The Utah Water Journal
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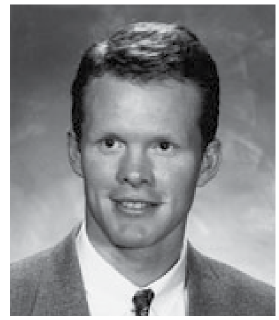
Hydraulic Model Study of Tom Miller Dam

Originally constructed in 1893, the Austin Dam (Tom Miller, Austin, TX) was designed to provide water and hydroelectric power to the City of Austin

Texas flash floods 'hit' Logan. Water experiments help researchers plan update of dam

Guest Editorial



Organizations

Substitute Teachers

The Substitute Teaching Institute (STI) was created at Utah State University in 1995 to provide substitute teachers with handbooks containing educational "how-to's" and classroom fill-in activities.

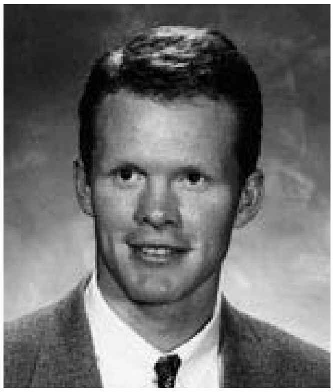
Projects

A Field Method for Analysis of Arsenic in Drinking Water

Predicting Flow Resistance due to Vegetation in Flood Plains

USU students competed in the Air and Waste Management Association Convention in Orlando, finishing in first place for their undergraduate category presentation "National Trends in Tropospheric Ozone."

Editorial



Dr. Michael Johnson's expertise is in Hydraulic model studies; spillway analysis and operation.

In this issue . . .

As you will see, we have designed this issue of the UWJ to illustrate the large scope of water-quality issues facing not only Utah citizens and water experts, but other experts in Texas to relate the important progress being made in this area, and to assist all our readers in obtaining a better understanding of the relationship between water quality and quality of life.

Welcome to the third issue of the Utah Water Journal. My name is Mike Johnson, and I am a researcher at the Utah Water Research Laboratory (UWRL) and an Adjunct Professor in the Department of Civil and Environmental Engineering at Utah State University. The focus of my commentary will be on the Tom Miller Dam and the hydraulic model of the dam that is currently being tested in the hydraulics bay of the UWRL.

Originally constructed in 1893, the Austin Dam (Tom Miller Dam) was designed to provide water and hydroelectric power for the City of Austin, TX. The dam consisted of a masonry overflow section with a length of approximately 1,100 feet and a height of 68 feet. The dam failed in 1900 resulting in major damage to the structure and the loss of eight lives. The dam was reconstructed in 1914. During the largest flood of record in 1935, the dam again failed, destroying nearly all of the piers that had been added during the reconstruction.

The Lower Colorado River Authority (LCRA), formed in 1934, and under an agreement with the City of Austin, rebuilt the dam in 1940 and renamed the dam the Tom Miller Dam. The dam has remained intact from that date to the present; however, there are stability concerns with the aging structure. The dam has an uncontrolled gravity section, four large (51 feet long by 18 feet high) Tainter gates, and five small (51 feet long by 12 feet high) Tainter gates. The Figure shows an aerial overview of the dam.

In 1992, the Dam Safety Evaluation Project redefined the Probable Maximum Storm and the Probable Maximum Flood (PMF) for Tom Miller Dam. The PMF is approximately 834,500 cfs with a corresponding reservoir elevation that is approximately 30 feet higher than the crest of the uncontrolled overflow section. State Dam Safety regulations in Texas for all large, high hazard dams require safe passage of the full PMF. As previously mentioned, there are some concerns regarding the stability of the dam and its structural integrity when passing the PMF and other large flood events.

Utah State University (USU) was contracted through the USU Research Foundation to conduct a hydraulic model study of the dam and to provide the data to Freese and Nichols of Austin, Texas. Freese and Nichols will use the data to design modifications to stabilize and strengthen the dam. The physical model is being completed in three parts; first, a sectional model of the uncontrolled spillway (1:30 scale) was modeled to obtain hydrodynamic loading data, second, a sectional model of the gated spillway (1:36 scale) was modeled to obtain hydrodynamic loading and gate performance data, and third, a full-width model (1:50 scale) was constructed to evaluate scour, gate sequencing operations, scour characteristics, overtopping, and flow patterns over and near the dam.

It is anticipated that the hydraulic model will provide the data necessary for the design team of Freese and Nichols to produce a stabilization design that will see the dam well into the next century.

We invite you to contact us if you have additional questions or comments.

Michael Johnson
Guest Editor
Last Revised: August 3, 2001

Tom Miller Dam

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Air View of Miller Dam

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Miller Dam Model Demonstration at the UWRL

The general purpose of this hydraulic model study was to:

Provide hydrodynamic pressure and flow data for a section of the dam representative of the uncontrolled spillway section. This was accomplished using a 1:30 scale sectional model.

Provide hydrodynamic pressure and flow data for a section of the dam representing the damÕs profile at gate number 5 and gate number 6. Determine the piezometric conditions in the hollow section of the dam for each section. This was accomplished using a 1:36 scale sectional model.

Provide a rating curve of the entire dam and quantify the scour potential existing downstream from the dam.

Identify modifications that would reduce the scour potential downstream from the dam.

Another view of the Miller Dam Model at the UWRL

The aforementioned items briefly discuss the purpose of the study. The full scope of the model study is available from Dr. Mike Johnson.

This report discusses the results of the hydraulic model study of Tom Miller Dam conducted at the Utah Water Research Laboratory (UWRL) in Logan, Utah.

The hydraulic performance of the dam was verified up to the PMF. may contact Ms. Judith L. Sims, Research Assistant Professor, at (435) 797-3159, (435) 797-3663 (Fax), jlsims@cc.usu.edu, or the training center website at [http://www.neng.usu.edu/uwrl/training].

Texas flash floods 'hit' Logan

Water experiments help researchers plan update of dam

By James Thalman
Deseret News staff writer
Deseret News, Wednesday, April 11, 2001

LOGAN -- The Logan River has been turned into a notorious Texas flash flood repeatedly and on demand the past few months.

USU research scientist Michael Johnson adjusts gates on a scale-model Texas dam at the Utah Water Research Lab.
Jeffrey D. Allred, Deseret News

As part of a $40 million dam modernization effort in central Texas, a pet project of former Gov. George W. Bush, northern Utah mountain runoff is being used to replicate water at its worst on the Lower Colorado River, which runs through Texas and is not connected to the main Colorado River that flows through Utah and five other western states.

Safely diverted through the pipes and confines of the Utah Water Research Lab at Utah State University, the water in minutes reaches simulated "probable maximum flood level" that is held back by a scale model of the infamous Tom Miller Dam just outside Austin.

The dam, which was the largest dam in the world spanning a major river when it was finished in 1893, has failed twice. Floodwaters broke through in April 1900, and again in 1915 when a nearly completed rebuild was washed away. The dam stood with its middle torn out for 20 years before it was repaired again.

It has stayed put since 1940, but 60 years of water pushing against it is also pushing its lifespan, said John King, principal engineer for the state's $50 million dam modernization project.

About $220,000 of that money has been spent building a dam one-fiftieth the size of the real thing inside the USU water lab. The 32-feet-wide concrete, wood and Plexiglas model allows scientists to replicate the movement of water as well as debris during a flood.

One reason the dam failed in 1915 is debris would not pass through and clogged its floodgates, causing too much pressure to build up.

