Evaluating Landscape Connectivity and Habitat Fragmentation Effects on Elk in the Roaring Fork and Eagle Valleys

Paul Millhouser

Vail Daily | weekly

Where has all the wildlife gone: CPW officials cite 50 percent drop in Eagle Valley's elk population

Pam Boyd
June 16, 2018

Daily file photo

This elk, spotted near Red Cliff, is stuck in the snow and weakened from winter. Harsh conditions, as well as human interference with the animals' hab...

EAGLE COUNTY — Imagine if, over a 10-year period, half of Eagle County's human population disappeared.

We would be using the terms "drastic," "alarming" and maybe even "catastrophic" to describe the situation.

During the past decade, that exact scenario has played out for one group of county residents. Today's elk population in the area — from Vail Pass to Glenwood Canyon — is 50 percent lower than it was in 2007. This precipitous drop has personnel from Colorado Parks and Wildlife concerned.

Overview

Introduction

Research Question

Effects on Wildlife

Study Area

Understanding Fragmentation and Connectivity

Research Methods

Data Sources

Anticipated Results

Photo credit: Craig Daily Press

Research Question

Are declines in elk population in the Roaring Fork and Eagle valleys of Colorado correlated with changes to connectivity and habitat fragmentation over recent decades, after accounting for other possibly contributing variables (*e.g.*, hunting pressure and vegetative health)?

Impacts on Wildlife

- Loss of access to crucial habitat
- Pollution, including noise and light
- Changes in wildlife behavior and activity
- Increased potential for human-wildlife conflicts
- Direct wildlife mortality—vehicle collisions

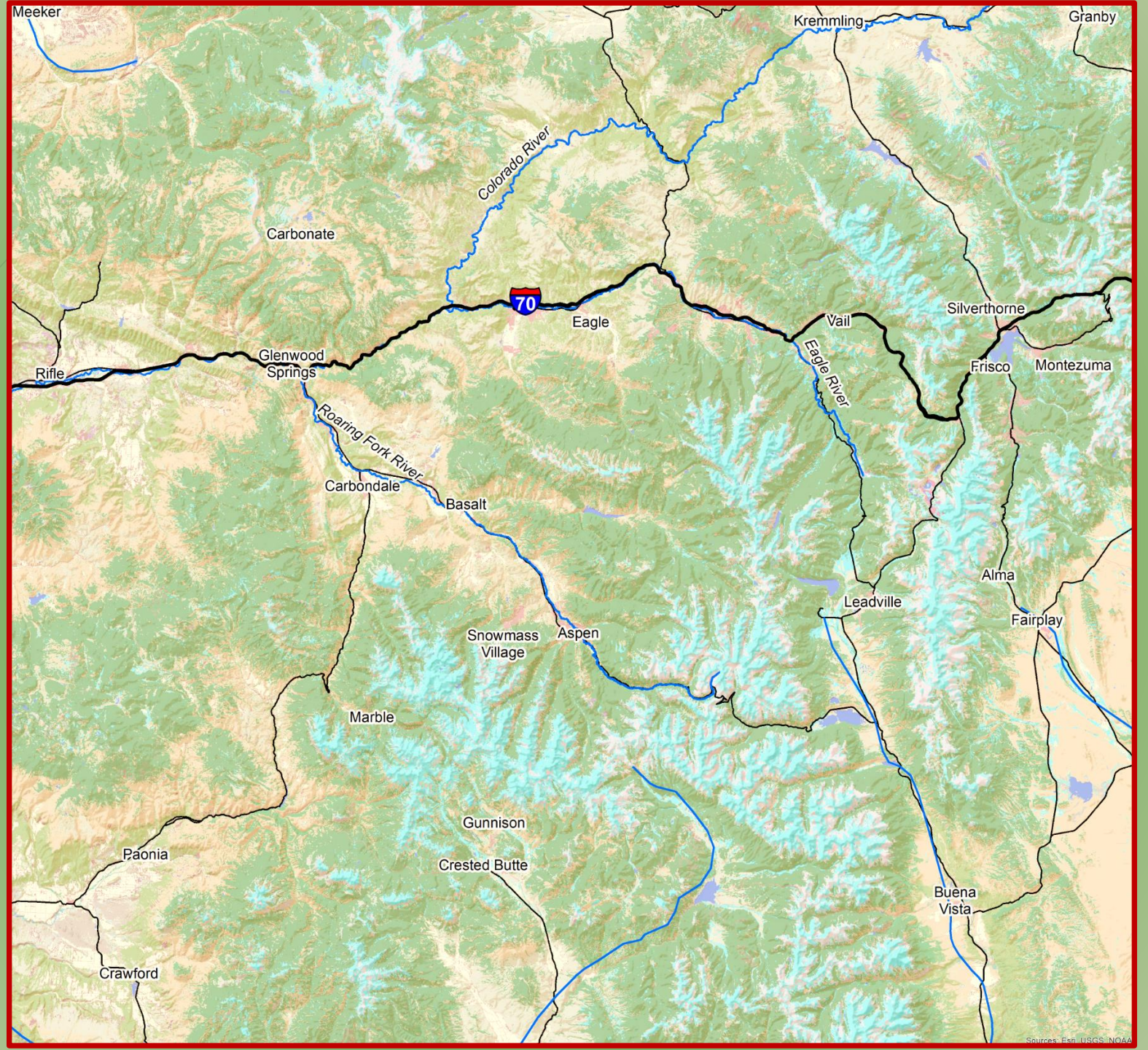
Long Term Effects

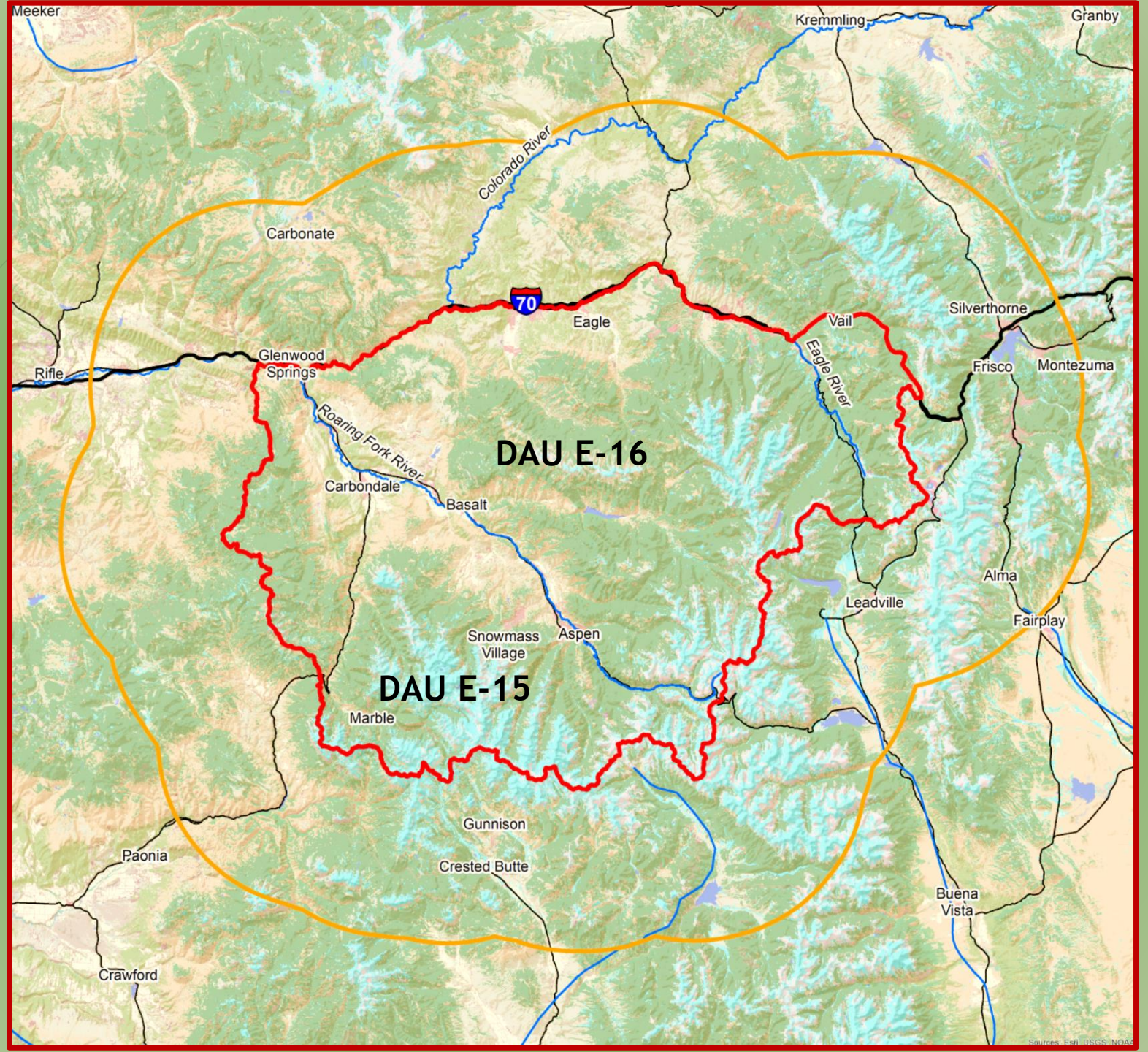
- Invasive species
- Reduced biodiversity—fewer species
- Decreased population viability

