ECOREGIONS

Ecoregion development by EPA

purpose, definitions, methods, applications, and interagency activities

Perspectives on the nature of ecoregions and their definition

- ecoregions do <u>not</u> nest
- why there is disagreement over how to define ecoregions

The process of refining and subdividing ecoregions

General purpose and special purpose regions

Distinguishing between ecoregions, watersheds, and hydrologic units (HUCs)

ECOREGIONS

Areas of similarity regarding patterns in the mosaic of biotic, abiotic, aquatic, and terrestrial ecosystem components, with humans being considered as part of the biota

General Purpose

A spatial framework to allow resource mgmt. agencies and programs with different responsibilities for the same geographic areas to integrate their research, assessment, and management activities regarding environmental resources.

Ecoregions were not designed to serve a single purpose or to correspond specifically to patterns of specific components such as fish, macroinvertebrates, soils, or vegetation.

Ecoregions are intended to serve as a geographic organizational tool for ecosystem management.

- -The quality and quantity of water at any point reflects the aggregate of characteristics upgradient from that point.
- -Water quality and quantity will tend to be similar within areas where this "aggregate" is similar.
- -<u>Therefore</u>, for effective water resource research, assessment, and management we must 1) define these regions with similar characteristics and 2) identify sets of "reference" watersheds/areas within each region.
- -These regions of similarity (ecoregions) can be used to set expectations, standards, management practices, etc.
- -Basins and watersheds may then be identified to address contributions to particular points. The regional reference data will be used to determine the contributions.

"Ecological land classification is a process of delineating and classifying ecologically distinctive areas of the earth's surface. Each area can be viewed as discrete system which has resulted from the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water, and human factors which may be present. The dominance of any one or a number of these factors varies with the given ecological land unit. This holistic approach to land classification can be applied incrementally on a scale-related basis from very site-specific ecosystems to very broad ecosystems."



Report to Congressional Requesters

August 1994

ECOSYSTEM MANAGEMENT

Additional Actions Needed to Adequately Test a Promising Approach



MEMORANDUM OF UNDERSTANDING

AMONG THE

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE FOREST SERVICE AGRICULTURAL RESEARCH SERVICE

AND THE

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT U.S. GEOLOGICAL SURVEY FISH AND WILDLIFE SERVICE NATIONAL BIOLOGICAL SERVICE NATIONAL PARK SERVICE

AND THE

U.S. ENVIRONMENTAL PROTECTION AGENCY

RELATIVE TO

DEVELOPING A SPATIAL FRAMEWORK OF ECOLOGICAL UNITS OF THE UNITED STATES

This Memorandum of Understanding (MOU) is entered into by the Department of Agriculture, Natural Resources Conservation Service (NRCS), Forest Service (FS), and Agricultural Research Service (ARS); the U.S. Department of the Interior, Bureau of Land Management (BLM), U.S. Geological Survey (USGS), Fish and Wildlife Service (FWS), National Biological Service (NBS), and National Park Service (NPS); and the U.S. Environmental Protection Agency (EPA)).

I. PURPOSE

This MOU documents and defines the responsibilities of the cooperating agencies to develop a common spatial framework for defining ecological units of the United States. It also provides a vehicle for other Federal agencies with natural resource management responsibilities to become part of the cooperative effort nationwide.

II. BACKGROUND AND BENEFITS

Examples of "Ecoregion Frameworks

- U.S. NRCS major land resource regions USEPA ecoregions
- U.S. Forest Service
 - Bailey ecoregions
 - ECOMAP terrestrial ecological units (Keys et al.)
 - aquatic ecological units (Maxwell et al.)

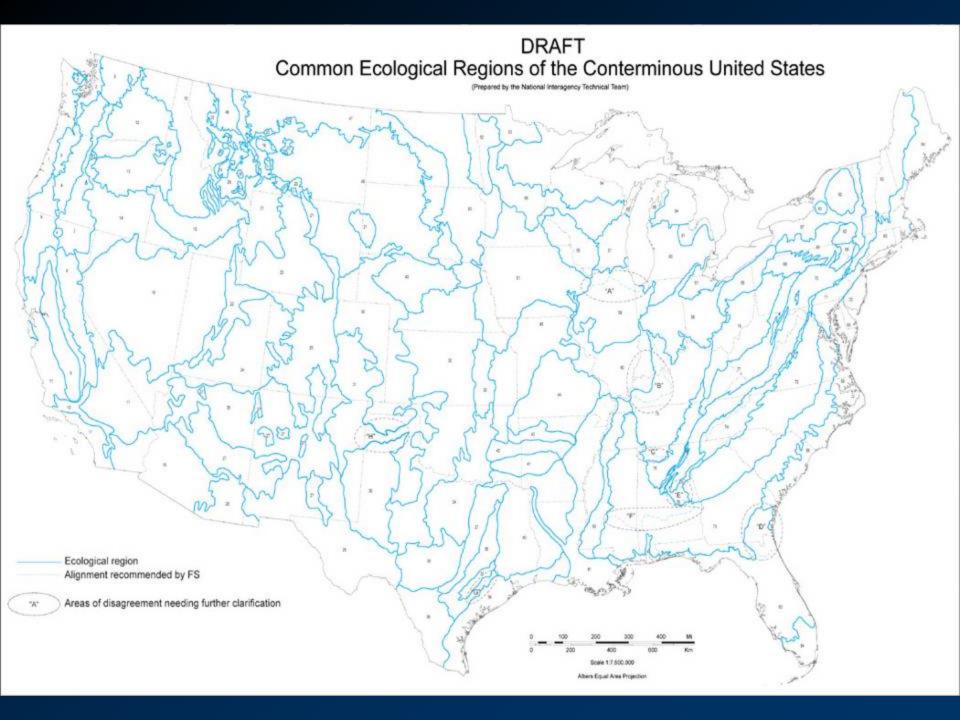
World Wildlife Fund

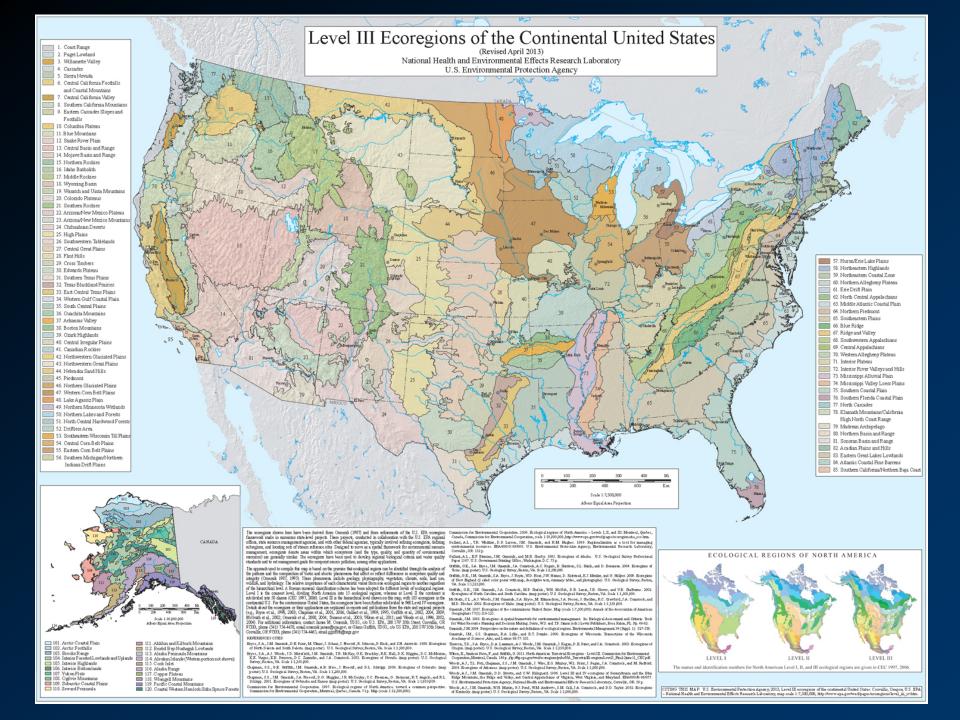
- terrestrial ecoregions
- freshwater ecoregions

Commission for Environmental Cooperation ecological regions NITT common ecological regions

Quantitatively developed ecoregions (e.g. Hargrove and Hoffman)

McMahon and others. 2001. Developing a Spatial Framework of Common Ecological Regions for the Conterminous United States. *Environmental Management* 28(3):293-316





REASONS FOR DISAGREEMENT OVER HOW TO DELINEATE ECOREGIONS

- 1. Disagreement on the definition of ecosystems
- 2. The complexity of the nature of ecoregions and ecoregion boundaries
- 3. Bias toward particular characteristics
- 4. Inability or reluctance to embrace a holistic ecosystem concept and preoccupation with specific objectives and reductive methods
- 5. Disagreement on whether to use quantitative (rule-based) or qualitative (weight of evidence) approaches
- 6. Disagreement over whether watersheds comprise ecoregions
- 7. Investment in existing frameworks and reluctance to change.

A major problem:

A common belief that ecoregion boundaries must be based on a single characteristic

Ecoregion Boundaries

Places where the mosaic of geographic phenomena that characterize on ecoregion meet those of an adjacent ecoregion.

