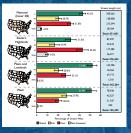
# **\$EPA**

### **Wadeable Streams Assessment**

A Collaborative Survey of the Nation's Streams



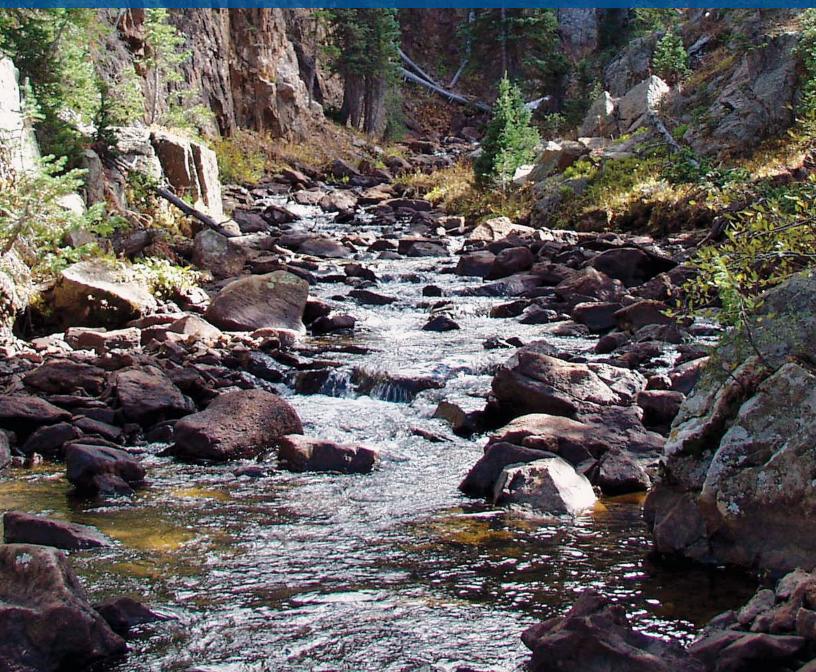














Front cover photo courtesy of the Colorado Division of Wildlife
Inside cover photo courtesy of Michael L. Smith, U.S. Fish and Wildlife Service

### Acknowledgments

This report resulted from a ground-breaking collaboration on stream monitoring. States came together with the U.S. Environmental Protection Agency (EPA) to demonstrate a cost-effective approach for answering one of the nation's most basic water quality questions: What is the condition of our nation's streams?

The EPA Office of Water would like to thank the many participants who contributed to this important effort and the scientists within the EPA Office of Research and Development for their research and refinement of the survey design, field protocols, and indicator development. Through the collaborative efforts of state environmental and natural resource agencies, federal agencies, universities, and other organizations, more than 150 field biologists were trained to collect environmental samples using a standardized method, and more than 25 taxonomists identified as many as 500 organisms in each sample. Each participating organization attended a national meeting to discuss and formulate the data analysis approach, as well as regional meetings to evaluate and refine the results presented in this report.

