

Using the Relative Risk Model for Managing Water Quality with Multiple Types of Stressors and Sources using Lake Whatcom, Washington as a Case Study.

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<http://www.wvu.edu/toxicology/>

Water Quality Management and Risk Assessment

- Multiple stressors and sources
- Multiple routes of exposure
- Humans and other biotic species present within the same geographic area



- The approach naturally integrates multiple sources of multiple stressors to multiple endpoints in contrast to typical approaches.



Location...Lake Whatcom

- Washington State
- Puget Sound
- Whatcom County
- Bellingham



Why is Lake Whatcom unique?

- Only drinking water supply for 86,000+ people.
- Multiple land uses in watershed.
- No comprehensive management plan.
- Several jurisdictions with conflicting management objectives



Purpose of Study

- Integrate ecological and human health risk assessment frameworks using Relative Risk Model
- Analyze cumulative risks to the endpoints within both ecological and human health risk regions to address water quality in the watershed.
- Address current management goals and stakeholder values within context of risk assessment model



Endpoints

- **Abiotic**

- Flood Control
- Water Quality

- **Biotic**

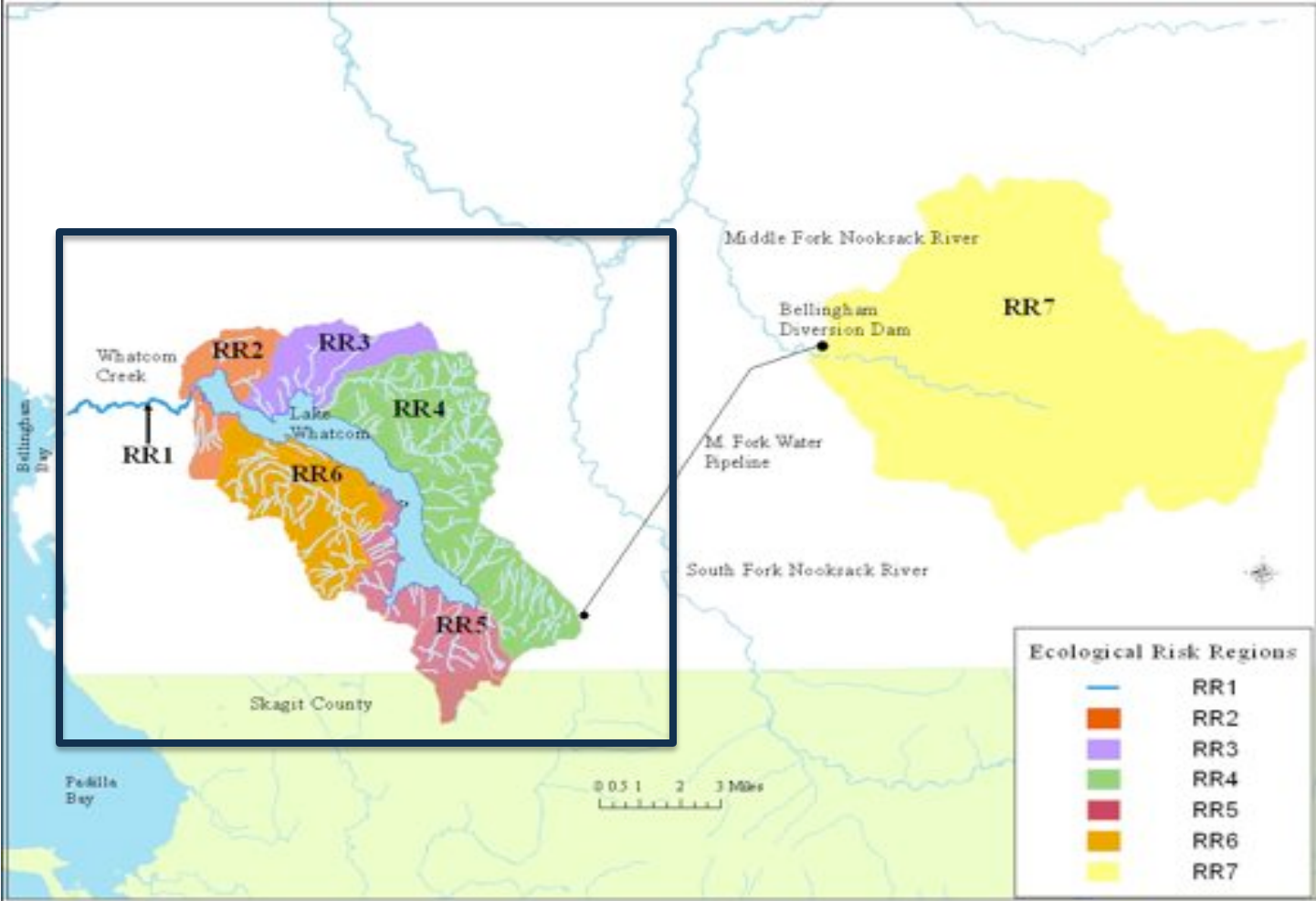
Birds: Bald Eagle, Canada Geese

Fish: Salmonid - Kokanee, Chinook, Cutthroat Trout

Non salmonid - Smallmouth bass, Yellow Perch



Lake Whatcom: Not necessarily adjacent risk regions



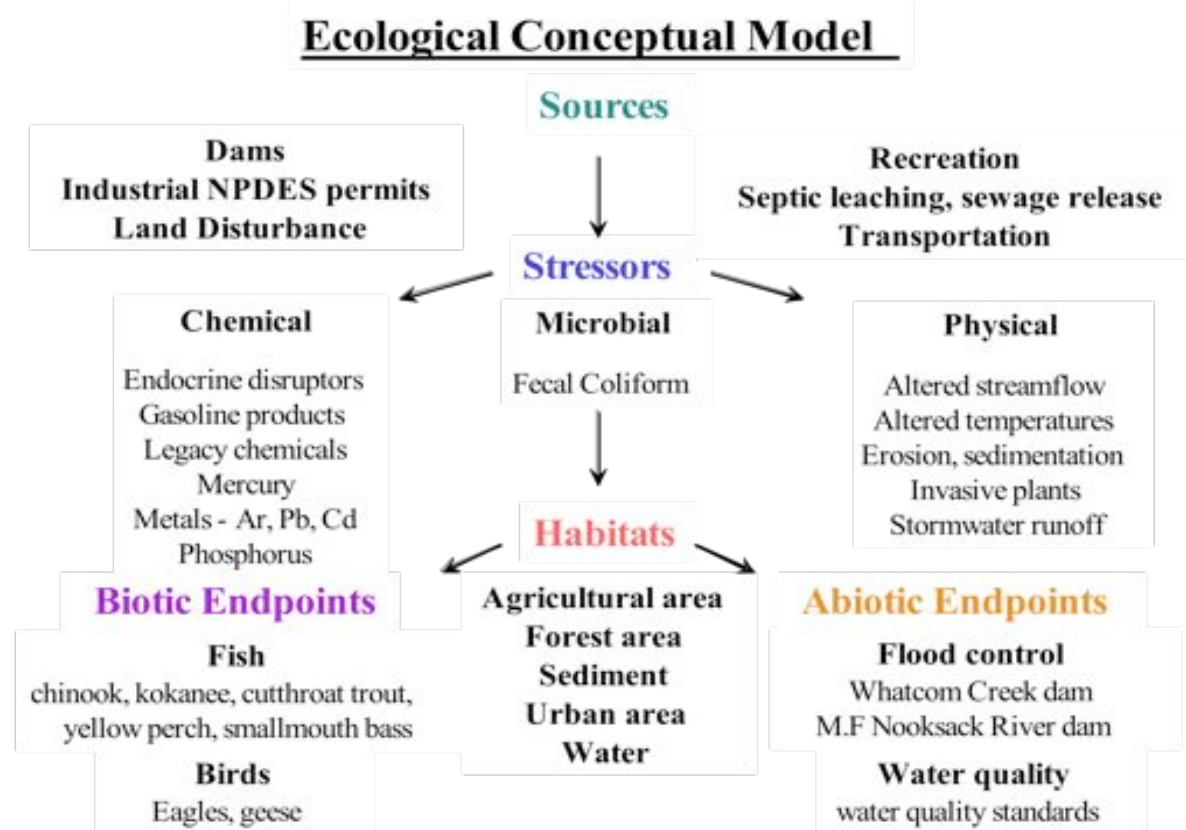
Assumptions

Ecological

- 10% of Middle Fork Nooksack risk region sources and habitat were used in calculations due to approx 10% of surface water contribution to Lake Whatcom.
- Whatcom Creek: due to its outlet being outside the Lake Whatcom watershed, as well as its highly urbanized nature, only some sources were assessed in risk model.
- For Transportation source, road width type was assumed to be primary: 50m, secondary: 40m, collector: 30m, residential: 20m, and logging: 10m.



