Which wicked problem to solve?

Identifying priority threats when "everything is broken"

Urbanization imposes a wide range of wicked problems on stream health, making it difficult to identify priority actions. Current information suggests:

Culverts are the greatest threat to fish communities in Portland streams

- **Strong negative effect on resident as well as migratory species**
- **Strong culvert effect confounded ability to detect impact of other threats**

Lack of riparian canopy was the greatest threat to macroinvertebrate communities

- **Stormwater indicators were also important to macroinvertebrates, but inverse distance weighting and accounting for spatial autocorrelation are needed to more accurately assess these threats**

INTRODUCTION

Urbanization imposes a wide range of "wicked problems" on stream health, including flashy flows, degraded habitat, high temperatures, poor water quality and impaired biotic integrity. The City of Portland, OR monitors an extensive set of instream, riparian and upland land use features to identify the greatest threats to stream health and prioritize restoration actions.

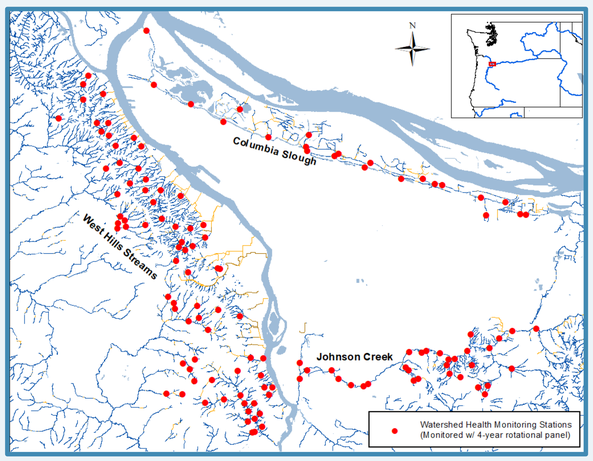

Figure 1: Sites monitored to assess stream health

METHODS

- Streams monitored with EPA's National Rivers & Streams Assessment protocol (USEPA 2017). 128 randomized sites are monitored over a 4-year rotational panel (32 sites/year)
- Upland land use characterized with GIS layers on impervious area, tree canopy, stormwater infrastructure and other urban features.
- Catchment areas delineated through a GIS model incorporating topography and stormwater routing. This captures the urban "pipeshed."
- Riparian zones of 100, 200 and 300 ft around streams and 1 km above sampling point were created through buffer analysis. Results from 300 ft buffers are presented here, but findings from 100 & 200 ft buffers are similar.
- Response variables: Fish Index of Biotic Integrity (IBI; Hughes et al. 1998) and the Observed/Expected ratio* from a macroinvertebrate predictive model (Hubler 2008).

* - The O/E ratio compares the number of species found at the sampled site (Observed) to the number of species typically found in healthy regional reference areas (Expected) (Hubler 2008)

RESULTS

Culverts & Fish

Culverts had a strong negative effect on fish: 45% of the reaches above impassable culverts had no fish (Index of Biotic Integrity = 0). No accessible reach ever had an IBI below 35. Effect does not appear to be due to catchment size: some of highest IBIs are in the smallest streams.

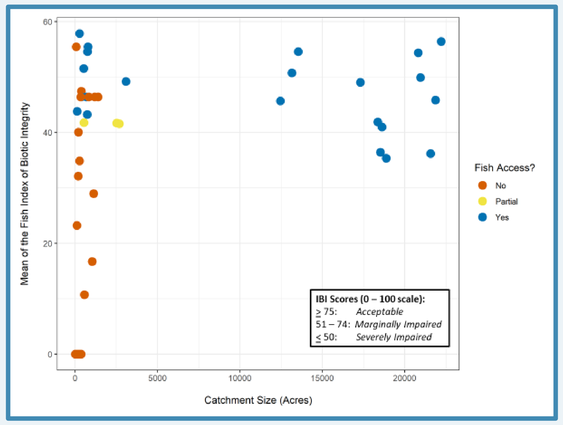

Figure 2: Impact of culverts and stream size on fish IBI

Evaluating additional factors affecting fish communities beyond culverts was hampered by:

1) The strong effect of culverts.
2) Confounding effects of land use (the best habitat in Portland is often located above impassable culverts.)
3) A strong watershed effect—the Columbia Slough, Johnson Creek, and West Hills streams have very different fish communities, and likely always did.

