Western Airborne Selected Contaminants Assessment Program: Focus on SEKI/CA Results Compared and Interpreted

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SEKI Workshop – Three Rivers, CA – 8 April 2009

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Key Issues for SEKI

- **Lake sites are among the most dilute of all lakes sampled in WACAP and ANC indicates that they are poorly buffered against acidic deposition.**
- **Most SOCs in the passive air sampling devices were high compared to other parks and included both CUPs and HUPs.**
- **Deep snow packs mean high potential loadings (i.e. fluxes) of SOC while Hg in snow was generally low.**
- **Vegatation concentrations of SOCs, Hg and nutrients were mid to high range, reflecting proximity to regional agriculture as well as contaminant emmisions. S and N were enriched in lichens. The high forest productivity likely translate into high loadings from needle fall.**
- **Current use SOCs in the average fish were among the highest measured with Dieldren and DDE , exceeding contaminant thresholds in both lakes.**
- **Sediments showed similar historic patterns in both lakes, DDT and chlordanes decrease after being banned in the US but PCBs are still accumulating. Hg increased in late 1800 and is now noisily stable at about 100% enrichment.**

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How much of the contaminants in North America are from Trans-Pacific Transport?

In a new NASA study, researchers taking advantage of improvements in satellite sensor capabilities offer the first measurement-based estimate of the amount of pollution from East Asian forest fires, urban exhaust, and industrial production that makes its way to western North America. (Credit: Image courtesy of NASA/Goddard Space Flight Center)

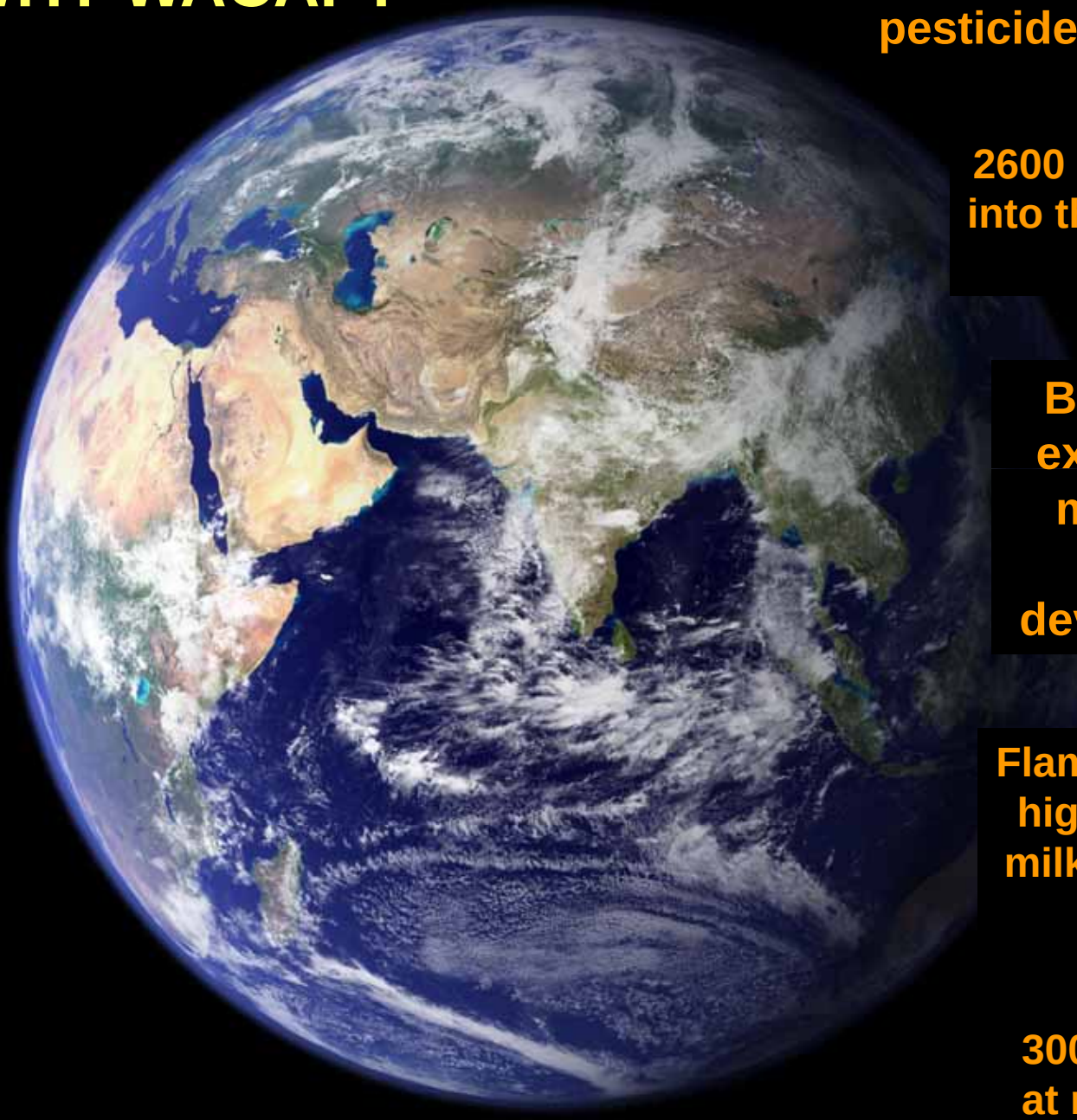
"We used the latest satellite capabilities to distinguish industrial pollution and smoke from dust transported to the western regions of North America from East Asia. Looking at four years of data from 2002 to 2005 we estimated the amount of pollution arriving in North America to be equivalent to about 15 percent of local emissions of the U.S. and Canada,"

"Our study focused on East Asian pollution transport, but pollution also flows from Europe, North America, the broader Asian region and elsewhere

"So we should not simply blame East Asia for this amount of pollution flowing into North America."

http://www.sciencedaily.com/releases/2008/03/080317164336.htm

WHY WACAP?



1.3 million metric tons of pesticides used in China (WHO)

2600 metric tons of Hg emitted into the air from anthropogenic sources (UNEP)

Between '92-'94 the US exported at least 30,000 metric tons of banned pesticides to the developing world (AAAS)

Flame retardants 10-1000 fold higher in American's breast milk compared to Europeans (EHP)

300,000 American newborns at risk from Hg toxicity (CDC)

Presentation Outline

- Conclusions
- Brief WACAP Overview
- Results
- Discussion and Questions

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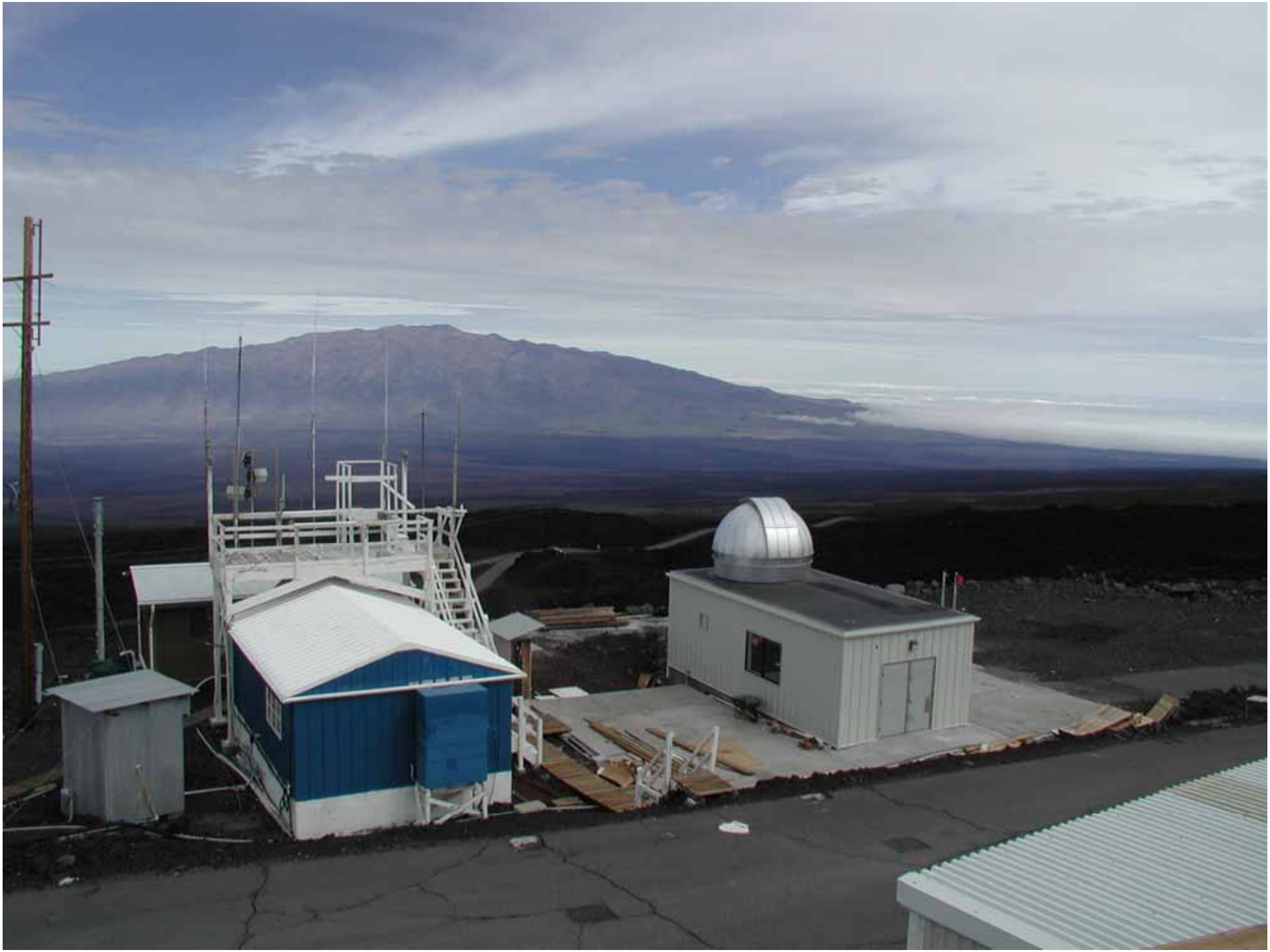
WACAP GOAL:

