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The Future of *Great Plains Research*

This issue marks the beginning of a change in stewardship of *Great Plains Research*. The Center for Great Plains Studies has been promoting the study of the people, cultures, and environment of the Great Plains since 1976, and for 25 years *GPR* has been an important part of that effort. The beginning of a new editorship is a convenient time to consider the future of the journal.

For centuries, academic journals have endured the test of time. For instance, *The Philosophical Transactions of the Royal Society (Philosophical Transactions)* has survived for 350 years, and its mission continues to provide meaning in the twenty-first century: "The Society's fundamental purpose, reflected in its founding Charters of the 1660s, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity." The charge to "recognise, promote, and support excellence" can serve well as a guide for us: in the future as in the past, *GPR* will be committed to publishing excellent research on diverse topics about the Great Plains.

But *GPR*, like other journals, has also changed with the times, so let's look ahead and consider how together we can further strengthen the journal. First, we invite you, our readers and authors, to think of *GPR* as the hub of a large, connected, and collaborative effort to help all of us gain new insight into this fascinating place, the Great Plains. Every article, essay, or review we publish should contribute in some way to that larger goal, and we encourage authors to help us see how their work contributes to this larger understanding. Why is this particular piece of research important, and how does it provide insight into broader scientific or social questions?

GPR itself can advance this collaborative goal by opening our pages to new kinds of contributions. While traditionally refereed articles will remain *GPR*'s principal content, we will add as a new feature occasional invited essays by recognized experts on topics of high interest—an example is John Hibbing's essay in this issue entitled "Could the People of the Great Plains Have Distinctive Character Traits?" We expect invited essays to be provocative, engaging, accessible, often controversial, and reflective of the author's deep scholarship on the issue. We hope that whether or not you agree with the author, you will find yourself unable to resist reading the piece.

We will continue to publish cogent reviews of important Great Plains–related books, but we intend to add as well short, accessible reviews of scholarly articles published in other academic journals. These reviews, often written by graduate students, will give readers access to some of the best research tucked away in disciplinary journals; readers not in that particular discipline, who are unable to keep up with journals in other fields, will thus be able to read across disciplinary boundaries.

We will also intermingle and blend articles instead of putting them into the separate categories of "natural sciences" and "social sciences." Given the tremendous growth of research that draws upon multiple disciplines, and even more the escalating importance of multidisciplinary approaches in examining so many topics, it becomes increasingly difficult and unproductive to pigeonhole submissions. John Hibbing's article in this issue is an example: Hibbing is a political scientist writing about epigenetics and behavior. Instead of seeking research in a particular category, *GPR* will be searching for the best research *regardless* of category; often such research defies disciplinary categorization.

Finally, the editor is establishing, for the first time in *GPR*'s history, an Editorial Advisory Board. Below are the initial members recruited to serve three-year terms on the Board.

These changes and others perhaps to come—we invite your suggestions!—are all aimed at creating a sense of shared endeavor among authors and readers as we study and teach each other about the Great Plains. *GPR* derives its excellence entirely from its authors, and we hope that it, along with its sister publication *Great Plains Quarterly*, will be the research outlet of first choice for Great Plains scholars. Our region is a complex, sometimes surprising, important, and endlessly fascinating place. We encourage you to help us make *Great Plains Research* the lively, informative, never-to-be-missed publication that the region deserves.

Peter J. Longo, Editor
Richard C. Edwards, Center Director

Editorial Board

Charles J. Bicak

Dr. Charles Bicak is the Senior Vice Chancellor for Academic and Student Affairs at the University of Nebraska at Kearney (UNK). Dr. Bicak graduated with a BSc degree in biology from Kearney State College in 1974. He earned an MS in plant science from the University of British Columbia and a PhD in range science from Colorado State University. He taught biology at California State University, Bakersfield, for nine years and served as Chair of the Department of Biology. In 1992 he joined the faculty in biology at the University of Nebraska at Kearney where he also served as Chair. In 2005 he accepted an appointment as Dean of Natural Sciences at Saint Edward's University in Austin. He then returned to UNK in the spring 2009. Dr. Bicak's research has focused on plant/ecosystem response to environmental stress, including water and nutrient use efficiency by both native and introduced grassland plant species. He also has professional interest in environmental policy and ethics and currently serves on both the Central Platte Natural Resources District Board in Nebraska and the Audubon Rowe Sanctuary/Iain Nicolson Board on the Platte River.

Richard Edwards

Richard Edwards is the Director of the Center for Great Plains Studies and Professor of Economics at the University of Nebraska–Lincoln. He received his PhD in economics from Harvard University in 1974 and is the author or editor of 14 books and approximately 75 professional articles; his most recent book is *Natives of a Dry Place: Stories of Dakota before the Oil Boom* (2015). He is one of six authors of the *Atlas of Nebraska* (2017) and is the series editor for a series of short books called "Discover the Great Plains," forthcoming from the University of Nebraska Press. His current research focuses on the history of homesteading and the conservation of the biodiversity of the Great Plains grasslands through promotion of ecotourism.

William E. Farr

William E. Farr is Professor Emeritus of the Department of History and Senior Fellow of the Center for the Rocky Mountain West at the University of Montana in Missoula, Montana. Professor Farr spent his entire career at the University of Montana, first as a medievalist and then concentrating in western history with a special interest on Blackfeet and the Salish experiences on the northwestern Great Plains. His latest book, *Blackfoot Redemption: A Blood Indian's Story of Murder, Confinement, and Imperfect Justice*, won the Great Plains Distinguished Book Prize for 2013 from the Center for Great Plains Studies at the University of Nebraska. "Going to Buffalo: Indian Hunting Migrations across the Rocky Mountains" is the current research project, a topic previously explored in two articles appearing in *Montana: The Magazine of Western History.*

Susan Fritz

Susan Fritz is Executive Vice President and Provost and the Dean of the Graduate College of the University of Nebraska system. She is a 1979 graduate of the University of Nebraska–Lincoln (UNL) and received her master's degree in 1989 and her PhD in 1993, both from UNL. In 2009 Dr. Fritz was inducted into the Nebraska Hall of Agricultural Achievement and is the recipient of numerous awards for teaching excellence. She completed a Fulbright Senior Specialist assignment at the University of Zagreb (Croatia), and she serves as a North Central Higher Learning Commission Consultant Evaluator and a Commissioner with the Food Systems Leadership Institute.

B. Byron Price

B. Byron Price currently holds the Charles Marion Russell Memorial Chair in Art History at the University of Oklahoma and is Director of both the Charles M. Russell Center for the Study of Art of the American West and the University of Oklahoma Press. Before taking his current positions, Price spent nearly 25 years in the museum profession, serving as executive director of the

Panhandle Plains Historical Museum in Canyon, Texas; the National Cowboy and Western Heritage Museum in Oklahoma City; and the Buffalo Bill Center of the West in Cody, Wyoming. He is the author of more than three dozen magazine and journal articles on western American history and art and has written or edited nearly a dozen books and monographs.

Richard P. Reading

Richard Reading is part-time Director for Research and Conservation at the Butterfly Pavilion; a consultant in conservation biology; Adjunct Professor within the Department of Biology at the University of Denver; and Scholar in Residence in the Graduate School of Social Work at the University of Denver. He received a PhD and three master's degrees from Yale University in Wildlife Ecology and Human Dimensions of Wildlife and an honorary doctorate from the National Education University of Mongolia. Dr. Reading has worked primarily on grassland ecosystems on six continents, with a focus on the Great Plains of North America, the steppes of Mongolia, the savannahs of Botswana, and the Altiplano of Peru and Bolivia. His work focuses on developing pragmatic, effective, and interdisciplinary approaches to the conservation of wildlife and protected areas through research, capacity development, and working with local people and governments. Dr. Reading serves on the boards of directors or advisors for several nonprofit organizations in the United States and overseas. He has published over 180 scientific papers and book chapters, dozens of popular articles, and has written or edited eight books.

Eleanor G. Rogan

Eleanor Rogan is Professor and Chair of the Department of Environmental, Agricultural, and Occupational Health in the College of Public Health at the University of Nebraska Medical Center (UNMC) in Omaha, Nebraska. Eleanor Rogan's research primarily revolves around the initiation of cancer by estrogens and cancer prevention by specific dietary supplements. She also maintains an interest in environmental causes of cancer. While most of her research has been on the natural estrogens, it also includes synthetic estrogens such as DES and environmental phytoestrogens such as bisphenol A. She served on a European Commission working group from 1999 to 2001, which wrote a comprehensive report on estrogen carcinogenesis and the possible health concerns posed by hormones in beef.

She served as Interim Associate Dean for Research in 2014–15. In addition, she has been a leading member of the intercampus Center for Environmental Health and Toxicology since its inception in 1997. This Center includes faculty from UNMC, the University of Nebraska–Lincoln, and the University of Nebraska at Omaha, and she has developed mutual interests with faculty on all four University of Nebraska campuses.

Dr. Rogan received a PhD from Johns Hopkins University in biochemistry and an AB from Mount Holyoke College in biochemistry. She received the 12th Linus Pauling Functional Medicine Award in 2006 and a UNMC Distinguished Scientist Award in 2007.

Jessica A. Shoemaker

Jessica A. Shoemaker is an Assistant Professor of Law at the University of Nebraska College of Law. She graduated first in her class from the University of Wisconsin Law School and then clerked for the Honorable David M. Ebel on the United States Court of Appeals for the 10th Circuit. Following her clerkship, she was awarded a prestigious Skadden Fellowship to work at a national nonprofit law firm devoted to advocacy around systemic legal issues affecting farmers and rural communities. She then spent five years in private practice, working in nearly every phase of dispute resolution in many different courts (including the United States Supreme Court) and on a variety of complex legal issues, including Native American land use and renewable energy development. At the University of Nebraska, her scholarship focuses on American Indian land tenure, property law, land use, and community economic development. She is also a faculty affiliate of the Rural Futures Institute at the University of Nebraska.

Elizabeth Theiss-Morse

Elizabeth Theiss-Morse currently serves as Associate Dean for Faculty in the College of Arts and Sciences of the University of Nebraska–Lincoln. She received her BA in history and her PhD in political science from the University of Minnesota. Her research is focused on understanding American public opinion and how it relates to various aspects of democracy, including support for civil liberties, Congress, democratic processes, and the American people as a national group. She is the

author or coauthor of four Cambridge University Press books: *Who Counts as an American?* (2009), winner of the Robert E. Lane Award for the best book on political psychology; *Stealth Democracy* (2002), coauthored with John Hibbing and named an Outstanding Academic Title by *Choice* magazine; *Congress as Public Enemy* (1995), coauthored with John Hibbing and winner of the Fenno Prize for the best book on legislative politics; and *With Malice Toward Some* (1995), coauthored with George Marcus, John Sullivan, and Sandra Wood and winner of the Best Book in Political Psychology award. She has received five National Science Foundation grants, is the winner of a distinguished teaching award, and was named the Willa Cather Professor of Political Science in 2010.

Ethel Williams

Ethel Williams is the Reynolds Professor of Public Affairs and Director of the School of Public Administration at the University of Nebraska at Omaha (UNO). She has more than three decades of experience in the field of public administration, with particular expertise in the area of human resource management. Her research interests include social equity, health disparities as a policy issue, and workforce planning with an emphasis on succession planning. In addition to her teaching and research, she serves on numerous professional and public boards and commissions, including two terms on the National Council for the American Society for Public Administration; the Commission on Peer Review and Accreditation, which is the accrediting body for the Network of Schools of Public Policy, Affairs and Administration; the Environmental Quality Council and the Judicial Nominating Commission for the State of Nebraska; and has served for more than a decade on the Personnel Board for the City of Omaha. She recently served (2013–14) as President of the Network of Schools of Public Policy, Affairs and Administration, which is the membership organization of graduate education programs in public policy, public affairs, public administration, and public and nonprofit management. NASPAA's more than 300 member schools and programs are located across the United States and in 13 countries around the globe. NASPAA is recognized as the global standard in public service education around the world.

In 2011 Dr. Williams was elected fellow of the National Academy of Public Administration. She is the 2012 recipient of UNO's Chancellor's Medal and a 2013 recipient of the Women's Center for Advancement's Tribute to Women Award. Dr. Williams received the Outstanding Alumna Award from the Graduate School of Public and International Affairs at the University of Pittsburgh in 2014 and was appointed to their distinguished Board of Visitors in 2015.

Dr. Williams holds a bachelor's degree in history from Talladega College, a master's degree in public administration from the Graduate School of Public and International Affairs at the University of Pittsburgh, and a doctorate in political science from the University of Nebraska–Lincoln.

Invited Essay: Could the People of the Great Plains Have Distinctive Character Traits?

Looking to Scientific Research for Clues

John R. Hibbing

"Flat Places, Deep Identities." The first two words of the title of the 2017 Great Plains Symposium mesh nicely with the intended emphasis on geography and mapping, but it is the final two words that are potentially more controversial and that serve as the point of departure for this essay. Is it possible that people residing in the Great Plains have deep and distinct identities, values, philosophies, creeds, and personalities? More generally, is there such a thing as national or regional characters? If the people living in individual countries or areas are indeed distinct, what produces these differences? In other words, what are the precise mechanisms by which variations in character across geographical territories appear and are perpetuated? Disputes and conflicting claims on these matters have persisted since the beginning of history (Herodotus [1968]), and I do not pretend to offer firm answers here, but recent work in leading scientific journals sheds interesting new light on the topic. My purpose in this essay is not to make claims of my own but rather to summarize and integrate several of these studies so that readers might be better positioned to reflect for themselves on whether and why there could be such a thing as a Great Plains identity or character.

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Do National and Regional Character Exist?

Are Germans serious and hardworking? Are Japanese conformists? Are Canadians friendly? Are Australians outgoing? Are Californians laid back? Are Northeasterners brusque? Are Southerners polite? Are Indigenous People of the Plains more assertive than those hailing from coastal areas? To some, even considering the possibility of behavioral and attitudinal differences across groups is deeply troublesome, yet beliefs in the existence of distinct character traits are widespread and stubborn. To take one oft-cited example, Daniel Elazar argues that people living in certain states of the Upper Midwest display "moralistic" tendencies; that those living in many states in the South are "traditional"; and that those living in many states primarily in the Northeast are "individualistic" (Elazar 1972). Does systematic empirical research provide guidance on whether national and regional character traits are myths or have a basis in fact? Yes, though it would seem the answers suggested by that research are anything but consistent. Two major studies, each including dozens of coauthors from around the world and each appearing in the leading journal *Science*, come to remarkably different conclusions.

Terracciano et al. (2005) asked individual samples of people in 49 diverse countries (or distinct subcultures within selected countries), from Burkina Faso and Indonesia to Canada and Denmark, to rate their

own personality traits as well as those of acquaintances. Mean ratings for each country were then compared to the results of a separate survey in the same countries and subcultures in which people were asked to "describe the typical member of your culture." For example, a German Swiss might be asked to report whether a typical German Swiss is "anxious, nervous, and worrying" or "calm and relaxed." The juxtaposition of the results from these two surveys is interesting. Though perceptions of national character traits often followed expected patterns, with Australians believing Australians in general to be extraverted, Germans believing typical Germans to be conscientious, and Canadians believing Canadians to be agreeable, averaging people's perceptions of themselves and their acquaintances produced quite a different message. Beliefs about national characteristics did not at all reflect the traits that people saw in themselves or the people they knew. In fact, self-assessed personality traits varied remarkably little from country to country while perceptions of national character varied dramatically, leading the authors to conclude that the existence of real rather than perceived national character differences is either exaggerated or simply "not descriptive of the people themselves" (99).

Another equally ambitious but more recent effort to collect data on cross-cultural differences comes to a very different conclusion, however. Gelfand et al. (2011) focus not on personality traits but rather on the degree to which cultures are "tight" or "loose." Tight cultures are those that have numerous strong norms and a low tolerance for deviant behavior, whereas loose cultures give evidence of weak social norms and a corresponding tolerance of deviant behavior. The authors asked nearly 7,000 residents spread across 33 different countries to answer questions such as "in this country, if someone acts in an inappropriate way, others will strongly disapprove," and "people in this country almost always comply with social norms." Respondents were also asked to indicate the appropriateness of behaviors such as arguing, laughing, cursing, and flirting in specific places such as at a bank, on a city sidewalk, and at a job interview. People within given countries were in general agreement on the answers to these survey items and there was substantial variation from country to country. Moreover, the results seem to square with common expectations in that the tightest countries were Pakistan, Malaysia, India, Singapore, and South Korea while the loosest countries were Ukraine, Estonia, Hungary, Israel, and the Netherlands.

Taken together, the two studies just described lead to the conclusion that personality traits may not vary much from country to country and culture to culture but the existence and strength of, and obedience to, social norms does. As such, it appears that even the most thorough and inclusive empirical studies arrive at very different conclusions regarding the existence of distinct national and regional characters, identities, values, and traits. Despite this mixed message, given that suspicions about the existence of mean character variations are so persistent, it is worthwhile to consider interesting and often controversial research on the factors that could serve as the sources of national and regional variations—if they exist.

Whence National and Regional Character Differences?

Elazar asserted that the primary reason for regional differences within the United States is immigration and settlement patterns—for example, whether ancestors of the current population hailed primarily from, say, Scandinavia or from elsewhere in Europe. In many respects, however, such a formulation begs the question of why different points of origin would produce people who brought such different character traits with them to their destinations. What is it about Sweden or about Italy that generates widely varying character traits in the first place? It is at this deeper level that scholarly research provides provocative answers.

In Jared Diamond's widely read account (1997), geography and climate play key roles because they influence the kinds of agriculture that can be practiced, foodstuffs that can be foraged, animals that can be domesticated, innovations that can be diffused and beneficially adopted, and threats that need to be countered. These features then shape the traits of the humans who live in the relevant geographic area. It is interesting to note that Gelfand et al. (2011) cite similar factors as likely reasons for some cultures being tight and some being loose.

A great example of the potential for something like farming practices to affect behavior is provided by Talhelm et al. (2014). Using 1,162 Han Chinese students from numerous Chinese provinces, they measure self-reported individualism, loyalty, cultural thought, incidence of divorce in families, performance on matching exercises, and individualism (as measured by the tendency to draw pictures of themselves that are larg-

er in size than pictures they draw of their friends and relatives). With these variables, they test for the possibility that farming rice, which requires intensive, time-sensitive coordination and cooperation, and farming wheat, which can typically be done more independently, lead to different approaches to life. Their results show that people living in areas of China heavily dependent on rice farming think more holistically rather than analytically, while those living in areas of China heavily dependent on wheat farming (or similar crops such as corn) are more psychologically independent and less holistic. They also test two alternative hypotheses but find them to fit the patterns in the data less well (though their conclusions on these points have been subjected to critiques (e.g., Hu and Yuan 2015). On the basis of these findings, Talhelm et al. (2014) further speculate that differences in the predominant mode of agriculture could explain acknowledged cultural differences between the East and the West. Previous research has identified differences across people depending upon whether their groups are primarily engaged in subsistence-style agriculture as opposed to irrigated agriculture (Berry 1967; Harris 1977), but the Talhelm research on the potential effects of individual crops on character and values takes that conclusion to another level.

As important as style of food procurement and production could be to explaining attitudinal and behavioral variations, the potential source of culture and character receiving the most attention recently is the prevalence of parasites. For example, Thornhill et al. (2009), building on research dealing with the behavioral immune system (Faulkner et al. 2004), provide evidence that local levels of infectious diseases deeply affect people's values and attitudes regarding such issues as ethnocentrism, authoritarianism, individualism, gender equality, property rights, innovation, and sexual restrictions or freedoms. Their analysis of 169 countries shows a fairly strong positive correlation between parasite load, as measured by the incidence of 22 important human diseases, and attitudes that could be interpreted as xenophobic, conservative, anti-democratic, anti-women, and anti–sexual diversity. These correlations hold up even after controlling for latitude, per capita gross domestic product, and several common demographic variables. The takeaway is that important variations in character, values, and behaviors—concepts central to identities—appear to be generated by the degree to which people in a culture are at risk of being the victims of infectious diseases.

Are National and Regional Character Differences Durable and Persistent?

Factors such as farming practices and parasite load are plausible explanations for geographic variations in people's traits, values, and orientations, but for these variations to rise to the level of a people's "character" there must be some consistency over time. If the predispositions of the people in a geographical area are in a constant state of flux, they could hardly be viewed as part of a meaningful national character, so we now turn our attention to the difficult matters of the extent to which and the manner by which traits could persist from generation to generation. With regard to the latter, the most obvious mechanism is that the traits and values of the younger generation are shaped by the same geographical and climate-related factors that shaped the older generations or that the traits and values were learned from the conscious teachings of the older generation. In these ways, traits would acquire longitudinal stability and could be viewed as something approaching a character that could be the source of identity.

But is learning the only way that values, attitudes, and traits can be transmitted? To the extent national and regional characters exist, they also could run deeper than learned behavior. In fact, mounting evidence drawn from twin studies, adoption studies, and DNA-based identity-by-descent techniques supports the somewhat surprising conclusion that values, attitudes, behaviors, and traits have a substantial heritable component as well. Personality traits are believed to be at least 50% heritable (Bouchard 2004), obesity is almost as heritable as height (Wardell et al. 2008), and even political preferences and behaviors appear to be at least 20% and perhaps as much as 40%–45% heritable depending upon the estimation technique employed (Alford et al. 2005; Benjamin et al. 2012). As an example, researchers report that the biological parents of adopted-away offspring appear to shape the tendency of their children to vote or abstain from voting, even biological parents and offspring who have had no opportunity to interact and even controlling for the influence of the adoptive parents (Oskarsson et al. 2014).

Animal studies can provide an indication of the way genetic variations could filter through to attitudes, values, and behaviors. *Peromyscus* mice sometimes build an escape route out of their burrows and sometimes do not. A fascinating recent discovery is that mice with

certain alleles (versions of genes) are significantly more likely to build escape routes (Weber et al. 2013). As such, it seems as though a sequence of DNA disposes some mice to be more security conscious than others and leaves open the very real possibility that the same thing happens in humans. The key cross-species difference simply may be that for humans the outlet for being more security conscious is not building an escape route but rather advocating public policies thought to promote security, including greater spending on defense, strong leaders, restrictions on immigration, capital punishment, gun rights, and general support for law and order. Of course, all this is little more than speculation at this point, but the documented heritability of human political attitudes in combination with the relevance of DNA patterns to desires for security in mice make the connection possible.

Ding et al. (2002), among others, have documented that mean human genetic variations do exist cross-culturally. A gene involved with dopamine receptors in the brain comes in several different versions; one of these, known as the 7-repeat allele, has been associated with risk-taking behavior and even attention deficit disorder. This 7-repeat version of the gene is virtually absent from East Asian societies, especially in the north, but is very common in some indigenous tribes in South America, including the Yanomami. (Europeans and Northern Hemisphere Native Americans tend to be between these two extremes in terms of the frequency of the 7R DRD4 allele.) Could this variation in allelic frequency help to explain the conformist tendencies of some Asian societies and the more aggressively individualistic tendencies of select South American indigenous peoples? Several other possible explanations for these differences certainly exist, but it would seem that genetic variation cannot be ruled out as a potential influence (for more on this point, see Harpending and Cochran 2002).

For genetics to play a role in accounting for variation in national and regional character traits, however, issues concerning timing and variation still need to be worked out, and at first blush this is where problems could arise. The ability of selection pressures to alter allelic frequency is generally thought to take a very long time. This is why evolutionary psychologists worry that humans may be predisposed toward behaviors that are better suited to the relatively small hunter-gatherer bands in which humans survived (and had their genomes shaped) for hundreds of thousands of years than to modern-day large-scale agricultural societies in which humans have survived for only the last few thousand years. How could the ostensibly nearly fixed nature of genetics be made to square with the fact that, though regional and national character traits have some stability, they clearly change noticeably over shorter periods of time? Is there an account of intergenerational transmission that is somewhere in between glacially changing DNA patterns on the one hand and social learning that has to occur anew each generation on the other?

As it turns out, there is. Genes are sequences of DNA that produce chemical compounds such as proteins that bodies need to function; different versions of genes produce different chemical compounds. Recent discoveries show that substances around DNA such as methyl groups and histone tails affect the degree to which genes produce the intended chemical compounds. The study of these non-DNA substances is known as epigenetics, and it is one of the most exciting newer areas of genetics. It was first thought that the epigenetic variations that affect the rate of protein production were the result of an organism's environmental experiences. Astonishing recent discoveries, however, show that a parent's acquired epigenetic patterns are actually passed along to offspring. One of the clearest examples of this transmission is seen in mice. Mice that had been conditioned to fear a certain odor actually passed along that fear to their offspring without any intergenerational contact or learning occurring. They did so by way of selected epigenetic markers near the genes relevant to an olfactory pathway (Dias and Ressler 2013). These effects appear to last for at least a couple of generations and perhaps more. Similar patterns have been observed in humans where distinct epigenetic markers can result from stressors such as droughts and famine and can be transmitted intergenerationally (see Zimmer 2015 for a readable explanation). Nature and nurture are not nearly as distinct as many people tend to assume and in fact can now be seen working in concert.

The key point is that research on epigenetics offers the exciting possibility that features relevant to a national or regional character do not need either to be retaught from scratch each generation or to spring entirely from relatively fixed nucleotide patterns in the DNA. Epigenetic transmission has some stickiness but is malleable enough over time to yield biological changes over the course of only a generation or two, especially when acting in concert with changes in the environment such as modes of agricultural production and disease risk (for a general treatment of gene-culture interaction, see Richerson and Boyd 2005).

A Distinctive Great Plains Character?

Where does all this leave us with regard to the possible existence of distinct Great Plains character traits and the deep identities that would follow? For several reasons, a single overarching character seems highly unlikely. For starters, there is the diversity and sheer geographic size of the Great Plains. Another factor working against the existence of a reasonably common set of character traits is that the Great Plains tend to run north–south, whereas, as we have seen, most accounts of the reasons for national and regional commonalities rest on east–west axes. Moving along a north–south axis tends to involve too much variation in climate, crops that can be grown, and parasite load to support a compelling set of reasons for a distinct Great Plains character. Perhaps this is why Elazar's map of the United States shows the Great Plains including at least two of his three cultures. Colin Woodard divides North America into 11 regions and the Great Plains covers parts of at least five of them (Woodard 2012). Should we really expect the character of Texans to be the same as people living in North Dakota and even farther north into Canada? Moreover, it does not seem as though the character traits of the people of the Great Plains have stayed stable enough over time to permit the conclusion that the region has an identifiable "character." Finally, if we were to claim that there is a Great Plains character, how exactly would it be described?

To take the last question first, one putative aspect of the Great Plains character is an emphasis on individuality at the expense of collectivism. The usually wide-open spaces and less intensive agricultural practices of the Great Plains may provide the raw material for an individualistic mentality that is suspicious of collectivism and governmental interventions. In political terms, it certainly seems as though the Great Plains of late embraces an individualistic conservatism. When looking at recent electoral maps, it is difficult not to notice that the spine of the United States, running from Texas through Oklahoma, Kansas, Nebraska, and the Dakotas, has been reliably red (Republican) since the LBJ landslide of 1964. During that half century, only Texas has ever failed to vote Republican in a presidential election, and even that was more than 40 years ago. Is this indicative of a regional character of sorts? Perhaps not, given that the situation was quite different a few decades ago. Until recently, many parts of the Upper Midwest, including areas of the Great Plains, had a definite collectivist bent (remember Elazar's depiction of these states as "moralistic" and not "individualistic"), raising questions about whether the region's recent embrace of individualism and political conservatism equates to the existence of a meaningful, relatively broad character and identity.

Sometimes it seems as though what can appear to be a Great Plains character is instead a "low population density" character. People residing in urban areas have been shown to have different values and attitudes than those residing in rural areas. Only four major US cities (Phoenix, Fort Worth, Salt Lake City, and Oklahoma City) voted Republican in 2012 even though many of the country's remaining (Democratic-voting) cities (for example, Dallas, Houston, San Antonio, and Austin) are in reliably red states (Kron 2012). This division certainly exists within the Great Plains as well, where people living in the region's urban areas consistently reflect more collective and progressive values than those living in rural areas.

The scientific research summarized here in no way provides definitive answers to questions pertaining to the existence of, reasons for, and transmission of mechanisms of distinctive national and regional character traits. It does provide something to think about, and it does show how character traits could vary in meaningful ways from nation to nation, region to region, and era to era. Thus, though the size, diversity, and north–south orientation of the Great Plains render it less likely, it is possible that geographic, population, disease, and agricultural patterns, perhaps working in concert with epigenetics, could conspire to produce an evolving and far from homogeneous Great Plains character around which the people of the region could potentially form not one but several deep identities. Be this as it may, relying on recent scientific discoveries for guidance in pondering the degree to which and the mechanisms by which the land and climate of a region can shape the traits and behaviors of the humans living on that land is something students of the Great Plains should continue to do.

John R. Hibbing is the Foundation Regents Professor of Political Science and Psychology at the University of Nebraska–Lincoln, where his research focuses on the biological and deep psychological bases of political ideology. He has been a NATO Fellow in Science, a Senior Fulbright Fellow, a Guggenheim Fellow, and is an elected Fellow in the American Association for the Advancement of Science. His research has appeared in *Science, Current Biology, Behavioral and Brain Sciences, and American Political Science Review.* He is coauthor, with Kevin Smith and John Alford, of *Predisposed: Liberals, Conservatives, and the Biology of Political Differences*.

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Social and Environmental Influences on Female White-Tailed Deer Dispersal Behavior

Charles M. Nixon and Philip C. Mankin

ABSTRACT—Dispersal behavior is primarily a male-biased behavior in white-tailed deer (*Odocoileus virginianus*) throughout the species range. However, in the agriculture-dominated lower Midwest and Great Plains, female dispersal also occurs. We examined the effects of the social and physical environment experienced by female fawns marked in central and northern Illinois, where dispersal rates were high (31%–61%) and forest cover occupied <5% of the county landscape. Dispersal probability was high for females born to subordinate mothers (25 of 26) and for fawns paired with a sibling that also dispersed (25 of 31). Females that dispersed came from populations with similar densities as those of females that remained sedentary. The lower dispersal rate for females born to dominant mothers suggests that the higher resource availability present within the home ranges of dominant mothers affects dispersal behavior. Subordinate mothers generally inhabit smaller, less secure ranges with fewer resources available to offspring. Resource availability appears to be one of the proximate factors influencing female fawn movement behavior.

Key Words: behavior, dispersal, environmental, social, white-tailed deer

Introduction

Natal dispersal behavior (defined in this article as a one-way movement away from the natal range to a location where deer settle and breed) has important implications for the dynamics and persistence of populations (McCullough 1985; Martin 1998; Dieckmann et al. 1999; Nathan 2001; Perrin and Goudet 2001; Andreassen et al. 2002). Dispersal is motivated by internal and external stimuli and is controlled by the distribution and abundance of resources and the assorted risks associated with vacating the natal range (Gaillard et al. 2008; Quinn et al. 2013). White-tailed deer conform to male-biased dispersal behavior throughout their continental range as expected of a polygynous breeding system (Greenwood 1980; Dobson 1982). Most females are philopatric, organized as matrilines of related females anchored to an extensive home range shared among these females (Teirson et al. 1985; Aycrigg and Porter 1997; Nelson and Mech 1999; DeYoung and Miller 2011). Female survival and fecundity depends upon female kin support and home range familiarity with food resources in areas that reduce the likelihood of predation on fawns (Moore and Ali 1984; Pusey 1987).

