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Local Knowledge, Environmental Politics, and the Founding of Ecology in the United States

Stephen Forbes and "The Lake as a Microcosm" (1887)

*By Daniel W. Schneider**

ABSTRACT

Stephen Forbes's "The Lake as a Microcosm" is one of the founding documents of the science of ecology in the United States. By tracing the connections between scientists and local fishermen underlying the research on floodplain lakes presented in "The Lake as a Microcosm," this essay shows how the birth of ecology was tied to local knowledge and the local politics of environmental transformation. Forbes and the other scientists of the Illinois Natural History Survey relied on fishermen for manual labor, expertise in catching fish, and knowledge of the natural history of the fishes. As Forbes and his colleagues worked in close contact with fishermen, they also adopted many of their political concerns over the privatization of the floodplain and became politically active in supporting their interests. The close connection between scientists and local knowledge forced the ecologists to reframe the boundaries of ecology as objective or political, pure or applied, local or scientific.

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ON 25 FEBRUARY 1887 Stephen A. Forbes delivered "The Lake as a Microcosm," one of the founding papers of the new science of ecology, to a small scientific society in the Illinois River town of Peoria. Forbes spoke of the ecology of "fluviatile" lakes, "situated in the river bottoms and connected with the adjacent streams by periodical overflows." Less than thirty miles downstream, a battle brewed that same year as members of the Peoria elite began placing "No Trespassing" signs on several thousand acres of the same types of fluviatile lakes analyzed by Forbes. Local residents who had been hunting and fishing in these lakes for decades shot down signs in protest and claimed the land and resources as theirs by poaching fish, ducks, and muskrat. Over the next several decades the battles over the Illinois River floodplain escalated, culminating in gunfire, armed blockades, and court fights.[1]

Forbes and the other scientists at the Illinois Natural History Survey had begun their systematic investigation of the Illinois River and its floodplain at the precise moment that the ecosystem became the focus of a struggle over rights to lands and waters. Indeed, the rise of the science of ecology in the United States, from the first use of the term "oekologie" in 1866 to the establishment of the Ecological Society of America in 1915, coincided with and was shaped by a dramatic transformation of society's relation to the natural world as subsistence, artisanal, and traditional patterns of resource use were supplanted by capital intensive resource extraction, on the one hand, and recreational fishing and hunting by an urban elite, on the other.[2] During the period that ecology was developing into a science, Americans fought intense battles over the new science's very object of study.

The development and practice of ecology was linked to the politics of environmental transformation from the beginnings of the science in the United States. Historians of science generally agree that the post–World War II politics of environmental degradation,

[1] Stephen A. Forbes, "The Lake as a Microcosm," *Bulletin of the Peoria Scientific Association,* 1887, pp. 77–87, on p. 77. I reference the original in this essay, but it is more easily available as reprinted in *Illinois Natural History Survey Bulletin,* 1925, *15*:537–550. On the 1887 conflict downstream of Peoria see testimony of Ferdinand Luthy, transcript of *Duck Island Hunting and Fishing Club v. Chester L. Whitnah et al.,* 306 Ill. 291 (1923), Record Series 901, Supreme Court Trial Transcripts, Vault 39941, Illinois States Archives, Springfield, Abstract, pp. 109–112, Record, p. 736. For discussion of the conflict in general see Daniel W. Schneider, "Enclosing the Floodplain: Resource Conflict on the Illinois River, 1880–1920," *Environmental History,* 1996, *1*:70–96.

[2] The Natural History Society of Illinois, formed in 1858, became the State Laboratory of Natural History in 1877. In 1917 it was reorganized as the Illinois State Natural History Survey, its current name. I call the organization the Natural History Survey throughout this essay. For an institutional history see "A Century of Biological Research," *Illinois Nat. Hist. Surv. Bull.,* 1958, 27(2):85–234. On "oekologie" and the Ecological Society of America see Robert P. McIntosh, *The Background of Ecology: Concept and Theory* (Cambridge: Cambridge Univ. Press, 1985), pp. 2, 66. On the transformation of resource use see Richard White, *Land Use, Environment, and Social Change: The Shaping of Island County, Washington,* rpt. ed. (Seattle: Univ. Washington Press, 1992); William G. Robbins, *Colony and Empire: The Capitalist Transformation of the American West* (Lawrence: Univ. Press Kansas, 1994); and Richard W. Judd, *Common Lands, Common People: The Origins of Conservation in Northern New England* (Cambridge, Mass.: Harvard Univ. Press, 1997). For forests see James Willard Hurst, *Law and Economic Growth: The Legal History of the Lumber Industry in Wisconsin, 1836–1915,* rpt. ed. (Madison: Univ. Wisconsin Press, 1984); and Michael Williams, *Americans and Their Forests: A Historical Geography* (New York: Cambridge Univ. Press, 1989). For fisheries see Arthur F. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850–1980* (Cambridge: Cambridge Univ. Press, 1986); Schneider, "Enclosing the Floodplain"; and Margaret Beattie Bogue, "To Save the Fish: Canada, the United States, the Great Lakes, and the Joint Commission of 1892," *Journal of American History,* 1993, *79*:1429–1454. For game see Louis Samuel Warren, *The Hunter's Game: Poachers, Conservationists, and Twentieth-Century America* (New Haven, Conn.: Yale Univ. Press, 1997). For grasslands see Donald Worster, *Dust Bowl; The Southern Plains in the 1930s* (Oxford: Oxford Univ. Press, 1979); Allan G. Bogue, *From Prairie to Corn Belt: Farming on the Illinois and Iowa Prairies in the Nineteenth Century,* rpt. ed. (Ames: Iowa State Univ. Press, 1994); and John Mack Faragher, *Sugar Creek: Life on the Illinois Prairie* (New Haven, Conn.: Yale Univ. Press, 1986).

and particularly the politics of nuclear weapons and energy and pesticides, strongly influenced the science of ecology. Scholars have also traced the influence of environmental politics on ecologists' response to the Depression and Dust Bowl in the United States in the late 1930s. Yet historians have debated the extent to which the early science of ecology reflected the environmental politics of forestry, agriculture, and fishing.[3]

Examination of the social and political context of Forbes's foundational paper "The Lake as a Microcosm" demonstrates the linkage between the science of ecology and environmental politics, formed through the intimate connections between ecologists and the local cultures of resource use at their study sites. This work builds on investigations into the "place of knowledge" in science studies. Scholars have increasingly investigated the role of the specific locations where knowledge is produced in the process of building scientific facts. Originally emphasizing the laboratory as a place of production, they have recently begun looking to the field in sciences such as geography, oceanography, anthropology, biology, and soil science, adapting approaches from laboratory studies to analyze field practices of sampling, collecting, sorting, and displaying material.[4]

This study shifts the focus to how scientists related to the social environment at their field sites and the importance of these social relations to ecology. Fieldwork is a distinguishing feature of ecological science. In the late nineteenth century ecology began to differentiate itself from the more established biological disciplines such as botany and zoology by stressing the study of the adaptations of organisms to environmental conditions in nature. This emphasis led ecologists out of museums and laboratories and into the field. Indeed, one leading early ecologist emphasized these aspects of the new science in defining

[3] On the role of environmental politics see Stephen Bocking, *Ecologists and Environmental Politics: A History of Contemporary Ecology* (New Haven, Conn.: Yale Univ. Press, 1997); McIntosh, *Background of Ecology,* pp. 289–323; Donald Worster, *Nature's Economy: A History of Ecological Ideas,* 2nd ed. (New York: Cambridge Univ. Press, 1994), pp. 218–253; Worster, *Dust Bowl*; Paolo Palladino, "On 'Environmentalism': The Origins of Debates over Policy for Pest-Control Research in America, 1960–1975," in *Science and Nature: Essays in the History of the Environmental Sciences,* ed. Michael Shortland (Oxford: British Society for the History of Science, 1993), pp. 181–212; and Joel B. Hagen, *An Entangled Bank: The Origins of Ecosystem Ecology* (New Brunswick, N.J.: Rutgers Univ. Press, 1992), pp. 100–121. On the debates over environmental politics in the early history of ecology see Eugene Cittadino, "Ecology and the Professionalization of Botany in America, 1890–1905," *Studies in the History of Biology,* 1980, *4*:171–198; and Ronald C. Tobey, *Saving the Prairies: The Life Cycle of the Founding School of American Plant Ecology, 1895–1955* (Berkeley: Univ. California Press, 1981), pp. 60–62. Richard Judd argues that local fishermen and foresters influenced scientific conservation in New England in *Common Lands, Common People,* esp. Ch. 9: "Tradition and Science in the Coastal Fisheries," pp. 229–262. Gregg Mitman, in *The State of Nature* (Chicago: Univ. Chicago Press, 1992), identifies the influence of the broader politics surrounding World War I on the Chicago school of ecology. Michael L. Smith connects the rapid transformation of the California environment to the history of the earth sciences in the United States in *Pacific Visions: California Scientists and the Environment, 1850–1915* (New Haven, Conn.: Yale Univ. Press, 1987), esp. pp. 143–185.

[4] On the "place of knowledge" see Adi Ophir and Steven Shapin, "The Place of Knowledge: A Methodological Survey," *Science in Context,* 1991, *4*:3–21; Charles W. J. Withers, "Reporting, Mapping, Trusting: Making Geographical Knowledge in the Late Seventeenth Century," *Isis,* 1999, *90*:497–521; David N. Livingstone, "The Spaces of Knowledge: Contributions towards a Historical Geography of Science," *Environment and Planning D: Society and Space,* 1995, *13*:5–34; and Jan Golinski, *Making Natural Knowledge: Constructivism and the History of Science* (Cambridge: Cambridge Univ. Press, 1998), pp. 79–102. On laboratory studies see Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (1979; Princeton, N.J.: Princeton Univ. Press, 1986); and, for a recent review, Karin Knorr-Cetina, "Laboratory Studies: The Cultural Approach to the Study of Science," in *Handbook of Science and Technology Studies,* ed. Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch (Thousand Oaks, Calif.: Sage, 1995), pp. 140–166. On the movement to the field see Henrika Kuklick and Robert E. Kohler, eds., *Science in the Field, Osiris,* 2nd Ser., 1996, *11*; Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge, Mass.: Harvard Univ. Press, 1999), pp. 24–79; Richard W. Burkhardt, Jr., "Ethology, Natural History, the Life Sciences, and the Problem of Place," *Journal of the History of Biology,* 1999, *32*:489–508; and Kohler, "Place and Practice in American Field Biology," unpublished MS.

ecology as "field physiology."[5] As ecologists moved into the field, they selected particular locations for detailed scientific observation and analysis. Scientists new to a particular area depended on local people to provide manual labor but also relied on their knowledge of its animals, plants, and habitats. Thus connected to a particular biological habitat, ecologists were also connected to the locale's myriad of other characteristics—its people, culture, and politics.

