ADA HAYDEN HERITAGE PARK
Ames, Iowa

Background

The City of Ames Water Treatment Plant uses groundwater as its raw water source. While there is not a direct water quality relationship between the groundwater and area streams, there is a well-documented hydraulic connection. In 1975, central Iowa experienced a moderately severe drought that resulted in the South Skunk River going completely dry. This resulted in a significant drop in the local groundwater table and a reduction in the ability of the Ames Water Plant to meet the needs of the community.

Research performed by Dr. Merwin Dougal of Iowa State University indicated that a primary recharge area for the local groundwater supply was located just north of 13th Street. Working with Dr. Dougal, City staff developed a plan to construct a sand dam in the river bed and then pump water from an active sand and gravel quarry owned by Hallett Materials just outside the northern boundary of Ames. Within a few days, the groundwater levels began to rise, as well as the productivity of the potable supply wells. Later, a permanent concrete dam was installed in North River Valley Park. At that point, the quarry became an integral part of the emergency water supply plan for the City of Ames.

In the early 1990s, Hallett Materials ceased operation of the quarry. In 1999, the City of Ames received a request from a developer to construct "Grand Harbour," a large residential development immediately adjacent to the abandoned quarry. City staff were concerned about the potential impact this may have on both the in-lake water quality as well as the city's continued access to the water for stream flow augmentation. Additionally, many members in the community felt that the abandoned quarry offered a unique opportunity to create a naturalized recreational feature.

On November 6, 2001, the citizens of Ames overwhelmingly approved a bond issue to acquire 437 acres of land surrounding and including the abandoned sand and gravel quarry. The area, now renamed the Ada Hayden Heritage Park, provides a number of passive recreation features such as fishing docks, ramps for non-motorized boats, three miles of hard surface pathway, two miles of crushed-rock paths, bird and wildlife viewing areas, and a pedestrian bridge over the lake. Much of the park was restored to prairie and wetlands. Rare bird species such as loons, sand hill cranes, and bald eagles have been sighted in the park.

About the Park's Physical Environment

The total watershed that drains through the lake is approximately 2,200 acres. The watershed is roughly bounded on the south by 24th Street, on the east by U.S. Highway 69/Grand Avenue, on the north by 180th Street, and on the west by George W. Carver Avenue. The majority of the topography in the watershed is gently sloping, changing to

moderately steep at the central creek that runs from the southwest corner of 190th Street and Grant Avenue. The soils in the watershed range from very poorly drained to well drained, with the majority being poorly drained.

Presently, the land draining to the park's lake from the north and west are dominated by agricultural land uses, primarily row crops and pasture. Drainage coming from the south is largely residential with some commercial uses.

Latitude:	42.0679°N
Longitude:	93.6272°W
EPA Region:	7
USGS Major Basin:	Mississippi
USGS Minor Basin:	South Skunk
USGS HUC-7 Code:	07080105

About the Lake's Physical Structure

When the extraction process was completed, the quarry consisted of two large lakes separated by a central causeway. During development of the park, the causeway was opened to allow the movement of boats between the two lakes. The total surface area is approximately 130 acres. The shoreline is very steep. Bathymetric mapping revealed that the lakes have an average depth of approximately 30 feet, with a maximum depth of about 60 feet.

Summary of In-lake Water Quality

In general, the lake had good water quality near the surface but poor water quality at lower depths. The upper water quality is the result of the cooler, deeper waters' ability to absorb the silt and nutrient loading. Total Phosphorus levels in the upper 15 feet tend to range between 20 and 30 ppb as P, and suspended solids range between 2 and 4 mg/L. The lakes are strongly stratified in the summer and mix from top to bottom in both the spring and fall. Hypoxic conditions have been observed in lower levels of the lake. Analyses performed on lake sediments in 2001 revealed no levels of pesticides, metals, or hydrocarbons that would be of concern.

Summary of Groundwater Adjacent to the Lake

The lake appears to be a classic "flow-through" lake, with groundwater entering from the north, west, and southwest sides and discharging on the east side toward South Skunk River. It is estimated that approximately 85 percent of the inflow into the lakes is via groundwater. Tritium dating suggests that most groundwater discharging into the lake is "modern" water and entered the groundwater flow system less than 10 years ago.

