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Keeping Up with the *E. coli*: Considering Human-Nonhuman Relationships in Natural Resources Policy

ABSTRACT

Environmental policies, from the management of microbes to the management of wolves, demonstrate that natural resources policy can either overlook or ignore important relationships between humans and nonhumans. This is, in part, because the regulatory science and sociology of expertise that inform policymaking can exacerbate a preconceived separation between humans and other beings. This article begins by exploring the limits and inadequacies of current agricultural policy through an analysis of the antimicrobial politics of food safety, from the creation of organic compost to artisanal cheeses. Next, it considers the shortcomings of natural resources policy in light of another set of emerging human-nonhuman relationships: the reemergence of wolves in Wisconsin. These case studies are useful for rethinking how policymaking should focus more on relationships between people and nature and less on individual human agency and exclusive, separate elements such as an endangered species or pathogenic microbes. Lastly, this article concludes by describing possible natural resources policy attributes conducive to building and creating new relationships of stewardship and sustainability.

I. INTRODUCTION: MICROBES AS AN EMERGING NATURAL RESOURCE

A flood of new information about microbial life, generated during the past decade by advances in genetics research and information technologies, has opened up new possibilities for industry and offered a fundamental rethinking of some of our most basic ideas regarding species, organisms, and evolution. New lab technologies have allowed scientists to move beyond isolated explorations of single, cultured microbes to being able to analyze the collective genomes of thousands of microorga-

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nisms harvested from their natural environments. Scientific research on microbial behavior reveals that individual microbes of the same species can exhibit quite different behaviors and that microbes communicate and respond to environmental conditions in complex ways.¹ In this section, a brief summary of some of the new microbial science and its implications is provided. Also discussed is food-safety legislation and practices that have emerged in the wake of a number of large-scale food illness outbreaks caused by microbial contamination of food as well as a contradiction between new science about microbes and existing agricultural policy. Current agricultural policy is dominated by a “command-and-control” approach to human-microbial relationships; however, actual control over microbes is proving an elusive goal. The ability of microbes to evolve rapidly makes controlling them a challenge, and, as is discussed in the following section, efforts to exert control run counter to many sustainable agricultural practices and may actually compound problems.²

Microbes form heterogeneous assemblages of different species called biofilms. Biofilms represent a prevalent mode of microbial life and involve a shift in both the physiology of individual cells and also in the behavior of those cells. “We liken the multispecies bacterial biofilm to a city where bacteria settle selectively, limit settlements of new bacteria, store energy . . . and transfer genetic material horizontally all for the good of the many,” state researchers Watnick and Kolter.³ These biofilms have been discovered on a wide array of natural and human-made surfaces including human skin, the surface of the ocean, hot springs, water pipes, and teeth. The nature of these microbial communities is inspiring a rethinking of long-held notions about life’s processes and organization. Scientists have observed microbes communally discarding and absorbing genes as needed, in response to changes in their environment. This “horizontal gene transfer,” the non-genealogical transfer of genetic material from one organism to another, explains the rapid development of

1. Jo Handelsman & Kornelia Smalla, *Conversations with the Silent Majority*, 6 CURRENT OPINION IN MICROBIOLOGY 271–73 (2003); CARL ZIMMER, *MICROCOSM: E. coli and the New Science of Life* (2008); Ece Karatan & Paula Watnick, *Signals, Regulatory Networks and Materials that Build and Break Bacterial Biofilms*, 73 MICROBIOL. MOL. BIOL. REV. 310–47 (2009); Henry Fountain, *Bacteria on the Move, Eating Their Fill*, N.Y. TIMES, NOV. 4, 2008.

2. GEOFFREY CANON, *SUPERBUG: NATURE’S REVENGE: WHY ANTIBIOTICS CAN BREED DISEASE* (Virgin 1995).

3. Jeffrey Perkel, *Microbiology Vigil: Probing What’s Out There*, THE SCIENTIST, May 5, 2003, at 40; Paula Watnick & Roberto Kolter, *Biofilm, City of Microbes*, JOURNAL OF BACTERIOLOGY, May 2000, at 2675, 2678.

drug resistance in some strains of bacteria and suggests new avenues for evolution.⁴

Research on the microbial communities of the human body has revealed that each of us possesses unique microbial communities. For example, the human forearm has been found to harbor some of the most diverse assemblages of microbial species anywhere on the body.⁵ The human gut has “indigenous” microbes that researchers believe play a positive role in intestinal health, but some of these microbes have disappeared due to the widespread use of antibiotics. Other types are associated with lower rates of asthma in children.⁶ Pharmaceutical and other industries are watching these developments carefully, banking on commercial technologies relating to everything from treatments of bacterial infections, to environmental cleanup and energy production.⁷

Reading the pages of scientific publications and the mainstream press detailing these remarkable discoveries and their implications, one might be led to anticipate a growing appreciation for microbial diversity

4. Nigel Goldenfeld & Carl Woese, *Biology's Next Revolution*, NATURE, Jan. 25, 2007, at 369. They write, “[o]ur view of competition in a communal world as a dynamical process is very different from the widely understood notion of Darwinian evolution ‘Survival of the fittest’ literally implies that there can only be one winner from the forces of selection, whereas in a communal world, the entire distributed community benefits The most general sense in which we mean competition . . . is the complex dynamical rearrangement of the community structure. This is an extraordinary time for biology,” the authors conclude, “because the perspective we have indicated places biology within a context that must necessarily engage other disciplines more strongly aware of the importance of collective phenomena.” Tal Dagan et al., *Networks and Cumulative Impact of Lateral Transfer in Prokaryote Genome Evolution*, 105 PNAS 10039–44 (2008); Howard Ochman et al., *Lateral Gene Transfer and the Nature of Bacterial Innovation*, NATURE, 18 May 2000, at 299. New research indicates that microbial species do not always have set beneficial or negative characters but change according to conditions and context. Even pathogenesis, for example, has been described as a “relationship” between host organisms and microbes, which cannot be grouped into strictly “virulent” and “nonvirulent” categories.

5. Elizabeth K. Costello et al., *Bacterial Community Variation in Human Body Habitats Across Space and Time*, SCIENCE, at 1694.

6. Elizabeth Bik et al., *Molecular Analysis of the Bacterial Microbiota in the Human Stomach*, PROC NAT'L ACAD SCI, Jan. 17, 2006, at 732; Martin Blaser, *Pathogenicity and Symbiosis: Human Gastric Colonization by Helicobacter Pylori as Model System of Amphibiosis*, Presentation at the National Academy of Sciences' workshop: *Ending the War Metaphor: The Future Agenda for Unraveling the Host-Microbe Relationship* (Mar. 16–17, 2005), available at <http://www.iom.edu/Object.File/Master/25/911/Blaser%20War%20Metaphor%20Talk%20REV.pdf>; Yu Chen & Martin J. Blaser, *Helicobacter pylori Colonization Is Inversely Associated with Childhood Asthma*, 198 THE JOURNAL OF INFECTIOUS DISEASES 553–560 (2008); Imke E. Mulder et al., *Environmentally-Acquired Bacteria Influence Microbial Diversity and Natural Innate Immune Responses at Gut Surfaces*, 7 BMC BIOLOGY 79 (2009).

