

1/29/2025

Public Comments on Oregon's Draft 2024 Integrated Report

For development of the Water Quality Status
Report and List of Impaired Waters.

Pursuant to Clean Water Act Sections 303(d) and 305(b) and OAR 340-041-0046



This document was prepared by
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Introduction

The individuals and organizations shown in Table 1 provided comments on the 2024 Integrated Report during the Public Comment period, which was held from April 18, 2024, through July 1, 2024. All comments received during the public comment period have been reviewed by DEQ and addressed in this document. Comments which required modifications to the report are noted and the 2024 Integrated Report is updated accordingly. In total there were 49 unique comments from 53 entities. DEQ made modifications to the report based on 9 of the comments. The full text of submitted comments can be found at [Public Comments Received](#).

Commenter #	Commenter	Acronym
1	City of Portland Bureau of Environmental Services	BES
2	Columbia Riverkeeper	CRK
3	Clean Water Services	CWS
4	Deschutes Redbands Chapter of Trout Unlimited	DRCTU
5	National Association of Clean Water Agencies and California Association of Sanitation Agencies	NACWA-CASA
6	Northwest Environmental Advocates	NWEA
7	Oregon Association of Clean Water Agencies	O-ACWA
8	Oregon Department of Fish and Wildlife	ODFW
9	Special Districts Association of Oregon, the League of Oregon Cities and the Oregon Association of Water Utilities	SDAOLOC-OAWU
10	U.S. Environmental Protection Agency	USEPA
11	UCLA's Institute of Environment and Sustainability 2024 Ocean Acidification and Hypoxia Practicum Team	UCLA
12	Willamette Riverkeeper	WRK
13	Bill Obrien	BO
14	Charles Loos	CL
15	Celeste Wolf	CW
16	Chris Shults	ChS
17	Cory Starr	CrS
18	David Kenney	DK
19	Dennis Pennell	DP
20	Emily Platt	EP

Commenter #	Commenter	Acronym
21	Glenn Gibson Creek Watershed Council	GGCWC
22	Inga Fisher Williams	IFW
23	Ignacio Gonzalez	IG
24	John Cluskey	JC
25	Jamie Knight	JK
26	Judith Lienhard	JL
27	Jim Stuller	JS
28	Jeff Malmquist	JfM
29	Jeff Malmquist	JfM.1
30	John Maroney	JhM
31	Kristy Overton	KO
32	Linda Leyva	LL
33	Lucinda Pierpont	LP
34	Lydia Stivers	LS
35	Mariam Higgins	MH
36	Melody Long	ML
37	Marilyn McWilliams	MM
38	Michael Kipley	M
39	Michael Schilmoeller	McS
40	Mark Scantlebury	MrS
41	Nikki Dennis	ND
42	Nora Stern	NS
43	joziedonaghey	Nj
44	perpetuatetruth@proton.me	Np
45	Roger Kofler	RK
46	Roberta Schwarz	RS
47	Ray Thomas	RT
48	Susan Huston	SH
49	Sarah Wetjen	SW
50	Tammie Bardowell	TB
51	Theo Cantalupo	TC
52	Tom Fawell	TmF
53	Teresa Frye	TrF

Comments from: City of Portland Bureau of Environmental Services



CITY OF PORTLAND ENVIRONMENTAL SERVICES



1120 SW Fifth Ave, Suite 613, Portland, Oregon 97204 ■ Mingus Mapps, Commissioner ■ Dawn Uchiyama, Director

Lesley Merrick
700 NE Multnomah Street, Suite 600
Portland, Oregon 97232-4100
Submitted to: IntegratedReport@deq.oregon.gov

June 17, 2024

RE: Comments on the Draft 2024 Integrated Report

Dear Lesley Merrick:

The City of Portland's Bureau of Environmental Services (BES) appreciates the opportunity to provide comments on the draft 2024 Integrated Report (IR). BES manages Portland's wastewater and stormwater infrastructure to protect public health and the environment, and leads the development and coordination of the City's TMDL Implementation Plan.

We would like to express our appreciation of DEQ's continued efforts to improve the Integrated Report, including the updated assessment methodology and tools that DEQ has made available to the public. The interactive web map and online searchable assessment database allowed BES to thoroughly review the draft 2024 Integrated Report assessments. This letter includes comments related to the assessment units and associated assessment categories within the jurisdiction of the City of Portland.

Assessment Units

The following section includes comments related to the Integrated Report assessment units, including application issues and GIS representations.

1. DEQ should remove the Tanner Creek assessment unit (OR_SR_1709001202_02_104174) and all associated determinations from the Integrated Report. The Tanner Creek assessment unit included in the draft Integrated Report is not a surface waterbody and the samples used in the assessment were collected from stormwater pipes in the City's Collection System. This assessment unit should be removed.
2. DEQ should update the watershed boundaries for the two Columbia Slough assessment units to distinguish between the lower (OR_WS_170900120201_02_104554.1) and upper (OR_WS_170900120201_02_104554.2) watersheds. The current GIS layer has the same watershed boundary for the two assessment units.

Listing Errors/Issues

This section includes comments related to the listing determinations included in DEQ's assessment database, including determinations that BES has identified as incorrect, conflicting, or duplicative.

1. DEQ should update the alkalinity determinations to be consistent with DEQ's Assessment Methodology. DEQ's 2024 Assessment Methodology specifies that "for Integrated Report evaluations, analytical data indicating alkalinity less than the criterion is flagged as a Category 3B Insufficient Data: Potential concern." (p. 118) The assessment units in the table below have 'Category 5' determinations in the assessment database. Based on DEQ's 2024 Assessment Methodology for alkalinity, these determinations should be revised to be 'Category 3B'.

Assessment Units with Incorrect Determinations for Alkalinity			
Assessment Unit ID	AU Name	Assessment	IR Category
OR_SR_1709001201_02_104170	Johnson Creek	Alkalinity	Category 5
OR_WS_170900120202_02_104555	HUC12 Name: Balch Creek-Willamette River	Alkalinity	Category 5
OR_WS_170900100401_02_104506	HUC12 Name: Beaverton Creek	Alkalinity	Category 5
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Alkalinity	Category 5
OR_WS_170900120305_02_104561	HUC12 Name: Multnomah Channel	Alkalinity	Category 5
OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek	Alkalinity	Category 5

2. The Category 2 determination for dissolved oxygen spawning for the Willamette River (OR_SR_1709001202_88_104175, from Johnson Creek to the Columbia River) should be removed. This assessment unit should not be assessed for dissolved oxygen spawning as the Salmon and Steelhead Spawning Use Designation map for the Willamette basin (Figure 340B) notes that there is "no spawning use" for this assessment unit.
3. The Category 4A determination for dissolved oxygen spawning for the Oswego Creek-Willamette River HUC12 assessment unit (OR_WS_170900120104_02_104553) should be changed to Category 5. The assessment database includes the Tualatin Subbasin Total Maximum Daily Load and Water Quality Management Plan (DEQ, 2012) as the applicable TMDL for this parameter and assessment unit, however, the Tualatin TMDL does not cover any of the surface waters located in the Oswego Creek-Willamette River HUC12 assessment unit.

4. The Category 4A determination for pH for the Oswego Creek-Willamette River HUC12 assessment unit (OR_WS_170900120104_02_104553) should be changed to Category 5. The assessment database includes the Tualatin Subbasin Total Maximum Daily Load and Water Quality Management Plan (DEQ, 2012) as the applicable TMDL for this parameter and assessment unit, however, the Tualatin TMDL does not cover any of the surface waters located in the Oswego Creek-Willamette River HUC12 assessment unit.
5. DEQ should consolidate the duplicate determinations in the assessment database or provide information to explain the distinction between the different entries. In the Portland area, there are two identical Category 3 entries in the assessment database for the Columbia River (OR_SR_1708000302_88_100670) for aluminum aquatic life, but with different rationales and stations.
6. Where more extensive datasets are readily available and accepted, but were not used, DEQ should re-assess the assessment units using the full set of records to evaluate attainment of water quality standards. In the Portland area DEQ should re-assess the Lower Johnson Creek HUC12 (OR_WS_170900120103_02_104552) for ammonia, chloride, copper, dissolved oxygen, *E. coli*, lead, mercury, pH, and zinc. BES provided DEQ with monitoring data for all of these parameters for the following monitoring stations located in the assessment unit: PDX_BES-0380, PDX_BES-0428, PDX_BES-0940, PDX_BES-1148, PDX_BES-P0060, PDX_BES-P0828, PDX_BES-P1148, PDX_BES-P1292, PDX_BES-P1552, and PDX_BES-P1916. These data were accepted by DEQ and are available in AWQMS, but no assessment is included in the assessment database for these parameters.
7. The Category 5 determination for Ethylhexyl Phthalate bis 2 (human health) for the Oswego Creek-Willamette River HUC12 assessment unit (OR_WS_170900120104_02_104553) should be changed to Category 3D. DEQ's 2024 Assessment Methodology specifies that "Water bodies will be assessed as Category 3D; Not Technologically Feasible to Assess where samples have been collected but all values are reported below the lowest available QL, and the QL is greater than the numeric criteria." (p. 36) The rationale included in the assessment database ("Tryon Creek: All results are non-detects with detection limits above criteria- 35 total samples") is consistent with a Category 3D determination.
8. The Category 3 determination for Ethylhexyl Phthalate bis 2 (human health) for the Willamette River assessment unit (OR_SR_1709001202_88_104175) should be changed to Category 3D. DEQ's 2024 Assessment Methodology specifies that "Water bodies will be assessed as Category 3D; Not Technologically Feasible to Assess where samples have been collected but all values are reported below the lowest available QL, and the QL is greater than the numeric criteria." (p. 36) The rationale included in the assessment database ("All results are non-detects with detection limits above criteria- 3 total samples") is consistent with a Category 3D determination.

Missing Information

The following section identifies information that should be made available to the public to support the 2024 Integrated Report determinations.

1. DEQ should update the assessment database to include the 2024 rationale and station list to support the determinations listed below.

Assessment Units with Missing Information			
Assessment Unit ID	AU Name	Assessment	Missing Information
OR_WS_170900100401_02_104506	HUC12 Name: Beaverton Creek	Alkalinity	• 2024 rationale • Station list
OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek	Alkalinity	• 2024 rationale • Station list
OR_WS_170900100401_02_104506	HUC12 Name: Beaverton Creek	Dissolved Oxygen	• 2024 rationale • Station list
OR_WS_170900100502_02_104513	HUC12 Name: Fanno Creek	Dissolved Oxygen (spawn)	• 2024 rationale • Station list
OR_WS_170900100502_02_104513	HUC12 Name: Fanno Creek	Iron (total) Aquatic Life	• 2024 rationale • Station list

Thank you again for the opportunity to provide input. If you have any questions regarding these comments, please contact Julia Bond at Julia.Bond@portlandoregon.gov or 503-823-7753 for more information.

Sincerely,

Dawn Uchiyama

Director, Bureau of Environmental Services

Comments from: Columbia Riverkeeper



COLUMBIA RIVERKEEPER

P.O. Box 950

Hood River, OR 97031

columbiariverkeeper.org

June 20, 2024

Oregon Department of Environmental Quality
ATTN: Water Quality Program
700 NE Multnomah St. #600
Portland, OR 97232

Submitted via email to: IntegratedReport@deq.oregon.gov

RE: Comments Regarding the Oregon Department of Environmental Quality's 2024 Draft Integrated Report on Surface Water Quality, 2024 Draft 303(d) List of Impaired Water, 2024 Draft Delistings, and 2024 Draft TMDL Priority Ranking and Schedule

To Whom It May Concern,

Please accept these comments on behalf of Columbia Riverkeeper regarding the Oregon Department of Environmental Quality's (DEQ) 2024 Draft Integrated Report on Surface Water Quality, 2024 Draft 303(d) List of Impaired Water, 2024 Draft Delistings, and 2024 Draft TMDL Priority Ranking and Schedule. Columbia Riverkeeper's mission is to protect and restore the Columbia River and all life associated with it, from its headwaters to the Pacific Ocean. We are committed to clean water, strong salmon runs, and healthy communities. Columbia Riverkeeper represents roughly 16,000 members and supporters in Oregon and Washington and regularly engages in decisions and policies impacting the water quality of the Columbia River Basin.

Below are general comments centering on DEQ's failure to use relevant, up-to-date Environmental Protection Agency (EPA) guidance and failure to provide rationale supporting its priority and de-listing decisions. Columbia Riverkeeper urges DEQ to revise these important aspects of the Draft Integrated Report and supporting documents to better protect human health, salmon recovery, and water quality in Oregon.

I. The DEQ Failed to Meaningfully Consider Relevant 2023 EPA Guidance and Recommendations to Incorporate Environmental Justice Principles.

On March 29, 2023, the EPA issued an important guidance document, "Information Concerning 2024 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions."¹ This document includes a range of topics and recommendations relevant to

¹ EPA, Information Concerning 2024 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions (2023), https://www.epa.gov/system/files/documents/2023-03/2024IRmemo_032923.pdf.

the 2024 reporting cycle, including clarification regarding priority rankings, TMDL submission schedules, and ways to better integrate environmental justice principles into the 303(d) process. The DEQ apparently failed to review and account for the recommendations contained in this guidance document, as the EPA’s 2023 Guidance is not reflected in the Draft Integrated Report or Draft 303(d) List of Impaired Water and TMDL Priority Rankings. The 2023 Guidance was also not referenced at all in any of the Draft Integrated Report documents. As noted in the 2023 Guidance, poor water quality can have disproportionate impacts on communities that are predominantly people of color, Indigenous, low-income, rural, linguistically isolated, or impacted by other compounding environmental and economic stressors. Including environmental justice perspectives and the realities of community health are vital to a functioning, meaningful water quality and TMDL program.

EPA’s 2023 Guidance “encourages states, territories, and authorized tribes to incorporate environmental justice considerations as they carry out water quality monitoring, assessments listing, and TMDL programs.”² Incorporating environmental justice concerns starts with examining where monitoring and TMDL development occurs.³ Working closely with communities most in need of water quality management and helping to eliminate barriers to participation in decision-making processes and data collection are all ways Oregon can better integrate environmental justice into DEQ’s TMDL prioritization.

