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ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM-SURFACE WATERS:

FIELD OPERATIONS AND METHODS FOR MEASURING THE ECOLOGICAL CONDITION OF WADEABLE STREAMS

Edited by

James M. Lazorchak[1], Donald J. Klemm[1], and David V. Peck[2]

[1] U.S. Environmental Protection Agency
Ecosystems Research Branch
Ecological Exposure Research Division
National Exposure Research Laboratory
Cincinnati, OH 45268

[2] U.S. Environmental Protection Agency
Regional Ecology Branch
Western Ecology Division
National Health and Environmental Effects Research Laboratory
Corvallis, OR 97333

NATIONAL EXPOSURE RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

NATIONAL HEALTH AND ENVIRONMENTAL EFFECTS RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

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Section authors are listed on the following page. Complete addresses for authors are also provided in each section.

Section 1:	J.M. Lazorchak[1], A.T. Herlihy[2], H.R. Preston[3, 4], and D.J. Klemm[1]
Section 2:	B.H. Hill[1], F.H. McCormick[1], J.M. Lazorchak[1], D.J. Klemm[1], P.A. Lewis[1, 5], V.C. Rogers[6, 7], and M.K. McDowell[5]
Section 3:	D.J. Klemm[1], B.H. Hill[1], F.H. McCormick[1], and M.K. McDowell[5]
Section 4:	A T. Herlihy[2]
Section 5:	A T. Herlihy[2]
Section 6:	P R. Kaufmann[2]
Section 7:	P R. Kaufmann[2] and E.G. Robison[2, 8]
Section 8:	B.H. Hill[1]
Section 9:	B.H. Hill[1]
Section 10:	J.M. Lazorchak[1], and M. E. Smith[9]
Section 11:	D.J. Klemm[1], J.M. Lazorchak[1], and P.A. Lewis[1, 4]
Section 12:	F.H. McCormick[1] and R. M. Hughes[10]
Section 13:	R.B. Yeardley, Jr.[8], J.M. Lazorchak[1], and F.H. McCormick[1]
Section 14:	J.M. Lazorchak[1], A. T. Herlihy[2], and J. Green[3]
Section 15:	J.M. Lazorchak[1]

[1] U.S. EPA, National Exposure Research Laboratory, Cincinnati, OH 45628.

[2] Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97333.

[3] U.S. EPA, Region 3, Wheeling, WV 26003).

[4] Current address: Canaan Valley Institute, Davis, WV 26260.

[5] Current Address: 1037 Wylie Road, RR #2, Seaman, OH 45679

[6] OAO Corp., Corvallis, OR 97333

[7] Current address: Linn-Benton Community College, Albany, OR.

[8] Current Address: Oregon Department of Forestry, Salem, OR 97310

[9] So Bran Environmental, Inc., Cincinnati, OH 45628.

[10] Dynamac International, Inc., Corvallis, OR 97333.

FOREWORD

The National Exposure Research Laboratory (NERL) and the National Health and Environmental Effects Research Laboratory (NHEERL) provide scientific understanding, information and assessment tools that will reduce and quantify the uncertainty in the Agency's exposure and risk assessments for all environmental stressors. Stressors include chemicals, biologicals, radiation, climate, and land and water use changes.

Research at NERL focuses on: (1) characterizing the sources of environmental stressors and the compartments of the environment in which they reside or move; (2) studying the pathways through environmental compartments that lead to exposure of receptors to stressors; (3) investigating intra- and inter compartmental stressor transfers and their transformations; and (4) studying and characterizing receptors and their activities as required to predict or measure stressor exposure. Research products from NERL provide effects researchers and risk assessors with information on stressor sources, pollutant transport and transformations and exposure, and state-of-the-science source-to-receptor predictive exposure models applicable at the appropriate temporal scales and site, watershed/regional and global scales. It also provides risk managers with receptor-back-to-source and stressor-back-to-cause analyses and evaluations of alternative mitigation, management or restoration strategies from an exposure perspective.

