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Introduction by Jacob Darwin Hamblin, Oregon State University

One of the jarring elements of the blockbuster sci-fi film *The Hunger Games* was the setting of its quasi-gladiatorial combat. Rather than enter an arena and fight to the death, kids from all over the land arrived in the woods, in what appeared to be a gorgeous wilderness. As the characters try to survive, the movie seems poised to take on the classic "human vs. nature" plot characteristics. But it soon becomes clear that the wilderness is *wired*. It is a completely controlled environment, with its contours and "wild" inhabitants manufactured at will by the game managers. Everyone and everything is tracked, never able to hide, never out of surveillance. The film draws on familiar Orwellian tropes, but puts even the natural world under the watchful eye and controlling hand of Big Brother.

Is this the future we have wanted – electronic surveillance, control, and management of the natural world? In the latter half of the twentieth century, scientists acquired extraordinary technological tools for tracking. The idea of putting identifying markers on animals was not new, but using radiotelemetry to keep tabs on them over long distances certainly was. It allowed for a wired, or rather wireless, wilderness. For the ambitious scientist, being able to track wildlife across vast terrain had extraordinary appeal, as it moved field sciences ever closer to controlled experiment. For conservationists it promised a new era of wildlife management, and for animal lovers it seemed to offer a means to find ways to protect favored critters from harm. It brought lots of people together who shared a singular faith in science and technology.

In *Wired Wilderness*, **Etienne Benson** tells the story of wildlife radiotelemetry, and in doing so he tackles the enthronement, as he puts it, of science and technology as keys to mitigating wildlife challenges. In the postwar era, radiotelemetry became the ultimate machine in the garden, a sophisticated tracking tool for the surveillance and study of animals in their habitats. And yet the use of this technology, Benson suggests, highlighted serious points of discord. Radiotelemetry became a focal point for clashes about the meaning and value of wildlife.

I asked **Sara Dant** to comment on *Wired Wilderness* for this roundtable because of her insights into the politics of wilderness protection in the United States. Dant shares with Benson a deep interest in wilderness in the postwar era, and she has written extensively about the political struggles to establish defensible notion of "wild" areas that might receive protective legislation. She shows how politicians such as Idaho Senator Frank Church "made wilderness work" in the political realm through legislative compromise, not by committing to a pure, unchanging definition, but rather by accepting that the definition can and will evolve over time.[1]

[1] Sara Dant, "Making Wilderness Work: Frank Church and the American Wilderness Movement," *Pacific Historical Review* 77:2 (2008), 237-272.

Michael Lewis has devoted much of his scholarly attention to the practice of wildlife ecology, particularly in India. In *Inventing Global Ecology*, he notes that by the 1970s and 1980s, American-influenced ecology placed so much emphasis on the importance of biodiversity that it had important ramifications for wilderness areas far outside the United States. Government officials in India began to choose large parks and reserves, relatively free from humans, as a key part of conservation strategy. He sees the universalizing of conservation practices, whether conceptually or technologically, as a kind of cultural imperialism.[2]

Robert M. Wilson adds the perspective of a historical geographer to this roundtable. Wilson's book *Seeking Refuge* starts with a story of wildlife tagging, with bird banding, leading to the identification of a huge area of avian migration in the West: the Pacific "flyway." His work reveals the political and legal complexity of trying to ensure the integrity of such a sweeping habitat. Beginning with tracking technology, the U.S. Fish and Wildlife Service tried to make wildlife legible for conservation practices, including the construction of an ambitious national wildlife refuge system.[3]

Before turning to the comments, I would like to pause here and thank all the roundtable participants for taking part. In addition, I would like to remind readers that as an open-access forum, *H-Environment Roundtable Reviews* is available to scholars and non-scholars alike, around the world, free of charge. Please circulate.

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[2] Michael L. Lewis, *Inventing Global Ecology: Tracking the Biodiversity Ideal in India, 1947-1997* (Athens: Ohio University Press, 2004).
[3] Robert M. Wilson, *Seeking Refuge: Birds and Landscapes of the Pacific Flyway* (Seattle: University of Washington Press, 2010).

Comments by Sara Dant, Weber State University

In his thoughtful and thorough *Wired Wilderness: Technologies of Tracking and the Making of Modern Wildlife*, Etienne Benson explores the evolution of radiotelemetry and scientists' efforts to track and monitor wild species. Obviously informed by William Cronon's provocative essay "The Trouble with Wilderness," Benson's four (fifty-page) chapters tell an "alternative story of conflict and contestation over the practices of wildlife biology" (3).

Not surprisingly, the earliest animal tracking technology emerged during the Cold War. In the 1950s, the military's use of miniature radio transmitters inspired scientists to adapt the devices to tag and track fish. Wildlife biologists quickly embraced this new technology as "a Russian Sputnik to shatter our complacency" (13) - an effective conservation tool that would allow them to better manage game populations and "improve hunting" (12). But early tags proved cumbersome and awkward, both for the scientist and the wildlife. Initial tagging was often violent and invasive and clunky radio collars impeded the animals' natural activities. Moreover, as Benson illustrates, some of these early wildlife biologists were simply "following animals around" (39) without applying the scientific method or testing hypotheses - dazzled by the technology itself and the reams of data it generated. At the same time, however, ethical debates also emerged, which questioned the intrusiveness of these new devices and called for a balance between cutting edge technology and traditional field-based observation.

