

The
Heart
of the
Continent



Ontario, Canada • Minnesota, U.S.A.

Heart of the Continent Partnership

1st Science Symposium

March 10-11, 2016

International Falls, MN



Welcome to the 1st Annual Heart of the Continent Partnership's Science Symposium! We are excited to share this opportunity to learn, communicate, and collaborate about the role of science in managing the Heart of the Continent. The Heart of the Continent Partnership (HOCP) is a Canadian/U.S. coalition of land managers and local stakeholders working together on cross-border projects that promote the economic, cultural, and natural health of the lakes, forests, and communities within the 5.5 million acre (2.2 million hectare) landscape. The Heart is comprised of a blend of working forests, rugged scenery, pristine watersheds, abundant wildlife and outstanding biodiversity. This ecosystem encompasses separately managed natural areas, including Quetico Provincial Park, Superior National Forest (including the Boundary Waters Canoe Area Wilderness), Voyageurs National Park, Grand Portage National Monument and numerous Minnesota state forest lands and parks and Ontario provincial parks.

The Science Symposium strives to: 1) Improve understanding of natural and cultural resources across the HOCP, 2) Raise awareness of threats and management challenges to those resources, and 3) Promote collaboration among scientists, managers, and other stakeholders across political, cultural, and administrative boundaries so that resources can be better managed in a landscape context.

We look forward to learning, communicating, and collaborating with you during this and (hopefully) future events!

Sincerely,

Science Symposium Organizing Committee

Steve Windels
Voyageurs National Park

Pooja Kanwar
Superior National Forest

Jesse Anderson
Minnesota Pollution Control Agency

Shannon Barber-Meyer
US Geological Survey

Shannon Boehm
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Andrew LaBounty
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Lisa Radosevich
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Ingrid E. Schneider
University of Minnesota

Ann Schwaller
Superior National Forest

Chris Stromberg
Heart of the Continent Partnership

Schedule

Thursday, March 10, 2016, AmericInn Hotel and Suites

6:00p-8:00p Welcome Reception and Poster Session. Appetizers and cash bar provided.

Presenter	Poster Title
Barber-Meyer, Shannon	White-Tailed Deer (<i>Odocoileus virginianus</i>) Fawn Risk From Gray Wolf (<i>Canis lupus</i>) Predation During Summer
Schneider, Ingrid	Forest Health Concerns and Management among Resort and Campground Owners in Minnesota
Christensen, Victoria	Artificial Water-Level Management and Other Factors Affecting Fish Mercury Concentrations, Voyageurs National Park, Minnesota, USA
Kipfmueller et al.	Revisiting Fire History in the Border Lakes Region: An Overview of Fire History, Climate, and Ojibwe Land Use Over the Last 400 Years
Olson, Bryce	Restoration of Hybrid Cattail Dominated Wetlands in Voyageurs National Park
Qian, Xinyi	Impact of Hotels' Energy Efficiency on Guests' Perceived Comfort
Schneider, Ingrid	Exploring Travel Interests and Constraints Among Minnesota Hmong
Schneider and Qian	Perceptions of Invasive Species and their Control Among the MN Tourism Industry
Texler, Hannah	Highlights of the Minnesota Biological Survey in the Heart of the Continent Area



Friday, March 11, 2016, Rainy River Community College

TIME	EVENT	SPEAKER
8:00a	Registration Opens. Coffee, rolls, etc. are available in RRCC Cafeteria.	
9:00a	Welcome/Housekeeping	Doug Franchot
9:15a	Plenary Speaker: Understanding How Ecological Disturbance Influences Biological Diversity in Protected Areas: The Rules Aren't What They Used to Be!	Erik Beever
10:15	After the Fires, After the Storm: Rapid Successional Change Following Multiple Disturbances in the Boundary Waters Canoe Area Wilderness	Elias Anoszko
10:25	Forest Response Following Pagami Creek Wildfire: Mapping Structure & Understanding Drivers	Peter Wolter
10:35	Climate Readiness on Lake Superior's North Shore: Perspectives on Preserving Place in a Changing Climate	Karen Katz
10:45	10 minute Q&A	
10:55	An Analysis of Late Woodland Archaeological Site Locations in the Eastern Upper Peninsula of Michigan	Sean Dunham
11:05	Ancient Connections: Research, Interpretation and Management at Grand Mound Historic Site	David Mather / Ben Leonard
11:15	Geoarchaeology of the Knife Lake Siltstone Quarry District: 2015 Exploration of the U.S. Quarries	Dan Wendt / Susan Mulholland
11:25	Culturally-Modified Red Pine at the L' Anse aux Sable site on Lake Saganaga, Minnesota, USA	Lee Johnson
11:35	10 minute Q&A	
11:45	Lunch (provided); poster session	

(CONTINUED ON NEXT PAGE)

Friday, March 11, 2016, Rainy River Community College

TIME	EVENT	SPEAKER
12:45	Rainy River-Headwaters Monitoring and Assessment	Nathan Mielke
12:55	Reconnaissance Level Fate and Transport Modeling of Mine-Impacted-Water Threats in the Rainy Headwaters	Tom Myers
13:05	Slowing the Spread of Rusty Crayfish	Derrick Passe
13:15	Are Pelagic Forage Fish the Key to the Trophy Northern Pike (Esox lucius)?	Patrick Kennedy
13:25	10 minute Q&A	
13:35	Deer Migration and Habitat Use Within Moose Range in Northeast Minnesota	Amanda McGraw
13:45	Landscape Structure Damps and Desynchronizes Cyclic Outbreak Behavior in Spruce Budworm	Brian Sturtevant
13:55	Inferring Snail-Plant and Snail-Habitat Associations Using Ordination	Trevor Vannatta
14:05	10 minute Q&A	
14:15	Facilitated Discussion	
15:30	Adjourn!	

Plenary Talk, Friday March 11, 2016, 9:15-10:15a

Understanding How Ecological Disturbance Influences Biological Diversity in Protected Areas: The Rules Aren't What They Used to Be!

Dr. Erik A. Beever, U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, MT

Abstract: Ecological disturbance has profoundly shaped species, communities, and landscapes across multiple spatial and temporal scales. Natural systems often respond very differently to disturbances that differ in terms of their intensity, duration, frequency, timing, and spatial pattern. Furthermore, the ecological and evolutionary contexts of where and when a disturbance occurs also profoundly influence how biological diversity responds to such disturbance. I will draw from research across North American ecosystems and species to provide some take-home messages about how species and communities are responding to different types of disturbances, especially in the face of contemporary climate change. This will include what we know and some of what we don't know about species' natural ability to accommodate climate change. I will show, for example, that the rules governing systems seem to be changing: factors that predicted patterns of abundance or of extirpation were totally unable to predict those same patterns, in the same species and in the same ecoregion, as little as 6-10 years later. I suspect that countless other surprises await us, as we learn more and more about what makes systems tick, in the face of new ecological disturbances. I will juxtapose this with more-hopeful news about species' natural ability to accommodate climate change, what resource managers can do amidst climate change, and how microrefugia facilitate persistence in some unlikely places. Finally, I will share some lessons learned from organizations around the world working over the last >60 years on broad-scale conservation, especially as they apply to landscapes such as the Heart of the Continent.

Author biography

Dr. Erik Beever received his B.S. in Biological Sciences from U.C. Davis and his Ph.D. in Ecology, Evolution, and Conservation Biology from the University of Nevada, Reno. He has published over 70 articles in diverse scientific journals and in numerous subdisciplines of biology. He has performed field research on plants, soils, amphibians, birds, reptiles, fishes, and insects, as well as small, medium, and large mammals. His work has spanned salt-scrub, sagebrush-steppe, alpine, subalpine, subarctic, riparian, primary and secondary temperate and tropical forest, and coastal ecosystems of the western hemisphere. In addition to seeking to



understand mechanisms of biotic responses to climate change, he has also focused on disturbance ecology and monitoring in conservation reserves, all at community to landscape scales, as well as other topics of conservation ecology, wildlife biology, and landscape ecology. He is a member of the IUCN Protected Areas Specialist Group, the IUCN Lagomorph Specialist Group, as well as The Wildlife Society, Society for Conservation Biology, American Society of Mammalogists, Sigma Xi, and the Union of Concerned Scientists.

SYMPOSIUM SPONSORS

The 1st Heart of the Continent Partnership Science Symposium would not be possible without the generous support from the following organizations. We truly appreciate their support for this first event and look forward to collaborating on future ones.

International Falls Chamber of Commerce



International Falls Convention and Visitors Bureau



Minnesota Chapter of The Wildlife Society



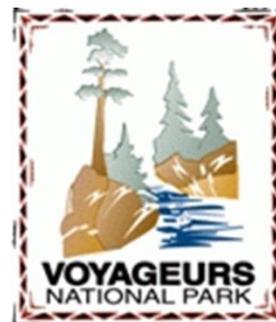
Friends of the Boundary Waters Wilderness



Voyageurs National Park Association



Voyageurs National Park



Superior National Forest



AGENCY PERSPECTIVES

The Heart of the Continent landscape encompasses several different land management agencies and tribal interests in Ontario and Minnesota. To better inform participants at the 1st Science Symposium we solicited 1-page “fact sheets” that addressed the following four questions:

- Describe your agency/organization/government’s history within the boundaries of the HOCP.
- Describe your agency/organization/government’s management responsibilities within the boundaries of the HOCP.
- Describe the role of science in your agency/organization/government’s mission/mandate/management.
- Describe a success story/example of collaboration within the boundaries of the HOCP.



