

**LAKE SUPERIOR WETLANDS CONFERENCE, DULUTH, MN  
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**ABSTRACTS FOR THE CONTRIBUTED PAPER SESSIONS** (Alphabetical listing by Author, paper presentation number listed in parentheses)

**MACROINVERTEBRATE RESPONSES TO WETLAND  
HYDROGEOMORPHIC CLASSES IN THE LAURENTIAN GREAT LAKES.**

<sup>1</sup>Brady, V., <sup>1</sup>L. Johnson, <sup>2</sup>J. Ciborowski, <sup>1</sup>D. Breneman, <sup>1</sup>T. Hollenhorst, and <sup>2</sup>J. Gathman.  
<sup>1</sup>Center for Water and the Environment, Natural Resources Research Institute, University of Minnesota, Duluth, MN 55811 USA, <sup>2</sup>Department of Biological Sciences, University of Windsor, Windsor, ON, CAN. (PL 10)

As part of a larger research project on Great Lakes coastal wetlands, we investigated whether macroinvertebrate assemblages differ with varying amounts of lake and river influence. Wetlands were classified as open lacustrine (most exposed to wave action, no significant river influence; n=29), protected (little exposure to either wave or river influence; n=22), or riverine (influenced by a second order or larger stream, varying exposure to wave action; n=30). Macroinvertebrates were collected using dip nets in 2002 and 2003. Indirect gradient analyses revealed differences in macroinvertebrate assemblages related both to wetland type and to ecological province. Open lacustrine wetlands (characterized by larger average particle sizes, less soft sediment, and more open water) had the lowest macroinvertebrate diversity. Riverine wetlands contained more rheophilic taxa and had the highest invertebrate and vegetative diversity. Protected wetlands had intermediate invertebrate and vegetative diversity. We propose that wave action creates a harsher physical environment and limits fine sediment and organic matter accumulation, all leading to lower invertebrate diversity. Invertebrate and vegetative diversity are maximized by sediment and organic matter deposition and flow heterogeneity from connected streams. Ecoprovincial differences in macroinvertebrate assemblages may reflect regional patterns of anthropogenic activity in addition to biogeographic patterns.

**WETLAND HYDROLOGY AND BIODIVERSITY LINKAGES IN THE FLOOD-  
PRONE RED RIVER BASIN.** Chapman, K. Applied Ecological Services, Prior Lake, MN. (PL 13)

Flat topography and poor soil drainage in the Red River Basin of northwest Minnesota result in highly damaging flooding in residential areas and excess water on agricultural lands, even though most agricultural areas are extensively drained artificially. Following a lengthy period of stakeholder negotiation, the state-sponsored Technical Science and Advisory Committee (TSAC) recommended strategies to study and implement wetland restoration as a solution to the flooding problem. In addition to assisting TSAC as a technical representative during stakeholder negotiations, Applied Ecological Services conducted a technical literature review which revealed minimal technical understanding

of the impact of water level bounce on biodiversity and flood water storage availability in wetlands. Subsequently, AES conducted studies to determine the relationships between water level bounce and biodiversity in 28 natural and restored wetlands throughout the Red River Basin. AES found that wetlands provided more spring and summer flood water storage than anticipated and experienced fewer adverse biodiversity impacts due to bounce than expected. Wetland hydrology was projected for a 20-year period using two years of recorded water level data, calibration, and water budget modeling. Magnitude, duration and frequency of flooding were evaluated. Relationships between plant, bird and macroinvertebrate diversity with hydrology and with land-use were evaluated using parametric and multivariate analyses. Consistent moderate-to-strong relationships to biodiversity were found with hydrological variables and stronger relationships for watershed land-use variables. The wetlands fell into three quality categories that can assist in the development of potential wetland restoration siting criteria in Flood Damage Reduction (FDR) programs in the Basin. High quality wetlands were found to have lower amplitude and lower frequency bounce events. Medium and low quality wetlands were found to have durations generally meeting a 10-day bounce draw down and 2-3 foot bounce amplitude. TSAC Bounce Criteria recommendations of 2-3 feet and the draw down rates of 90% of the volume in the bounce hydrograph reduced in 10 days are supported by this study where a strategy to provide FDR and biodiversity benefits is desired. Where high quality wetland biodiversity is desired, lower bounce levels, frequencies and durations during the growing season are encouraged.