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Quote from an ecologist/botanist on his state map of ecoregions:

"My ideas have not changed since the first time I started putting these notes together some 7+ years ago; this is not because I am getting old and conservative, it is because I am right and I know it(!).

I have emphasized vegetation and plant distributions, which I think is useful, and gives my map an edge over the others that claim to be biogeographic, but do not really take details into consideration.

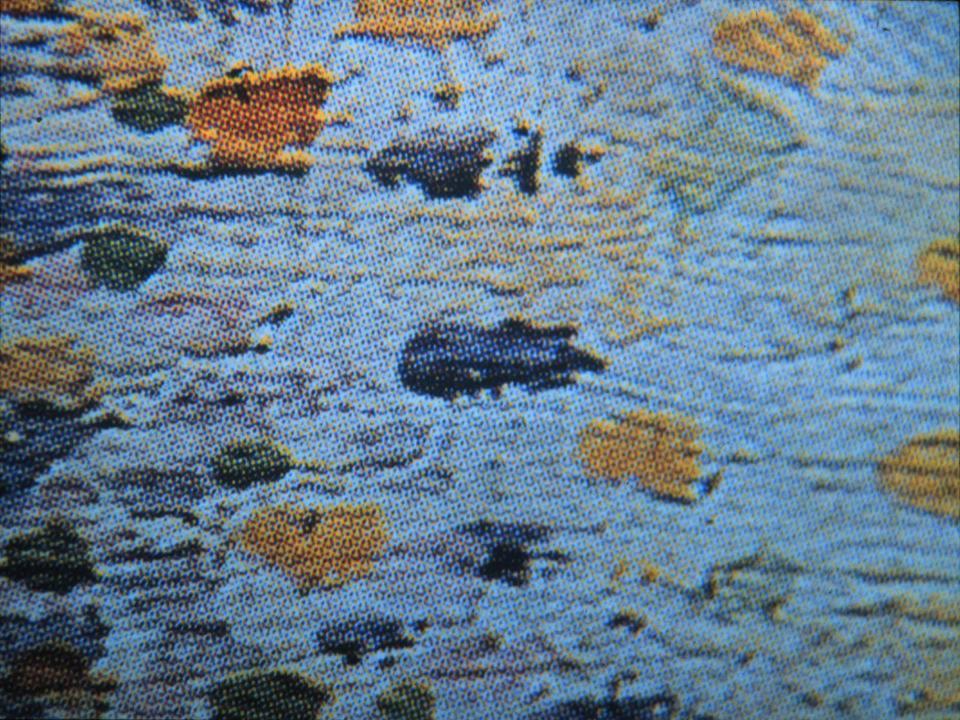
ACTUALLY, my main conclusion is that there is no perfect eco/regional map — there are too many viewpoints, applications, and biases to allow a perfect map."

General purpose ecological regions

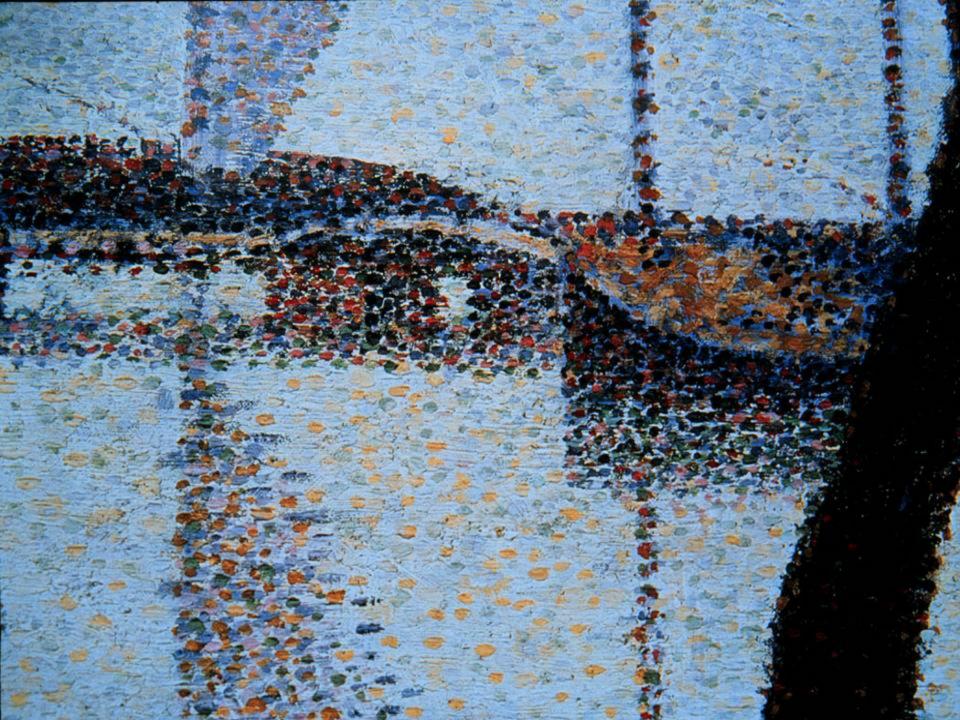
Based on spatial coincidence of numerous geographic phenomena affecting or reflecting ecosystem characteristics

Specific purpose regions (e.g. alkalinity, soils, or geology regions)

Based on patterns of one characteristic and spatial associations with causal or reflective geographical phenomena













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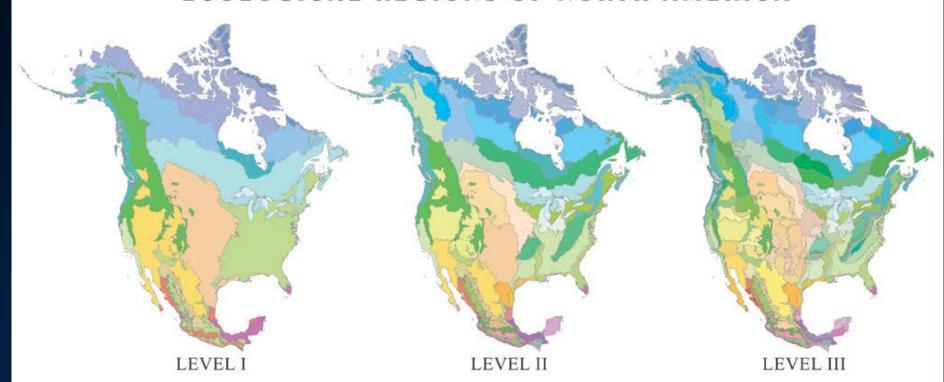
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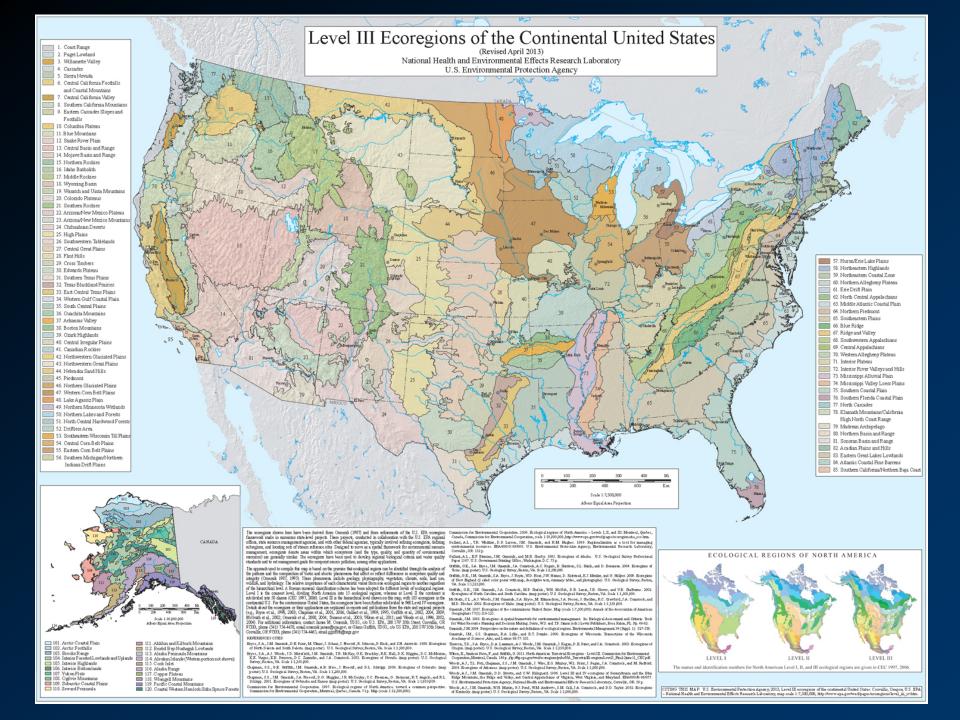
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North American Ecoregions (CEC) Levels I, III, & III