TO ASSESS THE DEPOSITION OF AIRBORNE CONTAMINANTS IN WESTERN NATIONAL PARKS, PROVIDING REGIONAL AND LOCAL INFORMATION ON EXPOSURE, ACCUMULATION, IMPACTS AND PROBABLE SOURCES



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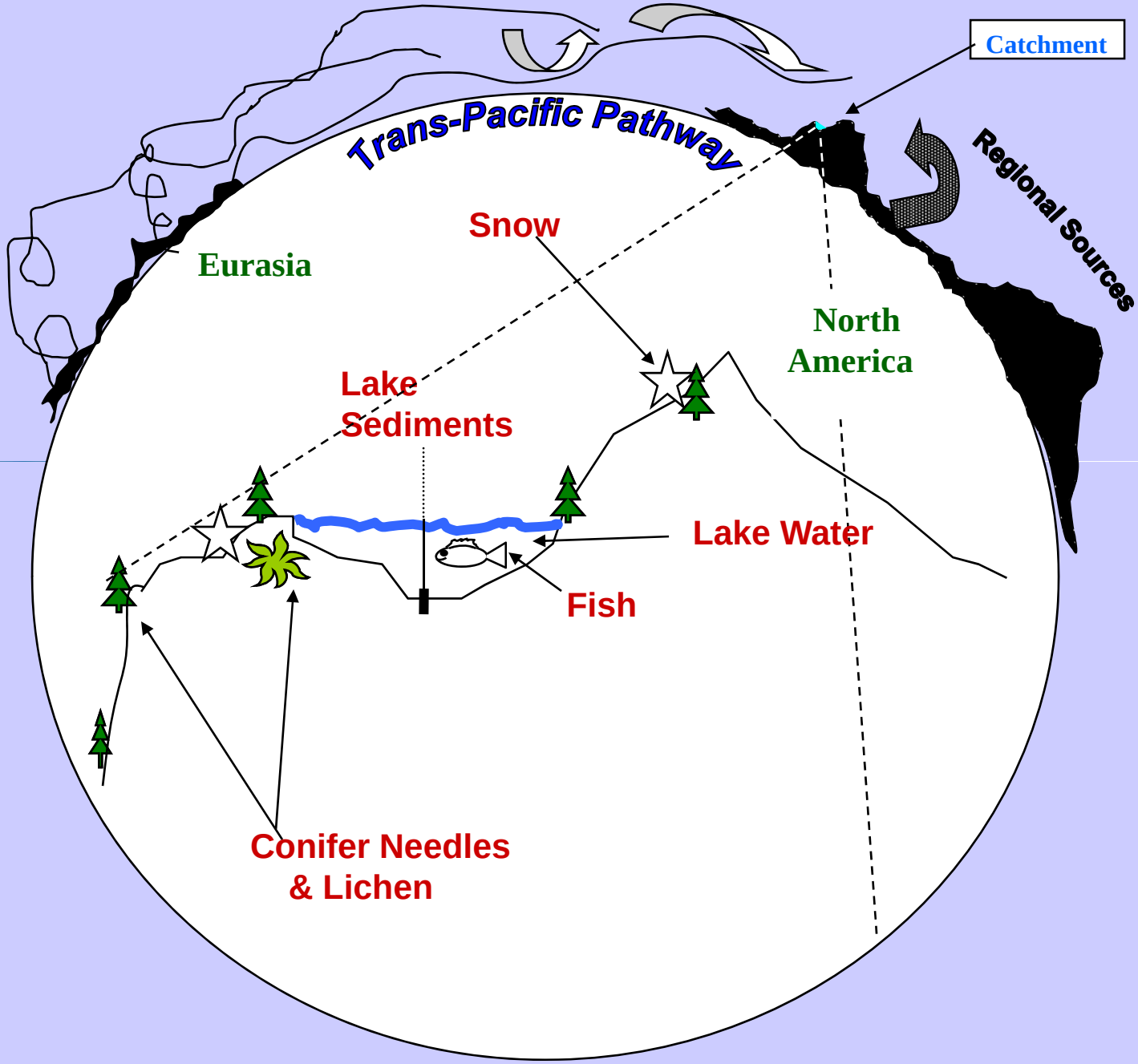
Pear Lake, CA, Sequoia-Kings Canyon National Park, 2908 m.a.s.l.



WACAP Indicators and Conceptual Diagram

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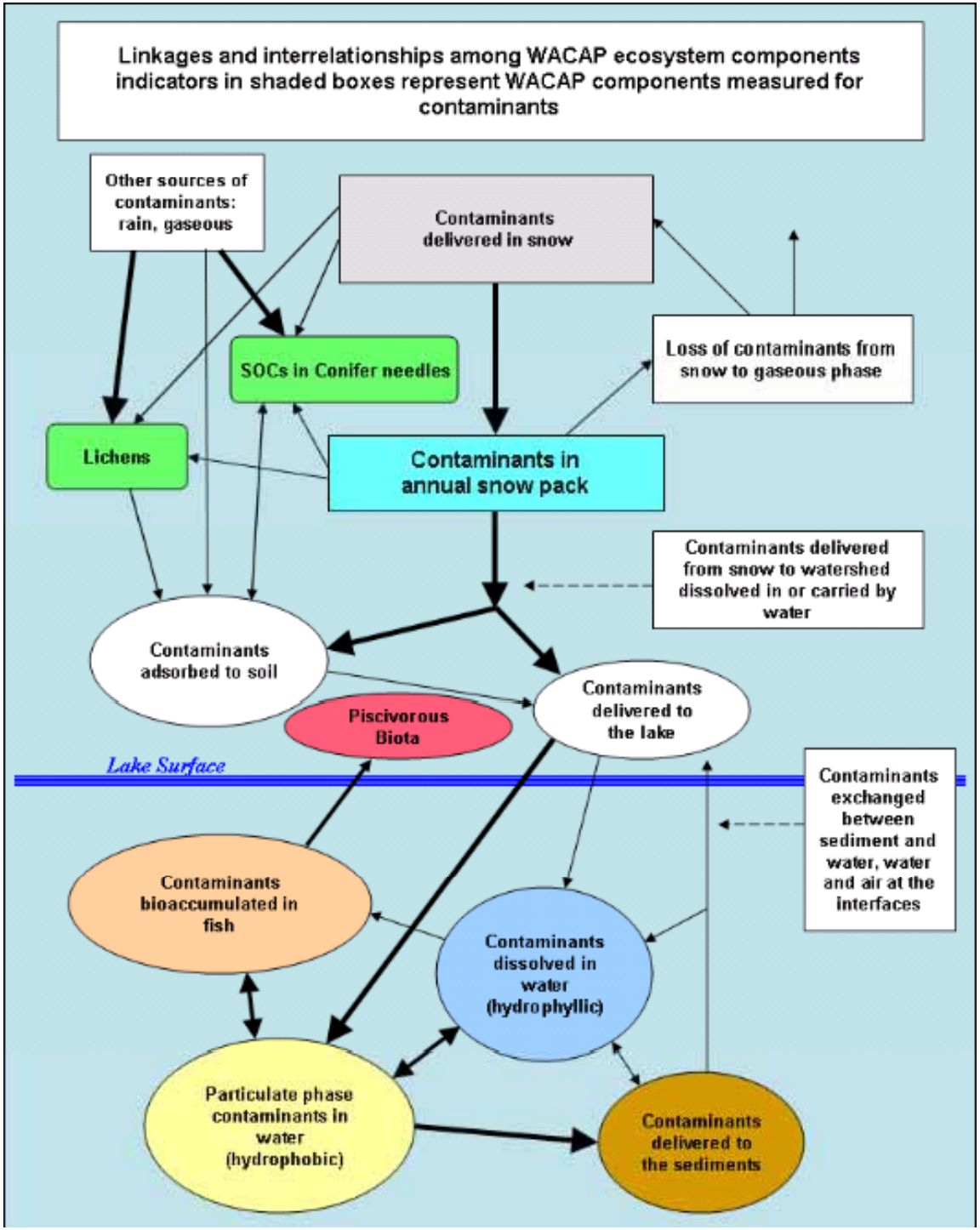
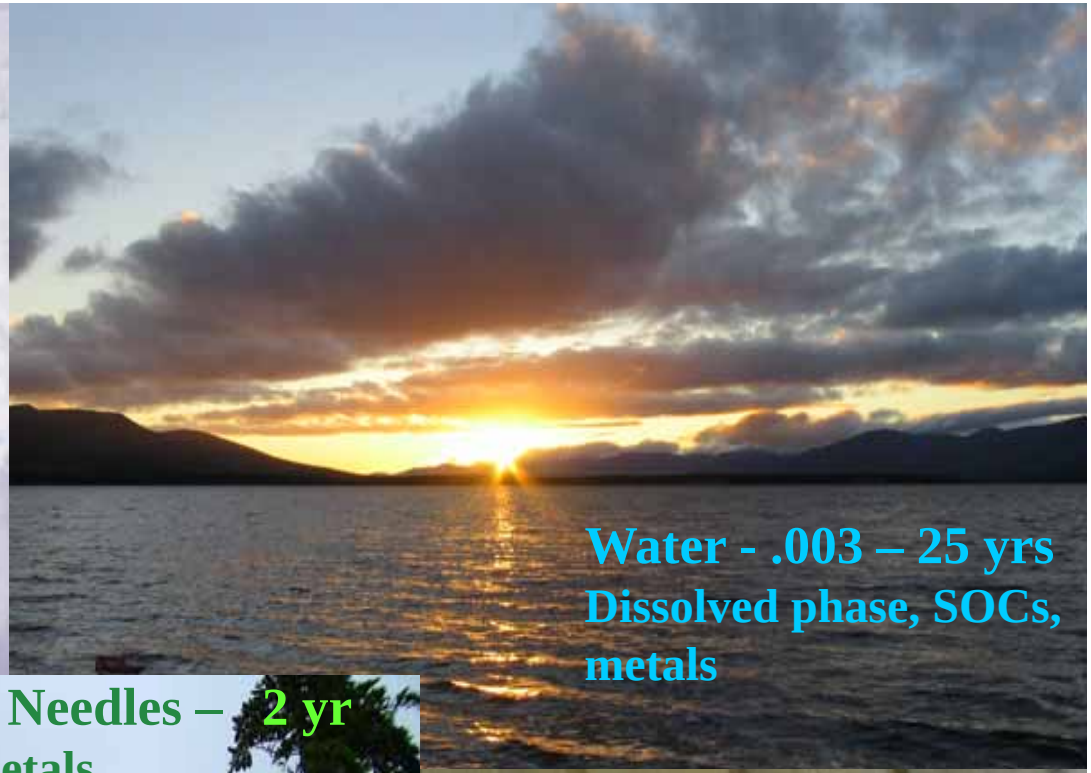