The adaption of deer to exploiting subclimax vegetation that often develops quickly means deer must also respond quickly to benefit from these landscape changes, and dispersal behavior provides a means to do so (McCullough 1979). Dispersal behavior is apparently not genetically fixed in the female deer genome but allows females to use this behavior as one option to deal with adverse circumstances (McCullough 1985). At least some female dispersal behavior have been documented throughout the continental range, including regions where winter weather is life-threatening (Nelson and Mech 1992) and in subtropical climates where weather effects are unimportant (Kilgo et al. 1996; Comer et al. 2005). At present, female dispersal behavior is most evident in the Midwest agricultural region and the Great Plains, encompassing what was once the mixed-

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grass and tallgrass prairie regions (Sparrow and Springer 1970; Gladfelter 1984; Kelly et al. 2010). Permanent cover has been reduced to scattered small woodlots and linear strands of forest along watercourses in these regions (Sparrowe and Springer 1970; Nixon et al. 1991; VerCauteren and Hygnstrom 1994; Hansen et al. 1997; Brinkman et al. 2005).

Female dispersal behavior has ranged from 6% to 7% in South Dakota and southwest Minnesota (Brinkman et al. 2005; Grovenburg et al. 2009) to 24% in Iowa (Gladfelter 1978) and 49% in east-central Illinois (Nixon et al. 2007). There are similarities in landscape characteristics between an eastern prairie state like Illinois and the mosaic of crops, stream-lined watercourses, and scattered small towns and villages found throughout the Great Plains. Crops make up 39.5% of South Dakota, 43.9% of Nebraska, 42.4% of Minnesota, 73.5% of Iowa, and 66.8% of Illinois (USDA-NASS 2012).

Males respond to both female dominance and aggression associated with parturition (spring dispersals) and male dominance associated with breeding behavior (fall dispersals) (Shaw et al. 2006; Long et al 2008). The causes of natal dispersal behavior among females remain obscure. There have been five major causes proposed to explain the behavior: avoidance of inbreeding, competition for resources, competition for mates, competition among kin, or a response to habitat instability (Hamilton and May 1977; Greenwood 1980; Dobson 1982). These social behaviors impacting individual females have not been specifically linked to female movements. Because there has been no concerted effort to explain female dispersal behavior but merely to document its occurrence (Brinkman et al. 2005; DeYoung and Miller 2011), the hypothesis proposed by Nelson and Mech (1992) that dispersal by females was a voluntary response to their social and physical environment should be addressed. The authors' conclusion was based on these observed differences in movements by siblings (Nelson and Mech 1992).

VerCauteren and Hygnstrom (1994) noted that future research efforts regarding movement behaviors in white-tailed deer living in the eastern Great Plains should examine the extrinsic and intrinsic factors that instigate dispersal behavior. We recently examined female dispersal behavior in Illinois and noted the effects of sex, fawn condition, mother and sibling movements, and litter size on fawn dispersal behavior and concluded that fawn behavior was most influenced by mother's movement behavior (Nixon et al. 2007). The present study was designed to investigate the effects of various other life history attributes and large-scale habitat composition of the natal range on female fawn movement behavior.

Study Areas

We captured females in Piatt County (east-central Illinois) (1980–85) (87 fawns, 24 yearlings, 27 adults) and DeKalb County (northeast Illinois) (1990–93) (36 fawns, 12 yearlings, 20 adults) (Fig. 1). These areas were a mix of public (Piatt—20% of the study area, DeKalb—29%) and private lands surrounded by extensive agricultural fields. The Piatt area (2,953 ha) was covered by 64% row crops (corn or soybeans), 22% second-growth upland deciduous forest, and 14% bottomland deciduous forest. There was a wooded corridor along the Sangamon River that extended northeast–southwest across and well beyond the study area that afforded females a dispersal corridor (Nixon and Mankin 2011). Piatt County was only 2.7% forested in 1985 (Iverson et al. 1989). Winter deer densities (based on aerial counts conducted once each winter) ranged from 7 per 100 ha in 1980 to 17 per 100 ha in 1985 in the wooded portion of the study area.

The DeKalb site (1,648 ha) is at the headwaters of the Fox River and was surrounded by agricultural fields. The area was covered by 59% row crops, 14% second-growth deciduous upland forest, 7% reconstructed tallgrass prairie, 6% mixed-species pine plantations, and 5% savanna. The remaining 9% consisted of a small suburban area, a golf course, and a 128 ha lake. There was no forest cover for at least 16 km north and west and 10 km east of the study area. There was a small woodlot 5 km south and 2–3 woodlots (<1 ha each) 7 km southwest of the area. DeKalb County was only 1.6% forested in 1985 (Iverson et al. 1989). Winter deer densities (based on Peterson-Lincoln index calculations using marked:unmarked ratios of yearling and older females observed during spotlight counts and population reconstruction data from late summer–fall observations of fawns and antlered males) averaged 48 per 100 ha of forest cover during 1990–93 and was much higher than the average DeKalb County deer densities during those years (Roseberry and Woolf 1998).

Methods

We captured deer using a 4.6 m^2 drop net (P. Meyer, Indiana Department of Natural Resources, pers. comm. 1980) or a rocket-powered net (Hawkins et al. 1968).

Figure 1. Study area locations used to examine female white-tailed deer fawn movements in east-central and northern Illinois, 1980–85 and 1990–93.

We manually restrained all deer, ear-tagging females and aging them as fawn (<12 months), yearling (12–23 months), 2-year-old (24–35 months), or adult (≥36 months) using tooth replacement and wear as observed on live deer at capture (Severinghaus 1949). These capture techniques were approved by the Animal Welfare Committee of the University of Illinois.

In addition, we marked females with radio collars (Wildlife Materials, Murphysboro, IL, Telonics, Mesa, AZ, or Advanced Telemetry Systems, Isanti, MN) or with 7.5 cm wide plastic collars bearing reflective numbers allowing for identification day or night. We located radio-marked females 3–4 times each week while on the study areas, and we tracked by truck or aircraft those dispersing after they reached their new range. We frequently observed females marked only with plastic collars while they were on the study areas and occasionally after dispersing. For this study, we refer only to those females with known postweaning movement behaviors.

The factors that may influence fawn movement (either dispersed or sedentary) include social, biological, or environmental influences. Social factors included mother's social status (known to be dominant or subordinate), change in size of social group (integrity of dominant vs. subordinate led social groups), and density of breeding females in and adjacent to each natal area. Biological factors included sibling movement behavior, sibling gender, fawn condition (chest girth in centimeters), and fawn growth (hind foot length in centimeters). Environmental factors included the size of the mother's home range size (in hectares) (effectively, the natal range), and the composition of the landscape in the natal range. Data were collected for each female by capture (chest girth and hind foot measurements), radiotelemetry, and direct observations. Contingency tests or *t*-tests were used to test for differences between dispersed and sedentary deer (Zar 1999).

To determine if the mother's social status was relevant to the natal home ranges, we compared the habitat composition of these natal ranges for fawns of socially dominant vs. subordinate females. We used a combination of radio fixes (dominant females $\bar{x}$ = 601 fixes; subordinate females $\bar{x}$ = 427 fixes) and observations (dominant $\bar{x}$ = 47; subordinate $\bar{x}$ = 29) to delineate the boundaries of natal ranges of dominant (n = 16) and subordinate (n = 15) mothers on the study areas.

We cover-mapped landscape components of the natal home ranges once to include the amount of linear agriculture-forest edge, as well as the percentage of home range in forest (upland or bottomlands), early successional cover (shrubs, young trees, grasses and forbs), crop fields, grasslands (pastures, golf course, reconstructed prairie), and water features. We also compared, using *t*-tests, the number of patches of different landscapes in each natal range between dispersers and sedentary females.

Results

During our studies, the proportion of female fawns that dispersed averaged 43.9% (range 33.3%–50%) for females marked in DeKalb County in the years 1990–1993 and 44.8% (range 31.2%–61.1%) for fawns in Piatt County in the years 1980–1985. Dispersal distance averaged 49.0 ± SE 4.8 km from the Piatt area and 37.0 ± SE 5.6 km from the DeKalb site.

Our observations of 64 marked fawns showed that some dispersing females often departed from the family group before mother's next parturition and well before sedentary fawns left their mother's immediate vicinity just prior to parturition. All six fawns last observed in April dispersed, but the dispersal proportion of females last observed in May (47.9% of 48 fawns) and June (50.0% of 10 females) was similar.

Over 95% (25 of 26) of female fawns born to known subordinate females dispersed, compared with only 36.1% (22 of 61) for fawns belonging to known dominant females (χ^2 = 31.80, df = 1,86, P < 0.0001). Dispersal behavior was more disruptive to social group cohesion in subordinate-led groups. Female dispersals reduced subordinate group size 44.8% ± SE 0.04 on average compared to 22.7% ± SE 0.04 for dominant led groups (t = −4.17, df = 1,29, P = 0.0003). There was no significant difference in the number of known breeding females present on or adjacent to the natal ranges of females that dispersed or remained sedentary in the spring (mean = 11–13 females per natal range, n = 101 total female fawns).

Sibling behavior appeared to influence female littermate behavior. Twenty-five of 31 female pairs also dispersed compared to 11 of 29 pairs that remained sedentary (χ^2 = 11.8, df = 1,58, P = 0.0006). Sibling gender did not affect this response in mixed-sex litters (χ^2 = 1.91, P = 0.38).

Fawn condition and growth in mid- to late winter did not affect subsequent dispersal tendencies. Chest girths for dispersing females (n = 21, $\bar{x}$ = 78.5 ± SE 0.82) was somewhat higher than for sedentary females (n = 13, $\bar{x}$ = 77.8 ± SE 1.04) but not significantly (t = 0.51, df =

32, $P = 0.62$). Similarly, hind foot lengths for dispersing females ($n = 21, \bar{x} = 43.5 \pm$ SE 0.29) was somewhat higher than for sedentary females ($n = 15, \bar{x} = 43.0 \pm$ SE 0.34) but not significantly ($t = 1.17$, df = 34, $P = 0.25$). All females were observed to be in good general physical configuration at capture and during subsequent observations.

Large-scale habitat components were similar for dominant and subordinate female annual home ranges ($P > 0.05$) for all tests of individual habitat components (forests, cropland, etc.). Dominant females on the DeKalb County study area had annual home ranges ($n = 6, \bar{x} = 370.5 \pm$ SE 63.64) nearly double in size to that of subordinates ($n = 7, \bar{x} = 188.7 \pm$ SE 58.9). The large variation in range sizes resulted in a nearly significant difference ($t = 2.08$, df = 11, $P = 0.06$). Home ranges for dominant females on the Piatt County area averaged slightly smaller ($n = 7, \bar{x} = 149.0 \pm$ SE 44.62) than subordinate females ($n = 8, \bar{x} = 173.2 \pm$ SE 41.73) ($t = -0.40$, df = 13, $P = 0.70$). Croplands, providing an important forage component of deer range in Illinois and throughout the Midwest and Great Plains, was slightly more abundant in the ranges of dominant mothers ($n = 25, \bar{x} = 56.2\% \pm$ SE 3.38) than subordinate mothers ($n = 5, \bar{x} = 54.3\% \pm$ SE 7.56). Forest cover was less abundant in dominant ranges (dominant: $n = 25, \bar{x} = 43.6\% \pm$ SE 14.09; subordinate: $n = 5, \bar{x} = 45.7\% \pm$ SE 28.09), but patch densities and edge were more prevalent, indicative of a more heterogeneous landscape.

Discussion

Wahlstrom and Kjellander (1995) examined the effect of habitat quality on the physical condition and fawn recruitment of roe deer (*Capreolus capreolus*) and concluded that female natal dispersal was "voluntary," with a proximate cause of maximizing resource acquisition. These authors felt that white-tailed deer dispersal behavior would also later prove to be resource driven. Nelson and Mech (1992) also concluded female dispersal behavior in white-tails was voluntary based on the different movements observed among siblings exposed to similar social and environmental influences since birth.

The results of our studies support a similar conclusion, where the mother's social position directly affects the availability of resources to female fawns, including both forage quality and quantity as well as providing safe parturition sites. Dominant females on our study areas provided offspring with access to large home ranges, for the most part free of hazards, allowing females to survive and recruit large fawn crops (Nixon et al. 2010). Even though home range size was similar for dominant and subordinate females on the Piatt area, dominant females occupied areas better cushioned against large changes in quality (more heterogeneous). On the DeKalb area, the much larger home ranges of dominants provided female kin with a landscape of abundant parturition sites and forage opportunities.

However, Lutz (et al. 2015) inferred that dominant females exclude subordinate females from resources and that this promotes female dispersal. We showed that female dispersal is indeed resource driven, but that dominant females, by controlling access to resource-rich home ranges, actually decreased female dispersal behavior for females within the same social group.

Other explanations for female dispersals do not appear credible, based on our findings. Inbreeding avoidance does not appear to influence female movement behavior. Fawn females often breed on their natal range in the Great Plains and Midwest when six to seven months old (Haugen 1975; Harder 1980; Menzel 1984), at a time when inbreeding with sedentary male kin would be possible.

Mate competition, while very important for males (Shaw et al. 2006; Long et al. 2008), has not been demonstrated to be as important for females. Apparent mate choice by females may occur within populations having both low density (Labisky and Fritzen 1998) and high density (Kolodzinski et al. 2010) as females increase movements away from their home range during estrous. However, radio-marked females on either of our study areas did not move out of their normal range during breeding. We also did not observe fawn females vacating their mother's range in search of mates during the late November–January period when fawns typically breed in Illinois.

Kin competition for resource allocation within the natal range might influence movement decisions, but at least for the densities encountered on our study areas, it appeared not to directly influence dispersal behavior. The number of breeding females occupying parturition sites in and around the natal range was higher for dominant-led social groups, where female dispersals were lower. Also, we found no indication that overall population densities on the study areas affected female dispersal behavior. The percentage of fawns dispersing from the DeKalb area ranged between 30% and 40% at a time when the population was slowly increasing. The proportion of female fawns dispersing was not signifi-

cantly correlated with the estimated spring densities observed during aerial counts on the Piatt area (r = 0.04) and actually declined in 1985 when resident deer reached their highest density (Nixon et al. 1991). Long et al. (2008) and Oyer and Porter (2004) found male dispersal was not density dependent in Pennsylvania and New York, respectively.

Sibling movement behavior also affects female dispersal behavior. Marked female siblings showed a mixed reaction to dispersal by one member, some moving also and some remaining sedentary. Those pairs where both members dispersed often moved separately, at different times, and located a different distance from the natal range (Nixon et al. 2007). Sibling movement behaviors would be expected to exhibit similar behavior because they are subject to the same social and environmental stimuli throughout their first year.

Conclusion

The key to continued successful occupancy of the fragmented habitat of the Great Plains and Midwest agricultural regions lies in the dispersal behavior of both sexes of white-tailed deer. The ability of both sexes to disperse often over long distances means deer can exploit all available landscapes present (Nixon et al. 1991; Brinkman et al. 2005; Frost et al. 2009). Losses due to hunting and other hazards can be mitigated annually and favorable changes in landscapes quickly exploited. Deer have a robust response to habitat fragmentation and have evolved a high movement probability where the benefits outweigh the costs (Stewart et al. 2011).

VanCauteren and Hygnstrom (1994) called for further study of the factors affecting deer movements in the Great Plains. We concur that further research into the effects of social behaviors on female dispersal behavior is needed. We have demonstrated that social status is one factor affecting this behavior, but there is undoubtedly more to unraveling the complex array of factors that lead to dispersal behavior in this usually philopatric sex.

Charles M. Nixon (cenixon@mchsi.com), Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820

Philip C. Mankin (pmankin@illinois.edu), Department of Natural Resources and Environmental Sciences, University of Illinois, 1102 South Goodwin Street, Urbana, IL 61801

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Invasion during Extreme Weather

Success and Failure in a Temperate Perennial Grassland

James C. Han and Stephen L. Young

ABSTRACT—Invasive and native plant species compete for resources in similar pools, with disturbances often favoring the invader. Yet, increased climate variability may be shifting the competitive edge back toward the natives. We conducted field studies in perennial grasslands to determine the effects of clipping and drought on resource availability (light and moisture) and subsequent establishment of *Carduus nutans*. We measured light penetration and soil moisture content in *C. nutans* monoculture, clipped and nonclipped grassland with *C. nutans*, and bare ground control plots. We also tracked phenology of the invader and grasses. Our studies revealed that light was a limiting resource in normal precipitation years; removing biomass (e.g., clipped grassland plots) allowed *C. nutans* to successfully establish, while not removing biomass (e.g., nonclipped grassland plots) resulted in premature death. Similarly, soil moisture was a limiting resource when light was abundant; a lack of precipitation in the second year reduced grass growth, which opened the canopy and allowed adequate light for *C. nutans* seedlings that also died prematurely under extremely low soil moisture levels. We found that *C. nutans* was unable to compensate for the low light and soil moisture in offsetting, yet consecutive seasons and failed to establish in a nonclipped grassland. The emergence of *C. nutans* in a temperate perennial grassland is not a sure sign of success. If left undisturbed, *C. nutans* seedlings may eventually die without having a significant impact on grasses.

Key Words: *Carduus nutans*, climate change, clipping, drought tolerance, extreme weather events, fitness, grazing, invasion resistance, musk thistle, plant plasticity, resource competition

Introduction

Invasive plant species in grasslands of temperate regions have modified biotic communities and altered natural cycles with increasing frequency (Charles and Dukes 2007). In order to prevent negative impacts from invasive plant species, the focus of many restoration efforts has been on the creation of diverse grassland communities that provide a barrier against invasion (Berlinger and Knapp 1991; Bottoms and Whitson 1998). This approach provides a good base for understanding competition for resources by native and invasive plant species, including those in temperate regions (Pokorny et al. 2005). Access to available resources is important for invasive plant species (Thomas et al. 2002; Maron and Marler 2007). Moreover, spatiotemporal resource acquisition by native and invasive plant species is considered to be a key factor in invasion success (Zavaleta and Hulvey 2007).

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Invasive plant establishment is often due to niches in plant communities that are created by variations in phenologies and traits (Godoy and Levine 2014; MacDougall et al. 2009). Wolkovich and Cleland (2010) argue that many invasive plants adapt quickly to changes in the environment through altered phenology (i.e., plasticity), thus making them better competitors for limited resources in niches (Hooper and Dukes 2010, Fargione and Tilman 2005). Over time, the change in phenology could be considered a fitness advantage that allows for invasive plants to become established and eventually dominate resident plant species (MacDougall et al. 2009; Chesson 2000).

In grasslands, a well-established perennial grass community can preempt belowground space by extending roots (Blank and Morgan 2012) and depleting resources to the detriment of the invader (Milbau et al. 2005). However, disturbance can reduce resistance by a perennial grassland community as openings in the canopy create niches that allow invasive plant species to establish (Feldman et al. 1968). Overgrazing is a disturbance that can lead to invasive plants establishing

in openings, which fail to fill in with new vegetation (Leininger 1988; Beck 1999).

Invasive plants that successfully establish, initially may avoid direct competition with residents by accessing excess or incompletely used resources (Elton 1958; Hierro et al. 2011). Yellow starthistle (*Centaurea solstitialis*), an invasive plant with similar characteristics as *Carduus nutans*, used water and light during phenological stages that functionally matched the target grassland plant community (Young et al. 2011). In this case, even an increase in available soil water during the vegetative stage of yellow starthistle was not enough to overcome the lack of light transmission through the dense canopy of the grasses. With overlapping resource use patterns and adequate biomass and cover, harsh conditions (e.g., drought) often will favor the established resident plant community over the invader (Cahill 2003).

Several resources have been studied as possible factors contributing to invasion, including moisture, light, and nutrients (e.g., Hovick et al. 2011; Throop et al. 2012; Novoa et al. 2014). Light availability, which is a function of leaf area, influences the success of invasive plant species (Reinhart et al. 2006; Thomsen and D'Antonio 2007; Young et al. 2011). The manipulation of light, through either blocking by the resident community or accessing by the invader, is largely a function of plant growth habit. Often, those species that grow taller or bushier and at a faster rate will be more successful in outcompeting neighboring plant species. In arid and temperate regions, soil moisture contributes to successful invasion, especially if the invader germinates earlier in the growing season (Davis and Pelsor 2001; Larson et al. 2001). Sheley et al. (1999) found *Centaurea diffusa* produces less seed when it is mowed compared with producing seed after mowing when soil moisture is adequate or replenished.

A short-lived biennial, *C. nutans* was introduced into the United States from Eurasia and now commonly occurs in the Midwest (Kok 2001). *Carduus nutans* begins as a rosette that develops extensive roots and then after bolting and flowering, senesces by flowering (~1,000 capitulum/plant) and dispersing seed prolifically (>20,000 seeds/plant) (Roeth et al. 2003). On range and pastureland, *C. nutans* competes with desirable forage and its sharp spines can deter livestock and wildlife from grazing (Hull and Evans 1973; Desrochers et al. 1988; Beck 1999). At low densities, *C. nutans* may reduce production of desirable plants (Reece and Wilson 1983; Sindel 1991). Perennial grass production in Nebraska increased about 212% following chemical control of *C. nutans* (Reece and Wilson 1983). Dense infestations of the plant discourage animals from occupying infested areas (Rees 1991). Feldman et al. (1968) report greater *C. nutans* establishment in less vegetated habitats, which is in part due to a high level of irradiance (Wardle et al. 1992).

The Midwest is not immune to the effects of climate change, including extreme weather events and the threat of invasive species, like *C. nutans*. However, the concern with regard to increasing challenges for managing prairie grasslands could be unfounded in the future. Human efforts to actively control and contain invasive species have in the past been justified due to their seemingly rapid advancement, but as we enter into a new era of climate uncertainty, earlier springs, later falls, rising atmospheric CO_2, and drought during years of normal annual precipitation will amplify what little we know about invasive species and the plasticity they exhibit that leads to life or in some cases death, as first described by Young (2015) and now here.

For two years, we studied *C. nutans* during normal (2011) and extremely low (2012) annual precipitation. Our goal was to determine the survivability of *C. nutans* in grasslands that had niches with resources that were available in offsetting, yet consecutive, seasons. We used (1) introduction or no introduction of *C. nutans* and (2) clipped or nonclipped perennial grasslands as factors with which we compared the spatiotemporal changes in light and soil moisture for *C. nutans* invasion during discreet phenological stages.

Materials and Methods

Experimental Design

Our study was conducted in the mixed-grass prairie region of central Nebraska, where average annual precipitation is 508 mm of which 80% occurs from late April to mid-October. The total seasonal precipitation was 513 mm in 2011 and 113 mm in 2012, which was 3% higher and 77% lower, respectively, than the historical average. The dominant and uniformly distributed soil type was Cozad silt loam (fine-silty, mixed, mesic Fluventic haplustoll).

Our site was located in an area with a diversity of warm-season perennial grasses that included *Panicum virgatum*, *Andropogon gerardii* Vitman, *Schizachyrium scoparium* (Michx.) Nash, *Andropogon hallii* Hack., *Sorghastrum nutans* (L.) Nash, *Bouteloua curtipendula* (Michx.) Torr., *Desmanthus illinoensis* (Michx.) MacMill. ex B. L. Rob. & Fernald, *Dalea purpurea* Vent., and

Lupinus perennis L. Due to the limited size of the area (300 m²) for our study and the need to uniformly apply clipping treatments and collect data with minimal disturbance, our experimental design followed a split-plot within a strip layout, according to Steel et al. (1997). We established three 18 × 5 m strips side by side, 0.3 m apart in an east–west direction. One strip was kept free of vegetation by cultivating and hand weeding (bare ground), while grasslands remained in the other two strips. For the two grassland strips, we clipped one and left the other one nonclipped. A total of 24 split-plots or plots (5 m × 2 m) were established in replicates of four on April 11, 2011. Within each strip, we randomly selected half the plots to be either planted (4) or not planted (4) with *C. nutans* seeds. We clipped, did not clip, or left bare any remaining area within respective strips.

Plant Phenology and Carduus nutans *Populations*

The factors in our study were (1) *C. nutans* and (2) clipping during years of normal (2011) and extremely low (2012) annual precipitation. Treatments included introduced *C. nutans* (IC) or no introduction of *C. nutans* (NC) in the first year (2011) and clipped (CL) or nonclipped (NCL) perennial grass in both years (2011 and 2012). We carried out the study by measuring (1) survival (density), cover, aboveground biomass, plant basal diameter, number of branches and leaves, and height of *C. nutans*, (2) light transmission, and (3) soil moisture content at shallow and deep depths in *C. nutans* monoculture and both clipped and nonclipped grassland plots. For survival and cover of *C. nutans*, we applied the IC treatment to half of the clipped (CL-IC) and nonclipped (NCL-IC) grassland and bare ground (BG-IC) plots, which became *C. nutans* monocultures.

We administered clipping treatments at 10 cm above the ground using a rotary mower, electrical hedge trimmers, and minor amounts of hand weeding. We removed the grass residue from the strips immediately. In 2011 we clipped the grass strips approximately every two weeks (five times) beginning on June 1, which coincided with *C. nutans* rosette growth stage. In 2012 we applied a single clipping treatment to the grasses on May 28, with no further clipping for the remainder of the season due to little growth from the severe drought conditions. We avoided clipping *C. nutans* in order to more closely match natural conditions and also to maintain competitive ability.

On April 28, 2011, we planted 140 *C. nutans* seed into individual 5 m × 2 m plots in the strips of perennial grasses (clipped and nonclipped) and bare ground. A preliminary germination test indicated seed viability was near 30% for the collection (data not shown). In perennial grass and bare ground plots, three *C. nutans* seeds were hand planted at a point 0.5 cm below the soil surface. Points were equidistant from neighboring planting points. Seedlings emerged approximately one month after planting. We recorded the survival of *C. nutans* each month by counting plants in each plot and converting to plants per square meter. We placed small nylon bags on all flower heads in 2011 to prevent new seeds from being dispersed back into the plots. In the second year (2012), we recorded only newly emerged *C. nutans* plants, similar to 2011. No new seeds were planted in the second year. On a weekly basis, we recorded the phenology of the perennial grasses and *C. nutans*, along with detailed plant measurements for *C. nutans* (e.g., basal diameter, plant height, leaves per plant, and number of branches per plant) over the two seasons. We collected biomass of *C. nutans* in perennial grassland and BG-IC plots in the second year before the cessation of *C. nutans* growth.

We measured cover of *C. nutans* in BG-IC, CL-IC, and NCL-IC plots monthly from May to October in 2011 and May to August in 2012. Measurements were conducted within permanent 0.25 m² quadrats located randomly in each plot. We estimated cover visually to within 1% up to 10% and thereafter to the nearest 5% (10%–100% cover).

Spatiotemporal Changes in Light

We measured light transmission in grassland and BG-IC plots during the growing seasons of 2011 and 2012. Measurements were conducted during the noon hour when the sky was clear. One measurement was taken once above the canopy and four times below. Photosynthetically active radiation (PAR) was measured using a ceptometer (AccuPAR LP-80; Decagon Devices Inc., Pullman, WA, USA). The ceptometer sensor arm (80 cm long) was inserted on the soil surface below the canopy at four separate locations within each plot. The average of the readings was compared with PAR values of full sunlight above the canopy. Data was presented as the percentage of maximum light penetrating to the soil surface.

TABLE 1. Phenology of perennial grasses and *Carduus nutans* in the Midwest.

		Carduus nutans				Grasses	
		BG-IC		CL-IC	NCL-IC	CL-NC	NCL-NC
Year	Date	Majority	Minority	All	All	All	All
2011	May 25	Emergence	Emergence	Emergence	Emergence	Dormancy	Dormancy
2011	June 1	Rosette	Rosette	Rosette	Emergence	Vegetative	Vegetative
2011	Aug. 5	Rosette	Flower	Rosette	Died	Inflorescence	Inflorescence
2011	Sep. 24	Rosette	Senescence	Rosette		Dormancy	Rosette
2011	Oct. 1	Dormancy	Died	Dormancy		Dormancy	Dormancy
2012	Mar. 31	Rosette		Rosette		Dormancy	Dormancy
2012	Apr. 20	Bolt		Bolt	Emergence	Vegetative	Vegetative
2012	May 25	Flower		Flower	Emergence	Vegetative	Vegetative
2012	June 17	Flower		Flower	Emergence	Inflorescence	Inflorescence
2012	July 4	Senescence		Senescence	Died	Inflorescence	Inflorescence
2012	July 8	Senescence		Senescence		Dormancy	Dormancy

Notes: *Carduus nutans* growth stages are rosette, bolting, flowering, dormancy, and senescence. Perennial grass growth stages are vegetative, inflorescence, and dormancy. BG-IC = bare ground with *C. nutans* introduced, CL-IC = clipped grasslands with *C. nutans* introduced, NCL-IC = nonclipped grasslands with *C. nutans* introduced, CL-NC = clipped grasslands without *C. nutans* introduced, and NCL-NC = nonclipped grasslands without *C. nutans* introduced. Majority indicates 85% of established *C. nutans* in the BG-IC plots and minority is the remaining 15% of *C. nutans* in the same plots.

Spatiotemporal Changes in Soil Moisture

We measured shallow soil water moisture in CL-NC, NCL-NC, BG-NC, and BG-IC throughout the growing season using a soil moisture sensor (EC-5; Decagon Devices, Inc., Pullman, WA, USA) that was vertically inserted 8 cm below the soil surface of each plot. Measurements were recorded hourly and averaged over a 24-hr period. We used a hydroprobe (503DR, CPN, Martinez, CA, USA) to take monthly measurements of deep soil water content at depths of 30, 60, 90, and 120 cm. We installed an access tube in the center of the same plots that were used for measuring shallow moisture. We calibrated the hydroprobe before taking measurements and converted the values to volumetric soil water content (Evett and Steiner 1995).

Statistical Analysis

We tested homogeneity and normality before the analysis of variance and data were log-transformed. We used a mixed-model repeated-measures analysis of variance to compare the effects of year and clipping on the number of *C. nutans* plants m^{-2} (density) or *C. nutans* cover for BG-IC, CL-IC, and NCL-IC treatments. Fixed factors in the model included year (2011 and 2012), clipped (CL) or not (NCL), introduced *C. nutans* (IC) or not (NC), block effect, and all possible interactions. We used only block effect in the model for cover analysis and not for light transmission, which was an average ratio generated by multiple readings from the ceptometer in each plot, or density, which was based on plants per plot. Our previous studies on this experimental area show that block effect is not significant (Han and Young 2014a, 2014b). Subsequently, the model for analyzing cover also showed no significant effect from blocks.

We analyzed the light transmission ratio using the same approach as for comparing the effects of year and clipping on survival and cover, except CL-NC and NCL-NC treatments were included. Hurlbert (1984) suggested the use of data from repeated sampling is acceptable for statistical analyses only if successive dates are not considered independent replicates. We determined the differences among response of *C. nutans* to clipped (CL) and nonclipped (NCL) treatments by comparing the least-square means.

