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By

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Abstract

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This dissertation examines an unlikely set of air pollution controversies in rural west Texas to illustrate the function of the fixing or shifting of scale to gain advantage or build support in environmental conflicts, and to explore possibilities for pragmatic environmental collaboration and problem solving using alternative scalar approaches. Such alternative approaches include, for government environmental agencies, "jumping" higher and lower within a hierarchy of spatial scales in order to match environmental goals, institutional capacities, and political realities; and for activists, forming networked alliances spanning multiple places, in order to scale up local efforts and engage with regulatory agencies and other "big" interests on a more equal footing.

The project brings together two theoretical streams: analysis of the politics of spatial scale, primarily occurring in the geographical disciplines; and theories of problem definition and agenda setting from the political science and public policy realms. Scale is a particularly apt concept within which to conduct this analysis, as it is a primary defining factor not only of the atmospheric phenomena of concern, but also the landscape, human geography and policy venues within which this case study takes place.

The case study begins with a controversy over visible haze pollution in Big Bend National Park in the early 1990s. Staff in U.S. and Texas environmental regulatory agencies initially attributed responsibility for the sulfur dioxide emissions causing the haze to two large coal-fired power plants in the city of Piedras Negras, which together constituted the major emissions source closest to the park. Strong opposition to this attribution of blame by Mexican government representatives opened the possibility of a jump from the "border" scale to the much larger domain of "regional haze." Subsequent technical analysis effectively shifted the scale of the haze phenomenon to a continental level, showing the polluting particles were emitted from locations far beyond the border. My proposal here is that when a scale jump occurs, the "old" scale does not disappear, but rather continues to frame social phenomena; this suggests a framework consisting of layered spatial scales. This assertion opens the possibility for an adaptive model of scale shifts, which presents the opportunity to engage environmental problems at different scales over time. In the present case, this means that scale jumps are not irrevocable; actors can choose to "try" a scale more than once as the problem's definition and context continue to evolve.

Meanwhile, environmental activists first emerged as an organized movement within the Big Bend in 1996, taking haze pollution–and its impacts on the region's spectacular landscape and tourist economy–as their founding issue. In subsequent years, local residents organized to around additional air pollution-related issues, including the siting of a new rock crushing plant. When confronted with these issues, community members conceived that problem primarily as a threat to their fiercely loved home and landscape. This home area had very specific geographical

boundaries, with air pollution conceived as a particularly egregious breach of those boundaries– and pollution outside of those boundaries considered marginally more acceptable. However, I propose that activists' discourses on vulnerability, clean energy and border-area cooperation present an opportunity to form connections with broader activist communities across different locales, transcending the hierarchical state structures of environmental regulation. This type of network building strategy may provide an opportunity for local movements to scale up their efforts and engage more effectively with regulatory agencies, either as partners or as opposing interests.

Finally, I examine scale as one dimension along which science and place-based activism can engage with one another, either through cooperation or conflict. Public agencies hold promise as mediators for this engagement, with the ability to both lead and follow science across scales, take actions and monitor results over time, and yet maintain links to specific geographical jurisdictions and an imperative to democracy.

DEDICATION

For my wife Devanie, who stuck with me through it all, with all my love.
and...
For Patrick and Kate, born in Berkeley and ready for the world. ¡Sí se puede!

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Thanks also to the various communities that I have been privileged to be part of, including the faculty, staff, and graduate student colleagues in the Energy and Resources Group; staff and graduate fellows at the Institute for the Study of Social Change; staff and fellows of the Robert & Patricia Switzer Foundation; the residents and staff at Smyth-Fernwald Family Housing; and my colleagues at US EPA Region 9.

CHAPTER 1
BACKGROUND AND SUMMARY

This dissertation examines an unlikely set of air pollution controversies in rural west Texas as (1) efforts by various environmental policy stakeholders to affix or evade responsibility for air pollution through the setting or shifting scalar framings; (2) attempts by local environmental and community activists to protect their region's environment and culture by deploying a rigid and exclusive scalar frame; and (3) opportunities for adaptiveness and learning through scalar strategies in both environmental policy and activist realms. It is my goal with these two case studies to illustrate the function of the fixing or shifting of scale to gain advantage or build support in environmental conflicts, and to explore possibilities for pragmatic environmental collaboration and problem solving using alternative scalar approaches. Such alternative approaches include, for government agencies, "jumping" higher and lower within a hierarchy of spatial scales in order to match environmental goals, institutional capacities, and political realities; and for activists, forming networked alliances spanning multiple places, in order to scale up local efforts and engage with regulatory agencies and other "big" interests on a more equal footing. Both of these approaches hold potential for achieving environmental improvements outside of narrowly construed regulatory jurisdictions, while also facilitating learning and adaptive capacity in government agencies and activist movements alike. Taken together, they may also point the way for government science and policy and place-based activism to find common ground for mutual learning and cooperation.

Theory- scales and scale jumps

This dissertation brings together two theoretical streams: analysis of the politics of spatial scale, primarily occurring in the geographical disciplines; and theories of problem definition and agenda setting from the political science and public policy realms. Scale is a particularly apt concept within which to conduct this analysis, as it is a primary defining factor not only of the atmospheric phenomena of concern, but also the landscape, human geography and policy venues within which this case study takes place. As will be shown in the following chapters, scale comprised an important independent variable affecting the problem definition of visible haze and other air pollution threats in the Big Bend region.

Theories on problem definition and agenda setting, while used more explicitly in Chapter 3, also provide a backdrop to the entire dissertation project. As outlined below, this literature is primarily concerned with how policy problems gain purchase–or fail to do so–on various institutional agendas. The particular theoretical strand that has most influenced this project is the concept of conflict expansion, whereby an actor can mobilize previously uninvolved interests around an issue, thereby disrupting closed "policy monopolies" and changing the political equilibrium. While the same mobilizations described in this literature can be seen in the present case, this study also shares an underlying imperative for democratic participation that underlies this literature. This dissertation is strongly concerned not only with how to achieve environmental improvements in the policy and activist realms, but how to accomplish those improvements through the meaningful participation of stakeholders outside of the technocratic policy apparatus.

In addition, both the scale and problem definition literatures discussed here tend to emphasize the power dynamics of environmental politics, as various actors and interests jockey to gain or maintain political or economic power. While this dynamic is certainly present in many

aspects of the case discussed here, the case also illuminates possibilities for adaptiveness and learning, adding a different dimension to these bodies of theory.

The politics of scale

The notion of scale pervades scholarly efforts across a wide swath of academic disciplines. Through the late 20th century, this concept was unproblematically used to denote size, or level within a hierarchy. However, constructivist scholars increasingly began to develop the idea that scale, like space, is socially reproduced. In a study of scale and environmental justice, Williams (1999) points out that the politics of scale are based on the difference between the "scale of a societal problem and its political resolution." This disjuncture necessitates the building of linkages between problems as experienced at a local scale and opportunities for recourse at another. Smith (1992) originally proposed the *scale jump* concept to describe local actors' attempts "to organize the production and reproduction of daily life and to resist oppression and exploitation at a higher scale–over a wider geographical field" (Smith 1992, 60). States and other large entities can also jump scales to the detriment of local empowerment, by framing or reframing issues at a scale outside the "range" of local actors.

The scale jump is a vivid and useful concept in cases involving two or more distinguishable (albeit socially constructed and reproduced) scales. However, the scale jump concept also denotes an oversimplified and hierarchical dichotomy contrasting smaller scales ("the local") against larger ones ("the global"). According to Howitt (2003),

> Discussing the politics of scale in this framework becomes a relatively simple matter, identifying the ways in which relatively local groups constitute their identity within a relatively local politics, and how they seek to counteract disempowerment by jumping scales to assert their specific concerns at a wider, more general scale. This seems attractive. For activist politics, it provides a way of engaging with the challenge of thinking globally and acting locally. Yet, like all binaries, this one has its limits. Conflating the global-economic-general and contrasting it with the local-cultural specific obscures important dimensions that an alternative approach to scale might bring to critical geopolitical analysis, and responses built from it (138).

Subsequent geographical research has attempted to highlight the relational aspects of scale instead of (or in addition to) its hierarchical qualities.

Cox (1998) contested the idea "that issues are clearly definable in scale-exclusive terms, as local or national or regional or whatever" (Cox 1998, 3). He applied this insight to local politics, defining those politics in terms of spaces of dependence and spaces of engagement.[1] He argued that the politics of scale should be analyzed not as a series of mutually exclusive, state-defined spaces or scales to be "jumped" between, but as relational, with the politics occurring as connections among a series of network nodes.

Judd (1998) argued that Cox "greatly overestimates the ability of political agents to escape state structures through the social construction of scales. ... [T]he scales constructed by the state often make it very difficult for political agents to construct a scope of conflict more advantageous to them (what Cox calls a space of engagement)" (Judd 1998, 30). He pointed out that the power relations embedded in the state's jurisdictional, regulatory and administrative structures constrain the "flexibility of resistance" at the local level (Howitt 2003).

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1. Towers (2000) echoes this formulation in his depiction of interactions between "scales of meaning"–the scales at which actors experience and frame a problem–and "scales of regulation," defined by the overlapping jurisdictions of various types of decision making processes.

Scale frames

Also applying scalar concepts to the study of environmental justice, Kurtz (2003) develops the notion of scale frames as a type of collective action frame (Benford 1997). Collective action frames are defined as sets of beliefs that underpin social movement actions. Scale frames "are the discursive practices that construct meaningful (and actionable) linkages between the scale at which a social problem is experienced and the scale(s) at which it could be politically addressed or resolved" (Kurtz 2003, 894). She also proposes the concept of scale idioms, defined as specific ways of invoking scalar relationships: scale as scales of regulation, as a means of inclusion and exclusion, and as an analytical category. Scale frames can also be contested via counter-scale frames, "discursive strategies directed at undermining one or more elements of the scale-oriented collective action frames" (Kurtz 2003, 896). I borrow this terminology in Chapters 2 and 3 to describe the two prevalent scales between which Big Bend haze "jumped" between 1993 and 2004.

Kurtz's formulation originated within the sphere of analysis of environmental justice (EJ) movements. Although the case of Big Bend air pollution discussed here is not an environmental justice problem per se, and though none of the activists involved in these issues made any indication of identifying with the environmental justice movement, I suggest that this case study resonates with the EJ literature because (1) it involves vexing questions of attribution and blame for air pollution that are explicitly framed in scalar terms; and (2) the regional activists involved in Big Bend air pollution express concerns and deploy strategies with some resemblance to EJ activism, but are hemmed in by the restrictive scalar frame they are using. In Chapter 5 I speculate that this community and others like it show promise as allies of a broader, justice-oriented environmental movement.

Problem definition and conflict expansion

We can also theorize the Big Bend air quality case as an instance of policy problem definition. Deborah Stone (1989) interprets the definition of policy problems as a process of image making, or the creation of causal stories. While actors in the policy process might be well aware that a problem has many interlocking causes, it is not politically useful to offer complex causal explanations. Rather, they prefer to create stories that are designed to create support for their own side. As shown in Chapters 2 and 3, this explanation is most applicable to the period in the early 1990s when the binational controversy over Big Bend haze was at its height. The dissertation also illustrates some limits to the power of causal stories, as it appears that scientific conclusions proved quite effective–though not completely effective–at countering the initial story of the haze problem.

With a focus on the mechanisms of conflict expansion, Baumgartner and Jones (1993) describe a model of punctuated political equilibria, where interests can disrupt supposedly stable policy monopolies through different types of mobilizations. Specifically, they describe a Schattschneider mobilization (referring to Schattschneider 1960) as an effort by opponents of the status quo to expand the scope of conflict around an issue. Schattschneider described this type of mobilization in terms of bringing previously uninvolved interest groups into the political discussion. Baumgartner and Jones augment this concept with the idea of venue shopping:

> "[T]hose on the losing side of a debate will have the incentive to look for allies elsewhere. These conflict expanders are not limited only to appealing to wider and wider groups; rather, their strategies may be much more complex and specific. They may identify particular venues, such as congressional committees, state government organizations, courts, private businesses, or any other relevant institution in their search for allies" (Baumgartner, et al. 1993, 36).

Both Schattschneider and Baumgartner and Jones position their arguments as refinements of

Downs's argument in "Up and Down With Ecology" (1972) that policy problems are addressed in a patterned way, with a period of alarmed discovery—termed a Downsian mobilization by Baumgartner and Jones—followed by a period of declining interest and motivation as stakeholders realize the costs of addressing a problem.

This dissertation mirrors the ideas of problem definition and conflict expansion in an explicitly spatial realm. While the concept of conflict expansion already has geographical connotations inherent in its name, as well as its reference to various political jurisdictions, this case study shows that space, place and scale can be determining factors in constituting and selecting venues of action and analysis. The following chapters together address the questions of (1) how scientific, political, and activist venues are constructed at specific scales, or across multiple scales; and (2) what the implications of each of those scale-venue constructions are in terms of environmental improvement, democratic participation, and adaptiveness and learning. Building on both the scale politics and conflict expansion literatures, my argument here is that the ability and willingness to shift within and/or among scale hierarchies may be a crucial element in allowing government agencies and local activist movements to work toward environmental improvements on cooperative and pragmatic terms, even in the absence of regulatory mandates or jurisdictional authority.

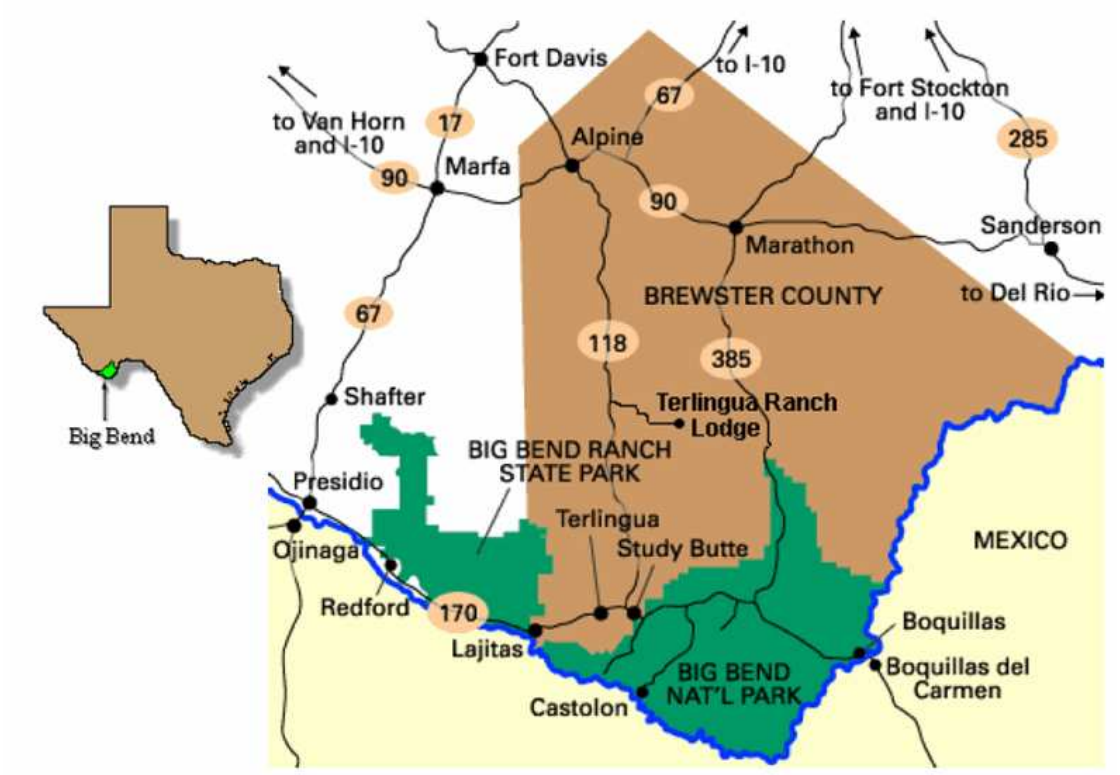

Figure 1 - The Big Bend region

Case overview: Big Bend haze and other air pollution threats

The Big Bend takes its name from the path of the Río Grande as it flows toward the Gulf of Mexico. (See Figure 1.) Southeast of El Paso-Ciudad Juárez, the river switches from a southward flow towards the north—outlining the "Big Bend"—before reversing itself again towards the Gulf. The region is encompassed by the Chihuahuan desert, whose harsh climate

and rugged terrain have ensured a sparse human population through its history. Big Bend National Park is located at the tip of the bend, adjacent to the U.S.-Mexico border. Established in 1944, the park encompasses 324,427 hectares containing desert, the Chisos Mountains, and the Río Grande (Gómez 1990).

Big Bend haze

As early as the 1970s, park visitors and personnel began to notice a thick layer of haze obscuring the park's scenic vistas. In early 1993, staff at EPA Region 6 in Dallas received word about two coal fired power plants outside the town of Piedras Negras, Coahuila, about 120 miles from Big Bend National Park. These two plants, nicknamed Carbón I and Carbón II ("Coal I" and "Coal II"), would have about 2600 megawatts of combined electricity generation capacity, for the needs of expanding populations and industrial activities in northeastern Mexico. Carbón I had actually been in operation since the middle 1980s; Carbón II went online in 1996. The Piedras Negras plants did not have scrubbers to reduce their sulfur oxide emissions, an omission allowed by Mexican air quality regulations. Currently, the combined plants produce about 17 million MWh of electricity and emit an approximate total of 200,000 metric tons of SO_2 annually (Miller and Van Atten 2004).[2]

Unable to address this perceived international issue within a domestic regulatory framework, Region 6 staff notified Administrator Carol Browner in Washington, at a particularly sensitive moment. In early 1993, the North American Free Trade Agreement (NAFTA) was under spirited discussion and negotiation, with environmental impacts of liberalized trade being one of the hottest topics. As it happened, the American news media obtained some internal EPA memos on this issue through the Freedom of Information Act. Soon afterward, the story hit the front page of the Washington Post (Robberson 1993) and was also picked up by other major U.S. news outlets. In this way, Carbón I and II became primary exhibits in the debate over NAFTA's environmental effects.

Over the following months, U.S. interests, including EPA, the State Department, the Texas state government under George W. Bush, and numerous environmental groups, strongly pressed the Mexican government to mitigate SO_2 emissions from Carbón I and II. Mexico publicly refused to do so, maintaining that the plants were in full compliance with Mexican law and citing high costs and other environmental priorities, including choking pollution in Mexico City. According to one U.S. State Department official, "We're asking a fair bit for Mexico to adopt the values that we've adopted. Their response is, 'Well, if we have to spend a hundred million dollars, we think it's better to spend that money to give people clean water so they won't get cholera anymore.' And frankly, when you're dealing with a country that doesn't have infinite resources, that's a very difficult argument to rebut" (Robbins 1994). The Mexican government also dismissed the idea of fuel switching (from coal to natural gas) as absurd, given that the two power plants were sited in Piedras Negras ("Black Rocks") specifically to use the large coal deposits there.

However, Mexico had strong interest in seeing this disagreement resolved amicably. Aside from the imperative to successfully negotiate and approve NAFTA, Mexico with Carbón II was making its first attempt at privatizing the electricity sector, which was until that time wholly owned and controlled by the government through the Federal Electricity Commission (CFE). The plant was slated to be sold to a partnership between the Mexican company Grupo Acero del Norte and Mission Energy, a subsidiary of Southern California Edison, as part of a broad Mexican drive to attract private investment to fulfill its energy needs. However, the negative attention resulting from the plant's supposed contribution to Big Bend air pollution greatly complicated the planned transaction. The deal collapsed in October 1993, though reportedly

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2. As a rough comparison, the Belews Creek coal-fired plant in West Virginia also produces about 17 MWh of electricity per year, but emits only about 94,000 metric tons of SO_2.

more over disagreements between CFE and its private partners over financial risks than over Big Bend haze (Golden 1993).

In the wake of NAFTA's passage in 1994, under the auspices of the La Paz Agreement for the Protection of the Border Environment, the U.S. and Mexico agreed to conduct a joint "preliminary study" to get more information on source regions and source types for the pollution impacting the park. Completed in 1996, the study report signaled for the first time that the problem of Big Bend air pollution was a complex one; the results indicated that the pollution in the park probably originated not only from northern Mexico but also from east Texas, a region containing numerous coal-fired power plants and petroleum refineries. The report's authors also indicated that more study was necessary to further pinpoint possible pollution sources (Big Bend Air Quality Work Group 1999).

The Big Bend haze controversy aroused domestic political interest to the point that political and regulatory entities made resources available for scientific research on Big Bend haze, culminating in a $7 million Congressional earmark for additional study. The Big Bend Regional Aerosol and Visibility Observational Study (BRAVO) was commissioned to obtain more precise information on whom to blame for the visibility problems at Big Bend. The project involved the release of inert tracer gases at or near emission sources to be studied, and the installation of detectors in various locations in west Texas (Green, Kuhns, Etyemezian, et al. 2000). Mexico participated in the initial study design for BRAVO, but in the end declined to participate in the study. One Mexican official asserted that the study design was biased toward getting definitive information about pollution from Carbón I and II, but deliberately designed to avoid precise conclusions regarding U.S. sources (Gidi, A. D. 2000).