Snow – annual flux SOCs
and metals


Water - .003 – 25 yrs
Dissolved phase, SOCs,
metals

Lake
Sediment ~ 135 y
Chronology
SOCs, metals, SCPs

Conifer Needles – 2 yr
SOCs, metals
Lichen – unknown age
N, S, metals

Fish: 2 – 34 yr (selectable)
SOCs, metals, condition,
enzymes, pathology

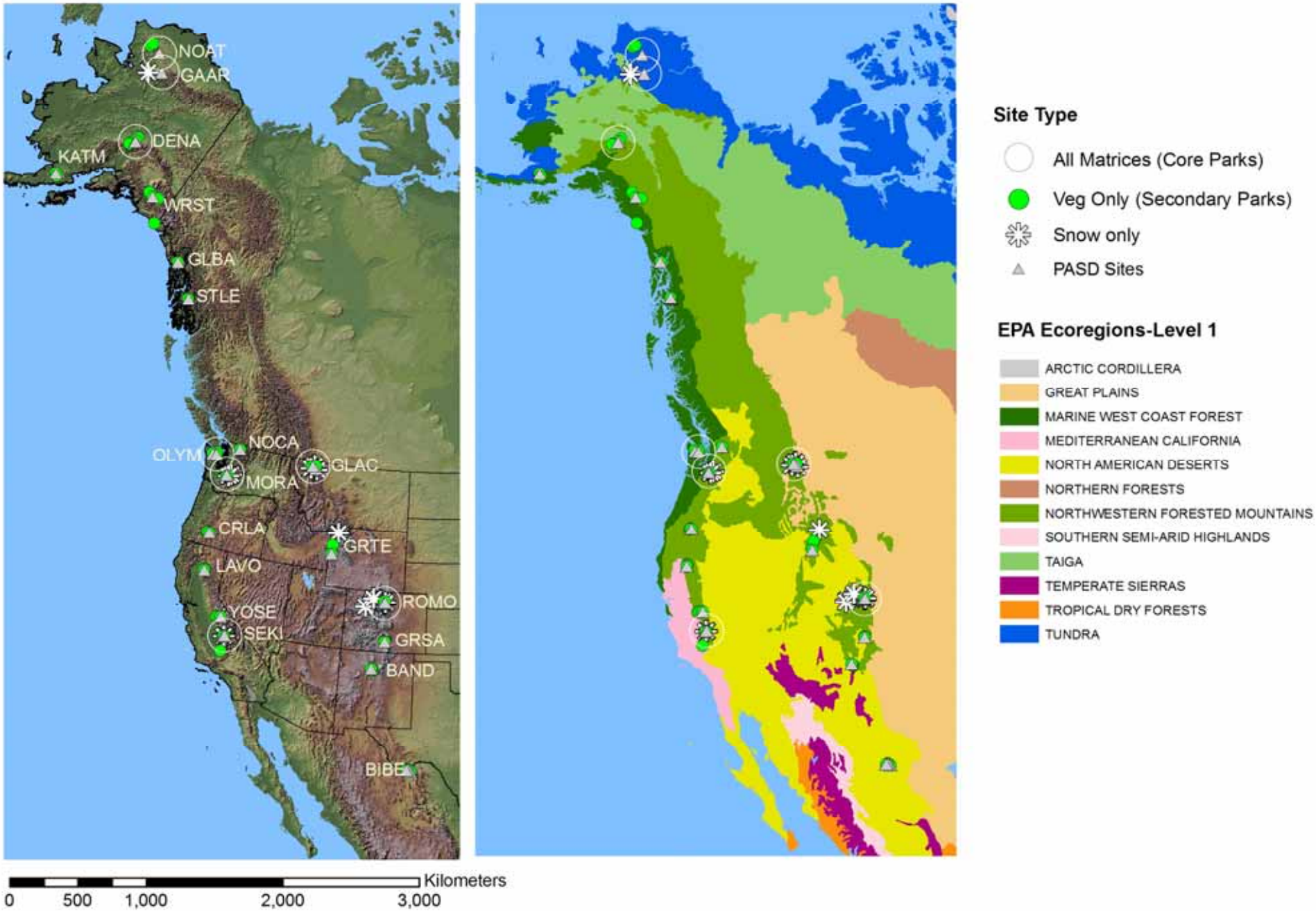


Figure 1. WACAP Sites mapped on North American shaded relief map and EPA Level 1 Ecoregions (Biomes).

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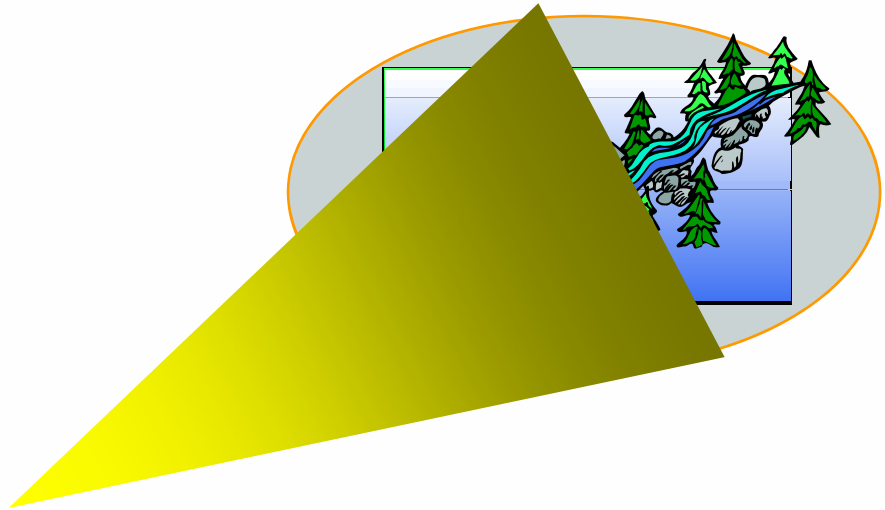
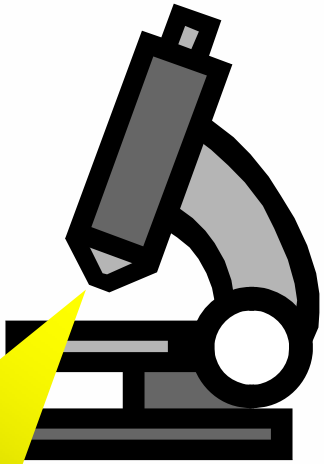


Macroscope



NEED TO UNDERSTAND AT MULTIPLE SCALES

Microscope

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2002

Pilot Studies:

Design & Methods

WESTERN AIRBORNE CONTAMINANTS ASSESSMENT PROJECT FINAL REPORT: VOLUME I

The Fate, Transport, and Ecological Impacts of Airborne Contaminants in Western National Parks (USA)

Burial Lake, Noatak National Preserve
Photo: Adam Schwindt

Dixon H. Landers
Staci Simonich
Daniel Jaffe
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Donald H. Campbell
Adam Schwindt
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Technical Editor:
Susan Christie

EPA/600/R-07/138
January 2008

2007

Interpre-tive report and publica-tion..

We are Here!

WACA

http://

What are the contaminant categories of potential risk to the Western National Parks due to the deposition of airborne contaminants?

- Current Use Pesticides (CUPS)
- Historic Use Pesticides (chemicals) HUPS (i.e. POPs)
- Mercury (and other metals)
- Emerging Chemicals (PBDE)