Appendix B of the EPA’s 2023 Guidance has numerous recommendations DEQ can use to create and maintain its 303(d) list to make it more protective of community realities, human health, and environmental health.⁴ While this would take time and resources, it is effort well spent. The DEQ’s water quality decisions—especially this Draft Integrated Report, Draft 303(d) List, and the other accompanying documents—should aim to eliminate disparities leading to disproportionate burdens of cumulative pollution impacts for communities along the Columbia River and throughout Oregon. Thus far, this approach is severely lacking.

As the 2023 Guidance states, “the needs of communities with the most significant pollution burden and/or communities with environmental justice concerns should be considered when prioritizing resources for water quality monitoring and TMDL development.”⁵ The DEQ’s water quality division should strive to use its time and resources in ways that lead to equitable water quality outcomes and increased community and environmental health. Columbia Riverkeeper strongly urges DEQ to consider the EPA’s 2023 Guidance in this reporting cycle as it develops Oregon’s TMDL priorities for a more protective stance on water quality.

² EPA 2024 Guidance at 8.

³ *Id.* at 23 (Appendix B. Additional Considerations for Environmental Justice).

⁴ *See id.* at 24–25 (Appx. B) (listing ideas for broader community outreach to improve monitoring, assessment, and listing processes).

⁵ *Id.* at 22 (Appx.B).

II. The Draft 2024 TMDL Prioritization and Schedule Lacks Necessary Rationale, Particularly Regarding Prioritizing Toxic Substances.

The 2024 Draft TMDL Priorities and Schedule provides little rationale or basis for how DEQ decided its TMDL priorities. In the interest of transparency and government accountability, Columbia Riverkeeper urges DEQ to develop and disclose more of the agency’s strategy and rationale for how it completed its TMDL prioritization. Specifically, DEQ failed to provide a rationale for why it qualifies toxic substances as a “low” TMDL priority. The DEQ has not updated its TMDLs for toxics since 2008—over a decade and a half ago. The proposed schedule goes until 2030, meaning it would be over two decades before DEQ completed any new toxics TMDLs, except mercury for the Snake River. The DEQ should establish its priorities for toxics and nutrient TMDLs according to (1) the likelihood that NPDES sources are causing or contributing to impairments and (2) considerations that these toxics have on Oregon community health.

Many Oregonians enjoy fishing and eating locally caught fish; however, growing evidence suggests that many fish in Oregon’s waters may contain unhealthy levels of toxic contaminants from pollution. This pollution along the Columbia River also has a disproportionate impact on people of color, which underscores the importance of viewing water quality issues through an environmental justice lens. Studies show that Native Americans in the Columbia Basin eat significantly more locally caught fish and shellfish than non-tribal members.⁶ Further, according to both Oregon and Washington’s environmental agencies, recreational fishers may consume more fish than the general population, and some population groups consume especially large amounts of fish and shellfish as part of traditionally influenced diets, including Native Americans and Asian and Pacific Islanders.⁷

As highlighted above, considering environmental justice considerations with the development of TMDL priorities and schedules is vital. Doing so will not only improve the functionality of the TMDL program but also improve its real-time impacts on human and environmental health.

⁶ Columbia River Inter-Tribal Fish Commission, A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs of the Columbia River Basin (Oct. 1994), <https://www.critfc.org/wp-content/uploads/2015/06/94-3report.pdf>.

⁷ Washington Department of Ecology, Fish Consumption Rates: Technical Support Document: A review of data and information about fish consumption in Washington (Jan. 2013), <https://fortress.wa.gov/ecy/publications/documents/1209058.pdf>; Oregon Department of Environmental Quality, Oregon Fish Consumption Rate Project Rulemaking and Public Input Process (2011), <https://www.oregon.gov/deq/FilterDocs/shhFacilitatorsReport.pdf>; *see also* Indian Country Today, Oregon sets highest fish consumption rate in U.S. based on peoples’ higher rate (July 27, 2011).

III. Columbia Riverkeeper Requests More Information Regarding Proposed De-listings.

There are three proposed de-listings for portions of the Columbia River for pH, bacteria, and dissolved oxygen respectively.⁸ Please provide more information and complete explanations for the proposed de-listings and supporting rationale, including what new data determined these portions to be categorized as “in Attainment.”

Conclusion

Columbia Riverkeeper is deeply concerned about the impacts of toxics on the Columbia River, the numerous communities that depend on it, and the many Oregonians who eat locally caught fish. As written, the 2024 Draft Integrated Report and its supporting documents fall short of incorporating necessary environmental justice considerations and supporting rationale. Columbia Riverkeeper urges DEQ to revise the Draft Integrated Report and supporting documents to reflect public comment on these critical decisions for human health, salmon recovery, and water quality. Further, we strongly urge DEQ to consider the EPA’s 2023 Guidance as it develops Oregon’s TMDL priorities for a more protective stance on water quality and communities.

Sincerely,

Teryn Yazdani
Staff Attorney
Columbia Riverkeeper

⁸ The three proposed de-listings are:

- OR_LK_1707010504_88_100137 - Columbia River - pH
- OR_LK_1707010511_88_100135 - Columbia River - E.coli/bacteria
- OR_LK_1708000605_04_100323 - Columbia River - dissolved oxygen

Comments from: Clean Water Services

July 1, 2024

DEQ Integrated Report Team
Water Quality Division
700 NE Multnomah
Portland, OR 97232-4100
Submitted via email to: IntegratedReport@deq.state.or.us

Re: Clean Water Services comments on draft 2024 Integrated Report

To Oregon Department of Environmental Quality:

Clean Water Services (CWS) appreciates the opportunity to comment on the draft 2024 Integrated Report (draft 2024 IR). CWS is a special service district located in Washington County that provides sanitary sewer service, stormwater management, and watershed management for more than 600,000 residents, and the businesses and industries that support the local and global economy. CWS holds an integrated watershed-based NPDES permit covering the sanitary sewer conveyance system, four water resource recovery facilities, and the municipal separate storm sewer system serving urbanized Washington County. CWS also acts as the agent for DEQ in administering the industrial stormwater (1200-Z) and construction stormwater (1200-C and 1200-CN) permit programs. Please accept CWS' comments on the draft 2024 Water Quality Assessment.

Aldrin

The lower Tualatin River (OR_SR_1709001005_02_104018) was newly listed in the draft 2024 WQ Assessment for Aldrin as Category 5 (WQ Limited; TMDL needed). The listing was based on six data points from Oregon DEQ at two monitoring stations at Tualatin River at Boones Ferry Road and Tualatin River at Bridge upstream of mouth (aka Weiss Bridge). Four of the six data points were detected on reanalysis; the other two data points were below the Minimum Reporting Level (MRL) or the Method Detection Level (MDL). The WQ Assessment database does not provide information about if the MRL or MDL is used to censor data, and the column heading is "Result Operator". The WQ Assessment uses either the MRL or MDL as available and calls it the Quantitation Limit (QL) (page 28). For results less than the "QL", half of the criteria (0.000005 ug/l) or half the QL will be used, whichever is less. This gives us the annotated dataset shown in Table 1.

Table 1: Annotated data points from the WQ assessment database used to evaluate aldrin in the lower Tualatin River

Station name	Date	Result_ Operator	WQ Assessment Value	Value for calculation	Units	Note
Tualatin River at Boones Ferry Road	5/10/2021	=	0.07	0.07	ng/L	Detected on reanalysis with 8270E method (lower reporting limit)
Tualatin River at Bridge upstream of mouth	2/1/2021	=	0.205	0.205	ng/L	Detected on reanalysis with 8270E method (lower reporting limit)
Tualatin River at Boones Ferry Road	11/3/2020	<	0.0567	0.0025	ng /L	Below reporting limit on reanalysis with 8270E method (lower reporting limit)
Tualatin River at Bridge upstream of mouth	5/10/2021	=	0.0623	0.0623	ng/L	Detected on reanalysis with 8270E method (lower reporting limit)
Tualatin River at Boones Ferry Road	2/1/2021	=	0.237	0.237	ng/L	Detected on reanalysis with 8270E method (lower reporting limit)
Tualatin River at Bridge upstream of mouth	9/21/2020	<	0.0469	0.0025	ng /L	Below reporting limit on reanalysis with 8270E method (lower reporting limit)

Using this dataset, the geomean of the results in “value for calculation” is 0.000033 ug/L, which is above the human health water quality standard (WQS) criteria of 0.000005 ug/L. However, DEQ’s WQ Assessment geomean result was 0.000120648540742012 ug/L. This geomean occurs when the censored results are excluded from the dataset, leaving only the quantified concentrations. Excluding results so low that they are not quantifiable or detectable is not consistent with the WQ Assessment Methodology. On page 29, the WQ Assessment Methodology says, “Assessment conclusions will be based on the geometric mean of samples (based on a minimum of three samples) representative of the water body.” Samples with no detectable concentration of a pollutant are representative of the water body and should be included in the basis of the assessment, which is the geometric mean. CWS understands that zero values cannot be used as a value in the dataset for a geometric mean calculation, but the WQ Assessment Methodology has already addressed this issue with the use of half of the QL or half of the WQS criterion, whichever is less. **CWS requests** that water bodies are evaluated

using whole data sets by including censored data in the geomean calculations, as described in the WQ Assessment Methodology.

Chlordane

Similar to aldrin, the lower Tualatin River (OR_SR_1709001005_02_104018) was newly listed in 2024 for chlordane as Category 5 (WQ Limited; TMDL needed). The chlordane listing was based on the same six dates and locations as the aldrin listing. None of the six data points as presented in the available documentation showed detectable levels of chlordane (see Table 2). Therefore, CWS questions how a determination of Category 5 (WQ Limited; TMDL needed) can be made when no chlordane was detected in any sample.

According to the WQ Assessment Methodology, the value substituted for nondetects should be half the WQS criterion of 0.000081ug/L or half the QL, whichever is less, therefore, the geomean of the dataset should be half or less than 0.000081 ug/L. Chlordane and PCBs are unique in that they are aggregated sums of several chlordane species (e.g., cis-chlordane, trans-chlordane, and oxychlordane). In EPA's WQX database, DEQ's data are shown by chlordane species. There was one detection of trans-chlordane that was less than the WQS criterion. Seeing the species data is helpful for transparency of the basis of the calculations. **CWS suggests** printing a note in the chlordane and PCB data points that these are aggregated data and direct to a website where the raw data may be found.

In the listing explanation, the geomean was stated as 1 ug/L, far above any QL. In the IR database, the censored dataset column AV ("Result_cen") and column BC ("evaluation_result") showed the values that were used in the geomean calculation were all zero. In this program, the geomean of zero was calculated to be 1. Instead, **CWS suggests** that the sum of the chlordane species is represented by half of the lowest QL or half of the WQS criterion, whichever is less. When there is a mix of the quantified and censored data in the chlordane species, CWS prefers the method of summing only the quantified values.

See the note in the aldrin section above about retaining and including the substituted values for censored data in the geomean calculation. Using these suggestions, the geomean will calculate properly, account for censored data, and evaluate the water body to the most accurate category.

CWS does not agree with Category 5 designations based on results with concentrations below the QL, either the MRL or the MDL. Since there were no excursions, **CWS requests** the chlordane listing be moved into Category 2 (Attaining).

In addition, **CWS requests clarification** of how a listing may be recategorized from Category 5 (WQ Limited; TMDL Needed) to Category 2 (Attaining) when the WQS criteria are less than the Quantitation Limits.

Table 2: Data points from the WQ assessment database used to evaluate chlordane in the lower Tualatin River

Station Des	Pollutant	Sample Start Date	Sample Start Time	Char_ Name	Result_ UID	Result_ Numeric	Result_ Unit	IRResult NWQ Sunit	Result Operator
Tualatin River at Bridge upstream of mouth	Chlordane	9/21/2020	12:30	Chlordane	69064085	18.8	ng/l	0.0188	<
Tualatin River at Boones Ferry Road	Chlordane	11/3/2020	10:07	Chlordane	69082941	0.0567	ng/l	0.0000567	<
Tualatin River at Bridge upstream of mouth	Chlordane	2/1/2021	13:00	Chlordane	69551295	0.0553	ng/l	0.0000553	<
Tualatin River at Boones Ferry Road	Chlordane	2/1/2021	13:18	Chlordane	69547334	0.0524	ng/l	0.0000524	<
Tualatin River at Bridge upstream of mouth	Chlordane	5/10/2021	16:10	Chlordane	83600310	0.0542	ng/l	0.0000542	<
Tualatin River at Boones Ferry Road	Chlordane	5/10/2021	14:08:	Chlordane	69601099	22.1	ng/l	0.0221	<

Alkalinity

The WQ Assessment Methodology states that the EPA-recommended alkalinity threshold will not be used to determine Category 5 (WQ Limited; TMDL needed) listings because alkalinity alone may lead to incomplete conclusions about the water body's health. Instead, the WQ Assessment Methodology states that assessment units with alkalinity measurements <20 mg/L will be listed as Category 3b (Insufficient Data; Potential Concern). **CWS requests** that the Beaverton Creek watershed alkalinity listing (OR_WS_170900100401_02_104506) be recategorized from Category 5 to Category 3b to be consistent with the stated methodology.

Chromium VI

CWS agrees with the attainment of Gales Creek of the WQS for chromium VI and sensible reclassification from Category 5 to Category 2 using the recent data. On a quarterly sampling schedule, CWS was only able to obtain the minimum dataset for delisting in the five-year assessment cycle. Since CWS cannot continue to collect data indefinitely, it is important to assess the full dataset in the correct cycle. Using an accurate dataset makes the 303d list more accurate, and reclassifying water bodies using new data allows resources to be focused on truly impaired water bodies.

Copper

There were three new Category 5 listings in the Tualatin Basin for copper (Beaverton Creek: OR_SR_1709001004_02_104134, HUC 12 Beaverton Creek; OR_WS_170900100401_02_104506, HUC 12 Fanno Creek; OR_WS_170900100502_02_104513). Upon exploration of the copper BLM dataset, the "excursions" column does not match the acute TU and chronic TU columns (calling "0" when TUs are greater than "1" and "1" when TUs are less than "1"), so it is not a reliable summary of the excursions (some of the entries to the "excursions" column are "Dissolved" instead of 0 or 1); The Category 5 listings were made on CuBLM results using incomplete datasets. Complete data sets were available for some of these listings. Comparing results of the application of the CuBLM demonstrated the importance of using completed data sets where available. DEQ correctly identifies that results using a complete data set is preferential than those from partial data sets.

