Comments on Public Notice POA-2007-1586
The proposed Port Mackenzie Railroad extension
Knik Arm, Upper Cook inlet, Alaska

On behalf of the Appalachian Center for the Economy and the Environment

By
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These comments relate to an application by the Alaska Railroad Corporation (ARRC) to permanently discharge fill material to 101.8 acres of jurisdictional wetlands, and cause temporary impacts to an additional 38.9 acres of wetlands to the north of Knik Arm in upper Cook Inlet, in South-central Alaska. Stream and floodplain impacts will also result.

There are several concerns related to the wetland impacts that will result from the proposed project. Points of concern are listed below and described in more detail in subsequent sections:

1) as acknowledged in the OEA Environmental Impact Statement (Surface Transportation Board), the proposed rail extension will cause significant impacts to wetlands. The wetlands are described as "highly functional" due to their intact, undisturbed condition (4-5 Wetland Impacts p. 5), particularly for the functions of storm and flood water storage, water quality benefits, and provision of habitat for wetland flora and fauna. Direct impacts (fill) will eliminate these functions, and indirect impacts related to hydrologic and habitat alterations (e.g., habitat fragmentation) may lead to the degradation of the wetlands that remain.
2) While substantial hydrological alterations to wetlands and streams are proposed, the application contains inadequate information needed to make a determination of the full extent of hydrological impacts, including alterations to local hydrology from the presence of the railroad bed, which can act as a lateral dam isolating wetlands, streams and floodplains from other surface waters and potentially impeding groundwater flow.
3) The mitigation plan is general and brief, and does not demonstrate adequate mitigation for the proposed wetland losses. For instance, no details are provided on the location of the mitigation site(s), nor

on the methods that will be used to restore wetland acreage and function.

4) The functions of the wetlands proposed for impact were evaluated using several methods, including in the EIS, a rapid functional assessment method that was developed for use in the New England states (Hollands and Magee 1985, Magee and Hollands 1998). It is unclear why this method was selected when a more recent and rigorous (based on data collected in the region) assessment method was available (the Wetland Functional Assessment Guidebook for the Cook Basin Ecoregion; Hall et al. 2003). The latter is based on the ACoE's hydrogeomorphic approach to wetland assessment (Brinson 1993). A third assessment method, found in Appendix A of the Alaska District Regulatory Guidance Letter (RGL 09-01) was used to evaluate the general level of wetland functions, categorize wetlands and set mitigation ratios. The latter is a highly qualitative method that relies exclusively on best professional judgment to assess function. It is unclear where this method originated and why it is used, for example, instead of the HGM method.

5) The results of the functional analysis were used to categorize wetlands and, based on those categories, set mitigation ratios. The information used to determine the wetland functional scores are not presented, making it very difficult to assess the adequacy of the required mitigation.

1. The proposed rail line will adversely affect wetlands both directly and indirectly

Wetlands are among the world's most valuable and important ecosystems, providing services such as the improvement of water quality, replenishment of water supply (groundwater exchange, surface water storage, contribution to stream base flow), carbon sequestration, flood protection, support of biodiversity, and the provision of recreational activities (MA 2005). As a result, wetland ecosystem services have high economic value (Costanza et al. 1997). Over the past century, an estimated 50% of the world's wetland habitat has been lost (Mitsch and Gosselink 2007). The loss of 101.8 acres of wetlands due to this project will directly eliminate the functions they provide. Table 45.5 of the EIS (conducted by the Surface Transportation Board) shows that 96% of the wetlands in the rail line footprint (the 200 foot ROW) are high functioning with respect to the export of detritus, 87% contribute highly to groundwater discharge, 99% are high functioning for wildlife habitat and support of vegetation diversity, and 100% are high functioning for the modification of water quality (these assessments are based on the Magee Hollands (1998) method). Indirect effects are commonly related to hydrologic alterations that can lead to changes in water quality and declines in the diversity of fish and other species. Eliminating wetlands can lead to water quality degradation in the project area, a reduction in habitat due to direct loss of wetland acres and the fragmentation of the habitat that remains, and a reduction in flood storage capacity. Fragmentation reduces the flow of ecosystem services since the provision of many ecosystem services depends on large, intact areas to be sustained (for example, habitat for some species). When wetlands are isolated from adjacent habitats, the dynamic exchange of water, materials and biota is reduced, compromising a site's functional capacity (Nadeau and Rains 2007).

The presence of particularly sensitive wetlands should be avoided altogether since their loss cannot be mitigated for. This includes the Goose Creek Fen and other peat-accumulating wetlands. Not only are these extremely valuable as a unique habitat type, peatlands also store enormous quantities of carbon making them important in regulating the global carbon cycle (Gorham 1991, Zedler and Kercher 2005). The Big Lake South Bank Plan Su-Knik Wetland Mitigation Bank should also be avoided. Mitigation banks by definition exist to compensate for earlier or on-going wetland losses, and are expected to be maintained in perpetuity.

2. The information needed to make a determination of the extent of hydrological impacts, including alterations to local hydrology, is inadequate.