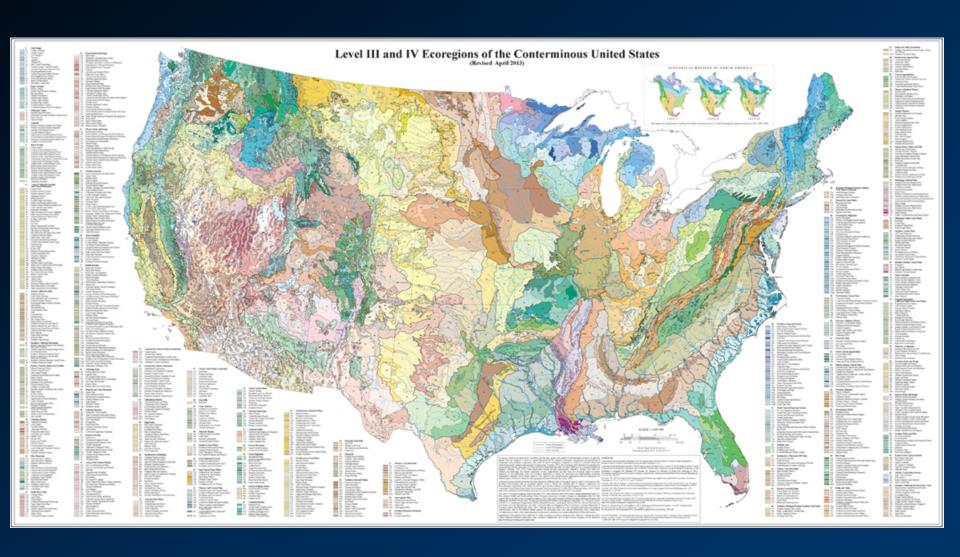
ECOLOGICAL REGIONS OF NORTH AMERICA



The names and identification numbers for North American Level I, II, and III ecological regions are given in CEC 1997, 2006.



Level III and IV Ecoregions of the Conterminous U.S. Revised April 2013 85 Level III, 967 Level IV ecoregions



ECOREGION DEVELOPMENT

Collaborative projects with states, EPA Regions, other federal agencies, and NHEERL-WED to refine and subdivide ecoregions and locate reference cites.

Provides a framework for:

- ecosystem management
- developing biological criteria
- setting water quality standards
- establishing lake management goals
- assessment and management of nonpoint source pollution
- TMDL allocations and NPDES evaluations
- extrapolation from "watershed" studies

DEVELOPING LEVEL III AND IV ECOREGIONS

- Projects are collaborative and always driven by needs
- EPA/USGS geographers facilitate work to decrease spatial inconsistency

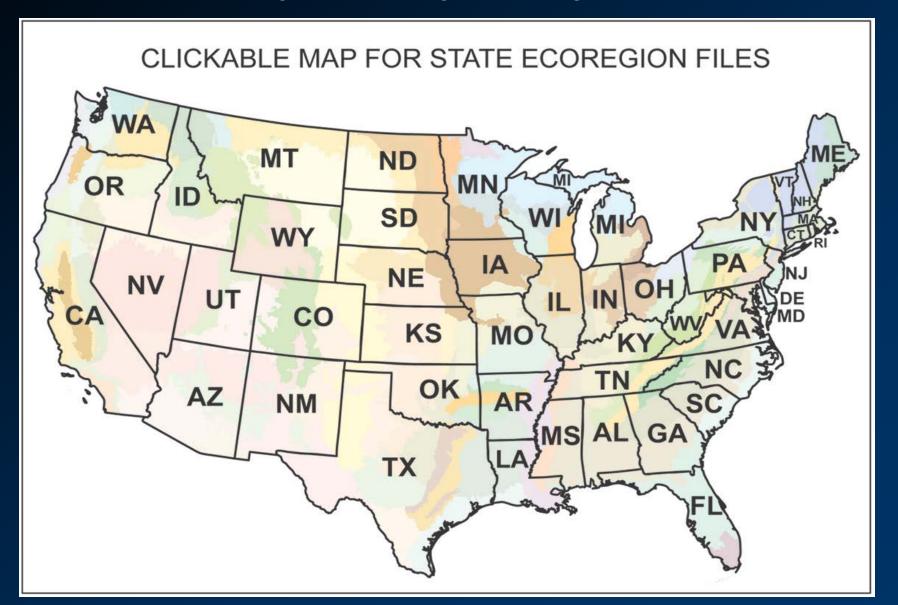
Process:

- 1. Initial meeting to gather information and ideas, determine participants, and discuss purpose, approaches, and timelines
- 2. Research subject region (gather maps, books, ideas etc. on the geography, ecology, and resources of the region)
- 3. Develop level III and IV scenarios
- 4. Draft map and descriptions sent out for review
- 5. Review meeting
- 6. Revise map and descriptions
- 7. Second review meeting and field verification

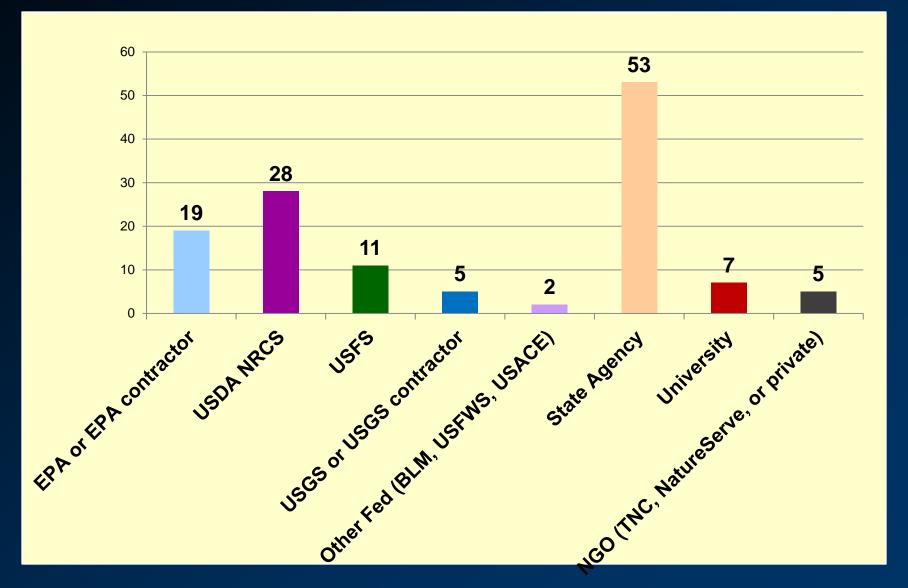
Process (continued):

- 8. Revise level III and IV ecoregions and descriptions
- 9. Peer review
- 10. Produce co-authored and co-endorsed maps/posters

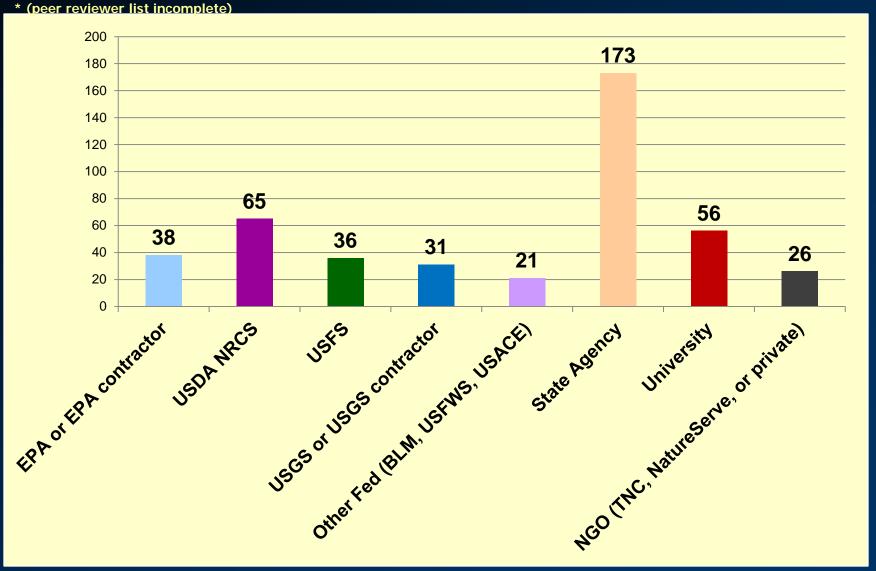
http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm



Number of individuals listed as principal authors on Level IV Ecoregion mapping publications, 1994-2011, and their affiliations. (Total number of individuals = 130)



Number of individuals listed as coauthor, collaborator, contributor, or peer reviewer* on Level IV Ecoregion mapping publications, 1994-2011, and their affiliations. (Total number of individuals = 446)



