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Confronting Collapse: Environmental Science at the End of the World

Michael Egan, Ph.D.
Department of History
McMaster University

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On 1 May 1973, the biologist Barry Commoner appeared on *Firing Line*, hosted by William F. Buckley, the conservative political pundit. By 1973, Commoner was arguably the most visible and outspoken radical voice in American environmental politics. He had, in 1970, appeared on the cover of *TIME* magazine as "the Paul Revere of Ecology," and his book, *The Closing Circle* (1971), which articulated his now-famous Four Laws of Ecology, had been well received. For his part, Buckley, an erudite and articulate writer and broadcaster, presented a worthy debate foe. The subject was "Is there an Ecological Crisis?" In his preamble Buckley insinuated the question seemed less urgent in 1973 than it had a few years earlier. Commoner disagreed. The discussion veered toward environmental policy, with Commoner criticizing President Richard Nixon for backing away from much of the strong environmental policy he had signed during the first two years of the decade. Commoner wanted more: more investment in environmental remediation, more enforcement of environmental legislation, more stringent guidelines for various production processes. In effect, Commoner insisted that the economic system needed to be confined by the limits of the ecological system:

> Buckley: "I hope you, if President of the United States, would not appoint as Secretary of Defense somebody who would superordinate the problems of ecology over those of national sovereignty."
> Commoner: "Well, that is your hope; mine is the reverse."
> Buckley: "Why would you call him Secretary of Defense? Call him Secretary of Undefense, or Secretary of Surrender."
> Commoner: "Why don't we call him Secretary of Survival?"[1]

Commoner's is a good line. But set aside, for the moment, any wistfulness for a time in American politics when disagreement could be engaged through civil discourse or for a time in which such interlocutors might correctly pronounce and use the word "superordinate." Set aside, too, the fact that Commoner would indeed run for President of the United States in 1980 (this was not a long-range announcement of his candidacy, or that an oil crisis later that year would vindicate Commoner's case that the environment remained a topic of critical importance. Concentrate, instead, on Commoner's final idea of having a Secretary of Survival. For Commoner, this was not a rhetorical flourish but rather a sincere assertion that the urgency required to address the environmental crisis superseded (and, indeed, was interconnected with) geopolitical and socioeconomic imperatives. This paper, like Commoner, takes seriously the idea of survival as it relates to the science developed to confront the environmental crisis.

The post-World War II period witnessed a shift in environmentalism. Whereas before 1945 environmental protection was understood in terms of saving nature from the onslaught of civilization, after 1945 it had become an exercise in saving civilization from itself. At risk was not just the physical environment, but also people and their health. Through growing concerns over nuclear radiation and the ubiquity of synthetic chemicals in air, soil, and water—as demonstrated, for example, by Rachel Carson in 1962's *Silent Spring*—the popular consciousness came to realize that the body was an ecological landscape under threat. In 1948, Fairfield Osborn and William Vogt penned neo-Malthusian treatises that examined humanity's growing rapaciousness for natural resources, and warned that over-consumption and population growth had us hurtling towards an apocalyptic tipping point. The Cold War—with its new weaponry and its potential to turn hot at any

[1] "Is There an Ecological Crisis?" *Firing Line with William F. Buckley Jr.* First aired on PBS (1 May 1973).

moment—presented the first context in human history for the complete and utter destruction of civilization. And the view of Earth from space underlined the planet's finite nature.[2]

Against this backdrop, the prospect of ecological collapse seemed frighteningly possible. The Club of Rome's classic 1972 book, *The Limits to Growth*, showed that humanity was in grave danger of overshooting the Earth's carrying capacity in the imminent future. A year later, E. F. Schumacher's *Small is Beautiful* presented a compelling argument that countered the necessity of economic growth. Humanity needed to control its appetite for the world's finite resources and learn to work with less. In times past, doomsday prophets had emerged as a counterweight to spiritual authority. Apocalyptic warnings came from outsiders, dissenters, radicals, and their predictions were ignored in the hallways of power. After World War II, well-established science and scientists were communicating the warning and world leaders were heeding the message.[3]

