Application of Logic and Decision Models in Sustainable Ecosystem Management

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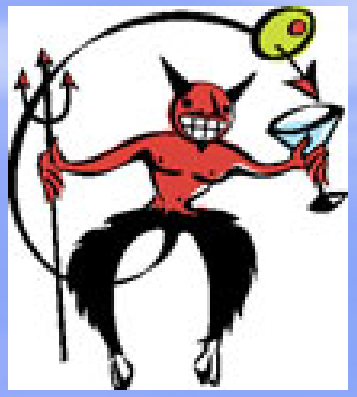
(HICSS – 42)



Outline for Presentation

- Describe EMDS Assessment Models
- Present some R1 EMDS Assessment Models
- Describe EMDS Decision Models
- Display some R1 EMDS Decision Models

EMDS

- ✓ Ecosystem
- ✓ Management
- ✓ Decision
- ✓ Support
- ✓ System

Background

- Developed by PNW Station
- Corporate USDA – FS Software
- Maintained by U. of Redlands and Others
- www.Institute.redlands.edu/emds
- COOL STUFF!

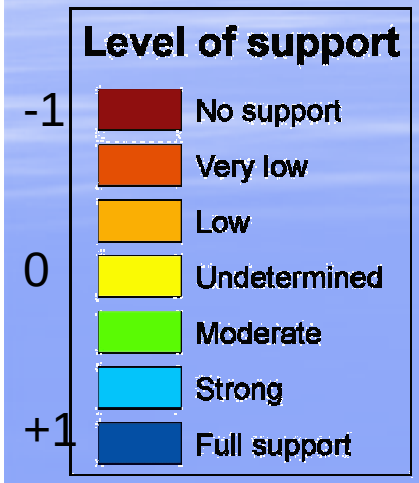
Features

- Build knowledge bases for assessment with Net Weaver
- Build decision models for landscape restoration (treatment) with Criterion Decision Plus
- Operates through GIS (ARCMAP Tool)
- **Facilitates *Transparency* and *Reproducibility* in the evaluation of monitoring data and the identification of treatment areas !**

EMDS Knowledge Bases

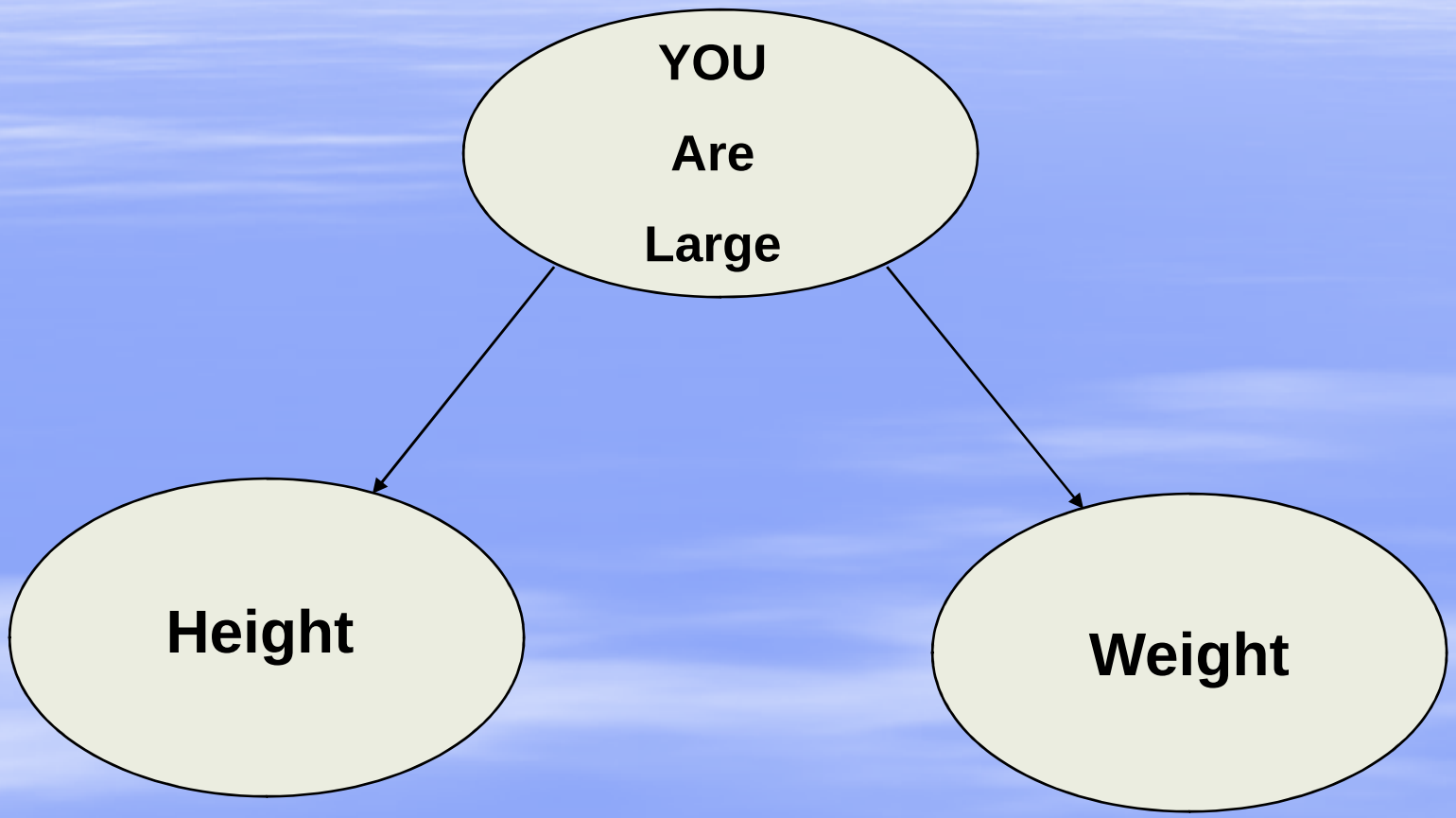
- Evaluate Multiple Propositions that are Hierarchically Designed (i.e., from the top down where they end with data elements)
- A Proposition is “Something that can be believed or denied based on the degree to which it is true or false” given all antecedent network conditions
- Uses “ Fuzzy Membership Functions” to Interpret Data

How to interpret map symbology



- EMDS is an extension to ArcMap (ArcGIS), and its basic products are maps..
- Each map displays the strength of evidence (or level of support, as in the legend to the left) for a specific proposition.

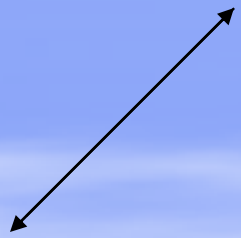
Proposition



Evaluation of Proposition

Height

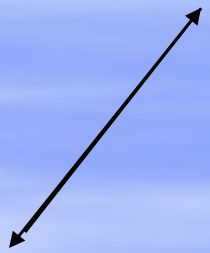
True, if > 6ft.



False, if < 5ft.

