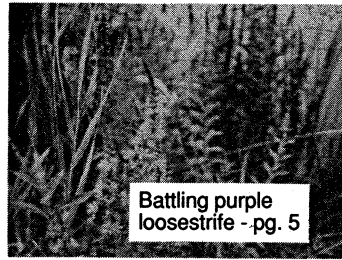




**US Army Corps  
of Engineers**  
Waterways Experiment  
Station



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## The Wetlands *Research Program*

# Bulletin

Volume 4  
Number 1  
March 1994

## Study of hydraulic roughness in wetland vegetation takes new look at Manning's *n*

by Brad R. Hall and Dr. Gary E. Freeman, U.S. Army Engineer Waterways Experiment Station

Hydraulic calculations often parameterize the effects of roughness and associated frictional loss in the Manning equation, in which the roughness parameter is designated as the Manning's *n* value. The calculation of *n* values has been of interest since the Manning equation was presented in the late 1800s. While estimation of *n* values for normal channels has been fairly well standardized, the estimation of *n* values in areas of dense vegetation continues to be subject to large variations depending on the experience of the engineer and perceived density of the vegetation. Value of flow resistance in densely vegetated environments is important in design of constructed wetlands, flood routing through existing wetlands, and determination of flood heights for flood damage studies. Due to limited information on vegetative roughness in wetland environments, the Wetlands Research Program funded a study to determine Manning's *n* values for vegetative and hydraulic conditions characteristic of wetlands.

### Experimental facility and approach

The facility used to test *n* values in vegetated channels consisted of a 1.2-meter-wide and approximately 150-meter-long concrete lined drainage channel at the Lewisville Aquatic Ecosystem Research Facility in Lewisville, Texas. The channel has 0.67-meter-high vertical sidewalls. The test section (approximately

### What are Manning's *n* and the Reynolds Number?

Robert Manning, an Irish Engineer, introduced an empirical equation for computing average velocities in channel flows in 1889. This equation, commonly called the Manning's equation, subsequently gained wide use in the engineering community. Central to the use of the Manning's equation is the specification of the roughness coefficient, which is most commonly called the Manning's *n* value. The value of Manning's *n* is proportional to the degree of roughness and obstruction of flow, with "rougher" channels (i.e. boulder and cobble bedded streams) having a higher *n* value than "smoother" (i.e. sand and concrete channels).

Reynolds Number, named after the English fluid mechanician Osborne Reynolds, is a dimensionless number which characterizes the turbulent state of a given flow. Low Reynolds number flows are called "laminar" and the flow structure is characterized by motion in laminae or layers. High Reynolds number flows are called "turbulent." In this case the flow structure has characteristic random fluctuations around the mean fluid motion. Most common flows in pipes and channels are characteristically "turbulent."

15 meters) of the drainage channel was modified by placing a bulkhead at the downstream end. This allowed placement of a 0.05- by 0.15-m stoplog, retention of approximately 0.15 m of soil on the floor of the channel, and control of tail water depth through placement of additional 0.05- by 0.15-m stoplogs. Testing for backwater conditions included increasing downstream water condition by using either one or two stoplogs, thus increasing the water depth in the vegetated area by 0.15 to 0.30 m above the level of the soil in the test section.

A weir placed in the channel 77 m upstream from the test section allowed free flow at the weir for all test conditions. A triangular weir was used for flows up to 0.044 cubic meters per second (cms). A contracted rectangular weir was used for higher flows.

Water for the series of tests was obtained from ponds adjacent to the upstream end of the drainage channel. Pond volume was sufficient to allow a 2- to 3-hour test for each run with a nearly constant flow rate in the test channel. Maximum flow rate was 0.057 cms, which allowed overtopping the vertical portion of the channel to create a high backwater condition. Tests to determine Manning  $n$  values were run at flow rates of 0.009 cms, 0.026 cms, 0.044 cms, and 0.057 cms.

Soft stem bulrush (*Scirpus validus*) was planted in late April 1992 in soil placed in the bottom of the concrete channel. A continuous supply of water due to seepage and releases from nearby ponds used in ecosystem research allowed the bulrushes to grow from late

April until late July 1992. At the conclusion of the initial test phase, bulrush samples were analyzed for stem count, diameter, and dry weight of the plants. Growth continued until late November 1992 when additional testing took place.

The bulrush stand, when tested for the  $n$  value determinations, was well established in late July with an average of 403 stems per square meter. The average diameter for the bottom 50 cm of the stems was 0.7 cm and the volume of stems in the lower 50 cm of water was  $8,704 \text{ cm}^3/\text{m}^2$  or 1.7 percent of the total channel volume. By the November test date, plant densities had doubled from an average  $402 \text{ stems}/\text{m}^2$  to  $807 \text{ stems}/\text{m}^2$ .

Stem diameter had also increased from 0.70 cm to 0.76 cm. The bulrushes occupied an average of 4 percent of the channel volume in November compared with 1.7 percent in July. Total plant dry matter content had increased from 442 grams per square meter in July to 1,502 grams per square meter in November.

### Manning's $n$ Value determination

The water-surface profile was measured for each test flow rate for two different tailwater conditions. The first condition tested in July was with two stoplogs in place, one to retain soil and the second to raise tail water above channel bed. The second condition tested used three stoplogs, creating the high tailwater condition. Water surface elevations and velocity measurements were taken at five stations along the test section (Fig. 1) located at the upstream and downstream ends

of the section and at 3-meter intervals along the test channel between the ends of the bulrush stand. One set of water surface profile measurements was also taken during the November tests for a flow rate of 0.044 cms. Since the water surface slope was relatively constant during high tailwater testing in July, water surface elevations were measured at the upstream and downstream ends of the test channel during the the November tests only.

