Wetlands Ecosystem Services Protocol for Alaska -Southeast Wetlands Review Board Methodology Workshop

with Dr. Paul Adamus, Adamus Resource Assessment and Debbie Hart, Southeast Alaska Fish Habitat Partnership, Facilitator

March 12, 2016, 8:30-5:30 p.m.
CBJ Assembly Chambers

AGENDA

A. Welcome, Introductions, and Purpose (8:30-9:00)

B. Overview of WESPAK-SE methodology, Dr. Paul Adamus (9:00-10:15)

Break (10:15-10:30)

C. Overview of CBJ Wetland Methodology, Dr. Paul Adamus (10:30-12:15)

D. Lunch on your own (12:15-1:15)

E. Southeast Alaska Land Trust use of WESPAK-SE, Allison Gillum, SEALTrust Director (1:15-1:45)

F. Wetlands Review Board Member Questions (from 11-19-15 WRB Meeting)

(1:45-5:30 with a 15 minute break from 3:15-3:30)

1. Explanation of how the metrics are calculated for the 22 functions and 18 values
2. Address the value determination for anadromous fish and an explanation of all 18 values
3. Walk through an example of how you would take a wetland analysis and categorize it; provide different versions of how you would do that.
4. Explain how a previous community took the data to categorize wetlands and how they used the data.
5. Explain how connectivity has or has not been addressed in the methodology (as addressed in NMFS' comments)
6. Explanation of specific bird habitat questions
7. Explanation of specific questions on amphibians and nitrogen fixers
8. Explanation of weighting for anadromous fish

G. Next steps. Questions unaddressed above plus additional questions.

H. Next Meeting

Wetlands Review Board Regular Meeting and Wetland Methodology Workshop continued, Thursday March 24, 5:15 pm - 8 pm, Marine View 4th floor conference room

Thursday April 7, wetland methodology workshop, 5:15 – 8 pm, Marine View 4th floor conference room

Thursday April 21,wetland methodology workshop and regular meeting, 5:15 pm – 8 pm City Hall room 224

Community Development

City & Borough of Juneau • Community Development
155 S. Seward Street • Juneau, AK 99801
(907) 586-0715 Phone • (907) 586-4529 Fax

DATE: March 3, 2016

TO: Wetlands Review Board

FROM: Teri Camery, Senior Planner
Community Development Department

SUBJECT: WESPAK-SE Wetlands Methodology Workshop Handouts

Dr. Adamus has asked me to provide the following handouts for the Saturday March 12 wetland methodology workshop, listed below:

1) Dr. Adamus' Curriculum Vitae

2) Table 1, pages 9-10, from the current draft of the Juneau Wetlands Management Plan, which provides the definitions for the functions and values used in the WESPAK-SE methodology

3) Pages 15-16 from the current draft of the Juneau Wetlands Management Plan, which provides an explanation of the limitations of the WESPAK-SE methodology

4) Page 26 and the first paragraph of page 27 from the current draft of the Juneau Wetlands Management Plan, which explains the watershed context used in the WESPAK-SE methodology

Please contact me at 586-0755 if you have any questions.

PAUL R. ADAMUS
6028 NW Burgundy Dr.
Corvallis, OR 97330
Email: adamus7@comcast.net
Reports: http://people.oregonstate.edu/~adamusp/

As a wetland scientist and ecologist, Dr. Adamus has twice been invited to testify on wetland matters to the U.S. Congress. He also testified as the sole expert witness on wetlands in a major legal case in Michigan. He is best known as the author of several rapid assessment methods and of WET (Wetland Evaluation Technique), developed originally for nationwide use by the Federal Highway Administration in the early 1980's and used widely by federal agencies for assessing the functions of wetlands in the decade that followed. Over the past 40 years he has authored over 100 publications, including 9 regional methods that use practical indicators to assess the ecosystem services of wetlands. He is currently nearing completion of a book on wetland and stream assessment on contract to Elsevier Publishers. He also is assisting the provincial governments of Alberta, New Brunswick, and Nova Scotia in developing and calibrating rapid methods for assessing functions of their boreal wetlands.

His involvement in Alaska extends back to 1986, when the City-Borough of Juneau contracted him to help apply science to their first effort to prioritize local wetlands. At the request of the Alaska District - Corps of Engineers, he trained their staff in wetland functions assessment in 1992, and taught similar courses to agencies and consultants in Juneau, Haines, and Anchorage in 2012-15.

He began his career at The Smithsonian's Center for Natural Areas and in 1987 accepted a contract position in EPA's National Wetlands Research Program in Corvallis, Oregon. For EPA, he helped develop a framework for cumulative impacts analysis, conducted research on requirements of wetland bird communities, and designed GIS-based wildlife habitat models for the Alternative Futures Analysis for the Willamette Valley. Ten years later he accepted a research faculty courtesy position at Oregon State University and simultaneously re-established his practice as a natural resources consultant exclusively to environmental agencies, communities, and non-profit organizations. From 1994-2000 he initiated and directed the Oregon Breeding Bird Atlas project, recruiting and coordinating over 800 volunteers in the largest wildlife inventory ever conducted in Oregon. He advises graduate student research at Oregon State University and has taught wetland assessment to hundreds of consultants, local planners, college students, and agency staff in 3 continents and many states. He is skilled at identifying and monitoring wetland plants, birds, amphibians, and aquatic invertebrates.

Education

Ph.D. Wildlife Science, Oregon State University, Corvallis
M.S. Biology (Aquatic), University of Utah, Salt Lake City
B.S. Wildlife Science, University of Maine, Orono

Current Positions

Oregon State University, Corvallis, Oregon (2002-present), Assistant Professor (Courtesy)
Water Resources Graduate Program, and
Marine Resource Management Program, and
Environmental Sciences Graduate Program
Institute of Applied Ecology (Estuarine Technical Group), Corvallis, Oregon. Principal Scientist.
Adamus Resource Assessment, Inc., Corvallis, Oregon. President. 1997-present.

Certified Verifier for Ecosystem Services Crediting Program, Willamette Partnership
HAZWOPR certification

Prior Positions

Dynamac International, Inc., Rockville, MD, Senior Ecologist, 1996-1998

- Designed a statistically-valid study to investigate possible impacts of acid mine drainage at a Superfund site near Redding, California, on behalf of plaintiffs (the USDI Bureau of Land Management and others) in litigation under the National Resource Damage Act (NRDA). Then directed and helped conduct an extensive survey of riparian plants, birds, and amphibians which established harm to the watershed's resources.
- Led effort to define a statistically valid strategy for resampling 4000 stream reaches and wetlands in the western United States.

USEPA Wetlands Research Program, Environmental Research Laboratory, Western Ecology Division, Corvallis, Oregon. Project Scientist on contract to EPA for:
Dynamac International, Inc., 1996-1997
ManTech Environmental Research Services Corporation, 1989-1996
Northrop Services Incorporated, 1987-1989.

- Authored or co-authored major EPA reports: ecological indicators, impacts to wetlands, biodiversity, wetlands biomonitoring methods, cumulative impact assessment.
- Wrote book chapters: riparian classification, state wetland programs, wetland birds as indicators.
- Designed and conducted research: habitat requirements of riparian and wetland birds at multiple scales.
- Organized and chaired national symposia: wetlands water quality, wildlife indicators.
- Was called upon frequently by EPA regional offices and states for wetland technical assistance.

Adamus Resource Assessment, Inc., Augusta, Maine (Principal), 1985-1987

- Designed and directed comprehensive wetlands analysis project for City-Borough of Juneau, Alaska. Obtained support of regulatory agencies. Implemented community involvement program. Designed, supervised, and helped conduct field data collection (salmonids, stream & estuarine wetland habitat, birds, water quality, groundwater) to calibrate functional assessment models for regional use.
- Delineated jurisdictional wetlands and prepared mitigation plans. Assisted private clients with permit negotiations.
- Assisted the Wetlands Research Program of the US Army Corps of Engineers.
- Trained wetlands personnel from the USEPA and US Army Corps of Engineers.

EcoAnalysts Inc., Bath, Maine, Senior Scientist, 1983-1985
Co-directed statewide monitoring of biological effects of forest pesticides.

Maine Department of Energy, 1983
Published an analysis of strategies for development of tidal power in Maine estuaries.

Center for Natural Areas, Gardiner, Maine, Scientist, then Senior Scientist, 1976-1982
Prepared and published several dozen "best management practices" manuals, biological surveys, impact statements, and risk assessments for national nonprofit research institute affiliated with the Smithsonian Institution, under contract to government agencies.

