



BUFFALO BILL CENTER OF THE WEST

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All images of James Prosek's artwork courtesy of the artist and SCHWARTZ • WAJAHAT, NEW YORK.

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Front and back cover: James Prosek. *American Elk (Wyoming)*, 2016. Oil, acrylic and mixed media on wood panel, 56 x 90 in.

Page one: Thomas Moran (American, born England, 1837–1926). *The Grand Canyon of the Yellowstone (detail)*, 1872.

Oil on canvas, 84 x 144 1/4 in. Smithsonian American Art Museum, Lent by the Department of the Interior Museum,

I.1968.84.1 (Full image, page 6). **This page:** Elk on spring migration from the ranches of the Greybull

River, across the Shoshone National Forest, toward Yellowstone National Park,

late May 2015. Photograph © Joe Riis. **Contents page (overleaf):**

A mature bull elk on fall migration, near the boundary of

Yellowstone National Park in the Shoshone National

Forest, October 2014. Photograph © Joe Riis.

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FOREWORD

THOMAS E. LOVEJOY



It was not until I was in my mid-forties that I had the privilege of visiting Yellowstone, but, like most Americans, I had been aware of—and lusted to visit—the national park from a very young age. So when invited to speak at the 1987 annual meeting of the Greater Yellowstone Coalition, not a second passed before I said, “Yes!”

I was invited because of the giant experiment I began in the Amazon in 1979 to study fragments of forest of various sizes left in the course of deforestation. The experiment was designed to resolve a huge debate about habitat fragmentation; we saw almost immediately that major changes had occurred because the fragments were no longer part of continuous forest. Although far away in equatorial South America, the initial results revealed the validity of concerns about fragmentation. Our research may have helped lead to the creation of the Greater Yellowstone Coalition and its ongoing work not only to stem the increasing isolation of the Yellowstone ecosystem, but also to restore connections to a larger wilderness spanning far beyond the park.

This may seem obvious, but in reality habitat fragmentation—and its obverse, habitat connectivity—had only recently been recognized as a major

conservation issue. Those impacts of species loss after species loss spread over time, increment by increment, so that each species disappearance seems idiosyncratic and not part of a larger trend. It took theoretical biology, looking at the question of what determines the number of species on islands, to raise the question: Do the same kinds of considerations apply to islands of habitat created when humans modify landscapes?

In retrospect it seems inevitable that David Quammen (future author of the May 2016 issue of *National Geographic* devoted exclusively to Yellowstone) and I would meet at the Old Faithful Inn’s bar after my 1987 talk. David sought my views about his plan to write a book on island biogeography. I was instantly enthusiastic. What transpired became an eight-year odyssey for him; the result was *The Song of the Dodo*—a triumph of a book that did much to highlight, in general, what the *Invisible Boundaries* project is about.

In 1986, conservation biologist William Newmark applied island biogeographic theory to Yellowstone and predicted a major loss of mammal species if it were to become “isolated” as a virtual habitat island. That highlighted the issue and made connectivity an imperative. The idea of establishing and protecting a corridor of continuous nature from Yellowstone to

Yukon has since gained traction with the public, but the task of maintaining the biological integrity of Yellowstone is much more complicated than that.

Not only do many species (think grizzly bears and wolverines) need to be part of larger populations that extend beyond the park; some species only use the park for part of the year. Elk leave the park for the colder months and are then completely dependent on private lands for their winter range. In a remarkable feat of wildlife biology, Arthur Middleton has traced all the Yellowstone elk migrations. Clearly, to maintain and conserve the elk populations requires conservation while they are outside the park boundaries. This highlights an opportunity for a magnificent public-private partnership to maintain the integrity of Yellowstone and its elk in perpetuity.

But this is not just a problem about elk. Many other species also use the park for only part of the year, including migratory birds, as well as some bat and insect species. Until we truly understand their biological requirements and conservation status, they are elements of Yellowstone under threat.

More than half a century ago, a report to the Secretary of the Interior by wildlife ecologist Starker Leopold laid out the principles for management of the national parks. It has served as a hallowed guide. Two years ago, because of the extent of subsequent environmental change (land use and climate change and more), a “Revisiting Leopold” report was delivered to the Secretary of the Interior. Thoughtfully developed and exquisitely written in only fourteen small pages (like the original report fifty years prior), its purpose is to lay out the basic principles for management of national parks (they could apply equally to all federal and state public lands). The principle of connectivity is prominent in the report’s statement that individual parks should be viewed as conservation anchors in larger conservation landscapes.

This is additionally important because of the obvious and growing impacts of climate change in nature almost everywhere across the globe. Glacier National Park will soon be that in name only. Species are beginning to alter their geographical ranges. Joshua trees are now growing outside of Joshua Tree National Park, for example. The more connectivity there is in the landscape, the more likely species are to make it through the changes wrought by a human-modified climate.

The lesson of *Invisible Boundaries* is that we—and nature with us—are better served by a landscape in which human aspiration is imbedded in nature

rather than one in which nature survives marginally in human-dominated landscapes. That may sound very radical but there are multiple associated benefits. For example, restoring riparian vegetation not only enhances natural connectivity, but also prevents soil erosion and restores water quality. Restoring ecosystems at scale can significantly reduce climate change by pulling CO² back from the atmosphere—after all, living things are built with carbon.

The biology of the planet nurtured the rise of human civilization through multiple direct and indirect benefits. Beyond those, the diversity of life is made up of individual species, each with solutions to a series of biological challenges—any one of which has the potential to transform the life sciences. One of the more recent discoveries is a soil fungus from Nova Scotia that has the capacity to disarm the defenses bacterial superbugs use to resist antibiotics.

The conclusion is we would be wise to embrace nature and respect its natural fabric rather than think, with hubris, that we can dominate it.

This exhibit and this book explain and celebrate the important implications of these invisible boundaries and the multiplicity of links between humans and nature. They do so with the powerful synergy that comes of bringing science and art together, and of the resonance between the scientifically rational approach of Arthur Middleton’s research and the aesthetic achievements of Joe Riis’s photography and James Prosek’s paintings.

It is not surprising that this collaboration is transpiring in and around Yellowstone. An icon since before it was named a park, Yellowstone always has had the capacity to inspire, whether it is experienced in person or by viewing a representation such as Thomas Moran’s spectacular *The Grand Canyon of the Yellowstone* (1872), now in the Smithsonian American Art Museum. That capacity led to the establishment of the world’s first national park. May it similarly lead to a recognition of invisible boundaries and linkages between humanity and nature everywhere.

THOMAS E. LOVEJOY, PH.D. is University Professor of Environmental Science and Public Policy at George Mason University as well as Conservation Fellow at the National Geographic Society and Senior Fellow at the United Nations Foundation. He was the first to use the term “Biological Diversity” in 1980 and a founder of the science of conservation biology. He started the forest fragmentation research program in the Brazilian Amazon in 1978. He and Lee Hannah are just finishing the third book on biodiversity and climate change. He is the founder of the Public Television series *Nature*. He received both his B.S. and Ph.D. in biology at Yale University.

AT THE CROSSROADS OF ART, SCIENCE, AND CONSERVATION IN YELLOWSTONE

KAREN B. MCWHORTER

Though it was not the first government expedition into the Yellowstone region, the party led by Dr. Ferdinand V. Hayden in 1871 was the first to include fine artists in its ranks. Hayden engaged photographer William Henry Jackson, who had accompanied him into the field the year before, to help document the geological wonders of the area. When neither Albert Bierstadt nor Sanford Gifford was able to make the journey, the Northern Pacific Railroad suggested that Hayden allow painter Thomas Moran to accompany him as a guest artist. Hayden consented and Moran excitedly headed west, sketchbook and paint box in hand.

On the trail, Jackson, the photographer, and Moran, the painter, quickly established good rapport, a critical element to any successful collaboration. Historian Thurman Wilkins wrote, “The immediate cooperation between the two began the most effective teamwork between artist and photographer seen in the whole era of the Great Western Surveys.” Moran assisted Jackson with the arduous process of taking photographs in the field and helped select the most compelling vantage points, recognizing the potential benefit of his colleague’s photographs as source material for his planned studio paintings. The painter also frequently served as a model for his colleague, standing next to this geyser or that rock formation (as he does in the photograph on the facing page, top right) to provide a sense of scale. On a July day early in their adventure, Moran recorded in his diary, “Sketched but little but worked hard with the photographer selecting points to be taken &c.”

Theirs was a collegial partnership that turned into a life-long friendship and, working side by side in the western wilderness, they successfully documented the Yellowstone area so that the world might know—might see—its breathtaking sights.

Because of the geological impetus behind Hayden’s mission, the artists focused on geysers, hot springs, mountains, and canyons as principal subjects. During the course of the expedition, Jackson produced hundreds of photographs and Moran compiled a portfolio of delicate field sketches of such features. Back in Washington, Jackson’s crisp black and white photographs and Moran’s atmospheric, jewel-toned watercolors made tangible the awe-inspiring places Hayden and others before him had touted, but of which they couldn’t quite convey the magnitude in words or statistics.

Hayden, Jackson, and Moran joined a chorus of support for acknowledging and protecting Yellowstone’s geological and scenic significance upon their return from the West. Two of the most passionate advocates were Nathaniel P. Langford and Lt. Gustavus C. Doane, members of an 1870 survey of the Yellowstone area led by Gen. Henry D. Washburn. By 1871, Doane had submitted to Congress a detailed account of their expedition and Langford was busily publicizing the wonders he’d witnessed in speeches and articles. Hayden bolstered his predecessors’ advocacy by writing about his own experience, but also by organizing at the U. S. Capitol an exhibition of geological samples, Jackson’s photographs, and Moran’s watercolors. Art historian Thomas Patin has observed that in Hayden’s interdisciplinary display “the watercolor sketches,

photographs, and geological specimens worked in a supportive interrelationship.”

Jackson’s photographs conveyed the distinctive topographical character of the area in sharp detail; Moran’s sketches revealed the vivid, otherworldly palette of Yellowstone and the particular quality of light in the high country of the American West; and the specimens functioned as physical evidence of Yellowstone’s unique geology. Together, the multiple media presented a more holistic view of a truly remarkable region and strengthened the cases of Hayden, Langford, Doane, and many

Right: William Henry Jackson (American, 1843-1942). *White Mountain Hot Spring, Cap of Liberty—Near View*, printed 1874. Alberttype. U.S. Geological Survey of the Territories, Hot Spring Series Plate 9. Image courtesy of Robert Enteen.

Below: Thomas Moran (American, born England, 1837-1926). *Liberty Cap and Clematis Gulch*, 1871. Watercolor (and possibly gouache) and pencil field sketch on paper, 6 7/8 x 10 in. Courtesy of National Park Service, Yellowstone National Park, YELL 8524.





Left: Thomas Moran (American, born England, 1837–1926). *Crystal Fall, Crystal Creek*, 1871. Watercolor (and possibly gouache) and pencil field sketch on light brown paper, 11 x 8 1/8 in. Courtesy of National Park Service, Yellowstone National Park, YELL 8541.
Below: William Henry Jackson (American, 1843-1942). *Crystal Falls, Cascade Creek*, 1871. Albumen print, 25 x 31 1/2 cm. Courtesy of National Park Service, Yellowstone National Park, YELL 50364.

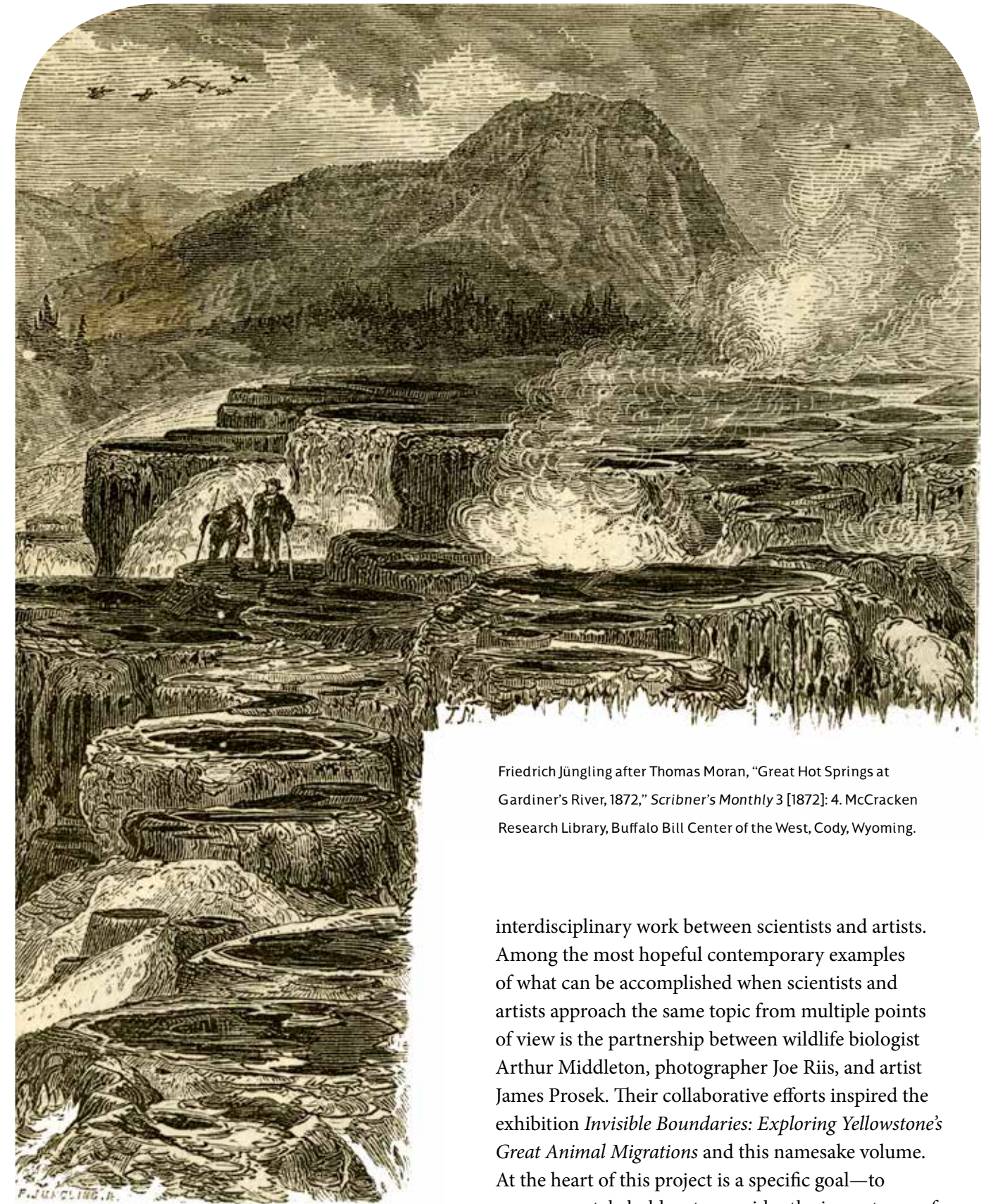


others (including banks and railroads with commercial interests) whose entreaties helped inspire members of Congress to preserve the Yellowstone area as the world's first national park. In 1938, Jackson remarked that "Back in Washington that winter of 1871–72, in the proceedings before Congress for the creation of the Yellowstone National Park, the water colors [sic] of Moran and the photographs of the Geological Survey were the most important exhibits before the committees."

THE POWER OF VISUAL IMAGES, particularly in this chapter of Yellowstone's history (and American conservation history), is undeniable. Hayden's display at the Capitol spoke to both the hearts and minds of congressmen. Moran's sketches tapped the emotional power of color; his prismatic paintings were celebrations of the power and majesty of the western landscape, a uniquely American asset worthy of preserving. Jackson's photographs would have been perceived by most as truthful and unbiased depictions of the Yellowstone area, quelling any doubt that its wonders were real.

It seems Yellowstone had to be seen to be believed. Jackson's and Moran's images helped convince not only Congress, but also the American public, of the region's appeal and importance. Among the first professional images of Yellowstone to reach eastern audiences, they were reproduced in popular magazines (first as woodblock prints and later, in Moran's case, as chromolithographs) and captured the nation's attention. Their powerful visual testimony helped an incredulous public imagine Yellowstone.

THE COMBINATION of scientific inquiry and compelling imagery helped substantiate the *geological and scenic value* of the Yellowstone area in 1872. Since that time, interest in studying and preserving the *biological value* of Yellowstone has continually increased and has encouraged new avenues for



Friedrich Jüngling after Thomas Moran, "Great Hot Springs at Gardiner's River, 1872," *Scribner's Monthly* 3 [1872]: 4. McCracken Research Library, Buffalo Bill Center of the West, Cody, Wyoming.

interdisciplinary work between scientists and artists. Among the most hopeful contemporary examples of what can be accomplished when scientists and artists approach the same topic from multiple points of view is the partnership between wildlife biologist Arthur Middleton, photographer Joe Riis, and artist James Prosek. Their collaborative efforts inspired the exhibition *Invisible Boundaries: Exploring Yellowstone's Great Animal Migrations* and this namesake volume. At the heart of this project is a specific goal—to encourage stakeholders to consider the importance of elk migration in the Greater Yellowstone Ecosystem (GYE)—but it will surely have much broader resonance. *Invisible Boundaries* celebrates the enduring power of partnerships between scientists and artists and helps blur perceived distinctions between their fields.

SO WHAT CAN ART CONTRIBUTE to a conversation about elk migration? Just as Jackson's photographs and Moran's paintings persuasively illustrated Hayden's reports of Yellowstone, so too can contemporary artists' work complement and, indeed, augment, recent scientific findings. Art can narrow the lens through which we see the world, but can also broaden our view immeasurably, extending a conversation from the local to the global. In both ways, art fosters new ways of seeing. Consider the research that drives the *Invisible Boundaries* project: decades' worth of tracking collar data from elk in the Yellowstone region. These data help illuminate when, how, and why elk migrate within (and, as it turns out, well beyond) the national park. Comprising the movements of thousands of elk, it's an impressive, but daunting, set of figures. As Riis and Prosek show, using a visual vocabulary can help make these numbers and the conclusions drawn from them more convincing and reliable.

JOE RIIS is a photojournalist and biologist who has been in the Yellowstone backcountry for the better part of two years, documenting animal migrations. He roams wildlife corridors in the footsteps of the animals he photographs, allowing their daily rhythms to determine

his own. Riis sets up camera traps to capture animal movements remotely and also waits patiently along newly-discovered migration routes to photograph his subjects in person. He has studied mule deer and pronghorn antelope, but for the past three years, he has turned his camera primarily toward elk while working with Middleton on the Greater Yellowstone Migrations (GYM) project, the inspiration behind the *Invisible Boundaries* exhibition and this publication. In recognition of their work on the GYM project, Riis and Middleton were named *National Geographic's* 2016 Adventurers of the Year. The award honors "remarkable achievements in exploration, adventure sports, conservation, or humanitarianism."