At the forefront of this polarizing conflict, Benson reveals, were John and Frank Craighead and Adolph and Olaus Murie. The Craigheads had begun using radio tags on Yellowstone National Park bears in 1960, drawing the ire of Adolf Murie, who viewed radiotelemetry as "destroying the very essence of the poetry of wilderness" (69). Especially in national parks. The Craigheads argued that "the point was to get close and observe them [bears] without being detected" (60), but Murie protested that there were plenty of places outside the "sacred" parks where the Craigheads and others could "play with the marking technique" (69). The Craigheads' research and findings did lead to immediate and positive changes in the park's management of its bear population (the elimination of dumpster feeding, for example), but also to colossal public relations fiascos like the death of a recently collared park elk named Monique in 1969.

While Benson's first two chapters dutifully detail the machinations of radiotelemetry in the United States, the third chapter on the politics and personalities swirling around tiger tagging in India strays from the larger purpose of the book and feels a little like a throw-in. But his final section on tracking marine mammals returns to the contentious American debate between scientists and wildlife advocates and reinforces several common themes that run through the entire history of radiotelemetry: rudimentary and error-prone early technology, tagging itself as violent and invasive, enduring polarization, and erratic funding.

Unfortunately, by organizing *Wired Wilderness* by species type instead of chronologically, Benson misses the opportunity to analyze and provide historical context for these larger themes and to address how this story fits into Cronon's call "to rethink wilderness."

Where Benson really succeeds, though, is in challenging readers to think critically about the ethics of using technology in the study of wildlife. The author argues that forging a connection between the public and wildlife via technology and wildlife programs "made it possible for wild animals to tell their own stories directly to mass audiences" (192). The *Free Willy* movies and web-based programs like the Albatross Project, which enabled school children to track satellite-tagged birds, were gambits that brought critical attention and funding to conservation and protection efforts true enough, but at what cost? As a lifelong fan of Marlin Perkins and Jacques Cousteau, I certainly gained an abiding appreciation for the complexity of the natural world via weekly doses of *Wild Kingdom* and *Undersea World*. Yet as Marlin hovered in the helicopter while Jim mud-wrestled a massive crocodile "in its natural habitat," the nagging question (other than Jim's fate) was often how "natural" can this be? And is it good for the crocodile? To "honor the wild," Cronon asserts, "deep reflection and respect must accompany each act of use."

To tag or not to tag, that is the question *Wired Wilderness* provokes. Do scientists learn enough to justify harassing and stressing and sometimes killing wild animals? At what cost do we acquire knowledge? As one scientist conceded, "it is very, very, very difficult – it is impossible – to predict beforehand how the results of certain kinds of research may contribute to or benefit a species" (178). Are tagged and tracked animals in fact still wild?

The trouble with wilderness, Cronon cautions, is that in western culture we have concocted "a dualistic vision in which the human is entirely outside the natural." The world without us would certainly function much differently, but barring an immediate Mayan-predicted apocalypse, we seem to have settled in for the longue durée. This "wilderness dualism," Cronon contends, "tends to cast any use as abuse, and thereby denies us a middle ground in which responsible use and non-use might attain some kind of balanced, sustainable relationship."[4] Yet as a species capable of fundamentally altering ecosystems, surely humans have a moral responsibility to strive for a reasonable equilibrium between intrusive science and wild nature.

Whether we like it or not, as Benson's study demonstrates, wilderness and wildness debates have to take place in a political realm. This, perhaps, is the real trouble with wilderness. The realities of consensus and compromise mean that neither scientists nor wilderness purists will ever get all they want. But it is also true that we care

[4] William Cronon, "The Trouble with Wilderness; or, Getting Back to the Wrong Nature" in William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature* (New York: W. W. Norton & Co., 1995), pp. 69-90.

about what we know. And in order for scientists to know, sometimes the wildness of wilderness must yield. In the end, if we are to heed Cronon's call to "get on with the unending task of struggling to live rightly in the world" and be good stewards, then we must *listen* to the world around us.

Comments by Michael Lewis, Salisbury University

To spend much time looking for or at wildlife in the contemporary US is to viscerally experience the contradictions that are at the heart of Etienne Benson's intriguing *Wired Wilderness*. In 2010 when I first saw a group of Roosevelt Elk in Olympic National Park, I snuck as close as I could, pulled out my binoculars, and promptly identified what appeared to be a radio collar around the neck of the largest elk. Although I told myself this was great – a sign that these magnificent animals were being studied, and thus, hopefully, better managed – I couldn't escape the nagging feeling that I was in a zoo, a very large, very beautiful zoo.