Oak Ridge National Laboratory, Oak Ridge, Tennessee, research intern, summer 1971
Designed and conducted study of power plant impacts on zooplankton.

Maine Department of Inland Fisheries & Wildlife, intern, summers 1969 & 1970
Did field assessments for statewide wetlands inventory, led wildlife refuge tour groups.

Wetland Program Consultations

State/Province/Tribe Wetland Program Consultations:
Alberta, Nova Scotia, New Brunswick, Maine, Alaska, Washington, Oregon, Michigan, North Carolina, Illinois, Oklahoma, Confederated Tribes of the Umatilla Indian Reservation, Tulalip Tribe, Upper Skagit Tribe

Regional Wetland Functional Assessment Projects:
Klamath Region (Lassen Volcanic & Crater Lakes National Parks)
Oregon Coast: HGM data collection, model development, and application
Willamette Valley, Oregon: HGM data collection, model development, and application
Juneau, Alaska: Wetlands Management Plan (the second such plan approved in the U.S.)
New Jersey (Hackensack Meadowlands, Raritan Estuary)
Salt Lake City, Utah: Wetlands Advanced Identification Project
Southern Maine: Wetlands Advanced Identification Project
Washington (Mill Creek Watershed): Special Area Management Plan
Washington (Puget Sound - Island County and San Juan County)

Review Committees for Awards or Project Funding Decisions

National Wetland Achievement Awards (Environmental Law Institute)
US Environmental Protection Agency (STAR grants)
EPA Region 9/ Pima County (Independent Scientific Review Team for Arid West Water Quality Research Program)
Fund for Ornithology (Oregon Field Ornithologists, Committee Chair)

Graduate Students Recently Advised

Michael Anderson, Cheryl Barlett, Tyler Beemer, Jacqueline Brenner, Julie Custer Doumbia, Elise Ferrarese, Joshua Grabel, Jennifer Larsen, Russell Scranton, Rebecca Tully, Bill Buckley, Megan MacClellan, Heather Hill, Sara Wyland, Ben Wishnek.

Publications of Paul R. Adamus

1. Wetland/Riparian Publications

Adamus, P.R. and P. Harris. 2016. *Nearshore Assessment Tool for Southeast Alaska.* Report and software for the Southeast Alaska Land Trust and US Fish & Wildlife Service, Juneau, AK.

Adamus, P.R. 2016. *Wetland Ecosystem Services Protocol for Atlantic Canada (WESP-AC).* Report and software for Nova Scotia Dept. of Environment and New Brunswick Dept. of Environment & Local Government, Fredericton, NB.

Adamus, P.R., M. Wilson, and M. Trites-Russell. 2016. *Alberta Wetland Rapid Evaluation Tool (ABWRET): Boreal Region.* Alberta Dept. of Environment & Parks, Edmonton, AB.

Adamus, P.R. 2013. *Wetland Ecosystem Services Protocol for Southeast Alaska (WESPAK-SE).* Report and software for the Southeast Alaska Land Trust and US Fish & Wildlife Service, Juneau, AK.

Adamus, P.R. 2014. *Wetland Research and Monitoring Strategy: Forest Practices and Wetlands.* Cooperative Monitoring Evaluation and Research Report CMER 12-1203. Washington State Forest Practices Adaptive Management Program. Washington Department of Natural Resources, Olympia, WA.

Adamus, P.R. 2014. *Effects of Forest Roads and Tree Removal in or Near Wetlands of the Pacific Northwest: A Literature Synthesis.* Cooperative Monitoring Evaluation and Research Report CMER 12-1202. Washington State Forest Practices Adaptive Management Program. Washington Department of Natural Resources, Olympia, WA.

Adamus, P.R. 2013. *Wetland Ecosystem Services Protocol for Southeast Alaska (WESPAK-SE).* Report and software for the Southeast Alaska Land Trust and US Fish & Wildlife Service, Juneau, AK. http://people.oregonstate.edu/~adamusp/Alaska/WESPAK_SE/

Adamus, P.R. 2013. *Wetland Ecosystem Services Protocol for Southern Alberta (WESPAB).* Report and software for Alberta Environment and Water, Government of Alberta, Edmonton, AB.

Adamus, P.R. 2013. *A Protocol for Rapidly Assessing and Comparing Nearshore Marine Habitats in Puget Sound, Washington.* Report and software for AECOM Inc. and US Navy, Bremerton, WA.

Adamus, P.R. 2013. *Wetland functions: Not only about size.* National Wetlands Newsletter, September - October 2013. pp. 18-19.

Adamus, P.R. 2012. *A Protocol and Metric for Rapidly Assessing Floodplain Habitat in the Western United States.* Peer-reviewed report for the USDA-NRCS and Defenders of Wildlife, West Linn, OR.

Adamus, P.R. 2011. *Best Available Science for Wetlands and Their Buffers in San Juan County, Washington.* Report to San Juan County Dept. of Community Development & Planning, Friday Harbor, WA. http://www.co.san-juan.wa.us/cdp/docs/CAO_BASsynthesis/FINAL_WetlandsBAS_2011-05-20.pdf

Adamus, P.R. 2011. *Best Available Science for Streams and Upland Habitats of San Juan County, Washington.* Report to San Juan County Dept. of Community Development & Planning, Friday Harbor, WA. http://www.co.san-juan.wa.us/cdp/docs/CAO_BASsynthesis/FINAlUplandBAS_2011-05-20.pdf

Adamus, P.R. 2010. *Survey of the Ecological Condition and Functions of Enhanced, Restored, and Reference Wetlands in the Willamette Valley, Oregon.* Report to Oregon Watershed Assessment Board (OWEB). http://people.oregonstate.edu/~adamusp/Willamette/OWEB%20Willamette%20Veg%20Data/

ESA Adolfson Inc. and P.R. Adamus. 2011. *Updated Local Wetland Inventory for Creswell, Oregon.* Report to Lane County Council of Governments, Eugene, OR.

ESA Adolfson Inc. and P.R. Adamus. 2011. *Local Wetland Inventory for the Upper Deschutes River Area, Oregon.* Report to Upper Deschutes Watershed Council, Bend, OR. http://www.deschutes.org/getattachment/e83cd887-1da5-4fa4-82b7-ac7b62b0b298/South-Deschutes-County-Local-Wetland-Inventory-Rep.aspx

Adamus, P., J. Christy, A. Jones, M. McCune, and J. Bauer. 2010. *A Geodatabase and Digital Characterization of Wetlands Mapped in the Willamette Valley With Particular Reference to Prediction of Their Hydrogeomorphic (HGM) Class.* Report to USEPA Region 10, Portland, OR. http://people.oregonstate.edu/~adamusp/Willamette/WillametteGeodatabase2010/

Adamus, P., J. Morlan, and K. Verble. 2010. *Wetland Ecosystem Services Protocol for the United States (WESPUS).* Beta test version 1.0. http://people.oregonstate.edu/~adamusp/WESPUS/

Adamus, P. 2010. *Strategies and Procedures for Testing Rapid Protocols Used to Assess Ecosystem Services.* Report to the Willamette Partnership, Salem, OR. http://people.oregonstate.edu/~adamusp/WESPUS/

Brophy, L., J. Doumbia, P. Adamus, J. Christy, C. Cornu, and R. Tully. 2010. *User's Guide to the Temperature Logger Method for Determining Tidal Inundation Regime.* Prepared for the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET). http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/25763/02%20Brophy-Cornu_UsersGuide_TSM_FINAL_30-Aug-2011.pdf?sequence=3

Adamus, P.R. and K. Bosworth. 2010. *Delineation and Functional Rating of Jurisdictional Wetlands on Two City-owned Parcels in Juneau, Alaska.* Community Development Department, Juneau, AK.

