Ecoregions

-Purpose, definition, methods, applications, and interagency activities

-Perspectives on the nature of ecoregions and their definition

-General purpose vs special purpose regions

-The process of refining and subdividing regions

-The process and scenarios specific to New England

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.

-**Therefore,** 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.

General purpose ↑

ECOLOGICAL REGIONS

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

AGGREGATED ECOREGIONS
(for specific purposes)

LAKE MANAGEMENT REGIONS

LAKE PHOSPHORUS REGIONS

Based on patterns of one characteristic and the spatial associations with causal and reflective geographic phenomena

ALKALINITY REGIONS
NUTRIENT REGIONS

↓ Specific purpose

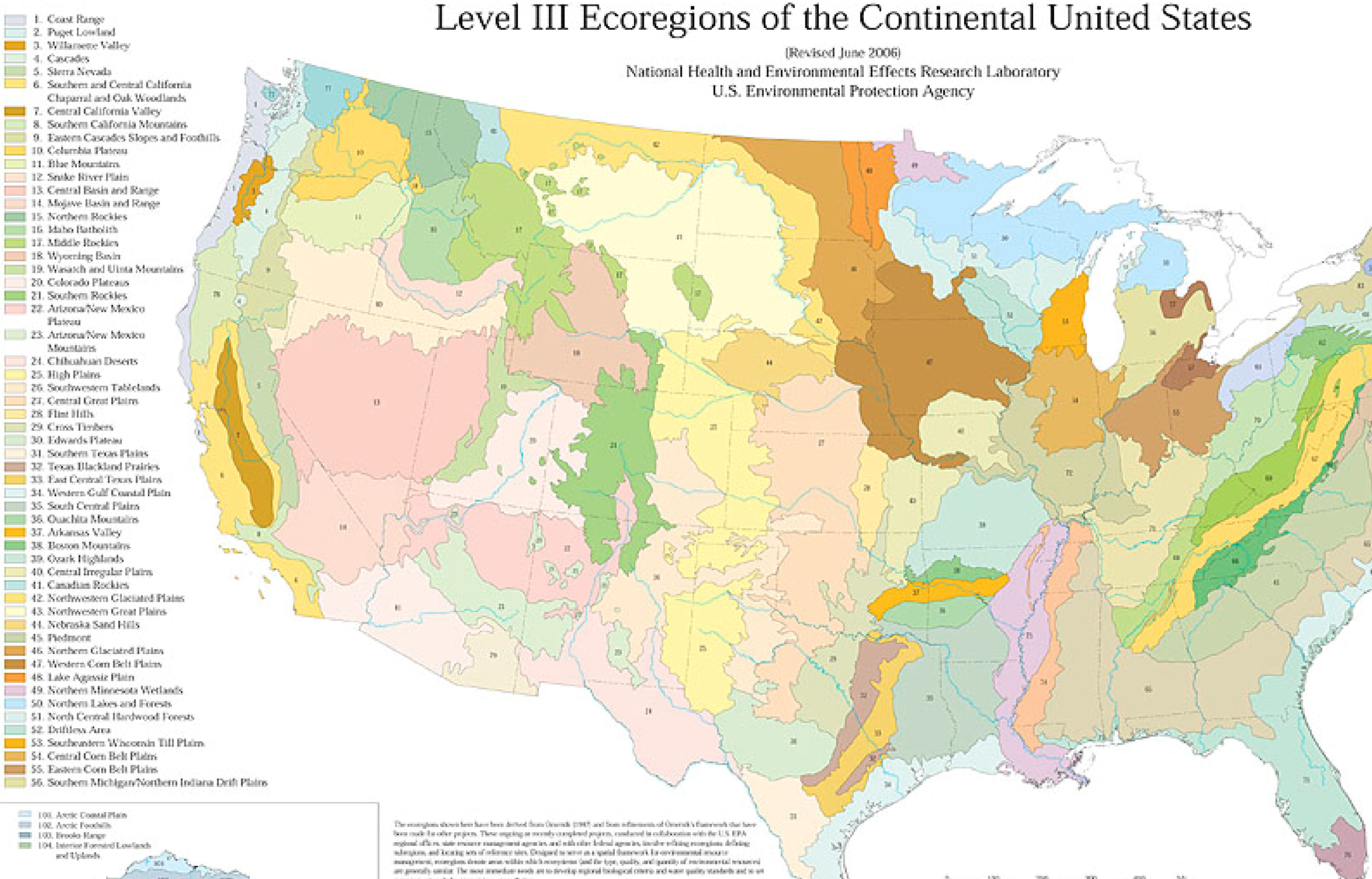
“Ecological land classification is a process of delineating and classifying ecologically distinctive areas of the earth’s surface. Each area can be viewed as discrete system which has resulted from the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water, and human 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.”

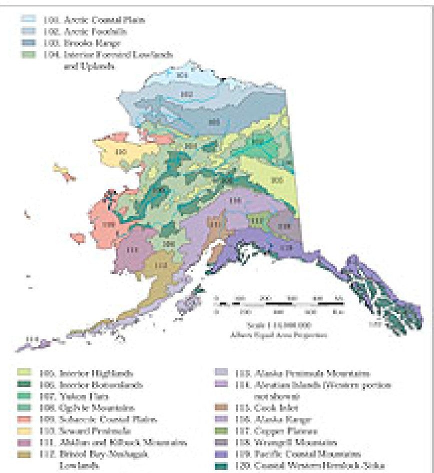
Wiken ‘86

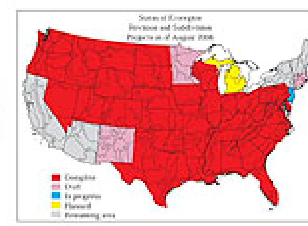
Level III Ecoregions of the Continental United States

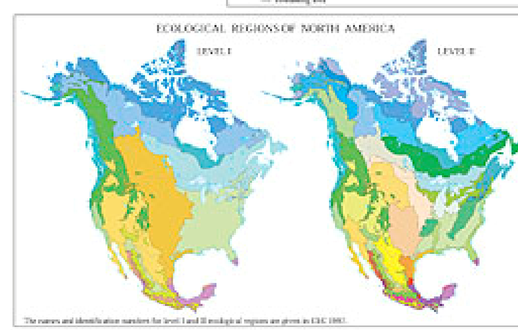
(Revised June 2006)

National Health and Environmental Effects Research Laboratory
U.S. Environmental Protection Agency









United States General Accounting Office

GAO

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.)

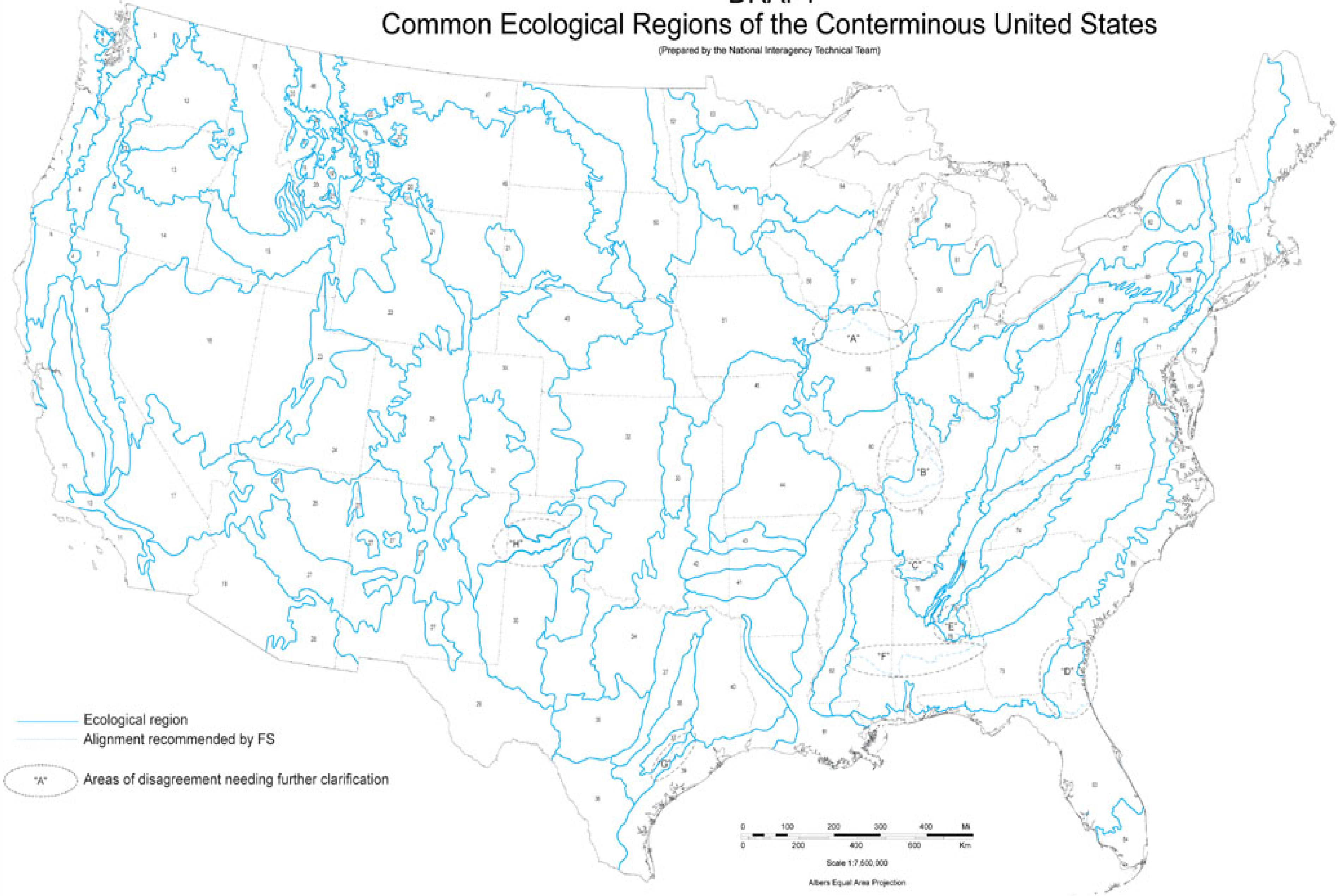
World Wildlife Fund
- terrestrial ecoregions
- freshwater ecoregions

Commission for Environmental Cooperation ecological regions
NITT common ecological regions

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

DRAFT
Common Ecological Regions of the Conterminous United States

(Prepared by the National Interagency Technical Team)



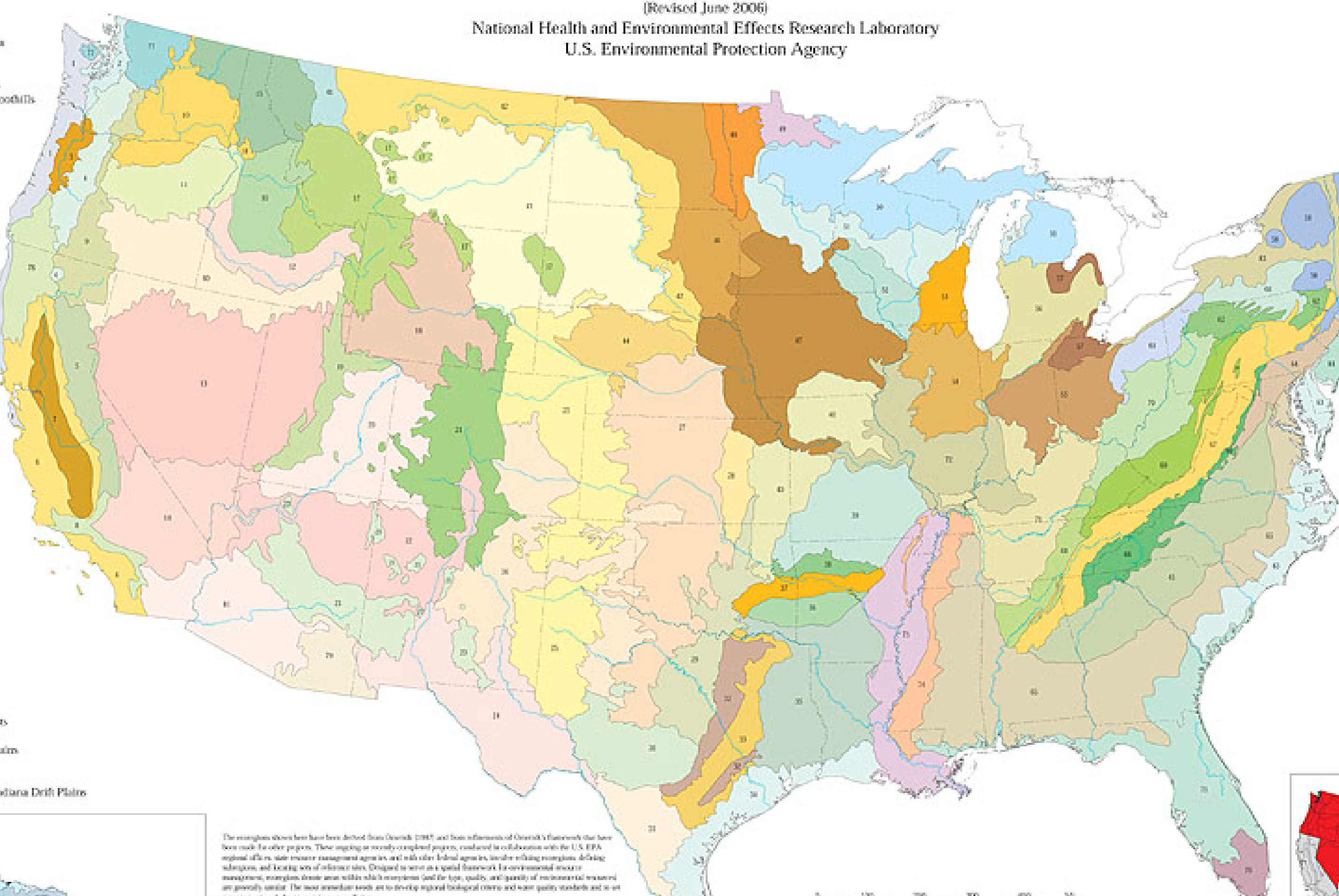
Level III Ecoregions of the Continental United States

(Revised June 2006)

National Health and Environmental Effects Research Laboratory

U.S. Environmental Protection Agency

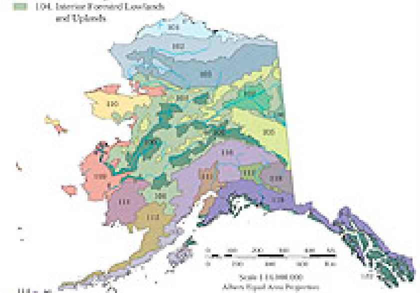
1. Coast Range
2. Puget Lowland
3. Willamette Valley
4. Cascades
5. Sierra Nevada
6. Southern and Central California Chaparral and Oak Woodlands
7. Central California Valley
8. Southern California Mountains
9. Eastern Cascades Slopes and Foothills
10. Columbia Plateau
11. Blue Mountains
12. Snake River Plain
13. Central Basin and Range
14. Mojave Basin and Range
15. Northern Rockies
16. Idaho Batholith
17. Middle Rockies
18. Wyoming Basin
19. Wasatch and Uinta Mountains
20. Colorado Plateaus
21. Southern Rockies
22. Arizona/New Mexico Plateau
23. Arizona/New Mexico Mountains
24. Chihuahuan Deserts
25. High Plains
26. Southwestern Tablelands
27. Central Great Plains
28. Flint Hills
29. Cross Timbers
30. Edwards Plateau
31. Southern Texas Plains
32. Texas Blackland Prairies
33. East Central Texas Plains
34. Western Gulf Coastal Plain
35. South Central Plains
36. Ouachita Mountains
37. Arkansas Valley
38. Boston Mountains
39. Ozark Highlands
40. Central Irregular Plains
41. Canadian Rockies
42. Northwestern Glaciated Plains
43. Northwestern Great Plains
44. Nebraska Sand Hills
45. Piedmont
46. Northern Glaciated Plains
47. Western Corn Belt Plains
48. Lake Agassiz Plain
49. Northern Minnesota Wetlands
50. Northern Lakes and Forests
51. North Central Hardwood Forests
52. Driftless Area
53. Southeastern Wisconsin Till Plains
54. Central Corn Belt Plains
55. Eastern Corn Belt Plains
56. Southern Michigan/Northern Indiana Drift Plains



57. Huron/Erie Lake Plains
58. Northeastern Highlands
59. Northeastern Coastal one
60. Northern Appalachian Plateau and Uplands
61. Erie Drift Plain
62. North Central Appalachians
63. Middle Atlantic Coastal Plain
64. Northern Piedmont
65. Southeastern Plains
66. Blue Ridge
67. Ridge and Valley
68. Southwestern Appalachians
69. Central Appalachians
70. Western Allegheny Plateau
71. Interior Plateau
72. Interior River Valleys and Hills
73. Mississippi Alluvial Plain
74. Mississippi Valley Loess Plains
75. Southern Coastal Plain
76. Southern Florida Coastal Plain
77. North Cascades
78. Klamath Mountains
79. Madrean Archipelago
80. Northern Basin and Range
81. Sonoran Basin and Range
82. Laurentian Plains and Hills
83. Eastern Great Lakes and Hudson Lowlands
84. Atlantic Coastal Pine Barrens

Scale 1:7,500,000

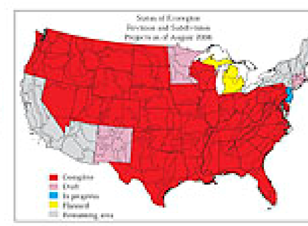
Albers Equal Area Projection



101. Arctic Coastal Plain
102. Arctic Foothills
103. Brooks Range
104. Interior Forested Lowlands and Uplands
105. Interior Highlands
106. Interior Bottomlands
107. Yukon Flats
108. Ogilvie Mountains
109. Subarctic Coastal Plains
110. Seward Peninsula
111. Ahklun and Kilbuck Mountains
112. Bristol Bay-Nushagak Lowlands
113. Alaska Peninsula Mountains
114. Aleutian Islands (Western portion not shown)
115. Cook Inlet
116. Alaska Range
117. Copper Plateau
118. Wrangell Mountains
119. Pacific Coastal Mountains
120. Coastal Western Hemlock-Sitka Spruce Forests

Scale 1:16,000,000

Albers Equal Area Projection



ECOLOGICAL REGIONS OF NORTH AMERICA

BIBLIOGRAPHY

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

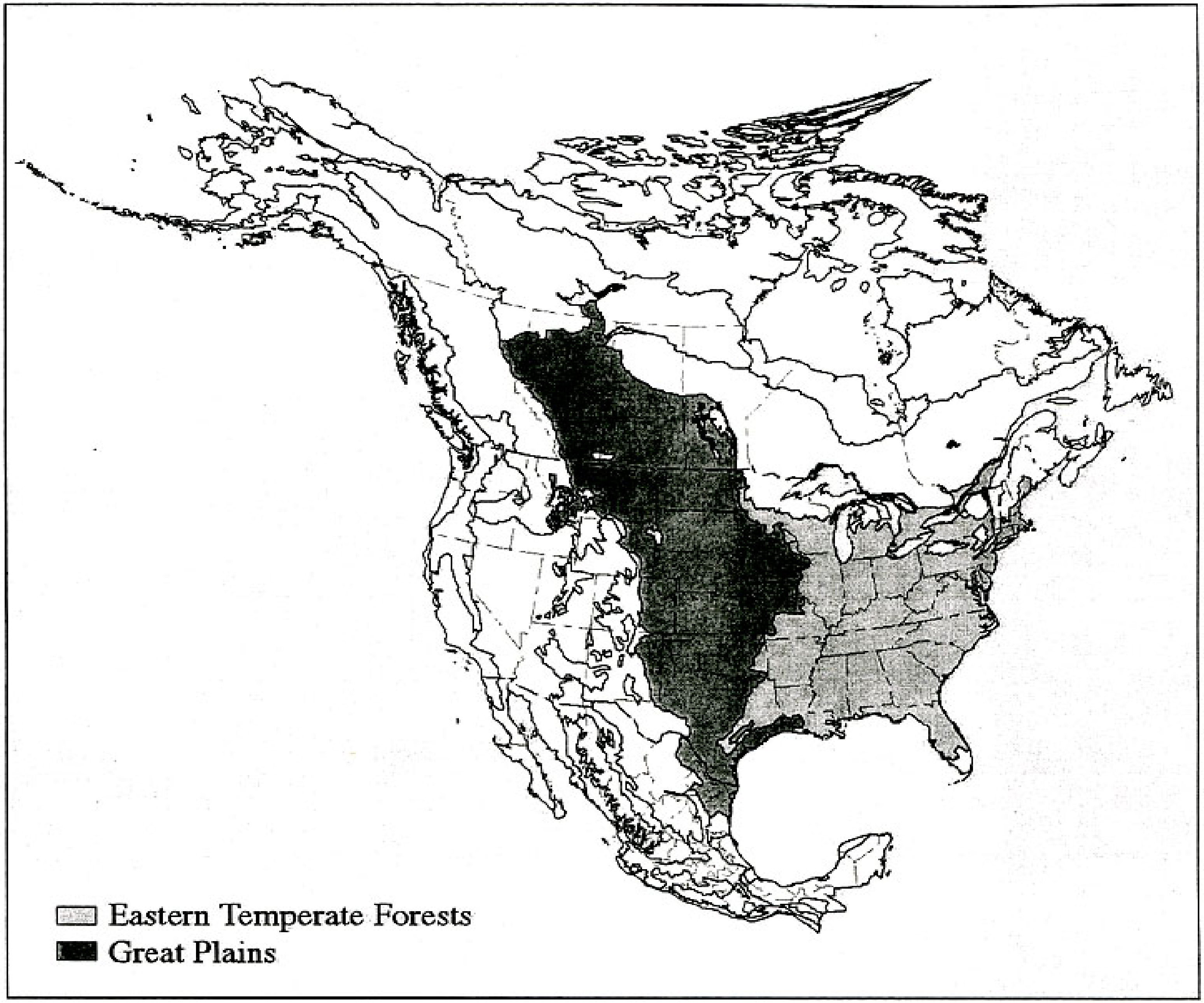


Figure 1. The Great Plains and Eastern Temperate Forests ecological regions. The names and identification numbers for level I ecological regions are given in CEC 1997.

Draft Level I Ecological Regions of North America

Many of the environmental issues which we face today are ecosystem in scope and do not correspond to jurisdictional or administrative boundaries. Adopting an ecosystem approach to environmental resource management and risk assessment requires an understanding of the spatial nature of ecosystems as well as knowledge of their interrelationships, capacities, and resiliency to stresses caused by human activities. Such an approach has been sought by professionals, associations, government agencies, business, industry, and academia to serve as a common ground for integrating information about ecosystems. A descriptive ecoregional framework is an essential element for the ecological approach to be applied effectively across state, provincial, and country jurisdiction boundaries. An example of an immediate application of the framework involves North America Free Trade Agreement (NAFTA) decisions that will have an effect on ecosystem quality and characteristics.

This map of Level I Ecological Regions of North America depicts the coarsest level of the hierarchical framework that has been jointly prepared by the State of the Environment Directorate (Environment Canada), the National Institute of Ecology (Secretariat of Social Development, México), and the Environmental Research Laboratory (United States Environmental Protection Agency), Corvallis, OR. The approach used to compile the map is based on the premise that ecological regions can be identified through the analysis of the patterns and the composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity (Wiken 1986, Omernik 1987, 1995). These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another, regardless of the hierarchical level. Because of possible confusion with other meanings of terms for different levels of ecological regions, a Roman numeral classification scheme has been adopted for this international effort. Level I is the coarsest level, dividing North America into nine ecological regions, whereas at Level II the continent is subdivided into 32 classes.

The map represents an approximation based on comments from numerous contributors and the source material listed below. In order to maximize consistency in the definition of ecological regions and thereby increase the usefulness of cross-boundary applications, revisions to the map are planned. These refinements will follow developments in the process of ecoregionalization, clarification of the meaning of the term ecosystem across agencies and countries, and attaining convention regarding the generalization and naming of regions.

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ECOLOGICAL REGIONS OF NORTH AMERICA REGIONES ECOLÓGICAS DE AMÉRICA DEL NORTE RÉGIONS ÉCOLOGIQUES DE L'AMÉRIQUE DU NORD

Level I Nivel I Niveau I

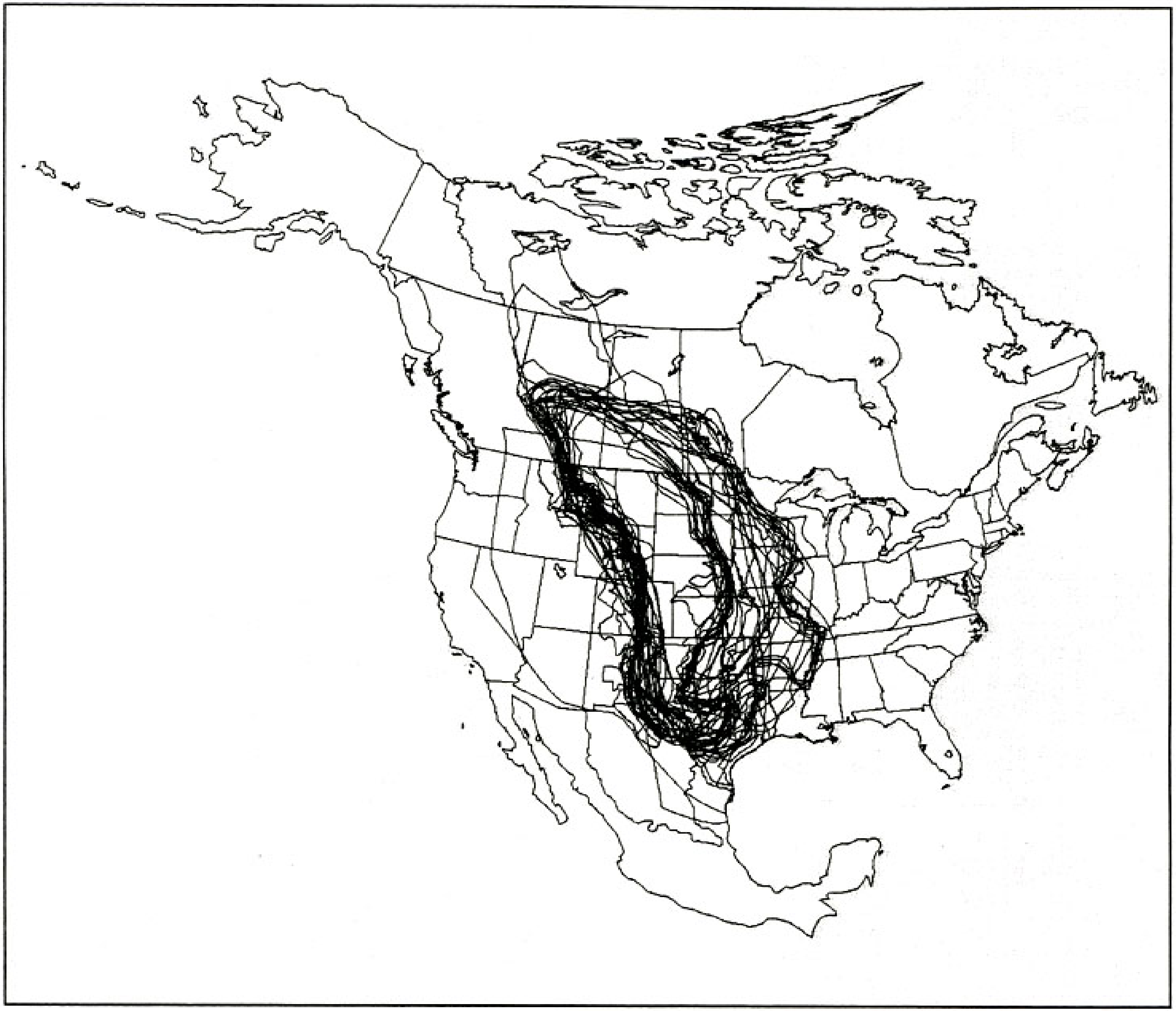


Figure 2. "Fifty versions of the Great Plains" (Rossum and Lavin, 2000). Permission granted by Blackwell Publishing, Oxford, UK.

REASONS FOR DISAGREEMENT OVER HOW TO DELINEATE ECOREGIONS

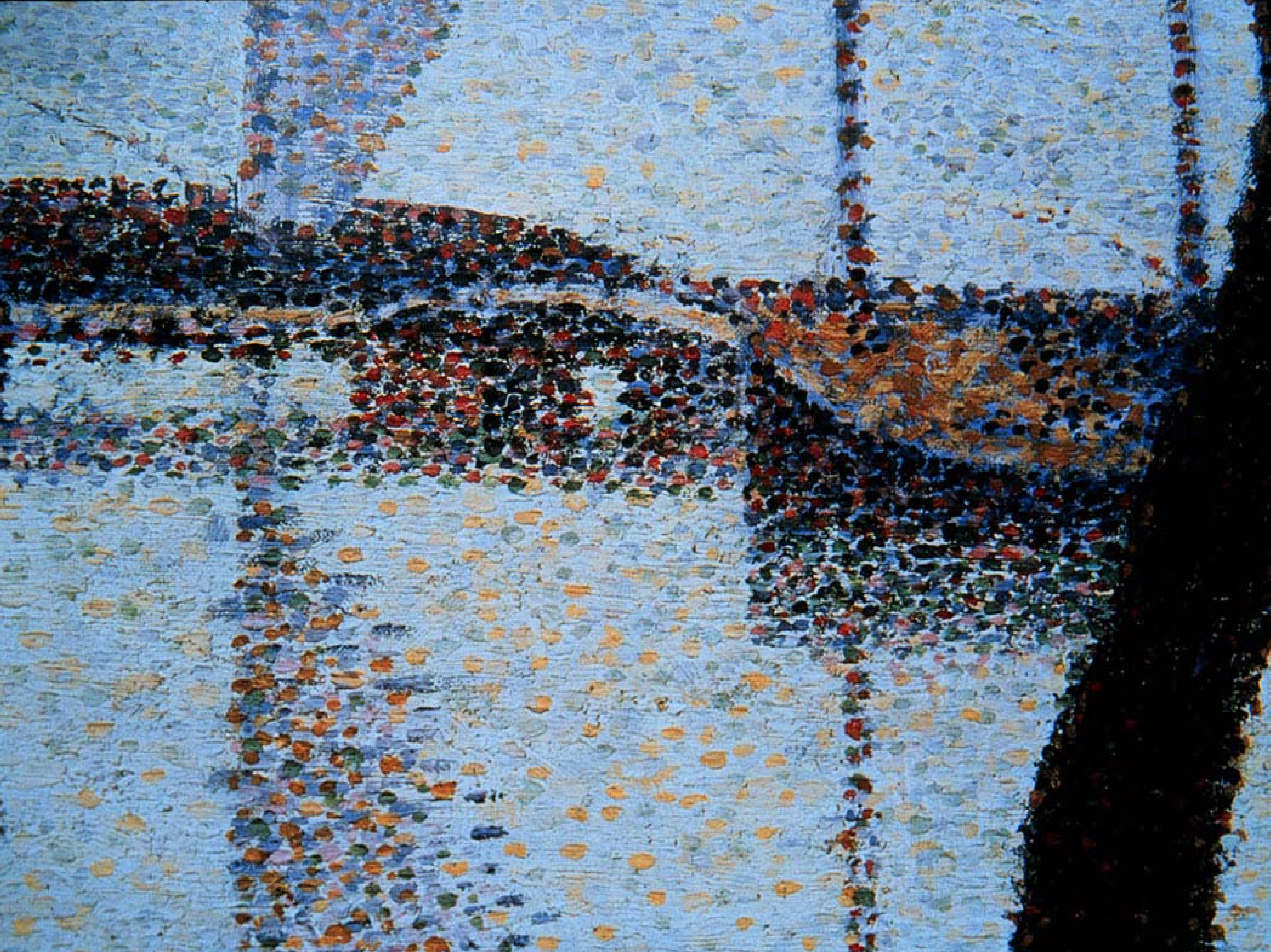
1. Disagreement on the definition of *ecosystems*
2. The complexity of the nature of ecoregions and ecoregion boundaries
3. Bias toward particular characteristics
4. Inability or reluctance to embrace a holistic ecosystem concept and preoccupation with specific objectives and reductive methods
5. Disagreement 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.

