

**SHIFTING THE PARADIGM FOR THE 21<sup>ST</sup> CENTURY: PROTECTING AND RESTORING THE NATURAL RESOURCES AND FUNCTIONS OF FLOODPLAINS**

John H. McShane

**INTRODUCTION**

Floods have caused a greater loss of life and property and have disrupted more families and communities in the United States (U.S.) than all other natural hazards combined (McShane, 2007). In their natural state, however, coastal and riverine floodplains provide more value to society per acre than any other landform; in fact, although floodplains comprise just 2% of the land area worldwide they provide approximately 25% of all terrestrial ecosystem service benefits (Opperman *et. al.*, 2010). Protecting and restoring these ecosystem services, or the natural resources and functions of floodplains, have significant economic and environmental benefits that are a “natural” asset for a community and are of immense value to the Nation.

Floodplain management is not just “flood control” but encompasses two co-equal goals – reducing the loss of life and property caused by floods and protecting and restoring the natural resources and functions of floodplains. Although there have been significant efforts at all levels of government over the past century or so to address the first goal, the latter has often received only cursory attention at best. However, as flood losses continue to escalate, a new paradigm of floodplain management is beginning to emerge that promotes the protection and restoration of natural resources, considers the economic and environmental benefits of nonstructural measures, and seeks to achieve more resilient and sustainable communities.

Using nonstructural measures to reduce flood risk is often more cost effective than other methods, such as dams and levees, if all the benefits of nonstructural measures and all the economic and environmental costs of structural measures are included in the cost/benefit analysis. Nonstructural measures also help to maintain natural floodplain functions, mitigate flood damages, and provide for the health and safety of the public as well. Allowing floodplains to function and using a “Make Room for Rivers” strategy protects wetlands and riparian areas, maintains natural areas, and reduces flood risks, all part of achieving the goals of floodplain management in an economically and environmentally sound manner. Working with natural systems instead of trying to “control” flood waters also achieves multiple objectives, such as improving water quality, facilitating ground water recharge, and protecting fish and wildlife habitats.

**THE NATURAL RESOURCES AND FUNCTIONS OF FLOODPLAINS**

Although there has been some debate in the floodplain management community regarding the difference between “natural resources” and “functions” there is general agreement that natural resources are considered to be the physical features of a floodplain, such as a wetland or bottomland hardwood forest, while a function refers to a service, such as conveying floodwaters (see Figure 1 and Table 1). However, some features of floodplains, such as wetlands, are natural resources that also provide functions such as storing floodwaters.

Wetlands are perhaps the most important feature of floodplains, as well as upland sites. Depending on its location, one acre of wetland can store up to three acre feet of water, or about one million gallons, and slowly release it over time, protecting adjacent and downstream property from flooding (USEPA, 2006). However, since European settlement more than half of the wetlands in the U.S. have been lost (of the original 225 million acres only 107 million acres remain), most having been drained for agriculture or filled for development (USEPA, 2006). Building levees and other structural measures to facilitate and protect development and agricultural land has disconnected rivers from their floodplains causing extensive loss of wetlands, as well as other important floodplain resources. Significantly, the loss of flood water storage, in conjunction with the increase of impervious surfaces in many watersheds has correlated with an increase in flooding in many communities.

By adapting to the natural phenomenon of flooding, rather than trying to control floodwaters, we can reduce the loss of life and property, protect critical natural and cultural resources, and contribute to the sustainable development of communities across the country.

Coastal wetlands are especially important for providing the critical function of reducing storm surge; depending on the type of vegetation the surge can be reduced by up to one foot for every mile of wetlands (USEPA, 2006). Coastal wetlands have been called “nurseries of life” because of the myriad species of commercially and recreationally valuable fish along the Atlantic and Gulf coasts that are directly dependent on these

Floodplains are low lying areas adjacent to inland and coastal waters that are occasionally and temporarily inundated during high flows. This intermittent flooding is necessary for maintaining the natural hydrological, biological, geomorphic, and other functions of floodplains. For regulatory purposes the floodplain is defined as the area inundated during the “100-year” flood, or more accurately the flood having a 1% chance of being equaled or exceeded in any given year.



