Air Toxics Around a Pulp and Paper Mill

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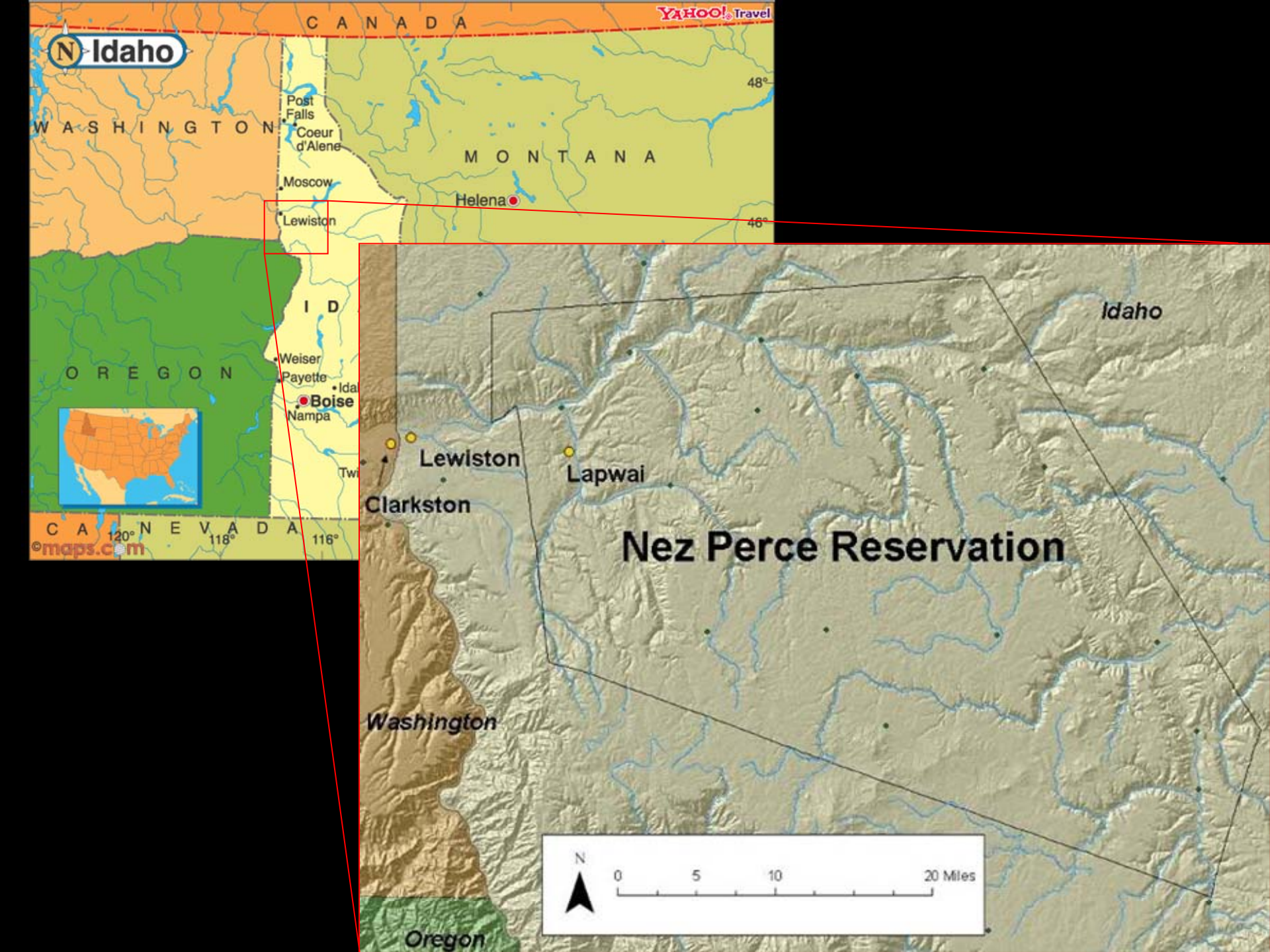
Study Objectives

- Characterization of air toxics concentrations in Lewiston, Idaho, and nearby Nez Perce Reservation
  - Assessment of spatial pattern and gradient in toxics concentrations (especially around a pulp and paper mill)
  - Assessment of the mill's contribution to air toxics concentrations in the valley
  - A picture of spatial patterns of air toxics concentrations
  - *Prediction of concentrations in areas without monitors*
- *Dispersion modeling* *(sub-objectives not listed)*
- Characterization of air toxics risk with a focus on the risk from pulp and paper mill emissions

Note: Objectives highlighted in green were not a focus of STI's analysis.


CANADA
YAHOO! Travel
N Idaho
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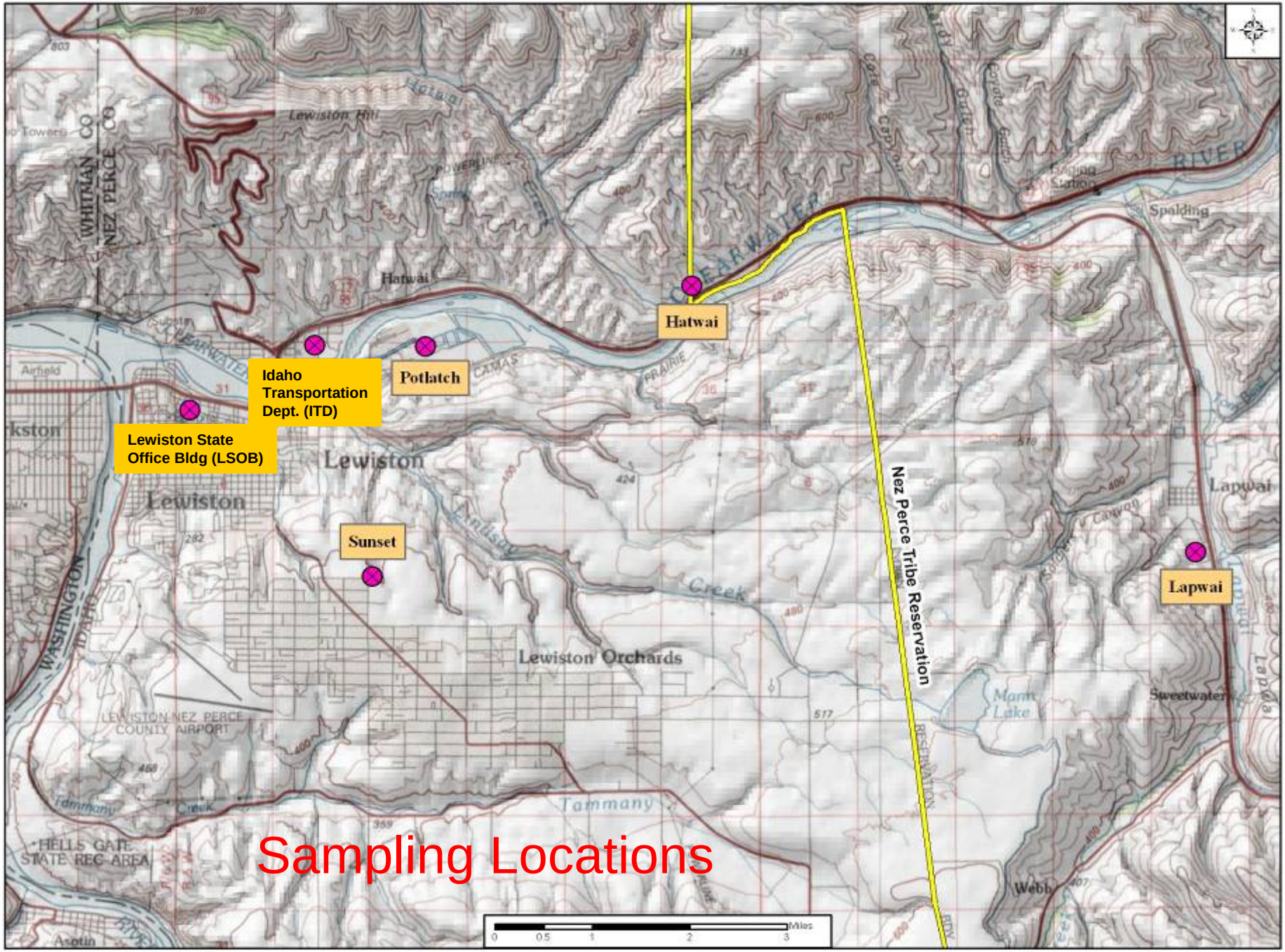