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."



ECOLOGICAL REGIONS OF NORTH AMERICA — REGIONES ECOLÓGICAS DE AMÉRICA DEL NORTE — RÉGIONS ÉCOLOGIQUES DE L'AMÉRIQUE DU NORD

Level I — Nivel I — Niveau I


Canada
United States of America
Estados Unidos Mexicanos
ECOLOGICAL REGIONS OF NORTH AMERICA
REGIONES ECOLÓGICAS DE AMÉRICA DEL NORTE
RÉGIONS ÉCOLOGIQUES DE L'AMÉRIQUE DU NORD
Level I-II
Nivel I-II
Niveau I-II
cec.org
Canada
INEGI
ARCTIC OCEAN
OCÉANO ÁRTICO
OCÉAN ARCTIQUE
PACIFIC OCEAN
OCÉANO PACÍFICO
OCÉAN PACIFIQUE
ATLANTIC OCEAN
OCÉANO ATLÁNTICO
OCÉAN ATLANTIQUE
Gulf of Mexico
Golfo de México
Golfe du Mexique
ECOLOGICAL REGIONS OF NORTH AMERICA
REGIONES ECOLÓGICAS DE AMÉRICA DEL NORTE
RÉGIONS ÉCOLOGIQUES DE L'AMÉRIQUE DU NORD
Level I
Nivel I
Niveau I
Scale Escala Échelle
1:10,000,000
Lambert Azimuthal Equal Area Projection
Proyección Azimutal de Equi-área de Lambert
Projection Azimutal de Equi-aire de Lambert

Level III Ecoregions of the Continental United States

(Revised June 2006)

National Health and Environmental Effects Research Laboratory
U.S. Environmental Protection Agency

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53. Southeastern Wisconsin Till Plains
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56. Southern Michigan/Northern Indiana Drift Plains
57. Huron/Erie Lake Plains
58. Northeastern Highlands
59. Northeastern Coastal one
60. Northern Appalachian Plateau and Uplands
61. Erie Drift Plain
62. North Central Appalachians
63. Middle Atlantic Coastal Plain
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65. Southeastern Plains
66. Blue Ridge
67. Ridge and Valley
68. Southwestern Appalachians
69. Central Appalachians
70. Western Allegheny Plateau
71. Interior Plateau
72. Interior River Valleys and Hills
73. Mississippi Alluvial Plain
74. Mississippi Valley Loess Plains
75. Southern Coastal Plain
76. Southern Florida Coastal Plain
77. North Cascades
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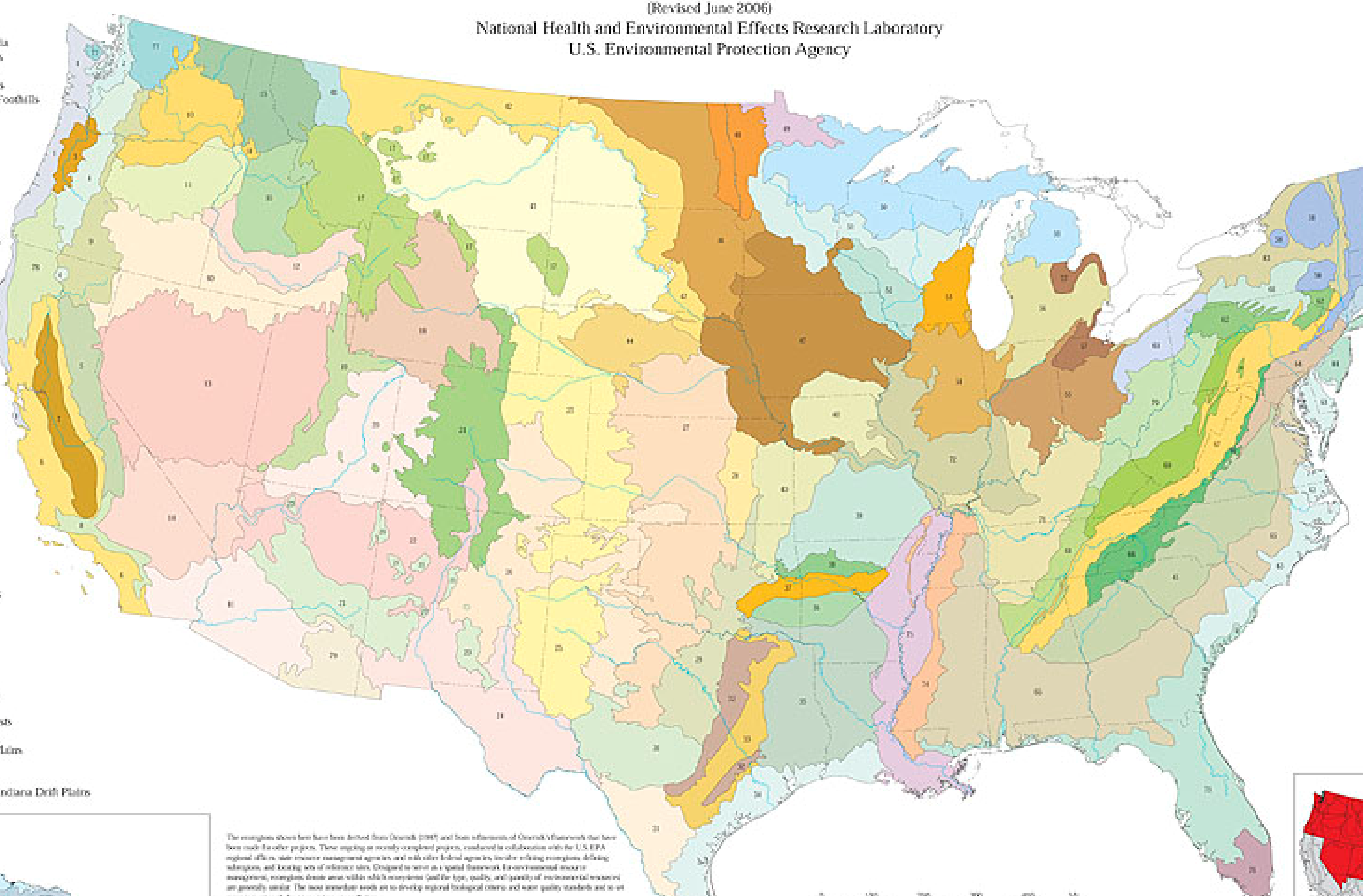
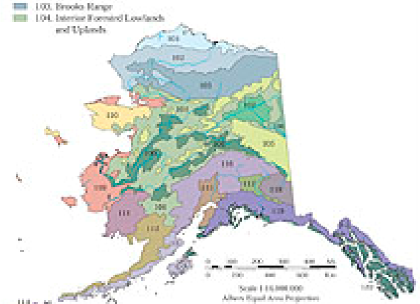
79. Madrean Archipelago
80. Northern Basin and Range
81. Sonoran Basin and Range
82. Laurentian Plains and Hills
83. Eastern Great Lakes and Hudson Lowlands
84. Atlantic Coastal Pine Barrens



101. Arctic Coastal Plain
102. Arctic Foothills
103. Brooks Range
104. Interior Forested Lowlands and Uplands



105. Interior Highlands
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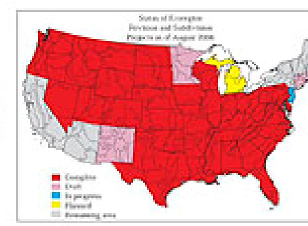
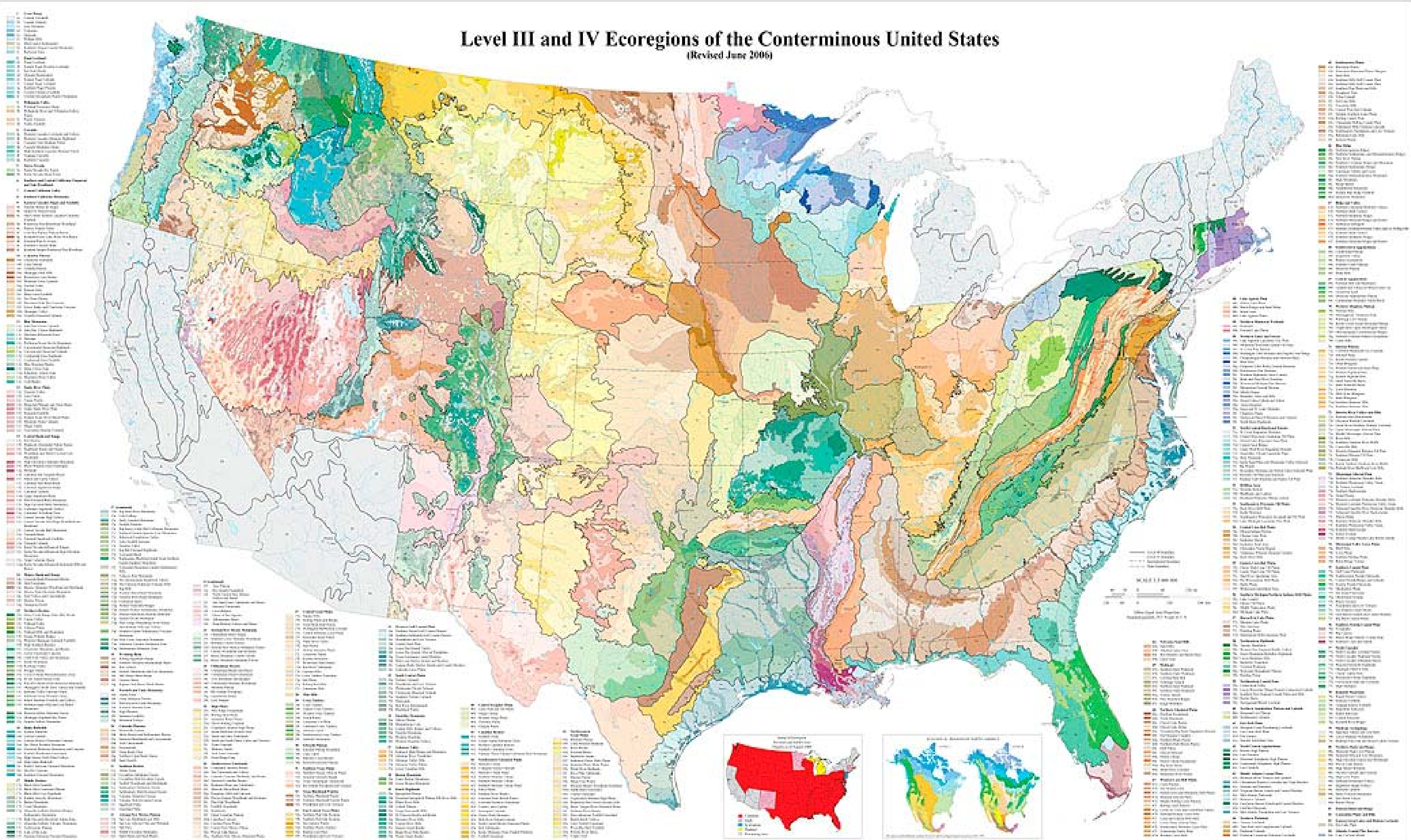
107. Yukon Flats
108. Ogilvie Mountains
109. Subarctic Coastal Plains
110. Seward Peninsula
111. Ahklun and Kilbuck Mountains
112. Bristol Bay-Nushagak Lowlands
113. Alaska Peninsula Mountains
114. Aleutian Islands (Western portion not shown)
115. Cook Inlet
116. Alaska Range
117. Copper Plateau
118. Wrangell Mountains
119. Pacific Coastal Mountains
120. Coastal Western Hemlock-Sitka Spruce Forests



ECOLOGICAL REGIONS OF NORTH AMERICA


Level III and IV Ecoregions of the Conterminous United States
(Revised June 2006)

Ecoregions of North Carolina and South Carolina

45 Piedmont
- 45a Southern Inner Piedmont
- 45b Southern Outer Piedmont
- 45c Carolina Slate Belt
- 45e Northern Inner Piedmont
- 45f Northern Outer Piedmont
- 45g Triassic Basins
- 45i Kings Mountain

63 Middle Atlantic Coastal Plain
- 63b Chesapeake-Pamlico Lowlands and Tidal Marshes
- 63c Nonriverine Swamps and Peatlands
- 63d Virginian Barrier Islands and Coastal Marshes
- 63e Mid-Atlantic Flatwoods
- 63g Carolinian Barrier Islands and Coastal Marshes
- 63h Carolina Flatwoods
- 63n Mid-Atlantic Floodplains and Low Terraces

65 Southeastern Plains
- 65c Sand Hills
- 65l Atlantic Southern Loam Plains
- 65m Rolling Coastal Plain
- 65p Southeastern Floodplains and Low Terraces

66 Blue Ridge
- 66a New River Plateau
- 66d Southern Crystalline Ridges and Mountains
- 66e Southern Sedimentary Ridges
- 66g Southern Metasedimentary Mountains
- 66i High Mountains
- 66j Broad Basins
- 66k Amphibolite Mountains
- 66l Eastern Blue Ridge Foothills
- 66m Sauratown Mountains

75 Southern Coastal Plain
- 75i Floodplains and Low Terraces
- 75j Sea Islands/Coastal Marsh

Level III ecoregion — Level IV ecoregion — County boundary — State boundary

Level III Ecoregions of the Conterminous United States

45. Piedmont

63. Middle Atlantic Coastal Plain

65. Southeastern Plains

66. Blue Ridge

75. Southern Coastal Plain

Summary Table: Characteristics of the Ecoregions of North Carolina and South Carolina

45. PIEDMONT

Level IV Ecoregion	Physiography	Geology	Soil	Climate	Potential Natural Vegetation	Land Use and Land Cover
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

65. SOUTHEASTERN PLAINS

Level IV Ecoregion	Physiography	Geology	Soil	Climate	Potential Natural Vegetation	Land Use and Land Cover
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

66. BLUE RIDGE

Level IV Ecoregion	Physiography	Geology	Soil	Climate	Potential Natural Vegetation	Land Use and Land Cover
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

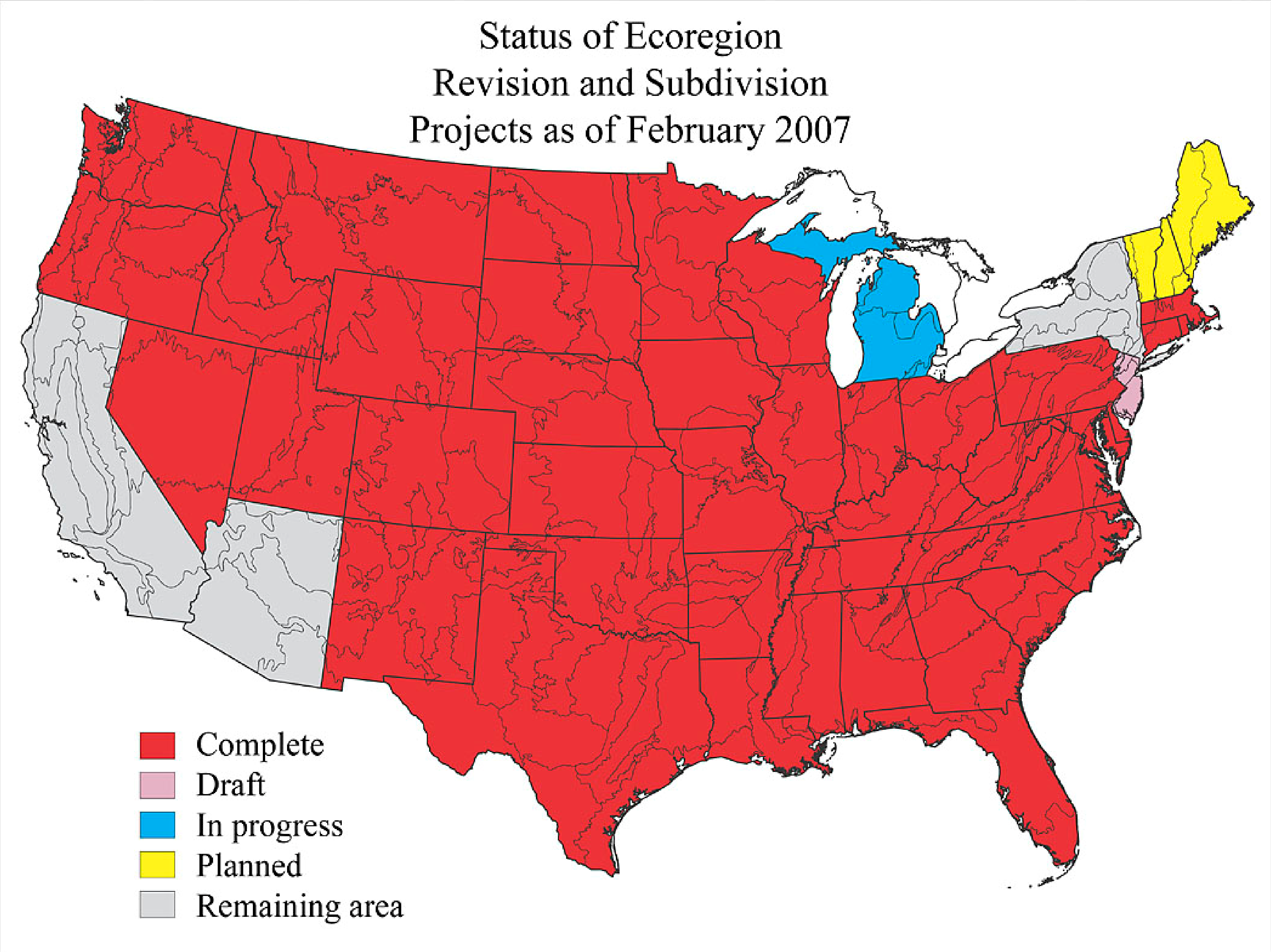
63. MIDDLE ATLANTIC COASTAL PLAIN

Level IV Ecoregion	Physiography	Geology	Soil	Climate	Potential Natural Vegetation	Land Use and Land Cover
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

75. SOUTHERN COASTAL PLAIN

Level IV Ecoregion	Physiography	Geology	Soil	Climate	Potential Natural Vegetation	Land Use and Land Cover
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]


Status of Ecoregion
Revision and Subdivision
Projects as of February 2007
Complete
Draft
In progress
Planned
Remaining area

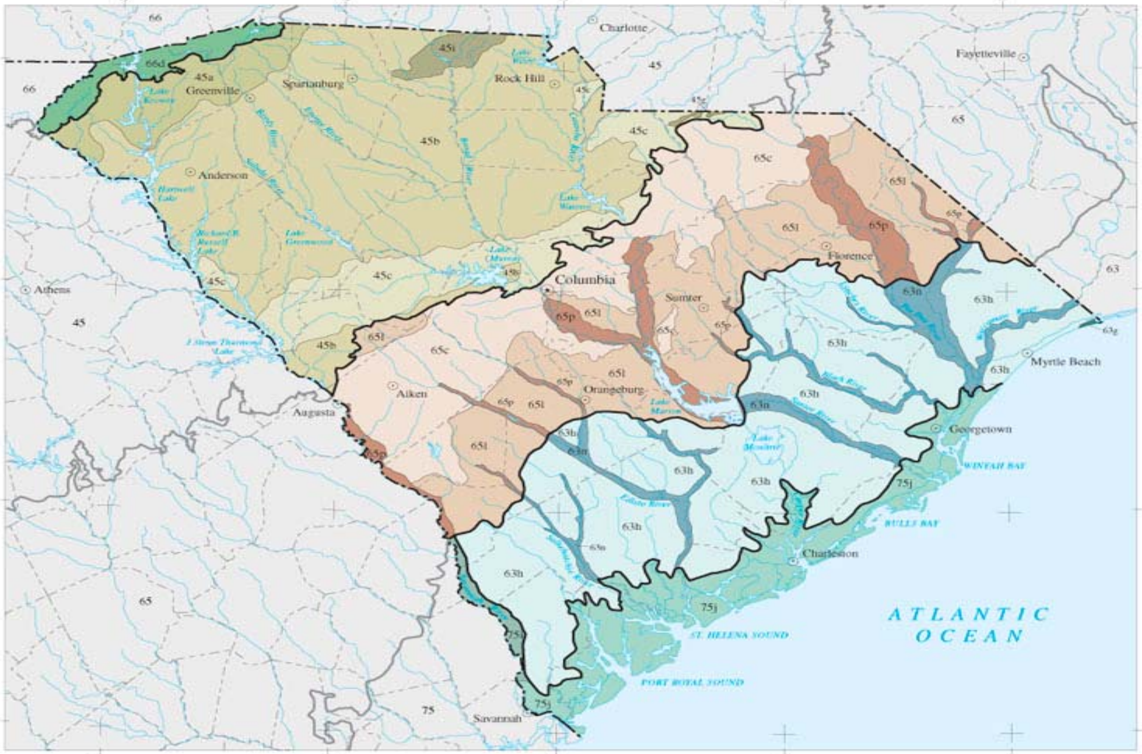
General purpose ecological regions

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

Ecoregions of South Carolina



45 Piedmont
- 45a Southern Inner Piedmont
- 45b Southern Outer Piedmont
- 45c Carolina Slate Belt
- 45g Triassic Basins
- 45i Kings Mountain

63 Middle Atlantic Coastal Plain
- 63g Carolinian Barrier Islands and Coastal Marshes
- 63h Carolina Flatwoods
- 63n Mid-Atlantic Floodplains and Low Terraces

65 Southeastern Plains
- 65c Sand Hills
- 65l Atlantic Southern Loam Plains
- 65p Southeastern Floodplains and Low Terraces

66 Blue Ridge
- 66d Southern Crystalline Ridges and Mountains

75 Southern Coastal Plain
- 75i Floodplains and Low Terraces
- 75j Sea Islands/Coastal Marsh

Level III ecoregion
Level IV ecoregion
County boundary
State boundary

SCALE 1:1 500 000

15 10 5 0 30 60 mi

30 20 10 0 60 120 km

Albers Equal Area Projection

Level III Ecoregions of the Conterminous United States

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. Ecoregions are directly applicable to many state agency activities, including the selection of regional stream reference sites, the development of biological criteria and water quality standards, and the establishment of management goals for nonpoint-source pollution. They are also relevant to integrated ecosystem management, an ultimate goal of many federal and state resource management agencies.

The approach used to compile this map of South Carolina is based on the premise that ecological regions can be identified through the analysis of the patterns of biotic and abiotic phenomena that reflect differences in ecosystem quality and integrity (Wiken 1986; Omernik 1987, 1995). These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions. Level I and Level II divide the North American continent into 15 and 52 regions, respectively (Commission for Environmental Cooperation Working Group 1997). At Level III, the continental United States contains 104 regions (United States Environmental Protection Agency [U.S. EPA] 2000). Level IV is a further subdivision of the Level III ecoregions. Explanations of the methods used to define the U.S. EPA's ecoregions are given in Omernik (1995), Griffith and others (1997, 2002a), and Gallant and others (1989).

The Level III and IV Ecoregions of South Carolina map was compiled at a scale of 1:250,000; it depicts revisions and subdivisions of earlier Level III ecoregions that were originally compiled at a smaller scale (U.S. EPA 1999; Omernik 1987). Compilation of this map is part of a collaborative project primarily between the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), the U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL), U.S. EPA Region IV, and the South Carolina Department of Health and Environmental Control (DHEC). This project is also associated with an interagency effort to develop a common framework of ecological regions (McMahon and others 2001, Griffith and others 2002b). Regional collaborative projects, such as this one in South Carolina where some agreement can be reached among multiple resource management agencies, are a step in the direction of attaining commonality and consistency in ecoregion frameworks for the entire nation.

Comments regarding this Level III and IV Ecoregions of South Carolina map should be addressed to Glenn Griffith, USDA-NRCS, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4465, email: griffith.glenn@epa.gov, or to James Omernik, USGS, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4458, email: omernik.james@epa.gov.

Literature Cited:

Commission for Environmental Cooperation Working Group, 1997, Ecological regions of North America - toward a common perspective: Montreal, Quebec, Commission for Environmental Cooperation, 71 p.

Gallant, A.L., Whittier, T.R., Larsen, D.P., Omernik, J.M., and Hughes, R.M., 1989, Regionalization as a tool for managing environmental resources: Corvallis, Oregon, U.S. Environmental Protection Agency EPA/600/3-89/060, 152 p.

Griffith, G.E., Omernik, J.M., and Azevedo, S.H., 1997, Ecoregions of Tennessee: Corvallis, Oregon, U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, EPA/600/R-97/022, 51 p.

Griffith, G.E., Omernik, J.M., and Comstock, J.A., 2002a, Ecoregions of South Carolina: Corvallis, Oregon, U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, 47 p.

Griffith, G.E., Omernik, J.M., Comstock, J.A., Schafale, M.P., McNab, W.H., Lenat, D.R., MacPherson, T.F., Glover, J.B., and Shelburne, V.B., 2002b, Ecoregions of North Carolina and South Carolina, (color poster with map descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

McMahon, G., Gregonis, S.M., Waltman, S.W., Omernik, J.M., Thorson, T.D., Freeouf, J.A., Rorick, A.H., and Keys, J.E., 2001, Developing a spatial framework of common ecological regions for the conterminous United States: Environmental Management, v. 28, no. 3, p. 293-316.

Omernik, J.M., 1987, Ecoregions of the conterminous United States (map supplement): Annals of the Association of American Geographers, v. 77, no. 1, p. 118-125, scale 1:7,500,000.

Omernik, J.M., 1995, Ecoregions-a spatial framework for environmental management, in Davis, W.S. and Simon, T.P., eds., Biological assessment and criteria-tools for water resource planning and decision making: Boca Raton, Florida, Lewis Publishers, p. 49-62.

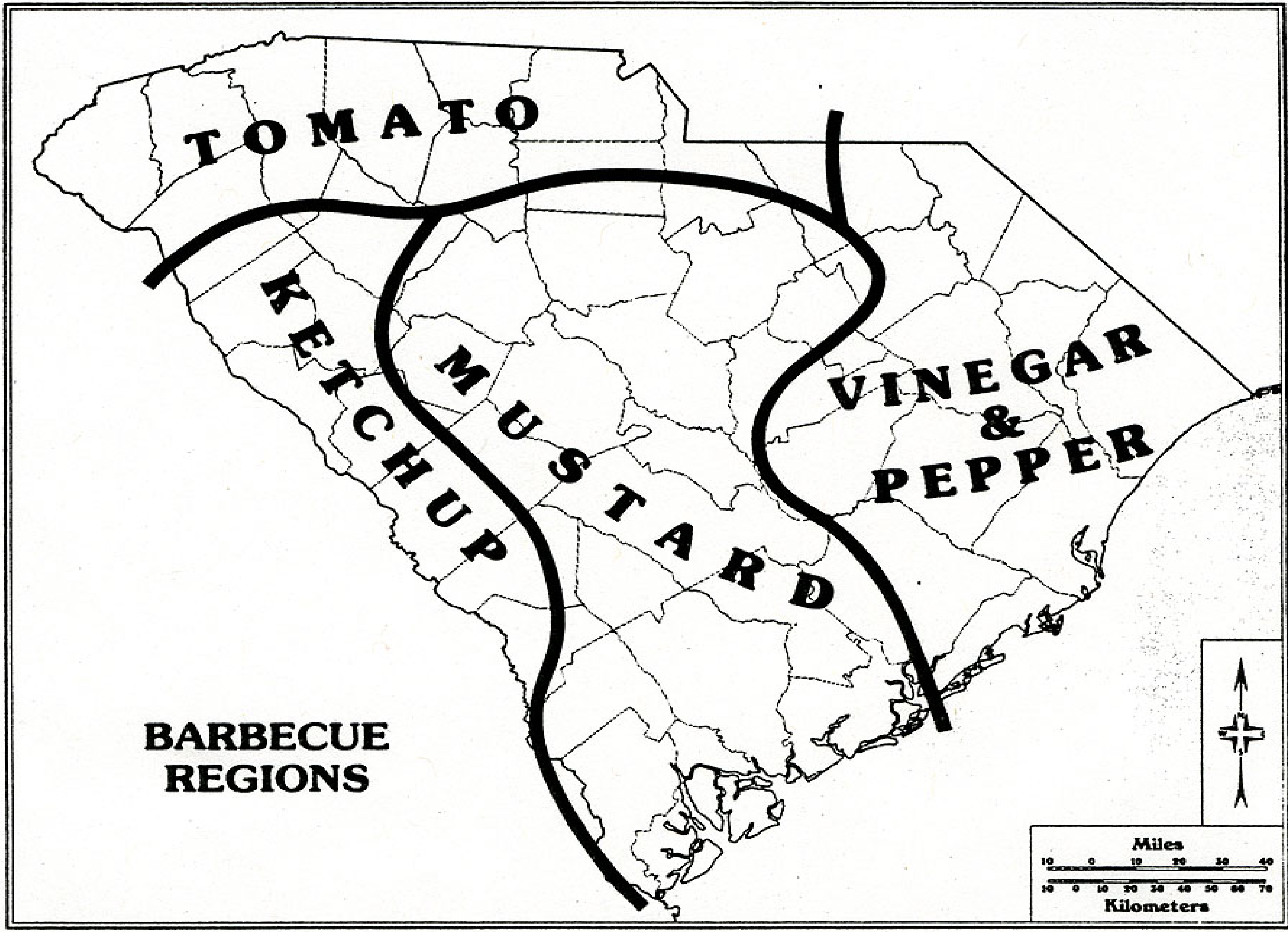
U.S. Environmental Protection Agency, 2000, Level III ecoregions of the continental United States (revision of Omernik, 1987): Corvallis, Oregon, U.S. Environmental Protection Agency-National Health and Environmental Effects Research Laboratory Map, M-1.

Wiken, E., 1986, Terrestrial ecozones of Canada: Ottawa, Environment Canada, Ecological Land Classification Series no. 19, 26 p.

PRINCIPAL AUTHORS: Glenn E. Griffith (NRCS), James M. Omernik (USEPA), Jeffrey A. Comstock (Indus Corporation), James B. Glover (SCDHEC), and Victor B. Shelburne (Clemson University).

COLLABORATORS AND CONTRIBUTORS: Jim Harrison (USEPA), Ronald C. Ahle (SCDNR), Roy L.Vick, Jr. (NRCS), Ben Stuckey, Jr. (NRCS), Dennis Law (USFS), Rick Renfrow (SCDHEC), Paul Nystrom (SCDNR), Rich Scharf (SCDNR), and Tom Loveland (USGS).

