

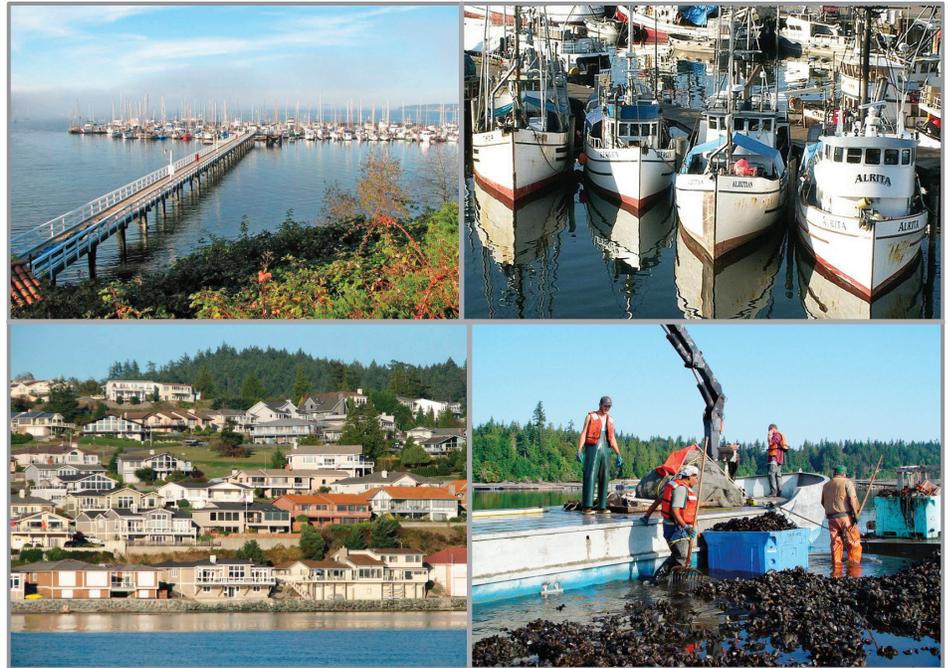
RESEARCH AT THE USGS WESTERN GEOGRAPHIC SCIENCE CENTER

Land-Use Planning for Nearshore Ecosystem Services— The Puget Sound Ecosystem Portfolio Model

The 2,500 miles of shoreline and nearshore areas of Puget Sound, Washington, provide multiple benefits to people—“ecosystem services”—including important fishing, shellfishing, and recreation industries. To help resource managers plan for expected growth in coming decades, the U.S. Geological Survey Western Geographic Science Center has developed the Puget Sound Ecosystem Portfolio Model (PSEPM). Scenarios of urban growth and shoreline modifications serve as model inputs to develop alternative futures of important nearshore features such as water quality and beach habitats. Model results will support regional long-term planning decisions for the Puget Sound region.

The Puget Sound region of northwestern Washington, home to more than 4 million people, comprises a major U.S. estuary with many rivers and streams draining an area of more than 13,000 square miles. The complicated bays and waterways of the sound have 2,500 miles of shoreline—bluffs, beaches, mudflats, kelp and eelgrass (*Zostera marina*) beds, salt marshes, gravel spits, and estuaries. This highly productive zone supports valuable fishing, shellfishing, and recreation industries, which contribute billions of dollars to the State’s economy. The food, water, cultural, and recreational benefits people obtain from nearshore environments are considered “nearshore ecosystem services.”

The Puget Sound region continues to experience rapid development and growth in population, which is expected to reach 5.4 million residents by 2025. This future growth can affect nearshore ecosystem services by increasing water pollution and nutrient loading and by modifying coastal habitats. The land-use decisions made to accommodate this growth will influence whether Puget Sound environments are further degraded, maintained, or successfully restored. Resource managers need tools to identify where and why potential impacts to ecosystem services may occur to plan for ensuring their long-term sustainability.



The many benefits to people (ecosystem services) of the Puget Sound, Washington, nearshore are illustrated by (clockwise from upper left) recreational boating at Port Hadlock marina (photo © Hugh Shipman); fishing (photo © JP Paul Grow); mussel harvesting (photo © Jon Rowley); and waterfront living in Anacortes (photo © Hugh Shipman). The Puget Sound Ecosystem Portfolio Model will provide planners data needed to accommodate expected growth and development while preserving and protecting these ecosystem services.

Although it is not known where and how much development will occur in the future, the influences of population growth, regulations, and public preference can be



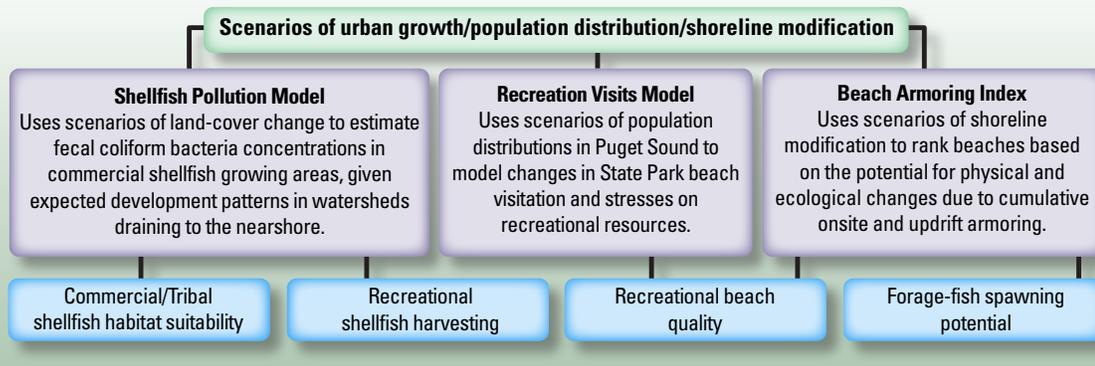
The Puget Sound, Washington, region (watershed outlined here) includes intricate waterways that stretch along 2,500 miles of shoreline and adjacent nearshore waters.

monitored. Instead of trying to predict development patterns, planners can develop scenarios, which may include maps that show, for example, where people might live and work in 2060. Scientists can then determine how the nearshore ecosystems may change under each scenario.