Information on the hydrological basis for the wetlands is lacking. What sources of water sustain these wetlands? How do the wetlands help sustain downstream systems (both in terms of water quality and quantity)? What is their typical hydroperiod (pattern of water levels over time) and/or water budget? Hydrology is the foundation for wetland ecosystem structure and function, affecting species composition, biogeochemical cycles and primary productivity, among other ecosystem characteristics (Mitsch and Gosselink 2007). Human actions that alter floodplains, rivers and wetlands, modify their functions and their physical, hydrologic and biotic character. A full assessment of project impacts cannot be accomplished without an explanation of the wetland's hydrology and the proposed alterations to it. The EIS states that hydrological impacts will be minimized through the installation of numerous culverts to provide for 'uninterrupted water flow'. While culverts may lesson impacts, they are unlikely to convey surface sheet flow or lateral groundwater movement. Mitigating for wetland losses requires an understanding and evaluation of hydrologic processes that maintain their characteristic structure and the functions and services they provide (Bedford 1996).

A critical issue that is not fully addressed in the assessment of impacts is the associated hydrological changes that will result from construction of the railroad bed. The hydrological impact of railroads on streams, floodplains and wetlands are commonly related to the creation of a physical barrier and the resulting lateral disconnections that break the hydrological links between a river, its floodplain, and wetlands in the surrounding landscape. This has a significant negative impact on the ecological functions of aquatic ecosystems that otherwise act as an integrated hydrologic system, with consequences to biodiversity, riparian habitats, fish movements and fish habitat use, and the provision of stream and wetland ecosystem services (Blanton and Marcus 2009). In essence, hydrological connectivity is critical for the exchange of materials that lead to aquatic ecosystem function, including the exchange of sediment, energy, and organisms (Nadeau and Rains 2007, Mitsch and Gosselink 2007). Structures such as railway embankments can modify local drainage and lead to serious changes in the wetland habitat.

Blanton and Marcus (2009) divide the impacts of railroad and road beds into two categories: those from crossings (bridges, culverts), and the lateral disconnection that can result from the construction of road beds (grades) and levees. Roadbeds act, in effect, as a lateral dam when they are placed adjacent to rivers and/or in wetlands. Consequences can include:

- altered fluvial processes such as flood and flow pulses;
- reduced exchange of water, biota and sediment between rivers and their floodplains that result from fluvial processes;
- over the long term, changes may occur in the meandering of streams and a consequent reduction in habitat value due to the loss of side channels, backwaters and oxbow lakes.

3. The mitigation plan does not demonstrate adequate mitigation for the proposed wetland losses

The crux of the mitigation plan is to compensate for the loss of 101.8 acres of wetlands (compensatory mitigation) through preservation and/or restoration - enhancement. The prescribed mitigation ratios are based on the Category of the wetlands to be impacted. Categories are based on results of the "Wetland Functions Data Form-Alaska Regulatory Best Professional Judgment Characterization" found in the AK District Mitigation RGL 09-01. Under this scheme, categories range from I (high) to IV (low). The bulk of the acreage proposed for impact was judged to be of Category III (moderately low) and IV (low), with only 0.7 acres of Category I (high). This directly contradicts sections of the Port Mackenzie Project Description (March 2011) that states that most of the wetland acreage to be impacted is high functioning wetland. Given the complexity of the region and the integration of wetlands, streams and floodplains, and the high habitat values reported in the EIS, it seems unlikely that the majority of wetlands should be rated as moderately low to low functioning sites.

Overall, the mitigation plan is inadequate due to its lack of detail and specificity. It is vague, with no concrete information on where or how the wetland preservation or restoration/enhancement that will serve as mitigation will be implemented, nor are mitigation project designs presented. The AK District Mitigation RGL 09-01 stipulates the necessary components of a mitigation plan, which vary depending on the mitigation instrument that will be used. Generally speaking, key components of a sound mitigation plan are not provided such as the criteria that will be used for site selection, how proper hydrology will be establishment and maintained, any requirements for the presence of hydric soils, and the methods of vegetation establishment (Mitsch and Gosselink 2007, Fennessy et al 2008). Thus, while the plan states that mitigation will be carried out, it does not address the methods by which it will be accomplished, nor the means to judge the likelihood of success (i.e., performance standards) and the establishment of ecosystem functions at the mitigation site.

4. The rationale for the choice of a rapid functional assessment method was not provided

There are several issues associated with the assessment of functions and subsequent determination of mitigation. In the OEA EIS conducted by the Surface Transportation Board, wetlands were assessed using the Magee -Hollands *Procedure for Assessing Wetland Functional Capacity* (1998), which was originally developed for nontidal wetlands in New England (it has also been approved for use in Wisconsin). This method was used despite the fact that the ACoE helped sponsor the development of a functional assessment method specifically for Alaskan wetlands in the Cook Inlet Basin Ecosystem (Hall et al. 2003) based on the hydrogeomorphic approach for two common wetland classes in this area, slope wetlands and organic flats (Brinson 1993). Assessing the condition and functions of wetlands is a cornerstone of mitigation implementation, however no explanation or rationale is provided as to why one method was selected over another. The HGM-based method ("Wetland Functional Assessment Guidebook: Operational Draft Guidebook for Assessing the Functions of Slope/Flat Wetland Complexes in the Cook Inlet Basin Ecoregion, Alaska, using the HGM Approach", Hall et al. 2003) was developed specifically for this region of Alaska, based on data collected from reference standard sites and reference sites, and was field tested and revised based on these data. The goal was to produce an assessment method based on data collected in the region using the hydrogeomorphic approach, and in doing so, rectify the need for a widely accepted assessment method. It appears to be a much more specific and extensively tested method for the assessment of ecosystem function than Magee Hollands.