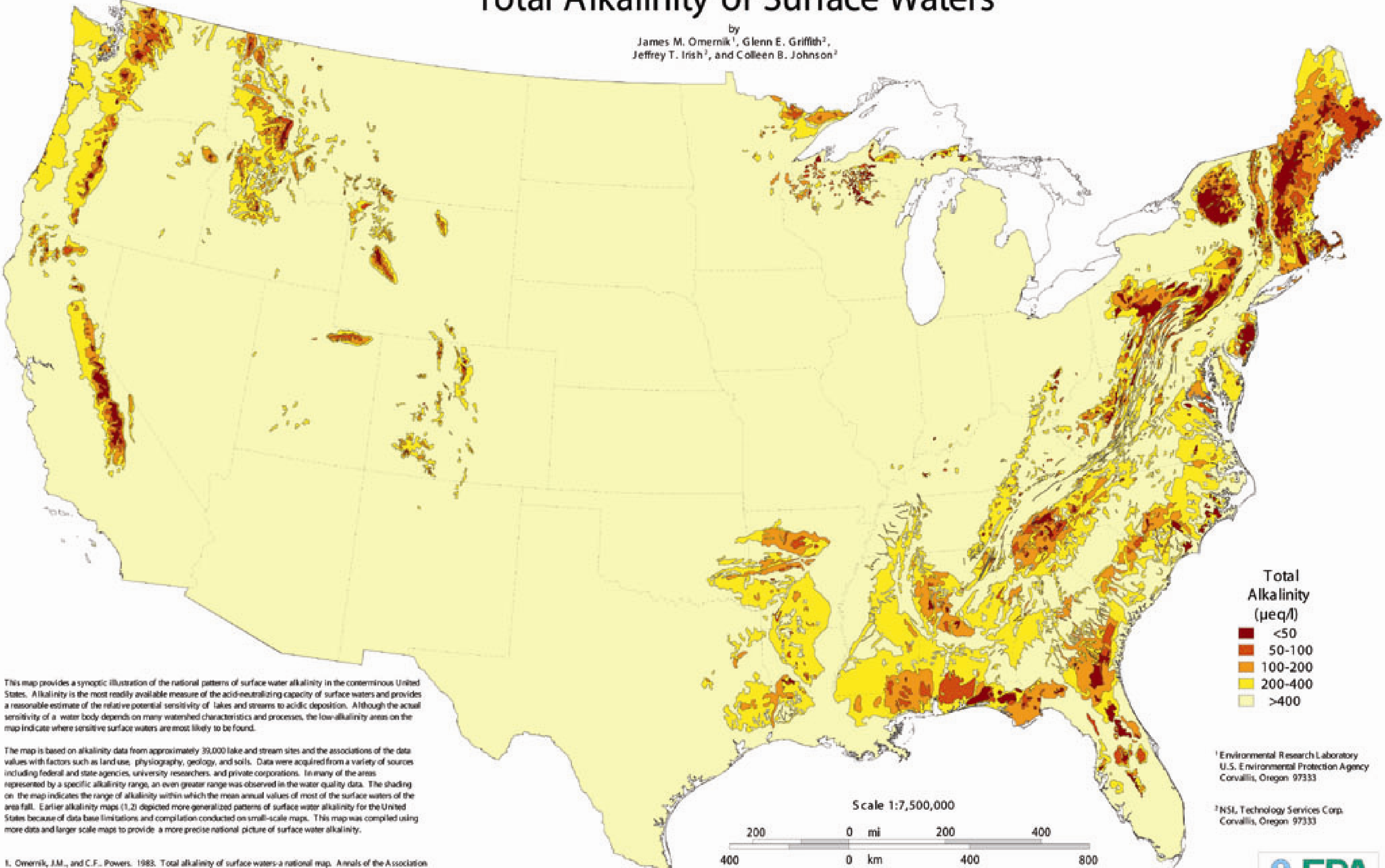
CITING THIS MAP: Griffith, G.E., Omernik, J.M., Comstock, J.A., Glover, J.B., and Shelburne, V.B., 2002, Ecoregions of South Carolina, U.S. Environmental Protection Agency, Corvallis, OR (map scale 1:1,500,000).



MAP 11.1 Source: Based on Wall and Larne (1979).

Total Alkalinity of Surface Waters

by
James M. Omernik[1], Glenn E. Griffith[2],
Jeffrey T. Irish[2], and Colleen B. Johnson[2]



This map provides a synoptic illustration of the national patterns of surface water alkalinity in the conterminous United States. Alkalinity is the most readily available measure of the acid-neutralizing capacity of surface waters and provides a reasonable estimate of the relative potential sensitivity of lakes and streams to acidic deposition. Although the actual sensitivity of a water body depends on many watershed characteristics and processes, the low-alkalinity areas on the map indicate where sensitive surface waters are most likely to be found.

The map is based on alkalinity data from approximately 39,000 lake and stream sites and the associations of the data values with factors such as land use, physiography, geology, and soils. Data were acquired from a variety of sources including federal and state agencies, university researchers, and private corporations. In many of the areas represented by a specific alkalinity range, an even greater range was observed in the water quality data. The shading on the map indicates the range of alkalinity within which the mean annual values of most of the surface waters of the area fall. Earlier alkalinity maps (1,2) depicted more generalized patterns of surface water alkalinity for the United States because of data base limitations and compilation conducted on small-scale maps. This map was compiled using more data and larger scale maps to provide a more precise national picture of surface water alkalinity.

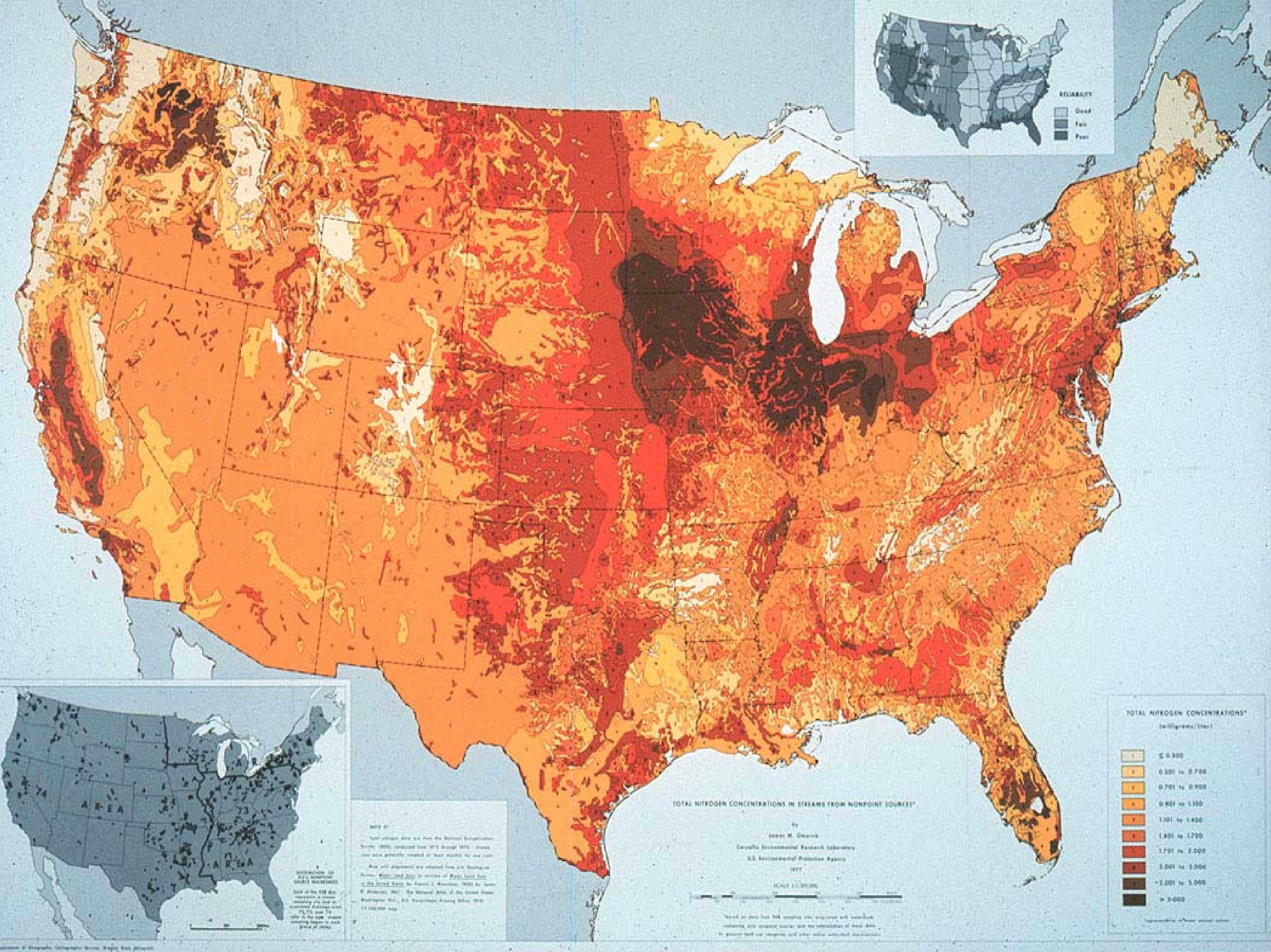
1. Omernik, J.M., and C.F. Powers. 1983. Total alkalinity of surface waters-a national map. Annals of the Association of American Geographers 73 (1):133-136.

2. Omernik, J.M., G.E. Griffith, and A.J. Kinney. 1985. Total alkalinity of surface waters. Corvallis Environmental Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon.

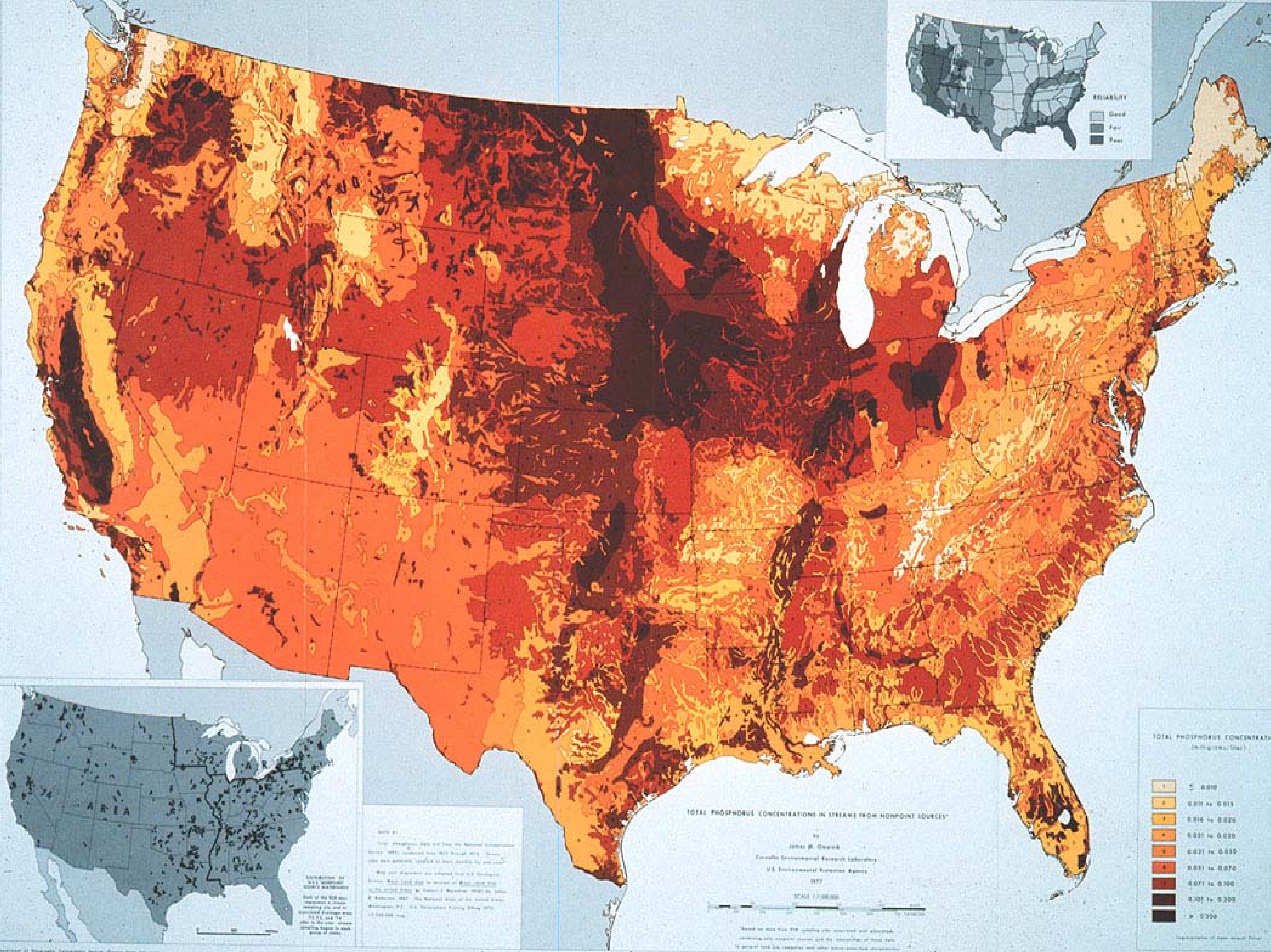
[1] Environmental Research Laboratory
U.S. Environmental Protection Agency
Corvallis, Oregon 97333

[2] NSI, Technology Services Corp.
Corvallis, Oregon 97333

EPA

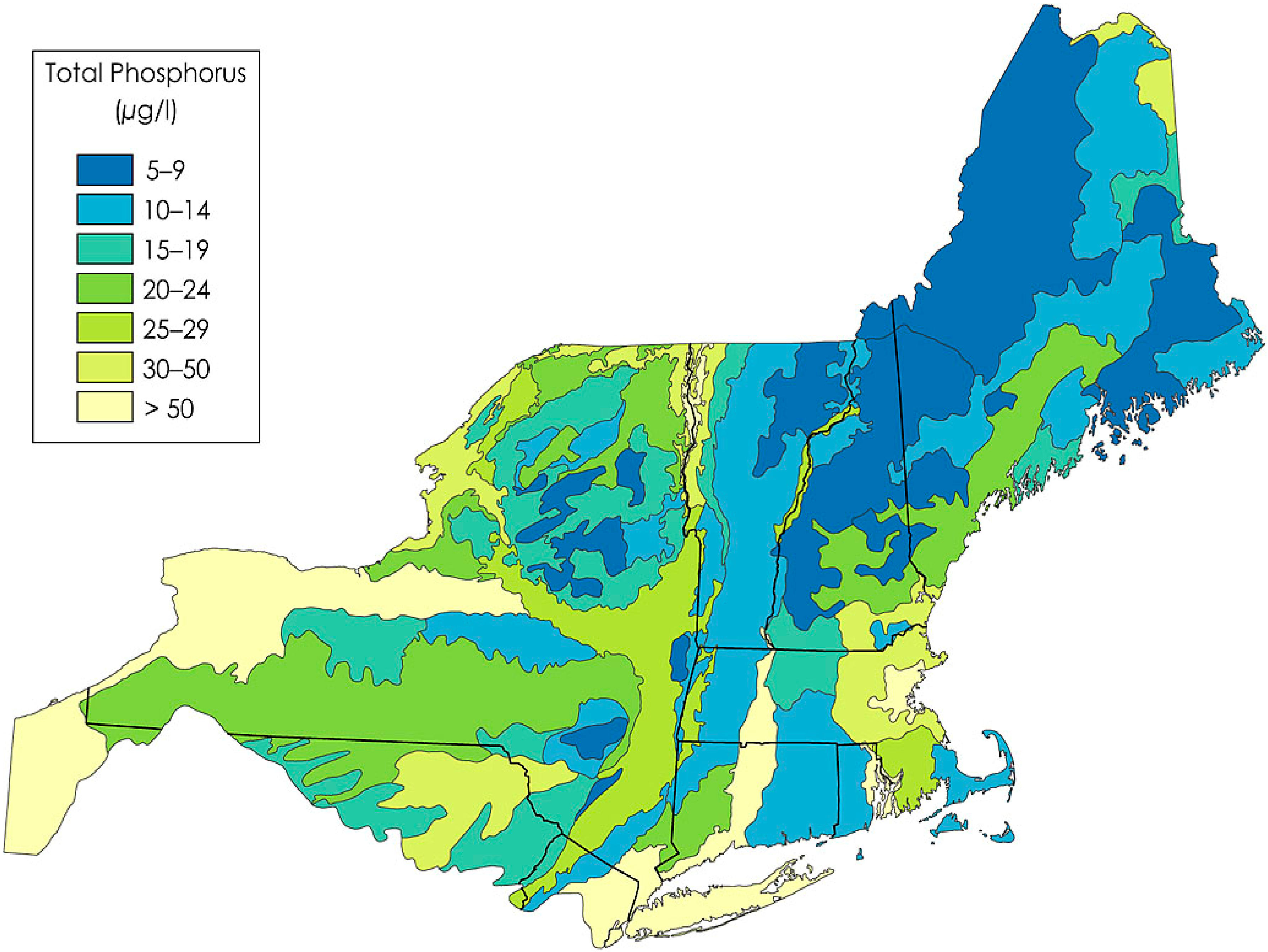


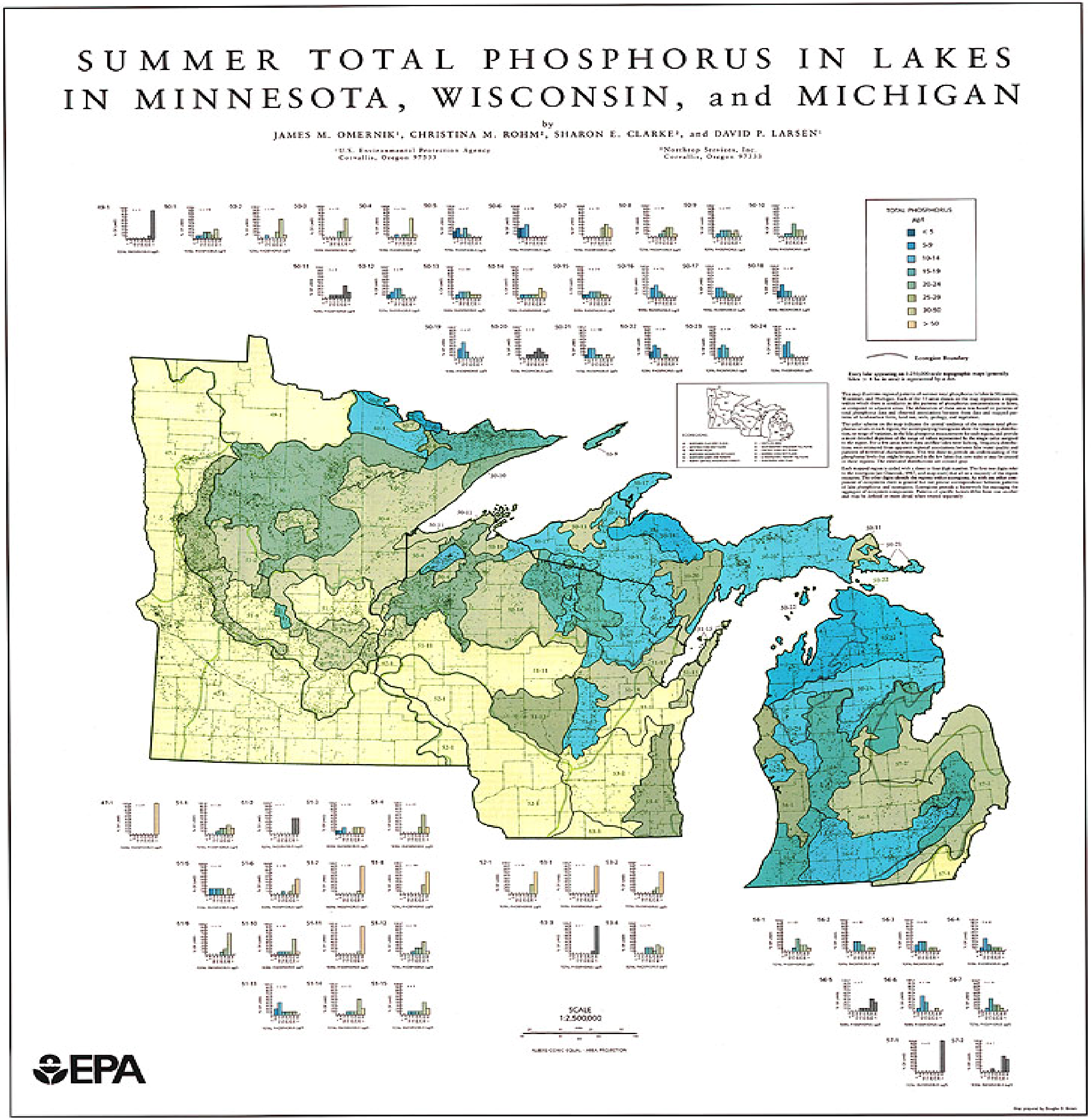
RELIABILITY
Good
Fair
Poor
TOTAL NITROGEN CONCENTRATIONS IN STREAMS FROM NONPOINT SOURCES*
by
James M. Omernik
Corvallis Environmental Research Laboratory
U.S. Environmental Protection Agency
1977
TOTAL NITROGEN CONCENTRATIONS*
(milligrams/liter)
≤ 0.500
0.501 to 0.700
0.701 to 0.900
0.901 to 1.100
1.101 to 1.400
1.401 to 1.700
1.701 to 2.000
2.001 to 3.000
3.001 to 5.000
> 5.000
AREA
AREA



TOTAL PHOSPHORUS CONCENTRATIONS IN STREAMS FROM NONPOINT SOURCES*
by
James M. Omernik
Corvallis Environmental Research Laboratory
U.S. Environmental Protection Agency
1977
RELIABILITY
Good
Fair
Poor
TOTAL PHOSPHORUS CONCENTRATION
(milligrams/liter)
≤ 0.010
0.011 to 0.015
0.016 to 0.020
0.031 to 0.050
0.051 to 0.070
0.071 to 0.100
0.101 to 0.200
> 0.200
AREA

TOTAL PHOSPHORUS REGIONS FOR THE LAKES IN THE NORTHEASTERN UNITED STATES





SUMMER TOTAL PHOSPHORUS IN LAKES
IN MINNESOTA, WISCONSIN, and MICHIGAN
by
JAMES M. OMERNIK[1], CHRISTINA M. ROHM[2], SHARON E. CLARKE[2], and DAVID P. LARSEN[1]
[1]U.S. Environmental Protection Agency
Corvallis, Oregon 97333
[2]Northrop Services, Inc.
Corvallis, Oregon 97333
TOTAL PHOSPHORUS
µg/l
< 5
5-9
10-14
15-19
20-24
25-29
30-50
> 50
Ecoregion Boundary
SCALE
1:2,500,000
EPA

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

<u>Process</u> (continued):

8. Revise level III and IV ecoregions and descriptions

9. Peer review

10. Produce co-authored and co-endorsed maps/posters

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

DEVELOPMENT OF REGIONALLY-BASED INTERPRETATIONS OF TENNESSEE'S NARRATIVE NUTRIENT CRITERION

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

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

HABITAT QUALITY OF LEAST-IMPACTED STREAMS IN TENNESSEE

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

United States
Environmental Protection
Agency

Office of Water
4501F

EPA840-S-96-001
June 1996

EPA

Watershed Approach Framework

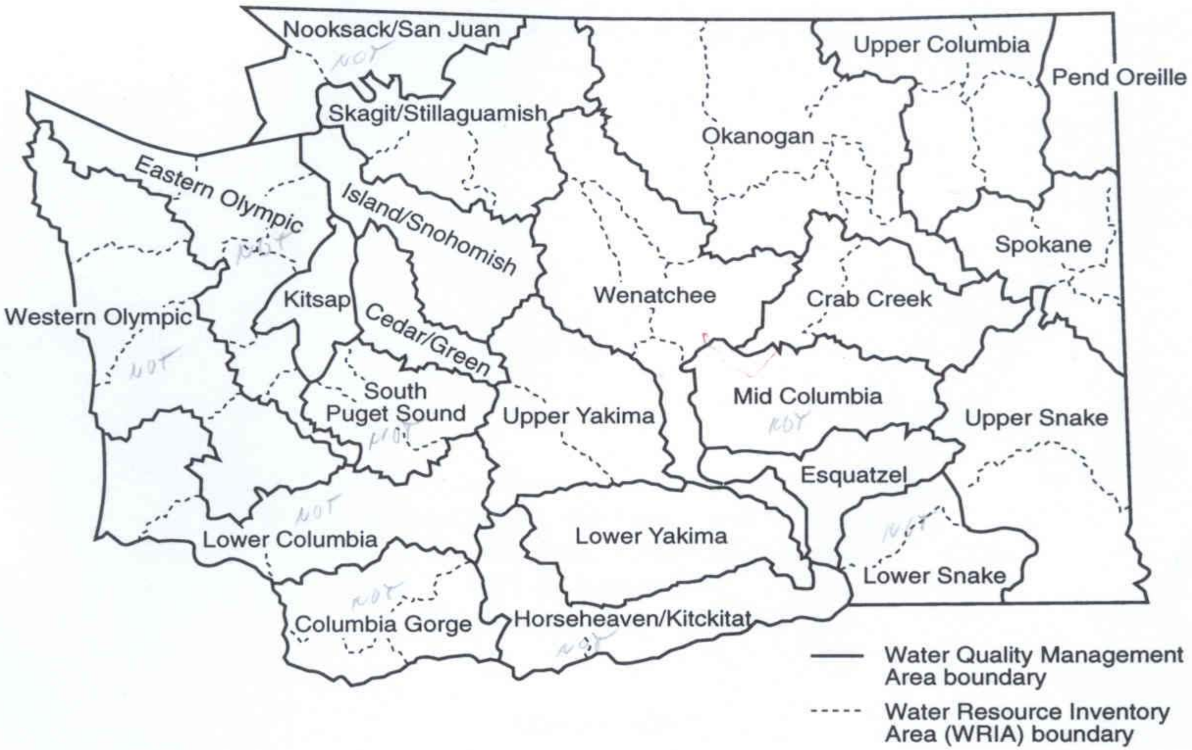
United States Environmental Protection Agency

Office of Water (4503F)

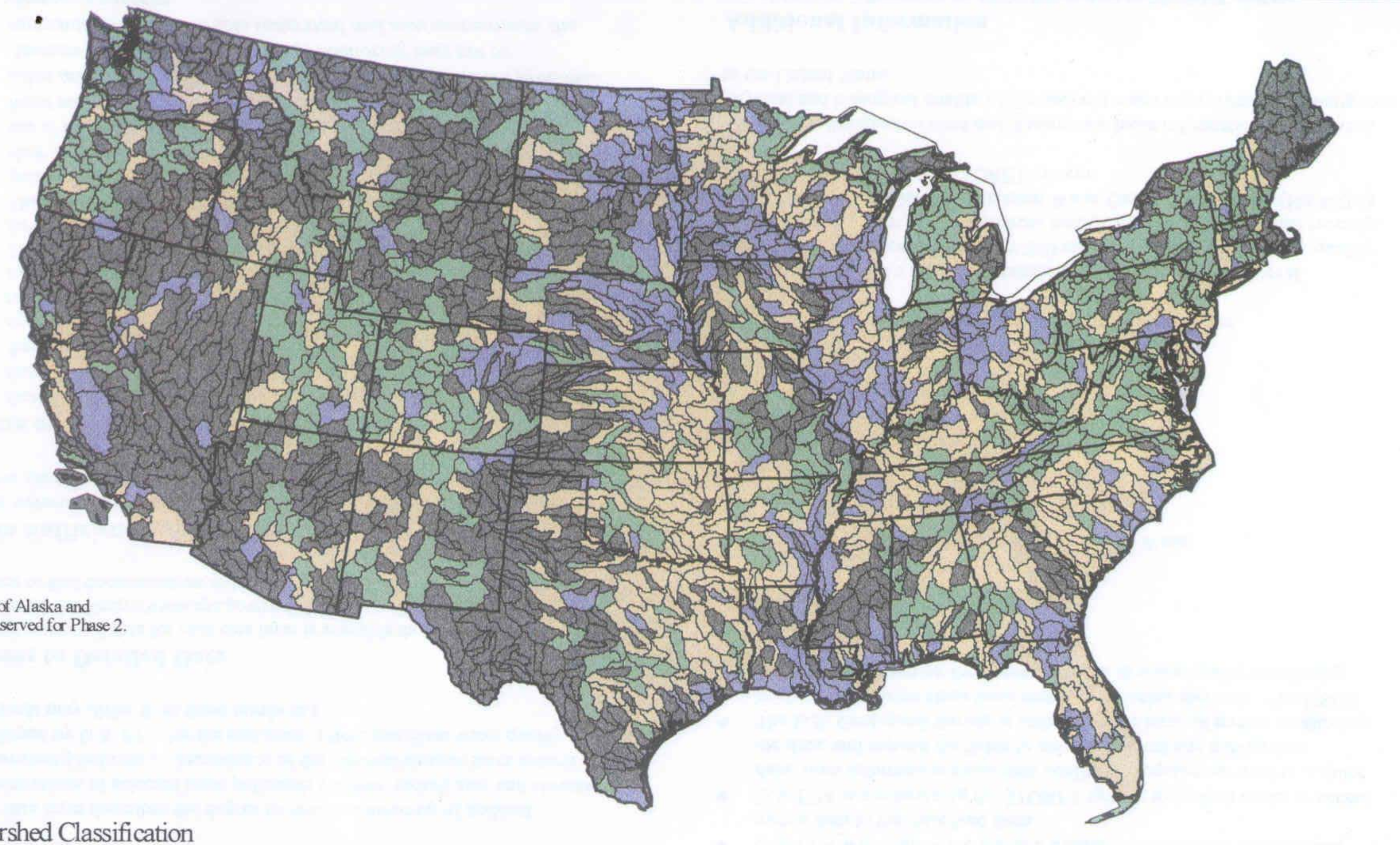
EPA 841-R-95-004
August 1995

EPA

Watershed Protection: A Statewide Approach



6. Ambient Water Quality Data - Four Conventional Pollutants
Ammonia, Dissolved Oxygen, Phosphorus and pH
1990 - 1995



Analysis of Alaska and Hawaii reserved for Phase 2.