On a less cosmic scale, scientists found themselves responding to myriad environmental problems the world over. Mercury pollution of water systems; synthetic fertilizer run-off from agriculture; hazardous emissions from manufacturing plants; air quality problems in major urban areas; new chemical compounds—dioxin, PCBs, etc.—appearing throughout the food chain and in human bodies. If any of these didn't seem as globally terrifying as the prospect of nuclear war, in many circles it did augur planetary death from a thousand cuts. While ecological integrity emerged in the popular consciousness as a new priority, the discovery of these assaults on the planet—and, by extension, on human health—recruited a novel or distinct scientific response.[4]

This essay proposes a lens for examining the recent history of science as it pertains to the environmental crisis. I introduce the concept of "survival science" as an organizing tool for understanding the working worlds in which various sciences functioned during a period of intense environmental disruption. Survival science as I use it here brings together a series of historical practices that worked at the social boundaries of scientific work. Many of its practitioners (some are discussed below) recognized that the work in which they engaged functioned beyond the traditional interpretations of "pure" or "proper" science. I draw on survival science as an organizing tool to bring together various labels and to stress the social significance of survival as a new environmental imperative.

By way of rough, working definition for survival science as it evolved through the post-war period, some general requisite criteria are necessary. Rather than a singular disciplinary practice, survival science constituted synthetic, multidisciplinary sciences in which the boundaries between "basic" and "applied" research were blurred or non-existent. It also demanded new approaches to environmental problems, and pitted scientists in a novel socio-political dynamic where scientific evidence ran up against economic and regulatory imperatives, local and industrial interests, and a newfound urgency provoked by fears of imminent environmental collapse on local and global scales. Survival sciences were reactionary, invariably responding to a newly-discovered but extant problem.

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[2] Rachel Carson, *Silent Spring* (Boston: Houghton-Mifflin, 1962); Fairfield Osborn, *Our Plundered Planet* (Boston: Little, Brown, 1948); & William Vogt, *Road to Survival* (New York: W. Sloane Associates, 1948).
[3] Donella H. Meadows et al., *The Limits to Growth* (New York: Universe Books, 1972); & E. F. Schumacher, *Small is Beautiful: Economics as if People Mattered* (New York: Harper & Row, 1973).
[4] This paper focuses on the scientific response. For popular ecological thinking, see Michael Egan, "Shamans of the Spring: 1960s Environmentalism and the New Jeremiad," in *New World Coming: The Sixties and the Shaping of Global Consciousness* edited by Karen Dubinsky et al. (New York: Palgrave Macmillan, 2009), 296-303.

Interest in the point at which a particular chemical exposure posed adverse health risks in humans was a line of inquiry typically inspired by the discovery of that chemical's presence in the environment. Survival sciences were also mission-oriented, which is to say that they were primarily problem-solving ventures, designed to quickly make sense of a discrete problem. In this respect, traditional scientific inquiry merged with engineering solution-based approaches. Such ventures were also invariably *adisciplinary*. In establishing his Center for the Biology of Natural Systems in 1966, Commoner argued that traditional academic disciplines were not independently equipped to tackle environmental problems. Adisciplinarity required a breaking down of traditional disciplinary jargon and vocabulary, creating a more vernacular method of communicating amongst collaborators, but also with the public and with regulators. Finally, survival science was politically engaged. Their findings, however incomplete, were designed to help shape remedial policies in the face of some environmental emergency. The conservation biologist Michael Soulé artfully used the metaphor of a "shuttle bus going back and forth, with a cargo of ideas, guidelines, and empirical results in one direction, and a cargo of issues, problems, criticism, constraints, and changed conditions in the other."[5] Historian Jerome Ravetz offers a nice comparison along this line, emphasizing the social importance of survival science. Whereas scientists in a less crisis-driven period "chose their problems and investigated them under the guidance of the criteria of value and adequacy established by a communal consensus of their peers and mentors …, that haven is no more."[6] It is hardly exaggeration to submit that survival science and the social politics it engendered constitute one of the most profound changes in the history of science since World War II.

