481. **Avian communities in forested riparian wetlands of southern Michigan, USA.**
Inman, Rainy L.; Prince, Harold H.; and Hayes, Daniel B.
Wetlands 22(4): 647-660. (2002)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: biodiversity/ biogeography: population studies/ modeling/ mathematical and computer techniques/ avian community/ breeding status/ floodplain/ forested riparian wetlands/ plant species dominance/ plant species richness/ plant species structure/ species composition/ vegetation composition/ vegetation structure/ wetlands ecology
Abstract: Descriptive studies are an important first step in developing assessment models for regional wetland subclasses. Objectives of this study were to gather benchmark information on the composition and structure of vegetation from minimally impacted riparian forested wetland sites in Michigan, USA, and to determine if species composition of the breeding bird community and relative densities of individual species varied among riparian and adjacent upland forest zones. Plant species richness, dominance, and structure differed greatly between floodplain wetlands and uplands and were similar among zones within floodplain forests. Of 54 breeding bird species recorded through point count surveys (1998-99), 39 were observed in both floodplain and upland forests, while 11 were found only in floodplains and 4 solely in the uplands. Detectable patterns of avian density across riparian and upland forest zones were evident for 31 breeding species. Most species preferred areas closest to the river over other zones, although a few species were more prevalent within interior floodplains or uplands as compared to riverside forests. Forested riparian wetlands in this region act as essential breeding habitats for many avian species not often found in upland areas and are especially important for obligate riparian species and rare or declining breeding birds observed within our sites. These results are consistent with many studies across North America, where riparian forests have been found to support disproportionately large numbers of breeding bird species as compared to more xeric forests and other upland habitats.

482. **Characterization of woody species distribution in riparian forests of lower Michigan, USA using map-based models.**
Baker, M. E. and Wiley, M. J.
Wetlands 24(3): 550-561. (Sept. 2004)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ forests/ ordination/ climate/ hydrology/ riparian environments/ floods/ geology/ climatic changes/ catchment area/ spatial variations/ ecological distribution/ community composition/ autecology/ modelling/ hydrologic models/ riparian vegetation/ structure/ ecosystems/ catchment areas/ trees/ USA, Michigan/ temperate forests/ habitat community studies/ water and plants
Abstract: The goal of this study was to identify and characterize the range of variation in riparian forests across Lower Michigan, USA as a basis for assessing the utility of map-based information in the characterization of riparian environments. We obtained a regional sample of riparian forests and valley-bottom physiography from 94 locations throughout Lower Michigan and distinguished seven major riparian forest types using hierarchical clustering and NMDS ordination. NMDS ordination distances accounted for more than 70% of the distances in species space and achieved excellent discrimination among riparian types. We then evaluated a set of map-based variables indicative of regional climate, catchment hydrology, and valley character relative to ordination axes and interpretations of the autecology of principal tree species from each forest group. Map-based predictors accounted for 83% of the variation in sample scores along NMDS Axis 1 and explained 42% of the variation in Axis 2. Species and riparian types varied along two principal gradients, one associated with climate and geology along a north-south gradient, the second associated with flood duration and power. Map-based interpretations of regional climate and hydroperiod dynamics agreed closely with species-based interpretations of riparian character, although in certain cases, a similar biotic response arose from apparently distinct hydrogeomorphic contexts. Such dynamic patterns underscore the need for better and more explicit linkages between the controls of riparian hydrology and more proximal physical cues on biotic communities in order to understand the drivers of spatial variation in riparian ecosystem structure and composition.

483. **Coastal wetlands of the Upper Great Lakes: Distribution of invertebrate communities in response to environmental variation.**
Gathman, Joseph P.; Burton, Thomas M.; and Armitage, Brian J.
In: Invertebrates in freshwater wetlands of North America: Ecology and management/ Batzer, Darold P.; Rader, Russell B.; and Wissinger, Scott A.
New York: John Wiley & Sons, 1999; pp. 949-994.
Notes: ISBN: 0471292583
NAL Call #: QL365.4.A1I58
Descriptors: Invertebrata/ community structure/ population density/ coastal wetland fauna/ response to environmental variables/ distribution within habitat/ influence of environmental variables/ semiaquatic habitat/ wetland communities response to environmental variables/ abiotic factors/ coastal wetland environmental variables influence on community/ water movements/ coastal wetlands/ influence on communities/ Great Lakes/ coastal wetland communities response to environmental variables

484. **Do created wetlands replace the wetlands that are destroyed?**
Hunt, Randall J. and Geological Survey (U.S.).
Madison, Wis.: USGS; Series: Fact sheet (Geological Survey (U.S.)) FS-246-96. (1998)
Notes: Title from caption. Includes bibliographical references.
NAL Call #: QH76.H86-1998
http://wi.water.usgs.gov/pubs/FS-246-96/FS_246-96.pdf
Descriptors: wetlands---United States/ wetlands---

Wisconsin/ wetland conservation---United States/ wetland conservation---Wisconsin/ wetland ecology---United States/ wetland ecology---Wisconsin
This citation is from AGRICOLA.

485. **The ecology of invertebrates in Great Lakes coastal wetlands: Current knowledge and research needs.**
Krieger, K. A.
Journal of Great Lakes Research 18(4): 634-650. (1992)
NAL Call #: GB1627.G8J6; *ISSN:* 0380-1330
Descriptors: wetlands/ benthic fauna/ Great Lakes/ invertebrates/ limnology/ path of pollutants/ water pollution sources/ zooplankton/ aquatic populations/ ecosystems/ energy transfer/ food chains/ lakes/ literature review/ nutrients/ population dynamics/ suspended sediments
Abstract: The composition of the invertebrate communities in the Great Lakes coastal wetlands is the result of natural factors and the effects of pollution. Information in the literature, summarized here, is comparatively sparse on the community structure, population dynamics, secondary productivity, and trophic relationships. Zooplankton species composition appears to be, in part, a function of the distance of the community from the connection with the Great Lake. The dominant species present appear to be variable, and are dependent on a complex of interacting biotic and abiotic factors. The zooplankton appear to provide a strong link in the transfer of carbon and energy between the phytoplankton and higher trophic levels. Benthic invertebrates in the Great Lakes proper are important agents of bioturbation, releasing regenerated nutrients in interstitial water back into the water column; they may have a similar function in the wetlands. In the coastal wetlands, they are a major nutritional source for numerous species of fish and waterfowl, and thus are an important link between the primary producers and decomposers to the higher trophic levels. Zooplankton and zoobenthos species composition and abundance appear to be controlled by the interaction of a combination of environmental variables; not all of the factors operate on all species, all wetlands, or at the same time. The abiotic factors include concentration gradients of nutrients and suspended sediments, sustained high turbidity, flushing with storm water runoff, intermittent separation from the lake by a barrier beach, long and short term water level changes, characteristics of available substrates, and pollution. Biotic factors include selective predation; the composition, distribution, and density of hydrophyte beds; the spatial and seasonal variation in food resources; habitat disruption of bottom feeding fish; and patch dynamics.
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486. **Effects of wastewater on wetland animal communities.**
Brennan, K. M.
In: Ecological Considerations in Wetlands Treatment of Municipal Wastewaters/ Godfrey, Paul J.
New York: Van Nostrand Reinhold, 1985; pp. 199-223.
Notes: ISBN: 0442230095
NAL Call #: QH545.S49E3
Descriptors: wetlands treatment/ wastewater treatment/ water pollution effects/ ecosystems/ wildlife/ environmental effects/ literature review/ economic aspects/ artificial wetlands
Abstract: An inventory of known discharges of wastewater to wetlands in Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin was performed. The results show that the use of natural wetlands for the discharge of treated wastewater is relatively common. However, the intentional inclusion of wetlands as part of the treatment process is rare. Both types of situations may become more attractive due to economic factors. Although the short-term benefits of the use of natural wetlands for the disposal or treatment of wastewater (cost-effectiveness, treatment efficiency, and convenience) appear promising, the long-term ability of these areas to treat wastewater is questionable. The construction of artificial wetlands for the treatment of wastewater would avoid any detrimental effects that might result from the use of natural wetlands and also could provide supplementary habitats for wetland wildlife and possibly reservoirs for rare species. Few animal-related studies have been performed at the small number of artificial wetland sites presently in existence; thus, the information base is too small and too short-term for any conclusions to be drawn.
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487. **Elemental dynamics in forested bogs in northern Minnesota.**
Grigal, D. F.
Canadian Journal of Botany 69(3): 539-546. (Mar. 1991)
NAL Call #: 470 C16C; *ISSN:* 0008-4026.
Notes: NSF grant no. DEB 7922142; Minnesota Agricultural Experiment Station Project 25-54
Descriptors: bogs/ limnology/ Minnesota/ nutrients/ wetland forests/ biomass/ calcium/ cycling nutrients/ magnesium/ nitrogen/ peat bogs/ phosphorus/ potassium/ primary productivity/ vegetation/ lakes/ chemical processes
Abstract: Dynamics of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) were determined for three perched bogs, formed by lake filling, and three raised bogs, formed by landscape swamping. N and K concentrations were higher in the undergrowth of perched bogs, and Ca and Mg concentrations were higher in subsurface anaerobic peat of raised bogs. Elemental pools in vegetation were in the order N > Ca > K > Mg > P; in surface peat, N > Ca > Mg > P = K. Differences in elemental mass between the bog types were closely related to biomass differences. The atmosphere potentially supplied from 3% of annual plant uptake of K to 20% of Mg; this fraction was inversely related to uptake as a proportion of the surface peat. Vegetation on raised bogs had a greater proportion of uptake from the atmosphere (15 vs. 12%), a faster rate of elemental turnover (3.8 vs. 4.8 yrs), and lower net primary productivity (NPP) than on perched bogs, all indicative of a lower nutrient status. The annual mineralization rate of the surface peat for both bog types was estimated 15 1.5%/yr; NPP predicted from N mineralized at this rate agrees well with observations. The better nutritional status of perched bogs may be related to landscape position, with potential inputs via runoff from adjacent uplands. The nutrient capital in both bog vegetation and substrate was similar to that in upland northern conifer forests. (Author's abstract)
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488. **Estimating the ground-water contribution in wetlands using modeling and digital terrain analysis.**
Gerla, P. J.
Wetlands 19(2): 394-402. (1999)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ analysis/ classification/ drainage/ groundwater flow/ water budget/ mathematical models/ equations/ groundwater recharge/ water table
Abstract: Wetland classification and management often requires information on the contribution of groundwater to a wetland's water budget. Direct estimation of this parameter, however, is time-consuming, expensive, and can typically only be accomplished for small areas. Thus, a method to characterize groundwater flow in wetland areas and regions may be useful in many applications. The estimation technique described combines the use of a digital elevation model (DEM) with transient numerical modelling and assumes that the water table reflects the general pattern of surface topography. The DEM grid elevations were used as initial heads in the model. Stepwise groundwater drainage from the flow domain was simulated until a reasonable match was obtained between the observed and model water tables. By knowing or assuming hydraulic conductivity and using the model water table configuration, an estimate for groundwater flow to and from each discretized grid node can be estimated from Darcy's Law and the Dupuit approximation. The net result, when mapped, shows the simulated distribution of recharge and discharge within and surrounding the wetland. Two examples from the Shingobee River headwaters in central Minnesota, USA show how the method may be used. Geologically recent development of glacial landforms has led to numerous lakes, ponds, and wetlands in the region. Using a 30-m, 1:24 000 scale DEM grid in combination with data from the U.S. Fish and Wildlife National Wetlands Inventory, the model predicts the most likely areas of groundwater interaction in and near wetlands and lakes. More quantitative results can be obtained by applying observed water budget and soil/aquifer parameter data.

489. **Evaluation of national wetland inventory maps in a heavily forested region in the upper Great Lakes.**
Kudray, Gregory M. and Gale, Margaret R.
Wetlands 20(4): 581-587. (2000)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: terrestrial ecology: ecology, environmental sciences/ national wetland inventory maps/ equipment/ cover type/ forested areas/ forested wetlands/ hydric nonhydric soil complexes/ topography/ wetland upland complexes
Abstract: National Wetland Inventory (NWI) maps are widely used in the United States but have not been independently evaluated in the Great Lakes region nor in forested areas with level topography. Field data from 148 plots in the Hiawatha National Forest ecological classification and inventory program were combined with an additional review to evaluate NWI mapping accuracy. NWI maps were over 90% accurate in identifying uplands and jurisdictional wetlands. All nonforested wetlands were identified correctly. Uplands were correctly identified 96.9% of the time. The lowest level of accuracy, 90.7%, was achieved in identifying forested wetlands. The most common error was the NWI classification of wetlands on the AuGres soil series, a somewhat poorly drained upland soil that often occurs in complexes with wetland soils in the region. Forested wetlands with a cover type similar to adjacent uplands were also a source of error on NWI maps. The already high accuracy of NWI maps could be improved by the mapping of wetland-upland complexes, a development corresponding to the increased mapping of hydric-nonhydric soil complexes in area soil surveys. The continued refinement of regional lists of hydrophytic vegetation is supported by indicator status discrepancies between an extensive Hiawatha National Forest database and the current NWI list for the region.

490. **Factors affecting the evolution of coastal wetlands of the Laurentian Great Lakes: An overview.**
Mayer, T.; Edsall, T.; and Munawar, M.
Aquatic Ecosystem Health and Management 7(2): 171-178. (2004)
NAL Call #: QH541.5.W3A682; *ISSN:* 1463-4988
Descriptors: freshwater wetlands/ wetland ecosystems/ wetland issues
Abstract: Coastal wetlands play a pivotal role in the Great Lakes ecosystem. As buffer zones between the land and open waters of the Great Lakes, they perform a variety of essential functions providing both direct and indirect anthropogenic benefits. Geology, morphology and climate are the dominant variables that influence Laurentian Great Lakes wetland development. However, anthropogenic factors are the major contributors to alteration of natural wetland processes. This paper provides an overview of natural and anthropogenic factors important in Great Lakes coastal wetland development and provides statistical information describing the Great Lakes Basin. A brief description of wetlands classification and research issues is also presented.

491. **The future of waterfowl habitats in the Canadian lower Great Lakes wetlands.**
Crowder, A. A. and Bristow, J. M.
Journal of Great Lakes Research 14(1): 115-127. (1988)
NAL Call #: GB1627.G8J6; *ISSN:* 0380-1330
Abstract: Waterfowl utilization of wetlands along the Canadian shore of the lower Great Lakes, and the impact of eutrophication, metal pollution, organic pollution, and sedimentation on both the wetlands and the birds are reviewed. -from Authors

492. **Great Lakes wetlands as amphibian habitats: A review.**
Hecnar, S.
Aquatic Ecosystem Health and Management 7(2): 289-303. (2004)
NAL Call #: QH541.5.W3A682; *ISSN:* 1463-4988
Descriptors: amphibians/ conservation/ endangered status/ conservation status/ literature review/ species diversity/ semiaquatic habitat/ importance as habitat and conservation/ Great Lakes/ wetlands importance as habitat and conservation/ review
Abstract: Amphibians are highly adapted for life in wetland habitats. They form a major component of wetland faunas, and being both prey and predator, they are important in ecosystem functioning. Wetlands provide aquatic habitats that amphibians require for breeding, development,

foraging, hibernation and refuge, and they form an interface with essential adjacent upland habitat. The size and type of wetlands as well as their spatial configuration and local structural characteristics are important features of these habitats for amphibian use. Because of their dependence on water, use of both aquatic and terrestrial habitat, permeable skin, and other biological characteristics, amphibians are considered to be excellent indicators of ecosystem health. Amphibians have a tremendous diversity of natural history characteristics and species differ in their patterns of habitat and microhabitat selection. Over 30 species of amphibians occur in wetlands within the Great Lakes Basin and an increasing trend in species richness exists from north to south across the region. Since European settlement, this region has lost over 50% of its wetlands. Loss rates of coastal and inland wetlands exceed 90% in some areas. Many restoration efforts are underway across the region but losses still exceed gains. No species have been extirpated from the entire basin but numerous local extirpations have occurred. However, nearly half of the species are officially designated as being of conservation concern somewhere in the basin. A more realistic estimate suggests that at least 2/3 of species are of concern. Habitat loss is reported as the primary cause of decline for 60% of species and habitat degradation by pollution is cited for 43% of the fauna. Considering the extent of wetland loss across the basin it seems reasonable to assume a similar magnitude of amphibian population loss. The current conservation status of amphibians indicates that Great Lakes wetlands are unhealthy ecosystems.

493. **Groundwater inflow measurements in wetland systems.**
Hunt, R. J.; Krabbenhoft, D. P.; and Anderson, M. P.
Water Resources Research 32(3): 495-507. (1996)
NAL Call #: 292.8 W295; *ISSN:* 0043-1397.
Notes: Affiliation: Water Resour. Div., U.S. Geological Surv., Madison, WI, USA
Descriptors: wetlands/ groundwater/ hydrology/ Darcy's law/ land management/ water use/ USA/ Wisconsin

494. **Human interference with natural water level regimes in the context of other cultural stresses on Great Lakes wetlands.**
Patterson, N. J. and Whillans, T. H.
In: Coastal Wetlands/ Prince, Harold H. and D'Itri, Frank M. Chelsea, Mich.: Lewis Publishers, 1985; pp. 209-251.
Notes: ISBN: 0873710525
NAL Call #: QH104.5.G7C63
Descriptors: wetlands/ water levels/ limnology/ Great Lakes/ stress analysis/ cultural control/ dikes/ channels/ ecosystems/ reviews
Abstract: Water level regime is but one of many manageable factors which could influence the condition or extent of a Great Lakes wetland. Some factors which could affect water levels such as river discharge into a wetland, diversion of lake water around a wetland, isolation from natural hydrologic influence (diking) or channelization through a wetland could also have independent influence and are subjects of considerable human tampering. It is therefore advisable to consider water level regime and human interference with it in the context of other human-engendered problems in Great Lakes wetlands. There are at least three major aspects which merit examination: (1) comparison of causal factors in order to isolate similarities among causes (and implied solutions); (2) contrast of stresses (biological, chemical or physical perturbation) and of long-term responses in order to clarify the ecosystemic significance of water level regime (and implied priority for action); and (3) investigation of interaction among causes, among stresses and among long-term responses in order to specify synergisms and antagonisms (and implied interpretation of (1) and (2)). The aspects (1) and (2) have been examined to a degree for the Great Lakes in general, for certain wetland-rich ecosystems within the Great Lakes, and for wetlands in general. This review is based in large part upon those studies.