Understanding the science produced on the Illinois River floodplain requires an analysis of the local context of that knowledge, in all the senses of "local." The "local" has many meanings in the scholarship of science studies. The social constructivist approach views all scientific knowledge as locally produced, generated under specific circumstances in particular locations, such as a laboratory or field site. Locally specific knowledge can also mean the knowledge of particular locales: how one patch of forest or floodplain lake is different from another. Finally, local knowledge refers to the knowledge of local users of the resource, obtained through their everyday interactions with the ecosystem. All of these meanings of the "local" are important for understanding early ecology on the Illinois River. In addition, I extend the concept of local knowledge and argue that as ecologists absorbed the practices and knowledge of local resource users they came to adopt their political concerns as well. The local politics and social relations of a site can be as important a part of the specific circumstances of knowledge production as the local ecology or particular laboratory practices.[6]

Their engagement with the many meanings of "local" forced turn-of-the-century scientists to undertake what Thomas Gieryn has termed "boundary work."[7] Ecologists' reliance on local knowledge and involvement in local politics jeopardized their assumptions about the objectivity of science and its demarcation from other kinds of knowledge, particularly that held by fishermen and hunters. Forbes and the other survey scientists responded by mapping and navigating boundaries between local and scientific knowledge, between pure and applied ecology, and between science and politics. This boundary work, undertaken on the Illinois River floodplain, established the contours of the science of ecology as fundamentally connected to the politics of environmental transformation.

SCIENTIFIC UNDERSTANDING OF THE ILLINOIS RIVER

Stephen Forbes is a key figure in the history of ecology. (See Figure 1.) One of the first presidents of the Ecological Society of America, he was recognized by the National Academy of Sciences as a "founder of the science of ecology in the United States." In "The Lake as a Microcosm" Forbes described ecological communities, one of the central con-

[5] Frederic Edward Clements, *Research Methods in Ecology* (Lincoln, Nebr.: Univ. Printing Company, 1905), p. 7, cited in Hagen, *Entangled Bank* (cit. n. 3), p. 15. See also Cittadino, "Ecology and the Professionalization of Botany" (cit. n. 3), pp. 174–181.

[6] I thank an anonymous referee for helping me clarify the meanings of "local." For a review of the social constructivist approach see Golinski, *Making Natural Knowledge* (cit. n. 4), pp. 27–46. Local knowledge may also be understood as practical knowledge, indigenous knowledge, working knowledge, or folk wisdom. James Scott calls it "mētis," emphasizing both its practical aspects and its adaptability, in *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, Conn.: Yale Univ. Press, 1998), pp. 309–341. See also Helen Watson-Verran and David Turnbull, "Science and Other Indigenous Knowledge Systems," in *Handbook of Science and Technology Studies,* ed. Jasanoff *et al.* (cit. n. 4), pp. 115–139.

[7] Thomas F. Gieryn, *Cultural Boundaries of Science: Credibility on the Line* (Chicago: Univ. Chicago Press, 1999); and Gieryn, "Boundaries of Science," in *Handbook of Science and Technology Studies,* ed. Jasanoff *et al.,* pp. 393–443.

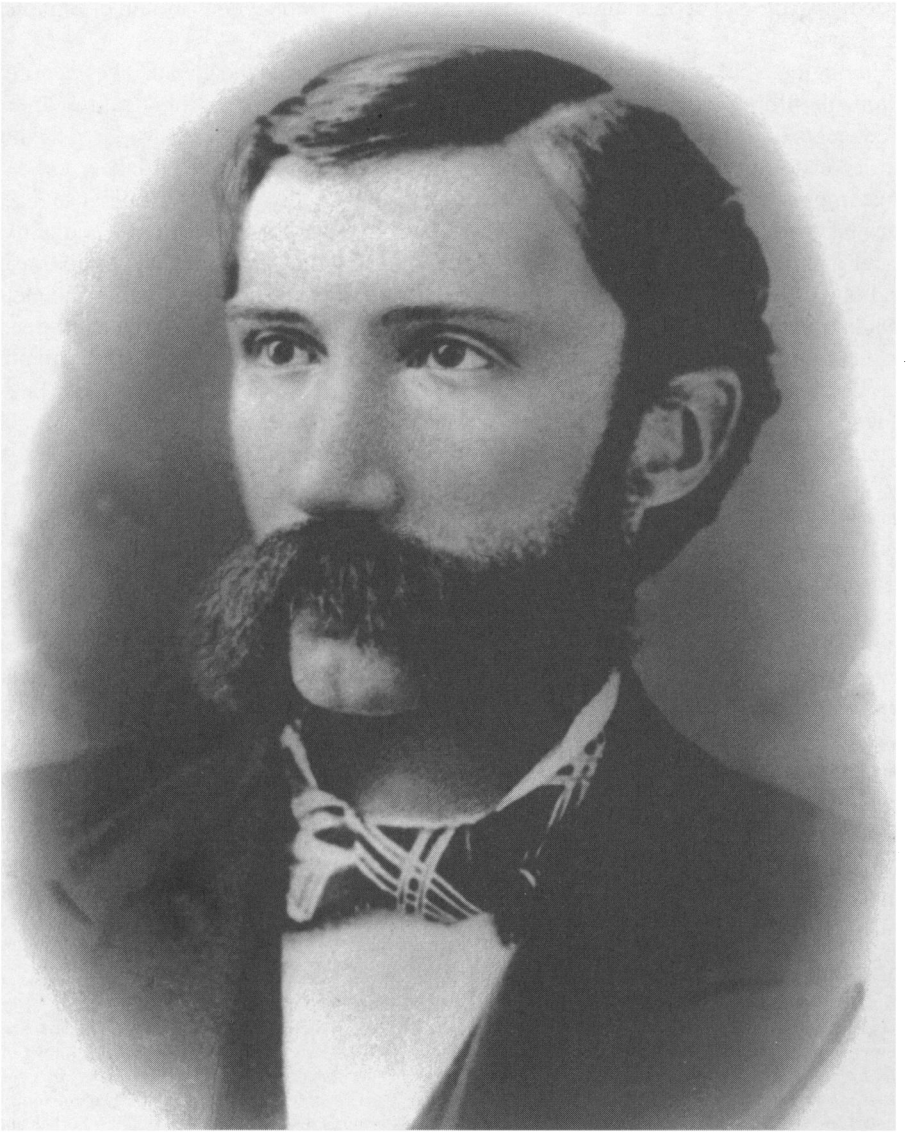

Figure 1. *Stephen A. Forbes, from the 1880s, around the time he wrote "The Lake as a Microcosm." Photo courtesy of the Illinois Natural History Survey.*

cepts of the field. The concept of community extended the focus of ecology from the interaction of organisms with the physical environment to their interactions with each other. Forbes thought that lakes provided the ideal environment for investigating these ideas: he called a lake "a little world within itself—a microcosm within which all the elemental forces are at work and the play of life goes on in full." Within this microcosm

existed an ecological community, a "complete and independent equilibrium of organic life and activity."[8]

Although the bulk of "The Lake as a Microcosm" concerned the glacial lakes of northern Illinois, the Illinois River floodplain was at the center of Forbes's ecological research and his concepts of the microcosm and the ecological community. Forbes considered the floodplain lakes to be "much more numerous and important" than the glacial lakes, and, as the "most important breeding grounds and reservoirs of life," they supported a large and active fishery. Forbes first used the idea of the microcosm in an 1880 article on the food of fishes, part of a series of papers investigating the feeding relations of fishes, birds, and insects. Food had a prominent place in Forbes's work because predation was one of the clearest ways in which an animal could affect others in its habitat. Thus Forbes looked to feeding to observe the interactions of animals with each other and their effects on the community as a whole. "Whatever affects any species" in a lake, he wrote, "must speedily have its influence of some sort upon the whole assemblage." Forbes introduced this approach to examining communities by documenting the feeding relations of fishes. He sampled river and lake fishes and analyzed the contents of their stomachs to determine their ecological relations with other species. Most of the material analyzed in the 1880 paper in which he first developed the idea of a microcosm came from the Illinois River and floodplain.[9]

In "The Lake as a Microcosm," Forbes developed these ideas further to examine the role of natural selection in maintaining a harmonious balance among the organisms inhabiting an area. Such a balance might have been expected in the northern glacial lakes because they varied "but little in level with the change of the season, and scarcely at all from year to year," giving species time to equilibrate with each other. The floodplain, however, subject to a continuous cycle of flooding and drying, provided Forbes with "perhaps no better illustration of the methods by which the flexible system of organic life adapts itself, without injury, to widely and rapidly fluctuating conditions."[10]

Forbes significantly expanded on his ideas about the importance of cycles of disturbances in aquatic ecology by establishing a year-round biological field station on the Illinois River at Havana in 1894. (See Figure 2.) The overall goal of the research program

[8] L. O. Howard, "Biographical Memoir of Stephen Alfred Forbes, 1844–1930," *Biographical Memoirs of the National Academy of Sciences,* 1932, *15*:2–54, on p. 16; and Forbes, "Lake as a Microcosm" (cit. n. 1), p. 77. For Forbes's role in the history of ecology see Stephen Bocking, "Stephen Forbes, Jacob Reighard, and the Emergence of Aquatic Ecology in the Great Lakes Region," *J. Hist. Biol.,* 1990, *23*:461–498; McIntosh, *Background of Ecology* (cit. n. 2), pp. 58–60; Frank B. Golley, *A History of the Ecosystem Concept in Ecology: More Than the Sum of the Parts* (New Haven, Conn.: Yale Univ. Press, 1993), pp. 36–37; Hagen, *Entangled Bank* (cit. n. 3), pp. 7–10, 15; and Robert Allyn Lovely, "Mastering Nature's Harmony: Stephen Forbes and the Roots of American Ecology" (Ph.D. diss., Univ. Wisconsin–Madison, 1995). For the importance of "The Lake as a Microcosm" in particular see Sharon E. Kingsland, "Defining Ecology as a Science," in *Foundations of Ecology: Classic Papers with Commentaries,* ed. Leslie A. Real and James H. Brown (Chicago: Univ. Chicago Press, 1991), pp. 1–13. Forbes's landmark paper appears as the first selection in this collection. "The Lake as a Microcosm" is still required reading in graduate programs in ecology, and, one hundred years after its publication, it is still regularly cited in scientific publications; see Institute for Scientific Information, *Science Citation Index.*

[9] S. A. Forbes, "The Food of Fishes," *Bulletin of the Illinois State Laboratory of Natural History,* 1880, *1*(3):18–65, on p. 18. The exposition of the microcosm is on pp. 17–19; this material was repeated almost verbatim in "The Lake as a Microcosm." Other articles by Forbes appearing in this volume were "On Some Interactions of Organisms," pp. 3–17; "On the Food of Young Fishes," pp. 66–79; "The Food of Birds," pp. 80–148; "Notes upon the Food of Predaceous Beetles," pp. 149–152; and "Notes on Insectivorous Coleoptera," pp. 153–160. Of twelve species of fishes whose sampling location is given, nine were from the Illinois River or floodplain. Of these, three were specifically from the Illinois River bottoms and one from the Mississippi River bottoms as well.

