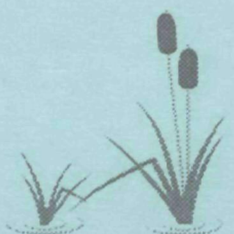
EPA

ECOSYSTEM RESTORATION:

A National Symposium to Bring Together Ecosystem Restoration Practitioners and Researchers



July 29 to July 31, 1998

Baltimore Marriott Inner Harbor

Baltimore, Maryland

Day 1 - July 29 - 8:30AM

Session I - Plenary

Moderator - Sue Schock, US EPA, NRMRL

8:30AM	EPA's Role in Future Research *Lee Mulkey, US EPA, NRMRL*
8:50AM	Mid-Atlantic Integrated Assessment (MAIA) *Stan Laskowski, US EPA, Region III*
9:10AM	Linkages Between Ecological Restoration & Ecological Risk Assessment *Glenn Suter, US EPA, NCEA*
9:30AM	Ecosystem Restoration: Developing Paradigms & Definitions *Eric Jorgensen, US EPA, NRMRL*
9:50AM	Break
10:10AM	National Ecosystem Restoration Programs *George Gann, Society for Ecological Restoration & Institute for Regional Conservation*
10:30AM	Sustaining the Health of the Salton Sea Ecosystem: A Challenge for Restoration Ecology *Milt Friend, USGS*
10:50AM	Questions and Answers

Session II - Management Issues/Case Studies

Moderator - Tim Canfield, US EPA, NRMRL

11:10AM	Strategy for Watershed Rehabilitation: Arkansas Remediation Example *Kent Thornton, FTN Associates*
11:30AM	Politics of Ecosystem Restoration - Great Lakes Basin *Jeff Farrah, Wayne State University*
11:50AM	Chesapeake Bay Habitat Restoration Framework: An Experiment Revisited *Steve Funderburk, US FWS*
12:10PM	Lunch
1:30PM	Overview of NRMRL's Ecosystem Restoration and Risk Management Research Program *Tim Canfield, US EPA, NRMRL*
1:50PM	Loads, Concentrations, & Critters: Challenges for Ecosystem Restoration *R. Peter Richards, Heidelberg College*
2:10PM	Geographic Information System (GIS) for Community-Based Environmental Protection *Sudhir Kshirsagar, Global Quality Corp. & Paul Koch, Pacific Environmental Services*
2:30PM	A Screening for Mercury Exposures in South Florida: Multistressor Dynamics and Ecosystem Restoration *Rochelle Araujo, US EPA, Ecosystems Research Division*
2:50PM	Questions & Answers
3:05PM	Break

Session III - Mid-Atlantic Integrated Assessment (MAIA)

Moderator - Tom DeMoss, US EPA, Region III

3:20PM	Panel Discussion - Ecosystem Restoration Management & Technical Issues *Tom DeMoss, Rick Kutz, & Ron Landy, US EPA, Region III & Kent Thornton, FTN Associates*
4:20PM	Questions & Answers
4:40PM	Reception (Cash Bar)

Day 2 - July 30 - 8:30AM

Session IV - Wetlands & Shallow Waters

Moderator - Dan Heggem, US EPA, ~~NRMRL~~ NERL

8:30AM	Everglades Ecosystem Assessment: Monitoring for Adaptive Management *Jerry Stober, US EPA, Region IV*
8:50AM	Restoration of the Northern Florida Everglades *Stephen M. Smith, South Florida Water Management District*
9:10AM	Creation & Restoration of Salt Marsh & Colonial Waterbird Nesting Habitat in MD's Coastal Bays *Christopher Spaur, US ACE*
9:30AM	Hole-In-the-Donut Wetlands Restoration & Mitigation, Everglades National Park *Michael Norland, South Florida Natural Resources Center*
9:50AM	Wetland Creation through Mining in Wyoming: What Works and What Doesn't *Mark McKinstry, University of Wyoming*
10:10AM	Break
10:30AM	Landscape Ecology Analysis of Forested Wetland Restoration Sites, Tensas River Basin *Daniel Heggem, US EPA, NERL*
10:50AM	Habitat Restoration Diversity & Partnerships - US FWS PF&W Program *Albert Rizzo, US FWS*
11:10AM	Ecosystem Restoration of Disney Wilderness Preserve *Michael Duever, Disney Wilderness Preserve/The Nature Conservancy*
11:30AM	Restoration of Submerged Aquatic Vegetation *Dave Goshorn, MD DNR*
11:50AM	Lunch
1:20PM	Riparian Forest Restoration from the Urban, Agricultural, & Forested Watershed Perspectives *Rob Northrop, Dan Hedderick, Bernadette Turner & Wayne Merkel, MD DNR, Forest Service*
1:50PM	Questions and Answers
2:10PM	Field Trip to Little Gunpowder Watershed ***This field trip will visit a cattle operation and will discuss how and why MD DNR identified this water system, how they developed a local partnership with the community, and how they decided to implement restoration activities.***

Session V - Rivers, Streams, & Riparian Areas

Moderator - Joan Colson, US EPA, NRMRL

2:10PM	Geohydrologic Foundations for Ecosystem Restoration *Mohamed Hantush, US EPA*
2:30PM	How Much Water Does a River Need? *Brian Richter, The Nature Conservancy*
2:50PM	Southwestern Riparian Sustainability & Restoration in a Man-made Ecosystem *Nita Tallent-Halsell, US EPA, NERL*
3:10PM	Break

3:30PM Preliminary Downstream Hydraulic Geometry Relationships for Hydrophysiographic Provinces in MD
Tamara McCandless & Richard Everett, US FWS

3:50PM US EPA Large River Ecosystem Criteria Initiative
Susan Davies, US EPA, OW

4:10PM Anadromous Fish Restoration
Scott Carney, PA Fish & Boat Commission

4:30PM Questions & Answers

4:50PM Reception (Cash Bar)

Day 3 - July 31 - 8:30AM

Session VI - Terrestrial/Uplands

Moderator - Eric Jorgensen, US EPA, NRMRL

8:30AM Forest Fragmentation in the Chesapeake Bay Watershed
Rick Cooksey, USDA

8:50AM Maintenance & Restoration of Northern Spotted Owl Habitat, Pacific NW
James Thrailkill, Oregon Cooperative Wildlife Research Unit

9:10AM NJ's Ecosystem Approach to the Conservation of Biodiversity
Larry Niles, NJ Fish, Game & Wildlife

9:30AM Break

9:50AM Managing Restoration Projects for Functional & Structural Objectives
John Heckman, Roy F. Weston

10:10AM Disease, Insects, & "Exotic" Ecosystems: Implications for Restoration Goals
William Otrosina, USDA

10:30AM 20yr. Woody Vegetation Changes in NE Illinois Upland Forest Ecosystems
Marlin Bowles, Morton Arboretum

10:50AM Sawmill Creek Watershed Restoration Project
Larry Lubbers, MD DNR

11:20AM Questions & Answers

11:40AM Lunch

12:40PM Field Trip to Sawmill Creek Watershed

This trip will examine an integrated set of Best Management Practices designed to address the cumulative impacts of urban and industrial land use on water quality, stream flow, and habitat in the riparian corridor. The tour will include: deicer management facilities, an automated water chemistry monitoring station, stormwater management retrofits and wetlands creations, bioengineered stream channel stabilization, and several types of fish passage projects.

EPA's Role in Future Research

Lee A. Mulkey
Associate Director for Ecology
National Risk Management Research Laboratory
U.S. EPA
Cincinnati, OH

The U.S. EPA's Office of Research and Development has recently completed a 10-year research strategy for a national research program to support EPA's mission to protect and restore ecosystems. Strategic choices identified in the strategy include: 1) an emphasis on aquatic endpoints; 2) a multimedia perspective; 3) an emphasis on watersheds within a regional and large-scale systems context; and 4) using ecological risk assessment and risk management as an organizing principle. ORD's research resources are being deployed to address four broad science questions: 1) what is the current condition of the environment, and what stressors are most closely associated with that condition; 2) what are the biological, chemical, and physical processes affecting the condition of ecosystems and their response to stressors; 3) what is the relative risk posed to ecosystems by these stressors, alone and in combination, now and in the future; and 4) what options are available to manage the risk to and restore degraded ecosystems? Ecosystem restoration as a component of ORD's research portfolio is relatively new but builds on a longer term investment in watershed management research. This Symposium is one of the several ways that we are using to ensure a strong scientific and programmatic foundation for our watershed restoration research.

Professional Biography, Lee Mulkey

Mr. Mulkey's role at the EPA's National Risk Management Research Laboratory is to develop and provide science policy guidance for EPA's research on protecting ecosystems. His professional experience includes watershed management research such as modeling, best management practice development and testing, and risk assessments. Mr. Mulkey holds a B.S.A.E. and an M.S.A.E.

Mid-Atlantic Integrated Assessment

Stanley L. Laskowski
Director, Environmental Services Division
U.S. EPA Region III
Philadelphia, PA

Since the early 1990s, the U.S. Environmental Protection Agency's (EPA) Office of Research and Development, EPA's Region III, and other federal and state Agencies have been working together to integrate numerous data bases and to characterize the environmental conditions of the Mid-Atlantic region.

To date, several reports have been published and many more are expected during the next several years.

This Mid-Atlantic Integrated Assessment (MAIA) program has utilized traditional pollutant data (e.g., water/air quality chemical data) together with resource, biological, and landscape data to define the environment. Probabilistic and other designs were used to ensure scientifically valid environmental characterizations. The MAIA Reports are precedent setting with respect to the variety of information that is integrated. However, to be most meaningful for environmental protection, EPA has taken a number of steps to ensure that the MAIA project serves as a basis to inform environmental decision-makers. Customer surveys will be included in all future reports. Feedback from these surveys will indicate the usefulness of these reports and serve as a basis to guide subsequent reports. MAIA Reports will be broadly disseminated both in hard copy and on the Internet. The MAIA Reports will serve as a basis for restoration projects in the Mid-Atlantic States. Already several restoration projects have been started.

Future plans for building on the success of the MAIA program also include further integration of the data bases, training users to access and understand to various data bases and reports, examining the current monitoring systems in the Mid-Atlantic States to see if they could be better integrated to provide information to decision-makers, promoting additional restoration projects, assessing how information can be made available for smaller geographic areas, and refining customer feedback techniques to ensure that MAIA products are most helpful to the users.

Professional Biography, Stanley Laskowski

EPA Region III Environmental Services Division (ESD) Director since 1997, Mr. Laskowski builds partnerships with the public, businesses, academia, and other stakeholders to find creative solutions to today's complex environmental problems. Mr. Laskowski also manages Region III's labs, oversees field activities, and implements the National Environmental Policy Act, coastal, estuaries, and wetlands programs.

From 1982 to 1997, Mr. Laskowski was Region III's Deputy Regional Administrator, when he and the Regional Administrator managed a staff of almost 900 engineers, scientists, and support personnel. He was responsible for overseeing all EPA federal environmental programs in the Middle Atlantic States. He was also responsible for overseeing Region III's compliance and enforcement programs and establishing overall enforcement directions. During that time he founded EPA Region III's Business Assistance Center, the Center for Environmental Learning and the International Program (now providing assistance to 14 countries on 5 continents).

In the early 1990's, Mr. Laskowski was on a one-year detail to EPA Headquarters as the Director of the Office of Pollution Prevention and was responsible for developing EPA's policies on strategic planning, pollution prevention, and environmental indicators. During that time he oversaw the development of EPA's first Agency-wide Strategic Plan and the design of numerous pollution prevention strategies.

Mr. Laskowski has been with the U.S. Environmental Protection Agency since 1972, and has initiated and developed many major programs. From 1968-72 he directed hydrologic field studies for the U.S. Geological Survey. Mr. Laskowski earned a B.S. in Civil Engineering (1968) and an M.B.A. (1973) from Drexel University.

Linkages Between Ecological Restoration and Ecological Risk Assessment

Glenn W. Suter II
National Center for Environmental Assessment
U.S. EPA
Cincinnati, OH

Ecological Risk Assessment has largely supplanted other approaches to assessing effects of human actions on the nonhuman environment because of certain inherently desirable properties of risk assessment. These include: 1) a standard logical structure, 2) clearly defined endpoints, 3) explicit conceptual models, 4) rigorous quantitative techniques, 5) explicit treatment of uncertainty, and 6) discrimination of technical decisions from policy decisions in the assessment process. Restoration projects can be analyzed in a risk assessment context. That is, one may assess the risks to a set of clearly defined properties (endpoints) of restoration alternatives, based on a clear description of the relationship between the environmental alterations and the endpoints (a conceptual model). The process would use the best models available of the relationship between environmental properties and endpoint properties, and would incorporate uncertainties. Much of the controversy concerning whether proposed restoration techniques are appropriate and whether restoration projects were successful could be alleviated by a risk-based approach. For example, there might be less disagreement about whether a wetland has been restored if individuals who are responsible to the public decided *a priori* what properties and what levels of those properties constitute the endpoints for the project. Similarly, the analysis of uncertainty would allow for events such as floods that could lead to failures of well planned and executed restoration projects.

The need for integration of risk assessment and restoration is particularly acute when the damage that prompts the restoration is due to site remediation to reduce risks from contaminants. Remediation of contaminated sites may destroy ecosystems by removing soil or sediment and by creating borrow pits, landfills, and other facilities. Assessments of risks from contamination seldom balance the risks from the contaminants against the risks from the remediation and almost never consider the risks that proposed restoration will not reestablish valued ecological properties. If the remediation is justified, the expected state of the environment following remediation and restoration should be significantly improved. Only an integrated assessment approach can assure the likelihood of that outcome.

Professional Biography, Glenn Suter II

Dr. Suter holds the position of Science Advisor in the U.S. EPA's Center for Environmental Assessment-Cincinnati, and was formerly a Senior Research Staff Member in the Environmental Sciences Division, Oak Ridge National Laboratory. He has a Ph.D. in Ecology from the University of California, Davis, and 23 years of professional experience including 18 years of experience in ecological risk assessment. He is the editor and principal author of the major text in the field of ecological risk assessment, and has edited another book and authored more than 70 open literature publications. He has served on task forces, boards, and expert panels. His research experience includes development and application of methods for ecological risk assessment, soil microcosm tests, aquatic toxicity tests, and environmental monitoring.

