NEWS
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CONTENTS

WATER CONSERVATION MANAGEMENT: CRISIS OR COMPETENCY

Everett Billingsley, Executive Director of the Orange Water and Sewer Authority, in a recent Drought Management and Water Conservation Seminar, stressed that water conservation is common sense resource management and not something to consider in a crisis situation. Speaking to other water supply officials he said we are going to find conservation is an alternative to some of the traditional responses that we have made to water supply problems.

Billingsley cited some benefits of water conservation. "Capital costs will decrease, operating costs will decrease and our customers will be the benefactors. These benefits will not happen automatically or exclusively, but predictably will happen when conservation is instilled as a permanent and prominent parameter in our decision-making process. Water supplies and treatment plants will have longer lives, distribution networks and system storage can be less expensive, waste treatment plant capacity will be better utilized and the sewage system will not be as greatly taxed. This lessened demand on the capital plant also is reflected in lower expenditures for chemicals and electricity, reduced labor costs and reduced debt service interest costs. Over the long-term these savings will result in lower cost for our customers to whom we are, or at least should be, accountable," he said.

"As stewards of the community water supply we can no longer permit water conservation to be thought of as a crisis situation," he said.

The seminar, held in Greensboro September 2, was sponsored by the North Carolina Section of the American Water Works Association and the N. C. Division of Health Services.

CITY OF DURHAM ADOPTS COMPREHENSIVE WATER RESOURCE CONSERVATION AND MANAGEMENT PLAN

The City of Durham has developed a water resource management policy and plan to insure having an adequate supply of high quality for its citizens. The plan contains a water resource management program, a drought management plan and a water conservation/customer information program.

Durham has adequate, high quality, raw water sources to meet the needs of the City for many years, if planned raw water impoundments are constructed as they are needed. City officials are concerned that its water resources not be wasted and with wise management and conservation its water resources should continue to meet the growing needs of Durham.

The water resources management portion of Durham's plan includes (a) planning for future needs, (b) metering to encourage conservation, (c) an educational program to encourage voluntary reduction of unnecessary water use, (d) reuse and recycle where possible, (e) leak detection and correction, and (f) pricing policies to encourage conservation.

The drought management section outlines alternatives for obtaining additional water, the implementation of specific water conservation customer information program, and water use restrictions.

The city plans a long term continuing program of water conservation to help meet its water supply needs. The third section of the plan provides more specific details on the water conservation and customer information.

A copy of Durham's conservation and management plan can be obtained from Terry Rolan, Division of Water Resources, City of Durahm, Durham, NC 27701.

STREAMBANK EROSION WORKSHOP IDENTIFIES RESEARCH NEEDS

A workshop on urban streambank degradation was held in Raleigh on August 12-13.

The purpose of the two-day session was to present a view of state-of-the-art research and to identify North Carolina's problems and research needs in the area of streambank degradation. The workshop was conducted for the N. C. *Sedimentation Control* Commission by the N. C. *Department of Natural Resources* and Community Development and the Water Resources Research Institute.

Speakers included noted authorities on various aspects of streambank degradation and protection. Dr. Daryl B. Simons of the Colorado State University Department of Civil Engineering spoke on the theoretical aspects of streambank degradation. He emphasized the need to know as much as possible about the whole river system when any alterations are made to a small section or cross reach. He presented a long list of interdependent variables that should be considered when protective devices or other changes are planned. Otherwise, he said, there is a risk of "creating two problems for every one you solve."

Ellis P. Pickett of the Corps of Engineers described their Section 32 Program, which includes a national assessment of streambank damage and and evaluation of existing and new control devices. Among the other speakers were two North Carolina researchers: Dr. Rooney Malcom of the N. C. State University Civil Engineering Department, who reviewed his recent WRRI study of detention, and Dr. Nelson Nunnally of the UNC-Charlotte Department of Geography and Earth Science, who spoke on his research in stream restoration.

A number of research needs were identified at the workshop. A top-priority need, it was agreed, is the development of an inventory of North Carolina streams, to include the location, magnitude, and associated costs of problems. Another important need identified was a state-of-the-art design and practice document for bank stabilization.

A summary report of the workshop was prepared for the Sedimentation Control Commission, and highlights are featured in the Institute's N. C. Stormwater Manager newsletter. Limited copies of both are available from the Institute.

CAROLINAS WETLANDS CENTER OPENS IN RALEIGH

The National Wildlife Federation has opened the Carolinas Wetlands Project education center in Raleigh for the purpose of increasing public involvement in wetlands conservation in North and South Carolina.

The Raleigh Project is one of two (the other is in New Orleans, La.) funded by a two-year EPA grant. Their main intent is to foster public understanding of an involvement in the Section 404 Permit Program. Section 404 of the 1972 Clean Water Act, which requires a permit for activities involving discharge of dredged or fill material into "waters of the U. S.," was designed to protect the wetlands and watercourses from unwise development. The permit process provides opportunity for public input.

The center will strive to make citizens aware of the value of wetlands, the magnitude and rate of changes now occurring, and how they can take part in the 404 process.

The Raleigh center staff includes Director Derb Carter, Jr., an attorney, and biologists Dr. Michael Corcoran and Manley Fuller, who are wetlands specialists. They will be working closely with EPA, the Corps of Engineers, and other government agencies. And through the center's open-door policy, they hope to share their expertise with individuals, interest groups, state and local governments, and others in need of consultation and information on wetlands and 404.

