

SEA GRANT PROJECT SUMMARY FORM 90-2 DEVELOPMENT PROPOSAL

- (1) INSTITUTION: Purdue University (1a) ICODE:
- (2) TITLE: Simulating the implications of recreational disturbance on Karner blue butterflies (*Lycaeides melissa samuelis*) at the Indiana Dunes National Lakeshore.
- (3) PROJECT NUMBER:
(4) REVISION DATE:
(5) PROJECT STATUS:
- (6) INITIATION DATE: February 1st 2010
(7) COMPLETION DATE: March 31st 2010
- (8) SUB PROGRAM:
- (9) CO-PRINCIPAL INVESTIGATOR 1: Dr. Patrick Zollner (9a)EFFORT: 0 mths
(9b) AFFILIATION: Purdue University
(9c) AFFILIATION CODE:
- (10) CO-PRINCIPAL INVESTIGATOR 2: Dr. Victoria Bennett (10a)EFFORT: 2 mths
(10b) AFFILIATION: Purdue University
(10c) AFFILIATION CODE:
- (11) CO-PRINCIPAL INVESTIGATOR 3: Dr. Vanessa Quinn (11a)EFFORT: 0 mths
(11b) AFFILIATION: Purdue North Central
(11c) AFFILIATION CODE:
- (12) ASSOCIATE INVESTIGATOR : N/A (12a) EFFORT:
(12b) AFFILIATION:
(12c) AFFILIATION CODE:
- (13) S.G. FUNDS: N/A
(14) STATE MATCHING FUNDS: N/A
(15) LAST YEAR'S SG FUNDS: N/A
(16) LAST YEAR'S MATCHING FUNDS: N/A
(17) PASS-THROUGH FUNDS: N/A
(18) LAST YEAR'S PASS-THROUGH FUNDS: N/A
- (19) RELATED PROJECTS: Indiana Academy of Science (IAS) funded project to explore the disturbance-related responses of the Karner blue butterfly to recreation at Indiana Dunes National Lakeshore, IN. This award has only funded the field work to collect the empirical data required to parametrize a simulation model.

(20) PARENT PROJECTS: N/A

(21) SEA GRANT STRATEGIC PLAN CLASSIFICATION: Great Lakes Health

(22) OBJECTIVES:

Using a simulation tool parametrized with empirical data collected in 2009:

- 1) To assess how recreation influences the behavior of the endangered Karner blue butterfly at Indiana Dunes National Lakeshore, IN.
- 2) To identify and predict the implications of such disturbance-related behavior on oviposition rate and larval host plant selection by the Karner blue butterfly.
- 3) To identify and devise active management strategies and site designs minimizing recreational disturbance to the Karner blue butterfly at sites with existing populations and restored sites proposed for the species re-introduction. These measures will comprise vital contributions to fulfilling the objectives and goals set out in the Karner Blue Species Recovery Program which both Illinois and Indiana are required to address.

(23) PROBLEM:

As a federally endangered species, the protection and persistence of existing Karner blue populations is of the highest priority. These populations are currently restricted to small isolated habitat fragments and therefore have an elevated risk of extinction. Recovery plan objectives aim to restore a viable metapopulation across the butterfly's historic range (including Illinois and Indiana). Subsequently, reintroduction schemes are underway. However, many of the existing sites and restored sites are commonly in areas with public access and are managed by the state to encourage recreation, such as the Indiana Dunes National Lakeshore on the shore of Lake Michigan. This site 1) contains one of the last remnant populations of the Karner blue butterfly, 2) is a major donor site for reintroduction schemes in the area, and 3) is a popular site for recreation. Thus understanding whether recreational disturbance is threatening the butterfly's persistence at these sites has been identified as a research priority in the Karner Blue Species Recovery Plan.

(24) RATIONALE (IMPACT OF PROBLEM):

The negative impact of eco-tourism and outdoor recreational activities on wildlife is a growing concern for site and wildlife managers worldwide. Numerous case studies demonstrate that recreation disrupts breeding success, survival, and abundance of a diverse array of species. Identifying the mechanisms and implications of anthropogenic disturbance on wildlife populations, particularly those of conservation concern, may therefore be critical to their preservation. The Karner blue butterfly is a conservation priority and its persistence at sites such as the Indiana Dunes National Lakeshore is paramount to the species' recovery. Recreation (such as jogging, hiking, and dog walking) in proximity to these specialist butterflies has the potential to cause disturbance-related behavior (such as flushing). One major concern is that cumulative impacts of multiple human caused disturbances can disrupt ovipositing females, detrimentally influencing oviposition rate and oviposition site choice, and thus breeding success.

