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Natural History and the Deep Roots of Resource Management

FROM THE EDGE OF THE ICE

I stand shivering at the edge of a block of ice roughly the size of Connecticut. The wind blows the coyote fur ruff on my parka hood; I stamp my feet to encourage circulation to my toes. Behind me a vast white plain stretches toward the unseen Brooks Range, while in front the cobalt blue water of the Arctic Ocean shimmers in the golden midnight light. Late May, the sun will not set again until mid-August. Instead, it rolls along the horizon each night, west to east, before arcing back into the sky. I'm perched atop a jumbled mass of icy blocks rumpled up a couple weeks ago by the slow, grinding collision of floating pack ice with the more stable shorefast ice. For a couple days the sea had simply disappeared—replaced by an immense interlocking puzzle of ice. Sure enough, though, the wind shifted direction and pushed the pack ice back out toward the northern horizon. I stand at the edge of this ice cliff, scanning the water intently.

This arctic springtime, on the sea ice near Point Barrow, Alaska, yields no flowers. Rather, the movement of animals marks the season of renewal. Seabirds and waterfowl stream past in flocks of tens and hundreds of thousands, all heading toward the bounty of the Mackenzie River delta. My quarry, too, heads in that direction, and for the same purpose—to transform the summer profusion of nutrients and invertebrates into offspring. Bowhead whales have traveled the ragged ice edge along the northern Alaskan coast since before human memory. But in the past few years, scientists and conservationists have become alarmed at the scarcity of bowheads. Local Inuit want to celebrate the spring return of the whales by hunting a few, as they always have. The American government, the world leader in the reform of international whaling laws, finds itself in an awkward political position—caught in the crossfire of two laudable intentions, honoring the traditional subsistence habits of indigenous peoples and saving the most

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endangered large whale in the world. Whaling nations seize upon this contradiction and press their advantage in the council rooms of the International Whaling Commission. How can you tell us to stop whaling, they say, when you let your own citizens kill one of the species most at risk? So, in an effort to buy time and find some solution, the National Marine Fisheries Service dispatched a team of field biologists to this far corner of its domain. One of the most junior members of that team, I squint at the sun on the horizon, anxious not to miss the passage of even one of these cetaceans. A half-mile behind me a cluster of canvas tents comprise our base camp—a jumble of white canvas flapping in the arctic wind, radio antennae protruding from poles, snowmobiles parked askew. Some biologists hunch over hydrophones dangled into holes in ice, while others scan the water from topwing aircraft, flying back and forth in mathematically determined parallel tracks. All together, we hope to find the answers to some very simple questions: How many whales are there? When do they pass by this part of the coast? Do they travel alone or in groups? Will they reproduce successfully?

THE ROOTS OF WESTERN SCIENCE

Who? What? Where? How many? How does it survive and reproduce? These are the questions traditionally asked by practitioners of the oldest Western science, natural history.[1] What *is* natural history? Bates described it as "the study of life at the level of the individual—of what plants and animals do, how they react to each other and environment, how they are organized into larger groupings like populations and communities."[2] Bartholomew stressed that naturalists (the practitioners of natural history) observe plants and animals *directly*.[3] He pointed out that these organisms are functionally inseparable from their habitats, and so naturalists pay attention to the physical aspects of plant and animal habitats as well. According to Greene and Losos, natural history focuses on where organisms are and what they do in their environments. Physiological and metabolic processes are considered insofar as they affect what these organisms do.[4] Greene defined natural history as