Ecoregions of Oregon

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■USGS



SCALE 1:1 500-000

Summary Table: Characteristics of the Ecoregions of Oregon

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Carcador Subalpino! Alpine	304	Charatel Despit deposy to authorizing to relation and relation profession continual deman, planed respon, and tests Charans and your read association even as the legislat- ceals.	160-1016	Qualman religious, gland diposis, hash, and achoits.	Belonia City orbaned	Remod extrattle	Oper Oper, Pende	75-140	1.00	2693	dyaffy all-give or shot registers, a after chands of countain broken, whether you, and adopting it. We applied to be record forward and a finite of	Eur ruit, glacore, euer ferid, rahalpor structiva, politicial, forcindros, bigrahati mate create fra Leen der plas, afrial, schaffes, and approfitatel etne.
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-	Grand For Mixed Femal	110	High, glasted plateau, streature, and carrier containing high-gradest, Attacks and crime. In altern lights it glasted rink higher wine.	200-200 00-200	Culturary relievas, values ad, adilina. Paytoria, Pourse, additional additi hadi, adilaformeros.	Anderic Trismodel. September Statements. Albeit Digitarials	Yalises, Boss, Boode, Cristily	Nati No.	10.81	30.90	1400. 40177	Workly great for Droglands Front and youterus deal Front Chapitle. Troglands, predictor pass, and written back. Valentino plants rached have eagle, basic, contract, and writing as	Potest Logging and morestrus, Sepretaed water proposition to tower day about series.
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10. COLUMBIA PLATEAU														
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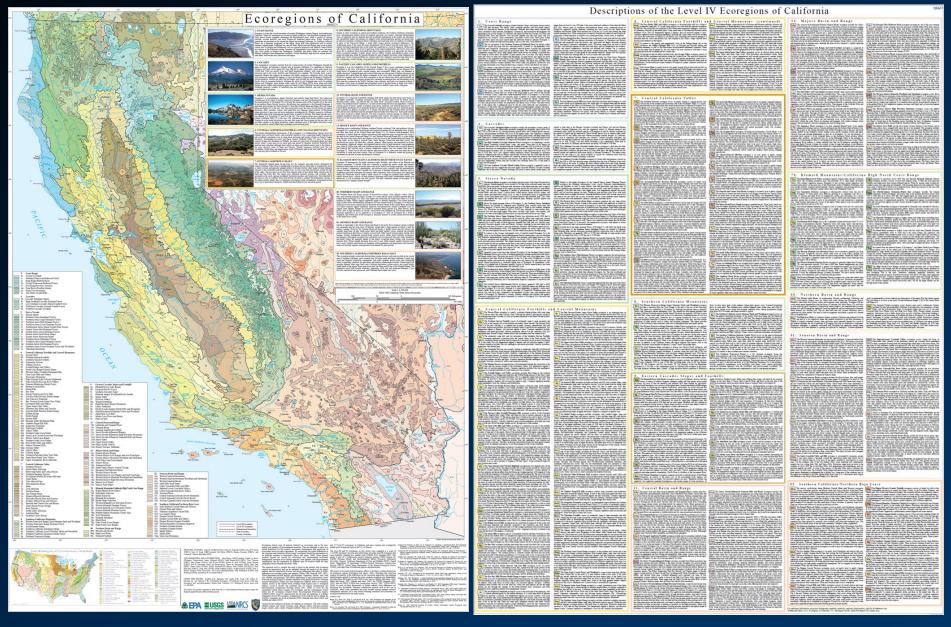
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California: 13 Level III and 177 Level IV Ecoregions

publication status: USGS Open-File Report, in peer review



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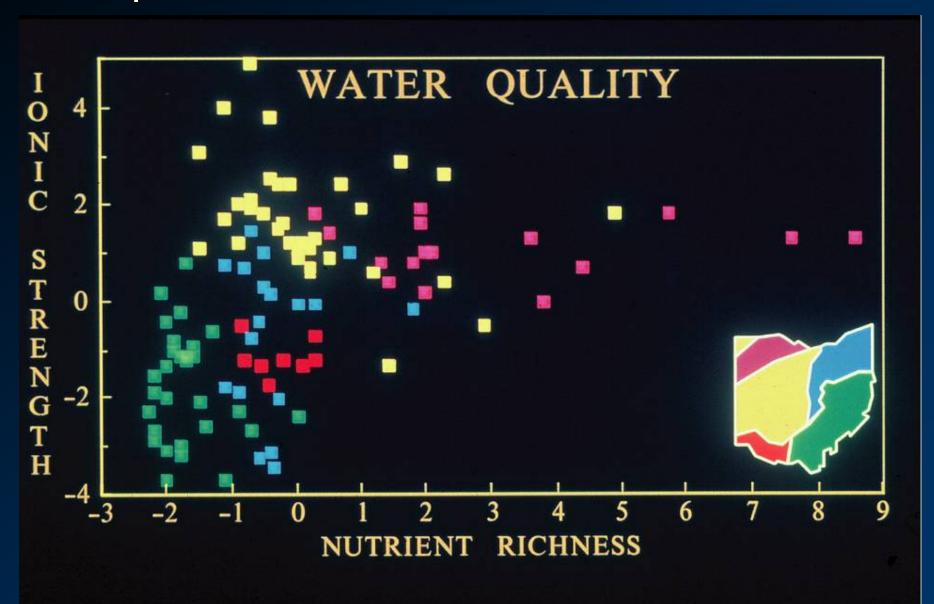




Applications

- Ecosystem management
- Developing biological criteria
- Setting water quality standards
- Establishing lake management goals
- Assessment and management of nonpoint source pollution
- TMDL allocations and NPDES evaluations
- Extrapolation from "watershed" studies
- Post stratification of EMAP data
- Evaluating land cover change

Principal components analysis showing Ohio ecoregional patterns in least-disturbed reference watersheds



Applications: State Water Quality

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Correspondence between stream macroinvertebrate assemblages and 4 ecoregions of the southeastern USA

JACK W. FEMINELLA¹

Department of Biological Sciences, 331 Funchess Hall, Auburn University, Auburn, Alabama 36849-5407 USA

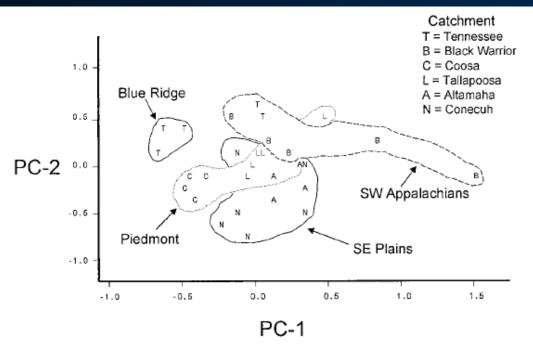
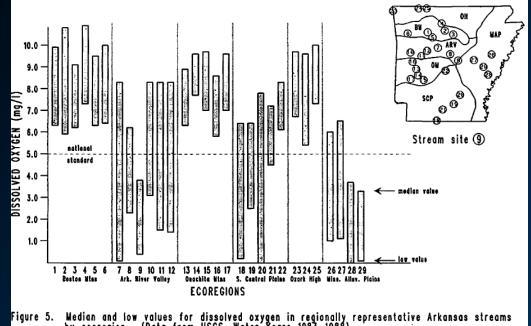


Fig. 2. Principal components analysis (PCA) ordination of physico-chemical variables measured from the 30 southeastern streams used in this study. PC-1 was largely associated with water chemical variables (conductivity, hardness, alkalinity, pH), whereas PC-2 was largely associated with % dissolved oxygen saturation at baseflow and several physical variables (median substrate size, current velocity, discharge, stream order, % of sand in substrate). PC-1 and PC-2 together accounted for 51% of the total variation. SW = Southwestern, SE = Southeastern.

"My study showed that the 4 southeastern ecoregions examined could be delineated on the basis of the stream invertebrate assemblages they contain. This finding supports the hypothesis that ecoregions represent a useful framework with which to characterize natural variation in aquatic biota"

Applications: State Water Quality Assessments, Regional Reference Conditions, WQ Standards

Arkansas



Median and low values for dissolved oxygen in regionally representative Arkansas streams by ecoregion. (Data from USGS, Water Years 1983-1988).

Tennessee

DEVELOPMENT OF REGIONALLY-BASED NUMERIC INTERPRETATIONS OF TENNESSEE'S NARRATIVE BIOLOGICAL INTEGRITY CRITERION



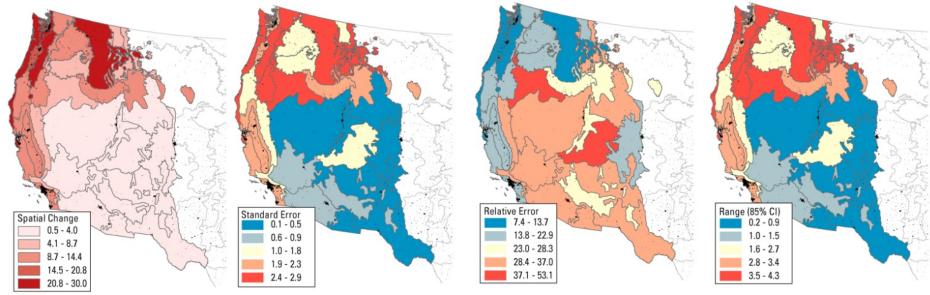




Tennessee Department of Environment and Conservation **Division of Water Pollution Control** 7th Floor L & C Annex 401 Church Street Nashville, TN 37243-1534