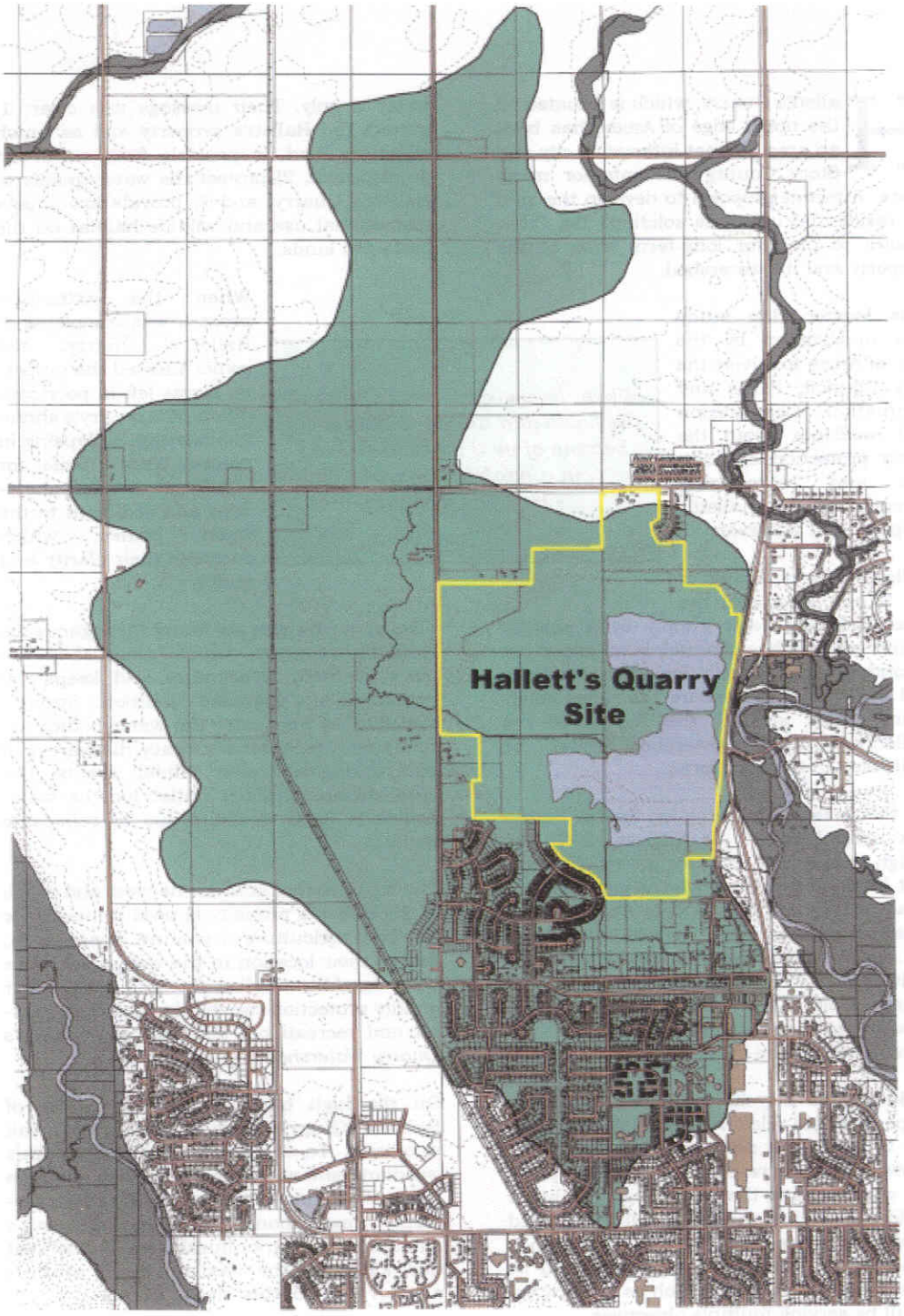
Groundwater is contributing between 14 and 54 percent of the total P load to the lake, with a significant portion existing as soluble reactive phosphorus.

Summary of Wetlands in Ada Hayden Park

Three wetland complexes were constructed during the park development for the purposes of intercepting and filtering surface water flows entering Hayden Park lake. Recent investigations revealed that the southwest wetland complex is poorly performing, primarily due to the intrusion of invasive fish species, primarily carp. The presence of the fish results in a low abundance of coarse particulate organic matter (living and dead plants) and invertebrates. In 2006, the City of Ames used Rotenone to attempt removal of fish from the southern wetland complex. Although the fish removal was successful, subsequent high water events have re-introduced fish back into the wetlands.

The west central and northern wetland complexes appear to be functioning better, as evidenced by the establishment of aquatic plans and the presence of large-bodied invertebrates. These complexes seem to be better protected from invasive fish due to the physical elevations of the complexes relative to the lake and by the fact that these wetlands are intermittent and have periodically dried out completely.

Hallett's Quarry Watershed



City of Ames, Iowa
Water and Pollution Control Department

Expert Panel
Council Workshop on Ecological Health of Hayden Park
September 16, 2008

Individuals who have conducted on-site research in Hayden Park

Bill Simpkins – Professor, Geological & Atmospheric Sciences, Iowa State University (Groundwater Quality)

Tim Stewart – Assistant Professor, Natural Resource Ecology & Management, Iowa State University (Wetland Performance)

Chris Rehmann – Professor, Civil, Construction & Environmental Engineering, Iowa State University (In-lake Water Quality Monitoring)

John Downing - Professor, Ecology, Evolution, and Organismal Biology, Iowa State University

Individuals who can offer a broad perspective on priorities and options

Wayne Petersen – Urban Conservationist, Iowa Department of Agriculture and Land Stewardship

Aaron Musselman – District Conservationist, Story County Soil & Water Conservation District

John Paulin - Director, Prairie Rivers Resource Conservation & Development

William W. Simpkins
Professor of Hydrogeology
Dept. of Geological and Atmospheric Sciences
Iowa State University, Ames, IA 50011

PROFESSIONAL PREPARATION

Degree	Year	Major	Institution
Ph.D.	1989	Geology and Geophysics	University of Wisconsin-Madison
M.S.	1979	Geology and Geophysics	University of Wisconsin-Madison
M.S.	1979	Water Resources Management	University of Wisconsin-Madison
B.A.	1976	Geology (*summa cum laude*)	Augustana College (Rock Island, IL)

APPOINTMENTS

2005 to present	Professor of Hydrogeology, Department of Geological and Atmospheric Sciences
1995 to 2005	Associate Professor, Department of Geological and Atmospheric Sciences
1989 to 1995	Assistant Professor, Department of Geological and Atmospheric Sciences
1985 to 1988	Research Assistant, Wisconsin Geological and Natural History Survey
1979 to 1985	Research Geologist, University of Texas at Austin, Bureau of Economic Geology