King says spending the money to build the miniature dam has probably saved $12 million so far in design changes.

"We use computers to mathematically model what water will do, but the problem is water doesn't follow mathematical models," King said. "It's like trying to herd cats; it goes where it likes, often in ways you don't expect."

Watching the water flow through the model dam showed several things computers wouldn't, King said. For example, the way it chisels at the base of the dam when the flood gates are open. The way the gates are constructed causes the water to essentially turn back on itself well below the surface and eat its way back upstream.

"In the reconstruction, we will add an upturn at the bottom of the gates that will shoot the water into the air far enough that it will be impossible for it to turn back on itself," King said. "The backflow that wasn't immediately evident without running it through this model would have definitely undermined the dam."

Mike Johnson, a researcher with the water lab, said the Logan River supplies enough water that it can realistically replicate flooding and allow tests of floodgate sequencing that mimic and mitigate worst-case scenarios.

Johnson said the dam is one of three the lab has built for the Lower Colorado River Authority, which first contacted USU in 1992 after completing a master plan to assess the flood risk and remodeling of six dams.

The real Tom Miller Dam is one of six dams on the lower Colorado River. It is more than 100 feet high, 1,590 feet long, 155 feet thick at the base and provides 15,000 kilowatts of electricity from two generating units. Behind it is a reservoir, Lake Austin, that is more than 20 miles long, covers 1,830 acres and supplies about 85 percent of Austin's water supply.

A Field Method for Analysis of Arsenic in Drinking Water

Due to increasing concern about the adverse health effects from exposure to low levels of arsenic in drinking water, the United States Environmental Protection Agency (USEPA) has proposed lowering the Maximum Contaminant Level (MCL) for arsenic from the current limit of 50 mg/L down to 5 to 10 mg/L. Thousands of drinking water utilities nationwide will be impacted by this new rule, and most will have to install new processes for arsenic removal. Water utilities in the Western US are expected to be especially hard hit by this new regulation.

Utilities trying to meet the new MCL must be able to accurately measure arsenic concentrations in their raw and treated water. Although there are well-established laboratory methods for quantifying arsenic at concentrations less than 1 mg/L, they require instrumentation that is expensive, complicated and not available at the typical utility. In fact, most water treatment utilities, especially the smaller utilities that will be most affected by the new arsenic MCL, must send samples off-site to a contract or state laboratory for arsenic analysis. This is not only expensive, but can also make it difficult for a utility to optimize arsenic removal due to the time lag between collecting a sample and receiving the analytical results. The ideal solution would be if utilities had a portable field technique that could accurately measure the concentration of arsenic in water, without the cost and complication of advanced laboratory analytical instruments. Although several field methods for arsenic do exist, they cannot achieve the low detection limit necessary for meeting the new MCL.

The Utah Water Research Laboratory was recently awarded an American Water Works Association Research Foundation (AwwaRF) project to examine this problem. The project is a collaborative effort with Virginia Polytechnic Institute and State University, Carollo Engineers, and nine water treatment utilities from Utah, Idaho, Nevada, and California. The goal of this project is to develop a fast, safe, easy-to-use and inexpensive field test that can quantify arsenic at the low mg/L level. The methods being investigated are based on standard hydride generation followed by arsine detection with a portable gas monitor. The specific issues to be addressed are:

1) Development of an apparatus with off-the-shelf technology that is easy to use.

2) Using hydride generation protocols that maximize safety.

3) Examination of the best means of detecting arsine gas in the field.

4) Careful identification of key limitations of the technology for water utilities.

An essential part of this project will be a rigorous on-site testing of the measurement method by water utility personnel to evaluate its accuracy and ease of use. The combined result will be a field measurement technique for arsenic with an optimal sampling protocol that is written in user-friendly language and lists the limitations of the method in terms of interferences and detection limits.

For more information, contact Laurie McNeill at (435) 797-1522 or lmcneill@cc.usu.edu

Predicting Flow Resistance Due to Vegetation in Flood Plains

by

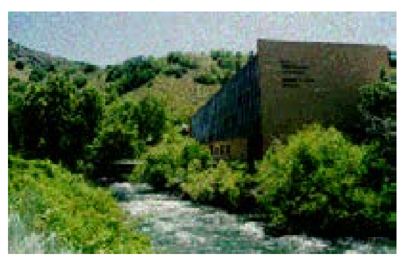
William Rahmeyer, P.E,. Ph.D., Utah State University
David Werth, Jr., Utah State University
David Derrick, Waterways Experiment Station
Gary Freeman, Waterways Experiment Station

ABSTRACT

To calculate flow or depth in a flood plain, it is necessary to accurately determine the flow resistance. Past research has made considerable progress in predicting the roughness of uniform channels based on both theoretical and experimental investigations. However, to determine the flow resistance associated with flood plains and over-bank flooding, the effects of vegetation must be considered. Over-bank flow typically submerges many types of plants and shrubs. Research has been conducted on vegetation such as dense-layered grasses and on the rigid blockage of cylindrical tree trunks. Very little has been studied on the resistance effects of plants and shrubs that are submerged by turbulent flows. The flexible stems and varying shapes of the plant's leaf mass greatly complicate the understanding of resistance.

The purpose of this study was to investigate the effects of vegetation, particularly ground cover plants and shrubs, on flow resistance. The primary objective of the study was to determine the head loss and resistance coefficients from plants in test conditions as close to in-situ as possible. The variables that were studied included: flow velocity, flow depth, plant geometry, drag force, plant density and spacing, plant distortion and bending, ecosystem groupings of plant types, sediment movement, and scour of bed material. It is not practical or feasible to test every type and size of plant in a large flume with varying plant densities and spacings. A methodology was developed to use either field measurements or the simpler sectional flume testing of single plants to predict head loss and resistance coefficients. The methodology includes the basis by which resistance can be predicted for different combinations of plant types and sizes. The objective of the sectional flume testing was to determine a correlation between drag force, geometric, and biomechanical plant properties. The overall goal of the sectional flume testing was to develop a methodology by which the vegetation resistance could be predicted from a field survey of plants and plant characteristics.

A number of species of riparian plants have been tested, resulting in a compilation of both resistance coefficients and drag force data for a wide range of flows and plant sizes. Methodology has also been developed to determine the drag force and resistance with in-situ nondestructive field tests. Current research promises a method by which to determine resistance occurring during over-bank flooding in channels with plant combinations of varying species and sizes. Information is also being gathered on the various flow regimes in and around plants and the effects of these regimes on channel erosion. This knowledge will in turn be used to determine the effectiveness of a channel to convey a given flow and to resist erosion during high flow events.



National Trends in Tropospheric Ozone

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Rank: Undergraduate

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Abstract

In 1997, EPA revised the national ambient air quality standards for ozone (O_3) by replacing the 1-hour ozone 0.12 parts per million (ppm) standard with a new 8-hour 0.08 ppm standard. However, subsequent implementation of the revised standard was delayed by a U.S. Court of Appeals decision favoring the petitioners, the American Trucking Association, Inc. In partial response, the EPA issued an RFP to update the O_3 criteria document. Utah State University was awarded a contract to compile the most recent nation-wide concentration data and examine the 1-hour and 8-hour trends since publication of the previous document (July 1996). In turn, parts of the task were incorporated into a group project for USU's senior-level Air Quality Management class.