[10] Forbes, "Lake as a Microcosm" (cit. n. 1), pp. 78–79. On Forbes and the balance of nature see Kingsland, "Defining Ecology as a Science" (cit. n. 8), pp. 1–4.

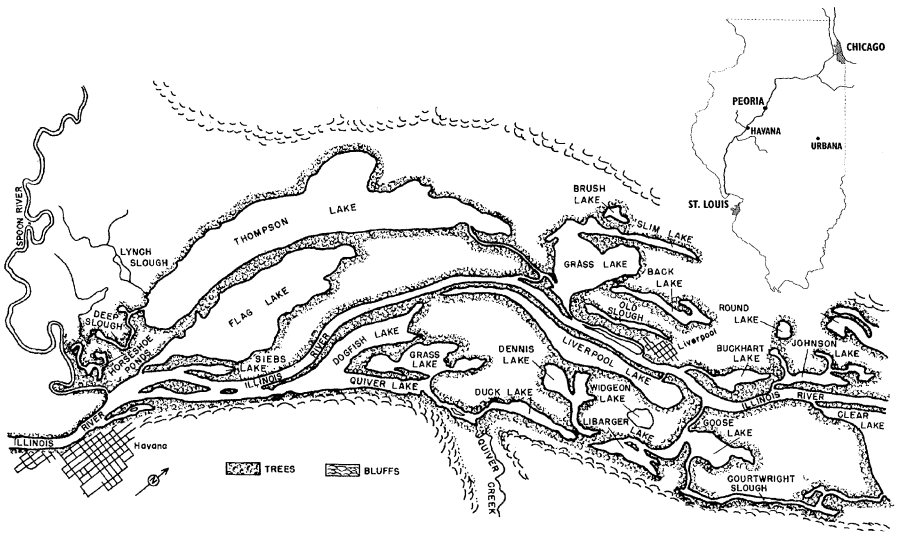

Figure 2. *"Map of the Illinois River and its adjoining bottomland lakes above Havana before 1912." The survey conducted detailed research on these lakes beginning in 1894. Most of the lakes in this map were drained for agriculture by the mid 1920s. Showing a continued reliance on local knowledge, this map, drafted for a 1965 survey bulletin, was reported as "checked by William Riley and Frank Rudolph, commercial fishermen residing in Havana; both had fished in the various lakes shown on the map." From William C. Starrett and Arnold W. Fritz, "A Biological Investigation of the Fishes of Lake Chautauqua, Illinois,"* Illinois Natural History Survey Bulletin, *1965, 29(1):14. The inset map, showing the location of the area in Illinois, is not in the original.*

there was to examine "the effect on the aquatic plant and animal life of a region produced by the periodical overflow and gradual recession of the waters of great rivers."[11] For the next three decades, under the direction of Forbes and the superintendents of the field station, Charles Kofoid and then Robert Richardson, scientists conducted studies of the plants, fish, and wildlife of the river and its floodplain. One of their main conclusions was that the productivity of the fishes was related to the area of the flooded land—the bottomland lakes, sloughs, and wetlands.

By 1910 Forbes could summarize the survey's scientific understanding of the Illinois River. The bottomland lakes contributed to fish productivity in two ways, he argued. First, they provided shallow, still water for breeding and feeding grounds. Second, they supplied food for the fishes in the river proper. Forbes's early work on fishes showed that "virtually all our young fishes, whatever their adult habits may be, live at first on the same kind of food. . . . This first food—the minute plant and animal life of the water, called its plankton—is produced almost wholly in the backwaters." In flowing water, without continuous replenishment, all of the plankton would eventually be washed downstream, leaving the river devoid of food. Periodic flooding, however, added plankton to the river from the backwater lakes. Fish, he argued, had adapted to use the resources provided by the flood. They moved on rising water into the backwater areas where they bred; there, too, the young fish found an abundance of food. With falling water, the fish moved back into the

[11] *Biennial Report of the Director, 1893–1894* (Chicago: Illinois State Laboratory of Natural History, 1894), p. 17.

main channel. "The longer the period and the larger the scale of the spring overflow," Forbes wrote, "the better is the prospect for a heavy annual contribution to the population of the stream." As a result, he concluded, "the fish-producing capacity of the stream is thus proportionate, other things being equal, to the extent and fertility of the backwaters."[12] The work of the survey provided the first quantitative estimates of the productivity of the backwaters and documented the importance of the floodplain to the maintenance of fish populations in the river.

Forbes's emphasis on the connections between the river and the floodplain differed from the work of contemporary fisheries scientists. At the time Forbes began his studies, biologists emphasized the longitudinal nature of rivers: how fishes moved up- or downstream rather than from the main channel to the backwater lakes. For instance, the eminent fish biologist David Starr Jordan classified fishes according to their usual location along a river, starting with those typical of "lowland" areas and moving upstream to "channel," "upland," and "mountain" fishes.[13] Even when scientists considered the effects of flooding, the focus was typically on how floods washed species out of upstream areas rather than on how fish used the habitats of the floodplain. This emphasis on the longitudinal nature of rivers was also a feature of the earliest European literature, which classified fishes by their location. The only other prominent work on floodplains, that of Grigore Antipa on the Danube, appeared over thirty years after Forbes began his work on the Illinois River.[14]

FISHERMEN AND THE DEVELOPMENT OF FORBES'S RIVER ECOLOGY

Forbes's divergence from fisheries scientists in his understanding of a river as the connected waters of the channel and its floodplain built on the local culture of fishing on the river. Although Forbes and his colleagues at the survey established the scientific evidence for the importance of the floodplain to the fishery, the relation of the backwaters to fish productivity was already well known to fishermen. Over twenty years before Forbes delivered "The Lake as a Microcosm," Isaiah Prickett used his knowledge of the backwaters

[12] Stephen A. Forbes, "The Investigation of a River System in the Interest of Its Fisheries," in *Biological Investigations of the Illinois River* (Urbana: Illinois State Laboratory of Natural History, 1910), pp. 11–12, 12.

[13] David Starr Jordan, "The Distribution of Fresh-Water Fishes," in *Transactions of the American Fish-Cultural Association: Seventeenth Annual Meeting* (1888), pp. 4–24. This classification scheme emphasizing the upstream–downstream axis in rivers was certainly known to Forbes, as Jordan's paper immediately preceded a paper given by Forbes at the meeting of the American Fish-Cultural Association. See also Fred Mather, "Poisoning and Obstructing the Waters," in *Proceedings of the American Fish Culturists' Association: Third Annual Meeting* (1888), pp. 14–19; Marshall Mc'Donald, "A New System of Fish-way Building," in *Transactions of the American Fish-Cultural Association: Twelfth Annual Meeting* (1883), pp. 57–62; and Mc'Donald, "Natural Causes Influencing the Movements of Fish in Rivers," in *Transactions of the American Fish-Cultural Association: Thirteenth Annual Meeting* (1884), pp. 164–170.

[14] For work on flooding see, e.g., Victor E. Shelford, "Ecological Succession, I: Stream Fishes and the Method of Physiographic Analysis," *Biological Bulletin of the Woods Hole Marine Biological Laboratory,* 1911, *21*:9–35; and Charles C. Adams, "Baseleveling and Its Faunal Significance, with Illustrations from Southeastern United States," *American Naturalist,* 1901, *35*:839–851. Classification of river fishes in the European literature is discussed in H. B. N. Hynes, *The Ecology of Running Waters* (Toronto: Univ. Toronto Press, 1970), pp. 383–397. For Antipa's work see Grigore Antipa, *Regiunea inundabilă a Dunării: Starea ei actuală si mijloacele de a o pune in valoare* (Bucharest, 1910), cited in Robin L. Welcomme, *Fisheries Ecology of Floodplain Rivers* (London: Longman, 1979), p. 276. Forbes was familiar with this work, as Antipa had sent him a 1912 German translation, and was intrigued by how it might apply to the Illinois River. He ultimately concluded that the specific conditions of the Danube River made Antipa's recommendations inappropriate for the Illinois. See S. A. Forbes to C. J. Dittmar, 9 Jan. 1914; Forbes to Lyman E. Cooley, 4 Feb. 1914; Forbes to Paulus Schiemenz, 18 Feb. 1914; and Forbes to Robert Richardson, 27 Feb. 1914, Natural History Survey, Chief's Office, 1912–1931, Record Series 43/1/5, Box 2, University of Illinois Archives, Urbana.

and the river's fishes to great effect. In the 1860s he built a fish trap in the narrow slough that connected the Illinois River with Thompson Lake, the largest floodplain lake along the river. When the river flooded, the fish would move into the slough from the river and then into the lake. Prickett's trap was simple in design, essentially a box with a door in the middle, placed across the entire width of the connecting slough. As the water levels dropped, the fish would try to move back into the river. Prickett would open the trap's door, "and it would fill up with fish. Then he would raise it up and shove the fish out and then lower it again." Fishermen called this and related techniques the "shutting of a slough"; because the fishermen understood fish behavior in relation to the flood, "every one of [the fish] can be taken."[15]

Richard White, in his history of the Columbia River, emphasized the importance of "knowing nature through labor."[16] Through their labor, the fishermen on the Illinois River knew the natural history of the river species, their habits, and how to catch them. This fishermen's knowledge, based on decades of observing fish in order to catch them, became part of the scientific understanding of the ecologists. Recognizing their value, Forbes worked with fishermen from the beginning of his studies on the rivers of Illinois. As he came to appreciate fishermen's ability to contribute to the scientific knowledge of the Illinois River, he also began to understand them as people. Because of this understanding, the scientists would eventually connect their ecological work to political efforts to protect the fishery.