Minnesota Department of Natural Resources

The mission of the Minnesota Department of Natural Resources (DNR) is to work with citizens to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life.

The Minnesota Department of Natural Resources works to integrate and sustain the interdependent values of a healthy environment, a sustainable economy, and livable communities. DNR's integrated resource management strategy shares stewardship responsibility with citizens and partners to manage for multiple interests. DNR protects the state's natural heritage by conserving the diversity of natural lands, waters, and fish and wildlife that provide the foundation for Minnesota's recreational and natural resource-based economy (M.S. 84, M.S. 97A). DNR manages natural lands such as forests, wetlands, and native prairies; maintains healthy populations of fish and wildlife; and protects rare plant and animal communities throughout the state. DNR manages the state's water resources, sustaining healthy waterways and ground water resources. DNR provides access to enrich public outdoor recreational opportunities, such as hunting, fishing, wildlife-watching, camping, skiing, hiking, biking, motorized recreation, and conservation education through a state outdoor recreation system that includes parks, trails, wildlife management areas, scientific and natural areas, water trails, and other facilities (M.S. 86A). DNR supports natural resource-based economies, managing state forest lands for multiple forest values (M.S. 89), ensuring the maximum long-term economic return from school trust lands (M.S. 127A), and providing other economic opportunities in a manner consistent with sound natural resource conservation and management principles.

Ontario Ministry of Natural Resources and Forestry Science –

Fort Frances District

The Ontario Ministry of Natural Resources and Forestry (MNRF) has a long history of overseeing the management and conservation of Ontario's natural resources within the boundaries of the HOCF. As stewards of Ontario's resource base, MNRF is responsible for managing the province's forests, lands, waters, fish and wildlife, aggregates and protected areas. This means being a leader in developing and implementing natural resource policies, plans and programs in an ecologically sustainable way to ensure that they are available for the enjoyment and use of future generations. Over recent years, MNRF has transformed the way we do business, improved how we provide services and put ourselves on a more sustainable path that enables us to deliver our core mandate. Through this process the MNRF has adopted a landscape-scale framework which promotes a better understanding of how natural systems work and how they are affected by human activities. This approach requires perspectives and strategies that extend beyond specific site or species, encompassing larger land and water areas or even entire ecosystems. Aboriginal communities, a wide range of stakeholders and many types of organizations and levels of government have an interest in natural resources management, requiring integration and coordination with a range of partners for implementation to be effective.

Science activities play an extremely important role in MNRF's broad-scale resource management system. Examples include assessment of risk and uncertainty, informing the development of management options, monitoring ecosystem status/trends and monitoring to evaluate the effectiveness of management actions. Moving forward MNRF will continue to focus on science and monitoring programs so that they appropriately support broader-scale management approaches within the MNRF and by other organizations. MNRF has always recognized the value and necessity of a strong science presence and has a long history of sustaining strategic collaborations with scientists in other agencies, the broader scientific community, natural resource industries and other stakeholders.

In 2006, the MNRF began an immense lake sturgeon research project on the Namakan River/Reservoir collaborating with the Minnesota Department of Natural Resources, United States Geological Survey, Voyageurs National Park, Superior National Forest, South Dakota State University, Lakehead University, Quetico Provincial Park and Lac La Croix First Nation. Lake sturgeon are listed as threatened based on review by the Committee on the Status of Species at Risk in Ontario. This research directly addressed questions regarding the status, distribution and exploitation lake sturgeon in the Namakan River. Working in this partnership resulted in numerous technical reports, three publications in peer review journals and two Masters of Science theses.

Quetico Provincial Park

Quetico has been a protected area since 1909, being set aside as a Forest and Game Preserve at the same time as the establishment of the Superior National Forest adjacent to it in Minnesota. It was designated as a provincial park in 1913 and classified as a wilderness class park in 1977. It encompasses an area of 4718 km² (1820 sq. miles) including almost 700 lakes larger than 10 ha (25 acres).

In 1994, Ontario signed an Agreement of Co-existence with the Lac La Croix First Nation whose traditional area includes what is now known as Quetico Provincial Park. The agreement calls for both parties to become partners in the management of Quetico. While this process is still evolving, Lac La Croix First Nation and Quetico are moving towards shared resource decision making, including monitoring, science and research.

Under the Provincial Parks and Conservation Reserves Act, Ontario Parks is responsible for management decisions within Quetico including land use, access and regulation of activities. Management direction is provided through Quetico Park Management Plan, which is currently being reviewed.

Provincial level objectives relating to science and research for all parks in Ontario which have been incorporated into Quetico's Management Plan include:

- To permanently protect representative ecosystems, biodiversity and provincially significant elements of Ontario's natural and cultural heritage and to manage these areas to ensure that ecological integrity is maintained.
- To facilitate scientific research and to provide points of reference to support monitoring of ecological change on the broader landscape.

Maintenance of ecological integrity guides all aspects of the planning and management of Ontario's system of provincial parks and influences the direction and priority of science and research. Ecological Integrity is defined as a "condition in which biotic and abiotic components of ecosystems and the composition and abundance of native species and biological communities are characteristic of their natural regions and rates of change and ecosystem processes are unimpeded".

Research across the Heart of the Continent landscape is one of the most effective ways to meet these goals and objectives for Quetico. One example of collaborative research across this area that helps meet park objectives is the study to look at changes in moose habitat use and activity in a warming climate in Quetico Provincial Park and Northern Minnesota. Led by Ron Moen from the University of Minnesota, this is a joint project that started in 2010 in the Superior National Forest, Grand Portage Indian Reservation, Voyageurs National Park and Quetico Provincial Park. Data is collected from radio collared moose to help identify changes in moose behaviour and habitat selection in response to changing temperatures. Results from this study can lead to improved management of moose habitat in the Heart of the Continent area and beyond.

Superior National Forest

National forests were established to provide clean water and forest resources for the nation while protecting and managing the land for future generations. The USDA Forest Service balances its management responsibilities to provide a variety of activities and uses, through programs that promote wildlife habitat and wilderness protection, clean water, timber and forest products, and recreation.

The Superior National Forest was a founding partner of the Heart of the Continent Partnership (HOCP), reaching across borders with other partners to build mutually beneficial cooperation that would ensure active management of 5.5 million acres of public lands for the purposes of conservation, preservation, recreation, and public education.

The Superior National Forest encompasses approximately three million acres. Ownership is mixed, with over 2.1 million acres of national forest system land, and the rest made up of State, county, and tribal land. Total surface water equals more than 445,000 acres, including more than 2,000 lakes at least 10 acres in size, 1,300 miles of cold water habitat and 950 miles of warm water habitat.

The Heart of the Continent Partnership (HOCP) protects lands and waters along over 300 miles of the Minnesota-Ontario border – from Rainy Lake on the west to Lake Superior on the east. It is located at the headwaters of three major watersheds – to Hudson Bay, the Atlantic Ocean, and to the Gulf of Mexico. The area shares common prehistory, history, biotic and physical resources, despite being separated by an international border and falling under multiple agency jurisdictions.

The mission of HOCP, which states that *“The Heart of the Continent Partnership seeks to sustain and celebrate the health, beauty, diversity and productivity of the natural and cultural resources of the Border Lakes Region through collaboration to meet the needs of present and future generations”* aligns with the mission of the Forest Service. The Superior National Forest Plan notes its work *“would not be complete without recognizing that the Superior National Forest is part of a larger ecological, social and economic landscape. Achieving the vision...will require working collaboratively with the public, tribes, other governments, and other land managers. ...and perhaps the most important aspect of the vision is one of people working together to accomplish shared goals...”*

HOCP provides a vehicle to accomplish these shared goals. Cooperative activities include:

- Exchange of technical and professional information, joint planning and research
- Shared (or exchange of) staff and resources
- Joint seminars, conferences, training courses, and workshops in areas of professional and technical interest
- Research programs to achieve success in preservation, restoration, ecological integrity and forest resilience
- Joint projects that focus beyond boundaries between different countries and owners.

Heart of the Continent Partnership enhances the stature and sustainability of all publicly managed lands around the border lakes. It provides an opportunity for all to better understand the ecological, social and economic value of this large scale ecosystem.



Forest
Service

Superior
National
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March 2016

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Superior National Forest website:

www.fs.usda.gov/superior

Voyageurs National Park

As early as 1891, the state legislature pushed the President for a National Park in northern Minnesota. A compromise with opponents resulted in a large federal forest reserve instead, but the desire for a National Park did not diminish. Early conservationists held a strong vision to preserve the beautiful lake and stream systems, as well as the cultural corridor of the 18th-19th century fur trade from Grand Portage to Lake of the Woods. Eighty years in the making, legislation authorizing Voyageurs National Park was finally signed into law by President Nixon on January 8, 1971 and formally established as the 36th National Park on April 8, 1975.

