



## Introduction

This chapter contains summary information for the eight core parks (pages 2-4 to 2-31) and the twelve secondary parks (pages 2-34 to 2-45). Information for the core parks includes a one-page written summary organized by media (air, snow, vegetation, fish, and sediment), and a two-page graphical summary of the results. The key to these two-page graphical summaries is on pages 2-2 and 2-3. The air and vegetation summary results from the secondary parks begin on page 2-32, with the key to the one-page graphical summaries for these parks on page 2-33.

## Core Parks

The park summaries that follow in this chapter have been prepared to provide the reader with an overview of selected contaminant results for each core WACAP national park. The descriptions for the Arctic parks, GAAR and NOAT, with one lake site each, have been combined into one summary.

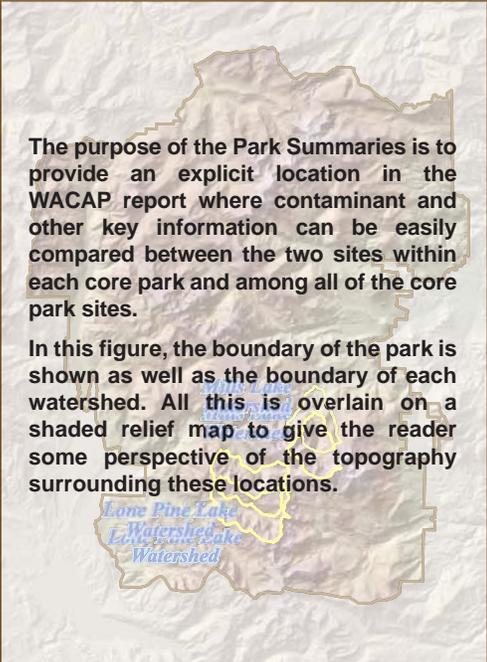
These summaries contain a considerable amount of information, but do not represent all data and information available for the parks. The two-page key for the core parks provides explicit detail regarding each block of information the reader will encounter on the two-page graphic summaries and is intended to guide the reader through the summaries. Summaries for all core parks are presented in the same format. The summaries are designed so that the two lake sites within each park can easily be compared and the relative position of these sites within the context of all WACAP core parks can also be visualized. The reader is encouraged to consult the other chapters of this report for more detailed information on the full range of WACAP results and their interpretation.



KEY

The Park Summaries that follow in this chapter have been prepared to provide the reader with a summary of selected contaminant results for each core WACAP national park. A set of reduced summaries for the secondary parks that contain only vegetation results follows the core park summaries, with a separate key. The Arctic parks GAAR and NOAT, with one lake site each, have been combined into one summary. These summaries contain a considerable amount of information, but do not represent all data and information available for the parks. This two-page Key provides explicit detail regarding each block of information the reader will encounter on the two-page graphical summaries and is intended to guide the reader through the summaries. Summaries for all parks are presented in the same format. The summaries are designed so the two lake sites within each park can easily be compared and the relative position of these sites within the context of all WACAP core parks can be visualized. The reader is encouraged to consult the other chapters of this report for more detailed information on the full range of WACAP results and their interpretation.

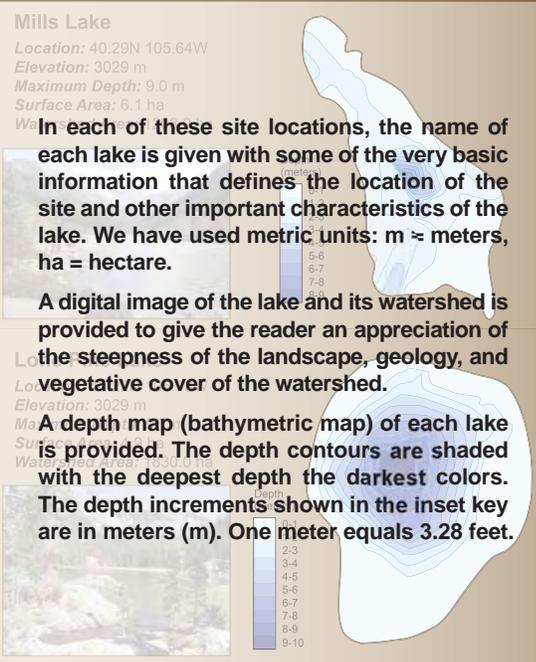
◆ Park and Lake Setting ◆



The purpose of the Park Summaries is to provide an explicit location in the WACAP report where contaminant and other key information can be easily compared between the two sites within each core park and among all of the core park sites.

In this figure, the boundary of the park is shown as well as the boundary of each watershed. All this is overlain on a shaded relief map to give the reader some perspective of the topography surrounding these locations.

**Mills Lake**  
 Location: 40.29N 105.64W  
 Elevation: 3029 m  
 Maximum Depth: 9.0 m  
 Surface Area: 6.1 ha

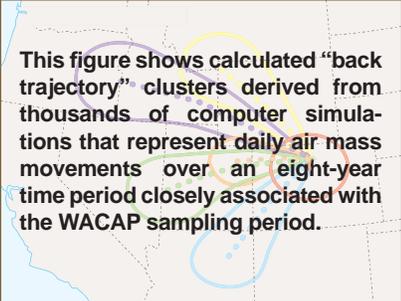


In each of these site locations, the name of each lake is given with some of the very basic information that defines the location of the site and other important characteristics of the lake. We have used metric units: m = meters, ha = hectare.

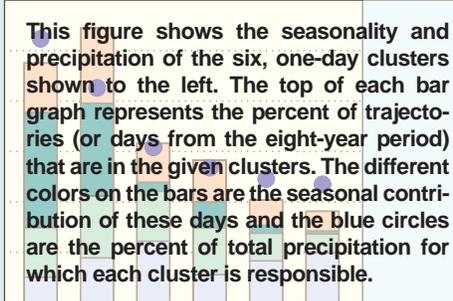
A digital image of the lake and its watershed is provided to give the reader an appreciation of the steepness of the landscape, geology, and vegetative cover of the watershed.

A depth map (bathymetric map) of each lake is provided. The depth contours are shaded with the deepest depth the darkest colors. The depth increments shown in the inset key are in meters (m). One meter equals 3.28 feet.

◆ Atmospheric Transport ◆

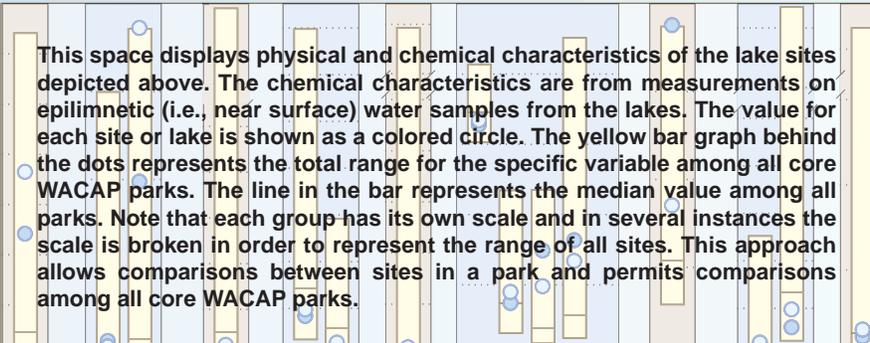


This figure shows calculated “back trajectory” clusters derived from thousands of computer simulations that represent daily air mass movements over an eight-year time period closely associated with the WACAP sampling period.



This figure shows the seasonality and precipitation of the six, one-day clusters shown to the left. The top of each bar graph represents the percent of trajectories (or days from the eight-year period) that are in the given clusters. The different colors on the bars are the seasonal contribution of these days and the blue circles are the percent of total precipitation for which each cluster is responsible.

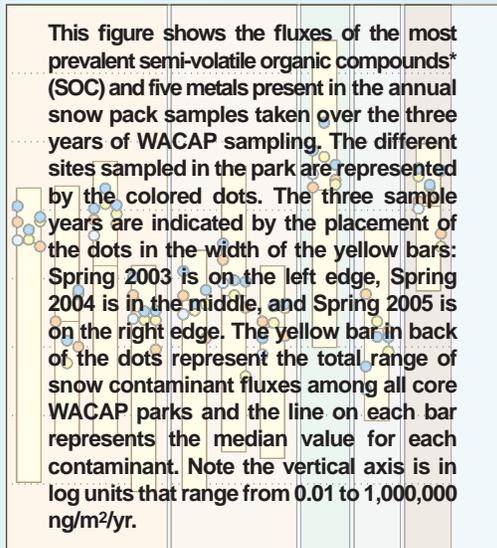
◆ Physical and Chemical Characteristics ◆



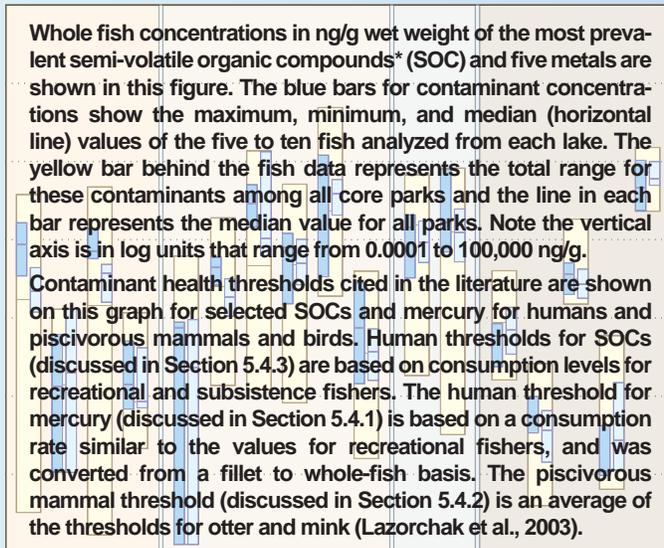
This space displays physical and chemical characteristics of the lake sites depicted above. The chemical characteristics are from measurements on epilimnetic (i.e., near surface) water samples from the lakes. The value for each site or lake is shown as a colored circle. The yellow bar graph behind the dots represents the total range for the specific variable among all core WACAP parks. The line in the bar represents the median value among all parks. Note that each group has its own scale and in several instances the scale is broken in order to represent the range of all sites. This approach allows comparisons between sites in a park and permits comparisons among all core WACAP parks.

# Key to Park Summaries: Contaminant Summaries

## ◆ Snow Contaminant Fluxes ◆

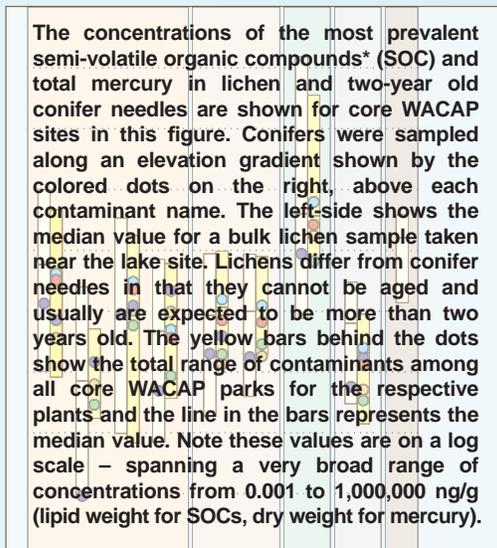


## ◆ Whole Fish Contaminant Concentrations ◆

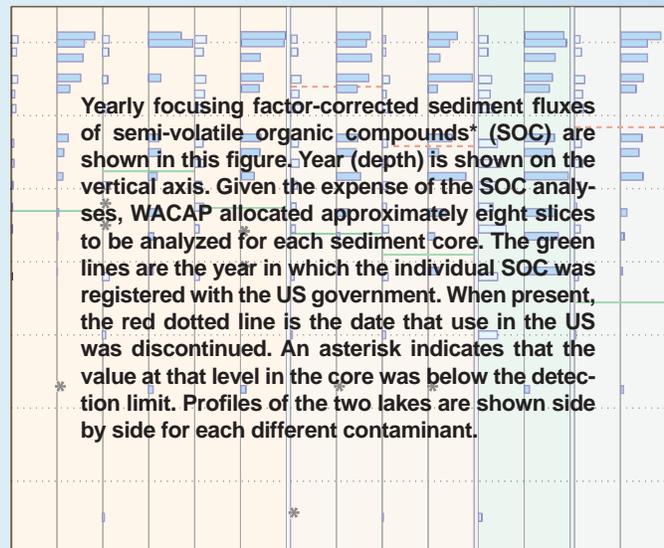


\*SOC groupings by compound class are listed in Table 4-1.

## ◆ Vegetation Contaminant Concentrations ◆



## ◆ Sediment Organic Contaminant Fluxes ◆



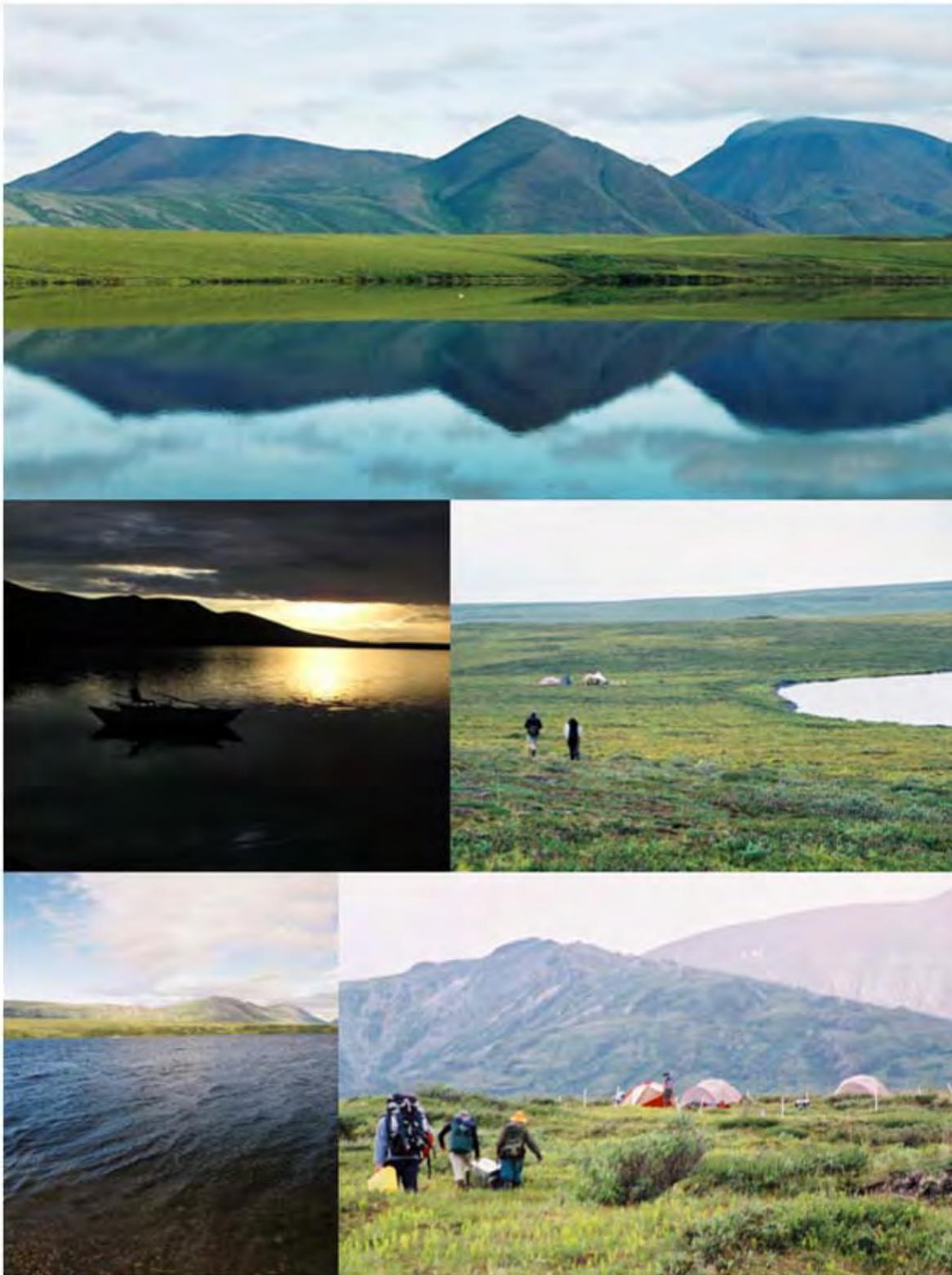
## ◆ Sediment Contaminant Fluxes ◆

These figures are sediment profiles for each site. The top of the graph represents the surface of the sediment core; the dates on the vertical axis are derived from <sup>210</sup>Pb dating. Each point on a graph represents results of an analysis of a sediment slice having an average date represented by the circle.

Sediment flux is expressed as mass per unit area per year. Spheroidal Carbonaceous Particles (SCP) are microscopic “fly ash” materials formed only by high temperature combustion associated with fossil fuel (coal and oil) combustion. They are excellent indicators of local or regional sources of human industrial activities. Total Organic Carbon is a component of the sediment record derived from in-lake photosynthesis production or watershed sources and typically decreases with depth as a result of biogenic processes in the sediment.

**Sediment Metals Enrichment:** Results of the analysis of four metals in lake sediments for each of the two lakes are shown here. The units are expressed as Percent Enrichment from historical (pre-industrial) background values near ~1880. The results have been “normalized” to titanium, which removes much of the noise in the profiles related to watershed processes (e.g., weathering, avalanches). These profiles show the recent history of metal deposition to each lake system with respect to background.

## Noatak National Preserve and Gates of the Arctic National Park and Preserve



## Summary: Noatak National Preserve and Gates of the Arctic National Park and Preserve

Burial and Matcharak lakes both have small watersheds, contributing to long hydraulic residence times. Burial Lake's surface area and volume are considerably smaller, but it had the highest total phosphorus of all WACAP lakes. Both lakes had fairly high dissolved organic carbon, an important factor in mercury methylation in lake systems. Acid neutralizing capacity of both lakes was high.

### Air

The primary SOCs detected in air were HCB and a-HCH, both historic-use pesticides known to be distributed by cold fractionation. Low concentrations of endosulfans chlordanes, g-HCH, and PAHs were also detected.

### Snow

Mercury flux to the snowpack at Burial and Matcharak lakes was low compared to that at the other parks. SOCs varied considerably among collection sites and inter-annually. Compared to values at the other parks, SOC flux was low for dacthal and chlorpyrifos and mid to high for endosulfans and a-HCH.

### Vegetation

No conifers were present at these Arctic sites, so we collected only lichens. Here we observed the lowest concentrations of SOCs, nutrients, and toxic metals, including Hg, among the parks. Concentrations approached detection limits for many SOCs. However, we detected dacthal, endosulfans, HCB, a-HCH, PCB153, and the PAHs retene, CHR/TRI, and FLA. Compared to values at other parks, concentrations of many rare and trace elements were relatively high at Matcharak Lake. High mineral content in regional lithology is the likely source.

### Fish

Numerous parasites (worms) were found in the overall normal lake trout from both lakes. Fish analyzed were the oldest in WACAP, with maximum ages of 33 and 41 years for fish analyzed for SOC and metals, respectively. Spleen macrophage aggregates were positively related to mercury in fish less than 15 years of age from Burial Lake. Concentrations of historic-use SOCs in fish were generally mid-range compared with those at all other sites, whereas current-use SOCs were some of the lowest measured in fish. The median dieldrin concentration in Burial Lake, as well as dieldrin concentrations in some individual Matcharak Lake fish, exceeded contaminant health thresholds for subsistence fishers. Mercury concentrations were high, indicating high mercury methylation and bioaccumulation in NOAT and GAAR. Mercury concentrations exceeded thresholds for wildlife health, and the median mercury concentration in Burial Lake and in some fish in Matcharak lake exceeded the human contaminant health threshold.

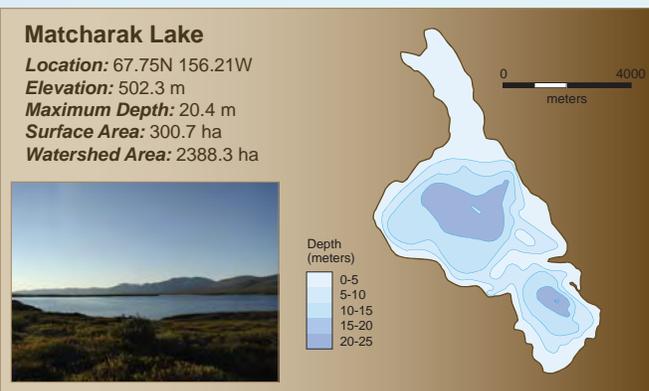
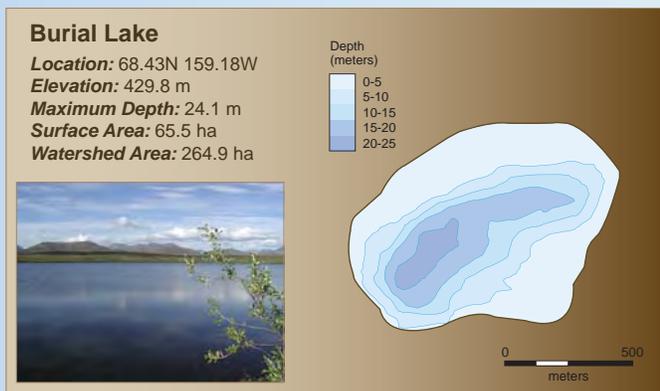
### Sediment

Many of the SOCs were below detection limits in the sediment profiles for both lakes. In addition, SCPs were not present. Mercury percent enrichment profiles were generally very low, but showed similar increasing trends from about 1875 in each lake. This pattern reflects the general increase in the global background of Hg in the atmosphere caused by human activities, largely coal burning and smelting.

