Selecting Reference Sites Across Ecoregions: The Rocky Mountain ReMAP

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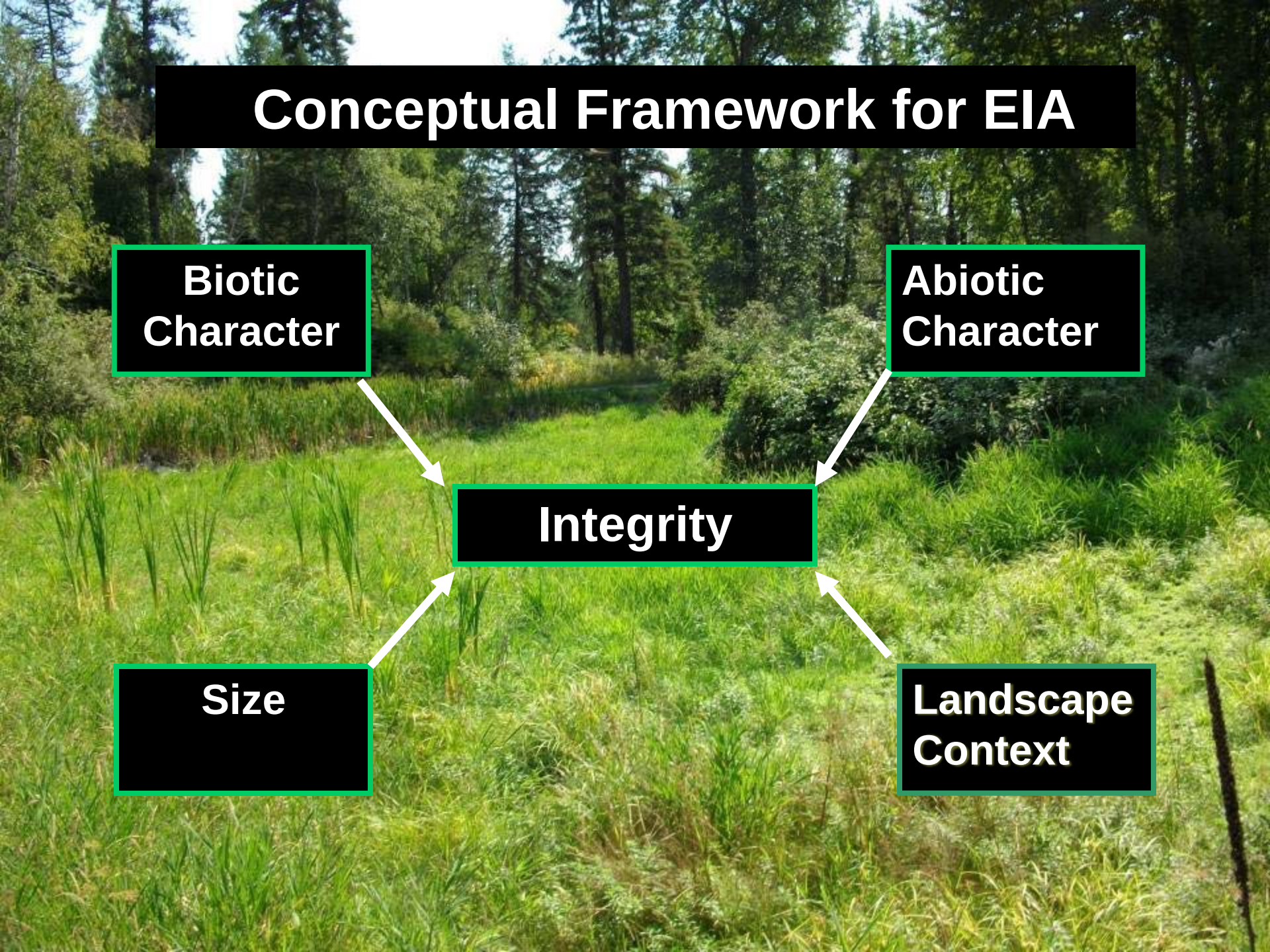
The Rocky Mountain ReMAP project

- EPA-funded project originally intended to
  - Identify reference standards for the wetland types found across the mountain areas of EPA Region 8 (Montana, Wyoming, Utah and Colorado);
  - Produce a regionally standardized Ecological Integrity Assessment method for evaluating and monitoring wetland condition.