As noted in past public reviews, **CWS recommends** using complete datasets to calculate IWQC, as they can mislead to listings that are miscategorized and inaccurate. Some chronic instantaneous water quality criteria (IWQC) that use georegional default substitutions were calculated with the CuBLM to be less than 1 ug/L dissolved copper. As noted in CWS comments on the draft 2024 Water Quality Assessment Methodology, CWS agrees with DEQ that measured datasets with complete sets of supporting information to calculate the instantaneous water quality criteria are superior to using georegional defaults and preference should be given to complete datasets with the supporting parameters. Similar to how DEQ handles total aluminum data, **CWS proposes** that only complete datasets with sufficient sample sizes should

be used to determine Category 2 or Category 5, but that datasets requiring use of georegional defaults should be placed in Category 3 or Category 3B.

Beaverton Creek - copper

For the 303d listed segments at Beaverton Creek at Orenco Station (Cornelius), the datasets are incomplete. In particular, on July 18, 2018, and April 11, 2018, the hardness, pH, temperature, and total organic carbon data are missing from the WQ Assessment. However, a complete data set was made available to USGS for these sampling events. CWS transferred the TOC data to USGS in 2019. In addition, alkalinity data from Beaverton Creek at Orenco Station in 2021 were missing from the assessment. The alkalinity data were transferred to USGS in spring 2023 and a link to the data was provided to DEQ on May 15, 2024. When using the measured dataset instead of georegional defaults, the copper concentrations are well below the WQS. Listing Beaverton Creek as WQ Limited for copper based on incomplete datasets, especially when data are available to show that the water body is attaining the water quality standard, makes the list inaccurate and diverts resources from water bodies that are truly WQ limited. In addition, there is a high data burden to delist a segment, even in error. For these reasons, **CWS is submitting the data** by attaching it to this letter, and **CWS requests** that DEQ use the complete dataset and correctly classify the listing from Category 5 to Category 2.

Beaverton, Fanno, and Saum Watersheds - copper

City of Portland and City of Lake Oswego both sampled for copper in the upper portions of these tributaries to the Tualatin Basin. The City of Portland and City of Lake Oswego boundaries overlap with the Tualatin watershed only in limited upper areas of the Tualatin watershed. Therefore, we can reasonably presume that the Cities only sampled in upper parts of the watershed, so their data sets are not complete with up to 9 missing input parameters. There were IWQC calculated on only pH as an input parameter to the CuBLM, which requires 9 measured input parameters, relying on georegional defaults for the remainder of the CuBLM inputs. For Fanno and Beaverton Creeks, CWS provided much more complete data sets showing the reaches and locations sampled in Fanno and Beaverton Creeks that they should be Category 2 (see “Beaverton Creek – copper” above). CWS agrees with DEQ that complete data sets should be given precedent over incomplete data sets. This approach by DEQ recognizes and incentivizes collecting complete data sets in support of accurate conclusions. Given the burden of delisting a segment once it has been listed as Category 5, **CWS requests** that Beaverton watershed (OR_WS_170900100401_02_104506) and Fanno (OR_WS_170900100502_02_104513) watershed are not listed as Category 5. Rather, DEQ should consider instead Category 3 (Insufficient Data) or identifying reaches for listing based on the available information for using the CuBLM. For similar reasons, **CWS requests** that DEQ evaluate the Saum watershed (OR_WS_170900100504_02_104515) consistent with other watersheds with limited data and potentially recategorize the 2018 listing from Category 5 to Category 3.

This map displays the Portland, Oregon metropolitan area, highlighting the locations of two types of creeks: Beaverton Creek (represented by blue dots) and Fanno Creek (represented by dark blue dots). The map shows major highways, including I-5, I-205, and US-26, as well as numerous neighborhoods and landmarks. The legend in the bottom right corner identifies the symbols used for each creek type.

HUC12_Name

- Beaverton Creek
- Fanno Creek

Although the upper Tualatin River segment (OR_SR_1709001002_02_104104) was listed as Category 2, the WQ Assessment database shows seven excursions of the CuBLM IWQC out of 99 samples. The WQ Assessment Methodology Table 6 states that for 99 samples, nine or more excursions will list a segment as Category 2 (Attaining). **CWS affirms** this listing as its recent data with full datasets shows attainment of the water quality standard in this segment. CWS notes that the Oct. 5, 2022, samples at Tualatin River at Golf Course were missing a majority of the CuBLM input parameters, including pH. DEQ did not specify a way to substitute missing pH values for CuBLM. Therefore, the IWQC cannot be calculated for this date and location. **CWS requests** that the Tualatin River at Golf Course data point is removed from the copper evaluation.

CWS supports the Oregon Association of Clean Water Agencies (ACWA) comments on the Willamette River trash listings. CWS, as do many others, recognizes that trash can be an aesthetic issue, along with causing other water quality issues. As noted by ACWA, there are broader social, legal, and policy issues related to the sources of trash. We agree with DEQ and ACWA that a TMDL may not be the best approach for responding to trash. CWS encourages DEQ to create an effective holistic, multi-jurisdictional, equitable, just, and data-based strategy

for responding to trash which includes, but is not limited to, actions by MS4 permit holders. CWS is willing to engage as a stakeholder.

Thank you for the opportunity to review and consider our comments on the draft 2024 Integrated Report. CWS wishes to acknowledge and thank DEQ for the extensive efforts in developing the list, and willingness to work with us in managing and accessing the extensive data sets provided. This effort to make sound judgements using data will be important in using the listing process to prioritize where we apply our common efforts toward improving water quality.

A handwritten signature in blue ink, appearing to read 'Robert P. Baumgartner', with a long horizontal flourish extending to the right.

Robert P. Baumgartner
Regulatory Affairs Director

Attachment: Beaverton Creek at Orenco (Cornelius) copper BLM data in EDD format

Applied filters:MeasureDate is on or after 04/10/2018 and is before 07/20/2

SourceDescription	MeasureDate	MeasureTime	SamplePoint
Aquarius	04/11/2018	08:46	3821012
Aquarius	04/11/2018	08:46	3821012
Aquarius	07/18/2018	10:08	3821012
Aquarius	07/18/2018	10:08	3821012
Sample Manager	04/11/2018	08:46	3821012
Sample Manager	04/11/2018	08:46	3821012
Sample Manager	07/18/2018	10:08	3821012
Sample Manager	07/18/2018	10:08	3821012
Sample Manager	07/18/2018	10:08	3821012

!018Parameter is Hardness (Report), NPOC, pH-fld, or Temp, CStoret is not 00927SamplePointDisplay

SamplePointDescription	Parameter	ParameterDescription
BEAVERTON CREEK NEAR ORENCO	pH-fld	pH, Field
BEAVERTON CREEK NEAR ORENCO	Temp, C	Temperature, degrees Celsius
BEAVERTON CREEK NEAR ORENCO	pH-fld	pH, Field
BEAVERTON CREEK NEAR ORENCO	Temp, C	Temperature, degrees Celsius
BEAVERTON CREEK NEAR ORENCO	Hardness (Report)	Hardness, Total
BEAVERTON CREEK NEAR ORENCO	NPOC	Non-Purgeable Organic Carbon, Total
BEAVERTON CREEK NEAR ORENCO	Hardness (Report)	Hardness, Dissolved
BEAVERTON CREEK NEAR ORENCO	Hardness (Report)	Hardness, Total
BEAVERTON CREEK NEAR ORENCO	NPOC	Non-Purgeable Organic Carbon, Total

' is BEAVERTON CREEK NEAR ORENCO (3821012)

AnalysisDescription	CasNumber	Storet	ResultFlag	Result	Units
Field Measurement		00400		7.44	S.U.
Field Measurement		00010		12.919	deg C
Field Measurement		00400		7.53	S.U.
Field Measurement		00010		21.147	deg C
ICP Metals, Total		00900		61	mg/L
Organic Carbon, Non-Purgeable, Total	1333-86-4	81280		3.47	mg/L
ICP Metals, Dissolved		22413		106	mg/L
ICP Metals, Total		00900		104	mg/L
Organic Carbon, Non-Purgeable, Total	1333-86-4	81280		5.37	mg/L

ReportingLimit	NonDetectFlag	Qualifier
		0
		0
		0
		0
0		0
0.25		0
0.5		0
0		0
0.25		0

Comments	TestingEntityName
	Water Quality Laboratory
	Water Quality Laboratory
	Water Quality Laboratory
	Water Quality Laboratory
Sample Comments: Note: Sampled time in PST.	Water Quality Laboratory
Sample Comments: Note: Sampled time in PST.	Water Quality Laboratory
Sample Comments: Note: Sample Date time in PST.	Water Quality Laboratory
Sample Comments: Note: Sample Date time in PST.	Water Quality Laboratory
Sample Comments: Note: Sample Date time in PST.	Water Quality Laboratory

Comments from: Deschutes Redbands Chapter of Trout Unlimited



Oregon Department of Environmental Quality

June 20, 2024

Submitted via email to: IntegratedReport@deq.oregon.gov

SUBJECT: Comments on DEQ's Draft 2024 Integrated Report on Surface Water Quality (supporting a High TMDL priority for Upper Deschutes and Little Deschutes Subbasins)

Dear DEQ Water Quality Assessment Program staff:

Trout Unlimited (TU) is a non-profit organization with a mission to conserve, protect and restore North America's coldwater fish and their watersheds. TU has over 3,000 members in Oregon, including approximately 720 members affiliated with the Deschutes Redbands Chapter (Chapter). Restoring water quality in the upper Deschutes River (i.e., upstream of Bend) and its tributaries is a key objective for our Chapter members. To that end, we have been involved with a variety of projects in the Deschutes Basin intended to restore fish habitat and improve water quality in priority waterways.

Our Chapter appreciates this opportunity to provide comments on the Oregon's Draft 2024 Integrated Report. One component of the report is typically a "TMDL Submission Schedule" document that prioritizes assessment units for development of a Total Maximum Daily Load (TMDL), based on an evaluation of factors set forth in OAR 340-042-0040(3).

We recognize the importance of TMDL priority-setting as a vital component of the Integrated Report process. The 2022 Integrated Report assigned a "medium" TMDL priority for the Upper Deschutes and Little Deschutes Subbasins, with a corresponding schedule to have a TMDL submitted to EPA by April 2030.¹ The 2024 Draft Integrated Report maintains this timeline. Our Chapter supports re-assigning the Upper Deschutes and Little Deschutes Subbasins to a "high" TMDL priority in the 2024 Integrated Report Submittal—with a corresponding tentative schedule to have a TMDL submitted earlier than 2030. This is based on the following assessment of relevant factors in the Oregon Administrative Rules.

OAR 340-042-0040(3) provides that DEQ or the Environmental Quality Commission will prioritize and schedule TMDLs for completion considering the following factors: (a) Severity of the pollution, (b) Uses of the water, (c) Availability of resources to develop TMDLs, (d) Specific judicial requirements, and (e) Any other relevant information. We provide the Chapter's analysis of each of those factors, in support of our recommendation that DEQ up list the TMDL priority for these Subbasins:

¹ See DEQ, TMDL Priorities and Schedule For Oregon's 2022 Integrated Report Submittal, May 2022 (available at: <https://www.oregon.gov/deq/wq/Documents/IR2022-TMDLPriorities.pdf>); DEQ, TMDL Submission Schedule, August 2022 (Approved) (available at: <https://www.oregon.gov/deq/wq/Documents/2020-22TMDLSubmissionSchedule.pdf>).

(a) Severity of the pollution (i.e., OAR 340-042-0040(3)(a))

The Upper Deschutes and Little Deschutes Subbasins are impaired for parameters including, but not limited to: Chlorophyll-a, Dissolved Oxygen, Harmful Algal Blooms, pH, and Temperature.² According to the 2022 Integrated Report,³ the Upper and Little Deschutes Subbasins were listed as impaired for at least some of these parameters 25 years ago. The only other waterbodies with more impairments in the 2024 TMDL Priorities and Schedule are the Lower Deschutes/Crooked/Trout Creek Subbasins and Rogue River Basin (each of which DEQ has also scheduled for a TMDL submission timeline April 2030).⁴ No waterbody in the 2024 Draft Integrated Report documents has a TMDL submission timeline later than April 2030.

Within the Upper Deschutes basin, members of our Chapter have observed severe bank erosion, high turbidity, and low water levels. Because these conditions can influence dissolved oxygen, temperature, algae growth, and related parameters, we are concerned that there is ongoing impairment to water quality and the survival of aquatic species. These are compelling reasons why data needs to be collected and evaluated to establish TMDLs in the upper basin.

In our Chapter's view, the Upper Deschutes and Little Deschutes have some of the most significant impairments of any waterbody slated for a TMDL in the 2024 TMDL Submission Schedule, but will wait the longest for implementation based on the DEQ's current schedule to complete the work.

(b) Uses of the water (i.e., OAR 340-042-0040(3)(b))

The impaired, designated beneficial uses in the Upper Deschutes and Little Deschutes Subbasins include private domestic water supply, public domestic water supply, and fish and aquatic life.⁵ These are among the most vulnerable and susceptible designated beneficial uses for a waterbody. Recreational use of the Upper Deschutes River basin is also an economic driver for the region. The river's users, including our Chapter members, rely on DEQ to help maintain the long-term integrity of the basin's ecosystem by establishing a TMDL—and then getting to work in implementing pollution control measures intended to address the impairments (which will itself take years after the TMDL is completed).

(c) Availability of resources to develop TMDLs (i.e., OAR 340-042-0040(3)(c))

It is our Chapter's understanding that DEQ already has draft TMDL documents in progress, and that there are several scientific reports available to DEQ containing evaluation data.⁶ We recommend a DEQ

² DEQ, TMDL Priorities and Schedule, For Oregon's Draft 2024 Integrated Report April 2024 (available at: <https://www.oregon.gov/deq/wq/Documents/ir24tmdlPriSchedPD.pdf>); see also EPA, How's My Waterway, Waterbody Report for Deschutes River Assessment Unit ID: (available at: https://mywaterway.epa.gov/waterbody-report/OREGONDEQ/OR_SR_1707030104_05_102628/2022).