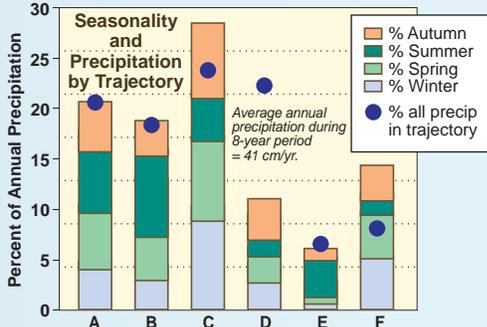
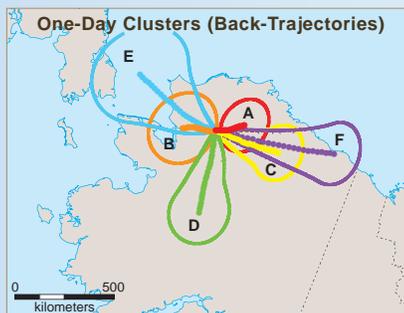
# Noatak National Preserve and Gates of the Arctic National Park and Preserve: *Site Characteristics*



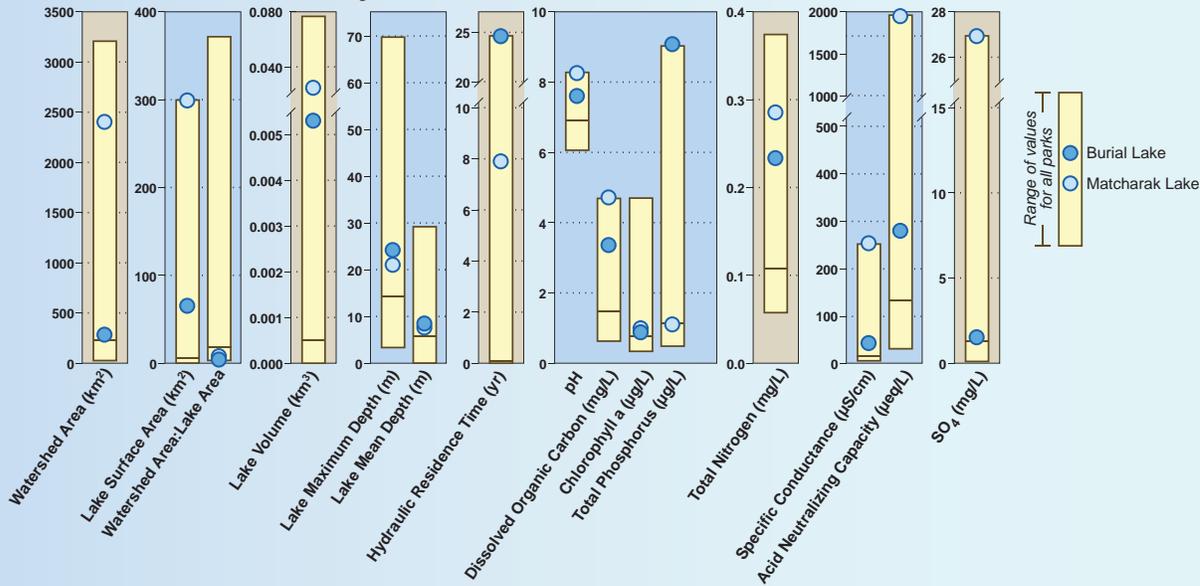
NOAT, GAAR



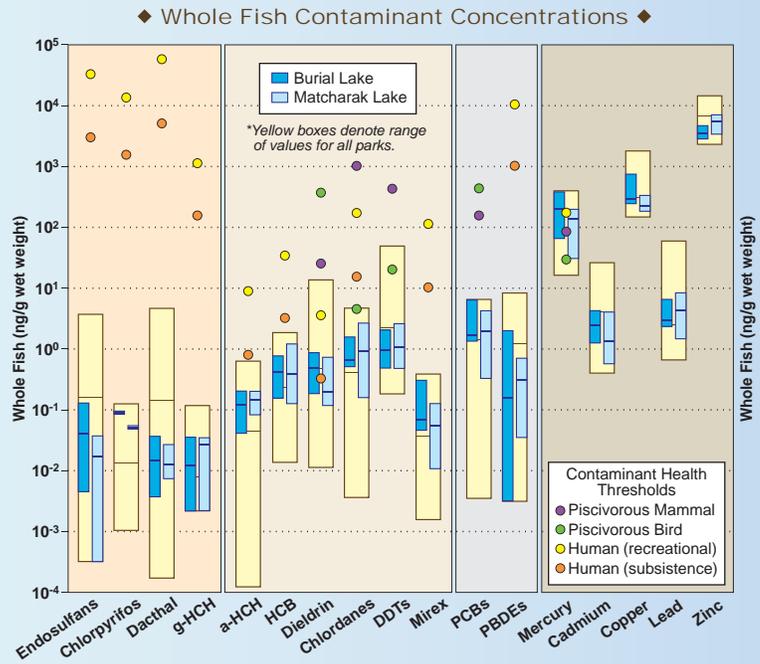
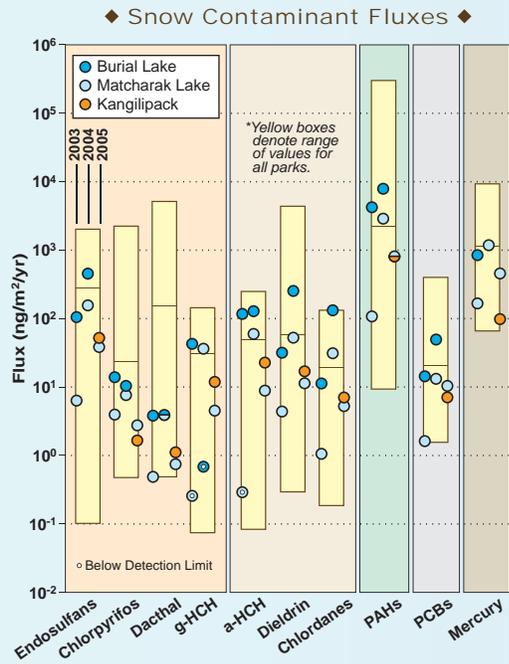
## ◆ Atmospheric Transport ◆



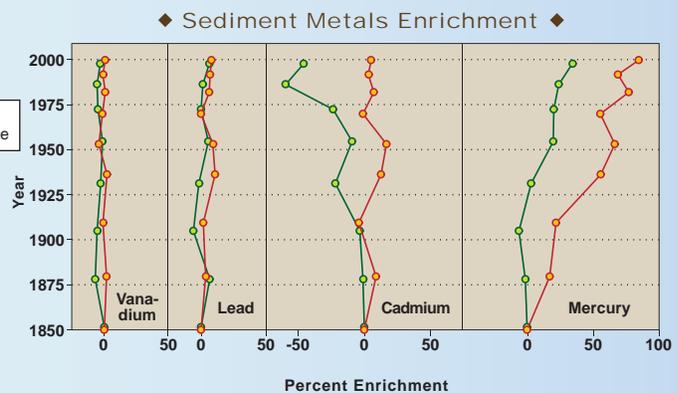
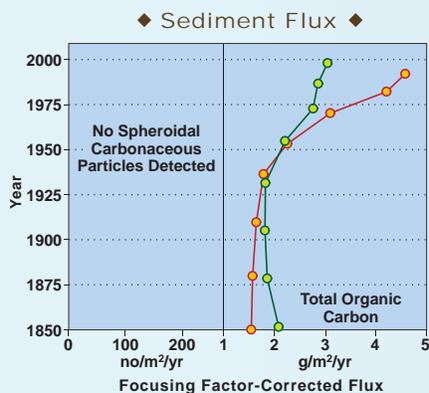
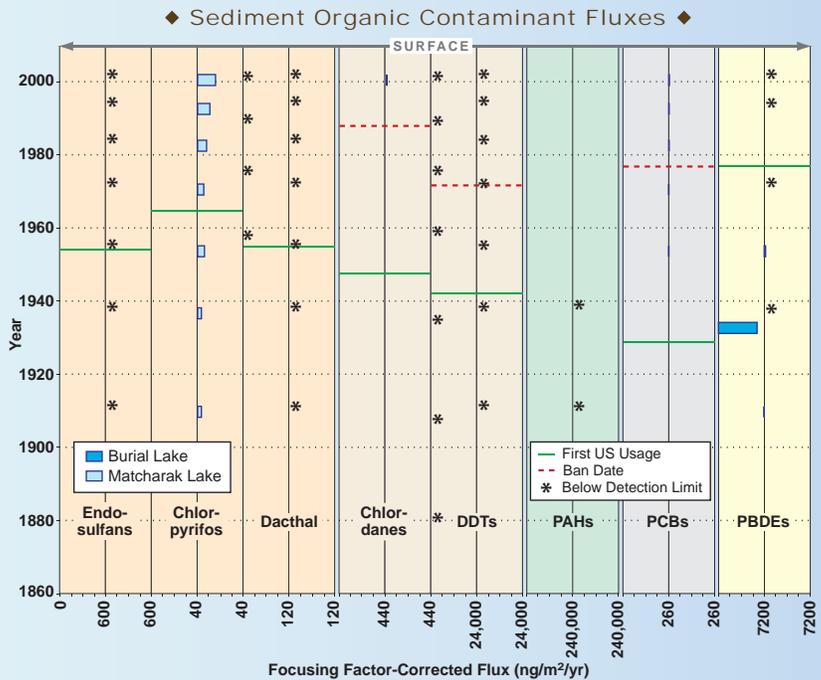
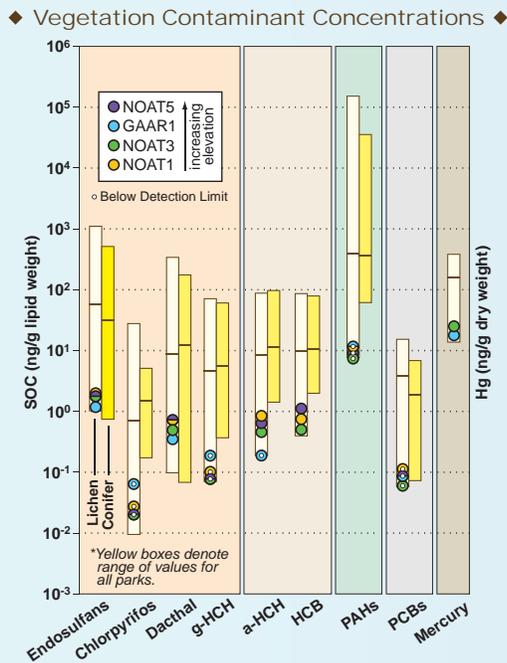
## ◆ Physical and Chemical Characteristics ◆



# Noatak National Preserve and Gates of the Arctic National Park and Preserve: Contaminant Summaries



■ Current-Use Pesticides ■ Historic-Use Pesticides ■ Combustion By-products ■ Industrial Compounds ■ Metals ■ Current-Use Chemical



## Denali National Park and Preserve



## Summary: Denali National Park and Preserve

Wonder Lake and McLeod Lake were very different from one another in most physical characteristics, as well as in many chemical parameters. Wonder Lake is a deep, large lake with high pH, specific conductance, acid neutralizing capacity, and sulfate concentration. McLeod Lake, by contrast, has very low specific conductance and acid neutralizing capacity. Both are characterized by fairly small watersheds.

### Air

Similar to SOCs at sites in the Arctic, the primary SOCs detected in air were HCB and a-HCH, both historic-use pesticides. In addition, low concentrations of endosulfans, chlordanes, g-HCH, and PAHs were detected.

### Snow

Contaminant deposition fluxes in snow for DENA were among the lowest in all the parks, with low concentrations and shallow snowpacks. Among the DENA snowpack samples, the Kahiltna site had the highest deposition fluxes of most contaminants. Concentrations were similar to those in the other samples in DENA, but greater snow water equivalent at this site caused contaminant fluxes to be higher than those measured at the lower elevation sites. This pattern is typical in mountains and other environments where large precipitation gradients are present. These results demonstrate that contaminant fluxes measured in snowpack at a single site might not be representative of an entire park.

### Vegetation

After NOAT and GAAR, DENA had the lowest concentrations of SOCs, nutrients, metals, and mercury in vegetation among the parks. Concentrations were low for agricultural chemicals and PCBs, but higher for PAHs. The pesticides detected were HCB, endosulfans, a-HCH, and dacthal, and all increased with elevation. The dominant PAHs were retene and CHR/TRI, possibly attributable to wildfire, and decreased with increasing elevation.

### Fish

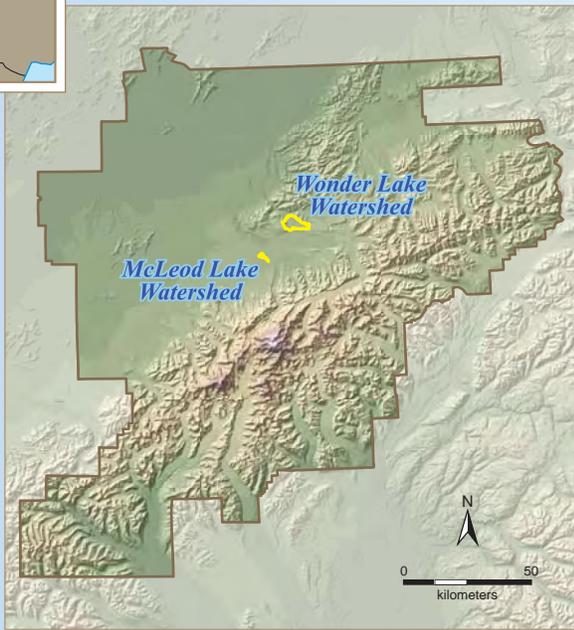
Fish historic-use SOC concentrations were in the mid to high range among parks for selected compounds and among the lowest measured for most current-use SOCs. Median dieldrin concentrations in Wonder Lake fish and in some individual fish in McLeod Lake exceeded contaminant health thresholds for subsistence fishers. Median mercury concentrations in both lakes exceeded contaminant health thresholds for piscivorous birds (kingfishers), and Wonder Lake also exceeded contaminant health thresholds for mammals (otter and mink). Spleen macrophage aggregates were significantly higher in Wonder Lake fish than those in lake trout from NOAT and GAAR. The reasons for this finding are unknown. Macrophage aggregates were positively related to mercury concentrations in Wonder Lake, a pattern that was observed for most of the lakes. Very few fish were available from McLeod Lake, despite two sampling efforts (2004 and 2005). All fish appeared reproductively normal.

### Sediment

Sediment fluxes of most of the SOCs found in other lakes were below detection in the DENA sediment profiles. PCBs were present, but at low concentrations—about the same order of magnitude as in the other Alaska lake sediments. Wonder Lake showed distinct and similar percent enrichment increases from at least 1920 to the surface for both mercury and lead, probably as a result of increasing global background concentrations. McLeod Lake sediments did not show a similar trend. No SCPs were found in either sediment profile.

# Denali National Park: Site Characteristics

DENA



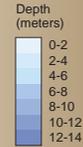
## Wonder Lake

**Location:** 63.48N 150.88W  
**Elevation:** 605.0 m  
**Maximum Depth:** 70.0 m  
**Surface Area:** 265.6 ha  
**Watershed Area:** 3212.4 ha

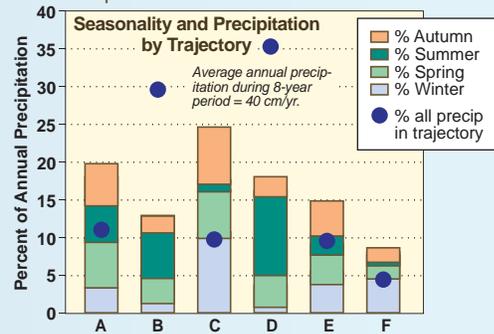
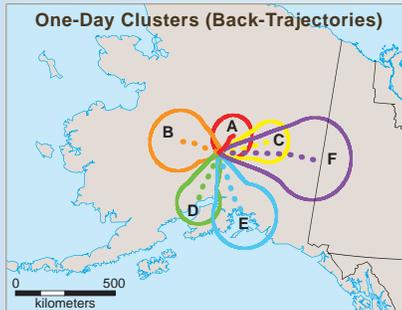


## McLeod Lake

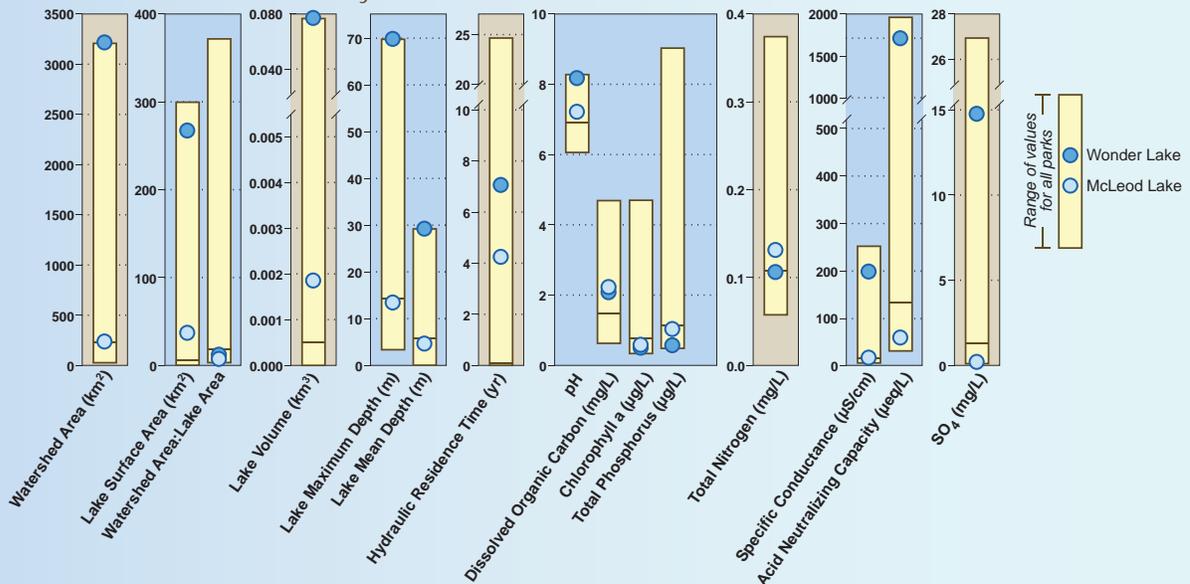
**Location:** 63.38N 151.07W  
**Elevation:** 563.9 m  
**Maximum Depth:** 13.5 m  
**Surface Area:** 35.9 ha  
**Watershed Area:** 236.8 ha



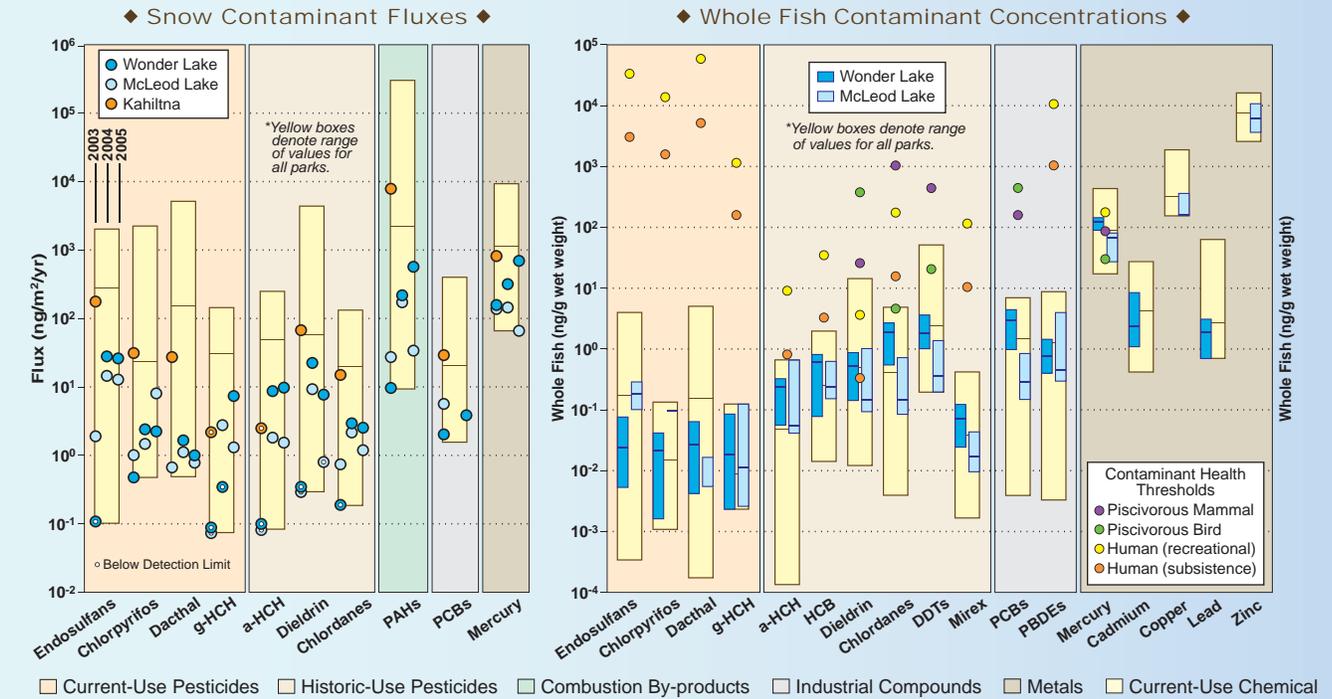
### Atmospheric Transport



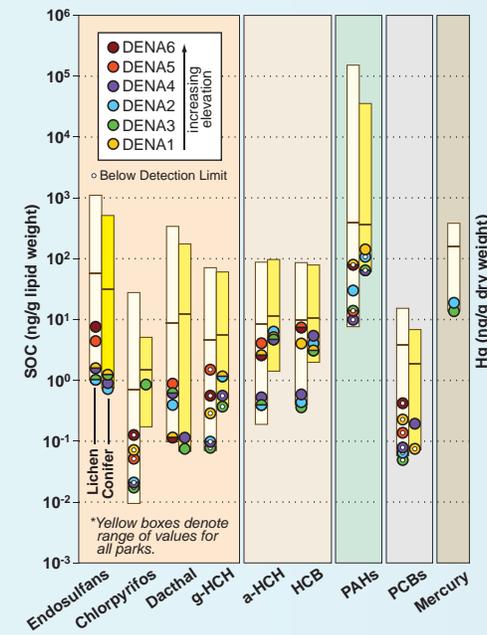
### Physical and Chemical Characteristics



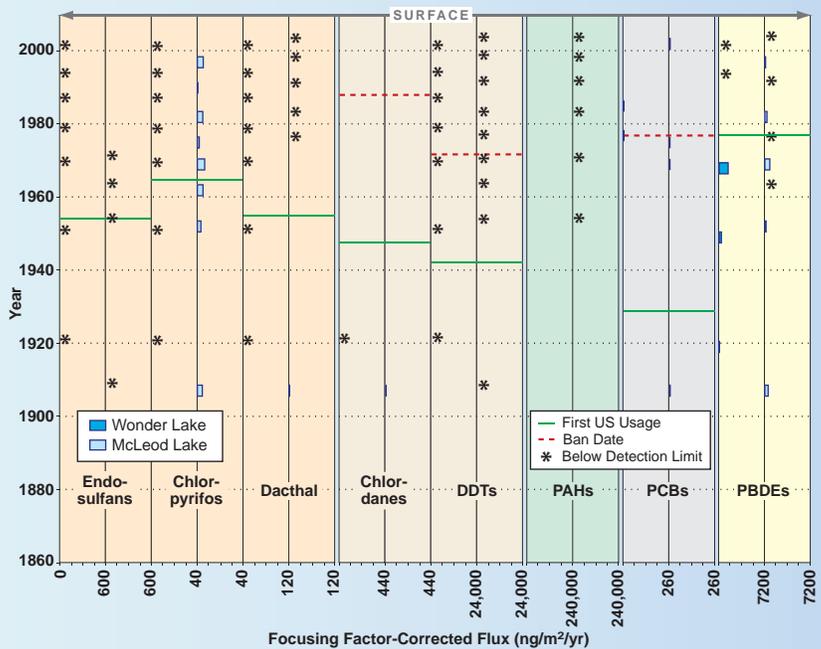
# Denali National Park: Contaminant Summaries



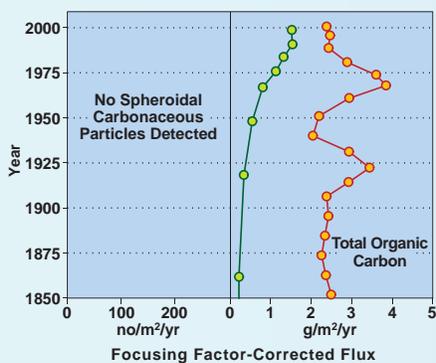
**◆ Vegetation Contaminant Concentrations ◆**



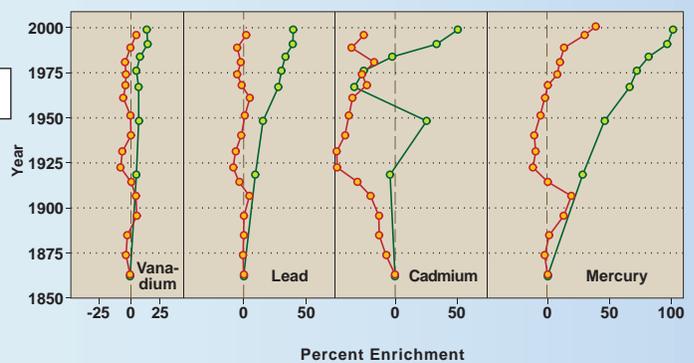
**◆ Sediment Organic Contaminant Fluxes ◆**



**◆ Sediment Flux ◆**



**◆ Sediment Metals Enrichment ◆**



## Glacier National Park



## Summary: Glacier National Park

Oldman and Snyder lakes share many physical characteristics. However, Oldman Lake has a much greater volume and greater maximum depth, as well as greater specific conductance, pH, and acid neutralizing capacity. Snyder Lake is more productive, with higher total phosphorus, nitrogen, and chlorophyll-*a*. At GLAC, air, vegetation, and snow had among the highest concentrations for current-use pesticides, compared with these media at the other parks. The source of these compounds probably was regional agriculture within a few hundred kilometers of the park.