The National Park Service will celebrate its 100th birthday on August 25. The anniversary has been cause for celebration, reflection, and planning for the next century. The mission is now front and center in every park's Foundation Document:

Preserves unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

“A Call to Action” outlines the Park Service’s strategic plan for the next 100 years. Under the goal, “To preserve America’s Special Places in the Next Century,” the NPS has made a commitment to:

- **MANAGE** the natural and cultural resources of the National Park System to increase resilience in the face of climate change and other stressors.
- **CULTIVATE** excellence in science and scholarship as a foundation for park planning, policy, decision making, and education.
- **ACHIEVE** a standard of excellence in cultural and natural resource stewardship that serves as a model throughout the world.
- **COLLABORATE** with other land managers and partners to create, restore, and maintain landscape-scale connectivity

Resource stewardship is codified as a leading duty of the NPS. Sound science and scholarship are critical for addressing challenges ahead, and in this international network of protected lands and waters, coordination and collaboration is both supported and essential.

As one of more than 400 units in the National Park system, Voyageurs National Park is relatively new. The recent collaborative effort to protect lake sturgeon populations in the Namakan Reservoir is one example of success. It took the involvement and support of several agencies, collaborators, and Heart of the Continent Partners, to collect data on sturgeon, understand potential threats from a proposed hydroelectric facility and prevent loss of crucial spawning, nursery, and feeding habitats.

The same strong partnerships and dedication to science that the NPS holds as its mission will better prepare the park—and the region—to deal with other challenges ahead.

Poster Abstracts and Biographies

Alphabetical Listing by Primary Author

POSTER PRESENTATION

White-tailed Deer (*Odocoileus virginianus*) Fawn Risk From Gray Wolf (*Canis lupus*) Predation During Summer

Shannon Barber-Meyer (Presenter and corresponding author), United States Geological Survey, Northern Prairie Wildlife Research Center, 8711 – 37th Street SE, Jamestown, North Dakota 58401-7317 USA (Mailing address: USGS, 1393 Hwy 169, Ely, MN 55731), 218-365-2087, sbarber-meyer@usgs.gov

L. David Mech, United States Geological Survey, Northern Prairie Wildlife Research Center, 8711 – 37th Street SE, Jamestown, North Dakota 58401-7317 USA, 651-649-5231, mechx002@umn.edu

Aaron Morris, Natural Science and Environmental Education, Hamline University, St. Paul, Minnesota 55104 USA, morris.aw@gmail.com

Little is known about how often various prey animals are at risk of predation by Gray Wolves (*Canis lupus*). We used a remote data logger system to monitor the presence during the day of two radio-collared Gray Wolves within 2 km of a radio-collared White-tailed Deer (*Odocoileus virginianus*) with a fawn or fawns from 29 July to 29 August 2013 in the Superior National Forest of northeastern Minnesota. We concluded that the fawn or fawns were at risk of predation by at least one wolf at least daily. We recommend several improvements in study design to better document wolf and fawn presence and we highlight future research needs.

Author biographies

Shannon Barber-Meyer (presenter) holds a BSc in biology from Eckerd College and a PhD in wildlife conservation from the University of Minnesota and was a postdoctoral scholar at Scripps Institution of Oceanography. She is a wildlife biologist with the US Geological Survey (USGS) on the Superior National Forest Wolf and Deer Project. Prior to joining the USGS, she taught graduate students in Grand Teton National Park, studied tiger conservation in Asia, emperor penguin populations in Antarctica and elk calf mortality in Yellowstone National Park, and helped reintroduce Mexican gray wolves into the southwestern United States.

L. David Mech is a Senior Scientist with the U.S. Geological Survey and an Adjunct Professor in the Department of Fisheries, Wildlife and Conservation Biology at the University of Minnesota. He received his B.S. degree from Cornell University and a Ph.D. degree and an honorary doctorate from Purdue University. He has studied wolves since 1958 in places such as Isle Royale, Minnesota, Italy, Alaska, Yellowstone National Park, and Ellesmere Island, Canada.

Aaron Morris has an M.A.Ed. in Natural Science and Environmental Education from Hamline University. He has participated in field research on wolves and deer in northern Minnesota, wolves and cougars in Yellowstone National Park, and most recently ice seals with the North Slope Borough Division of Wildlife Management in Alaska.

POSTER PRESENTATION

Forest Health Concerns and Management among Resort and Campground Owners in Minnesota

Bridget Bobick, University of Minnesota, Department of Forest Resources, 1530 Cleveland Ave. N, St. Paul, MN 55108, bobick007@umn.edu, 651-434-5910

Matthew Russell, University of Minnesota, Department of Forest Resources, 1530 Cleveland Ave. N, St. Paul, MN 55108, russellm@umn.edu, 612-626-4280

Ingrid Schneider (presenter), University of Minnesota, Department of Forest Resources, 1530 Cleveland Ave. N, St. Paul, MN 55108, ingridss@umn.edu, 651-624-2250

In the Heart of the Continent (HOC) the economy depends on natural resources and forests. While public land management practices are known and publicly proclaimed, information about private entities managing their natural resources is rather limited. In particular, commercial lodging in nature-based tourism areas like HOC is a significant element of tourism and land management as property owners may own large tracks of land with forest management opportunities. As such, this project assessed resort and campground owners concern on forest health and their management strategies in Minnesota, including HOC. An online questionnaire to Minnesota resort and campground owners assessed their level of concern with select forest health issues. Similarly, implementation of forest management activities to improve forest health was assessed. Of the 963 surveyed via email, 161 responded (17% response rate). Respondents were most concerned about non-native invasive insects and invasive plants. The most frequently used management actions to improve forest health included eliminating invasive plant species (35%), reducing unwanted insects (20%), and eliminating unwanted diseases (9%). Reasons respondents did not implement forest management plans most frequently included not wanting or needing one and not understanding how to get one. Results can inform and adapt education efforts in forest health management among this important group as well as consider opportunities for cross-sector collaboration. Future research opportunities include replicating this in other states and at other jurisdictional levels.

Author biographies

Bridget Bobick is a senior undergraduate student at the University of Minnesota, seeking her degree in Environmental Sciences, Policy and Management. She plans to graduate in May 2016 and has been working with the Department of Forest Resources for the past 3 years.

Matthew Russell is an Assistant Professor and Extension Specialist at the University of Minnesota and examines how changing environmental conditions influence the health and function of forests. He works with forest landowners and natural resource professionals to convey strategies to sustain the health and productivity of Minnesota's forests.

Ingrid Schneider (presenter) is a Professor in the Department of Forest Resources at the University of Minnesota. Her work focuses on park and protected area management with an emphasis on consumer behavior. Currently, she is the editor of the *Journal of Leisure Research*, working on the impact of terrestrial invasive species on visitors and finishing a book related to diversity and parks, recreation and tourism organizations. Schneider has worked with a variety of state, federal and international organizations interested in the human dimensions of natural resources. She received her Ph.D. from Clemson University, and her B.S. and M.S. from the University of Minnesota.

POSTER PRESENTATION

Artificial Water-Level Management and other Factors Affecting Fish Mercury Concentrations, Voyageurs National Park, Minnesota, USA

Victoria G. Christensen, U.S. Geological Survey, Minnesota Water Science Center, 2280 Woodale Dr., Mounds View, MN, 55112, vglenn@usgs.gov, 612-759-3187

Mark E. Brigham, U.S. Geological Survey, Minnesota Water Science Center, 2280 Woodale Dr., Mounds View, MN, 55112, mbrigham@usgs.gov, 763-783-3100.

Ryan P. Maki, National Park Service, Voyageurs National Park, 415 S. Pokegama Ave., Grand Rapids, MN, 55744, ryan_maki@nps.gov, 763-783-3112.

James H. Larson, U.S. Geological Survey, Upper Midwest Environmental Science Center, 2630 Fanta Reed Road, La Crosse, Wisconsin 54603, jhlarson@usgs.gov, 608-783-6451

Mark B. Sandheinrich, University of Wisconsin, LaCrosse, 1725 State Street, La Crosse, Wisconsin 54601, msandheinrich@uwlax.edu, 608-785-8261

The U.S. Geological Survey and the National Park Service studied water-level fluctuations and fish mercury concentrations in Voyageurs National Park, located in a mercury sensitive landscape. In this area a high proportion of deposited mercury is methylated, leading to high concentrations of toxic methylmercury in fish. Previous studies have indicated that large water-level fluctuations have been linked to increased mercury levels in young fish, likely as a result of disturbance to the oxygen dynamics of the lake, indirectly affecting methylmercury production. Methylmercury biomagnifies in aquatic food webs, potentially reaching concentrations sufficient to induce sublethal, toxic effects in wildlife and humans who routinely consume fish. Data on water levels and water quality were collected from the Park's large lakes (2013-2015). Additionally, approximately 20 young-of-the-year yellow perch were collected from at least two sites in each of five lakes during fall (2013-2015) for determination of total mercury. Recent studies show a significant decline in water-level fluctuation, whereas fish from these lakes continue to have high mercury concentrations. These data will be combined with earlier studies to determine if the trend in fish mercury concentrations over time are related to water-level fluctuations, water quality, and other factors. Resource managers at Voyageurs National Park will provide this information to the International Joint Commission, which has the authority to change required minimum and maximum water levels on these lakes. This study provides the scientific information to understand the relations between artificial water-level management and fish mercury body burdens.

Author biographies

Victoria Christensen (presenter) is a hydrologist with the USGS Minnesota Water Science Center. Her interests and project work include real-time water-quality monitoring, effects of land use on water quality, the fate of nutrients in reservoir systems, rule curve studies, and reservoir sediment studies.

