

Assessing the Risk of Microplastics to Marine Nearshore Environments and Biota Using the Bayesian Network-Relative Risk Model

Spellman, K.N.¹, Yang, S.², and Landis, W.G.¹

¹Western Washington University, Bellingham, WA 98225, ²SEA Discovery Center, Poulsbo, WA 98370; Email: spellmk@wwu.edu

Overview

This project will look to incorporate microplastics into an ecological risk assessment. Specifically, we will be using Bayesian network-relative risk model (BN-RRM) framework to determine the risk to pre-determined endpoints and habitats to answer the question of if the BN-RRM can be accurately applied to microplastics.

Background

- Plastics have been a pollutant in the environment since the 1950s.
- About 322 million tons of plastic were produced globally in 2015, and roughly 10-20 million tons are estimated to enter the marine environment every year¹.
- There is little data to support the specific locations or environmental concentrations of microplastics, so we will sample two locations, Bellingham Bay and Liberty Bay (seen in Figure 1) as the basis of microplastic exposure, and compare the risk at each site.
- Risk is defined as the probability of an effect to a specific endpoint or set of endpoints due to a stressor or set of stressors².
- An endpoint is defined as an entity plus its attribute. For example, Chinook salmon would be the entity and its spawning population would be the attribute.
- Endpoints are selected based on input from stakeholders. Stakeholders in ecological risk assessment are anyone with an interest in the outcome such as government agencies, citizen scientists, policy makers, or community members.
- Endpoints for this project were selected on a preliminary basis from the Puget Sound Partnership's Vital Signs program³, and are seen in Figure 3.