Beginning in 1876, while he was investigating the food habits of the fishes, Forbes worked with local fishermen on the Illinois, Ohio, and Mississippi Rivers. He was following in a tradition established by scientists at the U.S. Fish Commission, who interviewed marine and freshwater fishermen in their efforts to understand the causes of declines in the fisheries.[17] Yet unlike the Fish Commission scientists, Forbes established ties and a mode of research that continued for the next fifty years of his professional life. At first, Forbes felt both repelled and intrigued by the fishermen, whom he saw as extremely strange, "others" to whom he had difficulty relating. Though initially taken aback by the fishermen, their customs, and their living conditions, Forbes continued to work with them. Through ongoing contact, he forged an understanding and empathy that influenced his future work and contributed to his support of their interests. His letters home during these research trips are filled with descriptions of the fishermen and their families, houses, food, music, and character.

A series of letters that Forbes sent to his wife while on a collecting trip in the Kentucky

[15] Testimony of Richard England, transcript of *State v. New,* 280 Ill. 393 (23 Oct. 1917), RS 901, Supreme Court Trial Transcripts, Vault 36505, Illinois State Archives (hereafter cited as **transcript of State v. New**), Abstract, pp. 276–277 (describing how the trap worked). Because traps of this sort blocked access by other fishermen trying to enter the lake, they were often destroyed. After describing the trap, England, a fisherman, continued, "We took an ax and cut it out." *Report of Board of Illinois State Fish Commissioners, to the Governor of Illinois: October 1, 1894 to September 30, 1896* (Springfield, Ill.: Phillips Bros., State Printers, 1897) ("every one . . . taken").

[16] Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill & Wang, 1995), esp. pp. 3–29.

[17] S. A. Forbes to C. Forbes, 1 Nov. 1877, Folder I.B.1, Stephen Alfred Forbes Collection, Illinois Historical Survey Library, University of Illinois, Urbana (hereafter cited as **Forbes Collection**); and Dean C. Allard, *Spencer Fullerton Baird and the U.S. Fish Commission* (New York: Arno, 1978), pp. 92–93, 107. James W. Milner of the U.S. Fish Commission spent the summer of 1871 interviewing fishermen and fish dealers while investigating the Lake Michigan fisheries; see Milner, "Report on the Fisheries of the Great Lakes: The Result of Inquiries Prosecuted in 1871 and 1872," in *United States Commission of Fish and Fisheries: Report of the Commissioner for 1872 and 1873,* U.S. Senate, 42nd Cong., 3rd sess., 1874, Mis. Doc. 74, pp. 1–78. I thank Glenn Sandiford for directing me to these references. See also Bogue, "To Save the Fish" (cit. n. 2), p. 1439.

bottoms in 1879 documents his changing attitudes. At first horrified by the fishermen, Forbes wrote, "I am working alone on an indescribably dirty table . . . in the genuine Kentucky farm house—built up on stilts apparently to afford shelter for the pigs under it. . . . The boards of the floors are all loose and slip and rattle under our feet, and whatever is dropped falls through to the pigs." Three days later he continued, "My Kentucky friends with the best intentions, are fast becoming unendurable—but I shall endure them, nevertheless. . . . When you are worried [about our children] thank heaven that they are not pigs and drunkards, and vagabonds, and dogs and burs and dirt and flies in the butter and that they don't smell of mingled smoke and bacon grease nor swear nor drink nor chew. Whatever happens to you, console yourself by remembering that you are not in the Kentucky bottoms."[18]

Yet as he continued to work with them, Forbes developed an understanding of and empathy with the bottomlanders. While he complained of "our pigs—Kentuckians," he also began to realize that they might think him strange, and his activities annoying. "Perhaps they are writing scalding reports of us 'Yanks' to their friends and sweethearts," he speculated, asking his wife, "What would you think of a crew of boarders from a foreign land who should convert your back porch into a slaughter house, dress . . . catfishes thereon day after day, and tip all their scraps over the railing to the pigs under your house? Perhaps they don't like it any better." Displaying a growing empathy, he decided to set up his tent as a workroom rather than foul his hosts' house. After another week, Forbes had begun to establish a personal relationship with the fishermen. "I succeed quite to my own admiration," he declared, "in affiliating with these bottom-landers. We work and talk together with a mutual confidence quite touching." Although he still considered the Kentucky bottomlanders as "others," he began to paint them more sympathetically.[19]

Local fishermen played a crucial role in the scientific studies conducted by Forbes and the survey on the Illinois River over the following decades. The establishment of the field station was of paramount importance. The biological station at Havana linked Forbes's river research to a particular place. Prior to this, he had collected throughout the state, primarily on the Illinois, Mississippi, Fox, and Ohio Rivers. But with the establishment of the station, he set up a series of fixed sampling sites that linked his work not only to a particular habitat but to a particular community, its culture, and its politics. First and foremost, Havana was selected because of its access to floodplain lakes. Yet other considerations were important as well. It was on a direct rail line from the university, was situated on a bluff overlooking the river—which minimized the danger of malaria—and had access to springs providing clean water.

But Forbes and Kofoid, in different ways, also emphasized the broader context of the particular location, its specific social relations and importance to the state's economy. From the initial selection of the field site, aspects of the social environment entered into research decisions. Charles Kofoid's thoughts on the importance of location in planning fieldwork are made clear in his report on European biological stations, in which he drew on his experience at Havana. Kofoid wrote that biological stations were particularly well suited to take an important role in the "conservation of the aesthetic and economic resources of lakes and streams." Giving "special attention . . . to the economic or applied scientific phases of their activities," he discussed the pertinent considerations in locating a station. Biological stations that emphasized these applied questions, he noted, were "obviously

[18] S. A. Forbes to C. Forbes, 13 Sept. 1879, 16 Sept. 1879, Folder I.B.1, Forbes Collection.
[19] S. A. Forbes to C. Forbes, 17 Sept. 1879, 24 Sept. 1879, Folder I.B.1, Forbes Collection.

best located in or near great fishing centers where contact with fisheries problems is most intimate." Havana was just such a center. It had the largest fishery on the river, accounting for over 20 percent of the river's catch in 1896, just after the station was established. In 1908 Havana's catch amounted to 10 percent of that produced by all the freshwater fisheries in the United States.[20]

In his lyrical vignette on the Havana station, "Midsummer at the Biological Station," Forbes emphasized not Havana's practicality but its exoticism. Although "Biological Station" appeared in the title, no science was done in this piece; rather, it was an evocation of a place and its inhabitants. Though just a hundred miles from the survey's headquarters in Urbana, Havana was presented in the most exotic of terms: "a river scene, glowing under the semi-tropical heat of a July day." The wind was "an exhalation of the torrid zone, and leads one's imagination back along its course to the Orinoco and the Amazon." By the time Forbes wrote this piece the local bottomlanders were no longer the "pigs" of his first encounters; now his lyrical description romanticized them. Describing a family of bottomlanders, he wrote, "A boat juts out below—as primitive a boat as any on the Nile in the time of the Pharaohs,—and in it a man and two boys—also as primitive as Moses' Hebrews in the wilderness—they are crossing the stream from the little town behind us to the opposite bottom lands where they have their home in a temporary hut among the trees."[21]

While the vignette may seem odd as a description of a scientific research program, its emphasis on the local inhabitants was appropriate, given their importance to the station's work. These bottomlanders—fishermen, hunters, and boatmen—were central players in the scientific enterprise of the station. They worked as field assistants, guiding survey scientists in unfamiliar locations. They helped the scientists as laborers, rowing boats and collecting fish in their seines, trammel nets, and fish traps. Beyond this manual labor, however, they provided knowledge—both on how to catch fish and on their natural history. Because the fishermen had developed their working techniques over many decades, their gear was highly suited to the conditions of the Illinois River and its floodplain. They used a variety of nets and fish traps and developed boats that could navigate with heavy loads of fish on the often shallow and weed-choked backwaters. As scientists discovered that the techniques they brought from other areas were not effective, they adopted those of the local fishermen. Much of the equipment the survey scientists used to investigate the ecology of the river was modeled on that of the fishermen. When Kofoid needed a research boat to begin his studies of the river's plankton, he turned to a local builder to provide a boat designed "after the pattern of the fish boats—with a model bow, square stern and flat bottom." The fisheries researchers initially used a small, 40-yard seine, but Kofoid realized that the net was inadequate when he found that "we miss many things that the fishermen get." (See Figure 3.) He modified the survey's nets to match the commercial gear, with larger seines and the addition of gill nets.[22]

Fishermen also taught the scientists about the natural history of fish. Forbes filled his

[20] Charles Atwood Kofoid, "The Biological Stations of Europe," *United States Bureau of Education Bulletin, 1910,* no. 4, pp. xiii, 4. For the statistics see John W. Alvord and Charles B. Burdick, *Report of the Rivers and Lakes Commission on the Illinois River and Its Bottomlands, with Reference to the Conservation of Agriculture and Fisheries and the Control of Floods* (Springfield, Ill., 1915), p. 66.

[21] S. A. Forbes, "Midsummer at the Biological Station," n.d., Folder II.A.4, Forbes Collection.

[22] C. A. Kofoid to Forbes, 6 July 1897, Natural History Survey, Chief's Office, Chief's Correspondence, 1871–1909, Record Series 43/1/1, Box 8, Univ. Illinois Archives; and Kofoid to Forbes, 3 May 1899, RS 43/1/1, Box 10, Univ. Illinois Archives.