Applications: USGS Land Cover Land Cover with Ecoregions

Overall spatial change from 1973 to 2000 for all Western U.S. ecoregions (Sleeter et al., 2011)



http://landcovertrends.usgs.gov/

Contact USGS Land Cover Trends Project **Ecoregion Summaries** West Great Plains Midwest East . Coast Range 25.Western High Plains 34. Western Gulf Coastal Plain 58. Northeastern Highlands Puget Lowland 26.Southwestern Tablelands 35. South Central Plains 27.Central Great Plains Ouachita Moutains Arkansas Valley 4. Cascades 5. Sierra Nevada 6. California Chaparral and Oak Woodlands 29. Central Oklahoma/Texas 38. Boston Mountains Uplands 62. North Central Appalachians 63. Middle Atlantic Coastal Plain 39. Ozark Highlands 49. Northern Minnesota Wetlands 30. Edwards Plateau 7. Central California Valley 31. Southern Texas Plains 50. Northern Lakes and Forests 64. Northern Piedmont 32. Texas Blackland Prairies 33. East Central Texas Plains 51. North Central Ha 52. Driftless Area 8. Southern California Mountain 9. Eastern Cascade Slopes and 66. Blue Ridge Mountains 40. Central Irregular Plains 42. Northwestern Glaciated 67. Ridge and Valley 68. Southwestern Appalachians 53. Southeastern Wisconsin Till Plains Central Corn Belt Plains 11. Blue Mountains 55. Eastern Corn Belt Plains 69. Central Appalachians 12. Snake River Basin 43. Northwestern Great Plains 44. Nebraska Sandhills 56. Southern Michigan/Northern Indiana Drift Plains 13. Central Basin and Range . Interior Plateau 46. Northern Glaciated Plains 57. Huron/Erie Lake Plain Mojave Basin and Range 74. Mississippi Valley Loess Plains 15. Northern Rockies 16. Montana Valley and Foothill Southern Coastal Plain Erie Drift Plains 2. Interior River Lowland 6. Southern Florida Coastal Plain Laurentian Plains and Hills 17. Middle Rockies 83. Eastern Great Lakes and Hudso 18. Wyoming Basin 19 Wasatch and Hinta Mountains . Colorado Plateaus 21. Southern Rockies 22. Arizona/New Mexico Plateau 23. Arizona/New Mexico Mountains 77. North Cascades 78. Klamath Mountains 79. Madrean Archipelago . Northern Basin and Range

Applications: BLM Rapid Ecoregional Assessments

in 7 Level III Ecoregions started in 2010

- Partners: BLM, states, NatureServe, other contractors
- Objectives: 'wall-to-all' assessment of key resources and change agents including climate change - in preparation for resource management planning (under NEPA)

Rapid Ecoregional Assessments (REAs)

REAs synthesize the best available information about resource conditions and trends within an ecoregion. Tie to future projections.

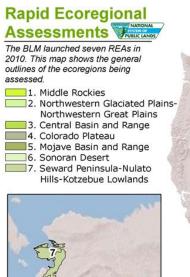
Ecoregional Direction

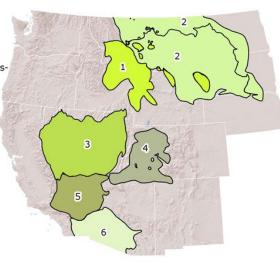
Ecoregional direction will use the results of the REAs to identify key management priorities for the public lands within an ecoregion.

Field Implementation

Management priorities and strategies identified in ecoregional direction put into practice on-theground.







Applications: State Wildlife Action Plans

e.g., http://www.wildlifearkansas.com/strategy.html



Arkansas Wildlife Action Plan

Announcements
AWAP in the News
Executive Summary
Wildlife Action Plan

Database Ecoregions

Grants

Project Reports

Legislative History Links

Partners Home

AR Ecoregions

ECOREGIONS

Explore Arkansas's Ecoregions by clicking on the ecoregion area you are interested in. Each ecoregion has a list of species and habitats. Or, use the hyperlinks below to download a PDF version of the ecoregion map for each area.



Download a PDF version of the ecoregion map for each area.

- · Mississippi Alluvial Plain
- · South Central Plain
- Boston Mountains

Applications: Bird Conservation Regions

North American Bird Conservation Initiative

Bird Conservation Regions (BCRs) created by aggregating CEC level II, III, and IV ecoregions in Conservation Initiative - United States combinations that reflect to the second s

Partners In Flight

"Physiographic Areas"
Based in part on Level III

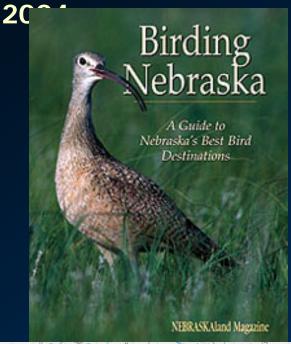


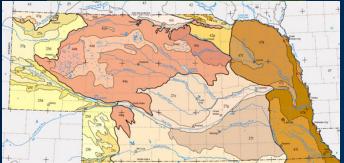


Applications: Bird Conservation Regions and Bird Atlases

Birding Nebraska NebraskaLand Magazine

Vol. 82, No 1, Jan/Feb





Author: Jon Farrar
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Audubon Spring Creek Prairie
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Burchard Lake Wildlife Management Are

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Applications: Forest Disturbance Assessments



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Table 3
Decision-tree modeling of species' mean % vulnerability in 34 ecoregions. The 1st and 2nd most vulnerable species in each ecoregion are listed if they were modeled to occur in >5% of the forested area and were judged >50% vulnerable.

Ecoregion	EPA code	1st species	2nd species	Mean % Vulnerability
Clear Hills and Western Alberta Upland	5.4.2	ENG	DF	36
Watson Highlands	6.1.5	ENG	WP	68
Yukon-Stikine Highlands/Boreal Mountains and Plateaus	6.1.6	ENG	WP	40
Skeena-Omineca-Central Canadian Rocky Mountains	6.2.1	WP	ENG	34
Chilcotin Ranges and Fraser Plateau	6.2.2	WL	-	23
Columbia Mountains/Northem Rockies	6.2,3	LPP	-	17
Canadian Rockies	6.2.4	-	-	20
North Cascades	6.2.5	YC	-	15
Cascades	6.2.7	LPP	-	13
Eastern Cascades Slopes and Foothills	6.2.8	LPP	MH	26
Blue Mountains	6.2,9	LPP	WH	27
Middle Rockies	6.2.10	WL	MH	38
Clamath Mountains	6.2.11	WH	-	26
Sierra Nevada	6.2.12	WH	MH	46
Wasatch and Uinta Mountains	6.2.13	MH	WRC	47
Southern Rockies	6.2.14	SAF	-	35
daho Batholith	6.2.15	WH	-	20
Pacific Coastal Mountains	7.1.4	ENG	WP	26
oastal Western Hemlock-Sitka Spruce Forests	7.1.5	WP	-	19
Pacific and Nass Ranges	7.1.6	ENG	LPP	17
Strait of Georgia/Puget Lowland	7.1.7	PP	-	29
Coast Range	7.1.8	YC	PP	21
Villamette Valley	7.1.9	PP	-	32
Thompson-Okanogan Plateau	10.1.1	LPP	-	24
Columbia Plateau	10.1.2	LPP	WH	49
Northern Basin and Range	10.1.3	WRC	PSF	52
Wyoming Basin	10.1.4	PSF	GF	69
Central Basin and Range	10.1.5	MH	LPP	60
Colorado Plateaus	10.1.6	LPP	WL	49
Snake River Plain	10.1.8	LPP	-	34
Mojave Basin and Range	10.2.1	PP	DF	80
California Coastal Sage, Chaparral, and Oak Woodlands	11.1.1	WP	MH	58
Central California Valley	11.1.2	DF	-	52
Southern and Baja California Pine-Oak Mountains	11.1.3	PP	DF	59

DF = Douglas-fir, ENG = Engelmann spruce, GF = grand fir, LPP = lodgepole pine, MH = mountain hemlock, PP = ponderosa pine, PSF = Pacific silver fir, SAF = subalpine fir, SS = Sitka spruce, WH = western hemlock, WL = western larch, WP = white pine, WRC = western red cedar, YC = yellow cedar.

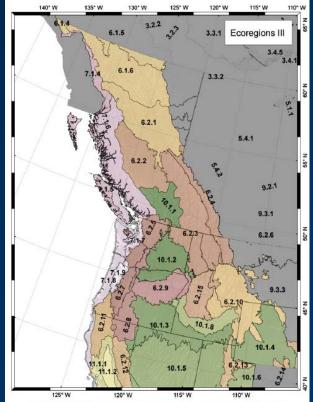
Predicting satellite-derived patterns of large-scale disturbances in forests of the Pacific Northwest Region in response to recent climatic variation

Richard H. Waring a,*, Nicholas C. Coops b, Steven W. Running c

- 2 College of Forestry, Oregon State University, Corvallis, OR 97331, United States
- b Department of Forest Resource Management, 2424 Main Mall. University of British Columbia, Vancouver, Canada V6T 124
- ^c College of Forestry & Conservation, University of Montana, Missoula, MT 59812, United States

Volume 115, Issue 12, December 2011

Modeling conifer species vulnerability to climate change within 34 Level III ecoregions and comparing to MODIS imagery disturbance



R.H. Waring et al. / Remote Sensing of Environment xxx (2011) xxx-xxx

Fig. 1. Defined boundaries of the Environmental Protection Agency's 34 level III ecoregions.