Ecological research at NHEERL contribute to improving hazard identification, dose-response assessments, and risk characterization at multiple spatial and temporal scales. Research products from NHEERL include improved assessment methods and improved approaches to interpreting the data acquired by these methods. Major uncertainties in assessing the effects on ecosystems resulting from exposure to environmental stressors are addressed through the development of the tools necessary for effective monitoring of ecosystems and their components, by mechanistic studies, and through modeling.

To accomplish its mission, NERL conducts fundamental and applied research designed to:

1. Characterize air, soil, surface water, sediment, and subsurface systems to evaluate spatial and temporal patterns, exposure to environmental stressors/ pollutants;
2. Identify, quantify, and predict the physical, chemical, biological and biochemical behavior of stressors, including characterization of their sources, transformations pathways and other factors that determine stressor exposure to humans and ecosystems across multiple media
3. Characterize the ecological and human receptors potentially impacted by stressors and pollutants;
4. Measure, predict, and apply data on environmental stressors to characterize exposure to humans and ecosystems;
5. Incorporate scientific understanding of environmental processes and ecosystem behavior, along with environmental exposure data, into predictive multimedia models to estimate exposure and to evaluate mitigation, restoration, prevention and management options;
6. Develop and implement receptor level exposure and dose models to provide risk assessors with better and more refined estimates of exposure and dose.
7. Develop chemical, physical, and biological measurement methods to identify and quantify environmental stressors and to characterize the environment;
8. Develop quality assurance methodologies for chemical, physical, radiological, and biological analyses;
9. Develop and apply geographical informational systems, remote sensing, photographic interpretation, information management technologies, software engineering technologies, computational chemistry, expert systems, and high performance computing to support the application of exposure and risk assessment tools;
10. Demonstrate, field test/evaluate, and transfer scientific information, measurement and quality assurance protocols, data bases, predictive exposure and risk assessment tools, and other innovative exposure assessment technologies, and provide environmental education materials to support Program Offices, Regions, State/Municipal/Tribal governments, and other Federal Agencies;
11. Provide technical support to Program Offices, Regions, State/Municipal/Tribal governments and other Federal Agencies to help in performing state-of-the-science exposure assessments of known certainty.

Research activities at NHEERL related to improving ecosystem risk assessment are designed to:

1. Develop and evaluate appropriate and meaningful indicators of ecological condition and develop associated criteria to characterize condition.

2. Develop and test approaches for monitoring frameworks that are integrated over multiple spatial and temporal scales to provide representative information about spatial extent of ecosystem resources, their current status (i.e., baseline condition) and how condition is changing through time.
3. Develop approaches to demonstrate relationships between effects on ecological condition and the relative magnitude of current stressors at multiple scales.

This field operations and methods manual represents a collaborative effort among principal investigators at NERL and NHEERL. The manual describes guidelines and standardized procedures for evaluating the biological integrity of surface waters of streams. It was developed to provide the Environmental Monitoring and Assessment Program (EMAP) with bioassessment methods for determining the status and monitoring trends of the environmental condition of freshwater streams. These bioassessment studies are carried out to assess biological criteria for the recognized beneficial uses of water, to monitor surface water quality, and to evaluate the health of the aquatic environment.

PREFACE

The Ecosystems Research Branch (ERB), Ecological Exposure Research Division, National Exposure Research Laboratory, U.S. Environmental Protection Agency - Cincinnati is responsible for field and laboratory exposure methods and ecological indicators that are used in assessing aquatic ecosystems. Research areas include the development, evaluation, validation, and standardization of Agency methods for the collection of biological field and laboratory data. These methods can be used by USEPA regional, enforcement, and research programs engaged in inland, estuarine, and marine water quality and permit compliance monitoring, and status and/or trends monitoring for the effects of impacts on aquatic organisms, including phytoplankton, zooplankton, periphyton, macrophyton, macroinvertebrates, and fish. The program addresses methods and techniques for sample collection; sample preparation; processing of structural and functional measures by using organism identification and enumeration; the measurement of biomass and benthic metabolism; the bioaccumulation and pathology of toxic substances; acute, chronic, and sediment toxicity; the computerization, analysis, and interpretation of biological data; and ecological assessments. ERB also includes field and laboratory support of the ecological biomarker research program and transfer of monitoring technology to the regions and state programs.