We compared biomass of sampled *C. nutans* plants across treatments ($P < 0.05$). To assess the survivability of *C. nutans*, we used Tukey's HSD to test for dif-

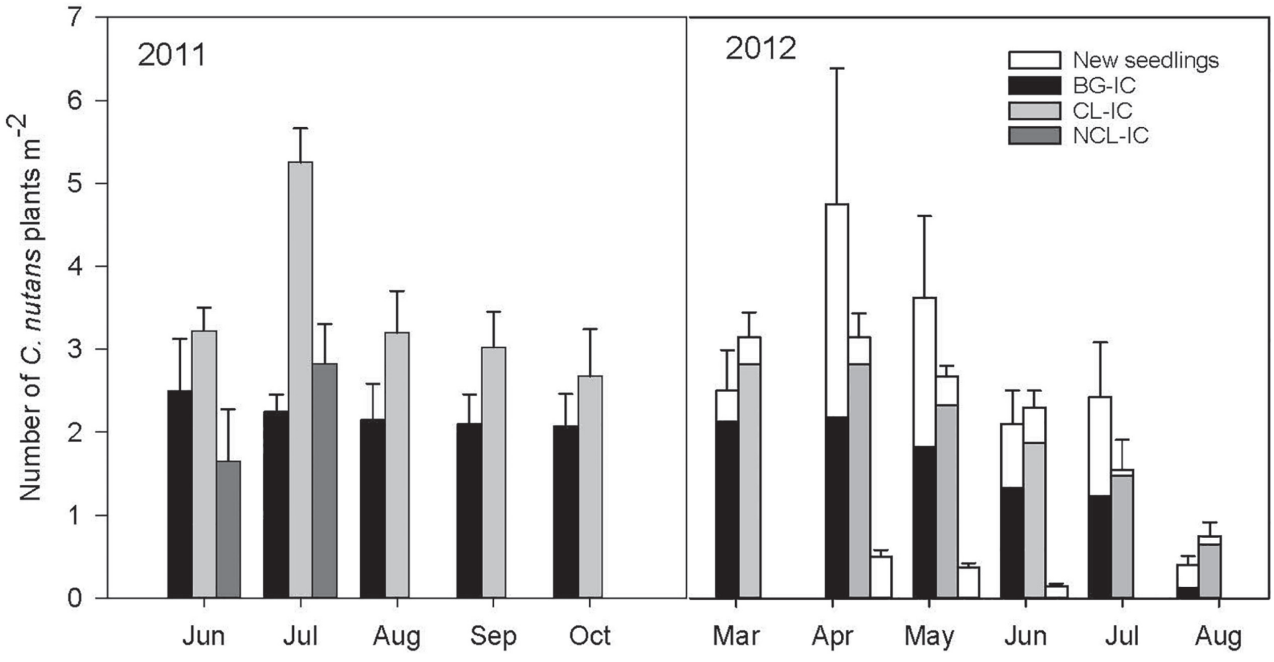

Figure 1. Number of *Carduus nutans* plants per m² in *C. nutans* monocultures (BG-IC = bare ground introduced *C. nutans*) and grasslands (CL-IC = clipped with the introduction of *C. nutans*; NCL-IC = nonclipped with the introduction of *C. nutans*) in 2011 and 2012. The error bars indicate standard errors of means.

ferences in mean values for *C. nutans* basal diameter, plant height, branches per plant, and leaves per plant in *C. nutans* monoculture (BG-IC), clipped (CL-IC), and nonclipped (NCL-IC) treatments. We used the monthly periods for analysis and the stages were early, mid-, and late rosette, bolting, and early and late flowering. All statistical analyses were conducted using SAS version 9.3 (SAS Institute, North Carolina).

Results

Plant Phenology and Carduus nutans *Populations*

In May 2011 the emergence of *C. nutans* from seed began, which was two months before the grasses came out of dormancy. Both plant types remained vegetative through midsummer, except for *C. nutans* in the NCL-IC plots, which grew slowly for one month and then died (Table 1). Seedlings of *C. nutans* in CL-IC and BG-IC developed into rosettes and from June to September remained vegetative before normal dormancy in late fall. Grasses were vegetative from June through mid-August with inflorescence in September and dormancy in late October. In the BG-IC plots, three out of 20 *C. nutans* plants progressed to full maturity (bolting, flowering, seed dispersal) the first year.

By the end of April 2012, *C. nutans* rosettes had emerged from dormancy and were beginning to bolt (Table 1), while grasses were in the vegetative stage. Mature *C. nutans* plants flowered from May to August and were tallest in BG-IC (176 cm, $P < 0.05$) and CL-IC (158 cm, $P < 0.05$) plots. The grasses had started the inflorescence stage in late June, which was two months earlier than the previous year and likely the result of the extreme drought conditions.

Newly germinating *C. nutans* seedlings were observed in all IC plots in the second season (Fig. 1). A few *C. nutans* seedlings in the nonclipped grass plots (NG-IC) grew, but eventually died without producing capitula (Table 2) (see Young 2015).

In July 2011 precipitation was above normal and the maximum average number of *C. nutans* that established was greater than 5 plants m^{-2} in the CL-IC plots (Fig. 1). In April 2012 the highest number of new *C. nutans* seedlings occurred in the BG-IC plots, but all seedling populations declined to zero by July (NCL-IC) or less than one by August (BG-IC, CL-IC). The decline in older *C. nutans* (nonseedlings) in year 2 was due to the drought conditions that caused one or two to mature sooner (Fig. 1).

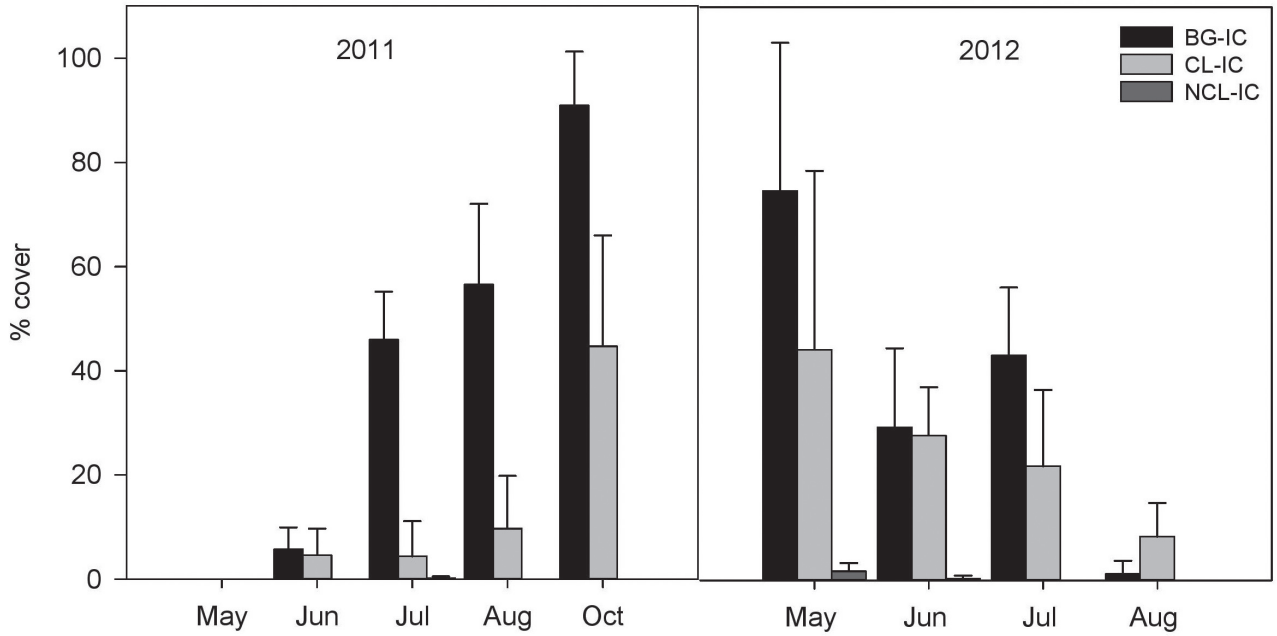

Figure 2. Mean percentage of cover of *Carduus nutans* in *C. nutans* monocultures (BG-IC = bare ground introduced *C. nutans*) and grasslands (CL-IC = clipped with the introduction of *C. nutans*; NCL-IC = nonclipped with the introduction of *C. nutans*) in 2011 and 2012. The error bars indicate standard errors of means.

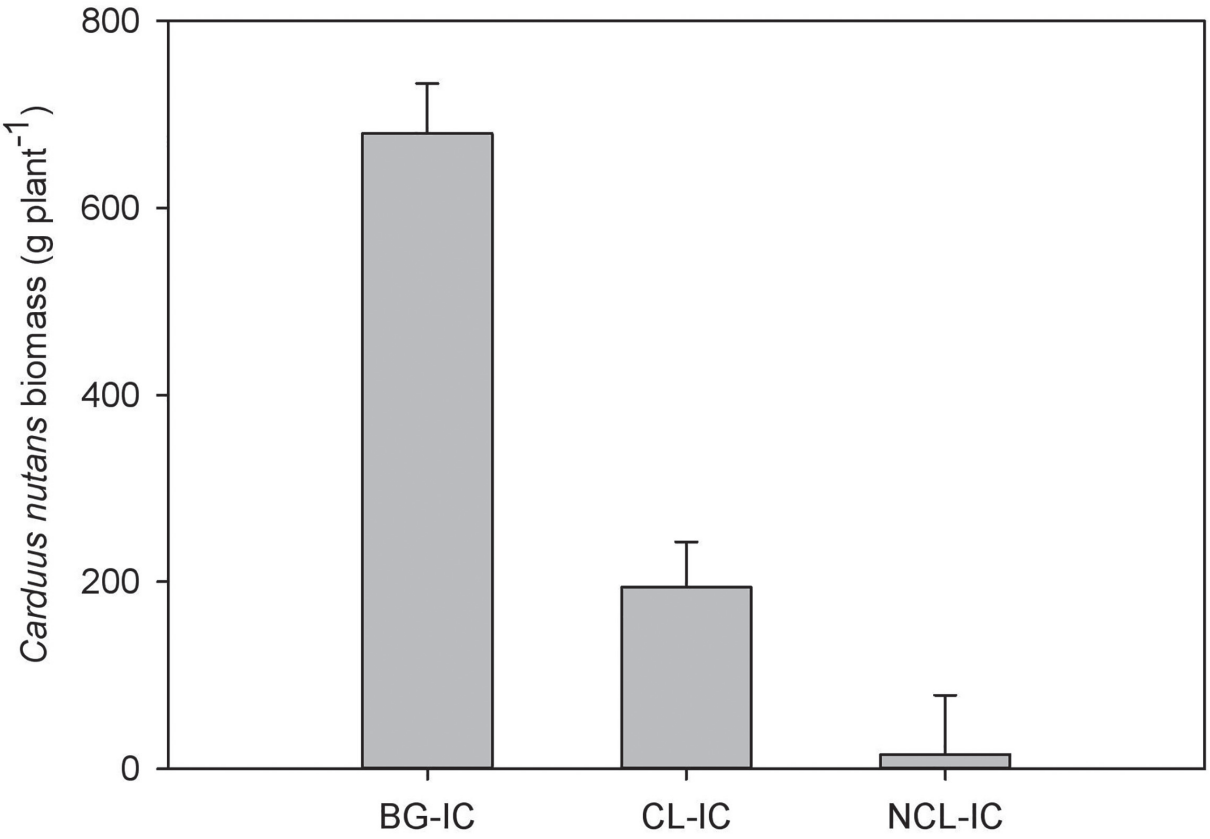

Figure 3. Aboveground biomass of *Carduus nutans* plants in *C. nutans* monocultures (BG-IC = bare ground introduction of *C. nutans*) and grasslands (CL-IC = clipped with the introduction of *C. nutans*; NCL-IC = nonclipped with the introduction of *C. nutans*). The error bars indicate standard errors of means.

TABLE 2. For each phenological stage and parameter, the statistical difference between treatments ($n = 4$) denoted by a letter ($p < 0.05$) using Tukey's HSD test.

Growth stage and timing	Date	BG-IC	CL-IC	NCL-IC
		Basal diameter (cm)		
Rosette, early	June 22, 2011	26a	11b	7b
	June 29, 2011	38a	15b	11b
Rosette, mid	June 11, 2011	65a	21b	14c
	Aug. 5, 2011	71a	19b	0c
Rosette, late	Sept. 24, 2011	98a	48b	0c
	Oct. 23, 2011	106a	59b	0c
Rosette, early	March 23, 2012	46a	34b	0c
Bolt	April 21, 2012	93a	71b	10c
Flower, early	May 22, 2012	81a	72a	36b
Flower, late	June 27, 2012	48a	24b	1c
		Height (cm)		
Bolt	April 21, 2012	57a	41b	0c
Flower, early	May 22, 2012	159a	143a	32b
Flower, late	June 27, 2012	176a	158b	28c
		Leaves plant^{-1}		
Rosette, early	June 22, 2011	9a	6b	5b
	June 29, 2011	12a	7b	5c
Rosette, mid	July 11, 2011	25a	11a	6b
	Aug. 5, 2011	48a	13b	0c
Rosette, late	Sept. 24, 2011	88a	26b	0c
	Oct. 23, 2011	104a	32b	0c
		Branches plant^{-1}		
Flower, early	May 22, 2012	7a	1b	0c
Flower, late	June 27, 2012	8a	3b	0c

Note: Phenological stages (rosette, bolt, flower) of *Carduus nutans* introduced into bare ground (BG-IC) and either clipped (CL-IC) or nonclipped (NCL-IC) perennial grasslands.

By the end of 2011, *C. nutans* rosette leaf cover had expanded across nearly the entire BG-IC plots and over 40% of the CL-IC plots (Fig. 2), which was also reflected in the basal diameters (59 cm, $P < 0.05$ for CL-IC and 106 cm, $P < 0.05$ for BG-IC) (Table 2). Early in 2012, *C. nutans* cover began to decline as plants matured under the increasingly intense drought conditions. The CL-IC plots had less than half the cover of *C. nutans* as BG-IC in May and July 2012. By August, *C. nutans* cover in the two treatments was near zero. During the two years, cover of *C. nutans* was never measured after July in NCL-IC because no plants remained.

The growth of *C. nutans* plants varied depending on the type of vegetation present (e.g., *C. nutans* or grasses) and whether the grasses were clipped (Fig. 3). The biomass of *C. nutans* in the bare ground plots (BG-IC) was greater than in the CL-IC and NCL-IC plots ($P < 0.0001$). The difference in biomass was also reflected in height, with taller plants in the BG-IC when compared to NCL-IC plots (see Table 2), indicating that grass competition may have had an effect on the growth of *C. nutans*.

Spatiotemporal Changes in Light

In 2011 clipped grassland plots with *C. nutans* (CL-IC) had similar light transmission compared to clipped grassland plots with no *C. nutans* (CL-NC) ($P = 0.088$), but by 2012 significantly less light was being transmitted in the CL-NC plots ($P < 0.0001$) (Fig. 4). In all grassland plots, light transmission was greater by July and August of 2012 during the drought than for the same months in 2011 ($P = 0.0024$) (Fig. 4). By June 2011, the nonclipped grassland plots (NCL-IC, NCL-NC) had almost complete canopy cover that lowered full sunlight reaching the soil surface to less than 2% (Fig. 4). During the same period, the clipped grassland (CL-IC, CL-NC) plots had 35% of full sunlight reaching the soil surface ($P < 0.0001$).

In May 2012, light transmission was less than 16% in BG-IC ($P = 0.02$) and CL-IC ($P = 0.04$) plots, as *C. nutans* plants had increased in size and subsequently covered much of the area of each plot (see Fig. 2). Later in 2012, light transmission increased in these plots as *C. nutans* plants began to flower and senesce. The interaction among the factors of clipping and adding *C. nutans* and year on light transmission was significant ($F_{1,168} = 20.91$; $P < 0.0001$).

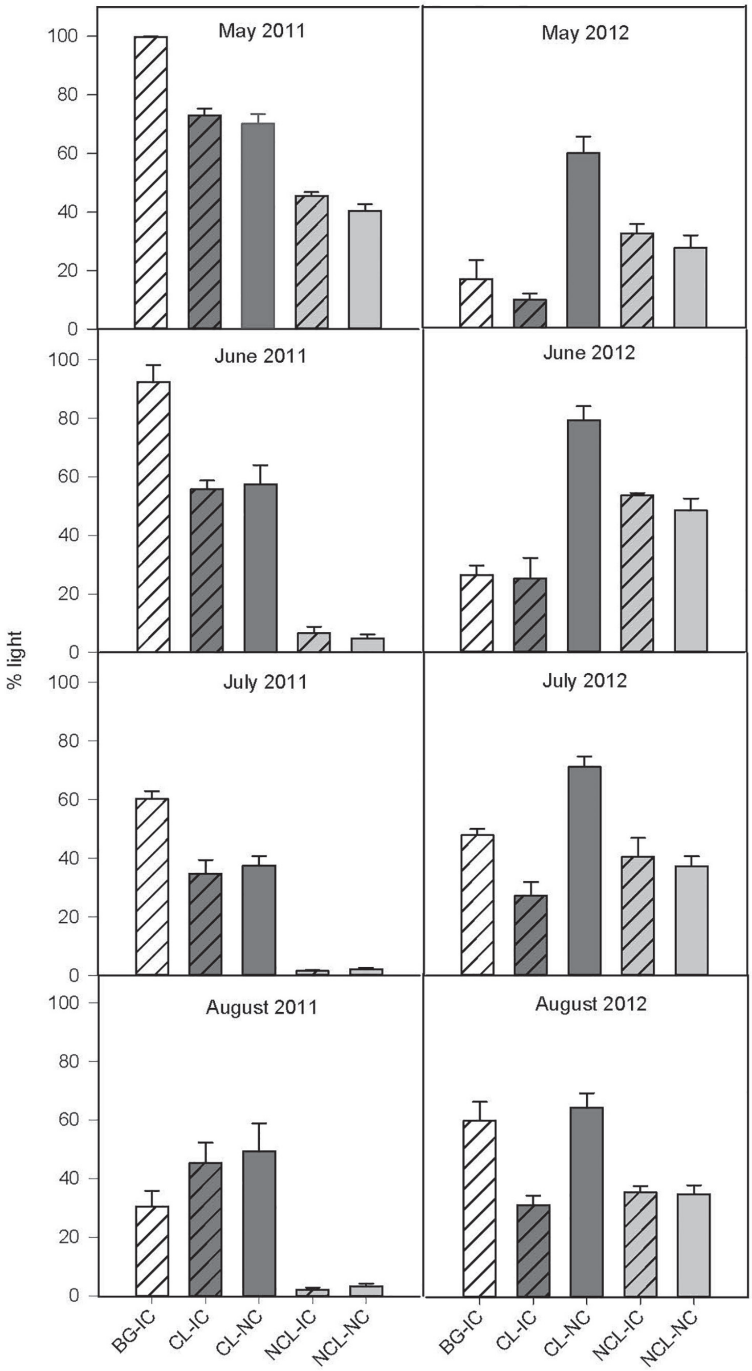

Figure 4. Percentage of light transmitted to the soil surface in *Carduus nutans* monocultures (BG-IC = bare ground introduced *C. nutans*) and grasslands (CL-IC = clipped with the introduction of *C. nutans*, CL-NC = clipped without the introduction of *C. nutans*, NCL-IC = nonclipped with the introduction of *C. nutans*, and NCL-NC = nonclipped without the introduction of *C. nutans*) in 2011 and 2012. The error bars indicate standard errors of means.

Spatiotemporal Changes in Soil Moisture

In April 2011 surface soil moisture was ≥ 0.18 m^3 m^{-3} in bare ground without (BG-NC) and with (BG-IC) *C. nutans*. Surface soil moisture in clipped and nonclipped grassland plots (CL-NC, NCL-NC) declined rapidly from 0.26 m^3 m^{-3} in July to 0.13 m^3 m^{-3} in September (Fig. 5). The severe drought in 2012 caused surface soil moisture to decline from greater than 0.26 m^3 m^{-3} in April to 0.12 m^3 m^{-3} in June and near 0.07 m^3 m^{-3} by late September (Fig. 5). In BG-IC plots, surface soil moisture was less than for the other treatments during the months when the plants were bolting, flowering, and beginning to set seed. Short rain events in late June and July briefly increased surface soil moisture.

In July 2011, deep (>30 cm) soil water content was similar for BG-IC, BG-NC, CL-NC, and NCL-NC (Fig. 6). A month later, the nonclipped grassland (NCL-NC) plots had the least soil water content at depths deeper than 30 cm (0.085 m^3 m^{-3}), while clipped grasses (CL-NC) and *C. nutans* (BG-IC) had similar deep soil water content. In June 2012, BG-IC plots had the least deep soil water content (0.08 m^3 m^{-3}), but for July and August, deep soil water content was similar for all treatments (Fig. 6).

Discussion

Following planting in the first year, *C. nutans* successfully established in bare ground (BG-IC) and warm-season perennial grasslands that had been disturbed by clipping (CL-IC). The act of overseeding an invasive plant species could be viewed as a type of invasion and thus corresponds with other studies that report greater *C. nutans* survival and development in open or overgrazed pastures and rangelands (Hamrick and Janet 1987; Beck 2001). Similar to actual grazing, the clipping that we administered in

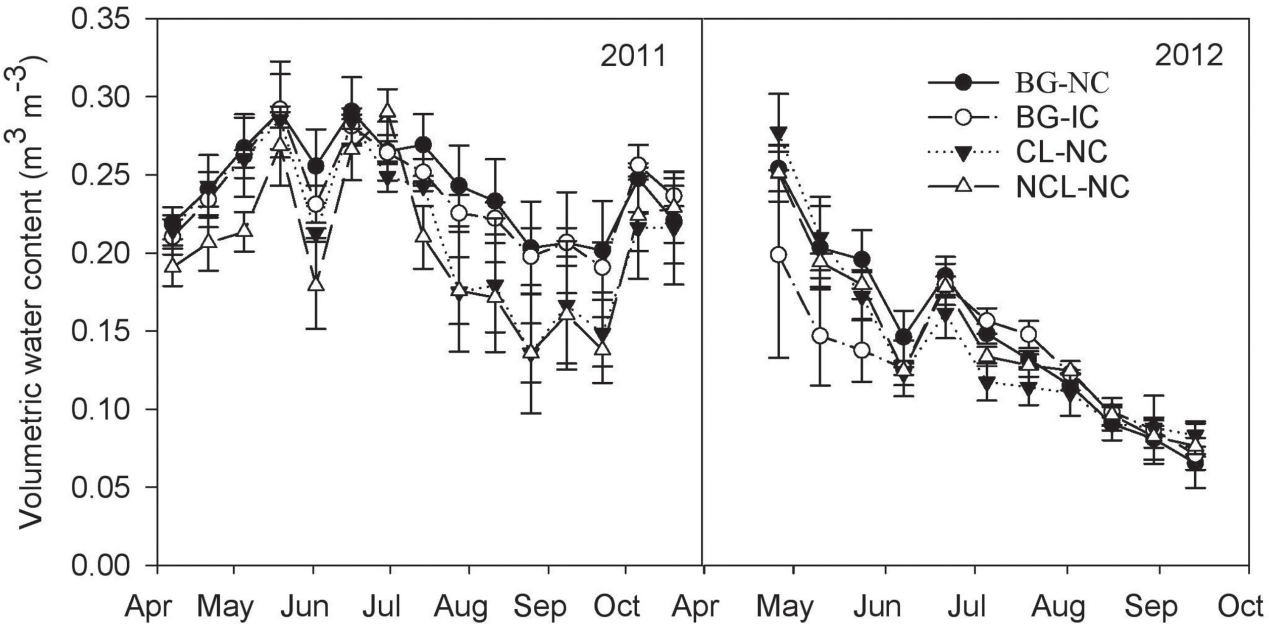

Figure 5. Average daily surface (0–8 cm) soil moisture reported biweekly in 2011 and 2012. BG-NC = bare ground without introduced *Carduus nutans*, BG-IC = bare ground with introduced *Carduus nutans*, CL-NC = clipped grasslands without the introduction of *C. nutans*, and NCL-NC = nonclipped grasslands without the introduction of *C. nutans*. The error bars indicate standard errors of means.

our study created openings or niches in the perennial grass canopy, which allowed more light to reach the soil surface based on the cover data shown in Figure 2. This benefited initial *C. nutans* establishment and eventually allowed for plants to reach full maturity in the second year.

Biomass of *C. nutans* was greatest in the *C. nutans* monoculture (BG-IC) plots, which we suspect was due to fewer plants and lack of interspecific competition. Although *C. nutans* biomass was lower in clipped grasslands (CL-IC) compared to BG-IC plots, the plants were well established among the grasses. Kok et al. (1986) report high intraspecific mortality can occur in the early seedling stage of *C. nutans*, but this self-thinning characteristic may be less of a factor in the overall establishment due to rapid and large growth habit that includes a long rosette stage, thus eliminating the need for excessive seedlings to emerge at one time. In addition, Smith and Shea (2010) and Zhang and Shea (2012) related increasing levels of disturbance (e.g., tillage, mowing, or hand weeding) to the successful establishment of *C. nutans*, which supports our findings that clipping can facilitate the establishment of *C. nutans* in warm-season perennial grasses.

In order to preempt available light and avoid shade by regrowth of perennial grasses, *C. nutans* rosettes produced leaf area more quickly in BG-IC and CL-IC plots, which relates to current invasion theories (e.g., superior competitor, niche resources) to make the resources less available (see Craine 2005 and others). Moreover, we observed *C. nutans* plants in the CL-IC plots projecting their leaves directly into vacant areas early in the season before perennial grass growth (Han, personal observation). Bazzaz (1996) has suggested greater plant plasticity and leaf acclimation can occur during alternating intensities and exposures to light. From our results and those of others (e.g., Wardle et al. 1992; Renz and Schmidt 2012; Sanderson et al. 2012), it is evident that *C. nutans* invasion success is highly dependent on access to light within a stand of perennial grasses. It could be that the plasticity in *C. nutans* growth is accentuated when gap size within perennial grasses varies widely from clipping disturbances.

For two years, *C. nutans* plants failed to survive in the nonclipped warm-season perennial grasses (NCL-IC). In the first year (2011), most of the *C. nutans* germinated and the seedlings began to grow among the established plants just prior to grass emergence from dormancy and subsequent canopy closure. Once aboveground competition intensified, *C. nutans* seedlings were forced to adjust to rapidly declining light conditions by elongating stems a short distance. Within the first season, even the appear-

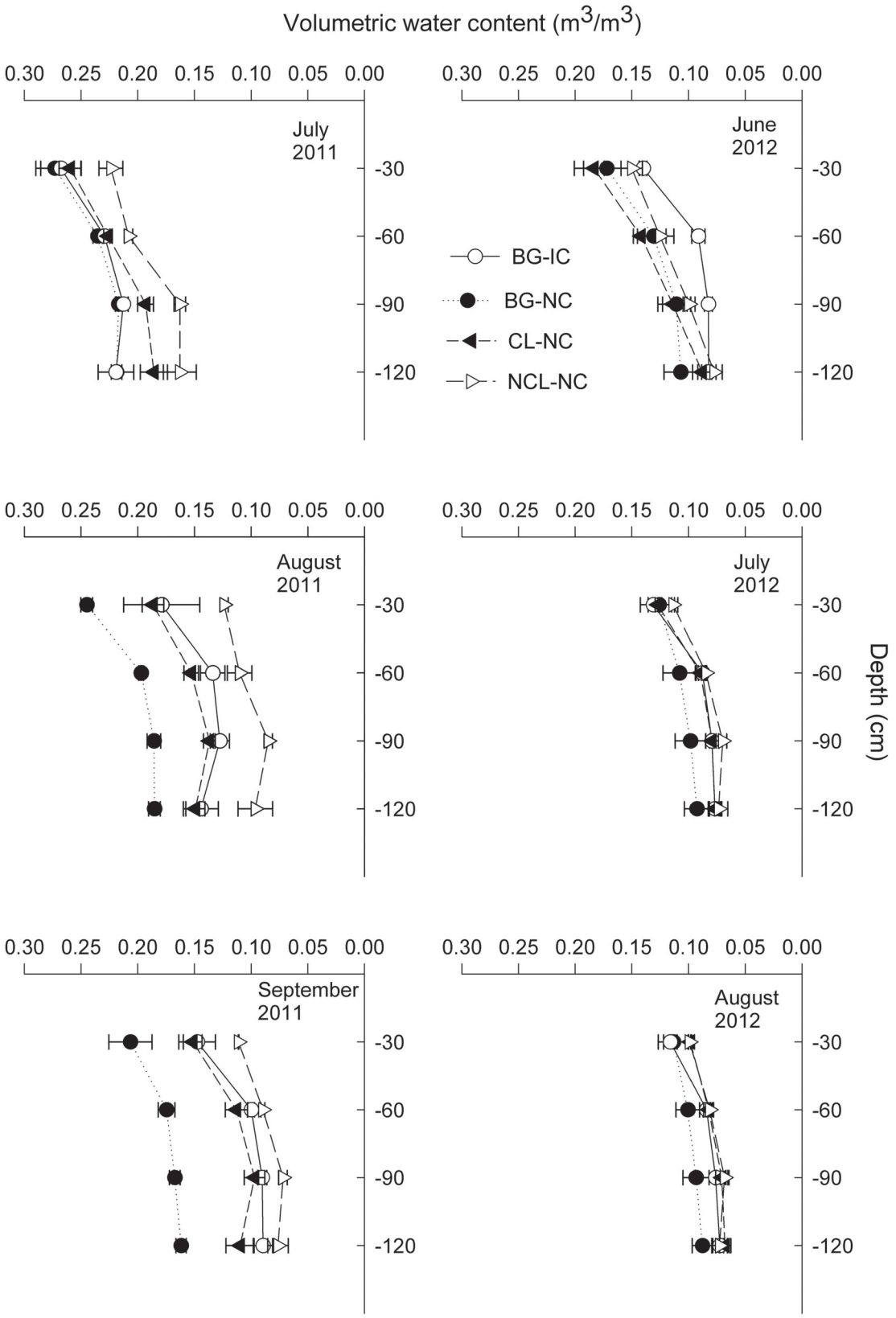

Figure 6. Volumetric soil water content at 30, 60, 90, and 120 cm in 2011 and 2012. BG-NC = bare ground without introduced *Carduus nutans*, BG-IC = bare ground with introduced *Carduus nutans*, CL-NC = clipped grasslands without the introduction of *C. nutans*, and NCL-NC = nonclipped grasslands without the introduction of *C. nutans*. The error bars indicate standard errors of means.

ance of bolting is atypical of growth that usually occurs by *C. nutans* (Wardle et al. 1992; Han and Young 2013). The plasticity in growth that allowed *C. nutans* to survive in the CL-IC plots was inadequate for survival in the NCL-IC plots. Thus, a trade-off may be occurring in *C. nutans* during long periods of low light or darkness whereby normal rosette development is substituted for stunted, misshapen seedlings that progress through a modified bolting stage and result in a single terminal flower bud that fails to become mature or set seed; a similar phenomenon identified in other invasive plant species (Chun et al. 2007; Gandiaga et al. 2009; Molina-Montenegro et al. 2013). In areas where *C. nutans* is common or has the potential to invade, a dense and healthy pasture that is grazed minimally can prevent *C. nutans* establishment, primarily from the inability of the invader to tolerate long periods of shade (Hamrick and Janet 1987).

Plasticity is a change in a plant in response to the environment, while resource use timing relates to plant life history; both contribute to successful invasion by *C. nutans*, but we believe the latter could be a more important factor. Wardle et al. (1992) studied the response of *C. nutans* seedlings to pasture canopy and found that preflowering thistle mortality was strongly related to vegetation type (bare, legume, or grass). In our study, shade from tall statured perennial grasses contributed to the lack of early growth of *C. nutans* (see Han and Young 2014a). The continuous removal of biomass through clipping and subsequent opening in the canopy allowed *C. nutans* rosettes to become established, similar to Smith and Shea (2010). Surface soil moisture resources, which were adequate for *C. nutans* plants to germinate early in 2011 and 2012, were reduced in the perennial grass plots as the season progressed, most dramatically in the second year when drought conditions intensified. Weaver (1958) and Young et al. (2010) showed perennial grass roots extend deep in the soil and can access available water during important aboveground biomass growth stages. Alternatively, a reduction in perennial grass root vigor and subsequent lack of development in deep soil profiles have been correlated to high grazing intensity in the prairies of Nebraska (Weaver 1950).

