Exploring Political Solutions to the Chlorine Controversy

by

Andrew P. Cap

B.A., Government
Harvard University, 1992

Submitted to the Department of
Political Science in Partial Fulfillment of
the Requirements for the
Degree of

MASTER OF SCIENCE
in Technology and Policy

at the

Massachusetts Institute of Technology

June, 1995

© 1995 Andrew P. Cap
All rights reserved

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part.

Signature of Author .

Department of Political Science
May 15, 1995

Certified by . . . .

John R. Ehrenfeld
Director, Technology, Business, and Environment Program
Thesis Supervisor

Accepted by . . . .

Richard de Neufville
Chairman, Technology and Policy Program

Accepted by .

Barry R. Posen
Chairman, Graduate Program Committee

MASSACHUSETTS INSTITUTE

JUN 20 1995
Exploring Political Solutions to the Chlorine Controversy

by

Andrew P. Cap

Submitted to the Department of Political Science on May 15, 1995 in partial fulfillment of the requirements for the Degree of Master of Science in Technology and Policy

Abstract

Environmental groups led by Greenpeace have called for a ban or phaseout on the use of chlorine in industrial chemistry on the grounds that such use inevitably leads to the production of persistent, bioaccumulative toxins. This policy prescription is based on an application of the Precautionary Principle which holds that industry should demonstrate that its products and processes are safe before allowing releases of product or waste into the environment. The chemical industry, represented by the Chlorine Chemistry Council, has rejected the call to ban chlorine, and claims that currently available data on either the environmental exposure pathways or the toxicology of chlorinated compounds are inadequate to support responsible decision-making. Industry leaders have called for environmental policy to be based on sound science, comparative risk assessment, and cost-benefit analysis.

The usefulness of a multistakeholder dialogue process designed to foster the generation of consensus on major scientific questions relating to chlorine was explored. It was hoped that such a process might help to avoid the acrimonious and costly litigation that has characterized so much of U.S. environmental policy-making. A thorough analysis of the rhetoric in the chlorine controversy revealed that the roots of the debate lay not so much in disagreements over science, as in whether environmental policy should be based on the Precautionary Principle or on the Risk paradigm. Investigation into each side's strategic calculus showed that negotiation would be unlikely to yield any meaningful agreement in the foreseeable future. Industry and environmentalists will continue to pursue their confrontational strategies they have already adopted as they struggle for political power.

Analysis of the rhetoric as well as available facts of the controversy show that the current U.S. environmental policy-making framework, which is based on the Risk paradigm, is incapable of resolving the debate over chlorine. Moreover, it appears inadequate to the greater challenges that await American society as it faces the necessity of building a more sustainable economy. Although potentially problematic, the Precautionary Principle seems to provide a better alternative for guiding environmental policy.

The special interest clash between industry and environmentalists clearly shows the pitfalls in the assumption underlying our current approach to environmental policy-making that policy decisions are best left to experts. The chlorine controversy dramatically illustrates the need to re-invigorate public debate, particularly in Congress, over the character and form of future U.S. environmental policy.

Thesis Supervisor: Dr. John R. Ehrenfeld

Titles: Senior Lecturer, Technology and Policy Program
Director, Technology, Business, and Environment Program
Acknowledgments

I would like to thank my thesis advisor, Dr. John Ehrenfeld, not only for helping me make this thesis much better than it ever would have been without his guidance and inspiration, but most of all for being my mentor and friend for the past two years at MIT. I will always be grateful for having had the opportunity to learn from, and be challenged by, the many extraordinary people I met here. It quite simply would not have happened without your support.

I would also like to thank Professor David Marks, who guided me in my study of the chlorine controversy. I thank him most of all for agreeing to financially support my studies by awarding me a V. Kann Rasmussen fellowship. I am also very grateful to the V Kann Rasmussen Foundation for their generosity.

I send my thanks as well to all the faculty and staff of the Technology and Policy Program for making a unique, and I believe vital, contribution to higher education. I thank my friend, John Weiss, TPP '94, for telling me about it in the first place, and for introducing me to John Ehrenfeld. Of course, I thank my classmates for the hours of stimulating discussions, and for listening to me go on about chlorine (especially Edmond Toy). I also thank Jennifer Nash for her advice on my thesis and other research.

I would like to express my gratitude to all the members of my family for their support, and most of all to my parents and my wife, Becky. I thank her for patiently enduring the many strains of being married to an MIT graduate student. I greatly appreciate her help in writing this thesis and in the many other projects I have undertaken in the last two years. I thank my parents for their guidance and constant encouragement, and for the way they prepared me to face the intellectual and moral challenges of life. Finally, I thank my daughter, Natalie, for filling my life with the joy that only a parent can know, and for reminding me why I entered the field of environmental policy.
Biographical Note

The author is originally from Easton, PA, where he attended Notre Dame High School. He also spent one year studying at the Lycée Pasteur, in Neuilly, France. He attended Harvard University from 1988-1992, graduating cum laude with a Bachelor of Arts degree in Government.

After working for one year as a Research Associate in the Chemicals and Plastics Industry Management Practice of the consulting firm Arthur D. Little, Inc. (Cambridge, MA), he entered the Technology and Policy Program at the Massachusetts Institute of Technology. His research, out of which this thesis was developed, focused on the politics of the chlorine controversy in the United States, and the role of science in environmental policy making.
Chapter 1: Introduction to the Chlorine Controversy: A Watershed in American Environmental Policy Debate

Over the last five years, a controversy has arisen in the United States regarding an environmentalist call to ban the manufacture of chlorinated organic chemicals, and ban the use of elemental chlorine and inorganic chlorine bleaches (often referred to as "a ban on chlorine"). Proponents of the ban, led by Greenpeace, claim that the release to the environment of persistent, bioaccumulative toxins (PBTs) is an unavoidable result of all industrial chlorine chemistry. They further claim that the PBTs in question are causing cancer and disrupting endocrine, immune, and nervous systems as well as developmental processes in the fish, wildlife, and human populations in the Great Lakes basin. Environmentalists believe that any further increases in environmental levels of dioxins and other PBTs will cause significant adverse health effects in both human and wildlife populations throughout the country. The only prudent course of action then, is to begin eliminating the sources of chlorinated PBTs.

Environmentalists' opponents in industry, led by the Chlorine Chemistry Council of the Chemical Manufacturers Association, argue that the toxicology of even the most notorious organochlorine compounds, like dioxins and poly-chlorinated biphenyls (PCBs).
is poorly understood, and that the release of these chemicals has not been conclusively linked to most industrial uses of chlorine. Furthermore, opponents of the ban point out the economic importance of chlorinated chemicals and claim that only proof of harm established by sound science should be accepted as evidence to support the drastic measures sought by environmentalists.

The debate over chlorine is a watershed in the history of American environmental controversies. In the past, environmental debates mostly focused on narrow questions like setting limits for chemical and radiation exposure, or choosing best available technologies for "end-of-pipe" pollution control. Rarely were bans on products or processes proposed, and then only on individual products, such as DDT. The current debate over chlorine is the first example of a proposed environmental regulation that would eliminate a broadly-defined class of products and processes and, in so doing, force extensive technological change on almost half of the industries in the U.S. economy. A chlorine ban would represent a fundamental shift in the goals of environmental policy. No longer would regulators be required to estimate safe exposures to a vast family of chemicals; a ban would imply zero exposure. Such a ban would effectively subordinate industry concerns to public health and environmental quality. The importance of this debate for the American environment and economy cannot be overstated. It seems evident that a policy debate of such significance should engage the public and the institutions of our representative democracy, and stimulate the development of a societal consensus on the future character of environmental protection in the United States.

Unfortunately, the history of our environmental policy-making process has been characterized by deference to scientific experts on the part of the public and Congress. It has been assumed that scientific research could provide answers to thorny policy questions. In the case of chlorine, however, it is clear that the scientific facts are uncertain, and probably always will be, given the large number of chlorinated chemicals in commerce (estimates range from 10,000 to 15,000) and the extraordinary complexity of their interactions with natural systems. However, the rhetoric of this debate suggests that a battle over "the facts" of the case has already been joined, with one side arguing that currently available scientific data on the health effects and exposure pathways of industrial organochlorines provides an adequate basis for "rationally" advocating a ban. The other side, comprised of industry groups as well as a number of academic scientists, argues just the opposite, that there is insufficient scientific knowledge to support "rational" environmental policy-making.
It is important, at this juncture, to define what is meant by "rational" policy-making. In the United States, this has traditionally referred to the combination of a legislative policy framework upon which is built an administrative framework which makes policy-implementing decisions based on analyses that are neither "arbitrary," nor "capricious." Historically, administrative decisions have been supported by scientific inquiry (the only process commonly agreed to be neither arbitrary nor capricious), and have been thought of as being simply technical in nature.¹

That is not to say, however, that controversies in American environmental policy-making have been resolved in a simple manner. To the contrary, the promulgation of virtually every major environmental regulation or standard has been attended by highly acrimonious, lengthy, and extremely costly litigation. Both environmentalists and their opponents have used litigation to attempt to resolve disagreements over science, the basis for the "rational" policies in question. But the courts are ill-equipped to resolve scientific debates. Indeed, the judiciary has jurisdiction only over matters of administrative procedure and questions regarding the constitutionality of legislation.² Furthermore, the adversarial nature of the courtroom leads to the use of "advocacy science," in which each side carefully selects the evidence and experts most supportive of its position. The search for truth is, of course, ill-served by such a process.³

In the hope of avoiding litigation over major policy questions, like chlorine, a number of observers of American environmental politics have proposed the use of a multistakeholder dialogue process to foster the generation of consensus on at least some of the major scientific questions that may be at the root of controversy.⁴ It is hoped that through negotiation in a neutral, scientific forum, stakeholders will be able to better understand the scientific complexities of the controversy, identify research priorities, and achieve consensus on which, if any, actions should be taken immediately to eliminate or reduce threats to the environment and public health.

This proposal sounds reasonable, even laudable, on its face. One might want to immediately set about organizing the proposed dialogue. This type of situation would ordinarily warrant a thorough exploration of the theoretical literature on negotiation, and a search for an appropriate model to predict the dynamics between these particular groups and thus aid in the design of an appropriate discussion format. In the case of chlorine, however, we have an excellent opportunity to gather empirical data, and potentially design a better political decision-making process than would be possible on the basis of theory alone. A number of conferences and "round table discussions" on the chlorine question have already taken place over the last five years, including one held recently at MIT. One could investigate whether, in the minds of the participants, these meetings have been helpful in moving the debate in a productive direction. One could further examine what factors were important in making such judgments (format, setting, types and numbers of groups participating etc.).

Before engaging in such an effort, however, it is worth reconsidering whether the critical assumptions underpinning its logic are, in fact, valid. In particular, the stakeholders' rhetoric about the scientific facts may conceal a deeper, more enduring conflict of values, of ideologies. If the debate is not really an argument over each side's position on the toxicities or exposure pathways of chlorinated chemicals, the logic behind the proposed consensus-seeking negotiations over the science of the case may be flawed. Such a consensus may be unattainable, or even irrelevant. While arguments over positions are amenable to resolution through negotiation, real conflicts of ideologies are considerably less so. They are resolved through power struggles. In such situations, negotiation is always the last resort of the defeated.

In the United States, a contest between two ideologically-driven groups generally translates into a battle between special interest lobbies, and, as previously noted, litigation. As we have seen in many cases ranging from abortion to international trade policy, this is not the best way of making important decisions in a democracy. It may be time to expand our notions about how environmental policy should be made. A purely scientific approach, in which decision-making is delegated to the experts, may no longer be capable of producing solutions to environmental problems that satisfy important constituencies within our society. It may be time for an explicit recognition of the role of values in decision-

---

5 For a discussion of how negotiation can be used to avoid positional bargaining, see Fisher, R., W. Ury, and B. Patton, (1991) Getting to Yes: Negotiating Agreement Without Giving In, Penguin Books, New York, NY, USA.
making under conditions of scientific uncertainty, as well as for an expanded role for public debate.

This thesis will begin by carefully studying the rhetoric put forward by both sides in order to probe the assumption that this policy debate is about science and can therefore be resolved through negotiations. To this end, the stakeholders' positions as originally stated will be examined in historical context. The results of interviews designed to explore the antagonists' positions as they have evolved after several years of debate, scientific discovery, and political change will also be discussed and analyzed.

