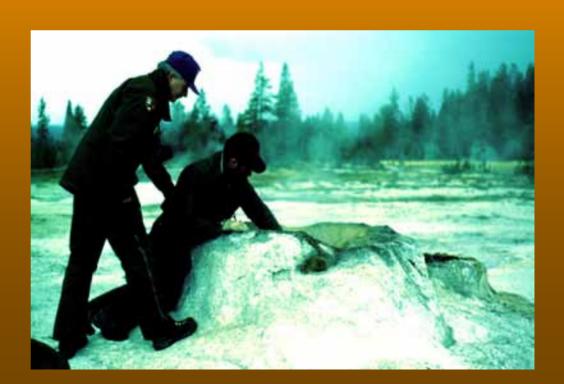


Integration of Science into Park Management:

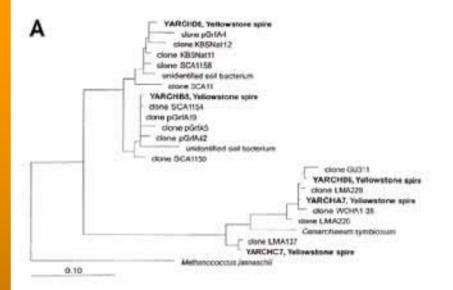
Yellowstone Case Studies

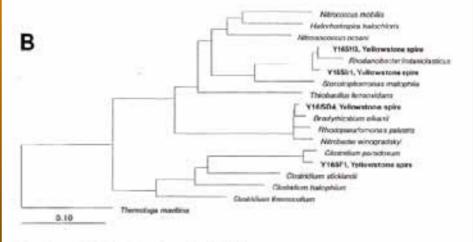








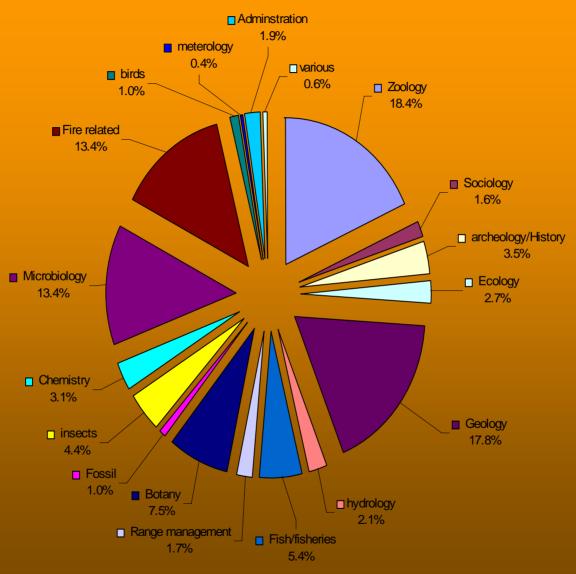




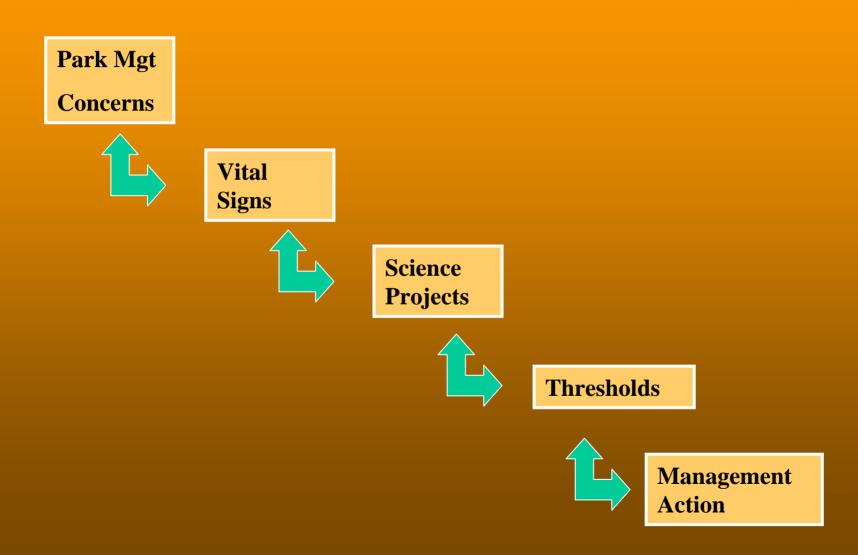
Reconstructed phylogenetic tree based on 165 rRNA sequences that were retrieved from a spire of Yellowstone National Park.

