Review of the California Ambient Air Quality Standard for Ozone

April 28, 2005

Air Resources Board

California Environmental Protection Agency

Overview

- Criteria for standard setting
- Process for standard setting
- Findings of the scientific review
- Basis for the standard recommendations
- Health impacts of current ozone exposure
- Public comments and staff responses

Criteria for Standard Setting

What is an Ambient Air Quality Standard?

- Legal definition of clean air
- Has four parts:
  - Pollutant definition
  - Concentration
  - Averaging time
  - Monitoring Method
- Based solely on health and welfare

Standard Setting Does Not Include

- Attainment designation
- Cost of controls
- Feasibility of controls
- Implementation of controls
- Addressed by separate regulatory processes

Why Are We Reviewing the State Ozone Standard?

- Address requirements of Children's Environmental Health Protection Act (SB25, Escutia, 1999)
- Assure public health protection
- Comply with State laws and regulations requiring periodic review

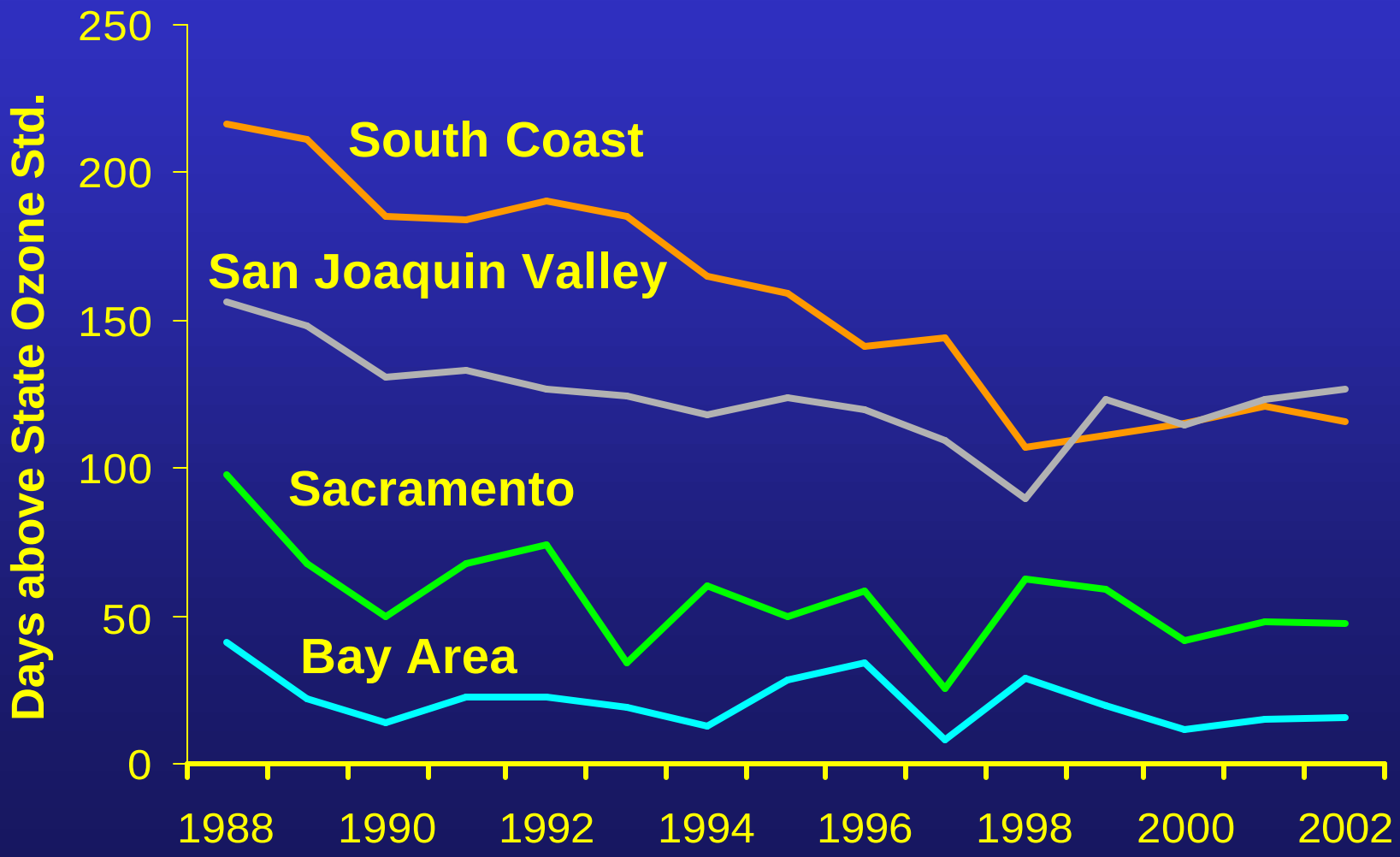
Why Are We Concerned about Ozone?

