



The Alaska Fisheries Science Center Auke Bay Laboratory

The Impacts of Two-stroke Gasoline Engines on Fish

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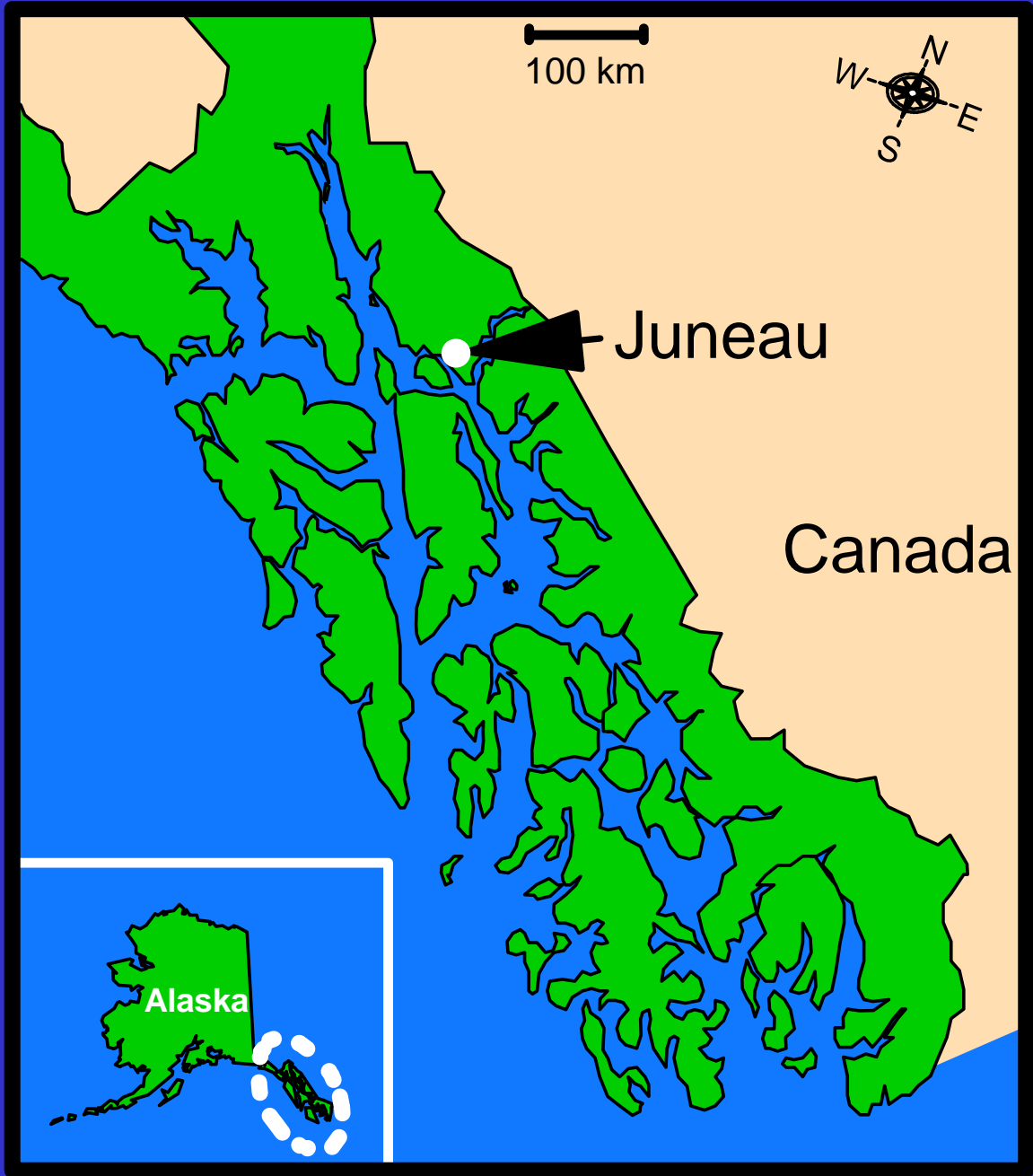
Recreational Boating

- 1 pleasure boat per person in U.S.
- Average use of jetski style craft is 77 hours
- Average for outboard motors is 35 hours

Two-stroke Engines

- Older engines are inefficient
- Can discharge 1/3 uncombusted
- Two-strokes discharge 2-200 million gallons per year

