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September 2008 | Volume 10 | Number 5

WETLAND RESTORATION, MITIGRATION, AND PERMITTING

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WETLAND RESTORATION, MITIGATION, AND PERMITTING

Jefferson G. Edgens ~ Associate Editor
jedgens@bpc.edu

This issue of *IMPACT* explores a variety of concerns involved with efforts to blend land use and wetland protection. The authors explore biological, physical, and administrative aspects of living in a watershed while maintaining the integrity of one of the significant water resources of the basin.

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A Bi-Monthly Publication of the
AMERICAN WATER RESOURCES ASSOCIATION

American Water Resources Association
4 West Federal Street • P.O. Box 1626
Middleburg, VA 20118-1626
(540) 687-8390 / Fax: (540) 687-8395
E-Mail: info@awra.org • Homepage: www.awra.org

Water Resources IMPACT is owned and published bi-monthly by the American Water Resources Association, 4 West Federal St., P.O. Box 1626, Middleburg, Virginia 20118-1626, USA. The yearly subscription rate is $80.00 domestic and $95.00 for International subscribers. For the International Priority Shipping Option, add $50.00 to the subscription rate. Single copies of *IMPACT* are available for $15.00/each (domestic) and $20.00/each (international). For bulk purchases, contact the AWRA Headquarters office.

IMPACT is a magazine of ideas. Authors, Associate Editors, and the Editor-In-Chief work together to create a publication that will inform and will provoke conversation. The views and conclusions expressed by individual authors and published in *Water Resources IMPACT* should not be interpreted as necessarily representing the official policies, either expressed or implied, of the American Water Resources Association.

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POSTMASTER: Send address changes to *Water Resources IMPACT*, American Water Resources Association, 4 West Federal St., P.O. Box 1626, Middleburg, VA 20118-1626.

• VOL. 10 • NO. 5 • SEPTEMBER 2008 •
ISSN 1522-3175

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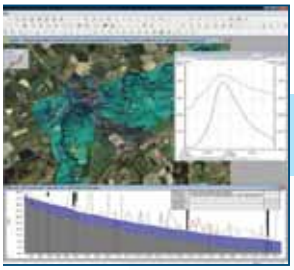

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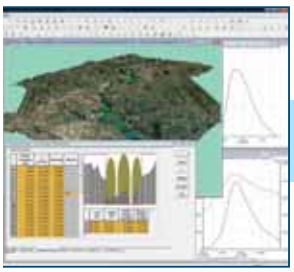

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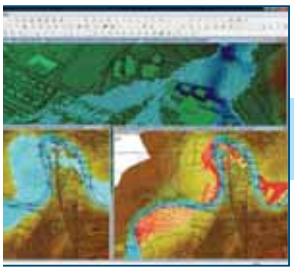

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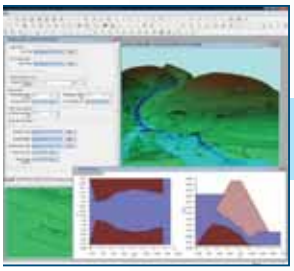

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WATER RESOURCES IMPACT

WETLAND MITIGATION: WHICH FUNCTION?

Kelly Chinners Reiss

Wetland functions have been described as the physical, chemical, and biological processes and components that are characteristic of and necessary for maintenance of a wetland ecosystem. Examples of wetland functions includes water storage and flood abatement; sediment retention; biogeochemical cycling, nutrient retention, and associated water quality improvement; biological productivity, carbon cycling and sequestration, fish and wildlife habitat, and aesthetics. Does every wetland provide every function at an optimal level? The short answer is "no." That is, wetland ecosystems can be classified into many different community types, each providing a unique set of wetland functions. Any given wetland does not provide all wetland functions, and the level of function varies by wetland type and location in the watershed (e.g., upstream, downstream, central, peripheral, depressional, and coastal). Considering the complexity involved in determining which functions a wetland performs and at what level, assuring suitable mitigation (i.e., compulsory replacement of wetland functions lost through impacts from human development activities) is much more difficult than it sounds. Can we simply restore, enhance, preserve, or even create another wetland and expect the return of the same wetland functions at the same optimal level of what has been lost, or do we have to pick which functions to return?

Replacement of lost wetland functions is the cornerstone of wetland mitigation. Consider that over 35 years ago the Water Pollution and Control Act (later referred to as the Clean Water Act, 1972) required states to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Due to this national policy, when a proposed human development activity will affect a wetland resource a dredge or fill permit is required. By law, any alteration must be first avoided, then minimized, and, if deemed unavoidable, the loss must be compensated. In wetland permitting such compensation generally falls into the framework of what is known as wetland mitigation. In the past decade wetland mitigation has shifted from on-site or piecemeal mitigation projects focusing on small disjointed wetland areas towards a national mitigation policy authorizing and encouraging more consolidated mitigation projects, such as wetland mitigation banks and regional offsite mitigation areas (ROMAs). These larger tracts of land include wetland, stream, or aquatic resources that have been restored, enhanced, preserved, or created as compensation for unavoidable impacts permitted under Section 404 of the Clean Water Act or similar state or local regulations.

Policy supporting restoration, enhancement, or preservation, and in some instances creation, of wetland resources on contiguous lands intuitively makes sense, particularly when considering the importance of the location and landscape support for natural resources. Natural wetland ecosystems in the interior of large tracts of lands should, theoretically at least, reflect high ecological condition and perhaps support the full suite of wetland functions (e.g., flooding and erosion control, biogeochemical cycling, fish and wildlife habitat, trophic food-web dynamics) at the level expected of a natural, undisturbed, or otherwise unaltered ecosystem. This scenario assumes that required mitigation activities (e.g., backfilling ditches, recontouring bed rows, removal of exotic species) have been successfully completed and that the outcomes of these activities result in the return of full ecosystem functions; but, wetland mitigation banks do not exist in the midst of wilderness or roadless areas. Instead, mitigation policy requires wetland impacts to be compensated for within the same watershed (though the watershed scale generally varies by geographic region). What happens in a watershed with a high density of human land use activities (e.g., row crops, pasture, residential, commercial)?

Until we can confidently assess each wetland function (i.e., the functional signature) and determine what is being lost to impacts we will continue to measure wetland condition and assume we have a handle on wetland function

When natural lands are developed through human activities, whether agricultural or urban, changes can be seen in the natural communities of adjacent areas. These changes stem from the multitude of assaults on the remaining natural communities from increases or decreases in the quantity or change in chemical and physical characteristics of water inflows and/or outflows, changes in sedimentation, changes in fire pattern, and/or changes in genetic exchange such as introduction of cultivated and/or exotic species, and loss of wildlife habitat connectivity, among others. Wetlands surrounded by human land use activities or in early stages of development after restoration have detectably different community structure from reference, unaltered, or otherwise undisturbed wetlands (e.g., McKenna, 2003; Lane and Brown, 2007); but how much influence such activities have on all ecological functions remains unclear. While it has been shown (McKenna, 2003) that community productivity and respiration rates were similar in a restored and a reference wetland, biotic community structure and trophic pathways were not. Restoration of one function (i.e., community metabolism) did not equate to restoration of another function (i.e., trophic food web dynamics). In this case, which function is more important? Should we consider this restoration a success because community metabolism was restored, or should we consider it a failure because trophic food web dynamics were not? Are you wondering if the glass is half full or half empty?

Wetland mitigation is intended to replace lost wetland function, which is rarely measured but generally implied from estimates of wetland condition (i.e., assess-

ment technique aimed at measuring the current chemical, physical, and/or biological state of the wetland resource). There is no generally agreed upon, universal, single measure of total wetland function. So, we are tasked through national policy with replacing something (i.e., functions) that we do not as of yet routinely measure. Further, even if we did have agreed upon scientifically defensible methods, which function would we focus on for our replacement efforts? Would we instead consider a functional signature, where all possible wetland functions were measured and scaled?

For example, consider the functional signature of a forested depressional wetland in a natural or otherwise unaltered landscape. Is it reasonable to assume that this reference wetland would have moderate water storage function, low water purification function, and high wildlife habitat function? Now, imagine that the lands surrounding this depressional wetland have been transformed into agricultural row crop production with the associated drainage features (e.g., ditches) and chemical applications (e.g., pesticide, fertilizer). It is reasonable to assume that this agricultural wetland now has low water storage function (i.e., it was ditched and drained), high water purification function (i.e., it now receives a much higher load of nutrients and inorganic chemicals), and moderate wildlife habitat function (i.e., some animals can survive). Now imagine that a residential development is built on this property, which is characteristic of the pattern of urban development encroaching on former agricultural lands. The stormwater system for this development is directed into the depressional wetland and the assault of chemicals continues from residential landscaping applications. It is reasonable to assume that this urban wetland now has high water storage function (i.e., it receives much more water in the form of stormwater than it ever did in the reference landscape), high water purification function (i.e., it continues to receive a high load of nutrients and inorganic chemicals), and low wildlife habitat function (i.e., generalists and opportunists may survive, but any species with special requirements, especially those pertaining to the need for adjacent upland habitat, will likely not survive).

Having had the opportunity to explore and research Florida's wetlands over the past decade, it has become clear to me the important role the surrounding landscape plays in supporting and shaping wetland community structure. In the above example, in the course of development from natural to agricultural to urban land use the depressional forested wetland went from having moderate to low to high water storage function, low to high to high water purification function, and high to moderate to low wildlife habitat function. For mitigation purposes, which function should be replaced? Should the water storage and water purification functions be lowered to match the reference condition? Certainly not, as this would come as a great loss of flood protection to the urban dwellers in the new residential neighborhood; but, how do we mitigate for an increase in some functions and a decrease in others? If we rely on measures of wetland condition, which is the practice in many mitigation scenarios, will it provide an acceptable tradeoff considering an increase in some functions and a decrease in others? Considering the distribution of land use activities within the southeastern United States, of 123.3 million acres of land in Alabama, Florida, Georgia, and South Carolina, 23.1 million acres (18.7%) host cropland, grassland pasture, and rangeland and an additional 8.7 million acres (7.1%) host urban land use activities (Lubowski *et al.*, 2006). This translates into roughly one-quarter of the lands of the southeastern United States in agricultural or urban land uses. That is a large area covered by human land use activities equating to an ever increasing need for wetland mitigation and a national policy supporting the development of wetland mitigation banks.

The HT Odum Center for Wetlands and the Florida Department of Environmental Protection recently completed an evaluation of Florida wetland mitigation banking (Reiss *et al.*, 2007). A major unanswered question coming from this study: are wetland mitigation banks achieving *no net loss* of wetland function? We considered mitigation plans and state permits to understand how mitigation credit was determined. Looking for specific values of assessment scores (e.g., Wetland Rapid Assessment Procedure scores, Uniform Mitigation Assessment Method scores) for wetland future scenarios (i.e., wetland condition at the completion of restoration, enhancement, creation, or preservation), we found condition assessments were used at 5 of 29 banks. Further, documented scores were anticipated to be nearly identical to that of reference wetlands (i.e., those wetlands with the highest ecological condition, generally defined as those unaltered or unimpaired by human activities). With this in mind, one might expect that these banks were located in remote areas of the landscape, far removed from human development activities. In fact, this was not the case. Reviewing land use in the 100 m zone surrounding 47 land parcels in Florida banks (some banks have more than one disconnected parcel of land) revealed that 85% of the banks shared a border with agricultural land uses, 36% shared a border with silvicultural land uses, 77% shared a border with urban land uses, and 34% shared a border with reservoirs. (Numbers add to greater than 100%, as a single bank could be surrounded by multiple land use activities.) Clearly Florida banks are adjacent to and influenced by human land use activities.

We recognize that wetlands are influenced by adjacent land use activities. But there is a tradeoff in wetland mitigation that is rarely acknowledged. That is, wetlands provide many multiple and arguably competing functions. Consider our previous example of the depressional forested wetland where floodwater storage was maximized, but at the cost of fish and wildlife habitat, aesthetics, and biological productivity. In a sense, we are left not wanting to mitigate for all lost wetland functions, but rather for wetland value. That is, it is unlikely that any mitigation activity can fully replace every wetland function lost through impact, so society may instead focus on those functions that provide a direct or indirect benefit to human society, or the ecosystem services (e.g., production of food and fiber, storm protection, flood abatement, and recreation). In the end, will we lose out on the functions that are not considered to provide ecosystem ser-

vices? Further, if we are concerned not with replacing the full suite of wetland functions but rather the ecosystem services wetlands provide, who decides which functions are important? The regulator? The developer? The urban dweller? The water engineer? The coastal fisher?

In a study in 2004, J.G. Ehrenfeld (2004) identified indicators of biological, hydrologic, biogeochemical, and social functions associated with 21 urban wetlands. She concluded that in the end, there are tradeoffs between human use of wetlands and the functions performed. Her conclusions ring true for all restoration, mitigation, and conservation areas that generally must contend with human development activities. A recent study on the demographics of Florida wetland mitigation banks suggested that the location of banks in more rural areas redistributes wetland resources and the associated ecosystem services away from urban areas and thus removes some of the services afforded by these systems (Ruhl and Salzman, 2006). Locating banks within developed urban areas may improve the distribution of certain ecosystem functions across the landscape (e.g., flood attenuation, carbon sequestration), but it will not necessarily replace all of the lost functions from wetland impact. Wetland mitigation in general must be considered a tradeoff between competing ecosystem functions. Until we can confidently assess each wetland function (i.e., the functional signature) and determine what is being lost to impacts we will continue to measure wetland condition and assume we have a handle on wetland function. By promoting this assumption, which wetland functions are we replacing and which are we losing? Further, are the wetland functions being replaced the ones providing ecosystem services? Are there certain wetland functions that are not being replaced by mitigation designed to emulate reference wetland structure (i.e., ecosystem condition)? Until we develop reliable tools to accurately assess wetland function we will be left guessing.

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AUTHOR LINK

Kelly Chinners Reiss
H.T. Odum Center for Wetlands
Dept. of Environmental Engineering Sciences
University of Florida, PO Box 116350
Gainesville, FL 32611-6350
(352) 392-2425
kcr@ufl.edu

Kelly Chinners Reiss is a Postdoctoral Research Associate at the H.T. Odum Center for Wetlands and a Lecturer with the School of Natural Resources and Environment at the University of Florida. She has worked on projects relating to wetland creation and development after phosphate mining, wetland condition assessment, and wetland mitigation banking. She is an advocate of wetland condition assessments, but strongly supports further research aimed at integrating wetland structure (e.g., ecological condition) and wetland function.

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WATER RESOURCES IMPACT

THE IMPORTANCE OF AN INTERDISCIPLINARY APPROACH TO RESTORATION IN WETLANDS AND NATURAL COMMUNITIES

Jane O. Rowan

The most effective means of restoring well-functioning wetlands and other natural habitats requires an overarching multidisciplinary approach. Limiting any one discipline from the equation may result in the construction of an unbalanced, ineffective system and is nearly always the reason for failure. The disciplines of importance to the practice of habitat creation and restoration are:

- Botany
- Civil Engineering
- Entomology
- Fisheries Biology
- Geology
- Geomorphology
- Geotechnical Engineering
- Herpetology
- Hydrogeology
- Hydrology and Modeling
- Mammology
- Ornithology
- Water Chemistry
- Wildlife Biology

Believe it or not, this list is not exhaustive. To tie these fields of study together necessitates knowledge of Population Biology and Wetland Ecology, fields of Engineering and Architecture, Earth Science and Law.