Target Semi-Volatile Organic Compounds

Electron Impact Ionization	Electron Capture Negative Ionization
PAHs: Acenaphthylene, Acenaphthene, Fluorene, Phenant[illegible] Pyrene, Retene, [illegible] phenylene, Benzo[b[illegible] ene, Benzo[e]pyrene, Benzo[a]pyrene, Indeno[1,2,3-cd]pyrene, Dibenz[a,h]anthracene, Benzo[ghi]perylene **Combustion**	**PCBs:** PCB 74 (2,4,4',5-Tetrachlorobiphenyl), PCB 101 (2,2',4,5,5'-Pentachlorobiphenyl), PCB 11[illegible]), PCB 13[illegible] yl), PCB 153 (2,2',4,4',5,5'-Hexachlorobiphenyl), PCB 183* (2,2',3,4,4',5',6-Heptachlorobiphenyl), PCB 187 (2,2',3,4',5,5',6-Heptachlorobiphenyl) **Industry**
Pesticides and degradation products: o,p'-DDT*, p,p'-DDT, o,p'-DDD*, p,p'-DDD, o,p'-DDE, [illegible] Ethion, Etradia[illegible] Methyl - Parathi[illegible] xychlor, Acetochlor*, Alachlor, Prometon, Pebulate, EPTC, Carbofuran, Carbaryl, Propachlor, Atrazine and degradation products, Simazine, Cyanazine **Agriculture**	**Pesticides and degradation products:** Hexachlorocyclohexanes (HCH) - α*, β, γ-(lindane), and δ, Chlor[illegible] chlor – cis, trans, Heptach[illegible] ulfans - I, II, and sulf[illegible] in Aldehyde, Hexachlorobenzene, Dacthal, Chlorothalonil, Chlorpyrifos and oxon, Trifluralin, Metribuzin, Triallate, Mirex **Agriculture**
Surrogates: d_{10}-Fluorene, d_{10}-Phenanthrene, d_{10}-Pyrene, d_{12}-Triphenylene, d_{12}-Benzo[a]pyrene, d_{12}-Benzo[ghi]perylene, d_{14}-EPTC, d_{10}-Phorate, d_5-Atrazine, d_{10}-Diazinon, d_7-Malathion, d_{10}-Parathion, d_8-p,p'-DDE, d_8-p,p'-DDT, d_6-Methyl Parathion, d_{13}-Alachlor, d_{11}-Acetochlor	**Surrogates:** $^{13}C_{12}$ PCB 101 (2,2',4,5,5'-Pentachlorobiphenyl), $^{13}C_{12}$ PCB 180 (2,2', 3,4,4',5,5'-Heptachlorobiphenyl), d_{10} - Chlorpyrifos, $^{13}C_6$-HCB, d_6-γ-HCH, d_4-Endosulfan I, d_4-Endosulfan II, d_{14}-Trifluralin
Internal Standards: d_{10}-Acenaphthene, d_{10}-Fluoranthene, d_{12}-Benzo[k]fluoranthene	**Internal Standard:** $^{13}C_{12}$ PCB 138 (2,2',3,4,4',4',5'-Hexachlorobiphenyl)

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BROOKS RANGE AVIATION

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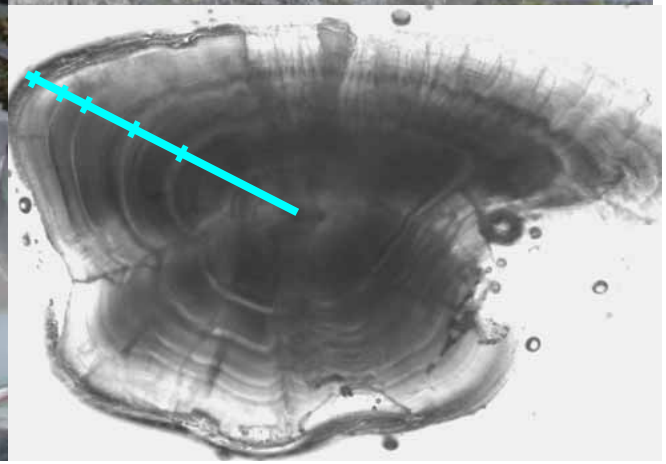
Sequoia and Kings Canyon National Parks



WACAP Results:

(Sediments and Source Allocations With a SEKI/CA perspective)

Snyder Lake, Glacier National Park
1597 masl

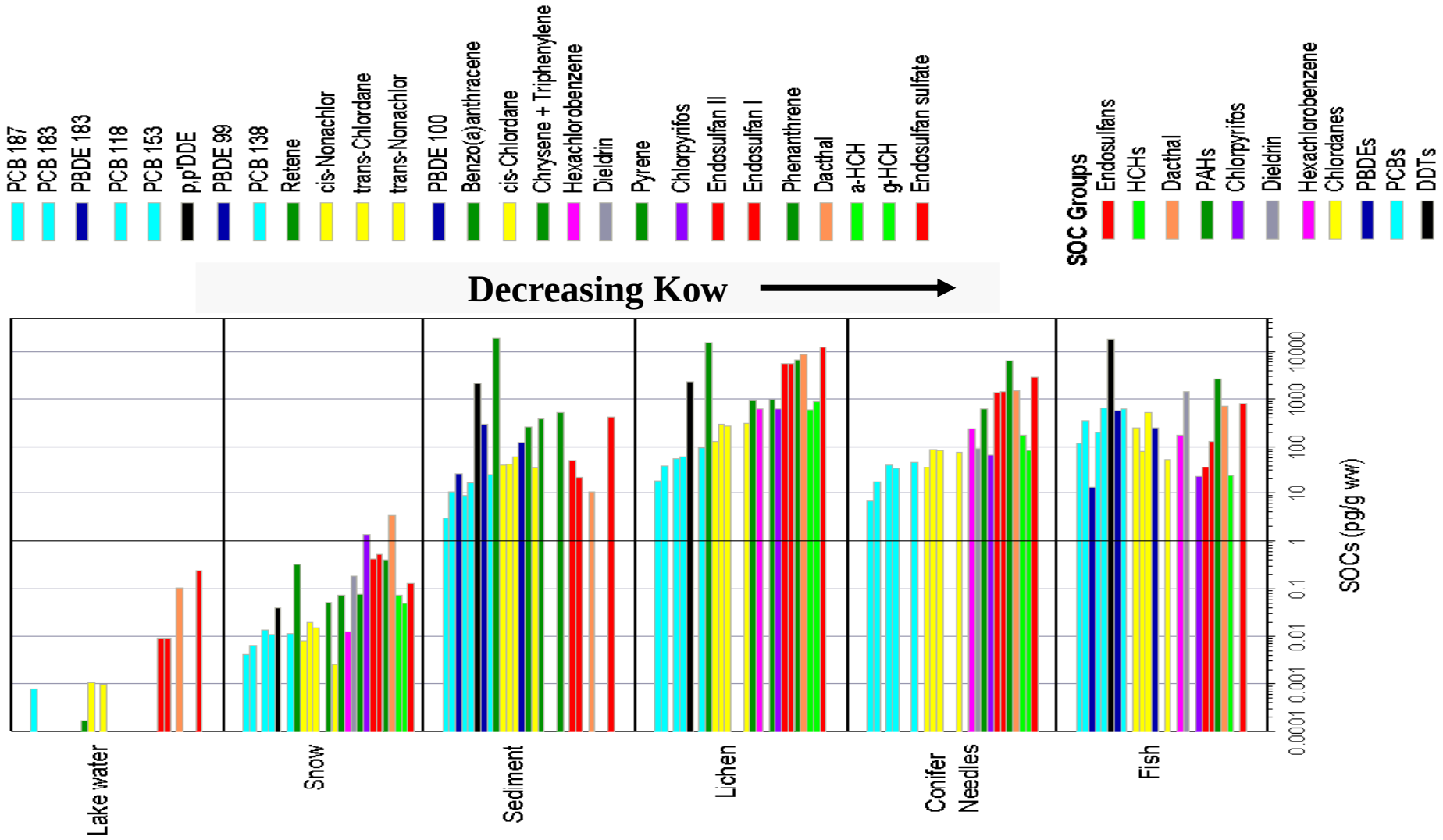


Figure 2. Mean SOC Concentrations (pg/g ww) in Lake Water, Snow, Sediments, Lichens, Conifer Needles, and Fish from Emerald Lake (SEKI). SOCs are ordered by increasing Kow, or decreasing polarity and solubility in water, color-coded by group. SOC concentrations were 3 to 7 orders of magnitude higher in sediments and biota relative to snow and water. SOC concentrations in water, snow, and vegetation, but not sediments and fish, generally decreased with decreasing polarity. Compared to vegetation, fish were better accumulators of PCBs and dieldrin and poorer accumulators of PAHs, endosulfans, HCHs, dacthal, and chlorpyrifos. If no data are shown, all samples were below detection limits; PBDEs were measured in sediments and fish only.

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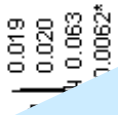
Current Use Pesti



ES&T March 2008

Atmospherically Deposited PBDEs, Pesticides, PCBs, and PAHs in Western U.S. National Park Fish: Concentrations and Consumption Guidelines

LUKE K. ACKERMAN,†
ADAM R. SCHWINDT,‡ STACI L. MAS
SIMONICH,*,†,§ DAN C. KOCH
TAMARA F. BLETT,4 CARL B. S
MICHAEL L. KENT,‡ AND
DIXON H. LANDERS#

Historic Use Pesticides

ES&T February 2008

Mercury Concentrations in Salmonids from Western U.S. National Parks and Relationships with Age and Macrophage Aggregates

ADAM R. SCHWINDT,
JOHN W. FOURNIE,
DIXON H. LANDERS,
CARL B. SCHRECK, AND
MICHAEL L. KENT

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e pesticides.