Lake Whatcom: Same structure as typical RRM



Clearly not the TMDL Process!

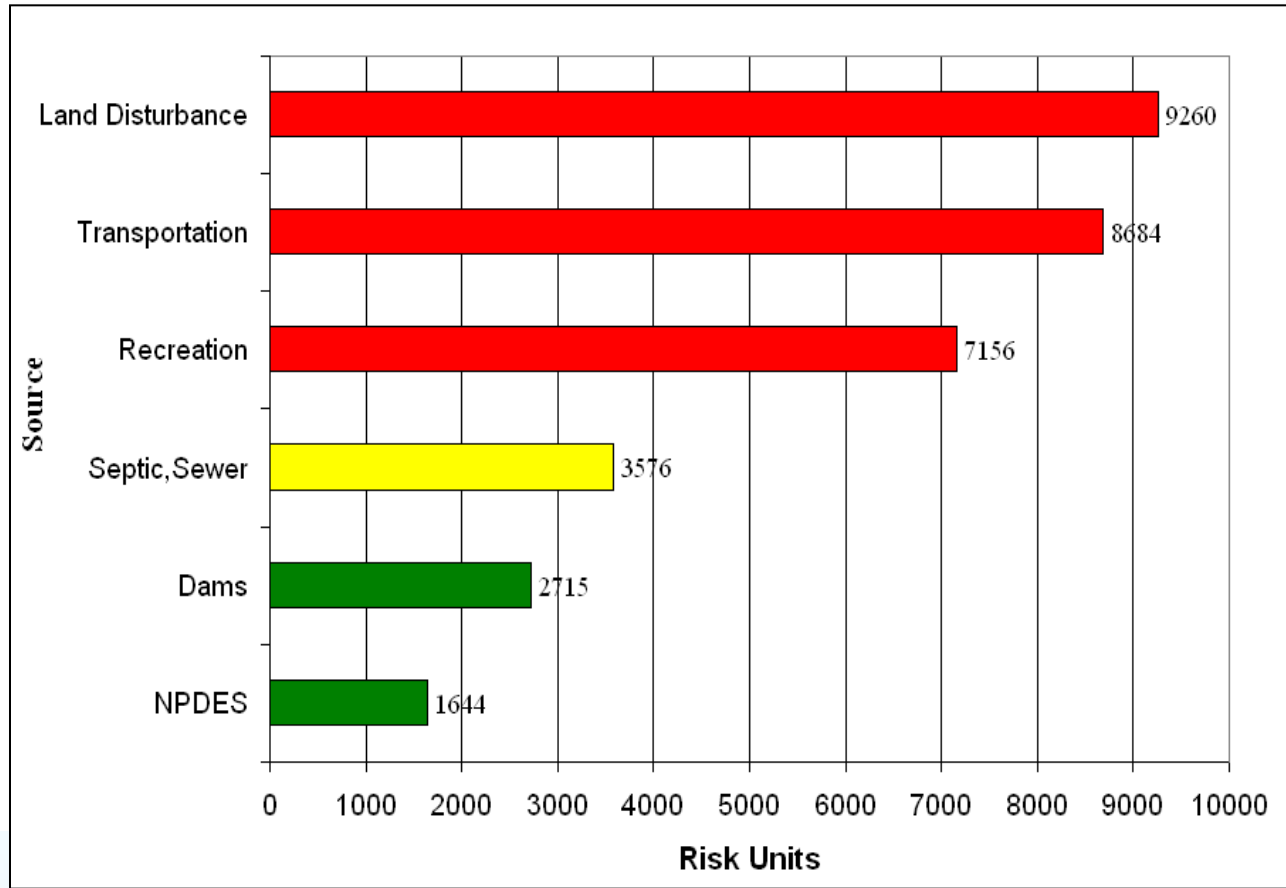


Ecological Summary

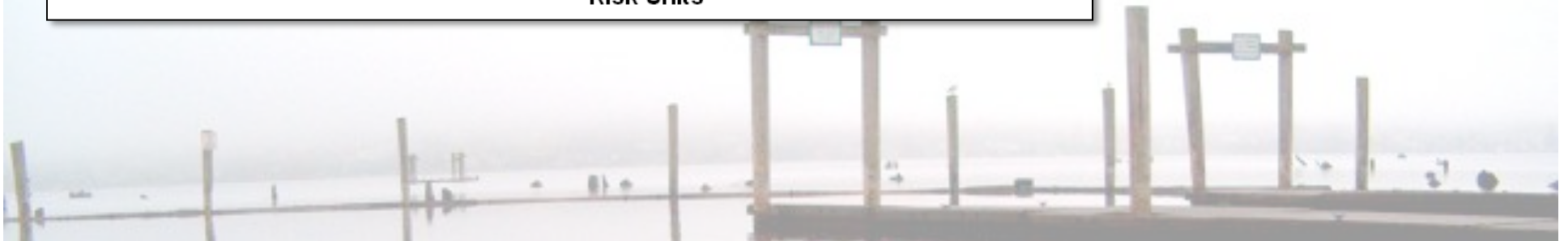
- Sources - Land Disturbance, Transportation, Recreation
- Stressors: Phosphorus, Mercury, Erosion
- Habitats at risk: Water, Urban areas
- Endpoints at risk: Water Quality
- Risk Regions with highest risk scores:
 - Risk Regions 6, 4 and 2