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1. G.A. Bartholomew, *The Role of Natural History in Contemporary Biology*, 36 BIOSCIENCE 324 (1986); T.L. Fleischner, *Revitalizing Natural History*, 9 WILD EARTH, Summer 1999, at 81.
2. MARSTON BATES, THE NATURE OF NATURAL HISTORY (1990).
3. Bartholomew, *supra* note 1 (emphasis added).
4. H.W. Greene & J.B. Losos, *Systematics, Natural History, and Conservation*, 38 BIOSCIENCE 458 (1988); *see also* H.W. Greene, *Natural History and Evolutionary Biology*, *in* PREDATOR-PREY RELATIONSHIPS: PERSPECTIVES AND APPROACHES FOR THE STUDY OF LOWER VERTEBRATES 99 (Martin E. Feder & George V. Lauder eds., 1986); H.W. Greene, *Systematics*

descriptive ecology and ethology[5]. Wilcove and Eisner define natural history as "the close observation of organisms—their origins, their evolution, their behavior, and their relationships with other species."[6] Halfpenny and Ozanne point out that natural history is primarily descriptive and comparative, rather than experimental or theoretical.[7] What all these definitions have in common is a focus on individual organisms in their natural settings and a reliance on direct observation as the most trustworthy tool for learning about the more-than-human world. Direct observation leads to careful description, which then allows comparison between species, habitats, and geographies.

Contemporary biologists tend to place the origins of natural history in seventeenth and eighteenth century Europe.[8] This myopic view represents a truncated version of our cultural history. In fact, the practice of natural history goes back to the dawn of our species. Natural history in this more expansive sense has been defined as "a practice of intentional, focused attentiveness and receptivity to the more-than-human world, guided by honesty and accuracy.[9]" As we shall see below, this form of natural history was a pragmatic practice, integrated into daily life, crucial to survival.

Natural history is more commonly considered from a narrower historical perspective—as the root of Occidental natural sciences. Even in this narrower view, natural history should be regarded as the oldest science in Western civilization, tracing its roots back almost two and a half millennia to Aristotle's meticulous observations of animals.[10] The term "natural history" was first used shortly after the death of Christ, when the Roman writer Pliny the Elder entitled his masterwork *Historia Naturalis*. Pliny explained his purpose as the study of "the nature of things, that is, life." Pliny simultaneously invented natural history and the encyclopedia. *Natural History* collected, edited, and arranged an

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and Natural History, Foundations for Understanding and Conserving Biodiversity, 34 AM. ZOOLOGIST 48 (1994).

5. Harry W. Greene, *Organisms in Nature as a Central Focus for Biology,* 20 TRENDS IN ECOLOGY & EVOLUTION 23 (2005).

6. D.S. Wilcove & T. Eisner, *The Impending Extinction of Natural History*, CHRON. HIGHER EDUC., Sept. 15, 2000, at B-24.

7. JAMES C. HALFPENNY & ROY DOUGLAS OZANNE, WINTER: AN ECOLOGICAL HANDBOOK (1989).

8. S.J. Arnold, *Too Much Natural History, or Too Little?*, 65 ANIMAL BEHAVIOR 1065–68 (2003); PAUL LAWRENCE FARBER, FINDING ORDER IN NATURE: THE NATURALIST TRADITION FROM LINNAEUS TO E.O. WILSON (2000); K.P. Schmidt, *The New Systematics, the New Anatomy, and the New Natural History*, 1946 COPEIA 57.

9. T.L. Fleischner, *Natural History and the Spiral of Offering*, 11 WILD EARTH, Fall/Winter 2001, at 10.

10. Fleischner, *supra* note 1.

enormous amount of material into 37 "books" that covered cosmology, astronomy, geography, zoology, botany, agriculture, medicine, and minerals.[11] Pliny's all-inclusive approach to natural history influenced naturalists for at least 1500 years. Ever since Aristotle and Pliny, the interdisciplinary science of natural history has continued to seek answers to those fundamental questions about our planetary coinhabitants—*who? what? where? when? how?*—through direct observation, description, and comparison of organisms and their habitats, rather than on mental abstractions.

