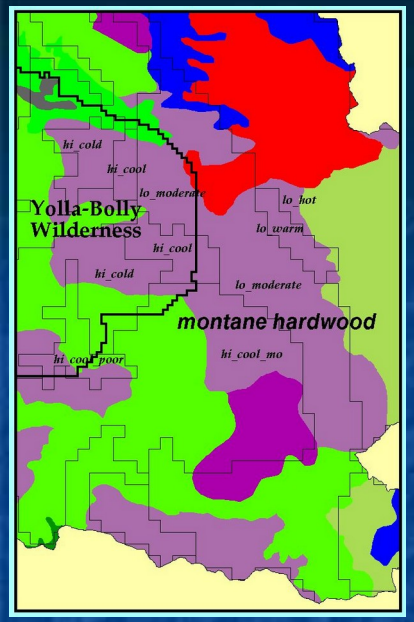
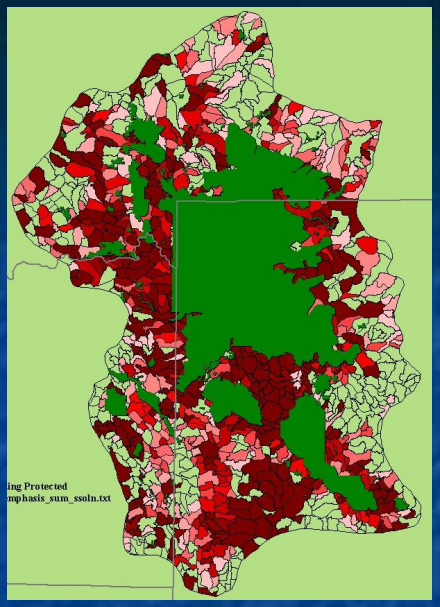
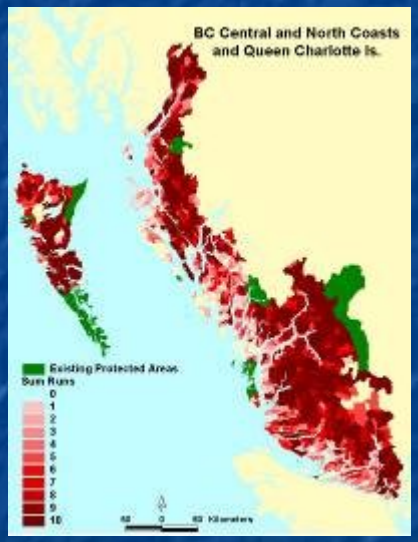
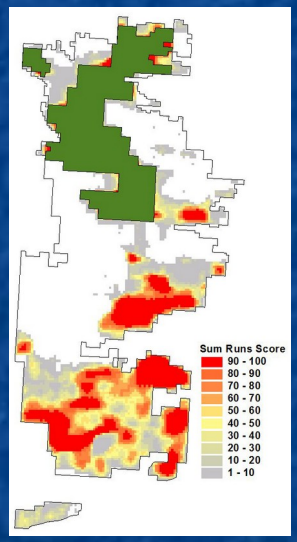


Conservation Planning and GIS







Ken Vance-Borland
The Conservation Planning Institute

A Burning Question:

Given that money for biodiversity protection is limited, where should it be invested for maximum benefit?



Conservation planning includes five stages

1. Gathering data on the locations of biodiversity components (species, communities, ecosystems, processes);
2. Assessing the extent to which biodiversity is represented in existing protected areas;
3. Identifying additional areas needed for full biodiversity protection;
4. Implementing protection of those areas; and
5. Monitoring protected areas to assure persistence of biological diversity over time.

Margules and Pressey. 2000. Systematic conservation planning. Nature 405:243-253.

A Conservation Plan for the Klamath-Siskiyou Ecoregion

Reed F. Noss, James R. Strittholt, Kenneth Vance-Borland, Carlos Carroll, and Pamela Frost

1999. Natural Areas Journal 19:392-411



The Noss 'Three-Pronged Approach':

- **Special Elements**
- Coarse-filter habitat representation
- Focal species

Criterion	G
G1/G2 species occurrences	
All heritage elements	
Late-seral forests	
Serpentine	
Port-Orford-cedar: High presence, low disease Mod. Presence, low disease	
Key watersheds	
Roadless areas (designated wilderness excluded)	
Representation: ≥ 10% ≥ 25% ≥ 50%	
High-quality fisher habitat	

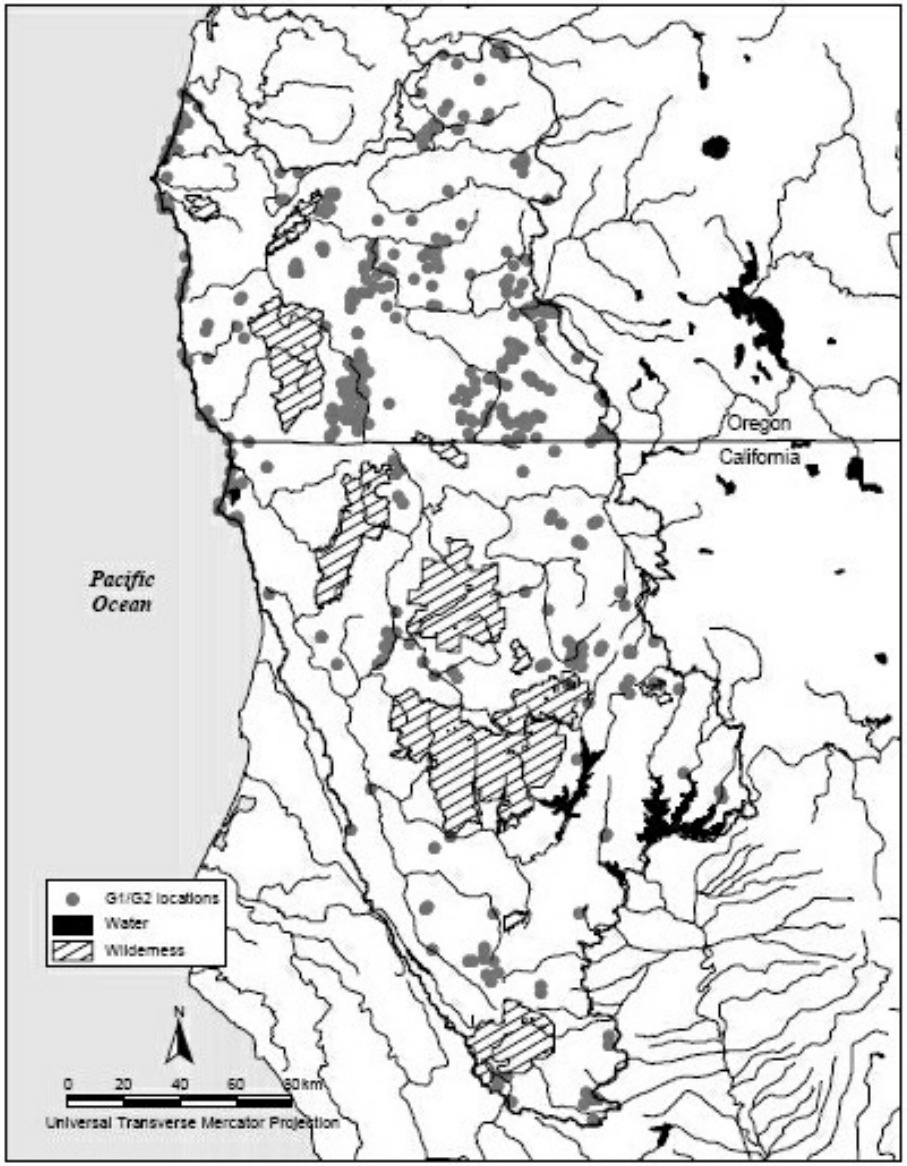


Figure 21. Known locations of G1/G2 species occurrences on public land within the Klamath-Siskiyou study area.

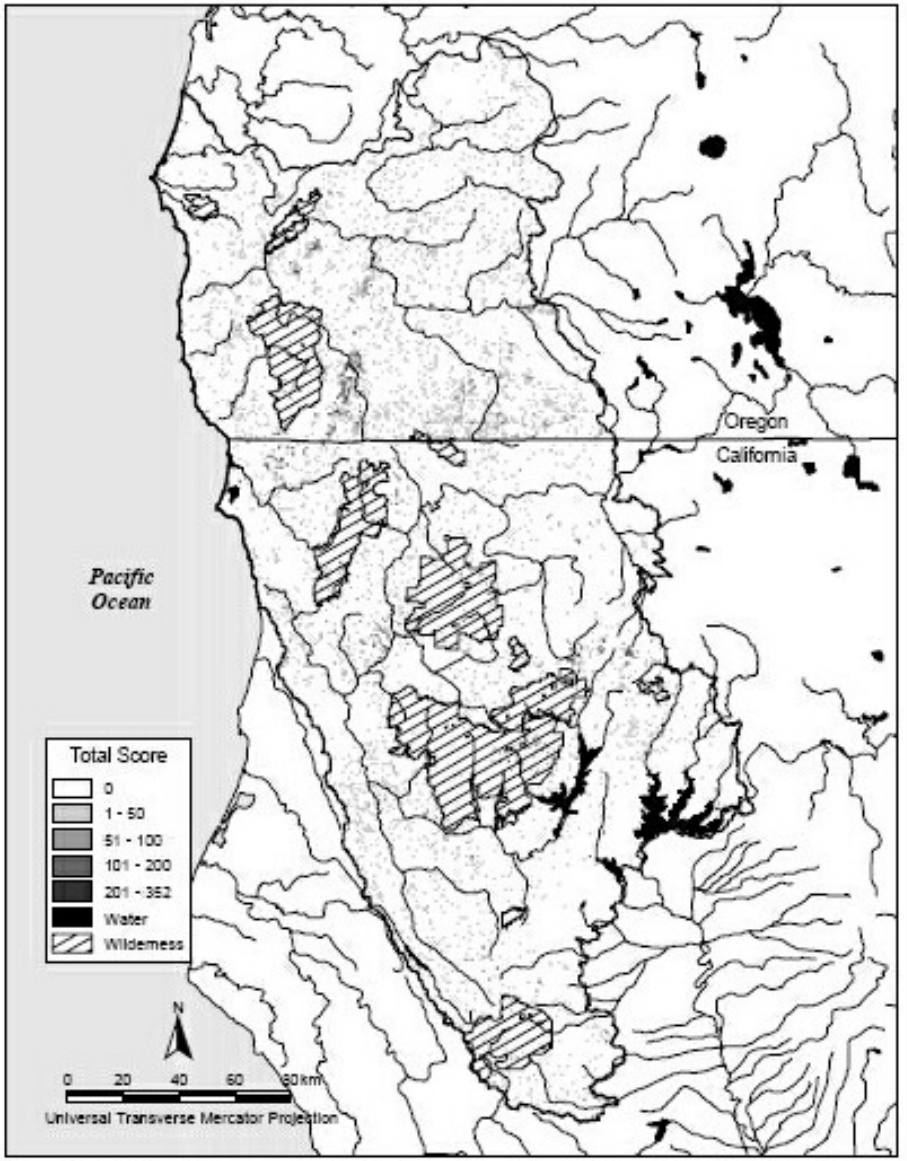


Figure 19. Total heritage score organized by 1km x 1km grid cells for the Klamath-Siskiyou study area.

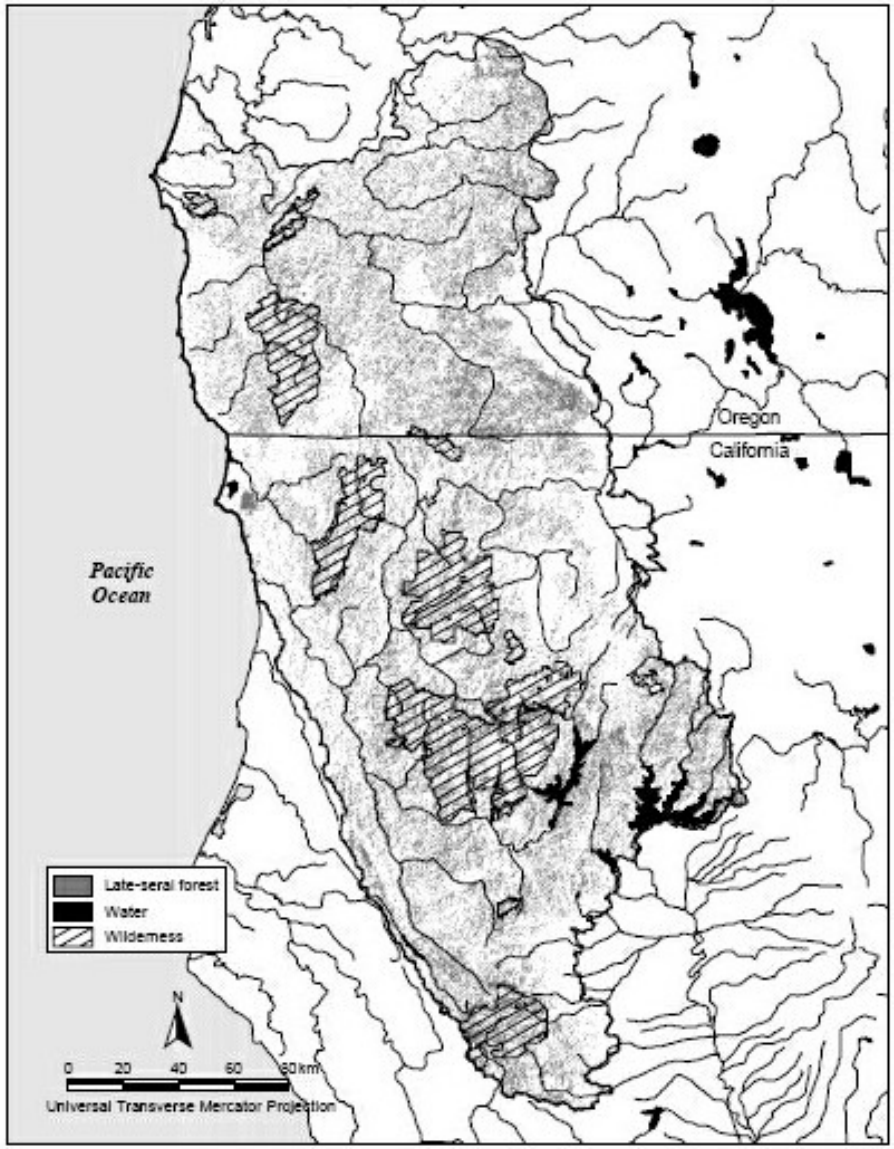


Figure 22. Late-seral forest distribution throughout the Klamath-Siskiyou study area based on 30m x 30m resolution satellite imagery (1994-95).

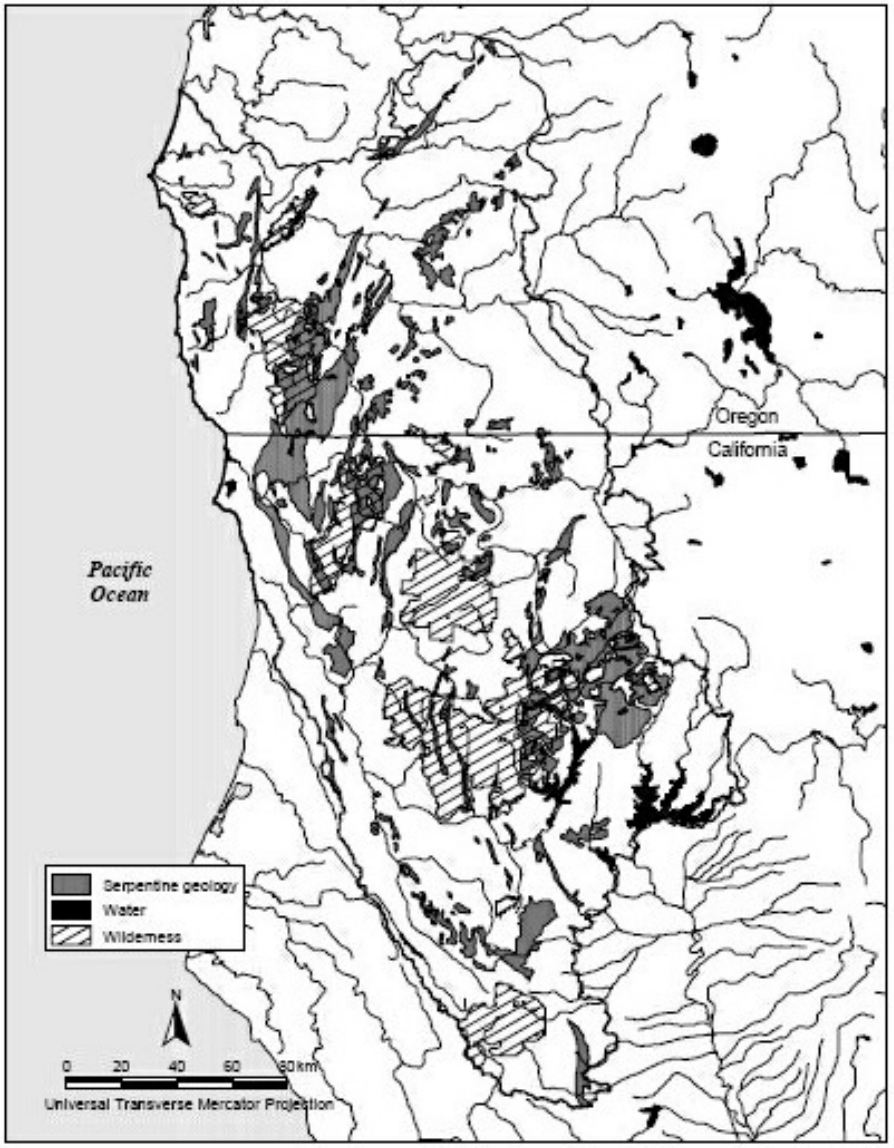


Figure 25. Serpentine geology within the Klamath-Siskiyou study area displayed with wilderness areas.