Ecosystem Restoration: Developing Paradigms and Definitions

Eric E. Jorgensen
National Risk Management Research Laboratory
U.S. EPA
Ada, OK

Restoration is a comparatively new term that includes some activities that have been practiced for decades. Types of activities/terms include re-forestation, reclamation, clean-up, etc. As restoration becomes the term of choice – encompassing these previous activities as well as new practices with other desired outcomes (e.g., ecosystem services including but not limited to provision of wildlife habitat, carbon sequestration, nutrient utilization, and contaminant attenuation) – significant uncertainty has developed on the part of scientists and citizens whose activities bring them to the periphery of the ecosystem restoration movement. In part, this uncertainty is caused by the wide array of activities presented as "restoration." In particular, there is a risk that restoration will be seen as that subset of activities including neighborhood clean-ups and Arbor Day celebrations. Valuable as these activities are – they alone do not constitute restoration. Restoration is in a period of transition. More frequently, questions are being asked. Why are we doing this? How will we know if and/or when we have succeeded? These questions are especially relevant in ecosystem restoration.

Why are we doing this? This question bears upon the important problem of restoration prioritization. Many active practitioners in the restoration field recognize the need for improved tools to identify and prioritize sites for restoration. Prioritization is needed to help determine which sites, when restored, will produce the greatest or most desired benefit relative to ecosystem services – both in terms of magnitude of effect (e.g., level of water quality improvement) and diversity (i.e., number of services benefitted).

How will we know if and/or when we have succeeded? Increasingly, the question of success criteria is being raised. This question is particularly relevant in ecosystem restoration where any good scientist, having measured enough variables, can claim success for at least one. Claims of ecosystem restoration must be viewed in light of the number and types of variables measured. Improvement in a single variable does not constitute ecosystem restoration.

Professional Biography, Eric Jorgensen

Dr. Jorgensen is an ecologist for the U.S. EPA's National Risk Management Research Laboratory in Ada, Oklahoma. He completed his Ph.D. in 1996 at Texas Tech University, his M.S. in 1992 from the University of Wisconsin-Stevens Point, and his B.S. in 1984 from the University of Wisconsin-Madison. He has worked with and published papers about mammal, reptile, and bird habitat management in temperate and desert ecosystems. His current interests include ecological risks and restoration technologies associated with anthropogenic nitrogen; the function of riparian buffers as tools for ecosystem restoration; and consumer/seed interactions. Dr. Jorgensen hopes that his paper at this symposium will help participants recognize important distinctions concerning restoration and ecological terminology than can seriously inhibit communication – especially across disciplines.

This is even more the case where the impacts of the improvement of the single variable on other constituents in the ecosystem are not even measured.

Restoration has reached a point where prior measures of risk and success are insufficient. Compliance status, trees planted, nutrients attenuated, dollars spent, and tons of garbage removed tell us little about restored ecosystem function. These are valuable activities. However, risk management based restoration requires utilization of fundamentally different types of data and recognition of ecologically relevant measures of success.

Notice: This abstract does not necessarily reflect EPA policy.

National Ecosystem Restoration Programs

George D. Gann
Society for Ecological Restoration *and*
Institute for Regional Conservation
Miami, FL

The Society for Ecological Restoration (SER) is an international society of restoration practitioners and researchers comprising some 2,500 members from 25 countries and all 50 of the United States. SER was founded in 1988 with the goal of advancing the science and art of restoring damaged ecosystems. SER believes that active restoration of damaged ecosystems, in combination with the preservation and management of key natural areas, will be a vital component of strategies to maintain biological diversity and function in the coming century.

As the organization that brings together and synthesizes the restoration field in the United States and abroad, SER is concerned with a number of issues which pertain to the goals of this symposium. First, in order to understand restoration, it is important to understand who and what comprises the restoration field. The restoration field is unique in the breadth of people and organizations who are involved with some aspect of restoration. From agency personnel to academic researchers, to volunteers working for the National Park Service or a local community restoration organization, the field of restoration incorporates a remarkably wide spectrum of individuals, organizations, experiences, and goals. Second, it is important to distinguish between restoration ecology – that is, the scientific study of restoration – and the practice of ecological restoration. Furthermore, it is important to understand the relationship between the two,

Professional Biography, George Gann

George D. Gann holds a B.A. in Environmental Studies and International Affairs from the University of Colorado. In 1986, Mr. Gann formed Ecohorizons, Inc., a design-build firm which specialized in ecological restoration and natural areas management. Mr. Gann was responsible for the design and/or implementation of over 200 inventory, revegetation, mitigation, restoration, and natural areas management projects. In 1994, Mr. Gann formed the Institute for Regional Conservation, a non-profit research organization currently conducting a floristic inventory of southern Florida . Mr. Gann recently completed a 10-year term on the Board of Directors of the Florida Native Plant Society. He currently serves as Chair of the Board of the Society for Ecological Restoration, of which he has been a member since 1989.

specifically how restoration ecology informs the practice of restoration, and correspondingly how restoration practice provides useful insights to science.

Third, restoration is a global enterprise with a global impact, and SER has committed itself to promoting restoration worldwide. This includes the publication of international papers in our journals, and to the development of international symposia on topics such as tropical forest restoration and cross-borders cooperation at our annual conferences. Outside of the U.S., restoration often has a different flavor. While the regulatory process and the conservation of biodiversity *per se* has been a major initiator of restoration projects in the U.S., other motivating factors, such as the need for timber or arable land, often drive restoration practice and research in other countries. Restoration in this context addresses both ecological and economic sustainability; indeed, without both, restoration projects will likely fail.

Finally, restoration is as much about culture as it is about nature. Restoration has the unique capacity to heal not only the environment, but also the people and communities who are doing the healing.

Sustaining Health of the Salton Sea Ecosystem: A Challenge for Restoration Ecology

Milton Friend
Executive Director, Salton Sea Science Subcommittee
U.S. Geological Survey

This presentation highlights the historical perspective regarding the origin of the Salton Sea, the highlights of current environmental conditions at the Sea, the values (objectives) to be addressed in pursuing the goal of restoration of the Sea, and processes initiated to provide objective scientific evaluation for guiding management decisions to achieve the project goal. The Salton Sea is the largest inland body of water in California. It is approximately 35 miles in length and varies in width from 9 to 15 miles. The Sea is approximately 35 miles north of Mexico and 30 miles south of the city of Palm Springs. It lies in a climactic zone of hot desert where summer temperatures reach 120 degrees F. The surface elevation of the Sea is -227 feet below sea level.

Waters flowing into the Sea are primarily Colorado River irrigation drain water from the surrounding areas; there is no outflow. Evaporation of about 5.5 feet per year and rainfall of less than 3 inches per year contribute to the continually increasing salinity of the Sea, which is now 26 percent greater than ocean water.

Collapse of the sport fishery and the food base for the large numbers of fish-eating birds that use the sea is assured unless salinity can be brought under control. However, salinity is only one of several problems that must be addressed. Since 1994, recurring large-scale mortality at the Sea of migratory birds has raised concern among the wildlife conservation community about the declining environmental quality of the Sea. These and other problems have recently resulted in a partnership being formed among the federal, state, tribal and local authority stakeholders to enhance the environmental quality of the Sea.

A National Environmental Policy Act (NEPA)/California Environmental Quality Act (CEQA) process has been initiated to select a course for action. The Department of the

Interior and Salton Sea Authority are the lead management agencies for these processes and are served by an autonomous interagency Salton Sea Science Subcommittee. The role of the Subcommittee is to provide high quality information to guide the lead agencies in considering various management actions, but does not include proposing solutions for restoration of the Sea.

The Subcommittee also provides objective scientific evaluations relative to impacts (positive and negative) on project objectives that are likely to result from specific management actions being considered. A challenge associated with this task is to provide quality evaluations without advocating or opposing the management actions being considered.

Professional Biography, Milton Friend

Mr. Friend is employed by the Biological Resources Division of the U.S. Geological Survey. For 23 years, prior to his current assignment, he served as Director of the National Wildlife Health Center within the U.S. Fish and Wildlife Service, which was transferred to the National Biological Service with the science reorganization within the Department of Interior. Recently, Secretary Babbitt appointed him to serve as Executive Director of the Salton Sea Science Committee, a multi-agency subcommittee charged with scientific evaluations for selection of a course of action for restoration of the Salton Sea. He received his undergraduate education from the University of Maine (Wildlife Conservation) and graduate degrees from the University of Massachusetts (Wildlife Management) and University of Wisconsin - Madison (Veterinary Science and Wildlife Ecology).

A Strategy for Watershed Rehabilitation: The Arkansas Remediation Example

Kent W. Thornton[1] and Jarvis Harper[2]
[1]FTN Associates and [2]ALCOA Arkansas Remediation
Little Rock, AR

After nearly 100 years of mining ceased in 1990, approximately 9,000 acres in south-central Arkansas required reclamation. An interdisciplinary ecosystem reclamation team was formed, including former miners, earthmoving contractors, civil and agricultural engineers, agronomists, hydrogeologists, terrestrial, wetland and aquatic ecologists. An holistic, systems approach was used to address watershed rehabilitation/ecosystem reclamation. This team initiated a three phased process for ecosystem reclamation: Phase I - Problem Formulation and Focusing; Phase II - Strategic Plan Implementation; and Phase III - Beyond Reclamation. The Problem Formulation Phase included characterizing the entire 9,000 acres: existing slopes and terrain, underground mine and surface pit characteristics and water quality, runoff water quality, soil physicochemical characteristics; vegetation types; and natural/managed resources in disturbed areas, naturally reclaimed areas, reclaimed spoil areas, and existing spoil areas. The public, including federal, state, local agencies, civic organizations, and private entities (e.g., real estate developers), were involved through focus groups to identify potential uses for the property following or in lieu of reclamation. Reclamation objectives and criteria were established and prioritized. The final stages of Phase I included the development of the strategic plan for an initial watershed rehabilitation of about 1,000 acres. This included the development of a Remediation Decision-Making Tool for evaluating and assessing the feasibility of various land use alternatives, development of digital terrain models to formulate grading plans, experimentation on growing media, soil amendments, and fertilization formulations and rates, electrochemical neutralization, and reuse/recycling feasibility studies. These studies also considered not only applicable regulations, but also proposed innovative regulatory strategies.

The Strategic Plan Implementation Phase is ongoing. Ecological experimentation is integrated with traditional construction activities to continuously evaluate better alternatives for reclamation. Partnership agreements have been developed with The Nature Conservancy and negotiations are proceeding with state agencies to reclaim and manage the area so it will sustain several unique glade ecosystems that exist on the property, permit the development of a Nature and Education Center, and provide outdoor recreation and aesthetic benefits.

Beyond Reclamation will begin in 2005. This phase will emphasize management of reclaimed areas and provide insight into the types of management activities needed to sustain large scale reclamation efforts. The lessons learned over the past seven years and the critical elements in each of the phases will be explained and illustrated in greater detail during the presentation.

Professional Biography, Kent W. Thornton

Dr. Kent W. Thornton is a principal and systems ecologist with FTN Associates, Ltd. in Little Rock, AR. Dr. Thornton has been involved with ecosystem restoration of lakes, streams, wetlands, and watersheds since 1972. He was an editor and author of the 1988 EPA Lake and Reservoir Restoration Guidance Manual, contributor to the Mid-Atlantic Ecosystem Restoration Strategic Initiative, Wetland Restoration Strategic Plan, South Florida Everglades Ecosystem Restoration Assessment, and has been working on watershed reclamation for over 10 years. He is currently involved with restoration and reclamation projects that range in scale from local sites to geographic regions.

Politics of Ecosystem Restoration

Jeff Farrah
Wayne State University
Detroit, MI

This study examines the political challenges and barriers to ecosystem restoration in the Great Lakes region, with special references to the Southeastern Michigan context. After 25 years of local, regional, statewide/provincial, federal, and bi-national efforts geared toward "restoring and maintaining the biological, chemical, and physical integrity" of Great Lakes waterways, many initiatives have been brought forth under the guise of restoring the Great Lakes ecosystem. As a whole, these efforts may provide a potential model for the equitable restoration of large ecosystems. Institutional mechanisms for carrying out ecosystem management and restoration efforts at the watershed level have been in place in 43 Areas of Concern through the Remedial Action Plan (RAP) process. The establishment of local watershed organizations through the RAP process is one step towards meaningfully moving toward ecosystem restoration.

This study examines significant trends toward ecosystem restoration in the Great Lakes Basin, with a special reference to the RAP process in urban watersheds, the potentials and pitfalls of achieving water quality and approaching ecosystem restoration in large, bi-national regions. Personal interviews, case studies, and trends and patterns of economic development in the Great Lakes basin provide the empirical foundation for the study. The RAP process basin-wide represents a significant achievement in the urban contexts of the Great Lakes region. At the same time, the RAPs are an ongoing and active model for the potentials of sustainable development and watershed restoration in the modern period. Finally, RAPs represent a great challenge to traditional political, economic, and social arrangements. A "successful" RAP process involves participation among important "stakeholders" within the basin itself, from fishing, manufacturing, commercial, or energy interests, to scientists, administrators, politicians, citizens, educators, Native American Nations, or environmentalists. The nexus however between translating ecosystem principles into public policy outputs is meaningful participation. To restore ecosystems then, institutional outlets of meaningful participation must not only exist, they must be self-reinforcing and empowering to a large diversity of interests. On the basis of the author's ongoing empirical study of the RAP process in southeastern Michigan urban watersheds and the Great Lakes basin, two important determinants of potentially restoring ecosystems are bringing in multi-sectorial participants on meaningful terms, and establishing what "success" really is in local, bioregional, and international contexts. Ultimately, dialogue must move beyond short-term, narrow costs and concerns and toward a deeper, more long-term set of perspectives and timelines for restoring healthy environments.

Professional Biography, Jeff Farrah

Currently an adjunct faculty in the department of political science at Wayne State University (Detroit) and the University of Michigan (Dearborn). He also works with the political science department and the Wayne County Regional Education Service Association (RESA) training public school teachers how to teach civic literacy skills in the classroom. He holds an M.A. in Political Science from Wayne State University and is currently A.B.D. (all but dissertation) in Political Science. His Ph.D. research involves examining trends toward ecosystem politics in the Great Lakes basin.

