

2. INTRODUCTION

2.1 Setting

In a remote area of southwestern Texas, where the Rio Grande makes a large U-turn along the U.S./Mexico border, lies an area known as the “Big Bend Country.” Within this expanse lies Big Bend National Park (BBNP), Texas,—a 324,247 hectare (1,252 square miles) reserve—established as a national park in 1944 and designated as a Biosphere Reserve in 1976 (Figure 2-1). Big Bend is a land of contrasts: the Rio Grande—portions of which have been designated as a Wild and Scenic River; desert—BBNP is 97 percent Chihuahuan Desert; and mountains—the Chisos Mountains, which tower 2,400 meters (7,800 feet) above the desert floor, and the Sierra del Carmen across the river in Mexico. Along the Rio Grande are deep cut canyons—Santa Elena, Mariscal, and Boquillas—alternating with narrow valleys walled by towering cliffs (U.S. Dept. of the Interior, 1983). Figure 2-2 shows the terrain of Texas and the surrounding region. The mountains surrounding BBNP are the southern extension of the Rock Mountains called the Trans-Pecos. To the east the Texas hill country extends to the Gulf Coast Plains. BBNP is a region of large biological diversity containing more than 1,000 species of plants, 434 birds, 78 mammals, 71 reptiles and amphibians, and 35 fish (Big Bend Natural History Assoc., 1990). Endangered species include the peregrine falcon, black-capped vireo, Mexican long-nose bat, Big Bend gambusia (a fish), and three threatened cacti (Big Bend Natural History Assoc., 1990). Because of its contrasting landscapes, however, Big Bend is also known and appreciated for the beauty of its scenic vistas located in both countries.

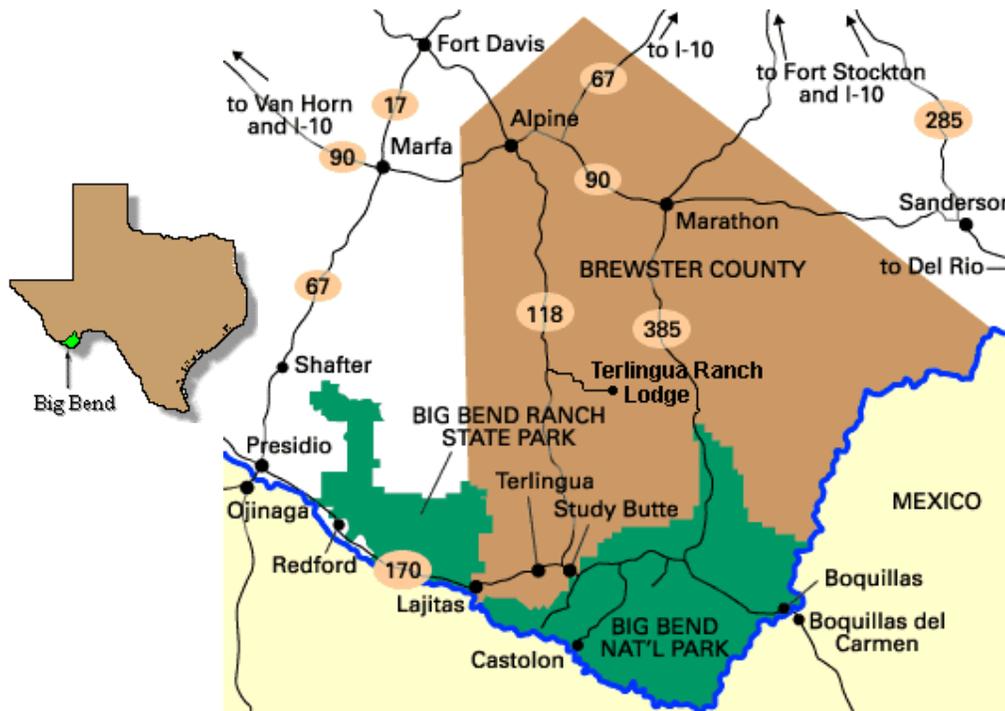


Figure 2-1. Location map of Big Bend National Park in southwestern Texas.