The Project will include some documentation of the rate of landclearing and associated drainage through use of literature and field work in order to show the magnitude of problems facing wetlands. The staff educational program (through the media, speaking engagements, workshops, etc.) will extend to a broad spectrum of the public, including individuals and groups not usually reached by such efforts, according to Corcoran.

The Project extends from May, 1981 to May, 1983, at which time further funding will be sought to continue and possibly expand the work to include public participation in more general wetland and local issues.

NATURAL AREAS SURVEY LOOKS AT 10 N. C. COUNTIES

The Natural Heritage Program, through the NRCD Parks and Recreation Division, is doing a natural areas survey of 10 North Carolina coastal counties with funds from the Coastal Energy Impact Program.

Field and aerial surveys and site visits are being used to identify relatively unique, undisturbed areas. The information will be used to help ascertain the significance of the areas and which ones should be

given the highest priority for protection. Such data are needed for decisions regarding agriculture, energy, forestry, and other activities in the coastal zone.

The survey began in May, 1980. Three counties--Tyrrell, Carteret, and Brunswick--have been completed with final reports about to be published. Three more--on Craven, Gates, and Pender--are due to be completed later this fall; and the final four--Dare, Washington, Hyde, and Pamlico--will be completed in spring, 1982.

In addition, the Natural Heritage Program and the Division of Coastal Management are negotiating the funding of a survey for the other 10 coastal counties next spring or summer.

N. C. COASTAL ZONE TO BE PART OF NATIONAL WETLANDS INVENTORY

An aerial photography survey of North Carolina's wetlands by the U. S. Fish and Wildlife Service should get underway this winter, weather and other conditions permitting.

The survey is part of the U. S. Fish and Wildlife Service's National Wetlands Inventory and is intended to produce large-scale maps classifying and showing wetlands. The maps will be used by Fish and Wildlife and other agencies including local governments.

The survey is emphasizing priority areas first, according to John Hefner of the Fish and Wildlife Service in Atlanta. These include North Carolina's coastal zone, the prairie potholes of the western U. S., and the Mississippi River floodplain. Once the aerial survey is completed, the information will be interpreted and the maps prepared, probably in the spring of 1982.

Among those contributing to funding of the survey are the SCS, the Corps of Engineers, some of the states, and other federal agencies such as the TVA.

POSSIBLE EPA REVISIONS OF WATER QUALITY STANDARDS COULD GIVE STATES MORE FLEXIBILITY

The Environmental Protection Agency is revising its Clean Water Act regulations on water quality standards with the result that states could have more control in considering the waste treatment cost of meeting the standards.

The regulations provide that states designate different uses for different bodies or portions of water bodies. These uses include protection of fish and wildlife, public water supply, recreation and agricultural and industrial water supplies.

EPA now feels that current regulations are inflexible and too costly for industry and municipal treatment works to achieve.

The water quality standards provide the basis for issuing national discharge elimination system permits. If waters carry a high-use designation, the level of treatment for discharge to those streams is higher and requires more costly pollution control technology.

The exact date for the revisions has not been determined but will probably not occur before November, 1981.

CHLORINE DIOXIDE FOR WASTEWATER DISINFECTION: A FEASIBILITY EVALUATION

Chlorine dioxide was compared with chlorine for disinfecting wastewater in laboratory experiments. Chlorine dioxide disinfection was also demonstrated at a full-scale wastewater treatment plant. The criteria compared included coliform kill, inactiviation of poliovirus and other indicators, and formation of halogenated organic byproducts.

Laboratory experiments were conducted using mass doses of disinfectant and contact times as independent variables. The fractional survival of coliform bacteria was correleated with the project of disinfectant residual $\times$ contact time.

In general, chlorine dioxide accomplished a given fractional kill of total coliforms with a smaller product (residual $\times$ time) than did chlorine. For a given contact time, the residual required to achieve a given fractional kill of coliforms was 2 to 70 times smaller for chlorine dioxide than for chlorine. Considering both required residual and disinfectant demand, the required doses of the disinfectants were estimated to satisfy three assumed coliform disinfection levels with two types of effluents: conventional activated sludge and filtered, nitrified activated sludge. The required mass doses of the disinfectants were approximately equal for treating conventional activated sludge effluent. The required dose of chlorine was approximately 2 to 10 times greater than that of chlorine dioxide for treating filtered, nitrified effluent, depending on the coliform standard. The results of studies conducted at a full-scale plant generally agreed within a factor of two with the predictions from laboratory studies, when compared on the basis of the product (residual $\times$ time) required to accomplish a given fractional kill.

For the cases likely to be most typical in practice, chlorine dioxide is approximately two to five times as expensive as chlorine for disinfection. On the other hand, chlorine dioxide forms much lower quantities of halogenated by products and is more effective in inactivating viruses than is chlorine.

The complete report, entitled "Chlorine Dioxide for Wastewater Disinfection: A Feasibility Evaluation," (Order No. PB 81-213 357; Cost $14.00, subject to change) will be available only from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Telephone: 703-487-4650. The EPA Project Officer, Mark C. Meckes, can be contacted at: Municipal Environmental Research Laboratory, U. S. Environmental Protection Agency, Cincinnati, OH 45268.

OXYGEN-CONSUMING ORGANICS IN NONPOINT SOURCE RUNOFF

A recent EPA study report presents the results of a comprehensive survey and review of recent literature relating to nonpoint source (NPS) runoff. It summarizes the findings on loadings of oxygen-consuming materials discharged to freshwater nonpoint source runoff and is an attempt to

synthesize the more significant findings on the oxygen demand of both urban and rural nonpoint sources. It also attempts to estimate the impact of these loadings upon the dissolved oxygen resources of freshwater systems and the ecological effects upon freshwater environments. Emphasis has been placed upon urban sources of NPS biodegradable organics; rural sources of NPS biodegradable organics; the impact of NPS constituents upon stream dissolved oxygen (DO); and the effects of DO depletion upon fish.