Chesapeake Bay Habitat Restoration Framework: an Experiment Revisited

Steve Funderburk
Chief, Living Resources Branch
U.S. Fish and Wildlife Service
Annapolis, MD

A variety of habitat types continue to be lost and degraded within the Chesapeake Bay's 64,000 square-mile watershed. Recent information shows that 14,000 acres of palustrine forested wetlands were destroyed between 1982 and 1989. Nearly 1,000 acres of emergent wetlands were lost during that same period. Submerged aquatic vegetation, considered an essential food source and habitat element within the nearshore environment, slowly has increased from record lows in the mid-1980s, yet remains ~10 percent of estimated abundance several decades ago. Forest cover continues to remain a dominant vegetative type (58 percent), yet declined by over 471,000 acres from 1985 to 1995. Although hundreds of miles of freshwater spawning habitat have been reopened to anadromous fish due to passage created at dams, culverts, and other forms of impediments, thousands of miles of suitable habitat remain blocked. Reliable numbers are unavailable on the extent of degraded riparian habitat, but conservatively range in the multiple thousands of miles.

The Chesapeake Bay Program, a longstanding federal, state and local government coalition, has recognized the importance of habitat protection and restoration on a watershed scale via the 1987 Chesapeake Bay Agreement. Following, the Program published *"Habitat Requirements for Chesapeake Bay Living Resources"* (Funderburk *et al.* 1991) to guide protection and restoration efforts. Associated reports designed to further refine understanding of habitat and water quality dynamics were borne out of this initial effort. These reports serve as useful guides to protection and restoration of ambient water quality conditions for biota, for guiding transplanting activities of SAV, and in characterizing the relative health of aquatic habitats.

In 1994 the Program committed to developing a comprehensive means to restore site-specific habitat across the watershed (Chesapeake Executive Council 1994), and soon thereafter published *Chesapeake Bay Habitat Restoration: A Framework for Action* (Chesapeake Bay Program 1995). The framework has enabled funding support for over 50 separate projects within Pennsylvania, Maryland, the District of Columbia, and

Professional Biography, Steve Funderburk

Steve Funderburk is Chief of the Living Resources Branch with the Chesapeake Bay Field Office, U.S. Fish & Wildlife Service, having been involved in the Chesapeake Bay Program for over 13 years. He has served as Chair of the Bay Program's Habitat Objectives and Restoration Workgroup since 1988, and maintains local oversight responsibility of the Service's Partners for Fish & Wildlife Program, and Coastal Program.

Mr. Funderburk's previous work experience includes serving as a Congressional Fellow for U.S. Senator Paul Sarbanes, senior staff for the Fish & Wildlife Service in Washington D.C., and biologist for the U.S. Army Corps of Engineers in St. Paul, Minnesota, and the Louisiana Department of Wildlife and Fisheries.

Steve received his M.S. from Humboldt State University and B.S. from Louisiana Tech University.

Virginia. The framework also has stimulated development of a means to target restoration projects (GIS and charette) within an ecological context, while calling for building extensive and diverse partnerships to promote creative restoration projects.

This presentation highlights lessons learned from this broad-scale approach to protecting and restoring habitats within the Chesapeake Bay watershed.

Overview of NRMRL's Ecosystem Restoration and Risk Management Research Program

Timothy J. Canfield
National Risk Management Research Laboratory
R.S. Kerr Environmental Research Center
U.S. EPA
Ada, OK

The National Risk Management Research Laboratory (NRMRL) has instituted a program for Risk Management Research for Ecosystem Restoration in Watersheds. This program is one component of the Office of Research and Development Ecosystem Protection Research Program. The outline for this research is contained in the Risk Management Plan for Ecosystem Restoration in Watersheds (EPA/600/R-97/078) and follows the risk paradigm described in the ORD Research Strategy (U.S. EPA 1996). This plan describes the scope of NRMRL's ecosystem restoration risk management research in watersheds and is intended to produce technically sound restoration and decision support tools for local communities and stakeholders. The goals of this program are in line with both the performance measures of the Government Performance Results Act of 1993 (GPRA) as well as the objectives outlined in the ORD strategic plan. This program is designed to facilitate research that moves past traditional chemical specific criteria by focusing on additional stressors at the landscape level. Although water quality is typically focused on as the measure of success for the restoration activities, this plan considers water quality as only one component of success. Indicators in landscape cover and wildlife

Professional Biography, Timothy Canfield

An ecologist at the Robert S. Kerr Environmental Research Center, Ada, OK, Mr. Canfield holds an M.S. from the University of Missouri-Columbia. He has conducted research for the last 12 years for the U.S. Fish and Wildlife Service, the National Biological Service, and the U.S. Geological Survey. He has conducted research, published papers, and made many presentations on algal and zooplankton communities, benthic macroinvertebrate communities and contaminated sediments. His current responsibilities include developing the Ecosystem Restoration Research in Watersheds Program for the National Risk Management Research Laboratory of EPA while also conducting Ecosystem Restoration Research projects.

usage as well as water quality still form the basis for the success criteria. This program is designed to conduct research in an integrated fashion, by looking at the problems from a watershed perspective and researching solutions in such a way as to integrate effects from top to bottom in a watershed. An overview of NRMRL's program will be presented, giving more detailed information with regard to the goals of the program, number and types of projects currently funded, status of projects, and future plans and directions for this program.

Loads, Concentrations, and Critters: Challenges for Ecosystem Restoration

R. Peter Richards
Water Quality Lab
Heidelberg College
Tiffin, OH

Effective ecosystem restoration can only occur when the impacts that have caused ecosystem degradation are thoroughly understood. The required understanding goes far beyond knowing the pollutants of concern, though even identifying the most important pollutants can be a daunting challenge.

Understanding the temporal aspects of a pollutant's presence in the environment is critical. An average concentration or an average load tells us little about potential ecological effects, since it may represent an impact that is constant over time, one that ranges seasonally between no-effect and chronic-effect levels, or one that exceeds acute levels for short periods of time. For pollutants that impact components of the ecosystem by interfering with energy flow (e.g., effects of some herbicides on aquatic plants), ecosystem impacts are controlled by the pattern of pulses of critical exposures followed by periods of recovery.

Temporal patterns of loadings are different from those of concentrations for a given pollutant, and have different implications for organisms in rivers and in lakes. For particulate pollutants of nonpoint origin, 80 percent or more of the loading occurs in 10 percent of the time in many rivers and streams, whereas the temporal distribution of the concentrations is less extreme. Organisms in rivers and streams are probably more affected in many cases by the concentrations that occur during the 40 percent of the time when concentrations are between the median and the 90th percentile than they are by the higher concentrations present during the 10 percent of the time with the highest loading rates. Organisms in lakes, however, are more affected by the total pollutant loading. This is true even when the direct ecological effect is concentration-related, because it is the total loadings combined with the volume and residence time of the lake that determines the in-lake concentrations, outside of the mixing zones. Nonpoint sources dominate loads in many watersheds, but point sources may still dominate ambient water quality conditions, which may be more important to the stream biota.

Scale effects also have important implications. Systematic changes in ecosystem structure occur as a function of position in the watershed. These are accompanied by systematic changes in hydrology and pollutant chemistry, particularly higher peak concentrations more rapid flow and concentration fluctuations, and lower low concentrations in small watersheds compared with larger ones.

Finally, setting restoration goals requires recognition of the possible existence of ecological threshold effects. For example, a bay ecosystem degraded by elevated sediment concentrations experiences structural changes that tend to perpetuate the altered state (e.g., loss of macrophytes, dominance of bottom-feeding fish such as carp). Simply returning sediment concentrations to pre-degradation levels may not be sufficient to bring the ecosystem back to its original state.

Professional Biography, R. Peter Richards

Dr. Richards holds undergraduate degrees in German and Geology from Oberlin College. He earned an M.S. in Crystallography and a Ph.D. in Paleoecology from the University of Chicago. After becoming frustrated with studying critters that have been dead for 400 million years, he took a post-doc at the University of Michigan in ecology and limnology. For the last 20 years, he has been a water quality hydrologist at the Water Quality Lab at Heidelberg College, specializing in the transport of pollutants in tributaries of the Great Lakes, and in techniques for the determination of pollutant loads. He has authored several dozen papers related to this work, and has developed a computer program which is becoming widely used for load calculations.

Geographic Information System (GIS) for Community-Based Environmental Protection

Sudhir Kshirsagar
President
Global Quality Corp.
Cincinnati, OH
Paul Koch, Pacific Environmental Services, Inc.
Mason, OH

The U.S. Environmental Protection Agency (EPA) has shifted the focus of many of its ecosystem protection programs from the command-and-control approach to the Community-Based Environmental Protection (CBEP) approach. In contrast to the regulatory approach, the CBEP approach emphasizes decision-making by local stakeholders to address community-wide environmental issues. As the CBEP approach to ecosystem protection and restoration becomes more widespread, effective implementation tools that meet the needs of a wide spectrum of communities will become necessary.

A geographic information system (GIS) is computer software that allows the user to identify the spatial relationships between map features, to utilize the computerized representation of these map features to provide the input data to a wide range of environmental models, to serve as the receptor for the output of these models and analytical tools, and to display impacts and results of development/management scenarios in both a graphical and tabular fashion. Researchers, governmental agencies and large communities have utilized GIS as a key tool in many ecosystem restoration projects. However, certain factors inhibit the deployment of GIS in smaller communities. This paper presents some of the key factors, and suggests alternatives for overcoming those obstacles.

One of the major problems in implementing a GIS is the significant cost of data acquisition, and the associated long time delays. It is recommended that the top-down approach to data collection (what type of data do we need and where is it available) should be favored over the bottom-up approach (if we get the best data, then we will have what we need) that is commonly used. Another major issue often faced is the lack of skilled human resources to manage and use the GIS technology. It is suggested that there are various ways of tackling that including the decision to "start small with in-place talent."

Professional Biography, Sudhir Kshirsagar

Dr. Kshirsagar is the President of Global Quality Corp., a company whose mission is to provide quality services and products globally to meet customer needs. He has over 12 years of professional experience in the fields of information systems, computer graphics, and environmental engineering. He has managed and directed several key projects in his career, and he is specially trained in project management methodologies for information systems development and support. His recent efforts include the design and implementation of several GIS-based projects, including systems for the Wright-Patterson Air Force Base and the U.S. EPA and the Ohio River Valley Water Sanitation Commission (ORSANCO).

He holds a B.S. in Electrical Engineering from the Indian Institute of Technology, an M.S. from the Indian Institute of Science, and a Ph.D. in Environmental Engineering from the University of Illinois, Urbana. He is a licensed Professional Engineer.

A Screening Model for Mercury Exposures in South Florida: Multistressor Dynamics and Ecosystem Restoration

Rochelle Araujo and R.B. Ambrose
U.S. EPA
Athens, GA

The South Florida ecoregion is simultaneously a unique resource and one of the most intensively managed ecosystems in the U.S. Alterations in the hydrology of South Florida have halved the original extent of the Everglades and have resulted in nutrient enrichment, habitat fragmentation, contamination, introduction of invasive non-native plants and animals, and altered fire regimes. Populations of wading birds have decreased by almost 95 percent and mercury contamination of fish and wildlife is widespread. A screening model was developed to assess the relative importance of external and internal sources of mercury and as a framework for investigating transport and transformation dynamics that contribute to mercury exposures. The WASP model was modified to represent the hydrology and vegetation patterns characteristic of the region. Using process rate constants from the literature and field studies, a model calibration was based on a partial data set from the Regional Environmental Monitoring and Assessment Program (REMAP) of EPA Region IV. The model accurately predicted concentration ranges and dynamics of mercury species for average marsh conditions, and was found to be sensitive to rainfall, mercury partitioning, and interactions with vegetation, including periphyton. The model was subsequently used to assess mercury exposures resulting from management actions, including source reductions and the hydrologic alternatives under consideration as the basis of ecosystem restoration.

Professional Biography, Rochelle Araujo

Dr. Araujo received a bachelor's degree in genetics from Cornell University where she subsequently worked as a laboratory technician on studies of nutritional and reproductive toxicology in minks. She temporarily returned to her sea-faring roots, pursuing a master's degree in marine sciences at the State University of New York, continuing Darwin's investigations into the chemistry of seasonal anoxia in the Bay of Concepcion, Chile. A Ph.D. in environmental toxicology from Cornell University led to a position as ecologist with the U.S. EPA in Athens GA. At the EPA, Dr. Araujo has conducted research on biodegradation of oil spills (including the Valdez cleanup), and regional vulnerability of ecosystems; she is currently team leader for research in support of the restoration of South Florida, including ecological exposures to mercury under current and restoration conditions.

Mid-Atlantic Integrated Assessment – Panel Discussion

Thomas B. DeMoss, Frederick W. Kutz, Ronald B. Landy[1], and Kent Thornton[2]
[1]Environmental Services Division
U.S. EPA Region III
Annapolis, MD
[2]FTN Associates
Little Rock, AR

During this session, panelists will discuss strategic ecosystem initiatives planned for the Mid-Atlantic Region over the next 5-10 years. EPA's Office of Research and Development, with Region III's Mid-Atlantic Integrated Assessment (MAIA) program, will explore the role of restored riparian buffers relative to ecosystem function in MAIA. These plans will include the process of restoration, its effects on biologically significant resources, and the use of measures of success to evaluate restoration efficiency and effectiveness. In addition, the Governors of Chesapeake Bay states have set a stream buffer restoration goal of 2,010 miles of stream restoration by year 2010. Various state representatives will discuss their plans for addressing this goal and barriers that need to be overcome. The panelists will also discuss the role of science in ecosystem restoration in areas such as design, implementation, evaluation of progress, and the value of science for alternative management approaches to ecosystem restoration.

Professional Biography, Thomas DeMoss

Mr. DeMoss received his M.B.A. from the University of Maryland in 1971. In the EPA Office of Research and Development from 1978-1979, he developed strategic research plans and operating guidance. He directed the Chesapeake Bay Program from 1979-1983 and the EPA National Estuaries Program from 1984-1989. At present, he is Director of EPA Region III's Ecological Analysis group in the Environmental Services Division. He has helped to develop the regional scale prototype assessment on the Mid-Atlantic Region and serves as lead for the Community-based Assessment Team (CBAT), Region III. He has a continued interest in ecological integrated assessment at local, regional, and national scales.

