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CLIMATE CHANGE SCIENCE

High Quality Greenhouse Gas Emissions Data are a Cornerstone of Programs to Address Climate Change

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Natural Resources & Environment

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Highlights

Highlights of GAO-423T, a testimony to the Subcommittee on Energy and Environment, Committee on Science and Technology, House of Representatives

Why GAO Did This Study

Elevated levels of greenhouse gases in the atmosphere and the resulting effects on the earth's climate could have significant impacts in the United States and internationally. Potential impacts include a change in sea levels, ecosystems, and ice cover. The United States Congress is considering proposals to limit greenhouse gas emissions using market-based mechanisms that would place a price on emissions. Such programs would create an economic incentive for regulated entities to limit their emissions.

Limiting greenhouse gas emissions requires an understanding of existing emissions as well as the development of a program to monitor, report, and verify emissions from entities that might be affected by a future regulatory program. A greenhouse gas mitigation program also requires an understanding of the numerous emissions sources and methods for calculating emissions of six major greenhouse gases—carbon dioxide, methane, nitrous oxide, and several synthetic gases.

This testimony focuses on (1) the importance of quality data on emissions in the context of a program intended to limit greenhouse gas emissions, and (2) key considerations in developing reliable data on greenhouse gas emissions. This testimony is based on several prior GAO reports and a review of related literature.

View GAO-423T or key components. For more information, contact John Stephenson, (202) 512-3841, stephensonj@gao.gov.

What GAO Found

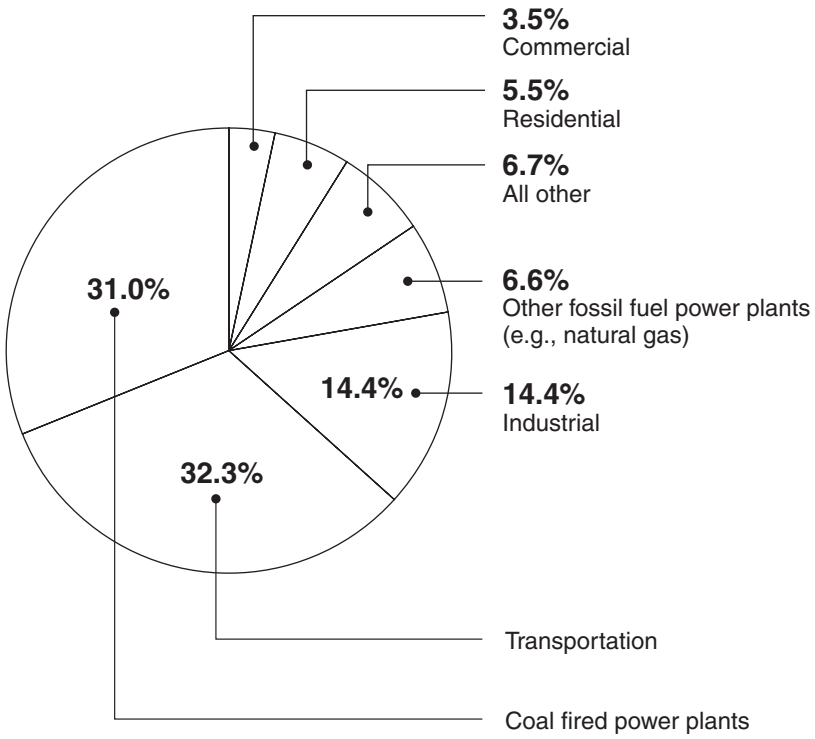
Quality data on emissions are essential to the development and implementation of a system intended to limit greenhouse gas emissions. Domestic and international experiences with cap-and-trade programs, which place a price on emissions, demonstrate the importance of data quality in establishing baselines, monitoring results, and maintaining the integrity of a program. Existing cap-and-trade programs establish an overall allowable level of emissions and distribute allowances to regulated entities, which in turn are able to buy or sell excess allowances. The United States has operated a cap-and-trade program to limit emissions of sulfur dioxide—a pollutant that contributes to acid rain— from electric utilities since 1995. Based on prior GAO work and independent studies, the program has benefited from the development of an accurate emissions baseline for regulated entities as well as strong monitoring, verification, and reporting requirements. The European Union has also employed a cap-and-trade system to limit emissions of carbon dioxide—the most prevalent greenhouse gas—from electricity generators and certain industrial sectors since 2005. In November 2008, GAO reported that the program has faced challenges because of a lack of facility-specific data on baseline emissions. While the program has addressed many of these challenges, the European Union's experience demonstrates the importance of data quality in establishing a market-based program to limit greenhouse gas emissions.