Ecological Integrity Assessment (EIA)

- "The ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region." (Parrish et al. 2003)

- An ecosystem has integrity when:
  - its dominant ecological characteristics (e.g., elements of composition, structure, function, and ecological processes) are present within their expected natural ranges of variation; and
  - can withstand and recover from (or is resilient to) most perturbations imposed by natural environmental dynamics or human disruptions.


Conceptual Framework for EIA
Biotic Character
Abiotic Character
Integrity
Size
Landscape Context

Goals and Approach

- Classify the target wetland types
- Stratify by ecological units
- Identify minimally disturbed landscapes
- Carry out a spatially stratified sampling design
- Visit and characterize key ecological attributes of sites

Classify the wetland types

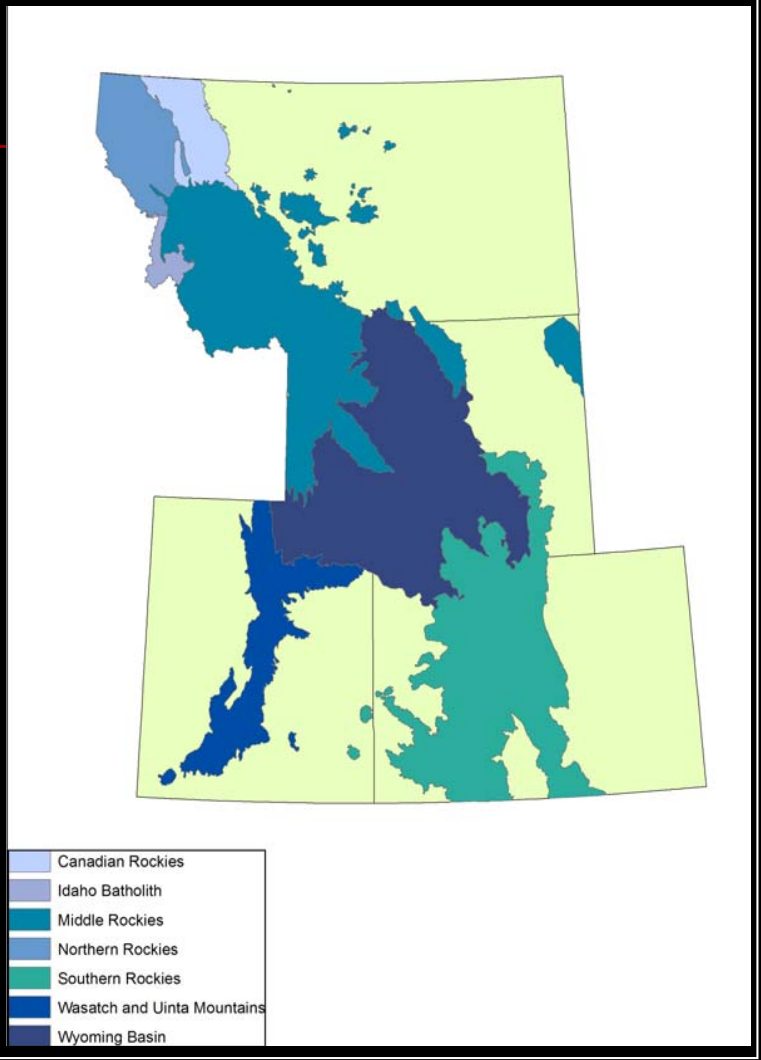
- Ecological systems:
  - composed of predictably recurring groups of biological communities,
  - in similar physical environments,
  - influenced by similar dynamic ecological processes (like fire or flooding)
  - More regionally-specific than Cowardin classes

Rocky Mountain Wetland Systems

- North American Arid West Emergent Marsh;
- Rocky Mountain Subalpine-Montane Fen;
- Rocky Mountain Alpine-Montane Wet Meadow;
- Rocky Mountain Subalpine-Montane Riparian Woodland;
- Rocky Mountain Subalpine-Montane Riparian Shrubland;
- Rocky Mountain Lower Montane Riparian Woodland/Shrubland;

