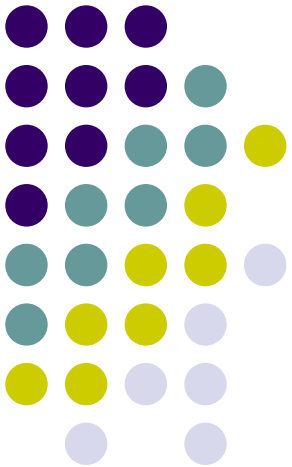
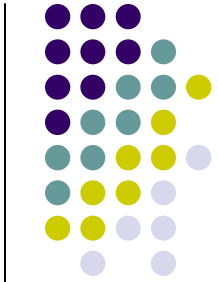
Greater Lake Washington

Human Health Risk Assessment

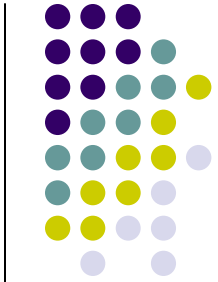


Objectives



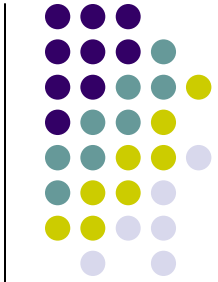
- Using existing data (~1995-2003)
- Tier 1: Which parameters deserve additional inquiry?
- Tier 2:
  - Based on site specific exposure which chemicals pose carcinogenic, non-carcinogenic or pathogenic risks?
  - **Which exposure routes and locations pose the greatest risks?**

The bottom line objective…



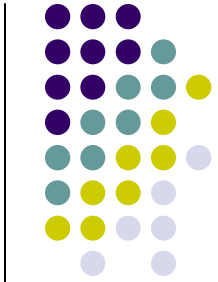
- Are we monitoring the “right” things in the right places to ensure that significant human health threats are not slipping under the radar?
- What are we missing?

Environmental Data Sources



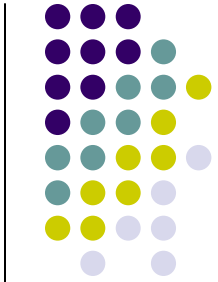
- Water
  - Ambient program
  - USGS/WA DOE/KC special studies
    - Sammamish River
    - Small Streams Toxicity
    - DOE pesticide monitoring
- Sediment
  - Ambient program
  - Major Lakes Capital
- Tissue
  - D. Houck samples
  - J. McIntyre (MS student funded by KC)

Exposure Scenarios



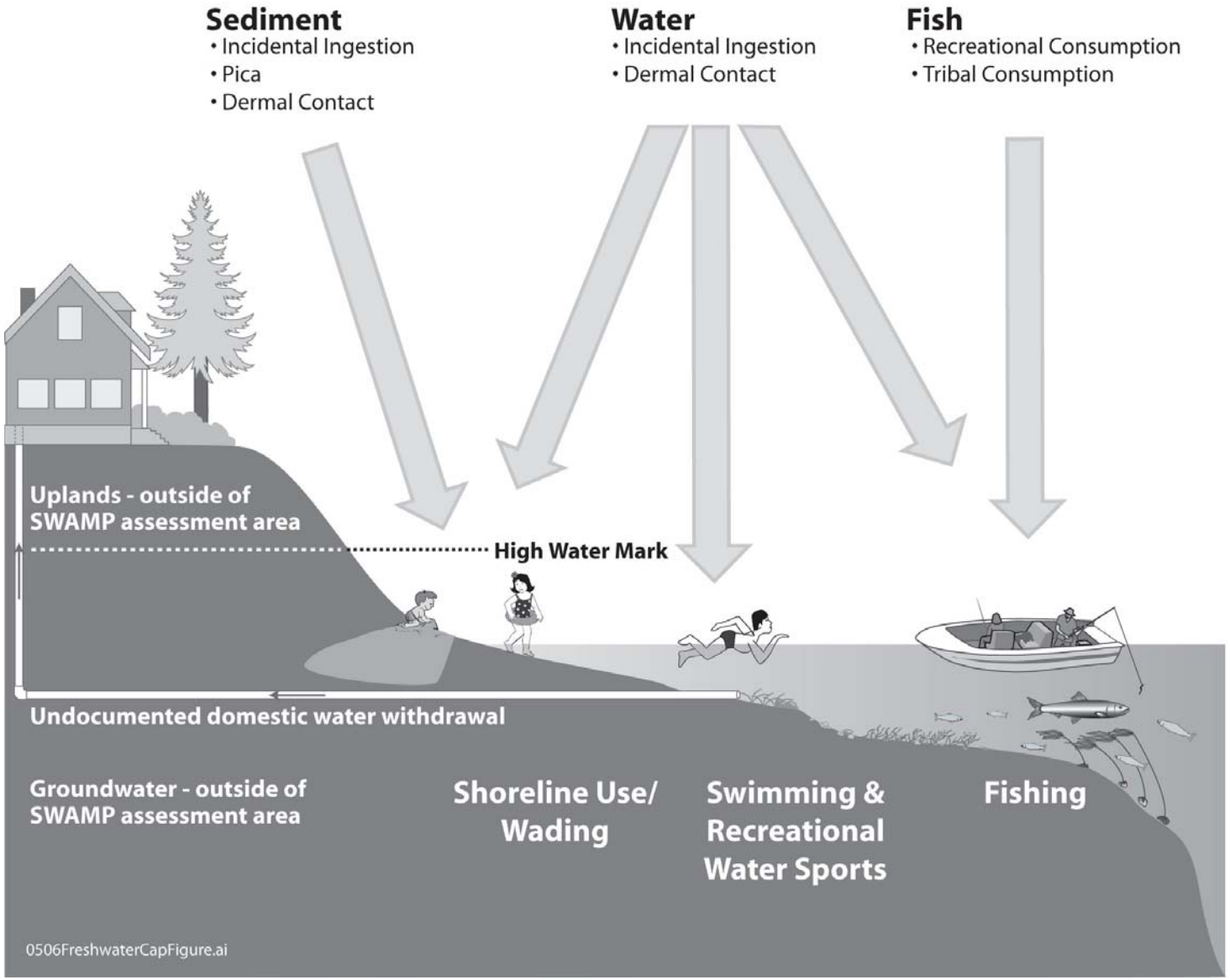
HHRA Tier	Domestic water supply + sediment	Swimming	Wading	Fish consumption
Tier 1	Yes	No	No	Yes
Tier 2	Yes	Yes	Yes	Evaluated by WA Dept. of Health