Data collection occurred from July to October, 1999. The study then passed a number of years in the analysis and review phase, encountering a series of delays partly attributed to data quality and peer review tasks, but also to interagency politics, all exacerbated by the consensus process. EPA and its partners released the BRAVO final report in late 2004, three years after its scheduled completion date. The report concluded that while emissions from Carbón I and II did contribute to the haze problem, the majority of the pollution affecting the park originated from power plants and refineries in the eastern United States, from east Texas to the Ohio Valley (Pitchford, Tombach, Barna, et al. 2004). Furthermore, while pollution from Mexican sources made relatively steady contributions to Big Bend haze throughout the year, the worst haze episodes were dominated by U.S. sources. The BRAVO results expanded and complicated the oversimplified picture of pollution blowing into the Big Bend by prevailing winds from Piedras Negras, showing that emissions from U.S. sources could blow across the border or the Gulf of Mexico into inland Mexican territory before entering Big Bend.

Air quality activism within the Big Bend

All of this diplomatic tension and scientific analysis took place at national and binational scales; few people within the Big Bend region were directly involved. But residents were taking notice, and the haze issue inspired the emergence of environmental organizations in the Big Bend region, where there previously had been none. Haze in the park became the founding issue for the newly formed Big Bend Regional Sierra Club (BBRSC) chapter, based in Alpine. The BBRSC closely followed the BRAVO study and related happenings and pressured EPA and NPS for the study results. The club also spearheaded several public meetings, very well attended by local residents, to hear about the study's progress and air citizen concerns with government officials. After the final BRAVO report was released, the BBRSC began pressuring the Texas and U.S. governments to take action to reduce pollution from the U.S. regions identified in the study. However, the EPA did not make any moves toward specific actions based on the BRAVO results.

Around 2000, several new environmental groups formed, including the Ad Hoc Clean Air Group and the Binational Chihuahuan Desert Big Bend Clean Air Alliance. In addition to educational activities on both sides of the border, these groups engaged in direct action to prevent

the possibility of further pollution in the region. In late summer 2003, activists organized public actions against the permitting of a new rock crushing plant outside of the town of Alpine, primarily on grounds of possible health effects from particulate matter pollution originating at the plant. The plant was never built, though possibly more for economic reasons than because of local protests.

Research methodology

I first became aware of haze pollution in Big Bend National Park through hallway conversations at U.S. EPA headquarters, where I was employed before beginning my doctoral studies in fall 2001.[3] Though I did not learn any details until starting my own research, I quickly developed an initial impression that the haze problem was a border issue that had at some point become highly politicized. In attempting to merge my environmental policy experience with my academic interest in the social construction of air pollution, the case of Big Bend haze presented an ideal case, with the additional advantage of involving the U.S.-Mexico border region, an area to which I had long been attracted.

The project used a case study methodology, with Big Bend haze constituting the initial case of interest. Unstructured interviews comprised my primary data collection instrument; I conducted 26 interviews between 2004 and 2007 with government agency personnel, scientists at various locations, and local residents within the Big Bend. In fall 2004, during the first of three trips to Texas and the border region, I first became aware of the strong mobilizations around air quality taking place within Big Bend communities, leading me to add local Big Bend activism as a major topic within the research study.

All of the interviews conducted for this research except one–with a community leader in the border city of Ojinaga, Chihuahua–were with subjects in the United States. Because of personal circumstances, I was unable to commit to the time consuming task of locating and contacting the Mexican actors relevant to this case. Furthermore, it became clear early in the study that Big Bend haze was almost exclusively a U.S. issue. The Mexican government's views on this case seemed adequately covered by the written documents and articles they produced during the course of binational consultations.

I chose interview subjects using a snowball methodology, starting with contacts listed in U.S. government documents and public notices by local activists. I interviewed each subject once, with the exception of several local activists. Given the immediacy of the rock crushing plant controversy, as well as the immediate aftermath of the BRAVO study, I decided it was important to conduct follow-up interviews with activist leaders. In addition to interview data, I conducted extensive searches for written accounts, primarily in national, state, and local newspaper articles. I also gathered primary documents provided by local activists, and utilized numerous secondary sources including scientific journal articles and reports.

I converted my interview transcripts into electronic form[4] for further analysis, performing several iterative rounds of keyword searching, coding, and composition of early draft working and conference papers. Believing early in the process that exclusion and border narratives were

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3. I continued to work for EPA during the entire course of my doctoral studies. My positions during that time were based at the Pacific Southwest Regional Office (Region 9) in San Francisco and from 2008-2010 at the Southern California Field Office in Los Angeles. Though I worked on various air pollution issues for the agency during that time, I was not directly involved in any work related to Big Bend air pollution, which was administered from a different regional office.

4. I coded and analyzed data and composed successive drafts of this dissertation using Nota Bene software, an academic writing package notable for its text coding and searching capabilities.

the most salient aspect of the case, I pursued that angle in my data analysis until it became apparent that the more general attribute of scale would provide for a richer interpretation of the data. I finalized the analysis and writing during spring and summer 2010.

Outline of subsequent chapters

Chapter 2 outlines the history of visibility regulation in the U.S., and of the Big Bend haze issue beginning in 1993. Visible haze pollution in Big Bend National Park in Texas, along the U.S.-Mexican border, started off as a phenomenon with inscrutable origins, but in the early 1990s became linked by government analysis to sulfur dioxide emissions from two Mexican power plants located a short distance from the park. Strong opposition to this attribution of blame by Mexican government representatives opened the possibility of a jump from the "border" scale to the much larger domain of "regional haze." Subsequent technical analysis effectively shifted the scale of the haze phenomenon to a continental level, showing the polluting particles were emitted from locations far beyond the border.

Chapter 3 digs deeper into both the border and regional haze scale, analyzing their implications for the Big Bend case so far, and speculating on how they might play into this issue in the future. The proposal here is that when a scale jump occurs, the "old" scale does not disappear, but rather continues to frame social phenomena; this suggests a framework consisting of layered spatial scales. This assertion opens the possibility for an adaptive model of scale shifts, which presents the opportunity to engage environmental problems at different scales over time. In the present case, this means that scale jumps are not irrevocable; actors can choose to "try" a scale more than once as the problem's definition and context continue to evolve.

In the case of Big Bend haze, an air quality problem initially formulated at the scale of the U.S.-Mexico border formed connections with discourses, institutions and practices tied to that scale. When policy makers and scientists subsequently reframed the problem at a broader continental scale, the border-scale discourses and institutions–such as the U.S.-Mexico Border Environmental Programs–also continued to evolve. This situation created an opening for agency staff to re-formulate the problem at the original scale at a later time, with the potential advantages of a different political context or modified policy goals. Over this ten-year time frame, then, we can see the opportunity for adaptive management at the policy level, with scale jumps and related processes playing the role of policy experiments, and developing discourses, institutions and practices as opportunities/repositories for learning.

Chapter 4 outlines the emergence of environmental and community activism oriented toward air quality beginning in 1995. Environmental activism within the Big Bend region was spurred by the phenomenon of visible haze in Big Bend National Park. Activists first became active in 1996, taking haze pollution--and its impacts on the region's spectacular landscape and tourist economy--as their founding issue. In subsequent years, local residents organized to around additional air pollution-related issues, including the siting of a new rock crushing plant. At a local level, my research found that when confronted with the proposed plant, community members within the Big Bend region conceived that problem primarily as a threat to their fiercely loved home and landscape. This home area had very specific geographical boundaries, with air pollution conceived as a particularly egregious breach of those boundaries–and pollution outside of those boundaries considered marginally more acceptable.

This is a classic "not in my backyard" (NIMBY) formulation, but the situation is more complex–and presents more opportunities–than that label implies. First, the rock crushing plant controversy revealed that a significant number of Big Bend residents self-identify as highly vulnerable to respiratory illness. These residents, many locals argued, were deserving of special protection from the threat of air pollution. This vulnerability-based argument closely resembles the rhetoric of the U.S. environmental justice movement. Without forcibly imposing a label on local activists that they would not apply to themselves, I nevertheless propose that their use of this discourse presents an opportunity to form connections between local activists and the broader environmental justice community, transcending the hierarchical state structures of

environmental regulation. This type of network building strategy may provide an opportunity for local movements to scale up their efforts and engage more effectively with regulatory agencies, either as partners or as opposing interests. Other common concerns such as clean energy and climate change, or border air quality issues, may also provide opportunities for this type of network building.

Chapter 5 examines scale as one dimension along which science and place-based activism can engage with one another, either through cooperation or conflict. Public agencies hold promise as mediators for this engagement, with the ability to both lead and follow science across scales, take actions and monitor results over time (spanning political cycles), and yet maintain links to specific geographical jurisdictions and an imperative to democracy.

CHAPTER 2
SCALE JUMPS AND SCALE LAYERS
THE CONDUCT OF BIG BEND VISIBILITY SCIENCE

Introduction

Overtly political conflicts influenced the BRAVO study in ways that actually improved the scientific outcome. The persistent framing of Big Bend haze pollution within the U.S. through the 1990s was in terms of a single pollution source–the Carbón I and II power plants–affecting a single "receptor"–Big Bend National Park. Despite broad trends within visibility science and policy away from that oversimplified "plume blight" framework, this construction of the haze phenomenon was actively maintained by federal and state agency staff, by preliminary but narrow scientific analyses conducted by those same staff, and by wider cultural discourses on national parks and the U.S.-Mexican border.[1] The government of Mexico succeeded in destabilizing this framing through their reluctant participation in Big Bend haze data analysis and field study development beginning in 1993. Engineers from Mexico did not argue for a "regional haze" approach specifically, but they did loudly protest the perceived inequity of targeting specific Mexican pollution sources while failing to characterize specific U.S. sources. Although Mexico ultimately withdrew from binational consultations regarding Big Bend haze, its representatives were able to nudge the definition of the haze problem from addressing the impacts of Carbón I and II toward comprehensively characterizing the broad array of sources contributing to Big Bend haze at a large scale. The large field study designed to address that problem subsequently validated Mexican concerns, as it concluded that the Mexican power plants were only one of a large universe of sources affecting the park, and that those sources causing the worst haze episodes were located in the U.S.

In this chapter, I briefly trace the history of contemporary air pollution regulation in the United States, beginning in general terms and then focusing on visible haze. I examine this history through the lens of responsibility and liability, showing how the early regulatory focus on single discrete pollution sources led to early successes in reducing both "criteria" and haze-causing emissions. However, in the visibility realm that early success soon gave way to confusion and conflict as increasingly complex empirical and political situations began to assert themselves. Visibility science, a specialized branch of atmospheric science that emerged beginning in the 1970s, demonstrated that visible air pollution at a given site rarely could be attributed to a single source or a narrow set of sources. Rather, visible haze was a regional phenomenon, comprising emissions from numerous air pollution sources spread over a wide area, and affecting various "receptors." As scientists continued to deepen their understanding of "regional haze," EPA lagged behind by a few years in revising its regulatory frameworks to accommodate this empirical reality.

It was in the midst of this shift in approach that the construction of two power plants in northern Mexico, and their possible impacts on visibility at Big Bend National Park came to the attention of EPA, setting off not only a minor diplomatic conflict between the U.S. and Mexico, but sustained attention and analysis to the Big Bend haze situation that would last well into the 2000s. The second part of this chapter outlines the history of Big Bend haze science from 1990 through 2004, with an emphasis on how, much as occurred in the broader visibility science and

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1. Chapter 3 discusses the various meanings of the border scale framing in detail.

policy community, the various analyses contributed to a shift from focusing on a narrow set of pollution sources to a large-scale, regional perspective. This analysis illustrates how the practices of U.S. government scientists and regulatory staff first restricted, then greatly expanded the spatial scale of the Big Bend haze phenomenon.

Air pollution and visibility regulation: A brief history

The liability model

The structure of air pollution regulation from the early 1970s was based on the premise that straightforward liability for air pollution problems would be possible to determine (Pellizzoni 2004). The idea of liability provided the basis for the dominant framework of "polluter pays," where polluters, usually construed as operators of large stationary pollution sources, are held responsible (through a system of statutes, regulations and rules in various jurisdictions) for mitigating the air pollutant emissions originating from their respective activities. In the early 1970s, a time when numerous stationary sources (in addition to vehicles burning leaded gasoline) provided low-hanging fruit for controlling emissions, the liability approach was an appropriate and productive one. For the six "criteria" pollutants for which EPA sets primary and secondary standards–particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead)–it was an initially straightforward task to decide what emissions reductions were needed within an air basin, target specific "source categories" to achieve those reductions, and require sources within those categories to meet certain emissions limits. Those emission reductions would contribute to improved ambient pollution levels within the local air basin.

Thus the liability focus of U.S. air pollution regulation from the 1970s was inextricably bound to a system of geographically bounded political and bureaucratic jurisdictions. These jurisdictions include state governments, which the Clean Air Act delegates to carry out many of the tasks of air quality regulation, but may also include sub-jurisdictions such as municipalities, counties, or air districts. In areas with serious air pollution problems sub-regions are usually designated to correspond with "air basins"–valleys or other topographical entities that trap air pollutants within the local area. In the first decade of air regulation, the attention of these delegated jurisdictional entities was fully occupied by problems specific to each specific area. Furthermore, except at the margins, the regulatory system assumed that air pollution problems originated within the same jurisdictions where they were felt.[2] Thus, for example, the Act required "nonattainment" areas (jurisdictions with measured air quality exceeding the national ambient air quality standards) to promulgate and implement an attainment plan specifying actions to be taken within the jurisdiction that (based on modeling) would bring the area into compliance within a certain timeframe. For regulatory purposes, then, these jurisdictions are treated by regulatory agencies as essentially isolated entities, unaffected by conditions outside their own boundaries.[3]

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2. This assumption also hampered efforts to regulate the sulfur emissions leading to acid rain. EPA created the acid rain trading program in 1989 because reducing SO_2 emissions from numerous sources located hundreds of miles from sensitive ecosystems proved to be an impossible task using traditional regulatory tools (McLean 2008).

3. Cross-boundary pollution under this framework is treated as a special case. Under the Clean Air Act Amendments of 1977, Section 126, states and other entities can petition EPA to control specific stationary sources in upwind states that interfere with the attainment of the National Ambient Air Quality Standards (NAAQS) in the downwind states. These provisions were the first effort by Congress to deal with the interstate transport of air pollution (Farrell and Keating 2002; Grumet 1998).

In the specific area of visibility pollution, the emphasis on liability was even more telling. Regulation of visibility pollution was codified in the Clean Air Act (CAA) Amendments of 1977 (CAA §169A), which the EPA subsequently implemented as regulations in 1980.[4] Those regulations adopted a "phased approach to visibility protection" (45 FR at 80085). Phase I controlled "Smoke, dust, colored gas plumes, or layered haze emitted from stacks…relatable to a single source or a small group of sources" (45 FR at [80084]), known informally as "plume blight" (Reitze 2005; Watson 2002). This liability-focused, source-endpoint approach framed haze pollution transport with a strong emphasis on discrete pollution sources and endpoints, or receptors, with visible pollution perceptibly traveling from source to receptor.

In the 1980 Phase I visibility rule, EPA deferred imposing controls on "regional haze," defined as "widespread, regionally homogeneous haze from a multitude of sources which impairs visibility in every direction over a large area." In justifying this deferment, the agency cited the "scientific and technical limitations inherent in attempts to identify, measure and control such broad scale visibility impairment" (45 FR at 80085-86), further noting that measurement techniques to accurately characterize regional haze, and modeling science to accurately estimate its sources, required further evaluation (Reitze 2005; Watson 2002). In effect, EPA admitted with this deferment that although the agency recognized regional haze as a more scientifically accurate model of haze pollution, regulating under a regional haze framework was not feasible under the measurement and modeling techniques available at the time. At that time, there simply was not an obvious way to plausibly identify the proper universe of sources linked to regional haze, or calculate and enforce the necessary emission controls.

The Phase I rule portrayed haze pollution as an explicitly local phenomenon, framing it as an invasion or penetration of one specific receptor by one specific source. Limited to cases where a visible plume could be seen to affect visibility in a given Class I area, the rule inherently focused on sources and receptors that were located within the reach of an industrial smoke plume. Thus, the rule limited the regulatory "gaze/resolution" to a local scale spanning a few miles, with larger scale phenomena unable to fulfill the requirement for a distinguishable plume connecting source and receptor.

Applying the plume blight rule

EPA's first application of the Phase I rule, to mitigate the visibility impact of smoke particles from a pulp and paper mill located near Maine's Moosehorne Wilderness, was successful. The agency's best available retrofit technology (BART) analysis indicated that reductions in particle emissions were feasible, and emission controls were applied at the mill. This case was aided by the fact that the visibility impacts were caused by primary particles directly emitted by the mill (not formed by intermediate atmospheric processes), which could be visually traced to the mill's smoke plume (Watson 2002).

The second application of the Phase I rule comprised an attempt to loosen this requirement. In 1985, a consortium of federal agencies and one electrical utility began the Winter Haze Intensive Experiment (WHITEX), which was directed at understanding the causes of wintertime haze at Canyonlands National Park and Grand Canyon National Park. WHITEX was a scoping study, meant to evaluate visibility monitoring network systems and test several air quality source attribution models. Scientists released an inert tracer gas from the Navajo Generating Station (NGS) in 1987 and monitored its movement in and near the national parks. Like many older coal-fired power plants in the region, NGS was not required to have controls for sulfur dioxide (SO_2, a precursor gas for visibility-impairing sulfate particles). In 1989, the authors of the study concluded that a "humanly perceptible" visibility impairment at Grand Canyon could be attributed to sulfate particles formed in the atmosphere from NGS SO_2 emissions (Malm, Gebhart, Cahill, et al. 1989). EPA translated a draft of this conclusion into a

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4. Visibility Protection for Federal Class I Areas, 45 FR 80084 (Dec. 2, 1980, codified at 40 CFR §51.300-51.307)

proposed rulemaking that declared "…a substantial portion of visibility impairment in Grand Canyon National Park is attributable to a specific source, NGS…" (54 FR 36948-36953). This same notice of rulemaking proposed to require BART controls for NGS (Watson 2002).

With this notice, "EPA established a regulatory precedent that any scientific evidence, not just visual observation, could be 'deemed appropriate' for making a source attribution" (Watson 2002, 636). In spatial terms, this conclusion allowed regulators to expand the scale of source attribution for visibility impairment beyond the reach of a visible smoke plume. This expanded spatial scale in turn opened the possibility for sources beyond NGS to be considered contributors to Grand Canyon haze. In this way, an expanded scale led to an expanded role for scientific uncertainty and political maneuvering in the regulatory process.[5] Without a clear, visible link between the alleged source and receptor pair as in the Moosehorne Wilderness case, there was plenty of room for doubt and argument in linking source with receptor. In the case of the Grand Canyon, utility operators disputed the WHITEX results and conducted their own study (the Navajo Generating Station Visibility Study, NGSVS), which also found sulfate contributions from NGS to the Grand Canyon, though not as large as those found in WHITEX. The NGS eventually installed SO_2 scrubbers under a negotiated agreement with EPA, though it is unclear to what extent that agreement was driven by the WHITEX results[6] (Watson 2002).

From plume blight to regional haze

The plume blight framework was an emblematic example of an oversimplified liability discourse and its shortcomings.[7] In large part resulting from this Grand Canyon experience, visibility scientists concluded that a one-to-one, source-receptor framework was oversimplified and not useful for policy purposes. A National Research Council committee report stated:

> A program that focuses solely on determining the contribution of individual emission sources to visibility impairment is doomed to failure. Instead, strategies should be adopted that consider many sources simultaneously on a regional basis, although assessment of the effect of individual sources will remain important in some situations (National Research Council 1993, 6–7).

With this in mind, the CAA Amendments of 1990 added §169B to the Act, which gave EPA the explicit authority to address interstate transport of pollutants contributing to visibility impairment

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5. At the same time, time pressures left little possibility for the necessary scientific analysis to significantly shape regulatory action. Watson claimed that "casting WHITEX as the justification for a regulatory action that might cost a generating station a lot of money, rather than the exploratory scientific endeavor it intended to be, created an adversarial atmosphere that clouded objective scientific interaction" (Watson 2002, 636). He cites the publication of scientific papers based on NGSVS as late as 1999 as evidence of "the mismatch between regulatory and research timetables." (Watson 2002, 636). See Markowski 1992 Malm, Gebhart, Iyer, et al. 1993 Markowski 1993,, and Williams, M. D. 1993 for more background on this adversarial atmosphere.

6. Watson asserts that single-source attribution studies such as WHITEX "did not have the major influence on control decisions attributed to them" (Watson 2002, 636); since NGS did not have SO2 controls and was located between Canyonlands and Grand Canyon, it was an obvious candidate for regulation.

7. "The shift from liability to accountability has been fostered by increasing evidence that the attempt to establish strong, definite connections between actors, prescriptions and events in most situations is bound to fail" (Pellizzoni 2004, 551).

(CAA §169B(c), 42 U.S.C. §7492(c)). However, regulations implementing these statutory provisions were not promulgated until 1999; until that time, the 1980 regulations comprised the basic requirements[8] (Reitze 2005).

The first attempt to regulate regional haze occurred with the proposal of EPA's "Regional Haze Rule" in 1999. The Rule requires that all 50 states create state implementation plans (SIPs) individually or–recognizing the transboundary nature of visibility pollution–through Regional Planning Organizations (RPOs).[9] SIPs must establish "reasonable progress" goals for days with the most visibility impairment, and must prevent any degradation in visibility for the least impaired days. These goals are specified as a uniform rate of visibility improvement from baseline visibility conditions (measured from 2000 to 2004) to "natural visibility conditions" by 2065.[10] States and RPOs must provide technical justification for assigning emission reduction obligations among applicable sources, using modeling, monitoring, and emission inventory information. Emissions reduction strategies in a SIP must include the following at a minimum: (1) ongoing reductions from other air quality regulations; (2) control of fugitive dust and non-road engine exhaust from construction activities; (3) retirement and replacement of emission sources; (4) smoke management; and (5) trade-offs in point, area, and mobile source emissions. Progress is to be evaluated every five years, and emission reduction strategies are to be revised every ten years, beginning in 2018. Initial strategies were to be prepared in conjunction with PM2.5 SIPs in 2008.[11] The Rule encourages regional emission cap and trading of allowances as an efficient way to obtain necessary emissions reductions (Watson 2002).

