

**Generating Green Governmentality:  
A Cultural Critique of Environmental Studies  
as a Power/Knowledge Formation**

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In and of itself, Nature is meaningless unless or until particular human beings assign significance to it by interpreting some of its many ambivalent signs as meaningful to them. The outcomes of this activity, however, are inescapably indeterminate, or at least, they are a culturally contingent function of who decodes which signs when and how they find decisive meaning there. Because human beings will observe natural patterns differently, choose to accentuate some, while deciding to ignore others, Nature's meanings always will be multiple and unfixed.<sup>1</sup> Such interpretive acts only construct contestable textual fields, which are read on various levels of expression for their manifest and latent meanings. Before scientific disciplines or industrial technologies turn its matter and energy into products, Nature already is being transformed by discursive interpretation into "natural resources." And, once Nature is rendered intelligible through these discursive processes, it can be used to legitimize many political projects.

One vital site for generating, accumulating and then circulating such discursive knowledge about Nature, as well as determining which particular human beings will be empowered to interpret Nature to society, is the modern research university. As the primary structure for credentialing individual learners and legitimating collective teachings, graduate programs at such universities do much to construct our understanding of the natural world. Over the past generation, graduate programs in environmental science on many American university campuses have become the main source of new representations of "the environment" as well as the home base for those scientific disciplines that study Nature's meanings. Indeed, a new environmental episteme has evolved over the past three decades, allowing new schools of environmental studies either to be established de novo or to be reorganized out of existing bits and pieces of agriculture, forestry, science or policy studies programs.

In turn, these educational operations now routinely produce professional-technical workers with the specific knowledge--as it has been scientifically validated--and the operational power--as it is institutionally constructed--to cope with "the environmental crisis" on what are believed to be sound scientific and technical grounds. Still, graduate teaching in schools of the environment has little room for other social objectives beyond the rationalizing performativity norms embedded at the core of the current economic regime. To understand the norms used by this regulatory regime, as Lyotard asserts, "the State and/or company must abandon the idealist and humanist narratives of legitimation in order to justify the new goals: in the discourse of today's financial backers of research, the only credible goal is power. Scientists, technicians, and instruments are purchased not to find

truth, but to augment power."<sup>2</sup>

This chapter asks how specialized discourses about Nature, or "the environment," are constructed by American university programs in graduate-level teaching and research by professional-technical experts as disciplinary articulations of "eco-knowledge" to generate performative disciplinary systems of "geo-power" over, but also within and through, Nature in the managerial structures of modern economies and societies. The critical project of Michel Foucault--particularly his account of how discursively formed disciplines operate inside regimes of truth as systems of governmentality--provides a basis for advancing this critical reinterpretation. These continuously institutionalized attempts to capture and contain the forces of Nature by operationally deploying advanced technologies, and thereby linking many of Nature's apparently intrinsic structures and processes to strategies of highly rationalized environmental management as geo-power, develops out of university-level "environmental studies" as a strategic supplement to various modes of bio-power defined by existing academic "human studies" in promoting the growth of modern urban-industrial populations.<sup>3</sup> Moreover, the rules of economic performativity now count far more materially in these interventions than do those of ecological preservation.

The first efforts to realize these goals in the United States began with the Second Industrial Revolution and the conservation movement over a century ago as progressively-minded managers founded Schools of Forestry, Management, Agriculture, Mining and Engineering on many university campuses to master Nature and transform its stuff into "goods" and "services."<sup>4</sup> In the ecological upheavals of the 1960s and 1970s, however, schools of the environment or colleges of natural resources went beyond the conservationist project when they began training new even more specialized experts in environmental science--ranging from ecotoxicology to national park administration--needed to define, develop and deploy new varieties of geo-power more broadly in all dimensions of everyday work and play. The mission of redefining and then administering the Earth as "natural resources," as it is articulated, for example, by Yale's School of Forestry and Environmental Studies, expresses these managerial goals very powerfully:

The mission of the School of Forestry and Environmental Studies is to provide leadership, through education and research, in the management of natural resource systems and in the solution of environmental problems. Through its focused educational programs, the School develops leaders for major institutions concerned with the earth's environment. Through its research activities, the School fosters study in selected areas of particular importance for resource and environmental management.<sup>5</sup>

The entire planet, then, can be reduced by environmental studies at research

universities to a complex system of interrelated "natural resource systems," whose constituent ecological processes are left for humanity to operate--efficiently or inefficiently--as the geo-powers of one vast terrestrial infrastructure. Directed at generating geo-power from the more rational insertion of natural and artificial bodies into the machinery of global production, the discourses of a green governmentality produced by graduate programs in environment studies define many new physical and social ecologies where environmental professionals operate as disciplined representatives of geo-power and eco-knowledge in diffuse projects of "ecological modernization."<sup>6</sup>

There are scores of academic programs across the United States that now purport to offer this kind of comprehensive scientific instruction in environmental studies. This brief analysis cannot survey all of them in order to determine what the general foci of their curricula are or how each specific program varies in its substantive concerns. Instead it selects four well-known and highly regarded programs--two at elite private universities, two at respectable public institutions--from around the nation--one in the Pacific region at the University of California-Berkeley, one in the Mountain States at Colorado State University, one in the Northeast at Yale University, and one in the South at Duke University. These programs provide highly suggestive examples of how the discourses and practices of contemporary university training reimagine Nature as "the environment" in their graduate courses of study and professional codes of self-interpretation. While analyses of other American universities might yield additional insights, these institutions represent many of the most crucial disciplinary tendencies in mainstream academic environmental discourses today.

Most importantly, this investigation suggests university training discourses comprehensively reframe "the environment" as a highly complex domain far beyond the full comprehension of ordinary citizens or traditional naturalists: it instead becomes something to be managed by expert managerialists armed with coherent clusters of technical acumen and administrative practice.<sup>7</sup> Reading through the self-representation of environmental studies at these colleges of natural resources or schools of the environment in the United States, one sees this ideology at work as deans, directors and department heads promise to prepare prospective students to master the ins-and-outs of resource managerialism, risk assessment, and/or recreationist management. Resources, risks, and recreationists become "the three Rs" of higher education in contemporary environmental studies, giving students and faculty specific new foci for their knowledge and granting specialized managerial power by administering this green governmentality in

their mostly technocratic professional activities.

