MODELING THE ENVIRONMENTAL PROTECTION AGENCY'S LEVEL IV ECOREGIONS WITHIN THE KLAMATH MOUNTAINS OF SOUTHERN OREGON AND NORTHERN CALIFORNIA:

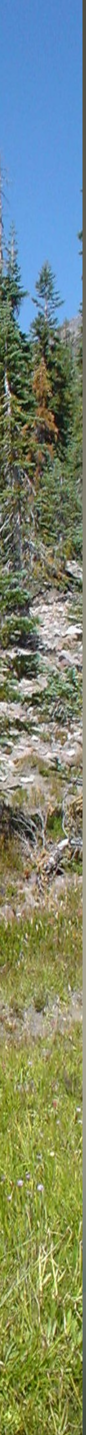
A Geographic Information System Approach

By
Chris Zanger
Master of Science Defense
November 30th, 2004

Committee

- Dawn Wright – Major Professor, Geosciences
- Dr. K – Minor Professor, Geosciences
- Alan Woods – Geosciences/EPA
- Denis White – Geosciences/EPA

Thanks!



Introduction

- Research rationale
- Research objectives
- EPA ecoregions background
- Methodology / Results
- Discussion
- Conclusions
- Future research

What are ecoregions?

Ecoregions are regions of relative homogeneity with respect to specific ecosystem variables (Omernik 1995)

Areas with similar ecology

Census blocks are used to inventory and analyze people, ecoregions can serve the same function for natural resource managers and researchers

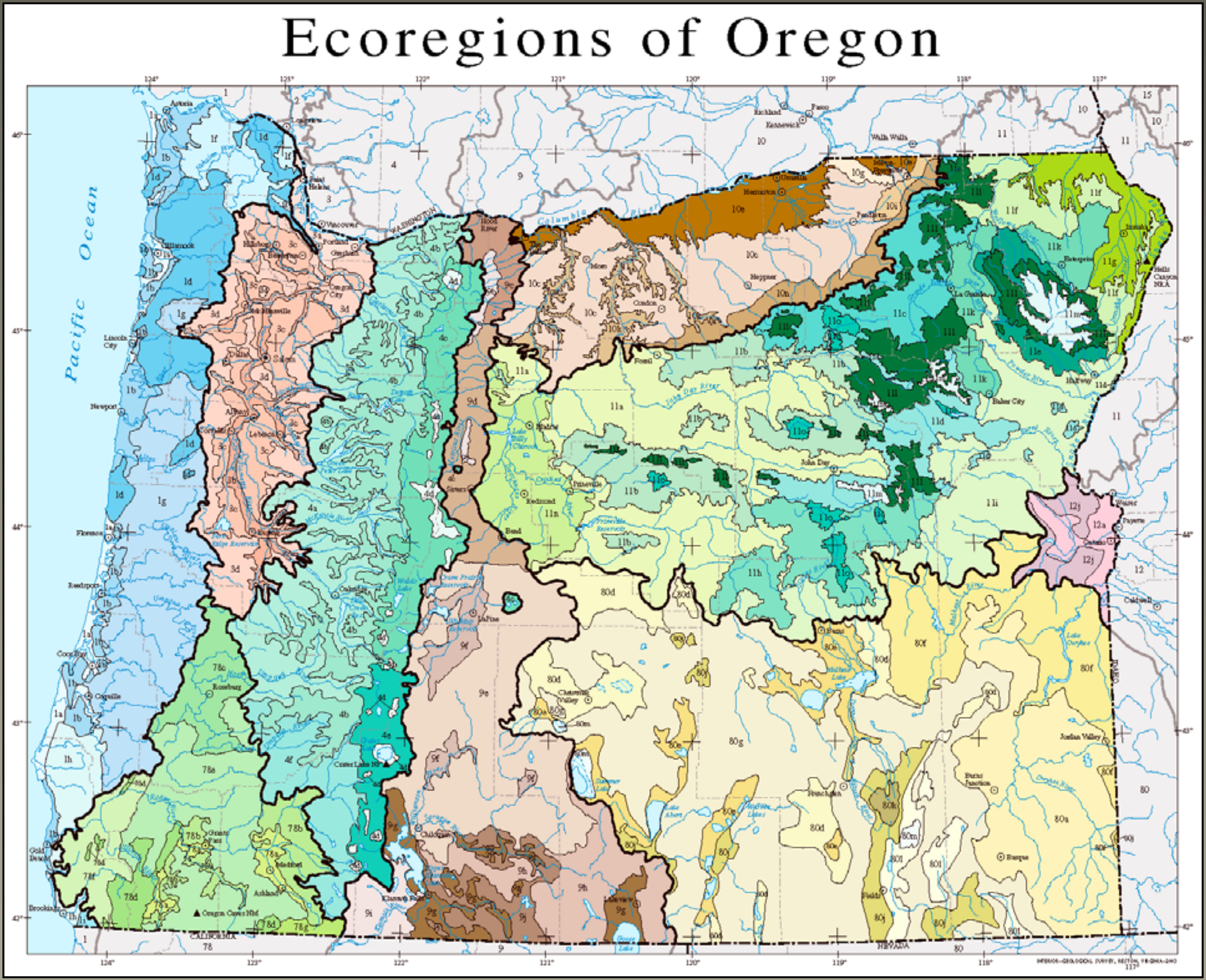
(EPA 2004)

What are ecoregions used for?

Ecoregions are used as a spatial framework for ecosystem management, inventory, and research (Omernik 1995)

Organizations using ecoregions include:

- E.P.A.
- Environment Canada
- U.S. Forest Service
- U.S.G.S.
- U.S. Fish and Wildlife Service
- The Nature Conservancy
- World Wildlife Fund
- The Sierra Club



(EPA 2004)

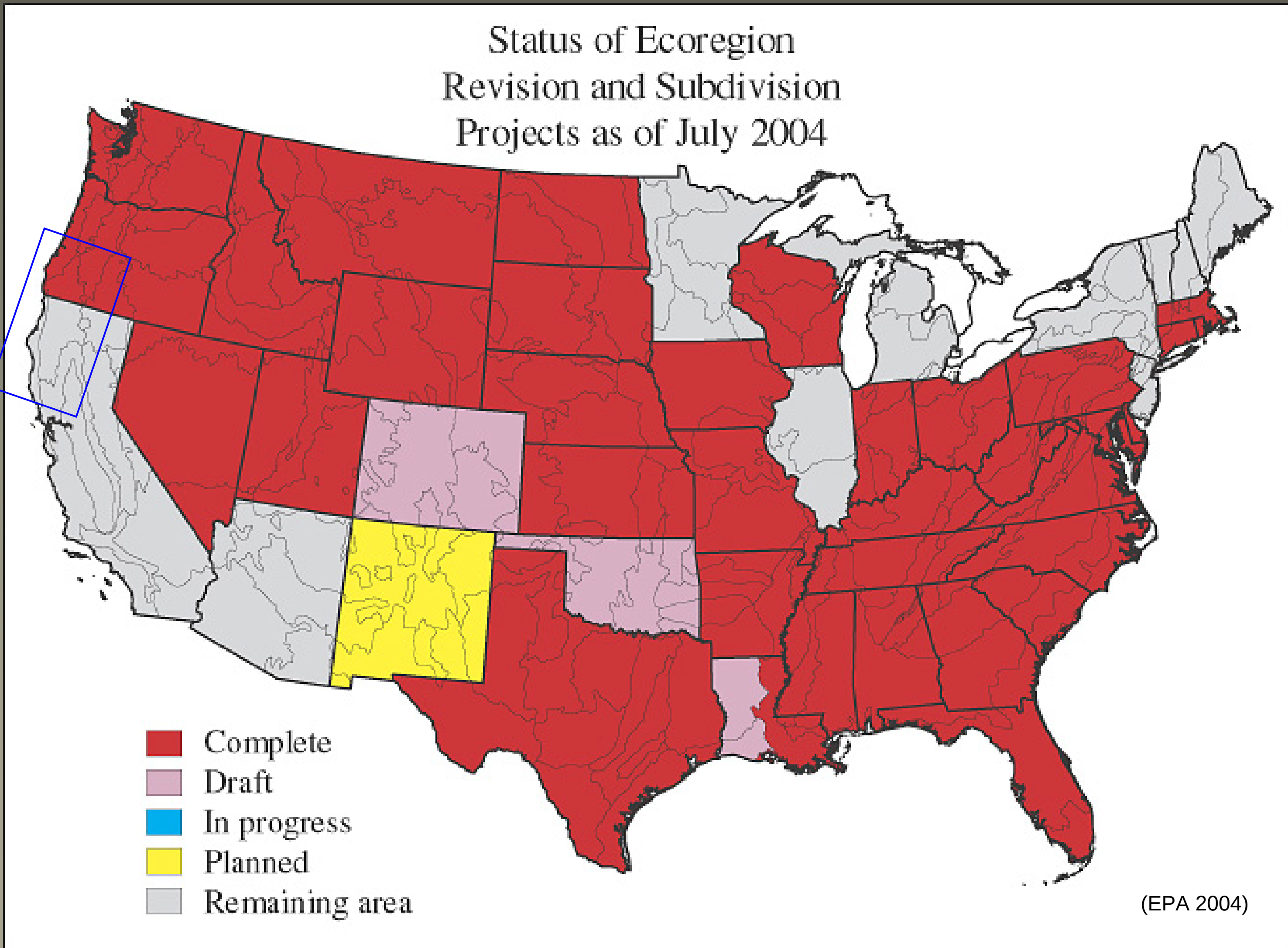
Research Rationale

Ecoregions' effectiveness as a management unit is significantly reduced when they are not transboundary

For example, note the Forest Service land and large-scale ecoregion delineations at the California/Oregon border

Research Rationale

Study Area is a transboundary ecoregion

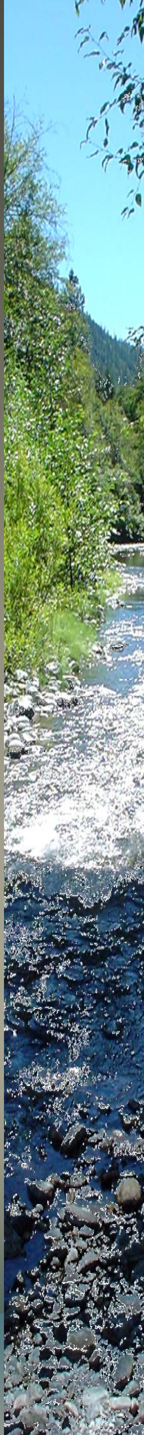


Research Objective

1. Build a descriptive GIS model of the seven large-scale ecoregions in Oregon
2. Prescribe the same scale ecoregion boundaries into the California portion of the Klamath Mountain Ecoregion
3. A transparent and repeatable process

Background:
EPA Ecoregions

- Multiple scales based on a spatial hierarchy developed by Jim Omernik (Bryce and Clark 1996)
- Developed by geographers through an iterative process of
    - Map analysis (multiple maps of geographic phenomena)
    - Collaboration and input from regional experts
    - Extensive literature review of the area
- Integrate all the information into a final map product…



EPA – Level I

(EPA 2004)