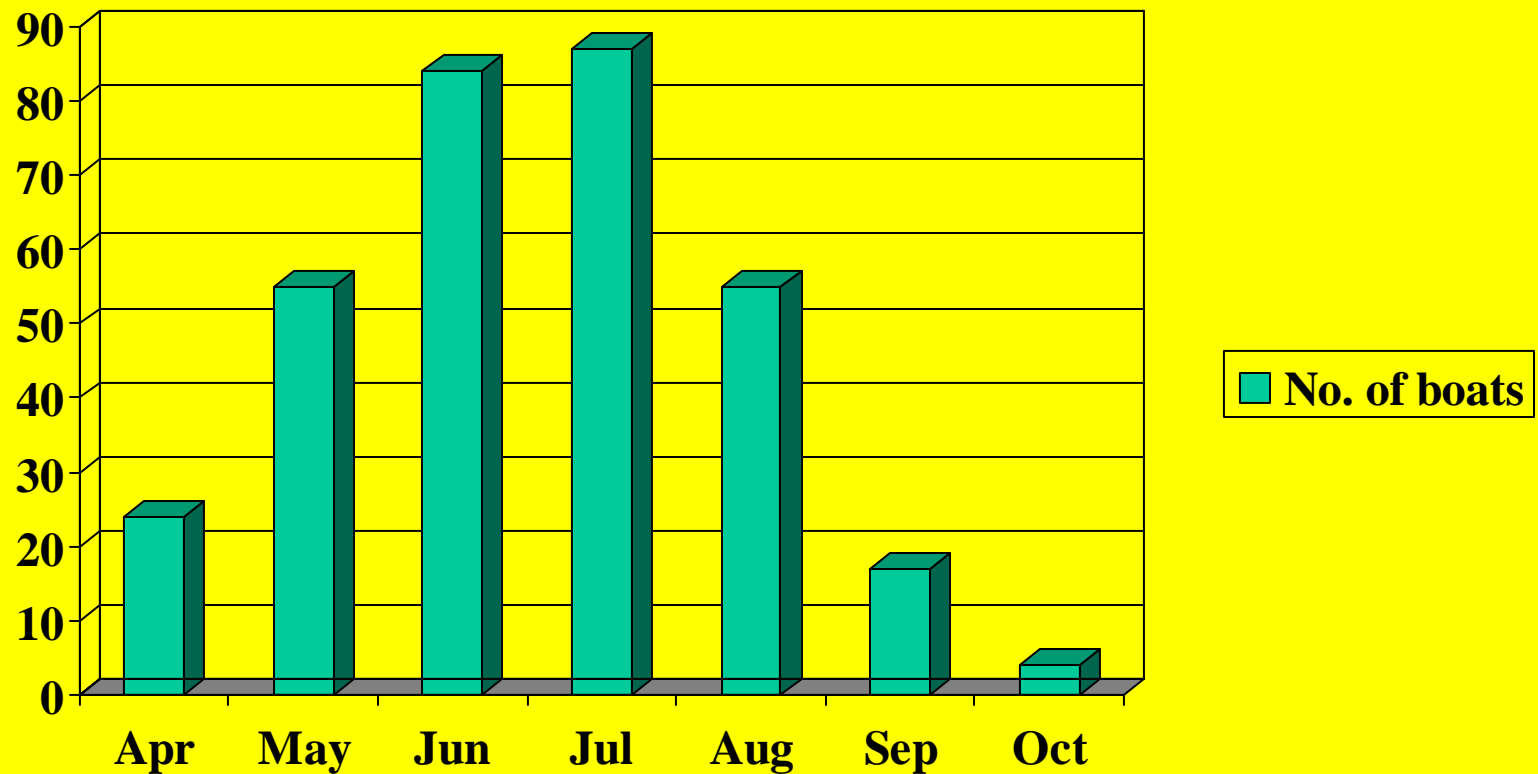




Auke Lake, Alaska

- Small (46 ha)
- 34 m deep
- Cold water
- Tannin stained
- 1103m X 410m
- 6 species of salmonids
- Used: Apr-Oct by motor craft

Boat Use on Auke Lake, 2003



Polycyclic Aromatic Hydrocarbon (PAH) research in Auke Lake

Passive samplers (plastic strips)

Integrate over time (21-30 days)

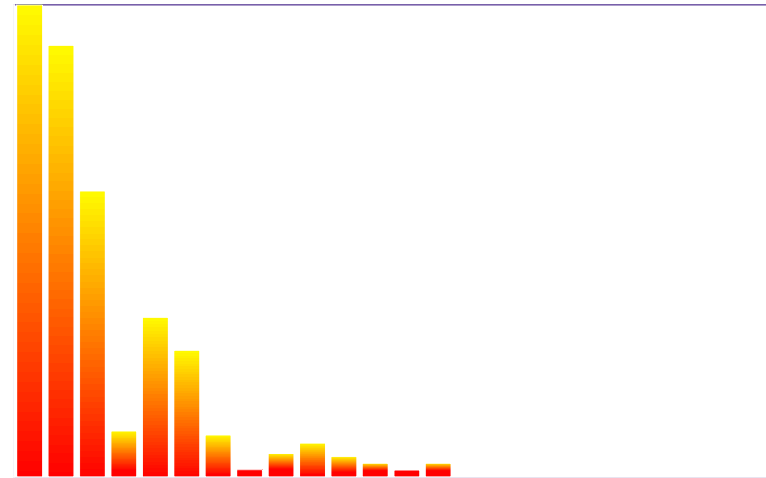
Very sensitive

- Seasonal inputs**
- Recreational use or urban run off**
- Spatial trends**
- Fingerprint sources**

What are PAH and Why Focus on Them?