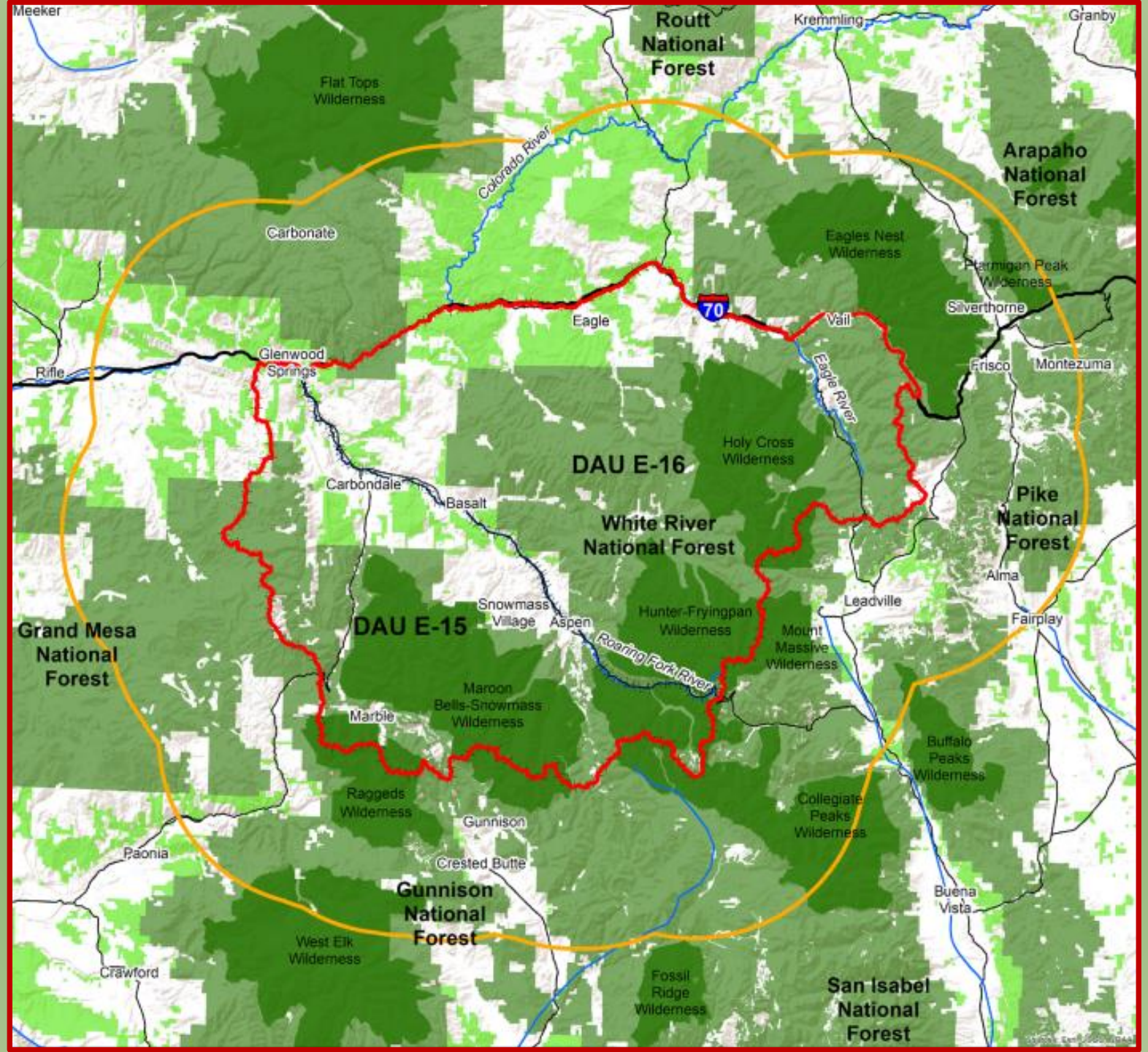
Research Approach

- Temporal approach from 2000 to present
- Track elk population and herd structure
- Quantify changes in habitat fragmentation and landscape connectivity
- Consider other explanatory variables


Rock Springs
Cheyenne
Fort Collins
Greeley
Longs Peak
4345 m
Longmont
Boulder
Denver
UNITED
Colorado
Mt Elbert
4399 m
WEST ELK
Colorado Springs
COLORADO
Pueblo
SAN JUAN MOUNTAINS
Source of the Rio Grande
SAN LUIS VALLEY
Farmington
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.


Meeker
Kremmling
Granby
Colorado River
Carbonate
70
Eagle
Vail
Silverthorne
Glenwood Springs
Rifle
Eagle River
Frisco
Montezuma
Roaring Fork River
Carbondale
Basalt
Alma
Leadville
Fairplay
Snowmass Village
Aspen
Marble
Gunnison
Paonia
Crested Butte
Buena Vista
Crawford
Area of Interest
Analysis Zone
Interstate Highways
Other Highways
Rivers
Sources: Esri, USGS, NOAA


Meeker
Kremmling
Granby
Colorado River
Carbonate
70
Eagle
Vail
Silverthorne
Glenwood Springs
Rifle
Eagle River
Frisco
Montezuma
Roaring Fork River
DAU E-16
Carbondale
Basalt
Alma
Leadville
Fairplay
Snowmass Village
Aspen
DAU E-15
Marble
Gunnison
Paonia
Crested Butte
Buena Vista
Crawford
Area of Interest
Analysis Zone
Elk Data Analysis Unit (DAU)
Interstate Highways
Other Highways
Rivers



Area of Interest

Analysis Zone

Elk Data Analysis Unit (DAU)

Interstate Highways

Other Highways

Rivers

Land Ownership

BLM

Forest Service

Wilderness Areas

What Are Habitat Fragmentation and Landscape Connectivity?