Weight

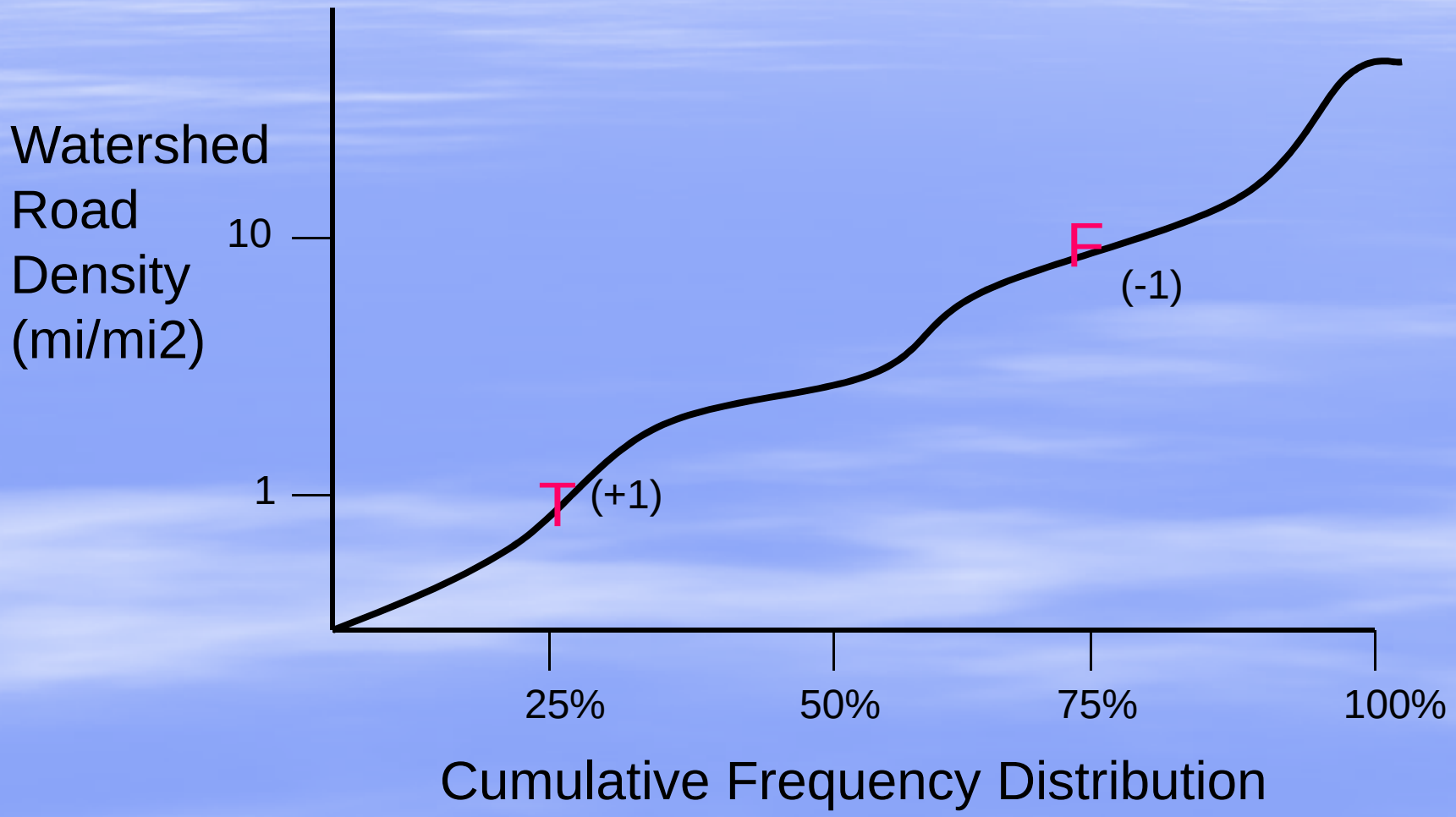
True, if >200lbs



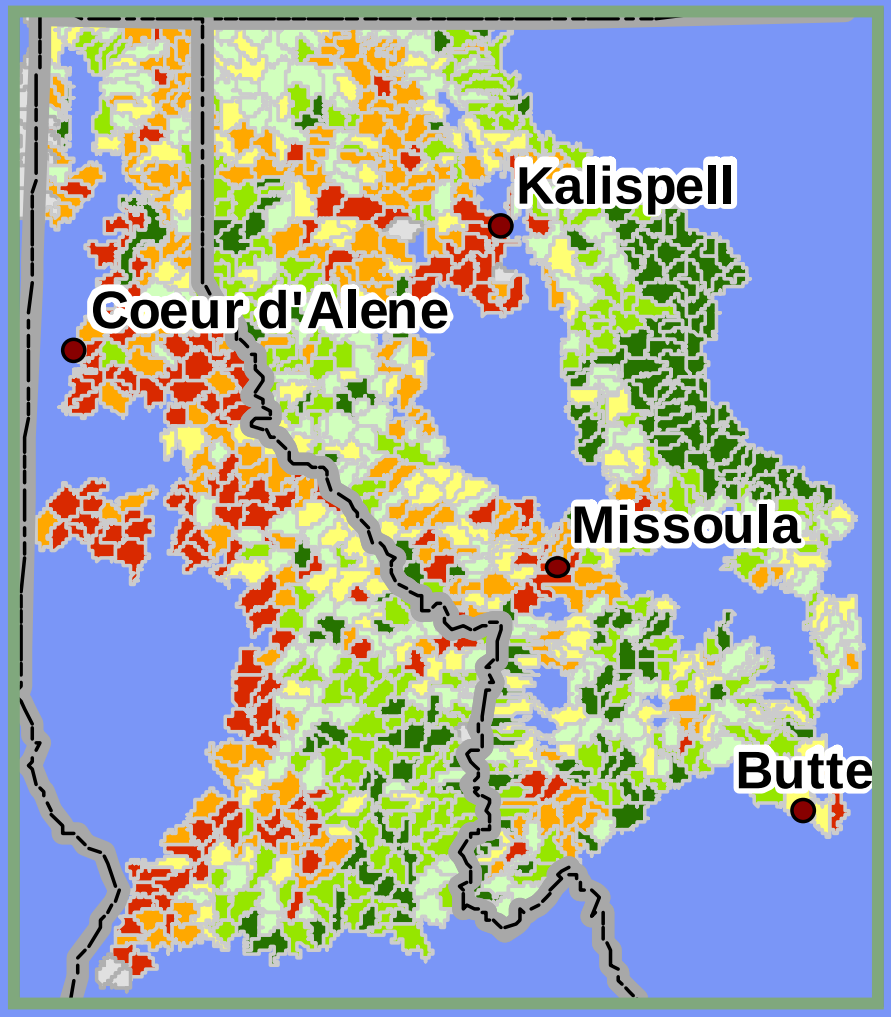
False, if < 100lbs

Fuzzy Single Ramp Function

(for evaluating the proposition that watershed road density is low)



Proposition: Road Density and # Stream Crossings are Low



Unit: subwatershed

Strength of Evidence for Proposition

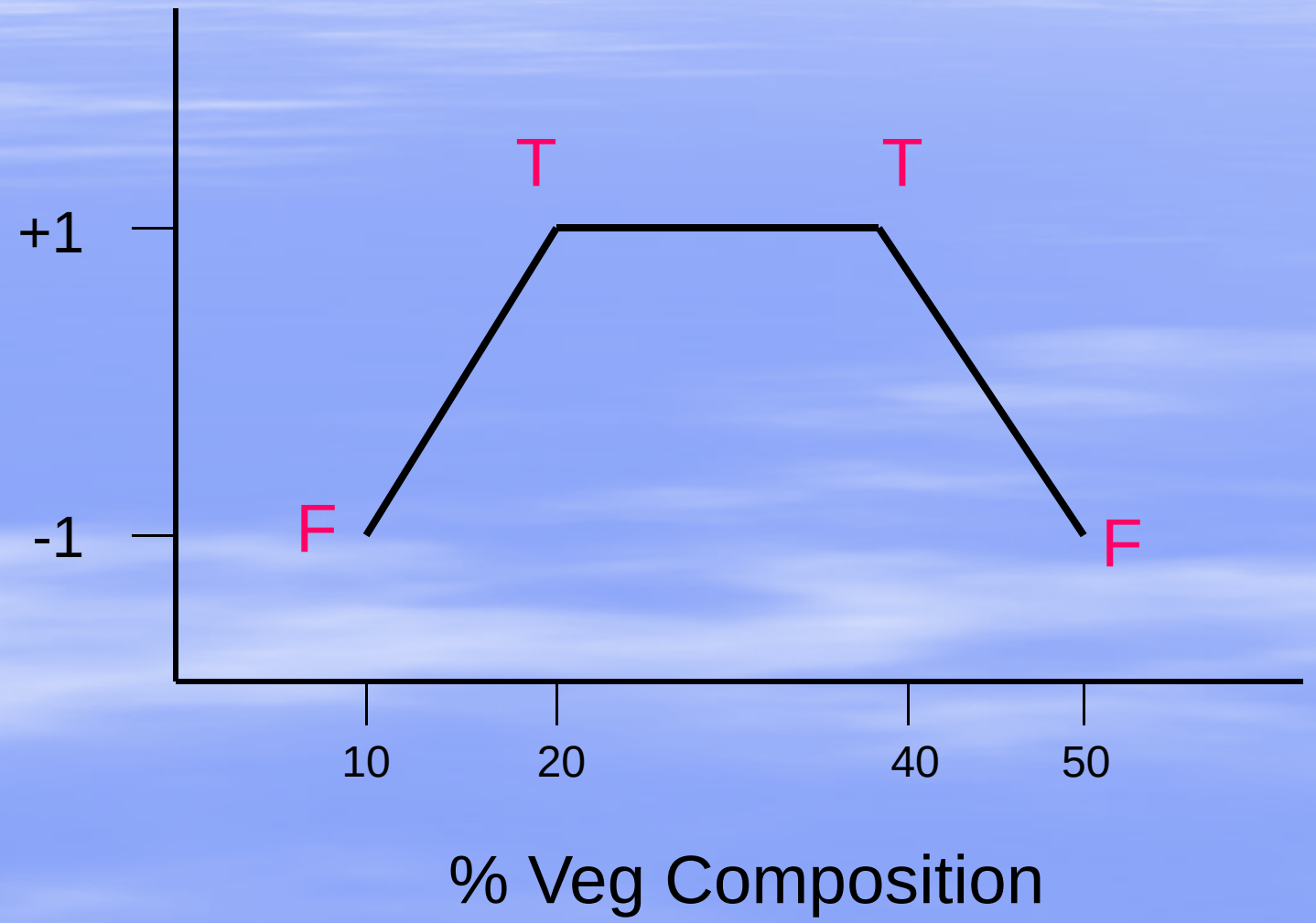
- No Support [-1]
- Very Low Support (-1, -0.5]
- Low Support (-0.5, 0)
- Undetermined [0]
- Moderate Support (0, 0.5]
- Strong Support (0.5, 1)
- Full Support [1]
- State Boundary
- Cities

80 40 0 80

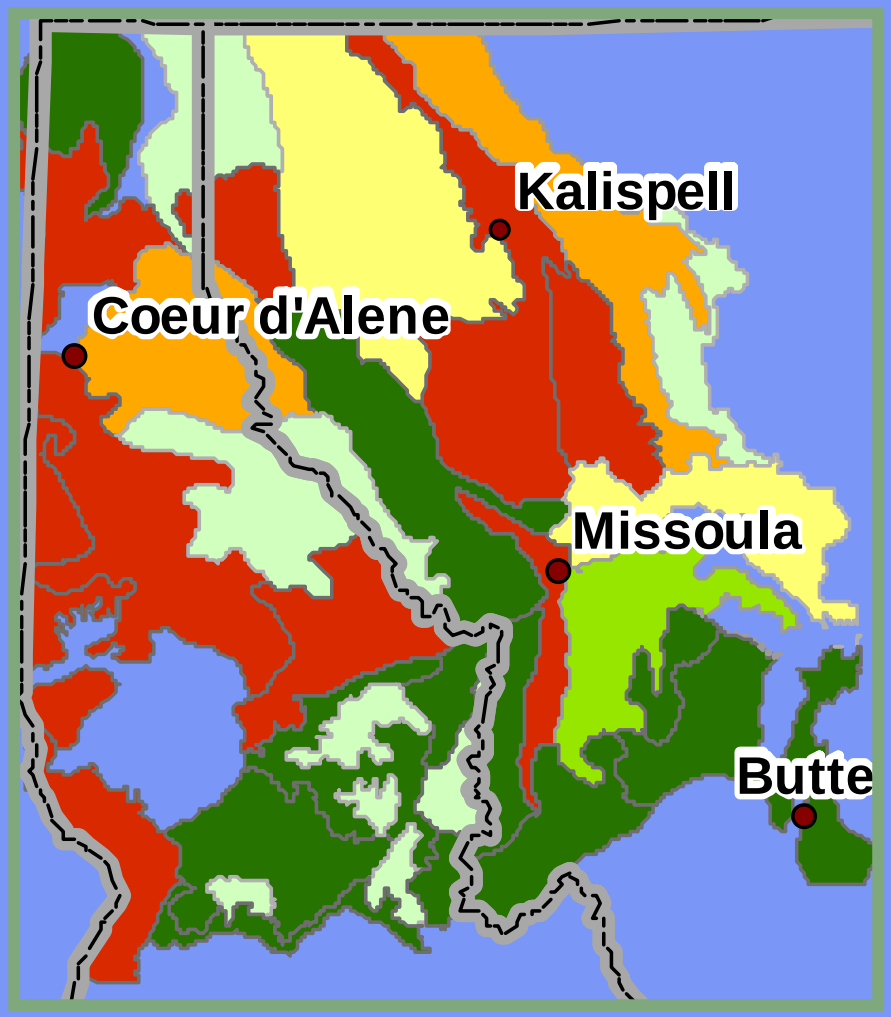
Kilometers

Fuzzy Double Ramp Function

(for evaluating proposition that old growth composition is within desired range of conditions)



Proposition: Composition of Old-growth Forests on Lower Subalpine Biophysical Settings is Within Desired Range of Conditions