Tier 1 pathways

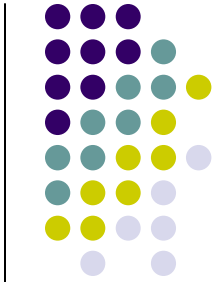


Media	Ingestion	Inhalation	Dermal
Water	Yes	Yes	No
Sediment	Yes	No	No
Tissue	Yes	No	No

Exposure pathways



Tier 1 approach

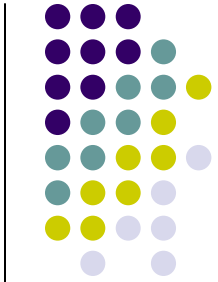


- Conservative screening values derived from EPA CERCLA program
  - 10^{-6} cancer risk
  - 0.1 HQ for noncarcinogens (accounting for multiple contaminants)
- Drinking water
- Inhalation of volatiles from showering
- Eating sediment as if it were residential soil
- Higher end fish consumption
- “Max” concentrations

Tier 1 results

Number of Chemicals			
	Water	**Sediment**	**Fish Tissue**
Number of unique chemicals for which data were available	382	141	119
Number of detected chemicals	115	74	21
Number of chemicals retained for Tier 2 evaluation	50 (13%)	47 (33%)	42 (35%)

Tier 1 uncertainties



- 187 chemicals had no toxicity information with which to evaluate them for further investigation
- 41 had inadequate detection limits
- Pathways skipped (e.g. dermal)
- Whole body fish (vs. fillets)

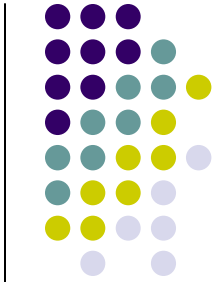
Tier 2
Chemical assessment

- More robust consideration of chemicals ‘passing’ Tier 1
- Use watershed specific exposure assumptions
- Location specific data
- Dermal assessment
- TEFs for PAHs without chemical specific data
- Exposure point concentrations
  - >10 detects = 95% UCL of arithmetic mean
  - <10 detects = max detected concentration used

Chemical assessment con’t

- Sum of intakes across all pathways and all media x CSF = cancer risk
  - Additive across all carcinogens
  - A lifetime (or exposure duration) risk
- Sum of intakes across all pathways and all media / RfD = noncancer risks
  - A daily average risk

Tier 2 pathways



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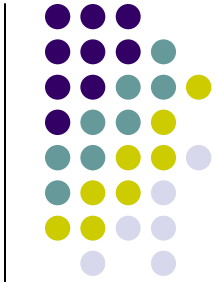
Sediment	Yes	No	Yes
Tissue	No	No	No