Mark Brigham joined the U.S. Geological Survey in 1991 and worked for several years assessing water quality in the Red River of the North Basin. He now examines methylmercury occurrence in impoundments and other waters of the Red River Basin; small lakes in Voyageurs National Park; and streams in the St. Croix River Basin.

Ryan Maki earned a B.S. in biology from the University of Wisconsin-Superior and a M.S. in biology from the University of Minnesota at Duluth. He currently works for Voyageurs National Park as an Aquatic Ecologist and is involved in mercury research, exotic species research, water quality monitoring, and assessment of the effects of lake level management on aquatic ecosystems.

James Larson works for the U.S. Geological Survey at the Upper Midwest Environmental Sciences Center in La Crosse, WI. His work primarily focuses on the controls over spatial variation in ecological processes in aquatic ecosystems. Dr. Larson completed his graduate work at the University of Notre Dame (Ph.D., 2006).

Mark Sandheinrich is Professor and Chair of the Department of Biology and Director of the River Studies Center at the University of Wisconsin-La Crosse. He and his students currently conduct research on (1) the bioaccumulation, maternal transfer, and reproductive effects of methylmercury exposure in fish; (2) bioaccumulation of methylmercury in aquatic food webs and (3) identification of controls on ecosystem sensitivity to mercury in atmospheric deposition.

POSTER PRESENTATION

Revisiting fire history in the Border Lakes Region: An overview of fire history, climate, and Ojibwe land use over the last 400 years

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Elizabeth Schneider, Department of Geography, Environment & Society, University of Minnesota, schn1029@umn.edu

Scott Weyenberg, Great Lakes Ecoregion Fire Ecologist, National Park Service, Scott_Weyenberg@nps.gov

More than four decades ago, M. L. Heiselman documented the crucial role of fire in creating landscape-scale patterns in forest community composition and structure in the Border Lakes Region, as well as the dramatic reduction of fire in the early 1900s. The landscape perspective of Heiselman's data purposely focused on big-picture patterns of fire history at the expense of finer-scale detail and lack the spatial and temporal precision to accurately capture detailed disturbance histories. Further, the frequent fire occurrence leading to observed fire histories begs the question of whether lightning was a sufficient ignition source or if fire regimes were augmented by people. These questions are important as managers seek to develop desired conditions and mitigate environmental change within the context of management plans. Over the last several years we have developed multi-century fire histories in Voyageurs National Park and the BWCAW using tree-ring analysis of ~500 fire-scarred red pine stumps and logs. Our findings include over 400 years of fire history data depicting a landscape of more frequent fire than previously realized, particularly in locations utilized by people during the fur trade era. Here, we provide an overview of our findings on local-scale patterns of fire history and potential controls on ignition and fire synchrony across the region. We focus on differences in fire activity between sites located on and near the historic Border Route trade corridor to advance conversations about the potential role of people in past and future fire regimes of the region.

Author Biographies

Kurt Kipfmüller (presenter) is Associate Professor of Geography, Environment & Society at the University of Minnesota in the Twin Cities. His research focuses on the linkages between natural disturbances and climate variability. He has worked extensively in the Rocky Mountains and the Cascades. For the last decade he has focused on the development of tree ring chronologies of disturbance and growth patterns in Northern Minnesota.

Evan Larson (presenter) is an associate professor of Geography at the University of Wisconsin-Platteville. His research interests fall within the broad field of biogeography and focus on understanding the ecological processes that create patterns in the living world. His current projects use tree rings to better understand the history of people, fire, and forest development in the Great Lakes Region and beyond.

Lane Johnson is currently a research technician working as part of the Jemez Mountains Field Station. Previously, he conducted fire history research in the Boundary Waters Canoe Area Wilderness as part of his graduate studies in geography and dendrochronology at the University of Minnesota.

Ben Mathys has been applying his degree of Reclamation, Environment and Conservation long before he received his diploma from University of Wisconsin-Platteville. Driven to restore and enhance natural ecosystems, he looks at all aspects to aid in restoration, relying on fire as a natural management strategy.

Elizabeth Schneider (presenter) is a second year Ph.D. student at the University of Minnesota. Her dissertation research investigates historical and modern vegetation structure, fire disturbance, and stand dynamics through forest simulation modeling using LANDIS-II.

Scott Weyenberg is the Great Lakes Eco-region Fire Ecologist for the National Park Service. He assists area parks with monitoring and fire related research. He also supports prescribed fire operations and coordinates prairie and savanna restoration at the St. Croix Scenic Riverway, where he is stationed.

POSTER PRESENTATION

Restoration of Hybrid Cattail Dominated Wetlands in Voyageurs National Park

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Steve K. Windels, Voyageurs National Park, 360 Highway 11 E, International Falls, MN 56649, steve_windels@nps.gov, 218-283-6692

The non-native narrowleaf cattail (*Typha angustifolia*) has the ability to hybridize with native broadleaf cattail (*Typha latifolia*) creating what is commonly known as 'hybrid cattails' (*Typha x glauca*). This aggressive hybrid is known to disrupt ecosystem balance by creating dense monotypic stands which displace native species and reduce biological diversity. Hybrid cattail is the dominant species in most wetlands in Voyageurs National Park, MN. A new project starting in 2016 aims to reduce cattail abundance to help restore these wetlands to more diverse, natural states to improve habitat for wildlife, fish, and other taxa. We plan to test various methods to remove invasive cattails and restore native plant species in Rainy and Kabetogama Lakes, designated as "Outstanding Resource Value Waters" where the use of herbicide is prohibited. Proposed methods of treatment include: harvest barges, hand tools, burning, freezing, and combinations of these methods timed with water level changes which are regulated under specific rule curves. We also are exploring the role of muskrats (*Ondatra zibethicus*) as natural biocontrol of cattails, including their role in creating and maintaining open water in large patch of cattails.

Author biographies

Bryce Olson (presenter) is a biologist for Voyageurs National Park where he has worked since 2008. He holds a Bachelor of Science in Fish & Wildlife Biology and a Master of Science in Biology. At Voyageurs, Bryce has worked on a variety of projects including forest restoration, air quality monitoring, and multiple wildlife research studies on moose, deer, bears, wolves, beaver, cormorants, and eagles. He is currently involved in a project to reduce exotic cattail abundance to help restore wetland habitats to a more diverse natural state.

Steve Windels is a Research Wildlife Biologist with Voyageurs National Park. His main interests focus on the ecology and conservation of mammals and birds in northern climates.

POSTER PRESENTATION

Impact of hotels' energy efficiency on guests' perceived comfort

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There have been concerns among hospitality businesses about how energy efficiency practices affect guest comfort, which should be the “the primary consideration in any hotel building project” (Energy Star, 2008, p. 2). However, little research on this topic exists. Therefore, the purpose of this project is to understand if and how energy efficiency affects guest comfort. This research is important to HOCP as it raises awareness of management challenges to resource preservation and sustainable practices.

In spring 2014, University of Minnesota Tourism Center worked with Michaels Energy, an energy engineering firm, to examine hotels' energy efficiency and guests' perceived comfort in five mid-scale 3-star hotels in Minnesota. Michaels Energy staff collected technical data on hotels' energy efficiency performance. Tourism Center staff conducted in-person survey of 125 hotel guests to assess indicators of perceived comfort. Data was analyzed using SPSS.

Guests in hotels with quieter heating and cooling units that maintain more accurate temperature perceived greater temperature consistency. Furthermore, guests in hotels with the least and most natural gas use perceived better room comfort. Meanwhile, water temperature, shower head flow, water use, and electricity use had no effect on guest comfort. The results indicate that (1) investing in more efficient heating and cooling units will reduce energy bills and result in greater perceived temperature consistency, and (2) regular maintenance that reduces gas use will increase guest comfort. Additionally, management can lower water temperature, lower water pressure to low-flow status, and reduce water and electricity use without negatively affecting guest comfort.

Author Biographies

Xinyi Qian is an Assistant Extension Professor in the Tourism Center at University of Minnesota. Dr. Qian conducts applied research on a variety of tourism-related topics, including sustainable tourism, visitor behavior, and active transportation, among others. Her work on sustainable tourism has been focused on sustainable practice implementation by tourism businesses, business attitude towards sustainability, and application of research findings.

Katrina Nygaard is an urban planner at Stantec, focusing on community engagement and research. She works with communities across the Twin Cities on development/redevelopment, land use, and zoning issues. She pairs her planning and research experience with strong graphics skills to develop materials for reports and presentations. Prior to working at Stantec, Katrina was a graduate student at the University of Minnesota's Humphrey School where her research focused on sustainability, local tourism, and environmental justice issues.

Carl Samuelson is the Manager of Client Solutions at Michaels Energy, an engineering and energy efficiency consulting firm. Carl works to help commercial and industrial customers and utilities, develop and implement programs and strategies to cost effectively reduce their energy expenses.