RESEARCH INTERESTS

Effects of agriculture on groundwater quality, effects of restored riparian buffers on water quality, aquifer sustainability and energy issues, groundwater/surface water interaction

TEACHING INTERESTS

Hydrogeology, watershed hydrology, field methods in hydrogeology, groundwater flow modeling, environmental impacts of energy production

SYNERGISTIC ACTIVITIES

Outstanding Achievement in Teaching, College of Liberal Arts and Sciences, ISU, 2008-09
Master Teacher Award, College of Liberal Arts and Sciences, ISU, 2002-03
Associate Editor, *Ground Water* (1996-2005)
Fellow, Geological Society of America, 2002; ***Chair***, GSA Hydrogeology Division (2001-2002)

SELECTED PUBLICATIONS

Helmers, M.J., T.M. Isenhart, C.L. Kling, T.M. Moorman, W.W. Simpkins, and Mark Tomer. 2007. Water quality in Agriculture 101: Heterogeneity of pollutants, practices, and programs. *Choices* (www.choicesmagazine.org).

Simpkins, W.W. 2006. A multi-scale investigation of ground water flow at Clear Lake, Iowa. *Ground Water* 44(1):35-46.

Helmke, M.F., W.W. Simpkins, and R. Horton. 2005. Simulating conservative tracers in fractured till under realistic timescales. *Ground Water* 43(6):877-889.

Helmke, M.F., W.W. Simpkins, and R. Horton. 2005. Fracture-controlled transport of nitrate and atrazine in four Iowa till units. *Jour. of Environ. Qual.* 34:227-236.

Carter, J.T., W.W. Simpkins, M.L. Thompson, and T.B. Parkin. 2005. Characterization of phosphorus sources and geochemistry in groundwater in the Clear Lake watershed. Proceedings of the 2005 Agriculture and the Environment Conference, Ames, IA, March 8-9, 2005.

Burkart, M.R., W.W. Simpkins, A.J. Morrow, and J.M. Gannon. 2004. Occurrence of total dissolved phosphorus in surficial aquifers and aquitards in Iowa. *JAWRA* 40(3):827-834.

Simpkins, W.W., M.R. Burkart, M.F. Helmke, T.N. Twedt, D.E. James, R.J. Jaquis, and K.J. Cole. 2002. Potential impact of earthen waste storage structures on water resources in Iowa. *JAWRA* 38(3):1-13.

Wayne Petersen, Urban Conservationist, CPESC
IDALS – Division of Soil Conservation
Wallace State Office Building
Office Phone: 515-281-5833
Cell Phone: 319-430-7480
Email: wayne.petersen@iowaagricluture.gov

Wayne Petersen worked for USDA's Natural Resources Conservation Service for nearly 32 years. The last 11 years he had been the Urban Conservationist for NRCS.

In early February 2008, Wayne retired from NRCS and accepted a job with the Iowa Department of Agriculture and Land Stewardship's Division of Soil Conservation. He will serve as the Coordinator of Urban Conservation for Iowa in this position. Secretary of Ag and Land Stewardship, Bill Northey, initiated an urban conservation program late last year to supplement traditional conservation assistance provided to farmers. He created four urban conservationist positions throughout Iowa and brought Wayne into the central office to help coordinate urban conservation. Wayne is stationed out of the Wallace State Office Building but works with IDALS's four field Urban Conservationists and other Soil and Water Conservation Districts throughout Iowa.

Adding water quality protection to traditional storm water management strategies is a top priority. Enhancing construction site erosion and sediment control will also be a priority. Promoting low impact development, stabilizing urban stream corridors, assisting with project and program development, and educational and training activities will also be part of the new urban conservation efforts that Wayne will assist with.

Timothy William Stewart
Curriculum Vitae

Assistant Professor
Department of Natural Resource Ecology and Management
339 Science II
(515) 294-1644
twstewar@iastate.edu
http://www.public.iastate.edu/~twstewar/homepage.html

Research Interests: Aquatic invertebrate ecology; use of aquatic invertebrate community characteristics to assess aquatic ecosystem health

Selected Refereed Publications

Stewart, T.W, and Downing, J. 2008. Macroinvertebrate communities and environmental conditions in recently constructed wetlands. Wetlands 28:141-150.

Litvan, M.E., Stewart, T.W., Pierce, C.L., and Larson, C.J. 2007. Local effects of grade control structures on the macroinvertebrate assemblage of an agriculturally-impacted stream. River Research and Applications 24: 218-233.

Stewart, T.W. 2007. Measuring animal movements in a natural ecosystem: a mark-recapture investigation using stream-dwelling snails. American Biology Teacher 69(1). http://www.nabt.org/sites/S1/File/pdf/069-01-0028.pdf

Stewart, T.W. 2006. The freshwater gastropods of Iowa (1821-1998): taxonomic composition, geographic distributions, and conservation concerns. American Malacological Bulletin 21:59-75.

Stewart, T.W. 2006. Observing and quantifying predator-avoidance behavior: habitat shifts in snails threatened by shell-crushing predators. Teaching Issues and Experiments in Ecology, Volume 4. Ecological Society of America. http://tiee.ecoed.net/vol/v4/experiments/habitat_shifts/abstract.html

Selected Research Funding (total received = $384,000)

Pierce, C.L., and Stewart, T.W. 2007. Effects of common carp and invading zebra mussels on water quality and the native biological community of Clear Lake. Iowa Department of Natural Resources ($241,654).