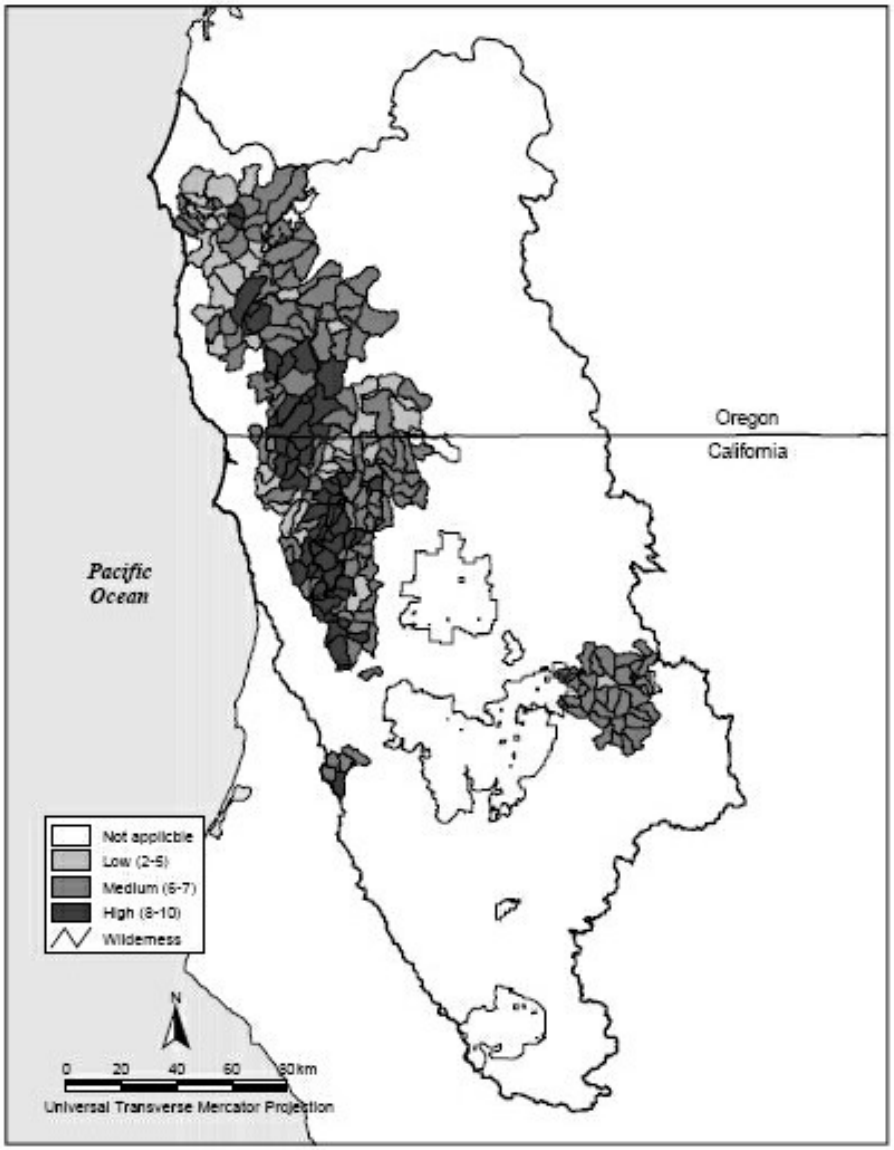


Figure 37. Priority protection subwatersheds for Port-Orford-cedar conservation within the Klamath-Siskiyou study area.

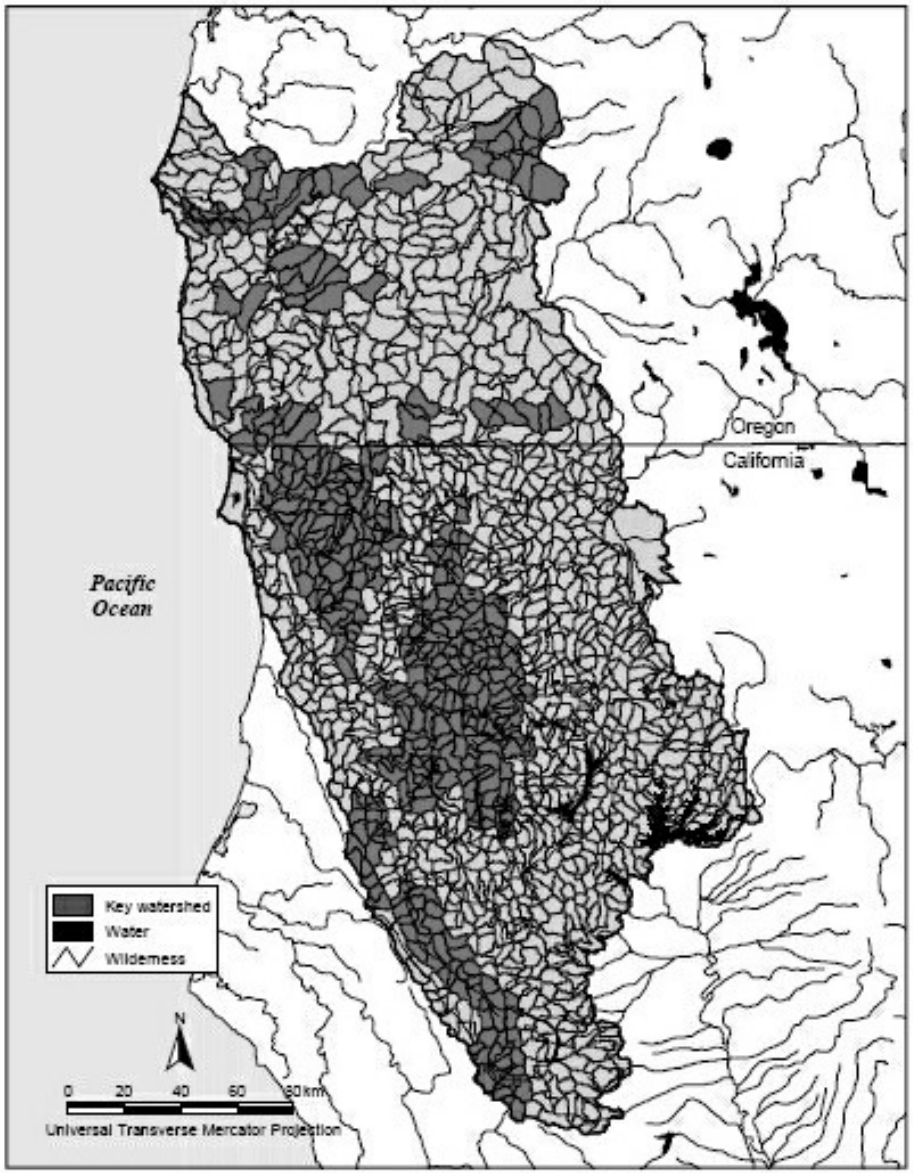


Figure 39. Key watersheds identified by FEMAT (1993) for the Klamath-Siskiyou study area.

Criterion	G
G1/G2 species occurrences	
All heritage elements	
Late-seral forests	
Serpentine	
Port-Orford-cedar: High presence, low disease Mod. Presence, low disease	
Key watersheds	
Roadless areas (designated wilderness excluded)	

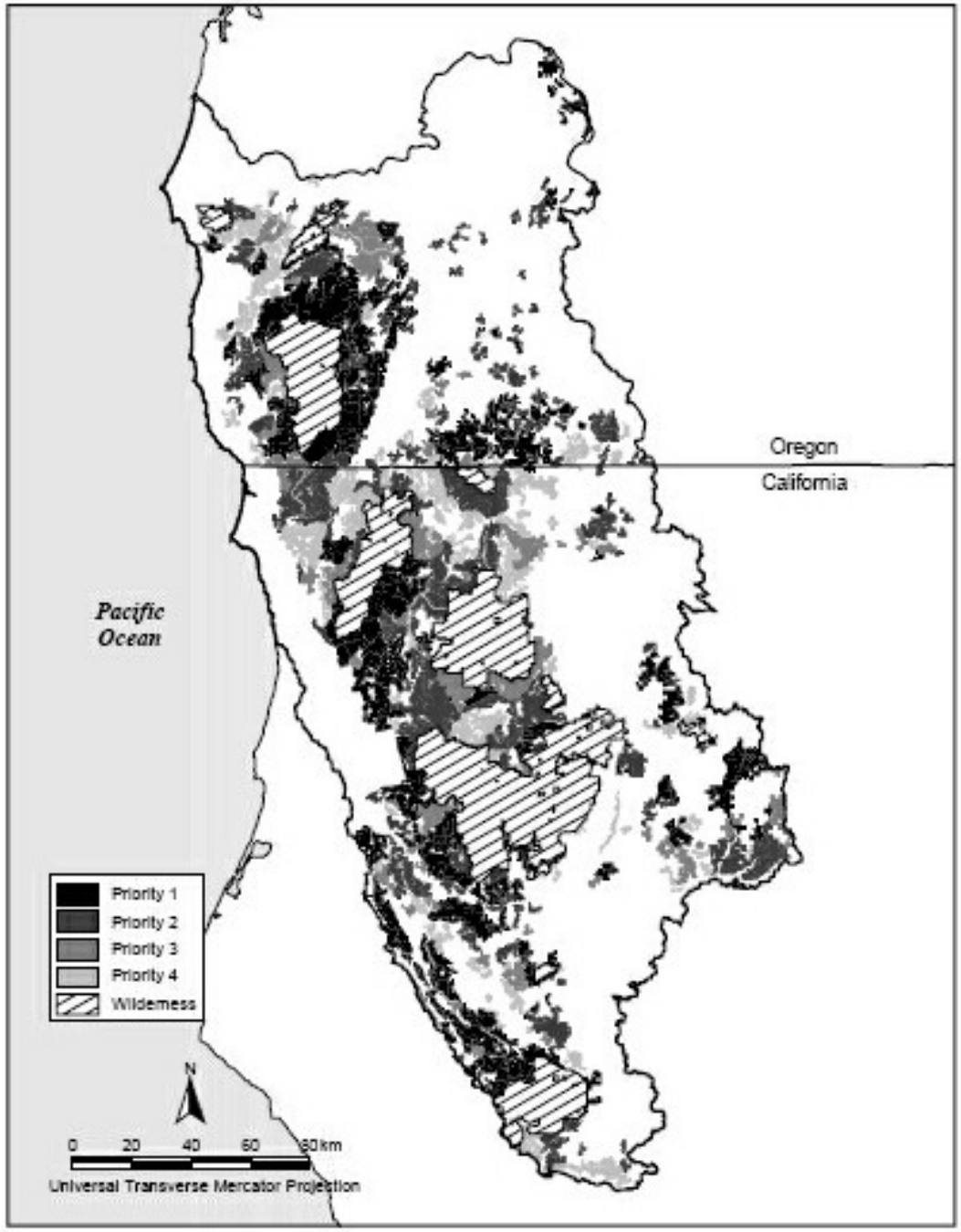


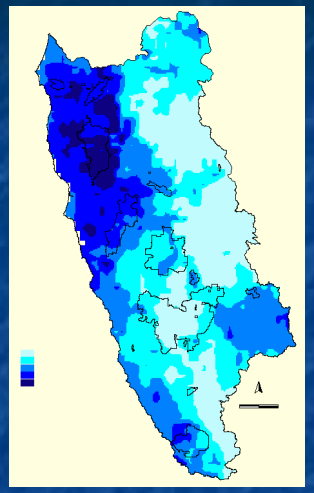
Figure 34. Roadless areas prioritization for the Klamath-Siskiyou study area. Priority 1 through 3 recommended for GAP 1 protection.

The Noss 'Three-Pronged Approach':

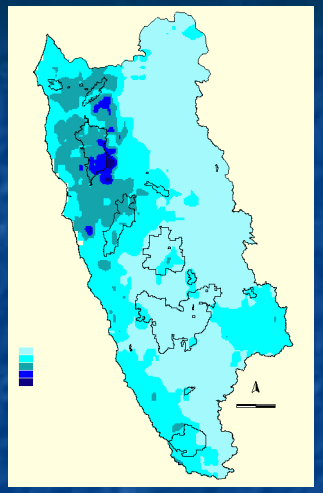
- Special Elements
- **Coarse-filter habitat representation**
- Focal species

Criterion	G
G1/G2 species occurrences	
All heritage elements	
Late-seral forests	
Serpentine	
Port-Orford-cedar: High presence, low disease Mod. Presence, low disease	
Key watersheds	
Roadless areas (designated wilderness excluded)	
Representation: ≥ 10% ≥ 25% ≥ 50%	
High-quality fisher habitat	

