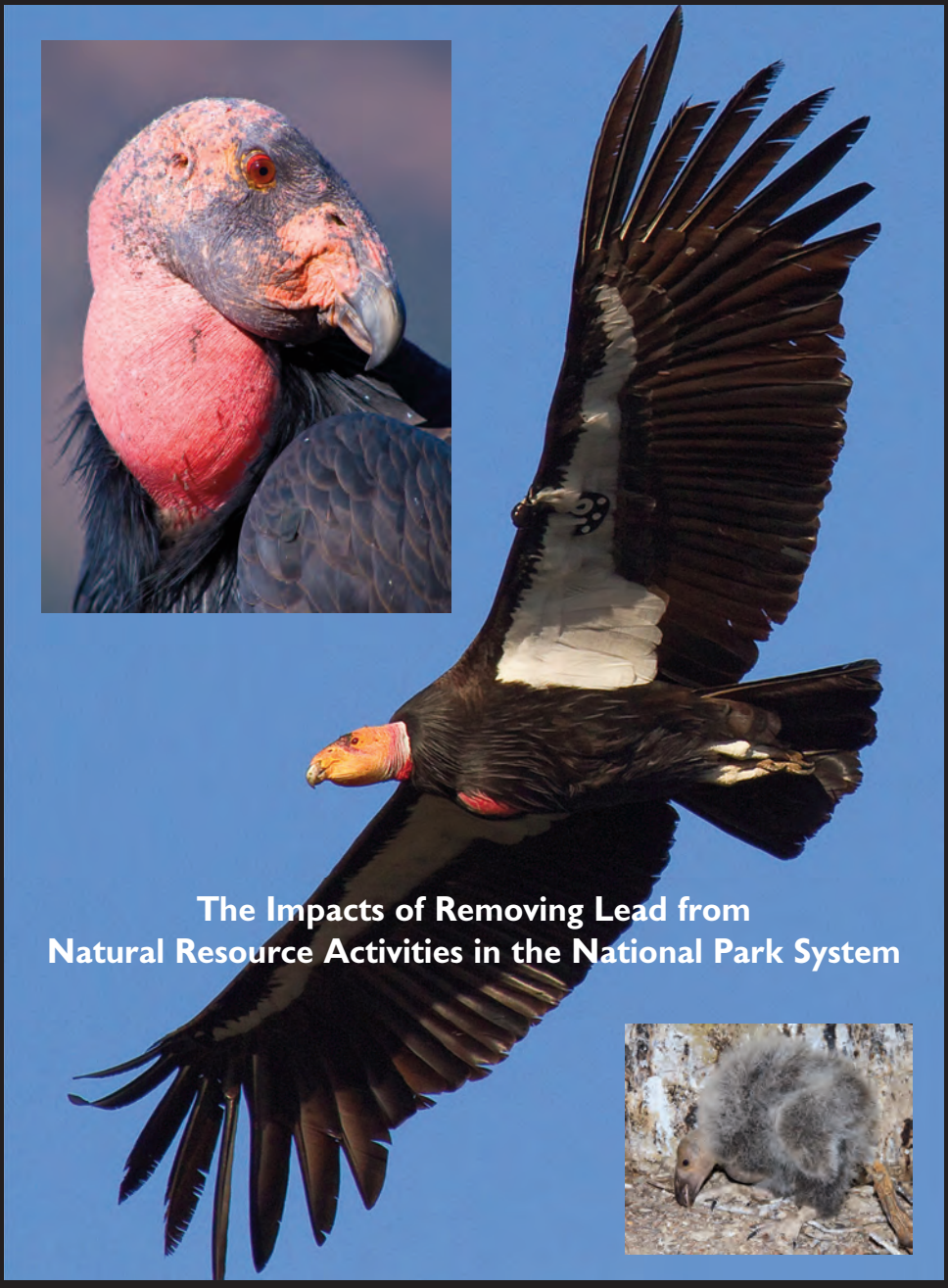

The Impacts of Removing Lead from Natural Resource Activities in the National Park System

The George Wright Forum

The GWS Journal of Parks, Protected Areas & Cultural Sites

volume 28 number 1 • 2011

Origins

Founded in 1980, the George Wright Society is organized for the purposes of promoting the application of knowledge, fostering communication, improving resource management, and providing information to improve public understanding and appreciation of the basic purposes of natural and cultural parks and equivalent reserves. The Society is dedicated to the protection, preservation, and management of cultural and natural parks and reserves through research and education.

Mission

The George Wright Society advances the scientific and heritage values of parks and protected areas. The Society promotes professional research and resource stewardship across natural and cultural disciplines, provides avenues of communication, and encourages public policies that embrace these values.

Our Goal

The Society strives to be the premier organization connecting people, places, knowledge, and ideas to foster excellence in natural and cultural resource management, research, protection, and interpretation in parks and equivalent reserves.

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On the cover: See p. 4 for a description and photo credits.

SOCIETY NEWS, NOTES & MAIL

Over 1,100 attend GWS2011 Conference in New Orleans

A record crowd of 1,139 people came to New Orleans the week of March 14–18 for Rethinking Protected Areas in a Changing World, the 2011 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites. These biennial conferences, whose origins go back to 1976, have established themselves as North America's leading interdisciplinary professional meeting on parks. Four plenary sessions, over 200 concurrent sessions, a large poster session, field trips and service projects, and an array of special events stepped attendees through a week of stimulating discussion about leading-edge research, innovative practices, and foundational values.

Complete information about GWS2011 is on the conference website: www.georgewright.org/gws2011. A conference proceedings will be published as an e-book in PDF format on the GWS website later this year. You can also view an extensive gallery of pictures, taken by conference photographers Dorothy Davis and Gary Davis of GEDavis Associates, at https://picasaweb.google.com/gedavis.assoc/2011_GWS_Conf_PIX#.

The GWS conferences are all about reflection, reconnection, and renewal—a chance to reconnect to the core values that motivate your work. You don't want to be left out! The next one will be March 11–15, 2013, in Denver, Colorado. If you missed GWS2011, but would like to be notified when the Call for Proposals for GWS2013 comes out (around June 2012), just fill out the form at www.georgewright.org/gws2013_notify.

Cole, Gladstone, Schullery, Sellars take home GWS awards

The capstone of the GWS2011 Conference was the joint NPS/GWS Awards Banquet on March 17. A GWS tradition, the top National Park Service awards for excellence in natural and cultural resource management and research, and in wilderness stewardship, were presented alongside the GWS's own awards.

- The 2011 George Melendez Wright Award for Excellence, the Society's highest honor, was given to Richard West Sellars. He was cited for his lifelong contributions to historic preservation and other forms of cultural resource management, and for his seminal book, Preserving Nature in the National Parks: A History, which has transformed natural resource research and management in the National Park Service.
- The 2011 GWS Cultural Resource Achievement Award was given to Ernie Gladstone of Parks Canada for his pathbreaking leadership in integrating Native science and worldviews into the management of Gwaii Haanas National Park Reserve and National Marine Conservation Area Reserve, of which he is superintendent.
- The 2011 GWS Natural Resource Achievement Award was bestowed on David N. Cole of the USFS Aldo Leopold Wilderness Research Institute for more than three decades of pioneering practical and applied research in recreation ecology and wilderness management.

- The 2011 GWS Communication Award was given to Paul Schullery, who was recognized for his career of distinguished publications in conservation history and the natural history of the Greater Yellowstone Area.

You can download a PDF of the 2011 awards banquet program containing full citations of these awards, as well as those of the NPS Director's Awards for natural resources, cultural resources, and wilderness, at www.georgewright.org/gws2011_banquet_program_email.pdf.

2011 GWS Board election: Call for nominations

This year, two seats on the Board of Directors are up for election. One is held by Gary E. Davis, who will be running for re-election, and the other by Rebecca Conard, who is stepping down. We are now accepting nominations from GWS members who would like to be candidates in this year's election. The term of office runs from January 1, 2012, through December 31, 2014. Nominations are open through July 15, 2011.

To be eligible, both the nominator and the potential candidate must be GWS members in good standing (it is permissible to nominate one's self). Potential candidates must be willing to travel to in-person Board meetings, which usually occur once a year; take part in Board conference calls, which occur several times per year; help prepare for and carry out the biennial conferences; and serve on Board committees and do other work associated with the Society. Travel costs and per diem to the annual Board meeting is paid for by the Society; otherwise there is no remuneration. Federal government employees who wish to serve on the Board must be prepared to comply with all applicable ethics requirements and laws; this may include, for example, obtaining permission from one's supervisor, receiving ethics-related training, and/or obtaining a conflict of interest waiver. Currently, the National Park Service prohibits its active-duty employees from running for the Board.

The nomination procedure is as follows: members nominate candidates for possible inclusion on the ballot by sending the candidate's name to the Board's nominating committee. The committee then, in its discretion, determines the composition of the ballot from the field of potential candidates. Among the criteria the nominating committee considers when determining which potential candidates to include on the ballot are his/her skills and experience (and how those might complement the skills and experience of current Board members), the goal of adding and/or maintaining diverse viewpoints on the Board, and the goal of maintaining a balance between various resource perspectives on the Board. (It also is possible for members to place candidates directly on the ballot through petition; for details, contact the GWS office.)

To propose someone for possible candidacy, send his or her name and complete contact details to: Nominating Committee, George Wright Society, P.O. Box 65, Hancock, MI 49930-0065 USA, or via email to info@georgewright.org. All potential candidates will be contacted by the nominating committee to get background information before the final ballot is determined. Again, the deadline for nominations is July 15, 2011.

This call for nominations is also an opportunity to remind members that the Board elections now take place exclusively on-line. We use your email address as the voting passcode, so this means we need a valid email address for you in our database or you won't be able to take part. If you have recently changed your email, please let us know by sending a note to info@georgewright.org.

Erratum

In Karen Merritt's article "The Le Conte Memorial Lectures and Park Interpretation: A Historical Account" (volume 27, number 3, 2010), there is an error on page 304. In the last sentence of the first full paragraph, the clause "As early as the beginning of 1918" should read "As early as the beginning of 1919."

On the front cover

Lead poisoning is a hazard for many wildlife species, especially carrion feeders such as the California condor (*Gymnogyps californianus*). Individuals may ingest lead from ammunition fragments or residues left behind in carcasses of animals that have been shot to death. See the series of articles beginning on p. 21. Cover main image: Adult male California condor in flight, Pinnacles National Monument, California. Upper left inset: Head detail of sub-adult female California condor, Pinnacles National Monument, California. Lower right inset: California condor nestling at cavity nest, "The Rocks" area, central California. All photos © 2011 by Gavin Emmons (www.gavinemmons .com). Used by permission.

A Personal Reflection on the 2011 George Wright Society Conference

Robert A. Winfree

The 2011 George Wright Society conference, held March 14–18 in New Orleans, Louisiana, was a great reminder of why we do what we do as park professionals, and that doing the right thing isn't always going to be as simple as we'd wish. Held every two years, the GWS conferences are arguably the single best opportunity for park scientists, scholars, managers, cooperators, educators, and students from all disciplines and all corners of North America to meet and interact with their peers and leadership. I first discovered the GWS in 1995 when I joined the National Park Service, and I haven't missed a conference since. I've come to regard the GWS as the preeminent professional organization for people interested in park resources and science. However, for many of our colleagues, fiscal uncertainty and limited travel opportunities made their decision about whether or not participate in this conference more difficult.

The 2011 conference also turned out to be a test of commitment for leadership of the Society, and for our agency. Although the GWS weathered the recent recession in better shape than some other professional societies, the success of the biennial conference has always been key to the success of the organization. There were still many clouds in the sky during the months leading up to the March 2011 conference date. The Society's relationship with the NPS, historically one of its strongest and most steadfast supporters, had been severely questioned by government investigators. As a consequence, a long-standing cooperative agreement lapsed, cutting off support for programs that were important to the NPS, other agencies and partners, and the GWS. The Society's Board of Directors also had to be reorganized to comply with new requirements that precluded Department of the Interior employees from serving in that capacity. As the deadlines approached for GWS to commit scarce funds to conference facilities and lodging, the specters arose of tighter travel caps, a possible travel freeze, and even a federal shutdown. The Society's leadership developed contingency plans where they could, but planning for the 2011 conference continued, as it must to meet the needs and expectations of the membership.

In the end, the winds of change turned again and blew favorably for the conference. A new agreement was put in place between the NPS and GWS, with a clear commitment to

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work together to plan and implement conferences in both 2011 and 2013. The NPS also provided critical financial support for GWS programs to increase participation by diverse students, and by Native and indigenous people. The vacancies on the GWS Board of Directors were refilled quickly, as experienced and committed professionals stepped up to the plate. With renewed support from NPS leadership, the outgoing board members continued providing support throughout conference planning and implementation, and the number of registered participants continued to increase. The Society's New Orleans conference was its largest and most successful ever, with more than 200 technical sessions and over 1,100 people participating, including many first-time participants. The program included keynote talks by internationally recognized authors and experts on climate change, tribal consultation, resiliency, and a thought-provoking discussion of relevancy with top leadership of the Canadian and US national park agencies. The increased participation by park professionals from other nations and tribes was especially gratifying. Although it sometimes required hard individual choices, this region was also very well represented in all stages of conference planning, implementation, and participation.

What can we learn from all this? The challenges of being a park professional come in many forms. Some are more obvious or more difficult than others, and our parks face a lot of bigger issues than this every day. In the greater scheme of things, our individual presence at any particular meeting may not always be significant to the outcome of the meeting. However, part of what makes us park professionals is our collective belief in the mission of the National Park Service, in sharing what we've learned with others, inspiring and being inspired by our peers. It's also about our individual commitments to do the right thing, whatever we understand that to be. This successful conference is another reminder of what a number of individuals can accomplish when they share a common purpose and strive to make it happen. I look forward to seeing you again in Denver in 2013.

[Ed. note: This short essay is taken from Bob Winfree's regular "Directorate Corner" column for National Park Service Alaska Region employees, which is published on the region's intranet site. Winfree recently served on the GWS Board of Directors and as an NPS liaison to the Board, and was also a member of GWS2011 Conference Committee.]

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Projecting America's Best Ideals: International Engagement and the National Park Service

Brent A. Mitchell

Imagine a majestic mountain, and rangers leading a group of children through an alpine meadow. They stop to point out orchids and other plants at their feet, and name the birds flying overhead. They tell stories of others who came before on the land. The scene is familiar, and you may have pictured flat hats, arrowhead patches, and a typical scene in any of a number of US national parks. However, I was describing a field trip of a century ago, in Switzerland. The only Americans were visitors,[1] and the "rangers" were Swiss guides. This visit is often cited as an inspiration for our familiar concept of the American ranger naturalist, a figure held in the public imagination as the personification of the National Park Service.[2] Like many inventions, our national park system is a combination of homegrown innovation and borrowed ideas. In fact, the formation of the National Park Service itself drew on the Dominion Parks Branch in Canada (now Parks Canada), established in 1911 as the world's first national park agency. From the advent of Yellowstone and Yosemite to the present day, America's national parks have both provided example to—and taken inspiration from—protected areas around the world.

The National Park Service earned a reputation as a leader in international parks development and management, particularly in the middle of its first century, hosting the first World Parks Congress, spearheading the World Heritage Convention, providing extensive training to international park professionals. However, that international engagement has declined, perhaps because the value back to America, its parks, and the National Park Service was underappreciated.

The National Park Service was almost 50 years old when the United States hosted the first World Parks Congress in 1962.[3] A half-century later, the global parks movement has expanded exponentially, both in number of areas nominally protected, and in innovation of

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management and governance. Throughout that time, America's involvement in the international parks movement has taken many forms, and its influence and engagement has waxed and waned with the times.

I will steadfastly avoid any discussion of the national parks as "America's best idea"—either in the sense of whether America has an exclusive claim, or the question of primacy of national parks among America's many great ideas. But certainly our national parks represent some of America's best *ideals*. Conserving for future generations, open to all for learning and enjoyment, telling the stories of history—good and bad—these are ideals that show America at its best, to ourselves and to the world.

Unfortunately, beginning in the 1980s the National Park Service's international role ebbed to an all-time low. Will it re-emerge in the agency's second century?

A tradition of international engagement

The National Park Service has assisted park creation and management efforts overseas almost from its beginning in 1916. During the 1930s, the Park Service sent a delegation to South America, leading to the Inter-American Convention on Nature Protection and Wildlife Preservation, signed by the US and 16 Latin American nations—a treaty calling for the establishment and extension of national parks and nature areas.

In 1936, our organization's namesake, George Melendez Wright, served on a commission to plan international parks and reserves along the border with Mexico. In fact, he and Roger Toll, superintendent at Yellowstone, were traveling from a binational meeting at Big Bend National Park when they were struck and killed by an oncoming car.

During the 1940s, the United States responded to requests for parks assistance in several countries, and was engaged in the rebuilding of national parks in Japan after World War II. In 1954, the Agricultural Trade Development and Assistance Act famously established the Food for Peace program, but also authorized the use of external currency for parks projects overseas.

The World Parks Congress in 1962 was part of a formalized effort to institutionalize NPS international programs, including the precursor to the Office of International Affairs. The Park Service sent staff on long-term assignments of two years or more to assist planning and development of national parks in Kenya, Ethiopia, Tanzania, and Jordan, and developed master plans for protected areas in Turkey and India.

In parallel with bilateral assistance, the National Park Service provided leadership in strategic global conservation initiatives, including creation of the World Heritage program and initiatives to professionalize and systematize parks management through the World Commission on Protected Areas. In 1965, NPS initiated an influential training program, the International Seminar on Administration of National Parks and Equivalent Reserves, which trained hundreds of park professionals through the 1980s.

Beginning in 1967, the National Park Service began to cooperate with the Peace Corps, initially training volunteers on their way to Africa, and later for Latin America and other regions. In 1972, the US hosted the Second World Parks Congress at Yellowstone, an event that may be seen as the apex of international engagement for the Park Service. A concurrent proposal to create a dozen NPS teams to advise international park programs was not real-

ized. In the mid-1970s, internal briefings pointed to a "huge imbalance" in NPS assistance overseas, asserting that US parks gained little in the exchange. By the 1980s, the Park Service was beginning to limit its international involvement to meeting its obligations under treaties and bilateral agreements.

Of course, the National Park Service never completely abandoned the international stage. Since 2000, the Park Service has hosted the first World Protected Area Leaders Forum, participated in the World Heritage program as a non-voting member, established a few sister park relationships, continued the International Volunteers program, and done other good things through its Office of International Affairs. And, significantly, individual staff have engaged in one-off programs of their own initiative, or those of other organizations. But few would argue that the National Park Service has participated in international programs at a level consistent with its previous reputation for leadership in park management.

"The field cannot be seen from within the field"

This famous quote from Ralph Waldo Emerson eloquently states why it is sometimes necessary to step outside the confines of one's usual arena in order to maintain clarity of vision. The mission of the agency needs innovation and creativity flowing in to adapt to ever-changing management challenges. Such innovation and creativity can be found outside as well as within.

Perspective. International engagement provides perspective on domestic management issues, both at the field level and among leadership. Both time and distance can provide perspective, but only distance can lend fresh viewpoints today. For example, 150 years after the start of the Civil War there is still great resistance in some quarters to discussing slavery as the primary cause of the war. Yet we have no difficulty agreeing on the root causes of this year's revolutions in Egypt, Tunisia, and Libya. The same principle applies to protected area management.

The first environmental book published in the US is a great historical example of the benefits of geographic perspective. George Perkins Marsh, first US ambassador to Italy, wrote *Man and Nature* in 1864 based on the desertification he saw around the Mediterranean, recognizing that the "action of man" in his native Vermont—then 80% deforested—could have the same devastating effect on the environment. It is tempting to speculate whether he would have seen the problem so clearly had he never left New England, though of course we may never know.

Keeping pace with new trends and innovations. Engaging internationally opens up access to decades of applied research in alternative park management strategies, and alerts us to emerging trends and issues that have not yet reached our shores. In the previous era, the prevailing presumption, on the part of managers if not participants, was that the National Park Service international programs were for the benefit of our partners in other countries, that is, that the bulk of the exchange would be in the direction of the US imparting its expertise and experience to others. *In the second century of the National Park Service, that balance will shift, with the agency gaining at least as much as it gives.*

A major trend in conservation globally in the past decade has been a proliferation in the diversity and extent of governance models for protected areas. Increasingly, countries are rec-

ognizing the existing protection of resources through indigenous and community conserved areas (ICCAs), and the potential for increasing conservation success by sharing or devolving management authority. Similarly, private protected areas have grown in number, scope, size and legitimacy, including in the United States. Unlike here, however, other countries are beginning to integrate both ICCAs and private protected areas formally into their national conservation strategies and official protected areas systems.

Another significant trend to watch, this one negative, is the discussion of protected area downsizing, downgrading, and degazetting (PADDD; "degazettement" means to decommission, or remove official authorization).[4] The subject is anathema to our traditional concepts of parks in this country, and has enormous disruptive potential. However, discussion of the decommissioning of protected areas is growing in many quarters.

Relevancy, recruitment, and renewal. As discussed in previous Centennial Essays, the National Park Service continues to grapple with issues of relevancy and diversity. Though the problem has long been recognized, and many intentional fixes have tried and failed, the NPS workforce continues to be largely homogeneous and out of sync with American demographic change. International programs provide one opportunity to address these problems by exposing staff to different cultures and worldviews in ways that may not be possible at home. For example, an international experience may be in a country where a different culture and worldview is the majority and dominant population. Short visits provide some exposure, and longer-term assignments might go deeper into a different culture and bring home new approaches to parks and conservation problems. This is not to say that specific lessons learned could be applied directly to a US park context. Latin American cultures and attitudes are in themselves diverse, for example, and quite distinct from Latino societies in the US. But exposure to parks work in other countries, or hosting peers from other cultures, can contribute to enhancing cultural sensibilities and awareness within the Park Service.

Working for the National Park Service can be demanding and challenging. Studies show that workplace satisfaction in NPS is low, though staff are dedicated to their work and proud to wear the uniform. Many of the rewards are intrinsic. I can attest that the same is often true of international conservation work. Like the Peace Corps slogan, it is "the toughest job you'll ever love." What better recruitment tool than to have a pathway to employment in the National Park Service that leads through an international experience, either through the Peace Corps or other means? Or what better in-service training than to step away from one's own socioeconomic context and develop new problem-solving skills?

Opportunities at hand

The current NPS director, Jonathan B. Jarvis, began his tenure in 2009 by traveling to global conservation conferences in Canada and Mexico. His message can be summed up in three words, "We're back!" The United States has re-engaged in the World Heritage Convention, serving formally on the World Heritage Committee, refreshing the tentative list of candidate sites, and listing a new site for the first time in 15 years. The second cohort of the National Parks Institute (a 12-day executive seminar open to protected area leaders from around the world) is preparing to convene next spring. All of these events are salutary. But much more

than that needs to be done to restore the National Park Service to its previous position of full engagement in the global protected area community.

Continue and revitalize existing programs. The first step is to maintain what is working. The Office of International Affairs has come through the desert with a cluster of programs that should be maintained. Chief among these is the World Heritage program, which continues to grow and mature, moving past merely naming new sites to assisting UNESCO (the United Nations Educational, Scientific, and Cultural Organization), IUCN (the International Union for the Conservation of Nature) and ICOMOS (the International Council of Monuments and Sites) in fulfilling the mission: to encourage the protection and preservation of cultural and natural heritage around the world considered to be of outstanding universal value to humanity.

Likewise the sister parks program should be continued and supported. To date it has depended largely on the ingenuity and creativity of individual staff, usually superintendents, to maintain activity. The program is very much in need of dedicated support. Similarly, the International Volunteers in Parks Program annually brings over 100 individuals from around the world to the parks, and should continue.

Global Protected Areas Program. IUCN is the only conservation organization in the world that is constituted of governmental and nongovernmental members. As such it provides unique opportunities for collaboration on common conservation issues and threats of global scale. Though the National Park Service has never ceased to be a member of IUCN, it is only very recently beginning to become more active in IUCN networks such as the World Commission on Protected Areas (WCPA).

Engaging in WCPA provides a conduit for the National Park Service to participate in achieving the goals of the Convention on Biological Diversity (CBD). Though the United States is not a signatory and is not bound by the convention, the WCPA program of work is now closely aligned with the CBD.

The World Protected Areas Leadership Forum, a joint venture of NPS and WCPA, aimed at the top leadership of park systems, has met nearly annually since 2000, a rare example of US initiative in this period. It should be complemented with programs that reach deeper into the ranks of the Park Service.

The World Parks Congress is the major global forum for establishing the agenda for protected areas. Held every decade, the Fifth World Parks Congress was convened in South Africa in 2003. With 3,000 delegates from 154 countries, it was the largest parks conference ever convened. Yet only a handful of delegates were officially representing the US National Park Service. A single university sent more people than the agency.

The next World Parks Congress, scheduled for 2014, will set the framework for cooperation on parks and protected areas for the next decade. It is in the interests of NPS to be engaged in setting and informing that agenda, an opportunity to look ahead at new challenges. For example, in 2003 climate change was hardly on the agenda, as hard as that is to believe just eight years later. In 2014, climate change may eclipse biodiversity conservation as the main threat around which programs and funding are organized. Or will a new threat appear that we have not yet detected?

Revive the World Conference on Cultural Parks. The First World Conference on Cultural Parks was an outgrowth of the World Heritage Convention adopted in 1972. The National Park Service hosted the meeting at Mesa Verde National Park, a World Heritage site, in 1984.[5] There has never been a second world conference with precisely the same theme. Part of the reason lies in the limited inclusion of cultural resource discussion in the program of the World Parks Congress, reflecting a diminution of the perceived divide between natural parks and cultural sites. (A similar integration of natural and cultural resource sessions in our own George Wright Society biennial conferences has generated much positive feedback.) However, historical parks and sites are still largely excluded from the World Parks Congress. A major conference dedicated to cultural parks would have much to offer the field, and hosting it in the United States would send a strong signal of support to the cultural resource staff of the National Park Service.

Peace Corps. Two years ago I was in Peru on a project and visited Huascarán National Park, one of the crown jewels of the Peruvian protected area system. At the visitor center near Lake Llanganuco, I noticed a small monument. It caught my eye because the names were not Peruvian, and one of them carried the same surname as my mother-in-law! Cory Slaymaker had contributed to the creation of the park as a Peace Corps volunteer and then returned in 1972 to become its first director. (I later learned that the plaque is a *monumento a los caídos*, a monument to the fallen. Tragically, Slaymaker and a colleague, Michael Rourke, died in a mountaineering accident just one year after the park was established.)

The 1970s were a high point in Peace Corps activity in parks and protected areas. Many mistakes were made in attempting to apply the US "model" of national parks directly in very different social, economic, and political contexts. Many of the areas established in this period resulted in "paper parks," officially designated but with little or no real protection on the ground. Huascarán stands as an exception and a reminder that a more concerted, organized program, guided by the National Park Service, might have corrected initial mistakes and adapted the model to local conditions. This would have both improved management effectiveness in the host countries *and* benefited US parks through the transfer of acquired adaptive management expertise.

I am particularly informed as to the potential of a renewed NPS/Peace Corps relationship. I served as a volunteer from 1979 to 1984, in three countries, helping to establish new systems of parks and reserves in two of them. Though these programs were largely successful, I worked in near total isolation. I can only imagine how much more we might have achieved had I, and others like me, had access to the expertise of the National Park Service in designing and implementing projects and, most importantly, helping to train our host country counterparts. In short, there is much to be gained in reviving and institutionalizing a relationship with the Peace Corps on parks and protected area establishment and management.

"Parks Corps." In addition to partnering with the Peace Corps to train and mentor volunteers, I can imagine a set of National Park Service employees who are trained and enabled to assist with strategic protected area development projects, and to respond to park management emergencies worldwide. There is some precedent in the role the National Park Service played in development of Japan's parks after World War II, also in the long-term advisors placed in Saudi Arabia and Sri Lanka in the 1980s, and even the ongoing Beringia shared

heritage program. The Park Service responds to requests for technical assistance, but to date this has been largely on an *ad hoc* basis. A "Parks Corps" would provide in-service training to NPS staff while tapping their expertise. It could also take advantage of the experience of NPS retirees. The idea of developing a "Parks Corps" is ambitious to be sure, but this level of engagement would provide an invaluable service to meeting park challenges, foreign and domestic, and a decidedly positive contribution to America's diplomatic posture.