### **I. Environments and Geo-Power**

Surveying the very focalized public representations made about "the environment" or "natural resources" at American universities with a distinguished "school of the environment" or an outstanding "college of natural resources" can indicate a great deal. Because so many environmental professionals and natural resource workers from all over the world now are being trained in these academic settings, one gains an important sense of how their professional practices both are shaped by, and, in turn, shape academic environmental discourse. Investigating the recruitment language used to enlist students for graduate study in their ecological curricula and analyzing the formal categories deployed to understand natural resources in the classrooms at such schools of the environment, then, permits us to reappraise what "the environment" means at these schools and which "natural resources" are valorized at such colleges.

As actions on the behalf of Nature have shifted from the avocational register of belle-lettristic naturalist writings into the professional-technical knowledge codes of environmental science, larger public discourses about ecological degradation, resource waste or environmental remediation also have changed significantly. On the one hand, many see this shift as positive: scientific personnel with positivistic technical knowledges allegedly now can identify ecological problems objectively as well as design efficient solutions for the most pressing ones. On the other hand, this change is regarded by others with suspicion: a spirit of "shallowness" occludes the enchantments of Nature in the dark shadows of anthropocentrism, capitalism, and statism as "the environment" often is treated as being little more than terrestrial infrastructure for global capital.<sup>8</sup> How "the environment" is understood today by most government bureaus, major corporations, and interest groups derives from discursive frameworks of technoscientific training that are propagated by "schools of the environment" or "colleges of natural resources" at major research universities.

Technoscientific knowledge about the environment, however, is, and always has been, evolving in response to changing interpretive fashions, shifting political agendas, developing scientific advances, and meandering occupational trends. Changes in those discursive principles of exclusion or inclusion, which are used to determine when to study, how to study it, what to exclude, where to include, or why, often cannot be pinned precisely. Instead, such variations designate "a will to knowledge that is anonymous, polymorphous, suspectable to regular transformations, and determined by the play of identifiable dependencies."<sup>9</sup>

This polymorphous combination of anonymous scientific environmental knowledge and organized market and/or state power is disclosed most baldly by the stated purposes of Berkeley's Environmental Science, Policy and Management faculty in the Division of Resource Institutions, Policy, and Management. That is, schools of the environment or colleges of natural resources are engaged quite concretely in "how current and historical configurations of social, economic, and political institutions, as well as cultural values lead to different environmental outcomes and consequences for the composition, level, and distribution of social well-being" inasmuch as their students, teachers and administrators "study and contribute to the formation of natural resource policy, the administration and management of natural resources institutions, and issues of territory, property, and sovereignty at different temporal, spatial, and institutional scales."<sup>10</sup>

As Berkeley's mission statement indicates, the channels of authority flowing within transnational corporate enterprise or modern nation-states have not carried many ideas, for example, from biocentric deep ecology into more widespread practice in either official American environmental policies or established academic teachings. Notions associated with anthropocentric shallow ecologies, however, have fused more coherently and cohesively in the power effects of such social formations. Their power, as Foucault indicates, "traverses and produces things....It needs to be considered as a productive network which runs through the whole social body, much more than a negative instance whose function is repression."<sup>11</sup> Schools of environmental studies and colleges of natural resources now provide one of the vital intellectual networks in which the relations of this productive power shape the categories of knowledge. In accord with the prevailing regimes of truth in instrumentalist technoscience, academic centers of environmental studies reproduce those bodies of practice and types of discourse, which the top executive personnel now managing most of the contemporary American state and social institutions, regard as "objective," "valid," or "useful."

From the concepts and categories embedded in mission-defining languages and practice-determining beliefs used by schools of the environment or colleges of natural resources, one can get a feel for the raw understandings of "environments" and "natural resources" shared by many environmental professionals in government, business and academe. By reconsidering how these academic institutions and their graduates discursively construct "the environment," as Foucault suggests, one can attempt "to define the way in which individuals or groups represent words to themselves, utilize their forms and meanings, compose real discourse, reveal and conceal in it what they are thinking or saying, perhaps unknown to themselves, more or less than they

wish, but in any case leave a mass of verbal traces of those thoughts, which must be deciphered and restored as far as possible to their representative vivacity."<sup>12</sup>

At the conjunction of life, labor, and language in discourses of environmental studies, one finds an analytic of power/knowledge "which shows how man, in his being, can be concerned with the things he knows, and know the things that, in positivity, determine his mode of being"<sup>13</sup> in highly focalized academic constructions of "the environment." The environment, if one follows Foucault's lines of reasoning, must not be understood either as the naturally given sphere of all ecological processes that human power keeps under control or as a mysterious domain of obscure terrestrial events which human knowledge works to explain. Instead, it emerges as a historical artifact that is largely constructed by technoscientific interventions, because it cannot remain an occluded reality that is difficult to comprehend. In this great network of technical interventions into Nature, the simulation of spaces, the intensification of resources, the incitement of discoveries, the formation of special knowledges, the strengthening of controls, and the provocation of resistances all can be linked to one another as "the empiricities" of academic environmental studies.<sup>14</sup>

## **II. The Three "Rs" of Eco-Managerialism**

The scripts of green governmentality embedded in environmental studies are rarely rendered totally articulate by scientific and technical discourses.

Yet, there are elaborate systems for guiding political activity in these scripts. The advocates of more radical ecological movements, like deep ecology, ecofeminism or social ecology, dimly perceive the destructive biases in these scripts in their frustrations with "reform environmentalism," which weaves logics of geo-power in and out of the technocratic eco-managerialism that has defined mainstream of environmental science and traditional natural resource policy-making.<sup>15</sup> The three foci of eco-managerialist interventions have coaligned in schools of the environment as the theories and practices of resource, risk, and recreationist managerialism.

The mission statements and core curricula of such educational operations identify and initiate the discursive practices which encircle "the environment" or "the resources" their training gives students knowledge-of and power-over as professionals. The association of resource managerialism/risk assessment/recreationist administration in range management at Berkeley, environmental toxicology at Duke, or visitor management strategies at Colorado State with "the environment" as a terrestrial infrastructure gives professionals the discursive practices they need in "the delimitation of a field of objects, the definition of a legitimate perspective for the agent of

knowledge, and the fixing of norms for the elaboration of concepts and theories."<sup>16</sup>

#### **A. Resource Managerialism**

Resource managerialism can be read as a geo-power/eco-knowledge of modern governmentality. While voices in favor of conservation can be found in Europe early in the nineteenth century, the real establishment of this stance comes in the United States with the Second Industrial Revolution from the 1880s through the 1920s and the closing of the Western Frontier in the 1890s.<sup>17</sup> Whether one looks at John Muir's preservationist programs or Gifford Pinchot's conservationist codes, an awareness of modern industry's power to deplete natural resources, and hence the need for systems of conserving their exploitation, is well-established by the early 1900s. Over the past nine decades, the fundamental premises of resource managerialism have not changed significantly. At best, this code of eco-knowledge only has become more formalized in bureaucratic applications and legal interpretations.