Tier 2 Bacteria (*E. coli*)

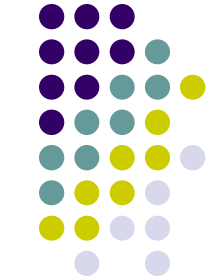


- Seasonal screen (6/1 to 9/15)
  - Most beaches provide lifeguards 6/15 to Labor Day
- Holding time exceedances included
- Estimated values included
- Location specific maxima <126cfu/mL (EPA beach criteria) screened out
- N<20 screened out due to insufficient data

Study design issues (bacteria)

- Best example of why “monitoring” cannot serve all needs
- Non-random sampling on Tuesdays with Thursday follow-ups
- Biased design to protect weekend users
  - Technically cannot be used to answer the question:
  - What is the probability of getting sick from swimming?

Bacteria approach

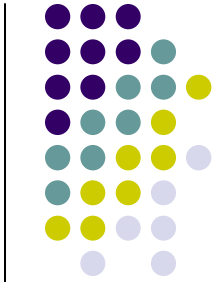


- Fit data to distribution
- Apply distribution to swimmer illness/concentration relationship
  - Illness per 1,000 = 11.74 + 9.397 (log *E. coli*)
- Rank by illnesses per 1,000 swimmers
- Ranks used to describe relative magnitude of bacteria problems and prioritize locations

Chemical Data Confidence

- Widely varied data density
  - Some locations N=50
  - Some locations 1 or 2 detections in similar number of sampling events
- 95%UCL (i.e. >10 results) = high confidence
- High FOD% (>50%) = high confidence
- <10 detections, <50% FOD = low confidence
- Frequent blank qualifications = low confidence (e.g. phthalates)

Data confidence bottom line

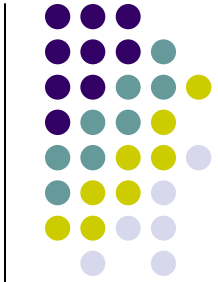


- Metals and bacteria = high
- Organic chemicals = low
- About 13 locations with higher confidence PAH data

Risk additivity and management thresholds

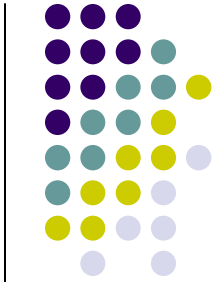
- Different programs have different ‘allowable’ risk thresholds
  - Drinking water (MCLs), CERCLA, FDA medications, FDA food, CWA, MTCA, etc.
- Unknown ‘background’ risk
  - E.g. geologic sources
  - No definitions on regional or global ‘background’ contaminants
- KC has no defined risk thresholds

For discussion here…



- Excess cancer = > 10^{-6}
- HQ >1 when non-carcinogenic risks are summed by target organ*
- Why these levels?
  - Common usage in other environmental risk assessments (as opposed to product or FDA pharmaceutical assessments)
  - Typical starting “points of departure” for CERCLA and MTCA assessments

*Non-cancer endpoint/target organs



Endpoint	# Tier2 chemicals
Cancer only	11
Liver	9
Other	6
Blood	4
Kidney	4
CNS	3
Eyes	2
Methemoglobinemia	2
Body weight	1
Hair	1
Heart	1
Lung	1
Skin	1

Legend

Cancer Probability

- 1E-6 to 1E-5 - Lowest Probability
- 1E-5 to 1E-4
- 1E-4 to 1E-3
- 1E-3 to 1E-2
- 1E-2 to 1E-1
- 1E-1 to 0.99 - Highest Probability