Hatwai
Idaho Transportation Dept. (ITD)
Potlatch
Lewiston State Office Bldg (LSOB)
Sunset
Lapwai
Nez Perce Tribe Reservation
Lewiston
Lewiston Orchards
Spalding
Sweetwater
Webb
Sampling Locations

View from Lewiston Hill to the south over Lewiston, ID, and Clarkston, WA

Mill

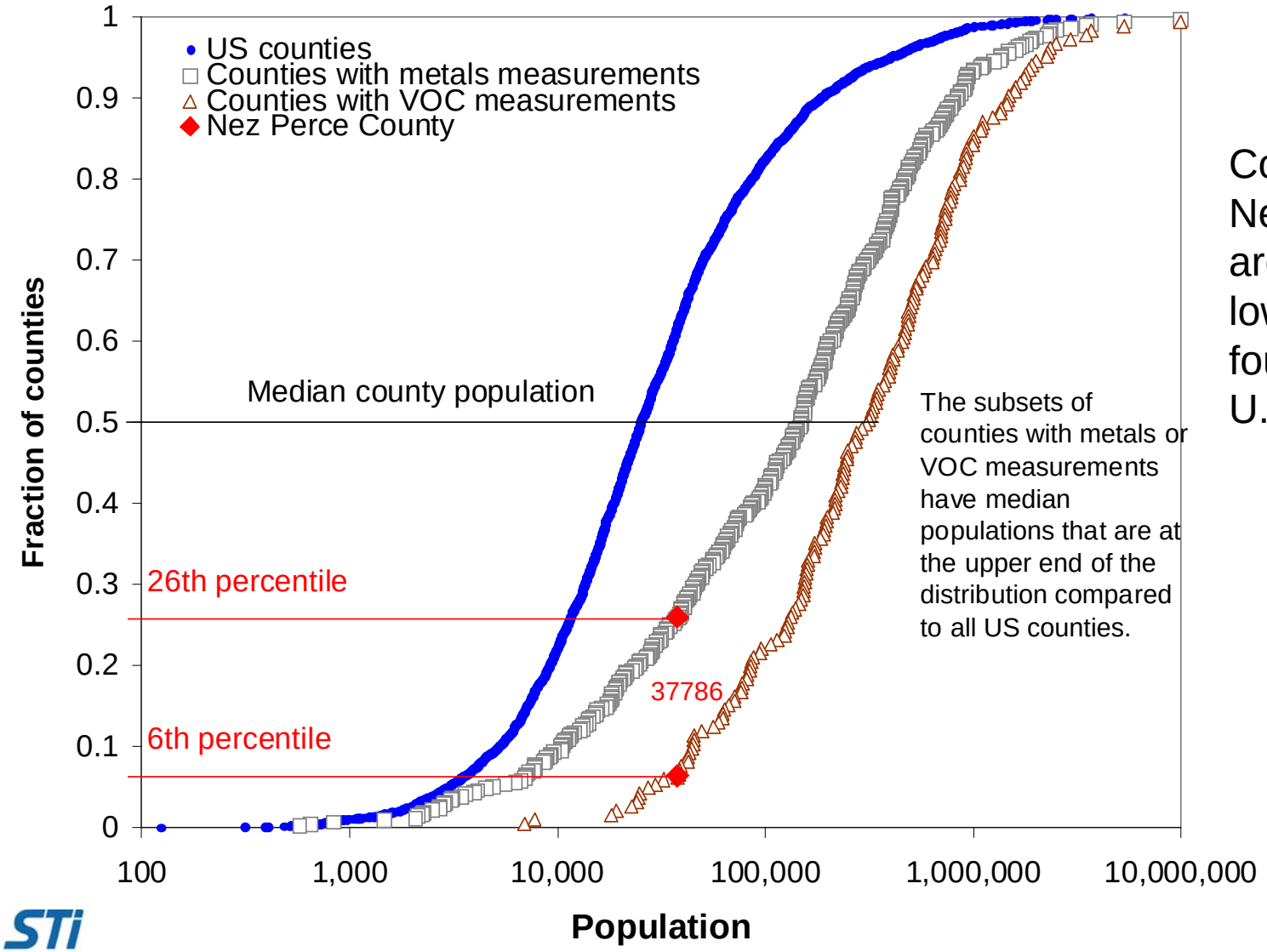
Clearwater River

Snake River

Conceptual Model

- We can identify the pulp and paper mill influence on air toxics concentrations through a combination of
  - Spatial analysis—a clear spatial gradient in air toxics concentrations is expected.
  - Temporal analysis—mill emissions will result in higher concentrations in winter (lower mixing heights and wind speeds).
  - Chemical analysis—distinct “fingerprints” of air toxics will reveal emissions sources (e.g., the mill vs. motor vehicles).
- Concentrations of most air toxics will be low compared to those monitored in other parts of the United States because of the area’s less dense population.
- A large fraction of toxics risk will originate from background air.