A particular challenge, but one with potentially great impact, is presented in the special case of transboundary protected areas in theaters of conflict, either active or potential. When I first visited Central and Eastern Europe in 1988, the most protected area on the continent was a continuous corridor running from the Baltic to the Adriatic. Though Churchill's dramatic label of "Iron Curtain" evokes images of razor wire, high walls and human despair, much of this no-man's land was actually wide and verdant, and a *de facto* refuge for flora and fauna. A few of these areas remain protected as parks and reserves, but the European Greenbelt initiative to protect it all comes too late to save most of it from development. Imagine if the global community had been prepared to respond with a broad vision of protection when the Berlin Wall came down in 1989? And what a legacy it might have been had the National Park Service played a role in healing the great Cold War wound across Europe. Will we be prepared, when the moment of opportunity comes, to help preserve the Korean DMZ (Demilitarized Zone) as a crane sanctuary and final legacy of that conflict?

Engagement over exceptionalism. Though famously credited with the advent of the national park idea, a concept of a *system* of protected areas may prove to be the most enduring American contribution to the global conservation movement. American park professionals led the drive to encourage other countries to develop national park system plans, yet ironically system planning is not part of the NPS vernacular and many observers doubt whether the collection of US national parks is truly a system, at least in comparison with other countries. IUCN has developed a systemization of protected area management categories, a *lingua franca* designed to sort through the bewildering array of park names (national park, national monument, national historical park, national heritage area, to name just a few of the dozens of examples in the US alone) as a first step toward a comparative analysis of effectiveness. The IUCN categories were developed and refined with the input of NPS and other US land management agencies, yet the US is perhaps the only country in the world where park staff are unfamiliar with the category system; most are not even aware the system exists, let alone where their park fits in the typology. Recently, governance has been added to management objectives in the category system, with timely lessons for NPS as it engages with diverse communities and attempts to be more effective at large landscape scales.

"Working around the world, and for America's future"

In its report, the National Parks Second Century Commission addressed the issue of international engagement in a section titled "Working around the world, and for America's future":

> The National Park Service has a long history of international engagement. Early Park Service leaders believed strongly in the global duty of the Service to help other countries develop and manage their own parks. They also understood that the Service had much to learn from con-

> servation agencies around the world. Ironically, while the Park Service has given up much of this role, the need for international engagement by the Park Service has never been more urgent. US national parks share responsibility for protection of critical habitats for migratory species, mitigation of transboundary air and water pollution, and the preservation of World Heritage sites. The commission recommends renewed international engagement by the National Park Service, in partnership with the State Department.

The Second Century Commission recommended that "the National Park Service should renew and revitalize its commitment and capacity to engage internationally."[6] The key words here are *commitment* and *capacity*. Unfortunately, the commission did not make a recommendation to Congress on this topic. While commitment is being renewed under current NPS leadership, that commitment will always be subject to change without a more clear and consistent mandate. *International cooperation must move from the fringes of NPS programs to a core, strategic element of the Park Service's work to achieve its mission.* The best way to institutionalize international engagement of the National Park Service is through clear legislative authority.

In this time of budget constraints and economic austerity, it would be easy to dismiss any question of expanding National Park Service international engagement as an untimely additional expense. But a thoughtful, strategic approach could open up partnerships while contributing to mission effectiveness. The Second Century Commission report specifically mentions partnership with the State Department, and for good reason:

> The diplomatic value of parks and places of cultural and natural heritage should not be overlooked. Sometimes the course of relations among nations leads to a vicious cycle of alienation. Nations that differ profoundly on only a few major issues may become so negatively-focused that they create greater and greater differences, demonizing one another and risking enmity and warfare. When nations reach a point where they cannot or will not talk with one another about profound differences, they sometimes can talk about more nearly universal values such as cultural heritage, parks, or nature.[7]

Symbolic of the best of America, the potential role of the National Park Service in soft diplomacy has historically been undervalued. Our country committed $34 billion in total overseas economic assistance last year, less than one-quarter of one percent of GDP (and of course a tiny fraction of defense appropriations). Strategic partnerships with the Department of State, through the US Agency for International Development, the Peace Corps, and other agencies, would pay dividends at home and abroad. And, though it would require great leadership and vision, a partnership with the Department of Defense on transboundary protected areas along borders of potential or active conflict is worth exploring. The potential is not limited to transboundary areas, of course. A case in point: Guantánamo Bay is arguably the most protected marine area in the world; an unintended consequence of the outpost is an important refuge of marine biodiversity. But it may not always be so. Here again the National Park Service could prepare now to rehabilitate the name of Guantánamo by protecting the bay as a reserve when the opportunity presents itself.

Conclusion

The primary mandate of the *National* Park Service is—and should be—to serve the American people. But our society is connected to a global community in increasingly obvious, immediate, and intimate ways. National Park Service programs and policy should reflect that reality. In an interconnected world, the Park Service will be better equipped to serve America by keeping an ear to, and a hand in, related work outside our borders.

The Sixth World Parks Congress in 2014 will in some sense mark the golden anniversary of the global protected areas movement. It would be a fitting opportunity to demonstrate National Park Service commitment to international engagement on the eve of its second century. A strategy is needed now to re-engage in meaningful ways. A legislative mandate could provide the authority, and a recognition of its value to soft diplomacy could provide the means.

Our national system of parks and related programs is one of the most positive reflections of our society that the nation can project out to the rest of the world. For over a century, the advent of national parks has been a cherished symbol of American creativity, stewardship, and leadership recognized around the globe. Collaborating internationally to fulfill their promise and potential will reap benefits at home and burnish America's reputation abroad.

Endnotes

1. The Americans were Charles and Mary Goethe, once hailed as "The father and mother of the National Park Service's interpretive program." A controversial figure today, Charles Goethe was the founder of Sacramento State College, but also of the Eugenics Society of Northern California.
2. Statement of Jonathan B. Jarvis, Director, National Park Service, before the US House of Representatives, Subcommittee on National Parks, Forest and Public Lands, Natural Resources Committee, concerning Building on America's best idea: The next century of the national park system. May 25, 2010.
3. At the time it was called the "First World Conference on National Parks." The name was the same for the second, at Yellowstone in 1972, but was changed to "Third World Congress on National Parks" for the conference held at Denpasar, Bali, Indonesia, in 1982. The fourth congress (Caracas, Venezuela, 1992) added "and Protected Areas" to the name. The more succinct "World Parks Congress" was used for the last conference (Durban, South Africa, 2003) and is expected to be repeated in 2014.
4. Mascia, Michael B., and S. Pailler. 2010. Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications. *Conservation Letters* 4 (1): 9–20.
5. World Conferences Collection, National Park Service History Collection, RG 7.
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The Heart of the Matter

New essential reading on parks, protected areas, and cultural sites

Uncertain Path: A Search for the Future of National Parks, by William C. Tweed. University of California Press, $24.95 (hardcover), 236 pp., index. ISBN: 978-0-520-26557-8. 2010.

Reviewed by David J. Parsons

The preservation of naturalness represents *the* core value of national parks and wilderness. Belief that there is a "natural" state that can be sustained indefinitely has long formed the basis for protected area management in the United States. However, in recent years there have been increasing calls to re-evaluate this core value.

Environmental change, including changing demographics and societal values, has spurred considerable recent discussion over the future of national parks and wilderness. In the last issue of the *Forum,* David Harmon reviewed a significant new contribution to this discussion. *Beyond Naturalness: Rethinking Park and Wilderness Stewardship in an Era of Rapid Change* (2010, Island Press, David N. Cole and Laurie Yung, editors) provides a thoughtful, science-based analysis of the key challenges facing park and wilderness managers in the 21st century.

Now, in another new book, *Uncertain Path; A Search for the Future of National Parks*, William C. Tweed uses a less technical but equally effective approach to present many of the same challenges. In *Uncertain Path*, Tweed uses the story of a 240-mile, 30-day hike through the high country of the Sierra Nevada to address many of the same issues, and ultimately reaches the same conclusions as found in *Beyond Naturalness;* namely, that if national parks and wilderness are to maintain their historic role it will be necessary to redefine their core mission and management goals.

Uncertain Path recounts the story of the author's journey along the John Muir and High Sierra Trails in the Sierra Nevada of California, revisiting landscapes he first visited 40 years earlier. Starting in Tuolumne Meadows in Yosemite National Park, Tweed ventures south through the Ansel Adams and John Muir Wildernesses (Inyo National Forest), and Kings Canyon National Park, before completing his trip in the heart of the Giant Forest of Sequoia National Park. The author's vivid prose brings out the best of the magnificent landscapes of the high Sierra: from the scenic grandeur of 14,000-foot peaks to the beauty of high-mountain wildflowers. His knowledge of natural history is reflected in descriptions of the local flora and fauna, such as the patterning of foxtail and lodgepole pines around the sandy

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plateaus and meadows on the Chagoopa Plateau and the activities of bird species using the willow communities bordering Hamilton Lake.

The story Tweed tells effectively intersperses observations of history, geology, ecology, and visitor use with provocative discussion of the critical "issues" faced by the stewards of these precious lands. These issues include such diverse topics as invasive species, bears, air pollution, fire management, stock impacts on streams and meadows, and the use of mechanized equipment to supply rangers or trail crews. Particular attention is given to climate change, which the author concludes is the greatest single threat to Sierra landscapes, leading, for example, to the likely loss of species and earlier snowmelt. Tweed's 30-plus years as a park naturalist and park planner give him a particularly insightful view of how these issues play into the challenge of updating park management practices to reflect ever-changing knowledge. His primary thesis is the need to recognize that change is inevitable and much of that change runs counter to the traditional expectation that parks are protected in a manner that will assure they remain "unimpaired" (intact and unchanged) for the enjoyment of future generations. The public has been educated to believe this, and agency policies and practices reinforce such beliefs.

As might be expected from a historian, this book provides important insights into the history of the national park and wilderness movements, as well as key players in the establishment of the Sierra parks. The latter include John Muir, the Sierra Club, Joseph Le Conte, Stephen Mather, Gifford Pinchot, and Ansel Adams. Tweed also explores the conflict between the historic idea of preserving wilderness as a place defined by the absence of humans (virgin, untouched landscapes) and the reality that most of these areas have been used by native peoples for centuries, if not millennia. For example, he notes the abundance of obsidian shards as evidence of past use of a number of the areas he traversed.

Uncertain Path combines historical analysis and astute observation of both natural history and social interactions to effectively address the myriad of challenges faced by our parks and wilderness. Given the enormous magnitude of the environmental changes (climatic, biological, social) experienced in recent years, and even more so projected into the future, it is important that this story be told in as many ways and to as broad an audience as possible. And, although the focus of the book is on the Sierra Nevada—the local environments as well as the day-to-day challenges of managing the Sierran parks and wilderness—most of the issues are the same as or similar to those faced by park and wilderness managers across the globe.

Among the many interesting storylines developed in *Uncertain Path* is that of the changing characteristics and values of wilderness users. For example, Tweed observes how the John Muir Trail has increasingly attracted goal-oriented through-hikers focused on the physical challenge of completing the Trail in as short a time as possible. This leaves little time to experience the local environment, likely leaving the visitor less aware of the fragile ecology of the area as well as the myriad of threats and challenges to it. He speculates how this lack of a connection to nature, together with an observed paucity of young hikers, likely reflects increased competition for leisure time provided by mechanized recreation and various forms of electronic entertainment. This leads to worries that traditional park values may be of less

importance to society as a whole, and, thus, whether there will be the public advocacy needed to assure future support for the national parks. This challenge is complicated in that a public that has bought into the concept of the protection of naturalness must now be convinced that a new paradigm is needed, a paradigm that recognizes the importance of change and that incorporates a more flexible management approach.

Ultimately, Tweed comes to the conclusion that the national park dream as envisioned over the past century (e.g., naturalness that is preserved unimpaired for future generations) is fast becoming obsolete and must be revised to reflect both modern science and evolving societal and cultural values. He recognizes that this will not be an easy task. It will require difficult choices as traditional values are questioned and challenged. After all, naturalness is a concept that is both inherently attractive and well ingrained in the public psyche. In a world increasingly dominated by pollution, non-native species, and a changing climate, serious questions must be asked as to what "natural" actually means and whether it can continue to provide useful direction for park and wilderness management. Yet, transitioning from a largely "hands-off" management approach to a more aggressive "hands-on" one is sure to be a politically dangerous process that will be opposed by many of those who have traditionally been the parks' biggest supporters. Ultimately, Tweed concludes that there really is no choice. If we want to maintain the most important resources and values of these special areas, we must adopt a new set of management policies and practices, ones that are likely to be more "hands-on" than we have traditionally accepted.

He proposes three basic conceptual options for future park management goals: managing for change, accepting the wild, or ecosystem museums. The first of these, managing for change (see Stephenson's chapter in *Beyond Naturalness*), is an experimental approach where active management is used to preserve the things most valued. Examples of such management actions might include watering, planting, feeding, or facilitated migration of key species.

Concern over past failures of attempts to manipulate ecosystems, together with a desire for minimal intervention, provide arguments in favor of the wildness option (see chapter by Landres in *Beyond Naturalness*). Wildness as the primary goal would have humans step back from active management, allowing ecosystems to evolve to new states, even if those states have not previously occurred on the local landscape.

Tweed articulates a third option, where in at least some areas active management would attempt to preserve certain landscapes essentially as museums, preserving key species as well as a general appearance of naturalness. He is particularly intrigued by the idea of focusing on aspects of both biodiversity and wildness. Such an approach would likely require managing different areas for somewhat different purposes, but would also recognize the uncertainties of current knowledge and the necessity of learning and adapting as we go. Perhaps most importantly, Tweed suggests that such a diverse approach is the most likely to generate the public support needed to assure future protection.

In the short term, the most urgent need is to start thinking into the future and to accelerate a dialogue about the future of these precious landscapes. This dialogue needs to incorporate innovative thinking that is based on modern science. And, regardless of what

approach is taken, it will be necessary to educate the public about how these most protected of lands are not truly protected from the inevitability of change. It is time to start to think differently about how we should manage our parks and wilderness.

As we approach the centennial of the National Park Service, it is particularly encouraging to see that the foreword to this book is written by NPS Director Jon Jarvis. His attention to and concern about these issues demonstrates understanding of the urgency of the dilemma. Yet we should take note of his caution against rushing too quickly into any single new paradigm. The challenge is daunting; and while time may be short, we must be careful to try to understand the outcomes of our options and choices.

I strongly encourage those interested in the future of parks and wilderness to add this jewel of a book to their libraries. It is an important work that is informative and thought-provoking as well as being enjoyable to read. It merits the attention of park professionals as well as those more broadly interested in conservation and natural history.

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THE IMPACTS OF REMOVING LEAD FROM NATURAL RESOURCE ACTIVITIES IN THE NATIONAL PARK SYSTEM

Elaine Leslie, guest editor

Introduction

Elaine Leslie

> A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it does otherwise.
>
> — *Aldo Leopold, A Sand County Almanac*

I grew up in southern California, not far from the Los Padres National Forest. Weekend outings included hikes and day trips into some of the most remote areas of the Los Padres. When you are 10–12 years old, hiking in rough chaparral is not exactly an activity you look forward to, but my father was an avid birder. As a student at UCLA in the 1940s, he would venture into this remote wilderness in search of the California condor—elusive even then. We heard his stories and participated in his personal quest, but our efforts were never rewarded with a sighting.

When the last seven condors were brought into captivity in the early 1980s, it was considered a highly controversial wildlife management decision. It was the ultimate in human interference, and was debated in scientific institutions, the media, and at our dinner table.

Years passed. On December 12, 1996, California condor restoration began in Arizona. Condors were released at Vermillion Cliffs National Monument—the first time in 100 years that condors once again soared over Arizona skies. In November 2002, the first wild-reared condor emerged from a remote redwall cave and took flight over Grand Canyon National Park. In 2003, I had the pleasure and honor of watching my aging father stand on the South Rim of the canyon, finally being rewarded with viewing free-flying condors, thus fulfilling his 60-year-long quest.

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Natural resource managers recognize the important roles hunting and fishing play in the complex management of wildlife populations. Given the increasing awareness of environmental lead poisoning, the National Park Service, as a leader in environmental stewardship, has a compelling obligation to mitigate lead's negative effects on ecosystem and wildlife health in national park units.

Scientific literature is replete with evidence that ingestion of spent ammunition and fishing tackle can be lethal to wildlife and have harmful effects on humans. The magnitude of poisonings in species (e.g., waterfowl, doves, quail, swans, and loons) and scavengers (e.g., vultures, eagles) continues to be reported annually. And in some instances, populations (e.g., California condors) are affected (Rattner et al. 2008). From a public health perspective, the presence of lead fragments in wild game meat, presumably from the bullets or shot used for hunting, has raised concerns about health risks from meat consumption where relatively low doses of lead may be the cause for a variety of human health problems, particularly in children. Even if a lead pellet or bullet fragment completely passes through an animal, a small amount of lead may be left behind and can be absorbed by a person consuming the meat (Iqbal et al. 2009).

In response to the overwhelming scientific data, there have been several actions taken to ban the use of lead in hunting and fishing activities:

- In 1991, the US government implemented a successful national ban on the use of lead shot for waterfowl hunting.
- In October 2007, California Governor Arnold Schwarzenegger signed into law Assembly Bill 821, which banned the use of lead ammunition from areas of the state inhabited by the California condor. All hunting of big game, small-game mammals, and game birds in the affected area require the use of non-lead ammunition.
- In 2009 and 2011, the National Park Service issued memos instructing managers to "remove lead as a source of contamination in natural resource related activities in national parks" in order to "benefit humans, wildlife, and ecosystems within and outside of parks." Yellowstone and Glacier national parks have successfully implemented fishing programs using non-toxic tackle. In the last two years, parks working on ungulate culling efforts, such as Valley Forge National Historical Park, Catoctin Mountain Park, and Rocky Mountain and Theodore Roosevelt national parks have all successfully implemented their contract and volunteer efforts using non-lead ammunition; ensuring thousands of pounds of safe meat donations to food banks as well as leaving lead-free deer and elk remains in the field for safe scavenging, where appropriate.
- In December 2010, the US Fish and Wildlife Service changed regulations governing control of depredating blackbirds, cowbirds, grackles, crows, and magpies to require the use of nontoxic shot or bullets when a firearm is used to "prevent toxicity hazards to other wildlife."

Minimizing and eliminating toxic substances in the environment that can evoke adverse impacts is at the core of our stewardship mission. Lead could be phased out with a goal of complete elimination from national park units, yet there are many who feel that banning lead

will affect their hunting and fishing experiences. This is the dilemma that we—not just the National Park Service, but every state and federal resource manager and, ultimately, the American public—face.

Is there any reason every park in the national park system should not have the same protective measures as Yellowstone or Glacier? Is there any reason anyone who ventures into our national parks to observe our national natural heritage—large or small, swimming, flying or ambling across our national landscape—should not have the opportunity that my father had, that my children have, or that I hope my grandchildren will have?

The time to act is now. And for anyone who may believe that we as stewards of terrestrial and aquatic ecosystems cannot collectively act to protect natural resources, I challenge you to stand on the rim of the world's grandest canyon and watch as condors take a leap of faith over the canyon, soar on the currents high above your head, and disappear into the far reaches of a remote side canyon.

Our nation's initiatives are clear: "Let's Move," "America's Great Outdoors," "Healthy Parks, Healthy People." It's time.

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Conflicts in Lead Ammunition and Sinker Regulation: Considerations for US National Parks

Vernon G. Thomas

Centuries of traditional use of lead in hunting and fishing constitutes a toxic risk to wildlife

Lead exposure in wildlife from ingested spent lead ammunition and lost fishing sinkers is well-documented in the primary scientific literature and is a global phenomenon. Lead toxicosis appeared, initially, as a disease of waterfowl caused by ingestion of spent shot in wetlands. Recent evidence reveals that the disease is prevalent in upland game birds, piscivorous waterbirds, avian predators, and scavengers exposed to lead of anthropogenic origin (Pain et al. 2009; Pokras and Kneeland 2009). Furthermore, humans who consume game killed with lead ammunition may be seriously lead-exposed (Johansen et al. 2006; Kosnett 2009). Awareness of this health risk to both wildlife and humans has evolved rapidly, as scientists have defined the various dimensions of this disease. Debate about the sources of the lead was settled by lead isotope ratio analyses that identified lead from spent ammunition and sinkers as the primary source of exposure in both wild birds and humans (Scheuhammer and Templeton 1998; Tsuji et al. 2008).

Much scientific research indicates that the chronic and acute manifestations of lead exposure are fundamentally similar across a wide range of animal species (including humans) that ingest lead, both in terms of the organ systems affected and the expression of the disease (Pokras and Kneeland 2009). Lanphear et al. (2005) and the US Centers for Disease Control and Prevention stated that, in humans, there may be no safe level of lead exposure, especially in children (CDC 2005a). Thus, there is a common environmental lead syndrome, regardless of the source(s) of the ingested lead and the species that ingest it. However, concerns about lead on the health of humans have trumped similar concerns about the impacts of ingested lead on the health of wildlife (Thomas 2010).

The history of regulating lead shot and sinkers is less than 40 years old, and continues to be extremely contentious, despite the enormous amount of scientific evidence identifying the precise cause of the disease. Replacement of toxic lead shot and sinkers by non-toxic substitutes has begun in a number of countries, but not in a consistent manner across all uses of

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lead ammunition and sinkers, and not in all jurisdictions of any nation (Mateo 2009; Thomas and Guitart 2010). Non-toxic shot use in wetland hunting has been regulated in some countries (e.g., the US, Norway, Canada, and the United Kingdom) where lead-induced mortality was most apparent in waterfowl, but non-toxic ammunition use in all categories of hunting and target shooting is not legally required in any country. The same situation exists for non-toxic sinkers and rifle ammunition. Where they are required, it is on a local basis, as in the US and the United Kingdom, or in certain areas such as Canadian national parks.

If recreational hunting, target shooting, and angling were newly created sports, current knowledge of the environmental toxicity of elemental lead and existing regulations would preclude its use in ammunition and sinkers. This raises the question of why it has been so difficult to ban such lead products, and to regulate use of proven non-toxic substitutes. This paper examines the issues and positions of US stakeholders that have proposed or prevented broad-scale adoption of lead substitutes for hunting and angling. The potential role of the US National Park Service (NPS) in regulating use of lead ammunition and sinkers in national park areas is presented. It is necessary to consider national parks and lead reduction in the context of what is occurring in other US jurisdictions, because the manifestations of lead exposure, the stakeholders, and resolution using non-toxic substitutes are the same. Central to this paper is the premise that resolving lead exposure and toxicosis of wildlife is more about the development of appropriate social and governmental policy than the state of science.

State of current science on lead exposure in wildlife

No single pathology of wildlife has been so well researched as lead toxicosis from ingested lead. Detailed reviews have been conducted by federal and state agencies, conservation organizations, professional organizations, and academics. The current state of knowledge of the dimensions of lead exposure is best represented by the symposium proceedings edited by Watson et al. (2009), and reviews by Rattner et al. (2008) and Goddard et al. (2008). The Wildlife Society has reviewed the science and presented its own expert policy recommendations in which it calls for a transition to the use of lead substitutes by hunters and anglers (The Wildlife Society 2009). The single, unequivocal conclusion is that ingested elemental lead is toxic to birds, mammals, and other animal life, and, depending on dose and factors that mitigate uptake, may cause chronic or acute exposure. This conclusion is based on controlled laboratory studies as well as observations from lead-exposed wild animal species. Numerous studies have attempted to estimate the total mortality from lead shot and sinker ingestion in individual species, but such estimates are crude, reflecting the problem of detecting fatally lead-exposed wildlife, and determining the degree of lead exposure across lead-exposed individuals.

Calls for yet more research on lead exposure in wildlife

The present understanding of lead toxicosis in wildlife is based on *individual* animals or experimental treatment groups, followed by extrapolation to wild populations. Most research has not dealt with entire populations of a species because that is beyond the scope of experimental reductionistic science. However, there are recent calls for such science (as by

the Western Association of Fish and Wildlife Agencies (WAFWA 2010)) to be undertaken, and for the impacts of lead ingestion to be measured at the population level before a decision to end the use of lead products is considered. Governmental wildlife agencies are mandated to manage at the population level, rather than the individual animal level, and to consider the impacts of various factors, both natural and anthropogenic, which determine population levels of species. The criterion of impact at the population level is not the vital criterion to use, and its absence does not negate decisions to ban use of lead sinkers and shot already implemented by a variety of agencies in the US and elsewhere. This criterion has not been invoked when dealing with the use of lead-based products in the human environment because of the accepted importance of individual health. Basing a decision on risks to individuals or segments of populations reflects human values and not scientific findings. Moreover, requiring that scientists assess population impacts across species could be interpreted as maintaining the *status quo* in use of lead sinkers and ammunition for many years. Deleterious impacts of ingested lead at the population level have been reported for California condors (*Gymnogyps californianus*) (Green et al. 2009), and formed the basis for the passage of the 2007 Ridley-Tree Condor Preservation Act by California that requires use of non-toxic ammunition when hunting in the range of condors. Similarly, the nationwide transition to non-toxic shot in the US in 1991 was predicated on the impact of lead poisoning on the then-endangered bald eagle (*Haliaeetus leucocephalus*), a species protected under several US federal laws (Anderson 1992).

A population-based criterion may arise from wildlife agencies dealing with human actions that may afflict more individuals in populations than lead exposure. Hunting has a high inefficiency level, based on wounding (crippling) losses that may exceed mortality from lead toxicosis, and is accepted as a conventional externality of hunting (Norton and Thomas 1994). Managers have factored such losses in with population losses from natural mortality and other anthropogenic actions. Given the traditional acceptability of these losses, hunters may find concerns about lead-induced mortality unwarranted. However, lead exposure from spent ammunition and sinkers is preventable, and it is impractical to recover spent sinkers and shot from most wildlife habitats.

Although more scientific investigations of this issue are welcome (Rattner et al. 2008), understanding of the causes of lead poisoning from ingested shot and sinkers has probably reached an asymptote. More research will add mainly to what is already known about prevalence, susceptibility, species affected, and geographic range of lead exposure. However, emphasizing that decisions have to be based on the best available science needs to be tempered with the realization that science, alone, does not make decisions: it provides only evidence accompanied by confidence limits. How that science is interpreted depends on other human considerations. Thus, Friend et al. (2009) stated that the US decision to ban the use of lead shot nationally in 1991 was as much a societal decision as an environmental science decision. Moreover, different regulatory agencies presented with identical rigorous scientific evidence of detrimental population impacts of ingested lead on California condors have made very different decisions. Thus, California passed a regulatory ban on lead ammunition use in condor range in 2007; Arizona opted for a voluntary adoption of non-toxic ammuni-

tion in its condor habitat, and Utah has made no decision about regulating the issue, despite sharing condors' range.

Wildlife agencies and jurisdictional issues

Jurisdictional authority is critical in understanding the regulation of lead products, and is based on which animal species fall under federal or state control. Individual states have jurisdiction over angling and the hunting of non-migratory game animals: federal jurisdiction applies to migratory birds and species protected under endangered species legislation. Thus, non-toxic shot requirements for hunting waterfowl and coots is federal law, non-toxic sinker use in New York state and five other states is state law, non-toxic shot requirements for taking pheasants in South Dakota is state law, and the Ridley-Tree Condor Preservation Act of 2007 requiring non-toxic bullet use is California state law. To date, no single federal agency has the jurisdiction to regulate *use* of non-toxic shot, sinkers, and rifle bullets, collectively, across the entire United States because they all lack jurisdiction (Thomas 2009a). The federal and various state agencies managing angling and hunting have not agreed on how to manage lead exposure, while acknowledging the importance of the issue. A large variation in the requirement for non-toxic shotgun ammunition exists in the US, as detailed by Thomas (2009a). Not all migratory bird hunting requires use of non-toxic shot. Species such as mourning doves (*Zenaida macroura*) and woodcock (*Scolopax minor*) can still be hunted with lead shot ammunition, despite strong evidence that mourning doves are subject to marked lead exposure from spent gunshot (Schultz et al. 2009). Twenty-six US states have regulations requiring the use of non-toxic shot for upland game hunting, although there is much variation among these states' regulations concerning their applications. Some apply to the hunting of federally regulated species (e.g., mourning doves) not addressed under federal law (Thomas 2009a). Only six states require non-toxic sinker use for angling, although non-toxic fishing weights are required when angling in other diverse federal locations (Thomas 2003; Rattner et al. 2008).