- Significant health effects
- Substantial scientific evidence for adverse health effects
- High exposure in California
- Children may be particularly vulnerable

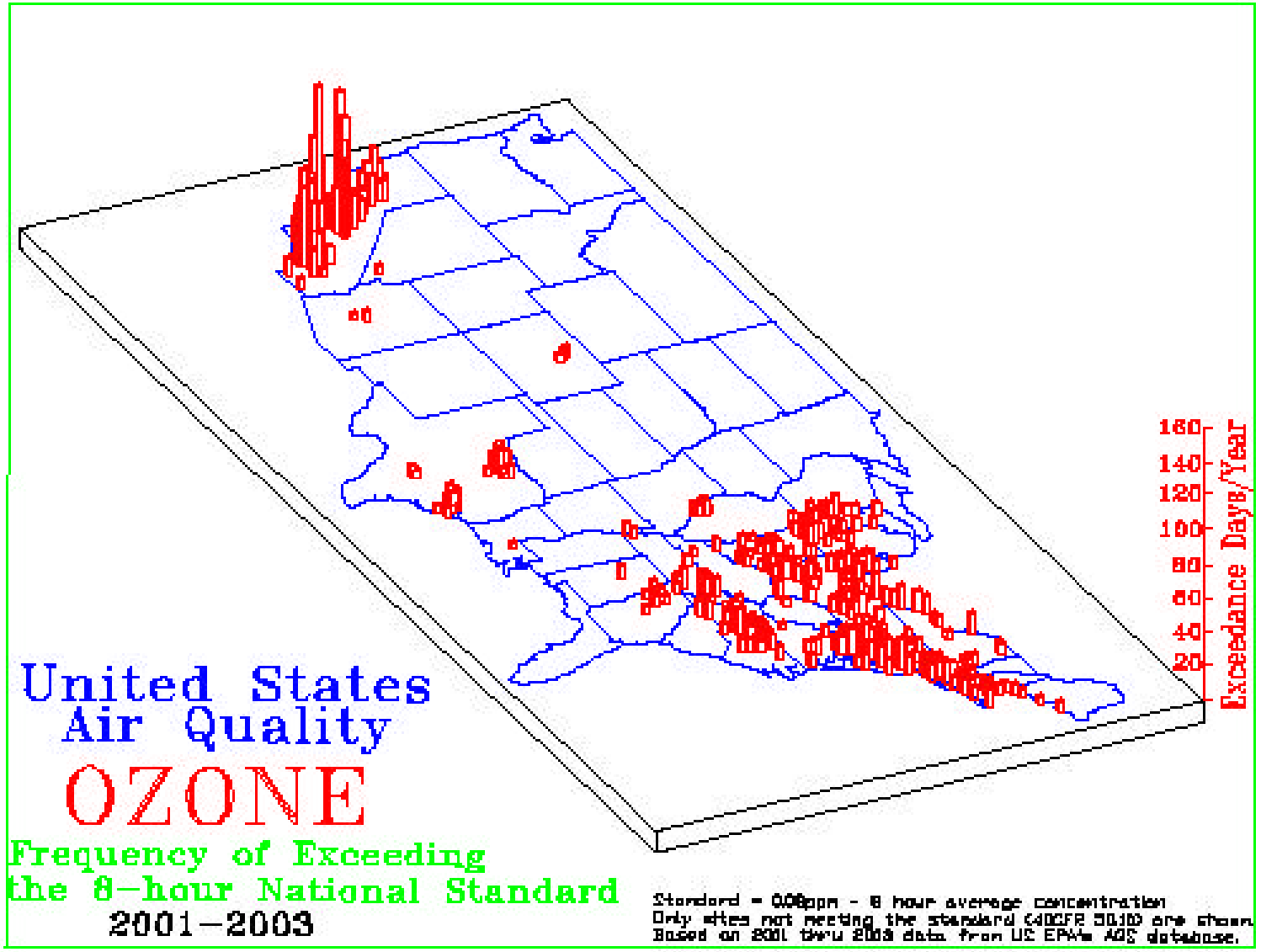
Nature of Public Health Risk Associated with Ozone

- Primarily an outdoor pollutant
- Risk proportional to inhaled amount of ozone
- Greatest risk to people who are active outdoors
  - Adults who exercise or work outdoors
  - Children

Days of Unhealthy Ozone Levels



National 8-Hr O_3 Standard Exceedances



Current Ozone Standards
(ppm)

	1-Hour	8-Hour
California (1987)	0.09	--
US EPA (1996)	0.12	0.08*
WHO for Europe	--	0.06
Canada	0.082	--