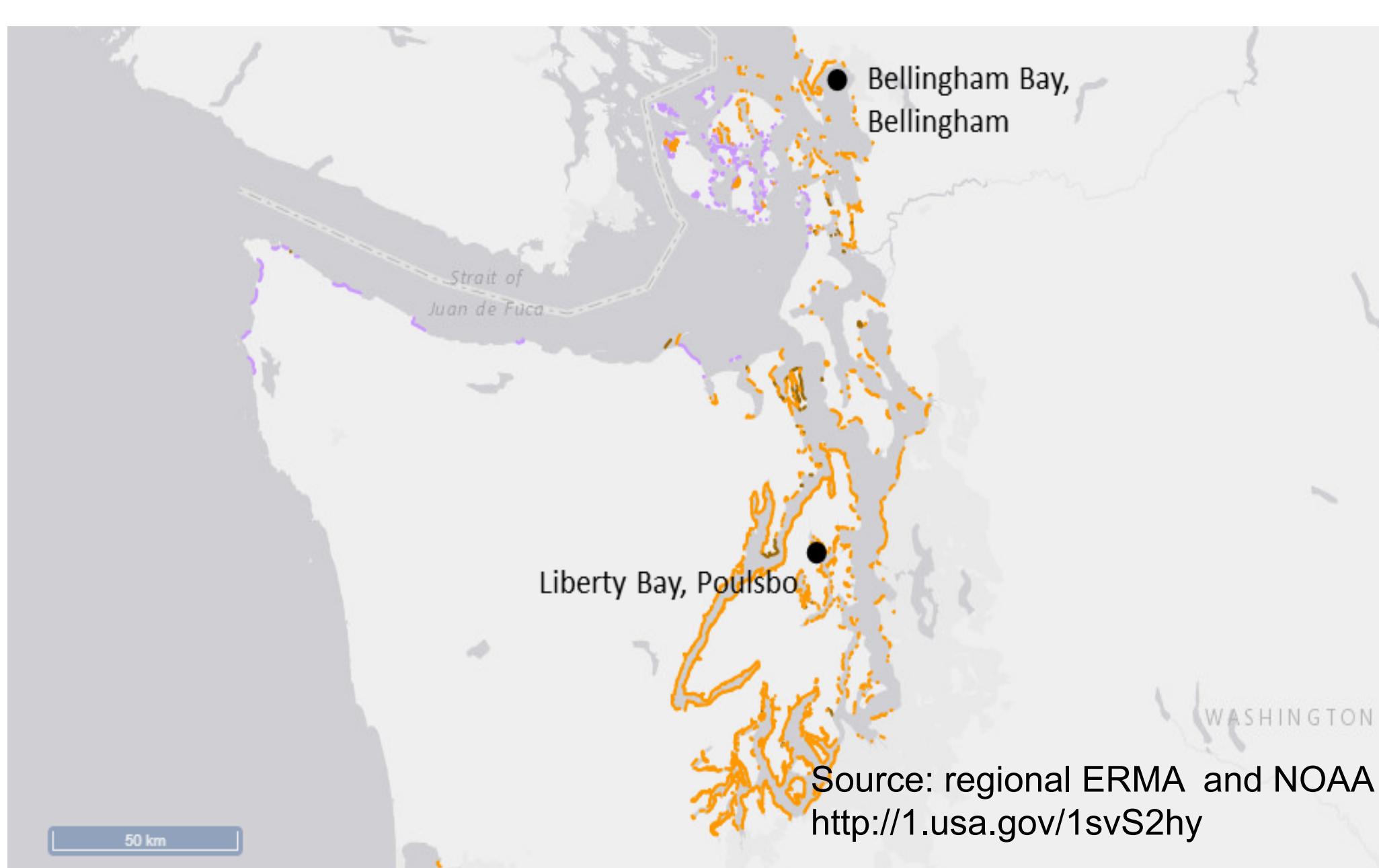


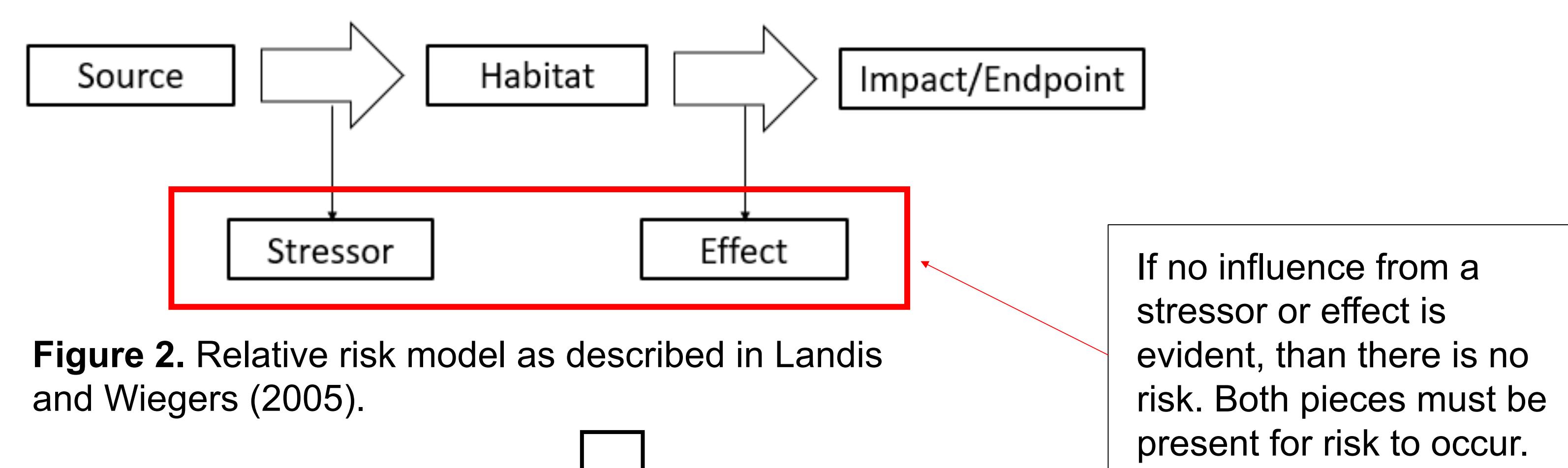
Figure 1. Map of WA state shoreline where sampling will occur. Known eelgrass marine habitats are in purple and estuarine habitats are in orange.

Sampling

- Long term sampling will be performed in association with RE Sources in Bellingham and the SEA Discovery Center in Poulsbo.
- No standard method is currently in place to sample microplastics, so we are following procedures from highly cited literature⁴.
- Microplastics will be grouped into three different size categories:
 - Smaller than 1 mm
 - Between 1 and 5 mm
 - Larger than 5 mm

Methods

Relative Risk Model



Relative Risk Model

The relative risk model (RRM) was developed by Landis and Wiegers (2005) to incorporate large spatial scales and habitats into a risk assessment².