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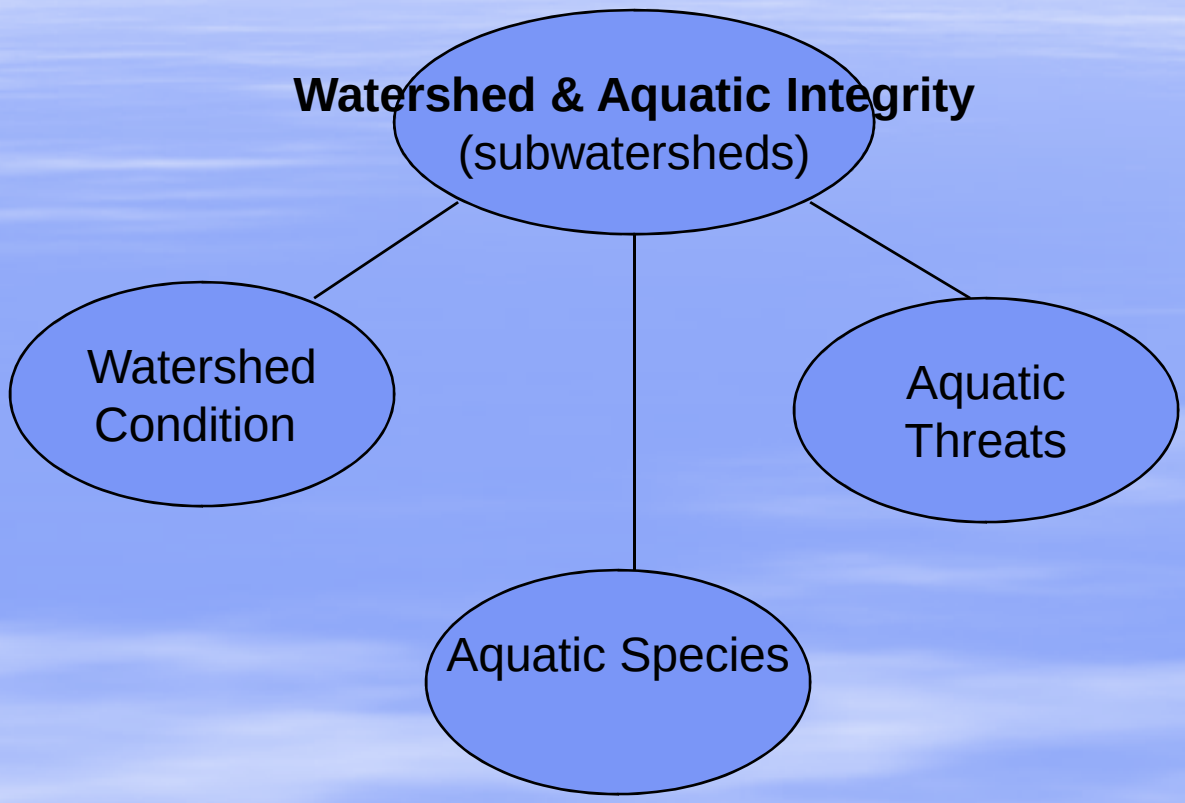
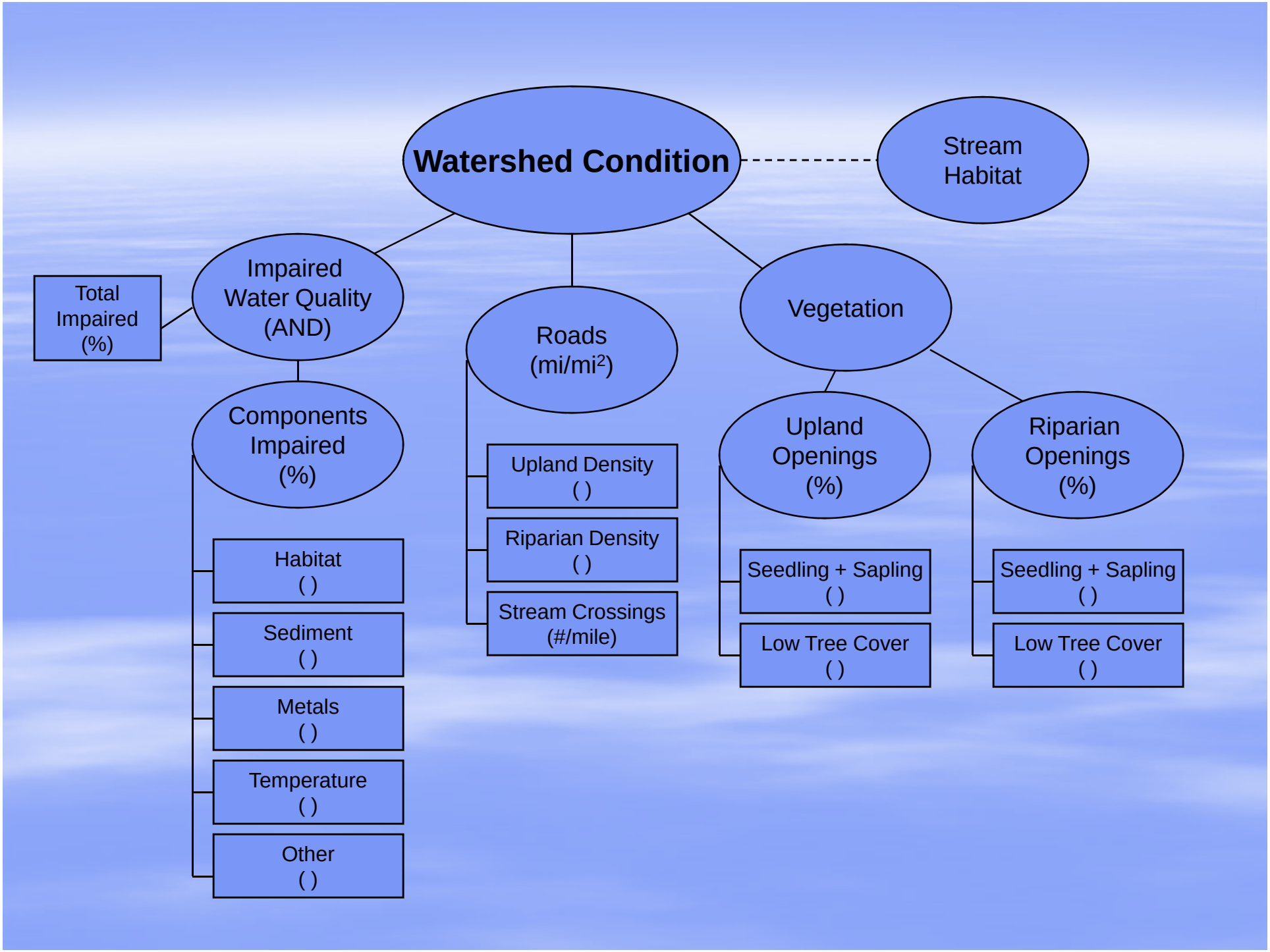
80 40 0 80

Kilometers

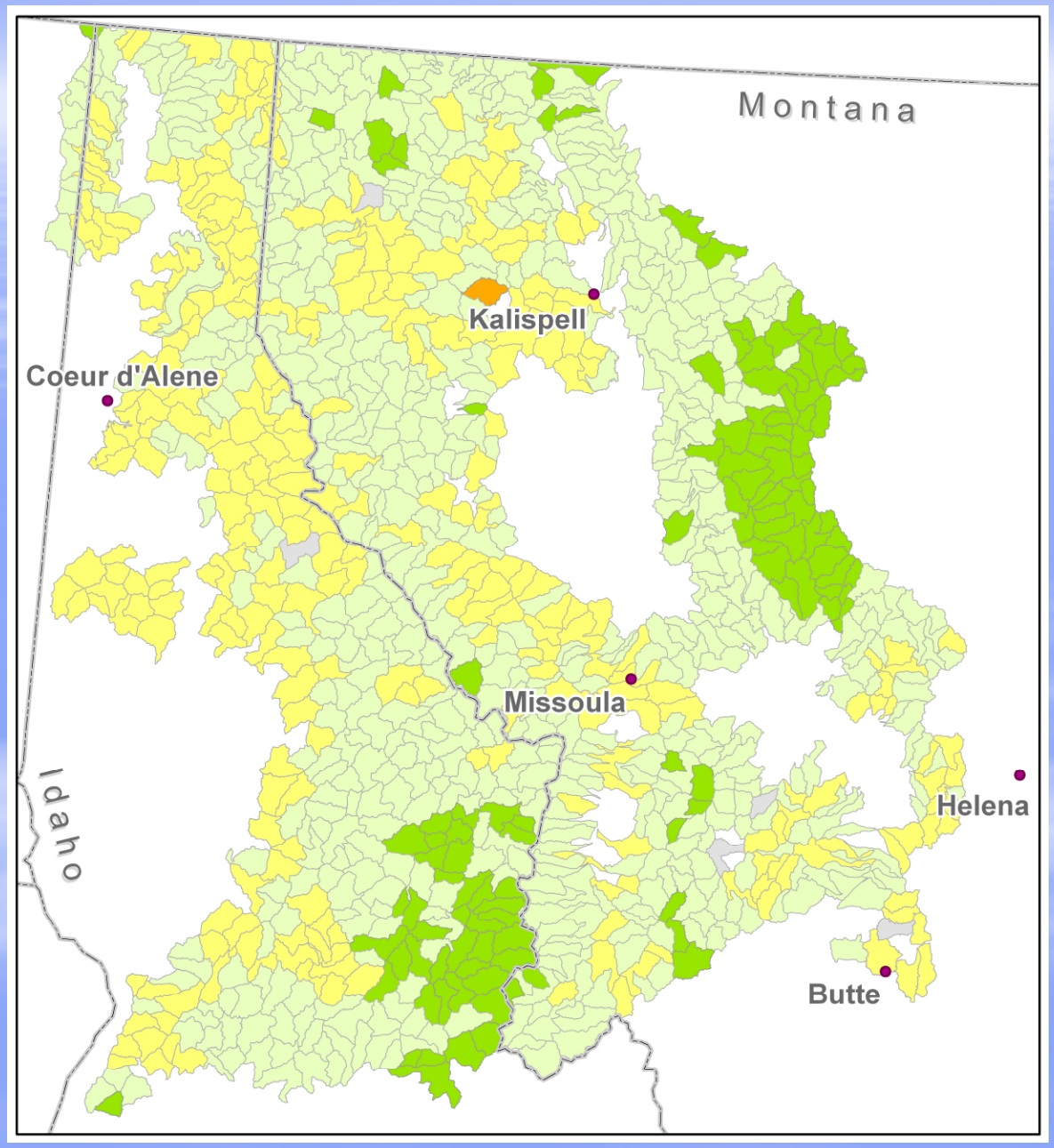
Unit: ecological subsection

- Some Watershed Integrity Proposition Examples


Watershed & Aquatic Integrity
(subwatersheds)
Watershed Condition
Aquatic Threats
Aquatic Species


Watershed Condition
Stream Habitat
Impaired Water Quality (AND)
Total Impaired (%)
Components Impaired (%)
Habitat ( )
Sediment ( )
Metals ( )
Temperature ( )
Other ( )
Roads (mi/mi²)
Upland Density ( )
Riparian Density ( )
Stream Crossings (#/mile)
Vegetation
Upland Openings (%)
Seedling + Sapling ( )
Low Tree Cover ( )
Riparian Openings (%)
Seedling + Sapling ( )
Low Tree Cover ( )