POSTER PRESENTATION

Exploring travel interests and constraints among Minnesota Hmong

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Minnesota's population is diversifying. As Minnesotans comprise about half of Minnesota's outdoor recreation and travel market (Davidson Peterson, 2012), understanding this population is important to attract and retain consumers, build support for natural resources, and, subsequently, support communities and economies. As of 2016, tourist data primarily focuses on white, non-Hispanics. A unique Minnesota market is the Hmong, as the state has the second highest Hmong population in the United States. Subsequently, understanding Hmong interest in travel, constraints to travel is important for destinations like the Heart of the Continent. Six focus groups occurred fall 2014 with a convenience sample of Hmong Minnesotans. The focus groups explored travel interests, behaviors, and preferences among participants in the language preferred by the group, were recorded, and ended with a traditional meal. Data revealed Hmong travel for and are generally constrained from travel for similar reasons as non-Hmong. Like other immigrant groups, the influence of culture on leisure travel was clear, as were constraints of discrimination. Discrimination was particularly prominent outside the Twin Cities Metropolitan area. Generational differences in existed and are in stark contrast to the broader U.S. and Minnesota population where the older generation has more money and interest in travel than. To attract and retain Hmong consumers, Hmong suggest 1) facility information, specifically for larger travel groups and parking; 2) Hmong marketing through word of mouth, traditional and electronic, 3) packages and tours including Hmong travelers.

Author biographies

Michele Schermann, RN MS is an Agricultural Health & Safety Research Fellow in the Department of Bioproducts & Biosystems Engineering at the University of Minnesota. A public health nurse researcher and educator, works at the intersection of human health, agricultural safety and natural resource management, with a special focus on working with immigrant and refugee populations. Michele translates her research findings into innovative, targeted communications for a variety of audiences, ranging from migrant children to natural resource professionals to Hmong farmers to local fresh fruit and vegetable growers. Michele's research interests include the agricultural practices of new American immigrants; pandemic zoonotic disease prevention and control; and the creation of multilingual health education media. She is a masters' graduate of the University's School of Nursing, with undergraduate degrees in nursing and in horticulture.

Ingrid Schneider, Ph.D. (presenter) is a Professor in the Department of Forest Resources at the University of Minnesota. Her work focuses on park and protected area management with an emphasis on consumer behavior. Currently, she is the editor of the Journal of Leisure Research and working on a book related to diversity and parks, recreation and tourism organizations. Schneider has worked with a variety of state, federal and international organizations interested in the human dimensions of natural resources. She received her Ph.D. from Clemson University, and received her B.S. and M.S. from the University of Minnesota

Chou Moua, M.P.A. is a PhD student at Tsinghua University, China. He holds a Masters of Developmental Practice from the Humphrey School of Public Affairs, and two undergraduate degrees: International Relations & Asian Studies & Language, all from the University of Minnesota.

Tou Thai Lee, M.P.H works as an educator in the field of alcohol, tobacco and other drugs prevention and as a community outreach specialist on a variety of projects. He has over 14 years extensive experience working with statewide and local community agencies/coalitions from various ethnic communities (Hmong, Vietnamese, Karen, Lao, Khmer, Somali and Hispanic) in Minnesota. Tou holds a Masters Degree of Public Health (MPH) from The University of Tennessee - Knoxville and a Bachelors Degree in Health Management from The University of Tennessee – Memphis.

POSTER PRESENTATION

Perceptions of Invasive Species and their Control among the MN Tourism Industry

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A variety of invasive species exist in or are imminent in the Heart of the Continent Partnership area, a premier tourism destination. Among other impacts, invasive species can change the physical environment upon which many outdoor recreation and tourism destinations and attractions depend. Subsequently, significant impacts could result from invasive species for the tourism industry and communities it supports. However, little research exists in this area or among industry professionals. Understanding tourism organizations' perception of invasive species and the efficacy of efforts to control them is important for a variety of reasons, including their potential in invasive species prevention and mitigation. An online questionnaire assessed Minnesota Tourism industry personnel perceptions about invasive plants and aquatic invasive species and their control. The majority of Minnesota tourism industry respondents agreed both plant-based and aquatic invasive species are harmful to the environment, economy and society. The majority also agreed all approaches presented in the questionnaire would help control invasive species. Online reference materials and local workshops were the two most preferred ways of receiving information on sustainable tourism in all five regions. Arguably, controlling invasive species is important for sustainable tourism and, subsequently, these methods would be effective for education and management workshops. Recommendations for education and information sharing is presented.

Author biographies

Ingrid Schneider, Ph.D. is a Professor in the Department of Forest Resources. Her work focuses on park and protected area management with an emphasis on consumer behavior. Currently, she is the editor of the Journal of Leisure Research and working on a book related to diversity and parks, recreation and tourism organizations. Schneider has worked with a variety of state, federal and international organizations interested in the human dimensions of natural resources. She received her Ph.D. from Clemson University, and received her B.S. and M.S. from the University of Minnesota

Xinyi Qian, Ph.D. is an Assistant Extension Professor in the Tourism Center at University of Minnesota. Dr. Qian conducts applied research on a variety of tourism-related topics, including sustainable tourism, visitor behavior, and active transportation, among others. Her work on sustainable tourism has been focused on sustainable practice implementation by tourism businesses, business attitude towards sustainability, and application of research findings.

POSTER PRESENTATION

Highlights of the Minnesota Biological Survey in the Heart of the Continent Area

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The Minnesota Biological Survey (MBS) systematically collects, interprets, and delivers baseline data on the distribution and ecology of rare plants, rare animals, native plant communities, and functional landscapes needed to guide decision making. The program began in 1987, and is nearing completion of the baseline survey of the state.

MBS is currently surveying Minnesota's portion of the Heart of the Continent (HOC) area, which contains a wealth of biological diversity. Surveys of landscapes and native plant communities have been completed for most of the area, and data entry and site mapping are in progress. Rare plant and animal surveys have begun and will continue over the next three years. Aquatic plant surveys have been completed for 400 lakes.

Significant discoveries in the HOC area include nine native plant species never before documented in the state and populations of four-toed salamanders, newly discovered in Minnesota in 1994. A total of 127 species of rare plants, 38 species of rare animals, and 21 species of rare fungi have been documented in the area. Many high quality examples of rare native plant communities have been surveyed, such as red pine-white pine forests and white cedar-yellow birch forests. To date, 169 sites with outstanding or high statewide biodiversity significance have been identified.

Findings have been used to inform management, protection and collaborative stewardship on many sites. For example, five High Conservation Value Forest areas and many old-growth forest stands have been designated on state forest lands, and 15 areas have been added for special management by the Superior National Forest.

Author biography

Hannah Texler has a BS in botany from the University of Florida and an MS in plant ecology from Michigan State University. She worked as a technician for the National Park Service for two years. She has worked for the Minnesota Department of Natural Resources for 30 years in several positions, with duties that include managing the statewide system of natural areas, conducting plant ecological surveys in five counties, and providing ecological assistance to a wide range of stakeholders. She currently serves as the Plant Ecology Supervisor of the Minnesota Biological Survey in a position newly created in June 2015.

Oral Presentation Abstracts and Bios

Alphabetical Listing by Primary Author

ORAL PRESENTATION

After the fires, after the storm: Rapid successional change following multiple disturbances in the Boundary Waters Canoe Area Wilderness

Elias Anoszko, PhD candidate in Natural Resources Science and Management at the University of Minnesota Department

Lee Frelich, director of the University of Minnesota Center for Forest Ecology

Peter Reich, Regents Professor Distinguished McKnight University Professor, F.B. Hubachek, Sr. Chair in Forest Ecology and Tree Physiology Resident Fellow at the University of Minnesota

Under a warming climate, the Boundary Waters Canoe Area Wilderness (BWCAW) is expected to see an increase in the frequency of forest disturbances such as wildfire and severe windstorms. While the forests of the BWCAW are disturbance adapted, projected increases in disturbance frequency could result in novel combinations of disturbances that may be more severe or have a greater impact on community composition. A series of recent disturbances in the BWCAW including the 1999 blowdown and the 2006 Cavity Lake Fire and 2007 Ham Lake Fire have provided a unique opportunity to examine how changing disturbance regimes are likely to affect the forest community. Using a network of permanent vegetation monitoring plots established after the 1999 blowdown we followed changes in forest succession and tree diversity in areas of the BWCAW that were subjected to disturbances ranging from severe windstorms or wildfires to areas affected by wind followed by fire or multiple fires within a short period of time. In cases of multiple disturbances, we found strong successional convergence towards aspen and birch forest types while stands subjected to single disturbance exhibited multiple successional pathways and mix of forest types. Our results suggest that predicted changes in boreal disturbance regimes could adversely affect disturbance adverse species, and alter the age structure and composition of forests in the BWCAW.

Author biographies

Elias Anoszko is a PhD candidate at the University of Minnesota in the Natural Resource Science and Management program. His thesis examines how recent disturbances have affected the forests of the Boundary Waters. Prior to starting graduate school at the University of Minnesota Elias worked as a research technician with the US Forest Service Pacific Southwest Research Station in Redding, CA.

Lee E. Frelich is Director of the University of Minnesota Center for Forest Ecology. He received a Ph.D. in Forest Ecology from the University of Wisconsin-Madison in 1986. Frelich has authored more than 150 publications with 152 coauthors from 19 countries, including major works for *Cambridge University Press* and *Oxford University Press*. Current research interests include fire and wind in boreal forests, old-growth hemlock and maple forests, invasive earthworms in forests, deer and moose browsing, patterns of tree height, and impacts of climate change.

Dr. Peter Reich is a regents professor, distinguished McKnight professor, F.B. Hubachek, Sr. Chair in Forest Ecology, and Tree Physiology Resident Fellow at the Institute on the Environment at the University of Minnesota and Dr. Reich is also the Chief Scientist of the Hawkesbury Institute for the Environment at Western Sydney University in Australia. His current research focuses on the effects of climate change, elevated atmospheric carbon dioxide, land use/management, fire and biotic invasion on health, biodiversity, function, and sustainability of forest and grassland ecosystems at local to global scales.