Accordingly, a group of non-governmental conservation organizations (American Bird Conservancy 2010) petitioned the US Environmental Protection Agency (EPA) in July 2010 to use provisions in the Toxic Substances Control Act to require use of non-toxic substitutes in the manufacture of shot, bullets, and lost sinkers. This petition contended that the EPA could prohibit use of toxic lead in the manufacture of ammunition and sinkers, provided that non-toxic substitutes were available. This novel approach would have bypassed the agencies mandated to manage wildlife and its consumptive use. In August 2010, the EPA denied the petition, contending that the agency lacked the authority to regulate such ammunition, nor was about to seek it (EPA 2010). Thus the search for a suitable jurisdiction continues. Were the use of non-toxic shot to be required for the hunting of all federally regulated bird species, an enormous transition to the hunting of birds with non-toxic shotgun shot would then have occurred, facilitating a complete nationwide transition (Thomas 2009a).

Two reasons beyond jurisdiction may explain the absence of concerted action by game agencies and the slow rate of transition to non-toxic materials. Not all wildlife professionals see the issue of lead exposure having such importance as to warrant wide-scale transitions to

non-toxic shot, bullets and sinkers (see WAFWA 2010 on this point). Other professionals fear that regulated bans on all lead products would drive hunters and anglers from their sports, resulting in a decline in dedicated funding (e.g., Pittman-Roberts funds) to state and federal agencies (Miller 2009; WAFWA 2010), and with that a reduced ability to manage. All agencies are obliged to serve the public, comprising those who favor species preservation or the consumptive use of wildlife, as well as the interests of wild species. Wildlife agencies are also self-interest groups, and therein lies the basis of conflict.

Public stakeholders' concerns

While sporting organizations purport to represent all hunters and anglers, individuals often fall into discrete camps according to their principal sporting interests. There are anglers, waterfowl hunters, upland game hunters and big game hunters, and clay target shooters each with their own special interests in the lead exposure issue and what regulation would mean to their sport. Most of the sporting public and their representative organizations in the US and other nations have resisted the adoption of non-toxic products. By contrast, non-hunters and their representative organizations tend to favor regulation of all lead products (Keats and Wolf 2009).

The principal reasons for resistance by hunters and anglers are concerns about the state of the science and the perceived extent of lead exposure, relative costs of substitutes, their availability and effectiveness. There are calls for more information and education before actions are considered (see WAFWA 2010) and for measures to be implemented to ease any proposed transition to non-toxic substitute use. There has been very little carry-over of the understanding and rationales for banning lead for wetland hunting in 1991 to the current issues of lead exposure from lost sinkers, upland game hunting, and big game hunting with lead-based ammunition. However, one may question the effectiveness of reliance on public education/awareness programs and providing optional use provisions to drive a transition to use of non-toxic sporting products in the absence of regulatory change. The costs of non-toxic tackle that are presented as obstacles to participation could be viewed as investments in a more sustainable sport and a public display of responsibility accompanying rights to fish, especially given the low entry-participatory costs for this sport in the US The same statement applies to upland game and big game hunting with lead-based ammunition, especially in view of the documented lead exposure it creates for upland birds, predators, scavengers, and humans eating shot game.

One aspect of non-toxic shot use deserving especial comment is the paucity of public information on how effective this management decision has been in protecting waterfowl from mortality. Given that it has been 19 years since the national ban was implemented, the public should know how this has benefited waterfowl populations. This is one area where both levels of government and sporting organizations could do much more to inform the public and to promote the use of non-toxic products (Thomas 2009a). Anderson et al. (2000), Samuel and Bowers (2000), and Stevenson et al. (2005) have reported on the rapidity with which use of non-toxic shot has reduced lead exposure in waterfowl and prevented loss of birds to lead shot poisoning. Given the large number of waterfowl estimated to have been saved from fatal lead poisoning by Anderson et al. (2000), this single measure ranks as

a most effective conservation tool for promoting waterfowl populations, and, in theory, could apply to other species known to ingest spent lead shot (Thomas 2009a).

Hunters, anglers, and clay target shooters can be compared to a municipality or industry that has discharged toxic lead to the environment for many years, has never practiced reclamation or cleanup, and has so far resisted efforts to change. Insofar as municipalities and industries are required to conform to modern federal and state standards of toxic waste regulation, the sporting communities ought to be subject to the same standards, especially in view of the tonnage of elemental lead released per year across the US (Thomas and Guitart 2010).

Position of the non-toxic ammunition industry

Cartridge manufacturers have created non-toxic shot cartridges suitable for waterfowl hunting, upland game hunting, and target shooting in a range of gauges and in various types of federally approved non-toxic materials (Thomas 2009b). Several companies make non-toxic rifle bullets in various calibers designed for big game hunting and destruction of pest animals. Such rifle ammunition is very effective in killing deer species (Knott et al. 2009). A wide range of lead-free fishing sinkers is also available in the US These manufacturers have allowed a complete transition to non-toxic materials to occur and do not constitute a hindrance to adoption of lead-free products. One has only to visit the catalogue of a large retailer such as Cabela's to see the large amount of non-toxic ammunition and fishing tackle available. The manufacturing issue is investigated further in Thomas and Guitart (2010). The fundamental request of manufacturers is an assurance of a market for their products that only regulation can provide. Voluntary use provisions do not create strong markets, especially when non-toxic products cost more than lead equivalents. It costs manufacturers a lot to develop, secure federal approval, market, and distribute new non-toxic products, and these costs must be recouped from retail sales. Product availability in a given region is a simple function of demand. Assured markets create competition and product development, and large economies of scale benefit consumers with lower market prices. World market prices for lead, copper, tungsten, and tin mean that the non-toxic substitutes will always be more expensive than their lead counterparts. However, fishing tackle has a long life span, cartridges made with steel shot are comparable in price with high-quality lead ammunition, and big game hunters do not fire large numbers of cartridges when hunting.

Considerations for the US National Park Service

NPS administers all US national park system units, which include national seashores, parks, recreation areas, preserves, and many other designations. Wilderness areas may be within such units, and also within units of several other federal land management agencies, such as the Bureau of Land Management and USFWS. Where sport fishing and hunting is permitted in the national park system, it has mostly been practiced with traditional lead materials. Concerns about lead exposure in wildlife have prompted NPS to consider banning the use of all lead ammunition and sinkers within its jurisdiction (National Park Service 2009). The agency is in a unique position to regulate use of non-toxic ammunition and sinkers in every national park unit in the US because it controls public use of these protected areas. The

Department of the Interior has exclusive jurisdiction within national parks and wilderness areas and can determine its own policy on all aspects of angling and hunting. The Park Service operates under the National Park Service Organic Act and administers designated wilderness areas under the Wilderness Act, both of which contain provisions to warrant banning the use of lead products. The Park Service already regulates use of non-toxic fishing weights in Yellowstone and Glacier national parks (Rattner et al. 2008), so a legal precedent exists. National parks and national wilderness areas contain the most pristine natural environments in the US, and their management is held to very high standards to maintain this attribute in perpetuity. While game management agencies are pre-occupied with sustainable consumptive use of wildlife by the public, the Park Service can focus on nature preservation, but still allow some consumptive use of wildlife. Implementation of a ban on lead fishing weight use in all areas under the Park Service's jurisdiction would complement similar regulations enacted in seven US National Wildlife Refuges, administered by the USFWS (Rattner et al. 2008), and would create a strong rationale for extending this progressive action.

The Wilderness Act requires that users of wilderness areas do not "impair" wilderness. This is a critical part of the rationale to end use of lead products in national parks and wilderness areas. Lost (unrecovered) lead sinkers impair freshwater systems, and their possible ingestion by waterbirds could impair the avian community. Spent lead shot may be ingested by birds within the parks, and may be exported to adjacent areas. Lead bullet remnants in gut piles of shot mammals could pass into avian and mammalian scavengers, causing lead exposure and toxicosis: this is impairment of the animal community. Migratory birds pass through many parks and wilderness areas during their annual cycle, and require unpolluted, unimpaired, flyway habitats. Thus, the Park Service is obliged to act on those preventable human activities that cause impairment and diminish the natural integrity of parks and wilderness areas under its control.

In Canada, Parks Canada administers all national parks. This federal agency amended its fishing regulations in the National Parks Act in 1997 to require use of non-toxic tackle within all national parks. The rationale for this amendment was that lead pollution and exposure from lost lead tackle conflicted with the concept of ecological integrity, a concept stated in the Parks Act that underlines management of all Canadian national parks. The same argument was used to extend a ban on lead tackle use to all Canadian national wildlife areas under the National Wildlife Act in 1997. It is noteworthy that both amendments were accomplished without large-scale risk analyses being conducted, or lengthy public consultations. Moreover, Parks Canada focused on lands under its own jurisdiction, and did not involve provincial and territorial agencies.

In September 2008, Executive Order (EO) 12962 on recreational fishing was revised by President George W. Bush. The EO directs federal agencies to maintain recreational fishing on all federal lands, including national parks, and stipulates that fishing be managed sustainably and responsibly (Center for Coastal Conservation 2008). The terms *responsible* and *sustainable* could be interpreted to include use of non-toxic tackle. The angling lobby that was successful in securing access to public fishing in federal areas could also be influential in leading its constituents towards more sustainable fishing practices. Insofar as NPS is mandated to provide public access to recreational fishing, it can also determine what is sustain-

able. Regulating use of non-toxic ammunition and fishing tackle by the National Park Service is completely consistent with the precautionary principle, the polluter pays principle, and principles of wise use. Moreover, the array of available non-toxic ammunition and tackle is large and does not impede public recreation in national parks. Access to national parks is controlled, so promoting compliance with regulations is feasible. Such a ban would be seen as progressive policy by a growing segment of US society that demands access to unspoiled natural areas (Friend et al. 2009) and is mindful of its ecological footprint.

Conclusions

The US transition to non-toxic ammunition and fishing tackle use is slow, despite scientific support for this progressive form of management and the availability of a wide array of approved lead substitutes. This is best explained by lack of consensus among wildlife agencies, disavowal of the issue of lead exposure by sporting groups, conflict among wildlife conservation groups, and perceived limitations of public awareness. The National Park Service has the rationale, jurisdiction, and legislative provisions to regulate use of hunting and fishing materials in park units. Implementing a proposed ban would complement similar initiatives in the US at the federal and state levels, and both promote and facilitate further adoption of non-toxic products.

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The Quest to Eliminate Lead from Units of the National Park System: Understanding and Reaching Out to Audiences

Danielle J. Ross-Winslow and Tara L. Teel

Introduction

THIS REPORT IS INTENDED TO SYNTHESIZE THE RELEVANT LITERATURE regarding issues involving the use of lead in recreational hunting and fishing activities. We begin the report with a brief overview of lead use in the US and the emerging awareness of the hazards of lead to human health and the natural environment. This overview is followed by a discussion of the National Park Service's (NPS's) efforts to reduce the impacts of lead from hunting and fishing in NPS units. We then turn to an important emphasis of this report, which is on the role of the social sciences and human dimensions information in addressing the issue of lead in the environment. Included in this section is a discussion of the need for public outreach to help raise stakeholder awareness and support for future management actions. Also included is an overview of relevant theories and frameworks from social psychology and risk communication that can be used to inform outreach activities. Later sections of the report provide additional background on the use of lead in hunting and fishing as well as specific measures, including regulatory action and voluntary mechanisms, that have been introduced by agencies and organizations in the US to reduce the lead-related impacts of these activities. We conclude with overall recommendations for future outreach initiatives and research to reduce the impacts of lead from hunting and fishing.

A brief history of lead use and effects on human health and the environment

For over 2000 years the toxic effects of lead in humans and animals have been well documented (Nriagu 1983). As far back as 1848, the famous medical observations of Tanquerel Des Plances described human lead poisoning (Pokras and Kneeland 2009). Despite the long history of lead's adverse health effects, approximately 3,600,000 metric tons of lead are refined annually for commercial uses (Eisler 2000). The use of lead for fishing net sinkers dates back to 3300–1200 BCE (Pulak 1988; Galili et al. 2002), and lead use for ammunition emerged in the 14th century (Tunis 1954). The production of lead ammunition and fishing

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tackle continues today; the US Geological Survey (USGS) estimates that roughly 10% of lead produced in, or imported to, the US is used for sporting purposes (Guberman 2007).

Lead ammunition and fishing tackle, when used as intended, release lead into the environment. The USGS estimates that 6,000–10,000 tons of lead are released by hunters and anglers annually in the US (Guberman 2007), but the use of lead ammunition and tackle is minimally regulated by state and federal agencies. This seems to contradict the efforts of state and federal regulatory agencies in the US that try to minimize the amount of lead released into the environment from mining, manufacturing, and the recycling of lead products by requiring permits for any sort of industrial lead release (Pokras and Kneeland 2009).

The effects of spent lead shot and bullets on wildlife have been recognized in the US since the 1870s (Sanderson and Bellrose 1986), and the hazards of lead fishing sinkers to waterbirds were recognized in the 1970s when swans were poisoned in the UK (Sears 1988). The documentation of lead's toxic effects on wildlife has accumulated; over 500 peer-reviewed articles have examined the impacts of lead ammunition on wildlife (Petterson 2009). Recent studies have illustrated that lead ammunition fragments on impact much more than previously believed, dispersing small lead particles throughout the tissues of game animals (Grund et al. 2010; Pain et al. 2010). Fragmentation varies widely by ammunition type; Grund et al. (2010) found that rapid-expansion bullets fragment to a higher degree than controlled-expansion bullets, for example. Fragments in the tissues of animals harvested with lead bullets or lead shotgun pellets are a serious source of lead exposure to scavenging animals that consume the meat with lead fragments; an estimated 134 species, including reptiles, birds, and mammals, have been poisoned by ingesting lead from spent ammunition and fishing tackle in the environment (Petterson 2009), and similar pathways exist for humans.

The ingestion of lead can lead to a range of molecular and behavioral effects as well as mortality and population-level consequences in some species (Rattner et al. 2008). Some of the noted adverse effects on human health are headaches, fatigue, myalgia, arthralgia, abdominal discomfort, renal system dysfunction, anemia, impaired fetal development, and brain dysfunction (NCM 2003; Kosnett 2009). Recent studies have also tied elevated bone or blood lead levels (BLLs) to increased aggression, delinquent behavior, and attention-deficit hyperactivity disorder (Needleman 2004; Braun et al. 2006). Many of the effects occur at moderate-to-low levels of exposure, and a statement from the Centers for Disease Control and Prevention (CDC) in 2005 stated that there is no threshold BLL value for which there is no effect. Due to the nonspecific nature of many of the symptoms, especially low-level exposure effects, the causes are often attributed to other relatively common acute and chronic diseases (Kosnett 2009). This may be one of the reasons that lead is still being used; even though empirical evidence suggests that lead ingestion does occur, the health risks are not overt enough to prove causation.

A lack of overt causation is one of many factors that have contributed to the protracted use of lead for ammunition and fishing tackle. The potential hazardous effects of lead on humans, ecosystems, and fauna have led to greater societal pressure and concerted efforts to reduce the amount of lead introduced into the environment by human activities (Goddard et al. 2008), but strong opposition from sportsmen and industries has limited the success of

such actions. To further mitigate the impacts of lead from spent ammunition and fishing tackle in the environment, the arguments, attitudes, and beliefs of all stakeholders need to be understood.

NPS efforts to reduce the impacts of lead on its lands

The NPS has stepped up efforts to reduce lead in national park environments, starting with the recent policies to eliminate lead from internal NPS activities for the protection of human health, wildlife health, and ecosystem health. Lead reduction efforts began in 2001 when the Environmental Protection Agency (EPA), per Executive Order (EO) 13148 (EO 2000), lowered the threshold for lead releases into the environment from 1,000 to 100 pounds per calendar year. Parks with outdoor firing ranges were required to meet the new requirements for lead, and parks releasing at or over the 100-pound threshold were required to submit a toxic release inventory (TRI) to the EPA. In 2003, to lessen the NPS's reporting burden, comply with the EO, and mitigate further lead contamination of the environment, NPS began phasing out the use of leaded ammunition for firearms qualifications and shooting practice. In 2007, EO 13423 (EO 2007) required federal agencies to reduce the quantity of toxic and hazardous chemicals and materials acquired, used, or disposed. NPS then mandated that a complete transition to non-lead ammunition for law enforcement qualification and training be achieved by October 1, 2008. The NPS transitioned to non-lead ammunition in culling operations and the dispatching of wounded and sick animals in 2009. These actions have advanced the NPS goal of being a leader in the use of least toxic products and services, for the protection of park employees, visitors, and the lands under NPS management.

Future efforts to further reduce lead contamination of the environment include exploring the prospect of reducing the effects from lead in public hunting and fishing activities in NPS units. Recreational hunting is generally prohibited in NPS units except in park areas where it is specifically mandated by federal law, and it may be allowed in park areas where it is specifically authorized as a discretionary activity under federal law; units with discretionary authorization must determine that hunting is consistent with public safety and enjoyment and sound resource management principles and must adopt special regulations to implement that authority (Code of Federal Regulations, Title 36, Pt. 2.2b, 2010). NPS currently manages 62 units that meet these criteria. Hunting is mandated or authorized and implemented on a discretionary basis under federal law in 61 of these units (Figure 1). Except in designated areas, or as outlined in the Code of Federal Regulations (Title 36, Pt. 2.3, 2010), fishing is allowed in park areas in accordance with the laws and regulations of the state in which the park is located. While the NPS is interested in all landscapes, it is first looking at its own footprint from lead use in parks and exploring ways to lessen that footprint as well as the impacts of park visitors who pursue hunting and fishing in units where these activities are allowed.

In March 2009, a NPS news release announced the goals of eliminating lead from NPS activities. It stated the intentions of the NPS to eventually remove all lead from NPS lands. Acting Director Dan Wenk was quoted as saying, "Our goal is to eliminate the use of lead ammunition and lead fishing tackle in parks by the end of 2010" (NPS 2009a). To some, this was an indication that the use of lead ammunition and fishing tackle by visitors in park units

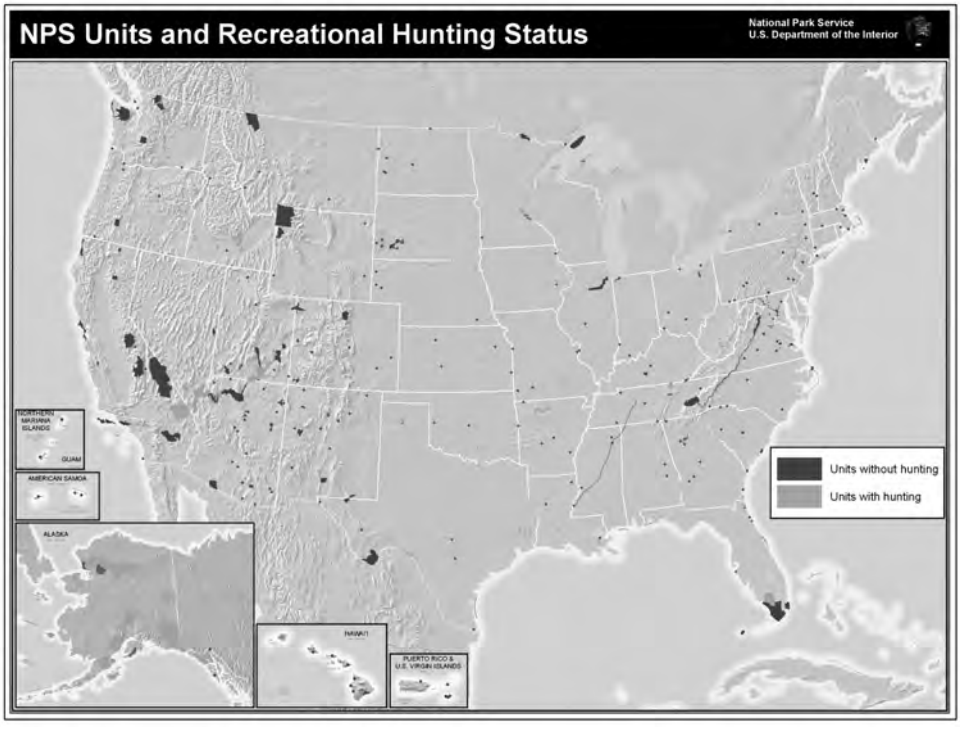

Figure 1. NPS units and recreational hunting status. "Units with hunting" include units where hunting is (1) mandated or (2) authorized and implemented on a discretionary basis, under federal law.

was in jeopardy. Reactions from stakeholders that followed indicated that this issue was highly visible and controversial. Several organizations were quick to offer comments and criticism. For example, the American Sportfishing Association (ASA), which opposes bans on lead fishing tackle, stated that if the NPS pursued such a ban, they would seek an appropriate rule-making process (ASA 2009). The National Rifle Association (NRA) also announced its intent to oppose NPS actions to eliminate lead ammunition, calling these actions unnecessary (NRA-ILA 2009). The response from the National Shooting Sports Foundation (NSSF) was similar (PLD 2009). Thirteen Republican US senators also spoke out against a possible NPS ban on lead ammunition, claiming that the ban would have negative impacts on hunters, the economy, and wildlife populations (PLD 2009).

While there was a strong response by opponents to the potential for future NPS action on this issue, there were also many proponents who demonstrated their support for requiring non-lead-based ammunition and fishing tackle. Public Employees for Environmental Responsibility (PEER) organized a group letter to Interior Secretary Ken Salazar urging him to support an NPS lead ban. In the letter, the groups stated, "We applaud the leadership demonstrated by this effort," and "We strongly support this effort to achieve a lead-free national park system by the end of 2010" (PEER 2009). Signatories included the Coalition of NPS Retirees, the Humane Society of the United States, Wildlife Stewards, the

Arizona Zoological Society, Desert Protective Council, Wilderness Watch, and Delaware Audubon. The groups cite the poisoning of wildlife and the potential for dissolved lead to contaminate groundwater as key reasons for their support.

Responses from all perspectives prompted the NPS to release a clarification statement days after the original news release; it stated that nothing had changed for the public and that the future potential for transitioning to non-lead for recreational use would enlist public involvement, comment, and review (NPS 2009b). The agency stated that its decision-making on this high-profile issue would be guided by a combination of the best available science, accurate fidelity to the law, and commitment to diverse public interests, along with significant public involvement, comment, and review. Further, the agency stated that it would address immediate controversies and long-term challenges, and ultimately improve its ability to preserve the integrity of park ecosystems. The NPS would review and consider all possible mechanisms for reducing the impacts of lead from hunting and fishing in park units. For example, conversion to the use of non-lead ammunition and fishing tackle would eliminate lead pathways to humans, wildlife, and the environment from hunting and fishing. Regulatory action is one way of attempting to achieve such a conversion, but issues of compliance and enforcement may affect the success of this type of action. Non-regulatory mechanisms, including provision of incentives and public outreach to raise awareness and motivate voluntary change, are also options to explore. It is important to note that these action categories (i.e., regulatory vs. non-regulatory) are not necessarily mutually exclusive; the most effective and realistic approach may involve a combination of techniques.

Most prior efforts to mitigate lead contamination from hunting and fishing focused on the switch to non-lead alternatives, but for hunting at least, there may be other strategies to consider. For example, in some areas, removal of visceral remains (or offal piles) of animals harvested with lead has been suggested. To illustrate, a proposed regulation by the US Fish and Wildlife Service (USFWS) for Turnbull National Wildlife Refuge reads, "Hunters must use nontoxic ammunition or remove or bury the visceral remains of harvested animals" (National Wildlife Refuge System 2010). While offal piles can provide wildlife with an excellent source of nourishment, they can also have adverse impacts when lead ammunition is used. High concentrations of lead can be found in these remains given that hunters typically aim for vital organs to ensure a humane and rapid takedown. Removal of the remains would eliminate this source of lead for wildlife, but there is some question as to whether simply burying the remains is effective (Sullivan 2009). Suggesting that remains be buried also may not be an option in some NPS units where digging is prohibited due to the presence of sensitive resources, such as soils and historical or archeological resources. This strategy also does not address game that is wounded but not recovered by hunters, which would still be a likely source of lead ingestion for wildlife.

In selecting among these and other alternatives for reducing lead in NPS units, an important consideration is the extent to which measures will be supported by different stakeholder groups and the effectiveness of these measures in producing desired changes. In recognition of this, we now turn to a discussion of the role of human dimensions in informing future NPS decisions and public outreach on the lead contamination issue.

The role of human dimensions in addressing lead in the environment

Management decisions regarding lead ammunition and fishing tackle have the potential to be highly controversial, with stakeholders with different perspectives becoming highly involved. As discussed in greater detail later on in this report, a nationwide ban on the use of lead shot for waterfowl hunting in 1991 was implemented without much regard for hunters' attitudes toward the regulation (AFWA 2007); it was subsequently met with much resistance and animosity, thereby diminishing its effectiveness (Pokras and Kneeland 2008). From past experiences like this, natural resource agencies have come to understand that stakeholders want to be included in the decision-making process; that they need to understand human behavior and its impacts upon natural resources; and that successful solutions to conservation and management problems will depend upon effective communication with and acceptance from the public. None of the NPS's current efforts to reduce impacts from lead ammunition and fishing tackle include human dimensions research, but the need for such research to inform NPS response to this issue has been recognized. Future decisions regarding these issues should begin with an understanding of factors at the root of human behavior and stakeholders' preferences for management. These social considerations are crucial to successfully address impacts of lead in NPS environments.

The need for public outreach

Human behavior is the root cause of lead in the environment from spent ammunition and fishing tackle; it is only by affecting human behavior that these pathways can be modified or eliminated. Public outreach includes a broad spectrum of activities, ranging from education and information provision to persuasive communication strategies, and can play an important role by serving as a mechanism to promote behavior change and build support for management actions. Outreach efforts often are among the preferred mitigation strategies to address undesirable behaviors and promote alternative forms of human action (Jacobson 2009). At times, outreach may be preferred over regulatory measures for altering behavior because it can provide an enduring solution that transcends many contexts; it retains one's freedom of choice and is typically less intrusive; and it is thought to be less expensive than other alternatives. For example, we may hypothesize that some hunters and anglers use non-lead products only in areas where there are regulations, but through effective communication these individuals might resolve to use non-lead products outside of regulated areas as well. Public outreach can also be viewed as a necessary complement to regulatory solutions. In situations where regulations may be the preferred management option, they contribute to mitigation only when individuals comply with them or when they can be stringently enforced. In these situations, outreach may be used to help raise awareness of the need for regulatory action and thereby contribute to greater levels of support and compliance.

In addition to the reasons stated above, public outreach can often attenuate contentious debates over scientific evidence that are commonplace with issues involving environmental impacts and their mitigation. Health and environmental policies are always based on scientific evidence, up to a point (Wilson and Anderson 1997). While this is necessary and valuable for many reasons, Wilson and Anderson (1997) argue that defining that point can

become particularly problematic and controversial for certain issues. They go on to articulate specific concerns in this matter. Scientific uncertainty and disagreement among scientists create the greatest challenges for applying science to policy. Policymakers, who often hear from different scientists who have drawn disparate conclusions, most often agree with evidence that is in line with their previously held views. Also, scientific uncertainty is frequently cited as a reason to hold off on decision-making, but waiting for science to be definitive, if that is achievable, may not be possible for matters of public health. Uncertainty can be introduced easily and there is no guiding principle for the amount of scientific evidence necessary to inform a particular course of action. The precautionary principle has emerged as a counter-argument to the belief that a lack of proof should suspend action. Sometimes described as "better safe than sorry," the precautionary principle has been defined as "a general rule of public policy action to be used in situations of potentially serious or irreversible threats to health or the environment, where there is a need to act to reduce potential hazards *before* there is strong proof of harm" (Harremoës et al. 2002, 4). Despite being frequently cited and discussed, there is no set criterion with which to apply the precautionary principle to decision-making and policy. With regard to the use of lead products in hunting and fishing, the perceived lack of scientific certainty has called into question the justification for policy decisions (e.g., regulatory bans) in many cases. Justification has become very subjective, as it often does when threats and causation are not visible, direct, immediately detectable, ignored, or the issue is political. Due to such concerns and the overall nature of environmental policy decisions in the US, public outreach (and more specifically, communication aimed at promoting voluntary behavior change) may prove to be the most promising alternative for effectively reducing the impacts of lead from hunting and fishing activities on a large scale.