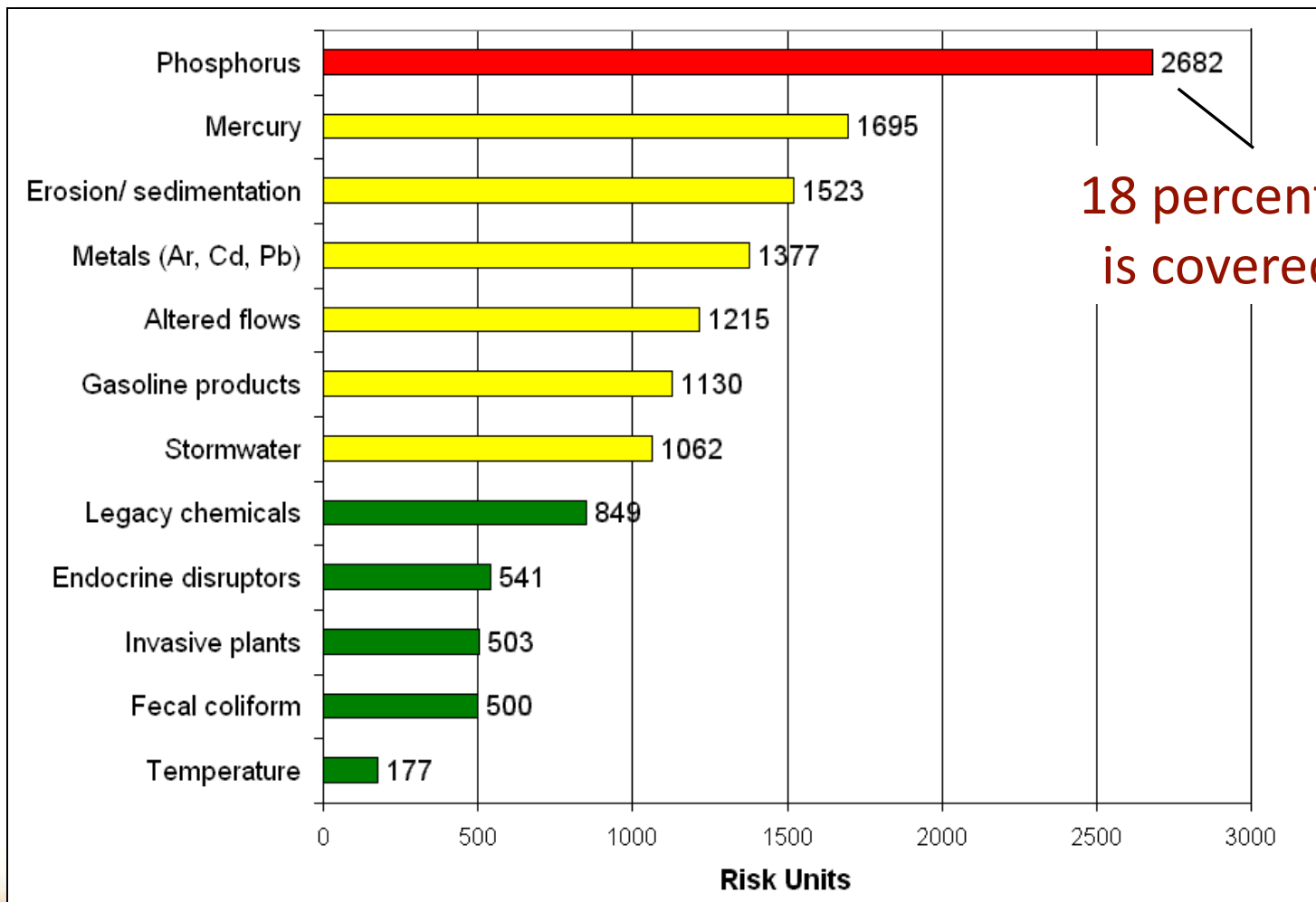
Total Risk from Sources



Non-point sources dominate the risk



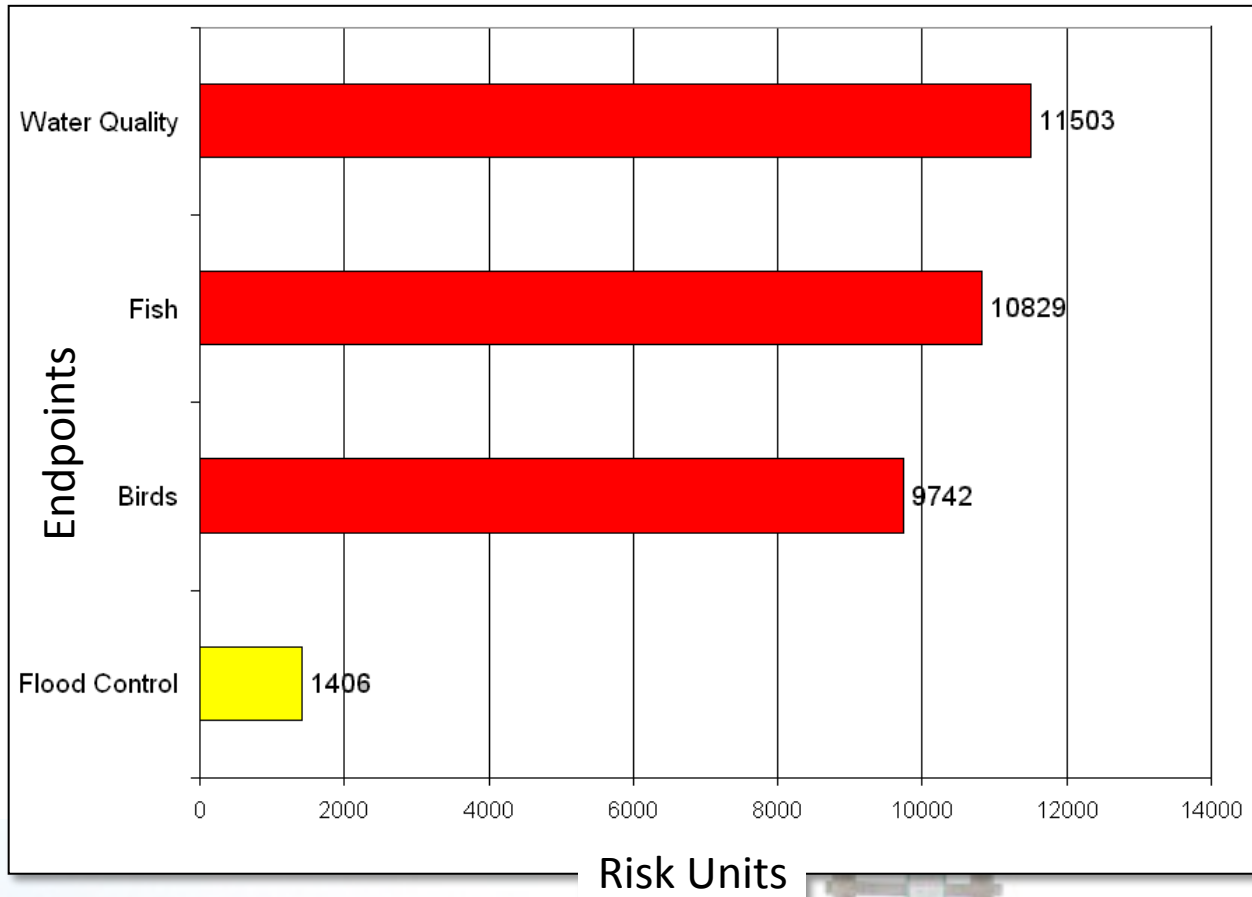