Stratify by ecological units

- To determine whether the range of natural variability within wetland types varies across the region
- Began by using multivariate analysis to cluster 6th code HUCs in the study area into distinct groups with similarities in hydrology, geology, climate, dominant land cover, elevation, etc., using both hierarchical and non-hierarchical cluster approaches
- Finding no meaningful clusters, we defaulted to Omernik Level III ecoregions

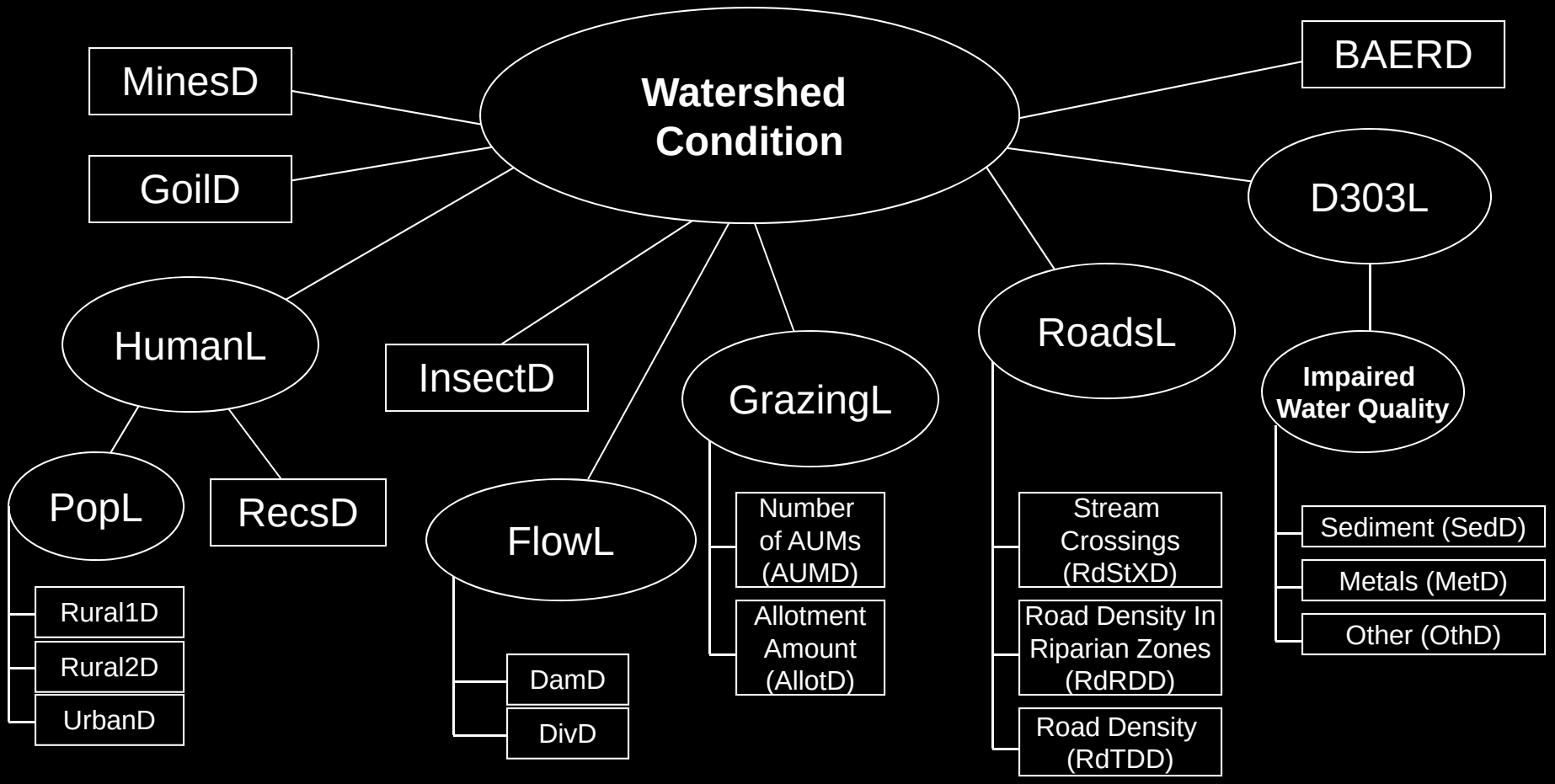


Identify minimally disturbed landscapes

- Reference standard wetlands can be (theoretically) pristine, minimally disturbed or least disturbed;
- The mountain areas of the Rocky Mountain West have large expanses of minimally disturbed landscapes, either in wilderness areas or areas that are otherwise too inaccessible to have suffered human impacts