Key considerations in developing reliable data on greenhouse gas emissions revolve primarily around the purpose and intended use of the data. In cases where the data are used to develop or implement a program to limit emissions, key considerations include (1) the scope of the program across emissions sources, such as whether it affects all emission-producing activities or a specified subgroup, and (2) the program's coverage across the six primary greenhouse gases. These considerations depend on the point of regulation—namely, whether the program affects a small number of "upstream" emitters such as fossil fuel producers and importers or instead affects smaller "downstream" emitters such as individual industrial facilities. Overall, the challenges in establishing baseline emissions data, as well as in monitoring, reporting, and verifying ongoing emissions will increase as the number of regulated entities, activities, and greenhouse gases increase. In some cases, existing emissions inventories (typically at the national, state, or industrial sector level) and registries (typically at the facility or project level) provide a starting point for understanding the challenges in establishing baselines and tracking emissions over time. For example, the United States Environmental Protection Agency maintains an official U.S. emissions inventory that provides national-level emissions data and background on methods to calculate emissions. In addition, several inventories and registries maintained at the regional level or by private and nonprofit entities provide a useful starting point for understanding data needs and developing standards for monitoring, reporting, and verification.

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss the importance of high quality data on greenhouse gas emissions in the development and implementation of programs intended to address climate change. In recent years, key scientific assessments have underscored the importance of reducing or stabilizing emissions of carbon dioxide and other greenhouse gases—including methane, nitrous oxide, and several synthetic gases—to mitigate the adverse effects of climate change. According to the National Academy of Sciences, global temperatures have already risen 1.4 degrees Fahrenheit since the start of the 20th century—with much of this warming occurring in the last 30 years—and temperatures will likely rise at least another 2 degrees Fahrenheit, and potentially more than 11 degrees, over the next 100 years. Most scientists agree that the warming in recent decades has been caused primarily by human activities that have increased the amount of greenhouse gases in the atmosphere. This warming will cause significant changes in sea level, ecosystems, and ice cover, among other impacts. In the Arctic region, temperatures have increased almost twice as much as the global average, and the landscape is changing rapidly. Figure 1 below identifies the contribution of carbon dioxide emissions, the most prevalent greenhouse gas, from various sources in the United States.

Figure 1: Contribution of Various Sources to Total U.S. Carbon Dioxide Emissions



Source: GAO analysis of data Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006* (April 2008).

The Congress is currently considering various proposals to address or mitigate the adverse effects of climate change, including actions to limit greenhouse gas emissions. In the United States, most debate over mitigation options generally focuses on market-based programs—such as carbon tax or cap-and-trade system—that would create a price on emissions of greenhouse gases. For either program, the point of regulation may occur (1) "upstream" and cover sources of carbon dioxide when they first enter the economy, such as fossil fuel producers; (2) "downstream" and cover direct and indirect emitters, such as power plants; or (3) at a combination of upstream and downstream sources.

In general, under a cap-and-trade program, the government would limit the overall amount of greenhouse gas emissions from regulated entities. These entities would need to hold allowances for their emissions, and each allowance would entitle them to emit a specific amount of a greenhouse gas. Under such a program, the government could sell the allowances, give them away, or some combination of the two. Firms that find ways to

reduce their carbon dioxide emissions to below their allowed limit could sell their excess allowances to firms that emit more than their limits, effectively creating a market for allowance trading and establishing a price for a ton of emissions based on supply and demand.

Another possible mitigation policy is a tax on greenhouse gas emissions. A tax would establish a direct price on emissions by levying a charge on every ton of carbon dioxide emitted, creating an economic incentive for emitters of greenhouse gases to decrease their emissions by, for example, using fossil fuels more efficiently. Unlike a cap-and-trade program, a tax would provide more certainty as to the cost of emitting greenhouse gas emissions, but the precise effect of the tax in reducing emissions would depend on the extent to which producers and consumers respond to higher prices.