The literature shows that there is a serious shortage of data on surface accumulation rates, stream-side loading rates, and DO concentrations resulting from nonpoint sources inputs--all measured concurrently within the same watershed. The data available indicate that the oxygen demanding loadings from urban runoff can be significant, but that estimates of effects upon fish and other aquatic organisms must await more information.

As a result of this literature review, the following conclusions were made: (1) Urban NPS runoff has been shown to contain large quantities of oxygen-demanding materials. Although few direct measurements have been made of the oxygen demands actually exerted in streams, modeling studies have indicated that the DO demand from urban NPS runoff can result in low DO concentrations, either alone or in combination with point source discharges; (2) It is more difficult to show serious oxygen depletion due to NPS runoff from rural areas. More serious rural NPS pollutants seem to be sediments from soil erosion, plant nutrients, and toxic materials such as pesticides; (3) Continuous exposure to DO concentrations significantly lower than air saturation concentrations seems to be harmful to fish, both salmonids and warmwater species; (4) Exposure to fluctuating DO concentrations between air saturation and 60-65 percent of saturation can reduce the growth rate of fish if the high and low concentration exposure periods are approximately equal (12 hours each) during each day; (5) Efforts should be made to achieve the appropriate DO standards by reducing the loads of BOD in NPS runoff as well as point source discharges. Reduction of the BOD loadings from NPS runoff should result in other improvements in receiving water quality by reducing the loadings of suspended solids, plant nutrients, and potentially toxic materials; (6) Research should be carried out to directly relate stream impact to end-of-pipe loadings and surface accumulation of urban NPS pollutants; and (7) Research should be performed to evaluate the effects of one exposure of 12 hours per week to DO concentrations of 2, 3, and 4 mg/l upon the growth rate of fish.

The complete report, entitled "Oxygen-Consuming Organics in Nonpoint Source Runoff: A Literature Review," (Order NO. PB 81-205 981; Cost: $6.50, subject to change) will be available only from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, Telephone: 703/487-4650 . The EPA Project Officer, A. Ray Abernathy, can be contacted at: Environmental Research Laboratory, U. S. Environmental Protection Agency, Corvallis, OR 97330.

USGS PUBLICATION EXPLORES STATEWIDE OBSERVATION-WELL APPROACHES FOR NORTH CAROLINA

A recent USGS report shows how a statewide observation-well program may be used to develop an effective groundwater level monitoring program for North Carolina. The report suggests a system of four networks of observation wells with different but clearly-defined objectives. These are referred to as the (1) climatic-effects network, (2) terrane-effects network, (3) local-effects network, and (4) areal-effects network.

The characteristics of each network are related to natural and manmade stresses in aquifers, and the areas and hydrogeologic units in North Carolina where these networks are needed are identified.

Formats for collection, processing, and publication of data from these networks are suggested.

The report is titled "An Observation-well Network Concept as Applied to North Carolina," by M. D. Winner, Jr. A limited number of free copies are availalbe from the U. S. Geological Survey, Water Resources Division, P. O. Box 2857, Raleigh, NC 27602.

NORTH CAROLINA'S ENVIRONMENT, 1981 REPORT

The first composite look at the state of North Carolina's environment has been published by the N. C. Department of Natural Resources and Community Development.

The report is magazine-style, with narrative and graphics to illustrate a number of elements of the environment. Sections deal with the quality of water and air, land resources, and plant and animal species.

The 40-page book contains a detailed questionnaire for readers to offer opinions. The book is entitled "North Carolina's Environment, 1981 Report" and is available from the Office of Regulatory Relations, N. C. Department of Natural Resources and Community Development, P. O. Box 27687, Raleigh, NC 27611.

LAND CLASSIFICATION FOR RADIO ISLAND DEFERRED

After receiving public hearing comments, the Coastal Resources Commission (CRC) decided to defer a request to change the land classification on Radio Island until a study is made of the environmental and socio/economic impacts of coal transport and shipping in North Carolina.

The CRC did amend the County's "rural" classification to include "lands whose highest use is for agriculture, forestry and other low intensity uses. These areas will not require public services such as water and sewer." The CRC also deleted a statement that all Areas of Environmental Concern have been classified as conservation.

The CRC's consideration of the island's classification came on a request by Gulf Interstate Co., which is planning a coal handling facility on 77 acres it owns on the island. The commission held a public hearing on the request on July 22 in Carteret County and received comments from approximately 30 speakers. A number of written comments were also received. The commission has authority over changes in classification of the County's plan because the County has not adopted its plan.

. .*Coastal Resources Commission Memorandum, July, 1981.*

ANNUAL CONFERENCE TO FOCUS ON
LAND USE AND ENERGY

The North Carolina Land Use Congress's Eleventh Annual Conference, set for October 23-24, in the McKimmon Center, N.C. State University, will focus on "Land and Energy: What's the Connection?"

Over 40 individuals representing different aspects of land use and energy will be involved in the program, according to conference chairperson Dr. Raymond J. Burby.

"Highlights of the conference, which is open to the public, will include an address by Jon Veigel, Executive Director of the North Carolina Alternative Energy Corporation and a series of panel discussions focusing on New Developments in Energy Production and Conservation," he said.