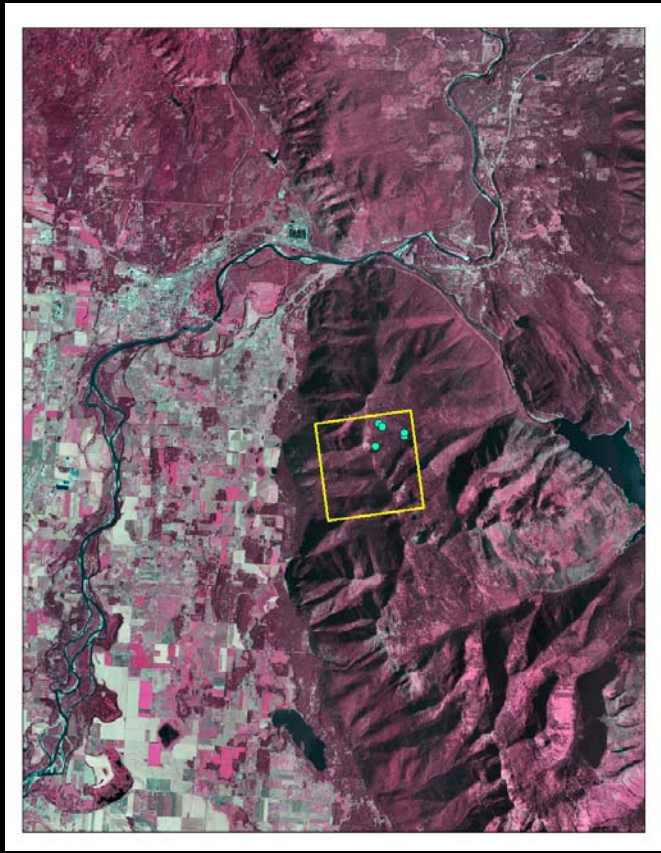
Methods for identifying minimally disturbed landscapes

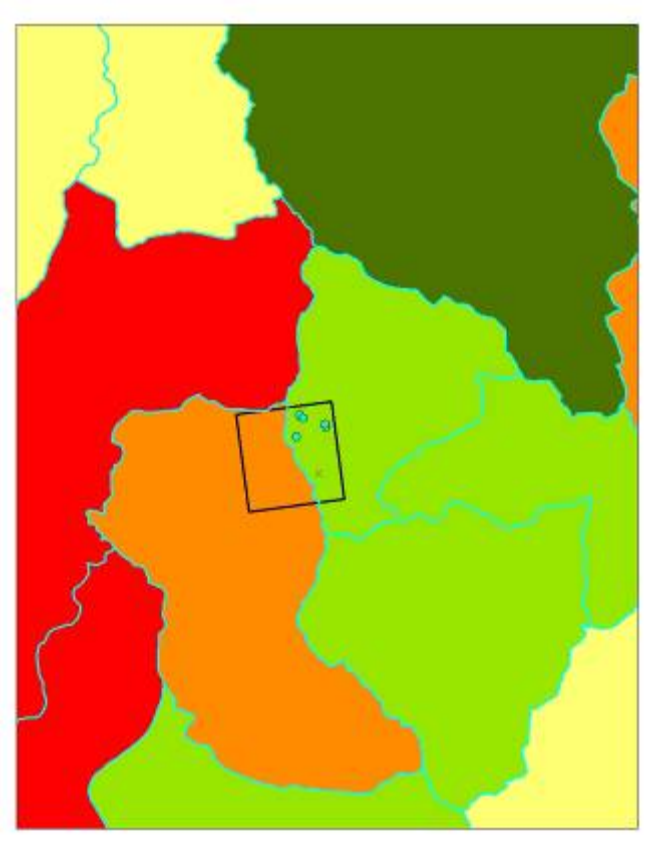
- Visual inspection of aerial photos– impossible over large scale
- Expert knowledge/maps to identify wilderness areas, low use landscapes, etc– favors very isolated, usually high elevation areas
- Synoptic maps or models based on data and/or best professional judgment
- Grid/raster models