Paradigm Shift in Ecotoxicity

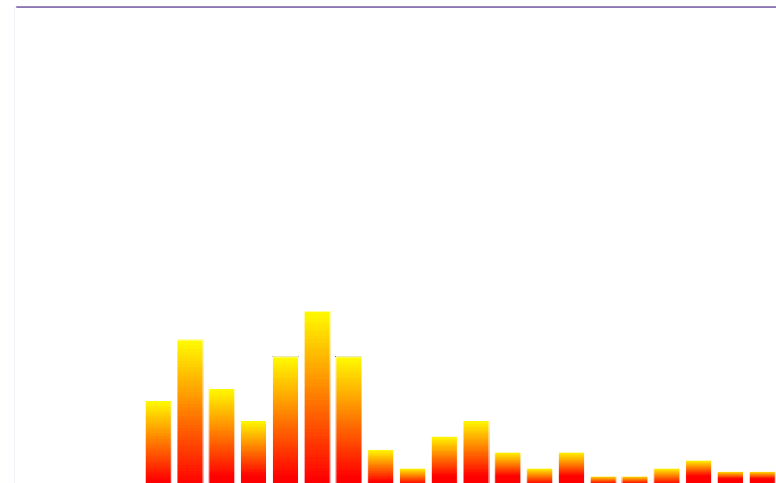
1 ppM



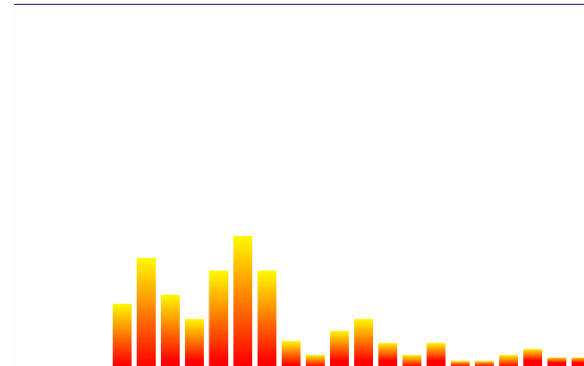
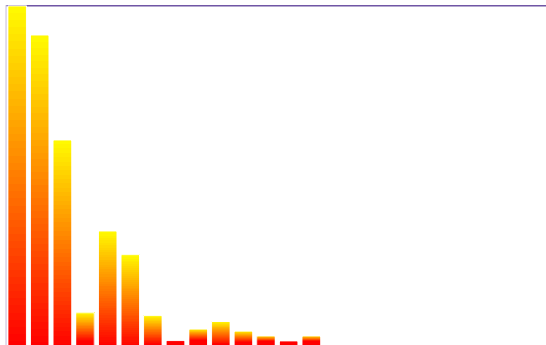
1990s:

3-5 PAH rings

effects = 1-20 ppB

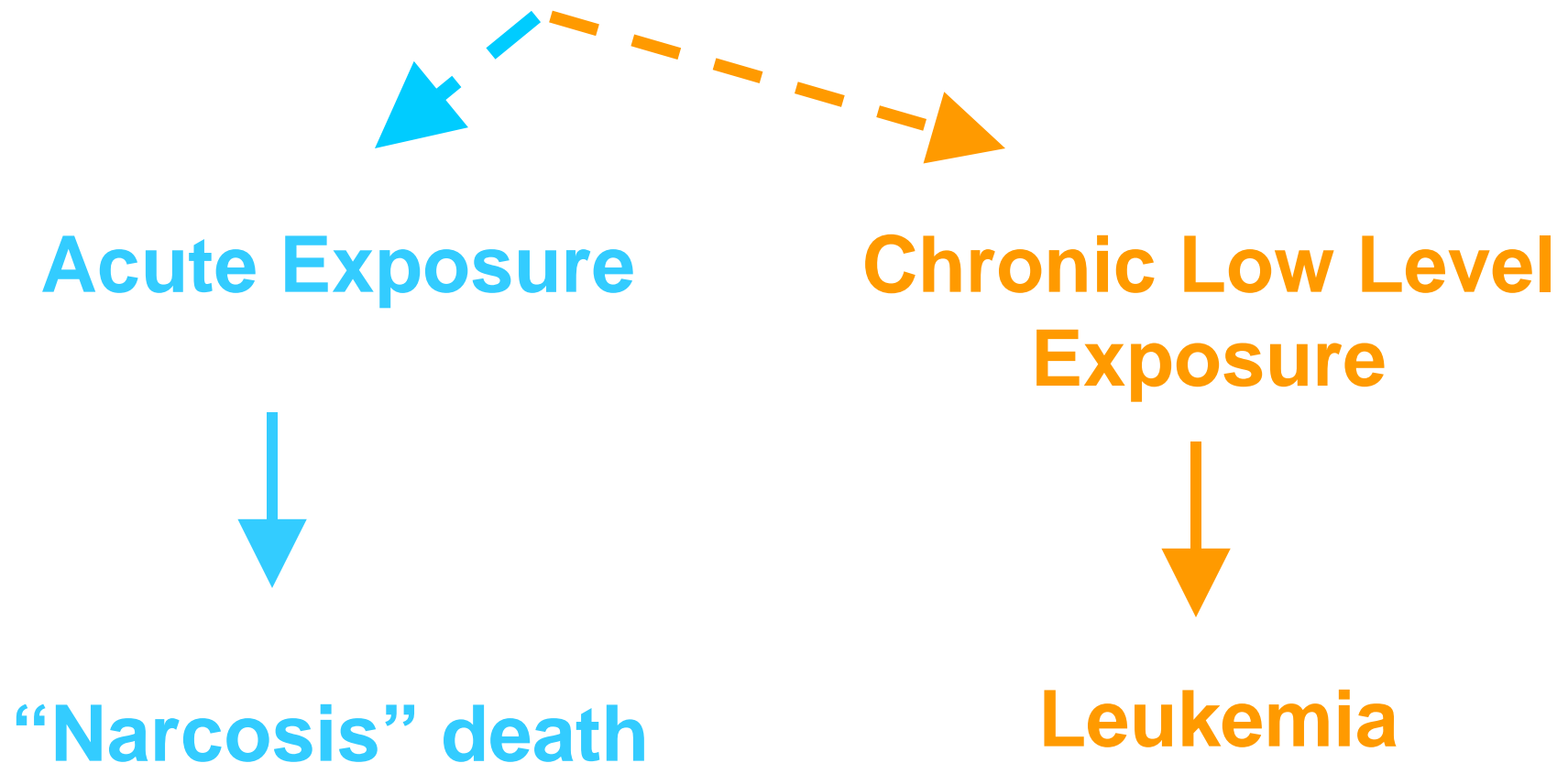


Different Toxic Mechanisms – from Different Toxic Compounds



Different Toxic Mechanisms -

Benzene



Why Passive Samplers?

**3-4 ring hydrocarbons; pesticides;
PCBs**

Integrated sampling over time

Hot spots; Intermittent inputs

Low concentrations

Seasonal Trends

Passive vs Grab Samples

- Integrates over time
- Easily deployed
- No chemicals
- Cover entire time
- Sensitive (ppb)
- Combines all sources
- Standards don't apply

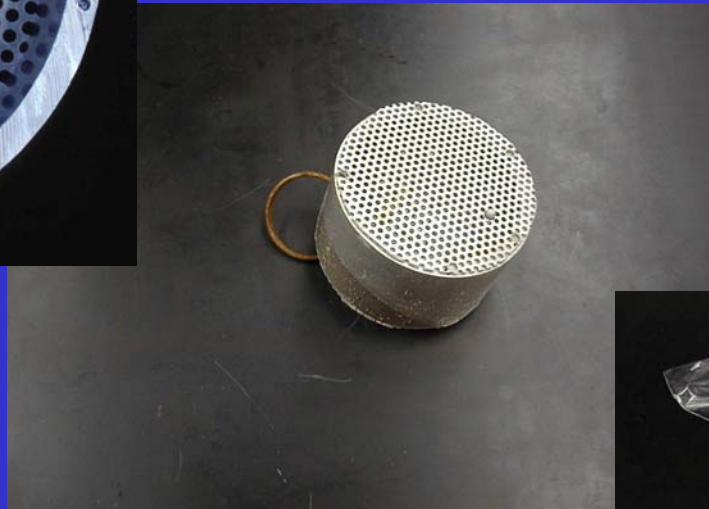
One time only
Sampling gear needed
Chemicals
Covers 1 time only
Crude (ppm)
Fingerprint source
Match State Standards



