Toxics Loading Studies

Puget Sound Stormwater Monitoring Workshop

Puget Sound Partnership

Puget Sound Partnership
Toxics Loading Studies

- **Current situation: Wide variety of regulations related to toxic discharges, cleanup actions, source control. Disjointed, sparse data collection**
- **Goal: Develop a reduction strategy to prioritize enforcement and development of regulations, legislation, spending on cleanups, source control related to toxics**
- **Strategy: Develop necessary underlying information needed for toxics reduction strategy**
- **Three phases of studies**

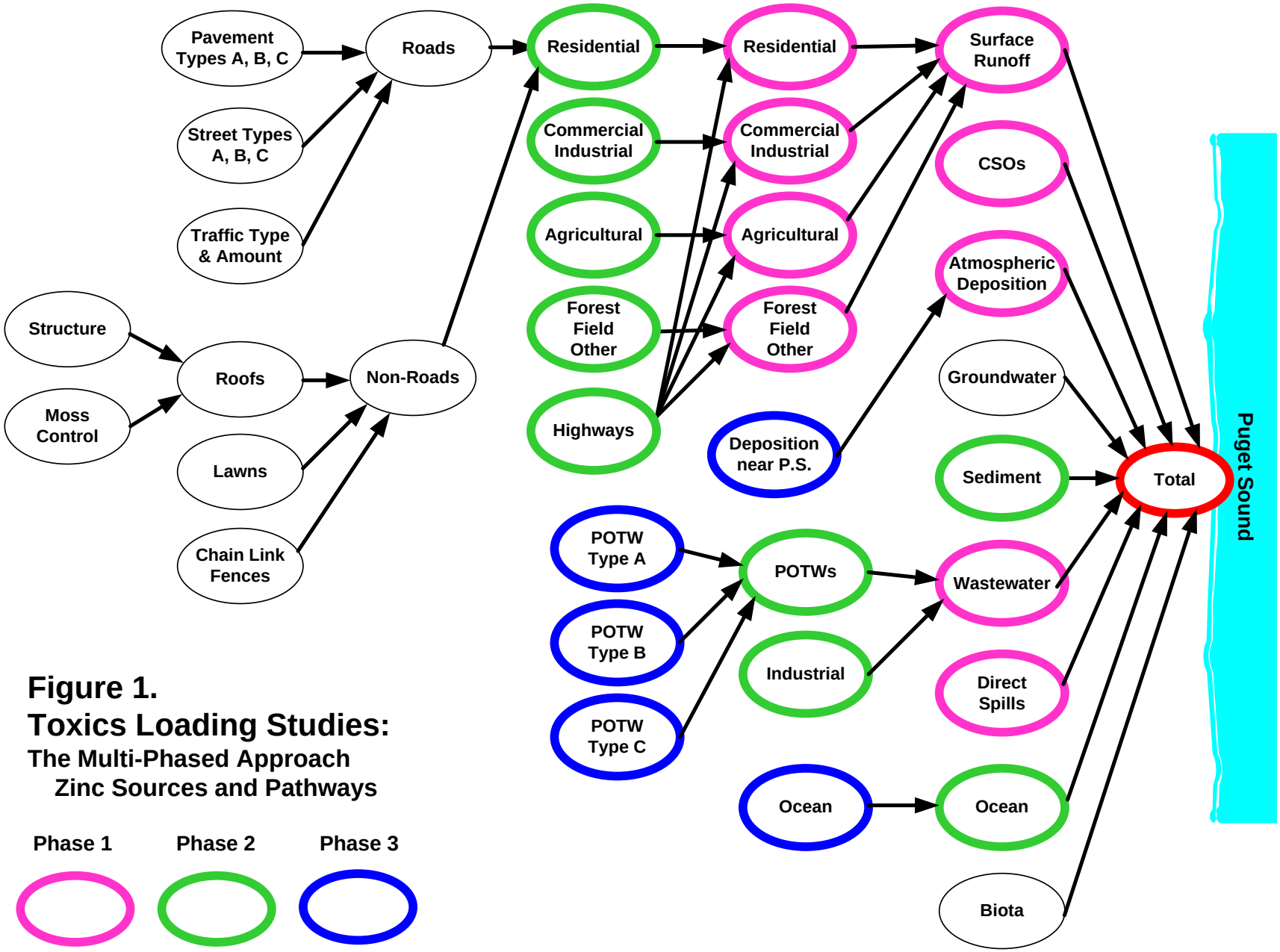


Figure 1.
Toxics Loading Studies:
The Multi-Phased Approach
Zinc Sources and Pathways

Known Harm or Possible Harm

- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Zinc
- Oil or Petroleum Products
- Total PCBs
- Total PBDEs
- Total Dioxins & Furans
- PAHs (H, L, c)
- BEHP
- Nonylphenol
- Triclopyr
- DDT

Phase 1 Toxic Chemical Loadings to Puget Sound

- **PSAT, Ecology, DoH, U.S.EPA**
- **U.S. EPA National Estuary Program (NEP) Grant: $135,000**

- **Goal: Begin quantifying toxics loads with existing data**

Phase 1 Outcomes

- First PSP results
- Broad participation in data sources and steering group
- Initial look at loadings and data gaps