HUC-based landscape model (watershed integrity)

Synoptic maps are too coarse when impacts are unevenly distributed





Inverse weighted distance model based on BPJ and field data

Most minimally disturbed pixels:

>200m from 4-wheel drive, >300m from local roads, >500m from highways;

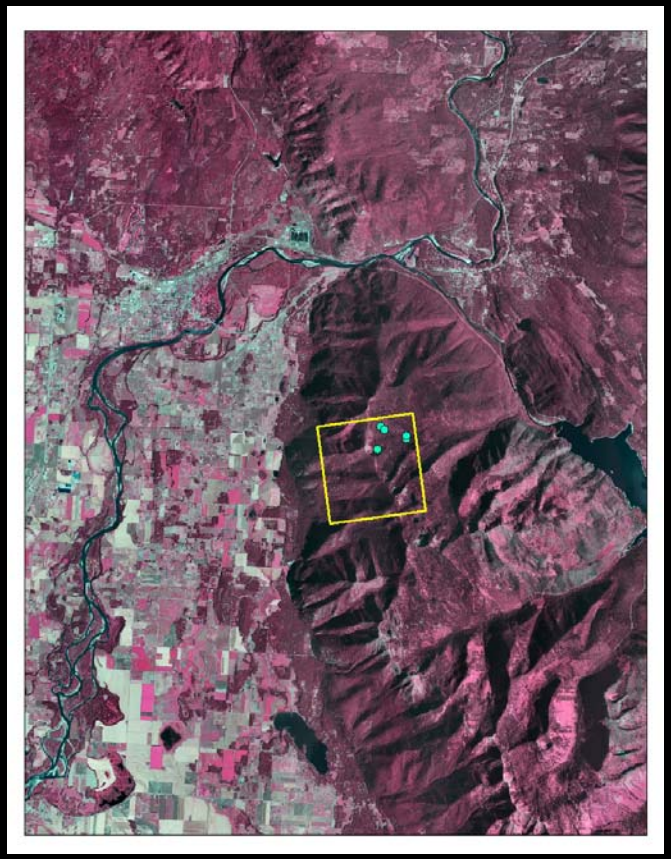
>2000m from urban, >500m from crop agriculture, >2000m from timber harvest;

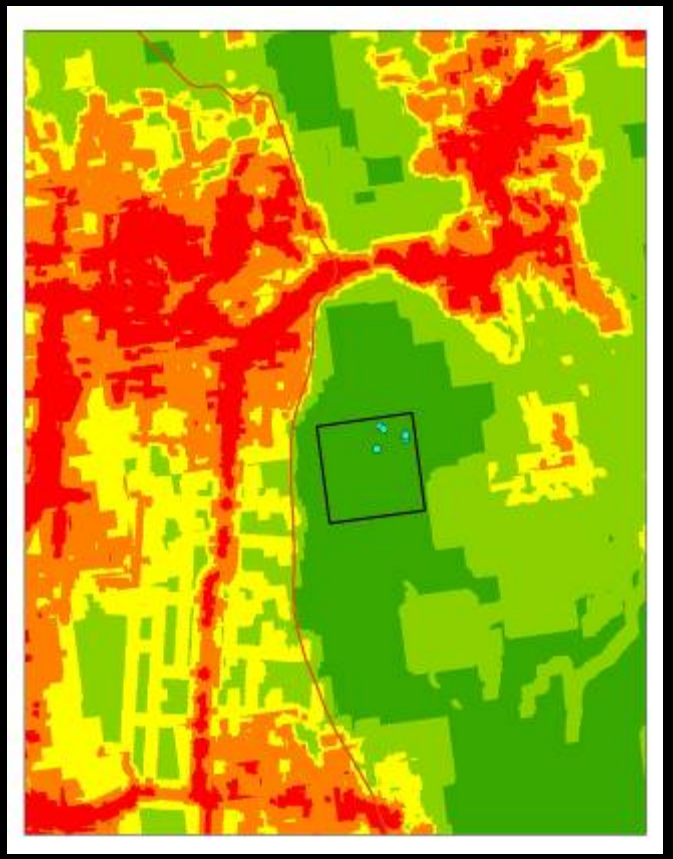
>200m from hydrologic modifications, withdrawals or 404d permits;