495. **Irreversible investment in wetlands preservation: Optimal ecosystem restoration under uncertainty.**
Bloczynski, J. A.; Bogart, W. T.; Hobbs, B. F.; and Koonce, J. F.
Environmental Management 26(2): 175-193. (Aug. 2000)
NAL Call #: HC79.E5E5; *ISSN:* 0364-152X
Descriptors: wetlands/ environmental restoration/ environment management/ global warming/ climatic changes/ hydrology/ lakes/ nature conservation/ environmental economics/ USA, Ohio, Metzger Marsh/ water management/ ecosystem recovery/ models/ USA, Ohio/ environmental protection/ ecosystem management/ ecosystem disturbance/ environmental impact/ land management/ environmental effects/ model studies/ USA, Ohio, Toledo/ environmental action/ reclamation/ conservation, wildlife management and recreation/ evaluation process
Abstract: The question of how to manage a lacustrine wetland is analyzed given the uncertain potential for long-term lake level changes resulting from global warming and the uncertain biological processes involved in creating wetlands. Three management options are considered: do nothing; construct a dike that removes hydrological connections with the lake ("closed dike); and build a dike that maintains a hydrological connection with the lake, but can be converted to a closed dike under adverse conditions ("open dike). For all practical purposes, dike construction represents an irreversible choice.The model, a stochastic dynamic program, is used to optimize the timing and type of protective structure under a range of management goals. A wetland can either be optimal for fish or optimal for mammals and waterfowl, but not both. Because credible estimates of the economic values of wetland services do not exist, we treat those values as parameters in a multiobjective analysis and show the decisions implied by alternative valuations. The model is applied to the case of Metzger Marsh, a Lake Erie coastal wetland near Toledo, Ohio, where the decision was made in 1993 to construct an open dike. We find that the optimal decision is robust with respect to varying assumptions about the formation of barrier beaches and the probability of climate change, but that the decision is not robust to assumptions concerning the health of an unprotected Metzger Marsh. The most important source of uncertainty is the biological health of an unprotected wetland.

496. **Lake Erie coastal wetlands: A review and case study of Presque Isle invertebrates.**
Botts, Pamela Silver
In: Invertebrates in freshwater wetlands of North America: Ecology and management/ Batzer, Darold P.; Rader, Russell B.; and Wissinger, Scott A.
New York: John Wiley & Sons, 1999; pp. 995-1012.
Notes: ISBN: 0471292583
NAL Call #: QL365.4.A1I58
Descriptors: Invertebrata/ literature review/ semiaquatic habitat/ Lake Erie/ coastal wetlands fauna/ literature review and case study/ Chironomidae/ community structure/ distribution within habitat/ Pennsylvania/ Presque Isle/ coastal wetland community spatial and temporal patterns overview

497. **Lake Erie coastal wetlands: An overview.**
Herdendorf, C. E.
Journal of Great Lakes Research 18(4): 533-551. (1992)
NAL Call #: GB1627.G8J6; *ISSN:* 0380-1330
Descriptors: wetlands/ aquatic plants/ Great Lakes/ Lake Erie/ limnology/ marshes/ coastal lagoons/ dikes/ lagoons/ river mouth/ shore protection
Abstract: Coastal wetlands of Lake Erie fall into three categories, depending on the type of protection available to the wetland vegetation:(1) coastal lagoons behind barrier beaches; (2) managed marshes protected by earthen and rip-rap dikes; and (3) estuarine tributary mouths. At one time, the most important protection was that afforded by barrier bars or other natural shoreline features which formed quiet lagoons and embayments. Very few natural wetlands of this type still exist on Lake Erie. Most of the lagoon-type coastal marshes, if they have not been drained of filled or engulfed by the lake, have been replaced by the second type: managed waterfowl marshes which are now protected by earthen rip-rap dikes. The third type of protection is the natural isolation from lake storms provided by the estuaries of virtually all of the tributaries entering Lake Erie, particularly at the western end. Large wetlands have developed along most of the estuaries where disturbance has been minimal. Estuarine coastal marshes currently form the majority of the naturally protected wetlands bordering western Lake Erie. (Author's abstract)
35 005518163

498. **Land-use correlates of anuran community richness and composition in southeastern Ontario wetlands.**
Findlay, C. S.; Lenton, J.; and Zheng, L.
Ecoscience 8(3): 336-343. (2001)
NAL Call #: QH540.E366; *ISSN:* 1195-6860
Descriptors: wetlands/ forests/ environmental impact/ man-induced effects/ Rana septentrionalis/ Rana palustris/ Canada, Ontario/ mechanical and natural changes
Abstract: In light of increasing evidence of declining anuran populations worldwide, an important conservation issue is the extent to which declines are consequences of smaller-scale stresses such as local habitat loss or degradation, or larger-scale stresses such as climate change. That anuran richness in 77 southeastern Ontario wetlands is negatively correlated with the density of roads on lands within 1 km of the wetland, and positively correlated with the percentage of forest cover is shown here. Logistic regression analysis shows that the presence of at least two species, the mink frog (Rana septentrionalis) and the wood frog (Rana sylvatica) is negatively related to road density, while the pickerel frog (Rana palustris) shows significant positive association with adjacent forest cover. These results suggest that in southeastern Ontario, significant conservation gains can be achieved through local land-use planning and management decisions that mitigate the effects of existing roads, minimize the construction of new roads, and discourage further forest conversion on lands adjacent to wetlands.

499. **Large-scale coastal wetland restoration on the Laurentian Great Lakes: Determining the potential for water quality improvement.**
Mitsch, W. J. and Wang, Naiming
Ecological Engineering 15(3-4): 267-282. (July 2000)
NAL Call #: TD1.E26; *ISSN:* 0925-8574
Descriptors: wetlands/ coastal environments/ environmental restoration/ lakes/ water quality/ nutrient concentrations/ coastal zone/ simulation/ phosphorus/ hydrology/ coastal waters/ environmental protection/ water pollution control/ water quality control/ restoration/ marshes/ nutrients (mineral)/ watersheds/ ecosystem management/ environment management/ pollutants/ agricultural land/ nutrient retention/ USA, Michigan, Saginaw Bay/ USA, Ohio, Sandusky Bay/ North America, Great Lakes/ USA, Michigan L., Saginaw Bay/ USA, Ohio/ USA, Ohio, Erie L., Sandusky Bay/ USA, Illinois/ USA, Great Lakes/ USA, Michigan/ nutrient sequestration/ reclamation/ environmental action/ estuaries/ prevention and control/ land/ general environmental engineering
Abstract: Coastal wetlands around the Laurentian Great Lakes, estimated to cover 1290 km super(2) in the USA after extensive losses in the past 200 years, are rarely restored for water quality enhancement of the Great Lakes, despite the need for minimizing phosphorus and other pollutant inputs to the lakes. A simulation model, developed and validated for a series of created experimental marshes in northeastern Illinois, was aggregated and simplified to estimate the nutrient retention capacity of hypothetical large-scale coastal wetland restoration in Michigan and Ohio. Restoration of 31.2 km super(2) of wetlands on agricultural land along Saginaw Bay, Michigan, would retain 25 metric tons-P year super(-1) (53% of the phosphorus flow from the upstream watershed). Hydrologic restoration of 17.3 km super(2) of mostly diked wetlands in Sandusky Bay, Ohio, would retain 38 metric tons year super(- 1) (12% of the phosphorus flow from the upstream watershed). A wetland distribution model developed for the Saginaw Bay site illustrated a technique for identifying sites that have high potential for being transition zones between open water and upland and thus logical locations for wetland restoration.

500. **Linkages between groundwater and coastal wetlands of the Laurentian Great Lakes.**
Crowe, A. S. and Shikaze, S. G.
Aquatic Ecosystem Health and Management 7(2): 199-213. (2004)
NAL Call #: QH541.5.W3A682; *ISSN:* 1463-4988
Descriptors: wetlands/ Great Lakes/ groundwater/ groundwater-surface water interaction

Abstract: Groundwater flow regimes adjacent to coastal wetlands of the Great Lakes are highly transient and vary among different types of coastal wetlands. Groundwater flow is controlled by (1) the physiography of the land adjacent to the wetland, (2) the relative elevations of the wetland and the lake, as they fluctuate over time, and (3) the amount of infiltration and evapotranspiration that occurs at the land and wetland. Groundwater from the mainland adjacent to a wetland will flow towards and discharge into the wetland throughout the year. In a spit that partially protects a wetland from a lake, the source ofgroundwater is precipitation and snowmelt; not water from the lake or wetland. Here, groundwater continually flows from either side of a central groundwater divide towards the lake or wetland, with the elevation of the lake only affecting the rate of groundwater drainage. Because barrier bars completely separate a lake from a wetland, the elevation of the lake and wetland are different. When the barrier bar is narrow, the resultant hydraulic gradient across the barrier bar causes groundwater flow to oscillate between flowing towards the lake during the fall and winter and towards the wetland during the spring and summer. But as the width of the barrier bar increases, the impact of the lake and wetland diminish relative to the amount of precipitation and snowmelt infiltrating into the barrier bar. Thus, the groundwater flow regime is characterized by a central groundwater divide with groundwater on either side continuously flowing towards the lake and wetland throughout the year. Intradunal wetlands are actually several small wetlands within a series of relic beach ridges and parabolic dunes. Groundwater flow regimes here are highly variable and transient with flow adjacent to different wetlands, and at different times of the year, exhibiting continuous flow to a wetland, oscillating direction of flow, and lateral migration of the groundwater divide. However, these groundwater flow patterns are caused by precipitation and evapotranspiration within the wetland complex and not by fluctuating lake levels.

501. **Literature review: Wetlands as a nonpoint source pollution control measure.**
Denison, Doug and Tilson, Don
Wayne County, Michigan: Rouge River National Wet Weather Demonstration Program, 1993. 31 p.
http://www.rougeriver.com/pdfs/wetlands/tm12.pdf

502. **Mass and nutrient content of dead wood in a central Illinois floodplain forest.**
Polit, J. I. and Brown, S.
Wetlands 16(4): 488-494. (Dec. 1996)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ wood/ biomass/ nutrient cycles/ flood plains/ plant populations/ forests/ detritus/ organic matter/ cycling nutrients/ USA, Illinois/ cycling nutrients/ plant populations/ organic compounds/ ecosystems and energetics/ temperate forests/ chemical processes
Abstract: The quantity and quality of dead wood in a central Illinois floodplain forest was measured to determine its role in organic matter and nutrient budgets. Dead wood (downed wood and standing dead trees) was inventoried using plots and the line intersect method for mass, and samples were analyzed for density and concentration of ash, N, and P. Total dead wood was estimated at 15.9 Mg ha super(-1) and was comprised of 9.3 Mg ha super(-1) as standing dead (59%) and 6.6 Mg ha super(-1) as downed wood (41%). Most of the downed wood (82% of the total) was in the intermediate decomposition class. Density of downed wood (0.19-0.47 g cm super(-3)) decreased and concentrations of N (0.18-1.29%), P (0.12-0.56 mg g super(-1)), and ash (1-23%) increased with increasing state of decomposition. Mean N, P, and ash pools in dead wood were 47 kg ha super(-1), 3.1 kg ha super(-1), and 481 kg ha super(-1), respectively. Downed wood contained 56%, 54%, and 69% of the total N, P, and ash pools, respectively. During periods of rapid decomposition of leaves and reproductive parts, downed dead wood is the dominant and often sole component of the floor litter mass.

503. **Modelling self-design of the aquatic community in a newly created freshwater wetland.**
Metzker, K. D. and Mitsch, W. J.
Ecological Modelling 100(1-3): 61-86. (1997)
NAL Call #: QH541.15.M3E25; *ISSN:* 0304-3800
Descriptors: wetlands/ marshes/ freshwater fish/ community composition/ ecological succession/ climax community/ fish/ evolution/ fish populations/ community development/ USA, Ohio/ Pisces/ models/ community structure
Abstract: A dynamic simulation model was constructed to predict the natural development of a fish community in a recently constructed, freshwater marsh in the midwestern USA, and to determine which forces are significant in shaping the self-design trajectory of the fish community. The model allowed immigration of five species of fishes from a nearby river into the constructed wetland system and allowed them to interact with each other as well as with the other biotic components of the wetland. Imported fishes included Micropterus salmoides, Lepomis macrochirus, Lepomis cyanellus, Cyprinus carpio and Ameirus natalis. These species were chosen because each is common in the nearby river and because each possesses physiological characteristics allowing survival in typical marsh conditions. Each species population was divided into three distinct ontogenetic stages and were graduated into the next ontogenetic stage as the normal consequence of growth. Modelled interactions included intra and interspecific competition; predation; feeding; reproduction; fish effects on system abiotic components (e.g., bioturbation) and mortality. The fish community underwent several major changes in structure during the first 4 years of its simulated existence, before establishing a stable structure. Under environmental conditions prevailing in the system, the fish community always evolved toward a stable state with a high-biomass population dominated by Cyprinus carpio and a smaller population of Ameirus natalis. If the effects of suboptimal environmental conditions were removed, then the system always evolved toward a low-biomass state consisting entirely of Micropterus salmoides. The role of chance was also tested and resulted in significant short term modifications to the community structure; however, these changes decreased in magnitude and were insufficient to prevent attainment of either of the two alternate steady states. These results indicate that the fish community in wetlands has a strong self-design trajectory, tending toward almost complete dominance by Cyprinus carpio unless typical wetland environmental conditions were significantly ameliorated.

504. **Non-native plant commonness and dominance in the forests, wetlands, and grasslands of Illinois, USA.**
Spyreas, Greg; Ellis, James; Carroll, Connie; and Molano Flores, Brenda
Natural Areas Journal 24(4): 290-299. (2004)
NAL Call #: QH76.N37; *ISSN:* 0885-8608
Descriptors: biodiversity/ terrestrial ecology: ecology, environmental sciences/ alien plant domination/ forest habitat/ grasslands habitat/ vegetation survey/ wetlands habitat
Abstract: Non-native species constitute one of the greatest threats to our indigenous biota. We used data from vegetation surveys of ground, shrub, and canopy strata from 1997-2001 at 399 randomly selected forests, wetlands, and grasslands to elucidate non-native plant pervasiveness throughout Illinois. The dominant non-native species in the ground layer of forests was Lonicera japonica Thunb., in wetlands it was Phalaris arundinacea L., in prairie grasslands it was Poa pratensis L., and across all grasslands it was Festuca arundinacea Schreb. Though rarely recognized as exotic, several of the most prevalent non-natives were introduced ecotypes or cultivars of cosmopolitan species. Conversely, some well-known exotics were surprisingly uncommon. Non-native species were more dominant in the ground cover (9% forests, 33% wetlands, 36% prairie grasslands, 76% secondary grasslands) than in the shrub and canopy strata across the state. Non-native ground cover varied regionally in forests and wetlands while, overall, the southern third of the state had significantly lower non-native cover. These regional patterns may be related to isolation from metropolitan areas, historical disturbances, current land use, unique edaphic features, as well as species-specific distributions for the most successful invaders. Our results show the extent to which non-native species have permeated Illinois habitats and replaced native plant communities.

505. **Nongame bird use of restored wetlands in Manitowoc County, Wisconsin.**
Guggisberg, A. C. Wisconsin Department of Natural Resources, 1996. 60 p.
Descriptors: land ownership/ questionnaire/ statistics/ surveys/ vegetation
Abstract: Nongame wildlife use and vegetation were monitored on 143 restored wetlands in Manitowoc County. Included is a supplement, entitled "Wisconsin's Coastal Lake Michigan Wetland Restoration Research Program: Getting Started & Data Sheets and Instructions."

506. **Pathways of nutrient loading and impacts on plant diversity in a New York peatland.**
Drexler, Judy Z. and Bedford, Barbara L.
Wetlands 22(2): 263-281. (2002)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: shannon wiener diversity/ fen/ groundwater/ hydrochemistry/ hydrogeology/ nutrient flux/ nutrient impact/ nutrient loading/ peat chemistry/ peatland/ peatland characteristics/ plant diversity/ potential pathway identification/ soil characteristics/ species richness
Abstract: Nutrient loading is a subtle, yet serious threat to the preservation of high diversity wetlands such as peatlands. Pathways of nutrient loading and impacts on plant diversity in a small peatland in New York State. USA were determined by collecting and analyzing a suite of hydrogeological, hydro-chemical, soil, and vegetation data. Piezometer clusters within an intensive network constituted hydro-chemical sampling points and focal points for randomly selected vegetation quadrats and soil-coring locations. Hydrogeological data and nutrient analyses showed that P and K loading occurred chiefly by means of overland flow from an adjacent farm field, whereas N loading occurred predominantly through ground-water flow from the farm field. Redundancy analysis and polynomial regression showed that nutrients, particularly total P in peat, total K in peat, extractable NH4-N, and NO3-N flux in ground water, were strongly negatively correlated with plant diversity measures at the site. No other environmental variables except vegetation measures associated with eutrophication demonstrated such a strong relationship with plant diversity. Nitrate loading over 4 mg m-2 day-1 was associated with low plant diversity, and Ca fluxes between 80 and 130 mg m-2 day-1 were associated with high plant diversity. Areas in the site with particularly low vascular plant and bryophyte species richness and Shannon-Wiener diversity (H') occurred adjacent to the farm field and near a hillside spring. High H' and species richness of vascular plants and bryophytes occurred in areas that were further removed from agriculture, contained no highly dominant vegetation, and were situated directly along the ground-water flow paths of springs. These areas were characterized by relatively constant water levels and consistent, yet moderate fluxes of base cations and nutrients. Overall, this study demonstrates that knowledge of site hydrogeology is crucial for determining potential pathways of nutrient loading and for developing relationships between nutrient inflows and wetland plant diversity.

507. **The physical effects of the Great Lakes on tributaries and wetlands: A summary.**
Bedford, K. W.
Journal of Great Lakes Research 18(4): 571-589. (1992)
NAL Call #: GB1627.G8J6; *ISSN:* 0380-1330
Descriptors: wetlands/ Great Lakes/ Lake Erie/ lake effects/ limnology/ seasonal variation/ tributaries/ water level fluctuations/ wind-driven currents/ hydrologic cycle/ lakes/ physical analysis/ storm surges/ water temperature
Abstract: Wetland and tributary confluences are susceptible to physical influences imposed by the Great Lakes, particularly through the effects of short and long-term water level fluctuations and accompanying transport disruptions including flow and transport reversals. With there being few, if any, direct observations of these disruptions based on velocity measurements, reviewing the possible physical effects can only be done by reviewing the current contributing physics known about the Great Lakes, and contrasting possible marine estuary transport mechanisms with what little is published about the Great Lakes. Lake Erie was chosen because that lake exhibits the strongest response to storms and the clearest measurable signals resulting from them. The important feature of Lake Erie physics is its seasonal variability. Lake Erie is shallow and responds robustly to the annual thermal heating and cooling cycle. Although ice covers 90% of the lake in the winter, the ice does not suppress wind driven circulation. The spring-summer-fall heating and cooling cycle is marked by both vertical and horizontal temperature variation. Due

primarily to prevailing storm tracks and shallowness, the lake responds to wind stress of storms with a combination of free and forced mode oscillatory responses in water level. An analogy with marine estuaries is correct in suggesting that the flood and ebb conditions are asymmetric in that the concentration of fluxes during flood are quite different than those during the subsequent ebb. The analogy is not correct in that the differential heating enhances springtime interfacial development which potentially reverses during the fall cooling season.