Figure 3. *"Seining in the Illinois River, Beardstown, Ill." This view is from a postcard mailed in 1909. Most seining took place not in the river itself, as depicted here, but in the backwater lakes. Prior to working for the Natural History Survey, Miles Newberry, Henry Allen, and other locals had worked on seine crews like this one. Postcard in possession of author.*

reports with commentary on the habits of the fish that he learned about from talking with fishermen. For instance, he noted that he had been "repeatedly assured by fishermen that the catfish seizes the foot of the mollusk . . . and tears the animal loose by vigorously jerking and rubbing it about. One intelligent fisherman informed me that he was often first notified of the presence of catfishes in his seine, in making a haul, by seeing the fragments of clams floating on the surface, disgorged by the struggling captives." Forbes was skeptical; yet when he examined the stomach contents of the catfish the absence of any shell fragments supported the observations of the fishermen. "How these fishes manage to separate mollusks . . . from the shell, I am scarcely able to imagine," he admitted. Later, when survey ecologists were investigating the effects of levee construction and sewage on fish populations, they specifically sought out the knowledge of locals, canvassing commercial fishermen along the length of the river for information on changing fish populations.[23]

As research frequently confirmed local knowledge, Forbes developed a trust in his informants that led him to seek their advice throughout his studies. When the survey established the field station in 1894 one of the first employees was a local fisherman, Miles

[23] For just a few examples of commentary on the habits of fish see S. A. Forbes, "Studies of the Food of Fresh-Water Fishes," *Bull. Illinois State Lab. Nat. Hist.,* 1888, 2(7):433–473 (quotation from p. 458); and Forbes and Robert Earle Richardson, *The Fishes of Illinois,* 2nd ed. (Springfield: Illinois State Journal Company, 1920), p. 70. On canvass of fishermen see Richardson to Forbes, 15 Apr. 1913; and "Fishes, Illinois River, De Pue to Hennepin: Testimony of F. L. Powers, De Pue, Ill., April 16," RS 43/1/5, Box 1, Univ. Illinois Archives. These data were published in Forbes and Richardson, "Studies on the Biology of the Upper Illinois River," *Bull. Illinois State Lab. Nat. Hist.,* 1913, *9*(10):481–574, on p. 537.

Newberry. (See Figure 4.) Newberry, born on a farm, had moved to the Illinois River at Havana in 1876, when he was eighteen. He was looking for farm work but soon got a job hauling a seine for a commercial fisherman on Thompson Lake. He acquired his knowledge of the Illinois River through his paid labor as a fisherman, deckhand, and engineer, as well as from subsistence activities: fishing in the summer, hunting in the spring and fall, and trapping in the winter. Newberry applied his skills for the survey, where he constructed and repaired nets, repaired the boats and engines, served as a river guide, helped with sampling, and acted as an unofficial liaison to other fishermen on the river. He also provided more specific advice on particular projects, recommending the sampling scheme for research on the distribution, migration, breeding habits, and food of the Illinois River fishes. Kofoid described Newberry as a "valuable" member of the survey staff; his experience as a fisherman and riverman played an important role in the development of their research program on the Illinois River.[24] Following the experience with Newberry, the survey continued to hire experienced fishermen to assist in its studies. When Newberry left after several years, his role was assumed by a young man, Hurley, who was the son of the foreman of a commercial fish crew. Hurley was initially hired as a laborer, to assist Newberry in the field sampling, but with Newberry's departure he became indispensable. When Hurley left in 1909 he helped train his replacement, Henry (Hank) Allen, the foreman of a commercial seine crew.

Not all local fishermen were regarded as experts. Kofoid, for instance, found some of them unreliable as to the location of good fishing grounds. The survey thus sought not just local knowledge, but expert knowledge. Some fishermen knew the habits of fishes better than others; some were more familiar with local waters. Discussions of the qualifications of the fishermen give an indication of the skills that survey scientists valued. Some fishermen, like Newberry, were hired for their local expertise—their knowledge of local waters and their skill at fishing and in piloting boats and repairing equipment. Allen, too, was "thoroughly experienced in handling fishing tackle, launches, and engines"; Richardson was a bit concerned that his "knowledge of local waters is perhaps not so minute . . . having moved here from Bath only 3 years ago." Others were hired simply for their labor, at least initially: Kofoid described Hurley as "a good steady stout lad of 19 who can do a man's work at seining and hauling boats."[25]

In addition to local knowledge and physical strength, the scientists also sought fishermen who would fit in with the more educated staff of the station. Some of the ambivalence that was revealed in Forbes's early letters from the field persisted in the dealings of the survey with the fishermen. Kofoid referred to some local fishermen as "river toughs," while Richardson wrote of "Havana's bed bugs, river rats and other human insects." Scientists described other fishermen with a backhanded compliment: "in intelligence far above ordinary fishermen." Other colleagues apparently shared Forbes's initial shock at the filthiness of the locals: one of the key criteria for hiring fishermen was personal cleanliness. "Personally he is neat and clean, above the ordinary for fishermen," wrote Richardson of Hank Allen. (See Figure 5.) Scientists were also concerned about maintaining proper authority. Allen "is a few years older than I am," Richardson worried. But he concluded that "considering

[24] Testimony of Miles Newberry, transcript of *State v. New,* Record, pp. 965–986; "University of Illinois Biological Station," *Illini* (Champaign), 28 Feb. 1896, *25*(20):315–320; Kofoid to Forbes, 23 June 1898, RS 43/1/1, Box 8, Univ. Illinois Archives; *Biennial Report of the Director for 1899–00* (Urbana: Illinois State Laboratory of Natural History, 1901), pp. 3–4; and Kofoid to Forbes, 31 July 1898, RS 43/1/1, Box 8, Univ. Illinois Archives.

[25] Kofoid to Forbes, 28 Apr. 1899 (?), 23 Apr. 1899, RS 43/1/1, Box 10, Univ. Illinois Archives.

Figure 4. *"Bottom-lands at High Water." Ecologist Charles Kofoid is in the bow, with fisherman Miles Newberry in the stern. Newberry was a local fisherman and hunter hired as a field assistant by the survey. This 1895 photograph appears staged to show the scientist as "local." Compare this scene with Stephen Forbes's vignette describing life on the Illinois River: "A boat juts out below—as primitive a boat as any on the Nile in the time of the Pharaohs,—and in it a man and two boys—also as primitive as Moses' Hebrews in the wilderness—they are crossing the stream from the little town behind us to the opposite bottom lands where they have their home in a temporary hut among the trees. One of them, standing in the bow, paddles the boat with a single oar, first on this side and then on that, another stands in the middle." (S. A. Forbes, "Midsummer at the Biological Research Station," n.d., Folder II.A.4, Forbes Collection.) Photo courtesy of the Illinois Natural History Survey.*

the facts as I have observed them . . . I think there is no good reason in sight for fearing we could not get along." Before hiring fishermen, survey scientists often asked around among the wealthier fish dealers for references. These fish dealers, among the "respectable" citizens of Havana, helped provide an entrée into the seamier world of the laborer and the independent fisherman.[26]

ECOLOGISTS AND THE STRUGGLE FOR THE FLOODPLAIN

Aside from local knowledge of fishes and their habits and habitats, scientific understanding of the river was also informed by the political struggles over resource use in which the fishermen were involved. Prior to 1880, the floodplain had been treated as a commons.

[26] Kofoid to Forbes, 21 July 1897, RS 43/1/1, Box 8; Richardson to Forbes, 16 Jan. 1913, n.d., RS 43/1/5, Box 1; and Richardson to Forbes, 3 Oct. 1909, RS 43/1/1, Box 10, Univ. Illinois Archives. The dealers reported, for instance, that Allen was regarded as "steady and well behaved, industrious and responsible."

Figure 5. *Robert Richardson (left) and Henry Allen (right) with a seine. Before working for the survey, Allen was a foreman of a fishing crew for one of the larger commercial fishing operations on the river. As a survey employee, he was to care for the boats and perform routine collecting. Richardson acknowledged Allen in a paper: "We had also as field helper, at the oars and in every service in which help was needed, an experienced, intelligent, and interested fisherman and mechanic, to whom is due no small part of the credit for whatever success attended the season's operations." (R. E. Richardson, "Observations on the Breeding Habits of Fishes at Havana, Illinois, 1910 and 1911,"* Bulletin of the Illinois State Laboratory of Natural History, *1913, 9[8]:405–416, on page 405.) Photo courtesy of the Illinois Natural History Survey.*

Up and down the river, people harvested the fish, hunted waterfowl, grazed their livestock on floodplain grasses, cut timber, and collected pecans. Beginning in the 1880s, wealthy sportsmen began buying up the floodplain and restricting access to these once-public areas. Independent commercial fishermen protested these changes by trespassing, poaching, and legal challenges. As the protests increased, hunting clubs and other landowners gave up on preserving flooded areas for the pleasure of private duck hunting and began looking for a new kind of profit. They converted their holdings to cropland by building levees and draining the enclosed lakes and wetlands. In response to the loss of these waters, fishermen increased their protests. Matters came to a head in 1908, when about fifty armed fishermen prevented a dredge from completing an agricultural levee that would drain an important fishing lake.[27]

Survey scientists quickly recognized the threat to the fishery that drainage represented. In the 1890s, early in the survey's studies, Kofoid wrote that "the development in recent

[27] Schneider, "Enclosing the Floodplain" (cit. n. 1).

years of extensive systems of levees in the bottoms of the Illinois River for the purpose of protecting farm lands from untimely floods increases the importance of, and necessity for, the reservoir backwaters." In 1910, as the pace of levee construction quickened and its harm to the fishery became apparent, survey scientists repeated their warnings against drainage. "Nothing can be more dangerous to the continued productiveness of these waters than a shutting of the river into its main channel and the drainage of the bottom-land lakes for agricultural purposes," declared Forbes to the American Fisheries Society. By 1910, two fifths of the floodplain had already been drained, and "in the face of the gigantic interests—agricultural, industrial, commercial, and political—which are now mustering along its course," Forbes worried that the remainder of the floodplain would be destroyed and the fishery permanently decimated.[28]

The impending loss of the floodplain suggested new research questions and experiments. Forbes's research began to focus on a new problem: how to protect the fishery of the river from drainage. This was both an ecological problem and a political one. "Since 1910," Forbes wrote, "we have given all our work a turn towards the fisheries interest." Forbes thought it would be exceedingly difficult to fight the "gigantic interests" threatening the floodplain; backwater lakes would be drained as long as drainage remained the most profitable use of the land. In an attempt to reverse the cost-benefit analysis, Forbes encouraged research to make the fishery more economically valuable so that it could compete with agriculture. One obstacle to protecting the fish industry was the low price commanded by the dominant commercial fish, the carp. While valued in Europe and among immigrant communities in the United States, the carp was not broadly popular in America. In collaboration with Forbes, Dr. Nellie Goldthwaite, a member of the household science department at the University of Illinois, developed recipes for carp that might increase demand and thus its price.[29] If carp sold at higher prices, floodplain areas might be more valuable as wetlands than drained and plowed into fields.