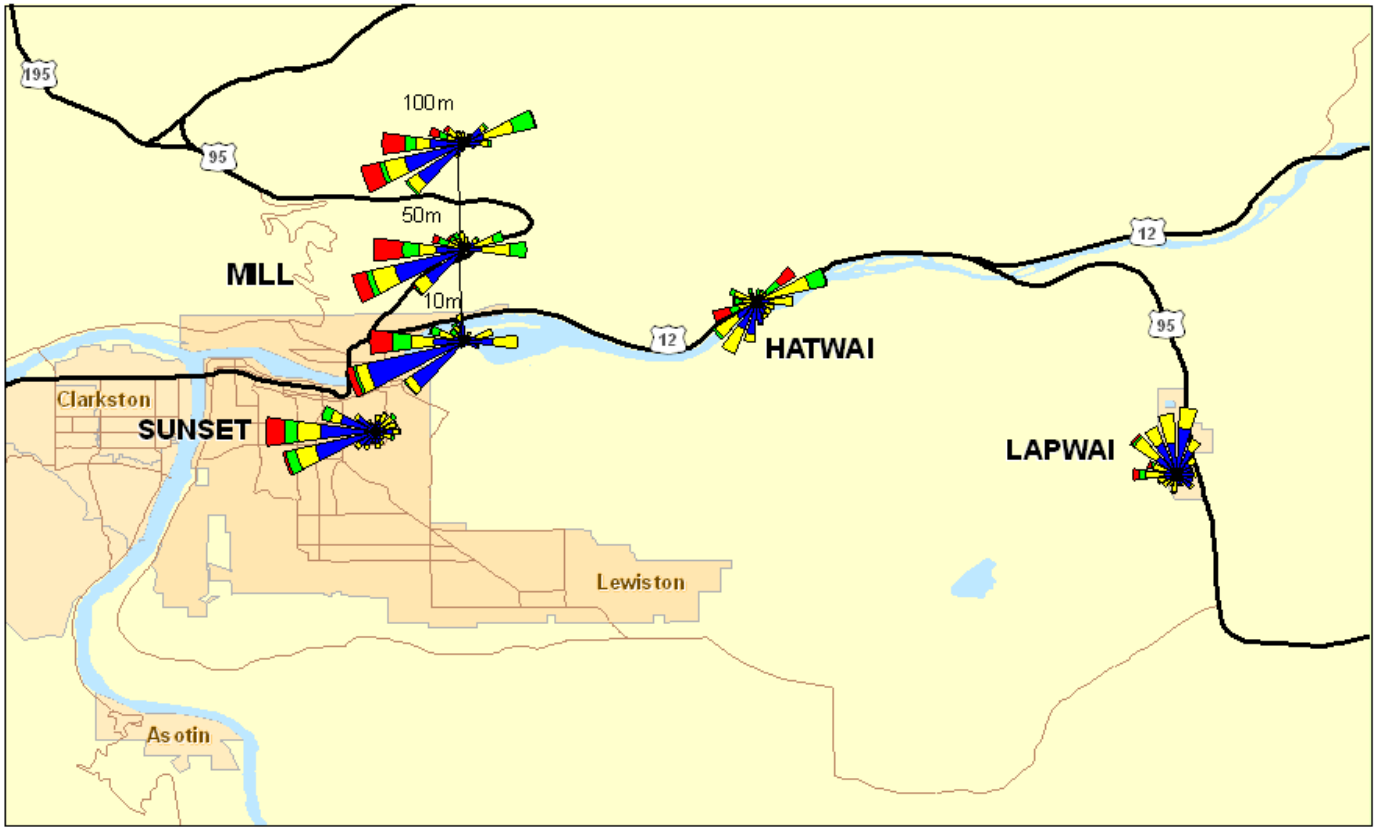
Nez Perce County Demographic Comparison



Concentrations in Nez Perce County are expected to be lower than those found in other U.S. data.

Daytime Wind Roses (9 a.m. to 5 p.m.)

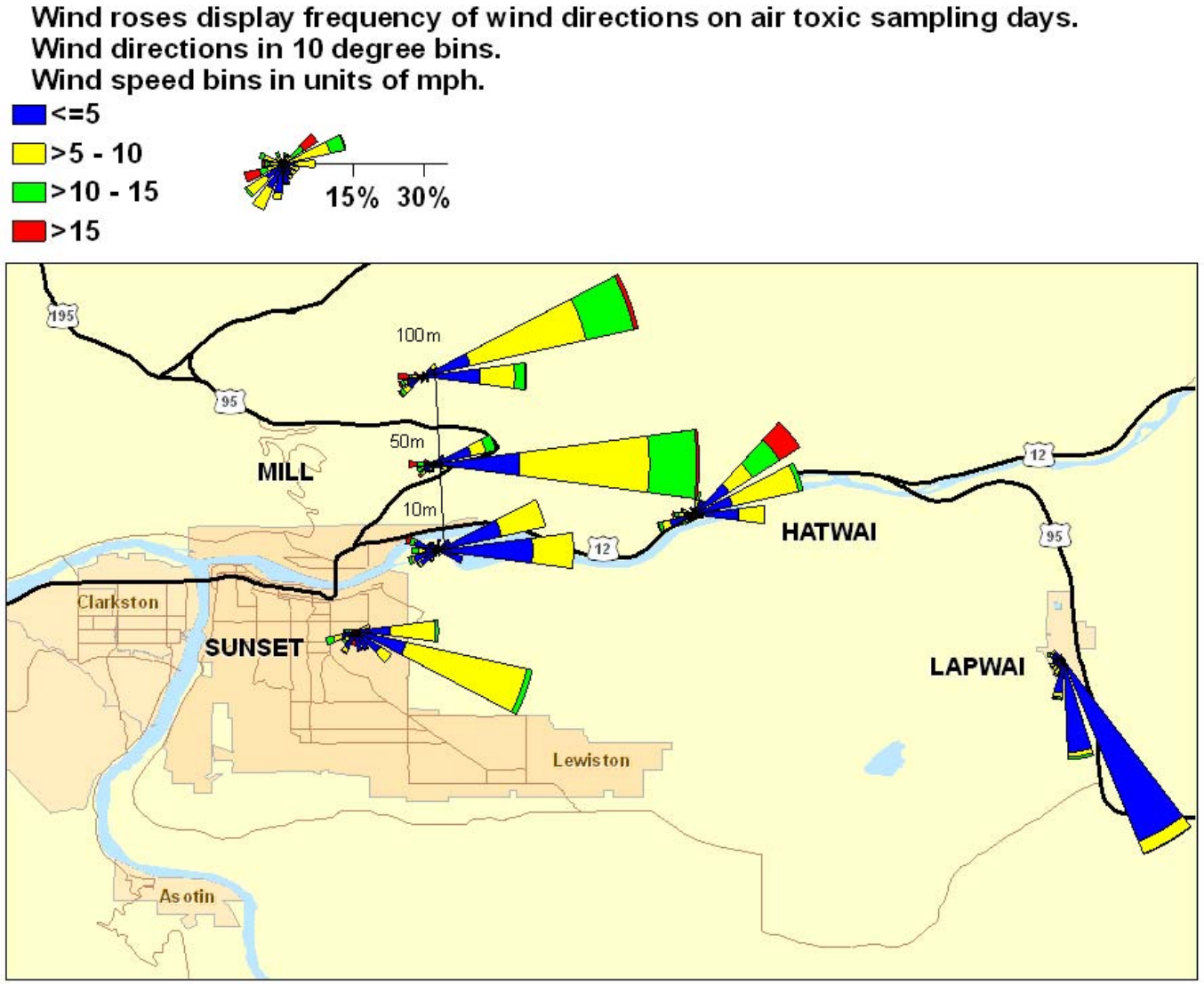
Wind roses display frequency of wind directions on air toxic sampling days.
Wind directions in 10 degree bins.
Wind speed bins in units of mph.