However, field studies that capture, disturb or kill this endangered butterfly are discouraged. With such limited scope for exploration a less intrusive approach is required, such as using a simulation model. Simulation models enable us to explore how and under what circumstances wildlife respond to human stressors and extrapolate the implications of such responses. One clear advantage of this approach is that it provides invaluable insights into the consequences of disturbance and management options without conducting years of complex and potentially detrimental empirical investigations. This is especially important when working with an endangered species requiring potential recovery strategies immediately, such as the Karner blue. Thus we propose using a spatially-explicit individual-based simulation model (known as Simulation of Disturbance Activities - SODA) to explore the implications of recreation on the breeding success of the Karner blue butterfly at the Indiana Dunes National Lakeshore.

(25) METHODOLOGY:

From late-July to the end of August 2009 observational data was collected on the behavior of ovipositing female Karner blue butterflies in the presence and absence of recreation. As part of an IAS Senior Research Grant award, undergraduates from the Purdue North Central undertook targeted observational surveys to explore the responses of female Karner blue butterflies to recreation at the Indiana Dunes National Lakeshore on the southern edge of Lake Michigan. All activities in the presence and absence of recreationists were recorded (such as basking, nectaring, flushing, in flight, ovipositing, and interactions with conspecifics) along with the duration of each activity and the location of the butterfly when basking, nectaring, and ovipositing.

From the behavioral data collected in this study, we will be able to determine flushing distances of the butterflies (i.e. the distance at which recreationists disturb ovipositing females), the time taken to resume ovipositing, the probability of selecting an alternative host plant, and that host plant's location post-disturbance. These values will be used to parametrize the simulation model SODA. It is a spatially-explicit individual-based model designed as a flexible practical tool to explore the effects of spatial and temporal patterns of recreational activities on wildlife (such as reductions in ovipositing rates and restricting host plant choice). Using site-specific maps to build a virtual environment (including position and extent of trails and host plants), SODA will be used to simulate the daily movement patterns of virtual female Karner blues and their responses (such as flushing) to a variety of recreational activities (e.g. joggers, bird watching, dog walking, etc.). For this case study, a series of simulations will be run in SODA which will explore the effects of recreational activity loads (i.e. visitor frequencies, intensities, and behavior will be varied). Another series of simulations will be undertaken to assess the responses of butterflies to a diverse array of possible management strategies (i.e. variations in the layout of trails and the application of buffer zones). For the analysis we will use a suitable statistical analysis, such as analysis of variance (MANOVA and ANOVAs) to examine the responses of the butterflies to alternative scenarios.

(26) EXPECTED RESULTS AND IMPACT:

The expected results of these simulation runs will be to reveal 1) whether the Karner blue is sensitive to recreational disturbance; 2) the implications of recreational activities in proximity to host plants and ovipositing females; and 3) a suite of management solutions and site designs minimizing disturbance to the Karner blue. Insights into the implications of recreational disturbance on the Karner blue butterfly will be used to inform the Karner Blue Recovery Program and recommendations will be made concerning the management and site design of existing and proposed reintroduction sites. It is intended that the latter will feed directly into the active management of such sites throughout the Karner Blue butterfly's range (notably Indiana and Illinois). However, these results will primarily be used to inform the active management of Karner blue sites within the Lake Michigan ecosystem. This will not only maintain the ecosystem's diversity, but as a specialist invertebrate the presence of the Karner Blue butterfly in this system is a good indicator of habitat quality.