³ Available at: <https://geo.maps.arcgis.com/apps/instant/sidebar/index.html?appid=7d13b19e01a44f1dbfd12903576e6d29>

⁴ DEQ, TMDL Priorities and Schedule, April 2024.

⁵ Oregon 2022 Integrated Report – Final, available at:

<https://geo.maps.arcgis.com/apps/instant/sidebar/index.html?appid=7d13b19e01a44f1dbfd12903576e6d29>

⁶ See DEQ, TMDLs by Oregon Basins, Deschutes Basin, <https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Deschutes-Basin.aspx> (summarizing past modeling and monitoring efforts and providing links to technical reports that could support TMDL development).

review of the status of TMDL development in the basin. As we have offered in the past,⁷ our Chapter is interested in supporting the study efforts and may be able to lend Chapter member volunteer time or other resources to data collection efforts needed and approved by DEQ (e.g., collecting pH, dissolved O₂, and temperature data pursuant to methodologies approved by DEQ). We have met with DEQ staff to discuss opportunities to engage in these efforts, and understand that DEQ would be receptive to Chapter efforts to collect and submit data pursuant to study methodologies approved by DEQ; our Chapter is interested in pursuing that and invites further conversation with DEQ staff about those opportunities.⁸

(d) Specific judicial requirements (i.e., OAR 340-042-0040(3)(d))

DEQ's TMDL website used to state (as of February 2023):

"We hoped to have [the Upper Deschutes and Little Deschutes Subbasin TMDLs] completed by the end of 2012, however we have put our temperature TMDL work on hold because of on-going litigation about DEQ's temperature standard. . . *DEQ staff will continue to refine the computer models for dissolved oxygen, pH and nutrients.* However, it is not yet clear if we will be able to proceed with these TMDLs, or if they may also get tied up in the litigation. Future committee meetings have been put on hold until the litigation is further resolved."⁹

The same website now provides the following language, which notably, now makes no mention of ongoing DEQ efforts to refine related monitoring:

"In March, 2012, DEQ convened the Upper Deschutes and Little Deschutes Technical Advisory Committee. The committee met five times in 2012 and provided valuable local input to DEQ on our technical analyses. DEQ postponed additional committee meetings and work on the models for temperature, dissolved oxygen, pH and nutrients in response to litigation on Oregon's temperature standard and the resulting court-ordered schedule for temperature TMDL replacement in 15 basins. DEQ has continued to implement nutrient monitoring that will support TMDL development."¹⁰

Our Chapter is not involved in the referenced litigation, but we note that much of the data collection and collaborative processes described on the DEQ website concluded over twelve years ago. If the referenced temperature litigation is not over and has no reasonably foreseeable end, then it may be time for DEQ to re-evaluate when and how it will complete a TMDL for the Upper Deschutes and Little Deschutes Subbasins. Right now, we're slated to wait another six years until DEQ completes a TMDL, and related on-ground water quality improvement measures won't occur until after that.

⁷ See Letter from Deschutes Redbands Trout Unlimited to DEQ, *Comments on DEQ's Draft Assessment Methodology for Oregon's 2024 Integrated Report (supporting a High TMDL priority for Upper Deschutes and Little Deschutes Subbasins)*, February 17, 2023.

⁸ Email from Gene Foster (DEQ) to recipients including Shaun Pigott and Steven Goldberg (Deschutes Chapter), Feb. 13, 2023.

⁹ DEQ, TMDLs by Oregon Basins, Deschutes Basin, <https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Deschutes-Basin.aspx> (emphasis added).

¹⁰ DEQ, TMDLs by Oregon Basins, Deschutes Basin, <https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Deschutes-Basin.aspx>.

(e) any other relevant information (i.e., OAR 340-042-0040(3)(e))

The Upper Deschutes and Little Deschutes also provide valuable habitat for threatened species (Oregon spotted frog), native trout, and beloved recreational opportunity. Of course, water quality in the Upper and Little Deschutes Subbasins affects water quality in the middle and lower Deschutes, portions of which provide habitat for anadromous salmon and steelhead (including threatened Middle Columbia summer steelhead). Improving water quality upstream of Bend can improve conditions in those areas downriver.

The Deschutes Redbands Chapter of Trout Unlimited appreciates DEQ for considering this input. We recognize the value of a TMDL to informing water quality improvement efforts, and our Chapter is interested in supporting DEQ's TMDL development effort by engaging in related processes, including citizen science (subject, of course, to DEQ quality controls and data collection methodologies).

Please let us know if you have any questions.

Sincerely,

A handwritten signature in blue ink that reads "Steve Goldberg". The signature is cursive and somewhat stylized.

Steve Goldberg, President
Deschutes Redbands Chapter – Trout Unlimited
baetis1@me.com

Comments from: National Association of Clean Water Agencies and California Association of Sanitation Agencies



July 1, 2024

Sent via email: IntegratedReport@deq.oregon.gov

Connie Dou

WQ Standards and Source Water Protection and Assessment Manager
Oregon Department of Environmental Quality (DEQ), Water Quality Division
700 NE Multnomah Street, Suite 600
Portland, Oregon 97232-4100

Subject: NACWA and CASA Comments on Oregon DEQ Draft 2024 Integrated Report

Dear Connie Dou:

The National Association of Clean Water Agencies (NACWA) and the California Association of Sanitation Agencies (CASA) respectfully submit comments to DEQ on [Oregon's draft 2024 Integrated Report](#) (2024 Integrated Report) which includes a [technical support document with a new methodology for assessing ocean acidification and hypoxia \(OAH\)](#). NACWA represents the interests of more than 350 public clean water utilities across the country that everyday provide the essential services of managing billions of gallons of wastewater and stormwater to ensure the continued protection of public health and the environment. CASA represents more than 135 public agencies and municipalities in California that engage in wastewater collection, treatment, recycling, and resource recovery.

Due to the prospective implications and far-reaching ramifications of DEQ's adoption of Oregon's 2024 Integrated Report, we have concerns with the associated processes to determine thresholds in Oregon for OAH, the associated methodology for assessing OAH, and the precedent for assessments along the west coast or elsewhere that could be established.

1. OAH is a global phenomenon due to CO₂ emissions and climate change – not point source discharges.

The Clean Water Act (CWA) is not an appropriate tool for addressing ocean acidification and hypoxia (OAH). OAH is an unfortunate global phenomenon due principally to excess atmospheric CO₂ levels. The only pollutant sources that can be regulated under the CWA are point source discharges. CO₂ in the atmosphere can come from sources all over the globe, and the CO₂ in ocean waters that result in acidification may have been absorbed years or even decades earlier. This complex spatial and temporal variability in the sources of CO₂ make it impossible to link CO₂ levels in the atmosphere or from any particular air emissions to ocean water quality in any particular area, much less a point sources of pollution subject to the Clean Water Act.

2. Management capabilities for addressing impacts of OAH are very limited under the Clean Water Act.

Under the CWA, the 303(d) impaired waters list triggers the development of a total maximum daily load (TMDL) for point source dischargers and the establishment of Load and Wasteload allocations. This TMDL, or pollutant budget, dictates how much a waterbody can handle before it is impaired, and the permitting agency must somehow allocate that budget among the pollutant sources. The time, energy, and expense that would be necessary to develop TMDLs to address ocean acidification would not achieve the goals of the CWA. The TMDL program relies on the ability to assign responsibility for making pollutant reductions. However, Oregon DEQ will be powerless to set limits on either national or international air emissions of CO₂, and even if CO₂ sources were identified within the state that were contributing to the acidification of the ocean waters of the state, the CWA does not provide regulatory tools for enforcing controls on those sources. When pollutants are coming from sources beyond the control of the state regulatory agency, the TMDL program is extremely limited in its ability to impose controls to address the underlying issue and concern. The likely cause of ocean acidification, excess atmospheric CO₂ levels, is an issue of global origin. Developing TMDL pollutant budgets for local coastal waters that are being impacted by global sources will not provide the sought-after benefit to water quality.

3. Defer until the 2026 Integrated Report – like California – inclusion of the OAH methodology since there are only two low priority sites, rather than create a new category – 5C – for a new type of impairment based on climate change, which the 2024 Integrated Report acknowledges the traditional TMDL approach is not efficacious.

The 2024 Integrated Report only lists two sites as impaired, and both were designated low priority for developing a TMDL: (1) Washington Border to Cape Lookout, i.e. the stretch of ocean west of Portland), and (2) Cape Foulweather to Siltcoos River, i.e. the stretch of ocean west of Eugene.

We appreciate that the [2024 Integrated Report](#) acknowledges our overarching concern with pursuing a TMDL for OAH in the section about creating a new assessment category for climate change, “5C”:

“The challenge of addressing climate change related impairments demands a strategic approach and will require additional tools and resources to accompany the suite of Clean Water Act management and implementation tools traditionally used to restore impaired waters. For this reason, DEQ will use Sub-Category 5C to identify climate change related waterbody impairments on the 303(d) list, while also recognizing a broader approach than the traditional TMDL and restrictions on permitted discharges may be needed to find effective solutions.” (p. 72)

In the light of this recognition about not solving 5C impairments through the Clean Water Act, we respectfully recommend instead that Oregon defer inclusion of the OAH methodology from the 2024 Integrated Report for the reasons described above and below, instead of proceeding with a framework with a tenuous premise that incidentally creates exposure to third-party liability if a TMDL is not pursued by DEQ.

4. California’s 2024 Integrated Report declined to list sites for OAH due to the need for more work on key issues – Oregon could utilize Category 3 or defer inclusion of OAH to their 2026 Integrated Report when it’s complete.

[California’s 2024 Integrated Report](#) considered aragonite saturation for OAH like Oregon but did not proceed with listing bodies as impaired for it “because it is not clear the number of days marine life would need to be exposed to the aragonite saturation state threshold for severe shell dissolution to occur” (p.76).

Beyond determining the number of days exposure for various aragonite saturation states, California also intends “in future listing cycles [to define] thresholds for likely impairment versus potential impairment with the varying aragonite saturation states” (p. 76). This is important work distinguishing likely from potential impairments and should be completed before creating a new Category for OAH impacts.

In addition to those issues, California also is working with the National Oceanographic and Atmospheric Administration (NOAA), and an interstate workgroup on OAH with DEQ and Washington to address the following issues that will inform future OAH assessments: (1) Depth in relation to aragonite saturation state: Should there be differing aragonite saturation thresholds depending on the depth in the water column? Within the 0-200 m, do specific depth ranges (i.e., 0-50m) illustrate higher dissolution rates than others? (2) Timing in relation to data collection: Determining the number of days at a certain threshold for pteropod life stages. (3) Understanding natural aragonite saturation state levels in an upwelling state. (4) Seasonal variation and shift in dissolution rates. (See p. 77-78).

Each of those four issues are a critical matter that need more understanding before pursuing and establishing a new methodology for evaluating impacts from OAH and assessing climate change derived impairments on waterbodies for resulting in the listing of waterbodies for which a TMDL likely could not effectuate restoration.

5. The Oregon DEQ OAH Technical Workgroup for establishing developing the methodology was not inclusive of dischargers or environmental organizations even though other non-experts from outside of Oregon were invited to attend and participate in meetings where regulatory thresholds were determined for this rulemaking.

Oregon is the first west coast state to propose a comprehensive methodology for assessing OAH impairments as a result of anthropogenic stressors under the CWA framework. To undertake this work, Oregon established an OAH Technical Workgroup in 2022 for which the group’s charter and meeting minutes were all made available online after the group finished. While CASA understands that group is scientific and technical by its nature, in reviewing the assessment methodology for OAH, CASA noted that [numerous external parties](#) who were not experts were invited to attend the meetings to set the 1.4 aragonite saturation threshold and develop the associated methodology. CASA is concerned that key stakeholders from the regulated community and environmental community who also are affected by this work were not invited to participate in these critical foundational meetings and discussions which could affect

the entire west coast, even if not ultimately Oregon. Accordingly, we think the process for determining OAH thresholds and establishing an OAH methodology should be better explained and more transparent since it is not immediately clear how the CWA framework offers solutions to point sources for addressing OAH impacts.

Only one commentor provided any feedback during the 2024 rulemaking about the OAH methodology, which suggests additional input should be solicited through a more formal process specific to OAH stakeholders from the same states whose regulatory agencies were involved in the OAH Technical Workgroup, and not just generically to Oregon stakeholders through the Integrated Report process, in which only five comment letters in total were received.

As two organizations from outside of the state of Oregon, we sense this OAH methodology could result in listing determinations of a higher priority to pursue a TMDL in other jurisdictions which would result in hundreds of millions in local costs without those local entities weighing in on the underlying standards. We respectfully request broader outreach by DEQ to stakeholders and environmental organizations before adopting the OAH methodology portion of the Integrated Report while Oregon pursues resolution of the same matters California is weighing.

Moreover, the reply in the [2024 Response to Comments](#) to the one commentor about OAH states, “DEQ’s primary objective in the development of new methodologies for assessing ocean acidification and hypoxia in Oregon’s marine waters was to identify what constitutes sufficient evidence to determine impairment based on the best available science. This objective was mainly based on compelling comments DEQ received during the 2022 IR comment period, which urges the agency to act in identifying biological impacts related to OAH stress in Oregon’s waters.” However, when examining [the 2022 comments DEQ received](#), only remarks from the Oregon Coordinating Council pertained to OAH, and they did not urge identification of what constitutes sufficient evidence to determine impairment, rather they noted they would be able to send a representative to the OAH Technical Workgroup which had been established, and the other comments were data processing related about filtering information and updating submission platforms. As such, the imperative and mandate is not clear for why the OAH methodology must be adopted in the 2024 listing cycle, and absent an immediate need to include the OAH methodology in the 2024 Integrated Report, we recommend DEQ continue working with other states in noticed, public, open meetings so all potentially impacted parties can timely participate in the efforts of the coalition of interstate regulatory agencies to develop an OAH methodology.

6. Apart from the previously mentioned work still needed to be performed, we also have underlying concerns with the certainty in the 1.4 aragonite saturation threshold which is based on a limited number of publications that provide various ranges of estimates for impairments and the singular selection of pteropods for OAH assessment.