Multidisciplinary teams may be large and unwieldy, and the time it takes to organize and direct a large team is significant. But how does one achieve successful results without them? Without an approach that considers all significant disciplines, one must recognize that a wetland design alternative may produce a substandard result. Perhaps the multidisciplinary approach, which may include a large team, is better replaced by an interdisciplinary team of multifaceted scientists and engineers. Gathering a small group of well-rounded scientists and engineers who are purposely "interdisciplined" may be the optimal choice.

A wetland construction project is as much a construction project as it is a gardening project ... the balance of physical, chemical, and biological science, architecture, and engineering is essential to project success

Consider, for example, there is a permit requirement to create a 10-acre wetland system in a dredge disposal area located on the coastline of an industrialized riverfront disconnected from any surface water. The site is covered with a monotypic stand of common reed (*Phragmites communis*). What are the steps to an interdisciplinary approach for creating a highly valuable, multipurpose wetland ecosystem, and what disciplines are needed at each step?

1. First, the location is optimal. Though the site is in an industrialized area, the dredged material is a great planting medium due to its grain size and organic content. The location near a large water body provides a source of hydrology, the driving force of wetland creation. One last check would need to determine if the dredge material was chemically contaminated. (The disciplines in this step could include Soil Science, Hydrology, and Environmental Chemistry.)

2. Next there must be an understanding of the elevation and vegetative community that was in the location before it became a dredge spoil site. Searching historical documents, old fire protection maps, topographical maps, and old photographs can help. If the site is located near a major river, more than likely the site was originally a wetland. Cores could be taken to see what the plant community was like just beneath the dredge disposal area. The potential for even more contamination below the surface is very high, from rubble fill or layers of impenetrable materials like fly ash. (The disciplines in this step could include Soil Science, Paleoecology, Botany, Wetland Ecology, and Surveying.)

3. Once the previous plant community is identified (say, it was a freshwater tidal marsh dominated by grasses and sedges, including cattails), it is the time to consider the target plant community. A balance of species is important. It may be necessary to choose between indigenous (native) species and species that can withstand a broader band of conditions while vigorously colonizing their particular hydrologic zone. The site would need to be surveyed to great detail (six-inch contour intervals) and the exact tide elevations known for dead low, low, mid, high and spring high tide. Grading the site would be required for a variety of hydrologic zones and suitable hydrology for the selection of the most appropriate plant materials. Review of old aerial photographs can give an idea of the tidal condition of the original area (i.e. whether there was there a large intertidal zone, or just an expanse of marsh). (The disciplines in this step could include Wetland Ecology, Botany, Engineering, Landscape Architecture, Agronomy, and Geology.)

4. There must be an understanding of the physical drainage system – whether to connect to the freshwater tidal river, grade to ground water levels, or rely on inflowing water. If there was flowing freshwater entering the site from the watershed, a model of the average flows along with the average flows for high water during 2-, 10-, 25-, and 50-year recurrence intervals would be important so that the mouth of the entering and exiting stream would be designed with the correct geometry to

withstand flood flows, and so that plant selection and necessary armoring would be appropriate for the potential velocity of flow at meanders or changes in elevation. If water chemistries are different between incoming water and the freshwater tidal river, adjustments in plant spectrum may be needed. (The disciplines in this step could include Wetland Ecology, Geomorphology, Hydrologic Modeling, Civil Engineering, Botany, Landscape Architecture, and Limnology.)

5. Plans and specifications must be developed so that the design intent is clear to the contractor. Often these designs have high expectations for very specific outcomes for plant community and wetland function and values due to permit requirements. The outcome as expected is essential with as few mistakes as possible leading to wetland failure or plant mortality. Success must be defined as well as failure, and warranties included in the specifications so the planting contractor is invested in wetland success. Monitoring plans and pesticide/weed removal requirements for the planting contractor should also be included. (The disciplines in this step could include Civil Engineering, Agronomy, Wetland Ecology, Cost Estimating, and Contract Management.)

6. Finally, a scheme for setting easements or other property controls for protection/nondevelopment in the future is required. Included in plans for property ownership should be a clear breakdown of property and land management and monitoring of the plant community to ensure continued performance for permit requirements. (The disciplines in this step could include Real Estate Law and Wetland Ecology.)

A wetland construction project is as much a construction project as it is a gardening project. The balance of physical, chemical and biological science, architecture and engineering is essential to project success. Interdisciplinary teams are an effective way of achieving this balance, but often a lack of awareness of the need results in an unbalanced design and lack of achievement of project goals. At times natural events like droughts and floods negatively impact even the best plans and designs. However, an interdisciplinary team will more likely be effective at understanding the problem, meeting the challenge, and designing a solution.

AUTHOR LINK Jane O. Rowan
Consultant
193 Mansion Road
Newtown Square, PA 19073
(610) 356-6334 / Fax: (610) 356-6334
janeorowan@comcast.net

Jane O. Rowan is a Professional Wetland Scientist who works in the field of wetland and watershed protection and restoration. She has worked professionally throughout the Eastern and Southeastern United States as a wetland ecologist and permitting specialist for an engineering firm, as a private consultant, and also for the federal government. She has a BS degree in Biology from the University of Massachusetts, and a MS in Environmental Science from SUNY College of Environmental Science and Forestry at Syracuse University. Ms. Rowan is the 2008 President of AWRA.

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WATER RESOURCES IMPACT

BALANCING DEMANDS FOR WETLAND HYDRAULIC RESIDENCE TIME

Richard H. McCuen and Kristin L. Gilroy

BACKGROUND

Wetlands serve many functions from those related to engineering, such as flood peak reduction, to social values, such as aesthetics of the surroundings. A wetland designed primarily for one function may have benefits for other functions, but then it may create problems for other functions. For example, a wetland constructed to provide uptake of nutrients may have positive auxiliary benefits for downstream users, such as flood control, but negative benefits for recreation such as kayaking where higher velocities are needed in the downstream reach. In designing a wetland, the effect of the design on each wetland function should be evaluated to minimize detrimental effects. Balancing of the demands will lead to more productive wetlands.

The hydraulic residence time (HRT) is often an important wetland design variable. It is central to many wetland design functions, such as sediment trapping and flood control. The mean hydraulic residence time is the time difference between the centers of mass of a storm inflow and outflow. For plug flow, the HRT is the difference in time between the entrance and exit of the flow. In completely mixed flow, some of the input theoretically reaches the outflow point immediately, while some inflow takes a long time. Nix (1985) showed that actually estimating the residence time for completely mixed flow is difficult. The more general definition applies in the design of an actual wetland because plug flows and continuously mixed flows do not occur. Numerous design elements affect the HRT. Some elements are related to the natural conditions, such as the slope of or soil in the wetland. Other elements can be significantly varied during design, such as the inclusion of islands or areas of dense vegetation at strategic locations within the wetland. Thackston *et al.* (1987) showed that the length-to-width ratio is the most important physical parameter related to hydraulic efficiency.

Given the general importance of HRT to many wetland functions, any design should consider the effect of the HRT on each function and then attempt to balance demands for the HRT needed to optimize the wetland function. This balancing should also be done for design criteria other than HRT. The intent here is to review the relationship between HRT and each wetland design function and discuss the benefit of balancing the demands for HRT.

WETLAND OBJECTIVES AND HRT

Wetlands have many benefits, with the most obvious being flood and pollution control and as a habitat for wildlife and aquatic life. The aesthetic value cannot be discounted as well as ground water recharge and discharge. Wetlands can protect downstream areas, both within the channel (e.g., limiting bank erosion) and on the floodplain. Some types of wetlands can provide recreation benefits. Given the wide array of benefits and the diverse HRT needs to optimize each of the benefits, it often is necessary to compromise on HRT design factors in order to balance the immediate needs.

The general objective of wetlands with respect to flood control is peak reduction. Volume control is often a secondary benefit. The volume of storage in the wetland will be the controlling factor in meeting this objective. The HRT increases with the volume of storage and should be sufficiently long to delay the flow well beyond the inflow peak. When compared with many of the other wetland objectives, the required HRT for flood control is relatively short to meet the demand for moderate peak reduction. Beyond the HRT needed to make a reasonable peak reduction, increasing the HRT to the time considered optimal for other benefits will yield marginal additional peak control.

Wetlands play an important role in nutrient retention, sedimentation, and water purification ... nitrogen and phosphorus are common nutrients in water bodies that result from agricultural and industrial sources

Ground water is the greatest source of drinking water, and wetlands are a key component in recharging aquifers and ground water. However, the effects of wetland design on residence time and flow velocity can influence the effectiveness of ground water replenishment. Infiltration rates are often low, so long residence times are needed to promote ground water recharge. Fast velocities hinder the ability for water to infiltrate and, therefore, minimize the amount of ground water recharge. Designs that increase the residence time will improve the ability for wetlands to contribute to ground water recharge.

The wetland objective of ground water discharge is to maintain dry period low flows. The obvious benefits with this objective would be to provide sufficient pollution dilution and flow for aquatic life. It might seem that the longer the HRT, the more benefit. However, if the wetland is designed for an excessively long HRT, then evaporation and infiltration may reduce the water supply such that water available for dry weather flow is insufficient to meet the need. The HRT will be affected by the elevation head difference and controlled by the outlet control structure. The HRT may also be sensitive to seasonal fluctuations that will need to be accounted for when assessing ground water discharge benefits.

In addition to downstream low flow control, wetlands have other benefits to the downstream area. The HRT will affect the flow velocity, which will be important to the aquatic life, with lower velocities associated with longer HRTs. However, if the HRT is too long, then the temperature of flow from a shallow, exposed wetland may ex-

ceed that tolerated by the aquatic life in the downstream areas. Also, if downstream sections are shallow sloped, then the volume and velocities of the discharge from the wetland may be insufficient to clear out the water in dead zones. This would call for shorter HRTs to ensure sufficient flow and velocity to flush out the stagnant pool areas.

Wetlands play an important role in nutrient retention, sedimentation, and water purification. Nitrogen and phosphorus are common nutrients in water bodies that result from agricultural and industrial sources. A lack of nutrient retention and sedimentation will inhibit growth of vegetation and create eutrophication downstream. Maximizing the time of contact between nutrients and vegetation within the wetland is the best way to maximize the nutrient retention and sedimentation and, therefore, water purification. Where vegetation is expected to reduce the pollution levels in the outflow, the HRT will need to be sufficiently long to allow for settling, infiltration, and uptake by plants. The HRT can be lengthened using baffles and islands to provide a meandering flow path (Persson *et al.,* 1999).

Wetlands have values other then those related to flood and pollution control. Specifically, they provide social benefits. For example, wetlands can contribute aesthetic benefits to an area depending on the design. However, different designs have different benefits and consequences to other uses of the wetland, particularly in regard to the water velocity and residence time. Vegetation can be considered an aesthetic addition to a wetland, which contributes to increasing the residence time and decreasing the velocity of water as a result of added drag force (Nepf, 1999). The shape of the wetland can also contribute to its beauty; however, the greater the length-to-width ratio, the greater the velocity of the water based on the continuity equation, thus reducing the HRT. Persson *et al.* (1999) found that poor placement of the inlet and outlet decreases the hydraulic efficiency. These factors should also be considered when designing for other purposes such as nutrient retention where slow velocities and high residence times are desired.

Wetlands also serve many recreational purposes. They are used for fishing, hunting, boating, watching wildlife, and education. Boating requires a certain depth of water. For a given volume of storage, increasing the depth would decrease residence time and the potential for sedimentation. Stagnant water due to low depths and velocities is ideal for fishing. For a given storage volume, the stagnant ponds would increase the residence time and contribute to sedimentation; however, the resulting environment may not be aesthetically pleasing.

CONCLUSIONS

The HRT is an important wetland design variable as it affects the performance of the wetland relative to a number of objectives. Unfortunately, individual wetland objectives benefit differently from different HRTs; therefore, an optimum wetland design will occur only when the HRT is set to balance the alternative demands. This will require knowledge of the effect of design variables (i.e., the outlet facility, pool depth, etc.) on the HRT for each wetland objective. Where a design is for multiple objectives, some balance between competing demands will be necessary. This may have engineering implications as well as implications to social and environmental objectives.

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AUTHOR LINK Richard H. McCuen
Dept. of Civil and Environmental Engineering
University of Maryland
College Park, MD 20742
rhmccuen@eng.umd.edu
kgilroy@umd.edu

Dr. Richard H. McCuen is the Ben Dyer Professor of Civil and Environmental Engineering at the University of Maryland, where he has taught for 37 years. His specialties include stormwater management, hydrologic modeling, statistical methods, and engineering ethics. He has been Book Review Editor of JAWRA for more than 20 years.

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HAVE SOME COMMENTS ABOUT THIS ISSUE OF IMPACT?

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Water Resources IMPACT is in its tenth year of publication and we have explored a lot of ideas. We hope we have raised some questions for you to contemplate. "Feedback" is your opportunity to reflect and respond. We want to give you an opportunity to let your colleagues know your opinions ... we want to moderate a debate ... we want to know how we are doing. For this issue send your letters by e-mail to Earl Spangenberg (espangen@ uwsp.edu).

Please share your opinions and ideas. Please limit your comments to approximately 350 to 400 words. If published, your comments may be edited for length or space requirements. Also visit AWRA's Water Blog at http://awramedia.org/mainblog/ to view past essays from our Future-ing Project (see pg. 28).

WATER RESOURCES IMPACT

WETLANDS PROTECTION THROUGH BUFFER MAINTENANCE ON PRIVATE PROPERTY (A Personal Approach to Wetland Protection Through Shoreline Restoration)

Mary Theresa Flynn

INTRODUCTION

Over the past 20 or 30 years much attention has been given to protection of wetlands and other waters through the delineation, protection, and maintenance of vegetative buffers to the wetlands. At the same time, invasive plant species have been recognized as destructive to natural habitats, and in particular to the buffers that protect our wetlands resources. Both issues have now crashed head-on as we recognize that the creation and maintenance of such buffers is severely threatened by their benign destruction from invasive nonnative plants.

Importantly, vast amounts of shoreline and buffer properties are privately owned. Accordingly, while their initial delineation and protected existence on private property may be mandated by state and local law, the resources to help the private property owner maintain a healthy state of that buffer comes most effectively from nonmandatory grass-roots sources.

This article examines one person's approach to the restoration of a privately-owned forest buffer that abruptly – and steeply – drops to a large brackish tidal cove off of the Patuxent River in St. Mary's County, Maryland. St. Mary's County was first settled and developed in 1634, and most of the area where this forest buffer exists has been farmed for many centuries. As a forest becomes more disturbed, the suppression of native species by exotics such as *Lonicera japonica* (Japanese honeysuckle), *Hedera helix* (English Ivy), and *Vinca minor* (periwinkle) becomes more pronounced (Thomas, 1980). An analysis and plan of action to deal with these common three invasives will be developed for this buffer.