During the first millennium after Pliny, the authority of the church discouraged natural history inquiry. In the Middle Ages, however, human curiosity reawakened. Visual artists pioneered more accurate naturalistic observations of plants and animals at least a century before such heresies found their way into print.[12] Into the Renaissance, some of the most astute observers of nature simultaneously practiced what we might now consider the disparate realms of science and art. Leonardo da Vinci exulted in the power of direct observation, declaring that all knowledge originates in our senses.[13]

Natural history began to achieve social acceptance and wider participation in Europe in the seventeenth century.[14] During the spasm of global exploration of the eighteenth and nineteenth centuries, new generations of naturalists avidly pursued the discovery, description, and naming of new plants and animals, bringing stories and specimens home to European museums. The Linnaean revolution in biological taxonomy in the mid-eighteenth century stimulated a boom in descriptive natural history in the nineteenth century. Linnaeus's binomial system provided a simplified and orderly framework for naming new discoveries and also offered a convenient mechanism by which naturalists could claim lasting credit for their work.[15] All the while, empirical realities revealed by naturalists provided irrefutable evidence that contradicted long-held mistaken assumptions about the world we lived in.[16] Natural history

11. *Id.*; C.M. Porter, *Natural History in the Twentieth Century: An Oxymoron?*, *in* NATURAL HISTORY MUSEUMS: DIRECTIONS FOR GROWTH (Paisley S. Cato & Clyde Jones eds., 1991).

12. P.C. Ritterbush, *Art and Science as Influences on the Early Development of Natural History Collections*, 82 PROC. BIOLOGICAL SOC'Y WASH. 561 (1969).

13. R.S. Stites, *Sources of Inspiration in the Art and Science of Leonardo da Vinci*, 56 AM. SCIENTIST 222 (1968).

14. DAVID ELLISTON ALLEN, THE NATURALIST IN BRITAIN: A SOCIAL HISTORY (2d ed. 1994).

15. HOWARD ENSIGN EVANS, PIONEER NATURALISTS: THE DISCOVERY AND NAMING OF NORTH AMERICAN PLANTS AND ANIMALS (1993).

16. ERNST E. MAYR, THE GROWTH OF BIOLOGICAL THOUGHT (1982).

description of fossils in British hillsides forced us to expand our sense of time. Naturalists' descriptions of plants and animals, along with tangible specimens placed in new natural history museums, made people realize that the world was wonderfully more diverse than they had ever dreamed and that the Middle Eastern fauna and flora portrayed in the Bible represented only a fraction of what was truly out there.

IN AND OUT OF FASHION

In the wake of the scientific revolution and the seductiveness of physicists' apparent ability to explain and predict any physical occurrence, and thus to seize control over more and more natural phenomena, natural history came to seem anachronistic—even irrelevant—to some scientists. Romance with the sense of control that derived from the predictive capacity of physical science, and the incipient development of "physics envy," continued to undermine respect for natural history into the nineteenth and twentieth centuries. Indeed, the term "natural history" fell out of favor in many circles, or was often preceded by the qualifier "just." *Webster's Third International Dictionary* defined natural history as an artifact—"a former branch of knowledge" of zoology, botany, and mineralogy "as they existed at that time." But natural history—careful description based on direct observation—had not only provided the empirical foundation for these and other sciences—biology, ecology, geology, and anthropology—in the distant past, but continues to do so.

Ecology in particular was built on a foundation of natural history. The first textbook in the field, Charles Elton's *Animal Ecology*, began with a clear statement: "Ecology is a new name for a very old subject. It simply means scientific natural history."[17] But other twentieth century ecologists were eager to distance themselves from descriptive natural history and align themselves with the glory of theorizing. Many ecological scientists judged success by how well their work fit models of scientific method described by philosophers like Karl Popper.[18] Popper himself was a philosopher, not a research scientist, but his outsider's view of the scientific process has been extremely influential. In practice, however, scientific discovery often occurs in less linear, preconceived

17. CHARLES S. ELTON, ANIMAL ECOLOGY (1927).
18. KARL R. POPPER, CONJECTURES AND REFUTATIONS: THE GROWTH OF SCIENTIFIC KNOWLEDGE (1968); KARL R. POPPER, OBJECTIVE KNOWLEDGE: AN EVOLUTIONARY APPROACH (1972).