Practitioners often embark upon communication initiatives rather naively, assuming that simply by making information available, desired behavior changes will follow. In reality, effective communication is notoriously difficult to develop. Various factors confound our ability to persuade someone with informational messages (Wood 2000). The extent of attitude and behavior change may depend upon source factors, recipient factors, and message factors (Eagly and Chaiken 1993; Petty and Cacioppo 1996; Wood 2000). Some important source factors to consider are how credible a source is to recipients and the perceived intent of the source. Pertinent characteristics of recipients include their prior knowledge and the strength and function of existing attitudes. Message factors that are important to consider may seem apparent, but many entities embark upon persuasive communication campaigns without asking these key questions: (1) Are messages relevant to the issue and to the audience? (2) How strong are the arguments being presented? (3) Are messages comprehensible to recipients? (4) What is an appropriate number of arguments to be persuasive, but not overwhelm and dilute key points? (5) Should messages be personal or non-personal in nature? (6) Are messages one-sided or do they provide both sides to an argument? (7) What is the channel of communication (e.g. radio, television, brochures, events) that will be most effective for conveying the message to the target audience? These factors are likely to be highly salient for communicating about lead issues; lessons learned by practitioners, discussed later in this

report, give credence to their importance to the development of effective communication with hunters, anglers, and other stakeholders.

While research has been unable to identify simple and broadly generalizable conclusions about persuasion, important conceptual advancements in relation to these and other factors have been made recently that can help guide communication programs (Crano and Prislin 2006). Adding to this body of literature, Schweizer et al. (2009) recently identified "10 key principles" for effective communication that provides practical guidance to natural resource agencies (Table 1). Although the focus was on informing strategies for communicating about climate change, the authors acknowledged that many of these principles apply to communication in any situation. This would be particularly important for this issue because, like climate change, communication about lead issues often spark highly adversarial and divisive debates.

Additional lessons learned from social psychology

Theories from social psychology can be useful in understanding the factors that form the basis for human behavior and in facilitating more targeted communication initiatives that are able to account for those factors (Teel 2008). Two theories which have been widely-applied in a natural resources context are the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB; Fishbein and Ajzen 1975; Ajzen and Fishbein 1980; Ajzen 1991; for example applications, see Manfredo et al. 1990; Bright et al. 1993). According to TRA, individual behavior stems from one's behavioral intentions, which are in turn a function of specific attitudes and norms. In many cases, hunters and anglers may have well-established social and personal norms for the use of lead-based ammunition and tackle; they may have grown up using lead products and close others (i.e., friends and family) may also use lead-based products. TPB, introduced later, also accounts for the role of perceived behavioral control, recognizing that some behaviors require certain resources and skills to enable individual action. Two possibly applicable considerations for communication with hunters

Table 1. Ten key principles for effective communication (adapted from Schweizer et al. 2009).

1.	Know your audience and select a credible messenger for that audience.
2.	Know what type of claim or argument you are asserting and why it is appropriate for your audience. Lead with your strongest argument or your most confident point.
3.	Connect your message to cultural values and beliefs; people react to traditions, experiences, and shared values – not abstract concepts and scientific data.
4.	Make the message meaningful; appeal to values that are meaningful for your audience.
5.	Make the message empowering; tell your audience what specific actions they can take to make a difference.
6.	Encourage your audience to engage in systems thinking and help them to understand dynamic interrelationships and interconnections.
7.	Partner with other organizations, key players, leaders, employees, entertainers, and neighbors.
8.	Start from the inside – get your organization's top leaders involved, inspire action internally first, then communicate about it.
9.	Communicate about actions and remember that actions and events are an effective mode of communication.
10.	Situate the issue in a specific location or place.

are that: (1) they may not know if or where they can acquire non-lead ammunition, and (2) they may believe that the performance of non-lead bullets is inferior. Strategies that focus on minimizing perceived barriers to individual action might yield better results than the mere provision of scientific information.

Another important theoretical framework that builds upon these attitude–behavior models is the cognitive hierarchy, which specifies relationships among attitudes and more general and more enduring cognitions such as values and value orientations (Manfredo et al. 2009). Attitudes are a key concept in each of these models and have been a major focus of human dimensions investigations because they are useful in predicting behaviors and can offer a parsimonious way of describing a group's thoughts on an issue (Manfredo et al. 2004; Manfredo 2008). Attitudes are defined as the evaluation of an object (e.g., an issue, entity, or behavior) with some degree of favor or disfavor (Eagly and Chaiken 1993). Individuals have thousands of attitudes in memory that are held with varying levels of strength and certainty. The extent to which attitudes guide behavior and are resistant to change is based in part on how strongly they are held by an individual (Petty and Krosnick 1995). A number of strength-related attributes of attitudes have been identified in the literature. These include, for example, degree of involvement with the issue or attitude object, level of emotion experienced in relation to the issue/object, and prior knowledge about the issue/object (Table 2).

The functions and characteristics of attitudes, especially their strength, make mere provision of information about a natural resource issue an oftentimes ineffective strategy if the goal is attitude (and ultimately, behavior) change. One approach to improving communication effectiveness is the belief-targeted approach, which builds upon attitude-behavior models such as TRA (Fishbein and Manfredo 1992; Bright et al. 1993). According to this approach, the content of messages should be designed to target beliefs that form the basis for attitudes. Here it is important to know which beliefs are accessible and salient to the audience; that is, which beliefs come to mind readily when thinking about the issue (Stutman and Newell 1984). For example, an angler may have a negative attitude toward using non-

Table 2. A sample of attitude strength-related attributes.

Attribute	Definition	Example
Involvement	- Outcome-relevant involvement (the decision affects me personally)	- A ban on lead ammunition will affect my success as a hunter.
	- Value-relevant involvement (the issue is important to me because of my basic values)	- A ban on lead fishing tackle will protect wildlife from lead poisoning.
Emotion	- Affective response (the issue make me angry, sad, happy, etc.)	- The thought of a lead ban makes me very angry. - The thought of lead poisoning in condors makes me very sad.
Knowledge	- Objective knowledge (factual information)	- I know a lot about the issue.
	- Subjective knowledge (what I believe to be true about the issue)	- My beliefs may not all be factual, but they are many.

lead sinkers. His/her attitude may be based on the belief that the monetary costs of using non-lead alternatives is too high, and/or that non-lead sinkers do not perform as well as lead ones. In this example, simply providing information about the scientific justification for transitioning to non-lead products is likely not enough to affect change. Instead (or in addition), it would be important to consider the angler's pre-existing beliefs in terms of what gets emphasized in the persuasive messaging. In the belief-targeted approach, the structure of the persuasive message consists of an argument followed by evidence. Ideally, the message recipient accepts the supportive evidence, which in turn leads to acceptance of the arguments, and ultimately a change in beliefs and corresponding attitudes. This approach often yields better results than providing information alone; however it is not a guaranteed success, as many other factors can intervene and influence communication effectiveness.

Another lesson learned from social psychology is that the level of attitude change can depend on the extent to which individuals elaborate on, or think about, the information in a message (Petty and Cacioppo 1986). Dual-process models, including the Elaboration Likelihood Model (ELM) and Heuristic–Systematic Model (HSM), detail the factors that make recipients more or less prone to do this (Petty and Cacioppo 1986; Giner-Sorolla and Chaiken 1997; Na 1999). According to these models, effortful processing can result in more lasting attitude change, but it demands understanding and elaboration of message content by the recipient. This type of processing can be facilitated by ensuring that recipients have both the motivation and ability to engage in thoughtful evaluation of information contained in the message. Tactics along these lines might include limiting distractions and making messages more personally relevant and understandable to members of the target audience. Alternatively, a less-demanding route to persuasion that does not depend on careful scrutiny of message content relies instead on heuristics, or simple decision rules. In this case, recipients may evaluate messages rapidly based on prior experience or intuitive judgments; source credibility can also serve as a heuristic. The use of celebrities in advertising and the use of simple slogans or visual images that appeal to recipients' basic values are examples of approaches that rely on heuristic cues for persuasion. Eagly and Kulesa (1997) discussed the relevance of these approaches for communicating about environmental issues, which indicate they would also be relevant to communicating about lead. Specifically, they used the northern spotted owl controversy in the western US as an illustration and described how stakeholders on both sides of this issue were effective in garnering support for their positions through persuasive techniques. The timber industry promoted an "owls versus people" slogan that portrayed the controversy as "a simple case of jobs for people versus habitat for one seemingly less important species" (Eagly and Kulesa 1997, 133). Environmentalist groups responded by releasing photographs to the media of devastation in the form of large expanses of clear-cut forests to convey the importance of environmental protection. Both groups were successful in framing the issue around human values and appealing to those values through simple heuristic-based approaches.

As Eagly and Kulesa (1997) argued, persuasive communication methods often involve cognitive-based appeals that, in order to be effective, presume recipients process information with care. However, the reality is that recipients may lack the motivation and/or ability to do so. As stated previously, various factors related to the source, message, recipient, and context

can influence communication effectiveness and, more specifically, the extent to which people elaborate on message content. A phenomenon known as "biased processing" sheds additional light on this topic of factors contributing to the complexity of attitude change. Biased processing occurs when an individual critically evaluates incoming information subjectively and in such a way as to confirm and protect existing attitudes and beliefs (Wood et al. 1995). In other words, information that is consistent with an individual's prior attitudes and beliefs is accepted, while information that is contradictory is discounted as erroneous. The end result is minimal, if any, attitude change following exposure to the new information. In a study of biased processing of information related to drilling for oil in the Arctic National Wildlife Refuge, Teel et al. (2006) found that recipients were not persuaded by arguments that contradicted their initial attitudes toward the issue, even though they were told the arguments were from credible sources. Further, they rated arguments in line with their preexisting attitudes more favorably. Evidence of biased processing serves as another example of why communicators can't assume that provision of factual information about an issue, especially a controversial one, is enough to produce desired attitude or behavior change. This is not to say that informational messages should be abandoned, but rather they should account for the characteristics of the target audience, including audience members' attitudes, beliefs, and values as well as their ability/motivation to process information.

Another consideration worth mentioning in the context of attitude/behavior change is the influence of norms on attitudes and behaviors. Norms have been conceptualized in the literature in a variety of ways, but here we refer to them as a person's beliefs about what is proper or improper behavior for individuals in a given context (Donnelly et al. 2000; Manfredo 2008). Norms are associated with social groups and social roles and can be a powerful influence on behavior. Therefore, an understanding of norms can enhance our ability to predict certain behaviors, particularly those more likely to be socially influenced. In thinking about issues related to lead ammunition and fishing tackle, two of the primary stakeholders are hunters and anglers. Generally, hunters and anglers identify strongly with other hunters and anglers. This may be informally with friends and family members who also participate in the activities, or more formally through affiliation with hunting and fishing organizations. In either case, hunters and anglers who identify themselves as part of a social group defined by these activities may consider whether others in the group would approve or disapprove of their behavior. They may also be guided by descriptive norms, i.e. what other people do will influence their actions.

Risk communication. Risk perception and risk communication are other areas of study that have particular relevance to lead issues. The use of lead products in hunting and fishing can pose health risks to humans, wildlife, and the environment. Risk has been defined as the possibility that actions or events will cause harm to humans or to things human beings value (Hohenemser et al. 1983; Kates and Kasperson 1983; Klinke and Renn 2002). Risk assessments are used to quantify risks by way of technological analyses that evaluate the possibility and/or severity of hazards, but risk perceptions often do not coincide with actual risk potential (Wilson and Arvai 2006a, 2006b). Risk perceptions, defined as intuitive judgments of risk (Slovic 1987), can be a function of personality traits (e.g., Flynn et al. 1994), group

membership (e.g., Burt 1987; Lee 1998; Scherer and Cho 2003), and cultural influences (e.g., Slovic and Peters 1998).

Risk communication involves a purposeful exchange of information about risk between interested parties, often with the goal of providing the public with the necessary information to make informed judgments about risk (Morgan et al. 1992). In designing effective risk communication messages it is important to understand the nature of individuals' beliefs, including their current perceptions of risk, that relate to the behaviors of interest; these perceptions influence attitudes and behavior (Knuth et al. 1992). Risk perceptions can also bear upon levels of support for management actions and receptivity to educational messages.

Efforts to reduce the impacts of lead from recreational fishing

Lead fishing lures, sinkers, lead core fishing line, downrigger cannonballs, and weights used on fishing traps and nets are introduced into aquatic ecosystems by commercial and recreational anglers through accidental or intentional breakage (Goddard et al. 2008). There is a range of potential consequences from lead introduced through fishing activities, but the extent of hazards is not fully known. Lost lead fishing tackle is thought to be relatively stable, with the potential to remain intact for decades to centuries (SAAMI 1996). Very few studies have examined the dissolution of lead from fishing tackle, and these have been inconclusive. More research is needed to determine the dissolution of all types of lead fishing tackle at varying densities and water chemistry conditions (Goddard et al. 2008).

A larger body of research has examined the impacts of lost lead on fauna with somewhat more conclusive evidence. No studies have been able to link lead exposure from ingested fishing tackle to fish mortality, and there is no evidence to suggest that ingestion of lead tackle by amphibians or reptiles is a widespread problem (Goddard et al. 2008). Turtles are one exception; published and unpublished literature has documented snapping turtles (*Chelydra serpentine*) suffering from lead poisoning caused by ingesting lead fishing weights (Borkowski 1997).

Lead fishing tackle has had the greatest impact on bird species that ingest fishing tackle lost or abandoned along banks or in water bodies (Goddard et al. 2008). Birds that normally ingest small pebbles to break down food in their gizzards may mistakenly ingest fishing tackle. They typically ingest lead fishing weights that are less than 57 grams (2 ounces); for this reason, most harm to waterbirds involves smaller lead weights used by recreational anglers (Scheuhammer and Norris 1995). Once ingested, lead can poison the birds and eventually kill them.

In the 1970s, lead poisoning of birds from ingesting fishing weights emerged as a significant issue in the UK due to the decline of mute swan (*Cygnus olor*) populations (Sears 1988). This resulted in the banning of lead fishing sinkers weighing less than 1 ounce in the UK in 1986 (Pattee and Pain 2003). In 1991, studies confirmed that fewer mute swans were poisoned by lead following the ban (Sears and Hunt 1991). Swans in the Thames River Valley also showed significant declines in BLLs after the ban, but 60% of swans sampled still had elevated BLLs (Perrins et al. 2003).

The hazards of lead fishing tackle to common loons (*Gavia immer*) were reported in North America in the early 1990s (Franson and Cliplef 1992; Pokras and Chafel 1992;

Stone and Okoniewski 2001). Since that time, many studies have attempted to quantify the impacts of lead fishing tackle on common loons. In areas where there are both loon populations, and recreational fishing, lead poisoning from swallowing lead sinkers has accounted for 10–50% of recorded loon mortality (USFWS 1999). In New England, over 50% of adult breeding loon mortalities were caused by ingesting lead sinkers and jigs. Similar evidence reported in Michigan, Minnesota, Ontario, and on Lake Erie in New York has shown that 40%, 17%, 27%, and 30%, respectively, of dead adult loons were likely poisoned by lead (USFWS 1999). Loons are not the only bird species in the US to be affected by lost lead fishing tackle; more than 30 species in at least ten states have reportedly suffered mortality as a result of lead fishing tackle ingestion (Nadis 2001). These species include swans, pelicans, geese, ducks, cranes, herons, and eagles. However, while the problem affects many bird species, loons are the most heavily impacted, followed by brown pelicans (*Pelecanus occidentalis*; Franson and Smith 1999).

Notable regulatory and voluntary actions in the US

For reasons cited above, loons have been at the center of regulations and outreach efforts regarding the use of lead fishing tackle in the US. Some US federal agencies have banned the use of lead tackle on lands with loon and swan populations, such as NPS units and national wildlife refuges (Table 3). In addition, the five states with regulations in place all cite the common loon as their primary purpose for a ban, while also recognizing benefits for other waterbirds (Table 4). The prohibition on the use of lead sinkers in Massachusetts, for example, applies to the Quabbin and Wachusett Reservoirs, the two bodies of water that support the bulk of the state's loon populations. In the four other states, the regulations are

Table 3. NPS units and national wildlife refuges (NWRs) with regulations on the use of lead fishing tackle.

Unit	State(s)	Regulation
Yellowstone NP	ID, MT, WY	Leaded fishing tackle such as leaded split-shot sinkers, weighted jigs, and shot lead-weighted ribbon for nymph fishing are not allowed.
Glacier NP	MT	The use of all lead associated with fishing is prohibited within the park. This includes weights, lures, jigs, line, etc. The only exception is a fisherman who is using a downrigger; cannon ball weights of 2 to 10 pounds may be used on the down-rigger cable.
Bear Lake NWR	ID	Use and possession of lead weights or sinkers is prohibited.
Union Slough NWR	IA	Use and possession of lead terminal tackle is prohibited.
Rachel Carson NWR	ME	Lead jigs and sinkers are prohibited.
Assabet River NWR	MA	Lead sinkers are prohibited.
Seney NWR	MI	Use or possession of fishing weights or lures containing lead is prohibited.
Red Rock Lakes NWR	MT	Use and possession of lead sinkers or any lead fishing product while fishing are prohibited.
Rappahannock River Valley NWR	VA	Use of lead sinkers is prohibited.

State	Year	Sportfishing Regulation
Maine	2002	A person may not sell or offer for sale a lead sinker for fishing that contains any lead and weights 0.5 ounce or less.
Massachusetts	2001	The use of lead sinkers is banned at two reservoirs (Quabbin and Wachusett).
	2012	Lead fishing sinkers and jigs less than 1 ounce will be prohibited in all inland waters of the Commonwealth effective January 1, 2012.
New Hampshire	2000	The use of lead sinkers and jigs in all fresh water in New Hampshire, including lakes, ponds, rivers and streams is prohibited. The ban prohibits the sale and use of lead sinkers weighing 1 ounce or less and lead jigs less than 1 inch long along their longest axis.
New York	2004	The sale of lead fishing sinkers weighing 0.5 ounce or less is prohibited.
Vermont	2003	A person shall not use a lead sinker in the state of Vermont which weighs 0.5 ounce or less. It is unlawful to sell or offer for sale a lead sinker in the state of Vermont.

Table 4. US states with restrictions on the use of lead fishing tackle.

statewide. The ban in Massachusetts will extend statewide in 2012. New Hampshire was the first state to ban the use of lead sinkers of one ounce or less, and according to New Hampshire Fish and Game personnel, enforcement has been done by performing random checks on anglers (Michael 2006). Violators are subject to a maximum fine of $250, but unless violators blatantly disregard the rules, they are educated about the ban and the reasons behind it rather than being fined (Michael 2006). Little information about angler compliance with the use of non-lead fishing weights is available in New Hampshire or the other areas where regulations exist. Officials in Maine, New Hampshire, Vermont, and New York have stated that regulations are too recent for compliance data to be obtained (Rattner et al. 2008). However, one study in New Hampshire has suggested that common loon mortalities due to lead toxicosis saw a 39% reduction after the ban (Vogel 2005).

In all five states where regulations have been enacted, targeted outreach has occurred prior to and following implementation. Four states (an online search turned up nothing from Maine) produced an informational brochure; displayed in all of the brochures is a picture of a loon along with the slogan "Get the Lead Out." This slogan has been used in many lead awareness campaigns, most notably to bring attention to the dangers of lead paint in residential buildings. Other common features of the brochures include information about the state's regulations; other states that have regulations; how lead fishing tackle impacts wildlife, with a focus on loons; what alternatives to lead are available; how to dispose of old lead sinkers; and ways that anglers can help prevent lead poisoning of bird species. Brochures, and a variety of other educational materials such as posters, have been distributed and exhibited through various means. For example, the Boy Scouts of America (BSA) from Massachusetts handed out materials, brochures, and sample fishing weights at local, nation-

al, and international sportsmen's events (Browne 2009). In 2001, a program sponsored by the National Wildlife Federation (NWF) in New England placed educational displays at dozens of state parks, tackle shops, and fishing events throughout the region (Nadis 2001). The Vermont Department of Fish and Wildlife (VTDFW) included a full-page description of the lead issue and specifics of the state law in the *Vermont Digest of Hunting, Fishing, and Trapping Laws* and in its 2005 *Angler's Pocket Guide* (Michael 2006).

Lead tackle exchange programs have also been implemented in these states. These programs encourage anglers to turn in lead fishing tackle to the sponsoring agency or organization to be safely disposed of, and in return anglers receive non-lead tackle. Lead exchanges often take place in conjunction with fishing events, such as fishing derbies. In Massachusetts, the lead tackle exchange program began as an Eagle Scout project with the BSA, which has collected over 65 pounds of lead through the effort (Browne 2009). Between 1999 and 2000, a campaign in Vermont and New Hampshire gathered more than 40,000 lead sinkers at fishing stores and state parks (Nadis 2001). The VTDFW has also distributed free samples of non-lead sinkers at its district offices, select state parks, fishing clinics and educational events, and at all of the state fish hatcheries (VTDFW N.d.). Exchange programs and free samples offer a way to introduce anglers to non-lead alternatives, and draw attention to educational campaigns designed to alert anglers to the toxicity of lead in the aquatic environments they use for recreation (Goddard et al. 2008).

In general, when these five states implemented their bans, they were not confronted with strong opposition or controversy. A notable exception to this was in Maine, where the Bass Anglers Sportsman Society (BASS) and people associated with youth fishing programs provided testimony against the proposed regulations during the legislative process (Michael 2006). Having donated thousands of dollars in fishing gear to kids, BASS was concerned that some of the gear would become illegal. In New Hampshire, most local sportfishing groups did not show much concern, and they did not get involved in the legislative process (Michael 2006). In New York, there was little resistance to regulations, although the ban that was passed was less restrictive than the one originally proposed; rather than banning the use of lead sinkers under one-half ounce, the ban applied only to the sale of the sinkers to allow anglers time to transition to alternative products (Michael 2006). In Vermont, where a very thorough program was directed by the legislature, the VTDFW had the support of the Vermont Federation of Sportsmen's Clubs and the NWF, and little opposition was encountered from either anglers or retailers (Michael 2006). Some small fishing-gear retailers in the different states were unhappy with the ban on sales of small lead tackle because they were left with unsellable inventory; for chain stores this was less of a concern because they could transfer stock to states where lead is legal. Contacting small retailers for purposes of implementing the bans also proved to be a bit of a challenge, whereas chain stores were easier to reach and communicate with (Michael 2006). It is unclear as to whether the level of opposition and the corresponding level of response by decision-making agencies has had an impact on the success of the such bans in terms of compliance and/or reducing negative impacts from spent lead.

Although widespread opposition was not encountered in these particular states, nationwide bans and bans on lead fishing tackle proposed in other states have not been successfully

implemented. For example, the EPA proposed a ban on the manufacture, processing, and distribution of lead and zinc sinkers in response to a citizen's proposal to require labels or warnings on lead fishing sinkers (Michael 2006). A bill containing this ban was introduced in Congress in 1994, but it was not passed. Had it become law, the economic impact of the ban was estimated to be less than $4 per year for the average angler, and an estimated 4,700,000 birds could have potentially been saved from lead poisoning. The EPA's proposed restrictions were unique in that they would have targeted all sizes and types of lead sinkers, whereas the state-level bans currently in place have only applied to sinkers of certain sizes that pose the greatest danger to waterbird species, such as loons. Another example of a failed effort at the national level was the 1999 announcement by the USFWS of its intent to establish additional lead-free fishing areas on units of the NWR system. The areas consisted of places where mortality of common loons from lead sinker ingestion had occurred, or where habitats used by loons co-existed with significant recreational fishing activities (USFWS 1999). The USFWS has yet to implement these proposed restrictions.

States outside of the Northeast region of the US have also encountered difficulties in implementing regulations. A bill before Minnesota's state legislature during the 2002–2003 session proposed a ban on the use and sale of some lead fishing sinkers and jigs; the bill was dropped due to opposition from angler groups and tackle manufacturers. Minnesota opted to change the bill from a ban to "a call on the state to encourage the use of non-lead tackle and educate the public about the potential perils of lead tackle" (Smith 2003). For nearly ten years, the Minnesota Pollution Control Agency (MPCA) has worked to raise public awareness of the need for non-lead alternatives and increase availability of these alternatives at retail stores (MPCA 2010). A variety of tools have been used by the MPCA, including lead exchange programs which collected 7,000 pounds of lead tackle from 2001 to 2008 and provision of free educational kits to members of lake associations to help them promote non-lead products. The MPCA also partnered with Minnesota's Department of Natural Resources and five Minnesota-based manufacturers to offer "Get the Lead Out" retail displays for stores; this came in response to feedback that anglers were frustrated by the difficulty of finding non-lead tackle in stores (MPCA 2010). While the regulatory actions pursued in Minnesota were opposed by many stakeholders, subsequent voluntary measures have achieved high levels of support as a result of cooperation among tackle manufacturers, retailers, lake associations, conservation organizations, anglers, and the government (MPCA 2010). Data are largely unavailable to indicate whether these efforts have been successful in reducing lead toxicosis in wildlife and if anglers are switching to non-lead alternatives. However, dead loons collected in Minnesota and Wisconsin are currently being examined in a lab in Wisconsin to determine the cause of mortality, and surveys from a recent Minnesota sportsmen's event suggest a behavioral change among some anglers (Amanda Baribeau, MPCA Electronic Waste Coordinator, phone conversation, April 12, 2010).

The Washington Fish and Wildlife Commission (WFWC) recently approved restrictions on the use of lead fishing tackle at 13 lakes with nesting common loons in early December 2010. The restrictions prohibit the use of lead weights and jigs that measure 1.5 inches or less along the longest axis at 12 lakes in Washington and the use of flies containing lead at Long Lake in Ferry County, Washington. The restrictions, which took effect on May 1, 2011,

are designed to protect loons from being poisoned by ingesting small lead fishing gear lost by anglers. The proposal was announced in early November 2009, and opponents, including the NRA, ASA, and BASS, criticized the motives behind the ban. These opponents claimed that the effects on loons are not substantial enough to support a ban. Chris Horton, BASS Conservation Director, stated that "the supporting data is ridiculously insignificant and in no way justifies, scientifically, the proposed ban on lead fishing tackle" (Robbins 2009). However, after a public hearing on the issue in October where the WFWC reviewed the findings of a Washington Department of Fish and Wildlife (WDFW) advisory group, the regulations to ban certain types of lead fishing tackle were determined to be the best way to minimize risks to loons.

Wisconsin has also been actively involved in educating anglers about dangers posed to wildlife from the accidental loss of lead fishing tackle. Many organizations have partnered in these outreach efforts; they include the Wisconsin Bird Conservation Initiative (WBCI), Wisconsin Society for Ornithology, Raptor Education Group, Wisconsin Wildlife Federation, Wisconsin Association of Lakes, Loon Watch, Trout Unlimited, and Gordon/St. Croix Flowage Association (WBCI n.d.). While management actions in Wisconsin have focused primarily on the promotion of voluntary use of non-lead tackle, the Wisconsin Department of Natural Resources (WDNR) has considered a ban that would phase out the use of lead fishing tackle of the sizes and weights that pose the highest risk to wildlife. Citizens voted on the proposal on April 12, 2010. Although the majority of the citizens voted "yes," 33 counties approved while 37 counties rejected. In addition, citizens in Bayfield County did not believe the result adequately reflected the wishes of Wisconsin sportsmen and proposed a citizen resolution, which revisited the topic with more specifics in the next sportsman vote. The resolution to proceed with some type of phase-out of lead tackle passed, but no one has figured out on how to proceed on this. The Natural Resources Board is currently in the process of reviewing recommendations from WDNR.

In addition to the above examples of where regulatory and voluntary measures are being pursued, many other states have engaged in outreach campaigns to reduce the impacts of lead from recreational fishing. Almost all states have at least some information publicly available regarding the hazards of lead tackle, often promulgated by the state fish and wildlife agencies. Many other organizations also disseminate information. For example, the Oregon Department of Human Services released a brochure, the cover of which reads, "Attention Fishermen, Fishing Weights Contain Dangerous Levels of Lead" (ODHS 2004). The contents of the brochure focus mainly on the threats to human health and how to avoid lead exposure; only one item suggests using non-lead fishing sinkers. While many of the messages espoused in outreach campaigns consistently focus on threats to birds, and in particular loons, there are various messages being used by different entities, and various forms of distribution. A final notable example is California's 2001 requirement that manufacturers of lures that contain lead print a warning on the packaging (Michael 2006). The warning states that lead can cause cancer, birth defects, and other reproductive harm in humans.