#### Collaborators

Alaska Department of Environmental Conservation

Arizona Game and Fish Department

Arkansas Department of Environmental Quality

California Department of Fish and Game

California State Water Resources Control Board

Colorado Department of Public Health and Environment

Colorado Division of Wildlife

Connecticut Department of Environmental Protection

Delaware Department of Natural Resources

and Environmental Control

Georgia Department of Natural Resources

Idaho Department of Environmental Quality

Illinois Environmental Protection Agency

Iowa Department of Natural Resources

Kansas Department of Health and Environment

Kentucky Division of Water

Louisiana Department of Environmental Quality

Maine Department of Environmental Protection

Maryland Department of Natural Resources

Michigan Department of Environmental Quality

Minnesota Pollution Control Agency

Mississippi Department of Environmental Quality

Missouri Department of Conservation

Montana Department of Environmental Quality

Nevada Division of Environmental Protection

New Hampshire Department of Environmental

Services

New Jersey Department of Environmental Protection

New Mexico Environment Department

New York State Department of Environmental

Conservation

North Carolina Division of Water Quality

North Dakota Department of Health

Ohio Environmental Protection Agency

Oklahoma Conservation Commission

Oklahoma Water Resources Board

Oregon Department of Environmental Quality

Pennsylvania Department of Environmental Protection

South Carolina Department of Health

and Environmental Control

South Dakota Department of Environment

and Natural Resources

South Dakota Game, Fish and Parks

Tennessee Department of Environment and

Conservation

Texas Commission of Environmental Quality

Utah Division of Water Quality

Vermont Department of Environmental Conservation

Virginia Department of Environmental Quality

Washington State Department of Ecology

West Virginia Department of Environmental

Protection

Wisconsin Department of Natural Resources

Wyoming Department of Environmental Quality

Fort Peck Assiniboine and Sioux Tribes

Guam Environmental Protection Agency

U.S. Geological Survey

U.S. EPA, Office of Environmental Information

U.S. EPA, Office of Water

U.S. EPA, Office of Research and Development

U.S. EPA, Regions 1–10

Center for Applied Bioassessment and Biocriteria

Central Plains Center for Bioassessment

New England Interstate Water Pollution Control

Commission

The Council of State Governments

Great Lakes Environmental Center

Tetra Tech, Inc.

**EcoAnalysts** 

University of Arkansas

Mississippi State University

Oregon State University

Utah State University

The data analysis team painstakingly reviewed the data set to ensure its quality and performed the data analysis. This team included Phil Kaufmann, Phil Larsen, Tony Olsen, Steve Paulsen, Dave Peck, John Stoddard, John Van Sickle, and Lester Yuan from the EPA Office of Research and Development; Alan Herlihy from Oregon State University; Chuck Hawkins from Utah State University; Daren Carlisle from the U.S. Geological Survey; and Michael Barbour, Jeroen Gerritson, Erik Lepow, Kristen Pavlik, and Sam Stribling from Tetra Tech, Inc.

The report was written by Steve Paulsen and John Stoddard from the EPA Office of Research and Development and Susan Holdsworth, Alice Mayio, and Ellen Tarquinio from the EPA Office of Water. Major contributions to the report were made by John Van Sickle, Dave Peck, Phil Kaufmann, and Tony Olsen from the EPA Office of Research and Development and Peter Grevatt and Evan Hornig from EPA Office of Water, Alan Herlihy from Oregon State University, Chuck Hawkins from Utah State University, and Bill Arnold from the Great Lakes Environmental Center. Technical editing and document production support was provided by RTI International. This report was significantly improved by the external peer review conducted by Dr. Stanley V. Gregory, Ecologist, Oregon State University; Dr. Kenneth Reckhow, Environmental Engineer, Duke University; Dr. Kent Thornton, Principal Ecologist, FTN Associates; Dr. Scott Urquhart, Statistician, Colorado State University; and Terry M. Short of the U.S. Geological Survey. The Quality Assurance Officer for this project was Otto Gutenson from the EPA Office of Water.

## Table of Contents

Acknowledgments	ii
Collaborators	iii
Executive Summary	ES-2
Introduction	2
Chapter 1 – Design of the Wadeable Streams Assessment	6
Why focus on wadeable streams?	6
What area does the WSA cover?	9
What areas are used to report WSA results?	13
How were sampling sites chosen?	15
How were waters assessed?	19
Setting expectations	23
Chapter 2 – Condition of the Nation's Streams	26
Background	26
Indicators of Biological Condition	26
Macroinvertebrate Index of Biotic Condition	28
Macroinvertebrate Observed/Expected (O/E) Ratio of Taxa Loss	31
Aquatic Indicators of Stress	33
Chemical Stressors	33
Physical Habitat Stressors	39
Biological Stressors	45
Ranking of Stressors	46
Extent of Stressors	46
Relative Risk of Stressors to Biological Condition	48
Combining Extent and Relative Risk	50
Chapter 3 – Wadeable Streams Assessment Ecoregion Results	52
Northern Appalachians Ecoregion	54
Physical Setting	54
Biological Setting	54
Human Influence	54
Summary of WSA Findings	55
Southern Appalachians Ecoregion	
Physical Setting	
Biological Setting	58
Human Influence	59
Summary of WSA Findings	59