Watershed Classification

- 0 - 10% Observations in Exceedence of Selected Reference Level
- 11 - 25% Observations in Exceedence of Selected Reference Level
- >25% Observations in Exceedence of Selected Reference Level
- Data Sufficiency Threshold Not Met

Index of Watershed Indicators

Sources: U.S. Environmental Protection Agency: Storage and Retrieval (STORET) System

EPA

June 27, 1997

TI 4-93.19f12

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

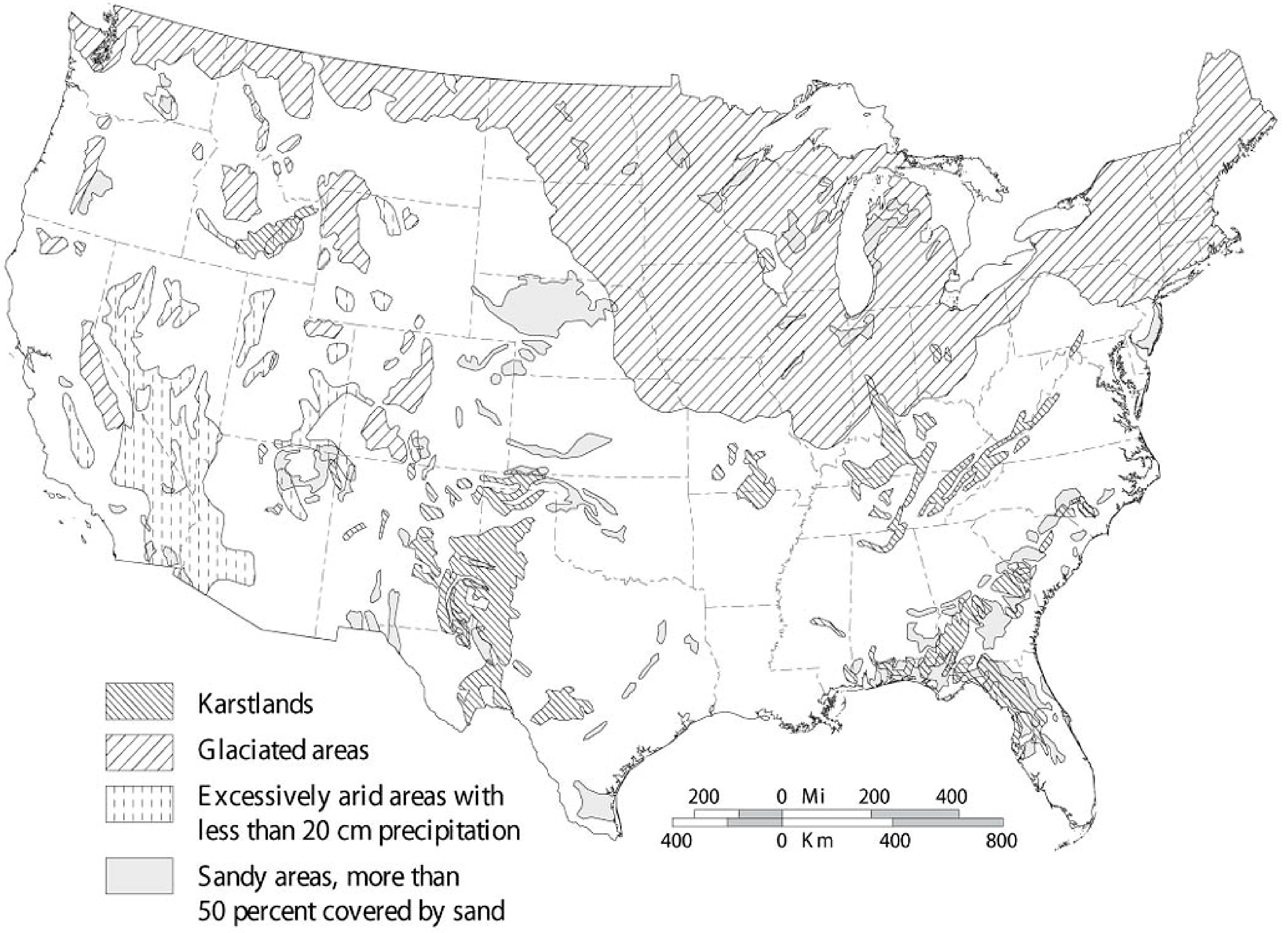
Watersheds and segments of watersheds and basins, often with adjacent intersticies

WATERSHEDS

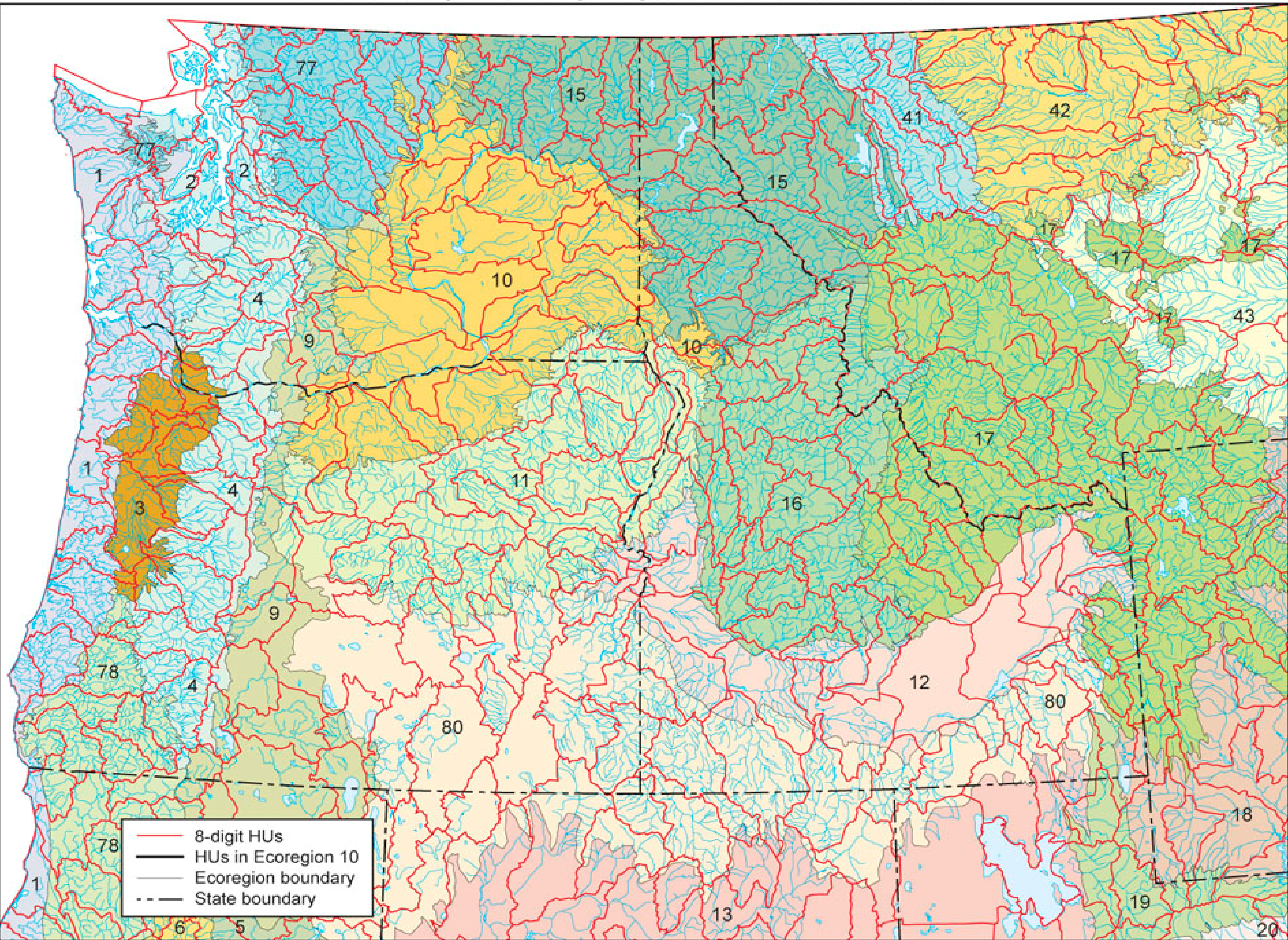
Useful for assessing the relative contribution of natural and anthropogenic characteristics to the quality and quantity of water at specific points on streams and on particular water bodies.

ECOREGIONS

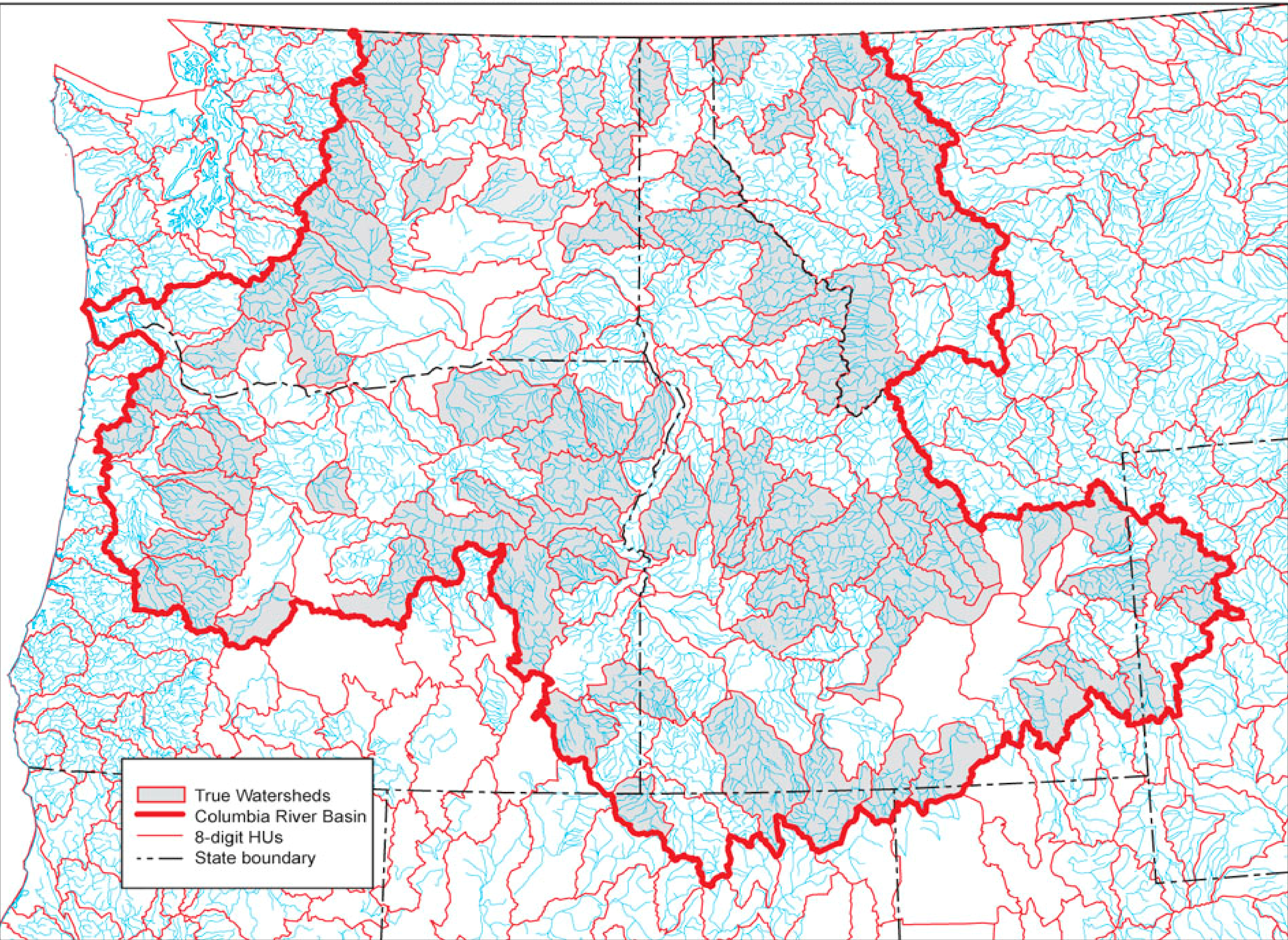
Provide a spatial framework for the research, assessment, inventory, monitoring, and management of ecosystems and ecosystem components.


Karstlands
Glaciated areas
Excessively arid areas with less than 20 cm precipitation
Sandy areas, more than 50 percent covered by sand
200 0 Mi 200 400
400 0 Km 400 800

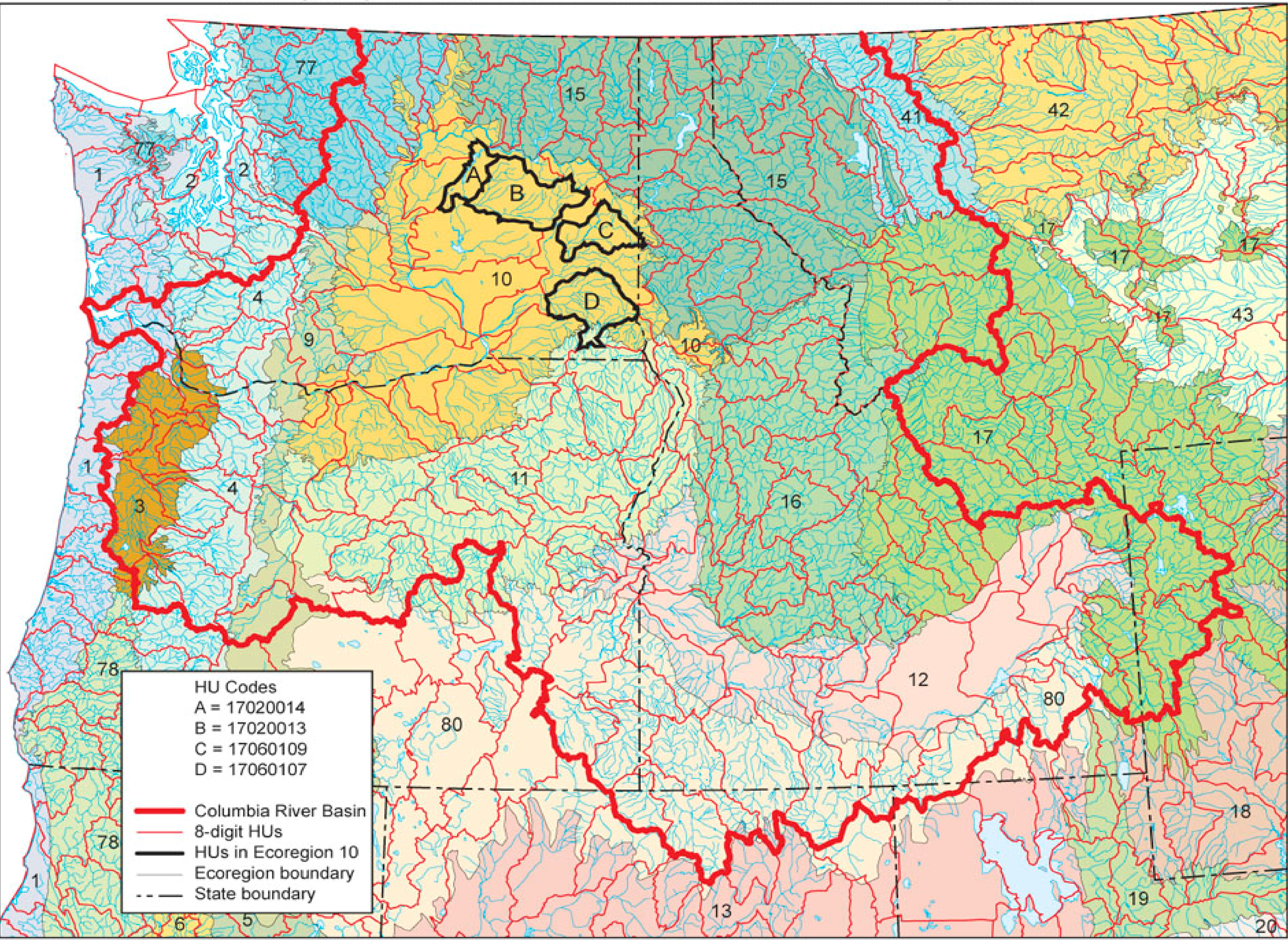
Level III Ecoregions and Eight Digit HUs in the Pacific Northwest



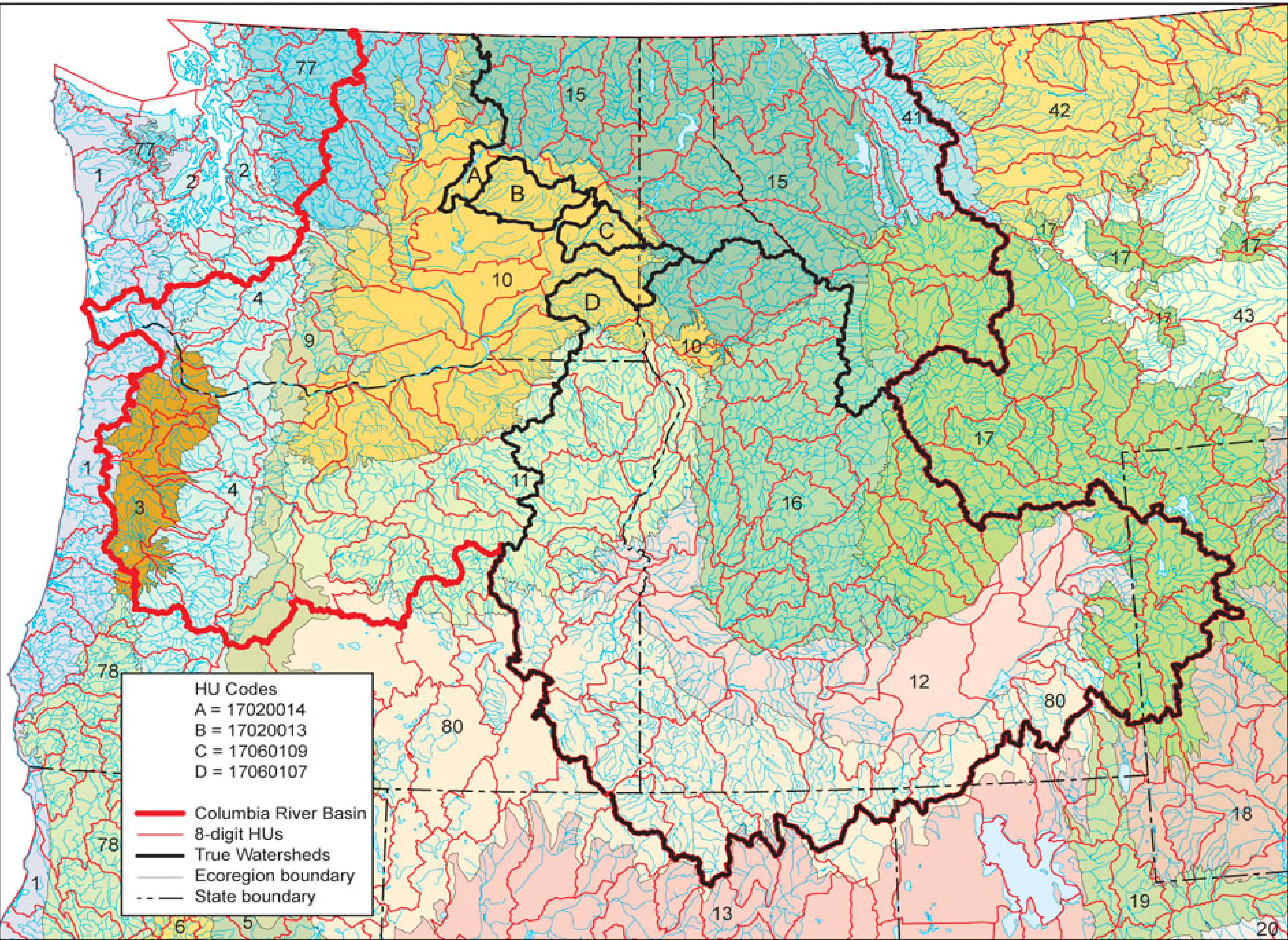
True Watersheds within the Columbia River Basin

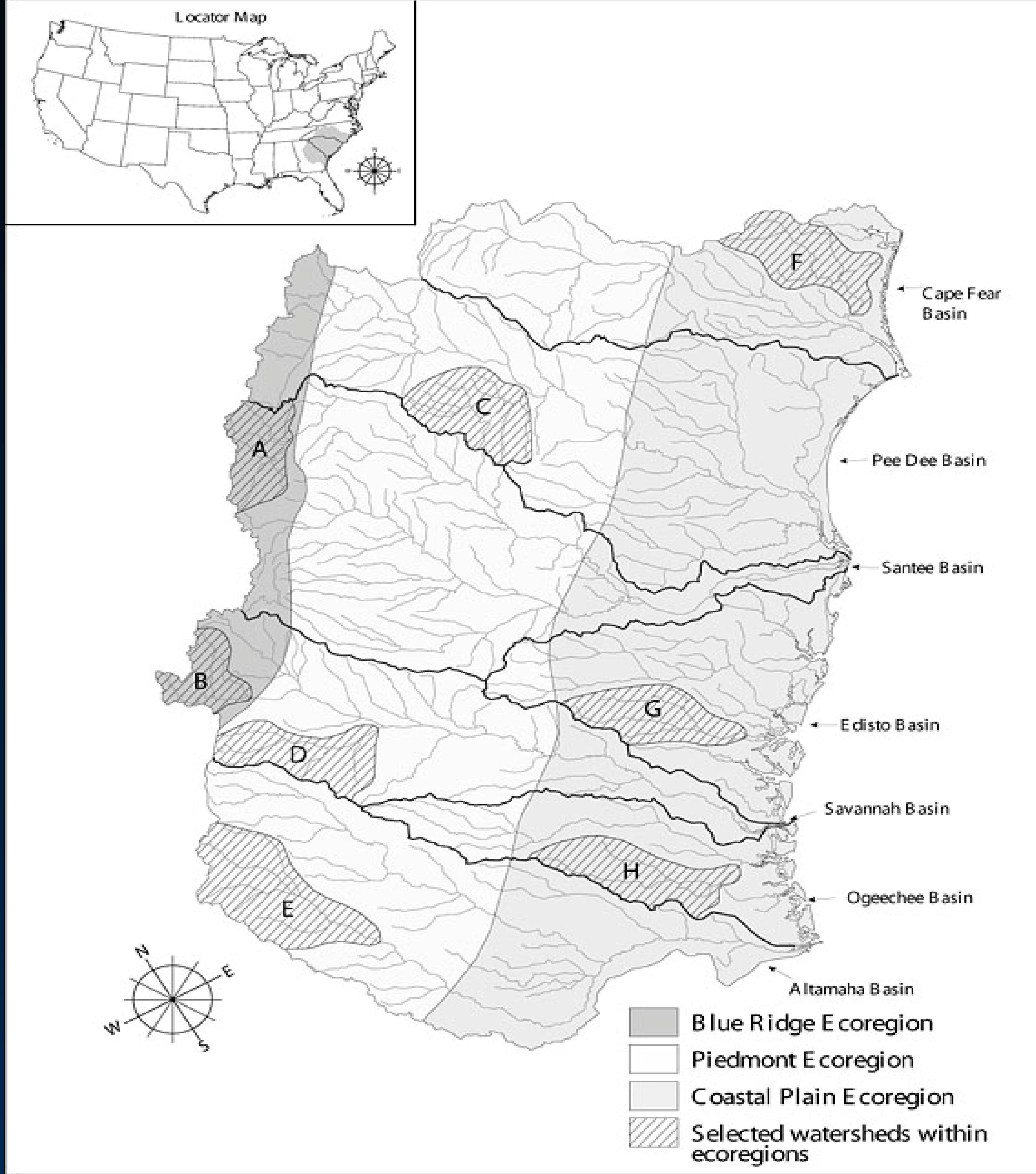


Four Eight Digit HUs (A, B, C, and D) in the Columbia Plateau Ecoregion (10)



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




Locator Map
F
Cape Fear Basin
C
A
Pee Dee Basin
Santee Basin
B
G
Edisto Basin
D
Savannah Basin
H
E
Ogeechee Basin
Altamaha Basin
N
E
W
S
Blue Ridge Ecoregion
Piedmont Ecoregion
Coastal Plain Ecoregion
Selected watersheds within ecoregions

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 <u>not</u> watersheds.

-In many areas (approx. 30%) watersheds are difficult to impossible to define or are irrelevant.

-Watersheds and ecoregions are complementary frameworks.

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

“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 a 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.*

ECOREGIONS

Ecoregion development by EPA

- purpose, definitions, methods, applications, and interagency activities

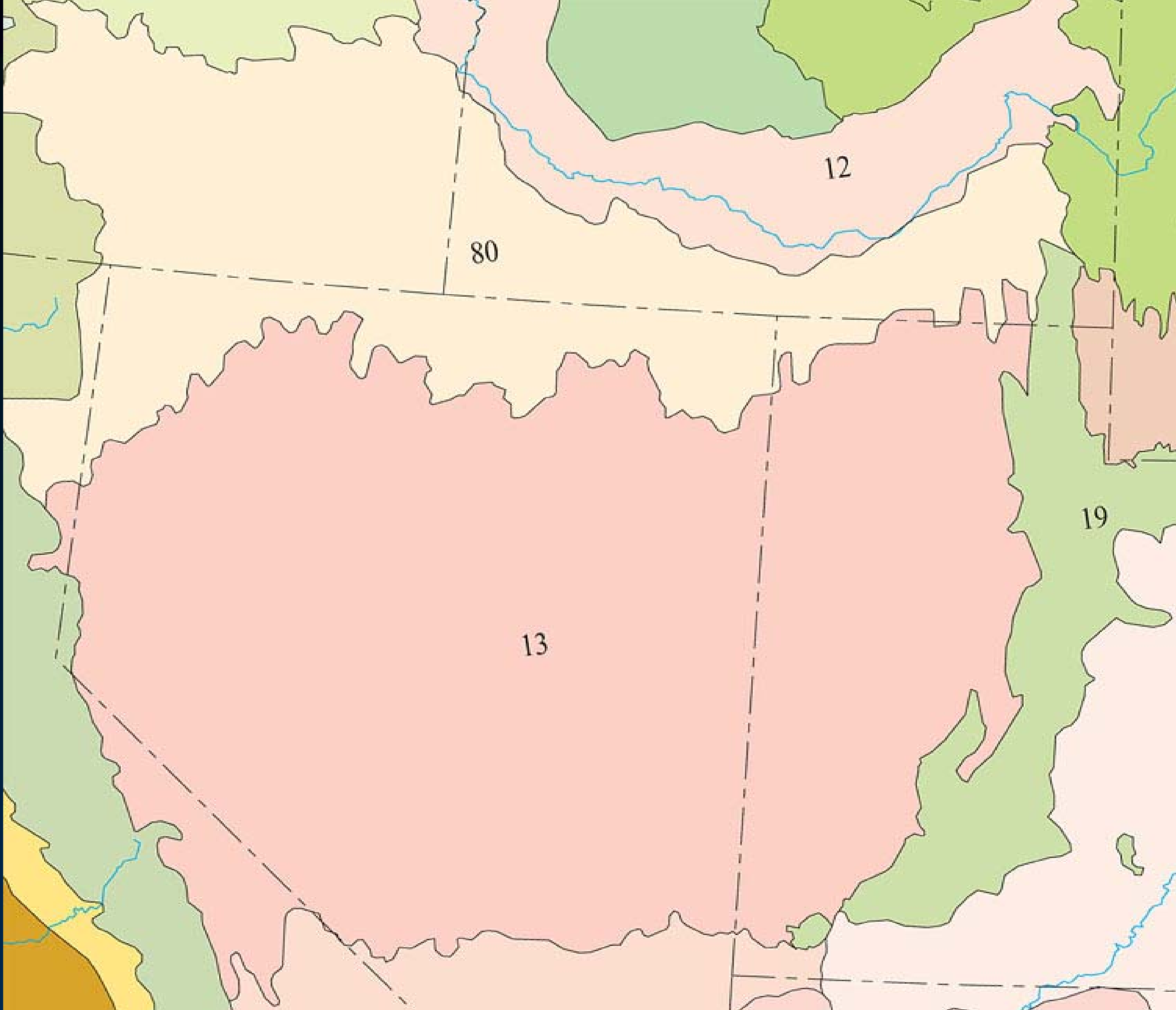
Perspectives on the nature of ecoregions and their definition

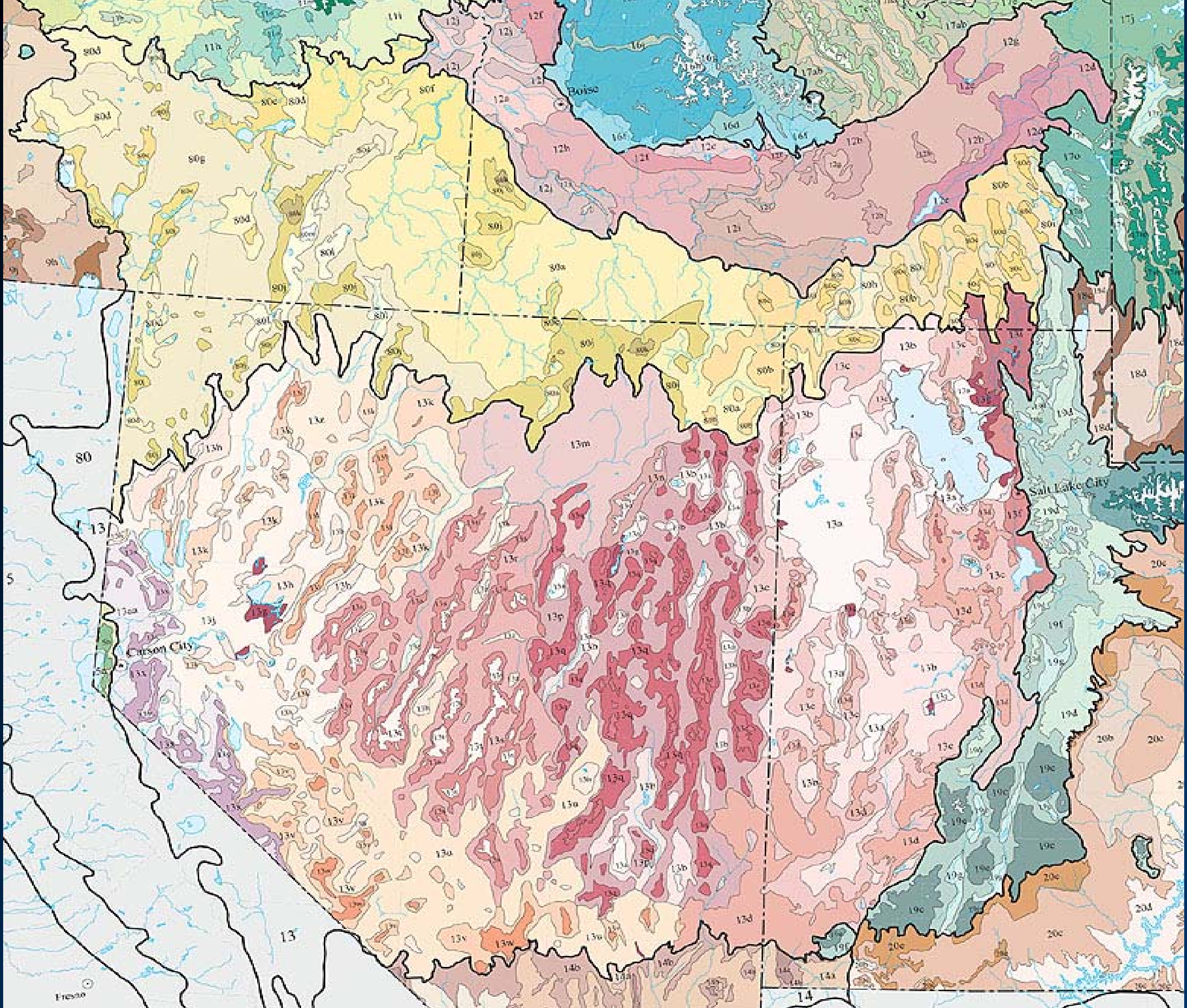
- ecoregions do not nest
- why there is disagreement over how to define ecoregions

The process of refining and subdividing ecoregions

General purpose and special purpose regions

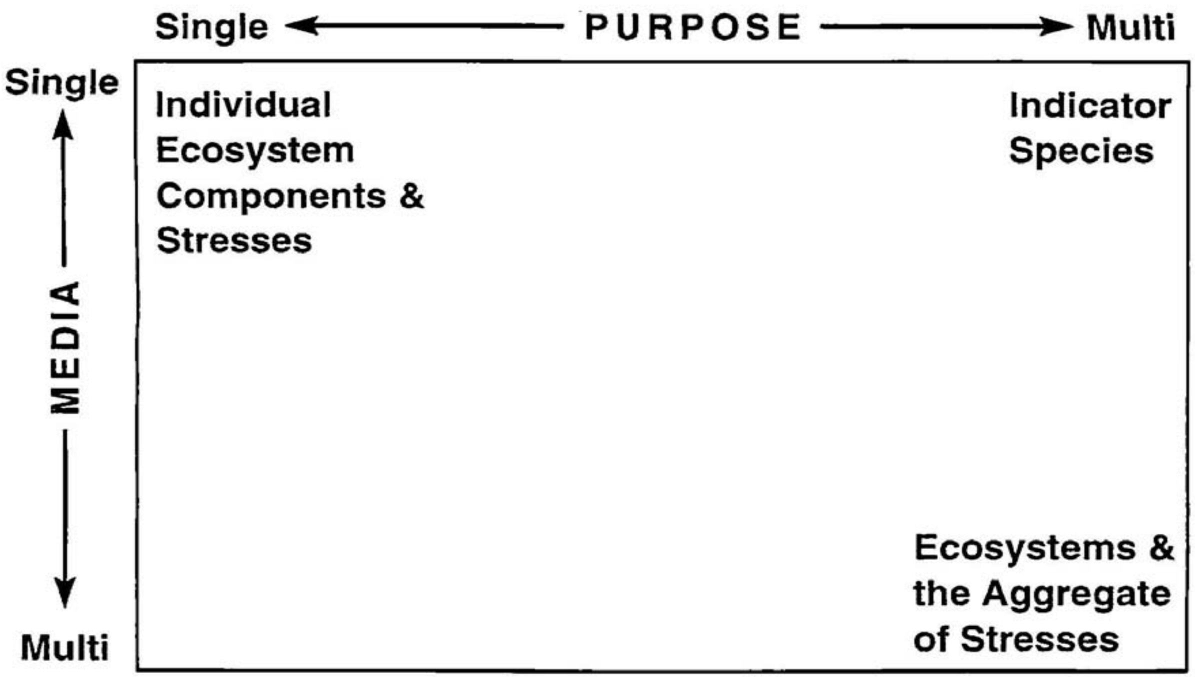
Distinguishing between ecoregions, watersheds, and hydrologic units (HUCs)


12
80
13
19


Boise
Salt Lake City
Carson City
Fresno
80
13
14

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.