I will focus mainly on the concerns of the “plaintiffs” in this case, the environmentalists. Their concerns merit careful analysis because they initiated the debate, and because considerable variations in opinions may exist within this loosely defined bloc. Unlike industry, these groups have not created a centralized lobbying organization that would enable them to speak with one voice. Industry’s position, as elaborated by the Chlorine Chemistry Council and the Chlorine Institute, has been both clear and, at least publicly, monolithic. Furthermore, the industry position has simply been a reaction to the environmentalists’ challenge. The U.S. government, meanwhile, has not taken a leading role in this debate. Government is currently trapped, by legal requirements, within the science-based decision-making framework and therefore has difficulty responding to policy proposals of a radically different, precautionary nature. It should be noted that the International Joint Commission, a treaty organization that was formed by the United States and Canada to monitor water quality issues in the Great Lakes basin, has been included in this discussion as an advocate of a chlorine ban since the position it took on the matter is very similar to that advocated by Greenpeace.
Chapter 2: A Closer Look at the Original Positions

The current debate over phasing out the use of chlorine as an industrial feedstock is the culmination and synthesis of about thirty years of debate, lobbying, and regulatory action which had focused on individual chlorine-containing "bad actors" like DDT, dioxin, and PCBs. In 1992, North American environmental advocacy groups were finally joined in calling for this ban by a governmental body, the International Joint Commission (IJC), which agreed that the toxicity and persistence of some chlorinated organics, and the apparent potential for their release from virtually all uses of chlorine, justified rapid and decisive action. The IJC called on both the U.S. and Canada to strive for a target of zero discharge of chlorinated organics into the environment, and to focus their attention on preventing further damage to the Great Lakes in particular. Although neither the U.S. nor Canadian government has yet seriously considered the implementation of this recommendation, the chlorine debate has received a great deal of attention from all bands of the political spectrum. An understanding of these recent events, and a clear perspective of the hurdles that must be overcome to resolve the issue in a satisfactory manner can only be derived from knowledge of this problem's history. It is therefore appropriate to begin this discussion with a brief chronological review of the chlorine controversy.
**Milestones in the Chlorine Controversy:**

1962 Rachel Carson calls attention to the disruption of the reproductive systems of birds by the organochlorine pesticide DDT in her book, *Silent Spring*.

1970s The environmental movement is born. Several organochlorine pesticides are banned. The use of chlorofluorocarbons (CFCs) as aerosol propellants is phased out. PCBs are banned in the United States. The Paris Convention on the North Sea is signed in the mid-1970s restricting chlorine use and the dumping of chlorinated wastes into the North Sea.

1972 The United States bans DDT.

1976 The United States bans PCBs after Monsanto, the only manufacturer, halts production. A chemical plant explosion in Seveso, Italy, results in extensive dioxin contamination and exposure of a human population. A controversy erupts in the United States over the exposure of troops and civilians in Vietnam to the dioxin-contaminated defoliant Agent Orange.

1978 The United States bans the use of CFCs as aerosol propellants.

1979 The United States bans the use of the herbicide 2,4,5-T due to its contamination with dioxin during manufacturing.

1980s The public in the United States becomes increasingly worried about the threat to public health from dioxin and PCBs. Paper mills come under pressure to switch to non-chlorine bleaching technology as the public becomes aware of dioxin contamination in mill effluent. Superfund environmental clean-up legislation passed as contamination of ground water by chlorinated organic solvents and PCBs is recognized as a widespread problem. Municipal solid waste incinerators become increasingly difficult to build as community activists generate concern by citing potential dioxin emissions due to incomplete combustion of PVC, paper, and wood. Several communities around the country, including Woburn, Massachusetts.
become known as cancer "hot spots" due to unusually high rates of leukemia. Groundwater contamination by chlorinated solvents such as trichloroethylene and perchloroethylene is suspected by environmentalists and victims' groups as being the cause.

1980 A community in upstate New York called Love Canal is evacuated due to dioxin contamination from a chemicals facility.

1982 Times Beach, Missouri, is evacuated due to dioxin contamination stemming from improper disposal of hazardous wastes.

1985 The first report is made of a hole in the ozone layer over Antarctica.

1987 CFCs are confirmed as agents of ozone depletion. The Montreal Protocol, which establishes a timetable for the phaseout of CFCs, is signed. PCBs are implicated as immune system suppressors that contributed to massive seal, whale, and dolphin die-offs in the North Atlantic.

1990s Environmentalists, led by Greenpeace, make public their conclusion that the problems described above, and others just becoming obvious, can only be prevented by eliminating that which they all share in common: chlorine.

1990 A number of Canadian provinces, as well as German and Austrian states and municipalities ban the use of PVC in construction. Environmental advocacy groups begin intense lobbying of European consumers to abandon PVC due to difficulties in recycling and concerns over dioxin production both in manufacture and incineration. The European Community's Bergen Conference calls for restrictions on chlorine use.

1991 Greenpeace issues its first report calling for a comprehensive chlorine ban. It is joined by the Sierra Club and other advocacy groups. Dr. Theo Colborn of the World Wildlife Fund sponsors a conference at the Wingspread Conference Center in Racine, Wisconsin on immune and endocrine system effects of organochlorines in Great Lakes wildlife populations. Scandinavian industry adopts a plan for the reduction and phaseout of chlorine in pulp and paper manufacturing.
1992 The International Joint Commission issues a report calling for a comprehensive chlorine ban due to contamination of the Great Lakes basin. The Paris Commission recommends reduction of emissions of organochlorines into the North Sea.

1993 The EPA proposes new guidelines on organochlorines and other pollutants in the Great Lakes basin. The Chlorine Institute, a U.S. industry trade group, commissions the consultancy Charles River Associates (CRA) to study the economic impact of a chlorine ban on the economies of the United States and Canada. CRA found the net cost of substitution of chlorine to be approximately $102 billion per year. The Chlorine Institute and the Chlorine Chemistry Council of the Chemical Manufacturers Association commission CanTox, a Canadian toxicology consultancy, to report on the current understanding of organochlorine toxicology. MIT's Technology, Business, and Environment Program releases a study sponsored by the Norwegian government and a Norwegian industry group on the dimensions of managing chlorine. The MIT study found that although environmentally problematic in many ways, chlorine would be very difficult to replace in a number of applications. The New Democratic Party government of Ontario orders the local paper industry to abandon chlorine bleaching by 2002.

1994 The International Joint Commission reaffirms its position favoring a comprehensive chlorine ban due to contamination of the Great Lakes basin with persistent bioaccumulative toxins such as PCBs and dioxins. The EPA includes language in the Clean Water Act reauthorization bill calling for a study of whether or not to ban chlorine; the CMA successfully lobbies to have the EPA proposal removed from the bill. The EPA also issues a draft of its dioxin health risks reassessment study which finds dioxin to be more dangerous than previously thought. The Republican party, gaining control of both the House of Representatives and the Senate, promises an overhaul of environmental regulations. MIT hosts a conference on the role of the University in determining the future of chlorine. The American Public Health Association adopts Resolution 9304: "Recognizing and addressing the environmental and occupational health problems posed by chlorinated organics."

In this resolution, the APHA voices its concern over the potential health effects of...
organochlorines and calls for phaseouts of most chlorine applications except water disinfection and pharmaceuticals.

1995 Republicans in Congress, encouraged by property rights advocates and industry, pass bills mandating that EPA perform comprehensive risk and cost-benefit analyses, which would be subject to judicial review, before issuing any major new environmental regulations. Environmentalists charge Republicans with seeking to reverse decades of progress in cleaning up the environment by tying the hands of regulatory agencies. As industry gains the upper hand in Washington, environmental groups redouble their efforts to organize a grassroots campaign to convince consumers that chlorine use leads to dioxin formation and poisoning of the environment. Chemical Week magazine, a trade journal, hosts a conference in New Orleans over April 11-12, 1995 at which chemical industry executives discuss the future of industrial chlorine chemistry. Although most came away from the conference feeling confident that the Chemical Manufacturers Association (CMA) position would ultimately prevail, few doubt that the controversy surrounding chlorine will continue to plague them for the next decade.

The preceding chronology clearly shows a steady escalation in the scope and intensity of this debate. In the following sections, the adversaries' original positions, as they began to crystallize by 1993, are explored in greater depth in order to gauge the difficulty of finding common ground between the two camps. In Chapter 4 of this thesis, the adversaries, including new parties to the dispute, are surveyed to determine whether they have become more amenable to engaging in a consensus-seeking policy process.
Analysis of Initial Positions and Strategies

Advocates of a Chlorine Ban

Greenpeace began the current phase of the North American debate over the use of chlorine in industry with its publication in 1991 of The Product is the Poison: The Case for a Chlorine Phase-out. This document, written by Greenpeace Research Coordinator Joe Thornton, is the culmination of a thirty-year crusade against a host of individual chlorine-containing “bad actors” like dioxin, DDT, PCBs, and others. In the years preceding publication of this Greenpeace document, certain chlorine derivatives and a number of chlorinated waste disposal practices had come under increasing regulatory pressure in the European Community. Despite this fact, no governmental body or major environmental advocacy group in North America had yet called for a complete ban on chlorine and all its applications and derivatives.

Although Greenpeace’s report was published in 1991, it elicited relatively little interest in North America until 1992, when the International Joint Commission lent its credibility to its own Sixth Biennial Report on Great Lakes Water Quality. The IJC’s recommendation to ban chlorine, which stemmed from essentially the same logic as the Greenpeace argument, prompted a vigorous response from the chemical industry and attracted media attention. Although other major environmental advocacy groups such as the Sierra Club had voiced their approval of the Greenpeace and IJC positions, only smaller groups, mainly based in the Great Lakes, such as Pollution Probe (Canada), Great Lakes Program and Great Lakes United actually played an active role in the anti-chlorine campaign. It is therefore difficult to gauge the depth of support for a chlorine phaseout that existed within the environmental community during this time period. In any event, the Greenpeace and IJC reports succeeded in bringing chlorine and its many derivatives into

---

8 Only Aktionskonferenz Nordsee had made a call for a “phaseout of chlorine chemistry” in No Future for Chlorine; Ökopol, Institute for Ecology and Politics, Hamburg, FRG, June, 1990.
9 According to Greenpeace, there were only two articles about its proposal in major US newspapers until the IJC report was released. (personal communication with Greenpeace representative, 8/23/95)
12 Personal communication with Greenpeace representative, 8/23/95.
the environmental policy spotlight. It should be noted that Greenpeace and the IJC have reaffirmed, on several occasions, the positions they took in their initial reports. Their arguments for a ban on chlorine must be carefully examined since they, in effect, generated the present controversy.

The Greenpeace "weight of evidence" argument for a chlorine ban begins with the observation that elemental chlorine and the vast majority of organochlorine compounds are mostly foreign to nature (especially in freshwater and terrestrial ecosystems) and are thus difficult for organisms to metabolize. Chlorine's high electron affinity ensures that bonds to electron-rich carbon are stable and hence, that organochlorine compounds are resistant to degradation and thus persist in the environment. This stability, combined with the lipophilic tendencies of organochlorines leads to the bioaccumulation of some large, non-volatile organochlorine molecules. As a number of these are known toxins, the potential for adverse health effects in both humans and wildlife is significant. Moreover, since chlorine can combine with any of the virtually infinite varieties of organic molecules, the number of possible organochlorines is also astronomically large. Approximately 10,000 chlorine-based chemicals are produced in industry. Furthermore, about 97% of organochlorine species found in the Great Lakes, which are produced as wastes in chemical or paper plants, or eventually as biometabolites, have not been formally characterized, let alone tested for toxicity. The weight of toxicological evidence accumulated on certain pesticides, PCBs, dioxins, and furans seems to imply a potentially enormous risk posed by the large pool of as-yet-untested organochlorines. As we continue to produce elemental chlorine and its organochlorine derivatives, this risk increases. It is in light of this hazard, the seeming availability of substitutes to chlorine-based chemicals, and the practical impossibility of identifying and testing for toxicity this vast pool of chemicals within an acceptable timeframe and budget, that Greenpeace and the IJC advocate a ban on chlorine.

Greenpeace and the IJC both point to the Great Lakes as a test case in organochlorine contamination of the environment. Significant increases in the rates of birth defects, tumors, and other adverse health effects in birds, fish and some mammals have been linked to the introduction of certain organochlorines such as DDT and its metabolite DDE, PCBs, dioxins, and furans into this ecosystem. Since the rate of replacement of the...
Great Lakes water supply is relatively slow, toxins have a tendency to accumulate more quickly in this water system than in others. Advocates of a chlorine ban suspect that it is only a matter of time before similar health effects are manifested elsewhere as total environmental organochlorine loading increases. The Great Lakes basin has become the focal point of the chlorine debate in North America, and will probably be the first theater of action for any regulatory initiatives.