A BRIEF SYNOPSIS OF RESOURCES ON BUFFER PROTECTION ON PRIVATE PROPERTY

Both Virginia and Maryland have longstanding, well thought-out and strictly enforced laws requiring the creation and protection of wetland, riverine, and other water body buffers through the mandating of "resource protection areas," (Chesapeake Bay Act) and "critical area buffers" (the Critical Area Act). Virginia's Riparian Buffer Implementation Plan even includes significant initiatives to landowners to encourage healthy buffers. Indeed, its *Sixth Annual Progress Report* asserts that as of 2005, Virginia had restored riparian buffers along 2,707 miles of rivers and streams statewide, but the emphasis of the program was on riverine and not wetlands buffers (Virginia Riparian Forest Buffer Panel, 1998).

The federal government approached invasive species through Executive Order 13112 (which revoked E.O. 11987 dealing with "exotic" species) but of necessity had a macro-approach to the problem not applicable to an individual property owner's desire to maintain a healthy wetlands buffer (Clinton, 1999). Similarly, the conceptual design of the *National Early Detection and Rapid Response System for Invasive Plants in the United States* placed the economy as the primary impact of concern regarding invasives, acknowledged that private property owners were primary stakeholders in the plan, but cited as the "rapid response" for infestation on private land as "action by" the owner, without specifying what action they had in mind (Federal Interagency Committee for the Management of Noxious and Exotic Weeds, 2003). This 2003 conceptual report also listed the creation of a list of target species that pose risks to land areas of the United States, as an objective of its plan, notwithstanding that the National Park Service had been doing primary research on the controlling factors of identified threatening species since the early 1970s (Thomas, 1980). Accordingly, some potential sources are bereft of information for the private landowner.

The protection of wetlands, especially through the protection and maintenance of wetland buffers on private property, is a responsibility of all of us who are entrusted with the stewardship of this magnificent resource

Fortunately, there is an abundance of grassroots and local government help that is more specific on the "how-to" of private buffer protection. Many of these organizations organize "Weed Warrior" days for specific sites (mostly parks) that involve training on invasive identification, safety, and provide the social environment of a group outing to attack invasives in a defined area, leaving the volunteers with the empowered recognition that they can do the same on their own property (Friends of Jug Bay, 2006). These "weed warrior weekends" are proving immensely popular and educational at the public level. Their well organized and thorough web material helped this property owner feel confident to undertake this project and that the "just yank it out" approach had merit (Imlay, 2008).

DESCRIPTION OF CURRENT STATUS OF THIS WETLAND BUFFER

The buffer at issue is located on the south side (north facing) finger of a large tidal cove formed at the mouth of north-flowing Cove Creek into the Patuxent River. The Patuxent River flows easterly to the Chesapeake Bay. The cove is home to Great Blue Herons, Egrets, Mute Swans, various ducks, numerous species of turtles and fish, and the occasional otter. The buffer is located on a single family subdivision lot, starting approximately 15 feet off the back porch of the house, and drops spectacularly about 100 feet as a wooded cliff at a 2:1 and sometime 3:1 slope directly into the cove. There are no alluvial deposits at the base of the cliff – the forest droops out

over the water. It is, in essence, a wetlands shoreline that is not a floodplain, due to its sheer height and steep gradient. It was left undisturbed initially because no farmer could navigate the precipitous drop, but is now protected as a part of the "critical area buffer" whose existence is required by Maryland's Critical Area Commission.

The buffer area is mapped as an oak-hickory forest (Brown and Brown, 1972) and indeed, an informal survey of existing species bears that out. No formal dendrological survey was necessary (or desirable, given the resources of individual property owner seeking to protect a buffer from invasives) to determine that a reasonably healthy oak-hickory forest habitat existed (U.S. Fish and Wildlife Service, 2001), but with evidence of significant intrusion of three common invasives, *Lonicera, Hedera*, and *Vinca*. Interestingly, no significant understory layer exists, other than some immature overstory species, possible due to culling by a previous owner to protect the view. A healthy colony of *Assimina triloba* (Paw paw) trees is evenly distributed as a shrub layer throughout the buffer (U.S. Department of Commerce *et al.,* 2007) (Table 1).

Table 1. Current Status of This Wetland Buffer.

Over Story	
Quercus prinus	Chestnut Oak, Rock Oak
Quercus Shumardii	Shumard's red oak
Ilex opaca	American holly
Carya tomentosa	Mockernut hickory
Shrub Layer	
Asimina triloba	Paw paw
Chionanthus virginicus	Fringe Tree
Cornus florida	Flowering dogwood
Herb Layer – Ground Cover	
Parthenocissus quinquefolia	Virginia Creeper
Rhus toxicodendron	Poison Ivy
Lonicera japonica	Japanese honeysuckle
Hedera helix	English Ivy
Vinca minor	Periwinkle

Some slight erosion from the house rain gutters across the back yard was noted, with evidence of additional light erosion occurring over the slope for about two-feet though the buffer. After the first two feet, stormwater disperses though the dense vegetation without evidence of erosion. The amount of the erosion is *de minimus* due to the small size of the roof area draining in that direction, and has not affected the plant life in the water path.

METHODOLOGY AND SITE SPECIFIC CHALLENGES

The steepness of the buffer presents a serious safety challenge for physical removal of the invasives. The slope also means that any removal of the ground-covering invasives must be done with discretion lest bare ground left by complete removal of the invasives results in erosion of the slope surface. Given the length and gradient of the slope, bare soil will result in a swift and significant erosion problem. The property owner remains committed to the removal of the exotics without herbicides, which in any event, are particularly problematic near water sources and animal habitat. The resources available to this property owner are essentially limited to one middle-aged person, boots, gloves, scissors, and a rappelling rope.

The first step will be to eliminate erosion to the buffer from the roof gutter so that a *de minimus* issue does not create problems where invasive species are removed (Chesapeake Bay Foundation, 2008). This will be accomplished by placing a small rain cistern under the downspout with a drainage hole in the bottom, so that rain-gutter water is retained temporarily, and allowed to drain slowly out the bottom of the vessel to percolate into the aquifer that supplies the house's well. Storm water in excess of that which the vessel can hold will spill out over the top, but its velocity will be reduced greatly and may percolate into the ground water before it reaches the precipice. Some of the water may percolate through the soil towards the slope, and will provide moisture to the forest plants through ground water rather than surface water.

No concern exists regarding water leaking into the house, as the house is on a slab without a basement. A large, low, decorative ceramic or fiberglass planter with a one-inch drainage hole has worked fine for this purpose at another property owned by this property owner, on a lot with significant water issues and a large basement. Winters are mild enough in St. Mary's County that a ceramic planter will likely survive winter freezes intact.

An initial plan to temporarily (*albeit* unartistically) line up decorative landscaping rocks along the backyard-buffer border (in essence, at the precipice of the slope) to stop sheetflow over the precipice, will be considered later, after an evaluation of the rain-cistern plan, and after due consideration can be given to slope stability where stormwater is diverted from the surface to ground water that may emerge through the slope.

An evaluation of all invasive plant species affecting the buffer will be made over time. Due to the limited resources of the property owner, it seemed beneficial to concentrate on eliminating one invasive at a time. A plan to initially address only the *Lonicera* was chosen due to *Lonicera's* aggressive habit of twining around woody plants, such as emerging native trees, and choking them to death, in order to open the canopy area to more sunlight to reach the forest floor, allowing the *Lonicera* to advance its insidious spread. *Lonicera* does not do well in the shade, so it creates its own best habitat by "murdering" the native trees though strangulation. A sinister cycle begins as the vertical structure of the forest becomes more open or empty upon the growth of the *Lonicera* that in turn permits the increased spread of the *Lonicera* (Thomas, 1980).

Lonicera has many advantages that allow it to outcompete native plants. Its stems elongate approximately

1.5 m (approximately 5 ft) in one growing season, and bloom profusely in full sun with a heavy production of fruit. Accordingly as it tears open the forest canopy, both vegetative growth and fruit production are increased. Moreover, as it is evergreen in the moderate Mid-Atlantic Region, it continues to grow as the native vegetation sleeps (Thomas, 1980).

However, the informal arboreal survey demonstrated that while *Lonicera* was in abundant supply at the top of the buffer where sunlight pervaded the forest, the healthy canopy and profuse *Asimina* (Paw paw) colony created enough shade that the insidious *Lonicera* had not (yet) out-competed the forest natives. Unfortunately, large amounts of *Hedera* and *Vinca* had colonized the majority of the forest floor in different portions of the buffer. An analysis of which controlling factor fomented the *Hedera* colony and which fomented the *Vinca* colony will be undertaken. It may be something as simple as where these imported invasives were originally planted by earlier settlers, or something as complex as soil analysis. In any event, the original plan to focus exclusively on *Lonicera* had to be abandoned.

In the end, the plan emerged to physically cut away those sections of each of the three invasives that are twining around, crowding, or interfering with the growth of existing native vines such as *Parthenocissus quinquefolia* (Virginia creeper) that are struggling to emerge from the invasives' colonies, or around young tree species, in order to eliminate or reduce competition to specific plants. Over time, lengths of each invasive will be hand cut and placed in a screened porch for drying, until the biomass can be safely returned to the forest without danger of the cut vines taking root. The goal of the project will be to enhance the forest habitat so that native species will thrive. The objective will be to remove three bushels of invasive vines – particularly those immediately interfering with natives – at each session.

Care must be taken to leave the root systems in place for the first year, until a determination on how to create enough appropriate ground cover to protect the precipice from erosion can be determined. In particular, concern remains about the effectiveness of a typical forest litter layer as an effective guard against erosion on such a steep gradient if the invasive ground covers are removed *in toto*. The plan is a work in progress.

SUMMARY

The protection of wetlands, especially though the protection and maintenance of wetland buffers on private property, is a responsibility of all of us who are entrusted with the stewardship of this magnificent resource. To some degree it remains a moral responsibility as not all that needs to be done can be accomplished through the adoption and enforcement of more statutes, regulations, or incentives. We just need to do it. Grassroots organizations have an important scientific contribution here, because they can accomplish through education, training, and just plain fun that which we lawyers cannot do with all of the laws in the world, nor which we scientists can accomplish with all of the erudite research and publications we can turn out. They make the science "happen."

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AUTHOR LINK

Mary Theresa Flynn
208 Battle Court SE
Vienna, VA 22180
(703) 801-9201

Mary Theresa Flynn is a former research biologist and bio-geographer for the National Park Service, Ecological Services Laboratory. She currently serves as a member of the Board of Directors of AWRA. She is also a lawyer and is counsel to the National Flood Insurance Program. The information and opinions contained herein are solely her own and do not represent the opinions of the Federal Emergency Management Agency or the Department of Homeland Security.

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WATER RESOURCES IMPACT

THE COASTAL DUNE LAKES OF FLORIDA: TRENDS IN WATER QUALITY AND CHANGING LAND-USE PRACTICES

Jehangir H. Bhadha and James W. Jawitz

BACKGROUND AND PROBLEM DEFINITION

Dune lakes are naturally formed fresh water basins that are typically found close to the coastline, delicately perched above the salt water fringe. Only a few hundred such lakes are in existence world wide, and similar ecosystems can only be found in Madagascar, Australia, New Zealand, and the Florida panhandle. Florida's 16 coastal dune lakes are found along approximately 48 km of Gulf Coast shoreline within Walton and Bay Counties. For thousands of years these lakes have withstood natural processes such as hurricanes, droughts, and land subsidence, but because of their sparing existence they were recently identified as globally rare and imperiled by the Florida Natural Areas Inventory.

What makes these coastal dune lakes unique is their intermittent connection to the Gulf of Mexico. This periodic connection serves as control for flood-level waters by opening a conduit to the Gulf. When a lake reaches a critical preflood level, breaching water forms an outlet through the dunes and empties the lake water into the Gulf (Figure 1). Salt water and biota from the Gulf exchange with the lake until equilibrium is reached and the opening eventually closes as sand refills the breach. This dynamic exchange forms a temporary estuarine ecosystem that can change rapidly – sometimes in front of your eyes within a matter of minutes. Each of the coastal dune lakes is individually characteristic, with outlet openings varying in length, frequency, and duration. These openings (or outfalls) occur based on individual lakes' critical water levels, which are driven by rainfall and storm events. As a result, some of the lakes can be completely freshwater, some brackish and/or salty, with varying degrees between stages. The changing condition of water in the coastal dune lakes makes them biologically diverse systems with a dynamic nature.

With an ever increasing demand for coastal beachfront properties, the coastal dune lakes are under constant threat from human activities like nutrient loading, recreational over use and rise in urban development. The U.S. Census Bureau estimated a population increase of 22% between 2000 and 2006 for Walton County, and projects an estimated 29% rise in housing development by 2012. Further, this region is also visited by 2.5 million tourists annually. Concerns about the "health" of these exceptional ecosystems have prompted Walton County to establish the Coastal Dune Lake Advisory Board, whose goal is to "serve, protect, and perpetuate these Lakes through mitigation of the effects of development." Achieving this goal will take a long-term collaborative commitment from stakeholders, citizens and technical teams alike.

SCOPE AND OBJECTIVES

In 2006, our group at the University of Florida initiated a collaboration with the Choctawhatchee Basin

Figure 1. Aerial Image of a Blowout of Dark Tannic Water From Big Redfish Lake Into the Gulf of Mexico (picture provided by Scott Jackson, PhotosFlorida.com).

Alliance (CBA) a citizen's group that includes area residents, developers, and educators in Walton County, and the Florida Lakewatch team. The purpose of this collaboration was to support preservation of these lakes by evaluating water quality in the lakes and comparing water quality trends to changes in land-use practices. Our plan was to identify baseline nutrient (nitrogen and phosphorus) concentrations that could be used as guidelines in setting impact standards for future work. The project also examined lake water salinity and outfall management, two equally compelling factors pertinent to these lakes.

HYDROLOGY AND WATER QUALITY

We found that all of the lakes were predominantly ground water fed. Ground water levels are relatively close to the ground surface even during the dry months. Lake water is generally colored (e.g., tea or black colored) due to watershed contributions of dissolved organic matter. The surface connection of several of the lakes to the Gulf is occasionally artificially maintained to control lake levels for the benefit of lakeside residents. In the late 1960s, an increased demand for water supply coincided with naturally low lake levels and concerns were raised that the lakes might dry up. An increased demand in water supply may trigger a similar situation if the lake water drops below a certain optimum level caused by rapid drawdown of the water table.

Over the past two decades Florida Lakewatch has monitored stage and water quality indicators such as total nitrogen (TN) and phosphorus (TP) concentrations on an approximately monthly basis in at least 10 lakes within the Choctawhatchee basin. While short-term fluctuations in concentrations are a direct effect of seasonality, gradual rise in long-term concentrations may be a result of increased nutrients driven by the rise in land use conversion and development surrounding the lakes. For example, in Oyster Lake, nitrogen and phosphorus concentrations have increased significantly between 2001 and 2008, rising from 573 to 868 mg/L N, and 48 to 76 mg/L P (annual average). The north end of Oyster Lake is within a kilometer of a golf course; hence fertilizer applications may be a potential source of nutrients to the lake. Many of the lakes have shown limited or no increase in nutrient concentrations during the monitoring period, which is encouraging. However, land use conversion and development has recently accelerated around these lakes, and this trend may have implications for development related nutrient sources.