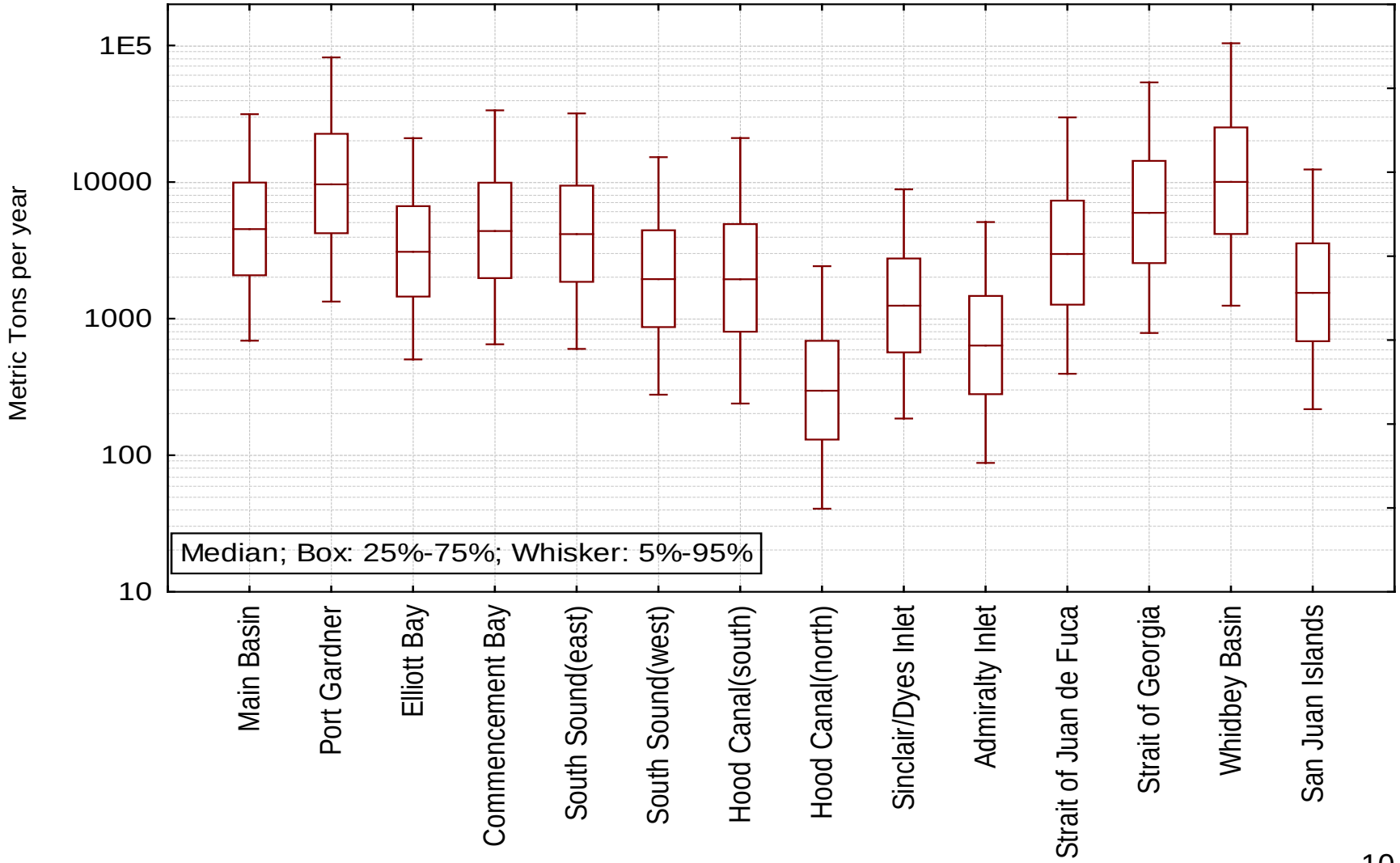
Phase 1 Findings

- **Data gaps abound**
  - **Some data don't interface well**
  - **Little to no data for some chemicals**
  - **Hydrology and regulatory data needs differ**
- **Surface runoff was the greatest loading source for most chemicals**
  - **Developed lands usually generated more runoff per unit area**
  - **Runoff from developed areas contained greater concentrations of toxic chemicals**
- **Air deposition**
  - **Loadings for most chemicals were a fraction of surface runoff**
  - **Loading rates for HPAHs, cPAHs, & PBDEs were comparable to surface runoff**