Greenpeace's argument for a ban on chlorine thus proceeds in an incremental fashion from a recapitulation of the observed and perceived dangers of organochlorine pesticides, PCBs, and dioxin, to an inference that toxicity and persistence are pervasive in the whole organochlorine family of chemicals. The ban is extended to all uses of chlorine, including the use of inorganic chlorine bleaches, because of the inevitable release of organically-bound chlorine in waste streams. The Greenpeace proposal is a broad application of the "Precautionary Principle" or "weight of evidence approach" to regulation of industry. To Greenpeace, the weight of evidence strongly suggests that virtually every industrial use of chlorine can lead to the production of dioxins and other persistent toxins, many of which we have yet to identify and properly test. Since we live in a world of dangerous uncertainty, Greenpeace concludes that it would be imprudent to take risks with our health and the health of future generations; the use of chlorine should be phased out.

This precautionary environmental management paradigm reverses the onus of proof in regulating environmental impacts of economic activities, forcing industry to demonstrate that its products and manufacturing processes are unlikely to have an unacceptably negative impact on the environment.15 Products and processes are no longer considered "innocent until proven guilty;" regulatory action may be based on a strong suspicion of a product's causing a threat to the environment. This worldview is pessimistic, or at least skeptical, of the scientific community's ability to anticipate problems stemming from technology. It is even more skeptical of society's ability to correct the results of unanticipated problems.

---

The Precautionary Principle has been recognized as a valid basis for environmental policy-making in many countries, including several members of the European Union. It was formally adopted by the signatory nations of the UNCED Rio Declaration as formulated in Principle 15.

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for post-poning cost-effective measures to prevent environmental degradation.\(^{16}\)

It should be noted that, here, cost-effectiveness is not to be interpreted as the cost of the precautionary measure being less than the cost of the damage. Principle 15 clearly states that "lack of full scientific certainty shall not be used as a reason for post-poning cost-effective measures to prevent environmental degradation." Scientific certainty would be essential in the calculation of costs of damages, and thus in the comparison with the costs of the measure in question.\(^{17}\) Because the Precautionary Principle places the highest value on protection of human health and the environment, economic costs cannot determine environmental policy goals, only the choice of means.

The precautionary approach, of course, stands in stark contrast to the system of regulation currently found in many countries, including the United States, in which regulators must generally assume the burden of demonstrating, through the use of scientific or probabilistic risk assessment, that particular industrial practices are likely to harm the environment before initiating regulatory action. Furthermore, economic tradeoffs are taken into account when determining whether a given environmental initiative should be pursued.

**Opponents of a Chlorine Ban**

The IJC and Greenpeace proposals for banning the industrial use of chlorine elicited a vigorous and varied response from industry as well as from academic circles.\(^{18}\) Although a number of large chlorine and chlorine derivative users moved rapidly to reevaluate their consumption of these products, industry's first response was to point out the enormous

---


\(^{17}\) op. cit.

economic costs of eliminating chlorine chemistry. In addition, researchers in academe and industry alike stressed the weak points in the current understanding of the toxicological effects of organochlorines on humans and wildlife.

The chlorine industry, primarily through the Chlorine Chemistry Council (CCC) and the Chlorine Institute, commissioned a number of reports from consultancies in response to the IJC and Greenpeace challenges. The first of these, by Charles River Associates (CRA), was an estimate of the benefits to the U.S. and Canadian economies attributable to chlorine. CRA determined that about 45% of all U.S. industries were direct consumers of chlorine and its derivatives. Chlorine was shown to contribute $2.9 billion per year to the U.S. balance of merchandise trade. It also accounts for $31.3 billion per year in direct and indirect wages through the employment of 1,315,000 workers. Chlorine and its derivatives represent $79.9 billion in annual sales for the chemicals industry and downstream users. CRA estimates the total net cost of substitution for these products in the U.S. and Canada would exceed $102 billion per year with U.S. consumers annually bearing $91 billion of that total. Figure 2.1 below shows the major uses of chlorine.21

21 Figure 2.1 taken from Tullos, B., "The Chlorine/Caustic Relationship," presentation to the Chemical Week conference, The Changing Chlorine Marketplace: Business, Science, and Regulations, April 11-12, 1995, New Orleans, LA.
The economic evidence presented by CRA is complemented by research done at MIT's Center for Technology, Policy, and Industrial Development (CTPID) for the Norwegian government and Norwegian industry. In this report, which addressed primarily the technological and policy implications of a chlorine ban, the MIT researchers...

showed not only that chlorine use is pervasive in industry and that its tight regulation would be an extremely complex undertaking, but that substitution would be both difficult and costly in many applications. An outright ban on chlorine would force on many industries technological change at the most basic levels, often with unpredictable consequences. The MIT researchers also show that restriction of chlorine use would raise a host of new environmental, health, and safety concerns.

The chlorine industry's response to toxicological concerns was led by the Canadian consultancy, CanTox. In a report accepted for publication in the *Journal of Regulatory Pharmacology & Toxicology*, CanTox attempted to set the scientific context for future discussions of the environmental and health effects of organochlorines.23 The authors of the report noted that many organochlorines were considered to be safe, and that much more research was necessary to establish with any certainty that an entire (broadly defined) class of compounds could pose a serious threat to the environment. They also stressed that the following four criteria should serve as the basis for any discussion of organochlorine toxicity.

- The relationship between chemical/physical properties for biological activity and fate of chlorinated organic chemicals in the environment.

- The relationship between dose and response, and recognition that a practical threshold exists below which adverse effects are not observed.

- The fact that a wide variety of chlorinated organic chemicals are produced from natural sources and that species have evolved to accommodate their presence.

- The specificity of the associations between specific chlorinated organic chemicals and reported adverse effects.

These have each been accepted to a greater or lesser degree by other scientists participating in the chlorine debate. A number of research groups, including most recently the EPA, have challenged the second point, having found no evidence for a threshold.

---

mechanism in a number of dioxin-mediated health effects. Also, while it is acknowledged that marine organisms produce a wide variety of organochlorines, none is known to occur naturally in humans or other terrestrial vertebrates. Finally, some researchers argue that the specificity of association between certain organochlorines and adverse health effects is uncertain. They point out that humans and wildlife are exposed to a complex "cocktail" of organochlorines and that some of these may in fact act synergistically to undermine, for example, the endocrine system.

In response to these and other critiques, the CCC and Chlorine Institute commissioned a comprehensive 4000 page report on the health and environmental effects of organochlorines which was published by the Journal of Regulatory Pharmacology & Toxicology. Industry reaffirmed its position that much more scientific research was needed before responsible regulatory action could be taken on chlorine.

In essence, the initial chlorine industry strategy was to defuse the momentum behind an all-encompassing ban on chlorine and its derivatives by replacing the "zero discharge, zero health risk" precautionary approach to policy making with a "no adverse impact," risk-based approach. The industry hoped to show that the costs of banning chlorine would outweigh the uncertain benefits to be gained. In particular, they hoped to show that, in all probability, the chemicals responsible for adverse health effects are mostly limited to the currently known pool of "bad actors," like dioxin, PCBs, and DDT. Furthermore, they tried to demonstrate that whichever bad actors were produced in waste streams could be tolerated at the extremely low concentrations in which they were likely to be released into the environment. Finally, they disputed the claim that virtually every use of chlorine would lead to the release of PBTs.

The position taken by the chemicals industry is based on the positivist scientific paradigm which holds that application of the scientific method will reveal objective facts about nature that man can then use to shape technology. Over the last quarter century, the need to make policy decisions on highly complex problems in the absence of scientific

24 U.S. Environmental Protection Agency (1994). Health Assessment Document for 2,3,7,8-
certainty prompted the development of the Risk paradigm. Although the Risk paradigm admits a degree of uncertainty is unavoidable in many situations, its adherents believe that the use of statistical analysis and probability theory can provide objective guidance in formulating policy. In the Risk paradigm then, an approximation based on probabilistic calculations is the only reasonable basis for making policy in the absence of incontrovertible scientific evidence. The Risk paradigm is fundamentally optimistic about man's ability to uncover the truth about how physical and biological systems function. Moreover, scientists and engineers who work within this system tend to be optimistic about their abilities to manage risk, to anticipate problems and correct those they fail to anticipate.

The positivist Risk paradigm has been applied jointly with the equally positivist theories of economics in making environmental policy. Thus, risk assessment provides data for cost-benefit analysis. If a risk assessment for a given chemical indicated a serious health hazard (or if conclusive scientific evidence indicated one), a cost-benefit analysis would be used to determine whether any of several possible regulatory measures would obviate the hazard without exceeding in cost the benefits derived. The premise of this combined approach to environmental policy-making, which will hereafter be termed the Risk paradigm, is that human health and environmental quality can be measured with the same metric as economic variables, money. Health and environmental quality are, of course, important in this worldview, but are seen as comparable to economic considerations.
Chapter 3: Chlorine: A Conflict Over Science or Values?

My primary purpose in this chapter is not to critique the technical aspects of the preceding arguments, but instead to explore the implications of the challenges posed by each side to the other. In particular, the challenges are probed for what they can reveal about the systems of values that guide the parties to this debate. The dynamics of this conflict will reveal the possibilities for resolving this policy controversy by consensual rather than adversarial means within the current U.S. policy-making framework.

Greenpeace's precautionary argument rests on three key assumptions:

- The majority of organochlorines for which toxicology information exists are toxic, and have caused harm to wildlife and human populations.

- The release of known "bad actors", or PBTs, is inevitable over the lifecycles of all chlorine-based technologies.

- The future toxicological studies on the majority of organochlorines that have not yet been tested will reveal most of these to be toxic as well.
These assumptions have been the focus of heated debate between environmentalists and industry, and the broader scientific community. The toxicology of even the most notorious organochlorines like PCBs is poorly understood; causation of adverse effects by environmental contaminants is often difficult to establish convincingly.\textsuperscript{27} Scientists, and the regulators who depend on them for guidance, are also highly skeptical of claims that the mere presence of a chlorine atom on a molecule is a reliable predictor of toxicity.

Greenpeace has based its precautionary policy on what is currently known, or at least strongly suspected to be true about the ecotoxicology of chlorinated "bad actors" in the Great Lakes basin. However, adherents to the Risk paradigm raise questions about Greenpeace's assumptions: How likely is it that the currently known chlorinated "bad actors" are in fact the main source of wildlife health problems? How big a contribution to environmental and health problems is made by the 97\% of unidentified organochlorine species in the Great Lakes? Have the potential effects of other common pollutants like heavy metals and aromatic hydrocarbons been adequately considered? If chlorinated compounds are to blame, are there ways in which we could either improve pollution control techniques or eliminate specific uses of chlorine that introduce large amounts of these chemicals into the environment without the vast economic disruption entailed in a chlorine ban? Could chemical plant siting be redirected to avoid particularly sensitive ecosystems like the Great Lakes? Listed below are further questions that scientists and regulators claim illustrate the need for more information to help resolve the objections outlined above.

**Which organochlorines might pose health threats?**

- What percent of the mass of adsorbable organochlorines in the environment is identifiable?

- What percentage of the mass of biologically stored (in animal fat, breast tissue, etc.) organochlorines is identifiable? What is its composition?

- Given that fish, bird, and wildlife health has improved with the fall in concentration of the "bad actors," how big a contribution to adverse health effects can be attributed to the 97\% of unidentified, but feared toxic organochlorine species in the environment?

• Of the 10,000 to 15,000 chlorine-containing chemicals "in commerce," what percent either have a transitory lifetime (intermediates) or are otherwise highly unlikely to reach the environment (for instance, those produced in small, custom batch sizes for highly specialized and uncommon uses)?

• Of all organochlorines produced, what percent bioaccumulate?

Where do the threats come from?

• What is the approximate total annual production of "bad actors" in North America? Where is it produced (chemical plant waste streams, incinerators, pulp/paper plants)?

• What percent of the total environmental organochlorine load is likely to be from current production as opposed to re-suspended sediments, persistence, or biometabolites of old pollution?

• What are the current avenues and rates of organochlorine input into the environment (dumping of wastes, pesticide application, solvent evaporation/dumping, polymer degradation, etc.)?

What options do we have?

• Can the inputs be practically controlled? (e.g. Waste streams from chemical plant reactors containing dioxin could be treated with innovative technologies like thermal decomposition in molten iron as proposed by Molten Metal Technologies, Inc.)

Scientists and industry leaders claim that answers to these types of questions, even in the form of very rough estimates, could pose a significant challenge to the proponents of an "weight of evidence" approach to the chlorine debate. On the other hand, some note that
they could reinforce the "weight of evidence" position and add a degree of urgency to the matter.