E. coli Illness Rank

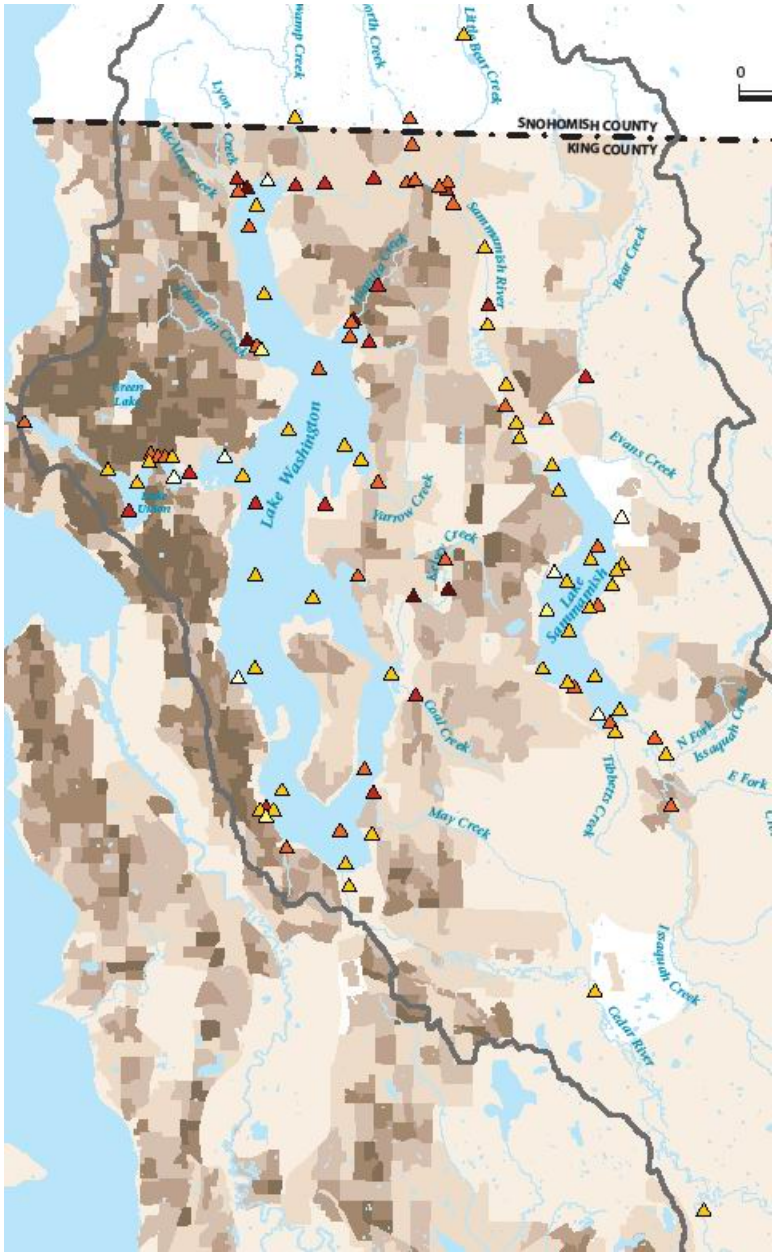
- 1 - Highest E. coli Illness Rank
- 2
- 3
- 4
- 5 - Lowest E. coli Illness Rank