The following major topics will also be addressed: 1) Saving Energy Through Urban Land Use Planning, 2) Energy from Renewable Resources in North Carolina, 3) Energy from Nonrenewable Resources in North Carolina, and 4) Land Use/Environmental Impacts of Energy Production.

Registration information and a detailed schedule of the entire conference are available from Dr. Raymond J. Burby, Center for Urban and Regional Studies, 108 Battle Lane, Chapel Hill, NC 27514 (Phone: 919:962-3074). Advance registration of $25 includes the conference, luncheon, and dinner banquet. To take advantage of this special pre-conference rate, reservations must be received by Friday, October 16, 1981.

MEETING TO INCLUDE SESSION ON RADIOACTIVITY IN N. C. DRINKING WATERS

S. W. "Felix" Fong, Head of Environmental Surveillance for the N. C. Radiation Protection Operation, will discuss "Natural Radioactivity Levels" in N. C. Waters" at a September 29th meeting on Low Levels of Radiation Exposure. For more information on this program contact: Jerry Kohl, Nuclear Engineering Department, North Carolina State University, 737-2303.

URBAN HYDROLOGY PIONEER DIES

Murray McPherson Remembered
by Neil S. Grigg

Murray McPherson, known for his work in stormwater and water management worldwide, died August 20th in Marblehead, Massachusetts at the age of 62.

McPherson had a long and distinguished career in water management. He had served as Director of the ASCE Urban Water Resources Research Program since 1967. Most recently he had been the rapporteur on urban hydrology for UNESCO in connection with the International Hydrological Program and since 1977 had been a part-time invited professor at Ecole Polytechnique, University of Montreal. He was a member of the AGU Committee on Urban Hydrology and was its first chairman. He authored or co-authored over 70 published papers and works on hydraulic structures and urban water resources.

Members of the ASCE Urban Water Resources Research Council credit McPherson with much of the internationally known work done by the Council. His influence will continue for many years, and several activities to honor McPherson are currently in the planning stage. Contributions can be made in his memory to Marblehead YMCA Sailing Program, c/o YMCA, Pleasant Street, Marblehead, Massachusetts 01945.

WORKSHOPS AND CONFERENCES

Environmental Law Courses. The American Law Institute-American Bar Association Committee on Continuing Professional Education (ALI-ABA) will present two courses of study this fall of interest to the environmental law practitioner.

1. Water and Air Pollution, October 22-24 in Washington, D. C., will provide detailed discussions of major recent judicial, administrative, and legislative developments in pollution control law and a review of issues likely to shape air and water pollution control programs in the first years of the Reagan administration. A faculty of experts drawn from private practice, government, and environmental groups will discuss recent developments and expected changes in pollution control law. The program features addresses by a prominent member of Congress and a top administrative environmental official and plenary sessions on key programs of the Clean Air and Water Acts, the Resource Conservation and Recovery Act, and the Superfund, as well as sessions on topics such as enforcement and regulatory reform, which cut across media lines. This course is cosponsored by the Environmental Law Institute.

2. Environmental Litigation, October 22-24 in Minneapolis, is a shorter and somewhat compressed version of the week-long ALI-ABA course of study on the same subject offered July, 1981 in Boulder, Colorado. As with that program, it will deal both with particular actions and proceedings under the major environmental statutes and regulations and with the recurring general problems of environmental litigation.

For details write: ALI-ABA, 4025 Chestnut Street, Philadelphia, Penn. 19104, (215) 243-1600.

Advanced Water Pollution Control and Environmental Impact -- Physical and Chemical Waste Treatment. The objective of this course is for participants to learn the fundamentals of physical and chemical methods of treatment, which will serve as a framework in the analysis, design, and operation of waste treatment facilities. The most practicable and best available technologies are identified in addressing the goals of the Water Quality Act of 1972. Dates are Nov. 9-13.

This five-day seminar will use lecture, laboratory, and problem-solving sessions. Emphasis will be on applications of the principles, methods, and calculations related to physical and chemical treatment to domestic sewage and several wastes from industries, including pulp and paper, pharmaceutical, canning, petroleum, and chemical.

For additional information write: Continuing Engineering Studies, Ernest Cockrell Hall 2.102, The University of Texas at Austin, Austin, Texas 78712, Phone: 1-512/471-3506. This short course is being sponsored by Environmental Health Engineering and Civil Engineering Department, The University of Texas at Austin.

5th Southeastern Groundwater Conference. This conference is to be held November 12-13, 1981 at Georgia Southwestern College. It will include lectures and discussions of current hydrogeologic problems and research in the Southeast.

For conference details and information regarding presentations contact: Dr. Barry F. Beck, Department of Geology and Physics, Georgia Southwestern College, Americus, Georgia 31709.

Fourth Conference on Water Chlorination: Environmental Impact and Health Effects. This conference is to be held at the Asilomar Conference Center, Pacific Grove, California on October 18-23, 1981. Nationally and internationally known scientists and other experts in disciplines such as biology, chemistry, engineering, public health, water treatment, and the environmental sciences will present papers and discuss major facets of their research. A principal objective will be to maximize discussion between the conference participants.

For additional information, please contact: Dr. Robert L. Jolley, Fourth Water Chlorination Conference, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, TN 37830, Phone: 615-574-6838.

Fundamentals of Groundwater Management. An intensive two-day seminar to be held November 2-3 in Atlanta, Georgia. This is a practical program designed to acquaint professionals with the occurrence and movement of groundwater and the techniques available for managing subsurface water resources. It is for professionals who have little or no formal training in groundwater and who wish to acquire a working knowledge of the principles and professional practices involved in this field. In particular, engineers, planners, and administrators of water-related agencies on the local, state, and federal level, as well as engineers, geologists, environmentalists, and other professionals from consulting firms and industry should find this program valuable.