In contrast, the Magee Hollands Wetland Assessment Method (1998) was originally developed over 25 years ago (1985) in order to assess wetland functions in nontidal wetlands in the glaciated northeastern U.S. In the original method, functions are assessed based on an evaluation of site elements and a series of steps that lead to weightings of site observations and an assessment model that describes wetland function using a qualitative approach. Generally, this type of method can lack robustness and repeatability, two hallmarks of a sound assessment method (Fennessy et al. 2007). Because the method was not developed for this region and its appropriateness has not been demonstrated, any conclusions based on its results are necessarily weak.

While the HGM method appears better suited than the Magee-Hollands method in evaluating wetlands in the Cook Inlet Basin (at least for slope and organic flat systems), the HGM approach to assessment can be problematic because typically the models used to assess function have not been verified with empirical data documenting actual levels of function in wetlands. For this reason, HGM models do not directly measure functions as is sometimes claimed, rather they work by using structural data to infer function. Without testing this assumption it is unclear what the HGM method is measuring. For instance, there is recent evidence that structural measures do not necessarily indicate function. In a study linking structural characteristics to in-depth measures of ecosystem function, Hossler et al. (in press) demonstrated that biogeochemical processes in created wetlands are not reflected by structural attributes. This suggests that there could be negative consequences when HGM methods are used to assess wetlands and the adequacy of mitigation projects to compensate for wetland impacts.

5. No explanation or rationale is provided for how the results of the functional assessment method were used to place wetlands into categories and set mitigation ratios

The results of the functional assessment (based on the 'Wetland Functions Data Form – Alaska Regulatory Best Professional Judgment Characterization found in the RGL 09-01) that led to the categorization of wetlands are not provided. Neither is there an explanation for how the categories were determined or mitigation ratios derived. Because the functional assessment data are not presented it is impossible to assess the validity of these findings. Given the high quality nature of the environment in the Knik Arm Inlet region, it strains credulity that only 0.7 % of the wetlands fall into Category 1 while 76% fall in the two lowest categories (III and IV). This leads to a proposal of nearly the lowest possible compensatory mitigation ratios in the mitigation plan. Thus, for a total loss of 101.8 wetland acres, only 165.7 acres of mitigation would be required through preservation, and a mere 102.6 acres through restoration/enhancement (essentially a 1:1 trade which does not allow for the failures or temporal losses that are common to mitigation projects, see below (NRC 2001)).

Requiring so little mitigation for these proposed impacts is problematic because of the distinct possibility that at least some portion of the mitigation project(s) will not be an ecological success, i.e., they will be unable to meet the no net loss goal. In the U.S., approximately 40,000 acres of wetlands are restored, established, enhanced, and preserved each year to compensate for approximately 20,000 acres of permitted losses. There has been debate whether this compensation leads to the effective replacement of lost wetlands. Recent studies on wetland compensatory mitigation suggest that the proportion of compensation sites that meet administrative and ecological performance standards is quite low (NRC 2001, Environmental Law Institute 2006, Kihslinger 2008). For example, a recent review found that wetland restoration sites were able to replace only about 20% of the wetland functions that were lost (Turner et al. 2001). And if the mitigation wetland is an ecological success, there may still be problems associated with the temporal loss of wetland functions (NRC 2001). Mitigation is a risky business. In a recent study of the biogeochemical functions performed by wetlands, Hossler et al. (in press) found that, despite the assumption of the no-net-loss policy that wetlands can be created/restored/enhanced to be functionally equivalent to natural wetlands, the loss of biogeochemical functions (e.g., carbon sequestration, nitrogen processing) are not being mitigated. The authors go on to say that this "study suggests that subversion of natural wetlands into restored or created wetlands could have large-scale environmental consequences such as reduced capacity for nitrate removal and C sequestration." While mitigation wetlands may look structurally like natural sites, there is scant evidence that they function as such.

The trading of natural for mitigation wetlands has been called a 'losing game' (Roberts 1993) because when a natural wetland is destroyed, its functions, or ecosystem services are also destroyed and mitigation wetlands are not making up for those losses (NRC 2001, Hossler et al. 2011). Wetland ecosystem processes lead to the flow of services such as water purification, removal of sediment, nutrients and metals from water that flows through them, water storage and flood flow regulation including reduction of peak flows (including in nearby residential areas) and maintenance of stream base flows, the cycling of carbon and nitrogen leading to carbon sequestration and nitrogen processing, organic matter production and export, support of biodiversity, and provision of habitat (including spawning grounds) for fish, birds, mammals, amphibians, invertebrates, etc. (NRC 2001).

These are compelling reasons that if the permit is approved, the mitigation ratios should be considerably higher than 1:1.

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<u>**CURRICULUM VITAE**</u>

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Professor (2009 - Present)
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EDUCATION

The Ohio State University, Columbus, Ohio:

Ph.D. 1991. Environmental Biology. Presidential Fellow, 1990-1991.
Dissertation Title: Ecosystem Development in Restored Riparian Wetlands.
Advisor: William J. Mitsch, Stockholm Water Prize Laureate.

B.S. 1986. Botany.

ACADEMIC AND PROFESSIONAL POSITIONS

Kenyon College, Department of Biology, 1998 – present. Professor, 2009 – present, Associate Professor 2002–2009, ***Chair of Biology, 2003 - 2005***, Assistant Professor, 1998-2002.

Kenyon College, Environmental Studies Program, Co-*Director, 2001- 2004; 2006 – present.*

Ohio Environmental Protection Agency, 1993-1998, Environmental Specialist for Research and Policy Development, Wetland ecologist/aquatic biologist with The Ohio Environmental Protection Agency. Wrote state rules protecting wetlands and developed the state's wetland biological assessment program.