ORAL PRESENTATION

An Analysis of Late Woodland Archaeological Site Locations in the Eastern Upper Peninsula of Michigan

Sean B. Dunham, USDA Forest Service

The relationship between people and their physical environment is a critical facet of the study of human culture in the past as well as the present. This research revisits Late Woodland (AD 700 to AD 1600) settlement and subsistence models for the Upper Peninsula of Michigan. The dominant model for this region derives from a relatively small number of coastal Great Lakes sites and coalesced as the Inland Shore Fishery model. More recently, heritage surveys conducted by the USDA Forest Service have identified coastal and interior archaeological sites resulting in a fuller picture of Late Woodland settlement dynamics than was available before. The results show that Late Woodland peoples exploited certain site settings and habitats more extensively than others. Some site settings appear to change over time, and others exhibit characteristics of culturally modified landscapes. While it can be assumed that the distribution of Late Woodland sites reflects the location of resources used by Late Woodland peoples, their distribution is not entirely random and suggests other, likely cultural, factors play a role in the selection of site locations. Although this research was conducted outside the Heart of the Continent geographic boundaries, it provides a useful baseline for considering these dynamics in this region.

Author biography

Before his career with the Forest Service, **Dr. Sean Dunham** worked as a heritage resources consultant on many projects in the Lake States National Forests. His current research interests focus on the relationship between people, their culture, and their environment.

ORAL PRESENTATION

Culturally-Modified Red Pine at the L' Anse aux Sable site on Lake Saganaga, Minnesota, USA

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Kurt F. Kipfmuller, Department of Geography, Environment and Society, University of Minnesota, Minneapolis, MN 55455, PH: (612)-625-9668, Email: kurt@umn.edu

Culturally-modified red pine (*Pinus resinosa*) can be added to the long list of natural and cultural features that comprise the cultural landscape of the Boundary Waters Canoe Area Wilderness of Minnesota, USA. This study provides historical context for the first cultural modification dates of primary-growth, fire-killed red pine derived using dendrochronological methods in the Border Lakes region. Tree-ring records are used in conjunction with the archaeological record, fur trade era travel accounts, and ethnohistorical information to shed new light on the economy of the Border Lakes Ojibwe from the late 1700s to the early 1900s. Multiple lines of evidence from Lake Saganaga suggest that the culturally modified red pine were intentionally scarred in order to extract pitch, which was likely used to repair and construct birch bark canoes. Culturally-modified red pine are a tangible artifact class that may serve to reframe modern perspectives on the critical role of the birch bark canoe for personal and commercial transport in the historical Border Lakes landscape. Bark-peeled red pine are living symbols of historical land use patterns and indicative of the strategic geography of the fur trade. As such, an intensified effort to locate, document, and interpret mature and senescent bark-peeled red pine in the Border Lakes region is warranted.

Author biographies

Kurt Kipfmuller is Associate Professor of Geography, Environment & Society at the University of Minnesota in the Twin Cities. His research focuses on the linkages between natural disturbances and climate variability. He has worked extensively in the Rocky Mountains and the Cascades. For the last decade he has focused on the development of tree ring chronologies of disturbance and growth patterns in Northern Minnesota.

Evan Larson is an associate professor of Geography at the University of Wisconsin-Platteville. His research interests fall within the broad field of biogeography and focus on understanding the ecological processes that create patterns in the living world. His current projects use tree rings to better understand the history of people, fire, and forest development in the Great Lakes Region and beyond.

Lane Johnson is currently a research technician working as part of the Jemez Mountains Field Station, a collaboration between the National Park Service and US Geological Survey in northern New Mexico. Previously, he conducted fire history research in the Boundary Waters Canoe Area Wilderness as part of his graduate studies in geography and dendrochronology at the University of Minnesota.

Lee Johnson (presenter) has served as the Forest Archaeologist for the Superior National Forest since 2012. Lee has worked for the Wisconsin State Historic Preservation Office, the Minnesota Department of Natural Resources and as a wilderness canoe guide for private and non-profit organizations. Lee's research interests include the archaeology and history of the fur trade period in the western Superior Basin and historic period land use among the Ojibwe of the Border Lakes.

ORAL PRESENTATION

Climate readiness on Lake Superior's North Shore: perspectives on preserving place in a changing climate

Karen Katz, Graduate Student, University of Minnesota

Mae Davenport, PhD., Associate Professor, University of Minnesota

Erin Seekamp, PhD., Associate Professor, North Carolina State University

Tourism-dependent communities on Lake Superior's North Shore may be vulnerable to climate change if recreation and tourism resources including natural and built environments, onsite experiences, and visitor expectations are altered. Changes in forest community types, more variable winter weather, population declines of iconic wildlife species, and severe flood and fire events have raised concern and prompted action. Local resource managers and business owners have expressed the need for long-term climate adaptation planning informed by science and shaped by a community-centered vision for the future.

Twenty-five semi-structured interviews approximately one hour in length were conducted with community members living or working in the North Shore region. Participants expressed how they identify strongly with the North Shore and recognize the significant role natural resources play in tourist experiences and expectations. Further, participants explained how communication and collaboration within the communities are currently enhancing their community readiness; however, concern for climate change impacts to the region and perspectives on the need for adaptation were varied. Among concerns of a changing place were loss of iconic species, a need to diversify recreational offerings, and the vulnerability of a tourism dependent economy. Alternate climate narratives include themes of "wait and see" attitudes, climate change as a low priority, and rejection of climate change as a local problem. Study findings will be disseminated to the community in a set of workshops in March 2016. This collection of narratives will be a useful resource for the community as members seek to motivate collaborative adaptation efforts, designate leadership roles, and design climate education strategies for community members and tourists.

Author biographies

Karen Katz is a graduate student at the University of Minnesota pursuing a master's degree in Natural Resource Science and Management with an emphasis on Recreation Resources, Tourism, and Environmental Education. She is interested in connecting people to natural landscapes and understanding how place meanings and environmental education play a role in pro-environmental behavior. In her free time she enjoys outdoor recreation activities including skiing, paddling, and ultimate frisbee.

Dr. Mae Davenport is an Associate Professor of Human Dimensions of Natural Resources and the Environment in the Department of Forest Resources and the Director of the Center for Changing Landscapes at the University of Minnesota. Her research emphasis is in two primary areas: (1) human beliefs, attitudes, and behaviors related to natural systems and landscape change and (2) community capacity for sustainable environmental management. She is particularly interested in cultural and natural system interactions including individual and community-level responses to ecological problems and threats such as non-point source water pollution, stormwater runoff, aquatic invasive species, wildfire, and climate-related impacts.

Dr. Erin Seekamp is an Associate Professor in the Department of Parks, Recreation & Tourism Management (PRTM) at NC State University. Her research focuses on conservation behaviors, partnerships, and community capacity building within the human dimensions of natural resource management and sustainable tourism fields. Currently, Erin is examining climate readiness in communities dependent on nature-based recreation and tourism, as well as assessing perceptions of adaptive planning options for managing cultural resources vulnerable to sea level rise and shoreline erosion. Erin also serves as the PRTM Department Extension Leader for the NC Cooperative Extension Service, serving rural communities by facilitating sustainable and equitable tourism development.

ORAL PRESENTATION

Are pelagic forage fish the key to the trophy northern pike (*Esox lucius*)?

Patrick J. Kennedy, Department of Biological Sciences, University of Manitoba

Michael D. Rennie, Department of Biology, Lakehead University

Northern pike (*Esox lucius*) are popular sport fish and opportunistic apex predators that have a ubiquitous distribution across North America. Northern pike are typically viewed as sit-and-wait ambush predators that use the cover of nearshore vegetation. However, recent research has highlighted that predatory species in the Canadian boreal shield may be exhibiting increased omnivory and coupling of habitats (Bartley et al. 2015). Our study used a mixed-effects model approach to investigate the relative influence of offshore prey species on northern pike growth and life history variation across a large portion of the Canadian boreal shield ($N= 478$ lakes) using Ontario Fall Walleye Index Netting (FWIN) survey data from 1993 to 2003. Our analysis revealed that the asymptotic fork lengths of both male and female northern pike were significantly greater in lakes with greater abundances of lake herring (*Coregonus artedii*). Furthermore, the presence of rainbow smelt (*Osmerus mordax*) resulted in significant positive increases in the early growth rates and Brody's growth coefficients of female northern pike. Our results indicate that the growth and life history characteristics of northern pike populations in Ontario are significantly influenced by the abundance of offshore prey, and that northern pike may be exploiting offshore resources more than previously thought.

Author biographies

Patrick Kennedy is a Master of Science candidate at the University of Manitoba in the department of Biological Sciences under **Dr. Michael D. Rennie**. Patrick has received a few awards while at the University of Manitoba, including the International Graduate Student Entry Scholarship and the IISD-Experimental Lakes Area Graduate Fellowship. He received a Bachelor of Science degree in Biological Sciences from Illinois State University in 2013. As an undergraduate student, Patrick volunteered at the John G. Shedd Aquarium and worked as an undergraduate research assistant with a study on denitrification in constructed wetlands. Patrick then had an internship with the Illinois Environmental Protection Agency where he helped survey streams, rivers, and lakes across northern Illinois. After his internship and before starting his graduate degree, Patrick worked as an aquatic research technician at the Illinois River Biological Station where he assisted with research projects on the Illinois, Mississippi, and Ohio rivers.

