major claims and counter-claims made by NCD critics and practitioners. Critics allege, for example, that Rosgen teaches trainees to approach stream restoration as simple when it is not; Lave reports that Rosgen teaches restoration as doable, but not simple. Additionally, critics suggest Rosgen asserts NCD-based field measurements can be used to estimate stream evolution processes when they cannot; Lave reports that critics use similar field measurements to diagnose stream processes. A more substantive critique comes from those who suggest that NCD's goal is to restore streams to a stable or dynamic equilibrium condition when streams are inherently unstable; Lave reports that scientific consensus considers streams as unstable and NCD training needs to be brought up to date on this issue. Other claims address whether NCD is overly interventionist, whether NCD properly addresses aquatic ecosystems, and whether NCD over-relies on elusive indicators of bankfull discharge. Lave's review of NCD counter-claims provides a rich read—you can find out whether the enemy to stream restoration is the Army Corps of Engineers, whether NCD critics really have little practical experience, and why Rosgen considers critics ignorant of what is actually taught in NCD short-courses.

Beyond this useful summary of the tenets of and controversies over NCD, Lave makes a broader argument about the ways neoliberalism is shaping science. For Lave, the Rosgen Wars highlight a troubling trend in which markets are becoming the granters of scientific legitimacy and neoliberal policies are increasingly governing how scientific knowledge is produced, distributed, and applied. Neoliberal policies aim to privatize government services and tend to value the market above all else. Lave argues that the academy, and the science produced within it, will find difficulty fitting with an environment centered on privatization, particularly when a marketplace decides what is valid science. In stream restoration, government legislation and grants helped to bring Rosgen's approach to prominence. Lave is convincing in describing the importance of groups outside of the academy in legitimating NCD. At the same time, it is not totally clear that neoliberalism is as new, or as unique, as Lave argues. Commercial interests, government regulations, and funding have shaped the development of science throughout U.S. history. Stream restoration is hardly the first time that many academic scientists have felt that their message is being ignored by government agencies. Nonetheless, Lave's work raises important issues for anyone interested in understanding the ways social pressures can shape science.

Everyone involved in stream restoration should read Lave's chapter 4 for perspective on how combatants in the Rosgen Wars have more to agree on than fight over. By focusing on watersheds and streams rather than disciplinary fields the restoration community can make our waters drinkable, fishable, and swimmable. Several academics have taken the pacifist path, including the accomplished Peggy A. Johnson, the President of the Environmental and Water Resources Institute of the American Society of Civil Engineering (ASCE). In 2001, Johnson, Rosgen, and others co-authored two journal papers on the efficacy of NCD structures in reducing bridge scour. With a bit of work, war veterans and pacifists can together restore the watershed.

The NCD approach to stream restoration has steadily evolved since its debut in the mid-1980s. Rosgen regularly updates NCD methods based on research of his own and that of NCD critics, including a recent effort to use deformable bioengineering for inherently unstable channels and to separate archival bank and streambed sediment samples to address national database needs. Stream restoration practitioners are also evolving, and in interviews with Lave most practitioners reported that their stream restoration toolkit has grown substantially over the past decade and NCD is now but one of several approaches. The prospects for peace seem good, but Lave's larger argument about neoliberlism's influence on science suggests we may see more such wars in the future.

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Observation and Ecology

Rafe Sagarin and Anibal Pauchard. 2012. Washington, D.C.: Island Press. Paperback, $30.00. ISBN: 978-1-59726-826-4. 240 pages.

In this book, Sagarin and Pauchard argue for the value of observation-based ecology, which they define as "ecology that relies on observations of systems that have not been manipulated for scientific purposes" (pg. 2). Drawing extensively on their own research, the authors argue that ecological science is undergoing a methodological change away from experimentation and theory, and argue that this change will facilitate application of ecology in environmental problem solving.

The book is organized into four parts. The first outlines the historical and current roles observation plays in ecology, the second describes methodological approaches to observation, the third discusses some of the issues and challenges with taking a strictly observational approach, and

the final part explores how observation-based ecology can bridge the gap between scientists and the broader public. In addition to the authors' perspectives, 1–2 page boxes scattered throughout the book present those of a dozen other investigators.

In Part 1, the authors describe the transition in ecology from natural history observation to experimental and theoretical science through the 20th century. They then argue that the heightened emphasis on experimentation and theory in recent decades has been of limited use for addressing current environmental challenges because the clearest experimental results are obtained at small scales and divorced from the environment. This argument may be valid for many laboratory studies—their example of the current emphasis on funding single-species lab experiments to explore ocean acidification is particularly appropriate and timely—but it overlooks the compelling contributions of large-scale field experiments to several of our most pressing environmental concerns. Examples include the whole-watershed harvesting experiments and lake manipulations that were enormously influential in recognizing and implementing policies on eutrophication, forestry practices, fisheries, and acid precipitation (e.g., Likens et al. 1970; Schindler 1974, 1988; Carpenter and Kitchell 1996); these experiments in turn were motivated by the results of small-scale experiments and field observations.