508. **Regional analysis of fringe wetlands in the Midwest: Creation and restoration.**
Willard, D. E. and Levine, D. A.
In: Wetland Creation and Restoration: The Status of the Science.
Covelo, Calif.: Island Press, 1990; pp. 299-325.
Notes: ISBN: 1559630450
NAL Call #: QH541.5.M3W462
Descriptors: artificial wetlands/ lake shores/ reservoirs/ water resources management/ wetland restoration/ monitoring/ plant populations/ planting management/ shoreline cover/ vegetation establishment/ water level fluctuations/ water resources development
Abstract: 'Fringe ' wetlands are those found along lakes and reservoirs, abundant in the midwest United States. Very few documented cases of fringe wetland mitigation are found. Their prevalence in this region suggests that Midwestern administrators of the regulatory program will be confronted with permits which impact fringe wetlands. Specific goals must be clearly outlined in the mitigation permit and include the following: detailed construction plans; a list of target species consistent with project goals; a long-term management plan; and a complete monitoring plan. To further ensure the success of mitigation, the following is recommended: the establishment of a fringe wetland should not be attempted where the fetch is greater than 13 km unless a dike is constructed to reduce wave action; and revegetation should utilize a combination of both natural (i. e., seed bank) and artificial (i.e., transplants) methods. Further research is needed (1) to determine how fringe wetland plant species and plant communities as a whole influence water quality, (2) to determine how water level fluctuations affect species composition and nutrient cycling in these wetlands, (3) to quantify shoreline stabilization needs and functions, and (4) to develop ecotypically-adapted planting stocks.
(Author 's abstract)

509. **Regional-scale measurements of CH sub(4) exchange from a tall tower over a mixed temperate/boreal lowland and wetland forest.**
Werner, C.; Davis, K.; Bakwin, P.; Yi, C.; Hurst, D.; and Lock, L.
Global Change Biology 9(9): 1251-1261. (Sept. 2003)
NAL Call #: QC981.8.C5G6323; *ISSN:* 1354-1013
Descriptors: wetlands/ forests/ atmospheric conditions/ methanogenesis/ soils/ water table/ annual variations/ methane/ gas exchange/ atmospheric gases/ carbon dioxide/ precipitation/ Bowen's ratio/ soil temperatures/ ecosystems/ forest ecosystems/ ground temperatures/ oxidation of methane/ methane exchange, air-marsh/ biosphere-atmosphere interaction/ carbon dioxide flux/ snow melting/ USA, Wisconsin, Chequamegon-Nicolet Natl. Forest/ atmosphere/ ecosystems and energetics/ atmospheric chemistry/ composition of the atmosphere/ biometeorology and bioclimatology/ microclimates of forests and forest clearings/ swamps, marshes
Abstract: The biosphere-atmosphere exchange of methane (CH sub(4)) was estimated for a temperate/boreal lowland and wetland forest ecosystem in northern Wisconsin for 1997-1999 using the modified Bowen ratio (MBR) method. Gradients of CH sub(4) and CO sub(2) and CO sub(2) flux were measured on the 447-m WLEF-TV tower as part of the Chequamegon Ecosystem-Atmosphere Study (ChEAS). No systematic diurnal variability was observed in regional CH sub(4) fluxes measured using the MBR method. In all 3 years, regional CH sub(4) emissions reached maximum values during June-August (24 plus or minus 14.4 mg m super(-2) day super(-1)), coinciding with periods of maximum soil temperatures. In 1997 and 1998, the onset in CH sub(4) emission was coincident with increases in ground temperatures following the melting of the snow cover. The onset of emission in 1999 lagged 100 days behind the 1997 and 1998 onsets, and was likely related to postdrought recovery of the regional water table to typical levels. The net regional emissions were 3.0, 3.1, and 2.1 g CH sub(4) m super(-2) for 1997, 1998, and 1999, respectively. Annual emissions for wetland regions within the source area (28% of the land area) were 13.2, 13.8, and 10.3 g CH sub(4) m super(-2) assuming moderate rates of oxidation of CH sub(4) in upland regions in 1997, 1998, and 1999, respectively. Scaling these measurements to the Chequamegon Ecosystem (CNNF) and comparing with average wetland emissions between 40 degree N and 50 degree N suggests that wetlands in the CNNF emit approximately 40% less than average wetlands at this latitude. Differences in mean monthly air temperatures did not affect the magnitude of CH sub(4) emissions; however, reduced precipitation and water table levels suppressed CH sub(4) emission during 1999, suggesting that long-term climatic changes that reduce the water table will likely transform this landscape to a reduced source or possibly a sink for atmospheric CH sub(4).

510. **Snowmelt ponds in Wisconsin: Influence of hydroperiod on invertebrate community structure.**
Schneider, Daniel W.
In: Invertebrates in freshwater wetlands of North America: Ecology and management/ Batzer, Darold P.; Rader, Russell B.; and Wissinger, Scott A.
New York: John Wiley & Sons, 1999; pp. 299-318.
Notes: ISBN: 0471292583
NAL Call #: QL365.4.A1I58
Descriptors: Invertebrata/ community structure/ snowmelt ponds/ pond/ temporary water/ physical factors/ hydroperiod influence on community structure in snowmelt ponds/ Wisconsin/ North America/ snowmelt ponds community structure/ influence of hydroperiod

511. **Techniques for restoration of disturbed coastal wetlands of the Great Lakes.**
Wilcox, D. A. and Whillans, T. H.
Wetlands 19(4): 835-857. (1999)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ degradation/ environmental quality/ land reclamation/ land management/ hydrology/ water control/ environmental restoration/ methodology/ coastal environments/ restoration/ sedimentation/ community composition/ water levels/ pollution control/ sediment pollution/ decomposition/ environmental quality standards/ land restoration/ North America, Great Lakes/ North America/ land restoration
Abstract: A long history of human-induced degradation of Great Lakes wetlands has made restoration a necessity, but the practice of wetland restoration is relatively new, especially in large lake systems. Therefore, we compiled tested methods and developed additional potential methods based on scientific understanding of Great Lakes wetland ecosystems to provide an overview of approaches for restoration. We addressed this challenge by focusing on four general fields of science: hydrology, sedimentology, chemistry, and biology. Hydrologic remediation methods include restoring hydrologic connections between diked and hydrologically altered wetlands and the lakes, restoring water tables lowered by ditching, and restoring natural variation in lake levels of regulated lakes Superior and Ontario. Sedimentological remediation methods include management of sediment input from uplands, removal or proper management of dams on tributary rivers, and restoration of protective barrier beaches and sand spits. Chemical remediation methods include reducing or eliminating inputs of contaminants from point and non-point sources, natural sediment remediation by biodegradation and chemical degradation, and active sediment remediation by removal or by in situ treatment. Biological remediation methods include control of non-target organisms, enhancing populations of target organisms, and enhancing habitat for target organisms. Some of these methods were used in three major restoration projects (Metzger Marsh on Lake Erie and Cootes Paradise and Oshawa Second Marsh on Lake Ontario), which are described as case studies to show practical applications of wetland restoration in the Great Lakes. Successful restoration techniques that do not require continued manipulation must be founded in the basic tenets of ecology and should mimic natural processes. Success is demonstrated by the sustain -ability, productivity, nutrient-retention ability, invasibility, and biotic interactions within a restored wetland.
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512. **Temperate zone fens of the glaciated midwestern USA.**
Amon, J. P.; Thompson, C. A.; Carpenter, Q. J.; and Miner, J.
Wetlands 22(2): 301-317. (June 2002)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ USA/ glaciers/ temperate zone/ boreal forests/ literature review/ species diversity/ groundwater/ hydrogen ion concentration/ root zone/ organic matter/ conductivity/ fens/ inland water environment/ classification systems/ hydrology/ physicochemical properties/ community composition/ species diversity/ habitat community studies
Abstract: A study of more than 70 fens in the Midwestern United States and a review of the literature indicates that these temperate zone wetlands may differ from fens of the boreal zone and are not adequately differentiated from them by present classification systems. Fens of the Midwestern temperate zone 1) are wetlands with high botanical diversity, 2) are supported in part by ground water with conductivity > 100mS/cm and circumneutral pH, 3) contain water in the root zone during most of the growing season yet are not usually inundated, and 4) accumulate organic and/or carbonate substrates. Individually, none of these descriptors is adequate to distinguish fens from other wetland communities of the Midwest such as marshes, sedge meadows, and wet prairies; yet, when they are taken together, such discrimination is possible. While fens of this zone share many species, our study does not support using indicator species because too few are both faithfully represented and geographically widespread. Midwestern temperate fens are sustained by forces of climate, landscape, and geology, which permit ground water to seep continuously into the root zone in a focused location. Since water availability in the temperate Midwest is less than in the boreal zone, continuous discharge is needed to maintain the saturation conducive to peat formation.
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513. **Temporary woodland ponds in Michigan: Invertebrate seasonal patterns and trophic relationships.**
Higgins, Michael J. and Merritt, Richard W.
In: Invertebrates in freshwater wetlands of North America: Ecology and management/ Batzer, Darold P.; Rader, Russell B.; and Wissinger, Scott A.
New York: John Wiley & Sons, 1999; pp. 279-297.
Notes: ISBN: 0471292583
NAL Call #: QL365.4.A1I58
Descriptors: Invertebrata/ trophic structure/ community structure/ temporary woodland pond community seasonal dynamics/ pond/ community seasonal dynamics and trophic relationships/ temporary water/ woodland ponds/ Michigan/ temporary woodland ponds/ community seasonal dynamics and trophic relations
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514. **Use of historical and geospatial data to guide the restoration of a Lake Erie coastal marsh.**
Kowalski, K. P. and Wilcox, D. A.
Wetlands 19(4): 858-868. (Dec. 1999)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212.
Notes: Conference: Temperate Wetlands Restoration Workshop, Barrie, ON (Canada), 27 Nov-1 Dec 1995
Descriptors: wetlands/ North America, Erie L./ water level/ vegetation/ land reclamation/ aerial photography/ geomorphology/ hydrology/ marshes/ environmental restoration/ historical ecology/ coastal environments/ management/ USA, Ohio/ vegetation cover/ plant populations/ geographical reference systems/ water levels/ aerial photographs/ historical account/ ecosystem management/ barrier beaches/ shore protection/ restoration/ photography/ North America, Erie L./ USA, Ohio, Erie L., Metzger Marsh/ watershed protection/ reclamation/ protective measures and control/ coastal zone management/ water resources and supplies
Abstract: Historical and geospatial data were used to identify the relationships between water levels, wetland vegetation, littoral drift of sediments, and the condition of a

protective barrier beach at Metzger Marsh, a coastal wetland in western Lake Erie, to enhance and guide a joint federal and state wetland restoration project. Eleven sets of large-scale aerial photographs dating from 1940 through 1994 were interpreted to delineate major vegetation types and boundaries of the barrier beach. A geographic information system (GIS) was then used to digitize the data and calculate the vegetated area and length of barrier beach. Supplemented by paleoecological and sedimentological analyses, aerial photographic interpretation revealed that Metzger Marsh was once a drowned-river-mouth wetland dominated by sedges and protected by a sand barrier beach. Extremely high water levels, storm events, and reduction of sediments in the littoral drift contributed to the complete destruction of the barrier beach in 1973 and prevented its recovery. The extent of wetland vegetation, correlated to water levels and condition of the barrier beach, decreased from a high of 108 ha in 1940 to a low of 33 ha in 1994. The lack of an adequate sediment supply and low probability of a period of extremely low lake levels in the near future made natural reestablishment of the barrier beach and wetland vegetation unlikely. Therefore, the federal and state managers chose to construct a dike to replace the protective barrier beach. Recommendations stemming from this historical analysis, however, resulted in the incorporation of a water-control structure in the dike that will retain a hydrologic connection between wetland and lake. Management of the wetland will seek to mimic processes natural to the wetland type identified by this analysis.

Effects of Agricultural Conservation Practices on Wetlands

515. **Analysis and conservation implications of landscape change in the Wisconsin River floodplain, USA.**
Freeman, Ross E.; Stanley, Emily H.; and Turner, Monica G.
Ecological Applications 13(2): 416-431. (2003)
NAL Call #: QH540.E23; *ISSN:* 1051-0761
Descriptors: wetlands/ aerial photography: applied and field techniques/ orthophotography: applied and field techniques/ agriculture/ conservation implications/ deciduous forest/ floodplain forest ecosystem/ forest connectivity/ grassland/ land cover change/ landscape change/ resource management/ riparian buffer
Abstract: River floodplain landscapes are diverse and dynamic, yet little is known about long-term changes in land-cover patterns in these systems. We quantified floodplain land-cover change between the 1930s and the 1990s along nine 12-21-km reaches of the Wisconsin River by analyzing and digitally classifying 200 historic aerial photos corrected against modern orthophotographs. Several metrics of landscape structure were used to determine changes in amount and connectivity of deciduous forest, wetlands, grassland, and agriculture within the 100-yr floodplain. Deciduous forest increased by up to 51% between the 1930s and the 1990s. However, number of patches declined, and edge density increased in almost every reach, indicating that amount and connectivity of forest cover increased but that forest patches became more complex in shape. Grasslands declined, and the number, edge density, and mean size of grassland patches illustrated a progression to fewer, smaller, isolated remnants. Wetland patch dynamics demonstrated complex and divergent patterns, as wetland cover decreased in northern reaches, increased in patch density but not mean patch size in the central region, and increased in both patch density and patch size in the south. Agricultural areas declined in eight of nine reaches, and tended to fragment into fewer, smaller patches. These trends underscore a complicated and dynamic pattern of landscape change over a relatively short time scale. We explored realistic conservation scenarios to determine how disparate strategies would affect floodplain forest connectivity in four of the study reaches. One approach filled gaps in the buffer zone immediately adjacent to the river channel; the other reverted small or large agricultural patches to forest cover. Filling buffer zone gaps resulted in dramatic changes in forest connectivity in one half of the reaches, whereas greatest forest connectivity was gained by reverting agricultural patches to forest in the other half of the reaches. These scenarios emphasize that the way that forest conservation occurs (e.g., filling gaps vs. patch conversion) is just as significant as how much land is actually protected, and the ideal management option must be tailored to the specific land-cover arrangements of a given river reach. In addition to evaluating changes in forest connectivity, the number of land-owners that would be affected by conservation strategies was determined. Greatest increases in forest connectivity under the buffer scenarios involved from 15 to 21 different land-owners, whereas the greatest increases under the reversion scenarios affected from 14 (using several large agricultural parcels) to 67 (using many small parcels) landowners. Thus the number of landowners affected by different management scenarios represents a critical constraint on idealized conservation plans. Such scenarios may prove useful in floodplain management and facilitate synthesis of ecological research and land management.

516. **Analyzing cumulative environmental effects of agricultural land drainage in southern Ontario, Canada.**
Spaling, H.
Agriculture, Ecosystems & Environment 53(3): 279-292. (1995)
NAL Call #: S601.A34; *ISSN:* 0167-8809
Descriptors: wetlands/ agricultural land/ drainage/ environmental impact/ area/ geographical distribution/ spatial distribution/ water flow/ volume/ water quality/ nitrate nitrogen/ nitrogen content/ atrazine/ models/ geographic information systems/ Ontario
This citation is from AGRICOLA.

517. **Anthropogenic correlates of species richness in southeastern Ontario wetlands.**
Findlay, C. S. and Houlahan, J.
Conservation Biology 11(4): 1000-1009. (Aug. 1997)
NAL Call #: QH75.A1C5; *ISSN:* 0888-8892
Descriptors: wetlands/ plant populations/ community composition/ man-induced effects/ anthropogenic factors/

species diversity/ plants/ roads/ forestry/ vertebrata/ Canada, Ontario/ species richness/ forest practices/ vertebrates/ conservation/ mechanical and natural changes/ water and plants
Abstract: We examined the relationship between the richness of four different wetland taxa (birds, mammals, herptiles, and plants) in 30 southeastern Ontario, Canada wetlands and two anthropogenic factors: road construction and forest removal/conversion on adjacent lands. Data were obtained from two sources: road densities and forest cover from 1:50,000 Government of Canada topographic maps and species lists and wetland areas from Ontario Ministry of Natural Resources wetland evaluation reports. Multiple regression analysis was used to model the relationships between species richness and wetland area, road density, and forest cover. Our results show a strong positive relationship between wetland area and species richness for all taxa. The species richness of all taxa except mammals was negatively correlated with the density of paved roads on lands up to 2 km from the wetland. Furthermore, both herptile and mammal species richness showed a strong positive correlation with the proportion of forest cover on lands within 2 km. These results provide evidence that at the landscape level, road construction and forest removal on adjacent lands pose significant risks to wetland biodiversity. Furthermore, they suggest that most existing wetland policies, which focus almost exclusively on activities within the wetland itself and/or a narrow buffer zone around the wetland perimeter, are unlikely to provide adequate protection for wetland biodiversity.

518. **Assessing the potential impacts of alternative landscape designs on amphibian population dynamics.**
Rustigian, H. L.; Santelmann, M. V.; and Schumaker, N. H.
Landscape Ecology 18(1): 65-81. (2003)
NAL Call #: QH541.15.L35 L36; *ISSN:* 0921-2973
Descriptors: landscape/ population dynamics/ models/ land use/ geographic information systems/ conservation/ environmental impact/ agriculture/ watersheds/ breeding sites/ habitat selection/ climatic changes/ life history/ dispersion/ vegetation cover/ prediction/ Amphibia/ USA, Iowa/ amphibians
Abstract: An individual-based, spatially explicit population model was used to predict the consequences of future land-use alternatives for populations of four amphibian species in two central Iowa (midwest USA) agricultural watersheds. The model included both breeding and upland habitat and incorporated effects of climatic variation and demographic stochasticity. Data requirements of the model include life history characteristics, dispersal behavior, habitat affinities, as well as land use and landcover in geographic information systems databases. Future scenarios were ranked according to change in breeder abundance, saturation, and distribution, compared to baseline conditions. Sensitivity of simulation results to changes in model parameters was also examined. Simulated results suggest that while all four species modeled are likely to persist under present and future scenario conditions, two may be more at risk from future landscape change. Although the study species are all widespread generalists regarded as having a low conservation priority, they depend on wetlands and ponds, increasingly endangered habitats in agricultural landscapes. Broader conservation strategies in the region would ensure that these currently common organisms do not become the endangered species of the future.