Despite the risk-based objections raised above, however, environmentalists can return to several facts that remain unsettling even to their critics: the global environmental concentrations of dioxins, PCBs, and a number of other organochlorines increased from virtually nil in the first half of this century to become ubiquitous; the environmental half-lives of many of these compounds are quite long, on the order of decades to centuries; and wildlife populations in areas where these compounds are found in higher than average concentrations tend to suffer from a large number of health problems.28

These facts do not prove, in the traditional scientific sense of the word, that organochlorines are as dangerous as Greenpeace would have the public believe. But Greenpeace places considerably less value on scientific certainty than other parties to this conflict, like industry leaders and members of the scientific community. Greenpeace places the highest value on protection of public health and environmental quality. This approach is similar to that taken by the medical and public health professions. A physician will often instruct an ailing patient to stop smoking and drinking excessively, as well as adopt a range of preventive measures like increased exercise and a low fat diet. To be sure, this advice is complemented by sophisticated diagnostic procedures designed to find the specific causes of a patient's illness. But in the event that medical technology fails to provide a clear diagnosis and treatment, precautionary measures, even ones that involve significant changes in lifestyle, and may not be proven to help, are recommended because the patient's health is of paramount importance. A physician will not wait for the results of new research to settle scientific debates before trying to help his or her patient. This is the essence of the Precautionary Principle.

Environmentalists have attacked the chemical industry's risk-based position on chlorine as being unrealistically optimistic, even duplicitous, in the wake of the long string of environmental contamination problems caused by such economically and technologically vital products as DDT, PCBs, and heavy metals (lead, mercury, cadmium). They note that

industry scientists failed to anticipate these problems and raised arguments calling for proof of harm before regulations were passed.

In the case of chlorine, industry has demanded that critics prove scientifically, on a chemical by chemical basis, that its products cause harm before mandating their withdrawal from the marketplace. Furthermore, it has demanded that research identify exposure pathways so that attempts could be made to limit releases of toxins, or in some other way prevent their uptake by biological systems. This position is consistent with the Risk paradigm. Environmentalists note, however, that there are over 10,000 chlorinated chemicals in commerce. Testing each one for carcinogenicity and toxicity to the endocrine, immune and nervous systems would require the devotion of an army of researchers working for decades. Given that this process would yield uncertain results and be impossibly expensive, the industry has been considered self-serving, at best, for insisting on a chemical-by-chemical approach to regulation.29

Furthermore, industry's demand for proof of causation has been the target of criticism since, in the best of cases, establishing causation in questions of environmental toxicology is exceedingly difficult; takes years of research; and is always expensive. For example, research on dioxin, conducted over the last fifteen years, has yet to show precisely how dioxin causes adverse health effects. In fact, the research on dioxin has not even been able to definitively establish which effects one can reasonably expect it to cause in humans. Thus, proof that one chemical or another, in the complex mixture humans absorb from the environment, causes a given effect is simply impossible to obtain. Proof that chlorinated chemicals cause the reproductive and developmental failures, as well as the cancers, seen in wildlife populations where these chemicals are pervasive will forever remain elusive. The interactions of vast natural systems with industrial wastes are simply too complex. The chemical industry's past resistance to environmental protection efforts fuels criticism that its current position is merely a delaying tactic. Comparisons have been drawn to the defensive arguments raised by the tobacco industry regarding the health risks of smoking: the precise mechanisms of nicotine addiction and carcinogenesis have not been clarified; therefore smoking has not been proven to cause lung cancer; and therefore, its sale should not be restricted.

29 ibid
Industry's demands that policy discussions on chlorine adequately treat economic considerations are reasonable within the current U.S. policy-making framework. Both the CRA and MIT reports on the economic and technological impacts of a chlorine ban confirm that a ban would cause significant dislocations in industrial systems and would impose large net costs on consumers. Although Greenpeace did address some economic issues in its initial call for a ban, mainly by noting that substitutes were available for most applications of chlorine, and by calling for the creation of "Superfund for Workers" to aid those displaced by a ban, it did not do so in a thorough fashion. For example, the group did not provide its own estimate of the costs of substitution to chlorine-free technologies. However, industry's reliance on comparative risk assessment and cost-benefit analysis for policy answers is indicative of a value system that differs fundamentally from that held by environmentalists. The prominence given to economic considerations in the defense of chlorine indicates that at least the leadership of the chemicals industry views such things as profits and the value of shareholder equity to be at least comparable to the health of the environment. In addition, industry leaders have, on numerous occasions, expressed the desire to see these values reinforced in law by mandating more extensive use of risk paradigm methodologies like cost benefit analysis. However, environmentalists charge that these methodologies are ill-matched to the problem of assigning relative values to such disparate things as shareholder earnings and the health of bald eagle populations when not all stakeholders to the dispute share the belief that they are in any way comparable.

The dynamics of the chlorine debate illustrated in this section clearly reflect the philosophical divide between those that favor a precautionary stance on the environment and those that have greater confidence in society's ability to effectively and responsibly manage the risks generated by a modern industrial economy. Environmentalists see the world in a fundamentally different way than do industry leaders, scientists and other adherents to the Risk paradigm. Environmentalists presume that technology can cause harm to human health and the environment, and so are extremely cautious about permitting its use. When they see such harm done, they are willing to take whatever steps are necessary to correct the problem and prevent its recurrence. Therefore, while it is evident that the rhetoric of this debate contains many references and appeals to science, the conflict does not stem from disagreements over the validity of particular experiments or the relative

merits of conflicting mechanistic theories of molecular toxicology. Instead, we see on one side paramount value placed on health and environmental quality, and a willingness to take precautionary measures to safeguard them. On the other side, we see a higher, or at least equal, value placed on the technological and monetary fruits of the modern industrial economy, and thus a desire to be much more circumspect in adopting measures designed to correct the unintended effects of industry on nature. This debate is less about chlorine than about the relative merits of the Precaution and Risk paradigms.

This conflict of ideologies accounts for the harsh, polarizing nature of the debate. Neither side recognizes the legitimacy of the other’s perspective. Under such circumstances, it appears that negotiation designed to produce a consensus on scientific matters would be pointless. When a conflict is not concerned with positions, but rather with ideologies, it cannot be settled by negotiation. There is no half-way point to Precaution; there is no middle ground. Such conflicts have always been settled through confrontation, because for negotiation to succeed, one or both sides would have to set ideology aside, publicly recognize the legitimacy of the other’s position, and negotiate, at least in part, within the other’s paradigm. It is, however, well known that exhausting power struggles have forced combatants to adopt pragmatic positions. On occasion, this leads to the negotiated resolution of pressing matters that, under normal circumstances, might never be settled. Could the scientific discoveries, economic changes, or shifts in political power of the past two years (1993-95) have changed one or both side's strategic calculus enough to make negotiation worthwhile? Chapters 4 and 5 will explore these possibilities.
Chapter 4: What the Stakeholders Say About the Prospects for a Negotiated Resolution

Evaluation of the current (1995), and longer term, potential for achieving a consensus-based resolution to the highly polarized chlorine controversy, within the current U.S. policy framework, first required a reliable, up-dated map to the positions, strategies, and ideological stances of the stakeholders most engaged in the dispute. The creation of such a map required the use of a number of information-gathering techniques, the most important of which was direct, verbal communication. Since the ultimate aim of this effort is peaceful and fruitful conversation between stakeholders, it seemed that the best way to assess the possibilities would be through a conversational format rather than by relying on position papers and statements made to the press. Of course, written statements issued by relevant parties were also carefully studied; however, it was often difficult to gauge whether a given document adequately reflected a group’s most current position, or whether all nuances were captured.

Recognizing the leading role of environmental organizations in both initiating and sustaining this debate, I spoke with a representative sample of such groups which had been most involved, like Greenpeace, or which were just planning to join the fray. It was particularly important to accurately characterize their concerns and goals since, unlike industry, they had not developed centralized lobbying and public relations organizations.
Also, due to the grassroots origins of many of these organizations, opinions and agendas often varied internally, sometimes leading to a diversity of positions and thus, perhaps, to organizational dynamics favorable to the exploration of alternate methods of dispute resolution like multi-stakeholder dialogues. In all cases, I sought out senior members of relevant organizations who had policy-making responsibilities. In one case, I was unable to speak directly with staff members, and thus had to rely on published materials they sent me. In Table 3.1 below, I have listed all the organizations and individuals I contacted.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Name of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citizens Clearinghouse for Hazardous Waste</td>
<td>Lois Gibbs</td>
</tr>
<tr>
<td>Environmental Defense Fund</td>
<td>Peter De Fur</td>
</tr>
<tr>
<td>Greenpeace</td>
<td>Lynn Thorp</td>
</tr>
<tr>
<td>Massachusetts Public Interest Research Group</td>
<td>Paul Burns</td>
</tr>
<tr>
<td>Natural Resources Defense Council</td>
<td>Dr. Evelyn Mauss, other staff</td>
</tr>
<tr>
<td>Sierra Club</td>
<td>Doris Cellarius</td>
</tr>
<tr>
<td>Sierra Club</td>
<td>Mark Woodall</td>
</tr>
<tr>
<td>United States Public Interest Research Group</td>
<td>Carolyn Hartman, other staff</td>
</tr>
<tr>
<td>World Wildlife Fund</td>
<td>written statement by Dr. Theo Colburn</td>
</tr>
</tbody>
</table>

My research into the current position and strategy of the chemicals industry was built on a thorough review of numerous industry reports and statements to the press. I then interviewed William F. Carroll, Director of Science and Stewardship Programs for the Chlorine Chemical Council, and attended two conferences focusing on the future of industrial chlorine chemistry, one at MIT in November of 1994, and one sponsored by
Chemical Week magazine in New Orleans in April 1995, at which industry representatives made public comments on the chlorine controversy. I also made use of written materials distributed at these conferences. In addition, I relied on notes from a seminar given at MIT in December of 1994, by Clifford P. (Kip) Howlett Jr., Vice-President and Managing Director of the Chlorine Chemical Council. Due to the constancy and unity with which representatives of industry have spoken, and because the industry position on chlorine is well documented, I have presented my observations from the two conferences in condensed form. I attempted to capture in these summaries not only the essence of industry statements, but also reactions to challenges that were presented by other conference participants.

Although my research focused primarily on environmental groups and industry, I also attempted to contact EPA officials and representatives of labor organizations. I was unable to contact senior EPA officials responsible for policy issues, but I did speak with Dr. Linda Birnbaum, of the EPA Health Effects Research Laboratory in Research Triangle, North Carolina, who is a leading researcher on environmental toxicology, and who has been active in organochlorine toxicity research. Recognizing that labor organizations would also be likely to take on an important role in determining the future of chlorine, I interviewed Sylvia Keating, a Health and Safety Analyst for the Oil, Chemicals, and Atomic Workers (OCAW) union.

Finally, in addition to EPA and labor, I sought out third party organizations that were actively trying to foster discussions between stakeholders on chlorine, or had organized such dialogues on other issues in the past. Thus, I spoke with Ms. Barbara Stinson of the Keystone Center which is an organization devoted to sponsoring negotiations leading to mutual understanding and consensus on environmental issues. In a similar vein, I also spoke with Katie Smythe of Science and Policy Associates, a Washington, D.C., consulting firm that is attempting to organize an industry-funded series of round table discussions between industry and environmentalists on the future of chlorine.
The interviews I conducted with the individuals mentioned in the preceding paragraphs were structured around the following main points:

- What is your group's position on the chlorine question and how has it evolved?
- How would you rank your environmental and public health concerns relating to chlorinated compounds?
- How do you see the controversy evolving over the next five years? How do you think the 1994 midterm Congressional elections affected the issue?
- Do you think a consensus between stakeholders will emerge? If so, how do you think this will be achieved? Do you think universities can play a significant role in fostering consensus?
- Have you, or has anyone in your group attended meetings, conferences, or negotiations on chlorine at which opposing parties were present? If so, do you think these encounters were productive? Why or why not?

Naturally, many discussions strayed from these topics onto broader issues such as the comparative merits of precautionary versus risk-based approaches to environmental management. Thus, instead of providing a verbatim transcript of each conversation, I have summarized relevant comments and attempted to capture the general tone of the discussions. I proceeded in a similar manner in my treatment of written materials and oral statements made by chemical industry executives at the conferences I attended. The summaries that follow begin with environmental organizations, then labor, government (the EPA), third party organizations, and finally industry.