Keying off of the managerial logic of the Second Industrial Revolution, which empowered technical experts, or engineers and scientists, on the shop floor and professional managers, or corporate executives and financial officers, in the main office, resource managerialism imposes corporate administrative frameworks upon Nature in order to supply the economy and provision society through centralized state guidance. These frameworks assume that the national economy, like the interacting capitalist firm and household, must avoid both overproduction (excessive resource use coupled with inadequate demand) and underproduction (inefficient resource use coming with excessive demand) on the supply-side as well as overconsumption (excessive resource exploitation coming with excessive demand) and underconsumption (inefficient resource exploitation coupled with inadequate demand) on the demand side.

To even construct the managerial problem in this fashion, Nature is reduced--through the encirclement of space and matter by national as well as global economies--to a system of geo-power systems that can be dismantled, redesigned, and assembled anew on demand to produce "resources" efficiently and when and where needed in the modern marketplace. As a cybernetic system of biophysical systems, Nature's energies, materials, and sites are redefined by the eco-knowledges of resource managerialism as manageable resources for human beings to realize great material "goods" for sizeable numbers of some people, even though greater material and immaterial "bads" also might be inflicted upon even larger numbers of other people, who do not reside in or benefit from the advanced national economies that basically monopolize the use of world resources at a comparative handful of highly developed regional and municipal sites. Echoing California-Berkeley's declaration that environmental

studies boil down to mobilizing the biological, physical and social sciences to address the major social and political effects of current and future anthropogenic environmental problems, Yale's Dean Cohon tells would-be environmental studies enrollees that their professional power/knowledge will be crucially significant in the coming years: "Your role in helping to protect and manage the integrity and survival of natural systems and human health globally could not be more important. Since so much is now in human hands, people are needed, more than ever, who are focused, informed, and dedicated to learning."<sup>18</sup>

Here, environmental sciences infrastructuralize the Earth's ecologies. The Earth becomes, if only in terms of technoscience's operational assumptions, an immense terrestrial infrastructure. As the human race's "ecological life-support system," it has "with only occasional localized failures" provided "services upon which human society depends consistently and without charge."<sup>19</sup> As the environmentalized infrastructure of technoscientific production, the Earth generates "ecosystem services," or those derivative products and functions of natural systems that human societies perceive as valuable.<sup>20</sup> This complex system of systems is what must survive; human life will continue only if such survival-sustaining services continue. And, as Colorado State's, Yale's, Berkeley's or Duke's various graduate programs all record, these infrastructural outputs include: the generation of soils, the regeneration of plant nutrients, capture of solar energy, conversion of solar energy into biomass, accumulation/purification/distribution of water, control of pests, provision of a genetic library, maintenance of breathable air, control of micro and macro climates, pollination of plants, diversification of animal species, development of buffering mechanisms in catastrophes, and aesthetic enrichment.<sup>21</sup> Because it is the terrestrial infrastructure of transnational enterprise, the planet's ecology requires highly disciplined reengineering to guide its sustainable use. In turn, the academic systems of green governmentality will monitor, massage, and manage those systems which produce all of these robust services. Just as the sustained use of any technology "requires that it be maintained, updated and changed periodically," so too does the "sustainable use of the planet require that we not destroy our ecological capital, such as old-growth forests, streams and rivers (with their associated biota), and other natural amenities."<sup>22</sup>

This infrastructuralization of the environment can be illustrated in Colorado State's Forest Science recruitment brochure, which casts its knowledge as being dedicated to "Valuing our Forests and Natural Resources" both inside the classroom and outside in the mountains. To imagine what

forests are and do, the Department of Forest Science asks:

Have you ever stopped to think how the health of our forests affects your own life? Without forests, there would be no wood for homes or fiber for countless paper products we use every day. Forests also help maintain watersheds and keep our air free of harmful pollutants. And, for centuries, forests have been a very special place where people go to see and enjoy nature. Whether you live in a city or small town, forests impact your life in many ways.<sup>23</sup>

Forests are represented as open infrastructural networks, or quasi-subjective agencies whose health, growth, and location are quasi-objective structures needed by human beings as building materials, watershed maintenance mechanisms, air cleaners, or human enjoyment zones.

Moreover, the environmental infrastructure of our forests "need people who can understand and manage them" but, as Colorado State claims, "only with well-educated professionals can we ensure that our resources will be available for the benefit of present and future generations."<sup>24</sup> So to rightly manage this vital green infrastructure it provides four concentrations of discursive understanding and applied practice--forest biology, forest fire science, forest management, and forest-business--to prepare environmental professionals. Learning about forests "from actual experience, not just from textbooks," Forest Science pledges comprehensive training as forest biology focuses "on the biology of trees and the ecology of forest;" forest fire science examines "fire as a forest management tool" as students "learn how prescribed fire can be used to enhance wildlife habitat, prepare seedbeds, control forest insects and disease, and reduce fuel hazards;" forest management concentrates on how state and commercial agencies exploit "forest productivity, economics, and conservation, along with the latest in computer-based management tools;" and, forest-business teaches business applications "if you seek employment with a private timber company, or you wish to develop your own forest business."<sup>25</sup>

Colorado State's Forest Science Program, therefore, promises to open doors to professional-technical jobs that oversee the technoscientific nexus of discipline/sovereignty/territoriality in managing forest resources as students either are able "to qualify as a professional forester and work with traditional national and international resource organizations" or find avenues that "pursue employment in fields such as land use planning, youth agency administration, natural resource communications, mining reclamation, business, law enforcement, or conservation biology."<sup>26</sup> Indeed, forest science is a system of discursive truth production by which environmental professionals "learn to manage forests for maximum growth; to protect forests from fires and disease; and to conserve forest, soil, and water resources," because such

knowing mediations of power do provide "a truly unique and rewarding opportunity"<sup>27</sup> to exercise their professional-technical power/knowledge ecologically.