Adamus, P., J. Morlan, and K. Verble. 2009. *Oregon Rapid Wetland Assessment Protocol (ORWAP): calculator spreadsheet, databases, and data forms.* Oregon Dept. of State Lands, Salem, OR. http://oregonstatelands.us/DSL/WETLAND/or_wet_prot.shtml

Adamus, P., J. Morlan, and K. Verble. 2009. *Manual for the Oregon Rapid Wetland Assessment Protocol (ORWAP).* Version 2.0. Oregon Dept. of State Lands, Salem, OR. http://oregonstatelands.us/DSL/WETLAND/or_wet_prot.shtml

Rempel, M., P. Adamus, and J. Kagan. 2009. *Oregon Wetlands Explorer: an internet tool for ORWAP wetland assessment support and data archiving.* Oregon State University Library and Institute for Natural Resources, Oregon State University, Corvallis, OR. http://oregonexplorer.info/wetlands/orwap/

Willamette Partnership, Parametrix, and P.R. Adamus. 2009. *Crediting and Debiting of Ecosystem Services.* Counting on the Environment Project: http://www.willamettepartnership.org/ongoing-projects-and-activities/nrcs-conservation-innovations-grant-1/nrcs-conservation-innovations-grant

Adamus, P.R. and C.L. Bartlett. 2008. *Wetlands of Crater Lake National Park: An Assessment of Their Ecological Condition.* Natural Resource Technical Report NPS/KLMN/NRTR—2008/115. National Park Service, Fort Collins, CO. http://science.nature.nps.gov/im/units/klmn/Inventories/Adamus_Wetland/Adamus_Wetland.cfm

Adamus, P. R., and C. L. Bartlett. 2008. *Wetlands of Lassen Volcanic National Park: An Assessment of Vegetation, Ecological Services, and Condition.* Natural Resource Technical Report NPS/KLMN/NRTR—2008/113. National Park Service, Fort Collins, Colorado. http://science.nature.nps.gov/im/units/klmn/Inventories/Adamus_Wetland/Adamus_Wetland.cfm

Adamus, P.R. 2007. *Wildlife Species Associations with Specific Attributes of the Wetland Vegetation Communities of Michigan* Report and database prepared for the Michigan Natural Features Inventory and Michigan Department of Transportation.

Albert, D.A., P. Adamus, D. Campbell, J. Christy, J.G. Cohen, T. Cook, H. Enander, L. Hardison, M. A. Kost, K. Mitchell, J. Sackinger, and B. F. Slaughter. 2007. *Rapid wetland assessment for Michigan: biological framework.* Report to Michigan Department of Transportation. Michigan Natural Features Inventory, Oregon State University, and Adamus Resource Assessment, Inc.

Adamus, P.R. and K. Bosworth. 2007. *Delineation and Functional Rating of Jurisdictional Wetlands on Potentially Developable City-owned Parcels in Juneau, Alaska.* Community Development Department, Juneau, AK. http://www.juneau.org/cddftp/documents/FinalWetland1-011707.pdf

Adamus, P.R. 2007. *Best Available Science for Wetlands of Island County, Washington: Review of Published Literature.* Report to Island County Dept. of Planning & Community Development, Coupeville, WA. Internet: http://www.islandcounty.net/planning/criticalareas/wetlands/

Adamus, P.R., J. Burcar, K. Harma, C. Luerkens, A. Boscolo, J. Coleman, and M. Kershner. 2006. *Wetlands of Island County, Washington: Profile of Characteristics, Functions, and Health.* Report to Island County Dept. of Planning & Community Development, Coupeville, WA. Internet: http://www.islandcounty.net/planning/criticalareas/wetlands/Phase1_Complete-doc.pdf

Adamus, P.R., M. Pakenham-Walsh, and N. McCarten. 2006. *Hydrogeomorphic (HGM) method for assessing functions and values of vernal pool wetlands of the Agate Desert, Medford, Oregon.* Report to Oregon Dept. of State Lands, Salem.

Lev, E., R. van der Schaaf, J. Christy, K. Popper, P. Adamus, and J. Alexander. 2006. *Young's Bay conservation and restoration plan.* Report of The Nature Conservancy (Oregon Chapter) and The Wetlands Conservancy to the US Fish & Wildlife Service, Portland, OR. http://people.oregonstate.edu/~adamusp/ColumbiaEstuary/

Adamus, P.R. 2006. *Wetland mitigation performance standards and permit tracking systems: a survey of State programs.* Report to the Association of State Wetland Managers.

Adamus, P.R. and N. Holzhauser. 2006. *Wetland restoration plan for the Yachats Commons Park.* Report to City of Yachats, Oregon. http://people.oregonstate.edu/~adamusp/Yachats/Yachats%20wetland%20restoration%20plan.pdf

Adamus, P.R. 2006. *Hydrogeomorphic (HGM) Assessment Guidebook for Tidal Wetlands of the Oregon Coast: Part 1. Rapid Asssessment Method.* Produced for the Oregon Department of State Lands, USEPA, and Coos Watershed Association. Internet: www.oregonstate.edu/~adamusp/HGMTidal

Adamus, P.R. 2006. *Science Review and Data Analysis Results For Tidal Wetlands of the Oregon Coast: Volume 2 of a Hydrogeomorphic Guidebook.* Oregon Department of State Lands, USEPA, and Coos Watershed Association. Internet: www.oregonstate.edu/~adamusp/HGMTidal

Adamus, P.R., R. Scranton, and J. Larsen. 2006. *Wetland profiles of Oregon's coastal watersheds and estuaries. Volume 3 of a Hydrogeomorphic Guidebook.* Oregon Department of State Lands, USEPA, and Coos Watershed Association. Internet: www.oregonstate.edu/~adamusp/HGMTidal

Adamus, P.R. 2006. *HGM-based Function Assessment of the Proposed Nygaard (Johnson Farm) Wetland Mitigation Bank, Youngs Bay, Astoria, Oregon.* Report to Warrenton Fibre Company, Warrenton, OR.

Adamus, P.R. 2005. *Software and database for selected tidal wetlands of the Oregon Coast.* Oregon Department of State Lands, USEPA, and Coos Watershed Association. Internet: www.oregonstate.edu/~adamusp/HGMTidal

Adamus, P.R. 2005. *Assessment of functions and potential mitigation credits from proposed Wilbur Mitigation Bank, Florence, Oregon.* Report to MBRT, Wetlands Program, Oregon Dept. of State Lands, Salem.

Adamus, P.R. et al. in review. *Position paper on appropriate use of rapid methods for assessment of wetlands.* Society of Wetland Scientists and Association of State Wetland Managers.

Adamus, P.R. 2005. *An assessment of wetland restoration and enhancement potential on Metro properties.* Metro Department of Parks and Greenspaces, Portland, OR. http://people.oregonstate.edu/~adamusp/PDX_Metro/

Adamus, P.R. 2004. *Classification, Assessment, Monitoring, and Evaluation of Riverine and Palustrine Wetland Ecosystems.* Chapter 12 In: M. McKinstry (ed.). Wetland and Riparian Areas of the Intermountain West. University of Texas Press. http://www.utexas.edu/utpress/books/mckwet.html

Adamus, P.R. 2002-2009. *Annual monitoring reports for the Amazon Wetland Mitigation Bank.* Oregon Department of State Lands and Mitigation Bank Review Team (MBRT).

Lev, E., R. van der Schaaf, J. Christy, P. Adamus, and J. Alexander. 2004. *Scappoose Bay Bottomlands conservation and restoration plan.* Report of The Nature Conservancy (Oregon Chapter) and The Wetlands Conservancy to the Scappoose Bay Watershed Council, Lower Columbia River Estuary Partnership, and USEPA.

Adamus, P.R. 2004. *Comparison of bird use of nearshore wetland habitats along the Raritan Estuary during summer 2003.* Report to PSS, Inc., Warren, NJ.

Adamus, P.R. 2004. *Functions of diked and restored wetlands of the Raritan Estuary, New Jersey: a literature synthesis.* Report to PSS, Inc., Warren, NJ.

Windham, L. and P.R. Adamus. 2004. *Analysis of nitrogen processing and other water quality functions of Phragmitis australis wetlands of the Raritan Estuary during summer 2003.* Report to PSS, Inc., Warren, NJ.