Distinguishing between ecoregions, watersheds, and hydrologic units (HUCs)



Watershed Approach Framework

EPA Watershed Protection: A Statewide Approach



WATERSHEDS

Areas within which apparent surface water drains to a particular point.

ECOREGIONS

Regions of relative homogeneity in ecological systems and/or relationships among organisms and their environments

BASINS

Large watersheds

HYDROLOGIC UNITS

Watersheds and segments of watersheds and basins, often with adjacent intersticies

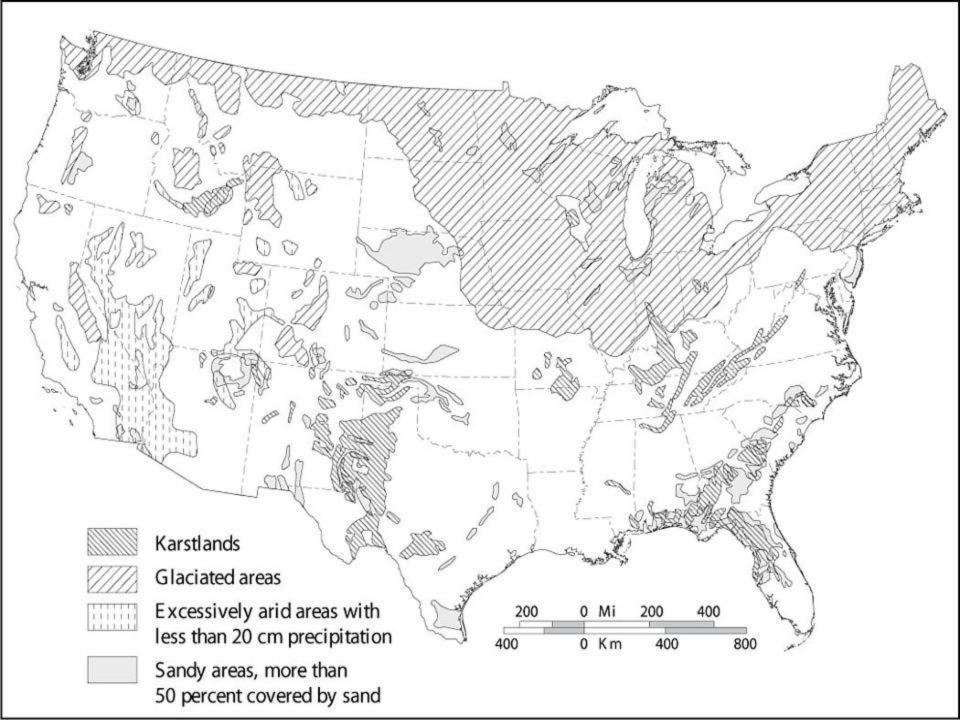
WATERSHEDS

Useful for assessing the relative contribution of natural and anthropogenic characteristics to the quality and quantity of water at specific points on streams and on particular water bodies.

ECOREGIONS

Provide a spatial framework for the research, assessment, inventory, monitoring, and management of ecosystems and ecosystem components.

- -The quality and quantity of water at any point reflects the aggregate of characteristics upgradient from that point.
- -Water quality and quantity will tend to be similar within areas where this "aggregate" is similar.
- -<u>Therefore</u>, for effective water resource research, assessment, and management we must 1) define these regions with similar characteristics and 2) identify sets of "reference" watersheds/areas within each region.
- -These regions of similarity (ecoregions) can be used to set expectations, standards, management practices, etc.
- -Basins and watersheds may then be identified to address contributions to particular points. The regional reference data will be used to determine the contributions.









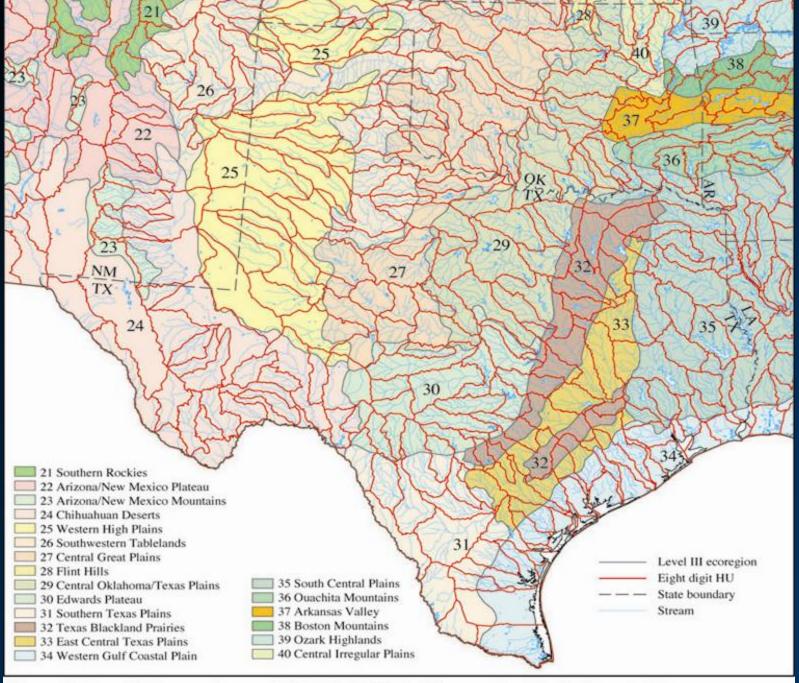


Figure 1. Level III ecoregions and eight digit HUs in Texas and parts of adjacent states.

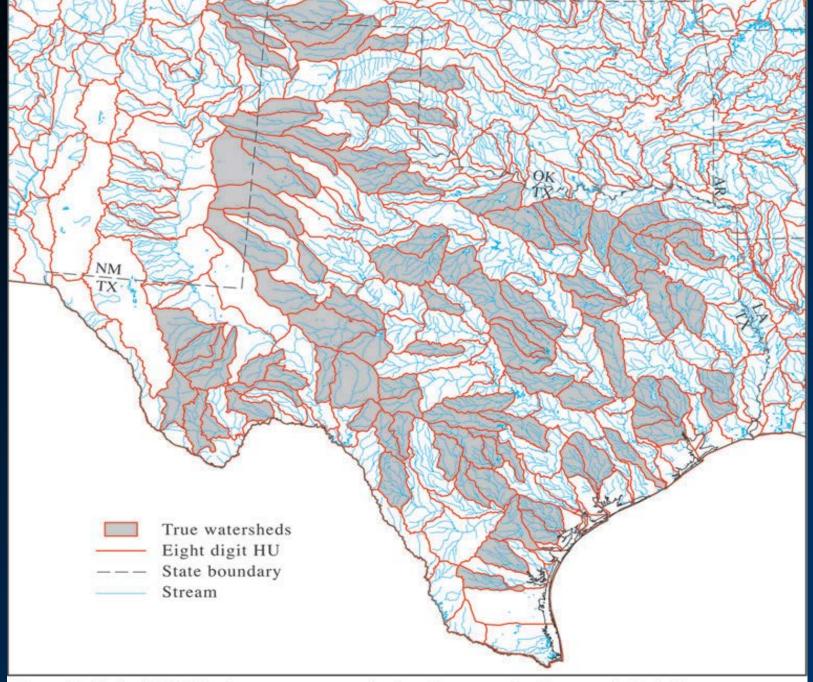


Figure 2. Eight digit HUs that are true watersheds and are completely or partially in Texas.

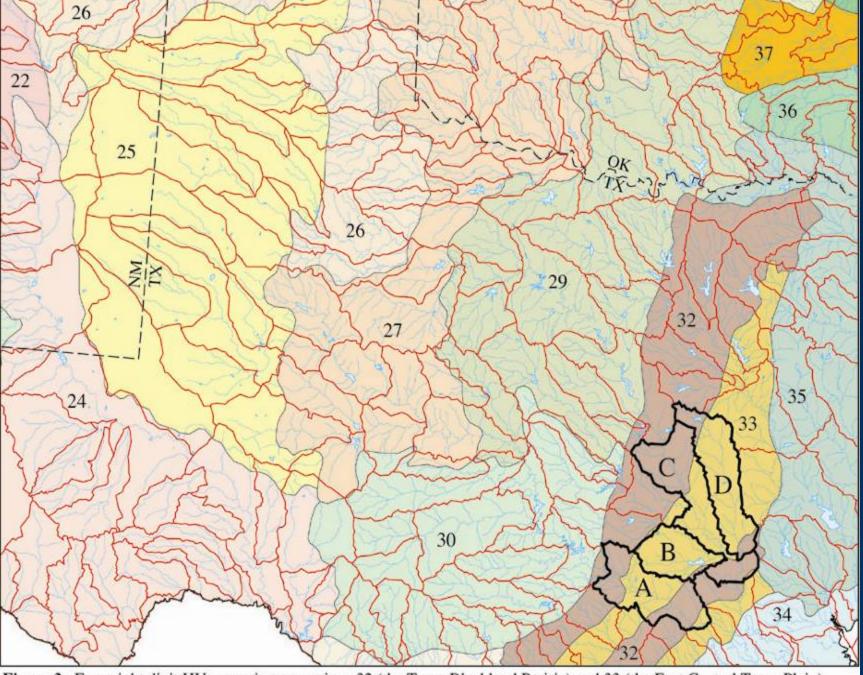


Figure 3. Four eight digit HUs covering ecoregions 32 (the Texas Blackland Prairie) and 33 (the East Central Texas Plain). The hydrologic unit codes for A, B, C, and D are 12090301, 12070102, 12080101, and 12070103 respectively.