In 2001, a local field biologist was radio-tracking Northern Bobwhites in Eastern Maryland. She was approached by a property owner who was funding part of the study on quail mortality (populations in this portion of Maryland have been, and are, in decline). He informed her that he was in the area and going hunting, and wanted to know where the coveys were located. My friends and I tell this story with great delight: of the urban hunter with his dogs who still needed radio tracking to find his prey – the punch line being that he still didn't kill one that day. The irony of an erstwhile sportsman "hunting" his game with the latest radio-tracking technology never fails to amuse, but a quail with a radio-collar on its neck caused him no cognitive dissonance in his enjoyment of his back-to-the-woods holiday. Other local hunters, more successful and more circumspect, were apparently similarly unbothered, as the radio collar signals occasionally led the biologist to trash bins where the transmitters were tossed with other inedible portions of the dead birds. We might assume that the quails tasted the same whether or not they had a radio-collar around their living necks. And they were wild birds – legally killed. So why does it seem like cheating – or at least amusingly unsporting - to shoot a radio-collared quail?

It is exactly this – the cultural contradictions embedded in the use of space age radio telemetry to study, and ultimately preserve, wild animals as both symbols and constituent parts of wild nature – that Benson takes as the subject of his enjoyable book. And he is an able guide. *Wired Wilderness* is exhaustively researched, clearly and well written, and it engages important questions in the cultural history of wilderness, the history of technology, and the history of wildlife biology. Again and again in his text, I had the joy of reading passages and case studies which crystallized my own thinking and helped me to understand better both my scholarly work on wilderness and conservation science in the US and India, as well as my personal "elk moment" in Olympic.

In 1964, just as radio telemetry was being developed in the prairies and forests of the American Midwest and the Wilderness Act passed into law, literary scholar Leo Marx published his classic *Machine in the Garden: Technology and the Pastoral Ideal*

in America. Although there is no mention that any of Benson's actors were aware of this book, concerns about the disruptive role of technology and science within the environment were clearly circulating within the US, particularly within the environmental movement. Marx's central theme – the disorienting impact of the introduction of industrial technology in a previously wild or pastoral landscape, and the centrality of this conflict in US culture – would have resonated with scientists and citizens in their debates and discussions about the appropriateness, or not, of radio tracking wild animals in a wild landscape. The explosive growth of the ecological sciences and environmentalism in the 1960s provides the fertile and contentious ground within which Benson's book begins.

Wired Wilderness is tightly organized around four case studies, each a substantial chapter: the first on the atomic age beginnings of radio telemetry, focused on two field stations in Minnesota; the second on the Craigheads' radio collaring of grizzly bears, particularly in Yellowstone; the third on the Smithsonian-Nepal Tiger Ecology Project; and the last focused on debates about the radio tracking of cetaceans (principally Orcas). In each case study there are people and institutions arrayed in a range of positions concerning radio telemetry technology, from advocacy to opposition (primarily scientists, but also the Office of Naval Research, the Smithsonian, Sea World, NSF, engineers, eco-tour operators, reserve managers, politicians, and environmental activists, among others). The advocates saw radio telemetry as a method for improving the state of wildlife biology and as an essential tool for more effective management of often imperiled species. In opposition to this position, others perceived the radio collaring and tracking of wild animals as an act of domestication, or destruction of wildness – an unwelcome machine in the garden.

Benson is not alone in contemporary scholarship considering these themes, as he acknowledges in his extensive notes and a helpful essay on sources. In addition to historians such as Peter Alagona (whose work on condor conservation illuminated similar conflicts between those who supported captive breeding to save the species, versus those who advocated letting the last condors live – and die – free) and social theorists such as Donna Haraway, many philosophers and activists consider these questions in what are sometimes called "the wilderness debates." Philosopher David Johns, in as essay for *The Great New Wilderness Debate*, wrote eloquently of the danger of the enlightenment project of setting human rationality above nature. At root, Johns (and many other US deep ecologists) are skeptical of the scientific attempt to study, and then manage, nature – they perceive this as a form of domination destined to fail. Benson's carefully documented study has much to offer here, as he grounds these wilderness arguments in places such as Yellowstone and Denali, and argues that wilderness absolutism is "only one thread in a much broader tapestry."(4) When he discusses the debates about tagging elk and bears in Yellowstone (for instance), he does so in a context rich narrative that shows that wilderness rhetoric could be mobilized for a variety of reasons and in the interest of a number of particular political situations – such as the necessity of presenting a wild Yellowstone to international visitors when hosting the 1972 Second World Conference on National Parks. (83)

As with all successful books, *Wired Wilderness* left me wanting more. The book ably described the debates surrounding the development and use of radio telemetry. Through extensive work in archives and oral histories, Benson has documented how this technology was created and understood. The actual science that was accomplished through radio telemetry was less thoroughly discussed or analyzed. Were there scientific breakthroughs associated with the use of this technology? Were there classic papers that significantly advanced what was known about particular species or about ecology more broadly, besides papers that popularized the technology to a larger audience, or that simply showed other scientists that the technique was possible? In sum – was the technology a legitimate improvement in the state of the science, on its own terms? Or was it, as Benson reports one critic claiming, lacking in basic scientific questions, and ultimately just fancy natural history (39), or used as a "sign of the modernity and sophistication of [scientists'] work" (50)? Or even worse, as a critical Nepali scientist claimed (with regard to rhinos), had scientists "been diverted by the glamorous work of radio-tagging and tracking" away from more crucial and basic goals of understanding the overall ecosystem, particularly through studies of herbivore impact on plant distribution (133)?