Adamus, P.R., J. Webster, C. Shippentower, S. O'Daniel, D.E. Williams, and S. Minthorn. 2002. *Umatilla River Floodplain and Wetlands: A Quantitative Characterization, Classification, and Restoration Concept.* Confederated Tribes of the Umatilla Indian Reservation, Pendleton, OR. http://www.umatilla.nsn.us/database/wetlands

Adamus, P.R., T.J. Danielson, and A. Gonyaw. 2001. *Indicators for Monitoring Biological Integrity of Inland Freshwater Wetlands: A Survey of North American Technical Literature (1990-2000).* Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA843-R-01. http://www.epa.gov/owow/wetlands/bawwg/monindicators.pdf

Teels, B.M. and P.Adamus. 2001. *Methods for Evaluating Wetland Condition: Developing Metrics and Indexes of Biological Integrity*. United States Environmental Protection Agency, Office of Water, Washington, DC. EPA 822-R-02-016. http://www.epa.gov/waterscience/criteria/wetlands/6Metrics.pdf

U.S. EPA. 2001. *Methods for Evaluating Wetland Condition: Biological Assessment Methods for Birds.* Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA-822-R-02-023. http://www.epa.gov/waterscience/criteria/wetlands/13Birds.pdf

Adamus, P.R. 2001. *Guidebook for Hydrogeomorphic (HGM)–based Assessment of Oregon Wetland and Riparian Sites. Statewide Classification and Profiles.* Oregon Department of State Lands, Salem, OR. http://statelands.dsl.state.or.us/hgm_guidebook.htm

Adamus, P.R. and D. Field. 2001. *Guidebook for Hydrogeomorphic (HGM)–based Assessment of Oregon Wetland and Riparian Sites. I. Willamette Valley Ecoregion, Riverine Impounding and Slope/Flat Subclasses. Volume IA: Assessment Methods.* Oregon Department of State Lands, Salem, OR. http://statelands.dsl.state.or.us/hgm_guidebook.htm

Adamus, P.R. 2001. *Guidebook for Hydrogeomorphic (HGM)–based Assessment of Oregon Wetland and Riparian Sites. I. Willamette Valley Ecoregion, Riverine Impounding and Slope/Flat Subclasses. Volume IB: Technical Report.* Oregon Department of State Lands, Salem, OR. http://statelands.dsl.state.or.us/hgm_guidebook.htm

Adamus, P.R. and A. Gonyaw. 2001. *National Database of Wetland Plant Sensitivities to Enrichment and Hydrologic Alteration.* Office of Water, U.S. Environmental Protection Agency, Washington, DC. http://www.epa.gov/owow/wetlands/bawwg/publicat.html

Adamus, P.R. and A. Gonyaw. 2001. *National Database of Wetland Invertebrate Sensitivities to Enrichment and Hydrologic Alteration.* Prepared for Office of Water, U.S. Environmental Protection Agency, Washington, DC. http://www.epa.gov/owow/wetlands/bawwg/publicat.html

Bolte, J.P., M. Santelmann, P. Adamus, C. Smith, J. Li, P. Jepson, F. Lamy, K. Vache, and C. Langpap. 2001. *Integrating ecological, economic, and social goals in restoration decisionmaking.* In: Proceedings, Integrated Decisionmaking for Watershed Management Symposium, Chevy Chase, MD.

Adamus, P.R. and L. Fish. 2000. *Biological Evaluation of the Willamette River and McKenzie River Confluence Area. II. Restoration of Wildlife and Riparian Habitat.* Report to the McKenzie Watershed Council, Springfield, OR.

Adamus, P.R. 1999. *Wetlands.* pp. 695-697 In: D.E. Alexander and R.W. Fairbridge. Encyclopedia of Environmental Science. Kluwer Academic Publishers, Boston, MA.

Adamus, P.R. 1996. *Bioindicators for Assessing Ecological Integrity of Prairie Wetlands.* EPA/600/R-96/082. USEPA Environmental Research Laboratory, Corvallis, OR. http://www.epa.gov/owow/wetlands/wqual/ppaindex.html

Adamus, P.R. 1995. *Validating a habitat evaluation method for predicting avian richness.* Wildlife Society Bulletin 23:743-749.

Rosen, B.H., P. Adamus, and H. Lal. 1995. *A conceptual model for the assessment of depressional wetlands in the Prairie Pothole Region.* Wetlands Ecology and Management 3(4): 195-208

Adamus, P.R. 1993. *User's manual: Avian richness evaluation method (AREM) for lowland wetlands of the Colorado Plateau.* EPA/600/R-93/240. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR. http://www.epa.gov/owow/wetlands/wqual/arem_man/

Adamus, P.R. and R. Owen. 1993. *Computer program: Avian richness evaluation method (AREM) for lowland wetlands of the Colorado Plateau.* U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R. 1993. *Irrigated wetlands of the Colorado Plateau: Information synthesis and habitat evaluation method.* EPA/600/R-93/071. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR. http://www.epa.gov/owow/wetlands/wqual/wetlands_co.html

Leibowitz, S.G., B. Abbruzzese, P.R. Adamus, L.E. Hughes, and J.T. Irish. 1992. *A synoptic approach to cumulative impact assessment.* EPA/600/R-62/167. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R. 1992. *Condition, Values, and Loss of Natural Functions of Prairie Wetlands of the North-Central United States.* EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR. http://www.epa.gov/OWOW/wetlands/wqual/appendixb.html

Adamus, P.R. 1992. *Conceptual Process Model for Basin-type Wetlands of the Prairie Pothole Region.* EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR. http://www.epa.gov/owow/wetlands/wqual/pphmodel.html

Adamus, P.R. 1992. *Data sources and evaluation methods for addressing wetland issues.* pp. 171-224 In: *Statewide Wetlands Strategies.* World Wildlife Fund and Island Press, Washington, D.C.

Adamus, P.R. 1992. *Choices in monitoring wetlands.* pp. 571-592 In: Ecological Indicators. Elsevier Applied Science, New York, NY.

Adamus, P.R., E.J. Clairain, Jr., D.R. Smith, and R.E. Young. 1992. *Wetland Evaluation Technique (WET). Volume I. Literature Review and Evaluation Rationale.* U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Adamus, P.R. 1991. *Potential approaches for classification of wetland uses for protecting wetland quality.* Conditionally accepted for publication in Water Resources Bulletin.

Adamus, P.R. 1991. *Use of water quality characteristics in classification of nonpoint pollution control priorities.* Conditionally accepted for publication in Journal of the Water Pollution Control Federation.

Adamus, P.R. and T. Muir. 1990. *Method for Assessment of bottomland hardwood functions.* U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R. 1990. Indicators for wetlands. In *Environmental Monitoring and Assessment Program ecological indicators.* EPA/600/3-90/060. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR

Adamus, P.R. and K. Brandt. 1990. *Impacts on Quality of Inland Wetlands of the United States: A Survey of Indicators, Techniques, and Applications of Community Level Biomonitoring Data.* EPA/600/3-90/073 (NTIS PB 113 837/AS). USEPA Environmental Research Lab, Corvallis, Oregon. http://www.epa.gov/owow/wetlands/wqual/introweb.html

Adamus, P.R. 1989. *Determining the cumulative effects of forested wetlands: EPA's research program, and choices for research and monitoring designs*. pp. 36-47 In Best management practices for forest wetlands: Concerns, assessment, regulation, and research. National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI), Corvallis, OR.

Adamus, P.R., J.S. Larson, and E.J. Clairain, Jr. 1989. *Functional Assessment of Freshwater Wetlands: A Manual and Training Outline.* Publication No. 89-6. World Wildlife Fund, Gland, Switzerland, and The Environmental Institute, University of Massachusetts, Amherst. 62 pp.

Adamus, P.R. 1989. *Wetlands and Water Quality: EPA's Research and Monitoring Implementation Plan for the Years 1989-1994.* USEPA Environmental Research Lab, Corvallis, Oregon. 44 pp.

Adamus, P.R. 1989. *Technical Information Sources for Support of USEPA Advanced Identification Projects.* USEPA Office of Wetlands Protection, Washington, DC.

Adamus, P.R. 1988. *Criteria for created or restored wetlands*. pp.369-372 In: D.D. Hook et al. (eds.). The Ecology and Management of Wetlands. Vol. 2: Management, Use and Value of Wetlands. Croom Helm, London & Sydney.

Adamus, P.R. 1988. *The FHWA (WET) method for wetland functional assessment.* pp. 128-136 In: D.D. Hook et al. (eds.). The Ecology and Management of Wetlands. Vol. 2: Management, Use and Value of Wetlands. Croom Helm, London & Sydney.

Adamus, P.R. 1987. *Juneau Wetlands: An Analysis of Functions and Values.* USEPA and Dept. of Community Development, Juneau, Alaska. http://oregonstate.edu/~adamusp/Puget/Juneau_Wetlands.pdf

Adamus, P.R., E.J. Clairain, R.D. Smith, and R.E. Young. 1987. *Wetland Evaluation Technique (WET). Volume II. Methodology.* US Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Adamus, P.R. 1986. *The Cumulative Impacts of Development in Southern Maine. Wetlands: Their Locations, Functions, and Value.* Eco-Analysts, Inc., report to Maine State Planning Office, Augusta.