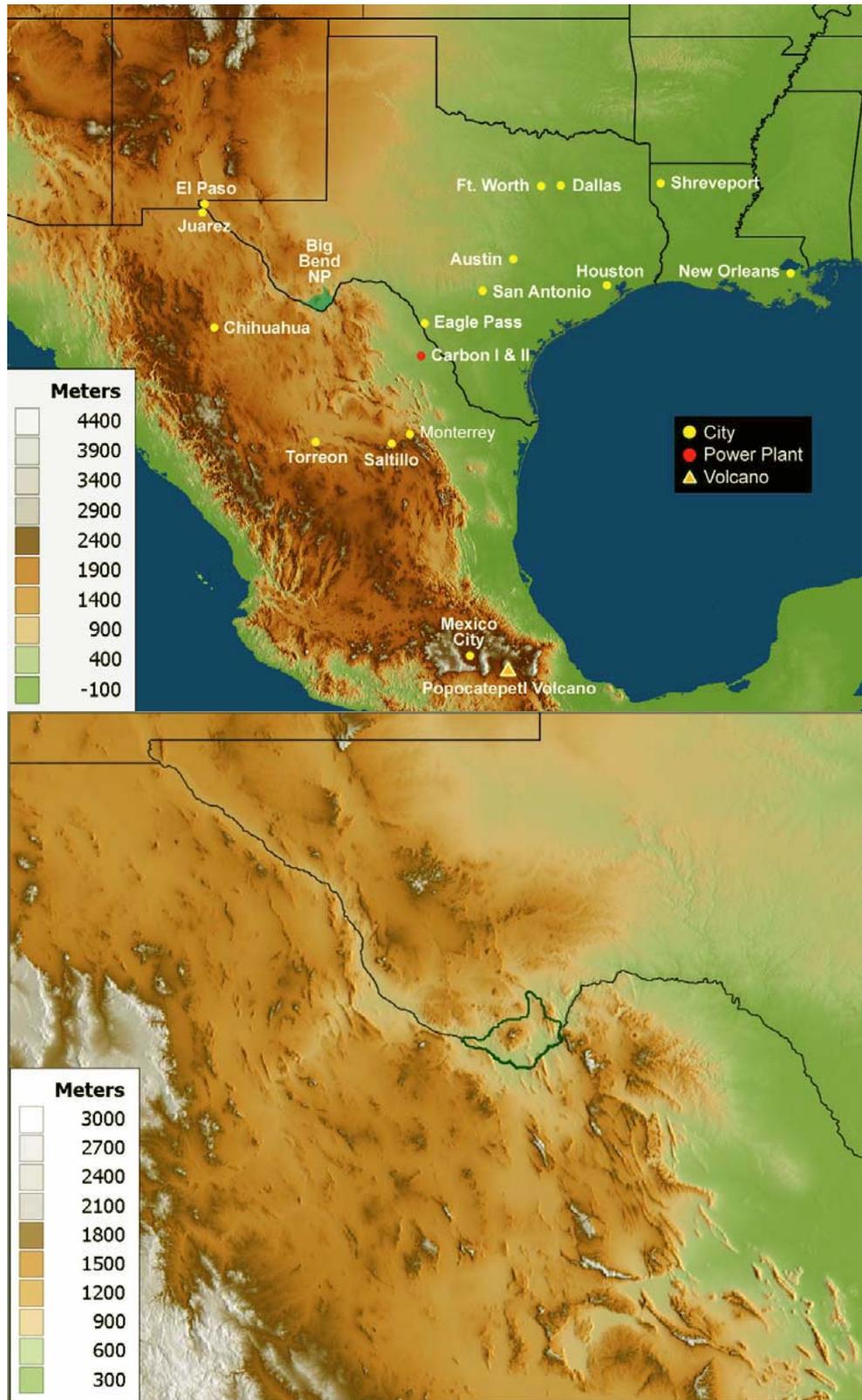


Figure 2-2. Texas and Mexico (above) and the terrain surrounding Big Bend National Park in western Texas and northern Mexico (below).