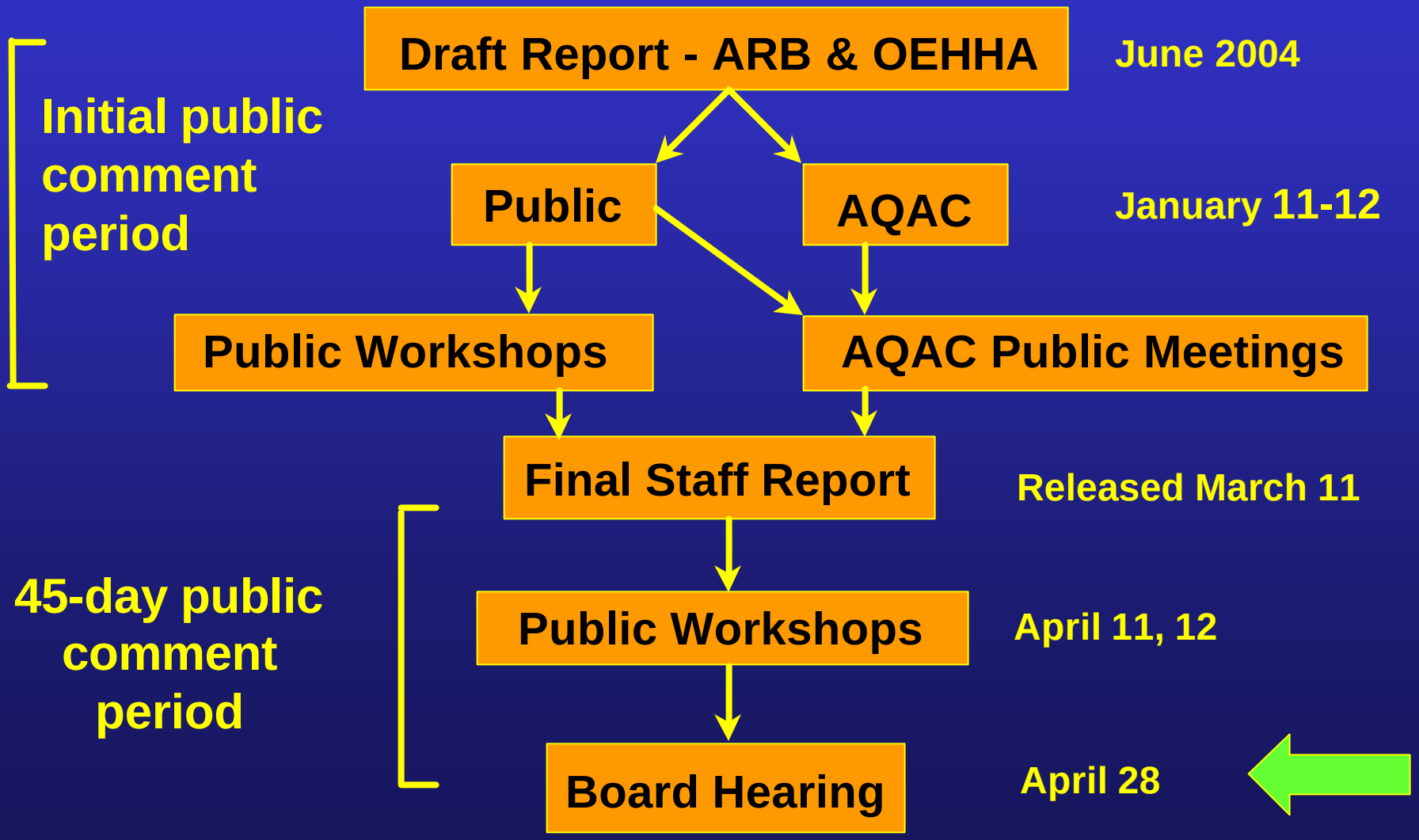
*selected from a range of 0.07 to 0.09 ppm

Recommendation to Revise the California Ozone Standard

- Retain ozone as the pollutant definition
- Establish a new 8-hr standard of 0.070 ppm, not to be exceeded
- Retain the current 1-hr standard of 0.09 ppm, not to be exceeded
- Retain the UV monitoring method

Process for Standard Setting

The Standard Review Process



Air Quality Advisory Committee (AQAC) Review

- Required by State law
- Members appointed by University of California President
- Purpose of AQAC review:
  - Assess adequacy of scientific basis for proposed standards
  - Assess adequacy of proposed standards to protect public health

Findings of the AQAC Review

- Scientific conclusions and findings consistent with available data
- Staff recommendations scientifically sound, and well justified
- Suggested clarifications, additional papers and/or more detail in some sections of the report
- Staff responses to the AQAC review

Findings of the Scientific Review

Health Studies

Three types of health studies:

- Controlled human exposure
- Controlled animal exposure
- Epidemiological

What Are the Health Effects of Ozone?

- Reduced lung function
- Respiratory symptoms
- Airway inflammation
- Increased hospital and ER usage
- Increased school absenteeism
- Asthma induction in active children (needs confirmation)
- Premature death

Controlled Human Exposure Studies

- Simulate real world exposures
- Typical subjects: healthy adults
  - Some studies on children, older adults, and people with chronic heart or lung disease
- Advantage: Good measures of exposure and response
- Disadvantages: Mostly healthy adults; small samples; limited endpoints; only investigate acute exposures

Controlled Human Studies (1 to 3 Hours): Lowest Concentrations Showing Effects

- Lung Function Decrements: 0.12 ppm
- Increased Respiratory Symptoms: 0.12 ppm
- Increased Airway Resistance: 0.18 ppm
- Airway Inflammation: 0.20 ppm