### Air

Compared to measurements at the other parks, high concentrations of SOCs detected in air include PAHs, dacthal, endosulfans, HCB, *a*-HCH, and *g*-HCH. Low concentrations of chlordanes and PCBs were also detected. Concentrations at Oldman Lake, east of the Continental Divide, were higher than those at Snyder Lake, west of the Continental Divide.

### Snow

Snow water equivalents, contaminant concentrations (except PAHs), and contaminant flux to the snowpack in GLAC were similar to those at the other parks. For PAHs, the concentrations and fluxes at Snyder Lake were substantially higher than those at Oldman Lake. Mercury flux to the snowpack was near average among parks, but fish concentrations of mercury were below average, indicating low rates of mercury methylation and bioaccumulation, similar to rates at ROMO. SOC concentrations in snow varied considerably among the sites sampled. However, within the same year, the range for all contaminants in GLAC was typically within an order of magnitude. PAH concentrations in snow at Snyder Lake were always higher than at the other sites, and among the highest at all parks.

### Vegetation

Numbers and concentrations of PAHs detected were highest at GLAC than at other parks. Proximity to an aluminum smelter suggests a local source of PAHs contributing to the high concentrations. Other SOCs (endosulfans, dacthal, DDTs, *g*-HCH, *a*-HCH, HCB, triallate, chlorpyrifos, and PCBs) were in the mid to upper ranges compared to those at other parks. Dacthal, endosulfans, HCB, *a*-HCH, chlorpyrifos, DDTs, PCBs, and PAHs were higher on the west side of the park, attributable to precipitation and temperature. Triallate, chlorpyrifos, and *g*-HCH were higher on the east side of the park, probably because of agricultural intensity. Enhanced nitrogen and sulfur deposition related to regional agricultural intensity is of concern. Many rare but not highly toxic elements were higher in lichen at GLAC than in lichen at other parks. Because forest productivity is high, pesticides scrubbed from the air by vegetation probably contribute significant contaminant loads to the ecosystem via canopy through-fall and needle litter-fall.

### Fish

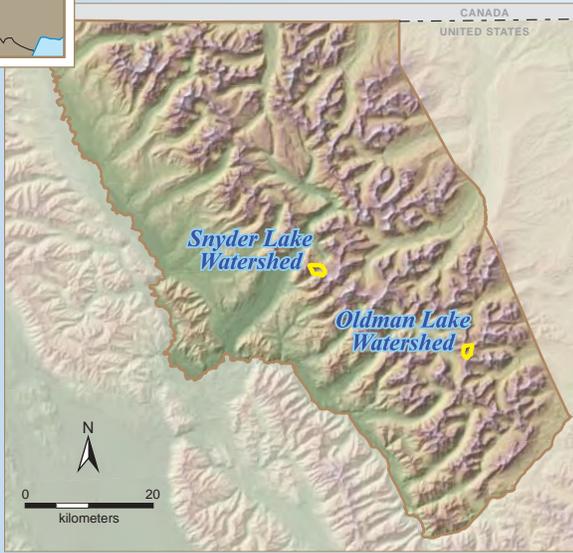
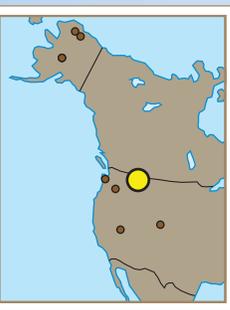
Pesticide concentrations (dacthal, *g*-HCH, HCB, dieldrin, and chlordanes) in fish in Oldman Lake were higher than those in Snyder Lake, possibly related to agricultural intensity. One fish from Oldman Lake exceeded contaminant health thresholds for piscivorous birds (kingfishers) for chlordanes, and the median concentration of DDTs from Oldman Lake exceeded the contaminant health thresholds for piscivorous birds. Fish in both lakes exceeded kingfisher thresholds for Hg. Lake average dieldrin and *p,p'*-DDE fish concentrations in Oldman Lake exceeded contaminant health thresholds for subsistence fishers. Dieldrin concentration in one fish from Oldman Lake exceeded the contaminant health threshold for recreational fishers. Mercury increased with increasing age of fish in Snyder Lake. Kidney and/or spleen macrophage aggregates were significantly related to mercury and age at both lakes. All fish appeared reproductively normal, but elevated concentrations of estrogen-responsive protein were found in males from both lakes. One intersex male was found at Oldman Lake. These data suggest endocrine disruption.

### Sediment

SOC profiles are consistent with the first usage of these chemicals in the United States, but most have not decreased since use ceased. Snyder Lake profiles generally show greater contaminant flux than Oldman Lake profiles. PAHs in Snyder Lake indicate some decline in the recent sediments since approximately 1990. Lead, cadmium, and mercury profiles increase from approximately 1875 and decrease beginning in the 1960s. These profiles suggest a common historic source that might have been affected by reductions in emissions related to the Clean Air Act. This relationship is supported by the pattern observed in SCPs.

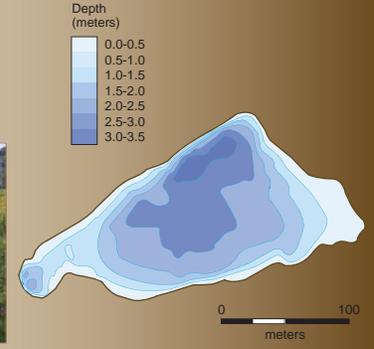
# Glacier National Park: *Site Characteristics*

GLAC



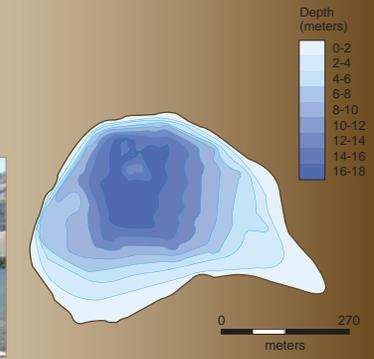
## Snyder Lake

**Location:** 48.62N 113.79W  
**Elevation:** 1597.2 m  
**Maximum Depth:** 3.5 m  
**Surface Area:** 2.6 ha  
**Watershed Area:** 303.7 ha

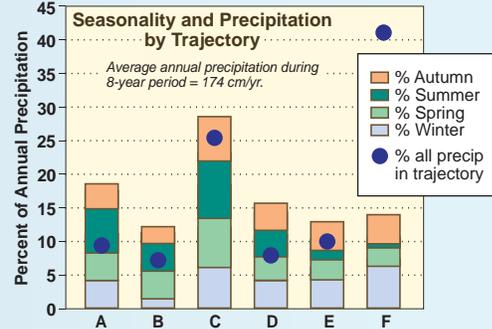
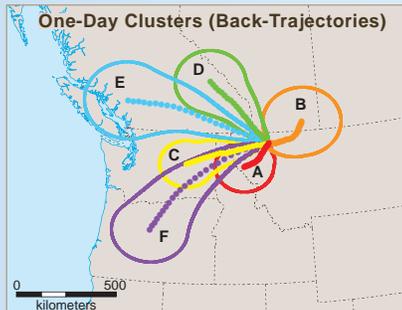


## Oldman Lake

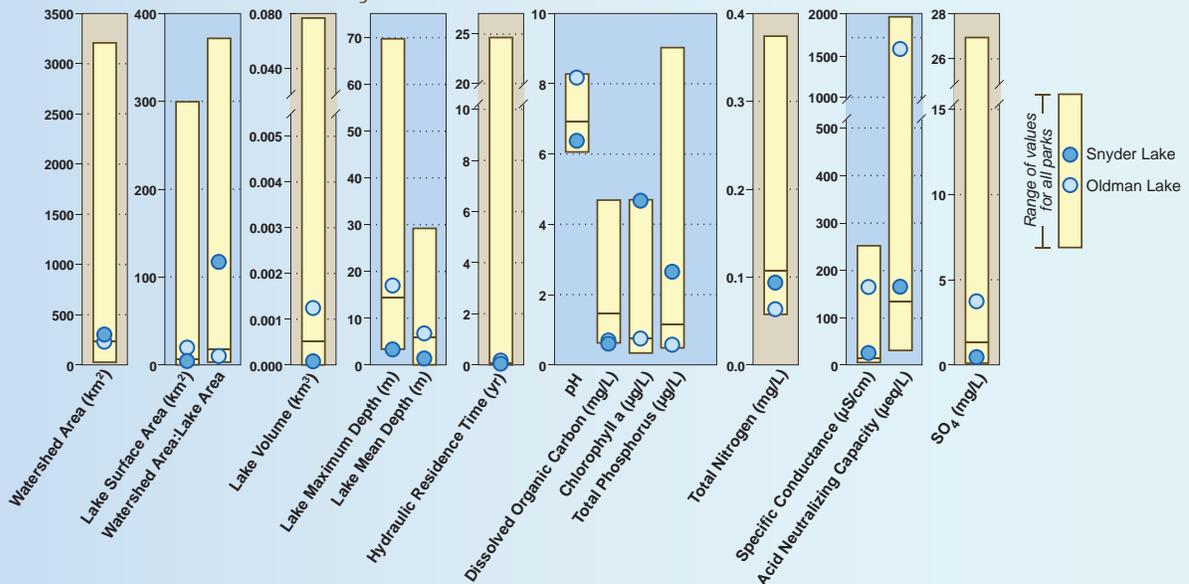
**Location:** 48.50N 113.46W  
**Elevation:** 2025.7 m  
**Maximum Depth:** 17.0 m  
**Surface Area:** 18.2 ha  
**Watershed Area:** 230.3 ha



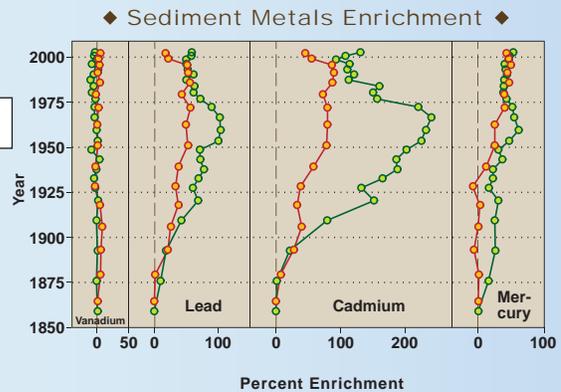
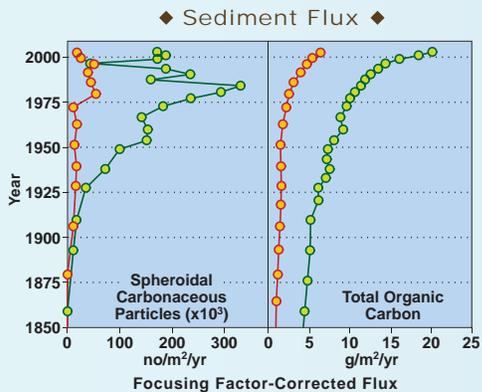
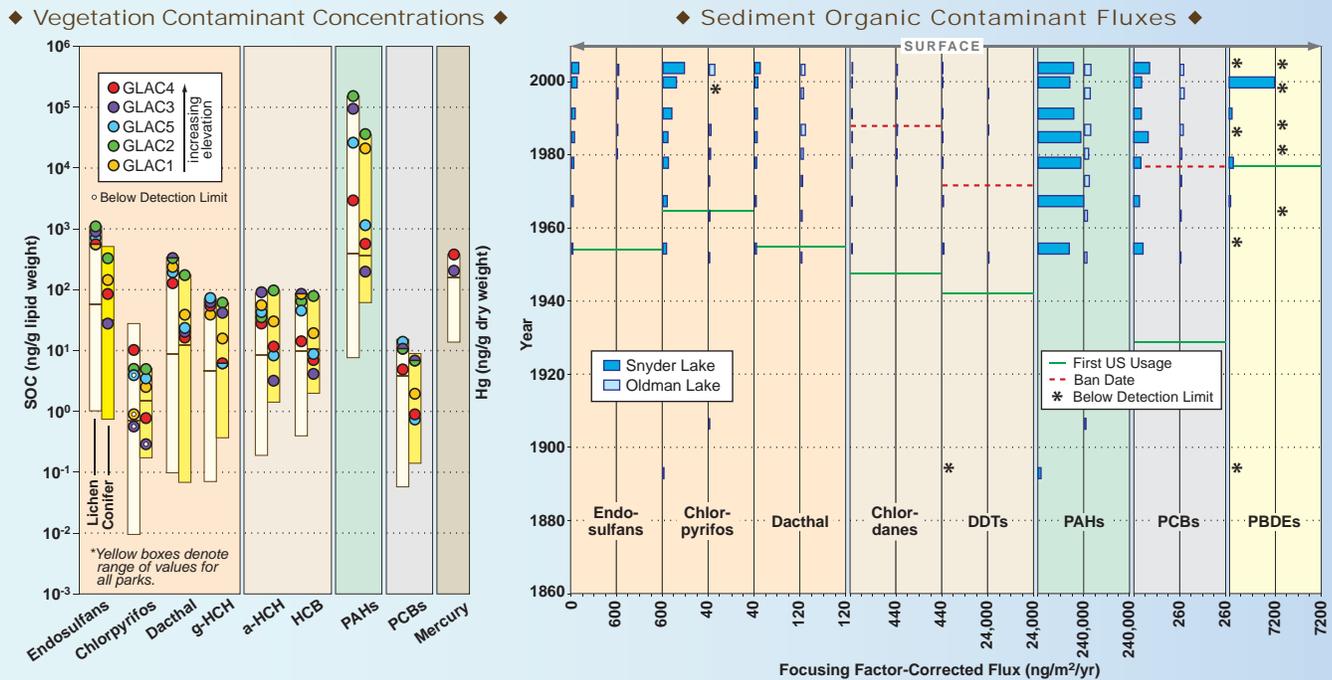
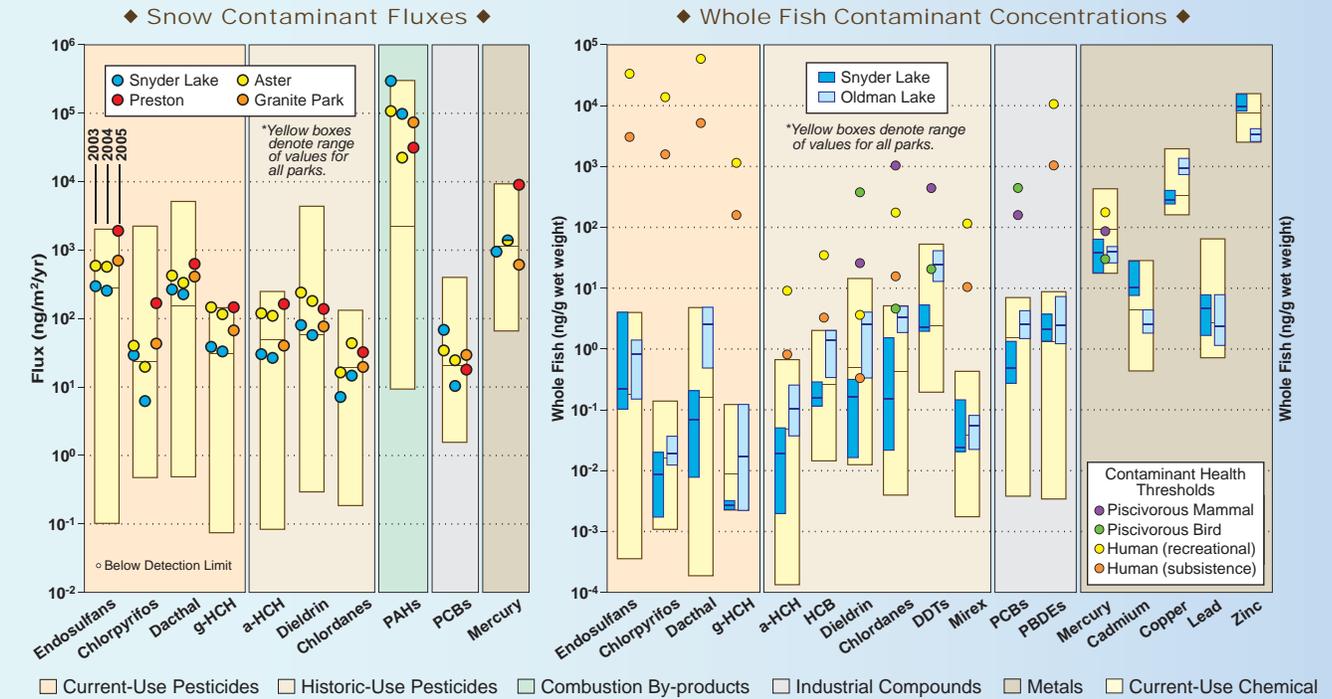
### ◆ Atmospheric Transport ◆



### ◆ Physical and Chemical Characteristics ◆



# Glacier National Park: Contaminant Summaries



## Olympic National Park



## Summary: Olympic National Park

The two OLYM lakes, Hoh and PJ, were similar in many ways, both physically and chemically. However, PJ Lake was clearly more productive, with higher total phosphorus, chlorophyll-*a*, pH, and specific conductance. PJ Lake had smaller mean and maximum depths and was frequently affected by avalanches that brought trees and other debris into the lake.

### Air

The primary SOCs detected in air were endosulfans, HCB, and *a*-HCH. Low concentrations of PAHs, PCBs, *g*-HCH, trifluralin, dacthal, and chlordanes were also detected. SOC concentrations at Hoh Lake on the west side of the park and PJ Lake on the east side were nearly identical.

### Snow

Unusually warm conditions with heavy mid-winter rains occurred during the study period (2002-2005). Because mid-winter rain or snowmelt can wash contaminants out of the snow, and ancillary data indicated substantial loss of water from the snowpack prior to spring sampling in 2003 and 2005, snowpack samples were collected in 2004 only. Two sites near PJ Lake had fairly high mercury fluxes in the 2004 snowpack, whereas mercury deposition flux in the Hoh Lake snowpack was somewhat less. These results were surprising, given that there are few known local or regional upwind sources. One possible explanation is that deposition from regional sources to the east can reach OLYM on easterly airflows.

### Vegetation

Like those for MORA, SOC and Hg concentrations in vegetation were at mid to upper ranges compared to concentrations at other parks. PAHs were the dominant SOCs detected. Other SOCs were endosulfans, *a*-HCH, HCBs, and dacthal, and concentrations of these SOCs varied substantially. We observed low concentrations of chlorpyrifos, trifluralin, and PCBs. Nutrients and other metals in vegetation were within expected ranges. Because forest productivity is high, pesticides scrubbed from the air by the vegetation probably contribute significant contaminant loads to the ecosystem via canopy through-fall and needle litter-fall.

### Fish

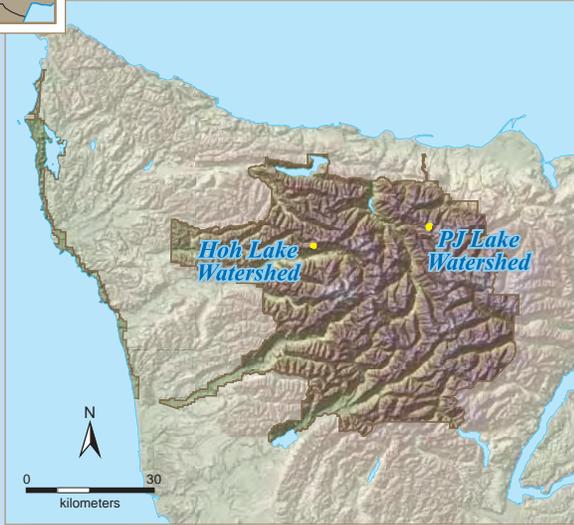
Concentrations of SOCs in OLYM were generally among the lowest for dieldrin, mirex, and chlordanes, and average for other pesticides. Fish mercury concentrations were among the highest of all parks, exceeding contaminant health thresholds for piscivorous mammals (otter, mink) and birds (kingfishers), and some fish from both lakes exceeded the human contaminant health threshold. Mercury and macrophage aggregates increased with increasing age of fish in both lakes. Spleen and kidney macrophage aggregates were also positively related to mercury in both lakes. All fish appeared reproductively normal.

### Sediment

Sediment profiles for SOCs in both lakes were generally below detection limits (except for PAH and PCB). Mercury, cadmium, and lead show increasing percent enrichment toward the surface (present time) beginning in the late 1800s, and stabilize at the surface at fairly high percent enrichment values. This relationship suggests a possible common source. SCPs showed a historic peak in both lakes around 1950 and generally decreased toward the surface.