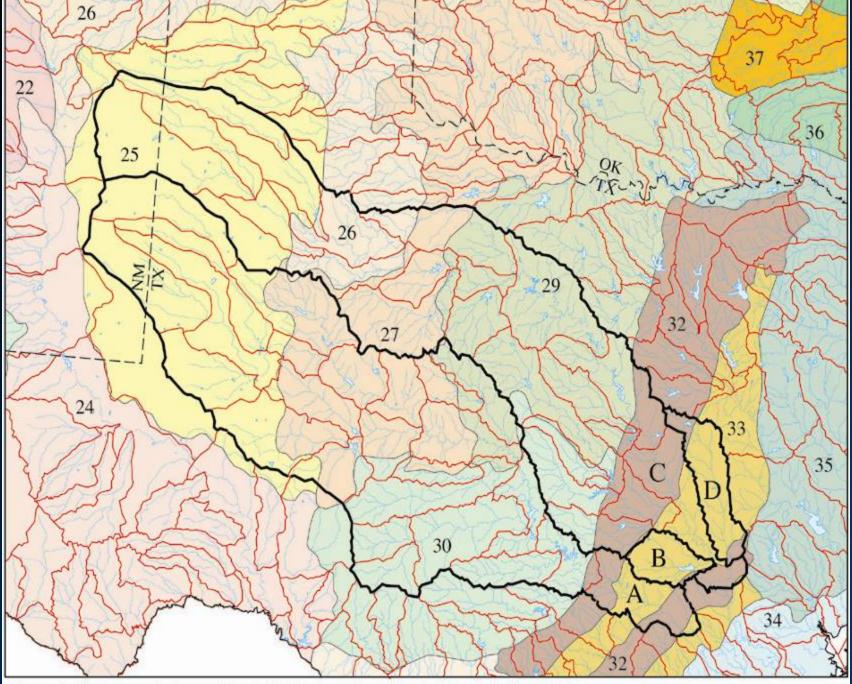


Figure 4. True watersheds associated with downstream points in HUs A, B, C, and D.

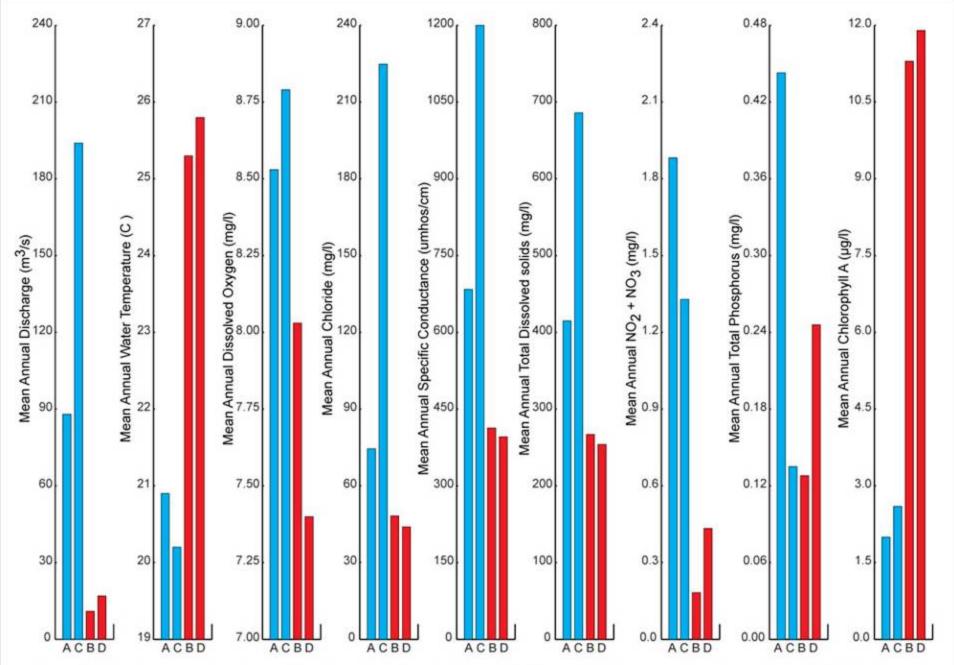


Figure 5. Discharge and water quality characteristics for HUs A, C, B, and D. Sources: Gandara et al. 1995; Gandara et al. 2001a; Gandara et al. 2001b; Texas Natural Resources Commission, 1996.

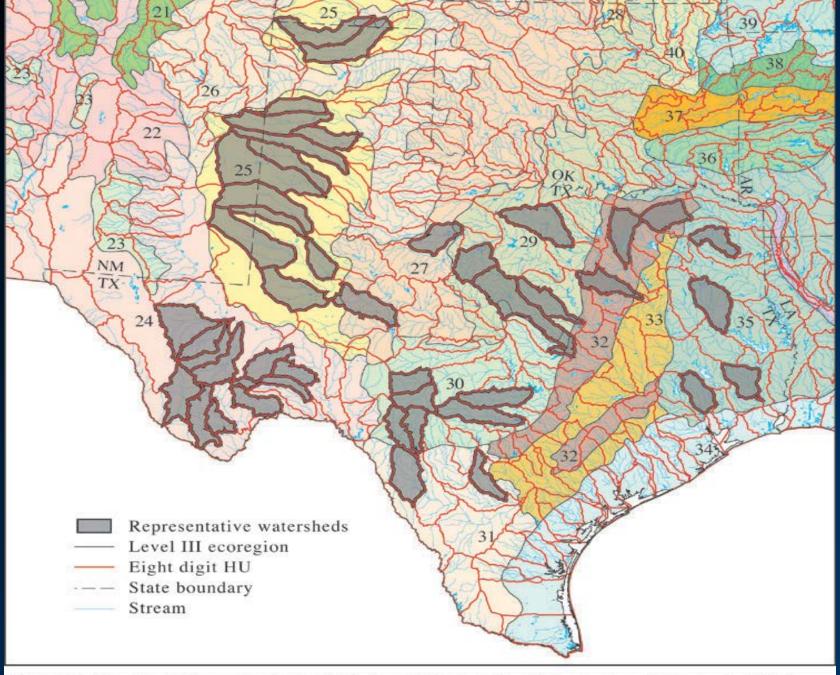
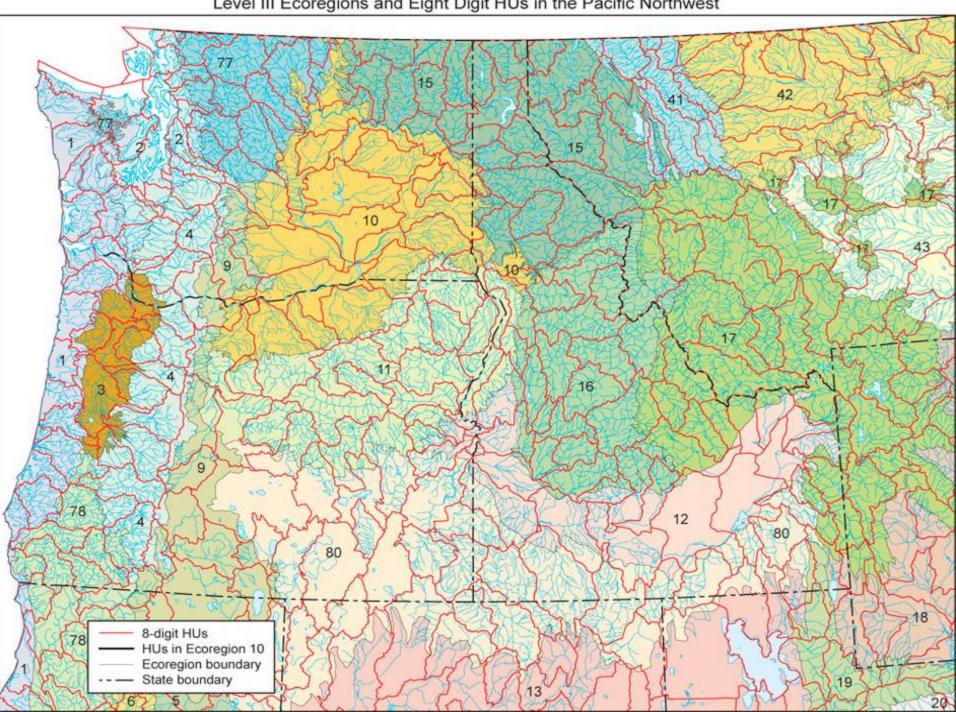
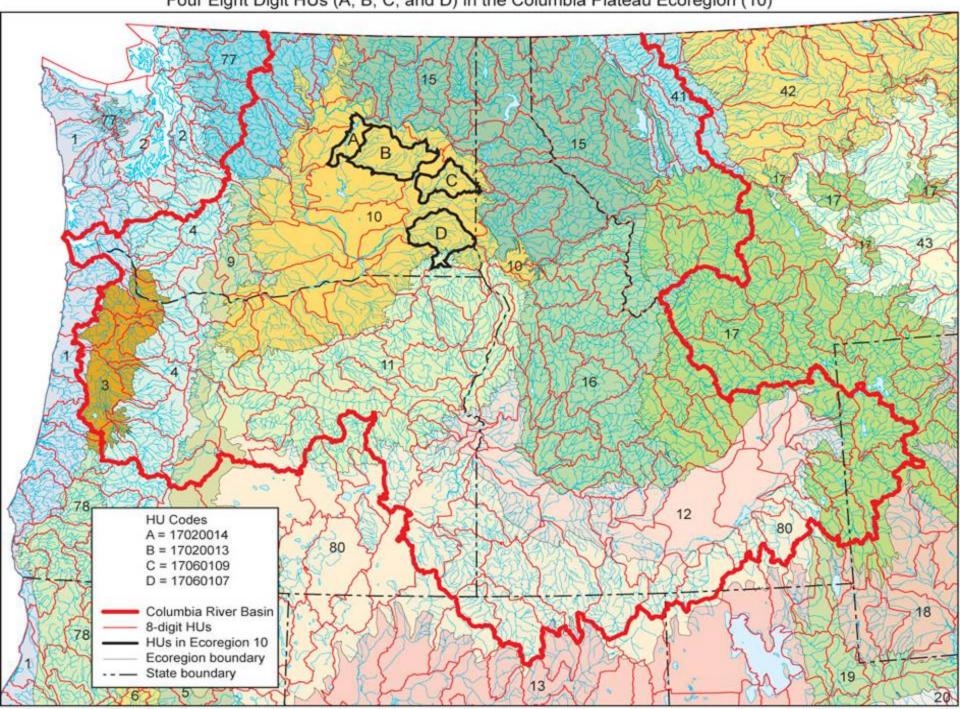