University College London, Department of Geography, 1992 – 1993, Assistant Professor (Lecturer), Department of Geography, University College London, University of London. Taught courses on Environmental Hydrology, Hydrological Systems Management, International Geographical Problems and a graduate course on Wetland Ecology and Restoration.

Station Biologique de la Tour du Valat, 1992 – 1993, **Research Biologist**, Concurrent research appointment at the Station Biologique de la Tour du Valat, Arles, France. Conducted research on the ecology, hydrology and sustainable use of deltaic Mediterranean wetlands. Established a research program at the station on wetland hydrology, restoration, and ecosystem modeling.

GRANTS FUNDED

2010 *U.S. Environmental Protection Agency, Cooperative Agreement.* Integrating Indicators of Ecological Condition and Services into a Policy Framework. With Michigan State University

Great Lakes Colleges Association. New Directions Initiative for floodplain research in the Peruvian Amazon.

2009 *U.S. Environmental Protection Agency, STAR Grant.* Forecasting the provision of ecosystem services from measures of ecological condition. With Penn State University

2008 *U.S. Department of Agriculture, Natural Resources Conservation Service.* Quantifying ecosystem services derived from wetland conservation practices in the Glaciated Interior Plains. With Indiana University.

2007 *U.S. Environmental Protection Agency.* Ohio Center for Wetland and River Restoration. Teaching, Research and Outreach Initiative 2006-07. Kenyon Component: $36,000. River ecology and monitoring in the Kokosing Watershed.

2005 *U.S. Department of Agriculture, Managed Ecosystems Program.* Establishment of Plant- and microbial- mediated functions in wetlands: a comparative and mechanistic study to provide guidance for wetland restoration. With University of New Hampshire and Ohio State University.

2004 *U.S. Environmental Protection Agency.* Using a probabilistic sampling design for whole watershed wetland assessment.

2003 *U.S. Environmental Protection Agency.* Development of Rapid Assessment Methods for State Wetland Monitoring Programs. With Mary Kentula and Amy Jacobs.

2002 *U.S. Environmental Protection Agency,* Watershed Assessment of Wetlands using a Probabilistic Sampling Design (partnered with Ohio Environmental Protection Agency).

2000 *The Horatio B. Ebert Charitable Foundation,* A Gift for Teaching Ecology in the Liberal Arts Curriculum. 2nd award (2001), 3rd Award (2003), 4th Award (2004).

*U.S. Environmental Protection Agency***.** Using wetland bioindicators and biogeochemical studies to evaluate success in wetland restoration projects (partnered with Ohio Environmental Protection Agency).

The Denison-Kenyon Mellon Program, $15,000. GIS Workshops for Enhancing Spatial Analysis in the Classroom. (Collaborating Faculty with Karl Korfmacher).

1999 *Ohio Board of Regents*, Establishment of the Ohio Center for Wetland and River Restoration at the Olentangy River Wetland Research Park (Co-principal investigator with W. Mitsch).

1999 *The Denison-Kenyon Mellon Program,* Developing Collaborative Capacity with Geographic Information Systems.

1999 *The Environmental Policy Initiative (OARDC)*, Ecological and Economic Analysis of Natural Capital: Analyzing and Modeling the Substitutability of Constructed Wetlands for Natural Sites (Co-principal investigator with F. Hitzhusen).

1996 U.S. Environmental Protection Agency, The Ecological Assessment of Wetlands using Wetland Reference Sites.

1995 U.S. Environmental Protection Agency, Testing the Floristic Quality Assessment Index as an Indicator of Riparian Ecosystem Health.

1995 U.S. Environmental Protection Agency, The Identification of Wetland Restoration Sites in the Cuyahoga River Watershed, Ohio: a landscape analysis using GIS.

1992 World Wildlife Fund, UK. Wetlands and Nutrient Stripping: science and policy implications for the United Kingdom.

1992 Ove Arup for the United Kingdom Department of Transport, The Hydrology of the Isle of Sheppey Coastal Wetlands: Impacts and Enhancement Possibilities of the A249 Iwade to Queensborough Project.

1992 Station Biologique de la Tour du Valat, France, Ecological studies and modeling of Mediterranean Coastal Wetlands.

SERVICE TO THE KENYON COMMUNITY

2001- 2004; 2006-present Chair of the Environmental Studies Concentration
2006 – present Co-Director, Brown Family Environmental Center
2007 - 2010 Resource Allocation and Assessment Subcommittee
2003-2005 Chair, Department of Biology
2001-2005 Campus Design Committee
2001-2002 Library and Information Systems subcommittee
2002- 2004 Faculty representative to the College Senate
2003 Inaugural Planning Committee for President Georgia S. Nugent
2001-2003 Knowledge Works (Gates Foundation) Committee to develop Early College proposal
1999 - 2001 Committee for Academic Standards and the Petitions Subcommittee