Daytime winds in the mill area are predominantly from the west along the Snake River and in Lapwai, from the north.

Wind speeds are more likely to be high during the day.

Nighttime Wind Roses (9 p.m. to 5 a.m.)



Nighttime winds are from the east (south in Lapwai).

Wind speeds are low.

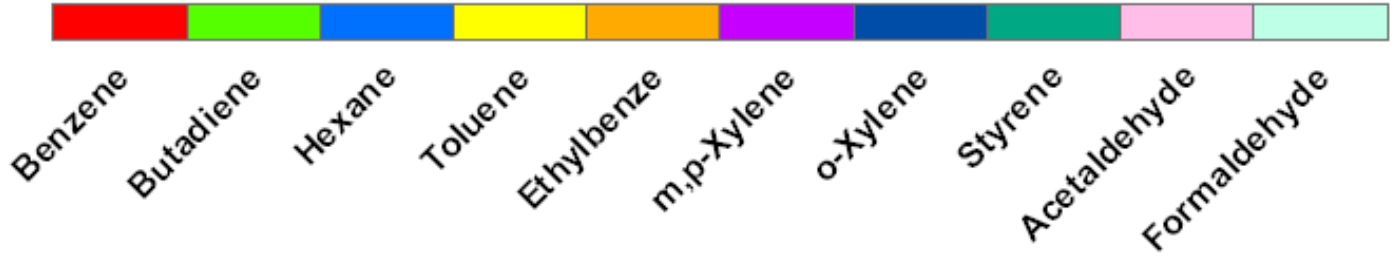
Overall, winds flow upslope during the day and downslope during the night. This is classic drainage flow.

Chemical Fingerprints

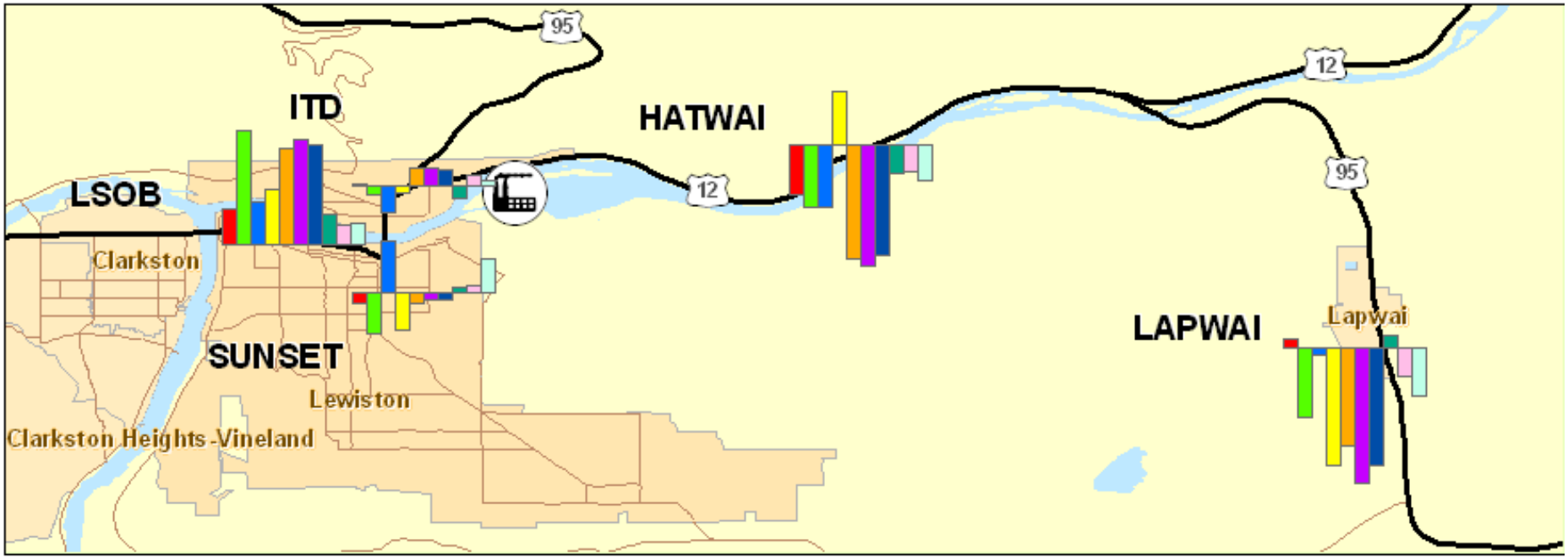
Emissions from different sources can have identifying signatures of chemicals in characteristic ratios.

- Motor vehicles have characteristic emissions of hydrocarbons such as benzene, 1,3-butadiene, toluene, and xylenes.
- The Clearwater pulp and paper mill emits acetaldehyde, formaldehyde, lead, manganese, and chlorinated hydrocarbon byproducts.
- Other sources may also be important. Using fingerprints with spatial gradients and temporal patterns may provide consensus for identifying emissions sources for some pollutants.