These outreach initiatives, which have occurred mostly at the state level, have been less controversial than regulatory bans. In fact, the ASA, one of the strongest opponents to lead bans, supports efforts aimed at encouraging voluntary use of non-lead tackle (ASA 2009).

The ASA also acknowledges that lead toxicosis of waterbirds such as loons can occur, and that areas that are "hot spots" for ingestion of sinkers should promote restrictions based on sound science (ASA 2009). Despite the increasing levels of support for voluntary action, the ASA and other groups have spoken out against bans on lead tackle based on the conclusion that there is insufficient scientific data; loon populations are stable and increasing; there are more serious threats to loons, such as loss of habitat due to shore development; alternatives cost six to twenty times more than lead; alternatives do not perform as well as lead; and bans would require significant changes from industries and anglers that aren't justified (Goddard et al. 2008; ASA 2009). A similar argument is that lead sinkers have not been shown to cause widespread population-level effects or to cause substantial changes in species distributions (Goddard et al. 2008). Many argue that population-level impacts should not be a prerequisite for corrective action (Goddard et al. 2008). The arguments over the scientific basis for bans also extend to the inconclusiveness of reports on dissolution of lead from fishing tackle in aquatic ecosystems as well as impacts on human health; these debates tend to be the most controversial and difficult to resolve.

The extent to which price factors are problematic depends on the fluctuating cost of alternative materials and general economic conditions. However, alternatives to lead fishing tackle have been available in Canada, the US, and European countries for several years, and many manufacturers already produce non-lead tackle (Scheuhammer and Norris 1995; NCM 2003). In addition, the actual cost differences may be minimal. Doug Crumrine, owner of the company Bullet Weights, says that a pack of steel sinkers costs only 10 to 20 cents more than a lead pack of comparable size (Nadis 2001). Nevertheless, some argue that the increased cost will discourage or restrict the ability of recreational anglers to use non-lead products, especially during difficult economic times. Tied to this is the argument that a decline in angler numbers could result from further restrictions, which would lead to a decrease in conservation funding partially derived from the sale of fishing licenses. No evidence exists, however, to suggest that this trend has occurred in areas where regulations have been imposed.

Another leading argument against bans on lead tackle relates to the performance of non-lead alternatives. Alternatives are not as dense as lead and therefore need to be larger to be of the equivalent weight. Many anglers believe that the increased size is detrimental because it can discourage fish from biting (Goddard et al. 2008). Although it is difficult to debate an angler's performance preferences, some claim there are benefits to using non-lead fishing tackle. For example, brass and steel alternatives are advertised as making more noise than lead as they bump over the bottom of water bodies, which is claimed to attract fish (Goddard et al. 2008). Steel sinkers are also said to be more sensitive, thus providing anglers with a better feel for what is happening at the end of their line. Steel is less malleable than lead too, so it retains its shape and holds paint longer. Both sides of the debate have developed talking points to support their positions, but those in support of non-lead alternatives recognize that the burden is on them to prove these products can provide desired performance at a reasonable cost.

A challenge of a different nature that can interfere with efforts to reduce the use of lead fishing tackle entails the manufacture of lead fishing weights by people in their homes. In 1994, the EPA estimated that approximately 800,000–1,600,000 people make lead fishing

weights in their homes, either for personal use or to sell (Goddard et al. 2008). According to the EPA, this "cottage industry" represents 30–35% of lead sinker production in the US. In areas where the sale of lead weights is prohibited, it is likely that lead product use still occurs due to availability of homemade options. This is additionally concerning due to the potential for lead poisoning in humans through lead inhalations that may coincide with the manufacture of these products in the home (EPA 2004). Moreover, it makes clear the need for well-informed communication strategies aimed at enhancing compliance with the use of non-lead fishing tackle.

As suggested by the above experiences and arguments that reveal the complexities associated with a transition to non-lead tackle, regulations alone are not likely to produce desired behavior change. In addition, regulations are likely to result in greater public controversy as compared with other alternatives such as promotion of voluntary action. Clearly, public outreach efforts will play a critical role in efforts to reduce the impacts of lead from recreational fishing and building support for management strategies aimed at addressing this issue in the future. To ensure the success of these efforts, additional research is needed to determine the effectiveness of existing outreach mechanisms, as well as to assess the diversity of stakeholder beliefs and attitudes regarding the use of non-lead products. Similar conclusions can be drawn from a review of the literature on the use of lead in recreational hunting, which we address in the next section.

Efforts to reduce the impacts of lead from recreational hunting and shooting sports

Incidents of lead poisoning of waterfowl at hunting sites appeared in the press and scientific literature in the late 1800s (Sanderson and Bellrose 1986; Friend et al. 2009). Continued investigations by leading scientists led to reports of widespread lead poisoning in the 1930s (Friend et al. 2009). Then, in the mid-1950s, attention to the issue of lead poisoning declined; it wasn't until the publication of *Lead Poisoning as a Mortality Factor in Waterfowl Populations* (Bellrose 1959) that interest in the hazards of spent lead shot was renewed. The continued decline of major waterfowl populations resulted in a sustained and heightened concern about lead poisoning (Friend et al. 2009), yet it took decades more research and contentious debate to reach scientific consensus that ingesting lead from ammunition was a significant mortality factor affecting waterfowl populations (Dolton 2008). Data during this time span estimated that the annual mortality of waterfowl in North America due to lead poisoning was between 1,600,000 and 3,900,000 birds (Bellrose 1959, Feierabend 1983).

Most of the scientific research related to lead poisoning from ammunition has focused on avian species, due to the fact that the most pronounced exposures and effects have been seen in waterfowl (Sanderson and Bellrose 1986), certain upland game birds (Kendall et al. 1996), and predatory and scavenging birds (Pattee and Hennes 1983). Exposure depends on species-feeding and grit-ingestion habits, and birds that forage in areas where lead objects accumulate are more at risk (NCM 2003). Early evidence of upland bird mortality from lead ingestion was gathered in labs, and while it showed that ingesting lead ammunition was fatal to upland birds, more research is needed to determine the extent of exposure for upland species in the wild (Hunter and Rosen 1965; Westemeier 1966; Buerger et al. 1986; Stowe et

al. 1972). In predatory and scavenging species, secondary poisoning from consumption of wounded or dead prey is the most significant source of toxicosis; this has had significant effects on bald eagles (*Haliaeetus leucocephalus)* (Figure 2; Griffin et al. 1980; Pattee and Hennes 1983) and the California condor (*Gymnogyps californianus*) (Kramer and Redig 1997; Meretsky et al. 2000; Church et al. 2006). Shot, bullets, and bullet fragments have been observed in wounded prey and gut piles that hunters discard (Janssen et al. 1986; Hunt et al. 2006; Knopper et al. 2006). For California condors (Figure 3), poisoning from lead bul-

Figure 2. Bald eagle perched on branch, California. US Fish and Wildlife Service photo.

Figure 3. Upper left: Head detail of sub-adult female California condor, Pinnacles National Monument, California. Lower left: Juvenile California condor sunning in the High Peaks, Pinnacles National Monument, California. Right: Adult male California condor with 2-day old nestling at cavity nest, Pinnacles National Monument, California. All photos © 2011 by Gavin Emmons (www.gavinemmons.com). Used by permission.

let fragments in scavenged carcasses and offal piles has been identified as the greatest mortality factor for this species (Meretsky et al. 2000; Sieg et al. 2009).

The effects of lead from spent ammunition are well documented for avian species, and, more recently, the literature has focused on impacts to other wildlife. Reports have shown elevated lead concentrations in invertebrates, amphibians, reptiles, and small and large mammals in areas that are heavily hunted and/or in close proximity to shooting ranges (Rattner et al. 2008). At a small firing range at West Point in New York, for instance, lead concentrations in earthworms (*Oligochaeta* spp.) were reported to be 90 times greater than levels in earthworms at a distant reference site (Labare et al. 2004). Some evidence also suggests that lead from spent ammunition could be a challenge for the conservation of large carnivores and other scavenging mammals (Rogers et al. 2009). These include black bears (*Ursus arctos*), grizzly bears (*U. americanus*), grey wolves (*Canis lupus*), and coyotes (*C. latrans*) that scavenge on ungulate and offal piles left by hunters (Wilmers et al. 2003). Studies are ongoing in Yellowstone National Park, and the area surrounding the park, to determine the effects of the fall hunting season on carnivores in the region (Rogers et al. 2009). Grizzly bears have been shown to alter their movement patterns around the park during hunting season to feed on wounded elk (*Cervus elaphus*) and gut piles (Ruth et al. 2003; Haroldson et al. 2004), and more research is need to determine the immediate and long-term effects.

Notable regulatory and voluntary actions in the US

By 1986, the scientific research and numerous lawsuits surrounding the use of lead in hunting and shooting sports resulted in the passing of federal regulations that phased out the use of lead shot in hunting waterfowl and American coots (*Fulica americana*) over a five-year span in the US (Rattner et al. 2008). The ban, which applies specifically to hunting activities on federally regulated lands, has been in effect since 1991.

The ban on lead shot for waterfowl and coot hunting was met with resistance from the ammunition industry and sportsmen (Pokras and Kneeland 2008). Resistance took the form of lawsuits that were filed against state and federal wildlife agencies for instituting the bans, as well as noncompliance with the regulations. A lack of communication between scientists and other stakeholders was largely to blame for the contentiousness of the debate (Pokras and Kneeland 2008). One of the most poignant lessons to be learned from the events leading up to and following the 1991 ban is that strict legislation banning the use of lead for hunting that does not account for the interests of sportsmen and the ammunition industry will likely result in ardent protest, low compliance, and ultimately failure to resolve lead poisoning issues. Others cite the ban from the opposite perspective, arguing that the ban was contentious, but now people comply with the regulation without objection. While the controversy has waned over time, by learning from past situations, and acting proactively, agencies may reduce the initial level of controversy and increase the rate of acceptance.

Given that large amounts of spent lead ammunition are still deposited in the environment through a variety of other hunting, depredation control, and shooting sport activities (Scheuhammer and Norris 1995; Schulz et al. 2002), with a range of associated implications for wildlife and the environment, it is prudent for those advocating for further reductions of lead use to understand the factors that inhibited and facilitated the 1991 ban and other regulatory measures in the US. The Association of Fish and Wildlife Agencies (AFWA) conducted a survey of people who were involved in the ban in the 1990s that provides useful insight in this context (AFWA 2007). A few of the key findings are summarized in Table 5.

Many US states have taken additional regulatory actions to restrict the use of lead in hunting; these actions are specifically directed at lead shot, not all lead ammunition. Nearly half of US states have regulations requiring the use of non-lead shot that extend beyond the federal law for waterfowl hunting (Figure 4). However, these restrictions are not statewide; they have been applied in ranges where there are species of concern. Use of lead ammunition to hunt certain species was banned in some cases because their habitats coincide with waterfowl (e.g., crane, snipe rail). In Alaska, for example, the risk of lead exposure to waterbirds, including the threatened spectacled eider (*Somateria fischeri*), was an important factor leading up to additional regulatory measures (D.J. Case and Associates 2006).

In addition to these regulatory actions, several states have employed public outreach campaigns, again, aimed primarily at species of concern, to reduce the impacts of lead from hunting. In Arizona, California, and Utah, outreach efforts were initiated based on concerns about lead in the California condor's range. A report on condor–lead issues produced in 2003 by the lead mitigation subcommittee of the California Condor Recovery Team (CCRT), which found that lead poisoning from spent ammunition was the leading cause of condor fatalities (Redig et al. 2003), was influential in inciting action in this area. In the late fall of

1. More effort should have been made to obtain input from hunters prior to making policy decisions.
2. Greater attention and analysis of supply issues should have occurred.
3. Actions moved too fast; there should have been more time afforded to inform, educate, and convince agencies, nongovernmental organizations, manufacturers, retailers, media, and sportsmen of the need for the policy.
4. Sales people, especially in large stores, should have been trained to provide accurate information because they may be the main source of information for buyers.
5. Sources should have been established for reliable and accurate information.

Table 5. Suggestions about what should have been done differently for the 1990s federal ban on lead shot use for waterfowl hunting, from a survey of people involved in the ban (adapted from AFWA 2007).

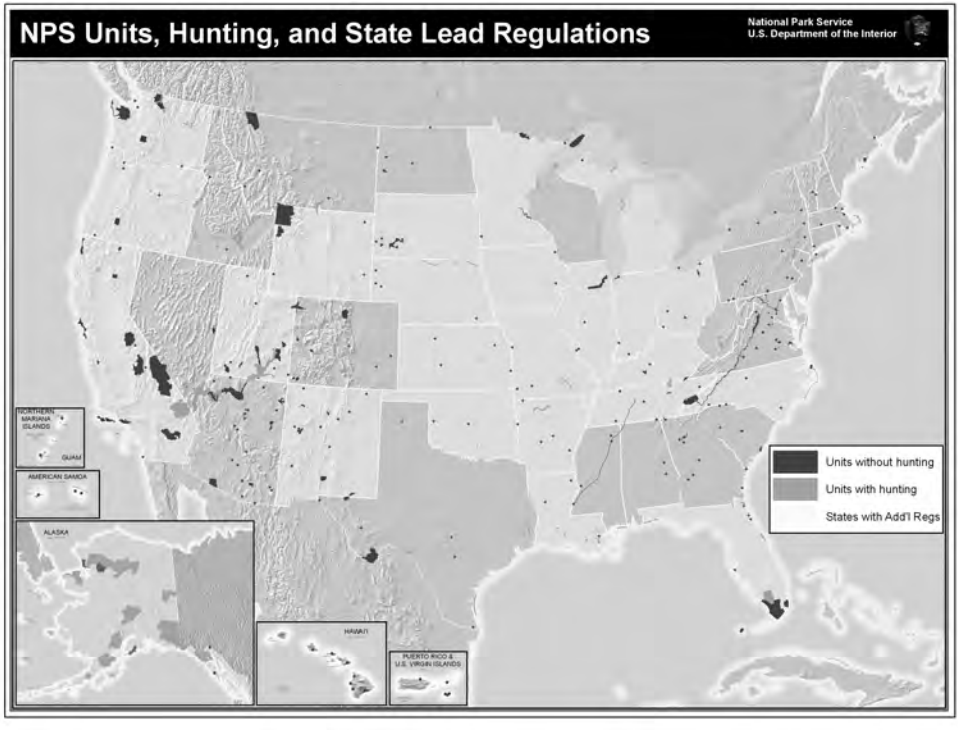

Figure 4. NPS units, recreational hunting status, and states with lead regulations. States shown in light gray have implemented lead ammunition restrictions beyond federal bans on the use of lead shot in hunting waterfowl.

2003, the USFWS and the Wildlife Management Institute (WMI), following the recommendation of the CCRT, conducted hunter surveys in the three states to understand hunters' knowledge and attitudes of condor–lead issues (Sieg et al. 2009). Information obtained from these surveys was intended to inform communication with hunters and ranchers, and it revealed that hunter awareness of lead poisoning of California condors was relatively low (D.J.

Case and Associates 2005). Awareness was highest in California; 45% of hunters there responded "yes" to the question, "Are you aware that lead poisoning is a problem currently faced by condors?" compared with 23% of Arizona hunters and 12% of Utah hunters. Despite the low levels of awareness, the majority of respondents indicated that they would be willing to take some action to help prevent lead poisoning. Arizona and California have since implemented extensive outreach programs that have many similarities, but also unique differences. In December 2007, the California Fish and Game Commission modified the methods authorized for taking big game species, nongame birds, and nongame mammals in areas designated as California condor range by prohibiting the use of lead ammunition for these purposes. The regulations became effective in July of 2008. Arizona is currently limited to voluntary participation tactics due to the status of the California condor there (i.e., its being designated as a "non-essential and experimental" population), so regulatory actions are not being considered. Utah has not implemented a formal outreach campaign, but recently began working on plans to do so (Sieg et al. 2009). Below are more detailed descriptions of existing outreach initiatives in Arizona, California, and other states where active programs have been pursued.

Arizona. The Arizona Game and Fish Department (AZGFD) began efforts to educate the public and engage hunters in voluntary lead reduction efforts in 2003 (Sieg et al. 2009). As mentioned above, results of a phone survey conducted in the fall of 2003 with 205 hunters who held tags in Arizona's condor range that year revealed that only 23% were aware of the problems posed to condors from lead use (RM 2003). Additionally, only 9% of respondents were aware of educational efforts pursued in this context, despite the fact that they would have received a letter in the mail from the agency containing details about the issue prior to the survey, and information had been published in the 2003 Arizona hunting regulations (Sieg et al. 2009).

In December 2003, focus groups were conducted in Arizona to test messages for communicating with hunters and to further investigate the barriers to reducing lead use in the condor's range. Results suggested that the best message for communication was, "Hunters and ranchers have a long history of caring for the land and conserving all kinds of wildlife. They can continue this tradition and help prevent lead poisoning in California condors by taking one or more of the following actions in the condor's range: remove all carcasses from the field; hide or bury carcasses and gut piles; remove bullets and surrounding affected flesh; or use non-lead ammunition" (D.J. Case and Associates 2005). The focus groups also revealed that hunters and ranchers wanted to be shown credible data that linked lead from spent ammunition to condor poisoning and then, if they were asked by a credible source to help condors by adopting specific actions, they would be willing to do so (D.J. Case and Associates 2005). The AZGFD and sportsmen's groups were identified as credible sources. Federal agencies and non-profit entities received much lower ratings in the Arizona surveys. This highlights the need to build partnerships. In Arizona, for example, most of the research on the impacts of lead ammunition has been conducted by the Peregrine Fund, a source with lower credibility among hunters. However, the Peregrine Fund has partnered with AZGFD, a partnership that benefits both organizations and provides a credible source for message delivery. It is especially important to partner with trusted sportsmen's groups. The NRA,

one of the most outspoken and active opponents of non-lead initiatives, is less credible than some sportsmen's groups but more credible than federal agencies. Messages coming from non-credible sources can set back progress rather than further it.

Results of the phone surveys and focus groups were used by the AZGFD to develop a strategy for communicating with hunters (Sieg et al. 2009). In 2003–2004, information was included in the hunting regulations booklet, and between 2,000 and 7,000 hunters with big game tags for the condor range were mailed information. During that time, the AZGFD also began to deliver educational presentations and lead reduction messages to the general public through such channels as wildlife fair displays, legislative contacts, the AZGFD website, the AZGFD *Wildlife Views* magazine and television programs, as well as through other general media outlets (Sieg et al. 2009). The AZGFD also sought the partnership of sportsmen's organizations in Arizona, asking them to support the agency's efforts (Sieg et al. 2009). The AZGFD has been successful in forming a coalition that includes the Arizona Antelope Foundation, the Arizona Desert Bighorn Sheep Society, the Arizona Deer Association, the Arizona Elk Society, and the Arizona Chapter of the National Wild Turkey Foundation.

In 2005, the AZGFD partnered with Sportsman's Warehouse and Cabela's to begin a voluntary free non-lead ammo program which distributed coupons good for two free boxes of non-lead ammunition to 2,390 hunters in the core condor range (Seng 2006). Hunters could redeem their coupons either at a Sportsman's Warehouse store or by mail from Cabela's. Included with the coupons was a letter outlining the issues related to lead ammunition that asked for voluntary help with the program; 65% of hunters redeemed their coupons that year (Sieg et al. 2009). Surveys of hunters who did not redeem their coupons identified the primary reasons as non-lead ammunition not being available in their caliber or preferred bullet weight; that it would take too long to sight in new ammunition; that the redemption coupon was too complicated; that they were not convinced that lead from spent ammunition was a problem for condors; and that they believed that the nature of the program was "anti-hunting" (Seng 2006). In response to some of these barriers to participation, the AZGFD provided significantly more information to hunters in 2006, but subsequently received a negative response for providing too much information that most hunters did not read (Sieg et al. 2009).

A number of additional efforts were made in 2007 to increase hunters' participation in voluntary non-lead programs. Among these efforts were lead articles about condors in sportsmen's publications, increased media coverage of how hunters were helping to recover condors, simplified outreach messages that only emphasized using non-lead alternatives, mailing of follow-up information to hunters who did not redeem their non-lead ammo coupons, and an increased number of field staff to directly contact hunters about this issue. In addition, a DVD hosted by Nolan Ryan and entitled "How to be successful in your upcoming deer hunt" was produced; it contained five minutes of information on lead exposure and asked for hunters' help. Outreach materials and the DVD were mailed to hunters along with their tags.

Since 2007, the AZGFD has continued to focus on improving its outreach and increasing voluntary non-lead program participation. Specific emphasis has been on working with ammunition distributors to increase availability of non-lead alternatives and placing

non-lead displays with educational materials in retail locations. Human dimensions surveys conducted since 2004 suggest that the agency's efforts have been successful in encouraging behaviors that reduce lead in the condor range (Table 6; Sieg et al. 2009). The AZGFD appears to be the only organization administering outreach that has comprehensively evaluated the impacts of its initiatives.

California. The hazards of spent lead ammunition to condors have long been recognized in California, and over the past few years major efforts have been taken to address this issue. As mentioned previously, only 45% of California hunters surveyed by phone in 2003 (n = 200) were aware of lead poisoning problems faced by condors (D.J. Case and Associates 2005). Around that time, some communication initiatives had been launched, but they had not been well researched or well implemented (D.J. Case and Associates 2005). Only 24% of respondents were aware of these initiatives. In 2007, the Institute for Wildlife Studies (IWS) received a grant from the National Fish and Wildlife Foundation (NFWF) to launch an outreach program to raise awareness about alternatives to lead bullets among hunter and ranchers (Theyerl et al. 2010). The program was launched in collaboration with Pinnacles National Monument (PNM), whose own effort to reduce lead available to condors began in 2006. PNM is one of five sites where California condors have been released, and with a flock of 28 condors, it hosts one of the main populations of free-ranging condors in California. Partnerships were also forged with the USFWS, Ventana Wildlife Society, Pinnacles Partnership, the Peregrine Fund, and AZGFD.

While initially looking to encourage hunters to voluntarily switch to non-lead ammunition, the program's objective were slightly modified with the passing of the Ridley–Tree Condor Preservation Act, which was signed into law by the governor in January 2008 (Theyerl et al. 2010). The act, effective as of July 1, 2008, mandated the California Fish and Game Commission enact regulations requiring the use of non-lead bullets when taking big game and coyote within the historic California condor range. Recognizing that new legal requirements are often defied by a portion of the public, and/or are resisted due to encountering misinformation or a lack of information, the efforts still focused on encouraging hunters to use non-lead ammunition and offering venues for trying non-lead calibers for free, with the goal of gaining full compliance with the ban.

The California Lead Ammunition Awareness Campaign, spearheaded by the IWS in conjunction with PNM, initially set out to offer hunters and landowners opportunities to evaluate non-lead ammunition and learn about the hazards of ammunition containing lead. Outreach efforts to meet these objectives included: (1) shooting demonstration events, (2) booths at sporting equipment trade shows and county fairs, (3) meeting with local NRA chapters, (4) opportunities for hunting guides, hunting clubs, and local ranchers to field-test ammunition through visits to local ranches, and (5) presenting information about the threats of non-lead ammunition and the results of outreach efforts at professional conferences (Theyerl et al. 2010).

All of the objectives initially set forth were met or exceeded during the awareness campaign from 2007 through 2009 (Theyerl et al. 2010). A total of 14 shooting events were held, providing 319 sportsmen the opportunity to try non-lead ammunition. Over 15,000 rounds of non-lead ammunition were given out as free samples to sportsmen at the shooting events.

Year	Successful Hunters[1]	Took Lead Reduction Actions	Used Non-Lead Ammunition	Used Lead Ammunition & Packed Out Gut Pile	Took No Lead Reduction Action
2008	910	90%	72%	61%	10%
2007	767	83%	61%	54%	17%
2006	548	60%	58%	3%	40%
2005	909	50%	50%	N/A	50%
2004		<5%			

[1]Number of hunters who harvested a deer.

Table 6. Human dimensions survey results showing hunter participation in voluntary non-lead programs in Arizona's condor range, 2004–2008 (Sieg et al. 2009).

Through participation in community forums to educate community members about lead and condors, 1,900 individuals were reached. Booths were also placed at 15 county fairs and community event, resulting in contacts with 2,663 individuals. The IWS outreach coordinator also volunteered on the Hollister Friends of the NRA committee. According to the outreach coordinator, participation with the NRA helped to create better relationships with local sportspersons and countered the common misconception that the lead campaign is anti-hunting or anti-firearms (Theyerl et al. 2010).

Another important focus of the program is on educating willing ranchers surrounding PNM, encouraging them to use non-lead ammunition when hunting or eradicating animals they consider "pests" (e.g., feral pigs, coyotes, squirrels) and to educate hunters who may also use their ranchlands (PNM 2010). The IWS outreach coordinator met with 215 ranchers, vineyard operators, and other large property managers on an individual basis. Tejon Ranch Company, the largest state-licensed private hunting operation in California, became the first to voluntarily discontinue and ban the use of lead ammunition in its hunting and ranching operations (Hill 2009). Other operations have considered and/or implemented similar policies since Tejon's was implemented in 2008. In addition, US Army Garrison Fort Hunter Liggett began phasing out lead ammunition for hunting on their lands in 2007.

IWS and PNM personnel involved in the outreach efforts believe that hunters do come to understand the threats leaded ammunition can pose, and are typically convinced of the high performance of non-lead ammunition when they are provided with well-prepared information and demonstrations (Theyerl et al. 2010) Surveys distributed following shooting demonstrations have shown that hunters attending these events are accepting of non-lead ammunition and that most are surprised by the amount of lead fragments that result from lead ammunition. The outreach efforts are continuing in California and will extend to areas beyond those in close proximity to PNM.

Minnesota. Minnesota is among the states that have been active in public outreach to address the use of lead shot in hunting. In May 2006, the Minnesota Department of Natural Resources (MDNR) and Division of Fish and Wildlife (FAW) formed the Nontoxic Shot Advisory Committee (NSAC). The NSAC comprised representatives from the manufacturing and retail industry, hunting constituencies, environmental groups, and technical ex-

perts from other state and federal agencies (NSAC 2006). The goals of the committee were to develop recommendations for future restrictions on lead shot in Minnesota, a time frame for implementation, and a public communication/education plan, and to identify gaps in understanding and potential research needs. Based on several meetings held throughout 2006, accompanied by a thorough investigation of lead issues, the NSAC reached a consensus that the MDNR should (1) regulate lead shot on managed dove fields (which was implemented in 2006) and for shotgun hunting in general, and (2) implement regulations that are more restrictive than current state and federal legislation (NSAC 2006). The committee did not, however, reach consensus as to what the extent of these regulations should be.

A cooperative human dimensions investigation was conducted in 2007–2008 by the Minnesota Cooperative Fish and Wildlife Research Unit and MDNR to provide information about small-game hunter perceptions and knowledge of non-toxic shot and to help identify appropriate messages for communication programs (n = 927; Schroeder et al. 2008). The study was very context-specific and focused on attitudes and norms about a potential ban on lead shot in the Minnesota farmland zone. Results indicated that over half of the respondents believed that a ban on lead shot would help protect wildlife from lead poisoning, benefit the quality of the environment, prevent the spread of lead in the natural environment, and improve awareness about lead contamination issues. Half of the respondents also believed that such a ban was likely to increase crippling and wounding losses for small game hunting and would require the use of less effective shot. Over 75% believed the ban would require hunters to use more expensive ammunition, and over 40% thought the ban was unnecessary government regulation that would make it more difficult for some people to hunt. Much of the data suggests that many hunters perceived both positive and negative impacts. Over 70% of respondents felt that it was good to protect wildlife from lead poisoning, and most thought that hunters would adjust to the ban after a few seasons. Respondents' intent to support or oppose the ban was fairly evenly split, indicating the potential for high controversy; 44% said it was unlikely that they would support the ban, and 42% said it was likely (Schroeder et al. 2008). The likelihood of supporting the potential ban was positively correlated with respondents' trust of the MDNR.