Everglades Ecosystem Assessment: Monitoring For Adaptive Management

Quentin J. (Jerry) Stober[1]
D.J. Scheidt[2], R.D. Jones[3], K. Thornton[4], D.L Stevens[5], J. Trexler[3] and S. Rathbun[6]
[1]Science and Ecosystem Support Division
U.S. EPA, Region IV
Athens, GA

[2]U.S. EPA, Region IV, Water Management Division, Atlanta, GA, [3]Southeast Environmental Research Program, Florida International University, Miami, FL, [4]FTN Associates, Little Rock, AR, [5]Dynamac Corp., Corvallis, OR, [6]Dept. of Statistics, University of Georgia, Athens, GA

A systemwide (4,000-square-mile) research and monitoring study of the Everglades ecosystem was conducted from 1993-96 to address the interactions of mercury contamination, eutrophication, habitat alteration, and hydropattern modification issues. Synoptic monitoring of canal and marsh populations, using a random EMAP survey design, during wet and dry seasons determined the extent and magnitude of total (HgT) mercury and methylmercury (MeHg) in water, soil/sediment, periphyton and mosquitofish (*Gambusia holbrooki*) with associated water quality parameters. Factor analyses of canal and marsh data partitioned HgT in fish and MeHg in water as two components with total phosphorus (TP), total organic carbon (TOC), and sulfate (SO_4) aggregated as a third component. Significant north to south spatial gradients existed in these constituents. In order to synthesize and integrate the interactions of these variables the central Everglades flowway was parsed by latitude into seven units averaging approximately 27 km (north-south) over a total distance of 189 km. Latitudinal parsing of the data aggregated the major plant responses to anthropogenic phosphorus in this system. The canal data illustrated a biodilution of mercury in mosquitofish north of Alligator Alley with increased bioaccumulation south of that point with declining TP. Both parameters declined in the southernmost canals when TP declined to a median of 14 ppb. The marsh data were even more definitive showing biodilution north of Alligator Alley, however, as median TP declined from 16.4 to 12.1 ppb, the median mercury concentration in mosquitofish doubled to 208 ug/kg and remained at these concentrations south through the northern ENP. The mercury concentration in fish declined significantly to 156 ug/kg in southern ENP when median TP in water declined to 8.6 ppb. Median MeHg concentrations in water declined north to south in both canal (0.3 - 0.059 ng/L) and marsh (0.538 - 0.151 ng/L) habitats indicating higher methylation in the marsh. The median mosquitofish BAF for mercury increased from 0.6×10^5 in the north to 8.5×10^5 in southern ENP indicating an increasing bioaccumulation efficiency in the food chain from northern to southern areas. HgT in periphyton, great egrets and mosquitofish was spatially correlated. High MeHg concentrations in water in the northern Everglades was not bioaccumulated into fish due to biodilution and associated changes in the food chain. The stimulatory effects of

TP in this system on the methylating microbes is a key component – for it is apparent that when the fertilizing effect is minimal in southern ENP, the available MeHg declines in both water and biota. Establishment of these baseline conditions will be used to evaluate the effect of future management alternatives.

Professional Biography, Jerry Stober

Dr. Stober received his Ph.D. in Zoology from Montana State University in 1968. He was Research Professor of Fisheries at the Fisheries Research Institute, University of Washington, Seattle, for 18 years. In 1986, he joined EPA in his current position as Fisheries Scientist with the responsibility to evaluate bioaccumulative contaminants in fish, and to conduct ecological risk assessments to aid in remediation and control strategies. He now leads Region IV activities in the ecological risk assessment of mercury in the Everglades ecosystem. He has authored or co-authored over 90 technical reports and publications. In 1989, 1992, and 1995 he received EPA Bronze Medals for the Pigeon River Dioxin Study, participation in development of the Agency's ecological risk assessment framework, and leadership in the South Florida Ecosystem Assessment Project.

Restoration Efforts in the Northern Florida Everglades

Stephen M. Smith, Paul McCormick, Jennifer Leeds, and Brian Garret
Everglades Systems Research Division, Ecosystems Restoration Department
South Florida Water Management District
West Palm Beach, FL

The Florida Everglades is a vast, shallow subtropical marsh that once extended from the southern shores of Lake Okeechobee to Florida Bay. Historically, the system was hydrologically driven by the Kissimmee River watershed, Lake Okeechobee, and local rainfall patterns, yielding a broad sheet of water that slowly proceeded in a north-south direction. At present, however, approximately 50 percent of the original wetland remains as a number of discrete entities which include Everglades National Park to the south and three main Water Conservation Areas (WCAs) to the north. The WCAs lie downstream from a large farming region known as the Everglades Agricultural Area (EAA). Water that is delivered to the WCAs from the EAA (via an extensive network of canals and pumping stations) is subject to volumetric and temporal controls which have interfered with normal water level fluctuations. Furthermore, this water is often highly enriched with nutrients, particularly phosphorus. Alterations in both hydropattern and water quality have led to dramatic effects on this ecosystem that evolved in response to natural hydrologic regimes and oligotrophic conditions.

The current remedy and main thrust of Everglades nutrient and hydroperiod restoration efforts is the construction of seven large wetlands termed Stormwater Treatment Areas (STAs). Primarily through macrophyte and algal uptake, it is expected that the STAs will effectively sequester excess nutrients to allow for the discharge of "clean" water into the desired areas. A prototype system, the 3,800 acre Everglades Nutrient Removal project (ENR), has managed to reduce EAA phosphorus loads approximately 80 percent. Two areas scheduled to receive STA outflow in the year 2000 are northern WCA2A and a remote region called the Rotenberger Wildlife Management Area (RWMA). This presentation will discuss the conceptual design of the STAs, initial hydrological and biological characteristics of receiving areas, and possible trajectories for ecosystem structure and function in response to STA operation.

Professional Biography, Stephen M. Smith

Dr. Smith is a Staff Environmental Scientist at the Everglades Systems Research Division, Ecosystems Restoration Department, of the South Florida Water Management District. He holds a B.S. from Florida State University, an M.S. from the University of Miami, and a Ph.D. from the University of Miami. His projects have included monitoring of Everglades nutrient and hydroperiod restoration through stormwater treatment areas (water quality, soils, periphyton, macrophytes).

Proposed Creation and Restoration of Salt Marsh and Colonial Waterbird Nesting Habitat in Maryland's Coastal Bays

Christopher C. Spaur and Stacey M. Underwood
U.S. Army Corps of Engineers, Baltimore District
Baltimore, MD

Ecosystem restoration and creation necessitates value judgements based on consideration of a variety of environmental, economic, and engineering factors. The Army Corps of Engineers' Ocean City Water Resources Study provides a case example of the planning process undertaken to formulate several proposed environmental restoration projects. Plan formulation for the study roughly followed the standard Corps' planning process. The study identified water resources problems and potential environmental restoration opportunities for these problems within the coastal bays. The opportunities were then evaluated for engineering and environmental practicability. A determination of need was made based upon magnitude of loss, likelihood of self recovery, and indirect ecological impacts of the loss. Through this process, the study team selected environmental restoration objectives within the coastal

Professional Biography, Christopher Spaur

Mr. Spaur has worked as an ecologist with Corps of Engineers for the last four and one-half years. He works in the Planning Division, primarily on "Environmental Restoration" mission projects. Prior to being with the Corps, he worked for several years as a park naturalist with various park systems in New Jersey and New York. He holds an M.S. in Marine Science and a B.S. in Natural Resources Management.

bays watershed that could be implemented within the purview of the Army Corps of Engineers' water-resources based environmental restoration mission. The objectives focused on creating and restoring salt marsh, forested wetlands, and colonial waterbird nesting habitat. Because of prevailing private ownership of potential forested wetlands restoration and creation sites, and the sizable effort that would have been required to solicit landowners, forested wetlands restoration/creation was not pursued as part of this study. Instead, efforts focused on locating salt marsh and colonial waterbird nesting habitat restoration and creation sites. Environmental and societal guidelines and constraints specific to each objective were developed to aid in site selection and project design. A GIS-based site selection process was utilized to determine suitable areas for these restoration and creation projects, and avoid environmentally sensitive areas. Field surveys for finfish, SAV, and hard clam were undertaken to evaluate potential environmental trade-offs, and to aid in site-specific design. A series of alternative plans were developed for each site, and a cost-effectiveness analysis aided in project selection. Resource agency input was sought throughout the process to provide guidance in plan formulation, and in the hope of obtaining "buy-in," however, achieving interagency consensus was not possible because of the divergent perspectives and missions of the agencies involved.

Hole-in-the-Donut Wetlands Restoration and Mitigation, Everglades National Park

Michael Norland
South Florida Natural Resources Center
Homestead, FL

Everglades National Park encompasses 689,000 hectares and is the only subtropical wilderness in the continental United States. Invasion of exotic plant species into the principal ecosystem types within the park is threatening both the form and the function of the various ecosystems. Within Everglades National Park, at least 217 introduced plant species are known to occur, which accounts for about 25 percent of the total number of plant species in the Park. A major site of exotic plant invasion is an area of former freshwater prairie and upland abandoned farmland known as the Hole-in-the-Donut (HID). This area of about 4,050 ha of abandoned farmland has within it an area of about 2,430 ha dominated by a stand of a single exotic woody species, Brazilian pepper (*Schinus terebinthifolius* Raddi). The objective of the HID Wetland Restoration and Mitigation Program is to eliminate *Schinus* and restore the wetland and forest ecosystem form. These tests included bulldozing, burning, mowing, and chemical treatment of *Schinus*, and planting and seeding of native wetland species, hardwoods, and pines. The only treatment method that showed any wetland restoration success involved the complete removal of disturbed substrate. The current restoration and mitigation will be described and will include engineering, construction, and environmental mensuration methods used during years one and two of this multi-year program.

Opportunities for Wetland Creation Through Mining Activities in Wyoming: What Works and What Doesn't

Mark C. McKinstry and Stanley H. Anderson
Wyoming Cooperative Fish and Wildlife Research Unit
Laramie, WY

Wetland creation is currently viewed as a means to offset wetland losses within the U.S. and mining activities are thought to provide an inexpensive means to facilitate wetland construction. In northeast Wyoming over 1,000 wetlands have been created through bentonite mining, constituting one of the largest wetland creation projects in the world. These wetlands are located in a region where few natural wetlands exist and they have developed into functional wetlands providing habitat for a wide variety of fish and wildlife. We examined 1) whether post-creation wetlands meet original predictions from engineering plans and 2) what physical factors have the most influence on waterfowl use. We compared wetland-creation predictions with actual created habitat (size, water quality, and # of islands, bays and peninsulas) to determine if wetland creation within this landscape is predictable. We also examined waterfowl habitat use to determine what factors could be manipulated during the construction phase to increase the wetland's value for breeding and migrating waterfowl. Created wetlands did not meet the criteria in engineering plans at over 65 percent of the wetlands (n = 90 wetlands). Faulty hydrologic models are thought to have overestimated predicted habitat. Created wetlands that were most successful at attracting waterfowl were typically large (>0.5 ha), located within complexes (> 4 wetlands within 1 km), and had abundant submersed and emergent vegetation. We recommend that future wetland construction in this region emphasize creating wetland complexes and providing a diversity of habitat for all waterfowl that use the area. Also, we suggest that monitoring programs be developed that evaluate the success of wetland creation projects and that wetland function goals be met, especially if they are used for wetland banking. Finally, these wetlands provide a unique opportunity to examine the effects of cumulative wetland values and plant succession since they are an island of habitat in an otherwise dry system. Our current research focuses on wetland plant establishment.

Professional Biography, Mark McKinstry

Mr. McKinstry completed his B.S. in Wildlife Biology at Colorado State University and an M.S. in Zoology and Physiology/Water Resources at the University of Wyoming. He worked for the California Waterfowl Association as a Waterfowl Biologist before moving to Wyoming in 1990. He is now employed as a Research Associate for the Wyoming Cooperative Fish and Wildlife Research Unit in Laramie, Wyoming. He works on a wide variety of projects including waterfowl use of created wetlands, transplanting beaver for wetland creation and riparian improvement, plant propagation at created wetlands, and survey methods for midget-faded rattlesnakes.

He and two others at the Unit are currently editors of a book titled "Wetlands and Riparian Areas of the Intermountain West: Their Ecology and Management" (in press).

A Landscape Ecology Analysis of Potential Forested Wetland Restoration Sites, Tensas River Basin, Mississippi River Delta Region, Gulf of Mexico

Daniel T. Heggem, Curtis M. Edmonds, Anne C. Neale, Lee Bice, and K. Bruce Jones
Landscape Ecology Branch, Environmental Sciences Division
National Exposure Research Laboratory
U.S. EPA
Las Vegas, NV

The Tensas River Basin is a target watershed of several U.S. Environmental Protection Agency environmental studies including the Nonpoint Source Management Program and the Gulf of Mexico Program. The Nonpoint Source Management Program has identified watersheds in Louisiana which have been impaired by nonpoint pollution and where land use practices contribute to these pollutant problems. This program identified specifically what types of best management practices need to be implemented to improve environmental conditions. Using the existing data and with the cooperation of landowners, the Tensas River Basin offered a unique opportunity to implement best management practices that could help reduce the concentration of sediment, excess nutrients, or pesticides leaving the Basin. The nutrients leaving the Tensas River Basin, combined with other Mississippi Valley watersheds, are of concern to the Gulf of Mexico Program because research has shown that excess nutrients cause hypoxia (<2 mg/l oxygen) in the bottom waters of the Gulf of Mexico. This condition represents a threat to the coastal marine ecosystem and fisheries in this region of the Gulf. The landscape analysis methods described in this presentation will show how to use these methods to assess the impact of human land use practices that are being implemented to improve environmental quality.