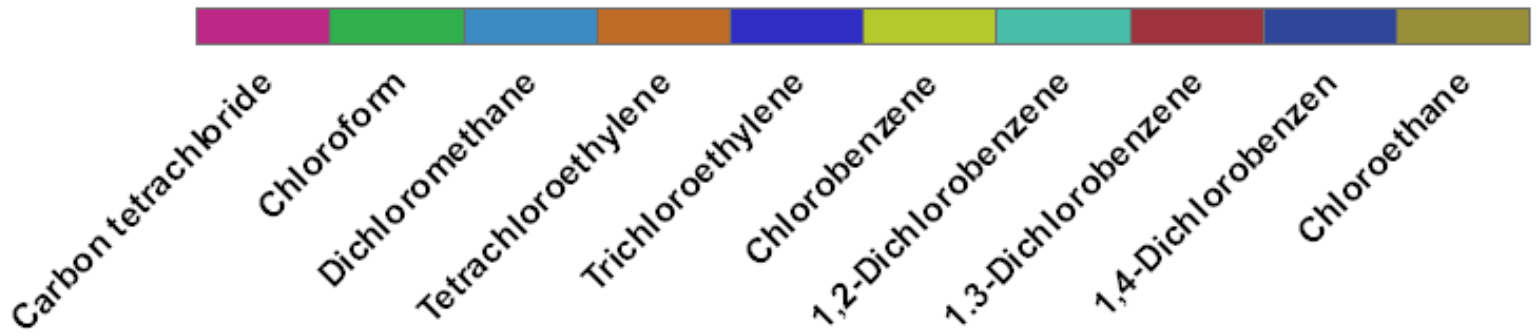
Hydrocarbons



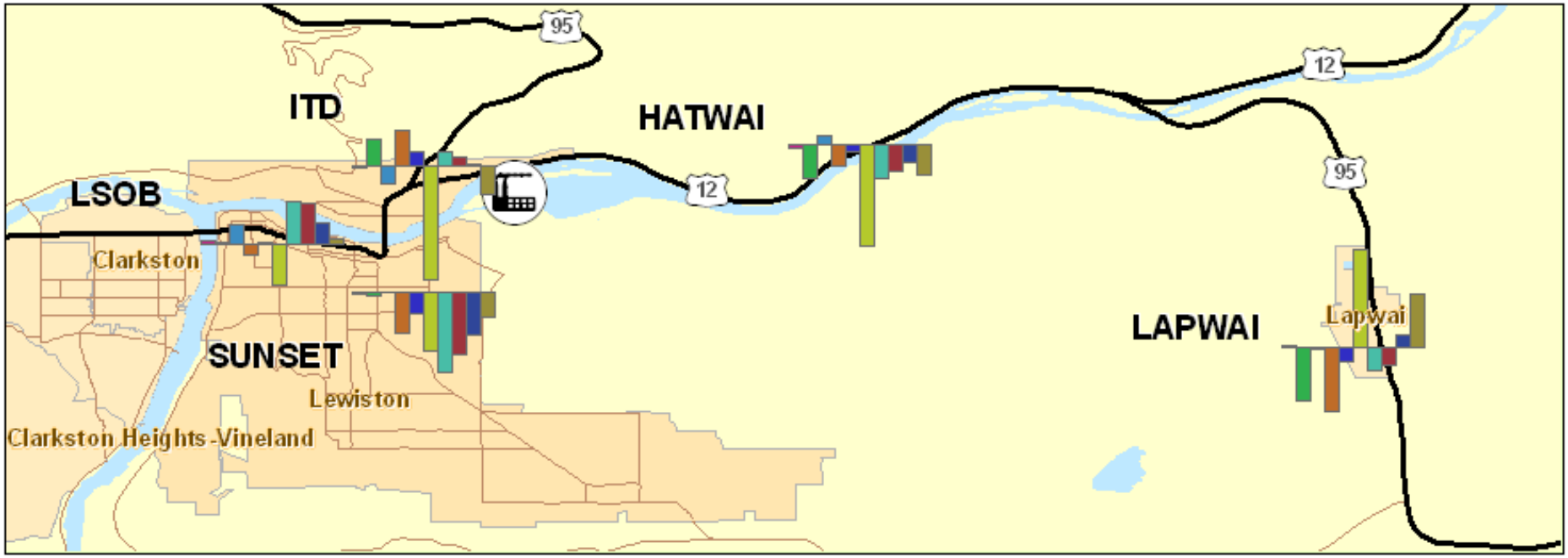
The spatial gradient in concentrations goes from west (highest) to east (lowest) for most hydrocarbons.



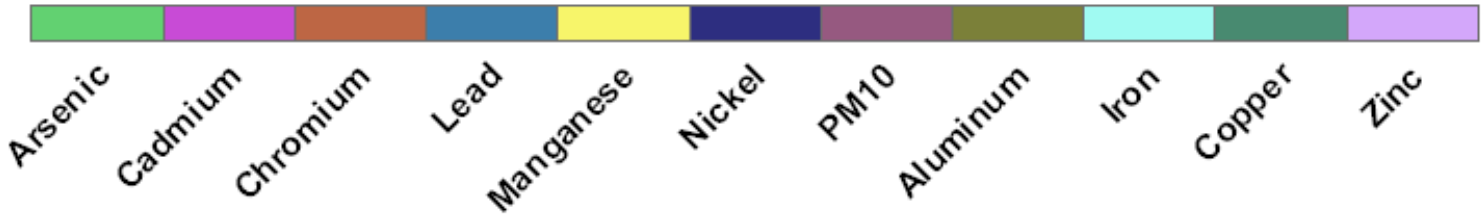
Chlorinated Hydrocarbons



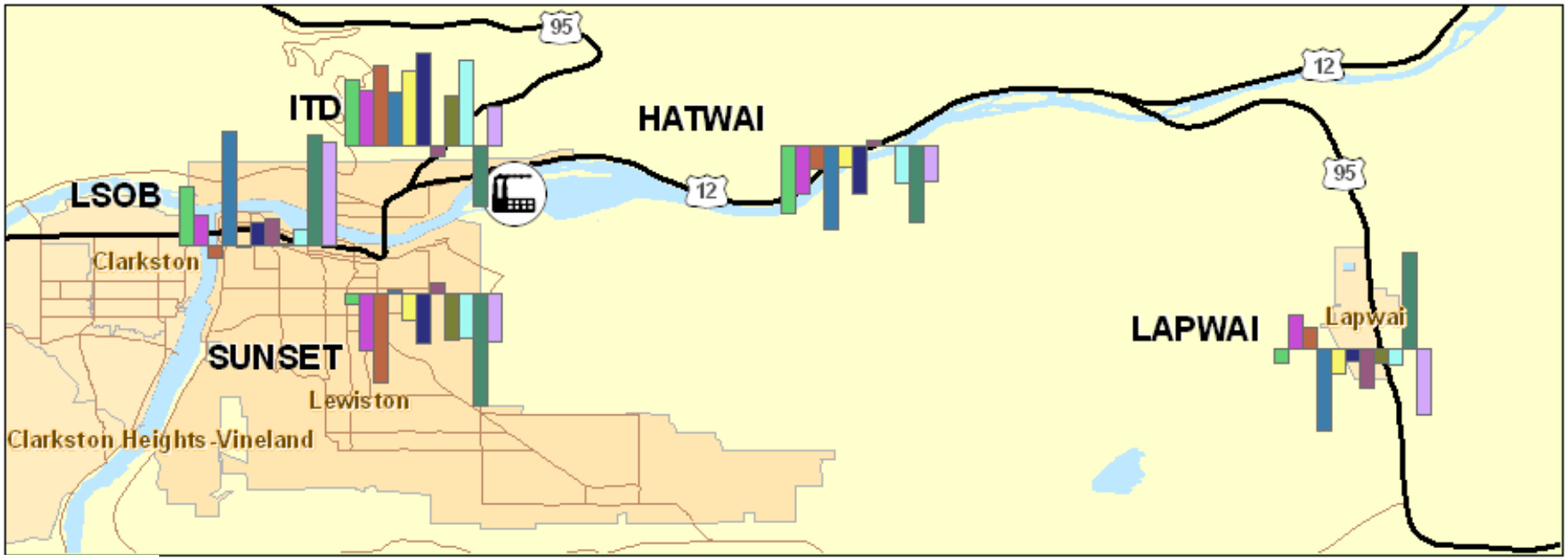
No clear pattern. Some pollutants are high at individual sites.