7. Andrew Pollack, *Drug Makers Listen In While Bacteria Talk*, N.Y. TIMES, Feb. 27, 2001.

and increasing tolerance for an ecological point of view on human-microbial symbiosis. There are certainly calls for a shift in discourse and practice;⁸ however, a tolerant view of microbes has been challenged by recent food-related illnesses. Furthermore, many U.S. policies related to managing microbes in agricultural production reveal a dominant antimicrobial and command-and-control approach, with broad implications for agricultural practice.⁹ Although new restrictions on the indiscriminate use of prophylactic antibiotics in meat and egg production have emerged,¹⁰ antibiotic drug use continues to be routine in spite of increasing evidence of the spread of antibiotic resistance in animals, people—especially farm workers—and even soil. In fact, increased concern over food safety in recent years has encouraged new policies and management practices that actually discourage microbial diversity and fly in the face of longstanding sustainable agricultural practices.¹¹

II. THE ANTIMICROBIAL POLITICS OF FOOD SAFETY

Food safety is a hot issue in the United States. Food-related illnesses have been growing, if not in number, certainly in scale, in part a

8. Ari Johnson & John Swerdlow, *Living with Microbes*, THE WILSON QUARTERLY, Spring 2002, at 42.

9. According to the Union of Concerned Scientists, livestock operations add human antibiotics to the feed of animals to accelerate animal growth and prevent diseases common in crowded and unsanitary living conditions. “An estimated 70 percent of antibiotics produced in this country—nearly 13 million pounds per year—are used in animal agriculture for these nontherapeutic purposes. This amount is estimated to be more than four times the amount of drugs used to treat human illness,” available at http://www.ucsusa.org/food_and_agriculture/solutions/wise_antibiotics/pamta.html (last visited Sept. 19, 2010).

10. The Preservation of Antibiotics for Medical Treatment Act of 2009, H.R. 1549, 111th Cong. The bill proposes “[t]o amend the Federal Food, Drug, and Cosmetic Act to preserve the effectiveness of medically important antibiotics used in the treatment of human and animal diseases.” The bill was introduced by Rep. Louise Slaughter [D-NY] in March of 2009 and referred to the House Committee on Energy and Commerce, available at <http://www.govtrack.us/congress/bill.xpd?bill=H111-1549> (last visited Aug. 5, 2010). A previous iteration introduced by Slaughter in 2007, was referred to House Subcommittee on Health in February of 2007 and no further action was accomplished, available at <http://www.govtrack.us/congress/bill.xpd?bill=H110-962> (last visited Sept. 19, 2010). In 2003, McDonald’s Corp. made a move to prohibit the use of antibiotics belonging to classes of compounds approved for use in human medicine when used solely for growth promotion purposes. The effort applies to suppliers where McDonald’s has a direct relationship in the meat purchasing supply chain, which means poultry suppliers, available at http://www.crmcdonalds.com/publish/csr/home/report/sustainable_supply_chain/product_survey/antibiotics_and_animal_cloning.html (last visited Aug. 5, 2010).

11. Mirill Ingram, *Fermentation, Rot, and Other Human-Microbial Performances*, *Knowing Nature: Conversations Between Political Ecology and Science Studies*, in KNOWING NATURE: CONVERSATIONS AT THE INTERSECTION OF POLITICAL ECOLOGY AND SCIENCE STUDIES (Mara J. Goldman, Paul Nadasdy & Matthew D. Turner eds., forthcoming 2011).

reflection of an increasingly concentrated industrial food production system. Our troubled food production system and concerns over public health and food-related illness have led to new “clean farming” practices, which ironically run directly counter to farming practices developed by sustainable farmers with human health and the larger healthy functioning of the food production system in mind. In this Part, food-safety regulation is examined in terms of sustainable farming practices and food-safety risks. This new regulation ignores existing beneficial human-microbial relationships with unfair implications for the people most intimately involved. These regulatory relationships affect everything from farmers working to create compost to nourish organic crop fields to growing produce in a way that minimizes synthetic chemical use and even the methods for producing a variety of specialty cheeses.

The extremely dangerous, sometimes lethal, 0157:H7 strain of the common *Escherichia coli* (*E. coli*) bacteria was found in Nestlé Toll House refrigerated cookie dough made in Virginia in June 2009 after 72 people in 30 states were sickened. In October of 2008, salmonella bacteria in peanut butter from a Peanut Corp. of America plant in Georgia killed nine people, and an estimated 22,500 became ill. Some of these outbreaks have occurred from contaminated fresh produce, implicating practices in the field as well as food processing. In June 2008, salmonella on serrano peppers grown in Mexico sickened over 1,000 people in 41 states, with 203 reported hospitalizations and at least one death. Dole bagged spinach processed at Earthbound Farms in California was contaminated by *E. coli* 0157:H7 in September 2006. The outbreak killed four people, sent 103 to hospitals, and devastated the spinach industry.¹²

A. Scorched Earth Farm Policies

In direct response to the increasing number of large-scale food-safety illness outbreaks during this decade, the U.S. Department of Agriculture (USDA) and a number of commercial vegetable producer organizations and buyers are creating new guidelines to minimize the possibility of bacterial contamination of field crops. These “Good Agricultural Practices” require farmers to remove vegetative buffers along waterways and around organic crop fields and to eliminate hedgerows, ponds, and other places that might harbor *E. coli*-spreading wildlife.¹³

12. Carol Lochhead, *Crops, Ponds Destroyed in Quest for Food Safety*, S.F. CHRON., July 13, 2009.

13. Western Growers Association. *Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens*, available at <http://www2.wga.com/DocumentLibrary/scienceandtech/LGMAAcceptedGAPs07.10.09.pdf>. Also, *Commodity Specific Food Safety Guidelines for the Lettuce and Leafy Greens Supply Chain*, Apr. 25,

Under the guidelines, areas that were once left unplowed, unmowed, or unplanted to promote biodiversity, harbor beneficial insects, and to protect water quality now may be required to be cleared or baited with poison in order to kill any wildlife harbored there that could potentially spread bacteria to crops. Farmers following these guidelines report poisoned wildlife being eaten by hawks and other birds of prey, who then become sick themselves.¹⁴

Consumer concern about the safety of food can be a formidable political force. In the 1990s, U.S. consumer groups were very active in changing a recalcitrant food system to include regulation for the production of organic foods, which many consumers saw as a healthier alternative to the existing industrial paradigm.¹⁵ In an ironic twist on this concern, practices designed to protect wildlife and promote biodiversity, with the end goal of producing healthier crops in a more sustainable manner, are now considered food-safety risks.¹⁶ Organic farmers, for example, aim to create a biodiverse farm system and to avoid synthetic fertilizer and pest-control inputs by exploiting natural relationships between microbes, insects, plants, and animals to create fertile soil, to manage weeds and pests, and to produce bountiful, nutritious crops.¹⁷ However, under the USDA's National Organic Program, organic farmers are required to pursue practices such as planting hedgerows and vegetative buffers to minimize soil erosion, provide refuge for beneficial insects, and increase farm biodiversity.¹⁸ All these practices can now be viewed as potential sources of bacterial contamination of crops.

