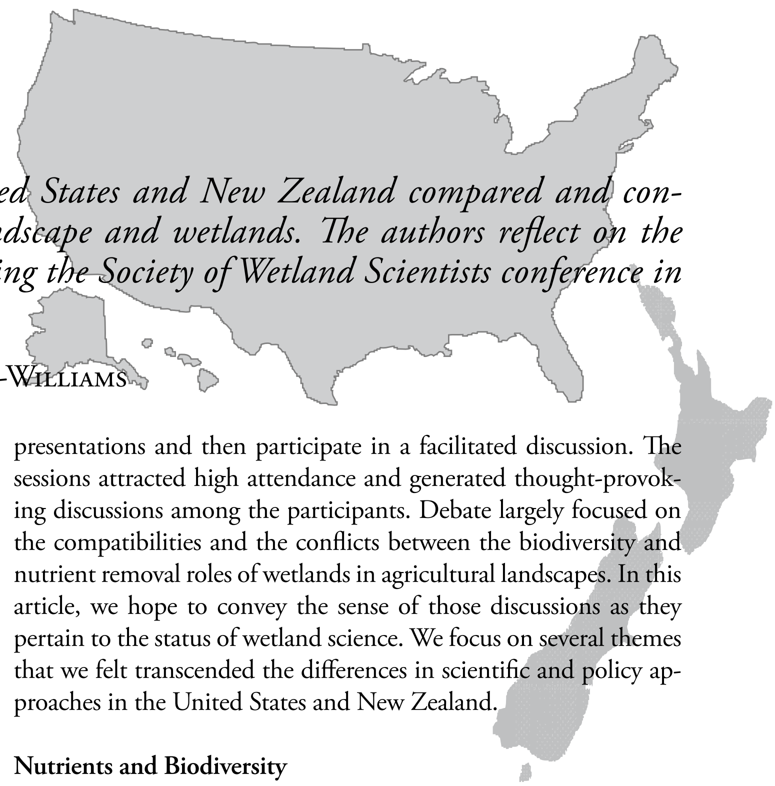
National Wetlands Newsletter, Vol. 31, No. 6, Copyright© 2009 Environmental Law Institute® Washington, DC, USA.

Discussing Wetlands, Agriculture, and Ecosystem Services

Perspectives From Two Countries



Recently, a bilateral exchange between the United States and New Zealand compared and contrasted approaches in managing agricultural landscape and wetlands. The authors reflect on the outcomes of conversations from a symposium during the Society of Wetland Scientists conference in Madison, Wisconsin, this past June.

By Mark Tomer., Chris Tanner, and Clive Howard-Williams

We face a number of challenges in finding ways to better understand and encourage wetlands as an important component of agricultural landscapes and watersheds.

Can biodiverse wetlands and agriculture co-exist?
Can wetlands receive diffuse agricultural inputs sustainably?
How can wetlands be incorporated into sustainable agricultural landscapes?

These were the key questions discussed during the recent symposium, "Wetland Ecosystem Services in Agricultural Landscapes—Comparing Approaches in USA and New Zealand," held at this year's Society of Wetland Scientists' (SWS) annual conference in Madison, Wisconsin.

The symposium was a bilateral exchange to review the science of wetlands and the role wetlands can play in ensuring the environmental sustainability of agriculture. It included three sessions focused on the overlapping themes of wetland ecology, nutrient processing in wetlands, and wetland hydrology and modeling. Each session provided the audience opportunity to listen to four research presentations and then participate in a facilitated discussion. The sessions attracted high attendance and generated thought-provoking discussions among the participants. Debate largely focused on the compatibilities and the conflicts between the biodiversity and nutrient removal roles of wetlands in agricultural landscapes. In this article, we hope to convey the sense of those discussions as they pertain to the status of wetland science. We focus on several themes that we felt transcended the differences in scientific and policy approaches in the United States and New Zealand.

Mark Tomer is a research scientist with the U.S. Department of Agriculture's Agricultural Research Service in Ames, Iowa. Chris Tanner is a research scientist for the National Institute of Water and Atmospheric Research (NIWA) in Hamilton, New Zealand. Clive Howard-Williams is the chief scientist for freshwater and coastal systems at NIWA in Christchurch, New Zealand

Nutrients and Biodiversity

We know agricultural nutrient loads to wetlands can decrease biodiversity, because nutrients encourage opportunistic and invasive plant species that crowd out the competition. Increased nutrients can alter vegetative communities and their structure, often decreasing habitat quality for flora and fauna. We need better information on how to manage the trade offs and synergies between nutrient treatment and biodiversity functions of wetlands. A decrease in biodiversity in response to increased nutrient flux can in turn decrease the long-term capacity of the wetland to process nutrients efficiently. This is because biodiverse wetlands are likely to be more resilient to perturbations, e.g., pests and diseases, have extended seasonal periods of active growth, and support more intensive biotic interactions and resource cycling. We need to better understand how management can leverage this potential synergy between biodiversity and nutrient removal. We also need to better understand how some of the other contaminants in agricultural runoff, such as pesticides and endocrine disruptors, can affect sensitive species of plants and