Although early travelers called the land “*el despoblado*”, the barren land, there is a rich history associated with the land extending back in time to ca. 8500-6500 BCE. The area is remote and sparsely populated, with approximately 13,000 people occupying an area about the size of the State of Maryland (12,407 square miles). In the 1930s many people who loved the Big Bend country saw that this land of contrast, beauty, and solitude was worth preserving for future generations--an effort that resulted in the establishment of Big Bend State Park and BBNP.

2.2 Study Goals

The Big Bend Regional Aerosol and Visibility Observational (BRAVO) Study is a multi-year assessment of the causes for increased haze in the vicinity of Big Bend National Park, Texas (BBNP). The Study was performed in response to public reports of decreased visibility at the Park, historical data showing decreased standard visual range, and the construction of the *Carbón* facilities, two coal-fired power plants, in Mexico, approximately 225 kilometers southeast of the Park. The Study was designed to identify the source regions and source types responsible for the haze at BBNP. Because of the Park’s location on the U.S./Mexico border, it was surmised that emissions from both countries contributed to the haze, but the degree of impact due to such source regions and types was unknown.

2.3 Management

Overall direction of the BRAVO Study was the responsibility of the BRAVO steering committee. The steering committee had representatives of the United States Environmental Protection Agency (USEPA), the National Park Service (NPS), and the Texas Commission on Environmental Quality (TCEQ). A sub-committee of the steering committee consisted of representatives of non-governmental organizations (NGOs), such as industry and environmental groups. While comments on BRAVO have been welcome from all members of the public, the NGO sub-committee regularly discussed study plans, data analysis methods, and study results.

The technical sub-committee included investigators who collected data or performed data analysis, including quality assurance. This sub-committee provided a forum for presentation of technical analysis as well as scientific debate regarding the conclusions of various data analysis methods.

2.4 Preliminary Study

As a result of concerns over visual air quality at BBNP, a preliminary regional visibility study was conducted in Texas and northern Mexico in September and October 1996. A more detailed description of the study and the reasons for conducting it are contained in the report “Big Bend National Park Regional Visibility Preliminary Study” prepared by the Big Bend Air Quality Work Group for the USEPA, National Park Service, and the Mexican governmental agencies PROFEPA and SEMARNAT on January 7, 1999.



Figure 2-3. Map showing monitoring sites for preliminary visibility study.

The primary objective of the preliminary 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 BBNP. The study was conducted at 19 monitoring stations (ten in Texas, nine in Mexico – see Figure 2-3) from September 9 through October 13, 1996. All sites sampled $PM_{2.5}$ and Big Bend and Guadalupe Mountains national parks sites sampled PM_{10} . The $PM_{2.5}$ filters were analyzed for chemical composition.

Among other things the preliminary study found that fine particulate sulfate plays a large role in visibility impairment at Big Bend National Park and that sources in both the U.S. and Mexico are likely responsible. The preliminary study work group made the recommendation that a more extensive field study should be conducted to quantify the impacts from specific sources to visibility impairment at Big Bend National Park. More information on the preliminary study is available elsewhere (Gebhart et al., 2000; Gebhart et al., 2001).

The BRAVO Study is the more detailed study recommended in the report of the preliminary study. The United States and Mexico did not reach agreement on study design; as a result, the BRAVO Study includes monitoring in the United States only. A more complete description of the planning process for BRAVO can be found in Green et al. (2000).

2.5 Seasonality of the Aerosol Components of Light Extinction

Figure 2-4 shows the seasonal pattern of aerosol-calculated light extinction (i.e., light extinction estimates made by scaling the major aerosol species concentrations by extinction efficiency factors) determined using the IMPROVE (Interagency Monitoring of Protected Visual Environments) concentration data from two to three 24-hour duration samples weekly, available on the IMPROVE web site (<http://vista.cira.colostate.edu/improve/>), and on-site relative humidity measurements at Big Bend National Park. The contributions by each of the major aerosol component as well as the contribution by particle free air, known as Rayleigh scattering, are also shown in the time plot, while the average contribution by each component to light extinction on all days and on the 1/5 haziest days are displayed in pie diagrams.