Manning's  $n$  values were determined using the average of the measured velocities within the bulrush stand and the computed cross-sectional average velocity. In all cases, the  $n$  value shows a trend of reduction with increasing velocity, and an exceptional outlier based on measured velocities during the July test. At very low

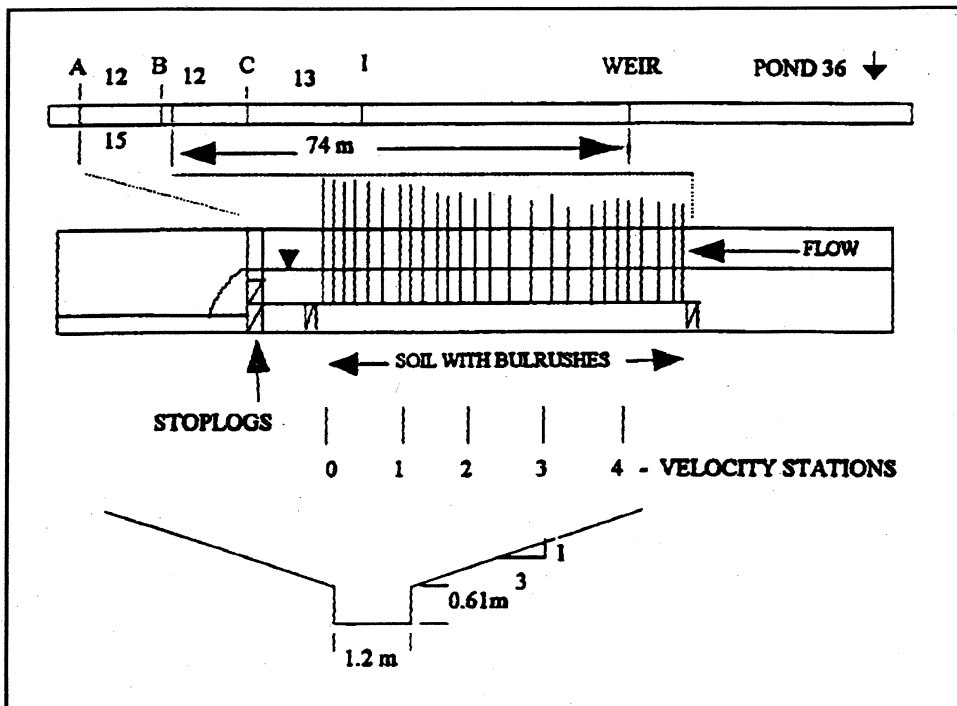


Figure 1. Schematic of test flume



velocities the accuracy of the velocity meter and water surface slope measurements may account for much of the large difference between observed and calculated values. In general, the values show a definite trend towards reduction in  $n$  value with increasing velocity (Fig. 2). This decrease cannot be construed as a result of bending of the bulrush stems since all velocities were well below threshold where the stems would begin to bend. The November tests, with double the number of bulrush stems, show a similar trend at a significantly higher range of  $n$  values.

The effect of bulrush density can be seen in Figure 3 where the  $n$  value for a condition with no bulrushes in the channel was determined upstream of the test channel and estimated to have a value of 0.03. The data indicate that the increase in  $n$  value with increasing plant density is nearly linear for the range tested. The ratio of this increase in  $n$  averaged 182 percent for a doubling in plant density from 403 to 807 stems per square meter. The reduction in  $n$  value with increasing velocity is reflected in the observation that for a given stem density there is a reduction in  $n$  value with increasing flowrate.

Reynolds numbers for the various flows were calculated to determine if a change in the coefficient of drag ( $C_d$ ) could be responsible for the change in Manning's  $n$  values due to reduction of  $C_d$  with increasing Reynolds number. Stem Reynolds numbers ( $Re = \rho V D / \mu$ , in which  $\rho$  is the fluid density,  $V$  is the unobstructed flow velocity,  $D$  is the stem diameter, and  $\mu$  is the fluid viscosity) range from a low of 661 for the 0.009 flow rate in July to a high of 3171 for the 0.0064 flow in the November test. These Reynolds numbers are in the range of a laminar boundary layer and are significantly below the