In years past, the freshwater marshes, stream bank areas, and bottomland swamps of the Tensas River Basin were under strong development pressures. Large portions of forest near streams and in backwater swamp areas were converted to agriculture. This loss of forested areas interfered with the interaction of forested wetlands with soil and water that removes pollution before it enters streams, lakes, and estuaries. Wetland forests also absorb peak flows during floods and release the water more slowly, reducing damage to downstream farms and cities. Preserving or restoring wetland forests have other economic benefits such as wetland-based recreation, including hunting and harvesting wetland plants. The people who live within the Tensas River Basin realize that the vegetation along a stream and in backswamp areas can influence the condition of both the stream bank and the

Professional Biography, Daniel Heggem

Mr. Heggem is an Environmental Research Scientist with the Landscape Ecology Branch, Environmental Sciences Division, Las Vegas Nevada. He graduated with a degree in Biology from Capital University, Columbus, Ohio. He worked at EPA Headquarters in Washington, D.C. before he joined the EPA Research Laboratory here in Las Vegas. Dan has worked on many environmental projects dealing with water, soil, air, and monitoring ecological condition. Dan received the EPA's Gold Medal for Exceptional Service for his work following the Exxon Valdez oil spill. Dan is presently conducting research to develop measurements of landscape characteristics and patterns and understand the relationship between landscape characteristics, as indicators of ecosystem condition, and ecological values.

water in the stream. Restoration efforts began in the early 1990s.

Combining Geographic Information System (GIS) data layers with remotely sensed data is a powerful analysis method for ecological assessments. With this method, we were able to look at land use practices over the past twenty years in the Tensas River Basin of Louisiana. A simple land use classification was applied to multispectral scanner (MSS) data from 1972 to 1991. After combining existing GIS data with the classified MSS data, we were able to identify potential forested wetland restoration sites.

Notice: The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), funded this research and approved this abstract as a basis for an oral presentation. The actual presentation has not been peer reviewed by EPA.

Habitat Restoration and Partnerships

Albert Rizzo
U.S. Fish and Wildlife Service
Annapolis, MD

The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife program is designed to restore habitat primarily on private lands. To accomplish this task, the Service works in concert with a variety of state agencies, soil and water conservation districts, non-government organizations and other federal agencies. Since 1992, Partners for Fish and Wildlife (PFW) restoration efforts have historically focused on wetland environs which have resulted in the restoration of 800 acres of wetlands. With the advent of ecosystem management strategies and an enhanced emphasis on water quality in the Chesapeake Bay, PFW projects are designed with a landscape context approach (matching habitat type to a site's maximum potential within the appropriate landscape setting). Balancing the landowners desires with mixed agency missions can be challenging. By communicating with all parties on their level, these obstacles can be overcome with the end result being a quality habitat restoration and most importantly, a contented landowner.

Wetland restoration techniques have evolved over the past decade into a hybrid of standard engineering practices mixed with ecological and biogeochemical enhancements. By choosing the appropriate landscape position and soil types, adequate hydrology to sustain a wetland is easily accomplished. Commonly, PFW wetland restoration projects allow plant communities to establish naturally from the soil seed bank or recruitment from adjacent wetlands. If the site is not conducive to natural colonization, we have utilized standard construction equipment to transplant 5- to 6-inch diameter trees, and 3- to 4- foot tall shrubs with a resulting survival rate of 95 percent. The transplanted trees and shrubs provide vertical and horizontal habitat structure as well as a source of germplasm. This technique has also been employed on PFW projects to establish upland forest buffers around constructed emergent wetlands. Microtopographic complexity is also necessary to maximize plant species diversity. Agricultural lands have had the natural pit-mound topography graded out from years of tillage. By leaving the site in a roughed condition with small hummocks and depression, plant communities establish quicker due to seed scarification and lower soil bulk densities.

A low cost technique to establish hydrophytic emergent/forb vegetation on site with depleted seed banks and low recruitment potential, was developed by the PFW in conjunction with the Delaware Department of Natural resources and Environmental Control. Wet meadows with diverse assemblage of plant species are mowed and baled with conventional hay making equipment. The 40 pound bales are easy to store and spread. We have spread the mulch in "nurse" plots which serve as a germ plasm source for further site colonization. The results from five trial sites have demonstrated the viability and cost effectiveness of this technique.

Biogeochemical functions of wetlands are commonly misunderstood and overlooked in wetland restoration projects. By amending exposed subsoils with organic matter, anaerobic conditions are rapidly induced which results in greater rates of denitrification which is important if the wetland is receiving agricultural runoff. Organic matter in the form of manures, straw, and logs have been used on PFW projects in Delaware. The logs not only provide habitat structure, but contribute to long term organic carbon inputs to the wetland system. Phosphorus has been shown to become labile in reducing environments which is of concern in agricultural landscapes. PFW projects comprised of excavated shallow depressions and hummocks (which do not impound water behind berms) have no outfall pipes which eliminates the potential for the release of "slugs" of water with low dissolved oxygen concentrations and high phosphorus concentrations.

Professional Biography, Albert Rizzo

Mr. Rizzo holds a B.S. in Wildlife Biology and an M.S. in Soil Science from West Virginia University. He now works as the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife program Coordinator for Maryland and Delaware. Working out of the Chesapeake Bay Field Office in Annapolis, MD, his primary duties involve field assessments, coordination, and administration of habitat restoration projects in Maryland and Delaware. He has 18 years of experience working with the restoration of disturbed lands (surface coal mined land) and wetlands.

Ecosystem Restoration And Management on The Nature Conservancy's Disney Wilderness Preserve in Central Florida

Michael Duever
Disney Wilderness Preserve/The Nature Conservancy
Kissimmee, FL

The Disney Wilderness Preserve (DWP) is an 11,500-acre mitigation project located in the headwaters of the Everglades watershed in central Florida. The site is located on a peninsula, almost completely surrounded by extensive floodplains along several streams and lakes. This setting means we control the watersheds aligned along the peninsula's ridgeline, and thus, the hydrology of the numerous wetlands we are restoring within these watersheds. It also means that we have excellent boundaries within which to conduct our prescribed burning program, a crucial component for maintaining the site's natural communities. The Preserve's large size and isolated setting has limited invasion of exotic plants. Those present at the time of acquisition in 1992 have been largely eliminated, and a low level maintenance program continues to control noxious exotics and nuisance natives.

The Preserve is dominated by about 9,000 acres of hydric-to-xeric pine flatwoods communities, with numerous embedded herbaceous and forested wetlands. We also have portions of two large lakes and a stream. Extensive areas of lands upstream and downstream are currently owned or are scheduled for acquisition by public land conservation agencies. Listed species include bald eagles, scrub jays, and gopher tortoises. Management includes protecting eagle nest trees from fire and human disturbance, and maintaining habitat for scrub jays and gopher tortoises with our prescribed burning program.

Wetlands restoration and enhancement primarily involves filling ditches that were draining about 2,000 acres of wetlands, along with preservation of surrounding uplands. The goal is to restore natural ecosystem processes, particularly hydrologic and fire regimes, and allow the system to recover on its own. We are relying on seedbanks and nearby seed sources to facilitate recolonization of restored areas. This approach may take longer than would be expected with standard restoration practices, but maintains the genetic integrity of the communities and provides for a more diverse plant community distributed along natural gradients present at each site.

As part of our efforts to restore the overall DWP ecosystem, we have initiated studies designed to develop practical techniques for restoring 1,355 acres of improved pasture to pine flatwoods. Currently there is no proven technology available for eradicating exotic pasture grasses and reestablishing the diverse natural pine flatwoods ground cover.

A major monitoring program is evaluating restoration success as required to meet our mitigation permit requirements. At the same time, it is providing a critical baseline for evaluating our own land management activities and the influence of future off-site activities on the Preserve. This program currently includes 56 vegetation monitoring transects, 250 monitoring wells, and numerous photopoints.

This large mitigation project is providing resources on a scale not normally available for the restoration and long term management of a conservation site. It is allowing us to effectively and efficiently restore the site, while documenting the entire process of acquisition, restoration, monitoring, and management, so the lessons learned can help others.

Professional Biography, Michael Duever

Dr. Duever is project ecologist at The Nature Conservancy's Disney Wilderness Preserve (DWP) near Orlando, where he is in charge of monitoring and research. The DWP is an 11,500 acre mitigation site established to offset impacts caused by development on property owned by Walt Disney Imagineering and the Greater Orlando Aviation Authority. Prior to joining The Nature Conservancy in 1993, Mike worked for 20 years as Director of the National Audubon Society's Ecosystem Research Unit, which was based at Corkscrew Swamp Sanctuary in southwest Florida. His main interests are wetland ecology, biohydrology, dendroecology, and natural area management. He has conducted research on these topics and worked with private and governmental land managers at numerous sites throughout the United States and northern Latin America. He has also worked to apply this information in the development of realistic wetland protection regulations. Mike received his B.S. from the University of Illinois, and his M.S.. in Zoology and Ph.D. in Forest Resources from the University of Georgia.

Restoration of Submerged Aquatic Vegetation

David M. Goshorn
Resource Assessment Service
Maryland Department of Natural Resources
Annapolis, MD

Maryland and the EPA Chesapeake Bay Program have long placed high priority on the restoration of submerged aquatic vegetation communities as part of the larger efforts to restore and protect Chesapeake Bay. Historically, most of this effort has focused on improving habitat (water) quality on the assumption that natural reestablishment of grass beds will follow. This has proven to be the case in many areas, and much success has been realized through this strategy. However, there are substantial portions of Chesapeake Bay where improvements in water quality have not resulted in subsequent reestablishment of grass beds. One explanation is that adequate seed sources no longer exist in these areas. To promote restoration of grass communities in these areas, several efforts have been launched recently to plant SAV beds in the anticipation that their presence will promote greater reestablishment. Maryland DNR is working with sister agencies, schools, watermen, and private individuals to develop a targeting system for locating promising restoration sites and then carry out public-based restoration projects throughout the Bay.

Professional Biography, David Goshorn

Dr. Goshorn holds the position of Chief of the Living Resource Section. He received his bachelor's degree from Bucknell University in 1984 and his Ph.D. in Marine Studies from the University of Delaware in 1990, and also held a post-doctoral position with University of Georgia from 1990-1992. His current responsibilities include the assessment of living resources in the tidal waters of Maryland. This includes habitat restoration efforts, primarily directed at submerged aquatic vegetation.

Riparian Forest Restoration from the Urban, Agricultural, and Forested Watershed Perspectives

Rob Northrop, Dan Hedderick, Bernadette Turner, and Wayne Merkel
Maryland Department of Natural Resources Forest Service
North East, MD

Riparian forests provide society with multiple ecological values, including the protection and enhancement of water resources. For these reasons, the Maryland Department of Natural Resources Forest Service has targeted riparian forest as a key habitat for restoration.

The DNR-Forest Service is taking a watershed based approach to assessing the value of riparian forest efforts in restoring ecosystem function and process at the site-specific scale and at the watershed scale, and providing guidance in targeting assistance to its public and private partners. Riparian forest restoration strategies for specific watersheds are tailored to meet the opportunities and constraints imposed by land use patterns present within the watershed.

Professional Biographies, Robert Northrop and Wayne Merkel

Mr. Northrop began work with the Maryland Department of Natural Resources in 1983 as a CFM Forester. He now works as the Watershed Forester within the central region of the state, where his responsibilities include technical watershed planning assistance to a variety of local, state, and federal projects within the context of the Chesapeake Bay restoration program. He is also an adjunct faculty member, both for the University of Delaware (Wildlife Management and Human Dimensions of Wildlife Conservation) in Newark, DE and Cecil Community College (General Biology and Environmental Science) in North East, MD.

Wayne Merkel is Project Manager for Harford and Cecil Counties. He has 20 years of experience providing forest management services, afforestation/reforestation services, urban and community forestry services, and managing a State Forest.

Geohydrologic Foundations for Ecosystem Restoration: Modeling of Baseflow Loadings of Nutrients in Mid-Atlantic Coastal Plain Watersheds

M. M. Hantush[1], L. J. Bachman[2], S. R. Kraemer[1], J. K. Böhlke[2], D. E. Krantz[2], Jerome Cruz[3], and J. M. Denver[2]
[1]National Risk Management Research Laboratory
U.S. EPA
Ada, OK

[2]USGS, [3]MERSC

Elevated levels of nutrients have been implicated in the eutrophication of surface waters, and may have contributed toward the decline of the living resources in the Chesapeake Bay. A significant portion of nonpoint-source nutrient loading to the Chesapeake Bay is attributed to groundwater discharge: approximately 60 percent of the fresh water in the Chesapeake Bay is composed of base flow, with its associated load of nutrients. The effectiveness of water quality management alternatives could be compromised by overlooking groundwater transport of nutrients. Understanding of the role of the hydrologic landscapes and the subsurface flow in transporting nitrate from the source to surface waters, is essential for an effective ecosystem restoration approach. A three-year cooperative research project between the U.S. EPA and the USGS was initiated in October 1997 with the aims at developing an understanding of the role of the subsurface water and its associated nutrient loading to Chester-River watershed of the Delmarva peninsula, and to develop management tools (maps and models) supporting ecosystem restoration goals. The study emphasizes a comprehensive modeling approach to understand nitrate loading to a Chester-River watershed (Locust Grove, MD) in response to historic nutrient loading at the source. Two-dimensional hydrogeomorphic maps and three-dimensional geologic model of the surficial aquifer will be constructed to support residence-time and nutrient yield analyses. The modeling approach implements three-dimensional numerical models to simulate groundwater/surface water interactions, fate and transport of nitrate in groundwater, and base-flow loading of nitrate to streams. The U.S. Geological Survey will support the modeling effort by supplying bore holes for constructing the geological model, and conducting spatial and synoptic field measurements of hydraulic and water quality properties. On the basis of the calibrated and verified models, the impact of source control, denitrification in shallow marine sediments, and nitrate removal by riparian zones will be investigated using state-of-the-art graphical displays. The results of this project can be viewed as decision support tools by resources managers and policy makers for ecosystem restoration.

Professional Biography, Mohamed Hantush

Dr. Hantush holds a Ph.D. in Civil Engineering from the University of California at Davis. He works as a hydrologist with EPA's National Risk Management Research Laboratory in Ada, OK.

How Much Water Does a River Need?