SERVICE TO THE PROFESSIONAL COMMUNITY

2008-2011 Appointed by The National Academy of Sciences as a member of the National Research Council on the St. Johns River, Florida; Water Supply Cumulative Impact Study for the St. Johns River Watershed.
2009-2011 President, Society of Wetland Scientists North Central Chapter
2009-2011 Chair, Ramsar subcommittee of the Education and Outreach Committee of the Society of Wetland Scientists
2009-2011 Appointed by USEPA to develop a wetland assessment methods for use in the National Wetland Condition Assessment (NWCA, field work to be conducted in 2011).
2008 Invited member of Expert Panel on Wetland Indicators for the Report on the Environment, 2008, U.S. EPA.
2007- Elected President-elect for the Society of Wetland Scientists, North-Central Chapter.
2004 Performed external review of Hawai'i Pacific University's Environmental Science Department and Program, November 22-24.
2004 – present Invited Advisory member, Mid-Atlantic Wetland Workgroup (8 state research consortium).
2004 Invited member of grant review panel, STAR grant program, U.S.EPA
1997 - 2002: U.S. EPA National Technical Workgroup on the Biological Assessment of Wetland Ecosystems (appointed)
1997 - 1998: Wetland Assessment Project Coordinating Committee, Association of State Wetland Managers (appointed)
1994 - 1996: Tillamook Bay National Estuarine Project Watershed Scientific and Technical Advisory Committee, Tillamook, Oregon (appointed)
1994 - 1996: Advisory Committee of The Wetlands Initiative, a project to restore wetlands in the Great Lakes Watershed, Chicago, Illinois (appointed)

PROFESSIONAL SOCIETY MEMBERSHIPS

Ecological Society of America
Society of Wetland Scientists

HONORS AND AWARDS

- Recipient of the Robert J. Tomsich Science Award for excellence in scientific research, 2001
- Invited speaker for Kenyon College Founders Day, 2002
- Finalist for the U.S. National Academy of Sciences, National Research Council to investigate Innovative Approaches to Integrated Watershed Management, 1995
- Certified by the Society of Wetland Scientists as a Professional Wetland Scientist, 1995
- Ohio State University Presidential Fellowship for Outstanding Doctoral Research, 1990.
- Morton L. Ryerson Fellowship. Awarded by the Lake County Forest Preserve District, Lake County, Illinois. 1988.

EDITORIAL BOARDS

2006- 2009. **Associate editor,** *Wetlands*

1991 – 1993. Book review editor***, Ecological Engineering: the Journal of Ecosystem Restoration***

Served as reviewer for the following journals: Ecological Applications, Frontiers in Ecology and the Environment, Wetlands, Ecological Indicators, Environmental Monitoring and Assessment, Ecological Engineering: the journal of ecological restoration.

BOOKS

Wali, M., F. Evrendilek, and S. Fennessy. 2009. **Environmental Science: Issues and Solutions.** Taylor and Francis, CRC Press. 619 pages.

Cronk, J.K. and M. S. Fennessy. 2001 **Wetland Plants: Biology and Ecology**. CRC Press/Lewis Publishers. Boca Raton, FL. 440 pages.

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Fennessy, M. S., and J. K. Cronk . 1997. The effectiveness and restoration potential of riparian ecotones for the management of nonpoint source pollution, particularly nitrate. *Critical Reviews in Environmental Science and Technology* 27:285-317.

Fennessy, M. S., J. K. Cronk, and W. J. Mitsch. 1994. Productivity and macrophyte community dynamics in created wetlands subjected to experimental hydrologic regimes. *Ecological Engineering: the Journal of Ecotechnology* 3:469-484.

Fennessy, M. S., C. Brueske, and W. J. Mitsch. 1994. Sediment deposition patterns in restored freshwater wetlands using sediment traps. *Ecological Engineering: the Journal of Ecotechnology* 3: 409-428.

Fennessy, M. S., G. K. Sims, and S. R. Kehrmeyer. 1992. A model laboratory system for teaching concepts important in Soil Microbiology. *Journal of Natural Resources and Life Science Education* 21:79-83.

Mitsch, W. J. and M. S. Fennessy. 1991. Modeling nutrient cycling in wetlands. Pages 249 - 276 *In* S. E. Jorgensen ed. Developments in Ecological Modeling 17: Chemical Cycling in the Environment. Elsevier, Amsterdam.

Baker, K. A., M. S. Fennessy, W. J. Mitsch. 1991. Designing wetlands for controlling coal mine drainage: an ecologic-economic modeling approach. *Ecological Economics* 3: 1-24. Reprinted in: The Development of Ecological Economics. 1997. R. Costanza, C. Perrings and C. Cleveland editors. E. Elgar Publishing, LTD.

Fennessy, M. S. and W. J. Mitsch. 1989. Treating coal mine drainage with an artificial wetland. *Journal of the Water Pollution Control Federation* 61:1691-1701.

Fennessy M. S., and W. J. Mitsch. 1989. Design and use of wetlands for renovation of drainage from coal mines. Pages 231-254 *In* S. E. Jørgensen and W. J. Mitsch, eds. Ecological Engineering: An Introduction to Ecotechnology. J. Wiley, New York.

SELECTED PAPERS PRESENTED WITH PUBLISHED ABSTRACTS

Kenyon Students Indicated in **Bold**

Anderson, C., **P. Moriarty**, Fennessy, M. S. 2010. Ecosystem services provided by restored wetlands in agricultural landscapes. *In* Proceedings of the 30th Society of Wetland Scientists Annual Meeting, June 27 – July 2, 2010. Salt Lake City, UT.

Fennessy, M. S. 2010. Assessing variability through classification: are we lumpers or splitters? *In* Proceedings of the 30th Society of Wetland Scientists Annual Meeting, June 27 – July 2, 2010. Salt Lake City, UT. (***Invited Symposium***).

Fennessy, M. S. 2008. Nitrogen retention by restored wetlands in the Glaciated Interior Plains to combat downstream impacts in the Gulf of Mexico. *In* Proceedings of the 28th Society of Wetland Scientists Annual Meeting, May 26 - 30, 2008. Washington, D.C. (***Invited Symposium***).