The decline in surface soil moisture of the *C. nutans* bare ground (BG-IC) plots in 2012 was most likely due to roots at these shallow soil layers and not soil evaporation, as cover was near 75%. As plants developed early in the season, shallow and deep soil moisture content rapidly declined, beginning in September of the previous year (deep soil moisture) and then as *C. nutans* growth in 2012 proceeded from rosette (March and May) to bolting (June) and then more gradually as plants senesced over the remainder of the summer. This same pattern of rapid soil moisture decline during a short but intensive change in growth stage (e.g., rosette to bolting) has been documented for yellow starthistle in California (Young et al. 2011). The period of declining surface and deep soil moisture content in *C. nutans* plots was similar to CL-NC plots during 2012 when grasses progressed from vegetative to flowering stages. The overlap in declining soil moisture content of the grass and *C. nutans* plots during periods of relatively quick and intense growth indicates that a narrow but important period of competition may exist between two functionally different species. Without disturbance (e.g., repeated clipping) and enough soil moisture, newly germinating *C. nutans* plants are at a competitive disadvantage and will likely fail to establish in healthy perennial grass stands.

At the beginning of a drought period, *C. nutans* may germinate but ultimately fail to survive, most likely due to lack of soil moisture in the 0–30 cm depths of the soil. In competitive conditions, whether interspecific (grasses) or intraspecifc (*C. nutans*), newly germinated *C. nutans* plants may extend roots past the surface layer, only to encounter dry conditions created by established plants (perennial grasses, second-year *C. nutans*) that grew during the same period. Not surprisingly, the rapidly changing conditions that occur with drought causing a decrease of soil moisture are a significant factor that contributes to the lack of success of some invasive plants being able to establish in native plant communities (Cahill 2003). Had 2011 been a drought year, we suspect soil moisture would have been a more significant factor limiting the success of *C. nutans* establishment in the CL-IC plots in 2012.

Conclusion

In this study, we set up a midwestern perennial grassland for invasion by *C. nutans* and then captured the process, which was influenced by extreme drought and eventually ended in survival or death of the invader. While extensive research has been published on terrestrial plant invasion success relating to plant traits (Kempel et al. 2013), disturbance or stress (Alpert et al. 2000), functional or species diversity (Shea and Chesson 2002), and biotic interactions (Mitchell et al. 2006), our study has placed an equal emphasis on *C. nutans* failure and success in attempting to establish in

perennial grassland niches. Kolar and Lodge (2001) and Theoharides and Dukes (2007) describe the transitions that nonindigenous plant species must overcome for the invasion process to continue, including transport, colonization, establishment, and landscape spread. Our study demonstrates *C. nutans* was unable to colonize in the nonclipped grasslands due to the abiotic filters of low light and soil moisture, while in the clipped grasslands the invader had successfully established and with additional years and favorable conditions (e.g., continued disturbance) would probably spread throughout the landscape.

Drought and shading are effective for preventing *C. nutans* from colonizing perennial grasslands of temperate regions. Less well known is the degree to which *C. nutans* invading perennial grasslands uses available resources during critical periods, such as the flowering stage, and/or alters growth to better access limited resources. Similar is the dichotomy between resource acquisition and conservation by invasive and native plants described in a review by Funk (2013). While the identification of a "switch" has yet to be identified that allows *C. nutans* to shift between uptake of and growth to resources, our study shows that plasticity and the availability of resources contribute to both the success and failure of *C. nutans* invading perennial grasslands of the midwestern United States.

James C. Han (chengchouhan@huskers.unl.edu), Department of Agronomy and Horticulture, University of Nebraska–Lincoln, Lincoln, NE 68583

Stephen L. Young (sly27@cornell.edu), Soil and Crop Sciences Section, Cornell University, Ithaca, NY 14853

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Plowprint

Tracking Cumulative Cropland Expansion to Target Grassland Conservation

Anne M. Gage, Sarah K. Olimb, and Jeff Nelson

ABSTRACT—Conversion of grassland to cropland has accelerated over the past decade due to high crop prices, government incentives, and a growing global human population. Conversion of grasslands leads to loss of habitat and threatens the ability of the land to provide ecosystem services, such as carbon sequestration, water filtration, and reduced erosion. We developed a method for identifying remaining intact habitat across the Mississippi River Basin–Great Plains area by stacking subsequent years of the Cropland Data Layer (United States) and Annual Crop Inventory (Canada). We call the resulting cumulative plowed lands the "plowprint." The total size of the plowprint increased by 27,159,278 ha from 2009 to 2013. As of 2013, approximately one-third of the study area had been plowed. We conclude that developing the ability to monitor cumulative change over time will allow disparate agencies and organizations to align their goals, strategies, and activities, and to measure progress in a uniform way.

Key Words: agricultural expansion, cropland, grassland conversion, intact habitat, land-cover change

Introduction

Temperate grasslands are among the most modified ecosystems on the planet due to productive soils and the absence of extreme topography, which lend them to being easily modified with modern technology to produce food and fuel for the burgeoning global human population. Recent studies suggest that rates of conversion of grasslands to cropland in the United States vary from about 1% to 5% annually, with many areas of the tallgrass prairie already almost completely converted (Goldewijk 2001; Rashford et al. 2011; Claassen et al. 2012; Faber et al. 2012; Sylvester et al. 2013; Wright and Wimberly 2013; Lark et al. 2015). The temperate grassland biome is the least protected on the planet (Hoekstra et al. 2005), and the modification of these grasslands impacts their ability to store carbon, filter water, reduce erosion, and provide habitat for important wildlife species (Sustainable Rangelands Roundtable 2008).

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The United States is one of the top producers of agricultural commodities at the global scale, leading the world in the production and exportation of corn and soy (USDA-ERS 2016a, 2016b). Most of the major commodity crops, including corn, wheat, and soy, are grown across the central grasslands of the United States, and current and past crop production has led to increased eutrophication of freshwater resources and inputs to the Gulf of Mexico hypoxia zone (Costello et al. 2009). Coarse-level analyses show, however, that avoiding continued conversion of remaining grasslands could save substantial quantities of water and avoid inputs of nitrogen, phosphorous, and sediment to the freshwater systems of the United States (Flynn and Redder 2014).

While the tallgrass prairie of North America has largely been converted from its native state to cropland, shortgrass and mixed-grass prairies located along the western portion of the Great Plains still contain large, intact blocks of habitat. Some estimates suggest that up to 50% of the central shortgrass prairie remains intact (Landscope America 2016). This remaining habitat generally has lower soil quality and receives lower amounts

of annual precipitation than the tallgrass prairie, but it is still under threat due to technological innovations, government incentives to plow up land, and the influence of high crop prices on landowner decision making (Rashford et al. 2011; Claassen et al. 2012).

Tracking the loss of grassland through time has proven to be complicated, with researchers using various methods for refining estimates of annual loss during recent decades and tying those losses to changes in crop prices, government payments or federal policies (Goldewijk 2001; Rashford et al. 2011; Claassen et al. 2012; Faber et al. 2012; Sylvester et al. 2013; Wright and Wimberly 2013; Lark et al. 2015). Most of these studies rely on the accuracy of datasets developed by the US Department of Agriculture (USDA) to track land-use change over time (Boryan et al. 2011). However, distinguishing between some categories, such as grassland versus hay, can be difficult using satellite data, with producer's and user's accuracy rates for the "other hay/non-alfalfa" category falling in the 50% to 80% range (USDA-NASS 2014b).

We sought to develop a methodology for tracking change in grasslands over time, with the goal of identifying remaining habitat that is largely intact and has not recently been plowed. For the purposes of this study, we use the term "grasslands" to refer to all grasslands (shortgrass, mixed-grass, tallgrass), vegetated wetlands, and shrubland-steppe habitats. To accomplish our goal of locating remaining intact habitat, we developed a method of stacking a time series of cropland data and then subtracting that crop footprint from the remaining habitat across the Mississippi River Basin–Great Plains (MRB-GP; Fig. 1) geographic area. The result is a baseline against which to monitor further incursions into remaining habitat by cropland agriculture, and an intact habitat layer for use in prioritizing conservation actions.

Methods

The MRB-GP region encompasses 2.7 million km² and stretches from the Rocky Mountains in the west to the Appalachians in the east. The region contains a mix of habitats, including grasslands, shrub-steppe, wetlands, and forests, as well as numerous large natural and artificial lakes (Forrest et al. 2004). This region has long been the agricultural heart of the country, with nearly half the US cropland contained within the Corn Belt and Northern Plains regions (NRCS 2007). Lands that are not cropland, developed land, or open water are generally forested or used as pastureland or rangeland throughout the region (NRCS 2007). Throughout this paper, we also reference two subregions: the Northern Great Plains (NGP) ecoregion, as defined by World Wildlife Fund (Forrest et al. 2004), and the Plains and Prairie Potholes Landscape Conservation Cooperative (PPP LCC), as defined by the US Fish and Wildlife Service (Fig. 1; Landscape Conservation Cooperative Network 2016).

Due to data availability, we used five years of data in Canada and six years of data in the United States to develop the baseline map of plowed lands in the MRB-GP region. Data for Canada spanned 2009–2013, and data for the United States covered the years 2008–2013 (USDA-NASS 2014). Data for the US portion of the study area was derived from the USDA National Agricultural Statistics Service Cropland Data Layer (CDL; USDA NASS 2014), and data for the Canadian portion of the study area is from the Agriculture and Agri-Food Canada Annual Crop Inventory (AAFC 2013). CDL data is derived from the Indian Remote Sensing RESOURCESAT-1 (IRS-P6) Advanced Wide Field Sensor (AWiFS) and supplemented with Landsat 5 TM and Landsat 7 ETM+ data. Annual Crop Inventory data is derived from Landsat 7, AWiFS, and Disaster Monitoring Constellation sources. CDL data is available at 56 m resolution prior to 2010, and 30 m resolution since 2010. Similarly, Annual Crop Inventory data is available at 56 m resolution prior to 2011, and 30 m resolution since 2011. Both datasets were resampled to 56 m resolution to account for this change (AAFC 2013; USDA-NASS 2014).

Plowprint

For this analysis, cropland was defined as any annually planted agricultural commodity (e.g., corn, soybeans, wheat, etc.) or fallow agricultural land. Because alfalfa is a perennial crop that is periodically planted in rotation with annual crops, we chose not to define it as cropland. To circumvent the issue of misclassifications due to, for example, fallow land being identified as grassland and very wet or very dry years causing misclassification of some cover types, we developed a methodology that aggregates crop pixels from six subsequent years (five in Canada) by stacking datasets across years and allowing cropland/fallow pixels to be added to the dataset, but never removed. We call the resulting layer the plowprint, and it represents a footprint of cropland throughout the study area over the time period of the datasets.

Figure 1. Study area, including the sub-boundaries of the Northern Great Plains (World Wildlife Fund), the Plains and Prairie Potholes Landscape Conservation Cooperative, and the Northern Great Plains Joint Venture.

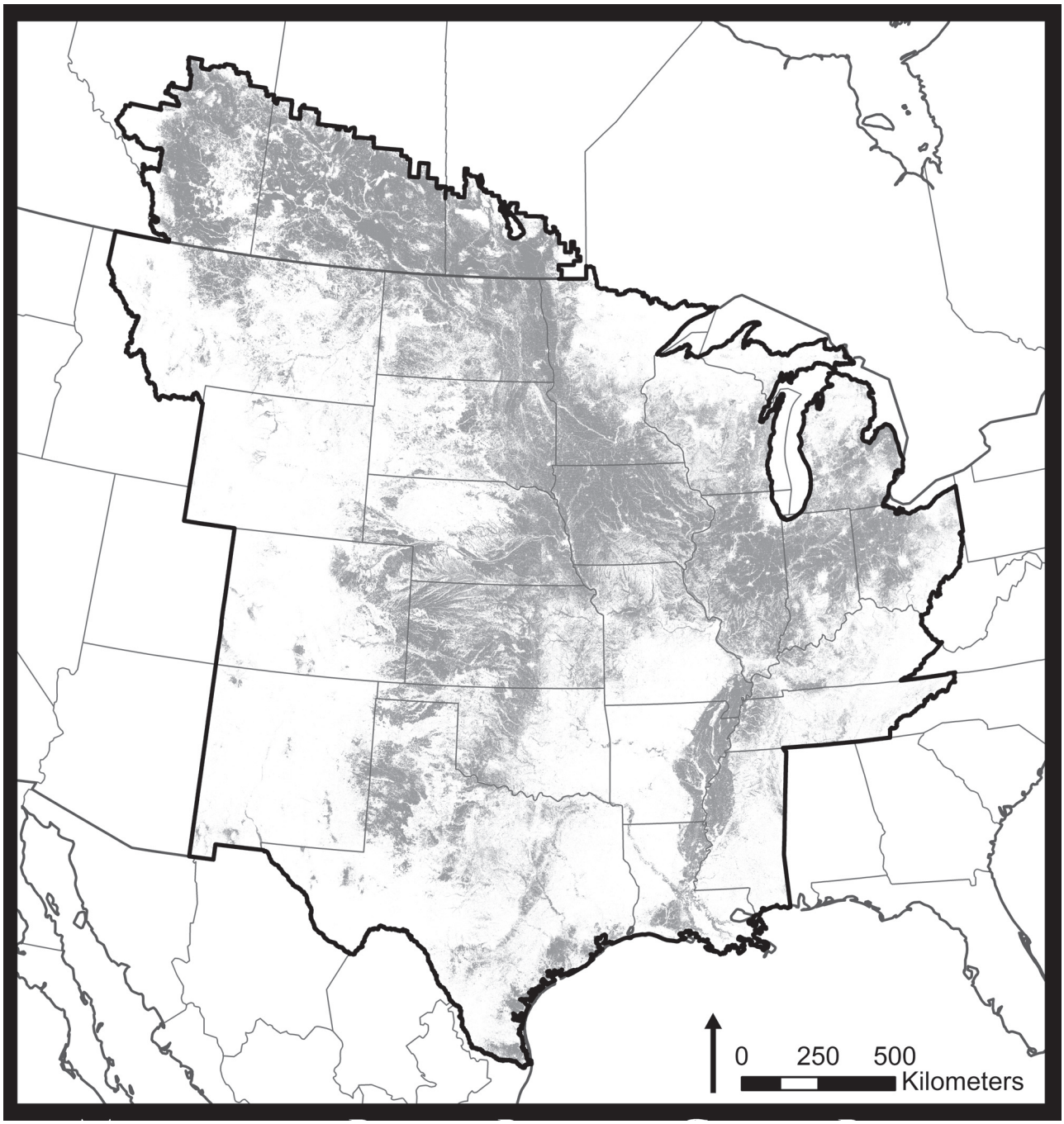

Figure 2. Extent of plowprint across the study area in 2013.

Conversion Rates and Plowprint Composition

Due to changes in the interpretation and resolution of the imagery (e.g., grassland) between 2008 and 2009 in the United States, we chose 2009 as our starting point against which to measure increases in cropland and decreases in remaining intact habitat. Changes in Canada were tracked starting in 2010 for the same reasons. We mapped additions of cropland to the plowprint annually, thus tracking the footprint of crop agriculture on the landscape as it expanded annually between 2009 (2010 in Canada) and 2013. Within the Northern Great Plains ecoregion, our area of conservation focus, we calculated the average rate of change for three county types (i.e., focal, buffer, other), which were classified according to the amount of remaining intact habitat and relative species

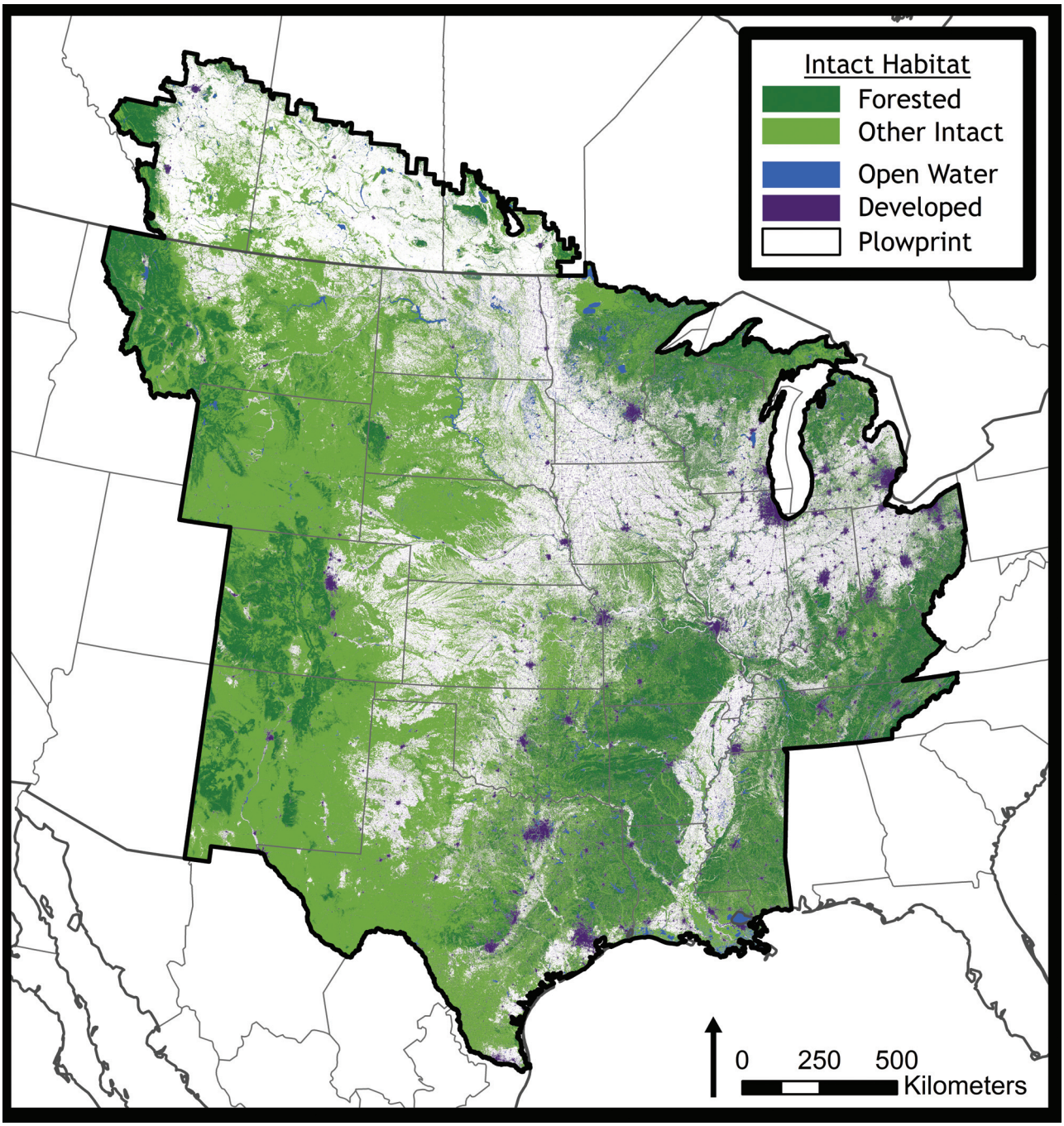

Figure 3. Intact habitat remaining in the MRB-GP study area in 2013. Dark green represents forested intact habitat. Light green represents all other remaining intact habitat, mostly grassland. Open water and developed lands are also shown.

diversity for the purpose of directing organizational resources. We then calculated the deviation from this average rate of change for each county type, scaled to the size of the county, to depict those counties that are experiencing faster and slower than average rates of conversion.

Within the plowprint, we grouped land-cover classes to provide an annual snapshot of the composition of the converted land footprint as it changes over time. For example, lands that were converted in the past could be restored back to grasslands or shifted to a different use. Previous research has shown that consolidation of similar classes within the CDL leads to decreased error rates associated with those classes (Lark 2015). Thus, we grouped crops and other land-cover types into the following categories: cropland/fallow, alfalfa/other hay,grassland/pasture/shrubland/wetland, barren/developed, open water,

and forest. Using this information, we can track different categories of land-cover types within the plowprint, which is of interest because restored lands can provide suitable habitat for some wildlife and avian species of conservation interest (Gebhart et al. 1994; Reynolds et al. 1994; US Geological Survey 2015).

Intact Habitat Layer

Our intact habitat layer was developed by subtracting the plowprint, open water, and developed layers from all habitat within the study area. We used the most recent National Land Cover Dataset (NLCD) from 2011 (Homer et al. 2015) as the baseline land cover for noncropland cover types in the US portion of the study area and, similarly, the Land Cover Data from 2000 (Government of Canada 2000) for the baseline land cover for the Canadian portion of the study area. An open water category was developed for the US portion of the study area by redefining pixels classified as water to correct for annual variation. Thus, any pixel in the NLCD layer that was defined as "water" in 2001, 2006, or 2011 (the most recent land-cover classifications available) was included in the open water category. We used this process to account for pixels that might be impacted by wet and dry years and therefore might switch back and forth between water and a nonwater land-cover class (e.g., grass), depending on the year. Because only one year of recent data was available for Canada, we did not perform this correction for the Canadian portion of the ecoregion. Developed lands were defined using the developed categories from both the NLCD and Land Cover Data.

Once the open water, developed, and plowprint layers were defined as outlined above, we subtracted them from the base land-cover layers for Canada and the United States. The remaining pixels were classified as intact habitat. We assumed that any pixel that had not been converted, developed, or classified as open water was intact. Within this intact layer, we used the NLCD or Land Cover Data to show forested versus other intact habitat (grassland, shrubland, or wetland) across the study area. In the same manner that we tracked increases in the plowprint over the study period, we also tracked decreases in intact habitat over time.

Validation

We used two methodologies to validate our process for identifying tracts of land that have not been plowed since 2008 in the United States and since 2009 in Canada. First, we identified three types of classifications across the years of the study: (1) persistent cropland was defined as those pixels that were classified as cropland in two or more subsequent years or in the last year of the dataset; (2) intermittent cropland was defined as pixels that alternate between cropland and noncrop status, never with two subsequent years classified as cropland; and (3) probable misclassification was defined as those pixels that were classified as cropland in only one year, not including the final year of data. We calculated the percentage of each of these pixel types across the entire study area.

Our second assessment compared our plowprint data to a dataset compiled by Bauman et al. (2014) that primarily uses the USDA Farm Service Agency Common Land Unit data to delineate tracts of land with no cropping history, through 2012. This dataset covers a small portion of our MRB-GP study area, in the Prairie Coteau region of eastern South Dakota. We compared our dataset of plowed and intact habitat with this dataset and developed an error matrix that allowed us to identify those pixels that were classified as plowed in our dataset and intact in the Bauman et al. (2014) dataset and vice versa. We then compared those cells that were included in the 2012 plowprint, but identified as intact by Bauman et al. (2014), with land-cover classifications from the CDL for 2012.

Results

Plowprint and Intact Habitat Layers

As expected, the extent of the plowprint continues to grow over the study period, and intact habitat declines. Figure 2 shows the cumulative extent of the plowprint as of 2013. The extent of the plowprint across the MRB-GP study area in 2013 was 157,748,507 ha. The extent of the intact habitat in 2013 was 333,021,231 ha (Fig. 3). Thus, approximately 32% of the study area had been plowed as of 2013, not including the developed areas or open water. The majority of the remaining intact habitat is privately owned, including both forested lands and grasslands (Table 1).

Conversion Rates and Plowprint Composition

The total size of the plowprint increased by 27,159,278 ha over the time period from 2009–10 to 2013, roughly 10% of the study area, not including open water and already developed lands. The annual increase in acreage

TABLE 1. Percentage of total intact acreage (2013) that is publicly and privately owned within the study area.

	Forest	Grassland
Public	8.4	14.2
Private	19.8	57.6

of the plowprint was much larger at the beginning of the study period, likely due to the change in the resolution of the dataset (from 56 m to 30 m) and the improvement in crop classifications as years were added to the dataset. The annual conversion rate for the Northern Great Plains focal geography was 1.5% during the 2009–2013 time period. The counties showing the fastest and slowest rates of change, by county type within the Northern Great Plains, are shown in Figure 4. We calculated these rates of change for the 2011–2013 time period to show the most recent change in conversion in this focal region. The percentage of the plowprint classified as grassland/pasture/shrubland/wetland in 2013 was 9.8%, while the percentage classified as alfalfa/other hay was 6.5%. Active cropland/fallow land made up 81.5% of the plowprint. The remaining 2.2% was split between forest and barren/developed lands.

Validation

Our within-dataset validation methodology yielded a probable misclassification rate of 11% within the plowprint. Persistent cropland represented 86% of the study area, and intermittent cropland encompassed 3% of the study area.

Our across-dataset validation methodology suggests that most of the pixels classified as cropland (70%) and intact (15%) are classified the same way in the Bauman et al. (2014) dataset. The error matrix is shown in Table 2. Thus, 15% of the cells were classified differently between the two datasets. The cells that our analysis identified as intact and Bauman et al. (2014) identified as plowed (10%) were likely plowed prior to 2008, the first year of our data, since their dataset extends back to the early 1900s. The cells that our analysis identified as plowed and that Bauman et al. (2014) identified as intact (5%), however, are likely misclassifications in our dataset. When we examined the 2012 plowprint classification data, most of these cells were classified as some type of hay or other grasslike cover, which are the classifications that are most likely to be confused with intact habitat.

TABLE 2. Error matrix showing the percentage of the total number of pixels that fall within each category.

	Intact acreage (this study)	Plowed acreage (this study)
Intact acreage (Bauman et al.)	15%	5%
Plowed acreage (Bauman et al.)	10%	70%

Note: Across-dataset validation of plowed versus intact pixels.

In fact, only 7% of the cells that we classified as plowed and Bauman et al. (2014) classified as intact, or 0.3% of the total cells in this validation dataset, were in active cropland in 2012.

Discussion

Developing metrics for tracking conversion of grasslands and other intact ecosystems to cropland over time can provide clarity for agencies and organizations that are working toward conservation of these important habitats as to how much is being lost and where. The results of our study mirror those of similar studies from the past decade: cropland expansion is increasing. The size of the plowprint in 2013 was over twice the size of the state of Texas, or equivalent to four times the size of Montana. Much of the remaining untilled lands in the study area are forested and publicly owned. We conclude that privately owned grasslands in this region are at high risk of conversion because publicly owned lands are largely protected from this type of land-use change.

Our study improves on the ability to monitor cumulative change over time, thus allowing disparate agencies and organizations to align their goals, strategies, and activities, and measure progress in a uniform way. Stacking subsequent years of data allows us to circumvent many of the common issues associated with using satellite-derived data to track annual change in cropland extent, and our validation efforts suggest that we are capturing most of the converted lands using our methodology. Previous studies reported conversion rates of 1% to 5% annually (Goldewijk 2001; Rashford et al. 2011; Claassen et al. 2012; Faber et al. 2012; Sylvester et al. 2013; Wright and Wimberly 2013; Lark et al. 2015); our calculated rates of conversion fit within this range, which further suggests that our methodology is doing an accurate job of monitoring conversion of intact habitat to cropland over time.

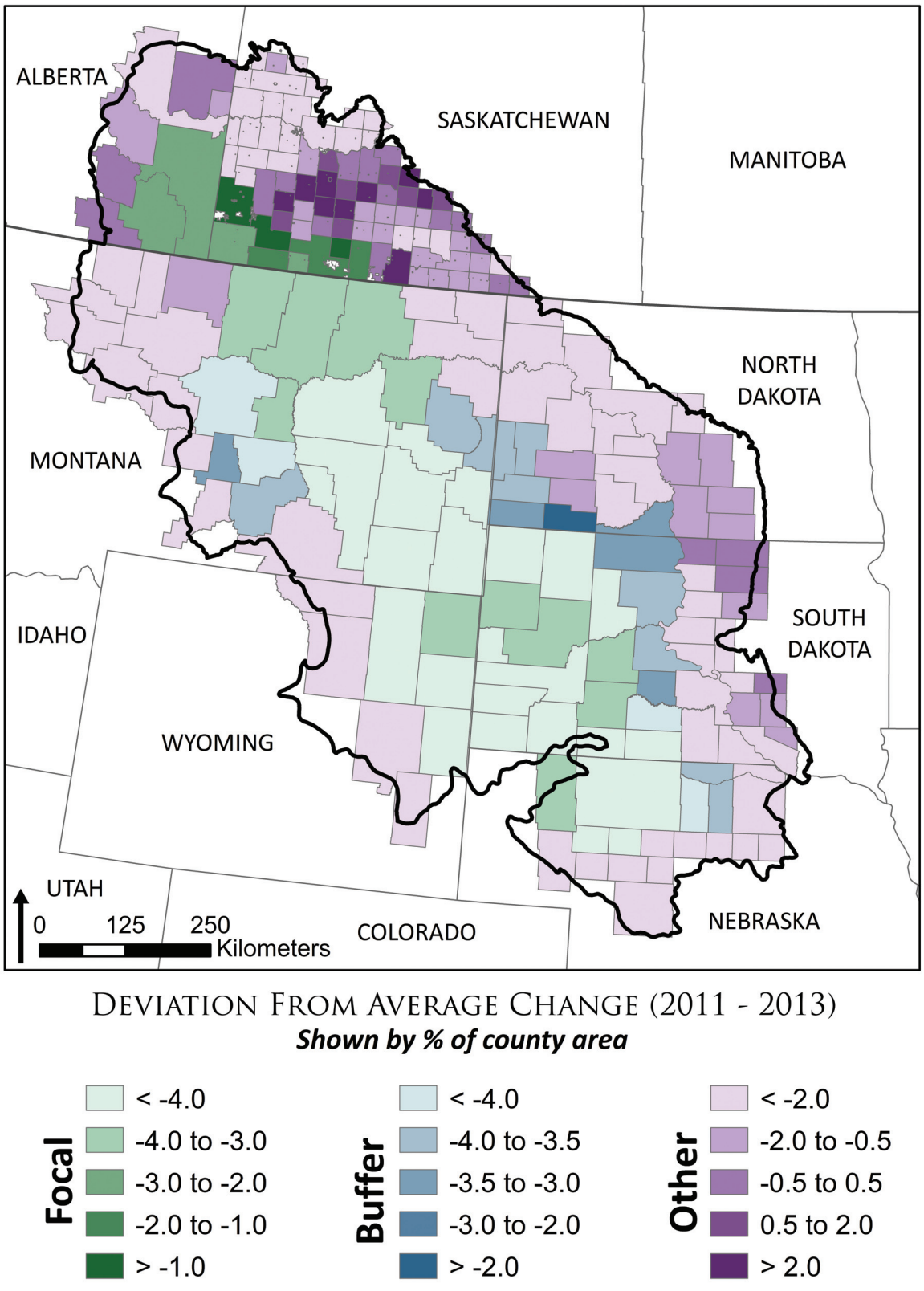

Figure 4. The deviation from average of conversion from grassland to cropland, as a percentage of county size, 2011–2013. Focal counties are shown in green; buffer counties in blue; and other counties in purple. Darker shades represent higher rates of conversion and lighter shades represent lower rates of conversion.

The broader implications of the conversion of intact lands to cropland, including decreased habitat for wildlife and declining ecosystem services, are significant and will require the attention of policy makers, as well as other conservation stakeholders. Previous coarse-scale analysis in the Northern Great Plains region suggests that, depending on the soil type, avoided conversion could lead to savings of hundreds of thousands of gallons of water per acre (Flynn and Redder 2014). Conserving intact grassland ecosystems into the future will have lasting impacts on water availability while also improving water quality for downstream users.

Conclusions

The implementation of regional monitoring programs can help identify remaining intact habitat so that resources may be directed to those areas. In areas that are not currently experiencing high rates of conversion, working with landowners to find incentives for keeping land intact could be a potential avenue forward. In addition, government policies that seek to reduce the motivation to convert should be implemented. Working together, we can maintain the remaining intact grasslands to provide habitat, ecosystem services, and other benefits to communities and wildlife across this region.

