

Water Quality Modeling in Puget Sound

Water quality models are mathematical tools that scientists use to represent a water system. With these tools, we can visualize and understand what factors may be contributing to pollution both now and in the future.

Why do we need water quality models, and why do we need more than one for Puget Sound?

Human activities have compromised Puget Sound's health. We can't distinguish which activities have the greatest influence with monitoring programs alone. Models are tools that help us (1) understand what factors may be responsible for water quality problems, and (2) plan a course of action to fix the problems.

We need a variety of models to diagnose Puget Sound for the same reason that we need a variety of medical doctors to diagnose our health problems. Some doctors are general practitioners and some are specialists, just as some models are general and others are specialized. Several doctors may work on the same health problem but approach it from different perspectives.

Human health problems may be obvious: a broken leg. Other health problems are less apparent: a sore abdomen. Similarly, Puget Sound health problems may be obvious: fish kills in Hood Canal. Other health problems are less apparent: fewer salmon return to spawn. Multiple factors influence fish counts, including food, reproduction, dissolved oxygen to breathe, shelter from predators, and disease.

But first we need information—what are the symptoms and underlying problems?

Water quality models complement our water quality monitoring programs that measure water properties. Monitoring programs are like taking the pulse of Puget Sound. But we can't just take the pulse once. Instead, we need to understand the patterns that produce high or low pulse rates. We use models to understand patterns in monitoring data. We can use models to optimize monitoring plans for Puget Sound to help us spend money wisely. Monitoring programs



Scientists collecting data in Puget Sound to check against model output.

Department of Ecology Puget Sound website

[www.ecy.wa.gov/
puget_sound/index.html](http://www.ecy.wa.gov/puget_sound/index.html)

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are a necessary complement to models because monitoring helps us identify the symptoms and isolate the factors that contribute to the problem.

How can models help us improve the health of Puget Sound?

We know some general actions make sense, regardless of the specific problems. But unless we really understand the problem, we have no guarantee that particular actions are enough. Several organizations, including the Department of Ecology, are developing a suite of models to diagnose Puget Sound health problems and recommend courses of action. Rather than waiting years to see if a change in pollution control will improve water quality, we can use models to help us understand the effectiveness of management actions now. Models can be used to prioritize which actions are needed to improve the health of Puget Sound.

What kinds of water quality models address the health of Puget Sound?

Generalists. Generalist models predict how water moves around. We use circulation modeling to address a wide variety of questions about the health of Puget Sound. If a pollutant spill or shellfish larvae is released in one location, we can use a circulation model to identify where the spill or larvae might go under different tide or wind conditions. In the case of a pollutant spill, we need to know quickly which direction the spill might move, so an intermediate or fine-scale model is most beneficial.

Specialists. Specialist models include a variety of water quality and food web models. These answer questions such as: Is nitrogen loading from point (discrete) sources or nonpoint (diffuse) sources a major contributor to low dissolved oxygen levels? If we can reduce discharges of PCBs in the water, what levels of PCBs will remain in Puget Sound marine mammals? We can't use specialty models interchangeably, just as we wouldn't want our dermatologist to manage our heart problems. However, doctors may consider some of the same medical information, just as various water quality and food web models consider similar data.

Domain and scale. Generalist and specialist models are further complicated by domain and scale. *Domain* is the total area of interest, such as all of Puget Sound, or maybe only South Puget Sound. *Scale* is the smallest critical size within the domain, such as the bottom water of southern Budd Inlet or a particular shellfish growing area.

We use a range of models from coarse to fine. Coarse models can be used to assess region-wide factors, such as bioaccumulation (build up) of toxics in marine mammals or birds. However, other questions may need more spatially-detailed models. For example, during what times of the year does a shellfish bed in Oakland Bay meet bacteria standards for harvesting? Coarse, fine, and intermediate scale models with different domains all address specific questions.

Summary. Generalist and specialist models complement each other. For example, they may cover all of Puget Sound or a specific management area or bay. We need both types of models to diagnose the problems affecting Puget Sound's overall health. Diagnosing water quality problems and determining a course of action requires generalists and specialists working on different scales. Just as *health* covers a broad area for humans, *Puget Sound health* is equally complex.