A. Relationships of archivel clones. B, Relationships of bacterial clones. Bars indicate 10% esitmated sequence divergence.

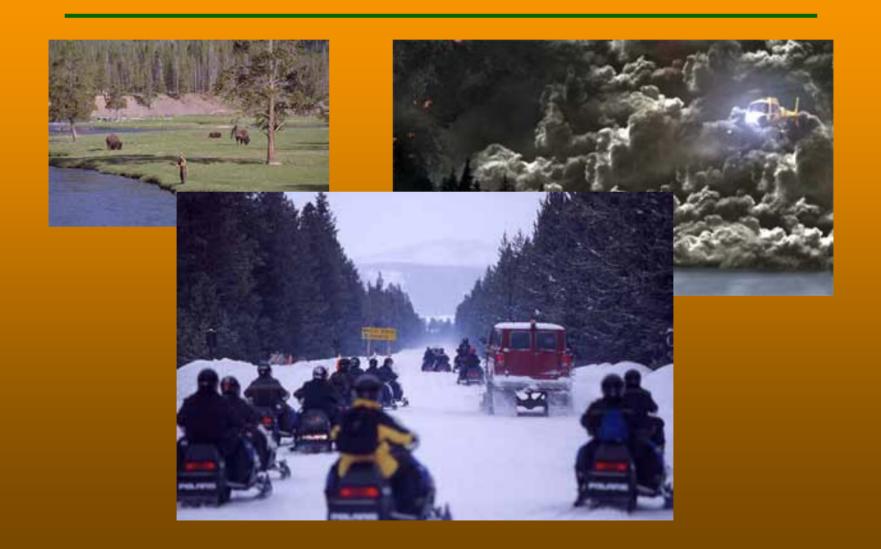
Scientific Research 1989-1996 Total No. of 1444



General Conceptual Model



Case Studies



Dozens of Vital Signs have been identified for the Greater Yellowstone Network

| Level 1 | Level 2 | Vital Signs |
|----------------|------------------------|----------------------------------|
| | Air Quality | Atmospheric deposition |
| Air and | | Oversnow emissions |
| Climat e | | Visibility |
| Ü | Weather | Climate |
| | Geomorphology | Glaciers |
| | | Stream sediment transport |
| Geolog | Subsurface Geologic | Geothermal features |
| y and Soils | | Geothermal water chemistry |
| Solis | Processes | Seismic activity |
| | Soil Ouality | Soil structure and stability |
| | Soil Quality | Soil biota |
| Water | | Ground water quantity |
| | Hydrology | Arid seep and spring |
| | | Reservoir and lake elevation |
| | | Streamflow |
| | Water Quality | Biogeochemical flux |
| | | Chloride flux |
| | | Water chemistry |
| | | Ground water quality |
| | | E.coli (Escherichia coli) |
| | | Algae |
| | | Aquatic invertebrate assemblages |
| | | Water temperature |

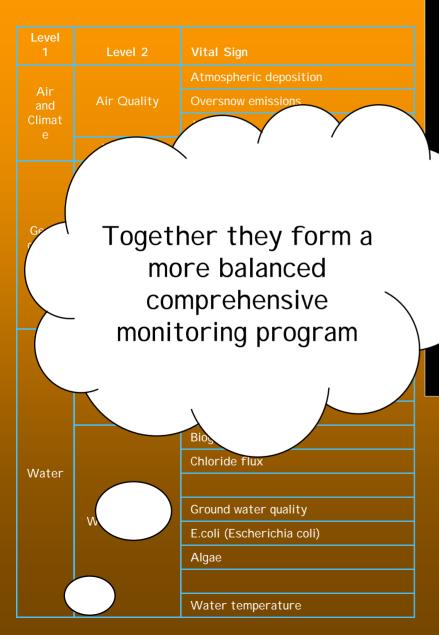
| Level 1 | Level 2 | Vital Signs |
|--|-------------------------------|----------------------------|
| | I nvasive | I nvasive plants |
| | Species | Exotic aquatic assemblages |
| | | Forest insect and disease |
| | Infestations and Disease | Whitebark pine |
| | | Vertebrate disease |
| | | Aspen |
| | | Riparian/riverine |
| | | Shrub-steppe |
| Biologi | | Insects |
| cal Integr | | Beaver |
| ity | Focal Species | Meso-carnivores |
| | or Communities | Amphibians |
| | | Landbirds |
| | | Native aquatic assemblages |
| | | Alpine |
| | | Cushion plant |
| | | Ungulates |
| | At-risk Biota | Birds of concern |
| | | Large carnivores |
| Human use | Visitor and Recreation Use | Backcountry day use |
| | | Backcountry overnight use |
| | | Visitor use |
| Ecosys tem Patter n and Proces | Fire | Fire |
| | Land Use and Cover | Land use |
| | | Land cover |
| ses | Soundscape | Soundscapes |