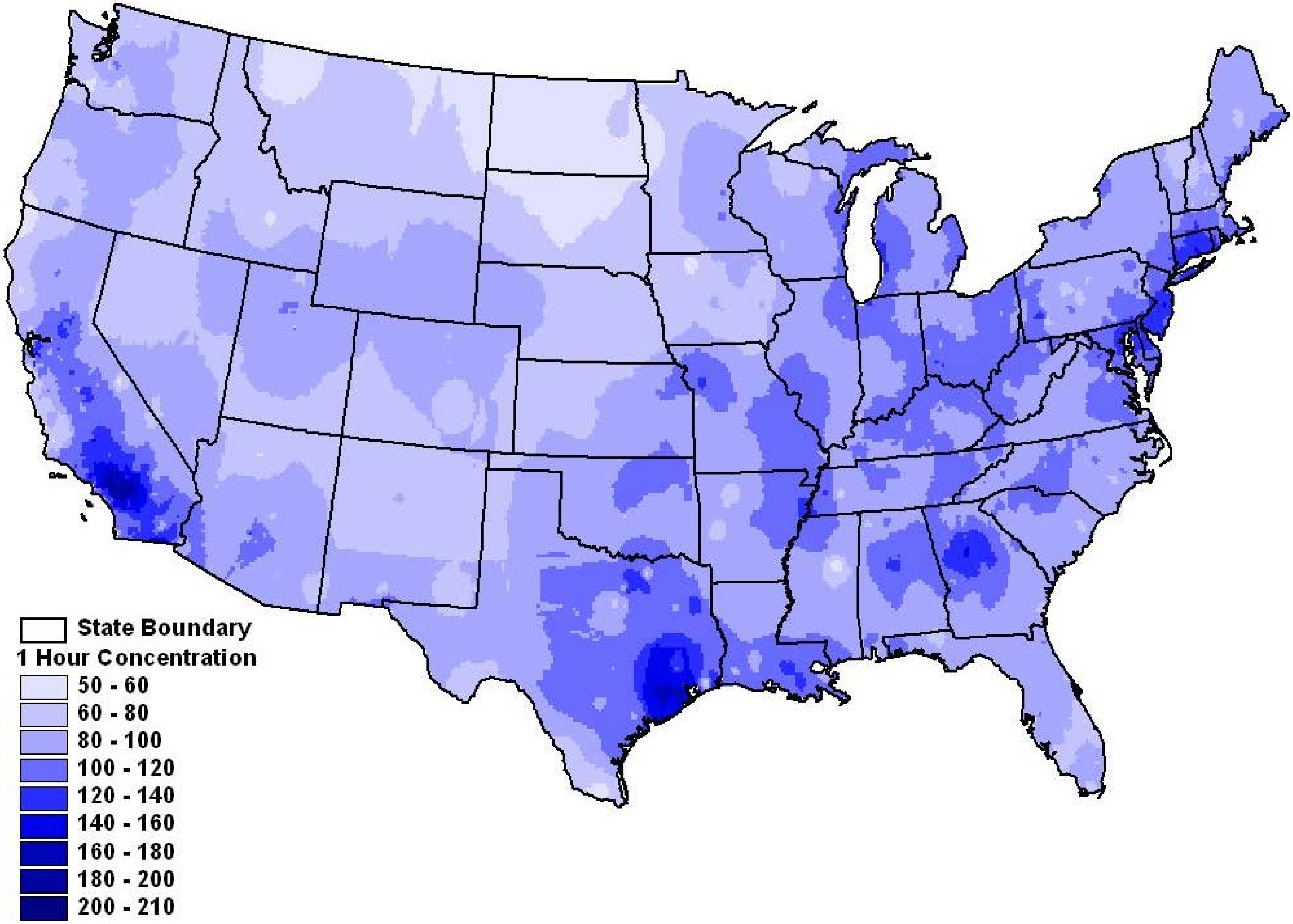
For 1998 data, the nation-wide average second highest 1-hour maximum was reported as 110 ppb and the fourth highest 8-hour maximum was found to be 87 ppb. From 1995 to 1999, the overall number of exceedances (1-hour) decreased from 2,017 to 804 even though the total number of monitoring stations increased from 998 to 1,092. In the 20 years since O_3 was first specifically regulated as a U.S. criteria pollutant, the national ozone concentrations (1-hour) have shown a downward trend of approximately 17% (total) or -1.5 ppb per year. However, most of this reduction occurred during the early years. From 1991, the most recent data reported within the 1996 document, until present (1998), the trend is less well defined and indicates only a slightly decreasing trend (-0.3 ppb/yr). From 1989 to 1998, the 8-hour O_3 trend showed no significant decrease or increase. This presentation presents detailed analyses of the national 1-hour and 8-hour O_3 concentrations, as well as an examination of selected urban areas, rural and Class I areas, and typical diurnal and seasonal O_3 concentration behavior.

Objectives

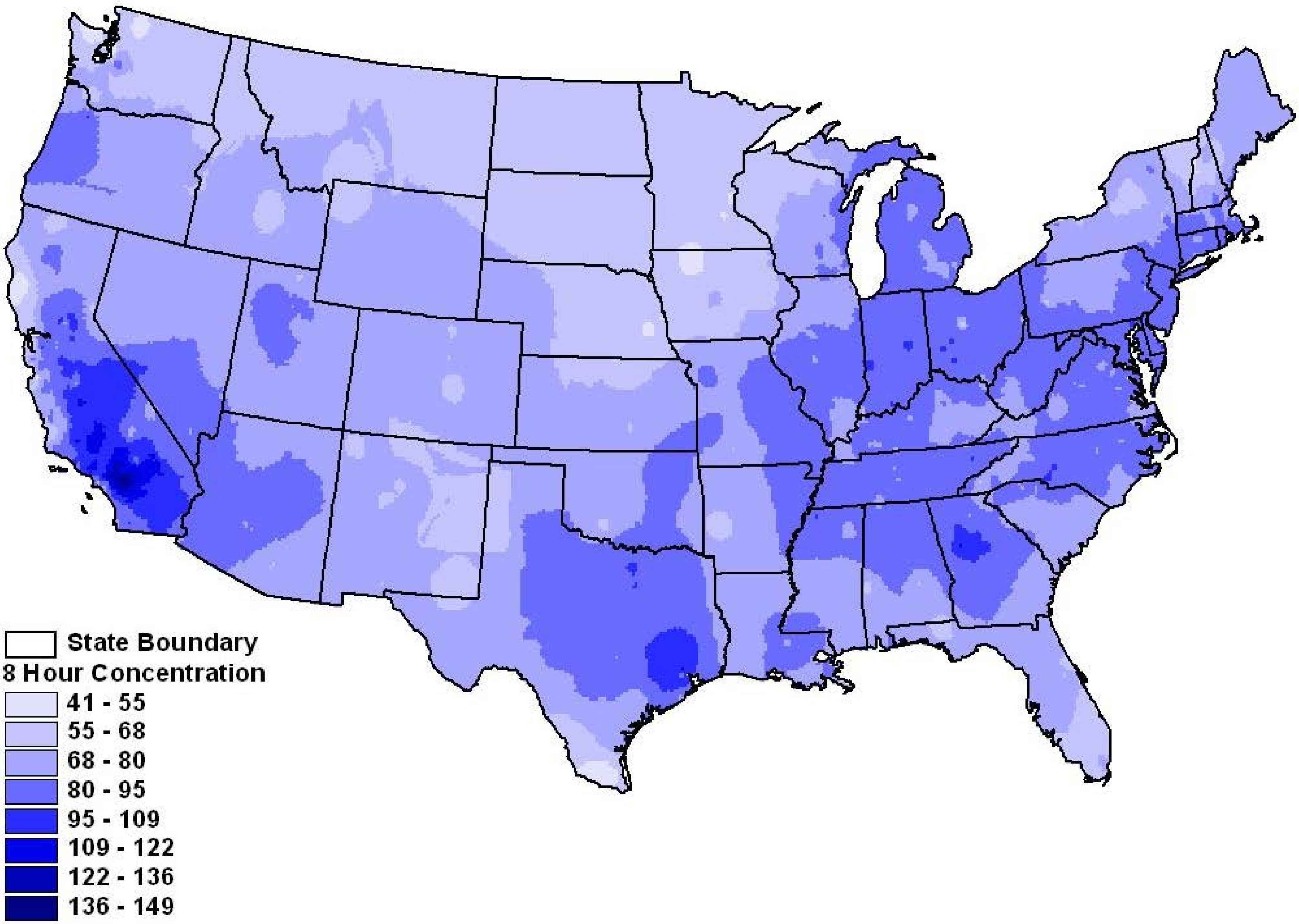
- Update 1996 Ozone Criteria Document in response to proposed 8-hour standard.
- Calculate and compare long-term national ozone trends for both 1 and 8-hour standards.
- Compile background ozone concentrations and trends, including Class 1 areas.
- Analyze seasonal and diurnal ozone variations.
- Examine spatial variance in ozone concentrations.