SALINITY AND OUTFALL MANAGEMENT

With diurnal tidal cycles, stochastic annual weather cycles, decadal climate cycles, and increasing mean sea level, the dynamic behavior of dune lake hydrology and chemistry is clearly nonlinear and complex. Despite this challenge, it is important to make an effort to understand how development in the watershed may impact the hydrology, chemistry, and ecology of these globally rare ecosystems. The variations observed in lake water salinity are controlled by the interactive effects of tidal activity, the timing of outfall opening, and volume of salt water mixed at times when outfall is open. Spatial variability in salinity concentrations can occur in both the vertical and horizontal directions. Vertical variations in salinity may be caused if the lakes were stratified and not well mixed, in which case one would expect lake water salinity to be higher at the bottom than at the surface. Horizontal variability in salinity concentrations may be due to uneven distribution of surface and/or ground discharge, proximity to the sea, wind-driven mixing, and potentially other morphological factors that affect mixing, including location and structure of plant communities that isolate sections of the lake from its effective volume. In our limited sampling of six coastal dune lakes, we observed both vertical and horizontal variability (Table 1).

With an ever increasing demand for coastal beachfront properties, the coastal dune lakes are under constant threat from human activities like nutrient loading, recreational over use, and rise in urban development

CHANGING LAND-USE PRACTICES

Using a GIS tool we mapped land-use changes from 1966 to 2005 within the watershed surrounding six coastal dune lakes, three of which are shown in Figure 2. The GIS coverages were created based on aerial photography and land use maps from the U.S. Geological Survey for 1966 and 1974, the Northwest Florida Water Management District for 1995, and the Florida Department of Transportation for 2005. We found that many of the lakes' watersheds have already been heavily developed (such as Oyster and Draper Lake), while others are less developed, but are in transition, being rapidly converted to be used for development purposes (such as, Western and Camp Creek Lake). While each lake has

Table 1. Higher Conductivity and Salinity Are Observed in Lakes Whose Outfalls Were Open* to the Gulf of Mexico at the Time of Sampling (note that average ocean salinity is approximately 35 ppt).

	Campbell	Oyster	Western	Camp Creek	Draper*	Powell*
Conductivity (mS/cm)	0.2-0.4	2.2-5.1	0.2-6.0	1.1	19.1-20.8	8.5-21.1
Salinity (ppt)	0.1-0.2	1.2-2.8	0.1-3.2	0.5	11.5-12.0	5.0-12.1

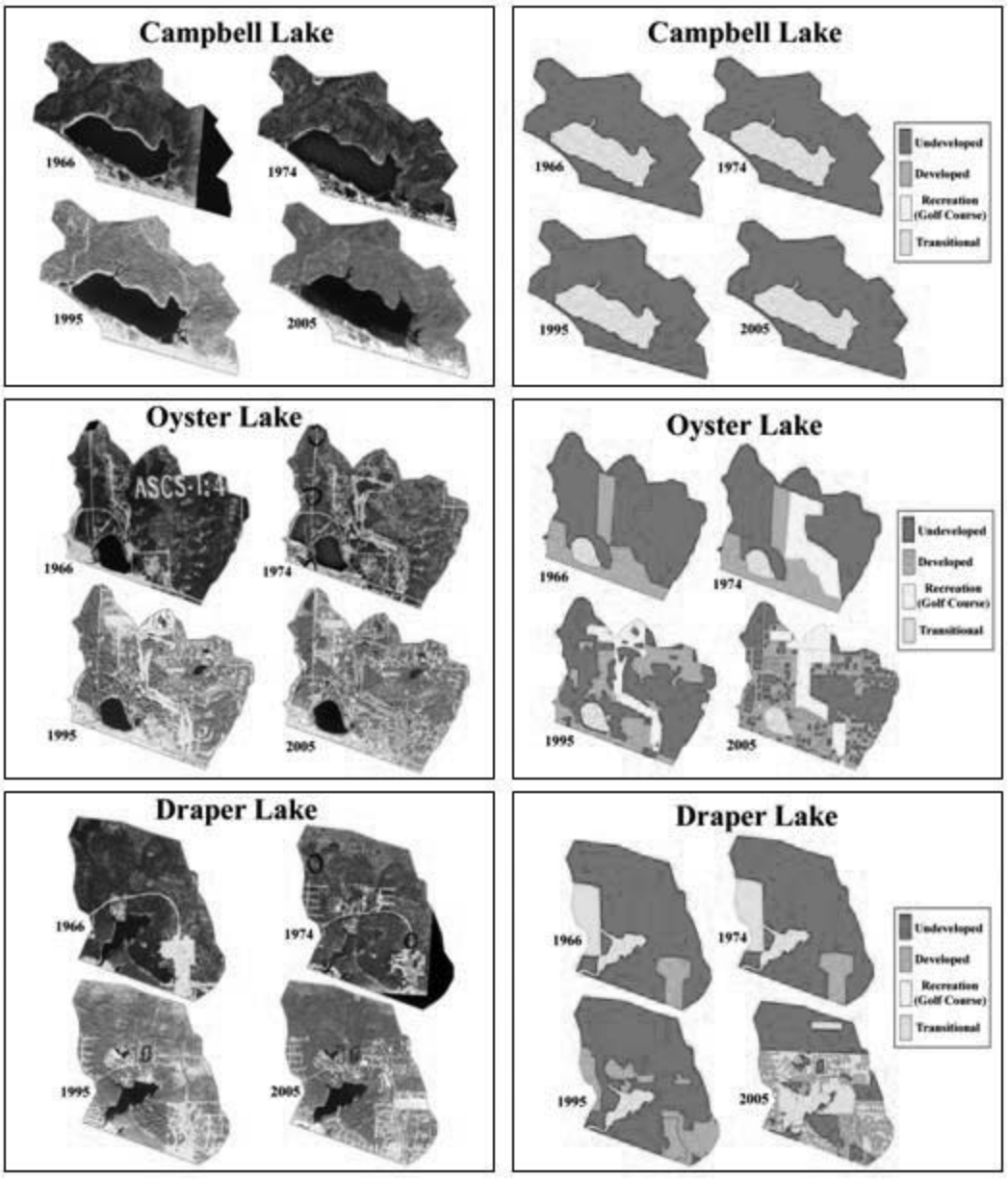

Figure 2. Changes in Urban Development Around the Lakes Over the Past Four Decades.

some proportion of protected land within its watershed, only three Fuller, Morris and Campbell Lake (within Topsail State Park) remain completely undeveloped and protected. A large portion of Western Lake's watershed still remains undeveloped, but its future will depend on private landowners. Camp Creek Lake is the most recent to be developed, but 50% of the watershed will likely remain undeveloped since it is surrounded by the Deer Lake State Park and Point Washington State Forest. Each lake has varying degrees of protected lands within its watershed; however, local land use decisions will influence development, and hence the future of the lakes.

CONCLUSION

We believe that these lakes respond to changes in hydrology and chemistry on numerous time scales; from the rapid changes that occur during hurricanes and outfall events, to the seasonal scale variations of wet and dry periods, to decadal and century-long time scales that reflect land use conversion and sea level rise. Many of these changes in the water and chemical balances can be modeled or represented using known trends in long term data sets. However, the sporadic nature of variations due to drastic switches caused by outfall events, and the uncertain effects of longer-term changes due to global

warming, combined with current anthropogenic perturbations adds a distinct element of unpredictability which may act as overwhelming forces on these lakes at opposite ends of the time scale. It is still yet unclear how to define a stable (or median) state for these systems, if one exists at all.

In addition to the long-term collaborative ventures, we feel that there exists a vast difference in public perception towards the coastal dune lakes. During our multiple field visits to the lakes we had the opportunity to interact with numerous people who associate with the lakes on a daily basis such as local residents, land owners, State park officers, and CBA staff. We found that almost everyone we spoke to had some concern regarding the lakes' future. Their opinions ranged from pseudo scientific, to anecdotal, to simply indignant. Seeing the rise in urban development and population growth around these lakes, it is only a matter of time before this growth in development will take its toll on these lakes. To counterbalance this rise in growth, it is important to publicize these lakes and educate people about the impact their actions could have on these lakes. We believe an integrated education campaign can provide a strong foundation towards preserving the lakes future by promoting awareness, imparting good housekeeping concepts to local residents, and sustainable land-use practices administered by land developers.

ACKNOWLEDGMENTS

Our work has been funded by the Choctawhatchee Basin Alliance and the U.S. EPA-People, Prosperity, and Planet Program. We thank Mark Hoyer (Florida Lakewatch) for access to water quality data, and Dr. Mark Brenner and graduate students Aaron Bunch, Corey Catts, Kristen Blanton, David Kaplan, John Linhoss, and Gordon Brown for assistance with sample collection and data analysis.

AUTHOR LINK

Jehangir H. Bhadha
Soil and Water Science Department
Univ. of Florida, 2169 McCarty Hall
Gainesville, FL-32611
(352)392-1951x222/Fax: (352)392-3902
jango@ufl.edu
jawitz@ufl.edu

Jehangir Bhadha is currently pursuing his PhD from the Soil and Water Science Dept. at the Univ. of Florida (UF), where he is conducting research in evaluating ground water nutrient fluxes from impacted wetlands within the Lake Okeechobee drainage basin. In 2003 he received his Master's degree in Geological Science from UF where his research involved internal loading of nutrients in the Indian River Lagoon, Florida. His undergraduate studies and Bachelor's degree were from St. Xavier's College, Mumbai (India), that involved geologic mapping and field work in the Great Aravalli Complex.

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▲ HIGHLIGHTS OF JAWRA TECHNICAL PAPERS • AUGUST 2008 • VOL. 44 • NO. 4

Nadine Schuurman *et al.,* describe the challenges of integrating multiple source, large datasets for development of a ground-water hydrostratigraphic model crossing the U.S.-Canadian border. Numerous interoperability challenges including the availability of data, metadata, data formats and quality, database structure, semantics, policies, and cooperation were identified as inhibitors of data integration for cross-border studies.

Joanna Endter-Wada *et al.,* found that the most significant factors predicting actual water use in Utah were the type of irrigation system and whether the location was a household or business; attitudinal and motivational characteristics were not consistently associated with water use. This implies that water conservation programs should identify potential wasteful users through analyses of water billing data and should direct water conservation measures at these users by focusing on site-specific evaluations and recommendations.

Joshua Galster *et al.,* show that high-resolution topographic surveys for the channels of paired watersheds in the Lehigh Valley, Pennsylvania, are comparable, but have channel widths that have changed dramatically in the past five decades. These data suggest that the increase in urban area-generated peak discharges is the mechanism behind the widening that occurred.

G.B. Senay *et al.,* evaluated the Global Data Assimilation System (GDAS)-based reference evapotranspiration (ET) estimates using data from the California Irrigation Management Information System (CIMIS). While the study revealed the potential of GDAS ETo for large-scale hydrological applications, site-specific use of GDAS ETo in complex hydro-climatic regions such as coastal areas and rugged terrain may require the application of bias correction and/or disaggregation of the GDAS ETo using downscaling techniques.

Liz Dent *et al.,* describe preharvest spatial and temporal patterns in summer stream temperature for small streams of the Oregon Coast Range in forests managed for timber production. They conclude models of increasing temperature in a downstream direction may oversimplify fine-scale patterns in small streams.

D.Q. Kellogg *et al.,* report that riparian sites with deep water tables (naturally or because of increased urbanization or other hydrologic modifications) or shallow root zones may not generate groundwater upwelling to meet evaporative demand, thereby increasing the risk of nitrogen movement to streams.

A full Table of Contents may be viewed at http://www.blackwell-synergy.com/toc/jawr/44/4.

JAWRA ~ Journal of the American Water Resources Association

WATER RESOURCES IMPACT

RAPANOS, STATE ASSUMPTION AND WETLAND POLICY

Jefferson G. Edgens

INTRODUCTION

A divided U.S. Supreme Court in the summer of 2006 ruled the U.S. Army Corps of Engineers (Corps) must show a significant nexus between a wetland and a navigable body of water in order to assert regulatory control under the Clean Water Act. At issue were two separate cases in which Michigan land owners sought to develop "wetlands" they owned.

In the first, John Rapanos was told he could not develop his land, although the site in question was more than 20 miles from the nearest body of water. The second case concerned June Carabell, who sought to develop land she owned that is connected to Lake St. Clair via a series of man-made ditches. In both cases the Corps ruled the land qualified as wetlands, and thus could not be developed without a permit from the Corps.

A COURT DIVIDED

Justice Antonin Scalia wrote an opinion for four justices asserting the Clean Water Act's definition of "navigable waters" applies to "relatively permanent, standing or flowing" waters "with a continuous surface connection" to navigable waters.

Justice John Paul Stevens wrote an opinion for four justices asserting the Clean Water Act's definition of "navigable waters" applies to any parcel of land or water that drains to or is in the extended watershed of navigable waters.

Justice Anthony Kennedy, representing only himself but controlling the outcome of the case by virtue of his tie-breaking vote, took the middle ground, asserting the Clean Water Act's definition of "navigable waters" applies to any parcel of land or water that has a "significant nexus" to navigable waters, such that the parcel at issue is significant enough "to perform important functions for an aquatic system incorporating navigable waters."

SCALIA: 'BEYOND PARODY'

Scalia adamantly argued the Corps exceeded its authority in denying the respective landowners use of their property. Scalia noted that if the Corps' broad interpretation of "waters of the United States" was invoked, it would put every drop of water that falls on the ground in the hands of the federal government. In effect, Scalia pointed out, "this would place the federal government in the role of land use czar."

Scalia disagreed with the Corps' use of the term "waters of the United States," and he emphatically stated the Corps took an overly expansive reading of the term. He wrote, "In applying the definition to 'ephemeral streams,' 'wet meadows,' 'storm sewers and culverts' ... man-made drainage ditches and dry arroyos in the middle of the desert, the Corps has stretched the term 'waters of the United States' beyond parody."

STEVENS: DEFERENCE TO CORPS

Stevens argued the courts should defer to the Corps' interpretation of the Clean Water Act. In addition to asserting deference to the executive branch, Stevens accused the Scalia opinion of "antagonism to environmentalism" that "needlessly jeopardizes the quality of our waters."

KENNEDY: 'SIGNIFICANT NEXUS'

Most legally significant in the case was Kennedy's wayward opinion in which he advanced the notion of a "significant nexus" to determine if lands fall within the jurisdiction of the Corps. Kennedy noted that in nature, isolated wetlands serve a valuable function as water recharge areas. Often a wetlands miles from a river is connected below the ground, something referred to as a "hydrologic connection."

According to Kennedy, jurisdictional arguments over wetlands stem from whether the land significantly interacts with, or is isolated from, "navigable waters." Therefore, according to Kennedy, the 6th Circuit Court of Appeals incorrectly used the overbroad definition of "navigable waters" asserted by Stevens. Accordingly, the cases must be sent back to the lower courts to determine whether such a significant nexus existed.