The network selected 12 Vital Signs to be funded by the I&M program

| Level | | |
|---------------------------|-------------------------------------|----------------------------------|
| 1 | Level 2 | Vital Sign |
| Air and Climat e | Air Quality | Atmospheric deposition |
| | | Oversnow emissions |
| | | Visibility |
| | Weather | Climate |
| | Geomorphology | Glaciers |
| | | Stream sediment transport |
| Geolo | Subsurface Geologic Processes | Geothermal features |
| gy and | | Geothermal water chemistry |
| Soils | | Seismic activity |
| | Soil Quality | Soil structure and stability |
| | Soli Quality | Soil biota |
| Water | Hydrology | Ground water quantity |
| | | Arid seep and spring |
| | | Reservoir and lake elevation |
| | | Streamflow |
| | Water Quality | Biogeochemical flux |
| | | Chloride flux |
| | | Water chemistry |
| | | Ground water quality |
| | | E.coli (Escherichia coli) |
| | | Algae |
| | | Aquatic invertebrate assemblages |
| | | Water temperature |

| Vital Sign Invasive plants Exotic aquatic assemblages Forest insect and disease Whitebark pine Vertebrate disease Aspen Riparian/riverine Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern Large carnivores | \/i | tal Sid | anc | |
|---|-----|-------------------------|-----------------------|----------------------------|
| Exotic aquatic assemblages Forest insect and disease Whitebark pine Vertebrate disease Aspen Riparian/riverine Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | VI | tai Si | giis | Vital Sign |
| Forest insect and disease Whitebark pine Vertebrate disease Aspen Riparian/riverine Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | I nvasive plants |
| Whitebark pine Vertebrate disease Aspen Riparian/riverine Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Exotic aquatic assemblages |
| Vertebrate disease Aspen Riparian/riverine Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Forest insect and disease |
| Aspen Riparian/riverine Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Whitebark pine |
| Riparian/riverine Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Vertebrate disease |
| Shrub-steppe Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Aspen |
| Insects Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Riparian/riverine |
| Beaver Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Shrub-steppe |
| Meso-carnivores Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Insects |
| Amphibians Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Beaver |
| Landbirds Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Meso-carnivores |
| Native aquatic assemblages Alpine Cushion plant Ungulates Birds of concern | | | | Amphibians |
| Alpine Cushion plant Ungulates Birds of concern | | | | Landbirds |
| Cushion plant Ungulates Birds of concern | | | | Native aquatic assemblages |
| Ungulates Birds of concern | | | | Alpine |
| Birds of concern | | | | Cushion plant |
| | | | | Ungulates |
| Large carnivores | | | | Birds of concern |
| | | | | Large carnivores |
| Backcountry day use | | | | Backcountry day use |
| n use Recreation Use Backcountry overnight use | | | | Backcountry overnight use |
| Visitor use | | | | Visitor use |
| Ecosy Fire Fire | | stem Patter n and | Fire | Fire |
| Londuco | | | Land Use and Cover | Land use |
| | | | | Land cover |
| sses Soundscape Soundscapes | | | Soundscape | Soundscapes |

