CHAPTER 1

JOINING ENVIRONMENTAL HISTORY WITH SCIENCE AND TECHNOLOGY STUDIES

PROMISES, CHALLENGES, AND CONTRIBUTIONS

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This edited volume is the product of recent dialogue within and between the fields of environmental history and science and technology studies (STS). It is also the outcome of a workshop that examined one piece of this larger intellectual puzzle: how perspectives gleaned from STS might facilitate and ultimately extend the contributions of environmental history. Indeed, disciplinary hybridity has marked the professional identities and trajectories of the three editors of this collection (not to mention many of the authors whose chapters are included here). We self-identify as environmental historians who were also trained and publish in the history of technology and science and technology studies. At the beginning of this project, we all held positions in STS departments.

Although there has been growing interest in how environmental history and science studies have engaged with and can contribute to one another, and stimulating scholarship has begun to develop at their nexus, we were interested in fostering more explicit theoretical dialogue between the fields. In particular, we wanted to think deeply about the ways in which our skills, developed from our experience in these fields, could enhance our work as environmental historians. For example, how might fundamental STS tenets

such as knowledge production as a social process, the politics of professionalization, and negotiations over expertise help us gain a richer understanding of how "the environment" is constructed, perceived, contested, and (re)shaped by historical actors? How might unpacking the processes of knowledge making and technological development illuminate human interactions with nonhuman nature and therefore enrich our analyses of those relationships? Most broadly, how might conceptual STS tools such as black boxes, boundary-work, and technological systems offer insights that enable, but also deepen and sometimes even transform, our understanding of past human-natural interactions? The title of this book, *New Natures,* seeks to suggest how new natures emerge from studies that join environmental history with science and technology studies.

From the very outset, then, this project has been premised on an asymmetrical relationship between environmental history and STS. Indeed, it is appropriate that we here use the concept of symmetry to frame the dynamic between the two fields, since it is basic to STS.[1] Yet in framing the disciplines and their relationship in this way, it is essential that we make two crucial caveats.

First, we acknowledge that we are certainly not the first scholars to engage STS in the writing of environmental history. To the contrary, as I have already suggested, this volume builds on conversations within and between the fields that emerged during the 1990s and 2000s. During those years, a number of conferences, publications, and institutional changes not only reflected but also fostered growing interest at the intersection of STS and environmental history, both relatively new fields.[2] Conference panels at the American Society for Environmental History, the History of Science Society (HSS), and the Society for the History of Technology (SHOT) explored these concerns empirically and analytically. In 1997, the theme of the Max Planck Institute for the History of Science's Summer Academy was "Nature's Histories," which focused specifically on the history of science and environmental history. Influential monographs such as Gregg Mitman's *The State of Nature,* Robert Kohler's *Lords of the Fly,* Conevery Bolton Valenčius's *The Health of the Country,* Michelle Murphy's *Sick Building Syndrome and the Problem of Uncertainty,* and Linda Nash's *Inescapable Ecologies,* among others, made crucial interventions in these discussions.[3] Meanwhile, hybridity and actor-network theory had become increasingly prominent within environmental history.[4] Research at the intersection of science, technology, and the environment eventually became institutionalized within subspecialties affiliated with relevant professional organizations. In 2000, James C. Williams and I cofounded Envirotech, a special-interest group within SHOT; the Earth and Environment Forum, a parallel group within HSS, was officially established the following year.[5] Meanwhile, several PhD programs further

institutionalized the convergence of the fields, while environmental history began to have a stronger presence in some STS departments.[6] As this brief overview suggests, significant dialogue, scholarship, and professionalization efforts have emerged over the past two decades. This volume therefore both reflects the conversation thus far and seeks to develop additional contributions.

Second, readers familiar with even a few of the authors, publications, and professional communities mentioned above will already know that intellectual traffic between the fields has not been one-way—far from it. Scholars trained in STS and particularly those specializing in the history of science, technology, and medicine have enriched environmental history; but environmental historians have also offered critical insights to those working in science studies.[7]

Thus, although the scholarship in this volume, like that of authors not included here, is predicated upon the productive, synergistic effect of integrating environmental history and science and technology studies, ultimately we decided to retain our original goal: a focused, sustained discussion of how concepts, methods, and approaches taken from STS might develop the aims, narratives, and insights of environmental history. In other words, this volume foregrounds the contributions of STS to environmental history, even as we, editors and authors alike, assume in our larger work that they inform and enhance one another. To borrow another concept from STS, individually and collectively, we work from the assumption that the disciplines have shaped—and should shape—one another.[8] However, the chapters in this collection isolate and develop one part of that reciprocal relationship.