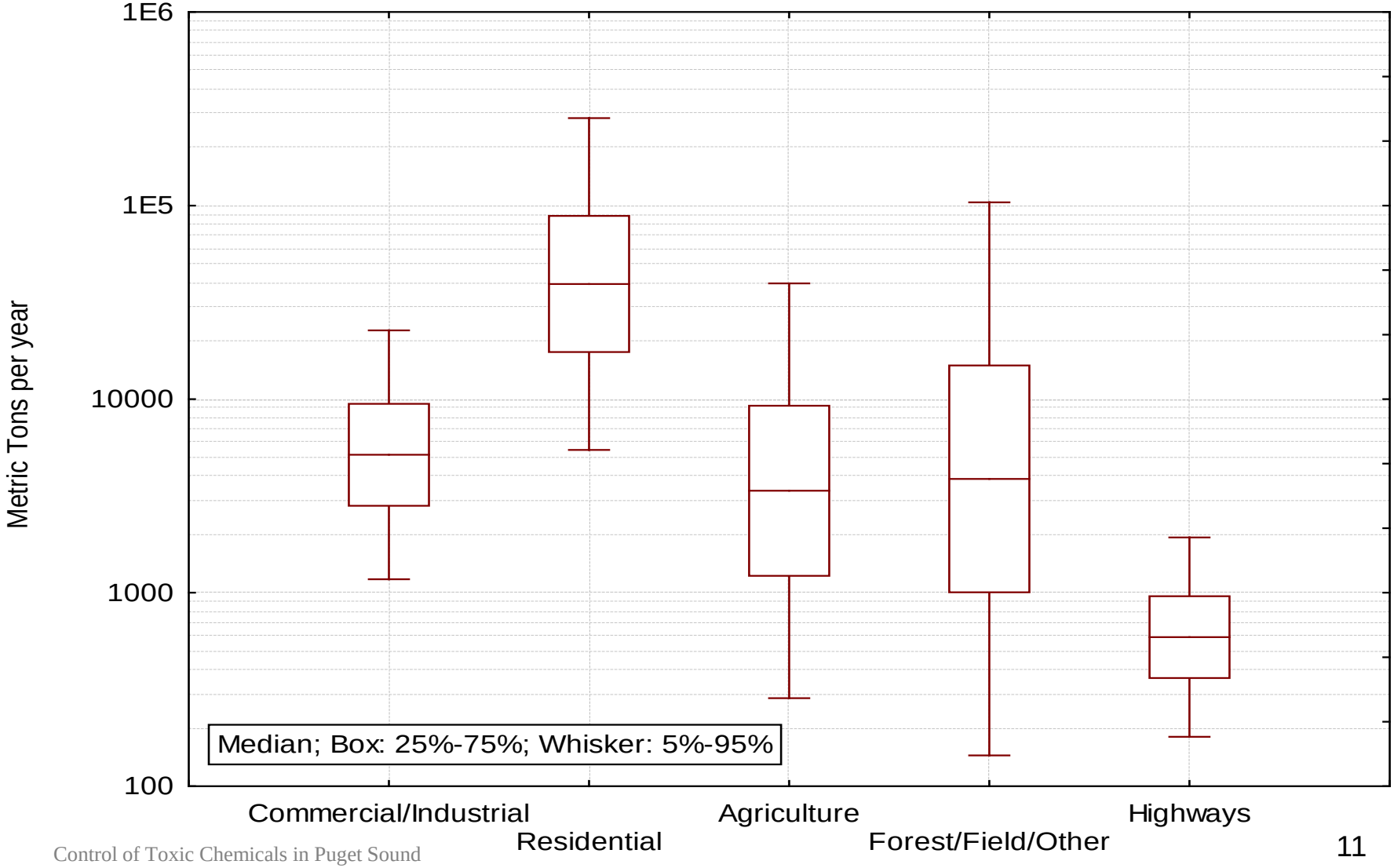
Phase 1 and Phase 2 Summary

	Metric Tons per Year	
	Total Loading	**Loading from Surface Runoff**
Metals	1,210 (555 – 2,900)	1,050 (508 – 2,230)
Oil & Petrol. Prods.	52,400 (22,900 – 123,000)	52,300 (22,900 – 123,000)
Other Organics	230 (68.7 – 840)	206 (56.0 – 779)

Oil & Petroleum Products



Oil & Petroleum Products



Phase 1 Findings (2)

- **Wastewater: municipal and industrial wastewater data were incomplete**
  - **Of over 1 million data points, only 5,770 matched pairs of flow and concentration were available**

- **CSOs: represented <1% of total loading**
  - **Concentrations of toxics similar to runoff from developed lands but had much lower flow rates and total flow**
  - **Did not evaluate localized impacts (e.g., Lower Duwamish)**

- **Direct oil spills**
  - **Loading represented 4% of that from runoff (Includes only oil & petroleum products)**

Phase 1 Recommendations

- **In filling the data gaps:**
  - **Search agencies' existing sources**
  - **Conduct more extensive literature searches**
  - **Extrapolate from existing data**
  - **Collect and analyze new environmental data**
- **Conduct further study to:**
  - **Estimate contributions from:**
    - **Sediment**
    - **Ocean Input**
    - **Biota**
  - **Evaluate specific chemicals and pathways:**
    - **Phthalates**
    - **PAHs**
    - **PCBs**
    - **Hormone disrupters**
    - **PBDEs**