Hageman, K. I. et al. 2006. Atmospheric Deposition of Current-U in Snow at National Parks in the Western United States. ES & T

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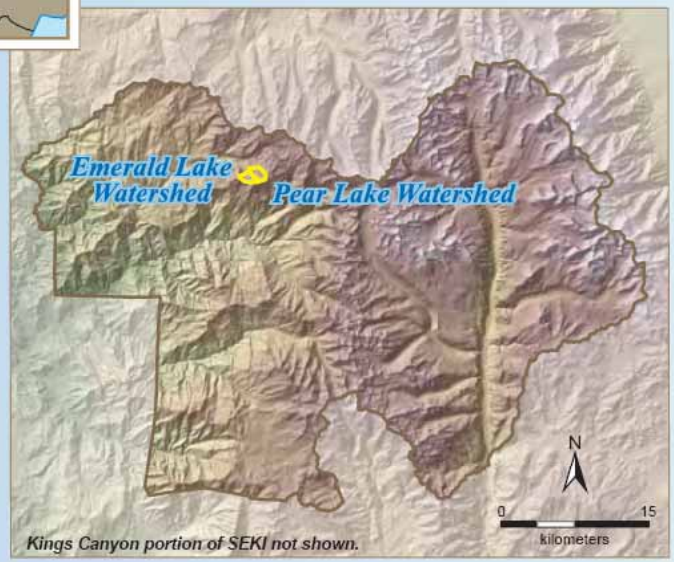
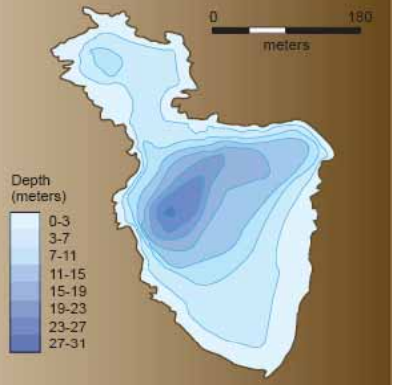
SEKI



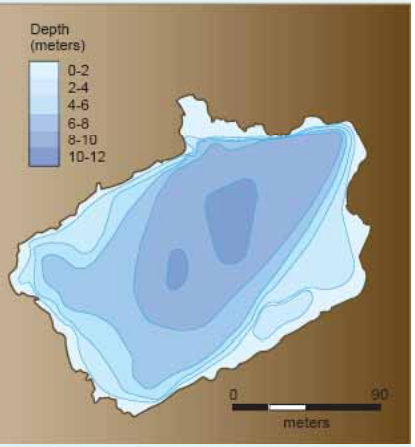
Pear Lake

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

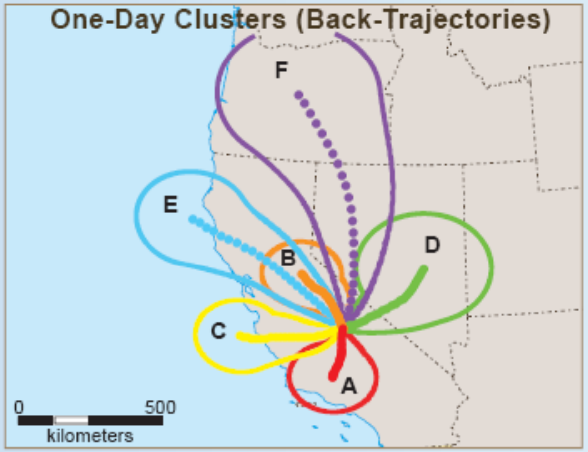


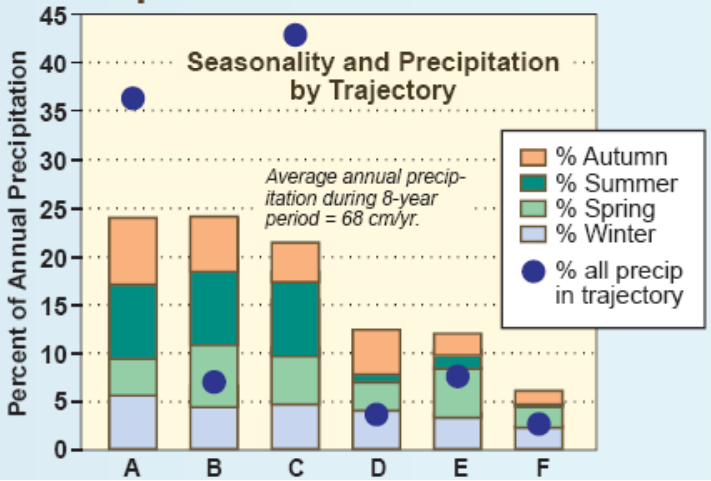
Emerald Lake

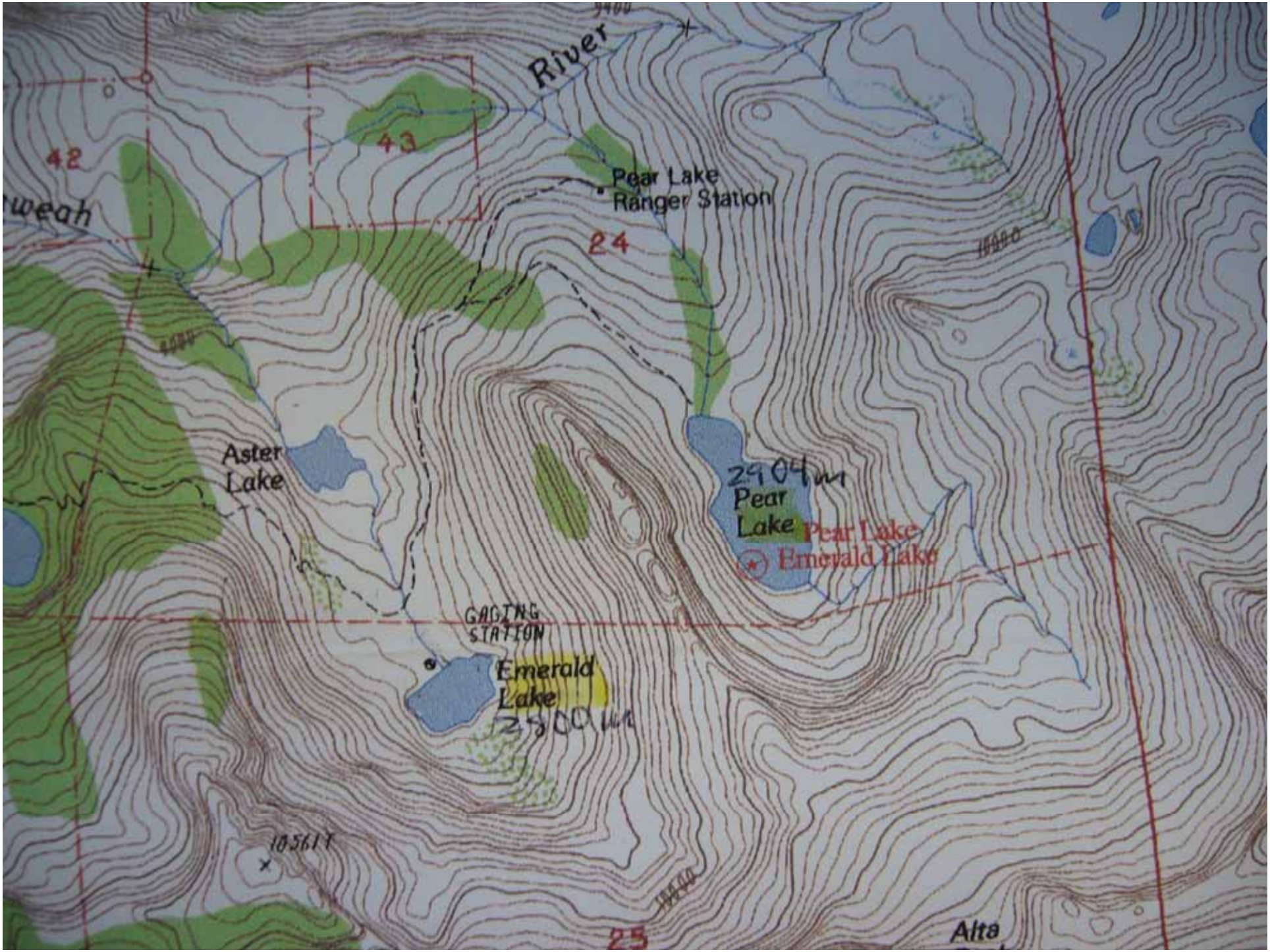
Location: 36.58N 118.67W
Elevation: 2810.3 m
Maximum Depth: 10.0 m
Surface Area: 2.5 ha
Watershed Area: 121.3 ha



◆ Atmospheric Transport ◆






River
42
43
weah
Pear Lake
Ranger Station
24
Aster
Lake
2904 m
Pear
Lake
Pear Lake
Emerald Lake
GAGING
STATION
Emerald
Lake
2500 m
105611
25
Alta

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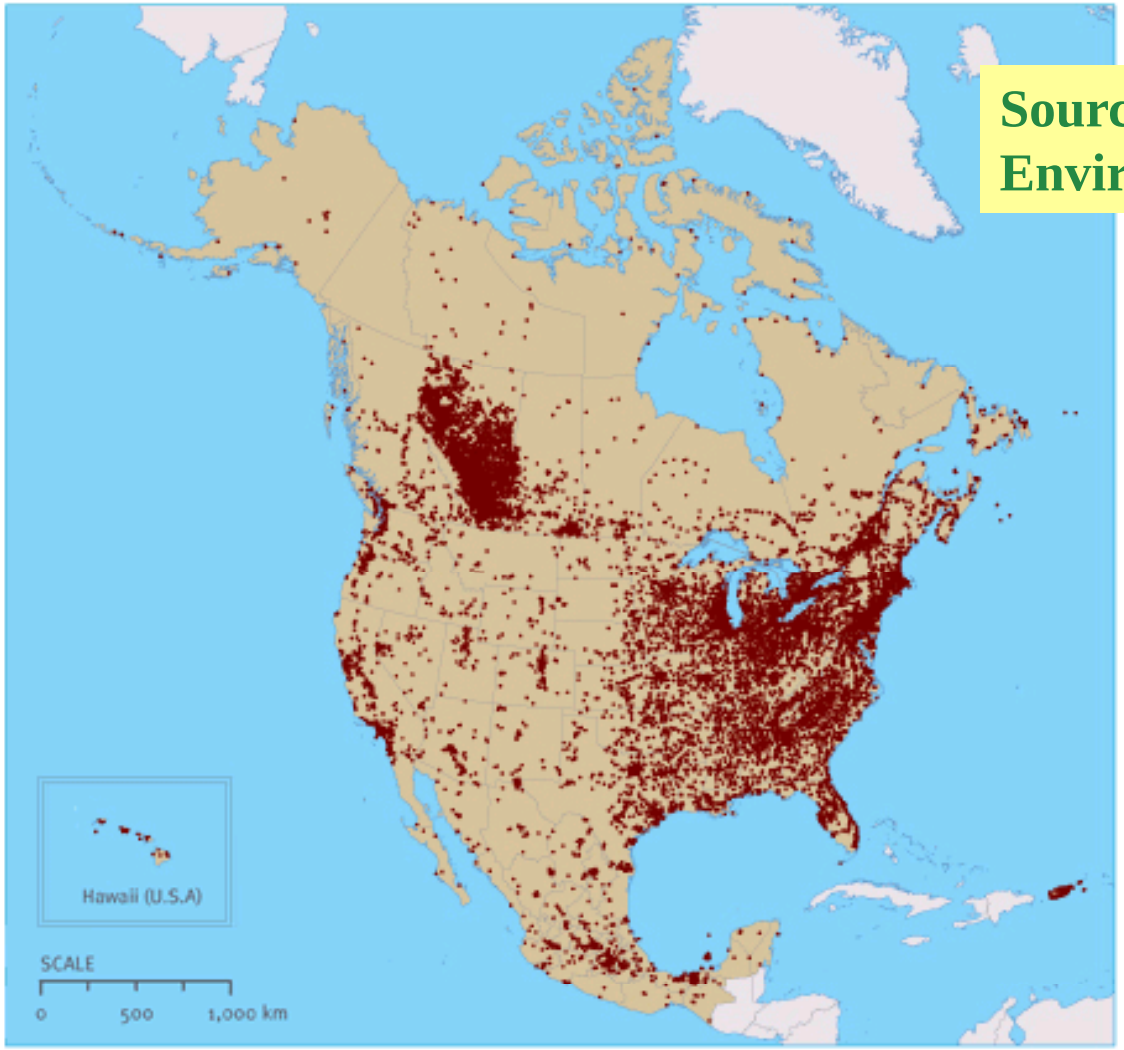
Industrial pollutants, 2004