Resource Seminars in Water Resources is sponsoring this seminar and additional information may be obtained from Jannie Dresser, Seminar Coordinator, by calling 415/841-2091.

POSITIONS AVAILABLE

Faculty Position in Environmental Engineering Program. The University of Iowa is seeking applicants for a faculty position at the assistant or associate professor level in its Environmental Engineering Program. Candidates should have strong interests and capabilities in both teaching and research. It is desired that research interests of applicants be in the area of physical-chemical processes, with special emphasis on water treatment.

For additional details contact: Richard R. Dague, Professor, Civil and Environmental Engineering, College of Engineering, The University of Iowa, Iowa City, Iowa 52242.

Duke University has four positions available in its School of Forestry and Environmental Studies. The positions are in (1) Forest and Natural Resource Management Systems Science, (2) Forest Ecology, (3) Environmental Toxicology, and (4) Watershed Hydrology.

For details write to: Chairman, Faculty Council, School of Forestry and Environmental Studies, Box DM, Duke University, Durham, NC 27706.

WATER RESOURCES CONDITIONS IN NORTH CAROLINA

Streamflow was extremely variable across the State and ranged from drought conditions in the northern Mountain and western Piedmont regions to excessive flow (upper 25% of record) in the eastern Coastal Plain region. Most flows in the eastern Piedmont region were near normal.

During the month, the most severe drought conditions were centered around several northwestern counties, including Watauga, Ashe, Wilkes, Surry, Rockingham, and Stokes. In the drought area, flows in the larger streams were down to the 7Q2 to 7Q20 levels and many small headwater streams were dry. Rainfall for most of the drought area during August was less than an inch. Monthly-mean flow at the French Broad River gaging station located at Asheville was the lowest since 1930. Restrictions on water usage were imposed in several towns including Marion, Weaverville, Boone, and Canton. On the 31st, flows had receded to the 20 year drought level on many streams and were near record lows throughout much of the area.

In the eastern Piedmont and Coastal Plain regions, heavy rains on the 11th and 19th caused minor flooding on headwater streams and near bank-full stages on most larger streams. The rises on the 19th were caused by tropical storm Dennis which soaked eastern areas such as Wilmington, Clinton and Manteo with up to 10 inches of rain, while areas west of Greensboro were rainless.

Ground-water levels in shallow, water-table wells continued to decline in most of the Mountain and Piedmont regions and were generally 1 to 3 feet below normal. Levels in most Coastal Plain wells rose and were near or slightly above normal.

. . . . . *U. S. Geological Survey*

NEW PUBLICATIONS RECEIVED BY THE INSTITUTE

(Residents of North Carolina may borrow these from the Institute for a two-week period. Where individual copies are desired, readers are encouraged to request copies from the organization issuing the publication. The addresses are provided by the *NEWS* for this purpose.)

Water Resources Planning

"Flood-Plain Management: Administrative Problems and Public Responses," (completion report), 6/79, by E. J. Baur, et al, WRRI, KSU, Manhattan, Kansas 66506. (04A)

"Groundwater Management: The Use of Numerical Models," 1980, by Y. Bachmat, et al, avail. from American Geophysical Union, 2000 Florida Avenue, NW, Washington, DC 20009. (04B)

"Proceedings and Recommendations of the Workshop on Groundwater Problems in the Ohio River Basin, 4/81, by A. Rao, et al, WRRC, Purdue U., Lilly Hall of Life Sciences, West Lafayette, Indiana 47907. (04B)

"An Observation-Well Network Concept as Applied to North Carolina," (WRI #81-13), 3/81, by M.D. Winner, Jr., avail. from U. S. Geological Survey, Box 2857, Raleigh, NC 27602. (USGS)

"Peat Deposits of Dismal Swamp Pocosins Camden, Currituck, Gates, Pasquotank, and Perquimans Counties North Carolina," 7/81, by R. L. Ingram, et al, for North Carolina Energy Institute, 430 N. Salisbury St., Raleigh, NC 27603. (E&W)

"Guidelines for Water Reuse," (#68-03-2686), 3/80, by J. Donovan, et al, avail. from Camp Dresser & McKee, Inc., One Center Plaza, Boston, MA 02108. (03E Reuse)

"Interim Report to Congress: The Streambank Erosion Control Evaluation and Demonstration Act of 1974," (Section 32 Program), 9/78, U. S. Army Corps of Engineers, Washington, DC 20310 (Streambank Erosion)

Water Quality Management

"Contact Chamber Aeration Effects on Effluent Disinfection," (#137), 3/81, by S. Iwamoto, et al, avail. WRRC, U. of Hawaii at Manoa, 2540 Dole St., Holmes Hall 283, Honolulu, HI. (05D)

"Seven-Year Performance of CRREL Slow-Rate Land Treatment Prototypes," (SR #81-12), 7/81, by T. Jenkins, et al, avail. from U. S. Army Cold Regions Research & Engineering Lab., Hanover, NH 03755. (05E Land Treatment)

"Securing Support for Nonpoint Pollution Control with Local Compensation," (#134), 8/81, by W. Park, et al, avail. from VWRRC, VPI & SU, 617 N. Main St., Blacksburg, VA 24060. (208)

"Streamflow and Water Quality Modeling of the Chowan River," (#119), 8/80, by D. Contractor, et al, VWRRC, VPI & SU, 617 N. Main St., Blacksburg, VA 24060. (05G)

Water Quantity Management

"Methods for Forecasting Urban Water Demands," 1981, by D. R. Gallagher, et al, avail. from Dept. of National Dev. & Energy, Australian Water Resources Council, Canberra, Australia (06D)

Miscellaneous

"Current Published Searches, Bibliographies from the NTIS Bibliographic Data Base," 1981, by NTIS, USDC, 5285 Port Royal Rd., Springfield, VA 22161. (NTIS)

"Register of Environmental Engineering Graduate Programs," (4th Edition), 1981, compiled by P. Vesilind, et al, avail. from Ann Arbor Science Publishers, Inc., 230 Collingwood, P. O. Box 1425, Ann Arbor, MI 48106, price: $49.95. (HB)

"Proceedings of the Specialty Conference Water Forum '81," (Volume I and II), pub. by the American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017.