Habitat Comes First

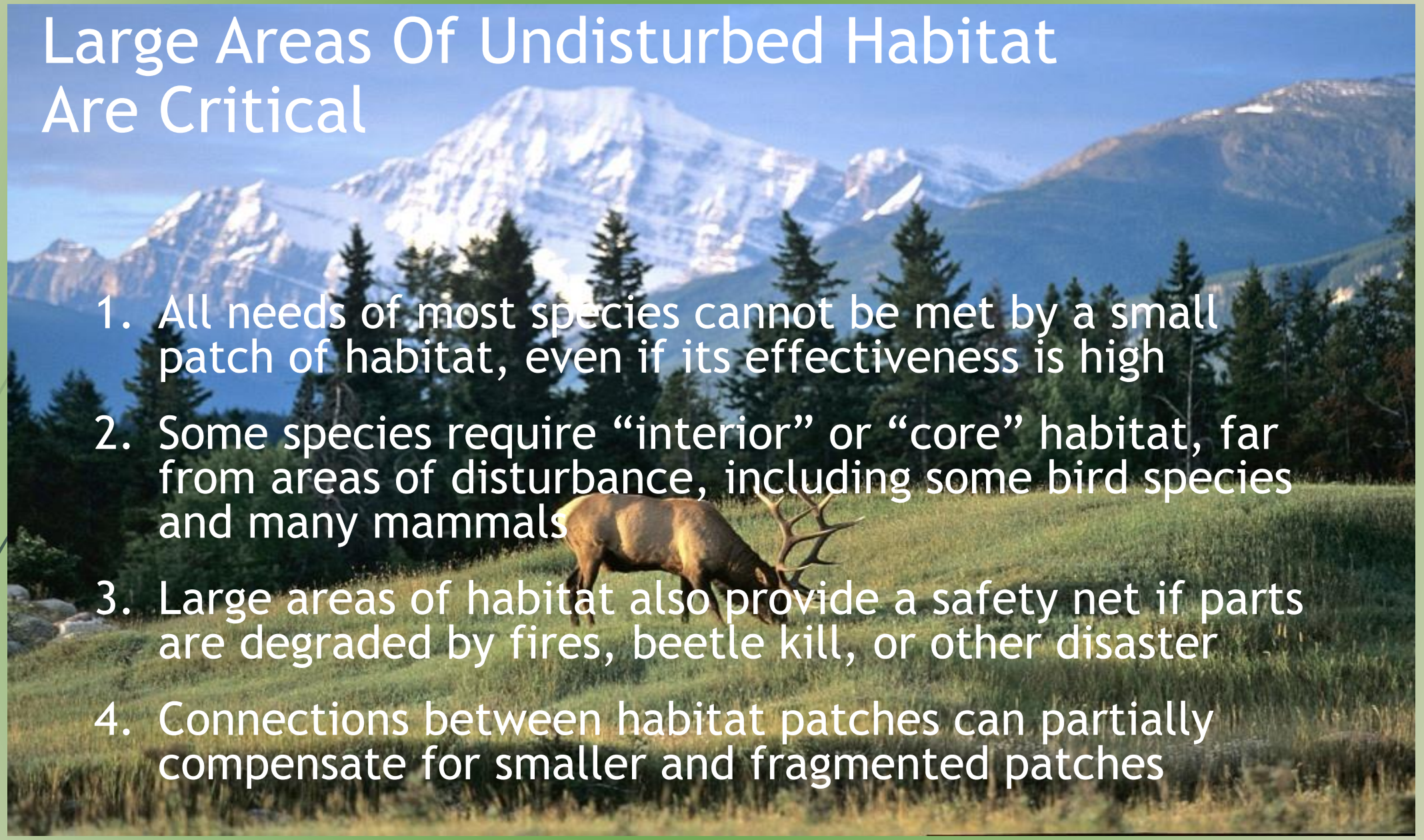
Photo credit: Steve Wagner, Blue Heron Communications

Habitat Comes First

1. The land and/or water environment in which a species lives, feeds, and reproduces
2. A species may use different habitats at different times of year or for special activities, like breeding
3. Areas of habitat can be measured by both their "effectiveness" (the degree to which they meet the needs of a particular species) and their size

Photo credit: Steve Wagner, Blue Heron Communications

Large Areas Of Undisturbed Habitat Are Critical



1. All needs of most species cannot be met by a small patch of habitat, even if its effectiveness is high
2. Some species require “interior” or “core” habitat, far from areas of disturbance, including some bird species and many mammals
3. Large areas of habitat also provide a safety net if parts are degraded by fires, beetle kill, or other disaster
4. Connections between habitat patches can partially compensate for smaller and fragmented patches

Photo credit: Steve Wagner, Blue Heron Communications


What Is Habitat Fragmentation?


What Is Habitat Fragmentation?
The division of habitat into smaller patches.

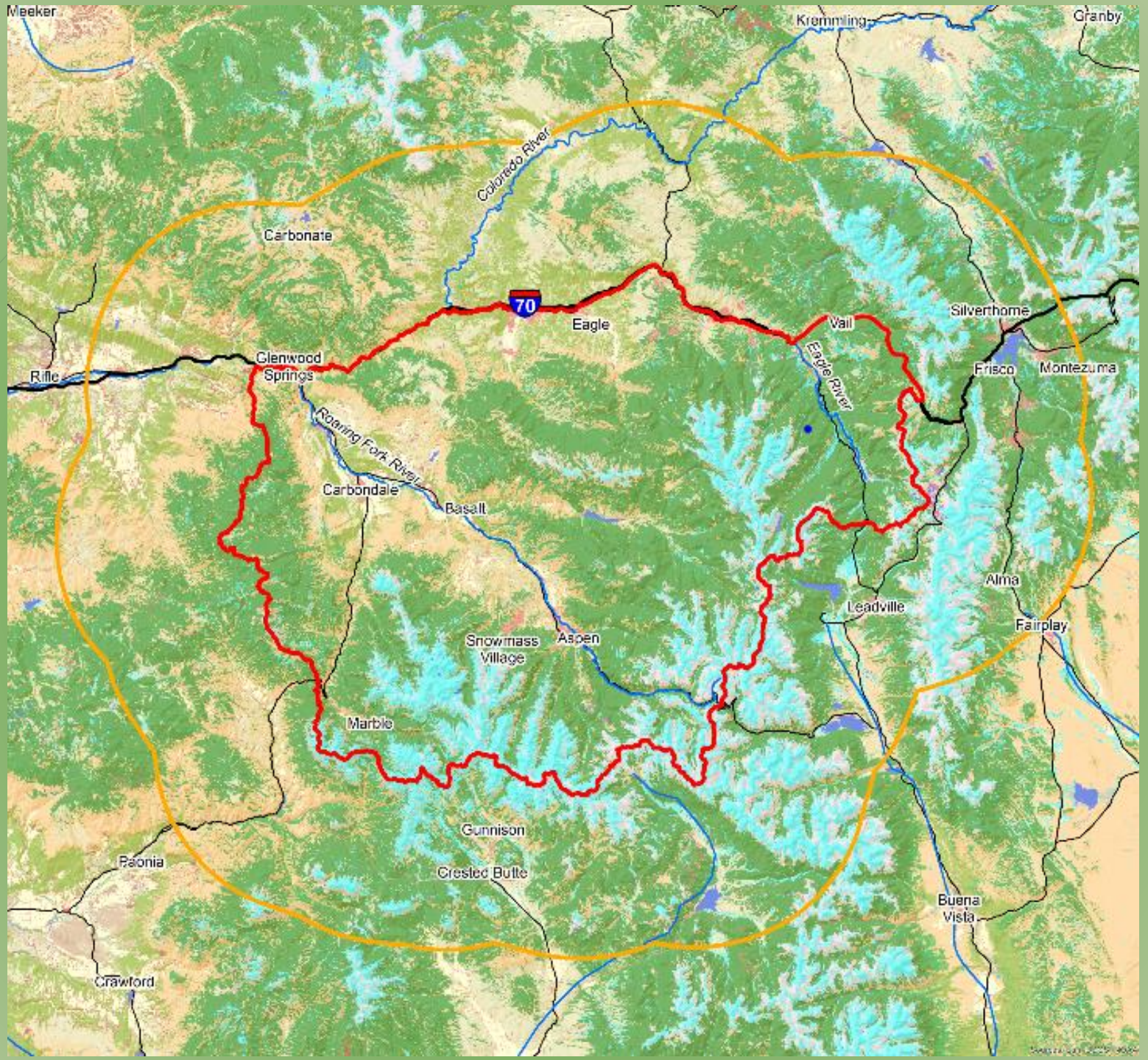
What Is Landscape Connectivity?