Source: North American Environmental Atlas

Description

This map shows the locations of almost 34,000 industrial facilities in North America that reported on releases or transfers of pollutants in 2004. Data for this map was assembled from each of the North American country's Pollutant Release and Transfer Registers (PRTRs): the National Pollutant Release Inventory (NPRI) in Canada, the Registro de Emisiones y Transferencias de Contaminantes (RETC) in Mexico, and the Toxics Release Inventory (TRI) in the United States.

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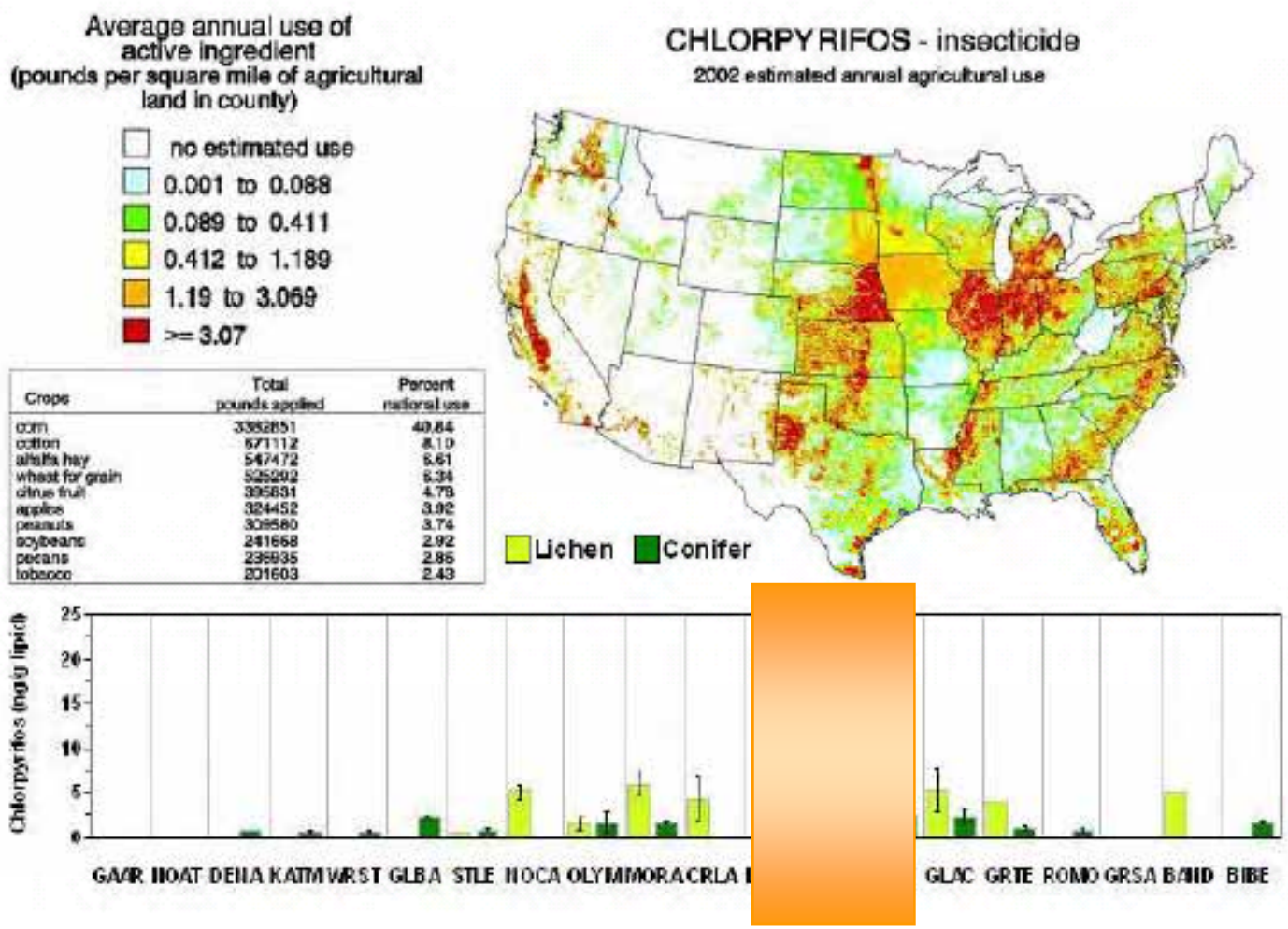

Crops	Total pounds applied	Percent national use
corn	3382851	40.84
cotton	671112	8.10
alfalfa hay	547472	6.61
wheat for grain	525292	6.34
citrus fruit	395631	4.78
apples	324452	3.92
peanuts	309580	3.74
soybeans	241668	2.92
pecans	236935	2.86
tobacco	201603	2.43

Figure 4-14. Uses and Estimated Application Intensity in 2002 of the Current-Use Insecticide Chlorpyrifos in the Conterminous 48 States vs. Mean Concentration in Vegetation (ng chlorpyrifos/g lipid conifer needles or lichens) from WACAP Parks. Chlorpyrifos were detected in vegetation in all parks except NOAT and GAAR, but highest concentrations were observed in SEKI and YOSE, close to the San Joaquin Valley in California, a particularly high use area. Error bars indicate one standard error.

Source of chlorpyrifos data:
http://ca.water.usgs.gov/pnsp/pesticide_use_maps/show_map.php?year=02&map=m6009.

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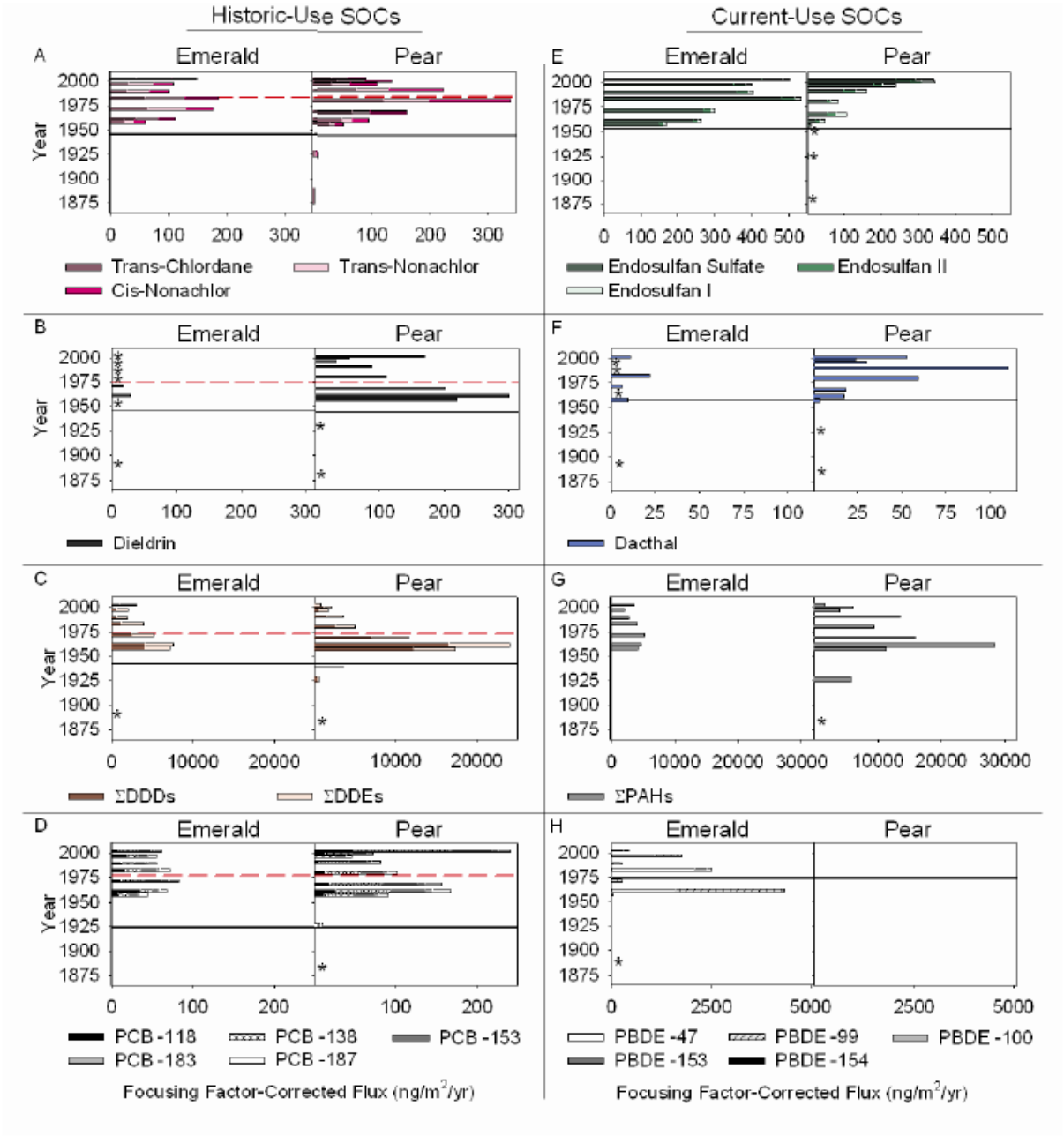

Figure 4-29. Focusing Factor-Corrected Flux (ng/m^2/yr) Profiles of Current- and Historic-Use SOCs in Emerald Lake and Pear Lake Sediment Cores at SEKI. Solid lines (——) indicate US registered use dates, dashed lines (– – –) indicate US restriction dates, and asterisks (*)indicate below method detection limit.