Adamus, P.R. 1985. *Inventory and Management Plan for Kahrl Freshwater Marsh, Bath, Maine.* Eco-Analysts, Inc., report to landowner.

Adamus, P.R. (contributor). 1984. *Proceedings of the National Wetlands Value Assessment Workshop.* FWS/OBS-84/12. U.S. Fish & Wildl. Serv., Washington, D.C.

Adamus, P.R. and L.T. Stockwell. 1983. *A Method for Wetland Functional Assessment.* Vol. I. Critical Review and Evaluation Concepts. Report No. FHWA-IP-82-23. Federal Highway Administration, Washington, D.C.

Adamus, P.R. 1983. *A Method for Wetland Functional Assessment.* Vol. II. Methodology. Report No. FHWA-IP-82-24. Federal Highway Administration, Washington, D.C.

Adamus, P.R. 1982. *Wetlands Ordinance, Inventory, and Access Analysis*. Town of Kennebunk, Maine.

2. Ecological Inventory, Assessment and Management

Adamus, P.R., G. Jones, D. Odion, and L. Groshong. 2013. *An Assessment of Natural Resource Conditions for Crater Lake National Park.* Peer-reviewed report for National Park Service, Fort Collins, CO.

Adamus, P.R., G. Jones, D. Odion, and L. Groshong. 2013. *An Assessment of Natural Resource Conditions for Lassen Volcanic National Park.* Peer-reviewed report for National Park Service, Fort Collins, CO.

Adamus, P.R., G. Jones, D. Odion, and L. Groshong. 2013. *An Assessment of Natural Resource Conditions for Lava Beds National Monument.* Peer-reviewed report for National Park Service, Fort Collins, CO.

Adamus, P.R. 2012. *A Protocol and Metric for Rapidly Assessing Oak Woodland and Savanna in the Western United States.* Peer-reviewed report for the USDA-NRCS and Defenders of Wildlife, West Linn, OR.

Adamus, P.R. 2012. *A Protocol and Metric for Rapidly Assessing Sagebrush Habitat in the Western United States.* Peer-reviewed report for the USDA-NRCS and Defenders of Wildlife, West Linn, OR.

Adamus, P.R. 2009. *Protocol for Rapidly Assessing the Ecological Condition of Upland Prairies.* Peer-reviewed report of the Willamette Partnership, Salem, OR.

Adamus, P.R., C. Wilson, K. Harma, and J. Marcel. 2008. *Island County Surface Water Monitoring Program.* Year 1 Annual Report of the Island County Dept. of Planning & Community Development, Coupeville, WA. http://people.oregonstate.edu/~adamusp/IslandCountyWA/

Adamus, P.R. 2007. *Profiles of 30 methods for assessing ecological condition of terrestrial ecosystems.* Database for National Biological Information Infrastructure, National Park Service, Fort Collins, CO. http://assessmentmethods.nbii.gov/

Adamus, P.R., J. Eilers, and Island County Dept. of Planning & Community Development. 2006. *Water Quality Data Synthesis and Recommendations for a Surface Freshwater Monitoring Program.* Island County Dept. of Planning & Community Development, Coupeville, WA.

Adamus, P.R. 2004. *Protection, Restoration, and Management of Terrestrial Habitats and Species of the Willamette Sub-Basin. Technical Appendix D.* In: Willamette Subbasin Plan. Northwest Power Conservation Council, Portland, OR. http://www.nwcouncil.org/fw/subbasinplanning/willamette/plan/

Adamus, P.R. 2004. *Amphibians and Reptiles of Green Island, Willamette River: Survey Data and Management Recommendations.* McKenzie River Trust, Eugene, OR. http://www.registerguard.com/news/2004/05/30/c1.cr.greenisland.0530.html

Adamus, P.R. (co-PI, with EarthDesign). 2004. *Luckiamute Watershed Assessment.* Luckiamute Watershed Council, Monmouth, OR.

Adamus, P.R. (contributor, with Ecotrust, Salix Associates, Winterbrook Associates, PHS Inc.). 2004. *Corvallis Natural Features Inventory.* Planning Dept., City of Corvallis, OR. http://www.inforain.org/corvallis/

Adamus, P.R. 2003. *Distribution of Western Pond Turtle Populations in the Willamette River Basin, Oregon: Field Survey and Literature Review.* Interagency Western Pond Turtle Working Group, Eugene, OR.

Adamus, P.R. 2003. *Potential For Conservation and Restoration of Western Pond Turtle Habitat in the Willamette River Basin.* Interagency Western Pond Turtle Working Group, Eugene, OR.

Adamus, P.R. 2003. *Bullock's Oriole.* detailed literature synthesis in: Marshall, D., M. Hunter, and A. Contreras (eds.). Birds of Oregon: A General Reference. Oregon State University Press, Corvallis, OR

Adamus, P.R. 2002. *Multiscale relationships of wintering birds with riparian and wetland habitat in the Willamette Valley, Oregon.* Doctoral dissertation, Oregon State University, Corvallis, OR.

Adamus, P.R., K. Larsen, G. Gillson, and C. Miller. 2001. *Oregon Breeding Bird Atlas.* Oregon Field Ornithologists, Eugene, OR. http://thebirdguide.com/atlas/atlas.htm

Adamus, P.R. 2000. *Terrestrial Vertebrate Species of the Willamette River Basin: A Species-Habitat Relationships Matrix and Spatial Modeling Approach.* Report to the USEPA Environmental Research Laboratory, Corvallis, OR. http://www.fsl.orst.edu/pnwerc/wrb/access.html

Schumaker, N. and P.R. Adamus. 2000. *User Manual For PATCH, A Spatially-Explicit Computer Model For Wildlife Demographic Forecasting.* U.S. Environmental Protection Agency, Corvallis, OR.

Adamus, P.R. and D. Thomas. 1998. *Sample size and database requirements for resampling and reporting BLM's attainment of the national riparian PFC Goal.* Dynamac, Inc. report and software for USDI Bureau of Land Management, Washington, DC.

Adamus, P.R. 1997. *A characterization of early-summer terrestrial fauna and flora associated with acid mine drainage areas in the vicinity of Iron Mountain, Redding, California.* Dynamac, Inc. report to USDI Bureau of Land Management, Denver, CO.

Adamus, P.R. and M.E. Kentula. 1995. *An evaluation of avian richness in Willamette Valley wetlands and riparian areas: Research plan.* EPA/600/R-95/025. Corvallis, OR: U.S. Environmental Protection Agency, Environmental Research Laboratory.

Adamus, P.R. 1995. *Handbook for participants: Oregon Breeding Bird Atlas Project.* Corvallis Environment Center, Corvallis, OR.

Adamus, P.R. (Editor and Regional Coordinator). 1987. *An Atlas of Birds Breeding in Maine, 1978-1983.* Maine Department of Inland Fisheries and Wildlife, Bangor, ME.

Adamus, P.R., P. Leeper, C. Spies, and H.L. Brown. 1984, 1985. *Long-term environmental monitoring study of Maine's forest ecosystems (birds, aquatic invertebrates).* Maine Forest Service, Augusta, Maine.

Adamus, P.R. 1985. *A wildlife baseline for northern Maine forests.* Appalachian Mountain Club, Boston, MA.

Adamus, P.R. 1983. *Techniques for Monitoring the Environmental Impact of Insecticides on Aquatic Ecosystems.* Agriculture Handbook No. 613. USDA Forest Service, Broomall, PA.

Adamus, P.R. 1983. *Shorebirds of Muscongus Bay, Maine.* Maine Department of Inland Fisheries and Wildlife, Bangor, Maine.

Adamus, P.R., P. Leeper, and H.L. Brown. 1983. *Assessment of aquatic invertebrates in the Magalloway River below Aziscohos Dam.* Central Maine Power Company, Augusta, Maine.

Adamus, P.R. 1982. *Shorebirds of Sheepscot, Kennebec, and Damariscotta Estuaries.* Maine Dept. of Inland Fisheries and Wildlife, Bangor.

Hynson, J.R., S.W. Tibbetts, P.R. Adamus, and R. Darnell. 1982. *Handbook for Protection of Fish and Wildlife from Construction of Farm and Forest Roads.* U.S. Fish & Wildlife Service, Washington, D.C.