This document contains the EMAP-Surface Water field operations and bioassessment methods for evaluating the health and biological integrity of wadeable freshwater streams.

ABSTRACT

The methods and instructions for field operations presented in this manual for surveys of wadeable streams were developed and tested during 5 years of pilot and demonstration projects (1993 through 1997). These projects were conducted under the sponsorship of the U.S. Environmental Protection Agency and its collaborators through the Environmental Monitoring and Assessment Program (EMAP). This program focuses on evaluating ecological conditions on regional and national scales. This document describes procedures for collecting data, samples, and information about biotic assemblages, environmental measures, or attributes of indicators of stream ecosystem condition. The procedures presented in this manual were developed based on standard or accepted methods, modified as necessary to adapt them to EMAP sampling requirements. They are intended for use in field studies sponsored by EMAP, and related projects such as the USEPA Regional Environmental Monitoring and Assessment Program (R-EMAP), and the Temporally Integrated Monitoring of Ecosystems study (TIME). In addition to methodology, additional information on data management, safety and health, and other logistical aspects is integrated into the procedures and overall operational scenario. Procedures are described for collecting field measurement data and/or acceptable index samples for several response and stressor indicators, including water chemistry, physical habitat, benthic macroinvertebrate assemblages, aquatic vertebrate assemblages, fish tissue contaminants, periphyton assemblages, sediment community metabolism, and sediment toxicity. The manual describes field implementation of these methods and the logistical foundation constructed during field projects. Flowcharts and other graphic aids provide overall summaries of specific field activities required to visit a stream site and collect data for these indicators. Tables give step-by-step protocol instructions. These figures and tables can be extracted and bound separately to make a convenient quick field reference for field teams. The manual also includes example field data forms for recording measurements and observations made in the field and sample tracking information. Checklists of all supplies and equipment needed for each field task are included to help ensure that these materials are available when required.

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ACRONYMS, ABBREVIATIONS, AND MEASUREMENT UNITS

Acronyms and Abbreviations

AFDM	Ash-free dry mass
APA	Acid/Alkaline Phosphatase Activity
BPJ	Best Professional Judgment
BOD	Biological Oxygen Demand
CENR	(White House) Committee on the Environment and Natural Resources
CFR	Code of Federal Regulations
DC	Direct Current
DIC	Dissolved Inorganic Carbon
DLGs	Digital Line Graphs
DO	Dissolved oxygen
EERD	Ecological Exposure Research Division
EMAP	Environmental Monitoring and Assessment Program
EMAP-SW	Environmental Monitoring and Assessment Program-Surface Waters Resource Group
EPA	U.S. Environmental Protection Agency
ERB	Ecosystems Research Branch
GPS	Global Positioning System
ID	identification
LWD	Large Woody Debris
MAHA	Mid-Atlantic Highlands Assessment
MAIA	Mid-Atlantic Integrated Assessment
NAWQA	National Water-Quality Assessment Program
NERL	National Exposure Research Laboratory
NHEERL	National Health and Environmental Effects Research Laboratory
ORD	Office of Research and Development
OSHA	Occupational Safety and Health Administration
P-Hab	physical habitat
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control

ACRONYMS, ABBREVIATIONS, AND MEASUREMENT UNITS (CONTINUED)

Acronyms and Abbreviations (continued)

RBP	(EPA) Rapid Bioassessment Protocol
R-EMAP	Regional Environmental Monitoring and Assessment Program
SL	Standard length
SOP	Standard Operating Procedure
TIME	Temporally Integrated Monitoring of Ecosystems
TL	Total length
USGS	United States Geological Survey
WED	Western Ecology Division
YOY	young of year
YSI	Yellow Springs Instrument system

Measurement Units

amps	amperes
cm	centimeter
gal	gallon
ha	hectare
Hz	Hertz
in	inches
L	liter
m	meter
m^2	square meters
mg/L	milligram per liter
mm	millimeter
:m	micrometer
:S/cm	microsiemens per centimeter
msec	millisecond
ppm	parts per million
psi	pounds per square inch
V	volts
VA	volt-ampere