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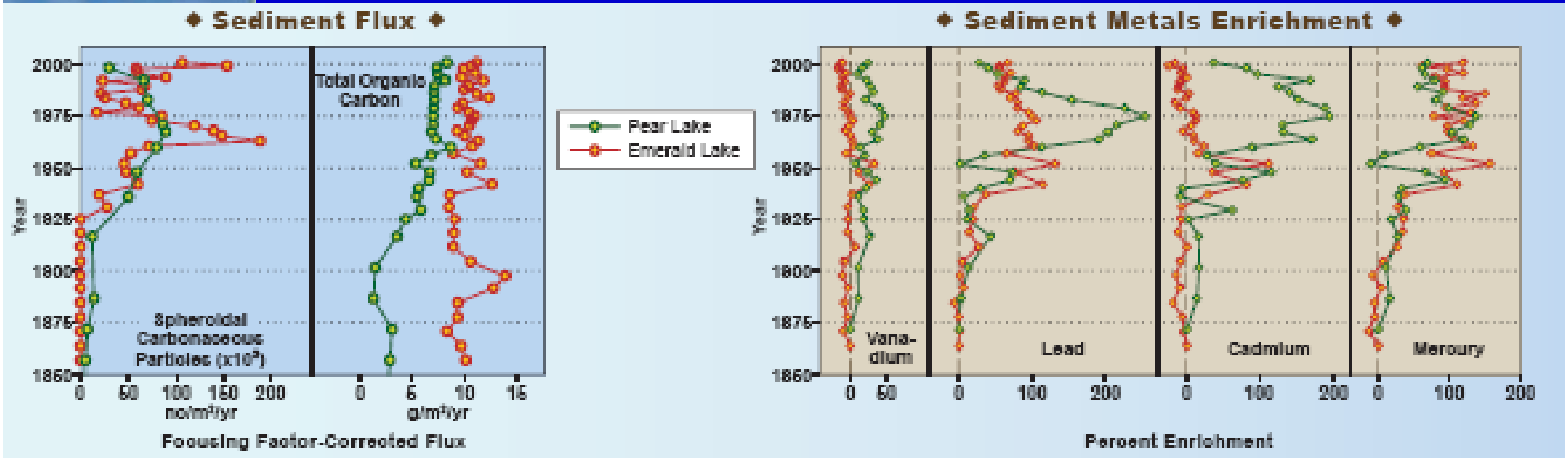

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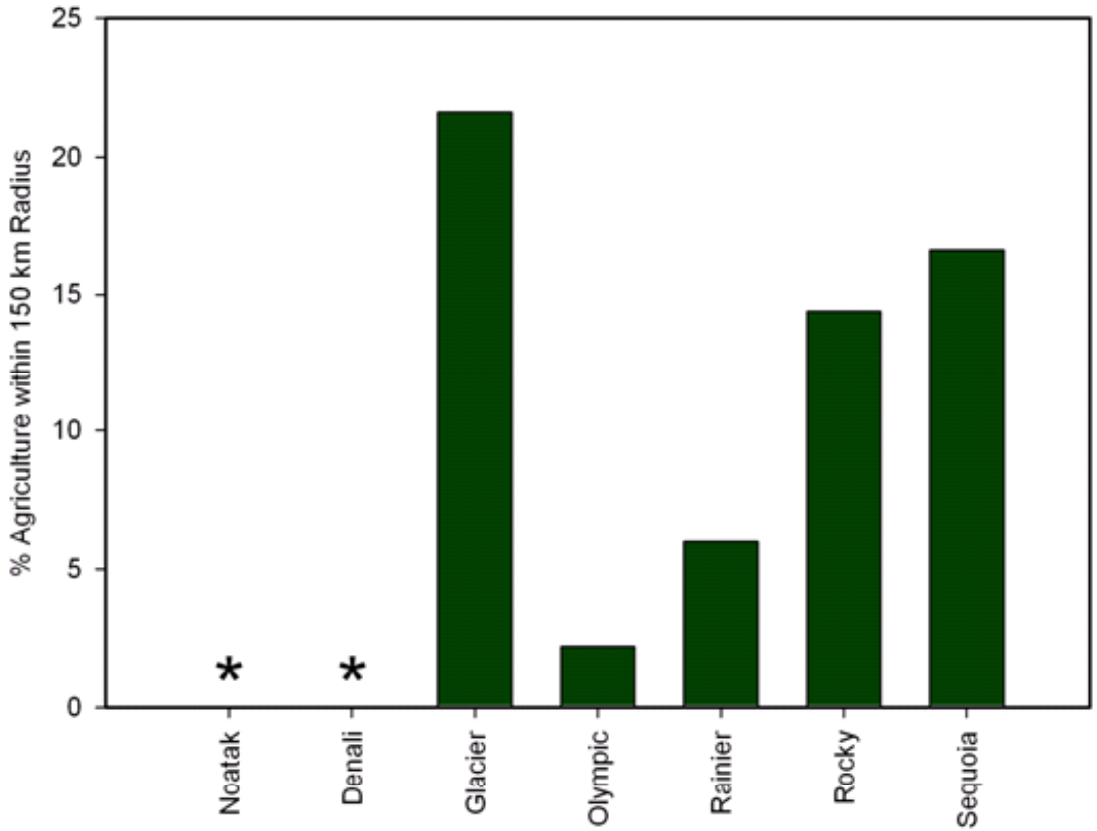


Figure 6: Percent of agricultural land within 150 km of the primary WACAP parks. Alaskan parks have no surrounding agriculture.

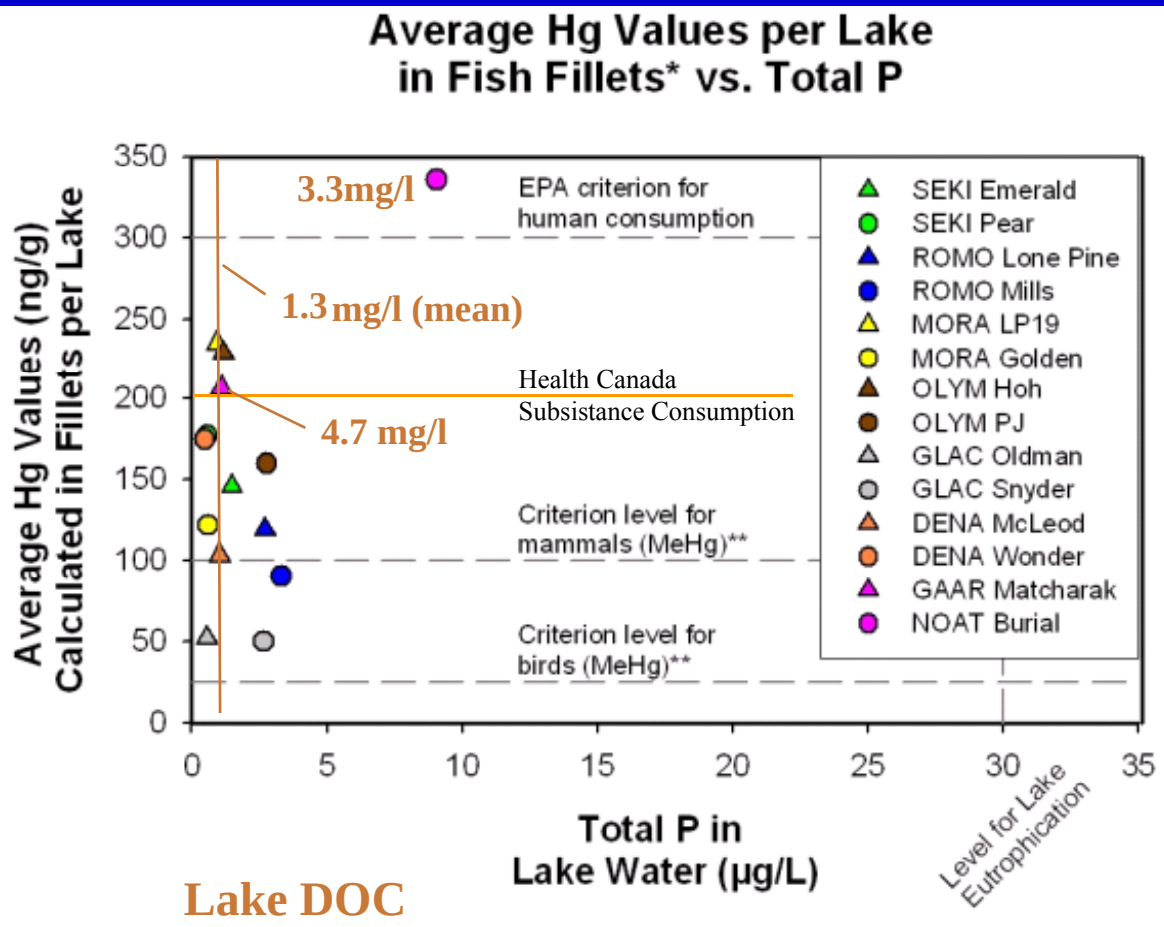
Proposed and Existing Coal Fired Power Plants
in the Western U.S.
Proposed Coal Fired Power Plant
Existing Coal Fired Power Plant
Tons NOx - 2006
< 9000
9000 - 18000
18000 - 27000
27000 - 36000
36000 - 45000
7/07
Produced by NPS Air Resources Division

Finis

WACAP WEB SITE:
http://www2.nature.nps.gov/air/studies/air_toxics/wacap.cfm

"Well, thank God we all made it out in time. ...'Course, now we're equally screwed."