While the science is uniformly settled that aragonite saturation state levels < 1.0 can lead to severe shell dissolution, there is less information about where to set the upper-bound for impacts. 1.2, 1.3, 1.4, and 1.5 all have been mentioned. The 2024 California Integrated Report observes, “In Bednaršek 2019, thresholds between 0.9 and 1.5 were found to indicate severe to mild shell dissolution of pteropods, with potential impairment indicated at approximately 1.2 ± 0.1 (for an overall threshold of 1.3).” However, California ultimately relied on older science from a 2015 study which concluded that the maximum uncertainty of ± 0.2 in the calculation of mean omega aragonite saturation state is required to adequately link changes in ocean chemistry to changes in ecosystem function, so the mean omega aragonite saturation state of 1.4 (1.2 ± 0.2) was concluded to be a more accurate reflection of potential OA impairment.

Beyond the issue of where to set the threshold for one species, there also is the broader issue of a TMDL framework centered around seawater chemistry changes and ecological effects for only one organism, i.e. pteropods. Focusing on one indicator taxa is an understandable simplification in the initial stages of developing a framework for identifying impairments, and pteropods are widespread and particularly sensitive to ocean acidification. However, many fundamental ecological questions remain: are pteropods replaceable in the diet of their predators by other zooplankton that are less sensitive to ocean acidification, or do they play a unique and irreplaceable role? To what extent can species adapt in a particular ocean region, and are some regions more crucial as habitat than others? These questions were proffered by an independent group of international oceanographic experts to a California group comprised of regulators, wastewater dischargers, a statewide environmental organization, and the scientific team building a model to predict OAH in southern California. While that work is ongoing, much more work remains to

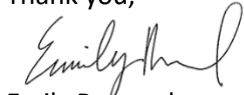
increase that community's confidence in that OAH model, including adapting approximately thirty-five recommendations from the independent experts to the modeling team. ("National Water Research Institute: Independent Peer Review Panel Draft Report for the ROMS-BEC Model"; you can read more about the overall project on its webpage: <https://www.nwri-usa.org/socal-coastal-model-review>, where the final report will be posted later this summer.)

Likewise, before DEQ adopts the 2024 Integrated Report with the inclusion of the OAH methodology and listings, CASA recommends more investment and time to address these ecosystem-level questions, alongside investment in more transparency and outreach in formalizing a methodology to assess and determine OAH impacts.

For over the last half-decade, NACWA, CASA, and our members have been tracking efforts to understand, model, and assess impacts from OAH. While the level of confidence and certainty required by reviewers for peer-reviewed academic publications is sufficient for such purposes, an altogether different level of scrutiny likely would be applied by academic reviewers if they were informed the publication would result in the establishment of standards to be incorporated into government agency rulemakings that could lead to public works projects costing tens of billions of dollars to ensure regulatory compliance. A guiding principle for our community is that the level of confidence needed is commensurate to the associated costs for complying. While in Oregon, these initial two listings would not result in a TMDL anytime soon, our organizations have concerns with the work still needing to be done before DEQ adopts a complex, unfinished methodology that has not undergone a satisfactory public review process yet could result in treatment plant upgrades elsewhere if utilized, despite point sources not being the cause of OAH and thereby lowering the likelihood of restoration to the water body by costly treatment plant upgrades.

To close, we are grateful for the extension of time and opportunity to submit comments to DEQ on [Oregon's 2024 Integrated Report](#) and [technical support document for OAH](#). Due to the prospective ramifications of DEQ's adoption of Oregon's 2024 Integrated Report and the precedent it would provide other states, we submit these concerns, request for additional stakeholder processes, and recommend deferring inclusion of OAH from the 2024 Integrated Report until the 2026 listing cycle. We are worried about the decision to include OAH at this time, especially given that just a few months ago, California did not choose to move forward on OAH in their 2024 Integrated Report for the reasons provided above, instead referencing OAH for possible inclusion in future listing cycles once the remaining matters were resolved (p. 78). We think this same course is more advisable, and respectfully request Oregon consider the same in the short term. Otherwise, DEQ's work convening an interstate group to develop a scientific threshold could in practical implementation in Oregon be immaterial to managing point sources of pollution for OAH under the CWA yet have wide sweeping implications to point sources in other states. We appreciate your consideration of these remarks and would welcome the opportunity to meet to discuss them further. Please reach out to Jared Voskuhl with questions or to schedule meeting at (916) 446-0388 or jvoskuhl@casaweb.org.

Thank you,



Emily Remmel

NACWA Senior Director of Regulatory Affairs



Jared Voskuhl

CASA Director of Regulatory Affairs

Cc: Connie Dou

Comments from: Northwest Environmental Advocates

NORTHWEST ENVIRONMENTAL ADVOCATES



June 25, 2024

Lesley Merrick
WQ Assessment Program Lead
Oregon Department of Environmental Quality
700 NE Multnomah Street, Suite 600
Portland, OR 97232-4100

via email only: IntegratedReport@deq.oregon.gov

Re: 2024 Integrated Report and Proposed TMDL Schedule and Priorities

Dear Ms. Merrick:

The following are Northwest Environmental Advocates' comments on Oregon's 2024 Integrated Report, including its schedules and priorities for TMDL development.

Schedule and Priorities

DEQ's proposed schedule and priorities for TMDL development is pointless and misleading. One of the very few changes from the 2022 schedule and priorities to that for 2024 concerns the Coquille, which has been pushed forward two years, from April 2024 to April 2026. These Coquille TMDLs were first planned for an issuance date of June 2012 and there is a very long history of repeated delays since the 2010-2012 Performance Partnership Agreement, in which the 2012 date was first announced, to DEQ's current proposal of April 2026. That history is comprised of DEQ's repeated changes in its expected issuance dates for the Coquille TMDLs—2012, 2013, 2014, 2015, 2016, 2017, 2018, 2021, and 2024. That DEQ cannot manage to complete these purportedly “high” priority TMDLs after 14 years of work—plus two additional years—is certainly pathetic. More to the point, it demonstrates that there is nothing real at all about any of the proposed dates in DEQ's schedule for TMDL development in Oregon.

This issue applies to most of the non-court-ordered TMDLs in the schedule and priorities, for which DEQ has chosen to retain the April 2030 completion date (Deschutes River basin, Powder nutrient-related, Rogue nutrient-related, Schooner Creek and Siletz turbidity) that were set out in the 2022 schedule for these waters. Why does DEQ think that it can meet an April 2030 completion date for these waters when it has slipped the Coquille date once again after 14 years of delay? Why does DEQ think it can meet an April 2030 completion date when it has not been able to complete any other new TMDLs since 2010 with the exception of the nine TMDLs for the Upper Yaquina River and the seven TMDLs for Powder River Basin?

www.NorthwestEnvironmentalAdvocates.org

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Why has DEQ not added any other new TMDLs to its 2024 schedule and priorities to those that were on its 2022 schedule and priorities? With the passage of two years, and the long-awaited completion of the Upper Yaquina and Powder TMDLs, the agency should be able to add new waters to its “medium” priority and its schedule.

Among those TMDLs that should be added to the priorities and schedule are 303(d) listings for persistent pollutants, such as bioaccumulative toxics and nutrients. With the exception of the court-ordered mercury TMDLs for the Snake River, DEQ has no plans to complete new TMDLs for toxic impairments between now and 2030. As its last new TMDLs for toxics were from 2008—16 years ago—and its schedule goes to 2030, that would be a total of 22 years before DEQ completed any new TMDLs for toxics, with the exception of mercury in the Snake River.

Moreover, DEQ should establish its priorities for toxics and nutrients TMDLs by likelihood that there are NPDES sources that are causing or contributing to these impairments. As DEQ has demonstrated itself incapable of using TMDLs to control significant nonpoint sources, such as logging and farming, and it does have both the legal authority and the legal obligation to control pollutants from NPDES sources, this further consideration should drive its TMDL priorities.

Finally, an additional overlay should be for those pollutants that are having an adverse impact on threatened, endangered and candidate species; species that are on the verge of extirpation in Oregon, such as amphibians; and species at the top of the food chain, such as piscivorous birds and mammals.

DEQ’s method of choosing priorities is not transparent and objectively does not make any sense. For example, bacteria pollution in the Powder River is simply not putting as many people or species at risk as any number of other pollutants. The Upper Yaquina TMDL addresses only an average of 266 cow-calf pairs in a state that has 1,250,000 cows and calves (2020 end-of-year inventory), according to the Oregon Department of Agriculture. It is well past time for DEQ to establish a rational basis for its work.

Proposed De-Listings

Some of the proposed de-listings for toxics are based on the change in the ratio between excursions and total samples. Of greatest concern is how DEQ prevents polluters from collecting additional samples solely for the purpose of “diluting” the ratio and obtaining a de-listing. For others, DEQ simply does not provide enough information on which to judge its proposal or we are not reading the spreadsheets correctly. For example, the following proposed de-listings are confusing:

- OR_SR_1709001005_02_104141 Fanno Creek Copper gives as its rationale, that 1 excursion is less than the 3 needed to list from a total of 20 samples. But the information in column “R” of the spreadsheet indicates 0 of 8 samples in 2022 exceeded criteria and 15 of 55 in 2018 did. This is confusing because a total number of samples would be $8+55=63$, not 20, and $0+15=15$.

Lesley Merrick

June 25, 2024

Page 3

- OR_SR_1709001201_02_104170 Johnson Creek Endosulfan similarly does not make any sense, comparing the information in columns “J” and “R.”

Please provide more complete explanations for the proposed de-listings of the two above along with:

- OR_SR_1707010211_16_101465 Middle Mud Creek Chlorpyrifos
- OR_SR_1707010211_16_101466 West Branch West Crockett Branch Chlorpyrifos
- OR_SR_1708000107_02_103616 Sandy River Copper
- OR_SR_1709000306_05_103854 Willamette River Iron

Please also explain how DEQ prevents the use of additional data gathered—especially from times and locations expected to yield non-exceedances—by those who have a vested interest in obtaining a de-listing result.

Sincerely,

A handwritten signature in black ink, appearing to read "Nina Bell", with a stylized, flowing script.

Nina Bell
Executive Director

Comments from: Oregon Association of Clean Water Agencies



*Working with community wastewater treatment and stormwater management agencies
across the state to protect Oregon's water quality since 1987.*

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July 1, 2024

Connie Dou
WQ Standards and Source Water Protection and Assessment Manager
DEQ Water Quality Division
700 NE Multnomah Street, Suite 600
Portland, Oregon 97232-4100

Sent via email: IntegratedReport@deq.oregon.gov

Subject: Oregon ACWA Comments on the DEQ 2024 draft Integrated Report

Dear Connie Dou:

Thank you for the opportunity to provide comments on the DEQ 2024 draft Integrated Report (IR). These comments are provided on behalf of the Oregon Association of Clean Water Agencies (ACWA), which is a not-for-profit organization of Oregon's wastewater treatment and stormwater management utilities, along with associated professional consulting firms. We are dedicated to protecting and enhancing Oregon's water quality. Our members provide wastewater and stormwater services to over 3 million Oregonians, serving over 75% of Oregon's homes and businesses.

ACWA appreciates DEQ's willingness to engage with stakeholders including ACWA in this process. Ms. Dou has been willing to explain the background and DEQ's perspective on the need for the three new pollutants being added to the 303(d) list. ACWA's comments largely address the practical implications of addressing these pollutants of concern and ask questions about the role that ACWA member holders of NPDES permits can be expected to play. To develop effective responses to reduce these pollutants will likely require serious state, national and even global cooperation, including difficult societal choices to eliminate PFAS at its source and determine how to provide better housing and sanitation solutions for communities that have limited options. ACWA looks forward to contributing to the discussion in hopes of addressing these seemingly intractable problems.

DRAFT INTEGRATED REPORT

The IR identifies three novel listings: 1) PFOS; 2) Aquatic Trash; and 3) Ocean Acidification and Hypoxia. This letter will address each one in turn, providing comments and concerns intended to recognize the serious water quality impacts and consider the practical challenges in addressing them through a regulatory mechanism. One technical point to make first, however. ACWA found it difficult to navigate the IR and struggled to match data to the related Assessment Units. ACWA has created an instruction sheet that it would be happy to share with DEQ that may be used to help others.

PFOS in the Columbia Slough

ACWA members and DEQ are in agreement that any successful approach intended to reduce PFAS in the environment will be source identification and reduction or elimination. Chemicals containing PFAS are ubiquitous and difficult if not impossible to break down once they enter the environment. ACWA is engaging with member agencies, DEQ, Oregon State University and others to study the extent and magnitude of the presence of PFAS in the environment and, more specifically, wastewater and its many beneficial products including biosolids and reuse water.

Listing the Columbia Slough for PFOS based on Oregon Health Authority (OHA) fish consumption advisories and recognizing specific sources that include fire-fighting foam and industrial processes is consistent with ACWA's approach to PFAS reduction. However, given the relative lack of a deep understanding of appropriate PFAS limits and the degree of human health impact, OHA's recommendations are likely intentionally very conservative. The decades-long bioaccumulation of legacy pollutants such as PCBs and pesticides in the Slough further complicates the picture. Having said that, reducing PFAS in the Columbia Slough is an important effort. Ideally, a targeted approach will be utilized to identify significant sources and reduce or eliminate the pollutant at its source. The focus on private parties that release pollution in the Slough and the needed remediation of sediment contamination will be critical. The first step to making the strides that need to be made to reduce PFAS in the environment is to track the most significant release of pollutants to the source and eliminate their release. Taking direct action to reduce release of known sources of pollution will be a far more effective approach than adding PFAS-related chemical pollutants to the 303(d) list and a future TMDL.

Aquatic Trash

No one likes seeing trash in or near Oregon's streams or other waterbodies. With people comes trash, but there is no denying that the accumulation of trash is accelerating, not decreasing. As DEQ notes, acknowledging the environment concern of aquatic trash getting into waterways is not subject to controversy. The sources and solutions of course will require considerable thought, differences of opinion, effective and well-thought-out strategies, and considerable physical and monetary societal investment. ACWA applauds DEQ for its brave recognition that a "TMDL may not be the most effective tool for reducing aquatic trash."