Types of Environmental Research

THINK	PLAN ACT
Multi-scale	Local
Long Term	Short Term
Holistic	Reductionistic
Multi-stakeholder/Multi-issue	Single Problem/Issue

“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”

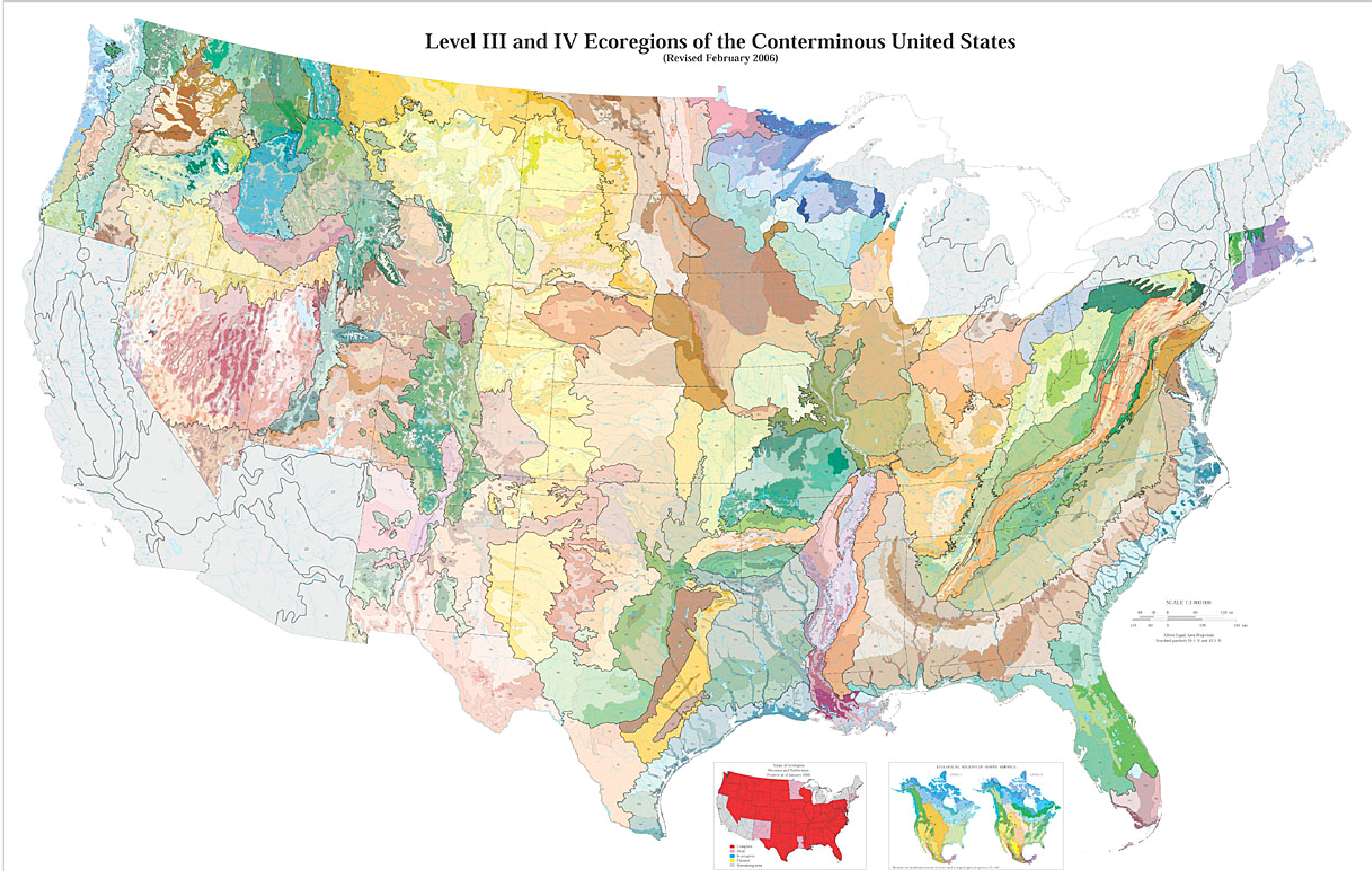
C.S. Holling ‘95

ECOREGION DEVELOPMENT

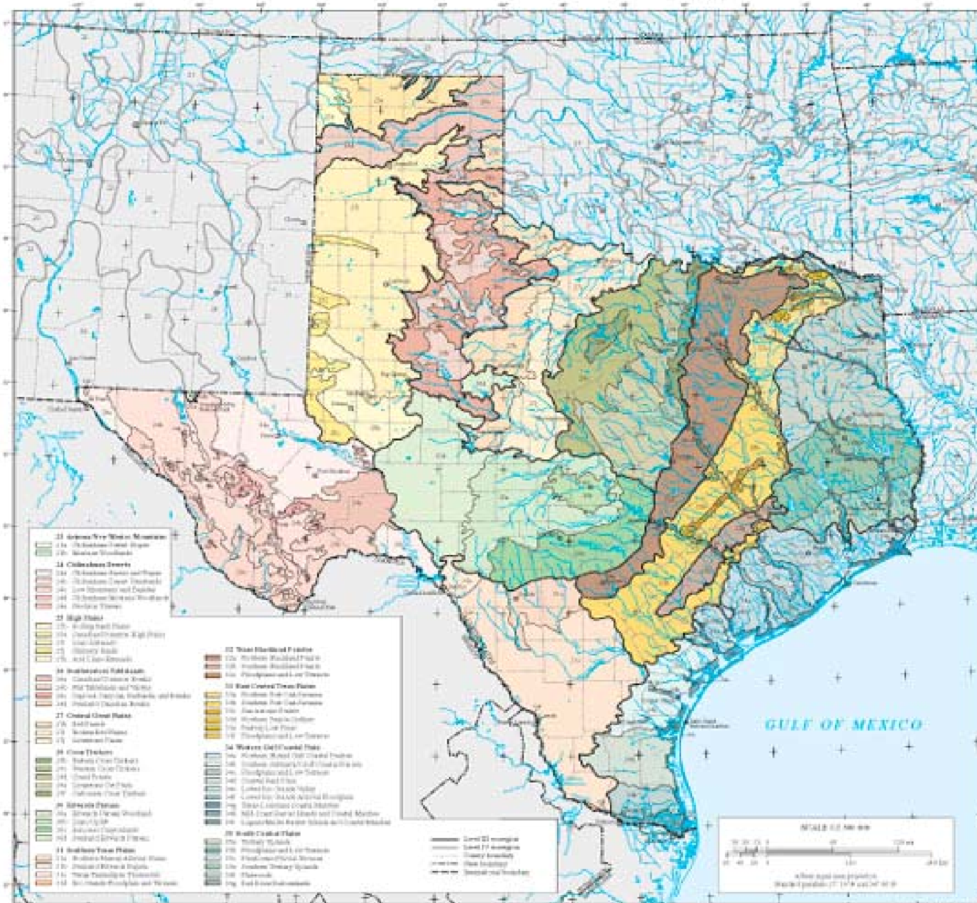
Collaborative projects with states, EPA Regions, other federal agencies, and NHEERL-WED to refine and subdivide ecoregions and locate reference cites.

Provides a framework for:

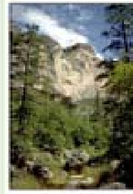
- ecosystem management
- developing biological criteria
- setting water quality standards
- establishing lake management goals
- assessment and management of nonpoint source pollution
- TMDL allocations and NPDES evaluations
- extrapolation from “watershed” studies


Level III and IV Ecoregions of the Conterminous United States
(Revised February 2006)

Ecoregions of Texas



23. Arizona/New Mexico Mountains

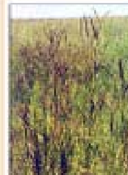


24. Chihuahuan Deserts

25. High Plains

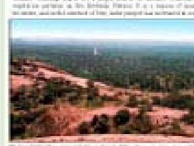
26. Southwestern Tablelands

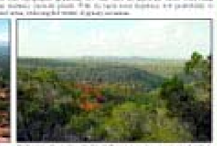
27. Central Great Plains



29. Cross Timbers

30. Edwards Plateau





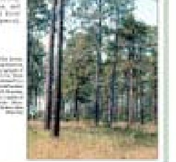
31. Southern Texas Plains

32. Texas Blackland Prairies

33. East Central Texas Plains

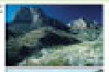
34. Western Gulf Coastal Plain

35. South Central Plains



Descriptions of the Level IV Ecoregions of Texas

23. Arizona/New Mexico Mountains

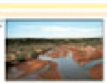
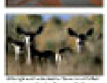



24. Chihuahuan Deserts

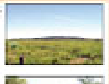


25. High Plains

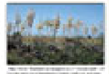

26. Southwestern Tablelands

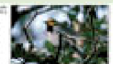
27. Central Great Plains

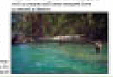



29. Cross Timbers

30. Edwards Plateau

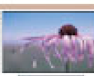




31. Southern Texas Plains



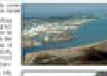

32. Texas Blackland Prairies

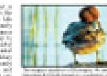


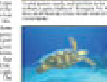

33. East Central Texas Plains



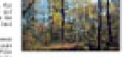
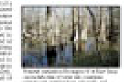
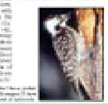
34. Western Gulf Coastal Plain

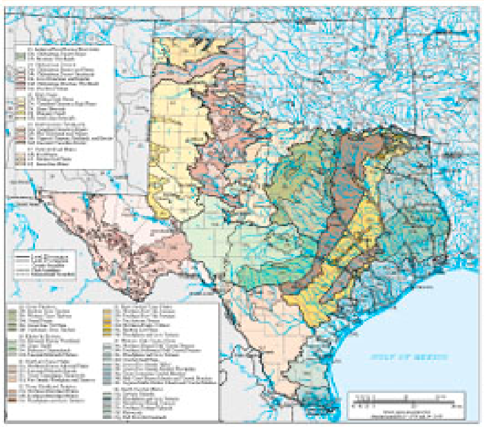




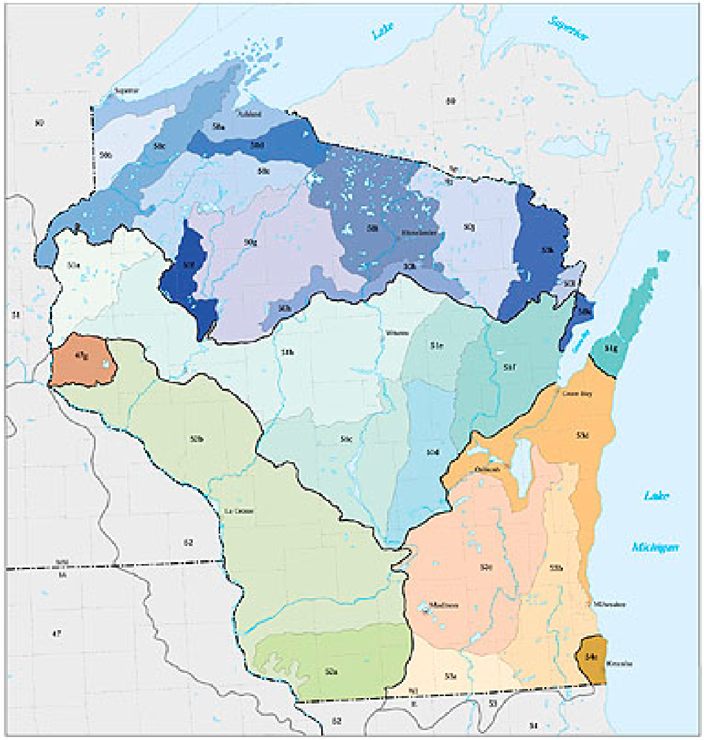


35. South Central Plains



Level III and IV Ecoregions of Wisconsin



47 Western Corn Belt Plains
- 47g Prairie Pothole Region

50 Northern Lakes and Forests
- 50a Lake Superior Clay Plain
- 50b Minnesota/Wisconsin Upland Till Plain
- 50c St. Croix Pine Barrens
- 50d Ontonagon Lobe Moraines and Gogebic Iron Range
- 50e Chequamegon Moraine and Outwash Plain
- 50f Blue Hills
- 50g Chippewa Lobe Rocky Ground Moraines
- 50h Perkinstown End Moraine
- 50i Northern Highlands Lakes Country
- 50j Brule and Paint River Drumlins
- 50k Wisconsin/Michigan Pine and Oak Barrens
- 50l Menominee Ground Moraine

51 North Central Hardwood Forests
- 51a St. Croix Stagnation Moraines
- 51b Central Wisconsin Undulating Till Plain
- 51c Glacial Lake Wisconsin Sand Plain
- 51d Central Sand Ridges
- 51e Upper Wolf River Stagnation Moraine
- 51f Green Bay Till and Lacustrine Plain
- 51g Door Peninsula

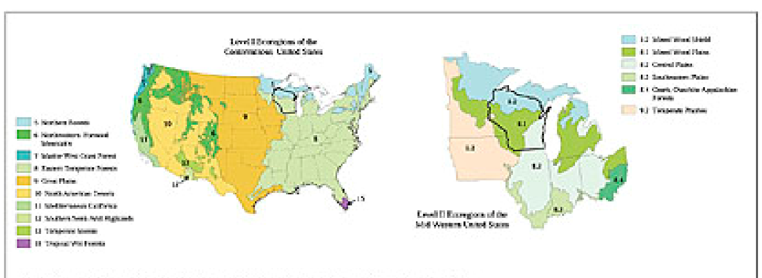
52 Driftless Area
- 52a Savanna Section
- 52b Coulee Section

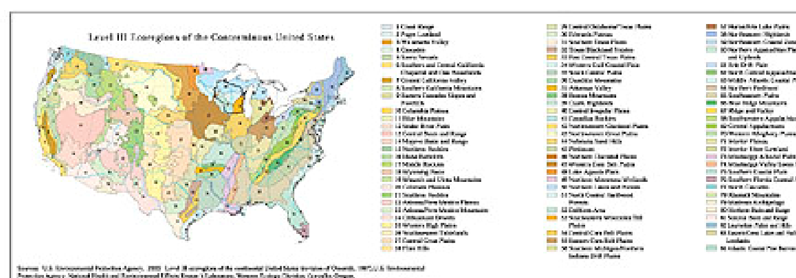
53 Southeastern Wisconsin Till Plains
- 53a Rock River Drift Plain
- 53b Kettle Moraines
- 53c Southeastern Wisconsin Savannah and Till Plain
- 53d Lake Michigan Lacustrine Clay Plain

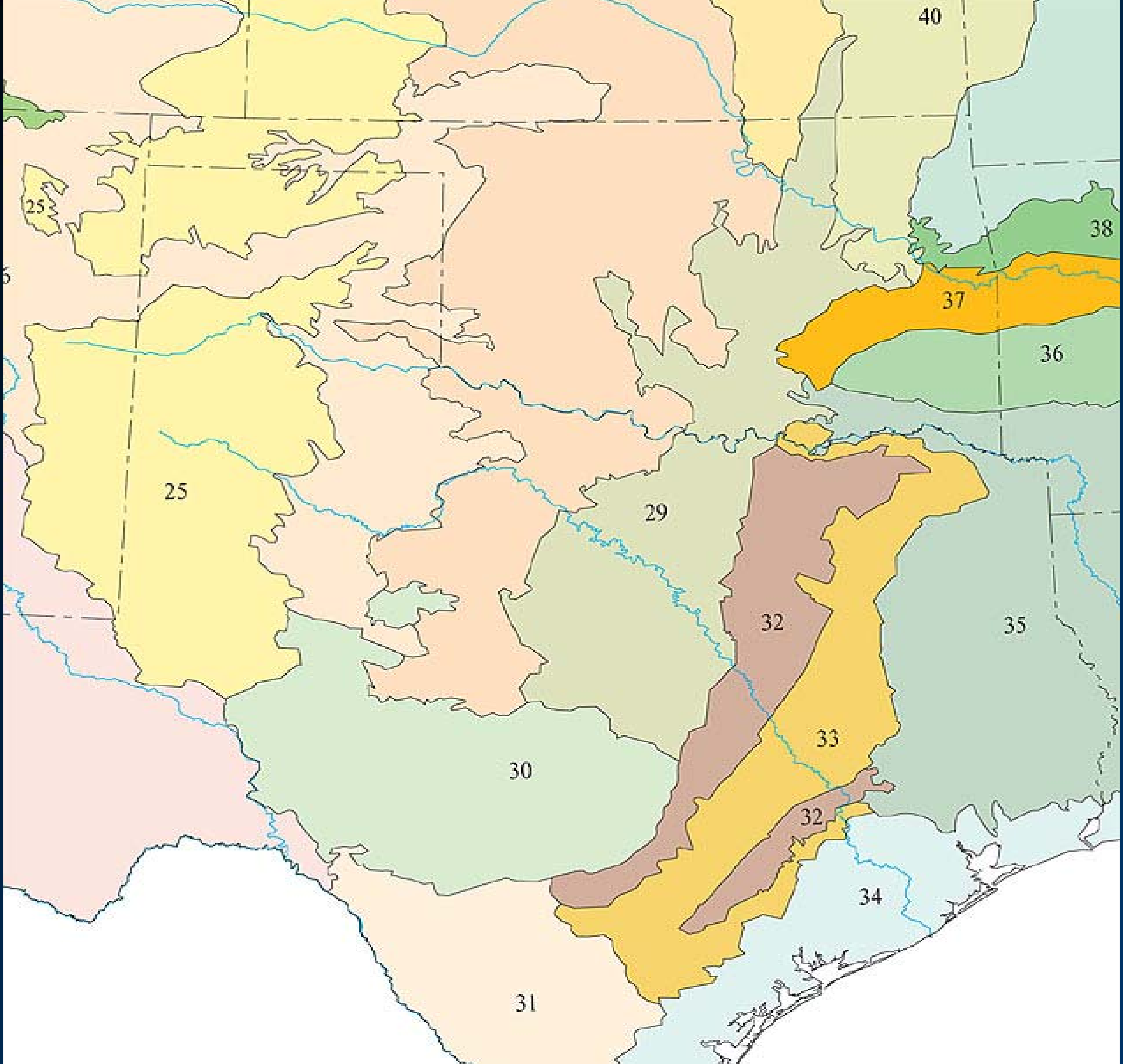
54 Central Corn Belt Plains
- 54e Chiwaukee Prairie Region

State boundary — County boundary — Level III ecoregion — Level IV ecoregion

Scale 1:1 500 000







40
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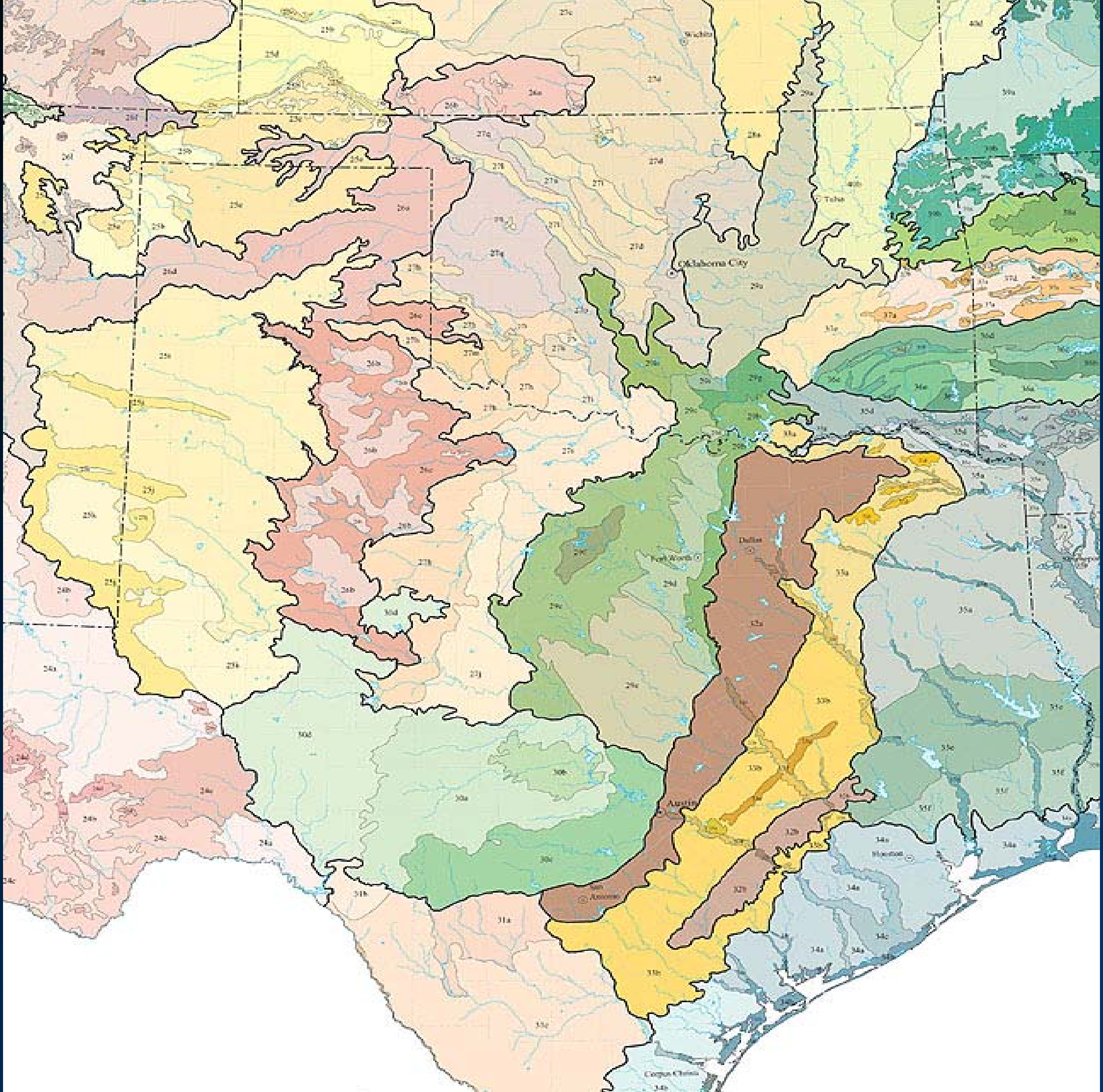
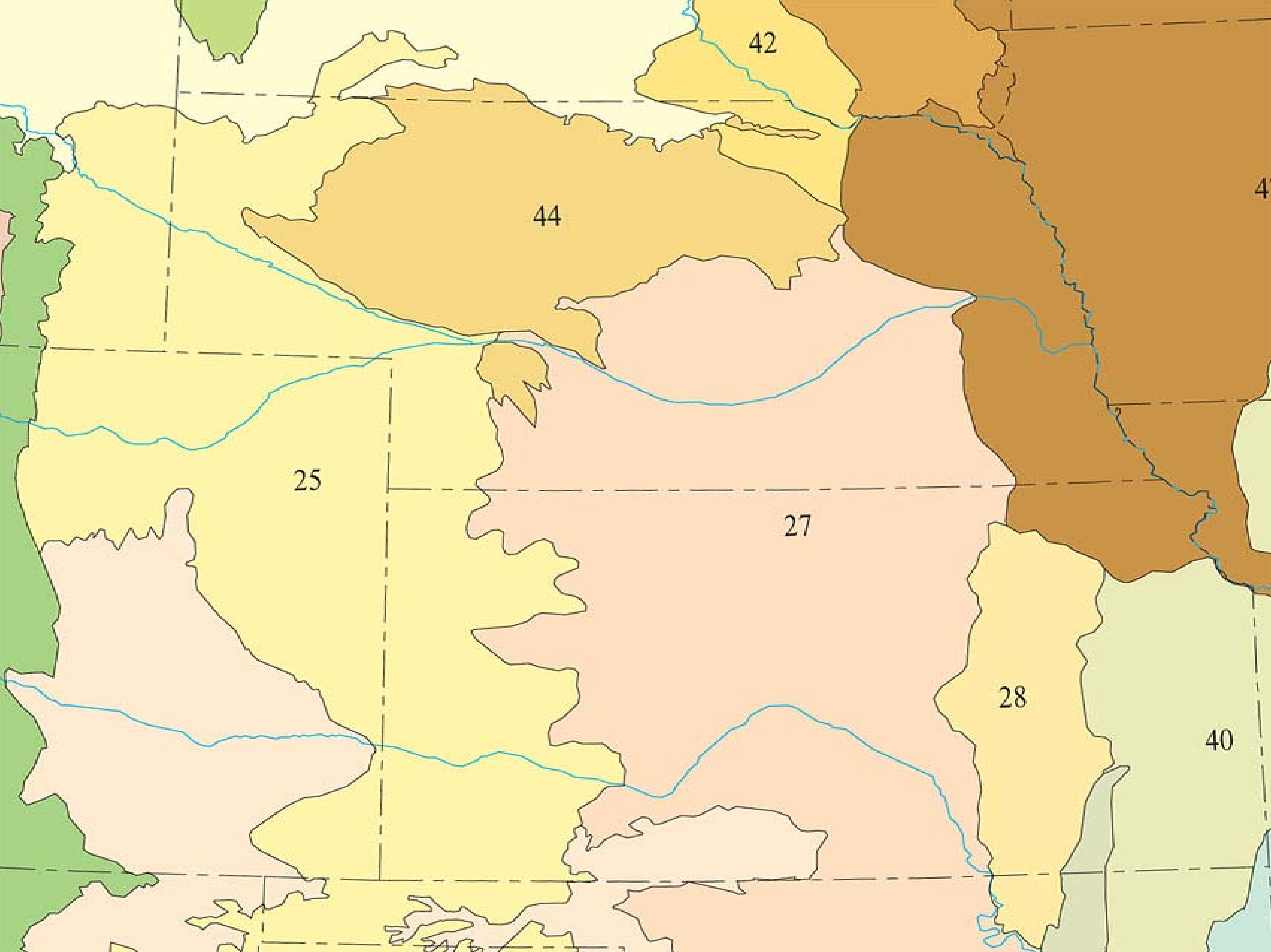

Oklahoma City
Fort Worth
Dallas
Austin
Houston
San Antonio
Corpus Christi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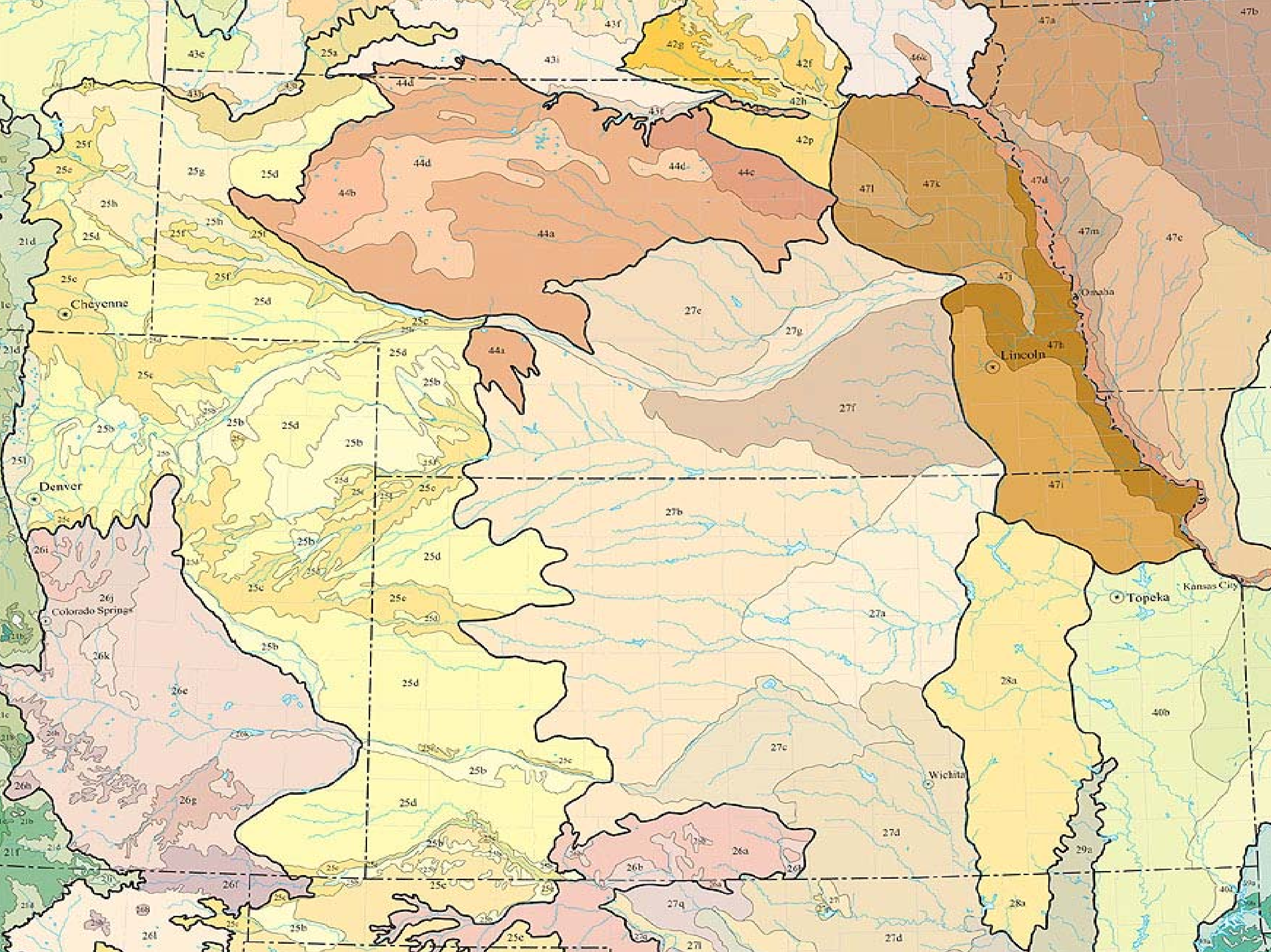
44
25
27
28
40



Cheyenne
Denver
Colorado Springs
Lincoln
Omaha
Topeka
Kansas City
Wichita
44a
44b
44c
44d
47a
47b
47c
47d
47h
47i
47j
47k
47l
47m
42p
27a
27b
27c
27d
27f
27g
25b
25c
25d
25e
25f
25g
25h
26a
26b
26e
26g
26j
26k
28a
29a
40b
21d

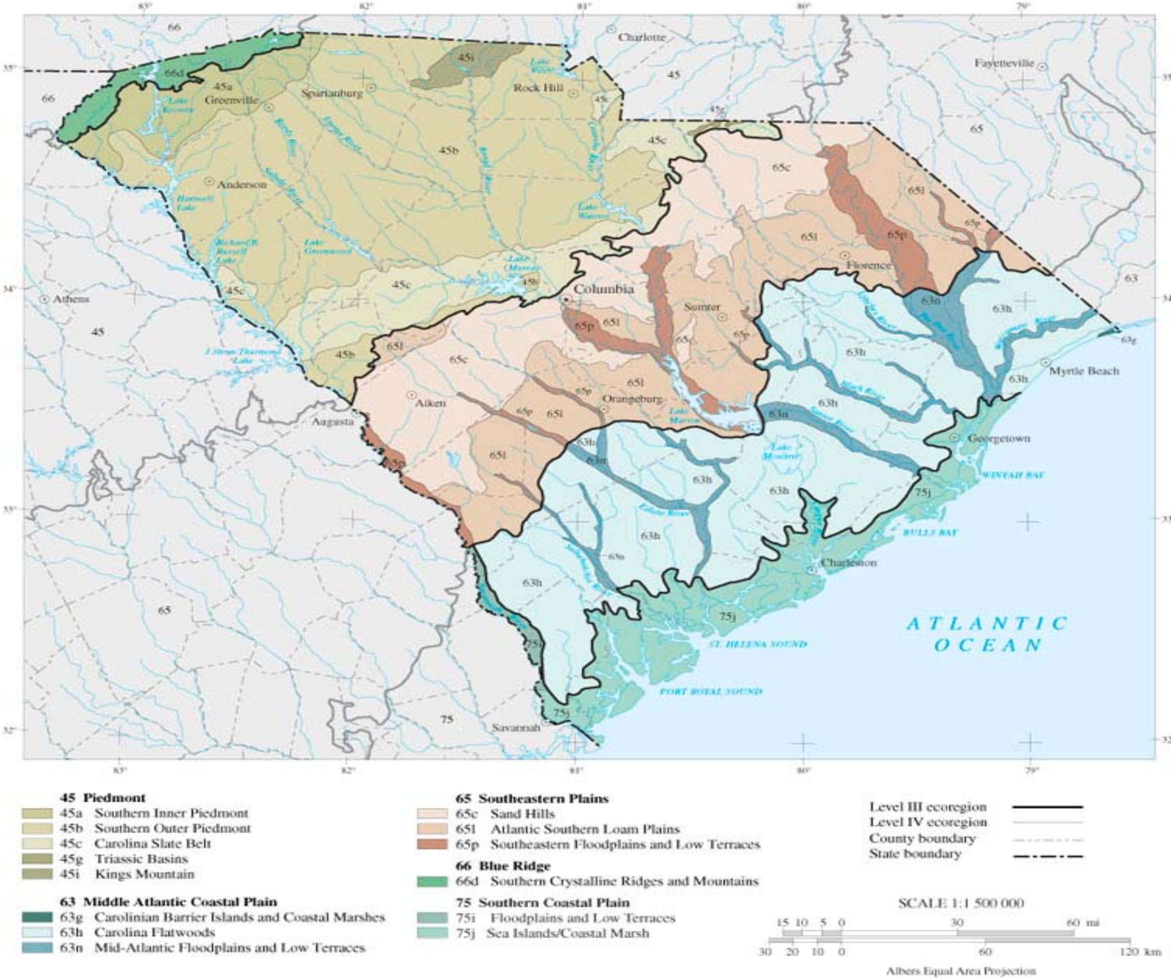
General purpose ecological regions

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

Ecoregions of South Carolina



Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. Ecoregions are directly applicable to many state agency activities, including the selection of regional stream reference sites, the development of biological criteria and water quality standards, and the establishment of management goals for nonpoint-source pollution. They are also relevant to integrated ecosystem management, an ultimate goal of many federal and state resource management agencies.