Part II considers some of the approaches to observation currently available. The first chapter emphasizes the importance of classical natural history observations and discusses ways that multiple senses can be incorporated to promote richer observation. Extending this sensory theme, the second chapter highlights how technology is expanding our observation abilities at both the macro and micro scales, and argues that technology is in part responsible for the increasing reliance of ecology on observational studies. Prominent technologies include remote and automated sensing, molecular methods, and electronic access to data and literature that promote meta-analysis. The authors also mention some of the shortcomings of depending on technology: the lack of uniform access that creates uneven coverage of observations around the globe, the potential ephemerality of collection methods, software capabilities, and data stored on rapidly evolving electronic media, limited access to collected data arising from both institutional barriers and the need for accessible "data translation" software, and the separation of researchers from direct interaction with the ecosystems being studied. I agree with the authors that the last aspect is particularly problematic and creates a curious tension between field and technological observations when trying to carry out effective ecological studies. I was also left wondering, however, why the authors finger field experiments as a leading culprit in the demise of field based observation, given that the best experimental practitioners often log thousands of field hours and make numerous observations, whereas that the emphasis on technology-based observation necessarily divorces ecologists from direct observation of ecosystems.

Part III considers the potential challenges of observational studies from several angles. One issue arising from technologically facilitated observation is the massive amount of data that can be created, and the authors highlight several difficulties that have not fully been solved. These include the simple logistics of storing and accessing the data for analysis. Massive data may also pose the problem of being too powerful, in that influences of variables may be detected statistically, even if they explain fractions of a percentage of the variation of interest, which may distract from identifying core processes. Yet the authors also note that critical observations are often extremely limited because they are not derived from a systematic data collection program and/or are derived from a specific ecological context, place and time. The authors suggest a way around this though diligent accumulation of varied relevant observations. They also highlight the value of repositories of such observations, notably museums, while acknowledging the biases that come from such collections.

The second chapter in Part III asks the question "are observational approaches scientific?" To this, all readers will probably reply, "of course." The point of contention is over the strength of conclusions that can be drawn. The chapter touches on several philosophical approaches, focusing in particular on the Popperian perspective embodied by "Strong Inference" (Platt 1964). According to the authors, widespread application of strong inference in ecology over the last half-century led to an emphasis on experiments and theory in ecology and a marginalization of observations. They subsequently summarize some of the critiques for using strict strong inference in ecology, and also consider some of the broad criticisms that they suggest are leveled at many observational studies. These include dependence on inductive reasoning, perception that observation-based studies are "story-telling", and equating correlation with causation. These are critical issues to tackle in considering approaches to ecology, and I wished the authors had delved into them more deeply. I found the critique of strong inference juxtaposed with arguments to address the criticisms of observation-based science particularly incongruous, a viewpoint echoed in Paul Dayton's pithy foreword to the book. At its core, the strong inference approach is about seriously considering multiple working hypotheses, then identifying and making the critical observations necessary to efficiently distinguish them. There is no requirement that the observations arise from experiment, and the broad approach seems especially well suited to circumventing the criticisms of observational studies that the authors discuss. Whether their proposed alternative, amassing numerous observations to create a robust picture, is a more effective way to proceed seems open to debate—though Darwin could certainly be held up as a case in point. The authors do highlight the importance of constructive hypothesis

building, a necessary enterprise that is strangely de-emphasized in the original strong inference literature, and they correctly point out that observation dominates this activity.

The final part of the book discusses the ways that observations can connect science with the broader public. The authors emphasize the key role that direct observation, particularly over extended time periods, plays in convincing policy makers and the general public that the environment is changing, and the ways that actively engaging the general public through citizen science activities yields benefits in greatly expanding the coverage of data collection, in cultivating the next generation of scientists, and in increasing the understanding of, and therefore the confidence in, the scientific process by the general public. The authors' experiences in these areas add some helpful insights that may prod academic ecologists to move some of their efforts in this direction.

Overall the book makes some important points about effectively carrying out and transmitting environmental research. Their call to focus on studying natural ecosystems and how they work, rather than on testing particular theory, resonates particularly well. I do think that the authors' de-emphasis of theory is unfortunate; the recent incorporation into ecology of statistical methods of selection among competing models (Burnham and Anderson 2002, Clark 2007) is a development that offers a much richer and stronger set of conclusions for observational studies. Competing quantitative models can integrate multiple ecological processes, addressing a shortcoming of applying strong inference in its most extreme form to ecology (Quinn and Dunham 1983).

The book seems best suited for motivating spirited graduate seminars that consider alternative approaches to studying ecology, ideally using some pro-experiment writings as a counterpoint, and for prodding researchers to make their activities more accessible to the general public and managers. Restoration ecologists may also find the book interesting because it places them as potential bridges among different methodological schools: their known manipulations appeal to experimentally-oriented ecologists because causal factors are known, but as their manipulations are typically large scale and are arguably not "for scientific purposes," observationally-oriented ecologists also welcome them to their fold. Regardless, this book should motivate restoration ecologists to make detailed observations as their restoration efforts progress to better understand their ecosystems of interest, to facilitate adaptive management, and to make stronger links with the public.

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