ENVIRONMENTAL HISTORY'S CONTRIBUTIONS

As an introduction to the heart of our discussion, it is worth highlighting some of environmental history's established insights writ large, with an eye to examples of their relevance to STS. Put another way, this section briefly shifts foci: it summarizes the background, given the foreground stated earlier, to the rest of this collection.

One foundational contribution of environmental history is that human perceptions of and interactions with nonhuman nature are valuable objects of historical inquiry. One might say that environmental historians helped put nature into the past (history), as well as into studies of the past (historiography).[9] Furthermore, environmental historians have offered detailed understandings of the ways in which influential historical phenomena such as capitalism, consumerism, and industrialization are modes of production or cultural values predicated not solely on social relations but also on assumptions about the environment and particular relationships between humans and the natural world. By doing so, environmental historians have shown

how human-natural interactions are fundamental to what are often seen as purely "social" processes.[10] In the process, they have exposed intended and unintended consequences for both humans and nonhumans.

Environmental history has also invited us, scholars and citizens alike, to consider how natural entities and processes are not only legitimate objects of historical study but also important factors that shape historical phenomena, an idea often abbreviated as "nature's agency": even if, as several scholars have ably demonstrated, human agency is a problematic notion, the "nonhuman" is actually entangled with the "social," and human knowledge always mediates our representation and understanding of the natural world.[11] Recent events such as the triple disaster at Fukushima drive home the point. Of course, the development of nuclear power in Japan and the government's regulation of TEPCO (the owner of the fated nuclear reactors) are crucial to understanding exactly how events began to unfold on March 11, 2011. Yet the massive earthquake and destructive tsunami are also key, and environmental historians push us to remember this vital point: not all historical contingencies emanate from humanity.[12] To recall this insight is not just an academic exercise. Stressing the presence and dynamics of the natural world in human history has the potential, for instance, to alter the selection, design, and use of technologies and to shape policy making.[13] One of environmental history's most valuable contributions, then, has been to call attention to the role of the material world—from genes and organisms to disease and hydrology—in shaping the past. As such, our accounts of historical processes need to change, and to some extent have already changed, accordingly.[14]

However, environmental historians have also convincingly shown how "natural" entities and processes like these have, in fact, usually been mediated by human activities. Native Americans shaped the evolution of corn and cotton in the so-called New World, while flies, mice, dogs, and viruses were carefully selected and bred to facilitate scientific and medical research.[15] These examples thus highlight another central premise of the field that is also one of its most important contributions: the *reciprocal* dynamics between human and nonhuman nature. Edmund Russell's recent analysis of the ongoing interplay between human choices and evolutionary processes in antibiotic resistance offers an excellent illustration of these dynamics at work. Indeed, as his example shows, that very reciprocity calls into question tidy categories and entities. It also challenges simplistic representations of causality. Overall, environmental historians have shown how the terms *human* and *nonhuman nature* are convenient yet also problematic abbreviations for much more complicated objects that encapsulate the complex, dynamic, ongoing interactions between people and the environment.[16]

Placing such complexity at the center of historical analyses, rather than

relying on a reductive understanding of the past, is one of environmental history's real strengths. Using ecology as both science and metaphor has been one important tool for environmental historians to achieve this goal. Indeed, ecology has been especially influential within the field.[17] There are several probable explanations for this pattern, including the field's strong political and moral origins, particularly its ties to late-twentieth-century environmentalism and the relevance and utility of the ecological sciences in helping to delineate, understand, and explain environmental change—and humans' role in it—over time.[18] Moreover, because ecology is fundamentally about dynamics and interrelationships, rather than seeing things in isolation, as metaphor, it has offered a particularly useful way to describe such complex, ongoing dynamics of reciprocal shaping that many environmental historians seek to capture in their studies.[19] While ecology as science and metaphor aids environmental historians in their work, I also suggest several cautions regarding this practice later in this chapter.[20]