There is often a danger that historians of science impose a presentist interest on past actors, but in coining "survival science," I am responding to a very conscious change in praxis orchestrated by numerous environmental scientists all over the world. At the end of 1985, for example, in a short essay in the journal *BioScience*, conservation biologist Michael Soulé used the term "crisis discipline" to describe his area of specialization. In "What is Conservation Biology?," Soulé argued that conservation biology was to other biological sciences as "surgery to physiology and war to political science."[7] The analogy stressed the imperative of action in conservation biology—or practice over theory—but also the nature of the problems scientists confronted. In his conclusion, he observed:

> The current frenzy of environmental degradation is unprecedented, with deforestation, desertification, and destruction of wetlands and coral reefs occurring at rates rivalling the major catastrophes in the fossil record and threatening to eliminate most tropical forests and millions of species in our lifetimes. The response must also be unprecedented. It is fortunate, therefore that conservation biology, and parallel approaches in the social sciences, provides academics and other professionals with constructive outlets for their concern.[8]

Crisis disciplines also implied an epistemological shift away from traditional scientific practice. "In crisis disciplines," Soulé wrote, "one must act before knowing all the facts; crisis disciplines are thus a mixture of science and art, and their pursuit requires intuition as well as information." Such a statement might undermine traditional scientific authority, but to Soulé this was an unavoidable reality. The nature of crisis rarely permitted sufficient time to complete exhaustive research, never

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[5] Soulé, "Conservation Biology and the 'Real World,'" in *Conservation Biology: The Science of Scarcity and Diversity* edited by Soulé (Sunderland, MA: Sinauer, 1986), 3.
[6] Jerome R. Ravetz, *Scientific Knowledge and its Social Problems* (New Brunswick, NJ: Transaction, 1996), xi. The quotation is from a new introduction; *Scientific Knowledge and its Social Problems* was originally published in 1971.
[7] Michael E. Soulé, "What is Conservation Biology?," *BioScience* 35 (December 1985), 727-734. Quotation is on page 727.
[8] Soulé, "What is Conservation Biology?," 733.

mind definitively answer scientific or policy questions posed of it. Scientists engaged in crisis disciplines "may have to make decisions or recommendations about design and management before he or she is completely comfortable with the theoretical and empirical bases of the analysis."[9] Reflecting on this period more broadly, Ravetz referred to a shift in scientific practice, which he called "post-normal science," where "facts are uncertain, values in dispute, stakes high, and decisions urgent."[10]

Conservation biology, environmental toxicology, cancer biology, the science of the total environment, as well as much more direct responses to such environmental problems such as mercury pollution, acid rain, and chlorine-based contamination functioned in just such a context. Scientific investigations into environmental problems took on an urgency that required the rapid delivery of new kinds of knowledge, not always complete. For example, when scientists in Sweden deliberated on what constituted an acceptable level of mercury in fish for human consumption, the toxicological values were altered after discovery that their preliminary evaluations threatened to close an entire fishery in Lake Vänern. Their data was sufficiently incomplete that policymakers and representatives from the fishing industry could claim that since no cases of mercury poisoning had yet emerged in Sweden, the numbers were far too conservative.[11]

Soulé's essay was written in the middle-1980s, but he was introducing conservation biology into an older development in scientific discourse. In 1972, the nuclear physicist Alvin Weinberg lamented that responses to social problems "hang on answers to questions which can be asked of science and yet *which cannot be answered by science*."[12] For example, seeking an answer to what constituted an acceptable exposure to low-level nuclear radiation was impossible in terms of receiving a specific, individual accounting. There was no magic number after which exposure should be taken more seriously. The best scientists could do was extrapolate averages at which they felt confident that minimal hazard might occur. To some degree, this was educated guesswork. But evaluating risk was steeped as much in qualitative moral values and fears as it was in quantifiable scientific empiricism. Scientists, Weinberg contended, were at home with quantifiable empiricism and technically sweet problems, but they had no special expertise when it came to moral questions. And yet, these questions—which science could not answer—were being asked of it with increasing concern and regularity. To Weinberg, this was a "trans-scientific" question, because its answer transcended, or demanded, more than just science.