AQUATIC INTEGRITY is High



Proposition Support Level

- No Support
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- Low Support
- Undetermined
- Moderate Support
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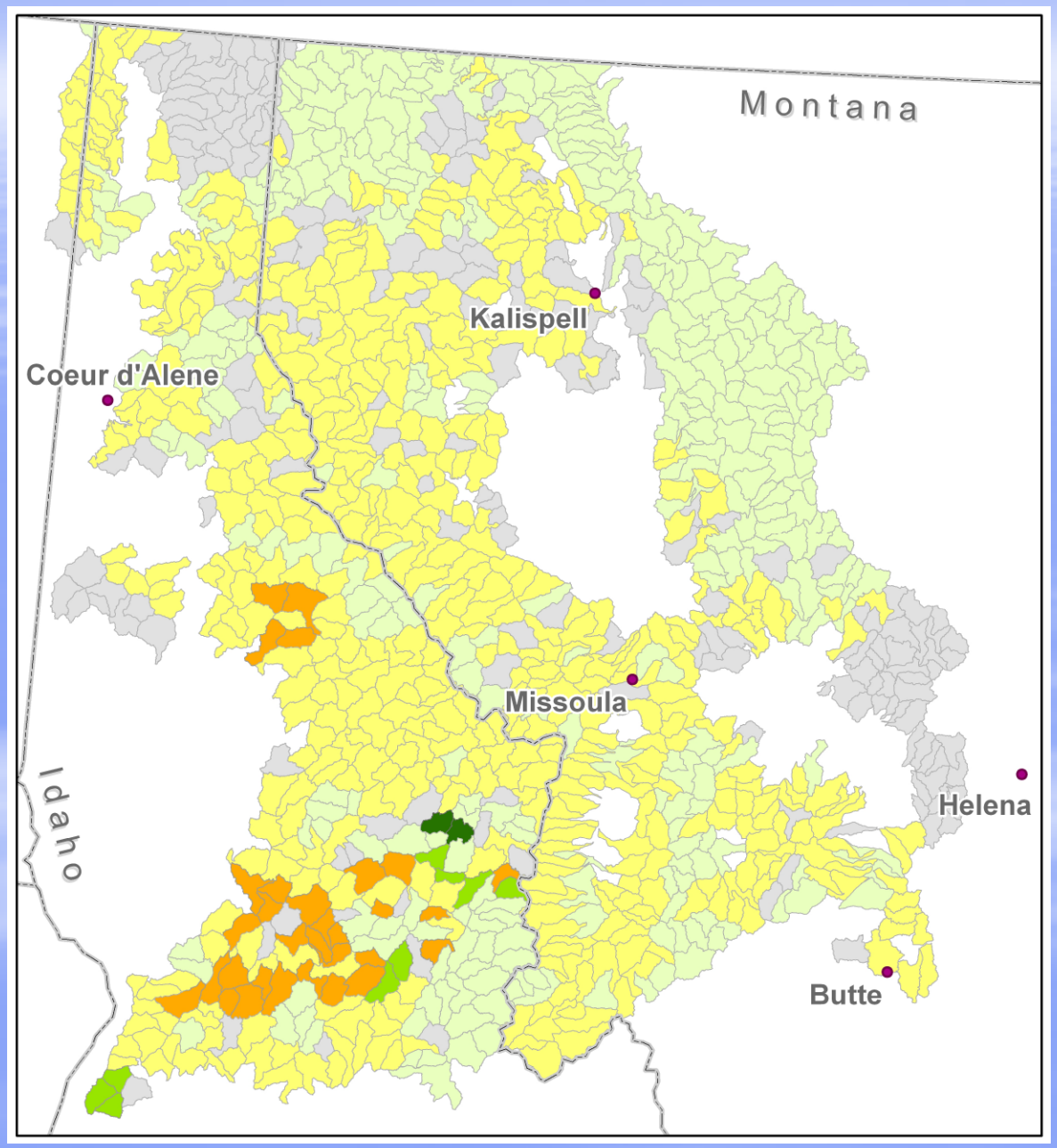
FISH SPP DIVERSITY is High



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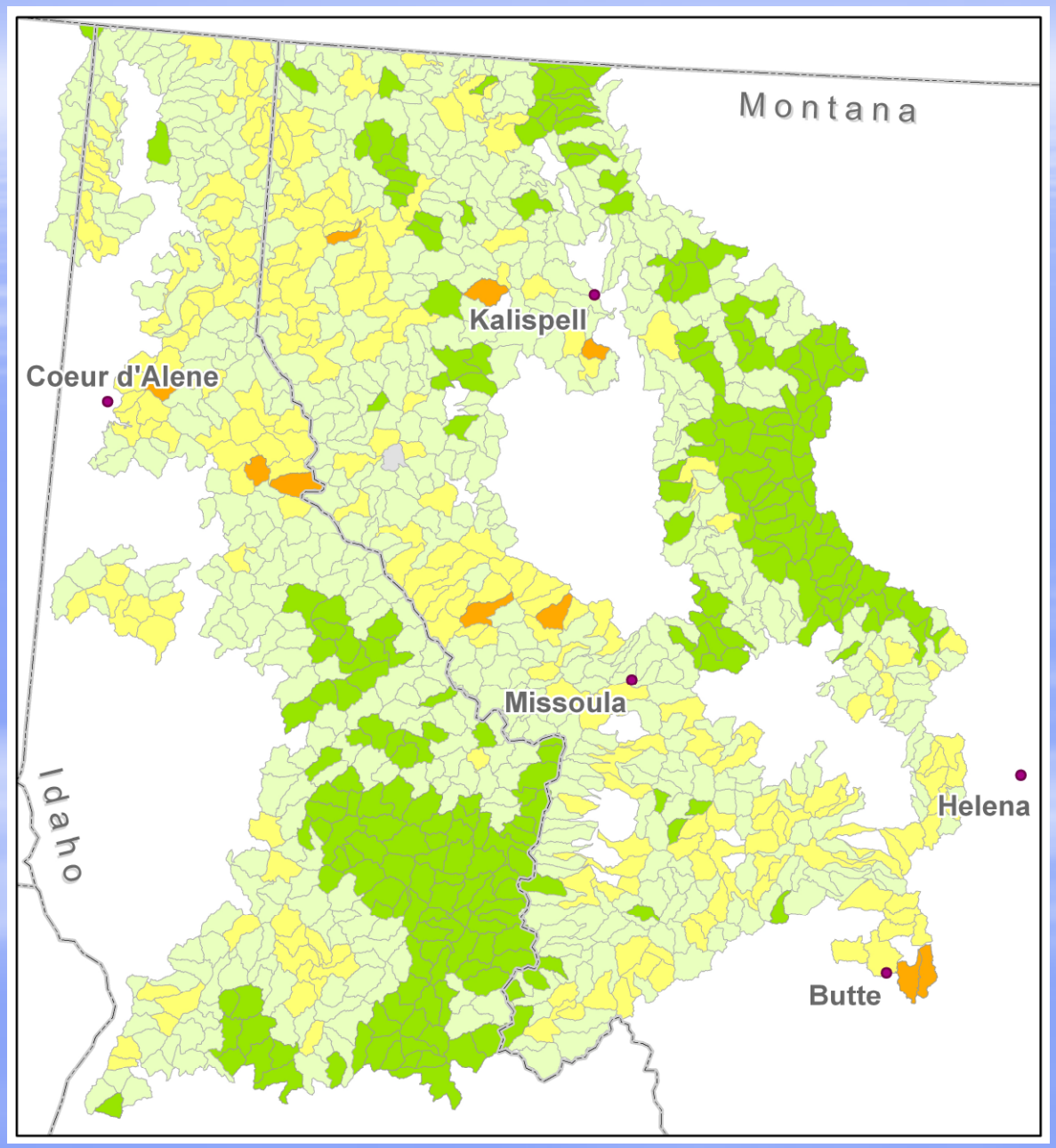
AQUATIC THREATS are Low



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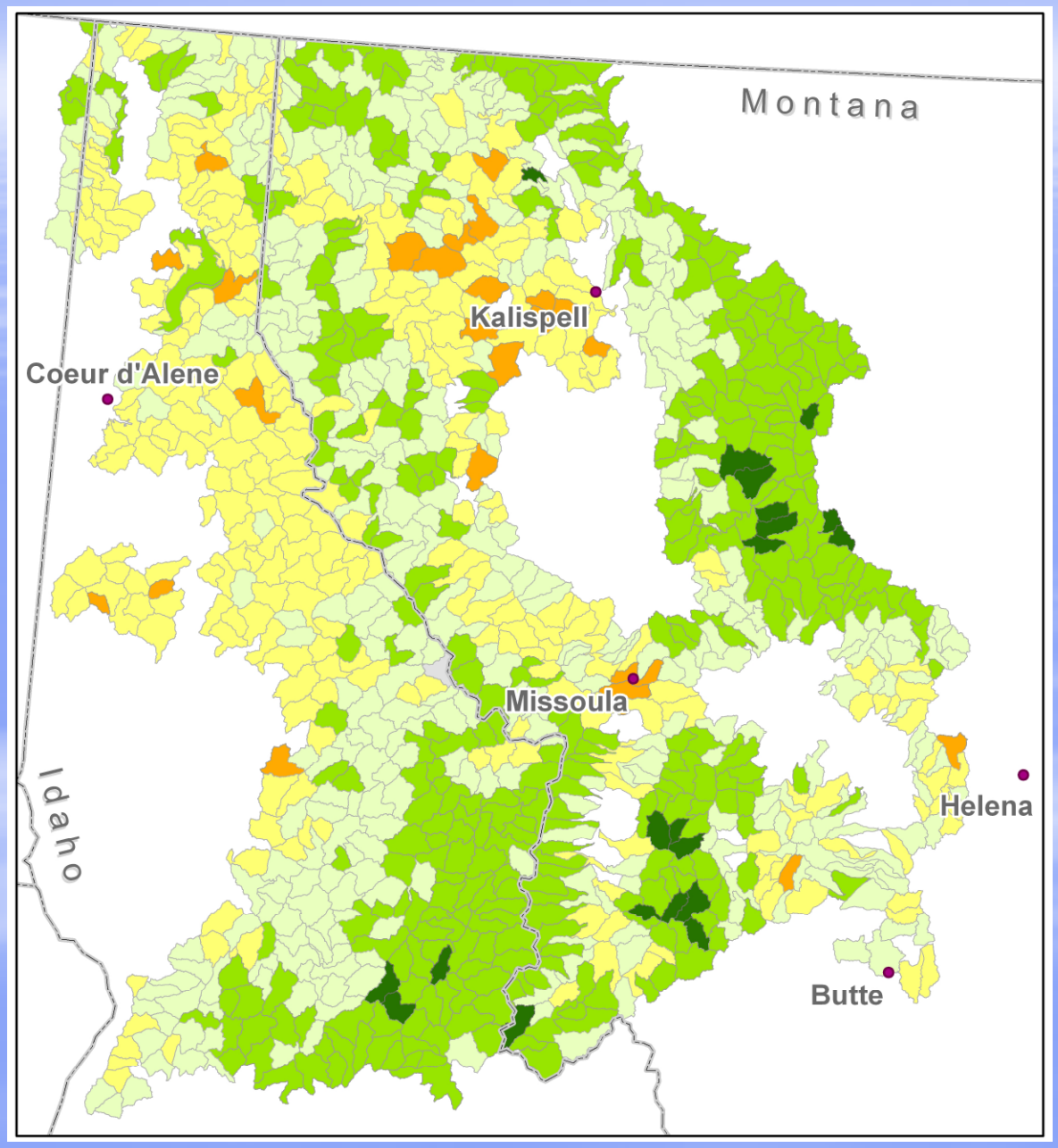
WATERSHED CONDITION is Good