Fennessy, M. S. 2007. Teaching nitrogen biogeochemistry in aquatic ecology courses. *In* Proceedings of the 27th Society of Wetland Scientists Annual Meeting, June 10 - 15, 2007. Sacramento, CA. (***Invited Symposium***).

Herbert, E., S. Fennessy, **J. Rosenbluth**, V. Bouchard, K. Hossler. 2007. Establishment of plant-based mediated functions in restored wetlands: a comparative and mechanistic study. *In* Proceedings of the 27th Society of Wetland Scientists Annual Meeting, June 10 - 15, 2007. Sacramento, CA.

Rosenbluth, J., **E. Herbert**, **S. Burns**, and S. Fennessy. 2007. Controls on decomposition in restored and natural wetlands: implications for biogeochemical cycling. Poster presentation. *In* Proceedings of the 27th Society of Wetland Scientists Annual Meeting, June 10 - 15, 2007. Sacramento, CA.

Deimeke, E., S. Fennessy, and J. Bishop. 2007. Assessing the ecological condition of wetlands on a watershed basis. *In* Proceedings of the 27th Society of Wetland Scientists Annual Meeting, June 10 - 15, 2007. Sacramento, CA.

Rokosch, A., R. Dick, S. Fennessy. 2007. The use of soil parameters as indicators of condition in forest depressional wetlands. *In* Proceedings of the 27th Society of Wetland Scientists Annual Meeting, June 10 - 15, 2007. Sacramento, CA.

Symposium Chair, Society of Wetland Scientists Annual Meeting, July 2006. Using Rapid Indicators to Document the Ecological Integrity of Wetlands. Cairns, Australia.

Rheinhardt, R. and S. Fennessy. 2006. Rapid Indicators: what works and what doesn't? *In* Proceedings of the 26th Society of Wetland Scientists Annual Meeting, July, 2006. Cairns, Australia (***Invited Symposium***).

Fennessy, M. S., A. Jacobs, M. Kentula. 2004. An analysis of existing rapid methods for assessing wetland condition. Page 7 *In* Proceedings of the 25th SWS Conference, 18-23 July, Seattle, WA (***Invited Symposium***).

Fennessy, M. S. 2004. Translating an assessment of wetland mitigation success into performance standards. Page 21 *in* The Changing Landscapes of Oceans and Freshwater, The American Society of Limnology and Oceanography annual meeting, 13-18 June, Savannah, GA. (***Invited Symposium***).

Craft, C.B., I.A. Mendelssohn, and M.S. Fennessy. 2004. Vegetation Ecology in Wetlands. Pg. 16 *In* The Changing Landscapes of Oceans and Freshwater, The American Society of Limnology and Oceanography annual meeting, 13-18 June, Savannah, GA. (***Invited Symposium***).

Ward, E. and S. Fennessy. 2003. Wetland ecosystem response to landscape change: functional and structural indicators. Poster presentation. Page 20 *In* Proceedings of the 24th SWS Conference, 8-13 June, New Orleans, LA.

Fennessy, M. S. 2003. Wetland restoration at a hierarchy of scales. Presented at the Ohio State University Wetlands Invitational, May 13-15. (***Invited Symposium***).

Nahlik, A. and S. Fennessy. 2002. Using amphibians as indicators of wetland restoration success. Poster presentation. Proceedings of the 23rd SWS Conference, 2-7 June, Lake Placid, NY.

**** This poster won the <u>Best Student Poster Award</u> at the meeting.**

Fennessy, M.S and **A. Rokosch**. 2001. Linking measures of wetland ecosystem integrity with ecosystem processes. Changing Wetlands Conference, the British Ecological Society. Sheffield UK. September 11-13, 2001.

Rokosch, A. and M.S. Fennessy 2001. Testing biological indicators to assess the impact of habitat fragmentation on wetland ecosystems. Poster presentation. Page 20 *In* Proceedings of the 22nd SWS Conference. 27 May - 1 June, Chicago, IL.

Book, J.A. and M.S. Fennessy 2001. The effects of wetland mitigation on amphibian species richness. Poster presentation. Page 4 *In* Proceedings of the 22nd SWS Conference. 27 May - 1 June, Chicago, IL.

Bush, C. and M. S. Fennessy. 2000. Effects of plant diversity on wetland ecosystem processes. Poster presentation. Page 232 *In* Proceedings of the INTECOL V International Wetlands Symposium and 21st SWS Conference. 6 - 12 September. Quebec, Canada.

*__Marx, L__. and M. S. Fennessy. 2000. The effects of mycorrhizal inoculation on the growth of a perennial wetland grass. Poster presentation. Page 233 *In* Proceedings of the INTECOL V International Wetlands Symposium and 21st SWS Conference. 6 - 12 September. Quebec, Canada.

Fennessy, M.S., J. Mack, and R. Lopez. 1999. Developing indicators to evaluate wetland ecosystem condition using reference sites. Page A-15 *In* Proceedings of the Society of Wetland Scientists, June 6 - 12, Norfolk, VA.

Fennessy, M. S., C. Crook and M. Micacchion. 1997. Using floristics as an indicator of wetland condition in the agricultural Midwest. Page 58 *In* Proceedings of the Society of Wetland Scientists, June 1 - 6, Bozeman, MT.

Fennessy, M. S. 1997. Applying concepts derived from the development of stream biological indicators to wetland ecosystems. Pages 29 - 30 *In* Proceedings of the Association of State Wetland Managers, The Future of Wetland Assessment. Annapolis, MD, U.S.A.