Total Risk from Stressors



18 percent of the risk is covered by TMDL



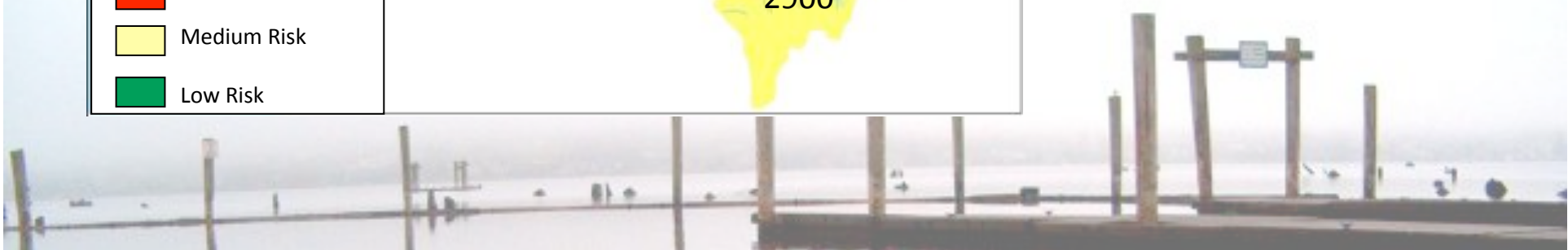