Benson reports these critiques, but in most cases does not choose to adjudicate their validity. Many an environmental historian has complained of histories of science that are completely internalist, focusing on the gradual or triumphal development of particular scientific ideas, with little or no attention to the larger cultural/social/political context in which that science was produced. This history goes in the other direction – it is impeccably focused on the various external contexts in which radio tracking science occurred, the human actors involved, and its larger cultural resonance. But I was left uncertain of the scientific (as opposed to cultural or political) impact of radio tracking. I recognize that this was by design – at no point does this book advertise itself primarily as a history of science. But I think that its arguments about "the making of modern wildlife" would be strengthened by attention to a few examples of the specific types of scientific knowledge that these studies generated, and how that knowledge became part of what society "knows" about those animals, or conversely, how radio tracking distracted ecologists and wildlife biologists from research that would have "made" the wildlife in different ways. It would be difficult to walk this line without using a normative vision of science, but a focus upon impact within the existing paradigms might have been possible.

Each of Benson's four case studies can be read independently, though the additive benefit from reading them sequentially makes this strategy less than optimal. Nonetheless, I could not resist reading his case study on the Smithsonian-Nepal Tiger Ecology Project first, and then later in context with the rest of the book. It was good both times – and I have recommended it to colleagues in India. Benson is to be congratulated for adding this transnational case study to his book. The quality of this chapter led me to desire even more explicit attention to non-US actors and

trans-border science elsewhere in the book. In the cold war, were there restrictions on the export of this technology to other countries? How was this technology received in other national contexts? Benson explains well the prohibitive cost of early radio telemetry projects, which would have prevented many developing world scientists from adopting the technology, but did European scientists adopt this technology in the 60s, 70s, or 80s? Did the Craigheads ever work in Canada? How did the non-US scientific discussions differ from those in the US? For Benson's case study on cetaceans, he does describe some developments in British Columbia, particularly with an aquarium in Vancouver, but what was the larger Canadian or European response to radio tracking Orcas? Was the US Marine Mammal Protection Act unusual or typical of Western democracies? In an intriguing multi-page discussion of the "Free Willy" phenomenon, Benson describes Keiko's eventual fate in Iceland and Norway, where the attempt to rehabilitate Keiko was largely funded by a US billionaire (179-188). This would have been one potential place to focus more upon cross-cultural comparison – how did nationality matter in debates about technology and border-crossing "wild" whales as symbols of wild nature, especially in these two whale-hunting cultures? I understand that I am outlining practically a new research project – so perhaps these thoughts could be filed under "future projects" – but I persist in thinking that more cross-cultural comparison of responses to radio telemetry could be interesting in follow up work. This would help to specify what might be specifically "American" about the radio-tracking debates that Benson describes, and what was more a shared response to modernity, science, and industrialization.

Finally, as Benson points out, the Office of Naval Research was one of the most important funding sources for the development of radio tracking technology. Benson also points out that the Smithsonian accepted Department of Defense funding for the Pacific Ocean Biological Survey, and that military funding of basic ecological sciences was fairly common in the 1960s and 1970s. In my own work, I found that many Indians assumed that radio telemetry was in some way an arm of American military power – most famously when a crocodile with a US radio transmitter floated from Nepal across the Indian border and made local headlines as a new and nefarious CIA plot. Again, a full analysis of the military links with the development of radio telemetry is a large project, but as much information as Benson can uncover on this intriguing topic would be welcome. This seems like an obvious entry point to the military-industrial-scientific complex in the cold war, insofar as it influenced the ecological sciences. Radio tracking is a space-age technology, but it is also a military technology. Benson acknowledges this at several points in his text, but I would encourage him to be even more explicit in analyzing the importance of this strand of his story. I suspect that this would also shed additional light on the trans-border aspects of this story, as in the paragraph above. The archival sources needed for this might not be forthcoming now, or in the near future, but at some point in the future this will be an important additional study.

I would be remiss if I did not draw attention to Benson's superb concluding pages. In these last five pages, he is more speculative in considering the impact of instantaneous radio tracking data posted on-line, and used as a form of scientific and environmental outreach. This phenomenon is one manifestation of the popular citizen science movement in the US. Benson also suggests that the American public has embraced radio telemetry in part due to a more widespread cultural acceptance of the ubiquity of human-influenced environments: "If 'pool' is taken as a metaphor for a human-constructed environment, all killer whales were in pools, and they all could potentially benefit from the kind of continuous surveillance and intervention that radio tags made possible." (188) In a world in which human populations are increasingly resigned to surveillance by video cameras, satellites, and even drones, perhaps it is not surprising that there is greater tolerance for radio tracking of wild animals as well. The panopticon is not just for people anymore.