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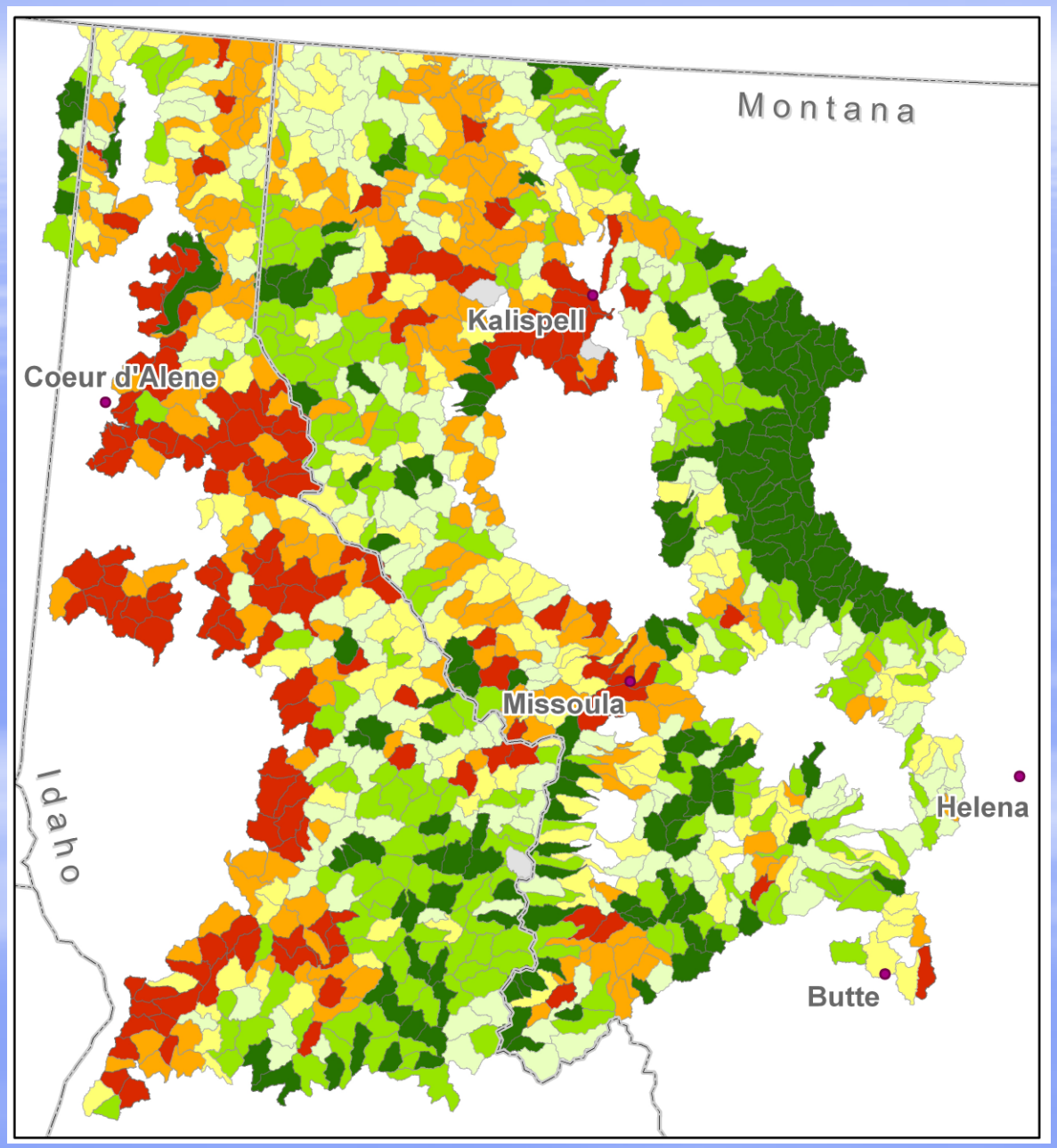
Low Road Density and Stream Crossings



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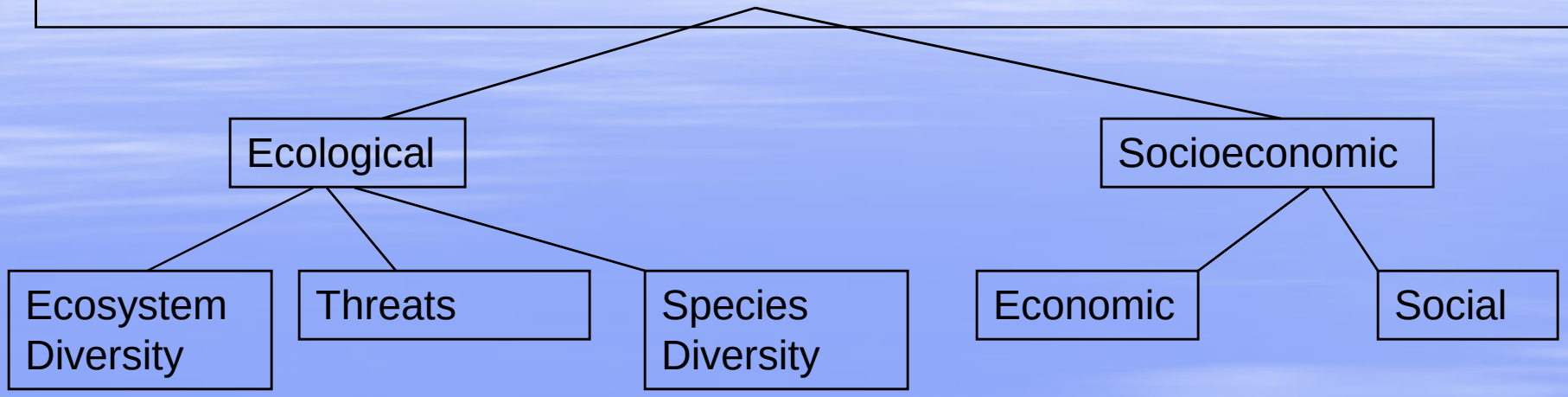
R1 Knowledge Base Design for the Evaluation of Desired Conditions in Forest Planning

Ecosystem Sustainability



Overview of NetWeaver logic model designs used to evaluate ecosystem sustainability.

NetWeaver model (cartographic base)	*Primary propositions*	*# Sub-propositions evaluated*	*# Data links evaluated*
Aquatic integrity (subwatershed)	Subwatershed condition is good	19	13
	Fish species status is strong	8	8
	Threats to subwatershed are low	17	12
Terrestrial integrity (ecological subsection)	Vegetation ecosystem diversity is high	156	76
	Wildlife species habitat diversity is high	9	9
	Threats to ecological subsection are low	19	13
Fire danger (subwatershed)	Fire hazard is low	8	5
	Fire behavior is acceptable	5	4
	Fire regime is acceptable	4	3
	Ignition risk is low	8	5
Social opportunity spectrum (subwatershed)	Potential for commercial uses is high	6	5
	Diversity of commercial uses is high	6	5
	Primitive recreation opportunity is high	5	5
	Developed recreation opportunity is high	5	5
	Recreation opportunity diversity is high	5	5
	Special area diversity is high	10	9
	Infrastructure capacity is high	24	17
Economic integrity (National Forest)	Economic opportunity is high	7	6
	Overall jobs and income are high	6	4
	Component jobs and income are high	22	14

Selected results of NetWeaver evaluations

Evidence that:

A) subwatershed condition is good;

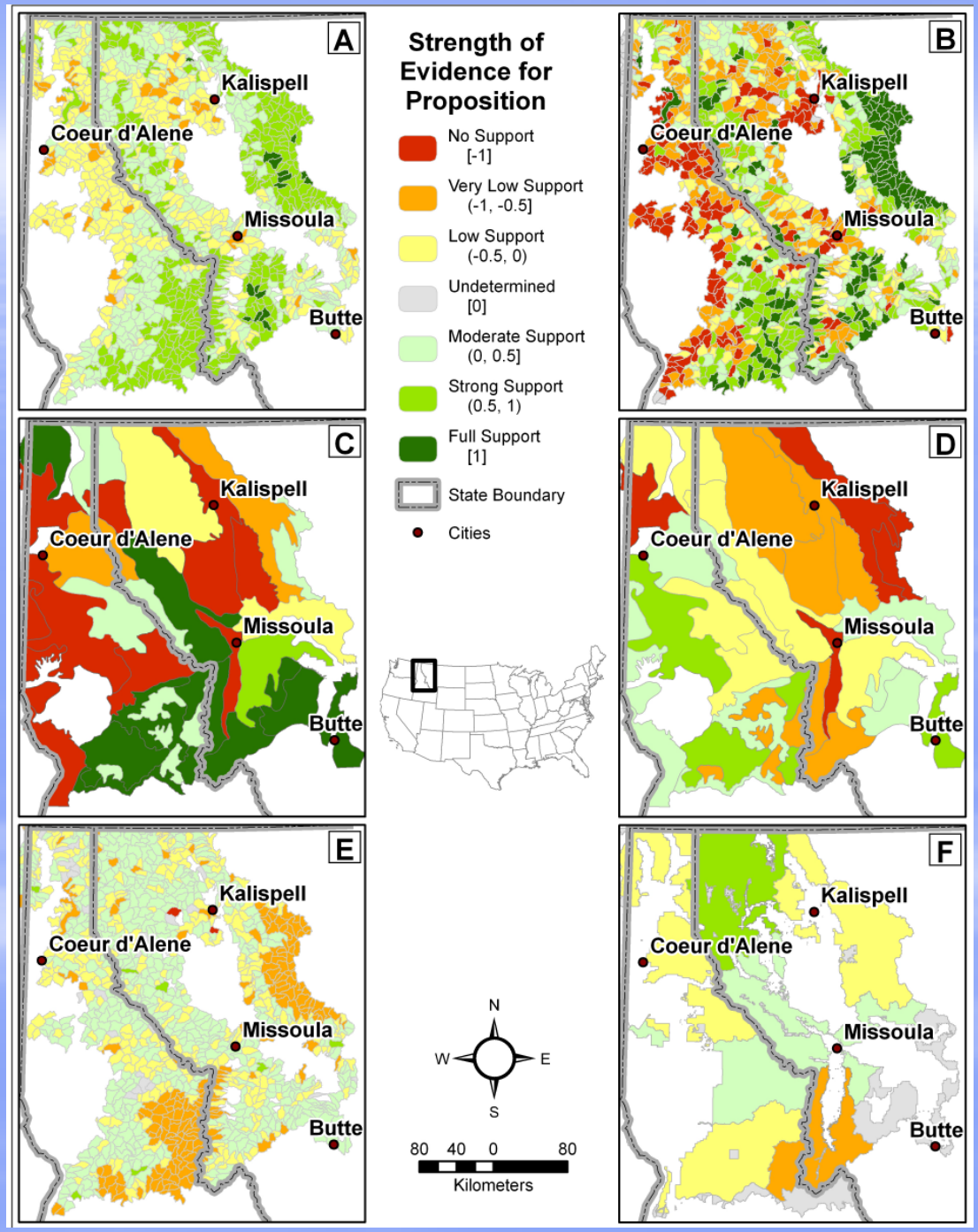
B) road density and number of stream crossings within a subwatershed are low;

C) composition of old-growth forests on lower subalpine biophysical settings within an ecological subsection is within desired range of conditions;

D) an ecological subsection has a high proportion of goshawk habitat;

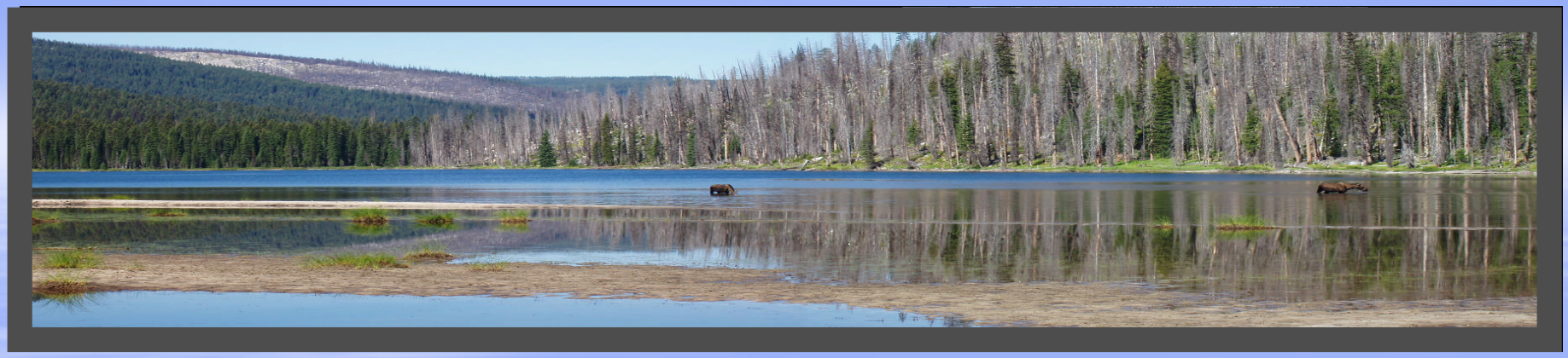
E) a subwatershed has high potential for developed recreation use; and

F) a National Forest has high economic opportunities.