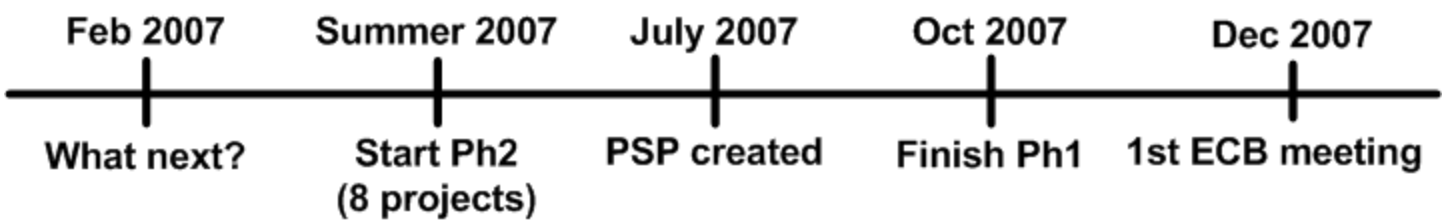
Phase 1 Recommendations (2)

- Quantify contributions from industrial and municipal wastewater
- Improve surface runoff loadings based on land use
  - Paved surfaces and other land uses
- Develop and test regional air pollutant transport models

- Use a mass balance (model) approach to:
  - Assess whether load estimates are consistent and realistic
  - Evaluate contaminant fate:
    - Degradation
    - Transformation
  - Predict effects of reductions to loadings

Phase 2 Toxic Chemical Loadings to Puget Sound

- **Refine Phase 1, still existing information, more time**
- **Series of projects**



Phase 2 Studies

A. Roadways & Surface Runoff
B. Wastewater Dischargers
C. Assess Sediment to Biota Transfer
D. Ocean Boundary
E. Box Model
F. Develop Toxics Biological Observing System

Phase 2 Conclusions & Recommendations

- **Ocean Flux**
  - **Conclusions**
    - **Most usable data (15,000 records) were for metals (mostly KC)**
    - **Limited or no data existed for organics**
  - **Recommendation**
    - **Collect samples for analyses of organics (and some metals) from the Straits of Juan de Fuca and Georgia**
- **Sediment**
  - **Conclusions**
    - **Insufficient data for sediment-to-water calculation**
    - **Sediment-to-food web bioaccumulation model verified**
  - **Recommendation**
    - **Assess sediment-to-water exchange of toxics with new data**

Phase 2 Conclusions & Recommendations

- **Roadways**
  - **Conclusions**
    - **Unit Loading $_{C / I, Hwy}$ was High, but Total Loading $_{C / I, Hwy}$ was Low**
    - **Loading $_{Resid}$ was largest source of toxics**
  - **Recommendations**
    - **Collect empirical Puget Sound-specific data**
    - **Collect empirical data for specific toxic chemicals**
- **Priority Pollutants**
  - **Conclusions**
    - **Discharge flow more important than concentration**
    - **"ND" results created most of the loading uncertainty**
  - **Recommendations**
    - **Require lower analytical reporting limits**
    - **Collect samples paired with measured flow rates**

Phase 3 Toxic Chemical Loadings to Puget Sound

- **Fill data gaps with field studies**
- **Goal: reduction strategy**

Phase 3 Projects

- 17 Proposed Projects
- 11 Received Funding (2 only for half)

  1 Project Split; 1 Project Merged

  Plus 1 Project Funded by WA Legislature

U.S. EPA 2008 NEP Grant	$1,983,800
U.S. EPA	$ 30,000
U.S. EPA (NOAA / USFWS)	$ 475,000
Washington Legislature (PSP)	$ 310,000

- Project Leads: Ecology U.S. EPA WDFW NOAA U.S. FWS

Potential Phase 3 Projects (1 of 2)

- **Atmospheric deposition of toxics**
  (Ecology Air Quality Program, Batelle NW)
- **Sampling & analyses of surface runoff**
  (Ecology Water Quality Program)
- **Exchange between Puget Sound & Ocean**
  (Ecology Environmental Assessment Program)
- **Refine model and run simulations**
  (Ecology Environmental Assessment Program)
- **Analyze Priority Pollutants for small POTWs**
  (Ecology Water Quality Program)

Potential Phase 3 Projects (2 of 2)

- **Sampling & analyses of biota**
  (NOAA & USFWS)
  - Harbor seals
  - Marine mammal prey
  - Stormwater toxicity to salmonids
  - Plankton
- **Estimate PPCP input and removal by POTWs**
  (U.S. EPA & Ecology Env'l Assessment Program)

Phase 3 Year 2 Toxic Chemical Loadings to Puget Sound

- Action Agenda for guidance
- Remainder of U.S. EPA 2008 NEP Grant

Potential
Phase 3 Year 2 Projects

- Proposals submitted to U.S. EPA
- Proposed projects:
  - Air Deposition
  - Surface Runoff Complete Ocean Exchange
  - Link Sources to Puget Sound
  - Effects of Urban Stormwater on Salmon
  - Synthesis Report

Interagency Steering Committee

- **Limited to coordinating delivery of loading projects**
- **Toxics reduction strategy will require broader participation**