519. **Atrazine fate and transport in the Des Plaines wetlands.**
Alvord, H. H. and Kadlec, R. H.
Ecological Modelling 90(1): 97-107. (1996)
NAL Call #: QH541.15.M3E25; *ISSN:* 0304-3800
Descriptors: wetlands/ models/ pesticides/ herbicides/ pollution dispersion/ residence time/ atrazine/ fate of pollutants/ solute transport/ USA, Illinois/ atrazine/ residence time/ pollution dispersion/ fate of pollutants/ solute transport/ models
Abstract: Atrazine fate and transport in three constructed pond and island wetlands in north east Illinois, USA, were studied in the field (1991) and modeled. The wetlands received pumped inflow from the Des Plaines River. The nominal residence time was about eight days for two, but was longer for the third. The river atrazine chemograph had two peaks that rose quickly after heavy spring rains and then subsided slowly. Maximum concentrations exceeded the United States federal drinking water standard (3 mu g/l). The wetlands delayed, reduced, and spread out the peaks, removing 26 to 64% of their inflows depending on residence time. Flow and mixing models idealized the wetlands as single flow reactors or as networks of them. Atrazine reactions on biofilms with mass transfer rate limitation and when sorbed to sediments and litter were postulated. Simulation results were consistent with almost all atrazine reactions on biofilms. Mass transfer coefficients were 10-15 m/year with the wetland bottom taken as the biofilm area. The corresponding wetland half-lives were about 10 days. Best calibration resulted when most of the reaction took place near the pumping inlet. Model coefficients were similar to values for BOD and nutrients in other surface flow wetlands or to those derived from tracer data. The results suggest that observed removal rates of many pollutants in wetlands may reflect similar underlying mass transfer rate limitations.

520. **Buffer zone and windbreak effects on spray drift deposition in a simulated wetland.**
Brown, R. B.; Carter, M. H.; and Stephenson, G. R.
Pest Management Science 60(11): 1085-1090. (2004)
NAL Call #: SB951.P47; *ISSN:* 1526-498X
Descriptors: agricultural land/ weed control/ herbicides/ spray drift/ wetland plants/ phytotoxicity/ plant damage/ windbreaks/ spray deposition/ Ontario
Abstract: The amount of agricultural spray that drifts into a wetland from an adjacent crop field is influenced by vegetation along the field boundary or any intentional setback distance (buffer zone) between the sprayer and the edge of the arable field. In this study, spray tracer drift deposits were measured in a simulated wetland area under different conditions of wind speed and buffer zone width. The effect of an artificial windbreak at the upwind edge of the simulated wetland was also evaluated. A level of tolerance of 0.1% of the in-swath spray deposition was established as a no-effect level for the response of aquatic plants to common herbicides. Our results indicate that a

vegetated 10-m field margin (eg a fencerow) alone provides adequate protection from herbicide drift into a wetland area under wind conditions normally considered acceptable for spraying. For high winds (>4 m s-1) when field spraying would not normally be advised, adequate protection was afforded by the same 10-m margin plus a dense windbreak (25% porosity) or by the margin plus a 20-m buffer zone. This citation is from AGRICOLA.

521. **Carbon storage response to harvesting and site preparation in a forested mire in northern Michigan, USA.**
Trettin, Carl C.; Gale, Margaret R.; Jurgensen, Martin F.; and Mclaughlin, James W.
Suo (Helsinki) 43(4-5): 281-284. (1992)
NAL Call #: 54.8 SU7; *ISSN:* 0039-5471
Descriptors: wetlands/ biochemistry and molecular biophysics/ climatology: environmental sciences/ development/ ecology: environmental sciences/ forestry/ freshwater ecology: ecology, environmental sciences/ soil science/ decomposition/ ecosystem/ organic matter/ plant community regeneration/ productivity/ whole tree harvest

522. **Comparisons of P-yield, riparian buffer strips, and land cover in six agricultural watersheds.**
Reed, Tara and Carpenter, Stephen R.
Ecosystems 5(6): 568-577. (2002)
NAL Call #: QH540 .E3645; *ISSN:* 1432-9840
Descriptors: agricultural watersheds/ eutrophication/ land cover/ non point source pollution/ percent wetland land cover/ phosphorus yield variability/ riparian buffer strips/ riparian continuity/ riparian patch size/ stream sinuosity
Abstract: Riparian buffer strips may protect streams from phosphorus (P) pollution. We compared 2 years of daily P-yield (mug m-2 day-1) from six southeast Wisconsin watersheds with contrasting riparian buffer attributes. Of the variables measured, mean daily P-yield was most closely correlated with the variability in riparian patch size. Variability in P-yield was most closely correlated with characteristics of the riparian buffer, such as percent wetland land cover, riparian continuity, and stream sinuosity. During the most extreme events, mean P-yield was negatively correlated with the percentage of wetland land cover in the upland watershed. Correlations suggest that riparian continuity may influence P-loading in these watersheds. Our results corroborate the importance of continuity and uniformity of riparian buffers as moderators of P flow from upland agricultural lands into streams.

523. **A conceptual model of cumulative environmental effects of agricultural land drainage.**
Spaling, H. and Smit, B.
Agriculture, Ecosystems & Environment 53(2): 99-108. (1995)
NAL Call #: S601.A34; *ISSN:* 0167-8809
Descriptors: wetlands/ environmental effects/ drainage/ model studies/ ecosystems/ pollutants/ spatial distribution/ temporal distribution/ agriculture/ land use/ environmental impact/ ecosystem disturbance/ models/ Canada, Ontario/ cumulative effects/ environmental impact/ ecosystem disturbance/ models/ environmental effects/ model studies/ pollutants/ spatial distribution/ temporal distribution/ drainage
Abstract: Cumulative environmental effects are characterized by the temporal and spatial accumulation of change in environmental systems in an additive or interactive manner. Theoretical frameworks of cumulative environmental change generally follow a causal model consisting of the source of cumulative change, pathways of accumulation, and a typology of cumulative effects. These components, and the notion of temporal and spatial accumulation, are used to develop a conceptual model of the cumulative effects of agricultural land drainage in southern Ontario, Canada. Drainage is a source of cumulative effects because of its temporally repetitive and spatially expansive nature. Drainage modifies flow regimes and contributes a mechanism for the spatial movement of water and contaminants from one location to another. Potential cumulative effects of drainage include the repeated addition of drain water to receiving streams (time crowding), the systematic gathering of contaminants at higher concentrations relative to the source (spatial crowding) and their transport from agroecosystems to aquatic ecosystems downstream (cross-boundary movement), and the severing of natural areas resulting in altered landscape structure and functioning (spatial fragmentation). The model hypothesizes that, as drainage density increases, changes in environmental components or processes manifest themselves as cumulative effects, and that these effects accumulate at broader temporal and spatial scales.

524. **Consequences of prairie wetland drainage for crustacean biodiversity and metapopulations.**
Jenkins, D. G.; Grissom, S.; and Miller, K.
Conservation Biology 17(1): 158-167. (Feb. 2003)
NAL Call #: QH75.A1C5; *ISSN:* 0888-8892
Descriptors: wetlands/ prairies/ drainage/ biological diversity/ metapopulations/ historical ecology/ temporary ponds/ community composition/ freshwater crustaceans/ species diversity/ historical account/ long-term records/ genetics/ population genetics/ species extinction/ man-induced effects/ land use/ agriculture/ Crustacea/ USA, Illinois/ conservation/ mechanical and natural changes
Abstract: Much of Illinois was once wet prairie, dotted with ancient (ca. 10,000-year-old) ephemeral wetlands. Most wetland habitat (85%) was converted to agriculture over a span of about 100 years (ca. 1850-1950). The consequences of this severe habitat fragmentation on wetland communities and metapopulations are unknown. We studied crustacean communities (weekly stovepipe samples throughout hydroperiods) for 3 years in a set of extant ephemeral wetlands in Illinois. We generated species-sites curves by rarefaction and extrapolated those curves to conservatively estimate that 83-85 crustacean species may have inhabited approximately 4 million ephemeral wetlands that once existed in Illinois; 8-9 crustacean species were driven to extinction in Illinois during drainage; and 75-76 crustacean species are extant in the few remaining ephemeral wetlands of Illinois. We also conducted cellular automata simulations to examine the potential effects of habitat fragmentation on the genetic structure of extant crustacean metapopulation. Simulations indicated that conversion of the former wet prairie to agriculture may have reduced crustacean metapopulations to isolated populations that are more vulnerable to future habitat loss. Despite severe habitat fragmentation,

curvilinear species-sites relationships suggest that the greatest extinction rates have yet to occur for ephemeral wetland crustaceans. However, selection for limited dispersal during habitat fragmentation may contribute to extinction debt for extant species. Conservation programs can preserve much of the historical biodiversity of ephemeral wetlands, but future wetland biodiversity will depend heavily on the success of those efforts. The consequences of historical wetland loss and the importance of wetland conservation efforts to agriculture in the United States should be instructive for other regions.

525. **The effect of forestry drainage practices on the emission of methane from northern peatlands.**
Roulet, N. T. and Moore, T. R.
Canadian Journal of Forest Research 25(3): 491-499. (1995)
NAL Call #: SD13.C35; *ISSN:* 0045-5067
Descriptors: wetlands/ forest hydrology/ methane/ peat bogs/ drainage/ air-earth interfaces
Abstract: Methane (CH sub(4)) flux was measured from undrained, drained, and ditched portions of treed fen, forested bog, and treed bog sites in the Wally Creek experimental drainage site (near Cochrane, Ontario), from May to October 1991. Drainage for 7 years lowered the water table from between -21 and -49 cm to -41 and -93 cm at the three respective sites. Drainage resulted in a conversion of the peatlands from a CH sub(4) source (0 to 15 mg CH sub(4)/m super(2)/d) to a small CH sub(4) sink (0 to -0.4 mg CH sub(4)/m super(2)/d). In contrast, CH sub(4) efflux from the ditches ranged from <5 to >400 mg CH sub(4)/m super(2)/d. The flux data were used to estimate the impact of forest drainage practices on net CH sub(4) emissions from a forest drainage complex. For the treed and forested bogs, there was a net increase in CH sub(4) emissions where ditch spacing was closer than 38 m. Even with very close ditch spacing (>12 m), there was a net decrease in CH sub(4) flux from the treed fen. The results of this study indicate that the combination of low antecedent CH sub(4) fluxes from an undrained peatland, and moderate fluxes from the drainage ditches, will produce a net increase in CH sub(4) emissions from forest drainage.

526. **Estimating the 'critical' distance at which adjacent land-use degrades wetland water and sediment quality.**
Houlahan, Jeff E. and Findlay, C. Scott
Landscape Ecology 19(6): 677-690. (2004)
NAL Call #: QH541.15.L35 L36; *ISSN:* 0921-2973
Descriptors: adjacent land use/ buffer zone/ natural forest/ sediment/ water quality/ wetland management
Abstract: Conversion of forested lands to agriculture or urban/residential areas has been associated with declines in stream and lake water quality. Less attention has been paid to the effects of adjacent land-uses on wetland sediment and water quality and, perhaps more importantly, the spatial scales at which these effects occur. Here we address these issues by examining variation in water and sediment nutrient levels in 73 southeastern Ontario, Canada, wetlands. We modeled the relationship between water and sediment nutrient concentrations and various measures of adjacent land-use such as forest cover and road density, measured over increasing distances from the wetland edge. We found that water nitrogen and phosphorous levels were negatively correlated with forest cover at 2250 meters from the wetland edge, while sediment phosphorous levels were negatively correlated with wetland size and forest cover at 4000 meters and positively correlated with the proportion of land within 4000 meters that is itself wetland. These results suggest that the effects of adjacent land-use on wetland sediment and water quality can extend over comparatively large distances. As such, effective wetland conservation will not be achieved merely through the creation of narrow buffer zones between wetlands and more intensive land-uses. Rather, sustaining high wetland water quality will require maintaining a heterogeneous regional landscape containing relatively large areas of natural forest and wetlands.

527. **Fate and effects of the herbicide atrazine in flow-through wetland mesocosms.**
Detenbeck, N. E.; Hermanutz, R.; Allen, K.; and Swift, M. C.
Environmental Toxicology and Chemistry 15(6): 937-946. (1996)
NAL Call #: QH545.A1E58; *ISSN:* 0730-7268
Descriptors: wetlands/ herbicides/ atrazine/ periphyton/ runoff/ water pollution/ USA, Midwest/ atrazine/ fate of pollutants/ periphyton/ pollutant persistence/ Daphnia magna/ Rana pipiens/ Pimephales promelas/ Ceratophyllum demersum/ Zizania aquatica/ pollution effects/ nutrients
Abstract: Wetland mesocosms were exposed to increasing concentrations of atrazine over time at levels typical of Midwestern surface waters following spring runoff (15 to 75 mu g/L). Atrazine had a half-life of 8 to 14 d in the 230-m-long wetlands. End points measured included nutrient levels; periphyton biomass; periphyton productivity and respiration; growth of selected macrophytes; and survival and growth of Daphnia magna (15, 25 mu g/L atrazine), Rana pipiens (15, 25 mu g/L), and Pimephales promelas larvae (25 to 75 mu g/L) and adults (50, 75 mu g/L). Interaction between nutrient status or grazing intensity and atrazine effects were measured using periphyton enrichment and grazing exclosure experiments. Only periphyton, Ceratophyllum demersum, Zizania aquatica, and Daphnia were significantly affected by atrazine at any of the concentrations tested. Periphyton net productivity was significantly depressed by incubation in treated water as compared to control water at greater than or equal to 25 mu g/L atrazine (9 to 27-d exposures). In response, dissolved nutrient concentrations increased in treated mesocosms after 14 d. Ceratophyllum length/weight ratios increased after 6-d exposures to 50 mu g/L atrazine, while Zizania senesced prematurely during treatments of 50 or 75 mu g/L atrazine (97 d of cumulative exposure). Periphyton developed resistance to atrazine only at concentrations greater than or equal to 50 mu g/L. Atrazine effects on periphyton composition varied with the N:P supply ratio. Daphnia survival was significantly depressed at 15 mu g/L atrazine (48-h exposures).

528. **Habitat fragmentation and the distribution of amphibians: Patch and landscape correlates in farmland.**
Kolozsvary, Mary B. and Swihart, Robert K.
Canadian Journal of Zoology 77(8): 1288-1299. (1999)
NAL Call #: 470 C16D; *ISSN:* 0008-4301
Descriptors: Amphibia/ farming and agriculture/ agricultural fragmentation of forest and wetland/ ecological effects/ community structure/ distribution within habitat/ agriculturally fragmented forest and wetland habitats/ semiaquatic habitat/ agriculturally fragmented wetland ecology/ forest and woodland/ agriculturally fragmented forest ecology/ cultivated land habitat/ agriculturally fragmented forest and wetland/ ecology/ Indiana/ Tippecanoe and Warren Counties/ Indian Pine Natural Resources Area/ agriculturally fragmented forest and wetland habitat ecology

529. **Organic carbon characteristics in a spruce swamp five years after harvesting.**
McLaughliln, J. W.; Liu, G.; Jurgensen, M. F.; and Gale, M. R.
Soil Science Society of America Journal 60(4): 1228-1236. (1996)
NAL Call #: 56.9 So3; *ISSN:* 0361-5995
Descriptors: Picea mariana/ forest litter/ mineral soils/ swamp soils/ whole tree harvesting/ site preparation/ regeneration/ environmental impact/ soil chemistry/ soil organic matter/ degradation/ carbon/ soil solution/ groundwater/ chemical composition/ biogeochemical cycles/ organic acids and salts/ dissolved organic carbon/ Michigan
Abstract: Forest harvesting and regeneration may cause changes in soil and solution chemistry that adversely affect environmental quality. Organic C content in the forest floor and mineral soil, and dissolved organic carbon (DOC) fractions in the soil solution and groundwater were investigated in a black spruce [Picea mariana (Miller) BSP] swamp 5 yr after the application of two silvicultural prescriptions: whole-tree harvest only and whole-tree harvest followed by site preparation bedding. Soil organic carbon (SOC) content in the forest floor of both treatments were significantly lower than that of an uncut control stand. However, SOC in the upper 50 cm of mineral soil of the bedded treatment was similar to that of the control, while both were about 20% higher than SOC in the harvest-only treatment. Total DOC concentrations ranged from 12 to 87 mg/L in the soil solution and 6 to 46 mg/L in the groundwater and did not differ among treatments. Hydrophobic acids were the dominant DOC fraction across all treatments, but the proportion of hydrophobic strong acids increased at the expense of hydrophilic acids in the harvest-only treatment. Carboxyl content of hydrophilic acids in the soil water was 7.0 mmol/g hydrophilic compound in the control stand and 4.4 mmol/g in the treatments. Hydrophobic acid carboxyl content across treatments was 4.6 mmol/g hydrophobic substance. Relative to C loss and changes in water chemistry, these results indicate that 5 yr after whole-tree harvesting, this forest site has not yet fully equilibrated.
This citation is from AGRICOLA.

530. **Organic matter decomposition following harvesting and site preparation of a forested wetland.**
Trettin, C. C.; Davidian, M.; Jurgensen, M. F.; and Lea, R.
Soil Science Society of America Journal 60(6): 1994-2003. (1996)
NAL Call #: 56.9 So3; *ISSN:* 0361-5995
http://www.srs.fs.usda.gov/pubs/679
Descriptors: wetland soils/ forest soils/ soil organic matter/ cellulose/ degradation/ soil depth/ soil temperature/ oxidation/ logging/ site preparation/ silviculture/ Michigan
Abstract: Organic matter accumulation is an important process that affects ecosystem function in many northern wetlands. The cotton strip assay (CSA) was used to measure the effect of harvesting and two different site preparation treatments, bedding and trenching, on organic matter decomposition in a forested wetland. A Latin square experimental design was used to determine the effect of harvesting, site preparation, and relative position within the wetland on organic matter decomposition at soil depths of 5, 10, and 20 cm. Repeated measures analysis of variance was used to test for treatment effects on organic matter decomposition, soil temperature, and soil oxidation depth. Cellulose decomposition increased at each soil depth as site disturbance increased, with bedding > trenching > whole-tree harvest > reference. The cellulose decomposition response was correlated with changes in soil temperature; the temperature coefficient Q10 equaled 6.0, which is greater than previously reported values. Position within the wetland relative to an adjoining river affected the decomposition and soil oxidation depth. Because the rate of decomposition is strongly controlled by temperature, higher rates of organic matter decay are expected to continue on harvested and regenerated sites until canopy closure reduces soil temperature.
This citation is from AGRICOLA.