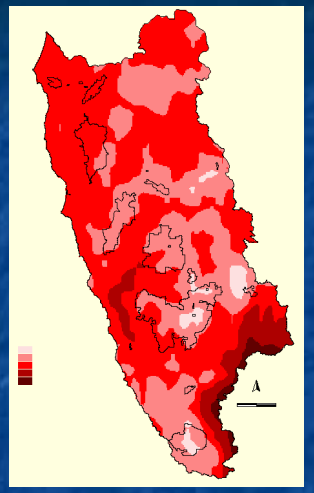
Mean Annual Precipitation



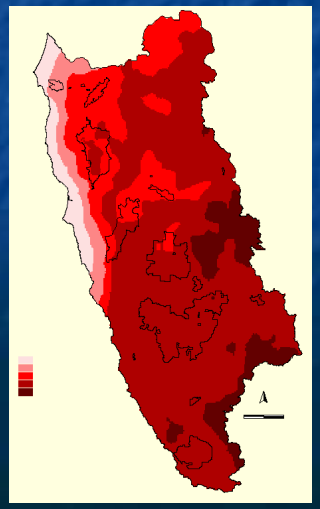
December-July Precipitation Difference



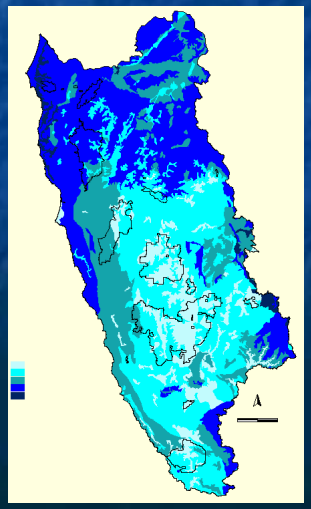
Mean Annual Temperature



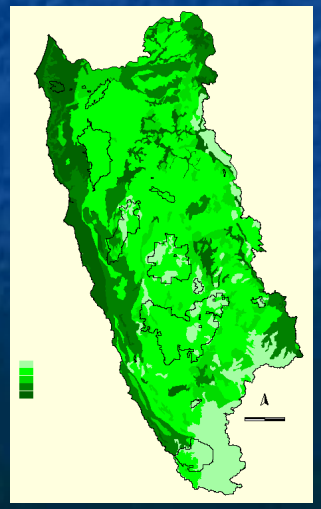
July-January Temperature Difference



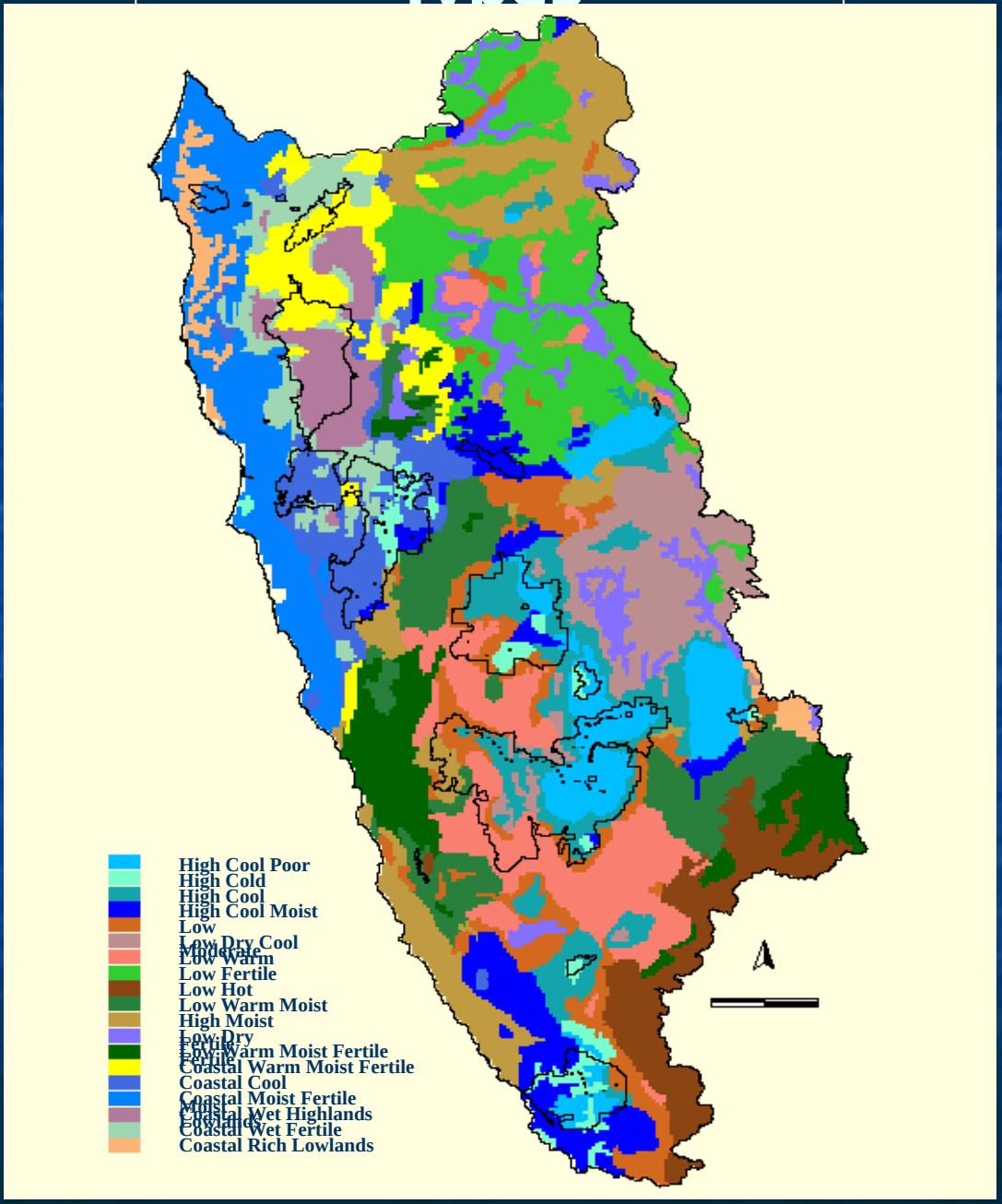
Soil Water-Holding Capacity

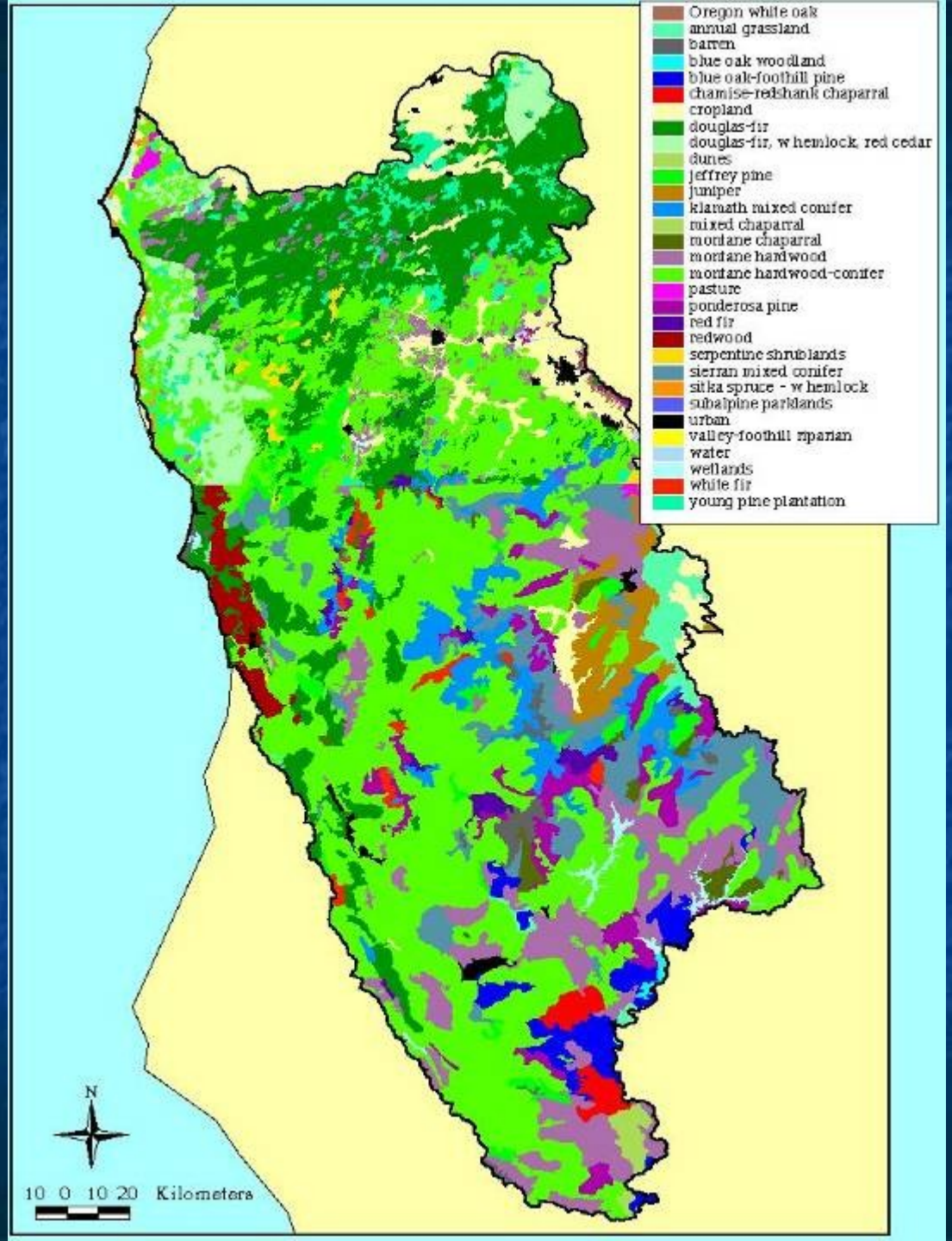


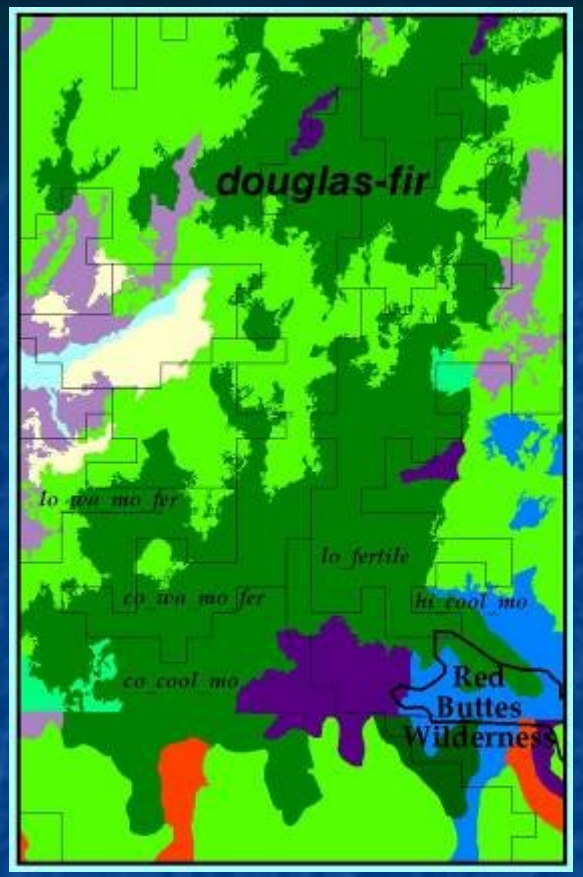
Soil Depth

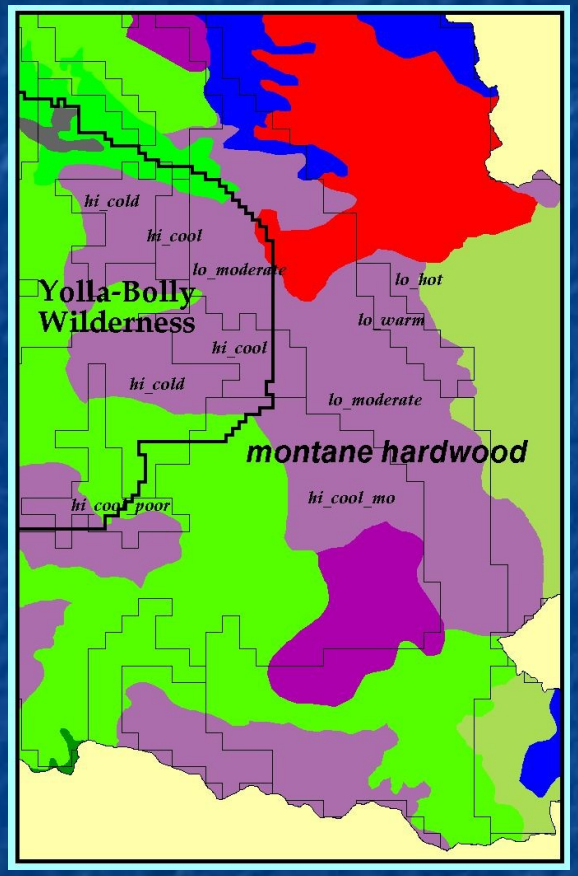


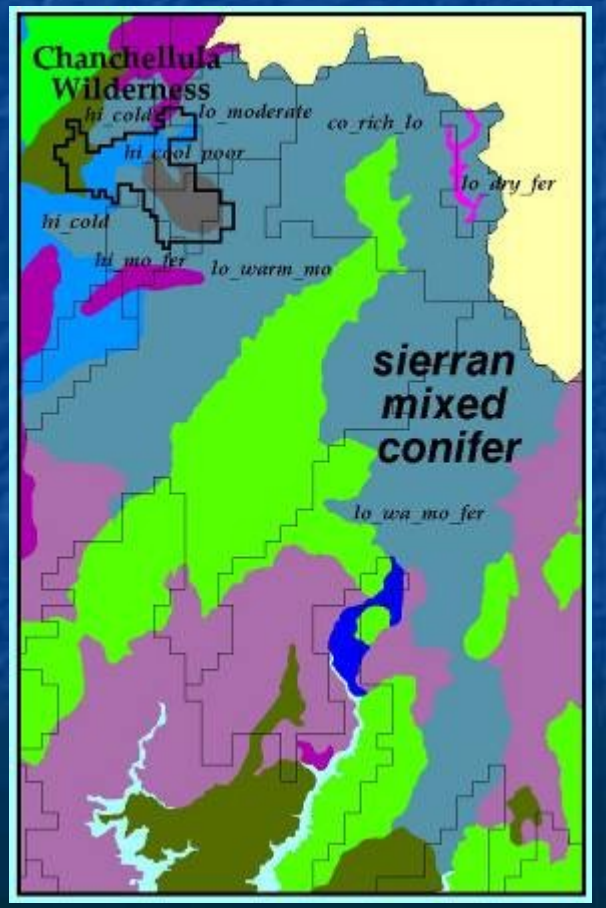
Physical Habitat Types




Oregon white oak
annual grassland
barren
blue oak woodland
blue oak-foothill pine
chamise-redshank chaparral
cropland
douglas-fir
douglas-fir, w hemlock, red cedar
dunes
jeffrey pine
juniper
klamath mixed conifer
mixed chaparral
montane chaparral
montane hardwood
montane hardwood-conifer
pasture
ponderosa pine
red fir
redwood
serpentine shrublands
sierran mixed conifer
sitka spruce - w hemlock
subalpine parklands
urban
valley-foothill riparian
water
wetlands
white fir
young pine plantation
N
10 0 10 20 Kilometers


douglas-fir
lo_wa_mo_fer
lo_fertile
co_wa_mo_fer
hi_cool_mo
co_cool_mo
Red Buttes Wilderness


hi_cold
hi_cool
lo_moderate
lo_hot
Yolla-Bolly Wilderness
lo_warm
hi_cool
hi_cold
lo_moderate
montane hardwood
hi_cool_poor
hi_cool_mo


Chanchellula Wilderness
hi_cold
lo_moderate
co_rich_lo
hi_cool_poor
lo_dry_fer
hi_cold
hi_mo_fer
lo_warm_mo
sierran mixed conifer
lo_wa_mo_fer

The Noss 'Three-Pronged Approach':

- Special Elements
- Coarse-filter habitat representation
- **Focal species**

Criterion	G
G1/G2 species occurrences	
All heritage elements	
Late-seral forests	
Serpentine	
Port-Orford-cedar: High presence, low disease Mod. Presence, low disease	
Key watersheds	
Roadless areas (designated wilderness excluded)	
Representation: ≥ 10% ≥ 25% ≥ 50%	
High-quality fisher habitat	

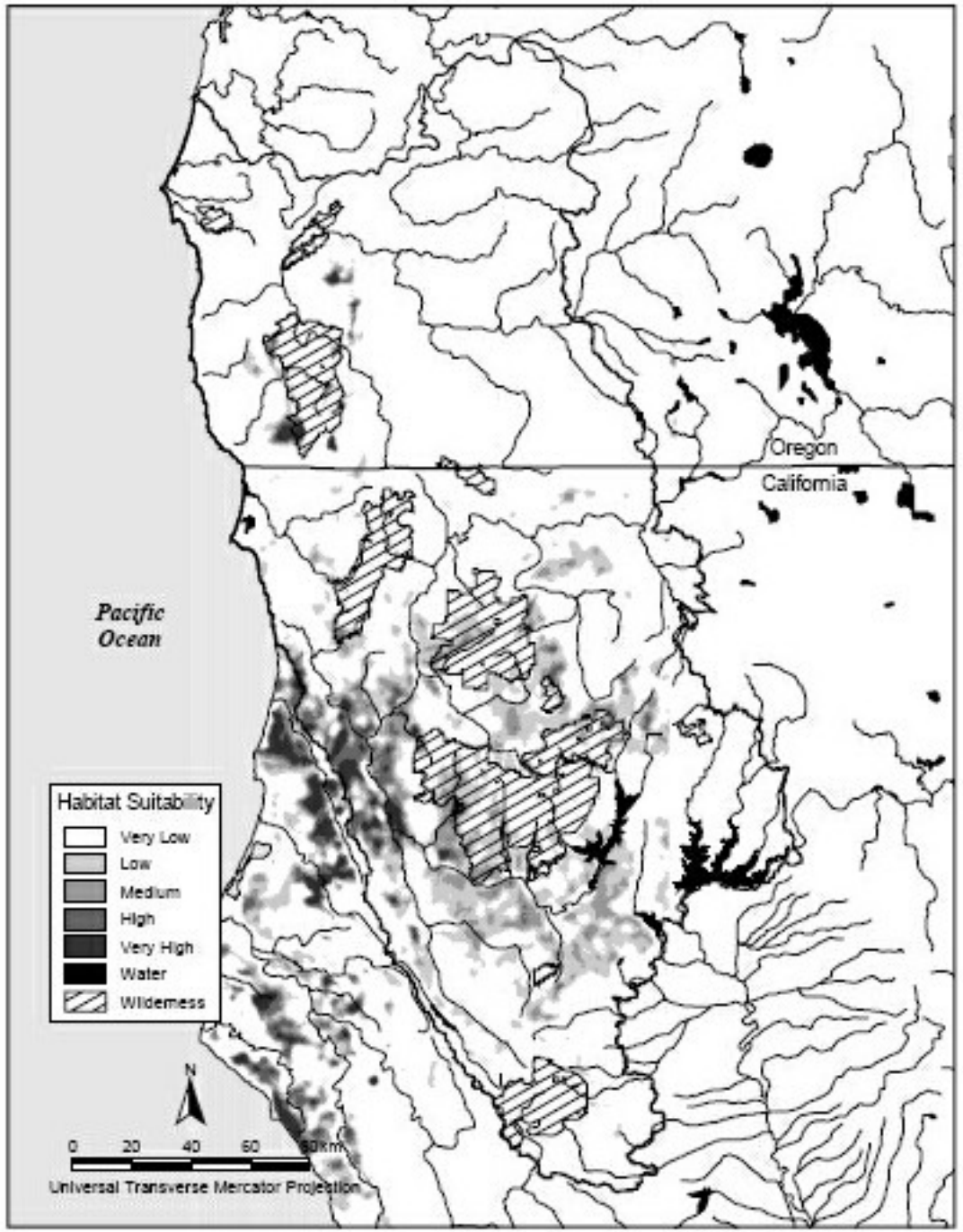
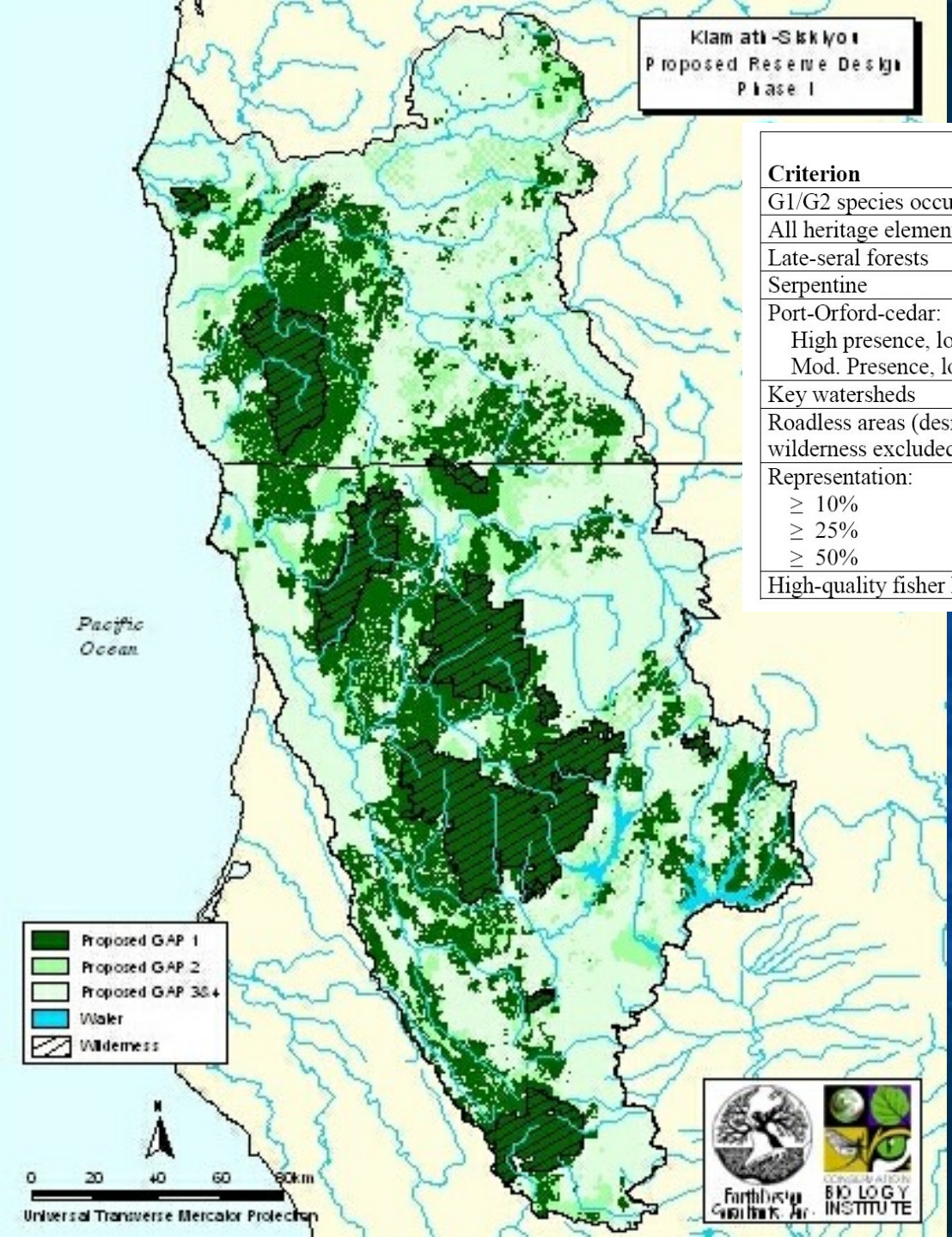