ways than the Popperian ideal—depending as much on leaps of imagination as it does on strict adherence to rules of logic.[19]

Nevertheless, the modern emphasis on hypothesis testing (the hypothetico-deductive method) tended to relegate natural history to the boneyard. But this conception of how science is supposed to work was modeled on physics and chemistry. It has never been as applicable to the biological sciences, simply because natural selection is a chance-driven, inherently unpredictable process.[20] As a result, many ecologists have been comparing their work to the wrong model for decades, denying their appropriate reliance on natural history. Kormondy referred to natural history as being overly anecdotal, unsystematic, and casual.[21] Peters declared that natural history had more in common with art than science,[22] and one could almost hear the sneer in his words.

Halfpenny and Ozanne described the science of ecology as a five-tiered pyramid: descriptive and comparative layers as a foundation, upholding causal questions, experimental manipulations, and theorizing.[23] While many ecologists are enamored of the experiments and theories at the top of the pyramid, the whole enterprise collapses without the solid foundation of description and comparison. As any science develops, it tends to become increasingly theoretical; theorists often reap rewards and re-create themselves within institutions.[24] As natural history's descendent disciplines developed, each had practitioners eager to construct abstract models—the competitive exclusion principle and succession in ecology, plate tectonics in geology, and so on. As enlightening as these ideas often were, they were only as dependable as the natural history information that supported them. In fact, theoreticians often became so fond of their abstractions that they ignored empirical natural history data that contradicted them.[25]

Most theoretical breakthroughs in ecology have come from thinkers accomplished in field natural history.[26] The two conceivers of the theory of natural selection, Charles Darwin and Alfred Russel

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19. W.I.B. BEVERIDGE, SEEDS OF DISCOVERY (1980).
20. Bartholomew, *supra* note 1.
21. READINGS IN ECOLOGY (Edward J. Kormondy ed., 1965).
22. R.H. Peters, *From Natural History to Ecology*, 21 PERSP. IN BIOLOGY & MED. 191 (1980).
23. HALFPENNY & OZANNE, *supra* note 7.
24. Wilcove & Eisner, *supra* note 6.
25. WILLIAM HOLLAND DRURY, CHANCE AND CHANGE: ECOLOGY FOR CONSERVATIONISTS (1998).
26. P.K. Dayton & E. Sala, *Natural History: The Sense of Wonder, Creativity, and Progress in Ecology*, 65 (Supp. 2) SCIENTIA MARINA 199 (2001); J. Weiner, *On the Practice of Ecology*, 83 J. ECOLOGY 153 (1995).

Wallace, were both committed naturalists. Darwin's painstaking observations in the Galapagos and Wallace's in Malaysia were carefully transferred into natural history field journals. Reflection upon these journals led both men to the idea of natural selection, now the cornerstone of biological thought.[27] One of the preeminent theoretical ecologists of the twentieth century, Robert MacArthur, was a dedicated and skillful field naturalist. His groundbreaking study of warblers along the coast of Maine, which radically altered ecologists' view of biological competition, was based on meticulous natural history—hundreds of hours of field observation.[28] William Hamilton, a leading animal behavior theorist, was continually inspired by his practice of natural history.[29] In these and so many other cases, theoretical insights would have been unthinkable without many years' grounding in natural history field observation. The bottom line: without accurate empirical observations, theory is just so much fluff. Additionally, as Greene pointed out, new natural history information about organisms continually resets research agendas—helping scientists ask better questions and refine theories.[30]

Conservation, too, has always depended directly on natural history. How can we save species from extinction if we don't know where they are? How can we prioritize natural communities for protection if we haven't mapped patterns of vegetation? The earliest formal conservation policy in the United States was the regulation of hunting seasons—closures motivated by natural history observations of decreasing game populations.[31] The exemplary Natural Heritage program of The Nature Conservancy—the most intensive survey of biodiversity ever undertaken in the United States—is a highly coordinated natural history project. Without natural history information, a species could never be nominated for protection under the Endangered Species Act, let alone protected. Caughley suggested that reductionist theoretical approaches in conservation biology contribute little to solving real world problems.[32] Natural history that interprets human-nature

27. MAYR, supra note 16.

28. R.H. MacArthur, *Population Ecology of Some Warblers of Northeastern Coniferous Forests*, 39 ECOLOGY 599 (1958).

29. D. Hughes, *The Value of a Broad Mind: Some Natural History Meanderings of Bill Hamilton*, 14 ETHOLOGY, ECOLOGY, & EVOLUTION 83 (2002).