SEA GRANT PROJECT SUMMARY FORM

(Continued)

PAPERWORK REDUCTION ACT, PRIVACY ACT, AND PUBLIC BURDEN

NOAA's National Sea Grant College Program exists to increase the understanding, assessment, development, utilization, and conservation of the Nation's ocean, coastal, and Great Lakes resources. It does this by providing grant monies to promote a strong educational base, responsive research, and training. The information requested on this form is required in order to be considered for an award under the authority of the National Sea Grant College Act, as amended. The Project Summary provides information on the project status (for continuing projects applying for additional funding), the investigators and their level of effort, the objectives and methodology of the project, and similar summary information. The information requested may be disclosed to qualified reviewers and staff assistants as part of the application review process; to applicant institutions/grantees to provide or obtain data regarding the application review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers as necessary to complete assigned work; to other government agencies needing information as part of the review process or in order to coordinate programs; and to another Federal agency, court or party in a court or Federal administrative proceeding if the Government is a party. Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.

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SEA GRANT BUDGET FORM 90-4

GRANTEE: Purdue University			GRANT/PROJECT NO.:		
PRINCIPAL INVESTIGATOR Patrick Zollner Co-PI: Victoria Bennett			DURATION: 2 months Yr. 1 2/1/10-3/31/10		
A. SALARIES AND WAGES:		man-months			
	No. of People	Amount of Effort	Sea Grant Funds	Matching Funds	
1. Senior Personnel					
a. (Co) Principal Investigator:		0	0	0	0
b. Associate (Faculty or Staff):		0	0	0	0
Subtotal:		0	0	0	0
2. Other Personnel					
a. Professionals:		0	0	0	0
b. Research Associates:		1	2	4615	0
c. Res. Asst./Grad Students:		0	0	0	0
d. Prof. School Students:		0	0	0	0
e. Pre-Bachelor Student(s):		0	0	0	0
f. Secretarial-Clerical:		0	0	0	0
g. Technicians:		0	0	0	0
h. Other:		0	0	0	0
Total Salaries and Wages:		1	2	4615	0
B. FRINGE BENEFITS:			1942	0	
Total Personnel (A and B)			6557	0	
C. PERMANENT EQUIPMENT:			0	0	
D. EXPENDABLE SUPPLIES AND EQUIPMENT:			0	0	
E. TRAVEL:					
1. Domestic			0	0	
2. International			0	0	
Total Travel:			0	0	
F. PUBLICATION AND DOCUMENTATION COSTS:			0	0	
G. OTHER COSTS:					
1. Communications			0	0	
2. Copying			0	0	
3. Postage/Mailing			0	0	
4. Contractual Services			0	0	
5. Membership/Sponsorship Fees			0	0	
6. Training/Continuing Education			0	0	
7. Project/Person Recognition			0	0	
8. Housing/Board/Research			0	0	
9. Tuition Remission			0	0	
10. Other			0	0	
11. Other:			0	0	
Total Other Costs:			0	0	
TOTAL DIRECT COST (A through G):			6557	0	
INDIRECT COST		On campus	52.50%	3443	0
		Off campus	0.00%	0	0
Total Indirect Cost:				3443	0
TOTAL COSTS:			10000	0	

BIOGRAPHICAL SKETCH -- Patrick Andrew Zollner

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PROFESSIONAL PREPARATION

Doctorate in Ecology, December 1998. Indiana State University, Terre Haute. IN, Dissertation
Advisor: Dr. Steven L. Lima
M.S. in Wildlife Ecology, 1993. Mississippi State University, Starkville. MS, Advisors: Dr.
Leonard A. Brennan & Dr. Winston P. Smith
B.S. in Natural Resources, 1989. University of Michigan, Ann Arbor.

APOINTMENTS

Assistant Professor of Quantitative Ecology, 2006 – present. Department of Forestry and Natural
Resources, Purdue University.
Permanent Research Ecologist, 2001–2006. US Forest Service Northern Research Station.
Post-doctoral Research Ecologist, 1999 – 2001. US Forest Service Northern Research Station.