Brian D. Richter
Freshwater Initiative, The Nature Conservancy
Hereford, AZ

The natural flow paradigm suggests that protecting the full range of natural hydrologic variability, and associated characteristics of timing, duration, frequency, and rate of change, is critical in sustaining the native biodiversity and ecological functions of freshwater ecosystems. Thus, the natural flow paradigm answers the question posed by the title of this presentation, and forms the goal of flow restoration efforts. Applying the natural flow paradigm in riverine ecosystem conservation requires that we quantitatively define the natural flow targets; characterize the degree of flow alteration that has transpired; and move forward in an adaptive ecosystem management context toward natural flow restoration. We have developed an "Indicators of Hydrologic Alteration" (IHA) method for assessing hydrologic alteration at locations where daily hydrologic records are available (e.g., USGS stream gauges). The method is based upon an evaluation of 33 different hydrologic parameters describing the magnitude, timing, duration, frequency, and rates of change in hydrologic conditions. This method reveals the direction and magnitude of hydrologic alterations associated with various human activities such as river damming or diversion, watershed conversion for agriculture or silvicultural use, ground water pumping, etc. When human land and water uses have pushed one or more of the IHA parameters outside of their natural range of variation, native biodiversity and natural ecosystem functions may be compromised. Ecosystem or biodiversity managers will want to consider alternatives for restoring natural flow characteristics, such as through modifying reservoir operations or stream diversion practices, restoring wetland or riparian areas and associated functions within a watershed, etc. Some examples of such restorative efforts will be presented in this talk.

Professional Biography, Brian Richter

Mr. Richter is the Director of The Nature Conservancy's new Freshwater Initiative. He has served as the Conservancy's National Biohydrologist during most of his 11 years with the organization. His new responsibilities include serving as a liaison to public agencies and other organizations involved in freshwater conservation, and leadership of a staff that includes other biohydrologists, aquatic ecologists, and educators. He works with science staff and conservation project teams across the U.S. and internationally to identify key hydrologic processes supporting biotic diversity, assess stresses to these processes, and design conservation strategies for restoring desired hydrologic conditions. He has published numerous scientific papers on the importance of restoring natural flow regimes, in journals such as Conservation Biology, Freshwater Biology, and BioScience.

Southwestern Riparian Sustainability and Restoration in a Man-made Ecosystem

Nita Tallent-Halsell
National Exposure Research Laboratory
U.S. EPA
Las Vegas, NV

Southwestern, man-made riparian ecosystem reproduction and sustainability is adversely affected by dramatic water-level fluctuations, increased soil salinization and interspecific competition. Often these adverse conditions make natural reproduction and artificial restoration efforts unsuccessful, driving existing communities to extinction. The effects of these conditions were studied on existing and introduced Goodding willows (*Salix gooddingii*) at Lake Mohave, a lower Colorado River impoundment bordering Nevada and Arizona. Restoration research was conducted in a two tiered approach through first characterizing existing stand habitat then following with greenhouse experiments. To characterize the shoreline, vegetation measurements and soil samples were collected at thirty-four 2,500 m^2 plots established along the 100 km shoreline. This survey revealed that there is a significant difference ($p = .0002$) between elevations at which *S. gooddingii* (194.43 ± .84 m) and the invader *Tamarix ramosissima* (195.10 ± .55 m) establish. These results suggest shoreline flooding suppresses *T. ramosissima* invasion into the flooded *S. gooddingii*-dominated zone. Additionally, I found that most willows are found in monospecific stands where individuals are the same height, suggesting clonal reproduction. Their survival depends on their ability to withstand 10 months of inundation per year. Such extended periods of inundation have inhibited seed germination and establishment of cuttings even though viable seeds are being produced. Such conditions are also prohibiting out-planting success. At 95 percent of the sites with willow, herbivory by beaver (*Castor canadensis*) and wind breakage were strongly evident. Active beaver dens were found at five of the 53 sample sites. Invasion of saltcedar (*Tamarix ramosissima*) into adjacent willow stands is restricted by the lower flood tolerance of saltcedar.

Greenhouse experiments were conducted to study the response of the dominant native, *S. gooddingii* and introduced *T. ramosissima* to different water levels and soil types comparable to those influencing Lake Mohave riparian plant communities. Cuttings were grown in sand or a sand-gravel mix in either inundated, surface-saturated or dry soils in a 2 x 2 x 3 factorial design. Survival was significantly higher ($p = .0010$) for both species (*T. ramosissima* 91 percent and *S. gooddingii* 82.5 percent) in surface-saturated soils. The within-species biomass was significantly different between water levels ($p = .0000$). The between species biomass was higher for the *T. ramosissima* cutting grown in surface-saturated and dry soils. Least growth and highest mortality (for both species combined, 71 percent) resulted when plants were kept flooded. My greenhouse results suggest that *S. gooddingii* cuttings are not flood-tolerant and therefore should not be outplanted at the lower elevational limit of mature *S. gooddingii* nor should be inundated during establishment. Based on this research I suggest that shifting the water-level cycle (lower the water level) to correspond to the natural reproductive cycle of the *S. gooddingii* may favor establishment of seedlings and artificial cuttings. However, it may also increase interspecific competition from *T. ramosissima*.

Notice: The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), funded this research and approved this abstract as a basis for an oral presentation. The actual presentation has not been peer reviewed by EPA.

Professional Biography, Nita Tallent-Halsell

Ms. Tallent-Halsell is a Research Environmental Scientist with the Landscape Ecology Branch, Environmental Sciences Division, Las Vegas Nevada. She earned her B.S. and M.S. in Biology from the University of Nevada in Las Vegas, Nevada. She has worked at the EPA Research Laboratory in Las Vegas for nine years, first as a contractor with Lockheed Martin then as a Natural Resource Specialist with the U.S. Department of Interior, Bureau of Land Management and for the past four years as an EPA employee. Nita has worked on many environmental projects dealing with surface waters, forest health, rangeland health, and monitoring ecological condition. Her current research has focused on the sustainability and restoration potential of riparian ecosystems on the regulated waterways using a watershed and landscape ecology approach.

Preliminary Downstream Hydraulic Geometry Relationships for Hydro-physiographic Provinces in MD

Tamara L. McCandless and Richard A. Everett
U.S. Department of Interior Fish and Wildlife Service
Chesapeake Bay Coastal Ecosystem Program
Annapolis, MD

Increasingly, engineers and environmental managers are attempting to design with, rather than against, the natural tendencies of rivers in flood protection, channel stabilization, stream crossing, channel realignment, and watershed management projects. There is also a great interest in restoring the physical, biological, and aesthetic characteristics of previously degraded rivers. For both these endeavors, designers need to predict the dimension, pattern, and profile of natural rivers.

Empirical relationships between dimensions of bankfull channel geometry (i. e., width, depth, meander length) and water discharge or drainage area have long been found useful in designing and evaluating river channels. An increasing number of river channel design approaches require or recommend the use of such relationships. As with all empirical relationships, the applicability of the derived predictive equations is limited to rivers similar to those providing the data. Thus, empirical relationships for channel geometry must be developed for specific hydro-physiographic regions with relatively homogeneous climate, geology, and vegetation.

The U.S. Department of Interior, Fish and Wildlife Service and the Maryland State Highway Administration are developing regional hydraulic geometry relationships for the five major hydro-physiographic regions in Maryland. The first phase of the study involves detailed channel geometry surveys at 26 active stream gages operated by the Maryland-Delaware-DC District of the U. S. Geological Survey in the Piedmont region. Later phases of the study, tentatively scheduled for 1999, will address the Coastal Plain, Blue Ridge, Ridge and Valley, and Appalachian Plateau provinces.

Channel surveys and gage flow records are used to establish discharge magnitudes, recurrence intervals, cross-section, planform, and longitudinal profile dimensions corresponding to the bankfull stage. Preliminary data reveal correlations between drainage area and bankfull channel dimensions and discharge. Comparisons with relationships for other regions in eastern North America, and a limited set of data from other physiographic regions in Maryland, suggest there are significant differences in the relationships between drainage area and bankfull channel characteristics.

Professional Biographies, Tamara McCandless and Richard Everett

Ms. McCandless is a habitat restoration specialist and is a program co-leader for the River Assessment and Restoration Program. She holds a B.S. in Biology and an M.S. in Environmental Science from Indiana University.

Richard Everett is a biologist and co-leader of the River Assessment and Restoration Program. He holds a B.A. in Biology from the University of California, Santa Cruz and a Ph.D. in Zoology from the University of California, Berkeley.

U.S. Environmental Protection Agency
Large River Ecosystem Criteria Initiative

Susan P. Davies
Health and Ecological Criteria Division
US EPA
Washington, DC *and*
Maine Department of Environmental Protection
Augusta, ME

The United States Environmental Protection Agency is developing technical guidance for bioassessment and biocriteria for non-wadeable rivers and riverine impoundments. In contrast to wadeable streams, few states have experience assessing the biota of deep rivers, although they are the site of the majority of point source and hydrologic modification impacts. Issues to be addressed range from straightforward re-scaling of traditional stream biological assessment approaches to account for non-wadeable conditions, to a comprehensive restructuring of technical, regulatory and public policy approaches to accommodate an holistic ecosystem management perspective. Technical issues include the need to assess multiple, interacting ecosystem components, issues of expanded temporal and spatial scales, the paucity of reference conditions, and difficulties establishing criteria to "restore and maintain...biological integrity" (U.S. Clean Water Act) in highly altered, unnatural waterbodies. Public policy issues include difficulties establishing criteria for resources that traverse political boundaries, and conflicting uses, longitudinally as well as between ecological and human values. A multidisciplinary scoping panel of senior aquatic scientists was convened in April, 1998 to identify critical scientific issues for the development of criteria for non-wadeable rivers. Criteria protective of ecological integrity should address biota, habitat, hydrology and water quality in an integrated, multidisciplinary approach that allows for data interpretation from the basin-level to the macrohabitat scale.

Professional Biography, Susan Davies

Susan Davies is a river and stream benthic biologist. She is currently on detail, from the State of Maine Department of Environmental Protection (MDEP) to the United States Environmental Protection Agency in Washington, D.C. She was recruited by the US EPA Health and Ecological Criteria Division of the Office of Water, Office of Science and Technology, Bio-Criteria Program to initiate technical guidance development for bioassessment and biocriteria for non-wadeable rivers. She has been an employee of the MDEP for 16 years, where she directs the state's Biological Monitoring and Criteria Program.

Anadromous Fish Restoration

R. Scott Carney
Anadromous Fish Restoration Coordinator
Pennsylvania Fish and Boat Commission
PFBC Benner Spring Fish Research Station
State College, PA

At the turn of the century, American shad *Alosa sapidissima* were abundant in Pennsylvania's Susquehanna River and tributaries with spring spawning migrations supporting extensive fisheries throughout the basin. Overfishing, pollution, and loss of spawning habitat through the construction of dams, reduced shad numbers. The final demise of the American shad and other migratory fishes in the Susquehanna basin came between 1904 and 1932 with the construction of four hydroelectric dams in the lower 88 km of river. Available spawning habitat was reduced by 99 percent. Since the early 1960s, federal and state fisheries agencies and fisheries interests have worked cooperatively with private utilities to restore American shad and other migratory fishes to the Susquehanna River. Spawning habitat suitability and fish passage feasibility studies were completed during the 1960s. Cooperative agreements among the parties were reached in 1970, 1982, 1985, 1988, and 1993 which lead to the development of fish trapping and passage facilities, stocking of adult shad and river herring *Alosa aestivalis, Alosa pseudoharengus* into spawning areas above all dams, construction and operation of a shad hatchery, and studies related to monitoring downstream passage of juvenile shad, turbine survival, and stock assessment. Present day restoration efforts are conducted under the auspices of the Susquehanna River Anadromous Fish Restoration Cooperative whose membership includes U.S. Fish and Wildlife Service, National Marine Fisheries Service, Maryland Department of Natural Resources, Pennsylvania Fish and Boat Commission, New York Department of Environmental Conservation, and the Susquehanna River Basin Commission. The Committee oversees all restoration activities, develops annual work plans, and tracks expenditures amounting to over $400,000 each year. Utility companies have additionally spent several hundred thousand dollars each year for trap and transfer of adult shad and herring , and turbine survival and passage studies at their projects. Funding provided by the EPA Chesapeake Bay Program has been used to conduct an inventory of blockages to fish migration on tributaries to the Susquehanna, develop fish passage at blockages, and support PFBC's Anadromous Fish Restoration Coordinator position. A multi-million dollar fish lift was completed and began operation at Conowingo Dam in 1991. An agreement with the licensees of the three upstream hydroelectric projects in Pennsylvania resulted in the construction of similar facilities at Holtwood and Safe Harbor which began operation in 1997 and York Haven which is scheduled to have fish passage in place by 2000. With the completion of fish passage at York Haven, over 400 miles of main stem river spawning habitat will be re-opened along with several hundred miles of tributaries. PFBC Van Dyke Research Station for Anadromous Fishes has stocked over 150 million shad fry and fingerlings since its establishment in 1976. Since the 1970s, the catch of American shad in fish lifts at Conowingo increased from a few hundred to a record 104,000 in 1997. Based on analysis of otoliths of returning shad in recent years, hatchery contribution has ranged from 45 to 70 percent. Ultimate goals of the program is to develop self-sustaining runs of 2 million American shad and 15 million river herring above all dams in the Susquehanna River. At this level, it is estimated that over 500,000 sport angling trips will be created annually generating $30 million for local communities. The program to restore American shad and other migratory fishes to their historic range in the Susquehanna drainage is one of the largest of its kind ever envisioned and has been a model of persistence, cooperation and long-term commitment among federal and state fisheries agencies, fisheries interests, and private utility companies.

Professional Biography, Scott Carney

Mr. Carney received a B. S. in Environmental Resource Management from the Pennsylvania State University and his M.S. in Biology from Clarion University of Pennsylvania. He works out of the PFBC Benner Spring Fish Research Station, State College, PA. He has been employed by PFBC for six years. Past employers include the Virginia Department of Game and Inland Fisheries and U. S. Forest Service. He is President of the Pennsylvania Chapter of the American Fisheries Society.