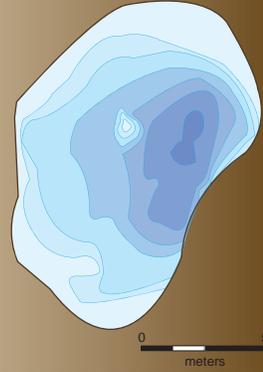
# Olympic National Park: Site Characteristics

OLYM



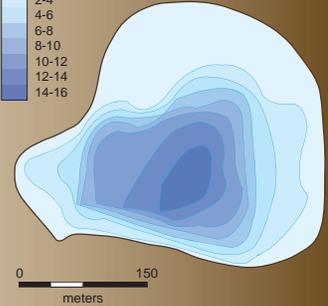
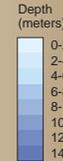
## PJ Lake

**Location:** 47.95N 123.42W  
**Elevation:** 1383.8 m  
**Maximum Depth:** 6.4 m  
**Surface Area:** 0.8 ha  
**Watershed Area:** 56.2 ha

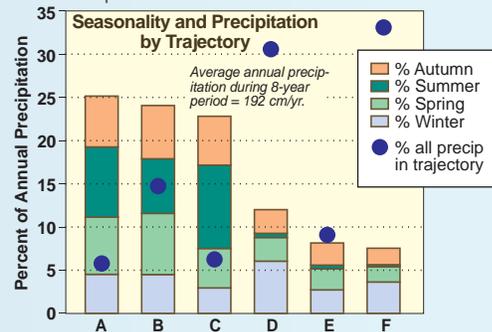
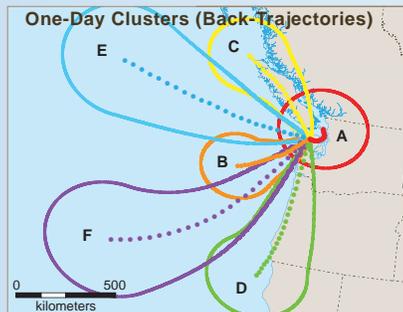


## Hoh Lake

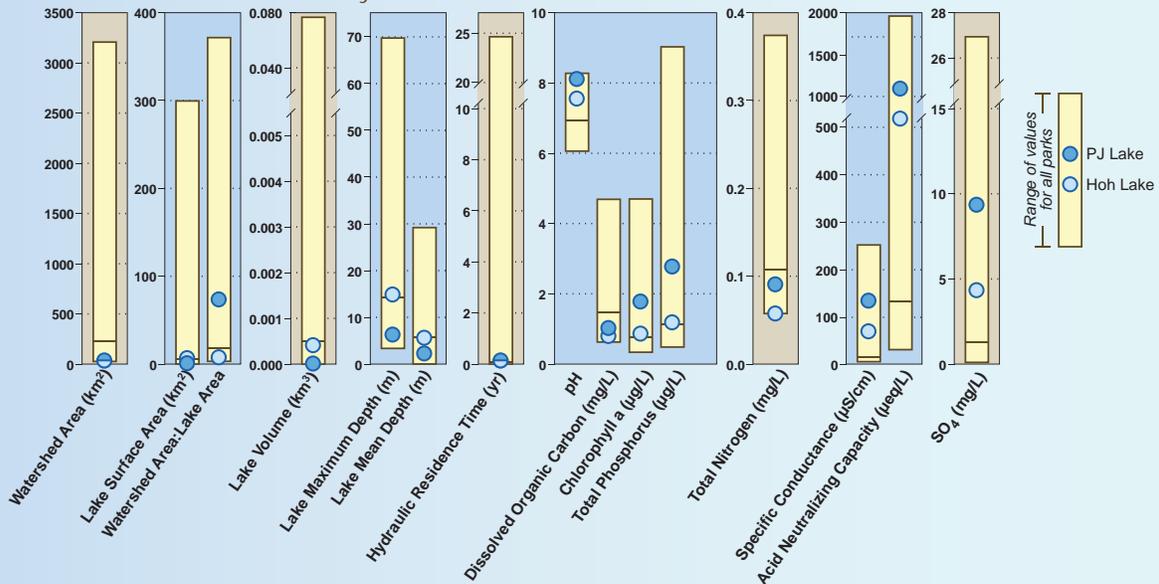
**Location:** 47.90N 123.79W  
**Elevation:** 1379.2 m  
**Maximum Depth:** 14.9 m  
**Surface Area:** 7.7 ha  
**Watershed Area:** 43.9 ha



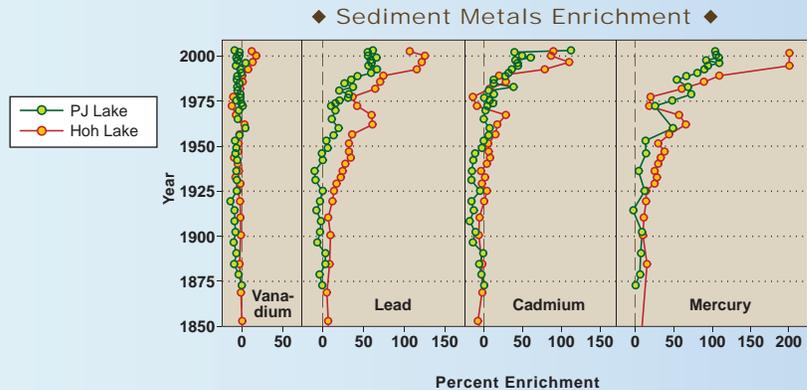
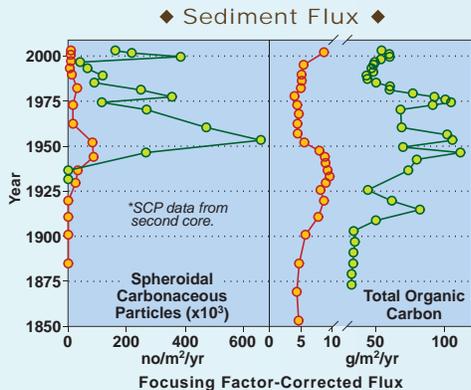
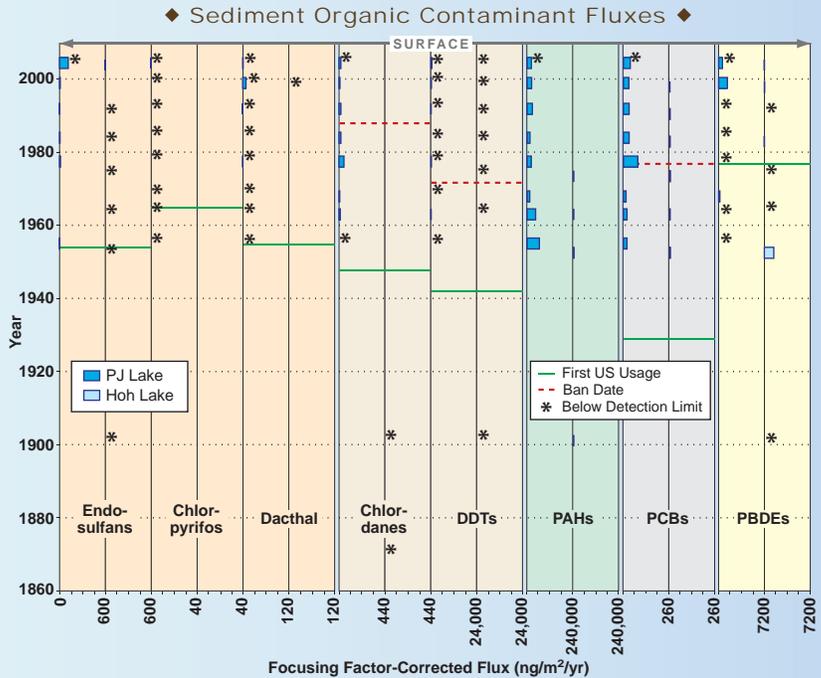
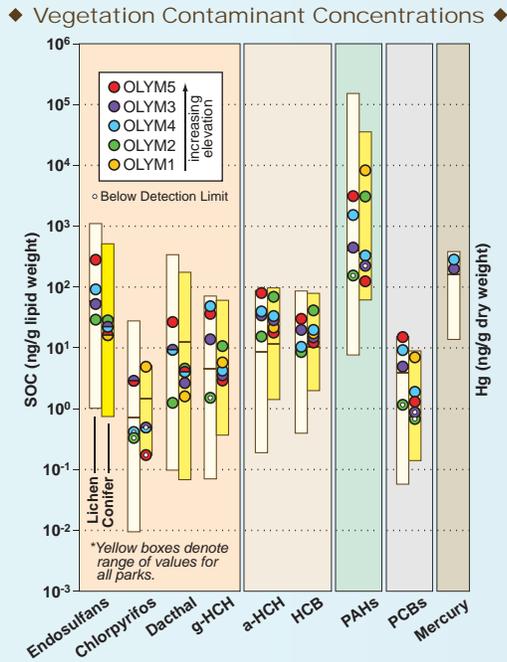
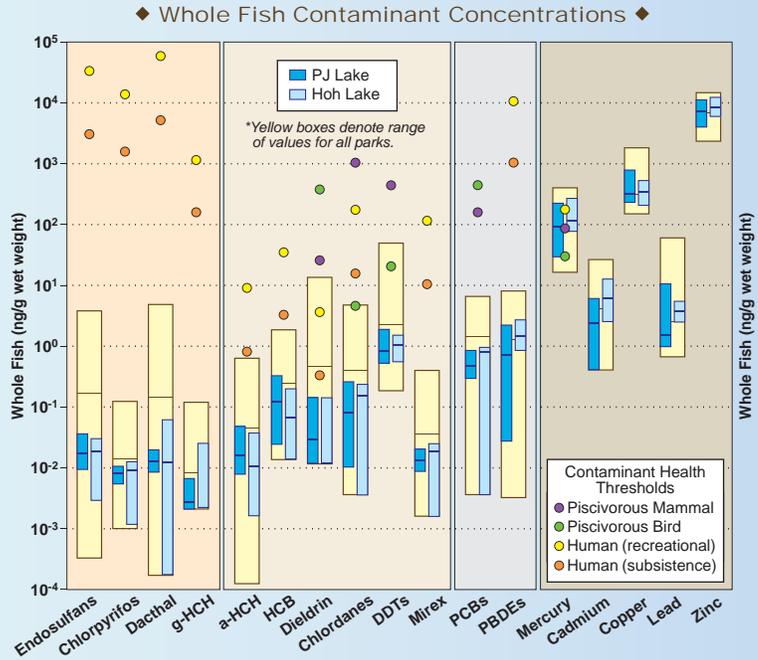
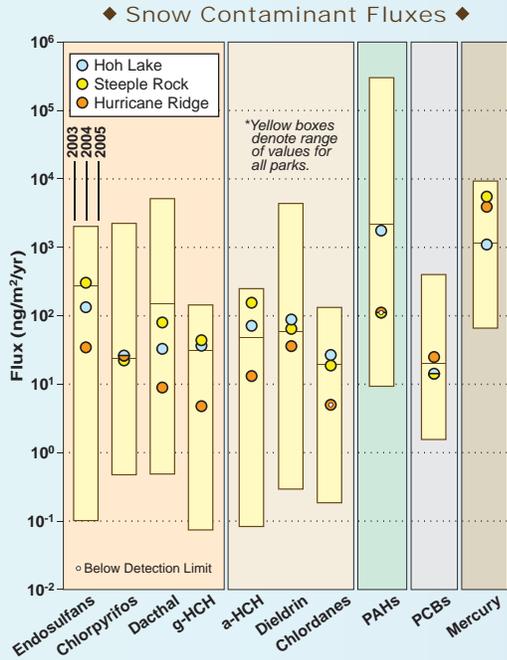
## Atmospheric Transport



## Physical and Chemical Characteristics



# Olympic National Park: Contaminant Summaries



## Mount Rainier National Park



## Summary: Mount Rainier National Park

Lake sites in MORA are very closely matched in both physical and chemical aspects. Golden Lake and LP19 are typical small sub-alpine lakes with low productivity, low conductivity, low nutrients, and small watersheds.

### Air

The primary SOCs detected in air were the endosulfans, HCB, and a-HCH. Low concentrations of g-HCH, trifluralin, dacthal, and chlordanes were also observed.

### Snow

Average winter precipitation rates at MORA are the highest among the parks, so contamination fluxes are moderate to high, even though snow concentrations are mid-range for the parks. Contaminant fluxes were fairly low in 2005, reflecting shallow snow accumulation and low snow water equivalent that year.

### Vegetation

SOC and Hg concentrations in vegetation were at or well above the concentrations observed at the other parks. Dominant SOCs were PAHs, endosulfans, a-HCH, HCB, and dacthal. Detectable but low concentrations of chlorpyrifos, dieldrin, DDTs, and PCBs were also observed. Chlorpyrifos, dacthal, endosulfans, HCBs, HCHs, chlordanes, DDTs, and PCBs increased with elevation. PAHs, dominated by CHR/TRI, PHE, and retene, decreased with increasing elevation. Nutrients and metals were within expected ranges. Because forest productivity is high, pesticides scrubbed from the air by vegetation probably contribute significant contaminant loads to the ecosystem via canopy through-fall and needle litter-fall.

### Fish

Contaminant concentrations in fish were generally mid-range, except for PBDEs in Golden Lake fish, which were the highest among all fish at all lakes. The median dieldrin concentration of fish in Golden Lake and some individual fish in LP19 exceeded contaminant health thresholds for subsistence fishers. Mercury concentrations in all fish from both lakes exceeded contaminant health thresholds for birds (kingfishers), and some fish exceeded thresholds for piscivorous mammals (otter, mink). Mercury concentrations in some fish from LP19 exceeded contaminant health thresholds for humans. These mercury values indicate favorable conditions for methylation and subsequent bioaccumulation of mercury. Mercury and macrophage aggregates increased with increasing age of fish in LP19, but not in Golden Lake. Spleen and kidney macrophage aggregates were positively related to mercury at LP19, but only kidney macrophage aggregates were related to mercury at Golden Lake. All fish appeared normal reproductively, although one male from Golden Lake had elevated concentrations of estrogen-responsive protein in the blood.

### Sediment

Many of the sediment SOCs were below detection limits. When they were present, the two lake profiles showed some similarities. PAHs and PCBs showed the highest sediment fluxes. Mercury and lead had both increased since about 1900, suggesting a common source. Mercury showed a rapid percent enrichment near the surface (present time) of both lakes. The source of this increase is unknown, but global warming, increased global background, and/or trans-Pacific sources could be responsible. SCP profiles declined towards the surface, and did not correspond to changes in metal profiles.

# Mount Rainier National Park: *Site Characteristics*

MORA

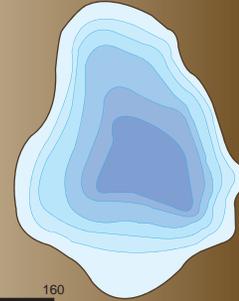


## Golden Lake

**Location:** 46.89N 121.90W  
**Elevation:** 1368.6 m  
**Maximum Depth:** 23.9 m  
**Surface Area:** 6.6 ha  
**Watershed Area:** 106.1 ha



Depth (meters)  
 0-4  
 4-8  
 8-12  
 12-16  
 16-20  
 20-24

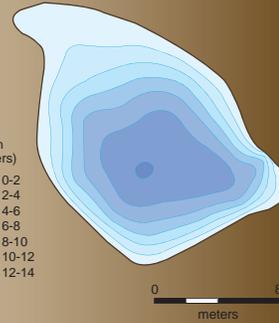


## LP19

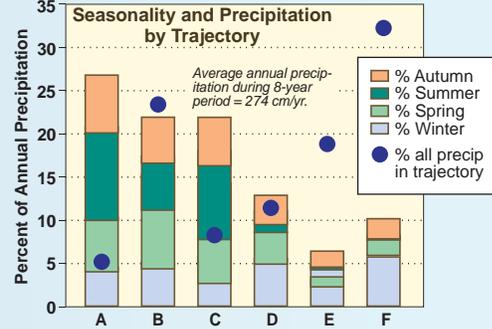
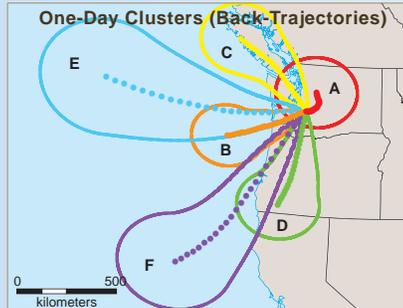
**Location:** 46.82N 121.89W  
**Elevation:** 1371.6 m  
**Maximum Depth:** 12.1 m  
**Surface Area:** 1.8 ha  
**Watershed Area:** 44.9 ha



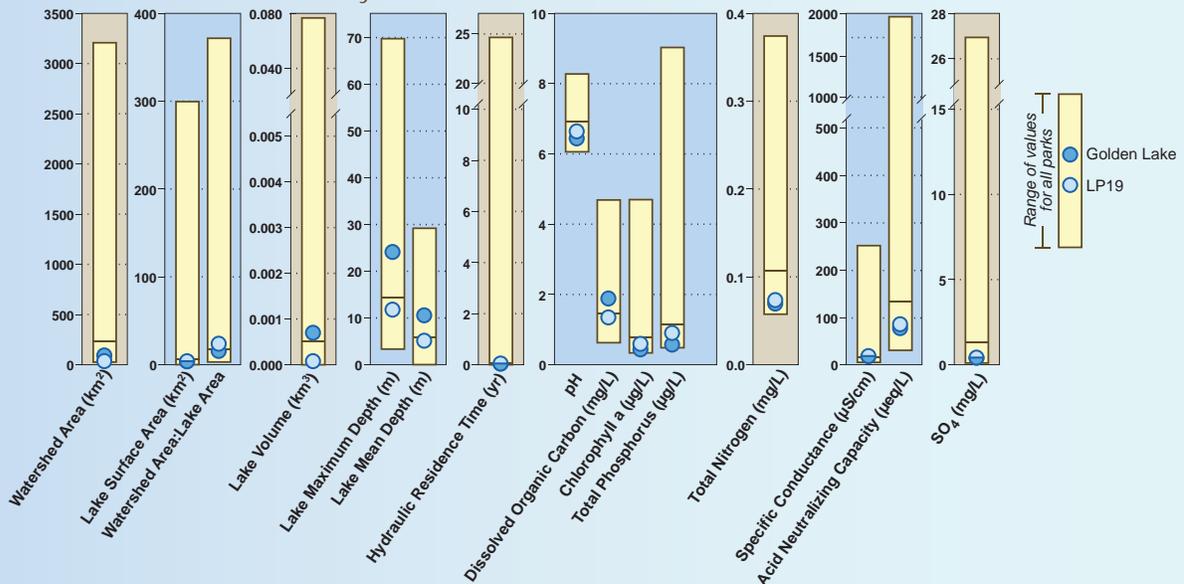
Depth (meters)  
 0-2  
 2-4  
 4-6  
 6-8  
 8-10  
 10-12  
 12-14



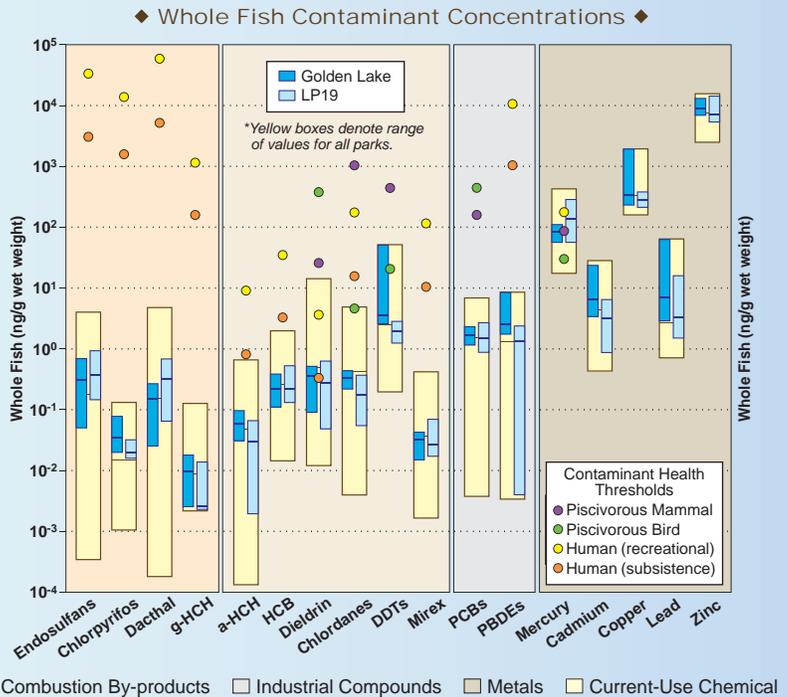
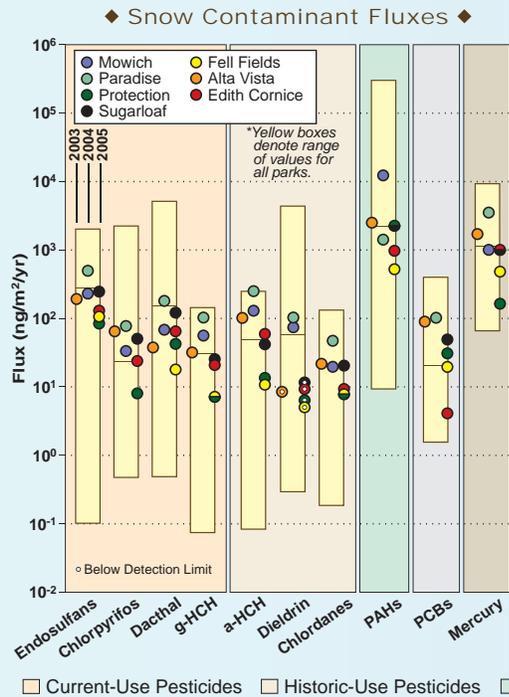
### ◆ Atmospheric Transport ◆



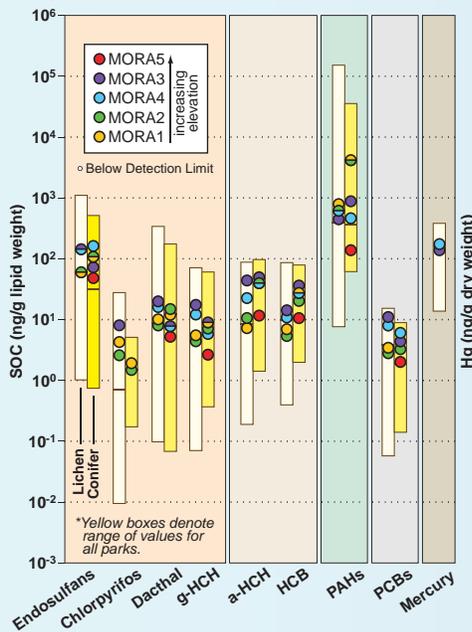
### ◆ Physical and Chemical Characteristics ◆



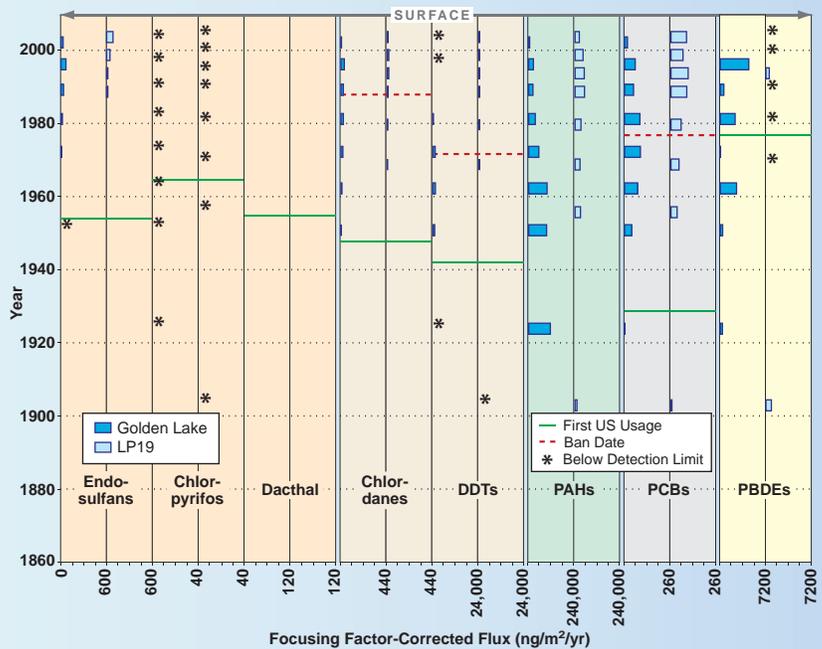
# Mount Rainier National Park: Contaminant Summaries



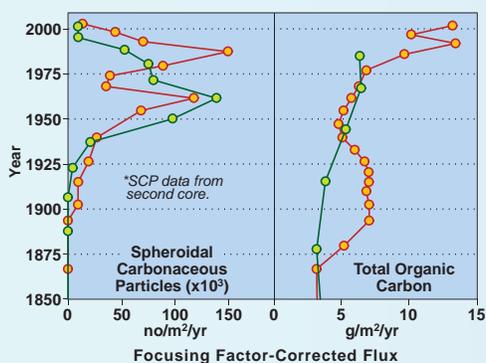
### ◆ Vegetation Contaminant Concentrations ◆



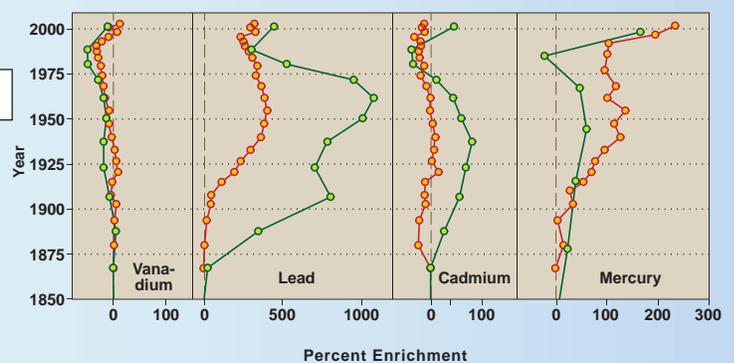
### ◆ Sediment Organic Contaminant Fluxes ◆



### ◆ Sediment Flux ◆



### ◆ Sediment Metals Enrichment ◆



## Rocky Mountain National Park



## Summary: Rocky Mountain National Park

Mills and Lone Pine lakes are characterized by low specific conductance and acid neutralizing capacity, typical of many sub-alpine lakes. Compared to lake surface area, their watershed areas are among the largest of all the lakes. Total nitrogen is fairly high at Mills Lake. For many SOCs, snow and sediment fluxes were higher at Mills Lake, on the eastern slope of the Continental Divide, where there is greater potential for transport from local and regional agricultural sources than for Lone Pine Lake on the western slope.