### **B. Risk Managerialism**

As Beck suggests, this risk managerialism is now an integral part of the self-critical production and reproduction of globally thinking, but locally acting, capitalism.<sup>28</sup> Schools of environmental studies train students to conceptually contain, actuarially assess, and cautiously calculate the many dimensions of ecological risk in their ecotoxicology, environmental assessment, or ecoremediation courses. Yet, the fictive assumptions of such modelling techniques only constitute a scientized first take for the sweep of reflexivity. They do not, and indeed cannot, capture the depth, scope, duration, or intensity of the damage they pretend to measure.<sup>29</sup>

Colorado State's Department of Fishery and Wildlife Biology, for example, casts itself as an international leader in the areas of risk assessment and analysis. Combining practical laboratory experiences and field studies, it suggests that areas of growing emphasis are risk analysis-centered concerns, like integrated resource management, conservation biology, and environmental risk analysis.<sup>30</sup> This quantitative surveillance and evaluation focus in risk analysis also can be found in the other graduate programs' curricula.

Yale's graduate course, Ecological Resource Risk Assessment and Management, for example, hints that related course work in statistics, ecotoxicology, and environmental chemistry will help its enrollees to understand the impact of pollution, disease, and ecological management practices on the health of ecosystems. However, "assessment of risk of an adverse impact on an ecological resource caused by one or more chemical, biological, or physical stressors, and monitoring the status and trends of an ecological resource are priority needs of contemporary environmental management."<sup>31</sup> Likewise, Duke's highly economistic reading of environmental studies stresses the benefits and costs of policies relating to sustaining resource productivity and maintaining environmental quality in its risk analyses. Its graduate course, Survey of Environmental Health and Safety, directs the attention of students toward "environmental risks from the perspective of global ecology, biology, chemistry, and radiation" such that "the nature and scope of environmental hazards" might be addressed by its understanding of "risk assessment and management strategies,"<sup>32</sup> the economics and ecologies of risk, then, create tremendous new opportunities for cadres of educated professionals to work productively as better resource managers.

Risk management at colleges of natural resources presumes its

calculations "are based on a (spatially, temporally, and socially circumscribed) accident definition" or that its analyses truly do "estimate and legitimate the potential for catastrophe of modern large-scale technologies and industries."<sup>33</sup> Superfund site after supertanker spill after superstack bubble, however, indicate that this degree of managerial knowledge is precisely what risk management sciences at schools of environmental studies fail to produce, "and so they are falsifications, and can be criticized and reformed in accordance with their own claims to rationality."<sup>34</sup> This trend toward developing a fully self-conscious risk managerialism grounded in economistic trade-offs also surfaces fully in the curriculum of the Yale School of Forestry and Environmental Studies, whose recent strategic restructuring commits it fully to risk assessment methods because these techniques are "redefining forestry to encompass all of the social and political factors which we know from experience to be fundamental to good forest management."<sup>35</sup>

These visions of environmental science recapitulate the logic of technical networks as they already are given in the states and markets of the existing world-system. Rather than the environment surrounding humanity, the friction-free global marketplace of transnational capital is what envelopes Nature. Out of its metabolisms are produced ecotoxins, biohazards, hydrocontaminants, aeroparticulates, and enviropoisons whose impacts generate inexorable risks. These policy problematics unfold now on the global scale, because fast capitalism has colonized so many more sites on the planet as part and parcel of its own unique regime for sustainable development. As Yale's Dean Cohon asserts:

The challenge we all face now, as you know, is not limited to one resource in one nation, but extends to the protection of the environment worldwide. The fabric of natural and human communities is currently torn or tattered in many places. There is hardly a place on earth where human activity does not influence the environment's current condition or its prospects for the future.<sup>36</sup>

In turn, well-trained environmental professionals must measure, monitor or manage these risks, leaving the rational operations of global fast capitalism wholly intact as "risks won" for their owners and beneficiaries, while risk analyses performed by each environmental school's practitioners and programs deal with the victims of "risks lost."

### **C. Recreationist Managerialism**

Schools of environmental studies also must prepare their students for more tertiary uses of Nature as recreational resources. As the USDA says about its managed public lands, the natural environment is "a land of many uses," and mass tourism, commercial recreation, or park administration all

require special knowledges and powers to be conducted successfully. Instead of appraising Nature's resources as industrial production resource reserves, recreationist managerialism frames them as resource preserves for recurring consumption as positional goods, scenic assets, or leisure sites. The entire idea behind national parks or protected areas is to park certain unique sites or particular undeveloped domains beyond the continuous turnover of industrial exploitation for primary products or agricultural produce. Yet, the recreational pursuits of getting to, using, and appreciating such ecological assets are mass produced through highly organized sets of practices. Consequently, recreationist managerialism "develops expertise in managing public lands and waters and in providing quality outdoor recreation experiences to their visitors."<sup>37</sup>

As Colorado State University's Department of Natural Resource Recreation and Tourism puts it, "there is an exciting trend to establish park and outdoor recreation programs worldwide."<sup>38</sup> So this graduate program moves beyond undergraduate studies of "recreationists and tourists" to examine other publics, like "concessionaires, private land owners, policy-makers, agency personnel, communities, and special interest groups," which need to be managed as part of providing "quality outdoor recreation experiences" to visitors of parks and protected areas.<sup>39</sup> This focus upon "the human dimensions of natural resources" in recreationist management, in turn, permits this disciplinary unit to tout its Human Resources Survey Research Lab to prospective enrollees, assuring them that this "state of the art telephone survey lab helps to develop skills in measuring preferences, perceptions, and behaviors among outdoor recreationists."<sup>40</sup>

Armed with this sort of knowledge about recreationist management, graduates are assured secure professional placement with some power center because the program "is oriented to employment with federal and state agencies, counties, and municipalities."<sup>41</sup> Beyond the recreationist management functions of governmental resource management agencies, this graduate program also underscores a U.S. Department of Commerce study that forecasts tourism will be the world's largest industry by 2000. Hence, prospective students are assured how easily recreationist managerial knowledge can be pitched to "that sector of the tourism industry that is dependent on natural resources: park and recreation concessionaires, adventure and tour guide companies, private campgrounds and hunting/fishing preserves, destination resorts, ecotourism establishments, and tourism development boards and advertising companies"<sup>42</sup> to embed green governmentality into private sector pursuits.