Use of Decision Models in Integrated Landscape Protection and Restoration

- Brief Overview of R1 Integrated Restoration and Protection Strategy Objectives
- Example of How EMDS Evaluation and Decision Models can be Applied to this Effort



Integrated Restoration and Protection Strategy

Northern Region's Strategy to Protect and Restore Fire Adapted Landscapes and Watersheds

Our Resource Focus

- **Restore** and maintain high value **watersheds**
- **Restore** and maintain **wildlife** habitats
- **Protect communities** and developments

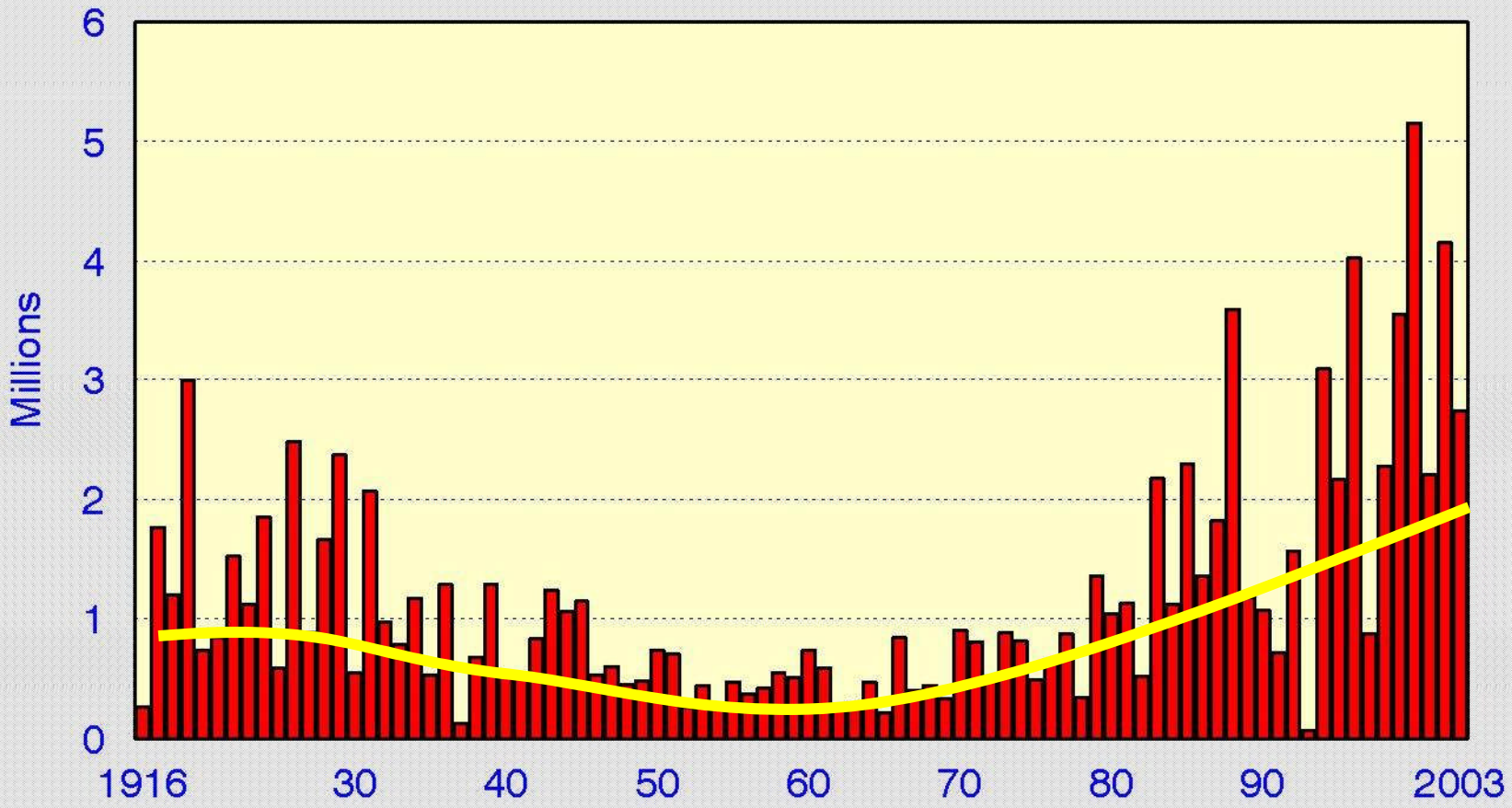
Our Management Focus

- **Effective integration at various levels, within the agency and with our neighbors**
- **Transparent, effective priority setting process given information at multiple scales**
- **Leading to being more effective at answering the questions: Why here? Why now?**

Highlighted Risk Agents

- Drought
- Bark beetles
- Invasive plant and animal species
- Forest encroachment into grasslands
- Erosion and sedimentation, and toxic chemicals
- Uncharacteristically dense vegetation that creates hazardous fuel conditions susceptible to large wildfire
- Climate change will increase disturbance

Wildfire Acres Burned in the 11 Western States*



* California, Oregon, Washington, Idaho, Nevada, Arizona, Utah, New Mexico, Colorado, Wyoming, Montana
2001 includes all geographic areas from NIFC data

Highlighted Resource Values At Risk

- Community infra-structure
- Municipal watersheds
- Watersheds and fish habitat
- Wildlife habitat, including resilient vegetation conditions, especially big game winter range

- Use of EMDS Decision Models in the Identification of Priority Areas for Integrated Landscape Restoration

Decision Model

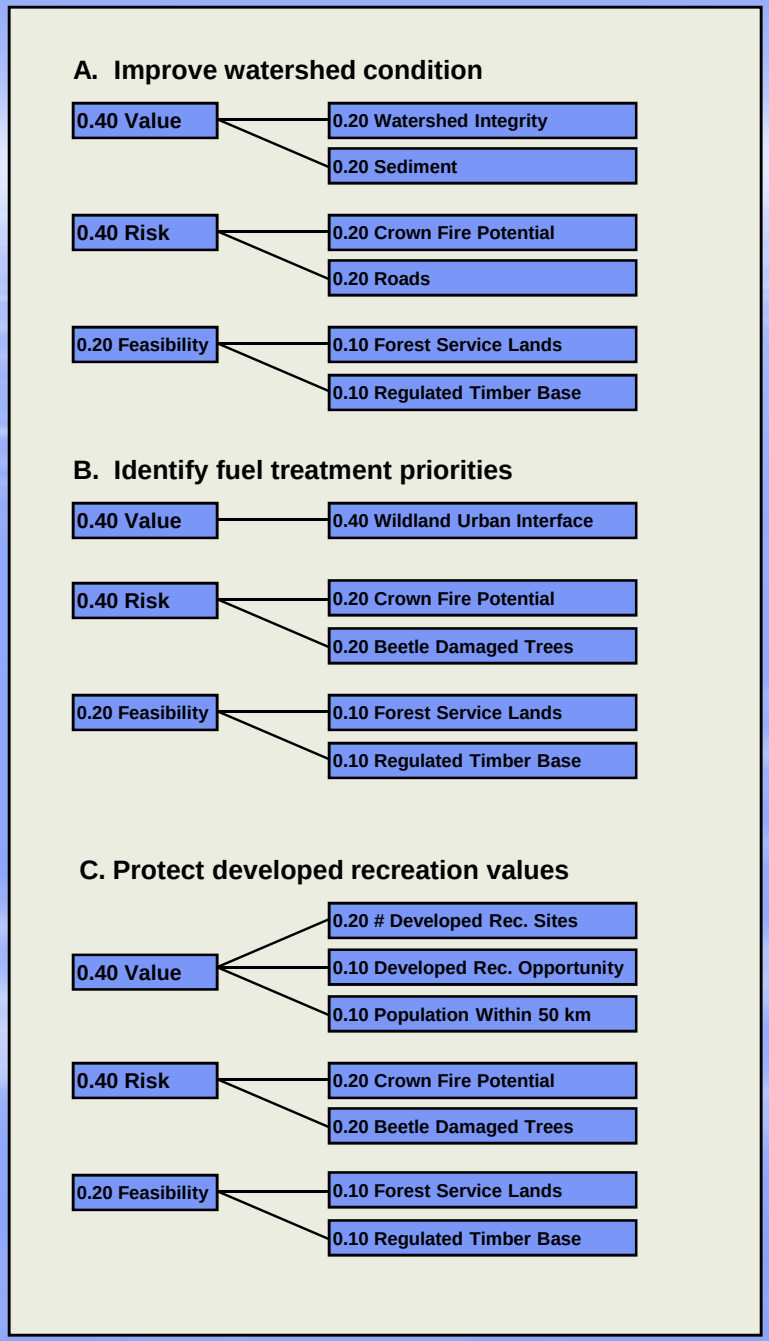
- May use Net Weaver Assessment Results and other information (e.g. risks, feasibility, etc…)
- Decision maker selects variables of interest
- Decision maker assigns weights to variables (as appropriate)
- May develop multiple decision models (scenarios) to reflect different resource concerns and public interests
- Output displays most efficient areas for treatment and criteria for their selection