Fennessy, M. S. and C. Yoder. 1996. Can we apply concepts from the development of biological criteria in Ohio streams and rivers to wetlands. Pages 21-22 *In* Wetlands: Biological Assessment Methods and Criteria Development Workshop, U.S. EPA, September 18 - 20, Boulder, CO.

Fennessy, M. S. 1992. Spatial reorganization of soil nutrients as a function of hydrology in four restored wetlands. Page 114 *In* Proceedings of the INTECOL IV International Wetlands Conference. 13 - 18 September. Columbus, Ohio. U.S.A.

Cronk, J. K. and M. S. Fennessy. 1992. Spatial distribution of phosphorus in the water column and sediments of four constructed freshwater wetlands. Eighth Annual Scientific Symposium of the Ohio River Basin Consortium for Research and Education. 12 - 14 November. Cincinnati, Ohio. U.S.A

Fennessy, M. S. and W. J. Mitsch. 1991. Spatial patterns of phosphorus bioavailability and sedimentation as a function of hydrology in four constructed freshwater wetlands. Proceedings of the Wetland Biogeochemistry Symposium. 11 - 13 February. Baton Rouge, La. U.S.A.

Mitsch, W. J., R. Kadlec, D. L. Hey, K. R. Barrett, and M. S. Fennessy. 1991. Chemical mass balances of constructed riverine wetlands - the role of hydrologic and seasonal conditions. Proceedings of the Wetland Biogeochemistry Symposium. 11 - 13 February. Baton Rouge, La. U.S.A.

Fennessy, M. S. 1990. Placement of wetlands in a landscape for water quality improvement: implications of soil characteristics on the ability of wetlands to retain nutrients. Fifth Annual Landscape Ecology Symposium. Miami University, Oxford, Ohio. March 21 - 24.

Mitsch, W. J. and M. S. Fennessy. 1990. Wetlands for control of coal mine drainage in Ohio. Pages 307 - 308 *In* Conservation and Development: the sustainable use of wetland resources. Proceedings of the Third International Wetlands Conference. 19 - 23 September. Rennes, France.

TECHNICAL REPORTS

Fennessy, M. S., J. J. Mack, M. Sullivan, M. Knapp, and M. Micacchion. 2007. Assessing wetland ecological condition in the Cuyahoga River Watershed. Ohio EPA Technical Report WET/2007-4. Ohio Environmental Protection Agency, Wetlands Ecology Unit, Division of Surface Water, Columbus, OH.

Fennessy, M. S., J. J. Mack, A. Rokosch, M. Knapp, and M. Micacchion. 2004. Biogeochemical and hydrological investigations of natural and mitigation wetlands. Ohio EPA Technical Report WET/2004-5. Ohio Environmental Protection Agency, Wetlands Ecology Unit, Division of Surface Water, Columbus, OH.

Mack, J. J., M S. Fennessy, M. Micacchion, and D. Porej. 2004. Standardized monitoring protocols, data analysis and reporting requirements for mitigation wetlands in Ohio, v. 1.0. Ohio EPA Technical Report WET/2004-6. Ohio Environmental Protection Agency, Wetlands Ecology Unit, Division of Surface Water, Columbus, OH.

Fennessy, M. S., M. A. Gray, and R. D. Lopez. 1998. An ecological assessment of wetlands using reference sites. Volumes 1 and 2. Ohio Environmental Protection Agency Technical Bulletin. Division of Surface Water, Wetlands Ecology Unit. Columbus, OH (www.epa.state.oh.us/dsw/401/).

Fennessy, M. S., B. Elifritz and R. Lopez. 1998. Testing the Floristic Quality Assessment Index as an Indicator of Riparian Wetland Disturbance. Ohio Environmental Protection Agency Technical Bulletin. Division of Surface Water, Wetlands Ecology Unit. Columbus, OH (www.epa.state.oh.us/dsw/401/).

Fennessy, M. S. 1997. A Functional Assessment of Mitigation Wetlands in Ohio: Comparisons with natural systems. Ohio Environmental Protection Agency Technical Bulletin. Division of Surface Water, Wetlands Ecology Unit. Columbus, OH (www.epa.state.oh.us/dsw/401/).

Fennessy, M. S. 1996. A Functional Assessment of Ohio's Wetlands using Reference Sites: A Hydrogeomorphic Approach: Quality Assurance Project Plan. QA/QC submitted to U.S. EPA, Region V, Chicago, Il.

Smith, R. and M. S. Fennessy. 1996. N-species transfers in groundwater in the riparian zone of the Olentangy River. 1995 Annual Report of the Olentangy River Wetland Research Park at the Ohio State University.

Fennessy, M. S. 1995. Testing the Floristic Quality Assessment Index as an Indicator of Riparian Wetland Disturbance: Quality Assurance Project Plan. QA/QC submitted to U.S. EPA, Region V, Chicago, Il.

Fennessy, M. S. 1993. Use of Riparian Wetland Buffer Zones to Control Nonpoint Source Nitrate Pollution. Final Report to the World Wildlife Fund UK. Surrey, UK.

Hollis, G.E., M. S. Fennessy and J. Thompson. 1993. The Hydrology of the Isle of Sheppey Grazing Marshes (A249 Iwade to Queensborough, UK). Final Report for the UK Department of Transport. London, UK.

Fennessy, M. S. 1992. Spatial Patterns of Soil Chemistry Development in Restored Freshwater Wetlands. Volume 4, Chapter 1, in The Des Plaines River Wetlands Demonstration Project. Chicago IL. Wetlands Research, Inc.