Many other critical Vital Signs are being monitored by other programs



Vital Signs

Climate

Streamflow

Water chemistry

Aquatic invertebrate assemble

Arid seep and spring

structure and stability

sive plants

c aquatic assemblages

bark pine

Huma

n use

Ecosy

stem

Patter n and

Proce sses

ibians

ndbirds

Land use

On-going monitoring

ital Sign

Visibility

Atmospheric deposition

prest insect and disease

Geothermal features

Seismic activity

Chloride flux

Water temperature

Reservoir and lake elevation

Vertebrate disease

Ungulates

At-risk Biot Large carnivores

Birds of concern

Land cover

Fire

Visitor and

Fire

Land Use an

Cover

Soundscape

Recreation U

Backcountry overnight use

Soundscape

General Observations

4. Monitoring tells us something has changed—additional science explains why

5. Thresholds are generally complex

General Observations

6. Communicating the results of science to managers is the most important thing we do—and we don't do it that well!

General Observations

Report to Management



Peer-Reviewed Manuscript



Popular Article



Soundbite

Drought Contingency—Angling

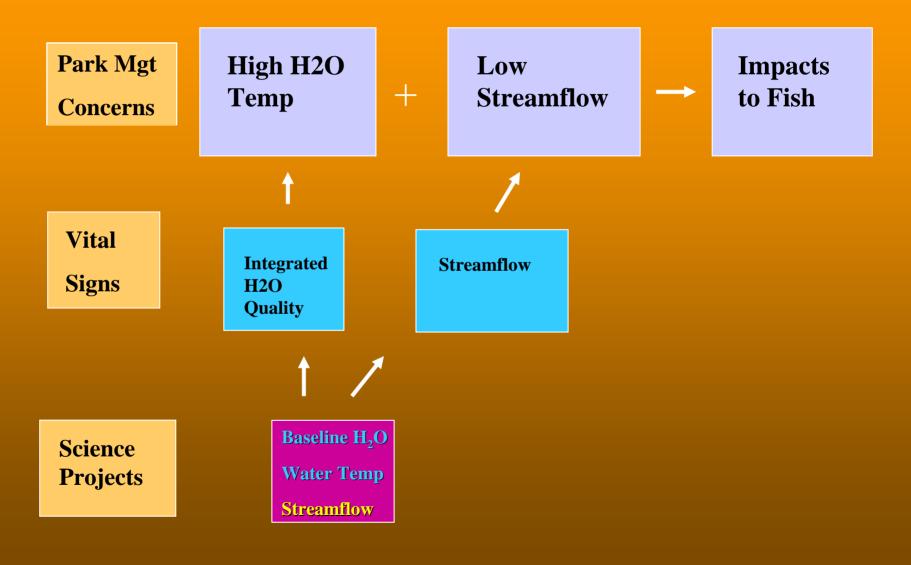








Drought Contingency—Angling



Drought Contingency—Angling

Vital

Signs

Thresholds

Integrated H2O Quality

Water Temp.

Close if >73 (22.7) 3 days

Open if < 73 degrees F (22.7); 3 consecutive days and forecast calls for cooler temps **Streamflow**

Streamflow

> close if 95% exceedence stage (5% annual average flow)