Photo credit: Colorado Parks & Wildlife

What Is Landscape Connectivity?

The degree to which wildlife are able to move freely across the landscape.

Photo credit: Colorado Parks & Wildlife


Meeker
Kremmling
Granby
Colorado River
Carbonate
70
Eagle
Vail
Silverthorne
Glenwood Springs
Rifle
Eagle River
Frisco
Montezuma
Roaring Fork River
Carbondale
Basalt
Alma
Leadville
Fairplay
Snowmass Village
Aspen
Marble
Gunnison
Paonia
Crested Butte
Buena Vista
Crawford

Natural

Photo credit: James Kaiser

Artificial

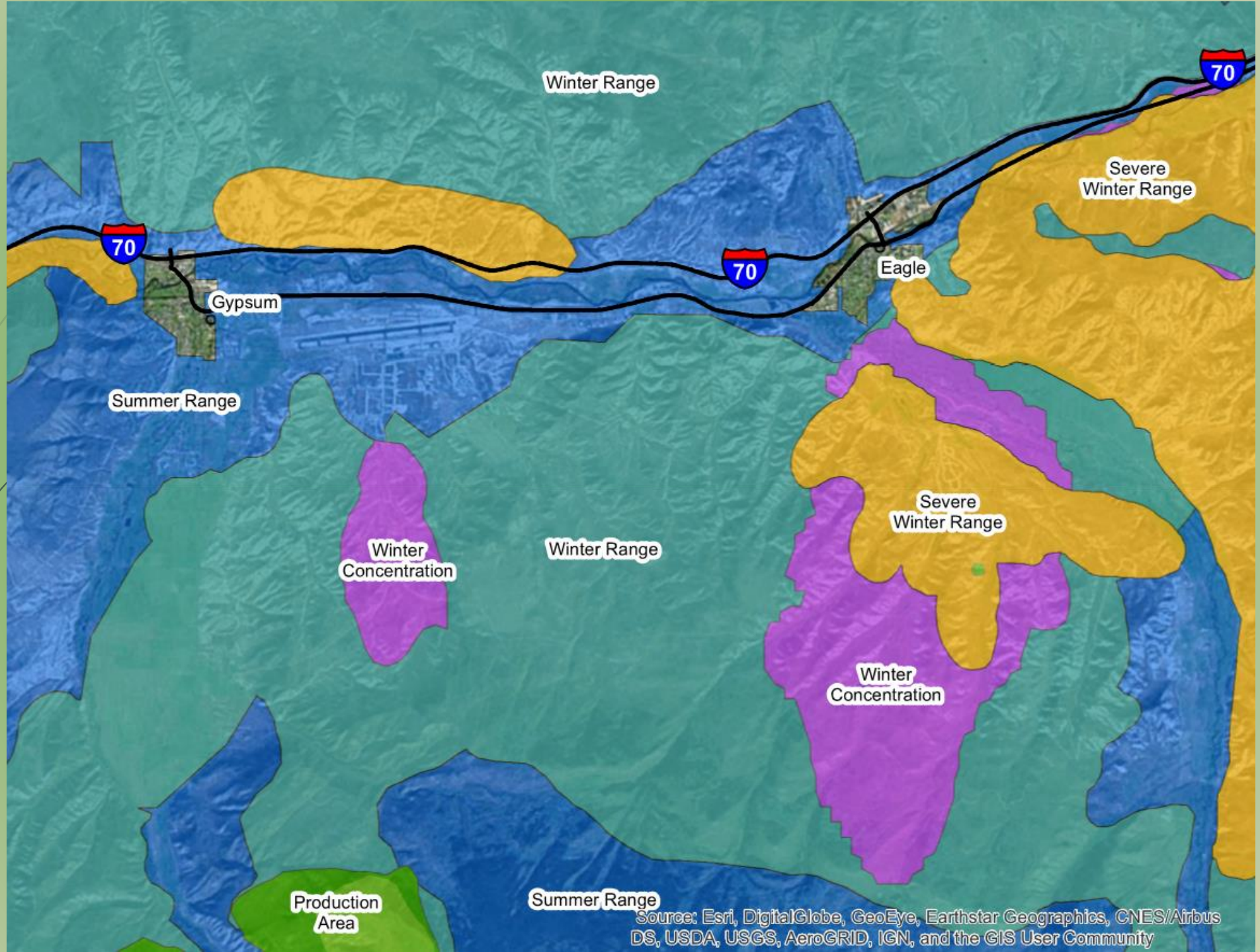
Photo credit: David Foster

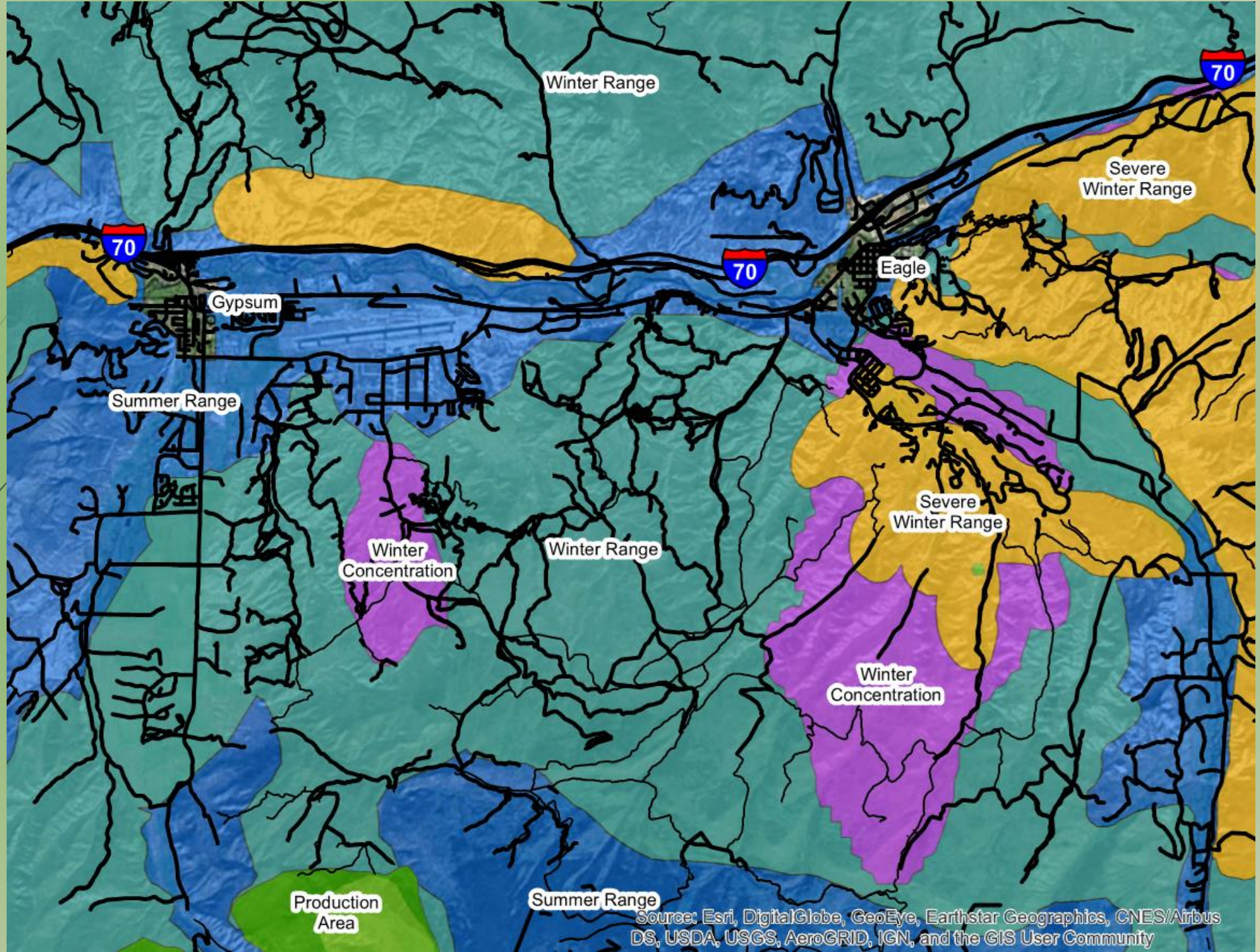
Artificial

Artificial

Photo credit: Noel Wallace

Habitat Fragmentation

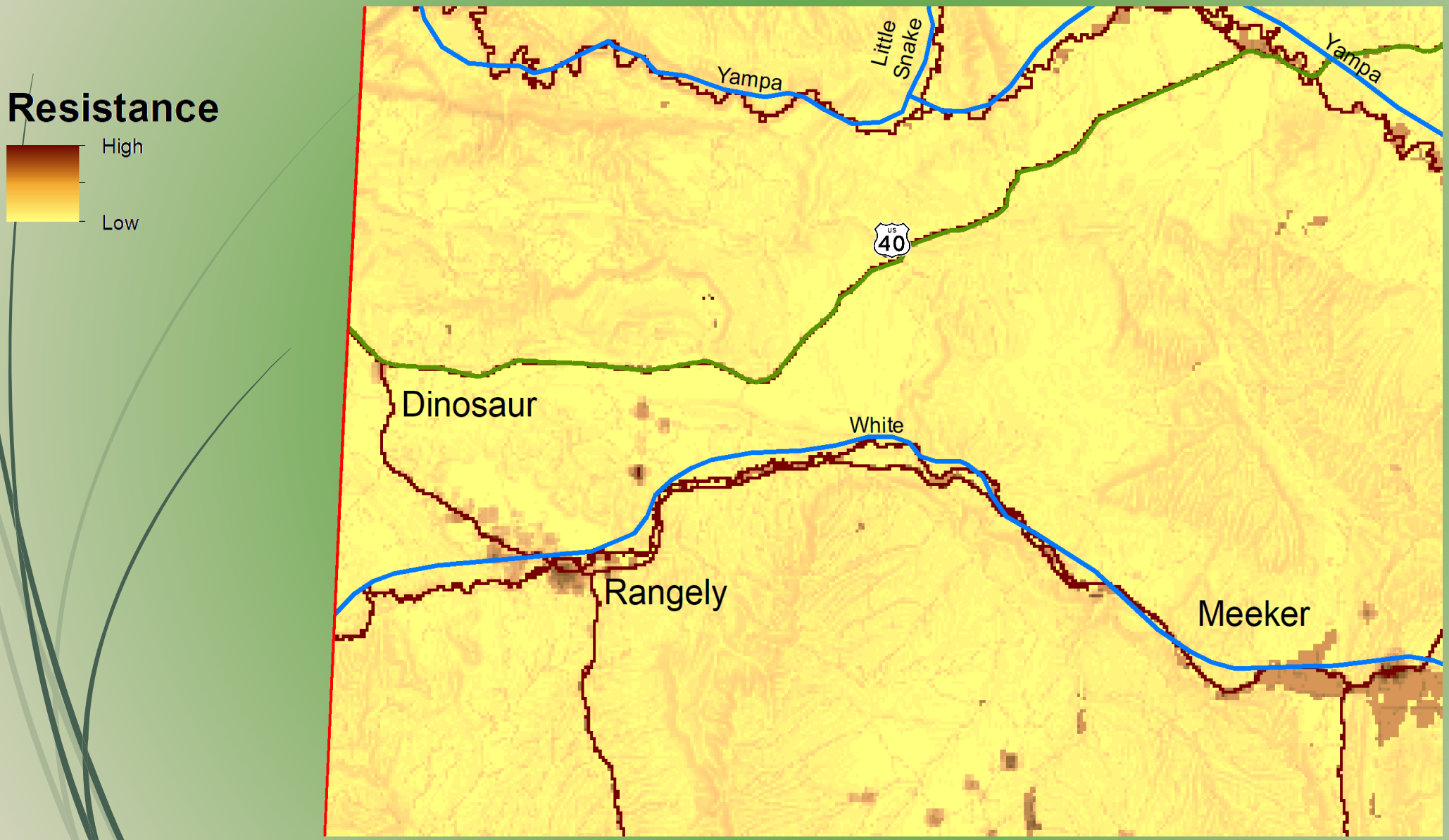

Winter Range
70
Severe
Winter Range
70
70
Eagle
Gypsum
Summer Range
Severe
Winter Range
Winter
Concentration
Winter Range
Winter
Concentration
Production
Area
Summer Range
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Winter Range
70
Severe
Winter Range
70
70
Eagle
Gypsum
Summer Range
Severe
Winter Range
Winter
Concentration
Winter Range
Winter
Concentration
Production
Area
Summer Range
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