**Environmental Organizations:**

**Citizens Clearinghouse for Hazardous Waste: Lois Gibbs**

Ms. Gibbs is an environmental activist with many years of grassroots campaigning experience. In addition to her work in bringing the dioxin contamination at Love Canal and Times Beach to the world's attention, she has participated in numerous other environmental toxics campaigns. Ms. Gibbs stated that her organization had not been closely involved with the broad attack on chlorine launched by Greenpeace in the late 1980's, but had
supported it. She emphasized, however, that she was in the process of coordinating with Greenpeace and numerous other organizations what she described as a massive grassroots effort to persuade consumers to abandon the use of chlorinated products.

This effort, the groundwork for which they began to lay three years ago, would be modeled on the 1980's campaign against McDonalds' use of polystyrene "clamshells" in packaging its hamburgers. Environmentalists then charged that the plastic packaging was creating a serious litter problem because of its non-biodegradability in the environment. Furthermore, opponents of the material faulted McDonalds for using it because there was virtually no market for recycled polystyrene at the time. Ms. Gibbs, who was involved in the McDonalds initiative, noted that although the fast-food chain resisted changing its packaging, and even sponsored material life cycle assessment studies which supported its position, the company was forced to bow to consumers' wishes. She pointed out that McDonalds had come to the conclusion that they were in the business of selling food, not packaging, and thus abandoned what had become an untenable position. Ms. Gibbs expects that although an analogous consumer education effort on chlorine may take more time, it will ultimately have similar results; chemical companies will alter their product lines to reflect consumers' demands for environmentally benign products. She further noted that efforts organized by the PIRG's, by Ralph Nader and Barry Commoner, and by Greenpeace to alter institutional procurement (federal, state, and local governments, hospitals, schools, etc.) of paper had already been quite successful at starting a transition first to recycled paper, and then to elemental chlorine free (ECF) paper.

The campaign to eliminate chlorine that Ms. Gibbs is helping to organize will attempt to firmly link chlorine with the public's fears of dioxin. Organizers are basing their position on the EPA's recent Dioxin Reassessment Study which has found dioxin to be both more pervasive and dangerous than previously suspected. Ms. Gibbs points out that according to the study, only 50% of dioxin emissions come from known sources. The other major, currently unmeasured sources of dioxin can only be those places where significant mixing of chlorine and organic compounds occurs: the chemicals industry and the paper industry. She and the other collaborating environmental groups hope to make the public understand that any industrial use of chlorine inevitably leads to the formation of dioxin; that dioxin is now ubiquitous in the environment and in human tissue; that dioxin levels in tissues are generally at or above levels deemed harmful; that reproductive and developmental effects of dioxin are particularly alarming; and that action must be taken immediately.
Ms. Gibbs and her collaborators realize that industry opposition to this line of reasoning is entrenched. Therefore, although she maintains that their long term goal is the total elimination of chlorine from industry, she and allies have prioritized their goals for phasing out the main segments of the chlorine marketplace to reflect what they see as the most pressing threats to public health. They place PVC and chlorine in pulp and paper at the top of their lists. Ms. Gibbs noted that PVC was chosen not only because of its link to dioxin in municipal solid waste and medical waste incinerators, but because PVC is the single largest end-use of chlorine; without PVC, chlorine manufacturers would be bankrupt. Ms. Gibbs vehemently denied that environmentalists had acknowledged defeat of their anti-chlorine efforts by prioritizing chlorine market segments -- something they had refused to do in the past. She did acknowledge that the current political climate, as well as industry's superior financial resources, had forced environmentalists to re-focus their efforts somewhat, but that this did not amount to a defeat.

When pressed to elaborate on the impact of the recent elections, she admitted that efforts to lobby the EPA or Congress to phaseout chlorine would not likely yield positive results in the near term. She did not see the removal of language proposing an EPA study on the phaseout of chlorine from the Clean Water Act Re-authorization bill of 1994 as a lobbying defeat. Rather, she saw it as a first step in educating Congress; merely getting such a proposal to be considered, however briefly, was a major accomplishment. Ms. Gibbs offered the opinion that a change in industrial practice of this magnitude could not be achieved by government edict anyway; the impetus for change would have to come from consumers. As examples, she pointed out that the impossibility of siting hazard waste dumps or nuclear power plants did not stem from insurmountable legal barriers but rather from the "NIMBY syndrome." Nevertheless, she did express the belief that current Republican efforts to dismantle environmental regulations would provoke a backlash that would reopen regulatory approaches to limiting the use of chlorine over a 3 to 5 year timeframe. She noted that the GOP's de-centralizing initiatives might well force industry itself to call for new national environmental standards since a proliferation of local standards would impose on them even more onerous compliance burdens.

When asked about the usefulness of multi-stakeholder dialogues in building consensus, Ms. Gibbs said that in the short term they would not be productive, but that in the long run they would prove to be essential. She believes that much more popular pressure must be applied to industry before consensus-seeking discussions would be
useful. She believes that current efforts by groups such as EDF and NRDC to engage industry in a dialogue are a waste of time, and that these groups allow industry to manipulate them. She believes these groups, as well as a large portion of the academic community are wasting resources by agreeing to debate the scientific merits of the anti-chlorine position. If one is to take a precautionary approach to environmental regulation, then the chlorine controversy should already be settled. Ms. Gibbs made clear, however, that her position did not rule out discussion with companies earnestly seeking to abandon chlorine. In fact, she said she would campaign for financial incentives to aid industries through the transition. In particular, she wanted to ensure that workers would not lose their jobs, but rather would be retrained or otherwise assisted during an industry overhaul. Worker concerns would be critical to evaluating changes in industrial practice from an environmental justice perspective.

Ms. Gibbs stated that although she had read about many chlorine-related conferences such as the ones sponsored by the IJC and by MIT, she had not attended any of them. This was mostly due to limitations imposed by scheduling and budgets, but also to her conviction that most of these forums did not constitute true multi-stakeholder dialogues. In order to foster a true dialogue that had the potential of yielding results, she said that conference organizers would have to make sure that all interested parties, including labor, community, Native American, and environmental justice groups were adequately represented. This meant not only assuring their physical attendance, but also furnishing them with resources like scientific and economic advisors so that the negotiating field was in fact even. Of particular importance would be assisting citizens groups who lacked adequate funding to meet together to develop negotiating strategies. She said that this was a major barrier to achieving a sense of equality and fairness in negotiations with industry, because industry representatives had virtually unlimited resources for such exercises. In anticipation of this sort of problem, Ms. Gibbs stated that she and her colleagues had already begun meeting whenever possible to discuss future potential negotiations with industry.

When asked about the possible role of universities in helping to build a consensus on chlorine, Ms. Gibbs responded that they could help to educate the public, but that the current academic focus on carefully arguing every technical detail of this controversy was counter-productive. She also doubted that a major research university, particularly MIT, could be perceived as a neutral forum for a dialogue or negotiation on the issue because of
extensive research ties to industry. In general, she seemed to feel that universities would play a limited role in the resolution of the chlorine debate.

**Environmental Defense Fund (EDF): Peter de Fur**

Mr. de Fur, a senior EDF scientist, views the chlorine controversy as a conflict over basic values relating to the environment. He believes that achieving a consensus on chlorine is vital; the chlorine debate highlights the deep philosophical divide between proponents of the precautionary and risk-based approaches to environmental management. This divide must somehow be bridged if humanity is to seriously attack the many environmental problems it faces. Mr. de Fur believes that the current political climate does favor consensus-building because politicians are not providing responsible leadership on environmental issues. He thinks Americans will rejects the GOP initiative to dismantle environmental regulations.

Issues like chlorine are not dead; the environmentalists' message will be well-received in contrast to what industry and GOP lawmakers propose. The attack on chlorine has become temporarily unbundled, with most attention being focused on certain segments like PVC and pulp and paper bleaching, because of tactical considerations. He asserted that, contrary to whatever groups like Greenpeace might say, a complete ban on chlorine in the relatively near future, even if slowly phased in, is an unlikely prospect. Thus, although a complete chlorine phaseout remains the goal, the battles along the way must be carefully chosen to reflect level of threat to public health and environment as well as the resources environmental groups can bring to bear. Mr. de Fur compared the situation to that faced by environmentalists in the late 1960's and early 1970's when they fought for a ban on lead. Although anti-lead activists were convinced that there was no safe use of the metal, they were forced by intense industry opposition to focus their attacks on only a few products. Eventually they succeeded in banning tetra-ethyl lead in gasoline and lead in paints. He noted that although lead still finds its way into the environment, levels have dropped significantly. Thus, only a focused approach, based on consumer education will work to force industry to change its products.

Mr. de Fur noted that industry's arguments in favor of chlorine are very similar to those that were made on behalf of lead: "There are safe levels of lead exposure; more research must be done to establish thresholds..." He believes consumers will accept the
environmentalist warnings about chlorine because most people already consider it to be hazardous based on experience with household chemicals: "One doesn't drink or touch chlorine bleach." Furthermore, many people across the country have been affected by or read about chlorine gas leaks, hydrochloric acid spills, chlorinated solvent well contamination, and PCBs or dioxins in Superfund sites. Finally, he noted that concern had already spread "beyond the Beltway," and that citizens groups around the country were taking an interest in the problem.

Mr. de Fur had participated in numerous meetings, conferences, and workshops on chlorine sponsored by such organizations as the Society of Toxicology, the American Association for the Advancement of Science, the American Public Health Association, the EPA, and others. He stated that EDF made it a priority to attend meetings that would foster consensus on environmental issues, and that he planned to attend more such gatherings. He expressed dissatisfaction with large conferences that were, in his words, "public shows" where nothing of substance was accomplished. Ideally, he thinks business, labor, and nonprofits should be able to achieve consensus on critical questions of values and join in a partnership to improve society. He believes that an organization seeking to initiate a multi-stakeholder dialogue on an important issue like chlorine should host the event outside of Washington, D.C. which, in his mind, has become too politicized. The forum should be non-partisan: a university might be suitable, but it would have to be a liberal arts college or small public university not burdened with links to industrial research which would make it appear biased in the eyes of most grassroots environmentalist organizations. All interested parties would have to be included. Of particular importance would be inclusion of all interested parties in the planning of such a process. Although it might take as long as two years to organize, the effort would undoubtedly yield better results for all than our current politics, which is unlikely to result in consensus.

Greenpeace: Lynn Thorp

Ms. Thorp, an experienced environmental campaigner based in Washington, D.C., believes that a consumer campaign will ultimately prevail on industry to stop manufacturing or using chlorine. She believes that government is incapable of catalyzing massive industrial change and that industry will only respond to the marketplace. Ms. Thorp feels that public awareness about the hazards posed by chlorine is growing rapidly. She asserts
that within 2 to 3 years, the average person will automatically associate chlorine with dioxin and myriad threats to public health and the environment. In Europe, awareness of chlorine's dangers is more widespread and many chlorinated products such as PVC, chlorine bleached paper, and chlorinated solvents are facing shrinking markets. Pressure on industry to change its ways in Europe will add to citizen concerns in the United States. She predicts that the chemicals industry will reverse its position within the next 5 to 7 years in an attempt to salvage its reputation.

Ms. Thorp thinks it unlikely that the chlorine controversy will be resolved in the United States within the next five years. One key problem is that the two sides of this debate cannot agree on the definition of the problem. The chemicals industry does not believe there is a problem with chlorine, but rather with an isolated few persistent bioaccumulate toxins. These should be individually regulated, with end-of-pipe measures taken to prevent their formation as byproducts of industrial processes. Greenpeace and other environmental groups reject this argument as providing too much "wiggle room" for the industry to tweak definitions of toxicity, safe levels, etc. They refuse to allow industry to change the terms of the debate; they refuse to abandon a precautionary stance in favor of a risk-based stance. Ms. Thorp feels that the public will support her position. She thinks that industry claims that the chlorine issue is part of Greenpeace conspiracy to dismantle the chemicals industry are ridiculous. She maintains that industry's job is to bring products to market; Greenpeace's job, given the ineffectiveness of government action, is to ensure that those products do not put the public at risk.

Ms. Thorp believes that once industry admits that chlorine is a problem, the final outcome of the debate will be a multi-stakeholder dialogue process that will result in the establishment of priorities for phaseouts and determination of how to treat "special case" products or processes like pharmaceuticals or water disinfection. Ms. Thorp believes the settlement of a major issue like chlorine could be a watershed for the development of a more sustainable economy in which many environmental regulations become irrelevant because at least some parts of industry will adopt a precautionary approach to environmental management. In fact, she believes that some companies like Dow anticipate a chlorine phaseout and are quietly developing alternatives. She hinted that a number of companies had, in fact, begun to discuss alternative technologies with Greenpeace and other environmental organizations. She rejected the notion that the recent elections marked a major defeat for Greenpeace. Although the momentum in Washington had shifted
temporarily in favor of industry, the campaign for public opinion had yet to really heat up. She believes that industry realizes this and anticipates an outcry.