For many, even those of us who live on the doorstep of Yellowstone, the concept of annual migrations of elk might be difficult to visualize. With the aid of contemporary technology, Riis helps reveal this little-known facet of Yellowstone's incredible biology. His photographs of elk and their epic journeys, and his images of the expedition team who've undertaken the field research, tell an intimate story that further enlivens the map of Greater Yellowstone elk migrations. Through his photographs, we can better comprehend the scale of elk migration in the GYE and also become acquainted



Left: Self-portrait testing camera trap lighting, June 2015. Riis eventually captured the image shown on pages 52-53 from this location. Photograph © Joe Riis.

Facing, top: Elk descending a high mountain pass on spring migration, late May 2015. Photograph © Joe Riis.

Facing, bottom: Riis in the field, June 2015. Photograph © Jenny Nichols.





Above: Middleton, Jack the Australian Shepherd, and Riis take shelter from a storm on a ledge along the Thorofare Plateau, July 2015. Photograph by Shane Moore. **Facing:** James Prosek. *American Elk*, 2016. Watercolor, gouache, and colored pencil on tea-stained paper, 28 x 30 in.

with individual members of this mass movement. Riis invites us vicariously to stand at his vantage point and look through his camera lens onto some of the most remote terrain in the contiguous United States so as to peer into the life histories of elk, an impressive and iconic species.

Riis's photographs taken from a plane, helicopter, or distant ridge help convey the monumentality of elk migrations in the GYE and underscore the difficulty of the elk's journeys. They allow wide-angle views onto the harsh terrain migrating herds cross annually and

the obstacles they encounter along the way. Natural obstacles range from pulsing rivers that threaten to sweep all but the strongest swimmers downstream, to predation, to treacherous, snow-packed mountain passes. Man-made obstacles include fences, sprawling urbanization, and highways—imposed barriers that migrating herds must surmount to reach summer or winter ranges.

The portraits and documentary film footage Riis takes of individual or small groups of elk help us better relate to these creatures and invite empathy on their

behalf. An investigative nose sniffing a trail camera, the vocalizations of a herd navigating a creek crossing, the percussion of hoof beats on a rocky, high mountain trail—these comprise unique insights into a previously unknown world. His photographs reveal the fragility and strength of elk, their vulnerability and resilience. They have the power to inspire us to care and to better understand our own impact on an increasingly fragmented but ever-important ecosystem.

JAMES PROSEK is an artist, naturalist, and author. If Riis's photographs hone our vision to the harsh realities and incredible moments along elk migration routes in and around Yellowstone, then the paintings of James Prosek extend the conversation beyond the elk's story and push us to imagine the larger implications of human-animal relations in a changing landscape. For the *Invisible Boundaries* project, Prosek turned his eye for detail and steady, expert hand to a diverse cast of characters in the Greater Yellowstone whose lives are inextricably connected. This interconnectedness among

lifeforms—particularly our relationship as humans to the world around us—is central to his work in general, and poignantly applies to this project in particular. In new field sketches, watercolors, and oil paintings the artist encourages us to see the bigger picture and critically analyze our place within it.

At first glance, many of his paintings might remind viewers of carefully-rendered scientific illustrations. Their familiarity derives from Prosek's use of an artistic vocabulary codified by artist-naturalists like Titian Ramsay Peale, John James Audubon, and Olaus J. Murie. Looking to these artists and the field guides they inspired, Prosek often isolates a particular animal or plant from its natural environment, depicting it in exacting detail against a monochromatic backdrop. As in *American Elk*, Prosek might flank a central creature—in this case a single elk—with a selective sampling of plant and animal specimens of a smaller scale, here elephant's head and king's crown sprigs and a western tanager. These species' juxtaposition suggests a relationship between them, and indeed, these three all are endemic to



northwestern Wyoming. His choices of subjects and the way he orders them calls into question the hierarchies and boundaries that we create in our minds between plants and animals, between species, between anything in nature.

Prosek's frequent choice of watercolor, his preferred medium since childhood, is also reminiscent of earlier artist-naturalists. In this way, too, his work evokes associations between watercolor paintings, science, and exploration. Artists historically used watercolors in the field for practical and philosophical reasons. Watercolors are more portable and dry more quickly than oils and were, and continue to be, a popular medium for painting *en plein air* (out of doors). Watercolors can also suggest immediacy and intimacy with one's subject. A personal, one-on-one experience with his subjects has long been an important part of Prosek's process, which is fundamentally informed by close, attentive observations of nature. His desire to study his subjects in their natural habitats has taken him on journeys to remote and

sometimes dangerous places across the globe and, for this project, frequently to the Yellowstone backcountry.

Though Prosek's choice of subject matter, painting style, and penchant for field work may nod to earlier artist-naturalists, his intended message is more provocative than that of his predecessors. He uses traditional representational techniques but moves beyond documentation to tackle contemporary issues, creating works of art that are engaging and often subtly subversive. Thus, Prosek creates stunningly beautiful works of art that offer lessons in environmental consciousness.

Prosek's paintings of wildlife paired with numbers suggest that there exists somewhere a corresponding enumerated list with the animals' names and perhaps more information about them (see the cover image, for example), but this is not the case. He leaves us at loose ends; there's no itemized list of the creatures he portrays. Rather than resolve this conundrum for the viewer, Prosek encourages us to reflect on our



Above: James Prosek. Cactus with Ant, Pitchfork Ranch, 2015. Watercolor, gouache, powdered mica and graphite on paper, 10 x 12 1/4 in.

Facing and below right: Prosek studying local flora and fauna of elk winter range, summer 2015. Photographs © Jenny Nichols.





James Prosek.
American
Bison
(Wyoming),
2014. Oil,
acrylic and
mixed media
on wood
panel, 45 x
56 in.

imposition of clean, orderly systems on a wonderfully messy world. This is a principal theme in Prosek’s work: an examination of our human propensity to name and order the natural world and, as he says, “our prejudices and priorities” in such attempts at classification and control. His paintings often confront the limitations of language in describing Earth’s incredible range of biological diversity. Nature is dynamic and yet we expect that a static system of names and categories can define it. We feel the need to organize nature, to chop it up, and though nature doesn’t lend itself to clearly-drawn lines, we impose them nonetheless.

Here is the common ground between Prosek, the artist, and Middleton, the scientist: both are interested in, as Prosek describes, “what happens when you draw lines in a nature that doesn’t have any lines.” Prosek is intrigued by the conceptual lines we draw between

things in nature, like the divisions we create when we ascribe names and classifications to plants and animals. Middleton is interested in the lines we draw on maps, like the line demarcating Yellowstone National Park and what lies around it. Both Prosek and Middleton are concerned with how these manmade lines affect how we think about and act toward nature.

For the *Invisible Boundaries* project, the protagonists of Prosek’s paintings are regionally-specific species, with starring roles played by Yellowstone’s hooved herbivores including elk and bison, two among the most familiar species of the region. Lesser-known actors in Prosek’s narratives include the western tanager, the rufous hummingbird, and the army cutworm moth, animals we might not readily identify with Yellowstone but which depend on the area as a stopover on their long-distance migrations. Prosek’s inclusion of these

species points to the fact that Yellowstone’s reach extends further than most of us realize. Perhaps elk migrations—though sometimes more than a hundred miles long—might be considered a fairly “local” phenomenon when compared to other species that travel many hundreds or thousands of miles? Prosek’s artwork, more so than documentary photography or scientific research alone, encourages us to think about Yellowstone as an ecosystem that defies its human-imposed borders.

Prosek’s paintings of animal silhouettes, including an original ten-by-ten foot mural of more than five hundred animals created especially for the *Invisible Boundaries* exhibition and reproduced on page 66 of this volume, speak further to the interconnectedness of the natural world. His sampling of plants and animals and their arrangement in couplings, trios, and larger groups suggest relationships between and among them. These silhouette paintings might remind viewers of a puzzle in which the animals should fit together in one pre-determined order but don’t. According to the artist, “We think that by just replacing a missing puzzle piece, like the wolf as apex predator, that the ecosystem will be “OK” again. That may be true to a certain extent but it’s certainly not the whole story. In some ways we have to simplify histories and biological interactions in order to tell a narrative, to communicate, but there is a lot of nuance left behind.”

At the heart of Prosek’s paintings—and indeed at the heart of the *Invisible Boundaries* project—is the idea of connectivity: Yellowstone as connected to surrounding and far-flung environs; Yellowstone’s plant and animal life as connected to and dependent on each other and their human neighbors.

The Hayden Survey of 1871—an early example of scientists and artists working together for the greater good of the Yellowstone area—stands as an important precedent for the *Invisible Boundaries* project. The collaborative, interdisciplinary efforts of Hayden, Jackson, Moran, and many others played an important role in Yellowstone becoming a national park, in the drawing of a roughly square perimeter around interesting geological and geothermal features of the region. Today, we understand that these boundaries encompass not only geological wonders but also biological wonders equally worthy of conservation. In the *Invisible Boundaries* exhibition, namesake publication, and ongoing outreach, art once again lends color and shape to conservation science in Yellowstone. Riis’s documentary photographs and Prosek’s stunning and thoughtful paintings enrich

and invigorate the data compiled by Middleton, proving art’s power to clarify and popularize scientific findings. Taken as a whole, *Invisible Boundaries* reveals the challenges and opportunities in conserving migrating wildlife in Yellowstone and beyond.

KAREN B. MCWHORTER is the Scarlett Curator of Western American Art of the Whitney Western Art Museum at the Buffalo Bill Center of the West. McWhorter was previously in charge of research and publications for the Petrie Institute of Western American Art at the Denver Art Museum. She has contributed essays to *Elevating Western American Art: Developing an Institute in the Cultural Capital of the Rockies* (2012), *A Place in the Sun: The Southwest Paintings of Walter Ufer & E. Martin Hennings* (2015), and *Fur Traders and Rendezvous: The Alfred Jacob Miller Online Catalogue* and has authored numerous articles on contemporary western American art. She received her B.A. at the University of Tennessee, Knoxville and her M.A. at the University of Colorado–Boulder.

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Prosek’s studio, 2016. Photograph courtesy of the artist.



Above: James Prosek. *Bison Cow, Hoodoo Ranch, Wyoming*, 2016. Watercolor, gouache and colored pencil on tea-stained paper, 27 x 30 1/2 in.

Facing page, top: James Prosek. *Late Summer Grasses*, 2015. Watercolor, graphite and gouache on paper, 9 3/4 x 12 in.

Facing page, bottom: James Prosek. *Yellowstone Cutthroat Trout and Indian Paintbrush*, 2015. Watercolor, graphite and gouache on paper. 10 1/4 x 13 in.



CHARLES R. PRESTON

**THE GREATER YELLOWSTONE ECOSYSTEM
WHERE DO WE DRAW THE LINES?**

It was one of those spectacular autumn days in northwestern Wyoming, when the golden aspen leaves and bright ruby rosehip berries contrast so beautifully with the rich green backdrop of mixed conifers. The temperature was mild, alternately warming and cooling slightly as the sun peeked through a broken blanket of lazy, gray clouds. Surprisingly for Wyoming, there was no wind. A few aspen leaves floated through the sky with no particular place to go and no deadline to meet. Armed with fly rod and elk-hair caddis fly, I had been testing the few deep runs remaining this time of year along the north fork of the upper Shoshone River, just outside Yellowstone National Park. Despite the relatively low water, I had caught and released a couple of nice trout and was walking back along the edge of a large meadow toward my car, parked a few miles up the trail.

Ever mindful of grizzly bears in this area, I called out “h-e-e-e-y bear” every few steps and kept my eyes and ears wide open and bear spray close at hand. I felt vulnerable and a little incautious for setting out in this area at this time of year without companions. But no one was available to join me, the day was too perfect, and this would be the last opportunity for me to get any significant time away from my office for several weeks. An American red squirrel announced his discontent at my presence with a series of loud, scolding, vocal rattles and tail flicks as I approached a bend in the trail between meadow and forest.

Suddenly, I heard the thrashing of shrubby willows dead ahead. All I could see through the thick branches and green-and-yellow leaves was a huge, brown, shaggy hide. The big animal was clearly in a frenzy, attacking the willows with a ferocity that quieted even the squirrel. My immediate thought was “angry grizzly,” and my immediate action was to freeze. I was initially relieved to see that the huge body that emerged from the willows was not a bear—it was an adult bull bison. My relief turned to something very close to panic, however, when I realized that this nearly two-thousand-pound behemoth was running straight toward me. I didn’t know how an

angry bison would react to bear spray, but I steadied myself to find out. Fortunately, the big bull veered away from me just before either one of us had the chance to learn what happens when bear spray meets bison.

As he crashed through an opening in the forest, I collected my thoughts and began looking around for what might have inspired the bison’s nasty mood. A small group of hikers was coming down the trail from the opposite direction, talking and laughing softly, enjoying the sights, sounds, and smells of this place. When they saw me they rushed my way and exclaimed with some excitement that one of the “park’s buffaloes” had gotten out of the park, and they had tried unsuccessfully to usher it back toward “where it belonged.”

The group was visiting from central Utah. After explaining how lucky they were not to have been injured or worse, I asked if they knew the exact location of the park boundaries. One of them started to produce a map until I stopped him. I asked if they knew where the boundaries were without looking at the map. When they looked around at each

other and shook their heads, I asked how they thought the bison would have known about the boundaries. We all had a bit of a laugh at that point, but the incident reminded me of how easily human minds grasp the concept of political boundaries even when they are invisible on the landscape. The incident underlined for me one of the great challenges we face in managing and conserving wildlife even in one of the world’s most renowned national parks and wildlife sanctuaries.

Previous pages: Hidden Creek in the Thorofare, near the southeast corner of Yellowstone National Park, August 2014. Many large elk groups from Cody, Dubois, and Jackson winter ranges spend summer grazing on the high plateaus in this region. Photograph © Joe Riis.

Above: Bison migrating outside park boundaries in winter, especially north of Yellowstone, come into conflict with area ranchers who fear the bison will transmit brucellosis to livestock. Photograph by C. R. Preston.

Facing: Some elk that spend summers in Yellowstone National Park overwinter on private lands well outside park boundaries. Photograph by C. R. Preston.



Yellowstone National Park is the world’s first and arguably most famous national park. It was established in 1872 primarily to protect several important physical attributes in the area, including Yellowstone Lake, the Grand Canyon of the Yellowstone, and especially the extensive and varied geothermal features that contain roughly half of all active geysers in the world. The park’s boundaries were drawn to address political considerations and encompass geological and scenic resources, but with little attention to biological resources.

As human development expanded, however, the 2.2 million acres of diverse and relatively intact native landscape became a stronghold and *de facto* refuge for an essentially complete complement of native wildlife species, including bison, elk, grizzly bear, and gray wolf, that once shared a much wider swath of the northern Rocky Mountain region. But Yellowstone National Park alone can neither contain nor sustain many of the most charismatic and wide-ranging species that inhabit the park at least part of each year. Most of the park is located at high elevation and covered with deep snow much of the year. The average elevation of the Yellowstone plateau is greater than 8,000 feet above sea level and

is virtually surrounded by higher mountain ranges, including some peaks of 13,000 feet. Therefore, many species must leave the park seasonally to find available resources in lower elevations. This understanding of the park’s limitations is almost as old as the park itself. U. S. Army General Philip H. Sheridan, a strong advocate for protection of Yellowstone National Park and its wildlife, was among the first to recognize that the boundaries defining Yellowstone National Park did not include adequate habitat to support viable “game” populations throughout the year. In 1882, Sheridan argued that the park should be nearly doubled in size, extended toward the south and east to meet the requirements of migrating elk and other large ungulates.

Daniel Kingman, an Army engineer and lieutenant who helped design the major roadways in Yellowstone National Park, reinforced Sheridan’s sentiments in 1886 when he suggested that the park be expanded to include both the summer and winter ranges of large game animals. Sheridan and others, including *Forest and Stream* Editor-in-Chief George Bird Grinnell and Missouri Senator George Vest, unsuccessfully fought to expand park boundaries to include additional wildlife habitat.

Nonetheless, these efforts to expand national park boundaries set the stage for Congress to eventually designate much of the lands surrounding the park as timberland reserves. In 1891, President Benjamin Harrison issued a proclamation that established the Yellowstone Park Timberland Reserve, and in 1897, President Grover Cleveland established the Teton Forest Reserve south of Yellowstone National Park. These reserves were the precursors of today's national forests, administered by the U. S. Forest Service under the U. S. Department of Agriculture. Their establishment reduced opportunities for private exploitation of public lands surrounding Yellowstone National Park, but even when expanded in subsequent years, they did not include some of the protections of national park lands administered by the National Park Service under the U. S. Department of the Interior. Recognizing the need for further protection for wildlife in 1897, acting Yellowstone Superintendent Colonel S.B.M. Young advocated expanding Yellowstone Park boundaries southward to Jackson Hole specifically to help protect migrating elk. Although Yellowstone National Park was not expanded, Grand Teton National Park was established in the Jackson Hole area in 1929 after many years of conflict and controversy.