The obligation to supervise human recreationists rightly in "the conduct

of their conduct" within the natural environments is aptly summarized by Yale's Dean Cohon, who characterizes environmental studies as almost another mode of police work, or "helping to protect and manage the integrity and survival of natural systems and human health globally," because recreationist management, like all environmental studies, needs skilled people "who are focused, informed, and dedicated to leading."<sup>43</sup> Discourses of green governmentality give dedicated students the right disciplinary paths for leading others to the right kind of information produced by professional schools of the environment. Their power/knowledge foci, in turn, authorize and legitimate the acts taken by "a corps of professionals" whose policing of anthropogenic environmental crises will bring about more positive recreational experiences.

#### **D. The Three Rs and Careerist Legitimation**

The discursive reconstruction of the environment around these "three Rs" as an ensemble of technocratic sites for managerialist intervention, according to such graduate schools, is quite significant, because, as Yale's Dean of Forestry and Environmental Studies suggests, their faculties have a long history of socializing "generations of leaders of government agencies, university faculties, and private forest products companies."<sup>44</sup> Moreover, such training purports to engage "the broad range of issues of environmental conservation and protection" through "the inclusion of biological, physical, and social science perspectives to provide basis for realistic, effective approaches to what are often subtle and complex issues."<sup>45</sup>

One sees the performativity agenda operating at each one of these graduate schools of the environment. Berkeley's now allegedly much more performative Department of Environmental Science, Policy and Management was formed from a merger of five pre-existing, and much less performative, academic units: Conservation and Resource Studies, Entomological Sciences, Forestry and Resource Management, Plant Pathology, and Soil Science. The rhetoric of its recruitment claims "each former department had world recognized expertise in disciplines relevant to natural resource and environmental issues," but that now, united as one, the Berkeley operation creates "a single academic unit which combines both disciplinary and interdisciplinary graduate education" capable of integrating "the biological, social, and physical sciences to provide advanced education in basic and applied environmental sciences" as well as conducting "research into the structure and function of ecosystems at the molecular through the ecosystem levels and their interlinked human social systems."<sup>46</sup> Such discursive framing of the environment as an integrated system of systems has, like those used by Berkeley's distinguished faculty, the multidisciplinary scope to help "raise

the environmental and scientific literacy of all students on the Berkeley campus" as well as to develop among its graduate classes "the intellectual leadership required to conserve and wisely manage the earth's resources."<sup>47</sup>

To certify the "diversity of its programs and employability of its graduates," the Nicholas School of the Environment at Duke also openly discloses "the placements and activities of Environment graduates" as that prospective professionals might assess "the effectiveness and marketability" of its programs.<sup>48</sup> Like California-Berkeley, Yale, and Colorado State, Duke wants to prove how resource/risk/recreationist managerialism pay off for rising new professionals. Because professional-technical employment is the key validation of such preparation for managing terrestrial infrastructures, the Nicholas School takes great pains to show how avidly its graduates are sought by public, private and non-profit organizations as "environmental professionals." Despite a very competitive labor market, Duke asserts "ninety percent of the graduates secured a position directly or closely related to their environmental training following graduation," while it also found 73 different organizations hiring first-year students as summer interns."<sup>49</sup>

Those who continue to imagine all environmentalists as some sort of countercultural resistance fighters only need to consult the Nicholas School of the Environment at Duke to get a sense of where academic environmental studies actually lead. While some of its graduates--only 16 percent--end up working for advocacy nonprofits, like the Rain Forest Alliance, World Wildlife Fund, or Chesapeake Bay Foundation, many also find positions with staid groups like Worldwatch, the Nature Conservancy or the National Geographic Society. Another 32 percent work for federal and state governments, and 42 percent work for private consulting and industrial firms, like ABT Association, ERM, Inc., ICF Kaiser International, General Motors, Texaco, or Westvaco Corporation.<sup>50</sup> The key validation of academic environmental studies at Duke is wholly careerist: good placement and respectable salaries for newly graduated natural resource professionals. Marketability of their labor equals effectiveness for their education. The performative truths such schools impart must be valid; otherwise, big business, federal agencies, and global NGOs would not drop by to recruit their graduates. Their training in Ecotoxicology and Risk Assessment, Resource Economics or Forest Resource Management does not stress post-anthropocentric deep ecology; likewise, the Nicholas School will not count holistic New Age Deep Ecology Studies among its in-house graduate programs. Technoscientific truths are those tied to reproducing environmental studies as the coda of careerist knowledge and professional power.

As Yale's School of Forestry and Environmental Studies flatly exclaims,

these educational institutions deploy curricula and employ faculty to serve both academic and applied markets with their knowledge. Consequently, different power and knowledge formations in the state and corporate sectors are continuously interwoven through environmental studies: "some of the faculty's work is research-oriented, and some is management-oriented, as befits our dual role as a graduate school and a professional school. The work takes place in forests and wilderness areas, in the inner city and multinational corporations, and in libraries and laboratories, around the globe."<sup>51</sup> In these curricula and their professional tracking, the discourses of resource managerialism/risk assessment/recreationist administration become, as Foucault argues, "embodied in technical processes, in institutions, in patterns for general behavior, in forms of transmission and diffusion, and in pedagogical forms which, at once, impose and maintain them."<sup>52</sup> Environmental studies graduates, then, find in their professional labor the callings of green governmentality--mediated through their formal knowledges of environmental study and implemented through their institutionalized powers over natural resources. Under this managerial regimen, power/knowledge systems bring "life and its mechanisms into the realm of explicit calculations," making the disciplines of environmental knowledge and discourses of managerial power into many concrete networks devoted to the "transformation of human life."<sup>53</sup>

### **III. Environmental Studies as Heterogeneous Engineering**

The "three Rs" of environmental studies now implicitly acknowledge how thoroughly most human ecologies on Earth are "a sociotechnical order." As Law suggests, the networks of humans and machines, animals and plants, economies and ecologies, which now constitute our environment, are mixed media of power and knowledge: "what appears to be social is partly technical. What we usually call technical is partly social. In practice nothing is purely technical. Neither is anything purely social."<sup>54</sup> Approaching the environment as terrestrial infrastructure, at the same time, admits that the professional-technical graduates of environmental studies programs are in many ways trained to operate as "heterogeneous engineers." That is, he/she must work "not only on inanimate physical materials, but on and through people, texts, devices, city councils, architectures, economics, and all the rest," such that if his/her designs are to work as a system, then he/she always must travel effectively "between these different domains, weaving an emergent web which constituted and reconstituted bits and pieces that it brought together."<sup>55</sup>

Too few articulations of environmental studies acknowledge these basic operational conditions, but they form the sociotechnical terrains upon which environmental studies experts must negotiate their professional worklives

through in order to heterogeneously engineer Earth's ecologies as the infrastructures of anthropogenic environments. Transforming the raw stuff of Nature into natural resources, while minimizing the associated risks of such processing and maximizing the aggregate access of recreationists to yet-to-be or never-to-be transformed Nature, is a constant challenge for heterogeneous engineers from the environmental science disciplines to pull off with any aplomb. The green fixations of so many conventional environmentalists makes it difficult, if not impossible, for environmental studies to recognize all of the natural/artificial networks that its practitioners must tend as essential parts with a complex system for their projects of heterogeneous engineering. Owning up to full immensity of these tasks, however, leads those who would be the tenders of Nature to the project of "terraforming," or reshaping the Earth so completely that it obviously becomes an essentially sociotechnical planetary order.