Rapanos in many ways left wetlands jurisprudence more cloudy than before ... but at the same time it appears states are spurred to act in order to seek clarification over issues they believe are closer to home and state officials know more about

FEW SATISFIED WITH OPINION

Court watchers and all parties in the cases appeared confused by the Court's 4-1-4 decision. Although the Court vacated and sent the cases back to the 6th Circuit Court of Appeals, the decision fails to advance common law to clarify wetlands jurisdiction.

Rebecca Wodder, president of American Rivers, one of the organizations that filed a friend of the court brief in support of the Corps, asserted in a news release, "The Supreme Court leaves protection of clean water law in this country in a horrible muddle with this decision." A similar position was echoed by the Sierra Club's president, Carl Pope. "We are concerned that, as Chief Justice Roberts laments, the 'lower courts and regulated entities will now have to feel their way on a case-by-case basis.' "

PROPERTY RIGHTS AT RISK

Property rights supporters largely tried to emphasize the positive in the Court's decision. "Today's ruling delivers a welcome victory by curtailing federal regulators'

overbroad reading of their wetlands regulatory powers," legal analyst Patrick Wright explained in a Mackinac Center news release.

To most of the Rapanos supporters, private property is at the center of the legal storm. Cato Institute's Tim Lynch and Mark Moller explained the Court's reasoning this way: "If the government can regulate any land from which water occasionally drains, no matter how speculative the effect of this drainage on navigable water, wetlands law gives it almost limitless jurisdiction over private property."

"We are delighted with this ruling It is about time that the Court stop these out-of-control bureaucrats who thumb their noses at congressional intent," observed Mountain States Legal Foundation President William Perry Pendley.

KENTUCKY ATTEMPTS TO CLEAR THE WATER

Kentucky officials set forward as early as 2005 to assume Section 404 authority of wetlands and join the two other states with such authority. The Roberts court decision in Rapanos only hastens the desire for some states to seek state authority of the Section 404 permit approval process. The Section 404 program requires a permit from the U.S. Army Corps of Engineers for any discharge of dredged or fill materials into designated sites of navigable waters covered by the Clean Water Act.

One part of Section 404 allows states to assume responsibility for the permitting process. If things go according to plan, Kentucky will be only the third state to do so. Michigan and New Jersey are the other two. Kentucky officials want to take on the process in order to improve efficiency and state control of decision-making regarding wetlands.

GOVERNOR INITIATED PROCESS

Before any state can begin the process, certain steps must take place. The first step for Kentucky began with Gov. Ernie Fletcher (R) issuing a directive for the Environmental and Public Protection Cabinet to undertake the review process. From there Environmental and Public Protection Cabinet Secretary LaJuana Wilcher created a 28-member task force to study the issue. Fletcher submitted legislation to enable and make legal the review process. The task force produced a 60-page report reviewing the current 404 system. The report concludes with a 20-page appendix containing recommendations from delineation to enforcement actions. But one sticking point in the process is adequate funding for a state to assume control of Section 404 permitting.

CONCERNED ABOUT FUNDING

Critical to a state's assumption of a permitting program is the financial cost and whether it can pay for such a program. The Kentucky General Assembly made a modest downpayment of $833,926 available in the first year of a two-year budget cycle, with $600,000 allocated in fiscal year 2007-2008 for Section 404 administration costs.

Budgetary shortfalls for the state would be closed with permit fees or reorganization of Division of Water offices to improve efficiency and save money. Questions remain about the sustainability of funding and whether the increase in funds for section 404 might shortchange enforcement actions in other environmental programs in the state.

The move is not without its critics. Russ Harding, former director of Michigan's Department of Environmental Quality, said, "If Michigan had it to do over again an assumption program should not be followed." Harding added, "Michigan's program is not any easier for applicants than people originally thought it would be."

SUSTAINABILITY A CONCERN

Among the recommendations from the State Task Force a primary concern is that "a state run process should not only be transparent and predictable, but also sustainable." Task force coordinator Amanda Waters said, "The real goal of state assumption is better science and wetlands monitoring with expedited application review." It remains to be seen whether those goals can be met.

Among the topics addressed by the task force recommendations are electronic submission of permit applications, public notice and education, wetlands mitigation tracking and monitoring, coal mining, timeliness of application review by state agencies, sufficient consultation in advance of the application process, technical review concerning other federal and state laws, adequate resources and training for agency staff, public interest review, and an ability to consider applications by impact rather than activity.

Task force members hope a new program, if approved, will provide greater public participation, transparent enforcement, and coordinated permit application and review processes.

Kentucky, is not alone is pursuing state assumption of the Section 404 permitting process. Florida, too, is conducting its own review process as well. Stakes are high for Florida with its interconnected watersheds and coastal areas.

FLORIDA SEEKS AUTHORITY FOR SECTION 404

Florida officials seek to strengthen the state's water policy and make for a more efficient permitting process and with a stroke of the pen, then Governor Jeb Bush signed into law a bill to streamline stormwater regulations and develop a more efficient wetlands permitting system for the state.

Due to slow approvals and an unclear chain of permitting authority between the state and numerous federal agencies, Florida is seeking greater clarity and streamlined process. One of the key issues is the lack of any deadline to approve or reject permits under Corps review. Delays lead to the loss of economic revenue for businesses and uncertainty that creates unintended fines and penalties for developers trying to abide by the law.

"Wetlands within state boundaries are state issues and should be dealt with by the states themselves," this according to Daniel Simmons, director of the American Legislative Exchange Council's Natural Resources Task Force. "Not only does the federal government have no power to regulate wetlands that are not navigable waters, but there is certainly no need in the case of Florida to do so," Simmons added. "Florida is clearly taking the lead in ensuring clean water and responding to citizen inquiries in an efficient and responsible manner."

Rapanos in many ways left wetlands jurisprudence more cloudy than before. But at the same time it appears states are spurred to act in order to seek clarification over issues they believe are closer to home and state officials know more about.

ADDITIONAL READING

Edgens, Jefferson G., 2006. Kentucky Seeks State Control of Wetlands Program. *Environment and Climate News*, August 1, 1996.

Taylor, James M., 2006. Florida Seeks Authority Over State Wetlands. *Environment and Climate News*, August 1, 1996.

[Reprinted, adapted, and updated from a series of articles appearing in the August 1, 2006, *Environment and Climate News*, a publication of the Heartland Institute.]

AUTHOR LINK

Jefferson G. Edgens
Dean of External Programs
Brewton-Parker College
Mt. Vernon, GA
(912) 583-3243
jedgens@bpc.edu

Jefferson G. Edgens, Ph.D., is Dean of External Programs at Brewton-Parker College and before that was Assistant Dean for Academic Affairs at Georgia Military College. He has written on wetlands and watershed management for numerous publications.

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▲ SCHEDULED TOPICS FOR FUTURE ISSUES OF *WATER RESOURCES IMPACT*

NOV. 2008 – DATA MGMT. IN WATER RESOURCES
TREVOR CAMPBELL (GUEST) ~ trevor@plato-consulting.com
JONATHAN E. JONES (ASSOCIATE) ~ jonjones@wrightwater.com

JAN. 2008 – SEA LEVEL RISE & COASTAL ZONE MGMT.
ERIC J. FITCH (ASSOCIATE) ~ fitche@marietta.edu

MARCH 2009 – MANAGING WATER RESOURCES DEV. IN A CHANGING CLIMATE (SPRING SPECIALTY CONFERENCE)
MICHAEL LILLY (GUEST) ~ mlilly@gwscientific.com
MICHELLE HENRIE (ASSOCIATE) ~ mhenrie@atkinson-thal.com

MAY 2009 – ADAPTIVE MGMT. OF WATER RESOURCES II (SUMMER SPECIALTY CONFERENCE)
GERALD SEHLKE (GUEST) ~ Gerald.Sehlke@inl.gov
JONATHAN E. JONES (ASSOCIATE) ~ jonjones@wrightwater.com

JULY 2009 – LANDFILL & LANDSPREADING HAZARDS
LAUREL E. PHOENIX (ASSOCIATE) ~ phoenixl@uwgb.edu

SEPT. 2009 – WATER RESOURCES & BOUNDARY ISSUES
ASSOCIATE EDITOR-TBA

NOV. 2009 – SPIRITUALITY & WATER MGMT.
ERIC J. FITCH (ASSOCIATE) ~ fitche@marietta.edu

All of the topics listed above are subject to change. For information concerning submitting an article to be included in the above issues, contact the designated Associate Editor or the Editor-In-Chief N. Earl Spangenberg at espangen@uwsp.edu.

AWRA OUT-OF-PRINT PUBLICATIONS STILL AVAILABLE

Recently, AWRA's "books-on-demand" provider for out-of-print publications has stopped providing this service. If you are interested in a single article ($15) or a complete proceedings or monograph, send an email to info@awra.org. A complete listing of available publications is provided at the link.

SPOT WATER MARKET AIDES CALIFORNIANS DURING SEVERE DROUGHT

Clay J. Landry and Christina Steinhoff

In an unusual move to address drought conditions, California's Gov. Schwarzenegger announced in July a State of Emergency for nine Central Valley counties. The State of Emergency allowed for the exchange of 62,500 acre-feet of State Water Project (SWP) supplies and the movement of 50,000 acre-feet of non-SWP ground water through SWP facilities to reach drought-stricken farmers. The announcement followed the U.S. Bureau of Reclamation's reduction of Central Valley Project (CVP) water supplies to 40% for agricultural water users.

Although the exchange did not require any payment for the water, the move signified the growing need for drought-year water transfers throughout the state. Many water users rely on the spot water market to provide short-term relief during dry years. The spot market allows water right holders to lease all or a portion of their water on an annual basis. Generally, the water comes from agricultural water users north of the Sacramento-San Joaquin Delta who either have a water surplus or have determined that leasing water is more profitable than farming. The market provides an alternative to state-facilitated water transfers.

HISTORY OF THE CALIFORNIA SPOT MARKET

The ability to transfer water from the Sacramento region south through the Delta has been key to the reliability of California's water supply. The market has been active since the state established a drought-year water bank in 1991. The temporary bank paid farmers a fixed amount for water supplies and sold the water. In 1994, the last year of the water banking program, the purchase price was $50 per acre-foot. After the water bank ended, an increasing number of buyers negotiated private lease agreements and commonly used the California Aqueduct to transfer the water.

CURRENT TRADING ACTIVITY

The spot market facilitates the movement of more than 475,000 acre-feet annually during an average water year. During dry years, the volume of water traded can exceed 1 million acre-feet. The types of buyers participating in the market generally fall under three categories – municipal, agricultural, and environmental.

Municipal Water Demand. The largest municipal water purchaser is the Metropolitan Water District (MWD), which uses a significant volume of SWP entitlement water to meet demands in southern California. Because SWP supplies generally decrease during dry years and water demand continues to increase, the MWD is actively pursuing alternative water supplies throughout the state. The district has twice entered into option agreements with farmers north of the Delta to provide a back-up water supply during dry years. The MWD also has an agreement with the PaloVerde Irrigation District that pays farmers annually to fallow their crops. These programs help the MWD serve nearly 17 million people.

Agricultural Water Demand. Irrigation districts representing farmers of perennial crops also actively participate in the water market. The CVP and SWP contractors in the central region of the state represent a large portion of the irrigation water buyers. These contractors generally lease water supplies from farmers north of the Delta to supplement decreases in CVP and SWP water supplies.

Environmental Water Demand. Environmental water buyers play a significant role in the water market. Two large environmental water leasors are the Water Acquisition Program, which Reclamation and the U.S. Fish and Wildlife Service operate, and the Environmental Water Account, which comprises a group of 23 federal and state agencies. Both programs primarily purchase water north of the Delta to support downstream environmental water needs.

Market Outlook. Spot market prices are on the rise, as Figure 1 shows. During the first half of 2008, the median lease price for nontreated water was $162. However municipal buyers paid approximately $200 per acre-foot. The price also depends on water supply reliability and water year conditions, among other factors. The record high annual median price was set in 1993 after three consecutive drought years. The median price was $246 per acre-foot in 1993. The state should expect similar prices in 2009 because of increasing crop prices and population growth. Worldwide market conditions have created record prices for rice, a major crop that has been a primary source of water for the state's spot market. According to the U.S. Department of Agriculture, the average price for rice has more than doubled since the last drought in the early 1990s. The combination of high commodity prices, increasing water demand, and additional environmental constraints on water pumping from the Delta could lead to record high water prices in California in 2009.

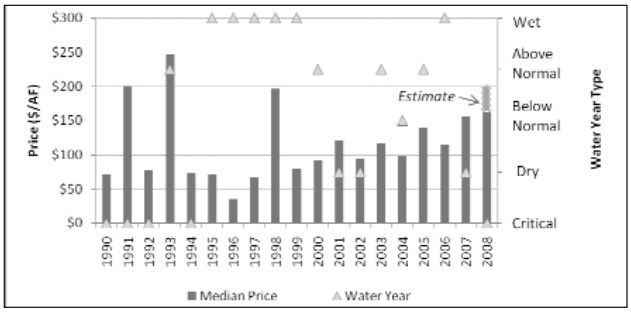


Figure 1. Annual Spot Market Prices by Water Year Type. (Note: Water Year type is based on the Sacramento Water Index. Prices are adjusted to 2008 dollars using the U.S. Consumer Price Index.)

E-MAIL CONNECTION

landry@waterexchange.com
steinhoff@waterexchange.com

XERXES, MADAME PELE, AND BOILING LOBSTERS

Eric J. Fitch

You remind me of the lobster who is delighted by the warm feeling of the water he has just found himself thrown into ~ Anon

Every form of refuge has its price ~ Lyin' Eyes ... The Eagles

Current anthropological analysis has surmised that waves of Polynesian people set sail in double hulled canoes from Tahiti, the Marquesas, and perhaps other islands across vast stretches of open water from 1700 to 1400 BCE to colonize a chain of unspoiled islands that came to be called Hawai'i. A few weeks ago, I stared out the window of a Boeing 777 as it made its final approach to the Honolulu airport. I had traveled over 5,000 miles in less than a day to get there. It was the beginning of two months as a visiting research fellow at the East-West Center. My work was on the policy responses of Pacific Rim nations, especially in Oceania, to sea level rise. As I looked down, the reptilian part of my brain started to clash with higher brain functions. My rational self was telling me how lucky I am to have been selected to spend time working in this beautiful place doing research of great interest to me, and that I live during a time when travel is possible with relative speed and comfort. My reptile brain meanwhile was going, you idiot, you never learned to swim and you are putting yourself voluntarily on an island; a mountaintop surrounded by nothing but water for hundreds and hundreds of miles in every direction, except for other islands. Not a coastal barrier or Great Lakes island but Oahu, an island that rises up a little over 4,000 feet above sea level and plunges down thousands of feet below sea level to the abyss. Once I got the reptile back in its mental cage, I got thinking about how fragile so many of the places humans live are and how vulnerable water resources are to even the smallest changes in the Ocean world.