The approach used to compile this map of South Carolina is based on the premise that ecological regions can be identified through the analysis of the patterns of biotic and abiotic phenomena that reflect differences in ecosystem quality and integrity (Wiken 1986; Omernik 1987, 1995). These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The relative importance of each characteristic varies from one ecological region to another regardless of the hierarchical level. A Roman numeral hierarchical scheme has been adopted for different levels of ecological regions. Level I and Level II divide the North American continent into 15 and 52 regions, respectively (Commission for Environmental Cooperation Working Group 1997). At Level III, the continental United States contains 104 regions (United States Environmental Protection Agency [U.S. EPA] 2000). Level IV is a further subdivision of the Level III ecoregions. Explanations of the methods used to define the U.S. EPA's ecoregions are given in Omernik (1995), Griffith and others (1997, 2002a), and Gallant and others (1989).

The Level III and IV Ecoregions of South Carolina map was compiled at a scale of 1:250,000; it depicts revisions and subdivisions of earlier Level III ecoregions that were originally compiled at a smaller scale (U.S. EPA 1999; Omernik 1987). Compilation of this map is part of a collaborative project primarily between the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), the U.S. EPA National Health and Environmental Effects Research Laboratory (NHEERL), U.S. EPA Region IV, and the South Carolina Department of Health and Environmental Control (DHEC). This project is also associated with an interagency effort to develop a common framework of ecological regions (McMahon and others 2001, Griffith and others 2002b). Regional collaborative projects, such as this one in South Carolina where some agreement can be reached among multiple resource management agencies, are a step in the direction of attaining commonality and consistency in ecoregion frameworks for the entire nation.

Comments regarding this Level III and IV Ecoregions of South Carolina map should be addressed to Glenn Griffith, USDA-NRCS, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4465, email: griffith.glenn@epa.gov, or to James Omernik, USGS, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4458, email: omernik.james@epa.gov.

Literature Cited:

Commission for Environmental Cooperation Working Group, 1997, Ecological regions of North America - toward a common perspective: Montreal, Quebec, Commission for Environmental Cooperation, 71 p.

Gallant, A.L., Whittier, T.R., Larsen, D.P., Omernik, J.M., and Hughes, R.M., 1989, Regionalization as a tool for managing environmental resources: Corvallis, Oregon, U.S. Environmental Protection Agency EPA/600/3-89/060, 152 p.

Griffith, G.E., Omernik, J.M., and Azevedo, S.H., 1997, Ecoregions of Tennessee: Corvallis, Oregon, U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, EPA/600/R-97/022, 51 p.

Griffith, G.E., Omernik, J.M., and Comstock, J.A., 2002a, Ecoregions of South Carolina: Corvallis, Oregon, U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, 47 p.

Griffith, G.E., Omernik, J.M., Comstock, J.A., Schafale, M.P., McNab, W.H., Lenat, D.R., MacPherson, T.F., Glover, J.B., and Shelburne, V.B., 2002b, Ecoregions of North Carolina and South Carolina, (color poster with map descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

McMahon, G., Gregonis, S.M., Waltman, S.W., Omernik, J.M., Thorson, T.D., Freeouf, J.A., Rorick, A.H., and Keys, J.E., 2001, Developing a spatial framework of common ecological regions for the conterminous United States: Environmental Management, v. 28, no. 3, p. 293-316.

Omernik, J.M., 1987, Ecoregions of the conterminous United States (map supplement): Annals of the Association of American Geographers, v. 77, no. 1, p. 118-125, scale 1:7,500,000.

Omernik, J.M., 1995, Ecoregions-a spatial framework for environmental management, in Davis, W.S. and Simon, T.P., eds., Biological assessment and criteria-tools for water resource planning and decision making: Boca Raton, Florida, Lewis Publishers, p. 49-62.

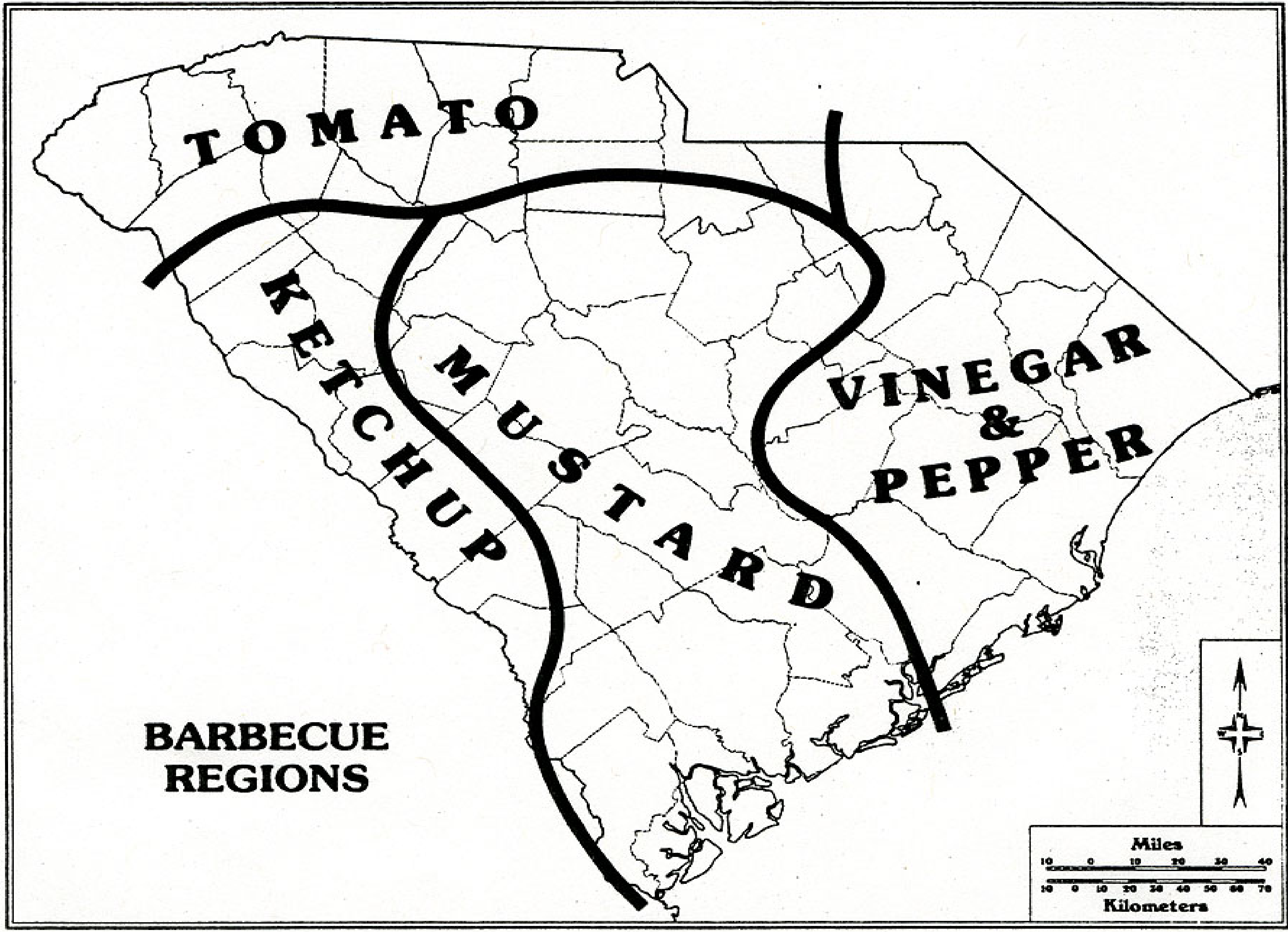
U.S. Environmental Protection Agency, 2000, Level III ecoregions of the continental United States (revision of Omernik, 1987): Corvallis, Oregon, U.S. Environmental Protection Agency-National Health and Environmental Effects Research Laboratory Map, M-1.

Wiken, E., 1986, Terrestrial ecozones of Canada: Ottawa, Environment Canada, Ecological Land Classification Series no. 19, 26 p.

PRINCIPAL AUTHORS: Glenn E. Griffith (NRCS), James M. Omernik (USEPA), Jeffrey A. Comstock (Indus Corporation), James B. Glover (SCDHEC), and Victor B. Shelburne (Clemson University).

COLLABORATORS AND CONTRIBUTORS: Jim Harrison (USEPA), Ronald C. Ahle (SCDNR), Roy L.Vick, Jr. (NRCS), Ben Stuckey, Jr. (NRCS), Dennis Law (USFS), Rick Renfrow (SCDHEC), Paul Nystrom (SCDNR), Rich Scharf (SCDNR), and Tom Loveland (USGS).

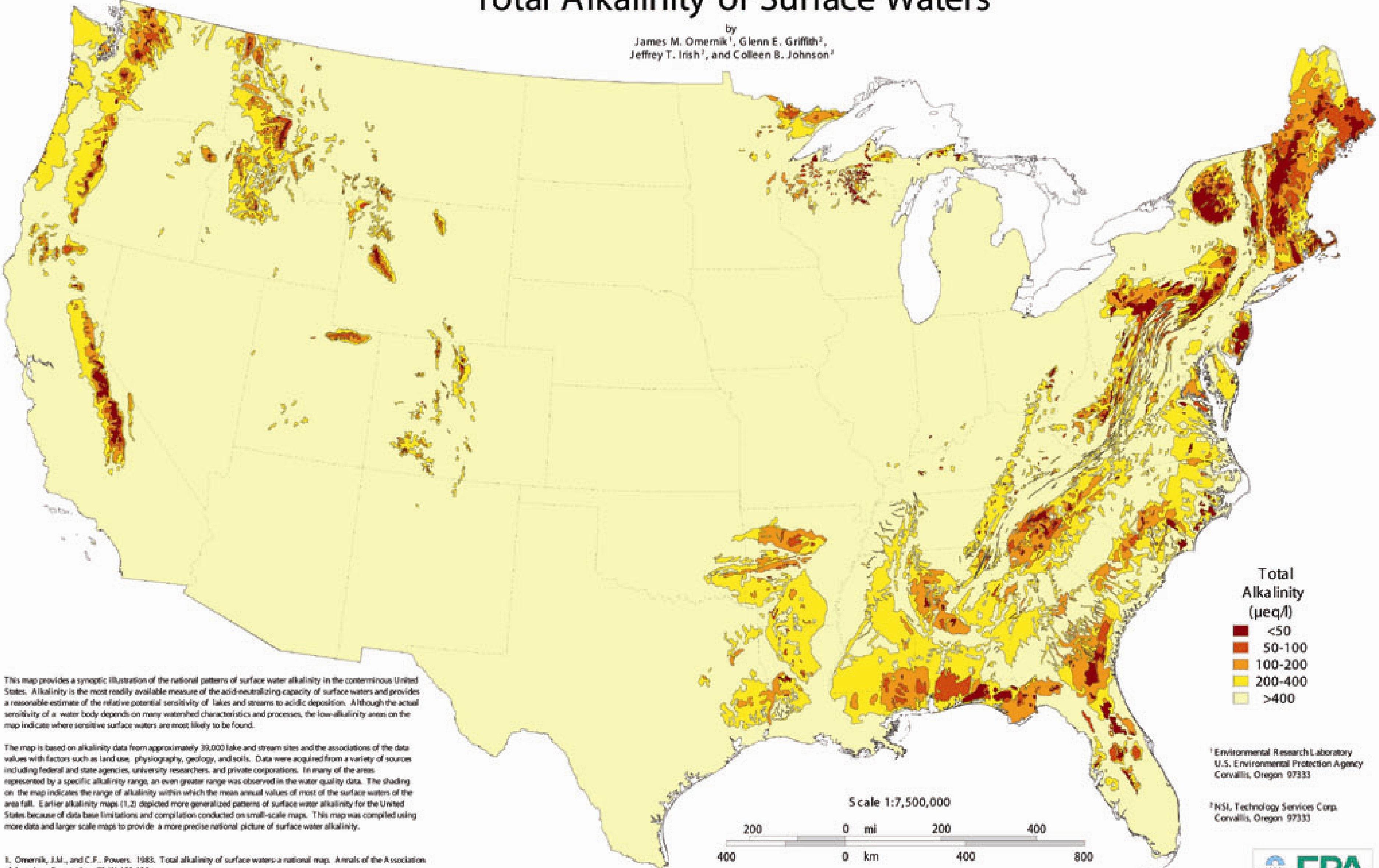
CITING THIS MAP: Griffith, G.E., Omernik, J.M., Comstock, J.A., Glover, J.B., and Shelburne, V.B., 2002, Ecoregions of South Carolina, U.S. Environmental Protection Agency, Corvallis, OR (map scale 1:1,500,000).



MAP 11.1 Source: Based on Wall and Larne (1979).

Total Alkalinity of Surface Waters

by
James M. Omernik[1], Glenn E. Griffith[2],
Jeffrey T. Irish[2], and Colleen B. Johnson[2]



This map provides a synoptic illustration of the national patterns of surface water alkalinity in the conterminous United States. Alkalinity is the most readily available measure of the acid-neutralizing capacity of surface waters and provides a reasonable estimate of the relative potential sensitivity of lakes and streams to acidic deposition. Although the actual sensitivity of a water body depends on many watershed characteristics and processes, the low-alkalinity areas on the map indicate where sensitive surface waters are most likely to be found.

The map is based on alkalinity data from approximately 39,000 lake and stream sites and the associations of the data values with factors such as land use, physiography, geology, and soils. Data were acquired from a variety of sources including federal and state agencies, university researchers, and private corporations. In many of the areas represented by a specific alkalinity range, an even greater range was observed in the water quality data. The shading on the map indicates the range of alkalinity within which the mean annual values of most of the surface waters of the area fall. Earlier alkalinity maps (1,2) depicted more generalized patterns of surface water alkalinity for the United States because of data base limitations and compilation conducted on small-scale maps. This map was compiled using more data and larger scale maps to provide a more precise national picture of surface water alkalinity.

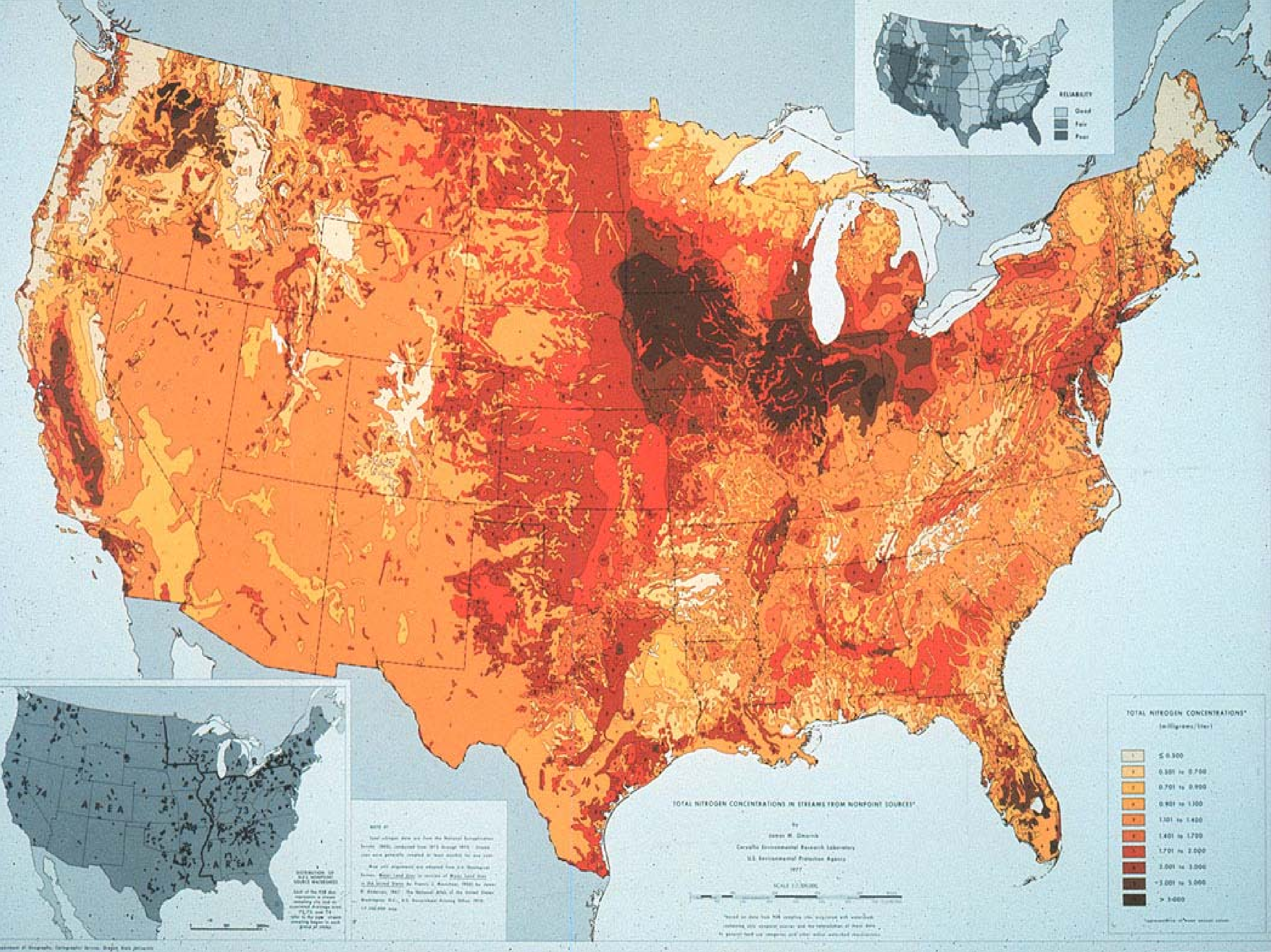
1. Omernik, J.M., and C.F., Powers. 1983. Total alkalinity of surface waters-a national map. Annals of the Association of American Geographers 73 (1):133-136.

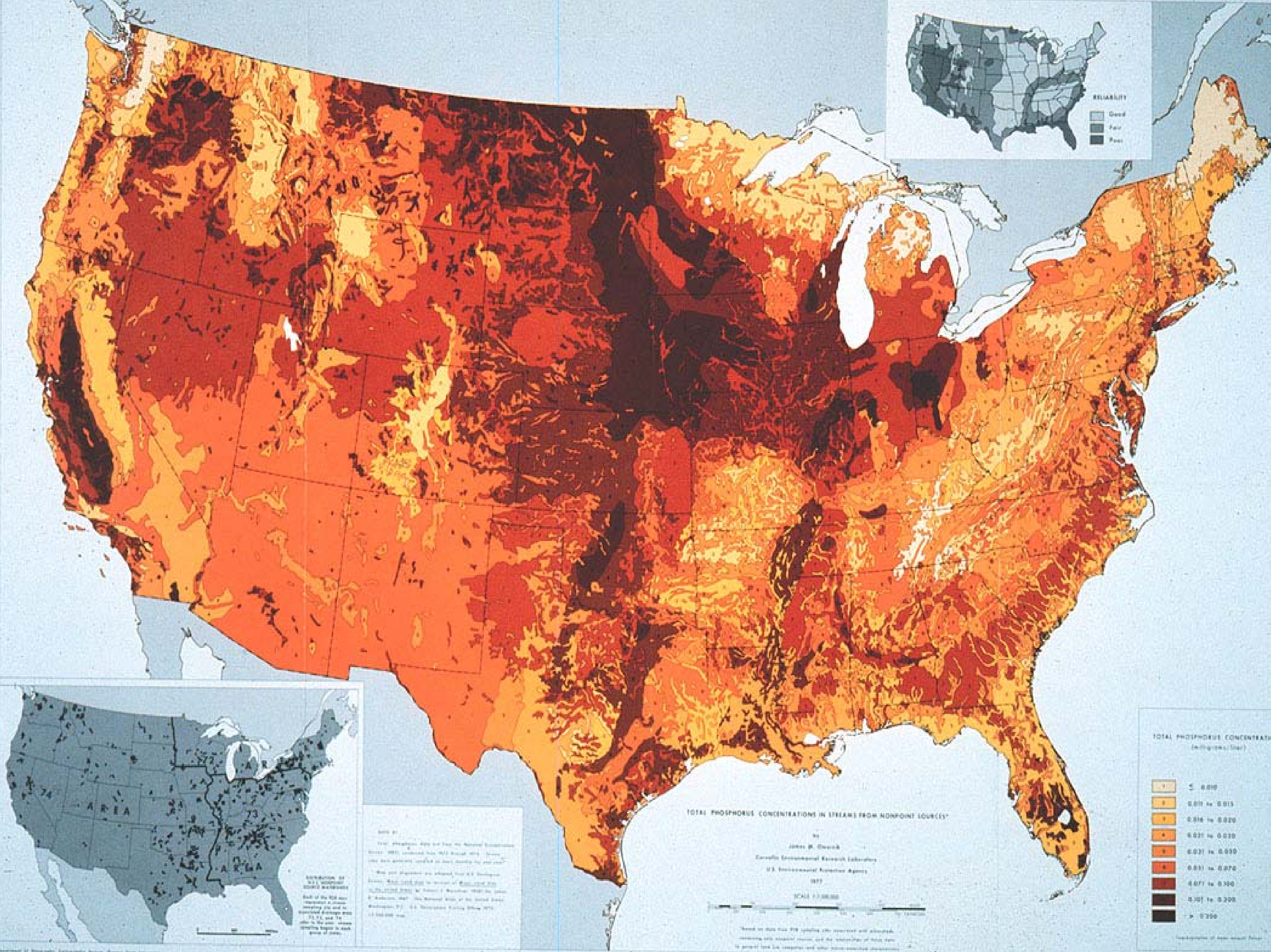
2. Omernik, J.M., G.E. Griffith, and A.J. Kinney. 1985. Total alkalinity of surface waters. Corvallis Environmental Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon.

[1] Environmental Research Laboratory
U.S. Environmental Protection Agency
Corvallis, Oregon 97333

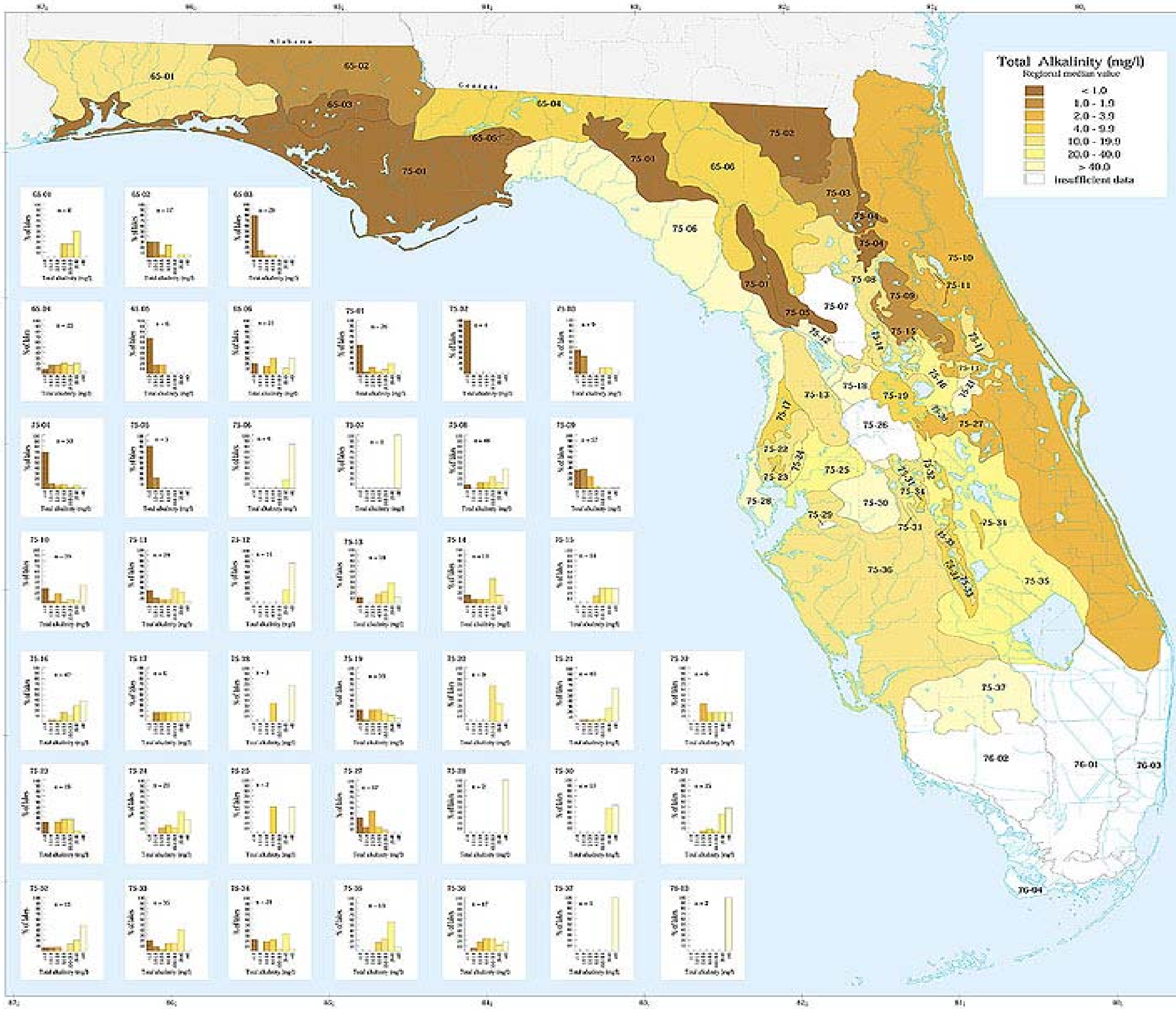
[2] NSI, Technology Services Corp.
Corvallis, Oregon 97333

EPA

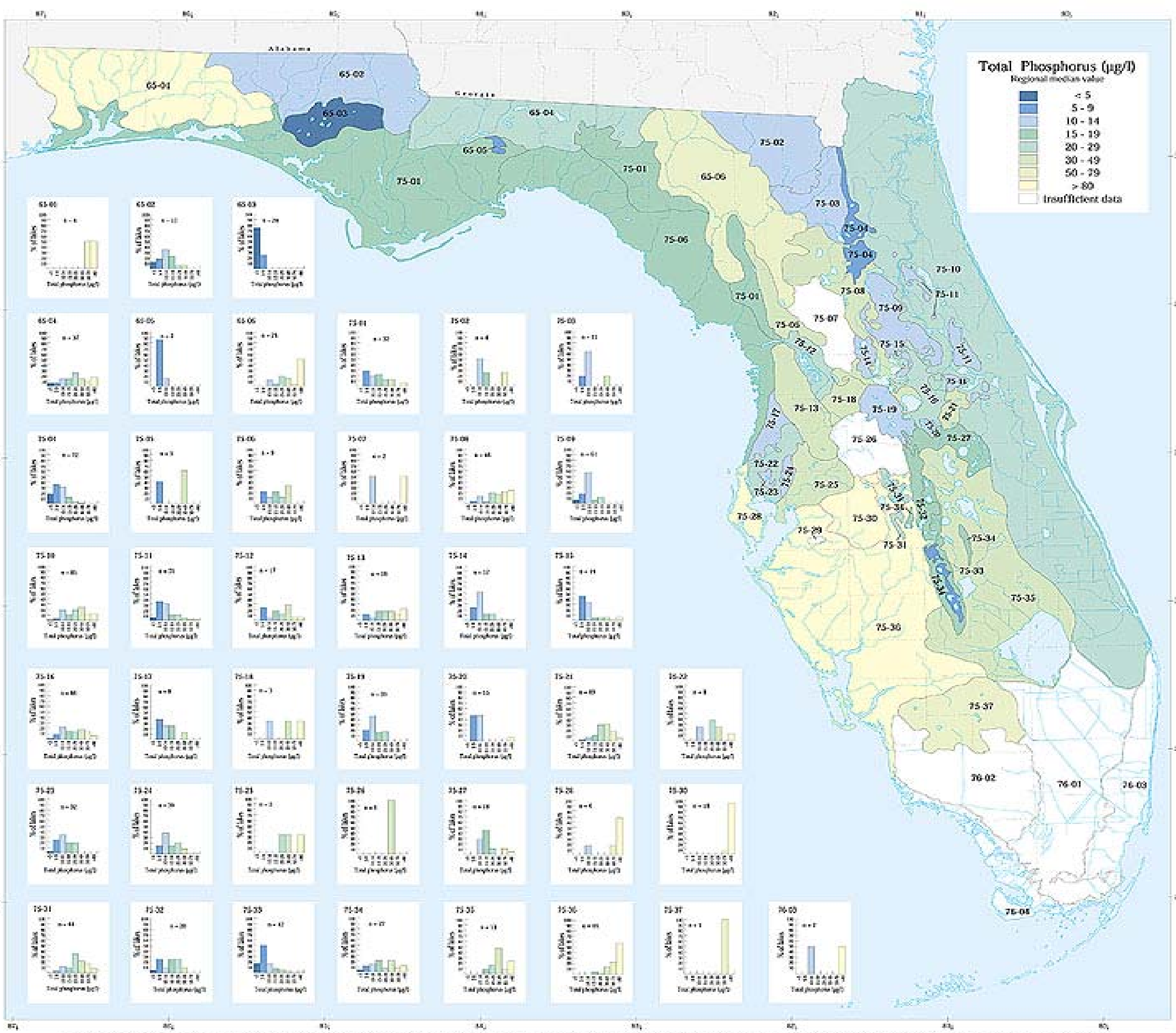

RELIABILITY
Good
Fair
Poor
TOTAL NITROGEN CONCENTRATIONS IN STREAMS FROM NONPOINT SOURCES*
By
James M. Omernik
Corvallis Environmental Research Laboratory
U.S. Environmental Protection Agency
1977
TOTAL NITROGEN CONCENTRATIONS*
(milligrams/liter)
≤ 0.500
0.501 to 0.700
0.701 to 0.900
0.901 to 1.100
1.101 to 1.400
1.401 to 1.700
1.701 to 2.000
2.001 to 3.000
3.001 to 5.000
> 5.000
AREA
AREA


RELIABILITY
Good
Fair
Poor
TOTAL PHOSPHORUS CONCENTRATIONS IN STREAMS FROM NONPOINT SOURCES
by
Corvallis Environmental Research Laboratory
U.S. Environmental Protection Agency
TOTAL PHOSPHORUS CONCENTRATI
(milligrams/liter)
≤ 0.010
0.011 to 0.015
0.016 to 0.020
0.071 to 0.100
0.101 to 0.200
AREA
AREA


Lake Regions of Florida
65-01 Western Highlands
65-02 Dougherty/Marianna Plains
65-03 New Hope Ridge/Greenhead Slope
65-04 Tifton/Tallahassee Uplands
65-05 Norfleet/Spring Hill Ridge
65-06 Northern Peninsula Karst Plains
75-01 Gulf Coast Lowlands
75-02 Okefenokee Plains
75-03 Upper Santa Fe Flatwoods
75-04 Trail Ridge
75-05 Northern Brooksville Ridge
75-06 Big Bend Karst
75-07 Marion Hills
75-08 Central Valley
75-09 Ocala Scrub
75-10 Eastern Flatlands
75-11 Crescent City/DeLand Ridges
75-12 Tsala Apopka
75-13 Southern Brooksville Ridge
75-14 Lake Weir/Leesburg Upland
75-15 Mount Dora Ridge
75-16 Apopka Upland
75-17 Weeki Wachee Hills
75-18 Webster Dry Plain
75-19 Clermont Uplands
75-20 Doctor Phillips Ridge
75-21 Orlando Ridge
75-22 Tampa Plain
75-23 Keystone Lakes
75-24 Land-o-Lakes
75-25 Hillsborough Valley
75-26 Green Swamp
75-27 Osceola Slope
75-28 Pinellas Peninsula
75-29 Wimauma Lakes
75-30 Lakeland/Bone Valley Upland
75-31 Winter Haven/Lake Henry Ridges
75-32 Northern Lake Wales Ridge
75-33 Southern Lake Wales Ridge
75-34 Lake Wales Ridge Transition
75-35 Kissimmee/Okeechobee Lowland
75-36 Southwestern Flatlands
75-37 Immokalee Rise
76-01 Everglades
76-02 Big Cypress
76-03 Miami Ridge/Atlantic Coastal Strip
76-04 Southern Coast and Islands
MILES
KILOMETERS
Pensacola
Tallahassee
Jacksonville
Gainesville
Orlando
Tampa
St. Petersburg
Ft. Lauderdale
Miami



Total alkalinity measures the components in water, such as carbonates, bicarbonates, and hydroxyl bases that tend to elevate pH and buffer against increases in acidity. Although much of Florida is underlain by limestone, many lakes in the state are situated in overlying sands and are softwater, acidic lakes with low alkalinity. Low alkalinity is found in many clear lakes of some of the sandy upland ridge regions (e.g., 65-03, 65-05, 75-04, and 75-09), as well as in some darkwater lakes in lowland regions (75-01, 75-02, 75-10). Higher alkalinity is generally found in central and southern Florida or in lakes with groundwater contacts. High alkalinity occurs in lake regions where limestone is near the surface (e.g., 75-06, 75-12), where lakes are limed for fish production (65-01), or in urbanized regions with a combination of groundwater influence and human disturbance (75-21, 75-28).