❖ *Information for data analyses obtained from AIRS database, TTN database, CASTNET data, State/Local agencies, NOAA/CMDL data, and published data.*

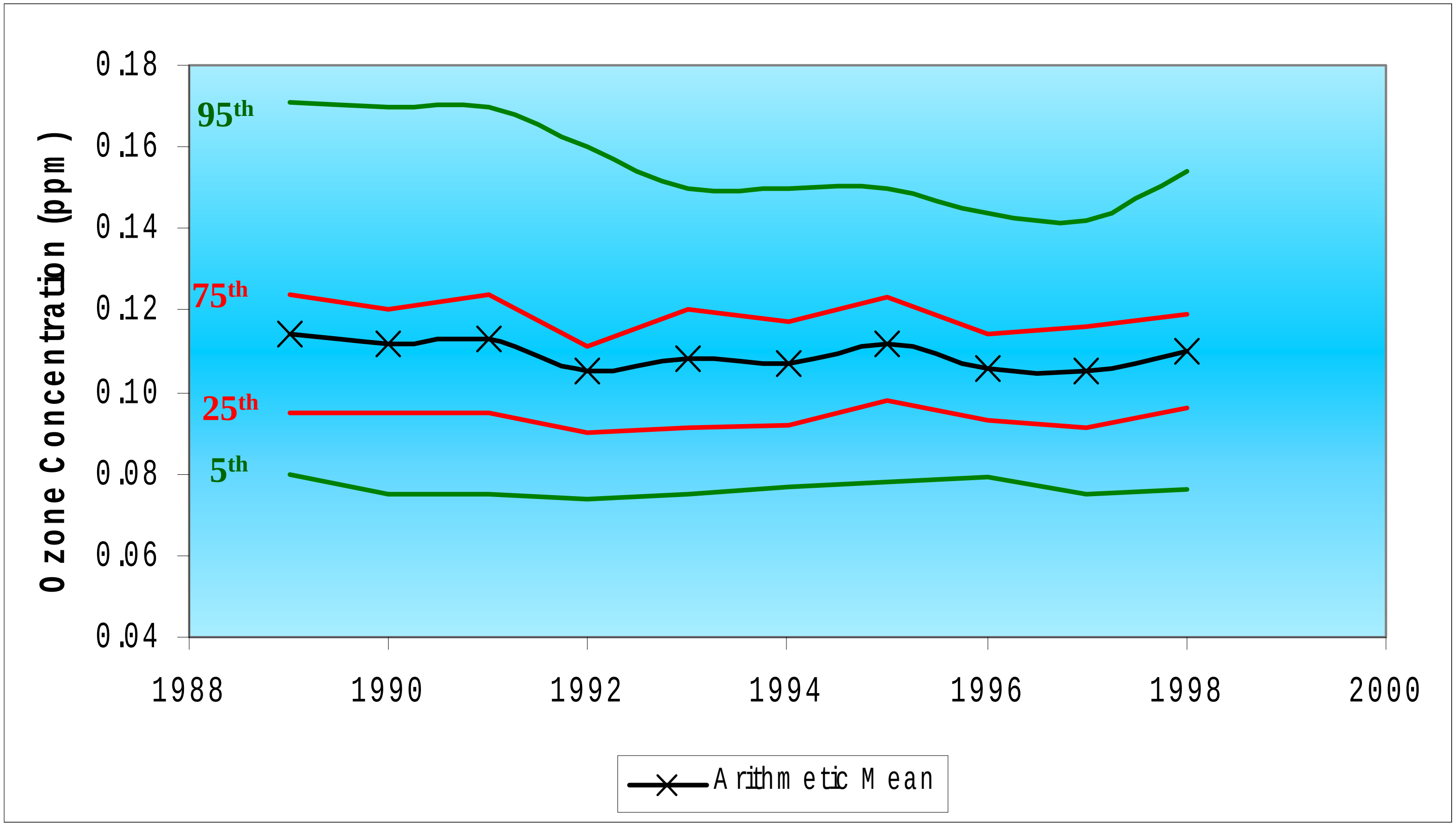
Surface Map of the 1-Hour 2nd Maximum Daily Average Ozone Concentration (ppb) from 1995 to 2000.



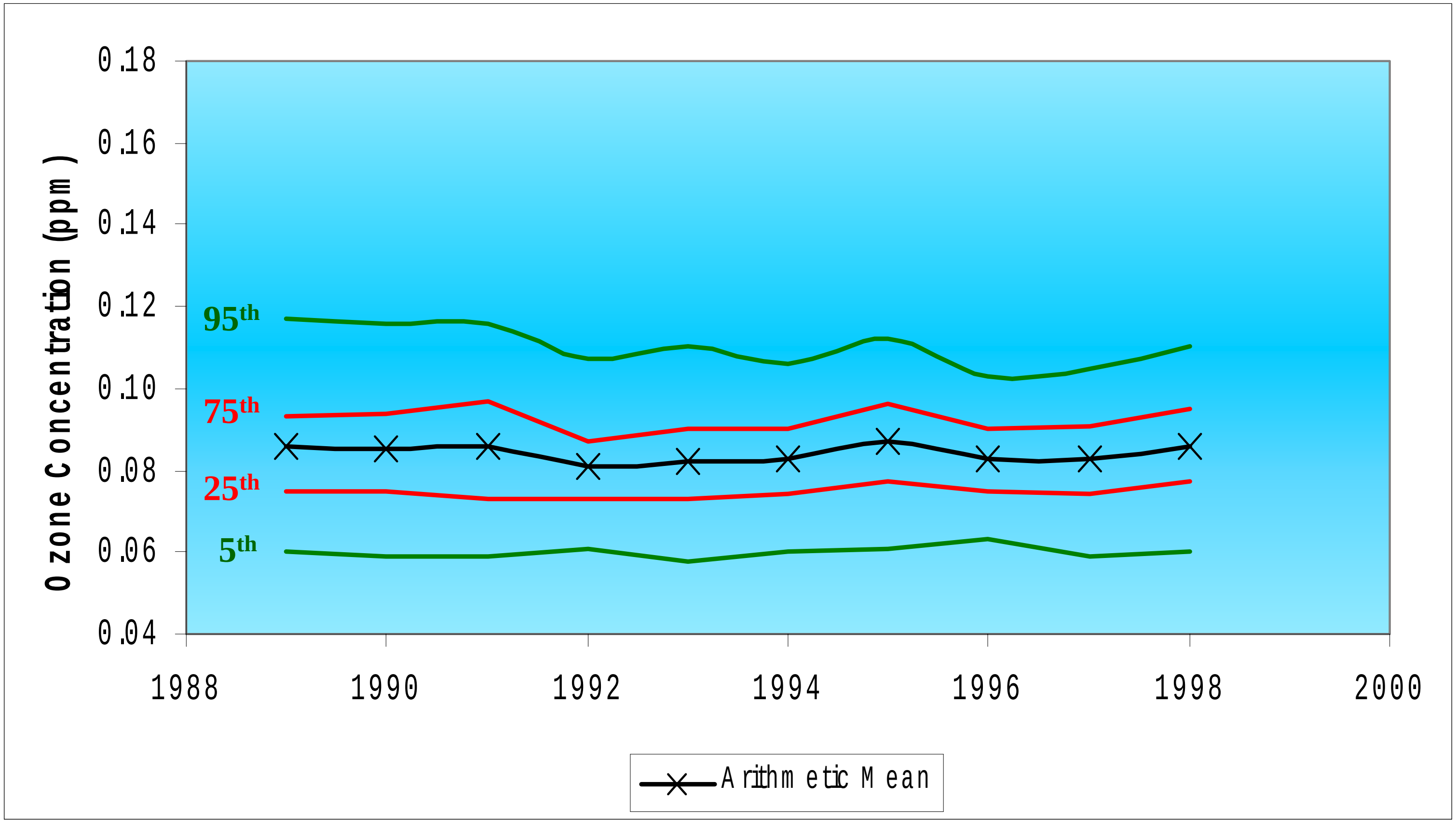
Surface Map of the 8-Hour 4th Maximum Daily Average Ozone Concentration (ppb) from 1995 to 2000.