And science was facing its own inner crisis. Weinberg was consciously responding to the transformation that had occurred in American science in the previous decade (in 1971, Weinberg famously referred to nuclear energy as a "Faustian bargain"). Whereas in 1960 *TIME* magazine had heralded American scientists as "statesmen and savants, builders and even priests"—they were the "true 20th century adventurers, the real intellectuals of the day"—whose work had touched the "life

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[9] Soulé, "What is Conservation Biology?," 727.
[10] S. O. Funtowicz & J. R. Ravetz, "Three Types of Risk Assessment and the Emergence of Post-Normal Science," in *Social Theories of Risk* edited by S. Krimsky & D. Golding (Westport, CT: Prager, 1992), 251-273. Quotation is on 254.
[11] Egan, "Communicating Knowledge: The Swedish Mercury Group and Vernacular Science, 1965-1972," in *New Natures: Joining Environmental History with Science and Technology Studies* edited by Dolly Jørgensen, Finn Arne Jørgensen, and Sara B. Pritchard (Pittsburgh: University of Pittsburgh Press, 2013), 103-117. See 112-113.
[12] Alvin M. Weinberg, "Science and Trans-Science," *Minerva* 10 (April 1972), 209-222. Quotation is from page 209.

of every human on the planet," by 1970, a popular hostility towards science had emerged.[13] Science was an integral part of the "war/space machine," according to *The Nation*. Suspicion towards science had grown, as Americans identified in the apparently merged science and technology the source of "war, pollution, and every manner of evil."[14] Confidence had waned in science, but science was also seen as responsible for the period's disillusionment. For Weinberg, some of this disenchantment with science stemmed from asking trans-scientific questions, which "science" could not answer. Science seemed fallible, unable to explain or understand the brave new world it had created or the health and environmental hazards that the new world presented. While survival science represented a recognition that the threat of environmental catastrophe required new approaches, it was also situated in time. By the beginning of the 1970s, distrust in traditional science—which occurred in technical language and was conducted behind closed doors—demanded a new approach to science communication. That became a central tenet of politically engaged crisis disciplines.

As a scientific counterpoint to the decline of scientific authority, *TIME*'s 2 February 1970 cover showed the biologist Barry Commoner, an irreverent and anti-authoritarian scientific voice. Commoner was "the Paul Revere of Ecology," and championed the "emerging science of survival" against the backdrop of the plundered planet wrought by science and technology. Commoner was an apt choice for the *TIME* cover on the eve of the first Earth Day (22 April 1970). After raising public awareness of the radiation hazards posed by aboveground nuclear fallout in the late 1950s, he spent the 1960s shifting his focus to a number of different issues that rested at the heart of the new environmentalism. In addition to fallout, Commoner expressed concerns about the increasing use of synthetic pesticides and fertilizers and their contamination of groundwater. He communicated his fears about the abundance of plastics being produced and the petrochemical industry's turn to materials that did not break down in nature; he campaigned for stiffer controls over such hazardous heavy metals such as mercury and lead, which were omnipresent in production methods and spreading into the food chain and into humans at alarming rates. His writing, teaching, and activism during this period featured waste, pollution, and the need for measures to restore clean air, soil, and water. In addition, Commoner articulated explicit links between conflict, poverty, and environmental deterioration. If any single environmentalist effectively captured the complex panoply of new environmental issues confronting Americans and the world during the 1960s, it was Barry Commoner.[15]

Commoner also acted as an important contributor to the rise of survival science. His emphasis that the new approach to environmental problems must necessarily be adisciplinary stemmed from his growing appreciation that the environment must be analyzed in its entirety. This is not ecology, but rather a more systems-oriented approach to the environment's interrelations and interconnections. As he noted in 1965: "The scale and intensity of the biological and technological activities of man which affect the environment has now begun to approach the scale of the environment itself."[16] Whereas the environment had typically been regarded as an infinite sink for the hazardous products