In addition, Forbes began investigating a method of growing both crops and fish on the floodplain. In this scheme, akin to crop rotation, the floodplain would be rotated between wetlands and crops as it was flooded one year and kept dry the next. Forbes outlined a set of experiments to determine whether aquatic plants and animals could remain dormant in the floodplain soils until reflooded. He instructed Richardson to collect earth "from places which were overflowed last spring and are now dry, and from other places which were overflowed two years ago but not since—possibly from some which have been now dry for three years"—and to place the earth in aquaria where it would be reflooded.[30] Forbes

[28] C. A. Kofoid, "Plankton Studies, IV: The Plankton of the Illinois River, 1894–1899, with Introductory Notes upon the Hydrography of the Illinois River and Its Basin, Pt. 1: Quantitative Investigations and General Results," *Bull. Illinois State Lab. Nat. Hist.,* 1903, *6*(2):95–629, on p. 568; and Forbes, "Investigation of a River System" (cit. n. 12), p. 14. Other ecologists also became concerned with the protection of their research sites. Henry Cowles was involved in efforts to protect the Indiana Dunes where he had done his pioneering work on succession; see J. Ronald Engel, *Sacred Sands: The Struggle for Community in the Indiana Dunes* (Middletown, Conn.: Wesleyan Univ. Press, 1983), pp. 79–84.

[29] S. A. Forbes, "Notes of Conference between the Illinois State Game and Fish Conservation Commission and the Director of the Natural History Survey, Urbana, Ill., November 11, 1913," p. 3, RS 43/1/5, Box 1; and Forbes to Rivers and Lakes Commission, 19 Mar. 1914, RS 43/1/5, Box 2, Univ. Illinois Archives. On the status of the carp—which fetched about a fifth its German price in U.S. markets—see Alvord and Burdick, *Report on the Illinois River and Its Bottomlands* (cit. n. 20), pp. 124–126. Regarding the efforts to increase demand see Forbes to Dittmar, State Game and Fish Conservation Commission, 12 Dec. 1913; and Forbes to N. E. Goldthwaithe [*sic*], Household Science Department, 20 Mar. 1914, RS 43/1/2, Box 2, Univ. Illinois Archives. For some recipes see N. E. Goldthwaite, "The Cooking of Carp," *University of Illinois Bulletin,* 1915, *13*(9):1–9.

[30] Forbes to Rivers and Lakes Commission, 19 Mar. 1914. This scheme was suggested by the work of Antipa.

was interested in which plants and animals would be present after various periods of desiccation. This information would be necessary to determine the potential availability of food for newly hatched fish larvae and thus the proper cycle of rotation between dry-land agriculture and fish culture.

Forbes's research priorities had political implications. Recreational and commercial fisheries interests were in conflict over this period. Research on rotational use of the floodplain and encouraging the use of carp was directed toward preserving the health of the "wild fishery" rather than developing methods of fish culture.[31] While fish culturists of the period emphasized the role of hatcheries in augmenting populations produced in the wild, Forbes worked to protect the floodplain lakes from drainage and so to preserve the ability of the river and floodplain to produce fish without augmentation. While hatcheries were primarily developed for increasing sport-fish production, the effort to preserve the wild fishery of the Illinois River supported the political interests of the commercial fishermen because it emphasized protection of the habitat—the floodplain lakes that produced the wild fishes they targeted.

In addition to concerns with overall productivity, conflict on the river centered on access: whether fishermen would have the right to fish on the privatized floodplain. Denial of access affected researchers as well and helped move the survey into a direct political role in the struggle. As privatization expanded, the survey could no longer get access to important study sites, and the scientists found themselves to be political allies of the fishermen in much more direct ways. Further, as the conflict over access propelled agriculturalists and speculators to levee the bottomlands, the very lakes the biologists were studying were destroyed. "Owing to the drainage of this lake our operations in this locality must cease with the present season," Kofoid wrote of Phelps Lake in 1898.[32]

The political interests of the fishermen and the survey coalesced in the struggle to prevent Thompson Lake from being drained. The survey's relationship to both fishermen and locale was epitomized by its long history of involvement with this lake. Thompson Lake was one of the largest of the backwater lakes on the Illinois River and had supported a commercial fishery since the mid-nineteenth century. In 1894 Forbes chose it as one of the regular sampling stations for his work on the backwaters of the Illinois River. Starting that year, every one to three weeks survey scientists sampled the fishes, plankton, and bottom organisms of Thompson Lake and five other nearby localities. In 1901, however, the owner sold the lake to the Thompson Lake Rod and Gun Club, which began restricting access.[33] Fishermen became militant in protecting their rights of access, while survey scientists first became explicitly involved in the politics of conservation. Individual fishermen and scientists who had begun working together in the field in the 1890s joined forces in the courts to involve the State of Illinois in the effort to preserve public access to the floodplain and protect the fishery interests.

As the club put up "No Trespassing" signs and hired wardens to patrol the lake, local fishermen and hunters fought back. In March 1907 wardens attempted to arrest William Cobb for poaching in Thompson Lake. A gun battle ensued in which Cobb was seriously

[31] Forbes to Richardson, 28 Feb. 1911, RS 43/1/5, Box 2, Univ. Illinois Archives. On the interest conflict see *Report of State Fish Commission to the Governor of Illinois: September 30, 1884* (Springfield, Ill.: Rokker, State Printer and Binder, 1884), p. 18; and *Report of State Fish Commissioners, from October 1, 1898, to September 30, 1900,* p. 2.

[32] *Biennial Report of the Director for 1897–98* (Urbana: Illinois State Laboratory of Natural History, 1898), p. 15.

[33] Transcript of *State v. New,* Abstract, p. 214.

wounded. That fall fishermen began to poach in earnest; this protest continued well into 1908 as the traditional users of the lake continued to assert their rights to harvest its resources. The club responded by seeking injunctions against trespass by the commercial fishermen. The federal court obliged and in 1908 granted an injunction preventing anyone from fishing, hunting, or boating on Thompson Lake without the permission of the club.[34]

These restrictions applied to the survey scientists as well as the belligerent fishermen. Without permission from the club, they could not conduct their research on Thompson Lake. At the time, Richardson was exploring new ideas about why fish populations were greater in some areas of the river than others. He was especially interested in how physical conditions, such as the characteristics of the bottom material and the size of inlets and outlets to the river, affected fish populations. To answer this question, he wanted to compare Thompson Lake, the most productive on the river, with Matanzas Lake, which supported far fewer fish. However, with the injunction in force, the club had forced Richardson to agree to a rigid set of conditions before he was allowed to conduct fieldwork on the lake. Rather than being allowed to design the sampling to answer the research questions, he had "been forced to it by conditions and events." The resultant sampling scheme left Richardson frustrated, "without any certain feeling . . . that it is the one we should continue to follow." In 1909 he complained bitterly to Forbes about these restrictions. Survey workers were prevented from taking any fish to sample; that right was reserved to John Schulte, a wealthy commercial fisherman who had signed a lease from the club. Instead, they had to examine Schulte's hauls to collect their data. They were allowed to sample plankton, but their access was severely proscribed and they could not use their motor launches, a restriction that turned what should have been short research trips into day-long endeavors. Even permission for this limited access was precarious. "For the purposes of keeping the ducks undisturbed," Richardson wrote, "even row boats are excluded, except in special cases, from the lake." At first Richardson merely asked Forbes to contact the club's manager to seek broader permission for sampling, noting sarcastically, "I suppose we must put up with such trivial inconveniences as that in the interests of a few full game bags." After a few days' consideration, however, he requested a more political intervention. He again wrote to Forbes, this time suggesting that the Illinois attorney general should challenge the injunctions against trespass on the survey's behalf.[35] These injunctions were originally filed to prevent poaching by poor fishermen. Suggesting that they be challenged put the survey firmly on the side of the local fishermen in their dispute with the wealthy sportsmen.

Richardson's concerns appeared to be primarily scientific: he wanted to address particular research questions but was prevented from doing so by the privatization of the floodplain. It was Forbes who placed these concerns in the broader context of conserving the river and its fisheries for both scientific and social reasons. While Forbes did not take the specific steps Richardson suggested, he became active in supporting public access to the floodplain. He recommended to Illinois's newly established Rivers and Lakes Commission that "the reservation of the most valuable feeding grounds and breeding grounds of fishes might well be undertaken by whatever legal process is necessary and possible. . . . Conservation of the fish and game of the state, and a permanent maintenance of the fertility of the reclaimed lands, must be taken into full account." When the commission asked for comments on a draft report concerning the future of the floodplain, Forbes suggested strengthening its conclusion regarding the importance of public waters: "I wish it might

[34] *Ibid.,* Abstract, p. 130.
[35] Richardson to Forbes, 19 Oct. 1909, 21 Oct. 1909, RS 43/1/1, Box 10, Univ. Illinois Archives.

be possible to add something further on the importance of retaining or obtaining for the public these waters."[36]

As pressure—from both poachers and the State of Illinois—to establish public rights to Thompson Lake increased, the Thompson Lake Rod and Gun Club gave up the plan to maintain a hunting and fishing reserve and reorganized itself into a levee district in order to drain the lake for agriculture. The affected fishermen, recognizing the permanent threat that drainage represented, went out on Thompson Lake in 1913, in deliberate defiance of the injunction and intending to be arrested, in order to test the ownership of the lake in the courts. Among them was Miles Newberry. This former survey employee, whom Forbes described as having "served the station very efficiently from the beginning," now tested the law in order to challenge the right of the gun club to drain Thompson Lake. The fishermen argued that "Thompson Lake is a public body of water owned by the State of Illinois." When the club sued them for trespassing, the State of Illinois joined the case on the fishermen's side.[37] Thompson Lake became a test case of the state's right to assert ownership and control on the Illinois River floodplain in the interests of conservation.

The state developed a strategy for establishing public rights to the floodplain that reflected the complicated nature of local and scientific knowledge developed on the river. Part of the strategy was based on testimony as to the half-century of use of the lake by the public: the state called upon local fishermen, hunters, and rivermen to document the navigability of the lake and its history as a public hunting and fishing area. Second, the state called upon survey scientists to testify as to the public importance of the lake in scientific terms. In 1914 the Rivers and Lakes Commission wrote to Forbes, inviting him to testify "regarding action against the encroachment on Thompson Lake." Forbes, in turn, instructed Richardson to "make a special point of attendance there, being especially prepared, of course, to testify concerning the value of the lake as a public fisheries ground." In the hearing on trespass, both Richardson and Newberry spoke in support of public access to Thompson Lake. Newberry testified to his knowledge of the river, drawing on his history of use of Thompson Lake from 1877 on, including his work for the Natural History Survey. Richardson testified concerning his scientific studies of the river.[38] The Thompson Lake case, which ultimately reached the Illinois Supreme Court, was decided in 1917 in favor of the Thompson Lake Rod and Gun Club, despite the combined testimony of fishermen and scientists. In 1922 the lake was drained and the land converted to agriculture.