Metals



High concentrations at the ITD and downtown Lewiston sites.

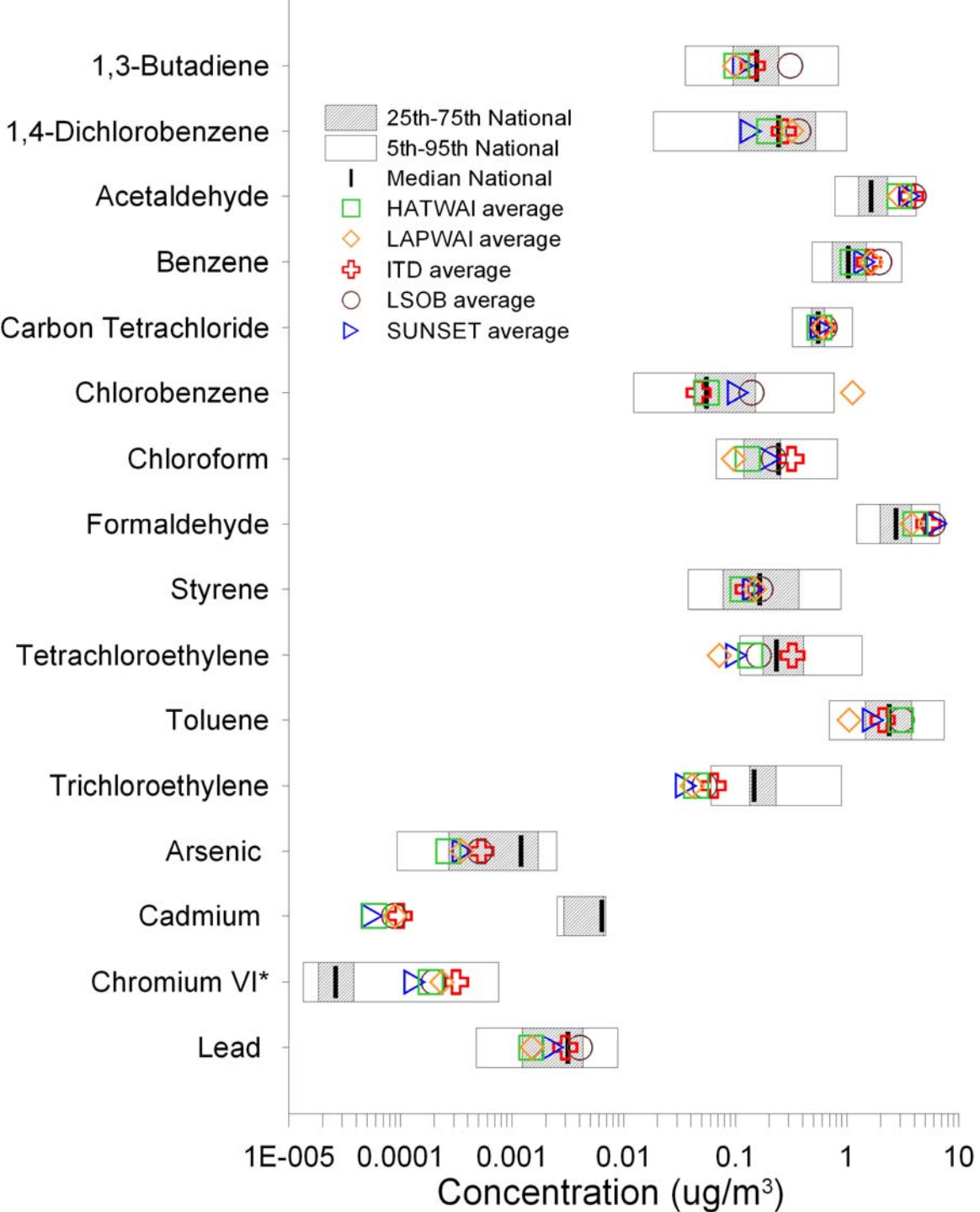


Fingerprints Implications

- Hydrocarbons were highest at LSOB. Motor vehicles, trucks, boats, and the port may be likely sources.
- Chlorinated hydrocarbons were variable.
  - Dichlorobenzenes and dichloromethane were highest at LSOB, perhaps attributable to solvent use.
  - Chloroform, tetrachloroethylene, and trichloroethylene were highest at ITD, likely as chlorination byproducts from the mill.
  - Chlorobenzene was high at Lapwai. The local source is unknown.
- Most metals were high at ITD and some were high at LSOB. Sources could include the port, brake linings, road dust, and the mill.

National Comparison

- Lewiston area concentrations compared to national averages at all monitoring sites (mostly urban) from 2003 through 2005.
- Selected pollutants only compared; see also
  - http://www.epa.gov/ttnamti1/files/ambient/airtox/2007-workshop/03_100407_hafner_mccarthy.pdf
  - McCarthy M.C., O'Brien T.E., Charrier J.G., and Hafner H.R. (2009) Characterization of the chronic risk and hazard of hazardous air pollutants in the United States using ambient monitoring data. *Environmental Health Perspectives* (in press). Available on the Internet at http://www.ehponline.org/docs/2009/11861/abstract.html.



All sites reported >50th percentile acetaldehyde, benzene, formaldehyde, and estimated chromium VI.