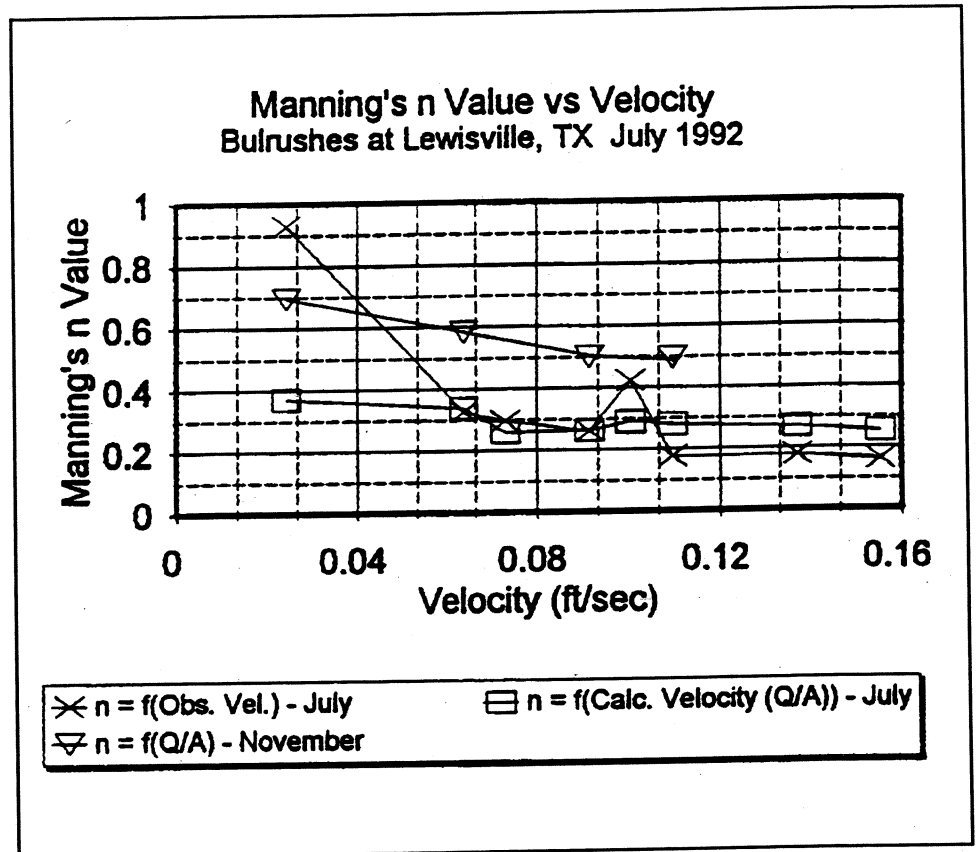


Figure 2. Manning's  $n$  value vs. velocity

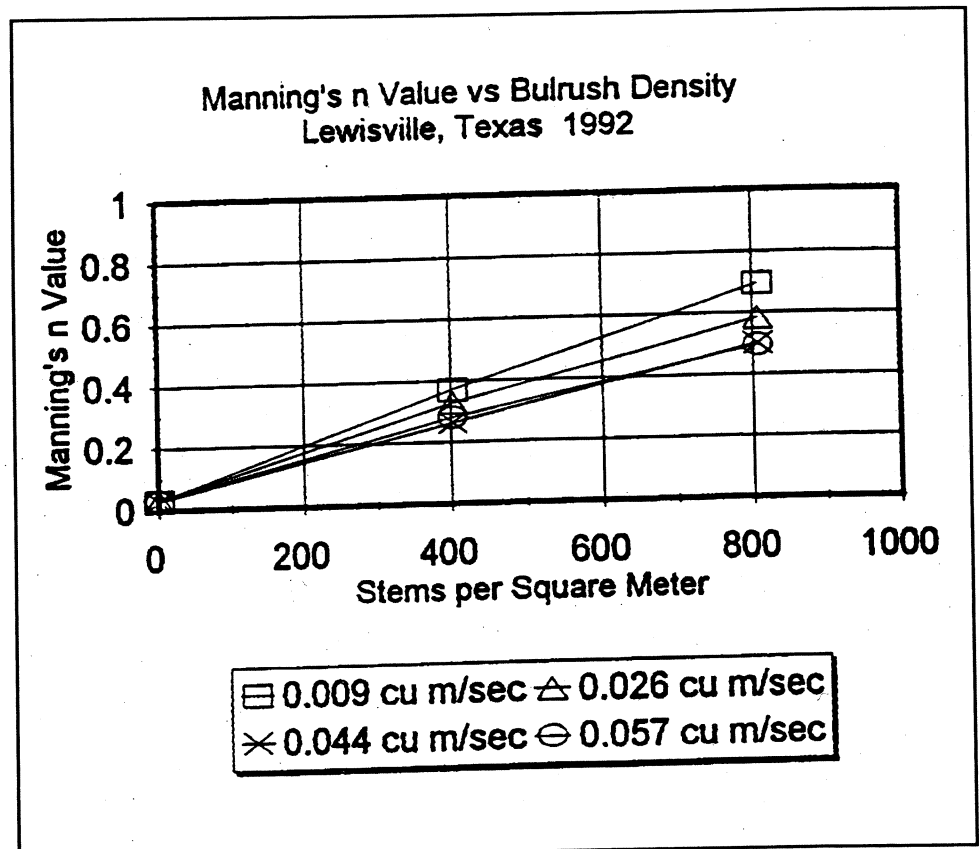


Figure 3. Manning's  $n$  value vs. bulrush density

range of the transition to a turbulent boundary layer for flow around a single cylinder. The Reynolds number is high enough to indicate a turbulent wake behind a single cylinder. These Reynolds numbers suggest that the drag coefficient is relatively uniform over the range of velocities tested. It can be concluded that the drag coefficient does not account for the variation in Manning's  $n$  value when velocities are varied. This assumption was also true when  $n$  was compared to velocity multiplied by the hydraulic radius of the channel. An untested hypothesis for this phenomenon may be that the reduction in  $n$  values with increasing velocity results from advection of turbulence from upstream bulrush stems on flow around the downstream bulrush stems. Advection turbulence may reduce flow resistance by causing early transition to a turbulent boundary layer at the downstream bulrush stems, reducing their local drag characteristics. These effects are presently under investigation by University of Illinois researchers under contract with the Waterways Experiment Station, using a numerical turbulence model.

### Comparison with existing vegetation roughness guidelines

In 1989, the United States Geological Survey published "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains." This publication indicates that a base  $n$  value of from 0.026 to 0.032 should be used for straight uniform channels in firm soil. A maximum of 0.100 for "dense cattails growing along channel bottom" should be added. If applied to the WRP study, dense cattails and dense bulrushes could be assumed to be similar in hydraulic

characteristics. Other adjustments would be for channel irregularity, variation in cross section, and obstructions in the channel. All of the other factors used in the USGS guidelines would be zero for the WRP experiment. Using the maximum values from the above range indicates the  $n$  value for this test channel with bulrushes to be 0.132.

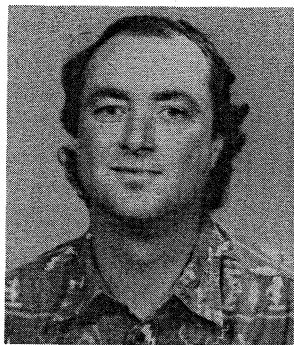
### Conclusions

The measured  $n$  values determined from these experiments were found to vary from 0.27 to 0.70 for bulrushes, dependent on stem density and flow conditions. These measured Manning's  $n$  values are 2 to 5.4 times higher than the value obtained using the USGS vegetated channel roughness guidelines. The  $n$  value was found to decrease with increasing velocity for both growth conditions tested. Variations in  $n$  value could not be accounted for by changes in the drag coefficient  $C_d$ .