30. Greene, *supra* note 5.

31. JAMES B. TREFETHEN, AN AMERICAN CRUSADE FOR WILDLIFE (1975).

32. G. Caughley, *Directions in Conservation Biology*, 63 J. ANIMAL ECOLOGY 215 (1994).

relationships for the general public continues to be an essential element of conservation.[33]

Sophisticated natural history observations of indigenous peoples, with no need for modern theorizing, guide resource management from the tropical Pacific[34] to the Arctic.[35] This traditional wildlife management has been referred to as "data-less management"[36] to highlight that the cumulative insight that derives from careful long-term monitoring of home ecosystems transcends the need for reams of statistical analyses. Indigenous naturalists often tend to be more reluctant than Western scientists about extrapolating from the specific circumstance to the generalized principle.[37] Thus, their natural history information tends to be both local and reliable.

My own youthful vigil along the edge of the Arctic sea ice was just one of countless examples of the essential role natural history plays in conservation policy. What marine scientists needed to learn about bowhead whales wasn't something theoretical. Rather, they sought the answer to the most basic of natural history questions: How many are there?

Recently, academia's derogatory spin on the concept of natural history has begun to be challenged; increasingly, laments for the loss of natural history can be heard. Reed Noss, for example, expressed concern in the professional journal *Conservation Biology* that "middle-aged biologists of today may be the last generation...to have been taught serious natural history as part of their professional training."[38] He worried, "Will the next generation of conservation biologists be nothing but a bunch of computer nerds with no firsthand knowledge of natural history? Does it follow that they will have no personal emotional ties to the land?"[39] The gush of affirmative letters in response—one of the largest outpourings in the history of the journal[40]—made clear that his was not an isolated concern. Prominent biologists David Wilcove and Thomas Eisner worry about "the impending extinction of natural

33. S.C. Trombulak & C.M. Klyza, *The New Natural History*, 20 NAT. AREAS J. 267 (2000).

34. R.E. Johannes, *The Case for Data-Less Marine Resource Management: Examples from Tropical Nearshore Fisheries*, 13 TRENDS IN ECOLOGY & EVOLUTION 243 (1998).

35. BARRY LOPEZ, ARCTIC DREAMS: IMAGINATION AND DESIRE IN A NORTHERN LANDSCAPE (1986).

36. Johannes, *supra* note 34.

37. LOPEZ, *supra* note 35.

38. R.F. Noss, *The Naturalists Are Dying Off*, 10 CONSERVATION BIOLOGY 1 (1996).

39. *Id*.

40. R.F. Noss, *Does Conservation Biology Need Natural History?*, 8 WILD EARTH, Fall 1998, at 10.

history" in academia.[41] Their concern is echoed by numerous other authors,[42] who note that the elimination of natural history coursework from academia portends problems for both theoretical and applied biology, as well as agency wildlife management. Museum-based scientists, too, are increasingly alarmed about the rampant underfunding and undervaluing that threatens natural history collections that have inestimable value for both conservation and theoretical biology.[43] Natural history also holds tremendous economic potential as a guidepost in the pursuit of new medicines and materials from floras and faunas little studied by Western scientists.[44]