Photo courtesy of Mark Tomer/USDA Agricultural Research Service

Following the SWS conference, a contingent of the symposium presenters participated in a three-day tour of river-valley wetlands in the upper Midwest. Above, participants observe Mississippi River wetland reconstructions, hosted by scientists from the U.S. Geological Survey's Upper Mississippi Environmental Sciences Center near La Crosse, Wisconsin. For more information, see www.umesc.usgs.gov.

animals, and in turn impact on the ability of wetlands to provide nutrient removal and other ecosystem services.

Trade Offs Among Nutrients

Research is needed to clarify how we can manage wetlands for improved retention and removal of multiple nutrients, particularly the combination of nitrogen (N) and phosphorus (P). We know that maintaining saturated anoxic conditions will optimize denitrification of incoming nitrates to nitrogen gas and minimize loss of nitrous oxide gases. In concept, a wetland should be able to sustainably function to provide nitrate reduction for many years. But factors such as pH, seasonal declines in water level, and spikes in nitrate dosing rates may determine whether this capacity is achieved consistently. Also, where phosphorus builds up in wetlands, anoxic conditions may allow chronic release of soluble P, to the detriment of downstream aquatic habitats. Long-term phosphorus accumulation in wetlands is not always problematic, as studies of several long-operating waste treatment wetlands have shown. Where P release is an issue, however, allowing oxygen to enter the system might decrease mobility of P in some reduced, high-P wetland environments. But this kind of management intervention could easily have a negative impact on denitrification efficiency. What is our strategy to balance the trade offs among contaminants, and how do we tailor it at the landscape scale to ensure biodiversity?

Nutrient removal through harvesting of wetland vegetation is an option that may be important in some situations, especially if P stores have accumulated to a point of being chronically released and aeration is not feasible. We need to understand how to protect biodiversity and its benefits, where and when the biomass removal option is exercised. There is also the critical need to sustain organic matter levels that are necessary for denitrification, if biomass is being harvested and removed.

Optimal Locations for Wetland Reconstructions

From a landscape perspective, an understanding of how to locate wetlands in order to best leverage their capacity for denitrification is becoming well-developed. We know that wetlands receiving nitrates from large contributing areas of landscapes, i.e., multiple fields, should be more efficient for nitrate removal than those receiving contributions from small (field-sized) areas.

Research on glacial landscapes in the U.S. Midwest has shown this. But we do not necessarily understand how this concept can be scaled up to river basins, across which land use, terrain, and climate become varied.

In contrast to nitrate removal, wetlands may be most effective in P retention if they are distributed in the uppermost reaches, below small contributing areas where surface waters are generated. This suggests wetlands distributed in differing landscape positions could provide complementary functions for removing N and P from agricultural runoff. Improved understanding of pathways and mechanisms of P delivery into wetlands will help us improve nutrient retention in uplands to the extent possible, and identify the need for possible companion practices like sediment retention ponds. This information is needed to develop sustainable loading guidelines and concomitant performance expectations where wetlands are constructed to treat runoff from livestock facilities. Also, an understanding of how wetland placement impacts nutrient removal is needed because nutrient trading strategies are being developed that would encourage wetlands be placed where the greatest nutrient removals can be anticipated.

We questioned whether our concern for managing nutrient loads into natural wetlands will long continue, given larger global issues. To sustain ongoing increases in worldwide population, agriculture will have to become optimally efficient at nutrient utilization. Production of nitrogen fertilizer consumes natural (methane) gas, and world stocks of phosphate rock, our sole source of P fertilizer, will likely become exhausted within decades. As costs of these critical resources rise, agricultural production systems will need to progress toward integrating energy efficiency with maximized production and nutrient utilization.

Balancing Ecosystem Services

We know well that nutrient removal is only one benefit from agricultural wetlands. How do we balance the different roles of wetlands? On our agricultural landscapes, do we have the flexibility to prioritize some wetlands as being ideally suited for nutrient removal, while others have greater ecological significance and should be sheltered from nutrient impacts? This issue touches on the topic of habitat connectivity and its importance in maintaining and expanding biodiversity. In the United States, how will we recognize the full benefits of biodiversity in agricultural landscape if nutrient removal is our only goal, and meso- (or even oligo-) trophic wetlands are seldom restored? This question would probably not be posed in New Zealand, where restoration of naturally occurring wetlands is primarily aimed at enhancing biodiversity, and nutrient-removal wetlands are often artificially constructed features intercepting subsurface drainage and surface runoff from livestock-grazed pastures. These differences occur largely because of differing agricultural systems and policy emphases in the two countries.