Quist, M., Stewart, T.W., and Isenhart, T. 2007. Effects of managed riparian buffers on the integrity of stream systems: a biological assessment using fish and invertebrate communities. Iowa Water Center and United States Geological Survey ($16,609).

Stewart, T.W. 2006-2008. A macroinvertebrate-based index of biotic integrity for semipermanent and permanent Iowa wetlands. Iowa Department of Natural Resources ($34,261).

Stewart, T.W. 2005. Pollution-filtering capacity of Ada Hayden wetlands: an assessment focusing on biological components. City of Ames Departments of Parks and Recreation and Water and Pollution Control ($2,959).

Pierce, C.L. and Stewart, T.W. 2004-2005. Effects of stream stabilization structures on fish movements and fish and invertebrate communities in a southwestern Iowa stream. Iowa Department of Natural Resources, Hungry Canyons Alliance, and United States Geological Survey Science Support Program ($65,973).

Courses Currently Taught (Iowa State University): General Ecology, Natural History of Iowa Vertebrates, Ecology of Freshwater Invertebrates

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
510 S 11th Street
Nevada, IA 50201

September 10, 2008

Information about Aaron Musselman for Ada Hayden panel

Aaron.Musselman@ia.usda.gov

- Ames resident since 2003
- Graduated Iowa State University in 2000 with a degree in Agricultural Systems Technology
- Soil Conservationist with Natural Resources Conservation Service (NRCS) from 2000-2002 in Union and Polk counties
- District Conservationist with NRCS in Story County since 2002
- Responsible for outreach, promotion, installation, and follow-up of conservation practices on Story County land
- Partnered with several entities during 2002 & 2003 to implement Ada Hayden watershed project which focused on soil and water quality benefits in the watershed
- Currently working on watershed projects for Hickory Grove Lake & Squaw Creek Watershed
- Certified Natural Resources Conservation Planner
- Extensive experience working with private landowners to install conservation practices to improve soil & water quality

Link to the project website:
http://www.story-swcd.org/Halletts.html

Chris R. Rehmann
Department of Civil, Construction, and Environmental Engineering
Iowa State University

Professional preparation

Massachusetts Institute of Technology	Civil Engineering	B.S., 1989
Stanford University	Civil Engineering	M.S., 1990
Stanford University	Civil Engineering	Ph.D., 1995
Stanford University	Postdoc. researcher	1995-1996
Woods Hole Oceanographic Institution	Postdoc. scholar	1996-1998

Appointments

2008-present	Associate Professor, Iowa State University
2004-2008	Assistant Professor, Iowa State University
1998-2004	Assistant Professor, University of Illinois at Urbana-Champaign
1995-1996	Lecturer, Stanford University

Selected external research grants

National Science Foundation: "Molecular Diffusivity Effects on Mixing in a Diffusively-Stable, Turbulent Flow", 2000-2002, $169,771.

National Science Foundation: "Mixing at a Sheared, Fingering Interface", 2001-2004, $212,104.

South Florida Water Management District: "Development of Field Data Collection Plan for Characterization of Vegetative Flow Resistance in the Kissimmee River", 2005, $50,000.

National Science Foundation: "Transport by Intrusions Generated by Boundary Mixing", 2007-2010, $482,115.

U.S. Geological Survey: "Guidelines for Sampling and Averaging in Measurements of Discharge with Acoustic Doppler Current Profilers", 2007-2008, $40,335.

Selected recent publications

Wain, D.J. and Rehmann, C.R. 2005 Eddy diffusivity near bubble plumes, *Water Resources Research*, **41**, W09409, doi:10.1029/2004WR003896.

Martin, J.E. and Rehmann, C.R. 2006 Layering in a flow with diffusively stable temperature and salinity stratification, *Journal of Physical Oceanography*, **36**, 1457–1470.

Carr, M.L. and Rehmann, C.R. 2007 Measuring the dispersion coefficient with acoustic Doppler current profilers, *Journal of Hydraulic Engineering*, **133**, 977–982.

Nystrom, E.A., Rehmann, C.R., and Oberg, K.A. 2007 Evaluation of mean velocity and turbulence measurements with ADCP's, *Journal of Hydraulic Engineering*, **133**, 1310–1318.

Selected service

Associate Editor, *Journal of Hydraulic Engineering*, 2005-present

Associate Editor, *Limnology and Oceanography*, 2005-present

Chair, Technical Committee on Hydraulic Measurements and Experimentation, Environmental and Water Resources Institute of the American Society of Civil Engineers. 2006-present.

John T. Paulin

email: john.paulin@ia.usda.gov

EDUCATION

Iowa State University, 1998-2001, Ames, IA
Bachelor of Landscape Architecture, 2001
Master of Landscape Architecture, 2001
Major: Landscape Architecture
GPA: 3.79/4.0

Iowa State University, 1991-1995, Ames, IA
Bachelor of Science, 1995
Major: Fisheries and Wildlife Biology
GPA: 3.53/4.00

PROFESSIONAL EXPERIENCE

U.S.D.A. Natural Resources Conservation Service, Ames, IA

***Coordinator, Prairie Rivers of Iowa Resource Conservation and Development* (March 2008 – Present)**

Facilitation/Coalition Building: Acts as liaison between Natural Resources Conservation Service and a not-for-profit 501©3 board representing Boone, Story, Marshall, Hardin, Hamilton and Webster Counties to develop and guide project efforts in the areas of land conservation, water management, community development and land management. Works to build public/private partnerships under the umbrella of the RC&D utilizing the resources of individuals, county, state and local governments toward a common goal.