2006, available at <http://www.fda.gov/Food/FoodSafety/Product-SpecificInformation/FruitsVegetablesJuices/GuidanceComplianceRegulatoryInformation/ucm168630.htm> (last visited Sept. 19, 2010).

14. Glen Martin, *Farms May Cut Habitat Renewal over E. coli Fears*, S.F. CHRON., Dec. 19, 2006, available at http://articles.sfgate.com/2006-12-19/news/17326089_1_wildlife-habitat-coli-restoration-projects (last visited Sept. 19, 2010).

15. Mrill Ingram & Helen M. Ingram. *Credible Edibles: The Development of Federal Organic Regulations*, in ROUTING THE OPPOSITION: SOCIAL MOVEMENTS, PUBLIC POLICY, AND DEMOCRACY 121–48 (David Meyer ed., 2005).

16. “[T]he process of establishing these guidelines and turning them into standards that must be met to enter certain markets has been a purely technical one, and has not included organic or diversified farms as part of the discussion. Neither the FDA nor the USDA uses these guidelines or the certification process to address root causes of this specific *E. coli* problem. The bacteria *E. coli* 0157:H7 is most often traced to contamination from manure produced in large feedlots.” Russell Libby, *Food Safety Concerns Are Leading to Solutions That Won't Work for Small and Diversified Farms*, Maine Organic Farmers & Gardeners Association, May 9, 2007.

17. Mrill Ingram, *Biology and Beyond: The Science of Back-to-Nature Farming*, 97 ANNALS OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS 298–312 (2007).

18. USDA National Organic Program, 7 U.S.C. §§ 6501–6522; 65 Fed. Reg. 80637 (Dec. 21, 2000) (to be codified at 7 C.F.R. pt. 205.2(C)).

Fears over food safety in crop production are also challenging sustainable agriculture by producing legislative proposals that eclipse hard-won distinctions between conventional agriculture and organic and other alternative growing practices. Organic farmers are wondering how a new food-safety law might affect the National Organic Program's requirements for cover crops, intercropping, vegetative buffers, and other practices fundamental to farming systems based on managing interspecies relationships and promoting biodiversity. For instance, the Food Safety Enhancement Act of 2009, passed by the House of Representatives in July of 2009¹⁹, authorizes the Food and Drug Administration (FDA) to promulgate wide-ranging regulations to "ensure the safety of the nation's food supply."²⁰ A similar bill, the F.D.A. Food Safety Modernization Act, was overwhelmingly approved by the Senate Health, Education, Labor and Pensions Committee in November 2010.²¹ Farmer advocates have voiced concerns about record-keeping and surveillance requirements, as well as the types of marketing arrangements that may ensue from the law, all of which can create disadvantages for smaller-scale and direct-market farmers.²²

B. Limits on Organic Compost

Another example of how antimicrobial attitudes affect environmental policy and limit the practices of organic farmers is the rule for the use of compost in the USDA's National Organic Program. The rule requires that farmers follow specific guidelines for producing and using compost. These requirements, informed by existing federal agency guidelines on municipal compost production rather than by organic agricultural tradition, lay out a very specific definition of proper compost. For example, the compost guidelines detail temperatures reached and the number of times the compost must be turned.²³ The results provide

19. Food Safety Enhancement Act of 2009, H.R. 2749, 111th Cong. (2009).

20. Congressman John D. Dingell, Remarks after the Committee on Energy and Commerce unanimously passed the "Food Safety Enhancement Act of 2009 (June 17, 2009), <http://dingell.house.gov/news/press-releases/2009/06/090617FoodSafetyMarkup.shtml>.

21. F.D.A. Food Safety Modernization Act, S. 510, 111th Cong. (2010).

22. National Sustainable Agriculture Coalition, *A Sustainable Agriculture Perspective on Food Safety*, (Nov. 11, 2010), http://sustainableagriculture.net/wp-content/uploads/2010/11/Sustainable-Food-Safety_FINAL.pdf (last visited Dec. 8, 2010); see also, Russell Libby, Commentary, Food Safety Policy Update: Sept. 23, 2009, Maine Organic Farmers and Gardeners Association (MOFGA), available at <http://www.mofga.org/Programs/PublicPolicyInitiatives/MOFGAPositionStatements/FoodSafety/tabid/1102/Default.aspx?PageContentID=421> (last visited Nov. 18, 2010).

23. Soil fertility and crop nutrient management practice standard, 65 Fed. Reg. 80637 §§ 205.203 (Dec. 21, 2000).

good compost but ignore other proven routes to safe compost production. Furthermore, the guidelines are scale-insensitive and place additional burdens on smaller organic farmers who must keep paperwork and invest in compost pile-turning technologies in order to produce “certified” compost.²⁴

C. A Case Study on the Food-Safety Regulatory Limits on Artisan Cheese

If the idea of defending technologies that promote a diversity of microbial life seems to be an unnecessary flirtation with risk, it might be useful to consider the regulation of a different product of human-microbial relationships: cheese. In recent decades, artisan cheesemaking has blossomed in the United States and has provided critical cultural and economic opportunities in a climate that is otherwise extremely difficult for small producers.²⁵ Many of these artisan cheesemakers use unpasteurized milk, also known as raw milk. In the United States, these producers have never been able to legally engage in interstate commerce of traditional raw-milk cheeses such as Camembert, but many make their own popular raw-milk cheeses, including ones styled on cheddar, emmentaler, gruyère, morbier, parmigiano-reggiano, pecorino romano, reblochon, tomme de Savoie, and Vermont shepherd. The artisan cheese industry, virtually absent in the United States until the last 20 to 30 years, is now supporting a diversity of farmers across the country.²⁶

In attempting to control illness outbreaks associated with milk, however, the U.S. food-safety command-and-control approach threatens to ban all raw-milk cheese. A comparison of different regulatory approaches to cheese production reveals that U.S. regulations, in contrast to the European Union (E.U.) policies, place limits on agricultural practice

24. Mrill Ingram, *Disciplining Microbes in the Implementation of U.S. Federal Organic Standards*, 39 ENVIRONMENT AND PLANNING D 2866–82 (2007).

25. JEFFREY P. ROBERTS, *THE ATLAS OF AMERICAN ARTISAN CHEESE*. WHITE RIVER JUNCTION, VERMONT (2007). Roberts reports on over 350 artisan cheesemakers across the United States.

26. Artisan, or farmstead, cheese production has increased significantly in the United States to almost 900 million pounds in 2006. There does not appear to be any reliable data on the number, size, or ownership of artisan cheese producing facilities, and it is not unlikely that, as the specialty cheese market grows, larger dairies may be increasingly moving into what was a dominantly small farm enterprise. However, according to a report produced by the California Milk Advisory Board, specialty cheese consumption, produced by at least 350 different farms in that state alone, increased 94 percent between 1994 and 2003, for a value of \$6.4 billion in 2003, available at <http://www.allbusiness.com/food-beverage/food-industry-dairy-dairy-products/5542373-1.html> (last visited Aug. 4, 2010).

that inhibit the creation of products that many people value highly for economic, cultural, and health reasons.