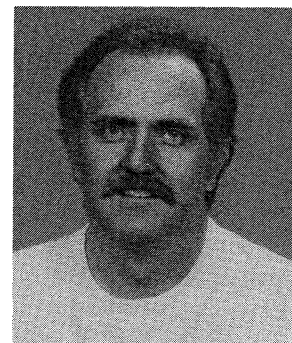
The variation in  $n$  value with vegetation density and flow parameters indicates that care must be taken to assure proper characterization of hydraulic roughness in vegetated channels. The information based on the WRP study can serve as a preliminary guideline for estimating Manning  $n$  in dense, emergent vegetation; however, professional judgement must be applied when analyzing wetland systems with hydraulic and vegetative characteristics that differ from those tested and reported in the WRP study.

More information may be obtained by calling Brad Hall at (601) 634-3392 or Gary Freeman at (601) 634-4303.

*Brad R. Hall is a research hydraulic engineer in the Math Modeling Branch, Waterways Division of the Hydraulics Laboratory. He received his B.S. in Environmental Resources Engineering from Humboldt State University, his M.S. in Civil Engineering from Utah State University, and is currently working towards his PhD in Civil Engineering through the University of Minnesota. In addition to his WRP research, Hall focuses on identifying the channel forming discharge in alluvial channels. He led the development of mobile bed modeling capabilities in the CH3D-WES three dimensional hydrodynamic model. Prior to coming to WES in 1989, Hall worked in the Hydraulics Section of the U.S. Army Engineer District, Seattle. He is a registered Professional Engineer in the State of Washington.*



*Gary E. Freeman is a research hydraulic engineer in the Math Modeling Branch, Waterways Division of the Hydraulics Laboratory. He received his B.S. degree in Agricultural and Irrigation Engineering and his M.S. degree in Irrigation Engineering from Utah State University and his PhD in Civil Engineering from Texas A&M University. Freeman is the principal investigator for a joint research project with the EPA on developing sedimentation models for prairie pothole wetland systems. He recently completed an assignment with the White House sponsored Science Assessment and Strategy Team in Sioux Falls, S.D., for developing flood plain management guidelines in response to the upper Mississippi River floods of 1993. Prior to coming to WES in 1991, Freeman consulted on numerous irrigation and hydraulic design studies in several north and west African countries.*



# Battling purple loosestrife brings some success

by Linda S. Nelson and Dr. Kurt D. Getsinger, U.S. Army Engineer Waterways Experiment Station

Purple loosestrife, an erect, herbaceous perennial, is most readily identified by its tall, showy spikes of purple flowers that bloom from late June to early September. Nicknamed the "Purple Plague," these beautiful flowers disguise the serious threat that purple loosestrife poses to wetlands of North America. Purple loosestrife (*Lythrum salicaria* L.) is of Eurasian origin and was first reported along the northeastern coast of North America in the early 1800s. Since then, this highly invasive wetland plant has spread to 40 states and Canada. Serious infestations extend to the Pacific Northwest and populations are reported as far south as Huntsville, Alabama and Beaumont, Texas.

Once purple loosestrife is established in a wetland, it displaces native vegetation through rapid growth and heavy seed production. It is estimated that a single mature plant can produce more than 2.5-million seeds per growing season. Additionally, this seed bank is highly viable with a germination rate greater than 95 percent for fresh seed and 80 percent after 2 to 3 years' submergence. A monotypic stand of purple loosestrife (Fig. 1) not only decreases the vegetative diversity of a wetland, but also provides little food or habitat for wildlife. Estimates show an annual loss of almost 200,000 ha of wetland in the United States through invasions of purple loosestrife. The states of California, Idaho, Minnesota, Ohio, Washington, and Wisconsin and the Canadian province Manitoba currently have legislation to combat the spread of this plant.

Management techniques to control purple loosestrife include flooding, draining, handpulling, burning, cutting, and herbicide applications. Evaluations of these techniques indicate varying degrees of success, and rarely result in long-term control. In addition, these measures can be too destructive for areas with specific management objectives, such as maintenance of wildlife habitat or community diversity. Scientists also report that physically disturbing an area can be an open invitation for a purple loosestrife invasion. The need to maintain wetland community integrity calls for the development and use of minimum impact management strategies. Although it is not practical to assume that purple loosestrife will ever be eradicated from wetlands in the United States, new chemical and biological control strategies