Anne Gage (anne.gage@wwfus.org), *Sarah Olimb* (sarah.olimb@wwfus.org), *Jeff Nelson* (jeff.nelson@wwfus.org), Northern Great Plains Program, World Wildlife Fund–US, 13 South Willson Avenue, Suite 1, Bozeman, MT 59715

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iButton® Temperature Loggers Effectively Determine Prairie Grouse Nest Absences

Josiah D. Dallmann, Edward J. Raynor, Lars C. Anderson,
Larkin A. Powell, and Walter H. Schacht

ABSTRACT—Recent technological innovations allow the monitoring of avian nest attendance in ways that reduce disturbance and expense without altering nesting activities. Yet the efficacy of these techniques to assess nest absences has not been determined for ground-nesting prairie grouse. We sought to determine the timing of nest absences by means of accurate detection without intrusive human visitations technology. During the nesting season (May and June), we inserted iButton® Thermochrons (Maxim/Dallas Semiconductor Corp., Sunnyvale, CA) into active greater prairie-chicken (*Tympanuchus cupido*) nests in the Sandhills of Nebraska, USA. We simultaneously monitored the nests with solar-powered video cameras to determine if the lower-cost iButtons would record noticeable changes in nest bowl temperature when video indicated a hen absence. Our data showed that iButtons detected 88% of nest absences in 49 off-bouts (instances of nest absence) and accurately portrayed the length of absence from the nest. In total, average lag time, departure lag time, and arrival lag times were detected by iButtons less than 2 minutes after the actual time recorded by the camera. We also obtained valuable information regarding the timing of hen absence, predation events, and optimal iButton recording intervals. Our study suggests that iButtons could be effectively used to monitor absences at greater prairie-chicken and likely other species of prairie grouse nests in future studies.

Key Words: iButton, nest absence, nest monitoring, nest predation, prairie grouse

Introduction

During incubation, birds must balance the requirement to attend the nest for proper embryological development with the need to leave the nest and forage to meet nutrient intake requirements (Webb 1987; Conway and Martin 2000). Each time a bird leaves its nest, the nest microclimate changes temperature and the nest is more susceptible to predation. Furthermore, nest attendance patterns can influence seasonal nest success, energetic costs of incubation, and lifetime reproductive success (Clutton-Brock 1991). Knowledge of nest attendance patterns could help inform resource management decisions by establishing when a predation event or nest abandonment occurred or how nest attendance is affected by habitat type or other extrinsic disturbances.

A wide variety of methods to monitor nest attendance of birds has included such techniques as direct observation (Norment 1995), video (Cox et al. 2012), electronic balance (Becker et al. 1997), transponders (Kosztolányi and Székely 2002), and thermocouples (Schneider and McWilliams 2007). A number of disadvantages limit the widespread applicability of these techniques, including the monetary expense of direct observations and video camera systems (Hoover et al. 2004), increased predation rates due to video surveillance (Cox et al. 2012), and time required to review video. Recent technological advancements in nest monitoring equipment have allowed for remote monitoring of nest temperature (Richardson et al. 2009; Sutti and Strong 2014); however, the efficacy of such techniques to assess nest attendance has not been determined for obligate grassland ground-nesting birds such as prairie grouse.

Previously, iButtons (Maxim/Dallas Semiconductor Corp., Sunnyvale, CA, http://www.maxim-ic.com/) have been used successfully with ground-nesting birds to determine the onset of incubation and occurrences of nest abandonment or predation (Hartman and Oring 2006; Schneider and McWilliams 2007; Wilson and Martin 2010). For example, when ground-nesting shore-

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birds' nest attentiveness was measured with iButtons, researchers were able to effectively determine when nest incubation was terminated due to abandonment or predation for both exposed nests of piping plover (*Charadrius melodus*) on beaches (Schneider and McWilliams 2007) and less-exposed nests of long-billed curlew (*Numensis americanus*) in grasslands (Hartman and Oring 2006). Although patterns of nest attendance have been estimated with iButtons, use has been primarily limited to the relatively closed environment of cavity nests (Cooper and Mills 2005; Zangmeister et al. 2009; Cooper and Voss 2013; Ellenberg et al. 2015). Further investigation of the capability of this nest monitoring technique with a species of obligate grassland ground-nesting bird is crucial to aiding population management and monitoring programs of grassland birds. To better understand the key demographic parameter of nest survival that may regulate productivity and the growth or decline of populations of greater prairie-chicken (*Tympanuchus cupido*; hereafter, prairie-chickens) (McNew et al. 2012), we provide some insight into how iButtons can be used to monitor nest attentiveness of this ground-nesting grassland bird. Our goal was to determine the effectiveness of iButton® data loggers to detect prairie-chicken hen absences and to document the length of absences. Time of day of hen departures from nests and video footage of nest predations and hen behaviors also were recorded.

Methods

Our study site was in the eastern Sandhills of Nebraska (Rock and Brown Counties), USA. Prairie-chicken hens were collared with radio transmitters in late March and then followed throughout the nesting season in order to locate nests. We inserted two dime-sized (16-mm-diameter, 6-mm-thick, 2.9 g) temperature loggers (iButton Thermochrons DS1921G-F5) into the nest bowl and lightly covered each iButton with nesting material (forbs and grasses) for 3 active nests during the peak nesting season (May and June) of 2011 to record nest temperatures. iButtons are small, self-contained thermal data loggers that record and store temperature data (range = –40° to 85°C) at intervals set by the researcher. Animal research protocols were approved by the University of Nebraska–Lincoln Institutional Animal Care and Use Committee (Protocol #05-02-007).

A digital video recorder (Archos® AV340) coupled with a weatherproof infrared-capable camera (Supercircuits® PC1841R; shell: 6 cm × 5 cm × 5 cm; 8 LEDs) to capture video images (30 fps) was placed at each nest with iButtons in May and June. Video cameras were placed 0.25–1.37 m off the ground facing the nest at a distance of 1 m. This elevated approach to filming was beneficial in that vegetation did not obstruct footage of the nest, and minor grass movements did not frequently trigger the motion sensor. Black electrical tape was placed on the video camera lens to limit the white light emitted by the infrared night-vision sensors from washing out the view of the nest. Video files were stored and analyzed following the methodology of Powell et al. (2012).

The video cameras recorded the actual length of hen absences and were used to assess the accuracy of iButtons. The length of a hen absence, according to the iButton, was determined from the temperature data. Absences were considered correctly identified by an iButton if there was a significant fluctuation in nest temperature (≥2.8°C) in a relatively short period of time (<1.5 hours). Average lag times were calculated and represent the net number of minutes that an iButton deviated from the actual length of a hen absence as recorded by the video camera.

iButton hen departure time was determined to be the time stamp (iButtons record the temperature at set intervals of minutes) just before the temperature began to rise or fall (Fig. 1). During an absence, temperatures usually reached a maximum or minimum and then began to gradually return to normal. The time stamp recorded just before the maximum or minimum temperature was deemed the iButton hen arrival time. iButton departure and arrival lag times were calculated and represent the net number of minutes that an iButton deviated from the actual hen departure or arrival time. Negative values indicate iButtons recorded the hen departing from or arriving at the nest before the actual time, while positive values indicate iButtons recorded the hen departing from or arriving to the nest after the actual time. A correlation analysis was used to compare absence duration as recorded by iButtons and cameras.

The video and iButton data were analyzed and the total number of unprovoked absences over the span of the study were grouped into daily time periods. Provoked absences were documented instances when incubating hens were flushed from the nest as a result of either human or wildlife influence, whereas unprovoked absences were recorded instances when hens left nests without being flushed by human or wildlife influence. Linear regression in the programming language R (R Founda-

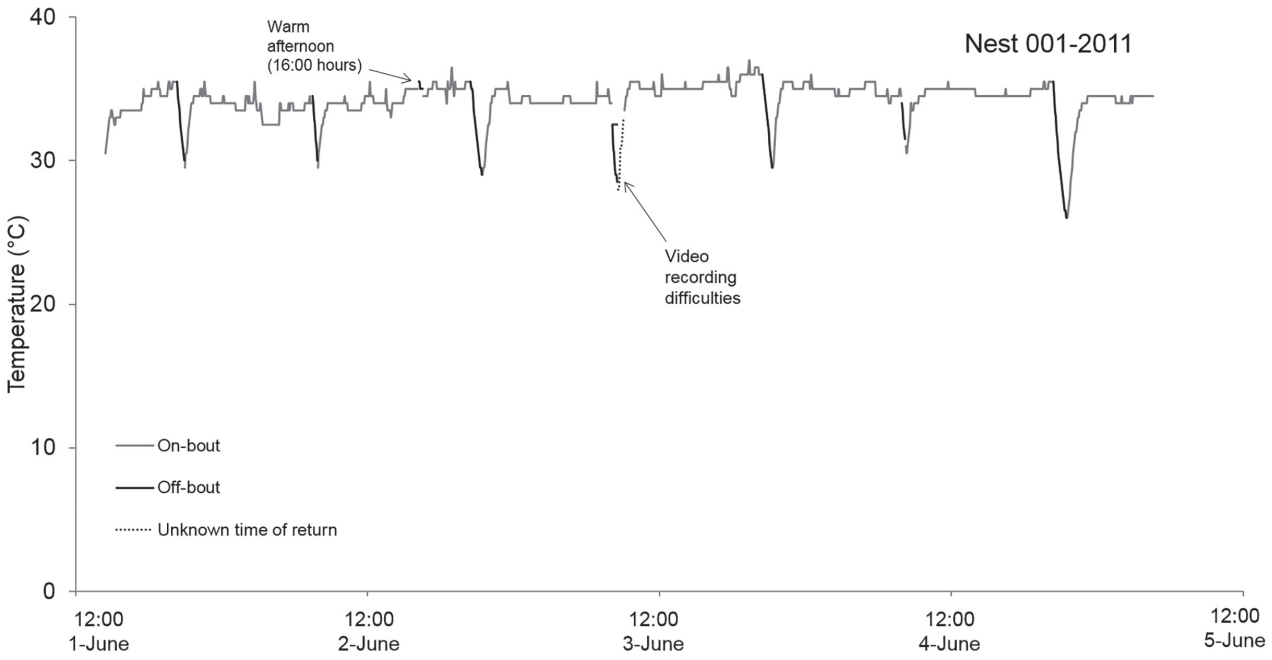

Figure 1. iButton temperature data for a greater prairie-chicken hen nest (#001) over an 88-hour period in Brown County, Nebraska, USA, between May and June, 2011.

tion for Statistical Computing) was used to determine iButton efficacy in correctly identifying nest absences detected by video camera. We analyzed duration of nest absence detected in video recordings to explain the variation in matched time periods of absences detected by the iButtons. In addition, we documented hen behaviors and predation events. A "control camera" was placed at random at the study site between 23 June and 7 July at a height of 0.25 m to test for the artificial effect of predator attraction to the cameras, which could indirectly affect frequency and/or length of hen absences in our study. We placed a single "control" iButton 1 m outside nest #001 at ground level to monitor ambient temperature for 14 days (23 June to 7 July 2011).

Results

We studied three nests: #001 between 30 May and 8 June, #362 between 16 and 20 May, and #542 between 16 and 24 May 2011. A total of 49 unprovoked hen absences were recorded by either iButton or video data over the course of the study. During an absence, iButton data generally recorded a rapid change in temperature. iButtons correctly identified 43 (88%) hen absences, with failed detections occurring on days that were ≥35°C (Table 1). iButtons were also accurate in portraying length of absence from nest (~1-minute average lag time, $F_{1,28} = 119$, $P < 0.0001$, adj $r^2 = 0.80$; Fig. 2). In total, average lag time, departure lag time, and arrival lag times were detected by the iButton less than 2 minutes after the actual time recorded by the camera. Average nest temperature spanned 21° to 33°C, with nest #001 showing the highest average temperature over the 9-day monitoring period. Nest checks found that no eggs were damaged by iButtons. The control camera did not record evidence of predators in the immediate area. Hens generally departed the nest just before sunset and after sunrise (Fig. 2).

Nest #001 started incubation on 21 May and iButton monitoring spanned 9 days (30 May to 8 June). Video of the nest showed that it was depredated by a bull snake (*Pituophis catenifer*) on 8 June 2011 following a struggle between the snake and hen (see video footage: https://youtu.be/DiO22U-R6JA and https://youtu.be/U3T-tKmJ-k1g). The next day the hen was found deceased yet physically intact ~3 m away from the nest. Prior to the depredation event, a hailstorm producing golf-ball-sized hail on 30 May likely detached the power cable of the video camera from the solar panels (see video foot-

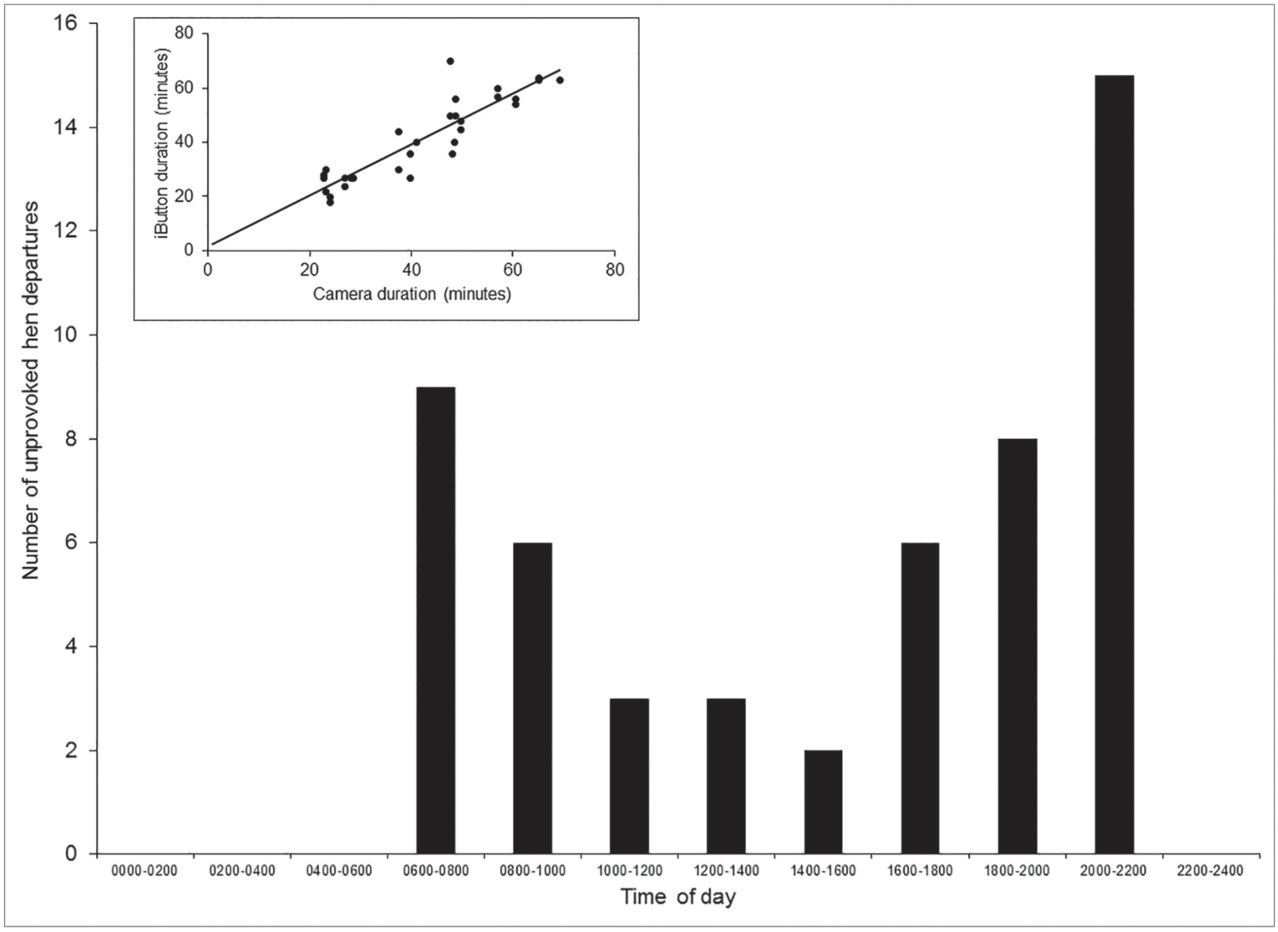

Figure 2. Frequency of unprovoked nest departures of greater prairie-chicken hens (N = 52) during 2-hour time periods, with inset comparing duration of greater prairie-chicken nest absences, as measured by iButtons and video cameras (r^2 = 0.80) at nests in Rock and Brown Counties, Nebraska, USA, between May and June 2011.

age: https://youtu.be/LP4NV6yivMQ). Video surveillance did not begin again until 1 June, when technicians reattached the power cable to the camera. On 3 June, a 40-min recording section of the continuous video was deleted accidently when the camera's secure-digital (SD) card was switched out. The average lag time of iButtons set at 4- and 9-min recording intervals was –1 min, 22 sec, and –4 min, 12 sec, respectively (Table 1), which suggests that the use of 4-min intervals resulted in less error in determining when the nest was incubated than the longer 9-min recording intervals. The iButton placed ~1 m outside the nest to measure ambient temperature appeared to have been pushed deeper in the soil during the hailstorm; however, prior to the hailstorm this "control" iButton's temperature graph revealed a daily sine curve of low temperatures at night and high temperatures during the day. On one occasion, the iButtons set to record at 4- and 9-minute intervals failed to display a drop in temperature during an absence. Video showed that the hen had left for 25 min on a warm afternoon and the nest temperature stayed relatively constant, thus indicating nest temperature did not change due to the high ambient temperature.

On 16 May 2011 we flushed the hen at nest #362, put in place the iButton and nest camera, and monitored the nest for 4 days (16 to 20 May). At 1327 on 20 May, a rodent was filmed at the nest; 2 hours later we found the nest absent of eggs. Average lag time was inestimable because only one error in absence was detected between iButton and camera during this nest's short lifespan.

Nest #542 was initiated on around 12 May and was monitored for 8 days (16 to 24 May 2011). The nest was lost to coyote (*Canis latrans*) depredation around 2300 on 21 May except for one egg. The egg was 9–12 days along in growth. The average lag time, departure lag time, and arrival lag time for the iButton set at 2-min

TABLE 1. Data from iButton analysis of greater prairie-chicken nests in Rock and Brown Counties, Nebraska, USA, between May and June 2011.

Nest number (iButton interval)	Mean nest temperature (°C)	Mean lag time	Mean hen-departure lag time	Mean hen-arrival lag time	Number (and percentage) of iButton-detected camera-documented absences
001 (4 min)	33.34	–0:01:22	0:00:23	–0:00:47	8/9 (89%)
001 (9 min)	33.17	–0:04:12	–0:02:11	–0:05:37	12/13 (92%)
362 (3 min)	22.36	—	—	—	2/2 (100%)
362 (15 min)	21.16	—	—	—	1/2 (50%)
542 (2 min)	26.66	0:01:54	0:02:50	0:04:44	9/10 (90%)
542 (10 min)	22.51	0:01:29	–0:04:51	–0:03:23	11/13 (85%)
Average	—	–0:01:05	–0:01:22	–0:02:10	42/49 (86%)

Note: Lag times indicate deviation of iButton detection before and after actual (camera-documented) times, denoted by negative and positive values, respectively.

recording intervals occurred after the actual time that the hen departed or returned to the nest, whereas the average arrival and departure times of the 10-min iButton occurred before the actual time and after the actual time for the average lag time, respectively (Table 1).

Conclusions

Overall, the overlap between video footage and iButton data was optimized when the iButton was set at a 10-min recording interval. An iButton set to 10 minutes will keep recording data without overwriting previously recorded data for approximately 14 days. Placing two iButtons in a nest and programming one to begin recording after 14 days would allow nest monitoring for an entire prairie-chicken nest incubation period (~25 days). If multiple human visits occur during their incubation period, a 4-min interval may provide the most temporally resolute information for prairie grouse nest monitoring. However, these recommendations are based on low replications of time intervals and a small sample size.

iButtons provided an effective way to monitor prairie-chicken nests by ascertaining daily nest status and timing of nest failure. Daily nest status was identifiable through iButton readings which were validated by scoring camera footage. The iButtons showed nest absences with 88% accuracy. The maintenance of a set nest temperature of ~33°C was revealed by iButtons whenever the hen started an incubation bout. A "V" shape in the graph was typically depicted when a hen left the nest. An extended leave showed a "V" in the graph that was very noticeable, while short-term absences were generally less evident. The lowest point (temperature) on the graph was almost always recorded immediately before the time a hen returned to tend the nest. Similar findings using iButton readings have been reported in other large ground-nesting birds (Hartman and Oring 2006; Wilson and Martin 2010). In contrast to our study, these studies did not confirm nest absences with video footage.

Our video camera analysis, which corroborated iButton-derived nest attendance, also recorded unique footage of nest predations by a bull snake (S1), coyote, and an unidentifiable small rodent. The control camera, however, did not attract any carnivorous predators into view of the camera. There are contrasting views of the effect that video camera presence at nesting sites has on the frequency of predator visitations (Richardson et al. 2009; Powell et al. 2012). For example, Powell et al. (2012) found higher predation rates in ground-nesting western meadowlark (*Sturnella neglecta*) nests when the nests were filmed to determine activity, whereas a meta-analysis by Richardson et al. (2009) suggested that on average, nest cameras may reduce the risk of nest predation of several bird species.

Understanding the efficacy of nest monitoring techniques for species of conservation concern such as the greater prairie-chicken, which exhibit uniparental care

of offspring and rarely re-nest after brood loss in a single breeding season (McNew and White 2012), is paramount to their conservation because maximizing data quality at the lowest expense can improve management efforts of this vulnerable species. Although there have been many studies of nest attendance in birds, few can be practically applied to ground-nesting prairie grouse. Our study suggests that iButtons could be effectively used in future studies to monitor hen absences from prairie grouse nests. Here, iButtons were unobtrusive, inexpensive, and able to effectively measure nest attentiveness of greater prairie-chickens. The two other prairie grouse of the North American Great Plains, lesser prairie-chicken (*T. pallidicinctus*) and sharp-tailed grouse (*T. phasianellus*), construct nests in a similar fashion to our study species (Rodewald 2015). Thus, our findings likely extend to these species as well, although high ambient temperature may mask the detection of lesser prairie-chicken hens' nest departure in the southern Great Plains. Therefore, a thorough investigation of iButton efficacy for this species of conservation concern is warranted.

Josiah D. Dallmann (josiah.dallmann@gmail.com), *Lars C. Anderson* (lars.c.anderson@gmail.com), School of Natural Resources, 419 Hardin Hall, University of Nebraska–Lincoln, Lincoln, NE 68583; Department of Agronomy and Horticulture, 312 Keim Hall, University of Nebraska–Lincoln, NE 68583

Edward J. Raynor (eraynor2@unl.edu), *Larkin A. Powell* (lpowell3@unl.edu), School of Natural Resources, 419 Hardin Hall, University of Nebraska–Lincoln, Lincoln, NE 68583

Walter H. Schacht (wschacht1@unl.edu), Department of Agronomy and Horticulture, 312 Keim Hall, University of Nebraska–Lincoln, Lincoln, NE 68583

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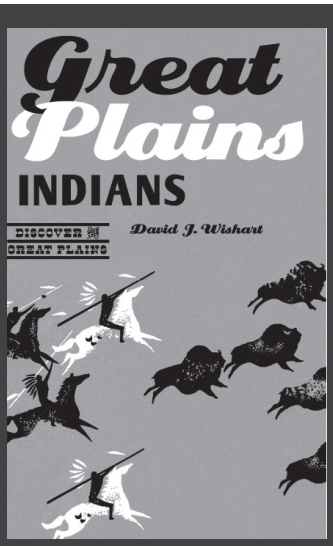

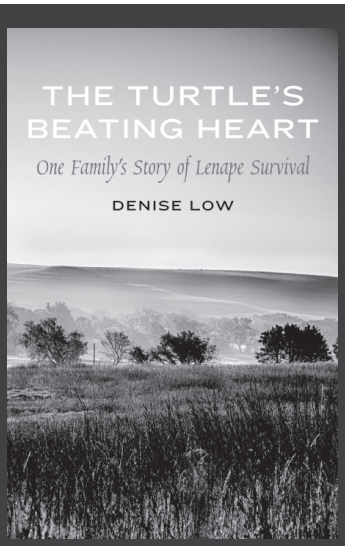

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REVIEW ESSAY

What's the Matter with Meat?

Don D. Stull

The Chain: Farm, Factory, and the Fate of Our Food. By Ted Genoways. New York: HarperCollins, 2014. xiv + 303 pp. Notes, index. $28.99 cloth, $15.99 paper.

Defending Beef: The Case for Sustainable Meat Production. By Nicolette Hahn Niman. White River Junction, VT: Chelsea Green Publishing, 2014. viii + 274 pp. Notes, index. $19.95 paper.

Cowed: The Hidden Impact of 93 Million Cows on America's Health, Economy, Politics, Culture, and Environment. By Denis Hayes and Gail Boyer Hayes. New York: W. W. Norton, 2015. 392 pp. Notes, index. $27.95 cloth.

Farmageddon: The True Cost of Cheap Meat. By Philip Lymbery with Isabel Oakeshott. New York: Bloomsbury USA, 2014. xv + 426 pp. Notes, index. $19.99 paper.

Political Ecologies of Meat. Edited by Jody Emel and Harvey Neo. New York: Routledge, 2015. xxi + 368 pp. Notes, index. $155.00 cloth, $57.95 paper.

Meat is what Mary Douglas (1970) called a natural symbol. Not only the most highly prized food and the pinnacle of the food hierarchy (Twigg 1983, 21), meat is "the food most directly associated with the idea of both symbolic and functional power" (Montanari 2006, 123). But meat is also abhorred as an inexcusable exploitation of our fellow creatures, blamed for a host of diseases, and accused of causing the destruction of the tropical rainforest, global warming, and widespread hunger. It has, in fact, become "the symbol of a balance needing to be restored, of a cultural challenge aimed at rebuilding and reshaping attitudes on food issues" (Montanari 2006, 122). To that end, a growing number of writers—and eaters—condemn the current system of "industrial meat" production and search for humane and sustainable alternatives. Each of the books reviewed in this essay condemns industrial meat, calling for alternatives to it. Just how viable, sustainable, and humane these alternatives are, is another matter.

In *The Chain*, investigative journalist Ted Genoways recounts in detail the disturbing history of industrial hog production and pork processing. Rather than broadly examining the pork industry, he focuses on one company, Hor mel, and its plants in Fremont, Nebraska, and Austin, Minnesota, laying bare the dark underbelly of modern meat production as he traces the origins of Hormel in the 19th century and its rise to prominence, largely through its signature product—Spam. The book's title, *The Chain*, is a literal reference to the conveyor system used on production lines in modern meat plants: an "endless chain" bringing animals to workers, its speed controlled by floor supervisors. The book's title is also a metaphor for the industry's relentless efforts to increase production by speeding up the chain without regard to safety, whether of food, workers, or the environment.

Genoways moves back and forth between Hormel's history—from its origins as a progressive family company to a modern corporation that stresses production and profit over workers' welfare—and stories of workers, in the early years of the first decade of the 21st century, who contracted a mysterious disease while working on the "head table" in the Austin, Minnesota, plant. Along the way, he recaps the infamous strike by union Local P-9 workers in Austin in the mid-1980s. Hormel broke the strike by reorganizing, introducing a two-tier wage system, increasing automation, and speeding up the chain. Increased line speed, Genoways believes, is the ultimate cause of the mysterious outbreak of progressive inflammatory neuropathy (PIN) in 2006. He also traces the rise

of concentrated animal-feeding operations (CAFOs), the decline of diversified family farms, and efforts to pass anti-immigrant ordinances in Fremont, Nebraska.

By concentrating on one company and the lives of its workers in two of its plants, Genoways brings immediacy and emotion to events that were much in the news at the time. The richness of his book lies in its detailed microanalysis, but he often ignores or minimizes the macrolevel processes at work within and upon the industry and the communities that host its plants. He also ignores the considerable scholarly literature, dating to the late 1980s, which would have indicated a deeper timeline to industry trends and placed his work in a wider context.

In contrast to Genoways's damning exposé of the industry that has brought us "the other white meat" stands Nicolette Hahn Niman's *Defending Beef*. Subtitling her book "The Manifesto of an Environmental Lawyer and Vegetarian Turned Cattle Rancher," Hahn Niman reflects on her own evolving views as she seeks to debunk common criticisms of beef and the erroneous assumptions upon which she claims they are based. In the first six chapters, devoted to defending cattle, she uses various sources to challenge their descriptions as contributors to climate change and global problems related to water, biodiversity, and overgrazing. She then turns to beef as food, rebutting health attacks and touting it as "good food."

According to Hahn Niman, "Nothing about livestock is *inherently* damaging to the environment. . . . The problem lies instead with today's methods of raising them" (11, emphasis in original). The authors of all the other works more or less agree. What sets *Defending Beef* apart from these is not her condemnation of industrial beef production, but her systematic deconstruction and occasional dismantling of the various cases against cattle as animals and beef as food. A good example is her analysis of the much-quoted 2006 United Nations Food and Agriculture Organization (FAO) report called *Livestock's Long Shadow*, which blamed meat for 18% of greenhouse gas emissions. In 2013 FAO updated its report and lowered the figure to 14%. In its *Emissions Gap Report 2013*, the UN Environmental Program blamed all of agriculture for only 11% of greenhouse gas emissions (10–18). Her effort to balance the debate is both rare and refreshing.

Defending Beef is a worthwhile addition to the literature on meat in general and beef in particular. Sadly, Hahn Niman is not a disciplined writer; she meanders, often wandering off topic, repeating herself, and quoting herself. Moreover, she overrelies on websites, popular media, and obscure sources. And she is prone to hyperbole, as when she declares that "cutting up the natural sod was tantamount to exploding a vault with our nation's most precious jewels" (62).

Reading *Defending Beef* and *Cowed* back to back, at times I wasn't sure if I was reading about the same animal. After a close encounter with some Holsteins while staying at a bed-and-breakfast in the south of England, Denis and Gail Hayes claim they became fascinated with cows. Like Nicolette Hahn Niman, Gail Boyer Hayes is an environmental lawyer, and her husband, Denis, was the national coordinator of the first Earth Day in 1970. Their serendipitous meeting with some milk cows in the English countryside led them to examine all things bovine, from ancestral aurochs to modern-day range wars between the Bundy family and the US Bureau of Land Management in Nevada's sagebrush sea. The result is an attack on what they call the bovine industrial complex (247), which they conclude "is undermining the entire natural world—squeezing out wild animals, shredding ecosystems, slashing biodiversity" (87). They argue that "because cows require such a large portion of our resources [to produce our beef and milk], keeping too many cows could make it impossible to . . . feed all Americans at affordable prices" (89).

Cowed and *Defending Beef* often draw on the same sources. Both praise holistic range management and The Land Institute in Salina, Kansas, which hopes to revolutionize agriculture by developing viable perennial grain plants. But they often come to different conclusions about the potential to ameliorate the problems created by industrial beef and milk production. *Cowed* is sprinkled with interesting "cow facts," such as the wonders of the bovine digestive system and all the marvelous things produced from cow parts, while *Defending Beef* takes aim at sugar and carbohydrates and praises meat-based diets of hunters and gatherers. Both are enamored of personal anecdotes, which rarely inform readers or advance their arguments.

Cowed is an alarmist attack on the bovine industrial complex. *Farmageddon* expands its attacks to include all farmed animals—beef, pork, poultry, fish—and ratchets up the rhetoric. Written by the chief executive of Compassion in World Farming, *Farmaggedon* is based on two years of traveling around the world with the political editor of London's *Sunday Times* and a camera crew to document the maladies of industrial flesh production and the socioeconomic, health, environmental, and moral consequences of its consumption. Philip

Lymbery is British, and much of his discussion centers on the United Kingdom, but his team also traveled to the United States, China, Argentina, Peru, and Mexico for short periods of focused research. Topical coverage ranges from the impact of intensive agriculture and CAFOs on birds and butterflies to swine flu and the rise of so-called superbugs, to the obesity epidemic, to GMOs, to food and country-of-origin labeling, to the impending groundwater crisis, and how we will feed an additional two billion people by 2050.