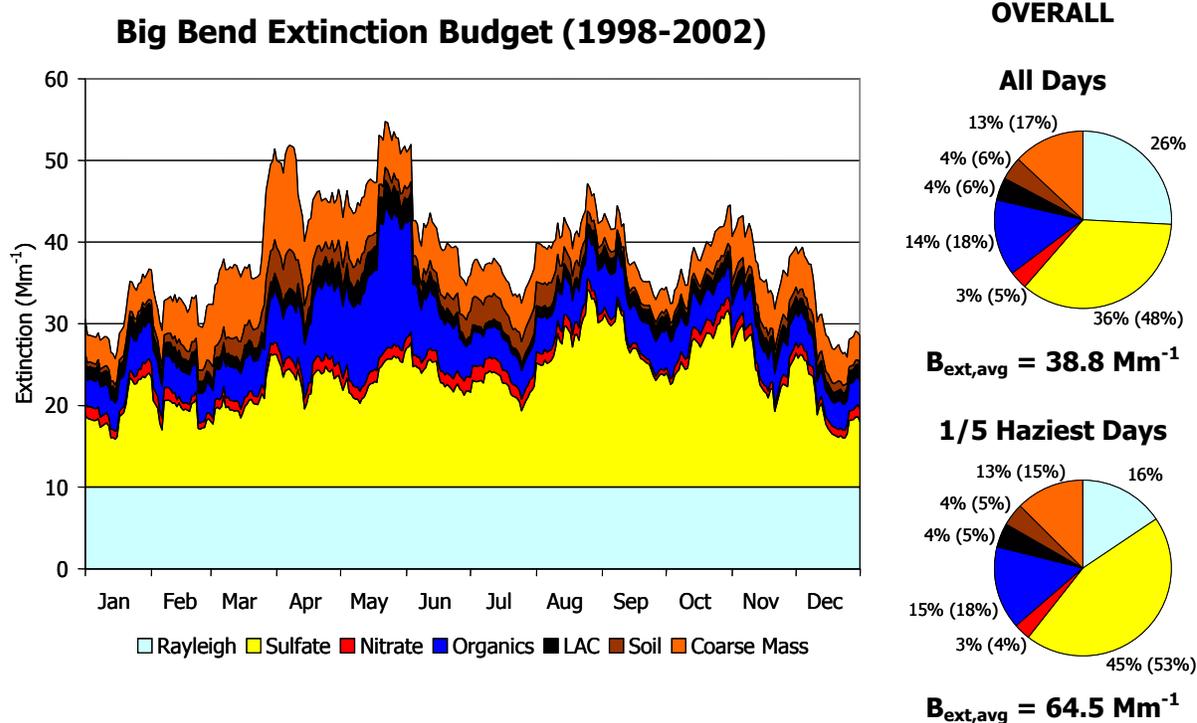


Figure 2-4. Big Bend National Park five-year composite contributions to haze by components. The time plot was smoothed using a 15-day moving average. The pie graphs show the average percent contributions to light extinction for all days (top) and the annual haziest 1/5 of the days (bottom). Percent contributions to particulate haze (the non-Rayleigh light extinction) are shown in parentheses.

The yearly components contributions to light extinction time plots in Figure 2-5 show that there can be substantial variability from year to year. However in general there are two periods of high haze levels at Big Bend National Park. One is in the spring when particulate sulfate and carbonaceous compounds contribute in similar amounts and another is in late summer and fall when particulate sulfate compounds are the largest contributors to haze. A few very high values of light absorbing carbon (LAC) and organic aerosol species mass in May suggest that agricultural burning and wildfires may be particularly important during this time of year, especially for May 1998 (Gebhart et al., 2001). Average monthly particulate

sulfur is similarly high for May through October. Fine soil and coarse mass are lowest in winter, with higher values in the spring and in mid summer. Much of the July soil and coarse mass is believed to result from transport of African dust transported across the Atlantic Ocean (Perry et al., 1997; Ashbaugh et al., 2001; Gebhart et al., 2001).