You can run, But you can't hide



Lake DOC

* Fillet concentrations calculated from whole fish Hg concentrations with method from Peterson *et al.* (2005), Arch Environ. Contam. Toxicol. 48:99-107

**MeHg limits taken from Yeardley et al., 1998 Environ. Toxicol. Chem. 17:1875-1884

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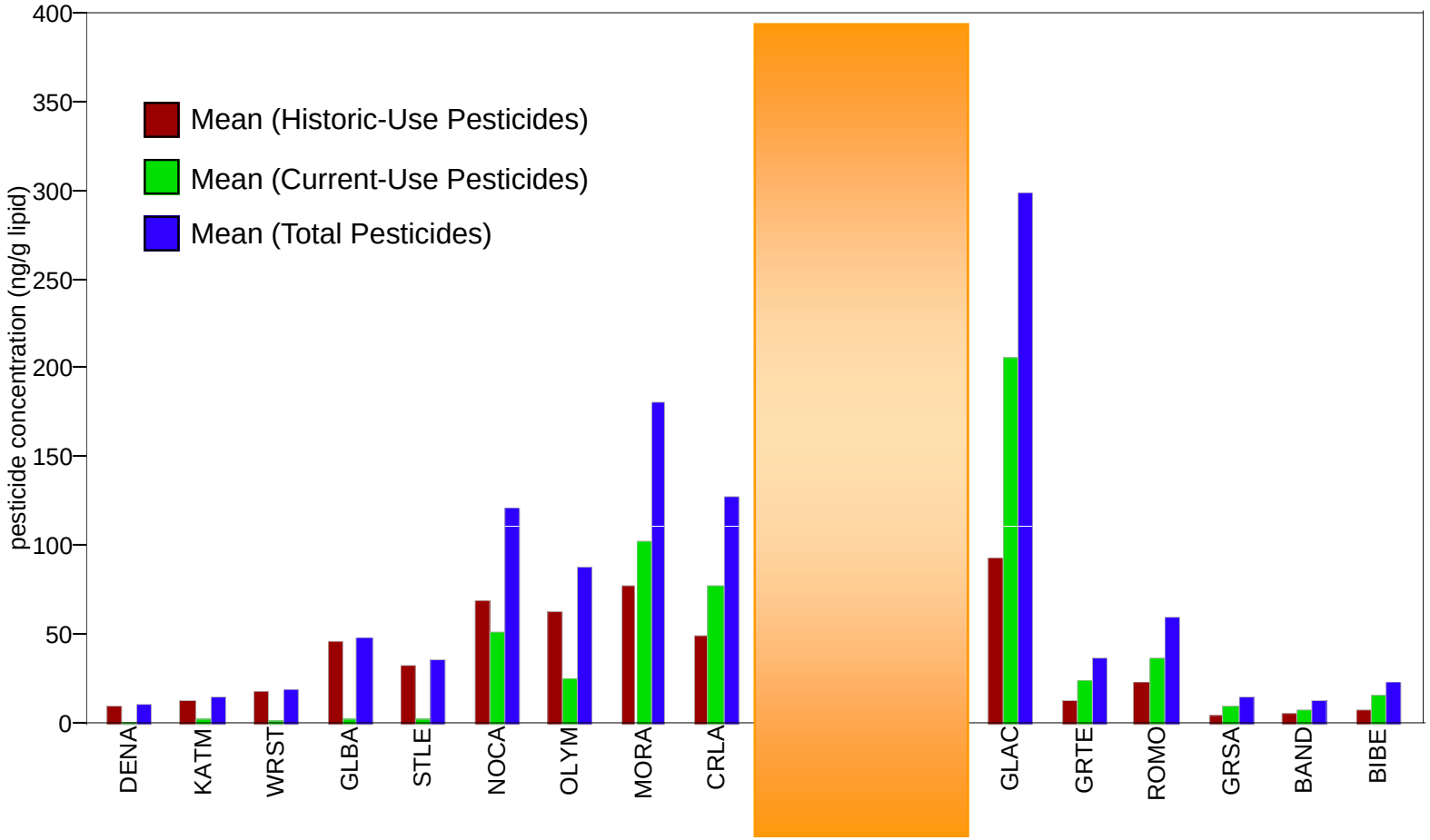

Figure 4-31. Mean Concentrations of Historic-Use (HCB, HCHs, Chlordanes, DDT, Dieldrin) and Current-Use (Trifluralin, Triallate, Chlorpyrifos, Dacthal, Endosulfans) Pesticides in Two-Year-Old Conifer Needles from WACAP Parks. Parks are ordered, left to right, from north to south along the Pacific Coast (DENA → SEKI), and from north to south in the Rocky Mountains (GLAC → BIBE). Current-use pesticides were not detected often in Alaska parks, comprised about one-third to one-half the total pesticide concentrations in northern Washington, and most of the pesticide burden elsewhere. Conifer needles were not sampled in NOAT and GAAR. Total pesticide burdens (current-use + historic-use) were highest in national parks of Washington, Oregon, California, and Montana.

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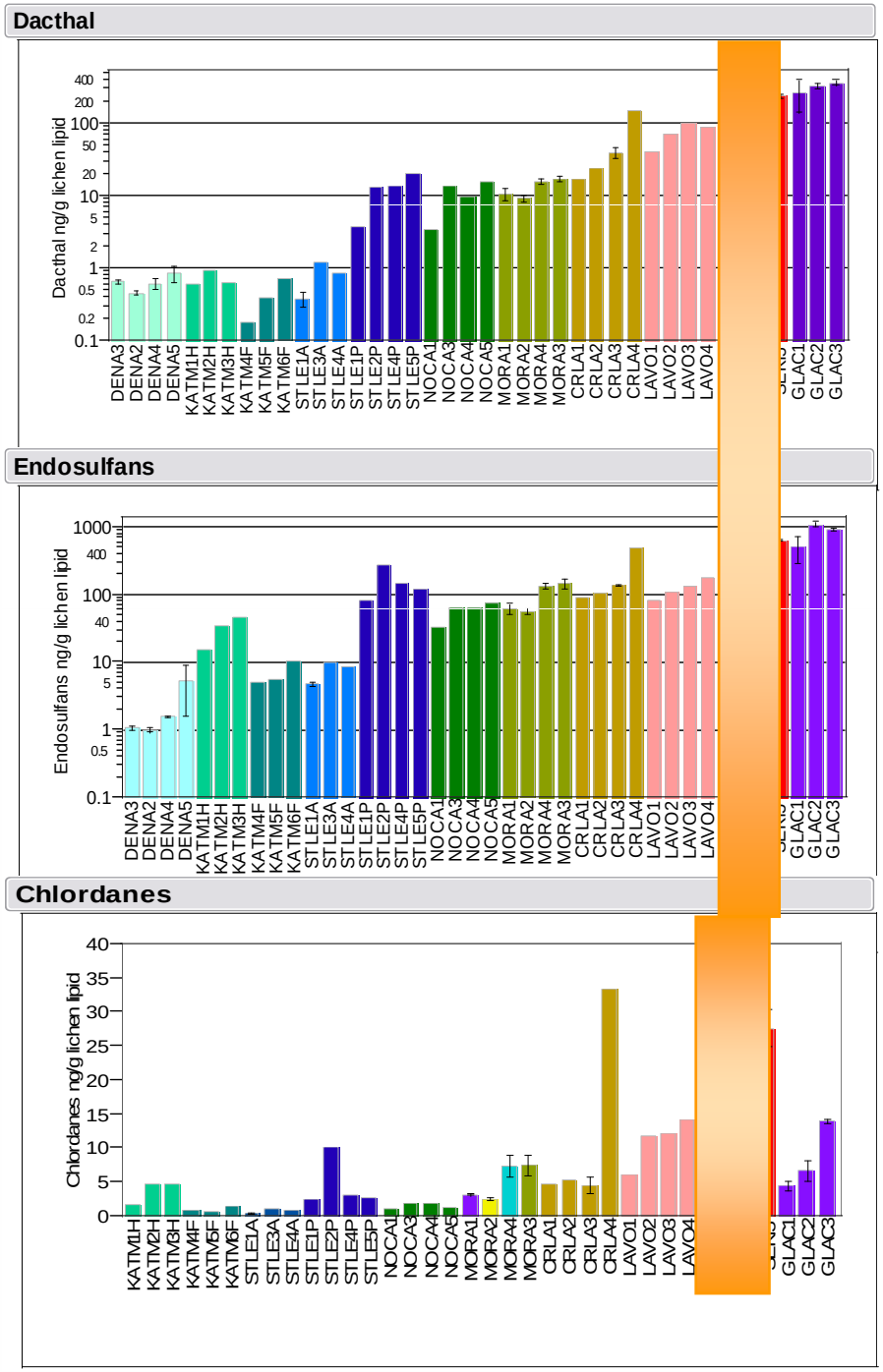

Lichens plotted by elevation within Parks

Figure 4-22. Elevational Gradients for Sum Dacthal, Sum Endosulfan, and Sum Chlordane Concentrations in Lichens. Within each park, sites are listed in order of increasing elevation. Codes H, F, A, and P refer to lichen species sampled (see Table 4-4). Bars show the standard error. Statistical analyses of elevational gradients are reported in Tables 4-3 and 4-4. Additional graphic displays for other SOCs are given in Appendix 4A.10. See Chapter 3 for data selection criteria for elevational trends analyses.