Aldo Leopold, the intellectual godfather of conservation biology, frequently deplored the loss of traditional natural history study. In 1938, he delivered an address at the University of Missouri on "Natural History—the Forgotten Science."[45] Leopold criticized the new wave of science that increasingly took things apart but failed to explain how they were connected. He observed that, should we drop in "on a typical class in a typical zoology department, we [would] find there students memorizing the names of the bumps on the bones of a cat." It is important to study bones, he continued, "but why memorize the bumps?" Leopold objected to the way science "relegated natural history to the dusty backroom at a time when society needed it most."[46]

Recently, debate has raged anew amongst theoretical evolutionary biologists on the role of natural history. In a presidential address to the American Society of Naturalists (publisher of *American*

41. Wilcove & Eisner, *supra* note 6.

42. V.C. Bleich & M.W. Oehler, Sr., *Wildlife Education in the United States: Thoughts from Agency Biologists*, 28 WILDLIFE SOC'Y BULL. 542 (2000); P.K. Dayton, *The Importance of the Natural Sciences to Conservation*, 162 AM. NATURALIST 1 (2003); Dayton & Sala, *supra* note 26; S.G. Herman, *Wildlife Biology and Natural History: Time for a Reunion*, 66 J. WILDLIFE MGMT. 933 (2002); W.B. Kessler & A.L. Booth, *Professor Leopold, What Is Education For?*, 26 WILDLIFE SOC'Y BULL. 707 (1998); R.M. Pyle, *The Rise and Fall of Natural History*, 20 ORION, Autumn 2001, at 17.

43. W.D. Allmon, *The Value of Natural History Collections*, 37 CURATOR 83 (1994); M.A. Lane, *Roles of Natural History Collections*, 83 ANNALS OF THE MO. BOTANICAL GARDEN 536 (1996); J. McCarter et al., *Safeguarding the World's Natural Treasures*, 294 SCIENCE 2099 (2001); N.R. Morin & J. Gomon, *Data Banking and the Role of Natural History Collections*, 80 ANNALS OF THE MO. BOTANICAL GARDEN 317 (1993); A.F. O'Connell, Jr., et al., *Contribution of Natural History Collection Data to Biodiversity Assessment in National Parks*, 18 CONSERVATION BIOLOGY 1254 (2004); H.B. Shaffer et al., *The Role of Natural History Collections in Documenting Species Declines*, 13 TRENDS IN ECOLOGY & EVOLUTION 27 (1998); K. Winker, *Natural History Museums in a Postbiodiversity Era*, 54 BIOSCIENCE 455 (2004).

44. A.J. Beattie, *Natural History at the Cutting Edge*, 13 ECOLOGICAL ECON. 93 (1995).

45. ALDO LEOPOLD, ROUND RIVER (Luna B. Leopold ed., 1991).

46. CURT MEINE, ALDO LEOPOLD: HIS LIFE AND WORK 383 (1988).

Naturalist), Futuyma pondered the future of the naturalist.[47] At a more recent meeting, the same group explored the question, "Is the future in genomics or in natural history?"[48] Some biologists were apparently serious in contending that natural history observation had outgrown its usefulness in the study of life. Arnold mistakenly equated contemporary natural history with the development of theoretical concepts, rather than with the direct observations that yield them.[49] Dayton, however, championed the traditional role of field natural history to the development of theory in evolutionary biology.[50] In this, he echoed Mayr, who, in his authoritative history of biology, insisted that "anything that contributed to a flowering of natural history is part of the history of evolutionary biology."[51] Other scientists pointed out that ecology benefits from a diversity of scientific styles, rather than on a narrow focus on theory.[52] Furthermore, the broad-minded inter-disciplinary approach of natural history inspires insightful research questions, stimulating advances in theoretical research in a way that narrow specialization cannot.[53]

THE DEEP ROOTS OF HUMANITY AND HUMILITY

As essential as natural history is as an ongoing foundation for the natural sciences and conservation—and this importance cannot be overestimated—its value to humanity is much broader and deeper, for natural history's roots lie orders of magnitude further in the past than ancient Greece. Barry Lopez noted that natural history "is as old as the interaction of people with landscape."[54] Simply put, there have never been people without natural history. Natural history in this more expansive sense can be understood as a practice of intentional, focused attentiveness and receptivity to the more-than-human world.[55] Through the long millennia of Paleolithic times (which is to say for most of human existence) people engaged in this oldest form of paying attention because their lives depended on it. Human ecologist Paul Shepard suggested that