Steering Committee Members

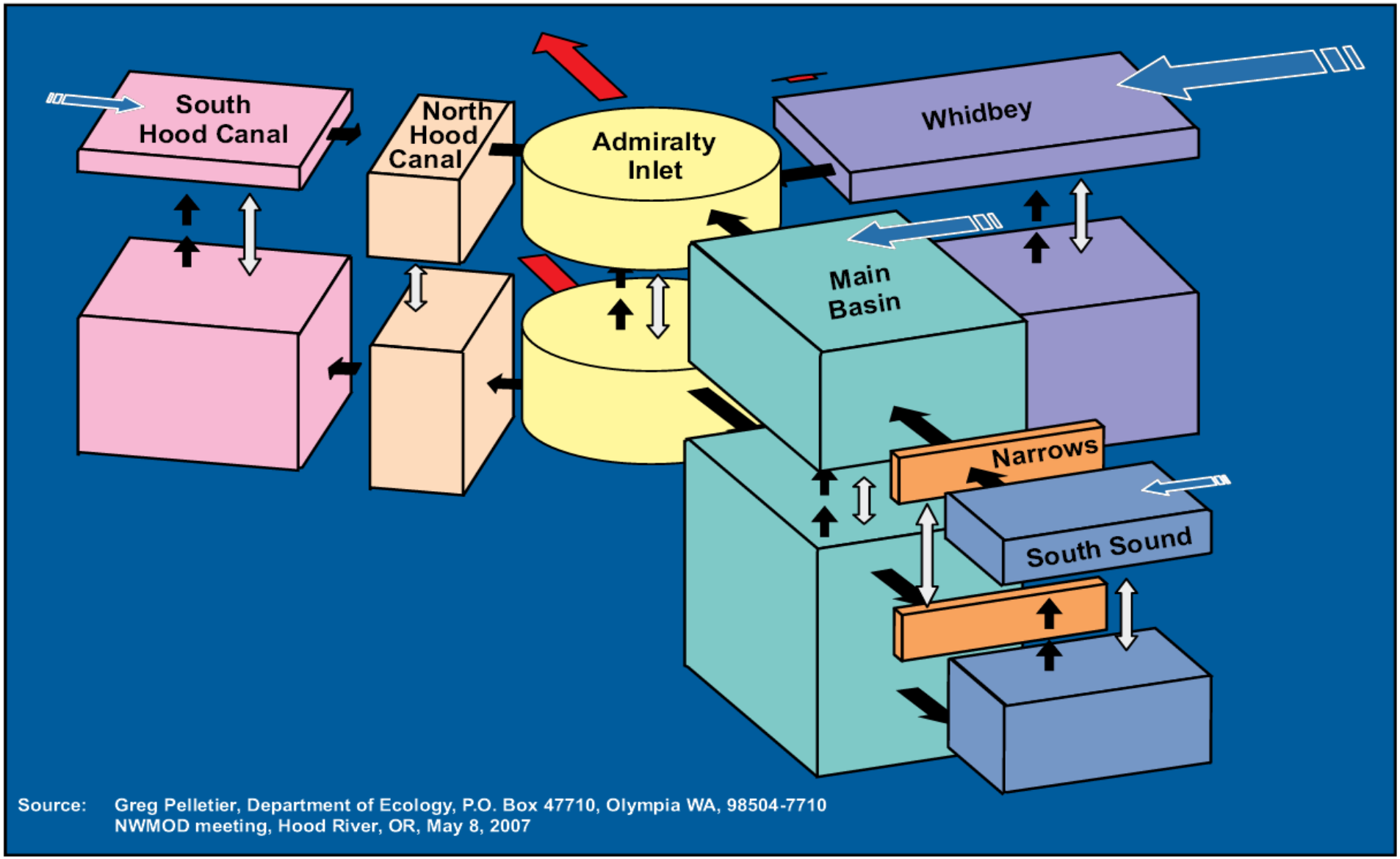
Ecology	**USEPA**
PSP Science Panel	
NOAA	**NMFS**
USGS	**WA Dept of Transportation**
WA Dept of Health	**Wa Dept of Ag**
US Fish and Wildlife	**Puget Sound Partnership**

More info ?