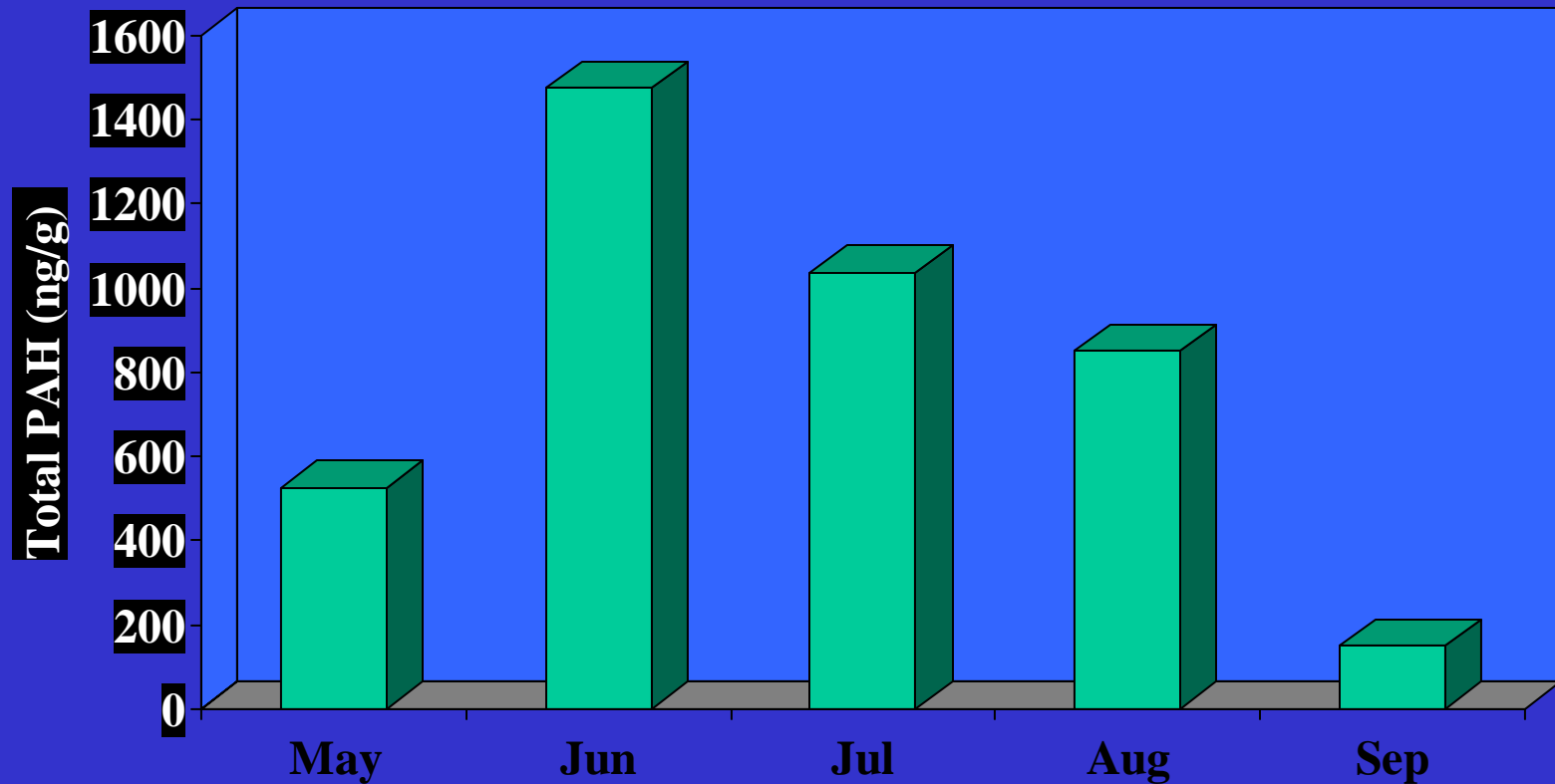
Bioavailability of Lingering Oil: PEMD Deployment and Retrieval