Figure 47. Habitat suitability for Pacific fisher within the greater Klamath-Siskiyou study area.

Model Variables

- Vegetation size and composition
- Roads
- Hydrography
- Digital elevation, slope, aspect
- PRISM mean annual precipitation





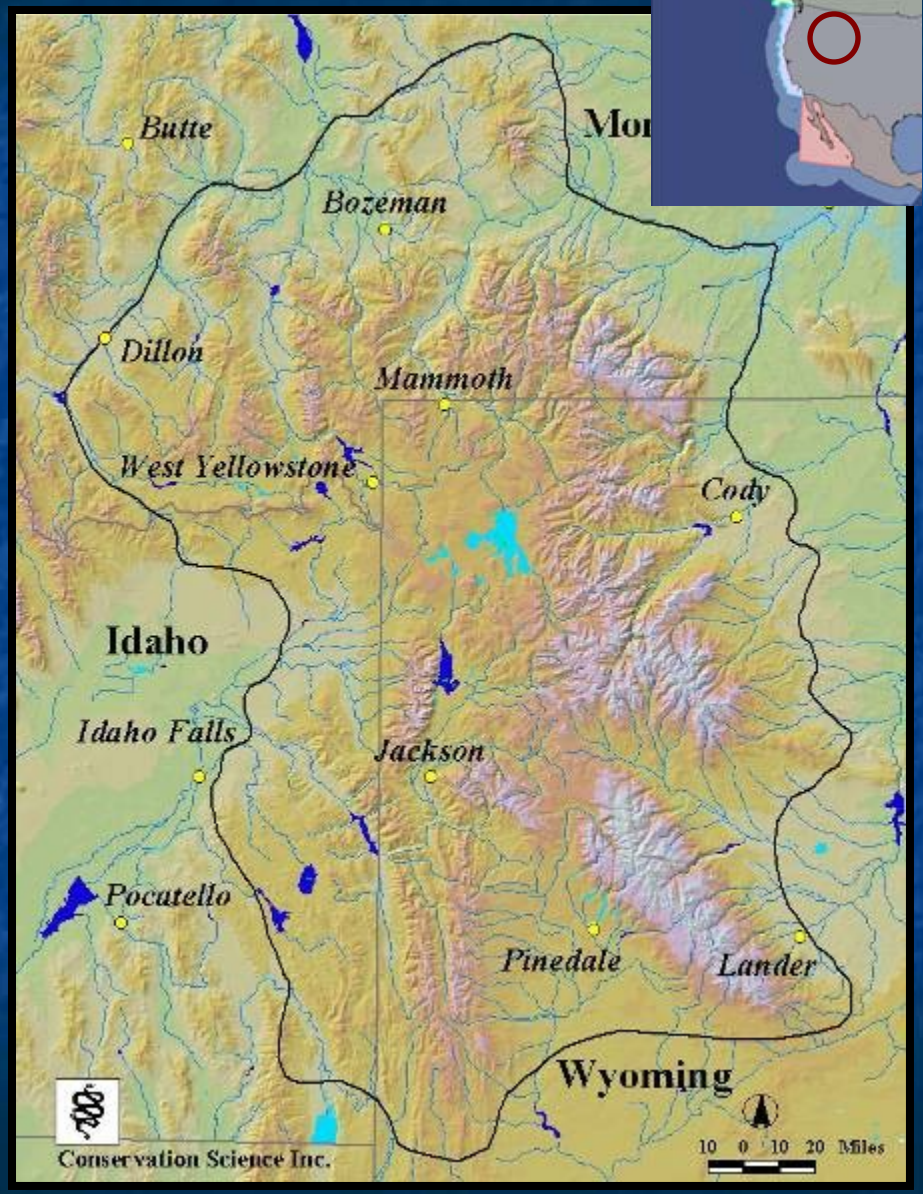
Criterion	Current Condition			Proposed Phase I			Δ
	GAP 1	GAP 2	GAP 1+2	GAP 1	GAP 2	GAP 1+2	
G1/G2 species occurrences	11.0	25.0	36.0	68.0	14.0	82.0	+46.0
All heritage elements	8.0	30.0	38.0	45.0	21.0	66.0	+28.0
Late-seral forests	16.5	27.0	43.5	50.0	18.0	68.0	+24.5
Serpentine	18.0	25.0	43.0	50.5	11.0	61.5	+18.5
Port-Orford-cedar:							
High presence, low disease	36.0	46.5	82.5	88.0	8.0	96.0	+13.5
Mod. Presence, low disease	31.0	42.0	73.0	73.0	12.0	85.0	+12.0
Key watersheds	27.0	32.0	59.0	62.0	16.0	78.0	+18.0
Roadless areas (designated wilderness excluded)	1.0	48.0	49.0	83.0	9.0	92.0	+43.0
Representation:							
≥ 10%	na	na	72.5	na	na	86.0	+13.5
≥ 25%	na	na	59.5	na	na	77.0	+17.5
≥ 50%	na	na	39.0	na	na	59.0	+20.0
High-quality fisher habitat	na	na	36.0	na	na	50.0	+14.0

Proposed: 80% of public land, 50% of entire region. Reserve design based on high-priority roadless areas, with other areas included for:

- G1/G2 element occurrences
- Other element occurrence concentrations
- Late-seral forests
- Connectivity between

A Multicriteria Assessment of the Irreplaceability and Vulnerability of Sites the Greater Yellowstone Ecosystem

Reed Noss, Carlos Carroll, Ken Vance-Borland, and George Wuerthner



2002. Conservation Biology 16(4):

Grizzly bear (*Ursus arctos*)

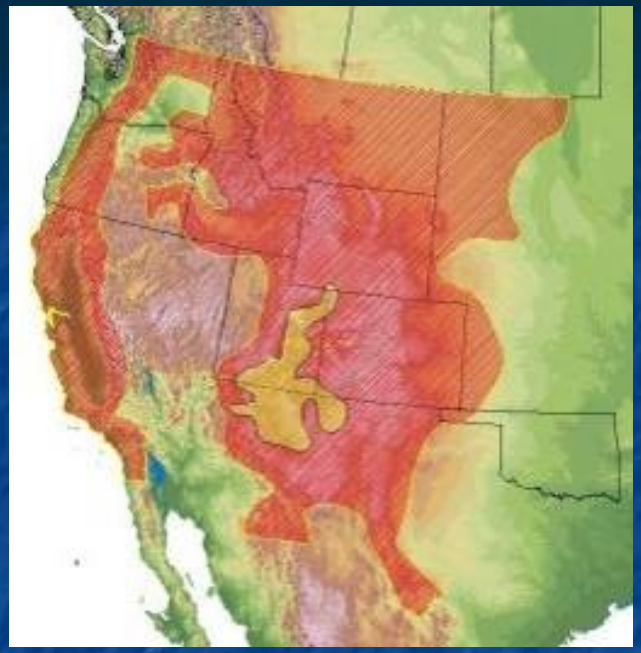




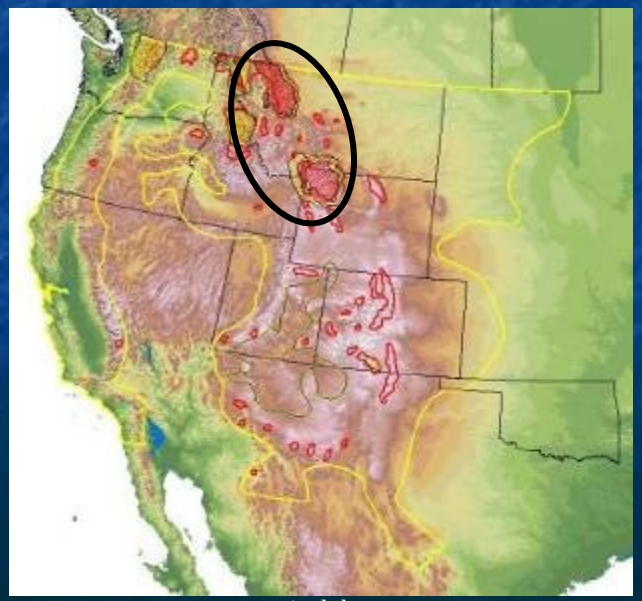


Images: Chuck Rumsey, TNC

1850



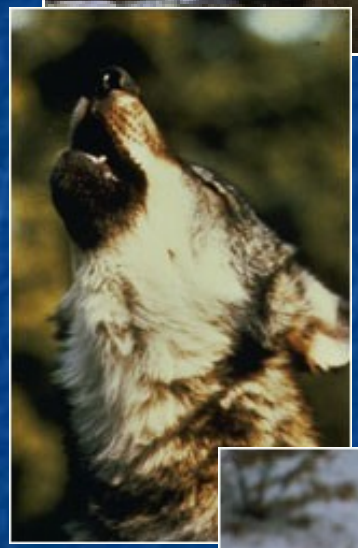
1970



www.grizzlybear.org

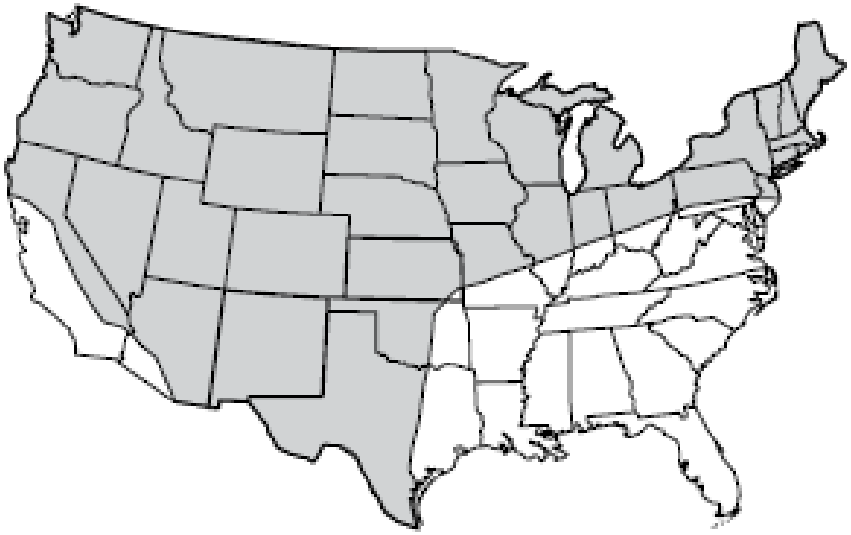
Wolf (*Canis lupus*)





Images: Nova Online





Historic Gray Wolf Range



Current Range and Mexican Wolf Recovery Area

March 2006

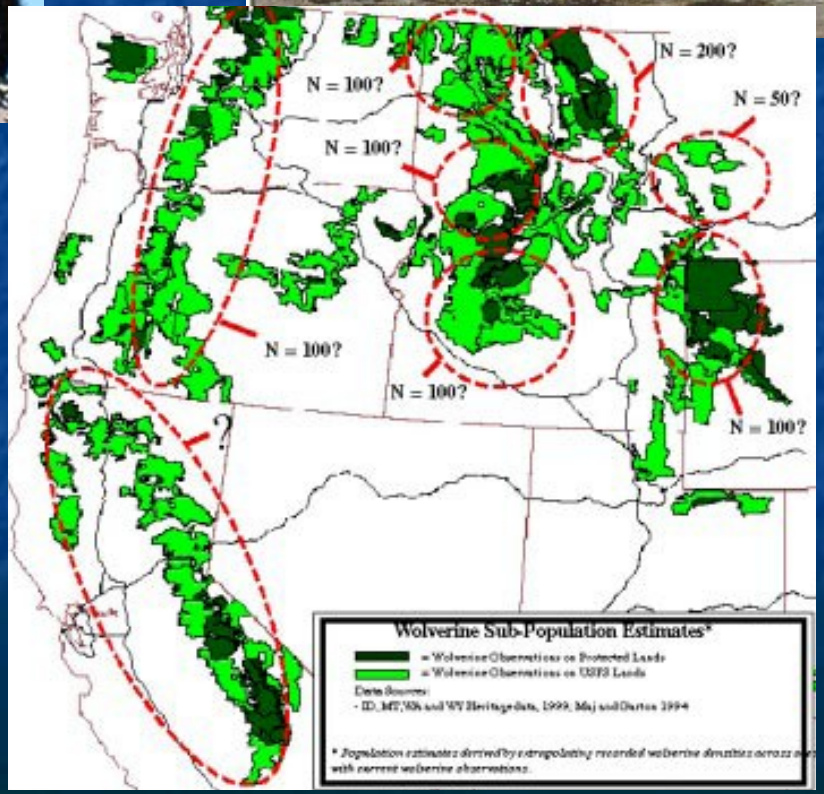
U.S. Fish and Wildlife Service

Wolverine (*Gulo gulo*)









Gerald and Buff Corsi

Elk (Cervus elaphus)









Rocky Mountain Elk Foundation

Vegetation-derived variables

Grizzly Bear forage value - seasonal

Grizzly Bear forage value - annual

Other biological data

Elk winter range

Bison range

Satellite imagery metrics (MODIS)