PUBLICATIONS

5 Most Closely Related Publications from 30 in Peer Reviewed Publications

- Bennett, V.J., Fernandez-Juricic, Zollner, P.A., Beard, M., E., L. Westphal, and C. Le Blanc. (In
Review). Modeling the responses of 'species of management concern' to ecotourism to
contrast the impacts of recreational scenarios. Submitted to *Biological Conservation*
5/11/2009.
- Bennett, V.J., Beard, M., Zollner, P.A., Fernandez-Juricic, E., L. Westphal, and C. Le Blanc. 2009.
Understanding wildlife responses to human disturbance through simulation modelling: A
conservation tool. *Ecological Complexity*. 6:113-134.
- Fernandez-Juricic, E., P.A. Zollner, Le Blanc, C. and Westphal, L. 2007. Responses of nestling
Black-crowned Night Herons (*Nycticorax nycticorax*) to aquatic and terrestrial recreational
activities: a manipulative study. *Waterbirds*, 30(4):554-565.
- Blumstien, D.T., E. Fernandez-Juricic, P.A. Zollner, and S. C. Garity. 2005. Inter-specific variation
in wildlife responses to human disturbance: a review and synthesis. *Journal of Applied
Ecology*. 42:943-953.
- Smith, W.P, and P.A. Zollner. 2005. Sustainable management of wildlife habitat and risk of
extinction. *Biological Conservation*. 125:287-295.

5 Other Significant Publications

- Zollner, P.A., and S.L. Lima. 2005. Behavioral trade-offs when dispersing across a patchy
landscape. *Oikos*. 108:219-230
- Conradt, L., Zollner, P.A., Roper, T.J., Frank, K. & Thomas, C.D. 2003. Foray search: an
effective systematic dispersal strategy in fragmented landscapes. *The American Naturalist*.
161:905-915.
- Zollner, P.A., and S.L. Lima. 1999. Search strategies for landscape-level inter-patch
movements. *Ecology* 80: 1019-1030.
- Zollner, P.A., and S.L. Lima. 1997. Perceptual range and its implications for landscape-level
ecological phenomena. *Oikos* 80: 51-60.
- Lima S.L., and P.A. Zollner. 1996. Towards a behavioral ecology of ecological landscapes.
Trends in Ecology and Evolution 11: 131-135.

BIOGRAPHICAL SKETCH -- Patrick A. Zollner

SYNERGISTIC ACTIVITIES

- 1) I am committed to broadening the participation of underrepresented groups (particularly Native Americans) in science. I have extensive experience collaborating with the Great Lakes Indian Fish and Wildlife Commission on joint research. Since arriving at Purdue I have become co-chair of the Tecumseh program's efforts to establish a learning community for native scholars on Purdue's campus. In this capacity I have recently co-submitted a renewal of an existing grant to the Alfred P. Sloan foundation to fund graduate studies in STEM disciplines by Native American students at Purdue. I also have an ongoing collaboration with Lac Courte Oreilles Ojibwa Community College that is funded by the USDA Tribal College Research Grant program. Finally, Ms. Tanya Aldred (Keweenaw Band Ojibwa) is an MS student in my lab funded as a Sloan scholar (program at Purdue for recruitment of Native American students in the sciences).
- 2) I involve local communities in my research by conducting programs for grade school children at a local nature centers and by bringing high school classes out in the field to gain experience collecting data.
- 3) I have provided service to the scientific community through my participation on committees in the American Society of Mammalogists and the US Chapter of the International Association of Landscape Ecologists as well as by reviewing 115 articles for 40 peer reviewed journals and seven NSF proposals.
- 4) The impact of my research is greatly expanded by my efforts to link my investigations directly with managers and other potential end users who adaptively modify their activities to consider the implications of my finding. Including the development of extension materials to transfer the results of my research to managers.
- 5) I directly involve undergraduates in all phases of my research providing invaluable opportunities for these students to be exposed to all of the dimensions of research.

COLLABORATORS WITHIN PAST 48 MONTHS

Resit Akçakaya, Dan Blumstien, Matt Beard, Victoria Bennett, Dave Cleland, Tom Crow, Deahn DonnerWright, Joseph Dumyahn, Esteban Fernandez-Juricic, Susan Garity, Jonathan Gilbert, Adam Green, Eric Gustafson, Hong S. He, William Karasov, Cheri LeBlanc, Steven Lima, Dave Lytle, David Maldenoff, Linda Parker, John Probst, Volker Radeloff, Lance J. Roberts, Robert Scheller, Lisa Schulte, Winston Smith, Brian Sturtevant, Lynne Westphal, Bronwyn Williams, John Wright