Studies of Multi-Hour Ozone Exposures: Lowest Concentrations Showing Effects

- Lung function decrements: 0.08 ppm
- Increased respiratory symptoms: 0.08 ppm
- Increased airway reactivity: 0.08 ppm
- Airway inflammation: 0.08 ppm
- No effects reported at 0.04 ppm

Change in FEV1 with Length of Exposure

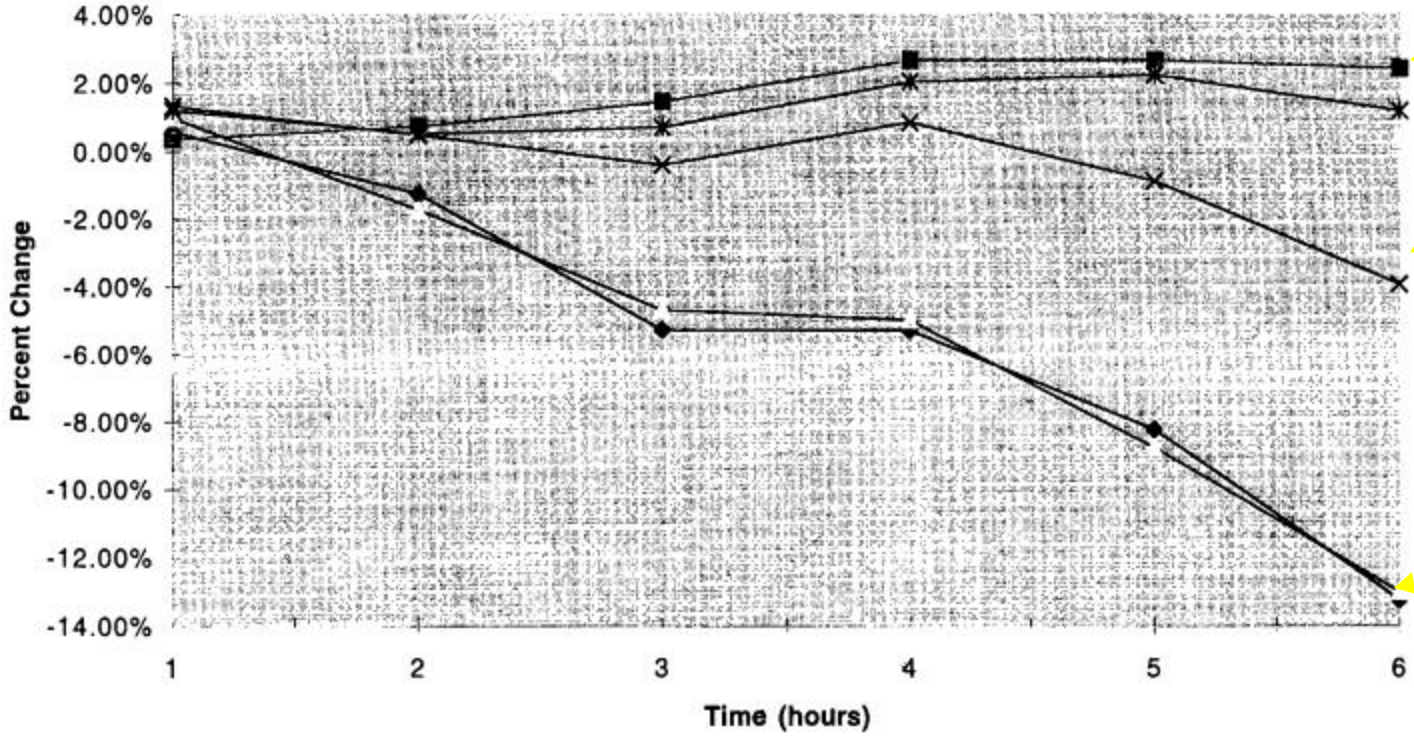


FIGURE 1. Hour-by-hour percent change in $FEV_{1.0}$.