531. **Patch and landscape characteristics associated with the distribution of woodland amphibians in an agricultural fragmented landscape: An information-theoretic approach.**
Weyrauch, S. L. and Grubb, T. C.
Biological Conservation 115(3): 443-450. (2004)
NAL Call #: S900.B5; *ISSN:* 0006-3207
Descriptors: wetlands/ landscape/ patches/ habitat fragmentation/ agricultural ecosystems/ ecological distribution/ conservation/ man-induced effects/ land use/ agriculture/ patchiness/ forests/ habitat/ nature conservation/ amphibia/ USA, Ohio/ amphibians
Abstract: In the Midwestern United States, agricultural landscapes with scattered patches of fragmented forest are common. To investigate the relationship between amphibian distributions and wetland, woodlot, and landscape characteristics, we studied the pond-breeding amphibians within a 15, 450-ha plot in rural north- central Ohio. We surveyed 25 woodlots and one area of continuous riparian forest for amphibians, and each surveyed woodland contained at least one temporary wetland. We used Akaike's Information Criterion (AIC) to evaluate the effectiveness of 13 a priori models in predicting total amphibian species richness, anuran richness, caudate richness, and the presence of individual species in woodlots. We identified 13 species of amphibians within the study plot, and every woodlot contained at least one amphibian species. The most important variable in predicting total amphibian and anuran

species richness was hydroperiod. For caudates, woodlot edge-to-area ratio, hydroperiod, pH, and ammonia were important characteristics in predicting species richness. Woodlots within agricultural landscapes are important refuges for amphibians.

532. **Percentage land use in the watershed determines the water and sediment quality of 22 marshes in the Great Lakes Basin.**
Crosbie, B. and Chow-Fraser, P.
Canadian Journal of Fisheries and Aquatic Sciences 56(10): 1781-1791. (1999)
NAL Call #: 442.9 C16J; *ISSN:* 0706-652X
Descriptors: wetlands/ land use/ watersheds/ water quality/ sediment pollution/ marshes/ Canada, Ontario, Great Lakes/ watershed management/ sediment contamination/ land management
Abstract: Data from 22 Ontario marshes were used to test the hypothesis that distribution of forested, agricultural, and urban land in the watershed determines the water and sediment quality of Great Lakes wetlands. The first three components of the principal components analysis explained 82% of the overall variation. PC1 ordinated wetlands along a trophic gradient; species richness of submergent vegetation decreased with PC1 scores. PC2 reflected the content of inorganic solids and phosphorus in sediment and the ionic strength of the water. Both PC1 and PC2 scores were positively correlated with percent agricultural land, whereas PC1 scores were negatively correlated with forested land. Correlation between PC1 and agricultural land improved when best-management practices were considered. Accounting for common carp (Cyprinus carpio) disturbance did not confound the relationship between land use and water quality. PC3, driven by soluble reactive phosphorus and nitrate nitrogen concentration in the water, was not correlated with land use. Concentrations of polycyclic aromatic hydrocarbons and Metolachlor were correlated with urban and agricultural land, respectively, and may be useful as land use surrogates. Watershed management favouring the retention of forested land, or creation of buffer strips to trap agricultural runoff in the drainage basin, should help maintain aquatic plant diversity in coastal wetlands.

533. **Plant community responses to harvesting and post-harvest manipulations in a Picea-Larix-Pinus wetland with a mineral substrate.**
Gale, M. R.; McLaughlin, J. W.; Jurgensen, M. F.; Trettin, C. C.; Soelsepp, T.; and Lydon, P. O.
Wetlands 18(1): 150-159. (Mar. 1998)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ forest industry/ plant populations/ harvesting/ species diversity/ community composition/ fertilizers/ ecological succession/ man-induced effects/ North America, Great Lakes/ Picea/ Larix/ Pinus/ USA, Michigan/ mechanical and natural changes/ water and plants
Abstract: Forested wetlands in the Northern Great Lakes Region are becoming increasingly used as a timber resource. Yet, limited information is available on the effects of harvesting and post-harvest manipulations (site preparation and fertilization) on tree and ground vegetation in these wetland communities. The objective of this study was to examine production changes and species diversity in the vascular plant community four years after a forested, mineral wetland in Northern Michigan was whole-tree harvested, site prepared (bedded or trenched), and fertilized (N, P, N + P). The wetland had an original overstory of black spruce (Picea mariana), tamarack (Larix laricina), and jack pine (Pinus banksiana), with a significant cover of Sphagnum and Ericaceous shrubs. Site preparation techniques were done immediately after harvesting. The site was then planted with jack pine seedlings (1-0 stock). Fertilization occurred four years after harvesting and site preparation. Results indicate that trees in bedded areas with N fertilizer applied had significantly greater total seedling height, basal diameter, and height increment when compared with those from harvest-only or trenched areas. On harvest-only areas, seedling production was greater with P and N + P fertilizers than with N fertilizer alone. Fertilizer responses were attributed to which type of site preparation (bedding versus trenching) was used and the degree of organic matter and Sphagnum incorporated into the mineral soil. Only site-preparation treatments (not fertilization treatments) had significant effects on numbers and cover of vascular plant groups (woody, herbaceous, and grass/sedge). Number of species and total cover of all vascular plants were significantly greater on the harvest-only areas than on trenched, bedded, or uncut areas. As expected, relative cover of the grass/sedge group increased with increasing site disturbance (bedded and trenched), mainly due to disturbance and lack of the thick Sphagnum mat. When compared to the adjacent uncut area, relative cover of herbaceous species was significantly reduced on treated areas. In future years, if the significant effects of manipulation treatments on tree productivity and vascular plants continue, the resulting community may be different than the successional sequence witnessed by the original forest. This will, however, depend on the rate of crown closure and the invasion of bryophyte species.

534. **Response of breeding birds to shearing and burning in wetland brush ecosystems.**
Hanowski, J. M.; Christian, D. P.; and Nelson, M. C.
Wetlands 19(3): 584-593. (1999)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ wild birds/ population density/ prescribed burning/ cutting/ Minnesota
This citation is from AGRICOLA.

535. **Sediment loads and accumulation in a small riparian wetland system in northern Missouri.**
Heimann, D. C. and Roell, M. J.
Wetlands 20(2): 219-231. (2000)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ USA/ Missouri/ Long Branch Creek/ sediment load/ accumulation/ sediment transport/ deposition/ regression analysis/ flood plains/ monitoring/ variability/ riparian land/ clays/ forests/ hydrology/ geomorphology/ land use

536. **Soil organic matter and nitrogen cycling in response to harvesting, mechanical site preparation, and fertilization in a wetland with a mineral substrate.**
Mclaughlin, J. W.; Gale, M. R.; Jurgensen, M. F.; and Trettin, C. C.
Forest Ecology and Management 129(1-3): 7-23. (2000)
NAL Call #: SD1.F73; *ISSN:* 0378-1127
Descriptors: wetlands/ soil organic matter/ cycling nutrients/ nitrogen/ minerals/ substrates/ fertilization/ forests/ decomposition/ soil solution/ organic carbon/ microorganisms/ agricultural practices/ North America, Great Lakes/ USA, Michigan
Abstract: Forested wetlands are becoming an important timber resource in the Upper Great Lakes Region of the US. However, there is limited information on soil nutrient cycling responses to harvesting and post-harvest manipulations (site preparation and fertilization). The objective of this study was to examine cellulose decomposition, nitrogen mineralization, and soil solution chemistry four years after a forested, mineral soil wetland in Northern Michigan was whole-tree harvested, site prepared, and fertilized (N, P, N + P). Organic matter decomposition was greatest in the site preparation bedding treatment and lowest in whole-tree harvested with no mechanical site preparation treatment. Both N and P additions, alone and in combination resulted in increased cellulose decomposition regardless of site preparation treatment (15-38% for the harvest-only treatment, 20-40% for the bedded treatment, and 15-44% for the trenched treatment). However, based on dissolved organic carbon concentrations in the soil solution, organic matter decomposition was inhibited on an overall plot basis; that is, outside the area of cellulose strip placement. The site preparation bedding treatment resulted in a net mineralization of N (9.2 g-N m super(-2)) over a 10 week incubation period. The disc trench and harvest-only treatments resulted in a net immobilization of N (3.1 g-N m super(-2) and 1.5 g-N m super(-2), respectively). Nitrogen, P, and N + P inhibited N mineralization in the bedded treatment by 10-25% over the control. There was a fertilizer-induced increase in N immobilization of 50-60% and 25-50% in the harvest-only and trenched treatments, respectively. It appears that soil microorganisms at this site are limited by soluble C more than N or P. By adding cellulose strips to the soil, the soluble C limitation was, in part, overcome. Once the soluble C limitation was alleviated, then the soil microorganisms responded positively to N and P additions.
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537. **The vegetation of wet meadows in relation to their land-use.**
Galatowitsch, Susan M.; Whited, Diane C.; Lehtinen, Richard.; Husveth, Jason; and Schik, Karen
Environmental Monitoring and Assessment 60(2): 121-144. (2000)
NAL Call #: TD194; *ISSN:* 0167-6369
Descriptors: conservation/ ecology: environmental sciences/ plant guild relative abundance/ assessment method: species composition/ assessment method: wetland biomonitoring/ biota shifts: land use response/ floristic composition/ landscape disturbance: agriculture, urbanization/ prairie glacial marsh: ecosystem/ site impacts: cultivation, stormwater/ vegetation: graminoid, herbaceous perennials/ wet meadow: ecosystem, land use changes, stressor response, vegetation
Abstract: Wetland biomonitoring approaches are needed to determine when changes in response to stressors are occurring and to predict the consequences of proposed land-use changes. These approaches require an understanding of shifts in biota that occur in response to land-use, data that are lacking for most kinds of wetlands. Changes in floristic composition corresponding to land-use differences at multiple scales (site to 2500 m radius) were characterized for 40 wet meadows associated with prairie glacial marshes in Minnesota (U.S.A.). In general, guild was more useful than species composition for indicating land-use impacts. Site impacts (stormwater, cultivation) and landscape disturbance (agriculture and urbanization, combined), coincide with a reduction in native graminoid and herbaceous perennial abundance (e.g., Carex lasiocarpa, Calamagrostis canadensis, Spartina pectinata). This vegetation is replaced with annuals (e.g, Bidens cernua, Polygonum pensylvanicum) in recently cultivated sites or introduced perennials (e.g., Phalaris arundinacea, Typha angustifolia) and floating aquatics (lemnids) in stormwater impacted wetlands. Ditches also reduce native perennial importance and increase perennials, but only when they are in highly impacted landscapes.
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Wetlands as Agricultural Conservation Practices

538. **Agricultural ponds support amphibian populations.**
Knutson, Melinda G.; Richardson, William B.; Reineke, David M.; Gray, Brian R.; Parmelee, Jeffrey R.; and Weick, Shawn E.
Ecological Applications 14(3): 669-684. (2004)
NAL Call #: QH540.E23; *ISSN:* 1051-0761
Descriptors: wetlands/ Ambystoma tigrinum/ Caudata/ agricultural ponds/ agriculture/ communities/ conservation/ ecosystems/ freshwater ecology/ habitat management/ habitat use/ Houston & Winona Counties/ land zones/ management/ Minnesota/ nearctic region/ nitrogen/ North America/ phosphorus/ ponds/ productivity/ reproduction/ reproductive success/ species diversity/ USA/ wildlife/ tiger salamander
Abstract: In some agricultural regions, natural wetlands are scarce, and constructed agricultural ponds may represent important alternative breeding habitats for amphibians. Properly managed, these agricultural ponds may effectively increase the total amount of breeding habitat and help to sustain populations. We studied small, constructed agricultural ponds in southeastern Minnesota to assess their value as amphibian breeding sites. Our study examined habitat factors associated with amphibian reproduction at two spatial scales: the pond and the landscape surrounding the pond. We found that small agricultural ponds in southeastern Minnesota provided breeding habitat for at least 10 species of amphibians. Species richness and multispecies reproductive success were more closely associated with characteristics of the

pond (water quality, vegetation, and predators) compared with characteristics of the surrounding landscape, but individual species were associated with both pond and landscape variables. Ponds surrounded by row crops had similar species richness and reproductive success compared with natural wetlands and ponds surrounded by non-grazed pasture. Ponds used for watering livestock had elevated concentrations of phosphorus, higher turbidity, and a trend toward reduced amphibian reproductive success. Species richness was highest in small ponds, ponds with lower total nitrogen concentrations, tiger salamanders (Ambystoma tigrinum) present, and lacking fish. Multispecies reproductive success was best in ponds with lower total nitrogen concentrations, less emergent vegetation, and lacking fish. Habitat factors associated with higher reproductive success varied among individual species. We conclude that small, constructed farm ponds, properly managed, may help sustain amphibian populations in landscapes where natural wetland habitat is rare. We recommend management actions such as limiting livestock access to the pond to improve water quality, reducing nitrogen input, and avoiding the introduction of fish.

539. **Alternative uses of wetlands other than conventional farming in Iowa, Kansas, Missouri, and Nebraska.**
Leventhal, E., EPA/171/R-92/006; Washington, DC: Environmental Protection Agency, 1990.
Descriptors: wetlands/ land use/ agriculture/ economic analysis/ sociological aspects/ environmental impact/ ecosystem disturbance/ USA/ conservation, wildlife management and recreation
Abstract: Conversion of wetlands in Iowa, Kansas, Missouri, and Nebraska into agricultural dry lands in the past several decades has occurred as a means to obtain profit from what landowners would otherwise consider unprofitable land. The activity has resulted in substantial losses of wetlands valued for their unique ability to mitigate flood and storm damage, control erosion, discharge and recharge groundwater, improve water quality, and support a wide diversity of fish, wildlife, and vegetation. Utilizing fish, wildlife, and vegetation from wetlands for profit is a way for wetland owners to recognize the value their wetlands add to their property. Landowners then have an incentive to preserve rather than convert their wetlands. [Sponsored by Environmental Protection Agency, Kansas City, KS. Region VII.] (DBO)

540. **Atrazine mineralization potential in two wetlands.**
Anderson, K. L.; Wheeler, K. A.; Robinson, J. B.; and Tuovinen, O. H.
Water Research 36(19): 4785-4794. (Nov. 2002)
NAL Call #: TD420.W3; *ISSN:* 0043-1354
Descriptors: wetlands/ water pollution/ fate of pollutants/ atrazine/ sediments/ comparison studies/ mineralization/ microbial degradation/ bacterial physiology/ microbiological studies/ pollution (water)/ sediment/ comparative studies/ mineralization/ biodegradation/ bogs/ agricultural runoff/ microbial activity/ USA, Ohio, Olentangy R./ USA, Ohio, Cedar Bog/ genetics/ sources and fate of pollution/ water treatment/ freshwater pollution/ water pollution: monitoring, control & remediation
Abstract: The fate of atrazine in agricultural soils has been studied extensively but attenuation in wetland systems has received relatively little attention. The purpose of this study was to evaluate the mineralization of atrazine in two wetlands in central Ohio. One was a constructed wetland, which is fed by Olentangy River water from an agricultural catchment area. The other was a natural fen (Cedar Bog) in proximity to atrazine-treated cornfields. Atrazine mineralization potential was measured by super(14)CO sub(2) evolution from [U-ring- super(14)C]-atrazine in biometers. The constructed wetland showed 70-80% mineralization of atrazine within 1 month. Samples of wetland water that were pre-concentrated 200-fold by centrifugation also mineralized 60-80% of the added atrazine. A high extent of atrazine mineralization (75-81% mineralized) was also associated with concentrated water samples from the Olentangy River that were collected upstream and downstream of the wetland. The highest levels of mineralization were localized to the top 5 cm zone of the wetland sediment, and the activity close to the outflow at the Olentangy wetland was approximately equal to that near the inflow. PCR amplification of DNA extracted from the wetland sediment samples showed no positive signals for the atzA gene (atrazine chlorohydrolase), while Southern blots of the amplified DNA showed positive bands in five of the six Olentangy wetland sediment samples. Amplification with the trzD (cyanuric acid amidohydrolase) primers showed a positive PCR signal for all Olentangy wetland sediment samples. There was little mineralization of atrazine in any of the Cedar Bog samples. DNA extracted from Cedar Bog samples did not yield PCR products, and the corresponding Southern hybridization signals were absent. The data show that sediment microbial communities in the Olentangy wetland mineralize atrazine. The level of activity may be related to the seasonality of atrazine runoff entering the wetland. Comparable activity was not observed in the Cedar Bog, perhaps because it does not directly receive agricultural runoff. Qualitatively, the detection of the genes was associated with measurable mineralization activity which was consistent with the differences between the two study sites.

541. **A constructed wetland treatment system designed for accommodation of both high nutrient nursery pad effluent and agriculture stormwater runoff.**
Lippmann, B. E.; Bouchard, V.; Quigley, M.; Martin, J.; Granata, T.; and Brown, L.
Ohio Journal of Science 102(1)(Mar. 2002)
NAL Call #: 410 Oh3; *ISSN:* 0030-0950.
Notes: Conference: 111th Annual Meeting of the Ohio Academy of Science, Columbus, OH [USA], 5-7 Apr 2002
Descriptors: suspended sediments/ artificial wetlands/ wastewater treatment/ nutrients/ urban runoff/ agricultural runoff/ pollutants/ storm runoff/ drainage/ nonpoint pollution sources/ settling basins/ wastewater treatment processes/ water & wastewater treatment
Abstract: Constructed wetlands have been developed for two main reasons: to substitute function for a natural wetland that was lost or removed, or to enable watershed managers to reduce or remove toxic or harmful substances from drainages. Many agricultural constructed wetlands are designed to ameliorate impacts of stressful environmental inputs, such as high nitrogen concentrations, chemical

pollution and sediment. Urban "detention ponds" are usually designed to slow runoff and to filter petrochemical pollutants, but not sediments. This study focuses on the potential for treating multiple land-use inputs within a single wetland system. A double basin constructed wetland treatment system (CWTS) has been constructed on the OSU Waterman Farm to test the treatment of a consistently high nutrient influent--a nursery container production pad-- while providing sufficient retention of periodic storm water runoff from agricultural drainages. Nutrient and suspended sediment concentrations will be quantified at several points in the CWTS. Random soil samples will be tested periodically for bulk density, percent carbon and methane, carbon dioxide and denitrification potentials. Plant community structure (LAI, biomass, species composition) and sediment dynamics will indicate water treatment performance. Initial results include bulk density range between 1.18-1.98 g/cm super(3) and LAI range between 0.04-0.44. It is hypothesized that from the inlet to the outlet of each wetland cell, plant density will decrease, species diversity will increase and sediment deposition and pollutant level will decrease. This CWTS was created to explore minimization of costs and land requirements for agricultural wetlands, and to demonstrate a method for zero-discharge farming practice.