Ms. Thorp thinks universities can play an important role in resolving both the chlorine issue and the implementation of the precautionary principle to environmental management more broadly. In particular, she thinks universities could use a multi-stakeholder dialogue process to help establish criteria for testing the safety of products that would reflect a "reverse onus of proof." That is, universities could provide guidance on how to show, before a product is brought to market, that it is unlikely to threaten public health or the environment. She cited the work being done at MIT on chlorine, and the research done on toxics use reduction at the University of Massachusetts at Lowell as being very helpful.

Massachusetts Public Interest Research Group (MASSPIRG): Paul Burns

My conversation with Mr. Burns, an attorney, was very brief due to his busy schedule. He stated that MASSPIRG, which operates in Massachusetts and is affiliated with the national organization USPIRG, had been involved in the chlorine debate. In particular, MASSPIRG had been very active in campaigning for the phaseout of chlorinated solvents use in Massachusetts. In general, it had taken a broader view of the dangers associated with industrial chlorine use than USPIRG which had mainly focused its efforts on reducing the use of chlorine in the paper industry. MASSPIRG continues to campaign for toxics use reduction, and especially for reductions in the use of chlorine. It anticipates further involvement in the broader chlorine debate as environmental groups nationwide launch a grassroots campaign to steer consumers away from products containing chlorine. Although MASSPIRG had not participated in any consensus-seeking multi-stakeholder dialogues on chlorine, Mr. Burns seemed very interested in discussing the idea.

Natural Resources Defense Council (NRDC): Dr. Evelyn Mauss

Dr. Mauss is a physiologist with considerable experience in lobbying on issues relating to environmental toxins such as lead and other heavy metals. She had not been directly involved with NRDC's chlorine campaign and suggested that I speak with Jessica Landman, an NRDC attorney based in Washington, D.C. I was unable to contact Ms.
Landman due to her participation in committee hearings on proposed changes to environmental legislation proposed by Republican lawmakers under the aegis of the GOP "Contract with America." Dr. Mauss, as well as NRDC staffers in Washington, stated that NRDC would continue to play a leading role in the chlorine debate. NRDC generally favors a precautionary approach to environmental management and rejects claims that chemicals must be proven, in the strongest scientific sense of the term, to cause harm to the environment before they are regulated. NRDC has participated in multi-stakeholder dialogues on environmental issues in the past and favored a consensus-based solution to the chlorine problem.

**The Sierra Club: Doris Cellarius**

Ms. Cellarius is a Sierra Club volunteer and experienced environmental campaigner based in Washington state. She is active in developing Sierra Club's national policies and strategies.

Ms. Cellarius began by stating that because she takes a precautionary perspective on environmental and public health issues, she feels that enough is known about chlorinated organics to raise concern and prompt action. In particular, she believes that uses of chlorine that lead to wide exposures to dioxin, such as PVC (via incineration) and pulp and paper bleaching should be phased out as soon as possible. On the other hand, she believes that there may be uses of chlorine for which alternatives might be less desirable still. Therefore, she generally supports the idea of using multi-stakeholder dialogues to help achieve consensus. That being said, she is concerned that industry may try to use these discussions to stall regulatory initiatives and manipulate environmental groups. She also worries that many stakeholders are not fairly represented at these negotiations due to inadequate financial backing. When pressed, then, on the desirability of holding, in the near future, a series of meetings with industry on the chlorine issue, Ms. Cellarius felt that grassroots efforts to change consumer attitudes should be given a chance to work. She is directly involved in this and claims to have met with success in urging municipalities and other public institutions in the states of Washington and Oregon to purchase totally chlorine-free paper. She and her colleagues in the Zero Toxics Alliance of the Pacific Northwest are now planning to expand their anti-chlorine campaign to other products like plastics.
The Sierra Club: Mark Woodall

Mr. Woodall is a Sierra Club volunteer and environmental activist based in Georgia. His experience of the chlorine debate has centered mainly on the use of chlorine in pulp and paper bleaching by Georgia Pacific. He had just begun to get involved with Sierra Club’s activities relating to the broader chlorine controversy when I spoke with him. He noted that although Sierra Club operates on a national level, its structure is very decentralized and its leadership consists of volunteers. Therefore, opinions on what to do about chlorine and interest in the question were likely to vary somewhat with geography. For example, it was the Club’s Great Lakes chapters that had been most active on the chlorine issue. Nonetheless, the organization was in the process of educating its membership on chlorine and coordinating its anti-chlorine efforts nationally.

Mr. Woodall doubted that organized dialogues between industry and environmentalists would accomplish anything at this point. He felt that the grassroots effort to educate the public about the dangers of chlorine should be given a chance to put pressure on industry. Mr. Woodall was generally pessimistic about the potential for finding an negotiated solution to the problem. He also thought that universities had only a minor role to play in resolving this conflict, since enough research had already been done to show the dangers of industrial chlorine chemistry.

United States Public Interest Research Group (USPIRG)

Representatives from this national organization refused to talk to me at any length due their extremely busy schedules. They did, however, state that USPIRG had been, and would continue to be deeply involved in the anti-chlorine grassroots campaign. They said that they had not participated in multi-stakeholder dialogues on the chlorine problem, but were committed to working with other environmental groups to try to educate consumers on the dangers of chlorine.
World Wildlife Fund (WWF): Dr. Theo Colburn (written materials only)31

Dr. Colburn, who holds a Ph.D. in zoology, is a leading researcher on endocrine system disruption in wildlife populations of the Great Lakes basin. Her work has had a catalytic effect on the chlorine debate; the IJC as well as many environmentalist groups cited it as persuasive enough to warrant invoking precaution and calling for a chlorine phaseout. Dr. Colburn, however, has never called for a ban on all chlorinated products. Instead, she has focused her efforts on changing the way chemical risk assessments are designed to include other health endpoints besides those traditionally monitored, cancer and lethality. In particular, she advocates careful study of developmental, immunological, and neurological toxicities. Dr. Colburn is very concerned that by focusing almost exclusively on cancer, we may have released into the environment chemicals that have dramatically lowered the reproductive capacity of certain wildlife populations and even some human populations. She has noted that many chemicals known to, or suspected of, causing these effects contain chlorine, and that industrial chlorine chemistry may be a problem, but her first priority is the elimination of those chemicals which cause the effects she has studied.

Dr. Colburn has called upon industry, government, and academic scientists to work together to develop new testing protocols for non-traditional health endpoints and to retest all chemicals in commerce for these effects. This recommendation has drawn criticism from industry representatives, whom Dr. Colburn has accused of mischaracterizing her position as a call for broad-based chemical bans.

Although she is an advocate of precaution in environmental affairs, and believes that currently available data should raise concerns, Dr. Colburn believes that more research, particularly on the development of new testing protocols, is essential to the resolution of the chlorine debate, and, more broadly, the debate over man-made chemicals in the environment.

Labor:

Oil, Chemical & Atomic Workers: Sylvia Keating

Ms. Keating, a union official in the Health and Safety Department, stated that OCAW had not yet taken an official position on the advisability of phasing out chlorine. However, the union maintains that any assessment of a chlorine phaseout must take into account the impact on the 20,000 chemical industry workers that would be displaced by such action. In general, however, union sympathies lie with the environmentalist cause. Workers are very concerned about the potential health effects of factories on their communities. Of course, they are even more alarmed about threats to their own health from exposure on the job. Rank and file members' attitudes differ only slightly along generational lines; younger workers who do not yet have children or mortgages tend to be more vocal, but concerns run deep regardless of age, gender, race, or geography.

OCAW has called for the creation of a "Superfund for Workers," to be modeled on the GI Bill, in the event of a chlorine phaseout. The aid to displaced workers should include funding for job re-training and relocation up to the cost of a four year college education. The union has refused to allow management to represent its interests in this debate and wishes to be included in any future negotiations over the fate of chlorine.

Government:

EPA: Dr. Linda Birnbaum

Dr. Birnbaum is a senior toxicologist at EPA's Environmental Health Effects Laboratory in Research Triangle Park, North Carolina. She has studied the various health effects of a number of organochlorine compounds and is particularly interested in endocrine system effects. She believes that although most workers in this field acknowledge the uncertainties in currently available data, most also agree that enough is known to take certain actions to reduce exposures to endocrine-disrupting chemicals. She deplores the heated rhetoric of the chlorine debate as well as the over-bearing influence of financial considerations. She feels that a step-wise precautionary approach is called for in attempting
to resolve complicated environmental issues like this. For instance, she feels that enough is
known about dioxin's ill effects to warrant taking immediate actions to lower exposures
like mandating proper control of incinerator emissions. Whether broader, more dramatic
steps should be taken, like banning chlorine, is unclear to her at this point. She believes
that most scientists, including a majority at EPA, do not think a complete ban on chlorine is
necessary, but that it would be advisable to study the question further.

Dr. Birnbaum feels that, in addition to more research, multi-stakeholder dialogues may be helpful in developing testing protocols and setting testing priorities. She finds that
negotiations held behind closed doors are more likely to produce results than more open
meetings where people worry about distorting media coverage. She noted that having a
diversity of sponsors for such a process, potentially including universities, would help to
alleviate fears of bias. She added that this would be less of a problem with strictly scientific
meetings. Dr. Birnbaum also pointed out that many organizations would require financial
assistance in order to participate.

Third Party Organizations:

The Keystone Center: Barbara Stinson

The Keystone Center is a non-profit, independent organization devoted to seeking consensus-based solutions to environmental problems. The Center has served as neutral
organizer and facilitator for negotiations on a wide variety of issues like natural resource
management, energy, environmental quality, occupational safety, mining, and hazardous
materials handling. Ms. Stinson stated, however, that the Center had not worked on water
quality issues or on chlorine. (She saw chlorine as being primarily a water quality
problem.) Furthermore, no group had yet proposed a workshop on chlorine to the Center's
staff. From what she knew of it, the issue did not seem ready for negotiation at the Center,
but this was only speculation on her part. She did think that this type of issue would be
amenable to a multi-stakeholder process however, and she hoped that such an approach
would be pursued.
Science and Policy Associates (SPA): Katie Smythe

Ms. Smythe is a Senior Project Manager for Science and Policy Associates, a Washington, D.C. environmental consulting firm with both private and public sector clients. With industry funding, SPA has initiated a series of meetings on chlorine to which they have invited representatives of industry, government, and environmental groups in the hopes of producing an agreement on chlorine-related research priorities. Ms. Smythe noted that all participants seemed to believe that an agreement on which questions were most important could help to break the stalemate on the issue.

Ms. Smythe described the difficulties involved in organizing a multi-stakeholder process as daunting, particularly in the current political climate. Many potential participants were very busy attending Congressional hearings on proposed changes to environmental regulations and could not devote time to SPA’s effort. Furthermore, environmental politics has become quite acrimonious over the past several months and eagerness to discuss issues with opponents has waned. By far the most difficult problem SPA faces, however, is logistical: a multi-stakeholder dialogue must, by definition, be inclusive. On the other hand, large groups become rapidly becomes unwieldy. Also, a very large number of organizations consider themselves legitimate stakeholders: what constitutes a balanced invitation list? Where does one draw the line? SPA has managed to alleviate some concerns over bias in design of the process (since the effort is industry-funded) by including stakeholders in the planning process. Of course, this has aggravated the invitation list problem.

Ms. Smythe stated that the project had been temporarily put on hold until after certain bills now being debated in Congressional committees had been voted on.

Industry:

Chlorine Chemistry Council (CCC): William F. Carroll

Mr. Carroll, who has held both technical and managerial positions at Occidental Chemical, now helps the CCC, an industry lobbying and research organization, to respond to environmentalist challenges to the use of chlorine in industrial chemicals. Mr. Carroll
sees the chlorine controversy as a thinly veiled assault on the whole chemicals industry. He attributes the attention recently given to endocrine disruption as the promotion of a new "scare campaign" by environmentalists who see the "cancer scare" as having reached the end of its "product lifecycle." He believes that the recent elections have not deterred environmental groups; they have only slightly altered their rhetoric as a means of attaining the same end, a ban on chlorine. He believes such a ban would not only be crippling for many companies, but would set a precedent for additional drastic regulation of the industry, possibly forcing it overseas. Thus, industry leaders are worried that any negotiation they enter into over even subsets of chlorinated compounds would rapidly expand to gravely threaten the whole industry.