Wetlands have other potential and tangible benefits that include flood attenuation, increased groundwater recharge, aesthetics, improved hunting opportunities, and encouragement of beneficial insects and other fauna that control insect pests. Interdisciplinary research will help us define the full matrix of benefits that wetlands can provide in agricultural landscapes. Depending on a catchment's characteristics, the relative wetland area required will differ depending on whether nutrient removal, flood attenuation, biodiversity, or other benefits are prioritized. Benefit thresholds may vary depending on the type and location of wetlands being installed, as well as the types of benefit being measured. Efforts to review results across multiple wetland research efforts could help answer the key questions and guide decisions to ensure that policy and management support ecosystem functionality of wetlands.

Several of the presentations and comments during our symposium mentioned the interactions that are recognized between wetland hydrology and nutrient removal efficiency in wetlands, i.e., large runoff inflows have minimal retention time and, hence, little opportunity for nutrient removal. Research is also showing us how faunal activity can drive the recycling of nutrients from wetland and aquatic ecosystems back to the uplands. An integrated understanding of how ecological, hydrological, and biogeochemical functions, rates, and cycles interact in wetlands should be our goal as we continue to pursue wetland research.

"On our agricultural landscapes, do we have the flexibility to prioritize some wetlands as being ideally suited for nutrient removal, while others have greater ecological significance and should be sheltered from nutrient impacts?"

Conservation drivers in the United States and New Zealand

A few comments on policy differences between the two countries are warranted. The United States and New Zealand share a form of government based on elected representative governance and an independent judiciary. However, approaches to environmental and agricultural policymaking differ considerably. New Zealand does not subsidize agricultural production nor conservation practices on private land. Producers can receive partial cost-sharing for some practices, e.g. fencing and planting of stream riparian zones, usually from regional authorities. The regulatory framework in New Zealand is focused on effects rather than standards, which impacts agriculture in highly sensitive watersheds where farmers may now be required to apply for consent (a permit) to expand or intensify operations. New Zealand agriculture is export-focused, with European markets that reward environmental certification being important customers. Such market forces encourage environmental stewardship. New Zealand agriculture has improved performance through enhanced nutrient and effluent management, and riparian fencing and buffer schemes. These trends, however, have been countered by impacts from a rapidly expanding dairy industry.

Agricultural policies in the United States are substantially different with formalized conservation programs that fund voluntary adoption of conservation practices. Some of the discussion in our sessions went into considerable depth on conservation incentives

Resources

A summary of USDA's Conservation Effects Assessment Project's (CEAP) National Assessment of Wetlands is available at **www.nrcs.usda.gov/TECHNICAL/NRI/ceap/wetlands.html**.

Research on protection and restoration of natural wetlands in New Zealand can be found at **www.landcareresearch.co.nz/research/research_details.asp?Research_Content_ID=7**.

A review of diffuse pollution attenuation tools (including wetlands and riparian buffers) identified for New Zealand pastoral farming systems can be found at **www.niwa.co.nz/our-science/freshwater/tools/pollution-attenuation-tools**.

Photo courtesy of Mark Tomer/USDA Agricultural Research Service

Above, a wetland research site in Central North Island, New Zealand, that receives nutrients from a grazed pasture.

and interactions of policy, economics, and conservation ethics that influence landowner decisions about conservation in the United States, which we will not detail here. One key point was that demand for these programs substantially exceeds current funding levels. Therefore, alternative funding mechanisms such as reverse auctions and nutrient trading schemes are being developed. Despite the large differences in agricultural and conservation policies between our two countries, there are important similarities that include an emphasis on voluntary implementation of conservation practices, the need for landowner education programs focused on conservation, and regulatory approaches that are moderated in view of agriculture's breath and vital importance.

Conclusion

This symposium highlighted the significant advances in our understanding of how wetlands are impacted by and function within agricultural landscapes. It has helped clarify the role that wetlands can play in agricultural systems, particularly in the area of contaminant attenuation in water flow paths. It has also identified some important gaps in our knowledge, especially with respect to the relationships and inherent trade offs between wetland biodiversity and water quality functions in agricultural landscapes. Comparing and contrasting practices and perspectives from different countries has proved fertile ground for looking anew at our own respective situations and identifying new research questions for the future.

Readers may wish to peruse the abstracts of presentations at the symposium, available at the SWS conference website: http://sws.org/2009_meeting/docs/SWS0021.pdf. Searching this document for "Symposium 15" will lead you to the twelve abstracts presented as part of the symposium. ■

Acknowledgements

We thank the New Zealand Ministry of Research Science and Technology for providing travel grants for the New Zealand contingent of symposium speakers to participate in the SWS Conference, and USDA-Agricultural Research Service for sponsoring the symposium. We also extend our thanks to the audience for their interest and participation in the discussions that we hope to have captured here. Finally, we thank the discussion reporters Beverly Clarkson, Bob Wilcock, and Brian Sorrell.