Scientists greeted the Regional Haze Rule with some relief. According to one scientist interviewed, "So the regional haze rule came along and a lot of us were very happy to leave this chasing one at a time power plants or smelters or refineries or whatever, you know, it didn't seem to make a lot of sense" (interview, visibility scientist).

Another visibility scientist asserted in an interview that another effect of the Regional Haze Rule was to make special studies such as BRAVO obsolete, given that the needs of states and regional planning organizations were for analysis that examine all emission sources rather than focusing on specific stationary sources. (interview, visibility scientist).

The pressures behind EPA's promulgation of the regional haze rule were several. On the one hand, the scientific case for a regional approach to haze pollution had been growing over the past two decades or more, as described earlier in this section. Secondly, absent visible evidence in the form of an obvious smoke plume, the owners and operators of polluting entities, and their allies, vigorously disputed any technical study that pointed to single facilities as primarily

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8. 45 FR at 80084, codified at 40 CFR pt. 51

9. The Rule places the burden for visibility assessment and planning on individual states and Native American tribes. Recognizing that regional haze is caused by pollutants crossing state lines, tribal boundaries, and international borders, the Rule also offers states and tribes to coordinate their efforts through RPOs. Forty-eight states (all except Nevada and Hawaii), the District of Columbia, and many recognized Native American tribes have opted into one of five RPOs representing western, central, midwestern, mid-Atlantic and northeastern, and southeastern states.

10. "The Rule sets a goal of attaining "natural visibility conditions" rather than an emission or ambient concentration standard. Accordingly, the only federally enforceable requirements of the rule are the control measures adopted by individual states to meet that vague goal.

11. In reality, many states were late in submitting their regional haze SIPs, with some submissions–including Texas's–delayed until 2010 (Tresaugue 2009).

responsible for any case of haze pollution (see for example Markowski 1992 and Gidi, A. D. 2000). Finally, several people made a scarcity argument against these attempts at single-source attribution, as illustrated by a letter to the editor during the WHITEX controversy.

> The important question arising from the WHITEX study and the EPA action is not whether the science was good. The question is are we asking science to solve the right question? Does it make sense that we put the burden of proof on the park service or EPA to show that any given source has a large contribution to visibility impairment at a specific Class I area? We know that sulfur aerosols comprise a major part of the visibility impairment throughout the country. We also know, through the smelter studies, that emissions of sulfur influence the sulfur aerosol measurements at receptors which are many hundreds of miles away. We have left the biggest problem in visibility degradation, regional haze, alone while we have asked for specific attributions under the plume blight regulations. Further studies of improved source attributions could probably be done, but I wonder if they are the best use of our limited science dollars (Williams, M. D. 1993, 1305).

In an era of declining budgets, it seems that the heyday of resource-intensive single source attribution studies and regulatory actions ended by collapsing under its own weight.

Big Bend haze studies: a shift in scale

Though U.S. scientists might have responded to a larger trend in the science moving toward regional haze framings, it took Mexican officials' criticism of the U.S.-designed study to initiate what eventually became a scientifically supported shift in scale. Despite the emergence of the "regional haze" framing within visibility science and policy, and the gradual discrediting of the plume blight framework, U.S. federal and state government staff and other stakeholders initially addressed the Big Bend haze problem as one of a single Mexican pollution source affecting a single U.S. receptor. Mexican environmental enforcement personnel only destabilized this framing through their extended combative participation in Big Bend haze data analysis and field study development beginning in 1993. By persistently highlighting apparent biases in the framing of Big Bend haze as attributable to the Carbón plants, Mexico's representatives were ultimately able to precipitate a shift of the haze problem definition from addressing the impacts of Carbón I and II toward comprehensively characterizing the broad array of sources contributing to Big Bend haze at a large scale.

The problem of haze at Big Bend National Park, along with many other Class I areas in the U.S., came under scientific and regulatory scrutiny beginning in the late 1980s, subsequent to the promulgation of the Phase I visibility rule. EPA and the National Park Service (NPS) had noted since that time that standard visual range within the park had been decreasing noticeably. In 1990, EPA and NPS staff brought some early scientific research on this subject to the attention of their Mexican counterparts:

> There was a National Park Service study done by Bill Malm,[12] Kristi Gebhart and others in the late 80s, I think it might have been published in 1990 in Atmospheric Environment, using, doing some semi-quantitative analysis of what the impacts were at Big Bend National Park, what some of the source regions might be. Following up on that, we invited our Mexican counterparts at the National Environmental Coordinators meeting in San Antonio in 1990, to a session led by Bill Malm, actually, talking specifically about this issue. And, I can remember that we asked, we were sort of brainstorming as a group,

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12. William Malm is a pioneer of visibility studies, having done some seminal work as a graduate student and university professor in the late 1960s and 70s, and building teams of current and former graduate students who continued to work together over the years.

> what might be the causes…of this decrease of visibility. The Gulf coast, industrial pollution, Houston, Galveston, Corpus Christi, Beaumont area, there's a lot of industry there, perhaps any sources in Mexico we didn't know about at the time, our counterparts at INE could not offer any clues at the time, so it was pretty much just an esoteric discussion without reaching any closure, and that was in 1990 (interview, EPA staff).

The National Environmental Coordinators meeting mentioned here is the annual high-level meeting of the U.S.-Mexico Border Program, created by the La Paz Agreement between Mexico and the U.S. in 1983.[13] This context is significant here because it indicates that at least from 1990, U.S. government staff were framing Big Bend haze *as a border problem.* In the EPA context, the border region has a very specific definition: Article Two of the La Paz Agreement states that both sides will work to "prevent, reduce, and eliminate any contaminating sources along the border zone extending sixty-four miles [100 km] on either side of the border." EPA's activities within this border region also occur within a strictly defined institutional framework, including the National Coordinators meeting.

The 1990 discussion described above was followed by some quantified estimates in 1992, when Malm summarized recent research on haze affecting numerous U.S. national parks and monuments. The last section of this article draws statistical inferences (based on monitoring data) of the fraction of sulfate pollution affecting each park. In the Big Bend case, Malm made the following assertion.

> At Big Bend NP, Texas (see Fig. 22c), it is estimated that about 41% of the ambient sulfur is associated with emissions in the Monterrey, Mexico area, and about 29% from central Mexico. Thus, about 60% of the sulfur found at Big Bend NP have their origin in Mexico. It is not known what types of sources are responsible for the SO_2 emissions (Malm 1992, 31).

Malm qualified this assertion with cautionary statements elsewhere in the article regarding the preliminary nature of his analysis and the limitations of statistical models. In an interview for this project, he noted that this was one of the first papers ever published using back trajectory analysis–the tracing of blocks of air backwards in time and space from a given location–for apportioning, by region of origin, pollutants affecting specific receptors:

> at the time, you know, we were using the tools available, it was, you know, back in those days that was really our first goal or first application those kind of tools…but we didn't

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13. The agreement signed in La Paz committed the two countries to address border environmental problems within a comprehensive framework. The EPA and Mexico's newly created environmental ministry, the Secretaría de Desarollo Urbana y Ecología (SEDUE), were designated as national coordinators for each country. The agreement established a series of Annexes to address specific pollution problems including Annex I, which deals with the Tijuana River sewage problem. Over the years, the scope of La Paz was broadened to include hazardous materials emergency response (Annex II), the handling and transport of transboundary hazardous waste (Annex III), emissions from copper smelters (Annex IV), and urban air pollution (Annex V). A series of bilateral working groups were also established, both to examine the issues and to ensure compliance with the objectives of the Annexes. There was no formal enforcement mechanism (Wirth 2000, 182).

know, you know, exactly how severe those limitations were.

Nevertheless, these unambiguously presented estimates appear to have been relied upon heavily by U.S. scientists and government staff through much of the 1990s. A 1995 newsletter of the National Park Service air monitoring program contains an explanation of conclusions similar to Malm's, but without the caveats.

> Researchers calculate that approximately 75% of the visibility impairment in this area originates from Mexican sources. This is due to predominate weather patterns, the easy transport of sulfate pollutants over long distances, and large emissions of sulfur dioxide. The remaining air pollution comes from sources in the United States including Houston/Galveston, El Paso, and the Midwest.
>
> In 1993, National Park Service officials learned about the expansion of a coal-fired power plant in Coahuila, Mexico. Although they comply with Mexican law, neither the existing plant, Carbon I, nor the new expansion, Carbon II, have air pollution controls for sulfur dioxide. When Carbon II is completed, it is estimated that this power plant complex will emit 250,000 tons of sulfur dioxide into the atmosphere each year making it the seventh largest source of sulfur dioxide emissions in North America. In the prevailing southeasterly wind pattern of the area, Big Bend sits directly downwind, 130 miles away from Carbon I and II. The imminent addition of 130,000 tons per year of sulfur dioxide from Carbon II into the atmosphere poses a significant threat to the region's air quality.

While this article appeared in a trade newsletter distributed to a general audience, and was almost certainly not reviewed by any NPS technical staff, it nevertheless illustrates the widespread acceptance, at least within that agency, of Malm's preliminary estimates.

In 1993, the coal-fired power plants in Piedras Negras came to the attention of EPA Region 6 staff in Dallas.[14]

> In…early 1993, we did learn, in fact, that two power plants were being constructed in Mexico, about 18 miles south of the US border. One was actually already in operation, another, Carbon II, was under construction, and, we subsequently learned that Southern California Edison was in the process of purchasing those two plants from CFE, the national utility of Mexico. And, that also was a very sensitive time, because, the North American Free Trade Agreement, the proposed NAFTA agreement was being debated in a pretty, spirited way, in the media, and so it was a very sensitive time, yet, when we learned about the power plants, we, along with the National Park Service and the [EPA] Office of Air Quality Planning and Standards, started doing some initial modeling, uh, very cursory modeling using the emissions that we really had estimated from this size plant. We'd learned bits and pieces from the literature, from hearsay, from the Mexican government, from the American firm that was planning to buy Carbon II, because there was an EIS [environmental impact statement] of sorts that had to be done for the Mexican government before the purchase.
>
> So, given that information, we did run modeling, and we found, that, in fact, the impacts from that plant were a problem…in terms of the sulfur dioxide increments in South Texas

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14. Neither the Mexican nor the U.S. governments was under any formal obligation to notify the other country of major industrial projects near the border. In informal conversations, EPA staff members recounted that that news of the plants had actually been passed to an EPA employee in a different office by his brother, a contractor for Southern California Edison. That employee passed the information along to his counterparts at Region 6.

including the park, and also the perceived visibility impact at the park. Based upon the level of emissions and the size of plant we also concluded that if the plant were proposed for the United States, it could not be built as a new source. So…

FD: What were the reasons for, that it wouldn't be approved?

RE: Well, the main reason was that it had no controls at all on sulfur dioxide, so it would not meet the NSPS, the New Source Performance Standards, or BACT, Best Available Control Technology requirements, in the US, that's one reason. The other reason would be the ambient impacts would be too great.

The language in this sentence can also be construed as biased toward a localized scale. NSPS and BACT are regulatory terms typically used in the federal permitting process for major new emission sources in the U.S. Describing the Carbón plant emissions in terms of permits frames the plants' emissions in relatively local spatial terms, corresponding to the physical concept of a single air basin, or the political construction of a single air district or other regulatory jurisdiction.

Although by the early 1990s analysis of visibility issues in terms of single-source plume blight was largely discredited, in the case of Big Bend haze the possibility of a single source–the Piedras Negras plants–contributing a large fraction of BBNP's visibility impairment seemed quite plausible, in both commonsensical and back-of-the-envelope technical terms. U.S. government staff and NGO representatives alike relied particularly heavily on the assumption that prevailing winds, blowing from the southeast along the border, were the dominant mechanism in bringing haze-causing pollutants to the park. Back-trajectory calculations with wind transport models, using data from 1982-1994, indicated that the prevailing winds blowing into Big Bend National Park were indeed dominated by southeasterly flows along the international border during the summer months, with some increase in easterlies in the fall months (Green, et al. 2000, 9–14). Again, however, those calculations were undertaken at a regional scale, and neglected to analyze where air masses might have been located before arriving in the border region. Nevertheless, the image of prevailing winds carrying pollutants directly from Carbón I and II to Big Bend National Park seems to have been treated as accurate by most of the U.S. actors involved in the Big Bend haze issue.[15]

In October 1993, at the National Coordinators Meeting in Ensenada, Baja California, under the auspices of the La Paz Agreement for the Protection of the Border Environment, EPA Administrator Carol Browner expressed the U.S. government's concern to her counterpart, Luis Donaldo Colosio (Mexico's Secretary for Social Development) regarding the probable impact on visibility at Big Bend National Park from sulfur dioxide emissions from Carbón I and Carbón II.

This concern was based on the results of preliminary air quality dispersion modeling analyses conducted by the U.S. Environmental Protection Agency (EPA) and the U.S.

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15. Mexican government representatives would later contest this image of prevailing winds. Writing about joint U.S.-Mexican Big Bend Preliminary Study undertaken later in the decade, Mary Kelly of the Texas Center for Policy Studies noted with frustration that the "working group [for the Big Bend Preliminary Study] took almost a year to agree that the prevailing summer wind direction was from southeast to northwest, which would move Carbón I/II air pollution toward the Big Bend-Maderas del Carmen area" (Kelly 1998, 195). In truth, the group did not agree at all; the Big Bend Preliminary Study final report indicates a lack of consensus between the U.S. and Mexican research teams on prevailing transport patterns (Big Bend Air Quality Work Group 1999).

> National Park Service (NPS) using single-source, Gaussian models.[16] The results showed that the emissions from the Carbón I-II plants could result in concentrations of sulfur dioxide (SO2) at Big Bend National Park in excess of the Prevention of Significant Deterioration (PSD) air quality allowable increments established by the U.S. Congress for certain U.S. national parks and wilderness areas, known as Class I areas. Based on an assumed conversion rate of SO2 to fine particle sulfate, the results also indicated that visibility at the park could be degraded significantly from existing levels (Big Bend Air Quality Work Group 1999, 1).

At the end of the meeting, the two leaders issued a joint communiqué establishing the Big Bend Air Quality Work Group, whose tasks were to "develop bilateral measures to preserve air quality and to address existing situations of substantial air quality degradation including visibility problems at Big Bend National Park" and "make recommendations for an equitable reduction strategy to address any problems so identified" (Big Bend Air Quality Work Group 1999, 1).

The Work Group carried out those tasks over the next three years. Its activities were fraught with conflict between the U.S. and Mexican delegations, according to some interviews and implied in the stiff prose of Big Bend Air Quality Work Group 1999. The Mexican delegation disputed several of the basic technical assumptions utilized by the U.S. research team, including the assumption regarding prevailing winds described above. (See the next section for more information.) For their part, U.S. participants in the Work Group discounted the Mexicans' technical claims using an expertise argument, situating enforcement engineers–members of the Mexican delegation were staff members at PROFEPA, the Mexican environmental enforcement agency–as less qualified than research scientists:

> They had three individuals from their PROFEPA, their environmental enforcement group, involved primarily. It was not INE, the National Institute of Ecology [the research arm of Mexico's environmental agency]…that we interacted with, but the Attorney General for the Environment, the PROFEPA group. They were engineers, they were very good engineers; they approached the problem I think from an enforcement standpoint. And I think there was a different perspective, quite frankly, than the perspective that most of the US researchers had. Not being enforcement people, we were interested in a little bit more free ranging study and evaluation of data. I think enforcement engineers anywhere, certainly on our side of the border too, sort of respond to a different set of data, and I think they were expecting a bit more in the way of demonstration that the study was needed, that in fact…what we had planned was truly equitable, so I think there was a…philosophical difference up front. And again, I think all the engineers that we dealt with were very fine folks, very well trained, but I think that again, there was a, maybe a different expectation from them about what this study should be (interview, EPA staff).

It appears that because of the vastly lesser resources devoted to Big Bend haze by the Mexican government in terms of personnel, funding, and physical infrastructure, the Mexican delegation to the Work Group here ended up playing the role of skeptical citizens in conflict with a technocratic "policy community" which both shaped and dominated the realm of visibility science (Fischer 2000).

The Work Group undertook two separate efforts. First, the U.S. delegation–led by William Malm, by now working for the National Park Service and based at the Cooperative Institute for Research in the Atmosphere (CIRA) at Colorado State University–performed an analysis using regional scale dispersion and climatological models. Based on that analysis, the U.S. delegation–not the Mexicans–concluded that "the operation of the power plants would cause 63 episodes of perceptible visibility impairment per year at Big Bend National Park. …

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16. The same type of model used in Malm 1992.

Similarly, the model predicted 20 episodes of perceptible visibility impairment at the park as a result of emissions from nearby Texas sources" (Big Bend Air Quality Work Group 1999, 1–2). The report dryly notes that "these results were presented to the Mexican delegation of the Workgroup" (Big Bend Air Quality Work Group 1999, 2); it appears that the Mexicans may have received them with some skepticism.

Second, the Work Group reviewed air monitoring data collected at Big Bend National Park between 1982 and 1992 by NPS, keeping in mind that CFE activated the four units of Carbón I between September 1981 and November 1996.

> [The Work Group] found that the average sulfur concentrations in the park during the summer, when the predominant winds are from the southeast and presumably when the Mexican sources would affect the visibility at Big Bend the most, decreased at a rate of 38 ng/m3 per year, although this trend was not statistically significant. (This means that there is likely to have not been a change in average sulfur concentrations at the park during this time period.) ...
>
> As a result of the preceding, the binational Work Group concluded, that in the event the operation of the Carbón I power plant had an impact on Big Bend, it was unlikely that it was the predominant contributor to sulfur concentrations, and, hence to visibility impairment, measured at Big Bend National Park. It also concluded that if there were any impacts from the Carbón II plant, while possibly the largest single source in the vicinity of the park, they were likely to be small relative to the cumulative impact from the numerous other regional sources that could be farther away from the park (Big Bend Air Quality Work Group 1999, 2).

These conclusions comprised an early technical acknowledgment that Big Bend haze might originate from multiple sources in addition to the Piedras Negras power plants.

These results were presented to the National Environmental Coordinators at their March 1996 meeting in El Paso, Texas. The heads of delegation at that meeting, William Nitze of EPA and José Luís Samaniego Leyva of SEDESOL, issued a joint statement declaring:

> The preliminary results of the studies conducted demonstrate that there is no significant trend in the deterioration in the air quality of the Park.
>
> …[I]n the event that Carbón II has any impact on the air quality of the park, it is small, and
>
> To continue the study of the possible degradation of air quality in the Park, there must be a regional approach that considers the probable causes of both anthropogenic and natural origin (Big Bend Air Quality Work Group 1999, 2–3).

Again, this public statement constituted the first formal government declaration that scientists needed to examine Big Bend haze at a broader spatial scale.

The Workgroup agreed in June 1996 to conduct a preliminary study later that year. The primary objective of the study was:

> ...to obtain information that would allow for the identification of possible source regions in both countries and source types responsible for visibility degradation at Big Bend National Park. It should be emphasized that the preliminary study was not intended to be, nor was it designed as, an attribution study to determine the quantitative impact of specific sources (such as individual U.S. or Mexican coal-fired power plants) on Big Bend's air quality. The study was intended to obtain preliminary information on pollutant

> gradients over a rather broad area of Texas and Northeast Mexico to assist both governments in the design of any future study that might follow to identify the causes of visibility impairment at Big Bend National Park (Big Bend Air Quality Work Group 1999, 3).

According to Malm, the Big Bend Preliminary Study, as it became known, was as much a bureaucratic and political tactic as a scientific study, in that it functioned as a stalling mechanism to gather momentum and resources for a full field study (BRAVO), and also a tactic to keep the Mexican government involved and engaged. At the same time, its results did indeed provide insights for future analysis.

Workgroup members carried out The Big Bend Preliminary Study from September 9 to October 13, 1996. Air samples were gathered and analyzed for various sizes and constituents of particulate matter (PM_{10}, $PM_{2.5}$, sulfates, nitrates, elemental and organic carbon) during the study period at 10 sites in Texas and 9 in northeastern Mexico.

The workgroup presented the findings of the Preliminary Study to the U.S. Mexico Border Environmental Program National Coordinators Meeting in March 1998. As the summary document delicately stated, "the Work Group was able to achieve a consensus on many of the findings. There were some analyses, and conclusions based on these analyses, where consensus could not be reached" (Big Bend Air Quality Work Group 1999, 39). The top three consensus findings (of eight total) were:

> 1. To the northeast of Big Bend National Park (BBNP), there are significant sulfur sources well traced by selenium, and likely to be coal-fired power plants located at distances that can exceed 700 kilometers, causing high concentrations of fine particle mass and fine particle sulfur in large areas of Texas, including Big Bend National Park.
>
> 2. On some occasions with southerly wind flows as measured at the meteorological station at Big Bend National Park, Mexican emissions appear to be associated with significant sulfur concentrations at the park.
>
> 3. With southeasterly wind flows, fine particle mass and fine particle sulfur concentrations at Big Bend National Park appear to be influenced by a combination of sources. These sources may be in the United States and Mexico. The lack of correlation of Selenium and Vanadium with Sulfur at Big Bend National Park for these wind directions indicates that there are sources in addition to power plants that contribute to these concentrations.