National 2nd Maximum 1-hour Ozone Trend Statistics



National 4th Maximum 8-hour Ozone Trend Statistics



Selected City Summarization of Ozone Trends

Site	State	EPA Region	2000 1-hr 2nd Max, ppm	1995-2000 1-hr Trend, ppb/year	1999 8-hr 4th Max, ppm	1996-1999 8-hr Trend, ppb/year
Atlanta	GA	4	0.104	- 3.3	0.112	+ 5.9
Cook County	IL	5	0.078	- 5.8	0.084	+ 1.4
Houston	TX	6	0.129	- 2.8	0.105	+ 2.0
Los Angeles County	CA	9	0.116	- 7.2	0.078	- 6.3
Maricopa County	AZ	9	0.096	- 4.0	0.082	- 1.1
Philadelphia	PA	3	0.111	- 2.5	0.090	+ 0.5
Salt Lake County	UT	8	0.085	- 3.9	0.078	- 1.1
Seattle	WA	10	0.077	- 3.5	0.058	- 4.8
Averages			**0.099**	**-4.13**	**0.086**	**-0.4375**

Class 1 Area Ozone Trends

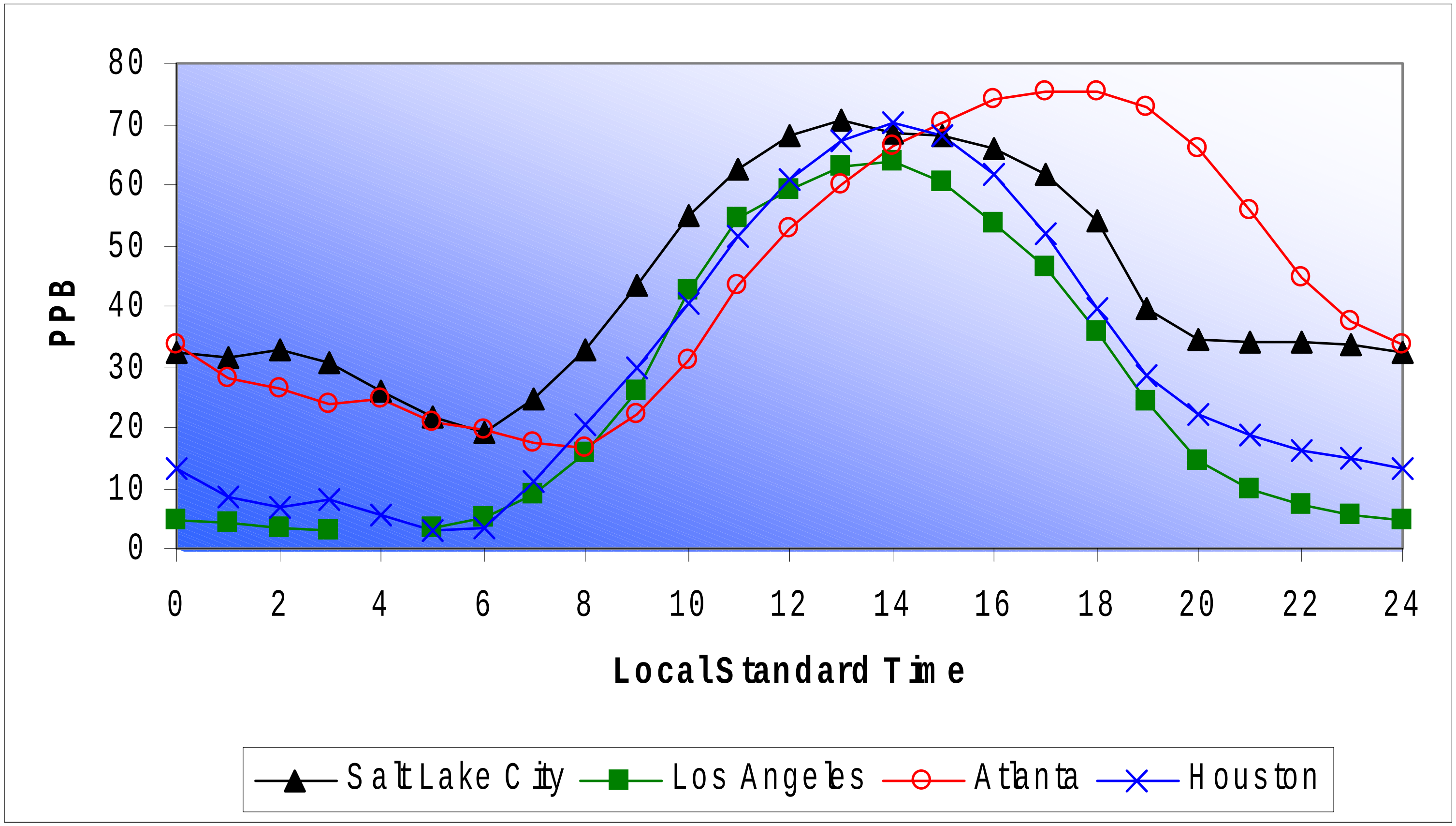
Site	State	EPA Region	2000 1-hr 2nd Max, ppm	1995-2000 1-hr Trend, ppb/year	1999 8-hr 4th Max, ppm	1989-1999 8-hr Trend, ppb/year
Acadia NP	ME	1	0.099[1]	-10*	nd	- 0.9*
Big Bend NP	TX	6	0.065	-1.9	0.064	+ 1.0*
Brigantine	NJ	2	nd	nd	nd	- 1.2*
Cape Cod NS	MA	1	0.107	-4.0	0.101	- 0.8
Cape Romain WR	SC	4	0.101	+1.1	0.080	+ 1.8*
Chiricahua NM	AZ	9	0.076	+ 0.03	0.072	+ 0.1
Congaree Swamp NM	SC	4	0.088	+ 0.1	0.080	+ 2.3*
Cowpens NB	SC	4	0.115	+2.4	0.094	+ 1.7
Denali NP	AK	10	0.046	-1.8	0.054	+ 0.7
Everglades NP	FL	4	0.076	+ 0.7	0.067	+ 0.6
Glacier NP	MT	8	0.054	+ 0.09	0.050	- 0.4*
Grand Canyon NP	AZ-UT	9-8	0.077	+ 0.6	0.076	+ 0.6*
Great Smoky Mtn	NC	4	0.102	+ 0.06	nd	+ 2.4*
Lassen Volcanic	CA	9	0.079	+1.0	0.084	+ 0.7
Mammoth Cave NP	KY	4	0.103	- 0.06	nd	- 0.1*
Olympic NP	WA	10	0.057	-2.9	0.043	+ 0.1
Pinnacles NM	CA	9	0.057	-8.1	0.082	+ 0.4
Rocky Mountain	NC	4	0.093	+ 0.03	0.074	+ 1.1
Saguaro NM	AZ	9	0.083	-3.3	0.069	+ 0.1
Sequoia/Kings C	CA	9	0.102[2]	-2.2	0.097	+ 0.1
Shenandoah NP	VA-WV	3	0.089	+ 0.9	0.093	+ 2.0
Theodore Rooseve	ND	8	nd	nd	nd	+ 0.2*
Yosemite NP	CA	9	0.093	-2.6	0.085	+ 0.03
Average Values			**0.084**	**-1.42**	**0.076**	**0.54**