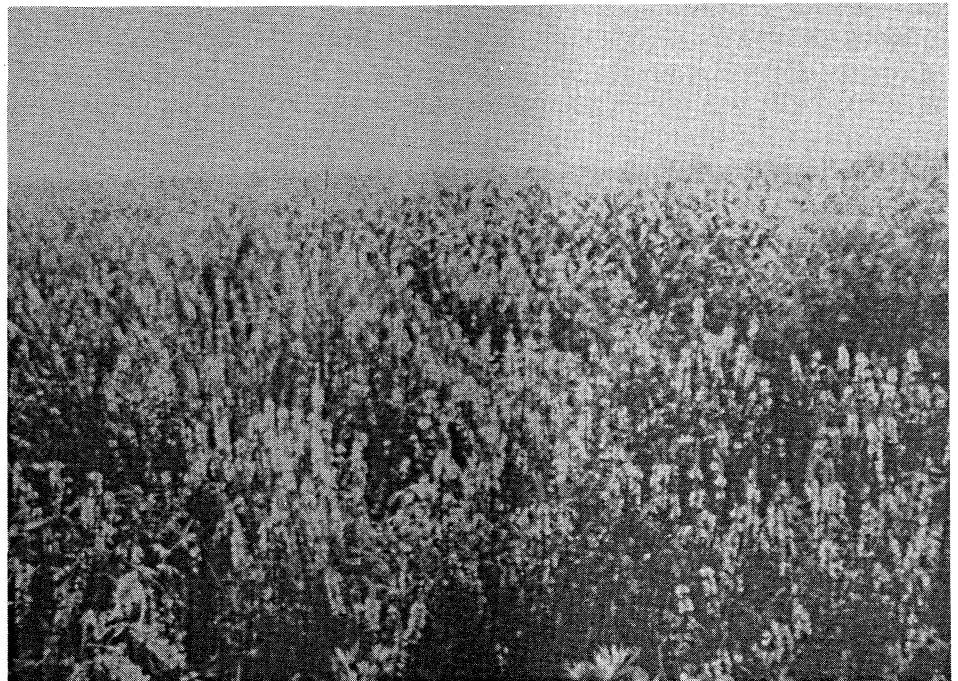
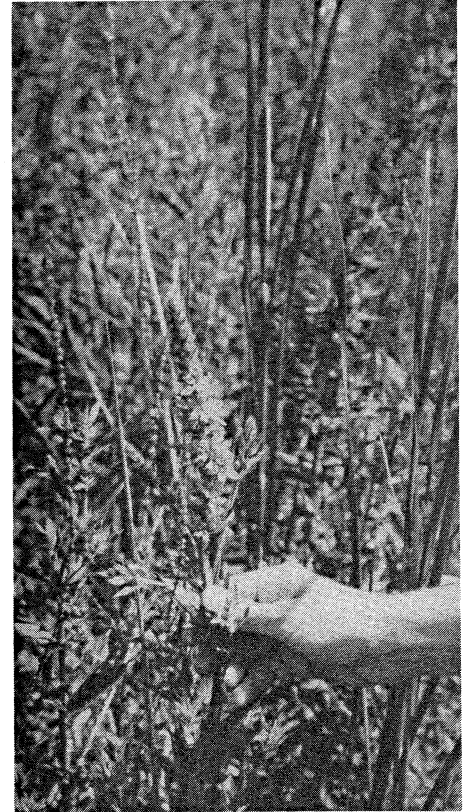


Figure 1. Purple loosestrife (*Lythrum salicaria* L.) stand at WRP study site



currently under investigation promise to provide better management of this exotic pest.

Unfortunately, some herbicides presently available for application to aquatic environments are non-selective, and kill all of the vegetation in the area of treatment. This type of chemical treatment is acceptable for "spot" applications to remove small infestations; however, it may not be the treatment of choice in situations where purple loosestrife is well established and where a large seedbank exists. The lack of chemical selectivity, coupled with the invasive nature of purple loosestrife only increases the accessibility of a treated area to seedling recruitment.

Recent field tests with the herbicide triclopyr have revealed a new potential chemical management tactic against purple loosestrife. Triclopyr is an auxin-type herbicide used for selective control of many woody and herbaceous broadleaf (dicot) plants in industrial, forestry, and non-cropland sites. Triclopyr is currently undergoing evaluation for use in aquatic environments

through an Experimental Use Permit (EUP) issued by the U.S. Environmental Protection Agency. The fact that purple loosestrife is a dicot, whereas many beneficial aquatic plants are monocots, combined with the broadleaf selective properties of triclopyr give this herbicide a distinct advantage over other chemical management strategies currently in use. Vegetation tolerant to triclopyr remains in place and competes with germinating loosestrife seedlings. Indications are that this type of selective control reduces the target plant species, maintains desirable vegetation, increases biodiversity, and minimizes the dependency of repeated herbicide applications. Triclopyr has been found to have a low level of toxicity to microbial communities and aquatic organisms, and residue accumulation in sediment, shellfish, and fish is negligible.

### **WRP project evaluates herbicide**

Scientists at WES are evaluating the effects of triclopyr on shoreline populations of purple loosestrife

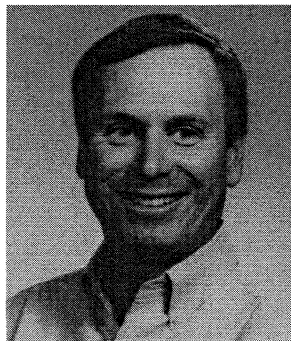
along the upper Mississippi River in Minnesota. They will document the efficacy of triclopyr on purple loosestrife, as well as resulting vegetative changes to the remainder of the wetland plant community.

The study site is located in Pool 5 of the Mississippi River near Weaver Landing, and is managed by the U.S. Fish and Wildlife Service as part of the Upper Mississippi River National Wildlife and Fish Refuge. According to plant surveys, purple loosestrife was well established in this area by 1989. A spray program using the non-selective herbicide glyphosate was initiated several years ago by refuge managers to control small infestations. However, large, mature populations were considered impractical to treat in this manner, and thus remained intact.

Permanent transects measuring 25 m were established in mature stands of purple loosestrife and were randomly assigned one of the following treatments: 1.0 percent triclopyr formulation, 0.75 percent triclopyr formulation, or untreated control. The triclopyr formulation used was a triethylamine (TEA) salt of which 44.4 percent is active ingredient. Treatments were replicated three times. To improve spray coverage, a nonionic surfactant was added to the spray mixtures at a rate of 0.25 percent v:v. Treatments were applied on June 30, 1992, using an airboat equipped with a high-volume handgun sprayer. Vegetation was sprayed to wet with two passes of the airboat. Swath width was approximately 6 m along either side of each 25-m transect. At the time of treatment, purple loosestrife was in the late bud to early flower stage of development. Previously conducted studies by other researchers showed that timing triclopyr application with early flowering is important for maximizing chemical effectiveness.