Comments by Robert M. Wilson, Syracuse University

Wildlife radio tracking—the subject of Etienne Benson's new book—has a prized place in my childhood memories. One of my distant relatives was a wildlife manager with the New Mexico Department of Game and Fish. He occasionally showed up at Christmas parties and other family gatherings in a cowboy hat and boots; his outfit alone made him far more interesting than the other adults around. He impressed me even more when he had a small but pivotal role in Mutual of Omaha's *Wild Kingdom*, the long-running TV series hosted by Marlin Perkins and his assistant Jim Fowler. In the episode "Elk Drive" (1984), my relative corralled elk from the passenger seat of a helicopter, which through the pilot's skillful flying, directed sprinting elk into a quarter-mile long net erected by department personnel.[5] Men descended on the captured elk, sedated it, and affixed a radio collar. The episode came to a close with the elk released—physically unharmed, but probably a bit traumatized by the experience. The result of all this activity, host Perkins assured the audience, was a better understanding of the lives and movements of elk, and in turn, better game management.

As a boy, I thought this was all pretty cool. The episode combined my fascination with wildlife and my interest in helicopters specifically and technology more generally. Watching the video recently on YouTube, I felt a bit uneasy. Was it really necessary to drive these elk at breakneck speed into tall nets and then wrestle them to the ground? What sort of data did they get from the radio-collared elk? Was it worth all the money, time, and distress for the animals? In short, while the show was exciting to watch, did radio tracking wildlife yield good science and did it lead to better management of these animals?

These are the sorts of questions at the heart of Benson's *Wired Wilderness*. He shows how concerns about intervening in the lives of animals and the data obtained from radio-collared wildlife were a source of tension since the method was first developed about fifty years ago. Benson shows how radio tracking was a child of the Cold War. Technological developments, in part spawned by military research, had led to the creation of small transmitters that biologists could attach to deer, bears, and even small birds without affecting their movements. (Or so wildlife researchers argued. Benson shows that some biologists worried that the transmitters altered animal behavior, and as a consequence, sullied the data these animals were

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[5] "Mutual of Omaha's Wild Kingdom : Elk Drive," YouTube video, 22:24, posted by "WildKingdomTV," December 21, 2010, http://www.youtube.com/watch?v=pX5RwYgugPg. Gregg Mitman discusses the *Wild Kingdom* series and Marlin Perkins' other animal shows in *Reel Nature: America's Romance with Wildlife on Film* (Seattle: University of Washington Press, 2009 [1999]), 132-156.

supposed to generate in the first place.) Researchers erected large towers with radio receivers, which in effect, turned the landscape the birds traversed into a vast outdoor laboratory. Some biologists worried that such research diminished the value of first-hand field observation, and they argued that radio telemetry studies could never replace watching the animals in the field.

Through a series of case studies, Benson shows the fate of remotely tracking wildlife as a scientific method. He tells the story of John and Frank Craighead, twin brothers who became famous for radio tracking grizzly bears in Yellowstone National Park. Tracking grizzly bears proved a particularly thorny public relations problem for the National Park Service. Did tracking the bears somehow tarnish their wild qualities? Was such research compatible with the wilderness character of Yellowstone? Esteemed wildlife biologist Adolph Murie thought it was acceptable to collar and track Yellowstone grizzlies; feeding at the park's garbage dumps had already "contaminated" the bears (*Wired Wilderness*, 61-63). The grizzly bears of Mt. McKinley National Park, on the other hand, remained truly wild. Attaching radio collars would compromise their wild character.

In his final two chapters, Benson explores the fate of radio tracking in different contexts, both politically and ecologically. Remotely tracking wildlife allowed researchers to follow the movements of wildlife, but the technology and methods travelled, too, most notably, Benson shows, to Nepal. There, American and Nepalese scientists caught, collared, and tracked endangered tigers. In post-colonial India and Nepal, the challenges of tracking tigers had less to do with the animals themselves than with the conflicting agendas of the different participants involved in the research, which at various times included the Smithsonian Institution, World Wildlife Fund, International Union for the Conservation of Nature, as well as Indian and Nepalese researchers. Challenges also abounded as scientists sought to employ radio telemetry to study marine mammals. Tagging animals such as killer whales proved very difficult, and animal rights groups protested the practice. This dynamic of technical hurdles, recalcitrant animals, and a public wary of disrupting animals for this sort of research is a recurring feature in Benson's story.

Wired Wilderness is a deeply researched, empirically-rich study. The book would have benefitted in the introduction and conclusion, and at various points throughout the text, from a richer discussion of why scientists embraced radio tracking. For instance, Benson devotes little space to discussing the history of other ways of tracking wildlife movements, such as banding birds or tagging fish such as salmon.[6] These are two methods with long histories. Indeed, I would suspect it was the

[6] For example, see Robert M. Wilson, *Seeking Refuge: Birds and Landscapes of the Pacific Flyway* (Seattle: University of Washington Press, 2010), 72-75 and Matthew Evenden, *Fish Versus Power: An Environmental History of the Fraser River* (New York: Cambridge University Press, 2004).

perceived deficiencies with these approaches that probably led wildlife scientists to adopt radio telemetry. Also, the book's main chapters are quite discrete. There's little transition from one case study to another, so it's difficult to see how the history examined in one part of the book informs the history in another.