Continental scale

15 Transboundary ecoregions in Canada, USA, and Mexico

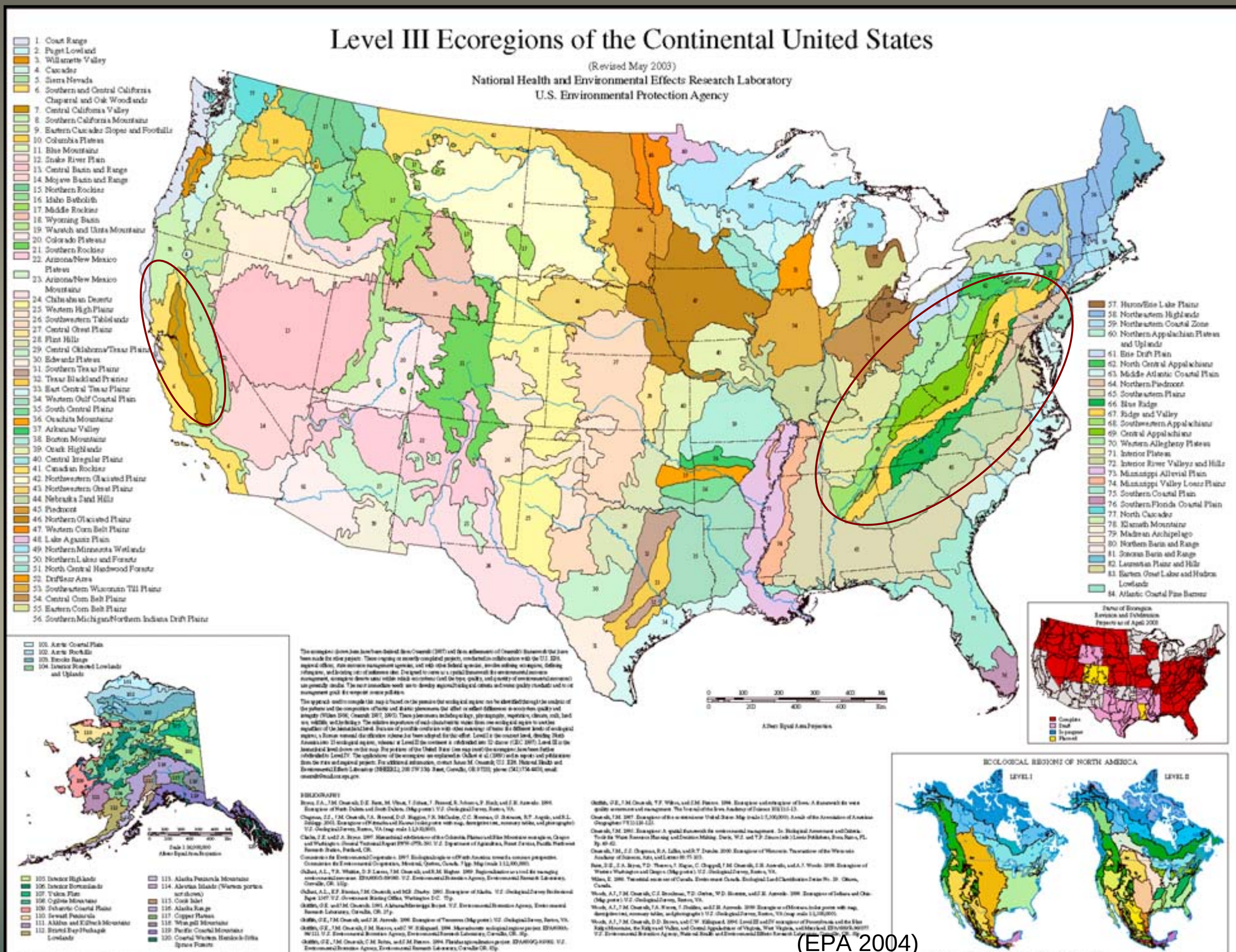
EPA – Level II

(EPA 2004)

Continental scale

52 Transboundary ecoregions in Canada, USA, and Mexico

EPA – Level III



(EPA 2004)

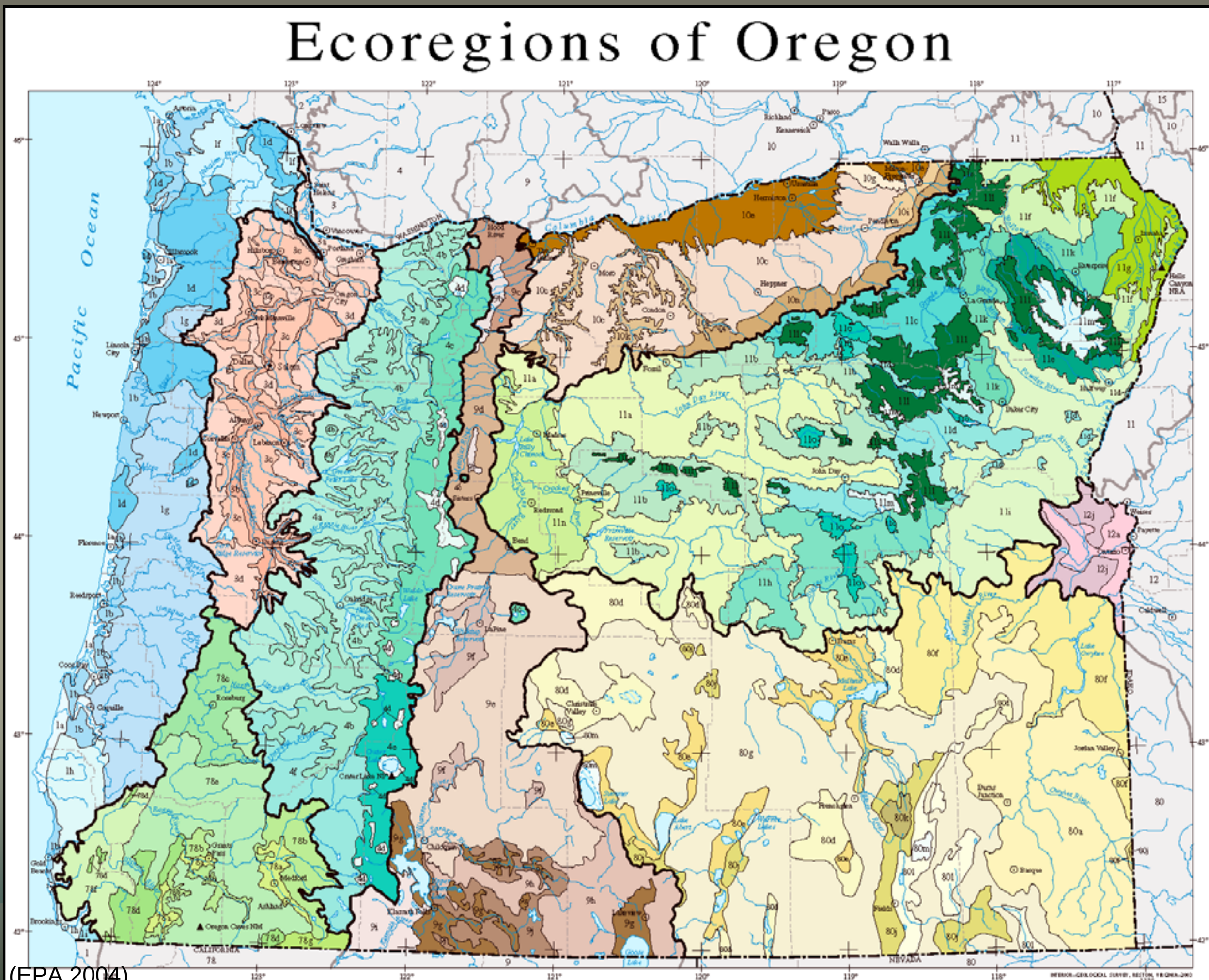
Sub-continental scale

84 ecoregions in the conterminous U.S., and an additional 20 ecoregions in Alaska

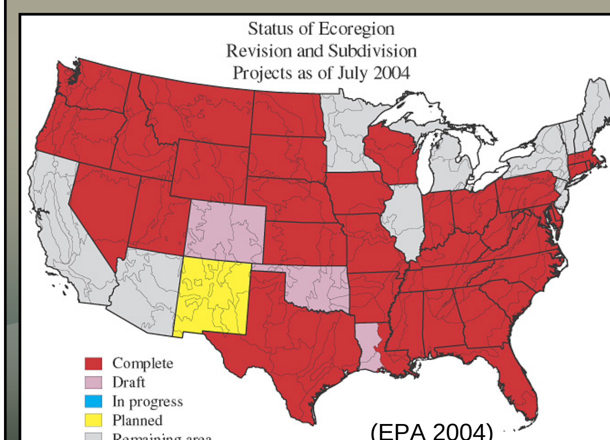
EPA – Level IV

State wide scale

Level IV ecoregions are sub-regions (denoted by similar chroma) within the Level III boundaries



(EPA 2004)



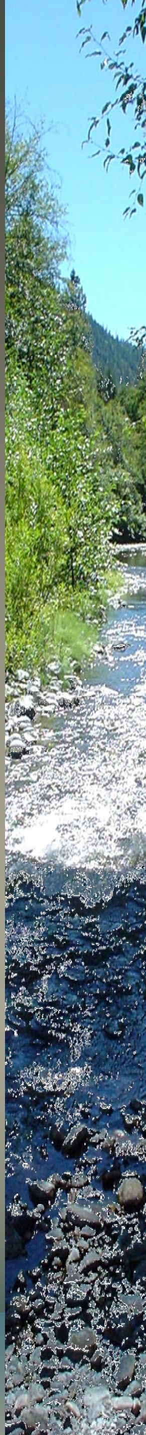
(EPA 2004)

Methods

- Surface water variable analysis
- Calculated Ecoregions
  - Functional Operations
    - IDW
    - Neighborhood
- Unsupervised classification - ISODATA