Conceptual Model

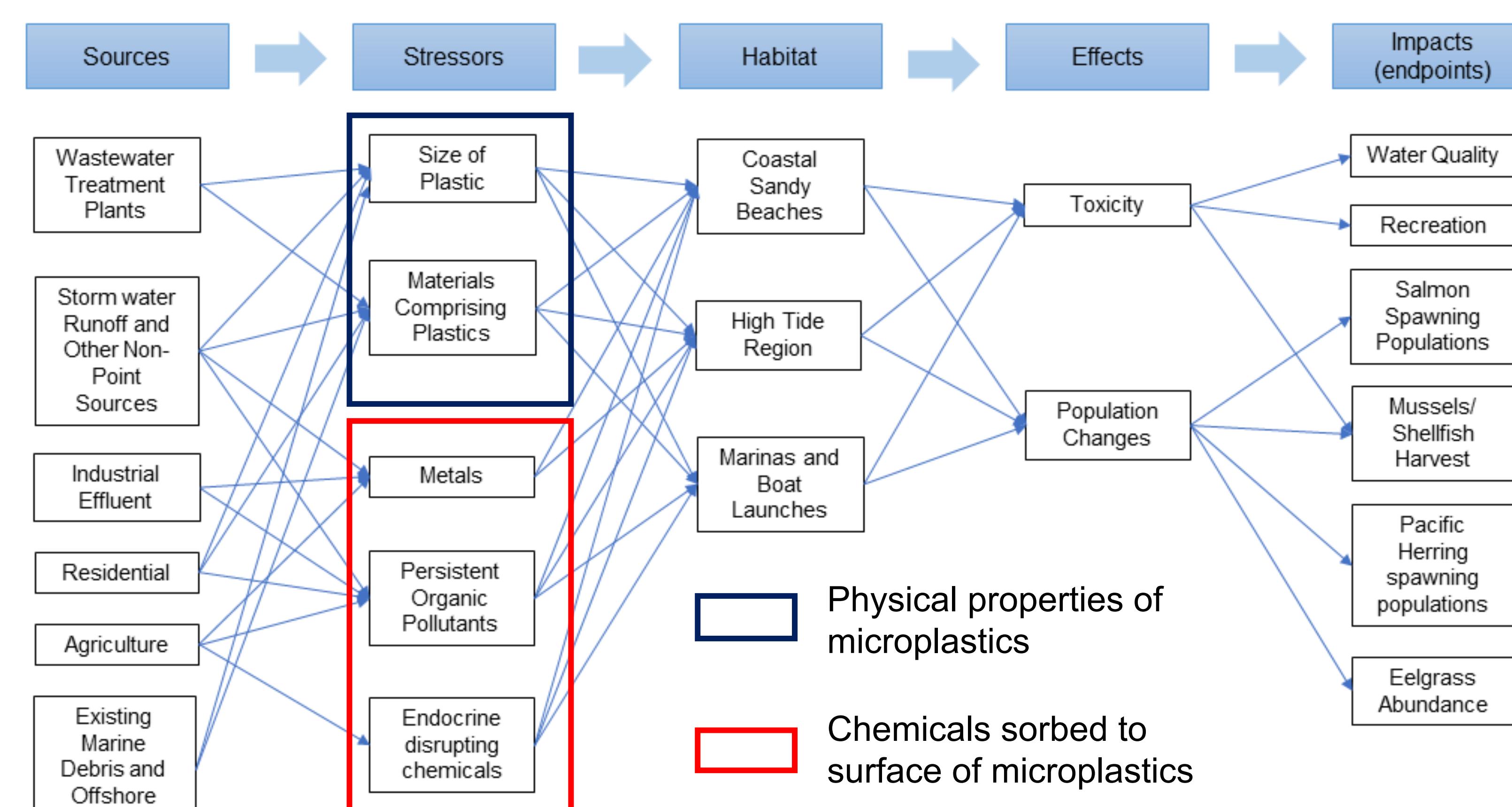


Figure 3. Conceptual model of the sources, stressors, habitat, effects to the endpoints.