Philip Sheridan, Daniel Kingman, and S.B.M. Young were pioneers in recognizing that large, unbroken tracts of appropriate habitat were critical for wide-ranging elk and other wildlife to persist in the Yellowstone–Grand Teton region. They understood that landscapes and wildlife in this broad region were profoundly interconnected, and that ungulate migration routes did not conform to and could not be limited to political boundaries. It was nearly a century later, in the 1970s, when grizzly bear researchers John and Frank C. Craighead coined the term Greater Yellowstone Ecosystem (GYE) to describe a contiguous geographic area including Yellowstone and Grand Teton national parks and surrounding landscapes. Where Sheridan, Kingman, and Young were primarily concerned with migratory elk, the Craigheads drew the boundaries of their GYE to encompass an area of adequate size (more than twice the area of Yellowstone National Park) and habitat resources that would sustain a viable Yellowstone grizzly bear population. As quoted by Seymour Fishbein in National Geographic Society's *Yellowstone Country: The Enduring Wonder*, Frank Craighead described the GYE as "... a unit that includes all the physical, chemical,

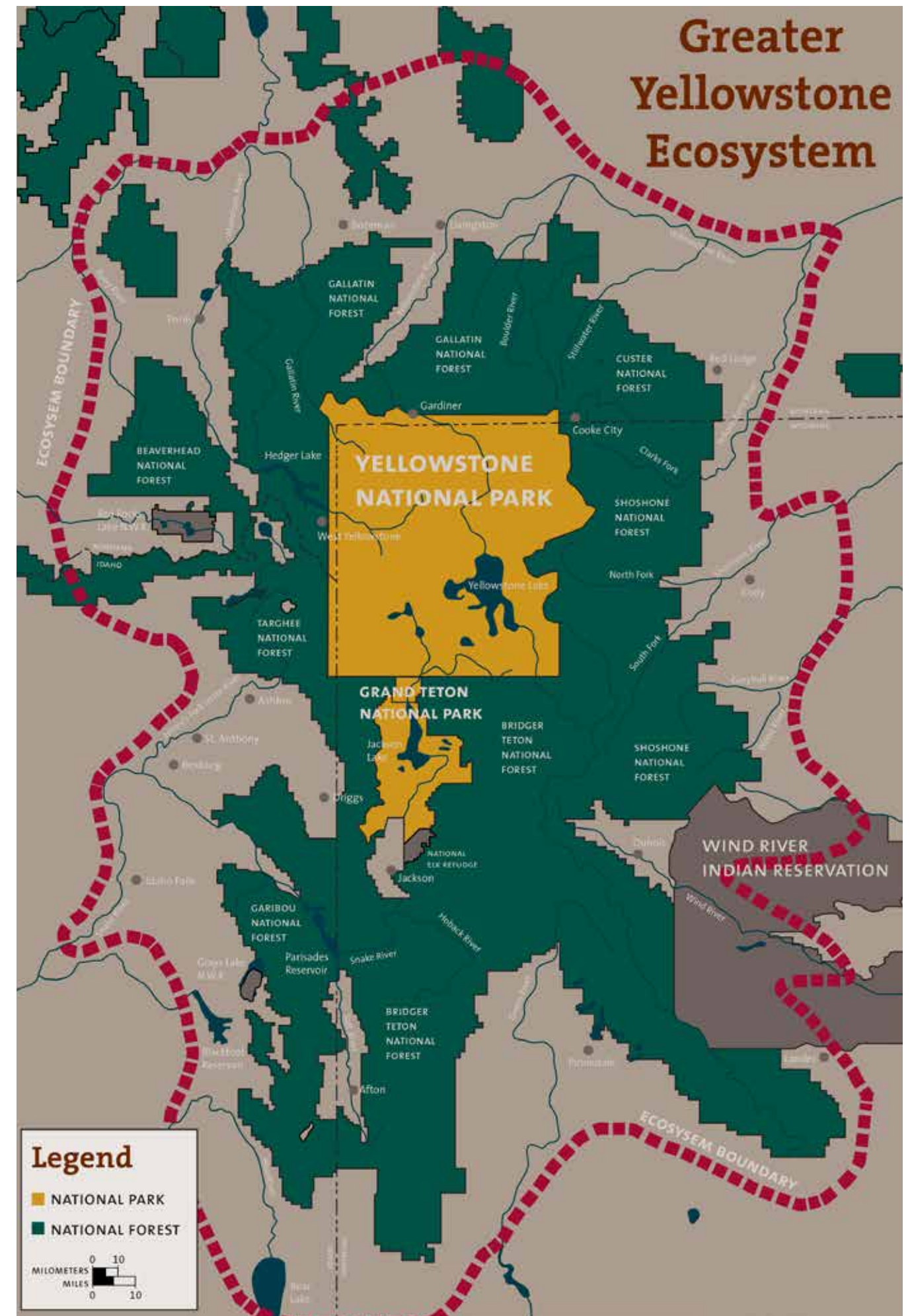
and biological elements necessary for the existence and perpetuation of a complex of animal species."

The concept of a GYE has gained wide acceptance and use, and is often described as the last large, nearly intact ecosystem in Earth's northern temperate zone. It has become a centerpiece for discussions and debates of ecosystem management and transboundary stewardship. Yet there is no universally-accepted size or boundary for the GYE, or of the specific complex of animal species to which it should be applied. Different interpretations of the area range from about 4 million acres to more than 18 million acres, depending on the species being considered and the perspective of the author.

The importance of the GYE concept is that it recognizes that the destinies of wildlife and the resources on which they depend transcend political and jurisdictional boundaries. Despite the inextricable links binding wildlife and their resources, management of the landscapes in the various versions of the GYE is segregated among several agencies and jurisdictions with often conflicting goals and objectives. The GYE as most commonly defined encompasses state lands in portions of Wyoming, Montana, and Idaho; two national parks; three national wildlife refuges; portions of six national forests; lands managed by the Bureau of Land Management; tribal lands; and private lands. More than twenty-eight federal, state, and local government agencies and thousands of private landowners manage parts of the area.

The varied jurisdictions, management objectives, and philosophies found within its imprecise borders challenge the idea of coordinated, holistic management. The Greater Yellowstone Coordinating Committee (GYCC) was formed with a Memorandum of Understanding between the National Park Service and the U. S. Forest Service in 1964 to foster communication and coordination in the management of federal lands in Yellowstone and Grand Teton national parks and adjacent landscapes. The U. S. Fish and Wildlife Service joined the Committee in 2002, and the Bureau of Land Management was added in 2012. The establishment and work of the GYCC have enhanced opportunities for transboundary federal stewardship in the region, but obstacles remain as these agencies struggle to clearly define common goals and generate adequate resources to consistently overcome bureaucratic hurdles and effectively pursue management objectives.

Even with complete agreement and synergy among



One interpretation of the Greater Yellowstone Ecosystem. Modified from Greater Yellowstone Coalition, Craighead 1979, and other sources. Image courtesy of the author.

federal agencies, a comprehensive vision and strategic plan for holistic management of the entire area must also include active cooperation of state, municipal, and tribal governments, and private landowners. Effective wildlife management across an ecosystem partitioned by so many human-imposed boundaries and so many diverse stakeholders ultimately will depend on identifying common goals that include socioeconomic and cultural considerations, as well as ecological ones. Identifying the appropriate mix of stakeholders to cooperate in a management plan requires that we delineate the area to be managed and the specific goals of management. The four- to eighteen-million-acre area identified by various authors to comprise the GYE has been heralded as the appropriate landscape for effective wildlife management in the Yellowstone region by those who claim it encompasses the resources and space needed for the perpetuation of the region's most wide-ranging wildlife. But it doesn't.

To this point, definitions, discussions, and debates surrounding wildlife conservation and management in the GYE have focused primarily on large, wide-ranging, terrestrial mammals, including grizzly bear, gray wolf, elk, bison, and other ungulates, and, to a lesser degree, Yellowstone cutthroat trout. The various published boundaries of the GYE apply reasonably well to these species, though concerns about genetic isolation and increasing habitat fragmentation have prompted some to focus more on connectivity to much broader areas, such as a Yellowstone-to-Yukon corridor for adequate grizzly bear conservation, and a western Wyoming corridor for pronghorn antelope and mule deer. But if we consider the long-distance migrations of flying animals that inhabit Yellowstone National Park and the surrounding region during part of the year, even the most expansive boundaries usually applied to the GYE are clearly inadequate.

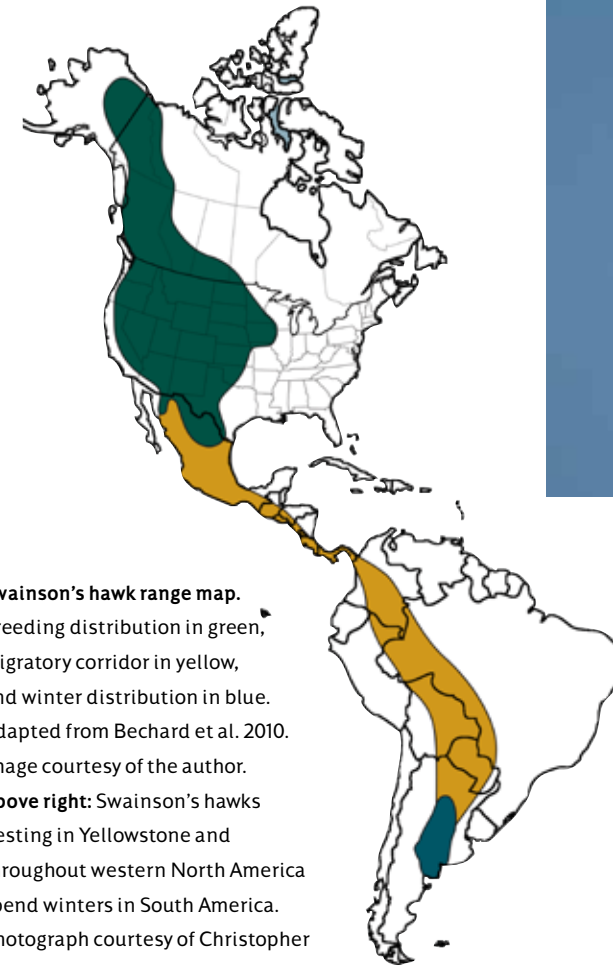
For example, of the estimated thirteen species of bats occurring in Yellowstone National Park, at least one, the hoary bat, migrates far beyond both park boundaries and current GYE boundaries to overwinter and obtain needed resources elsewhere. Little is known about the specific movements of individual hoary bats breeding in Yellowstone, but evidence indicates that a large portion of the hoary bat population that breeds and spends summers in the western United States, including the Yellowstone region, spends the winter as far south as southern Mexico, more than 1,600 miles away.



Western tanagers nesting in Yellowstone in summer may migrate as far as Costa Rica for the winter. Photograph by C. R. Preston.

Approximately 150 to 160 species of birds nest and spend much of the spring and summer in Yellowstone National Park. Only about one-fourth to one-half of these species are year-round residents in the park or adjacent areas. The other species migrate to lower elevation landscapes outside the park or to lower latitudes far beyond the traditional boundaries of the GYE. As James Prosek describes in his essay in this book, the colorful western tanager, a common breeding bird, is a spring, summer, and early fall resident of mixed conifer and mixed aspen-conifer woodlands in Yellowstone National Park and surrounding areas. However, it spends the winter in the pine-oak woodlands of Mexico to Costa Rica. The GYE for some western tanagers may thus extend up to 3,100 miles beyond Yellowstone National Park.

For some bird species, the GYE boundaries must be stretched even farther. The Swainson's hawk is an open-country raptor that breeds through much of western North America. It is a fairly common breeding bird that nests in isolated trees and tall shrubs in large grassy and shrub-steppe areas in and around Yellowstone National Park, where the parents typically feed their nestlings a steady diet of small rodents. In September, large groups, or kettles, of the Swainson's hawks begin their southerly migration. It is not uncommon to encounter scores of these birds foraging on grasshoppers and other insects in agricultural and grassland areas along the first stage of their broad migration route, which stretches as far east as western Iowa.



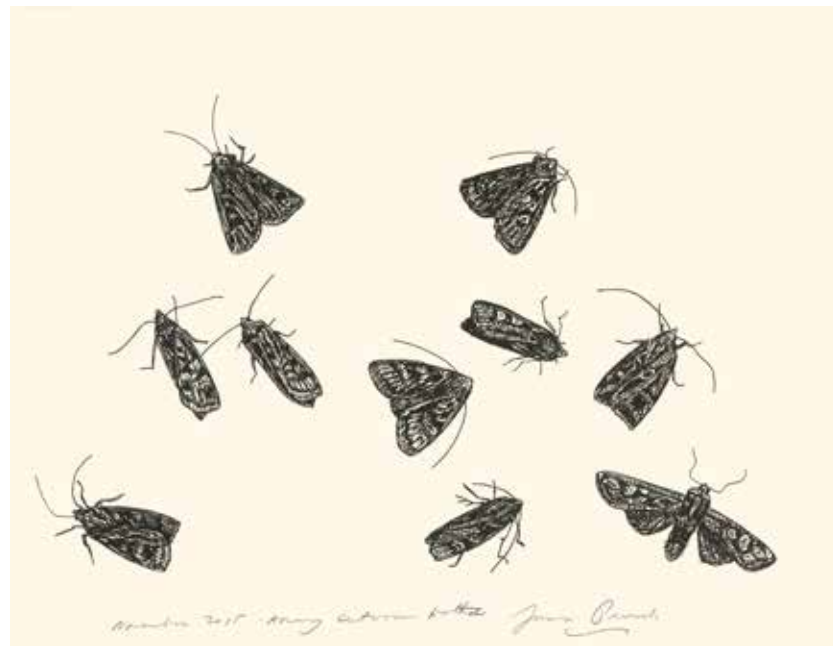
Swainson's hawk range map. Breeding distribution in green, migratory corridor in yellow, and winter distribution in blue. Adapted from Bechard et al. 2010. Image courtesy of the author. **Above right:** Swainson's hawks nesting in Yellowstone and throughout western North America spend winters in South America. Photograph courtesy of Christopher Vennum.

Although we don't have much information about the initial migratory movements of Swainson's hawks nesting in Yellowstone, we know that virtually all Swainson's hawks in existence eventually migrate to South America through the narrow Isthmus of Panama. After entering South America, these hawks follow a narrow corridor along the Andes on the way to their eventual wintering grounds in the pampas of southern Brazil, Uruguay, and Argentina. Insects comprise the bulk of the Swainson's hawk diet in winter. Large incidents of Swainson's hawk mortality were documented in the 1990s due to widespread use of pesticides applied to agricultural fields in Argentina to control grasshoppers and locusts. In one 300-acre field alone, an estimated 3,000 Swainson's hawks were killed after insecticide application. Subsequently, the U.S. and Argentinian governments cooperated to resolve the problem. Nonetheless, this episode dramatically demonstrates how events more than 6,200 miles beyond the boundaries of Yellowstone National Park can impact Yellowstone wildlife.



Many other bird species, especially shorebirds such as the black-bellied plover, semipalmated plover, black-necked stilt, American avocet, and semipalmated sandpiper, rely on Yellowstone as a stopover during migratory flights between breeding and overwintering areas far outside the park. Some semipalmated sandpipers, for example, forage for aquatic insects and small crustaceans on specific mudflats in Yellowstone each year. The mudflats are a key stopover for a portion of the western population of semipalmated sandpipers as they journey from their summer breeding range in the North American arctic tundra to their winter range along the coasts of South America. Numbers of semipalmated sandpipers have declined in recent years, and some authorities consider the species vulnerable to further declines due to their dependence on a small number of key migratory stopover sites.

In addition to bats and birds, many insect species exhibit long-distance migrations in western North America. The life history of one insect species in particular stands out as a reminder that the current concept of a Greater Yellowstone Ecosystem must be considered in a much broader context. The army cutworm moth represents a remarkable connection between the grizzly bears of Yellowstone and the distant croplands of the Great Plains. Adult army cutworm moths lay eggs in late summer and early fall in weedy areas of alfalfa, wheat, and other agricultural and overgrown fields in the plains of Nebraska, Kansas, Oklahoma, eastern Colorado, and eastern Wyoming. The eggs hatch within a few weeks, and the young caterpillars forage before hibernating through most of the winter. The partially-grown caterpillars resume foraging in early spring, damaging crops and



Top: James Prosek. *Army Cutworm Moths I*, 2015. Pen and ink on paper, 11 x 14 in.

Above: Army cutworm caterpillar. These little cutworms are agricultural pests in portions of the Great Plains before they mature into moths and migrate to higher elevations in the Rocky Mountains, including Yellowstone. Photograph by Nancy Hamlett and Bernard Field Station.

Above right: Army cutworm moth, also commonly referred to as miller moth. Large aggregations of these moths are an important part of the summer diet for many Yellowstone grizzly bears. Photograph by M. J. Dreiling, Bugworld.org.

Facing page: Overview of multiuse landscapes in Wyoming's Bighorn Basin, October 2015. Some of these lands are used seasonally by Yellowstone wildlife. Photograph © Joe Riis.



gardens. Some of the caterpillars become victims of pesticides. The survivors complete their growth by mid-spring and pupate in the soil. A few weeks later, the adult moths emerge and begin migrating toward the Rocky Mountains. The fine scales that cover the wings of these moths easily flake off, reminding some people of powdery flour associated with milling grain. Thus, the army cutworm moth is one of the species of moth that is commonly called a “miller moth.”

Some of these 1.5- to 2-inch grayish-brown adult moths settle for the summer at high elevations in and around Yellowstone National Park. Here they feed on the nectar of alpine flowers at night, and rest in the cool temperatures under rocks of talus slopes in the day. These alpine aggregations of moths are an important food source for many grizzly and a few black bears each summer. Tens of thousands of moths may occupy a single boulder field, and each moth is packed with fat

and protein. Bears roam through the boulder fields, turning over rocks large and small. A single bear may eat thousands of nutrient-rich moths in a day, and as many as a dozen or more bears may forage in a single boulder field at the same time. By late summer, the moths that survive begin to migrate back to the plains to lay eggs and repeat the cycle.

Human-imposed boundaries mean something to humans. We can identify and trace them on maps

and even recognize them on the landscape with the help of signs and fences. But animals aren't so good at recognizing or adhering to human-imposed boundaries. They tend to roam where they need to roam in order to survive and reproduce. These movements are not usually random, and many of their routes significantly predate our presence on this continent. Yet we continue to be surprised and sometimes even indignant when animals escape the little islands of habitat we graciously set

aside for them with great self-satisfaction. Those of us interested in or charged with managing and conserving wide-ranging wildlife struggle to reconcile the morass of political and jurisdictional boundaries and value systems with the transboundary needs of wildlife. To make matters worse, we often complain about wildlife invading our ever-expanding neighborhoods, gardens, and recreational trails.

As I write this, there is much discussion here in Cody, Wyoming, about a fresh grizzly bear track discovered in the middle of a newly-developed mountain bike trail in the Bighorn Basin a couple of miles south of town. The site is more than fifty miles outside Yellowstone National Park and more than twenty-five miles outside the Shoshone National Forest. Prior to human settlement, the Bighorn Basin was used extensively by grizzly bears. Some people are alarmed that the recovering Yellowstone grizzly bear population is expanding its range again into the Bighorn Basin. It is true that the Yellowstone grizzly bear has expanded its range as the population has recovered from fewer than 200 bears in the mid-1970s to more than 700 bears by 2015. But the location of the recently-discovered track lies at the eastern margin of the Craigheads' proposed

GYE encompassing the area needed to support a viable grizzly bear population. The site also lies within my long-term golden eagle/sagebrush-steppe ecology research site in the Bighorn Basin, where my team and I have encountered grizzly bear spoor nearly every year during the last decade, especially when whitebark pine nuts and other foods are scarce at high elevations to the west. During the same period of my fieldwork, we've encountered very few people and no recreational trails. Is the grizzly bear suddenly expanding its range into the Bighorn Basin this year, or are the region's people continuing to expand their range and awareness of grizzly bear presence?

