How do we effectively manage nutrients to support healthy marine life in Puget Sound?

Washington is taking important steps to manage nitrogen pollution in Puget Sound, particularly to prevent low dissolved oxygen levels that can harm marine life. But the presumptive dissolved oxygen standard and nutrient regulations may be overly protective, while requiring massive investments in wastewater treatment upgrades and globally unprecedented watershed reductions. Ongoing research is helping clarify which oxygen levels truly pose a risk to Puget Sound species.

Explore key scientific insights and tradeoffs to support strategic nutrient management decisions.

PUGET SOUND INSTITUTE
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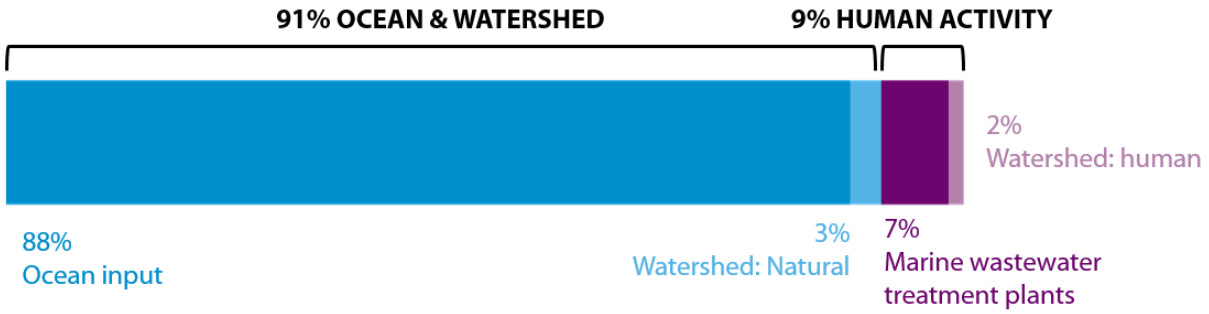
A digital copy of this factsheet with the hyperlinked sources is available at bit.ly/Nutrients4Policy.

Photo courtesy of Conrad Gowell, WFC

Sound-wide oxygen levels are generally healthy, but do changes in Hood Canal and embayments pose a risk to marine life?

Regulation is particularly focused on the impacts that nitrogen from human sources has on low dissolved oxygen in Puget Sound. A few key scientific insights help ground these management decisions:[1]

1. While most of Puget Sound has sufficient levels of dissolved oxygen throughout the year, low dissolved oxygen does occur naturally in some areas.
2. Although just 9% of the nitrogen in Puget Sound comes from human sources, modeling suggests it can worsen low oxygen conditions, particularly in Hood Canal and some shallow embayments.
3. Despite decades of major population growth, wastewater nutrient loads only increased slightly.[2] & [3]
4. Not all oxygen declines are necessarily harmful. Marine life may escape, acclimate, or adapt to mild drops in oxygen, but more severe or prolonged exposures may lead to stress or death.



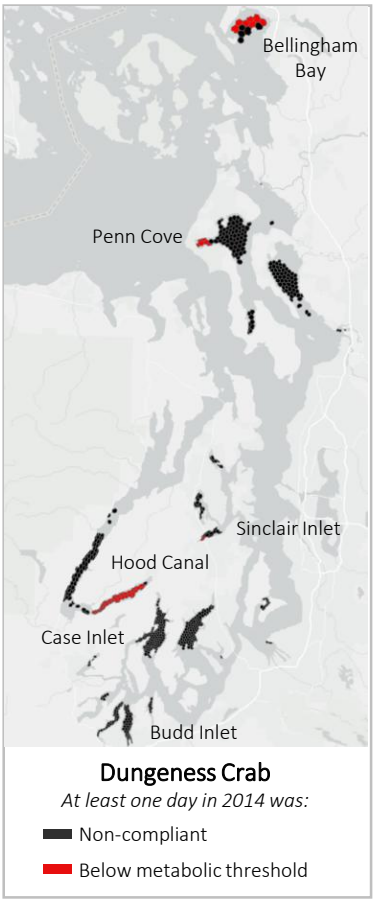
Focusing on temperature & oxygen jointly may better protect marine life

Warmer water holds less oxygen while also increasing how much oxygen marine species need to thrive.