Forest Fragmentation in the Chesapeake Bay Watershed: Addressing its Impacts and Seeking Solutions

Richard A. Cooksey
USDA Forest Service, Northeastern Area
Annapolis, MD

In the Chesapeake Bay watershed, forests are the dominant land cover at 59 percent of the land base or 24 million of the 41 million acres in the basin. However, we are losing forest land at more than 100 acres per day, mostly due to development. Forests are being fragmented by sprawling development patterns that carve into unbroken tracts of forest, and frequently change associated land ownerships from one owner to many as the land area is parcelized. The results of this loss of contiguous forest and land ownership contiguity is potentially negative for our forest ecosystems' ability to protect water quality, provide diverse habitat, and as a viable economic resource to provide recreation, timber and other forest products.

Forest fragmentation can have several meanings, but the term has been widely used to describe various removals of forest overstory; ranging from small to large areas, temporary to permanent. But, put simply, it is the process by which larger contiguous forest lands are broken into smaller, more isolated fragments or islands, surrounded by human-modified environments – agriculture and urban land uses. The importance of such removals and "forest islands" to wildlife, fish, and people habitats, is directly related to their size and permanence. The area of greatest concern and primary focus of the Bay's effort is the effects on forest lands with long-term or permanent conversion to non-forest use.

The U.S. Forest Service, Northeastern Area, State and Private Forestry (S&PF), Society of American Foresters (SAF) and the Chesapeake Bay Program (CBP) have formed a partnership to assess the impacts of forest fragmentation and find ways to address it. The Forestry Workgroup (FWG) of the CBP, which has representatives from each Bay state forestry agency, federal agencies, industry, and nonprofit organizations, has concluded that forest fragmentation is occurring in the Bay states and that the declining forest land base, forest fragmentation, and ownership parcelization are among the most important issues facing forest management today, with possible ecological and economic consequences. The Bay Workgroup are focusing on three key areas to study forest fragmentation and to ultimately develop recommendations and sensible conservation and restoration solutions. They are:

1. A better scientific definition and characterization of forest fragmentation in the context of various management objectives;
2. Data showing the current condition and trends; and
3. Consensus on the issues related to fragmentation and its impacts, with input from the scientific, management, and stakeholder communities.

Professional Biography, Richard Cooksey

Mr. Cooksey has a diverse background which includes training in social science, law, finance, forest resource management and policy. Rick holds a B.A. in social science from Western Connecticut State University and an M.S. in Forestry from the University of New Hampshire that focused on forest economic applications to forest conservation policy. He works for the USDA Forest Service, State and Private Forestry, Northeastern Area and is currently a liaison to the Chesapeake Bay Program in Annapolis, Maryland. Rick assists in developing Bay Program, Forest Service, and State policies and programs related to forest resources. He represents the Forest Service on Bay Program task forces and implementation committees, and serves as the principal staff for its Forestry Work Group. As liaison, Rick works to integrate forests as part of solution to Bay restoration issues and integrates forest resource planning and consensus-building into land use and water quality programs. Rick has written many articles related to the status and trends of forests in the Bay region, forest conservation strategies and planning, the economics of riparian forest buffers to landowners, riparian forest dynamics, and forest fragmentation.

Maintenance and Restoration of Northern Spotted Owl Habitat in the Pacific Northwest

Thrailkill, James A., R.G. Anthony, E.D. Forsman[1], and K.A. Swindle[2]
[1]USDA Forest Service, Pacific Northwest Research Station
Corvallis, OR
[2]Oregon Cooperative Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University
Corvallis, OR

Forest ecosystems in the Pacific Northwest have been markedly altered by past land management activities carried out to implement public policy. As a result of these activities, significant fragmentation and reduction in the amount of old-growth (200 years and older) forest occurred over the past 25 years. Changing social values, in conjunction with a greater scientific understanding of the effects of past management practices on fish and wildlife, have resulted in a closer scrutiny of the consequences of forest management practices on public lands. Consequently, listing under the Endangered Species Act of the northern spotted owl (*Strix occidentalis caurina*) have occurred (1990). Studies of the northern spotted owl during the last 20 years have shown the subspecies to be strongly associated with late-successional/old-growth forests throughout much of its range in the Pacific Northwest, leading to much stronger efforts to protect remaining late-successional habitat.

In 1993, the Forest Ecosystem Management Assessment Team developed the Northwest Forest Plan (NWFP). A primary objective of the NWFP is to ensure the long-term maintenance and restoration of late-successional habitat conditions in the Pacific Northwest, which will lead to a well-distributed and viable population of spotted owls. To accomplish this, a system of late-successional reserves (LSRs) were established, in part, as a means of achieving recovery of the northern spotted owl. Two prominent factors related to the owl were considered in this reserve design: 1) appropriately sized reserves for demographic considerations and 2) reserve spacing to facilitate genetic interchange. In addition, where disturbance has set back succession within the LSRs, management strategies such as the use of silvicultural treatments in forest plantations have been suggested to hasten restoration of late-successional conditions.

Monitoring of late-successional forest amount and process is a key component under the NWFP. Monitoring, as it relates to northern spotted owls, includes the continued assessment of owl demographic trends in response to the LSR system and habitat restoration activities. We provide an overview of the range-wide demographic and habitat monitoring strategy for spotted owls under the NWFP, our study's role in this strategy, and examples of planned habitat restoration activities.

Professional Biography, James Thrailkill

Mr. Thrailkill is a Faculty Research Assistant and Project Leader for the Central Oregon Cascades Northern Spotted Owl Ecology Research Project. He is employed by the Oregon Cooperative Fish and Wildlife Research Unit, located in the Department of Fisheries and Wildlife at Oregon State University, Corvallis, OR. He has worked for the Cooperative Wildlife Research Unit for almost 10 years. During this time, he has served as Project Leader on a succession of spotted owl research projects. In addition, he has served on several other projects studying the relationships of forest-wildlife species in Oregon and the Pacific Northwest.

He holds a B.S. in Wildlife Science and a minor in Forestry from Humboldt State University, Arcata, CA.

The Landscape Project: New Jersey's Ecosystem Approach to the Conservation of Biodiversity

Lawrence J. Niles, Chief and M. Valent, Zoologist
Endangered and Nongame Species Program
New Jersey Division of Fish, Game and Wildlife
Trenton, NJ

The primary goal of the Landscape Project is to create a large scale and long-term perspective for the protection of our state's wildlife diversity. Animals need a variety of habitats that are both interconnected and of sufficient size to support viable populations. We see this as necessary if we are to preserve wildlife populations into the next generation.

The second goal is to provide a usable mechanism for integrating habitat protection needs into existing systems. The Endangered and Nongame Species Program (ENSP) will provide agencies within the NJ Department of Environmental Protection with digital and hard copy maps depicting critical areas for rare species. The ENSP will also provide technical support for interpreting critical areas maps as well as helping users to realize the strengths and limitations of the products. The maps will help guide land acquisition, habitat management, the purchase of development rights, and easements, CAFRA and freshwater wetland permits (under the current policy), state planning, and other land protection initiatives. The maps are not intended to delineate regulatory boundaries but instead will serve as a guide for identifying the most important critical areas of rare species habitats. The products from the Landscape Project will provide users with the ability to understand the long-term needs of wildlife. At this point the ENSP intends to use the data from the Landscape Project to guide existing protection efforts. However, the products will be useful to any future protection initiatives that may arise.

Finally, products from the Landscape Project will be made available to any individual, group or agency that has a need for this type of information. This may include local and county planning boards, county open space programs, consultants and any other individual or organization that can benefit from it.

Due to the intended uses of the products generated from the Landscape Project, it is essential that the information be updated on a frequent and regular basis. We are currently working to develop habitat classifications based on reflectance values from satellite images. The work has already been completed for the Delaware Bay Landscape and is underway for the Highlands Landscape. Once completed, we will have the ability to update our habitat maps as often as necessary.

The Landscape Project has, from its

Professional Biography, Larry Niles

Dr. Niles is now Chief of the New Jersey Division of Fish, Game and Wildlife's Endangered and Nongame Species Program and has held this position for the last eight years. He has worked with the Endangered and Nongame Species Program since 1982 and, prior to that, as a regional biologist for Georgia Fish and Game for five years. He received his Ph.D. in Ecology at Rutgers University, his dissertation focusing on migrant bird ecology. He received his B.S. and M.S. degrees from Penn State University. His primary research interests are landscape level protection of rare and endangered species, as well as migrant shorebird and passerine ecology and protection.

inception, been a cooperative partnership and we have maintained regular interaction with experts from a variety of disciplines in an attempt to stay on the cutting edge of wildlife science. It is our intention to provide users with the most useful, accurate and up-to-date products available.

Managing Restoration Projects for Functional and Structural Objectives

John R. Heckman
Roy F. Weston, Inc
Lakewood, CO
John Cairns, Jr.
Virginia Polytechnic Institute and State University
Blacksburg, VA

Restoration projects need to be designed with specific, measurable performance goals integrated within the project's entire life cycle. To meet the challenges of ecological sustainability, these goals must include two categories: structural components chosen to ensure compatibility with the surrounding landscape and functional components chosen to ensure the broader provision of ecological services within a human-dominated ecosystem. The authors explore the requirements for these goals through experiences in three areas: 1) field experiments designed to compare functional and structural measurements of restoration success on disturbed old-field sites, 2) management programs on active landfills that included restoration activities concurrent to the actual disturbance, and 3) comparisons of natural vs. facilitated succession on reclaimed coal mined land in southwestern Virginia. Functional objectives prove to have more difficult data collection challenges but they are far from insurmountable and offer specific benefits unavailable from structural measurements. Chief among the benefits is the ability to extrapolate functional measurements to economically important ecological services. Well-designed restoration projects should take both types of objectives into account; the resulting data may be extremely important for monitoring both the ecological and economic importance of restoration.

Professional Biography, John Heckman

Dr. Heckman's research has focused on the interplay between structural and functional methods for assessing restoration success. It has involved a variety of ecosystem restoration experiments as a part of the Virginia Tech Center for Environmental Studies, the Powell River Project, and the Rocky Mountain Biological Station. He is currently a Scientist and Project Manager within the Strategic Management Group at Roy F. Weston, Inc.

Disease, Insects, and "Exotic" Ecosystems: Implications for Restoration Goals

William J. Otrosina
USDA Forest Service, Tree Root Biology
Athens, GA

The potential exists for novel disease problems to arise as a consequence of ecosystem restoration efforts. A case in point is the longleaf pine ecosystem in the southeastern United States. This tree species once occupied nearly 30 million ha but now its range is reduced to approximately 1.5 million ha. Restoring this species to many sites in its former range is an important goal involving several natural resource organizations. Increased mortality has been observed in 30-40 year-old stands on many sites where this tree species was established. This mortality is associated with prescribed burning. Several species of root infecting fungi (*Leptographium* species, *Heterobasidion annosum*) and certain root colonizing insects are also associated with this mortality. However, longleaf pine has evolved with frequent fires and is dependent upon fire for successful regeneration and for maintenance of stand health. This tree species is generally regarded to be either resistant to or highly tolerant of these fungi. It may be that many sites no longer have certain edaphic and environmental conditions under which the species evolved. Such "exotic" ecosystems may result from altered fire regimes, changes in soil conditions, or many other factors that create mal-adaptation of a given species to current conditions. Why, in a species that has evolved for eons with fire and is dependent upon regular fire regimes, are we now observing root pathogenic fungi that heretofore have not been regarded as pathogens in this tree species? What role do these fungi play in mortality and productivity loss in affected stands? Could the presence of these fungi serve as indicators of ecosystem health and therefore a measure of success at restoration? The answers to these questions are important in assessing the degree of success in restoration, for addressing potential problems, and for increasing awareness of the potential that exists for unforseen problems to arise through the course of restoration efforts in other ecosystems.

Professional Biography, William Otrosina

Dr. Otrosina is a Research Plant (Forest) Pathologist, USDA Forest Service, Southern Research Station, Tree Root Biology Team, Athens, Georgia. His research interests include root diseases, causal fungi, and their ecological relationships with forest ecosystems. Effects of prescribed burning, disturbances, and stress on susceptibility to insects and diseases. Also, research on root disease-bark beetle interactions. Prior to coming to Georgia, he was with USDA FS at the Pacific Southwest Research Station in Berkeley and Albany, California as Research Forest Pathologist. He studied root disease- insect interactions and population structure of root disease fungi. He hold a B.S. in forestry from Penn State University, and an M.S. and Ph.D. in forestry from the University of Georgia .

Twenty-year Woody Vegetation Changes in Northeastern Illinois Upland Forest Ecosystems and Their Management and Restoration Implications

Marlin Bowles, Jenny McBride, Christopher Dunn, Michael Jones, & Tim Bell
The Morton Arboretum
Lisle, IL

Conservationists in the upper Midwest are concerned that forest fragmentation and loss of natural processes such as fire allow an increase in shade-tolerant fire-intolerant maples and a decline of fire-adapted shade-intolerant oaks and understory species. The expected result is a negative impact on forest biodiversity. We tested these hypotheses by resampling woody vegetation in 28 old growth forest stands comprising a species gradient dominated by maple, red oak, and white oak. The results were compared with data collected from these stands in 1976, allowing temporal comparison of changes in composition and structure within and among stands. Maple stem densities and basal area increased in both lower and upper size classes in maple and red oak stands. But in white oak stands, maples were less abundant and increased only in lower size classes. Substantial declines occurred across all stands for density and basal area of mid-size class oaks, and for density and species richness of shrub layer vegetation. Because oak and shrub layer decline was significant in white oak stands that had little maple invasion, other factors must be involved. We attribute these changes to a combination of reduced fire and other historic disturbance processes allowing canopy closure associated with forest development and maturation, and a shift from wide-scale disturbance to canopy gap-dynamics in old-growth stands. Ground layer species richness was lowest in maple stands and highest in white oak stands, probably due to greater shade under maple canopy cover. Browsing from white-tail deer was frequent and has reduced shrub and ground layer species in some stands. These changes indicate that loss of structural and biological diversity has occurred in maple and oak forests in the past 20 years. Forest ecosystem management and restoration priorities and research needs will be discussed.

Professional Biography, Marlin Bowles

Mr. Bowles is a plant conservation biologist and administers the Morton Arboretum Rare Plant Program and conducts research on vegetation management at the Morton Arboretum. He holds an M.S. from the University of Illinois at Urbana.