The top two recommendations from the Preliminary Study both requested further investigation of Big Bend haze and prefigured the results of that further study: "1. A more extensive field study will be needed to quantify the impacts from specific sources to visibility impairment at Big Bend National Park. 2. The spatial domain of the study should be expanded, particularly towards the northeast, the south, and into the Gulf of Mexico" (Big Bend Air Quality Work Group 1999, 40).

At this point, though the U.S. and Mexico briefly continued to discuss Big Bend haze through the U.S.-Mexico Border Program, Mexican government representatives had effectively succeeded in "jumping" the scale of the Big Bend haze problem from the border region to a much larger domain. Effectively, they were able to shift the problem definition from a plume blight framework to a regional haze framework, destabilizing the border-centered causal story (Stone 1989) that had been dominant up to that time. From this point forward, scientists would attempt to characterize the sources of the haze problem over a much wider scale than the near-border region. That venue shift would enable Mexico to opt out of the imminent BRAVO study, citing unfair emphasis on Mexican emissions as their justification.

The BRAVO study

It was at this time that several related events around Big Bend haze converged to provide an opening for the large BRAVO field study, and shape the way that government-affiliated scientists and their brokers conducted it. The political importance of Big Bend haze–linked to the broad concern over NAFTA's environmental effects, strong consternation in west Texas about the haze phenomenon, and growing concern about regional haze in U.S. national parks–focused enough attention on the problem to merit a congressional earmark to cover its $7 million cost. The fracas surrounding the WHITEX study led the government scientists leading BRAVO to be quite inclusive in terms of institutional representation on the technical committee directing the study. Finally, the conclusions of the Preliminary Study, as well as the broader trend to consider visibility impairment as a "regional haze" problem, pointed toward a wider geographical domain for the BRAVO study, rather than the small scale dictated by the plume blight framework.

Planning for BRAVO started in 1997. The BRAVO steering committee spent 1998 scrambling for funding. Congressman Henry Bonilla, whose west Texas district included Big Bend National Park, inserted an earmark for the study in the 1999 federal appropriations bill (Sage 2000). At that time, the technical team rushed to prepare study protocols, obtain equipment and deploy it to the field, and so on.

The field study portion of the project took place between July and September 1999. The field study consisted of data collection from 40 fine particulate monitoring sites (operated by the National Park Service's air quality monitoring network), which helped scientists to characterize various aspects of the fine particle mass. Scientists also released atmospheric tracer compounds from likely source regions–including power plants–and traced the flows of those tracers continuously over the four month study period, using over twenty monitoring sites. The tracer study was the most resource intensive and expensive part of the field study. The project also included supplementary meteorological monitoring, stack testing of various sources in and around the national park, and the compilation (from existing data, including the national hourly emissions inventory of the U.S.) of a complete emissions inventory for North America.

Securing Mexican participation in BRAVO was difficult, and eventually proved impossible. Alfredo David Gidi, an official in the Mexican environmental enforcement agency PROFEPA, expressed concern in a public newsletter article (Gidi, A. D. 2000) and a technical submission to the Border Environment Cooperation Commission (Gidi, A. F. D. 1999) that the study design was biased toward getting definitive information about pollution from Carbón I and II, but deliberately designed to avoid precise conclusions regarding U.S. sources.

> Despite the fact that previous binational studies of Big Bend air quality have shown that there is less impact from Mexican sources and a bigger one from U.S. sources, the United States' proposal for the BRAVO study considers inserting tracers only in two potential sources in each country--which is an inequitable arrangement. The two Mexican sources identified for tracer insertion, Carbon I and Carbon II, are responsible for 50% of Mexican emissions that potentially impact Big Bend, while the two U.S.-side tracer insertion points are responsible only for 3.6% of emissions in the southeastern United States potentially affecting the park.
>
> To complement the use of tracers, the United States Government has included in BRAVO the use of mathematical models. But these models must be calibrated with real data in order to obtain trustworthy results. Ideally, in order to do this, tracers would be inserted in the other 96.4% of potential pollution sources in the United States and in the other 50% of potential pollution sources in Mexico.
>
> …

> Ultimately, the BRAVO study is designed to determine with the least degree of uncertainty possible the impact of the two Mexican coal power plants on Big Bend air quality, while avoiding any similar evaluation of the numerous facilities in the southeastern U.S. which could play a role in the region's visibility problems. As a result, Mexico opted not to follow through with the study, which was initiated unilaterally by the U.S. government in July, 1999 (Gidi, A. D. 2000).

Interviewees at EPA acknowledged that the BRAVO steering committee had attempted to be responsive to the concerns of the electric utility industry:

> We had proposed that at least one of the tracers be released from Carbon I and II, because that was one of the main reasons that we, that the whole study was instigated in the first place. They were uncomfortable with that. They thought that would be unfairly singling out that plant. So they were not interested in having any tracer released in Mexico. We understood their position, but, from the US position, we were trying to balance the desires, the needs, the sensitivities of our industry, which was part of our team. So, the electricity generating industry basically told us, that's not equitable from our standpoint, we can't release everything on our side, and nothing on the Mexican side (interview, EPA staff).

Gidi also referred back to analysis conducted by Malm (1992), asserting that study's constrained temporal–and by extension, spatial–domain provided an incomplete picture of the pollution sources affecting Big Bend.

> The major flaw in the Malm report was the time period used to determine the back trajectories–just 24 hours, which drastically limited the identification of other regions generating pollutants that might end up in the Big Bend area. Aerosol, for example, can stay suspended in the air several weeks–as was accepted at the meetings of the binational Border XXI Big Bend Air Quality Working Group. If the models used by Malm had been applied for longer time, for example five days or more, it is probable that U.S. regions far to the northeast and east would have been linked to Big Bend air problems (Gidi, A. D. 2000).

This statement indicates the skepticism within the Mexican research team regarding the presumed prevailing wind patterns in the region.

Finally, the Mexican government seems to have decided that there was no reason to devote its scarce resources to study an issue with very little domestic relevance. With the passage of NAFTA and the failure of the privatization deal with Mission Energy, there was little incentive for Mexico to continue their participation. U.S. and Mexican agency staff and scientists held extended negotiations, but the Mexican government in the end withdrew from the study. If the Mexican delegation's stubborn persistence since Browner and Colosio first created the Big Bend Air Quality Work Group in fall 1993 had enabled them to nudge the problem definition for Big Bend haze toward a larger spatial scale, their withdrawal from the BRAVO study decisively pushed the haze issue into the U.S. domestic regulatory realm. From that point forward, Big Bend visibility would be analyzed as one of many domestic regional haze problems, or more precisely, one manifestation of the national regional haze problem in the U.S.

Mexico's withdrawal from BRAVO also created a boundary problem for the study team. Data collection for BRAVO was spatially confined to U.S. soil; the project team was unable to perform any monitoring or tracer releases in Mexican territory. Scientists simulated a tracer release from the Piedras Negras power plants by releasing the tracer compound from atop a transmission tower in Eagle Pass, Texas, directly across the border from Carbón I and II.

BRAVO was originally scheduled for completion in 2001, but the tasks subsequent to the field study took much longer than expected. The data compilation and quality assurance process, originally expected to last a few months, took a whole year to complete. The validation of the atmospheric tracer analysis also contributed to delays. Analysis of the various data sets took nearly two years. Finally, the interpretation of the results and writing of the final report proved to be a laborious process, because of the inclusive and consensus-based structure the study organizers had implemented.

> The Texas Commission on Environmental Quality, the National Park Service, and EPA comprised the steering committee for this study, so we were the managerial committee that was in charge of an ultimate product. But we were advised by a technical committee, which…an EPA employee, actually a NOAA employee assigned to EPA in Las Vegas, was in charge of. That consisted of about thirty individuals, again from industry, from environmental groups, from all of our contractors, all over the country. So that group actually wrote the results, and interpreted data, and supplied that to the steering committee, but it was the steering committee's role to further interpret that, and to put it in a balanced sense. So, that process, for an example, it took us four months to agree on eighteen pages of the Executive Summary. So, that process took a long time (interview, EPA staff).

The implementation of this consensus process stemmed from the BRAVO technical leader's experience with the contentious WHITEX study, described earlier. The process came under strong pressure by competing interests among the various stakeholders, as described in Chapter 3. To partially defuse those competing interests, the BRAVO technical team conducted runs of numerous types of mathematical models. This approach mirrored the stakeholder consensus framework implemented by the study leaders, with some analysis done with government models and other models run by the utility industry.

It was a discrepancy among the modeling results that gave the project a decisive nudge away from attributing Big Bend haze primarily to the Piedras Negras power plants, and toward a much larger scale. In the course of modeling the paths of wind flows passing through the national park, BRAVO scientists discovered discrepancies in their model's boundary conditions; the results of their analysis were telling them that their initial assumptions of the meteorological conditions at the edges of their study region were not consistent with measured conditions. This finding implied that scientists were mistakenly treating those conditions as independent variables in their analysis, when they should have been included among the dependent variables. In practical terms, the spatial domain of the analysis, until that point largely confined to Texas and the border region, was too small. The scientists responded to this discrepancy by expanding their modeling domain to the continental scale.

The expansion of the modeling domain opened the door to some surprising results for the study, which was finalized in 2004. Specifically, the eastern United States source region–including Arkansas, the Ohio River Valley, and the southeastern U.S.–turned out to have much higher impacts in Big Bend than expected. More precisely, on the 20 percent haziest days during the BRAVO study period, sulfur emissions from the eastern United States comprised the largest single impact on visibility at the park, followed by Mexico, followed by Texas. (On those same 20 percent worst days, the largest single source that impacted the park was the Carbon I and II power plant complex, responsible for about nine percent of the particulate haze.)

> The most surprising BRAVO Study attribution finding was that an infrequently occurring set of conditions that promotes air flow over SO_2 source regions in the eastern U.S. including eastern Texas was associated with and appears to be responsible for most of the worst haze conditions during the fall at Big Bend. This result could easily be missed by aggregated attribution results (e.g., on a monthly or seasonal basis) (Pitchford, et al. 2004, 12–24).

The jump to a larger spatial scale of analysis enabled scientists and agency staff to move beyond the previous, spatially restricted understandings (in the U.S.) of Big Bend haze pollution.

> So I think going into BRAVO, if you're going to take a step back seven or eight years, if someone had that result at that time that was talking to you about it, I don't think we would have believed that, simply because of the wind flow characteristics, the general wind flow characteristics of North America, it's very, statistically, fairly unusual for you to have easterly flow into this part of the continent. Yet, we found with BRAVO that when it does occur, it's quite important, and it can be quite major in terms of visibility impacts (interview, EPA staff).

> …there were times in the fall where you would have the air from the Gulf Coast States and further north come swing out all through the Gulf and come in over Mexico and then up into Texas. So in fact if a person we're sitting in Big Bend and said, "Hey, it's hazy and did you notice the air is all coming from Mexico," they'd have been right, but if you were on the coast of Mexico, the Gulf Coast in the right place you'd say, "Hey, where is all that pollution coming from out over the coast," and if you were in Louisiana you'd know, "Hey, there's a lot of pollution and it's heading out over the Gulf." So, in fact we were polluting Mexico; had we had monitoring sites with tracer in Mexico, I don't doubt that we would have seen some cases where Texas was polluting Mexico but Mexico is also polluting Texas; their emissions are there much more frequently it's just they're rarely the big episodes, the really big episodes were all from Texas and the rest of the sort of Eastern U.S. (interview, scientist).

So the BRAVO results pushed the phenomenon of Big Bend haze from a relatively small scale, spanning roughly the distance between the national park and the Piedras Negras power plants, to a large scale encompassing much of the U.S. and Canada. In this way, well into the 21st century, the understanding of Big Bend haze finally caught up with the scientific understanding of haze pollution more generally, with the conclusion that haze phenomena could rarely be accurately attributed to a single, narrowly defined set of sources.

The BRAVO technical and steering committees also concluded that for modeling fine particulates and haze in general, if a study could deploy a wide variety of models, utilizing different techniques and seeing how they might converge or diverge, then analysts could have more confidence in the study results.

> By design, the BRAVO Study employed a number of different approaches for source attribution assessments including air quality simulation models, transport regression approaches, and a spatial distribution analysis. The advantages of using multiple techniques include utilization of more of the available data, and the creative synergy resulting from collaboration among different analyst organizations. These advantages promoted more thorough assessments, and provided the ability to apply a weight of evidence methodology (Pitchford, et al. 2004, 12–22).

By recommending this multiple model approach, the study team intended to spare future study planners–such as members of the multi-state regional planning organizations–the expense of conducting site-specific field studies.

> …one sort of ulterior motive we had in doing BRAVO was, long range, is to try to suggest simpler ways of doing regional haze evaluations or fine particle modeling. …I think we realize these days, the regional planning organizations are not going to be able to

> afford field studies on the order of what we did in BRAVO. We spent seven million dollars on this, just looking at one national park. …but I think the lessons can be transferred, and that is, if you possibly can, look at more than one regional air quality model, and perhaps also use back trajectory source receptor models, …which don't use emissions but give you, really, a residence time picture where air masses have been, and one can infer, then, what relative impacts there may be for different parts of the country. So, using those techniques in tandem, we think, has worked out well in BRAVO, and probably would be smart in other RPO activities for regional haze too.

This recommendation can be seen, then, as the last gasp of expensive, site-specific field studies for the purpose of visibility pollution source attribution. Again, this conclusion from Big Bend haze studies parallels the previous admonitions in response to the WHITEX controversy (Williams, M. D. 1993) and the concerns of the National Academies (National Research Council 1993) discussed above.

Big Bend haze science provides a signpost in the broader world of air pollution and atmospheric science and policy, its analyses having taken place in the years 1990 to 2004, roughly the same period when consciousness of large-scale atmospheric pollution–from regional haze to trans-oceanic dust plumes to global warming–was on the rise. During the same period, technological advances enabled the implementation of increasingly complex mathematical models of atmospheric phenomena. Global air pollution issues, and the models used to analyze them, indicate the diffusion of both causes and effects of air pollution over wide spatial domains, a characteristic that is quite different from the plume blight framing.

This case also provides a window on the complex relationship between science and politics. It is evident from this case that the initial, incomplete scientific finding that Big Bend haze had its primary origins in Mexico provided the basis for that issue's high profile in the media and the environmental policy realm. With its commonsensical emphasis on the proximity of Big Bend National Park and the Piedras Negras power plants, the widely accepted assumption regarding prevailing winds in the Texas-Mexico border region, and the absence of other obvious pollution sources, the border-scale conclusion attributing Big Bend haze emissions to Piedras Negras retained credibility even as the wider scientific and regulatory community moved toward a regional haze framework. As discussed in Chapter 3, this narrative also corresponded closely to prevailing discourses north of the border regarding wilderness, immigration, and Mexicans. This simple, powerful causal story (Stone 1989) gave the U.S. government leverage to ensure Mexico's continued engagement in the issue over the six year period from 1993 to 1999. It also opened the door to obtain significant funding for the Preliminary Study and BRAVO, as Congress responded to national and constituent pressure.

The Mexican government was able to destabilize this story by stubbornly pressing technical arguments–which U.S. officials discounted on the grounds of insufficient expertise–based on equally intuitive information, including the sheer numbers of U.S. SO_2 emission sources and the limited spatial scales of early source attribution studies. Perhaps more importantly, Mexican government staff used their political standing as an equal partner in the U.S.-Mexico Border Environmental Program to press for an expansion of the haze issue's spatial domain from the border region to include Texas, northern Mexico and the Gulf of Mexico. They successfully changed the research question from determining the impact of the Piedras Negras plants to characterizing the widespread sources of Big Bend haze pollution, a significant shift which not only allowed them to opt out of the issue and shift it to the U.S. regulatory venue, but which may have also positioned the BRAVO steering and technical committees to confirm the large-scale nature of the haze phenomenon. In effect, stretching Schattschneider's (1960) formulation for a moment into the international realm, Mexico's performance of its function as a "semi-sovereign" entity–a weak country, but one with certain rights as a sovereign nation–*pushed*

the science of Big Bend haze toward a more appropriate scale. The BRAVO study would cement this scale jump five years later.[17]

Some unique physical and geographic characteristics led technocrats in the U.S. and Texas governments to strongly emphasize a plume blight framing for Big Bend haze, rather than the more diffuse regional haze framing. The isolation of Big Bend National Park, the location of the Piedras Negras power plants as the closest SO_2 emission source to the park, and the unproblematized assumption of southeasterly prevailing winds along the Texas-Mexico border all pointed toward the conclusion that Carbón I and II were primarily to blame for the haze problem; these factors may also have reinforced a regulatory inclination toward simplicity: reducing emissions from a single large pollution source. The regional haze framing, though more accurate, was less concrete and legible under these circumstances. However, the Mexican government put that alternate framing in concrete terms: Mexican enforcement engineers not only contested the prevailing winds assumption, but pointed out the sheer quantities of emissions sources on the U.S. side of the border. Arguing that scientific analysis inevitably becomes politicized in environmental controversies, Sarewitz (2004) makes the following assertions:

> First, science supplies contesting parties with their own bodies of relevant, legitimated facts about nature, chosen in part because they help make sense of, and are made sensible by, particular interests and normative frameworks. Second, competing disciplinary approaches to understanding the scientific bases of an environmental controversy may be causally tied to competing value-based political or ethical positions. The necessity of looking at nature through a variety of disciplinary lenses brings with it a variety of normative lenses, as well. Third, it follows from the foregoing that scientific uncertainty, which so often occupies a central place in environmental controversies, can be understood not as a lack of scientific understanding but as the lack of coherence among competing scientific understandings, amplified by the various political, cultural, and institutional contexts within which science is carried out (1).

As this passage points out, environmental controversies can stem not only from technical and disciplinary differences, but from normative ones as well. In the case of Big Bend haze, certain societal discourses also played strong parts in amplifying and reinforcing the border scale framing of Big Bend haze in the U.S. In the next chapter, I explore the political and cultural contexts of this controversy, as a gateway to discussing the meanings of the border scale and regional haze scale framings of Big Bend haze, and the implications of jumping–or accumulating–spatial scales.

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17. Though it is quite possible that Big Bend haze science would have arrived at this scale jump absent Mexican pressure, it is equally possible that without Mexico's refusal to accept the border-scale causal story, the Preliminary Study and BRAVO might not have been carried out at all.

CHAPTER 3
FROM SMALL TO BIG...AND BACK AGAIN?
SCALE AND ADAPTIVENESS IN THE BIG BEND HAZE CONTROVERSY

Introduction

This chapter takes a closer look at the scale shift of Big Bend haze, examining the meanings of that change in both the policy and activist realms. I contend that while the early construction of Big Bend haze as a border problem was incomplete, and perhaps even unjust, it also provided opportunities for action–through established institutions and grassroots activism– that were ineffective when deployed against an intractable, technocratic "regional haze" problem. The jump to a large-scale regional haze scale moved Big Bend haze into a weak, conflict-ridden regulatory structure with a 60 year implementation schedule. It also moved the problem into the technocratic realm of environmental regulation, driven by experts and with few opportunities for citizen participation or influence.

However, the case of Big Bend haze also enables us to push the scale jumping concept further, by moving toward a notion of *scale layering* over time. This essay proposes that when a scale jump occurs, the "old" scale does not disappear, but rather continues to frame social phenomena. More precisely, discourses and institutions tied to "former" scales continue to develop and act over time, even as the problem of concern is addressed at a currently dominant scale. While this assertion on the one hand states the obvious, it also opens the possibility for an adaptive model of scale shifts, where policy actors can engage and re-engage environmental problems at different scales as time passes. In other words, multiple scale jumps can happen in sequence, and in both directions; having constructed various layered scales related to an environmental problem, actors can choose to "try" a scale more than once as the problem's definition and context continue to evolve. On this view, the scale jump may be seen as less a tactic for achieving a goal or gaining advantage than an opportunity for reassessment and learning.

The individual and institutional actors most directly involved in the struggle over Big Bend haze were the policy staff in U.S., Texas, and Mexican regulatory and natural resource agencies; scientific staff affiliated with a closely overlapping set of agencies, as well as the energy utility industry and the academic sector; and to a less powerful extent, U.S. environmental NGOs and regional activists in west Texas. With the exception of the Mexican stakeholders, all of the above actors played a part in producing or reproducing the border scale of the haze phenomenon. Regulators at the Texas Commission for Environmental Quality (TCEQ) actively relied on the border scale as a strategy to deflect responsibility for regulating emissions related to the haze problem. On the other hand, U.S. visibility scientists and regulators eventually disengaged with the border scale and moved to the regional haze scale, an action with specific policy and political consequences. This chapter discusses the implications and consequences of both of these scale frames in detail, and then explores the concept of scale layering as a pragmatic framework pointing the way toward reassessment, action, and learning on complex environmental problems.

The border scale: conflating pollution, immigration, and invasion

As demonstrated in the previous chapter, the framing of Big Bend haze during most of the 1990s gravitated toward the border scale. This tendency originated from the regulatory

discourse of visibility pollution, which through the 1980s retained a legalistic emphasis on attributing individual source liability for pollution problems. However, the preliminary characterization of the haze phenomenon as primarily influenced by the Carbón I and II plants emerged during a specific historical moment, when U.S. politics at the national level were dominated by the NAFTA negotiations with Mexico and Canada. That historical moment in turn imparted a specific meaning to the border scale framing of this problem. Hill (2006), building on Douglas (1966), describes a powerful, media-driven discourse regarding the U.S.-Mexico border that exerted particular power in the early 1990s.