Adamus, P.R. (contributor). 1981. *A Search for Possible Effects of Orthene on Bird Reproduction.* Maine Forest Service, Augusta, Maine.

Adamus, P.R. 1980. *Benthic Invertebrates as Water Quality Indicators: St. Croix River.* Maine Dept. of Environmental Protection, Augusta, Maine.

Adamus, P.R. 1980. *Marine Birds.* In: A Summary and Analysis of Environmental Information on the Continental Shelf and Blake Plateau from Cape Hatteras to Cape Canaveral. U.S. Bureau of Land Management, New York, NY.

Adamus, P.R. (contributor). 1980. *A Resource Management Plan for Santa Catalina Island.* Dept. of Parks and Recreation, County of Los Angeles, California.

Adamus, P.R. (contributor). 1980. *Aberdeen Proving Ground Natural Resources Management Plan.* Army Corps of Engineers, Philadelphia, Pennsylvannia.

Adamus, P.R. 1985. *Environmental Risk Assessment of 10 Pesticides Used in Maine: Literature Review and Synopses.* Maine Board of Pesticides Control, Augusta.

Adamus, P.R. 1985. *Impacts of forest management practices on stream ecosystems and wetlands.* pp. 91-106 In: Symposium on Fish and Wildlife Impacts of Forest Management. Maine Agric. Exp. Stn. Misc. Pub. 689.

Hynson, J.R., P.R. Adamus, J.O. Elmer, and T. Dewan. 1984. *Environmental Features for Levee Projects.* U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Contract DACW39-82-C-0027.

Adamus, P.R. 1983. *User handbook on SCS and U.S. Fish and Wildlife Service Cannel Modification Guidelines.* U.S. Fish & Wildlife Service, Washington, D.C.

Adamus, P.R. (contributor). 1985. *Ecological Assessment: Great Diamond Island.* Dictar Associates Project. Land Use Consultants, Portland, Maine.

Adamus, P.R. 1984. *Foster (Ingalls) Pond, Bridgeton, Maine: Historical and Recommended Water Levels for Ecological Management.* Maine Dept. of Environmental Protection, Augusta.

Adamus, P.R. (contributor). 1983. *BTI Efficacy and Non-Target Effects When Sprayed for Salt Marsh Mosquito Control in Maine.* Georgetown Mosquito Committee, Georgetown, Maine.

Adamus, P.R. 1983. *Potential Economic and Technical Feasibility of Tidal Power in Maine.* Maine Office of Energy Resources, Augusta.

Adamus, P.R. 1983. *Maine Science Curriculum Studies Program: Birds and Reptiles.* Downeast Press, Rockland, Maine.

Adamus, P.R. 1982. *Vail Estate Ecological Management Plan.*

Adamus, P.R. 1982. *Maple Juice Cove Ecological Management Plan.*

Adamus, P.R. and T. Bigford. 1980. *Issues in Mapping Atlantic Coast Ecological Data.* pp.160-178 In: Coastal Zone '80: Proceedings of the Second Symposium on Coastal and Ocean Management. Amer. Soc. Civil Engineers, New York, NY.

Adamus, P.R. (contributor). 1980. *Oil Sensitive Areas of the South Atlantic Coast.* U.S. Bureau of Land Management, New York, NY.

Adamus, P.R. (contributor). 1979. *Use of Exclusion and Restriction Criteria in the Siting of Energy Related Facilities*. U.S. Dept. of Energy, Washington, DC.

Adamus, P.R. 1979. *Brookside Condominiums Ecological Site Plan.*

Adamus, P.R. 1979. *Ecological Assessment for the Augusta State Airport Expansion.* Maine Dept. of Transportation.

Adamus, P.R. 1979. *Dow's Woods Condominiums Ecological Site Plan.*

Adamus, P.R. 1978. *Yarmouth Public Shoreland Ecological Management Plan.* Town of Yarmouth, Maine.
Adamus, P.R. 1978. *Hinckley Park, South Portland, Ecological Management Plan.* City of South Portland.

Adamus, P.R. 1978. *Penobscot Bay Oil Spill Contingency Plan:* Ecological Resources. Maine Dept. of Environmental Protection, Augusta.

Adamus, P.R. 1978. *Benthic Invertebrates as Water Quality Indicators: Molunkus Stream, Stacyville, Maine.* USDA Soil Conservation Service, Orono, Maine.

Adamus, P.R. 1977. *Dickey-Lincoln Transmission Line Environmental Impact Assessment: Ecological Resources.* Bonneville Power Administration, U.S. Dept. of Energy, Portland, Oregon.

Adamus, P.R. and W. Drury. 1977. *Marine Birds.* In: A Summary and Analysis of Environmental Information on the Continental Shelf from the Bay of Fundy to Cape Hatteras. U.S. Bureau of Land Management, New York, NY.

Adamus, P.R. (contributor). 1977. *EIS for Disposal of Surplus Federal Properties in Rhode Island: Quonset Naval Air Station, Davisville CBC, and Newport Naval Base: Ecological Resources.* U.S. General Services Administration, Boston, Massachusetts.

Adamus, P.R. 1977. *Spring Point Shoreway Ecological Management Plan.* City of South Portland, Maine.

Adamus, P.R. (contributor). 1976. *Perley Brook Watershed Environmental Assessment.* USDA Soil Conservation Service, Orono, Maine.

Adamus, P.R. (contributor). 1976. *The Decision to Transport Alaskan Natural Gas from Prudhoe Bay: Issues and Decisionmakers.* US EPA and Council on Environmental Quality.

Adamus, P.R. 1976. *The Natural Regions of Maine.* Maine State Planning Office, Augusta.

Adamus, P.R. 1976. *The Noteworthy Natural Features of Maine.* Maine State Planning Office, Augusta.

Adamus, P.R. and G.C. Clough. 1977. *Evaluating species for protection in natural areas.* Biological Conservation 13: 165-178.

Adamus, P.R. 1976. *Dynamics of Drift and Benthos: Diversity and Environmental Influences in Mill Creek.* M.S. Thesis.

Adamus, P.R. and A.R. Gaufin. 1973. *A synopsis of Nearctic taxa found in aquatic drift.* American Midland Naturalist 95:198-204.

Adamus, P.R. 1971. *Effects of Bull Run Steam Plant on zooplankton populations of Melton Hill Reservoir, Tennessee.* Environmental Sciences Division, Oak Ridge National Lab, Oak Ridge, Tennessee.

were not included in the field surveys. Instead, they were mapped and assessed using a different, off-site method, described below in Section 2.3.4, Off-Site Assessments.

1.5 Wetland Functions and Values

The Federal Clean Water Act (CWA), under Section 404, requires regulatory agencies to consider a wetland's function and value when reaching decisions about permit approval and mitigation needs. *Functions* are what wetlands do naturally, such as store water, purify polluted runoff, and provide habitat. Dozens of functions could be described for any given wetland, but some are of unknown or limited importance to society and/or ecological resources, and others are difficult to assess. Therefore, most wetland assessments focus on a limited set of generally recognized functions and other attributes that are most relevant in a given region. Those considered having the greatest potential relevance to Southeast Alaska, and which therefore were assessed in this study and could be used to prioritize Juneau wetlands, are defined in Table 1. As contrasted with Functions, wetland *Values* describe the context of a wetland in a broader physical, biological, and social landscape, as well as addressing the extent to which one wetland function may contribute to others. Assessments of functions and values together help regulators evaluate whether altering a wetland may have a negative effect on people and/or ecosystems.