A final contribution I will emphasize here is the broad temporal and spatial scale of many environmental histories. Environmental historians often tackle big issues and write "big histories."[21] This is not to imply that other historians or STS scholars shy away from significant, "meta" processes such as imperialism, slavery, capitalism, industrialization, or the emergence of the atomic age.[22] Nonetheless, many STS studies use specific, bounded sites or communities of knowledge production to delineate their analyses. Some of the field's earliest contributions, for instance, emerged from rich, fine-grained studies of individual laboratories and specific scientific controversies.[23] William Cronon's influential books *Changes in the Land* and *Nature's Metropolis* are emblematic (and, needless to say, exemplars) of the ways in which many environmental historians have taken up wide historical and geographical scales in their analyses. Other scholars across the field's forty-year history in the United States reinforce the point. Alfred Crosby's influential *Ecological Imperialism* spans several centuries and several European imperial powers. More recently, David Blackbourn has shown how managing water was central to the making of modern Germany, and Russell's *Evolutionary History* uses evolutionary theory to help explain human history over *la longue durée*, in the broadest sense of the term. Clearly, these are not microhistories.[24]

Together, these insights help both scholars and citizens understand the roots of contemporary environmental dilemmas, in the process deepening yet simultaneously transforming our understanding of the past. They have also enriched historical and contemporary studies of knowledge making and technological development in several important ways. Environmental historians have begun to show how human-natural interactions both shape and are shaped by knowledge and technical change. Environmental history's

interest in "nature's agency" has also called attention to the ways in which nonhumans such as biological organisms literally matter in the practice of science, technology, and medicine.[25] In addition, the field's commitment to nature as a material object has pushed scholars to refine social constructivist approaches, inviting them to consider the materialization of ideas and assumptions, as well as the ways in which the material world constrains what can be known.[26] These contributions, along with hybridity and complexity, are some of the vital contributions of environmental history.[27] With this overview of the collection's background, let us return to its focal point.

THEORY AND ENVIRONMENTAL HISTORY

In organizing this edited volume, we sought to engage *explicitly* with theoretical approaches and concepts developed in STS. Each author in this collection uses a particular analytical tool or school of thought to frame the study and ultimately deepen the analysis. Thus, while the empirical research and historical analyses in these chapters are contributions in their own right, the volume has been conceptualized and organized primarily in terms of how the authors engage with key STS theories, in an effort to elaborate the wider implications and contributions of these concepts to environmental history as a field.[28]

Of course, historians, including environmental historians, have developed their own theoretical approaches and conceptual tool kits. After all, history is not the past, but the *study* of that past.[29] As such, theorization is inherent to historical inquiry. Historical analyses are predicated, for instance, upon theories of historical agency and causality. Other historians, such as Joan Scott, have shown how scholars' categories of analysis such as gender alter our understanding of the past. Such categories do not simply add to historical analyses; they can fundamentally transform them.[30] Overall, however, many historians adopt more subtle, implicit theoretical frameworks in their studies and tend to be cautious about generalizing from historical specificity. In many ways, history is a narrative-driven discipline that values a rich elaboration of context and contingency over theoretical arguments that seek primarily to extrapolate generalizations from historical phenomena.[31]

In contrast, the role of theory in science studies, both as a mode of analysis and as an objective of scholarly production, is generally more explicit. Indeed, STS scholars have formulated a number of useful concepts and sophisticated theories to describe the relationship between knowledge and society, and they have sought to use such analytic tools to understand the contested social and historical processes of knowledge making in particular contexts. The influential role of sociology within science studies, particularly during the discipline's early years, may offer one reason for the field's theoretical orientation.[32]

We suggest that using theory more extensively and deliberately can enhance analyses in environmental history in at least four ways beyond the specific insights of a given concept. First, analytic tools can encapsulate and thus *crystallize* the central lessons that emerge from the rich details of empirical studies. For instance, in *Irrigated Eden,* Mark Fiege traces the transformation of agricultural landscapes in late-nineteenth- and early-twentieth-century Idaho. He shows how irrigation networks altered the land. Yet he also demonstrates how these "artificial" systems were imposed on earlier creeks and streams that cut across the landscape. In this sense, irrigation networks associated with early industrial agriculture shaped—but were also shaped by—existing hydrologic processes. Fiege's influential notion of "hybrid landscape" captures this ambiguous, complicated dynamic between nature and culture (and therefore between nature and technology) in few words. Fiege's concept thus emerges from his particular study, yet it offers a way to synthesize and distill those wider insights in an astute shorthand. Various science studies scholars have sought to make parallel arguments through their concepts of hybridity, nature-culture, "nature-cultures," and envirotech.[33]

Second, building off this point, concepts such as hybrid landscape or nature-cultures provide a specific *language* for describing significant yet complicated historical phenomena. In other words, they can help make complex processes, not to mention historians' nuanced interpretations of those processes, more legible and therefore comprehensible.[34]