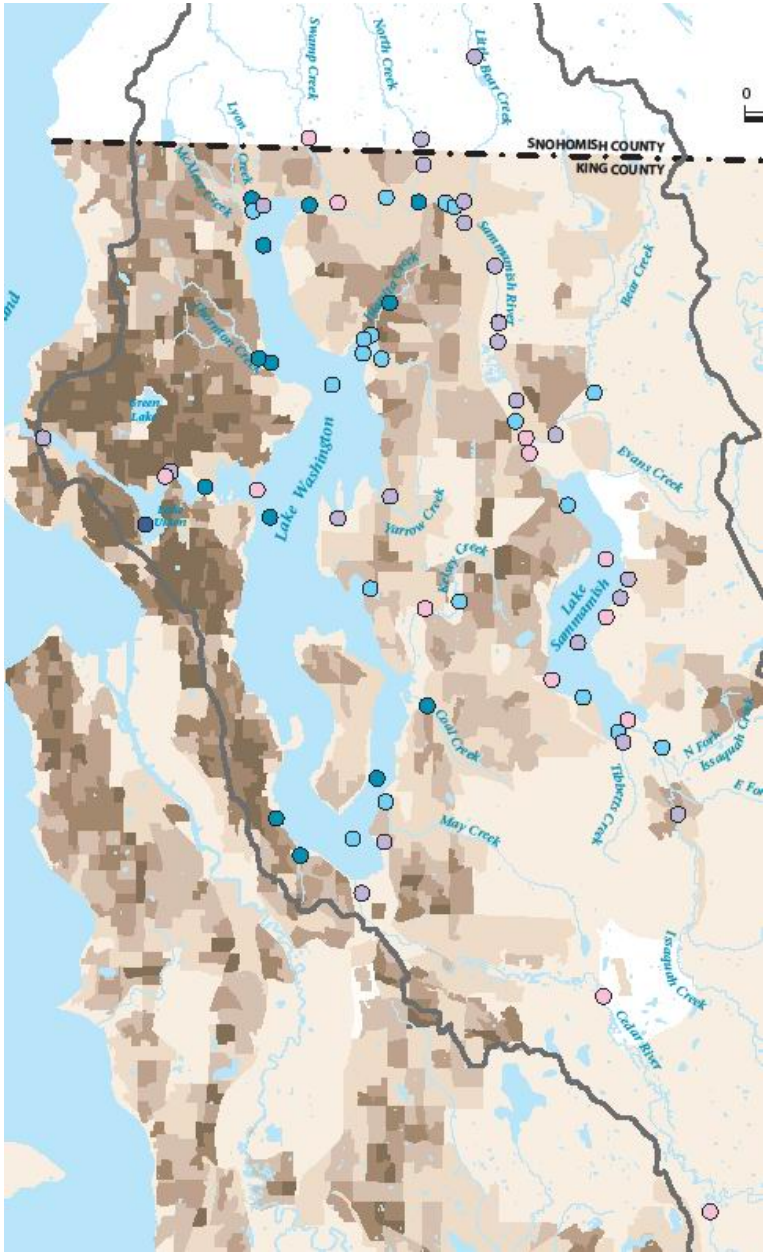
Maximum Non-Cancer Hazard Quotient

- 1.1 - 3.0 - Lowest Risk
- 3.1 - 5.0
- 5.1 - 15.0
- 15.1 - 100.0
- 100.1 - 300.0 - Highest Risk

Population Density (per sq. mile)

- 2 - 1389
- 1389 - 3316
- 3316 - 5056
- 5056 - 6592
- 6592 - 9169
- 9169 - 87809





Drink + wade when access-able

Legend

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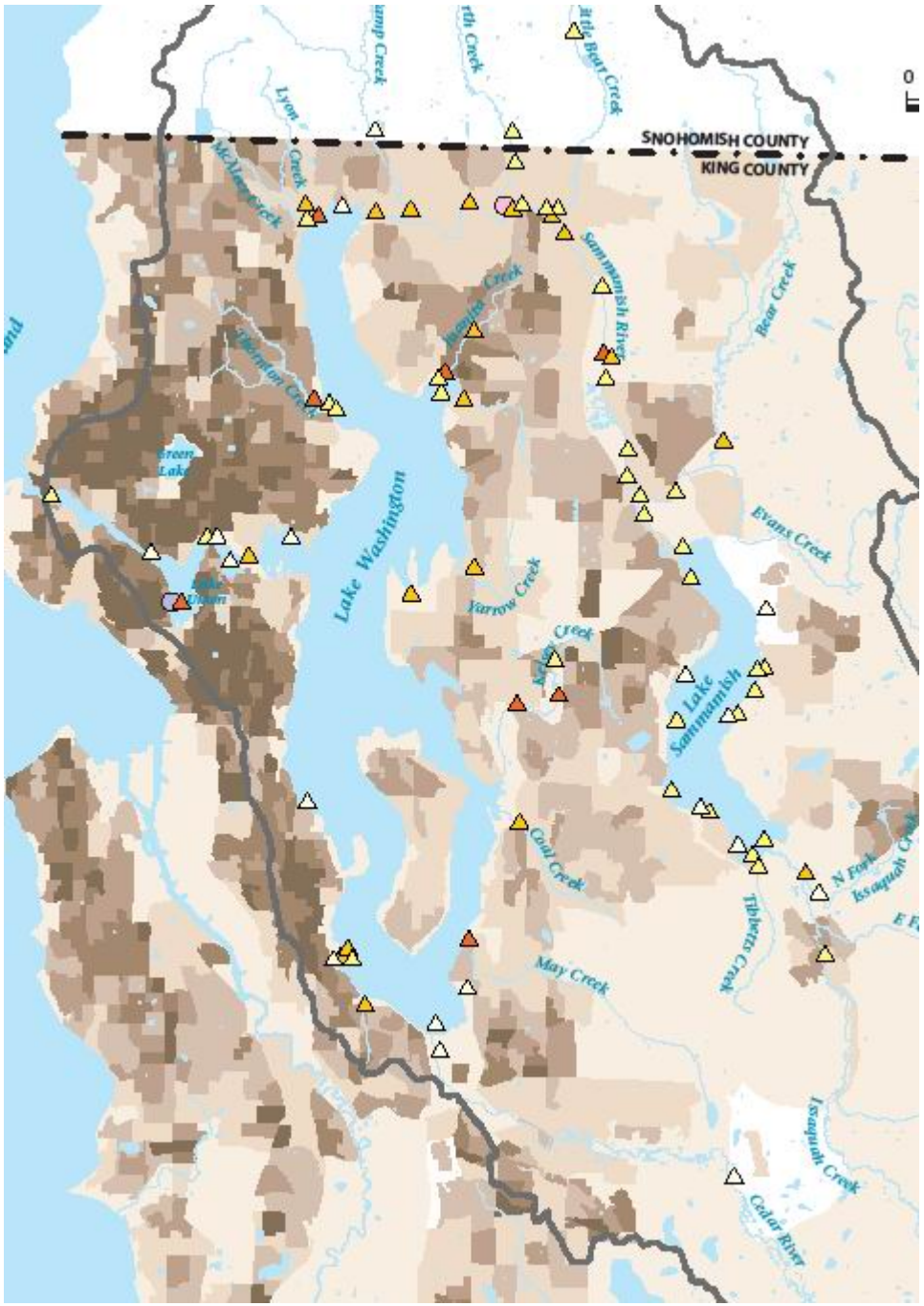
SNOHOMISH COUNTY
KING COUNTY
Lake Washington
Lake Sammamish
Sammamish River
Bear Creek
Evans Creek
Yarrow Creek
Kelsey Creek
Coal Creek
May Creek
Tibbetts Creek
Issaquah Creek
Cedar River
Green Lake
Lake Union
Lyon Creek
McAleer Creek
Thornton Creek
Juanita Creek
Little Bear Creek
N Fork Issaquah Creek