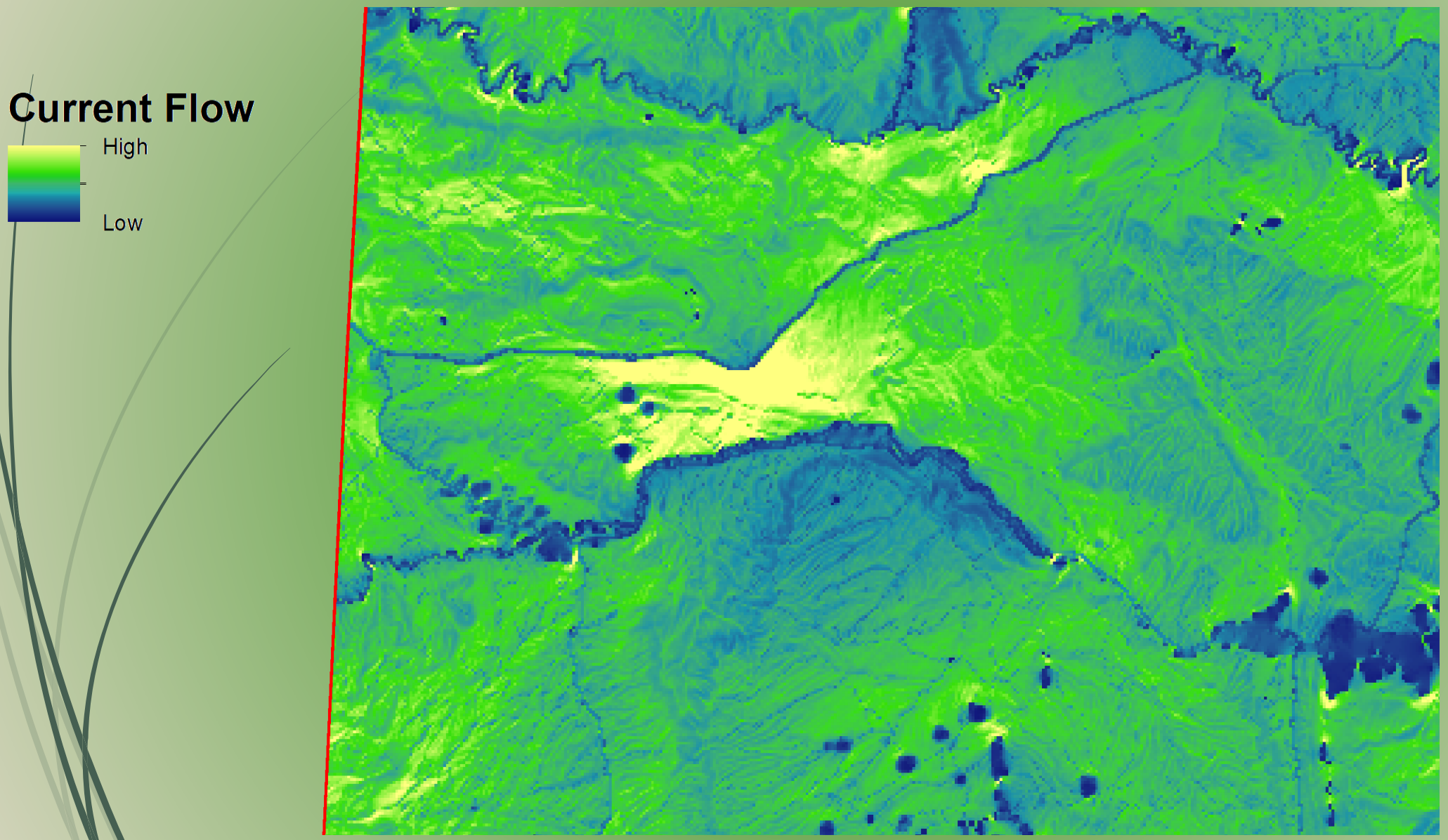

70
70
70
Gypsum
Eagle
Summer Range
Winter
Concentration
Winter Range
Severe
Winter Range
Summer Range