Political ecologists in geography and environmental historical geographers such as myself would see Benson's story as one chapter in the development of environmental governance strategies in the twentieth century. Drawing in various degrees from the work of James Scott and Arun Agrawal, these scholars see modern wildlife mangers as deeply concerned with making resources legible.[7] Scott shows how foresters in a sense created the modern forest through surveying, mapping, and assessing timber. Such assessment is absolutely essential for managing mobile populations, be it salmon, waterfowl, grizzly bears, or killer whales. To manage them, wildlife scientists had to convert the animals they studied (at least the ones they could catch) into data machines. These interventions into the natural world and the knowledge they help generate are part and parcel of modern resource management. In this way, the making of the modern state and modern wildlife went hand in hand.

No doubt, my relative in the helicopter on *Wild Kingdom* would have found it puzzling to learn he played a key role in the state's environmental governance project. But the show highlighted, and as Benson does so well in *Wired Wilderness*, the inherit contradiction in using the most sophisticated of technologies to preserve the wildness of North America's animals and their habitats.

[7] James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998) and Arun Agrawal, *Environmentality: Technologies of Government and the Making of Subjects* (Durham, NC: Duke University Press, 2005).

Author's Response by Etienne Benson, Max Planck Institute for History of Science

On a humid summer evening in 2006, I joined a small team to search for turtles in the Great Meadows National Wildlife Refuge, which stretches along parts of the Concord and Sudbury Rivers outside of Boston. The team consisted of employees of a local environmental consulting company hired by the town of Concord a few years earlier to study and protect the refuge's population of Blanding's turtles, which had been declining since the 1970s. During the nesting season, employees of the company monitored the turtles' movements, recorded causes of mortality, and set up protective fences around egg-laden nests, which were sometimes plundered by raccoons and dogs. Their monitoring work had revealed that many female Blanding's turtles never even got to the point of laying eggs; instead, moving away from the wetlands in search of dry ground, they were crushed by cars on the roads surrounding the refuge. Like most such refuges, Great Meadows was intimately connected to the landscape surrounding it.

I didn't see any Blanding's turtles that evening, living or dead, but I did hear them on the radio. Several dozen of the refuge's turtles had been fitted with radio-tags, each broadcasting on a unique frequency. After walking some of the refuge's trails, we stopped near a municipal wastewater treatment facility to try to triangulate the turtles' signals. At first, holding the receiver in my hand and rotating slowly with the tip of the antenna pointed toward the horizon and the tines parallel to the ground, I picked up nothing but the whine of interference from Hanscom Air Force Base, located a few miles east of the refuge. Hanscom is the home of the Electronic Systems Center, whose mission is to provide the Air Force and its partners with the "latest command, control, communications and information systems." Standing a few miles from where Henry David Thoreau had lived in a one-room shack a century and a half earlier, the entangled history of nature protection and cold war science and technology was difficult to ignore.

After rotating the tines of the antenna by ninety degrees at the recommendation of one of the members of the team, I managed to pick up a faint beep through the static in the direction of the wetlands at the heart of the refuge. We noted down the location and moved on to the next frequency. During an evening spent amid the sounds of buzzing insects, the hum of distant traffic, and the crackling static of the radio-tracking receiver, that beep was the only evidence I had that Great Meadows still harbored the Blanding's turtle, although I was told that it was not unusual to encounter a turtle in the flesh. As we scrambled up dirt piles and squelched through meadows, one of the team members, with palpable frustration in his voice, told me about a local resident who had recently discovered a radio-tagged turtle resting along one of the refuge's trails. Believing the turtle to be in distress, she had removed the tag and turned it in to refuge authorities, thereby rendering that turtle once more anonymous, untrackable, unprotectable.

It was this messy world of field research on wildlife and endangered species, with its human and nonhuman actors, thorny ethical brambles, local practices, embodied knowledges, and misunderstandings among scientists, conservationists, and animal lovers, that I tried to depict in *Wired Wilderness*. I am grateful to Sara Dant, Michael Lewis, and Robert Wilson for their generous commentaries on the book and to Jacob Darwin Hamblin for organizing the roundtable. It has given me a welcome opportunity to think again about some the book's themes and to assess some of its strengths and weaknesses.

As several of the commentators suggest, *Wired Wilderness* can be counted among the numerous responses to the debate set off by William Cronon's essay on "The Trouble with Wilderness" and other critiques of the American wilderness ideal that emerged in the 1990s. In the wake of these critiques, radiotracking seemed to offer a way of examining the tension between visions of a pristine, untrammeled nature that needed to be protected from civilization and the gritty work of actually protecting it. In the late-twentieth-century United States, the latter seemed to me to have become an extraordinarily technocentric and often technocratic practice. By tracing the technique's history, I hoped to show how a community of people who cared deeply about the preservation of wild animals and places came to place much of their hope in technologies of surveillance and control. As someone trained in science and technology studies, I felt this was an important factor that had been neglected in the voluminous literature of the "great new wilderness debate."