> In the early 1990s, the U.S.-Mexico border region acquired an environment–a polluted and threatening environment.
>
> During this time, there appeared in the media, in numerous policy and "gray literature' documents, in the parlance of activists, and increasingly in the everyday imaginings of Americans living both near and far from the boundary line something commonsensically called "the border environment." This commonsensicality achieved enough recurring believability that "the border environment" took on iconic status and intuitively came to index the predicted dangers inherent in the then-being-debated North American Free Trade Agreement (NAFTA). In fact, "the border environment" became one of the NAFTA critics' most potent weapons for galvanizing popular opposition to the treaty.
> …
> The environment at the center of projections of NAFTA's future was the far-distant environment of the U.S.-Mexico border region. Yet media coverage succeeded in making this threat seem immediate to the lives of Americans all over the nation, so much so that many Americans initially opposed NAFTA, reportedly for environmental reasons. I contend that the environment depicted in NAFTA media coverage was so alarming, even to Americans living far from the border, because this environment mimicked something already antipathetic and threatening to many Americans: Mexican immigration. Indeed, the implicit link drawn in media representations between immigration and the border environment not only enhanced what historians have shown is a traditional American stereotyping of Mexicans as dirty, unhygienic and self-soiling; it also made the prospects of uncontrolled immigration seem both naturally inevitable and consequently more threatening. By linking "dirty" immigrant Mexicans to a "dirty" border environment, the NAFTA-era media coverage of the U.S.-Mexico border not only reinforced existing stereotypes but also provided nativists with another seemingly natural reason to disparage and denigrate Mexicans. Furthermore, it stoked demands for greater immigration control, which in turn further fueled seemingly logical associations between immigration and environmental degradation (777–79).

This discourse had specific roots in Texas, where it was deployed as justification for the widespread disenfranchisement of Mexicans and Mexican-Americans in the 19th and early 20th centuries. Perpetrators of this often-violent disenfranchisement appealed to narratives of imperial expansion—popularized in rhetoric of the frontier and manifest destiny—that juxtaposed able, hardworking Anglos against lazy and incompetent Mexicans. The general story line claimed that Mexicans were inferior and therefore undeserving of the status and benefits accruing to their Anglo residents, including suffrage. The strategy most relevant here was a narrative of cleanliness and hygiene, which constructed the dualism of Anglo cleanliness versus Mexican filth. This narrative provided considerable impetus to the geographical segregations of Mexicans in both agricultural and urban settings (Montejano 1987).

Discourses of the Mexican-U.S. border environment predominant in the U.S. during the 1990s reduced trans-border environmental issues to two dimensional phenomena where the breaching of the border comprised the most salient aspect. Hill's analysis of press accounts and

gray literature found that "almost without exception, references to transboundary health problems in the late 1980s began, like immigrants, in Mexico and migrated with their ill effects to the U.S. side of the border" (Hill 2006, 778). The understanding of the haze as a border problem made it very easy to conflate the dynamic process of haze pollution with the quintessential border process of migration, primarily Mexican immigration. This conflated view characterized both immigration and haze pollution as unidirectional, invasive processes involving the movement of pollutants across the boundary from Mexico into the U.S. For example:

> The sulfury cloud comes from the smokestacks of two coal-fired electrical plants on the outskirts of Piedras Negras, and prevailing winds are carrying it straight across the border into Big Bend National Park, a wilderness area 100 miles to the northwest that is one of the most popular outdoor recreational sites in Texas (Robberson 1993).
>
> A curious sight has appeared recently in the stark desert landscape near Piedras Negras, Mexico: the towering smokestacks of a mammoth coal-burning plant called Carbon II. When finished, Carbon II will supply a big dose of Mexico's growing power needs and hundreds of jobs. But it will also create an unwelcome export: sulfur dioxide emissions, vastly exceeding U.S. standards, that will drift north of the border. Together Carbon II and Carbon I, built a few miles away in the 1980s, may spew 230,000 tons of sulfur dioxide per year. Much of it will head straight for Texas's Big Bend National Park, where National Park Service officials believe it could reduce visibility by as much as 60 percent (Robbins 1994).

As these excerpts show, the preliminary scientific conclusion that pollution carried from northern Coahuila to Big Bend via "prevailing winds" was the primary contributor to Big Bend haze was accepted and amplified to a portrayal of Mexican pollution headed "straight for" to the national park. In turn, the framing of Big Bend haze as an invasion of pollution from a dirty Mexico reinforced the tendency toward a localized scale.[1]

This portrayal was undoubtedly also amplified by the involvement of an isolated national park as the pollution "receptor." Wilderness preserves such as national parks are inherently exclusive, with their entire reason for being to guard what is inside (valuable natural or cultural spaces or artifacts) from what is outside (messy, urbanized, frenetic, polluted and polluting society) (Cronon 1996). But in setting up these preserves, as with any bounded space, the creators of national parks and other preserves set up the terms of interaction between these places and the "rest of the world." Large-scale environmental and socio-political phenomena that might be considered unremarkable in other contexts are susceptible to framing as border crossings or incursions.

The classification of Big Bend haze as a "border" problem was codified by the U.S. government in the handling of the issue through the U.S.-Mexico Border Environmental Program. The Big Bend haze problem, as framed in 1993, fell neatly into the U.S.-Mexico border program's geographical domain; the La Paz Agreement[2] defines the U.S.-Mexico border region as covering 100 kilometers, or 62.5 miles, on either side of the border. Thus it was logical to some extent the U.S. government chose to bring up the issue of Big Bend haze at one of the

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1. In geometrical terms the view of haze pollution–a highly complex atmospheric phenomenon–as a linear, unidirectional process could only be sustained by focusing on a relatively local scale; as with graphs of mathematical functions, the useful illusion of linearity can only be maintained by zooming in to a fine scale.

2. See http://www.epa.gov/border2012/docs/LaPazAgreement.pdf for a copy of the agreement; last accessed June 27, 2010.

Border Environmental Program's high-level consultations. The next section summarizes some of the consequences of the border scale frame for the Big Bend haze phenomenon.

Consequences of the border scale

The border scale framing of Big Bend haze first of all made that air pollution phenomenon relevant to a large population of stakeholders, resulting in perhaps the most attention given to any regional visibility problem. The news of the construction of Carbón II resonated with the concern over NAFTA to give Big Bend haze an extremely high level of interest at the national level. As seen above, the press, governments and NGOs directed this intense gaze within an atmosphere of alarm over the conflated issues of Mexican immigration and Mexican pollution. The causal story of the Piedras Negras plants causing visibility reductions in Big Bend took hold because it directly corresponded to this "national mood" (Stone 1989, 294).[3]

Self-interested actors were able to strategically utilize that causal story for their own purposes. For example, the Texas state government took several opportunities to explicitly blame the Piedras Negras power plants for the haze problem in Big Bend, most notably in their outright repudiation of the BRAVO study at the public meeting presenting the study results (interviews, EPA and Big Bend NP staff), but also in the text of their 2010 regional haze state implementation plan (Tresaugue 2009). However, representatives from TCEQ also played strong roles on the BRAVO Steering and Technical Committees, roles that enabled them not only to influence the study in substantive ways, but also to wordsmith the results to appear more favorable to Texas and less favorable to Mexico (interviews, BRAVO scientist, NGO representative).

The high level of attention devoted to this issue, filtered through the border scale frame, ultimately enabled U.S. federal agency staff to obtain budget resources to conduct the Preliminary Study and the BRAVO study. However, it also antagonized the government of Mexico, putting them on the defensive during a delicate negotiation over electric utility privatization centered on Carbón II. Taking a stereotypical defensive posture when under "attack" by the U.S., Mexican representatives used scientific and moral arguments to defend that country's sovereignty regarding operation of the Piedras Negras plants. Ultimately, the persistence of the border scale in the technical framing of the issue led the Mexicans to conclude that the BRAVO study was inherently unfair, and they opted out of the haze issue.

Big Bend haze science also closely tracked the border scale frame. I cannot assert any causal relationship here: I have found no evidence that any form of the "border environment" discourse to the early scientific and policy conclusion that Mexican emissions generally, or the Piedras Negras power plants in particular, were the primary contributors of Big Bend haze pollution. As explained in Chapter 2, the history of visibility science and policy, and the reliance in this specific instance on a flawed but defensible back trajectory analysis and an accurate but incomplete characterization of the prevailing winds blowing through the Río Grande Valley suffice to explain the border-scale scientific framing of the haze problem. Nevertheless, the science and the wider scalar discourse of this problem mutually reinforced one another remarkably well from 1993 until the initial reports of the Big Bend Air Quality Workgroup in 1996; there may be evidence here of the encompassing power of the "border environment" discourse.

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3. Though Stone's framework has been criticized for its failure to explain the mechanism that allows causal stories to persuade others (Social Learning Group 2001), in this case the causal story fits well with the idea of the discourse coalition (Hajer 1993). The causal story of Big Bend haze (pollutants from the Piedras Negras power plants crossing the border and causing the haze at the national park) fit into a broader national discourse on immigration and the Mexican border (Hill 2006), which in turn meshed comfortably with the exclusionary discourses characterizing both the wilderness protection movement and local environmental activism.

However, the institutionalization of the border scale via the U.S.-Mexico Border Environment Program also opened the possibility of consultation regarding the haze issue outside of formal diplomatic channels. As mentioned above, the goal-oriented U.S.-Mexico Border Environment Program was established in 1983. While the border program was far from perfect, it did create the opportunity–and the obligation–to undertake long-term joint efforts among the U.S. and Mexico.

> Perhaps the most important result of these interactions was to create personal contacts, familiarity with each other's problems, and new expectations, all of which began to build the new, close working relationship that exists today. 'The La Paz working groups meeting every six months created a new relationship,' [Cliff] Metzger [a foreign service officer at the U.S. embassy who worked on La Paz] reflected, which happened on the official side and also among the NGOs, starting in the late 1980s (Wirth 2000, 190).

The combination of high-level political attention with an on-the-ground staff highly knowledgeable of complex regional realities has enabled the deployment of attention and resources to the border region in service of both pragmatic and visionary priorities. The sister environmental agencies EPA and SEDESOL structured the joint environmental program in an explicitly adaptive fashion, with the structure and goals of the program renegotiated every 5 years.

The Border Environmental Program has generally not performed well in situations where U.S. and Mexican goals/policies have conflicted directly with one another; in the case of Big Bend haze, the National Coordinators meeting under the program served mainly as a forum for the two federal governments to make and deny accusations of culpability for the haze. However, the program did cultivate a cadre of rank-and-file government environmental staff in Washington, DC, Mexico City, and in regional offices in the border states with both detailed knowledge of local conditions along the border and extensive contacts with staff counterparts in both countries and in various border states and localities. It is unlikely that the U.S. would have been able to persuade Mexico to even consider participating in the Big Bend Preliminary Study or BRAVO if not for the continuous contact between scientists and other staff in the two countries.

The status of the Border Environmental Program as a non-regulatory effort is crucial here. While the program does frequently facilitate regulatory enforcement or compliance activities in the border region, it also sponsors individual projects and studies on a pragmatic and experimental basis, often with the simple objective of obtaining measurable emissions reductions. Additionally, the Border Environmental Program has consultations with border state and local governments, tribes, and non-governmental organizations built into its structure.

> When Annex IV [addressing emissions from copper smelters] was finally signed in 1987, it bore the stamp of ... NGO activity in the space and importance given to citizen monitoring, participation, and transparency. ... Thanks to La Paz and the opportunities it gave for networking among federal, state, and local officials and citizens' groups, the process of border diplomacy was changing from the old conventions, including the traditional Mexican preoccupation with sovereignty, into a cooperative mode (Wirth 2000, 190).

The U.S. and Mexican governments designed the program so that concerned environmental organizations and citizens had a fighting chance to have their voices heard through its various consultation mechanisms.[4] These mechanisms function to undermine the binary "incursion"

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4. This is even more true today than previously, as the latest incarnation of the Border Program ("Border 2012") strengthened the program's opportunities for citizen participation.

model of border pollution issues, as they attempt to place many stakeholders, on both sides of the border, on equal footing. Although neither this provision nor the informal consultation opportunities yielded any emissions reductions from the Piedras Negras plants during the course of the haze controversy, it is nevertheless important to note this pragmatic–and often productive–institutional incarnation of the border scale frame.

Implications of the regional haze scale frame

The regional haze scale frame carries its own set of meanings and implications. Those meanings have their roots in the disciplinary community of air pollution science and policymakers, those concerned with visibility pollution in particular. The most salient feature of this scale is its *comprehensiveness and robustness.* Unlike the border scale frame, the regional haze scale framing of Big Bend visibility pollution was complete and detailed in its portrayal of the widespread source regions contributing to the haze problem. With the huge expenditure of efforts and $7 million in spending for the Preliminary Study and BRAVO, the combined results of those two studies comprised the closest robust approximation that could be made of the complete "reality" of the haze phenomenon.

The price paid for this comprehensiveness was the wide dispersion of the Big Bend haze problem over space and time. This dispersion occurred at both the front and back ends of the scientific study of the problem. The modeling and assessment activities outlined in Malm (1992) and those undertaken by the Big Bend Air Quality Work Group for the Preliminary Study and BRAVO occurred for the most part in centers of calculation (Latour 1987) far removed from Texas and the isolated Big Bend region. The BRAVO technical leader was physically located at the Desert Research Institute in Las Vegas, Nevada. Many of the study's participants worked for the NPS air pollution unit based at Colorado State University, while others were located Brookhaven National Laboratory in New York and the Electric Power Research Institute (EPRI) in the San Francisco Bay area. The entire BRAVO effort was led by EPA staff in Dallas.

In terms of time, the BRAVO study took six years to complete rather than the originally planned three. This delay occurred for two reasons: First, the enormous amounts of data collected for the study required a large processing and quality assurance effort, which took much longer than study leaders had originally planned. Second, the collaborative aspect of the study, while largely fulfilling its purpose of gaining widespread buy-in from project stakeholders and also improving the quality and robustness of the study, required large investments of time to implement. As mentioned in Chapter 2, drafting the 18 page executive summary of the BRAVO final report took four months.

On the back end, the source regions subject to regulation for their contributions to regional haze affecting Big Bend covered a wide swath of territory, from east Texas to the Gulf states to the Ohio Valley. In addition, the jump of Big Bend haze to the regional haze framework situated the haze problem in a regulatory structure that relegated it to "secondary" status, ranked below the "primary" air quality standards meant to protect against human health threats. Accordingly, the timeframe for states to fulfill their regulatory obligations under the regional haze program was 60 years long, much longer than the attainment schedules for primary air pollutants. The politics of the regional haze program may extend the timeline even further, as state governments, utility companies and other interests have fiercely contested one aspect of the program after another.

The end result of this dispersal over space and time was the cementing of the Big Bend haze issue within the disciplinary domain of regulatory scientists and professional policy staff. This is not to say that those scientists and staff did not have a leading role in the issue prior to the scale shift. Rather, the construction of Big Bend haze at the border scale provided a small opening for other types of actors to participate in the policy discussion. Corresponding to an intuitive understanding of both liability-focused environmental politics (i.e., plume blight) and border area meteorology (southeasterly prevailing winds), and institutionalized within a Border Environmental Program framework that had at least a nominal role built in for NGO and citizen participation, the border scale allowed for at least some theoretical level of "public" involvement.

However, the regional haze framing situated Big Bend haze squarely within the purview of scientific and regulatory experts. The concept of "policy communities" is relevant here:

> Today each policy area is the domain of a professional group made up of a network of policy experts, entrepreneurs, administrators, researchers, and writers who specialize in the particular area, for example, health, welfare, environment, and transportation (Heclo 1978; Kingdon 1995). Aptly described as "hidden hierarchies," such policy communities have a disproportionate influence not only over the definitions of specific policy issues but over decisions regarding both the advisability and the feasibility of various solutions. Although such communities still have to sell their ideas to the political elites, it is not infrequent for the basic ideas that emerge from them to become public policy (Schneider and Ingram 1997). Indeed, in face of the escalating complexities of advanced technological societies, it is appropriate to assume that both the ideologies and practices of expertise will continue to expand, often at the expense of traditional elites and assuredly at the expense of the broader public (Fischer 2000, 22).

The regional haze framework was conceived and designed within the small policy community of visibility experts; for example, a scientist at NPS-CIRA in Colorado was credited by one interviewee as the author of the Regional Haze Rule. Furthermore, once the BRAVO study was finished, the only pathway for its findings to be turned to actions–with Mexico having closed the route of binational collaboration–was through the implementation of the Regional Haze Rule. Finally, the shift in scale away from the border corresponded to a translation of the issue into highly technical models and terminologies that were fully understood only by the small community of visibility science researchers, and subject to translation to lay terms primarily by "policy brokers" (Litfin 1994) in EPA and NPS. Although the BRAVO steering committee included representatives from environmental NGOs, one such NGO participant told me that many of the technical details of the study were outside of his area of expertise (interview, environmental NGO representative).

Not only did the regional haze policy community dominate the scaled up framing of Big Bend haze, it was they who performed the scale jump. Though the scale jump outward from the border was initially precipitated by Mexican participants in the Big Bend Air Quality Workgroup, it was legitimated in the domestic policy realm by the BRAVO technical team. This raises the broader question of which actors have the power to perform such scale shifts in the environmental policy realm. The status of Big Bend haze as an *externally defined* phenomenon– a subjective change in perceived visibility defined by the visibility policy community using standardized terms such as deciviews and standard visual range– is a crucial element of this ability. While the external gaze of policy makers and scientists does not imply a single scale of analysis, that external positionality or detachment does correspond to increased freedom to move across a range of scales.[5] Thus, if defining and addressing Big Bend haze at a given scale does

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5. Not all politicians, diplomats and agency staff dealing with Big Bend haze exhibited this scalar flexibility. Rather, it appears that many defined the problem exclusively in terms of the border/NAFTA scale, with the relevant actors being the nations of Mexico and the U.S., their industrial enterprises, and their executive branches of government, their interactions mediated by the barrier and space of the international border. When their efforts ceased to be relevant (i.e., NAFTA was approved and ratified, Mexico refused to give in to U.S. demands to mitigate the power plant sulfur dioxide emissions), those specific actors (politicians, diplomats, high-level agency appointees) did not change their approach to the haze problem, in terms of scale or any other factor. Rather, they simply dropped the issue back to the regulatory staff level, moving their own attention to other matters. As mentioned above, agency staff--primarily at EPA--then continued to address the issue *from within the evolving regional haze regulatory framework,* rather than as a pseudo-enforcement problem directed at the Río Escondido power plants. At this

not "work," scientists and policy makers have enough flexibility built into their positioning to allow them to shift the scaling of the problem.

Members of the visibility policy community could also count on their influence as experts in the political realm to give them the flexibility to scale the Big Bend haze to satisfy the scientific imperatives of comprehensiveness and accuracy. This community's decisive influence over political elites can be seen in both the acceptance of their recommendations by the Border Environmental Program's National Coordinators, and the vote of confidence shown by Congressman Henry Bonilla's multi-million dollar earmark for the BRAVO study. This last example also points to the necessary ability of a policy community to deploy material resources to defining and analyzing a problem.

Thus the shift from the border to the "regional" scale placed Big Bend haze squarely in the insular realm of technocratic environmental politics, driven by experts and with few opportunities for citizen or NGO influence. Whether or not we consider this technocratic dominance a necessary price to be paid for a comprehensive picture of the haze problem, my proposal is that we need not see it as an endpoint. In the following section, I propose a refinement of the scale jump concept that may point the way toward wider engagement with the Big Bend haze issue, as well as the possibility of concrete environmental improvements.

Theory- Scale layering, opportunity and adaptive policy

I propose that this project will contribute to the literature on the social (re)production of scale by elaborating on the notion of *layered scales*. The analysis in this chapter relies on the premise that when a scale jump occurs, "former" scale frames do not disappear, but rather continue to frame–or hold the possibility of framing–certain social phenomena. This assertion opens the possibility for an adaptive model of scale shifts, which enable actors to engage and re-engage environmental problems at different scales over time. In the present case, this means that scale jumps are not irrevocable; faced with multiple layered scales related to an environmental problem, a given set of actors can choose to "try" a scale more than once as the problem's definition and context continue to evolve.

This type of back-and-forth scale jumping can be deployed to overtly political ends, as in the Texas state government's repudiation of the BRAVO study because of Mexico's non-participation, and TCEQ's continued blame of Mexican pollution for Big Bend haze (Tresaugue 2009). This type of jockeying for advantage is a spatialized version of venue shopping for political advantage (Baumgartner, et al. 1993). However, I am interested here in a more pragmatic vision of this strategy: mobilizing layered scales to achieve concrete environmental improvements in parallel with scientific investigation and broader policy developments.

Using the present case study as an example, this vision might imply a reassessment of Big Bend haze not as a border problem, but *as a border project*. As noted above, the Border Program was founded as both a consultative discussion forum and a mechanism for funding and implementing specific environmental projects. In the years since Big Bend haze emerged as a major issue, staff-level relationships among U.S. and Mexican federal and state environmental agencies have continued to grow. For the current incarnation of the program, called "Border 2012," the various partners placed a strong emphasis on meaningful participation by NGO and public stakeholders. In addition, EPA and other institutions such as the North American Development Bank (NADBank) continue to make funds available through the Border Program for environmental projects of various types. Furthermore, budgetary pressures impel EPA specifically to demonstrate concrete "environmental results" (such as reduced air pollutant emissions) as justification for continued funding of border grant programs.