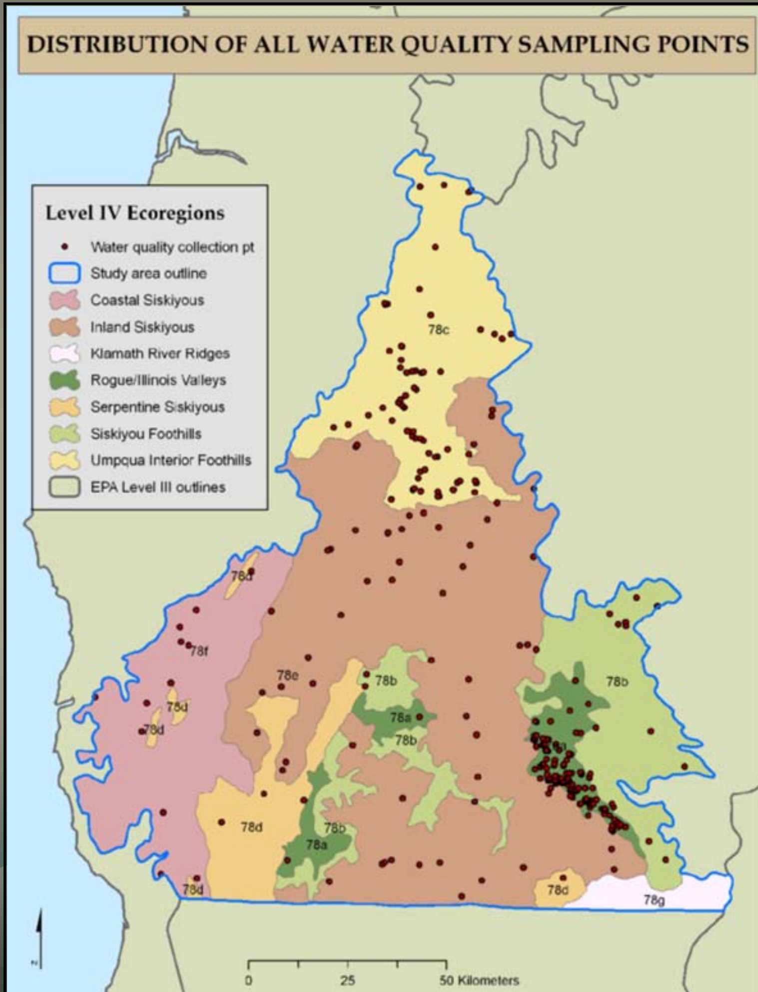
Surface Water Analysis

- Surface Water reflects the aggregate of characteristics of the watershed in which they drain (Omernik 1995)
- Surface-water-quality variables can be correlated with ecoregions through which the water primarily flows (Clarke et al. 1991, Hughes and Larsen 1988, Larsen et al. 1986, Lyons 1989, Omernik and Griffith 1991, Griffith et al. 1999)
- Hypothesis – Interpolated surfaces of variable concentrations could be used to model ecoregions



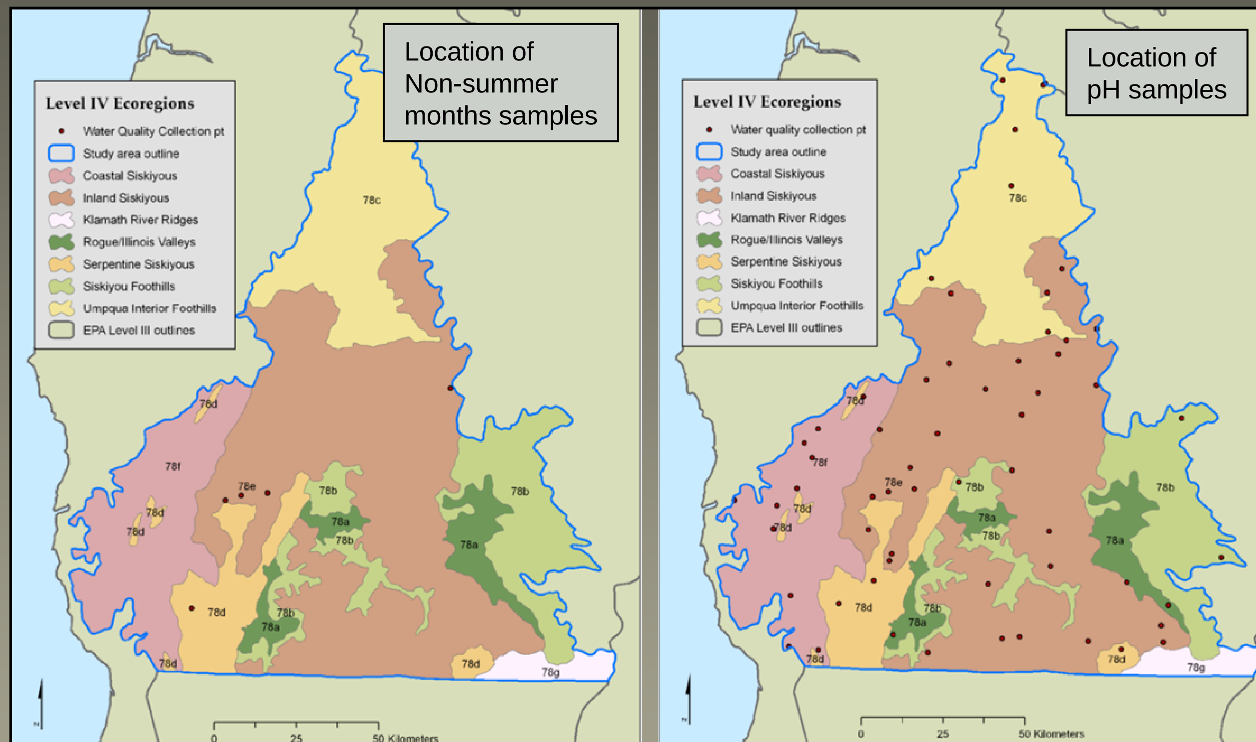
Surface Water Analysis cont…

- Tabular data of water quality samples were gathered from EPA and USGS
- Each of the sampling locations were plotted on a map of Level IV ecoregions



Surface Water Analysis cont…

- The data were plotted on a map for each of the variables in the table
- There were lack of spatial and temporal richness in the data when plotted by variable



- Due to the limited number of sampling points a substitute modeling technique was pursued…

Calculated Ecoregions

- Goal was to build a model based on a set of “rules” or definitions for each of the Level IV ecoregions
- Model based on the descriptive table of EPA Level IV ecoregions

Model Criteria Table

Region	Grid #	Elevation (ft) Min	Elevation (ft) Max	Precipitation (in) Min	Precipitation (in) Max	Geol values	Soil values	Veg values
78-A	1	900	2000	20	60	2, 6, 41, 113, 79	27, 34, 45, 46	5, 7, 51, 52
78-B	2	1400	4000	25	45	2, 58, 76, 113, 114	27, 41, 44, 83, 134	7, 23, 26, 28, 52
78-C	3	400	2800	30	50	2, 40, 69, 74, 75, 96, 104	4, 27, 78, 83	6, 7, 8, 28
78-D	4	1500	4300	45	120	14, 30, 73, 118	34, 44, 83, 160	28, 52, 60, 62
78-E	5	800	7000	35	70	14, 47, 60, 76, 109	34, 41, 45, 47, 89	6, 7, 28, 51, 52
78-F	6	600	5300	70	130	69, 73, 96, 108	48, 81, 83	8, 28, 52, 55
78-G	7	3800	7500	25	35	48, 58, 76	43, 44, 48, 172, 175, 197	6, 13, 45, 52

78. KLAMATH MOUNTAINS

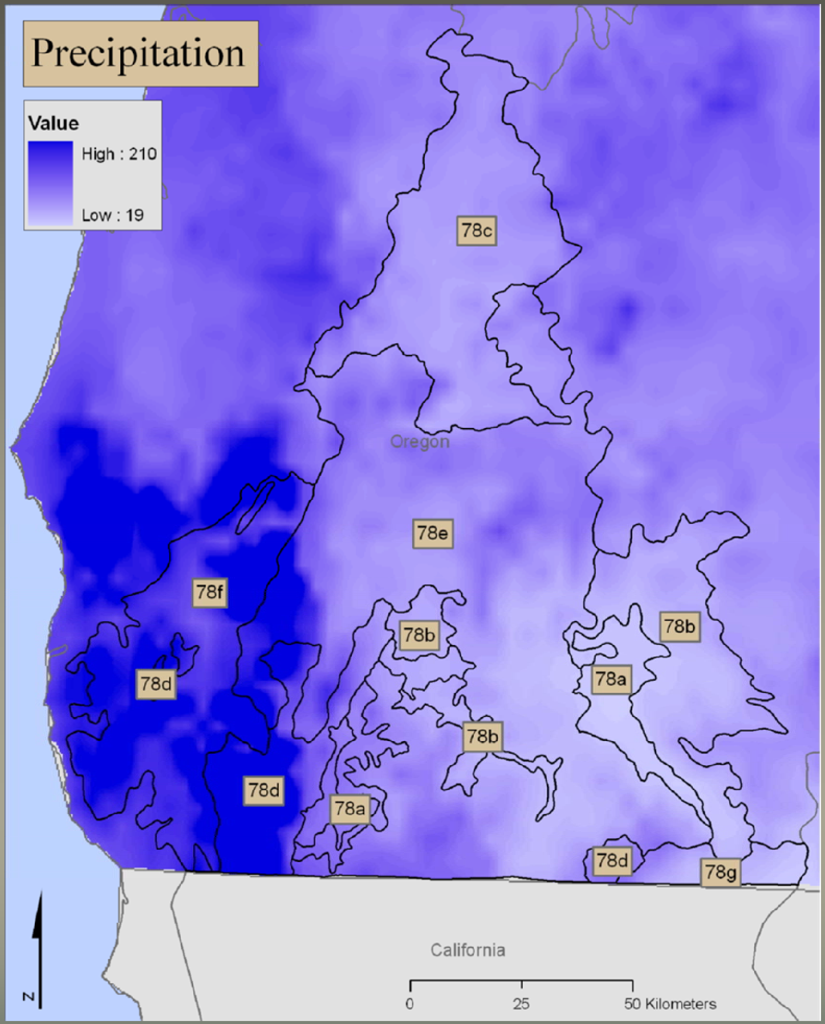
Level IV Ecoregions	Area (square miles)	Physiography	Elevation/ Local Relief (feet)	Geology: Surficial and Bedrock	Soils: Order (Great Group)	Soils: Common Soil Series	Soils: Temperature/ Moisture Regimes	Climate: Precipitation Mean annual (inches)	Climate: Frost Free Mean annual (days)	Climate: Mean Temperature January min/max; July min/max (°F)	Potential Natural Vegetation*/ Present Vegetation (*Source: Kuchler, 1964)	Land Cover and Land Use
78a. Rogue/Illinois Valleys	285	Terraces and floodplains in mountain valleys.	900-2000/ mostly less than 100-200; max. 600	Quaternary fluvial terrace and floodplain deposits.	Mollisols (Haploxerolls, Argixerolls), Alfisols (Palexeralfs), Inceptisols (Haploxerepts, Endoaquepts)	On floodplains: Newberg, Camas, Evans. On valley terraces: Medford, Foehlin, Central Point. On fans: Ruch, Barron, Clawson.	Mesic/ Xeric	20-60	120-180	31/47; 51/89	Mostly Oregon oak woods; scattered Douglas-fir forest and grasslands/ Oregon white oak, madrone, California black oak, ponderosa pine, and grasslands. Common understory plants include California fescue, snowberry, and serviceberry. In riparian areas: willow and cottonwood.	Woodland, grassland, orchards, cropland, pastureland, and rural residential, residential, and commercial development.
78b. Oak Savanna Foothills	818	Moderately sloping mountain foothills with medium gradient streams.	1400-4000/ 400-2000	Quaternary colluvium and alluvium. In east: Eocene basaltic lava flows. In west: Jurassic sandstone and shale.	Mollisols (Haploxerolls, Argixerolls), Inceptisols (Haploxerepts), Vertisols (Haploxererts)	Medco, McMullin, McNull, Brader, Debenger, Carney	Mesic/ Xeric	25-45	110-160	28/45; 50/87	Oregon oak woods and Douglas-fir forest/ Oregon white oak and California black oak woodlands, madrone, and ponderosa pine, grassland savanna. Wetter areas: Douglas-fir and incense cedar. Understory species include oceanspray, poison oak, snowberry, Idaho fescue, California brome, roughstalk bluegrass, and ceanothus.	Woodland, forest, grassland–savanna, rangeland, orchards, and some row cropland. Rural residential development and some logging.
78c. Umpqua Interior Foothills	921	Foothills and narrow interior valleys containing fluvial terraces and floodplains.	400-2800/ less than 100-1900	Quaternary alluvium and colluvium. Pliocene marine sandstone. Eocene basalt.	Mollisols (Haploxerolls, Argixerolls, Argiaquolls), Alfisols (Haploxeralfs), Inceptisols (Dystroxerepts)	On terraces: Conser, Newberg, Roseburg. On foothills: Oakland, Sutherlin, Nonpareil.	Mesic/ Xeric	30-50	120-180	34/49; 53/84	Douglas-fir forest and Oregon oak woods/ Oregon white oak, Douglas-fir, ponderosa pine, grand fir, madrone, tanoak, and chinkapin. Understory plants include snowberry, salal, Oregon grape, poison oak, oceanspray, and swordfern.	Woodland, forest, pastureland, vineyards, orchards, cropland, and rural residential, commercial, and residential development.
78d. Serpentine Siskiyous	440	Highly dissected mountains containing perennial, high gradient streams.	1500-4300/ 600-2400	Quaternary colluvium. Jurassic ultramafic and related rocks.	Alfisols (Haploxeralfs), Inceptisols (Dystroxerepts)	Pearsoll, Dubakella, Eightlar, Perdin, Gravecreek	Mesic, Frigid/ Xeric	45-120	70-140	32/44; 49/82	Mixed conifer forest and montane chaparral/ Jeffrey pine, tanoak, incense cedar, Douglas-fir, and chaparral composed of manzanita, ceanothus, Idaho fescue, and Lemmon needlegrass. Soils derived from serpentine support unique understory species and sparse woodland vegetation.	Sparse woodland. Recreation, logging, and mining. Historical gold, nickel, chrome, copper, and mercury mining.
78e. Inland Siskiyous	2610	Highly dissected mountains with high gradient streams. A few small lakes are found at higher elevations.	800-7000/ 1000-2800	Quaternary colluvium. Jurassic granitic rocks, shale, and sandstone.	Alfisols (Haploxeralfs), Inceptisols (Haploxerepts, Dystroxerepts), Ultisols (Haploxerults)	Vannoy, Caris, Offenbacher, Josephine, Beekman, Kanid, Siskiyou, Tethrick	Mesic, Frigid/ Xeric	35-70	90-160	29/44; 50/86	Mixed conifer forest/ Douglas-fir, ponderosa pine, Oregon white oak, California black oak, madrone, serviceberry, snowberry, Oregon grape, California fescue, and poison oak.	Forest. Logging, recreation, rural residential development, and mining.
78f. Coastal Siskiyous	853	Highly dissected mountains with high gradient streams.	600-5300/ 1000-2700	Quaternary colluvium. Cretaceous and Jurassic conglomerate, sandstone, and siltstone.	Inceptisols (Dystrudepts, Dystroxerepts), Ultisols (Palehumults, Palexerults)	Fritsland, Bravo, Cassiday, Deadline, Barkshanty, Nailkeg, Jayar, Althouse, Skymor, Atring, Kanid, Acker	Mesic, Frigid/ West: Udic; East: Xeric	70-130	100-190	38/50; 50/76	Mostly mixed conifer forest/ Tanoak, Douglas-fir, madrone, bigleaf maple, California laurel, Port Orford cedar, chinkapin, salal, rhododendron, and swordfern; some western hemlock in west on udic soils.	Forest. Logging, recreation, rural residential development, and some mining.
78g. Klamath River Ridges	121	Highly dissected mountains containing high gradient streams.	3800-7500/ 800-3000	Quaternary colluvium. Miocene and Oligocene basaltic and andesitic flows. Jurassic granitic rocks.	Mollisols (Argixerolls, Haploxerolls)	Skookum, McMullin, McNull	Mesic/ Xeric	25-35	90-160	24/42; 49/88	Montane chaparral and mixed conifer forest/ Higher altitudes and north-facing slopes: Douglas-fir and white fir. Lower altitudes and south-facing slopes: ponderosa pine, western juniper, and chaparral. Oregon grape, western fescue, snowberry, bluebunch wheatgrass, and ceanothus.	Forest, woodland, savanna, and chaparral. Logging, livestock grazing, and recreation.