Islands like those in the main part of the Hawaiian chain (Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, Hawaii, and baby Loihi that will break the surface in approximately 18,000 years) are relatively young and present significant areas of elevated habitable lands to humans with generally reliable supplies of fresh water. The ancient Hawaiians came to know how special a place these islands truly are and this knowledge was reflected in their creation of myths and legends. In a reversal of the mythologies of many other peoples, the native Hawaiians saw fire as neither a creation of the gods nor an evil, destructive deity. The goddess of fire, lightning, dance, volcanoes, and violence – a respectable portfolio for any deity – is one of the most revered in native Hawai'ian traditions. Pele (or Madame Pele) elicited reverence and respect from the Hawai'ian people as "Ka wahine'al honua" – literally "she who devours the land;" figuratively, she who destroys and creates the land that is Hawaii. She is constantly at war with her sister, Na-maka-o-kaha`I, goddess of water and the sea. This warfare is in no small measure due to Pele stealing Namaka's husband, killing her dog, and other indignities. The conflict between these two leads to the renewal of the land, indeed, to the creation of new land.

Many of the islands and coasts that humans have colonized in the Pacific Basin, and throughout the world are not so shielded from the effects of sea level rise. Here in the midst of the Pacific there are many examples: Kiribati, Nauru, Tuvalu, etc. All are or will be suffering from the impacts of sea level rise. The main question is not if, but when. Inundation, subsidence, salt water intrusion, over wash from storm surge, and other impacts of sea level rise all threaten both the land and the fresh water in these tropical paradises. If ocean warming increases the intensity and/or the frequency of tropical storms, you can add another prime danger. It would be hard to find a place more fitting of the term unspoiled tropical paradise than Niue. Though Niue is one of the largest coral islands in the world, it has the protection of high rising coastal cliffs and a central plateau. Even these were not sufficient to protect the island from the impact of a Category 5 tropical cyclone. From the Maldives to the Seychelles to the coasts of Louisiana and Florida impacts are being felt. Unfortunately, most of the world's leadership are taking one of three approaches: (1) ignore/deny sea level rise, (2) act as though they can engineer their way out of the problem (if it arises) "down the line," or (3) take action in response. Unfortunately, these last are few in number and usually the most threatened and least able to act.

Humans have long believed themselves to have power over nature, even over the vastness of the sea. In 482 B.C., Xerxes I of Persia had two great bridges built over the Hellespont to allow his armies to march against the Greeks. A storm came in across the sea and destroyed both bridges. Xerxes had the architects executed and ordered the royal executioner to whip the sea with 300 lashes and throw shackles into the water to demonstrate both Xerxes' anger with the sea and his mastery over it. Today, Xerxes is dust and the Hellespont still flows. Unfortunately, today's leaders share Xerxes' ignorance and arrogance. Or to put it another way, right now, the pot of water is relatively cool. In a few decades we may be the equal of a lobster being thrown into boiling water and not be able to do a darn thing about it.

E-MAIL CONNECTION

fitche@marietta.edu

PRIVATE SHORTAGE SHARING AGREEMENTS – CONTRACTUALLY AVOIDING HARSH LEGAL CONSEQUENCES

Michelle Henrie and Kyle S. Harwood

Our home state of New Mexico recently turned the corner on drought. It is now experiencing a relatively wet summer. According to the Palmer Drought Index (PDI), the south-central and southwest portions of the state are "moist" or "extremely moist" – including that kind of extreme moisture that results in flooding. Until the recent summer monsoons, however, one could not help but to wonder whether we would make it through the summer. For the northwest corner of the state, which the PDI logs as "near normal," not "moist," the question may not be entirely off the table.

Northwestern New Mexico is known for the high elevation desert landscapes of Four Corners National Monument and the Navajo Reservation. The San Juan River flows through this corner of New Mexico. The river originates in the San Juan Mountains in southern Colorado, flows through New Mexico, and discharges into the Colorado River upstream from Lake Powell, Utah. The San Juan River is a huge river for New Mexico: over 60% of New Mexico surface waters are San Juan River flows. Because nature is ironic, fresh ground water is not readily available in this area. This means that surface waters are relied on heavily for domestic, agriculture, and industrial use.

New Mexico is a prior appropriation state. This means that in times of drought, junior water users can be legally forced to forego water use so that senior users may continue to use their full quantity water (which is a "priority call" on the river). It is a harsh system: juniors lose and seniors win. There is no common shared burden.

How does one know who is "junior" and who is "senior?" Traditionally, prior appropriation states have relied on adjudications. Adjudications determine the extent and ownership of each water right within a specific geographical area. The non-Indian claims for water use on the San Juan River were adjudicated in 1948. Thus, one can determine between some water users which user has a relatively senior right and which has a relatively junior right, but it would be difficult to fully administer a priority call on the San Juan River.

Despite practical difficulties, the San Juan River came close to a priority call during the drought of 2000 to 2004. During this time, San Juan River flows were as low as 10-15% of average. Plus the river had flow requirements for native fish recovery, so water could not be managed solely for the benefit of water users.

Faced with the inevitable, major water users on the San Juan River looked for alternatives to a priority call. In 2003, they negotiated and signed a shortage sharing agreement that provided for a percentage reduction in use. The parties who came together and voluntarily agreed to do what they did not need to do under law included industry, municipal, tribal, and agricultural interests.

There is a lesson to be learned from this story. While statutes, regulations, and caselaw (also called "common law") dictate rights and relationships, they are not necessarily the only way to articulate rights and relationships. Contracts are another way to articulate rights and relationships. When the anticipated result under law is too harsh, consider whether a contracted-for result might be appropriate.

Under a contract, the parties get to identify their rights and duties. They may choose to include measurables, such as performance criteria and deadlines. The parties can determine remedies if the contract is breached. For example, "specific performance" means that a court can require the breaching party to take the action that it was supposed to take under the contract. By contrast, an alternate remedy would be reimbursing a nonbreaching party for hiring someone else to do what the breaching party was supposed to do as "damages." Most importantly, contracts allow the parties to control elements that otherwise are dictated by regulators.

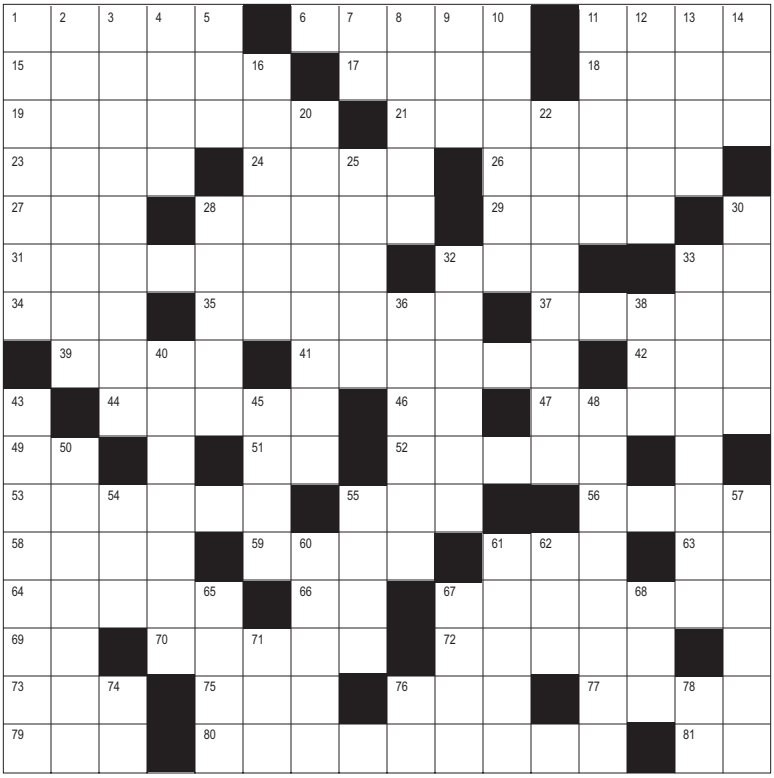
Keep in mind that a contract will not be enforced in court if the contracted-for action is illegal. For example, the major water users on the San Juan River could not have contractually agreed to use more water than their permits allowed. These water users were able to agree among themselves that they would use less water (which is legally allowed).

Given precedent in northwestern New Mexico, drought remains a serious concern but it is less of a doomsday scenario. In addition, New Mexicans have witnessed how a group of water users can take control of a situation and better the common good by making voluntary sacrifices – an idea that was absolutely contrary to the principle of prior appropriation, yet entirely the right thing to do.

E-Mail Connection

mhenrie@atkinson-thal.com
kyle@harwood-consulting.com

WATER RESOURCES PUZZLER (answers on pg. 27)



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47 ballpark boo-boo
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51 Green Mtn. state
52 singing cowboy
53 follows penny
55 mil. rank
56 one of HOMES
58 type of light
59 brief sleeps
61 to pat
63 Atomic no. 99
64 tree houses
66 Atomic no. 28
67 most gloomy
69 Wynn or McMahon
70 indifferent person
72 sidebar picture
73 followed by fox or light
75 USDA group
76 Tallahassee coll.
77 oldies group
79 full house (abbr.)
80 put into office again
81 loc. of Yazoo R.

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7 cousin of B.C.
8 summer TV program
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12 show talk
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14 followed by line or point
16 _____ with a kiss
20 most frightening
22 sled puller?
25 TO DO and Most Wanted
28 spirited horse
30 cleaner
32 one of 8 (or 9?)
33 tunes
36 wide expanses of water
38 _____ and feather
40 results of genetic change
43 follows city and land use
45 tied
48 deli purchase
50 type of reactor
54 trig function
55 Beowulf or the Iliad
57 impedes (law)
60 salt-water taffy flavor
61 morning junk food
62 Eur. country
65 famous celebrity
67 data storage device
68 JFK posting
71 an aggregate of minerals
74 first tone
76 Atomic no. 26
78 house unit (abbr.)

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PRESIDENT'S MESSAGE ... A NATIONAL WATER VISION AND THE REAUTHORIZATION OF THE NATIONAL FLOOD INSURANCE PROGRAM

Jane O. Rowan

How would a National Water Vision affect the development and implementation of legislation related to flooding and the floodplain?

In 1968, Congress passed the National Flood Insurance Program (NFIP) based on the following: (1) flood disasters have created personal hardships and economic distress that require disaster relief measures and place increasing burdens on the Nation's resources; (2) despite public programs designed to reduce losses caused by flood damage, these programs have not been sufficient to protect adequately against exposure to future flood losses; (3) a reasonable method of sharing the risk of flood losses is through a program of flood insurance that can complement and encourage preventive and protective measures; and (4) if such a program is initiated and carried out gradually, it can be expanded eventually, making flood insurance coverage available on reasonable terms and conditions to persons who have need for such protection.

The House and Senate currently have before them for reauthorization, versions of amendments to NFIP called the Flood Insurance Reform and Modernization Act of 2007. Both versions continue to provide insurance to those living in floodplains in participating communities with some expansion and/or tightening of conditions for coverage. In the Senate version (Senate Bill 2284), the general intent is restoring "financial solvency of the flood insurance fund, and for other purposes." The House version (House Bill 3121) states the Act's purpose is "to restore the financial solvency of the National Flood Insurance Program and to provide for such program to make available multiperil coverage for damage resulting from windstorms and floods and for other purposes." I encourage you to look at these two bills. A version of one of them hopefully will be passed by late September.

This reauthorization follows shortly the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (Blumenauer Act). The Blumenauer Act's stated purposes were to identify flood risk, provide flood risk information to the public, to encourage State and local governments to make land use adjustments to constrict development of land exposed to flood damage, and make flood insurance available on a nationwide basis. The Blumenauer Act focused mainly on repurchase of repetitive-loss properties and the justification, process, and means to compensate the property owners. The Blumenauer Act also referred to the Stafford Act that covers those who have lost property during a disaster of some type. People who do not participate under the NFIP, fall under the protection of the Stafford Act for financial disaster relief. The current House bill says the Blumenauer Act has not been fully implemented.

This current legislation raises the issue of what is actually guiding congressional action on the myriad of issues pertaining to water and related land resources. Through a series of three Water Policy Dialogues, AWRA has emphasized the need for the development of a National Water Vision that states America's commitment to valuing water in the floodplain, as well as persons and property and our national security. The Vision would not necessarily exist for the purpose of creating more legislation, but rather to appeal to the national conscience – to our federal and state legislators, government employees, educators, and all Americans. The application of a Vision to all appropriate legislation could revolutionize the ways Americans value and treat ground and surface water, including the watersheds in which floodplains reside. It might even help fulfill the intent of the current legislation.

Is the NFIP and related legislation truly fulfilling its original intent to limit exposure to future flood losses? Restating my original thought: How would this legislation be different if it were written in the shadow of a National Water Vision? Would water quality protection during floods be included? Would there be a statement of the importance of preventative measures to flooding by restoring functions and values of floodplains, or enhanced management of the watershed's "flood relief valve?" Would there be grants to authorize buy-back of floodplains at fair market value? Would the legislation allow for tax incentives for those who own land but choose not to develop within the floodplain? Shouldn't these things be in the National Floodplain Protection Act? If you would like to comment on the subject of the NFIP or ideas for a National Water Vision, visit the AWRA Waterblog at http://awramedia.org/mainblog/.

We look forward to seeing you in New Orleans at our Annual Conference. If floodplain issues or a National Water Vision is important to you, there will be ample opportunity to connect and converse within one of the largest and most effective water communities in the world. Come hear about the efforts taking place in this great city to repair the devastation of the 2005 hurricane season. If you had always hoped you could lend a hand in the restoration efforts, AWRA plans to provide an opportunity for you to do so. Keep your eye on our website for details!

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DON'T MISS ANY OF AWRA'S FUTURE MEETINGS

SEE A COMPLETE LISTING ON PG. 8

JOIN US AT OUR ANNUAL WATER RESOURCES CONFERENCE IN NEW ORLEANS IN NOVEMBER

SEE CENTER PAGES FOR ADDITIONAL INFORMATION

COMMENTS FROM THE EDITOR-IN-CHIEF
AN UPDATE ON THE FUTURE

N. Earl Spangenberg

IMPACT's Associate Editors' project on the future is well under way. Our stellar list of experts winds up their essay contributions with the last issues of this year. We have had some great contributions, which you can view at AWRA's Water Blog (http://awramedia.org/mainblog/).

The plan for 2009 has changed slightly. You can participate in the "Future-ing" project by responding to the survey form that will be available in mid-2009. Keep your eyes open for it. In the meantime, don't hesitate to drop us an email line to give us your thoughts and ideas (espangen@uwsp.edu). Just to keep the thought in front of you, here's a reminder about the vision of the future developed by the Associate Editors.

TEN WATER RESOURCE CONCERNS FOR THE NEXT DECADE

1. Water Resources Sustainability – We need to learn more of the requirements for sustainable water development, and work to develop a national consciousness of sustainability.

2. Water Resources Education and Information – We need to evaluate and encourage expansion of advances in water resources education in elementary schools and secondary schools, and at the college and university levels. Further, we need to develop water resources education and public awareness programs beyond and outside the schools to better communicate technological concepts about water to the public.

3. Water Resources and Climate – We need to determine how climate change/global warming will affect sustainable fresh water supplies, and how water storage and conveyance systems will be affected. In addition, we need to evaluate the potential concomitant impacts on water planning and management programs, and on shoreline planning.