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13 "Men of the Year," *TIME* (2 January 1961), 40.
14 "The Scientists' Dilemma," *The Nation* (18 January 1971), 69. *TIME* and *The Nation* are quoted in Kelly Moore, *Disrupting Science: Social Movements, American Scientists, and the Politics of the Military, 1945-1975* (Princeton: Princeton University Press, 2008), 1.
15 For more on Commoner, see Michael Egan, *Barry Commoner and the Science of Survival: The Remaking of American Environmentalism* (Cambridge, MA: MIT Press, 2007).
16 CBNS Grant Proposal (1965). Document held in the Barry Commoner Center for Health and Environment offices, CUNY-Queens, NY.

of human activity, the intensity of technological activity after World War II put into question the total environment's capacity as a reservoir. Nuclear weapons, the massive expansion of chlorinated hydrocarbons, the widespread adoption of synthetic biocides and fertilizers combined with discoveries that the Earth's biological systems did not function as previously imagined. New, synthetic materials did not break down. Many accumulated, detrimentally, within biological organisms, most concerningly within humans. Commoner's Four Laws of Ecology—that everything was connected to everything else; that everything must go somewhere; that nature knew best; and that there was no such thing as a free lunch—highlighted these facts. They were the product of research into a much broader examination of the physical environment than had previously been undertaken. His adisciplinary approach resisted the boundaries established by singular disciplines such as biology, ecology, or plant physiology (in which he had originally been trained).

Much of this work had been conducted at the Center for the Biology of Natural Systems, which he had founded at Washington University in 1966. In September 1965, Commoner submitted a proposal to the U.S. Public Health Service for funding for the creation of a scientific research centre that would tackle the growing number of environmental threats to human health. Commoner was the principal investigator of a team of St. Louis-based collaborators, who included members of the departments of botany, zoology, physics, and chemistry, as well as colleagues from the Medical School at Washington University, the St. Louis Zoo, and the Missouri Botanical Garden. As Commoner wrote in the grant proposal:

> At the present time, the interactions between man and his environment are undergoing quantitative and qualitative changes of such a magnitude as to create wholly new problems. The present problems of environmental health have rapidly begun to outrun our understanding of the complex processes that mediate the interaction between organisms and the environment. There is, therefore, an urgent need to reorganize our scientific approach to environmental health problems, so that we can find new ways to bring the growing power of modern science to bear on them.[17]

The application is a remarkable document. It articulated the state of the environmental crisis and how the new center could serve as intermediary between knowledge production, policy-makers, and the public. The Center became a clearinghouse for all manner of environmental investigations. Their work on synthetic fertilizer use and run-off in the farm area around Decator, IL, in the late 1960s reinforced the manner in which new technologies did not always behave the way people wanted them to. During the same period, the Center's researchers were among the first to raise awareness of mercury pollution in the United States. They also tackled the question of photochemical smog in cities. In each instance, their efforts consisted of raising public awareness, translating technical information into accessible language for the public, and working collaboratively across a number of scientific disciplines.[18]

If the crisis disciplines that made up survival science changed the nature of science and how it approached the environmental crisis, it is important to stress that the environmental crisis provoked new ways of looking at the physical environment. The potential harm of rising mercury levels in fish for human consumption, for example, demanded quantitative and qualitative evaluations (Weinberg's trans-science) of newly gathered data, drawn from very specific and urgent questions. The environmental crisis also dictated that the physical environment was bereft with human-induced

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[17] CBNS Grant Proposal.

[18] For more on Commoner and the Center for the Biology of Natural Systems, see Egan, *Barry Commoner and the Science of Survival: The Remaking of American Environmentalism* (Cambridge, MA: MIT Press, 2007).

problems that threatened to strike back at human health. Indeed, much of the new work was reactionary in nature—trespasses into nature had already occurred, and scientists scrambled to resolve the environmental problem while simultaneously trying to understand the nature of the hazard.

By way of conclusion, a few caveats and thoughts for further analysis. This paper deliberately skirts the subject of expertise. Survival science radically transformed what expertise meant in modern science and how expertise was used to advance knowledge and justify policy decisions. Practitioners of crisis disciplines were still regarded as experts and often as public intellectuals, even if many of them were disinclined to claim definitive knowledge. Tellingly, Soulé pointed out, in crisis disciplines, "tolerating uncertainty is often necessary."[19] Uncertainty is a critical component of crisis disciplines—and of survival science more broadly. Further work needs to illuminate the place of uncertainty in science, especially as it pertains to ideas about expertise and authority.