Lymbery's writing mixes travelogue with hyperbole about food apocalypse. He starts each chapter with a personal vignette, too often forced and tangential, then launches into its subject. His coverage of industrial poultry and pork production is quite good, and he makes a strong argument about "ghost acres"—land used to produce feed for meat production—required for CAFOs and industrial agriculture (203–4). He presents some very intriguing—and disturbing—numbers but often fails to cite sources, as in his discussion of the energy needed to produce crops and livestock relative to the energy output (calories) they produce (238). All too often he relies on his own calculations without saying how he reached them (ghost acres is one of many examples). When he does credit sources, they often relate to trivial matters, such as the number of backyard chickens in the United Kingdom.

Farmageddon's final section, "Tomorrow's Menu," is its most provocative, exploring trends in industrial agriculture—GMOs, cloning, ocean ranching, in vitro meat—and looking toward the future of food and agriculture, which we often forget are not the same thing. Its chapter on China is quite illuminating; unfortunately, it was written before a Chinese company purchased Smithfield and another planned to purchase Syngenta.

Farmageddon is commendable for trying to present a comprehensive critique of industrial meat. It raises many important issues and shows just how pervasive the global grain-based confined-animal agriculture industry has become. But in trying to cover industrial food production in its entirety, it is too shallow, its field research superficial, and its scholarship based on too few sources, most of which come from the web.

The four works I have considered thus far are trade books, written for a general audience by an investigative journalist, a vegetarian environmental lawyer and activist who married a prominent pioneer of grass-fed beef and branded meat, two self-proclaimed naïve environmentalists who take readers along on their voyage of discovery of the ills of industrial beef and milk production, and the chief executive of a farm animal welfare organization. With the exception of Genoways, the investigative journalist, none are experienced researchers. All are on crusades, selecting sources to justify their causes, and generally ignoring the considerable work of numerous researchers, most notably social scientists, who have thoroughly plowed this ground before them. Other than *The Chain*, these books are thin on field research. When their authors do venture into "the field," it is for brief forays selected to reinforce preexisting positions, or to feature exemplars of alternative agricultural practices they believe show the way to sustainable food systems. Name dropping and personal anecdotes abound—intended to bolster arguments; often as not they distract and annoy.

Political Ecologies of Meat, a collection of 20 scholarly essays edited by geography professors Jody Emel and Harvey Neo, stands apart from these other works. Most contributors are geographers, but other essayists represent the fields of sociology, city and regional planning, and environmental policy studies. Authors include university professors, researchers, and graduate students as well as scholars from nonacademic institutes and centers. The book looks at livestock production and consumption worldwide; its contributors come from Austria, Brazil, Canada, Indonesia, Italy, Kenya, South Africa, Singapore, Spain, the United Kingdom, and the United States.

Part 1 of the book's four parts concerns the so-called livestock revolution. Ian MacLachlan carefully documents the dramatic global expansion of "livestock source foods," which has resulted in a quadrupling in global meat production since 1960 (1) and offers a scholarly balance to the portrayals of these trends found in some previous works. Other chapters deal with cattle ranching in the Brazilian Amazon, trends in livestock production in South Africa, and factory farming in East Africa—or its lack (offering instead a general summary of meat production and consumption). With the exception of MacLachlan's overview of livestock production and meat consumption in the developing world, these chapters are review essays with virtually no original research and too broad and shallow to interest readers not already specialists in those specific countries.

Part 2, "Environmental Justice and Meat Production/Consumption," begins with Ryan Gunderson's brief polemic on the social, health, and environmental sins of CAFOs, which are legion, concluding that "a truly sustainable food system may need to eliminate the pro-

duction of meat altogether" (105); however, he fails to interrogate the problems that would accrue with the agricultural transformation necessary for the world to go vegetarian. David Sauri and Hug March document groundwater pollution in Catalonia, Spain, and the loss of public springs and fountains caused by an increase in hog confinement operations. Using geographic information system (GIS) analysis of populations at the census-tract level, Julia Lenhardt and Yelena Ogneva-Himmelberger found higher proportions of children and Hispanics in regions with high densities of dairy and swine CAFOs in Ohio. This association would suggest these populations are at greater risk for negative environmental health outcomes.

Elisabeth Stoddard's examination of "normal accidents" in North Carolina's swine industry, the section's strongest chapter, emphasizes that "accidents are built into today's complex industrial systems, making them 'normal' or expected" (137). Hog production in North Carolina, second only to Iowa in the United States, is concentrated in floodplains near poor communities of color. The governor and state legislators have created a series of laws allowing for the likelihood of "normal" accidents with devastating environmental and health consequences to occur and, when they do, shielding industry from blame. Based on solid scholarship and careful analysis of legislation and specific "normal" accidents, the well-written jargon-free chapter argues powerfully that "these so-called accidents are produced by the intentional tolerance of risk built into the state's neoliberal governance reforms" (137).

Part 3, "Biopolitics, Knowledge, and the Materialism of Meat," lacks clear focus or direction. Its first chapter, chronicling the making of a premium heritage breed—Piedmontese cattle—though an interesting case study, suffers from poor copyediting and a tendency to lose readers in its details, problems that appear elsewhere in the volume. Lewis Halloway's chapter examines the newest form of livestock breeding, called "geneticization," framing his analysis in terms of Foucault's notion of biopower and examining the consequences for both the breeders and the animals ensnared in today's meat production system.

Cattle have been demonized as a major source of greenhouse gas emissions, most notably in *Livestock's Long Shadow*. The authors of the chapter titled "Cows, Climate, and the Media" combine actor-network theory with framing theory to examine the arcs of "story networks" of livestock-related articles in the *Los Angeles Times* from 1999 to 2010, which focused most commonly on human health, followed in frequency by animal welfare, environmental impacts, business and technology, and workers' rights and safety, with climate change taking up the rear. I was surprised by the infrequency of stories related to climate (5%), but not by the paucity of stories on worker welfare (7%). The chapter is an exemplary analysis of the political ecology of knowledge, both in media and in science, and shows the value of actor-network and framing theory.

Growing public concern for the welfare of farmed animals is manifested in Connie Johnston's examination of the trajectories of efforts to improve farm animal welfare in the United States and European Union, using the concepts of bare ("animals . . . literally brought into existence as bare, material life to be killed" [232]) versus social life of Georgio Agamben and Foucault's biopower. Farmed animals occupy a liminal space between bare and social life. Even though animals were born and raised to be killed, these writers' claim of moral and legal obligations on the part of citizens and governments in the European Union and the United States is increasingly recognized.

Closely aligned with the animal welfare movement have been efforts by vegetarians and vegans to convince others to reduce or eliminate meat consumption. But how do antimeat proponents construct convincing arguments? Harvey Neo interrogated this question in interviews with key members of the Vegetarian Society of Singapore. Arguments are made either as "emotional appeals" to the heart (animal rights and welfare) or "factual appeals" to the head (health and environmental benefits). His informants, recognizing that moral arguments based on animal rights were not always successful, emphasized health and environmental benefits of a meatless diet. Yet they continue to "struggle to come up with meaningful narratives that inform and persuade the public about doing the right thing" (246).

The book's final part deals with "The Governance of Meat Production Systems." Halal meat must be produced according to Islamic rules for slaughtering animals, which may preclude stunning prior to death, as required under humane slaughter laws. Several European countries have banned religious slaughter without stunning on the grounds that animal rights come before religious rights. Islam does allow stunning if it does not lead to death, and in the United Kingdom, with its rapidly growing Muslim population, halal slaughter with and without stunning is practiced. The coexistence of two

halal slaughter methods raises serious issues for both Muslim and non-Muslim consumers as well as government regulators in the United Kingdom and countries that import its halal meats.

Urban agriculture, growing rapidly in the United States, as evidenced by the popularity of "backyard chickens," has a long tradition in Hong Kong, including pig farming. Recent outbreaks of severe acute respiratory syndrome (SARS) and avian flu have led its government to adopt new regulations and initiate a program to buy back licenses of current pig farmers. The government's manipulation of public fears all but eradicated urban animal agriculture and the businesses that supported it.

Sustainability, a much ballyhooed notion, is both contentious and too often co-opted by corporations wishing to drape their questionable practices in its green mantle. Such is the case for the Global Roundtable on Sustainable Beef, formally launched in 2012 with the stated goal of reducing the social, economic, and environmental impacts of beef production. Founding members include not only the World Wildlife Fund, the Nature Conservancy, and the Rainforest Alliance, but also Cargill, JBS, McDonald's, Merck, and Walmart. How could such an unholy alliance reduce beef's environmental hoofprint? Adrienne Johnson turns to the well-established Roundtable on Sustainable Palm Oil for possible answers, concluding that such arrangements "obscure the environmental and social effects of resource production while reinforcing and justifying the perpetuation of the capitalist agro-production chain" (291–92).

In contrast to Big Beef's efforts to cloak itself in the glow of sustainability, New Zealand has recognized the real threat of climate change and is pursuing workable policies to regulate greenhouse gas emissions by including agricultural emissions in its national greenhouse gas mitigation plan. New Zealand is the first country to establish mandatory regulations on greenhouse gas produced by livestock. They have yet to be implemented, however, and livestock producers oppose such regulation for fear it will force them to cut production. New Zealand farmers, like farmers everywhere, "experience climate as annual and seasonal variations in weather rather than regional expressions of anthropogenic climate change" (323). And there, as Christopher Rosin and Mark Cooper's excellent chapter makes clear, is the rub.

Livestock's hoofprint has gotten lots of attention, but fish is the flesh protein that holds the greatest promise for global growth, largely because it has the best feed-conversion ratio—less than two pounds of feed for every pound of gain (compared to a ratio of about 10-to-1 for cattle). In fact, 2012 saw farmed fish surpass both beef and wild-caught fish for the first time (329). In their review of aquaculture in the United States, Paula Daniels and Colleen McKinney present an informative table showing state-by-state governance of aquaculture and case studies of three states with different regulatory approaches.

Emel and Neo conclude their volume by claiming that we are all abused by the current system of industrial meat production—farmed animals, those who raise and turn them into meat, and those who consume their flesh. None of the actors in industrial meat production are blameless, except the animals, of course. But they let corporate owners and consumers off with little more than a slap on the wrist.

Political Ecologies of Meat leaves readers with a new awareness of the broad scope of flesh production and how it intertwines with climate change. But there is no central message, other than that the livestock revolution has many villains and no real solutions, at least none that are readily apparent. While the editors are ambitious and their volume's coverage is wide-ranging, several key concerns are largely ignored. For example, industry concentration and vertical integration are only tangentially discussed in a few chapters. The collection also suffers from poor copyediting and tedious academic phrasing.

The books reviewed here, and many before them, expose what has gone wrong with our current system of industrial meat production. How, then, is the system to be repaired? That solutions are difficult to conceive and implement is evident in the chapters in *Political Ecologies of Meat* dealing with the governance of meat production. The complexities of the problems and the conflicting interests of various actors in the chain of meat production and consumption are evident even at the local level; national and international efforts are all the more daunting. While several chapters of *Political Ecologies of Meat* analyze current or emergent social policy, neither the editors nor any of the contributors make much of an effort to look for solutions. Political ecology examines power relations and the social, economic, and the cultural interactions they generate. Is that all political ecologists owe their readers? I don't think so, but then academic researchers are much better at identifying problems than crafting solutions.

What then of journalists? *The Chain*'s mission is also to expose, condemn, and thereby inspire reform. But Genoways is skeptical: "today, it seems that we are not so much concerned with safety as promoting the illusion

of safety. We feel assured that we are protected from illness, when, in fact, the real illness is the pretense that we, as Americans, must collectively agree upon in order to maintain the mirage of safe food, a safe workplace, well-treated livestock, a healthy environment, a strong economy, and a coherent and equitable culture" (261). Like Upton Sinclair, he has aimed at America's heart, and he knows he will probably miss—as have so many other investigative journalists and social scientists before him. But he seems even more pessimistic than most. As long as Americans want only the mirage of safe and healthy food, neither they nor their government will demand anything more. I fear he is right.

Neither *Defending Beef* nor *Cowed* pays much attention to those who produce our meat and dairy; their primary concern is how to replace the "factory farms" of industrial beef and dairy production with sustainable alternatives better for the environment, farmers, local communities, and our health. Denis and Gail Boyer Hayes say "Americans should eat much less beef and what we eat should be of higher quality and produced in a more humane, sustainable manner" (163). Not a particularly original proposal. But they take a more radical approach when asserting the United States must cut its cattle herd in half, with the remainder raised organically and fed and finished on grass. The national herd, they state, now stands at 93 million head, already down from 140 million in the mid-1970s. They favor an American Prairie Preserve in the Great Plains, modeled on Frank and Deborah Popper's notion of a buffalo commons (254–55), but don't seem to recognize—or care—that between 1980 and 2009, the number of beef cattle operations in the United States fell by more than 40%, leaving most production in the hands of large operators (Stull and Broadway 2013, 16). Small cow-calf operators are being run out of business. Who will be left to raise what remains of America's cattle? How will the Hayeses accomplish their goal? It must occur gradually, they admit, and will depend on you and me cutting our beef consumption in half. If we eat only half the beef we do now, we'll need only half the cattle. Simple, or so they imagine.

Nicolette Hahn Niman is both the only self-identified vegetarian and animal producer among the authors of these works. "I don't urge people to eat meat," she says. "But for those who do, I encourage them to seek meat that is well raised. At the same time, I don't consider abandoning meat an effective strategy for positively affecting the food system. Instead, I believe the most important thing a consumer can do to change the way meat is produced is to *buy meat* from well-raised animals" (239, emphasis in the original). And for her, that means the Niman Ranch way—grass-fed, organic, branded—an approach pioneered by her husband, Bill. Although her book is peppered with plugs for Niman Ranch, she has several concrete recommendations that, if adopted, would definitely improve US meat and how it is produced: improve grazing management; stop killing primary predators; stop nontherapeutic use of antibiotics and other drugs in animal agriculture; stop using growth hormones; stop slaughtering cattle under two years of age; stop long-distance transport; improve slaughter practices. If adopted, these recommendations wouldn't solve all the problems of Big Beef, but they would clearly make things better for the animals and those who eat them.

"Avoiding Farmaggedon is easy," Philip Lymbery tells us (353), after spending 330-odd pages describing the worldwide food system in apocalyptic terms. Citing United Nations estimates that the world's food supply needs to increase by 70% to 100% by 2050 (a figure some question), we can abandon factory farming by raising ruminants on pasture, not in sheds; feed fish to people, not livestock; feed food waste to poultry and swine; invest in waste reduction; eat less meat, and only high-quality meat when we do; and produce food from mixed farms of crops and animals to enhance soil sustainability (336–42). Good ideas, all, but what can the individual eater do? "Compassionate consumerism is a great way to choose wonderful food and save the world from Farmaggedon . . . : buy foods from the land—reared on farms, not factories; love leftovers, so as to reduce food waste; and choose a balanced diet without eating too much food" (346).

"Industrial meat" is the product of many actors—from growers to consumers, from processors to retailers, from multinational corporations to unauthorized immigrant workers. Each of the works reviewed here deals in some way with one or more of these actors. All agree the system that produces industrial meat is broken and in need of dramatic reform. Some of the authors have specific recommendations, and all ultimately call on eaters to change their ways. If we don't demand reforms and support them with our food choices, nothing will change. But this has all been said before, many times, by many people.

These books are but the latest volley in what Tim Lang and Michael Heasman (2004) call the food wars, a fight between the dominant paradigm, which is based

on corporate agriculture and oligopolistic food industries, and an emerging alternative integrated-ecological paradigm, in which food is produced locally, naturally, and sustainably on family farms. Consumer demand for organic and "natural" foods is rapidly growing. Supermarkets are stocking more local and regional foods and selling grass-fed, free-range, and antibiotic-free meat. Restaurant chains are responding to public demand for hormone- and antibiotic-free "natural" foods. Farmers' markets are ubiquitous, community-supported agriculture (CSAs), once an oddity, are now commonplace. Even Walmart offers a wide range of organic products. Nevertheless, this alternative paradigm, what Michael Pollan (2006) calls the "pastoral food chain," represents a small, if growing, segment of the total food market—one largely supported by eaters who can afford to pay premium prices. Local, organic, free-range, and grass-fed food sources are neither cheap nor convenient. And price and convenience remain prime considerations when Americans shop for food.

These critiques come amid the livestock revolution, as increasing disposable income, population growth, and urbanization fuel a worldwide surge in demand for meat and other animal products. Meat consumption may be leveling off in developed nations, but in many of the world's poorest countries, meat consumption is rapidly rising.

Wendell Berry began his 1989 essay on "The Pleasures of Eating" with the now-famous "proposition that eating is an agricultural act" (227). A decade later, Warren Belasco (1999, 32) described food as a "digestible ideology." The works reviewed here all argue, in one way or another, that eating is not only an agricultural act but a cultural and a moral act as well. They maintain that industrial meat is the product of a culture dominated by multinational corporations, whose thirst for profits and market share mistreats animals, degrades the environment, and threatens the health of those who produce, process, and consume its product. These authors sound a clarion call for eaters everywhere to take up their forks and become foot soldiers in the food wars, to fight with their shopping lists for meat that is moral and healthy—and tastes better to boot. The food wars will certainly be long, the outcomes in doubt. One thing, however, is certain: there will be many more books like the ones reviewed here.

Don D. Stull, professor emeritus of anthropology at the University of Kansas, is the author, with Michael Broadway, of *Slaughterhouse Blues: The Meat and Poultry Industry in North America* and coeditor of *Any Way You Cut It: Meat Processing and Small-Town America*.

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Book Reviews

The Texas Tortoise: A Natural History. By Francis L. Rose and Frank W. Judd. Norman: University of Oklahoma Press, 2014. vii + 188 pp. Figures, tables, maps, references, index. $39.95 cloth.

The Texas Tortoise covers the life work of Drs. Rose and Judd, who spent much of their scientific careers studying this ancient survivor. It provides a wealth of information on this species but also warns us of its plight. Included are many black-and-white figures and drawings as well as two sets of excellent color photographs. The preface provides insight into the authors' motivation for undertaking this project. In the introduction, I enjoyed reading the history of the early naturalist Jean Louis Berlandier, after whom the tortoise would later be named. In each successive chapter that follows, the authors explain the natural history and biology of the Texas tortoise in a way that readers will enjoy.

Chapter 1 not only describes the relationships between the five currently recognized species of North American tortoises but also explains the complexity of determining a genus and species. Chapter 2 follows with an in-depth description of the species' range and habitat. North American tortoises once traveled throughout the Great Plains of North America during the Pleistocene but are now restricted to more southern habitats. We know little about the species in the southern part of its range in Mexico.

Following chapters discuss aspects of the Texas tortoise's biology and allude to areas that need further research or study. These chapters also cover reproduction, sexual size dimorphism, growth, temperature regulation, and population ecology. The work concludes with a discussion of conservation and the future of the Texas tortoise, which is experiencing the same declines witnessed for turtles and tortoises around the world. I especially enjoyed the way the authors inserted anecdotes from the past.

The book provides a thorough coverage of our understanding of the Texas tortoises but occasionally falls short in its current coverage of more recent literature on North American tortoises. There is some redundancy, but it is limited and does not hinder the flow of the book. That being said, I found its coverage of early foundational papers by early scientists such as Walter Auffenberg to be enlightening.

The authors in some cases express their strong personal opinions regarding aspects of the biology and conservation of the Texas tortoises, which I appreciated. Many of these classic papers are hard to access today in our modern world of electronic literature. From that standpoint alone it is a book anyone interested in tortoises or turtles will want to have in their library. I have thoroughly enjoyed reading the book and know I will find it an important reference in my personal library. *The Texas Tortoise* is a must for anyone interested in tortoises or herpetology.

David C. Rostal
Department of Biology
Georgia Southern University

Beyond the Farm Gate: The Story of a Farm Boy Who Helped Make the Wheat Pool a World-Class Business. By E. K. (Ted) Turner. Regina: University of Regina Press, 2014. ix + 210 pp. Illustrations. $24.95 paper.

Beyond the Farm Gate is an autobiography by E. K. (Ted) Turner, with a focus on the history of farming and the development of farm organizations on the Canadian Prairies. The book's 15 chapters are preceded by an excellent introduction that inspires one to read to the end. The first three chapters describe the personal and social struggles facing new immigrants upon establishing family farms in the province of Saskatchewan. The bold decision to

come to Canada, the challenges in the new country, the dedication to overcome hardships, culminating in triumphs and the establishment of homesteads—all are legendary and represent thousands of settlers in this part of the world at the turn of 20th century. The early part of the 20th century was also notable for the strong cooperation and community-building on the Prairies, related to agrarian political actions on grain trade. These cooperative movements resulted in the creation of the Saskatchewan Wheat Pool.

Chapters 4, 5, and 6 provide a very personal account of the workings of the world's largest grain cooperative and constitute a very important narrative in democracy and political processes. Turner's involvement in the Saskatchewan Wheat Pool started with his becoming a delegate in 1957, continued as elected director in 1960, and culminated in his being president from 1969 to 1987. The most interesting part of the book is Turner's account of the functioning and rapid evolution of the Saskatchewan Wheat Pool from a farmer's cooperative to a complex business enterprise that strove to maintain members' involvement and interest in the organization. Turner describes the pre–World War II farming community on the Prairies as homogenous, with consensus achieved on important policies. Toward the end of the 20th century, the farming community became more heterogeneous and diversified, making it difficult to reach agreement on any major policy.

Chapters 7 through 15 give a personal perspective on issues confronting Canadian and global grain producers when dealing with production, marketing, and global trade. As Saskatchewan Wheat Pool president, Turner actively supported upgrades of the Canadian Wheat Board, a uniquely Canadian establishment. He also represented Canadian farmer interests on several government and international trade committees and commissions. The book provides a very detailed picture of the concerns and issues raised by farmers on the Prairies, and the interpretations—and resolutions—of these concerns by cooperatives and provincial and federal governments.

This book will greatly interest a diverse group of readers because it provides a unique account of the settlement and beginning of agriculture on the Canadian Prairies. The superb work ethic and endurance displayed by the first settlers made the Canadian Prairies a major agricultural producer whose products are traded around the world. The book's uniqueness is its intersection of biography with history, specifically the rise of the Saskatchewan Wheat Pool, created as a farmer cooperative and evolving into a very diverse commercial enterprise. Further illustrating the complexity of the agricultural industry is the author's account of member meetings and discussions within the Saskatchewan Wheat Pool Board, government committees, and international organizations.

Ravindra N. Chibbar
Department of Plant Sciences
University of Saskatchewan

Journeys in Community-Based Research. Edited by Bonnie Jeffery, Isobel M. Findlay, Diane Martz, and Louise Clarke. Regina: University of Regina Press, 2014. vii+ 190 pp. Figures, index. $80.00 paper.

For at least the last half century, scholars have increasingly endeavored, especially among the social sciences, to apply their research in an effort to produce meaningful results. Paralleling the evolution of applied research, studied communities and peoples increasingly demanded not only that the research have some benefit but also that they have greater input in shaping the orientation and direction of the research process. *Journeys in Community-Based Research* is composed of 10 substantive essays, or chapters, celebrating the applied efforts of two research institutes in carrying out community-university research partnerships in an effort to assist vulnerable populations. Overall the work examines the successes and challenges in building meaningful relationships, while translating research efforts into meaningful results.

The volume is organized into three major sections, highlighting several major themes. The first section, "Ethics of Community-Based Research," consists of three chapters addressing the ethical issues researchers faced in the development of university-community partnerships and issues of engagement. The authors struggled with identifying power imbalances, understanding and respecting cultural diversity, using culturally competent practices, and managing research participation, as well as issues of community capacity building. As each essay illustrates, ethical questions are project specific, each with unique challenges and potential solutions. However, as the essays reveal, ethics is a foundation-

al component to the development and continuation of community-university relationships and must be sustained throughout the research process and beyond, especially in advocacy research within community-based research projects.

Section 2, "Advocacy and Community-Based Research," offers two essays on advocate strategies or methods employed in an effort to build relations and community participation. As the authors note, for any degree of success in carrying out community-based research with an advocate orientation, the subject communities must be empowered to contribute to the shaping of research direction, and to remain active and willing participants. To achieve these two goals and overcome the emerging issues, the chapters discuss strategies employed to lessen, if not overcome, major issues of community inclusion in a politically engaged research agenda.

The final section, "Impact of Community-Based Research," is composed of five grounded case studies that highlight the impact of community-based research. It emphasizes critical examinations of a specific topical community-based research endeavor that led to an identifiable change in policy, program, or capacity development in reducing various inequalities among the subject communities. As each chapter illuminates, community-based research projects involve a collaborative approach in which decision making is shared; in reality, different levels of participation exist along a continuum of control. Each essay offers concrete lessons on the challenges and successes of conducting research in a shifting landscape that is action-oriented and directed toward reducing inequalities. It can be achieved through recognition of the importance of values such as self-determination, protection of confidentiality, equal distribution of resources, recognition of power issues, and the promotion of cultural diversity.

In the final analysis, the work illustrates the merging of critical practices with community-based approaches that not only will contribute to positive change at the individual, community, and societal level, but also offer avenues for research design, including the building of method and theory in conducting community-based research. As the introduction and conclusion acknowledge, conducting activist research is filled with contradictions. Such research must embody and invoke the principles of social science while generating data that accurately reflect, as well as impact, the research subjects. *Journeys in Community-Based Research* provides a diverse topical venue that discusses openly the challenges and lessons learned surrounding advocacy research.

Gregory R. Campbell
Department of Anthropology
University of Montana

Historical GIS Research in Canada. Edited by Jennifer Bonnell and Marcel Fortin. Calgary: University of Calgary Press, 2014. vii + 317 pp. Figures, maps, bibliography, index. C$39.95, US$45.95 paper.

Canada has a rich tradition of collaboration between geographers and historians, as evident, for example, in the award-winning *Historical Atlas of Canada*'s three magnificent volumes published between 1987 and 1993. This tradition has recently deepened in profound ways as scholars embrace digital technologies in order to identify and understand the complex relationships among humans and between humans and the rest of the environment. In historical GIS (HGIS) research, mapping has become an analytic tool. In order to support and expand this approach, Jennifer Bonnell and Marcel Fortin, two key figures in HGIS, invited a diverse group of scholars to reflect both on their research process and on their interpretive insights. Along with an excellent introductory chapter, the results of this initiative comprise a compelling volume that will enhance scholarly debate as well as undergraduate and graduate courses. Published in the Canadian History and Environment Series, under the inspired leadership of Alan MacEachern, *Historical GIS Research in Canada* is available in print and open-access form.

This volume will attract a wide readership for multiple reasons. Bonnell and Fortin represent the emerging scholarly partnership between professors and librarians who co-create and pursue research projects in light of complementary abilities. Various chapters reflect the importance of this partnership, particularly on those campuses with institutional support for redefining librarians as active participants in research projects. Secondly, the volume combines attention to the "how" as well as the "what" of the new efforts to study the past systematically in terms of both time and place. The authors describe the challenges and opportunities of collaborative research, including the importance of substantive engagement based on mutual learning.

Moreover, they discuss in helpful detail the value and difficulties of integrating evidence from quite different historical sources, ranging from census enumerations, land records, and newspapers to aerial photographs, forest inventories, and many more. The chapters include examples from Newfoundland to Victoria as well as from micro-historical and pan-Canadian projects that are now benefiting from the availability of geographic frameworks at the census subdivision level. The editors also compiled an appendix listing HGIS studies in Canada, including those focused on the Great Plains, where researchers are reinterpreting not only the meaning of provincial boundaries but also the continental context of the Canadian and American experiences.

While highlighting the encouraging steps forward in Canada and elsewhere, Bonnell and Fortin's volume also implies that digitally enabled, collaborative HGIS initiatives require special effort. Scholars must characteristically overcome institutional legacies of 20th-century scholarship as well as restrictive public policies and continued systemic underfunding in the humanities and social sciences. The availability of new digital tools helps scholars deal with these limitations, but as the authors make clear in this impressive volume, more work is urgently needed to facilitate HGIS.

Chad Gaffield
Department of History
University of Ottawa

Highland Park and River Oaks: The Origins of Garden Suburban Community Planning in Texas. By Cheryl Caldwell Ferguson. Austin: University of Texas Press, 2014. ix + 323 pp. Figures, notes, bibliography, index. $70.00 cloth.

Planned garden suburbs were first conceptualized and implemented in late 18th-century England. The intent of the planned garden suburb was to provide relief for newly arrived residents—mostly wealthy—from less desirable living conditions in high-density urban neighborhoods and city centers. Planned garden suburbs were designed to evoke the pastoral physical environment of villages in the countryside. These suburbs became popular with the advent of the automobile and are characterized by curved streets, generous park areas, thoughtfully designed landscaping, and distinctively designed houses on large lots.

The idea of the planned garden suburb was imported to the United States in the 19th century, and it eventually became an internationally adopted concept in the first two decades of the 20th century. In the United States, there are several important examples of planned garden communities, such as Roland Park in Baltimore (established in 1891), Beverly Hills in Los Angeles (1906), Country Club District in Kansas City (1907), Forest Hills Gardens in Queens, New York (1912), Shaker Heights in Cleveland (1916), and Coral Gables in Miami (1921), among others.

Cheryl Caldwell Ferguson's book focuses on the early 20th-century emergence of planned garden suburbs in Texas, with detailed analysis of Highland Park, today a landlocked 2.2-square-mile municipality surrounded on three sides by the City of Dallas and located just four miles north of downtown Dallas, and River Oaks, a 1.7-square-mile neighborhood located in the center of Houston.

While Dallas and Houston usually are not considered Great Plains cities, Ferguson's research is relevant in the study of Great Plains cities because she also describes the significant influence that Highland Park and River Oaks had upon the development of similar planned garden suburbs and residential areas in other Texas cities, specifically Fort Worth, San Antonio, Wichita Falls, Amarillo, and Corsicana.

Ferguson also points out the important influence of developer J. C. Nichols's Country Club District in Kansas City, Missouri—on the eastern fringe of the Great Plains—as a design precedent and economic model for the development of Highland Park and River Oaks.

The first two of the book's six chapters describe the general context for planning residential communities in Dallas and Houston, followed by three chapters focusing on development of Highland Park and River Oaks. The sixth chapter briefly describes planned garden suburbs in other Texas cities. This handsomely designed book is lavishly illustrated with about 200 high-quality photographs, over half of which are full color.

Using a wealth of primary sources, Ferguson insightfully describes the planning, design, implementation, and financing of these suburbs, including observations about the roles of specific developers, architects, landscape architects, and other key players who created the physical environment of these suburbs. Over 80 single-family homes in these suburbs are described in some detail, most also illustrated with exterior-view color photographs. Photographic reproductions of original floor plans are included for over half these featured houses.

Even though the text meanders somewhat among the themes addressed, this book is a thoroughly researched, unique, and valuable contribution to the history of garden suburban community planning and development in Texas.

Gordon Scholz
Community and Regional Planning Program
University of Nebraska–Lincoln

The Courthouses of Central Texas. By Brantley Hightower. Austin: University of Texas Press, 2015. xiii + 161 pp. Illustrations, figures, notes, bibliography, index. $45.00 cloth.

The Texas county courthouse—there's at least one for each of the state's 254 counties—has been the subject of numerous books. There are courthouse guidebooks, coffee-table books, history books, but surprisingly few academic books. As a courthouse chronicler, I've acquired and read most if not all of them. My contribution to the subject is not a book but a website—www.254texascourthouses.net—where I document each county's courthouse(s) and update them as they're replaced, remodeled, restored, neglected, and, sometimes, demolished.