Steps For Building a Decision Model

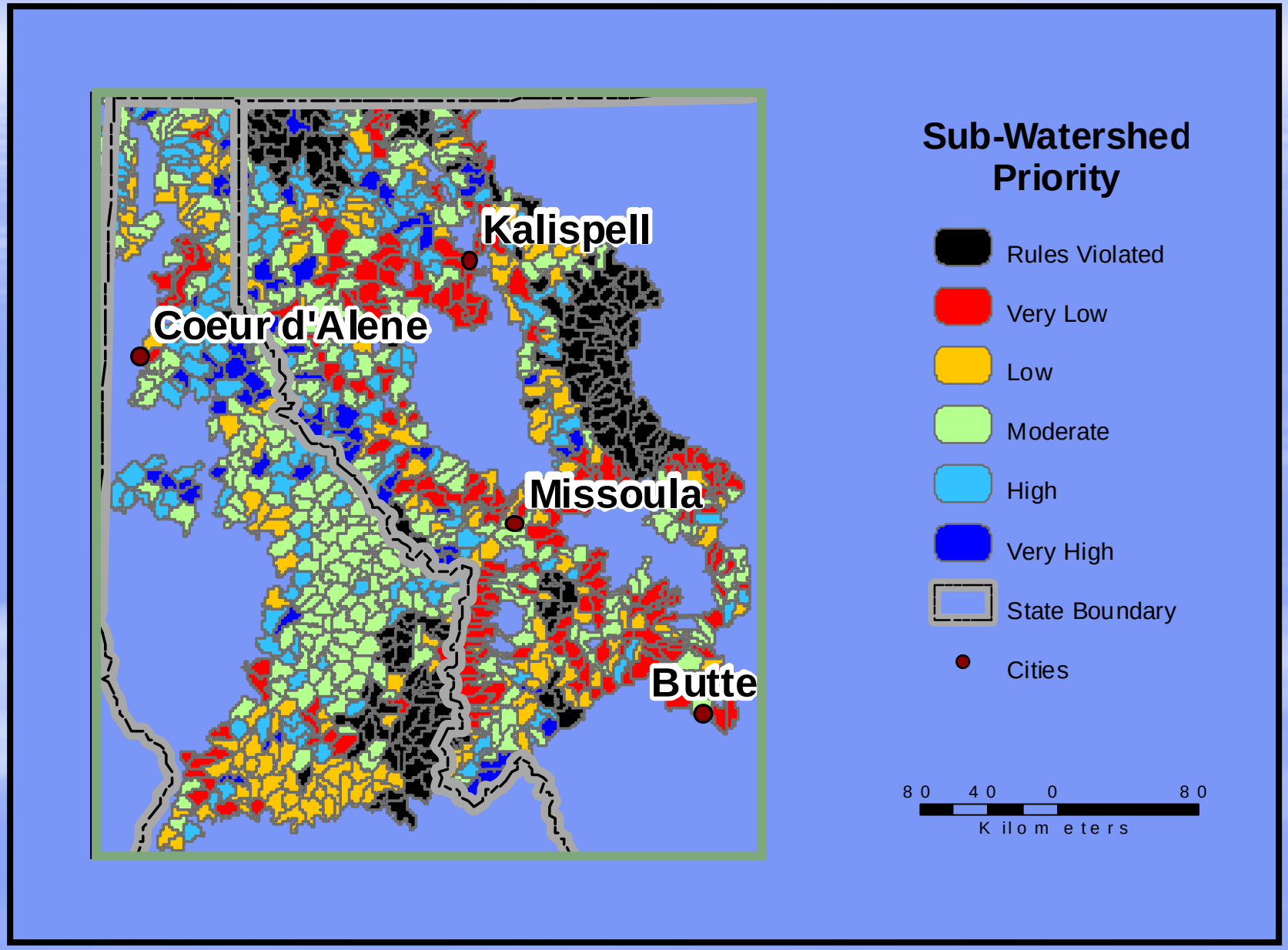
1. Identify the integration unit to be used in map display (e.g., sub watersheds)
2. Identify the scenario to be evaluated (e.g., watershed condition improvement, fuel reduction, etc)
3. Identify the information to be used in scenario evaluation (e.g., values, risks, and feasibility)
4. Assign weights to the information used to reflect the objectives of the scenario
5. Generate map of high priority treatment areas

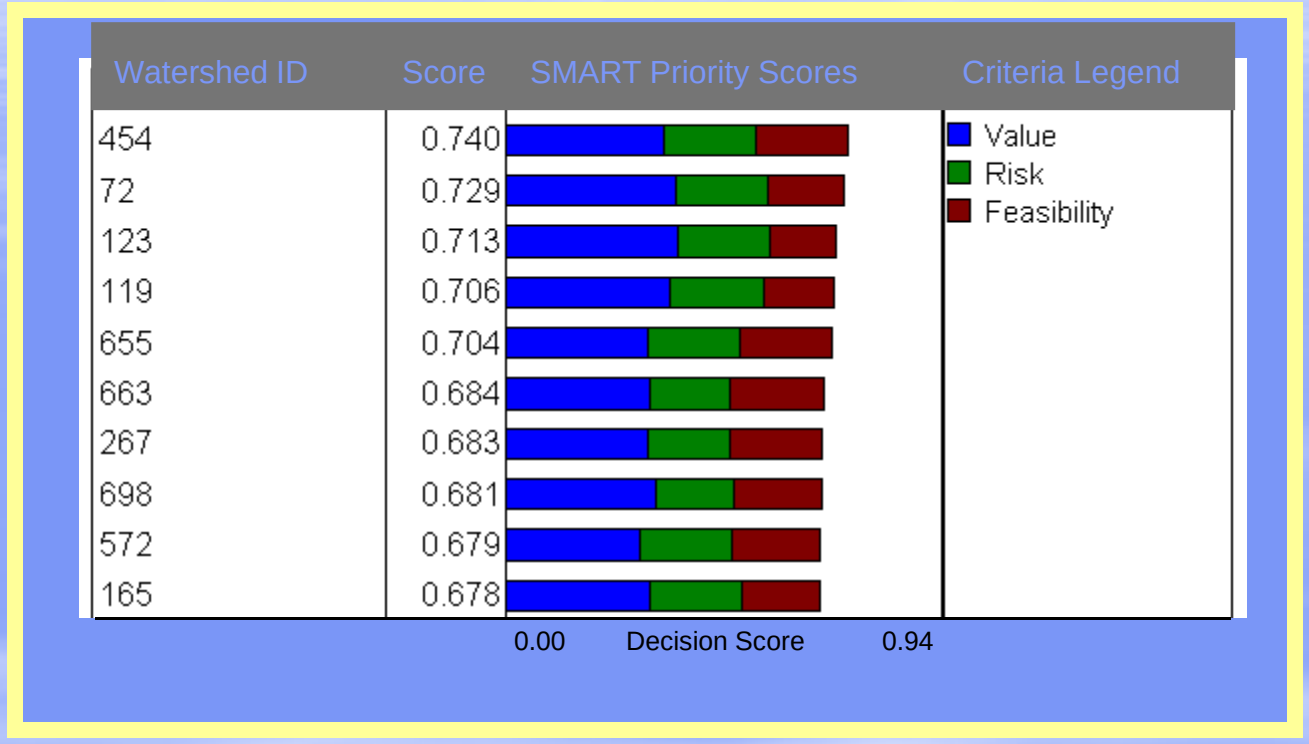
Scenario Examples

Decision models for selecting subwatershed priority treatment areas.



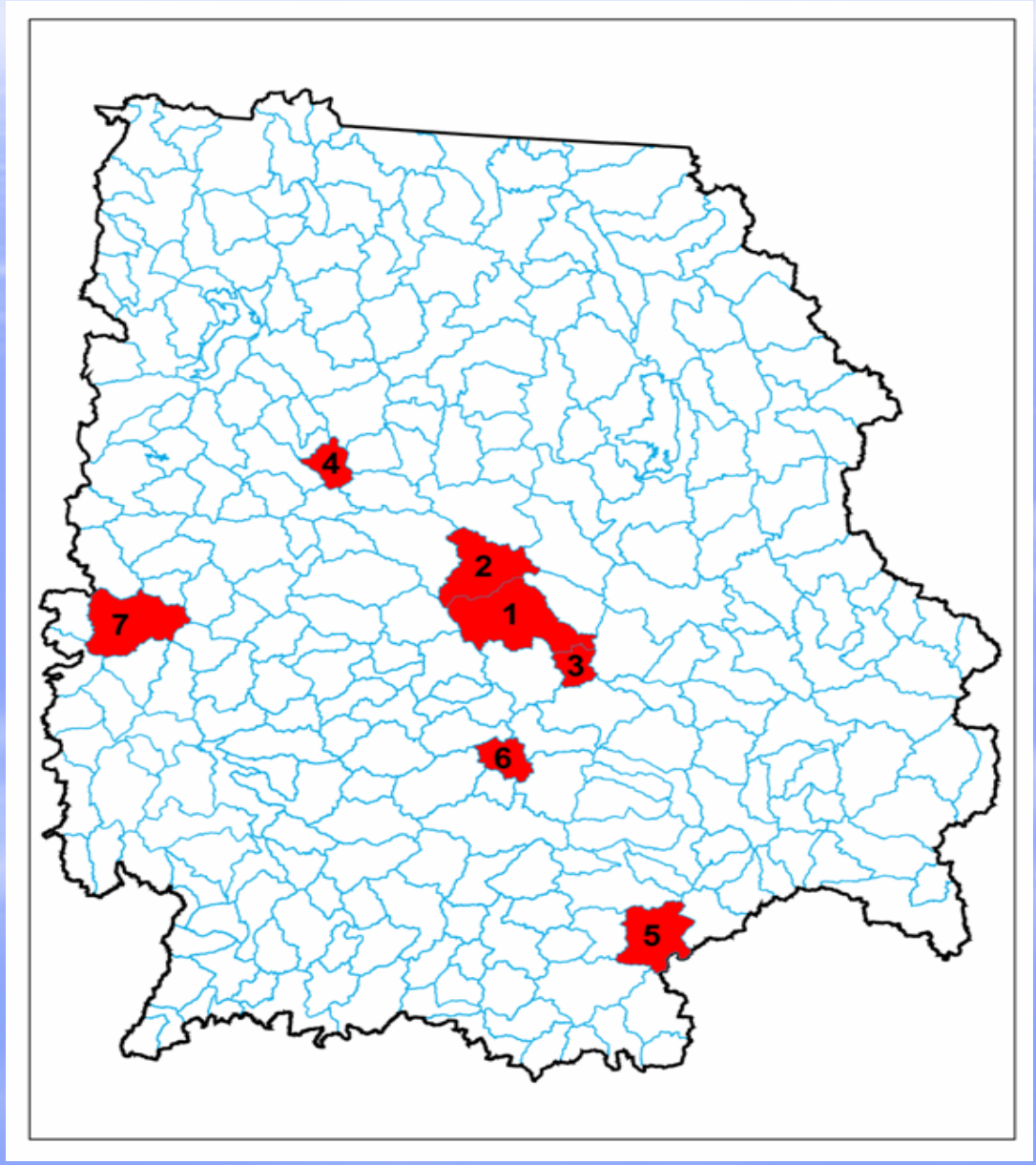
CDP Scenario Results: Priorities for Improving Watershed Condition