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time visibility science and scientists, whose influence at the height of the binational controversy was overshadowed by NAFTA politics, moved back into an active role.

I propose that this set of institutional characteristics presents an opportunity to "go back" to the border while taking advantage the comprehensive understanding provided by the BRAVO study. For example, the NPS/CIRA report on the BRAVO study results noted that "[t]he greatest individual contribution to haze is the Carbón I & II power plant in northern Mexico. Substantial changes in that facility's emissions would likely result in small but noticeable changes in haze levels on many days, but it would not make much difference to the worst haze episodes during late summer and early fall" (Schichtel, Gebhart, Barna, et al. 2004, E-15). With this result in mind, EPA Border Program staff might resume negotiating with the Mexican government and seeking funding for SO_2 scrubbers at Carbón I and II, while at the same time seeking opportunities to fund energy efficiency projects in Mexican border states, or to install solar and wind generating capacity near the Piedras Negras complex. While by no means assured of success, this type of strategy presents the possibility of achieving concrete results even as the Regional Haze program lumbers along its 60 year schedule.

It also opens the possibility of learning and adaptiveness. As with the "adaptive management" model developed in the natural resource management realm (Lee 1993; Gunderson and Holling 2002), individual projects can be seen as experiments to test or refine findings of larger-scale scientific studies. In the optimistic scenario developed here, visibility data from Big Bend obtained after obtaining sulfur emissions reductions from Carbón I and II could be productively compared to the BRAVO study results. Such information could also feed into the development and implementation of the Regional Haze program by EPA, state governments, and regional planning organizations. Conceptualizing the idea of adaptive environmental management within a spatial framework increases the potential flexibility of environmental governance, particularly for phenomena like air pollution that tend to ebb and flow across different spaces, scales, and boundaries. In such contexts, where regulatory mandates may be rendered irrelevant by jurisdictional limits, the pragmatic approach outlined here provides a possible avenue for environmental improvements.

The passage of time is a key consideration here; as a proposal for addressing environmental problems occurring at a very large spatial scales, this strategy must also contend with the extended time scales associated with those phenomena. We might consider this extended time scale to be a pragmatic advantage, as smaller-scale efforts can respond to changing circumstances. In the case of Big Bend haze, some factors have faded in importance since the early 90s, such as the xenophobic "border environment" discourse and the pending negotiation of a major and problematic bilateral trade agreement. Others have remained stable or grown more important, such as the professional relationships around the U.S.-Mexico border program, the inadequacy of Mexico's energy infrastructure, and the general public's awareness of large-scale air pollution and climate change issues.

This adaptive model has distinctive institutional characteristics as well. Knowledge, learning and action here do not reside in a fixed set of institutions. Rather, they accumulate in different institutions connected to distinct scales and their associated policy problems. This hierarchical, layered model of institutions implies a distribution of knowledge, skills, abilities, discourses, across different scales that can each potentially be brought to bear on a given problem. A problem can be constructed and re-constructed ("jumped") at different scales, where the associated institutions can address it. In the Big Bend haze example, the inability of regulatory institutions within EPA and TCEQ to make headway on the problem can be remedied–albeit partially and imperfectly–by addressing the problem in a piecemeal fashion through the multi-stakeholder Border Program. An unfortunate possibility inherent in this institutional diversity is that there is no obvious repository for knowledge and learning gained at different scales. In the absence of such a repository, this layered-scale approach might comprise not so much an adaptive strategy as a capitulation to "muddling through" with inadequate policy information (Lindblom 1959).

Nevertheless, the approach is attractive in the present case because it expands the prospect of democratic participation in environmental governance. Rather than ceding Big Bend

haze exclusively to the technocratic policy apparatus, stakeholders in this scenario have the possibility of exerting real influence on the issue, and perhaps of achieving concrete environmental improvements, even in the absence of strong domestic regulatory action. In particular, activists and NGOs within Texas, in the border region, or locally in the Big Bend might be able to make their voices heard by working to "re-activate" the haze issue at the border scale.

Conclusion

In this chapter, I envisioned a pragmatic model of scalar environmental politics, with interested actors moving up and down a concentric hierarchy of scalar frames not only for political advantage, but potentially with the goals of concrete environmental improvement, scientific and policy learning, and perhaps most important, increased possibilities for democratic participation. While this model holds promise as a strategy to bypass political, diplomatic, or regulatory paralysis, it is also a top-down framework that accepts as given the hierarchical policy structure imposed on environmental issues by U.S. and Mexican legal structures. Chapter 5 examines the emergence of air quality activism within the Big Bend region as a jumping off point to consider alternate strategies for scaling up environmental politics outside of this hierarchical structure.

CHAPTER 4
NOT IN OUR SCENIC BACKYARD
SCALE AND AIR QUALITY ACTIVISM IN THE BIG BEND

Introduction

This chapter, once again through the lens of spatial scale, examines the emergence of Big Bend air quality activism as an expression of multiple discourses active among the region's inhabitants, including isolation and exclusion; cleanliness and purity; and tradition and authenticity. Local activists imposed a rigid scalar framing upon the Big Bend area that resulted in air pollution being constructed as an unacceptable breach of protective boundaries. While activist efforts in this "not in my backyard" (NIMBY) framework resonated with the community and achieved some early successes, the framework was ill-suited for addressing haze pollution or other air pollution problems occurring at regional and global scales. Nevertheless, this community of activists has succeeded in shaping local conversations regarding environmental protection, economic development, and envisioning a future for the region in ways that might enable the transcendence of current rigid scalar frameworks in the future. The following sections contain additional details on the Big Bend region's resident population, followed by an empirical summary of Big Bend air quality activism from 1995-2005. The chapter concludes with an analysis of the scalar construction of the region by local activists, and a discussion of how a more relational scale framing might enhance activists' capacity to confront regional haze and other large-scale problems.

Context: The Social Construction of the Big Bend Region

The research informing this paper is geographically anchored in Big Bend National Park and the surrounding Texas counties of Brewster and Presidio. (See Figure 1 in Chapter 1.) Both of these jurisdictions are sparsely populated. With an estimated population of 9,247 in 2003, Brewster County (where Big Bend National Park is located) has a population density of about 0.6 persons per square kilometer; its largest town is Alpine, pop. 6,800. Presidio County, with a total population of 7,591, has a density of about 0.8 persons per square kilometer. The regional population is dominated by Anglo Americans and Mexicans; the Census Bureau reports approximately 43 percent of residents in Brewster County and 84 percent in Presidio County to be of Hispanic origin, with most of the remainder classified as "non-Hispanic whites" (U.S. Census Bureau 2005).

Though ranching continues to be a dominant cultural force, the Brewster County economy is now primarily based on government–including the U.S. Border Patrol, Sul Ross State University, and other state and local agencies, all based in Alpine and Marfa–and tourism. The national park and other protected areas provide the main tourist draw, but the towns in Brewster County have also developed their own attractions, marketing themselves as arts centers, resorts, and retirement havens. The same is true of the town of Marfa in Presidio County (pop. 2121) which is undergoing a rapid transformation from declining farm town to elite arts center.

Much of Presidio County's remaining population resides in the city of Presidio (pop. 4,555), located at the international border (U.S. Census Bureau 2005). The city of Ojinaga, Chihuahua, located just across the border from Presidio, has an estimated population of 20,371 (INEGI 2000). The near-border region surrounding Presidio and Ojinaga is known by the distinct name of La Junta de los Ríos, or the joining of the rivers. The name refers to the joining of the Río Grande/Bravo and the Río Conchos, both flowing northward from Mexico, a short

distance upstream from Presidio-Ojinaga (Morgenthaler 2004). The benefits of tourism have largely bypassed La Junta, a struggling agricultural area and quiet port of entry which is not considered a destination.

The Big Bend can be plausibly understood as peripheral hinterlands relative to the various urban centers in both the U.S. and Mexico.[1] This framing is incorporated into localized constructions of regional identity. Sometimes these constructions are negative, portraying the borderlands experience as a form of exile or hardship.[2] However, the more publicized interpretations of Big Bend as periphery, most originating in Texas or the U.S. more broadly, portray the region in a more positive light. In the Big Bend, the dominant cultural forces are ranching (in northern Brewster and Presidio Counties) and farming (around La Junta De Los Ríos). The rancher's framing of the hinterland understands space and nature as vital inputs to production, subject to careful stewardship by private owners. At the same time, nature is regarded in the ranching imaginary as a formidable, sometimes adversarial force to be dealt with cautiously and respectfully. These framings of nature (along with the historic availability of numerous, inexpensive Mexican laborers) contributed to and supported the myth of ranchers as strong, self-reliant tamers of nature (Knight, Gilgert and Marston 2002; Starrs 1998).

The peripheral Big Bend also became known in the 20th century as a refuge or retreat. For example, the "ghost town" of Terlingua in Brewster County has a longstanding reputation as a haven for eccentrics who have declared for one reason or another, "stop the world; I want to get off" (interview, 2003). These predominantly white refugees greatly value their perceived isolation from the wider American society. Many make their living as business operators, artists, or service providers for tourists. Typical of the region's popular image, one press account considers these "rugged individualists" to be the people "who make the Trans Pecos and the Big Bend so appealing" (Patoski 2005). Space and nature from these retreatants' perspective serve primarily as a buffer providing separation from the wider urban society, and as a source of inspiration derived from the spectacular and clean landscape and natural environment.

This discourse of the Big Bend region as a retreat may also have reinforced the idea that air pollution was a phenomenon that could be in some way blocked or prevented from entering the region. From the discussion of visibility pollution regulation above, this proved to be a particularly problematic assumption for the phenomenon of regional haze. According to one regulatory agency staff member:

> [W]e've had a number of public meetings out there since 1998, and I think, when I first went out in 1998 for a public meeting, I think the perception was, this is my opinion, a lot of people thought that they had escaped from civilization, and in fact, as we told them at a couple of our last public meetings, you're not so much, haven't so much escaped, but you're sort of in a donut hole, in a way. You're kind of in a, in kind of an eddy. Around

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1. The term "periphery" is used here in a generic sense. While it may be productive to fit the Big Bend into the core-periphery framework of dependency theory or world systems theory, that framework is not crucial to the arguments in this chapter.

2. One interviewee claimed that the post of Mexican consul in the border town of Presidio, Texas, is officially designated a hardship post. In the wake of the September 11, 2001 terrorist attacks, informal border crossings between Big Bend National Park and the Mexican villages of Santa Elena and Boquillas were halted by the U.S. Border Patrol in the name of border security (Lisheron 2003). This suppression of cross-border activity, the main source of income for these communities from services and entertainment provided to tourists, effectively cut them off from the United States. With little access to jobs or services on the Mexican side, except by difficult roads through the mountainous Sierra del Carmen, Boquillas and Santa Elena have suffered enormously from this exile, losing large portions of their population.

> you to the north, and around you to the south, there are huge sources, there are big pollution sources. So, you can't, we can't exclude ourselves from all this. You happen to be in a remote area, but it's not free from the influences of all these places (interview, EPA staff).

The Big Bend also has a related identity as a sanatorium or therapeutic landscape (Dunsby 2004); literal healing attributed to a beautiful landscape and pristine environment also are also frequently touted by area residents.[3] The town of Alpine is home to a significant and growing population of retirees and other recent arrivals from other parts of the U.S.; significant numbers of those retirees chose to move to Alpine primarily for health reasons. The air quality in this region is considered superior to most other parts of the country, such that people with respiratory conditions can live comfortably, in some cases without the face masks they need in other circumstances.

Other recent arrivals are strongly attracted to what they see as one of the last pristine natural zones in the continental U.S. One interviewee, self-identified as an environmentalist, mentioned that when asked why he had moved to the Alpine area, he replies, "It's the only place where…the sky is the right color" (interview, local activist). Indeed, regional identification with the supposedly pristine Big Bend natural environment provided the basis for many newcomers to take on new roles as environmental advocates.

These constructions of the Big Bend as a pristine environment are tightly coupled with an aesthetic sense of landscape and more precisely, the visibility and appearance of that landscape. As with many western landscapes in the U.S., much of the Big Bend landscape's perceived value corresponds to its immensity, clarity, and perceived cleanliness. Indeed, this cleanliness corresponds as much to what cannot be seen as to what can be seen. What cannot be easily seen in the Big Bend landscape are cities or other glaring indications of human presence or influence. What can be seen are countless miles of open, apparently unoccupied land punctuated with rolling hills and distant mountains. On a clear day, as the saying goes, you can see forever.

A Very Big Backyard: Overlapping Community, Urban, and Regional Scales

It is worth noting here that the stretched concept of the local within the Big Bend region. Smith (1992) proposes a typology of scales–ranging from the body to the global–as normalized by social and political practices. For the present purpose, the community, urban, and regional scales are most relevant. Working down from the broader to the typically narrower, we will start with regional spaces, which Smith defines in economic and occupational terms: "regional identity is constructed disproportionately around the kinds of work performed there" (73). This definition is recognizable in the implicit definition of the Big Bend region as the collection of west Texas places where tourism plays a dominant role. Smith goes on to make the following observation:

> Regional political movements may be highly defensive, combating some perceived external invasion. This would apply to some antideindustrialization coalitions of recent years which identified external capital or foreign nations as the villain, but it also describes some emerging environmental and antigrowth coalitions. ... At worst, regionalism can give vent to racism and other forms of localism generated at lower spatial scales (73).

Regional politics, then, can also tend toward rigid localism (see also Escobar 2001).

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3. The notion of nature as a healer dates back to the 18th century. See Schmitt 1990. For a discussion of southern California in a similar vein, see Dunsby 2004.

Regarding urban space, Smith claims that "The urban represents the daily sphere of the labor market" (Smith 1992, 71). He further proposes that "The spatial extent of the urban scale is demarcated much more acutely by the field over which a daily journey to work is feasible" (Smith 1992, 72). Again, this formulation maps well on to the space and scale of the greater Big Bend, where residents commonly commute 30 miles or more between towns to work or access services. Finally, political movements at the community scale–at least when a community is geographically defined–can also tend toward the defensive and constrained by localized space. Smith quotes Harvey's (1989) contention that community movements "are...generally better at organizing in and dominating place than they are at commanding space" (236).

For the purposes of this analysis, I suggest that the community, urban and regional scales in the Big Bend describe the same geographical space: that of the scenic areas of the national park and its gateway communities. This stretched concept of the local/community/urban to match the regional scale is reflected not only in long commuting distances, but in the character of local institutions. Many regional institutions span several individual towns in terms of both membership and influence. For example, the Big Bend Regional Sierra Club, while based in Alpine, had members from Marfa and Terlingua, and routinely dealt with air quality and other issues in Big Bend National Park. I also propose that this overlap among the community, labor and regional scales could reinforce local activists' inclination–discussed below–to define a rigid, defensive boundary around the greater Big Bend region when threatened by pollution. In effect, it sets the stage for a "not in my *very big* backyard" phenomenon.

Big Bend Air Quality Activism

Big Bend air quality activism emerged via a pair of major Downsian mobilizations (Baumgartner, et al. 1993; Downs 1972) in 1995 and 2003. The first mobilization was a response to visibility pollution in the region. Local resident concerns regarding haze pollution lagged tourist and regulatory agency interest in haze within Big Bend National Park by a few years. This lag may be attributable to the contingency of one of the Big Bend Regional Sierra Club's founding members not arriving in the Alpine area until 1994-95. This person attributed their impulse to action not to a strong concern about visibility in the national park, but to the personal experience of visibility impairment in the neighborhood of their new ranchette home.[4]

> The source that we believed was polluting out here when we came out here and was believed before we came out here, we came out here in August 94, moved into this house out here in November of 95. But the notion was, it was the Carbón plant, in Mexico, just out of Piedras Negras, which is just across the border from Eagle Pass, Texas, which is a ways from here. And I don't remember when Carbón I, which is the name of the first plant, went on line, but it had been online a long time. I can't prove it, because I can't ever pin anyone down exactly when Carbón II went fully online, but my belief was it was the middle of August of 95, because we had started building the house out here in the spring, and didn't particularly notice haze or anything, and dramatically one day, the pollution was coming in, and it shocked us. We'd moved out here thinking we were coming out to a really clean area, and had been told it was. So that was really shocking (interview, local activist).

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4. Within the Big Bend, spurred by the decline in ranching and mining, community leaders across the ideological spectrum relied on the wilderness ideal to transform the regional economy, now strongly supported by tourism and leisure activities (Gómez 1990). Local environmentalists are also strong advocates of the local tourism economy. Indeed, it was this economic development path, especially the redevelopment of failed ranches into inexpensive home lots, which paved the way for many residents who became activist leaders to relocate to the Big Bend during the 1990s. In a very real sense, tourism brought environmentalism to the Big Bend.

This particular interviewee had moved with her husband from Austin, roughly ten years before the date of our first interview. The theme of a supposedly clean area now soiled was echoed by other interviewees.

> I've lived in this region for about seven years now, but my family history goes back a lot further. My grandfather taught school in this area in the 1920s to the 1940s including the San Vicente, which is now the school district for the Big Bend National Park employees' kids to go to. So I'd say I don't remember the first time I ever came to this region and have loved it my whole life. My grandfather had a picture that was actually, it was taken by [name removed] who owns Hot Springs down in the park. It's a picture from… I can go and stand exactly where it was taken from under the palm trees on the river looking up at El Pico. It's a picture, it was a hand-tinted picture, so the river is bluer than it ought to be, but he was all, you know, he would always talk about how clear the sky was and that was part of his remembrances of working there when he, he actually just taught in San Vicente for one year, but I've been to the place where he lived, and he has a view one way of El Pico and the other way of Chisos Mountains, you know, it's beautiful a place to live. So, I've always had a, you know, a love for this region and part of that has sort of always been tied in with the idea of air quality and being able to see so far and the sparkle in the sky.
>
> ...
>
> I remember coming out here in 1993, which is the year that Carbon I and II opened outside of Piedras Negras, the Carbon plants. It is the first time that I had been out here in the, I came in spring break time and it's the first time I had been here not, I've been here a lot in the winter just because that, you know, over Christmas, Thanksgiving kind of timeframe because you have time, you know, I was coming by long distance, and this time I had come in and I remember my wife asking, you know, saying the air just doesn't look right, you know, it's dirty, why is, I mean I remember asking a park ranger that at the Panther Junction station, you know. Then when we moved out here, you know, and sort of, you know, joined up with the Sierra Club here, I wasn't a founding member of the Sierra Club, I came here about a year after it got started but, you know, when the air is bad out here, it's, you know, I mean it's just amazing, you know. You can't, you know, … you can't see Twin Peaks, you know. I remember going to a thing at ... Rio Grande Village and the air was so polluted that you couldn't see El Pico from there, which is probably, you know, maybe six miles or something…you know, and it just breaks your heart, you know. I mean if you have a sense of what it's supposed to be like here, you know, you're supposed to be able to go up on the South Rim and see the Davis Mountains, you know. I don't know anybody who's been able to do that for 15 or 20 years, you know, but I used to be, you counted on that, that was the way it was supposed to be, you know. If you climb up Mt. Livermore and the Davis Mountains you know, you can see the entire Trans-Pecos, Guadalupe and the Chisos. I've been up there about six times. I've seen Guadalupe once, but I've never seen the Chisos, you know, but that's what people say, you know, it's what you got "ought to be able to see" (interview, local activist).

This was a continuing explicit or implicit theme in interviews with local activists and residents: what you ought to be able to see, the way it was supposed to be, and outrage or sadness that things had now changed.

Haze in the park became the founding issue for the newly formed Big Bend Regional Sierra Club (BBRSC) chapter, based in Alpine. One of the founding members described its genesis as follows:

> At any rate, we met here and there were 8 people that met, and that was a little disheartening, it was so few, and the state office [of the Sierra Club] sent a staff person out. And at a crucial time, we ask, well what should we do, should we go forward. And I can remember a woman sitting over there, [name removed] is her name, she says, we have to do something. And so we formed the Big Bend Regional Sierra Club. We have a hundred and thirty one members now out of that area, which may not sound like a lot to you, coming from a large city, but … given the population pool here, it's not bad (interview, local activist).

As residents organized into an activist community, their main role with regard to Big Bend haze was as gadfly to the EPA, Park Service and other government agencies, dutifully awaiting the results of the BRAVO and pressing the agencies for progress reports at every opportunity. In this way their role more resembled dissatisfied customers of the agencies rather than activists per se, impatiently waiting for the agencies' promised services (i.e., the BRAVO study and presumed actions afterwards) while also deferring to agency scientists and staff as the experts who must be relied upon to perform those services.

BBRSC members kept closely in touch with EPA and Big Bend National Park staff, as well as NGO allies at Environmental Defense and the Texas Center for Policy Studies, as the Big Bend Preliminary Study and the BRAVO Study developed over the years. They also spearheaded and publicized two public meetings during the BRAVO process that were attended by high-level state and federal officials.

> Finally, and in fact, to give you an example of the problem, before the TNRCC came out here twice, once in, gosh, it must have been the fall of 98, because it was before the BRAVO study, and held a public meeting. It wasn't a… "hearing" has a more formal legal definition. But they were just overcome, all of them, at the turnout for it. We managed to get, fill the room, pack it in, people that couldn't get in. I was overcome myself at how many people came out for that. And they heard the enormous concern, and so forth, of it. And so, they have that evidence that there was real community concern out here. And for some of them it was their first trip out here to be in the Big Bend. Anyway, they came out the second time, later, and I must confess I've kind of lost when it was. I think it was around April, no, around the fall of 2002. But I'd have to look back in notes to know precisely if that's true. Gregg Cooke, who'd been an appointment of the Clinton administration, was head of Region 6 at the EPA…he stood out in, you know, a good room, to another crowd, … and said you can count on us, this will not be put on the shelf (interview, local activist).