**CHARACTERIZING LAKE SUPERIOR COASTAL WETLANDS USING READILY AVAILABLE GIS DATA.** <sup>1</sup>Hollenhorst, T., L.B. Johnson, G.E. Host, V. Brady, <sup>2</sup>J. Schuldt, <sup>3</sup>J. Ciborowski and <sup>4</sup>C. Richards. Natural Resources Research Institute, University of Minnesota-Duluth, University of Wisconsin-Superior, <sup>3</sup>University of Windsor and <sup>4</sup>Minnesota Sea Grant. (PL 11)

As part of a larger project developing environmental indicators for the Great Lakes, we inventoried emergent coastal wetlands on the US side of the great lakes within a geographic information system using wetland map data, digital quad maps and aerial photos. Coastal wetlands were defined as emergent wetlands occurring within 2.5 meters above the 10 year mean summer lake level. Inventoried coastal wetland complexes were classified as either 1) river influenced 2) protected or 3) coastal wetlands. Elevation data was used to delineate the contributing areas (watersheds) for each wetland complex and anthropogenic stressors were summarized for each watershed. Summarized stressors included the proportion of agricultural and urban land cover, population density, road density and point sources of pollution obtained from national data sets. Of 658 wetland complexes identified within the US side of the Great Lakes, 132 occur in Lake Superior. Results for Lake Superior wetlands and their landscape characterizations will be discussed.

**SPATIAL ANALYSES FOR QUANTIFYING ANTHROPOGENIC STRESS IN GREAT LAKES COASTAL WETLANDS.** <sup>1</sup>Host, G.E., <sup>1</sup>T. Hollenhorst, <sup>1</sup>L.B. Johnson, <sup>1</sup>V. Brady, <sup>2</sup>J. Schuldt, <sup>3</sup>J. Ciborowski, and <sup>4</sup>C. Richards. <sup>1</sup>Natural Resources Research Institute, University of Minnesota-Duluth, <sup>2</sup>University of Wisconsin-Superior, <sup>3</sup>University of Windsor and <sup>4</sup>Minnesota Sea Grant. (PL 8)

Identification of reference conditions for coastal wetlands is challenging in highly modified landscapes. We developed a mechanism for characterizing anthropogenic stress in coastal ecosystems using readily-available spatial data. Within ecoregions of the US Great Lakes coast, shoreline reaches were classified into five ecological types: high energy shoreline, embayments, open-coast wetlands, river-influenced wetlands, and protected wetlands. Degree of anthropogenic disturbance in contributing areas was assessed using a sliding window approach for high-energy shorelines or embayments, and a 'watershed' approach for wetlands. The sliding window entailed tabulating population and road density, proportions of agricultural or residential landuse, and distance from areas of concern within a 1-km<sup>2</sup> window around 30 m Landsat pixels along the coast. For wetlands, disturbance was summarized for each watershed, delineated by elevation. Cumulative distributions of each variable were used to rank pixels based on minimal levels of disturbance across all axes. A 'lowest 20<sup>th</sup> percentile' cut-off criterion was used to classify each pixel as 'reference' or 'nonreference'. Adjacent reference pixels were agglomerated into polygons and polygons  $\geq 2$  km<sup>2</sup> in area were then identified as reference areas. The mean rank of each polygon was used to order sites along an anthropogenic stress gradient. A similar approach was used for wetland types. Fish, macroinvertebrates, and physical attributes were characterized within selected polygons by ecoregion. This information will allow us to evaluate variability in ecological indicators under reference conditions, identify appropriate spatial scales for indicator development, and, ultimately develop mechanisms to assess the overall health of coastal wetland and shoreline ecosystems.

**NATIONAL WETLAND INVENTORY – STATUS AND TRENDS.** Huberty, B. U.S. Fish & Wildlife Service, Ft Snelling, MN (PL 7)

This presentation will review the 30 year old National Wetland Inventory program: 1) history, 2) mapping projects, 3) applications, 4) 2005 Status and Trends update, 5) funding, and future program directions. NWI is evolving into a truly national (local, tribal, state, and federal) and international wetland mapping and assessment program for all to use to assess local and global surface water and wetland impacts. There will also be a short update on the Great Lakes Navigation study.