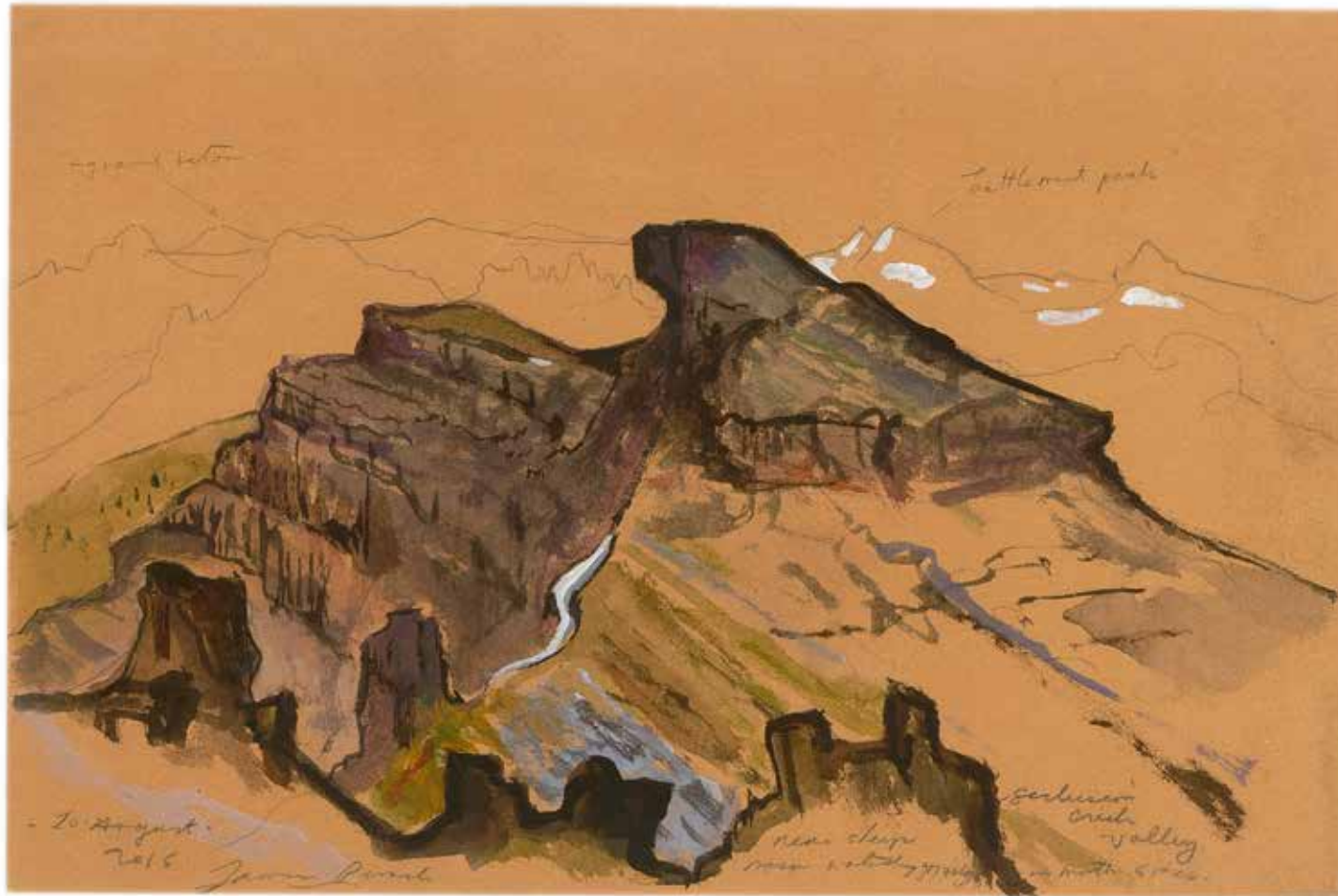
National parks and other land preserves provide an important foundation for constructing a long-term, sustainable strategy to manage and conserve our planet's biodiversity. But parks and preserves alone cannot conserve an area's biodiversity. They are too few, too small, too isolated, and are too often compromised by competing management goals and objectives. These challenges especially come into focus when we consider that the world's human population has more than doubled since 1950 and is expected to grow by an estimated 80 million people this year alone. The concept



of a Greater Yellowstone Ecosystem acknowledges and helps address some of these challenges. But without a cohesive, holistic vision and management strategy that involves multiple management authorities and stakeholders throughout the GYE, Yellowstone's most charismatic wildlife species remain at risk. Even if we overcome these obstacles for Yellowstone National Park and adjacent lands, Yellowstone's hoary bats, western tanners, Swainson's hawks, semipalmated sandpipers, army cutworm moths (and thus grizzly bears), and many other species are vulnerable to events and activities hundreds and thousands of miles beyond the boundaries of Yellowstone.

Facing: A Grizzly Bear sow and cub crossing a highway in the Shoshone National Forest twenty miles east of Yellowstone National Park. Photograph by C. R. Preston. **Above:** Grizzly Bear near Yellowstone Lake. Photograph by C. R. Preston.

The long-term solutions to these conservation challenges begin with the recognition that John Muir was spot-on when he declared "... when we try to pick out anything by itself, we find it hitched to everything else in the Universe." Conservation of wildlife and habitat in the GYE reaches well beyond this celebrated region, just as conserving wildlife and habitat in faraway landscapes reaches into the heart of the GYE. The fundamental theme of this volume and the exhibition that inspired it is that conservation in the twenty-first century and beyond must cross jurisdictional, geopolitical, philosophical, and disciplinary boundaries to engage a wide range of stakeholders with a vision and a strategy that links human destiny with the destiny of our planet's biodiversity—a great treasure that we too often take for granted.



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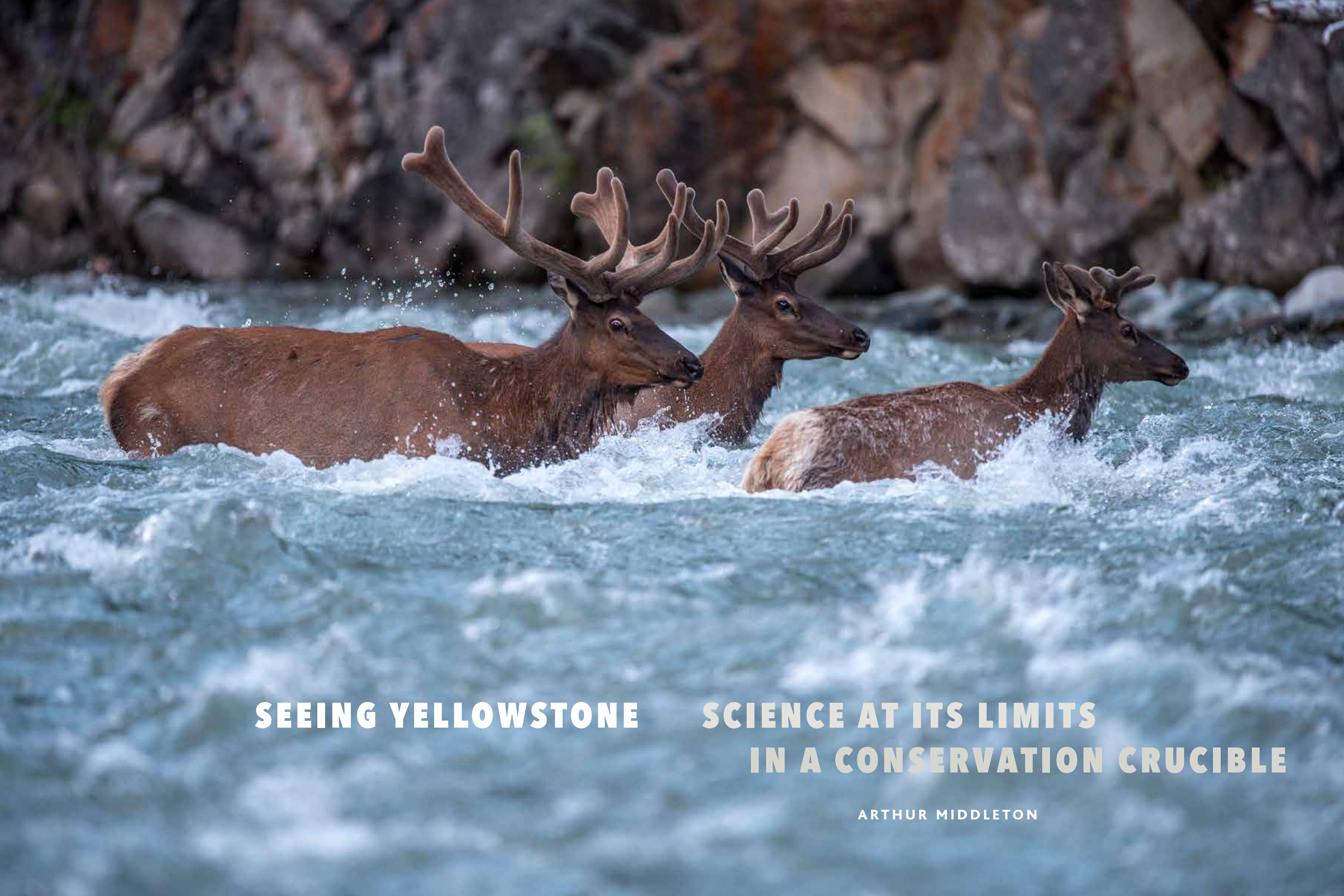
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Facing: James Prosek. *Seclusion Creek Valley—View off Sheep Mesa*, 2015. Watercolor, graphite and gouache on tea-stained paper, 8 x 12 1/4 in.

Left: James Prosek. *Blackwater Natural Bridge—View off Sheep Mesa*, 2015. Watercolor, graphite and gouache on tea-stained paper, 5 3/4 x 12 1/4 in.



SEEING YELLOWSTONE

SCIENCE AT ITS LIMITS

IN A CONSERVATION CRUCIBLE

ARTHUR MIDDLETON

On the afternoon of June 6, 2015, on the airport tarmac in Cody, Wyoming, the sun was warm and the sky was clear. But to the southwest, where we needed to fly, dark clouds flickered and pulsed with lightning.

I'd gone to great lengths to line up a helicopter and a cameraman for that day.

I had kept a close eye on the movements of our collared elk, and they had just started to break for the mountains. We had a chance at recording the first glimpses of a phenomenon I'd made it my mission to see and to share: the Cody elk herd's annual migration to Yellowstone National Park. This weather could ruin that chance.

"No worries!" said Mark Taylor, our pilot, chewing his gum as he surveyed the distant storm. "I'll fly that. That's the thing about helicopters. We can dodge the worst of it, set down if need be. Up to you, bud!"

I'd only met Mark a few hours earlier. He was a gentle giant in Wrangler jeans and cowboy boots, with a big, goofy smile. I don't love helicopters—they break too easily—and it takes time to trust a pilot. But I liked Mark, and he had a good reputation. I couldn't afford to lose this chance. "Sure," I said. "If you're in, I'm in."

The rotor whistled and droned as streets and lawns gave way to county roads and hayfields. Below, black Angus and white Charolais cattle dotted the open range. A few oil wells punctuated the vast Hoodoo Ranch, their pumpjacks bobbing against the velvet spring grass.



Previous pages: Bull elk of varying ages cross a river swollen with snowmelt on spring migration, June 2015. Their antlers are still developing, or "in velvet." Photograph © Joe Riis. **Above:** Middleton following migrating elk, summer 2014. Photograph © Joe Riis. **Facing page:** A large herd of elk congregate on traditional wintering grounds far outside Yellowstone National Park, March 2015. Elk retreat from higher elevations in winter to avoid even deeper snow. Photograph © Joe Riis.

Here and there pronghorn antelope sprinted along, as if to race us. At the foot of Carter Mountain, where the Rockies meet the Bighorn Basin—the edge of the great Midwestern plain—we banked west, up the Greybull River, into a building rain.

Carter Mountain stretches southwest for nearly 20 miles. More than a dozen streams drain its flanks. One by one, we crossed the ridges between them, the earth rising and falling beneath us. Patchy snow shone bright against green grass and gray sky. Down along the Greybull, to our south, I squinted to find the Pitchfork Ranch headquarters. I'd put GPS tracking collars on elk there during the past two winters.

We were heading for the first waypoint I'd given Mark, at Boulder Pass—a 10,500-foot saddle at the west end of Carter, where the elk leave the ranch country behind and enter the wilderness. As we slipped over the pass, we saw trails through the snow, darkened from muddy hooves. Dropping down the other side, we passed the gray ramparts of Castle Creek. We were into the real mountains now, and the helicopter felt small among tall sheets and spires of rock. Mark toggled to our next waypoint: Needle Mountain.

The Cody elk herd faces many obstacles on its migration—rushing rivers, hungry predators, and a series of high passes—but at 12,000 feet, Needle Mountain must be the toughest of them all. Working from local outfitters' and wardens' accounts, and more recently, from my own GPS collaring, I knew the elk crossed it. I'd even found their faint trails on a satellite image. Yet I still harbored slight disbelief. To traverse this mountain, they had to climb 5,000 feet from their winter range, then scale long knife ridges and struggle through miles of belly-deep snow—all out in the open, exposed—before dropping 5,000 feet down loose scree slopes to cross the South Fork of the Shoshone. It didn't make any sense.

The rain streaked sideways across the windshield as we approached Needle. Out ahead, through the mist, I could just make out a long, dark slash, angling up and across a steep snowfield. Mark saw it, too. "There's a trail there, but it can't be the elk trail," he said. "They would find something lower. They'd avoid a face like that."

The trail was still five hundred feet above us. Climbing toward it, Mark worked the helicopter back and forth slowly, like a hiker on switchbacks. In the thin, cold air around Needle, his machine was nearing its limits. The mountain flashed behind passing mist and clouds.



As we grew closer, the bottom lobe of a big, gray cloud cleared away in thinner and thinner wisps. Several dark shapes had appeared on the trail. "I don't believe this!" Mark said. "I... do not... BELIEVE this."

One by one, twelve cow elk pushed their way out into the snow. They would sink in, halt, then lunge forward again. Every few lunges, they would pause while the lead cow stopped them to breathe. We were seeing the vanguard of the Cody elk herd, among the first of 4,000 to start their annual journey.

More than 140 years ago, the United States Congress created Yellowstone National Park to preserve incredible geological wonders—geysers, fumaroles, canyons, and cascades. That single act, perhaps more than any other, sparked a global movement to protect the last wild places on earth. But the people who made our first park—they had never seen anything like this.

I FIRST CAME TO CODY in 2007, as a newly enrolled grad student at the University of Wyoming. For my dissertation research, I was going to work with state and federal agencies to study how re-introduced wolves were affecting the survival and behavior of their main prey—

elk—and whether those effects could explain the decline of the Clarks Fork elk herd. For three winters I would live in a place called Sunlight Basin, in the heart of the herd's expansive winter range.

Sunlight is a stunning, quiet valley of cattle and dude ranches, lined by long rows of jagged peaks, about an hour-and-a-half's drive northwest of Cody. The highway out to Sunlight snakes past big cattle ranches, then up over a high pass before dropping down into the valley. The gravel road peels west, cleaving straight up the valley bottom. About two thousand elk winter in Sunlight, and on any given day hundreds gather on the flats that flank the road, pawing a thin veneer of snow to get at the brittle, brown grass beneath it. Many a night in Sunlight in winter I've crept a truck along slowly as the herd parted around me, dozens of eyes lit yellow-green against the inky darkness. Heading back down the road at dawn, I've seen gangs of eagles and ravens hop up from a carcass into flight, leaving their crimson tracks—and the bigger, bloodier tracks of wolves—pressed into the crusty snow. From those flats, it's about thirty miles west, across the imposing Absaroka Divide, to Yellowstone National Park.



Previous pages: Wes Livingston, standing on a helicopter's skid, fires a net over a cow elk on a winter range near Cody, Wyoming, March 2014. Middleton and other researchers fit elk with tracking collars to study behavior and movements. Photographs © Joe Riis.

Facing page: A cow elk carrying a GPS tracking collar on spring migration, Shoshone National Forest, June 2015. Photograph © Joe Riis.

When I first arrived in Sunlight, I had never seen a wolf or an elk. This was a hard thing for me to admit. Wildlife stories can be front-page news in Wyoming, and by 2007, people in the communities that ring Yellowstone—places like Jackson and Livingston, Bozeman and Cody—had been debating the effects of wolves on elk (and cattle) for more than a decade. Elk are so familiar to people who live in northwest Wyoming that one of my colleagues refers to Jackson as “a town of 9,000 elk biologists.” Cody is similar, but more insular, and with a stronger independent streak. So there I was, an Ivy League graduate from the East Coast, joining the government to help the locals around Cody better understand their wildlife.

Though it wasn't totally clear to me then, my absolute lack of personal experience with the species I'd come to study meant that I would have to rely, at least for a time, on other peoples' stories. And there were many of those. For my colleagues in agencies and universities, the elk were a conduit for the wolf's effects on a larger stage. These stories centered on dropping elk numbers—like in Sunlight Basin—that might relieve the pressure of so many hungry mouths and trampling hooves on grasses, trees, and streams. For my new friends and acquaintances in outfitting and ranching, the wolf was an aggressive invader, and the elk its innocent victim. These stories began with pitiable elk and cattle running miles to escape wolves, and ended on the cumulative impacts, emotional and financial, for local hunters and ranchers.

Over those years in Sunlight, I came to see these stories as counterplots in the battle for an overarching narrative about Yellowstone. They were less about the wolves or elk than about the wildness of the “ecosystem”—about what configuration of animals and people would make the place healthy and whole. On one side, wolves were restorative, bringing back a lost Eden. On the other side, wolves were destructive and elk were a mascot for those who felt excluded. In this light, each wolf and elk story seemed like a bid for the heart and soul of Yellowstone. But they were also terribly divisive, driving wedges deep between the people, even the neighbors, on whom the future of the place depended.

All those stories shared something else that bothered me. Their main characters, the animals, had little identify of their own. They existed in relation to other ideas and other problems. And so over my years in Sunlight Basin, I began to wonder what would happen if we could see them for themselves. Would they tell us something new about the place? Could they tell us something new about our own relationships? Something new about ourselves?

WINTERS IN SUNLIGHT were busy for me. By November, I had hired three assistants—college biology graduates willing to work hard for ten bucks an hour and a new line on their resumes. In early January I brought in a helicopter crew—a roving band of New Zealanders who make their living catching wildlife for Western agencies and universities—to catch and collar animals. I arrived in Cody before Christmas and worked through the holidays to finalize logistics: permits, ranch access, GPS collar set-up. When the helicopter arrived, and we got a lull in the wind and snow, we set about darting and collaring. I aimed to keep at least two wolves collared in each of the packs that hunted the Clarks Fork elk, and about ninety of the elk themselves. The GPS collars recorded each animal's location every three hours. The data they logged—wolves' proximity to elk, and elk responses—were the heart of my work. After the captures, by mid-January, we started our daily grind. Days in the field started and ended in the dark. We split into pairs to make circuits across a patchwork of local ranches and forest lands. We tracked elk by truck and on foot, in wind, snow, and frigid Wyoming air. Often we climbed to high points to make our observations. One of them, “the Anthill,” stuck straight up in the middle of the valley. It was a near-perfect cone, draped in sagebrush and snowdrifts. We scrambled and post-holed to the top, unfolded the VHF antenna, and scanned for collars out in the folds of the valley. When we spotted our elk and their groups, we staked them out from above, watching through scopes for an hour or more. We narrated their doings into voice recorders, because it was too cold to write. “Now she's feeding... moving... now alert... feeding again... still feeding... moving... now she's bedding down...”