DEQ listed aquatic trash only for stream segments where it was presented with what it refers to as "overwhelming evidence". Using this methodology should truly be a method of last resort as both the evidence presented, and the conclusion reached of "overwhelming evidence", are far too subjective. The standard for credible evidence and the criteria to reach "overwhelming" should be elaborated on by DEQ in the future. In the meantime, ACWA does not quibble with the fact that DEQ was presented with a lot of pictures of trash that suggest an environmental concern to take seriously. DEQ correctly limited the reach of the listing to only those stream segments where evidence was presented.

So what should be done and who should do it? What would a plan look like? How would it be funded and implemented? What logical role would a wastewater treatment or stormwater management agency play in such a plan? Of all the state agencies, is there any reason that DEQ would be expected to lead the way? ACWA cannot answer these questions, and DEQ probably can't yet either. What ACWA can do, and is willing to do, is to provide DEQ with information. We will not look the other way when water quality is being impacted. Without question, a portion of the trash seen along waterways is associated

with the houselessness crisis. Most of ACWA's members are municipalities that have information or even programs on current efforts to address help alleviate the crisis. ACWA can work with DEQ to see if data is available that can be shared. Multiple partners will be involved in this effort and ACWA members will need to know how to interact with them within its lane as NPDES permits holders. In the meantime, the Portland Metro area is collecting significant tax revenue to fund programs along with the State of Oregon to address houseless issues, and one of the issues could include trash reduction and collection plans. As a related matter, there are laws regarding 72-hour notice to enter campsites and personal property protections that must be respected, making the issue even more complex to address.

DEQ should follow its instincts that a TMDL for aquatic trash and eventual inclusion in, most likely, MS4 stormwater permits is not the path to follow. ACWA is aware of the trash TMDL in Los Angeles, a very different situation to that faced in Oregon. Trash collection baskets at the end of storm pipes to the LA "River" no doubt collect trash that otherwise would enter the intermittent flow of water during the rare and irregular heavy storm events that occur. Oregon utilities face more regular wet weather patterns, and stormwater pipes are not a major source of trash. Oregon utilities follow Best Management Practices including regular street sweeping and catch basins and water quality facilities designed to protect water quality but that also serve the ancillary purpose of keeping trash out of storm pipes. Many if not most Oregon utilities mark storm drains with the legend "Drains Directly to Stream" to remind people to not rinse off their lawn mower, dump oil, or drop trash that could end up in the stream. The streamside trash accumulation in riparian areas shown in the evidentiary photos that DEQ is responding were likely not much contributed to by discharge from storm drains. Of course, the houseless contribution mentioned above is added to by the housed community, illegally dumping household refuse, litter, old tires, mattresses, etc. into streams. Riparian areas are not part of the MS4 and our utilities have limited jurisdiction to directly address some of these broader societal concerns related to the accumulation of aquatic trash. Solutions more oriented toward refuse receptacles and trash collection will likely yield more gains than a new MS4 permit requirement.

Ocean Acidification and Hypoxia

DEQ developed this "first in the nation" listing for impaired ocean acidification using methodologies to assess ocean conditions based upon narrative water quality criteria. Applying narrative criteria for ocean acidification and hypoxia (OAH), DEQ listed one ocean area for OAH and another area for hypoxia. Four other ocean units were not listed due to insufficient data. The assessment methodology used should be supported by significantly more quantitative data (biological, chemical, and physical measures) and less reliant on qualitative narrative evaluation.

DEQ makes the practical and welcome observation that "regulating small point source discharges into marine waters may not be the most effective use of resources given the global influence of changing ocean levels." ACWA supports DEQ's reasoning that a TMDL is not the correct mechanism to use to advance positive solutions. The suggestion to work within "existing state programs on climate solutions that will increase coastal resilience and with the scientific community to better understand effective solutions at the state level" is the place to start. The science should be further developed to better understand what is within the control of regulatory mechanisms and what is more related to global challenges requiring complex multi-national cooperation.

At this time, until further science and state programs to target climate change are developed, DEQ should resist any efforts to target the small communities along the Oregon Coast that have oceanic discharges, especially given the likely extremely low level of relative impact on the larger issue. These

communities already must meet stringent NPDES discharge requirements. They do not have the financial, technical, scientific or workforce resources to contribute. To expect these communities to foot any of the bill for the massive investments that may be needed would be unrealistic and place an unfair burden on these generally extremely low-income areas of the Oregon Coast. Additionally, effective solutions will need to include a consideration of non-point sources contribution, further highlighting that a TMDL approach is not the answer.

TMDL Priorities and Schedule

A final point not specifically related to the newly listed pollutants. For each of the three pollutants discussed, there is a common theme. What are the implications of a listing? Is a TMDL more or less likely to be effective? If not, what then? If there is a TMDL, what is the metric for success? Before DEQ takes any next steps, especially before TMDLs are seriously considered, it is important for DEQ to develop a plan. The plan needs to focus on practical solutions, appropriate funding sources, and identifying the right participants at the right level for meaningful progress.

In the 2024 draft Integrated Report, DEQ has included its TMDL priorities and schedule. The schedule identifies high, medium and low priority TMDL projects. Nearly all the high priority TMDL projects are related to addressing temperature listings. While we understand that DEQ's continued focus on temperature is being driven by legal action, the work on updating the temperature TMDLs will end in the next couple of years. DEQ should look at prioritizing the development of TMDLs for other pollutants that have languished on the 303(d) list. There are long-time listings for dissolved oxygen, aquatic weeds, algal blooms and other constituents in many streams that continue to be identified as low priority items in its TMDL schedule. The recent permit action for the City of Medford was particularly instructive in highlighting the need for watershed assessments and the development of timely TMDLs. Since it will take time for DEQ to develop TMDLs, we encourage DEQ to define compliance pathways during the interim period for de minimis activities that enable facility planning and construction of new facilities to address aging infrastructure and growth and incorporate technological improvements.

In closing, ACWA looks forward to being part of the conversation regarding these newly listed pollutants but urges DEQ to not get diverted by developing TMDLs for these pollutants. A better use of DEQ resources to benefit water quality would be to prioritize its activities on successfully implementing critical existing TMDLs, for instance for temperature and dissolved oxygen.

Thank you for your consideration of ACWA's comments. If you have any questions, please do not hesitate to contact me.

Sincerely,

Jerry

Jerry Linder
Executive Director, Oregon ACWA

Comments from: Oregon Department of Fish and Wildlife



Oregon

Tina Kotek, Governor

Department of Fish and Wildlife

Habitat Division

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June 14, 2024

Department of Environmental Quality
Attention: Water Quality Assessment
700 NE Multnomah Street, Suite 600
Portland, OR 97232



Re: Draft 2024 Integrated Report

Dear Water Quality Assessment Team,

The Oregon Department of Fish and Wildlife (ODFW) appreciates the opportunity to provide comments on the Department of Environmental Quality's (DEQ) Draft 2024 Integrated Report. ODFW supports the work done by DEQ to create and refine tools that allow the user access to detailed maps and data used in its water quality assessment. ODFW trusts that the comments provided below may guide current and future water quality assessments to adequately assess impacts to aquatic life.

ODFW's mission is to protect and enhance Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations. Through adoption of its climate and ocean change policy in 2020, the agency recognized that Oregon is already experiencing impacts from changing climate and ocean conditions, including high water temperatures which are a major threat to self-sustaining populations of vulnerable native species and severely limit population viability for Oregon's native anadromous cold-water-dependent species.

Here ODFW describes several key areas from the 2024 Integrated Report which support ODFW's mission and respectfully requests that DEQ consider the suggestions described below.

Alkalinity Listings:

The draft 2024 Integrated Report identifies 48 Assessment Units as Category 5 for alkalinity. As referenced on page 118 in its 2024 Assessment Methodology, EPA's recommendation for the aquatic life freshwater criterion for alkalinity is "20 mg/L or more as CaCO₃ except where natural concentrations are less." Because of the difficulty of determining whether low alkalinity concentrations are natural, the methodology states that "*For Integrated Report evaluations, analytical data indicating alkalinity less than the criterion is flagged as a **Category 3B Insufficient Data: Potential concern.***"

The following assessment units should be returned from Category 5 to Category 3B:

- OR_LK_1707030101_05_100040 Lava Lake
- OR_LK_1707030102_05_100063 Odell Lake
- OR_LK_1707030202_05_100084 Crescent Lake
- OR_SR_1706010505_02_103361 Minam River

*To protect and enhance Oregon's fish and wildlife and their habitats
for use and enjoyment by present and future generations.*

• OR_SR_1708000107_02_103616	Sandy River
• OR_SR_1708000305_05_103619	Clatskanie River
• OR_SR_1708000602_05_103678	Skipanon River
• OR_SR_1709000302_02_103806	Muddy Creek
• OR_SR_1709000305_02_103829	Luckiamute River
• OR_SR_1709000404_02_104571	Lookout Creek
• OR_SR_1709000406_02_103871	Mohawk River
• OR_SR_1709000407_02_103884	McKenzie River
• OR_SR_1709000502_02_103899	North Santiam River
• OR_SR_1709000504_02_103906	North Santiam River
• OR_SR_1709000506_02_103930	North Santiam River
• OR_SR_1709000608_02_103925	South Santiam River
• OR_SR_1709000804_02_104034	South Yamhill River
• OR_SR_1709000906_02_104093	Molalla River
• OR_SR_1709001104_02_104155	Clackamas River
• OR_SR_1709001106_02_104597	Clackamas River
• OR_SR_1709001201_02_104170	Johnson Creek
• OR_SR_1710020101_05_105827	Necanicum River
• OR_SR_1710020202_05_106442	Nehalem River
• OR_SR_1710020303_05_105886	Tillamook River
• OR_SR_1710020307_05_105939	Miami River
• OR_SR_1710020405_02_105978	Siletz River
• OR_SR_1710020407_02_106452	Siletz River
• OR_SR_1710020408_02_105997	Salmon River
• OR_SR_1710020502_02_106020	Five Rivers
• OR_SR_1710020504_02_106034	Alsea River
• OR_SR_1710020505_02_106047	Beaver Creek
• OR_SR_1710020505_02_106050	North Fork Beaver Creek
• OR_SR_1710020505_02_106051	South Beaver Creek
• OR_SR_1710020608_02_105077	Siuslaw River
• OR_SR_1710020608_02_105080	Siuslaw River
• OR_SR_1710030501_02_104959	Middle Fork Coquille River
• OR_SR_1710030504_02_104981	North Fork Coquille River
• OR_SR_1710030601_02_106304	Floras Creek
• OR_SR_1710031202_02_104653	Winchuck River
• OR_WS_170800060207_05_103708	HUC12 Name: Lower Lewis and Clark River
• OR_WS_170900100401_02_104506	HUC12 Name: Beaverton Creek
• OR_WS_170900110604_02_104546	HUC12 Name: Tickle Creek-Deep Creek
• OR_WS_170900120101_02_104550	HUC12 Name: Upper Johnson Creek
• OR_WS_170900120103_02_104552	HUC12 Name: Lower Johnson Creek
• OR_WS_170900120202_02_104555	HUC12 Name: Balch Creek-Willamette River
• OR_WS_170900120305_02_104561	HUC12 Name: Multnomah Channel
• OR_SR_1708000602_05_100322	Youngs River
• OR_SR_1708000602_05_100324	Youngs River

Temperature Delistings

DEQ revised its temperature delisting methodology for the 2024 Integrated Report to include greater than one year of data to remove a waterbody from the 303(d) list of impaired waters. Inherent variability in climate patterns made the need for multiple years of data essential to confirm that temperatures did indeed meet criteria to be removed from the 303(d) list of impaired waters. ODFW asks that DEQ consider adding an additional requirement that the monitoring locations that were used to list an assessment unit are also required to delist the assessment unit (or stations similarly located).

For example, Grant Creek, a stream in the Watershed Assessment Unit OR_WS_171002070101_02_106385 HUC12 Name: Maple Creek is proposed to be delisted for meeting its temperature criteria based on monitoring location 40046-ORDEQ Upper Grant Creek, 0.4 miles upstream of the Maple Creek Road crossing (upstream location). The original listing in 2022 was based on two monitoring locations (upstream and downstream), 40046-ORDEQ Upper Grant Creek, 0.4 miles upstream of the Maple Creek Road crossing (upstream) and 40044-ORDEQ Lower Grant Creek at Maple Creek Rd crossing (downstream). The twenty-five exceedances of temperature criteria in the original listing occurred at the downstream site while no exceedances occurred at the upstream location. The current delisting proposal is based solely on data collected at the upstream location. Were data to be collected and submitted from the downstream location, we presume that the stream may remain listed. Therefore, ODFW encourages DEQ to consider refining its temperature delisting methodology to reflect this requirement to maintain protection of aquatic resources and be certain that the delisting is appropriate before waterbody protections are removed.

Aquatic Trash Water Quality Assessment:

ODFW supports DEQ's assessment conclusions for aquatic trash. During its assessment, DEQ narrowed the affected beneficial uses from those proposed by Willamette Riverkeeper because there was not sufficient evidence in the data submitted to link the impact of aquatic trash to all uses. DEQ concluded there was sufficient evidence in the submittal to show impacts to aesthetic quality and water contact recreation. ODFW believes that the amounts of trash contained in or near the assessed waterways also impairs the Fish and Aquatic Life use and Wildlife and Hunting Use. Fact sheets from multiple states commonly identify the harm caused by wildlife ingesting trash. Trash can destroy habitats by choking out essential plant life and confusing wildlife into thinking it is food. The most common threats to wildlife include both physical hazards from ingestion and entanglement, and toxicological threats from ingestion of contaminants attached to and trapped within plastic particles¹. Trash does not just float on the surface of water, but also leaches harmful chemicals into the water. According to EPA, contaminants accumulated on the surface of plastic particles as well as those within the plastic can be released to the environment when the plastics break down into smaller particles because of ultraviolet (UV) radiation, mechanical forces, and weathering¹. Trash can also obstruct natural migration routes, disrupt nesting locations, and imperil habitats. When animals' usual paths are blocked or made unsafe by discarded waste, it disrupts their regular migration and habitats, contributing to ecological impairment². Consequently, ODFW encourages DEQ to add beneficial

¹ https://19january2021snapshot.epa.gov/trash-free-waters/impacts-mismanaged-trash_.html

² <https://nobodytrashestennessee.com/how-does-littering-affect-the-environment-and-local-wildlife/>

use impairments for both the Fish and Aquatic Life use and Wildlife and Hunting Use for the aquatic trash Category 5 assessment units (Table 1).