Third, using theoretical approaches and conceptual tools to frame a given historical case may facilitate *comparative* analysis. To return to Fiege's example, one might contrast Idaho's "irrigated Eden" with irrigation schemes in colonial Sri Lanka, post-1945 France, or nations in the global South "aided" by "technical assistance" during the Cold War, or compare different kinds of hybrid landscapes—from forests and rivers to cities—in an attempt to consider their similarities and their differences.[35]

Finally, adopting specific analytic frameworks makes one's theoretical assumptions *explicit,* rather than implicit. As a leading historian of modern France once declared, all historians have theories; the question is whether they are deliberate and explicit or unreflective and implicit. Making one's theoretical assumptions evident to readers enables them to begin assessing a study's premises and contributions, as well its limits.[36]

However, in conceptualizing the collection as a whole and the individual chapters in this way, we do not seek to reify theory—in environmental history or any other field, for that matter. To the contrary, it would be rather ironic to fetishize theory, especially unreflexively, in a volume that advocates, among other things, paying attention to hierarchies of knowledge, in part because those hierarchies have historically had significant implications for both humans and nonhumans.[37] Rather, as Fiege's book illustrates, the par-

ticularities of an empirical study can foster the reconsideration of existing conceptual frameworks and even spur the development of new analytic tools. The formulation of envirotechnical analysis at the intersection of environmental history and the history of technology offers another recent example of the ways in which empirical and historical studies have driven the formulation of theory, rather than the other way around.[38] In other words, conceptual frameworks and empirical material are always in ongoing dialogue with one another. As Paul Edwards has shown in the case of climate change models, this is certainly true for scientists, but it is true for other scholars as well.[39] Furthermore, it is worth paying attention to the context in which new theoretical approaches and conceptual tools are developed. After all, we, as analysts, are situated as well, and our concepts undoubtedly reflect our own cultural and historical contexts—for better and for worse.[40]

STS'S THEORETICAL CONTRIBUTIONS

To foster this volume's intellectual coherence, we have organized the chapters around three central concerns in science and technology studies. These issues thread through many of the chapters—at times explicitly, at other times implicitly—although they are particularly prominent in the chapters included in their respective sections.

Part I tackles questions of epistemology by examining ways of knowing. Taking knowledge out of the "black box," STS scholars seek to understand and tease out the specific ways and contexts in which knowledge is produced. Below, I discuss constructivism to highlight the social shaping of knowledge production and thus knowledge itself. As such, contextualizing knowledge making stresses how knowledge systems always mediate representations and understandings of the environment.

Part II focuses on constructions of environmental expertise and signals not only the historical emergence and making of the modern sciences, including the ecological sciences, but also how "science" and particularly "expertise" become differentiated from "mere" knowledge. This section therefore examines categories, categorization, and hierarchies of knowledge, all central to the construction of expertise. Such processes matter, in part, because they define whose knowledge of the environment counts and therefore whose ends up forming the basis of environmental policies and practices.

Part III examines networks, mobilities, and boundaries. These themes allude to actor networks, assemblages, and boundary-work, which together highlight the heterogeneity of knowledge systems, as well as the ways that historical actors construct various borders through their work. Part III thus highlights the diverse dimensions of environmental knowledge making and the boundaries that both shape and are shaped by these heterogeneous pro-

cesses. Here I focus on the concept of boundary-work, which helps illuminate both the processes and the stakes of boundary making. The creation, maintenance, and erosion of borders—all central to dynamic and mobile networks—have significant implications for both humans and nonhumans.

Finally, in the epilogue, Sverker Sörlin uses contemporary urban nature to consider the generative, "real-world" possibilities of fully embracing nature-culture, or the deep entanglement of people and the environment.[41]

Constructivism

Nature and ecology are central analytical tools within environmental history that play crucial roles in driving, organizing, and ultimately enriching analyses in the field. Paying attention to the natural world and incorporating knowledge from the ecological sciences have, for instance, helped generate new questions about the past, as well as fresh understandings of historical phenomena and causality.