### Air

There were four air monitors on the west side and one monitor on the east side of the Continental Divide. East-side concentrations for those SOCs detected by this method were similar to west-side concentrations, indicating no obvious east-west differences. The primary SOCs detected in air were PAHs, dacthal, endosulfans, HCB, a-HCH, and g-HCH. Low concentrations of the PCBs, chlordanes, and trifluralin were also detected.

### Snow

Snowpack deposition fluxes of endosulfans and dacthal were high in ROMO compared to fluxes at most other parks, and fish concentrations of these compounds were high as well. Mercury deposition fluxes in the snowpack were high relative to those at other parks; however, fish mercury was low, indicating low rates of mercury methylation and bioaccumulation. Contaminant fluxes measured in the snowpack do not account for atmospheric deposition during summer rains. However, summer precipitation is higher in ROMO than in most other parks, and rainfall concentrations of many contaminants are also high, indicating that a larger significant source of contaminant deposition was unmeasured. Deposition fluxes of dieldrin in the snowpack were also consistently higher at Mills Lake than at sites to the west, suggesting re-emission from contaminated soils to the east (dieldrin was manufactured in Denver) and subsequent transport on upslope airflow.

### Vegetation

Unlike concentrations in sediments and snow, SOC concentrations in vegetation were in the low to median ranges compared to those at other parks and not different on east and west sides of the Continental Divide. SOCs detected in vegetation were PAHs (mostly CHR/TRI, retene, PHE, and ANT), endosulfans, g-HCH, a-HCH, dacthal, HCB, chlorpyrifos, DDTs, and PCBs. Lichen concentrations indicate enhanced nitrogen and sulfur deposition; metals were within expected ranges for remote sites.

### Fish

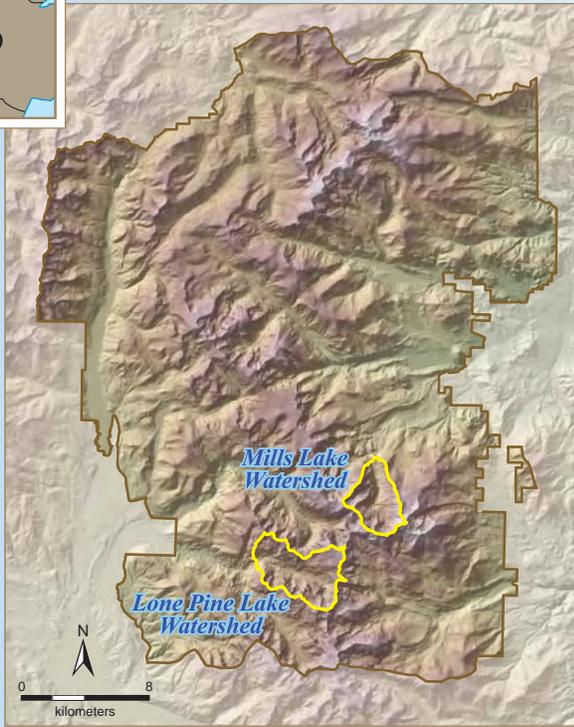
Mercury and macrophage aggregates increased with increasing age of fish in both lakes, although mercury was fairly low. Spleen and kidney macrophage aggregates were also positively related to mercury in both lakes. Endosulfans and dacthal were fairly high. Additional lakes (9 total) were sampled as part of a related NPS study and elevated estrogen-responsive protein was found in males from four of the nine lakes. Poorly developed testes and/or intersex male trout were also found in five of the nine lakes sampled. These data suggest that endocrine and reproductive disruption is occurring in several park lakes. Dieldrin concentrations in all fish exceeded contaminant health thresholds for subsistence fishers and some fish from both lakes exceeded thresholds for recreational fishers. Mercury concentrations in some fish exceeded contaminant health thresholds for piscivorous mammals (otter or mink) and/or birds (kingfishers) at both lakes.

### Sediment

Lake sediment profiles indicate that fluxes of most current-use pesticides, historic-use pesticides, and urban chemicals have steadily increased since their use in the USA began and no widespread decrease in flux or enrichment has occurred. In Lone Pine Lake, lead, cadmium, and mercury show a similar historic increase in the lake sediments beginning around 1875 that could be related to a common source, such as metal mining and smelting. Mills Lake shows similarity in the profiles for these metals beginning later, around 1915, but the two systems show similar mercury enrichment. All three metals have decreased in recent times.

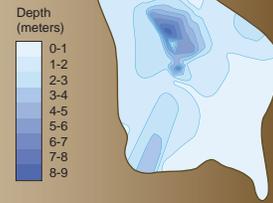
# Rocky Mountain National Park: Site Characteristics

ROMO



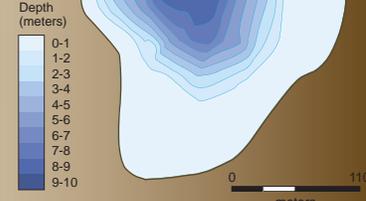
## Mills Lake

**Location:** 40.29N 105.64W  
**Elevation:** 3029.7 m  
**Maximum Depth:** 9.0 m  
**Surface Area:** 6.1 ha  
**Watershed Area:** 1208.9 ha

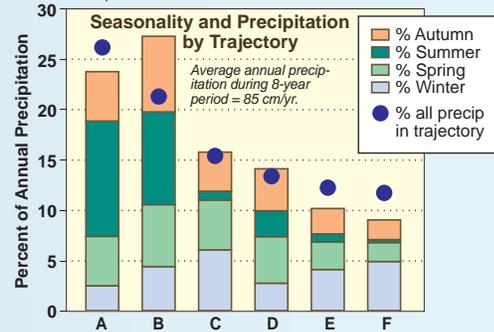
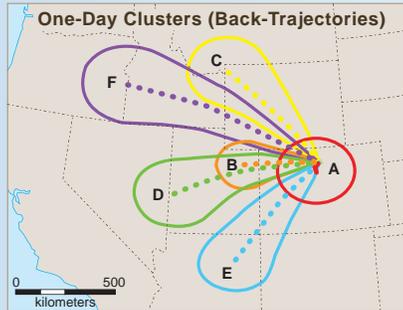


## Lone Pine Lake

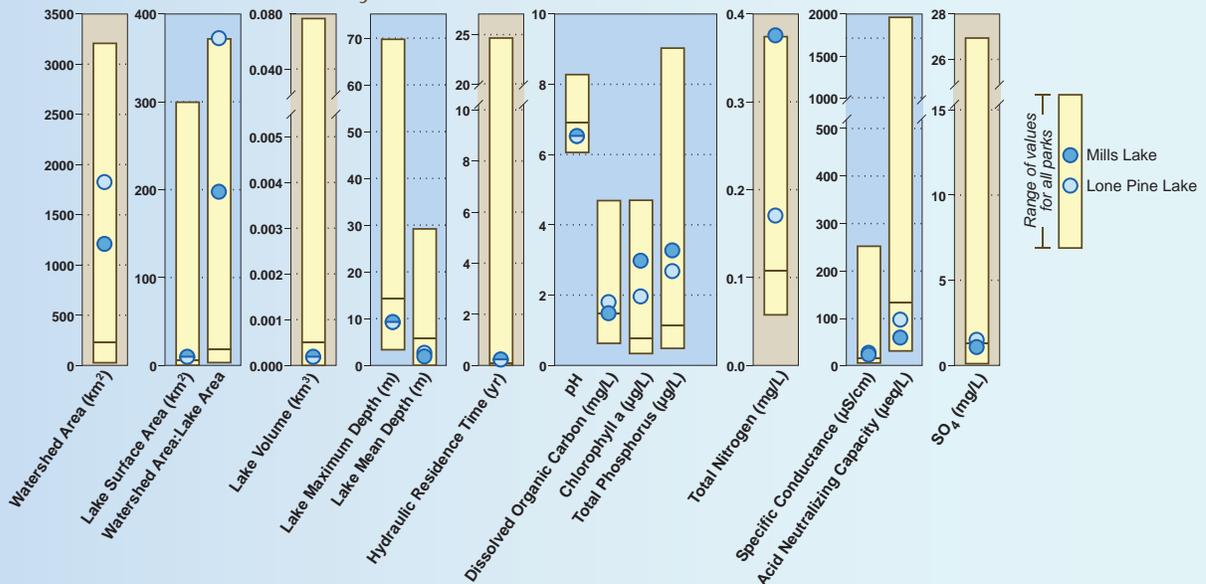
**Location:** 40.22N 105.73W  
**Elevation:** 3017.5 m  
**Maximum Depth:** 9.7 m  
**Surface Area:** 4.9 ha  
**Watershed Area:** 1830.0 ha



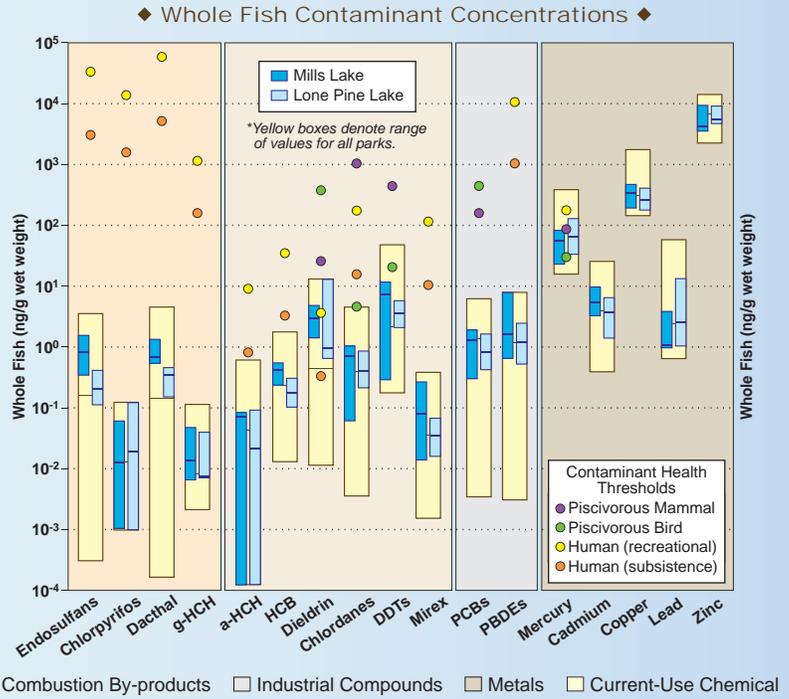
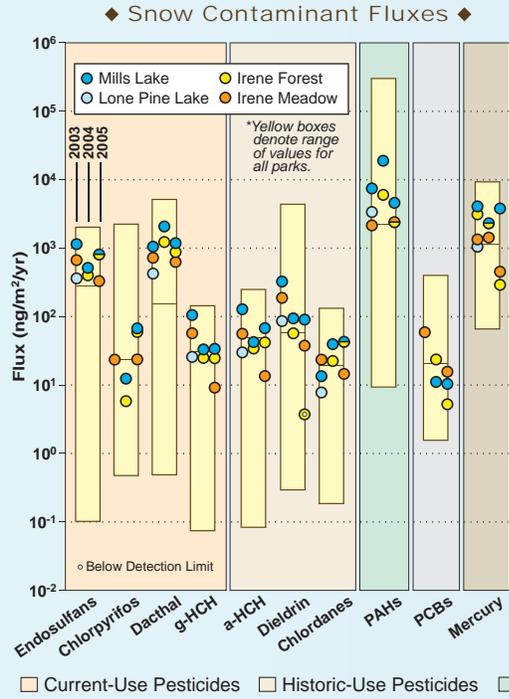
### ◆ Atmospheric Transport ◆



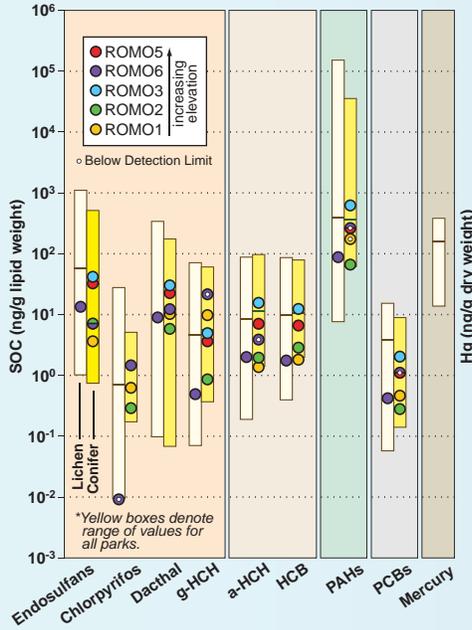
### ◆ Physical and Chemical Characteristics ◆



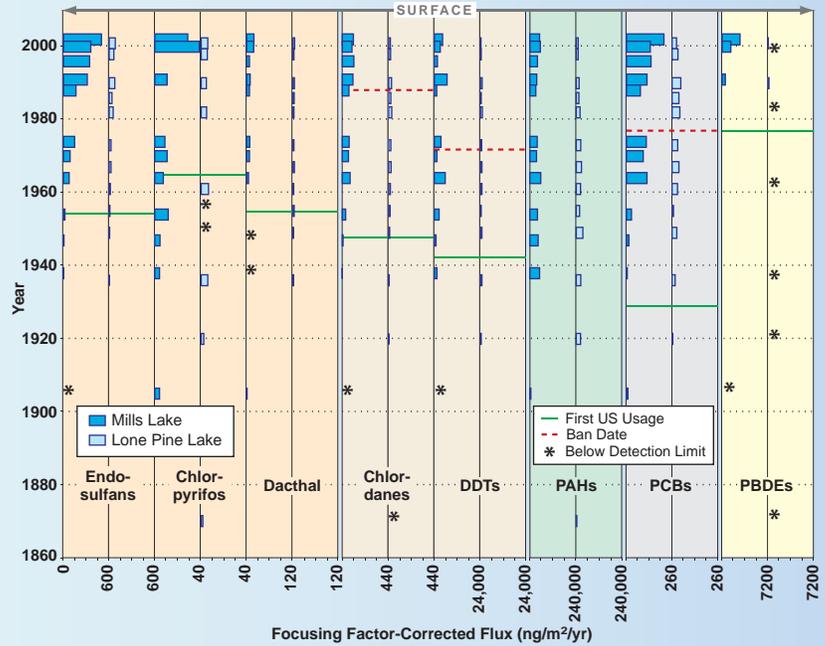
# Rocky Mountain National Park: Contaminant Summaries



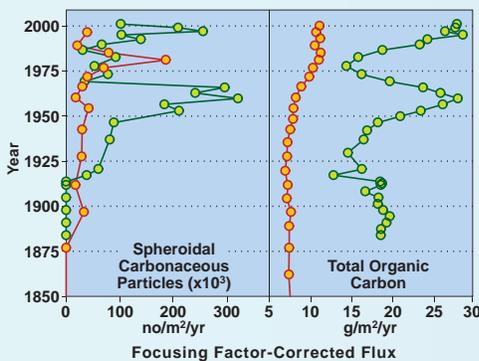
### ◆ Vegetation Contaminant Concentrations ◆



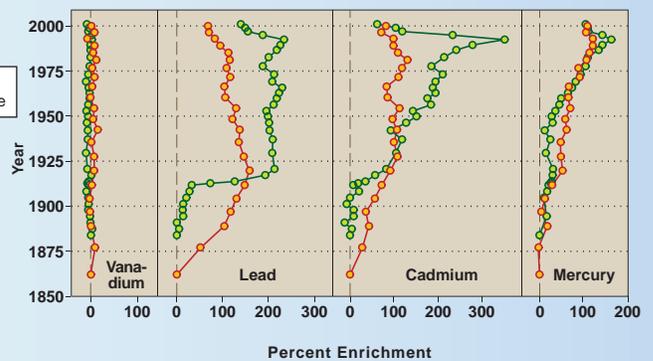
### ◆ Sediment Organic Contaminant Fluxes ◆



### ◆ Sediment Flux ◆



### ◆ Sediment Metals Enrichment ◆



## Sequoia and Kings Canyon National Parks



## Summary: Sequoia and Kings Canyon National Parks

Emerald and Pear lakes are similar physically and chemically, although Emerald Lake is a bit shallower and has slightly higher total phosphorus and nitrogen. Compared to the other sites, they are among the most dilute, poorly buffered (i.e., have low acid neutralizing capacity), and oligotrophic (low productivity) systems. At SEKI, air, vegetation, and snow had among the highest concentrations for current-use pesticides, compared with these media in the other parks. The source of these compounds could be regional agriculture within a few hundred kilometers of the park.

### Air

SOCs detected in air were trifluralin, dacthal, endosulfans, chlorpyrifos, and g-HCH, all of which are current-use pesticides. In addition, HCB, a-HCH, dieldrin, PCBs, and PAHs were detected. Most SOC concentrations in air ranked high relative to those in other parks and more SOC were detected in SEKI than in other parks.

### Snow

Atmospheric deposition in SEKI is dominated by deep snowpacks with high snow water equivalent. Concentrations of many current-use pesticides and historic-use pesticides were high, producing high deposition fluxes in the snow. In contrast, with few local or regional sources of mercury emissions upwind, mercury concentrations in the snow were generally low, producing only moderate fluxes of mercury deposition. Summers are generally quite dry in SEKI, providing less opportunity for wet deposition of contaminants in rainfall than wetter summers at parks in the Rocky Mountains.

### Vegetation

SOCs, Hg, and nutrient concentrations in SEKI vegetation were in the median to highest ranges among the parks, attributable partly to intensive regional agriculture. SOC detected in vegetation were PAHs (mostly retene, CHR/TRI, PHE, FLO, FLA, and PYR), endosulfans, dacthal, DDTs, chlorpyrifos, HCB, g-HCH, dieldrin, a-HCH, and PCBs. Lichen concentrations indicate enhanced nitrogen and sulfur deposition. Concentrations of endosulfan, dacthal, HCH, HCB, and chlorpyrifos in lichens increased with elevation. Because forest productivity is high, pesticides scrubbed from the air by vegetation probably contribute significant contaminant loads to the ecosystem via canopy through-fall and needle litter-fall.

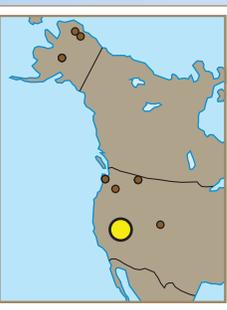
### Fish

Mercury and macrophage aggregates increased with increasing fish age in both lakes. Spleen and kidney macrophage aggregates were positively related to mercury at Pear Lake, but only kidney macrophage aggregates were so related at Emerald Lake. All fish appeared normal reproductively. Current-use SOC concentrations in fish were among the highest measured. Lake average dieldrin and individual fish p,p'-DDE concentrations in both lakes exceeded contaminant health thresholds for subsistence fishers; the dieldrin concentration in one fish in Pear Lake exceeded the threshold for recreational fishers. In at least one fish from each lake, contaminant health thresholds for mercury and DDTs were exceeded for one or more piscivores (otter, mink, kingfishers). Two fish from Pear Lake exceeded the human contaminant health threshold for mercury.

### Sediment

SOC flux profiles are very similar in both lakes, and SOC appear after being registered for use in the USA. DDTs and chlordanes decrease after being banned in the USA, but PCBs are still accumulating. Mercury began to increase in both lakes in the late 1800s, and lead began to increase around 1900. Mercury profiles are similar in both lakes, in that they tend to stabilize, noisily, at about 100% enrichment. Lead and cadmium profiles are similar in Pear Lake, both peaking in the 1970s and decreasing toward the surface (present time). SCPs were first detected in the late 1800s, but the patterns in both lakes are not closely associated with metal flux profiles, suggesting that major high temperature combustion sources were not the primary historic source of metals to the sediments.