1-Hour Ozone Nonattainment Area Summary With History

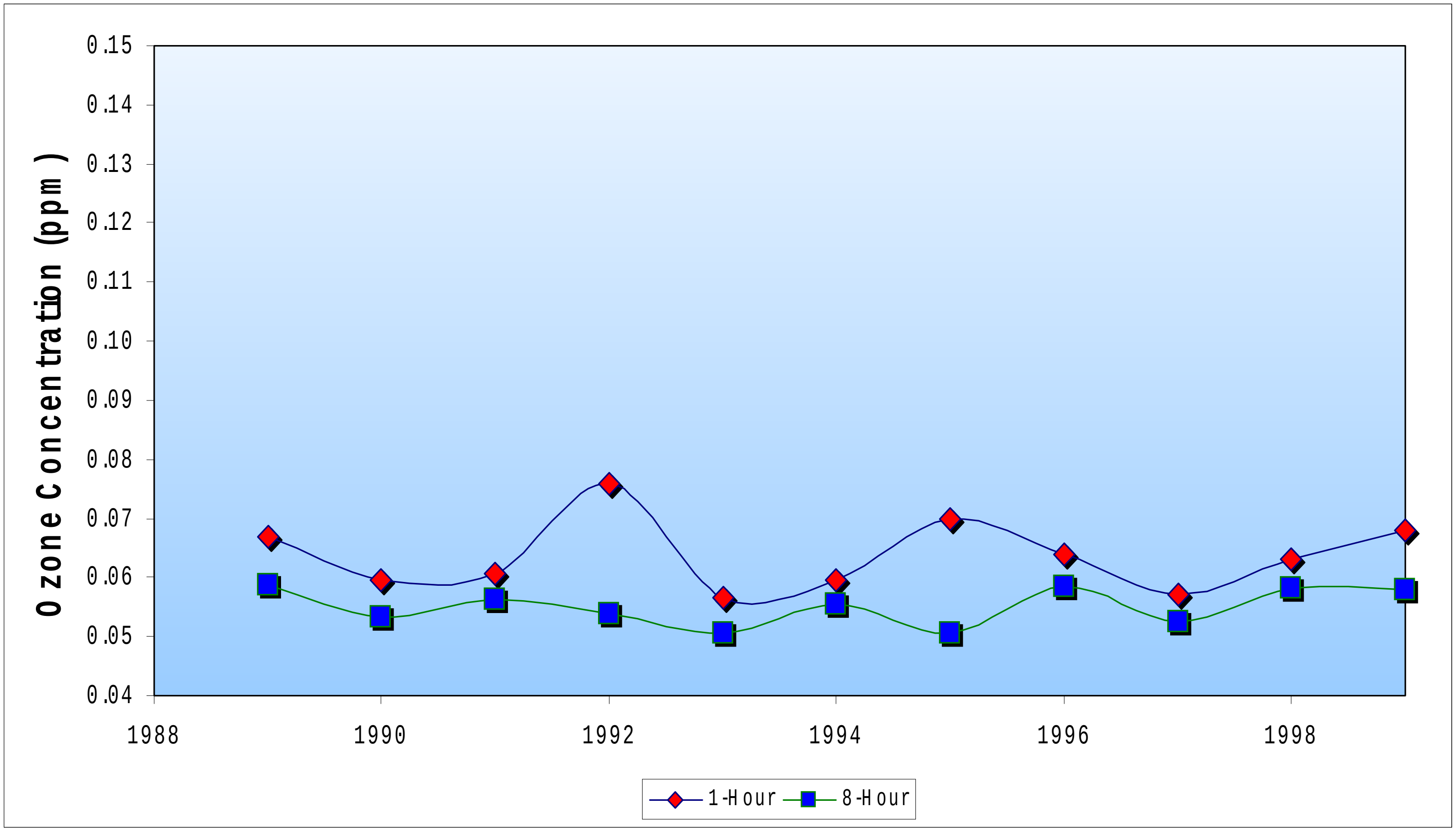
Classification	Number of Areas 1991	Number of Areas 2001	Number of Counties 1991	Number of Counties 2001
Extreme	1	1	4	4
Severe (2007)	5	5	51	51
Severe (2005)	4	4	27	27
Serious	14	14	80	80
Moderate	31	10	106	36
Marginal	44	21	90	43
Other	2	1	14	9
Section 185A	11	4	20	10
Incomplete Data	23	15	26	16
TOTAL:	**135**	**75**	**408**	**266**