*Linda S. Nelson is a plant physiologist in the Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station. Her research interests within the Chemical Control Technology Team include evaluating the use of plant growth regulators and herbicides as management tools for terrestrial (turfgrass) and aquatic environments. Nelson holds a B.S. degree in biology from the University of South Dakota and a M.S. degree in agronomy from Iowa State University.*



*Dr. Kurt D. Getsinger is a research biologist in the Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station. He leads the Chemical Control Technology Team and his expertise includes management of nuisance aquatic vegetation using herbicides and plant growth regulators. Getsinger has a B.S. degree in biology from Campbell University, a M.S. degree in biology from East Carolina University, and a Ph.D. in plant physiology from Clemson University.*

Prior to chemical application, percent cover of purple loosestrife was determined by line intercept techniques. Percent coverage for all associate species was determined by quadrat sampling, using 1.0 × 0.5 m quadrats placed at 3-m intervals along plot transects (Fig. 2). Purple loosestrife was the dominant plant species (>50 percent) in the test area; the most common associate species identified were broad-leaved arrowhead (*Sagittaria latifolia* Willd.), reed canary grass (*Phalaris arundinacea* L.), giant bur-reed (*Sparganium eurycarpum* Engelm.), and common cattail (*Typha latifolia* L.). Subsequent vegetation sampling was scheduled for 10 weeks, and 1 and 2 years posttreatment.



Figure 2. Researchers monitor vegetative changes to the wetland plant community following application with the selective herbicide, triclopyr

### WRP study shows positive results

To date, results indicate that triclopyr is effective at reducing purple loosestrife (Table 1). The higher treatment rate (1.0 percent solution) was most effective, reducing purple loosestrife cover by 95 percent, while untreated transects showed an increase (28.5 percent) in purple loosestrife cover. Germinating seedlings (1 to 2 cm tall) were observed in all triclopyr-treated areas at 10 weeks after treatment. Seedlings were most evident in bare ground areas adjacent to dead loosestrife plants. Resprouting stems from mature loosestrife rootcrowns were also visible. Resprouting was most evident in areas treated with the low rate of triclopyr (0.75 percent solution).

Future evaluations will determine the regrowth potential from these

late germinating seedlings and resprouting rootcrowns, as well as changes in the plant community following removal of purple loosestrife.

Record high water throughout the summer and fall of 1993 hindered 1-year posttreatment data collection, however sampling will continue in the spring of 1994 (2-yr posttreatment). Results from this

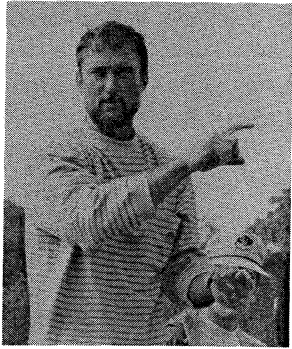
study will provide guidance on the use of triclopyr as a management tool to selectively control purple loosestrife.

Further information is available from Linda Nelson, phone (601) 634-2656, or Kurt Getsinger, phone (601) 634-2498.

Table 1. Percent change in purple loosestrife canopy cover as measured by line intercept techniques following application of triclopyr

Treatment in Loosestrife Cover	Percent Cover		Percent Change, Purple
	Pretreatment (6/29/92)	10 WAT (9/9/92)	
1.0% Triclopyr TEA <sup>1</sup>	51.5	2.6	-94.8
0.75% Triclopyr TEA	55.8	9.1	-85.1
Untreated Control	71.2	91.5	+28.5

<sup>1</sup>Triclopyr was formulated as a triethylamine (TEA) salt, 44.4% active ingredient; a nonionic surfactant was added at 0.25% v:v.



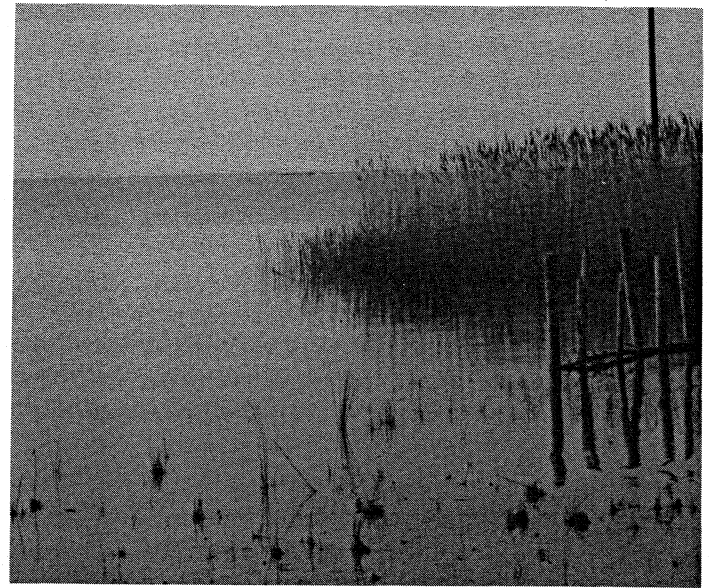
## Corps to hold national wetland workshop

A national interagency workshop on wetlands will be held at the Clarion Hotel in New Orleans, La., April 3 through 7, 1995. The workshop carries the theme "Technology Advances for Wetlands Science," and is sponsored by

the U.S. Army Corps of Engineers as part of the Wetlands Research Program. The theme emphasizes how research impacts wetlands technology and management strategies and how wetlands will be perceived by the public and wetlands professionals in the future.

The National Interagency Workshop on Wetlands will feature sessions from scientists and engineers who will present the results of the 4-year interdisciplinary Wetlands Research Program conducted by the U.S. Army Engineer Waterways Experiment Station, as well as research results from other national studies conducted by government agencies, academia, and private enterprise. The workshop will provide an opportunity for the interchange of ideas and contacts, for mutually beneficial interactions and for developing partnerships for future research.