THE BOUNDARIES OF ECOLOGY

Ecology's practical orientation and engagement with local resource politics stemmed from the nature of practitioners' work in the field. Working alongside local fishermen, hunters, and farmers, ecologists learned of an area's natural history; this knowledge was incorporated into the developing science. Similarly, the concerns of the local residents about

[36] Forbes to Rivers and Lakes Commission, 19 Mar. 1914, RS 43/1/5, Box 2; and Forbes to J. W. Alvord and C. B. Burdick, 22 June 1915, RS 43/1/5, Box 3, Univ. Illinois Archives.

[37] *Biennial Report of the State Laboratory and Special Report of the University Biological Station, 1895–1896* (Chicago: Illinois State Laboratory of Natural History, 1896), p. 19 (on Newberry); and Transcript of *State v. New,* Record, pp. 2059 (quotation), 2079.

[38] Forbes to Richardson, 5 Nov. 1914, RS 43/1/5, Box 4, Univ. Illinois Archives; and testimony of Miles Newberry, Record, pp. 965–986, and testimony of Robert Richardson, Record, pp. 1047–1060, 1068–1076, transcript of *State v. New.*

environmental change were also incorporated into ecology, moving scientists into the politics of conservation. In responding to the influence of local knowledge and politics, the scientists were forced to redefine ecology into what Thomas Gieryn terms a "hybrid," a science that could encompass expanding influences and aims.[39]

Two of Forbes's papers, which span his own career as well as the period of the birth of ecology in the United States, illustrate the development of this hybrid science and its connections to social relations. In the 1880 paper in which Forbes first expressed his concept of the microcosm, he also discussed the nature of applied ecology. He spoke of the need for a "*working knowledge*" of nature, an understanding of how to manipulate elements like "its edible fishes, its injurious and beneficial insects, and its parasitic plants" for the benefit of humans. Forbes argued that the only way for this working knowledge "to have an applicable value" was through a complete understanding of all an area's species and their interconnections, achieved via a "comprehensive survey of our entire natural history."[40] From his first thinking about the interdependence of life in an ecological community, Forbes was concerned with the applications of this work to issues of fisheries, forestry, and farming.

By the end of his career, Forbes had come to define his "working knowledge" of nature as "ecology." In his 1921 presidential address to the Ecological Society of America he discussed the basic nature of ecological science, which he defined not as "an academic science merely" but, rather, "that part of every other biological science which brings it into immediate relation to human kind."[41] Confronted with conflicts between the demands of a "pure" science and the need to establish and advance ecology and its institutions, Forbes had mapped the boundaries of the new science and developed a complex endeavor that straddled the borders of objective and political, pure and applied, local and scientific.

Local struggles over the floodplain brought the survey ecologists into the realm of environmental politics. Once there, the ecologists drew on locals for explicitly political ends that went beyond issues of the floodplain to questions concerning state fish policy and Chicago's sewage. This political involvement raised difficulties for the ecologists as they sought to maintain their reputations as objective scientists. Forbes, based at the Natural History Survey in Urbana, may have been physically removed from day-to-day interactions with the fishermen, but he was by no means politically distant. He relied on Richardson as his contact with the fishermen and other interests on the river. Just as ecologists had learned about the natural history of the river from the locals, they sought locals' perspective on the river's politics. In seeking Richardson's advice on how he should respond to proposed changes in the state fish and game laws, Forbes commented, "You have the great advantage that you have been in close contact with fishermen and fishing operations for several years."[42] Richardson lived on the river in Havana and was in close communication with many of its factions.

Forbes depended on Richardson's connections to help him fight the dumping of Chicago sewage into the river that began in 1900. George Soper, a member of a commission making recommendations on Chicago's sewage, wrote Forbes about his plan to recommend that the city invest in an expensive filtration plant to reduce its discharge to the Illinois River. He also warned Forbes that there was no chance that his plan would be implemented unless

[39] Gieryn, *Cultural Boundaries of Science* (cit. n. 7), esp. Ch. 5: "Hybridizing Credibilities: Albert and Gabrielle Howard Compost Organic Waste, Science, and the Rest of Society," pp. 233–335.

[40] Forbes, "Food of Fishes" (cit. n. 9), p. 19 (emphasis in original).

[41] Stephen A. Forbes, "The Humanizing of Ecology," *Ecology,* 1922, *3*:89–92, on p. 90.

[42] Forbes to Richardson, 29 Jan. 1913, RS 43/1/5, Box 1, Univ. Illinois Archives.

the politicians saw some evidence of downstream opposition to Chicago's waste. Forbes quickly wrote to Richardson, asking him to canvass his contacts on the river for information about political opposition to Chicago's sending sewage down the Illinois River. "Can you give or send me," he wrote, "any protests or other expressions, by people along its banks, of serious discontent with the condition of the river?"[43]

Forbes was convinced that preservation of the river depended on a marriage of scholarly science with practical politics. Having been warned by scientists in other states, however, about the dangers of political involvement, Forbes recognized that involvement in river politics could damage his and the survey's credibility.[44] He thus worked to create a public image of scientific objectivity even while striving to influence state policy. When a wealthy member of a hunting and fishing club asked Forbes to support his candidacy for fish commissioner, Forbes replied that even if he did have a preference, he was prevented by the new civil service law from supporting any candidate. This professed disinterest was belied, however, when Forbes quickly wrote to Richardson to ask who the commercial fishermen supported. He intended to send the governor a general list of qualifications for the position, thus influencing the makeup of the commission without explicitly supporting one candidate. As conflicts escalated and their political work became more crucial, Forbes sought to distance the survey from charges of playing politics. He defended attacks on Richardson for criticizing the Chicago Sanitary District in public lectures by describing him as "simply . . . a biological expert" whose research and conclusions were "public property and must be held at the disposal of any one concerned in their use and application."[45] This public face of scientific objectivity, however, was only a mask for the survey's deep political involvement.

The political goals of ecology were related to its practical applications, its influence on decisions concerning the harvesting of resources and the degradation of the environment. Working at the boundary of scientific and political ecology required simultaneously treading the border between ecology as pure and applied science. One of the reasons for Forbes's emphasis on the practical utility of ecology can be found in his struggles to fund the Natural History Survey. Scientific institutions in the nineteenth century often lacked secure funding, and administrators emphasized the practical benefits of their work to their patrons.[46] Forbes's annual reports and letters to the governor all stressed the benefits that accrued to the state from his work. As state entomologist, Forbes did a good deal of work with the farmers and the agricultural establishment of Illinois and frequently argued for the practical value of his basic entomological research. He saw agricultural experiment stations as an institutional model for supporting both basic and applied aquatic ecology. Forbes drew

[43] G. A. Soper to Forbes, 15 Mar. 1915, RS 43/1/5, Box 6; and Forbes to Richardson, 17 Mar. 1915, RS 43/1/5, Box 4, Univ. Illinois Archives.

[44] Tarleton H. Bean to Forbes, 21 Jan. 1914, RS 43/1/5, Box 2, Univ. Illinois Archives. The New York State Fish Culturist had written: "You know how nearly impossible it is to administer a scientific Bureau in politics. One of the prime requisites for success . . . is freedom from the handicaps which invariably exist wherever places depend upon political favor."

[45] Forbes to F. W. Shepardson, Director of Education, State Department of Registration and Education, 21 Feb. 1920, RS 43/1/5, Box 13, Univ. Illinois Archives (concerning Richardson). On the matter of the fish commissioner see B. G. Merrill to Forbes, 12 Nov. 1916; Forbes to Merrill, 14 Dec. 1916; Forbes to Richardson, 29 Dec. 1916; and Richardson to Forbes, 1 Jan. 1917, RS 43/1/5, Box 7, Univ. Illinois Archives.

[46] On efforts to fund the survey see Bocking, "Stephen Forbes" (cit. n. 8), pp. 471–472. On practical emphases more generally see Smith, *Pacific Visions* (cit. n. 3), pp. 107–122; Hugh Richard Slotten, "The Dilemmas of Science in the United States: Alexander Dallas Bache and the U.S. Coast Survey," *Isis,* 1993, *84*:26–49; and Sharon E. Kingsland, "An Elusive Science: Ecological Enterprise in the Southwestern United States," in *Science and Nature,* ed. Shortland (cit. n. 3), pp. 151–179, esp. pp. 175–179.

parallels between aquiculture and agriculture, referring to the Illinois River as a "flowing soil" and to plankton as its "crop," in an attempt to connect an agricultural perspective to river ecology. Kofoid also likened the benefits of aquatic field stations to those of agricultural experiment stations: "Biological stations may do in our country for aquiculture what experiment stations have done, and are doing, for agriculture."[47]

Forbes was concerned with applied issues not just because they could help fund the survey, however. He saw the utility of ecological work as a fundamental part of the science. One could no more study "pure" ecology than humans could remove themselves from nature. As the fledgling Ecological Society of America was beginning to deal with issues of conservation, pollution, the establishment of natural areas, and the like, Forbes took up the question of the "humanizing of ecology," its need to consider human welfare. If people were part of nature—which Forbes thought self-evident—then ecology, as the science that examines the interactions of animals and plants with each other, was uniquely able, of all the biological sciences, to address practical problems. "Ecology is . . . the humanistic science *par excellence,*" he argued. In fact, "the applied—the applicable—part of each of these sciences is simply and solely the ecological element which enters into its make-up."[48]

Yet Forbes resisted the notion that ecology was merely practical. When it was suggested that the survey be responsible for investigating fishing methods "with a view to the fullest utilization of remaining fisheries resources," he complained that such a task "would pull us completely off from our scientific program and put us into a field of purely practical experimentation." Forbes was driven to search for knowledge about the workings of nature as well as to provide practical advice for the exploitation of that nature. At the outset of the survey's studies, he emphasized that although the work they planned "should stand in the closest possible relation to the general public welfare," it should promote "pure science" and not be limited "to the economic field." In outlining to Richardson the series of experiments on floodplain rotation, Forbes emphasized the novelty of this research, stating that "nothing of the kind has been done in this country, at least." One of the attractive aspects of the work was that it would produce new knowledge, not simply that it would be useful. Forbes saw the two approaches to ecological study as complementary and always pursued both.[49]

Investigation of the Illinois River fisheries was one of the primary problems in applied ecology addressed by Forbes. The survey scientists developed a complicated relationship with the local knowledge they collected from inhabitants while doing this work: they appreciated its importance but sought to differentiate it from science. Perhaps in order to set his infant science of ecology apart from the local knowledge on which it was based. Forbes drew a distinction between the practices of ecology and fishing. "I have been at work on the Illinois River . . . as a biologist and not as a fisherman," he declared. Forbes

[47] Bocking, "Stephen Forbes," p. 472; Stephen A. Forbes and Robert Earle Richardson, "Some Recent Changes in Illinois River Biology," *Illinois Nat. Hist. Surv. Bull.,* 1919, *13*(6):147; and Kofoid, "Biological Stations of Europe" (cit. n. 20), p. xiii. See Charles E. Rosenberg, *No Other Gods: On Science and American Social Thought* (1976; Baltimore: Johns Hopkins Univ. Press, 1997), pp. 135–210, on the development of the agricultural experiment stations and tension between pure and applied research.