In retrospect, the decision to structure each of the book's chapters around a few key species and places had the disadvantage of sometimes obscuring the larger narrative, as several of the commentators note. I chose it because it allowed me to show just how very messy, contingent, and place- and species-specific research in wildlife biology has been. To select the particular cases, I conducted oral history interviews and searched in archives for evidence that would allow me to reconstruct these messy histories in detail. Although there is some overlap between the chapters, each moves the narrative progressively forward from the 1950s to the 2000s and each addresses a different set of themes. These include, roughly in order of appearance, the ideology of wildlife management, cold war science and technology, science in national parks, the wilderness movement, international wildlife conservation, postcolonial conservation biology, and the representation and regulation of field biology in legislatures, courtrooms, and the popular media.

Or at least these were the themes I hoped that readers would recognize underneath the stories about ruffed grouse, grizzly bears, Bengal tigers, and killer whales. I agree with the reviewers that more explicit framing of these themes would not have been amiss, and in several articles published since *Wired Wilderness* I have tried to provide some of that framing.

One chapter was perhaps especially in need of more framing than it ended up getting: the chapter on tiger research in India and Nepal, which both Dant and Lewis

single out, albeit for different reasons. (I should note that Lewis's *Inventing Global Ecology* was extremely helpful to my writing of this chapter.) Although it is the only chapter with a focus outside of the United States, it was not an afterthought or a throw-in. Early on in the project, I realized that the involvement of American biologists in conservation outside of the United States, particularly in the economically poor but biological rich parts of the world, was an essential part of the story. At its worst, American conservation biology fetishizes both technology and uninhabited wilderness, and as a raft of works in political ecology have demonstrated, American conservation biology has often been at its worst outside of the United States. Radiotracking is a small piece of this broader story. In many places, the technique symbolized not merely technological and modern solutions to wildlife conservation problems but also foreign, Western, and specifically American solutions. I wanted to show how what Ramachandra Guha famously described as "authoritarian biology" looked liked on the ground, where globe-trotting biologists from the United States and other rich countries were inevitably forced to work with, or around, local people and authorities.

Lewis is right to suggest that there are many other important "trans-border" stories that go untold in *Wired Wilderness*, and I hope that I or someone else will have the chance to tell them at some point. Nonetheless, although I can imagine writing, and sometimes wish I had written, a less U.S.-centric book, I still believe that the history of radiotracking cannot be disentangled from the very American idea that so-called pristine wilderness and wildlife can best be preserved through the deployment of complex technologies and armies of experts. Americans were not the only ones to believe in this idea, of course, but they believed in it with unusual fervency and had the wealth, power, and expertise to put it into practice on a grand scale.

On the subject of the Americanness of this story, I was happy to see Lewis's mention of Leo Marx's *The Machine in the Garden*, a landmark work in American studies that was written at about the same time that wildlife radiotracking was being invented. Marx co-taught the first seminar on the history of technology that I took as a graduate student at MIT, and, while my approach in *Wired Wilderness* is a long way from his, I was interested in some of the same questions. Lewis is right to suspect that some of the biologists who appear in the book were interested in them too. One biologist involved in developing some of the first radiotracking collars in the early 1960s told me that he had intended to pursue a graduate degree in American studies at the University of Minnesota, where Marx taught in the 1950s, before the need for a steady income to support his family pulled him back to wildlife biology. In the papers of another, I found a careful evaluation of a manuscript that Marx had submitted to *Science* in the early 1970s on the responsibilities of scientists in the face of the ecological crisis. (The reviewer was critical of the article's occasionally "biased and reproachful" tone but thought it was nonetheless worth publishing.) Other examples of shared concerns among biologists and cultural critics would be easy to find.

Just as Marx and other proponents of a contextual approach to American literature were sometimes accused of ignoring formal concerns, I stand accused of ignoring the scientific motivations for and consequences of radiotracking. I plead mostly guilty, with caveats. *Wired Wilderness* focuses on the situated practice of radiotracking and on the technique's broader cultural and political significance. It says relatively little, although not nothing, about the nature of the knowledge produced using the technique or the broader scientific context that made that kind of knowledge particularly alluring. But as both Lewis and Wilson note, wildlife radiotelemetry was not just a vision, a symbol, a technology, or a source of diplomatic tensions, and it did not emerge from a scientific vacuum. It was also a method of producing knowledge that was enormously attractive to many scientists for reasons that were rooted in the history of biology and ecology in the twentieth century, and it built on and was used together with a number of other technologies of tracking. Wilson's book *Seeking Refuge*, which describes the history of waterfowl refuges and the science of waterfowl migration in North America, provides some of the context necessary for understanding this history.

Much work remains to be done to understand the scientific motivations for and consequences of a dramatically improved ability to continuously locate moving bodies in space in the twentieth century. One of the challenges in elucidating the scientific impact of wildlife radiotracking or other tracking techniques is that there is no one classic paper or small set of papers in which these techniques were used to make an important new biological discovery. Radiotelemetry was often used simply as an aid to compiling life histories of particular species or as a method for relocating animals in the field, where they could be studied using other methods. This was important and very useful work, essential to the practical decisions of wildlife managers and conservationists, but it was often as theoretically thin as it was empirically and methodologically rich. Even so, it seems clear to me now that *Wired Wilderness* underemphasizes the intellectual stakes of radiotracking. If I were writing it now, I would include more about the history of biological ideas of home range, territory, and migration, all of which helped motivate the development of new tracking techniques.