In discussing the emissions data required for a climate change mitigation program, it also is useful to distinguish between emissions inventories and emissions registries. Emissions inventories aggregate emissions data on a high level—for example, by state, industrial sector or country. Inventories generally account for greenhouse gases emitted and removed from the atmosphere over a specific timeframe. An emissions registry, on the other hand, is a tool for collecting, verifying, and tracking emissions data from individual facilities or projects. Because registries can serve a variety of purposes, their structures may vary substantially. For example, registries may vary in terms of the gases monitored, the timing of data collection, and the method of data verification.

In this context, my testimony today discusses (1) the need for high quality data on emissions in the context of a program intended to limit greenhouse gas emissions, and (2) key considerations in developing reliable data on greenhouse gas emissions. This testimony is based on our previously issued work and a review of relevant literature.[1]

[1]We conducted our work in accordance with all sections of GAO's Quality Assurance Framework that were subject to the objectives of each engagement. The framework requires that we plan and perform each engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations in our work. We believe that the information and data obtained, and the analyses conducted, provided a reasonable basis for the findings and conclusions in these reports.

High Quality Emissions Data are Critical to the Integrity of Programs Intended to Limit Greenhouse Gas Emissions

The domestic and international experiences with market-based air pollution control and climate change programs demonstrate that comprehensive and accurate information on emissions is critical to a program's success. Since 1995, the United States has operated a cap-and-trade program to limit sulfur dioxide emissions, an air pollutant that contributes to acid rain, from electric utilities. Under Title IV of the Clean Air Act Amendments of 1990, this program has reduced sulfur dioxide emissions by capping total emissions, distributing allowances to emit sulfur dioxide through a combination of free allocation and auctions, and allowing electric utilities to buy and sell allowances as needed to cover their emissions.

Prior GAO reports and independent studies have shown that strong data collection, monitoring, reporting, and verification requirements have been central to this program's success. First, with respect to setting a baseline level of emissions from regulated entities, the program relied on data spanning several years rather than any one year in particular. Specifically, it used historical average emissions from 1985 to 1987 as the baseline against which to measure reductions required to begin in 1995 and 2000. The use of historical data reduced the covered entities' incentive to increase emissions prior to the program's establishment to obtain a greater allowance allocation—the baseline years occurred too far before the announcement of the program.[2] Averaging these data across several years also helped to ensure that the baseline reflected changes in emissions that can result in a given year due to economic and other conditions. As a result, the program achieved greater assurances that it reduced emissions from historical levels. In addition, electricity generating units regulated under Title IV of the Clean Air Act Amendments of 1990 are required to monitor and report their sulfur dioxide, nitrogen oxide, and carbon dioxide emissions, among other data. The monitoring and reporting requirement has ensured a high degree of compliance and overall program integrity. It is important to note that regulating a single pollutant, such as sulfur dioxide, from a largely homogenous population of electric utilities is less complicated than monitoring, reporting, and verifying emissions of up to six different greenhouse gases from diverse types of facilities.

The European Union also has experience implementing a cap-and-trade program that illustrates the importance of quality data in a market-based

[2]See GAO, *Air Pollution: Allowance Trading Offers an Opportunity to Reduce Emissions at Less Cost*, GAO/RCED-95-30 (Washington, D.C.: Dec. 16, 1994).

system. As discussed in our November 2008 report, the European Union's Emissions Trading Scheme (ETS) relies on a cap-and-trade model similar to that used in the U.S. acid rain program.[3] The ETS began with a learning period—phase I—to gain experience with emissions trading from 2005 to 2007. Phase I included approximately 11,000 electric power and industrial installations in 25 member states, which accounted for about half of the EU's carbon dioxide emissions.