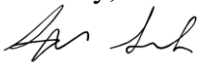
AU_ID	AU_Name	AU_Description
OR_SR_1709000306_05_103854	Willamette River	Confluence of Middle Fork Willamette River and Coast Fork Willamette River to Luckiamute River
OR_SR_1709001202_88_104175	Willamette River	Johnson Creek to confluence with Columbia River
OR_SR_1709000302_02_103812	Marys River	Muddy Creek to confluence with Willamette River

Table 1. Assessment units identified as Category 5 for aquatic trash in the draft 2024 Integrated Report.

Ocean Acidification and Marine Dissolved Oxygen Assessment:

The impacts of climate and ocean change on our aquatic and marine systems have become more severe and frequent over the past two decades. Oregon is also among the first places in the world to observe direct impacts of ocean acidification and hypoxia (OAH), due to its unique geographic and oceanographic context. Addressing intensifying OAH conditions here in Oregon is critical to our understanding of larger regional climate change impacts. ODFW commends DEQ for its collaborative work to develop a science-based assessment methodology for both marine dissolved oxygen and ocean acidification and the first ocean impairment listing for ocean acidification in the United States. The 2024 draft Integrated Report plays an important role in serving to codify science-based water quality assessments and identify several of Oregon's marine assessment units as impaired for both ocean acidification (WA border - Cape Lookout OR_OC_9999999999_01_107283, Cape Foulweather – Siltcoos River OR_OC_9999999999_01_107285) and hypoxia (Cape Foulweather – Siltcoos River OR_OC_9999999999_01_107285). ODFW encourages DEQ to collect sufficient data to assess both lines of evidence in subsequent Integrated Report cycles. This draft report represents an enormous effort and commitment by DEQ to protect Oregon's natural resources, and ODFW supports continued improvements to assess Oregon's waterbodies.

Sincerely,



Spencer Sawaske



Acting Water Program Manager
Oregon Department of Fish and Wildlife

Comments from: Special Districts Association of Oregon, the League of Oregon Cities and the Oregon Association of Water Utilities

To: Oregon Department of Environmental Quality (DEQ)

From: Special Districts Association of Oregon, League of Oregon Cities, and Oregon Association of Water Utilities

Subject: Public Comments on Aquatic Trash in Oregon's draft 2024 Integrated Report

DEQ Staff:

Thank you for the opportunity to provide comments on DEQ's draft 2024 Integrated Report following the extension of the public comment period. Comments in this letter are being submitted on behalf of the Special Districts Association of Oregon (SDAO), the League of Oregon Cities (LOC), and the Oregon Association of Water Utilities (OAWU). Collectively, these organizations provide the majority of wastewater, stormwater, and drinking water services to Oregon residents.

As stated in our public comment period extension request, responsible stewardship and protection of Oregon's waterways is a top priority for our members. We wholeheartedly support reduction of trash getting into our waterways. In addition, we appreciate DEQ's efforts to address this issue in light of the observed increases in trash along our waterways, which can largely be attributed to unhoused residents. As we are all aware, this is a deeply complex and challenging issue facing Oregon.

Our members are encouraged about the attention this issue is receiving while simultaneously concerned about the implications of a Total Maximum Daily Load (TMDL) designation for trash in the Willamette River Basin, which is a key focus of the draft 2024 Integrated Report. As such, we hope you find the following concerns, comments, and suggestions helpful as you work towards completion of the 2024 Integrated Report.

- 1. Jurisdiction.** Per the underlying photographic evidence submitted for the draft 2024 Integrated Report, aquatic trash in the Willamette River Basin is often the result of temporary encampments along a river, most often in areas where our members do not have jurisdiction (it's understood that additional sources of trash include recreational river activities not associated with a single point of origin). Given that temporary encampments associated with our unhoused residents are likely the main drivers for aquatic trash, we are concerned that a TMDL listing will disproportionately fall on the shoulders of water service providers who have little to no jurisdiction in and along Oregon's waterways. The Willamette River is a navigable stream and is thus considered to be owned by the state up to the high water mark. We recognize the intent behind DEQ's potential listing as a starting point for collaboration, but the lack of jurisdictional control could result in an untenable situation should the TMDL result in MS-4 permit requirements for a water service provider. It is also unclear how DEQ would identify and justify a list of Designated Management Agencies (DMAs) responsible for implementing a TMDL, when, as stated above, many DMAs have no jurisdiction over river shoreline areas and the river themselves.

- 2. Clean-up Efforts.** Related to item No. 1 above is the reality that clean-up efforts for trash – which, in the context of this situation, is being driven largely by the homelessness crisis – will require special training and legal requirements for encampment clean-up (e.g., 72-hour advance notice requirements). As noted in our public comment extension request, this issue is best addressed through a multi-jurisdictional, partnership-based approach, as DEQ has plainly stated in their own communications. It's our belief that a TMDL is less likely to promote this type of multijurisdictional collaboration. Rather, it has the potential to create a situation where the entities ultimately responsible for the TMDL implementation – water service providers – will bear the burden of these efforts simply by default, and notably from a financial perspective as others default to the DMAs responsible under a TMDL framework.
- 3. EPA Clean Water Act Section 303(d).** We agree with DEQ's acknowledgment that a "TMDL may not be the most effective tool for reducing aquatic trash." On that specific point, we feel that one of most compelling comments we'd like to share is there are more appropriate and pragmatic pathways under the Clean Water Act, specifically an Advanced Restoration Plan or a similar alternative plan as opposed to a TMDL. As of February 2023, EPA has accepted 87 advance restoration plans from 24 states (EPA, 2024a). Illinois EPA allows communities to develop Nutrient Reduction Plans (NARPs) as alternatives to TMDLs (IEPA, 2024). North Carolina Environmental Quality allows TMDL Alternative Plans and Kentucky also has a program for TMDL alternative approaches. EPA is supportive of alternative plans to TMDLs, as expressed through their 2013 Vision for Implementing the CWA Section 303(d) Impaired Waters Program Responsibilities (EPA 2022, 2024b). In addition, there are already examples in Oregon where agencies, nonprofits, and volunteers have been removing trash along rivers with extensive public access. For example, for the last 20 years, the Clackamas River Water Providers has been working with partner agencies and non-profits to remove several tons of trash from the Clackamas River – all without a TMDL designation.
- 4. Public Perception.** Multiple drinking water providers rely on the Willamette River to meet their communities' needs. Our members rely on high-quality water from the Willamette River, its tributaries, and its impoundments, and work diligently to protect this vital resource in multiple ways (e.g., legislative advocacy, riparian investments, source water protection). DEQ should endeavor in any further communications to make clear what "aquatic trash" accurately represents to the general public. Trash along and in our waterways is a risk and impairment to water quality; however, it is not the same as water quality degradation and contamination under the chemical and biological mechanisms associated with other risks, such as systemic industrial pollution, harmful algal blooms, or transient spills from transportation activities. Multiple federal, state, and local agencies have worked diligently to improve the health of the Willamette River over the last several decades, to great effect. The general public may not understand these nuances as well as DEQ or our members, which is understandable. Furthermore, the actual impact from aquatic trash needs further research (e.g., weathered plastic in the environment and its contribution to micro- and nanoplastics), resulting in a gap for this proposed TMDL listing. We understand the balancing act inherent to this issue and would encourage

DEQ to seek our members' feedback on appropriate and technically accurate public facing information, when appropriate. Water service providers are often the intermediary between regulatory issues and the general public, as well as the media, and have expertise in effective and appropriate communications best practices to promote transparency while not causing undue concern.

- 5. Data and Evidence.** While the evidence submitted to DEQ for this proposed TMDL listing is indeed a cause for action, it should also be noted the usage of the term "overwhelming evidence" is overly subjective in relation to the entirety of the evidence submitted. DEQ is correct in applying the impaired designation to only the assessment units where enough evidence was submitted, and we agree that trash in these reaches is a serious issue. We would still encourage DEQ to take a more rigorous approach to the application of data and information moving forward, specifically with this aquatic trash impairment designation given the potential precedent this may set for other waterways and waterbodies in Oregon. Requesting additional information via our academic research institutions is one example where collaboration would benefit the outcome. The seasonal and transient component of trash up to the wetted bank, combined with storm events, is one component that would further bolster and support where an impaired designation is most appropriately applied.

We applaud DEQ's leadership protecting Oregon's waterways and agree that aquatic trash needs to be addressed to protect Oregon's waterways, which are an important source of recreation, food, water, and livelihood for all Oregonians. We appreciate your consideration of SDAO, LOC, and OAWU's comments. If you have any questions, please do not hesitate to contact us.

Sincerely,

Mark Landauer, SDAO
Jim McCauley, LOC
Jason Green, OAWU

EPA. 2022. https://www.epa.gov/system/files/documents/2022-09/CWA%20Section%20303d%20Vision_September%202022.pdf

EPA 2024a. <https://www.epa.gov/tmdl/advance-restoration-plans>

EPA 2024b. <https://www.epa.gov/tmdl/2013-vision-implementing-cwa-section-303d-impaired-waters-program-responsibilities#vision>

IEPA. 2024. <https://epa.illinois.gov/topics/water-quality/watershed-management/narps.html>

Comments from: U.S. Environmental Protection Agency



July 1, 2024

Lesley Merrick
Water Quality Assessment Program Lead
700 NE Multnomah Street, Suite 600
Portland, OR 97232-4100

RE: EPA Comments on the 2024 Draft Water Quality Assessment

Dear Ms. Merrick,

The U.S. Environmental Protection Agency has reviewed the Oregon Department of Environmental Quality's Draft 2024 Water Quality Assessment and Integrated Report. The EPA's comments on the IR, which includes the 303(d) list of impaired waters, are included below.

1. In the draft 2024 IR, **OR_SR_1707010307_02_102616**, Umatilla River, is described in the rationale as being delisted due to a criteria change. It states, "Delist: Criteria Change - 2024 E. Coli assessment = Attaining - No Shell Fish Harvest Sub-Use in AU." However, it does not appear that the AU was moved to an attaining category and remains in Category 4a. Other AUs with the same rationale were moved to Category 2, so it appears that this is in error. Please verify the appropriate category placement for AU **OR_SR_1707010307_02_102616**.
2. In the draft 2024 IR Supplement, **OR_WS_180102041403_05_107134**, Klamath Strait Drain, was moved from Category 2-attaining water quality standards to Category 4a-impaired with an approved TMDL. While Klamath Strait Drain does have approved TMDLs for ammonia toxicity, chlorophyll-a and dissolved oxygen under the January 2019 Upper Klamath and Lost River Subbasins Nutrient TMDL and Water Quality Management Plan, that AU does not have an approved TMDL for pH. Please provide the EPA with the technical rationale documenting how the Upper Klamath and Lost River Subbasins Nutrient TMDL will address the pH impairment in **OR_WS_180102041403_05_107134** so that the EPA can review and take action on the proposed inclusion of this AU in the TMDL prior to placement of the AU in Category 4a. Until the EPA approves the pH TMDL for this AU, it will need to be placed in Category 5.

We appreciate the opportunity to work closely with ODEQ and look forward to continued coordination as you finalize the 2024 IR. If you would like to discuss these comments, please feel free to contact me at 206-553-2582.

Sincerely,

/s/ Jill Fullagar

Jill Fullagar
Assessment Coordinator
Water Division, EPA Region 10

Comments from: UCLA's Institute of Environment and Sustainability 2024 Ocean Acidification and Hypoxia Practicum Team

Comments from: UCLA's Institute of Environment and Sustainability 2024 Ocean Acidification and Hypoxia Practicum Team

June 30, 2024

The Oregon Department of Environmental Quality

Water Quality Assessment Program

700 NE Multnomah Street

Portland Oregon, 97232

Dear Oregon Department of Environmental Quality, Lesley Merrick, Travis Pritchard, and Kaegan Scully-Engelmeyer:

We, the students of the UCLA Institute of the Environment and Sustainability (IoES) California OAH Report Senior Practicum team, are providing comments and recommendations on the ocean acidification and hypoxia (OAH) assessment methodologies proposed by Oregon Department of Environmental Quality (Oregon DEQ) in the Assessment Methodology for Oregon's 2024 Integrated Report published on April 18, 2024. Our Practicum project was designed to compile the best available information about OAH in order to guide the California State Water Resource Control Board in creating OAH regulations, including by examining OAH policy from other West Coast states. Throughout the project, our team collaborated with experts on OAH from the policy, research, technology, data science, and spatial data fields in order to research the biological impacts of OAH, technologies designed to address OAH, wastewater plant data from California dischargers, spatial analyses of OAH problems, and existing policy on OAH.

During this investigation of existing policy, Oregon DEQ's draft assessment methodology was thoroughly reviewed. The methodologies developed by Oregon DEQ for assessing OAH are the first state-wide regulatory efforts of their kind designed to prevent and regulate the serious impacts from ocean acidification and hypoxia. We recognize this important

step forward, and recognize the work of Oregon DEQ and external parties in developing these methodologies.

However, we have significant concerns regarding the proposed assessment methodology. In particular, the benchmarks for severe shell dissolution and aragonite saturation state under the proposed ocean acidification assessment methodology and the dissolved oxygen threshold under the proposed hypoxia assessment methodology must be strengthened to more protective benchmarks consistent with extensive research, as detailed in the following sections and in the attached appendix, to better protect marine life from the accelerating impacts of OAH under climate change. Furthermore, there needs to be regulatory action beyond that of 303(d) and 305(b) listing, such as TMDL formulation and NPDES permitting with numeric effluent limits, in order to ensure the timely attainment of beneficial uses sought in Oregon's assessment methodology for the 2024 Integrated Report.