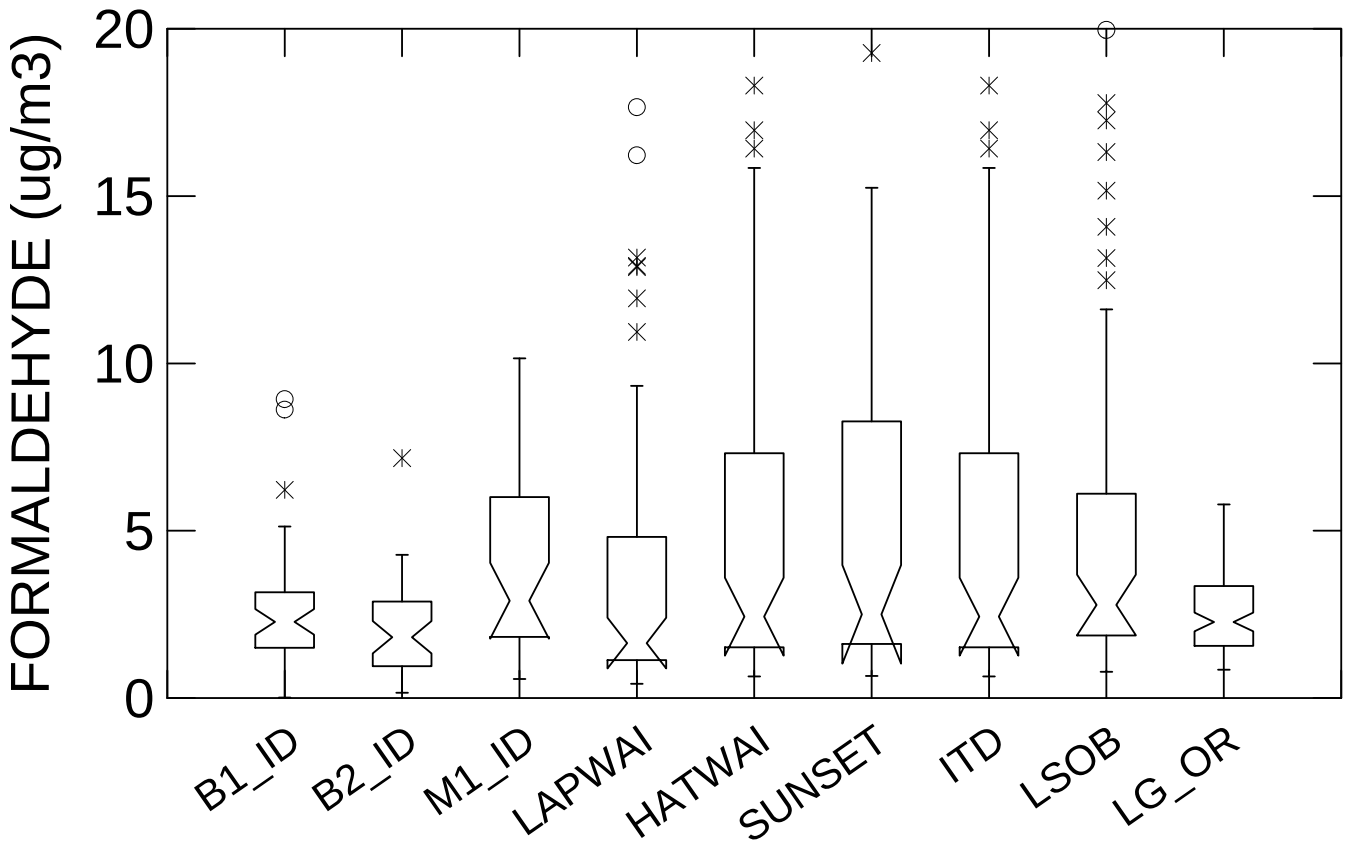
Chloroform, tetrachloroethylene, and trichloroethylene (pulp mill signature pollutants) are mostly lower than the national median, although higher at the ITD site.

National Comparison Implications

Concentrations of most pollutants are higher than expected based on population comparisons.

- Unfavorable topography may be a major reason for high concentrations. The river valley may trap emissions locally, especially under low-wind nighttime conditions.
- Pollutants with the highest relative concentrations are formaldehyde, acetaldehyde, chromium VI, benzene, and toluene. Other pollutants are high at certain sites.

Regional Comparisons – Formaldehyde

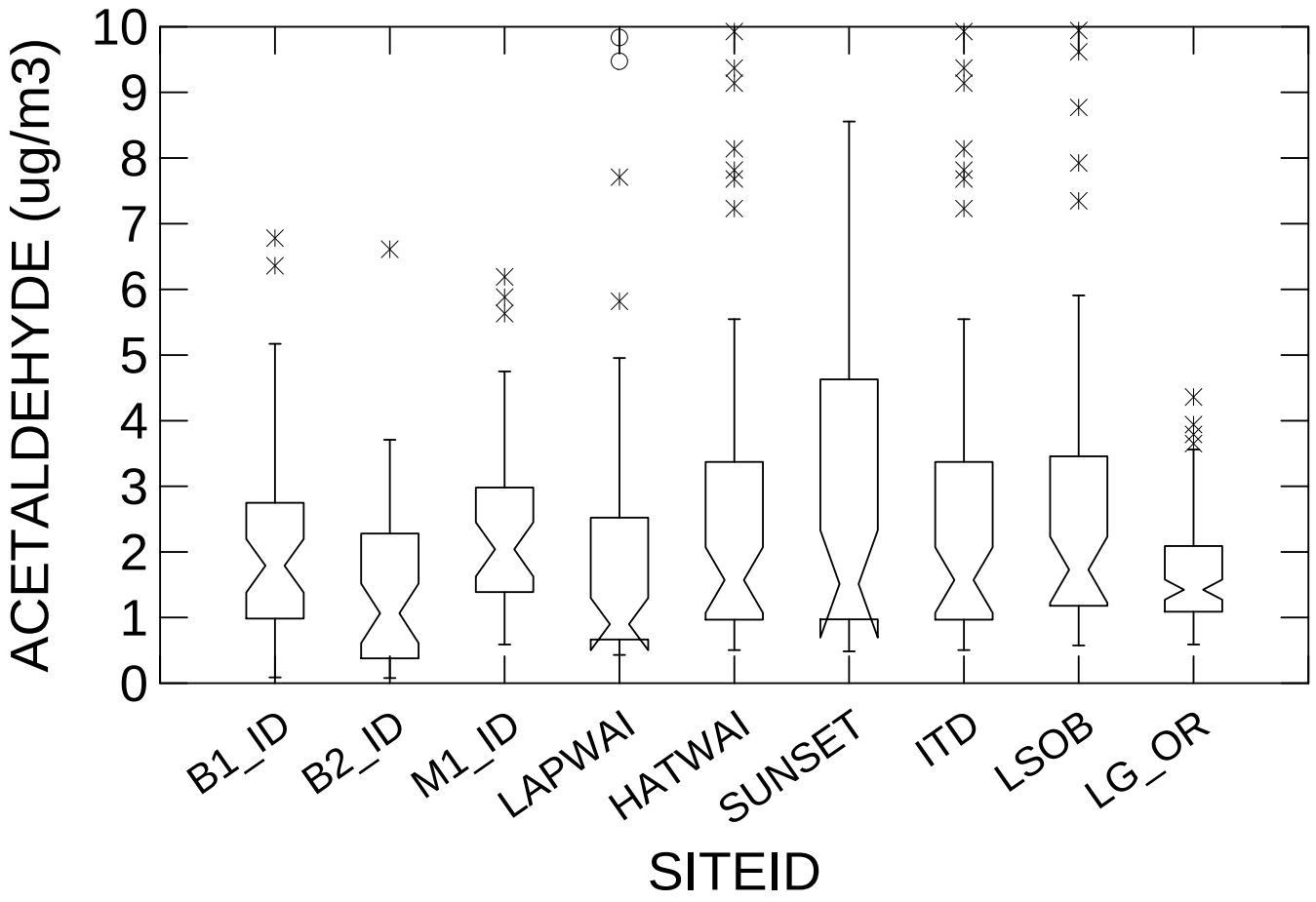


Median concentrations at these sites are statistically indistinguishable.

However, Lewiston shows much higher episodic concentrations of formaldehyde than those in other areas.