It turns out that wintering elk do little more than those four things. And from the accumulation of those simple behavior profiles—one every two weeks for each collared elk, for three winters—I hoped to see how wolves affected the finer details of elk feeding. Each night, we returned to a drafty state cabin we called



home. We thawed our feet, ate profusely, and transcribed the day's recordings onto paper before passing out on musty cots as close to the furnace as we could drag them.

After every winter I said farewell to the crew, packed the pickup full of my ragged gear and stacks of precious data sheets, and made the long, lonely trip to Laramie. There, back at the university, I resettled the basement cubicle where I worked through the summer and fall. I typed data into spreadsheets, caught up on my colleagues' latest work, and designed my computational analyses.

After three years cycling between the field in Cody and the desk in Laramie, I spent two more full years at work in that basement, finishing my analyses and writing a dissertation. And after five years in all—staring at elk until my face froze, and at screens until my eyes burned—the animals I saw were very different from the ones I'd been told about.

FROM AN ELK COW'S point of view, a winter's day must be a tedious proposition. In the smoky light of dawn she comes out to feed on the open ground. The grass is buried under snow, and what's left over from the summer isn't worth very much to her. Crystalline sheets of snow snake and slide across the valley like beach sands, whipping at her legs and face as she paws and noses the ground. Hour after hour, she gnashes at sharp, dry stubble. It takes hours to fill even a fraction of

her big belly. Step by step by step, the group around her drifts across the flat, pulling her along in its midst. By midday she beds down with the rest of them. If it's cold, they lie in the sun on a sagebrush slope. If it's warm, or windy, they lie in the shade and the shelter of nearby timber. She chews her cud. She digests. In the afternoon, she heaves her 500-pound body up to feed all over again. All the while—as she grazes, chews, and rests—she keeps a wary eye on the world around her. The 25, 100, or 500 elk around her are watching, too.

Inevitably, a threat comes. Those 25, 100, or 500 heads pop up in unison. Their ears cock forward, locking on a noise or a movement. It can be a false alarm—a door slamming on a distant ranch, a truck rumbling by, or a scientist accidentally knocking a rock loose on a hill. But other times, it's the wolves. In three winters, I saw wolves approach elk only about a dozen times. Once, the encounter ended in a kill. Five wolves split a couple bull elk off from a group of twenty, ran them for half a mile, and dragged one down by his neck, killing him as he sank out of view into the snow. The other times were different.

One day, I was watching a collared elk in a group of sixteen when their heads all jerked upslope. A pair of black wolves with bright yellow eyes was standing there, watching the elk patiently through sparse timber. The wolves sat down on their haunches, and the elk bunched together tightly. But soon, the elk began to slacken up



Wolves, reintroduced to Yellowstone National Park in 1995 and 1996, are now the primary elk predators on many winter ranges. Photograph © Joe Riis, March 2015.

and feed again, and the wolves moved on. They had seen and reacted to something about each other—something that was invisible to me.

Another time, farther up the valley, I was watching a group of fifty elk when I noticed that a few of them kept looking behind a little hill nearby. After I finished my observation, I repositioned to see what they were looking at. There, curled up in the snow, were the twelve wolves of the Sunlight pack. Through my scope, I could see the dark fur of their backs fluttering in the whipping wind. The elk kept feeding, checking the wolves from time to time, and after a few hours I was too cold to watch the strange spectacle any longer. Neither wolves nor elk were behaving as I'd been told they would.

Scientists like me learn to discount such anecdotes in favor of more systematic observation. Yet my analyses backed up what I saw in the field. The GPS collars showed that wolves came within a half-mile of

each individual elk less than once a week. After those encounters, the elk would typically drift a short distance, but they rarely abandoned the places they liked to feed. Sure, wolves killed elk, but not as many as I'd expected. Of the ninety collared elk cows I tracked over those three winters, only one was killed by wolves.

One of the most surprising things I learned was that wolves also die in the hunt. In early 2010, we collared a big male. Our capture pilot called him "Blue." His gray coat was made of black and white hairs that gave him a stunning, bluish hue. He was the breeder—the "alpha male"—in the Sunlight pack. A year later, he turned up dead in the prime of his life. We found him lifeless in the snow, with dark holes in his groin and his armpit. It seemed a bull elk had lifted him up, sunk antlers deep into his body, and tossed him down to die on the cold snow. He lay encircled by a spatter of blood from the struggle. The wolf was neither the saint nor the

sinner, the hero nor the villain that I'd been told it was. The elk was coming alive for me as a graceful creature, tougher and more sophisticated than I'd ever imagined.

I had come to Sunlight to understand what was causing the decline of the Clarks Fork elk, and I was in trouble. I sought strong wolf effects because I'd been told to do so by those around me—from the most overeducated of my academic colleagues, to the most reactionary of the locals. I was looking for answers on the elk winter range because that's where the animals were easiest to see, count, and study. But I was learning that the answers weren't so simple, and would have to come from somewhere else.

ONE SINGLE INSIGHT, more than any other, opened my eyes to that "somewhere." It came from my closest collaborator on the Clarks Fork study, and on much of my work since then: Doug McWhirter. Doug is a veteran biologist for the Wyoming Game and Fish Department. He's now stationed in Cody, after serving in the same role elsewhere in Wyoming. Soon after I arrived in Cody I asked Doug an awkward question I would ask many others: "So, um, can you describe a year in the life of an elk for me?" Doug has a modesty about him that makes it feel okay to ask dumb questions, even though he can answer them with total authority. Maybe he could relate—twenty years earlier, he'd come from Kansas to ply the road between Laramie and Cody for his own grad work on bighorn sheep.

A routine part of any Game and Fish biologist's job is to survey elk herds on their winter ranges. One of the most important numbers they track, year after year, is the ratio of elk calves per hundred cows. Most mature elk cows give birth to a calf each year, so at calving time in early June, there is a potential ratio of ninety or so newborns per hundred cows. But pregnancies can be lost, and calves are born weak. Many die. When the winter calf ratio drops below thirty, biologists worry how much hunting the herd can sustain. When it drops below twenty, they cut back on hunting, and worry whether they can sustain the herd at all. Doug had watched the Clarks Fork elk herd's calf ratio drop to twelve by the year of my arrival. He was alarmed.

The recovery of wolves in Sunlight Basin coincided almost perfectly with the elk decline—which was one of several reasons it was logical to investigate wolves' role. But Doug also knew that every spring, around the middle of May, the Clarks Fork elk went somewhere else. They left Sunlight for the high country in and around Yellowstone National Park. And it was on this annual

migration that most of them gave birth. They stayed in the high country, along with their calves, until the first snows of winter. A lot could happen to those little calves when they were away, behind the wilderness veil, where few of us ever go.

So in August 2007, as I was planning my first winter field season, Doug scraped the funds together for a summer helicopter survey. He came back with a surprise: the calf ratio was already down to fifteen, just three months after calving time. And he got the same result, year after year. It grew ever clearer that I was freezing my face off on elk winter range in an effort to explain something that was not happening there, but rather thirty, forty, and even sixty miles away, in the warm breezes of the summer. Back at work in my basement cubicle, I shifted focus. The depth and scale of the wilderness meant I couldn't easily go there for myself. And I couldn't fully redesign my study. So instead, I had to rely on indirect observations: weather records, satellite images, and routine agency observations.

Still, there were unmistakable patterns. The summers had grown hotter and drier. The period of spring "green-up," when the grass is young, tender, and easy for elk to digest, had grown three weeks shorter. More important, the number of grizzly bears on the summer range of the Clarks Fork elk had almost quadrupled, and the bears had lost other foods, like spawning trout, leaving them hungrier for elk. These changes in faraway places were shaping what I saw at the end of my nose in Sunlight Basin. Following the migration of Clarks Fork elk up to their summer range had led me to new answers for the questions I'd been asking. This was the closest to an "ah-ha" moment I've ever had in science. And this is how I came to see migration as a fundamental key to seeing Yellowstone. Finally, I'd found a thread that I could begin to follow into a system that for years I'd been struggling, and failing, to understand.

WHEN HARD AT WORK in the basements of our universities, grad students daydream. In the latter years of my own grad studies, one of my summer daydreams was about the elk migrations. I knew the migration of the Clarks Fork elk wasn't the only migration—that others also snaked into Yellowstone—but how many? As cold air hissed from the ceiling, fluorescent lights buzzed, and strange electrical systems hummed behind cinderblock walls, I wondered, what numbers of elk are involved? How far do they go? Where do they start, and where do they end?

I started asking agency biologists, hunting outfitters, and ranchers these questions. It's a state biologist's job to know the herds in her district, and it's a matter of pride and economics for an outfitter or a rancher to know a few of each herd's secrets. I found that nearly everyone I asked my questions had an answer, but only a partial one. I was getting somewhere, but I still had only half the pieces of a giant puzzle—and the pieces were still scattered across the floor.

Next I turned to historical reports. I read everything I could find. I quickly found that I was not, by any means, the first scientist to wonder about the migrations. Olaus Murie, a biologist for the old U. S. Biological Survey, had pioneered a long tradition of study on the Jackson elk herd. He followed the Jackson elk for years, and in 1931 he reported some of his findings to Herbert Hoover's Yellowstone Park Boundary Commission as the government considered (and rejected) an expansion of park boundaries. Then I found a journal article from the 1970s, where one of Yellowstone's most famed biologists, Frank Craighead, had reported on the migrations of five herds that summered within the park.

But through no fault of their own, my predecessors' reports were limited by the available technology. Up until the 1960s, tracking elk required luring them into a corral, clamping tags on their ears, turning them loose, and searching for them later, like needles in a fifteen-million-acre haystack. The VHF radio collars of the 70s, 80s, and 90s were an advance—given a line of sight to the collar, you could pinpoint its pulsing beacon with a handheld antenna. But finding that signal in rough country still required a plane, a bush pilot, and the funding to pay him.

The GPS revolution completely changed the game. Now, wildlife collars—like the ones I used in Sunlight—can uplink to satellites. A GPS collar creates a sort of high-tech trail of crumbs wherever a study animal goes. And many go places we'd never imagined. GPS collars opened the possibility of more comprehensive and revelatory exploration of animal movements the world over. What DNA sequencing has done for molecular biology and medicine, GPS tracking is now doing for the ecology and conservation of ecosystems.

In 2012, when I first began asking my colleagues to share GPS data from local elk herds, my calls were a shot in the dark. I suspected that many of the herds had never been collared. Five state and federal agencies manage wild animals in and around Yellowstone Park, and many universities study them. The inevitable results are fragmentation and territoriality. A biologist in Bozeman might collar 30 elk to see where they are during the hunting season, and her counterpart in Jackson might collar twenty others for a study of road crossings. Yet they work 200 miles apart, and might not like or even know each other. For all these reasons I didn't know if documenting and mapping out all the elk migrations of the Greater Yellowstone Ecosystem was a task we would ever complete.

Right: Middleton, guide Wes Livingston, and dogs Dee and Jack wait out a snow storm on the trail of migrating elk in late July 2015. The *Invisible Boundaries* project team depended heavily on the specialized horse-packing skills and backcountry knowledge of many Cody-area guides, particularly those of Livingston Outfitting, owned and operated by Lee Livingston. Photograph © Joe Riis.



To my surprise, the fragmentation was surmountable, and my colleagues were almost universally happy to help. The agencies of the Greater Yellowstone Ecosystem had generated so much GPS data—some 4 million GPS locations from hundreds of cow elk—that completing a map of the elk migrations seemed within reach. The last obstacle was a gap right in my own backyard. That gap, a few short inches on a regional map, was a vast swath of the Absaroka Range off the southeastern corner of the park, spanning the cattle ranches and the wilderness from Cody to Jackson. And no one was going to fill it for me.

IN THE FALL OF 2013, when I started my exploration of the migrations with wildlife photographer Joe Riis, I knew one thing for sure: I wanted to follow the trail of the Cody elk herd from the ranchlands all the way through the mountains up to the park. I thought we needed to experience it for ourselves. By summer 2015, the only portion of the trail that Joe and I had failed to travel together was the three-mile stretch over the top of Needle Mountain.

On our first try, in spring 2014, the slopes were so muddy that our string of pack mules couldn't get up the mountain safely. On our second try, over two eerily warm days the following November, we climbed almost 5,000 feet up the back side of Needle, mostly on foot. But as we got out on the flat top of the mountain, a frigid wind hit us with gusts so fierce that it was hard to walk. Soon we retreated to safety as a snowstorm engulfed the summit. Back at our base camp, the storm encased our tent in crackling sheets of ice.

By June 2015 we were determined to traverse that mountain. We planned to set out from the Pitchfork Ranch, following the path we'd scouted and filmed by helicopter the previous week. The first night, we'd camp near Boulder Pass. The second night, we'd camp just below Needle itself. The next morning, we'd get as high up the mountainside as we could on the horses, then send them back with our guide, Scott LaFevers, to finish the climb on foot. If we got an early start, we could get out on top and cross well before the customary afternoon thunder and lightning rolled in.

Over the first two days, we rode that same undulating terrain along Carter Mountain I had flown over with Mark Taylor. In nearly every creek basin, we saw a few dozen cow elk grazing loosely together. They were staging for the coming journey, waiting for their calves to gain strength. Twice, passing through timber, we startled grizzly bears from their daybeds. Once it was

a fat, shimmering sow with a cub almost her size, and the other time it was a young boar that streaked and splashed through a creek bottom. All of us—hunters, hunted, and curious observers—were on this migration trail together.

On the second night we slept at 10,000 feet, on one of Needle's flanking ridges. We lay side by side under a tarp, with saddles at our feet to stop us from sliding downhill. As we settled in, I complained about my aches and chills from two days' hard riding, and in his plodding way, Scott replied, "That's the thing about these mountains. You gotta take every step if you're gonna get where you wanna go."

The next morning, we woke early, packed the mules, and rode up the ridge toward Needle. Halfway along, we stopped to scope a route. The snowfields had shrunk since we'd flown over in the helicopter, but we could still make out sections of dark, braided trail. We could now see the most challenging stretch, where we'd have two options—to climb twenty or thirty yards up through a notch in a small cliff, or cross the soft snow on an open, steep face.

Scott stopped us at the last flat place we could see. "This is where we'll need to say goodbye. These mules ain't going any further." We dropped the loads and dug out our backpacks, heavy with four of Joe's camera traps.

We tired easily and moved slowly in the thin air. We followed elk trails across wet ground until they finally converged at the start of a long knife ridge approaching the face, and the summit beyond it. To one side, the rocks formed a ledge over one fork of Boulder Creek, dropping 500 feet. To the other, steep talus and scree dropped 3,000 feet or more to the South Fork of the Shoshone. We could hear the low, bass whoosh of the river as it flooded through the narrow canyon below. Here, where we could see that the elk trails were pinching together to follow the ridge, Joe began setting his camera traps.

While I waited for Joe, pale sulfur butterflies looped and flitted around in pairs and trios. Rosy finches chattered in the rocks below us, and mountain bluebirds dropped from nowhere onto sharp boulders along the ridge, cocking their heads at us. This time, the weather was perfect: a bright blue sky with only a few clouds to the east, hanging over the hazy Bighorn Basin.

As I turned to study the trail ahead of us, my gaze settled on a smooth, light-colored trough. I could see that it continued up the ridge, cutting four, five, six inches deep in the sharp brown volcanic rock of the mountainside. And in that moment, I knew I had found

what I had come to see. It was the ancient trail of the Cody elk herd, formed by a hundred or a thousand generations past. As we joined the trail to set forth again, I could feel, with each breath and every step, the pain and wonder of their journey.

ALONG WITH MY COLLEAGUES, I have now completed a map of the elk migrations of the Greater Yellowstone Ecosystem. It shows the paths of nine major herds braiding in and out of Yellowstone National Park. They reach 30, 75, and 100 miles across the park, the forests, and the ranches beyond their boundaries. Altogether, they encompass an area almost five times larger than the park itself, spanning portions of Wyoming, Montana, and Idaho. It is difficult to estimate the herds' numbers for the same reasons it was difficult to map the migrations, but collectively they probably hold about 20,000 animals. That equates to something like 5,000 tons of elk, pulsing in and back out of the wilderness each year. When I look at the map, I feel I can see Yellowstone's beating heart. The routes are the veins and arteries, and the animals the blood.

Like many of the hoofed mammals, or ungulates, elk migrate to get better food. Grass is a terrible thing to eat—the same fiber that helps it stand tall makes it very hard to digest—so many ungulates migrate long distances to find tender green shoots. In Yellowstone, they are following the green-up to the high plateaus, where cool air, a gradual snowmelt, and regular afternoon storms keep the grass green until long past the browning of the foothills. This strategy can result in high rates of weight gain. We don't have good estimates from Yellowstone elk, but one classic study of Alaskan caribou showed that a 14 percent increase in grass digestibility brought a 270 percent increase in weight gain.

The nutritional advantages elk gain from migration have profound consequences for Yellowstone and the surrounding region. Every elk cow that migrates into high country each spring gains fat and muscle that help her nurse her calf, conceive anew, and survive the long, cold winter. The migration helps bull elk rebuild their strength and re-grow the antlers that they will use to defend their harems, and themselves, in fall and winter.

When other creatures harvest this productivity, the elk become the raw fuel of a great ecological engine. Inside the park, the elk become food for Yellowstone's wolves, grizzly bears, eagles, and ravens. The spectacle draws busload upon busload of visitors who come to glimpse something of a lost America. Then, when the migrants cross back outside the park each fall, they

become our prey as well. Their migrations sustain a tremendous outfitting industry, boosting hotels and restaurants that serve its out-of-state clients. Locals hunt in vast numbers as well. On winter ranges north of the park, in Montana, nearly 11,000 hunters spent 65,000 hunter-days stalking elk in late 2014. Around Cody, Bozeman, and Jackson, banks are adorned with twelve-foot bronzes of elk. For many locals, "Get your elk?" is a common greeting in the autumn. Elk may be wrapped up more tightly in the culture than any other animal.

WITH MOST OF THE SNOW melted off, the flat top of Needle Mountain was covered by a huge alpine meadow—a rich, undulating carpet of grasses intermixed with banks of yellow cinquefoil, purple elephant's head, and snowy phlox. Now that we were above 12,000 feet, we could make out the faint, jagged outline of the Grand Teton to the west, and the spine of the Wind River Range to the south. Behind us we could see to the ranchlands of the Greybull, where we'd begun our journey three days earlier. Out ahead stretched the expansive Thorofare wilderness, where the next month we would meet the herd again, jaunty in their summer coats, trailing precious, spotted young calves closely behind them. We'd soon be in the heart of Yellowstone, where sun, the rain, and the snow gather to make an ecosystem.

I believe the animals I've been following offer us a new story of Yellowstone. Though Congress created Yellowstone National Park to protect its geological features, the American public, over the past century, has come to love the place as much for its wildlife—for a grand ecological spectacle that centers on the elk, their hoofed cousins, and the complex web of life that so depends on them. That web depends on a much larger area than the park, which we've come to call the "Greater Yellowstone Ecosystem." The conundrum is that we haven't yet created a system of management that will conserve this larger landscape for another century.