The CCC would therefore like to shift the focus of the debate to persistent, bioaccumulative toxins. He states that the CCC is eager to work with interested parties to solve real problems caused by PBTs. The CCC would like to participate in a multi-stakeholder process that would help to set research priorities and develop testing protocols that would identify PBTs and detect health effects like endocrine disruption. He believes that companies are willing to adopt a class-based approach to environmental regulation as long as the classes are based on functionality. In other words, industry might be willing to see all endocrine disrupters regulated the same way instead of asking for specific standards on each product within the class. On the other hand, industry rejects the environmentalist position that all chlorinated compounds should be banned as a precaution against the inadvertent production of undesirable byproducts, such as dioxin or PCBs, either in the manufacturing or disposal of otherwise desirable products. Mr. Carroll stated that industry will refuse to participate in any negotiations where chlorinated chemicals, as a class, is the topic of discussion. He did agree, however, that industry's refusal to discuss chlorine as an issue in fact paradoxically amounted to an acknowledgment of the issue.

Mr. Carroll felt the prospects for finding a consensus-based solution to the chlorine controversy were poor. He cited only EDF as a group industry might be able to work with. A major obstacle to resolving this debate in a democratic fashion would be the fact that if all interested parties were to attend a negotiation, industry would be pitted against hundreds of opponents ranging from environmentalists, to Native Americans, to environmental justice networks, and, of course, to labor in a process that could not possibly considered fair. On the other hand, if any plaintiff were excluded, the media would seize upon that fact to discredit the whole endeavor. Finally, if industry were to work with only a limited number of environmentalists in small focus groups, these groups would face charges of treason.
from other environmentalists. Ultimately, Mr. Carroll pointed out, negotiations only produce solutions when both sides feel they have something to gain; that situation does not exist today.

**Chemical Industry Perspectives: Conference Notes**

"The Future Uses of Chlorine: Symposium on the Role of the University"
November 14-15, 1994 • Cambridge, MA

The conference was sponsored by MIT and supported in part by a grant from the V. Kann Rasmussen Foundation. The primary goals of the conference were the determination of scientific research priorities relating to chlorine chemistry, and the establishment of the role of the university in resolving complex environmental problems like the chlorine controversy. Conference organizers hoped that discussions in plenary sessions and break-out groups would help to forge consensus on these two points and perhaps even point the way to broader agreements on the future uses of chlorine. Although representatives of all major factions in the debate were invited to participate, environmentalist and labor groups did not attend; most participants were industry, government, or academic scientists. The agreements that did emerge from the conference thus did not explicitly reflect the concerns of a crucial constituency.

Industry representatives, led by Clifford P. (Kip) Howlett Jr. of the CCC, emphasized the uncertainties in currently available data on the health effects of organochlorines. They highlighted the work done by Professor Gordon Gribble of Dartmouth College which showed that a remarkable number of organochlorines are produced in nature; they thus called into question environmentalist claims that such compounds are fundamentally xenobiotic and thus suspect. They also pointed out the contradictory conclusions reached on the carcinogenicity of a number of organochlorines.

Mr. Howlett stated that industry was very concerned about the newly discovered endocrine-disrupting properties of certain industrial compounds. He also noted, however, that many of these did not contain chlorine, and that no one had offered evidence that presence of chlorine on a molecule would make it more likely to display hormonal activity.
Mr. Howlett and others applauded advancements made in the development of new bioassays to measure such properties as estrogenicity, but cautioned that more work should be done to verify their predictive quality. Finally, Mr. Howlett called for a change in focus of academic research away from chlorinated chemicals to a more specific emphasis on persistent, bioaccumulative toxins.

Industry representatives urged academic and government researchers to improve the quality and quantity of data on organochlorines and other chemicals in the environment so that future regulation could be based on "sound science" and comparative risk assessment. They pledged their support for further research in academe and government and promised to continue their own efforts to improve the quality of the science available to regulators.

A majority of academic and government researchers seemed to agree that more research was required to support sound decision-making on the whole family of chlorinated compounds. However, a significant minority sided with panelists like biologist and noted environmental activist Dr. Barry Commoner, who expressed the view that current scientific knowledge justified taking a precautionary stance. Most seemed to agree that health effects like endocrine system disruption, which have been neglected in the past, deserved much more attention.

The MIT organizers of the conference, under the leadership of Professor David H. Marks, proposed the creation of a cooperative network of academic, government, industry, and non-profit organization researchers and policy-makers interested in chlorine-related issues. The network would help to disseminate information and serve as a forum for discussion of scientific and regulatory affairs; it might even serve as a catalyst for generating a consensus on how to resolve the chlorine controversy. The proposal was met with some interest, but many favored a looser form of cooperation based on interactions over the Internet. Some industry representatives voiced concerns that the creation of such a network would strengthen the focus on chlorine instead of shifting it to PBT's which they believe should become the targets of research.

The conference succeeded in building consensus on at least one important point: further research is needed on endocrine system disruption and other non-traditional health endpoints. Most participants also agreed that the university has an important role to play in the resolution of environmental problems as a center of research. However, no consensus
emerged on the question of whether the university should play a broader role as a forum for negotiating settlements to environmental conflicts.

April 11-12, 1995  •  New Orleans, LA

Chemical Week magazine hosted a conference in New Orleans over April 11-12, 1995 at which chemical industry executives discussed the future of industrial chlorine chemistry. Participants were exposed to a wide range of opinions on the problems facing the industry. Although most came away from the conference feeling confident that the Chemical Manufacturers Association (CMA) position would ultimately prevail, few doubted that the controversy surrounding chlorine would continue to plague them for the next decade.

Roger Hirl, CEO of Occidental Chemical, and Clifford P. (Kip) Howlett Jr., of the Chlorine Chemistry Council (CCC), re-iterated industry's position that environmental regulation should be based on sound science, comparative risk assessment, and cost benefit analysis, and that by these standards, the environmentalist challenge to industrial chlorine chemistry did not warrant any new regulatory action. They proposed to continue to counter environmentalist demands for a chlorine phaseout with cost benefit analyses that highlighted the economic importance of chlorine as well as with demands for hard scientific data on the effects of chlorinated chemicals on human health and the environment.

Their approach to the problem was challenged by a number of speakers. Dr. Terry Yosie of the E. Bruce Harrison Company, an environmental communication firm, and Susan Santos of the Columbia U. Risk Communications Program both expressed the view that CMA/CCC's current strategy of stressing the economic importance of chlorine while simultaneously denying any adverse health effects from its products would not improve the industry's already low level of credibility. Dr. Yosie warned that although the momentum of the debate had clearly shifted in favor of industry since the elections, it was bound to shift again. Dr. Carlos Sonnenschein, of Tufts Medical School, presented evidence of endocrine system disruption by a number of organochlorines; and Dr. William Toscano, of the Tulane U. School of Public Health, presented the current understanding of dioxins
toxicity to man. They underscored the dangers of underestimating the risks involved with endocrine disruption and with the myriad adverse health effects potentially produced by dioxin. Finally, the CMA/CCC strategy was indirectly challenged by a number of industry speakers. Among them, Richard Erickson, of Weyerhauser Co., predicted that the majority of pulp and paper bleaching mills would be totally chlorine free (TCF) in the United States within about a decade. In fact, he predicted that they would move to effluent-free technology within an only slightly longer timeframe.

The critical business trends regarding chlorine were explained by Billy Tullos, Business Manager for Chlor-alkali and Oxygenated Products at Elf Atochem North America. He noted that the current investment climate for expanding chlorine production capacity was very unfavorable despite high capacity utilization rates and significant projected demand expansions. He attributed this negative atmosphere to concerns over potential future environmental regulation of chlorine. He predicted that the tightening chlorine supply situation would force prices up and therefore force manufacturers to cannibalize lower value-added product lines in favor of PVC and specialty chlorinated organics. He also foresaw that chlorine could soon become a competitive issue between companies as consumers became more concerned about the adverse health effects of certain organochlorines and demanded chlorine-free alternatives.

Mr. Tullos' comments thus raise the prospect of possible future divisions within the industry with a number of firms distancing themselves from the CMA/CCC position. However, since a number of very large companies such as Occidental, Geon, and Vulcan are heavily dependent on chlorinated product lines, and have vowed to fight environmentalists to the bitter end, this controversy is unlikely to be resolved in the foreseeable future.
Chapter 5: The Precaution-Risk Stalemate

The discussions recounted in the previous chapter hold out little encouragement to those hoping to avoid a protracted confrontation over chlorine. It is true that many nuances are evident in the positions of the various environmental groups surveyed, and it appears that the CCC's leadership may find it difficult, over the long term, to maintain a unified position on chlorine. Also, most of those interviewed expressed an interest in consensus-seeking dispute resolution processes. Nevertheless, a number of discouraging trends clearly emerge to overshadow these positive signs.

All but one of the environmental groups surveyed (the World Wildlife Fund) stated that they believe chlorine and all its derivatives should eventually be phased out. All of the groups indicated a commitment to the Precautionary Principle. Furthermore, Greenpeace seems to have established cooperative relationships with the Citizens Clearinghouse for Hazardous Waste, the Sierra Club, and others to coordinate a nation-wide, grassroots campaign designed to permanently link chlorine use with the release of dioxin in the public's imagination. These groups have effectively opted out of the traditional science- and risk-based policy-making system. They firmly reject the notion that additional research should be conducted to provide a surer basis for regulation of chlorine. Even EDF and NRDC, organizations that have traditionally worked within the traditional regulatory system, and have sought the support of "sound" science for their positions, agree that industrial chlorine chemistry must be eliminated.
It is true that deep divisions exist between "mainstream" groups like EDF and NRDC, and "radicals" like Greenpeace and the Sierra Club. For example, each faction accuses the other of adopting counterproductive tactics; and the radicals accuse the mainstream groups of being industry pawns. Nonetheless, both factions agree on the essentials: the Precautionary Principle should guide policy-making, not Risk; and chlorine should be phased out. Both factions also seem to agree that negotiation over such things as setting scientific research priorities is relatively unimportant. They do not believe that such discussions will yield any significant agreements. Instead, environmentalists express support for the idea of using consensus-seeking negotiation in making policy choices that would eliminate specific uses of chlorine over time. A number of groups stressed the importance of having labor and environmental justice organizations adequately represented at such forums in order to properly safeguard the interests of workers and minorities. Other recommendations that focused on the logistical aspects of planning negotiations were also made.

The radicals and the mainstream seem to differ over when negotiations with industry would be most useful. Radicals tend to feel that industry must first be weakened by consumer pressure to abandon chlorine before negotiation will yield the desired commitments to phase it out. EDF, on the other hand, believes that a chlorine phaseout will occur only over a very long period of time. Therefore, EDF leaders think that a long-term strategy that carefully prioritizes policy actions over the whole range of chlorine applications can successfully be developed through negotiation with industry in the near term. This difference of opinion, however, stems only from differing tactical calculations, not from fundamental disagreements.

Regardless of their disagreements, it is clear that environmentalists of virtually all stripes believe that chlorine must go, and, what is more, they believe that they will be successful in their quest to eliminate it. The only possible exception is the World Wildlife Fund which has not yet joined in calling for a ban on chlorine. However, WWF has expressed concern over the possible effects of organochlorines on fish and wildlife in the Great Lakes, and has called for the development of a strategy to end the discharge of dioxins, PCBs, and other bad actors into the environment. It has expressed support for studying the option of a chlorine phaseout to accomplish this. Finally, Dr. Theo Colborn, a WWF scientist, has produced some of the most persuasive research showing that certain organochlorines may be disrupting reproduction in wildlife populations. While WWF may
be more willing than other groups to engage industry in dialogue over science, it is committed to a precautionary approach to environmental management.

Leaders of the CCC and the Chlorine Institute could not disagree more strongly with environmentalists. First, industry leaders refuse to accept the premise that chlorinated compounds, as a group, are problematic. While they acknowledge that many chlorinated chemicals are hazardous to work with, they believe that industry's record of operational safety justifies their desire to continue to provide useful chlorinated products to their customers. They reject as unfounded the assertion that PBTs like dioxin are produced whenever chlorine is reacted with organic compounds. They caution policymakers against accepting as conclusive the evidence implicating organochlorines in the disruption of reproduction and development in wildlife populations. Chlorine industry leaders seek to shift the debate away from chlorine, back to PBTs and the pathways by which they are released into the environment. Thus, they hope to persuade policymakers to resist the temptation to adopt sweeping, drastic solutions to problems like dioxin accumulation in the biosphere, and seek out more focused, less disruptive approaches based on risk assessments and cost-benefit analyses. By focusing attention on PBTs, they also hope to show that the toxicological threats posed by many so-called "chlorovillains" have been overblown by zealous environmentalists. Industry leaders welcome the prospect of consensus-seeking dialogues on scientific matters, as evidenced by their financial support for the Science & Policy Associates initiative. However, they refuse to allow discussion of a chlorine phaseout onto the agenda.