Grant Writing Services: Researches and prepares grants for both public and private clients in the RC&D area. Grants submitted and funded have been in the arenas of small business development, land acquisition and development, conservation education and infrastructure planning.

U.S.D.A. Natural Resources Conservation Service, Des Moines, IA

***Landscape Architect – Water Resources Planning Staff* (July 2001- March 2008)**

Conservation Technical Assistance (CTA): Provided landscape architectural technical assistance to communities, civic groups, field staff, RC&D's, and schools,. Assisted projects with conceptual planning and design, conducted focus group meetings, created presentation graphics and narratives for master planning, organized funding sources and coordinated with private practice landscape architects for project implementation and construction.

Watershed Planning (PL-06) and Rehabilitation: Wrote, reviewed and completed portions of one watershed plan-environmental impact statement, one watershed plan supplement, two watershed rehabilitation plans and numerous project investigations. Created various graphical products ranging from landscape inventory and analysis maps to 3D landscape animations. Responsible for all aspects of recreation project purpose planning and evaluation including facilities design and programming, cost estimates and economic benefit analysis. Provided regular informational updates at monthly sponsor meetings and open houses, drafted official responses to public and agency comments. Coordinated watershed planning efforts with Department of Natural Resources personnel, county conservation boards, city parks and recreation departments.

Farm Bill Programs (WRP, WHIP). Developed protocol for dealing with requests for trails on easements, acted as main point of contact for trail planning, assisted field office staff and easement holders in meeting landowner goals while maintaining the integrity of the WRP and WHIP program objectives.

**Received USDA Certificate of Merit for Superior Performance in Watershed and Area Planning, 2005*

I.S.U. Department of Landscape Architecture, Ames, IA

Teaching Assistant, LA 463 Comprehensive Landscape Planning, (January 2001-May 2001). Assisted instruction of senior level master planning studio. Coordinated and introduced City of Carlisle Gateway Annexation Project, attended town meetings, interacted with Mayor and City Administrator to gather community information and define student role. Created base maps, instructed students on use of GIS applications, presented lectures and critiqued student work.

Teaching Assistant, LA/Design Studies129 Introduction to Creativity, (August 2000-December 2000). Instructed three recitation sections on methods for unlocking creative thinking and design, developed and evaluated three major project assignments, scheduled and coordinated out of class student activities and public outreach programs.

Research Assistant, (August 1998-May 2000). Assessed and evaluated vegetative associations from false color infra-red photography, geo-referenced aerial photos and digitized landcover data. Scanned and photo-corrected historic photographs, researched and re-drew archival maps.

I.S.U. Department of Animal Ecology, Ames, IA

Undergraduate Research Assistant, (August 1993-December 1995). Maintained research databases and conducted statistical analyses, edited and prepared manuscripts for publication, conducted literature searches and compiled reference collection.

Field Research Technician, (May 1995-August 1995) Anderson Prairie, IA. Tended 300 small mammal traps in a study of prairie plant and animal interactions. Surveyed, referenced and plotted capture and disturbance locations relative to vegetative species structure and composition.

Field Research Technician, (May 1995-August 1995) Spirit Lake, IA. Operated and maintained electroshocking boat, fyke/gill nets, and beach seines in a survey of piscivorous fish. Extracted and analyzed piscivore gut contents, tagged fish for IDNR mark/recapture population estimates.

Field Research Technician, (May 1994-August 1994) Savannah River Ecology Lab, Aiken, SC. Measured vegetative structure using percent cover and horizontal obstruction estimates, tended 300 small mammal traps, entered data and prepared manuscripts and figures for presentation and publication.

LECTURES, PUBLICATIONS & TRAVEL EXPERIENCE

National Watershed Coalition, La Crosse, WI
Tenth National Watershed Conference (May 2007)
"Taking Benefits Where Benefits are Due: New Methods for Recreation Economic Analysis in PL-566"

National Watershed Coalition, Ft. Mitchell, KY
Ninth National Watershed Conference (May 2005)
"Watershed Landscape Graphics- Better Vision, Better Decisions, Better Understanding"

United States Army Corps of Engineers, Rock Island, IL
GIS User Group Lunch and Learn (March 2005)
"Integrating GIS and World Construction Set for Landscape Visualizations"

Iowa Watersheds, Des Moines, IA
Annual Meeting (January 2005)
"Watershed Landscape Graphics- Better Vision, Better Decisions, Better Understanding"

Adams County Backyard Conservation, Corning, IA
Faith Grebner Property **(September 2003)**
"Hands On! On-site Retaining Wall Construction"

Adams County Backyard Conservation, Corning, IA
Backyard Conservation Conference (March 2004)
"Gardens of Southern England" and "Backyard Terracing"

Trails and Greenway Workshop, Burlington, IA
Building Trails in Your Community (October 2003)
"Trail Building Process & Environmental Interpretation"

Iowa State University Department of Landscape Architecture, Ames, IA
Masters Thesis (December 2001)
"Richmond Park: A Case Study in Documenting an Extant Medieval Deer Park"

Iowa State University Department of Landscape Architecture, Ames, IA
Brown Bag Interactive Lunch Series, (March 2001)
"The Influence of Hunting and Pursuit of Game for Sport on the Development of the Medieval English Landscape."

Iowa State University Department of Landscape Architecture, Ames, IA
Horticultural Tour of the British Isles, (May 9-27, 2000)
Toured the historic landscape gardens of Southern England and Wales, conducted thesis research, met with officials from the Royal Parks, visited and photographed historic elements of Richmond and Bushy Royal Deer Parks.