The Earth, then, no longer is allowed to exist or evolve as such; instead it is consigned to the hands of terraforming professionals with graduate training in the environmental sciences. Duke University asserts "the mission of the School of the Environment is education, research and service to understand basic environmental processes and to protect and enhance the environment and its natural resources for future generations."<sup>56</sup> This engagement at "protecting" and "enhancing" the environment to transmit its natural resources to future generations is seconded by California-Berkeley, whose Ecosystem Sciences mission statement virtually writes the job description of terraforming technicians: "Ecosystem Sciences are concerned with quantitative understanding of ecosystem properties and processes, and the controls on these features. Central to this mission is a full partnership between physical and biological scientists, leading to an integrated understanding of ecosystem structure and function, and the extension of these findings in modeling and implementation activities."<sup>57</sup> The labor of environmental studies professionals must be dedicated to protecting and enhancing the performativity of our environments.

Whatever surrounds our increasing performative global economy must also become as operationally adaptable, flexible, and productive, as Colorado State labels them, through the problem-solving knowledges of riparian management, land rehabilitation, habitat evaluation, range economics, biotelemetric surveillance, wood engineering, resource interpretation, or visitor strategies. While students may enter schools of environmental studies and colleges of natural resources in search of wisdom from Aldo Leopold or John Muir, they mostly leave as adept practitioners of ecosystem management/analysis, ecological risk analysis, and recreation resource

administration.<sup>58</sup> Forests, range lands, waters, game animals, and soils all are integral components in terrestrial infrastructures for the vast machineries of commodity production, circulation, consumption, and accumulation, which are, in turn, terraforming the unruly ecologies of Earth to suit their mainly commercial requirements. Because, as the Dean of Yale's School argues, "there is hardly a place on Earth where human activity does not influence the environment's current condition or its prospects for the future," environmental studies and colleges of natural resources produce technoscientific experts, or those new "cadres of educated professionals," or who truly believe "that the best hope for developing sound knowledge and workable management solution for environmental problems is to bring science and policy together."<sup>59</sup>

Truths about ecology are not objective timeless verities, but rather are the operationalized findings of continuously evolving practices for heterogeneous engineering as they have been constructed by major research universities. These institutions are sites where "truth," or "a system of order procedures for the production, regulation, distribution, circulation, and operation of statements,"<sup>60</sup> arises from knowledge formations, like the disciplines of environmental science, to help steer power formations, like the decision-making bureaux of liberal democratic states and capitalist firms. As Foucault asserts, "there are manifold relations of power which permeate, characterize and constitute the social body, and these relations of power cannot themselves be established, consolidated nor implemented without the production, accumulation, circulation and functioning of a discourse. There can be no possible exercise of power without a certain economy of discourses of truth which operates through and on the basis of this association."<sup>61</sup> Environmental science, then, should reveal multiple traces of this vital cycle of cogeneration by which power charges truthful knowledges even as truthful knowledges mediate power in the scope and substance of its discursive construction at schools of environmental studies and colleges of natural resources.

## **VI. Conclusion: Environmentality as Governmentality**

This investigation's approach to some specific environmental discourses circulating through modern research universities may offend some in the academy because it asks how involved, and in what ways have academicians become implicated, in causing the current ecological crisis, even though they might believe themselves to be ameliorating it. The cultural politics of environmental discourse, however, can be studied most effectively by following the actors back to their sites of professional-technical training at schools of environmental studies or colleges of natural resources. This is where the

heterogeneous engineering cultures of mainstream environmentalists--or conventional understandings manifest in the acts and artifacts of these social groups--are both produced and reproduced. As this discussion illustrates, here is where one can discover how and why environmental studies are shaped by its disciplines of heterogeneous engineering as every environmental professional gets his or her education to protect and manage the Earth. A few may be engaged, on the one hand, by dreams of preservationist restoration ecology, but most others are devoted, on the other hand, to vast projects of conservationist eco-rationalization in which Nature's forests, lands, and waters technocratically are to be reengineered as vast terrestrial infrastructures for resource/risk/recreationist managers to administer.<sup>62</sup>

There are limitations to this analytical approach. On one level, it cannot delve beneath the manifest intentions of such schools and colleges as they portray themselves in their own literature. One must assume that they are what they profess to be, and actually do what their documents promise. On a second level, it cannot catch any resistances or all deviations from the official institutional line, which clearly are always afoot in any academic institution. Many courses carry bland descriptions of totally conformist approaches, but their instructors and students may very well follow none of them when their classes actually convene. And, on a third level, it does not consider how state or corporate power centers, in the last analysis, often will ignore or belittle academic knowledge, because its guidance contradicts what their organizational powers can, or will, in fact, do against all informed advice to act otherwise. So well-trained professionals, even when armed with sound science, can be flouted to serve the expedient goals of far more naked power agendas. Nonetheless, even this very tentative survey of the professional-technical practices fostered at schools of environmental studies discloses a great deal about how technoscience discourses frame regimes of discipline in the everyday workings of governmentality.

Power and knowledge are pervasive forces whose agents often move in quite different channels sometimes tied to interlocked, but at other times not thoroughly networked, social structures. Universities provide an unusual opportunity to view them working more in unison and out in the open as the formal knowledges needed by power centers are imparted to new generations in the ruling, owing, knowing, or controlling elites; and, at the same time, those specific power agendas required to define, implement or reproduce knowledges and their truth systems quickly get adopted through university programs of study and research. Therefore, this analysis has only begun the examination of discursive frames and conceptual definitions for common theoretical notions, like "the environment," "environmental studies," or

"environmental sciences." Nonetheless, contemporary American universities are giving Nature a new look as "the environment" by transforming their formal knowledges about its workings into the professional-technical practices of a managerialistic "environmentality" in their schools of the environment or colleges of natural resources.