GRADUATE AND POSTDOCTORAL ADVISORS

Eric J. Gustafson (US Forest Service Northern Research Station) Postdoctoral advisor
Steven L. Lima (Indiana State University) PhD advisor
Leonard A. Brennan (Texas A&M University Kingsville) MS Co-advisor
Dr. Winston P. Smith (US Forest Service PNW) MS Co-advisor

THESIS ADVISEE MS Students 4, PhD Students 3, Postdoctoral Researchers 1

Kevin J. Crane (MS) Indiana State University, Joseph B. Dumyahn (MS) Purdue, Nicholas McCann (PhD) Purdue, Ben Pauli (MS) Purdue, Chia-Chun (Tricia) Tsai (PhD) Purdue, Matthew Beard (PhD) Purdue, Victoria J. Bennett (Post-Doc) Purdue, Tanya Aldred (MS) Purdue, Valerie Clarkston (MS) Purdue

BIOGRAPHICAL SKETCH -- Victoria Jane Bennett

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Professional Preparation

University of Leeds	Zoology	B.Sc.(hon) 1997
University of Leeds	Biodiversity and Conservation	M.Sc. 1998
University of Leeds	Ecology (ecosystem modeling)	PhD. 2004
Purdue University	Ecology (human-wildlife disturbance)	Post-doc position 2007-2009

Appointments

Post-doctoral research scholar	Purdue University	2007-2009
Senior Ecologist	Cresswell Associates Ecological Consultancy	2004-2007
Bat Scientist	Operation Wallaca/Leeds University	2004
Invertebrate Field Assistant	English Nature/Leeds University	2004
Research Assistant (Albatross)	British Antarctic Survey	2004
Ph.D. candidate	University of Leeds	1998-2004
Research Assistant (Lepidoptera)	University of Leeds	2000-2001
M.Sc. candidate	University of Leeds	1997-1998

Publications

Bennett, V.J., Beard, M., Zollner, P.A., Fernández-Juricic, E., Westphal, L. & LeBlanc, C.L.
Understanding wildlife responses to human disturbance through simulation modelling: A
management tool, *Ecological Complexity – Special Edition*, 6, 113-134, 2009.

Other publications and products

Bennett, V.J., Fernández-Juricic, E., Zollner, P.A., Beard, M., Westphal, L. & LeBlanc, C.L.
Modelling the responses of 'species of local interest' in situ to ecotourism to inform park
design, *Biological Conservation* (in review)

E.J. Bodsworth, **V.J. Bennett** & C.D. Thomas Variation and colonisation success: a butterfly
expanding its geographic range, *Proceedings of the National Academy of Sciences, USA*. (in
review)

Cresswell Associates Nature Conservation advice in relation to invertebrates, *Design Manual for
Roads and Bridges, Volume 10, Section 4, Part X, HA XX, Highways Agency*. (in press)

Cresswell Associates, Nature Conservation advice in relation to southern damselfly, *Design
Manual for Roads and Bridges, Volume 10, Section 4, Part X, HA XX, Highways Agency* (in
press)

Cresswell Associates, Nature Conservation advice in relation to habitats, plants and fungi,
*Design Manual for Roads and Bridges, Volume 10, Section 4, Part X, HA XX, Highways
Agency* (in press)

Synergistic Activities

I have a strong academic background in conservation ecology, entomology, and simulation
modeling. I am currently a Postdoctoral Research Scholar under Dr. Patrick A. Zollner in the
Department of Forestry and Natural Resources at the Purdue University. My postdoctoral work
focuses on exploring the effects and implications of human activities on wildlife using individual-
based simulation models. I have applied this technique to a number of case studies,
investigating the effects of ecotourism and recreation on a black-crowned night-heron nesting

BIOGRAPHICAL SKETCH -- Victoria Jane Bennett

colony, barbastelle bat in maternity roosts and nesting yellow-headed blackbird. I am also currently collecting data for a case study involving the endangered Karner blue butterfly, in order to investigate the effects of recreation in proximity to ovipositing females. Other projects include exploring the impacts of road development of wildlife, primarily the influence of roads in proximity to maternity roost sites of the Indiana bat.