Figure 6. Representative watersheds within level III ecoregions that are completely or partially in Texas.

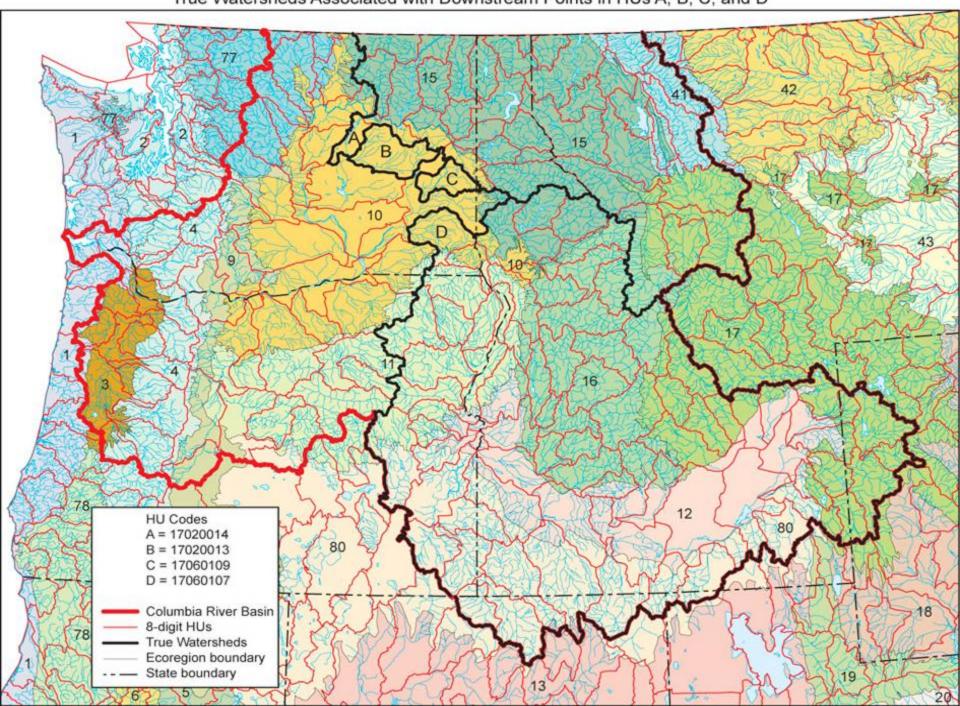
Level III Ecoregions and Eight Digit HUs in the Pacific Northwest



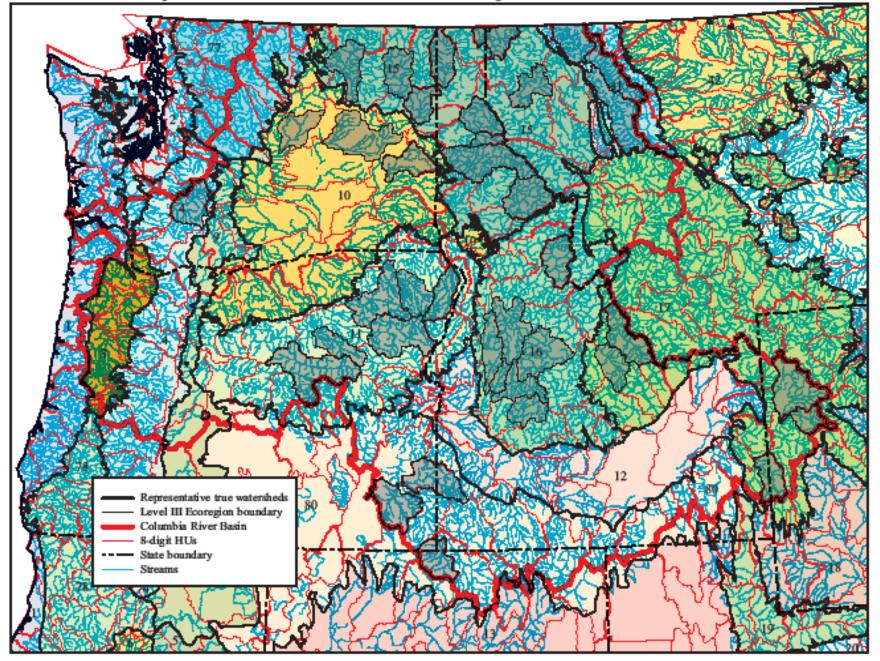
Four Eight Digit HUs (A, B, C, and D) in the Columbia Plateau Ecoregion (10)

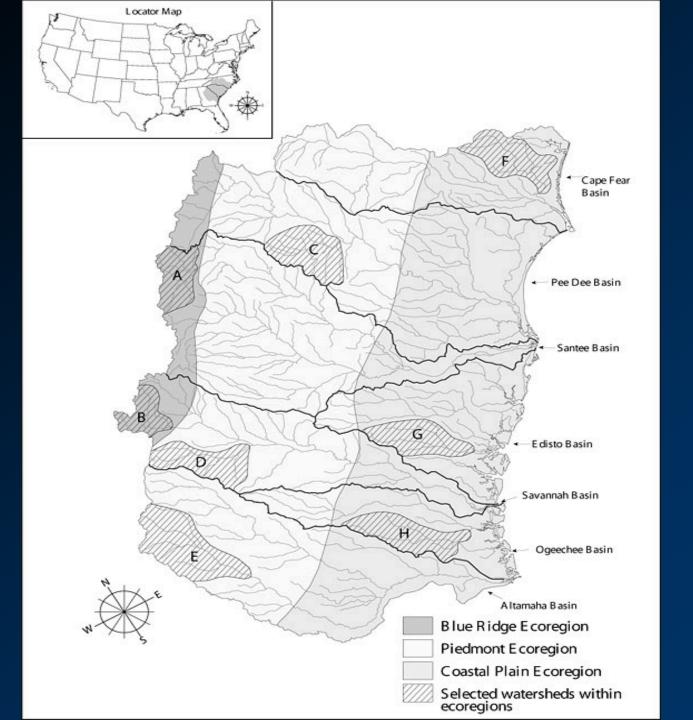


True Watersheds Associated with Downstream Points in HUs A, B, C, and D



Representative True Watersheds within Level III Ecoregions in the Columbia River Basin





KEY POINTS

- -Watersheds are imperative for understanding the associations between human and non-human characteristics and water quality and quantity.
- -Watersheds rarely correspond to areas within which there is similarity in characteristics affecting water quality and quantity.
- -Most hydrologic units (HUCs) are not watersheds.
- -In many areas (approx. 30%) watersheds are difficult to impossible to define or are irrelevant.
- -Watersheds and ecoregions are complementary frameworks.

NEEDED:

A set of national maps of true watersheds of each size (cataloging unit?) category

"People often ask, 'What is the single most important environmental/population problem facing the world today?" A flip answer would be, 'the single most important problem is our misguided focus on identifying the single most important problem! That flip answer is essentially correct, because any of the dozen problems if unsolved would do us grave harm, and because they all interact with each other"

Jared Diamond, 2006. COLLAPSE:

How Societies Choose to Fail or

Succeed.

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541 754-4465 ggriffith@usgs.go v "Two streams of science – one reductive and certain, and one integrative and uncertain. The first provides the bricks for the edifice, but not the architectural design"

C.S. Holling '95