Clean air

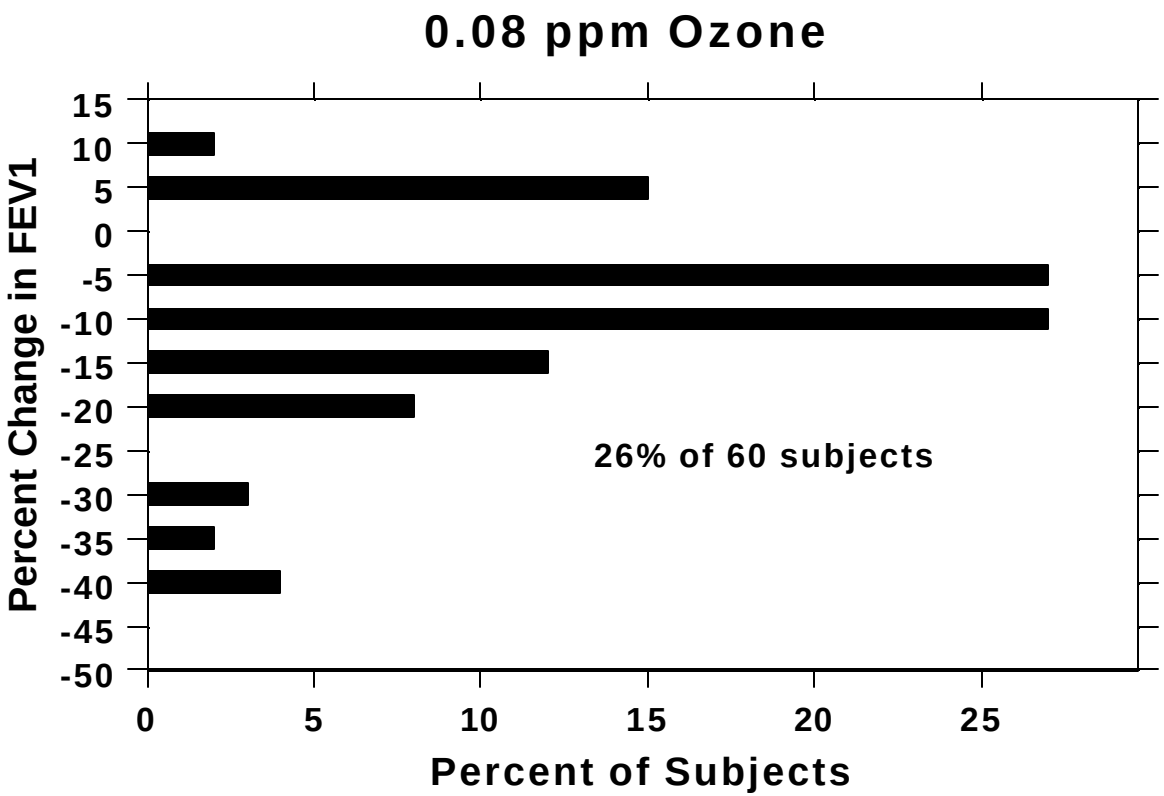
0.04 ppm

0.08 ppm

0.12 ppm

Adams, 2002

Some Individuals Are Particularly Responsive
(6.6 hr exposure)



Folinsbee et al., 1991

Influence of Demographics and Ethnicity on Responsiveness

- Few studies conducted
- Factors Investigated
  - Gender
  - Age
  - Socioeconomic Status
  - Ethnicity
- Insufficient data to draw conclusions, except for gender

Findings From Animal Studies

- Acute responses similar to humans:
  - Increased airway resistance
  - Airway inflammation
- Fibrosis with repeated injury-repair cycles (> 0.25 ppm)
- Altered airway architecture with chronic exposure to high O_3 concentrations (> 0.20 ppm)

Characteristics of Epidemiologic Studies

- Evaluate exposures and responses of free-living populations
- Difficult to determine relevant
  - Exposure averaging time
  - Lowest effects level
- Possible confounders, such as weather and co-pollutants

Findings From Epidemiologic Studies

Ambient concentrations of ozone have been associated with:

- Respiratory hospital admissions
- Emergency room visits
- Asthma exacerbation
- School absences and respiratory symptoms
- New onset of asthma (with exercise)
- Reduced lung function with long term exposure
- Premature death

New Evidence for an Association between Ozone and Mortality

- Study of 29 cities in Europe implicates summer ozone concentration (Gryparis et al. 2004)
- Study of 95 largest U.S. cities implicates both summer and all-year ozone concentrations (Bell et al. 2004)
  - Controlled for PM10 and weather
  - Multi-day concentrations increase effect

Findings on Infants and Children Under SB 25

- No evidence that children respond to lower O_3 concentrations than adults
- Exposure patterns:
  - Frequent high exposures due to outdoor activity
  - Greater exposure per unit lung surface
- Susceptibility: Early exposure may:
  - Affect lung development
  - Reduce adult lung function
  - Induce asthma
- No evidence for interactions between pollutants

Findings on Infants and Children (cont.)

- Adverse health outcomes reported for children include:
  - Asthma exacerbation and ER visits
  - Hospital admissions
  - School absenteeism
  - Upper and lower respiratory symptoms
  - Possible onset of asthma
  - Decreased lung function in young adults raised in high ozone areas

Basis for Standard Recommendations

Basis for 1-Hour Standard Recommendation

Retain the current 1-hr standard of 0.09 ppm

- Controlled human exposure studies report lung function and symptoms effects at 0.12 ppm
- Epidemiologic studies suggest adverse effects below 0.12 ppm, but relevant averaging time and concentration difficult to determine
- Studies on ER visits for asthma suggest a lowest effect level between 0.075 and 0.11 ppm

Basis for 1-Hour Standard (cont.)

- Includes a safety margin to address uncertainties in the data
- Protects against short, peak exposures
- Relevant averaging time for:
  - Children playing outdoors
  - Adults exercising outdoors
  - Outdoor home maintenance activities

Basis for 8-Hour Standard Recommendation

Establish an 8-hr standard of 0.070 ppm

- Controlled human exposure studies report symptoms, lung function changes, and airway responsiveness effects at 0.08 ppm
- 26% of individuals exhibited large changes with 6.6 hr exposure to 0.08 ppm
- Studies at 0.04 and 0.06 ppm reported no significant effects

Basis for 8-Hour Standard (cont.)