http://www.epa.gov/oar/oaqps/greenbk/onsum2.html

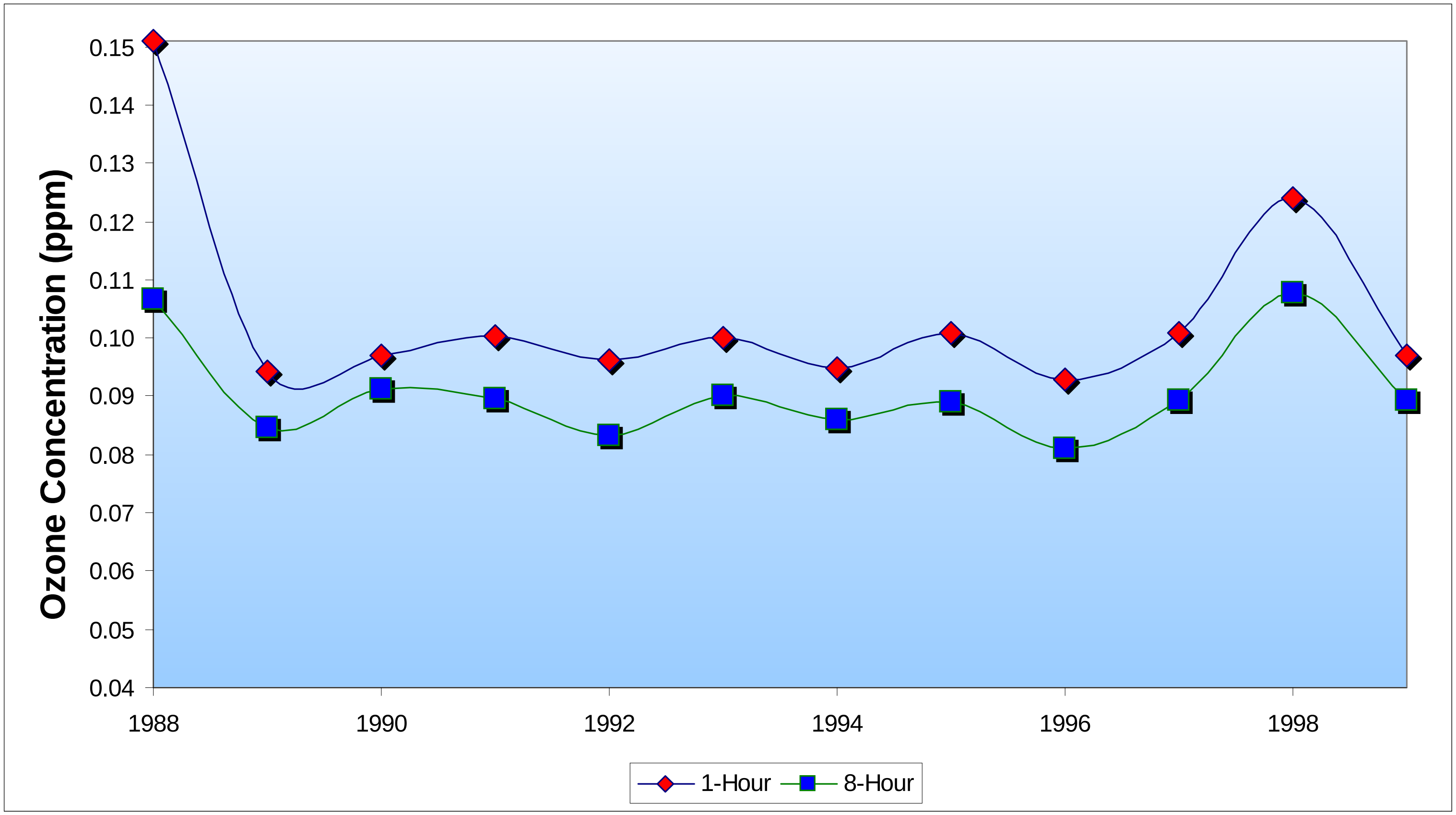
Average Diurnal O_3 Profiles for Four Cities (July 15-28, 1999).