At the same time, the environment and ecology are historical categories and objects to be examined and understood. In other words, they are not simply unproblematic *explanas*.[42] For instance, Valerie A. Olson demonstrates in her chapter in this volume how astronomers' recent research on "Near Earth Objects" in space led them to radically reconceptualize the boundaries and scale of "the environment." Instead of seeing Earth *as* environment, these scientists reframed the planet within a larger, *cosmic* environment that potentially posed dire threats to it. Olson's analysis offers a particularly powerful illustration of the ways in which concepts like "environment" are situated and historical. Olson also opens up new questions for environmental historians by suggesting how, based on this definition of the environment, environmental history could actually extend beyond the boundaries of planet Earth.[43]

Dolly Jørgensen's chapter examines a critical implication of the environment's constructed character: multiple understandings of the "same" nature. In her analysis of the recent "rigs-to-reefs" debate in California, Jørgensen challenges the idea that one side was "pro-environment" and the other "anti-environment." She instead shows how their different assumptions and practices led to quite different understandings of the ocean, which ultimately informed their positions in the controversy. Studies such as these emphasize how nature and knowledge are both analytical tools and historical objects in the field of environmental history.[44]

Constructivist frameworks call attention to this dual character and invite environmental historians to remain attuned to this critical point; they also offer powerful ways to investigate their historical particularities. At its core, adopting a constructivist approach to knowledge and technology means not treating them as "black boxes" and instead studying them as social and

historical phenomena. Although there are several constructivist schools of thought within science studies, they share an interest in examining how complex social and historical processes shape knowledge making and ultimately knowledge itself by studying what research questions are asked, which methods are used, who is included in (and excluded from) a given knowledge community, and so on.[45] This approach applies to even the intriguing case discussed by Frank Uekotter in this collection, in which agricultural knowledge in twentieth-century Germany is intentionally absent. Thus, tools of constructivist analysis provide useful ways to explore nature and ecology as historical objects that merit their own analysis, even as scholars simultaneously use these concepts to help frame their studies.[46] In many ways, this means taking the fundamental strengths of history, including its attention to contexts and contingencies, and applying them to various forms of knowledge (including science, technology, engineering, and medicine), even if such knowledge is often represented as outside society, politics, or culture and therefore beyond scholarly inquiry.[47]

Constructivist approaches can also be extended to studies of environmental problems, whether in the past or the present. The methodology is particularly fruitful here because it opens up the pivotal question of how an "environmental problem" became just that: conceived by certain historical actors as a concern and constituted specifically as a natural problem, rather than, for instance, as a social, political, or technical issue. Such categorizations imply differential policy and other solutions.[48] Moreover, STS scholars have shown how the making of environmental problems entails considerable work, rather than being self-evident. As John Law puts it, "successful large-scale heterogeneous engineering is difficult. Elements in the network prove difficult to tame or difficult to hold in place."[49] Kevin C. Armitage's chapter provides an instructive example of this process at work. He uses frame analysis to tease out how government scientists and bureaucrats carefully mobilized resources, institutions, and eventually farmers around the issue of soil erosion during the New Deal. Finn Arne Jørgensen offers another interesting case in his story of how beverage container recycling moved toward systemization at a particular moment in time and required institutionalization through systems and scripts so that consumers acted properly. Constructivist approaches, then, help environmental historians tease out how and why concerns over soil erosion, garbage, DDT, or endocrine disruptors emerged thanks to particular groups at specific historical junctures, even if these objects existed long before they were perceived as environmental problems.[50]

Influenced by these insights, scholars have thus teased out the complex processes by which environmental problems come into existence, emphasizing, in fact, how they are *brought* into existence by a constellation of histori-

cal, cultural, material, and epistemological factors. Michelle Murphy traces, for example, how surveys by women office workers enabled them to identify patterns in illness and therefore mobilize around previously imperceptible contaminants. Peter Thorsheim examines how pollution was "invented" in industrializing Britain, while Scott Frickel's research shows how certain 1960s scientists recast chemical mutagens from a useful research tool into a potent threat: environmental mutagenesis.[51] In his chapter in this collection, Michael Egan demonstrates how Swedish scientists not only constituted mercury pollution as a pressing issue but framed it in ways designed to reach a wider, public audience, to increase its likelihood of being taken up by government regulators and policy makers.

Exploring how particular groups constructed environmental problems as such may therefore help environmental historians understand how and why they were perceived, received, mitigated, or, as Frank Uekotter shows for German agriculture, ultimately ignored.[52] As Christopher Jones has argued with respect to BP's Deepwater Horizon oil spill and Dolly Jørgensen shows in the rigs-to-reefs case here, defining and framing environmental problems in specific ways is not just a question of rhetoric or semantics. Rather, doing so simultaneously shapes and thereby constrains the solutions proposed and eventually selected.[53] For these reasons, the particular construction of environments and environmental problems matters—for humans and nonhumans alike.[54]