We've certainly made progress. Starting in 1902, the federal government created a network of national forests and wilderness areas encircling the park, buffering the system from major threats of development and human disturbance. Over the course of the twentieth century, state wildlife agencies curtailed the excesses of unregulated hunting, the federal government slowed and in some cases reversed the loss of endangered species, and many responsible ranch owners found ways to improve their stewardship of critical lands along the ecosystem's frontiers. But this long-term effort—the

integration of conservation and economic development in a beloved Western landscape—remains unfinished. The challenge is not limited to the migrations. It spans human-carnivore conflict, wildlife disease, watershed integrity, invasive species, climate change, and every other issue whose emergence or solution cuts across our many boundaries. But migrations, I think, can illuminate the challenge most clearly. When a GPS-collared elk, deer, or bison leaves her trail of crumbs

across the map, she is telling us, loud and clear, that she is at our collective mercy.

What will we choose to do with this knowledge? What is our role in Yellowstone's evolution? As we work to answer these questions, science has a great deal to offer. The work my colleagues and I have done shows that we need to understand Yellowstone as a migratory system if we are to understand key wildlife populations and manage them wisely. Had I not awoken to the

migratory behavior of the elk I study, I could have easily laid the balance of the blame on wolves, failing to notice effects of grizzly bears, drought, and invasive species. As I've followed the migrations further, traversing the ecosystem, I have seen how our system of management is weakened by divisions among the many stakeholders that these populations depend on equally.

But when it's time to act on this learning, science quickly finds its limits. That is why I have come to feel that only through the fullness of collaboration between science and art, only by enlisting all our senses and all our humanity—our minds, our eyes and ears, our sense of pride and of community and of neighborliness—will we see Yellowstone more clearly. The work of my co-contributors to this book and exhibition, Joe Riis and James Prosek, helps us do that.

Where science fails to inspire us, Joe Riis's work succeeds. Riis's photographs reveal the extraordinary beauty of the animals I have studied, and the raw power of their routine experiences. The best of his frames capture a sense of movement and of struggle that we could not otherwise see. Riis's most intimate portraits re-introduce to us an animal we have taken for granted. At once, the work stirs wonder and empathy.

Like science, though, photography can only describe what it can see. James Prosek's paintings help us move past these confines to re-imagine the ecosystem as a whole. Taking a cue from our field investigation of the elk migrations, Prosek reminds us that a whole constellation of migratory creatures experience unseen journeys, linking Yellowstone not only to nearby ranches but faraway oceans and foreign countries. His grand hybrid cow-bison crystallizes the implications of migration for Yellowstone: that this is a hybrid ecosystem, encompassing, quite beautifully, both wild

and domestic (see page 20). Perhaps the sooner we can see and embrace this hybridity, the sooner we can come together around a vision for Yellowstone's future.

My hope is that through this collaborative exhibition, we can help our friends in this landscape, and our fellow Americans with shared interests, continue to re-imagine Yellowstone as a place inextricably connected to a wider world. Only then, and only working together, will we be able to secure the Greater Yellowstone Ecosystem—and its sister landscapes around the world—for another century.

ARTHUR MIDDLETON, PH.D., is a research scientist at the Yale School of Forestry and Environmental Studies and an associate of both the Wyoming Migration Initiative and the Draper Museum of Natural History. He works primarily on the ecology of large mammals, with field projects in the Rocky and Andes Ranges. He completed his Ph.D. in 2012 at the University of Wyoming, where he studied the interactions of wolves and elk in the Absaroka Range. Along with Joe Riis, Middleton was awarded the 2013 Camp Monaco Prize by Prince Albert II of Monaco for linking research and public outreach on the subject of trans-boundary wildlife migrations in the Greater Yellowstone Ecosystem.

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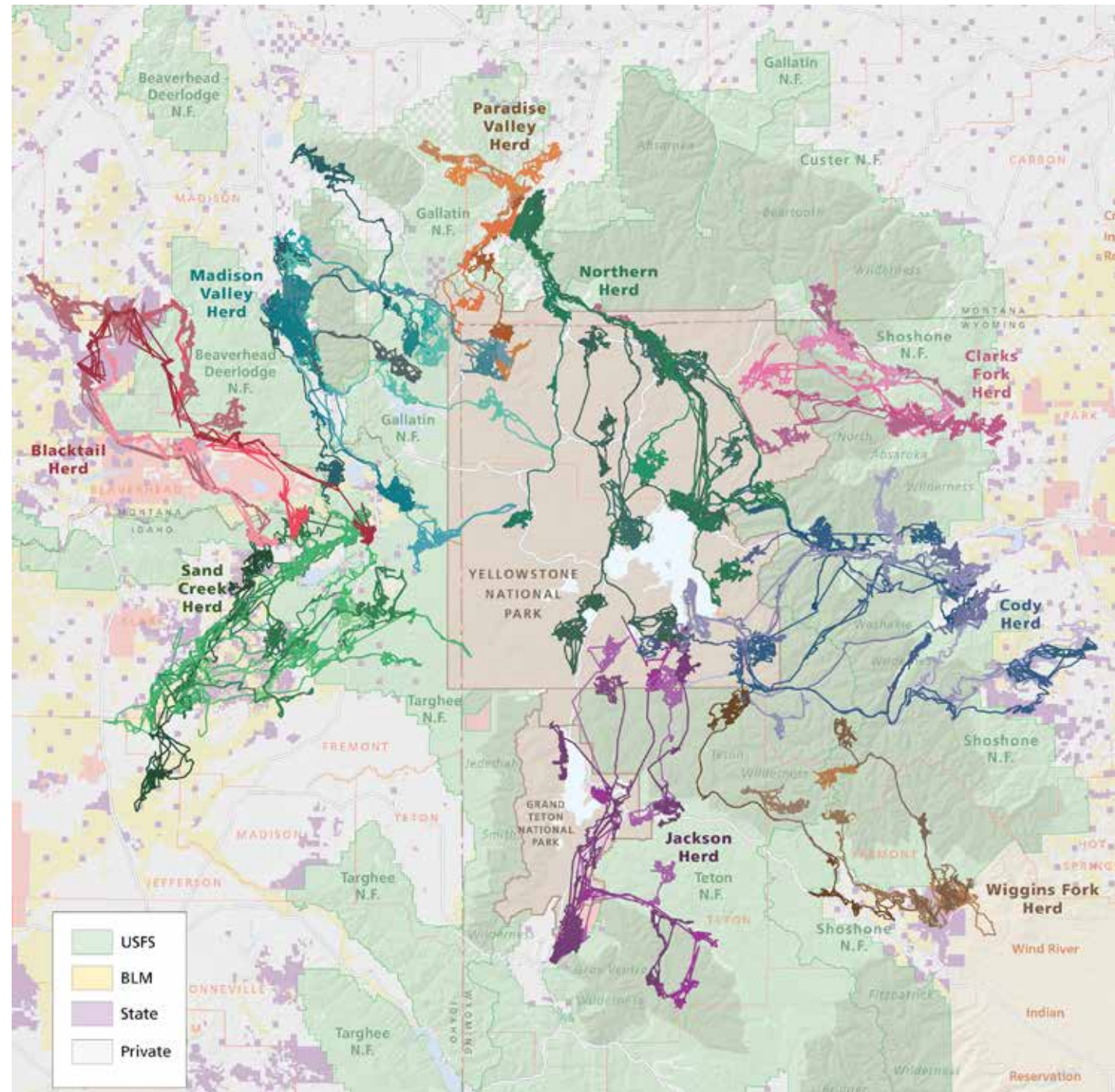
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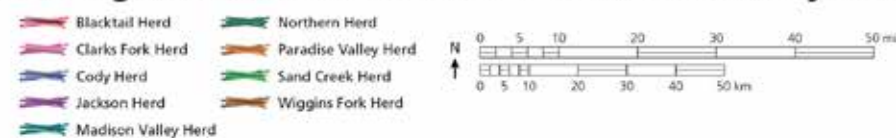
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Elk Migrations of the Greater Yellowstone Ecosystem



September 18, 2015 DRAFT

A photograph of a herd of elk and their calves on a rocky mountain slope. In the foreground, a large adult elk is partially visible on the right, with its head turned towards a young calf in the center. The calf is standing on a rocky path, looking towards the left. In the background, several other calves are scattered across the slope. The landscape is rugged, with large rocks and sparse vegetation. In the distance, a range of mountains is visible under a clear blue sky, with some peaks covered in snow. The overall scene is bright and sunny, suggesting a clear day in a high-altitude environment.

MIGRATIONS
A PHOTOGRAPHER'S
JOURNEY

JOE RIIS

When I was a kid, swarms of ducks and geese sometimes flew over our house at night, usually a few hours after the sun set. My dad would take me out onto the porch and say “Listen—hear those birds? The migration is here.” He would get me excused from school and we would go out to the slough.

Sometimes we shot a limit of birds by sunrise. These early memories—thousands of waterfowl migrating south in the Central Flyway—piqued my curiosity about migration. I always wondered, “Where did they come from, and where did they go?” This was my entry into the world of animal movements and migrations, a world I work in two decades later.

Imagine this with me. It’s early July, hot and dusty. A dirt trail traverses a steep, rocky mountainside. Pines cling alongside it. A silhouetted peak rises in the distance. Then add a burst of life. A group of three-week-old elk calves is following their mothers up the trail on their first migration. Less than 24 hours ago, they stood near the top of a 12,000-foot mountain. From there, they dropped 5,000 feet to the South Fork of the Shoshone River, swollen with snowmelt. They swam it, and now they are climbing 5,000 feet back

up on the other side. Soon, they will drop into the Thorofare Valley of Yellowstone, one of the remotest places in the continental United States, where they will spend the summer drinking their mothers’ fat-rich milk and preparing for the return journey to the winter range. The calves’ mouths hang open, gasping for air. They are exhausted, but they also are built for this. Over thousands of years, the species has honed these migrations to get the best food and shelter through the seasons. The elk are on the move.

This picture, shown on the previous two pages, took me two years to make, through much trial and error. I missed it entirely my first year out there. By the time the elk calves climbed past my camera, a grizzly bear had tossed my setup off the trail. I wouldn’t find that out for three weeks, after the migration had passed. I returned and reset the camera a year later. When I checked the photos after the migration, I saw that one afternoon everything had come together. A group of calves moved up the mountain right behind their mothers. Dust floated up from the trail and stuck to their legs, still wet from swimming the river. One calf bawled as it passed the camera, as if to call out both its great distress and its great purpose to the world around it. I got the photograph of my dreams.



Previous pages: On their first migration through their summer range in southeastern Yellowstone, three-week old calves follow their mothers up the mountain, July 2015. Photograph © Joe Riis.
Left: Riis and Middleton allow their horses to rest while following the Cody elk herd’s spring migration, June 2015. The ruggedness of the Absaroka landscape and the need to carry photographic equipment into the backcountry required horse support on most of the project team’s field expeditions. Photograph © Jenny Nichols.

THAT DREAM was a long time in the making. I have become known as a chronicler of animal migrations. That work began not far from Yellowstone, 75 miles south of the elk trail. On a blustery fall day in 2007, I stood on a knob in western Wyoming, looking north through binoculars. I did not know that what I was about to see through those lenses would change my life.

I was a senior in wildlife biology at the University of Wyoming, preparing to graduate the following spring, and I’d come here with my friend Emilene Ostlind, a creative writing student who’d read about biologists mapping a pronghorn migration in this area. Emilene wanted to follow the route on foot and write about the experience, and asked me to join the project as a photographer.

Neither of us was sure if it could be done. We had one crude, thumbnail-sized map from a scientific journal as reference, and not much else. We’d spent the previous two days hiking and driving in and around Grand Teton National Park, where we thought the pronghorn should be, but we hadn’t seen anything. Even if we found the animals, I wasn’t sure their migration could actually be photographed. I just didn’t know how it worked—whether they traveled by day or night, in small groups or big ones, single file or scattered. I hardly knew what I was looking for.

As we started the drive back to Laramie and approached the town of Pinedale, Emilene said, “Wait. It’s Trappers Point. Let’s stop here. I’ve read about this place.” I turned off the highway onto a gravel road, crossed a cattle guard, and drove to the top of a hill where a Wyoming State Historical Society sign described the fur trappers’ rendezvous that happened here in the 1830s. This was Trappers Point, a geographic bottleneck formed where two rivers sweep close together and back apart, outlining an hourglass-shaped bridge of land half a mile wide. The pronghorn migration study had highlighted this place because all the animals had to pass through one narrow strip of land.

I scanned the rolling, sage-covered bluffs beyond the highway, looking for motion, a flash of white. And to my surprise, I found it: A couple of miles away, a dozen pronghorn were walking single file right at me. I ran down the hill and set up my camera and tripod near the fence that lined the highway. Emilene and I crouched together in the sagebrush near the top of the hill and waited.

The antelope moved steadily closer until they came to the fence on the far side of the highway. They stared

through the wires at passing vehicles and moved back and forth along the fence line, looking for a good way through. Finally, one buck found a space under the bottom wire big enough to duck beneath. He ran out onto the highway, and the rest of the bunch followed one by one.

The animals ran across the asphalt as a truck slowed to let them pass. They came to another stop at the fence on my side of the highway, then ran back and forth looking for a way through. I held my breath, hoping they would cross the fence close to my camera. But they found an opening just downhill and out of sight, scooted under, and disappeared into a swale. I had missed the shot. All that remained to show their passing was a few hoof prints in the snow. Within an hour, another group of pronghorn came through, and again I missed the shot. We stayed until sundown, and then started the five-hour drive home to Laramie so both of us could make it to class the following day.

Despite that failure, something switched inside me. For the first time, I could imagine what a photograph of migration would look like, and what it would take to capture it. And I knew at least one specific place the animals crossed the highway and fences, a perfect place for a camera trap setup.

As soon as I graduated in the spring I bought three cameras and motion sensor triggers and moved into my pickup truck, where I lived for the next two years. I befriended Hall Sawyer, a biologist who had mapped this migration using radio collars a decade before. He explained the route and the timing of the migration. I developed a strategy, driving or walking to specific migration pinch points that I found on longer hikes through the corridor, places where I thought a motion sensor camera trap would work. I’d spend a day lugging a backpack of weather-proof boxes, cables, cameras, metal stakes, and motion sensors deep into the mountains, set up a camera, then walk back out to cook dinner and sleep in the back of the pickup. And I’d repeat it all the next day.

I spent many more days at Trappers Point. I watched desperate pronghorn fighting their way through the fences, sometimes snagging a horn or tangling in the wires. Dogs from the nearby subdivision chased the panicked animals along the highway. Sometimes I found pronghorn carcasses crumpled on the side of the road, struck by vehicles on a blind hill.

Over those two years I downloaded thousands and thousands of useless photographs. Photos with water



or snow or ice blurring the lens. Photos out of focus or with the wrong exposure. Photos taken by a camera face down in the dirt. Photos of animals as tiny specks in the distance or as an unrecognizable blur on the edge of a frame. A black bear knocked down and bit one camera housing, shattering the lens.

However, once every month or so, I'd get a frame among those thousands that worked, and after two years, I had a body of work that I felt showed the true urgency and determination in the migration. They started to reveal a journey that until now had only been documented as a series of dots on a map. I created an exhibit and a talk with photos, video clips, and maps. Emilene and I began to travel the state, sharing the stories and images of the migration with the public, with agencies, and with schools. Eventually I traveled farther afield to Salt Lake City, Denver, Banff (in Alberta), and even to Washington, D.C.

The response was overwhelming. As the science, the pictures, and the broader story percolated through the region and state, conservation and land management groups rallied to protect the migration. The National Park Service reached out to other agencies along the corridor seeking ways to keep it open. The Forest

Service designated the first "National Migration Corridor," protecting a forty-mile swath of the corridor on the Bridger-Teton National Forest. The Bureau of Land Management designated an Area of Critical Environmental Concern at Trappers Point, ensuring that the gas drilling so pervasive in nearby areas would never impede that bottleneck. The Jackson Hole Conservation Alliance took volunteer groups into the migration corridor to dismantle and carry away old, unnecessary fences. The Conservation Fund and a rancher put a critical piece of private land under a permanent easement to ensure that rural subdivisions would never block the migration there. The Green River Valley Land Trust retrofitted hundreds of miles of fence to make the journey easier for pronghorn.

And finally, the Wyoming Department of Transportation funded six wildlife underpasses and two overpasses designed especially for migrating pronghorn. One of those, at the Trappers Point bottleneck, meant that as of 2012 the animals no longer have to find their way through fences and traffic on Highway 191. Instead, without breaking pace, the migrating pronghorn flow over a big, wide, grass-covered bridge as vehicles speed by beneath.



Above, top: Pronghorn congregate at a wildlife-friendly fence with a smooth bottom wire strung at 16 inches above the ground, which allows migrating herds to safely slide underneath. **Immediately above:** Pronghorn cross Highway 191 near the town of Pinedale, Wyoming, October 2008. **Facing page:** Built in 2012, a highway overpass allows pronghorn to safely cross over Highway 191. Photographs © Joe Riis.

What happened in those first ten minutes at Trapper's Point and the two years after changed my life. Pronghorn changed my life. I fell in love with them. By triggering the motion sensors on the cameras, they essentially took their own photos, sharing with me the secrets of their migration. And in seeing their ancient migration, I began to see them as leftovers from a past world. They've seen the world change around them over thousands and thousands of years.

I also learned from that project the power of the photograph. People told me they had never seen these kinds of images of pronghorn before, with the animals so close to and facing the camera, with the motion and the migration story, the landscapes, the human obstacles. While I will never know exactly how much the photographs motivated conservation actions, I am happy to know they played an important role. The pronghorn helped me find my own way—helped me discover a purpose I had been looking for.

OVER THE FOLLOWING YEARS, my pronghorn work led me to other stories on four continents. I photographed wildlife and the scientists studying different species in far corners of the world for *National Geographic*—tigers in Thailand, tropical toads in Guyana and Venezuela, Gobi bears in Mongolia, lions and hyenas in Uganda, mountain goats in Canada, vicunas and pumas in Argentina.

Then, in 2012, my friend, the biologist Hall Sawyer, called me up and described a 150-mile-long mule deer migration he'd just discovered in western Wyoming. It was an incredible discovery, and I wanted to see it and photograph it to help Hall tell the story.

The deer were different from pronghorn. The migration was more than twice as long as the pronghorn's, spanning all the way from desert to high alpine. They didn't always walk in a line like the pronghorn and they spooked easily at



Doe pronghorn ford the Green River on their migration north towards Grand Teton National Park, May 2009. Photographer Joe Riis, says "this is the best photograph I've ever made and will ever make. The shadow on the rock was a gift, a moment in time full of beauty. I couldn't believe it when I saw the image on the back of my camera." Photograph © Joe Riis.

the camera. But Hall knew the country and had a new advantage: detailed GPS collar data from individual deer. He helped me find camera sites quickly, and identified the key parts of the story: the places where the deer swim lake outlets to avoid subdivisions or where they detour around elk feeding ground fences. Photographing the migration gave me new appreciation for deer, for their tenacity and vulnerability, and for the incredible way they link a southern desert to northern mountains, stitching together distant pieces of the landscape and complicating our ideas of ecosystems.