Landscape Connectivity

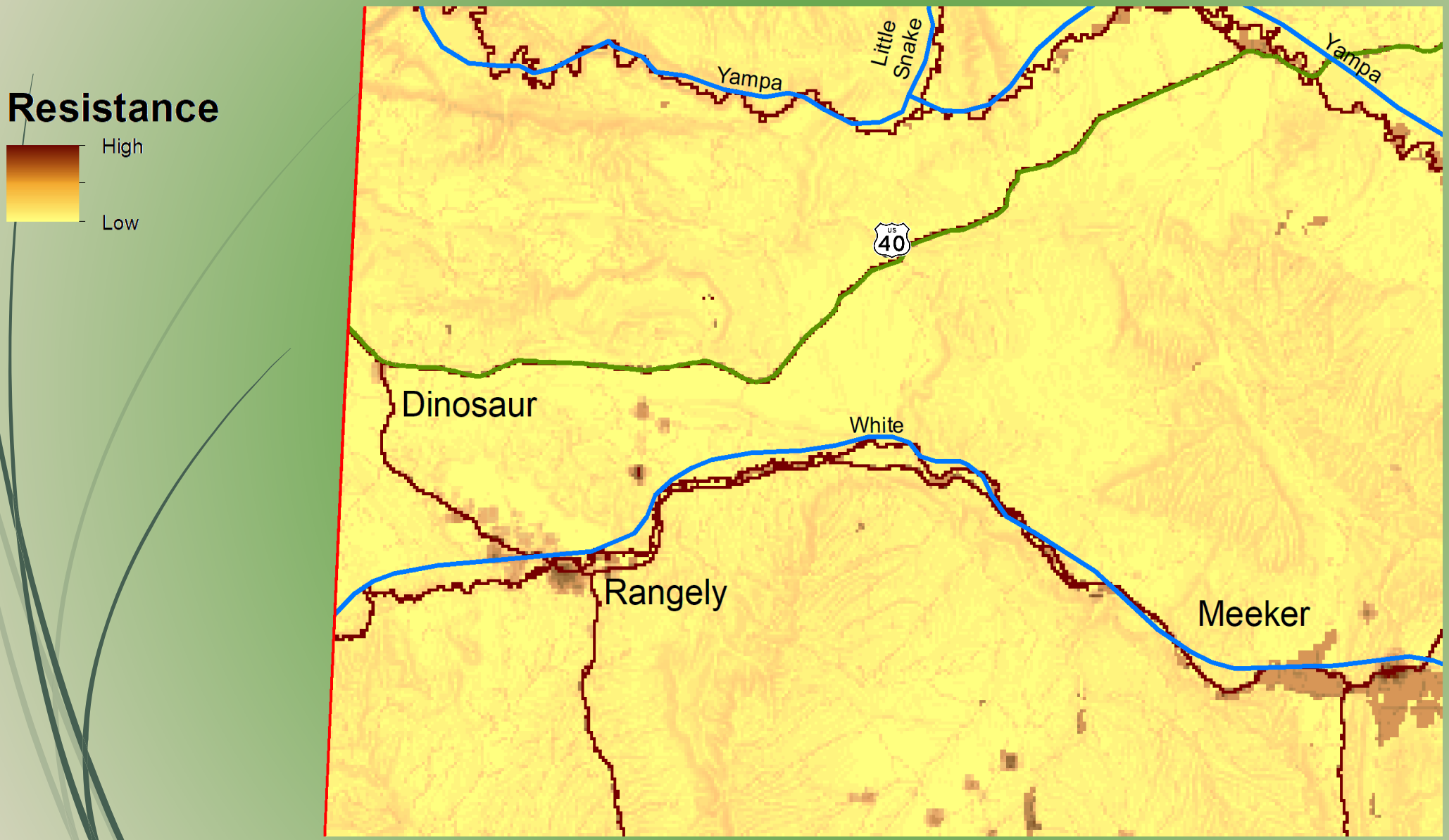
Northwestern Colorado



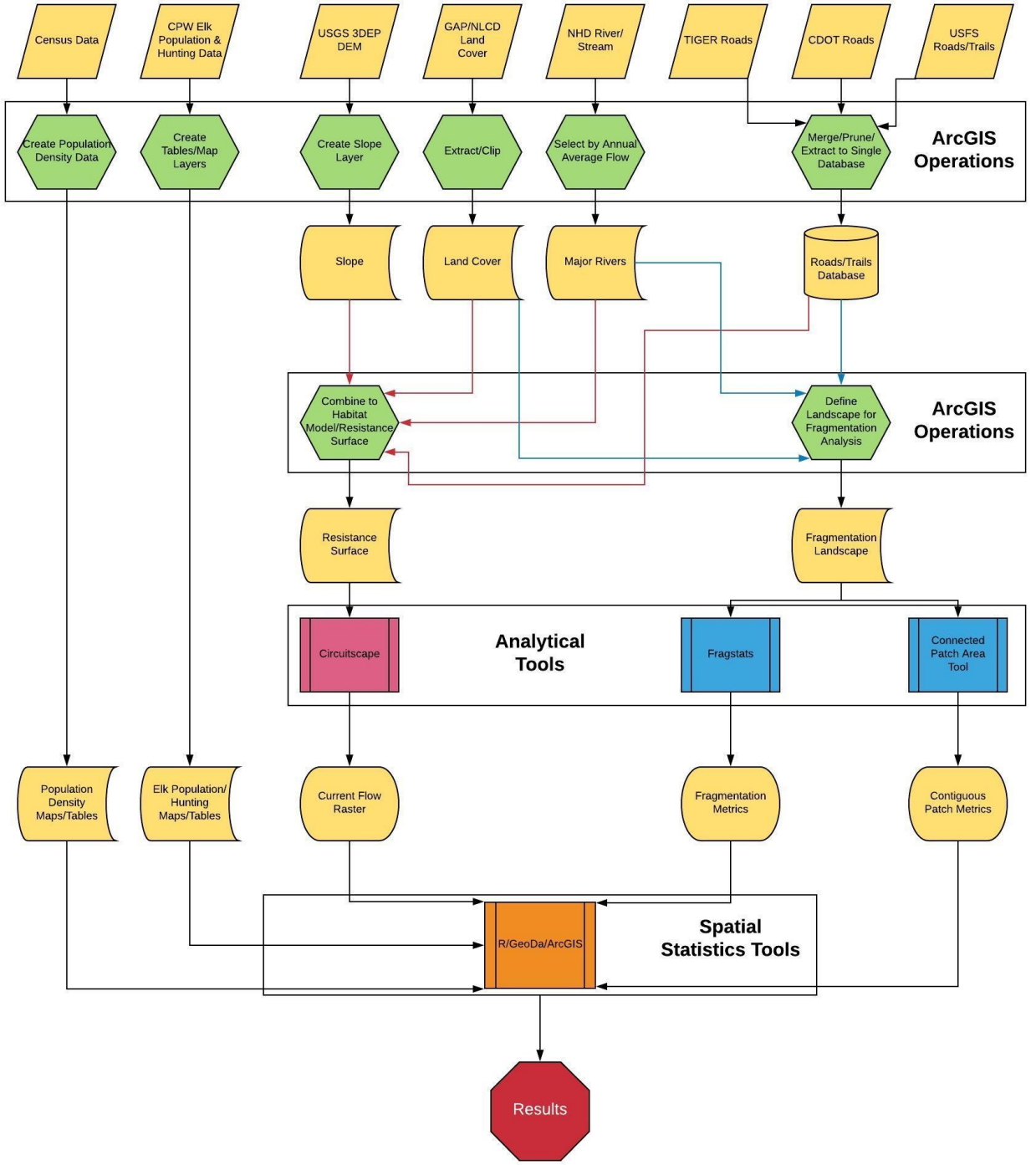
Current Flow in Northwestern Colorado



Northwestern Colorado



Research Methods


Census Data
CPW Elk Population & Hunting Data
USGS 3DEP DEM
GAP/NLCD Land Cover
NHD River/ Stream
TIGER Roads
CDOT Roads
USFS Roads/Trails
Create Population Density Data
Create Tables/Map Layers
Create Slope Layer
Extract/Clip
Select by Annual Average Flow
Merge/Prune/ Extract to Single Database
ArcGIS Operations
Slope
Land Cover
Major Rivers
Roads/Trails Database
Combine to Habitat Model/Resistance Surface
Define Landscape for Fragmentation Analysis