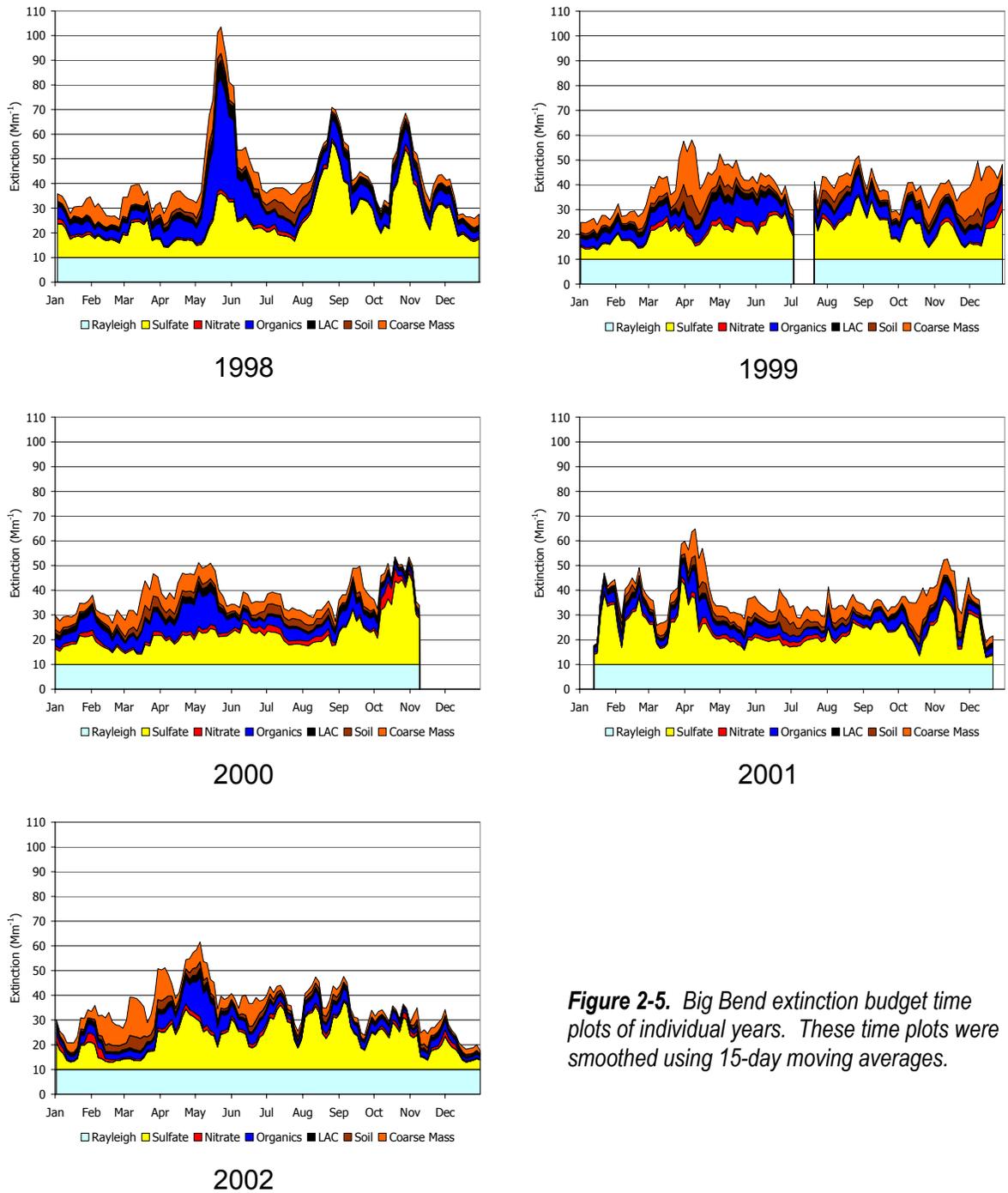


Figure 2-5. Big Bend extinction budget time plots of individual years. These time plots were smoothed using 15-day moving averages.