- Epidemiologic studies suggest adverse effects at 8-hr concentrations less than 0.08 ppm
- Studies on ER visits for asthma suggest a lowest effect level between 0.065 and 0.09 ppm
- Includes a safety margin to address uncertainties in the data
- Protects against multi-hour exposures
- Relevant averaging time for:
  - Outdoor workers
  - Multi-hour recreational and outdoor activities

Why Do We Need Two Standards?

- Responses related to inhaled dose
- O_3 concentration has greatest influence
- Address different exposure patterns

Health Impacts of Current Ozone Exposure

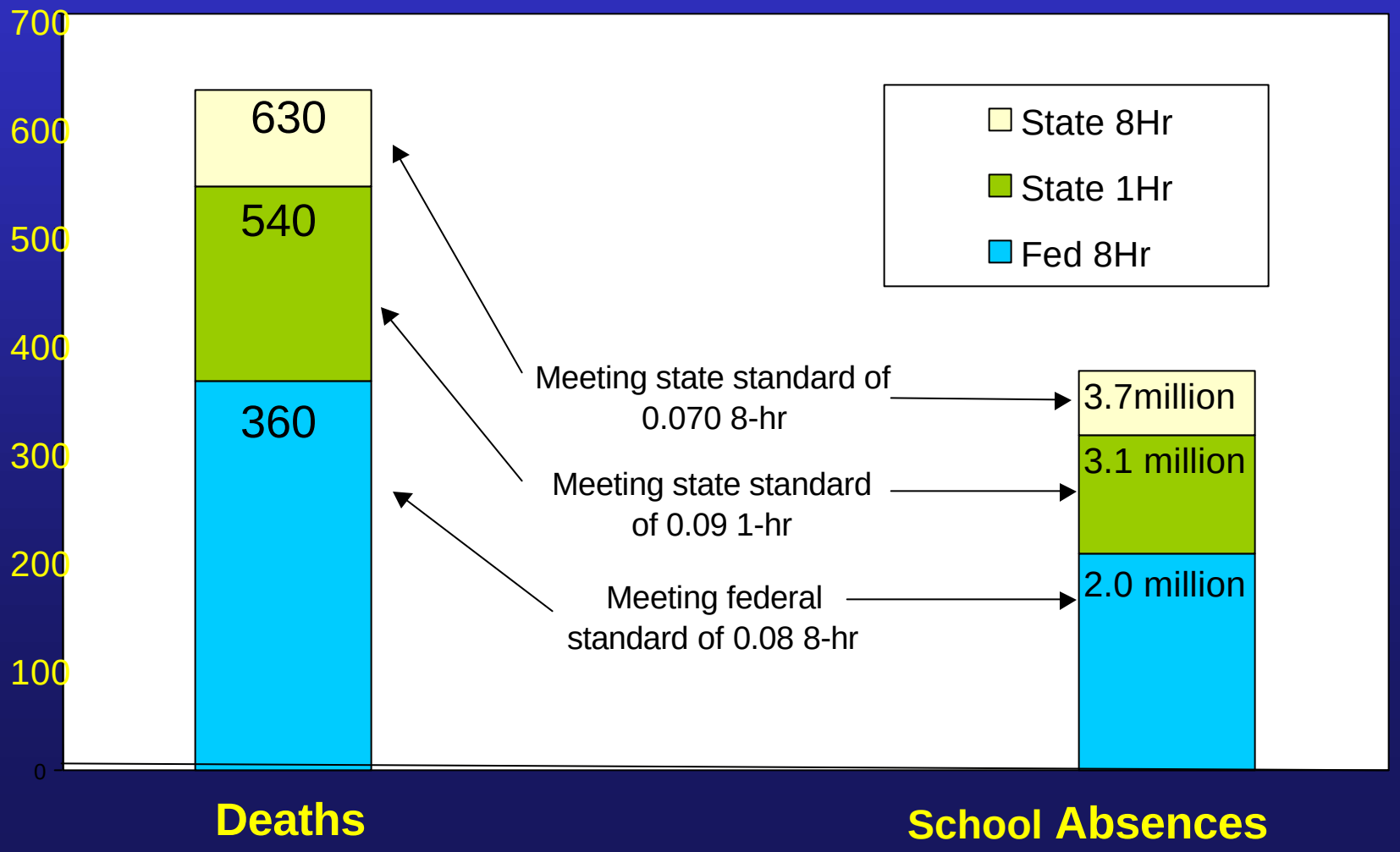
Health Impact of Current Ozone Concentrations

Estimated annual count comparing today to attainment:

- 630 (310 - 950) premature deaths
- 4,200 (2400 - 5800) hospitalizations for respiratory diseases
- 660 (400 - 920) emergency room visits for asthma for children under 18 years of age
- 3.7 million (470,000 - 6.8 million) school absences among children 5 to 17 years of age
- 3.1 (1.3 - 5.0 million) million minor restricted activity days for adults above 18 years of age