In the United States, the interstate commerce of raw milk was regulated in 1949 but the use of raw milk in cheese was not regulated until 1979, at which point the requirement was established that if a cheese is made with unpasteurized milk, it must be aged for 60 days at temperatures not less than 35 degrees Fahrenheit.²⁷ Advocates of artisan cheese argue strongly that milk, as the essential ingredient in cheese, must be extremely fresh, from healthy, well-fed cows, and unpasteurized. They contend that pasteurized milk negatively impacts the taste and texture of cheese,²⁸ and point to peer-reviewed science to argue that pasteurized-milk cheese presents its own risks. Pasteurization, they claim, destroys enzymes in raw milk that aid digestion of sugars, fats, and minerals in the milk and other foods, as well as a cortisone factor that can help control allergies.²⁹

There is ongoing disagreement in the United States about the safety of human consumption of raw-milk cheeses, however, and the federal government regularly entertains a complete raw-milk cheese ban.³⁰ In contrast, legislation in countries in the E.U. allows raw milk in cheese production as long as producers comply with self-controls based on the system of hazard analysis and control points. The regulations in both the United States and the E.U. are backed by plenty of peer-reviewed science, but the E.U. also considers “social factors” such as consumer demand, cultural expression, and economic opportunity.³¹ The sale of raw-milk cheeses in Europe has been valued at \$7 billion annually.

The efficacy of U.S. food-safety regulations in preventing food-illness outbreaks remains to be seen, but this case study reveals how

27. 21 C.F.R. §§ 133.150, 133.182, 133.187 all refer to the production of various cheeses, and create a 60-day aging requirements for raw-milk cheese. For example, 133.150(d) states: “If the milk used is not pasteurized, the cheese so made is cured at a temperature of not less than 35 [degrees Fahrenheit] for not less than 60 days.”

28. Burkhard Bilger, *Raw Faith: The Nun and the Cheese Underground*, NEW YORKER, Aug. 19, 2002, at 150. Bilger notes that a healthy underground market exists for fresh cheeses made with unpasteurized milk.

29. Harry G. West, *Food Fears and Raw-Milk Cheese*, 51 APPETITE 25–29 (2008).

30. Heather Paxon, *Post-Pasteurian Cultures: The Microbiopolitics of Raw-Milk Cheese in the United States*, 23 CULTURAL ANTHROPOLOGY 15–47 (2008).

31. Marsha A. Echols, *Food Safety Regulation in the European Union and the United States: Different Cultures, Different Laws*, 4 COLUM. J. EUR. L. 525, 530 (1998). Echols cites an E.U. “green paper” on general principles on food and law in the European Union: “Scientific advice is of primary, but not exclusive importance. Community legislation has on a number of occasions recognised that other factors, in particular consumer needs and concerns, must also be taken into consideration during the decision-making process.”

these policies can detrimentally and unfairly burden artisan farmers. In contrast to artisan producers, industrial cheese producers' concern is not the highest quality milk, but an assured, plentiful supply of affordable milk that is safe for human consumption even if it has traveled many miles to a cheesemaking plant. While pasteurization is a good way to accomplish this, as a mandatory requirement for cheesemaking, the process shuts out a whole economic and cultural world of cheese production.

The human health threats of pathogenic microbes are very real; we want to be extremely careful in how we manage human-microbial relationships. Medical and ecological science question the design of agricultural policies that indiscriminately minimize the diversity as well as the number of bacteria in our food system. Misuse of antibiotic drugs can produce more virulent strains of the microbes they were designed to eliminate, and removing vegetative buffers in crop fields also removes beneficial insects and invites an increase in soil erosion and water quality issues. It is not clear that these kinds of regulations will make our food system any safer, but it is clear that these policies have immediate inequitable implications for farmers pursuing diverse, sustainable production and for smaller-scale growers who must take on additional record keeping and surveillance technologies.

What is circumscribed by current food-safety policy is not only the existence of a particular microbe, but productive, negotiated relationships between humans and nonhumans worked out over time. The agricultural policies described above create an idea of risk such that a whole range of possible positive human-nonhuman interactions are precluded, and with the additional negative result that more people are excluded from practices that involve working with a diversity of nonhuman organisms. As demonstrated above, these practices affect the production of specialty cheeses and organic compost to nourish crop fields as well as produce grown in such a way to minimize synthetic chemical use and to protect water quality.

III. THE ENDANGERED SPECIES ACT AND WOLVES IN WISCONSIN

While these discussions over the pros and cons of relationships with invisible bodies may seem specialized, there are parallels in natural resource policy regarding relationships between people and other types of nonhumans. Protection of wolves under the Endangered Species Act (ESA) for the last 36 years has been remarkably effective in the upper Midwest. Thanks to the ESA, the subspecies eastern timber wolf (later reclassified as the gray wolf) was protected beginning in 1974 and has staged an impressive comeback, especially in northern Minnesota where

they were never totally extirpated. For most of the places in Wisconsin that wolves inhabit, they have only returned in the last one to two decades, however, and they are returning to a landscape utterly changed from that previously inhabited by their ancestors. Thus, new relationships have emerged between wolves and their environment, much of which now includes people. These relationships range from positive ones, if people experience a healthier forest ecosystem with more flowers in the woods and fish in the streams, and fewer deer on the roads, to negative relationships, as people repeatedly lose livestock, have to pay for fencing or other types of protection, or lose a beloved pet. As one might expect, this process of developing strategies for coexistence requires investment, such as providing people with opportunities for education, positive interactions, and a feeling of control and participation in the development of management plans. As will be discussed in this Part, endangered species policy can create barriers to this process by relying on thresholds that are not ecologically defensible, and by perpetuating static notions of nonhuman behavior.

A state bounty on wolves existed in Wisconsin from 1865 until 1957. Because of this bounty, by 1900, wolves had disappeared from southern Wisconsin, and by 1950, less than 50 wolves remained, living in the extreme northern part of the state. In 1957, wolves were listed as a protected species, but the wolf population was down to a handful of wolves, and in 1960 it was considered extinct.³²

Grey wolves were reclassified from endangered to threatened in Minnesota in 1978, and Minnesota has likely been the source for wolves subsequently moving into northern Wisconsin. The wolf was moved to threatened status in Wisconsin in 1999, when the state's wolf number reached 200. At that point, the Wisconsin Department of Natural Resources settled on a goal of a minimum of 350 wolves for further delisting "as a reasonable first attempt at assessment of social tolerance."³³ However, a number of subsequent rulings over the past few years by the U.S. Fish and Wildlife Service (USFWS) to delist the wolf have been followed by challenges from environmental groups and animal rights groups opposed to wolf hunts, calling for a reinstatement of ESA protections. Most recently, in September of 2009, the USFWS moved to rein-

32. RECOVERY OF GRAY WOLVES IN THE GREAT LAKES REGION OF THE UNITED STATES: AN ENDANGERED SPECIES SUCCESS STORY (Adrain P. Wydeven, Timothy R. Wan Deelen & Edward J. Heske, eds. 2009) [hereinafter RECOVERY WOLVES].