**LAND USE CHANGES IN RELATION TO SELECTED BASIN WETLANDS IDENTIFIED AS CRITICAL HABITATS FOR LAKES SUPERIOR.** Jereczek, J. and N. Larson, Wisconsin DNR, Superior, Wisconsin. (PL 6)

Historically wetlands have been viewed as impediments to development; wastelands that were best drained or filled. Recently, wetlands have been recognized as significant contributors to ecosystem functions and values. The inherent functions and values of wetlands can be degraded by hydrologic changes and pollutant loading associated with wetland fill and storm water runoff. We will look at land use changes in the Wisconsin Lake Superior Basin watershed as represented through WPDES Storm Water permits, Wetland Fill permits, and other data. We will examine the factors that could affect these habitat areas and discuss implications for the coastal wetlands. This will be done through the spatial exploration of the distribution of issued permits over time relative to the occurrence of Lake Superior Binational important habitat sites, Priority Wetlands and wetlands in the Wisconsin Wetland Inventory. In addition we will approach the question of "How are land use changes affecting these coastal wetlands" and discuss some of the indicators of change.

#### **DEVELOPING INDICATORS FOR GREAT LAKES COASTAL WETLANDS.**

<sup>1</sup>Johnson, L.B., <sup>1</sup>G. J. Niemi, <sup>1</sup>R.P. Axler, <sup>1</sup>V. Brady<sup>1</sup>, <sup>2</sup>J. Ciborowski, <sup>1</sup>J.M. Hanowski, <sup>1</sup>G.E. Host, <sup>3</sup>R.W Howe, <sup>4</sup>C.A. Johnston, <sup>5</sup>R.R Regal, <sup>6</sup>C. Richards, <sup>7</sup>M. Simcik, <sup>7</sup>D.L. Swackhamer. <sup>1</sup>Center for Water and the Environment, Natural Resources Research Institute, Duluth, MN, <sup>2</sup>Department of Biological Sciences, University of Windsor, Windsor, Ontario, Canada, <sup>3</sup>Department of Natural and Applied Sciences, University of Wisconsin, Green Bay, WI, <sup>4</sup>South Dakota State University, Brookings, SD, <sup>5</sup>Department of Mathematics and Statistics, University of Minnesota, Duluth, MN, <sup>6</sup>Minnesota Sea Grant College Program, Duluth, MN, <sup>7</sup>Department of Environmental and Occupational Health, University of Minnesota, Minneapolis, MN. (PL 5)

We have been undertaking a project to identify, evaluate, and recommend a portfolio of multi-scaled environmental indicators relevant to the coastal regions of the US Great Lakes basin. Our major question is "what environmental indicators can be developed to efficiently, economically, and effectively measure and monitor the condition, integrity, and long-term sustainability of the basin." We are testing existing indicators and evaluating new indicators of condition in wetlands and shoreline areas with a combination of existing data and comprehensive field data encompassing birds, amphibians, diatoms, water quality, wetland plants, fish, and macroinvertebrates. Field sampling employed a random stratified design using ecological provinces, watersheds, shoreline reaches, and ecosystem types as the basis for stratification. All field data are linked with stressors of the basin. Novel approaches for identifying the human disturbance gradient have enabled us to array samples along that gradient to capture the range of variation in stressors in the Basin. Major stressors in the basin include land use change, climate change, point and non-point discharges, exotic species, atmospheric deposition, and hydrological modifications. Stressor-response relationships are being evaluated and quantified for the biotic communities sampled. Data from Lake Superior will be discussed.

**WETLAND INVENTORY AND CLASSIFICATION FOR THE COASTALGIS PROJECT.** Meysembourg, P., G. Sjerven and G. Host Natural Resources Research Institute, University of Minnesota-Duluth. (PL 3)

Given recent increases in development pressure along the north shore of Lake Superior, it is essential to have an up-to-date wetlands inventory to ensure that information for responsible land use decisions is available. Funded through Minnesota's Lake Superior Coastal Program, we are conducting a wetland inventory and classification for several key watershed basins identified as areas of potential accelerated development; included in these are the Knife, Beaver, and Poplar River watersheds, as well as several small coastal watersheds. Wetlands are delineated and characterized based on recent MN DNR aerial photography and numerous other spatial databases. We use minor watershed boundaries to identify the specific photos needed to cover each watershed. To date, approximately 200 1:15,840 color-infrared (CIR) fall season photographs have been acquired from the MN DNR. The photographs are scanned at 800 dpi, and georectified using about twenty points in ArcView's ImageWarp extension and USGS DOQ's for control. Images are interpreted on-screen using heads-up digitizing. A Sokkisha 3x mirrored stereoscope is used for viewing the stereo pairs. A subset of wetland sites are evaluated in the field to determine accuracy with regard to wetland type and water regime. Georeferenced digital photos are collected at each field site for documentation and development of interpretive materials. The key products include rectified aerial photos in compressed and uncompressed format, the newly delineated wetlands shapefiles, digital camera field check photos, and web based summary data. GIS files, photos, and interpretive materials are delivered through the CoastalGIS website, found at [www.nrri.umn.edu/CoastalGIS](http://www.nrri.umn.edu/CoastalGIS).