ArcGIS Operations
Resistance Surface
Fragmentation Landscape
Circuitscape
Analytical Tools
Fragstats
Connected Patch Area Tool
Population Density Maps/Tables
Elk Population/ Hunting Maps/Tables
Current Flow Raster
Fragmentation Metrics
Contiguous Patch Metrics
R/GeoDa/ArcGIS
Spatial Statistics Tools
Results

Analytical Tools

Fragmentation

- FRAGSTATS
- Connected Patches Tool

Connectivity

- Circuitscape

Fragmentation Tools

FRAGSTATS

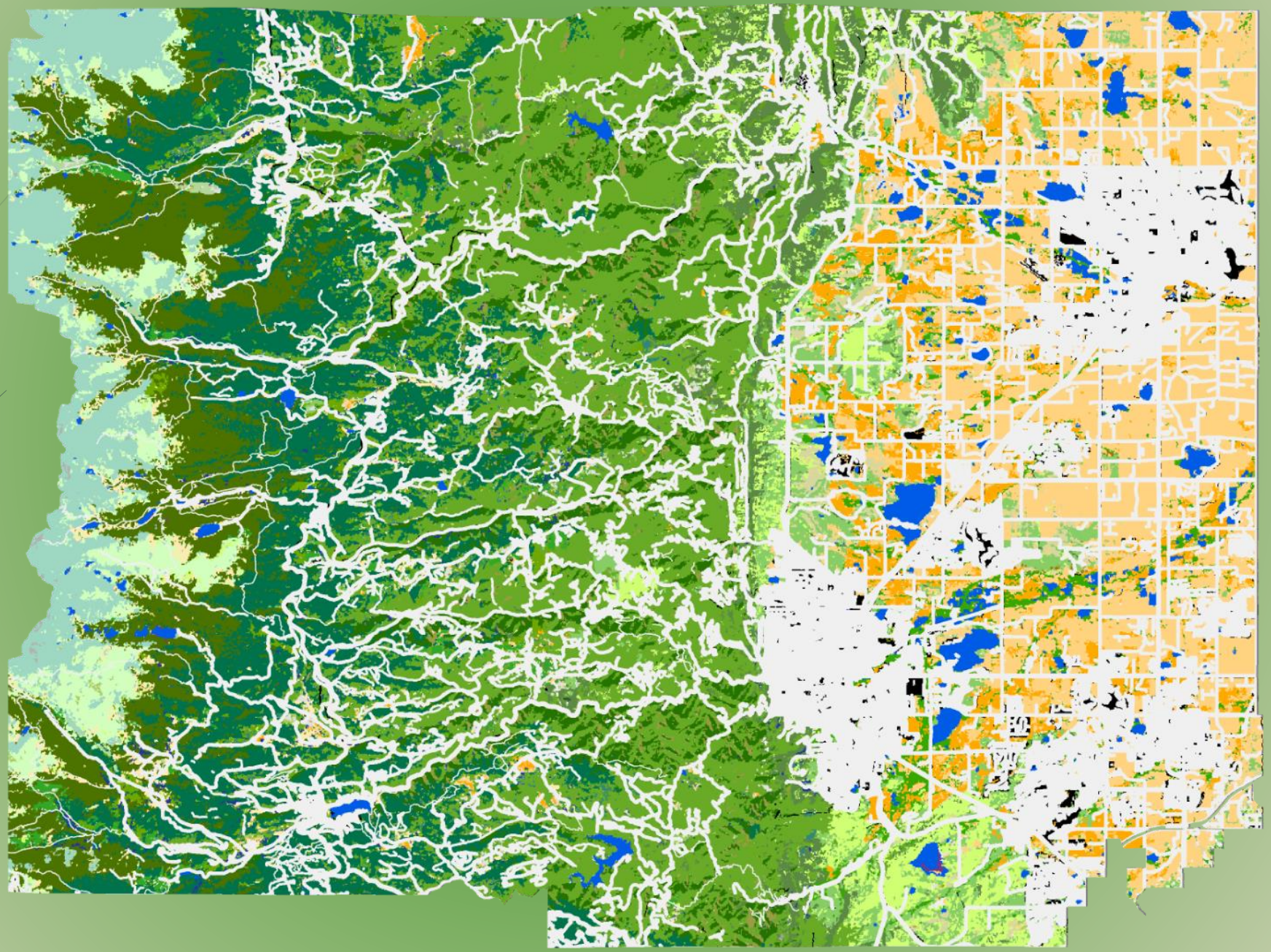
- Raster tool
- Considers every transition between habitat types as fragmentation
- Does not address fragmentation by roads, unless the user designates them as a new habitat type