Incremental Impacts Analysis

Annual Statewide Avoided Cases with Attainment of Ozone Standards



Public Comments and Staff Responses

Comments and Responses - 1

- Proposed standards overlap background ozone
  - Long-term average is 0.04 ppm
  - Exceptional events policy
- Ozone reduction of UVB radiation
  - Available literature does not support a benefit at ground level

Comments and Responses - 2

- Economic costs of attaining proposed standards not presented
  - Not a consideration under California law
- Request for incremental benefits assessment
  - Requested analysis included in presentation

Summary

Summary: Staff Recommendation

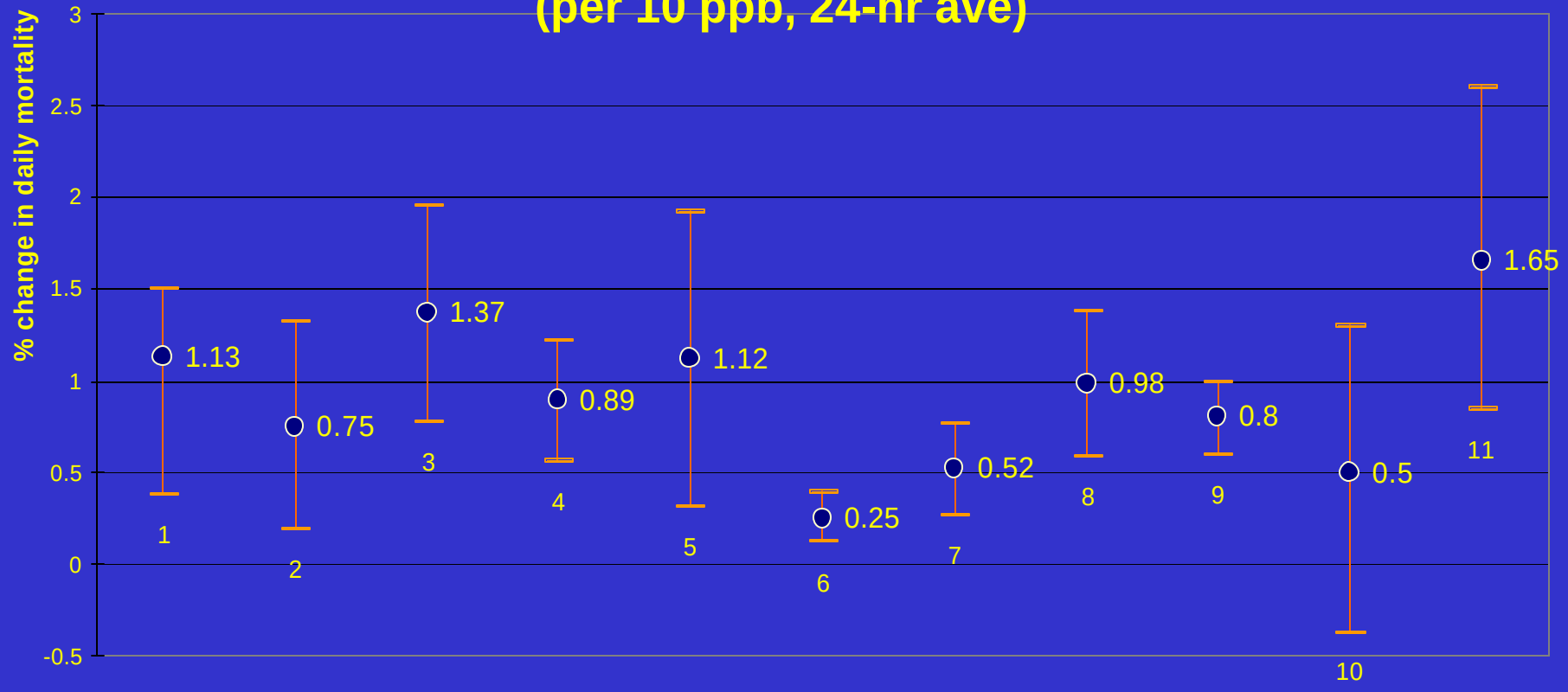
- Retain ozone as the pollutant definition
- Establish a new 8-hr standard of 0.070 ppm, not to be exceeded
- Retain the current 1-hr standard of 0.09 ppm, not to be exceeded
- Retain the UV monitoring method

ATS* Criteria For What Constitutes An Adverse Health Effect

- Physiologic or pathologic changes that interfere with normal activity
- Episodic or incapacitating respiratory illness
- Permanent and/or progressive respiratory injury/dysfunction.
- Reduction in quality of life
- Lung function changes with concurrent symptoms
- Hospitalization or emergency room visits
- Mortality
- Population health in addition to individual risk.