542. **Constructed wetlands for river water quality improvement.**
Kadlec, R. H. and Hey, D. L.
Water Science and Technology 29(4)(1994)
NAL Call #: TD420.A1P7; *ISSN:* 0273-1223.
Notes: Conference: IAWQ 3. Int. Specialist Conf. on Wetland Systems in Water Pollution Control, Sydney (Australia), 23-25 Nov 1992; Issue editors: Bavor, H. J. and Mitchell, D. S.
Descriptors: wetlands/ wastewater treatment/ urban watersheds/ agricultural runoff/ nonpoint pollution sources/ aquatic plants/ sediments/ phosphorus removal/ hydrology/ rivers/ drainage water/ water quality control/ biofilters/ pollutants/ biofiltration/ USA, Illinois, Wadsworth/ urban watersheds/ nonpoint pollution sources/ phosphorus removal/ biofiltration/ drainage water/ biofilters/ pollutants/ wastewater treatment processes/ methods and instruments/ freshwater pollution
Abstract: The Des Plaines River Wetlands Demonstration Project has reconstructed four wetlands in Wadsworth, Illinois, USA. The river drains an agricultural and urban watershed, and carries a non-point source contaminant load of sediment, nutrients and agricultural chemicals. Up to 40% of the average stream flow is pumped to the wetlands, and allowed to return from the wetlands to the river through control structures followed by vegetated channels. Native wetland plant species have been established, ranging from cattail, bulrushes, water lilies, and arrowhead to duckweed and algae. Pumping began in the summer of 1989, and has continued during the ensuing spring, summer and fall periods. The experimental design provides for different hydraulic loading rates, ranging from 5 to 60 cm/week. Intensive wetland research began in late summer 1989, and continues to present. Detailed hydrology is measured for each wetland. Sediment removal efficiencies ranged from 86-100% for the four cells during summer, and from 38-95% during winter. Phosphorus removal efficiencies ranged from 60-100% in summer and 27-100% in winter. The river contains both old, persistent and modern, degradable agricultural chemicals. The principal modern pollutant is atrazine, of which the wetlands remove approximately half. The project is successfully illustrating the potential of constructed wetlands for controlling non-point source pollution at an intermediate position in the watershed.

543. **Creation and restoration of riparian wetlands in the agricultural Midwest.**
Klarquist, J. E.; Levine, D. A.; Finn, V. M.; and Willard, D. E.
In: Wetland Creation and Restoration: The Status of the Science.
Covelo, Calif.: Island Press, 1990; pp. 327-350.
Notes: ISBN: 1559630450
NAL Call #: QH541.5.M3W462
Descriptors: artificial wetlands/ habitat restoration/ riparian land/ water resources management/ wetland restoration/ hydrologic budget/ planting management/ riparian vegetation/ riparian waters/ vegetation regrowth/ water resources development
Abstract: Effective restoration of riparian wetlands in the agricultural midwest region of the United States demands an early determination of project goals. There are no systematic records of the changes and developments that have occurred in and around several hundred large midwestern reservoirs with extensive wetland systems. Established goals will narrow the choices of potential project sites, which can then be evaluated based on hydrology, substrate, seedbank viability, and water quality. Creation and restoration plans should include a realistic timetable that accounts for construction and hydrology constraints, including specifications for revegetation species. Finally, plans should estimate long-term vegetation management requirements and establish monitoring schedules to assess project success.

544. **Denitrification in sediments of a Lake Erie coastal wetland (Old Woman Creek, Huron, Ohio, USA).**
Tomaszek, J. A.; Gardner, W. S.; and Johengen, T. H.
Journal of Great Lakes Research 23(4): 403-415. (1997)
NAL Call #: GB1627.G8J6; *ISSN:* 0380-1330
Descriptors: wetlands/ denitrification/ sediments/ cores/ analytical methods/ chemical reactions/ nutrients/ estuaries/ USA, Ohio, Old Woman Creek/ sediment chemistry/ nitrogen/ nutrient cycles/ agricultural pollution/ agricultural runoff/ USA, Ohio, Old Woman Creek/ USA, Ohio, Erie L./ chemical processes/ characteristics, behavior and fate/ freshwater pollution
Abstract: Denitrification in Old Woman Creek estuary (Lake Erie) sediments was measured by an in vitro N sub(2)-flux method with intact cores and by an in situ chamber method. In both methods, nitrogen gas, the end product of denitrification, was measured directly by gas chromatography. The in situ approach allowed measurement of denitrification directly over short time intervals but its use was limited to shallow depths. Denitrification rates measured with in situ chambers agreed well with those from in vitro intact cores when temperatures in the estuary remained constant. However, the two methods could not be accurately compared during the spring when temperature increased rapidly, because of the

4-day pre-incubation time needed for sparging for the in vitro method. In vitro denitrification rates ranged from ca 40 to 135 mu mole N sub(2) m super(-2) h super(-1) in October 1993 and from 66 to 428 mu mole N sub(2) m super(-2) h super(-1) in May and July 1994. Oxygen consumption rates in these experiments ranged from 0.71 to 3.0 mmole O sub(2) m super(-2) h super(-1). Denitrification rates tended to decrease along the flow axis but differences among stations were usually not significant. In situ N sub(2) accumulation rates ranged from 45 mu mole N sub(2) m super(-2) h super(-1) in dark chambers during October 1993 up to apparent values of 2,100 mu mole N sub(2) m super(-2) h super(-1) in May 1994, immediately after the water temperature had rapidly increased to 27 degree C. These calculated values included gas-solubility corrections due to the water-temperature increases. In situ measurements of denitrification rates in transparent chambers were 76-79% higher than rates measured in a similar dark chamber. The results suggest that denitrification is an important sink for nitrogen in Old Woman Creek estuary and that environmental conditions such as temperature, light, and available substrate affect denitrification rates.

545. **Development of community metrics to evaluate recovery of Minnesota wetlands.**
Galatowitsch, S. M.; Whited, D. C.; and Tester, J. R.
Journal of Aquatic Ecosystem Stress and Recovery 6(3): 217-234. (1998)
NAL Call #: QH541.5.W3 J68; *ISSN:* 1386-1980.
Notes: Special Issue: Recovery in Aquatic Ecosystems.
Descriptors: wetlands/ environmental monitoring/ indicator species/ methodology/ land use/ restoration/ ecosystems/ long-term changes/ community composition/ land management/ bioindicators/ surface water/ birds/ populations/ USA, Minnesota/ land restoration/ pollution monitoring and detection/ protective measures and control/ watershed protection/ environmental action
Abstract: Monitoring wetland recovery requires assessment tools that efficiently and reliably discern ecosystem changes in response to changes in land use. The biological indicator approach pioneered for rivers and streams that uses changes in species assemblages to interpret degradation levels may be a promising monitoring approach for wetlands. We explored how well metrics based on species assemblages related to land use patterns for eight kinds of wetlands in Minnesota. We evaluated land use on site and within 500 m, 1000 m, 2500 m and 5000 m of riverine, littoral, and depressional wetlands (n = 116) in three ecoregions. Proportion of agriculture, urban, grassland, forest, and water were correlated with metrics developed from plant, bird, fish, invertebrate, and amphibian community data collected from field surveys. We found 79 metrics that relate to land use, including five that may be useful for many wetlands: proportion of wetland birds, wetland bird richness, proportion of insectivorous birds, importance of Carex, importance of invasive perennials. Since very few metrics were significant for even one-half of the wetland types surveyed, our data suggest that monitoring recovery in wetlands with community indicators will likely require different metrics, depending on type and ecoregion. In addition, wetlands within extensively degraded ecoregions may be most problematic for indicator development because biotic degradation is historic and severe.

546. **Does facilitation of faunal recruitment benefit ecosystem restoration? An experimental study of invertebrate assemblages in wetland mesocosms.**
Brady, V. J.; Cardinale, B. J.; Gathman, J. P.; and Burton, T. M.
Restoration Ecology 10(4): 617-626. (Dec. 2002)
NAL Call #: QH541.15.R45R515; *ISSN:* 1061-2971
Descriptors: wetlands/ community structure/ aquatic ecosystems/ conservation/ zoobenthos/ macrofauna/ environment management/ nature conservation/ restoration/ transplantation/ stocking (organisms)/ biotic factors/ recruitment/ community composition/ colonization/ aquatic insects/ freshwater molluscs/ mesocosms/ comparative studies/ Chironomidae/ Gastropoda/ Invertebrata/ midges/ poor colonizers/ vegetation/ sediment plugs/ gastropods/ slugs/ snails/ aquatic entomology/ insects/ conservation, wildlife management and recreation
Abstract: We used wetland mesocosms (1) to experimentally assess whether inoculating a restored wetland site with vegetation/sediment plugs from a natural wetland would alter the development of invertebrate communities relative to unaided controls and (2) to determine if stocking of a poor invertebrate colonizer could further modify community development beyond that due to simple inoculation. After filling mesocosms with soil from a drained and cultivated former wetland and restoring comparable hydrology, mesocosms were randomly assigned to one of three treatments: control (a reference for unaided community development), inoculated (received three vegetation/sediment cores from a natural wetland), and stocked + inoculated (received three cores and were stocked with a poorly dispersing invertebrate group-gastropods). All mesocosms were placed 100 m from a natural wetland and allowed to colonize for 82 days. Facilitation of invertebrate colonization led to communities in inoculated and stocked + inoculated treatments that contrasted strongly with those in the unaided control treatment. Control mesocosms had the highest taxa richness but the lowest diversity due to high densities and dominance of Tanytarsini (Diptera: Chironomidae). Community structure in inoculated and stocked + inoculated mesocosms was more similar to that of a nearby natural wetland, with abundance more evenly distributed among taxa, leading to diversity that was higher than in the control treatment. Inoculated and stocked + inoculated communities were dominated by non-aerial invertebrates, whereas control mesocosms were dominated by aerial invertebrates. These results suggest that facilitation of invertebrate recruitment does indeed alter invertebrate community development and that facilitation may lead to a more natural community structure in less time under conditions simulating wetland restoration.

547. **Duffy's Marsh Wetland Restoration Project in Marquette County, Wisconsin.**
Nimmer, G. L.
In: ASAE Annual International Meeting. (Held 12 Jul 1998-16 Jul 1998 at Orlando, Florida, USA.)
St Joseph, Mich.: American Society of Agricultural Engineers; pp. 21; 1998.
Notes: ASAE Paper no. 982019
Descriptors: wetlands/ water management/ drainage systems
Abstract: In 1997, the 1722-acre Duffy's Marsh Wetland Restoration Project was completed through the cooperative efforts of nine landowners participating in the USDA Wetland Reserve Program (WRP). In comparison to the average WRP project size of 50-100 acres, this is the largest WRP restoration project in Wisconsin (USA). Prior to restoration, a surface drainage system comprised of ditches around nearly every 40 acre parcel drained the large muck farming area. The Natural Resources Conservation Service assisted in implementing a plan to install 3500 ft of embankments, 13 ditch plugs, and a rock spillway outlet to restore the wetlands. This study describes the characteristics of planning, design, and construction of a large wetland restoration and shares effective restoration techniques and experiences gained in this project.

548. **Early development of vascular vegetation of constructed wetlands in northwest Ohio receiving agricultural waters.**
Luckeydoo, L. M.; Fausey, N. R.; Brown, L. C.; and Davis, C. B.
Agriculture, Ecosystems & Environment 88(1): 89-94. (2002)
NAL Call #: S601.A34; *ISSN:* 0167-8809
Descriptors: wetlands/ vegetation/ irrigation water/ pollution control/ subsurface irrigation/ water management/ reservoirs/ seed germination/ land restoration/ natural regeneration/ Ohio
Abstract: Constructed wetlands are currently being explored for use in reducing non-point source (NPS) pollution. The Wetland Reservoir Subirrigation System (WRSIS) project links water management in agricultural fields, constructed wetlands and water storage reservoirs to enhance crop production and reduce delivery of agrichemicals and sediments to local waterways. Three WRSIS demonstration sites have been developed on prior converted cropland in the Maumee River watershed located in northwest Ohio. Construction of the wetlands was completed in 1996 and they were then allowed to passively revegetate while receiving drainage water from adjacent fields. The primary goal of this study was to characterize the initial development of vegetation, and the availability of propagules within these wetlands. Preliminary vegetation inventories conducted in 1998 identified moderate species richness but low percentage of wetland species. A germination study completed on soils from one location showed additional viable wetland species available in the seed bank. Passive revegetation of these three constructed wetlands associated with WRSIS systems has resulted in good vegetation cover, but it is lacking the desired percentage of wetland species to date. Passive revegetation may prove to be an effective and economical method of revegetating constructed wetlands within agricultural landscapes that have suitable propagule availability.
This citation is from AGRICOLA.

549. **Effect of plant species on denitrification and methane emission in constructed wetlands.**
Smialek, J.; Bouchard, V.; Quigley, M.; Granata, T.; Martin, J.; and Brown, L.
Ohio Journal of Science 103(1): A39. (Mar. 2003)
NAL Call #: 410 Oh3; *ISSN:* 0030-0950.
Notes: Conference: 112th Annual Meeting of The Ohio Acaemy of Science, Findlay, OH (USA), 4-6 Apr 2003
Descriptors: wetlands/ denitrification/ methane/ sediment contamination/ vegetation/ nutrients/ nonpoint pollution sources/ water pollution control/ agricultural runoff/ organic matter/ water quality control/ USA, Ohio/ chemical processes/ water pollution: monitoring, control & remediation
Abstract: Wetlands' ability to retain excess nutrients in waterways at low costs makes them an attractive method of controlling agricultural non-point source pollution. However, it is estimated that wetlands contribute more than 40% of the annual atmospheric methane (CH sub(4)) loading. Vegetation is an important factor in controlling methane emissions by contributing organic matter to the sediments, creating oxidized sediments, and acting as conduits for gas escape into the atmosphere. The objective of this project was to examine how vegetation can be utilized to construct a treatment wetland that has a maximum rate of denitrification and a minimum rate of methane emission. This research was conducted May-November 2002 on a constructed treatment wetland at Waterman Farm on the Columbus campus of Ohio State University. Measurements of CH sub(4) and CO sub(2) production and emission, denitrification, plant biomass, and nutrient concentration were estimated in 15 unplanted plots, 15 planted with woody (Salix) species, and 15 herbaceous (Juncus) plots. Water quality improvement by denitrification was evident along the wetland. At 15 cm below the sediment, CO sub(2) concentration averaged 7300-9200 ppm, higher than CH sub(4) (1200-4800ppm). CH sub(4) concentrations were significantly different between Juncus (1200ppm) and Salix (4800ppm) species. During evening hours, Juncus emission of CO sub(2) and CH sub(4) was 3-4 times higher than Salix; however, during morning hours Juncus species decrease their emission and Salix species emit 3-4 times more gas. The selection of specific plants could be used as a design tool in constructed wetlands to limit greenhouse gas emissions.

550. **The effect of water table depth on white spruce (Picea glauca) seedling growth in association with the marsh reed grass (Calamagrostis canadensis) on wet mineral soil.**
Rivard, P. G.; Woodward, P. M.; and Rothwell, R. L.
Canadian Journal of Forest Research 20(10): 1553-1558. (Oct. 1990)
NAL Call #: SD13.C35; *ISSN:* 0045-5067
Descriptors: wetlands/ bluejoint grass/ grasses/ forestry/ marsh plants/ spruce trees/ water table/ competition/ marshes/ nutrients/ plant growth/ seedlings/ water depth/ water and plants/ groundwater

Abstract: Whether or not the survival, growth, and nutrient content of white spruce seedlings were significantly affected by competition with marsh reed grass, under simulated water table conditions on wet mineral soil substrates was investigated. The effect of water table depth (10, 20, and 40 cm) in association with marsh reed grass (Calamagrostis canadensis (Michx.)Beauv.) on white spruce (Picea glauca (Moench)Voss) 2 + 0 seedling survival and growth was tested over a 5-month period. All spruce seedlings grown alone survived, whereas, 16.7% of the trees died when grown with reed grass. The root weight and total weight of spruce seedlings and marsh reed grass were significantly affected by the water table depth. The weight of both components increased as the water table decreased. Over 80% of the roots by weight for both species were found in the upper 10 cm of the soil profile regardless of water table depth. The presence of marsh reed grass significantly affected the growth of spruce seedlings. The nutrient concentration of the white spruce foliage was significantly affected by water table depths and the presence of grass. This accumulation of marsh reed grass near the surface demonstrates the semi-aquatic nature of this species and suggests why it is a successful competitor of white spruce on wetter sites. (Author's abstract)

551. **Effectiveness of a coastal wetland in reducing the movement of agricultural pollutants into Lake Erie.**
Krieger, K. A. and Ohio Sea Grant(2001).
Notes: Other numbers: OHSU-T-01-003
http://nsgl.gso.uri.edu/ohsu/ohsut01003.pdf
Descriptors: wetlands/ lakes/ freshwater pollution/ pollution dispersion/ barriers/ pollution control/ removal/ nutrients (mineral)/ pesticides/ chemical pollutants/ environmental factors/ hydrology/ atmospheric precipitations/ evaporation/ USA, Erie L./ USA, Ohio, Old Woman Creek Wetland/ Canada, Ontario, Erie L./ North America, Great Lakes/ pollution mitigation/ prevention and control
Abstract: The primary goal of this study was to characterize the nature and efficiency of pollution mitigation over a range of hydrologic conditions and for a broad range of substances within a representative riverine-palustrine coastal wetland. Old Woman Creek Wetland near Huron, Ohio, was selected for study because it is believed to represent many other Lake Erie tributaries prior to modification by dredging, development into marinas, filling, and other destructive activities. The authorities develop annual and seasonal surface water budgets based on fluxes of total suspended solids, nutrients, and pesticides into and out of the wetland, and precipitation, pan evaporation, and upstream and downstream flows.