- **http://www.ecy.wa.gov/programs/wq/pstoxics/index.html**

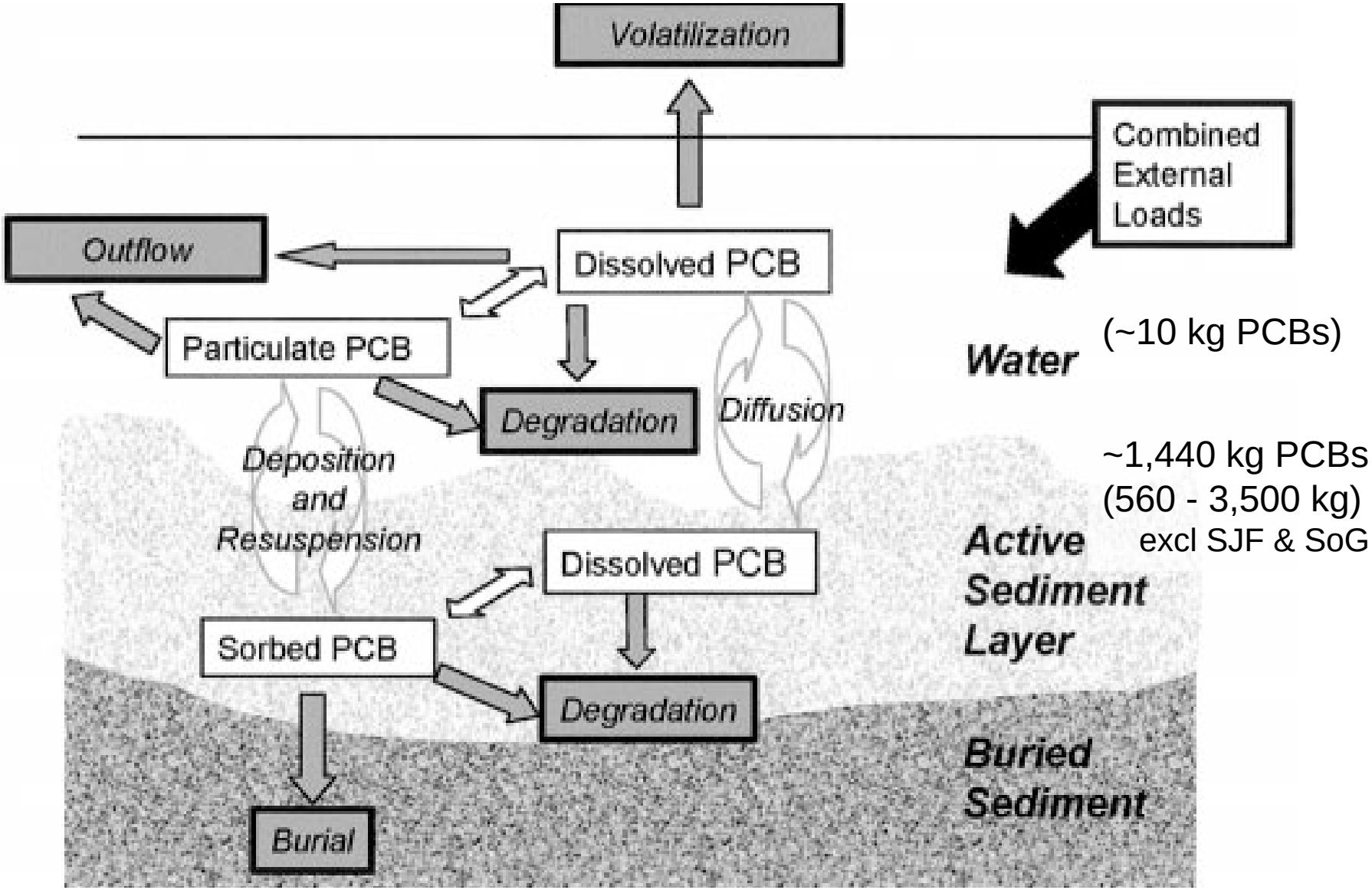
Ecology Box Model

Puget Sound Box Model for Analysis of Toxics and the Food Web



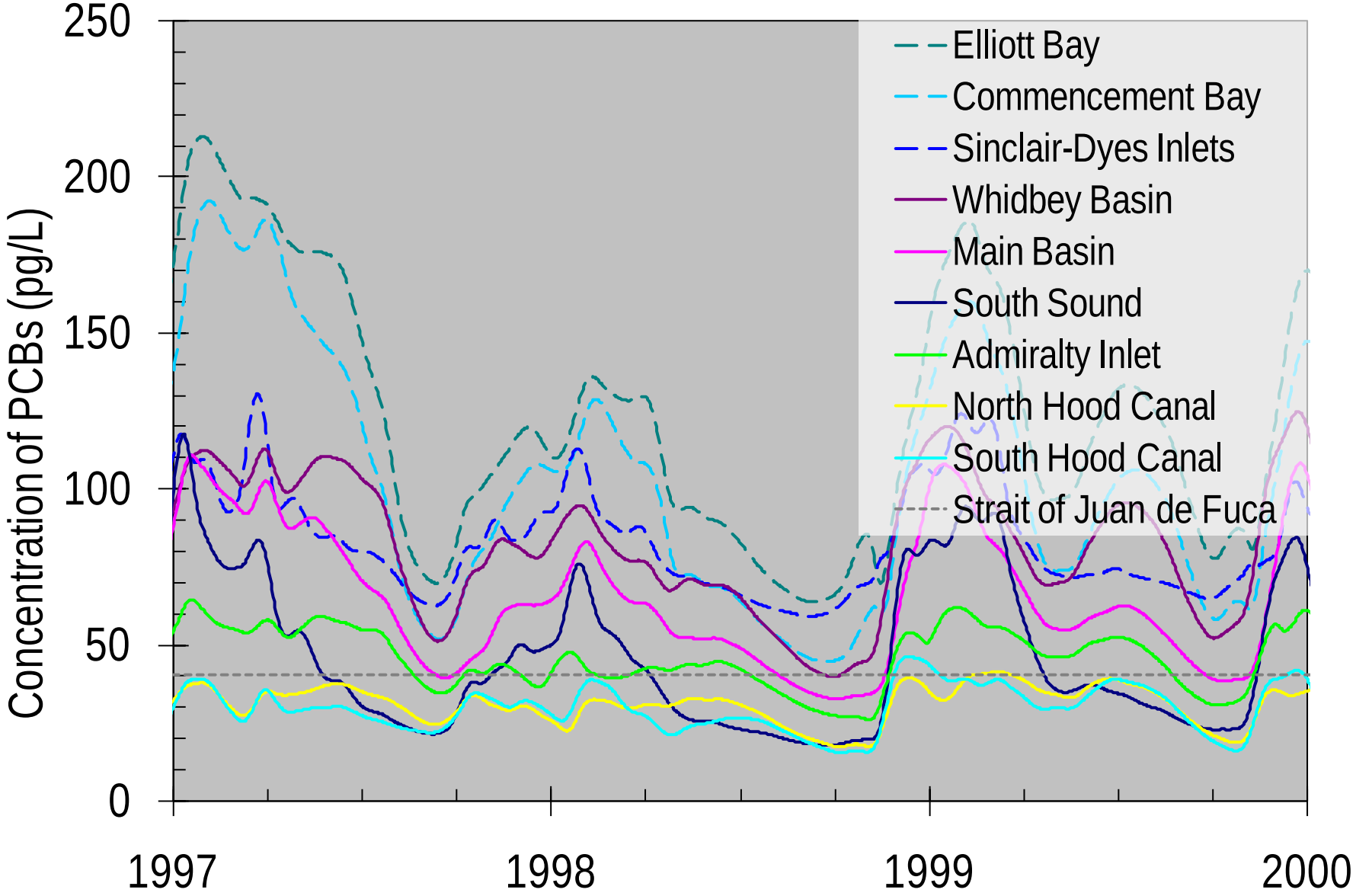
Source: Greg Pelletier, Department of Ecology, P.O. Box 47710, Olympia WA, 98504-7710
NWMOD meeting, Hood River, OR, May 8, 2007