Bayesian Network

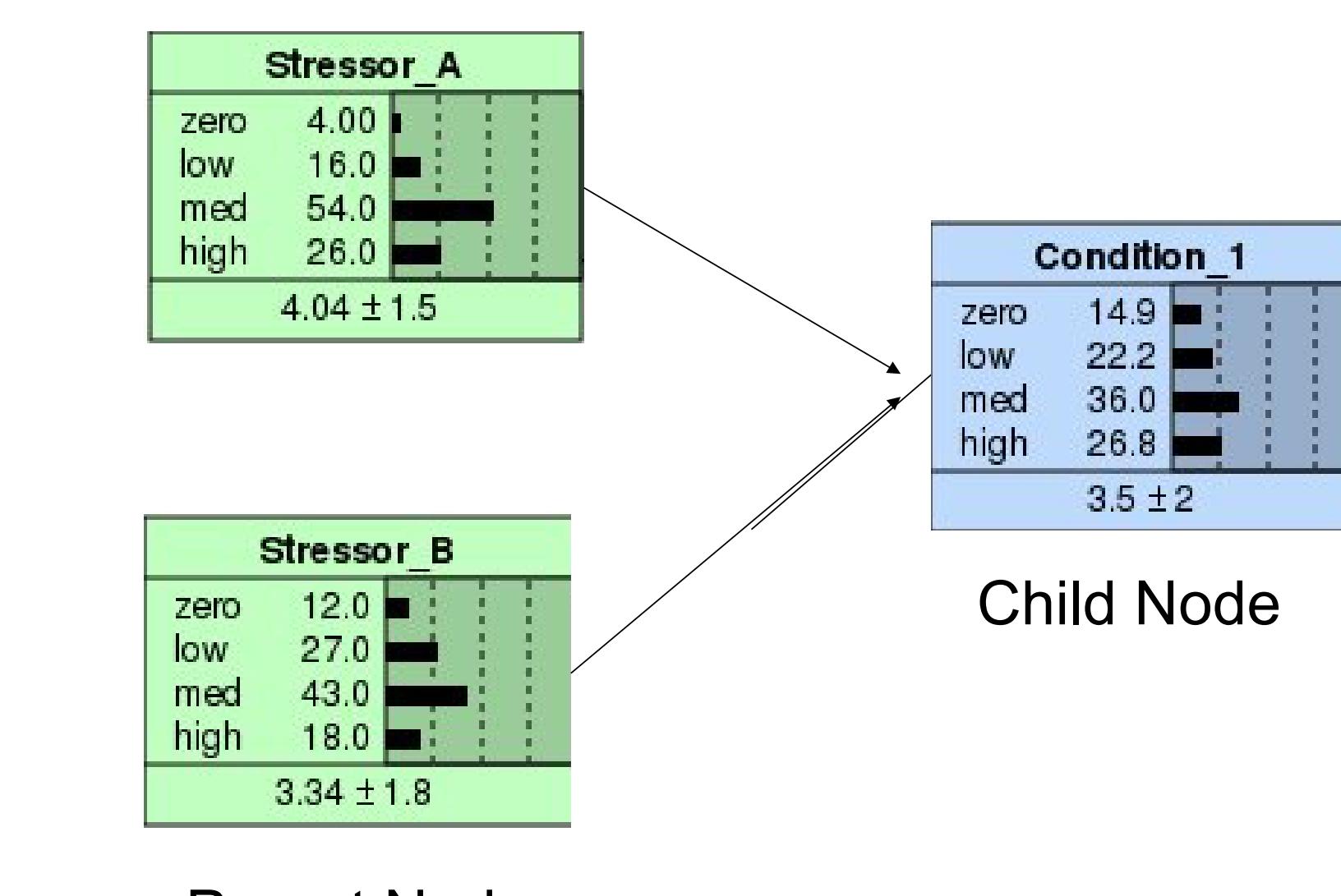


Figure 4. Bayesian network structure of linked parent nodes and child nodes.

Bayesian Network

- The conceptual model in Figure 3 will be used to create the Bayesian network (BN) that will be used to calculate the risk to the endpoint.
- BNs are made up of nodes, with parent nodes feeding into child nodes via the established linkages from the conceptual model.
- The probability levels in each node come from conditional probability tables (CPTs).
- The final risk to an endpoint will be displayed as a probability distribution.

Next Steps

- Initiate sampling in Bellingham and Liberty Bays to generate exposure data.
- With stakeholder input, narrow conceptual model endpoints to the one or two most important.
- GIS analysis of the two study areas to identify the land cover and land use types.
- Create the BN model and accompanying CPTs for each node.

References

- [1] PEMRG [PlasticsEurope Market Research Group]. 2016. World Plastics Production 1950 – 2015. PlasticsEurope Association of Plastics Manufacturers. Available online at <https://committee.iso.org/files/live/sites/tc61/files/The%20Plastic%20Industry%20Berlin%20Aug%202016%20-%20Copy.pdf> (accessed 19 October 2017).
- [2] Landis WG, Wiegers JA. 2005. Chapter 2: Introduction to the regional risk assessment using the relative risk model. In Regional Scale Risk Assessment: Using the Relative Risk Model. CRC Press, Boca Raton.
- [3] Puget Sound Partnership. 2016. Puget Sound Vital Signs. Available online at <http://www.psp.wa.gov/vitalsigns/index.php> (accessed 3 November 2017).
- [4] Masura J, Baker JE, Foster G, Arthur C. 2015. Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. NOAA Technical Memorandum NOS-OR&R-48.