33. WISCONSIN DEP'T OF NAT. RES., WISCONSIN WOLF MANAGEMENT PLAN (1999), available at <http://www.dnr.state.wi.us/org/land/er/publications/wolfplan/pdfs/wolfmanagementplan.pdf>.

state the ESA protections for the gray wolf in the western Great Lakes that were removed in February of 2007.³⁴

While the forests of the northern part of the state were expected to provide suitable habitats for wolves, wolves have also moved into Wisconsin's Central Forested Region (CFR). The area was not considered prime wolf real estate, in part because, while not densely populated by humans, it is crisscrossed by roads and cut off from the wilder, northern forests of the state by a wide belt of land intensively managed for agriculture. Since 2000, however, CFR wolves have thrived, increasingly inhabiting areas near humans. One pack's territory abuts the city of Wisconsin Rapids, which has a population of about 20,000 people. Other packs have regular rendezvous sites within view of workers in cranberry beds.³⁵

The presence of wolves in Wisconsin generates a whole gamut of responses, reflected in controversies generated by efforts to delist the grey wolf and to create post-delisting management. Bear hunters who use hunting dogs are a small but very vocal group, concerned over the potential loss of their dogs to wolves. Some people who live near wolves hold some of the more negative attitudes toward the animals because they more frequently suffer from losses of livestock or pets as a result of the proximity. As a result, wildlife managers in the area tend to emphasize the need for lethal as well as nonlethal approaches to "wolf-human" conflicts in order to avoid losing public support.³⁶ Other residents of areas with wolves have different attitudes. The Ojibwe people, who have tribal reservations in northern Wisconsin, traditionally view the wolf, *Ma'iingan*, as a brother. For an Ojibwe person, therefore, occasional conflict with a wolf is as natural, and about as significant, as occasional disagreements with a brother, and likewise, consider lethal control as fratricide.³⁷

The Endangered Species Act is generally regarded as a great success in bringing wolves back to Wisconsin. The ESA has clearly done its job in protecting gray wolves and allowing the animals to return to many areas in the state. At this point, however, a more finely tuned process is necessary to assist people in negotiating different attitudes toward wolves and to come to agreements about how humans and wolves can coexist. The Wisconsin State Department of Natural Resources has since

34. RECOVERY WOLVES, *supra* note 32.

35. Richard P. Thiel, Wayne Hall Jr., Ellen Heilhecker & Adrian P. Wydeven, *A Disjunct Gray Wolf Population in Central Wisconsin*, in RECOVERY WOLVES 107–15.

36. Adrian Treves, *Beyond Recovery: Wisconsin's Wolf Policy 1980–2008*, 13 HUMAN DIMENSIONS OF WILDLIFE 329, 329–38 (2008).

37. Peter David, *Ma'iingan and the Ojibwe*, in RECOVERY WOLVES, 267–77.

the 1980s pursued multiple strategies to “promote coexistence” and to develop workable wolf management plans at the state level supporting public outreach and education programs, providing forums for diverse stakeholders, and creating state policies to navigate the fraught territory created by divergent views on lethal control, wolf hunting, livestock compensation and other issues.³⁸

The ruling that overturned the February 8, 2007, ESA final rule to delist the gray wolf’s Western Great Lakes distinct population segment (DPS) reveals the judge tangling with the right of the USFWS to create and then delist a DPS of wolves.³⁹ The case presents an important issue, but does not support the creation of an agreed upon vision for how people and wolves can live together, undergirded by feasible plans to reach that vision. As research on public attitudes and wildlife conflicts reveals, participatory processes are needed where people can be involved in a whole range of activities, including sharing points of view, brainstorming solutions, developing feasible strategies, and monitoring wildlife.⁴⁰ Furthermore, when people on the front lines of human-nonhuman interactions are not involved in policymaking, results can be counterproductive and inequitable.⁴¹

Wolf numbers in the upper Midwest have increased to a level that many never anticipated. Preliminary information indicates that the return of a top predator is having a beneficial ecological impact on the health of northern forests, with more undergrowth returning as deer

38. RECOVERY WOLVES, *supra* note 32, at 330.

39. *The Humane Society of the United States v. Dirk Kempthorne*, No. 07-0677, 13 (D. D.C., Sept. 29, 2009) (stating “[t]he ESA is ambiguous with respect to the precise question at issue: whether the ESA permits FWS to use the DPS tool to remove the protections of the statute from a healthy sub-population of a listed species, even if that subpopulation was neither designated as a DPS nor listed as endangered or threatened beforehand”), available at http://www.biologicaldiversity.org/species/mammals/gray_wolf/pdfs/memorandum_opinion_remanding_and_vacating.pdf.

40. Adrian Treves, R.B. Wallace & S. White, *Participatory Planning of Interventions to Mitigate Human-Wildlife Conflicts*, 23 *Conservation Biology* 6, 1577, 1584 (2009) (stating that “[C]onservation expertise is not the sole province of formally trained scientists or field-tested conservation practitioners, but it should also engage civilians, policy makers, and other organizations. . . . This is particularly true when planners strive to balance human and biodiversity needs so that the eventual intervention (or lack of action) reflects sociopolitical acceptance”); see also Finn Danielsen et al., *Increasing Conservation Management Action by Involving Local People in Natural Resource Monitoring*, 36 *AMBIO* 7, 566, 566–70 (2007), available at <http://www.nordec.dk/assets/321/amFinnDanielsen.pdf>.

41. From research on turtle conservation in the Philippines, Raul Lejano and Helen Ingram report that when a national policy of turtle conservation replaced a locally designed program in 2000, the rate of turtle egg conservation took an alarming drop. Raul P. Lejano & Helen Ingram, *Place-based Conservation: Lessons from the Turtle Islands*, 49 *ENVIRONMENT* 18–26 (2007).

browsing eases, and fish increasing as beaver populations drop and more streams are free flowing.⁴² In addition, wolves are living in areas not anticipated as ideal wolf habitat, and are regularly interacting with humans as well as their pets and livestock. Long-held notions of wolves as the epitome of the wild have to be refigured when their geographies become so tightly knitted with human ones. How might a rural wolf, one that comes into regular contact with humans and their property, differ from a wild wolf that lives in the middle of a large wilderness area?

For most Wisconsin people—the Ojibwe are certainly one exception—their contact with wolves has a short history. Biological and ecological information about wolves, while a critical part of what we need to know to coexist, needs to be accompanied by stories from people who successfully live with wolves and by opportunities to devise new strategies for coexistence, whether it is a new livestock protection device or a new form of ecotourism. Thus, a critical piece of a species recovery plan is the socio-cultural context that shapes behavior of wolves and of people as well.