BBRSC members also wrote about the haze issue for a general audience, both in the local press and in regional newsletters (e.g Sage 2000.,). Their close scrutiny of the BRAVO study continued through the release of the study results in fall 2004.

EPA, the National Park Service and TCEQ scheduled a final public meeting in Alpine on September 22, which was, again, very well attended. At that meeting, TCEQ all but repudiated the just-finalized study. According to the then-superintendent of Big Bend National Park:

> I was very disappointed at TCEQ's response right before the BRAVO study was released, as a matter of fact the day before the study, or two or three days after the study was released, but the day before a public meeting was held in Alpine, TCEQ issued a letter basically questioning the integrity of the study and challenging the validity of the findings, and the, even though they were a participant in the study. And the reason that they cited was essentially that because Mexico had not participated, they thought that it called into question the, validity of the information, of the data that was collected and the conclusions that were reached. And so it was very apparent in reading that letter that they

> intend to do little, if anything, from this point forward. And they also went on in that letter to talk about some of the really good things that they've already done to reduce pollution in the state of Texas and how they've worked effectively on various fronts, but it was disappointing to see that the ink was not dry on the page and they were immediately starting to distance themselves from the study (interview).

A TCEQ representative read the letter out loud at the September 22 public meeting, provoking an outraged response from many attendees.

> On Monday [September 20] they sent out a letter from the chairman of the [TCEQ], Kathleen White, and we didn't see it until, they sent it to EPA, and the National Park Service. And it was a very critical letter, even though it was couched as though it, was, I guess it damned with faint praise. They had said wait for the science, and then they had problems for the science, and she said, it's flawed because Mexico didn't take place in it, and I thought, well, hey, you've known that for 5 years. Is it news? And then she said, which she thought seriously flawed it. And then she thought it was qualified, even though all the signers had said they thought that it was a creditable study and they stood by it. And she said, we might get some use out of certain kinds of data, which we can use as we continue, and the, oh it was enraging. It was a very patronizing letter, in which she sent some poor man to read to us all there. And it just set off an explosion. Our [state representative] Pete Gallego was very candid, which, he's usually not, puts himself on the line that much. But he did, at some length, criticizing them. And I criticized them harshly, which maybe was an indulgence, because I don't usually do that in public. But, and then person after person got up. [The representative from Environmental Defense] asked the man from the National Park Service, which I knew was a little bit of a risky question, the scientist who had presented that part of the material, he said, do you think it would have made any significant difference in the results if Mexico had been part of it. The man says, well this is just speculation you know, and, you know, there would be some differences but after he qualified everything enough so he felt like he could say it, he said, I don't think there would have been any significant differences, which was [the ED representative's] way of getting on record, and in the papers, that her position wasn't going to cut it as far as the science went. So that's where it is right now. A study that it isn't clear who's going to do what (interview, local activist).

Despite this local outrage and the mild technical rebuke of TCEQ's position from the NPS representative, the BRAVO results were finally placed on a shelf. Indeed, even the public response from Big Bend National Park management, which had been vocal in drawing public and government attention to the haze problem, turned out to be rather muted. A planned letter to TCEQ from park management was not sent, and even a joint effort between the BBRSC and the park to distribute fact sheets about the BRAVO results to park visitors was scrapped. Though EPA publicized the BRAVO results, they did so with little fanfare or stated next steps. This muted federal response was undoubtedly partly due to the still-uncertain regulatory climate regarding regional haze issues in 2004, as well as to the distinct policies and priorities of the second Bush Administration.[5]

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5. In 2001, as part of its Clear Skies legislative initiative, the Bush administration proposed eliminating the regional haze rule. Clear Skies failed to achieve passage in Congress, but in 2004 the administration proposed delaying its BART requirements for 10 years, until 2018 (Samuelsohn 2004). Perhaps because of this uncertain and dynamic regulatory environment, debate over Big Bend visibility issues seems to have occurred in a political context rather than a regulatory one.

Of the several groups concerned with air quality that emerged in the Big Bend after 1995, the Big Bend Regional Sierra Club chapter was the most explicitly environmentalist organization, founding itself on the issue of air quality but soon branching into water issues, landscape integrity, as well as policy concerns such as EPA's new source review rules for air quality permits (interview, local activist). As typical of mainstream environmentalists, communications and activities of the BBRSC typically reflected and utilized existing environmental policy and political structures.

Several factors made it difficult for BBRSC members to exert influence over the Big Bend haze issue. First, this group's decision to identify as mainstream environmentalists, incorporating their group as a regional branch of the Sierra Club, committed them to a specific approach to addressing environmental problems, as part of the technocratic policy process (Fischer 2000). The Sierra Club and other established mainstream environmental NGOs had, since the founding of the EPA in 1970, implemented a model of influencing environmental decisions as a knowledgable political stakeholder, through legislative, regulatory, and judicial processes (Gottlieb 1993). The Club thus bought into the environmental policy apparatus and committed its membership to solving environmental problems through that government structure. In the case of Big Bend haze, this meant waiting for EPA and its partners to painstakingly characterize the problem through the Preliminary Study and BRAVO.[6]

Second, given the scaling up of Big Bend haze to a large-scale scientific and policy problem, local activists were ill equipped to directly engage with the processes to address it. None of the activists had specialized environmental science expertise, and given their geographical isolation, they were not able to "be present" in a sustained way as the various scientific studies took shape in scattered and distant laboratory and bureaucratic sites.

The scale jumping concept (Smith 1992; Judd 1998) suggests a strategic attempt by powerful actors to contain or move an issue beyond the reach of a localized movement. There is no evidence of such an intentional move in the present case; EPA and other government agencies and their staff did ultimately jump the scale of the Big Bend haze from the border to the regional level, but they did so only when the Mexican government, followed by inconsistencies in scientific modeling, pushed them in that direction. Nevertheless, the effect was the same; this scale jump effectively moved the possibility of meaningful policy engagement with the haze issue out of the reach of local Big Bend activists.

The U.S. Clay controversy

Meanwhile, on May 8, 2003, a routine notice appeared in the local newspaper that the Texas Commission on Environmental Quality, or TCEQ, was considering a permit request from a firm called U.S. Clay for a new rock crushing plant on the outskirts of Alpine. The plant was to be a processing facility for a clay called bentonite, used in applications such as lubrication for oil well drilling and as a base for facial makeup. Raw materials would be transported from mines in southern Brewster County by truck, where the rocks would be pulverized and loaded on to trucks and/or rail cars for shipping. As Alpine residents demanded more details on the plant in the weeks after the permit notice appeared, U.S. Clay representatives claimed that the plant would bring 20 jobs to the area.

Three individuals–as it happened, active members of the regional Republican, Democratic, and Green Parties–quickly spearheaded a letter writing campaign to express community opposition to the plant within the allotted 30-day comment period. The campaign resonated quite well within the town of Alpine, with 247 letters submitted in opposition to the plant (press packet, Ad Hoc Clean Air Group). Having succeeded in galvanizing community

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6. Though the activists' affiliate/proxy–a representative from the Austin chapter of Environmental Defense–participated on the BRAVO technical committee, that position did not come with any particular influence. Indeed, that representative proved to be at a disadvantage because of his lack of specialized visibility science expertise (interview, NGO representative.

opposition, leaders of the newly-christened Ad Hoc Clean Air Group, later renamed the Big Bend Air Quality Group (BBAQG), organized themselves into a more formalized structure, with regular meetings, bylaws, and so on. Several Big Bend Regional Sierra Club leaders joined this effort.

Contrasting with the overt, mainstream environmentalism of the BBRSC, the Big Bend Air Quality Group was a single-issue group focused on the proposed U.S. Clay rock crushing plant, with a much wider range of ideologies and leadership styles. While highly concerned about air quality, BBAQG members framed their concerns in terms of economy and health, more so than the intrinsic value of the environment or landscape. Their tactics were much more confrontational, though still rooted in existing hierarchical regulatory and judicial structures.[7]

Alpine activists heavily emphasized the possibility of direct, first-order health effects from particle pollution in their efforts to prevent the rock crushing plant from getting built. They did this using two different lines of argument. First, activists argued that fine particulates–2.5 microns or smaller in diameter–could pose a danger to Alpine residents that was not being considered/given sufficient weight by TCEQ in the permitting process.[8]

Even more interesting, activists pointed out that this relatively prosperous rural county was home to a vulnerable population of its own, though not one that could be identified by racial or economic characteristics. Rather, this vulnerable group was notable for a shared physical disability: major respiratory ailments.[9] Alpine activists emphatically claimed that as described above, many locals had chosen to live in the Big Bend region because of its relatively pristine air quality. Those residents, activists argued, were particularly vulnerable to health impacts from particle pollution, and therefore deserved heightened levels of protection from pollution sources.

A press packet supplied by activist leaders (dated August 13, 2003) summarized the "lines of opposition" to the plant in this way:

> The following are subjects that we've identified as being affected by a rock crushing facility that will emit extremely fine particulate matter and known gaseous pollutants less than 5 miles from Alpine's city limits.
>
> Breathing Impaired/Chemically Sensitive – An informal survey of local physicians reveals as many as 500 persons locally are affected by asthma, emphysema and COPD [chronic obstructive pulmonary disease]. (Alpine's population is 5,687; Brewster County 8,000+.) This translates to as much as 8% of the local population, and doesn't count folks who receive treatment outside the area. The Big Bend Region is currently one of the last areas of the country where severely chemically sensitive and breathing impaired

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7. The BBAQG's tactics mirror a similar effort in the west Texas village of Sierra Blanca, whose residents spearheaded a strong grassroots effort from 1991-98 to prevent the siting of a low-level radioactive waste disposal facility in town (Betancourt 1998; Blakeslee 1998; Loftis 1998).

8. On this topic, the activists were ahead of their time; at the recommendation of its independent scientific advisers, US EPA promulgated air quality standards for fine particulates in 2006 (71 FR 61144). This argument is a good example of "citizen science" (Fischer 2000) practiced in the service of environmental activism.

9. I did not attempt to systematically count or characterize this population as part of this project. However, one interviewee told me that before relocating to Alpine from an urban area, he need to wear a face mask to walk outside. As described below, another pair of interviewees had conducted an informal survey of area medical professionals that they used to bolster their argument of a significant local population with chronic respiratory problems.

folks can live a relatively decent life. The particulate emissions from the proposed U.S. Clay facility will be the very smallest particles which escape the plant's filtering mechanisms, and will be extremely harmful over the long term to any human or animal that ingests them in their lungs. For persons who already suffer from pulmonary deficiencies, the added strain could literally be a killer.

Second, the packet claims that the facility's particulate emissions will also cause harm to Brewster County's elderly residents–with their compromised immune systems–and students at Sul Ross State University in Alpine. Third, it argues that the plant's operational schedule will require 35 to 40 truckloads of bentonite per day, trucks that would travel on the region's main north-south highway and through the City of Alpine; this truck traffic would emit additional air pollution and also contribute to automobile accidents by leaking bentonite on to roadways, which would become slick in wet conditions. Finally, it would directly hurt the area's economic development efforts:

> Economic Development/Tourism Impact – Alpine is not an industrial town. It never has been. Allowing one heavy industry to establish itself here will doubtless draw others, fundamentally changing Brewster County's economic base (and ecology) for the worse.
>
> Our environment is our economy. Tourism, art, cattle ranching, retirees, university faculty, staff and students, Government employees, and breathing impaired big-city "refugees" seeking clean air–these are the bases of the economy in Alpine and the surrounding area. Each of these sectors relies on a clean, healthy environment to flourish. It is clear that a rock crushing plant is inappropriate development for this area.
>
> The Big Bend region is one of the last truly wild areas in the United States. It comprises unique and fragile ecosystems and a majestic and peaceful grandeur that attracts tourists from across the nation and the globe. Visibility in Big Bend National Park, our region's staple tourist attraction, dropped to as low as 4 miles during spring 2003. Any additional emissions such as the ones U.S. Clay propose (sic) will only exacerbate pollution already in our region's skies.
>
> The preliminary results of the BRAVO study show that a majority of this region's pollution drifts in from East Texas and the Midwestern US – sources we can hardly control. Additionally, hazier skies will complicate the development of two of Brewster County's most plentiful resources – sun and wind. This region is a natural for alternative energy development sites. Introducing last century's smokestack economy here at present doesn't make sense for a county poised to move forward with a mainly ecologically driven economy.

The Ad Hoc Air Quality Group was explicitly goal-oriented, and its members prided themselves on their ideological diversity. The press packet contains the following narrative under the heading of "History":

> Alpine's Ad Hoc Air Quality Group was formed in early May of 2003 in response to U.S. Clay, L.P.'s application to TCEQ for Air Quality Permit No. 54973. We don't have any formal structure or hierarchy, preferring to invest our energy in actively opposing the application and researching and disseminating to the citizens of the Big Bend Region information concerning the proposed U.S. Clay (USC) facility. Our group includes current or former chairs of the West of the Pecos Republican Women's Club, Big Bend Democratic Women, and Big Bend Green Parties, as well as principals of the Big Bend

> Regional Sierra Club and the Bi-National Chihuahuan Desert Big Bend Clean Air Alliance, Inc.
>
> …
>
> Our initial goal was to generate as many letters as possible to TCEQ opposing the U.S. Clay permit application and asking for a contested case hearing in the original 30-day comment period, while we simultaneously collected information about U.S. Clay and learned about the permitting process.
>
> In response to citizen concerns Brewster County Judge Val Beard invited U.S. Clay representatives to a County Commissioner's meeting to speak with local residents about their plans. The meeting was very well attended and yielded a number of fields of inquiry. Following up the leads from the meeting revealed that U.S. Clay has been "conveniently accurate" concerning most of their assertions. As more and more discrepancies between U.S. Clay's claims and our research became apparent, we disseminated our findings to Alpine and the region through radio ads, regular press releases, flyers and word of mouth. TCEQ recently confirmed that they've received 247 letters regarding the mineral crushing facility, including letters from around the Big Bend Region and from a unanimous Alpine City Council opposing the plant.

Many public comments cited these instances of apparently missing or inconsistent claims by U.S. Clay, as well as anecdotal evidence of that company's practices in other locations, to support their opposition to the proposed facility.

On August 14, 2003, at the request of state representative Pete Gallego, TCEQ held a formal public hearing in Alpine to discuss the proposed permit. The meeting was attended by TCEQ officials, U.S. Clay representatives, and numerous local residents. TCEQ records show that a combined 350 comments (written and verbal) were made at the meeting and during its associated comment period, which ended on October 27, 2003.

Subsequently, on April 29, 2004, TCEQ issued a decision that the U.S. Clay permit application met the requirements of applicable law, thus opening the door for the governing board to issue the requested operating permit. In its "Response to Comments" document, the agency noted its conclusion–based on modeling–that "it is not expected that existing health conditions will worsen or that adverse health effects will occur in the general public, or sensitive receptors as a result of the emissions from the proposed facility." Distilling the hundreds of public comments into 43 main concerns, the document refuted each of those concerns in detailed, bureaucratic fashion.

In response to this decision, the BBAQG managed to raise a sufficient amount of money to hire a lawyer and file a lawsuit against TCEQ for improperly granting the permit. In a more informal vein, a splinter group of activists attempted to persuade U.S. Clay that the proposed plant would be more appropriately sited in the town of Ft. Stockton, a more industrial town on the edge of the oil industry-dominated Permian Basin, about 70 miles north of Alpine.

> Because of the border, we have a huge, we probably have more cops per corner than perhaps any other area, than anywhere in the world, but there's a lot of government because of the National Park, because of the immigration and, so, you know, those are, those are all kind of the economic bases of this area and the US Clay plant is just incompatible with everything this area is about. It's not about oil and so we don't really need the clay, you know, that they might process there. It's not going to be used in this community and it's not really about mining industry although Brewster County and Presidio County, you know, they have a history way back there of having mines. Cinnabar and all kinds of silver mines and things like that down in the Park area and in Presidio,

but that's not the economic basis of this community anymore, another aspect of it is ranching. So, this plant was just incompatible with the economic bases and everything about this community as well as the opening of the door so to speak for further degradation of the air quality, and the testimony that I gave that the public hearing that they had here, you know, I basically said that why don't they just go a few miles up the road, you know, where people want them and where they're compatible with the industry, I mean the whole oil industry starts about 60 miles up the road.

Question: [To the north?]

Interviewee: Yeah. If you head out toward Fort Stockton, after you get to Fort Stockton you go north of I-10 and you'll see the oil wells, you know, and that's the oil area and they want them up there. We don't want them here and it is not that far a distance, you know, and so we wanted to encourage them to come visit us any time, but if you can relocate some place else, you know (interview, local activist).

It is important to note here that the economic argument made by this community member is a plausible one, in terms of the location of a customer base for bentonite processing. However, it ignores the potential convenience of proximity to bentonite mining locations in Brewster or Presidio County. In any case, the validity of the economic argument does not change the fact that the interviewee was willing to surrender this industrial facility, and its presumed environmental harms, to a neighboring community located "across the border" as it were.

During the following year, it became apparent that U.S. Clay was not a financially healthy company. Its representatives stopped their correspondence with local residents, and activists found evidence that it had been bought by a larger company. Though a few large metal tanks had been delivered to the plant site after TCEQ had granted its permit, the rock crushing plant was never built. Activists' efforts probably did play some part in creating a hostile business environment for the proposed facility, although the company's acquisition and other business considerations (e.g., bentonite not being a high value-added material) may ultimately have played greater roles. In any case, the BBAQG and its allies succeeded in raising awareness and achieving a victory, if only by default.

A rigid scalar framework

In the controversy over the proposed rock crushing plant outside of Alpine, local residents left no ambiguity about the scale of analysis they were concerned with; their immediate concerns were circumscribed by the Alpine city limits and the immediately surrounding area. Alpine's residents and business community alike share a vision of the town as a gateway to the Big Bend, with the implication that some communities to the north (i.e., Marathon, Ft. Davis, and Ft. Stockton) are either not as much parts of the Big Bend region, or are not to be considered commercial and cultural hubs. This gateway status positions Alpine not only as a useful center for goods and services within the region, but also implies a set of privileges and responsibilities.

On the other hand, the designation of gateway also carries responsibilities and risks. The implied responsibility for Alpine as is to put its best foot forward as an attractive and hospitable entry to the region. This imperative of attractiveness and hospitality encompasses the offering of commercial services, cultural offerings, and crucially, an attractive visual landscape. I do not mean to imply that this requirement of attractiveness is a legal one, or even that it is universally accepted or applied–other light industrial operations do exist in town, including gravel and paving services. Nevertheless, I do claim that visual attractiveness is part of the shared community understanding in Alpine, a crucial attribute of both regional self-understanding and tourist promotion.[10] The Big Bend regional haze phenomenon triggered discontent, resentment,

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10. See Wilson 1994 for a discussion of the aesthetic and economic pressures for "scenic

and environmental activism because it violated this attractiveness requirement within the park boundaries itself, endangering the region's core narrative as well as its primary economic engine. However, the large scale of that phenomenon rendered it somewhat inaccessible at the local scale, while its centeredness in the national park placed it at a geographical remove from the town.

On the other hand, the proposed rock crushing plant on the town's outskirts was a tangible, accessible, completely local violation. The plant was planned during the lingering aftermath of the haze controversy, when locals were at least aware of–and probably sensitized to–the vulnerability of their visual landscape. Finally, the plant was sited a few miles north of Alpine on the main highway from the interstate, at the gateway to the gateway, so to speak. To have this large industrial artifact welcoming visitors to an area whose entire character was based on images of rurality and wilderness was considered unacceptable to local activists.

As shown above, Big Bend residents' strong affection for and identification with this region provided the basis for their defensive NIMBY posture in the face of the planned rock crushing plant. Defending the region against encroachment by polluters in turn required activists to define that region, maintaining a boundary between inside and outside. That boundary allowed activists to declare that locations outside of the region would be more appropriate for polluting activities, as when one interviewee claimed that the nearby town of Ft. Stockton as a location for the rock crushing plant.[11]

The commonality among these local activist groups is their construction around place, a place with the specific attributes of beauty, authenticity–referring to the preference for the ranching culture vs. the displaced New York artist lifestyle in Marfa–and purity/cleanliness. Those attributes translated into a fairly rigid boundary around the greater Big Bend region, encompassing the national park, Alpine, and the surrounding ranchlands, but excluding Presidio/Ojinaga and Ft. Stockton. The air quality-related activism occurred in reaction to real or threatened breaches of that boundary by air pollutants, translating in the case of U.S. Clay and La Entrada into a NIMBY posture. We can see here the framing of air pollution as matter out of place (Douglas 1966), with the clear implication that there are *other* places more appropriate for

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value."