Building on the results of this investigation, the MDNR's website currently contains many examples of outreach aimed at educating hunters about the hazards of lead to wildlife and human health. Along with the Minnesota Department of Health, the MDNR also has been very active in raising awareness among hunters about the specific risks associated with lead in venison. Informing these efforts are recent studies conducted by the agency to determine levels of lead bullet fragmentation and deposition in white-tailed deer (*Odocoileus virginianus*) and domestic sheep (*Ovis aries*; Grund et al. 2010). Results indicate that using copper bullets or bullets with no exposed lead can significantly reduce or eliminate lead exposure that would otherwise occur with lead bullets. This research was conducted in response to findings from investigations conducted in North Dakota which we discuss in more detail below.

North Dakota. In 2008, a study of lead in venison showed that, much like wildlife species, humans can be exposed to lead by consuming deer harvested with lead ammunition. Concerns arose after a study by a Bismarck physician found that, out of 95 packages of

ground venison donated to food pantries, 53 contained lead fragments (NDDoH 2008a). Following this discovery, the North Dakota departments of Health, Agriculture, and Game and Fish advised food pantries to stop the distribution of ground venison (NDDoH 2008b). A few weeks later, tests in Minnesota also discovered lead in venison donated to food pantries. As in North Dakota, Minnesota's departments of Health, Agriculture, and Natural Resources issued similar advisories to halt the distribution of venison. In addition to removing venison from food banks, public advisories were issued to the hunting community about the dangers of lead exposure, especially for children and pregnant women. Other Midwestern states, such as Wisconsin, also began to study venison and to issue letters of caution to food pantry managers (Warzecha and Thiboldeauz 2008).

The measures taken in North Dakota and Minnesota were highly controversial, and the NSSF emerged as the most outspoken opponent to the agencies' actions. The initial scientific evidence to support pulling venison was minimal and, in North Dakota, gathered very informally. Subsequent studies have been conducted to determine whether people who eat wild game harvested with lead bullets have higher BLLs than those who don't. A study of 738 North Dakotans showed a link between eating wild game shot with lead bullets and higher BLLs (NDDoH 2008b). However, while the correlation was statistically significant, other sources of lead exposure were not controlled for, and results were considered inconclusive. In fact, the results revealed that individuals who consumed game harvested with lead ammunition had lower BLLs than average Americans exposed to other sources of lead. Additionally, only a 0.3 microgram per deciliter difference was shown between participants who consumed game harvested with lead and those who did not.

These results added fuel to the controversy. The NSSF issued statements claiming that the study proved traditional ammunition poses no threat to humans. Those on the other side of the issue used the findings to claim that lead ammunition should be banned because humans are exposed to some amount of lead, and no amount is safe. Due to the study, and similar ones that followed, the agencies in North Dakota and Minnesota revised their initial advisories. New advisories stated that lead is a harmful substance, firearm ammunition used for taking deer contains lead, and venison processed by hunters and commercial processors has been shown to contain lead particles (Bihrle 2008). But, they also note that no incidence of human lead poisoning has been documented in the US and make recommendations for limiting the possibility of exposure. One of the recommendations is to use non-lead ammunition, but the rest focus on precautions to take when using lead bullets. As this situation suggests, more research is needed to determine if the exposure to lead from consuming game harvested with lead ammunition is detrimental enough to the health of humans to warrant regulatory action, or to be perceived as a high enough risk among hunters to prompt voluntary use of non-lead alternatives. (Following NPS internal policies, Theodore Roosevelt National Park in North Dakota now requires volunteers who are chosen to participate in elk reduction efforts to use non-lead ammunition.)

Wyoming. In 2009, officials in Grand Teton National Park (GTNP) and the National Elk Refuge (NER) began encouraging hunters to use non-lead ammunition during the elk and bison seasons (Skaggs and Iverson 2009). This came in response to a series of studies, beginning in 2004, that were conducted by Craighead Beringia South (CBS), a non-profit

science and education organization (CBS 2009). The studies found that BLLs of ravens (*Corvus corax*), bald eagles, and golden eagles (*Aquila chrysaetos*) in the Jackson Hole valley were highest during the fall hunting season. GTNP and the NER also cite the recent findings of research on potential lead contamination in humans, stating that one of the goals of the non-lead program is to raise awareness about the risks to hunters so that hunters can make informed decisions when choosing ammunition (Skaggs and Iverson 2009). To begin to monitor program participation, GTNP and the NER asked hunters to report their use of non-lead ammunition for the 2009 season; hunters were able to record their responses on their hunting permits. This baseline information will not only be used to track hunter behavior in the context of lead use but also to inform possible incentive strategies that can be used in the future to increase use of non-lead products. GTNP and the NER have stressed the voluntary nature of their program and are not pursuing regulatory bans in those areas.

CBS also recently began its own outreach program targeting hunters in the Jackson Hole area (CBS 2009). The focus of the program is on educating hunters about the hazards of lead and distributing non-lead rifle ammunition. In 2009, 194 boxes of ammunition were distributed. However, follow-up research to help determine the effectiveness of the program did not detect lower BLLs in eagles, and the drops in raven BLLs were minimal. The CBS has acknowledged that its program needs to be expanded, and future plans are to provide non-lead ammunition to more hunters while educating them about the positive impacts of voluntarily switching to non-lead alternatives. Future research on the impacts of these initiatives in the Jackson Hole valley may prove valuable in facilitating comparisons with other programs, such as those in Arizona's California condor range.

Emerging efforts in other states: The case of dove hunting. The use of lead for hunting mourning doves (*Zenaida macroura*) has attracted attention in states across the nation in recent years. Efforts aimed at reversing declines in hunter numbers in the US have prompted many states to provide more dove hunting opportunities (National Mourning Dove 2010). However, this has raised concerns about the potential for mourning doves and other wildlife to be exposed to significant quantities of lead shot in the future, particularly given that large amounts of lead have been shown through prior research to accumulate in relatively small areas from dove hunting (Lewis and Legler 1968; Best et al. 1992; Schulz et al. 2002). To inform future management decisions on this issue, several states have conducted human dimensions investigations. In Missouri, small-game hunters were surveyed to determine their attitudes toward regulations requiring the use of non-lead shot for hunting small game, specifically mourning doves (Schulz et al. 2007). The survey found that most hunters (72–85%) opposed additional regulations. Surveys were also recently administered in Illinois and Texas, but due to differences in study design, the results of these investigations are not comparable (National Mourning Dove Hunter Survey 2010). The need for a national survey to assess dove hunters' current awareness of lead issues and levels of support for the use of non-lead ammunition, which would be comparable across regions and states, has been identified. Results could also help in determining what information is needed to better inform and communicate with hunters about lead issues. Plans, including survey development, are currently underway to implement such an investigation in 2011 (National Mourning Dove Hunter Survey 2010).

WAFWA and AFWA activities. In June 2009, the Western Association of Fish and Wildlife Agencies (WAFWA) established an ad hoc work group charged with making recommendations to WAFWA with regard to lead use in hunting and fishing (Elicker 2010). Recognizing the sensitivities surrounding this issue, and its complexity, the work group members were drawn from multiple disciplines, including chairs of the Wildlife Health, Human Dimensions, and Resource Information and Education, Wildlife, and Fish Chiefs committees, and is chaired by the director of the Washington Department of Fish and Wildlife. The work group believes that fish and wildlife agencies should help lead efforts to address this issue due to the potential impacts on hunters, anglers, industry, retailers, and fish and wildlife management (WAFWA 2010). The work group focused on developing practical, realistic, and science-based recommendations and ultimately developed ten recommendations for WAFWA (Elicker 2010): (1) coordinate with other WAFWA committees; (2) develop consistent messaging; (3) utilize human dimensions research to develop messages; (4) monitor research on lead and wildlife; (5) collaborate with industry, partners, and public agencies; (6) seek consistent federal policy; (7) monitor state efforts; (8) encourage manufacturers to make non-lead products available and affordable; (9) address funding issues; and (10) identify further research needs regarding impacts on wildlife. The ad hoc work group will continue for an additional year and work towards reaching some of the objectives set forth in their recommendation (WAFWA 2010).

In September 2010, AFWA passed a resolution to adopt a number of principles regarding future regulation of lead ammunition and fishing tackle. These principles stated a belief that future regulation was best addressed by individual states and should focus on population-level impacts to wildlife that are substantiated by the best available science (AFWA 2010). However, they also noted that state fish and wildlife agencies should proactively coordinate with state health agencies, industry, conservation organizations, and hunting, angling, and shooting sports interests. In addition, they called for the development of effective human dimensions strategies, as well as the use of public education and voluntary programs where appropriate in lieu of regulation.

Lead ban petition to the EPA. On August 3, 2010, conservation groups petitioned the EPA for a nationwide ban on the production and sale of lead bullets, shotgun pellets, and fishing sinkers (EPA 2010). The petition was filed by the Center for Biological Diversity, American Bird Conservancy, Public Employees for Environmental Responsibility, Association of Avian Veterinarians, and the hunters' group Project Gutpile. The petitioners want the EPA to act under the auspices of the Toxic Substances Control Act (TSCA) which gives the EPA the broad authority to regulate chemical substances that pose a risk to the health of humans or the environment. The EPA is prohibited from regulating ammunition or firearms under the TSCA, but if non-toxic alternatives are commercially available, toxic elements of ammunition can be regulated (EPA 2010). There are no such restriction for regulation fishing sinkers. As with previous moves to impose regulations, the petition generated much debate and roused both those who support a ban and those who do not. On November 4, 2010, the EPA denied the petition, stating that the petitioners had failed to demonstrate that such a ban was necessary to protect against an unreasonable risk of injury to health or the

environment as required by TSCA. Following the denial of the petition, the groups sued the EPA in late November 2010 and further action is pending.

Partially in response to the petition, the chairs of the Congressional Sportsmen's Caucus—Senators Jon Tester (D-MT) and John Thune (R-SD) and Representatives Jeff Miller (R-FL) and Mike Ross (D-AR)—introduced the Hunting, Fishing and Recreational Shooting Sports Protection Act (S. 838 and H.R. 1558) on April 14, 2011. The bill would amend TSCA to deny the EPA authority to outlaw lead bullets, shot, and fishing tackle. In addition, Representative Paul Braun (R-GA) introduced two bills that would prohibit the EPA from regulating any type of firearm ammunition or fishing tackle based on material composition (H.R. 1443 and H.R. 1445). H.R. 1445 would also prohibit the Department of the Interior and the Department of Agriculture from newly prohibiting or limiting, based on material content, the use of traditional hunting implements on federal lands.

Overall findings for outreach to reduce the impacts of lead from hunting and fishing

Many important lessons have come out of the work being done by various states, agencies, and organizations that can inform development of effective outreach strategies and messages for addressing issues related to the use of lead in recreational hunting and fishing. While there are more examples to draw upon for hunting, many of these lessons would also be applicable to communicating about lead use in recreational fishing. Additionally, while recommendations stem largely from context-specific outreach efforts—e.g., efforts applied to condor conservation (Sullivan 2009) and lead shot use in Minnesota's farmland zone (Schroeder et al. 2008)—many are relevant for considering how the NPS might address lead issues on its lands in the future. The following lists are an attempt to synthesize key lessons learned from our review of the relevant literature.

Some general findings

- Surveys of hunters in Arizona and California showed that, depending on the nature of the request and the source, most hunters are willing to take some action to help prevent lead poisoning of wildlife (D.J. Case and Associates 2005).
- Many hunters may be unaware of the impacts of lead ammunition on wildlife, suggesting the need for strategies that can help raise basic awareness among sportsmen about lead issues (D.J. Case and Associates 2005).
- Voluntary measures typically require less concrete evidence ; i.e., they allow for more uncertainty than regulatory bans would. However, this should not be seen as an invitation to offer scientific evidence that is not rigorous or to avoid providing scientific evidence altogether (Sullivan 2009).
- Negative media has been a challenge in many cases, and researchers have found that a single negative media article can nullify the impacts of providing factual information (AFWA 2007). This indicates the need to develop good ties to the media and accurately disseminate information through media outlets.
- In states such as Washington, where proposed bans on lead fishing tackle have been controversial, it is recommended that agencies work to promote the use of non-lead

alternatives and the proper disposal of lead products until regulatory legislation can be enacted (Gumm and Poleschook n.d.).

- Tools used by many states to eliminate lead in the environment from fishing are: lead sinker exchanges (promoting proper disposal), brochures educating anglers about the hazards of lead, warnings for children and pregnant women about their susceptibility to detrimental effects of lead exposure, and promotion of responsible fishing practices such as retrieval and disposal of fishing line and tackle.

Outreach-specific findings, including tactics for message creation and delivery

- Many states have emphasized the importance of knowing one's audience, and educating oneself about hunters, hunting, and ballistics expertise to be well received and seen as credible by hunters (Sullivan 2009).
- Hunters in Arizona and California stated that they would be more supportive of non-lead alternatives if they were given credible scientific evidence of the detrimental impacts of lead on California condors (D.J. Case and Associates 2005). However, when the AZGFD responded by providing hunters with detailed information on the topic, they found that fewer hunters read the information and that it was therefore less effective than if the communication delivery had been less in-depth (Sieg et al. 2009). It is important to find the right balance of adequate information and home in on the key points in an appropriate communication style, given that the public may not have the time or level of interest to process large amounts of information.
- Providing hunters with incentives, such as free non-lead ammunition, has proven to be a powerful tool to enhance the success of outreach initiatives (Sieg et al. 2009). The AZGFD also points out the necessity of partnerships to implement this type of program, as some government and non-governmental organizations cannot distribute ammunition directly.
- Photos of x-rayed ballistics gel and wildlife carcasses have made a huge impression on hunters in Arizona and California (Petterson 2009). Many hunters are unaware of the amount of lead lost through fragmentation; a visual display is one of the most effective ways to portray this information.
- Participatory outreach mechanisms—e.g., demonstrations with ballistics gel and water jug testing—have been effective ways to engage the public on issues of lead use in California (Petterson 2009). They provide an opportunity for hunters to experience firsthand the degree to which lead bullets fragment compared with non-lead bullets. They also provide hunters a chance to test non-lead ammunition, which can help dispel negative misconceptions regarding non-lead products. For example, many hunters may believe that non-lead ammunition is less effective, but when non-lead bullets are shot into ballistics gel, participants can witness the hydraulic shock and compare it with that of leaded bullets.
- The Ad Hoc Mourning Dove and Lead Toxicosis Working Group has emphasized the importance of training salespeople—i.e., the people from which hunters buy their ammunition—as they are often the main source of information for hunters (AFWA 2007).
- Messages that highlight the importance of conservation heritage to hunters were rated

highly by focus groups in Arizona (D.J. Case and Associates 2005). These messages focus on deeply held core values for many hunters. Hunters are rightfully proud of the hunting tradition and its contributions to wildlife conservation in this country; using non-lead products can be seen as an extension of this tradition (Sullivan 2009). It is worth noting, however, that some research (Schroeder et al. 2008) has suggested that other message points may be more effective.

- The AZGFD has stressed in some of its communications that using non-lead ammunition makes hunting more beneficial to wildlife (e.g., the endangered California condor), which, again, invokes the conservation ethic of hunters (Sullivan 2009). Certain species depend on hunting for survival, and wildlife carcasses and offal piles (without lead fragments) can enhance survival of these species. This approach demonstrates that agencies are not blaming hunters, but rather asking for their help.
- Persuasive messages from credible sources may help generate support for bans on lead shot. More specifically, Schroeder et al. (2008) found that basic, factual, first-person narratives that mention a social group hunters identify with (e.g., Ducks Unlimited) may be more persuasive than other alternatives, including declarative statements from the state agency, counterarguments, value-expressive messages about hunting heritage, and third-person narratives.
- Tied to the above point, credible sources are needed to deliver messages aimed at promoting voluntary lead reduction measures. Surveys in Arizona identified sportsmen's groups as the most credible source (D.J. Case and Associates 2005).
- Hunter education instructors have been suggested by some researchers as important sources for getting messages out to new hunters (AFWA 2007).
- In Arizona, research found that references to endangered or rare species should not be used at the outset of communication messages (Sullivan 2009). This is important supportive information, but it is not the first topic that should be presented or emphasized.
- Focusing on one-to-one communication whenever possible has been an important strategy in outreach efforts in California and Arizona (Petterson 2009). The opportunity to do so occurs oftentimes in the field where agency staff can interact with hunters on a less formal basis. An important consideration in this context is the need to ensure field staff, concessionaires, interpreters, law enforcement, etc., are aware of, and on board with, the agency's agenda with regard to lead issues.
- Adding to the previous point, it is important for recipients to receive one unified message from all sources (AFWA 2007). Mixed messages from various organizations can decrease the credibility of all involved and confuse hunters as to what is fact or opinion.

Conclusion

Management decisions about the use of lead ammunition and fishing tackle are needed to mitigate further impacts of lead on wildlife, wildlands, and humans. Unfortunately, these decisions will have to be made in an environment of uncertainty and controversy. Despite the significant body of literature on lead poisoning caused by spent lead ammunition and fishing tackle, there are still gaps in scientific understanding that create an environment of scientific uncertainty, making lead product bans difficult and expensive to implement.

Previous efforts to reduce the amount of lead introduced by hunters and anglers in the environment are valuable for understanding the current issues surrounding lead bans and efforts to increase voluntary use of non-lead alternatives. However, most of the research aimed at informing these efforts thus far has been very context-specific, and the attitudes and beliefs of hunters and anglers regarding lead issues are still largely unknown. We do know that in areas with key species of concern, hunters and anglers are often unaware of the lead-related impacts of their activities, even though they may be more aware than in areas where there has been less attention paid to such impacts. There is a definite need for more thorough evaluation of existing communication strategies, as well as a need to understand the beliefs and attitudes of the diverse array of stakeholders, in order to inform more targeted outreach initiatives. While the political will at individual state levels, and at the national level, appears to be lacking to support a broad-scale ban on lead products in hunting and fishing, this has not been fully explored, and those who oppose such a ban have been more unified and vocal in their objections. Exploring the full range of beliefs and attitudes is an important next step to take if policy and outreach to reduce impacts from lead are to be considered viable options in the future.

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A Thumbnail Sketch of Federal Laws Governing Lead and the Environment

Frank Buono

Introduction

Humans have used a metal called lead for millennia. Ancient lead mines and smelting areas pockmark the Colline Metalliferae, the hills to the north of Rome in southern Tuscany. These mines predate both the Romans and Etruscans. The uses of lead are multiple. Industrialized economies rely on lead for many purposes. The use of lead-based ammunition, for warfare, public security, and recreational hunting, is common throughout the United States and the world.

The ways in which lead affects the environment and human health have become better known only in recent times. To reduce and prevent lead's harm to the environment and human health, Congress enacted several laws that address lead over the last half of the twentieth century.

On March 4, 2009, the acting director of the National Park Service (NPS) signed a memorandum to the highest agency managers (regional directors, associate directors and acting deputy director) announcing two goals. First, the agency is to eliminate lead-based ammunition for NPS-administered wildlife management. Among these actions are "dispatching animals within parks, whether for culling operations or dispatching wounded or sick animals." Second, NPS is directed to "draft Special Regulation language as necessary, prohibiting the use of lead in hunting and fishing activities for those parks that authorize such activities."

Congress authorizes recreational sport hunting in approximately 62 areas of the national park system. Congress has also authorized the subsistence take of wildlife in several park areas in Alaska and in Big Cypress National Preserve in Florida. Recreational fishing is widespread in the national park system.

NPS became concerned about the harm that lead causes to park animals during its efforts with the US Fish and Wildlife Service (USFWS) to restore California condors *(Gymnogyps californianus)* to Grand Canyon National Park, Arizona. The wide-ranging carrion eaters, foraging within and outside of park boundaries, would consume carcasses, some of which contained fragments of lead, resulting in mortality to both adult and young.

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Prior to the NPS's introduction to the hazards of lead, USFWS in 1991 issued a regulation that enforced a ban on the use of lead shot in migratory bird hunting throughout the United States (see Title 50 Code of Federal Regulations (CFR) 20.210)). This ban applies across the nation, including within those parks where hunting is authorized and waterfowl hunting occurs. USFWS acted under its authority in the Migratory Bird Treaty Act of 1916 (16 U.S.C. 703–711).

Conclusion

This analysis is not a summary of scientific data about the effects of lead in the environment or on human health and well-being. This analysis does not examine the history, efficacy, or practicality of substituting materials for lead-based ammunition and/or fishing equipment. This review analyzes only whether there are any federal laws, including executive orders, that NPS may apply to implement the prohibition on lead in recreational hunting and fishing in areas of the national park system.

This analysis concludes that of the six major federal environmental laws that address lead, none either mandates or authorizes NPS to prohibit lead in recreational sport hunting or fishing. NPS possesses statutory authority to carry out its announced intent to prohibit lead. That authority is the National Park Service Act of August 25, 1916 (the Organic Act), which requires that the secretary of the interior conserve the wildlife within the parks. In national park system units where Congress authorizes hunting, NPS may decide to manage that activity in such a manner as to ensure that non-target wildlife are protected from the incidental ingestion or other presence of lead. A decision of this nature is both a reasonable interpretation of the Organic Act authority and based upon sufficient scientific data so as not to be groundless or arbitrary. No further legislative authority is needed for NPS to implement such a decision.

NPS could restrict lead by amending general regulations at 36 CFR Part 2 to prohibit the possession and use of lead-based ammunition by persons engaged in recreational sport hunting. An analogous rule-making could be undertaken for fishing tackle. The memorandum of March 4, 2009, refers to a "Special Regulation." That reference does not mean that the NPS would adopt 62 separate special regulations for parks where hunting is authorized or the hundreds where recreational fishing occur. This would be administratively unworkable and result in a patchwork of individual park discretion, inappropriate for the pre-eminent national system of protected lands in the United States. Rather, the memo of March 2009 should be understood to mean special regulatory language to amend the existing general rules that govern hunting and fishing in the park system. Should the NPS move in this direction, it should be done carefully, with analysis under the National Environmental Policy Act and the Administrative Procedures Act.

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Lead Issues at National Park Service Units: Identifying Potential Sources and Minimizing Exposure

National Park Service Office of Public Health

Lead has been a long-standing public health issue, particularly with the introduction of lead in gasoline and paint and use of it in lead pipes in the past. Children have been considered particularly vulnerable to the effects of lead exposure because of their developing nervous system; however, adults can also be physically affected by lead exposure. Because there are ways to minimize exposure and lessen lead's harmful effects on the public's health, understanding sources of lead and how exposure occurs are ways to begin to understand an individual's risk to lead and ways that risk can be reduced.

The following document explores not only common lead issues within the general population but also park-specific lead issues and ways to reduce lead exposure and minimize its impact on human health. In order to address potential lead exposure issues, this document is divided into three sections: general lead information, potential sources of lead exposure at national parks, and NPS efforts to reduce lead exposure.

I. General lead information

Lead is a naturally occurring heavy metal that is blue-gray in color and is found in the earth's crust. Certain properties of lead, such as its low melting point, density, and corrosion resistance, have made it a popular metal for thousands of years, from Ancient Roman times when lead was used for plumbing to more recently, when lead was added to paint and gasoline to enhance performance (ATSDR 2007c). In the past three centuries, lead has increased in the environment by a thousandfold, primarily due to human activity, such as production of lead batteries by the automobile industry (ATSDR 2007a, 2007c). Lead can be released into the environment through mining and by factories that produce lead and lead alloys, and by facilities that release lead compounds into the air through the burning of coal, oil and waste. Prior to the banning of leaded gasoline, vehicle exhaust was the predominant contributor of lead in the environment (ATSDR 2007c). Although lead has many desirable properties and has been used in a variety of consumer products, it can have an adverse effect on the system and organs of the human body, particularly in children who are still undergoing neurological and physical development (ATSDR 2007c). In order to reduce lead in the environment and

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exposure to humans, federal agencies issue laws, rules, guidance, and recommendations that monitor the use of lead in commercial products.

Common human exposures to lead in the general population

The greatest likelihood of human exposure to lead still comes from historical use of lead as an additive in gasoline and from its use as a pigment in paints and other coatings. Lead as an additive in gasoline was slowly phased out and completely banned in 1995, whereas lead in paint was banned in 1978 for residential and consumer uses. Even though lead cannot currently be found in gasoline and new paint, human exposure continues because once lead has been released into the environment (e.g., through car exhaust pipes), it does not degrade into other substances and continues to persist in soil and in paint dust within buildings (ATSDR 2007c).

Nationally, lead paint continues to be the primary source of environmental exposure to lead, primarily through disturbances to old paint in the home, such as during renovation; through deterioration that can result in peeling, chipping, and chalking of paint; and by means of friction to parts of a home, such as doors and windows (ATSDR 2007b). Outside of homes, lead paint can mix with dust and soil and re-enter the home. Settled lead dust can re-enter the environment when there is a lot of traffic or activity in the home, such as vacuuming or sweeping (USEPA et al. 2003). However, lead-based paint which is in good condition is generally considered not a hazard (USEPA et al. 2003).

Aside from that which is found in the home environment, lead dust can also be produced from artificial turf, particularly from turf made from nylon or a nylon/polyethylene blend that has been well used, showing signs of weathering and visibly dusty (CDC 2009). Inadvertent exposure in indoor settings can occur when children put their hands in their mouths after playing, crawling around on floors, or touching toys which have been contaminated with lead, though the Consumer Production Safety Modernization Act (2008) currently bans children's products that contain more than a trace amount of lead (USEPA et al. 2003).

A potential exposure to lead is from air. Because of the phase-out of lead in gasoline, air emissions of lead from the transportation sector, and particularly the automotive sector, have greatly declined over the past two decades. Today, industrial processes, mostly metals processing, are the major contributor of lead emissions to the air. The highest air concentrations of lead are usually found near lead smelters, while other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers (USEPA 2009c).

Another potential human exposure to lead is through drinking water, and even though the amount of lead in pipes and plumbing fittings has been regulated by the US Environmental Protection Agency (USEPA) since 1988, possible exposure can still occur from corroding pipes and fixtures or solder that contains lead (ATSDR 2007c). On average, USEPA estimates lead in drinking water contributes to 10–20% of total lead exposure in children (USEPA 1993). In homes built prior to 1930, plumbing is likely to contain at least some lead pipes, and in new homes, lead solder with copper pipes have replaced lead pipes but contamination of household water from the solder and new brass faucets and fittings can still contribute to the leaching of lead into water (USEPA 1993).

Intentional use of lead in products such as remedies and cosmetics still occurs today (ATSDR 2007a). Alternative medicines used by East Indian, Indian, Middle Eastern, West Asian, and Hispanic cultures may contain large amounts of lead and other heavy metals that are thought to cure certain ailments (CDC 2009). Lead may be unintentionally added in food through production and processing (e.g., use of grinding or cutting equipment, the planting of vegetables in contaminated soil, being added in certain candy ingredients such as chili powder and tamarind), packaging (e.g., lead-soldered cans, wrappers of imported candies), and storage (e.g., of food or beverages in a container contaminated with lead) (ATSDR 2007a; CDC 2009).

In an occupational setting, the most common way workers are exposed to lead is through inhaling and ingesting lead-contaminated dusts and fumes. Workers that take part in lead smelting, refining, and manufacturing are at the highest risk for adult lead exposure, though other opportunities for occupational exposure occur among those working in battery manufacturing plants, construction (including renovation activities), rubber products and plastics industries, soldering, steel welding and cutting operations, bridge maintenance and repair work, municipal waste incinerator work, radiator repair, and the pottery/ceramics industry (ATSDR 2007a, 2007c).

Routes of exposure and absorption of lead

People are exposed to lead through three avenues: inhalation, ingestion, and dermal contact (ATSDR 2007a). Inhalation of lead in the ambient air through aerosols of particulates (usually dust) that can be deposited in the respiratory tract is the primary route of occupational exposures (ATSDR 2007a; OSHA 2008). Almost all inhaled lead is absorbed, compared with 20–70% of lead that is ingested, with children more likely than adults to absorb at a greater percentage (ATSDR 2007a). In the general population, lead exposure occurs mostly through ingestion. Among children, the major means of exposure is ingestion of lead paint by way of hand-to-mouth. Other ways people may be exposed to lead through ingestion is through contaminated food, water, alcohol, and alternative medicines. Dermal exposure through the skin is a more likely route of exposure for workers rather than in the general population (ATSDR 2007a).