552. **Effectiveness of constructed wetlands in reducing nitrogen and phosphorus export from agricultural tile drainage.**
Kovacic, D. A.; David, M. B.; Gentry, L. E.; Starks, K. M.; and Cooke, R. A.
Journal of Environmental Quality 29(4): 1262-1274. (2000)
NAL Call #: QH540.J6; *ISSN:* 0047-2425
Descriptors: wetlands/ water quality/ nonpoint pollution sources/ agricultural runoff/ nitrogen/ phosphorus/ tile drainage/ surface water/ drinking water/ water quality (natural waters)/ pollution (nonpoint sources)/ runoff (agricultural)/ drainage/ surface water/ water supplies (potable)
Abstract: Much of the nonpoint N and P entering surface waters of the Midwest is from agriculture. We determined if constructed wetlands could be used to reduce nonpoint N and P exports from agricultural tile drainage systems to surface waters. Three treatment wetlands (0.3 to 0.8 ha in surface area, 1200 to 5400 m super(3) in volume) that intercepted subsurface tile drainage water were constructed in 1994 on Colo soils (fine-silty, mixed, superactive, mesic Cumulic Endoaquoll) between upland maize (Zen mays L.) and soybean [Glycine max (L.) Merr.] cropland and the adjacent Embarras River. Water (tile flow, precipitation, evapotranspiration, outlet flow, and seepage) and nutrient (N and P) budgets were determined from 1 Oct. 1994 through 30 Sept. 1997 for each wetland. Wetlands received 4639 kg total N during the 3-yr period (96% as NO sub(3)-N) and removed 1697 kg N, or 37% of inputs. Wetlands decreased NO sub(3)-N concentrations in inlet water (annual outlet volume weighted average concentrations of 4.6 to 14.5 mg N L super(-1)) by 28% compared with the outlets. When the wetlands were coupled with the 15.3-m buffer strip between the wetlands and the river, an additional 9% of the tile NO sub(3)-N was apparently removed, increasing the N removal efficiency to 46%. Overall, total P removal was only 2% during the 3-yr period, with highly variable results in each wetland and year. Treatment wetlands can be an effective tool in reducing agricultural N loading to surface water and for attaining drinking water standards in the Midwest.

553. **Evaluating perturbations and developing restoration strategies for inland wetlands in the Great Lakes Basin.**
Detenbeck, N. E.; Galatowitsch, S. M.; Atkinson, J.; and Ball, H.
Wetlands 19(4): 789-820. (1999)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212.
Notes: Conference: Temperate Wetlands Restoration Workshop, Barrie, ON (Canada), 27 Nov-1 Dec 1995
Descriptors: wetlands/ land reclamation/ land management/ hydrology/ water quality/ vegetation/ exotic species/ sedimentation/ disturbance/ environmental restoration/ nature conservation/ ecosystem disturbance/ eutrophication/ land use/ land restoration/ land/ water quality (natural waters)/ land restoration/ North America, Great Lakes
Abstract: Wetland coverage and type distributions vary systematically by ecoregion across the Great Lakes Basin. Land use and subsequent changes in wetland type distributions also vary among ecoregions. Incidence of wetland disturbance varies significantly within ecoregions but tends to increase from north to south with intensity of land use. Although the nature of disturbance activities varies by predominant land-use type, mechanisms of impact and potential response endpoints appear to be similar across agricultural and urban areas. Based on the proportion of associated disturbance activities and proportion response endpoints affected, the highest ranking mechanisms of impact are sedimentation/turbidity, retention time, eutrophication, and changes in hydrologic timing. Disturbance activities here are defined as events that cause wetland structure or function to vary outside of a normal range, while stressors represent the individual internal or

external agents (causes) that act singly or in combination to impair one or more wetland functions. Responses most likely associated with disturbance activities based on shared mechanisms of impact are 1) shifts in plant species composition, 2) reduction in wildlife production, 3) decreased local or regional biodiversity, 4) reduction in fish and/or other secondary production, 5) increased flood peaks/frequency, 6) increased aboveground production, 7) decreased water quality downstream, and 8) loss of aquatic plant species with high light compensation points. General strategies and goals for wetland restoration can be derived at the ecoregion scale using information on current and historic wetland extent and type distributions and the distribution of special-concern species dependent on specific wetland types or mosaics of habitat types. Restoration of flood-control and water-quality improvement functions will require estimates of wetland coverage relative to total land area or specific land uses (e.g., deforestation, urbanization) at the watershed scale. The high incidence of disturbance activities in the more developed southern ecoregions of both Canada and the U.S. is reflected in the loss of species across all wetland types. The species data here suggest that an effective regional strategy must include restoration of a diversity of wetland types, including the rarer wetland types (wet meadows, fens), as well as forested swamps, which were extensive historically. The prevalence of anthropogenic stresses and openwater habitats likely contributes to the concentration of exotic species in inland wetlands of the southern Great Lakes ecoregions. Vegetation removal and site disturbance are the best- documented causes for plant invasions, and encroachment activities are common in marshes and ponds of the southern ecoregions.
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554. **GIS-based estimates of former and current depressional wetlands in an agricultural landscape.**
McCauley, L. A. and Jenkins, D. G.
Ecological Applications 15(4): 1199-1208. (Aug. 2005)
NAL Call #: QH540.E23; *ISSN:* 1051-0761
Descriptors: wetlands/ models/ landscape/ geographic information systems/ metapopulations/ man-induced effects/ land use/ ecological distribution/ hydrology/ biological settlement/ quantitative distribution/ agriculture/ USA, Illinois/ USA, Illinois, Champaign Cty./ habitat community studies/ mechanical and natural changes
Abstract: Before European settlement, 23% of Illinois (3.2 million of 14 million ha) was covered by wetlands. It is estimated that 90% of those wetlands were lost during conversion of the landscape to agriculture and urban use. Champaign County was one of the most extensively drained counties in Illinois, with 39-60% of original county area estimated to have been drained. Current and future efforts to conserve and restore wetlands would benefit from information on the number and distribution of former wetlands. We used GIS to estimate the spatial extent, density, pattern, and sizes of former and extant depressional wetlands in Champaign County. We derived several models of former wetlands; all models used hydric soils but varied by using Digital Raster Graphics (DRG), 30-m Digital Elevation Models (DEM), or Digital Orthophotography Quarter Quadrangles (DOQ). We also combined the DRG and DEM models, and we conducted visual field surveys for saturated or ponded conditions to test the models. The DRG model was conservative: it identified fewer and larger wetlands than the DEM model (the DOQ model was judged inadequate). Depending on the model selected, we estimated that 1077-4090 depressional wetlands formerly existed in the county, and that 78.6-91.6% were drained, accounting for 1108-2777 ha of lost wetland habitat in Champaign County alone. Thus, depressional wetlands accounted for the vast majority of historical wetland loss and should be a priority for wetland restoration efforts. Spatial pattern among wetlands also changed: an organism adapted to the former landscape had >50% probability of reaching another wetland within 260 m: today that same species faces a 7.8% probability at that distance. The modern landscape of Champaign County (and others like it) poses potential risk for remaining wetland metapopulations, and GIS models of precise former wetlands locations can be a valuable initial tool for wetland conservation and restoration efforts.
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555. **Groundwater impacts from an unlined constructed wetland system receiving waste from a swine operation.**
Reaves, R. P.; DuBowy, P. J.; Jones, D. D.; and Sutton, A. L.
In: Proceedings: 2nd International Conference on Groundwater Ecology. (Held 27 Mar 1994-30 Mar 1994 at Atlanta, GA.) Stanford, J. A. and Valett, H. M. (eds.) Herndon, VA: American Water Resources Association; pp. 349-358; 1994.
Descriptors: artificial wetlands/ groundwater pollution/ livestock/ experimental design/ monitoring/ lithium/ tracers/ groundwater movement/ wastewater lagoons/ agricultural runoff/ animal wastes/ environmental impact/ agricultural pollution/ pollution monitoring/ artificial wetlands/ USA, Indiana, West Lafayette/ environmental impact/ agricultural pollution/ pollution monitoring/ livestock/ experimental design/ groundwater movement/ wastewater lagoons/ animal wastes/ monitoring/ sources and fate of pollution/ characteristics, behavior and fate/ freshwater pollution
Abstract: A 16-cell experimental constructed wetland was installed at the Purdue University Animal Sciences Swine Research Complex in 1993 to examine treatment efficiency on swine lagoon wastewater. The system was placed in a mesic soil and all cells were unlined. The experimental design allows for extensive testing during operation to determine if groundwater contamination occurs. Prior to beginning system operation in the spring of 1994 a lithium tracer study was done to determine the level of initial leakage in the system. Results of this study show that groundwater contamination at system start-up was occurring in some cells. However, movement beneath cells was only along the flow gradient. There was no lateral movement across the groundwater flow. Groundwater monitoring will be continued for the two-year duration of the study to determine if there are changes in system performance.
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556. **Habitat contribution and waterbird use of Wetland Reserve Program sites in the Cache River watershed, Illinois.**
Hicks, Brianne M.
Carbondale, Illinois: Southern Illinois University, 2003.
Descriptors: wetlands/ birds/ wildlife habitat/ Illinois/ Wetland Reserve Program

557. **Historic and comparative perspectives on rehabilitation of marshes as habitat for fish in the Lower Great Lakes Basin.**
Whillans, T. H.
Canadian Journal of Fisheries and Aquatic Sciences 53(Supplement 1): 58-66. (1996)
NAL Call #: 442.9 C16J; *ISSN:* 0706-652X
Descriptors: marshes/ environmental restoration/ ecosystem analysis/ historical account/ sedimentation/ ecosystems/ fish/ aquatic habitats/ Canada, Ontario
Abstract: Retrospective and comparative assessments of fish habitat have been used to guide rehabilitation in Cootes Paradise, a marsh at Hamilton, Ont., on Lake Ontario. The marsh was severely altered by human and natural stresses, including high water levels, influx of fine eroded sediments, and channelization. Recovery has been limited by a different but overlapping set of stresses, including the continued influx of fine eroded sediments, resuspension of sediments, exotic fish, and increased fetch. Assessment has involved the use of "accumulator-," "residue-," and "replica"-type retrospective evidence and the comparison of Cootes Paradise with other reference marshes. The emergent narrative science (a synthesis of science in historical and environmental context that serves as a partially testable hypothesis), verified and adjusted by small scale experiments, has identified the need to re-introduce vegetation, reduce fetch, exclude common carp (Cyprinus carpio), anchor the marsh sediments, and reduce the influx of land use derived fine sediments. Narrative science uses the "ecological memory" of the marsh for historical information on ecological degradation and in the form of the remnant natural resilience upon which ecological rehabilitation could build. The narrative science provides the basis for adaptive management and the monitoring that it requires.
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558. **Hydrology of constructed wetlands.**
Zmolek, C.; Baker, J. L.; Crumpton, W. G.; and Kanwar, R. S.
In: ASAE Annual International Meeting. (Held 10 Aug 1997-14 Aug 1997 at Minneapolis, Minnesota.); pp. 17; 1997.
Notes: Paper American Society of Agricultural Engineers no. 972036; ISSN: 0149-9890
Descriptors: wetlands/ hydrology/ water flow/ water budget/ hydrodynamics/ tracer techniques/ models
Abstract: This paper covers research being conducted on a system of constructed wetland cells in Iowa, USA, receiving subsurface drainage water at three rates on inflow with each being replicated three times. The analysis of the hydrology consisted of accounting for all inflows and outflows, thereby determining and closing the systems water budget. An average seasonal water budget was developed, encompassing all nine cells' data. The budget for the entire system was closed with only 5.47% error. This error can be accounted to the inability to precisely measure flowmeter accuracy, berm seepage, pan A evaporation estimations, and pipe leakage. The budget shows seepage as the largest outflow component, being 16.1% of the total outflow. Evapotranspiration compromised only 1.69% of the recorded outflow. Direct precipitation was 1.01% of the total system's inflow. To examine flow patterns over time, a tracer study using rhodamine WT was conducted. Concentrations were determined using a fluorometer and then mapping the values into isopleths. The pattern for the high flow cell studied showed a definite preferential flow path along with areas of little or no contact. Knowing the significance of the hydrologic components as well as the hydrodynamic flows will provide for better information on the variables required to more accurately model the site's treatment capability and efficiency potentials.
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559. **Influence of hydrologic loading rate on phosphorus retention and ecosystem productivity in created wetlands.**
Mitsch, William J.; Cronk, Julie K.; and United States. Army. Corps of Engineers. U.S. Army Engineer Waterways Experiment Station. Wetlands Research Program (U.S.). Vicksburg, Miss.: U.S. Army Engineer Waterways Experiment Station; Series: Wetlands Research Program technical report WRP-RE-6; 84 p. (1995)
Notes: At head of title: Wetlands Research Program. "January 1995." Final report. Includes bibliographical references (p. 73-84).
NAL Call #: QH541.5.M3M57 1995
Descriptors: wetland conservation/ constructed wetlands/ freshwater productivity/ water---phosphorus content/ restoration ecology/ Glaciated Interior Plains
This citation is from AGRICOLA.

560. **Isotope evaluation of nitrate attenuation in restored and native riparian zones in the Kankakee watershed, Indiana.**
Sidle, W. C.; Roose, D. L.; and Yzerman, V. T.
Wetlands 20(2): 333-345. (June 2000)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ isotope studies/ nitrates/ riparian land/ watersheds/ oxygen/ hydrogen/ cycling nutrients/ water properties/ flow discharge/ levees/ dikes/ water budget/ land reclamation/ water reclamation/ agriculture/ nitrogen cycle/ nitrate/ catchment areas/ embankments/ USA, Indiana, Kankakee Watershed/ watershed protection/ ecosystems and energetics/ protective measures and control/ water resources and supplies
Abstract: Isotopic analyses of oxygen and hydrogen of water (delta super(18)O and delta D) and nitrogen and oxygen of nitrate (delta super(15)N and delta super(18)O) are used in conjunction with conventional water chemistry and hydrologic measurements to investigate water flow and nitrogen cycling mechanisms through two riparian zones adjacent to upland agricultural fields. Within the Kankakee watershed of northwestern Indiana, a native riverine wetland was compared to a constructed riverine wetland to assess the wetland restoration in terms of water flow and nitrate attenuation mechanisms and efficiency. Conditions in the constructed wetland are controlled by a system of individual cells separated by dikes and levees and into which water is periodically pumped, while the native wetland occupies an area of remnant river meanders or oxbows. Analyses of samples taken from well transects across both wetlands suggest that water flow across the constructed wetland has been greatly altered. Nitrate cycling characteristics show significant differences between the two wetlands and particularly, nitrate attenuation efficiency is greatly reduced in the constructed wetland.
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561. **Modeling of water routing in a Wetland-Reservoir SubIrrigation System using SIMULINK.**
Hothem, J. A. and Brown, L. C.
In: 1998 ASAE Annual International Meeting. (Held 12 Jul 1998-16 Jul 1998 at Orlando, Florida.)
St Joseph, MI: American Society of Agricultural Engineers; pp. 11; 1998.
Notes: ASAE Paper no. 982096
Descriptors: wetlands/ subsurface irrigation/ models/ subsurface drainage/ water quality/ reservoirs/ pollutants/ nitrates/ phosphates/ herbicides/ water balance/ water conservation/ simulation models/ herbicide residues
Abstract: Wetland-Reservoir-SubIrrigation Systems (WRSIS) have the potential both to improve downstream water quality by reducing discharge to streams and to provide a reliable supply of subirrigation water. To evaluate the performance of such systems, a model is being developed to simulate the routing of water between the system's components and to model the water balance within each of the components. This is being done using SIMULINK, a software package that uses block diagrams to define dynamic systems. In the model, an entire library of blocks representing each of the different components of the system (i.e., wetland, subirrigated field, pump station, etc.) is being developed. Each of these blocks actually represents a subsystem of blocks that model the dynamic behavior of that component. The system component blocks can be linked to model a wide range of system configurations for WRSIS sites. The model will be used to analyse a variety of different management strategies.

562. **Monitoring of Spunky Bottoms restored wetland in southern Illinois for biotic and abiotic pollution indicators.**
Kelley, Timothy R. and Huddleston, Eric
Transactions of the Illinois State Academy of Science 94(2): 69-78. (2001)
NAL Call #: 500 Il6; *ISSN:* 0019-2252
Descriptors: pollution assessment control and management/ culture method/ analytical method/ membrane filtration method/ analytical method/ agricultural runoff/ conductivity/ pH/ pollution indicators: abiotic, biotic/ restored wetlands/ temperature/ total coliform concentrations
Abstract: A study was conducted to determine and compare biotic (bacterial) and abiotic (physicochemical) pollution indicator levels generated from water samples collected from eleven sites within an aquatic wetland under restoration in Brown County in Southern Illinois. The approximately 700-acre "Spunky Bottoms" wetland, purchased by The Nature Conservancy, is currently being restored by The Wetlands Initiative to conditions prior to levying of the Illinois River and draining of adjacent floodplain for intensive agriculture (circa 1900). Water samples of approximately 200-ml were collected aseptically and analyzed for indicator bacteria (total coliform and Escherichia coli) concentrations using a membrane filtration technique and culturing methods. Predominant bacterial genera were also isolated from selected water samples and identified using standard culturing, microscopic, and biochemical techniques. Temperature, pH, dissolved oxygen and conductivity were also monitored concurrently in the field at water sampling sites. Levels of bacterial and physicochemical pollution indicators in water samples taken from the Illinois River and wetland sites adjacent to agricultural land use were substantially higher than levels found at other sampling sites, possibly due to agricultural runoff. Predominant bacterial genera recovered from all sampling sites were Pseudomonas and Bacillus, which may contribute to biogeochemical cycles. Results suggest that restored wetlands may contribute to pollution indicator reduction, and that wetland microbial populations may contribute to biogeochemical (N, P, C) element cycling. Further research is necessary to determine more specific contributions of aquatic wetlands to indicator bacteria concentration reduction and biogeochemical cycles.

563. **Monitoring system for water quality and quantity, and ecological parameters at the Dara wetland-reservoir subirrigation system site.**
Oztekin, T.; N' Jie, N. M.; Hothem, J.; Luckeydoo, L.; Brown, L. C.; Fausey, N. R.; Czartoski, B. J.; and Mills, G.
In: 1998 ASAE Annual International Meeting. (Held 12 Jul 1998-16 Jul 1998 at Orlando, Florida.)
St Joseph, MI: American Society of Agricultural Engineers; pp. 7; 1998.
Notes: ASAE Paper no. 982110
Descriptors: wetlands/ monitoring/ water quality/ subsurface irrigation/ reservoirs
Abstract: An integrated wetland reservoir subirrigation system (WRSIS) was constructed at three different locations in northwest Ohio, USA. The system was set up to recycle drainage and surface water from a subirrigated cropland through a constructed wetland to be stored in an upground reservoir for subirrigation of maize and soyabeans during the growing season. In the summer of 1998, the first of these three sites will be equipped with instruments to monitor the ecological, hydrologic, sediment and nutrient dynamics of the system. The data collected will be used in modelling studies to promote an understanding of the hydrological and ecological processes in the WRSIS. The monitoring programme of the WRSIS is presented and discussed in this paper.