Dr. John Downing

142 Science II, Ag & Biosystems Engineering
Iowa State University, Ames, IA 50011
Phone: 515-294-5724 • Fax: 515-294-8125
downing@iastate.edu

John Downing is a professor of Ecology, Evolution, and Organismal Biology and the Department of Agricultural and Biosystems Engineering at Iowa State University. His research interests include limnology, aquatic ecology, terrestrial ecology, microbial ecology, biogeochemistry, population conservation, global comparative limnology, and whole ecosystem restoration and management. His aquatic research programs have analyzed lakes and water courses ranging from pristine to the most highly eutrophic ecosystems in the world.

He is a member of SIL, ASLO, NALMS, NABS, and the Great Plains Limnologists and is on the Board of Directors of the American Society of Limnology and Oceanography and the North American Nitrogen Center. He received his BS from Hamline University (St. Paul, MN), his MS from North Dakota State University (Fargo, ND) and his PhD from McGill University (Montreal, Québec, Canada). He was formerly a lecturer at McGill University and a professor at the Université de Montréal where he was Director of the Station de Biologie des Laurentides.

He has been at ISU since 1995 and runs the Iowa State University Limnology Lab and the Iowa State Lake Survey. He also now runs the Itasca Lake Survey for the Minnesota Pollution Control Agency and has established a Water Quality Technology training program and testing laboratory through the Minnesota University System. He has been a water quality advisor to federal, state, and local governments in the U.S. and abroad and has presented invited keynote addresses to nearly every major aquatic professional association in the world. Dr. Downing has published over 100 peer-reviewed journal articles and books covering a broad range of topics across the aquatic and environmental sciences.

As a volunteer, he provided water quality data and advice to the City of Ames at the formation of the Ada Hayden Park and has regularly provided interpretations of water quality information ever since.

www.public.iastate.edu/~downing/

http://limnology.eeob.iastate.edu/

http://limnology.eeob.iastate.edu/lakereport/

Transport by Intrusions Generated by Boundary Mixing

Principal investigator: Chris Rehmann

My research group is using Ada Hayden Lake as a natural laboratory to solve a fifty-year-old oceanographic puzzle: What is the role of vertical mixing in the heat budget of the ocean or a lake? In particular, what happens to fluid mixed on the sloping sides of a lake? In lakes, internal waves, or waves arising from temperature differences in the interior of the lake, can drive the mixing. Therefore, in our field experiments in 2007 and 2008, we have measured the forcing from wind and solar radiation and the properties of the internal waves, including profiles of temperature, velocity, and turbulence quantities. To track fluid mixed on the lake's boundaries, we injected a fluorescent dye and tracked its spread. In the first tracer experiment, strong wind before the injection caused mixing that led to intrusions that moved toward the center of the lake. In the second tracer experiment, a lack of strong wind led to little mixing, and the dye was transported by background wave motions. As we continue this work, we will develop models of the transport from the lake bottom into the water column.

ABSTRACT

Ada Hayden Lake, a 49.6 ha gravel-pit lake set in alluvial and outwash sediment, comprises the emergency water supply for the city of Ames, Iowa. Understanding the groundwater flow system at the lake is essential to project its future as an emergency supply in terms of quantity and quality of water. For this study 23 piezometers were installed both upgradient and downgradient of the lake. Hydraulic head data along with samples for isotopes of hydrogen and oxygen were collected from the piezometers to understand groundwater flow near Ada Hayden Lake. This data suggest that Ada Hayden Lake is a classic flow-through lake system with respect to groundwater, which enters the lake on the southwest, west, and northwest sides, and leaves on the east and southeast sides, eventually discharging into the South Skunk River. A groundwater flow model was constructed to estimate the groundwater component of the lake water budget and to test the effects of pumping from the lake for emergency supply. Results of this analysis show that groundwater accounts for 85% of the lake water budget. Pumping from the lake for short periods should result in little drawdown at the lake. However, long term pumping may alter the groundwater flow system and result in significant drawdown.

Monthly sampling for nutrients in the groundwater from the piezometers surrounding the lake shows that the groundwater at depth is reducing and has high phosphorus concentrations. These high phosphorus concentrations are a concern for the future water quality in the lake. Phosphorus budget analysis shows that groundwater is a major contributor of phosphorus to the lake, accounting for approximately 42 percent of the total phosphorus load.

Downing

Summary

The two lakes in the Ada Hayden Heritage Park provide an emergency water source for the City of Ames and are an important part of the Park complex. Therefore, the water quality of these lakes is being monitored on an on-going basis. This report summarizes water quality information on the lakes and their tributaries from May 2001 through October of 2005. The Ada Hayden Lakes have good water quality at the surface but poor water quality at the bottom. The poor bottom-water quality occurs because the tributaries contribute high loading of nutrients and silt and the constructed wetlands are not yet fully functional. Good surface water quality can occur during summertime because the cooler, deeper waters can still absorb some nutrients and silt. All of the tributaries bring in very high concentrations of materials that are harmful to water quality, including nutrients, silt, and bacteria. The wetlands will be capable of removing some of this load when they are fully developed. Wetland establishment is now impeded by access of carp that uproot vegetation and stir sediments. Recommendations suggested by this interim report are:

1) steps should be taken to ensure that nutrient inputs from the watershed are as low as possible
2) the wetland complexes be managed to establish healthy wetland environments that stop excess nutrients and silt from entering the lake, and
3) future monitoring program focused on watershed loading, wetland function and their effect on water quality in Ada Hayden Lakes

Introduction

The purpose of this ongoing monitoring is to provide the City of Ames with data on the water quality of the lakes and tributaries in the Ada Hayden Heritage Park. This report provides the data allowing understanding of the nutrient sources and water quality in these lakes, as well as trends in these data. Recent additions to the study also allow ongoing monitoring of the effectiveness of the tributary wetlands in mediating water quality in Ames' emergency water supply. This analysis was requested by the City of Ames because moderating nutrient and sediment inflows is essential to improving and maintaining water quality in the Ada Hayden Heritage Park lakes. This interim report outlines the portion of the survey conducted between May 2001 and October 2005.