Over the past century, warming caused most of the 0.3–0.9 mg/L decline in fall, bottom-water oxygen at several long-term monitoring sites in Puget Sound.[4]

University of Washington scientists are studying temperature and oxygen to identify when and where species are most vulnerable. Early results show:[5]

- **Chinook salmon:** At a few sites, primarily near the bottom of the Sound, oxygen falls below what Chinook need, but they can avoid these areas by swimming into shallower waters. The majority of areas listed as impaired under water quality standards appear to pose limited direct risk.
- **Dungeness crabs & English sole:** In parts of Bellingham Bay, Penn Cove, Sinclair Inlet, Case Inlet, Budd Inlet, and Hood Canal, oxygen levels would fall below species needs even without human inputs. Nutrients from human activities make these low-oxygen periods last a few weeks longer each year.



Compared to noncompliant areas, only 12% fall below the oxygen levels crabs likely need, and a very small portion of compliant areas (0.05%) may also pose some risk.[6]

Marine life may be more resilient than the water quality standard assumes

Low dissolved oxygen poses a risk to marine life only when it falls below a species' specific tolerance. Washington's presumptive water quality standard for dissolved oxygen may be overly protective.

Chinook salmon and herring have been observed at oxygen levels far below the state's numeric criteria, even though more oxygen was available in waters just above them.[7]

- Most of Puget Sound falls below the numeric criteria even without human impacts, so it is important to consider natural conditions.
- How we draw the line matters—particularly since most noncompliant areas barely exceed the standard.[8]
- The standard does not reflect how much oxygen loss truly harms marine life, making it likely overprotective.
- Credibly implementing the standard requires model skill beyond what any model can likely ever achieve.[9]

WATER QUALITY STANDARD

Puget Sound is considered non-compliant if:

1. **Measured** oxygen levels fall below either the numeric criteria (4 to 7 mg/L) or modeled estimates of natural conditions, whichever is lower

&

2. **Modeled** results show that human activities reduce oxygen by more than 0.2 mg/L or 10% below natural conditions, whichever decrease is smaller

**EPA is currently reviewing the proposed natural conditions provision.*

Better aligning water quality standards with biological risk would ensure nutrient reductions deliver meaningful protection while making more effective public investments

Meeting the current standards would require unprecedented nutrient reductions in watersheds

Reducing nutrients from diffuse sources in watersheds is notoriously challenging.

- Actions are often voluntary, require buy-in from individual landowners, and are frequently undermined by competing agricultural incentives.
- The Draft Nutrient Reduction Plan sets watershed targets that would reduce nitrogen loads by 53 -67% region-wide, and up to 90% in some areas.[10]
- **These reductions exceed what has been achieved in the best cases globally**
  - *Denmark halved its nitrogen surplus over decades through strong political will and strict regulations on livestock, manure, and fertilizer.*[11]

↓ 53 - 67%

Proposed watershed reductions

Photos courtesy of Jim Chaote and Conrad Gowell, WFC.

Households will shoulder significantly higher sewer costs from upgrades

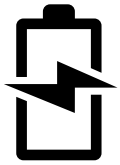
Most wastewater plants were not designed to remove nitrogen, which primarily comes from urine. Meeting the conservative, proposed nutrient limits will require major upgrades to plants that will:

1. Cost billions in capital investments and operating expenses. Initial estimates suggest that upgrading King County's system alone may cost $10 - $20 billion.[12]
2. Significantly increase household sewer bills.
3. Increase hardship for low-income households already paying 2–11% of their income on sewer bills.[13]

These added costs come on top of ongoing investments to replace aging infrastructure and treat other contaminants, often delaying other upgrades. State and federal funding helps, but remains limited.

Tradeoffs extend beyond cost

As the nitrogen levels that wastewater treatment plants are required to remove become more stringent, the tradeoffs increase exponentially. These tradeoffs include:[15]



Increased chemicals, energy, and greenhouse gas emissions

Nutrient removal not only requires more chemicals and energy, but it also produces nitrous oxide, which is 273× more potent than CO_2.

- *Edmonds projects a 30-50% rise in energy use and Tacoma a 2.8–3.6 x increase.* [16 & 14]

Less flexibility to treat new pollutants

Plants are hard to reconfigure, and no proven method exists to remove many emerging contaminants. Focusing upgrades solely on nitrogen could make this even harder later.

- *King County and Tacoma are advancing research to treat PFAS and 6PPD-Q.*

Reduced capacity for growth

Advanced nitrogen removal slows treatment, limiting how much wastewater plants can handle as the population grows to stay under fixed load limits.

- *King County could reach the 'limit of technology' by 2030.*[12]

Reduced ability to accept septic waste

Regional capacity to treat septage is already limited[17] and stricter nutrient limits may make it even harder for plants to accept this nutrient-rich waste.

- *Everett anticipates it may no longer be able to accept septage.*[18]