Brightness - July

Greenness - July

Wetness - July

Brightness - November

Greenness - November

Wetness - November

Climatic variables

Average annual precipitation

Average annual snowfall

Topographic variables

Elevation

Slope

Transformed Aspect

Topographic complexity

Cirque denning habitat

Human-impact associated variables

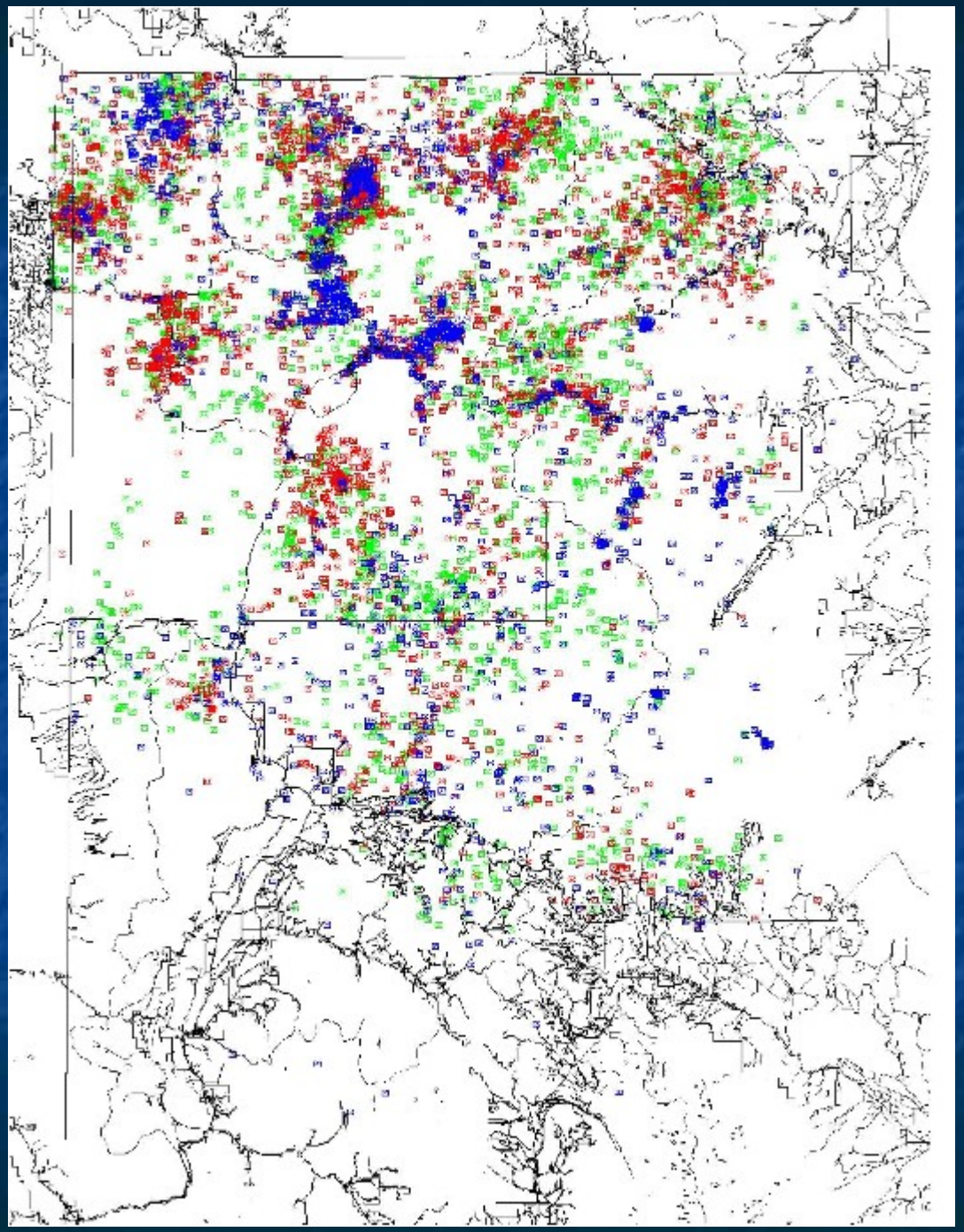
Human population density

Interpolated human population density

Road and trail density

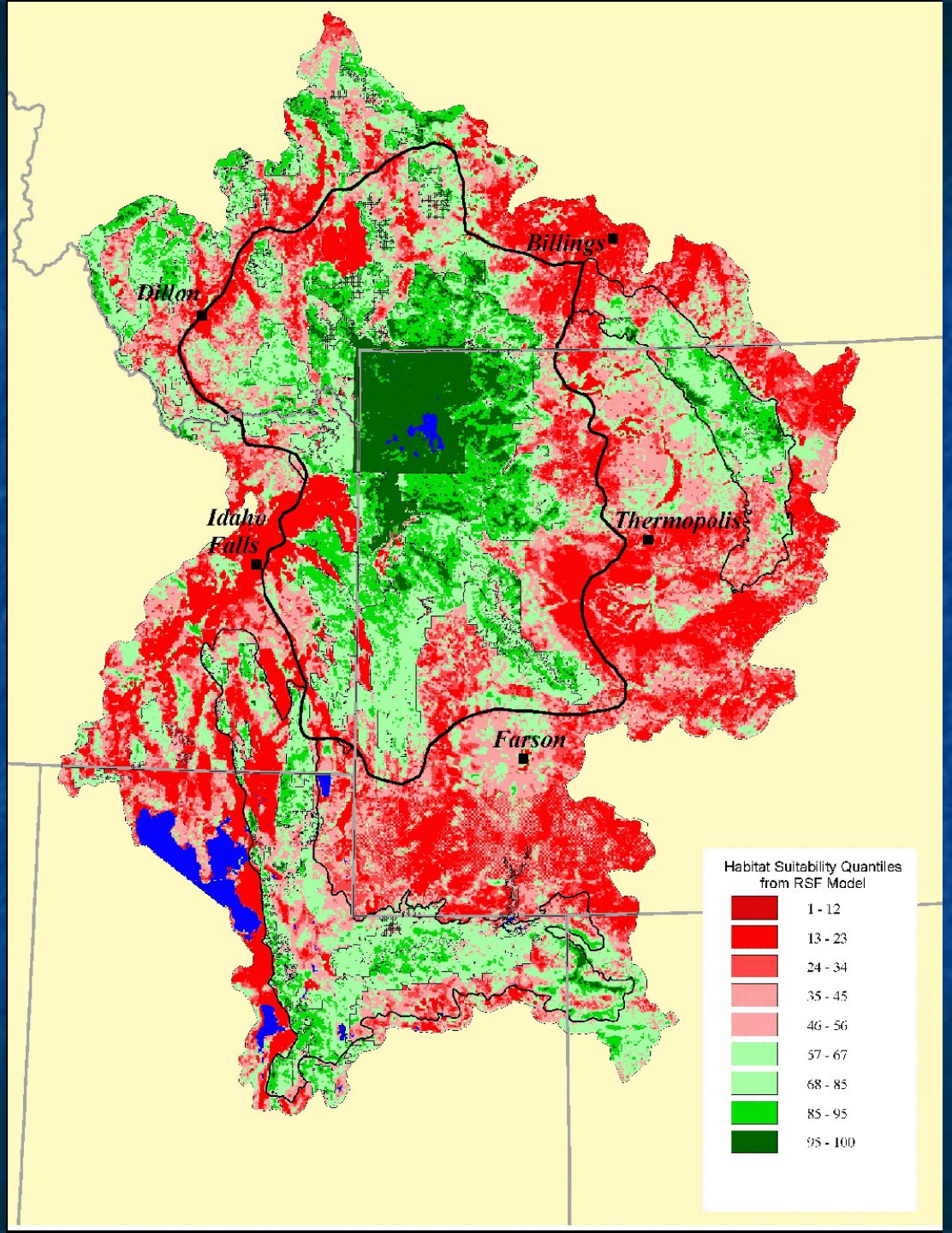
Management status







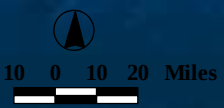
Variables for:
*MODIS July brightness and Greenness;
November brightness, greenness
and wetness
*Slope
*Elk winter range
*Road density
*Management class (private, general public, wilderness, or park)
*And interactions between road
density and management



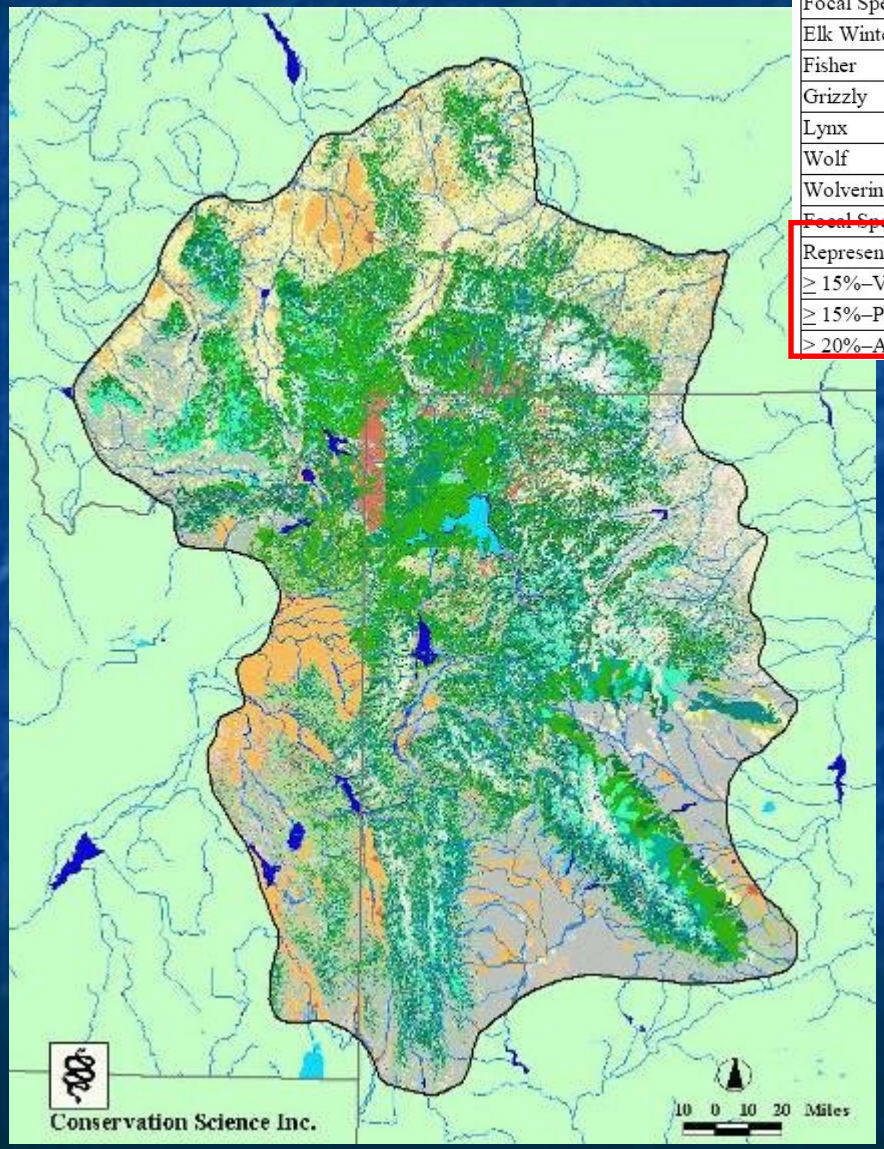
Special Elements
All G1-G2
Class 1–Local-Scale Species
Class 2–Birds
Class 4–Fish
Class 5–Plant Communities
Special Elements Average
Focal Species Resources
Elk Winter Range
Fisher
Grizzly
Lynx
Wolf
Wolverine
Focal Species Average
Representation
≥ 15%–Vegetation Types
≥ 15%–Physical Habitat Types
≥ 20%–Aquatic Types



Conservation Science Inc.



Special Elements
All G1-G2
Class 1–Local-Scale Species
Class 2–Birds
Class 4–Fish
Class 5–Plant Communities
Special Elements Average
Focal Species Resources
Elk Winter Range
Fisher
Grizzly
Lynx
Wolf
Wolverine
Focal Species Average
Representation
≥ 15%–Vegetation Types
≥ 15%–Physical Habitat Types
≥ 20%–Aquatic Types



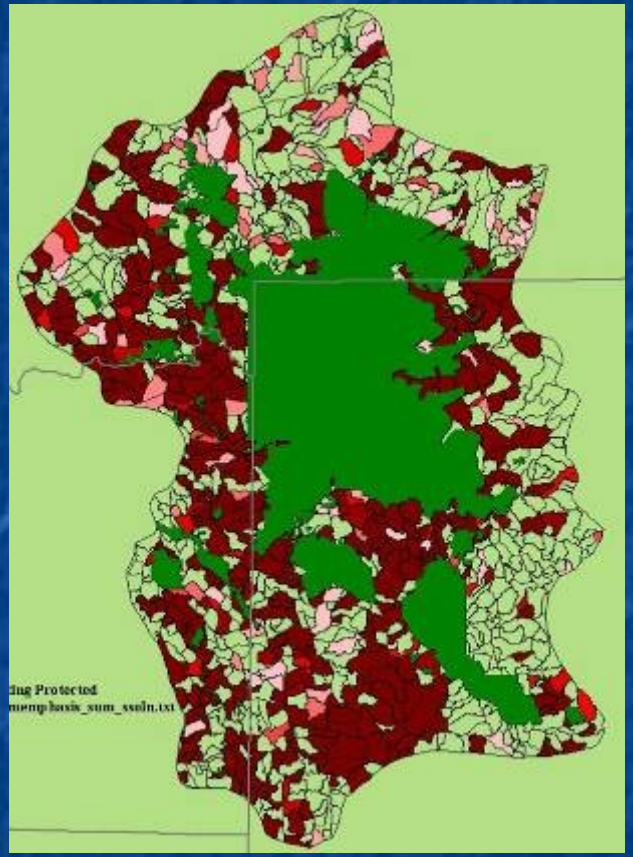
Conservation Science Inc.
10 0 10 20 Miles

Fine Filter Emphasis

Special elements: 90-100%

Biophysical habitats: 15-25%

Focal species: 30-50%

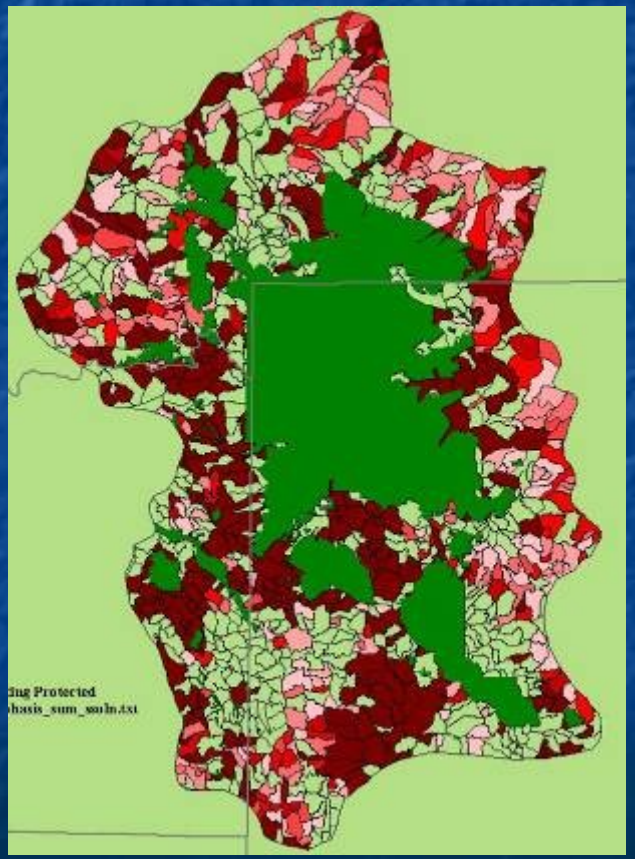


Coarse Filter Emphasis

Special elements: 50-100%

Biophysical habitats: 35-50%

Focal species: 30-50%



Focal Species Emphasis

Special elements: 50-100%

Biophysical habitats: 15-25%

Focal species: 50-75%

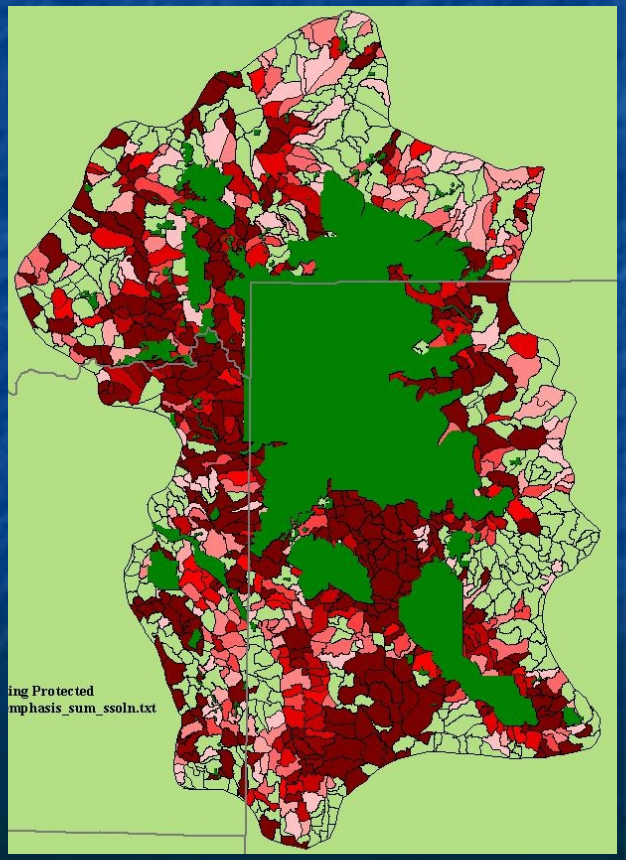
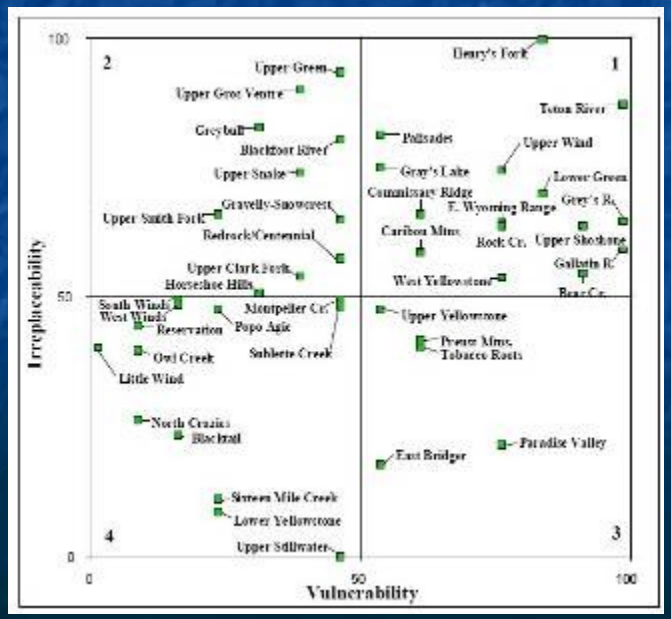


Table E1. GYE portfolio conservation target protection increases.