Total phosphorus is a measure of one of the primary nutrients that regulates algal and macrophyte growth in lakes. Phosphorus can enter the aquatic system through atmospheric deposition, groundwater percolation, and terrestrial runoff. Phosphorus loadings can be increased with inputs from sewage treatment plants, industrial sources, agricultural and residential runoff, or from phosphate mining and fertilizer processing activities. High phosphorus concentrations can accelerate the process of eutrophication. The highest regional phosphorus values are found in southwest Florida where phosphates are often naturally high (e.g., 75-30, 75-36), and the lowest regional values are found in some of the upland sandy ridges (65-03, 65-05, 75-04, and 75-33).

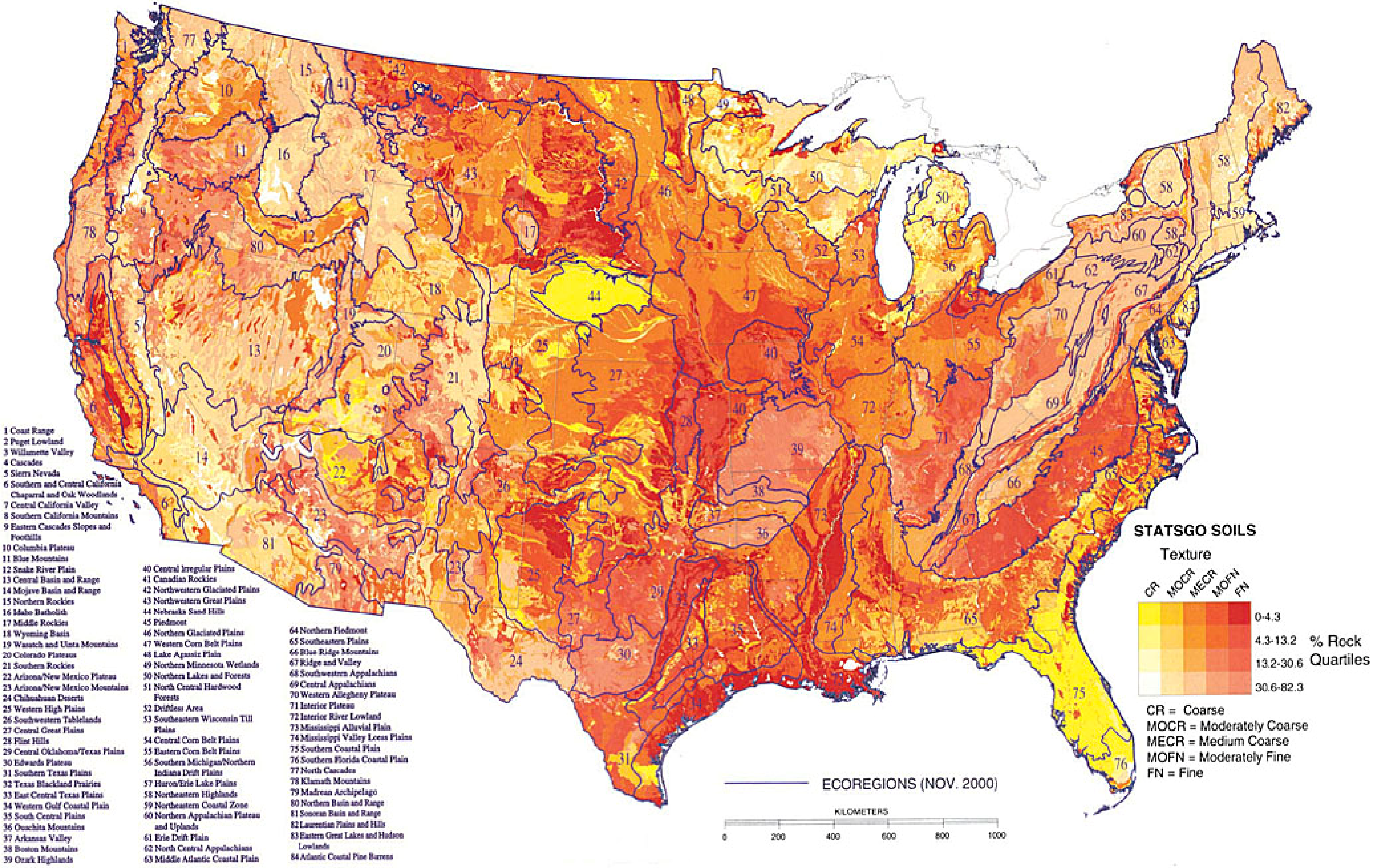
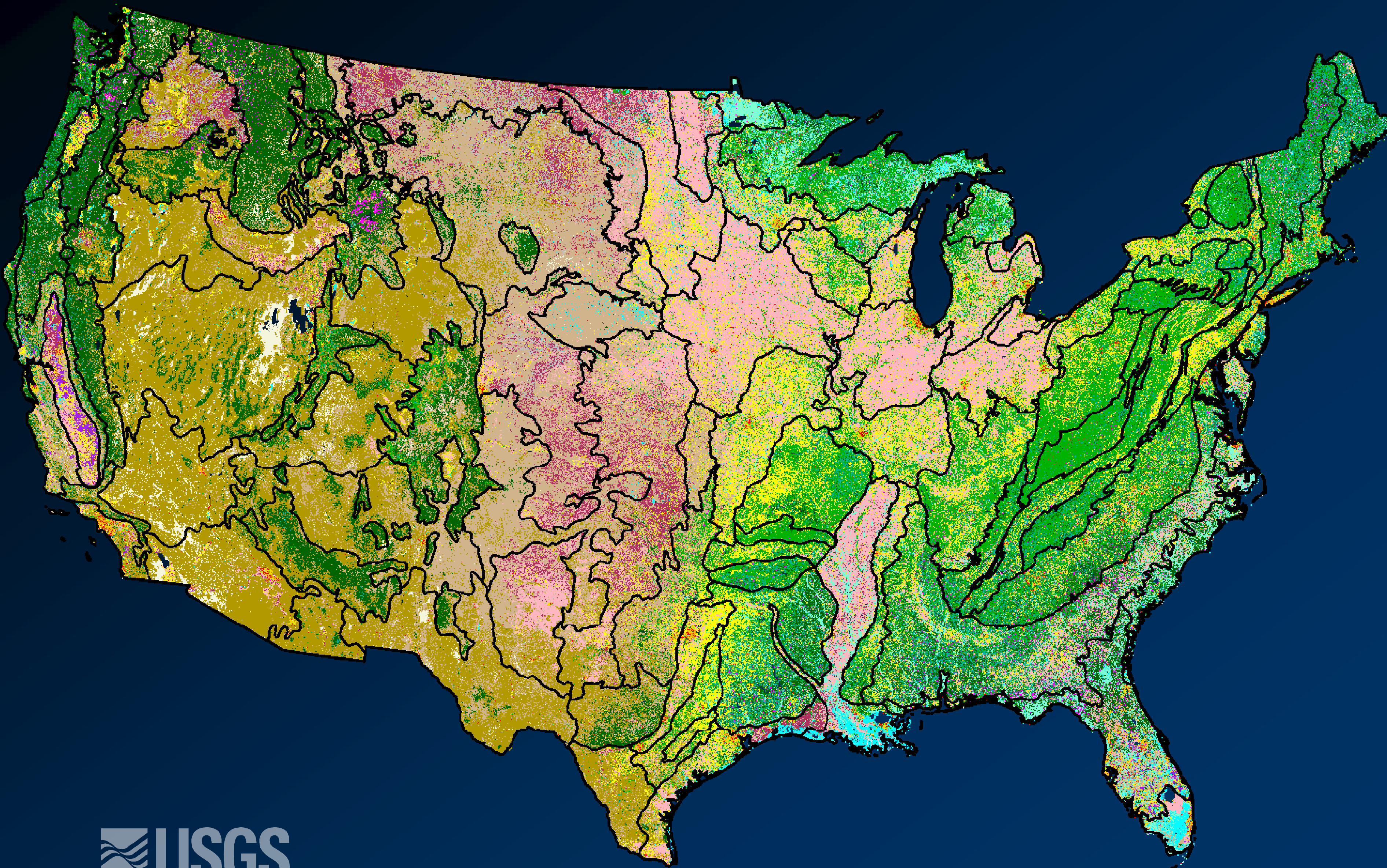


Fig. 1. Soil texture (USDA5) and rock contents of State Soil Geographic database (STATSGO) soil map units of the conterminous United States and the boundaries of 84 Level III Omernik ecoregions. The yellow color represents coarse (cr) soils with colors darkening through moderately coarse (mocr), medium coarse (mecr), moderately fine (mofn), and fine (fn) soils in the reddest shade. A higher percentage of rocks adds coarseness to a soil and is depicted as decreasing color intensity within the texture class.



USGS

USGS EROS Data Center

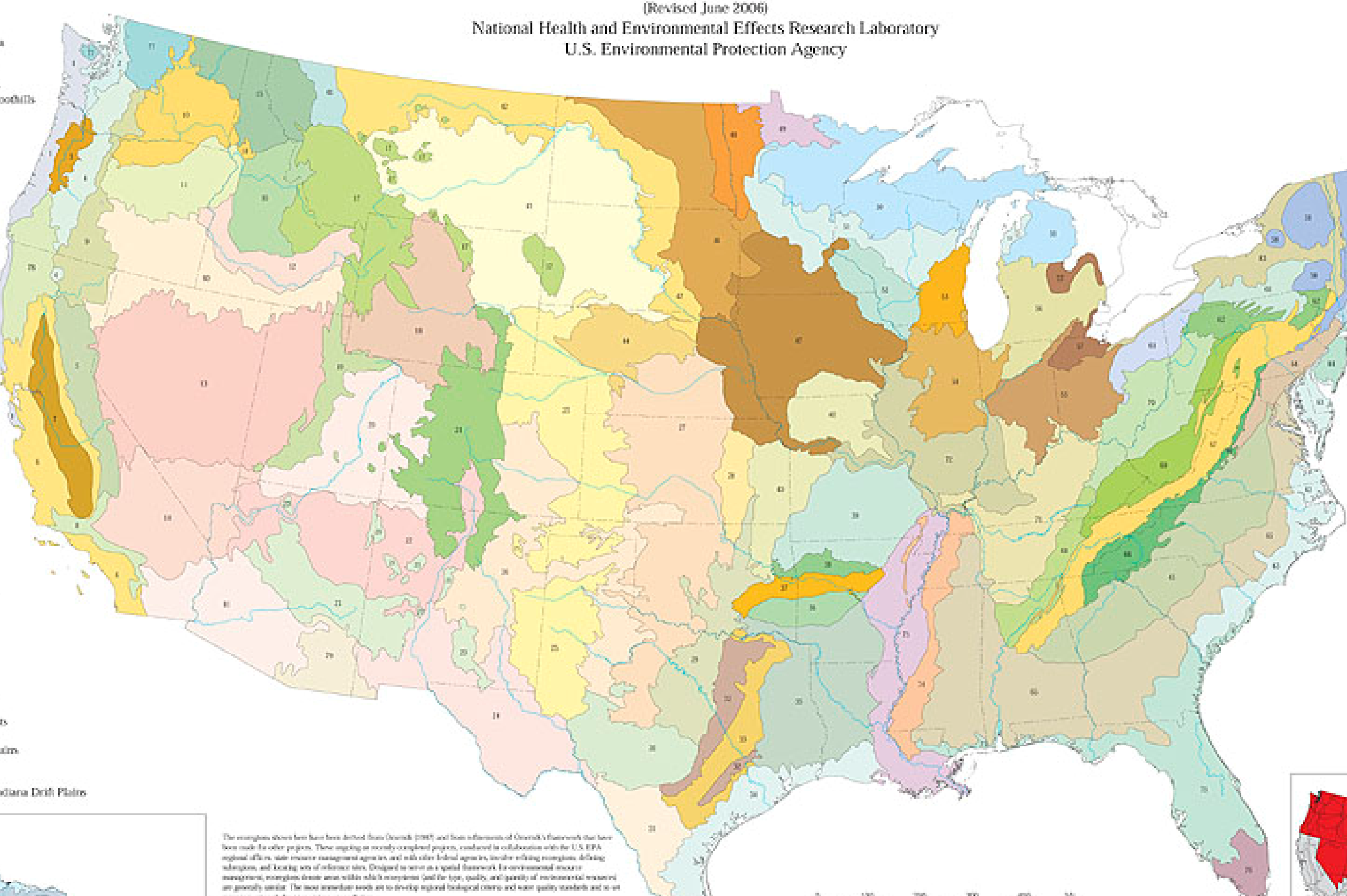
Land Cover with Ecoregions

Level III Ecoregions of the Continental United States

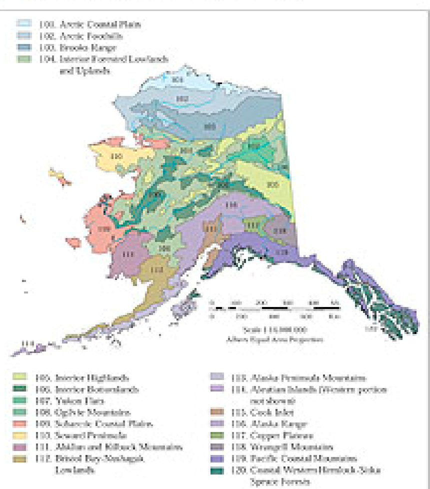
(Revised June 2006)

National Health and Environmental Effects Research Laboratory
U.S. Environmental Protection Agency

1. Coast Range
2. Puget Lowland
3. Willamette Valley
4. Cascades
5. Sierra Nevada
6. Southern and Central California Chaparral and Oak Woodlands
7. Central California Valley
8. Southern California Mountains
9. Eastern Cascades Slopes and Foothills
10. Columbia Plateau
11. Blue Mountains
12. Snake River Plain
13. Central Basin and Range
14. Mojave Basin and Range
15. Northern Rockies
16. Idaho Batholith
17. Middle Rockies
18. Wyoming Basin
19. Wasatch and Uinta Mountains
20. Colorado Plateaus
21. Southern Rockies
22. Arizona/New Mexico Plateau
23. Arizona/New Mexico Mountains
24. Chihuahuan Deserts
25. High Plains
26. Southwestern Tablelands
27. Central Great Plains
28. Flint Hills
29. Cross Timbers
30. Edwards Plateau
31. Southern Texas Plains
32. Texas Blackland Prairies
33. East Central Texas Plains
34. Western Gulf Coastal Plain
35. South Central Plains
36. Ouachita Mountains
37. Arkansas Valley
38. Boston Mountains
39. Ozark Highlands
40. Central Irregular Plains
41. Canadian Rockies
42. Northwestern Glaciated Plains
43. Northwestern Great Plains
44. Nebraska Sand Hills
45. Piedmont
46. Northern Glaciated Plains
47. Western Corn Belt Plains
48. Lake Agassiz Plain
49. Northern Minnesota Wetlands
50. Northern Lakes and Forests
51. North Central Hardwood Forests
52. Driftless Area
53. Southeastern Wisconsin Till Plains
54. Central Corn Belt Plains
55. Eastern Corn Belt Plains
56. Southern Michigan/Northern Indiana Drift Plains



57. Huron/Erie Lake Plains
58. Northeastern Highlands
59. Northeastern Coastal one
60. Northern Appalachian Plateau and Uplands
61. Erie Drift Plain
62. North Central Appalachians
63. Middle Atlantic Coastal Plain
64. Northern Piedmont
65. Southeastern Plains
66. Blue Ridge
67. Ridge and Valley
68. Southwestern Appalachians
69. Central Appalachians
70. Western Allegheny Plateau
71. Interior Plateau
72. Interior River Valleys and Hills
73. Mississippi Alluvial Plain
74. Mississippi Valley Loess Plains
75. Southern Coastal Plain
76. Southern Florida Coastal Plain
77. North Cascades
78. Klamath Mountains
79. Madrean Archipelago
80. Northern Basin and Range
81. Sonoran Basin and Range
82. Laurentian Plains and Hills
83. Eastern Great Lakes and Hudson Lowlands
84. Atlantic Coastal Pine Barrens



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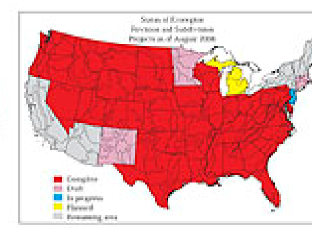
Albers Equal Area Projection



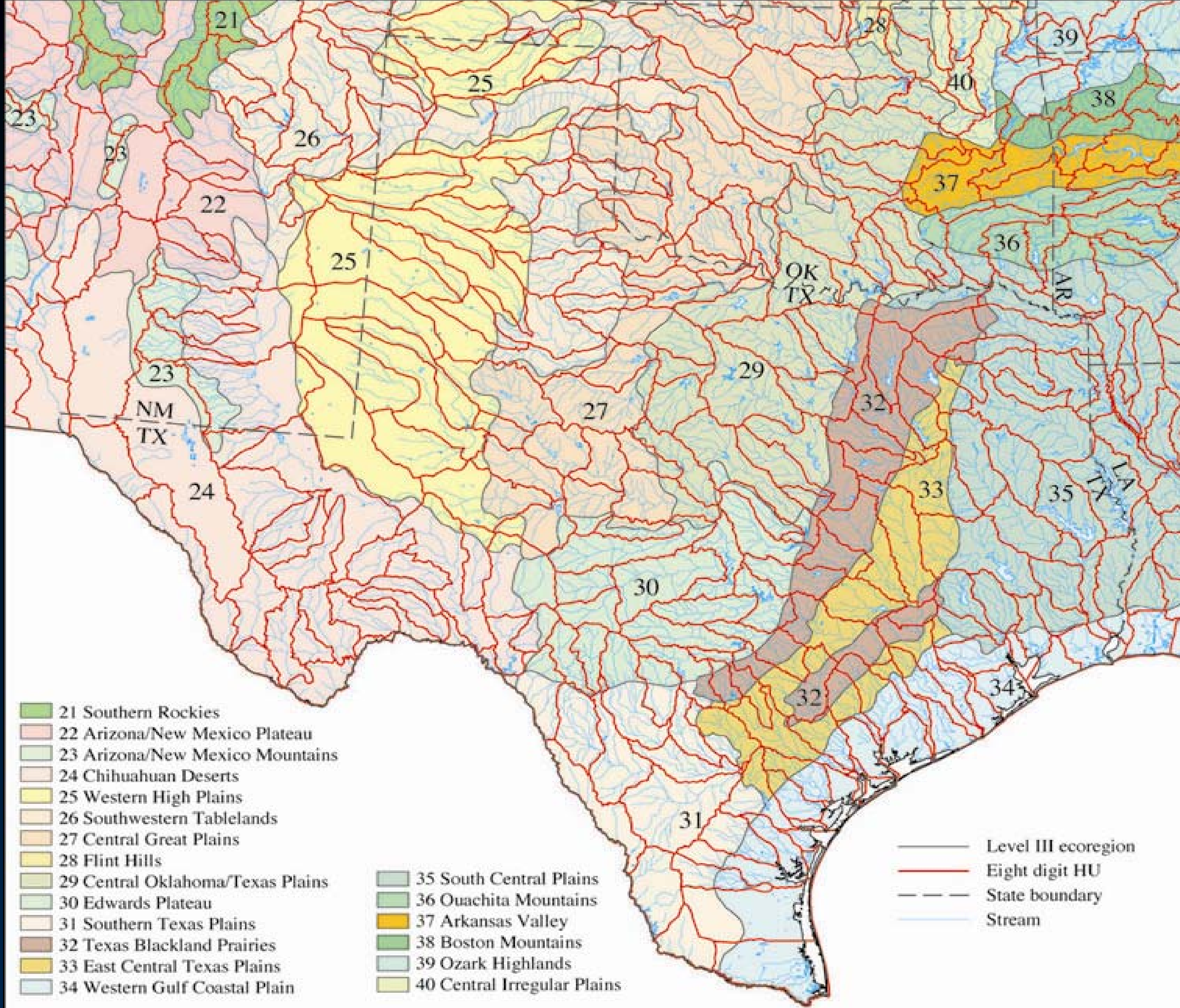


Figure 1. Level III ecoregions and eight digit HUs in Texas and parts of adjacent states.

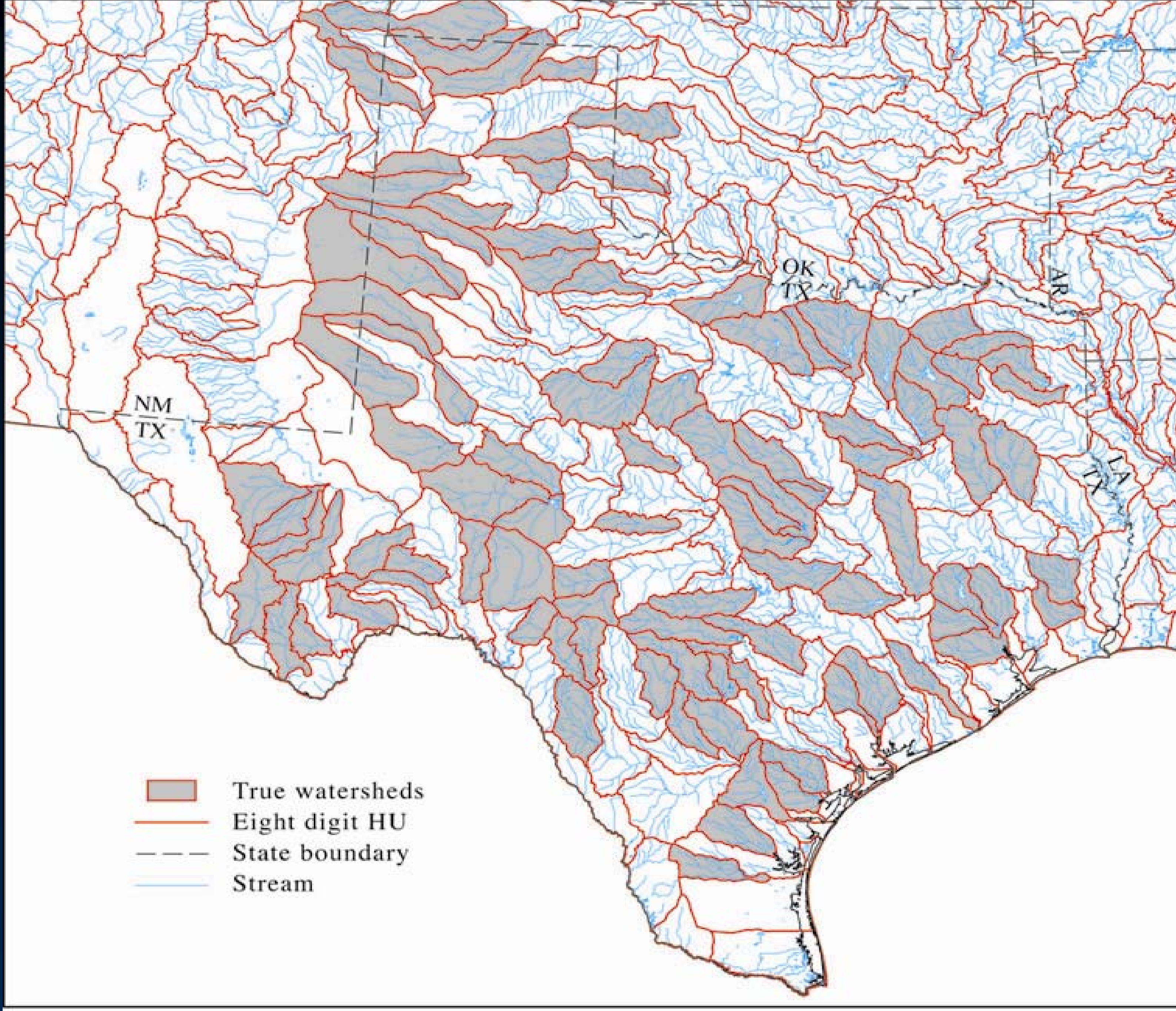


Figure 2. Eight digit HUs that are true watersheds and are completely or partially in Texas.

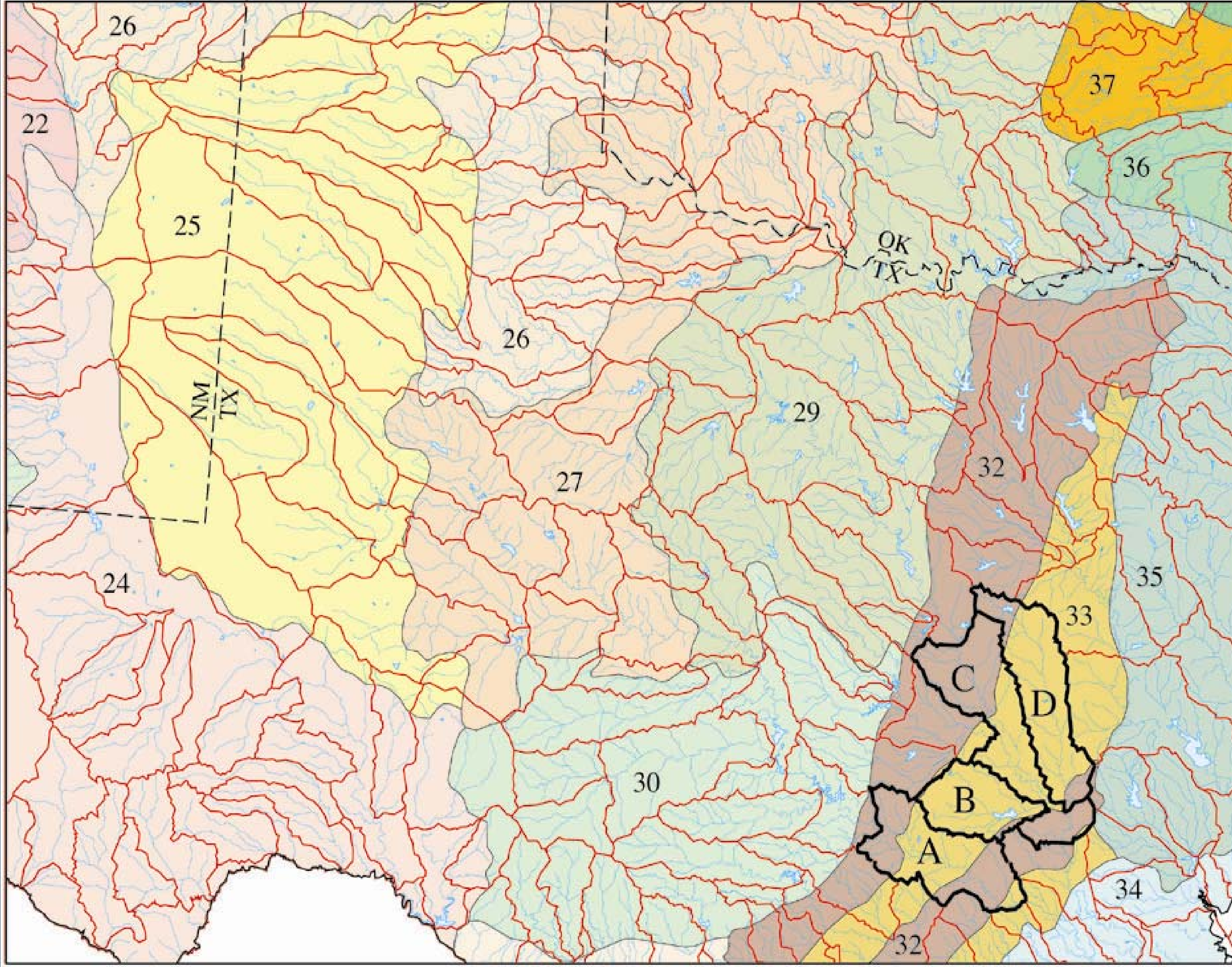


Figure 3. Four eight digit HUs covering ecoregions 32 (the Texas Blackland Prairie) and 33 (the East Central Texas Plain). The hydrologic unit codes for A, B, C, and D are 12090301, 12070102, 12080101, and 12070103 respectively.

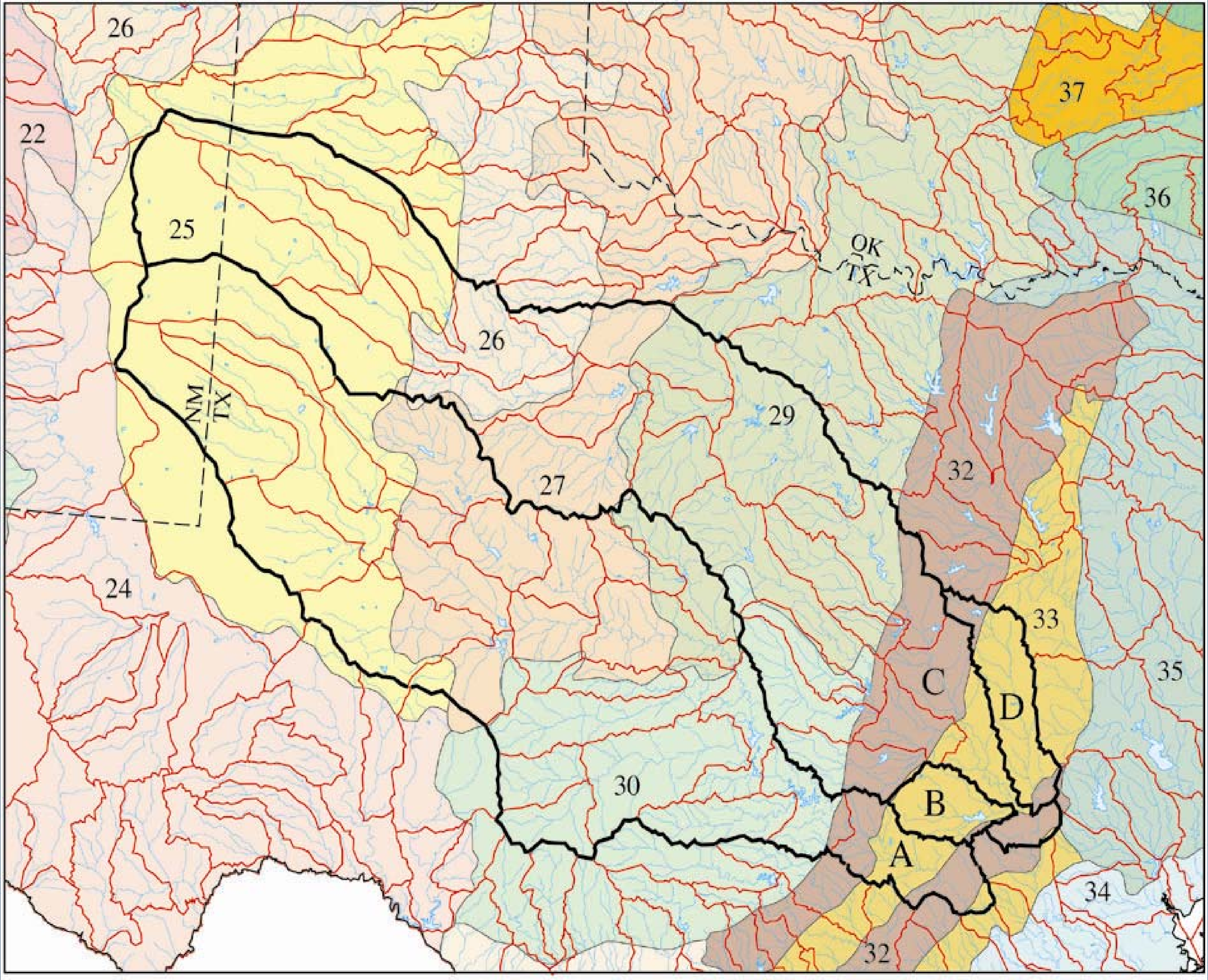


Figure 4. True watersheds associated with downstream points in HUs A, B, C, and D.