The Courthouses of Central Texas, published in 2015 by the University of Texas Press, presents a rigorous academic analysis of a select group of 50 courthouses in the somewhat subjective "central" region of Texas. By subjective, I mean that the author, Brantley Hightower, specifically chose 50 counties to represent this so-called central region; there could just as easily have been 49 or 51 counties. Regardless, the 50 courthouses that are the subject of Hightower's book offer excellent examples of the diverse courthouse architecture and squares found throughout Texas. Essentially, the book is, as Hightower writes, "a single snapshot of a specific time in a continuing evolution."

As a practicing architect and teacher, Hightower brings both a pragmatic and a theoretical eye to bear on the Texas courthouse. His systematic documentation of the buildings in two-dimensional drawings of the site plan, figure-ground plans, and exterior elevations reflects the traditional architectural approach to delineating a building. When coupled with Hightower's superb black-and-white photographs, the result is a delightfully fresh and provocative treatment of the subject. With this book, Hightower has raised the bar for scholarly studies of the Texas courthouse.

The Courthouses of Central Texas builds on the work of Robert E. Veselka, whose book *The Courthouse Square in Texas* was published posthumously by the University of Texas Press in 2000. Veselka writes, "The county seat exemplifies one of the more self-conscious expressions of American urban design, both spatially and symbolically." Hightower's emphasis on the Texas courthouse as representative of the collective "id"—the instinctive drives that found public expression in the built form of courthouse and square—places this book firmly in the scholarly tradition of Veselka. As such, *The Courthouses of Central Texas* is an important addition to the literature, especially for students of architecture and urban design.

Interestingly, recent trends in Texas courthouse architecture have diverged in two distinctive, if not exclusive, paths: restoration/preservation of historic structures and expansion/growth of county government utilizing either suburban "big box" or urban high-rise models. The former has been driven by grants funded through the Texas Historic Courthouse Preservation Program. The latter has been driven by the need to create additional space to house multiple courtrooms and related functions in more practical and less traditional courthouse buildings. In this context, *The Courthouses of Central Texas* is a commendable illustration of what Texas architectural historian Willard B. Robinson aptly described in the introduction to his 1983 book, *The People's Architecture: Texas Courthouses, Jails, and Municipal Buildings*, as "architecture as metaphor."

Leonard G. Lane Jr.
American Institute of Architects
Houston, Texas

Texas Lizards: A Field Guide. By Troy D. Hibbitts and Toby J. Hibbitts. Foreword by Laurie J. Vitt. Austin: University of Texas Press, 2015. xi + 331 pp. Illustrations, glossary, bibliography, indexes. $24.95.

As diverse as the 10 ecoregions comprising the vast Texas landscape are the lizards that call it home. *Texas Lizards: A Field Guide* is a 2015 installment of the Texas Natural History Guides from the University of Texas Press. Authors Troy D. and Toby J. Hibbitts's passion for herpetology is palpable with each page turn. Traversing

the High and Rolling Plains of the northern panhandle to the lower Rio Grande Valley, and stretching from the western Trans-Pecos region to the eastern Piney Woods, this field guide is perfect for planning herpetological expeditions and lightweight enough to toss into a backpack.

The first 70 pages offer an overview of the natural history of lizards, followed by a lesson in Texas biogeography. The authors discuss changes to the landscape over the last 200 years due to urbanization, agriculture, and pollution in the context of species diversity. A dichotomous key describes subtle characteristics visible from close range, but it requires binoculars from greater distances and may be distorted in preserved specimens. Rulers printed on the inside cover enhance the practicality of the guide. Informational resources, glossary terms, common and scientific names, and an enlarged map labeling Texas counties are included as appendixes. Missing from this guide are plate drawings that accentuate differences; their absence ultimately prolongs identification. Lack of plates is partially compensated by vivid photographs. With prior knowledge, readers may refer to the *Systematic Accounts* section to identify lizards. Otherwise, flip through the photos, then confirm the identity based on the text.

Several pages are devoted to each species, and content is organized into size, description, similar species, distribution, natural history, reproduction, and comments and conservation, and a rudimentary Texas counties map is included. Range maps are useful for determining which counties to visit or for identifying lizards by county. Two to several photographs depict dorsal patterns and occasionally bellies, sexual dimorphisms, or juvenile forms. Age or sex differences can be found under *Description*, and differentiating species of interest from look-alikes is simple using *Similar Species*. Separate size ranges for both sexes are not provided. Therefore, examining other sexually dimorphic traits may be necessary to determine sex. *Natural History* describes activity periods, diets, and ecoregions. *Distribution* contains geographical ranges and preferred habitat types. *Reproduction* details breeding behavior, clutch sizes, and reproductive mode. The threatened status designated by the Texas Parks and Wildlife Department, governing whether a species can legally be handled or collected, is reported under *Comments and Conservation*.

Student, amateur, and professional herpetologists will find this guide a useful addition to their collections. Local Texans can learn more about species inhabiting their backyards and receive tips for constructing habitat to entice settlers. Professional herpetologists will find information about state laws useful. The introduction contains informative tips for budding herpetologists to facilitate locating, photographing, and safely handling lizards. Lizards are adept escape artists, so these techniques will require practice and patience. As the authors mention, "the first, and only, rule of handling lizards is not to do it unless necessary." Remembering this sage advice is key.

Stephanie M. Campos
Indiana University Bloomington

Why Grow Here: Essays on Edmonton's Gardening History. By Kathryn Chase Merrett. Edmonton: University of Alberta Press, 2015. xi + 307 pp. Illustrations, notes, sources, index. C$34.95, US$34.95, paper.

Ever wonder why we bother to plant petunias or defend our gardens from the ravages of weather, insects, and disease—or why we don't just pave it? Some say we need contact with nature, to participate in ageless, seasonal rhythms. But could it also be an unconscious desire to show kinship with generations of gardeners who created North America's rich horticultural past?

Kathryn Chase Merrett certainly hints at this in these well-written, meticulously researched stand-alone essays that illustrate the long history of what she calls horticultural optimism in Edmonton, Alberta, on the Great Plains' northern edge. She interweaves major horticultural activities and the people who made Edmonton a garden city: from pioneer experimenter Alfred Pike to passionate hybridist Robert Simonet and horticultural activist Gladys Reeves.

Merrett traces a common North American horticultural story: a new settlement concentrates on survival and subsistence first, then slowly on beautification, as civic-minded people by example and charisma entice others to join with them to be, as Merrett calls them, "agents of social change."

Merrett explains how the Prairies were part of the nation-building vision of William Saunders, first director of Canada's influential Experimental Farms System. He urged plant breeders to create hardy edible and ornamental plants that would push horticultural borders ever northward. Merrett skillfully presents the fluid in-

terplay among governments, academia, commercial interests, the media, and individuals working to achieve this goal.

The late 19th- and early 20th-century City Beautiful movement found many champions in Edmonton. To bring this movement to life, which one keen beautifier called "a crusade against ugliness," Merrett focuses on the leaders who formed and led the Edmonton Horticultural Society. She follows them planning and creating public parks and public plantings near town centers, railway lines, schoolhouses and post offices, transforming backyard ash heaps into lawn and flowers, and cultivating vacant debris-strewn lots. Merrett then brings us up to present day with descriptions of current beautification and urban agricultural programs.

What makes Edmonton's story a bit different? I think it is the passionate plant breeders (almost a who's who of northern hybridists) who made it their life's mission to create hardy roses to make Edmonton the "city of roses." Theirs is a tale of dogged perseverance, which for Georges Bugnet paid off in his creation of the "Thérèse Bugnet" rose, still grown in northern gardens.

As well, Merrett puts a face on a group of gardeners who are often invisible in many horticultural histories—immigrant market gardeners. Through in-depth interviews with their descendants, she highlights in amazing detail the stories of Edmonton's early Chinese market gardeners.

Merrett ends by praising citizen gardeners who have influenced, and continue to affect, our urban landscapes. As she notes, these Edmontonians did not view the garden as a private refuge from the world, but as a model for action in it—carried on by a new generation of activist gardeners, reflecting our ongoing interest in nature and the environment, and our enjoyment of the beautiful.

Edwinna von Baeyer
Ottawa, Ontario

The Borderlands of Race: Mexican Segregation in a South Texas Town. By Jennifer R. Nájera. Austin: University of Texas Press, 2015. ix + 177 pp. Photographs, maps, notes, references, index. $45.00 cloth.

In her book *The Borderlands of Race: Mexican Segregation in a South Texas Town*, Jennifer R. Nájera uses evidence from both public education and the Catholic Church to trace the development of what she calls a "culture of Mexican segregation" in La Feria, a small South Texas town on the United States–Mexico border. Her historical ethnography traces the development chronologically through the 20th century. She concludes that despite the advances in breaking down the culture of segregation—especially following the social movements of the 1960s and the efforts of Mexican American activists in both the public schools and the Catholic Church—practices of segregation "endured well past the passage of the major civil rights legislation" in La Feria (9). Indeed, it appears to exist today, based on her description of class (if not racial) segregation that she witnessed at high school football games that she attended during her fieldwork, which she describes in the book's epilogue.

Nájera uses primary and secondary sources and oral histories to describe how the culture of Mexican segregation developed over time. The strength of the book is that by doing so, she links "global" or structural and racialized processes at work on the US-Mexico border to the local experiences of La Feria residents with those processes. Since racism is alive and well in the United States (despite popular claims that America is "postracial"), Nájera's finding that a culture of segregation continues to exist in La Feria should not surprise any of her readers. Yet the strength of her work is also a weakness: one wonders if she might have located more archival evidence of La Feria residents' personal experiences in order to more fully substantiate her narrative. Because she relies on the oral testimony of a small number of individuals as evidence of the local and personal impact of segregation, the evidence can seem anecdotal at points. Nevertheless, the personal and quotidian experiences of segregation outlined in the book should be a welcome addition to the literature on race in the US-Mexico borderlands.

Tracy Brown
Central Michigan University

Dam Projects and the Growth of American Archaeology: The River Basin Surveys and the Interagency Archaeological Salvage Program. Edited by Kimball M. Banks and Jon S. Czaplicki. Walnut Creek, CA: Left Coast Press, 2014. 318 pp. Figures, tables, references, index. $79.00 cloth.

Dam Projects and the Growth of American Archaeology is an educational read and a welcome look at the two most influential federal programs in American archaeology: the Interagency Archaeological Salvage Program (IASP) and the River Basin Surveys (RBS). Editors Kimball M. Banks and Jon S. Czaplicki hit their mark in wanting to understand the impacts of these two programs.

In the introduction, the editors clearly state their two goals for this book. First, they want to bring attention to the activities of the IASP and RBS, and second, they want to understand how these programs have affected the discipline of archaeology. The book is clearly laid out in a five-part format, and the chapters, although connected, read fairly independently.

This book is purposeful and fills a void in contemporary understanding of the roles of the IASP-RBS. It can readily play a role in many courses, especially within classrooms in the Great Plains. Further, the book clearly makes a point that needs repeating: much research still needs to be done on many of the collections recovered under these programs.

One of the main strengths of the work, due to the efforts of the editors, is its comprehensiveness. The first part provides a background of the programs and various connections to other organizations (universities, state agencies, etc.). The second part includes chapters written about each region IASP-RBS operated in. The third part looks at paleontology and a few of the subfields that received major contributions from IASP-RBS, and the many eminent researchers who made careers around these programs. The fourth part provides perspectives on two of the lesser-considered communities impacted by IASP-RBS. The book wraps up with some firsthand reflections on IASP-RBS and the many ways these two programs have impacted the field of archaeology today.

The number of perspectives collected in itself illuminates the impact of IASP-RBS: the list of contributors is a who's who of seasoned professionals and stakeholders. Readers can expect to find out just how impactful the post–World War II preservation legislation was on the field of archaeology. You may be surprised to learn that well into the 1950s, women couldn't ride in a state-owned vehicle in Kansas. You can also read firsthand how damaging these large-scale dam projects were to sovereign nations located along the Missouri River.

My critiques are few. With 16 semi-independent chapters, the reader can expect some overlap in background and context development of each chapter. The redundancy is not much of a hurdle, and it underscores the use of much of this compilation in educational settings. The book as a whole does require some interest in and understanding of archaeology and, to a limited extent, paleontology. While students, advocates, and professional archaeologists will be able to connect to the book in its entirety, it may have less appeal to the lay reader. The final, and least significant, critique is of the cover art.

From the seen-it-all, done-it-all professional to the first-year student, *Dam Projects* will create a greater understanding and needed appreciation for the significance of the Interagency Archaeological Salvage Program and the River Basin Surveys.

Brennan J. Dolan
Cultural Resources Management Division
Iowa Department of Transportation

Midwest Maize: How Corn Shaped the US Heartland. By Cynthia Clampitt. Champaign: University of Illinois Press, 2015. xi + 288 pp. Figures, notes, bibliography, index. $19.95 paper.

Many of us would never imagine the impact of a single grain crop upon a nation. But grains shaped empires and civilizations. Clampitt documents corn's role in the Midwest. I've worked and lived with corn all my life, but from this book I still gained a new understanding and appreciation of its importance in developing and sustaining this country.

Clampitt writes with clear, mostly nonscientific, creative language. The discussion of corn's origin and domestication, as well as transportation's role in providing vital linkages between cities and farmers, provide readers with new insight. Descriptions of the stockyards brought back vivid memories of Dad trucking livestock to Chicago's Union Stock Yards and our visits there when we sold cattle. The stockyards' insatiable demand for livestock and the grain to feed them spurred more grain production and the transportation system to deliver it!

The book includes the history of corn management and the role of mechanization. Some clarification is needed in a section on hand harvesting: Clampitt suggests that multiple harvests of field corn were necessary since plants ripened differently. In reality, my 90-year-old Dad reports, a single harvest occurred when all *field* corn ears were mature. One was necessary because wagons pulled by mules knocked over corn plants as they rolled through the fields. But, indeed, *sweet* corn was often harvested as the author suggests. I easily can forgive this and the one or two other small discrepancies.

Chapters on food, feed, and alternative uses provide interesting history and present application. One chapter even includes corn recipes and their history. I'll leave that to better cooks to read and to enjoy!

Clampitt documents the work done by people such as Mendel, Hopkins, East, Shull, Funk, and Wallace, among others, which led to or promoted corn hybridization. She sheds light on the impact of publications like the *Prairie Farmer* and *Wallace's Farmer* as well as the impact that land-grant colleges had on farmers: they provided knowledge that farmers needed in order to improve farm productivity. Add to this histories on soil testing, fertilization, and weed and pest control, and you have a book that well summarizes the history of Midwest corn production.

Clampitt does not shy away from topics such as transgenic, genetically modified corn, organic production, grass-fed versus corn-fed beef, among other of today's controversies. The book provides balanced reporting on these issues.

In addition to covering the subject superbly, Clampitt meticulously cites her sources in the text. Notes for each chapter lead readers to her original sources and more information. A seemingly complete index rounds it out.

Clampitt displays a knack of blending history, poetry, science, personal interviews, illustrations, and literature together in a way that kept my interest and compelled continued reading. It's an excellent resource for anyone interested in the Midwest. Historians, farmers, agribusiness people, professors, scientists, extension professionals, students—high school through graduate school—and, yes, those gifted with kitchen skills, will find this interesting.

Roger Elmore
Department of Agronomy and Horticulture
University of Nebraska–Lincoln

From Treaty Peoples to Treaty Nation: A Road Map for All Canadians. By Greg Poelzer and Ken S. Coates. Vancouver: University of British Columbia Press, 2015. vii + 324 pp. References and further reading, index. $37.95 cloth.

To understand the Great Plains as a region from the ground up, one should start, arguably, with the environment: the soil, the plants and animals, mountains and rivers, geographies and climates—the things that define it as a place. Beyond that, a firm understanding of its indigenous peoples should rank next. Unfortunately, this is one of the most routinely overlooked, underresearched, and misunderstood aspects of Great Plains history, experience, and contemporary living. This is true both north and south of the United States–Canadian border. For the Canadian Great Plains, issues of aboriginal homelands, pre- and postcontact migrations, involvement in European economic enterprise such as the fur trade, and reactions to Euro-Canadian expansion, war- and treaty-making, and continued presence in the region are all deeply woven into the historical contexts that explain modern-day realities. The Canadian Prairie Provinces cannot be divorced from their aboriginal roots. Indeed, this goes for the whole of Canada. In this light, the contemporary state of affairs in Canada grapples with the histories of European–First Nations interactions, and persisting problems within the same. According to Greg Poelzer and Ken S. Coates, Canada is made of treaty peoples (both aboriginal and nonaboriginal) and should be a treaty nation. It is, however, struggling to be such.

Surveying history and present, Poelzer and Coates attempt to explain the countless reasons for failures of Canada's people to live up to its treaty-bound relationships. Their coverage is impressively broad and complex. This is not casual reading and not for the faint of heart. It asks Canadians of all background to rise above hundreds of years of intense betrayal, insult, violence, and disagreement in order to chart a path forward together. They offer three keys for reform: providing honor and status for aboriginal peoples in state and society; empowering aboriginal peoples in government; and expanding economic opportunity to give aboriginal peoples equal footing with other Canadians (xx). Divided into four parts, their text offers aboriginal and nonaboriginal perspectives on historical problems, current affairs, and possible futures, stories of success, and various policy ideas and regimes that could provide the frame-

work for further fruitful development. A fair amount of diversity is represented, in terms of geography and the wide difference in aboriginal experiences and current issues. One lacking perspective relevant to the Great Plains is the unique status of Métis peoples. A robust dialog with new scholarship by the likes of Chris Andersen (University of Alberta) or Adam Gaudry (University of Saskatchewan) would certainly enrich the debates raised by Poelzer and Coates.

In the end, that is the greatest value of this volume. It seeks to force productive debate, not fruitless finger-pointing and rancor. Whether or not it succeeds in doing so for Canada remains to be seen. Whether the United States, including the many indigenous peoples in the Great Plains, takes notice and begins more meaningful discussions of Americans as "Treaty Peoples" and a "Treaty Nation" likewise remains unclear. As a region with strong indigenous history and presence, these are debates worth having—on both sides of the border.

Brenden W. Rensink
Charles Redd Center for Western Studies
Brigham Young University

A Naturalist's Guide to the Texas Hill Country. By Mark Gustafson. College Station: Texas A&M University Press, 2015. vii + 339 pp. Illustrations, references, index. $24.95 cloth.

Author Mark Gustafson remarks in the introduction of his book that the Hill Country is perhaps the best-loved region of Texas. It is a crossroads region of cultures, plants, and animals from the bordering ecoregions of South Texas brush country, western arid lands of the Trans-Pecos, and northern prairies of the Rolling Plains. The region's distinctiveness derives from its unique geology and topography, producing picturesque hills, canyons, and a multitude of perennial spring-fed rivers.

Because of these influences, the flora and fauna of the Texas Hill Country are rich and diverse. With 430 species of birds alone, choosing representatives from any of the wildlife categories (woody plants, flowers, grasses, birds, mammals, reptiles, amphibians, fish, and invertebrates) presents a daunting task to any author preparing a guide for this region. In this effort, I find the author has included species that characterize and reflect the diversity of the region, are taxonomically varied, and range from the abundant and obvious to the obscure. Importantly, species of conservation concern, such as the black-capped vireo, Cagle's map turtle, and Texas horned lizard, are among the listed species. Also, I find the inclusion of nonindigenous (exotic and, in some cases, invasive) species to be refreshing. Many guides to wildlife and plants ignore these ecologically important species.

In addition to the wild flora and fauna, this guide contains a wealth of information on geology, topography, and cultural aspects of the Hill Country. With simple and straightforward discussions on limestone karst, granite of the Llano Uplift, streams, rivers, and aquifers, Gustafson conveys the region's complex geological history. Added to this is the human cultural element, which has impacted plants and animals beginning with Paleoindians and historical native tribes such as the Apaches and Comanches, and stretching to European settlers and their modern descendants. The inclusion of brief, basic descriptions of selected state parks and recreational areas is a nice touch that helps to familiarize readers with Hill Country nature.

Along with the many positives of this book, there are missed opportunities. Some of the species' narratives are mystifyingly short. The addition of a sentence or two could have provided interesting natural history or conservation information. For example, facts about ecological problems created by nonindigenous and invasive species are generally lacking. However, additional information can be found through listed references to detailed species accounts.

This nicely produced volume with a wealth of vivid photographs is not a traditional "field guide" for identification of wild plant and animal species through distinguishing characteristics and distributions. This guide will find its best use by accompanying the target audience of amateur naturalists exploring the Texas Hill Country and offering glimpses and descriptions of the region's exceptional beauty.

Thomas R. Simpson
Department of Biology
Texas State University, San Marcos

The Hogeye Clovis Cache. By Michael R. Waters and Thomas A. Jennings. College Station: Texas A&M University Press, 2015. xiii + 149 pp. References, index. $30.00 cloth.

Caching is a well-known Clovis trait in the Great Plains. Lithic assemblages in these caches vary considerably. The Hogeye Clovis cache, consisting of 52 bifaces (37

displaced by quarrying in 2003, plus 15 recovered in 2010, also from disturbed contexts), is distinctive in consisting only of late-stage bifaces and projectile-point preforms, all of Edwards chert. The find site, circumstances of discovery, descriptions of the bifaces, and analyses of the cache are detailed. Conclusions and discussions address Clovis bifacial technology and caching behavior.

The locality, a 3-meter-deep commercial sandpit at the southern tip of the midgrass plains, is in Bastrop County, Texas. Investigations in 2010 inferred the predisturbance context of the cache at the base of the sand and indicated a Late Pleistocene age. The 52 cache pieces likely represent most of the original cache. Some pieces were broken by quarry operations. Missing fragments show that recovery efforts were not completely successful.

Both faces and longitudinal profile of each of these items, plus a finished Clovis point found in the quarry in 1993, are illustrated with color photographs and line drawings. Text and tables present technological details. Two groups are identified: 47 projectile-point trajectory bifaces and five ovate bifaces. These data are assessed and summarized for size, shape, thinning techniques, flaking patterns, and chert sourcing, leading to a comparison of the Hogeye Clovis with selected data from one area of the Gault site, 75 kilometers to the northwest.

This report affords another strong refutation of recent claims that overshot flaking in Clovis was accidental. Of 52 Hogeye preforms, 26 exhibit a total of at least 50 successful, controlled overshot flake scars. A good discussion of caching functions is presented, and Hogeye is inferred to be an insurance cache. The monograph ends with a whimsical, imaginary "just so" story of the people who secreted this cache.

In spite of its several strong points, I offer caveats to anyone reading this book. It is suggested (132–33) that this cache may have been made on chert from the vicinity of the Gault site and possibly manufactured in Area 8 of the Gault site. This is based in part on a 2011 preliminary chert-sourcing analysis of six Hogeye bifaces (HC4, 5, 6, 28, 30, and 39) by Charles Speer. Speer's subsequent, more reliable analyses (pers. comm. December 13, 2015) no longer support this specific inference and, therefore, undermine details of several interpretations and conclusions.

Certain claims are simply exaggerated. Comparisons of Hogeye are made only with the Gault site Clovis assemblage from Area 8 (132–44) and rely upon only 11 bifaces (of 336 from the entire site), and upon published data on 33 projectile points (of 40). Statements of the significance of these comparisons (such as Hogeye filling a gap in Clovis preform reduction [132] or the observation that Clovis knappers generally ceased removal of overshot and overface flakes prior to the final stage of point production [135]) are new in the narrow realm of Gault and Hogeye assemblages, but not in the broader universe of Clovis assemblages. Thus the "expanded understanding of Clovis biface production" (137) is limited. These overstatements, however, do not detract from the fact that this is an excellent report on an extraordinary addition to our data on Clovis caching.

Michael B. Collins
Department of Anthropology
Texas State University, San Marcos

Old Man's Playing Ground: Gaming and Trade on the Plains/Plateau Frontier. By Gabriel M. Yanicki. Gatineau: Canadian Museum of History and the University of Ottawa Press, 2014. xvii + 277 pp. Tables, figures, reference cited. C$65.00 paper.

Just as the intersection of the topographic, environmental, and cultural regions of Plains and Plateau provide the physical focal point for Gabriel Yanicki's study in *Old Man's Playing Ground: Gaming and Trade on the Plains/Plateau Frontier*, so, too, does he deftly employ this framework to highlight the interfacing of history, ethnography, archaeology, and environmental studies as essential strands in the reconstruction of past practices and events. Yanicki has undertaken to locate a site along the Old Man River at a place called The Gap in southern Alberta at the frontier of the Plains and the Interior Plateau. Using the only written account of the site, a journal entry of December 31, 1792, by young Hudson Bay Company surveyor Peter Fidler as a starting point, Yanicki attempts to verify the site's location and substantiate its importance as a gathering place for trading and social interaction between the Piikáni and Ktunaxa and other First Nations. *Old Man's Playing Ground* takes the reader step by step through Yanicki's journey and process of accumulating, comparing, testing, and evaluating various strands of historical, ethnographic, and archaeological evidence to corroborate the descriptions of gaming and gambling provided in Fidler's account.

While the use of every available source of informa-

tion is the sign of a thorough and conscientious archaeologist, what immediately sets Yanicki apart from many archaeologists of Native North America is his explicit and sincere concern for the respectful centering of this work on the First Nations peoples to whom it applies. In his preface, Yanicki explains how he uses self-referential group names for First Nations peoples rather than Anglicized names and provides notation guidelines for the ethnographic interviews that appear throughout the text as essential primary evidence. Yanicki attempts to decolonize the archaeology of Old Man's Playing Ground by using Native terminology and names, and through emphasizing and demonstrating its importance as a gathering place for intertribal interactions, remaining a vital site of cultural memory and identity despite no longer being accessible.

Old Man's Playing Ground: Gaming and Trade on the Plains/Plateau Frontier is essentially divided into three sections: historical, environmental, and archaeological. Chapters 1 and 2 provide historical background, including Native stories of Old Man and sense of place; ethnohistories of the hoop-and-arrow game associated with the Playing Ground (variations of which are found all across the Plains); and European accounts of the area and interactions with the First Nations peoples of the Plains and Interior Plateau. The extent and thoroughness of Yanicki's historical and ethnographic research is quite remarkable—he searches well beyond The Gap to document and understand the far-reaching interactions of trade and custom between The Gap's inhabitants and those from as far away as the Yellowstone River in southern Montana. Chapter 3 switches to a more scientific exploration of environmental data to establish what impact past hydraulic environmental events could have had on the Old Man's Playing Ground site. Although this chapter has a decided shift from historical to scientific evidence, the historical source descriptions continue to guide Yanicki's exploration and evaluation. Chapters 4 and 5 provide the archaeological meat of the book. Whereas the first three chapters can be easily understood and enjoyed by lay readers, the next two read more like a highly detailed archaeology site report. While perhaps difficult for nonarchaeologists to fully comprehend, the meticulous recording of process, methodology, results, artifacts, and interpretation of two possible sites related to Old Man's Playing Ground provide archaeologists with solid data and confidence in Yanicki's conclusions. I commend this book for its refreshing combination of profound cultural respectfulness and its detailed scholarship.

C. Riley Augé
Department of Anthropology
University of Montana

Kansas Wildflowers and Weeds. By Michael John Haddock, Craig C. Freeman, and Janét Bare. Lawrence: University Press of Kansas, 2015. vii + 517 pp. Illustrations, map, works cited, index. $39.95 cloth.

I ordered a copy of *Kansas Wildflowers and Weeds* as soon as it became available from the University Press of Kansas. I have long treasured my copy of the book's predecessor, *Wildflowers and Weeds of Kansas* (published in 1979), and was excited to see this new book. It did not disappoint.

Kansas Wildflowers and Weeds is a big book, in more ways than one. Its large size, 12 inches (30 centimeters) tall and nine inches (23 centimeters) wide, makes it more of a desktop reference than a guide you would take to the field. But the large format allows for the coverage of a lot of species and a wealth of photographs. The book has descriptions of 1,163 species, slightly more than half the native and naturalized vascular plants of Kansas, and features 742 color photographs. The price, $39.95, is very reasonable for such an authoritative, comprehensive, well-illustrated book.

The content of *Kansas Wildflowers and Weeds* reflects the latest scientific understanding of the plant life of the state and the most up-to-date nomenclature. Collectively, the authors have many decades of firsthand experience with the flora of Kansas, imparting authenticity and authority to the text.

The book begins with a helpful overview of the climate and physiographic regions of Kansas. This is followed by a series of identification keys to guide the reader to the family in which a plant in question is classified. Additional keys at the family and genus levels help the reader determine the actual species of the plant.

For each of the species covered, the authors provide the necessary descriptive information along with a summary of ecological associations and areas of distribution within Kansas. One unique feature is the inclusion of a coefficient of conservatism ranking for each species, a value of 0 to 10 that estimates a species' fidelity with natural communities such as prairies and woodlands.

Interesting ethnobotanical information is also provided where relevant.

The photography consists mostly of closeup images of flowers or images of flower clusters (inflorescences). Almost entirely the work of the two senior authors, the high-quality photos are not only helpful for identification purposes but also make the book a pleasure for casual browsing.

Janét Bare's 1979 *Wildflowers and Weeds of Kansas* is acknowledged as the starting point for *Kansas Wildflowers and Weeds*. The new book covers 332 more species and incorporates knowledge of biogeography and ecology gained from an additional four decades of field study across the state. The only element lacking in the new book is the fascinating information on pollination biology woven by Bare into many of her species descriptions. My recommendation: order the new book and start searching for a used copy of the older one!

While *Kansas Wildflowers and Weeds* is a must-have for Kansas botanists, resource managers, horticulturists, and native plant enthusiasts, most of the species profiled range well beyond the state's borders, making it a valuable and important resource for much of the Great Plains.

James H. Locklear
Lauritzen Gardens
Omaha, Nebraska

Ancestral Mounds: Vitality and Volatility of Native America. By Jay Miller. Foreword by Alfred Berryhill. Lincoln: University of Nebraska Press, 2015. ix + 187 pp. Figures, illustrations, notes, bibliography, index. $55.00 cloth.

Mounds and earthworks are scattered across a significant portion of North America, built by many groups of people for time immemorial. They have been observed in various shapes and sizes and their purpose speculated on for the last several hundred years. Although archeologists have understood the physical characteristics of mounds in terms of stratigraphy, solar alignment(s), and the landscape context of their placement, it has been difficult to understand their full meanings and roles within the ritual realm. In this volume, Jay Miller seeks to explain that mounds are much more than piles of dirt on the earth. In the first paragraph of his analysis, Miller asks the reader to consider mounds as "a steady microcosm of the dynamic world." He introduces the reader to the idea that mounds are living, practically breathing, and serve to weigh down the world and keep the earth's skin in place, thereby keeping its inhabitants safe. Mounds are also representative of and contributing to the earth's vitality.

Perhaps one of the more important things Miller does in this volume is challenge us to think of mounds as continual and ongoing, and be conscious of the fact that mound building as a cultural practice continues today. It is the modern use of mounds that truly informs the past; in the preface, he argues for looking to today's mound builders, who were forcibly removed from the southeast of North America to Oklahoma some 200 years ago, to truly grasp what mound building was and is. To set the stage for the rest of the analysis, Miller spends chapter 1 describing mounds' dynamism, which gives them place within the spiritual and ritual realm of Native groups. This treatment truly underscores the lack of understanding mound researchers have been able to achieve by failing to consider modern ethnographic examples of mound building. It was this chapter I found most fascinating; Miller provides a full, colorful, and dynamic picture of how mounds are active participants in the world, even though their physical mass is what has captivated most researchers.

In chapter 2, Miller describes several tribal and historic perspectives that delve into the physical act of mound building, discussing placement, burials, and construction. Chapter 3 provides historical context for the transport of mound-building culture from the southeast to the Great Plains, as the great confederacies well established in the southeast were removed to the west. Chapter 4 is where Miller brings the context established in previous chapters to the present day, wherein he discusses the Creek Green Corn Ceremony, the Seminole Busk, and other historical accounts of the world-renewal ceremonies that revitalize mounds and their internal central fire. Chapter 5, aptly titled "Mounds in Full," reminds us of the vibrancy and vitality that mounds contain and direct back to the world.