47. D.J. Futuyma, *Wherefore and Whither the Naturalist?*, 151 AM. NATURALIST 1 (1998).

48. J. Ruvinsky, *Metersticks and Microarrays*, 17 TRENDS IN ECOLOGY & EVOLUTION 496 (2002).

49. Arnold, *supra* note 8.

50. Dayton, *supra* note 42.

51. MAYR, supra note 16.

52. R.D. Applegate, *Diversity and Natural History Observation in Ecology*, 87 OIKOS 587 (1999); T.P. Weber, *A Plea for Diversity of Scientific Styles in Ecology*, 84 OIKOS 526 (1999).

53. Bartholomew, *supra* note 1; Dayton & Sala, *supra* note 26.

54. Barry Lopez & Edward O. Wilson, *Dialogue One: Ecology and Human Imagination*, *in* WRITING NATURAL HISTORY: DIALOGUES WITH AUTHORS (E. Lueders ed., 1989).

55. Fleischner, *supra* note 9.

the very nature of human intelligence represents an evolutionary response to the value of attentiveness in our earliest predator-prey interactions.[56]

Let me offer an example of the sophisticated natural history of in-place, pre-literate peoples from a landscape that contrasts dramatically with arctic sea ice. The Escalante River and its tributaries, in southern Utah, carve deep canyons of burnished sandstone through the Colorado Plateau in southern Utah. Polished rock walls rise vertically several hundred feet from the riparian strip along the river's edge to the arid uplands that stretch, dotted with small shrubs, toward high, timbered plateaus. To live in this stark land a thousand years ago required a naturalist's detailed knowledge of interlacing ecosystems and how they varied with the progression of the year. All the raw materials necessary for a good life were available, but never at the same time or place: food, medicines, animals to eat and their skins to wear, willows for baskets, dogbane for cordage, and clay for making pots. Small groups of people had to range geographically and seasonally to gather all that was needed. Elk skins for moccasins, clothes, and medicine bundles came from the adjacent high plateau country. Materials for baskets and bowls were found in the canyon bottoms. *Penstemon* leaves, which made a fine poultice for skin irritations, were available in spring. Sunflower seeds could be had in late summer, while piñon nuts were ripe in the fall.[57]

This comprehensive, taxonomically diverse knowledge of landscapes was essential to the survival of these foraging people. Their resource management required intimate understanding of whole landscapes. This level of intimacy is rare today, even among many indigenous cultures. Yet all resource management still relies ultimately upon knowledge of place. The practice of natural history remains the most reliable path to understanding the organisms, chronologies, and spatial patterns that comprise any given place—whether a desert canyon, an arctic wilderness, or a suburban park.

Among the many qualities embodied in the practice of natural history,[58] several concern us here as we contemplate the deep roots of resource management: vision, accuracy, humility, hope, and gratitude.

Vision? One task of naturalists, whether a Paleolithic hunter or a research ecologist, is "to see the unseen." Grass bent just so tells of the passing of a deer. "Seeing" a nitrogen cycle requires a special kind of

56. PAUL SHEPARD, THINKING ANIMALS: ANIMALS AND THE DEVELOPMENT OF HUMAN INTELLIGENCE 12 (1978).

57. For description of place and people, see THOMAS LOWE FLEISCHNER, SINGING STONE: A NATURAL HISTORY OF THE ESCALANTE CANYONS (1999).