Macroinvertebrates & Riparian Buffers

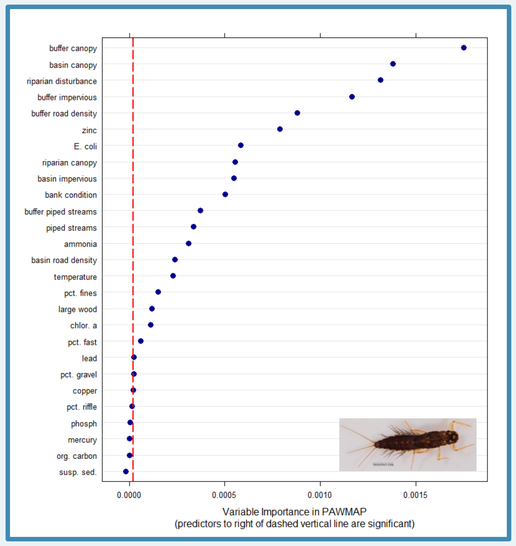

Figure 3: Variable importance from random forest statistical analysis of land use and instream indicators on macroinvertebrate communities.

Buffer canopy was the highest rated indicator. For other indicators, the buffer scale scored higher than the catchment scale, indicating the importance of riparian integrity.

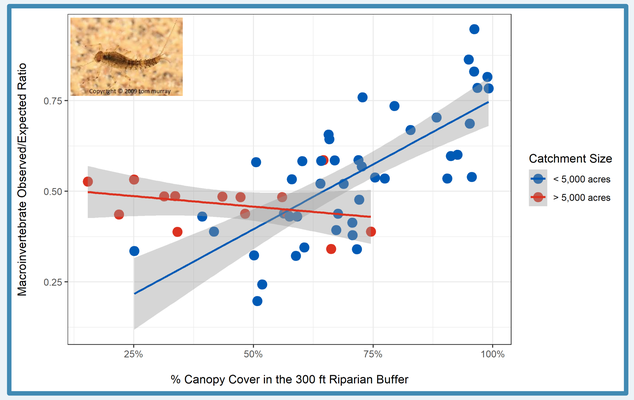

Figure 4: Macroinvertebrate O/E* vs. buffer canopy and catchment size.

There is a strong effect of canopy in smaller streams. For larger streams the effect is not evident, possibly because of 1) inappropriate spatial scale (larger streams may be influenced by conditions beyond 1 km upstream) and 2) spatial autocorrelation (the blue points are all from the mainstem of the same river). Stormwater indicators (e.g., zinc, impervious) were significant additions to the above model. The ability to detect stormwater impacts and land use effects in larger streams may be improved through inverse distance weighting and accounting for spatial autocorrelation, key next steps in the research.

DISCUSSION

Fortunately, culvert replacements and riparian revegetation have been high priorities in Portland stream restoration, and will continue to be.

Inverse distance weighting may improve the resolution of stormwater effects, since it accounts for overland and instream flowpath lengths, rather than weighting all features equally. It may also improve detection of land use impacts in large streams, since it avoids arbitrary, binary designation of a "riparian zone of influence".

Building a spatial stream network to account for spatial autocorrelation is another critical next step, since results suggest that independence of samples—an important assumption in many statistical tests—is violated.

KEY REFERENCES

Hubler, S. 2008. PREDATOR: Development and use of RIVPACS-type macroinvertebrate models to assess the biotic condition of wadeable Oregon streams. DEQ08-LAB-0048-TR.

Hughes, R. M., Kaufmann, P. R., Herlihy, A. T., Kincaid, T. M., Reynolds, L., & Larsen, D. P. 1998. A process for developing and evaluating indices of fish assemblage integrity. Canadian Journal of Fisheries and Aquatic Sciences, 55(7), 1618-1631.

USEPA. 2017. National Rivers and Streams Assessment 2018/19: Field Operations Manual – Wadeable. EPA-841-B-17-003a. U.S. Environmental Protection Agency, Office of Water, Washington, DC. https://www.epa.gov/sites/production/files/2019-05/documents/nrsa_1819_fom_wadeable_version_1.2_0.pdf

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

A number of people & programs are critical to these efforts. Portland Bureau of Environmental Services: Field Operations, Investigation & Monitoring Services, Water Pollution Control Laboratory, Stormwater/Regulatory Compliance, Watershed Services Group, Mapping, Data & Applications. Portland Bureau of Parks & Recreation. Oregon Dept. of Environmental Quality

FOR MORE INFORMATION
Chris Prescott, City of Portland Bureau of Environmental Services
chris.prescott@portlandoregon.gov

RESEARCH POSTER PRESENTATION TEMPLATE © 2019, www.PosterPresentations.com