Fragmentation Tools

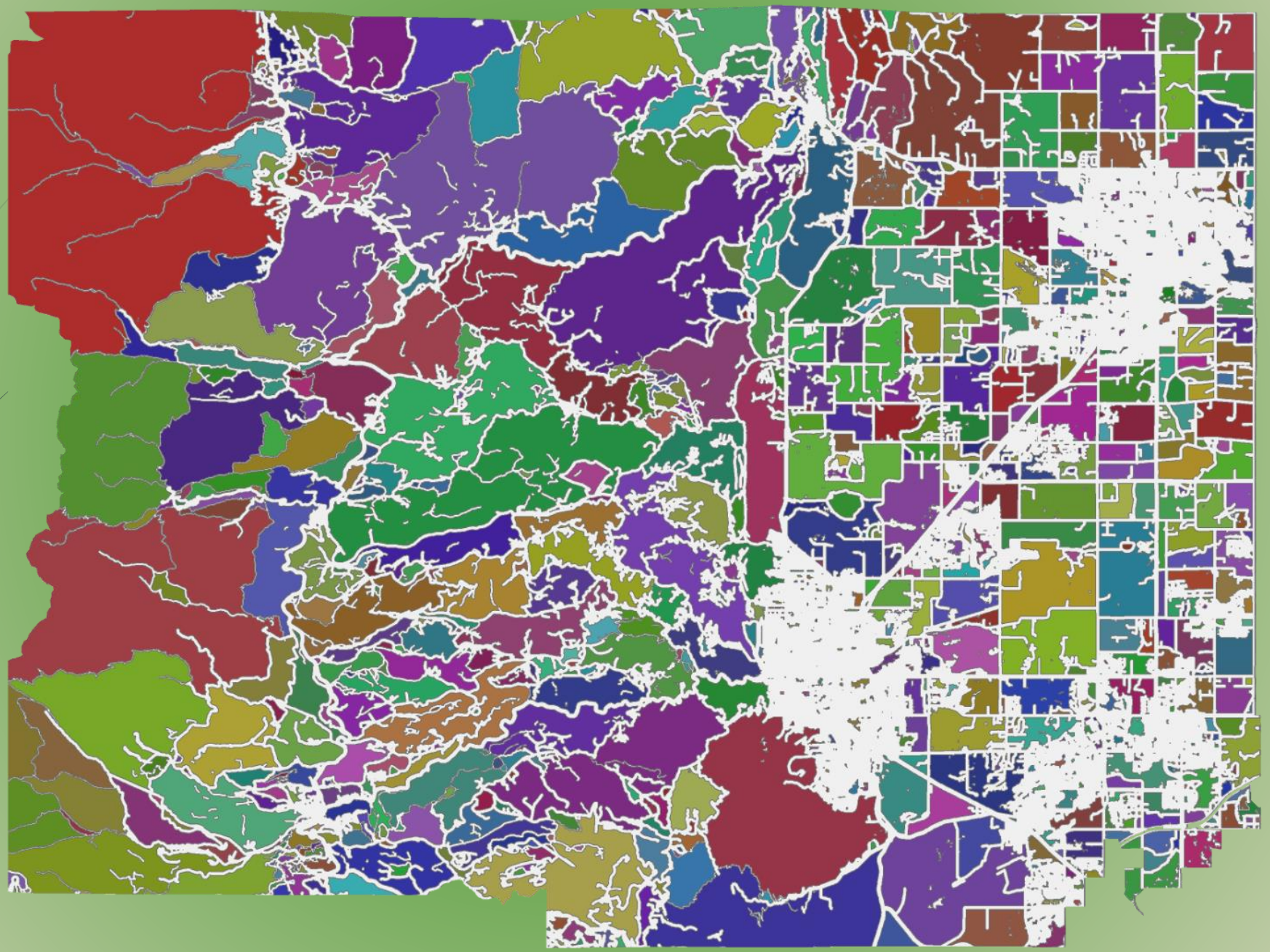
Connected Patches Tool

- Vector tool that I have modified based on original software developed by Rebecca Loraam
- Focuses on roads; as long as wildlife can move between patches without encountering a road or other human development, patches of the same habitat type are considered “contiguous”
- May provide a more realistic measure of how mobile wildlife uses the landscape

FRAGSTATS



Connected Patches Tool

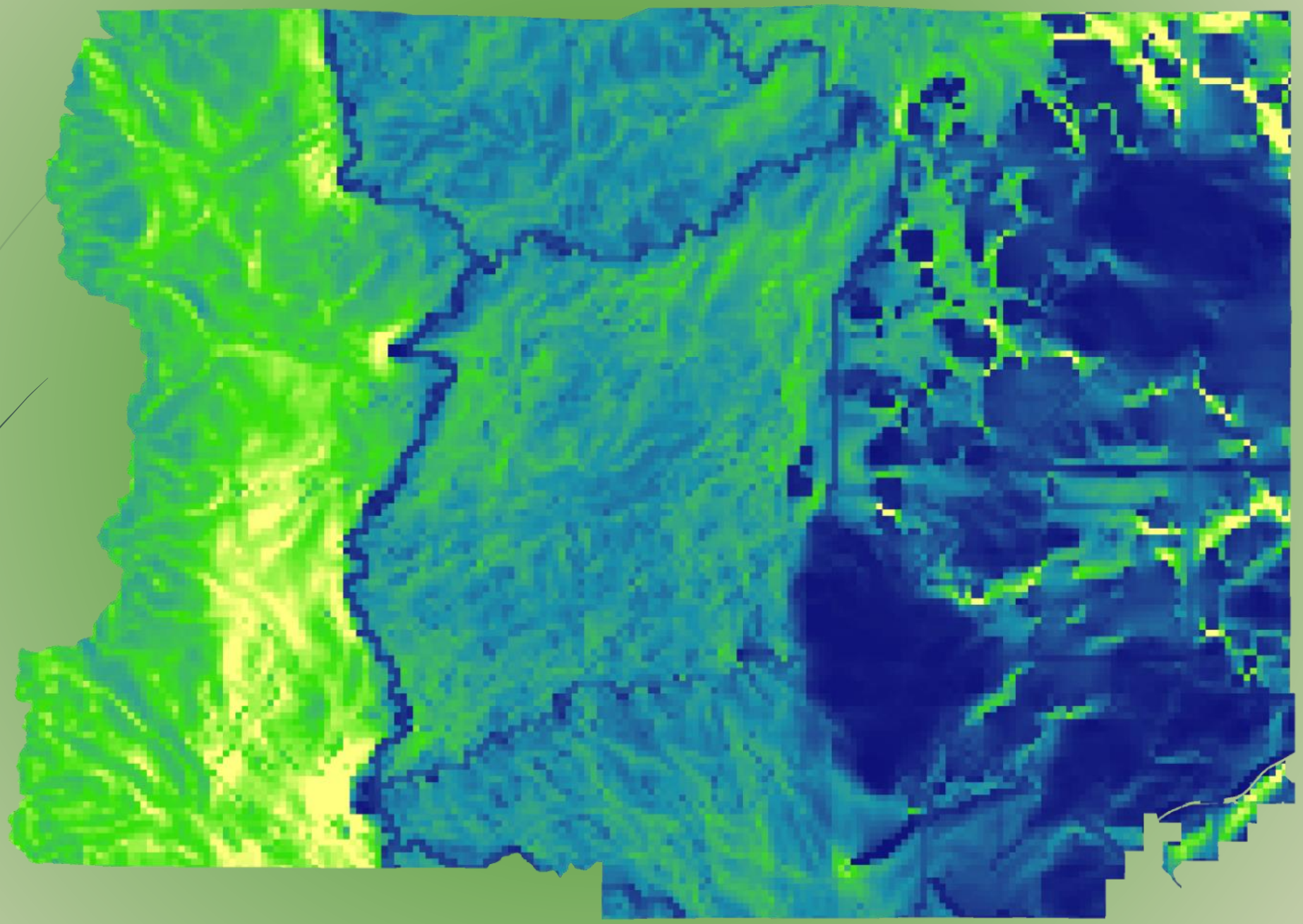


Connectivity Tool

Circuitscape

- Raster tool
- Requires a resistance surface reflecting difficulty of movement
- Simulates electric current flow
- Does not produce statistics

Circuitscape



Data Sources

Elk Population and Movement

- 2000-18 Colorado Parks & Wildlife Data

Land Cover

- GAP/LANDFIRE National Terrestrial Ecosystems 2011

Roads & Trails

- 2000-18 US Census TIGER/LINE
- Colorado Department of Transportation
- US Forest Service

Connectivity Data

Slope/Topographic Position Index

- USGS 3DEP Digital Elevation Data

River Data

- USGS National Hydrographic Dataset+

Other Independent Variables

Human Population

- 2000-17 Census Data

Hunting Pressure

- 2000-18 CPW Hunting Data

Vegetative Health

- USGS Remote Sensing Phenology (RSP) collection

Results

Answer the Research Question!

The Bigger Picture

Policy Change

Thank you!

Photo credit: Matt Inden/Miles