Calculated Ecoregions cont...

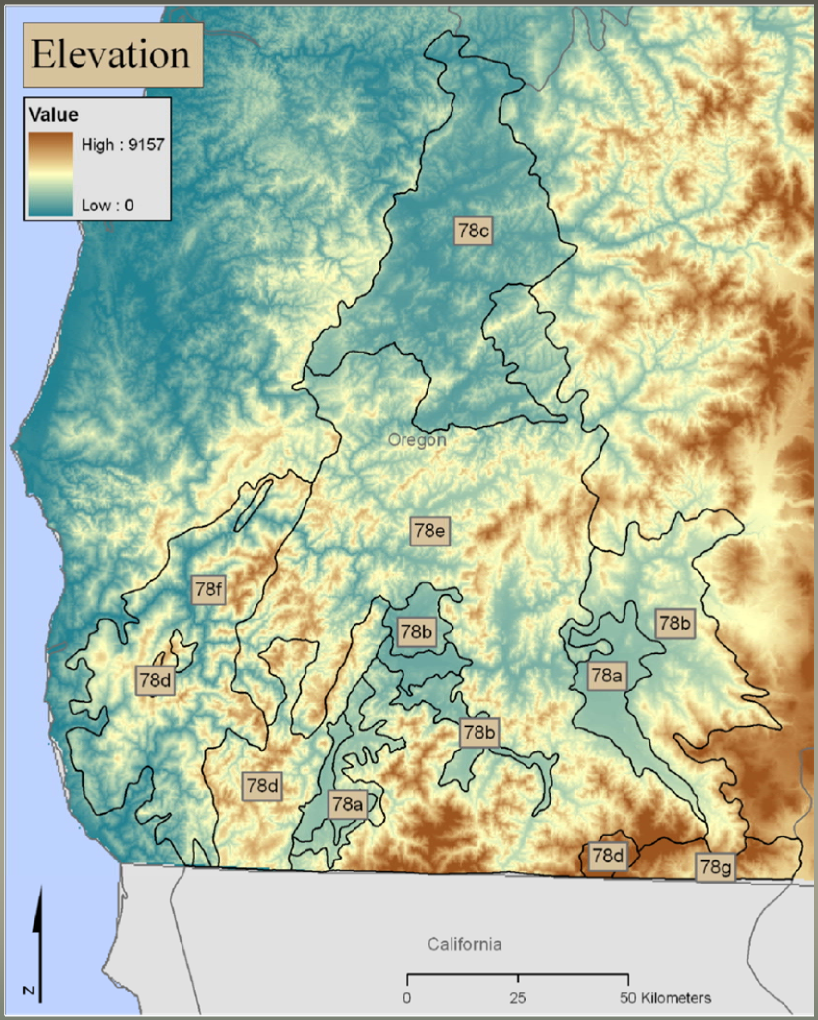
1. Develop a Model Criteria table for GIS data
2. GIS data were acquired for all available fields in Level IV definition table
3. The GIS data that are too homogenous across study area are not used
4. Identify and match attributes between GIS data and Level IV definitions
5. Qualitative assessment is used to determine matches and associated values

EPA definition table	**Model Criteria table**
Fields Available	Fields
Ecoregion Name	N/A
Area	N/A
Physiography	N/A
Elevation	Elevation
Local Relief	Elevation
Geology Age	N/A
Geology Lithology	Geology
Soil Order	N/A
Soil Common Series	Soil
Soil Temperature regime	N/A
Soil Moisture regime	N/A
Climate - Precipitation	Precipitation
Climate - Frost Free days	N/A
Climate - Mean Temperature	N/A
Vegetation - Potential	N/A
Vegetation - Present	Vegetation
Land Cover and Land Use	Vegetation

Data – *Raster*

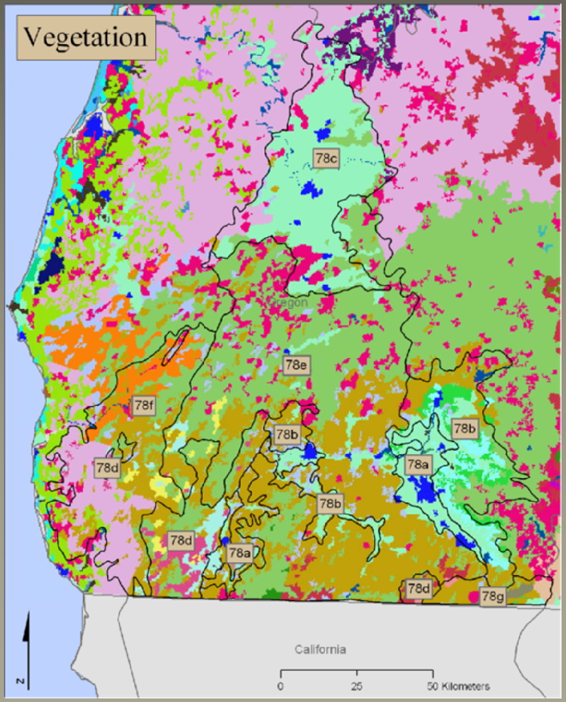


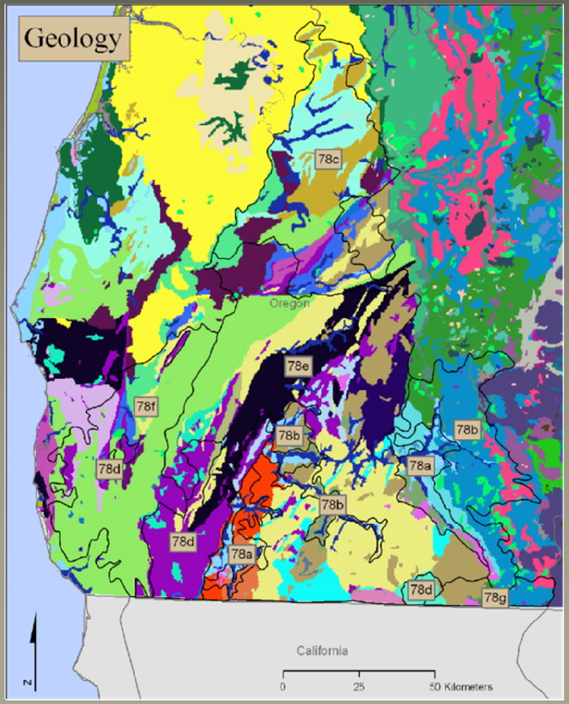
Precipitation
Value
High : 210
Low : 19
78c
Oregon
78e
78f
78b
78b
78d
78a
78b
78d
78a
78d
78g
California
0
25
50 Kilometers
N