# Sequoia and Kings Canyon National Parks: *Site Characteristics*

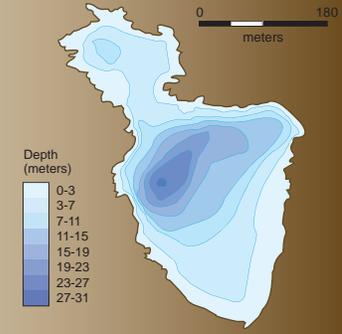


SEKI



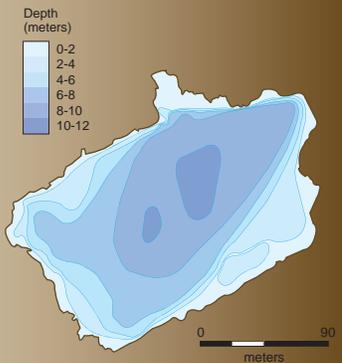
## Pear Lake

**Location:** 36.60N 118.67W  
**Elevation:** 2907.8 m  
**Maximum Depth:** 27.0 m  
**Surface Area:** 7.3 ha  
**Watershed Area:** 142.0 ha

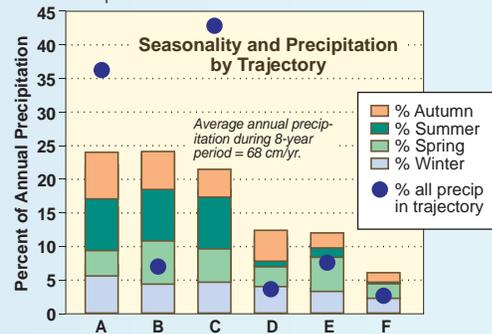
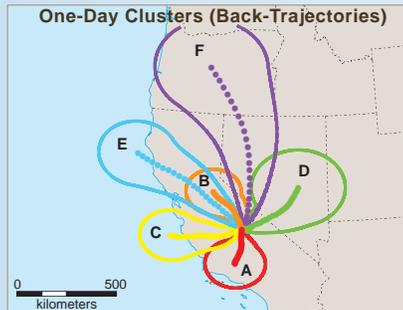


## Emerald Lake

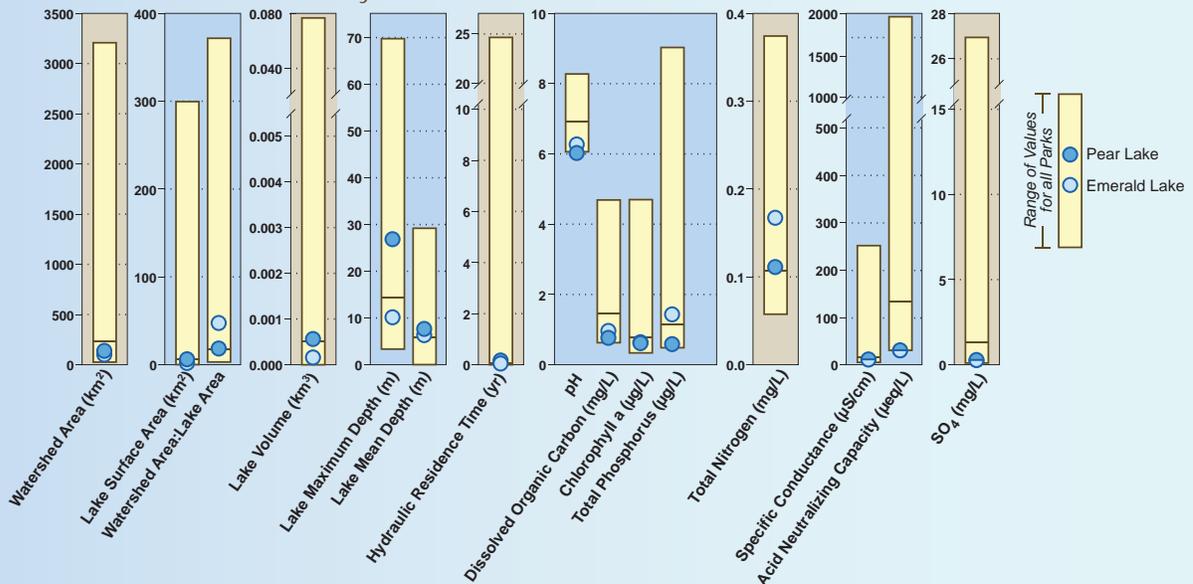
**Location:** 36.58N 118.67W  
**Elevation:** 2810.3 m  
**Maximum Depth:** 10.0 m  
**Surface Area:** 2.5 ha  
**Watershed Area:** 121.3 ha



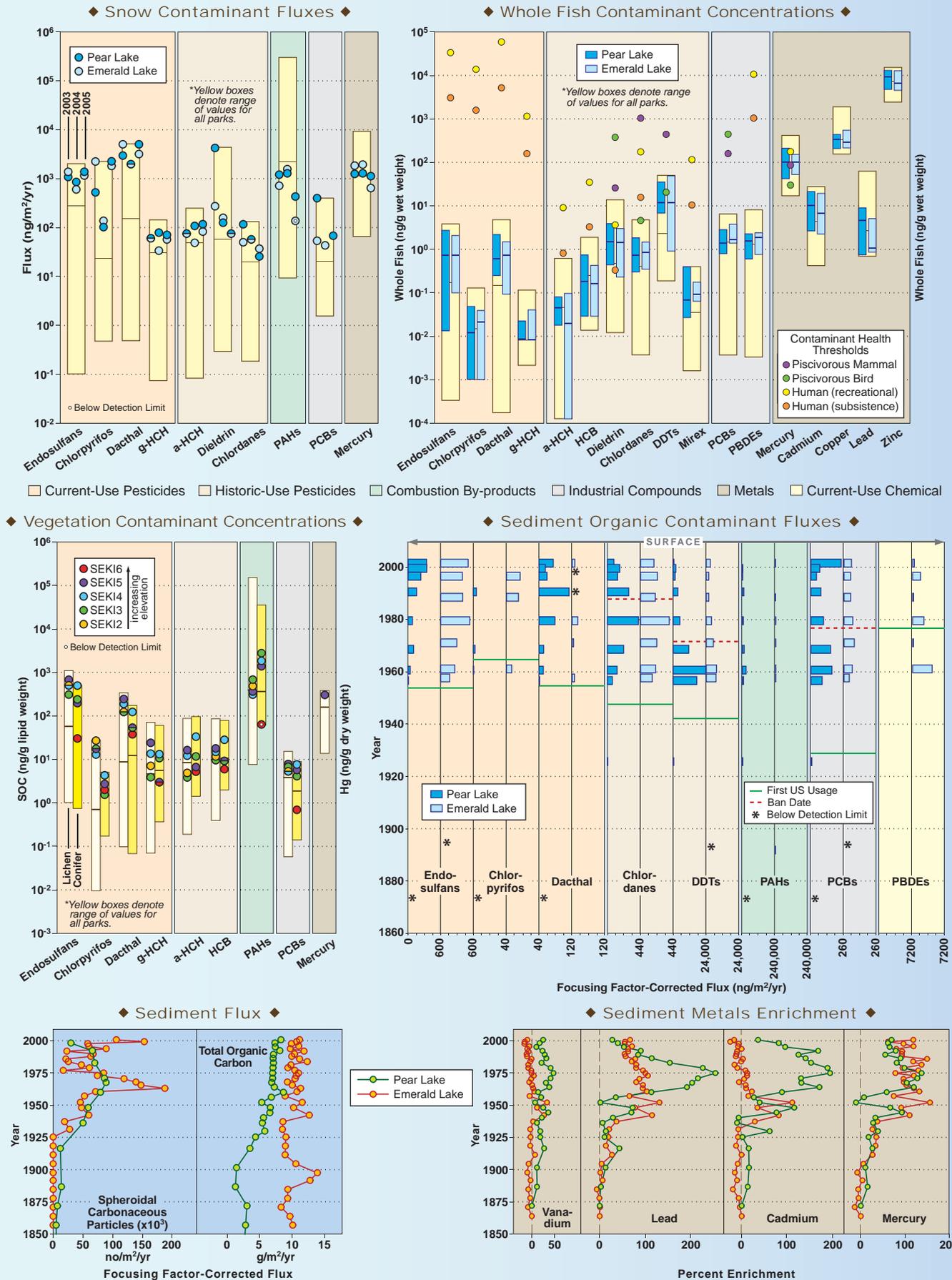
### ◆ Atmospheric Transport ◆



### ◆ Physical and Chemical Characteristics ◆



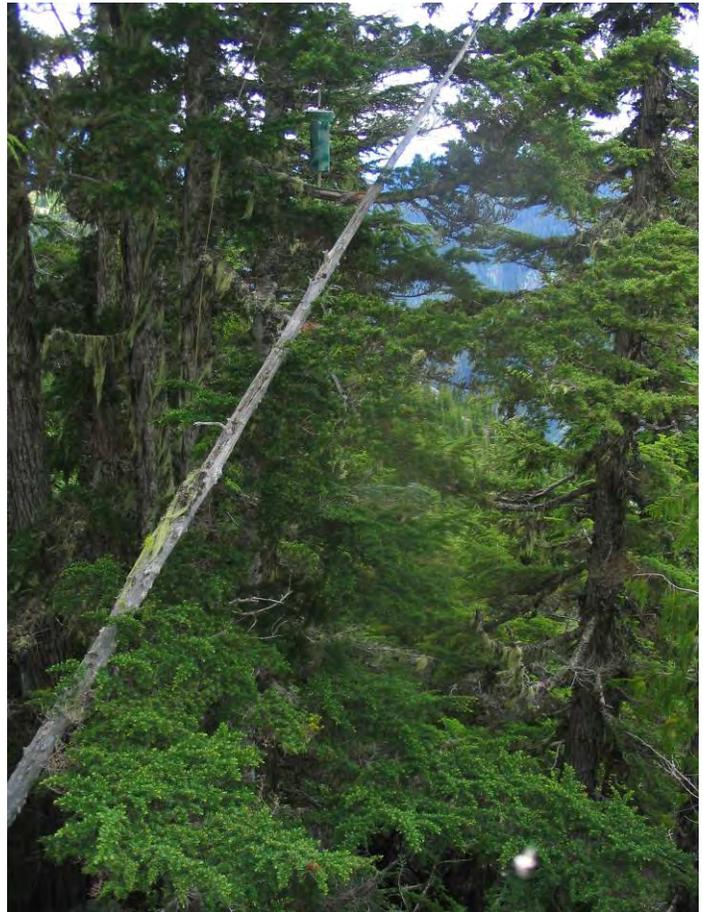
# Sequoia and Kings Canyon National Parks: Contaminant Summaries



## Secondary Parks

The pages that follow have been prepared to provide the reader with a summary of contaminant results for air and vegetation sampling in each secondary WACAP park. The word *park*, as used here, encompasses federally managed lands, including national parks, monuments, preserves, and wilderness. The objectives and design for sampling in the secondary parks are described in this report in Section 1.3, Park Selection, Section 3.4.3, Air, and Section 3.4.4, Vegetation.

The one-page key on page 2-33 provides explicit detail regarding each block of information the reader will encounter. Summaries for all secondary parks are presented in the same format. The summaries are designed so that the location and contaminant concentrations at the four to six sampling sites within each park and across all parks can easily be visualized and compared. The reader is encouraged to consult the other chapters of this report and the primary park summaries for more information on the full range of WACAP results and their interpretation.



# Key to Secondary Parks: *Summary*

## US Map

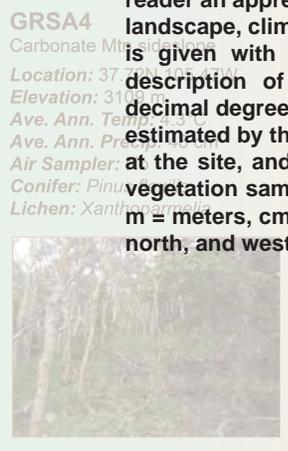
This inset shows the location of the park (yellow dot) in western North America relative to other WACAP secondary parks (brown dots).

### KEY

The pages that follow have been prepared to provide the reader with a summary of contaminant results for air and vegetation sampling in each secondary WACAP park. The word *park*, as used here, encompasses federally managed lands, including national parks, monuments, preserves, and wilderness. This one-page key provides explicit detail regarding each block of information the reader will encounter. Summaries for all secondary parks are presented in the same format. The summaries are designed so that the location and contaminant concentrations at the four to six sampling sites within each park and across all parks can be easily visualized and compared. The reader is encouraged to consult the other chapters of this report and the primary park summaries for more information on the full range of WACAP results and their interpretation.



Site Photos



### GRSA4

Carbonate Mts. side slope  
 Location: 37° 10' N, 105° 57' W  
 Elevation: 3100 m  
 Ave. Ann. Temp: 13°C  
 Ave. Ann. Precip: 43 cm  
 Air Sampler: at the site, and the scientific names of the conifer and lichen vegetation sampled at the site. Units follow the metric system: m = meters, cm = centimeters, °C = degrees Centigrade. N, W = north, and west.

### Park Relief Map

In this figure, the boundary of the park and the location of the vegetation and air sampling sites are overlaid on a shaded relief map to give the reader some perspective of the topography surrounding the sites.



### Air Summary Statements

This text block summarizes the results of the laboratory analysis of the passive air sampling devices (PASDs) and highlights the most important findings. These include the location of the monitors in the parks, the SOCs detected and their concentrations in picograms per gram XAD resin (dry weight), within-park differences in SOC concentrations if multiple samplers were deployed, and how park SOC concentrations ranked relative to other WACAP parks.

### Vegetation Summary

- The dominant SOCs detected in vegetation were PAHs, especially 4-5 ring compounds (30-1000 ng/g lipid), endosulfans (3-710, 10x higher in lichens than conifers), and dacthal (2-110, 10x higher in lichens), DDTs (10-100), HCB (1-67), a-HCH (0.1-40), chlordanes (24-32), and g-HCH (5-7); low concentrations of PCBs (1-11) were detected.

### Vegetation Summary Statements

This text block summarizes the results of the laboratory analysis of vegetation samples and highlights the most important findings. These include: the SOCs detected and their concentrations in nanograms per gram conifer needle lipid or lichen lipid; differences between concentrations in needles versus lichens, if important; effects of elevation on concentrations of SOCs in lichens; ranking of SOC concentrations in vegetation relative to vegetation in other WACAP parks; concentrations of nitrogen and sulfur (nutrients), mercury and other toxic metals in lichens relative to known or expected background ranges; and ecological implications of, or concerns indicated by, the results.

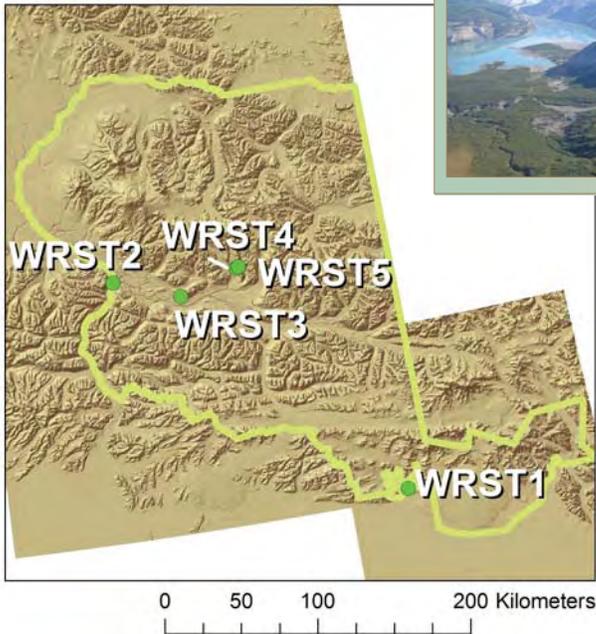
- Field notes and the park website indicate that the two sites where lichens were collected were very windy. It is possible that a disproportionately high absorption of SOCs from soil particulates contributed to high lichen SOC concentrations.
- Lichen nitrogen concentrations were within background ranges, indicating that nitrogen deposition is not elevated.

### Vegetation Contaminant Concentrations

The concentrations of the most prevalent semi-volatile organic compounds (SOCs) in lichens and 2-year-old conifer needles are shown for WACAP sites in the figure. Conifers and lichens were sampled along an elevational gradient. Concentrations at each site are represented by the shaded circles above each contaminant name. The middle horizontal line within each background bar behind the circles shows the median value for all WACAP sites across all parks; the top and bottom horizontal edges of the background bars show the maximum and minimum concentrations across all WACAP sites. Brown and green bars indicate lichen and conifer needle concentrations, respectively. These values are on a log scale – spanning a very broad range of concentrations from 0.001 to 1,000,000 ng SOC per gram of lipid in lichens or needles. When sample concentrations were below detection limits, the circle representing the site was placed at one-half the estimated detection limit and the circle is open. Circle shading intensity darkens with increasing elevation. SOCs are grouped by current-use pesticides (endosulfans, chlorpyrifos, dacthal), historic-use pesticides (g-HCH, a-HCH, HCB), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Metals were not analyzed in vegetation samples at secondary parks.



WRST



**WRST1**  
 Kageets Pt at Icy Bay  
**Location:** 60.05N 141.31W  
**Elevation:** 7 m  
**Ave. Ann. Temp:** 3.1°C  
**Ave. Ann. Precip:** 312 cm  
**Air Sampler:** No  
**Conifer:** *Picea sitchensis*  
**Lichen:** *Platismatia glauca*,  
*Hypogymnia apinnata*

**WRST2**  
 Chintina and Copper R confluence  
**Location:** 61.52N 144.40W  
**Elevation:** 219 m  
**Ave. Ann. Temp:** -1.9°C  
**Ave. Ann. Precip:** 31 cm  
**Air Sampler:** No  
**Conifer:** *Picea glauca*  
**Lichen:** None

**WRST3**  
 Crystalline Hills Trail  
**Location:** 61.39N 143.60W  
**Elevation:** 648 m  
**Ave. Ann. Temp:** -1.7°C  
**Ave. Ann. Precip:** 62 cm  
**Air Sampler:** Yes  
**Conifer:** *Picea glauca*  
**Lichen:** *Hypogymnia physodes*

**WRST4**  
 Bonanza Mine Trail 1020m  
**Location:** 61.50N 142.87W  
**Elevation:** 1020 m  
**Ave. Ann. Temp:** -2.2°C  
**Ave. Ann. Precip:** 85 cm  
**Air Sampler:** No  
**Conifer:** *Picea glauca*  
**Lichen:** None

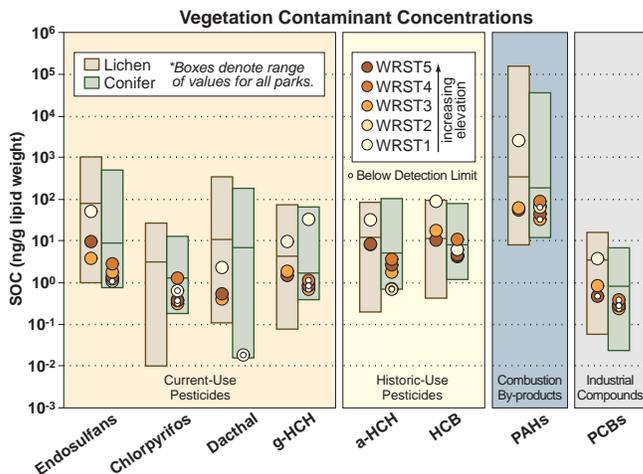
**WRST5**  
 Bonanza Mine Trail 1421m  
**Location:** 61.50N 142.84W  
**Elevation:** 1421 m  
**Ave. Ann. Temp:** -2.7°C  
**Ave. Ann. Precip:** 127 cm  
**Air Sampler:** No  
**Conifer:** *Picea glauca*  
**Lichen:** *Flavocetraria cucullata*,  
*Gladina arbuscula*

**Air Summary**

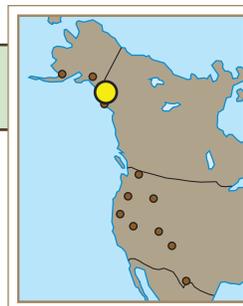
- The air sampler, at WRST3 in the Crystalline Hills, near McCarthy, Alaska, had the lowest number of detected SOC's among the 20 WACAP parks.
- Only PAHs (285 pg/g dry XAD, a mid-range level compared with concentrations in other WACAP parks) and low concentrations of g-HCH (18 pg/g dry XAD) were detected.

**Vegetation Summary**

- Among the 20 WACAP parks, SOC's in vegetation from interior WRST (sites 2-5) were at or below the median, or were not detected.
- Dominant SOC's were PAHs (17-74 ng/g lipid in conifers, 43-4346 in lichens), HCB (3-11 in conifers, 9-150 in lichens), a-HCH (4-54), and g-HCH (1-36).
- Small amounts of PCBs (<5 ng/g lipid), chlorpyrifos (<1), dacthal, and chlordanes (<4) were also detected.
- Highest concentrations of g-HCH and chlordanes in lichens and conifer needles, and highest concentrations of endosulfans, HCB, a-HCH, dacthal, PCBs, and PAHs in lichens were observed at the high precipitation, marine site at Icy Bay (WRST1).
- Nitrogen concentrations in lichens were within background ranges, indicating that nitrogen deposition is not elevated.



# Glacier Bay National Park: Summary



GLBA

## GLBA1

Beartrack Cove

**Location:** 58.60N 135.88W  
**Elevation:** 8 m  
**Ave. Ann. Temp:** 4°C  
**Ave. Ann. Precip:** 261 cm  
**Air Sampler:** Yes  
**Conifer:** *Picea sitchensis*  
**Lichen:** *Platismatia glauca*



## GLBA2

Beartrack Mtn footslopes

**Location:** 58.61N 135.88W  
**Elevation:** 168 m  
**Ave. Ann. Temp:** 4°C  
**Ave. Ann. Precip:** 261 cm  
**Air Sampler:** No  
**Conifer:** *Picea sitchensis*  
**Lichen:** *Sphaerophorus globosus*



## GLBA3

Beartrack Mtn glacial trim line

**Location:** 58.61N 135.87W  
**Elevation:** 457 m  
**Ave. Ann. Temp:** 4°C  
**Ave. Ann. Precip:** 261 cm  
**Air Sampler:** No  
**Conifer:** *Picea sitchensis*  
**Lichen:** *Sphaerophorus globosus*



## GLBA4

Beartrack Mtn treeline

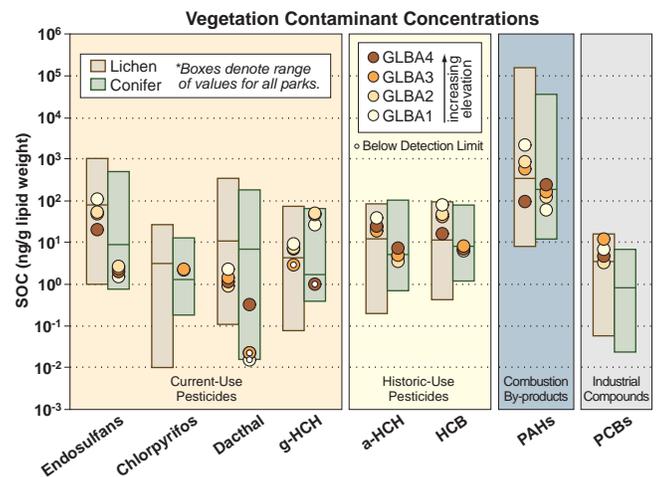
**Location:** 58.61N 1035.87W  
**Elevation:** 625 m  
**Ave. Ann. Temp:** 4°C  
**Ave. Ann. Precip:** 261 cm  
**Air Sampler:** No  
**Conifer:** *Picea sitchensis*  
**Lichen:** *Alectoria sarmentosa*

## Vegetation Summary

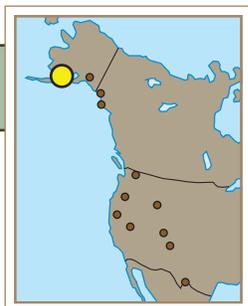
- The dominant SOCs detected in lichens were PAHs (100-3000 ng/g lipid), endosulfans (21-115), HCB (17-80) and a-HCH (20-41); the dominant SOCs detected in conifer needles were PAHs (45-23), g-HCH (1-53), HCB (7-9), and a-HCH (4-8).
- Concentrations of HCBs and a-HCH in lichens and g-HCH (all HUPs) in conifers ranked very high compared to concentrations at other WACAP parks.
- Other SOCs detected in vegetation were low concentrations of dacthal (<2.5), chlordanes (0.2-8), and PCBs (3-10).
- Although pesticide concentrations and compounds detected essentially replicate STLE in both lichens and conifer needles, with respect to PAHs, GLBA had a higher proportion of 4-5 ring PAHs and more retene than STLE to the south and WRST to the north, pointing to a local source.
- As at other parks, PAH concentrations decreased with increasing elevation. Pesticides and PCBs that were observed to increase with elevation in other parks did not increase at GLBA. A possible explanation is that a very good accumulator, *Platismatia glauca*, was collected at sea level and the poorest accumulator, *Alectoria sarmentosa*, was collected at the highest elevation.
- Lichen nitrogen concentrations were elevated at sea level, but concentrations at higher elevations were within species-specific background ranges expected for southeastern Alaska and remote sites in the Pacific Northwest.

## Air Summary

- The air sampler was near sea level at GLBA1, Beartrack Cove.
- Moderate concentrations of HUPs HCB (15 pg/g dry XAD) and a-HCH (17) and low concentrations of CUPs trifluralin (1.4), endosulfans (24), and HUP g-HCH (17) were detected.
- Overall, SOC concentrations in air at GLBA ranked very low compared to those at other WACAP parks.