While the first phase provided key lessons about emissions trading, its cumulative effect on emissions is uncertain because of a lack of baseline emissions data. In the first phase, each EU member state had to identify which entities to regulate under the ETS (such as power plants, oil refineries, and other manufacturing facilities), obtain baseline emissions data for the covered entities, establish an emissions cap, and determine how many allowances to distribute to each covered entity. At the time, most member states had high-level, aggregated estimates on carbon dioxide emissions that accounted for sources within and outside the scope of the ETS, but did not have baseline data on a facility-specific basis. This facility-specific data was necessary to determine both the total emissions released by all entities covered under the ETS—a downstream program—as well as how many allowances each particular entity would need to cover its annual emissions. In addition, some member states had limited authority to collect data because they did not yet have in place a national law or regulation mandating submission of emissions data. Accordingly, member states based their emissions caps and allocation decisions on business-as-usual emissions projections and baseline data voluntarily submitted by covered entities.

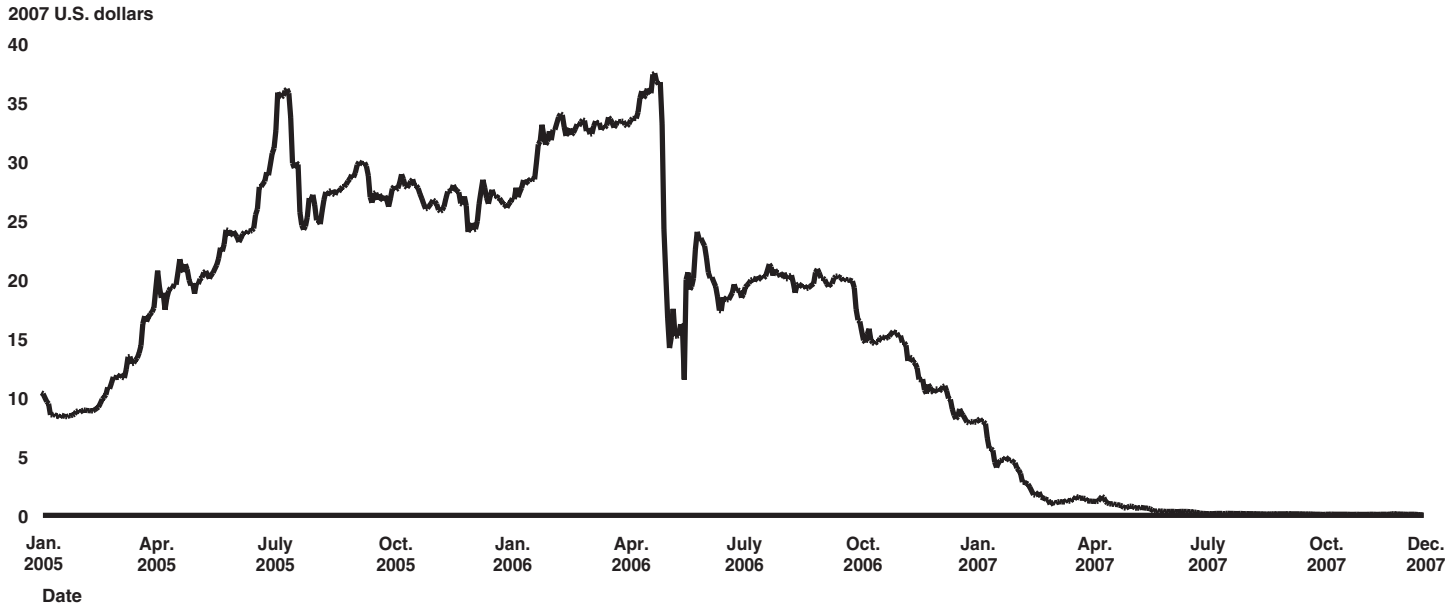
The inherent uncertainty about business-as-usual projections—i.e., how actual emissions compare to the emissions that would have occurred in the absence of the ETS—was compounded by the assumptions underlying the models used by member states to forecast emissions. The models incorporated assumptions about factors that influence business-as-usual emissions projections, such as economic growth and relative fuel prices. Some member states made relatively optimistic assumptions about economic growth, which resulted in higher projections of emissions. As such, while the first phase provided key lessons about emissions trading,

[3]See GAO, *International Climate Change Programs: Lessons Learned from the European Union's Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism*, GAO-09-151 (Washington, D.C.: Nov. 18, 2008).

the lack of facility-specific baseline data means its cumulative effect on emissions is uncertain.