Wade

Legend

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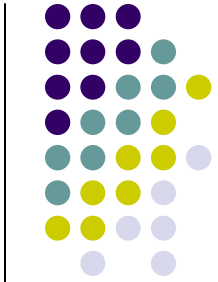
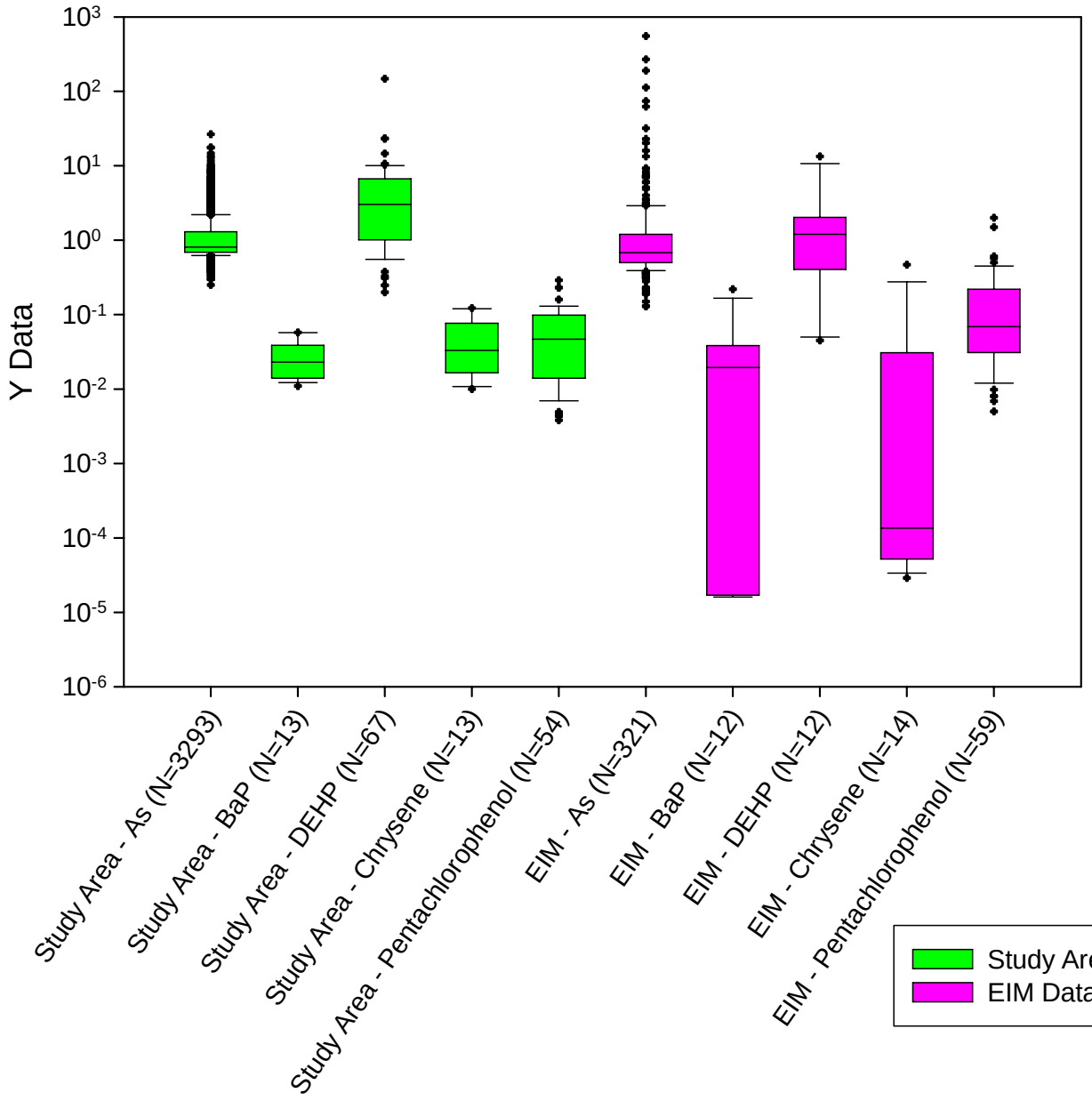
Swim,
water only