SPECIAL

Wetland Value Assessment--State of the Art

by

Joseph S. Larson
Professor and Chairman
Department of Forestry and Wildlife Management
University of Massachusetts

Since 1963, the term wetland has moved from limited circulation among wildlife biologists into everyday usage by lawyers, real estate developers, engineers, ecologists, and public health officials. In many Eastern states it has become a household word. Swamps, marshes, bogs, pocosins, and sloughs are all wetlands, but the generic term in current ecological and legal usage embraces the whole gradation of landscape units from seasonally flooded forests to coastal shores. Wetland is land where water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin et al.,1979).

The entry of this term into the vocabulary of many diverse professionals and into that of the general public has been due to enactment of state and federal statutes that require public review of most activities that may alter wetlands. Under certain conditions the landowner, public agency, or developer may encounter legal constraints that limit or prohibit him from using a wetland for the purpose of his project. Where wetlands were once valued primarily as habitat for wildlife, particularly migratory birds, the legal basis for present day wetland regulation is recognition that these landscape units have ecological functions of importance to public health, safety, and welfare.

In 1963, Massachusetts enacted the first wetland protection legislation. By 1978, 13 states had passed laws designed to specifically regulate wetland areas. In 19 others, state critical area regulatory programs contained some components of wetland protection (Kusler, 1978). In some states, particularly in the glaciated Northeast, both tidal coastal and inland freshwater wetlands are regulated. In other coastal states only marine and estuarine wetlands are affected. The federal government has expanded its involvement in wetlands from acquisition of areas of high value to migratory bird species to broad regulation of dredging and filling wetlands in "all waters of the United States." This followed passage of the 1972 amendments to the Federal Water Pollution Control Act (Pub. L.92-500), especially §404 of that Act. Under this statute, the Environmental Protection Agency sets and monitors guidelines for wetland protection and the U. S. Army Corps of Engineers implements these by requiring permits for all operations (except normal agricultural, forestry, and ranching) that involve discharge of dredged or fill material into wetlands. In 1977 President Carter issued Executive Order 11990 "in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands. . ." Under this order, all federal agencies must consider wetland alteration as a last resort when carrying out or assisting in programs affecting land use. A recent report to the Congress by the Comptroller General (1979) stresses the need for better understanding of wetland benefits in order to achieve the objectives of diverse federal programs, like the Water Bank Program, that are related to wetlands.

Each state and federal regulatory program does not recognize or protect all functional values of wetlands. When viewed collectively, however, these programs recognize values of wetlands that involve flood control, storm damage, water quality, fish nursery, nutrient productivity, groundwater supply, visual-cultural values, and wildlife. It is widely accepted, but not well specified by scientific documentation, that each wetland functions neither to provide all of these values nor any of them equally. Nevertheless, federal agencies have sizeable staffs of specialists who recommend upon and issue permits on the significance of individual wetlands to specific values. As an example of procedure on the state level, in Massachusetts the first line of permit authority is staffed by literally hundreds of unpaid municipal workers elected or appointed to local conservation commissions or wetland boards. Technical qualifications are not required for persons in these positions. In those states where a state agency is the permitting authority, staffs are small, underfinanced, and may lack personnel with recent training in all aspects of wetland functional ecology.

Federal wetland regulation is extensive and programs of states that have complex patterns of inland wetlands or equally complex coastal or estuarine wetlands can be intensive. The purpose of this paper is to examine both the functions of wetlands that give rise to human values and the state of the art of methods used to assess wetlands for these functional values.

FLood Control

Inland wetlands function as basins in the watershed that retain and detain water at various flood stages. Retained water leaves the surface water flow via evapotranspiration. Beyond the acknowledgement of this function, techniques have not been developed to permit regulatory agencies to readily assess this function for individual wetlands as it relates to downstream flood stages. Retention and delayed release of floodwaters significantly affected downstream flood stage and damage in two Massachusetts cases, according to state and federal studies in the Charles (Corps of Engineers, 1972a, 1972b) and Neponset River (Degen, 1977) watersheds. In the Charles, a U. S. Army Corps of Engineers' project is acquiring and protecting over 8,000 acres of natural wetlands that provide natural valley storage at

costs more favorable than would be provided by man-made structures. The Neponset River study indicated that significant increases in downstream flood stage occur with losses of 25-50 percent of the wetlands in the watershed. The Eastern Water Law Center of the University of Florida College of Law has developed a model surface water runoff control ordinance that involves wetlands (Water Law Center, 1979) and the Natural Resources Defense Council reviewed the flood control role of wetlands, as of 1975, for the Federal Insurance Administration (Rockefeller, 1975). Gupta and Foster (1976) have used avoided downstream flood damage data, resulting from upstream wetland protection, to estimate dollar values for wetland flood control. The U. S. Army Corps of Engineers has developed some "rule of thumb" generalizations on percent of total watershed area in wetlands as a flood storage factor and on percent wooded or shrub vegetative cover as a flood retardation factor (Reppert et al., 1979).