The lack of facility-specific baseline data also affected the price of ETS allowances. Under the ETS, covered entities are required to report emissions data that have been verified by third parties to their member states. In 2006, the release of emissions data revealed that the supply of allowances—the cap—exceeded the demand, and the allowance price collapsed. This illustrated the problems that can arise when a program relies on poor baseline emissions data and highlighted the need for accurate baseline data in setting an effective emissions cap and achieving the intended environmental objectives. See figure 2 for a graph displaying the allowance price trends in phase I.

Figure 2: EUA 2007 Prices



Source: Point Carbon (2007).

As we reported in our prior work on lessons learned from the international climate change programs, many experts participating on a panel we assembled in cooperation with the National Academy of Sciences would not expect the United States to encounter the data challenges experienced in the EU's first trading phase because some baseline emissions data are

already available.[4] Several experts also stated that existing data on fossil fuel consumption are sufficient to establish an emissions trading program. These data can be used to estimate economy-wide carbon dioxide emissions as well as facility-specific data on carbon dioxide emissions from certain industrial sectors, such as power plants that have participated in the US sulfur dioxide emissions trading program.

Collecting and reporting emissions data can also provide benefits beyond ensuring the integrity and results achieved through a greenhouse gas reduction program. Such data can be used by researchers to analyze environmental conditions and trends, create atmospheric and economic models, and provide early warning of potential environmental problems. It can also help inform and direct environmental management efforts. The availability of emissions data may aid strategic planning in the private sector, enabling individual firms to make better-informed decisions pertaining to capital investments and energy use. Because many states, municipalities, and private firms have established voluntary climate goals, emissions data will enable these organizations to assess progress and better account for performance. Finally, the availability of emissions data can provide a consistent and transparent basis for comparison between countries, industries, and individual firms and enhance public understanding of emissions sources.

Collecting Reliable Data on Greenhouse Gas Emissions Involves Key Considerations.

Monitoring, reporting, and verification needs for reliable data on greenhouse gas emissions depend first on the purpose and intended use of the data; for example, the data required for a mandatory program to limit emissions may vary substantially from that required for a business or governmental entity that voluntarily tracks its emissions for public relations or other purposes.

First, as we have previously reported, the scope of a data collection effort—i.e. monitoring, reporting, and verification activities—is determined by the program's point of regulation. An upstream mitigation program would affect a relatively small population of regulated entities, such as fuel importers and producers, whose products could be less difficult to measure and report. The quantity of emissions associated with

[4]See GAO-09-151.

those products could be calculated using available emissions factors.[5] Under a cap-and-trade program, each importer or producer would have to hold an allowance for each ton of carbon dioxide emissions associated with its products. Alternatively, under an emissions tax, each regulated entity would have to pay the government a pre-determined amount of money for each ton of emissions associated with the combustion of its products. Under either system, accurate reporting and verification of emissions would help ensure the integrity of the program, and accurate and reliable baseline data would be necessary to track progress.

On the other hand, data collection, monitoring, and verification requirements become more substantial under a downstream program because it could affect a larger population of regulated entities, potentially including industrial facilities, agricultural operations, mobile and other fuel combustion sources, and users of refrigerants. Again, each regulated entity would need to have accurate and reliable data on historical and current emissions, and in some cases, gathering such information would be relatively straightforward. For example, electricity generating units regulated under Title IV of the Clean Air Act Amendments of 1990 are required to monitor and report their carbon dioxide emissions. However, other regulated entities may face greater challenges in determining their emissions due to limited monitoring data or a lack of reliable emissions factors.

Furthermore, the data requirements for a mitigation program become more complex and challenging as the number and types of covered activities increases.[6] This challenge may be of particular concern in a downstream program that covers emissions from diffuse sources. Of the six primary greenhouse gases, emissions of some are better characterized than others.[7] For example, carbon dioxide emissions from energy-related activities and cement processing are relatively easy to estimate with a high degree of

[5]An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. See, for example, EPA's AP-42 emissions factors, available at http://www.epa.gov/ttn/chief/ap42/.

[6]See GAO-09-151.