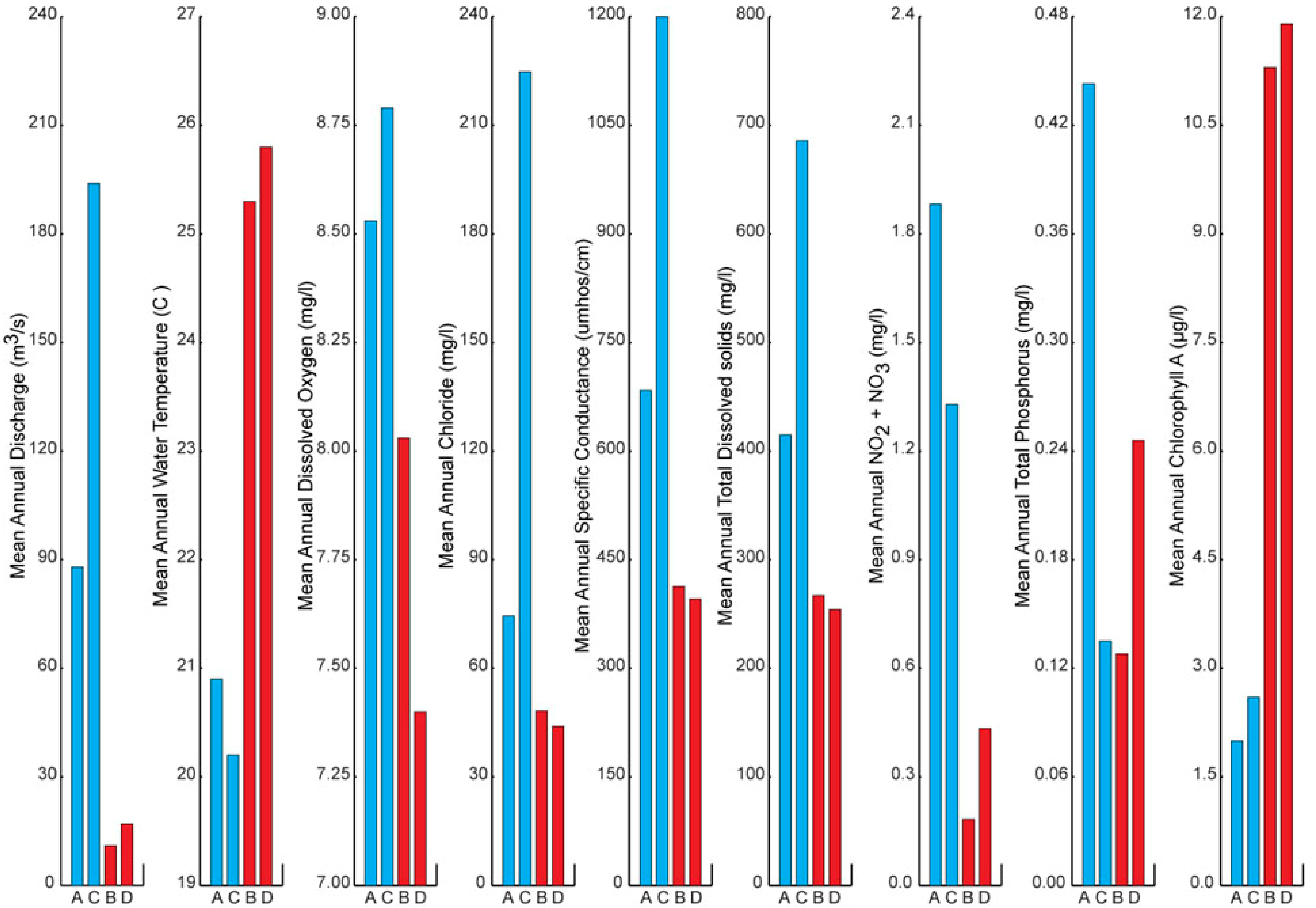


Figure 5. Discharge and water quality characteristics for HUs A, C, B, and D. Sources: Gandara et al. 1995; Gandara et al. 2001a; Gandara et al. 2001b; Texas Natural Resources Commission, 1996.

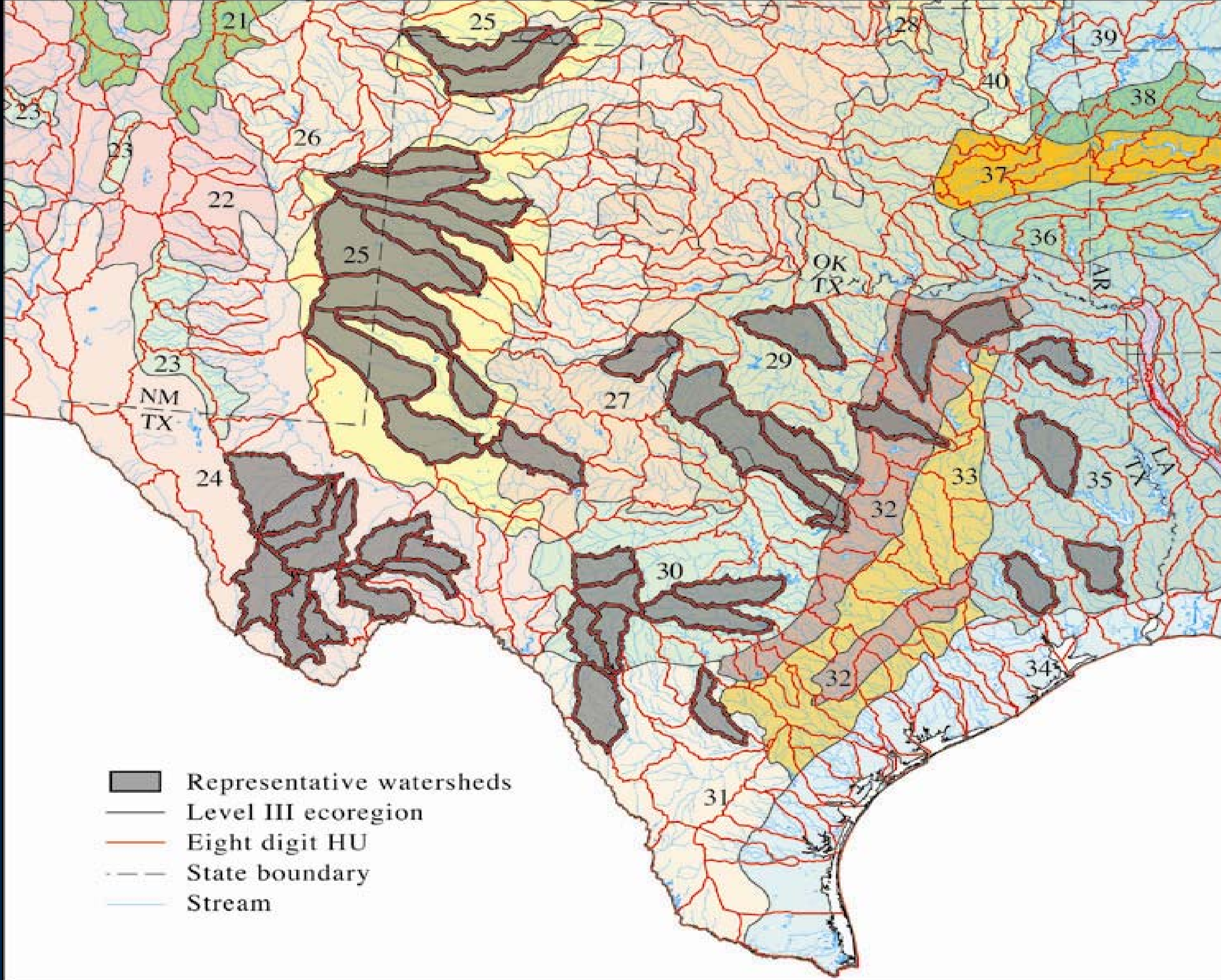
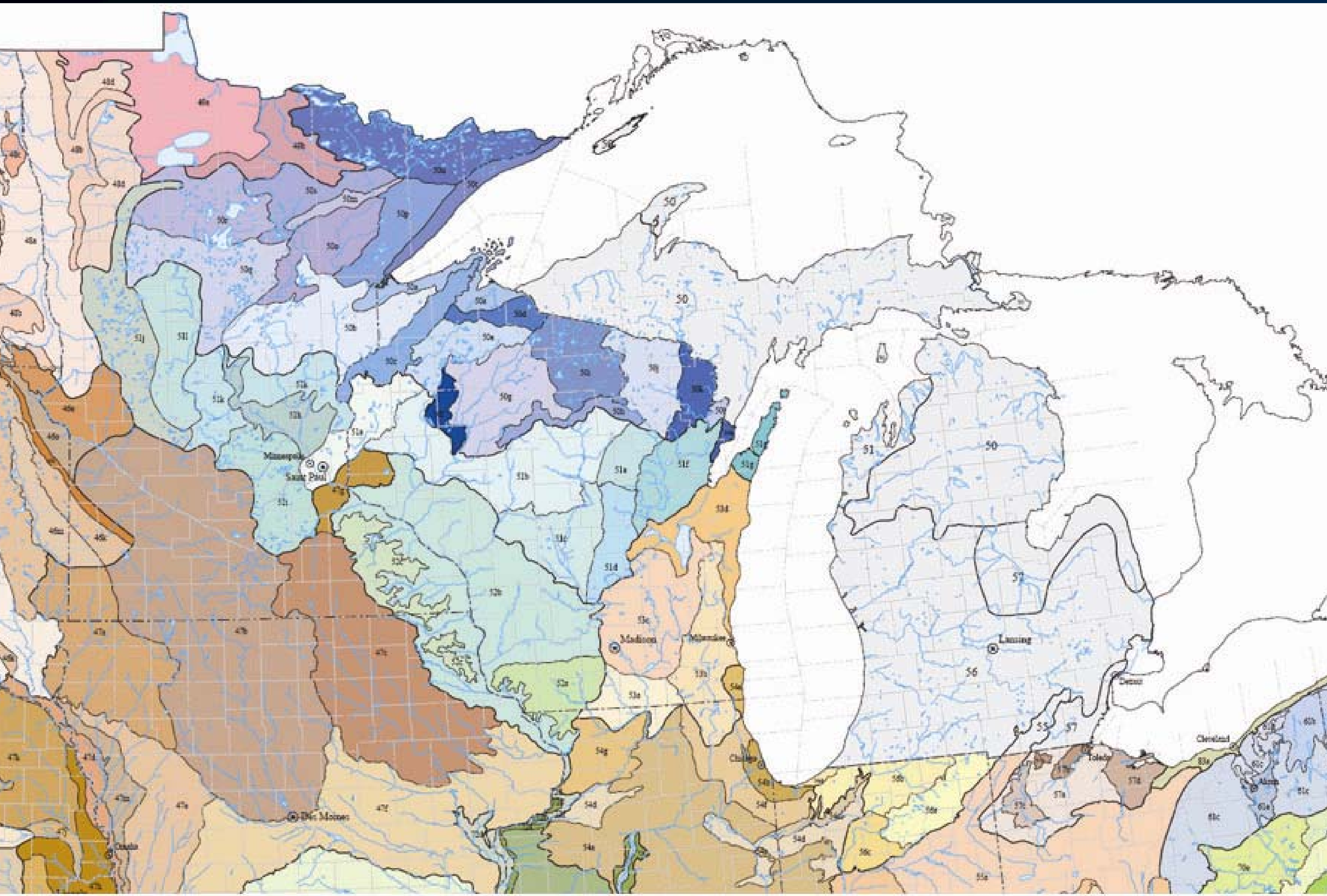
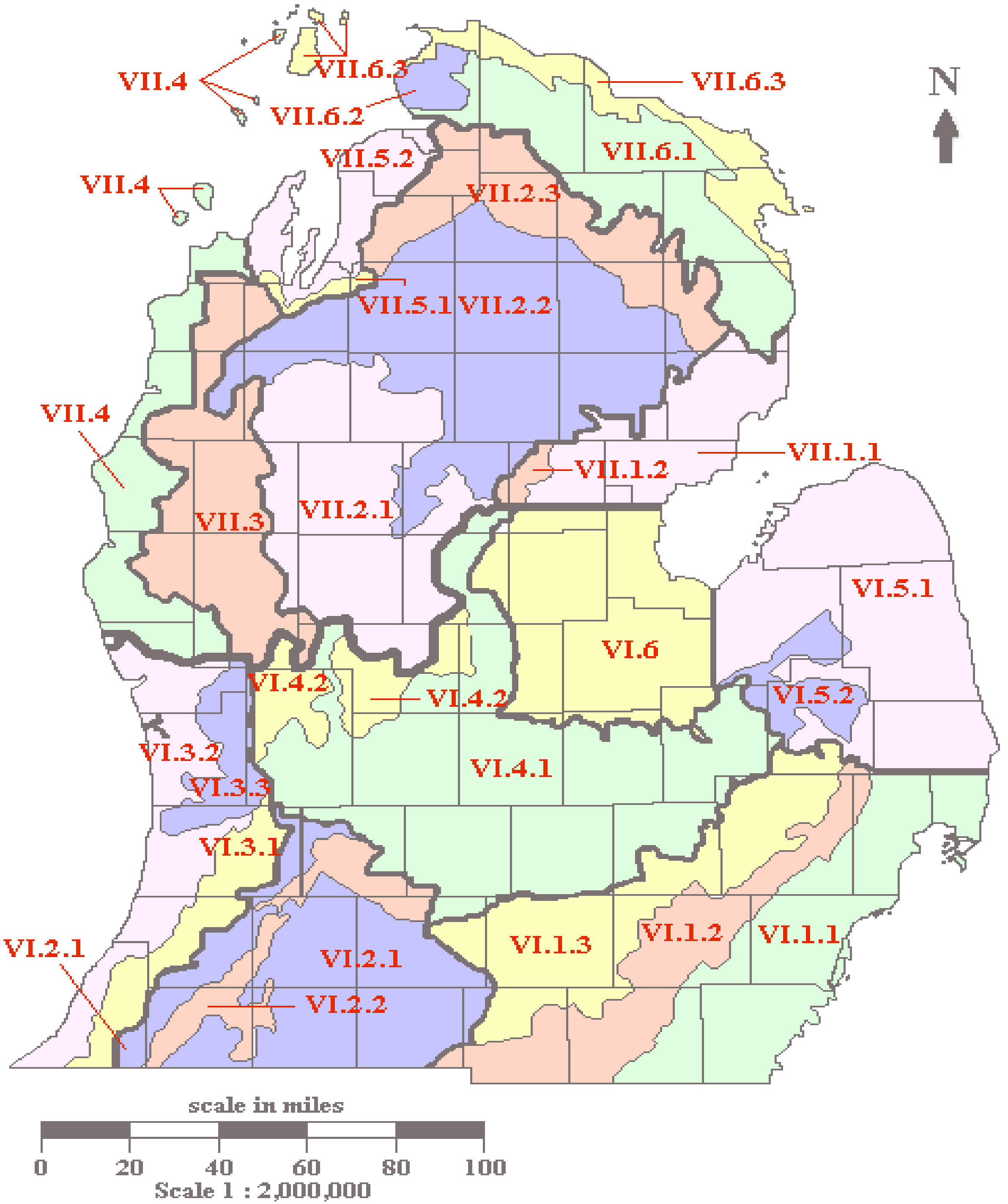
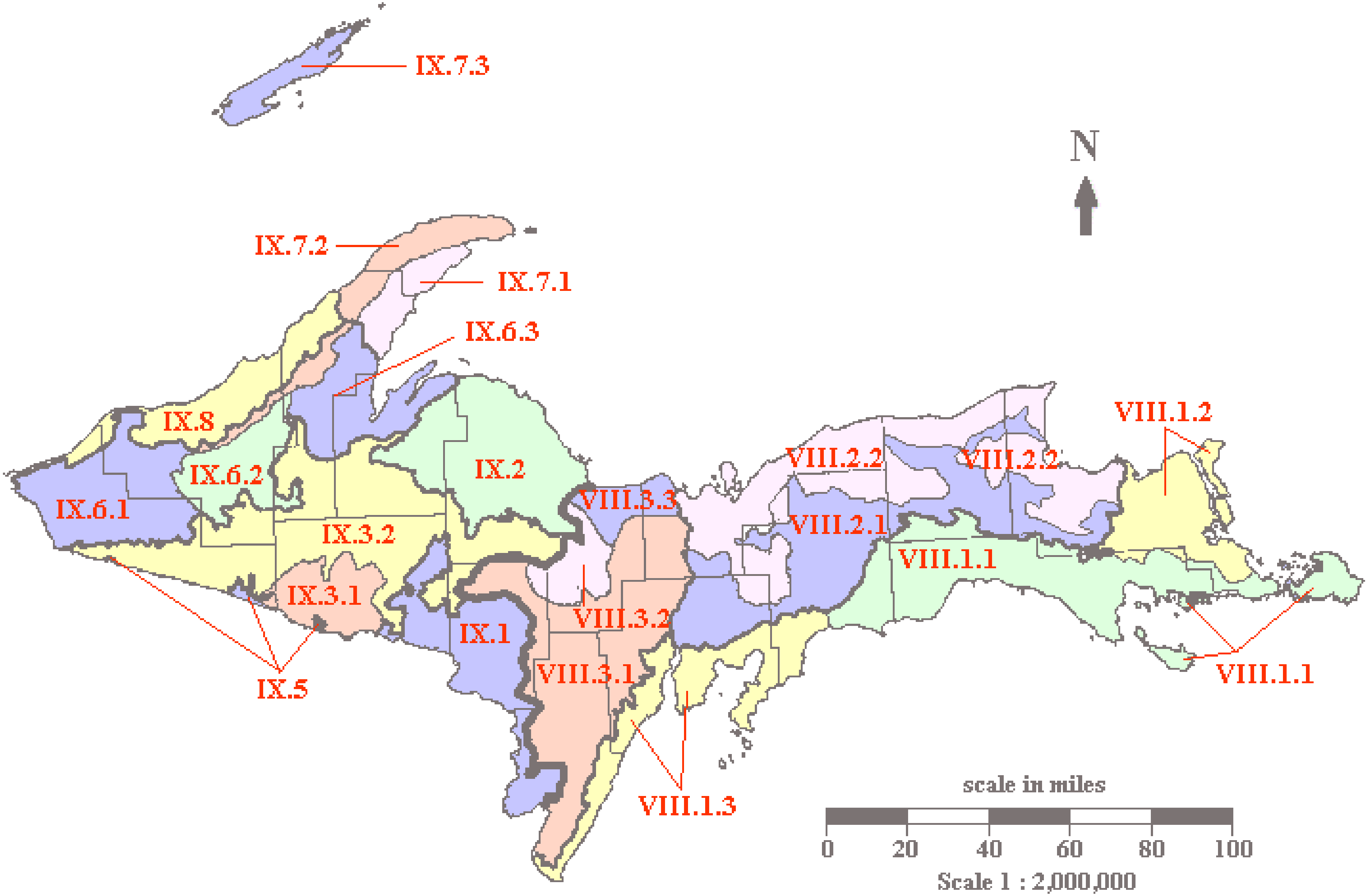


Figure 6. Representative watersheds within level III ecoregions that are completely or partially in Texas.


Minneapolis
Saint Paul
Madison
Milwaukee
Lansing
Des Moines
50
51
56
57


VII.4
VII.6.3
VII.6.2
VII.6.3
N
VII.6.1
VII.5.2
VII.4
VII.2.3
VII.5.1
VII.2.2
VII.4
VII.1.1
VII.1.2
VII.2.1
VII.3
VI.5.1
VI.6
VI.4.2
VI.4.2
VI.5.2
VI.3.2
VI.4.1
VI.3.3
VI.3.1
VI.2.1
VI.1.2
VI.1.1
VI.1.3
VI.2.1
VI.2.2
scale in miles
0
20
40
60
80
100
Scale 1 : 2,000,000


IX.7.3
N
IX.7.2
IX.7.1
IX.6.3
VIII.1.2
IX.8
VIII.2.2
VIII.2.2
IX.2
IX.6.2
VIII.3.3
IX.6.1
VIII.2.1
IX.3.2
VIII.1.1
IX.3.1
VIII.3.2
IX.1
VIII.3.1
VIII.1.1
IX.5
VIII.1.3
scale in miles
0
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40
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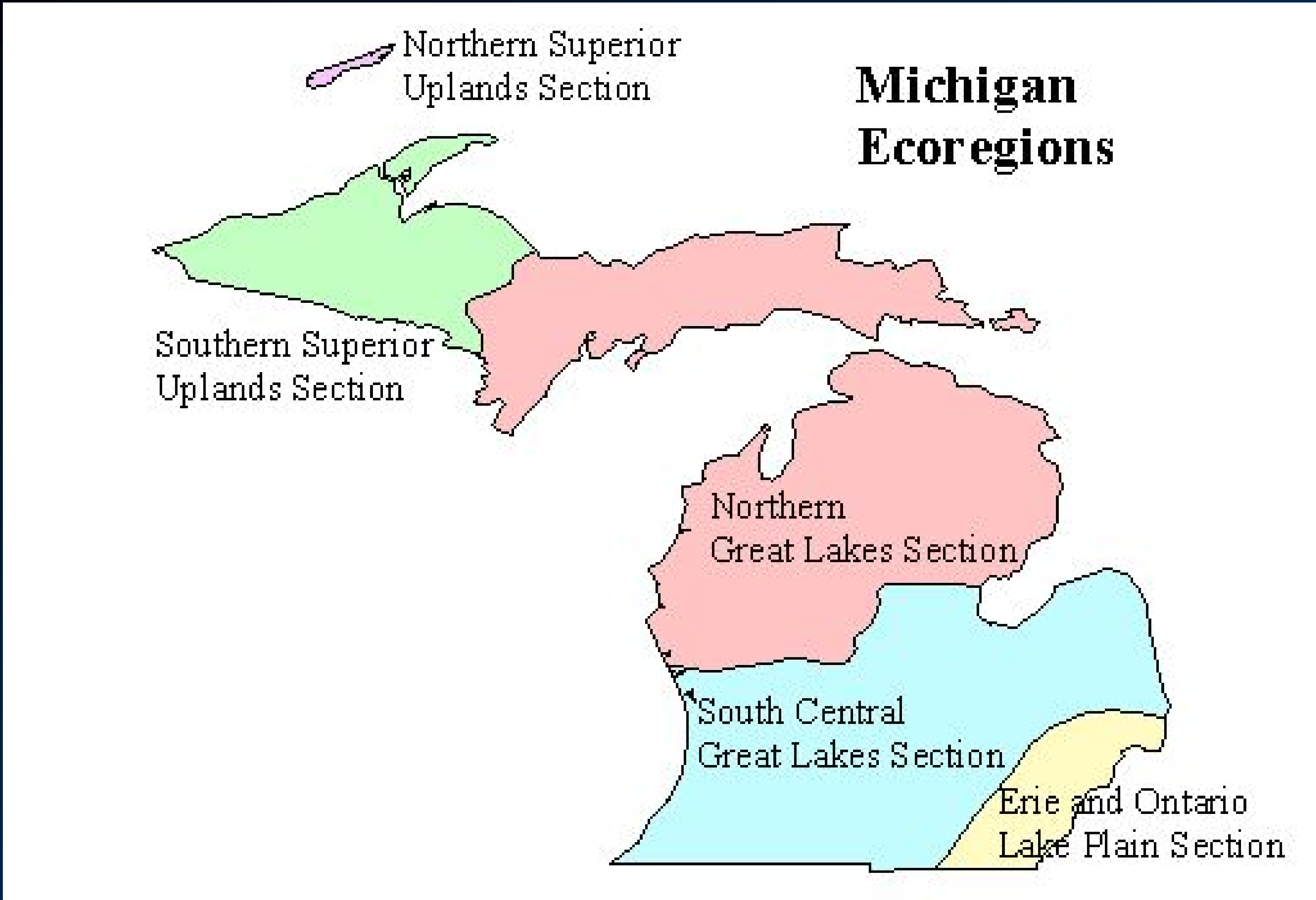
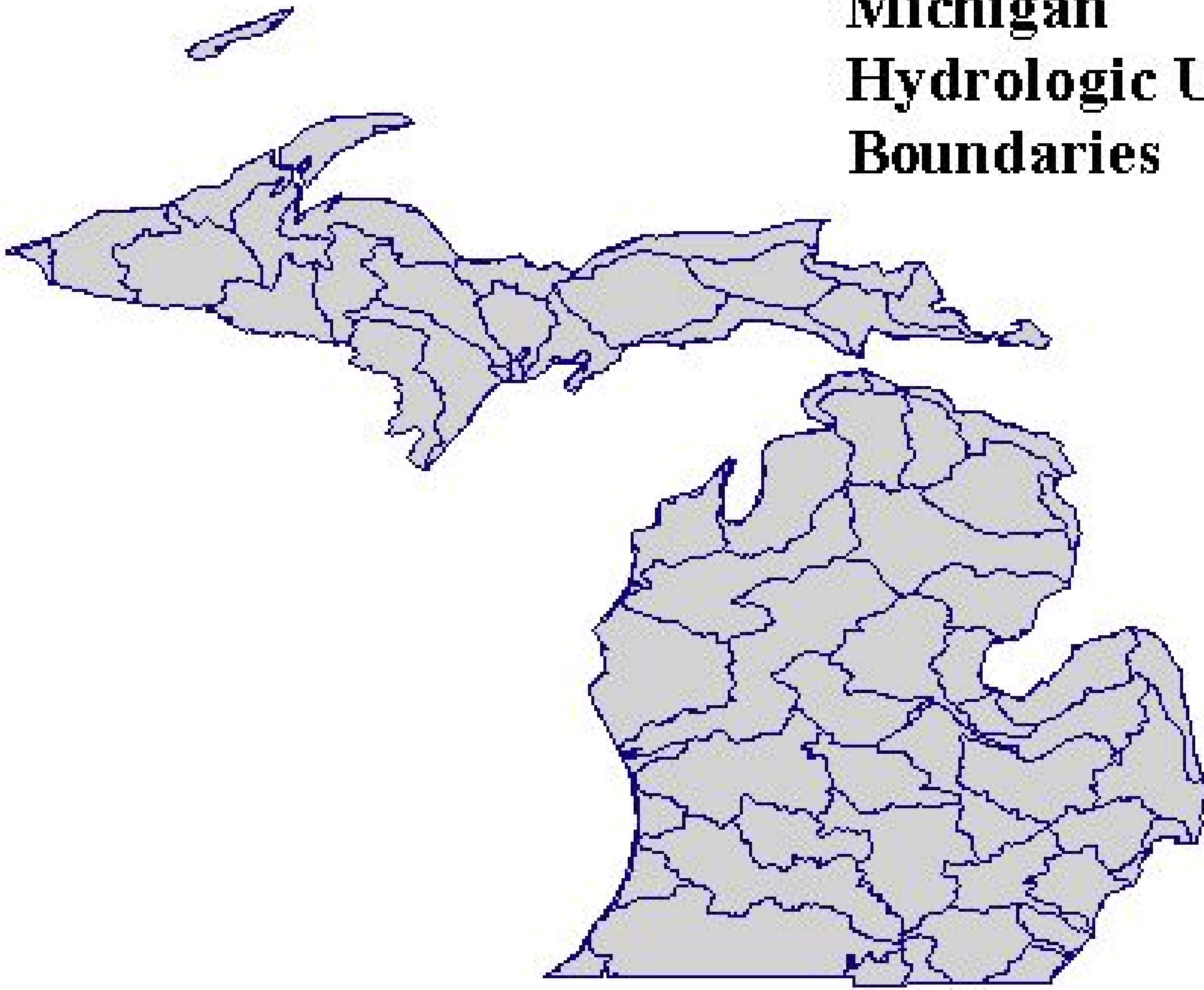
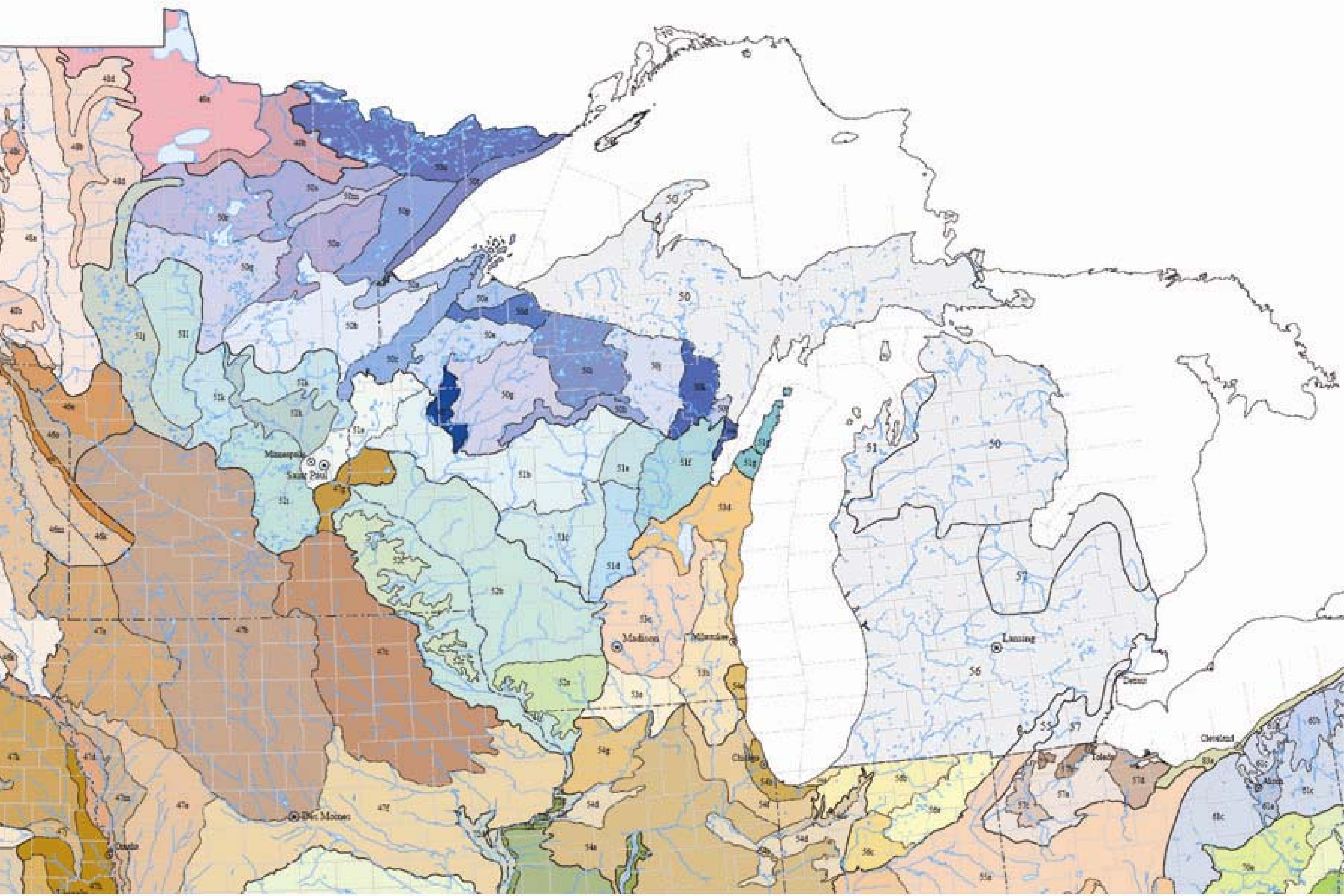
80
100
Scale 1 : 2,000,000


Michigan Ecoregions
Northern Superior Uplands Section
Southern Superior Uplands Section
Northern Great Lakes Section
South Central Great Lakes Section
Erie and Ontario Lake Plain Section

Michigan Hydrologic Unit Boundaries





Minneapolis
Saint Paul
Madison
Lansing
50
51
56
57

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