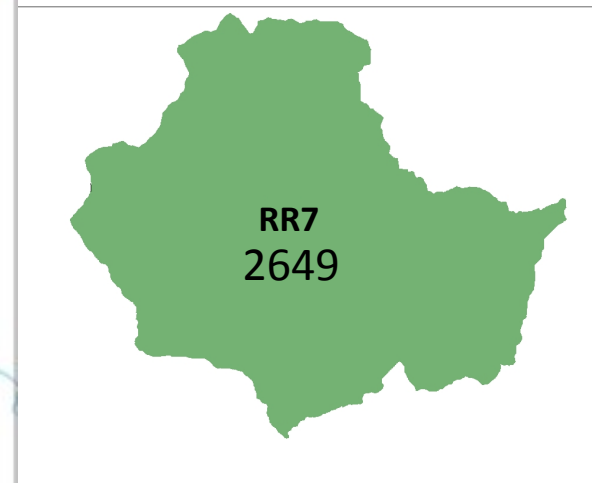
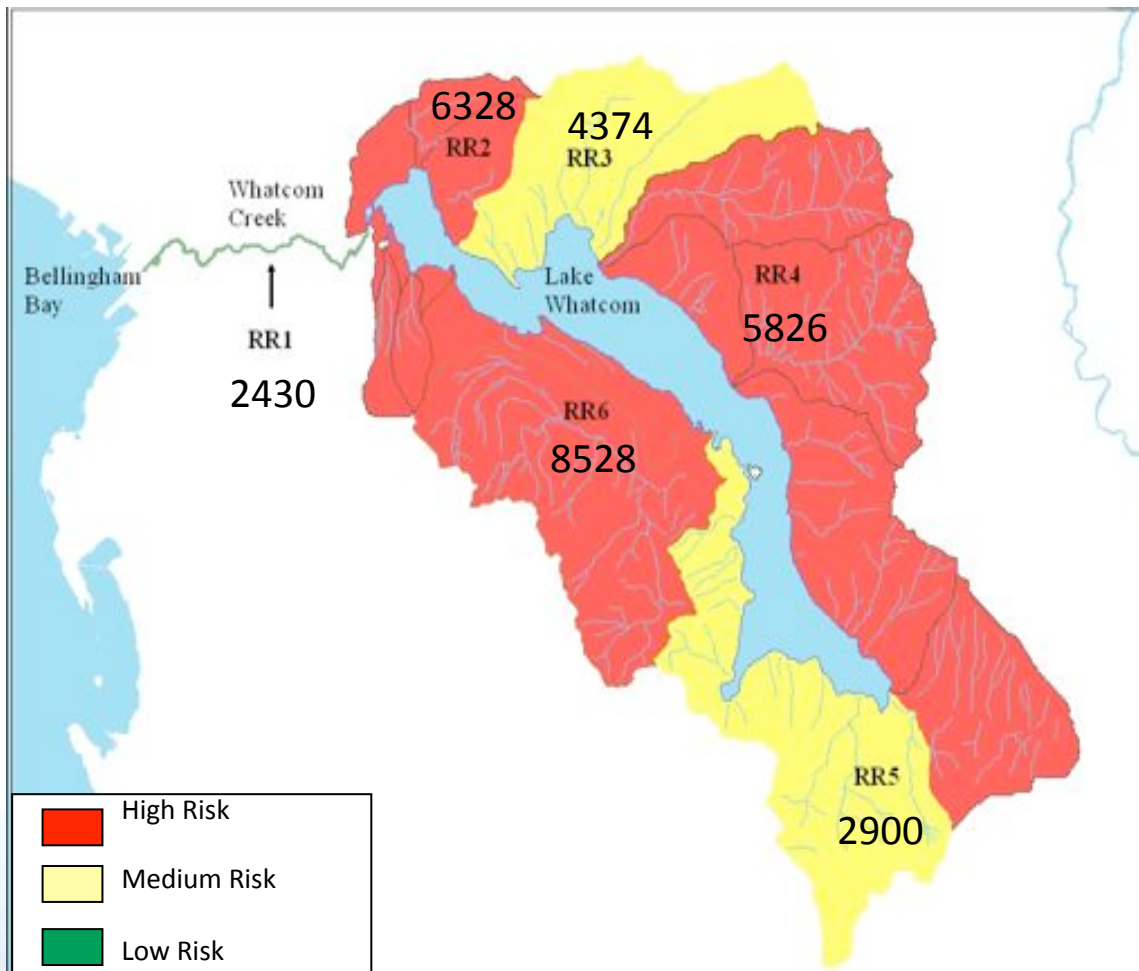
Total Risk to Ecological Endpoints