11. The same concerns and tactics were in evidence starting in 2003 when business leaders in Midland, Texas and northern Mexico actively promoted plans for a trade corridor called La Entrada al Pacífico, consisting of highway construction and improvements beginning at the port of Topolobampo in Sinaloa, passing through Chihuahua city and the Ojinaga-Presidio border crossing, and through the Big Bend on the way to Midland-Odessa–whose leaders sought to remake those cities from declining oil cities to goods movement hubs–and points north and east. The ambitious plan was to eventually provide an alternative port and shipping route for goods arriving by sea from Asia (MacCormack 2001). As in the U.S. Clay controversy, Big Bend activists (in a loosely organized group significantly overlapping with the Big Bend Air Quality Group) protested that in this scenario, the border crossing at Presidio-Ojinaga could become a much more active commercial point of entry, and some of the highways through the Big Bend could become active through-routes for large cargo trucks, with their attendant pollution and safety problems. Many activists' position on this issue was that if Presidio and Ojinaga wanted to welcome this truck traffic and its accompanying problems, they were free to do so; however, steps must be taken to avoid the routing of trucks through Alpine and Marfa. A small number of activists continued to monitor this proposal, spearhead letter writing campaigns, and so on, though the sheer improbability of the project dampened the urgency of local concerns. By 2010, the project had essentially died (Sage 2010).

such contamination.[12]

This theme of invasion resembled the same trope in the national discussions of Big Bend haze in 1993.[13] While several activists definitely had their theories on the origin of the region's haze pollution, the BBRSC's position paralleled the evolving EPA and NPS positions, beginning with the presumption that the Río Escondido plants were to blame and moving through the 1990s toward an awareness that U.S. pollution sources also played a role, and that realistically the U.S. had the best chance of reducing emissions from those sources within its own regulatory reach. However, as much as the national Big Bend haze controversy relied upon a vision of a pristine, isolated national park invaded by foreign taint, the local Big Bend construction of air pollution relied just as much on the framing of the entire region surrounding the park as isolated and pristine, but under increasing pressure from the outside.

The unlikely dilemma of Big Bend air pollution, then, was constructed and addressed by successive activist efforts through a conservative frame of landscape preservation and economic development. While it is true that Big Bend activists challenged powerful state institutions at very hierarchical levels, they did not undertake that struggle in an attempt to disrupt that hierarchy or reshape power relations in any fundamental way. Rather, these were reactive, goal-oriented attempts to exclude certain specific facilities, development projects, and even larger economic-environmental phenomena from penetrating the boundary around this "pristine" region.

The result was a series of grassroots activist efforts, exhibiting some characteristics of social movements (Escobar 2001), but closely tracking the goals of the conservation and wilderness preservation movements, and with tactics virtually identical to the stereotypical NIMBY. Thus, local activists' main attempts to connect their efforts to networks at a larger scale consisted of individual leaders building on their existing ties to the Sierra Club, Environmental Defense, and the Texas Center for Policy Studies, in order to capitalize on those organizations' knowledge and experience in the regulatory and policy realms. Their involvement and influence at higher scales occurred through existing state-sponsored avenues such as public meetings and comment periods, and BRAVO steering committee representation.

Activism in this "holding action" form is probably sufficient in cases where local opposition can reduce the appeal of a project that is already low value-added (e.g., U.S. Clay) or unlikely to succeed (as with La Entrada). However, this conservative model of activism is clearly insufficient for local activists to exert influence on large-scale phenomena such as regional haze affecting the area. While it may be true that area activists succeeded in publicizing the haze problem during the 1990s, and that the dilemma of Big Bend haze was taken up by some national NGOs as part of a broader emphasis on regional haze , the difficulties remain that (1) because of the BRAVO study and its predecessors, and the fading of NAFTA as a burning environmental issue, Big Bend haze is now a single example of the broad phenomenon of

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12. Bickerstaff and Walker (2001) describe the construction of air pollution to designate certain places as "stigmatized or spoiled" while at the same time setting others apart as pure. This construction tends to "reproduce existing patterns of power and exclusion" (59).

13. In the Big Bend, however, the specific theme of Mexican invasion barely appeared at all. However, while the scalar anchor for Big Bend haze as an early 1990s national political phenomenon consisted of the U.S.-Mexico border as both unidimensional dividing line and irredeemably tainted sacrifice zone, in west Texas in the middle to late 90s the polluting invasion was conceived in a much more egalitarian framework, with pollution potentially invading the Big Bend's splendid isolation from all directions. As residents of the border region, Big Bend inhabitants as a whole have a much less monolithic view of Mexico, Mexicans, and the region than overarching discourses such as that of the "border environment;" for the most practical reasons, they have fewer hangups about the border.

regional haze, not a unique situation clamoring for a solution; and (2) the current regulatory framework for regional haze is quite weak, consistently deemphasized in favor of health-based primary air quality standards applicable to urban and industrialized areas.

The literature on scale and social movements proposes an alternative model for local organizing: establishing and utilizing relational networks as a way of engaging in struggles at broader scales (Cox 1998; Kurtz 2003; Buell 2001). This idea contrasts with the model undertaken in Big Bend air quality activism thus far, of attempting to address air quality problems though the hierarchy of scales imposed by government structures. In a discussion of scale and environmental justice activism, Hilda Kurtz notes that

> Buell (2001) identifies a ''politics of elasticity'' in which a common sense of place and identity can be used to encompass either self-identified entities (neighborhoods, towns, townships) or bureaucratically imposed statistical districts such as zip codes. By extension, the language of populism, community, and grassroots resistance contains the possibility of forging networks of allied anti-toxics activists that extend beyond single locales (Kurtz 2003, 890).

Unfortunately, the experience of Big Bend air quality activists appears for the moment to have gone in the opposite direction, toward a spatial "politics of rigidity." Indeed, it appears that this community's sense of uniqueness and distinctiveness may betray a discursive tendency toward isolation rather than connection with other communities outside the region.

Thus Big Bend activism is rooted in a combination of the constructed western rancher discourse, the classic environmentalism of wilderness and landscape protection, and the vexing small-town imperative to create working class jobs and remain viable communities. To date, the vision emerging from this combination of influences has been the default paradigm of tourism, an economic development model with several benefits, but also carrying its own set of difficulties (Norris 1994). While some activist leaders have spoken about the need for a comprehensive vision for the region, there appears to be no urgency for such an undertaking.

Big Bend activists were constrained from playing a direct role in mitigating the large-scale Big Bend National Park regional haze problem by the scaling up of the issue far beyond their sphere of influence. Nevertheless, activists' engagement with Big Bend haze did allow them to give voice and form to their rootedness in a way that had not existed before. In addition, the haze problem has given a visual aspect to long-range air pollution that could potentially give powerful expression to arguments about global pollution such as that of greenhouse gases or ozone depletion. Their roots in place also allowed them to make common cause with politically conservative neighbors on later issues such as the rock crushing plant, a type of alliance that has eluded environmental activists of all stripes elsewhere in the country. It remains to be seen whether these overlapping activist movements will chose to—and be capable of—confronting environmental problems at the national, continental and global scales.

Conclusion - opportunities in relational networks?

This chapter, like the previous one, is about opportunity. The opportunity occurring in the greater Big Bend was twofold: First came the opportunity for the emergence of an environmental movement, which was opened by the growing awareness of the Big Bend haze phonomenon in the early-to-middle 1990s. Though the core of activists that emerged at that time was unsuccessful in directly impelling action to reduce visible haze in the region, they were able to articulate a common set of regional environmental values which prepared them to succeed in another smaller-scale community development battle in the early 2000s. The second opportunity is one of interconnections between Big Bend environmental activists and like-minded activists in other locations. The strategy of relational networking mentioned above may provide the opportunity for activists to construct "a politically resonant social grievance in which local pollution becomes a social problem by virtue of being part of a broader spatial pattern" (Kurtz

2003, 890). But which spatial patterns might prove resonant with air pollution issues in this region?

Environmental injustice might be one example. Without forcibly imposing a label on local activists that they would not apply to themselves, there are nevertheless some interesting discursive parallels between Big Bend activists and the environmental justice (EJ) community as constituted in the U.S.[14] Both groups are concerned with the impact of environmental pollution and hazards upon the health of vulnerable communities, with the EJ community taking this as its main concern and Big Bend activists–specifically those mobilizing against the rock crushing plant–using it as a major sub-theme. Though the context of "vulnerability" is very different for each of these groups–white, middle-class activists with respiratory problems in the Big Bend case vs. poor or working class people of color affected by industrial pollution in the EJ realm–the inherently multi-scalar characteristics of air pollution as a physical phenomenon provides an explicit linkage between the Big Bend and more traditional EJ communities, through the shared sources of air pollutant emissions. In addition, the community of Big Bend activists displays the same rootedness in place that is generally recognized as part of the environmental justice activist makeup. Nevertheless, two difficult facts remain: (1) no local activists have shown any inclination to explicitly frame their issues in this way, and (2) representing white, middle-class retirees as an environmental justice constituency could provoke a dissonance with that movement, given Alpine's and the entire region's uncomfortable legacy of racism and segregation.[15]

Another possibility for joining a networked alliance might be the global movements related to clean energy and climate change. First, for "environmentally"-minded local activists, this option has the advantage of being an effort they have already begun, by affiliating themselves with the Sierra Club. Second, it also lacks the overt association with racial or class conflict that characterizes the environmental justice movement.[16] Third, the universe of emission sources associated with energy and climate change includes those sources implicated in Big Bend haze, namely coal-fired power plants; eliminating those plants or powering them through alternate means should have a direct, beneficial effect on the haze problem. Finally, tackling climate change would enable local activists to organize around an alternative economic development framework with the potential to mitigate the Big Bend region's strong dependence on tourism.[17]

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14. "[T]he environmental justice framework incorporates the principle of the 'right' of all individuals to be protected from environmental degradation. The precedents for this framework are the Civil Rights Act of 1964, Fair Housing Act of 1968 and as amended in 1988, and Voting Rights Act of 1965" (Bullard 2001, 153–54).

15. Like other regions of Texas (Montejano 1987), the Big Bend has a history of racist practices. The school system in Alpine was not desegregated until the early 1970s (interviews), and in all the region's towns there remain noticeable differences in the neighborhoods found on the right and wrong sides of the railroad tracks.

16. Note, however, that in recent years many activists and analysts have come to frame clean energy and climate change in explicit terms of equity and justice (Gelobter, Dorsey, Fields, et al. 2005).

17. West Texas and the Big Bend have attracted notice as potential sites for renewable energy generating facilities, with several wind farms already sited in nearby Pecos County and at least one solar energy firm interested in siting a facility in the region (Perry 2010). The Ad Hoc Air Quality Group contrasted "clean energy" and "an ecologically driven economy" with the polluting rock crushing plant in its press packet, quoted earlier in this chapter.

Another scale idiom where Big Bend activists might connect their efforts is the scale of the U.S.-Mexican border. During the years 1995-2005, Big Bend air quality activists succeeded in building connections with counterparts in Mexico. For example, the Big Bend Regional Sierra Club arranged a large meeting devoted to air quality in Alpine in November 1999, which was attended by nearly two dozen Mexican participants. In the wake of that meeting, members of the Alpine-based Binational Chihuahuan Desert Big Bend Clean Air Alliance reached out to contacts in northern Mexico in attempts to build a broad regional coalition as well as bringing awareness to specific localized air pollution sources and impacts. [18] Several Big Bend environmental activists were active in the drive against the siting of a nuclear waste facility in the nearby border community of Sierra Blanca (interview, local activist). Outside of the environmental realm, many residents of Brewster and Presidio Counties in Texas have strong family ties to Mexico (Morgenthaler 2004), and residents of Terlingua and other towns have been active in providing assistance to isolated Mexican communities experiencing hardship because of the prevention of informal border crossings from Big Bend National Park. Finally, as outlined in Chapters 2 and 3, environmental issues at the border can be addressed within the U.S.-Mexico Border Environmental Program, a goal and project-driven institutional framework where local governments, NGOs, and other stakeholders have explicit roles to play.

These focal regions or concepts, along with the highly mobile and multi-scalar aspects of air pollution, may point the way toward constructing relational coalitions that can transcend NIMBY, while continuing to honor that model in appropriate situations. Such coalitions may enable Big Bend activists to effectively address large-scale issues using frameworks outside of hierarchical, state-dominated regulatory structures. Chapter 5 briefly discusses the implications of this possibility in combination with the layered scale framework outlined in Chapter 3.

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18. The Binational Chihuahuan Desert Big Bend Clean Air Alliance formed in 1999-2000 as a cross-border environmental organization concentrating explicitly on air quality. The group had some notable accomplishments, including the facilitation of a visit to Ojinaga by Alpine High School students and some networking assistance to an Ojinaga teacher who was working with local students to install an air monitoring network to measure particulate pollution. The Alliance as a group became largely inactive by 2004, though many individual group members continued to be active in the BBRSC and the Big Bend Air Quality Group (interviews, local activists).

CHAPTER 5
CONCLUSION
PROGRESS VIA CONCURRENT SCALAR STRATEGIES

This concluding chapter examines scale as one dimension along which state-sponsored science and policy and place-based activism can engage with one another in a cooperative mode. Public agencies hold promise as facilitators and convenors for this engagement, with the ability to both lead and follow science across scales, take actions and monitor results over time, and yet maintain links to specific geographical jurisdictions and an imperative to democracy. The preceding chapters illustrate two instances of attempted disruption of policy equilibria. In Chapters 2 and 3, the lingering plume blight framework of visibility pollution, manifested as the border scale framing of Big Bend haze, was successfully disrupted first by Mexican scientific dissension and political action and subsequently by the comprehensive analysis carried out by U.S.-based visibility scientists. This policy disruption was accomplished via a scale jump from a border-restricted domain to a large regional space covering much of central and eastern North America. Given that scale jump, I envisioned an alternative framework of layered scales in which government agencies–as the actors with the most freedom to move through the scale hierarchy–might choose to shift back to a "former" scale framework for pragmatic reasons, namely to accomplish concrete if incremental environmental improvements. I proposed that the mechanism applicable to the present case might be the U.S.-Mexico Border Environment Program, established by the La Paz Agreement in 1983.

In Chapter 4, local activists had less success influencing the technocratic regulatory framings of both Big Bend haze and localized environmental permitting decisions, though they were able to focus the attention of regulatory agencies on their issues of concern, and perhaps to disrupt U.S. Clay's plans enough to make its planned facility less attractive as a business proposition. Here activist actions were based primarily on a NIMBY framework, with activists effectively erecting a rigid, exclusionary boundary around the scenic Big Bend region and taking action to prevent the intrusion of pollution across that boundary. This defensive posture at a single scale was somewhat effective with the localized threat of the industrial facility permit, but did not gain much purchase with the regional haze issue. In this case I proposed that locals might be able to scale up their actions via a network strategy linking them to activists in other places; such networking efforts might be based on common interests in the border region, clean energy and climate change, or environmental justice.

The interaction between the layered scales strategy in the state realm and networked scaling strategies for local activists presents interesting possibilities for democratic participation, as well as learning, in environmental politics.[1] Presupposing the honorable intentions of all actors, and concentrating for now on large-scale atmospheric disruptions like regional haze and climate change, we can envision a scenario where first, activists in diverse places can combine their efforts to focus EPA's and other agencies' attention on relevant policy goals, as well as concrete non-regulatory actions that might be accomplished through staff time and/or funding assistance. This focusing effort might take place–indeed, already does take place–through national-level mechanisms such as the National Environmental Justice Advisory Council

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1. This discussion focuses solely on the spheres of environmental politics that fall under regulatory agency authorities or programs. While some of my arguments may apply to the legislative arena, that venue was not addressed in this study.

(NEJAC), a committee with rotating representatives that gives advice to EPA under the statutory authority of the Federal Advisory Committee Act (http://www.epa.gov/environmentaljustice/nejac/, last accessed August 8, 2010).[2] As discussed in Chapter 3, NGOs, community groups, and academic units focused on community needs also exert their combined influence across multiple state hierarchies, through the U.S.-Mexico Border Environment Program. The collaboration and funding opportunities available through this program, while not strongly influencing policy or regulatory decisions in either country, do open the possibility for small but focused projects leading to incremental environmental improvements. These networking strategies are no panacea, as they have real costs for community-oriented groups and there is no guarantee of productive collaboration or successful influencing of government actions.[3] Nevertheless, these networked strategies–perhaps facilitated by social networking or other low-cost communication media (Scearce, Kasper and McLeod Grant 2010)–may hold the possibility of scaling up activist efforts and influences into a powerful force; they may also help to strengthen fragile commonalities between activist communities, e.g., wilderness preservation and environmental justice (Gelobter, et al. 2005; Evans 2002).

Second, in the state realm, while continuing their mandated regulatory developmenta and implementation, and their conduct and sponsorship of scientific research, environmental regulatory agencies could concurrently pursue pragmatic, small-scale non-regulatory efforts with the explicit goal of broadening meaningful community engagement and achieving timely environmental improvements. Such efforts might consist of formal programs established by legislation or international agreement, such as the Border Environmental Program, or simply of grant funding programs administered out of regional or field offices.[4] EPA also facilitates numerous public-private partnerships such as the regional diesel emission collaboratives (http://www.epa.gov/cleandiesel/whereyoulive.htm#coll, last accessed on August 8, 2010) that utilize a network structure to share information and build collaborations around emission reduction technologies and practices.[5] In terms of administrative and geographical structure, federal agency regional and satellite offices hold promise as valuable bridges between community and policy realms, with local staff serving as information conduits between the hierarchical technocracy and their geographical clientele. Those local outposts of federal agencies, through their implied authority and legitimacy, can also provide a meaningful function as convenors of their own networks of place-focused environmental stakeholders.[6]

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2. An example body similar to the NEJAC at the state level is the Global Warming Environmental Justice Advisory Committee, which advises the California Air Resources Board on the implementation of the California Global Warming Solutions Act of 2006, or AB 32 (http://www.arb.ca.gov/cc/ejac/ejac.htm, last accessed August 8, 2010).

3. Thanks to Catalina Garzón for emphasizing this point during the development of this research.

4. Examples here include EPA's EJ Small Grants, Climate Showcase Community Grants, and Community Action for a Renewed Environment (CARE) grants.

5. Although the diesel collaboratives, like many EPA voluntary programs, have historically been oriented toward industry and state and local governments, as of this writing, under the Obama administration's emphasis on environmental justice, they are attempting to make their activities more relevant to community partners as well.

6. This last point is based on my own experience as a staff member at EPA's Pacific Southwest Regional Office (Region 9) in San Francisco from 2001 to 2008, and subsequently at Region 9's Southern California Field Office from 2008 to present. I mean this discussion to

Third, "big" science conducted and sponsored by state agencies will continue to provide crucial information not only for traditional regulatory activities, but for activist efforts as well. The continued *public* status of this government-sponsored information, as well as ongoing initiatives such as plain-language requirements and web-based information portals, will be crucial to the usefulness of these scientific resources going forward. Without underestimating the difficulties inherent in the interface between technocratic expertise and community activism (Fischer 2000), or overestimating the potential for science to "solve" environmental problems (Sarewitz 2004), the growing body of technical environmental knowledge nevertheless constitutes an important public resource. Even in instances where local stakeholders have only a general understanding of a given analysis or conclusion–as in the Ad Hoc Air Quality Group's deployment of information on the dangers of fine particulate pollution mentioned in Chapter 4– the conduct and circulation of environmental science can provide information on risks that can help activists to properly focus and express their concerns.

Finally, scale jumps, pragmatic activities at lower scalar layers and networked efforts spanning activist communities all point toward possible learning and adaptive opportunities by government, scientist, and activist communities alike. As discussed in Chapter 3, scale jumps to higher and lower hierarchical levels provided an opportunity for reassessment and learning within visibility science and policy community. However, all of these scalar strategies provide the same opportunity to transmit learning across activist, policy, and scientific communities. Much as Mexican government staff were able to disrupt the problem definition of Big Bend haze through their engagement with the political and scientific processes surrounding that issue, activists have the ability to change the way government agencies ask questions, much as the networked environmental justice community has succeeded in destabilizing–to a limited extent– EPA's technocratic paradigm of risk assessment. In the same way, pragmatic interactions and programs at lower scale layers, as well as activist campaigns spanning networked scales, generate information and insights that, if recorded and transmitted effectively, might feed productively into scientific and regulatory activities at larger scales. Again borrowing the language of adaptive environmental management (Lee 1993), all of the above efforts can be treated as experiments increasing learning in the broad realm of environmental governance. While the practical barriers are significant in terms of perenially scarce resources for information storage, transmission, and analysis, this rather messy vision of layered incremental processes punctuated by scientific paradigm shifts (Kuhn 1962) and stakeholder mobilizations within or outside hierarchical frameworks does seem to open the possibility for a way forward in addressing large scale environmental problems.

Environmental agency personnel and activists alike have struggled to move beyond a technocratic and liability-focused model of air pollution toward a model that might effectively confront regional and global-scale pollution (Shellenberger and Nordhaus 2004; Werbach 2004). This dissertation used scale as an anchoring concept because it seemed a key parameter for both scientific and political analysis of visibility pollution, whether that pollution was framed as plume blight or regional haze. Using the case of Big Bend air pollution as a departure point, this analysis demonstrated that several scalar strategies contributed to the social construction of Big Bend air pollution. I also argued that those combined scalar strategies, addressing the manifestations of air pollution at different scales, contain the seeds for real, democratic progress in environmental governance. While this rather disordered vision provides no assurance of success, it does provide a pragmatic illumination of multiple interacting strategies for building

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convey hope and possibility, but not undue optimism; EPA and other agencies continue to operate under difficult budgetary pressures, and in some cases lack resources to properly perform their core regulatory functions. At EPA specifically, though some leaders have declared their resolve to increase the agency's presence in key localities, how that resolve might translate into staff transfers or hiring remains uncertain.

knowlege and achieving interim environmental goals while also working toward transformative change.

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