IV. FOCUSING ON HUMAN-NATURE RELATIONSHIPS IN NATURAL RESOURCES POLICY

Ongoing policy guidance is needed for these unfolding relationships between humans and wolves in Wisconsin, including supplementing ecological thresholds in policy with tools that support ongoing management of complex and changeable phenomena. In other words, natural resources policy must also attend to the diverse and complex networks linking humans and the nonhuman species that share the world. Attending to these networks involves appreciating and nurturing existing networks, as E.U. food-safety policy does with traditional artisan cheesemakers, for example. Policy attention to human-nonhuman networks also involves fostering new relationships where there are few or predominantly negative ones. In Wisconsin, for instance, the state Department of Natural Resources for years recruited and trained volunteers from across the state to assist in annual wolf counts.⁴³ In addition, environmental management tools attuned to dynamic ecologies are needed in order to educate people and support participatory conservation planning such that people with existing relationships with a natural resource can be heard and become involved in strategizing.

42. Adrian Wydeven, Mammalian Ecologist and Conservation Biologist for the Bureau of Endangered Resources, Wisconsin Department of Natural Resources, Panel Presentation “Wolf Delisting and the ESA in a New Administration” at the Society for Environmental Journalists 19th annual meeting, Madison, WI (Sept. 2009).

43. Treves, *supra* note 36.

Barriers in natural resources policy to participatory management arise, in part, from the sociology of expertise, in which information created by impartial scientific experts is valued at the exclusion of input from lay people who may not have scientific knowledge of nonhuman beings but have relationships that connect them to these species in other ways. A corollary condition is that, by relying on scientific experts, we also fail to support the continued creation of on-the-ground knowledge and relationship-building by people engaged in various ways of managing and making a living in a community. It has often been observed that local sources of knowledge reveal critical information about natural resources, and that participation in environmental management planning is critical for long term success of any program.⁴⁴ Ultimately, limited notions of nonhuman agency (agency being the capacity for humans to make choices and impose those choices on the world) and human-nonhuman relationships may be at the root of the shortcomings of natural resources policy to recognize and build networks between humans and nonhumans. As will be discussed in the following section, this issue stems in part from a combination of a strong idea of individual human agency as independent of a natural world, and a rather weak sense of agency on the part of nonhuman beings such that their behavior can be easily captured in general descriptions of “species” and “thresholds” and controlled through top-down policies.

The ESA has been an effective and necessary instrument for wolf recovery. Holly Doremus, who has written extensively about the use of science in the ESA, has written about the law’s “strictly science” mandate in order to prevent economic information about the costs of protection from being included in decisions about whether or not a species is endangered. The mandate renders the law quite limited in terms of guiding a complicated and multidimensional process of negotiation.⁴⁵

44. See Treves et al., *supra* note 40, at 1585, in which, regarding participation in conservation planning, the authors note that “[p]otential benefits include the generation of diverse ideas: participation in decision making may raise tolerance for wildlife or management even in the absence of measurable reductions in threats; participants may offer help to implement or monitor interventions; and participants may gain skills in negotiation, democracy, and coalition building . . . our method for strategic choice of interventions based on feasibility requires local knowledge, scientific judgments, and broader sociopolitical experiences. Thus we caution against centralized, rigid, technocratic scoring systems that replace intuition and informal knowledge;” see also Lejano & Ingram, *supra* note 41.

45. Holly Doremus, *Listing Decisions Under the Endangered Species Act: Why Better Science Isn’t Always Better Policy*, 75 WASH. U. L.Q. 1029, 1056 (1997) (noting that “the reliance on science is, historically, the result of people trying to protect the dilution of the ESA by information regarding the economic and social costs of protecting species”). Doremus also writes: “If society asked which plants were generally preferable, responses would vary

Another take on the inadequacy of the strictly science mandate is the argument that the regulatory biological science that sets thresholds in natural resources law is not truly up to the task of supplying critical information needed for effective environmental management.⁴⁶ Laws rely on clear, predictable, and fair indicators that can be equitable and practical to enforce; thresholds provide managers with a critical foundation for clearly defining, for example, a number of species below which their protection is absolute. But given the dynamic and multifaceted nature of nature, this is just a starting place. Once legal protection of a species or an area is established, managers need to assess multiple indicators in an ongoing manner. The dynamics between population levels of deer and wolves may differ dramatically between different locations, for example, or vary from year to year depending on climate shifts. In addition, human or social factors are almost always critical not only in the decision of where to set a threshold, but also to changing the level of an indicator itself. The need to monitor the number of human-caused wolf deaths is just one example.

In the raw-milk cheese controversy, the existence of a well-established culture of cheesemakers and cheese consumers in France had a major role in creating advocates to inform a policy that is much more sensitive to traditional practices and human-microbial relationships. U.S. organic agriculture offers another example, where early proponents developed and advocated for practices that involve working with diverse microbes, plants, and animals, and taking advantage of natural

with the respondents' views of the values provided by plants. The question calls for a weighing of incommensurables, comparing beauty, productivity and other features, which cannot be performed on a wholly objective basis. It calls for a value judgment, not a scientific evaluation." *Id.* at 1065. See also Holly Doremus, *Science and Controversy*, in THE ENDANGERED SPECIES ACT AT 30: VOLUME 2, CONSERVING BIODIVERSITY IN HUMAN-DOMINATED LANDSCAPES, 97, 101 (Dale D. Goble, J. Michael Scott & Frank W. Davis, eds., 2006), in which Doremus argues that the uncertain nature of scientific information can lead to extended conflicts and litigation in policymaking, stating "[t]he hard reality is that the scientific information available to support ESA decisions is frequently incomplete, ambiguous, and contested."

46. See M.L. Hunter, M.J. Bean, D.B. Lindenmayer & D.S. Wilcove, *Thresholds and the Mismatch Between Environmental Laws and Ecosystems*, 23 CONSERVATION BIOLOGY 4, 1053, 1054 (2008), noting that "[c]onceptually, environmental laws do not have to be based on simple, polar distinctions; they could be designed around an ecological continuum. . . . Nevertheless, such complicated laws would be difficult to legislate and enforce"; see also George F. Wilhere, *The How-Much-Is-Enough Myth*, 22 CONSERVATION BIOLOGY 3, 514 (2008), who makes a similar argument that scientists who publish findings stating, for example, a definitive number for a minimum viable population promote the "erroneous idea that the amount of conservation necessary for the survival of species or the integrity of ecosystems can be determined solely through objective, evidence-based science."

processes, knowledge that was critical in informing recent legislation on organic farming practices.⁴⁷

In addition, regulatory science is often not disposed to forecast possible relationships between humans and other species. Traditional biological science can create very static definitions of species behavior that is perhaps less useful in imagining possible new scenarios for inter-species interactions.⁴⁸

V. RETHINKING INDIVIDUAL AGENCY IN POLICY

Our liberal humanist tradition views agency as held exclusively by humans, related to Lockean notions of the human individual, inalienable rights, and entitlements. Since the Enlightenment, we have banked on the argument that humans are an exception in the animal kingdom, separated from other animals by our own sense of cognition and individuality, along with other elements including tool use, cultural gesture, friendship, cooperation, a sense of history, of suffering, and so on. This exceptionalism is the basis of how we can have agency and rights to life and liberty and nonhuman beings do not.