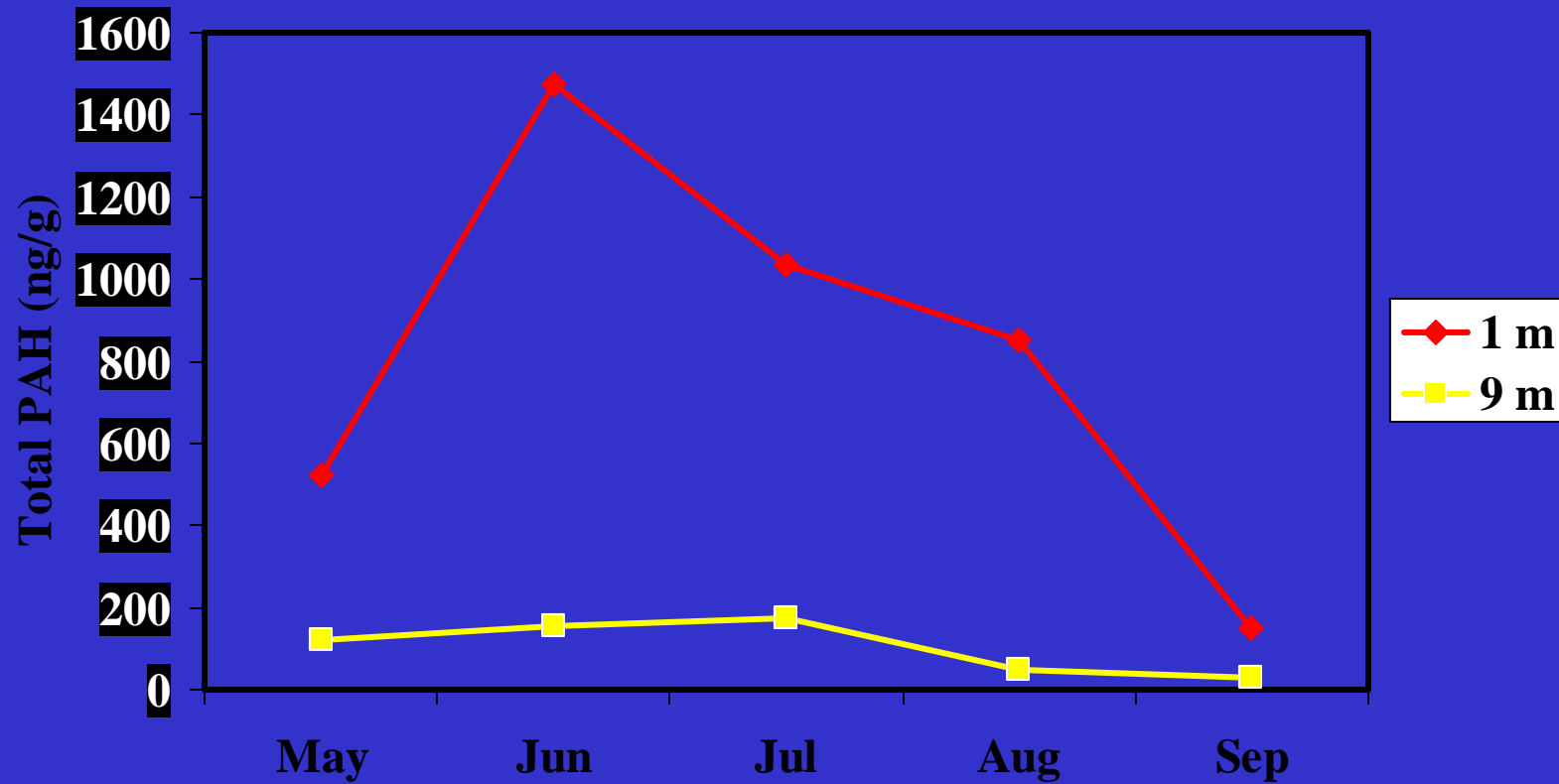
Polyethylene Membrane Device: PEMD



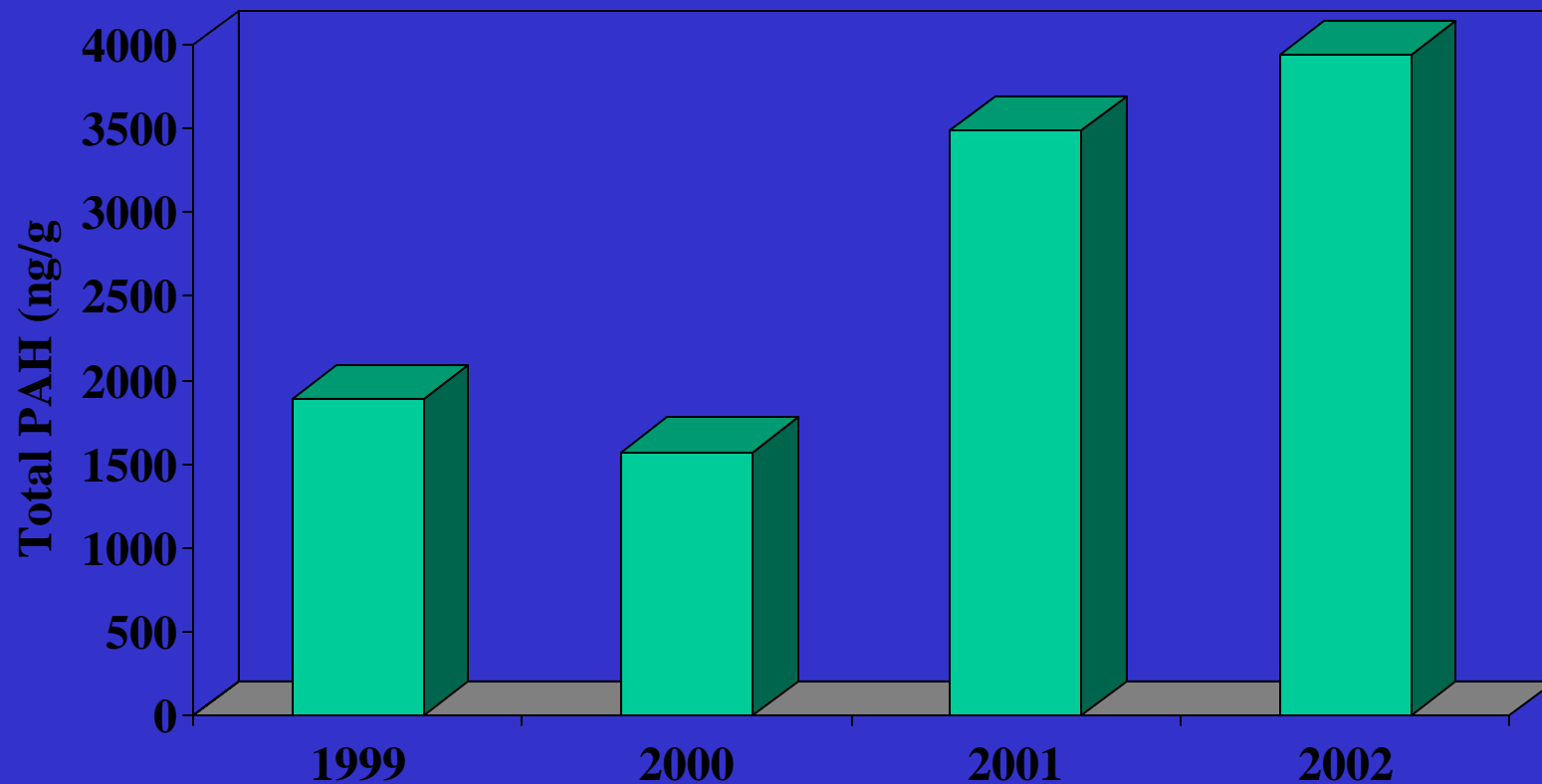
Seasonal Changes in PAH



PAH at two Depths

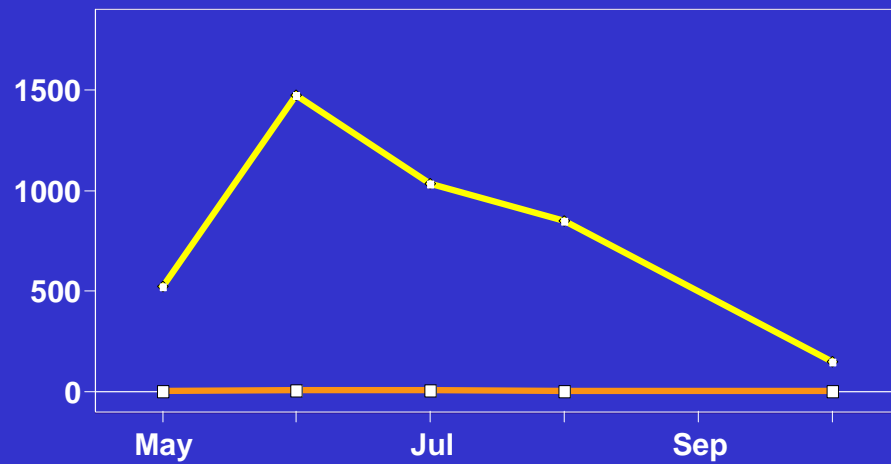


Interannual Variation in PAH

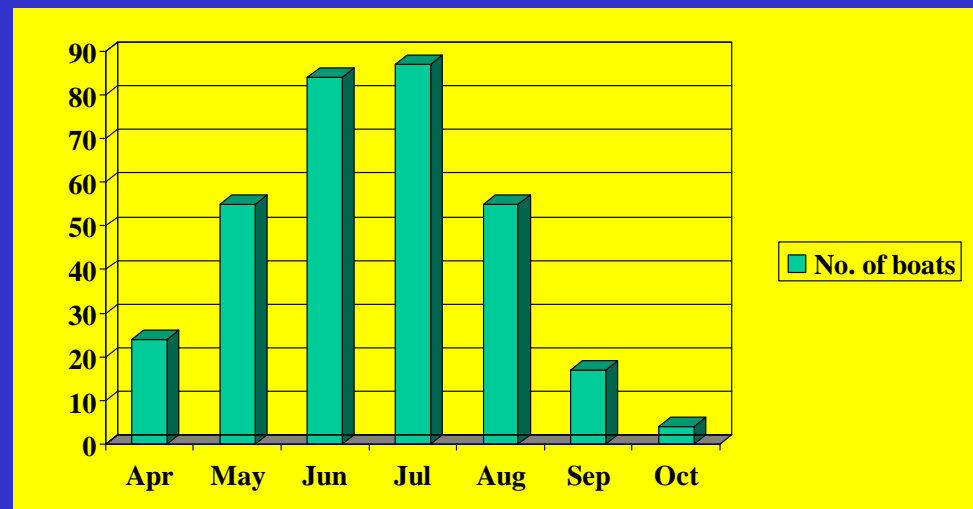


Boat Use and PAH