Figure 1. Naturally Functioning Floodplains Convey and Store Floodwaters, Provide Habitats for a Wide Variety of Flora and Fauna, and Provide Numerous Economic and Societal Benefits (photo courtesy of ©Gary P. Fleming).

Table 1. Natural Resources and Functions of Floodplains.

Naturally functioning floodplains provide a number of environmental and economic benefits that fall into three general categories, hydrological, biological, and societal. This table is adapted from the 1994 document, *A Unified National Program for Floodplain Management*.

<b>Hydrological</b>	
<p><i>Natural Flood and Erosion Control</i>                      Provide flood storage and conveyance                      Reduce flood velocities                      Reduce flood peaks                      Reduce sedimentation</p>	<p><i>Water Quality Maintenance</i>                      Filter nutrients and pollutants from runoff                      Process organic wastes                      Moderate temperature fluctuations</p>
<p><i>Groundwater Recharge</i>                      Promote infiltration and aquifer recharge                      Reduce frequency and duration of low surface flows</p>	
<b>Biological</b>	
<p><i>Biological Productivity</i>                      Support high primary productivity                      Enhance biodiversity                      Maintain ecosystem integrity                      Preserve wetland functionality</p>	<p><i>Fish and Wildlife Habitats</i>                      Provide breeding and feeding areas                      Create waterfowl habitats                      Protect habitats for rare and endangered species</p>
<b>Societal</b>	
<p><i>Wild and Cultivated Products</i>                      Enhance agricultural lands                      Provide sites for aquaculture                      Protect and enhance forest lands</p>	<p><i>Recreational Opportunities</i>                      Provide areas for active and passive uses                      Provide open space                      Provide aesthetic values</p>
<p><i>Areas for Scientific Study and Outdoor Education</i>                      Contain cultural resources (historic and archaeological)                      Provide opportunities for environmental studies                      Provide "wild" natural areas for experiencing and enjoying nature</p>	

wetlands during some part of their life cycle. Unfortunately, a recent study found that from 2004-2009 there was an average net loss of 60,000 acres per year of wetlands in coastal watersheds (Dahl and Stedman, 2013).

Because many species have a connection with the land/water interface, naturally functioning floodplains contribute to maintaining the biological integrity of rivers, streams, wetlands, lakes, and estuaries. Floodplains also provide habitats for numerous species of flora and fauna, provide critical wildlife corridors, and are areas of significant biodiversity. Many species not only tolerate the disturbance regime of intermittent flooding but are dependent on it (in this way floodplains are analogous to forests that need intermittent fires to maintain their long-term ecological integrity). For example, a recent study of 31 natural floodplain sites in the Hudson River Valley of New York State found 442 species of vascular plants, 25 species of mammals, 46 species of birds, and 12 species of reptiles and amphibians, including a number of rare and threatened species (Knap-Vispo and Vispo, 2010). The wide variety of soils, including rich alluvial soils, and the varying hydrology in different parts of the floodplain contribute to this biodiversity. Floodplains are critical spawning areas for many species of fish, as well as amphibians, as the shallow areas during floods provide the opportunity for the young to develop free from the presence of predators. Floodplains are also important breeding, nesting, and resting areas for migratory waterfowl and other birds and are a critical component of healthy watersheds.

### THE CLEAN WATER ACT

The goals of the Clean Water Act (CWA) are to maintain and restore the chemical, physical, and biological integrity of the Nation's waters. Naturally-functioning floodplains contribute to achieving these goals. While the CWA addresses aquatic health rather than floods, many of the same actions that protect and improve water resources also help to reduce flood damages and threats to human health and safety. For example, because of alternating wet and dry cycles floodplain soils denitrify nitrogen compounds (e.g., nitrate and ammonium from fertilizers), converting them to gases (e.g., NO). As nitrogen is a major factor in the outbreak of algal blooms, which cause hypoxia when the algae eventually die and use up the available oxygen, the denitrifying function of floodplains contributes to improving water quality. As most of the floodplains of the Mississippi and Missouri Rivers have been severely degraded, or disconnected from the rivers due to the construction of levees and other "flood control" structures, they are essentially pipelines carrying pollutants, such as nutrients (especially nitrogen and phosphorus), directly to the Gulf of Mexico. Restoring floodplains that have been disconnected from the rivers will reduce the amount of nutrients entering the Gulf and minimize the extent and duration of the annual hypoxic or "dead zone." Excess nutrients also contribute to harmful algal blooms (HABs) that can adversely impact public health as well as aquatic life.