Industry leaders believe that environmental radicals like Greenpeace seek nothing less than the complete dismantling of the chemicals industry. They point out the example of the moribund U.S. nuclear power industry to those who charge them with over-reacting. The CCC fears that a chlorine phaseout would be the first significant step in that same direction. On the other hand, individual companies see opportunities to carve out new markets as chlorine-free technologies are demanded by the public. Furthermore, the lack of investment in new chlorine production capacity in the U.S., coupled with increasing global demand, implies that lower value-added chlorine derivative products will be cannibalized in order to meet feedstock demand for higher value-added products. Thus, some current chlorine applications are bound to disappear unless additional production capacity is added soon which, in turn, is not likely to happen due to environmentalist pressure. CCC leaders are nonetheless confident of their ability to successfully argue their case to the Republican
lawmakers who will control Congress until at least 1996, as well as to the significant fraction of the voting public that elected them. However, they also worry about their vulnerability to charges of building "dioxin factories," as well as the potential for industry infighting if chlorine content becomes a competitive issue. CCC leaders believe their only viable long term strategy is to continue to insist on the use of sound science, risk assessment, and cost-benefit analysis as the only legitimate foundation for environmental policy-making.

It was originally proposed that a protracted and costly confrontation over chlorine could be avoided by setting up negotiations designed to achieve consensus on the value of currently available science, and the priorities for further research. We have seen, however, that the chlorine controversy is not about science, but rather about which ideology, Precaution or Risk, will shape environmental policy. While it was acknowledged that such a conflict could not, ordinarily, be resolved by negotiation, there remained the possibility that shifts in the balance of power could force one, or both, of the parties to the negotiating table. It seems clear however, on the basis of the preceding analysis of the Chapter 4 interviews, that such negotiations are extremely unlikely to occur in the near future, much less be successful.

There has been no convergence in positions; both sides are as ideologically driven as they were at the outset of the debate. Both sides remain confident in their abilities to prevail in this power struggle. In the language of negotiation theory, each side considers its best alternative to a negotiated solution (BATNA) to be preferable to the likely outcome of negotiation. Environmentalists speak of negotiations to determine which chlorinated products to phase out first. They hope to be able to find less painful ways of forcing industries to make transitions to chlorine-free technologies. The chemicals industry, on the other hand, refuses to even discuss chlorinated chemicals as a class to be studied, much less phased out. Environmentalists accept as a given the idea that environmental regulation should be precautionary in nature. They feel that the risk paradigm merely offers industry a convenient way of denying its culpability in polluting the environment. Industry leaders, virtually all trained as scientists and engineers, believe strongly in man's ability find truth through science, and to manage risk effectively in the pursuit of better technology and

---

higher levels of material wealth. Neither side believes the other to be capable of acting in
good faith. Neither side believes it has much to gain from negotiations. It is evident that
both sides will continue to fight.

It is possible that a degree of depolarizing pragmatism may be injected into this
debate after 1996 when the results of the presidential and Congressional elections are
known. For environmentalists, a GOP landslide would be represent a major setback. It is
their hope that the current Republican efforts to retrench environmental protection laws
under their "Contract with America" will provoke a backlash in public opinion. If, instead,
the public approved of these legislative efforts, it would be unlikely to support a campaign
to ban chlorine. Although most observers of American politics do not expect environmental
issues to figure prominently in the 1996 elections, it is also possible that a resurgent
Democratic party, strongly influenced by environmentalists, could return to power. The
leadership of the CCC, though generally supportive of Republican initiatives, has been
careful to avoid close association with the more radical faction of new GOP leaders in case
of precisely such an eventuality. Finally, the potential for a major accident at a chlorine or
chlorine derivatives plant is always a source of concern for chemical industry leaders,
particularly at a time when environmental legislation is being overhauled.

If the 1996 elections fail to significantly change the political balance of power
between environmentalists and industry, the course of the chlorine controversy will be
difficult to predict, although it is probably safe to assume that it will continue into the new
millennium.
Chapter 6: Conclusion: There is a better way.

The rhetoric of the chlorine debate, as well as that of most other environmental controversies, has appealed to science. Scientific evidence has served as the sole source of legitimacy in these conflicts because the American public has, for the most part, delegated environmental policy-making to the "experts." Americans have long assumed that given enough time and money, science would provide the best guidance for policy. The conclusion presented here is that, in fact, the process of inquiry traditionally termed "science" is, and will be, unable to provide a satisfactory answer to the question of whether or not to ban industrial chlorine chemistry. This conclusion stems from the following observations:

1) There are well over 10,000 organochlorines in commerce.

2) There are many more that are produced as byproducts to industrial processes.

3) Little is known about the fate and transport of these chemicals in the environment. Furthermore, actual inputs of these chemicals into the environment have been poorly quantified, at best.
4) While we know that the metabolic degradation products of certain compounds like DDT are toxic, little is known about the metabolites of most other chlorinated organics.

5) Environmental chemicals enter the body in complex mixtures, usually at extremely low concentrations. It is thus often impossible to distinguish between the separate biological effects of the components of such mixtures and to understand any synergistic effects.

6) A thorough scientific assessment of health risks would have to investigate not only carcinogenicity and lethality, but also the potential for endocrine, immune, and nervous system perturbations.

Traditional scientific inquiry into the environmental health effects of the entire class of organochlorines is impractical. Rigorously studying over 10,000 compounds will cost far too much money and take much too long to satisfy any of the key stakeholders. Thus, the critical requirement of our policy process, that decisions be based on science (the only process commonly agreed to be neither arbitrary or capricious), cannot be met practically. Further appeals to science for the "Truth" about organochlorines thus reflect an unrealistic view of both science and the policy process, and will fail to substantially inform this debate.

The regulatory community has, to some degree, relaxed its assumption that a consensus among scientists can be reached, and that such a consensus would represent The Truth about chlorine. As far as policy is concerned, the uncertainty inherent in a probabilistic risk assessment is accepted. However, there are many problems in using risk assessments as substitutes for scientific evidence. In the case of chlorine for instance, risk assessment will be inadequate to the task at hand because it depends on gaining an understanding of where specific problems lie. This implies a compound-by-compound survey of all organochlorines to determine the probabilistic risks involved with each. This approach will prove ineffective for the same reasons, outlined above, that apply to science. Also, Risk experts disagree about methodologies, and, to make matters worse, their contradictions during the course of litigation or lobbying only serve to further weaken the

---

33 For example, a standard rodent study of carcinogenicity requires 2 years and approximately $4 million to complete.
credibility of risk assessment. This state of affairs is partly a result of the fact that modern, quantitative risk assessment is relatively new. Risk has neither received the blessing of establishment science nor developed a sufficiently strong institutional base of its own.

Many in the scientific community have responded to this degenerating state of affairs by calling for a return to a "hard science-only" policy arena. As we have seen, industry researchers, as well as many in academe, have made this point in relation to the chlorine debate. But environmentalists are right to challenge the legitimacy of science as the sole basis for making policy decisions when science can neither provide definitive answers, nor inform the social, economic, and philosophical aspects of a debate. Furthermore, they are correct in pointing out that the application of both science and risk to policy questions is problematic because both are profoundly anti-democratic in nature. Both depend on elite practitioners who generate policy recommendations that few in the lay public understand or trust. A democracy's policy-making process should embrace the widest possible audience, if it is to inspire trust, and ultimately broad acceptance of, and compliance with regulations.

In reality, the need to make policy decisions in a world of uncertainty seems to be forcing us toward an even stronger rejection of "hard science" standards than Risk represents. The basic ideas underlying the Precautionary Principle are that The Truth, if it even exists at all, is probably unknowable. We should therefore not feel compelled to ascertain The Truth about an issue in making policy. Detailed risk analyses are also unnecessary since they are inherently unreliable. The Precautionary Principle, as it has been articulated in the Rio Principles and in Sweden, Norway, the Netherlands, and other European countries, actually assumes that most industrial activities are probably detrimental to the environment and to our own health. The Precautionary Principle represents a fundamental shift in paradigm that seeks to address non-marginal technological, economic and social questions that are usually avoided or forgotten in the debates over risk. The Precautionary Principle is gaining wide acceptance in Europe, and is becoming increasingly influential here in the U.S. as well, particularly within advocacy groups like Greenpeace.

Of course, one can also find problems with the environmentalist Precautionary Principle. In particular, it too rests on the notion that "enough" data can be gathered to

---

"indict" a chemical or class of chemicals. "Enough" is, of course, an arbitrary amount. Furthermore, "proof" of a product's "innocence" would be at least as difficult and time-consuming to obtain for industry as the "proof" of "guilt" outlined in the preceding discussions of governmental analysis and decision-making. Of course, it would also be necessary to determine whether the standards of "guilt or innocence" under the Precautionary Principle would be risk- or "certainty"- based. Application of the Precautionary Principle raises other vexing questions such as: Who would conduct the research necessary to "exonerate" a compound? Would industry be forced to pay the costs? Would industry-sponsored research be considered credible?

I conclude that calls for an expanded role for "hard science" in the policy debate around chlorine reflect a lack of awareness of current trends, and a lack of understanding of their causes, and are therefore misplaced. Basic science research, particularly within universities, will always be important, but what we need to recognize is that uncertainty about all the facts of a problem cannot be allowed to forestall indefinitely public debate over its resolution. Furthermore, the world of quantitative risk assessment will be of limited usefulness. Finally, even application of the seemingly straightforward Precautionary Principle will also be very problematic.

Our environmental policy-making process is wholly incapable of addressing many concerns raised by the clash of the differing value systems evident in the chlorine controversy. It is paralyzed because it is held captive to the standards of science and risk analysis which cannot be met. The proposal for finding a negotiated settlement on chlorine that was explored in this thesis was conceived within this dysfunctional policy framework. Instead, of focusing our efforts on trying to build, through negotiation, a consensus on the science of chlorine, we must overhaul our policy process. We must focus our energies on re-constructing participatory institutions and procedures that allow the parties to this debate to clearly frame their concerns for the public at large to see, and to actually attempt to resolve the difficult questions regarding the organization of our economy and communities that have been largely avoided for decades.

The United States has lost the leadership position it once held in environmental policy because the public and its elected officials have abdicated responsibility for policy to experts, and, in the end, to special interest lobbying and litigation. The U.S. Congress, ultimately the most legitimate and important participatory institution in our country, should begin the re-structuring of the policy process by following the examples set by a number of
its European counterparts. For instance, the German Bundestag established a parliamentary commission on the "Protection of Humanity and the Environment" which was charged with probing the challenges of building a sustainable industrial society. The commission, made up of parliamentarians from all the major German parties, not only set about identifying methodologies for analysis of industry-environment interactions, but also took up the philosophical debate on environment so necessary for fashioning wise and robust policy in a democratic country. Even if a bipartisan Congressional commission chose not to significantly alter the U.S. policy framework, and affirmed its basis in the Risk paradigm, a national debate on the subject would educate the public and diminish the importance of the special interest power struggle. Also, a reaffirmed, reinvigorated commitment to Risk-based policy-making might entail the allocation of increased funding to better implement this approach in solving problems like the chlorine controversy.

Although I believe that Congress is the most important forum for discussing the philosophical underpinnings and practical form of a new U.S. environmental policy, I agree with other observers who have suggested that institutions such as universities can play an important role in stimulating, sustaining, and informing this discussion. Universities can educate the public about the myriad ways in which societal activities intersect natural processes. They might also serve as neutral forums for debate, at both local and national levels, on difficult issues like Precaution vs. Risk and what to do about chlorine.

The chlorine controversy has thrust the debate over Precaution and Risk onto center stage. The choice of which will govern American environmental policy as we enter the twenty-first century is of vital importance to our society. I believe that the chlorine debate has shown the Risk paradigm, as it has been implemented in the U.S., to be inadequate to the problems we currently face, much less to the challenges of building a more sustainable economy. Although I believe that the Precautionary Principle may provide us with the necessary guidance to resolve many complex environmental problems safely and wisely, I also believe that neither I, nor my professional and academic colleagues have the right to make such a decision for the country. All those who share a concern for the future of our environment have the responsibility to educate the public, and exhort our elected officials to take up the debate in earnest.

Bibliography

In addition to the books and articles cited in the footnotes, I drew on the following works in writing this thesis:


Chlorine Coordinating Council, *Endocrine Policy of CCC*, 1994