[7]See U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006 (April 2008), http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

accuracy, whereas measuring the emissions of other greenhouse gases stemming from other types of activities is more challenging. Specifically, there may be insufficient scientific understanding to develop a data collection methodology, data may be incomplete or missing, or emissions factors may not be sufficiently developed. For instance, nitrous oxide emissions occur from the production of caprolactam—a chemical used to produce a polymer—but there are currently not enough data on the production of caprolactam to estimate these emissions in the United States.

In some cases, existing emissions inventories and registries that have been developed for a variety of purposes could help regulated entities in meeting potential requirements to establish baseline emissions levels and monitor, verify, and report their ongoing emissions. For example, the United States Environmental Protection Agency prepares an official U.S. greenhouse gas inventory each year to comply with its commitments under the United Nations Framework Convention on Climate Change (UNFCCC). This inventory provides national information on the activities that cause emissions and removals, as well as background on the methods used to make the calculations. In addition to the U.S. inventory, multi-state emissions reduction programs, such as the Regional Greenhouse Gas Initiative, a regulatory program targeting reductions in carbon dioxide from electricity generators, have developed emissions inventories to guide their programs. Many individual states also prepare greenhouse gas inventories using guidance provided by EPA. These existing inventories and registries could assist in the development of a mandatory emissions reduction program.

Other emissions inventories and registries developed by government and private entities also provide a useful starting point for understanding data requirements for establishing emissions baselines and monitoring, verifying, and reporting greenhouse gas emissions.[8] For example, the Department of Energy's Voluntary Reporting of Greenhouse Gases Program encourages corporations, government agencies, non-profit organizations, households, and other private and public entities to annually report their greenhouse gas emissions, emission reductions, and

[8]Pub. L. No. 110-161, tit. II, 121 Stat. 1844, 2128 (2007) directs EPA to develop a rule requiring mandatory reporting of greenhouse gas emissions from all sectors of the economy.

sequestration activities to a registry using consistent standards.[9] In addition, EPA's Climate Leaders Program, an EPA industry-government partnership that works with companies to develop comprehensive climate change strategies, has developed standards to measure and monitor emissions reductions from certain types of projects.

Several private and nonprofit efforts also provide data collection services. For example, the Greenhouse Gas Protocol, a widely-used international accounting system for quantifying and managing greenhouse gas emissions, has developed accounting and reporting standards that are compatible with most greenhouse gas inventory programs.[10] Another effort, the Climate Registry, is a nonprofit collaboration involving U.S. states and Canadian provinces that has developed standards to calculate, verify, and report greenhouse gas emissions. Both voluntary and mandatory programs can use the Climate Registry's standards and publicly report their emissions through its website. Other private initiatives, such as the Chicago Climate Exchange (CCX), a voluntary emission reduction and trading system, requires participants to establish emissions baselines and track their progress towards emissions reduction goals. Emissions reductions through CCX must be confirmed by an independent, third party verifier. Finally, an entire industry of companies exists to help companies track and monitor their greenhouse gas emissions and many have developed protocols and best practices for measuring baseline emissions levels and tracking reductions. Many of these companies also provide external third-party verification services to help industrial and other facilities ensure the accuracy of their emissions accounting practices.

Mr. Chairman, this concludes my prepared statement. I would be happy to respond to any questions that you or other Members of the Subcommittee may have at this time.

[9]Sequestration activities refer to biological projects that pull carbon dioxide out of the air by, for example, planting trees or enhancing the management of agricultural soils, and geological projects that capture and store carbon dioxide in underground formations.

[10]The Greenhouse Gas Protocol was developed by the World Resources Institute, a U.S. nongovernmental organization, and the World Business Council for Sustainable Development, a Geneva-based coalition of 170 international companies.

Contact and Staff Acknowledgments

Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. For further information about this testimony, please contact John Stephenson, Director, Natural Resources and Environment at (202) 512-3941 or stephensonj@gao.gov. Key contributors to this statement were Michael Hix (Assistant Director), Kate Cardamone, Jessica Lemke, Alison O'Neill, and Joseph Thompson. Chuck Bausell, Cindy Gilbert, Richard P. Johnson, Carol Kolarik, Micah McMillan, and Jeanette Soares also made important contributions.

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