These approaches are limited to case studies and general assumptions derived from them. Perhaps the sole attempt to evolve a detailed field procedure for evaluating wetlands for their flood control role is being developed by the U. S. Soil Conservation Service (SCS) in Massachusetts (Soil Conservation Service, 1979). This approach numerically rates wetlands according to actual storage, the effectiveness of the storage, and the need for control downstream or damage potential. The flaw in this procedure and in the case histories cited above is their dependence upon downstream man-made structures to generate values or calculate avoided losses. Wetlands that effectively detain floodwaters on streams that have little man-made development are rated low in flood control value. This ignores the value of current land uses that do not involve structures and the loss of future opportunities for alternative land uses if the flood detention function of wetlands is impaired.

The SCS approach points in the direction of prime research needs, but it would seem that hydrologists can apply current technology far more effectively to wetland flood control than has been done to date. Studies of the relations of wetlands to flood control in unglaciated areas are lacking.

Storm Damage

Coastal wetlands are regarded as landscape units that protect fastlands from erosion, and buffer coastal flooding and sea level rise. Silberhorn et al. (1974) state that saline marsh vegetation is able to absorb or dissipate wave energy and to establish a dense root system that stabilizes the soil. They report that freshwater species are less effective in this regard and that the peat substrate of some marshes acts as a giant sponge in receiving and releasing water. They have developed for use in the Virginia wetland regulation program a ranking system that rates 12 coastal wetland plant communities for effectiveness as buffers against erosion and flood. Experimental evidence of this role appears to be lacking, however, and Tilton et al. (1978) state that where physical processes combine to produce shore erosion, the energies involved prevent the establishment of wetland communities. Clearly this assumed function of coastal wetlands requires further study before it is employed as a basis for regulation.

Water Quality

In the anaerobic soils of wetlands, denitrification removes nitrogen from the water and during the growing season, plant uptake of nitrogen and phosphorous removes these nutrients from water in and passing through wetlands. Gosselink et al. (1974) have suggested that this role is a form of natural tertiary treatment that has an income capitalized value in southeastern tidal marshes of $50,000 per acre, assuming that replacement of this function, following wetland destruction, would require construction of a tertiary treatment facility. Sloey et at. (1978) have reviewed the management of freshwater wetlands for nutrient assimilation in various parts of the world and in the United States such diverse communities as cypress domes (Wharton et al., 1977) and northern peat marshes (Kadlec, 1979) have been intensively studied for their potential to treat wastewater. In addition to nutrient removal, wetlands may at times remove significant amounts of metals and reduce the sediment load transported in streams (Kibby, 1978).

Techniques for assessing the role of individual wetlands for this role in water quality control are crude. Kibby (1978) has suggested that estimates of primary productivity of a site may be useful. In Virginia (Silberhorn et al., 1974), guidelines for regulating wetland alteration rank plant communities in their ability to act as sediment traps. If current estimates of tertiary treatment value are at all reasonable, and if there is high potential for using some wetlands to treat effluent, then there is a critical need to translate current knowledge into procedures that can be used in practical wetland regulation.

Fish Nursery

The bulk of the United States commercial fish catch, by weight and value, and the saltwater sport fish catch, by weight, are dependent upon coastal estuaries and their wetlands for food sources, spawning grounds, nurseries for the young, or for all of these purposes (McHugh, 1976). The importance of the fin and shellfish industry and the general acceptance of these roles of coastal wetlands have persuaded most coastal states and communities that wetlands are "fish nurseries." Protection of these functions was the purpose of the earliest wetland legislation. These functions continue to be accepted as valid but no techniques have been developed to rank or rate specific wetlands for this value. Some state regulations single out certain wetland plant communities for protection of these functions, but this is usually based on the rate of primary productivity, covered below.

The role of freshwater wetlands as "fish nursery" areas has not received attention comparable to coastal wetlands. Studies in Michigan have identified northern pike, carp, yellow perch, and possibly smallmouth bass as wetland-dependent spawners. Degradation and elimination of wetlands have been associated with collapse of the commerical fisheries of northern pike, muskellunge, lake sturgeon, and whitefish

in the Great Lakes (Jaworski and Raphael, 1978). Tilton et al. (1978) have used capital cost and annual expenses of purchasing wetlands and constructing wetlands to develop initial values for northern pike production.

The SCS wetland evaluation system in Massachusetts represents the sole attempt to rate freshwater wetlands as fish habitat (Soil Conservation Service, 1979). It places relative numerical rankings for fish habitat on wetlands that abut open water. It is based simply on the size of the permanent water body, wetland size, and numbers of sport fish species present. Given the data available on freshwater fish ecology, more sophisticated approaches seem currently feasible and could be important aids in administration of wetland regulations.

Productivity

Primary productivity is used as a measure of the effectiveness of a wetland in converting solar energy to a form of energy that may be used to power biological processes that sustain life in general and give rise to many of the valuable functions of wetlands. Tidal saline marshes have long been recognized as among the most productive landscape units in the world and there is reason to believe that freshwater tidal wetlands may be equally productive (Whigham et al., 1978). Much of the regulation of coastal wetlands has focused on the protection of those marsh communities that most effectively produce organic matter to fuel the biological processes of adjacent waters.