Top risk drivers (locations)



- Arsenic (100+)
- HPAHs like Benzo(a)pyrene (13-22)
- Chyrsene (11)
- Pentachlorophenol (17)
- Bis (2-ethylhexyl) phthalate (39)
- Location frequency data skewed to uneven sampling

Are these chemicals unusual?



IM data from WA Urban Counties

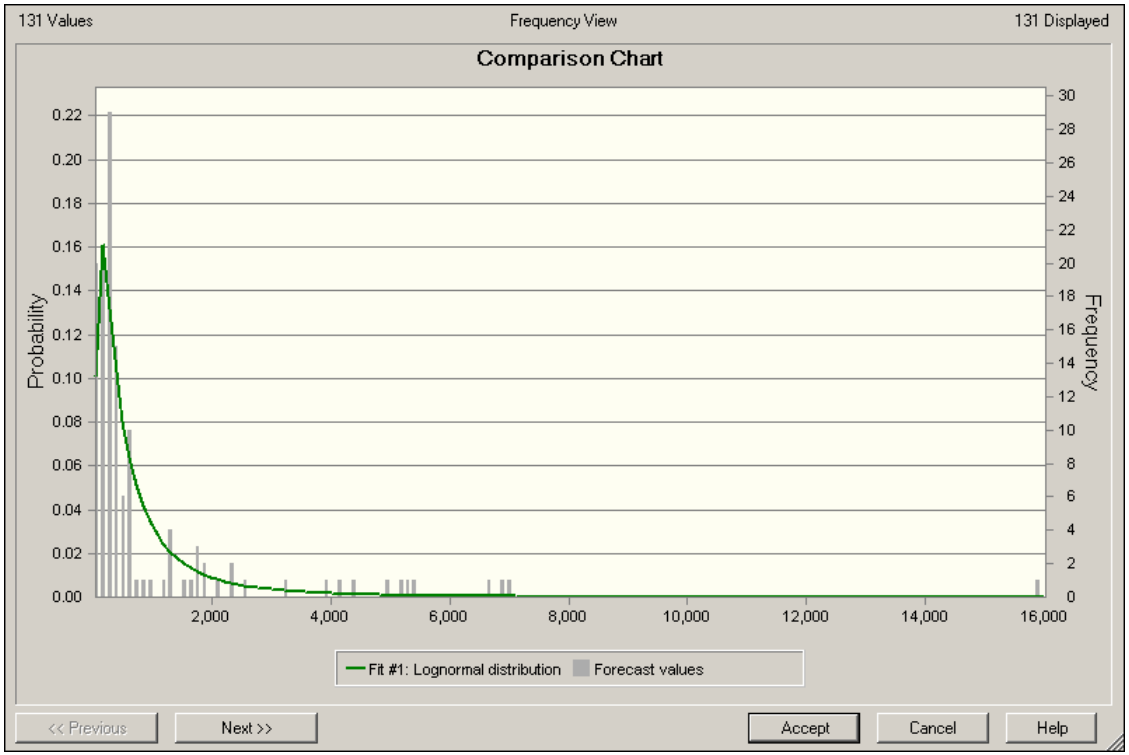
Where do the risks line up?

- Only 3 chemicals exceeded drinking water regulatory standards (DEHP, Pb, Tl)
- (does not include bioaccumulatives)

Scenario/Model	Carcinogenic Risk Probability
Average Puget Sound lifetime risk (NCI, 2005)	3.4E-1
Domestic water supply with backyard wading use (most conservative scenario in this study)	1.4E-2
Lung cancer risk in a 75 year old smoker who smoked 1 pack/day for 40 years (Bach et al. 2003)	8.0E-2
Lung cancer risk in a 75 year old smoker who smoked 2 packs/day for 50 years (Bach et al. 2003)	1.5E-1
Backyard or beach wading use alone	2.0E-4

Bacteria (*E. coli*) results

- Distributions fitted (e.g.)