**A WETLAND AND WATERSHED FRAMEWORK TO ADDRESS TOTAL MAXIMUM DAILY LOAD (TMDL) OUTCOMES IN A RAPIDLY URBANIZING AREA.** Nixon, E.H., J. Naber, M. Westrick. Emmons & Olivier Resources, Inc., North Oakdale, MN. (PL 1)

Golden Lake, MN is a high priority TMDL study site currently supported by the USEPA. A separate but parallel study of ditched wetlands in the Golden Lake watershed was undertaken by the Rice Creek Watershed District (RCWD) for the purpose of wetlands management and land use planning. The wetlands resource management plan (RMP) outcomes include a watershed-based regulatory framework, analysis of wetland functions, and resource protection zones for the 7680-acre watershed. The RMP includes both incentives and disincentives to limit the hydrologic volume increases associated with the development that is occurring and projected to occur in the watershed. The RMP also aims to restore wetland functions of an extensive system of partially drained wetlands. Linking the TMDL and RMP studies provide an ideal opportunity for testing the effect of watershed-based approaches to meeting TMDL outcomes. To do this, the TMDL study includes a comparison of existing nutrient loading to the projected 2020 traditional development and to the the RMP alternative. Results of the existing loading analysis indicate that the watershed loading is approximately 30%. This is due in part to

a relatively high internal loading. However, under the projected 2020 traditional development the watershed loading jumps significantly. Currently the watershed is approximately 70% agricultural/rural and 30% urban. This paper will discuss the RMP strategies addressing both stormwater BMPs as well as wetland restoration, which if implemented over the next several years are expected to significantly reduce nutrient loading to Golden Lake.

**EVALUATION OF THE OHIO RAPID ASSESSMENT METHOD FOR WETLANDS IN THE WESTERN GREAT LAKES: AN ANALYSIS USING BIRD ASSEMBLAGES** <sup>1</sup>Peterson, A., <sup>2</sup>G. Niemi, <sup>2</sup>V. Brady, <sup>2</sup>J. Hanowski, <sup>3</sup>R. Regal.

<sup>1</sup>Department of Biology, <sup>2</sup>Natural Resources Research Institute, and <sup>3</sup>Department of Mathematics and Statistics, University of Minnesota, Duluth Minnesota. (PL 4)

Rapid assessment methods are qualitative approaches to assessing wetland quality without detailed studies of wetland function and biology. We compared wetland quality data gathered using the Ohio Rapid Assessment Method (ORAM) to quantitative data gathered on bird assemblages to assess wetland condition. We focused on 51 coastal riverine wetlands of the western Great Lakes region. We evaluated ORAM using both total ORAM score and ORAM submetric scores. Wetland associated birds did not choose wetlands at random but appeared to be sensitive to vegetative structure and anthropogenic disturbance. ORAM scores indicated 50 wetland sites were of good to excellent quality while wetland bird assemblages indicated a wider range of wetland condition, including many more wetlands that were qualitatively considered poor for birds. ORAM reflected anthropogenic disturbance in the wetlands sampled but did not reliably predict wetland bird species richness or the abundance of obligate wetland bird species. However, ORAM submetrics related to anthropogenic disturbance and vegetative structure improved the ability to reflect conditions important to wetland bird assemblages. Overall, the ORAM evaluation procedure did not provide a dynamic range of values on wetland condition and was inconsistent its ability to reflect responses by bird species.