Once lead enters the body through the lungs, it disperses to other parts of the body through the blood system. When lead is swallowed, it enters the stomach where the acid breaks it down into absorbable components. The amount of lead absorbed into the blood system is dependent on a person's age, how well the particles are dissolved in the stomach, and when they ate their last meal. In general, children will absorb a greater proportion of lead into their bloodstream compared with adults who have ingested the same amount. The blood system distributes the lead to soft tissues and organs; after several weeks, it is deposited in the bones and teeth. Once lead is distributed to the organs, about 99% of that absorbed by an adult will leave as waste, whereas only 32% of lead taken in by a child will be eliminated from his or her body (ATSDR 2007a).

Children under the age of six are considered the most vulnerable to exposure to lead because they are undergoing rapid neurological and physical development and engage in frequent hand-to-mouth behavior. In addition, pregnant women are at significant risk for

adverse effects of lead (OSHA 2008). Lead exposure in the uterus can result in delays or impairment of neurological development; neurobehavioral deficits, including IQ deficits; low birth weight; and, in girls, low gestational age, growth retardation, and delayed sexual maturation (ASTDR 2008). However, lead exposure can also affect children older than six, as well as adults, by means of cardiovascular, renal, and neurological effects (USEPA 2006).

Lead toxicity in the human body: Toxicity levels and symptoms

Lead exposure affects the body's organs and systems to different degrees. The severity of symptoms of lead poisoning is dependent on amount of exposure (NIEHS 2005). Although lead toxicity could affect any part of the human system or organs, the areas most vulnerable are the developing nervous system, the blood and cardiovascular systems, and the kidneys (ATSDR 2007a).

High levels of exposure to lead in adults (i.e., concentrations of 100–120 micrograms per deciliter [μg/dL] of blood) are thought to lead to encephalopathy and alterations in brain function, with precursor symptoms including dullness, irritability, poor attention span, muscle tremors, and loss of memory (ATSDR 2007b). Blood levels ranging from 40 to 120 μg/dL have been observed in lead-exposed workers, which resulting effects that include depression/mood changes, headaches, decreased cognitive performance, decreased reaction time, decreased visual motor performance, dizziness, fatigue, forgetfulness, problems with concentration, increased nervousness, irritability, lethargy, impotence, reduced IQ scores, malaise, and paresthesia (ATSDR 2007c). A decrease in kidney function has been observed on a consistent basis in populations having concentrations of less than 20 μg/dL, and even in populations having concentrations of less than 10 μg/dL (ATSDR 2007b). A 2004 study showed that lifetime exposure to lead can increase the chances of cataract development (NIEHS 2005).

Infants and young children with lead levels of 10 μg/dL or greater are considered to be at risk for substantial health effects (ATSDR 2008). When lead levels are above an action level of 10 μg/dL—that at which the Centers for Disease Control and Prevention (CDC) recommend environmental and education intervention—anemia, neurological impairment, effects on the renal system, colic, and impaired metabolism of vitamin D may occur (ATSDR 2007a, 2008). Children with blood lead concentrations of less than 10 μg /dL are not currently considered as having an exposure to lead, although recent studies have shown that side effects still occur around 5 μg/dL (Landrigan 2000; Murata et al 2009). Pooled analysis results derived from seven prospective epidemiologic studies estimated a decline of 6.2 points on a full IQ scale is concurrent to an increase in blood lead levels from 1 to 10 μg/dL (USEPA 2006). Although these findings suggest that it may be necessary to lower the current action level for children, there are other considerations, such as the accuracy of measuring levels below 10 μg/dL and the desire to focus resources where potential adverse effects are greatest (CDC 2005b). Blood lead levels above 10–14 μg/dL require specific action be taken by health departments in most states, and levels of 15–44 μg/dL are considered significant exposures (NewYork State Department of Health 2009). Blood lead levels that are ≥45 μg/dl can cause mental retardation, coma, convulsions, or death (ATSDR 2007a; CDC 2009; NY State Department of Health 2009).

II. Potential sources of exposure at National Park Service units

Potential means of lead exposure at parks can include common pathways, such as working or living in areas with lead pipes and lead paint, but also through others, such as through hunting (recreational and subsistence), angling, and exposure at firing ranges. Hunting and angling are recreational activities that some visitors may participate in, while use of firing ranges is typically an occupational activity for law enforcement (LE) rangers. Employees who use indoor and outdoor firing ranges for practice and training requirements may have additional exposures at non-NPS firing ranges outside the park. Apart from employees who utilize firing ranges, maintenance workers who work in facilities, particularly older housing and historic buildings with lead paint, or who engage in other activities such as lead soldering, may also be at risk for potential lead exposure.

Historic buildings, employee housing, and other facilities

Lead-based paint can be found in older homes and historic buildings built prior to 1978. It is extremely important to recognize that older buildings and other park facilities, such as bridges painted with lead-based paint, are potential hazards to employees and their families, particularly children (HUD 2007).

Much of the employee housing in the parks was built prior to 1978, when use of lead-based paint was still legal. However, lead-based paint in housing is only a concern if the lead-based paint is deteriorated or has been disturbed, such as through renovation, repair, or painting activities. It is important that these activities be conducted by a USEPA-certified firm with properly trained and certified renovators. In addition, lead-based paint abatement should be conducted by trained and certified professionals.

The residential Lead-Based Paint Hazard Reduction Act of 1992 (also known as Title X of the Housing and Community Development Act) requires sellers, landlords, and agents to provide information concerning the hazards of lead-based paint, symptoms and treatment of lead-based paint poisoning, precautions to be taken to avoid poisoning, and maintenance and removal techniques (HUD 2007) to potential purchasers or tenants of "target housing" (that which was constructed prior to 1978; ATSDR 2007c). However, there are exceptions to this rule: housing for elderly or disabled persons, unless a child of less than 6 years of age is expected to reside in the dwelling; and dwellings without bedrooms, such as studio/efficiency apartments, individual room rentals, dormitories, and military barracks (ATSDR 2007c).

Hunting

Lead was made illegal for hunting waterfowl in 1991, but it continues to be a popular metal used in bullets marketed for big- and small-game hunting, upland bird hunting, and varmint hunting. In October 2007, California banned the use of lead ammunition in areas considered to be habitat for California condors. In addition, other types of lead ammunition, such as lead bullets, are still used for the harvesting of large game in the United States (Tsuji et al. 2009).

Hunters who form their own lead bullets risk exposure through inhalation of fumes while melting the lead and through inhalation of vapors upon firing. Melting the lead at

home can also result in exposures to children and other residents. People who conduct these activities, as well as their families, may be at risk from lead poisoning. In addition, there is a potential exposure by ingesting game meat that comes from an animal shot with lead ammunition, which can fragment into many tiny pieces when it enters an animal's body (Hunt et al 2004; Hunt et al 2009). Other published studies have documented elevated blood lead concentrations in consumers of meat hunted with lead bullets (Tsuji et al. 2008, 2009; Avery and Watson 2009; Kosnett 2009). In a CDC study examining the relationship between blood lead levels and wild game consumption among 742 participants residing in North Dakota, ranging from 2 to 92 years of age, not only did persons who consumed wild game exhibit higher blood lead levels than those who did not, but those who ingested larger portions of "other game" (e.g., moose, elk, etc.) had significantly higher blood levels (Iqbal et al. 2009).

Indoor and outdoor firing ranges

Indoor firing ranges have been the subject of several studies of occupational lead toxicity, which have documented elevated blood lead levels and associated adverse health effects in the employees and instructors at ranges (Landrigan et al. 1976; Smith 1976; Anderson et al. 1977; Fischbein et al. 1979; Novotny et al. 1987; Valway et al. 1989). These studies indicate lead exposure at firing ranges occurs primarily through inhalation of lead particulates suspended in the range air. The major source of airborne lead is in the breathing area of the shooter resulting from the ignition of the primer material containing lead styphnate and because the gun barrel and the bullet do not always align exactly, the shearing of lead particulates off of the bullet as it passes through the weapon (Valway et al. 1989).

There are currently 276 NPS firearms instructors and approximately 1,900 LE officers (roughly 1,440 permanent and 460 seasonal LE staff; NPS Firearm Program manager). The NPS internal website on outdoor firing range management states that "the majority of the toxic chemicals releases at NPS units are from the use of lead ammunition at outdoor small arms firing ranges" (National Park Service 2008). Since 2003, NPS has required all parks to calculate and report the amount of lead released to the environment at outdoor firing ranges regardless of whether or not these releases are reportable to USEPA under its Toxic Release Inventory Program (whose regulations require that lead releases of greater than 100 pounds be reported to USEPA).

The NPS Sustainable Operations and Climate Change Branch has been collecting lead release and non-lead ("green") ammunition data electronically through a web-based survey called the *Annual Lead Release/Green Ammunition Use Survey* (NPS 2009). The results of these surveys indicate a trend toward increasing use of green ammunition and a continual decline in the use of leaded ammunition since 2003 (NPS 2009). This decline in the use of leaded ammunition can be attributed to a policy change affecting NPS LE officers. In July 2006, the NPS associate director for visitor and resource protection sent a memorandum to the field approving LE officers to conduct all firearm practice and qualification with nontoxic, lead-free, frangible ("green") ammunition. After October 1, 2007, only green ammunition was to be purchased for training purposes. The stated purpose of the order was to begin the process of phasing out the use of leaded ammunition for firearms qualifications and

practice due to the highly toxic nature of the lead and the potential adverse impacts on human health and the environment. In November 2007, the associate director sent a memorandum to the field requiring NPS LE officers to discontinue use of leaded ammunition for all qualification and training by October 1, 2008. In response to safety concerns from NPS LE officers, current policy allows one qualification each year with the lead ammunition they carry on duty.

The NPS Risk Management Division created policy guidelines to address various types of lead exposures, including those at firing ranges (RM 50 B Health Policy Guidelines, Section 4.9: Lead Exposure Control, last updated June 21, 2005). The document identifies requirements and responsibilities to reduce lead exposure based on regulations of the Occupational Safety and Health Administration (OSHA), USEPA, and the Department of Housing and Urban Development (HUD). Appendix E of the RM 50 B document identifies sources of exposure and specific guidelines for reducing lead exposure dust at firing ranges.

Angling

Lead exposure in anglers can occur in handling and making lead jigs or sinkers, and through accidental ingestion (Goddard et al. 2008; Pokras and Kneeland 2008). If a lead sinker is swallowed, the amount of lead absorbed in the system depends on how long the sinker has stayed in the stomach (Goddard et al. 2008). In the past 20 years, US states, such as Vermont, New York, Maine, Massachusetts, New Hampshire, and other countries, such as Great Britain, Denmark, and Canada, have passed legislation restricting the use of certain types of lead fishing gear (Pokras and Kneeland 2009). Making lead sinkers at home provides another source for exposure both to the person making the sinker and children and other residents because the lead needs to be melted in order to form the sinkers and fumes can be inhaled during the process (Goddard et al. 2008; Watson 2009).

Reducing exposure at National Park Service units

The Department of Health and Human Services (DHHS) has concluded that lead and lead compounds are anticipated to be human carcinogens based on evidence from studies in humans and sufficient evidence from studies in experimental animals (ATSDR 2007c). Since 1980, federal and state regulatory standards have helped to minimize or eliminate the amount of lead in consumer-based products and occupational settings (ATSDR 2008). NPS, specifically, has implemented initiatives and issued guidance to parks to help further reduce lead in the environment.

III. NPS efforts toward reducing lead exposure

NPS's efforts towards lead reduction include the Visitor and Resource Protection Program's efforts in keeping account of and reducing the use of lead ammunition through the NPS lead control policies; the Natural Resource Program's initiative to reduce and eventually eliminate lead ammunition and lead fishing tackle in natural resource activities in parks; and the Office of Public's Health's water survey work to comply with the Safe Drinking Water Act and USEPA's Lead and Copper Rule (LCR; USEPA 2009b). Through individual and interoffice efforts, NPS is informing visitors and employees of the hazards of lead in the environment and workplace.

The NPS lead exposure control policy is divided into two sections: worker requirements for protection against lead exposure, and requirements for lead-based paint management for housing and building occupants. Subsections detail specific information about practice and guidance for reducing lead exposure in the park, with emphasis on regulations issued by OSHA, USEPA, and HUD. In practice, this document should be used in conjunction with applicable regulations of state and local jurisdiction. The NPS policy states that a program of lead management, including worker and facility occupant exposure protection, will be implemented in each park where lead hazards exist.

Historic buildings, employee housing, and other facilities

Circumstances where an employee or volunteer may be occupationally exposed to lead, including construction work, are addressed in NPS policy.

Lead in drinking water

Safe levels of chemicals in drinking water are determined by the Safe Drinking Water Act (SDWA), which was passed in 1974. The SDWA set the maximum contaminant level goal for lead, which is based on potential health risks and exposure to humans, at zero. The action level for lead is 15 parts per billion (ppb); once that level is exceeded, then the water supplier is responsible for reducing the amount of lead through corrosion control and notifying its customers about ways they can lower their exposure to lead, as well as even possibly providing the public with alternative drinking water supplies. Section 1417 of the SDWA prohibits the use of pipe and plumbing fittings or fixtures that are made from lead after August 6, 1998; however, this law excludes the use of pipes in manufacturing or industrial processing (USEPA 2009a).

The LCR is another USEPA rule regulating lead in drinking water, primarily through plumbing materials; it was established in 1991. The LCR, as part of the SDWA, applies to all community water systems as well as non-transient, non-community water systems and regulates lead and copper in drinking water through the following four basic requirements:

- Water suppliers must have a treatment system to control for corrosion in plumbing;
- Permissible tap water levels of lead and copper need to be established for customers with lead service lines or lead-based solder in their plumbing system;
- Source water should not be the source of any significant level of lead; and
- If the lead action level of 15 ppb is exceeded, then suppliers are required to provide education and outreach to the customers on lead and ways they can reduce their exposure to it (USEPA 2009b).

The SDWA and the LCR apply to public water systems; however, NPS also has many individual non-public water systems (e.g., those in ranger houses and individual wells) that are not covered by the SDWA or the LCR.

Hunting

International and domestic studies have shown elevated lead levels in humans consuming large and small game hunted with lead ammunition (Tranel and Kimmel 2008; Tsuji et al.

2008, 2009; Cornatzer et al. 2009; Hunt et al. 2009; Kosnett 2009). Modeling of regular consumption of game meat in adults and children found elevated blood lead levels compared with background levels, especially among the latter group (Kosnett 2009). Because non-lead alternatives exist (e.g., shell-shot is available in steel, bismuth, tungsten, and tin; bullets are available in copper), use of non-toxic ammunition could reduce lead exposure impacts on human health (Tranel and Kimmel 2008; Hunt et al. 2009; Kosnett 2009). Currently, the US Fish and Wildlife Service approves the use of 11 types of non-toxic shell-shot with various material compositions (Tranel and Kimmel 2008).

In terms of lead ingestion, risk is dependent on how much lead is consumed and the frequency of exposure; therefore, limiting the total amount of lead exposure reduces harm (North Dakota Department of Health 2008). Factors that increase dietary lead exposure from spent lead bullet fragments in wild game include the frequency and amount of hunted game that a person consumes, the age of the person consuming the meat, the degree of bullet fragmentation, the path which the bullet enters the wildlife, the care with which the meat surrounding the bullet wound is removed, and any acidic treatments of the meat that would dissolve the lead (such as coating the carcass with vinegar or use of acidic marinades in cooking), which can increase exposure (Hunt et al. 2009; Kosnett 2009).

Results from research studies on the degree of lead contamination in large and small animals are not consistent (Johansen et al. 2005; Tsuiji et al. 2009). The variability in findings regarding the extent of lead contamination in tissues of large-game mammals can be explained by various factors: lead ammunition fragment distribution is heterogeneous within an animal; the distance from which the prey was shot determines the amount of tissue contamination; the site where the bullet entered the tissue is important; and lastly, further fragmentation can occurred due to the bullet hitting something hard (e.g., bone). All these factors need to be considered (Tsuiji et al. 2009). There is expected to be a higher incidence of lead bullet fragments in ground venison than in loins or roasts because meat trimmed away from the bullet channel can contain more fragments. Variation in lead concentrations in small animals such as birds is large, most likely due to the shooting skill of the hunter. Birds where the hunter has not destroyed the body in killing it will have less lead exposure when consumed (Johansen et al. 2005).

At times, the muscle game tissue around the wound channel is not discarded, but rather is used in burger, stews, and sausages; thus, it is recommended that the tissue around the wound channel be removed during food preparation (Minnesota Department of Natural Resources 2007; North Dakota Department of Health 2008; Wisconsin Department of Natural Resources 2008). Animals hunted with lead ammunition can have lead fragments embedded in their meat far from the entry wound as well (Tranel and Kimmel 2008) and small lead particles may be further distributed during processing and grinding of meat (North Dakota Department of Health 2008). When preparing venison, avoiding vinegar and other acidic substances is suggested, as acids can make lead more soluble and more readily absorbed in the body. Also, when processing, minimizing the batching of multiple deer is thought to reduce cross-contamination (Wisconsin Department of Natural Resources 2008).

Guidelines have been suggested by the North Dakota Department of Health to limit the amount of lead in ground venison or venison sausage. Suggestions in reducing exposure

include determining the path of the bullet and if it had penetrated the bone; trimming far from the wound channel and discarding meat that is bruised, discolored, or contaminated with hair, dirt, bone fragments, or grass; when in doubt, consider cutting the venison into chops to reduce the amount of lead entering the grinder; and finally, check the grinder for lead fragments (North Dakota Department of Health 2008).

Indoor and outdoor firing ranges

As with hunters, one way of reducing lead exposure among those who use indoor and outdoor firing ranges is to use lead-free ammunition. Copper or nylon-clad bullets and non-lead primers are recommended in RM 50 B. Another strategy is through engineering controls that can be used to minimize employee exposure in indoor firing ranges by ensuring that buildings are properly ventilated and cleaned of dust or spent bullets. Air sampling is a method to monitor exposure levels in the air at firing ranges. OSHA requires employers of workers who are occupationally exposed to a toxic or hazardous substance to institute engineering controls and work practices that maintain or reduce exposure to a level that is at or below the permissible exposure limit established for the substance. For occupational exposures to lead, the employer must use engineering controls and work practices to achieve an occupational exposure of 50 μg/m3 or lower, based on an 8-hour time-weighted average (OSHA2008; 29 CFR 1910.1025).

In addition, employee education can reduce the hazards of lead exposure. Personal protective equipment can be used, in addition to providing on-site hand-washing and showering facilities. Clothes worn at the range can contribute to "take-home lead," which is avoided by showering and/or changing clothing before returning home. RM 50 B contains specific information about lead dust in firing ranges, steps to minimize lead absorption, and how lead dust exposure and take-home lead can be reduced.

Employees exposed to lead at work can be periodically monitored and asked to be assessed for blood and zinc protoporphyrin or free erythrocyte protoporphyrin levels. Medical surveillance under the supervision of a licensed physician may be made available to employees who have been exposed to lead above the action level for 30 days or more per year.

Prior to July 2006, NPS LE officers fired lead ammunition for all training and qualifications. Today, NPS LE officers fire green ammunition for all training and all but one qualification each year, whether they use an indoor or an outdoor range. The result is a reduction in lead exposure for the LE officer as well as a reduction in take-home lead.

Angling

Anglers can avoid risk of lead exposure by using fishing gear that does not contain lead compounds. Use of non-lead gear will reduce the amount of lead that is deposited into the aquatic ecosystem from unrecovered lead compounds, which can leach into the waterways (Goddard et al. 2008). Use of lead fishing sinkers has been routine, but use of non-toxic substitutes can reduce lead exposure to anglers and the environment. Alternative materials used in the making of sinkers include ceramics, tin, brass, and steel. Sinkers made from these materials are larger because they are not as dense as lead (Goddard et al. 2008). Currently, certain

parks prohibit the use of leaded fishing tackle. Prior to visiting a specific park, anglers should visit the respective park website to find out rules on the use and possession of lead fishing gear.

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> Defenders of the short-sighted men who in their greed and selfishness will, if permitted, rob our country of half its charm by their reckless extermination of all useful and beautiful wild things sometimes seek to champion them by saying the "the game belongs to the people." So it does; and not merely to the people now alive, but to the unborn people. The "greatest good for the greatest number" applies to the number within the womb of time, compared to which those now alive form but an insignificant fraction. Our duty to the whole, including the unborn generations, bids us restrain an unprincipled present-day minority from wasting the heritage of these unborn generations. The movement for the conservation of wild life and the larger movement for the conservation of all our natural resources are essentially democratic in spirit, purpose, and method.
>
> — Theodore Roosevelt, *A Book-Lover's Holidays in the Open,* 1916

Place-based Environmental Governance in the Waterton Biosphere Reserve, Canada: The Role of a Large Private Land Trust Project

Julia M. McCuaig and Michael S. Quinn

Introduction

There is increasing acceptance that the long-term sustainability and resilience of complex social–ecological systems requires management strategies that transcend the boundaries of state-managed protected areas (Knight 1999; Brown and Mitchell 2000; Berkes, Kofinas, and Chapin 2009). In western North America for example, private landscapes surrounding public protected areas not only buffer the effects of human activity, but tend to be more productive and lower-elevation, and can provide essential functional connectivity (Rissman et al. 2007). Land trusts have emerged as a dominant institution for formalizing the protection of biodiversity on private land. Two primary instruments have been employed by land trusts for private land conservation: conservation easements and full ownership of land (Hilts and Mitchell 1993; Meiners and Parker 2004). Conservation easements are legal contracts that prevent current and future landowners from engaging in certain activities on their land and/or compel the landowner to maintain certain attributes of the land (Anderson and Weinhold 2008). They avoid the costs of full-fee acquisition and allow compatible land uses to continue. Conservation easements can be effective tools for maintaining the quality of place and can avoid the bitter, divisive battles that characterize some more top-down legislative or regulatory approaches (Korngold 2009).

Conservation easements, the purchase of land by land trusts, and other conservation management strategies outside the realm of state-managed protected areas increase the number of "actors" involved in protected area management. New forms of environmental governance are required to effectively address the coordinated management of public and private lands to achieve societal goals. This evolution of environmental governance is part of a global phenomenon that has been characterized as a shift away from "government" to "governance" and reflects a much greater role for non-state actors (Plummer and Armitage 2007; Pahl-Wostl, Gupta, and Petry 2008). Best-practice principles for the establishment of the new governance arrangements include: legitimacy, transparency, accountability, inclusive-

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ness, fairness, integration, capability, and adaptability (Lockwood et al. 2010). These approaches tend to expand the goals of conventional conservation to include the cultural landscapes and livelihoods of people who live near national parks and equivalent reserves (Graham, Amos, and Plumptre 2003).

"Place-based governance," an approach that engages civil society and other actors in local decision-making processes, has been identified as essential in the quest for sustainable communities (Pollock 2004; Lerner 2006; Edge and McAllister 2009). Edge and McAllister (2009, 279) defined place-based governance as "one that seeks to utilise local or regional place-based identities to motivate and engage civil society, government and other organisations in decision-making processes that foster social capital and institutional learning, and as one that promotes a local sense of place and community development, without being constrained by politically delineated boundaries." The concept "combines ecological and political interpretations of 'space' with social and cultural interpretations of 'place'" (Pollock 2004, 28). In the case of protected areas and their greater regions, protected area managers and land trust organizations interact with local governments, landowners, and other regional actors in an attempt to transcend politically delineated boundaries.

Biosphere reserves have been cited as mechanisms that can achieve interjurisdictional cooperation and facilitate place-based governance in protected area regions (Edge and McAllister 2009). Biosphere reserves emerged in the 1970s as part of the implementation of the United Nations Educational, Scientific and Cultural Organization's (UNESCO's) Man and the Biosphere Program. They have three major functions: (1) conservation of biodiversity, (2) sustainable development, and (3) support for logistics (which is labeled "capacity-building" in Canada) (Batisse 1993). In theory, each biosphere reserve contains a "core area" that is a designated protected area (often a national park); a "buffer zone" around the core area; and an area of use that may include industrial, commercial, or residential use. Biosphere reserves are also initiated out of a shared sense of place, which adds to the potential for strong place-based governance in these regions.

The emerging role of private land conservation initiatives provides increased impetus to examine the management models proffered by biosphere reserves within the context of place-based environmental governance. This paper explores and derives lessons from a dynamic example of place-based governance that is evolving in the environs of Waterton Lakes National Park and the Waterton Biosphere Reserve of southwestern Alberta, Canada.

Methods

Study area. The Waterton Biosphere Reserve, designated in 1979, is located in the southwestern corner of Alberta, Canada. The reserve is part of a larger regional ecosystem which is generally referred to as the Crown of the Continent Ecosystem (Figure 1). The biosphere reserve is made up of Waterton Lakes National Park and an area dominated by ranch lands to the north and east of the park that has been designated as the reserve's "zone of cooperation." Included within this is Nature Conservancy of Canada's (NCC's) Waterton Park Front Project (WPFP), one of the largest private conservation initiatives in the history of Canada, an area of about 150 sq km of which approximately 80% or 113 sq km is covered by conservation easements or direct purchases (Figure 2). Both Waterton Biosphere Reserve and the

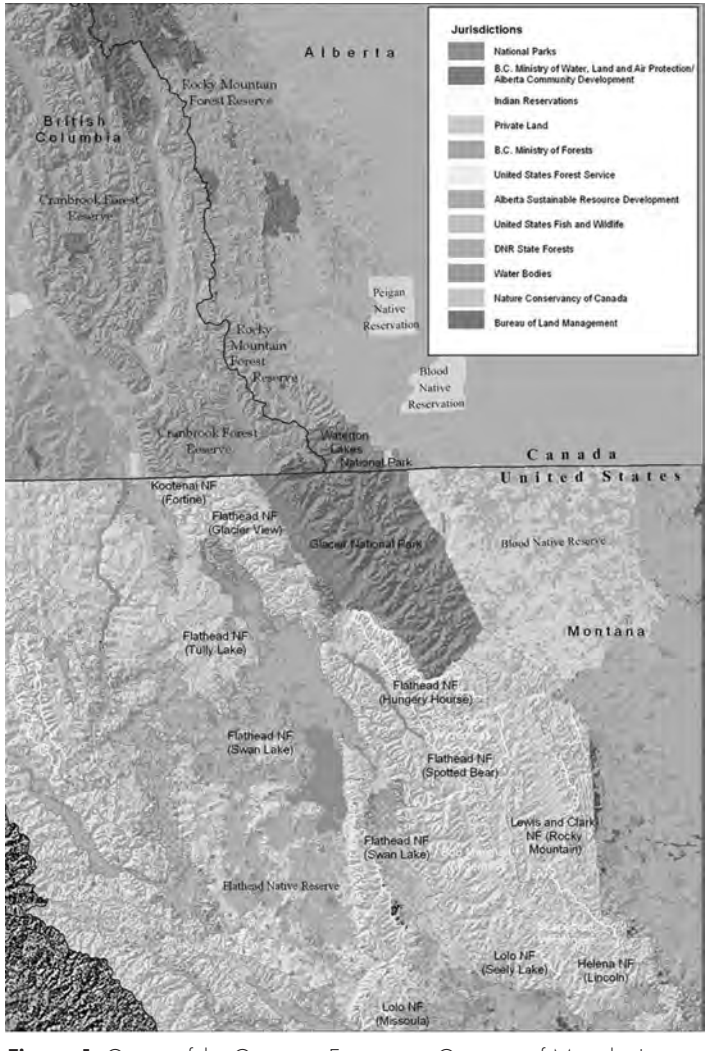

Figure 1. Crown of the Continent Ecosystem. Courtesy of Miistakis Institute for the Rockies.

WPFP are located within the municipal district of Pincher Creek and the county of Cardston.