4. Global Water Problems – We need to address the problems associated with the availability of drinking water and adequate sanitation in the developing world, with local emphasis on security of fresh water storage and distribution systems; and regional emphasis on investigation of new policy frameworks over multijurisdictional areas.

5. Infrastructure Concerns – We need to address the problems of aging infrastructure at all levels with particular reference to concerns for infrastructure financing as affected by such factors as resistance to rational pricing to support development.

6. Watershed Management Problems – As state and local government move towards adoption of watershed management and protection programs, we will need to evaluate such things as the nature of broad-scale management planning in fragmented ownerships, and the implications for private property rights.

7. Institutional Effects on Water Availability – We need to look further into the concept of privatization of water resources to see if it is a viable solution to enhancing availability; and we need to investigate the potential impact of states moving to prior appropriation concepts in water law. We need to determine the relative value/impact of making local proven water supplies the controlling factor in development versus moving water from where it is located to where demand exists.

8. Concerns in Water Resources Management Decisions – We need to evaluate the possibilities of incorporating new technologies and concepts such as risk analysis into water resources decision making, and we need to continue to develop tools for measuring the accuracy of water resources forecasting. We need to evaluate and account for the impact of special interest group influences in Congressional deliberations.

9. Water and Energy – The production of energy requires significant amounts of our fresh water resources. We need to research potential water savings in the production of energy.

10. Concerns About Water Quality – As detection limits are enhanced, trace amounts of many constituents not previously found in water are being detected. We need to reexamine water quality standards in light of these emerging contaminants.

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Solution to Puzzle on pg. 25

WATER RESOURCES CONCERNS IN THE NEXT DECADE: SEPTEMBER ESSAYS

This issue completes the series of essays from authorities, which is the second part of our "Future-ing" project. This issue's essays are from:

Dr. Peter E. Black, Distinguished Teaching Professor of Water and Related Land Resources, Emeritus, SUNY College of Environmental Science and Forestry, Syracuse, New York; President-Emeritus-AWRA; and Associate Editor of the first issue of *IMPACT*.

Dr. Peter H. Gleick is President of the Pacific Institute, Oakland, California; a member of the U.S. National Academy of Sciences; a MacArthur Fellow; and admits to having water on the brain.

Next issue we will have a tie-up of the essays. We will summarize the comments as we can, with an effort to highlight common concerns, and emphasize consequences for future planning. Early in 2009, look for an email survey soliciting your reactions and opinions about "Water Resources Concerns in the Coming Decade." The essays this year have highlighted a variety of concerns we will be facing in the next decade. They are all posted on AWRA's Water Blog (http://awramedia.org/mainblog/. Click on the category *Water Resources in the Next Decade* to see the essays from January through July. Please share your comments on these essays, or on your vision of the next decade's problems, by posting to the Blog, or by emailing me at espangen@uwsp.edu. Please take advantage of this opportunity for continuing conversation about water resources concerns by visiting us and leaving your comments.

N. Earl Spangenberg ~ *IMPACT* Editor-in-Chief

ECONOMY, ENERGY, ENVIRONMENT, BIODIVERSITY, AND WATER

Peter E. Black

Constant economic growth is both a financial benefit to our future and civilization's major environmental challenge. It may destroy our civilization unless we act to prevent it. Why?

First, we expect our economy to grow at the rate of about seven percent each year, doubling wealth every decade. The Federal Reserve monitors and tweaks interest rates to assure steady, controlled growth.

Second, the overall planet's human population is growing at an ever-increasing rate demanding more food and energy with less and less arable land, and many other natural resources spread thin. Witness the devastating impacts of global warming as increasing numbers of and more intense storms, wildfires, tornadoes, floods, and droughts. Next, add the misery to which we expose ourselves along with potential – and likely – widespread conflict and sustenance shortages of energy, water, space, and food, and we face colossal challenges.

Third, we fail to evaluate environmental costs of the watershed functions, life support services, and amenities on which we depend: floods, flushing, and biodiversity, for example. All natural water bodies (including us) flush except of course, the receiving oceans. Flushing peaks during and immediately after stormwater events, rain or snowmelt as surface runoff, channel interception, and near-stream subsurface runoff as the storm hydrograph. Precipitation that infiltrates and percolates to ground water reservoirs shows up slowly as base flow: the annual hydrograph. Hydrologists know all that; the public does not. Hydrologists, equipped with powerful and precise innovative tools, inadequately explain to a public that demands protection from floods yet occupies the floodplains; wants lower taxes; complains about noncommunicating professionals. Floodplain dwellers should know that levees do not protect against floods, which will still occur. Levees simply confine the same amount of water to narrower channels making the water higher, and are overtopped. The result is not a "natural disaster:" natural, no; disaster, yes; because Homo Sapiens are in the way of a natural event.

Fourth and most serious is the diminishing ability of Earth's biodiversity support systems to absorb within limits the impacts of diseases, shortages, and other enhanced assaults. Any further consequences of fossil carbon exploration, development, and use could more drastically promote conditions beyond our ability to control them. We are already in imminent danger of major environmental changes with irreparable shocks to Earth's biodiversity ... New petroleum exploration, development, or use? Not on my life!

In sum, humankind is clearly mismanaging its economic, energy, and environmental resources with potentially disastrous results. Attempts to find methods of creating large amounts of cheap energy are having inevitable unintended but not unexpected consequences. One solution is more and better conservation, the shift of rates of use toward the future. We should pay for our life styles now, not commit our descendants' paychecks for our wasteful ways. We know better. Our civilization's mindset inexorably links economy, energy, and environment. Until we figure out a way to nurture Earth's resources, our wealth will always be at the expense of our children and grandchildren. Do you have any ideas on how to fix that? Where are our priorities? Do we want to continue burdening our offspring for our luxurious, wasteful amenities and pleasures, in the face of dangerous consequences? Or are we willing to pay now? We must find ways to do it (© 2008).

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WATER IN THE FUTURE? MUSINGS WHILE IN AN OPTIMISTIC MOOD

Peter H. Gleick

I have spent a lot of time in the last couple of decades thinking about the future of water. I think there are some truly depressing possibilities facing us. But I swing back and forth between pessimism and optimism as I get older, and find I much prefer optimism. I don't know what the future will look like – there are, of course, many possible futures. But I can see, at least through occasional patches of clearing fog, the outlines of a future we might want to pursue.

Many of my recent research projects and even my policy musings (at www.pacinst.org and www.worldwater.org) have touched on the idea of a "soft path for water" – a new way of thinking about sustainable water planning, management, and use. I truly believe that we will, inevitably, move along such a path. The ways we managed water in the 20th Century brought many benefits to us – the water infrastructure and systems we developed have brought remarkable changes and advantages as the world has developed and advanced. But we also must acknowledge that many things we did in the 20th Century have inadvertently contributed to some of the worst water challenges we now face: the massive destruction of aquatic ecosystems; overpumping or contamination of nonrenewable ground water resources; and of course, the now inevitable consequences for our water systems of climate change.

But I also see signs of change, for the good. Things that we took for granted 20 years ago, or didn't even think about, are now de rigueur for water, at least in some places. The solutions to our water supply problems are no longer assumed, blindly, to be the narrow traditional solutions we applied – large centralized storage. Such solutions may still make sense sometimes, and in some places, but new concepts of "supply" are now joining the portfolio of options considered: advanced treatment and reuse of wastewater, modern versions of traditional rainwater harvesting, integrated management of surface water and ground water, and desalination. There is a classic saying, "When you know how to use a hammer, every problem looks like a nail." Fortunately, as we realize our problems are not just nails, we are expanding our tools.

Similarly, the days when we simply assumed that demand for water would inevitably grow, if not over, are coming to an end. I think the most powerful piece of data influencing U.S. water policy is the graph I use in many of my presentations showing that total withdrawals of water in the United States have been falling for more than two decades, despite the fact that almost all of our water policy is predicated on the assumption that it is growing, and must continue to grow. There is a revolution underway in thinking about water demand – a shift to the common sense idea that our ultimate objective is not to use water, but to do things, to produce goods and services. While many of these goods and services require water (growing food, making semiconductors, removing wastes, cooking, cleaning, and so on), almost all of them can be done with less water than we spend to do them. Hence, the new and critical concept of water efficiency must play a central role in any truly sustainable water management system.

Finally, the nascent effort to integrate ecosystem thinking into water policy is a critical part of any truly sustainable water future, and long overdue. We don't know how to do it well. But we do know that we have no choice. Water for humans and water for ecosystems must not be considered mutually exclusive but mutually necessary.

It is still easy to get depressed. The failure to meet basic human needs for water and sanitation for billions grates on me every second of the day. I agonize over heedless and massive ecosystem destruction. The continued pressure to do the wrong things in water policy because of greed or avarice or stupidity or ignorance delays our progress along the soft path for water. But I really believe that progress is inevitable, as we make it harder and harder to do the wrong thing and easier and easier to do what is right.

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▲ 2008 ELECTION RESULTS (take office effective January 1, 2009)

The AWRA Tellers Committee announces the following election results for officers and directors taking office on January 1, 2009.

PRESIDENT-ELECT
ARI M. MICHELSEN

Ari Michelsen, Ph.D., has been an active member of AWRA for 22 years. Currently, he is an AWRA Board Member (2005-2008), and serves on the Finance Committee. He regularly presents papers at AWRA conferences, publishes in *JAWRA* and *IMPACT*, and was Conference Organizing Committee Co-Chair for the 2001 Decision Support Systems in Water Resources Management Symposium.

Michelsen's goals for AWRA include promoting integrated water resources management and facilitating development of a sound national water resources policy that will coordinate the many competing interests. A sound policy requires focused input from a broad range of disciplines. Accordingly, AWRA's multi-disciplinary structure is the perfect vehicle to develop this policy. To achieve this, he will guide AWRA to provide outreach to a broader range of water professionals and foster opportunities for these professionals to form alliances across

water-related disciplines. Working with others, he will guide these alliances through AWRA to identify the objectives this nation must set for the effective management of its water resources and challenge these professionals to identify steps necessary to achieve those objectives.

Acceptance of a sound national water policy will require an educated public that understands the need for well managed water resources. Michelsen will position AWRA to promote water resources education on a national scale. Michelsen will also seek to further the fiscal soundness of AWRA by listening, observing, monitoring, and adjusting our conference strengths and membership benefits.

Michelsen is Director of the Texas A&M AgriLife Research Center at El Paso, Texas, and Professor of Agricultural Economics, The Texas A&M University System. His responsibilities include leadership and administration of the Center's research programs that are focused on scientific and policy advances in water resources and environmental management. He has authored or co-authored over 100 publications and technical reports. He serves on the Board of Directors of and is Past-President of the Universities Council on Water Resources, is a member of the Southwest Hydrology Advisory Board, the Paso del Norte Watershed Council Executive Committee and the New Mexico-Texas Water Commission. Michelsen has a Ph.D. in Agricultural and Resource Economics and a Master's Degree in Economics from Colorado State University and a B.S. in Conservation and Resource Management from the University of Maryland.

Director
Carol R. Collier

Carol Collier's background is in aquatic biology and regional planning. She has experience in the private sector, state government, and currently with an interstate/federal commission.

Carol has served as Executive Director, Delaware River Basin Commission (DRBC) in West Trenton, New Jersey, since 1998. She was Executive Director of Pennsylvania's 21st Century Environment Commission. Before that she served as Regional Director of the Pennsylvania Department of Environmental Protection (PADEP) Southeast Region. For 19 years, she was with BCM Environmental Engineers, Inc., Plymouth Meeting, Pennsylvania, beginning as a student intern and becoming Vice President of Enviromental Planning, Science and Risk.

Carol received a B.A. in biology from Smith College and a Masters in Regional Planning from the University of Pennsylvania. In addition she is a Professional Planner licensed in the State of New Jersey, American Institute of Certified Planners (AICP). She is a member of her township's environmental protection advisory board. She teaches graduate environmental management courses at the University of Pennsylvania, and has testified before the House of Representatives and the Pennsylvania Legislature. In 2004 she was a member of a nine person U.S./ China/Japan team to assist the Peoples Republic of China with river basin management. She also participated in a Pinchot Institute Board event on water management and sustainable forest practice in the rain forests of Ecuador. In 2007 she was awarded AWRA's Mary H. Marsh Medal for Exemplary Contributions to the Protection and Wise Use of the Nation's Water Resources.

Carol believes AWRA is the one organization that is really trying to integrate all aspects of water management. She believes in the AWRA mission and personally wants to forward the science (and art) of integrated water resources management. She strongly believes that proper management of water resources is the key to our economic and environmental future.

Director
Karl W.J. Williard

Since 1999, Karl W.J. Williard has been an Assistant and Associate Professor of Forest Hydrology at Southern Illinois University Carbondale (SIUC). He received a B.A. in Biology from Lehigh University, an M.S. in Environmental Pollution Control from Penn State University, and a Ph.D. in Forest Hydrology from Penn State University. Karl teaches courses in Watershed Management and Forest Hydrology and directs a graduate research program involving M.S. students and Research Scientists. His research interests include nitrogen and phosphorus dynamics in riparian buffers; the impacts of forest road construction, recreational trail use, and military training on erosion and sedimentation; and the water quality impacts of invasive plants.

Karl has been an active participant and leader in all three levels of AWRA. He has been a national member since 1995, a Pennsylvania and Illinois State Section member, a Lehigh University and Penn State student chapter member, and is the charter advisor of the SIUC student chapter. Karl has served as President of the Penn State Student Chapter and the Illinois State Section. He was Technical Program Chair for the 2007 AWRA Annual Conference and serves as an Associate Editor of Ecohydrology for the *Journal of the American Water Resources Association* (*JAWRA*).

Karl is interested in continuing to enhance the value of membership in AWRA. In particular, he would like to provide strategic guidance and support for two of AWRA's primary products: the annual conference and the flagship publication, *JAWRA*. He believes the national organization should continue to foster and nourish relationships with student chapters and state sections. Karl feels the student chapters are an important training ground for future water resource professionals and leaders. Overall, AWRA needs to focus on their market niche as the interdisciplinary home for all things water resources. Through all of his experiences with AWRA, he has found that the best aspect of the organization is the genuineness of the people involved. There is a true sense of community among the membership. He challenges us to get that message out to prospective members, so they can experience it first hand.

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AWRA's 2008 SUMMER SPECIALTY CONFERENCE STUDENT PRESENTER COMPETITION WINNERS ANNOUNCED

Congratulations to the two winners of AWRA's 2008 Summer Specialty Conference on *Riparian Ecosystems and Buffers* Student Presenter Competition held during the conference in Virginia Beach, Virginia, June 30-July 2. Twenty-six different presentations were evaluated by the conference attendees throughout the 36 oral sessions and the poster session. Attendees used the following criteria to evaluate both oral and poster competitors:

- Efficient use of allotted presentation time or poster space.
- Quality of responses to audience questions in oral or at poster sessions.
- Effective integration of audio-visual materials.
- Perceived preparedness.
- Logic and understandability of material (problem, methods, results, conclusions).
- Adequate description of context for material – conveyed purpose of paper, identified relevant literatures, etc.
- Overall style and presence; effective communicator – enthusiasm or persuasiveness.
- Suitability for AWRA/professional audience.
- Significance and originality of the material presented.