For my Ph.D. research my developed a simulation model depicting the Serengeti ecosystem in East Africa. I worked on a 2 year research project to investigate the ecology and recent UK range expansion of the brown argus butterfly (*Aricia agestis*). For this I undertook mark-release-recapture (MRR) experiments, investigated host plant choice by ovipositing females, conducted egg counts, and reared caterpillars. I also carried out rare species monitoring as part of a species recovery program on *Cryptocephalus primarius* (a leaf beetle). This included behavioral studies, MRR, and vegetation and habitat surveys. Following this I spent 2 years in industry as an ecological consultant and entomology specialist, coordinating high profile projects, developing management plans, producing national best-practice survey and management guidelines for wildlife and habitats of conservation concern in the UK (including invertebrates and the southern damselfly). I also carried out all invertebrate surveys (flight interception traps, pit fall traps, sweep netting, line transects, egg and larval surveys, moth trapping and host plant identification) and developed appropriate mitigation for black hairstreak, brown hairstreak, marsh fritillary butterflies, and the stag beetle.

Collaborators & Other Affiliations

Collaborators (no Co-Editors): Esteban Fernández-Juricic, Dale Sparks, Vanessa Quinn, Dan Blumstein, Steve Lima, Cherie LeBlanc, Lynne Westphal

Graduate and Postdoctoral Advisors: Bryan Shorrocks, Patrick Zollner

Thesis Advisor and Postgraduate-Scholar Sponsor (0):

Vanessa S. Quinn.
 Assistant Professor
 Department of Biology/Chemistry
 Purdue North Central
 Westville, Indiana
 765-430-7858
 vquinn@pnc.edu

EDUCATION

- 2001** Indiana State University PhD Life Science
 Dissertation Title: Proximate and Ultimate Factors Leading to the
 Loss of a Sexually Dimorphic Trait in *Sceloporus* Lizards.
- 1997** Northern Michigan University MS Biology
 Thesis Title: Geographic Variation in the Social Behavior of
 Redback Salamanders (*Plethodon cinereus*) and Ecological Factors
 Affecting the Absence of Territoriality
- 1993** University of Wisconsin BS Psychology and Zoology

PROFESSIONAL EMPLOYMENT

- 2007-Present** Assistant Professor, Department of Biology/Chemistry, Purdue University
 – North Central, Westville, Indiana
- 2006-2007** Visiting Faculty, Department of Biology, Wabash College, Crawfordsville,
 Indiana
- 2005-2006** Associate Lecturer, Department of Biology, University of Wisconsin
 Barron County
- 2002-2006** Research Ecologist, United States Forest Service, Rhinelander, WI

PUBLICATIONS

Kubiske, M.E., Quinn, V.S., Marquardt, P.E., Teclaw, R.M. and Karnosky, D.F. Growth and competitive interactions in mixed communities of trembling aspen, paper birch and sugar maple under elevated CO₂ and O₃. *Plant Biology*.

Kubiske, M.E., V.S. Quinn, W.E. Heilman, E.P. McDonald, P.E. Marquardt, R.M. Teclaw, A.L. Friend, and D.F. Karnosky. 2006. Feedback between climate change and the carbon cycle: Climatic variation mediates CO₂ and O₃ effects on forest growth. *Global Climate Change* 12:1054-1068.

King, J.S., M.E. Kubiske, K.S. Pregitzer, G.R. Hendrey, C. Giardina, E.P. McDonald, V. S. Quinn, and David F. Karnosky. 2005. Net primary production in young stands of trembling aspen, paper birch, and sugar maple as affected by elevated atmospheric CO₂. *New Phytologist* 168: 623-636.

Yellow highlighted names are undergraduates

Quinn V.S. and D.K. Hews. 2005. Detection and response to conspecific chemical cues by ornate tree lizards (*Urosaurus ornatus*). *Journal of Herpetology* 39(2):496-499.

Quinn, V.S. and D.K. Hews. 2003. Abdominal color variation in phrynosomatid lizards is correlated with dermal melanin density. *Copeia* 2003:858-864.

COLLABORATORS WITHIN THE LAST 48 MONTHS

Brent M. Graves, Northern Michigan University (MS Advisor)

Diana K. Hews, Indiana State University (PhD Advisor)

Brian R. Sturtevant, US Forest Service, Rhineland, WI

Philip Townsend, University of Wisconsin Madison, Madison, WI

Keith Woeste, US Forest Service, West Lafayette, IN