ORAL PRESENTATION

Ancient Connections: Research, Interpretation and Management at Grand Mound Historic Site

David Mather, Minnesota Historical Society, Heritage Preservation Department

Ben Leonard, Minnesota Historical Society, Historic Sites and Museums Division

Grand Mound is a National Historic Landmark, prominent in First Nations history, and a sacred place within the cultural landscape of the Rainy River. Proper management of this historic site requires consideration of complex and interconnected archaeological and ecological information, and traditional knowledge from First Nations elders. Grand Mound was preserved because of the leadership of Fred Smith and his family, and acquired by the Minnesota Historical Society in 1970. Archaeological investigations starting in the 1930s identified Laurel pottery, which has since been recognized as a diagnostic marker of the Initial Woodland Tradition (ca. 250 BCE – 650 CE) over a large part of North America. Later studies documented a village site surrounding the mounds, spanning at least 5,000 years. The village layers are rich in fish bone, including lake sturgeon (*Acipenser fulvescens*), indicating that the mounds were built in the spring when sturgeon and other fish were spawning. Indeed, Grand Mound and other sites are located at confluences and rapids that are natural spawning grounds. Grand Mound itself is an effigy, possibly symbolic of the Earth Diver in ancient world creation stories, which in turn may be connected to cultural memories or interpretations of Glacial Lake Agassiz. These connections are central themes as we develop updated interpretation for the historic site. More immediate issues such as vegetation management are also important, as plans progress to reopen the site to the public. Our model in these efforts is the Kay-Nah-Chi-Wah-Nung Historical Centre, operated by the Rainy River First Nations community in Ontario.

Author biographies

David Mather has been the National Register Archaeologist at the Minnesota Historical Society for ten years. Previous to that, he wrote the National Historic Landmark nomination for Grand Mound, and served as Consulting Archaeologist for the Mille Lacs Tribal Historic Preservation Office. Mather has MS in Environmental Archaeology from the University of Sheffield in England, and is working on a PhD at the University of Minnesota. He has written about the Rainy River for *Minnesota History*, *The Minnesota Conservation Volunteer*, and *The Minnesota Archaeologist*.

Ben Leonard is the Manager of Community Outreach and Partnerships for the Minnesota Historical Society's Historic Sites network. He previously served as Director of the Nicollet County Historical Society for 10. Leonard has a MA in History from Arizona State University. An exhibit he developed with students at Gustavus Adolphus College was recently featured at the Smithsonian's National Museum of the American Indian in Washington, D.C.

ORAL PRESENTATION

Deer migration and habitat use within moose range in northeast Minnesota

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Ron Moen, Natural Resources Research Institute, Biology Department, Swenson College of Science and Engineering, University of Minnesota Duluth, 1035 Kirby Drive, Swenson Science Building, Duluth, MN 55812, rmoen@d.umn.edu, 218-788-2610

Interactions between moose (*Alces alces*) and deer (*Odocoileus virginianus*) are of particular interest in light of moose population declines where moose and deer range overlap. Deer carry diseases that are known to have a negative impact on moose health. Identifying sites where moose and deer are most likely to come into contact with one another will increase our understanding of how and when diseases might be transmitted from deer to moose.

We used movement data from GPS radiocollared deer (n = 53) to examine movement patterns and habitat use within core moose range in northeast Minnesota.

Deer in interior northeast Minnesota displayed two seasonal movement strategies: resident (65%) and migratory (35%). Migratory deer moved 7.7 km (range: 1.0-15.6 km) and did not leave moose range during migration. Deer selected for land cover types associated with high forage availability (i.e. deciduous and mixed forests and shrublands). Woody wetlands were avoided at all times of year.

Deer in interior northeast Minnesota may pose a risk to moose throughout the year given their selection for land cover types associated with moose foraging habitat. A concurrent project assessing the effectiveness of moose habitat restoration suggests moose and deer overlap at 15-40% of restored sites. Additional analysis of GPS data from moose that overlap with collared deer will improve our understanding of biologically significant interactions.

Author biographies

Amanda McGraw is a doctoral candidate in the Integrated Biosciences Graduate Program at the University of Minnesota, Duluth where she studies under the direction of Dr. Ron Moen. Amanda received her Bachelor's degree in Wildlife Ecology from the University of Wisconsin, Madison, and her Masters degree from the University of Minnesota.

Ron Moen is an Associate Professor of Biology at the University of Minnesota Duluth and Senior Research Associate at the Natural Resources Research Institute. Recent research projects include assessing deer-moose interactions, characterizing habitat use by Minnesota bats and wood turtles, climate change adaptation modeling, monitoring the effects of moose browsing on forests, and tracking Canada lynx in Minnesota.

ORAL PRESENTATION

Rainy River-Headwaters Monitoring and Assessment

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In 2014, the Minnesota Pollution Control Agency (MPCA) undertook the intensive watershed monitoring effort of the Rainy River-Headwaters Watershed. A total of 74 biological monitoring stations were established in 2014/15 at the outlets of varying sized sub-watersheds. As part of this effort, MPCA staff joined with two soil and water conservation districts (Cook & Lake) and one community college (Vermilion) to complete stream water chemistry sampling at the outlets of 13 sub-watersheds. In 2016, a holistic approach was taken to assess all of the watershed's surface waterbodies for support of aquatic life, recreation, and consumption. Through this process, we have identified waters that were not meeting standards (impaired), as well as waters that were in exceptional condition. A number of streams with exceptional biological, chemical, and physical parameters are worthy of additional protections in order to preserve their valuable aquatic resources. Overall, water quality conditions are good and can be attributed to the forest and wetlands that dominate land cover within the Rainy River-Headwaters Watershed.

Author biography

Nathan Mielke is a stream fish biologist with the Minnesota Pollution Control Agency. He has been with the North Biological Monitoring Unit, based out of Brainerd, MN, since 2010. His research has focused on the relationships between stream fish communities and water quality.

ORAL PRESENTATION

Reconnaissance Level Fate and Transport Modeling of Mine-Impacted-Water Threats in the Rainy Headwaters

Tom Myers, Hydrologic Consultant

At least three mining projects present threats to the long-term water quality in the Rainy Headwater watershed if not properly planned for and designed. The threats include mining and tailings disposal on both sides of the Laurentian Divide. Drawdown in the Peter Mitchell Pit both during mining and long term will draw groundwater from at least two mine and mine waste disposal sites in the St Louis River watershed. The PMP, which straddles the Laurentian Divide, will create a surface water connection across the divide allowing water and contaminants from the St Louis River watershed to reach the Kawishiwi River watershed through surface water pathways. Additionally, mining deposits in the Kawishiwi River watershed could become sources of contaminants as well with the level of and rate the risk manifests depending on the location of the deposits and how their waste is disposed. A recently-published fate and transport model of the Rainy Headwaters shows that the risks of mining and waste disposal depend on location and transport pathways. Leaks from surface disposal areas can follow either surface or shallow groundwater pathways and reach valuable water resources quickly. Underground mining and waste disposal can create contaminant risks that continue for a very long time because of the long pathway. Watershed scale modeling at a reconnaissance level is an adaptive management tool that can help determine where to site facilities or whether the risks are too high to allow mining to occur before substantial funds have been spent planning a mine.

Author biography

Tom Myers is a hydrologic consultant who researches and consults on water resources and hydrogeology issues including mining and energy development, groundwater modeling, contaminant transport, and water rights. His clients include conservation groups and local governments. Tom has been working mine dewatering and contamination issues since 1993. He has M.S. and Ph.D. in Hydrology/Hydrogeology from the University of Nevada, Reno. Tom has recently published a paper in the *Journal of Hydrology* concerning the Rainy River Headwaters titled *Acid Mine Drainage Risks – A Modeling Approach to Siting Mine Facilities in Northern Minnesota USA*.

ORAL PRESENTATION

Slowing the spread of rusty crayfish

Derrick Passe, Lake County and Soil and Water Conservation District

Rusty crayfish are a crayfish species native to the Ohio River Valley. They first showed up in northern Minnesota approximately 20 years ago. Due to their larger size and rapid reproduction rate, they quickly displace native crayfish and have a damaging impact on aquatic vegetation. In 2006, the United States Forest Service conducted a trapping survey of many lake access points to determine the extent of rusty crayfish infestations on the Superior National Forest. They also conducted regional trapping in the White Iron Chain of Lakes and Birch Lake in Ely to determine the range of crayfish infestation in these lakes. In 2012 and 2013 volunteers from the White Iron Chain of Lakes Association repeated crayfish sampling at many of these same lakes and sampling points. The results indicated that rusty crayfish were rapidly displacing native crayfish and that their range in the Chain of Lakes was expanding. Since 2013, Lake County SWCD has worked with local and agency partners to implement a trapping plan to attempt to control the spread of rusty crayfish within the White Iron Chain of Lakes and into the adjacent Boundary Waters Canoe Area Wilderness.

