

Washington State's Marine Dissolved Oxygen (DO) Criteria: Application to Nutrients

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Water Quality Program



Overview

- Water Quality Standards
 - Numeric DO Criteria
 - Aesthetic Narrative Criteria
 - Anthropogenic Allowance

- History and Rationale for Marine DO Criteria

- Nutrient Criteria Alternatives

- Application of Marine DO Criteria
 - Water Column
 - Site Specific Locations
 - Anthropogenic Allowance





Water Quality Standards

Water Quality Standards

- The water quality standards set limits on pollution in our lakes, rivers and marine waters in order to protect beneficial uses, such as aquatic life and swimming.



DO Criteria

- DO criteria in the water quality standards are intended to set levels that protect healthy, robust aquatic communities, including the most sensitive species
- Assumption: if numeric criteria are met for the most sensitive organisms of each habitat, then the waterbody will protect all other species
- Criteria: **magnitude, duration, & frequency** component



DO Numeric Criteria

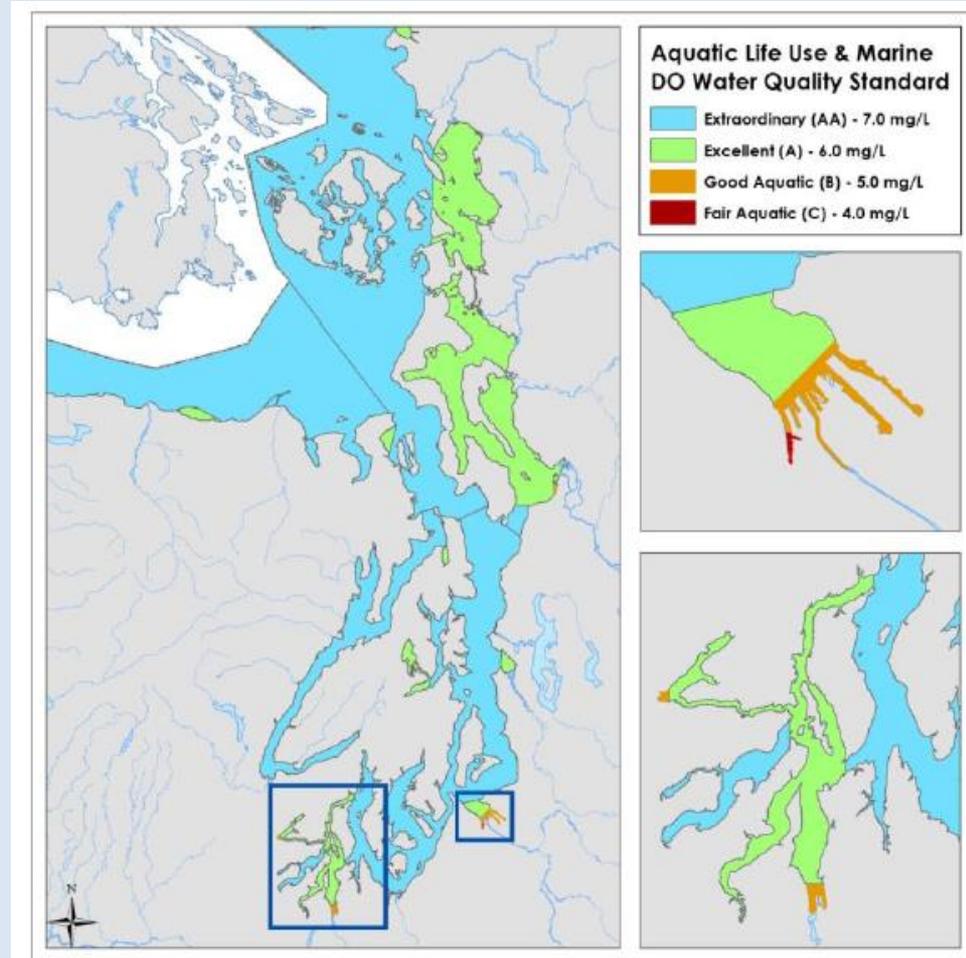
Aquatic Life Use	DO Criteria (1-day min.)	General Description
Extraordinary quality	7.0 mg/L	Extraordinary quality salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning.
Excellent quality	6.0 mg/L	Excellent quality salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning.
Good quality	5.0 mg/L	Good quality salmonid migration and rearing; other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning.
Fair quality	4.0 mg/L	Fair quality salmonid and other fish migration.