The period covered by this report included the pre-park analysis, the construction phase, and the first several months following the opening of the park. Separate monitoring was performed on the two Ada Hayden Heritage Park Lakes (North and South) as well as the major tributaries to the lakes. The lakes were monitored by sampling the water column at the deepest parts of the lakes. The three tributaries that flow into the South Lake were sampled at the points designated A-in, B-in, and D-in on Figure 1. During the monitoring period covered by this report, the tributaries were impounded into three constructed wetland complexes, also shown in Figure 1, and monitoring of the inflows and the outflows of these wetland complexes was begun. The purpose of this latter monitoring is to evaluate the function of the wetland complexes in removing nutrients and sediments from inflowing waters. Activities preceding and during construction impeded sampling at some points on various dates. Further, impoundment of the new wetlands resulted in frequent dry conditions of outflows so samples were frequently unavailable from those sampling sites.

Background information

Latitude:	42.0679°N
Longitude:	93.6272°W
EPA Region:	7

Summary

In October 2003, three wetland complexes were constructed in Ada Hayden Park, north Ames, Iowa, for purposes of intercepting and filtering (i.e., removing) nonpoint source pollutants contained in surface water flowing toward Ada Hayden Lake. The primary purpose of the study described in this report was to evaluate effectiveness of these wetlands in removing pollutants as of summer 2005. This was accomplished by measuring and assessing biological characteristics of these wetlands (i.e., abundance and kinds of organisms inhabiting them) and relating biological characteristics to physical and chemical features of the wetlands.

My results suggest that the wetland complex at the southwest end of Ada Hayden Park is in poor condition, and incapable of filtering pollutants at this time. In mid-summer 2005, ponds constituting the southwest wetland complex had low abundance of coarse particulate organic matter (i.e., living and dead plants) and invertebrates, two biological components that are critical to pollution-filtering functions of wetlands. Coarse particulate organic matter and invertebrates absorb, process, and store pollutants in their biomass. Therefore, paucity of coarse particulate matter and invertebrates severely compromises the capacity of a wetland to filter pollutants. Additionally, turbidity of southwest-wetland complex ponds was extremely high in 2005, and consistently failed to meet water quality standards for aquatic life that were established by the United States Environmental Protection Agency. Turbidity is a measure of the quantity of suspended sediments in the water column, and high turbidity suggests that large quantities of pollutants are entering Ada Hayden Lake from water flowing out of the southwest wetland complex.

The two remaining wetland complexes, located in the westcentral and northwest regions of Ada Hayden Park, appear to be functioning much better than the southwest wetland complex. In 2005, positive signs included establishment of aquatic plant populations in some of these ponds, relatively high invertebrate biomass and abundance, and occurrence of large-bodied invertebrates. Additionally, turbidity in these ponds usually met water quality standards established by the United States Environmental Protection Agency.

Invasion of the southwest wetland complex by common carp is a likely factor contributing to the failure of this wetland to filter pollutants. Carp adversely affect the capacity of a wetland to filter pollutants through several mechanisms. Foraging carp increase turbidity by suspending bottom sediments, prevent growth of plants by uprooting, and reduce invertebrate abundance through predation. I found no evidence of carp in either the westcentral or northwest wetland complex.

To improve pollution-filtering capacity of the Ada Hayden wetlands, I recommend constructing barriers that prevent movement of carp into the southwest wetland complex from Ada Hayden Lake. Subsequently, carp should be removed from the southwest wetland complex by pumping these wetlands dry or applying a piscicide (e.g., rotenone). It appears that carp control strategies are unnecessary in westcentral and northwest wetland complexes at this time. Ponds closest to the lake in westcentral and northwest complexes dried completely in late summer of 2004 and 2005; perhaps these drawdowns have thus far controlled carp by killing any fish that invaded these wetlands.

Additionally, I recommend working with Iowa State University Faculty to educate the public about the purpose of the wetlands in Ada Hayden Park, and how they function to filter pollutants. This should be accomplished through placement of educational signage at frequently-traveled locations overlooking wetland complexes. Signs should be attractive and provide pictorial and narrative descriptions of organisms and other important wetland components, and how such components absorb, process, and store pollutants. Signs should also be used to inform the public about adverse effects of fish on wetland pollution-filtering capacity, and therefore discourage release of fish into wetlands by well-meaning persons.

Finally, monitoring of physical, chemical, and biological components of the Ada Hayden wetlands should continue in 2006 and beyond. These wetlands are only a few years old, and abundance and diversity of organisms responsible for filtering pollutants should increase over the next several years. However, an increasingly larger quantity and variety of pollutants will enter the Ada Hayden wetlands as the human population in the watershed continues to increase. Without periodic biological assessment of wetland condition and pollution-filtering capacity, we have no way of knowing if these wetlands are protecting the water quality of Ada Hayden Lake.