Author biography

Derrick Passe was hired by the White Iron Chain of Lakes Association in 2011 to implement two grants aimed at determining the status of water quality in the Kawishiwi Watershed near Ely, MN. In addition to water quality monitoring and septic system inventory, aquatic species surveying and outreach was a large portion of these grants. The most common aquatic infestation in the watershed was rusty crayfish. Derrick worked with volunteers and agencies to publicize and document the extent of this infestation, going so far as dressing up as a rusty crayfish and appearing at local parades and regional celebrations. Derrick holds BS in Civil Engineering from UW-Platteville and a MS in Water Resource Science from the University of Minnesota. Derrick works for the Lake County and Soil and Water Conservation District as their Rainy River Watershed and AIS Coordinator. He enjoys bringing his technical and social skills to residents and recreationalists in the Minnesota Arrowhead to protect and preserve our water resources.

ORAL PRESENTATION

Landscape structure damps and desynchronizes cyclic outbreak behavior in spruce budworm

Brian R. Sturtevant, USDA Forest Service, Northern Research Station, 5985 Hwy K, RHINELANDER, WI 54501. (p) 715-362-1105 (e) bsturtevant@fs.fed.us

Coauthors: Louis-Etienne Robert, Patrick M. A. James, Barry J. Cooke, Marie-Josée Fortin, Philip A. Townsend, Peter T. Wolter, and Daniel Kneeshaw

Do landscape management legacies influence insect outbreak dynamics? We studied 20th century spruce budworm outbreak dynamics across a 6 million hectare “experimental” landscape at the international border between the Midwestern US and Canada, containing a large wilderness region bordered by two contrasting harvest patterns (Ontario large cuts vs. Minnesota small cuts). We reconstructed spruce budworm outbreak histories using tree-ring chronologies at 16 locations distributed throughout these three zones. Time-series of spruce budworm outbreaks were used in a multi-variate variance partitioning analysis to determine how the percentage of affected trees varied as a function of forest composition, forest configuration, and climatic variation. We found that forest composition and configuration explained 14% and 11% of the variance in outbreak variability, whereas climate explained only 0.2%. Outbreak patterns showed higher frequency and lower intensity in more fragmented and younger forests containing a lower proportion of host species. Our results show that reduced host abundance acts as a negative feedback on outbreak cycle intensity such that diverse forest landscapes have a lower probability of experiencing intense budworm outbreaks relative to landscapes with high host abundance. This study demonstrates the unintended impacts of human-induced landscape-scale changes in forest structure on natural ecosystem functioning in general, and on insect outbreak dynamics in particular.

Author biographies

Dr. Brian R. Sturtevant (presenter) is a Research Ecologist (Landscape Ecology of Forest Disturbances, Simulation Modeling) with the Northern Research Station, USDA Forest Service, Rhineland, WI, USA.

Dr. Louis-Etienne Robert is a postdoctoral student (Dendroecology, Spatial and Temporal Statistics) in the Department of Biological Sciences, University of Montreal, QC, Canada,

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ORAL PRESENTATION

Inferring Snail-Plant and Snail-Habitat Associations Using Ordination

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The Lymnaeidae are a diverse family of pulmonate snails with both ecological and veterinary significance. However, little is known about the basic biology of these snails in Minnesota.

Lymnaeid snail surveys were conducted in 70 locations across St. Louis and Lake Counties. Water chemistry measurements and land cover analyses were done for each location. A 1 m² vegetation quadrat was taken around every individual snail and each quadrat was considered as a site within the ordination matrices. This data was analyzed in PC-ORD.

Snail locations clustered on the plant-species-space ordination axes. All snail species showed a response to CaCO₃. However, *Fossaria* spp. clustered based on high concentrations of CaCO₃ and small amounts of open water on the landscape scale. *L. megasoma* and *L. stagnalis* clusters overlapped, but diverged in some sites based on sediment type, CaCO₃, and open water cover types.

Our analysis reaffirms conclusions from other lymnaeid snail habitat studies. Additionally, the overlapping clusters of *L. megasoma* and *L. stagnalis* suggest these two species are likely competitors in the Great Lakes region.

The success of *L. megasoma* in the Great Lakes basin may be contingent on its ability to persist in areas that *L. stagnalis* cannot. Preservation of these habitats may be important to the ecology of the unique regional species, *L. megasoma*. Additionally, an understanding of *L. megasoma* habitat will heighten the ability of managers to study and control this species as a trematode parasite vector.

Author biographies

J. Trevor Vannatta (presenter) earned an undergraduate Biology degree from the University of Wisconsin – La Crosse and is currently a Master's candidate in the Integrated Biosciences program at the University of Minnesota. His research interests include the impacts of parasites on ecosystems, host-parasite interactions, and wildlife disease.

Dr. Ron Moen is an Associate Professor of Biology at the University of Minnesota Duluth. Research interests are broad and include vertebrate studies, ecology and mammalogy. Recent research projects include deer-moose interactions, Minnesota bat habitat, riverine turtle telemetry, climate change adaptation, effects of moose browsing on forests, and tracking the Canada lynx in Minnesota.

ORAL PRESENTATION

Geoarchaeology of the Knife Lake Siltstone Quarry District: 2015 Exploration of the U.S. Quarries

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Sources of Knife Lake Siltstone, KLS, were explored within the BWCAW and Superior National Forest to understand the geological context of this distinctive material that was extensively utilized in the past for stone tools. KLS had a very complex geological origin resulting from sedimentary deposition of volcanic ash which was then subjected to metamorphism. It reflects the intersection of all three basic rock types. Regional metamorphic folding tipped and twisted layers, faulting split and displaced blocks of bedrock. Because of this deformation, layers are difficult to trace regionally but we now know that KLS outcrops across a broad area centered on Knife Lake. There is widespread evidence that people in the past explored this landscape and tested outcrops across the region seeking the best, fine texture material. Stone tool manufacturing tends to occur near the current shorelines of Knife Lake but sites are frequently situated on features about 18 feet above the current lake level which may represent an old lake shoreline. Some quarry sites occur on hilltops 130 feet in elevation above the current lake level and are far from the current lake. These hilltop quarries may be associated with a shoreline representing a maximum stage of Glacial Lake Agassiz which at one time covered much of the border lakes region. Relative dating of artifacts made from KLS indicates that these sites may date to early post glacial times and a key question is how this landscape looked when it was occupied.

Author biographies

Dan Wendt is a retired Chemical Engineer conducting research with the Minnesota Historical Society and the Duluth Archaeological Center on tool stone resources of the midcontinent. Dan is building a comparative collection at the Minnesota Historical Society and is collaborating on methods to discriminate the sources of over 340 types of stone now in the collection. A focus of his research has been how natural processes and cultural processes have moved these materials across the midcontinent. His published research across four decades has highlighted how people in the past habitually favored a few select reliable sources, reflecting their changing cultural traditions and technological requirements.

Susan Mulholland started as a phytolith analyst/paleoethnobotanist/geoarchaeologist with a M.S. and PhD in interdisciplinary archaeology from the University of Minnesota. Basic research interests were to interpret microscopic evidence (biological and geological) that can be recovered from sediments in archaeological sites. Later interest in cultural resource management (CRM), which is applied archaeology, became a large part of my professional life. Currently I am president and co-owner of the Duluth Archaeology Center, a for-profit CRM company, and adjunct assistant professor of Anthropology at the University of Minnesota, Duluth where I teach archaeology courses. Research interests include the first entry of people into Minnesota (especially northern Minnesota).

ORAL PRESENTATION

Forest Response Following Pagami Creek Wildfire: Mapping Structure & Understanding Drivers

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Compositional estimates of initial forest recovery following disturbance are rare, and yet critical for determining successional patterns resulting from disturbance processes. We investigate whether remote sensing data can be used to map nascent forest structure and the extent to which two factors—pre-fire aspen basal area and fire severity—affected post-fire aspen structure and richness. We used remote sensing data, field surveys, and partial least squares regression to model and map early-seral aspen structure and vegetation species richness following wildfire in Minnesota. Richness was our strongest model (RMSE=2.47 species, Adj. R²=0.60), followed by aspen stem diameter, basal area (BA), height, density, and percent cover (Adj. R² range = 0.22 - 0.53). Significant relationships existed between pre-fire aspen BA and all post-fire recovery attributes (Adj. R² range = 0.12 - 0.33, $p < 0.001$) except percent cover and richness. Fire severity was not significantly related to any post-fire variables. Remote sensing data may, indeed, be used to develop spatially explicit biophysical models of early-seral stage forest vegetation recovery in boreal forests of the upper Midwestern U.S., specifically aspen structure, abundance, and overall vegetation richness. The capability to quantify early-seral forest structure is a critical first step in understanding forest response following wildfire disturbance, as greater detail is sorely needed to understand forest successional trends in a landscape dominated by fire, and to assist research that strives to forecast future forest composition in lieu of multiple stressors, such as climate change.

Author biographies

Dr. Peter T. Wolter (presenter) is an Assistant Professor and Forest Landscape Ecologist (satellite remote sensing and forest structure modeling) at Iowa State University, Ames, IA, USA.

Ms. Rayma A. Cooley is a Forest Ecologist (Wildfire Ecology) with the U.S. Forest Service at Six Rivers National Forest in Eureka, CA, USA.

Dr. Brian R. Sturtevant is a Research Ecologist (Landscape Ecology of Forest Disturbances, Simulation Modeling) with the Northern Research Station, USDA Forest Service, Rhinelander, WI, USA.