**DESIGN OF A WETLAND CAP TO CHEMICALLY ISOLATE BIOTA FROM PAH IMPACTED SEDIMENTS.** Rogers, T. Service Engineering Group, St. Paul, MN (PL 12)

The St. Louis River/Interlake/Duluth Tar (SLRIDT) Superfund Site is located on the St. Louis River in the harbor of Duluth, Minnesota. Three water bodies make up a portion the SLRIDT Site; two industrial slips and a natural bay (Stryker Bay). Polycyclic aromatic hydrocarbons (PAHs) were discharged to Stryker Bay by coal tar manufacturing and refining operations in the early half of the 1900s. Proposed remedial alternatives for the SLRIDT Site include *in-situ* capping of contaminated sediments, or dredging of contaminated sediments followed by placement in a near-shore confined disposal facility. Wetlands might be established on the disposal facility after dredging if it is completed

with a sub-aqueous cap, on a post-dredging cap over residue from dredging, or on the *in-situ* cap. To be successful, mass transport of contaminants must not exceed the ability of the environment to process them without significant adverse impacts. The wetland plant communities currently found at the Site will most likely populate the constructed wetlands. Rooting depth data is available for many species of interest for the Site, but rooting depth data on a community-based level is limited. A site-specific study of rooting depths of wetland plant communities was performed to identify the average, 50<sup>th</sup>, and 95<sup>th</sup> percentile community root mass depth in existing wetlands over a predominately sandy substrate on or near the Site. To determine the thickness of a cap that would be protective of these overlying communities, push cores were advanced along transects placed in four wetland community types; submergent/floating, emergent, herbaceous, and shrub. The root mass profile was compiled along with other ecologically descriptive dimensions. The results of the rooting depth study were used to define the bioactive zone of the wetland cap and to establish monitoring intervals for protection of aquatic plants and rhizome consumers.

**WETLAND PROCESSING OF SEDIMENT AND NUTRIENT LOADS FROM MIXED LAND USE WATERSHEDS IN THE UPPER MISSISSIPPI RIVER BASIN.** <sup>1</sup>Schubauer-Berigan, J.P., <sup>2</sup>W.B. Richardson, <sup>3</sup>P. Hughes, <sup>2</sup>L. Bartsch, <sup>2</sup>J. Cavanaugh and <sup>2</sup>R. Kreiling, <sup>1</sup>M. Morrison. <sup>1</sup>US Environmental Protection Agency, Cincinnati, OH, <sup>2</sup> US Geological Survey, La Crosse, WI, <sup>3</sup> US Geological Survey, Middleton, WI. (PL 14)

We present results from our ongoing work examining the role of wetlands in the interception and processing of suspended sediment (SS), nitrogen (N) and phosphorus (P) loads from two suburbanizing watersheds near La Crosse, WI.. Using field measurements, we estimated SS, N and P loads for each of 2 small (25 and 100 sq. km) watersheds and loads entering a native (NW) and constructed wetland (CW). Spatial patterns of SS and C, N and P deposition in the CW were quantified using clay pads. Sediment denitrification (DN) and nitrification (NT) were estimated for a stream, CW, and NW using acetylene block. Stream DN rates ranged from 0.014 - 0.071 g-N cm<sup>-2</sup> h<sup>-1</sup>, highest upstream near the CW, lowest downstream; rates were C-limited upstream, N-limited downstream. DN rates in the CW ranged from 0.032 - 0.184 g-N cm<sup>-2</sup> h<sup>-1</sup>, highest near water inflow areas, lowest away from inflow (rates N-limited). DN in the NW ranged from 0.0004 - 1.137 g-N cm<sup>-2</sup> h<sup>-1</sup>, highest in the drier upper NW, lowest in the lower permanently inundated areas. Ambient DN rates were negatively correlated with sediment N and C; potential DN was positively correlated with NT. The NW sediments appear to denitrify greater quantities of N than stream sediments, and the CW sediments. However, due to deeply incised channels little N-rich water likely enters the NW except during high floods, while the CW is managed to capture and hold water, promoting high N removal rates.