Constructivist tools of analysis thus offer ways for environmental historians to study both nature and knowledge. However, the relationship between them is complicated; to paraphrase Kim Fortun and Douglas Weiner, knowledge systems always mediate human understandings and representations of the natural world. For example, as we see in Anya Zilberstein's chapter, colonial settlers in eastern North America sought to "improve" the landscape. This concern drove many of their studies of the region. Confidence in human abilities to transform and improve the environment thus shaped the questions naturalists asked and the kind of research they conducted. These studies were not, then, neutral descriptions of the natural world. Rather, they were wholly entwined with colonial political economy and culture. Bruno Latour might use Zilberstein's example to question the traditional boundaries between "matters of fact" and "matters of concern," or "science" and "politics."[55] It is therefore impossible to entirely separate nature from *knowing* nature.[56]

Overall, constructivism enables environmental historians to use key analytic tools—nature and knowledge—while remaining attentive to their very historicity. In other words, constructivism offers a way to disentangle actors' views from analysts' own terms, thereby providing the distance necessary to facilitate mindfulness of both.

Expertise

As we have seen, constructivism highlights and opens up the making of knowledge. In the second part of this volume, we turn to a related topic—expertise—focusing specifically on environmental expertise because it is most relevant to the field of environmental history. Experts and expertise, in both historical and contemporary settings, are generally associated with significant authority and its attendant power. Part of that power comes from the assumption that expertise is self-evident and beyond question. STS scholars instead study and contextualize expertise, investigating exactly how certain areas of knowledge became perceived as expert, how specialists in these fields acquired and maintained authority, and who benefited from (or was harmed by) these moves. STS analyses of expertise thus examine the categories, categorization, and hierarchies of knowledge in given contexts.[57] These processes matter, in part, because different forms and echelons of knowledge are generally associated with different levels of power. To examine the definition, production, and maintenance of experts and their associated expertise, then, is to explore the making of influential social relations and dynamics.[58]

Such STS insights regarding the production of expertise stress the politics of environmental expertise. Actors' views of ecological knowledge in general, and environmental expertise in particular, are not, then, merely abstract debates about "the best" knowledge of the environment.[59] Defining and negotiating what is perceived as cutting-edge knowledge may determine, for example, who gets to speak for nature in environmental controversies—what Latour calls the spokesperson.[60] It may also decide whose knowledge serves as the basis for both formal and informal environmental practices. Consequently, the construction of environmental experts and expertise and, in the process, who is not an expert and what is mere knowledge has significant consequences for not only the formulation and enforcement of environmental management strategies but also the environment itself, as well as for the people who have historically depended on those landscapes. In short, environmental experts play powerful roles in shaping what counts as the environment or specific natures such as ecosystems, species, or wetlands, as well as proper interactions with them.[61]

Several chapters in this collection explore these central questions in environmental history through detailed studies that expose the history and politics of environmental expertise. First, studying the contested definitions and negotiations over such expertise offers a richer understanding of how exactly specific environments are conceived, contested, and ultimately shaped by historical actors. Environmental experts and expertise are fundamental, rather than incidental, to this process. Second, Michael Egan's chapter raises

an important related issue: the opposition of lay and expert knowledge and how experts seek to translate specialized knowledge to the public.[62] Finally, examining the history and politics of expertise opens up the constitution of human-natural relations and particularly how knowledge regimes with differential levels of power shape what is sanctioned and, conversely, what is criticized—if not criminalized. In her chapter, Eunice Blavascunas traces negotiations over the management of Poland's Białowieża Forest, a rare old-growth forest in central Europe. As she shows, local people perceived foresters, who had historically been members of their communities, as experts, while they remained skeptical about wildlife biologists' claims to that position.

Examples from other environmental historians' work show how close studies of expertise can help explain the framing and mitigation (or lack thereof) of socioenvironmental problems. For one, expert/nonexpert status can mediate which environmental problems are perceived and treated as such. Michelle Murphy has demonstrated, for example, how scientific and medical experts tended to dismiss women office workers' complaints about the modern office building and people experiencing multiple chemical sensitivity, while Nancy Langston's recent book has also shown how expert forms of knowledge such as toxicological models of risk can make certain environmental problems such as endocrine disruptors invisible because they do not conform to these models.[63] In other words, although expert forms of knowledge have contributed to environmental regulations, reforms, and ultimately protection, at other times these very knowledge systems have neglected other issues, leading to longer periods of exposure and detrimental effects on both people and the environment.

Analyzing expertise thus often opens up contestation over nature: what it is, who knows it best, how it should be managed, and by whom. Being attentive to the social and historical contingencies of environmental expertise also suggests why some environmental problems are made visible and taken seriously, while others remain invisible or are dismissed entirely. As such, teasing out the workings and implications of expertise within particular environmental histories provides a valuable lens onto influential power dynamics both shaping and constituted through environmental conflicts in the past and the present.