Mgt Action

Close River to Angling

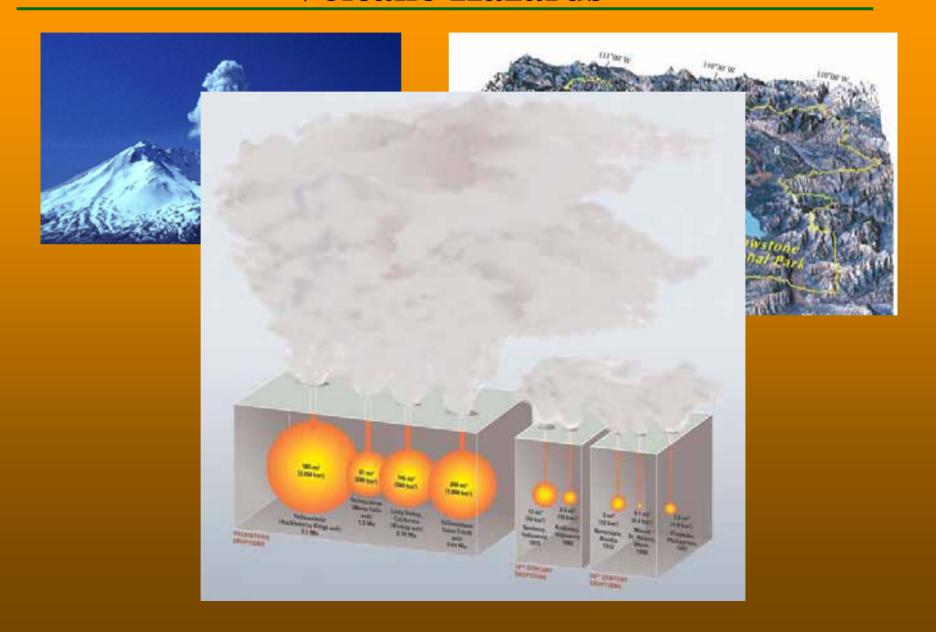
Open River to Angling

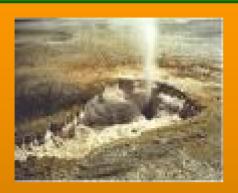
Drought Contingency—Costs

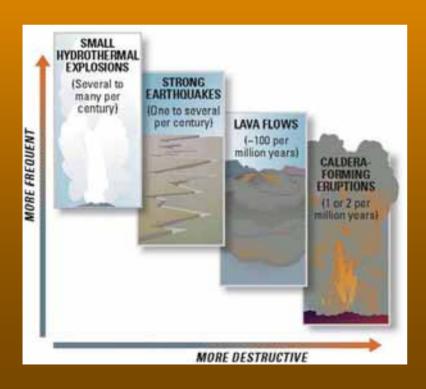
NPS Costs: Year 1: \$6000; Year

2: \$16,000

USGS Costs: Year 1: \$0; Year 2: \$50,000 (install gauging station)