564. **Optimizing the placement of riparian practices in a watershed using terrain analysis.**
Tomer, M. D.; James, D. E.; and Isenhart, T. M.
Journal of Soil and Water Conservation 58(4): 198-206. (2003)
NAL Call #: 56.8 J822; *ISSN:* 0022-4561
Descriptors: best management practices/ conservation planning/ conservation reserve enhancement program/ constructed wetlands/ riparian buffers/ watershed management
Abstract: Riparian buffers and constructed wetlands are best management practices (BMPs) that can improve water quality. However, these practices are not equally effective in all locations. Our objective was to develop maps to help plan the placement of BMPs in a watershed for water quality benefits. Tipton Creek, a 49,000-acre Iowa watershed, provided a case study. Buffer-placement maps, developed from analysis of 30 m (100 ft) elevation data, identified riparian locations with large wetness indices, where buffer vegetation could intercept sheet/rill flows from significant upslope areas. These sites were numerous, typically small (<200 m in length) and well distributed spatially. However results showed 57% of riparian grid cells

would receive runoff from less than 0.4 ha (1 ac). Candidate wetland sites were also mapped by applying interpretive and automated techniques to terrain analyses results. A team of conservation professionals evaluated the planning utility of these maps in the field through consensus-seeking discussion. Buffer maps highlighted areas where, team members agreed, perennial vegetation could effectively intercept runoff and/or manage seasonal wetness. The review team also located three feasible wetland sites, which were all identified by an automated technique showing 12 candidate sites. The methods only required public data and should be applicable to other watersheds.

565. **Passing of northern pike and common carp through experimental barriers designed for use in wetland restoration.**
French, J. R. P.; Wilcox, D. A.; and Nichols, S. J.
Wetlands 19(4): 883-888. (Dec. 1999)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212.
Notes: Conference: Temperate Wetlands Restoration Workshop, Barrie, ON (Canada), 27 Nov-1 Dec 1995
Descriptors: wetlands/ North America, Erie L./ fish passages/ coasts/ land reclamation/ fish management/ carp/ fish populations/ environmental restoration/ USA, Ohio/ fishways/ restoration/ ecosystem management/ population control/ body size/ freshwater fish/ Cyprinus carpio/ Esox lucius/ USA, Ohio, Erie L., Metzger Marsh/ common carp/ northern pike/ European carp/ fisheries engineering/ reclamation/ conservation, wildlife management and recreation
Abstract: Restoration plans for Metzger Marsh, a coastal wetland on the south shore of western Lake Erie, incorporated a fish-control system designed to restrict access to the wetland by large common carp (Cyprinus carpio). Ingress fish passageways in the structure contain slots into which experimental grates of varying size and shape can be placed to selectively allow entry and transfer of other large fish species while minimizing the number of common carp to be handled. We tested different sizes and shapes of grates in experimental tanks in the laboratory to determine the best design for testing in the field. We also tested northern pike (Esox lucius) because lack of access to wetland spawning habitat has greatly reduced their populations in western Lake Erie. Based on our results, vertical bar grates were chosen for installation because common carp were able to pass through circular grates smaller than body height by compressing their soft abdomens; they passed through rectangular grates on the diagonal. Vertical bar grates with 5-cm spacing that were installed across much of the control structure should limit access of common carp larger than 34 cm total length (TL) and northern pike larger than 70 cm. Vertical bar grates selected for initial field trials in the fish passageway had spacings of 5.8 and 6.6 cm, which increased access by common carp to 40 and 47 cm TL and by northern pike to 76 and 81 cm, respectively. The percentage of potential common carp biomass (fish seeking entry) that must be handled in lift baskets in the passageway increased from 0.9 to 4.8 to 15.4 with each increase in spacing between bars. Further increases in spacing would greatly increase the number of common carp that would have to be handled. The results of field testing should be useful in designing selective fish-control systems for other wetland restoration sites adjacent to large water bodies.

566. **Phytoremediation of herbicide-contaminated surface water with aquatic plants.**
Rice, P. J.; Anderson, T. A.; and Coats, J. R.
In: Phytoremediation of soil and water contaminants/ Kruger, E. L.; Anderson, T. A.; and Coats, J. R.; Series: American Chemical Society Symposium Series 664. Washington DC: American Chemical Society, 1997; pp. 133-151
NAL Call #: QD1.A45 no.664
Abstract: There is current interest in the use of artificial wetlands and macrophyte-cultured ponds for the treatment of agricultural drainage water, sewage, and industrial effluents. Aquatic plant-based water treatment systems have proved effective and economical in improving the quality of wastewaters containing excess nutrients, organic pollutants, and heavy metals. This investigation was conducted to test the hypothesis that herbicide-tolerant aquatic plants can remediate herbicide-contaminated waters. The addition of Ceratophyllum demersum (coontail, hornwort), Elodea canadensis (American elodea, Canadian pondweed), or Lemna minor (common duckweed) significantly (p less than or equal to <0.01) reduced the concentration of [14C]metolachlor (MET) remaining in the treated water. After a 16-day incubation period, only 1.44%, 4.06%, and 22.7% of the applied [14C]MET remained in the water of the surface water systems containing C. demersum, E. canadensis, or L. minor whereas 61% of the applied [14C]MET persisted in the surface water systems without plants. C. demersum and E. canadensis significantly (p less than or equal to < 0.01) reduced the concentration of [14C] atrazine (ATR) in the surface water. Only 41.3% and 63.2% of the applied [14C]ATR remained in the water of the vegetated systems containing C. demersum and E. canadensis, respectively. Eighty-five percent of the applied [14C]ATR was detected in the water of the L. minor and nonvegetated systems. Our results support the hypothesis and provide evidence that the presence of herbicide-tolerant aquatic vegetation can accelerate the removal and biotransformation of metolachlor and atrazine from herbicide-contaminated waters.
This citation is from AGRICOLA.

567. **Plant nutrient uptake and biomass accumulation in a constructed wetland.**
Hoagland, C. R.; Gentry, L. E.; David, M. B.; and Kovacic, D. A.
Journal of Freshwater Ecology 16(4): 527-540. (Dec. 2001)
NAL Call #: QH541.5.F7J68; *ISSN:* 0270-5060
Descriptors: nutrient uptake/ artificial wetlands/ biomass/ nitrogen/ phosphorus/ bioremediation/ uptake/ nutrients (mineral)/ plant populations/ primary production/ water pollution treatment/ pollution control/ agricultural runoff/ aquatic plants/ nutrient cycles/ plant nutrition/ agricultural pollution/ fertilizers/ biogeochemical cycle/ bioaccumulation/ plant growth/ vegetation/ nutrients/ water pollution/ macrophytes/ absorption/ tile drainage/ algae/ Plantae/ reclamation/ protective measures and control/ ecosystems and energetics/ effects of pollution/ water & wastewater treatment

Abstract: We examined the role of plants in the nutrient cycle of a 0.3 ha constructed wetland that received tile drainage water from agricultural fields. The objectives were to determine: 1) above- and below-ground production of wetland macrophytes; 2) production of algae; 3) accumulation and uptake rate of N and P by vegetation during the growing season; and, 4) role of wetland vegetation in the overall N and P budgets. Total biomass ranged seasonally from 12000 to 30000 kg ha super(-1) in the wetland, reaching a maximum in September, with roots accounting for 54 to 77% of the total. Above-ground macrophyte biomass ranged from 2000 to 5700 kg ha super(-1), and also reached a maximum in September. Algae were only present early in the growing season and had a maximum biomass of 233 kg ha super(-1) at the end of May. During the 1998 water year, tile input transported 715 kg ha super(-1) total N and 10 kg ha super(-1) total P into the wetland, whereas wetland output was 256 kg total N ha super(-1) (256 kg ha super(-1) in outlet flow and 120 kg ha super(-1) in seepage) and 7.3 kg total P ha super(-1). Therefore, the wetland removal efficiencies for N and P were 47 and 29%, respectively. Total N and P in biomass reached maxima of 367 and 57 kg ha super(-1) respectively, with below-ground biomass accounting for most of the N and P found in plants. Although the N accumulation by wetland plants was equal to the difference between the wetland input and output for N, most of the plant growth occurred after tile flow ceased. Plant removal of N and P from the water column was likely a small component of the overall effectiveness of the wetland due to the lack of synchronization between plant growth and tile flow.
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568. **Seasonal variation of selenium in outdoor experimental stream-wetland systems.**
Allen, K. N.
Journal of Environmental Quality 20(4): 865-868. (Oct. 1991-Dec. 1991)
NAL Call #: QH540.J6; *ISSN:* 0047-2425
Descriptors: nonpoint pollution sources/ path of pollutants/ selenium/ solute transport/ streams/ water pollution treatment/ artificial wetlands/ bioaccumulation/ experimental basins/ irrigation ditches/ seasonal variation/ vegetation/ sources and fate of pollution/ water quality control
Abstract: Two outdoor experimental stream-wetland systems were exposed continuously to 10 microg/L Se(IV) over a 2-yr period. A seasonal variation in the water column Se concentration was found in wetlands; a comparable variation was not observed in stream segments. Water column Se was never reduced by more than 20% in the streams, but was reduced by greater than 90% in midsummer in the wetlands. Accumulation of Se in plants was much higher in the wetlands than in the streams, particularly in duckweed (Lemna minor). The deposition of Se in sediments was extremely variable within the wetlands. The data indicate that the ability of wetlands to remove Se from the water column is seasonally dependent. The increased removal of Se in the wetlands found in late summer may be partially due to the physical effect of increased retention time of the water flowing through dense wetland vegetation, but much of the observed Se fluctuations are likely a result of biological activity in the wetlands. In areas where Se is a problem in free-flowing water, such as agricultural drainage and irrigation ditches, constructed wetlands and subsequent harvesting of plant material could be useful in removing Se, particularly in areas with little climatological variation. (MacKeen-PTT) 35 062954001
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569. **super(226)Ra and super(228)Ra activities associated with agricultural drainage ponds and wetland ponds in the Kankakee Watershed, Illinois-Indiana, USA.**
Sidle, W. C.; Shanklin, D.; Lee, P. Y.; and Roose, D. L.
Journal of Environmental Radioactivity 55(1): 29-46. (2001)
NAL Call #: QH543.5.A1; *ISSN:* 0265-931X
Descriptors: radium/ agriculture/ watersheds/ ponds/ radioactivity/ pollutant identification/ radium radioisotopes/ isotope studies/ agricultural watersheds/ drainage/ artificial wetlands/ spatial distribution/ water quality (natural waters)/ farmwastes/ agricultural areas/ fertilizers/ radioactive contamination/ radium isotopes/ agricultural pollution/ drainage water/ irrigation water/ USA, Illinois, Kankakee R./ USA, Illinois/ USA, Indiana/ radiation/ identification of pollutants/ water quality/ prevention and control/ water pollution: monitoring, control & remediation
Abstract: Radioactivity is elevated in many agricultural drainage ponds and also constructed wetland ponds in the Kankakee Watershed. During 1995-1999, gross- alpha and - beta activities were measured up to 455 and 1650 mBq L super(-1), respectively. super(226)Ra and super(228)Ra averaged 139 and 192 mBq L super(-1) in controlled drainage ponds compared to 53 and 58 mBq L super(-1) for super(226)Ra and super(228)Ra, respectively, in native wetland ponds. Analyses of applied ammonium phosphate fertilizers near both native and controlled ponds indicate comparable super(226)Ra/ super(228)Ra and super(228)Ra/ super(232)Th activity ratios with only the surface waters in the controlled ponds. For example, super(226)Ra/ super(228)Ra activity ratios in controlled ponds ranged from 0.791 to 0.91 and group with a local fertilizer batch containing FL phosphate compounds with super(226)Ra/ super(228)Ra activity ratios of 0.831-1.04. Local soils of the Kankakee watershed have super(226)Ra/ super(228)Ra activity ratios of 0.541-0.70. Calculated Ra fluxes of waters, in drainage ditches associated with these controlled ponds, for super(226)Ra ranged from 0.77 to 9.00 mBq cm super(-2) d super(-1) and for super(228)Ra ranged from 1.22 to 8.43 mBq cm super(-2) d super(-1). Ra activity gradients were measured beneath these controlled ponds both in agricultural landscapes and in constructed wetlands, all being associated with drainage ditches. Ra had infiltrated to the local water table but was below regulatory maximum contaminant limits. Still, measurable Ra activity was measured downgradient of even the constructed wetlands in the Kankakee watershed, suggesting that the attenuation of Ra was low. However, no Ra excess was observed in the riparian zone or the Kankakee River downgradient of the native wetland ponds.
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570. **Water table management to enhance crop yields in a Wetland Reservoir Subirrigation System.**
Allred, B. J.; Brown, L. C.; Fausey, N. R.; Cooper, R. L.; Clevenger, W. B.; Prill, G. L.; Barge, G. A.; Thornton, C.; Riethman, D. T.; Chester, P. W.; and Czartoski, B. J.
Applied Engineering in Agriculture 19(4): 407-421. (2003)
NAL Call #: S671.A66; *ISSN:* 0883-8542

Descriptors: agricultural production/ artificial wetlands/ crop production/ crop yield/ drain pipes/ irrigation systems/ maize/ reservoirs/ river water/ rivers/ soyabeans/ subsurface drainage/ subsurface irrigation/ water storage/ water table
Abstract: A Wetland Reservoir Subirrigation System (WRSIS) allows for capture, treatment, storage, and reuse of runoff and subsurface drainage waters from cropland, in turn providing both environmental and agricultural production benefits. The three WRSIS sites presently in operation are all located within the northwest Ohio portion of the Maumee River Basin and have been in use for five to six complete growing seasons. WRSIS components include an underground drainage pipe network tied to both a constructed wetland and a water storage reservoir. With this type of system, the drain pipes can be used at different times to either add water (subirrigation) or remove water (subsurface drainage) from the root zone, thereby enhancing crop yields, especially in dry years. Obtaining these crop yield benefits requires a proper water table management approach that includes practicing suggested operational guidelines and initiating as needed system modification improvements. By incorporating a proper water table management approach, and in comparison to control plots, WRSIS subirrigated field crop yield increases for corn and soybeans, respectively, were 34.5 and 38.1% during drier growing seasons, 14.4 and 9.7% during near average to wetter growing seasons, and 19.6 and 17.4% overall.

571. **A wetland to improve agricultural subsurface drainage water quality.**
Miller, P. S.; Mitchell, J. K.; Cooke, R. A.; and Engel, B. A.
Transactions of the ASAE 45(5): 1305-1317. (2002)
NAL Call #: 290.9 AM32T; *ISSN:* 0001-2351
Descriptors: herbicides/ water quality/ artificial wetlands/ atrazine/ evapotranspiration/ drainage water/ subsurface drainage/ orthophosphates/ agricultural runoff/ alachlor/ USA, Illinois
Abstract: The effectiveness of wetlands to cleanse event-driven agricultural drainage water in east-central Illinois was studied. A wetland was constructed at the outlet of a subsurface-drained agricultural field in a corn-soybean rotation. Hydrology data from the wetland inlet and outlet, including precipitation and evapotranspiration data, were used to develop a water budget for the system. Water quality data were collected from the wetland inlet, outlet, and the pond section of the wetland and analyzed for nitrate-nitrogen (NO sub(3)-N), orthophosphate (PO sub(4)-P), and nine common Midwestern herbicides: trifluralin, atrazine, alachlor, metolachlor, ethalfluralin, butylate, clomazone, cyanazine, and pendimethalin. Constituent mass loads were calculated at the inlet and outlet, and both concentration and mass load data sets were statistically analyzed. Results indicated variable performance based primarily on seasonal processes and individual chemical constituent. Overall, NO sub(3)-N mass load assimilation was approximately 174 kg (32.9%) over the course of the study, although assimilation rates were seasonally dependent. PO sub(4)-P and herbicide concentration and mass load assimilation were not significant.

572. **Zooplankton communities of restored depressional wetlands in Wisconsin, USA.**
Dodson, S. I. and Lillie, R. A.
Wetlands 21(2): 292-300. (2001)
NAL Call #: QH75.A1W47; *ISSN:* 0277-5212
Descriptors: wetlands/ watersheds/ zooplankton/ waterfowl/ agriculture/ sexual reproduction/ taxonomy/ daphnia/ ecosystems/ eutrophication/ turbidity/ surface water/ environment management/ community structure/ environmental restoration/ species richness/ agricultural land/ plankton/ ecosystem disturbance/ nutrient enrichment/ restoration/ evaluation/ community composition/ species diversity/ Cladocera/ Copepoda/ USA, Wisconsin/ restoration/ water fleas/ copepods
Abstract: Wisconsin has lost approximately 2 million hectares of wetland since statehood (1848). Through the combined efforts of state and federal agencies and private groups focused primarily on wetland restoration for waterfowl habitat management or compensatory mitigation, a fairly substantial gain in wetland area has been achieved. Much of the wetland restoration effort in Wisconsin has occurred on formerly agricultural lands. However, due to the nature of the past disturbance and possible residual effects not corrected by simply returning surface waters to these lands, there is some question regarding the resultant wetland quality or biological integrity. In an effort aimed at developing tools to measure wetland gains in terms of quality or ecological integrity, the Wisconsin Department of Natural Resources (WDNR) initiated a study of biological communities on restored wetlands in Wisconsin. In this paper, we report on the community of microcrustaceans and arthropods that can be collected with a plankton net in open water in wetlands. We examined zooplankton community structure in restored wetlands in terms of richness, taxonomic representation, and Daphnia sexual reproduction and related these metrics to attributes on wetlands representing least-disturbed conditions and agriculturally impacted wetlands. We sampled 56 palustrine wetlands distributed across Wisconsin. These wetland sites were categorized as agricultural, least-impacted, and restored (recently withdrawn from agricultural usage). The wetlands were reasonably homogeneous in many ways, so that taxon richness was not correlated with basin origin, presence of adjacent roads, presence or absence of fish, water chemistry, or the size of the open water. We identified a total of 40 taxa. Taxon richness was significantly lower in agricultural sites (average of 3.88 taxa per site) compared to that of least-impacted sites (7.29 taxa) and restored sites (7.21 taxa). Taxon richness of restored sites was significantly correlated with time since restoration. The data indicate that taxon richness changes from a value typical of agricultural sites to the average richness of least-impacted sites in about 6.4 years. The total taxon list for 8 agricultural sites (14 taxa) was significantly smaller than the average value for randomly chosen sets of 8 least-impacted sites (20.4 taxa). Agricultural and least-impacted sites tended to have the same common taxa. Many taxa of chydorid cladocerans and cyclopoid copepods that were rare in least-impacted sites did not occur in the agricultural sites, nor did fairy shrimp occur in agricultural sites. Daphnia populations only produced males in least-impacted and restored sites. Further research is needed to identify the mechanism(s) responsible for the reduced species richness and lack of sexual reproduction in agricultural wetland sites. Likely factors include eutrophication, turbidity, or chemical

contamination. We conclude that restoration of wetland watersheds works. Withdrawal of the watershed from agricultural usage is followed by an increase in taxon richness, and the sites resembled least-impacted sites in about 6-7 years.