Borders and Boundary-Work

Borders and what sociologist of science Thomas Gieryn calls "boundary-work" are important themes in this volume, especially in the third and final section.[64] Both STS and environmental history share a strong interest in analyzing the making, remaking, and unmaking of boundaries. In many ways, it is a premise of both fields. Environmental historians have generally

focused on the porous relationship between nature and culture, with some scholars focusing recently on the complicated dynamics between nature and technology.[65] Meanwhile, STS scholars have developed concepts such as "nature-culture," "sociotechnical," and "technopolitics" to describe the entanglement of other prominent modernist dualisms.[66] As an alternative to such binaries, several recent scholars in both fields have instead emphasized hybridity and multiplicity.[67] Overall, scholarly analysis of borders and boundaries has suggested that they are less self-evident, more unstable, and more multifaceted than historical actors often assert.

Gieryn's concept of boundary-work offers a useful way to critically examine the creation, maintenance, and erosion of borders, both physical and rhetorical, in environmental history. Gieryn originally proposed the concept to describe how emergent disciplines demarcate a specific terrain for their expertise and assert their authority over that area. These moves usually form a key step in discipline formation and professionalization.[68] For example, in *Fathoming the Ocean,* Helen Rozwadowski traces how "amateur" naturalists, including whalers and women, were eventually excluded from oceanography, even though their knowledge and collections had been vital to the field's development.[69] Most broadly, then, the concept of boundary-work calls attention to the ways in which historical actors not only differentiate between forms of knowledge but also forge hierarchies among them. In the process, they produce critical dichotomies such as science/not science and expertise/knowledge, as well as delineate professional terrains for given disciplines. The concept of boundary-work thus highlights the ways in which historical actors strategically construct intellectual, disciplinary, and professional boundaries, thereby revealing fundamental connections between knowledge and power.[70] As such, various borders and boundary-making should be studied and analyzed, rather than taken at face value.

As several chapters in this collection show, the concept of boundary-work can help environmental historians tease out the processes by which actors define and negotiate borders—literal and metaphorical, both consciously and unconsciously—as well as understand the larger stakes of these moves. These insights particularly hold for analyzing environmental knowledge, but they can also be extended to several related contexts.

First, as we have seen, the constitution of environmental expertise—who knows and can know the natural world—provides an illustration of Gieryn's original argument. Complementing Blavascunas's study of contestation over Poland's Białowieża Forest is Stephen Bocking's chapter on Arctic ecologists, in which he demonstrates how these scientists strategically framed their research as both particular and universal. These scientists worked to maintain that their scientific investigations contributed to understandings of northern

environments as unique places, while simultaneously creating knowledge that was germane far beyond those locales in order to bolster their relevance to wider intellectual and professional communities.

In addition, environmental knowledge and increasingly environmental "expertise" have played critical roles in environmental management strategies, including what are deemed appropriate interactions with the natural world. Boundary-work in environmental management can be both metaphorical and literal. When French hydraulic engineers naturalized multipurpose dams and described the Rhône River in technical terms, they conveniently justified the large-scale transformation of the river.[71] Yet some environmental management has also depended on quite literal boundary-work, such as the creation of national parks, the exclusion of peoples who had historically lived in those areas, and the criminalization of earlier practices such as hunting (now deemed poaching).[72]

Because boundary-work is process oriented (after all, it is called boundary-*work*), the concept helps environmental historians examine and therefore reveal the construction, contestation, and negotiation over borders. It thus foregrounds power and authority both reflected in and constituted through the regulation of "nature" and the establishment of norms in environmental management. This process is often exclusionary, as a number of environmental historians, political ecologists, and other scholars have convincingly shown.[73] Yet, as David Tomblin establishes in his study of recent ecocultural restoration efforts by the White Mountain Apache included in this volume, boundary-work also has the potential to be generative and empowering, sometimes even counter-hegemonic.

Together, these examples allude to the larger stakes of boundary-work: various borders and boundaries are not made (and unmade) for any old reason; they are profoundly political. As environmental historians know, nature—the category, object, and management thereof—is fundamentally political. Animals like the karakul sheep discussed by Tiago Saraiva have been molded by political concerns, including the overt political ideologies of fascism and imperialism in early-twentieth-century Europe. Meanwhile, Thomas D. Finger describes how grains were transported from New World to Old, breaking down historic natural boundaries, in the quest for economic profit (which is, of course, inherently political). As these cases suggest, the categories and borders of nature and culture are maintained (or erased) by historical actors for interested reasons.