Criteria exceedances may occur once every ten years on average.

WQ Dissolved Oxygen Standards in Puget Sound

- **7.0 mg/L** - most of Puget Sound and the Straits
- **6.0 mg/L** – Bellingham Bay, Samish Bay, Skagit Bay, around Whidbey, other inlets/bays
- **5.0 mg/L** - Commencement Bay, Budd Inlet, and portions of some inlets
- **4.0 mg/L** –finger of Commencement Bay



Aesthetics Criteria

- Aesthetic values must not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of light, smell, touch, or taste.
 - Used when numeric criteria are insufficient



Anthropogenic Allowance

- Allowance: 0.2 mg/L DO
- Based on concept of a measurable change
 - Measurable change: change in physical, chemical, or biological quality of the water to determine that a lowering of water quality occurred
 - Represents a detectable change in water quality based on precision of the instrument
 - **Not a biologically derived value**

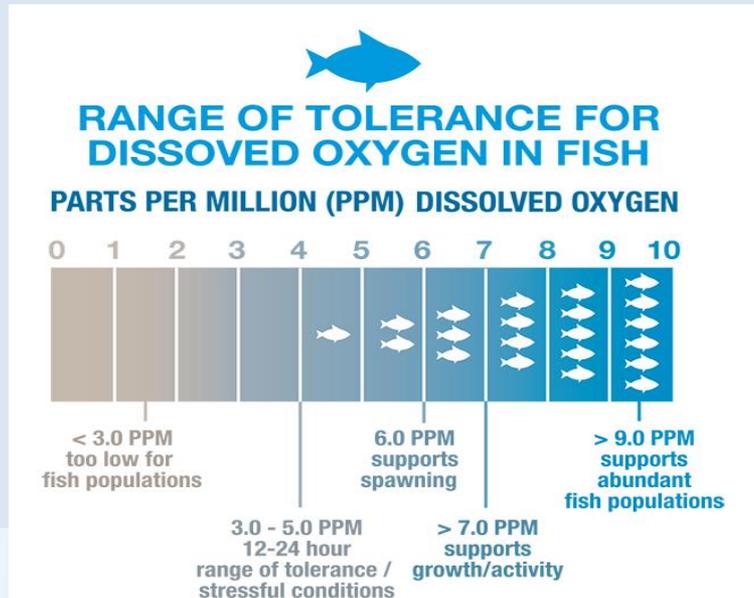




Marine DO Criteria Rationale

History of Marine DO Criteria

- 1968 Dept. of Interior recommendations:
 - DO levels between **5 and 8 mg/L** protect survival and growth of fish
 - Coastal waters shall not be **<5.0 mg/L**
 - Estuaries & tidal tributaries shall not be **<4.0 mg/L**