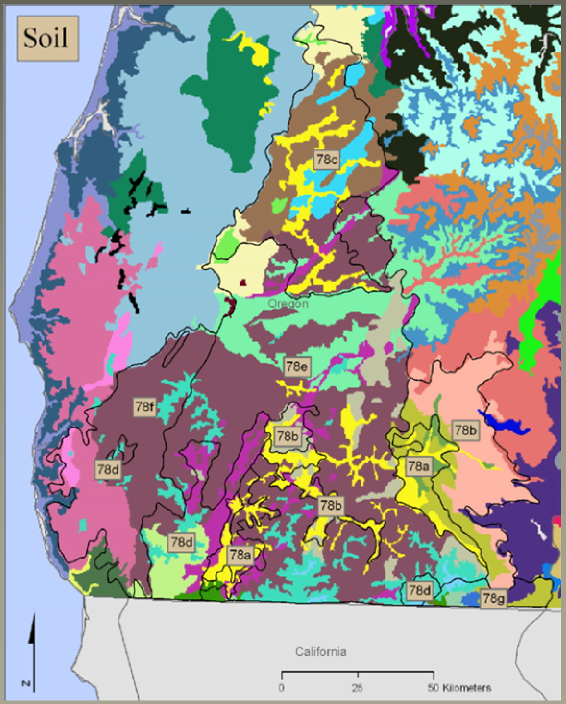


Elevation
Value
High : 9157
Low : 0
78c
Oregon
78e
78f
78b
78b
78d
78a
78b
78d
78a
78d
78g
California
0
25
50 Kilometers
N

Data – Vector


Vegetation
78c
Oregon
78e
78f
78b
78d
78b
78a
78b
78d
78a
78d
78g
California
0
25
50 Kilometers
N


Geology
78c
Oregon
78e
78f
78b
78b
78d
78a
78b
78d
78a
78d
78g
California
0
25
50 Kilometers
N


Soil
78c
Oregon
78e
78f
78b
78b
78d
78a
78b
78d
78a
78d
78g
California
0
25
50 Kilometers
N

Calculated Ecoregions cont...

- Completed Model Criteria Table
  - Numerical values were used for nominal data to allow for easy raster conversion

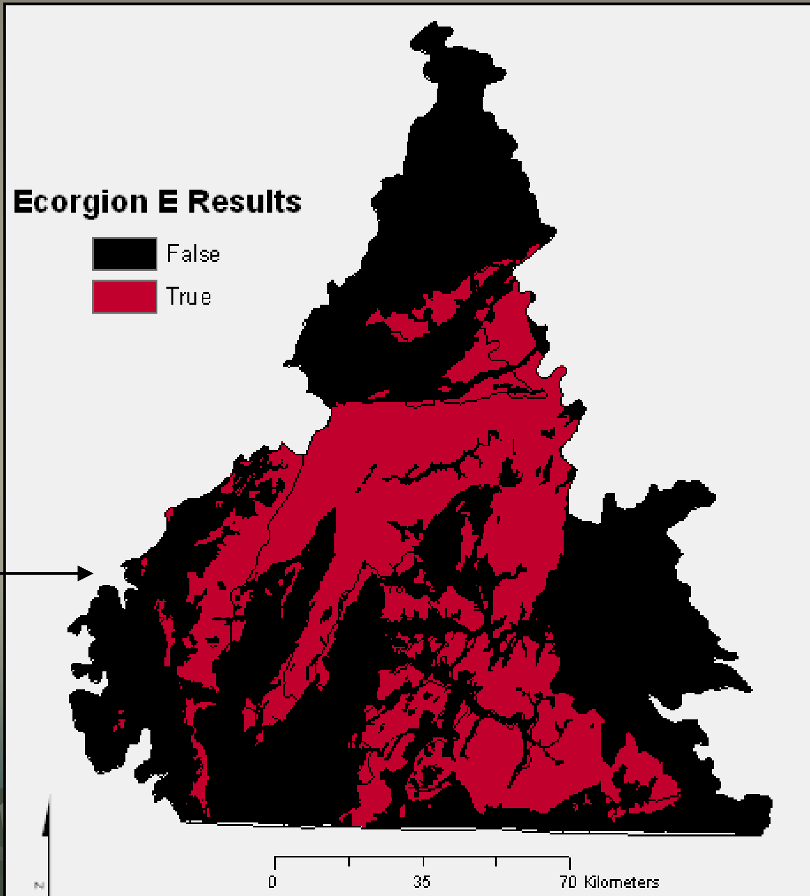
Model Criteria Table								
Region	Grid #	Elevation (ft)		Precipitation (in)		Geol values	Soil values	Veg values
		Min	Max	Min	Max			
78-A	1	900	2000	20	60	2, 6, 41, 113, 79	27, 34, 45, 46	5, 7, 51, 52
78-B	2	1400	4000	25	45	2, 58, 76, 113, 114	27, 41, 46, 83, 134	7, 23, 26, 28, 52
78-C	3	400	2800	30	50	2, 40, 69, 74, 75, 96, 104	4, 27, 78, 83	6, 7, 8, 28
78-D	4	1500	4300	45	120	16, 30, 73, 118	34, 48, 83, 160	28, 52, 60, 62
78-E	5	800	7000	35	70	16, 47, 69, 76, 109	34, 41, 48, 67, 83	6, 7. 28, 51, 52
78-F	6	600	5300	70	130	69, 73, 96, 108	48, 81, 83	8, 28, 52, 55
78-G	7	3800	7500	25	35	48, 58, 76	43, 46, 48, 172, 175, 187	6, 13, 45, 52

Calculated Ecoregions cont...

- All data were converted to raster with 300 meter cell size
- GIS analysis was performed in ArcGIS 9 (ArcInfo license)
  - ArcInfo GIRD and Raster Calculator in Spatial Analyst extension

Nominal Data

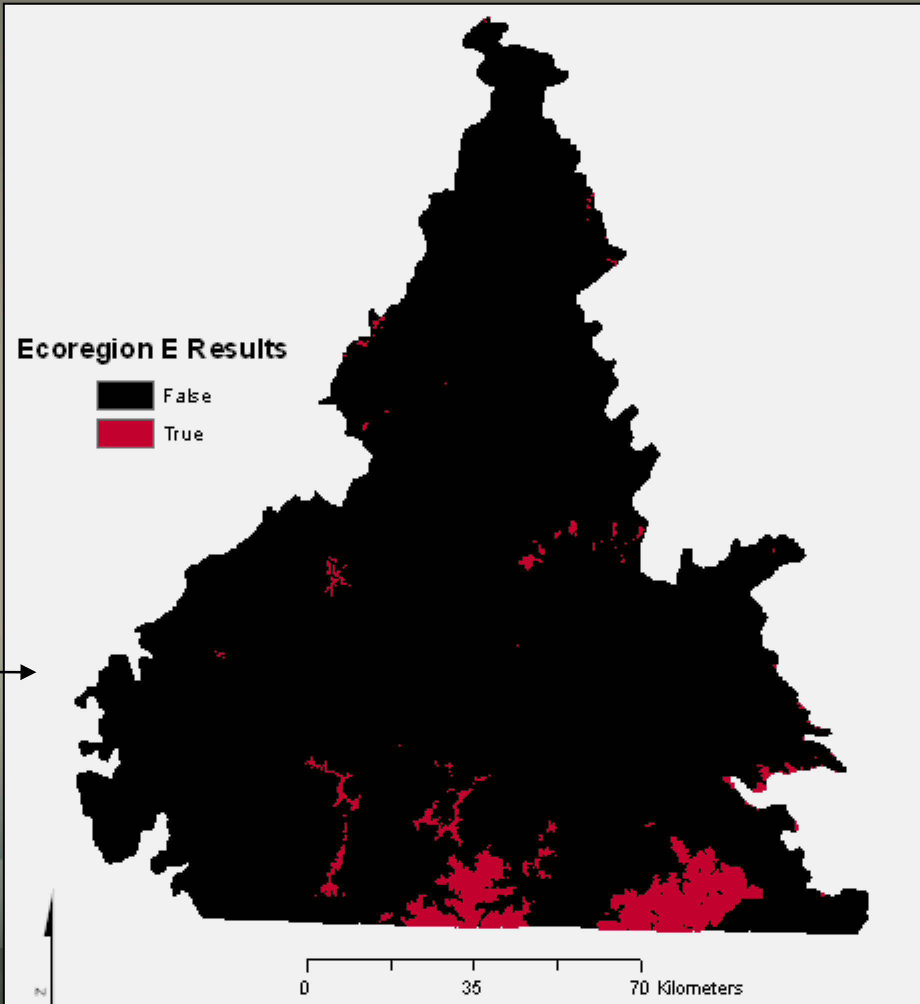
- A conditional argument (.con) was performed on the nominal data to identify locations that had values in each of the Geology, Soil and Vegetation fields – output was a binary grid of true/false for each ecoregion



Calculated Ecoregions cont...

Interval/Ratio Data

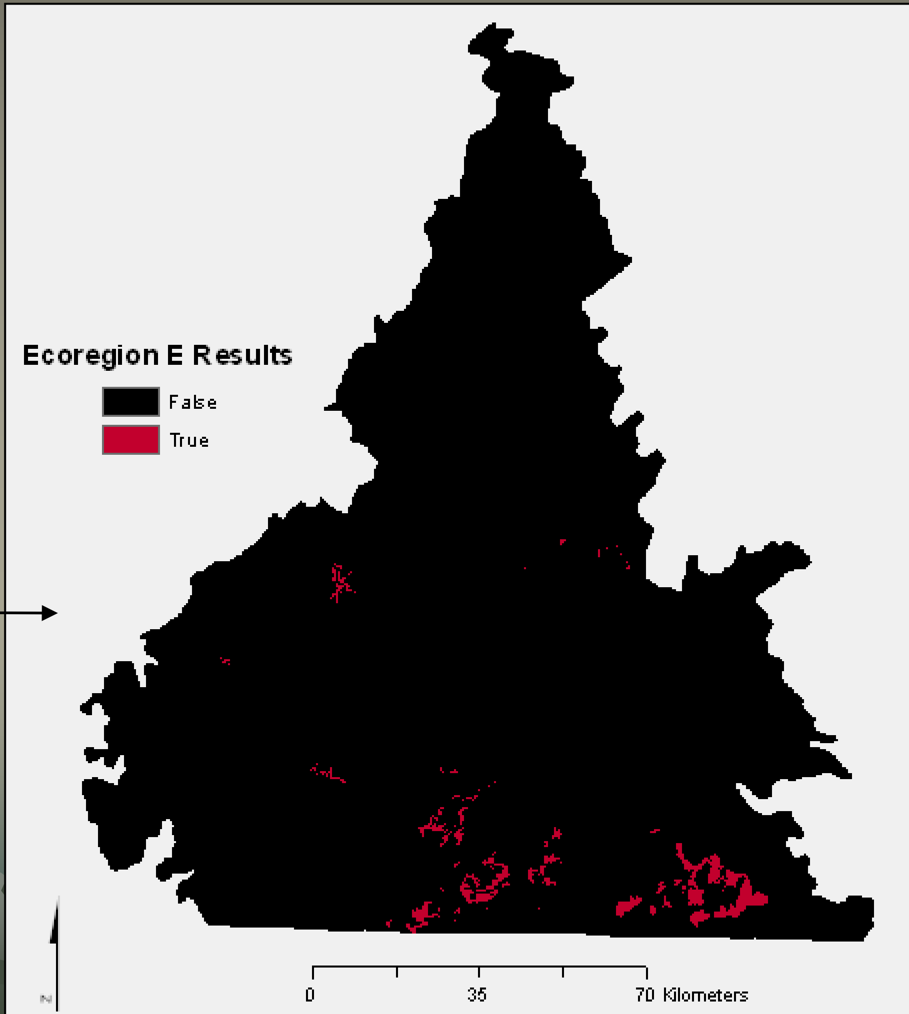
- An If-Then-Else query was performed on the Interval/Ratio data that identified locations that had values within the ranges for both the Elevation and Precipitation fields – output was a binary grid of true/false for each ecoregion



Calculated Ecoregions cont...