Mitsch, W.J., M. S. Fennessy, J. K. Cronk, et al. 1992. Final Report on the Ecosystem Studies of the Des Plaines River Experimental Wetlands - 1990/92. Report to Wetlands Research, Inc. Chicago, Il.

Mitsch, W.J., M. S. Fennessy, and J. K. Cronk. 1990. Ecosystem Studies of the Des Plaines River Experimental Wetlands - 1989/90. Report to Wetlands Research, Inc. Chicago, Il.

Mitsch, W.J., J. K. Cronk, M. S. Fennessy, and G. Snyder. 1990. Wetlands for the Control of Nonpoint Source Pollution: Preliminary feasibility study for Swan Creek Watershed of Northwestern Ohio. Report to the Ohio Environmental Protection Agency, P.O. Number 607107.

Fennessy, M. S. 1989. The Des Plaines River Wetlands Demonstration Project: Soil and Vegetation Geostatistical Analysis and Mapping. Final Report to Ryerson Fellowship Committee. Chicago, IL.

SELECTED INVITED PRESENTATIONS & SEMINARS

2010. Is wetland restoration a losing game? A comparison of diversity and nutrient cycling in natural and created wetlands. Invited seminar, School of Public and Environmental Affairs, Indiana University, Bloomington.

2007. Assessing the ecological condition of wetlands at the watershed scale using a rapid assessment method: the Cuyahoga River Watershed as a case study. Ninth annual Ecological Monitoring and Assessment Program, April 10 – 12. Washington, D.C.

2007. Wetland assessment at the regional scale and the impact of urbanization. Invited plenary speaker, Ohio Environmental Council Clean Water Conference, Feb. 2-3.

2006. Verification and monitoring of wetland performance in water quality trading programs: How can we be certain of result? Meeting sponsored by U.S.EPA and the Environmental Law Institute, February 13-14, 2006.

2006. An assessment of mitigation wetland performance. Meeting of Environmental Law Institute, Washington, D.C., May 22-23.

2005. Linking measures of ecosystem integrity and biogeochemical cycles in natural and restored wetlands. Invited seminar, Mississippi State University. University of Mississippi. March 11.

2004. Review and implementation of rapid assessment methods in the California State wetland monitoring program. Invited presentation and workshop, March 16-17, Sacramento, CA.

2003. A biogeochemical analysis of wetland restoration projects. Invited seminar, Biology Department, College of Wooster. September, 2003.

2003. Wetland biological assessment. Invited workshop leader, Coer d'Alene, ID. National Water Quality and Assessment Workshop.

2000. Using patterns in plant communities to indicate ecological integrity. Massachusetts Bays Program conference Using Biology to Signal Ecological Health. November 1-2, 2000.

2000. Wetland restoration using landscape profiles. Invited panelist U.S. EPA Workshop, The Design and Monitoring of Best Management Practices for Wetlands: Use of Landscape Profiles. September 14-15, Seattle, WA.

1999. Assessing wetland ecosystem condition: the link between diversity and ecosystem function. Invited seminar, Biology Department, University of Dayton, Ohio.

1998. Approaches for developing biological indicators for wetlands. Association of State Wetland Managers, Plenary Address. Washington D.C.

1996. Application of concepts from the development of biological criteria in Ohio streams and rivers to wetlands. Wetlands: Biological Assessment Methods and Criteria Development Workshop, U.S. EPA. Boulder, CO., September 18 - 20.

1996. Developing indicators to evaluate ecological change in Midwestern wetlands. Invited Symposium, Society of Wetland Scientists, Kansas City, Mo., June 10 - 13.

1995. An integrated strategy for the biomonitoring of wetlands and other surface waters. U.S. EPA Workshop on The Challenges of Wetland Assessment and Monitoring. Boston, Mass., September 22-23.

1993. The conservation and sustainable use of freshwater wetlands in Europe and the United States. Invited series of 4 lectures, University of Cambridge, Cambridge, UK.

1993. Short Course on Ecological Modeling. Sponsored by The Station Biologique de la Tour du Valat and The Fluvial Systems Ecological Laboratory, CNRS. May 1993. Arles, France, with John W. Day and Philippe Hensel.

1992. Effectiveness of wetland buffer zones in controlling agricultural pollution. Proceedings of the Workshop on Assessing and Monitoring Changes in Wetland Parks and Protected Areas. 9 - 13 October. Norwich, UK.

1990. Ecological approaches to water pollution: use of wetlands to control mine drainage. Invited seminar, Morehead State University Biology Department, Morehead, Kentucky. April 19.

BOOK REVIEWS

2006 *Monitoring stream and watershed restoration*. P. Roni, ed. Ecology 87: 530-531.

200, *Wetalnds – Nutrients, metals, and mass cycling*. J. Vymazal, ed. Journal of Paleolimnology 36: 229-231.

2001 *Biodiversity in wetlands: assessment, function and conservation*. B. Gopal, W. Junk, and J. Davis, eds. Ecology 82:1496-1497.

2001 *A Case for Wetland Restoration* by Donald L. Hey, Nancy S. Philippi. Journal of Environmental Quality 30: 1853-1854.

1997 *Treatment Wetlands*. R. H. Kadlec and R. L. Knight. Journal of Environmental Quality 26.

1997 *Wetlands: Environmental Gradients, Boundaries and Buffer*s. Ecology 78:2274-2275.

1993 *Restoration of Aquatic Ecosystems*: *Science, Technology, and Public Policy*. National Research Council, National Academy of Sciences. Ecological Engineering 2: 159 - 161.