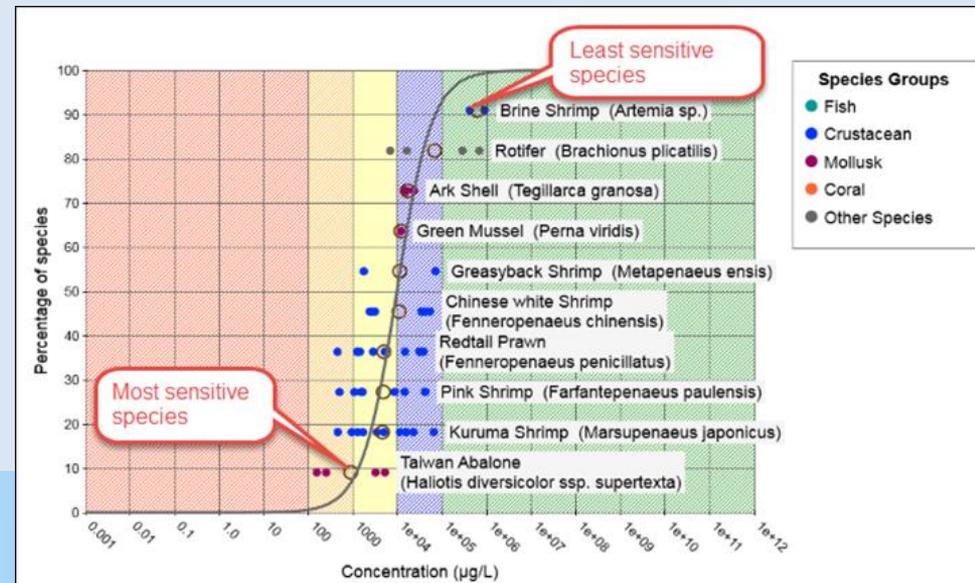


Supporting Scientific Data

- Vaquer-Sunyer & Duarte (2008):
 - Reviewed 872 experiments spanning 206 species
 - 4.6 mg/L DO: maintain most populations & biodiversity
 - 5.0 mg/L DO: protective of sub-lethal effects for most species
 - 4.6 and 5.0 mg/L values represent 90th percentile of LC50s
 - Most sensitive species not protected at these levels

- Conclusion:

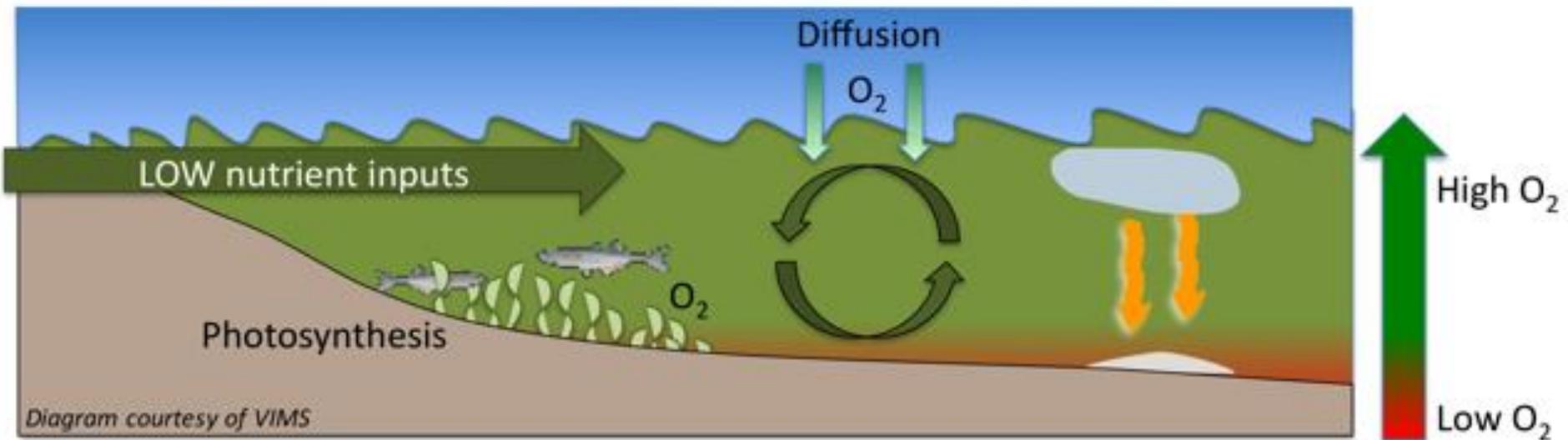
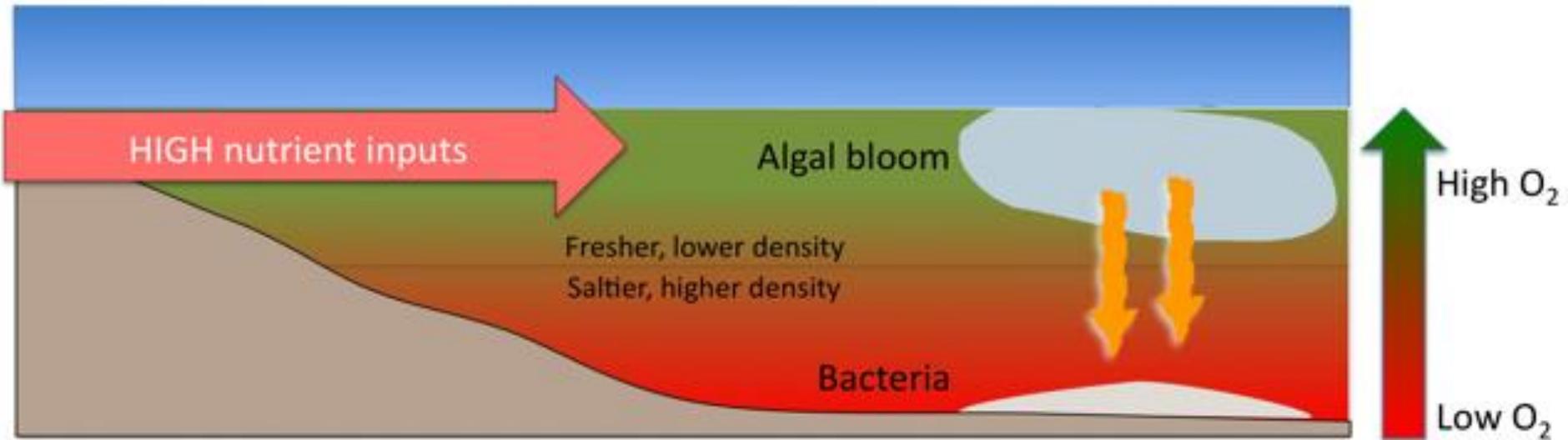
- Full protection >>>5.0 mg/L DO