The Sawmill Creek Watershed Restoration Project

Larry Lubbers
Watershed Assessment & Targeting Program
Maryland Department of Natural Resources
Annapolis, MD

The Sawmill Creek project is a comprehensive watershed restoration effort. The goal is to demonstrate that existing programs can be coordinated in order to improve water quality and habitat for living resources. Coordination of multiple restoration projects has been key to addressing the cumulative impacts in the watershed.

Water quantity management includes reducing stormwater discharge rates and increasing stream base flow. Habitat improvement projects were designed to match the best possible stormwater discharge rates. The habitat projects include stabilizing and revegetating 1,737 meters of eroded stream channels with natural materials. These projects will provide sediment and erosion control as well as restore fish, invertebrate, and riparian habitat and eliminate five fish passage blockages.

Water quality improvements include reducing nutrient loadings through bio-retention as well as isolating and treating deicing chemicals associated with airport storm water valley runoff. Funding for most of these restoration projects has been incorporated into existing budgets for the development and maintenance of the business and community infrastructure.

Professional Biography, Larry Lubbers

Mr. Lubbers has been employed by the Maryland Department of Natural Resources since1985. His original position in the Fisheries Division was to review state and federal environmental permits to provide recommendations on how to minimize impacts to aquatic resources. Currently, he is Chief of the Watershed Assessment & Targeting Program where he works with local communities and other government agencies to develop and implement watershed restoration and management plans. He also is the Restoration Team Leader for the multi-agency Sawmill Creek Targeted Watershed Project. He has also worked at the University of Maryland's Chesapeake Biological Laboratory where he performed research on estuarine nutrient cycling, fish population dynamics, and ecological characterizations of submerged vascular plant communities.

Development of Isotope Hydrology Techniques for Resolution of Recharge-discharge Processes in Natural and Constructed Wetlands: Application to the Grand Kankakee Marsh Within the Calumet Lacustrine Plain Ecosystem

William C. Sidle[1] Leslie D. Arihood[2] Randy Bayless[3] Noel Pavlovic[4]
[1]National Risk Mananagement Research Laboratory
U.S. EPA
Cincinnati, OH

[2]USGS, WRD, Indiana District Office, Indianapolis, [3]USGS, WRD, Indiana District Office, Indianapolis, [4]USGS, BRD, Porter

Recharge-discharge processes influence wetland functions in an ecosystem. Efforts to restore and construct wetlands are constrained by insufficient hydrologic information pertaining to water sources, pathways, and residence times contributing to a water budget. It is generally uncertain if developed wetlands will evolve into sinks for contaminants and transported into receiving waters; or evolve into infiltration galleries recharging local water supplies.

This research investigates how environmental isotopes can better define hydrologic processes occurring in the Grand Kankakee Marsh, once the largest wetland in Midwest America in the last century. Intensive efforts to reconstruct this ecosystem of northern Indiana has prompted a revaluation of the regional hydrologic regime which was altered by decades of channelization, ditching, and over-withdrawals of local aquifers.

Naturally-occurring isotopes in surface waters and ground waters are direct tracers of fluid properties of the water cycle. These stable and radiogenic isotopes can be measured with improved precision such that water sources, flow pathways, and residence times may be distinguished. Isotope behavior in dissolved gases, solutes, and in the water molecule permit less ambiguous evidence of transport phenomenon than is gained from chemical analyses.

Isotope analyses will be integrated with water quality analyses and hydrologic measurements in monthly intervals over three years. Measured isotopes include the water isotopes (O-18, H-2, H-3), stable solute isotopes (C-13, N-15, S-34), and specific radionuclides (Sr-87, Pb-210, Pb206-208, C-14, Kr-85, He-3, and Cl-36). Ongoing flow modeling in the Kankakee watershed will be updated and telescoped to include a finer mesh of transport simulations based on isotope data. The combined GIS-formatted database will aid the performance assessment of individual isotopes in discerning stressor transport processes.

Session I – Plenary

Lee A. Mulkey
Associate Director of Ecology
National Risk Management Research Lab.
U.S. EPA
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
513-569-7689
513-569-7549 (fax)
mulkey.lee@epamail.epa.gov

Stanley L. Laskowski
Director, Environmental Services Division
U.S. EPA, Region III
1650 Arch Street
Philadelphia, PA 19103-2029
215-814-2989
215-814-2783 (fax)
laskowski.stanley@epamail.epa.gov

Glenn Suter
U.S. EPA, NCEA
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
513-569-7808
513-569-7475 (fax)
suter.glenn@epamail.epa.gov

Eric Jorgensen
U.S. EPA, NRMRL
919 Research Dr.
Ada, OK 74820
580-436-8545
580-436-8703 (fax)
jorgensen.eric@epamail.epa.gov

George Gann
Society for Ecological Restoration
Chair, Board of Directors
Institute for Regional Conservation
22601 SW 152nd Ave.
Miami, FL 33170
305-247-6547
305-245-9797 (fax)
gann1@gate.net

Milt Friend
USGS-WRD
8505 Research Way
Middleton, WI 53562
608-821-3859
608-821-3817 (fax)
Milton_Friend@usgs.gov

Session II – Management Issues/Case Studies

Kent Thornton
FTN Associates, Ltd.
3 Innwood Circle, Ste. 220
Little Rock, AR 72211
501-225-7779
501-225-6738 (fax)
kwt@ftn-assoc.com

Jeff Farrah
Wayne State University
Department of Political Science
609 St. Louis
Ferndale, MI 48220
248-541-2069
jfarrah@igc.apc.org

Steve Funderburk
Chief, Living Resources Branch
U.S. Fish & Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
410-573-4555
410-224-2781 (fax)
steve_funderburk@fws.gov

Tim Canfied
U.S. EPA
R.S. Kerr Environmental Research Center
919 Kerr Research Dr.
Ada, OK 74820
580-436-8535
580-436-8703 (fax)
canfield.tim@epamail.epa.gov

R. Peter Richards
Water Quality Laboratory
Heidelberg College
310 East Market Street
Tiffin, OH 44883
419-448-2313
419-448-2124 (fax)
prichard@nike.heidelerg.edu

Sudhir Kshirsagar
Global Quality Corp.
7828 Beechmont Ave.
Cincinnati, OH 45255
513-474-9780
513-474-9781 (fax)
president@gqc.com

Paul Koch
Pacific Environmental Services
4700 Duke Dr., Suite 150
Mason, OH 45050
513-398-2446
513-398-3342 (fax)
pkoch@cin.pes.com

Rochelle Araujo
Ecosystems Research Division
U.S. EPA
960 College Station Road
Athens GA 30605-2700
706-355-8133
706-355-8104 (fax)
araujo.rochelle@epamail.epa.gov

Session III – Mid-Atlantic Integrated Assessment

Tom DeMoss
U.S. EPA
201 Defense Highway, Suite 200
Annapolis, MD 21410
410-573-2739
410-573-2771 (fax)
demoss.thomas@epamail.epa.gov

Frederick W. (Rick) Kutz
U.S. EPA
201 Defense Highway, Suite 200
Annapolis, MD 21401
410-573-2742
410-573-2771 (fax)
kutz.rick@epamail.epa.gov

Ronald B. Landy
U.S. EPA
201 Defense Highway, Suite 200
Annapolis, MD 21401
410-573-2757
410-573-2771 (fax)
landy.ronald@epamail.epa.gov

Session IV – Wetlands & Shallow Waters

Jerry Stober
Science and Ecosystem Support Division
U.S. EPA, Region IV
980 College Station Road
Athens, GA 30605-2700
706-355-8705
706-355-8726 (fax)
stober.jerry@epamail.epa.gov

Stephen M. Smith
South Florida Water Management District
Everglades Systems Research Division
Ecosystems Restoration Department
3301 Gun Club Road
West Palm Beach, FL 33406
561-682-2844
561-687-6442 (fax)
stephen.smith@sfwmd.gov

Christopher C. Spaur
U.S. Army Corps of Engineers, Baltimore District
Attn: CENAB-PL-P
P.O. Box 1715
Baltimore, MD 21203-1715
410-962-6134
410-962-2948 (fax)
Christopher.C.Spaur@nab02.usace.army.mil

Michael Norland
Everglades National Park
South Florida Natural Resources Center
40001 State Road 9336
Homestead, FL 33034
305-242-7806
305-242-7836 (fax)
Mike_Norland@nps.gov

Mark C. McKinstry
Research Associate
Wyoming Cooperative Fish and Wildlife Research Unit
Box 3166
Laramie, WY 92071
307-766-5491
307-766-5400 (fax)
markmck@uwyo.edu

Daniel T. Heggem
Landscape Ecology Branch
Environmental Sciences Division
U.S. EPA National Exposure Research Lab
P.O. Box 93478
Las Vegas, NV 89193-3478
702-798-2278
702-798-2692 (fax)
heggem.daniel@epamail.epa.gov

Albert Rizzo
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
410-573-4543
410-224-2781 (fax)
al_rizzo@mail.fws.gov

Michael Duever
DWP/TNC
6075 Scrub Jay Trail
Kissimmee, FL 34759
407-935-0002
407-935-0005 (fax)
ecology@phoenixat.com

Dave Goshorn
Resource Assessment Service
Maryland Department of Natural Resources
Tawes State Office Building, D-2
580 Taylor Avenue
Annapolis, MD 21401
410-260-8639
410-260-8640 (fax)
dgoshorn@dnr.state.md.us

Rob Northrop
Regional Watershed Forester
Maryland Department of Natural Resources
130 McKinneytown Road
North East, MD 21901
410-287-2918
410-287-0010 (fax)
rnorthrop@remote.dnr.state.md.us

Bernadette Turner
Maryland Department of Natural Resources
P.O. Box 116
W. Bowie, MD 20719-0116
410-287-2918
410-287-0010 (fax)

Dan Hedderick
Maryland Department of Natural Resources
Western Region Forest Office
3 Pershing St.
Room 101
Cumberland MD 21502
410-287-2918
410-287-0010 (fax)

Wayne Merkel
Maryland Department of Natural Resources
Harford County Project Office
2 S. Bond St.
Bel Air, MD 21014
410-836-4551
410-836-4552 (fax)

Session V – Rivers, Streams, & Riparian Areas

Mohamed Hantush
U.S. EPA
919 Kerr Research Dr.
Ada, OK 74820
580-436-8531
580-436-8703 (fax)
hantush.mohamed@epamail.epa.gov

Brian D. Richter
Freshwater Initiative
The Nature Conservancy
4774 E. Green Oak Lane
Hereford, AZ 85615
520-803-0882
520-803-0883 (fax)
brichter@tnc.org

Nita Tallent-Halsell
U.S. EPA, NERL
P.O. Box 93478
Las Vegas, NV 89193-3478
702-798-2487
702-798-2692 (fax)
tallent-halsell.nita@epamail.epa.gov

Tamara McCandless
Chesapeake Bay Field Office
USWS
177 Admiral Cochrane Dr.
Annapolis, MD 21401
410-673-4552
410-224-2781 (fax)

Richard Everett
Chesapeake Bay Field Office
USFWS
177 Admiral Cochrane Dr.
Annapolis, MD 21401
410-573-4518
410-224-2781 (fax)
rich_everett@fws.gov

Susan Davies
Health and Ecological Criteria Division
U.S. EPA
401 M St. SW
Mail Code 4304
Washington, DC 20460
202-260-2352
202-260-1036 (fax)
davies.susan@epamail.epa.gov

Scott Carney
Pennsylvania Fish and Boat Commission
PFBC Benner Spring Fish Research Station
State College, PA
814-353-2225
814-355-8264 (fax)
scarney@lazerlink.com

Session VI – Terrestrial/Uplands

Rick Cooksey
USDA Forest Service
Chesapeake Bay Program
410 Severn Ave., Suite 109
Annapolis, MD 21403
410-267-5706
410-267-5777 (fax)

Jim Thrailkill
Oregon Cooperative Wildlife Research Unit
H.J. Andrews Exper. Forest
P.O. Box 300
Blue River, OR 97413
541-822-3359
541-822-6329 (fax)
thrail@fsl.orst.edu

Larry Niles
New Jersey Div. of Fish, Game, & Wildlife
Endangered & Nongame Species Program
P.O. Box 400
Trenton, NJ 08625-0400
609-292-9101
609-628-2436 (fax)
lniles@dep.state.nj.us

John R. Heckman
Strategic Management Consulting
Roy F. Weston, Inc.
215 Union Boulevard, Suite 600
Lakewood, CO 80228-1842
303-980-6800
303-980-1622 (fax)
heckmanj@mail.rfweston.com

William J. Otrosina
USDA Forest Service
Tree Root Biology
3200 Green Street
Athens, GA 30602
706-559-4290
706-546-2143 (fax)
otrosina@negia.net

Marlin Bowles
The Morton Arboretum
Rt. 53
Lisle, IL 60532
630-719-2422
630-719-2433 (fax)
mbowles@mortonarb.org

Larry Lubbers
Maryland Department of Natural Resources
Tawes State Office Building
Annapolis, MD 21401
410-260-8811
410-260-8779 (fax)
llubbers@dnr.state.md.us

Moderators

Sue Shock
National Risk Management Research Laboratory
U.S. EPA
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
513-569-7551
513-569-7585 (fax)
shock.sue@epamail.epa.gov

Tim Canfied
U.S. EPA
919 Kerr Research Dr.
Ada, OK 74820
580-436-8535
580-436-8703 (fax)
canfield.tim@epamail.epa.gov

Thomas DeMoss
U.S. EPA
201 Defense Highway, Suite 200
Annapolis, MD 21410
410-573-2739
410-573-2771 (fax)
demoss.thomas@epamail.epa.gov

Daniel T. Heggem
Landscape Ecology Branch
Environmental Sciences Division
U.S. EPA National Exposure Research Lab
P.O. Box 93478
Las Vegas, NV 89193-3478
702-798-2278
702-798-2692 (fax)
heggem.daniel@epamail.epa.gov

Joan Colson
National Risk Management Research Laboratory
U.S. EPA
26 W. Martin Luther King Dr.
Cincinnati, OH 45268
513-569-7501
513-569-7585 (fax)
colson.joan@epmail.epa.gov

Eric Jorgensen
National Risk Management Research Laboratory
U.S. EPA
919 Research Dr.
Ada, OK 74820
580-436-8545
580-436-8703 (fax)
jorgensen.eric@epamail.epa.gov