The heterogeneous engineers behind fast capitalism's environmentalizing regime must advance eco-knowledges to activate their command over geo-power as well as operationalize a measure of operational discipline over environmental resources, risks, and recreationists in their reconstruction of contemporary governmentality as environmentality. Like governmentality, the disciplinary articulations of environmentality now center upon establishing and enforcing "the right disposition of things" by policing humanity's "conduct of conduct" in Nature and Society. Nature loses any transcendent aura, however, as its stuff appears preprocessed in the academy as mere "environments" full of exploitable, but also protectable, "natural resources" that university faculty and post-graduate students study continuously in order to rationalize how particular research-oriented and management-oriented applied sciences can get down to the business of administering their geo-power processes as terrestrial fast capitalism's "natural resource systems."

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2. Jean-Francois Lyotard, The Postmodern Condition: A Report on Knowledge (Minneapolis: University of Minnesota Press, 1984), 46.
3. For a preliminary overview of these processes, see Michel Foucault, The History of Sexuality, Vol. I: An Introduction (New York: Vintage, 1980), 140-141. The notion of governmentality is developed in Michel Foucault, "Governmentality," The Foucault Effect: Studies in Governmentality, eds. Graham Burchell, Colin Gordon, and Peter Miller (Chicago: University of Chicago Press, 1991), 93-98.
4. See Samuel P. Hayes, Conservation and the Gospel of Efficiency (Cambridge: Harvard University Press, 1959), and for additional discussion about the assumptions used in professional environmentalist training today see Penelope Reville and Charles Reville, The Environment: Issues and Choices (Boston: Jones and Bartlett, 1988); and, Eugene Bucholz, Principles in Environmental Management: The Greening of Business (Englewood Cliffs, N.J.: Prentice-Hall, 1993), 29-30. A recent defense of technoscientific ecology can be found in Wallace Kauman, No Turning Back: Dismantling the Fantasies of Environmental Thinking (New York: Basic Books, 1994).

5. Bulletin, Yale University School of Forestry and Environmental Studies, 1996-1997 (New Haven: Yale University, 1996), 10. A useful consideration of the power wielded by environmental professionals as managers can be found in Harold Perkin, The Third Revolution: Professional Elites in the Modern World (London: Routledge, 1996); and, Frank Fischer, Technocracy and the Politics of Expertise (London: Sage, 1990).
6. See Timothy W. Luke, "On Environmentality: Geo-Power and Eco-Knowledge in the Discourses of Contemporary Environmentalism," Cultural Critique, 31 (Fall 1995), 57-81. And, for a very useful discussion of "ecological modernization," see Maarten A. Hajer, "Ecological Modernization as Cultural Politics," Risk, Environment & Modernity, ed. Scott Lash, Bronislaw Szerszynski & Brian Wynne (London: Sage, 1996), 246-268.
7. For additional discussion of these distinctions, see Anna Bramwell, Ecology in the Twentieth Century: A History (New Haven: Yale University Press, 1989); Robert Paehlke, Environmentalism and the Future of Progressive Politics (New Haven: Yale University Press, 1989); and, Robyn Eckersley, Environmentalism and Political Theory: Toward an Ecocentric Approach (Albany: SUNY Press, 1992).
8. For additional discussion see Roderick Nash, The Rights of Nature: A History of Environmental Ethics (Madison: University of Wisconsin Press, 1989); Bill Devall and George Sessions, Deep Ecology: Living as if Nature Mattered (Salt Lake City: Peregrine Smith, 1985); and, Warwick Fox, Toward a Transpersonal Ecology: Developing New Foundations for Environmentalism (Boston: Shambhala, 1990).
9. Michel Foucault, Language, Counter-Memory, Practice: Selected Essays and Interviews (Ithaca, NY: Cornell University Press, 1977), 200-201.
10. Graduate Study, 1997-98: Department of Environmental Science, Policy, and Management (Berkeley: University of California, 1996), 2-3.
11. Michel Foucault, History of Sexuality, 119. One can read clear discursive declarations, echoing Foucault's insights, when, for example, the Yale School of Forestry and Environmental Studies admits that it "brings together faculty studying the social, legal, and political

arrangements which so strongly influence the state of natural communities" so that it can actively develop "relationships with a broad range of private corporations, as well as projects and research relating to industrial environmental management" as "the springboard to many more ventures in the future," Yale School of Environmental Studies, 2.

12. Michel Foucault, The Order of Things: An Archaeology of the Human Sciences (New York: Vintage, 1994), 353.
13. Ibid., 354.
14. Ibid., 362-363. Here, one encounters the closure of discursive totalities. As Foucault observes, "the analysis of thought is always allegorical in relation to the discourse that it employs. Its question is unflinchingly: what was being said in what was said?" However, the dissection of discursive fields must determine the material and cultural conditions of their operations, asking "what is this specific existence that emerges from what is said and nowhere else?" See Michel Foucault, The Archaeology of Knowledge & The Discourse on Language (New York: Pantheon, 1982), 27-28.
15. For discussion, see Timothy W. Luke, "Green Consumerism: Ecology and the Ruse of Recycling," In the Nature of Things: Language, Politics and the Environment, ed. Jane Bennett and William Chaloupka (Minneapolis: University of Minnesota Press, 1993), 154-172.
16. Foucault, Language, Counter-Memory and Practice, 199.
17. David Noble, America by Design: Science, Technology and the Rise of Corporate Capitalism (New York: Knopf, 1977).
18. Bulletin, Yale School of Forestry and Environmental Studies, 9.
19. John Cairns, Jr., "Achieving Sustainable Use of the Planet in the Next Century: What Should Virginians Do?" Virginia Issues & Answers, 2, no. 2 (Summer 1995), 3.
20. W. E. Westman, "How Much are Nature's Services Worth?," Science, 197, (1978), 960-964.