Nutrient Criteria Alternatives

DO : Nutrient Dynamics



Translating Numeric Criteria to Nutrients

Dissolved Oxygen

- Interrelationships between DO and nutrients
- Variations in DO can be associated with excessive nutrient inputs
- Marine models used to demonstrate relationships
 - Develop nutrient reduction volumes to achieve goals
 - Initiate actions to protect aquatic life



Translating Narrative Criteria to Nutrients

- Aesthetics narrative applies to effects of presence or offense to senses (light, smell, touch, taste)
- Various measures:
 - Percent oxygen saturation
 - Chlorophyll levels
 - Photographic evidence of algal mats/blooms
 - Others...
- Relationships between nutrient over-enrichment and aesthetics can be established





Application of DO Criteria

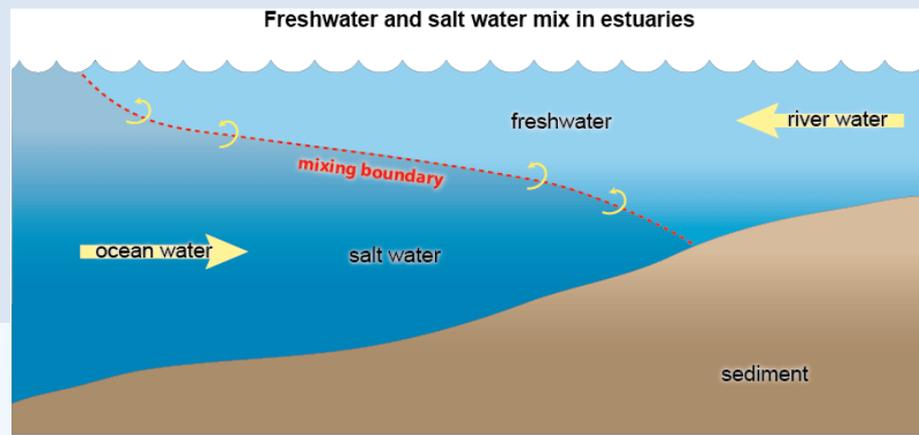
Application of DO Criteria: Water Column

- DO measurements should represent the dominant aquatic habitat of the monitoring site
 - Samples should not be collected from shallow stagnant backwater areas, within isolated thermal refuges, at the surface or at the water's edge
- Deep waters:
 - Water samples should be assessed within:
 - Relatively homogenous conditions (e.g. euphotic zone; below or above the pycnocline; bottom waters)
 - Various dominant aquatic habitat of communities (e.g. benthic, fish, phytoplankton, zooplankton communities)



Application of DO Criteria: Site-Specific Locations

- Water boundaries are established in the water quality standards
- Surface waters are required to be in compliance year-round at all assessment sites
- Fresh/marine water boundaries are determined by salinity measurements



Application of DO Criteria: Anthropogenic Allowance

- Human actions considered cumulatively may not cause DO concentrations to decrease by >0.2 mg/L
 - Does not apply if water body is in compliance
- Based on 1-day minimum concentrations
- Applies year-round at all locations unless otherwise noted in WAC 173-201A



Nutrient Criteria

- EPA provides national strategies for developing nutrient criteria
 - Nationally recommended numeric criteria not available
 - Chesapeake Bay guidance document for various refugia
 - Serves as a good template when robust data is available
- WA has elected to use water quality responses for excessive nutrients to protect aquatic life



Questions?

- Contact Information:

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