On some level, survival science merely constituted tacit acknowledgment that science and society were inextricably linked. Asking trans-scientific questions demanded that science come into conversation with economics, politics, values, and forms of local knowledge. While such a dynamic arguably weakened the authority of scientific expertise, it was hailed in some corners as a democratization of science. This is an important shift. Writing in the mid-1980s, Steve Shapin and Simon Schaffer concluded *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, their brilliant study of early modern science with a critique of mainstream scientific practice from their vantage point. "Now we live in a less certain age," they wrote:

> We are no longer so sure that traditional characterizations of how science proceeds adequately describe its reality. ... Our present-day problems of defining our knowledge, our society, and the relationships between them centre on … dichotomies between the public and the private, [and] between authority and expertise. ... We regard our scientific knowledge as open and accessible in principle, but the public does not understand it. Scientific journals are in our public libraries, but they are written in a language alien to the citizenry. We say that our laboratories constitute some of our most open professional spaces, yet the public does not enter them. Our society is said to be democratic, but the public cannot call to account what they cannot comprehend. A form of knowledge that is the most open in principle has become the most closed in practice.[20]

In many ways—explicitly and implicitly—survival science was a conscious break from this paradox. The democratization of science evidenced in much of the survival science practice was meant to be inclusive and designed to redirect science more squarely back towards producing knowledge for the public good (however urgently that knowledge was needed).

At the same time, crisis disciplines typically lacked the social and political standing of the more traditional scientific disciplines. This meant less funding. But it also meant—absent short-term responses to newfound problems—less policy influence. And, here, let me submit that climate science has become a crisis discipline with its myriad cooperations between meteorologists,

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[19] Soulé, "What is Conservation Biology," 727.
[20] Steven Shapin & Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985), 343.

oceanographers, geophysicists, biologists, physicists, mathematicians, geologists, and other specialists.[21]

But what of historical significance? Survival science persists. Health risks and hazards are still measured not objectively but in the context of a murkier algorithm that acknowledges myriad cultural and socio-economic priorities. I submit three lasting outcomes of crisis disciplines and their activities during the latter half of the twentieth century. Survival science helped give voice—and empirical evidence—to the environmental crisis as a crisis of civilization. In the manner in which groups of scientists were teamed in unorthodox ways to explain and resolve discrete environmental problems, survival science irrevocably altered scientific praxis. Finally, inasmuch as survival science engaged multiple audiences of local and industrial interests, policymakers, media, and other scientists, it authored a new, vernacular science, which transformed the public understanding of science as well as the public participation in science and politics. Lest this sound too triumphal, this third point requires further analysis and complication. In spite of the explicit attempts to create a more vernacular language for science information and practice in order to better encourage public participation, a growing science illiteracy has been the dominant trend in North America and in much of Europe. Science (traditional and survival) remains walled off from many aspects of public life, sequestered from people confronted with environmental hazards where they live, work, and play. But survival science has also opened avenues of dialogue through which citizen science and greater public participation might more effectively contribute to social efforts to realize a more resilient future.

BIOGRAPHY

Michael Egan is associate professor of History and University Teaching Fellow at McMaster University. His research examines the interstices between science, environment, and policy. He is the author of *Barry Commoner and the Science of Survival: The Remaking of American Environmentalism* (MIT Press, 2007), and the series editor for *History for a Sustainable Future* (MIT Press).

[21] "Until the 1980s, discussions of anthropogenic climate change had been confined largely to the scientific community. There had been some political awareness and media coverage during the 1970s, but the issue was too new and abstract to receive much of a hearing. Moreover, the scientific consensus about warming was relatively weak. But the 1980s were a watershed decade, as scientific agreement about anthropogenic warming strengthened and the issue became political for the first time." J. R. McNeill & Peter Engelke, "Into the Anthropocene: People and their Planet," *Global Interdependence: The World After 1945* edited by Akira Iriye (Cambridge, MA: Harvard University Press, 2014), 429.