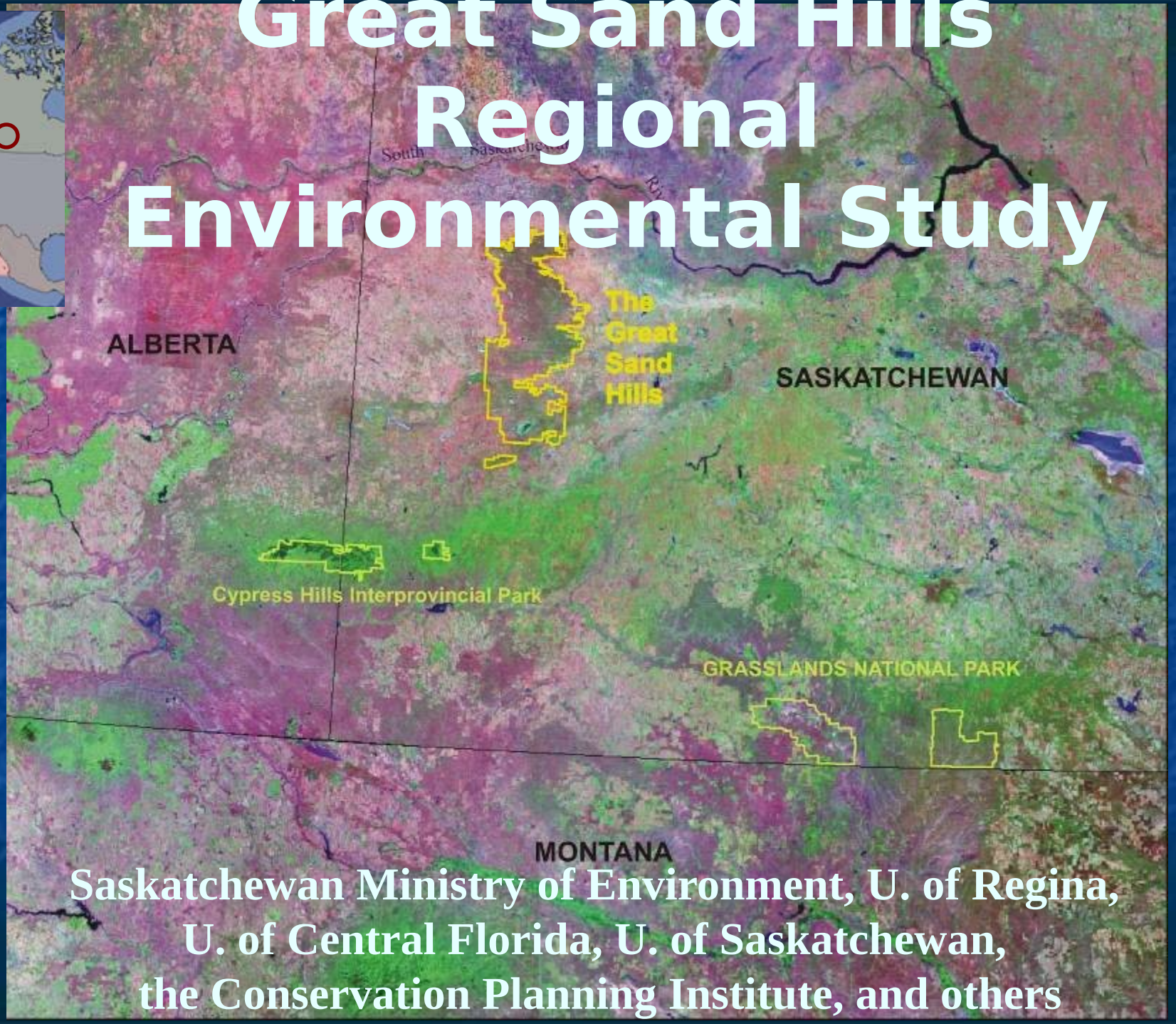
	Current %	Proposed %	Δ (%)
Protected Area	26.6	69.6	+43.0
Special Elements			
All G1-G2	30.0	100	+70.0
Class 1–Local-Scale Species	40.7	93.1	+52.4
Class 2–Birds	26.7	85.6	+58.9
Class 4–Fish	26.7	87.8	+61.1
Class 5–Plant Communities	28.7	95.0	+66.3
Special Elements Average	30.6	92.2	+61.7
Focal Species Resources			
Elk Winter Range	13.9	63.4	+49.6
Fisher	48.5	91.3	+42.8
Grizzly	94.4	98.9	+4.5
Lynx	36.3	84.6	+48.3
Wolf	77.8	96.3	+18.5
Wolverine	41.3	83.1	+41.8
Focal Species Average	52.0	86.3	+34.3
Representation			
≥ 15%–Vegetation Types	61.5	100	+38.5
≥ 15%–Physical Habitat Types	41.0	100	+59.0
≥ 20%–Aquatic Types	44.3	97.7	+53.4
Representation Average	48.9	99.2	+50.3
Total Average	43.7	91.3	+47.5





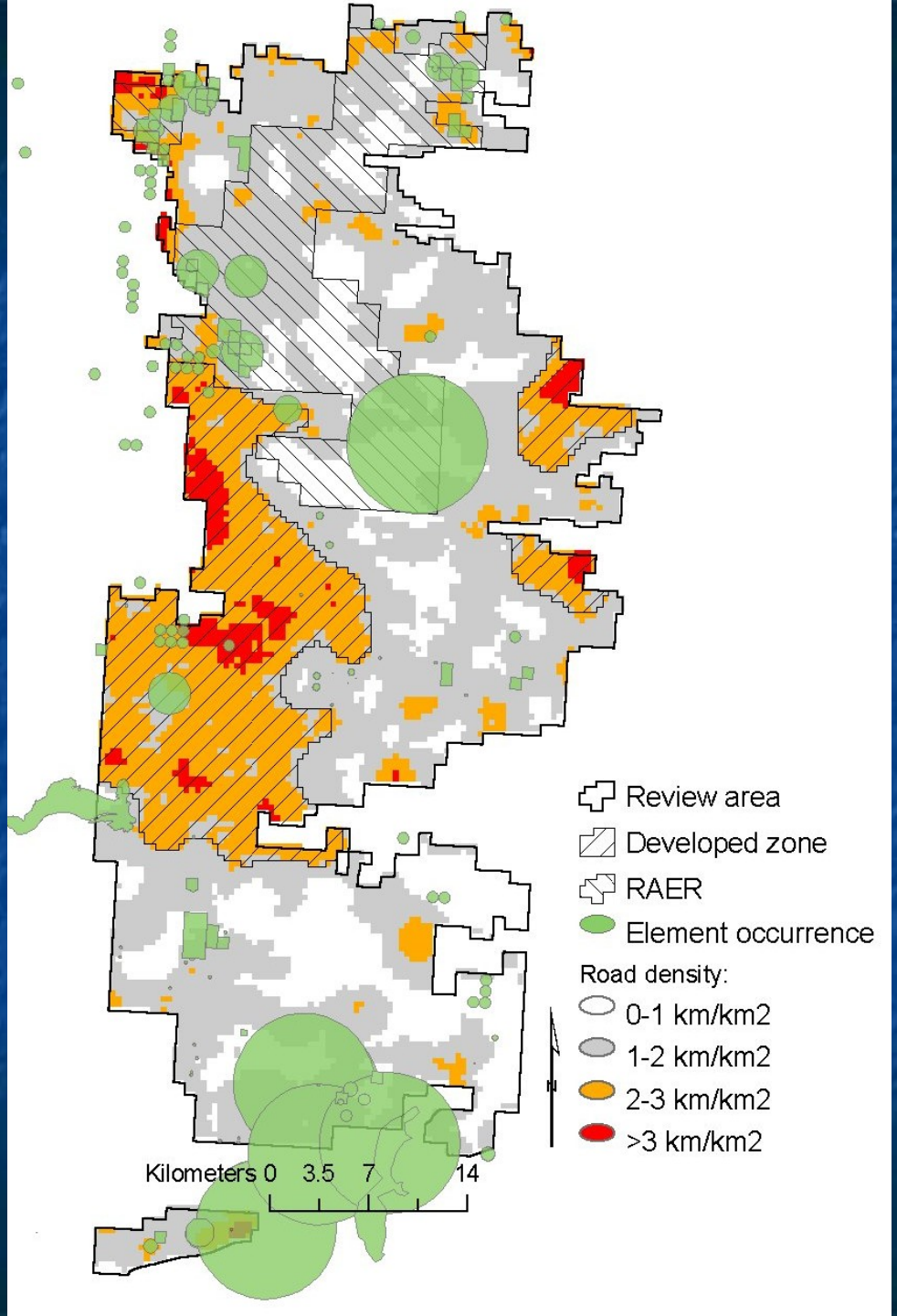


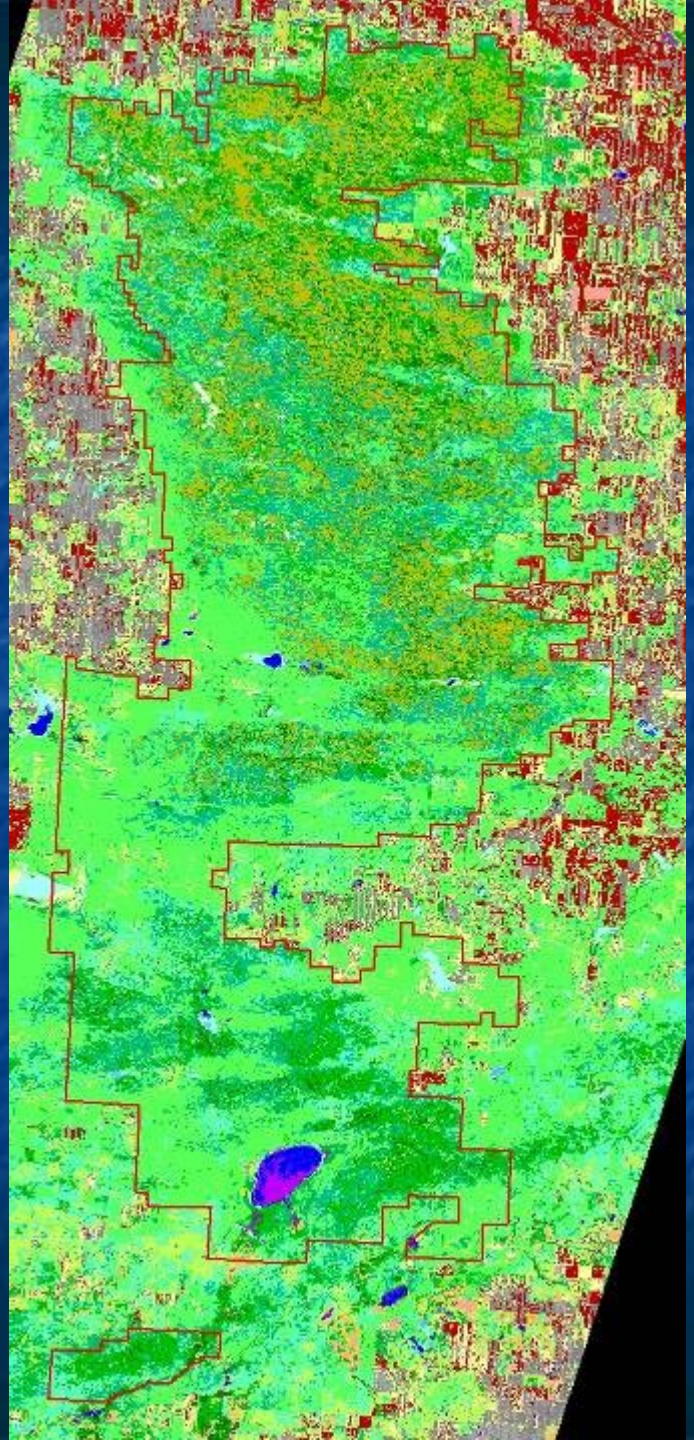
Great Sand Hills Regional Environmental Study



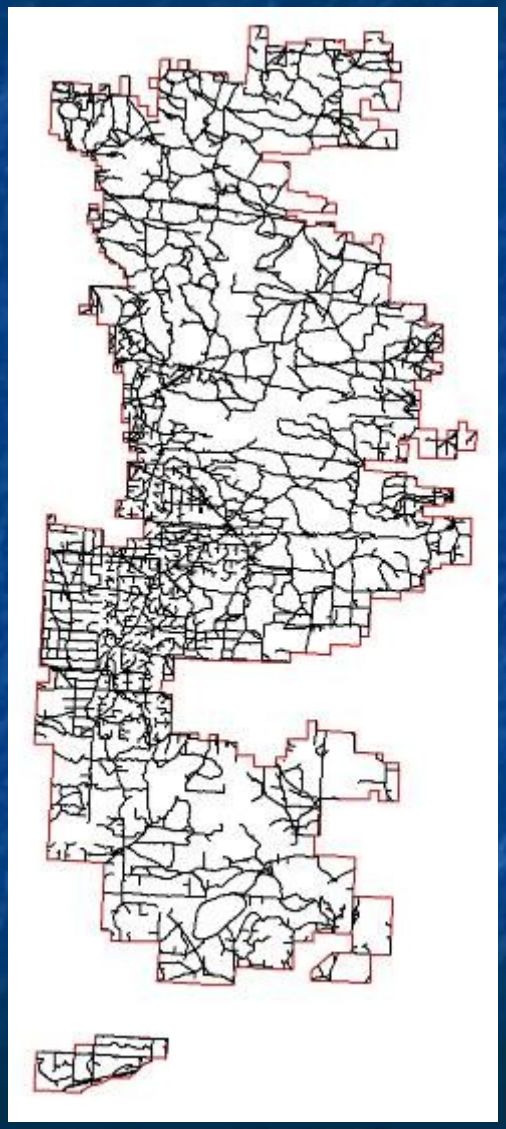
Saskatchewan Ministry of Environment, U. of Regina,
U. of Central Florida, U. of Saskatchewan,
the Conservation Planning Institute, and others

the Conservation Planning Institute

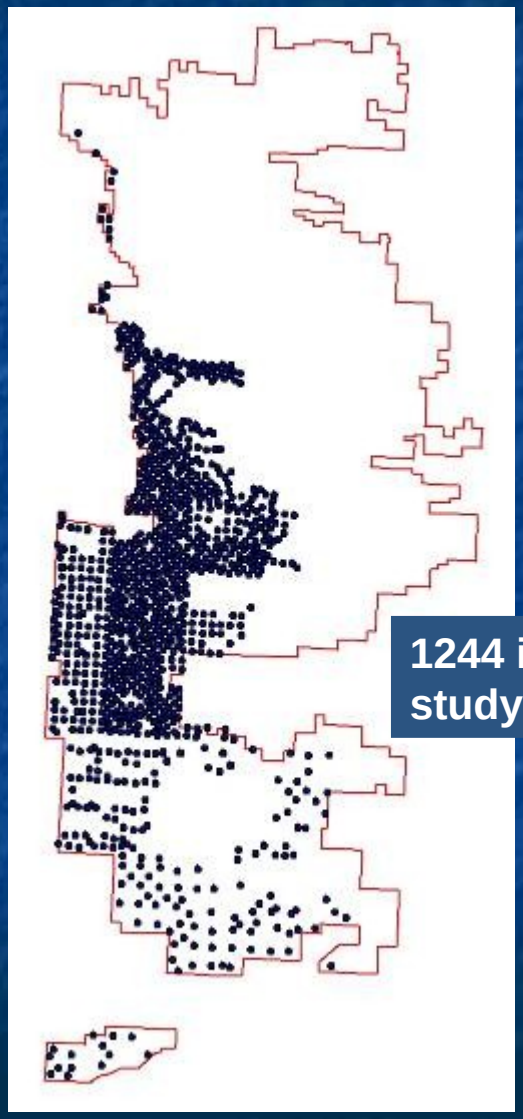

Review area
Developed zone
RAER
Element occurrence
Road density:
0-1 km/km2
1-2 km/km2
2-3 km/km2
>3 km/km2
N
Kilometers 0 3.5 7 14