Table 1. The definition and values of the wetland functions assessed in this study

Function or Other Attribute	Definition	Values
Water Storage & Delay	Storing runoff or delaying the downslope movement of surface water for long or short periods.	Flood control, maintain ecological systems.
Stream Flow Support	Contributing water to streams, especially during the driest part of a growing season.	Support fish and other aquatic life.
Water Cooling	Maintaining or reducing temperature of downslope waters.	Support coldwater fish and other aquatic life.
Water Warming	Increasing the temperature of downslope waters and extending length of the aquatic growing season.	Maintain late-season ice-free conditions.
Sediment Retention & Stabilization	Intercepting and filtering suspended inorganic sediments thus allowing their deposition, as well as reducing energy of waves and currents, resisting excessive erosion, and stabilizing underlying sediments or soil.	Maintain quality of receiving waters. Protect shoreline structures from erosion.
Phosphorus Retention	Retaining phosphorus for long periods (>1 growing season)	Maintain quality of receiving waters.
Nitrate Removal & Retention	Retaining particulate nitrate and converting soluble nitrate and ammonium to nitrogen gas while generating little or no nitrous oxide (a potent greenhouse gas).	Maintain quality of receiving waters.
Carbon Sequestration	Retaining both incoming particulate and dissolved carbon, and converting carbon dioxide gas to organic matter (particulate or dissolved), and then retaining that organic matter on a net annual basis for long periods while emitting little or no methane (a potent greenhouse gas).	Reduce risk of global climate warming.
Organic Nutrient Export	Producing and subsequently exporting organic nutrients (mainly carbon), either particulate or dissolved.	Support food chains in receiving waters. Facilitate transfer of iron to marine waters.
Anadromous Fish Habitat	Supporting rearing or spawning habitat of fish species that migrate from marine waters into freshwater streams to spawn, e.g., coho and sockeye salmon.	Support commercial, subsistence, sport, and ecological values. Infuse uplands with marine nutrients.

Function or Other Attribute	Definition	Values
Resident Fish Habitat	Supporting an abundance and diversity of native fish (both resident and visiting species) that are not anadromous, e.g., Dolly Varden and cutthroat trout.	Support commercial, subsistence, sport, and ecological values.
Invertebrate Habitat	Supporting or contributing to an abundance or diversity of invertebrate animals which spend all or part of their life cycle underwater or in moist soil. Includes dragonflies, midges, clams, snails, water beetles, shrimp, aquatic worms, and others.	Support salmon and other aquatic life. Maintain regional biodiversity.
Amphibian Habitat	Supporting or contributing to an abundance or diversity of native frogs, toads, and salamanders.	Maintain regional biodiversity.
Waterbird Feeding Habitat	Supporting or contributing to an abundance or diversity of waterbirds that migrate or winter but do not breed in the region.	Support subsistence, sport, and ecological values. Maintain regional biodiversity.
Waterbird Nesting Habitat	Supporting or contributing to an abundance or diversity of waterbirds that nest in the region.	Maintain regional biodiversity.
Songbird, Raptor, & Mammal Habitat	Supporting or contributing to an abundance or diversity of native songbird, raptor, and mammal species and functional groups, especially those that are most dependent on wetlands or water.	Maintain regional biodiversity.
Pollinator Habitat	Supporting pollinating insects, such as bees, wasps, flies, butterflies, moths, and beetles.	Maintain forest productivity and food chains.
Native Plant Habitat	Supporting or contributing to a diversity of native, hydrophytic, vascular plant species, communities, and/or functional groups.	Maintain regional biodiversity and food chains.
Public Use & Recognition	Prior designation of the wetland, by a natural resource or environmental protection agency, as some type of special protected area. Also, the potential and actual use of a wetland for low-intensity outdoor recreation, education, or research.	Commercial and social benefits of recreation. Protection of prior public investments.
Wetland Ecological Condition*	The integrity or health of a wetland, as defined operationally by its vegetation composition and richness of native species. More broadly, the similarity of a wetland's structure, composition, and function with that of reference wetlands of the same type and landscape setting, operating within the bounds of natural or historical disturbance regimes.	
Wetland Sensitivity*	A wetland's lack of intrinsic resistance and resilience to human and natural stressors (higher score = more sensitive).	
Stress Potential*	The degree to which a wetland has recently been altered by or is exposed to risk from factors capable of reducing one or more of its functions and which are primarily human-related.	

* These are other attributes of wetlands and are not considered to be either functions or values

2.0 METHODS

2.1 Mapping Wetland Boundaries

When an applicant applies for a permit to fill a wetland, by law, a determination must be made regarding the exact location of the boundary between what is wetland and what is non-wetland. For this study, wetlands were delineated using the Routine Determination Method according to the *Army Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987): Alaska Region (Version 2.0) (Army Corps 2010). For regulatory purposes under the CWA, Section 404, the Environmental Protection Agency (EPA) defines wetlands as “areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (EPA 2014). These three criteria were applied to draw wetland boundaries in the PAs described in this document.

- For question 31, part b concerning flow into a soil pit was disregarded.
- Question F43, Moss Extent, refers to the percent of the vegetated ground cover comprised of peat- forming moss (excluding moss on trees or rocks).
- Upland inclusions, F46, can be mounds of any type of upland soil. Invasive species (F54) can be woody or herbaceous.
- Shorebird feeding habitat, question F48, is further defined as non-acidic water shallower than 4 inches.
- In question F54, the slope from disturbed lands is to be considered uphill of the unit, or adjoining it if there are none.
- For F55 (Weed Source), the upland edge can be in any direction, not just uphill.
- For question 63, non-consumptive uses, walking refers to walking access for an average person. Interpretive centers, trails with signs or brochures, or regular guided tours apply only if within .25 mile of the AA and if they interpret the natural features of the AA or associated lands.
- All hunting is to be included (question F68) with waterfowl hunting; known berry picking areas are to be included with harvesting of native plants.

Tidal Wetlands

The definition of Tidal Wetland includes tidal freshwater as well as saline areas. "Dominated by emergent herbaceous or woody plants" was interpreted simply as "*dominated by vascular plant cover (excluding submerged aquatics)."* The criterion "level of surface water fluctuates every ~6 hours" was interpreted to mean *only when surface water is present,* which may be as little as once annually. *"Driftwood"* (Tidal Form question 12) refers to largely horizontal logs on the ground near the high water line. "*Large woody debris*" refers to wood such as root masses, large trunks and branches carried into the unit by currents or fallen from adjacent uplands.

2.3.6 Limitations

Known limitations of the WESPAK-SE tool used to score this study's wetlands are described in the WESPAK-SE manual and will not be repeated here. In addition, the following is a partial list of other significant limitations:

- In nearly all instances, and as a result of time and budget constraints, wetland AAs were visited only once during the two-year field component of this project. This has the potential to affect the location of some wetland boundaries but especially, the scores resulting from use of WESPAK-SE. To address this, the study teams used observable indicators and previously-acquired knowledge of the project area's climate and geology to interpret conditions that were not directly observable on the day of the visit.

- Although federal wetland delineation criteria served as a guide for mapping wetland boundaries in the field, test plot data routinely required in formal wetland delineation were not collected or recorded. Doing so over such a large area was not possible within the time frame and funding constraints of the grant that supported this project. For this reason, wetland boundaries and locations presented in this report are to be considered approximate; they provide an inventory of wetland resources rather than a delineation of wetland boundaries. Data presented in this report normally cannot be considered "final" for use in applications for wetland alteration permits. Primarily, it is intended to be used for land use planning

- Considerable variation in vegetation, water regime, and ultimately function may occur *within* a wetland. For example, a Forested Peatland could be split by form (shrub or tree) and/or foliage (deciduous or conifer), and Tidal Wetland could be split into low marsh (inundated daily) versus high marsh. In this example, splitting Forested Peatland into finer components could provide more-refined information useful for assessing biodiversity at broader scales. It could also indicate which areas within a wetland AA contribute more or less to its function score. However, using a wetland classification any finer than the current seven-class one, even if such existed, was beyond the time and budget constraints of this project. It is likely that much of the sort of variation within the project wetlands that is important for predicting their functions was captured by the 126 questions in the WESPAK- SE tool.

- The office form component of the WESPAK-SE score calculator requires the use of spatial data obtained from resource agencies. The source agencies typically make no claims as to the completeness, accuracy, precision, or recentness of the spatial data they provide. Nonetheless, excluding the data entirely from these wetland assessments would result in much poorer estimates of wetland function. The data obtained from other agencies have varying levels of influence on the scores and ratings of the wetlands described in this report. The degree of influence depends on which function is being assessed.

- Although it is not possible to state with certainty for how long the scores of any wetland AA will remain valid, a best estimate suggests approximately 10-30 years. A more exact estimate would depend on forecasting the likelihood of short and long-term changes in climate, uplift from glacial rebound, new debris flows or roads, beaver activity, natural succession of vegetation, development-related land cover changes in nearby areas, and a host of other factors. A particular wetland's capacity to resist functional change in response to these factors cannot be predicted, nor can the functions which would be most sensitive to these factors be identified beforehand. Major changes in any of these factors that are apparent in a wetland or within a few miles, especially along connected streams, could suggest a need to reassess the wetland using the same version of WESPAK-SE used in this study.