In addition, the riparian corridors of many floodplains are especially important for improving surface and

ground water quality. For example, the State of Ohio developed a Total Maximum Daily Load (TMDL) to improve water quality that eventually led to the protection and restoration of functioning floodplains to reduce non-point source pollution. The State of Vermont proved the effectiveness of this approach when it reconnected a small river with its floodplain and, over the following year, two moderate floods deposited 1,100 cubic feet of sediment and 1.2 tons of phosphorus on 21 acres of a restored floodplain site (Schiff *et al.*, 2008). There is a TMDL for phosphorus in Lake Champlain and restoring even this small floodplain helped to improve the river, its floodplain, and the water quality in the lake.

### FEDERAL ROLE IN FLOODPLAIN MANAGEMENT

The role of the federal government in managing flood risks has changed significantly since the early part of the 20th Century. This change started in the 1960s when the Congress, recognizing that flood losses and disaster relief expenditures were continuing to escalate, established the "Task Force on Federal Flood Control Policy" to investigate alternatives to structural measures to reduce flood losses. In 1966, the Task Force completed its report, *A Unified National Program for Managing Flood Losses* (House Document 465) (House of Representatives, 1966) that advocated a broader approach to "flood control," including the need to regulate land use in flood hazard areas. In some ways this report provided the foundation for the National Flood Insurance Program (NFIP) that Congress created in 1968 to make flood insurance available in those communities that agreed to adopt and enforce a floodplain management ordinance.

The most important provision of the NFIP with regard to protecting and restoring the natural resources and functions of floodplains is the designated floodway. The floodway is that area of the watercourse and floodplain land that must be preserved to allow the discharge of the base flood (the 1% annual chance flood) through a community without increasing flood heights by more than a designated amount. Any construction in a floodway that would increase flood heights is prohibited. A floodway designation can therefore be a powerful preservation tool. FEMA has already mapped more than five million acres of floodway, an area more than twice that of Yellowstone National Park.

The NFIP also provides credits for flood insurance discounts through its Community Rating System for communities that implement activities such as preserving wetlands in floodplains, adopting Low Impact Development ordinances, or promulgating other measures to preserve naturally functioning land. The primary purpose of the credits is to encourage activities that reduce flood losses but these also act to protect the natural functions of floodplains as well.

In 1975, the U.S. Water Resources Council established The Federal Interagency Floodplain Management Task Force to prepare reports for the President to transmit to the Congress on progress towards achieving the goals of floodplain management; the Task Force has prepared four reports since 1976. In the 1994 document, *A Unified National Program for Floodplain Management*, the

President emphasized the importance of protecting and restoring the natural resources and functions of floodplains in his letter transmitting the document to the Congress (The Federal Interagency Floodplain Management Task Force, 1994).

[The Unified National Program] urges the formulation of a more comprehensive and coordinated approach to protecting and managing human and natural systems to ensure sustainable development ... This is significant in that the natural resources and functions of our riverine and coastal floodplains help to maintain the viability of natural systems and provide multiple benefits for people.

The Task Force's current work plan includes an activity to assess the value of ecosystem services provided by the natural resources and functions of floodplains. A more comprehensive understanding of the values of natural floodplains will assist decisionmakers at all levels of government. The Task Force is also working closely with the Council on Environmental Quality to coordinate its activities with other task forces and committees, especially those developing recommendations and policies that address the hydrological impacts of climate change. With climate change already causing an increase in the frequency and duration of intense rainfall events in some parts of the country, protecting and restoring floodplains will be even more important in the decades and centuries to come.