Hall and I worked together to study and document the deer migration. It was the most direct collaboration with a scientist that I'd been involved in. Working with Hall meant that his science reached the public more quickly, and my work was not only more efficient but carried a strong message. The results of our work together—clear maps alongside striking pictures—

were almost a dare for people not to try to protect the migration. This short deer project had brought me back to Wyoming, and set the stage for my work for *Invisible Boundaries*.

FOR THE LAST TWO YEARS, I've worked with biologist Arthur Middleton documenting elk migration in the eastern Greater Yellowstone Ecosystem. Elk are, again, different from pronghorn antelope and mule deer. One of the major differences is simply their story. Elk are huge, and there are thousands upon thousands of them engaged in many migrations around Yellowstone. Their 30-, 50-, or 100-mile migrations each spring and fall are, as Arthur writes in this book, like Yellowstone's pulsing heartbeat. They sweep into the park and nearby wilderness areas in the spring, great herds trailed by speckled, bleating calves, seeking the fresh green grasses and cool high-elevation meadows where they'll spend



the summer. In fall, they surge back, dropping through immense valleys and scaling high passes again, to return to the lower-elevation winter ranges and escape from Yellowstone's impossible snowpack and bitter cold. Working on the elk, I have come to see that the migrations I photograph are not only inspiring, and a powerful connection to the past, but are all together—elk, deer, pronghorn—the engine of the landscape I have come to care so much about.

Facing: Dr. Hall Sawyer retrieves a mule deer radio collar in the Hoback Mountains, October 2012. Sawyer discovered the longest known mule deer migration in North America in 2012, the Red Desert to Hoback migration, a one-way distance of 150 miles. Photograph © Joe Riis.
Above: Mule deer, Big Sandy, November 2013. Photograph © Joe Riis.

But the most significant difference for my photography has been the challenge of simply following the elk's trail, of occupying their world. To document the pronghorn migration I usually could drive to within a few miles of any camera site. To document the deer migration I rarely had to climb high into the mountains. Not so for elk. To tell the story of the elk migrations, Arthur and I had to choose a single herd. We chose the Cody migration because it was little known, and because our friend Doug McWhirter, who works for the Wyoming Game and Fish Department, was finding success taking trail camera photographs along a few pinch points on the migration.

But I had never been in the Absaroka Mountains and I didn't have a clear idea of the terrain. My work



AFTER TWO DAYS of the initial helicopter capture work, as we wrapped up on the TE Ranch, the pilot took Arthur and me on a thirty-minute flight up the South Fork of the Shoshone River to see the upper valley. As we approached Needle Mountain, for the first time I realized that I would not be able to do this work with a backpack; at the base of the mountain we were already seven miles from the nearest trailhead. The mountains are too big, too massive, and quite frankly just impossible to hike with all my gear. To get to locations as far as twenty miles from a trailhead, I needed to learn how to ride a horse and use pack mules.

Lee Livingston Outfitting, a horse packer with extensive experience in the Absaroka Mountains, brought us in. I know now, through experience, that the Cody elk herd's migration is among the most epic of land animal movements. They scale 12,000-foot passes and scramble through snow-choked notches in the rock. They thrash across the



Top: Riis, Middleton, and Scott LaFevers work down a steep hillside.

Left and facing page, bottom: The project team with their horses and mules. Typically, the team needed between four and eight mules to support backcountry trips ranging from one to twenty-one days. Riis covered more than 1,500 miles on horseback during the course of his fieldwork. Photographs © Jenny Nichols, June 2015.

Facing page, top: Middleton, filmmaker Jenny Nichols, and Riis prepare to leave their horses behind and traverse an 11,900-foot pass crossed by the Cody elk herd on spring migration. Riis's compelling photographs prompted the project team to launch a film project in collaboration with Nichols. Photograph by Scott LaFevers, June 2015.

requires a lot of heavy equipment. I need to drive my pickup as far as possible, then backpack. The further I need to backpack, the less gear and food I can carry.

When we started our work, the first step was Arthur collaring elk to fill a gap in knowledge about the Yellowstone elk migrations. This would help me figure out where I could photograph the migration and set up camera traps. The Cody herd winters mostly on

private ranchlands in the foothills and valleys east of the park, and we knew in spring the elk would leave for the Absaroka Range, but we hadn't seen the migration trails for ourselves. I knew that I needed to find locations high in the mountains where I could capture these "mountain elk" doing what they do. I had to make pictures of them climbing mountains.





I WISH TO SHOW WHAT IS AT STAKE. To show migrating elk, pronghorn, deer, and all the animals that need the freedom to roam. I hope people see the pictures, and more importantly combine what they see with the science and paintings in *Invisible Boundaries*, to gain a new understanding and appreciation of our first national park. I've had to learn entirely new approaches to my photography. As in my previous projects, I've captured thousands of useless frames. But as before, I've also found moments of perfection, frames that tell this migration story in ways words never could.

JOE RIIS is a *National Geographic Magazine* contributing photographer and Photography Fellow at the Wyoming Migration Initiative. His work explores the migrations of animals in the Greater Yellowstone region of North America, highlights science and research expeditions, and connects people to some of the most remote and rare species on the planet through his photography and video. He is the recipient of several awards including three *National Geographic* Expeditions Council grants, the 2013 Camp Monaco Prize with Arthur Middleton, the Stanford Knight-Riser Award for western environmental journalism with Emilene Ostlind, an Emmy Award for his work on pronghorn migration in the Great Migrations series, and principal support from the George B. Storer Foundation. His short films have toured in the Banff Mountain Film Festival and Telluride Mountain Film Festival. His photographs have been exhibited widely, and are included in private and public collections worldwide. Riis graduated from the University of Wyoming in 2008 with a B.S. in Wildlife Biology.



Pronghorn cross the Green River in May 2014, in the same location as the image taken five years earlier shown on pages 58-59. Some of Riis's best work results from revisiting migration corridors over the course of several years. Photograph © Joe Riis. **Facing, center:** Riis holds several camera filters, June 2015 (detail). Photograph © Jenny Nichols. **Facing, right:** A buck pronghorn crossing the Green River was caught in a river snag and died, becoming a bald eagle's meal, May 2014. Photograph © Joe Riis.

raging South Fork of the Shoshone River. They face wolves and grizzlies, and they undertake some of this journey in spring with newborn calves. To follow them I've hefted cameras up steep, scree-covered mountainsides. I've been turned back by storms and lightning, learned how wonderful horses and mules are, and been awestruck by what these wild animals achieve.





... BEHIND THE WORLD
OUR NAMES ENCLOSE
IS THE NAMELESS:
OUR TRUE ARCHETYPE AND HOME.

RAINER MARIA RILKE

YELLOWSTONE WILDERNESS IN A BOX

JAMES PROSEK

W

hen the boundary around Yellowstone National Park was drawn in 1872, a near perfect rectangle, it was meant to encompass and protect stunning natural wonders more geological than animal. A hundred and forty-three years later, with the encroachment of man and his industry, this line, visible on a map but invisible on the landscape, has become something more concrete, and a grave problem for some of the animals that cross it seasonally.

As an artist and writer, one of my lifelong interests lies in how the lines we draw between things in our minds, such as those dividing species, can ultimately come to affect things in reality. Nature is fluid and continuous and interconnected and in a constant state of change, but in order to communicate that continuum—to say “this is this, and that is that”—we have to chop it into pieces. Fragmenting the world and labeling the parts is necessary—how would we understand and share our world without naming things and putting them into some order? And yet the process of fragmenting nature so that we can name and order it immediately gives a false impression of how nature works. We forget that language is just a tool, finding comfort in the sense of control over nature that it gives us.

In my artwork I attempt to critique, among other things, our eagerness to go out in nature and name and identify creatures. Too often, I feel, we rely on language to help us see, sometimes at the expense of having a novel experience of our own—one that doesn't involve seeing nature as an assemblage of units that fit neatly into mental boxes. In one body of work, I appropriate imagery from the endpapers of old field guides, where silhouettes of birds and numbers match up to a list of names to help us identify things in the field. I paint murals of birds and corresponding numbers, but leave out the key, so the viewer feels frustrated that they can't satisfy their urge to know “what they are.” What they are, of course, goes beyond simply what we call them.

Facing page: James Prosek. *Yellowstone Composition No. 1*, 2016. Mixed media on wood panel, 120 x 120 in.
Overleaf: James Prosek. *American Elk (Wyoming)* 2016. Oil, acrylic and mixed media on wood panel, 56 x 90 in.





Middleton and Prosek study the diversity of plant life on elk winter ranges, July 2015. Photographs © Jenny Nichols.



In the course of what has become a lifelong inquiry into how and why we name and order nature, I have drawn others from varied disciplines into my maze of thoughts. In Arthur Middleton, ecologist and collaborator on this exhibition, I have found a fellow traveler and friend. We share common ground on the problem of drawing lines and boundaries on nature.

Each of us explores how lines humans draw on maps and on the land come to affect the movements and experiences of animals. Humans have become so powerful and pervasive that the classification systems and maps we create in our heads and on paper have actually, in many cases, become the terrain. ✿

The elk, the animal at the center of Arthur's work, spend their summers in Yellowstone and their winters on lands outside of it—oftentimes large, private ranches. Their fates are absolutely determined by which side of which line they are on at any given time (not only the park demarcation line but a host of other property borders both public and private). In the park they are a tourist attraction. Outside the park during hunting season they are someone's trophy or dinner. Just as the action of a chainsaw transforms forest to lumber (two different words that can apply to the very same trees), the cutting lines of Yellowstone define the identity of the elk in our minds.

As a kid, I was obsessed with the diversity of the trout of North America. I could not tire of painting their colors and forms in watercolors on paper. At ten years of age, unable to find a book of trout paintings in the local library, I set out to make my own. In the course of research for the book I learned that no two biologists could agree on how many trout species there were in our country, or even what a species was. At the same time, the decisions we make about where to draw lines between this population and that population have real world consequences. If a trout population is not deemed to be significantly different enough to name, then it cannot be protected by law. It cannot be listed as threatened or endangered, and it might as well not exist in human reality. We live in a time when a creature's being named as a species may mean the difference between existence and extinction. What markers and criteria do we use to determine what is significantly different enough to name? Morphological? Genetic? Such questions are heatedly debated amongst taxonomists (those who name things professionally). The Yellowstone cutthroat trout and the Snake River fine-spotted cutthroat (native fishes of the Greater Yellowstone Ecosystem) are genetically nearly identical and will readily hybridize. Under most definitions of species or subspecies their differences would not warrant status as a named entity. But to anglers and western economies, their very clear physical differences allow them to be loved for different reasons. ✿

Yellowstone is an important place to think about names and boundaries, because it is one of the world's greatest study sites for the relationships between human and non-human animals. The challenges in Yellowstone are paralleled in wild zones as diverse as the Serengeti and the Sargasso Sea, and people around the world look to Yellowstone for ideas and inspiration as they struggle with their own variations on its problems.

"YELLOWSTONE IS GREAT TO THINK WITH," Paul Schullery told me. "It helps us with all these fabulous and hopeless questions." Paul and I were driving with his wife Marsha from Bozeman to Gardiner, Montana, to spend a day in the park. It was January 2011. The only road open to cars was from Mammoth to Cooke City.

Paul had been a park employee for more than thirty years, and has authored more than a dozen books on Yellowstone. It was very special to spend time with him here. He

✿ In the Anthropocene, the way we think about nature, the way we talk about nature, shapes our perceptions of nature—and thus the way we treat nature and, in turn, the future of ecosystems. Consider how we selectively breed populations of animals unwittingly by harvesting trophy animals that we arbitrarily covet. We have fished out all the largest cod to eat, so the genes for beautiful big cod are now erased from the gene pool. Poachers and other hunters in Africa have targeted the bull elephants with the largest tusks, so now we are seeing fewer elephants with big tusks. Some scientific studies have shown that nature is selecting elephants with smaller tusks, or even no tusks, because they have a better chance of survival. The same has been said about other trophy animals of different species, such as bighorn sheep.

✿ The concept of a species has kept us from seeing a great deal of diversity and beauty—has allowed us to sweep much of nature's messiness under the rug. Thankfully, that is changing. One example is the native trout of Yellowstone Lake. If we thought of just preserving species and not significant local populations, then we would let the introduced lake trout eat all the native cutthroat trout that live there. Why protect them? The species itself is not in danger of extinction—there are plenty of Yellowstone cutthroats all over Wyoming. But we now recognize that the Yellowstone cutthroats that evolved in Yellowstone Lake are unique to that place. And without them running up tributaries to spawn in spring (providing food for animals as diverse as osprey and grizzly bears), the park ecosystem is disrupted.



had invited me out West to give a talk at Montana State University in Bozeman. At that time, I was starting to think heavily about themes of naming and ordering nature—about the division and fragmentation of nature through that process—so those are the things I had spoken about the previous night. As we drove from Bozeman that next cold morning, I could see that Paul, a naturally pensive guy, was thinking particularly hard. He said our outing had taken on new meaning because of my talk. He promised he'd tell me why.

At the north entrance to Yellowstone Park at the edge of the town of Gardiner, Montana, you pass through the grand Roosevelt Arch, appropriately named for Theodore Roosevelt, who was president when it was built in 1903. It stands alone and tall, made of stone, large enough for a tourist bus to pass through, even though it was built before Yellowstone authorized motorized transportation in 1915. On either side are hills and sagebrush. It is a massive structure that lets you know without question that you've entered one place and left another behind.

Soon after passing the Roosevelt Arch, following a winding road, you come to Mammoth Hot Springs, which Thomas Moran, William Henry Jackson, and others made famous in the nineteenth century with their paintings and photographs. Mammoth is a large, calcareous mound of white residue. The steam that rises from it and occasional pits of bubbling water reveal a thin earth crust and a molten earth core dangerously close to the surface, one of the many constant reminders here that the park sits atop a giant unstable caldera, the largest volcano in the world. *

We know from geological evidence that the eruption of this hot spot has obliterated the landscape in the past, leaving scars on the North American tectonic plate as it moves over the earth's mantle. This swath of demolished land, called the Snake River Plain, clears a connection in a southwesterly direction between Yellowstone and the Pacific Ocean, and is a major reason why Yellowstone is lush in summer, attracting grazing animals.

Paul and Marsha pointed to the chapel in Mammoth where they were married fifteen years before. They had given a great deal of their lives to this place. The chapel,

along with the hotel and the administrative buildings, had a quaint orderliness to them (Mammoth is the former military complex Fort Yellowstone)—rows of khaki buildings with red roofs. In summer, elk graze in the green spots in town as people stop at the gift shop and concessions (though things were very quiet here in winter). Many people, too, have migrated long distances to get here and are relieved. They made it—they are officially in the park. We could point to this as the good, perhaps, of names and boundaries. They have come to witness something, even if they don't know what, and many will leave full of wonder and inspired to protect natural things.

Not far outside of Mammoth we were passing an area called Blacktail Ponds when Paul pointed to a herd of bison running on the left side of the road, black smears across the whiteness, like in a painting by George Catlin. I'm always moved to think we almost wiped out these wooly ice age relics completely—by 1890 the millions of bison that once roamed North America had been reduced to a few hundred individuals.

Paul wondered aloud why they were running like this, with such frantic urgency. I didn't know enough to know that this was unusual, seeing bison run, but then Paul spotted something that struck him as equally if not more odd—a dark hole, almost completely black on the ground. He stopped the car at a pull-off that had been cleared of snow, enough to fit a car or two.

"What's going on over there?" Paul asked, more to himself than to me or to Marsha. He took out his binoculars and lowered the driver's side window.

A frigid wind, filled with crystalline whorls of snow, swept warmth from the car. Paul scanned the flatness of Blacktail Ponds. "There's movement."

"Whoa," he said, and we got out of the car. It was hard to keep my eyes open it was so cold, gusts of wind driving snow horizontally over the road. Paul handed me the glasses and pointed.

As the water in my eyes cleared and I focused the lenses, I could see what Paul had seen. Three bison had fallen through the ice into one of the ponds and were using their front legs in an attempt, vain it seemed to us, to pull themselves out of the muck and the icy water. Once you knew what the black hole represented, you could discern what

Facing page: James Prosek. *On Carter Mountain above Pitchfork Ranch*, 2015. Watercolor, graphite and gouache on paper, 5 x 12 ¼ in.
Above: James Prosek. *West Fork of Blackwater Creek*, 2015. Watercolor, graphite and gouache on paper, 5 x 12 ¼ in.

* In most places in North America the earth's crust is 20 to 30 miles thick. In Yellowstone only two miles separates the surface from magma, molten and partly molten rock. This is specifically called the Yellowstone Hot Spot; the crust is thinner here than anywhere else on earth.

was happening without the aid of the glasses. Marsha took a look, briefly, and then passed the binoculars back to Paul. “I can’t look,” she said. My heart wrenched too. I hoped of course that the bison would get out, but if they did could they survive? Even with their thick coats of woolly fur, with temperatures near zero degrees Fahrenheit and fierce winds, wouldn’t they just freeze solid?

“I don’t think they’re getting out of there,” Paul said, glasses raised to his eyes.

And he was right. We remained at the spot for about thirty minutes, until Paul and I could no longer stand to watch. The suction of the mud and the weight of the bison were too great. The ice continued to break from beneath their front hooves every time they tried to get on hard land.

As the frothy water in the hole grew still, the chunks of ice began to rejoin and make a solid surface. Soon, all we could see were their wet heads barely peeping above the water and tendrils of steam rising from their black nostrils like the smoke from a dying campfire. Marsha finally asked if we could move on. We got back into the car, warmed our hands and bodies, and drove away.

No one spoke for a while. Then Paul breathed deeply and said, “This is what people come to the park to see.” What we had witnessed felt primal and ancient, like mammoths in tar pits. It was pure raw struggle, elements and animal engulfing each other in a realm beyond language (in a ... dare we say ... wilderness?). Complex organisms would be rendered to their component particles by decay, energy transferred to microbial communities of nearly infinite diversity. These visceral experiences for which there are no descriptions, which strangle the part of your brain that needs to name and tame what just happened, this is indeed what people come to a place like Yellowstone to experience—call it awe, call it wonder. There is truth to the expression “I couldn’t find the words,” or “I was speechless,” or “It took my breath away.” That is, the breath we use for speech. In such moments we have no mode to communicate the full reach and richness of emotion.

Marsha, who for eleven years had been Yellowstone’s Chief of Public Affairs, said they would get calls all the time about animals in dire situations like this.

“Can’t you help them?” they would ask,” Marsha said, in the voice of a mock visitor. “And we had to explain, ‘no, the whole point of this place is to not control these interactions, this is what Yellowstone is all about, this kind of pure experience which is deep and timeless, as close to a world before humans as we can get today.’”