- Apply dose – illness response relationship
- Categorize relative to swimming standard in WQS

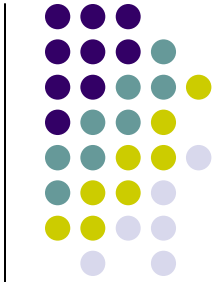
E. coli illness frequency and rank

Frequency of illness	Number of locations
Greatest	9
	20
	14
	24
Least	3

EPA recommended WQ standard = 8 illnesses/1,000 swimmers

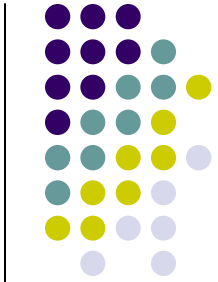
Waterbody	Illness Rates % ile		
	25th	50th	75th
Thornton Creek	11.85	14.97	18.17
Tributary to Thornton Creek	11.81	14.31	16.83
Juanita Creek	10.17	13.35	16.45
Juanita Creek	10.17	13.32	16.45
McAleer Creek	9.23	12.67	15.95
Idylwood Creek	9.11	12.92	16.65
Lyon Creek	9.10	13.28	17.41
Mercer Slough	8.70	12	15.47
Piper's Creek	8.40	12.60	16.82

Sensitivity, what's driving the bus?



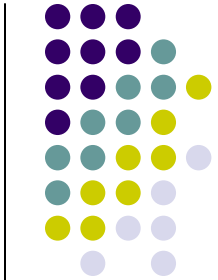
- Exposure duration
  - 78 yrs is high compared to other assessments
    - Less than an order of magnitude shift for both 15 and 30 year periods = moderate influence
- Hours of swimming and number so swimming days
  - 240 min 95th%ile vs. 60 min median
  - 58 days/yr 95th%ile vs. 8 days median
  - Average cancer probability RPD minus 180%
  - Only 3 highest (of 18) locations with non-cancer HIs >1 remain of concern

Sensitivity, con't



- Plus-minus 50% of raw data has no influence on number of locations with a carcinogen EPC of concern
- Due to the frequent use of maxima as EPCs
- Soil ingestion and soil ingestion rate not a significant source of risk
  - Pica child risks very similar to normal child due to the preponderance of the risks coming via water.

Uncertainties



- Scope
  - Almost 11,000 parcels in the watershed abut a waterbody
  - Non-random data collection limitations
  - 95% of location had water or sediment samples but not both
    - Limited ability to integrate risks across pathways
  - Assumed central range of exposures
    - No contaminated sites
    - No definition of “background”

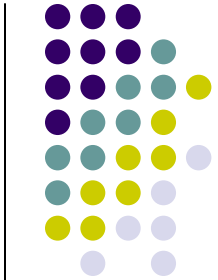
Uncertainties, con't

- **Analytical**
  - Analyte list variable (spatially+temporally)
    - Aldicarb N=4
    - Dibenzo(a,h)anthracene N=863
  - Total arsenic vs. speciated
  - PCBs
    - No confirmation via congeners
    - Whole fish not fillets
    - Spotty sediment coverage
  - CDDFs (none at all)
  - Phthalates
    - Lots of blank contamination

Uncertainties, con't

- Exposure
  - 1.4 million people
  - Almost 600,000 parcels
  - ~11,000 waterfront parcels
  - Wide spread in days of use
  - Hours of contact per event
  - Years of use
  - Need more targeted population of users and distinct risk questions

Uncertainties, con't



- Methods
  - Temporal changes in exposure unaccounted for
    - 8yrs data extrapolated to 70+
  - Upper bound of risk to sensitive groups vs. typical population-wide risks
  - Lead, widespread but challenging to evaluate via pharmokinetic model
    - Air and dust are likely major factors, water/sediment are uncertain
  - Do real exposures match the scenarios evaluated?
    - All pathways simultaneously for the durations/frequency considered?
    - How common?
      - Can you be a 95%ile user in multiple areas simultaneously?
    - By sensitive subpopulations?

Conclusions

- Urban nearshore lake and stream waters pose the highest risks
  - PAHs + bacteria
    - As background vs. area-wide?
  - Mid-lake WA or Sammamish have few risks
- Monitoring should focus on
  - Tracking changes in risk drivers
    - May-October for bacteria
    - Year round for PAHs and PCBs
  - Identifying sources
  - Documenting source reduction (post control)