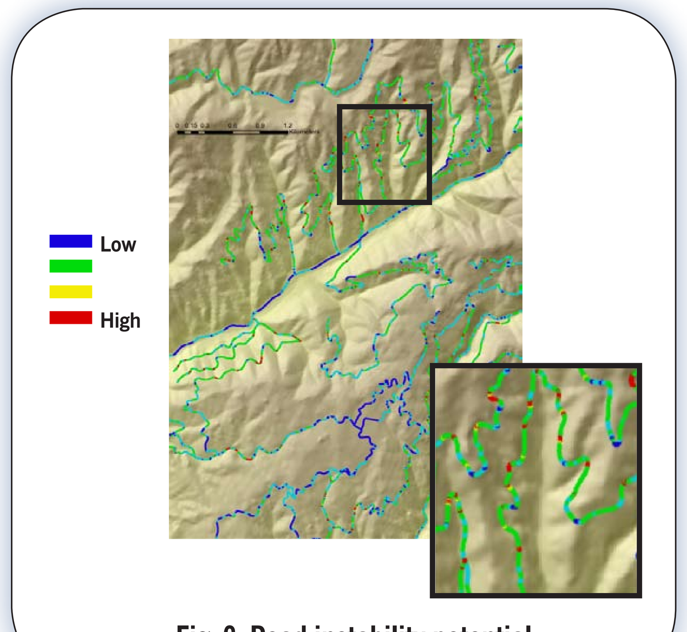


Fig. 6. Road instability potential.

Step 7: Roads & Debris Flows

Debris flows can be one of the most destructive events following fires or storms, events that could increase with climate change.

NetMap can classify all road – headwater stream crossings by debris flow potential (Fig. 7). Flagged areas could be used to prioritize field surveys and road maintenance programs.

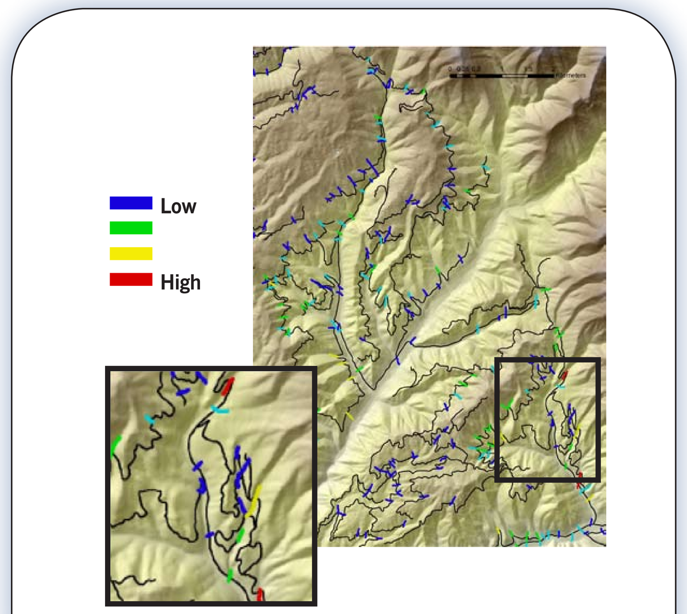


Fig. 7. Road debris flow risk.

Step 8: Putting the Pieces Together

There are numerous ways to put the pieces together to evaluate the risk posed by the road network in the context of climate change.

For example, NeMap's overlap tool can be used to search for locations where threshold values overlap between Bull trout habitat (Fig. 1, B) and debris flow potential (Fig. 8,A) or road density (Fig. 3,B) and habitat (Fig. 8,B).

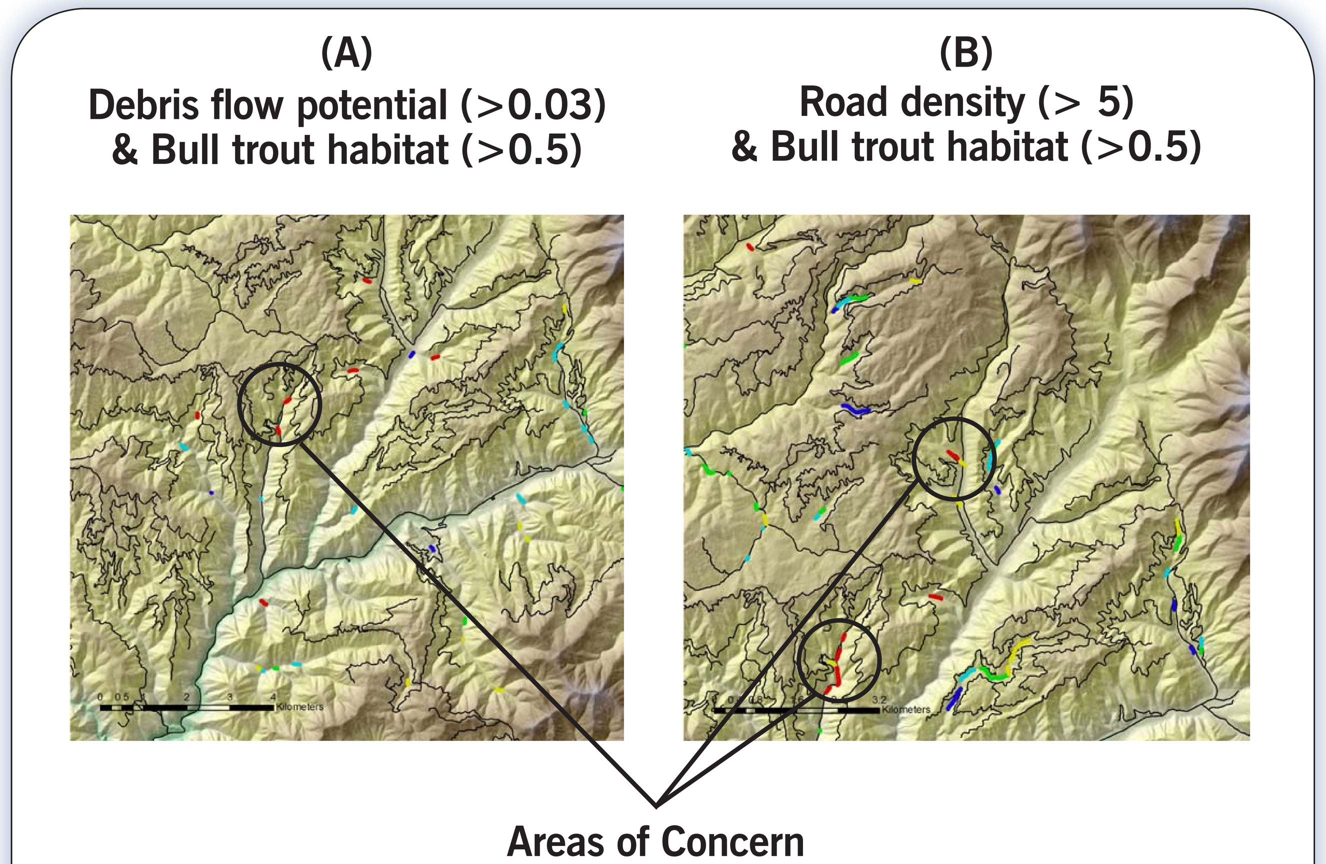


Fig. 8.

Refer to NetMap Technical Help for relevant citations

Contact Earth Systems Institute at:
www.earthsystems.net or www.netmaptools.org