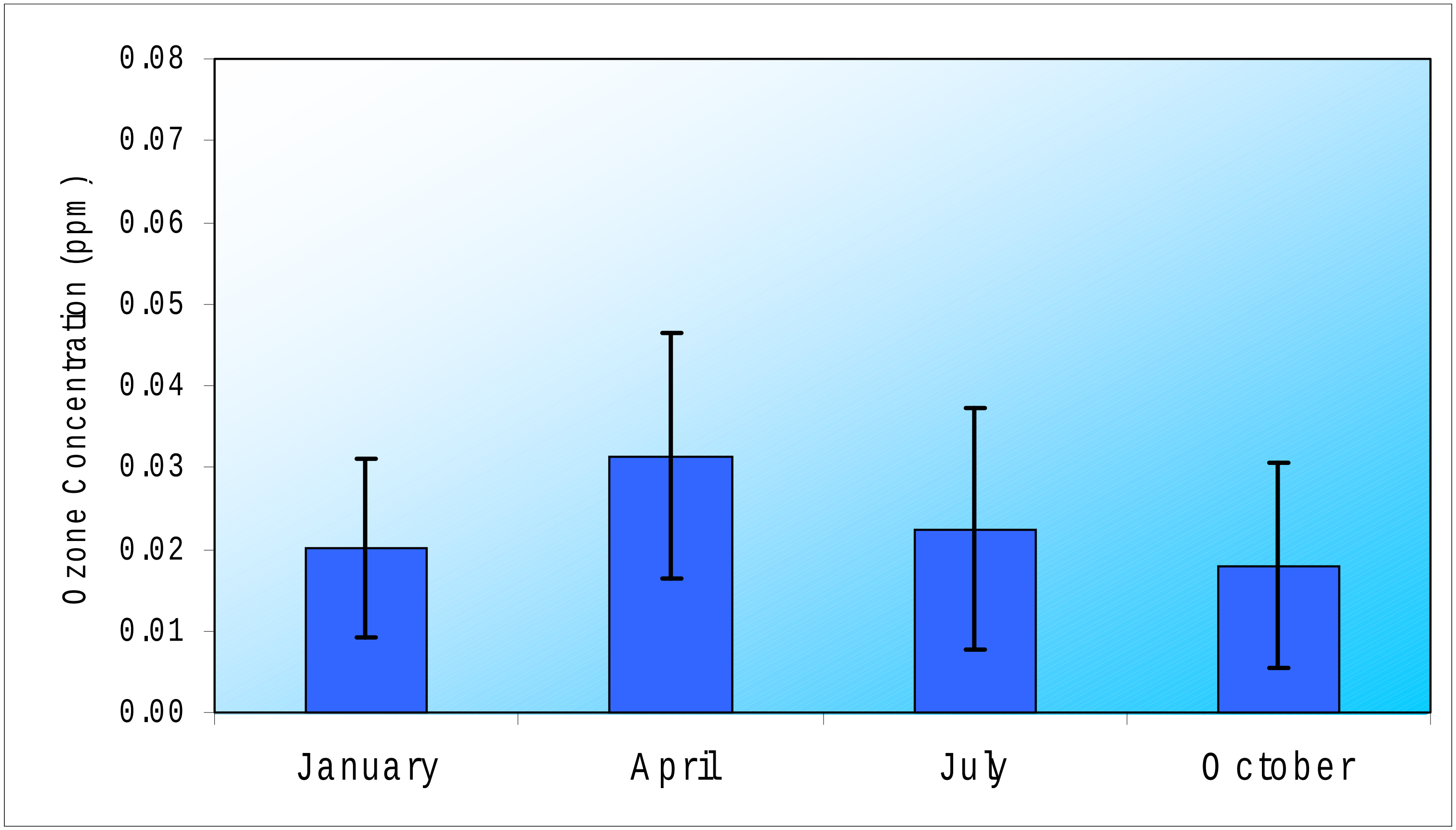
Glacier National Park Ozone Trends



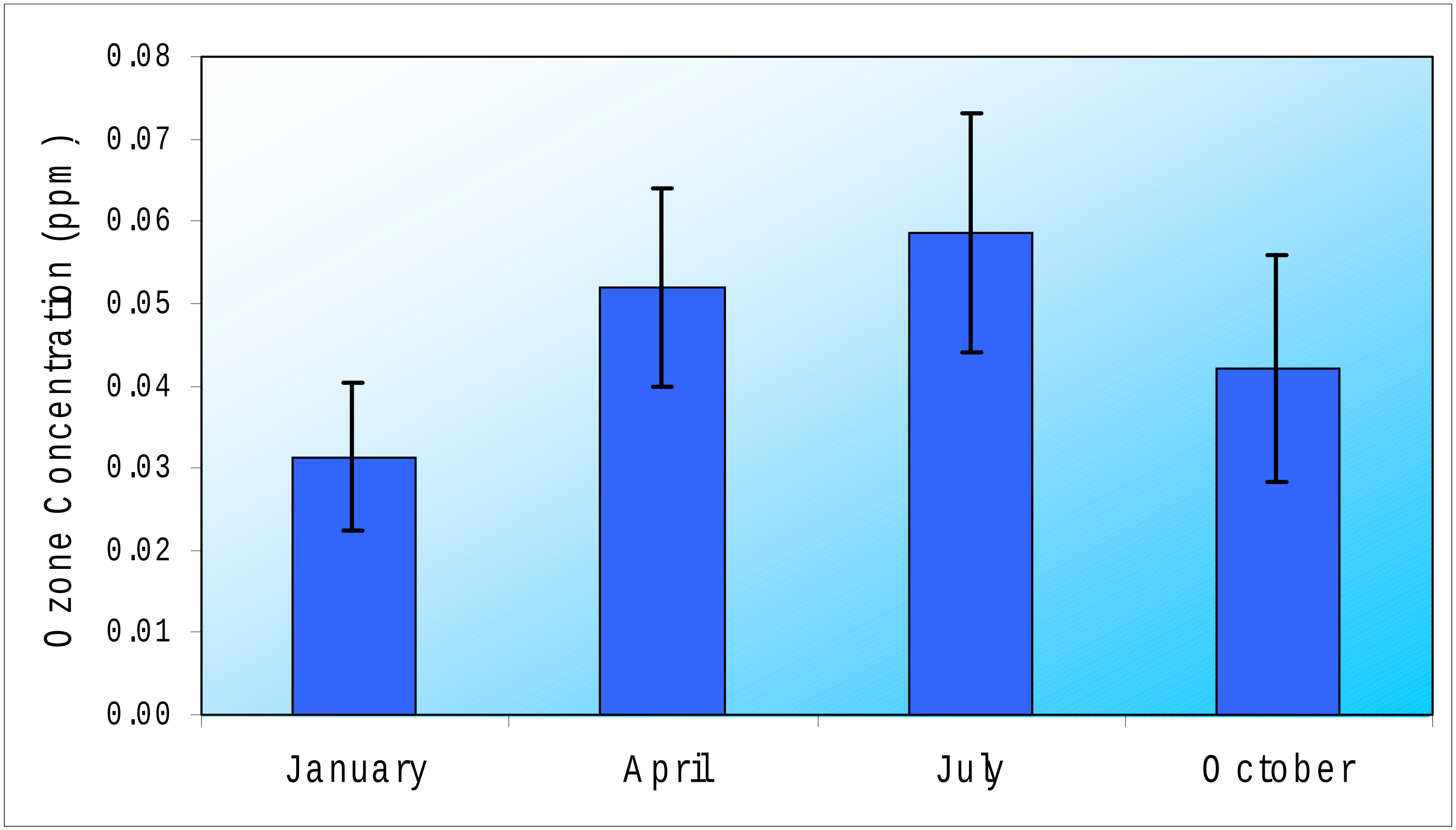
Shenandoah National Park Ozone Trends



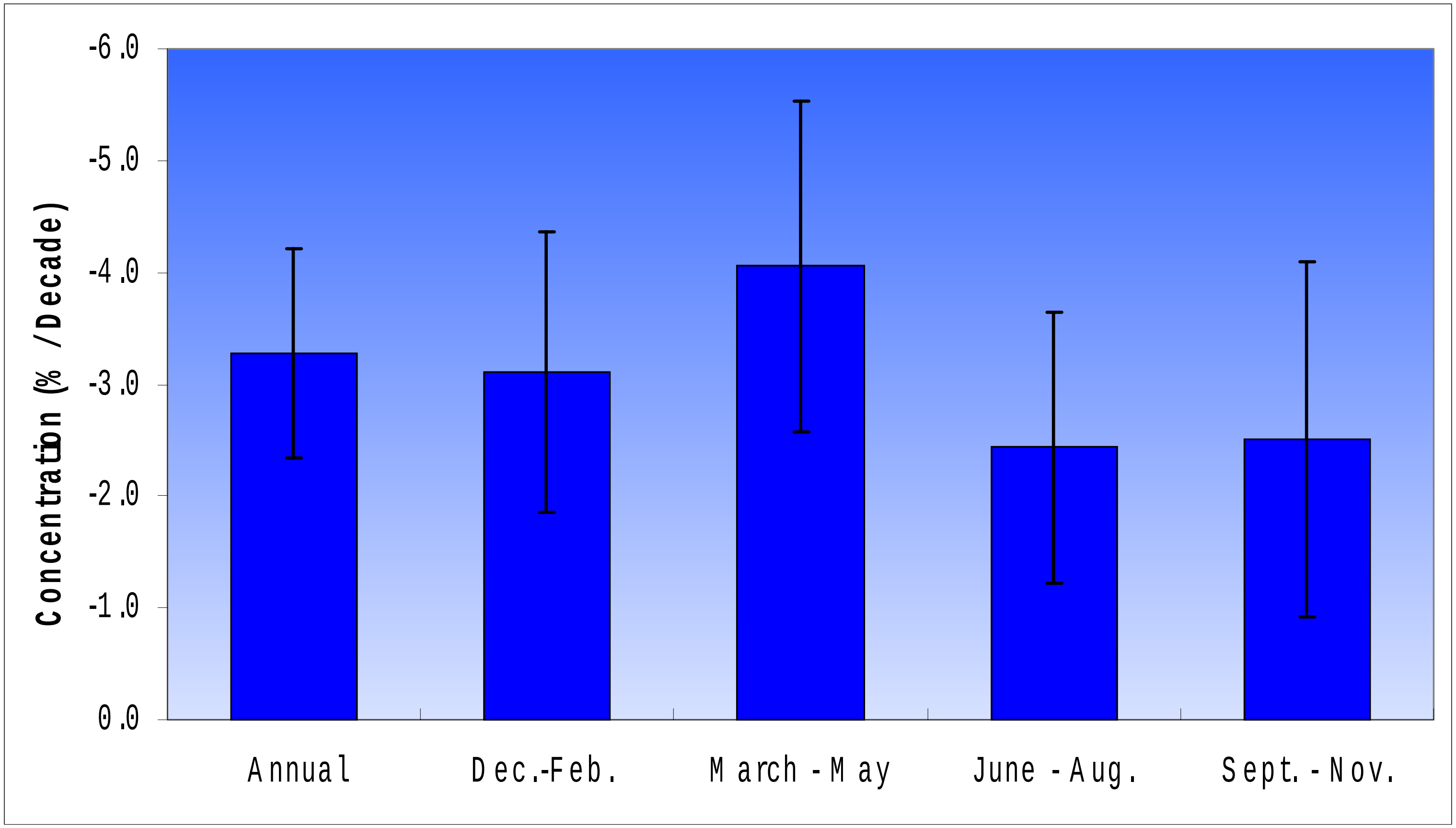
Glacier National Park Seasonal Ozone Trends



Shenandoah National Park Seasonal Ozone Trends



Global Annual and Seasonal Total Column Ozone Trends from 1979-1996



Conclusions

- The National 1-hour average ozone concentration from 1978 to 1998 has decreased 1.5 ppb/year and is below the 120 ppb standard.
- The National 8-hour average ozone concentration from 1989 to 1998 has had no significant change, but is above the proposed 80 ppb standard.
  - The number of nonattainment areas will increase.
- Several Class 1 Areas have concentrations higher than the expected background levels.
- Ozone concentrations are typically higher in Spring and Summer due to extended daylight and stagnant high-pressure systems.
- Areas of greatest concern are in highly populated Southern Regions.