After years of animal research, every one of these exceptional elements has been scientifically shown to be more a difference of degree and not kind.⁴⁹ In addition, the general post-modern movement, exem-

47. See Ingram & Ingram, *supra* note 15, noting that, “U.S. organic agriculture offers another example, where early proponents developed and advocated for practices that involve working with diverse microbes, plants, and animals, and taking advantage of natural processes, knowledge which was critical in informing recent legislation on organic farming practices.”

48. See Elliot Sober, *Comparative Psychology Meets Evolutionary Biology*, in THINKING WITH ANIMALS: NEW PERSPECTIVES ON ANTHROPOMORPHISM, 85 (2005), in which he notes that “[a]nthropomorphism is defined as the error of attributing human mental characteristics to nonhuman organisms; people are said to fall into this error because they are sentimental and uncritical. It is a revealing fact about current scientific culture that the opposite mistake—of mistakenly refusing to attribute human mental characteristics to nonhuman organisms—does not even have a ready name”; see also Gregg Mitman, *Pachyderm Personalities*, in THINKING WITH ANIMALS: NEW PERSPECTIVES ON ANTHROPOMORPHISM, 176, 193 (2005), who explains that, in a situation that highlights situations in which scientific assessments of species numbers and detached descriptions of behavior are not enough, different techniques can be used by scientist-conservationists in order to bring attention to endangered elephants. “Unlike other areas of science and public policy, the authority and expertise of scientist-activists like Douglas-Hamilton and Moss among politicians and the general public derives not from their detachment but from their long years of intimate associations with elephants in the wild.” Furthermore, “[t]rading upon intimacy, individuals, and emotions, scientist-activists like Douglas-Hamilton and Moss have found themselves and the elephants they live with active participants in and beneficiaries of celebrity culture.”

49. This has led, in some cases, for some to argue that our system of rights should be extended to animals, as reflected in the work of Peter Singer and Martha Nussbaum, for

plified by philosophers such as Michel Foucault, Jacques Derrida, and Gilles Deleuze has variously de-centered the individual self, emphasizing the societal, contextual relationships that shape and define actions, desires, and power. The general message is that we have been so focused on the idea of the human as based in a rational individuality that we have ignored the relationships that shape us as human beings.

Feminist writers including Donna Harraway and Carol Adams have added to this discussion from a different direction, arguing that liberal humanist (and patriarchal) traditions of thought have been a misrepresentation of the reality of human society, especially as these traditions have failed to acknowledge the multiple relations of reproduction that enable and create any single individuality. In sum, they argue, we have never been human—as defined in conventional humanist traditions—and have no desire to be. Philosopher Alva Noe has similarly argued that the form of individual is not the only form of being, and that what we think of as our individual selves is the result of our interconnectedness and relatedness to the rest of the world.⁵⁰

This de-centering of the individual is accompanied, therefore, with a strong focus on relationships between humans, things, and other beings. Karen Barad offers “posthumanist performativity” as a way to rethink what she sees as passive constructions of nonhumans and things. “Agency is not aligned with human intentionality . . . Agency is a matter of intra-acting; it is an enactment, not something that someone or something has . . . [it] is not an attribute whatsoever.”⁵¹ The idea of

example. While this is an obvious trajectory, it is also one that can descend into rather unfortunate questions such as whether this extension would include the right of the anthrax virus to exist. My point here, however, is not to argue for animal rights on par with human rights but to argue for less attention to individual rights of *any* being, with a focus on the network of relationships that define a being as a resource or a user of that resource.

50. See Christine Smallwood, *Backtalk: Alva Noe*, THE NATION, Mar. 16, 2009, in which, when asked about human relationships with other species, Alva Noe stated: “The classical picture of our human predicament is that we’re all interiority . . . we’re trapped inside the caverns of our one conscious mind. I’m offering a different picture, where the world and the others around us come first, and we are spread out and plugged in and implicated. Think of a row of bushes: each bush is interwoven with the other bushes, the roots reach down into the ground and entangle with each other. The picture that emerges is we’re at home in the world, we’re of the world, the world is not a projection or this alien thing, just as other people are not just merely acting bodies but are present for us as meaningful and important. The natural extension of that is to acknowledge that the species boundary is not a particularly special boundary.”

51. Karen Barad, *Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter Signs*, 28 JOURNAL OF WOMEN IN CULTURE AND SOCIETY 3, 801(2003); see also, Michel Callon, *Agency Cannot Be Disassociated from the Relationship between Actors, Techno-Economic Networks and Irreversibility*, in A SOCIOLOGY OF MONSTERS: ESSAYS ON POWER, TECHNOLOGY, AND DOMINATION (1991) for a similar discussion.

agency as emergent suggests that we might productively focus on the relationships between humans and nonhumans and things.

Bruno Latour's work on actor-networks, developed with colleagues including Michael Callon, Michael Serres, and John Law, has much to offer here.⁵² Actor-networks were devised to "reconnect the social," a way of comprehending and opening up for study the heterogeneous assemblages of people, animals, and things that are variously connected as a result of social activity. The actors in actor-networks can be microbes, scallops, rocks—any entity that can galvanize activity and interaction. Thus, microbes and cheesemakers associate in a network to produce cheese. Wolves and Wisconsin deer hunters create a common network by their shared geographies of prey. Although their agency is not equivalent, both actors are equally capable of (more or less) predictable action.

What actor-networks invite us to do, as we consider natural resources policy, is to complement preconceptions about "natural" behavior, with attention to context in order to understand the actions of any particular species or natural resource. Actor-networks relieve us of dichotomies like natural and human, or wild and tame, and invite focused research to explain the behavior of any actor as it is the result not only of anticipated biologically correct behavior but also arising from a situated time and place and interactions with other actors in a network. Thus we might expect different behavior from wolves in Yellowstone and wolves in the central forested region of Wisconsin. Because every actor is understood to have agency, this approach has the potential to open up strategies for new relationships by complementing the anticipated behaviors as defined by "species" with openness to unknown associations. Importantly, these possibilities for unanticipated behavior and relationships do not mean that we cannot foresee how patterns of equity might play out across different networks. Along with identifying actors in a network, a critical piece of policymaking is analyzing how different policies change relationships such that some groups may be less privileged than others.

VI. NEGOTIATING COEXISTENCE

Jumping in and out of concepts like "agency" and "individual" can seem like intellectual joyriding—and not always apparently useful in making policy. But a focus on relationship-building between humans and nonhuman species could complement policy like the Endangered Species Act. The ESA has had real success in protecting some

52. See BRUNO LATOUR, *THE PASTEURIZATION OF FRANCE* (1988); BRUNO LATOUR, *REASSEMBLING THE SOCIAL: AN INTRODUCTION TO ACTOR-NETWORK THEORY* (2005).

nonhumans but uneven results in ongoing management and building co-existence.⁵³ How can we create incentives for people to negotiate coexistence, especially if all possible arrangements are not readily evident?

More than eight years ago, Joseph Sax described a shift in environmental law from an “enclave theory of conservation” to a focus on habitat as people realized that species needed to be saved “where they are.”⁵⁴ This shift involved planning for species protection with a whole complex of different interests, and Professor Sax wondered at the time whether we might see new institutional arrangements and a “withering away” of old political boundaries. Certainly, the last decade has not witnessed a move away from political entrenchment. Yet, given the challenges of building new networks where there are none, as in the case of reintroduced wolves into Wisconsin, and of reconfiguring relationships when networks are restricting, as in the case of indiscriminant antimicrobial attitudes informing food-safety policy, we might continue to be hopeful for creating new ways of coexisting.