B1_ID = E. Linden St. Boise, ID
B2_ID = Cabarton Ln. Boise, ID
M1_ID = S. Worth Way, Meridian, ID
LG_OR = La Grande, OR

Regional Comparisons – Acetaldehyde



Median concentrations at these sites are statistically indistinguishable.

Again, Lewiston shows higher episodic concentrations.

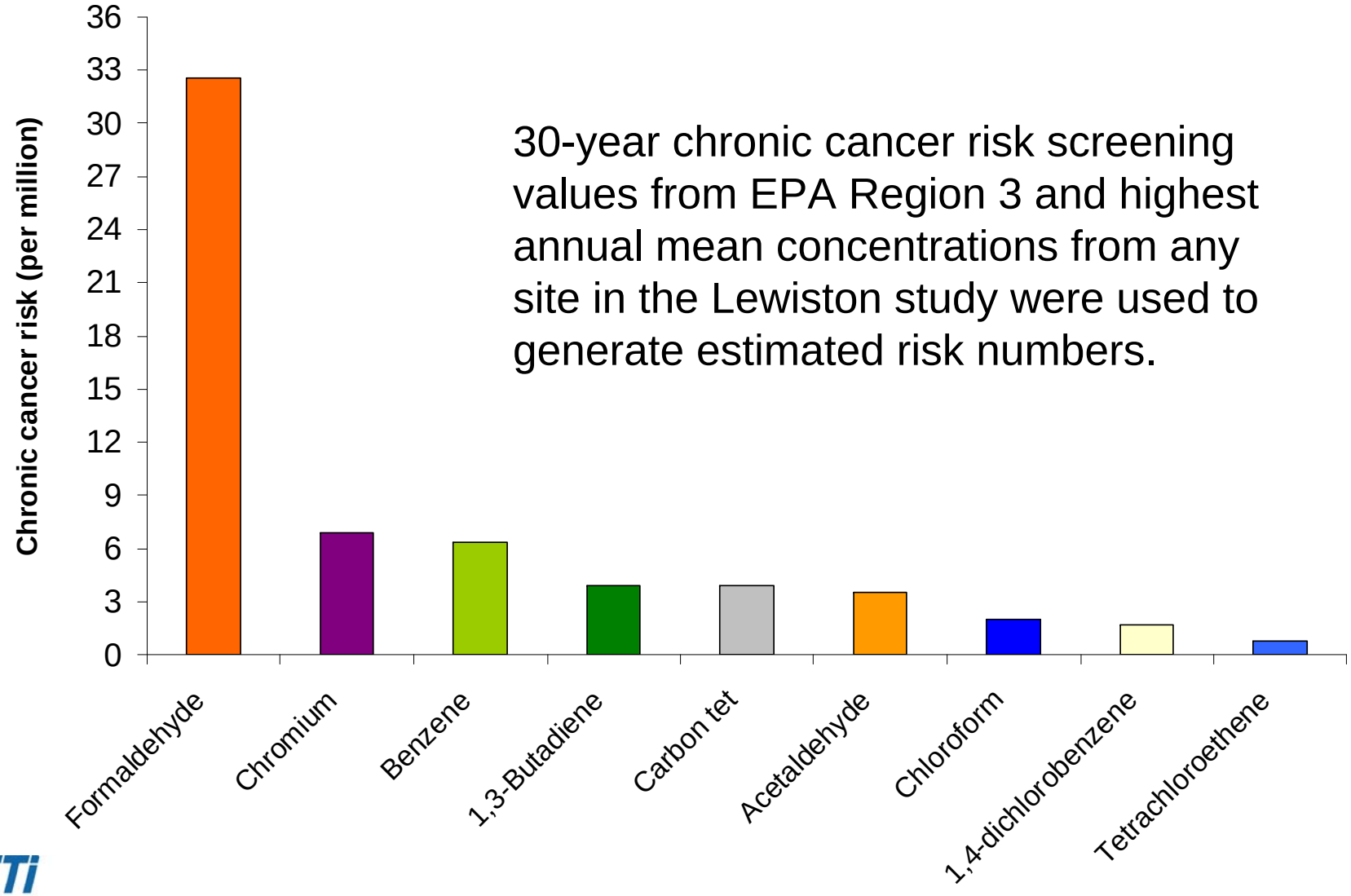
B1_ID = E. Linden St. Boise, ID
B2_ID = Cabarton Ln. Boise, ID
M1_ID = S. Worth Way, Meridian, ID
LG_OR = La Grande, OR

Possible Sources of Formaldehyde and Acetaldehyde in Lewiston

- Local emissions sources
  - Boats and pleasure craft
  - Fires
  - Motor vehicles
  - Mill
- Indirect sources (formed in the atmosphere or regional)
  - Any of the above
  - Biogenic (higher in Lewiston than La Grande?)
  - Transport (unlikely)

Of these sources, only those highly active in the summer are likely contributors.

Chronic Inhalation Cancer Risk Comparison



30-year chronic cancer risk screening values from EPA Region 3 and highest annual mean concentrations from any site in the Lewiston study were used to generate estimated risk numbers.

Key Conclusions

- Concentrations of formaldehyde and acetaldehyde are much higher than expected. Formaldehyde is the biggest contributor to estimated cancer risk and acetaldehyde is a significant contributor.
- The mill is likely responsible for local concentrations of chloroform and tetrachloroethylene. The mill may also contribute to high concentrations of other pollutants (e.g., formaldehyde), but the available data are not conclusive.

Contributions of Mill to Key Air Toxics Concentrations

- Chloroform, tetrachloroethylene, and trichloroethylene (high certainty, >50% contributor)
  - Concentrations were highest near the mill at the ITD site and lower farther away.
  - These pollutants are emitted from the mill (chlorine bleaching process).
  - The sites with lowest concentrations were at or below the 25th percentile nationally, consistent with expected concentrations for a community of this size.
- Formaldehyde and acetaldehyde (low certainty, potentially large contributor)
  - These pollutants are emitted from the mill as fugitive emissions.
  - Concentrations were highest at LSOB and Sunset, not ITD, and there was almost no gradient.
  - Average concentrations are dominated by very high episode days in the summer. The source could be the mill (although seasonality is not consistent) or some local summer contributor.

Contributions of Mill to Key Air Toxics Concentrations

- Benzene and 1,3-butadiene (no contribution, low certainty)
  - Spatial gradient is not consistent with emissions from the mill.
  - Mill does not emit these pollutants in large quantities.
- Carbon tetrachloride (no contribution, high certainty)
  - Carbon tetrachloride is a background pollutant in the atmosphere. The concentration in Lewiston is the same as everywhere else in North America.
- Chromium VI and other metals (potential contribution, low certainty)
  - Metals concentrations are high at the ITD site.
  - Mill emits manganese and lead in small quantities.
  - Source could also be road dust (high manganese, aluminum, and iron may indicate a soil signature).