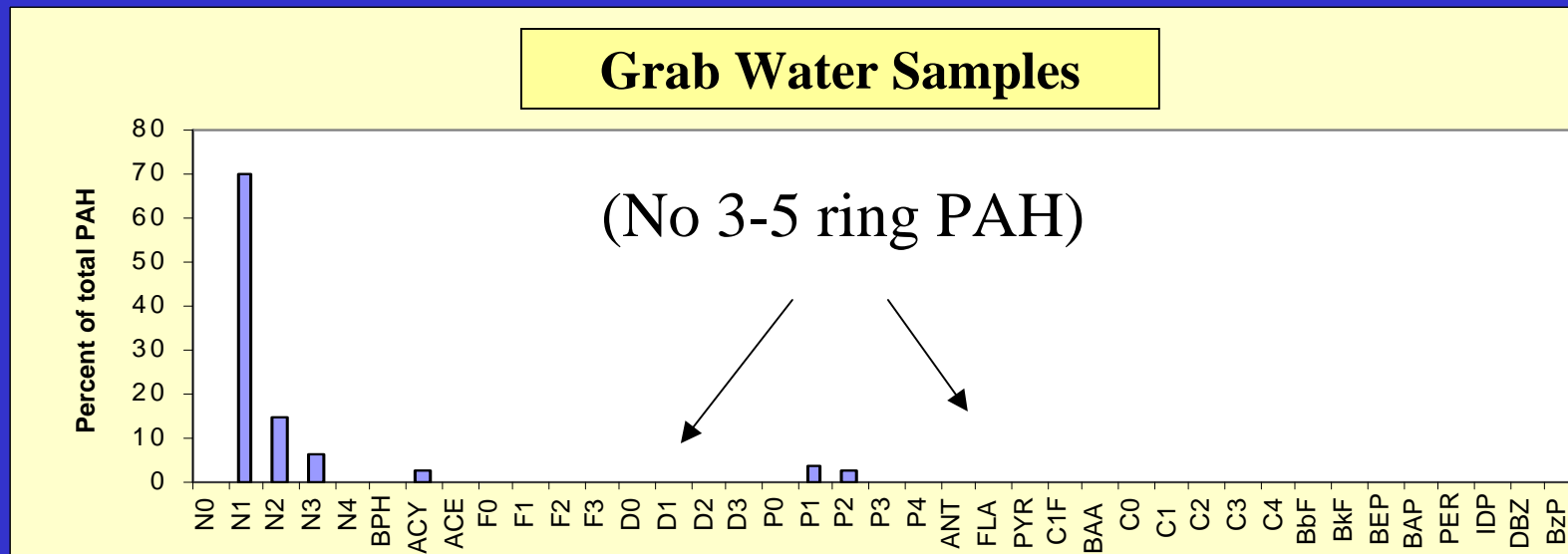
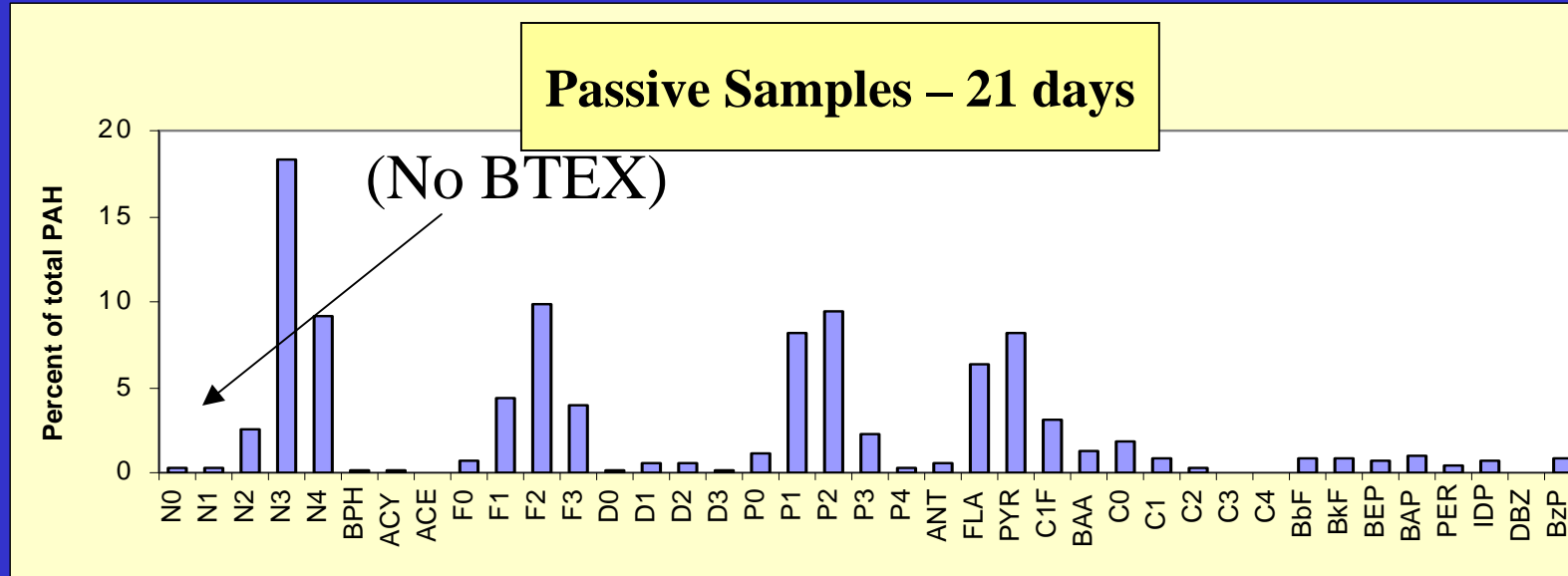
Total PAH (ng/g)



No. of boats



PAH Profiles from Auke Lake



Different Compositions

Different Sources

Urban vs Atmospheric inputs

Gasoline vs Fuel Oil

Combustion vs Spill

Potential Sources of PAH in Auke Lake

- Recreational Use (PWC, motor boats, floatplanes)
- Highway Runoff
- Residential Runoff
- Wood Smoke

Conclusions

- Personal Watercraft are correlated with seasonal increases in PAH
- PAH are very toxic
- Most PAH were in the top meter
- Passive samplers successfully monitor changes in PAH
- Goal: Replace 2 stroke with 4 stroke engines