The stories related here about microbes and wolves emphasize, as Professor Sax did, the need to restore not just species, but whole landscapes involving networks of relationships that include humans,⁵⁵ a core belief of the ecological restoration effort.⁵⁶ But these are not simple tasks, and are not easily generalized from one place to another. Much of this kind of negotiating, when it happens, is the result of people committed to a place, and who are willing to give and take.⁵⁷

53. HOLLY DOREMUS & A. DAN TARLOCK, *WATER WAR IN THE KLAMATH BASIN* 148 (2008).

54. Joseph L. Sax, *The New Age of Environmental Restoration*, 41 WASHBURN L.J. 1, 3 (2001), available at <http://www.washburnlaw.edu/wlj/41-1/articles/sax-joseph.pdf>.

55. See the film *In the Footsteps of Elephants* for other examples of the “working out” of emerging and changing human-nonhuman relationships, in which researchers and the film producers Gregg Mitman, Malcolm Moore, and Sarita Siegel reflect on how a history of violence and conflict in the region has had lasting repercussions for individual and cultural survival of two nomadic cultures—elephants and people. The film treats both humans and nonhumans as cultural groups that share a long history of living together and shows how both struggle in the context of forces beyond their control, specifically global climate change, which is reducing the amount of rainfall in the area, and international agreements on national parks boundaries, which have restricted the movement of these traditionally nomadic cultures. See also *Milking the Rhino*, a film that portrays ongoing efforts by citizens in Kenya and Namibia to develop workable models of community conservation.

56. See William O’Brien & Jennifer McIvor, *Is There Anything “Good” About Everglades Restoration?* 35 ENVIRONMENTS JOURNAL 52 (2007).

57. See Ted Kerasote, *Refuge, in YELLOWSTONE TO YUKON: FREEDOM TO ROAM* (2005), which discusses the efforts of Karl Rappold, who ranches near the Bob Marshall Wilderness in Montana and has not lost a cow to a bear since 1959 using multiple strategies. He breeds his herd earlier in the year than is traditional so calves are born earlier, and when they reach summer pasture, they are bigger and less easy prey for grizzly bears or wolves.

Policy needs to foster a middle landscape, somewhere between relationships of extraction and relationships of total conservation. As noted, regulatory science does not always serve us well as an exclusive source of information about relationships between humans and other species. First, this is because of traditions in biological sciences that produce conservative and generalized descriptions of species behavior. Second, while information from regulatory science is a necessary ingredient, it is not sufficient for informing and inspiring stewardship networks on the ground. This is not at all an attack on the process of science, which has served us well and has an ongoing critical role in helping to determine the “success” of restoration and conservation efforts, as well as helping inform how monitoring might be used to inform new strategies.⁵⁸ But regulatory science should be accompanied by other sources of knowledge—the legitimacy of which may not lie in objectivity—such as personal know-how, duration of experience, and cultural significance.

As Helen Ingram and other colleagues have noted during discussions of water and equity, “[w]ater flows through natural and human communities in such close association that abstracting it from its setting and rationalizing it by assigning a quantitative value is to do irreparable damage. In this reading of intrinsic value, humans, other living things, and water are inseparable.”⁵⁹ The links that connect human and natural communities are indeed inseparable, and they are often not adequately captured in markets and are thereby devalued. But these ties are not permanent nor even predictable, and in cases like the connections between landowners and wolves in northern Wisconsin, they do not exist or are newly emerging.

Incentives might be used to reward whole communities for working together to design successful programs that cultivate sustainable, equitable relationships. A policy that defines ecological reality as including humans will be more successful. Raul Lejano and Helen Ingram describe how conservation programs “fit” when they are informed by local community agendas and capabilities. They suggest co-designing programs

He has also worked with the local fish and game department to distribute cattle carcasses along the high perimeter of his ranch in the spring. When hungry grizzlies come out of their dens, they can fill up on the meat of dead cattle, and by the time the grizzlies are done with the carcasses, they can turn to vegetation and leave cattle alone. He also runs fewer cattle so the grass is plentiful, and his cows are bigger and stronger. This both helps his herd avoid being easy pickings for grizzlies and other predators, and also brings a better price at market.

58. Holly Doremus, *Adaptive Management, the Endangered Species Act, and the Institutional Challenges of “New Age” Environmental Protection*, 41 WASHBURN L.J. 50 (2001).

59. WATER, PLACE, AND EQUITY, 10 (John M. Whiteley, Helen Ingram & Richard Warren Perry eds., 2008).

with local communities as a way to take advantage of existing resources and to build critical relationships with people.⁶⁰ Voluntary incentives that complement but do not replace existing laws might include tax relief, for example, that would encourage a private landowner to not only expand a vegetation buffer beyond a legal requirement, but also to collect information on nonhuman beings making use of that buffer. Public recognition and green certification are other strategies for rewarding people for achieving more than meeting a threshold required by law.

Technology plays an important role, too. There is a whole range of ways to engage in stewardship, and in some cases people need to integrate their livelihoods directly into stewardship practices, while in other cases people dedicate free time in pursuing strongly held values of contributing to a better environment. Whether people track wolves by radio, use cell phones to locate elephants near their farms,⁶¹ pull invasive plants to protect an endangered plant species, or turn compost piles with a pitchfork, a whole range of technologies can assist people in engaging with and learning about nonhumans. Restoration and conservation projects rely on monitoring in order to manage adaptively, for example, and monitoring activities are one way of building relationships with a nonhuman species.⁶² Accessible technologies that provide a diverse set of users with a sense of ownership and responsibility can play a major role in negotiating coexistence and in building rewarding and sustainable networks between humans and nonhuman beings.

As the case studies of microbes and wolves suggest, natural resources policy that respects existing networks between humans and nonhumans, and also fosters new sustainable ones, stands a better chance of achieving its goals—and in an equitable way.

60. See Lejano & Ingram, *supra* note 41.

61. See www.savetheelephants.org, which notes, in terms of its communication research, that “[o]ver the last three years we have developed state-of-the-art GSM elephant tracking technology, ‘radio’-collars with built in mobile telephones, kindly supported by the Safaricom Foundation. These data go straight into a database accessible on the Internet via text messages . . . We believe that it is by understanding how elephants make their movement choices that we can understand their needs and those of the other animals that share their range . . . The refined program will allow us to examine pre-fence breaking behaviour so management teams can act prior to actual fence breakage. Another aspect of the program will allow the formation of a ‘cadastral’ system in Laikipia. Small-scale farmers will be able to register their farm, and the server can then direct messages to farmers about approaching elephants, empowering the farmers to protect their own crops rather than having them wake in the morning to a raided field.” *Elephant Voices*, available at <http://www.savetheelephants.org/research-reader/items/elephant-voices.html> (last visited Sept. 19, 2010).

62. Treves, *supra* note 36.