**INFLUENCES OF RIPARIAN BUFFERS AND SOIL VARIABILITY ON THE HYDROLOGY OF SEASONAL WETLANDS IN NORTHERN MINNESOTA.**

<sup>1</sup>Tersteeg, D. P., <sup>1</sup>J. C Bell, <sup>2</sup>R. Kolka and <sup>2</sup>B. J. Palik. <sup>1</sup>University of Minnesota, Department of Soil, Water, Climate, St. Paul, MN, <sup>2</sup>USDA - Forest Service, North Central Research Station, Grand Rapids, MN. (PO1)

Forest management guidelines are generally lacking for seasonal wetlands. Their abundance in northern, glaciated, forested landscapes and the importance of their habitat function has drawn attention to these systems in recent years. This study tests the effectiveness of buffering seasonal wetlands following harvesting of adjacent upland forest; and investigates the soils to better understand factors influencing hydrology. Hydroperiods were studied to distinguish any change associated with harvest treatments. A block design consisting of four treatments, each replicated in four blocks was established in north central Minnesota in 2000. Treatments were assigned randomly to each block and they include: 1) uncut forest; 2) upland clearcut, with 50-ft uncut buffers surrounding wetlands; 3) upland clearcut, with 50-ft buffers thinned to 50 ft<sup>2</sup>/ac surrounding wetlands; and 4) upland clearcut with no buffers around wetlands. One wetland per stand, ranging in size from 0.1-0.5 acre, was instrumented with staff gauges, piezometer nests, and shallow groundwater monitoring wells installed along transects running from the upland into the wetland. Measurements have been taken year round to monitor surface and subsurface hydrology. Current data indicates minimal variation in hydroperiods among treatments. An underlying layer of fine-textured material across the landscape acts as an impeding layer, perching a surficial water table that influences the duration of the hydroperiod of these systems. Soils capping this layer have higher rates of infiltration, therefore precipitation results in subsurface lateral flow across the landscape. Factors such as landscape position and catchment area may override any influence that treatments have on wetland hydrology.

## **WATER QUALITY AND BIOLOGICAL CONDITIONS OF LAKE SUPERIOR COASTAL WETLANDS IN THE CONTEXT OF THE GREAT LAKES AS A WHOLE**

Trebitz, A., J. Brazner, J. Morrice, M. Sierszen, D. Tanner, and J. Thompson. US-Environmental Protection Agency, Mid Continent Ecology Division, Duluth MN (PL 9)

EPA's Mid-Continent Ecology Division has been conducting research on coastal wetlands of Lake Superior for a number of years, most recently as part of a Great Lakes-wide study. Our current research seeks to understand wetland responses to increasing nutrient loading and habitat alteration as a basis for development of indicators and nutrient and habitat criteria. Compared to conditions elsewhere in the Great Lakes, Lake Superior wetlands are subject to relatively little direct habitat modification, although there has been considerable historical wetland loss and hydrological alteration. The intensity of development and agriculture in surrounding watersheds is also low, so nutrient and sediment loadings are relatively small. As a result, Lake Superior wetlands have generally good water quality and habitat conditions, and support a wide variety of fishes. One focus of our studies is the role of hydrology and geomorphology in determining water quality and biological patterns and how these influence responses to stressors. Larger tributary and lake water inputs and greater wetland morphological

complexity lead to a greater diversity of water quality and habitat, which has important implications for fish assemblages. Wetland function varies in response to both natural factors and human impacts; for example, there is a shift from periphyton to phytoplankton based food webs as water residence times and nutrient loading levels increase. Understanding such responses permits proper classification of wetlands in developing wetland indicators and expectations for their condition. *This abstract does not necessarily reflect EPA policy.*

**POPULATION OSCILLATIONS AND DELAYS IN NITROGEN CYCLING IN WILD RICE ECOSYSTEMS.** Walker, R. and J. Pastor. Water Resources Graduate Program and Natural Resources Research Institute, University of Minnesota, Duluth, MN. (PL 2)

It is well known that delay-differential and delay-difference equations can produce plausible simulations of population oscillations, but these equations lack a specific mechanism responsible for the delay. We suggest that delays in release of nitrogen from decomposing litter, caused by microbial uptake, could produce oscillations in populations if the delay in the release of nitrogen is longer than the characteristic time scale of nitrogen uptake. We present a model which undergoes period doubling bifurcations with increases in the parameter controlling microbial uptake of nitrogen during litter decay. We suggest that such a mechanism may be especially important for annual plants which do not store nitrogen in perennial tissues to buffer delays. Natural populations of wild rice (*Zizania palustris*), an annual plant, oscillate with approximately four-year periods. Our model qualitatively mimics the period and shape of population oscillations in wild rice with parameter values in the range of those determined by experiments. The model therefore demonstrates a logical and experimentally plausible link between plant population dynamics and the ecosystem processes delaying the cycling of limiting nutrients.