Park Mgt

Concerns

Vital

Signs

Earthquakes

Seismic Activity

Seismic Network

Campaign Seismic

Borehole Seismic

Volcanic Fruntions

Yellowstone Volcano Observatory U.S. Geological Survey University of Utah

Yellowstone National Park

Airborne gas

Tree Ring CO,

Campaign GPS

Campaign Leveling

InSAR Imaging

Steam **Explosions**

Geothermal Features



Hydrothermal Network

as

Geothermal **Monitoring**

Science **Projects**

Borehole Strainmeters

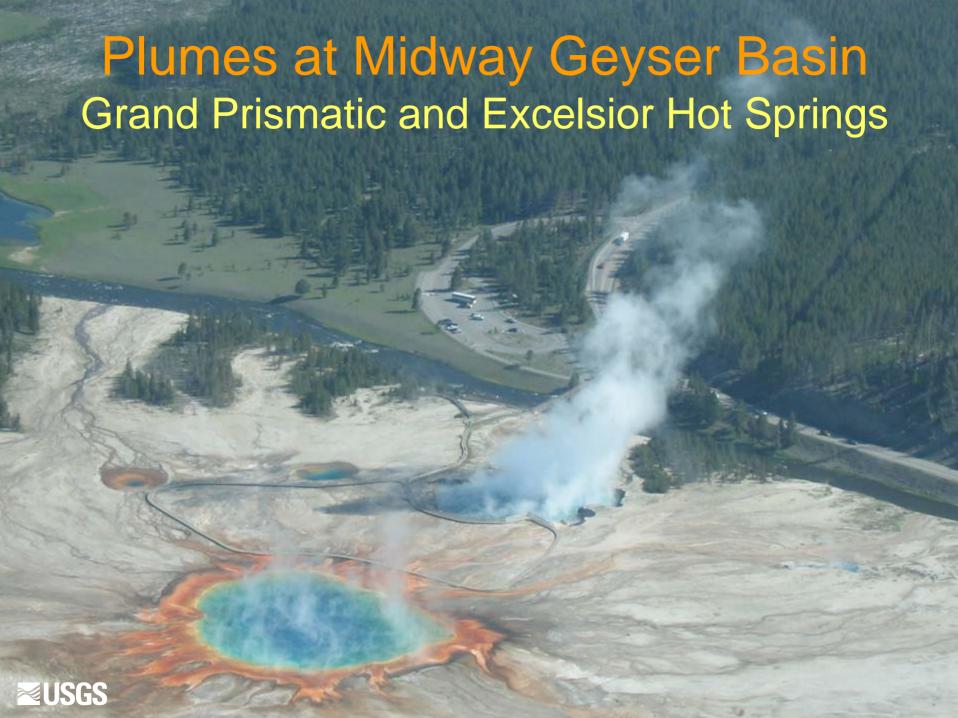
Titlmeters

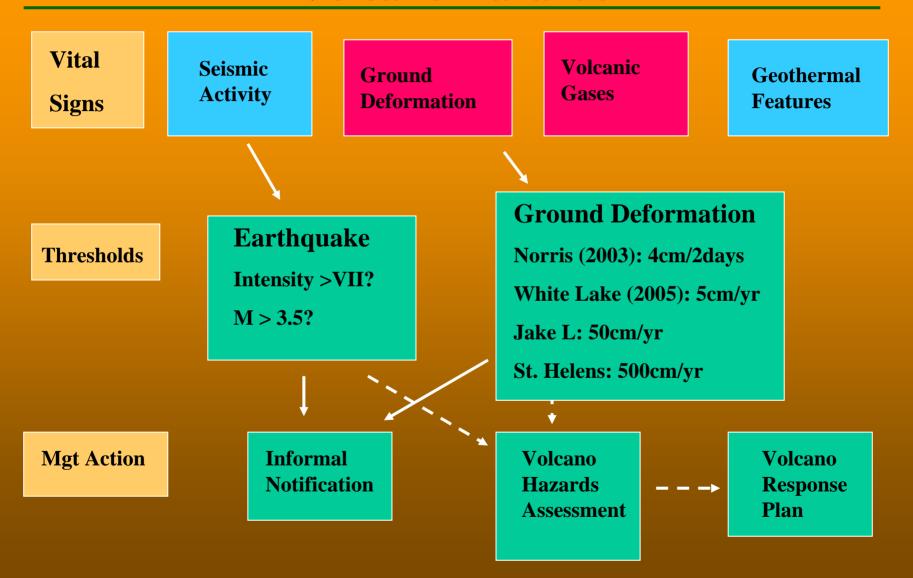












Volcano Hazards--Funding

NPS: ~ \$200,000/year

YVO: ~ \$430,000/year

USGS: ~ \$350,000/year

U of U: ~ \$75,000

Total Annual Ops: \$1,055,000

U of U/USGS: \$675,000

Earthscope: \$100K (05); \$400K (07)

Total Investments: \$1,175,000

Winter Use Plan 1990

> Winter Use Assessment 1999

> > Final EIS 2000

Final SEIS 2003

Temp Winter Use EA 2004 Final, Final SEIS *OR* Final SSEIS 2007

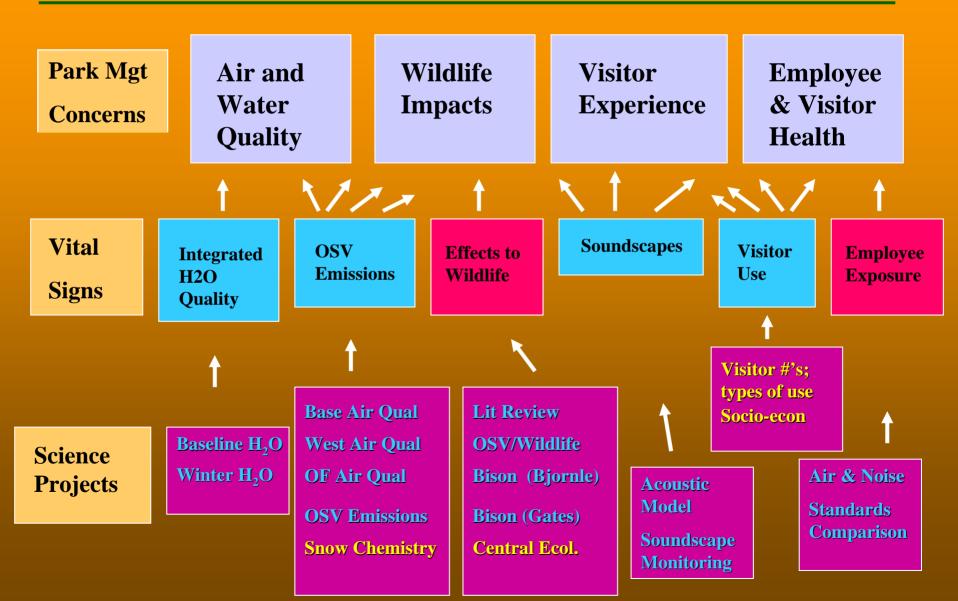






















Vital **Integrated OSV** Effects to **H2O** Visitor **Employee Emissions** Wildlife **Signs** Use Quality **Exposure Soundscapes Soundscapes Air Quality Thresholds** dB human noise <70dB(A) Developed: 8/3/3 Ave sound level <45dB(A) **Roads: 1/1/6 Audibility <50%** NAAQS: 35/9/65

Mgt Actions **BAT**

Limit OSV numbers

Time Entries Require Guides

Winter Use-Funding

NPS BASE: \$422,000/yr

NPS SOFT: >\$1,000,000

NASA: \$300,000

Conclusion