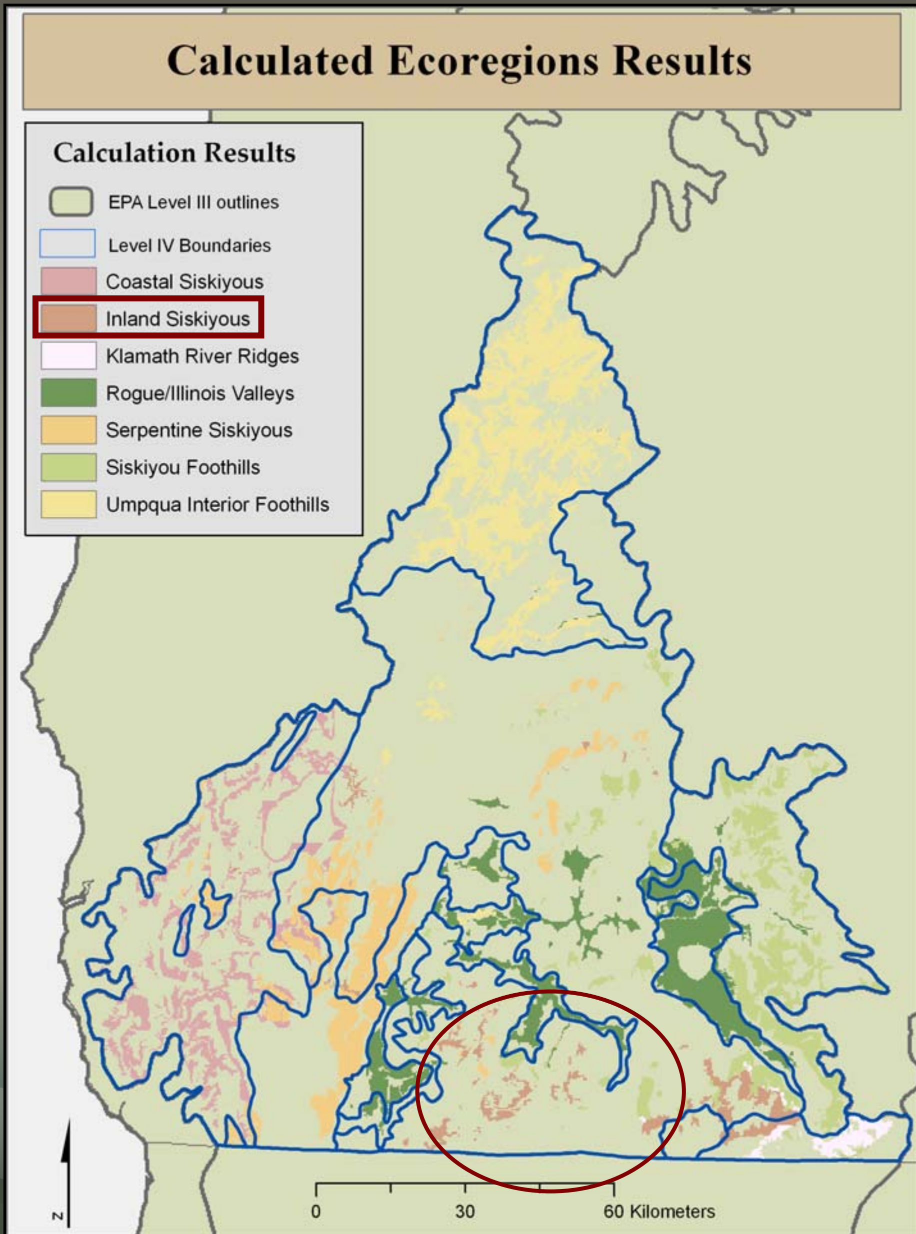
Interval/Ratio data combined with Nominal data

- The results of the Conditional Argument and the If-Then-Else query were combined
- Cells in the resulting grid were true when both the Interval /Ratio results and Nominal results are true



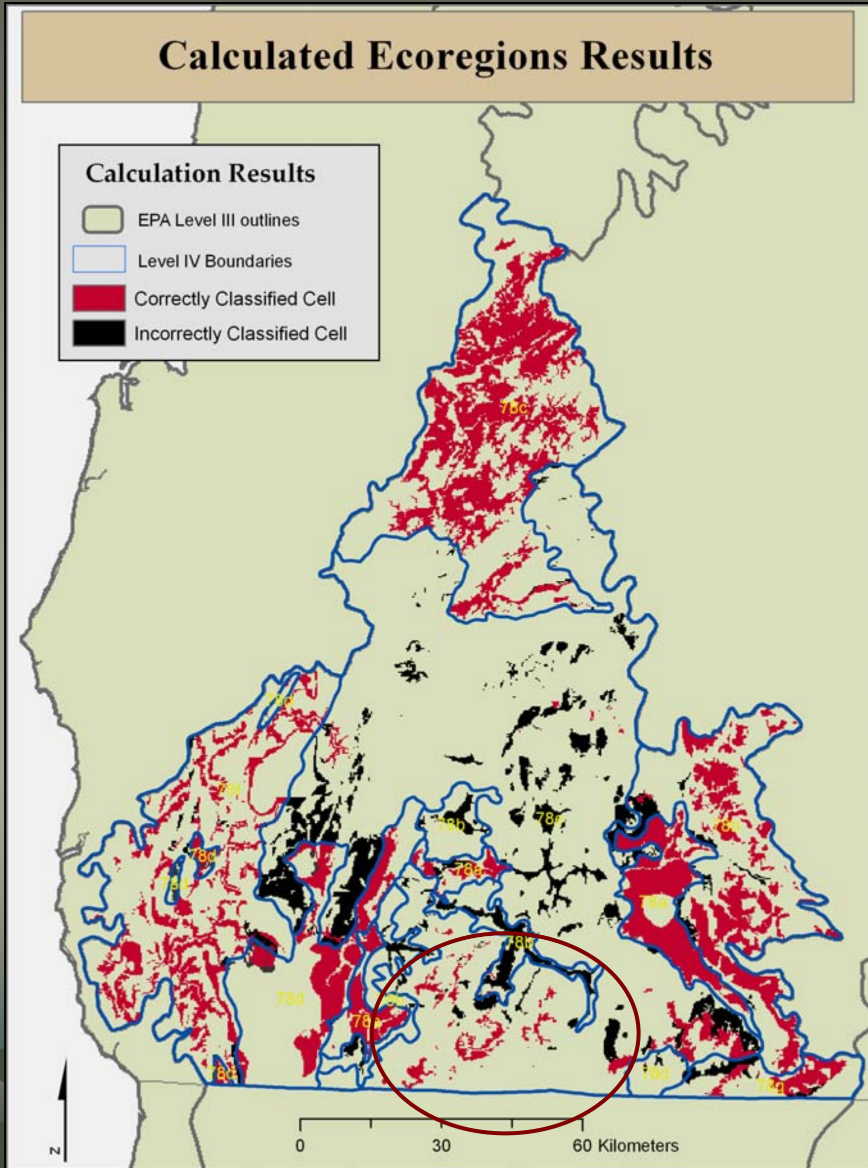
Calculated Ecoregions cont...

- Results for each ecoregion were combined into one grid with a unique value for each ecoregion
- Only true values were preserved



Calculated Ecoregions cont...

- A combined results grid was calculated
  - correctly classified
  - Incorrectly classified
  - null classified
- results were exported to Excel as a DBF file



Calculated Ecoregions cont...

- The results were summarized in Excel for each classification per ecoregion

Percent land cover of calculated Level IV Regions								
Grid #	**Level IV Region**	**Correctly Classified grid cells**		**Incorrectly Classified grid cells**		**Null Classified grid cells**		**EPA Level IV grid cells**
1	Rogue / Illinois Valleys	4,887	61%	139	2%	2,930	37%	7,956
2	Oak Savanna Foothills	4,594	20%	2,866	13%	15,359	67%	22,819
3	Umpqua Interior Foothills	10,157	40%	38	0%	15,481	60%	25,676
4	Serpentine Siskiyous	3,483	29%	425	3%	8,239	68%	12,147
5	Inland Siskiyous	1,979	3%	7,849	11%	62,800	86%	72,628
6	Coastal Siskiyous	5,462	23%	426	2%	17,909	75%	23,797
7	Klamath River Ridges	762	23%	367	11%	2,507	77%	3,269
Total		31,324	19%	12,110	7%	125,225	74%	168,292

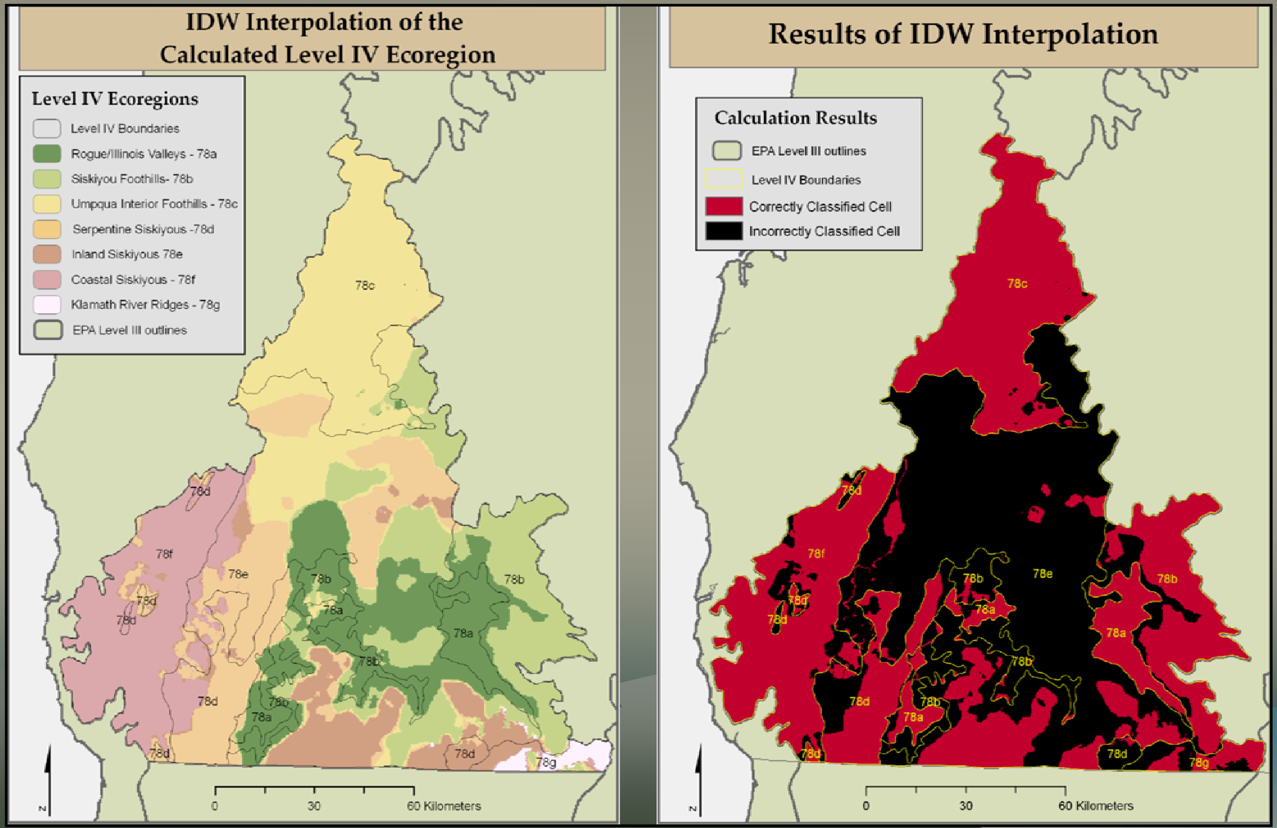
Functional Operations

- In an attempt to decrease the number of cells that were classified as null, some of the Functional Operations in Spatial Analyst were explored
  – Inverse Distance Weighting (IDW)
  – Neighborhood Analysis