Federal agencies are required to comply with the provisions of Executive Order (EO) 11988 (EO, 1977), *Floodplain Management*, in order to reduce future flood losses, although some provisions also act to protect floodplain functions. For example, agencies are to avoid occupying or modifying the floodplain environment, avoid any direct or indirect support of floodplain development, and must evaluate their proposed actions and select alternative sites outside the floodplain if practicable. The Executive Order 13653, *Preparing the United States for the Impacts of Climate Change* (EO, 2013), which the President signed on November 1, 2013, reinforces the principles of EO 11988 providing further protection for the natural resources and functions of floodplains. For example, EO 13653 includes a provision that agencies "reform policies and federal funding programs that may, perhaps unintentionally, increase the vulnerability of natural or built systems, economic sectors, natural resources, or communities to climate change related risks." Revising federal policies and programs to ensure resilient and sustainable communities with respect to climate change will also have significant benefits with regard to protecting the natural functions of floodplains.

In addition, the recently revised "Principles and Requirements for Federal Investments in Water Resources" (formerly the "Principles and Guidelines") includes a provision that agencies "avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts in any case in which a floodplain area must be used." Another objective of the "Principles and Requirements" is that federal agencies should take an active role in "protecting and restoring the functions of natural systems

and mitigating any unavoidable damage to natural systems" when planning and implementing projects. This is a significant shift in how federal agencies approach the management of water resources in America. This new approach will help to reduce the loss and degradation of the natural resources and functions of floodplains that too often occurred in the past due to federal actions to reduce flood risks. There has already been an effort to start "de-engineering" structures built in the 20th Century, including moving levees back from rivers that will increase natural areas and have the added benefit of reducing flood heights and flood damages.

### CONCLUSION

Riverine and coastal floodplains are dynamic and complex natural systems that provide important societal benefits, both economic and environmental. By adapting to the natural phenomenon of flooding, rather than trying to control floodwaters, we can reduce the loss of life and property, protect critical natural and cultural resources, and contribute to the sustainable development of communities across the country. Floodplain management research has shown that naturally functioning floodplains provide multiple benefits for society, and are of immense value to the nation. Their protection will enhance the quality of life for this generation and those to come. The role of the federal government in floodplain management will continue to evolve as climate change increases the extent of the regulatory floodplain and flood losses continue to rise. In response, stronger and more comprehensive programs and policies will need to be adopted in the coming years by all levels of government, as well as the private sector, to ensure that we can continue to protect and restore the natural resources and functions of floodplains while reducing flood losses.

### REFERENCES

- Dahl, T.E. and S.M. Stedman. 2013. Status and Trends of Wetlands in the Coastal Watersheds of the Conterminous United States 2004 to 2009. U.S. Department of the Interior, Fish and Wildlife Service and National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 46 pp.
- EO (Executive Order) No. 11988. Floodplain Management, May 24, 1977.
- EO (Executive Order) No. 13653, Preparing the United States for the Impacts of Climate Change, November 1, 2013.
- The Federal Interagency Floodplain Management Task Force, 1994. A Unified National Program for Floodplain Management. FEMA 248, Washington, D.C.
- House of Representatives, 1966. A Unified National Program for Managing Flood Losses. H.R. 465.
- Knap-Vispo, Claudia and Conrad Vispo, 2010. Floodplain Forests of Columbia and Dutchess Counties, NY: Distribution, Biodiversity, Classification, and Conservation. Hawthorne Valley Farmscape Ecology Program, Ghent, New York.
- McShane, John, 2007. Floodplain Management 2050; Protecting and Restoring the Functions and Values of Coastal and Riverine Floodplains. Gilbert White Policy Forum, Association of State Floodplain Managers, Madison, Wisconsin.
- Opperman, Jeffrey, Ryan Luster, Bruce McKenney, Michael Roberts, and Amanda Wrona Meadows, 2010. Ecologically Functional Floodplains: Connectivity, Flow Regime, and Scale.

## Shifting the Paradigm for the 21st Century: Protecting and Restoring ... . . . cont'd.

Journal of the American Water Resources Association 46(2): 211-226.

Schiff, R., J. Clark, and B. Cahoon, 2008. The Lamoille River and Black Creek Floodplain Restoration Project. AWRA Conference on *Riparian Ecosystems and Buffers: Working at the Water's Edge*, pp 72-77.