>150m from abandoned mines: 100%)

Category	Buffer distance (meters)	Score	Weight
Roads			**35%**
4-wheel drive (15%)	0-100	3	
	100.01-200	2	
	>200.01	1	
Local roads, city streets (35%)	0-100	4	
	100.01-200	3	
	200.01-300	2	
	>300.01	1	
Highways (50%)	0-100	5	
	100.01-200	4	
	200.01-300	3	
	300-500	2	
	>500.01	1	
Land Cover			**35%**
Urban (40%)	0-500	5	
	500.01-1000	4	
	1000.01-1500	3	
	1500.01-2000	2	
	>2000.01	1	
Crop agriculture (40%)	0-200	5	
	200.01-300	4	
	300.01-400	3	
	400.01-500	2	
	>500	1	
Timber harvest (20%)	0-500	5	
	500.01-1000	4	
	1000.01-1500	3	
	1500.01-2000	2	
	>2000.01	1	
Hydrology			**20%**
Artificial flow (25%)	0-100	3	
	100.01-200	2	
	>200.01	1	
Water right point of use (50%)	0-100	3	
	100.01-200	2	
	>200.01	1	
Section 404 permit (25%)	0-100	3	
	100.01-200	2	
	>200.01	1	
Land use			**10%**
Abandoned mines (100%)	0-60	3	
	60.01-150	2	
	>150.01	1	