Functional Operation – IDW

- IDW – calculated a value for every cell in the study area based on the value of the horizontally closest cell

- Again, a grid of the results was calculated and exported to Excel as a DBF



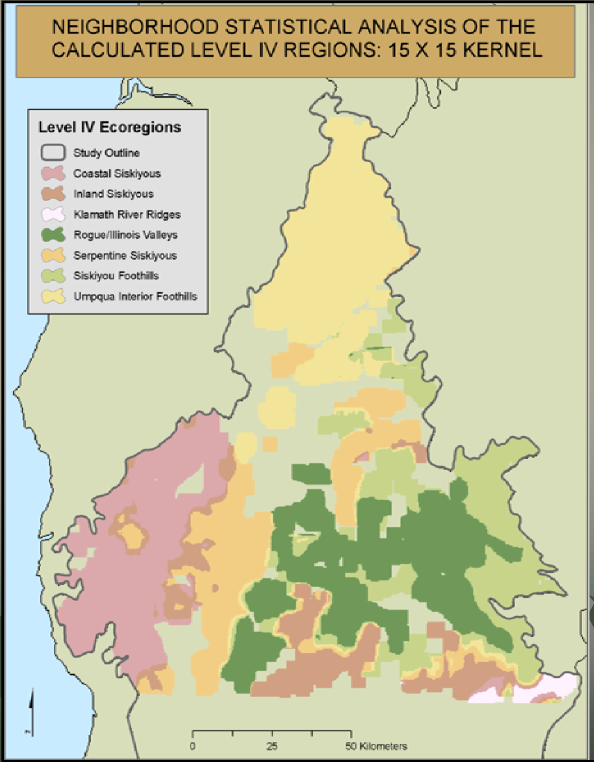
Results – IDW Functional Operation

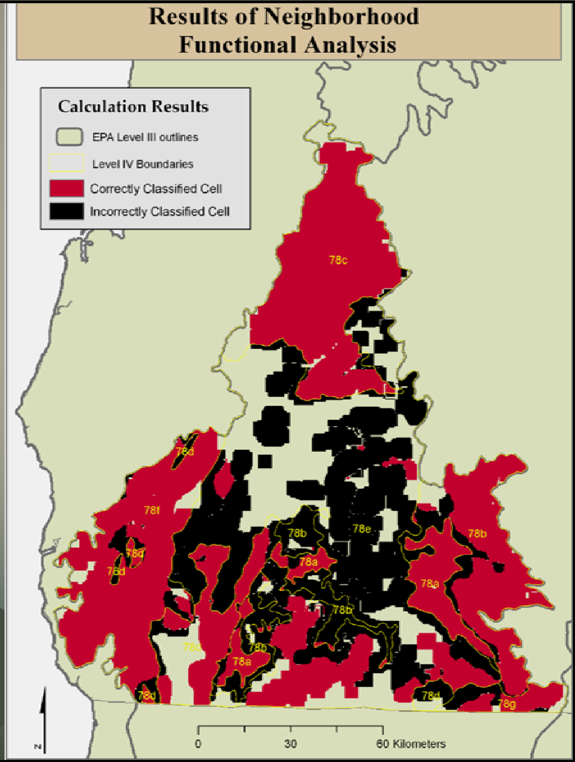
Percent land cover of IDW interpolation of Calculated Level IV Regions									
Grid #	Level IV Region	Correctly Classified grid cells		Incorrectly Classified grid cells		Null Classified grid cells		EPA Level IV grid cells
1	Rogue / Illinois Valleys	7,319	92%	637	8%	-	0%	7,956
2	Oak Savanna Foothills	12,894	57%	9,925	43%	-	0%	22,819
3	Umpqua Interior Foothills	24,714	96%	962	4%	-	0%	25,676
4	Serpentine Siskiyous	7,936	65%	4,211	35%	-	0%	12,147
5	Inland Siskiyous	11,662	16%	60,966	84%	-	0%	72,628
6	Coastal Siskiyous	21,203	89%	2,594	11%	-	0%	23,797
7	Klamath River Ridges	1,801	55%	1,468	45%		0%	3,269
Total		87,529	52%	80,763	48%	-	0%	168,292

Functional Operation
Neighborhood Analysis

- Neighborhood Analysis (Block Majority) – calculated a value for each cell based on the majority value in a specified 15X15 kernel or neighborhood around that cell

- Again, a grid of the results was calculated and exported to Excel as a DBF





Results – Neighborhood
Functional Operation

Percent land cover using Neighborhood Analysis of calculated Level IV Regions									
Grid #	**Level IV Region**	**Correctly Classified grid cells**		**Incorrectly Classified grid cells**		**Null Classified grid cells**		**EPA Level IV grid cells**
1	Rogue / Illinois Valleys	7,371	93%	565	7%	20	0%	7,956
2	Oak Savanna Foothills	12,272	54%	9,307	41%	1,240	5%	22,819
3	Umpqua Interior Foothills	23,163	90%	338	1%	2,175	8%	25,676
4	Serpentine Siskiyous	7,012	58%	2,295	19%	2,840	23%	12,147
5	Inland Siskiyous	10,138	14%	40,998	56%	21,492	30%	72,628
6	Coastal Siskiyous	20,455	86%	1,729	7%	1,613	7%	23,797
7	Klamath River Ridges	1,909	58%	969	30%	391	12%	3,269
Total		**82,320**	**49%**	**56,201**	**33%**	**29,771**	**18%**	**168,292**

Results – Combined all

Calculated, IDW, and Neighborhood

Averaged summary of all 3 quantitative analyses					
% of total Study Area	Level III Regions	Level IV Region	Correctly Classified grid cells	Incorrectly Classified grid cells	Unclassified grid cells
5%	78 a	Rogue / Illinois Valleys	82%	6%	12%
14%	78 b	Oak Savanna Foothills	43%	32%	24%
15%	78 c	Umpqua Interior Foothills	75%	2%	23%
7%	78 d	Serpentine Siskiyous	51%	19%	30%
43%	78 e	Inland Siskiyous	11%	50%	39%
14%	78 f	Coastal Siskiyous	66%	7%	27%
2%	78g	Klamath River Ridges	46%	29%	30%
100%	**Total**		**40%**	**30%**	**31%**

extra 1% due to compounded rounding

Unsupervised Classification

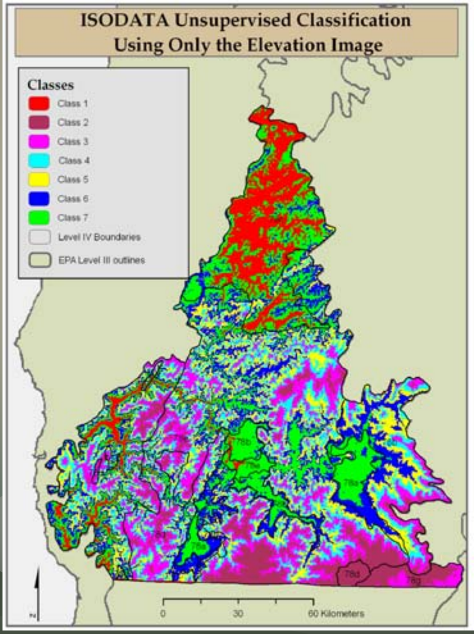
- The results of the previous analysis techniques were insufficient, so an additional technique was pursued…

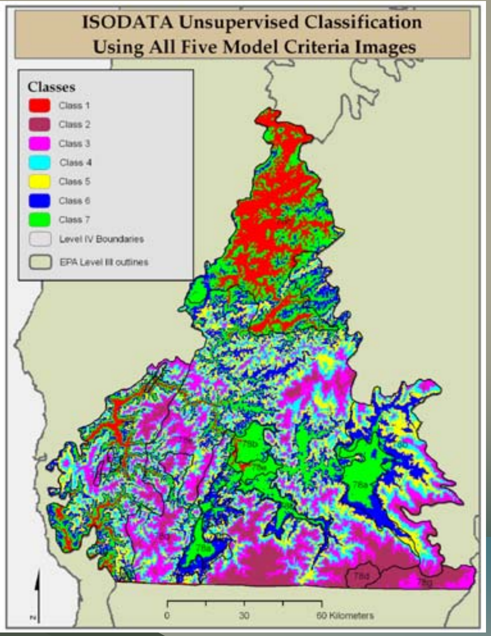
- An unsupervised classification was performed on the five grids of environmental variables used in the Calculated Ecoregions analysis in ENVI

Unsupervised Classification cont…

- ISODATA classification
  - Feature space classification traditionally used in remote sensing applications
  - An iterative process that clusters pixels into groups based on their similarity – 5 dimensions
    - Mandatory of seven classes

- Results were exported into ArcGIS and Excel





Results – ISODATA Classification

EPA Level IV Regions	
Level IV Region	**% of total**
Rogue/Illinois Valleys	4.7 %
Oak Savanna Foothills	13.6 %
Umpqua Interior Foothills	15. 3%
Serpentine Siskiyous	7.2 %
Inland Siskiyous	43.2 %
Coastal Siskiyous	14.1 %
Klamath River Ridges	2.0 %

ISODATA Classification Summary			
Class	**Classified using all 5 input images**		**Elevation only**
	# of classified grid cells	**% of total area**	**% of total area**
1	17,515	10 %	10 %
2	32,080	19 %	19 %
3	29,514	18 %	18 %
4	26,135	16 %	16 %
5	23,654	14 %	14 %
6	25,189	15 %	15 %
7	14,205	8 %	8 %
Total	**168,292**	**100 %**	**100%**