Coastal Plains Ecoregion	61
Physical Setting	61
Biological Setting	62
Human Influence	62
Summary of WSA Findings	63
Upper Midwest Ecoregion	65
Physical Setting	65
Biological Setting	65
Human Influence	65
Summary of WSA Findings	66
Temperate Plains Ecoregion	68
Physical Setting	68
Biological Setting	68
Human Influence	68
Summary of WSA Findings	69
Southern Plains Ecoregion	71
Physical Setting	71
Biological Setting	71
Human Influence	72
Summary of WSA Findings	72
Northern Plains Ecoregion	74
Physical Setting	74
Biological Setting	74
Human Influence	75
Summary of WSA Findings	75
Western Mountains Ecoregion	77
Physical Setting	77
Biological Setting	
Human Influence	78
Summary of WSA Findings	78
Xeric Ecoregion	
Physical Setting	
Biological Setting	
Human Influence	
Summary of WSA Findings	81

Chapter 4 – Summary and Next Steps	86
Summary	86
Next Steps	88
Glossary of Terms	91
Sources and References	93
General References	93
Stream and River Sampling and Laboratory Methods	94
Probability Designs	95
Ecological Regions	95
Indices of Biotic Integrity	96
Observed/Expected Models	96
Physical Habitat	96
Reference Condition	97
Other EMAP Assessments	97
Biological Condition Gradient/Quality of Reference Sites	97
Relative Risk	97
Nutrients	98

# **Figures**

1	Strahler stream order diagram	/
2	Stream characteristics change as the stream's size or stream order increases	8
3	Major rivers and streams of the conterminous United States	9
4	Average annual precipitation of the United States, 1961–1990	10
5	Major land cover patterns of the conterminous United States	11
6	Human population density (people per square mile) based on the	
	2000 U.S. Census Bureau data	12
7	Three major regions were surveyed for the WSA	13
8	Nine ecoregions were surveyed for the WSA	14
9	Length of wadeable, perennial streams in each WSA ecoregion	16
10	Sites sampled for the WSA by EPA Region	17
11	Reach layout for sampling	19
12	Stream macroinvertebrates	20
13	Biological condition of streams based on Macroinvertebrate Index of Biotic Condition	30
14	Macroinvertebrate taxa loss as measured by the O/E Ratio of Taxa Loss	32
15	Total phosphorus concentrations in U.S. streams	
16	Total nitrogen concentrations in U.S. streams	36
17	Salinity conditions in U.S. streams	37
18	Acidification in U.S. streams	39
19	Streambed sediments in U.S. streams	41
20	In-stream fish habitat in U.S. streams.	
21	Riparian vegetative cover in U.S. streams	
22	Riparian disturbance in U.S. streams	45
23	Extent of stressors	47
24	Extent of stressors and their relative risk to Macroinvertebrate Condition	
	and O/E Taxa Loss	
25	Ecoregions surveyed for the WSA	53
26	WSA survey results for the Northern Appalachians ecoregion	56
27	WSA survey results for the Southern Appalachians ecoregion	60
28	WSA survey results for the Coastal Plains ecoregion	
29	WSA survey results for the Upper Midwest ecoregion	67
30	WSA survey results for the Temperate Plains ecoregion	
31	WSA survey results for the Southern Plains ecoregion	72
32	WSA survey results for the Northern Plains ecoregion	75
33	WSA survey results for the Western Mountains ecoregion	
34	WSA survey results for the Xeric ecoregion	83

### Acronym List

°F degrees Fahrenheit

ANC acid neutralizing capacity
BMPs best management practices
CAAA Clean Air Act Amendments

CWA Clean Water Act

EMAP Environmental Monitoring and Assessment Program

EPA U.S. Environmental Protection Agency

FWS U.S. Fish and Wildlife Service

km kilometers mi<sup>2</sup> square miles

NAPAP National Acid Precipitation Program

NCA National Coastal Assessment

NCCR National Coastal Condition Report NCCR II National Coastal Condition Report II

NEP National Estuary Program

NEP CCR National Estuary Program Coastal Condition Report

NHD National Hydrography DatasetNLCD National Land Cover Dataset

NOAA National Atmospheric and Oceanic Administration

O/E observed/expected

PCBs polychlorinated biphenyls
RBS relative bed stability
TDS total dissolved solids

µeq/L microequivalents per liter
USGS U.S. Geological Survey
VOCs volatile organic compounds
WSA Wadeable Streams Assessment