Speakers are requested to choose from among the following topics, and to submit their topic with a brief statement by FAX no later than July 15, 1994:



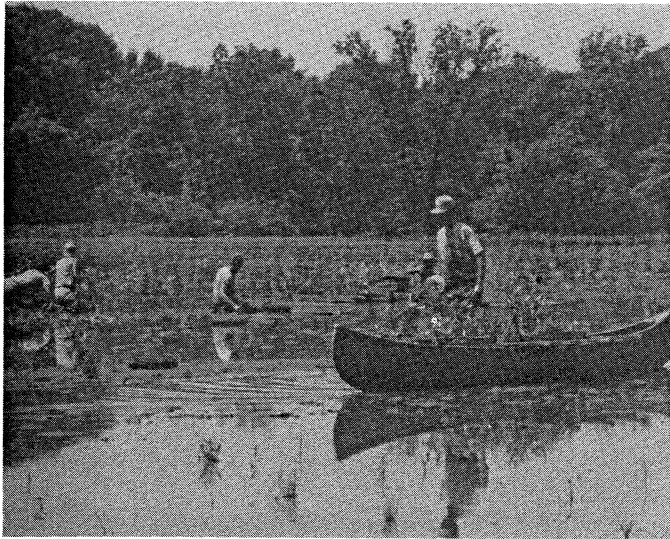
- Restoration, Protection, and Creation
  - Placement and design
  - Construction and implementation (engineering)
  - Monitoring for success
  - Research field studies
  - Constructed wetlands (cleanup and remediation)
- Identification and Delineation
  - Regional approaches
  - Hydrology of hydric soils
  - Hydrologic indicators
  - Hydrophytic vegetation
- Evaluation
  - Hydrogeomorphic classification system
  - New wetland assessment methods
- Processes
  - Hydrology and hydraulics
  - Sedimentation and erosion
  - Water quality
  - Soils chemistry
  - Biotic components
- Stewardship and Management
  - Change assessment
  - Automated wetland management systems
  - Cumulative impacts analysis
  - Mapping and inventory
  - Research field studies
- Other Issues
  - Mitigation and mitigation banking
  - Watershed planning
  - Ecosystem analysis
  - Landscape ecology/modeling





Authors desiring to submit papers must submit a 75 to 150 word abstract to be received by Sept. 30, 1994. The topic of the proposed paper should be clearly outlined in the abstract, since selection for presentations at the workshop will be based on review of the abstract.

Primary authors only will receive communications concerning presentations. Papers received must reflect the information as described in the accepted abstract and must be of professional quality. For presentation at the Workshop, 35mm slides are the preferred visual aids.



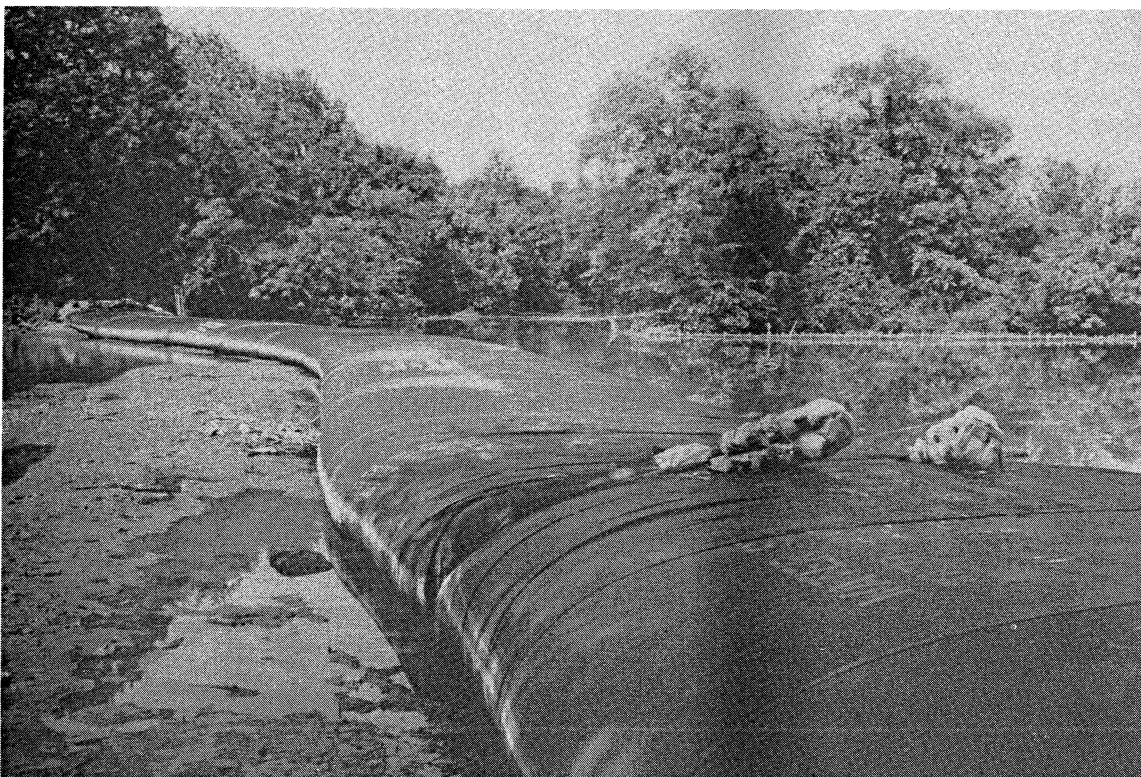
Additional information is available from

U.S. Army Engineer Waterways Experiment Station  
Wetlands Research & Technology Center

ATTN: CEWES-EP-W

3909 Halls Ferry Road, Vicksburg, MS 39180-6199

Telephone (601) 634-2569/4217, FAX (601) 634-3664.