Overall, Gieryn's notion of boundary-work offers environmental historians a productive way to explore the various processes by which historical actors preserve (or erode) borders, both literally and metaphorically. It also alludes to the broader professional, intellectual, and political stakes of these

moves. Boundary-work may therefore help explain, in part, why wilderness and nature-culture are so politicized.

The chapters in this volume illustrate how specific STS concepts such as enactment, systems, and model organisms can enrich environmental historians' analyses, but they also show how joining environmental history with science and technology studies yields several wider insights. Collectively, these authors historicize and contextualize knowledge. This approach complicates the place of scientific and technical knowledge in environmental history, but the authors demonstrate the importance of analyzing knowledge and knowledge making, rather than treating them as being outside scholarly investigation. By considering the construction and politics of expertise, these chapters also highlight the vital role of experts and expertise in defining, shaping, and mitigating environmental conflicts, as well as shaping human-natural interactions more broadly in complex ways. In addition, boundary-work particularly reveals the processes and wider stakes of critical borders, including nature and culture in environmental history. Overall, by being explicit about using STS theories in environmental history, the chapters in this collection exemplify the fruitfulness of cross-disciplinary thinking, regardless of the direction.

Given the value of this engagement, we hope that conversations between environmental historians and STS scholars will continue, and we especially hope that some of the specific concepts and approaches discussed here (as well as others not featured in this volume) are considered and extended in future studies. We also suggest four paths for additional research and dialogue with both academic and wider communities that might emerge from and build on some of the issues raised in this collection.

First, this volume speaks to ongoing debates within history over the role and utility of theory in the discipline. Although the editors and authors here are situated within the field of environmental history, we hope that historians will continue to consider how theory, writ large, is an analytic tool that can help sharpen historical analyses and their wider implications and specifically how concepts and approaches from STS might enrich historical studies of knowledge and technology, including within so-called mainstream history.[74]

Second, although the focal point of this edited volume is the contributions of STS to environmental history, many of the chapters in this collection actually speak to the productive synergies between the fields and thus to the benefit of bringing questions, methods, and insights from science and technology studies *and* environmental history to a given study. We hope that more scholarship will develop *both* dimensions in a single analysis and

thereby advance the potential for even more fruitful dialogue and reciprocity between the fields.

Third, given many pressing environmental issues in the contemporary world, environmental historians are well situated to engage with these debates, helping policy makers and citizens understand the deep roots and complex causes of these dilemmas. Indeed, some have already begun to do so. STS methods offer productive ways to analyze science, technology, engineering, and medicine, including their central roles in these environmental issues. For instance, in a recent editorial, historian Alan Brinkley defended the humanities and liberal arts education, arguing that "science and technology teach us what we can do. Humanistic thinking can help us understand what we should do."[75] Yet, as the chapters in this collection and STS insights more broadly demonstrate, values, politics, and power already thoroughly permeate science and technology. Thus, Brinkley's stereotypical divide between facts and ethics, knowledge and politics, is not only inadequate but problematic: it reproduces the common argument that science is apolitical, which is itself a political claim.[76] Many environmental debates, including those discussed in these chapters, powerfully demonstrate this false divide. STS scholarship therefore offers critical perspectives in terms of teasing out the complex histories and politics of both knowledge and nature, and environmental historians can harness these contributions to deepen their studies of the past while also contributing to contemporary debates.

Finally, as I have just begun to suggest, STS approaches are undoubtedly relevant in the "real world." Thus, STS concepts and methods offer both analytical and political work. Concepts such as agnotology and enactment help us, as scholars *and* as citizens, understand the social, cultural, economic, and political conflicts over environmental knowledge and management. They help explain the development of specific policies, resistance to changing current systems, and so on. Meanwhile, nature-culture helps us understand genetically modified organisms; boundary-work elucidates the efforts of environmentalists to maintain the idea of pristine nature, despite ample evidence to the contrary; and systems and momentum help explain the persistence and even maintenance of a carbon economy. Such theoretical tools enhance our ability to ascertain underlying assumptions and politics, enabling us not only to analyze current environmental debates but also to be more engaged in contemporary issues. These tools are not therefore just modes of *Kritik* (in the German sense of the term), but—as Sverker Sörlin suggests in the epilogue—they can also help us create generative possibilities. In this sense, the title of this edited volume, *New Natures,* alludes to the creative, productive opportunities for meaningful work in the scholarly world but also beyond.