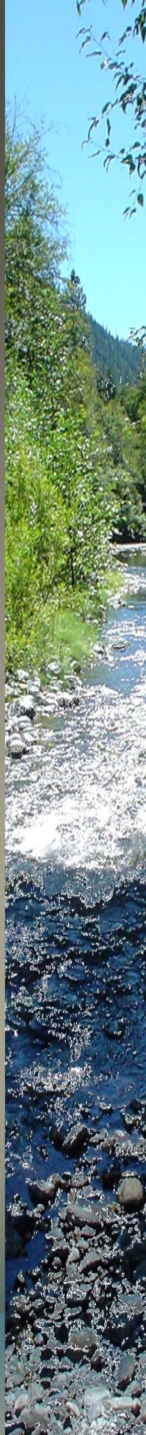
Any attempt to correlate the ISODATA classes with ecoregions would be purely qualitative

Discussion

- Surface Water Analysis was limited by data
- Calculated ecoregions were only accurate 19% of the time
- IDW had a large increase in misclassification
- Neighborhood analysis was best, with just under half the cells correctly classified
- ISODATA to ecoregions is problematic

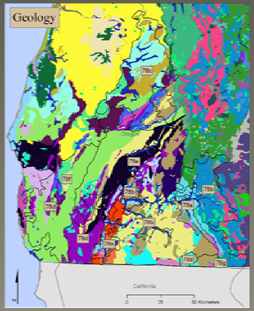
Discussion Continued…

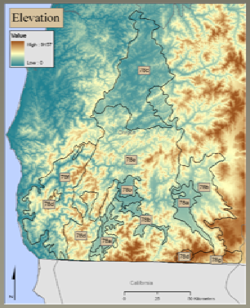
- Rules are qualitative
- Ecoregion cores and Ecotones
- Transparency and repeatability
- Converting complex quantitative analysis into management regions will be difficult

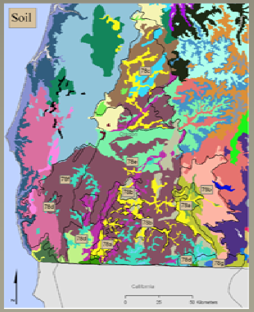


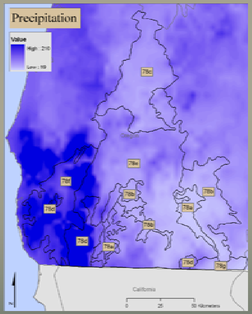
Discussion - Data

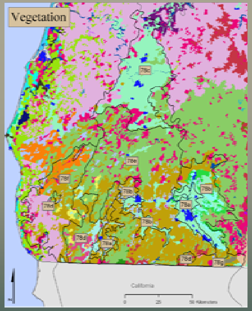
- Types
  - Nominal
  - Interval/Ratio
- Abundance
- Resolution
- Accuracy
- Richness
- Fuzziness issues











Conclusions and Future Research

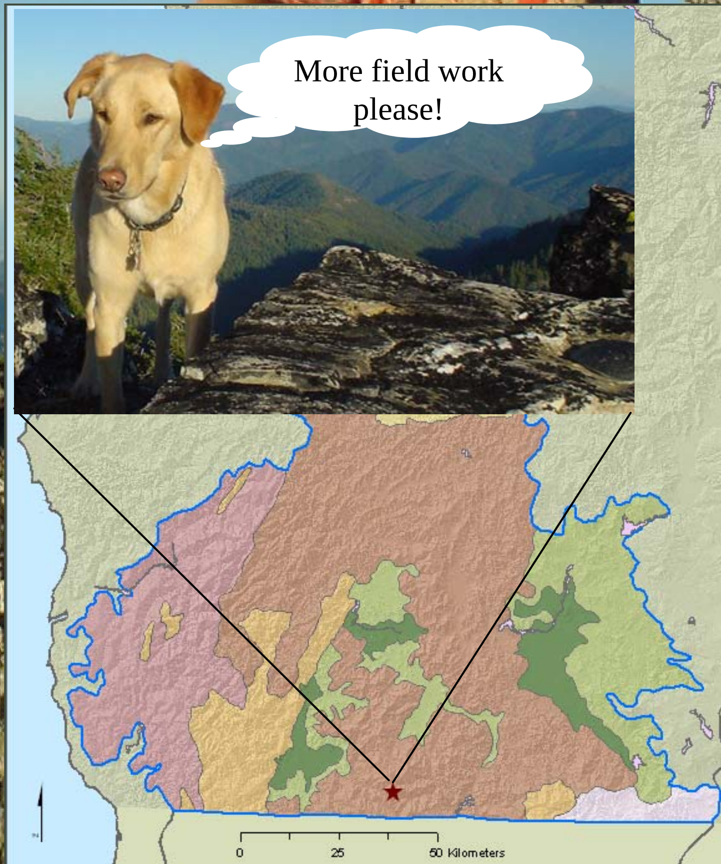
- The overall objectives of this research were met with limited success
- The need for Level IV delineations is real
- Transparent processes are increasingly necessary
- Additional quantitative analysis
- Data

Closing

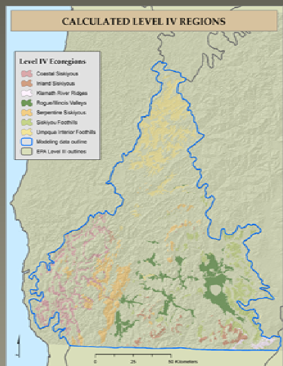
- On a personal note: I'd like to add that throughout this research process I've come to respect the value and necessity of Jim Omernik's ecoregion delineation process.
- The human impact on the land is only going to increase, therefore, human variables will be an increasingly necessary component in landscape classification. Especially if ecoregions are to be embraced as effective management units.

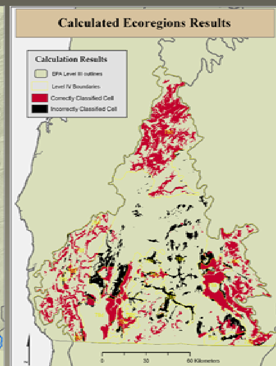
Acknowledgements

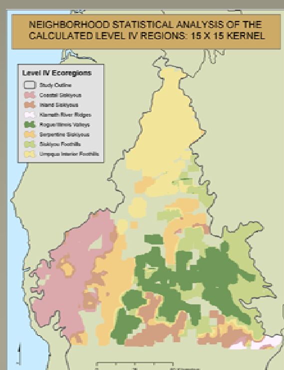
- My committee
  - Dawn Wright
  - Dr. K
  - Alan Woods
  - Denis White
- All the Rogues in DJL
- Mark Meyers and Joanne VanGeest in Geosciences
- My Family
- Andrea – for everything!!!
- My field assistant
  - Zoë

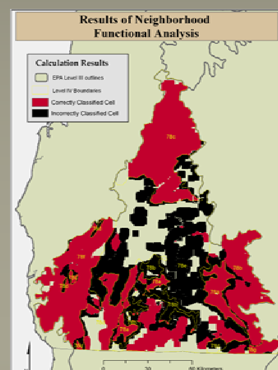


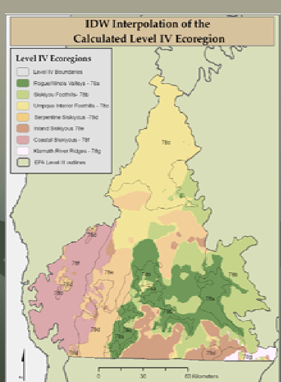
Cheerz,

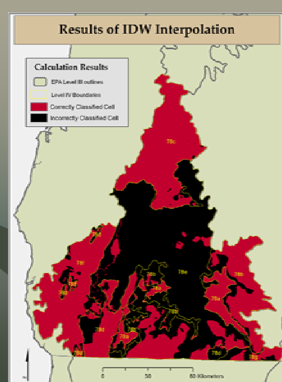

CALCULATED LEVEL IV REGIONS
Level IV Ecoregions

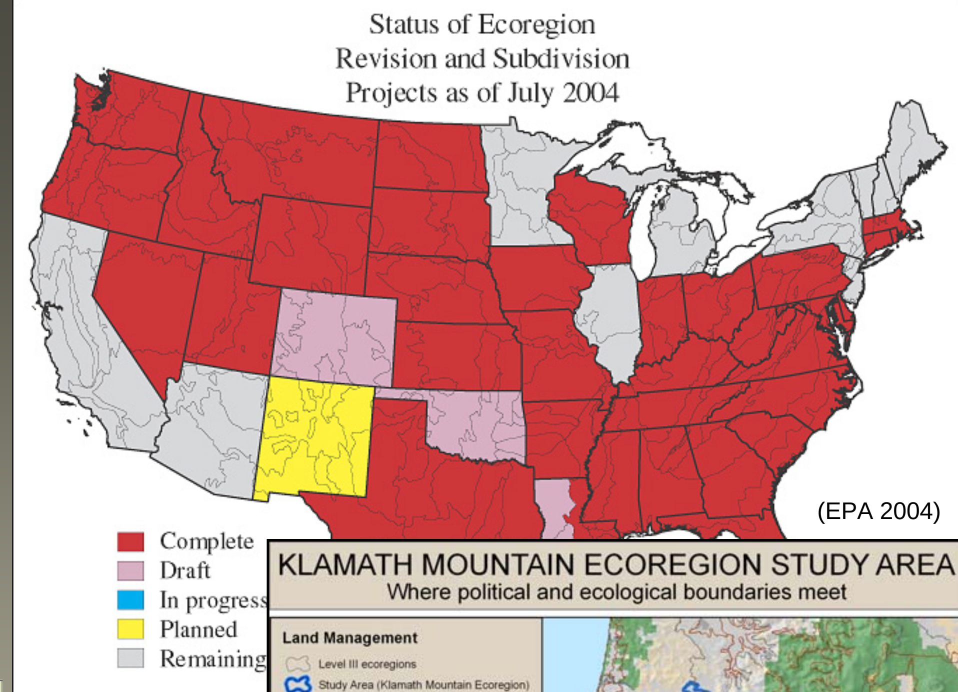

Calculated Ecoregions Results
Calculation Results
EPA Level III outlines
Level IV Boundaries
Correctly Classified Cell
Incorrectly Classified Cell


NEIGHBORHOOD STATISTICAL ANALYSIS OF THE CALCULATED LEVEL IV REGIONS: 15 X 15 KERNEL
Level IV Ecoregions


Results of Neighborhood Functional Analysis
Calculation Results
EPA Level III outlines
Level IV Boundaries
Correctly Classified Cell
Incorrectly Classified Cell


IDW Interpolation of the Calculated Level IV Ecoregion
Level IV Ecoregions


Results of IDW Interpolation
Calculation Results
EPA Level III outlines
Level IV Boundaries
Correctly Classified Cell
Incorrectly Classified Cell


Status of Ecoregion
Revision and Subdivision
Projects as of July 2004
Complete
Draft
In progress
Planned
Remaining
(EPA 2004)


KLAMATH MOUNTAIN ECOREGION STUDY AREA
Where political and ecological boundaries meet
Land Management
Level III ecoregions
Study Area (Klamath Mountain Ecoregion)
Oregon Level IV Ecoregion
Federal Lands
Forest Service
Department of Defense
Bureau of Land Management
Fish and Wildlife Service
National Park Service
Bureau of Indian Affairs
Bureau of Reclamation
Other Agencies
Oregon
California
Pacific
Ocean
N
0 20 40 80 120 Kilometers