Raster model limits scope of locally intense impacts

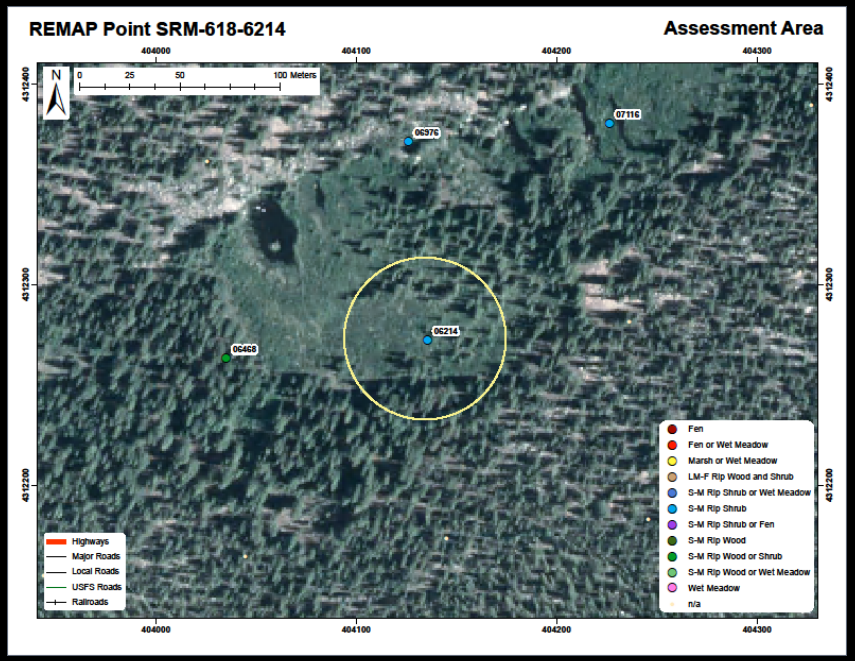




Sampling approach

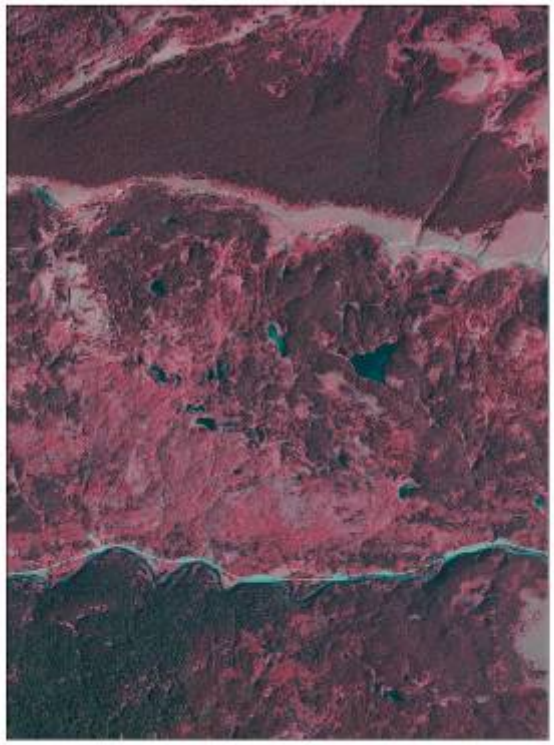
- General Random Tessellation Stratification using spssurvey in R to select 50 2 mile x 2 mile grid cells:
  - in minimally disturbed landscapes
  - within 10 miles of a four wheel drive road
  - in each Level III ecoregion
- Created a grid of points at 100 meter intervals within these selected cells and determined which points fell within the high integrity landscape using Spatial Analyst.
- Each of these points was then examined to determine if it occurred within one of the targeted wetland ecological systems.
- Continued to evaluate all of the points within each selected cell until we selected up to five examples of each wetland ecological system occurring within the cell.

First-ordered point of each class selected for field sampling



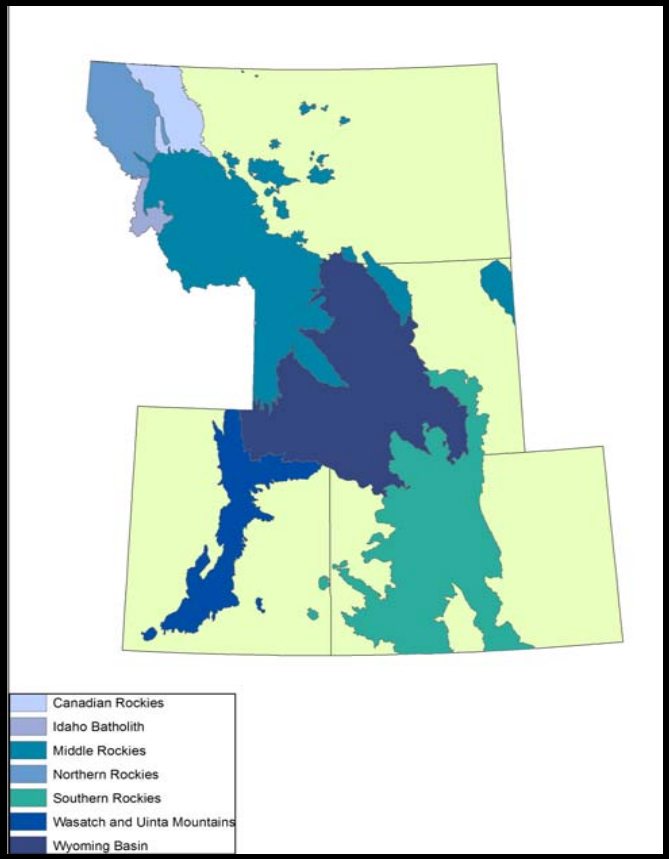
Should you try this at home? a.k.a. “Challenges”

- Wetland mapping did not exist for most of the study area, requiring intensive photointerpretation;
- Our emphasis on minimally disturbed sites led to exclusion of one wetland system and two ecoregions



GIS data quality was highly variable

Aiming for minimally disturbed cost us two ecoregions and the lower montane riparian woodland/shrubland



Minimally disturbed can be maximally dangerous

Will this be a more robust approach to selecting reference sites?

- We don’t know
- Montana has a suite of reference sites for herbaceous wetland types, developed through a targeted approach, so we will compare results after data is analyzed

Thanks to…

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Questions?