[48] Forbes, "Humanizing of Ecology" (cit. n. 41), p. 90. For a history of ecologists' thinking on the role of humanity in ecological systems see Eugene Cittadino, "The Failed Promise of Human Ecology," in *Science and Nature,* ed. Shortland (cit. n. 3), pp. 251–283.

[49] Forbes to Richardson, 8 Oct. 1915, RS 43/1/5, Box 6, Univ. Illinois Archives; *Biennial Report of the Director, 1893–1894* (cit. n. 11), p. 15; and Forbes to Richardson, 20 Jan. 1914, RS 43/1/5, Box 2, Univ. Illinois Archives. On the complementary roles of pure and applied in Forbes's science see Bocking, "Stephen Forbes" (cit. n. 8), pp. 471–473.

and his survey colleagues further distinguished their scientific knowledge from fishermen's knowledge by prefacing accounts of information provided by fishermen with qualifiers meant to assure scientific readers that the data were reliable. Richardson referred to one fisherman as "experienced and unusually intelligent," while Forbes and Richardson wrote of "reliable, experienced, and unusually well-informed fishermen of our acquaintance." At times Forbes commented on the fishermen's lack of ecological understanding. Claiming that they didn't understand the importance of noncommercial fishes like the gizzard shad as food for valuable species, he criticized them for leaving "long lines of this species to rot on the bank where the seines are hauled."[50]

These distinctions emphasized that scientific knowledge of the Illinois River, though based in the local culture of fishing, had different aims than the local knowledge of the fishermen. There were limits to the usefulness of fishermen's knowledge for the scientists. For instance, fishermen's information often pertained only to the time of commercial harvest, while the scientists wanted to sample fish from the river throughout the year. Further, the scientists often wanted live material for study, while fishermen generally didn't need to keep their catch alive. The set nets used by the commercial fishermen were not useful for the scientists because unless they were checked constantly the fish would be killed and unusable. Fishermen, on the other hand, sought efficient ways of catching the fish within the constraints of marketability. A good catch for the fishermen—one that made the effort expended worthwhile—was much larger than a good catch for the scientists, who simply wanted a representative sample of species composition and material for museum specimens and laboratory experiments. Given their different needs, fishermen and scientists regarded different areas of the river as interesting.[51]

Nonetheless, Forbes not only relied on the local knowledge of the fishermen in developing his science but began to make claims for the local nature of scientific expertise as well. In a summary of his research on the effects of pollution on the upper Illinois River, Forbes prefaced the scientific information with a discussion of his own and coauthor Richardson's qualifications. Forbes reported that he "began work, as a biologist, on Illinois River problems some thirty-six years ago." In contrast, he noted only one pertinent point about Richardson: "the junior author has virtually lived on the river for purposes of investigation during the last four years." Truly to understand the river and its ecology, Forbes implied, one needed not only the biologist's knowledge but also the insights gained by knowing the river in a different way: one had to live on the river, to understand it as a local. Richardson was uniquely able to write of the biology of the river because he had lived there, gaining knowledge from everyday experience as only a resident could. As Forbes emphasized the importance of local knowledge in understanding an ecological system, he was simultaneously claiming that Richardson could legitimately be considered a local—that his knowledge was of a similar nature to that of the fishermen. Richardson also saw himself as a local in Havana—albeit one placed in a particular class stratum. Working for over a month on algae in the Missouri Botanical Garden in St. Louis, he was eager to leave: "I am not seeking to stay here; on the contrary will be very glad when I

[50] Forbes,"Notes of Conference, November 11, 1913" (cit. n. 29), p. 2; R. E. Richardson, "Observations on the Breeding Habits of Fishes at Havana, Illinois, 1910 and 1911," *Bull. Illinois State Lab. Nat. Hist.,* 1913, *9*(8):405–416, on p. 405; Forbes and Richardson, "Studies on the Biology of the Upper Illinois River" (cit. n. 23), p. 537; and S. A. Forbes, "The Food of Illinois Fishes," *Bull. Illinois State Lab. Nat. Hist.,* 1878, *1*(2):71–89, on p. 72.

[51] Kofoid to Forbes, 3 May 1899, 8 May 1899, and Richardson to Forbes, 19 Oct. 1909, RS 43/1/1, Box 10, Univ. Illinois Archives.

am ready to leave." Despite Havana's problems and the escalating conflict between fishermen and gun clubs, he felt at home there. "I am usually pretty well there, have a few good friends there, and when it come to a choice would much rather be there than here"—even, he added, "if the day comes when I have to go armed."[52]

But the scientists were not the only ones drawing boundaries between authoritative and nonauthoritative knowledge of the floodplain lakes. As scientists were taking on the mantle of "local," fishermen attempted to take on the mantle of "expert." In some cases fishermen claimed their own authority and undertook their own scientific investigations. Since one of the issues in the legal arena concerned water depth and the definition of navigability, a number of fishermen skated out on the frozen waters of a disputed lake to measure its depth. Drilling holes in the ice, they sounded the bottom. These measurements were used to support their claim to the navigability and, thus, state control of the waters. Rather than relying on other locals' vague recollections of depth during certain seasons ("I have seen it plumb dry except a little pond which is kind of muddy, but what you might call plumb dry"), these fishermen provided facts: "The deepest water we found was five feet, ten inches. The shallowest water was five feet, two inches."[53]

Yet even though they could rightly be regarded as experts on the natural history of the river's fishes, fishermen ultimately ceded authority to scientists. This shift in claims to authoritative knowledge is evident in the Thompson Lake court case. Both scientists and fishermen testified to the importance of Thompson Lake to the fishery. Asked to state his "opinion" on this matter, Richardson replied: "I should say we can give more than our opinion. We have facts to prove that the general condition is superior to almost all the other lakes for fish." In contrast, when asked a similar question by the lawyers, a commercial fisherman, Charles Rudolph, testified, "It is the best lake we have along the Illinois River." Asked for his "opinion for the reason of that," he continued, "It has got a better feeding ground." When asked to justify his "opinion," he did not allude to his thirty-seven years of experience as a commercial fisherman or to the habits of the "thousands" of fish he had observed on the Illinois River. Instead of presenting himself as an expert on the fishery, he pointed to the new experts on the Illinois River, the ecologists. He knew Thompson Lake was a better feeding ground, he replied, because "this Bug Man tests it." Asked if he meant the man "from the University of Illinois," Rudolph agreed. "That man that comes down here says it is the best."[54]

CONCLUSION: THE "LOCAL" IN "THE LAKE AS A MICROCOSM"

By analyzing the local context of Forbes's famous paper "The Lake as a Microcosm," this essay demonstrates how social relations on the river shaped the ecological work done there

[52] Forbes and Richardson, "Studies on the Biology of the Upper Illinois River" (cit. n. 23), p. 481; and Richardson to Forbes, 16 Jan. 1913, RS 43/1/5, Box 1, Univ. Illinois Archives (I thank Rob Kohler for calling my attention to this letter). Richardson had been on the river four years; but note his worries that Allen's knowledge—based on three years' experience at Havana—was not "minute" enough.

[53] Testimony of Philip Horchem, p. 61; testimony of Wilton Bull, pp. 163–164; and testimony of John Whitehead, pp. 159–163, on p. 162, Abstract, transcript of *Schulte v. Warren,* 218 Ill. 108 (24 Oct. 1905), RS 901, Supreme Court Trial Transcripts, Vault 29362, Illinois State Archives.

[54] Testimony of Robert E. Richardson, transcript of *State v. New,* Record, p. 1051; and testimony of Charles H. Rudolph, transcript of *State v. New,* Record, pp. 957–964, on p. 960. When challenged under cross-examination—"How do you go at it to make the study of fish and their habits?"—Rudolph replied, "I have been in the fish business for thirty-seven years, almost. And I know pretty near every move a fish makes I have seen them. I have seen thousands of them spawning and I have seen thousands of them that wasn't spawning" (p. 963).

and the development of fundamental theories of ecology. The many connections between scientists and "the local" were embodied in the research described in and flowing from this paper. Forbes's ecological studies were localized on the Illinois River floodplain in complex ways. At its simplest, "local knowledge" referred to the ecologists' scientific knowledge of particular floodplain lakes. Understanding why one lake supported a large fishery while another was home to only a few fish required a detailed, localized study.

Although the understanding of fish populations in key lakes was in itself important to the ecologists, they also sought to apply that knowledge to novel situations. How did the knowledge of these particular lakes become generalized in the theories of ecologists? Forbes used the narrative trope of the "microcosm" to universalize the scientific knowledge he derived from one lake. In a single isolated lake an ecologist could see "the play of life" at work on a scale amenable to observation and "mental grasp."[55] The interactions Forbes observed in these microcosms revealed the importance of interactions in ecology in general.

Yet other aspects of the local were also key to the understanding of Forbes's ecology. Fishermen, too, knew individual lakes: specific areas in a lake good for trapping fish, beaches useful for landing a seine, or spots where particular species of fish spawned. The knowledge of fishermen and hunters about specific habitats, the natural history of the fish, and how to catch them was essential to the developing research of the survey. Fishermen worked for the survey scientists, contributing their labor and expertise. Further, as the scientists learned about the river and its aquatic life from the fishermen, they also learned about the fishermen's lives and political struggles. The scientists forged friendships and came to identify with the people who lived on the river and depended on its resources. Ecology incorporated not only the local knowledge of the resident fishers and hunters but their perspectives on the changing environment. As a result, the survey scientists became strong advocates for the preservation of public access and became embroiled in a struggle with elites over control of the floodplain. Over the course of almost five decades of working in close contact with commercial fishermen, Forbes's scientific research reflected the culture of fishing on the river. As ecology established itself, its borders were mapped and remapped, and the knowledge and concerns of local people over environmental transformation became incorporated into the science. Through that incorporation, however, ecology had simultaneously devalued the local knowledge on which it was based.

[55] Forbes, "Lake as a Microcosm" (cit. n. 1), p. 77.