In my early reading of Miller's volume, I was initially discouraged. He is correct in saying that archeologists and other researchers have misunderstood mounds and failed to consider fully the context that modern ethnographic examples can provide, but it seemed loaded and antagonistic. As I continued on, though, Miller's rich descriptions, layering of historical and modern perspectives, and holistic viewpoint of mounds made clear that what he really seeks is collaboration and understanding.

That made for an enjoyable and informative read, one that will stay with me.

Erin C. Dempsey
National Park Service,
Midwest Archeological Center
Lincoln, Nebraska

In Cold Storage: Sex and Murder on the Plains. By James W. Hewitt. Lincoln: University of Nebraska Press, 2015. vii + 132 pp. Illustrations. $16.95 cloth.

This book explores a rare occurrence in small rural towns: sensational, widely publicized crime. The author sets out to examine a particularly sensational murder that occurred in McCook, Nebraska, in the 1970s. Hewitt begins by establishing a clear picture of what life was like in a rural Nebraska community in the early to mid-1900s. The context in which the offenders and their victims lived is critical to understanding the events that later unfolded. After detailing the context of life on the plains, Hewitt explains that in 1973 Edwin and Wilma Hoyt disappeared from their farm. The author explores the fear this created in a rural community, the impact of the local media, and how family and neighbors coped with stress and suspicion. Ultimately, this small community learned that this was not simply a missing persons' case, but a double homicide. The homicide was discovered when the dismembered portions of the Hoyts' bodies floated to the surface of the local lake. Hewitt discusses how news of this brutal crime seems to have dominated the surrounding communities and shaped residents lives and behaviors.

Hewitt researched the case by exploring existing legal records associated with the case as well as local newspaper reports. He interviewed a variety of residents and families of both the victims and offenders who were familiar with the McCook area and the case. Further, he conducted an interview with Harold Nokes, the man who was ultimately convicted of committing both murders and remains incarcerated in Lincoln, Nebraska. Nokes's wife and possible accomplice was also contacted by the author, though she refused his requests for an interview. To set the scene, Hewitt describes the background and life events of the offenders, the victims, and many of their family members. He spends a significant portion of the early chapters describing the sexual practices of the victims' (potentially mentally ill) daughter and her past relationship with the offenders. This seems to have been of particular interest to the crime's initial investigators as well.

The book concludes with a discussion of Hewitt's more recent interview with Nokes. The author explores alternative assignments of responsibility for the murders and highlights various discrepancies between Nokes's current description of the crime and the original confession and investigation. Whether these discrepancies result from the passage of time and the failing memory of an elderly inmate or instead reflect deceptions and inaccuracies in the original investigation cannot be concretely established. Hewitt highlights the fact that a number of crucial questions were never answered in the course of the original investigation. It should be noted that any conclusions appear to be largely based on the author's own assumptions and speculations.

However, the book could certainly have significant pedagogical value, particularly in criminal justice classrooms. For instance, it allows for exploration of the impact of changes in Nebraska's justice system. It could provide a valuable opportunity for students to critically explore how police practice, investigation, forensics, oversight, and judicial practice have changed throughout Nebraska's history. The book would also allow for discussion of the impact of changing social norms on criminal investigation.

Timbre Wulf-Ludden
Department of Criminal Justice
University of Nebraska at Kearney

Winter's Hawk: Red-tails on the Southern Plains. By Jim Lish. Norman: University of Oklahoma Press, 2015. xi + 163 pp. Illustrations, map, references, index. $24.95 paper.

Approximately 15 miles northwest of Rochester, New York, the southern shore of Lake Ontario bends slightly to the southeast near Braddock Bay before continuing its eastward expanse toward Sodus Point. This innocuous feature on the map is unlikely to give anyone pause for thought, but for a red-tail hawk traversing the shoreline, a pause is exactly what this geographical twist demands. Carried by the southwest winds that develop during the warming days of early summer, thousands

of juvenile red-tailed hawks are pushed to the northeast from their Ohio Valley nesting grounds and then funneled into Braddock Bay as the cold Lake Ontario waters shut down the thermals that the hawks rely on for their migration. For naturalists and researchers, Braddock Bay's geographical location makes it one of the prime locations in North America to observe the mass migration of a variety of raptor species.

As a biologist studying red-tailed hawks, I have had the great fortune of having access to the natural treasure that exists along the shores of Lake Ontario. While my tenure observing and studying this raptor has spanned the last 10 years, this pales in comparison to the more than 50 years that Jim Lish has spent observing red-tails on the tallgrass prairies of Oklahoma. Like western New York, the Southern Plains are a unique geographical destination for a mass migration of red-tails moving along a flyway that stretches from Alaska and Canada, south along the Great Plains, and into Mexico. Every winter, red-tail hawks migrate south, often pushed along Arctic fronts sweeping out of Canada, to winter in the Southern Plains. Lish's observations, focused primarily in his home state of Oklahoma, include some of the highest densities of wintering red-tailed hawks ever reported. Observers traveling through portions of western Oklahoma during peak months may find wintering red-tails in densities of one per mile.

Lish combines basic biology with classic natural history and nature writing to engage the reader in a story that is both entertaining and educational. His passion for *Buteo*, and the depth of experience he has gained through years of observation and study, drive a narrative that will appeal to a broad audience. Scholars of natural history will at times recognize a style similar to the works of Aldo Leopold, and a structure resembling many classic 19th-century works. The hand-drawn color plates of a classic natural history work have been replaced here by over 180 color photographs that capture the characteristics and behavior of North America's most abundant hawk species. While some of the most engaging photographs include hawks posing on a variety of perch substrates, Lish clearly understands the need to utilize underside views of the raptors in flight—a view most commonly experienced in the field and used to identify birds of prey. A two-page, scaled, side-by-side comparison of 24 adult and juvenile red-tailed hawks of various races is a highlight of the text, and is at the core of a lengthy discussion of the variation that exists within Oklahoma's wintering population. *Winter's Hawk* is a must-read for anyone interested in red-tailed hawks, but it will appeal to all readers with an interest in ornithology, nature photography, and natural history.

James A. Hewlett
Department of Science and Technology
Finger Lakes Community College
Canandaigua, New York

As Far as the Eye Could Reach: Accounts of Animals along the Santa Fe Trail, 1821–1880. By Phyllis S. Morgan. Foreword by Marc Simmons. Illustrated by Ronald Kil. Norman: University of Oklahoma Press, 2015. xi + 218 pp. Illustrations, map, notes, bibliography, index. $19.95 paper.

In *As Far as the Eye Could Reach*, Phyllis S. Morgan presents a series of essays—most published previously in the journals *Wagon Tracks* or *Reptiles*—on human encounters with wild and domesticated animals along the Santa Fe Trail in the mid-19th century. In each of the book's 13 chapters, Morgan integrates firsthand narratives of Euro-American travelers with diverse secondary sources, yielding informative, yet concise, descriptions of emblematic species of the American West—from bison to burros—and the ways in which people perceived and interacted with them over space and time.

Through these narratives, the reader is invited to experience the diversity of emotions associated with animal encounters on the trail: awe at the sight of immense herds and perhaps regret of their indiscriminate slaughter, fear at the sound of nighttime howling and close encounters with predators, amusement in the observation of barking and scurrying in prairie-dog towns, relief in the return of a lost mule or ox, remorse at the death of a loyal dog, and so on. Although historical, geographical, ecological, and environmental literature often focuses on the transformative effects Euro-American resettlement had on North American species and ecosystems, accounts like these illustrate how species affected resettlement.

The referenced firsthand accounts cover an impressively broad spatial extent (present-day Franklin, Missouri, to Santa Fe, New Mexico), as well as a relatively long time period (1821–1880), both of which correspond with peak human use of the trail. Adjoined to these species-specific observations are complementary

descriptions from Native American perspectives, arrays of life-history information, estimates of population dynamics, and conservation prospects for the future. This additional information does not detract from the historical focus of the work, but rather builds a bridge between North American landscape conditions of the past (what they were), present (what they are), and future (what they could be). In this sense, these essays may be viewed as tributes to the species—whether currently common, rare, or extirpated—that once thrived in, and continue to shape, people's perceptions of the country in the vicinity of the Santa Fe Trail. Furthermore, they may be useful for spurring broader discussions related to human-wildlife interactions in contemporary landscapes—now often referred to as social-ecological systems—being altered by global change.

This book is suitable for a variety of audiences, including those with interests in Euro-American resettlement of the American West, historical geographic distributions of species, adventure stories, land-use and land-cover change, historical modes of transportation, and the like. The casual reader will appreciate the organization of the book by species, the straightforward presentation of facts, and the fine storytelling. Although it may constitute a general overview for the more detail-oriented researcher, the wealth of references provide avenues for further in-depth investigations.

Daniel R. Uden
Nebraska Cooperative Fish and
Wildlife Research Unit
School of Natural Resources
University of Nebraska–Lincoln

Still Turning: A History of Aermotor Windmills. By Christopher G. Gillis. Foreword by T. Lindsay Baker. College Station: Texas A&M University Press, 2015. ix + 271 pp. Illustrations, notes, glossary, bibliography, index. $35.00 cloth.

When I greet visitors at the Windmill Museum, they are amazed at the variety of windmills on display. Well over 100 different wooden and metal windmills tell the story of companies seeking to design and build a dependable water-pumping windmill. I always ask them, "What three things settled the West?" Responses vary, but the real answer is "Guns, windmills, and the pickup truck." That always draws a hearty laugh. Christopher Gillis has taken the windmill part of that question and produced a well-researched book describing the most successful metal windmill ever made. Following the enormous popularity of the Eclipse wooden water-pumping windmill, the Aermotor Company of Chicago manufactured a highly engineered wind machine that captured the entire world's market for windmills.

Gillis's very readable book is filled with details on how this remarkable machine was conceived, built, and sold by the hundreds of thousands. The Aermotor Company succeeded by taking a wheel designed by engineer Charles Perry and making a durable, efficient, and beautiful windmill that really could not be improved upon. It was just like reinventing the hammer: you couldn't make it any better. Perry's "mathematical wheel" is still working today. It's not hard to take the wheel that is on an 1890 Aermotor and, with slight modifications, put it on a new Aermotor. It will work just like it did over 100 years ago.

Everyone likes windmills. Their images show up in advertising and artwork, and most western towns use them for their promotions. Wooden windmills like the Eclipse have disappeared from daily use, and what everyone sees today standing in the field is almost always an Aermotor. It is amazing how many of these were sold and are still being sold, although in greatly diminished numbers.

With clear explanations, pictures, and drawings on the internal parts of a windmill, Gillis gives the reader an understanding of how these sturdy wind machines work, along with a detailed history of Aermotor's beginning by two unique men, entrepreneur Lavern Noyes and his trusty engineer, Thomas Perry. The culmination of their efforts was the 702 model Aermotor, the very best of the water-pumping windmills. They are still made today, and the history of that story is well worth reading.

Coy F. Harris
American Wind Power Center
Lubbock, Texas

Fog at Hillingdon. By David K. Langdon. Introduction by Rick Bass. College Station: Texas A&M University Press, 2015. ix + 130 pp. Illustrations, notes, bibliography. $35.00 cloth.

Fog at Hillingdon is David K. Langford's second book with Texas A&M University Press after the masterful *Hillingdon Ranch: Four Seasons, Six Generations* (2013).

That great and dense book, coauthored with writer Lorie Woodward Cantu, documents a year at Langford's 13,000-acre family ranch on the southern edge of the Texas Great Plains. With Langford's photographs and Cantu's writing, *Hillingdon Ranch: Four Seasons, Six Generations* provides the reader with access to the life, work, dedication, and traditions of a ruggedly elegant Texas Hill Country ranch. The new book, *Fog at Hillingdon,* is like a palliative encore after a powerful concert: short, sweet, and less intense. All the pictures in this new book contain expressions of fog on Langford's family ranch and are accompanied by a literary quotation.

Langford is a Texas nature and wildlife photographer who held the position of executive vice president of the Texas Wildlife Association for 12 years. He is a man dedicated to the health and conservation of the Texas landscape. What is it about fog that attracts him? Fog is apparently uncommon in the Texas Hill County. For a photographer, fog modulates the light, making it diffuse and at times momentarily magical. Langford writes in the preface about the transitory nature and transformative quality of fog. These pictures are Langford's meditative enjoyment of the moment of his favorite places.

In the introduction to the book, Rick Bass writes of emotional connections and meaningful memories that fog inspires. Fog, like our sense of smell, can connect us in potent and unexpected ways to our past. Fog also calls our mind to the present. Fog is moisture dancing in the air. Fog moves up and down the hills and valleys, manipulating and directing the light from above. It is here for a moment and then changes, and therefore demands our mind to be present, and in that way fog can encourage us more attentive to the moment. Fog is also like a fresh snow. It simplifies and abstracts the landscape, and reveals the forms and structures of the land.

The best pictures in Langford's *Fog at Hillingdon* express with light the intimate connections of moisture with earth and sky, and the magic of the life that they create. The goal of conservation is to protect and maintain the natural environments that sustain us and our fellow creatures on earth. It is difficult and likely endless work. These pictures remind us why that work is worthwhile, and provide a transcendental moment of enjoyment.

William Sutton
Department of Fine and Performing Arts
Regis College
Denver, Colorado

Roots of our Renewal: Ethnobotany and Cherokee Environmental Governance. By Clint Carroll. Minneapolis: University of Minnesota Press, 2015. ix + 227 pp. Figures, maps, notes, bibliography, index. $25.00 paper.

In *Roots of Our Renewal*, Clint Carroll does a masterful job of interconnecting many different and complex threads across culture, history, politics, social relationships, plants, and land. A Cherokee citizen himself, Carroll tells the story of his own experiences and insights in relation to an ethnobotany project he initiated under the guidance of elders and tribal leaders. The project was developed over a period of years, and was intended to renew and highlight the community's and young people's knowledge of medicinal and other kinds of plants with cultural significance. Far beyond the project itself, however, the book is about the sacredness of land-based knowledge and its centrality to the lives of Cherokee and other Indigenous peoples. It is a story about tensions, injustices, and clashes between different groups of people—Indigenous people, government officials, ranchers, industrial developers—and, most particularly, about Cherokee approaches to displacement, stewardship, and management of lands and resources in the American Great Plains. And it is a story about tenacity, visionary leadership, tribal sovereignty, and resilience.

In the late 1830s, as described in the book, many Cherokee people were forcibly evicted from their homelands in the mountains and valleys of the southern Appalachians, to be relocated west of the Mississippi following a traumatic and devastating forced march of over 800 miles—the "Trail of Tears"—in which thousands perished from hunger, exposure, and disease. The new lands in Oklahoma were completely different in vegetation and topography, yet using the same wisdom and ingenuity that Indigenous peoples across North America have shown since time immemorial, they adapted to their new land and its resources. Their ability to recognize both poor and effective leadership in the face of each crisis, and to take advantage of their own energy and rich cultural heritage, gave them the capacity to seize opportunities, to continue to develop their own culture, and to maintain their identity as Cherokee people.

The book is divided into seven easily read segments, starting with an informative introduction on Indigenous environmental governance and associated knowledge. Five numbered chapters follow, the first describing the early Cherokee people before most of their commu-

nities were forced to move to Oklahoma. The second tells how the western Cherokee, once displaced, were able to settle in their new lands and adapt themselves to different species and environments. The third chapter describes the environmental devastation of the Oklahoma dust bowl and its impacts on the Cherokee. Fourth is a chapter on Cherokee ethnobotany and relationships to plant medicines and the plant world, followed by a chapter on the sacred relationship the Cherokee have with their lands, and how this plays out in the governance of their territory. Finally, the conclusion provides insights and reflections on the role of ethnobotany in cultural continuity and renewal.

Although the book is about an ethnobotanical project that was initiated and eventually supported by Cherokee elders, leaders, and knowledge holders, it is really about much more. It fits firmly in the area of political ecology, because it provides the context and background for the ethnobotany project, which is really a project to support Cherokee environmental governance, their right to their lands and to manage their own resources. In a sense, this is a universal account—of cultural displacement, prejudice, racism, inequity, and environmental loss, on the one hand, and about community, caring, cooperation, respect, and determination on the other.

As an ethnobotanist who has worked with Indigenous knowledge holders and plants in the Pacific Northwest, but with little direct knowledge of the American Great Plains or of Cherokee history and culture, I found Carroll's account informative and fascinating. My experiences are mirrored in his: "As a tool, ethnobotany can help American Indian people arrive at desired outcomes. In the case of the Cherokee Nation ethnobotany project, these outcomes amount to no less than the maintenance of our relationships with, and responsibilities towards, each other and the nonhuman world. Thus tribally led ethnobotany . . . is much more than 'science': It entails attending to relationships, which make up the center of many indigenous ontologies" (137–38).

Nancy J. Turner
School of Environmental Studies
University of Victoria
Victoria, British Columbia

Jewels of the Plains: Wildflowers of the Great Plains Grasslands and Hills. By Claude A. Barr. Edited by James H. Locklear. Minneapolis: University of Minnesota Press, 2015. ix + 296 pp. Illustrations, maps, bibliography, index, scientific index. $27.95 cloth.

Twenty-five years ago I planted a small wildflower garden in front of my prairie home. It was meant to be an alternative to grass, which had to be mowed and watered. It has matured into a lovely little piece of prairie. Soon I was collecting grocery bags of Missouri evening primrose seedpods and smaller quantities of other seeds, which were given to others. When I started a "restoration" project on five acres of previously plowed ground, this little garden became a good source of native seed. It is easy for me to see how Claude Barr's wildflower garden became a source of income and inspiration.

In 1994 my husband and I returned from working abroad to our home in the Flint Hills of Kansas. I immersed myself into the prairie around my house, learning as much as I could about the native plants, animals, and geology. One of the first books I purchased was *Jewels of the Great Plains*. It was not a field guide you could slip into your pocket, but the rich stories and descriptions were inspiring. I decided to write about my experiences wandering the tallgrass prairie. A sample of my stories was sent off to a publisher. It was turned down. I put Claude Barr's book away and went on to other things. Now the opportunity has arisen to renew the joy of my 1994 reading in this revised edition.

Claude Barr was a true "plants man." His generation and the generations before him abounded with men scouring the globe for plants of agricultural and horticultural value. While others traveled the world, Claude did what he could on limited resources. He stayed "home" in the Great Plains of North America. His love for the land is obvious in this description of the Kansas-Colorado border: "The distant view has a lonely, quieting effect, bringing a sense of things as they ought to be and a wonderment that any portion of the earth's surface could be so perfect."

Barr was an intelligent and educated man. He turned down an opportunity to pursue graduate study at Harvard to help his parents survive on the farm in South Dakota. Self-educated in the botany and geology of the region, Barr presents his list of topographical features in order "to depict novel and attractive characteristics of the region, as well as to correct the common concept of the Great Plains as a featureless expanse." Chapter 1

describes the land from Saskatchewan to the High Plains of Texas, including the Llano Estacado. Interestingly, he explains the Llano Estacado without mentioning the legacy of Spanish exploration of the Great Plains.

His simple explanation of why the central portion of our continent is open prairie is the same as I taught in my role as educator at a biological field station, except that he speaks of the "shortgrass prairie" where drought is the greater enemy of trees than fire. His reiteration of the role water plays in the lives of prairie plants is important for gardeners to respect.

Barr's descriptions of Great Plains native plants, which is the majority of the book, are better than the field guides with their difficult botanical verbiage. For example, the lyrical description of pasqueflower brought back fond memories of my 17 years living in Minnesota. Some species not well known to him nor thriving in his garden have shorter descriptions, less lovingly described. He warns us about the dangers of species that spread (both introduced and native), a problem that has become of major importance today.

James Locklear's introduction and notes, especially the additional comments on other species of garden merit, add value to this edition without interfering with Barr's personal account. I highly recommend this book to gardeners and lovers of wildflowers everywhere.

Valerie F. Wright
Department of Entomology
Konza Prairie Biological Station
Division of Biology, Kansas State University

Wildlife Habitat Conservation: Concepts, Challenges, and Solutions. Edited by Michael L. Morrison and Heather A. Mathewson. Baltimore: Johns Hopkins University Press, 2015. vii + 175 pp. Figures, tables, literature cited, index. $75.00 cloth.

Habitat is a word familiar to elementary school students. It is used by wildlife enthusiasts in such terms as "backyard habitat." It is used widely among natural resource researchers, managers, and educators. However, the target audience of this book is not necessarily those with "habitat" in their vernacular; it is intended for students studying natural resources as well as professional resource managers and researchers.

Habitat is a word used on various spatial scales, from microhabitat to biome. Therein lies some of the problem addressed in this book. Attempts to define precisely habitat and associated terms are largely ineffective. Yet the take-home message is that the term "habitat" needs to be carefully defined.

The real value of the book is in the concepts presented. These range from factors affecting habitat to managing and restoring habitat. The concepts are general and thus broadly applicable. It is not a "how to" book on management.

One of the major concepts, for example, is habitat fragmentation and corridors. Anthropogenic fragmentation results primarily from urban sprawl and conversion of land to agriculture. Consultants, planners, and various managers describe a need for corridors to connect patches of habitat. However, where is the source habitat for colonization of patches? Are the patches large enough to support population persistence? How are the population genetics affected? There is very little research to substantiate the efficacy of corridors. Their requisite width, length, and vegetative composition are largely unknown as they pertain to effective corridors. Of course, those metrics also depend on the species for which the corridor is designed.

Answering these questions is paramount to prairie restoration and management. Tallgrass prairie in many areas exists because of restoration, serendipitous acquisition of patches donated or sold to conservation groups, and preservation of relic patches. It is a major challenge to connect these disparate patches so the network of patches may serve as a functioning prairie.

Another appropriate example that applies to the Great Plains is the situation in which habitat is lost without the actual disappearance of habitat, as when wind turbines are installed. How might species react to noise from the turbines? What impact does increased human activity have on species as the turbines undergo periodic inspections and maintenance? Finally, what is the impact of service roads leading to the turbines? Another anthropogenic factor is light. Lighted buildings attract birds, and millions are killed during migration. Light may influence seasonal activities that are normally synchronized by photoperiodicity.

In all management efforts, well-defined goals and followup studies or long-term monitoring are necessary. This paves the way for implementing adaptive management so that modifications can be made, if necessary, as monitoring progresses.

These are just a few of the items to consider when managing and conserving habitat. In this very worth-

while book, the editors and chapter authors have accomplished the important task of setting forth a path to guide habitat management and conservation.

Ronald M. Case
School of Natural Resources
University of Nebraska–Lincoln

Goodbye Mike, Hello Judge: My Journey for Justice. By Myron H. Bright. Fargo: Institute for Regional Studies Press, 2014. i + 182 pp. Photos, notes, index. $30.00 cloth.

"I'll follow the law when I must do so and when the law is clear. I'll follow the law regardless of my personal views of the results, even if it is an unjust one. But where the law is not quite clear, or in the process of change, I'll look to the precedents and legal reasons that can support a result which I think is just, even if somewhat contrary to existing law. . . . My personal creed is: 'Let justice be done'" (126).

This candid insight into judicial decision-making is courtesy of federal judge Honorable Myron H. Bright, United States Court of Appeals for the Eighth Circuit. With more than 45 years on the bench and still hearing cases in his 90s, Judge Bright is accustomed to speaking his mind, and his autobiography is brimming with anecdotes both personal and professional.

He recounts his childhood in Minnesota's Iron Range and credits the diversity of his hometown mining community with inspiring his commitment to equality and his empathy for outsiders and underdogs. In surprising and sparkling detail, he tells tales of North Dakota and national politics in the 1950s and 1960s, including his role in John F. Kennedy's attendance at a birthday party for Quentin Burdick in Fargo. Judge Bright also imparts what he considers to be his most significant decisions as a judge, including cases impacting employment discrimination, environmental protection, and federal sentencing guidelines.

The thread that runs throughout Judge Bright's accomplished and storied life is his strong connection to people. Most heartfelt is his relationship with his beloved Fritzie, his late wife, who directed her husband to seek a judgeship with the words, "Listen, Myron, I want a live husband, not a dead trial lawyer."

Most telling is his affinity for two people convicted of crimes, James Dean Walker and Dana Deegan. James Dean Walker's is a triumphant story—the successful overturning of an unjust conviction, a victory made sweeter by Walker's surprise appearance at a party for Judge Bright more than 25 years later, the first time they met in person. Dana Deegan's story is a plea for reform; despite Judge Bright's strong disagreement (expressed in a 65-page dissent) with her 10-year sentence for the crime of neonaticide, Deegan remains in federal prison. But for the fact that Deegan is American Indian and her crime occurred on a reservation (thus subjecting her to federal jurisdiction), Judge Bright believes her crime likely would have garnered a sentence of less than three years in state court. Deegan's case represents one of the rare instances in which Judge Bright has not been able to wield his considerable powers of influence and persuasion successfully, and his discomfort with the ongoing injustice in Deegan's case is unmistakable.

In the end, Judge Bright's autobiography provides much more than a glimpse behind the judicial bench. If, as Peggy Noonan says, "candor is a compliment; it implies equality" (*What I Saw at the Revolution*, 1990), then Judge Bright has paid his readers many kudos with his autobiography.

Kathryn R. L. Rand
University of North Dakota School of Law

News and Notes

Award Announcements

Great Plains Research presents two annual awards for the best articles published during a volume year: the Charles E. Bessey Award for natural science and the Leslie Hewes Award for social science. The awards are announced at the annual Fellows Luncheon of the Center for Great Plains Studies and include a cash stipend of $250.

The 2015 Charles E. Bessey Award for best natural science paper in Volume 25 of *Great Plains Research* was awarded to Kevin Gallo and Eric Wood for their paper "Historical Drought Events of the Great Plains Recorded by Native Americans," which appeared in the Fall 2015 issue.

The 2015 Leslie Hewes Award for best social science paper in Volume 25 of *Great Plain Research* was awarded to Christina Dando for her paper "Virtually Constructing a *Great* Plains: Booster Impacts on Plains Viewing," which appeared in the Fall 2015 issue.

Conferences

The **2017 Center for Great Plains Symposium** will be held March 30–31, 2017, at Innovation Campus at the University of Nebraska–Lincoln. The symposium will examine the topic "Flat Places, Deep Identities: Mapping Nebraska and the Great Plains." In part it will commemorate the publication of the *Atlas of the Great Plains* (2011) and anticipate the publication of the *Atlas of Nebraska* (2017).

Why are maps so fascinating? What do they tell us, what assumptions were necessary to construct them, how do they shape our knowledge? The symposium calls for a critical reexamination of maps and the mapping of our region, from earliest historical maps to present digital cartography and remote sensing, from Pawnee star charts to cadastral surveys. This topic is also to be understood figuratively, inviting us to consider the myriad ways in which "maps," "mapping," and "place" shape all aspects of how we see and understand the Great Plains. Thus included in our topic are questions of how place and mapping are used in or influence identity and culture, economy and society, agricultural practices, natural resources, environmental issues, business strategy, art and creative expression, literature of place, social relationships, politics and social movements, "deep mapping," and any other ways in which concepts of mapping and place are revealing and useful. Website: http://www.unl.edu/plains/2017-symposium.

The **Kansas Arborists Association** will hold their 62nd Annual Shadetree Conference January 11–13, 2017, at the Ramada Topeka Downtown Hotel and Convention Center in Topeka, Kansas. Features include Bill Elmendorf and Les Werner leading Wednesday's Advanced Training Workshop and Thursday and Friday sessions led by Peter Gerstenberger, Dr. John Ball, Dr. Raymond Cloyd, Dr. Jason Griffin, and others. Website: http://www.kansasarborist.com/shadetree-conference.html.

The 77th Annual **Midwest Fish and Wildlife Conference** will be held February 5–8, 2017, at the Lincoln Marriott Cornhusker Hotel in Lincoln, Nebraska. This annual event will attract over 800 biologists and students from state, federal, and tribal natural resources agencies from the Midwest, Great Plains, Rocky Mountains, and Canadian provinces. Highlights include over 400 technical presentations, poster displays, plenary sessions, networking opportunities, and social events. Website: http://midwestfw.org/index.html.

The 70th **Society for Range Management Meeting, Technical Training, and Trade Show** will be held January 29–February 2, 2017, in St. George, Utah. The theme of this year's conference is "Red Rock & Rangelands," and it highlights the juxtaposition of spectacular geology and diverse rangelands in the region around St. George. Website: http://rangelands.org/events/.

The 1st **World Conference on Soil and Water Conservation under Global Change (CONSOWA)** will be held June 12–16, 2017, in Lleida, Spain. The conference theme is "Sustainable Life on Earth through Soil and Water Conservation." This is a joint conference of the International Soil Conservation Organization (19th ISCO Conference), the World Association for Soil and Water Conservation (WASWAC), the European Society for Soil Conservation (Eighth ESSC Congress), the International Union of Soil Sciences (IUSS Commissions 3.2, 3.6), the Soil and Water Conservation Society (SWCS), the International Erosion Control Association (IECA), and the World Association for Sedimentation and Erosion Research (WASER) in parallel with the VIII Simposio Nacional sobre Control de la Degradación y Restauración de Suelos (SECS). Website: http://www.consowalleida2017.com.

Join the **Association of American Geographers** at the AAG Annual Meeting at the Hynes Convention Center, Marriott Copley Place, and the Sheraton Boston in Boston, Massachusetts, April 5–9, 2017, for the latest in research and applications in geography, sustainability, and GIScience. The conference will feature more than 6,600 presentations, posters, and workshops by leading scholars, researchers, and educators. Website: www.aag.org/annualmeeting.

Submissions

- All manuscripts must be concise: no more than 7,500 words excluding abstract and reference sections.
- Tables and figures (including maps) must be carefully composed to achieve the author's goal of clarity of presentation.
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- Informational footnotes are not accepted.
- Authors must prepare a separate title page with their name(s) and affiliation(s), and any acknowledgments, which will not be sent to reviewers. The title of the paper must be repeated directly above the abstract.
- Authors must submit manuscripts and all figures and tables via email to gpr@unl.edu.
- If the manuscript is accepted for publication, author(s) will be asked to send the final document as an email attachment in a Word (.docx) file.

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Title. Article titles should not exceed 10 words (or 82 characters) and should not have subtitles.

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Abstract. A short abstract of fewer than 200 words should precede the main text. The abstract should identify the problem addressed in the paper, indicate the methodology, and summarize the results. Authors should prepare an abstract that will be interesting to and understood by nonspecialists in the field. Five to eight key words should accompany the abstract.

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Reference Style. *Great Plains Research* uses *The Chicago Manual of Style*, 16th edition, as its reference guide. The journal uses author-date citations in chronological order in the text [for example: (Smith et al. 1990; Templer 1992; Jones forthcoming)] and a complete reference section that gives author, year, title, source, and page references for journal or newspaper articles. Include page numbers for quotations [for example: (Templer 1992, 45)].

For a journal article:

Murkin, H. R. 1998. "Freshwater Functions and Values of Prairie Wetlands." *Great Plains Research* 8 (1): 3–15.

For a book:

Blouet, B. W., and F. C. Luebke, eds. 1979. *The Great Plains: Environment and Culture*. Lincoln: University of Nebraska Press.

For an article in a book or conference volume:

Wedel, W. R. 1994. "Coronado and Quivira." In *Spain and the Plains*, ed. R. H. Vigil, F. W. Kaye, and J. R. Wunder, 45–66. Niwot: University Press of Colorado.

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Lemuel Berry, Jr., Ph.D.
Executive Director, NAAAS & Affiliates
PO Box 6670
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Telephone: 207/856-2500
Fax: 207/856-2800
Email: naaasconference@naaas.org
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