Contaminant Model Kinetics by Davis 2004



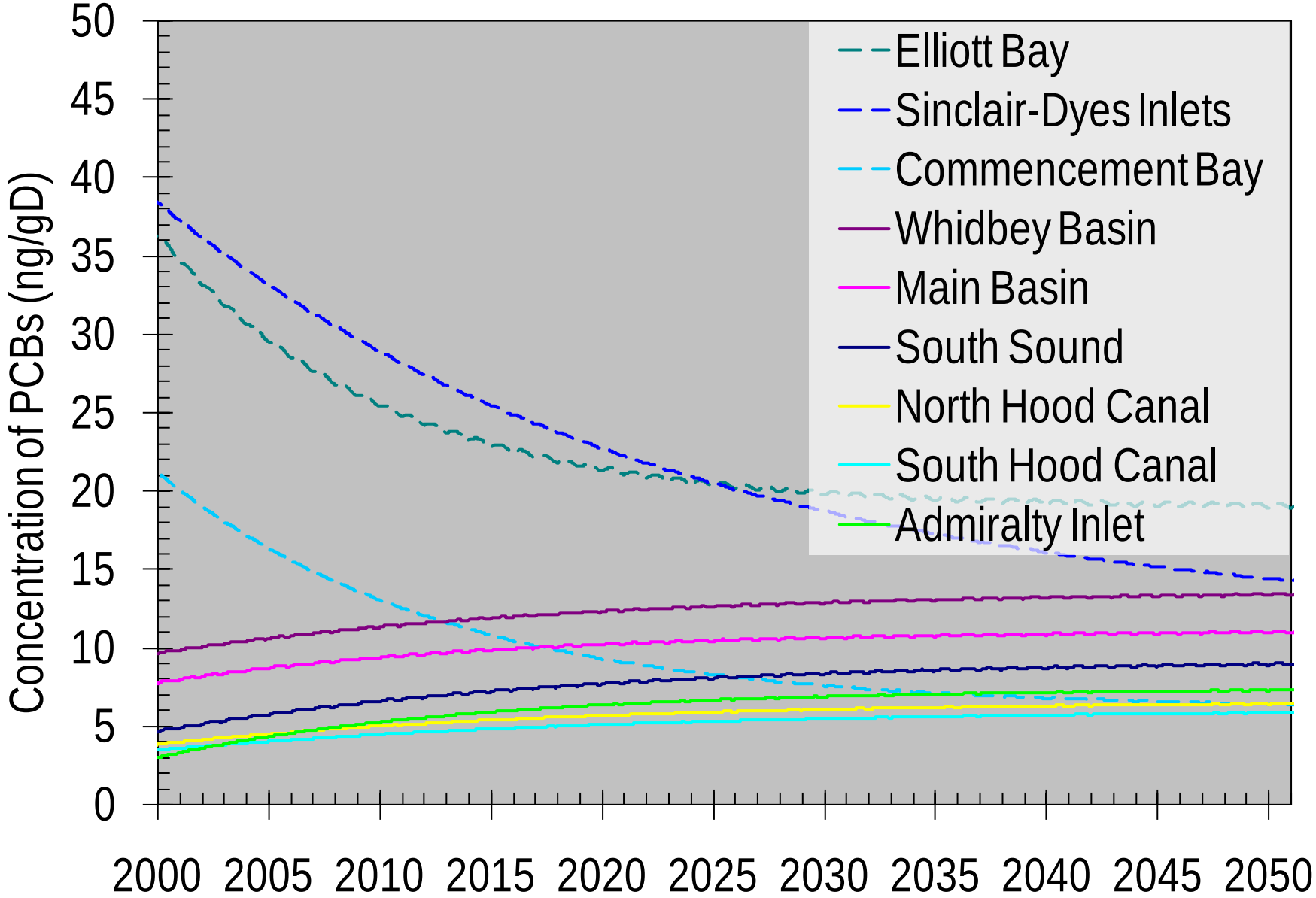
Davis, J.A. 2004. The long-term fate of polychlorinated biphenyls in San Francisco Bay (USA). Environmental Toxicology and Chemistry, Vol. 23, No. 10, pp. 2396-2409.