Water quality is very close to direct risk to Fish and Birds as an ecological endpoint.



Total Risk to Ecological Risk Regions



Lake Whatcom human health risk assessment



Human Health Risk Regions very different habitats.

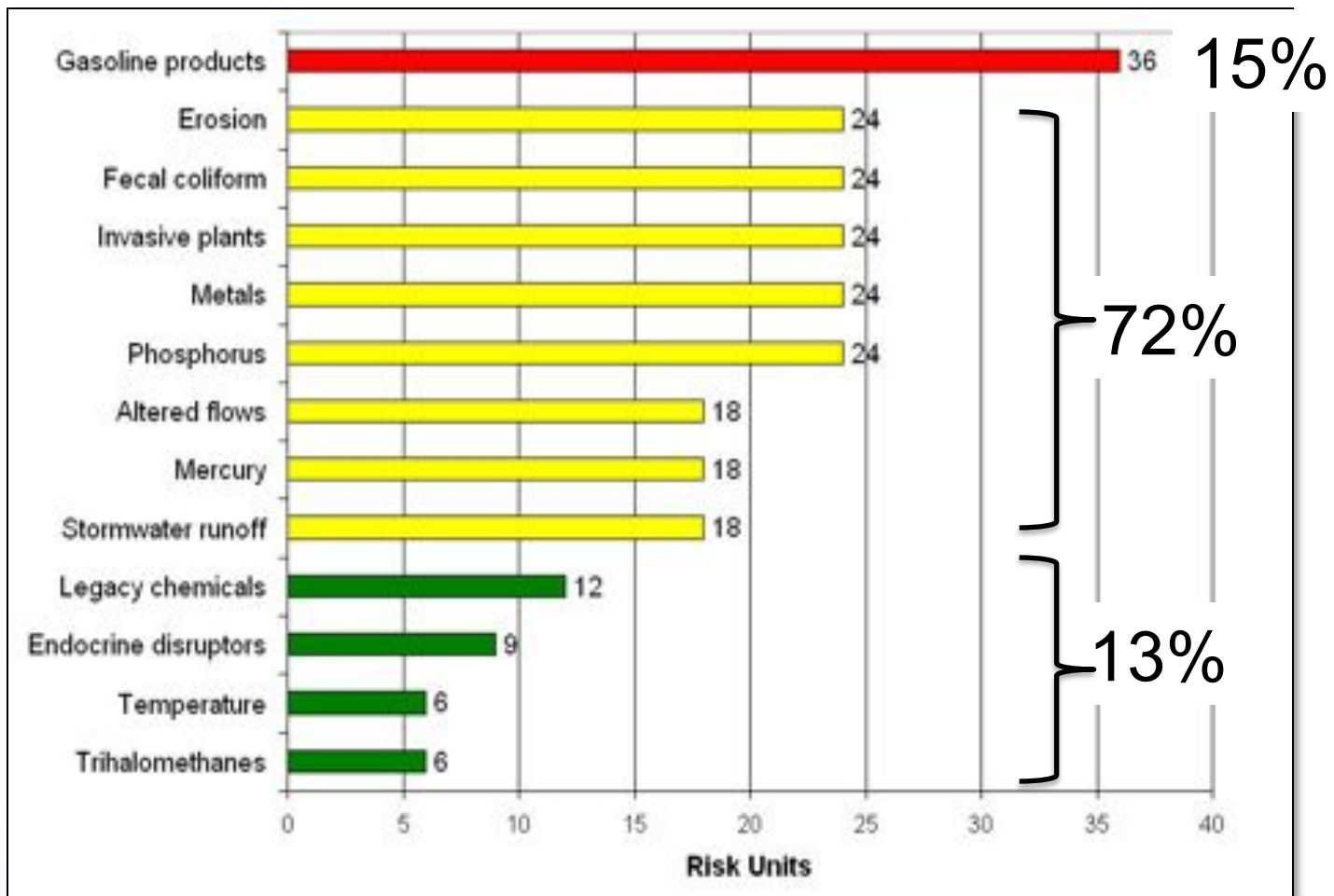


Human Health summary

- Sources: Land disturbance, Transportation
- Stressors: Gasoline products
- Regions: Direct Draw and Human Contact



Human Health Total Risk from Stressors



Washington State TDML Study Goals

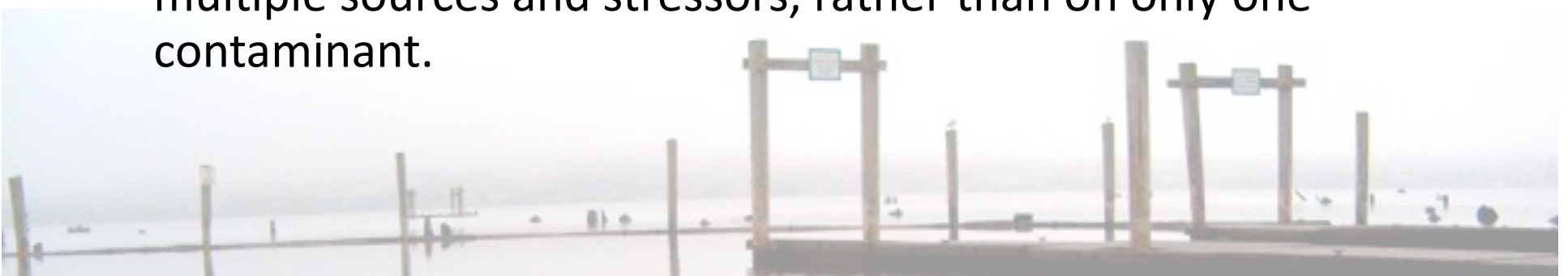
One stressor and one effect

- 303d listed water body for **Dissolved Oxygen** and **Total Phosphorus**
- WA Dept of Ecology requires clean up via Total Maximum Daily Loading (TMDL) study to reduce Total Phosphorus levels in Lake Whatcom.



Conclusions

- Risk is highest in urbanized risk regions from non-point sources
- Human health risk is highest for raw water contact or ingestion
- An elimination of Total Phosphorus as a stressor would reduce risk in the watershed by only 20 percent, but other stressors may also be reduced.
- In contrast, **integrated risk assessment** calculates risk for multiple sources and stressors, rather than on only one contaminant.



An aerial photograph of a large, deep blue lake, likely Lake Whatcombs, surrounded by forested mountains. A city is visible in the distance across the lake. The text "Thank you!" is overlaid in the upper center.

Thank you!

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Website

http://www.wvu.edu/toxicology/lake_whatcom.shtml