# Katmai National Park and Preserve: Summary



## KATM



**KATM1**  
 3 Forks Overlook Road 2 km  
**Location:** 58.55N 155.78W  
**Elevation:** 36 m  
**Ave. Ann. Temp:** 2.2°C  
**Ave. Ann. Precip:** 50 cm  
**Air Sampler:** No  
**Conifer:** *Pinus glauca*  
**Lichen:** *Hypogymnia physodes*



**KATM2**  
 Dumpling Mtn Trail at 183 m  
**Location:** 58.57N 155.79W  
**Elevation:** 213 m  
**Ave. Ann. Temp:** 1.9°C  
**Ave. Ann. Precip:** 54 cm  
**Air Sampler:** No  
**Conifer:** *Pinus glauca*  
**Lichen:** *Hypogymnia physodes*



**KATM3**  
 Dumpling Mtn Trail at 366 m  
**Location:** 58.57N 155.80W  
**Elevation:** 370 m  
**Ave. Ann. Temp:** 1.9°C  
**Ave. Ann. Precip:** 54 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus glauca*  
**Lichen:** *Hypogymnia physodes*



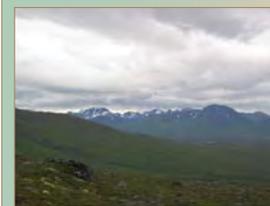
**KATM4**  
 Dumpling Mtn Trail at 563 m  
**Location:** 58.57N 155.84W  
**Elevation:** 563 m  
**Ave. Ann. Temp:** 1.4°C  
**Ave. Ann. Precip:** 68 cm  
**Air Sampler:** No  
**Conifer:** *Pinus glauca*  
**Lichen:** *Flavocetraria cucullata*



**KATM5**  
 Dumpling Mtn summit  
**Location:** 58.58N 155.86W  
**Elevation:** 724 m  
**Ave. Ann. Temp:** 1.4°C  
**Ave. Ann. Precip:** 68 cm  
**Air Sampler:** No  
**Conifer:** *Pinus glauca*  
**Lichen:** *Flavocetraria cucullata*



**KATM6**  
 Mt. Katolinat  
**Location:** 58.47N 155.49W  
**Elevation:** 1112 m  
**Ave. Ann. Temp:** 0.1°C  
**Ave. Ann. Precip:** 83 cm  
**Air Sampler:** No  
**Conifer:** None  
**Lichen:** *Flavocetraria cucullata*

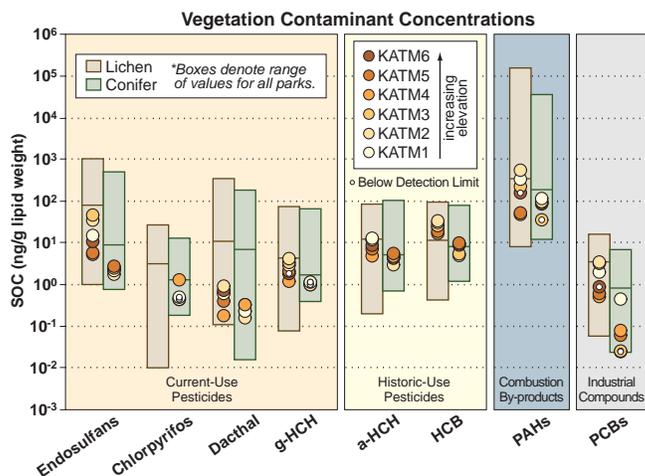


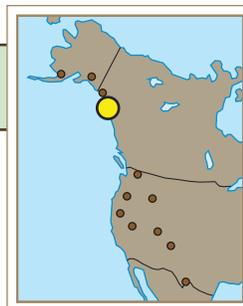
## Air Summary

- The air sampler was at KATM3.
- Concentrations of HUPs HCB (1260 pg/g dry XAD), a-HCH (340), and g-HCH (57) were among the highest values recorded from WACAP parks.
- Endosulfans (61 pg/g dry XAD), trifluralin (1), and chlordanes (14) were also detected, but concentrations were low compared to those at other WACAP parks.

## Vegetation Summary

- Concentrations in vegetation of all SOCs except HCB were at or below the median for WACAP parks; in general, KATM was one of the least contaminated WACAP parks.
- Dominant SOCs in KATM vegetation were PAHs (10-600 ng/g lipid), endosulfans (<2 in conifers, 5-47 in lichens), HCB (5-35), and a-HCH (10-24).
- Low concentrations of chlorpyrifos and dacthal (<1 ng/g lipid), g-HCH, chlordanes (<5), and PCBs (<3) were also detected.
- Small increases in spruce needle concentrations of endosulfans, dacthal, a-HCH, and HCB were observed with increasing elevation from 36 to 724 m; lichens also showed this trend when the tundra lichen, *Flavocetraria cucullata*, collected at the top three elevations, and the epiphyte, *Hypogymnia physodes*, a better accumulator, collected at the lowest three elevations, were considered separately.
- Lichen nitrogen concentrations were within background ranges, indicating that nitrogen deposition is not elevated.





STLE

## STLE1

Bussey Creek outlet in Icy Bay

**Location:** 56.79N 132.51W

**Elevation:** 1 m

**Ave. Ann. Temp:** 4.5°C

**Ave. Ann. Precip:** 318 cm

**Air Sampler:** Yes

**Conifer:** *Picea sitchensis*

**Lichen:** *Platismatia glauca*,  
*Alectoria sarmentosa*



## STLE2

Bussey Creek ridge line

**Location:** 56.80N 132.53W

**Elevation:** 254 m

**Ave. Ann. Temp:** 3.6°C

**Ave. Ann. Precip:** 378 cm

**Air Sampler:** Yes

**Conifer:** *Picea sitchensis*

**Lichen:** *Platismatia glauca*,  
*Lobaria oregana*



## STLE3

Muskeg bench over Bussey Creek

**Location:** 56.81N 132.54W

**Elevation:** 567 m

**Ave. Ann. Temp:** 3.6°C

**Ave. Ann. Precip:** 378 cm

**Air Sampler:** No

**Conifer:** *Picea sitchensis*

**Lichen:** *Alectoria sarmentosa*



## STLE4

0.4 km NW of Bussey Lake

**Location:** 56.83N 132.57W

**Elevation:** 815 m

**Ave. Ann. Temp:** 2.7°C

**Ave. Ann. Precip:** 488 cm

**Air Sampler:** Yes

**Conifer:** *Picea sitchensis*

**Lichen:** *Platismatia glauca*,  
*Alectoria sarmentosa*



## STLE5

Thunder Mtn summit

**Location:** 56.82N 132.61W

**Elevation:** 1064 m

**Ave. Ann. Temp:** 3.6°C

**Ave. Ann. Precip:** 431 cm

**Air Sampler:** No

**Conifer:** *Picea sitchensis*

**Lichen:** *Platismatia glauca*,  
*Cladonia arbuscula*

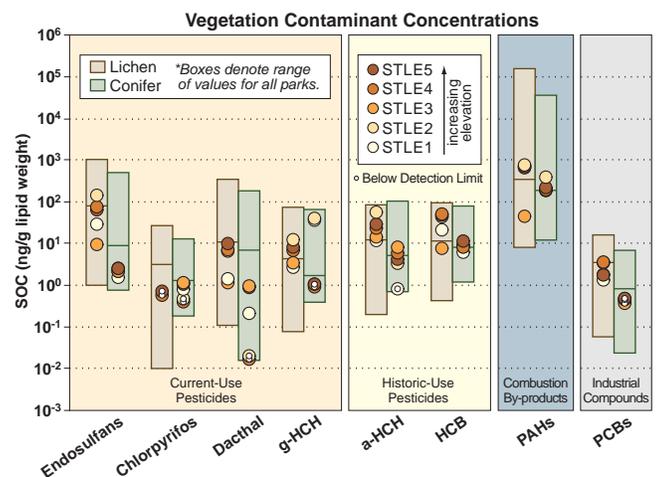


## Vegetation Summary

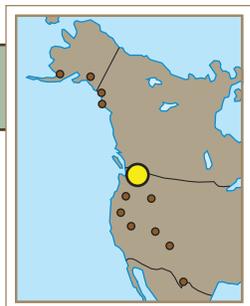
- Among the 20 parks, vegetation samples from STLE were at or below the median for CUPs, PCBs, and PAHs, and at or above the median for HUPs; this pattern was also observed at other high precipitation sites along coastal southeastern Alaska (i.e., WRST1, GLBA all).
- Dominant SOCs were PAHs (27-2251 ng/g lipid), endosulfans (<2 in conifers, 5-272 in lichens), a-HCH (3-110), HCB (5-100), and g-HCH (1-42); low concentrations of chlorpyrifos (<1), dacthal (0.2-20), and chlordanes (0.2-10) were also detected.
- Significant increases in pesticide concentrations and decreases in PAH concentrations in lichens with increasing elevation were discernible when the poorest (*Alectoria sarmentosa*) and best (*Platismatia glauca*) accumulators, sampled at alternating sites, were considered separately.
- Because needle productivity (kg/ha/yr) is high, the ecological effects of cumulative SOCs contributed by needle litter-fall are a potential concern.
- Nitrogen concentrations in lichens were within background ranges, indicating that nitrogen deposition is not elevated.

## Air Summary

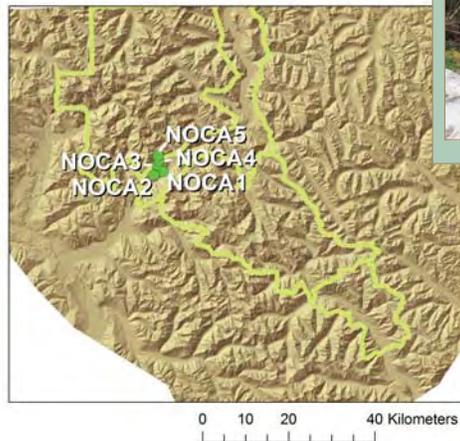
- Air was sampled at STLE1, 2, and 4.
- SOCs that increased with elevation in vegetation also increased in air. These were current-use endosulfans (17-96 pg/g dry XAD) and the HUPs HCB (490-1150), a-HCH (100-390), g-HCH (4-38), and chlordanes (10-21).
- Other SOCs were not detected or were near instrument detection limits (trifluralin and dacthal, <2 pg/g dry XAD).
- All SOC concentrations ranked low at the lowest elevation; concentrations at the highest elevation ranked moderate (g-HCH, chlordanes) to high (HCB, a-HCH) relative to concentrations at other WACAP parks.



# North Cascades National Park: Summary



## NOCA



**NOCA1**  
Thorton Creek  
**Location:** 48.65N 121.31W  
**Elevation:** 198 m  
**Ave. Ann. Temp:** 8.6°C  
**Ave. Ann. Precip:** 198 cm  
**Air Sampler:** No  
**Conifer:** *Pseudotsuga menziesii*  
**Lichen:** *Alectoria sarmentosa*



**NOCA2**  
Lower S slope Mt Triumph  
**Location:** 48.64N 121.34W  
**Elevation:** 614 m  
**Ave. Ann. Temp:** 8.6°C  
**Ave. Ann. Precip:** 196 cm  
**Air Sampler:** No  
**Conifer:** *Tsuga heterophylla*  
**Lichen:** *Platismatia glauca*



**NOCA3**  
SE slope Mt Triumph  
**Location:** 48.66N 121.33W  
**Elevation:** 945 m  
**Ave. Ann. Temp:** 8.3°C  
**Ave. Ann. Precip:** 222 cm  
**Air Sampler:** No  
**Conifer:** *Abies amabilis*  
**Lichen:** *Alectoria sarmentosa*



**NOCA4**  
Upper SE slope Mt Triumph  
**Location:** 48.67N 121.32W  
**Elevation:** 1228 m  
**Ave. Ann. Temp:** 8.7°C  
**Ave. Ann. Precip:** 198 cm  
**Air Sampler:** No  
**Conifer:** *Abies amabilis*  
**Lichen:** *Alectoria sarmentosa*



**NOCA5**  
S ridge Trappers Peak near treeline  
**Location:** 48.68N 121.32W  
**Elevation:** 1600 m  
**Ave. Ann. Temp:** 8.2°C  
**Ave. Ann. Precip:** 194 cm  
**Air Sampler:** Yes  
**Conifer:** *Abies amabilis*  
**Lichen:** *Alectoria sarmentosa*

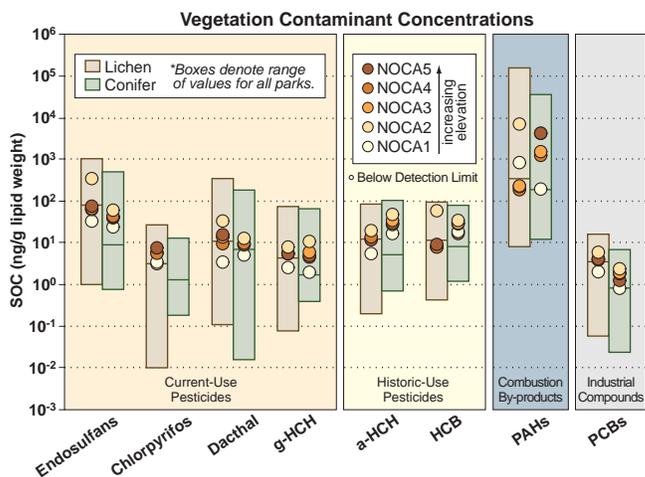


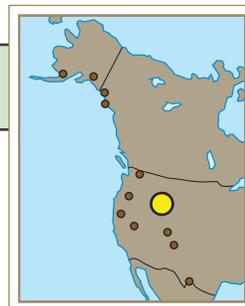
## Air Summary

- Air was sampled at NOCA5.
- SOCs detected, in order by decreasing concentration, were HCB (910 pg/g dry XAD), endosulfans (492), chlorpyrifos (220), a-HCH (200), PAHs (192), heptachlor (150), dacthal (91), chlordanes (63), g-HCH (32), and trifluralin (13); PCBs, dieldrin and DDTs were not detected.
- NOCA was the only park in which heptachlor was detected; concentrations of PAHs, CUPs chlorpyrifos, trifluralin, and endosulfans, and HUPs HCB, a-HCH, and chlordanes ranked well above the medians for the 20 WACAP parks.

## Vegetation Summary

- Among samples from the 20 WACAP parks, vegetation samples from NOCA were at or above medians for all SOC. Dominant SOC were PAHs (216-7768 ng/g lipid), endosulfans (24-355), dacthal (3-34), HCB (8-60), a-HCH 12-49), and g-HCH (3-11).
- Low concentrations of trifluralin (<0.2), chlorpyrifos (3-8), chlordanes (1-5), DDTs (2-7), and PCBs (<4) were also detected.
- Total SOC concentrations were similar to those in other Pacific Northwest parks (CRLA, MORA, OLYM). Pesticide and PCB concentrations in the lichen, *Alectoria sarmentosa*, increased with elevation.
- Because needle productivity (kg/ha/yr) is high, the ecological effects of cumulative SOC contributed by needle litter-fall are a potential concern.
- Nitrogen concentrations in lichens were within background ranges, indicating that nitrogen deposition is not elevated.





GRTE

## GRTE1

Lupine Meadows  
**Location:** 43.73N 110.74W  
**Elevation:** 2073 m  
**Ave. Ann. Temp:** 2.2°C  
**Ave. Ann. Precip:** 69 cm  
**Air Sampler:** No  
**Conifer:** *Pinus contorta*  
**Lichen:** *Usnea*



## GRTE2

Bradley Lake  
**Location:** 43.73N 110.76W  
**Elevation:** 2362 m  
**Ave. Ann. Temp:** 2.2°C  
**Ave. Ann. Precip:** 79 cm  
**Air Sampler:** No  
**Conifer:** *Abies lasiocarpa*  
**Lichen:** *Letharia vulpina*



## GRTE4

0.5 km E of Sunrise Lake  
**Location:** 43.73N 110.77W  
**Elevation:** 2804 m  
**Ave. Ann. Temp:** 1.1°C  
**Ave. Ann. Precip:** 103 cm  
**Air Sampler:** No  
**Conifer:** *Pinus flexilis*  
**Lichen:** None



## GRTE5

S rim above Amphitheater Lake  
**Location:** 43.13N 110.78W  
**Elevation:** 3048 m  
**Ave. Ann. Temp:** 2.2°C  
**Ave. Ann. Precip:** 68 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus albicaulis*  
**Lichen:** None



## GRTE3

Midslope Amphitheater Lake and valley floor  
**Location:** 43.73N 110.77W  
**Elevation:** 2591 m  
**Ave. Ann. Temp:** 1.1°C  
**Ave. Ann. Precip:** 102 cm  
**Air Sampler:** No  
**Conifer:** *Pinus flexilis*  
**Lichen:** None



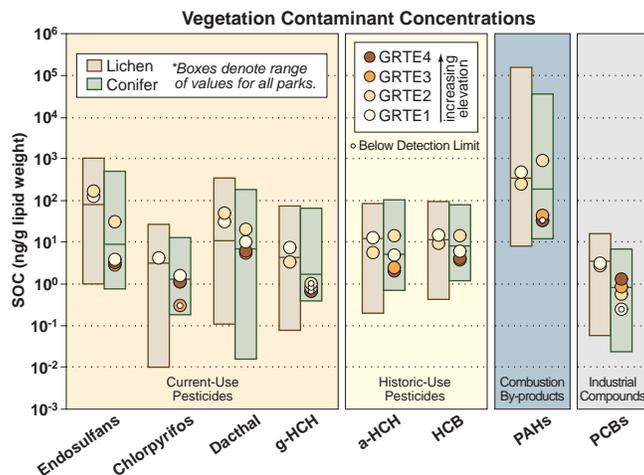
0 5 10 15 20 Kilometers

## Vegetation Summary

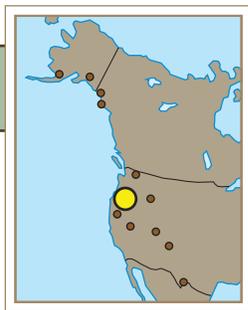
- As in other parks of the conterminous 48 states, the dominant SOCs in vegetation were PAHs (90-3300 ng/g lipid) and CUPs endosulfans (3-165) and dacthal (5-50).
- Compared with other WACAP parks, lichen SOC concentrations were at or above the median; conifer needle concentrations were at or below medians, except at GRTE2, where fir was collected, with concentrations at or above the median. (Pine, collected at other GRTE sites, tends to accumulate 2-10x lower SOC concentrations than to other WACAP conifers.)
- All other SOCs detected in WACAP vegetation were also detected at GRTE: trifluralin (<1 ng/g lipid), triallate (<6), chlorpyrifos (1-5), HCB (4-17), a-HCH (2-15), g-HCH (1-9), chlordanes (0.1-6), dieldrin (<2), DDTs (12-20), and PCBs (2-4).
- Elevation effects were not observed in lichens; there were only two sites, with different species. The two highest conifer sites often had lowest SOC concentrations, possibly related to extended snow burial in winter.
- Lichen nitrogen concentrations were within background ranges, indicating that nitrogen deposition is not elevated.

## Air Summary

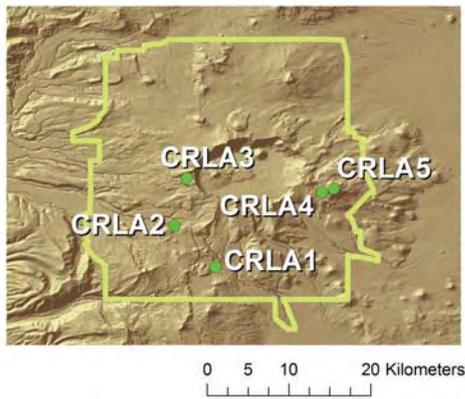
- The air sampler was at GRTE5.
- Concentrations of detected SOCs were above medians for the 20 parks [PAHs (232); CUPs dacthal (390 pg/g dry XAD) and endosulfans (359); HUPs HCB (840), a-HCH (140), g-HCH (44), and chlordanes (19)].



# Crater Lake National Park: Summary



## CRLA



**CRLA1**  
Lodgepole picnic area  
**Location:** 42.84N 122.15W  
**Elevation:** 1798 m  
**Ave. Ann. Temp:** 4.2°C  
**Ave. Ann. Precip:** 152 cm  
**Air Sampler:** No  
**Conifer:** *Abies magnifica*  
**Lichen:** *Letharia vulpina*

**CRLA4**  
Mt. Scott Trail 1.6 km  
**Location:** 42.92N 122.03W  
**Elevation:** 2423 m  
**Ave. Ann. Temp:** 3.5°C  
**Ave. Ann. Precip:** 108 cm  
**Air Sampler:** No  
**Conifer:** *Pinus albicaulis*  
**Lichen:** *Letharia vulpina*

**CRLA5**  
Mt. Scott Summit  
**Location:** 42.92N 122.02W  
**Elevation:** 2713 m  
**Ave. Ann. Temp:** 3.5°C  
**Ave. Ann. Precip:** 108 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus albicaulis*  
**Lichen:** None

**CRLA2**  
Whitehorse Pond  
**Location:** 42.88N 122.19W  
**Elevation:** 1859 m  
**Ave. Ann. Temp:** 3.5°C  
**Ave. Ann. Precip:** 155 cm  
**Air Sampler:** No  
**Conifer:** *Abies concolor*  
**Lichen:** *Letharia vulpina*

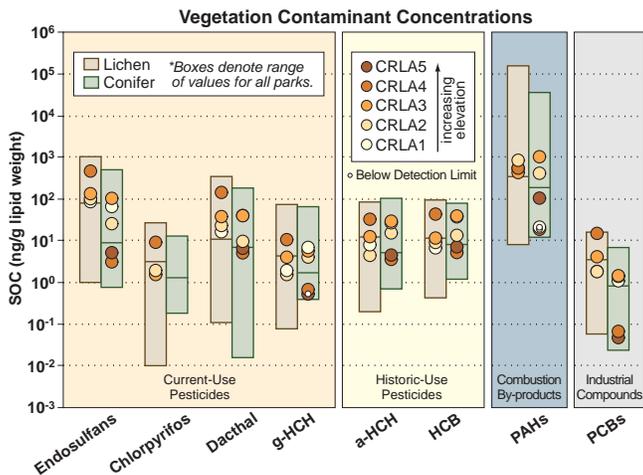
**CRLA3**  
Lightning Sprgs Trail near Rim Drive  
**Location:** 42.93N 122.18W  
**Elevation:** 2043 m  
**Ave. Ann. Temp:** 3.4°C  
**Ave. Ann. Precip:** 158 cm  
**Air Sampler:** No  
**Conifer:** *Abies magnifica*  
**Lichen:** *Letharia vulpina*

## Air Summary

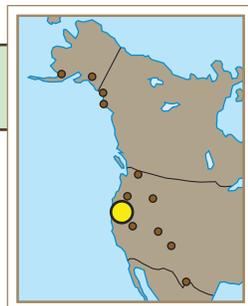
- The air sampler was deployed at CRLA5.
- Compared with other WACAP parks, concentrations of all SOCs detected were moderate [CUPs dacthal (160 ng/g dry XAD), endosulfans (467), and HUPs a-HCH (120), g-HCH (36), chlordanes (17), and PAHs (191)] to high [HCB (920)].
- No elevational or east-west patterns were observed.

## Vegetation Summary

- The CUPs endosulfans (3-486 ng/g lipid) and dacthal (10-150) comprised most of the pesticide burden in vegetation; other dominant SOCs were PAHs (1-3850) and the HUPs HCB (5-45), a-HCH (4-34), chlordanes (3-33), and DDT (5-17). Low concentrations of g-HCH (1-11), trifluralin (<0.4), chlorpyrifos (2-10), and PCBs (1-12) were also detected.
- Pesticide concentrations were at or above the median relative to other WACAP parks, except for consistently low values in conifers at the two highest sites, possibly related to deep snow burial in winter.
- Concentrations of endosulfans, dacthal, HCB, HCHs, and PCBs increased in lichens with elevation, most by an order of magnitude or more.
- Lichen nitrogen concentrations were within background ranges for remote sites in the Pacific Northwest, indicating that nitrogen deposition is not elevated.