21. Cairns, "Sustainable Use," 3.
22. Ibid., 6.
23. Department of Forest Science, Colorado State University (Ft. Collins, 1996), 2.
24. Ibid.
25. Ibid., 3-4.
26. Ibid., 4.
27. Ibid.
28. See Ulrich Beck, Risk Society: Towards a New Modernity (London: Sage, 1992), 20-50. Beck argues that advanced industrial societies are characterized by a shift from logics of wealth distribution to ones of risk distribution. Hence, for Beck, environmental studies are involved intimately in reflexive modernization as their practitioners ask, "How can the risks and hazards systematically produced as part of modernization be prevented, minimized, dramatized or channeled....How can they be limited and distributed away so that they neither hamper the modernization process nor exceed the limits of that which is tolerable," 20.
29. On the one hand, "science has become the protector of a global contamination of people and nature;" but, on the other hand, risks lie across the narrow specializations of traditional positive science, making necessary the development of interdisciplinary knowledges like environmental studies. Indeed, environmental studies programs emerge in some sense, because risks are so pervasive. That is, they always, "lie across the distinction between theory and practice, across the borders of specialties and disciplines, across specialized competencies and institutional responsibilities, across the distinction between value and fact (and thus between ethics and science), and across the realms of politics, the public sphere, science and the economy, which are seemingly divided by institutions," Beck, Risk Society, 70.
30. Department of Fishery and Wildlife Biology, Colorado State University

- (Ft. Collins, 1996), 3.
31. Bulletin, Yale School of Forestry and Environment Studies, 31.
  32. Duke Nicholas School of the Environment Bulletin, 101.
  33. Ulrich Beck, "Risk Society and Provident State," Risk, Environment & Modernity: Towards a New Ecology, ed. Scott Lash, Bronislaw Szerszynski & Brian Wynne (London: Sage, 1996), 32.
  34. Ibid., 33.
  35. Bulletin, Yale School of Forestry and Environmental Studies, 2. The statistical surveillance regime of governmentality within states, as Foucault maintains, emerges alongside monarchical absolutism during the late seventeenth century. Intellectual disciplines, ranging from geography and cartography to statistics and civil engineering, have been mobilized to inventory and organize the wealth of populations in territories by the state. Now they also are being turned to questions of risk assessment. For additional discussion, see Graham Burchell, Colin Gordon, and Peter Miller, The Foucault Effect: Studies in Governmentality, 1-48. A very useful example of sustainability thinking conjoined with professional-technical environmentality can be found in Thaddeus C. Trzyna, A Sustainable World: Defining and Measuring Sustainable Development (IUCN/California Institute of Public Affairs, 1995).
  36. Ibid.
  37. Department of Natural Resource, Recreation and Tourism, Colorado State University (Ft. Collins, 1996), 2.
  38. Ibid., 1.
  39. Ibid.
  40. Ibid.
  41. Ibid.

42. Ibid.
43. Yale School of Environmental Studies, 9.
44. Yale School of Environmental Studies, 1.
45. Ibid.
46. Graduate Study, 1997-98: Department of Environmental Science, Policy and Management, 1.
47. Ibid., 2.
48. Duke, Employment Profile Letter, 1.
49. Ibid.
50. Ibid. Each of the Nicholas School's disparate fields has a definite role to play in the heterogeneously contrived management of the Earth's terrestrial systems. And, in turn, all of the School's individual graduate programs--Forest Resource Management; Resource Ecology; Water and Air Resources; Environmental Toxicology, Chemistry, and Risk Assessment; Resource Economics and Policy; and, Coastal Environment Management--disclose openly both attained salary ranges and median pay for their 1995 graduates to give a sense of how the labor markets value the highly trained labor of the many diverse vocations needed for terrestrial infrastructure management. These placements illustrate how the School's administrators, faculty and students as heterogeneous engineers "have proven that we are among the best at what we do," which is, in addition to publishing research and processing students, realizing "wise and sustained management of our natural resources and a better environment for this and future generations," see Duke Nicholas School of the Environment Bulletin, 1996-97: 7.
51. Bulletin, Yale School of Forestry and Environmental Studies, 1.
52. Foucault, Language, Counter-Memory and Practice, 200.
53. Foucault, History of Sexuality, 143.

54. John Law, A Sociology of Monsters: Essays on Power, Technology and Domination, ed. John Law (London: Routledge, 1991), 10.
55. Ibid., 9.
56. Duke Nicholas School of the Environment Bulletin, 9.
57. Graduate Study, 1997-98: Department of Environmental Science, Policy and Management, 2.
58. Heterogenous reengineering as infrastructure poses an ironic contradiction between the autochthonous dynamics of Earth's ecologies and the actions of artifice circulating through human economies, technologies, and societies. The twin, but contradictory, objectives of protecting and enhancing the environment bedevil schools of the environment as the protective impetus of restoration ecology bumps up against the enhancing agendas of ecosystemic economics. Moreover, the anthropogenic origins of so many environmental problems as well as fundamental uncertainty over how pristine many environments actually ever were prior to their integration into the world capitalist system makes land rehabilitation, riparian restoration, or wildlife preservation a very inexact science. And, for the infrastructural managerialism of heterogeneous engineers, the lack of definitive ecological data in certain series longer than a decade at best or century at most makes any sort of optimization modelling of nutrient cycling, yield maximization, or population dynamics on a global scale essentially an exercise in technocratic fantasy. Both agendas for environmental practice remain in contention for the hearts and minds of students and faculty in environmental studies, since there is much truth in the preservationists desire "to let it be" when they discuss the Earth's ecologies, even though the conservationists' desire to use Earth ecologies in support of more Promethean projects, like "be all that you be," tend to prevail at many colleges of natural resources. For more discussion of how material practices shape space, see David Harvey, Justice, Nature & the Geography of Difference (Oxford: Blackwell, 1977), 150-175.
59. Bulletin, Yale School of Forestry and Environmental Studies, 9.

60. Michel Foucault, Power/Knowledge: Selected Interviews & Other Writings, 1972-1977 (New York: Pantheon, 1980), 133.

61. Ibid., 95.

62. For the emerging sciences of industrial ecology, this infrastructuralization of Earth is carried to its logical conclusion. As Frosch asks, "let us consider, industry, indeed, the whole of humanity and nature, as a system of temporary stocks and flows of material and energy." Ultimately, then, if industrial ecology comes to dominate environmental studies, then all ecological questions may become tied to "a framework for thinking about materials and their flows in the context of industrial waste, about the balancing of costs and environmental impacts in possible future states of industry, and about a method of policy examination." Therefore, he asserts,

My model for policy choice among industrial ecosystems is statistical mechanics, which has developed very successfully to study systems consisting of a large number of interacting elements--particularly systems in which the large number of elements and possible interactions present an otherwise almost insuperable challenge to understanding the behavior of the whole system.

See Robert A. Frosch, "Toward the End of Waste: Reflections on a New Ecology of Industry," Daedalus 124, no. 3 (Summer 1996), 201, 211, and 210.