Roads

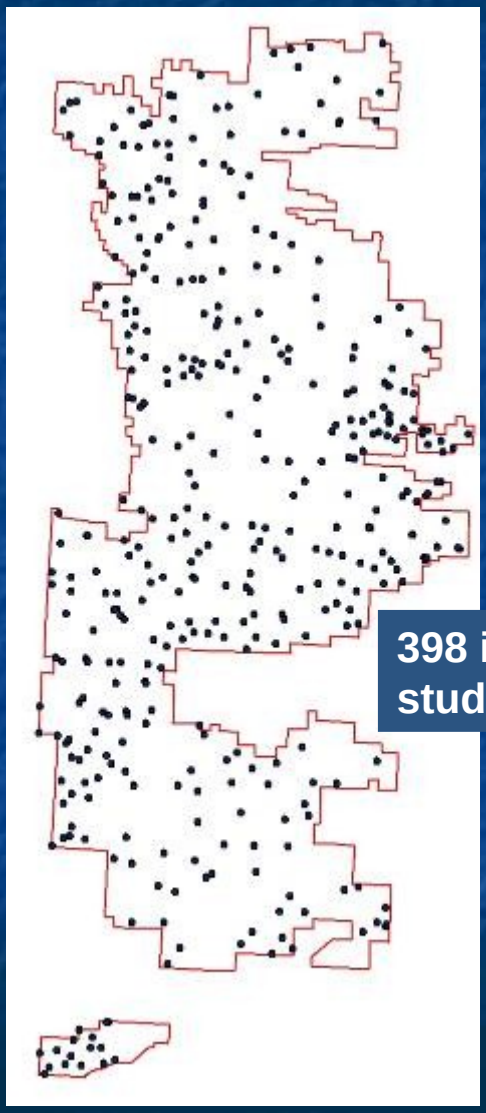


Gas well pads



1244 in study area

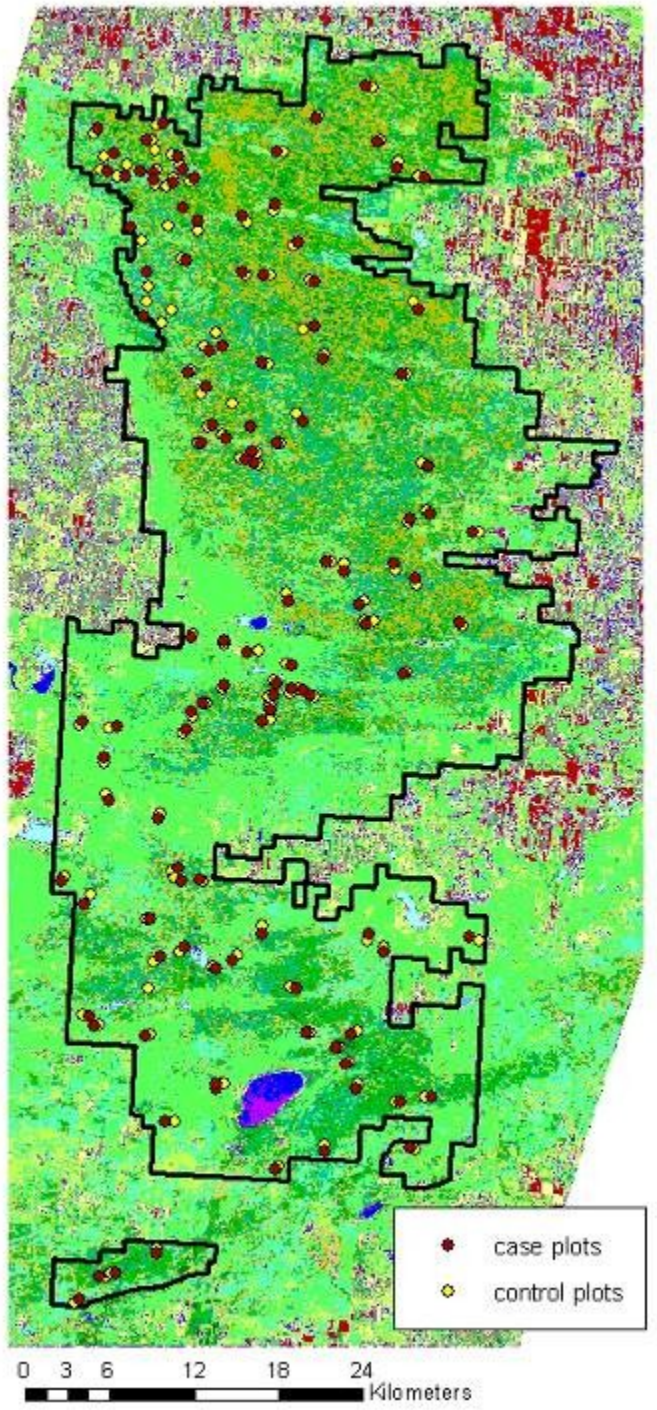
Cattle watering holes)



398 in study area

Impact strata	Landcover (grassland) strata: Herbaceous	Disturbed	Juniper	Shrubby	
Water holes	10 i + 10 c	10 i + 10 c	10 i + 10 c	10 i + 10 c	40 i + 40 c
Gas pads	10 i + 10 c	10 i + 10 c	10 i + 10 c	10 i + 10 c	40 i + 40 c
Roads	10 i + 10 c	10 i + 10 c	10 i + 10 c	10 i + 10 c	40 i + 40 c
Totals	30 i + 30 c	30 i + 30 c	30 i + 30 c	30 i + 30 c	120 + 120

i = impact (case) site, c = control (distant from impact) site



Species models from the 2006 field data

Birds and mammals:

1. Baird's sparrow
2. Brown-headed cowbird
3. Chestnut-collard longspur
4. Clay-colored sparrow
5. Common nighthawk
6. Grasshopper sparrow
7. Horned lark
8. Long-billed curlew
9. Marbled godwit
10. Ord's kangaroo rat
11. Savanna sparrow
12. Spotted towhee
13. Sprague's pipit
14. Upland sandpiper

Rare & Medicinal Plants:

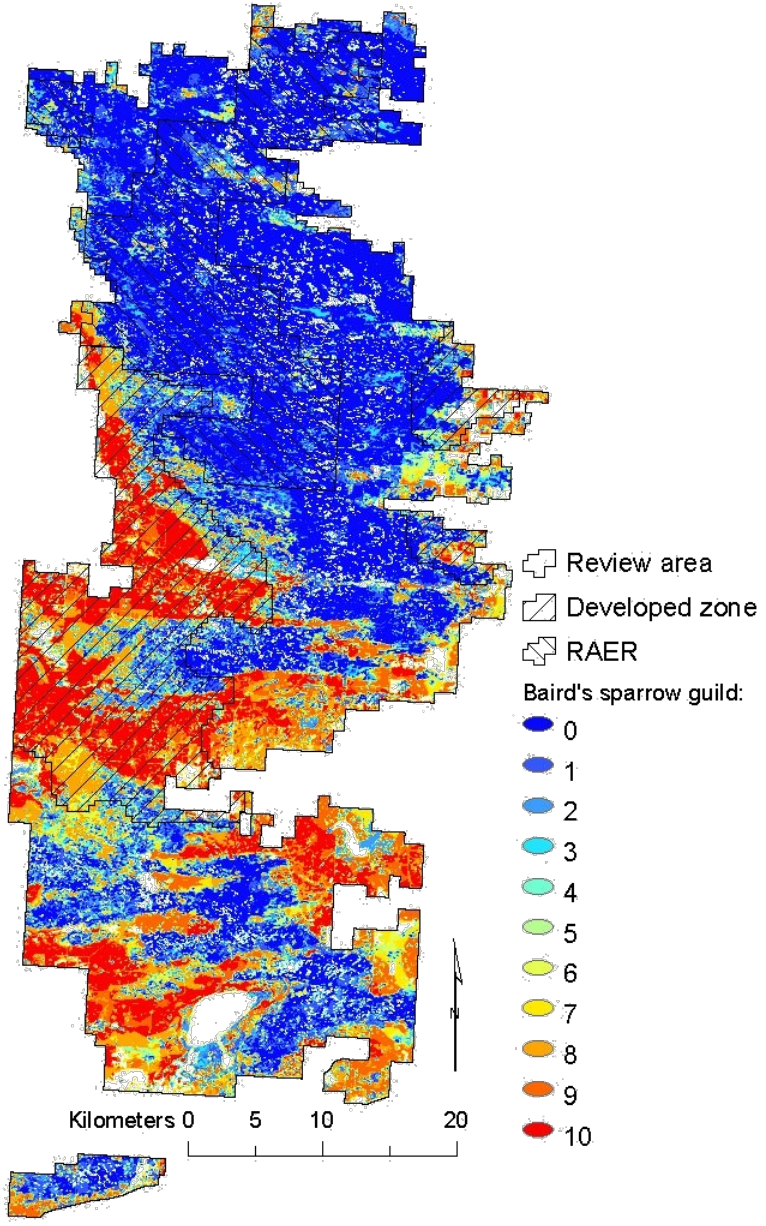
15. Beaked annual skeleton-weed
16. Chokecherry
17. Low milk vetch
18. Prairie moonwort
19. Six-weeks fescue
20. Small lupine
21. Smooth arid goosefoot
22. Windflower

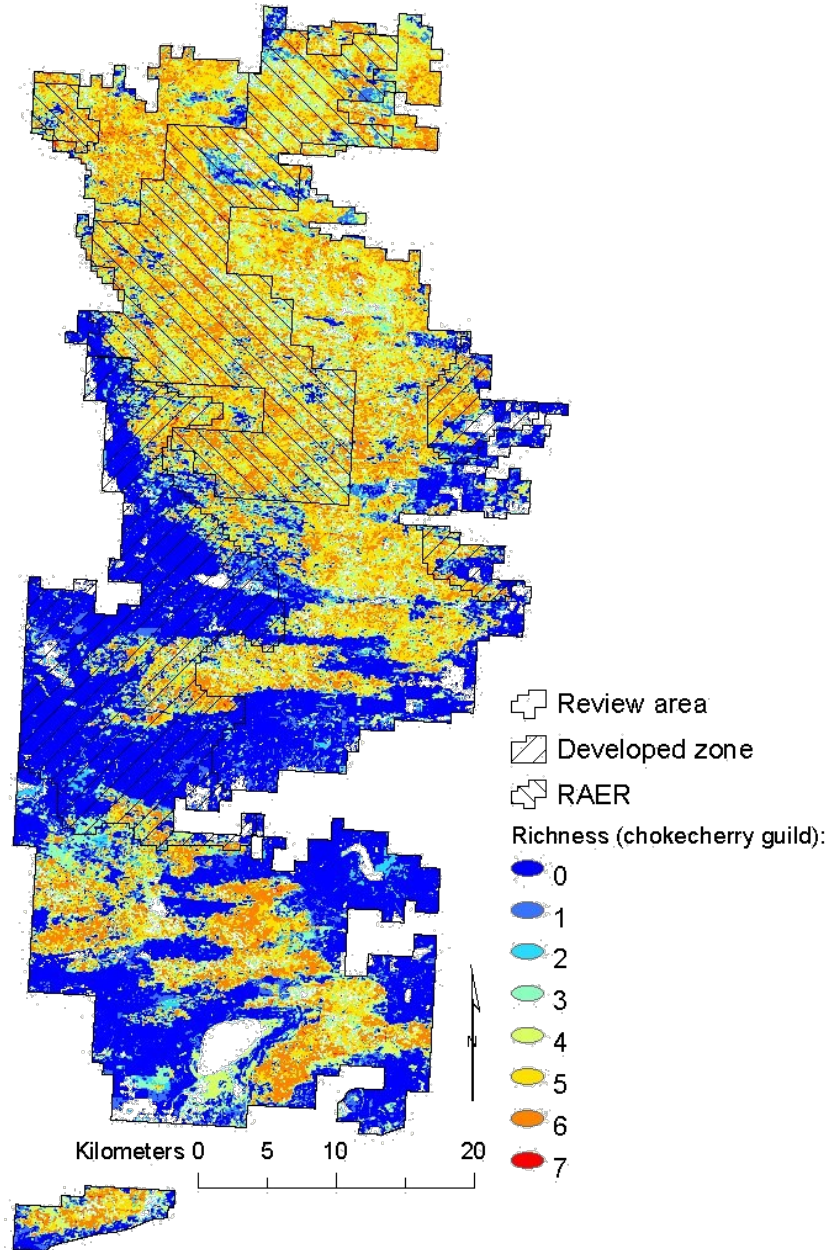
Exotic Plants:

23. Canada thistle
24. Crested wheat
25. Kentucky bluegrass
26. Smooth brome

27. Range health




Review area
Developed zone
RAER
Baird's sparrow guild:
0
1
2
3
4
5
6
7
8
9
10
Kilometers 0 5 10 20
N


Review area
Developed zone
RAER
Richness (chokecherry guild):
0
1
2
3
4
5
6
7
Kilometers 0 5 10 20
N

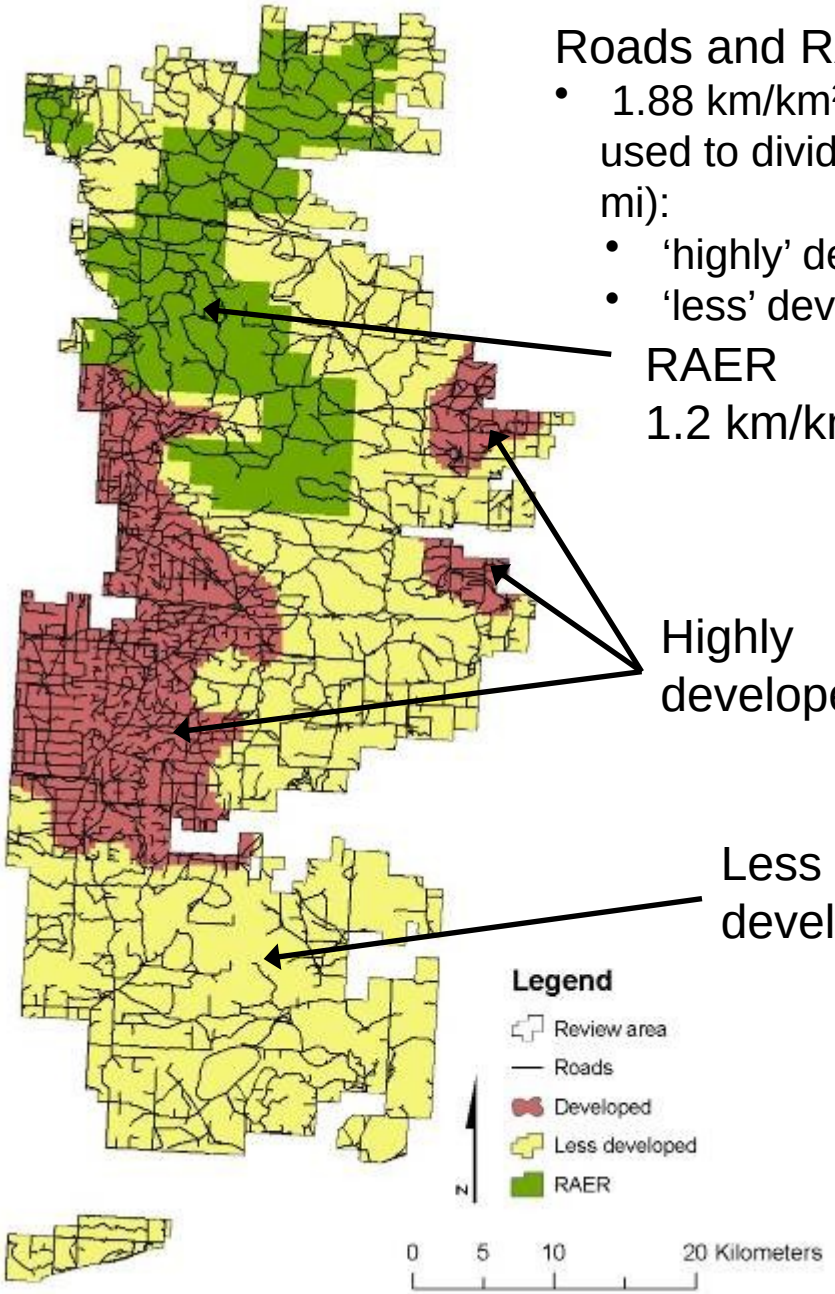
Roads and RAER were used to classify the GSH:

- 1.88 km/km^2 (mean [1.54] + ½ standard deviation) used to divide the GSH into 2 zones (min size 9-sq mi):
  - 'highly' developed zone (≥1.88 km/km^2)
  - 'less' developed zone (< 1.88 km/km^2)