58. For fuller discussion, see Fleischner, *supra* note 9.

vision, too. Charles Darwin declared that "the soul of natural history is accuracy."[59] To see what is really in the world, rather than what we think is there, keeps us from projecting too much the image of human consciousness onto the rest of the world. This, of course, can lead to a deep humility that would be hard to derive from interacting only with other humans. Those of us who regularly engage with this more-than-human world tend to find hope more routinely than those who dwell in a house built of human mirrors. For these gifts, and the embracing beauty of the world, naturalists feel gratitude. Barry Lopez concluded that the ultimate lesson of a naturalist's practice is to "pay attention to the mystery" and appreciate the gift of the world.[60]

The practice of natural history, then, often yields a fierce passion for the wild world. Noss commented that naturalists experience wonder, awe, deep respect, and humility before Nature.[61] Without *love* for the earth, he said, biologists are nothing more than technicians. Aldo Leopold stressed the importance of humility, respect, and, most of all, love of the land. As Kessler and Booth pointed out, however, his promotion of love as essential to the practice of ecology and conservation has generally been edited out of his teachings by academic biologists.[62] Dayton and Sala noted that natural history stirs passion, which in turn can inspire creative thinking in ecology.[63] Barry Lopez suggests that the essential task of naturalists is ultimately an ethical one: to draw upon insights gained from their close observation of the world "to reestablish good relations" with the rest of nature, to re-extend the boundaries of the moral universe.[64]

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My frigid nights on the sea ice are now a quarter-century in the past, but the intense beauty of that place teaches me still: the luminous nights, the immense graceful curve of a bowhead suddenly breaking the surface of the sea, the collective focus of a flock of murres so large it took several minutes to pass—none of these images has dimmed in my mind. One cannot stare with concentration and anticipation at the polar sea for weeks and come away unchanged. The answers we found to our research questions provided a more complete picture of bowheads in the Beaufort and Bering seas—for one thing, there are more of them than we

59. Letter from Charles Darwin to John Scott (July 2, 1863(?)), *at* http://pages.britishlibrary.net/charles.darwin/texts/more_letters/mletters2_10.html (last visited May 19, 2005).

60. B. Lopez, *The Naturalist*, 20 ORION, Autumn 2001, at 38.

61. Noss, *supra* note 40.

62. Kessler & Booth, *supra* note 42.

63. Dayton & Sala, *supra* note 26.

64. Lopez, *supra* note 60.

realized back then.[65] But for most of us who worked on that project, I suspect, our commitment to conserving the arctic was deepened by our personal encounters with its brilliant wildness more than by the data we collected. Polar bears roaming the broken ice; a pod of belugas abruptly slashing through the surface of the subpolar sea; the sudden swoop of an ivory gull, its ice-white wings unexpectedly tilting past your face; the steady, urgent migration of seabirds. These experiences echo across the years and sustain a lifelong commitment to conservation.

Natural history, in both the scientific and expansive senses, holds promise for a wiser form of resource management. Science grounded in the best natural history is more dependable and less vulnerable to political meddling. Managers and policy makers humbled and grounded by direct immersion in this world—once famously described as being not only more complex than we think, but more complex than we *can* think[66]—would be more likely to be truly conservative. This is the sort of conservation Aldo Leopold had in mind when he said, "to keep every cog and wheel is the first precaution of intelligent tinkering."[67] The rationale for natural history as the clarifying basis for scientific inquiry in life sciences is self-evident. But ultimately the deeper lessons of the more expansive form of natural history are what are most crucially needed in the realm of environmental policy and resource management. Natural history holds promise of a wiser, more grounded form of resource management—not only because of more informed science, but also because of gratitude for the uplifting beauty of the world, and the humility this engenders.

Think of it—gratitude, joy, and humility as pillars of resource management.

Step outside. What do you see?

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65. K.E.W. Sheldon & D.J. Rugh, *The Bowhead Whale,* Balaena mysticetus*: Its Historic and Current Status*, 57(3/4) MARINE FISHERIES REV. 1 (1995).

66. FRANK EDWIN EGLER, THE NATURE OF VEGETATION: ITS MANAGEMENT AND MISMANAGEMENT (1977).

67. LEOPOLD, *supra* note 45.