The commentaries raise a number of additional questions and themes that would be well worth pursuing if space allowed, but for the sake of keeping this response to a reasonable length I will focus on the two that seem to me most important: environmental governance and the ethics of wildlife research.

As Wilson notes, geographers and anthropologists have come to see tools such as radiotracking as part of a broader effort to render nature and human societies "legible." More specifically, radiotracking can be seen as one of many tools for "managing mobile populations," as Wilson nicely puts it. I find this phrasing particularly felicitous because "population" is broad enough to include many kinds of mobile beings, including humans. I intentionally left the history of the human surveillance and tracking out of *Wired Wilderness*, concerned that it would distract from my focus on wildness and wilderness. I now think that may have been a

mistake, even if including that history would have led to a very different book. While relatively few humans were involuntarily outfitted with radiotags and other tracking devices, many techniques and concepts of population surveillance and management traveled freely across the human-animal divide in the twentieth century, and many decisions were made with both humans and animals in mind. Maintaining an artificial divide between these closely related biopolitical histories is, I'm now convinced, not helpful to our understanding of either.

Nor do I think, incidentally, that the model of the panopticon is much help here, although like Lewis I have sometimes used the term when talking about radiotracking, usually to try to grab the attention of colleagues who are more interested in Foucault, Facebook, or the FBI than they are in wildlife. Unlike the prisoners in Bentham's design, wild animals are unlikely to be aware that the radiotags attached to them are mechanisms of surveillance, and they do not internalize their own oversight, at least not in the ways Bentham's inmates were supposed to. It might help conservationists (and ranchers) if radiocollared wolves would refrain from preying on sheep because they knew they were being tracked, but so far it has not turned out that way. Nonetheless, systems of pervasive, continuous, invisible surveillance transform the conditions and quality of their lives, just as they do those of numerous humans. *Wired Wilderness* was meant to show in detail how one such system was constructed and contested.

This leads me to the important question of the ethics of radiotagging. I would agree with Dant that one of the main themes of *Wired Wilderness* is the "ethics of using technology in the study of wildlife." My only qualification would be that all three of the key terms in this phrase—ethics, technology, and wildlife—deserve critical examination and historical contextualization. For example, as I have written elsewhere, "wildlife" is a term that only came into wide use in English in the 1920s and 1930s, that has no clear equivalent in most other languages, and that carries with it a number of assumptions about the proper relationship between humans and the fuzzy set of living beings that it picks out. One of these assumptions is that wildlife is a thing, or a set of things, that is amenable to management. In this sense, the category of "wildlife" was always technological, always modern. Wildlife radiotracking only made it obvious.

The concept of technology also needs to be handled with care. For example, although the idea that technology is inherently opposed to nature drove many of the wilderness-oriented critics of wildlife radiotracking, there is a long tradition of thinking of nature and technology as compatible or even inseparable. Figures like the Craighead brothers, who thrilled as much to the beep of a grizzly's radiocollar as they did to the honk of a migrating goose, should be seen as part of this tradition. For the Craigheads, it would have made little sense to speak of "balancing" the loss of wildness against the knowledge gained, since they understood grizzlies as creatures who had been living among humans and their technologies for thousands of years. Radiotracking was certainly a new and different technology, but it was no radical break. Although I am sympathetic to the wilderness purism of someone like

Adolph Murie, who fought to pull wildlife biology back from the technocratic brink, I find the Craigheads' vision ultimately more compelling. Since all of our interactions with wild animals are technological in some sense, there is no real difference between the "ethics of using technology in the study of wildlife" and the "ethics of studying wildlife" *tout court*.

Having spent an unreasonable amount of time thinking about the tiny radios that humans have strapped to, glued onto, implanted in, or otherwise attached to animals in order to keep track of their movements, I'm convinced that this technique is more diagnostic than distinctive. That is, it is important not because it is unique but rather because it makes visible an assumption that shaped American approaches to wildlife conservation and many other areas of nature protection or environmentalism in the early twentieth century. The assumption is that the only way to "save nature" is to bring it under ever-closer surveillance and ever-finer human control, using all of the scientific and technological methods available. This way of thinking is continually resurfacing in discussions of climate engineering and other areas of current environmental concern. My hope for *Wired Wilderness* is that it contributes something new to the ongoing discussion of the strengths and limits of such an approach.

I've occasionally been asked whether I'm for or against wildlife radiotracking, a question which I did my best to avoid answering in *Wired Wilderness*. For what it's worth, I think that radiotracking does not necessarily undermine the wildness of animals or places and can indeed help to preserve it, and that hands-on research techniques, when they are used with respect and care, can be just as ethical and humane as hands-off techniques. At the same time, the value of knowledge in wildlife conservation seems to me to have been highly overrated, not least by people who make their livings producing such knowledge, and radiotracking has clearly sometimes been used in ways that are inhumane and that hinder rather than help the conservation of wildlife and wilderness. The technique has a vital role to play, but I'd be happy to see it used less, and more carefully. The devil, as I tried to show in *Wired Wilderness*, is in the details.

About the Contributors

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