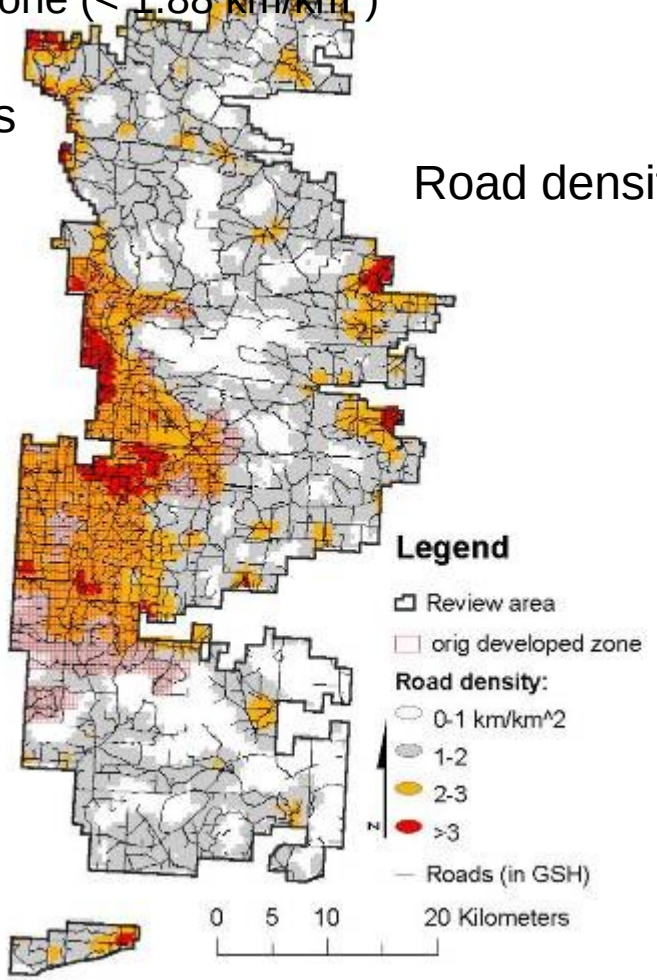
RAER
1.2 km/km^2 roads

Highly developed

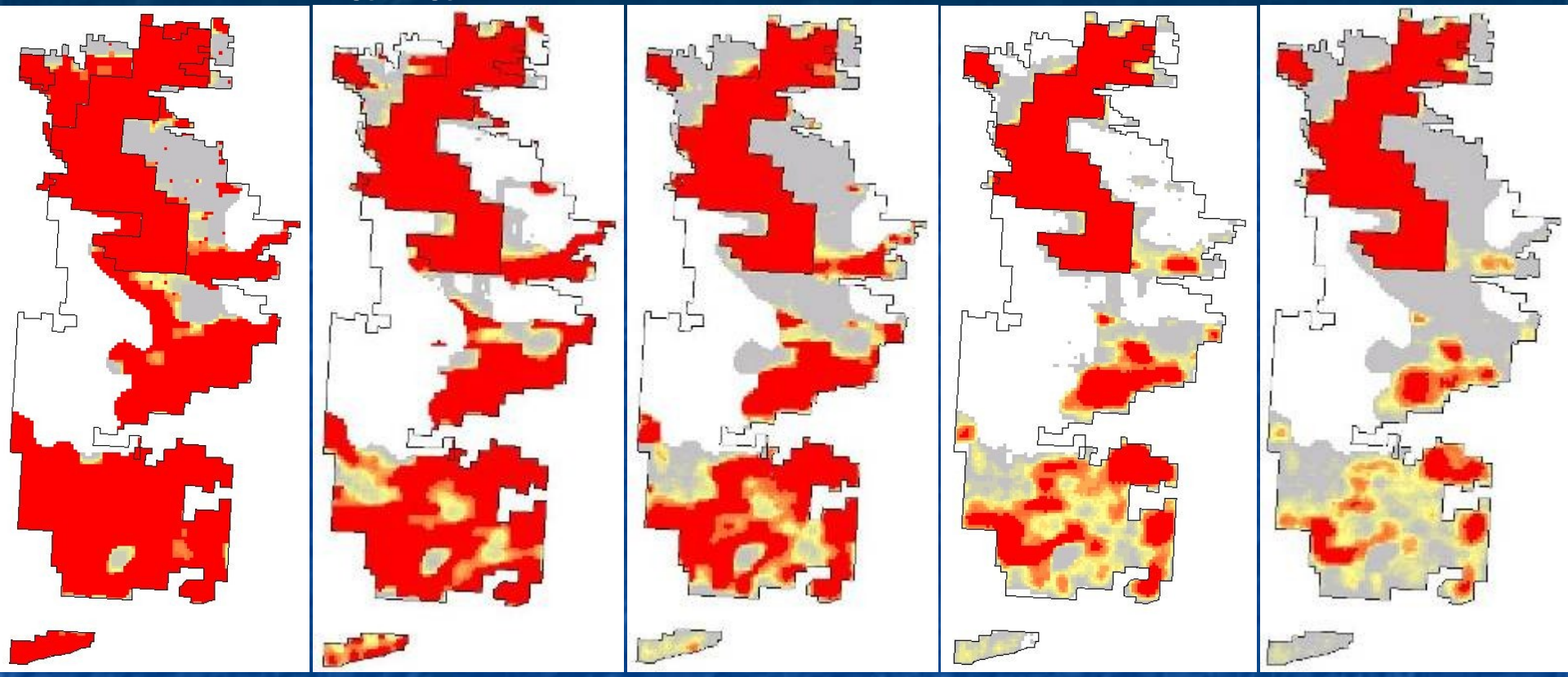
Less developed



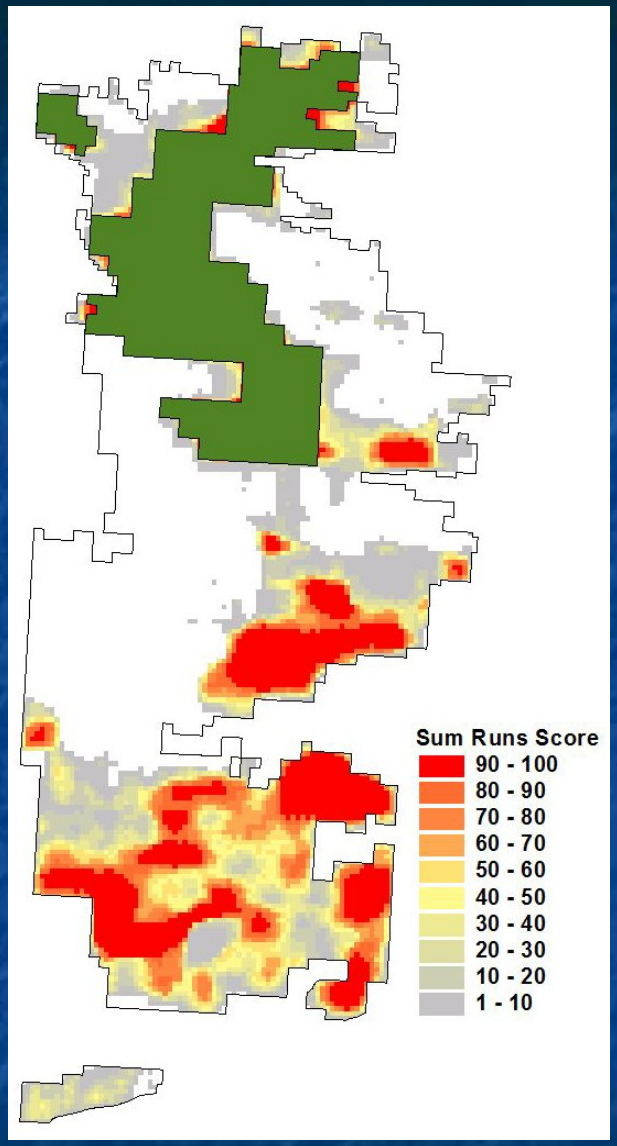
Road density:

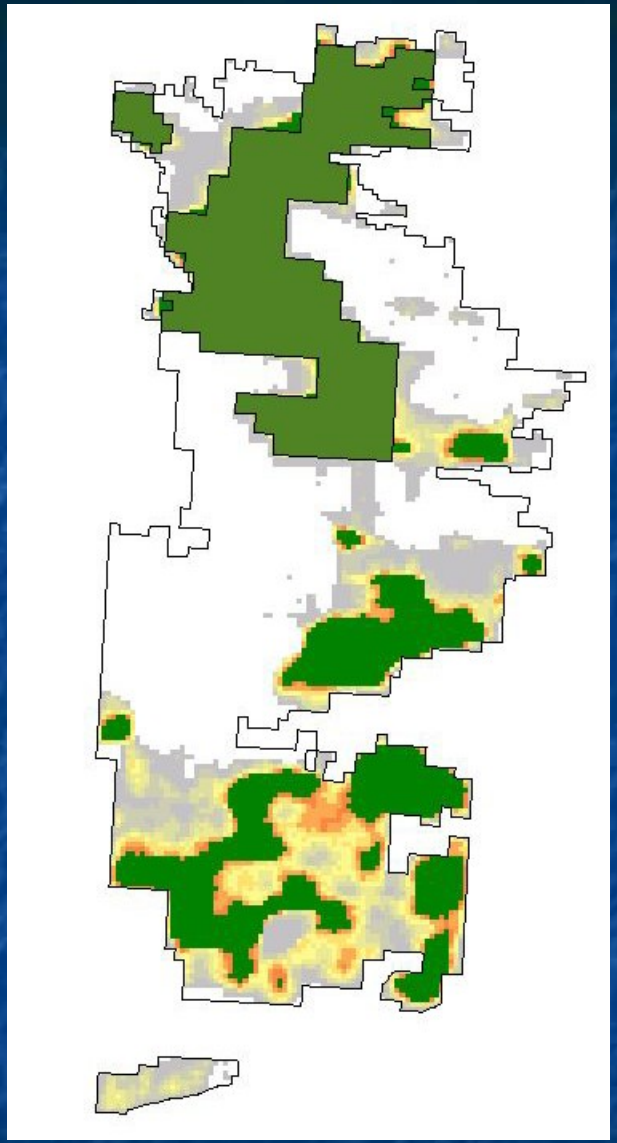


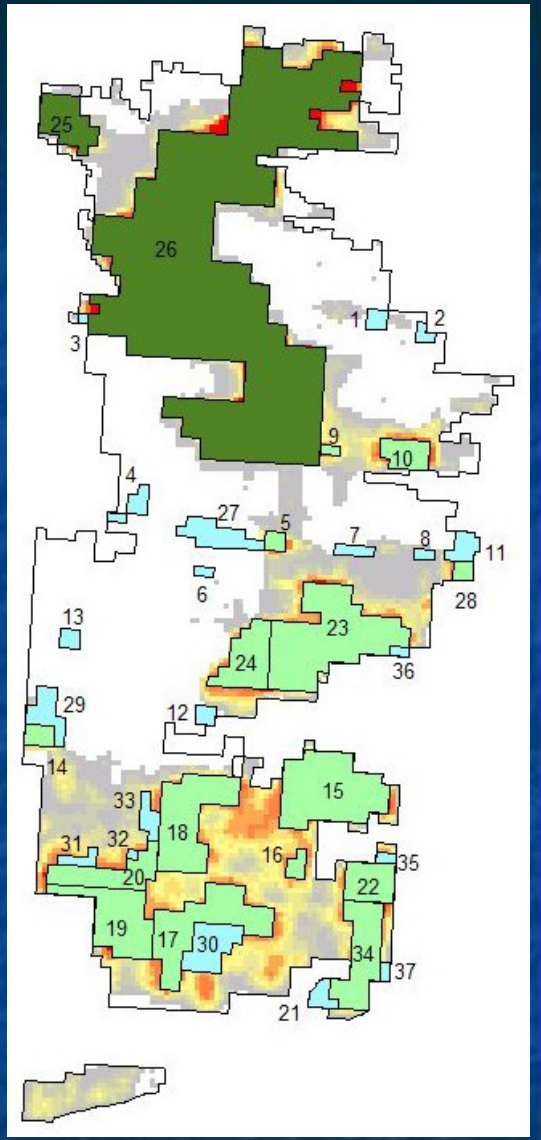
Exploring a range of goals with Marxan



65% 50% 40% 30% 20%



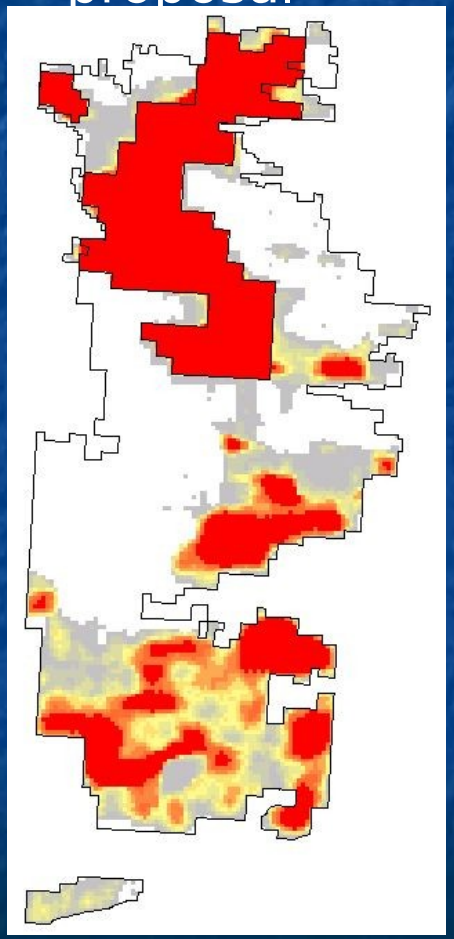




sum runs scores
≥75

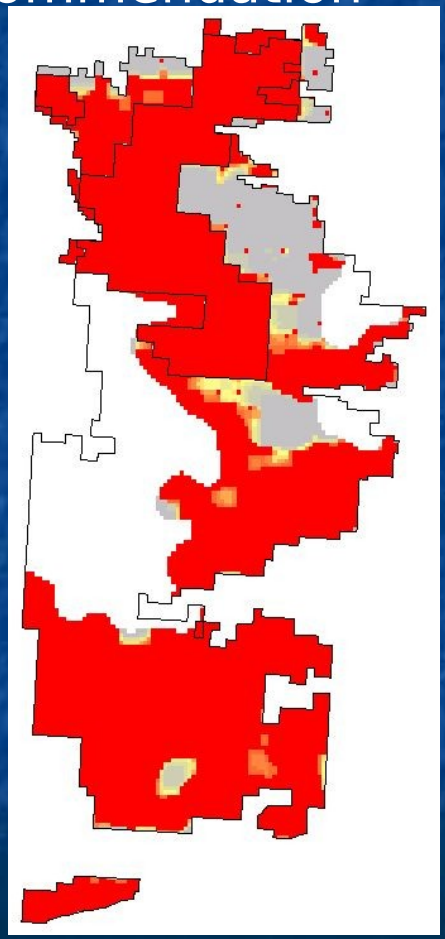
Epilogue

Our proposal



30%

Minister's recommendation



60%

ARC Centre of Excellence
Coral Reef Studies

Paired Study: Queensland and Oregon

the Conservation Planning Institute

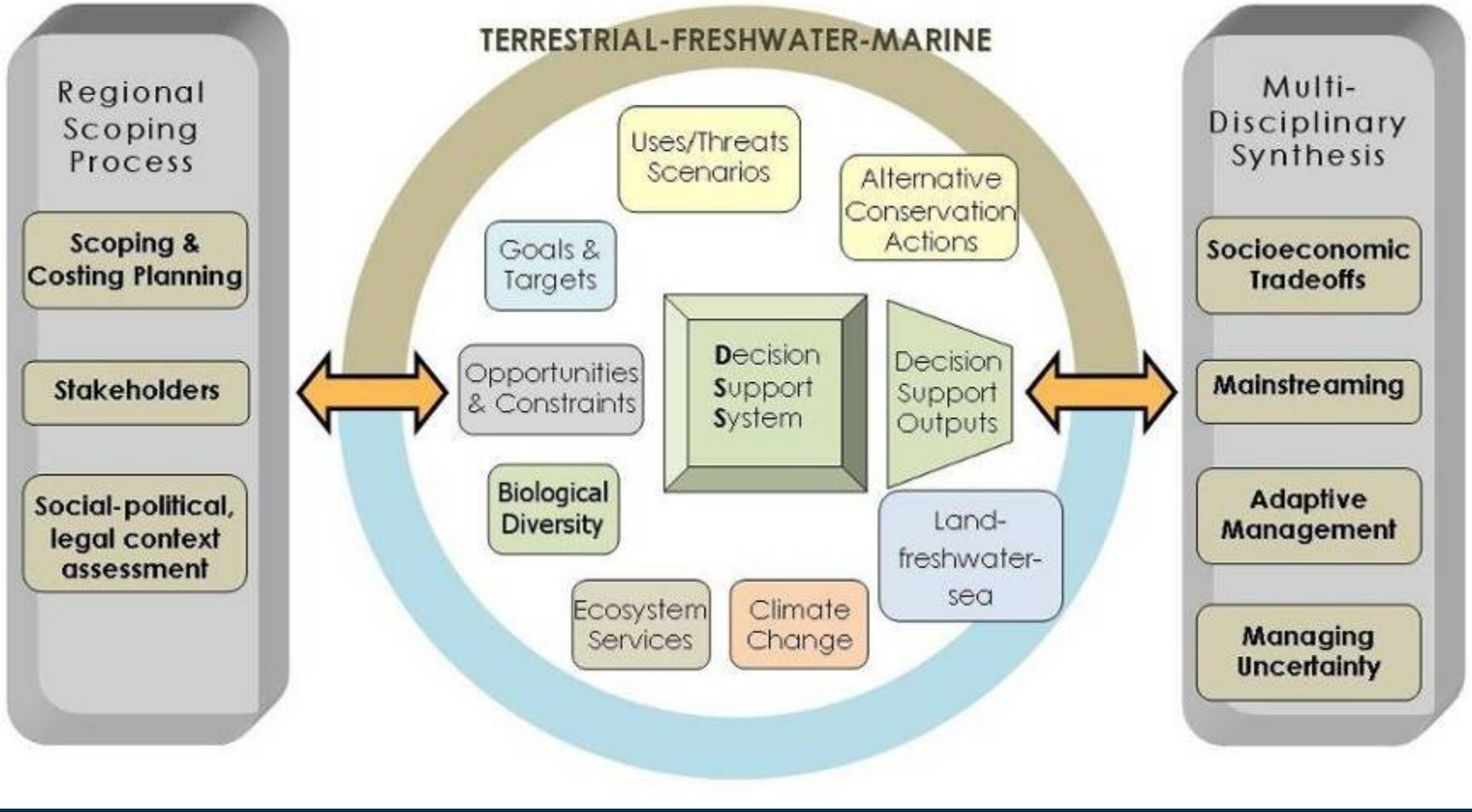




“The biodiversity planning component should be integrated into an implementation framework and not vice versa”

Cowling and Pressey 2003, Biological Conservation 112:1-13

Current Work: the Paired Study Project



Concluding thoughts

- Approaches to answering ‘the burning question’ are constantly evolving
- Frontiers in conservation science and planning include:
  - Freshwater conservation
  - Integrated land-freshwater-sea analysis and planning
  - Ecosystem services valuation and downstream cost/benefit sharing
  - Climate change
  - Limits to growth
  - Implementation: the knowing-doing gap

Burning Questions?



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