- The indicators and models featured in WESPAK-SE are intended to represent wetland science as it currently exists. As with all science, continued research in this region and elsewhere could yield new discoveries that might suggest a need to change some of the indicator variables and assumptions currently embedded in WESPAK-SE. It is recommended that new spatial data sets and new learnings about wetland science be reviewed at least once every 10 years and their impact on WESPAK-SE models, scores, and ratings be evaluated. However, any future changes made to the indicator variables WESPAK-SE uses, the wording of its questions, or the weights and combination rules of its models, will require that all the wetland AAs covered by this study be reassessed and re-categorized. That would be true regardless of which methodology had been used in this study.

3.0 INVENTORY OVERVIEW

3.1 Acreages, Wetland Distributions

During the 2014 and 2015 field seasons, 94 distinct (contiguous) wetlands were mapped within 60 PAs, dividing these into 345 units and covering 5,204 acres. Within these, the functions of 13 tidal and 332 non-tidal wetland AAs were assessed. The PAs surveyed were as follows: 13 of 21 in Priority I Area; 23 of 27 in Priority II Area, and 24 of 27 in Priority III Area. Two AAs surveyed on request from private owners were located outside of any PA.

PAs not covered in the wetland surveys included 15 priority I, II, & III private parcels (eight priority I; four priority II; three priority III); the private-land portions of three priority I areas, including a large area on the west side of Douglas Island; and the three priority IV areas.

Wetlands mapped totaled 5,584 acres, or 44% of the 12,717 acres of PAs surveyed. The most extensive wetlands occurred on level, poorly drained marine terraces, notably the raised benches of North Douglas (87%), West Juneau (67%) and West Douglas. To give a more realistic percentage for those ancient marine landforms on West Douglas, the estimated acres from off-site assessments on private lands seaward of CBJ property were added. Because this side of the island was more wave exposed at time of deposition (~9000 to 12,000 years ago), sediments are coarser, and wetlands fewer, with much less open peatland.

Underlying these patterns in wetland distribution are the geographic constraints governing PAs the CBJ wanted investigated. Steep slopes pose challenges to construction and are also avoided due to liabilities such as post-

4.3.2 The Watershed Context for Wetland Function Scores

This study assigned scores to individual AAs. However, the relationship of any one AA to others, as well as to anadromous streams, was partially factored into each AA's score. Thus, this study contained key elements of a watershed approach. The connectivity or contiguity (even ephemeral) of any AA to an anadromous stream is indicated by its Anadromous Fish Habitat function score--all those with a score of 0 cannot be accessed by anadromous fish. If a wetland unit has a channel outlet but no fish access, and the waters flowing through that outlet connect to tidewater or anadromous fish habitat further downslope, this was noted during the field work. The WESPAK-SE models are constructed such that it potentially increases the scores of that wetland unit for several functions: Stream Flow Support, Water Cooling, Organic Nutrient Export, Aquatic Invertebrates, and Native Plant Habitat. It does so because, despite the absence of anadromous fish in the AA itself, the AA potentially buffers environmental extremes and thus supports the temperature, hydrologic, and water quality regimes of anadromous fish habitat below blockages. Such blockages prohibit fish upstream movement into the AA but generally do not halt the seaward flow of surface water out of the AA.

Analysis of function ratings generated by the WESPAK-SE models support the importance of non-anadromous wetlands for a host of other functions. Of the sites rated Lower for Anadromous Fish Habitat, more than half were rated Moderate or Higher for the following functions by the WESPAK-SE models:

- Songbird, Raptor, & Mammal Habitat
- Water Cooling
- Carbon Sequestration
- Organic Nutrient Export
- Water Warming
- Pollinator Habitat
- Water Storage
- Native Plant Habitat
- Phosphorus Retention

Another aspect of connectivity concerns the contiguity of any single wetland AA to others. The identification numbers of all such contiguous AAs can be identified from the maps in JWMP Volume 2, which also shows the watershed ("subshed") boundaries in the project area. The WESPAK-SE models used to rate the wetlands are structured such that AAs which are adjoined by growing numbers of other AAs are more likely to have higher scores for all the habitat functions, provided they meet other requirements of most species associated with that function: Aquatic Invertebrate Habitat, Amphibian Habitat, Waterbird Feeding Habitat, Waterbird Nesting Habitat, Songbird-Raptor-Mammal Habitat, Native Plant Habitat, Pollinator Habitat.

Although beyond the scope of resources available in this current contract, an analysis could be undertaken in the future that would identify, from the current data set, which wetland functions are rarest in each subshed (watershed) or in the study area overall. Then, the value scores of any wetlands that do perform those rare functions in that subshed could be increased in proportion to the rarity of those functions in that subshed or study area or by some predetermined percentage. However, it must be recognized that watershed boundaries are not relevant to several wetland functions (e.g. Pollinator Habitat, Waterbird Habitat) and values (Public Use & Recognition) because the use of a wetland by pollinators, waterbirds, and people is virtually unaffected by a watershed boundary.

Another analysis that could strengthen a watershed approach would apply to AAs that are not accessible to anadromous fish but would involve using each AA's flow-path distance to anadromous fish habitat (stream, floodplain, or estuarine) as a weighting factor for Anadromous Fish Habitat function or value score. Preferably, the flow-path distance would be measured only after the study area's hydrologic connections are determined and mapped more thoroughly, and surveys are completed that document fish presence (especially coho) in smaller channels and floodplains of the study area.

Additionally, another examination that could strengthen a watershed approach, but was also beyond the scope of resources available, would involve using as a weighting factor the historical losses of wetlands or specific wetland types in the study area or its watersheds. However, comprehensive data on such losses do not exist. Looking forward, careful record-keeping of the extent of wetland alterations permitted, by watershed and function scores/ratings, could help address concerns about cumulative impacts of function losses associated with the permit programs.

4.4 Plan Implementation Options

If categories are needed for the implementation of JWMP, once they are agreed upon and established, the JWMP can be implemented through different options presented in this chapter. Since the first plan, written in 1993, CBJ's management strategy has involved the use of a General Permit from the Army Corps. This implementation chapter examines the successes and issues with wetland management in the past and proposes three options for future wetland management implementation in Juneau. Regional examples of wetland management are cited and compared for reference. The three options are 1) use the wetlands management plan as a planning and educational tool, 2) update enforceable policies and CBJ Land Use Code to reflect 1997 management strategy and apply for a General Permit from the Army Corps, 3) update the enforceable policies and CBJ Land Use Code to manage and permit wetlands by CBJ independent of the Army Corps.

Option 1: Planning and Education Tool Only - This option reflects the current status of wetland permitting in CBJ. Since the expiration of CBJ's General Permit in 2011, wetland permitting has been managed by the Army Corps for all categories of wetlands. The WRB is currently fulfilling an advisory role; in this capacity it could continue to function as an advisory body to the Planning Commission and to the Director of the Community Development on wetlands issues. Advisory functions would also include comments on wetland permit applications administered by the Army Corps, protection for stream side riparian areas and any affects that CBJ, state, or federal projects may have on wetlands and streams. This option could involve the continued advisory role of the WRB. CBJ could still comment on wetland fill permit applications through the Army Corps public process, but would not be involved in administering any wetland fill permits.

The detailed and extensive wetland mapping and WESPAK-SE assessments offer a science-based product that provides the JWMP an educational tool and guiding principles for wetland management. This tool is compliant with the 2008 Federal Rule as it takes into account regional differences in wetland resources and functions and, as much as possible, uses a watershed approach to wetland management. An example of this type of implementation can be found in Matanuska-Susitna Borough's (MSB) Wetlands Management Plan (MSBWMP, HDR, 2012). The purpose of the MSBWMP document is stated as:

This plan serves primarily as an educational tool and promotes coordination among all entities involved in wetland management. This plan does not propose or include any new regulations or permitting requirements. It encourages voluntary practices to conserve and protect wetland resources within the Mat-Su.

In addition to wetland and watershed mapping, the MSB Assembly passed several ordinances related to wetlands conservation and protection. Topics of these ordinances include flood control, shoreline setbacks, Best Management Practices (BMPs) for development, mitigation banking, and watershed classifications.

The overarching goals of wetlands planning in the MSBWMP involves taking a long-term management approach using three main goals; identify, assess, and protect. The MSB encompasses a much larger area than the CBJ. The goal is to identify wetlands at a planning scale of information that involves determining size, boundary and type of wetlands. Assessing wetlands for MSB involves developing unique functional assessment methodology. Lastly,