AND A WORLD WITHOUT HUMANS is a world without the imposition of language on it. No humans, no maps, no names for towns or mountains or rivers or waterfalls. That is why, as I came to find, names and ideas about wilderness can be at constant odds here.

Further up the road Paul pulled off and stopped the car. I knew this place—though it was hard to recognize at this season. Now hidden by ice and snow, a small willow-lined trout stream passed beneath the road. I had caught brook trout in this creek and had slept several nights in an old ranger cabin just upstream. It had been more than ten years since I’d been here, but I still remembered the name of the creek, Upper Blacktail, and the magical experience of being here alone. Apparently this place was also special for Paul. He had spent many days over the course of eighteen summers on top of a hill visible off the right side of the road, watching grizzly bears through binoculars and a spotting scope, making notes about the behavior of animals.

“You know,” he said, “some used to call this Paul’s Hill, but this name is only in the minds of a few park employees who worked in the park during that era. There was a plywood blind up there where biologists would sit and watch coyotes. During this coyote study they called this North Butte and the hill on the other side of the road South Butte. Some names are personal and come and go. The wolf biologists still call them North and South Butte. But you won’t find those names on any official map.”

This is how Paul’s narrative started. He had promised he would tell me what was on his mind, and now he did. “Your talk last night made me think of a few things about naming in Yellowstone. Now I want you to listen, and please don’t interrupt me.” Paul was emphatic. He knew even from limited experience that I have a bad habit of interrupting. And then he delivered a spotless, twenty-five-minute lecture about layers of naming in Yellowstone. Layers upon layers built up in his head over many years. He spoke about everything from the challenges of naming species of bacteria and other microbial life in the thermal pools and geysers (they can evolve rapidly and don’t reproduce like us), to why biologists give their study animals numbers instead of names, to a controversy over whether or not to name recently discovered waterfalls, to the overall challenges of the idea of a park with a border in a world where animals don’t obey the boundaries we set for them. I was grateful and stunned and wish I’d had the foresight to record what he said. He set my mind spinning about these intertwining issues, all relevant to my personal inquiry about what changes in the mind when we join words to the world. ✨

This moment with Paul was when I began to see Yellowstone as a place at the heart of my own personal journey. I was interested in exploring what this piece of land, delineated by a line and a name, meant to the human imagination, this place commonly referred to as “Wonderland.”

Toward the end of the day, as we approached Mammoth and the Roosevelt Arch again, I thought back to when I first visited Yellowstone with my family in 1979. I was four years old. We had driven across the country in an orange Volkswagen camper bus, all the way from Connecticut, over the Appalachian Mountains, through the plains to Wyoming and the foothills of the Continental Divide. My dad was a schoolteacher and had summers off. My mom was, well, a mom. We lived in the orange bus for two months, staying at KOA and other campgrounds. I have a Polaroid photo of Roosevelt Arch from that trip, and another of my mom posing way too close to a bison.

Since then, I’ve passed through the arch dozens of times. Each time I am affected by it. The landscape is altered in my mind. But until today I had never thought to ask why. Why is that stone structure so powerful? How can it be so critical to shaping my mood? Perhaps it creates a narrative by setting limits and giving us a border. Without limits we have no place from which to come, and nowhere to go, no acknowledgment of space. ✨ The arch has great authority. It declares, “This is no ordinary piece of land; this is a National Park.” I pass through with mixed feelings. The Roosevelt Arch has a positive message engraved in it: “For the Benefit and Enjoyment of the People.” But does this exceptionally unique piece of land need such an entrance? Isn’t the beauty and wonder inside enough? Is the arch a celebration of wilderness or of our victory over it—it is after all, architecturally, a triumphal arch.

Later I brought up the arch with Arthur. He said he found it creepy. “It makes Yellowstone feel like the Bronx Zoo,” he told me. “Like it was too expensive to get a wall put up around it, so they just settled for the gate part of a wall.” I asked Arthur in jest if anyone had ever proposed a great wall around Yellowstone. He said no. ✨

✨ Here, I’m alluding to the poet Lyn Hejinian’s essay “The Rejection of Closure.”

We delight in our sensuous involvement with the materials of language, we long to join words to the world—to close the gap between ourselves and things—and we suffer from doubt and anxiety because of our inability to do so.

✨ Defining spaces is as essential to being human as naming and is similar in concept. We draw a border around something where a border did not exist. Space cannot exist without borders. In 700 BC the Chinese philosopher Lao Tsu wrote: *Thirty spokes came together at one hub; because of the empty spaces we have use of a carriage wheel. Mould the clay; because of the empty spaces we have use of the pot. Cut out doors and windows; because of the empty spaces we have use of a room. Thus we gain something by making use of no-thing.*

✨ Paul Schullery mentioned to me that “fences were built and experimented with over the years along the park boundary on the northern range in the general vicinity of Gardiner, Montana. These were attempts to constrain the movements of the large mammals, some or all of them.”



And then together we imagined a Yellowstone wall as a thought experiment.

Let's say we did build a wall around Yellowstone. Which animals would live, and which would die? For the elk and other ungulates that migrate seasonally into and out of the park, a wall would be the equivalent of a dam for migrating salmon or eels. It would stop the flow of life, and render the circulatory system of the land—migrations being, in this metaphor, the lifeblood—in a state of cardiac arrest. The author-activist Todd Wilkinson calls the park border “the invisible killing line.” Since the mid-1980s the government, in the guise of the Montana Department of Livestock and, at times, the National Park Service, has shot nearly 8,000 bison for crossing that line. Ranchers fear the bison will transmit an infectious disease called brucellosis to their cattle, which then would have to be culled—shot—themselves. Their fears stem in part from rules that prohibit the export of beef from a state if cattle contract the disease—a huge and real economic peril for many of those who make their living near Yellowstone. And yet, no documented case exists for the transmission of the disease from bison to cattle.

It was hard enough watching those bison die that day by means that most would describe as natural. But knowing they die at our hands by crossing a line that we impose on the landscape, simply because they are heeding an instinct to move that is ingrained in their heads through thousands of years of evolution, is harder to accept. Even when we understand the reasons behind this conundrum, it seems we ought to be able to do better to honor the creature and its needs, and retain in

our world that nameless feeling the bison had given me, and gives to so many others.

This time, because of my experience that winter day, passing under the arch changed me. I decided to take on Yellowstone and its names, largely following the outline that Paul had given me on that cold winter day when we watched the bison freeze to death.

DURING THE RESEARCH for this collaborative exhibition (and for my book on naming, in which Yellowstone is a chapter) I spent time in the backcountry with co-contributor Arthur Middleton, visiting several of his study sites. On the first trip in the field with him and Joe Riis in July 2014, we went by horse and mule up the South Fork of the Shoshone River. As Arthur and Joe describe in their essays in this book, we were headed to a place along the migration route of the Cody elk herd, where elk are forced through a narrow canyon—a pinchpoint—and then must swim across the river, which, at this time of year, was raging with snowmelt. We rode into camp and pitched our tents, went to sleep and were up at dawn to sit behind a makeshift blind by the river and watch elk attempt the crossing. As light filtered into the canyon a few cow elk and bulls came down and dipped their toes in the water, even ankles and torsos. They seemed wary, lifting their heads high to sniff the air. Perhaps they sensed our presence in the blind. Or maybe they were just too cold. Still, it was remarkable to be so close to them, to glimpse these amazing animals on an epic annual migration from their winter range on the Pitchfork Ranch, over snow-capped mountains to their summer grazing grounds in the park.

Our last morning in camp we sat by the fire where we cooked a breakfast of eggs and bacon, waiting for the outfitter to come get us, resting our heads against piles of packed-up gear. Joe set up a camera trap at the campfire site. He said that a day or two after we left a grizzly usually would come and dig through the pit for scraps. I thought back to the day we arrived. We had ambled our way up the trail in the hot sun on horseback, through meadows of wildflowers and large fields of scree. I told Arthur I had seen a western tanager fly overhead and into a Douglas fir, a flash of red and yellow, “passing like a thought,” as Audubon once described the passenger pigeon gliding through the woods. The bird was already a memory by the time you acknowledged you'd seen it.

“You know that bird spends its summers here, and winters in Mexico and Costa Rica,” I said to Arthur. We marveled for a moment that the Yellowstone ecosystem is somehow connected to the tropics through this small migrating bird.

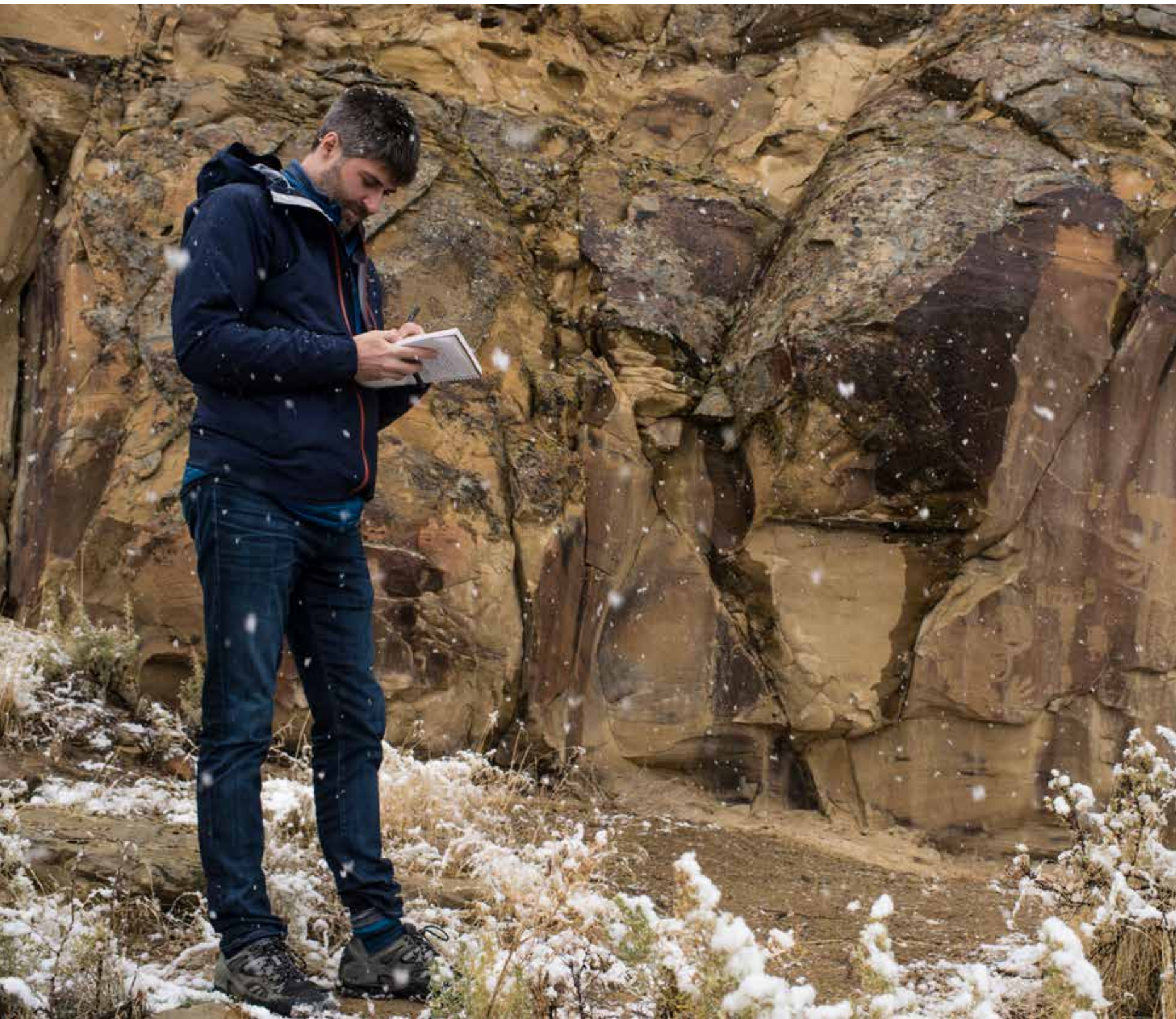
“What does that mean for the idea of the Greater Yellowstone Ecosystem?” Arthur asked.

We discussed the fact that in some ways the idea of an ecosystem itself is flawed. The existence of the word suggests that an ecosystem has a beginning and an end; the word puts up walls. Although the modern and accepted term “Greater Yellowstone Ecosystem,” or GYE, embraces the idea that Yellowstone doesn't end at the park border, the concept began to feel shortsighted when we considered that ecosystems overlap other ecosystems. We have yet to truly and finally embrace the visions of Humboldt, Darwin and Haeckel, Muir, Carson, Leopold, and many others, of a holistic, interconnected planet.

Perhaps it is time for a re-examination—a taking down of walls. If Yellowstone, in a word, has come to mean “a box with stuff in it...” then we have to work to make that word mean something else. And that, put simply, is the goal of our present work and of this exhibition.



Facing page: James Prosek. Western Tanager and Short-eared Owl Feather, 2015. Watercolor, graphite and gouache on paper, 5 x 13 in.
Above: James Prosek. Fracs Fork—Tributary of the Greybull River, 2015. Watercolor, graphite and gouache on paper, 8 ¼ x 11 ¼ in.



Prosek sketching at Legend Rock near Thermopolis, Wyoming, 2015. Photograph © Joe Riis.

Arthur and Joe asked how I thought I could portray these concepts through art. Arthur joked that I could paint a lonely pronghorn antelope in a tropical forest, to emphasize the web-like interactions the tanager had raised. I liked the idea, a very serious one to me. Later, considering the bison, and the cows that have largely replaced them as the grazing grassland animal outside the park, I mused of painting a hybrid creature of the two. The depiction of a two-headed cow-bison could help provoke conversations about domestic versus wild, and, with humor, allow us to loosen our grip on Yellowstone and keep expanding our idea of what it is.

In time, all boundaries, even the ones we erect that seem most permanent—will come down. I believe this is what Paul was trying to tell me when he spoke of the ephemeral nature of place names in the park. Our maps, names, and boundaries won't mean much, after all, when Yellowstone's caldera again erupts—as geologists forecast that it will. Given enough time, our impositions on nature will melt away. But that time has not yet come, so we must be mindful of the dangers that the names and the lines we draw can inflict. Though they may not be visible, they do mean something to the lives of the creatures here, and that includes us. The work of embracing the fluidity and interconnectivity of nature, of fighting our urge to draw lines between this and that, is more important today than it ever has been.

I felt this most strongly, and refreshingly, when I visited Legend Rock near Thermopolis, Wyoming, in a November snowstorm. Legend Rock is largely considered to be one of the most significant Native American rock art sites in North America. It is possible that some of the figures depicted on this long, exposed stone face were chipped 10,000 years ago. As a visual artist I wanted to see how humans before us had interpreted the creatures of this region—even if I could never fully know the intent or meaning of their work. Larry Todd, an archeologist who had grown up in the vicinity of Legend Rock, explained that the Shoshone Indians saw the rock face not as something rigid and hard, but permeable, an interface between the human and spirit worlds. Some of these figures were thought to exist between these two worlds. I was struck by the frequency and number of hybrid creatures depicted on the rock face, what appeared to be bison and elk heads on bodies of men. The works were double hybrids in a sense—between here and somewhere else, between human and non-human animals. I chose to interpret this abundant hybridity as an acknowledgment of a perpetual flow and web-like interaction in nature. We ingest nature and it becomes part of us. We are elk, we are bison, we are living somewhere between birth and death on a never-ending continuum with no permanent boundaries.

YELLOWSTONE was the first national park in the world, established by an act of Congress less than ten years after the Civil War. Before that, the idea of a park for a nation did not exist except in the minds of a very few farsighted people. 🌿 Parks were city parks. The designation of Yellowstone as a park created a huge perceptual shift in the minds of humans: the thinking that we should preserve some semblance of wilderness before it was too late, before wild disappeared. The park was created when a geologist named Ferdinand Hayden, a painter named Thomas Moran, and a photographer named William Henry Jackson, delivered evidence of a place that they thought was sacred and worthy of protection. 🌸 A big selling point was the remarkable thermal activity—puddles, pools, bubbling mud pots, fumaroles, geysers, and hot springs in all imaginable colors. Hayden drew a big rectangle around a monumental piece of land and they named it. 🌿 The name, very much like the arch, created something out of the nameless landscape, transformed this piece of land in our heads.

🌿 In 1841, the artist George Catlin proposed that the entire western U.S. be made into “a nation's park, containing man and beast . . .” The historian Aubrey Haines describes this and other pre-1872 proposals for such a park in *The Yellowstone Story: A History of Our First National Park*.

🌸 Of course, as is the case with any story, especially one as significant in American and world history, it's never just as simple as three people coming together to make something happen. There were other people involved, and there were other less lofty factors involved than the scientific and aesthetic aspects championed by Hayden, Moran, and Jackson. The Northern Pacific Railroad got behind the park idea at this stage, and without a doubt their commercial interests (i.e., the potential for a great tourist industry) were a major factor in the creation of the park. Paul Schullery writes about this in his book, co-authored by Lee Whittlesey, *Myth and History in the Creation of Yellowstone National Park*.

🌿 Paul Schullery discusses how Yellowstone got its name in *Searching for Yellowstone: Ecology And Wonder In The Last Wilderness*.

When a place receives a name, it enters our reality, it becomes something that it wasn't before—among other things, a destination. As problematic as the border may be, it's safe to say that if that line had not been drawn (if that land had not been partitioned and labeled) this wonderland would most certainly be worse off than it is today. Four million people now cross that line every year and enter a different world, go back in time. Perhaps it shouldn't be so surprising that the border has come to mean so much—when past and present collide there are bound to be deep misunderstandings. No single guide or translation can help us. Yellowstone represents something more than a park, something less tangible, not quite definable—a state of mind. That is why Paul Schullery titled one of his many books about the park *Searching for Yellowstone*. We can search all we want for what it means, but in a sense we never find it.

All these themes, this talk, may seem self-evident, but it can't hurt to reiterate. At times, yes, Yellowstone can appear like a wilderness in a box, but then again, when you're out on the land itself, filled with the scent of sage, the visual feast of a wildflower meadow, a trout holding in a thread of current, it is not in a box at all.

I can say for certain, back here in Connecticut as I write, that Yellowstone has reached at least this far. It is part of me now.

JAMES PROSEK is an artist, writer and naturalist living and working in Easton, Connecticut. He travels widely to research his works, which depend heavily on personal experiences in nature. He has had solo presentations of his work at various institutions including the Philadelphia Museum of Art, the Smithsonian American Art Museum, the Addison Gallery of American Art, and the North Carolina Museum of Art. Prosek is the author of twelve books including *Trout of the World*, and *Ocean Fishes*. He writes frequently for *National Geographic* and *The New York Times*. In 2012 he wrote and directed *The Mystery of Eels* for the PBS series *Nature*.



James Prosek. *American Bison*, 2014. Watercolor, gouache, and colored pencil on tea-stained paper, 24 1/4 x 28 1/2 in.