*** American Thoracic Society**

Percent Change in Mortality Associated with Ozone (per 10 ppb, 24-hr ave)



1. WHO (2004)
2. WHO (2004)
3. Thurston & Ito (2001)
4. Thurston & Ito (2001)
5. Stieb et al. (2003)
6. Bell et al. (2004)
7. Bell et al. (2004)
8. Levy et al. (2001)
9. Levy et al. (2001)
10. Gryparis et al. (2004)
11. Gryparis et al. (2004)

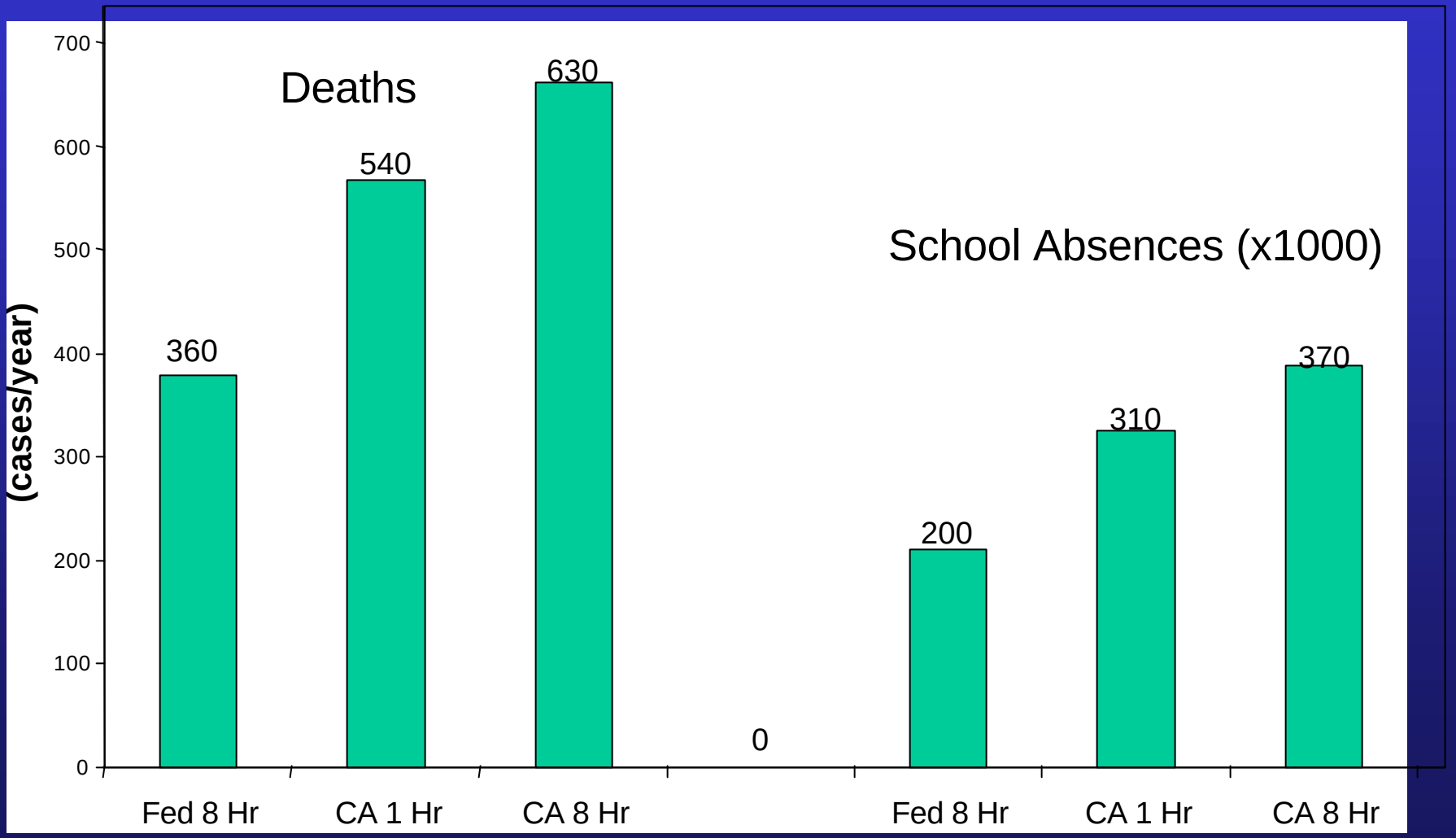
California's Disproportionate Air Pollution Exposure

8-Hour Ozone
(3-year mean 4th high)

Population-weighted and minus NAAQS, based on 2000-02 AIRS data

Incremental Impacts Analysis

Annual Statewide Benefits of Attaining Ozone Standards



Inhaled Dose is Important

- Responses proportional to inhaled dose
- Inhaled dose is a function of:
  - O_3 concentration - most important factor
  - Breathing rate
  - Exposure duration
- Susceptible populations:
  - Children
  - Workers
  - Active and exercising people

Quantifying the Health Impacts of Ozone Exposure

Estimated impact on health is the product of:

- Change in ozone concentrations
- Population exposed
- Baseline incidence of health outcomes
- % change in health outcome per unit increase in ozone based on epidemiologic studies

Uncertainties in the Health Impact Assessment

- Concentration-response functions selected
- Possible confounding by other air pollutants
- Appropriateness of weather modeling
- Air quality rollback methodology
- Baseline rates for the endpoints examined
- Adequacy of the exposure assessment