Waterton Lakes National Park is representative of the Rocky Mountains natural region and includes representation from four "compressed" ecoregions: montane, foothills parkland, sub-alpine, and alpine (Parks Canada 1997). The sudden transformation from flat prairie to the Rocky Mountains inspired the park's slogan: "where the mountains meet the prairies." The national park has a high level of biodiversity and supports over 1,000 species of vascular plants, 265 of birds, 62 of mammals, 20 of fish, 10 of reptiles and amphibians, and thousands of insects and invertebrates (Parks Canada 2010). The park adjoins Glacier

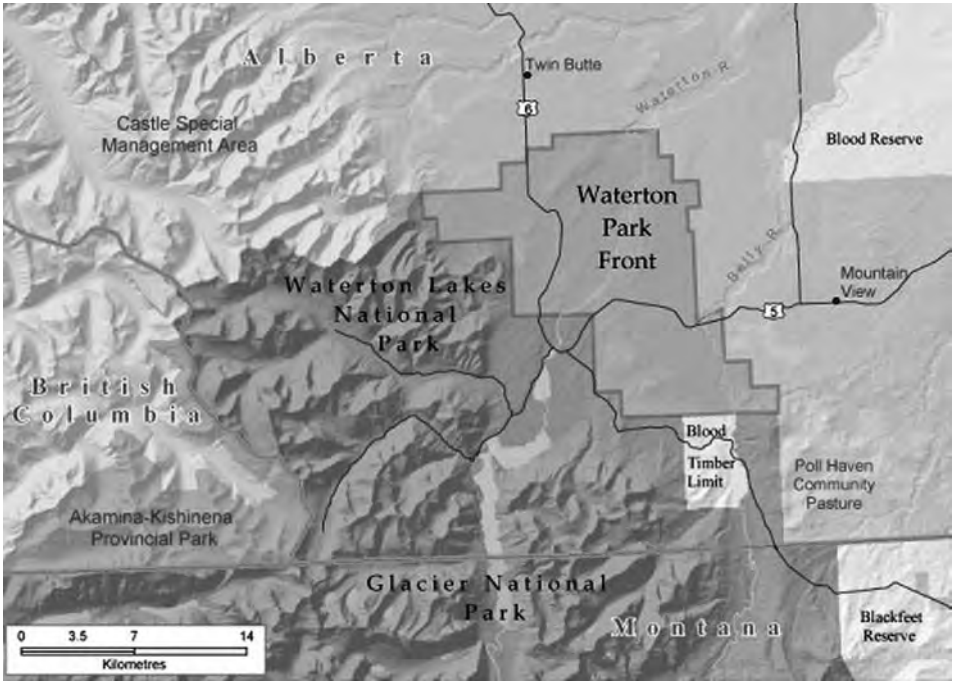

Figure 2. Location of the Waterton Park Front Project. Courtesy of Nature Conservancy of Canada.

National Park in Montana, USA, to the south, and together they constitute the world's first formally designated international peace park.

The private lands to the north and east of the park (i.e., the biosphere reserve's "zone of cooperation" and the location of the WPFP) and are mainly used for ranching, oil and gas exploration and development, and recreation. These ranchlands are critical to the ecological integrity of Waterton Lakes National Park, particularly due to wide-ranging mammals such as grizzly bears (*Ursus arctos*), wolves (*Canis lupus*) and elk (*Cervus elaphus*) that move back and forth from the park into the ranchlands (Parks Canada 2010).

As noted above, Waterton Biosphere Reserve was designated in 1979 under the Man and the Biosphere Program of UNESCO. The original nomination was driven by an application by Parks Canada during an era of long-term strategic planning and thinking, and conflicts between the park and local ranchers (Pollock and Pankratz 2008). In 1981, a biosphere reserve management committee was formed; the early activities of the committee were purposely non-controversial. In the late 1980s, a technical committee was set up which included researchers from various government agencies. The technical committee initiated its own scientific studies on the movement of elk and on cattle–elk interactions. During this period, the group tried to maintain a low profile due to the perception by some that the United Nations wanted to control the activities of landowners on their land. By 1990, funding for the biosphere reserve decreased substantially and waning interest and resources led to the abandonment of the technical committee (Dolan and Frith 2003).

Between 1990 and 2009, the Waterton Biosphere Reserve management committee continued to exist as a small group of volunteers, with some 5–7 people taking the main initiatives. These individuals helped to link biosphere reserve concerns to other informal networks of people or organizations devoted to particular conservation or resource issues (Pollock and Pankratz 2008). Dolan and Frith (2003) argued that although there was a decrease in the activity during the 1990s and early 2000s, the concept of the biosphere reserve continued in the region through other collaborative arrangements, such as the Crown Managers Partnership and the Waterton–Glacier International Peace Park. More recently, in 2009, the federal government provided a significant increase in funding and the Waterton Biosphere Reserve Association has become revitalized. The group was formally incorporated as a society in October 2009 and has formed an active board of directors. They have quickly become engaged in regional projects of concern, including management to reduce the negative interactions between ranchers and large carnivores.

Research questions. The goal of this research was to explore the role of a large private land trust project within place-based environmental governance. In order to accomplish this goal, the following research questions guided our investigation of the WPFP case study:

- How has NCC interacted with regional actors and processes/programs/structures within Waterton Biosphere Reserve?
- How did regional actors perceive the WPFP when it first started? How do regional actors perceive it now?
- How has the WPFP affected or influenced regional actors?
- What have been the implications of implementing a large-scale land trust project within close proximity to a government-managed protected area?
- How has the WPFP contributed to the sustainability goals of Waterton Biosphere Reserve?

Data collection. Data to construct the case study were collected through a review of relevant literature, policies, reports, and historical data, and by means of in-depth, semi-structured interviews. Twelve key informants were interviewed for the study, including NCC staff, Parks Canada staff, ranchers directly involved in the WPFP, ranchers not involved in the WPFP, Waterton Biosphere Reserve Committee representatives, a representative from the W. Garfield Weston Foundation (the primary project funder), and other regional actors such as municipal representatives. The interviews were intensive and semi-structured (Fontana and Frey 1994) and ranged from 25 minutes to 1.5 hours in length. An interview schedule was used to ensure that key themes were addressed, but the format was somewhat flexible and guided by the participant. Interviews were recorded on a commercial digital voice recorder with the consent of the participants and transcribed. The transcripts were analyzed for content using the software program NVivo 7.

Results and discussion

The results of our investigation are presented next by tracing the initiation and evolution of the WPFP and the interaction of NCC with the local community. We then examine the inter-

action between the WPFP and both Waterton Lakes National Park and Waterton Biosphere Reserve.

Initiation and development of the WPFP. The initiation and development of the WPFP arose out of several land-use challenges in the region that became apparent in the mid-1990s, notably the effects of increased demand for recreational "acreage" properties (rural residential development), challenges in the ranching economy (failure of the cattle market due to an outbreak of bovine spongiform encephalopathy), and a growing oil and gas industry. The increased demand for recreational properties is perceived by many in the region to have contributed to rising real estate prices, a declining ability of ranchers to buy property, and the increasing difficulty in pursuing ranching as a viable way to make a living (McCleave 2008). During this time a small group of conservation-minded ranchers who were concerned about the rapid pace of development in the region formed the Southern Alberta Land Trust, and several of the group's founding members placed voluntary conservation easements on their properties. As one participant explained, they wanted to set an example to other ranchers, but voluntary easements did not prove to be a popular idea.

Within this regional context, in 1997 a parcel of land bordering Waterton Lakes National Park within the municipal district of Pincher Creek was put on the market. The land included significant native grasslands and a small lake that provided breeding habitat for the threatened trumpeter swan (*Cygnus buccinator*). NCC, a private, not-for-profit conservation organization, recognized the critical value of the land, but did not have the funds available for acquisition. The W. Garfield Weston Foundation, a private Canadian family foundation, was, at the same time, interested in exploring opportunities for private land conservation initiatives with NCC. A field trip to the Waterton region by members of the Weston Foundation resulted in a deal to purchase the property and, more importantly, a desire on the part of both parties to discuss a larger regional private land conservation project. Discussions eventually led to the foundation providing over Can$40 million for the purchase of lands and conservation easements and the funding of stewardship activities. This represents one of the most significant private conservation gifts in Canadian history.

Subsequently, in 2000, a proposal for rezoning to allow a housing subdivision in Cardston County on the border of Waterton Lakes National Park resulted in heightened concern for the area. NCC contacted the landowner about negotiating a purchase, but mutually acceptable terms for the sale could not be reached. Although the rezoning application was eventually approved and the housing subdivision built, the events galvanized public interest in the area and provided the foundation for regional private land conservation.

The period between 1997 and 2004 can be characterized as the acquisition phase of the WPFP. The increasing pressure for recreational subdivision and the economic pressures faced by the ranching community created a need for rapid action if the high-quality, large ranchlands were to remain intact. The social circumstances of some families were also significant; for example, there were children of ranchers who did not want to continue ranching, multiple landowners who were having difficulty in "sharing" the ranches, and family breakups. NCC focused its activity on purchasing conservation easements, but also had to engage in fee-simple purchases. The latter were very costly, but necessary if the project were to be successful. Due to limited staff and resources, and the urgency with which the work was

being completed during this period, NCC operated largely opportunistically and focused the bulk of its efforts on acquisition rather than on the long-term management and stewardship of the properties. The strategic decision by NCC to focus on securing lands was not accompanied by a coordinated communication plan in the community. In a multi-generation, independent ranching community, this resulted in a great deal of rumor generation and suspicion.

In 2004, the Waterton Stewardship Endowment Fund was created and a local stewardship coordinator was hired for the project. This signified a shift in focus of the project from land and conservation easement acquisition to the stewardship and operational aspects of the project lands. Moreover, it demonstrated a commitment by NCC to actively engage in local environmental governance and build collaborative relationships with their direct partners, such as Parks Canada. Currently the WPFP is focused on undertaking such stewardship activities as weed control and range and riparian management, building strong relationships with lease and easement holders, and outreach to the public. There is an annual "Eat and Greet" event at a local community hall, organized by NCC, where local community members are invited to dinner and presentations by guest speakers about regional sustainability issues. In 2006, a local advisory committee comprising several ranchers who are involved in the project either as leaseholders or easement-holders was formed. In 2007, NCC opened a visitor center (the Weston Family Conservation Centre) as part of the WPFP, and built the Waterton Springs Interpretive Trail in a private campground (also part of the project lands) to provide a venue of communication and interpretation of the project and the value of the regional landscape in general.

NCC has undertaken the WPFP with a particular philosophy and style. NCC's 2000 annual report, released during the acquisition phase of the project, noted that the agency "takes a quiet, business-like approach to land conservation" (Nature Conservancy of Canada 2000, i). This approach has been exemplified in the way that the WPFP has unfolded. For example, NCC staff have not specifically discussed the details of the project at the annual Eat and Greet events, but have encouraged people who are interested in talking about the project to approach them privately. In addition, NCC staff have taken a one-on-one approach in their negotiations for conservation easements and property purchases. Each deal was unique and no general formula was used to determine price.

Two significant events contributed to local peoples' perceptions of NCC and the WPFP. Between 2004 and 2006, several oil and gas companies approached NCC about conducting seismic programs to assess the potential for petroleum extraction. As with most other private land in the province, NCC does not have the mineral rights to its properties. In the winter of 2005–2006, just prior to the development of detailed conditions for seismic operations on NCC lands in Alberta (for example, timing restrictions for wildlife and restrictions on certain activities), NCC permitted a non-speculative geophysical exploration project to occur on some WPFP properties. These are not binding guidelines but, according to an NCC staff person, "honest requirements for anybody that's doing any sort of industrial exploration on our land" (P1[1]). The staff member noted that they are trying to work with the oil and gas industry rather than engaging in adversarial hearings through the provincial energy regulation authority. Some regional residents, who were engaged in "battles" with the oil and gas

industry's activities, did not support this approach and felt that NCC should not have allowed the oil and gas companies to have access to their properties.

Another significant event involved the acquisition and subsequent selling of a property outside of the boundaries of the WPFP by NCC. The property was sold with a negotiated conservation easement on the deed, but the new owner of the property started a bison ranching operation, and altered the design of perimeter fencing which created a barrier to regional wildlife movement. This, as well as one particular incident where bison escaped from the property, influenced some local peoples' perceptions of bison farming and of conservation easements. NCC is currently in legal discussion about whether the bounds of the conservation easement have been contravened.

Interactions with the local community. We asked participants about their general perceptions of the WPFP, the influence that the project has had on their lives, and the interactions that they have had with NCC. A variety of perceptions and opinions emerged that represented those living within and near the boundaries of the project.

During the acquisition phase of the project, there were many rumors circulating in the two rural municipalities, the county of Cardston and the municipal district of Pincher Creek, about the actions of NCC. The local community, composed primarily of ranching families, many of which had been on the landscape for two or more generations, had a proud independence and a suspicion of intervention from outsiders. Concerns of some community members who were not involved in the project, particularly residents of Cardston County,[2] included fears that a conservation organization would not allow cattle grazing to continue, beliefs that land values were being artificially inflated by the acquisition interests of NCC, worries that a significant tax base for local governments would be lost, and, suggestions that the project was actually a covert activity to increase the size of the national park.

> I heard people say that the Conservancy was just a front for the government and they are just going to acquire all of this land and put it into the park. You know people just generally heard "conservation" and they had the impression that you wouldn't be able to have any cattle on it. (P2)

> Some folks, particularly in Cardston County, were quite suspicious, calling it a "land grab." I think everybody's first perception was a little bit of suspicion about what it is and what their agenda is so probably I was right in there. (P3)

Some participants became aware of the project after the initial land purchases and conservation easements were made. These participants described feelings of shock and surprise at both the concept of private land conservation and the amount of money involved. According to a former NCC staff person, there was no education or publicity campaign about the project and the land purchases and conservation easements were arranged quietly and quickly. Several participants noted that they were initially confused about the project and its long-term implications. One local rancher explained that he tried to become informed about the project but was unsuccessful:

> I kind of thought I knew why they were doing it but I really wanted to know a lot more about them and it seemed like whenever I asked someone in the Nature Conservancy, I always got the answer "Well every situation is unique and different." (P4)

Some participants, particularly those living in the county of Cardston, are still very suspicious of the project. One participant stated that NCC was opportunistic, and took advantage of landowners in financial or family difficulty during the acquisition stage of the project. Another participant used less harsh language, saying that he agreed with the concept of private land conservation but not the way in which the WPFP has developed, with "tenant farmers" on the landscape. Other participants expressed that they are somewhat skeptical about the project, due to a lack of information about the project and its future implications. A few participants perceived that the project has had some indirect negative impacts on them by increasing property values and by limiting the tax base of the municipalities.

Other members of the local community noted that although they were somewhat skeptical of the project in the beginning, they are more supportive of it now, especially since NCC has started to increase its stewardship efforts and the conservation implications of the project have become apparent:

> I would say it has been positive because I do think there was development pressure and had some of those lands not been purchased or easements been put on them then it would have been gone. So from that point of view I think it is a good thing. (P2)

> I think now people are really getting used to the Nature Conservancy being there and seeing that they aren't the big bad wolf and stopping all development. They are being responsible land tenders and owners. (P5)

Two participants contrasted the current situation in terms of land use in the region with what they envision would have been the reality if the project had not gone ahead:

> I think without it the area would have been toast. It'd be gone now. So I think probably, in my view, it's been very good. (P6)

> But given the choice of having that land all owned by cottage and acreage owners or having it owned by the Conservancy and people still ranching on it I would definitely take the second. (P2)

Those ranchers who participated directly in the project, by selling land to NCC or negotiating a conservation easement on their properties, were generally very supportive of the project. Interactions between NCC staff and these ranchers occur through numerous means, including stewardship activities on the land, one-on-one formal and informal meetings, and the annual Eat and Greets. One rancher noted that she did not perceive any "pushiness" or "aggressiveness" in the manner in which the project proceeded and that staff were well aware

of the difficult circumstances many of the families were in. Several participants spoke about the positive financial impact the project has had on their families:

> For some of the people there they didn't have the next generation interested [in ranching] so they were going to have to sell at some point. This was a good option for them. They knew that what they'd built, their legacy, would stay intact. Someone else would keep it in a good state, so it was a good option for them. (P1)

> To us it was a benefit from the point of view that it was becoming hard to know how to handle that land because there was a number of us that owned it. So it was better really, we got our money out of it and the siblings that aren't around here are happy and we still have access to use it. So it was worthwhile. (P7)

In 2006, the Waterton Front Park Advisory Committee was created. This group comprises six ranchers/landowners who are direct partners in the WPFP. The group has met approximately twice per year to act as liaisons between NCC and the community on topics related to stewardship of the WPFP. According to one NCC staff person, the group is currently a forum "to bounce ideas off of … on things from really small to larger issues" (P1). In keeping with NCC's low-key approach to working in the region, the group has not been highly publicized; rather, NCC supports committee members in taking the lead on communicating with the community. To date, much of its focus has been on publishing a newsletter on stewardship issues. Committee members have also initiated the formation of a local watershed stewardship group.

The WPFP and Waterton Lakes National Park. We asked some participants about the interaction between Waterton Lakes National Park, a government-managed federal park, and the Waterton Park Front Project, a private conservation initiative managed by a non-governmental organization, as well as the implications of having a large-scale land trust project on the boundary of a national park. Overall, most of the participants we asked described a very good relationship between Parks Canada and NCC staff. One of the main reasons for protecting ranch lands and preventing subdivision within the WPFP area is the project's location bordering the national park and within the larger "Crown of the Continent" ecosystem. Since the inception of the WPFP, most Parks Canada staff have been very supportive of the project:

> Well, my initial perception was that it was like a knight on the white horse running to save us. Because for years there were various development proposals made for outside the park that concerned us. (P5)

> We were very pleased to have the ranching community as a private land use on our boundary simply because they were in the business of maintaining large tracts of relatively undeveloped, often native prairie with cattle. (P8)

> Recognizing there are conflicts, there are—ten percent of the time there will be different views

on issues—but for the most part, 90 percent of the issues we have are very similar interests as the ranching community. (P8)

During the early days of the WPFP, some Parks Canada staff members assisted NCC staff in hosting the potential project donors in the Waterton region. The donors were taken on field trips in and around Waterton Lakes National Park and educated about the area's land use challenges and the benefits that private conservation would have on the park. These early field trips were perceived as key to educating the potential donor:

> You don't have to say a lot when you ride across the Front Range in Waterton and you look at the deeded private ranch lands and the public lands and you see, "Well, it all fits. It all makes sense." You don't have to say a lot about the connections in terms of habitat and wildlife. (P8)

As the WPFP proceeded, Parks Canada staff deliberately stayed somewhat uninvolved in the development and operation of the project, aside from supporting it and communicating about boundary issues. Some participants noted that there were rumors circulating during the early days of the WPFP that Parks Canada was funding the project in order to expand that park boundaries in the future. As a result, park staff were very careful about any public statement about the project or any involvement in the project's business:

> Well, I think initially we sort of tried to pull back. Because we wanted the Nature Conservancy to be able to stand on their own two feet, which they are obviously completely capable of doing. And we didn't want them to have to have a sort of feeling with the ranching community that they are kind of in Parks Canada's pocket or something. I think that Parks Canada really felt we needed to step back and let them do their job. (P5)

> I think the concern with the Nature Conservancy was that they were there interested in supporting and sustaining the ranching community. If we were seen as just another attempt to expand the park, which it wasn't and isn't, then there was a concern from our point of view and the Nature Conservancy that we'd be painted in a light that was inappropriate, that wasn't real. And so I think we maintained a very low-key supportive role, supporting the Nature Conservancy and helping donors understand the importance of that landscape from our perspective. But also, hopefully, to some degree in terms of the impact we had on the ranching community as a national park. (P8)

During the early years of the WPFP, Parks Canada staff were not actively educated about the project and this may have led to the development of some misconceptions about the project on the part of staff, particularly with regard to NCC's approach in allowing seismic operations to proceed on their lands. McCleave (2008) noted that an NCC staff person expressed frustration with the level of communication occurring between Parks Canada NCC at the time and indicated that NCC was not being used to its full potential as a conduit between the park and adjacent land users.

Operationally, NCC staff and Parks Canada staff have interacted about boundary issues such as fencing, signage, fire, youth education programs, and weed management, among others. The project provides a "more focused" regional actor that the park can go to if necessary, although park staff regularly communicate with individual ranchers. The existence of the national park on the boundary on the WPFP has also had some implications for the project. For example, one NCC staff person noted that the past (and somewhat strained) relationship between some ranchers and Parks Canada staff has influenced how some ranchers interacted with NCC staff, another large entity in the region. Also, the national park draws tourists to the region and this has had implications for some NCC properties due to tourists venturing onto the project lands from the park.

The WPFP and Waterton Biosphere Reserve. We also asked some participants about the interaction between the WPFP and the Waterton Biosphere Reserve. The questions were structured to learn about the role of a large private land trust project in meeting the goals of the biosphere reserve through private land conservation.

Overall, participants reported that the relationship between NCC and those involved in the Waterton Biosphere Reserve was friendly but somewhat distant until the biosphere reserve's recent revitalization. The two groups interacted during the early stages of the WPFP, and Waterton Biosphere Reserve volunteers were generally supportive of the project. Members of the Waterton Biosphere Reserve Committee developed a video about the threats of subdivision in the region, which was then shown to potential donors to the project. They were also involved in the early stages of the project in hosting the potential donors. The Waterton Biosphere Reserve Committee has also contributed funding to NCC's annual Eat and Greet events.

Some participants talked about the theoretical connections between the biosphere reserve concept and large-scale private land conservation. The main connection perceived by participants was that since the "buffer" of the Waterton Biosphere Reserve was loosely defined as an "area of cooperation," the WPFP was the default "buffer" within the biosphere reserve. Many participants perceived that the WPFP falls within the biosphere reserve's "area of cooperation" and is complimentary to the concept and aligned to the mandate of the biosphere reserve:

> Well, it's totally aligned to their mandate. I think the idea of Waterton being the core of the Biosphere Reserve, and then having the surrounding lands, the Nature Conservancy trying to preserve that way of life totally fits with the Biosphere Reserve. (P5)

> Well, the Biosphere in theory is almost what the Nature Conservancy accomplished. The Biosphere concept was that you needed a zone of cooperation around the park but the Biosphere didn't have any money and people were pretty reluctant around the park to have any limitations put on their land. So the Biosphere was a theoretical concept that the Nature Conservancy made practical, I guess. (P7)

The biosphere reserve's recent periodic review states that "without formal delineation, Waterton Biosphere Reserve has essentially one of the most effective buffers of any biosphere

reserve in North America" (Pollock and Pankratz 2008, 12). There have recently been discussions between members of the Canadian Biosphere Reserves Association and the Waterton Biosphere Reserve Association about contacting UNESCO and formally designating the WPFP land as part of the biosphere reserve's buffer zone. The 2008 review notes that some committee members are hesitant to formally establish boundaries since the informal "zone of cooperation" has been positive and highly collaborative (Pollock and Pankratz 2008).

Several participants were careful to state that it has been the ranching industry that has shaped the landscape over time, developed sustainably (one of the major functions of biosphere reserves), and provided a buffer to the national park within the biosphere reserve area. However, if the rate of development and subdivision had continued along the same path as it was on prior to the WPFP, as many participants speculated it would have, then it can be said that the project has had a significant impact on the present and future ecological integrity of Waterton Lakes National Park and surrounding lands, and the sustainable development of the ranching industry within the project boundaries:

> The Conservancy has bought land, they've bought a lot of easements on other land, and there are still a few holes in it, but it's really saved our butts as far as subdivision is concerned. I have no doubt that the majority of the park boundary would be split up in subdivisions now. It would have happened in the last five years had it not been for them. (P6)

> Since about the last eight years I think there probably would have been at least thirty percent more houses in that 30,000 acres than there are now if it hadn't happened. And once a house and a road is built it's forever gone. You know it is too late then. Roads may even be worse than houses, but so I think it has made a huge difference. (P4)

Besides contributing to the buffer of the Waterton Biosphere Reserve and the sustainable development of the ranching industry, the WPFP has also contributed to the two other functions of biosphere reserves, namely the conservation of biodiversity and support for logistics (or "capacity-building"). The project's effort in invasive plant management was the most frequently cited by participants as a contribution to the region's biodiversity. There is also ongoing work done in supporting sustainable riparian and range management. According to an NCC staff person, many of the positive stewardship attitude and action shifts that arise as a result of collaboration with the conservancy's partners cannot be quantified. However, the unassuming, supportive approach has indeed been successful in that the ecological health of most monitored range and riparian sites on NCC-owned WPFP lands has improved or been maintained.

The project has also had tangible effects in the area of capacity-building, mostly in terms of NCC staff contributing their time and expertise to various regional boards and committees and by organizing educational programs within the biosphere reserve. NCC staff have been involved in the Old Man River Watershed Council, Pincher Creek Watershed Group, Cows and Fish (Alberta Riparian Habitat Management Society), Southwest Alberta Cooperative Weed Management Area, Waterton Natural History Association, and Waterton Biosphere Reserve Association. NCC staff have also made presentations about the WPFP at sev-

eral conferences and events such as Waterton-Glacier International Peace Park's yearly Science and History Day, the Waterton Wildflower Festival, and the 2007 Parks, Peace & Partnerships Conference.

Conclusions

Several lessons can be learned from the WPFP in relation to large-scale land trust projects and their role within place-based environmental governance and biosphere reserves.

First, the approach with which NCC went about the WPFP is noteworthy. The "quiet, business-like approach" NCC took was important in this case in order to minimize land price inflation and/or speculation from occurring. Moreover, this approach allowed for NCC to negotiate a variety of individually appropriate conservation easements as well as direct land purchases with a limited (although substantial) amount of financial resources. However, the project still did garner a considerable amount of attention in the local community, as would any other large-scale land trust project that developed so quickly (e.g., with a large donation of money). The value of real estate in the region did increase during and following the acquisition period and some residents did blame the WPFP despite there being other likely influences on prices. This approach to doing business also had some unintended consequences due to some local residents being uninformed and confused about the project. Fundamentally, large-scale land trust projects require a balance between a low-key approach and sufficient information dissemination and transparency. The WPFP clearly indicates the need for land trust organizations to commit to long-term stewardship activities following large-scale land acquisitions activities.

The WPFP is also an interesting case study of the interaction between a large-scale land trust project and a government-managed national park. In this case, although the land trust project has had (and will have in the future) a significant positive effect on the ecological integrity of the national park, park staff were careful not to talk about the project publicly in order to lessen the chance that other regional actors would perceive a government influence in private land conservation. Unfortunately, this hands-off approach did not allow some staff members to be adequately informed about the project. Other cases where private conservation is implemented on the boundaries of public protected areas would face a similar dynamic, and the proper education of staff on the nature and intent of the project and regular communication between park and land trust staff could help to avoid misunderstandings.

This case study shows how large-scale land trust projects can make significant contributions to biosphere reserves. Many of the lands that have remained intact as viable ranches in the WPFP may have been lost to subdivision or less ecologically benign land uses were it not for the implementation of the project. It not only protects the physical land base, but also maintains the local human history and long tradition of ranching. Besides making tangible contributions to biosphere reserves' buffer zones (or, in the case of the Waterton Biosphere Reserve, the "zone of cooperation"), private land conservation can contribute to the three functions of biosphere reserves (biological conservation, sustainable development, and logistics). In the case of the Waterton Biosphere Reserve, which is currently undergoing a revitalization with the recent formation of an active, volunteer board of directors, the WPFP area is emerging as a key component in an effective zone of cooperation. The group has quickly

engaged other regional actors in governance discussions on issues of most interest to private landowners and of great relevance to regional sustainability (e.g., invasive weed control and reduction of conflicts among livestock, large carnivores, and humans).

Finally, the story of the WPFP exemplifies how private land conservation can change the nature of communication and action within place-based environmental governance. Besides becoming another actor that government agencies and industry can communicate with about regional issues, land trust staff can organize public education events (such as, in this case, the annual Eat and Greet) and other mechanisms for implementing place-based environmental governance. Having the WPFP within an active biosphere reserve has provided the ranching community with a new means by which to collaborate and has stimulated discussions and action on place-based environmental governance. The current conditions appear right for the ongoing evolution of a governance framework that embraces the interdependencies between the public and private landscapes that constitute the region. Biosphere reserves provide an ideal environment in which these new arrangements can be incubated, developed, modeled, and shared with other areas.

Endnotes

1. Each participant has been assigned a unique code that appears in parentheses following his or her quote.
2. McCleave (2008) perceived key differences in the culture of residents of Pincher Creek and the county of Cardston. Participants labeled residents of the county of Cardston as more "individualistic" and "pro-development," while residents of the municipal district of Pincher Creek were labeled as more "conservation-minded."

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