The Virginia regulatory system (Silberhorn et al., 1974) rates coastal plant communities according to their productivity and their location in the tidal flushing pattern and employs these as guides for wetland regulation. Laws in other states often specify certain productive plant communities for prime protection. Kibby (1978) has suggested measures of productivity as means to identify highly valuable wetlands.

Research is lacking on the productivity of many types of freshwater wetlands and on wetlands of the Pacific coast. Few productivity studies have adequate hydrologic data to document the movement of produced organic matter and little is known about below ground production. This role of wetlands is important to water quality considerations and the production of valuable marine food resources, but those who administer wetland permit programs have only the crudest means to incorporate these variables in the discharge of their legal responsibilities.

Groundwater Supply

A widely held assumption in need of correction is that freshwater wetlands generally recharge groundwater aquifers. Under some conditions, the groundwater system may receive some recharge from wetlands. However, wetland soils are typically less permeable than soils associated with groundwater-recharge areas, so recharge from wetlands will be less than from other areas. Most wetlands occur where water is discharging to the surface from the groundwater system (Novitski, 1979). In some cases, wetlands in the glaciated Northeast are indicators of surficial geology that may contain high-yield aquifers (Heeley and Motts, 1976) for water supply wells that are more economical than surface water supplies (Gupta and Foster, 1976). Where this indicator role prevails, water on the wetland surface is usually not closely related to the water tapped by the wells.

Helley and Motts (1976) have shown that many wetlands are indicators of potentially high-yield groundwater aquifers in Massachusetts, but furtherwork is needed in other portions of the glaciated landscape, especially where organic soils are extensive. The relationship between wetlands and groundwater in the unglaciated landscape is still a matter for speculation and further research.

Visual-Cultural

Visual-cultural or aesthetic values of wetlands are derived from the role that wetlands play in providing visual contrast and diversity on the landscape and in providing educational opportunities. Smardon and Fabos (1976) have developed a system for ranking freshwater wetlands for comparative visual-cultural values. Gupta and Foster (1976) developed economic values associated with this ranking based on public willingness to pay measures. The Soil Conservation Service (1979) has employed a simple version of this system for use in their wetland evaluation scheme.

The concept of uniqueness of a wetland enters into some evaluation systems (Larson, 1976; Soil Conservation Service, 1979; Reppert et al., 1979). The proposition put forth is that certain wetlands provide outstanding examples of biological, geological, historic conditions, or research potential, that merit protection of the wetland at all costs. It is usually suggested that relative ranking or economic evaluation of wetlands of this character are inappropriate. To be effective, systems that include this factor need to employ characteristics for qualification that clearly distinguish such wetlands from the remainder of the wetland population. Visual-cultural evaluation techniques are in need of more field testing to determine acceptance, but few wetland regulatory programs consider this feature of wetlands.

Wildlife

The protection of wetlands as habitat for wild birds and mammals was the original purpose of public wetland acquisition programs. This function and various attempts to place economic values on wetland wildlife are well documented (Leitch and Scott, 1977; Jaworski and Raphael, 1978). Early efforts at eval-

uation of the wildlife wetlands centered on estimates of the dollar value of the wildlife product or of man days of recreational use. Current techniques focus on the habitat that produces the wildlife. A system of ranking freshwater wetlands for wildlife value was developed by Golet (1976) based on biophysical characteristics of wetlands. Parallel economic values were derived from measures of public willingness to pay for purchase of wildlife wetlands (Gupta and Foster, 1976). The SCS has adapted this approach to their evaluation system in Massachusetts (Soil Conservation Service, 1979). The U. S. Fish and Wildlife Service (Schamberger et al., 1979) is developing a Habitat Evaluation Procedure (HEP) applicable to wetlands plus other aquatic and terrestrial sites. It is based on specific habitat needs of specified species of wildlife and generates a measure called habitat units. The procedure requires detailed information on the habitat requirements of a species and is applicable only to those species for which this information is available.

The HEP procedure is relatively untested and the Golet system was developed for northeastern conditions. Species-specific and biophysical systems have different assumptions and strengths. Both need wider testing and comparison and the potential for integration of the two should be explored.

Summary

The development of wetland regulatory legislation in the United States over the last 17 years has required municipal, state, and federal agencies to establish permit procedures that will allow reasonable use of wetlands while at the same time protecting essential ecological functions that give rise to the public values protected in the statutes. The permit process implies the existence of techniques for evaluating wetlands. The literature on wetland evaluation techniques is diffuse and the state of the art is highly variable.

A few case studies of wetland flood control have produced "rule of thumb" and very general field procedures for evaluating wetlands for flood control, but these have not been widely applied or tested. The role of coastal wetlands in reducing storm damage is questioned and research is lacking. High monetary values have been estimated for wetlands as natural treatment areas for removal of excess nutrients, but these economic values may be inflated and field evaluation techniques are not well developed.

The role of coastal wetlands as fish nursery sites is so well accepted that evaluation techniques for specific sites have not been developed and may not be required. Techniques are needed for evaluating freshwater wetlands in this regard. Crude assessment techniques have been offered for evaluating specific wetland communities for productivity but hydrologic information is frequently lacking for many research sites, hampering the acquisition of accurate estimates. Research shows that freshwater wetlands have a lesser role in groundwater recharge than is popularly believed. Most information in this regard comes from the glaciated northeastern United States and little from other, unglaciated areas of the country. Ranking techniques and economic assessment procedures are available for visual-cultural values of wetlands, but have not been widely used or tested. Ranking techniques are more widely developed for inland wildlife values and are being tested. More work is needed to determine if species-specific and habitat evaluation techniques can be combined.

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