## WRP activities

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### **North Dakota Soil and Water Conservation Meeting Held**

Wetlands Research Program results from non-point source pollution and wildlife studies conducted at Bowman-Haley Reservoir were presented during the annual meeting of the Soil and Water Conservation District of Bowman and Slope counties, North Dakota. Ongoing and future conservation projects within the Bowman-Haley Reservoir watershed, a U.S. Army Corps of Engineers, Omaha District facility, were discussed. In addition to the Corps representatives, U.S. Fish & Wildlife Service, U.S. Forest Service, SCS, North Dakota State University (extension), North Dakota Game & Fish, and Ducks Unlimited personnel, as well as some 40 local

farmers and ranchers, attended the February meeting and showed support for ongoing Corps efforts.

### **Ramsar site forested wetland research to be showcased**

A video documenting the research from the Cache River, Ark., is currently under production by Foley Productions, the University of Arkansas, Fayetteville, the WRP, and other federal and state agencies. The video will depict the forested wetland through the four seasons. Scientists and engineers from various agencies who worked at the Cache will talk about their research areas and their research results.

The video is scheduled for completion in fall of 1994.

## WRTC activities

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### **WRTC representatives attend interagency wetlands meeting**

Dr. Russell F. Theriot and Richard Coleman of the Wetlands Research and Technology Center recently attended the Fourth Annual Interagency Coordination Meeting in Washington, D.C., to discuss federal wetlands research and future development. Also represented were Corps Headquarters and 10 other Federal agencies.

### **Hydric soils subject of committee work**

Dr. Russell F. Theriot attended a meeting of the National Technical Committee for Hydric Soils in Washington, D.C., on Jan. 25 and 26, 1994, representing the U.S. Army Corps of Engineers. The committee sets policy on hydric soils that affects wetland regulations.

### **U.S. Air Force participates in wetland training course**

The Wetlands Research and Technology Center sponsored an Environmental Compliance Course for U.S.

Air Force personnel. The instructions took place at the Corps' Duck, N.C., training facility, December 6 to 10, 1993, with 30 environmental compliance coordinators attending.

### **WRTC exhibits support Earth Day activities**

The busy year for WRTC displays has started.

The displays travelled to support 14 events from January through May and schedules are filling up for the remainder of the year. During April, displays were used for Earth Day events in Washington, D.C., Texas, Florida, Georgia, Maryland, Missouri, and Minnesota. More than 40,000 visitors have had the opportunity to learn about wetlands through the exhibit program.

Corps District and Division personnel may request the displays for special occasions, lobby exhibits, public outreach events, etc. Handouts will be provided upon request. Exhibits may be reserved by calling (601) 634-3802 or 2349, FAX (601) 634-3664.

# Professional meetings announced

## Public Works organization to sponsor international symposium in 1995

An international public works symposium will be held at the Washington State Convention and Trade Center, Seattle, Wash., April 19 to 21, 1995. The symposium, "Public Works and the Human Environment," is sponsored by the Washington State Chapter American Public Works Association and coincides with the 25th Anniversary of Earth Day. Deadline for submission of abstracts is June 15, 1994.

Presentations will explore past public works accomplishments and solutions to future challenges as they pertain to shaping the human environment. Educational

sessions will include topics on solid waste management, disposal, and recycling; water resources use and management; project financing, administration, and human resources management; and transportation and intermodal demands for mobility and distribution of goods and services.

Registration, lodging and local information will be mailed with the advance program. Administrative support is provided by the University of Washington division of Engineering Professional Programs. Advance programs may be obtained by contacting: Engineering Professional Programs, 3201 Fremont Avenue North, Seattle, WA 98103, telephone (206) 543-5539, fax (206) 543-2352.

## WRTC active in Gulf of Mexico Program

The Gulf of Mexico Program was established in 1988 by the Environmental Protection Agency. The program provides a mechanism for addressing complex problems in the Gulf of Mexico that cross state, federal and international jurisdictional lines. More than 300 active participants, many of whom are volunteers, include representatives from citizen-interest groups, academia, government, and the general public.

Members serve on one of ten committees: Marine Debris, Public Health, Habitat Degradation, Freshwater Inflow, Coastal and Shoreline Erosion, Toxic Substances and Pesticides, Nutrient Enrichment, Living Aquatic Resources, Public Education and Outreach, and Data Information and Transfer. Glenn Rhett from the WRTC participates in bi-annual meetings of the Habitat Degradation Committee, assisting with prioritization of action items and reviewing and selecting research proposals for funding. Rhett's participation also serves the WRTC, WRP, and the Gulf of Mexico Program for information exchange.

(Ms. Belinda Duke is the Gulf of Mexico Program's public education and outreach coordinator, Telephone: (601) 688-1519.)



## New journal to explore wetland biogeochemistry

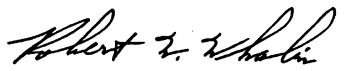
A reviewed journal titled *Current Topics In Wetland Biogeochemistry* is expected to debut during May, 1994. The journal will be issued annually. Subscriptions are \$15.00/yr (U.S.) postpaid and may be obtained by contacting Karen Gros, Wetland Biogeochemistry Institute, Louisiana State University, Baton Rouge, LA 70803-7511 USA.

## Institute to offer training

A wetland delineation training workshop will be offered July 25 through 29, 1994, at the Wetland Biogeochemistry Institute, Louisiana State University, Baton Rouge, La. The course will provide participants with information about wetland soils, vegetation, and hydrology in conjunction with the procedures used in the 1987 U.S. Army Corps of Engineers Wetland Delineation manual. Information is available by calling (504) 388-8810; FAX number is (504) 388-6423.



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