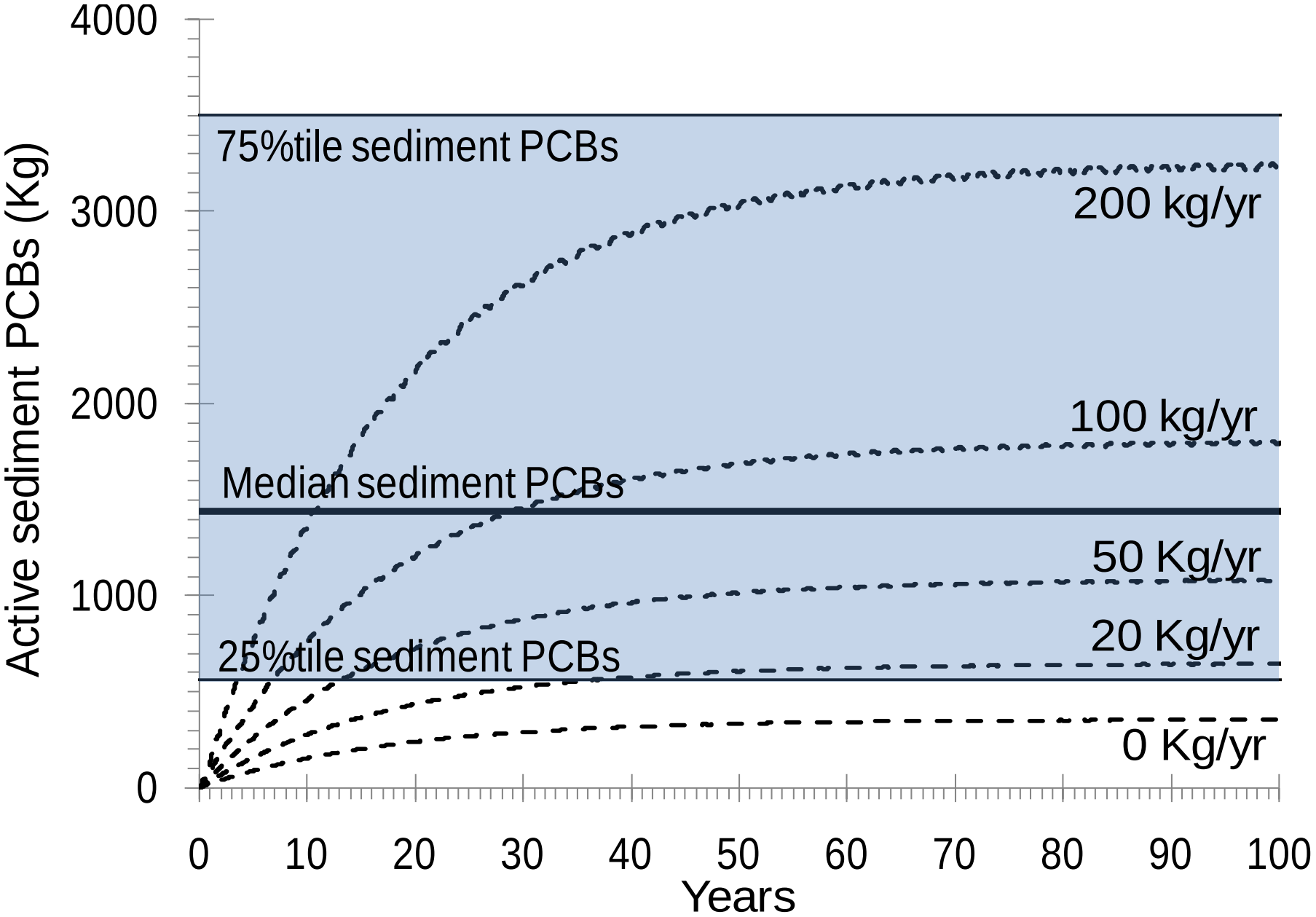
Concentration of PCBs in the Water Column



Elliot Bay: observed (2005): 125 +/- 41 pg/L; predicted: 120 +/- 41 pg/L

Concentration of PCBs in the Active Sediment Layer (top 10 cm)



- PCBs in the active sediment will reach steady state in 50-100 years
- Decreasing in the urban bays, increasing in the large basins

What is a plausible range of loading from the watershed?
About 20-200 Kg/year supports observed sediment PCBs.