Everyone did a terrific job making the decision difficult. However the following two individuals were selected as the outstanding winners.

Again, our congratulations on a job well done to all those students who were in the competition and we wish them all the best in their future endeavors. We look forward to hearing more from everyone at future AWRA conferences!

ANDREA LUDWIG
Virginia Tech
Blacksburg, Virginia

Poster Session, "Evaluating a Constructed Floodplain Wetland for Nutrient Removal Efficiences" (co-authors: W.C. Hession, Jim Lawrence).

Andrea Ludwig is a Ph.D. student in the Department of Biological Systems Engineering (BSE) at Virginia Tech. She graduated from the University of Arkansas with a B.S. in Biological Engineering (2004) and an M.S. in Environmental Engineering (2006). Her M.S. research focused on assessing nutrient limitation of periphyton (algae) and identifying the trophic state of streams using a rational index of potential algal production.

Currently at Virginia Tech, Andrea is studying the efficiency of best management practices in nutrient removal from stormwater in the Chesapeake Bay watershed by quantifying assimilative processes of constructed floodplain wetlands. Andrea is an active member of several professional societies including AWRA and the American Ecological Engineering Society (AEES). She is an Engineer in Training and pursues her professional engineer's license to practice in the field of water quality, restoration, and watershed management.

RYAN PANKAU
Southern Illinois University
Carbondale, Illinois

Session 10, "Assessment of Concentrated Flow Paths Within Riparian Buffer Zones of Southern Illinois" (co-authors: Jon E. Schoonover, Karl W.J. Williard, Pamela J. Edwards).

Ryan graduated from Southeastern Illinois College in 1999, earning an A.A.S in Urban Forestry. While at SIC, Ryan was the recipient of the Field Work Scholarship for outstanding work in the field. He then spent five years as a consulting arborist for a tree care company in Champaign-Urbana, Illinois. During this time, Ryan completed the requirements to become an International Society of Arboriculture Certified Arborist and currently maintains this certification. In 2004, he enrolled at SIU and by 2006, completed a B.S. in Forest Resource Management, graduating with honors. He was an active member in the SIU student chapter of AWRA and a club officer since the fall of 2007.

Currently, Ryan is a graduate research assistant with the Department of Forestry at SIU, Carbondale, with Dr. Jon Schoonover as the chairman of his graduate committee. He is working to complete his thesis project relating to concentrated flow path development in riparian buffers of southern Illinois. Previously as a graduate student, Ryan completed a project assessing the historic water quality data of the Kaskaskia River Watershed in Illinois. The project compiled all existing water quality data for the Kaskaskia River from the previous two decades and thoroughly analyzed these data. Ryan wrote and submitted a comprehensive report to the Illinois EPA and the Southwestern Illinois RC&D. In collaboration with the Southwestern Illinois RC&D, the information outlined in the final report was used to develop two best management practices (BMPs) workshops held for the stakeholders of the Kaskaskia River Watershed. Ryan's current research interests focus on the impacts of land use on water quality, hydrology, and sediment transport, specifically on the impacts of agricultural land use. His future goals are to pursue a career in water resources where he can contribute to developing and implementing management practices that will increase the quality and integrity of our nation's waters.

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HERBERT SCHOLARSHIP AWARD WINNERS FOR 2008-2009 ANNOUNCED ... GRADUATE & UNDERGRADUATE DIVISIONS

Graduate Student Recipient
KATHLEEN RUGEL
University of Georgia
Athens, Georgia

Kathleen's affinity for the study of the biological and hydrological aspects of water began well before her doctoral studies at the University of Georgia. In the mid-1990s, as a public school teacher, she became involved with Tennessee Educators of Aquatic and Marine Sciences (TEAMS), which provides teachers with methods for implementing aquatic curricula to increase awareness of water-related issues. While serving as its president, Kathleen sought out speakers from a diverse array of academic, research, industry, and government backgrounds to facilitate a state-wide exchange of water-related information and to generate partnerships in the aquatic education community with the goal of enabling teachers to show students how water connects to their daily lives. At her own urban high school, Kathleen garnered support in the form of funds, equipment, and time from the local community to develop an infrastructure of pathways and bridges in the 30-acre natural area behind the high school and turn it into a living classroom. The students have responded enthusiastically to the opportunity to participate in field studies.

All the while, Kathleen pursued her own informal limnological study of Reelfoot Lake in northwest Tennessee for 10 years. She performed water quality testing, macroinvertebrate sampling, and wetland studies. She familiarized herself with the physical, biological, and political threats to the watershed, becoming aware of the challenges inherent in managing areas where aquatic resources must be shared between competing stakeholders and opposing agendas.

Kathleen's doctoral research focuses on evaluating the potential ecological impacts of agricultural ground water pumping in the Coastal Plain region of southwest Georgia. She plans to address the question of how ground water extraction in the Spring Creek subbasin may be affecting ground water stream exchange and consequent water quality and quantity in these systems.

In her own words, the Spring Creek basin "located within the Lower Flint River Basin is the most heavily allocated watershed in Georgia for ground water use, with total permitted withdrawals of 1.45 billion gallons per day. Agricultural pumping to drought proof economically sensitive crops in this basin competes with equally important water use for waste assimilation, industry, and sustainable instream flows to support aquatic biota, within and out of this basin."

Kathleen is the current president of the AWRA Student Chapter at the University of Georgia, Athens, where they have sponsored speakers on multidisciplinary topics, increased attendance at regional water-related conferences, and facilitated connections between the student chapter membership and water resources professionals in the surrounding community.

Upon completion of her doctoral studies, Kathleen hopes to put her scientific and leadership experience to use in the area of watershed arbitration and policy development.

Undergraduate Student Recipient
VERONICA ALBA
University of Wisconsin
Stevens Point, Wisconsin

Veronica is a rising senior at the University of Wisconsin–Stevens Point (UWSP) where she is pursuing her B.S. degree in Watershed Management with minors in Soil Science and Spanish. After her transfer from Marquette University, Veronica dove right into the research opportunities in the Water Resources Program. She immediately began work in the Water and Environmental Analysis Lab as a laboratory assistant and at the Groundwater Center as a field technician measuring stream flows of the Wolf River throughout Wisconsin and assisting with a Shawano Lake runoff and infiltration study.

Upon receipt of the Kramer Family Global Environmental Program Scholarship, Veronica traveled to Guatemala to study drinking water quality and erosion and bank stabilization. The drinking water study included the design and implementation of a comprehensive water sampling strategy for the homes and water sources in a Guatemalan town. Findings were used to evaluate the importance of the delivery system integrity on drinking water quality. For the erosion and bank stabilization study, Veronica and her partner surveyed and mapped erosion susceptible areas along the Limón River for slope angle, surface area, soil texture, and surrounding vegetation.

Veronica is presently finishing her data collection on an infiltration error parameter study, which aims to estimate error parameters for a double-ringed infiltration method in coarse-textured soils. Preliminary findings were presented at the American Geophysical Union conference. Results of all three studies have been presented at the UWSP–College of Natural Resources Student Research Symposium.

No stranger to AWRA, Veronica has been active in the UWSP-AWRA Student Chapter where this fall she will serve as president. She attended the 2007 AWRA Annual Water Resources Conference to staff the UWSP exhibit and demonstrate the ground water model, which she did tirelessly. This year, Veronica will present the final results of her double-ringed infiltration study at the AWRA Annual Water Resources Conference in New Orleans.

Veronica hopes to work for a conservation organization and is especially interested in soil conservation and water-soil interactions. In her own words, "My ultimate goal is to apply my education and experience in the water resources field to real-world conservation issues."

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AMERICAN WATER RESOURCES ASSOCIATION MEMBERSHIP APPLICATION – 2008

MAIL THIS FORM TO . . . AWRA • C/O MIDDLEBURG BANK • P.O. BOX 2217 • LEESBURG, VA 20177-2217
FOR FASTEST SERVICE . . . FAX THIS FORM (CREDIT CARD OR P.O. ORDERS ONLY) TO (540) 687-8395
QUESTIONS? . . . CALL AWRA HQ AT (540) 687-8390 OR E-MAIL AT INFO@AWRA.ORG

➤ COMPLETE ALL SECTIONS (PLEASE PRINT)

LAST NAME FIRST MIDDLE INITIAL

TITLE

COMPANY NAME

MAILING ADDRESS

CITY STATE ZIP+4 COUNTRY

IS THIS YOUR ❑ HOME OR ❑ BUSINESS ADDRESS?

PHONE NUMBER FAX NUMBER

E-MAIL ADDRESS

RECOMMENDED BY (NAME) AWRA MEMBERSHIP #

➤ MEMBERSHIP CATEGORIES

REGULAR AND STUDENT MEMBERS

❑ REGULAR MEMBER.....$165.00
❑ REGULAR (HALF-YEAR: JULY 1-DECEMBER 31).....$82.50
❑ STUDENT MEMBER (FULL YEAR ONLY).....$30.00

REGULAR AND STUDENT MEMBERS RECEIVE ONLINE ACCESS TO 40 YEARS OF RESEARCH IN *JAWRA* (*REGULAR MEMBERS* RECEIVE A PRINT VERSION AS WELL), ONLINE ACCESS TO CONFERENCE PROCEEDINGS, ONLINE AND PRINT VERSIONS OF *WATER RESOURCES IMPACT*, AND DISCOUNTS ON PUBLICATIONS AND CONFERENCE REGISTRATIONS.

ASSOCIATE MEMBER – SINGLE OFFICE

❑ FULL YEAR.....$500.00
❑ HALF-YEAR (JULY 1-DECEMBER 31).....$250.00

ASSOCIATE MEMBER – ENTERPRISE OFFICE

❑ FULL YEAR.....$2,000.00
❑ HALF-YEAR (JULY 1-DECEMBER 31).....$1,000.00

ASSOCIATE MEMBERS RECEIVE PROMINENT VISIBILITY ON AWRA'S WEB-SITE, DISCOUNTS ON EXHIBIT OPPORTUNITIES AND AWRA JOB POSTINGS, AND *WATER RESOURCES IMPACT* ONLINE AND IN PRINT (SEVERAL COPIES, IF REQUESTED).

❑ AWRA MEMBERSHIP CERTIFICATE.....$11.00

➤ STUDENT MEMBERS MUST BE FULL-TIME AND THE APPLICATION MUST BE ENDORSED BY A FACULTY MEMBER

PRINT NAME SIGNATURE

ANTICIPATED GRADUATION DATE (MONTH/YEAR): _____

FACULTY SIGNATURE ENDORSEMENT: _____

➤ FOREIGN AIRMAIL OPTIONS: CONTACT AWRA FOR PRICING.

➤ PLEASE NOTE

* MEMBERSHIP IS BASED ON A CALENDAR-YEAR (JAN. 1-DEC. 31); AFTER JULY 1, REGULAR AND ORGANIZATIONAL MEMBERS MAY ELECT A SIX-MONTH MEMBERSHIP FOR ONE-HALF THE ANNUAL DUES.
* STUDENTS DO NOT QUALIFY FOR HALF-YEAR MEMBERSHIP.
* REMITTANCE MUST BE MADE IN U.S. DOLLARS DRAWN ON A U.S. BANK.

➤ PAYMENT MUST ACCOMPANY APPLICATION

PAYMENT MUST BE MADE BY CHECK OR ONE OF THE FOLLOWING CREDIT CARDS:
❑ VISA ❑ MASTERCARD ❑ DINERS CLUB ❑ AMEX ❑ DISCOVER

CARDHOLDER'S NAME_____

CARD # _____ EXP. DATE _____ CSC # _____

SIGNATURE (REQUIRED)_____

➤ YOUR PRIMARY REASON FOR JOINING? (CHECK ONE)

❑ TO RECEIVE INFORMATION THROUGH JAWRA AND IMPACT
❑ NETWORKING OPPORTUNITIES
❑ TECHNICAL COMMITTEE INTERACTIONS
❑ CONFERENCE DISCOUNT
❑ EMPLOYMENT OPPORTUNITIES
❑ OTHER: _____

➤ HOW DID YOU LEARN OF AWRA? (CHECK ONE)

❑ PROMOTIONAL MAILING
❑ INTERNET SEARCH
❑ JOURNAL (JAWRA)
❑ IMPACT
❑ BOSS/FRIEND/COLLEAGUE
❑ EMAIL RECEIVED
❑ OTHER: _____

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DEMOGRAPHIC CODES

(PLEASE LIMIT YOUR CHOICE TO ONE IN EACH CATEGORY)

JOB TITLE CODES

JT1	Management (Pres., VP, Div. Head, Section Head, Manager, Chief Engineer)
JT2	Engineering (non-mgmt.; i.e., civil, mechanical, planning, systems designer)
JT3	Scientific (non-mgmt.; i.e., chemist, biologist, hydrologist, analyst, geologist, hydrogeologist)
JT4	Marketing/Sales (non-mgmt.)
JT5	Faculty
JT6	Student
JT7	Attorney
JT8	Retired
JT9	Computer Scientist (GIS, modeling, data mgmt., etc.)
JT10	Elected/Appointed Official
JT11	Volunteer/Interested Citizen
JT12	Non-Profit
JT13	Other

EMPLOYER CODES

CF	Consulting Firm
EI	Educational Institution (faculty/staff)
ES	Educational Institution (student)
LR	Local/Regional Gov't. Agency
SI	State/Interstate Gov't. Agency
IN	Industry
LF	Law Firm
FG	Federal Government
RE	Retired
NP	Non-Profit Organization
TG	Tribal Government
OT	Other _____

EDUCATION CODES

HS	High School
AA	Associates
BA	Bachelor of Arts
BS	Bachelor of Science
MA	Master of Arts
MS	Master of Science
JD	Juris Doctor
PhD	Doctorate
OT	Other _____

WATER RESOURCES DISCIPLINE CODES

AG	Agronomy	GI	Geographic Information Systems
BI	Biology	HY	Hydrology
CH	Chemistry	LA	Law
EY	Ecology	LM	Limnology
EC	Economics	OE	Oceanography
ED	Education	PS	Political Science
EG	Engineering	OT	Other _____
FO	Forestry		
GR	Geography		
GE	Geology		

PLEASE NOTE YOUR SELECTED CODE NUMBERS FROM ABOVE

JOB TITLE CODE .....
EMPLOYER CODE .....
WATER RESOURCES DISCIPLINE CODE .....
EDUCATION CODE .....

AWRA By Phone • (540) 687-8390
AWRA By Fax • (540) 687-8395
AWRA By E-Mail • info@awra.org
AWRA Home Page ~ www.awra.org

SUBSCRIPTION RATES • WATER RESOURCES IMPACT

DOMESTIC	$80.00
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FOREIGN AIRMAIL OPTION	$50.00

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WATER RESOURCES IMPACT

DATED MATERIAL ENCLOSED

AMERICAN WATER RESOURCES ASSOCIATION
4 West Federal St., P.O. Box 1626
Middleburg, VA 20118-1626 USA
Telephone: (540) 687-8390

ISSN 1522-3175

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