# Lassen Volcanic National Park: Summary



LAVO

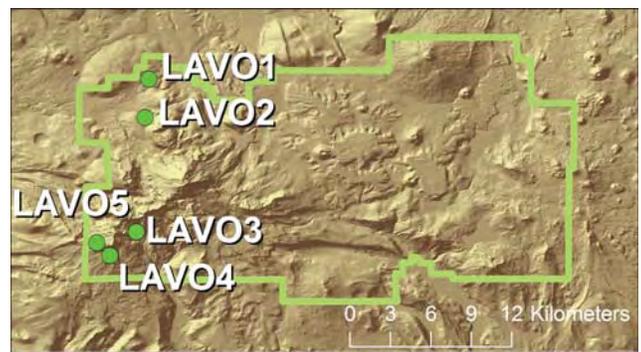
**LAVO1**  
Sunflower Flat  
**Location:** 40.56N 121.53W  
**Elevation:** 1829 m  
**Ave. Ann. Temp:** 7.4°C  
**Ave. Ann. Precip:** 123 cm  
**Air Sampler:** No  
**Conifer:** *Abies concolor*  
**Lichen:** *Letharia vulpina*

**LAVO2**  
Chaos Crags Trail 2.4 km  
**Location:** 40.53N 121.53W  
**Elevation:** 2012 m  
**Ave. Ann. Temp:** 6.6°C  
**Ave. Ann. Precip:** 168 cm  
**Air Sampler:** No  
**Conifer:** *Abies concolor*  
**Lichen:** *Letharia vulpina*

**LAVO3**  
Ridge Lake Basin  
**Location:** 40.46N 121.54W  
**Elevation:** 2271 m  
**Ave. Ann. Temp:** 4.1°C  
**Ave. Ann. Precip:** 267 cm  
**Air Sampler:** No  
**Conifer:** *Abies magnifica*  
**Lichen:** *Letharia columbiana*

**LAVO4**  
Broke-off Top Mtn Trail 3.2 km  
**Location:** 40.44N 121.56W  
**Elevation:** 2499 m  
**Ave. Ann. Temp:** 4.8°C  
**Ave. Ann. Precip:** 235 cm  
**Air Sampler:** No  
**Conifer:** *Abies magnifica*  
**Lichen:** *Letharia vulpina*

**LAVO5**  
Broke-off Top Mtn summit  
**Location:** 40.45N 121.57W  
**Elevation:** 2713 m  
**Ave. Ann. Temp:** 4.8°C  
**Ave. Ann. Precip:** 235 cm  
**Air Sampler:** Yes  
**Conifer:** *Abies magnifica*  
**Lichen:** *Letharia vulpina*

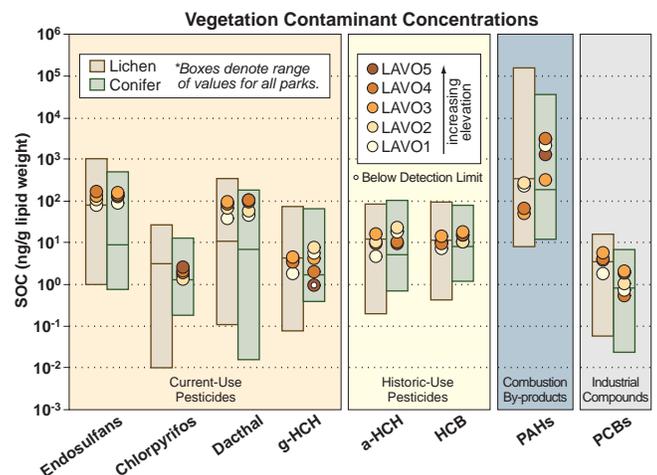


## Vegetation Summary

- The same genera (wolf-lichen and true fir) were collected at all sites.
- SOC concentrations in LAVO vegetation were close to, above, or well above the median for the WACAP parks.
- The dominant SOCs were PAHs (90-3300 ng/g lipid), endosulfans (90-180), dacthal (40-110), DDTs (2-65), and HCB (10-24). Proportions of PAHs were similar to those in southern Oregon and other California parks.
- Low concentrations of chlorpyrifos (<3 ng/g lipid), a-HCH (2-15), g-HCH (2-8), chlordanes (5-14), dieldrin (1-6), and PCBs (1-5) were also detected.
- Increases in endosulfans, chlorpyrifos, and dacthal, and decreases in PAH concentrations in lichens were observed with increasing elevation.
- Lichen nitrogen concentrations were within background ranges, indicating that nitrogen deposition is not elevated.

## Air Summary

- Air was sampled at LAVO5.
- Compared with other WACAP parks, concentrations of all SOCs detected were above the median [CUPS trifluralin (5 ng/g dry XAD), dacthal (380), and endosulfans (363), and HUPs HCB (840), a-HCH (150), g-HCH (30), and chlordanes (34), and PAHs (77)].



# Yosemite National Park: Summary



YOSE

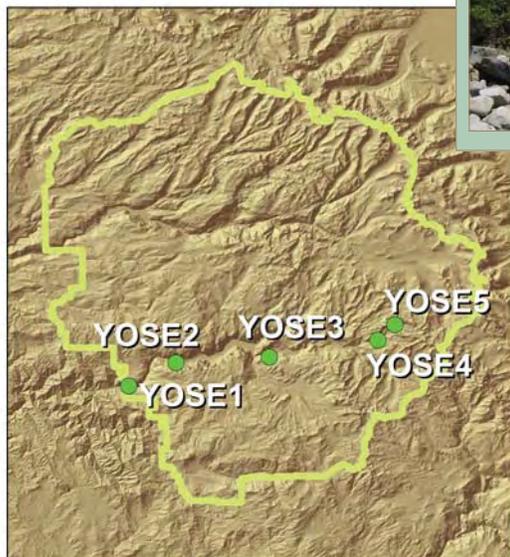
**YOSE1**  
Hwy 140 park boundary  
**Location:** 37.68N 119.75W  
**Elevation:** 661 m  
**Ave. Ann. Temp:** 12.1°C  
**Ave. Ann. Precip:** 87 cm  
**Air Sampler:** No  
**Conifer:** *Pinus sabiniana*  
**Lichen:** *Xanthoparmelia*



**YOSE2**  
Turtleback Dome  
**Location:** 37.72N 119.68W  
**Elevation:** 1433 m  
**Ave. Ann. Temp:** 10.7°C  
**Ave. Ann. Precip:** 92 cm  
**Air Sampler:** No  
**Conifer:** *Pinus ponderosa*  
**Lichen:** *Letharia vulpina*



**YOSE3**  
Nevada Falls  
**Location:** 37.72N 119.53W  
**Elevation:** 1829 m  
**Ave. Ann. Temp:** 10.3°C  
**Ave. Ann. Precip:** 104 cm  
**Air Sampler:** No  
**Conifer:** *Pinus lambertiana*  
**Lichen:** *Letharia vulpina*



0 5 10 20 30 40 Kilometers

**YOSE4**  
Lewis Creek at Cony Crag  
**Location:** 37.75N 119.36W  
**Elevation:** 2713 m  
**Ave. Ann. Temp:** 4.2°C  
**Ave. Ann. Precip:** 112 cm  
**Air Sampler:** No  
**Conifer:** *Pinus contorta*  
**Lichen:** None



**YOSE5**  
Lewis-Gallison Creek confluence  
**Location:** 37.77N 119.34W  
**Elevation:** 3048 m  
**Ave. Ann. Temp:** 3.1°C  
**Ave. Ann. Precip:** 109 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus contorta*  
**Lichen:** None

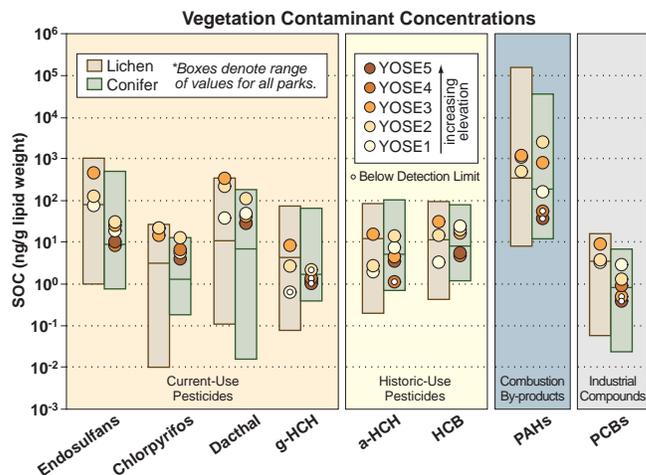


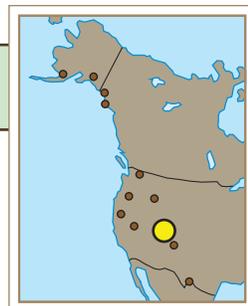
## Air Summary

- Air was sampled at YOSE5.
- Concentrations of all SOCs detected, except PAHs (97 pg/g dry XAD), ranked above medians for the 20 parks. CUPs detected were dacthal (36), endosulfans (413); HUPs detected were a-HCH (120), g-HCH (33), and chlordanes (30).

## Vegetation Summary

- The dominant SOCs were PAHs (517-19,326 ng/g lipid), the CUPs endosulfans (10-474), dacthal (30-350), and chlorpyrifos (4-31), and the HUPs DDTs (10-72) and HCB (3-32), all of which were at or well above medians for the 20 WACAP parks. Low concentrations of trifluralins (<1), g-HCH (1-9), and PCBs (0.1-7) were also detected.
- SOC concentrations were about 10x higher in lichens than conifers.
- A strong elevational effect was observed in lichens: concentrations of endosulfans, dacthal, HCHs, and PCBs increased by one-half to one order of magnitude, from 660 to 1830 m.
- Pine, the only conifer genus sampled in YOSE, appears to be a poor accumulator of SOCs compared with spruce, fir, and hemlock sampled in other west coast parks; had these species been collected, total pesticides would probably have ranked intermediate compared with concentrations in LAVO and SEKI, as did the lichen data.
- Lichen nitrogen concentrations were at or slightly above uppermost Pacific Northwest background ranges, indicating potential enhancement of depositional nitrogen.





GRSA

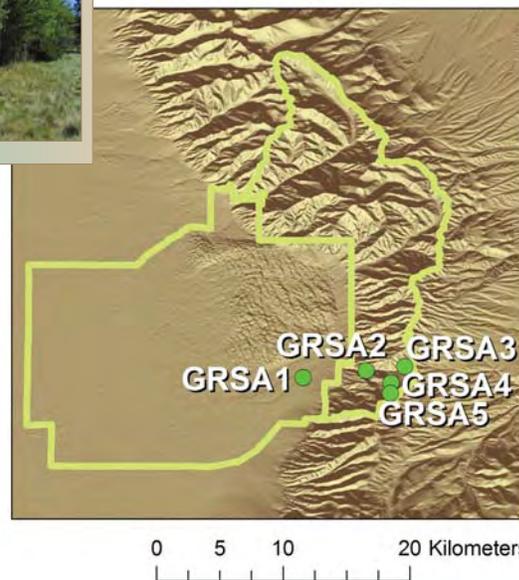
**GRSA1**  
Park headquarters  
**Location:** 37.73N 105.53W  
**Elevation:** 2469 m  
**Ave. Ann. Temp:** 5.3°C  
**Ave. Ann. Precip:** 25 cm  
**Air Sampler:** No  
**Conifer:** *Pinus edulis*  
**Lichen:** None

**GRSA2**  
Mosca Pass Trail midpoint  
**Location:** 37.73N 105.49W  
**Elevation:** 2774 m  
**Ave. Ann. Temp:** 4.3°C  
**Ave. Ann. Precip:** 48 cm  
**Air Sampler:** No  
**Conifer:** *Pinus edulis*  
**Lichen:** *Xanthoparmelia*

**GRSA3**  
Mosca Pass  
**Location:** 37.73N 105.46W  
**Elevation:** 2941 m  
**Ave. Ann. Temp:** 3.9°C  
**Ave. Ann. Precip:** 60 cm  
**Air Sampler:** No  
**Conifer:** *Pinus flexilis*  
**Lichen:** None

**GRSA4**  
Carbonate Mtn sideslope  
**Location:** 37.72N 105.47W  
**Elevation:** 3109 m  
**Ave. Ann. Temp:** 4.3°C  
**Ave. Ann. Precip:** 48 cm  
**Air Sampler:** No  
**Conifer:** *Pinus flexilis*  
**Lichen:** *Xanthoparmelia*

**GRSA5**  
Carbonate Mtn peak  
**Location:** 37.71N 105.47W  
**Elevation:** 3338 m  
**Ave. Ann. Temp:** 4.3°C  
**Ave. Ann. Precip:** 52 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus flexilis*  
**Lichen:** None

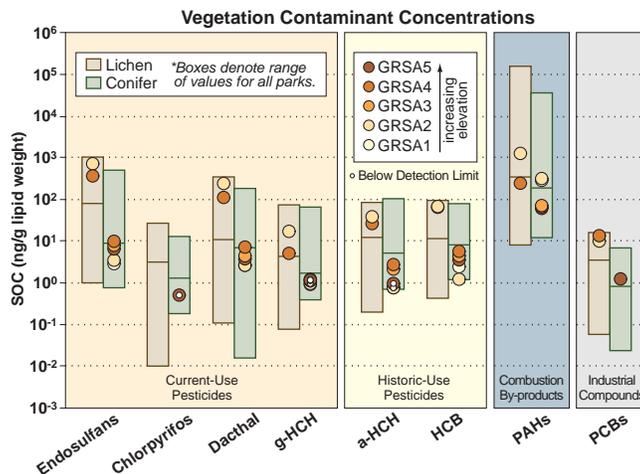


## Vegetation Summary

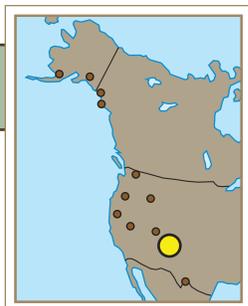
- The dominant SOC detected in vegetation were PAHs, especially 4-5 ring compounds (30-1000 ng/g lipid), endosulfans (3-710, 10x higher in lichens than conifers), and dacthal (2-110, 10x higher in lichens), DDTs (10-100), HCB (1-67), a-HCH (0.1-40), chlordanes (24-32), and g-HCH (5-17); low concentrations of PCBs (1-11) were detected.
- Lichen concentrations were generally higher than conifer needle concentrations by at least an order of magnitude.
- Although SOC concentrations in conifer needles from GRSA were comparable to those at BAND and BIBE, where the same target genus (pine) was collected, SOC concentrations in lichens were disproportionately high at GRSA compared to ROMO, BAND, and BIBE even though the same rock-dwelling lichen, *Xanthoparmelia*, was collected there.
- Field notes and the park website indicate that the two sites where lichens were collected were very windy. It is possible that a disproportionately high absorption of SOCs from soil particulates contributed to high lichen SOC concentrations.
- Lichen nitrogen concentrations were within background ranges, indicating that nitrogen deposition is not elevated.

## Air Summary

- The air sampler was at GRSA5.
- Compared with concentrations at other WACAP parks, concentrations of all SOCs detected were moderate [(CUPs dacthal (300), endosulfans (353), and HUPs HCB (580), a-HCH (120), and chlordanes (15)] to high [g-HCH (73), PAHs (1342 ng/g dry XAD)].



# Bandelier National Monument: Summary



BAND

**BAND1**  
 Burro Tr above Lummis Canyon  
**Location:** 35.73N 106.27W  
**Elevation:** 1854 m  
**Ave. Ann. Temp:** 10.5°C  
**Ave. Ann. Precip:** 35 cm  
**Air Sampler:** No  
**Conifer:** *Pinus edulis*  
**Lichen:** *Xanthoparmelia*



**BAND2**  
 NW of Juniper Campground  
**Location:** 35.80N 106.28W  
**Elevation:** 2076 m  
**Ave. Ann. Temp:** 9.9°C  
**Ave. Ann. Precip:** 41 cm  
**Air Sampler:** No  
**Conifer:** *Pinus edulis*  
**Lichen:** *Usnea*



**BAND3**  
 Lower E slopes of Frijoles Park  
**Location:** 35.82N 106.36W  
**Elevation:** 2348 m  
**Ave. Ann. Temp:** 8.1°C  
**Ave. Ann. Precip:** 51 cm  
**Air Sampler:** No  
**Conifer:** *Pinus ponderosa*  
**Lichen:** *Xanthoparmelia*



**BAND4**  
 Lower SW slope of Cerro Grande  
**Location:** 35.83N 106.39W  
**Elevation:** 2576 m  
**Ave. Ann. Temp:** 6.4°C  
**Ave. Ann. Precip:** 58 cm  
**Air Sampler:** No  
**Conifer:** *Pinus ponderosa*  
**Lichen:** *Usnea*



**BAND5**  
 Saddle SW of Cerro Grande Peak  
**Location:** 35.86N 106.42W  
**Elevation:** 2926 m  
**Ave. Ann. Temp:** 5.4°C  
**Ave. Ann. Precip:** 67 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus ponderosa*  
**Lichen:** *Usnea*

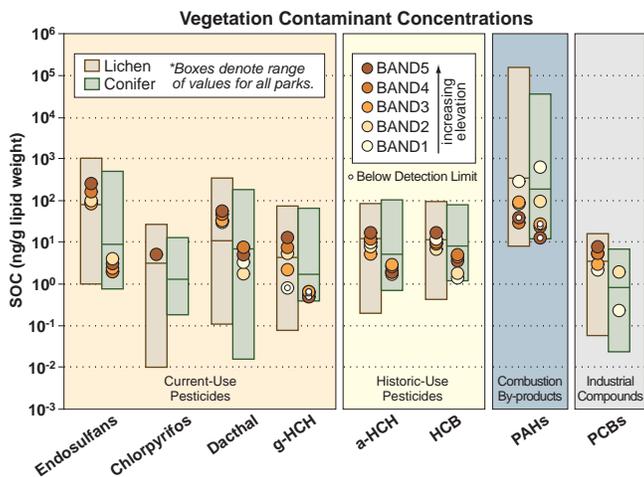


## Air Summary

- Compared with concentrations at the 20 WACAP parks, concentrations of all pesticides detected in the air sampler at BAND5 were near the median.
- Pesticides detected were the CUPs [endosulfans (494 ng/g dry XAD), dacthal (150), trifluralin (9)], and HUPs [HCH (11), g-HCH (37), chlordanes (19)]; PAHs were low (21).

## Vegetation Summary

- Concentrations of CUPs [endosulfans (2-256 ng/g lipid), dacthal (1-56), chlorpyrifos (<5)] were at or above medians and concentrations of HUPs [HCB and HCHs (1-17)] were at or below medians for the 20 WACAP parks.
- Other pesticides detected were trifluralin (<0.5) and DDTs (4-53).
- Pine is a poor accumulator of SOCs compared to other conifers and lichens, explaining the large range in concentrations observed within individual SOCs.
- Pesticides and PCBs increased and PAHs decreased in lichens with elevation.
- Abundance of nitrophytic lichens and elevated nitrogen concentrations in *Xanthoparmelia* and *Usnea*, relative to clean sites in the Pacific Northwest and northern Rockies, indicate enhanced nitrogen deposition.



# Big Bend National Park: Summary



BIBE

## BIBE1

Rio Grande Village  
**Location:** 29.19N 102.97W  
**Elevation:** 560 m  
**Ave. Ann. Temp:** 21°C  
**Ave. Ann. Precip:** 26 cm  
**Air Sampler:** Yes  
**Conifer:** None  
**Lichen:** None



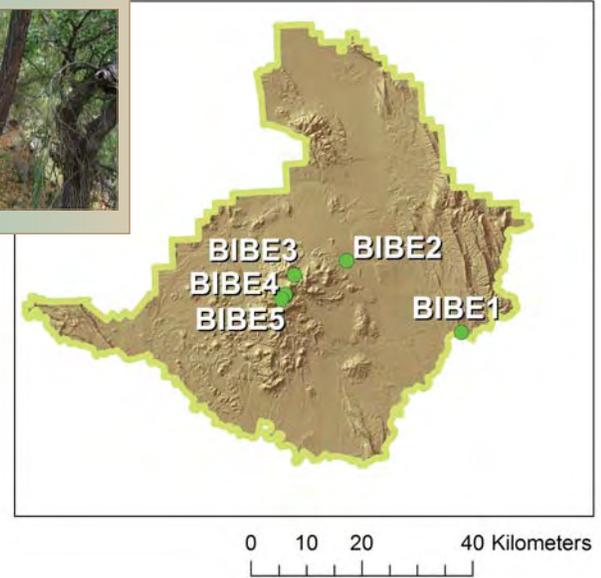
## BIBE2

Water Tank near Panther Jct  
**Location:** 29.31N 103.18W  
**Elevation:** 1067 m  
**Ave. Ann. Temp:** 18.6°C  
**Ave. Ann. Precip:** 37 cm  
**Air Sampler:** Yes  
**Conifer:** None  
**Lichen:** None



## BIBE3

Panther Pass  
**Location:** 29.29N 103.28W  
**Elevation:** 1608 m  
**Ave. Ann. Temp:** 17.5°C  
**Ave. Ann. Precip:** 46 cm  
**Air Sampler:** No  
**Conifer:** *Pinus cembroides*  
**Lichen:** None



## BIBE4

Pinnacles Campground  
**Location:** 29.25N 103.30W  
**Elevation:** 1920 m  
**Ave. Ann. Temp:** 16.7°C  
**Ave. Ann. Precip:** 51 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus cembroides*  
**Lichen:** *Usnea*



## BIBE5

Emory Peak  
**Location:** 29.25N 103.30W  
**Elevation:** 2316 m  
**Ave. Ann. Temp:** 16.7°C  
**Ave. Ann. Precip:** 50 cm  
**Air Sampler:** Yes  
**Conifer:** *Pinus cembroides*  
**Lichen:** *Usnea*



## Vegetation Summary

- Compared with other parks, concentrations in lichens and conifer needles were at or slightly above medians for CUPs, and at or below medians for HUPs, PAHs, and PCBs.
- Pine, the only conifer available at BIBE, is a poorer accumulator of SOCs than the spruce, fir, and hemlock collected in the northern Rockies, Pacific Coast, and Alaska parks.
- SOCs detected were CUPs [chlorpyrifos (<2 ng/g lipid), dacthal (1-14), endosulfans (9-255, up to 25x higher in lichens than pine)], HUPs [HCB, a-HCH, g-HCH, and chlordanes (<5), DDE (8-17)], PCBs (<3), and PAHs (10-828, up to 80x higher in lichens than pine).
- Lichen nitrogen concentrations and abundance of nitrophytic lichens at sites indicate enhanced nitrogen deposition; IMPROVE data indicate ammonium sulfate could be the main culprit.

## Air Summary

- Air was sampled at four sites from the Rio Grande to Emory Peak (BIBE1, BIBE2, BIBE4, and BIBE5).
- Dramatic differences among sites in annual precipitation, humidity, vegetation cover, and airborne soil particulates might have masked elevation effects on pesticide concentrations in air, although PAHs decreased markedly with increasing elevation from moderate to low concentrations (1491, 200, 276, 1 ng/dry XAD).
- Pesticides that ranked high compared with other WACAP parks were endosulfans (472-1096) and DDE (n.d.-43).
- Dacthal (67-390), HCB (6-21), HCHs (2-21), and chlordanes (16-37) ranked below or near the median; very low concentrations (7-11) of trifluralin were detected.