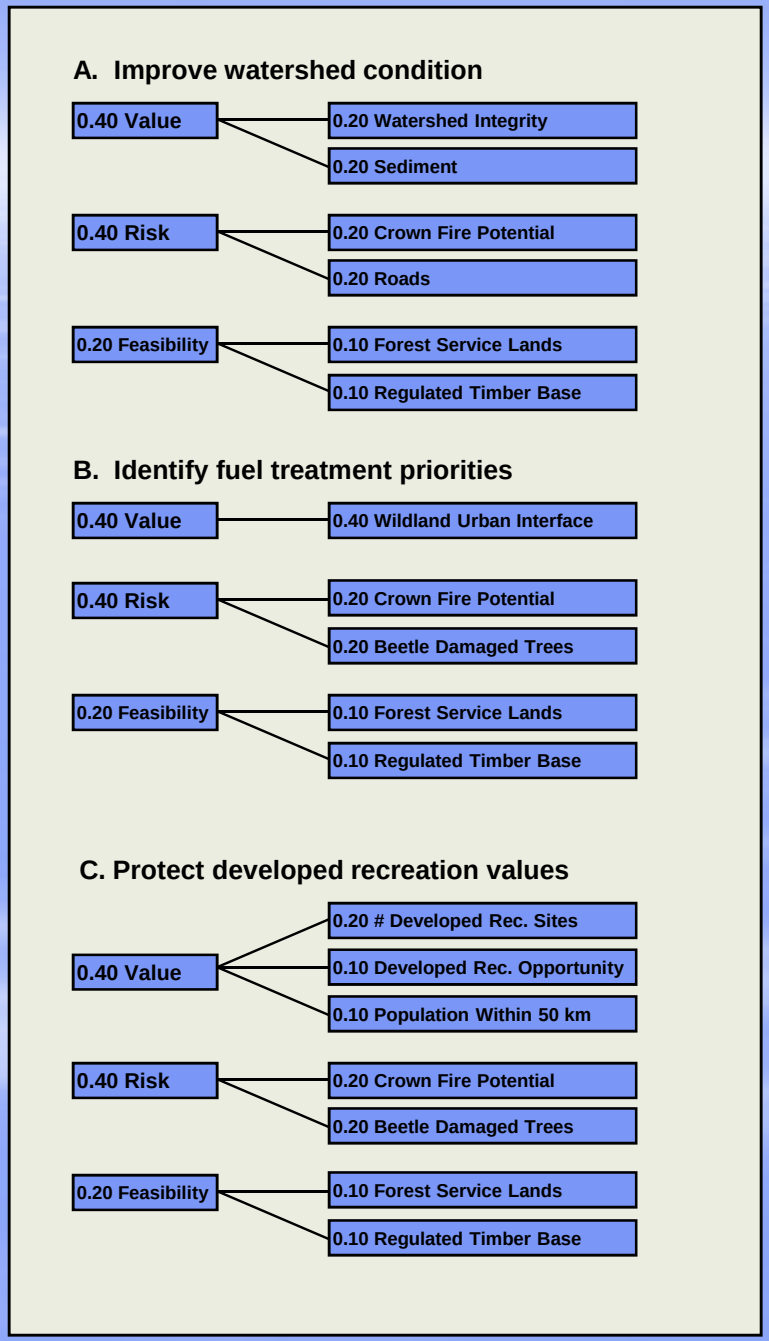


Highest priority subwatersheds for improvement of watershed condition.

Top 7 Priority Watersheds



Decision models for selecting subwatershed priority treatment areas.



CDP Scenario Results – Landscape Restoration

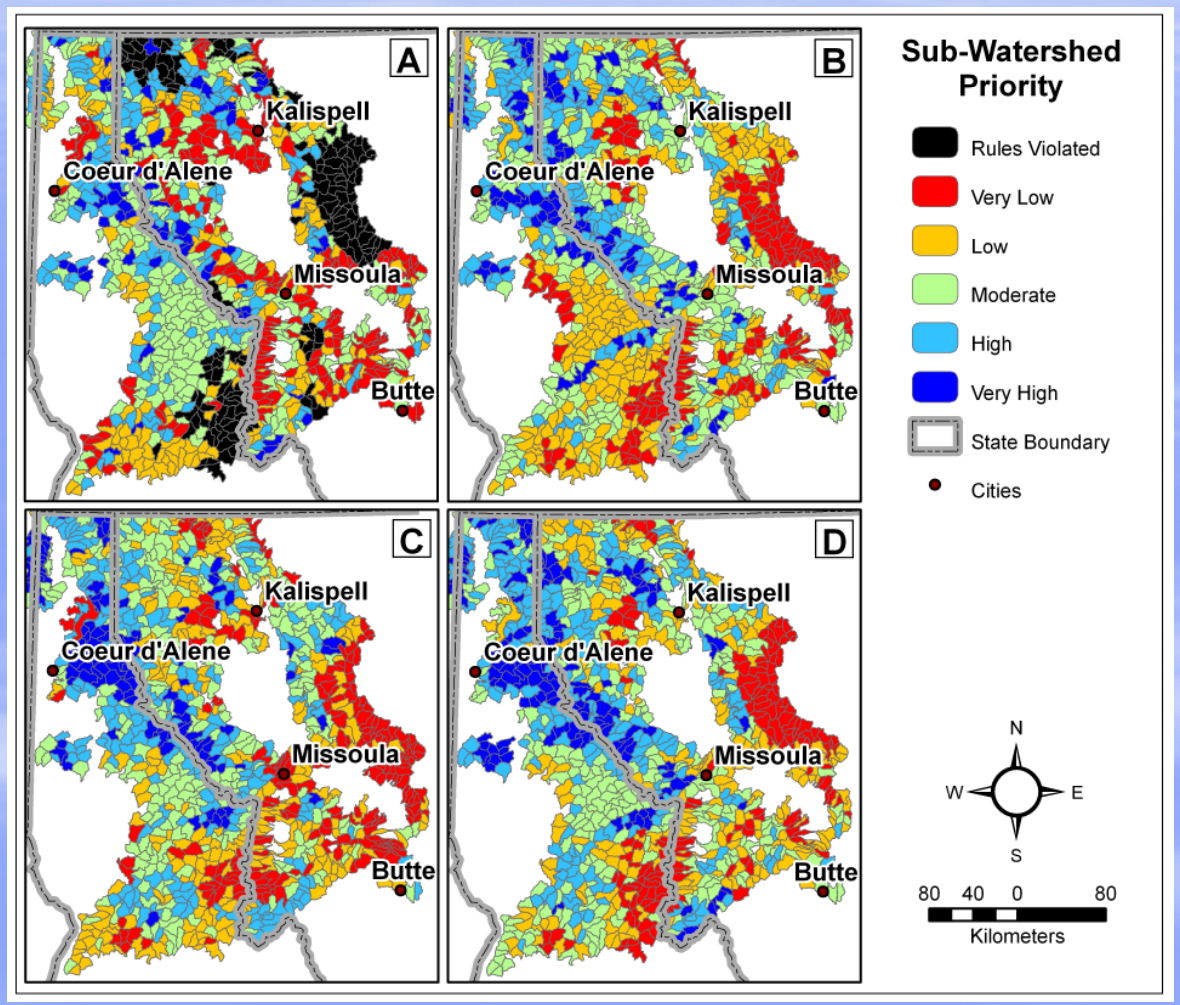
Suggested priorities for:

A) improving watershed condition,

B) hazardous fuel reduction in the wildland-urban interface,

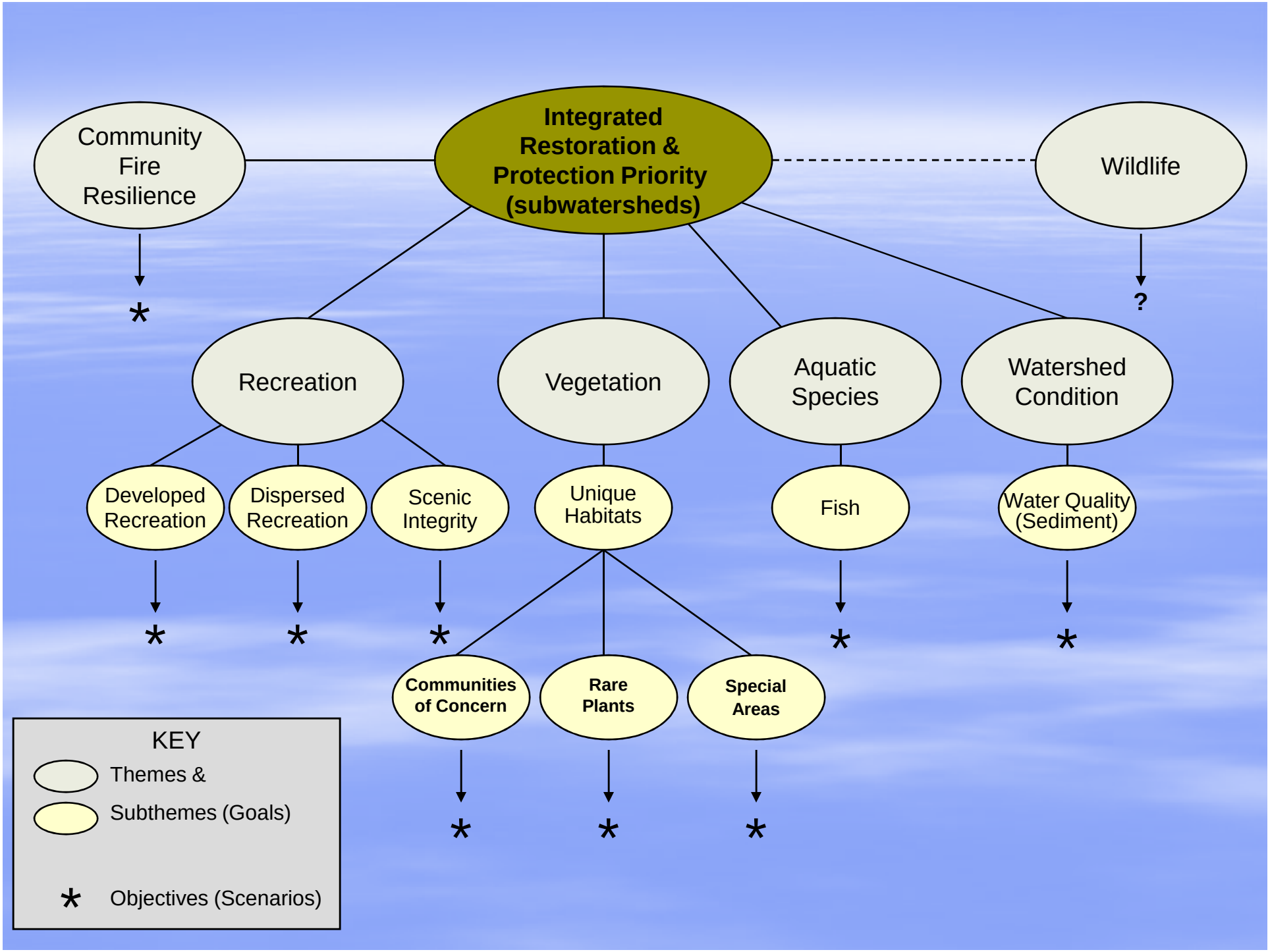
C) minimizing fire and bark-beetle hazards within areas with high developed recreation opportunities, and

D) composite priority scores averaged across all three decision models (A + B + C).



Other potential scenarios

- Improvement of watershed condition
- Improvement of bull trout habitat
- Protection of USFS infrastructure investments in fire prone areas
- Protection of private homes and infrastructure in WUI
- Improve species habitat for species of concern and interest
- Others?


Integrated Restoration & Protection Priority (subwatersheds)
Community Fire Resilience
Wildlife
Recreation
Vegetation
Aquatic Species
Watershed Condition
Developed Recreation
Dispersed Recreation
Scenic Integrity
Unique Habitats
Fish
Water Quality (Sediment)
Communities of Concern
Rare Plants
Special Areas
?
KEY
Themes &
Subthemes (Goals)
Objectives (Scenarios)

Discussion Time