Introduction

Ada Hayden Lake is an ecologically and economically important water body located at the northern city limits of Ames, Iowa. This lake is the central focus of the newly established Ada Hayden Heritage Park, and is used for a variety of recreational purposes, including fishing and boating. Additionally, the lake functions as a secondary water supply for the City of Ames during drought periods.

Because water contained in Ada Hayden Lake is of realized or potential importance to more than 50,000 central Iowa residents, maintenance of high water quality in the lake is essential. However, this water quality is threatened by nearby land use practices. The area surrounding Ada Hayden Lake is rapidly becoming urbanized due to an expanding human population, and much remaining land is used for intensive agriculture. Many pollutants associated with urbanization and agricultural activities enter streams and storm sewers and eventually drain into the lake. Prominent pollutants capable of degrading lake and drinking water quality include nutrients originating from fertilizers, sediments derived from soil erosion, and industrial chemicals.

In October 2003, three wetland complexes were constructed in the Ada Hayden drainage basin for purposes of filtering and removing pollutants contained in surface water flowing toward the lake (Figures 1-3). Each wetland complex consists of a series of 3 ponds separated by concrete weirs. Stream and storm sewer flow are primary modes of water entry to wetlands, and most inflow is concentrated at the pond located the greatest distance from the lake (hereafter pond 1; Figure 1). If a wetland is full of water, water enters pond 1 and slowly flows through this pond until entering the second pond (pond 2) through a weir. Water subsequently flows through pond 2 and into pond 3, before entering Ada Hayden Lake through a spillway. Water residence time will increase as some ponds draw down during periods of low precipitation and high solar inputs, such as those experienced in late summer of 2004 and 2005 (Figure 1).

Work by Dr. Bill Simpkins

Ada Hayden Lake

- Field hydraulic head data, stable isotope data, an analytic element model, and a 3-D finite difference model confirm that Ada Hayden Lake is a flow-through lake dominated by groundwater inflow and outflow. The 3-D groundwater flow model suggests that 85 percent of the lake inflow is from groundwater;
- Stable isotope data for groundwater from wells at the southeast corner of the lake plot along an isotopic evaporation line. Based on mixing ratio calculations, approximately 46 to 100 percent of the groundwater in wells on the eastern outflow side of the lake originates from lake water;
- Wetlands receiving overflow from Tributary A on the northwest side of the park are recharging the groundwater at Nest B to 35 ft depth and they eventually flooded Nest B in spring 2007 and 2008;
- Tritium data show that most groundwater discharging to the lake is "modern" and entered the groundwater flow system from less than 5 to 10 years ago. Older pre-bomb water (B64, A60) and possible mixtures of older and younger water (A35, B138, E105) also exist. The highest Cl concentrations occur in the youngest water, suggesting an anthropogenic source for Cl;
- The geochemistry of groundwater at depth is characterized by strongly reducing conditions, lack of nitrate-N, methane, nitrous oxide, hydrogen sulfide, and high Fe concentrations. Very little, if any, nitrate enters the lake from groundwater due to denitrification in groundwater prior to its arrival at the lake. Ammonia is the prevalent N form in most of the deeper groundwater;
- Nitrate-N and dissolved O_2 do occur together in groundwater from well A15 downgradient of the Oaks Golf Course and in well C35 downgradient of Stonebrooke. Both could be sources of NO_3-N to groundwater at these locations;
- Phosphorus is the main nutrient entering the Ada Hayden Lake via groundwater and mean concentrations of total P range from 6 µg/L (C35) to 338 µg/L (A60). Given the young age of most of the water (from ^3H data) and the particle-tracking data from the 3-D model, the source of P could

be agricultural (north and west) and/or urban (southwest). It could also be related to initial cultivation of pre-settlement prairie soils or a natural geologic source. Highest concentrations occur in deeper, reducing groundwater. The lake is likely a source of P to groundwater on the outflow side;

- We are re-testing groundwater with SF_6 and $^3H/^3He$ dating techniques in cooperation with the U.S. Geological Survey. These should enable groundwater age dates to within one to two years and resolve some of the age issues with nutrients. The SF_6 results should be back in October 2008;
- Based on the modeled groundwater discharge to the lake and measured SRP concentrations, groundwater delivers between 2.8 and 830 kg/yr of P ar to the lake. Thus, groundwater contributes between 14 and 54 percent of the total P load to the lake. Estimates of lake P concentration of 32 to 69 µg/L are higher than the observed 20 to 24 µg/L (Downing et al. 2006). Removal of P by sediments in the lake or groundwater and stream outflow at the spillway was not accounted for in the estimate;
- The 3-D groundwater flow model predicts that short term pumping of the lake for water supply should not result in significant lowering of the lake level. However, long-term pumping (greater than ~30 days) at rates similar to those in 1976-77 will produce significant declines in lake level and reverse the hydraulic gradient at the lake so that groundwater flow is induced from the South Skunk River (instead of flowing to the Skunk River). A larger scale groundwater model that extends beyond the South Skunk River is needed to fully test the effects of long term pumping on the lake level;
- A new well field could be established at Ada Hayden Park. Simulation of a single well pumping at 1000 gpm and west of the northern lake basin, showed that the well would induce flow from the west side of the lake and cause a decline of about 0.08 m (0.3 ft) in the lake level after one year. The potential regulatory issues of induced infiltration of surface water, along with trying to maintain water levels in the lake for emergency supply, make a new well field at Ada Hayden Park less desirable than other potential well sites in the alluvial aquifer south of Ames.