USEPA (U.S. Environmental Protection Agency), 2006. Wetlands: Protecting Life and Property From Flooding. EPA843-F-06-001, Washington, D.C.

### AUTHOR LINK

John McShane  
USEPA, Office of Water  
1200 Pennsylvania Ave. NW, MC 4504T  
Washington, DC 20460  
(202) 566-1381

### E-MAIL

mcshane.john@epa.gov

**John McShane, CFM**, works in the Office of Wetlands, Oceans, and Watersheds and represents USEPA on the Federal Interagency Floodplain Management Task Force Work Group. He started serving on the Task Force in 1989 while working at FEMA and chaired the Task Force in 1996-1997. John received a Master's from Cornell in Environmental Policy and a BS in Biology and Environmental Studies from SUNY Plattsburgh. John also spent ten years in the field as a Park Ranger/Interpretative Naturalist.

(Disclaimer: The views expressed in this article are those of the author and do not necessarily represent those of the United States or USEPA.)



## AWRA 2014-2015 RICHARD A. HERBERT MEMORIAL SCHOLARSHIP OPPORTUNITIES

**Background** – In 1980, AWRA established the Endowment-Memorial Fund to be used for the enhancement of education in water resources. The fund has since been renamed the Richard A. Herbert Memorial Educational Fund to honor Richard A. Herbert - a champion for water resources education -- who passed away in 1994. In order to carry out his vision, AWRA is proud to announce the availability of scholarships derived from the proceeds of this fund.

**Eligibility and Awards Available** – **Each applicant must be a national AWRA member.** At least one \$2,000 scholarship will be awarded to a **full-time undergraduate student** working toward his/her first undergraduate degree and who is enrolled in a program related to water resources for the 2014-2015 academic year. At least one \$2,000 scholarship will also be awarded to a **full-time graduate student** enrolled in a program relating to water resources for the 2014-2015 academic year. (The AWRA Board of Directors may, at its sole discretion, approve additional scholarship awards, based upon the performance of the Memorial Fund.)

**Selection Criteria** – The **undergraduate scholarship** will be awarded to the student most qualified by academic performance. Measures of academic performance include the cumulative grade point average, relevance of the student's curriculum to water resources, and leadership in extracurricular activities related to water resources. The **graduate scholarship** will be awarded to the student most qualified by academic and/or research performance. The measures of academic performance are identical to those of the undergraduate scholarship with the addition of the quality of the student's research and its relevance to water resources. Recipients will be selected by the AWRA Student Activities Committee and announced during summer 2014.

**Application Process** – A complete application packet contains:

- Title page that includes the applicant's full name, permanent mailing address, email address, phone number where he or she may be easily reached, and the type of scholarship (undergraduate or graduate).
- Two-page summary (approx. 500 words) of his/her academic interests and achievements, extracurricular interests, and career goals as they relate to the above selection criteria.
- Resume or curriculum vitae.
- Three signed letters of reference from professors and/or advisors. Letters of reference **MUST** include the signatures of the referee – PDFs of the signed letters work best.
- Transcripts of all college courses (undergraduate and graduate). **Legible** copies of "Issued to Student" transcripts are acceptable to save on fees but unofficial grade reports (such as those students can access from their online student accounts at the university) are unacceptable. **Application packets that include unofficial grade reports will not be considered.**

Application packets should be submitted electronically to [info@awra.org](mailto:info@awra.org) and limited to 5mb in size to ensure delivery. **All applications must be submitted in their entirety.** AWRA will provide an acknowledgement of receipt of your application but will not provide updates to your application status or request missing information. Please make sure your application is complete when it is submitted. We look forward to hearing from you.

**Deadline:** All applications and supporting materials must be received electronically by **APRIL 22, 2014**

**Questions?**  
Call AWRA at (540) 687-8390  
or send an e-mail to  
[info@awra.org](mailto:info@awra.org)



American Water Resources Association  
PO Box 1626 - Middleburg, VA 20118-1628  
Phone (540) 687-8390 - Fax: (540) 687-8395  
[info@awra.org](mailto:info@awra.org) - [www.awra.org](http://www.awra.org)