The Puget Sound Ecosystem Portfolio Model

The U.S. Geological Survey (USGS) Western Geographic Science Center (WGSC) has been working with the U.S. Environmental Protection Agency, shoreline planners, public health officials, and others to develop the Puget Sound Ecosystem Portfolio Model (PSEPM). Based on earlier efforts (<http://pubs.usgs.gov/sir/2009/5181/>), the PSEPM is a decision support tool that uses scenarios to evaluate where, when, and to what extent future population growth, urban development, and shoreline development may alter the nearshore environment

Puget Sound Ecosystem Portfolio Model Subcomponents



Scenarios of future growth (green box) drive submodels of nearshore change (purple boxes). Submodel outputs are used to assess future changes to ecosystem services (blue boxes). The submodel results may provide information about more than one ecosystem service. For example, Beach Armoring Index results affect the spawning potential of forage fish (small fish that larger predators eat) and recreational beach quality, which is also affected by Recreational Visits Model results.

50 years from now. The tool focuses on impacts to barrier beaches and bluff-backed beaches, which represent 50% of Puget Sound shorelines by length.

The PSEPM presents three possible futures of the nearshore by analyzing three growth scenarios developed out to 2060:

- Status Quo—continuation of current trends.
- Managed Growth—adoption of an aggressive set of land-use management policies.
- Unconstrained Growth—relaxation of land-use restrictions.

These scenarios were developed by scientists at Oregon State University and provide information on projected population, land cover, and, in coastal areas, shoreline modifications (see <http://envision.bioe.orst.edu/StudyAreas/PugetSound/index.html>). PSEPM model outputs include maps that identify shoreline sections where nearshore

resources may be more strongly affected by changes on the land.

Model Subcomponents and Results

The PSEPM comprises three submodels—the Shellfish Pollution Model, the Recreation Visits Model, and the Beach Armoring Index—that identify connections between changes on the land and the capacity of the nearshore to support ecosystem services. Results from the PSEPM identify where and when future changes to nearshore ecosystems and ecosystem services will likely occur within the three urban growth scenarios. The model results will improve understanding of potential changes in nearshore ecosystem services by:

- Highlighting resource-rich areas that may potentially be affected by multiple stressors;
- Helping to prioritize sites for further study and higher level conservation and restoration planning;

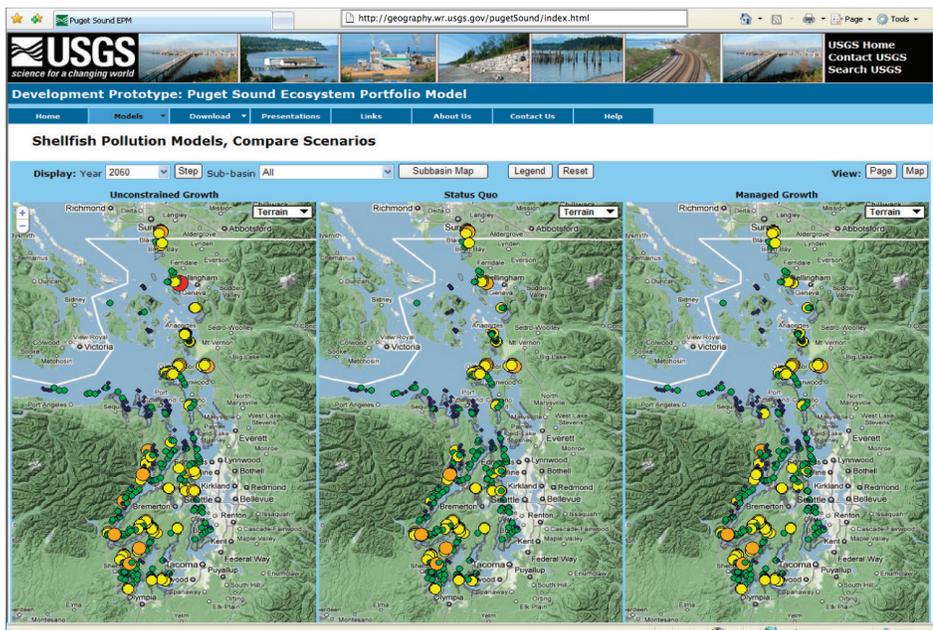
- Providing planners with the ability to focus on targeted areas in order to meet regional land-use planning goals; and
- Providing the foundation for evaluating changes in Puget Sound ecosystem services within integrated scenarios of climate change and land-use change.

The work of Western Geographic Science Center (WGSC) scientists in developing the Puget Sound Ecosystem Portfolio Model is only part of WGSC's efforts to better understand the causes and consequences of land-cover change. WGSC is continuing productive collaborations with public land managers, tribal leaders, and local communities to help ensure that they have the crucial information they need to make informed decisions about ongoing and future land-use choices.

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Users of the PSEPM Web site (<http://geography.wr.usgs.gov/pugetSound/index.html>) can view model results and compare scenarios using a Web-based mapping application. A three-map viewer allows the user to view, compare, and contrast results at the data-point scale or at the regional scale across three scenarios simultaneously. Model results can also be downloaded on a data download page.

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 Washington State Department of Health
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