Ocean Acidification - Severe Shell Dissolution

Oregon's 2024 draft ocean acidification methodology is based on a hybrid marine biocriteria framework which allows for the individual or combined assessment of biological and chemical metrics depending on data availability (Oregon DEQ, 2024). The biological metric utilized for impairment assessment is the percentage of individuals within a pteropod sample of *L. helicina* with severe shell damage, which is damage that falls under Type II/III dissolution as outlined in Bednaršek et al. (2012). DEQ selected 62% individuals with Type II/III dissolution as the Independently Applicable (IA) benchmark and 40% individuals with Type II/III dissolution as its Combined Line of Evidence (CLOE) benchmark. To establish its CLOE benchmark, DEQ adapted research from Feely et al. (2016) in which 36-39% Type II/III dissolution was the estimated pre-industrial natural background average dissolution of nearshore waters (less than

200M in depth). Oregon reasons the CLOE benchmark of 40%, which is slightly higher than the high end of background dissolution, accounts for variability in natural response and could indicate impairment when combined with chemical metrics (Oregon DEQ, 2024).

However, Feely et al. (2016) found that the average pre-industrial value for dissolution was 23.5%, calculated from the 36-39% cited above found in nearshore waters and 8-12% individuals with severe dissolution in offshore waters. A study by Bednaršek et al. (2014) found that the pre-industrial average for *L. helicina* pteropods with severe shell dissolution along the California-Oregon-Washington coast was 18%, which correlates more closely with the 23.5% average found in Feely et al. (2016) than the 40% pre-industrial value. Under this 40% CLOE benchmark, offshore waters, which increased from 8% and 12% severe dissolution to 34% and 37% in 2011 and 2013, would not be marked as potentially concerning, or under Category 3B of DEQ's 305(b) listing options, despite the increased potential for species-specific and ecological harms associated with such a stark increase in dissolution (Feely et al., 2016; Bednaršek et al., 2014). Furthermore, the 40% Type II/Type III dissolution standard allows for a percentage of individuals with severe shell dissolution that is nearly double the 23.5% average found in Feely et al. (2016).

In addition, Oregon's 62% Type II/Type III IA dissolution threshold allows for significant increases in high dissolution levels without indicating biological impairment. Feely et al. (2016) indicates a 19% increase across all nearshore waters in percent individuals with severe shell dissolution from pre-industrial time to 2011 and 2013. Even after these significant increases in percent individuals with severe shell dissolution in nearshore waters, from 36 and 39% pre-industrial to 56 and 58% in 2013 and 2011 respectively, nearshore waters with 56-58% dissolution would still fall below Oregon's 62% IA threshold (Feely et al., 2016). These

monitoring observations and analyses demonstrate a significant limitation in the assessment methodology's ability to assess severe dissolution increases since pre-industrial times. Therefore, Oregon's thresholds fail to prevent harms and dissolution increases caused by anthropogenic acidification and dissolution. At minimum, the CLOE benchmark must be strengthened in accordance with the findings of Feely et al. (2016) and supported by Bednaršek et al. (2014) to a threshold of 23.5% in order to serve as an impactful benchmark for OA assessment.

Ocean Acidification: Aragonite Saturation State

Aragonite saturation state (Ω_{ar}) is utilized as the basis for the chemical metrics of OA assessment under Oregon DEQ's assessment methodology. Oregon utilizes the threshold of 1.2 Ω_a with an uncertainty range of ± 0.2 , as established in McLaughlin et al. (2015), to determine its benchmarks for assessment (Oregon DEQ, 2024). In line with this threshold and uncertainty range, DEQ established its chemical metrics benchmarks at 1.0 Ω_{ar} ($1.2 - 0.2$) for the IA benchmark and 1.4 Ω_a ($1.2 + 0.2$) for the CLOE benchmark.

However, in accordance with extensive literature, we strongly recommend that Oregon DEQ change their benchmark/CLOE methodology so that an aragonite saturation state of 1.4 ($1.4 \Omega_{ar}$) serves as the independently applicable (IA) benchmark for ocean acidification assessment. In Bednaršek et al. (2019), an expert panel agreed upon a threshold for pteropods at 1.2 Ω_{ar} , with 1.5 Ω_{ar} serving as an early warning for OA impacts. The two thresholds determined by Bednaršek et al. (2019) are related to the dissolution and calcification process. Calcification is a primary pathway of the organismal sensitivity to OA, which can act as an early warning response, and is directly implicated in growth and (abnormal) development across most of the marine calcifiers. Numerous studies show that the threshold for calcification occurs at similar pH/aragonite saturation state values as the thresholds for metabolic and energy metabolism

processes (Lutier et al., 2022; Bednaršek et al., 2019, 2022). A study by Waldbusser et al. (2014) showed acute responses on early larval shell development and growth for Pacific oysters began to occur at roughly 1.2–1.5 Ω_{ar} . Studies examining habitat compression from ocean acidification utilize values ranging from 1.0–1.4 Ω_{ar} , indicating that 1.4 Ω_{ar} serves as a conservative benchmark for protection against habitat compression (Feely et al. 2024; Frieder et al., 2023). Furthermore, pH thresholds, which have traditionally been utilized to measure OA impacts, correlate with a threshold of 1.4 Ω_{ar} ; calculations translating pH to aragonite saturation state can be found in the section IV.A. Acidification Threshold of the attached appendix. Therefore, a 1.4 Ω_{ar} threshold is a more protective threshold that's necessary to ensure biological processes are not compromised. Sustaining vital biological processes leads to sustained fitness of the organisms and species in the longer term, supporting the beneficial use of the protection for marine life and sustaining biodiversity via the bottom-up approach. Furthermore, a threshold of 1.4 Ω_{ar} is also included in California's 2024 Integrated Report as the potential threshold for OA assessment based on Bednaršek et al. (2019) and McLaughlin et al. (2015), meaning that there is current state policy that would corroborate this modification.

The 1.4 Ω_{ar} threshold should be implemented as a geometric monthly (30-day) mean threshold. Geometric monthly means were selected as thresholds because they have policy precedence for water quality issues related to wastewater discharges such as fecal indicator bacteria densities, as included in water quality standards such as in the US EPA Clean Water Act Recreational Water Quality Criteria from 2012 and California's Final Staff Report for the 2024 California Integrated Report, and in OAH-related state regulations, such as the hypergeometric pH assessment methodology under Washington State's 2023 Water Quality Assessment Listing Methodology to Meet Clean Water Act Requirements. Effects at the recommended 1.4 Ω_{ar}

threshold have been assessed to occur after 14 days of exposure (Bednaršek et al., 2019), which could be considered as a conservative value. In the California Current Ecosystem, pteropods are exposed to close to threshold conditions for at least 1 or 2 months, with exposure times being dependent on their initial location (Bednaršek et al., 2017). In principle, longer monthly exposure may require a higher threshold value; however, we take it into account that pteropods also experience a variability in the ocean conditions in the coastal environment. Therefore, taking a conservative value of a constant exposure to $1.4 \Omega_{ar}$ for 14 days was utilized for the determination of the recommended monthly geometric mean threshold. In order to prevent acute impacts, a maximum single day threshold value of $1.0 \Omega_{ar}$ should be considered. This modification would still be in line with Oregon DEQ's more stringent impairment threshold since a $1.0 \Omega_{ar}$ threshold is utilized as the independently applicable benchmark under the current draft assessment methodology.

Hypoxia

To assess hypoxia impacts, DEQ introduced a methodology in the 2024 IR utilizing a biological numeric benchmark at 1.4 ml L^{-1} or 2.0 mg L^{-1} dissolved oxygen (DO) (Oregon DEQ, 2024). While it is true that severe biological harms occur under these hypoxic conditions, and 2.0 mg L^{-1} is the defined DO concentration at which hypoxic events occur, there are numerous studies that indicate that this threshold is far too low to prevent lethal and sublethal impacts across marine species (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021). For example, biological harms occur at DO concentrations as high as 5.5 mg L^{-1} for sea urchins, 4.1 mg L^{-1} DO for rockfish, and 3.5 mg L^{-1} DO for echinoderms and mollusks (Flannery & Bjorkstedt, 2024, Hamilton et al., 2019, Low & Micheli, 2018; 2020, Sampaio et al., 2021). Northern anchovies, a key species on the West Coast due to their role in

ecosystem health and the fishing economy sector, have an ecological hypoxia tolerance of 5.35 mg L⁻¹ DO, at 7.5°C as calculated through metabolic index and temperature-dependent determinations (see appendix for full calculations) (Howard et al., 2020). Salmon species such as Chinook salmon have DO thresholds of 5.5 mg L⁻¹ at 10°C and 5.9 mg L⁻¹ at 14°C (Del Rio et al. 2019). Barnes et al. (2011) found consistent DO thresholds for Atlantic salmon at 3.42 ± 0.42 mg L⁻¹. Vaquer-Sunyer & Duarte (2008) found that salmon-related species have sublethal effects at a range of 4.5 mg L⁻¹ to 8.85 mg L⁻¹ DO, with Atlantic salmon at the lower end and sockeye salmon at the upper end. Utilizing a DO level that protects salmon is imperative in light of their cultural and economic importance and the severely declining west coast salmon populations over the last few decades.

Given the extensive research that indicates lethal and sublethal harms occur to a range of ecologically and economically important species at DO concentrations higher than 2.0 mg L⁻¹, this DO threshold should be substantially raised to better protect marine life (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021). The current assessment methodology and threshold proposed by Oregon DEQ will not adequately assess harms to marine life, and will instead allow for continued impairment of the Fish and Aquatic Life beneficial use which this methodology attempts to protect.

Policy should be written in a way that protects and sustains vital biological processes over a broad range of species and particularly the most sensitive taxa. Studies of sea urchins, crustaceans, and northern anchovies provide an initial range of potential dissolved oxygen thresholds of 5.0 mg L⁻¹ to 5.5 mg L⁻¹ based on the impacts they experience within this range (Howard et al., 2020; Ho et al., 2023); this threshold range is corroborated by research which indicates these thresholds will also prevent significant sublethal effects on rockfish and salmonid

species (Vaquer-Sunyer & Duarte, 2008; Flannery & Bjorkstedt, 2024; Hamilton et al., 2019; Del Rio et al., 2019). Thus, in order to mitigate hypoxic impacts and protect beneficial uses, Oregon DEQ should revise its standards to a dissolved oxygen threshold of 5.35 mg L⁻¹. This threshold was determined by a calculated temperature-dependent threshold in line with the findings of Vaquer–Sunyer & Duarte (2010) and Penn & Deutsch (2024) in which the temperature–dependent threshold for northern anchovies at ≤ 7.5 °C is 5.35 mg L⁻¹. This general threshold based on temperature-dependent calculations and extensive research indicating DO thresholds within this range would provide protection against critical sublethal (including habitat compression) and lethal effects in nearly every situation for most marine species.

Furthermore, this DO threshold should be implemented as a geometric monthly (30-day) mean threshold. This time scale recommendation is based on the longer-term impacts of low DO concentrations on sea urchins—significant impacts on sea urchins at a 5.5 mg L⁻¹ DO concentration were demonstrated at 35 and 64 days by Low & Micheli (2020)—as well as previously discussed northern anchovy thresholds which correspond to monthly exposure (Low & Micheli, 2020; Deutsch et al. 2020, Howard et al., 2020). A maximum single day threshold value should also be considered to protect marine species. A possible range for the maximum single day threshold value could be 2.0–3.0 mg L⁻¹ DO, given that these values are below lethal effects for the majority of marine species and fall into the widely accepted range of what constitutes hypoxia events (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021). Full information on the calculation of the recommended 5.35 mg threshold can be found in the attached appendix in the section entitled IV.B. Hypoxic Threshold.

The Need for Regulatory Action

Another weakness of Oregon's IR methodology for OA is that it does not identify a specific pollutant which should be addressed by a TMDL or other point/nonpoint source controls, making enforcement of water body recovery from OA impacts difficult to successfully achieve. Oregon acknowledges that broader approaches than TMDLs or restricting permitted discharges may be necessary to find effective solutions to increasing ocean acidification, but does not provide concrete actions which will be used to mitigate OA further than 303(d) listing (Oregon DEQ, 2024). 303(d) listing of ocean acidification alone will not combat OA impacts.

There are several paths that Oregon DEQ can and should take in order to effectively protect against OAH. One path is the TMDL approach, which has proven successful in Chesapeake Bay when voluntary nutrient reduction policies failed to restore aquatic life beneficial uses. Under this approach, in the event that 303(d) listed waters are not on a measurable path to beneficial use attainment via discharge permitting programs, TMDLs shall be developed and implemented to reach attainment by a date certain. Another strategy is utilizing NPDES permitting to regulate OAH. Washington State took the approach of utilizing the NPDES permit program to reduce nutrient loadings with their Puget Sound Nutrient General Permit. Extensive information on this approach can be found in the attached appendix below under III - Washington State Policies in the Policy section of the report. This is another promising approach that should be used in conjunction with a TMDL approach because it can include numeric waste load allocations as enforceable limits in permits. Additionally, strict numeric limits for nutrients have been used extensively in California for Los Angeles Region NPDES permits for over twenty years.

Conclusion

We commend Oregon DEQ for initiating work for the Assessment Methodology for Oregon's 2024 Integrated Report. However, given the accelerating nature of OAH processes under climate change, stronger, protective regulations and thresholds in OAH assessment are necessary to ensure effective protection of beneficial uses and of biodiversity and health of marine life. We strongly recommend strengthening the percent individuals with severe shell dissolution CLOE benchmark to 23.5% and the aragonite saturation state benchmark to be an independently applicable threshold of 1.4 implemented on a 30 day geometric mean timescale with 1.0 as the single day maximum for ocean acidification assessment. Furthermore, we recommend a 5.35 mg L 30 day geometric mean threshold for DO.

Our Practicum report, which is centered on California but is applicable to Oregon particularly in the Biological and Ecosystem Impacts, Technology, and Policy sections, is attached to this comment letter and is referred to as the appendix throughout this comment. Please refer to the report for more information on the substantiation for these recommendations. We thank you for the opportunity to comment and look forward to reading the finalized assessment methodology. Please contact us if you have any questions.

Sincerely,

Mackenzie Van Valkenburgh

Amani Tubaishat

Joshua Quinn

Likhitha Yettela

Sophie Rockefeller

Ella Walker

Isabel Sheng

Amanda Cusenza

Advisor: Dr. Mark Gold, UCLA IoES Adjunct Professor and Director of Water Scarcity Solutions at NRDC

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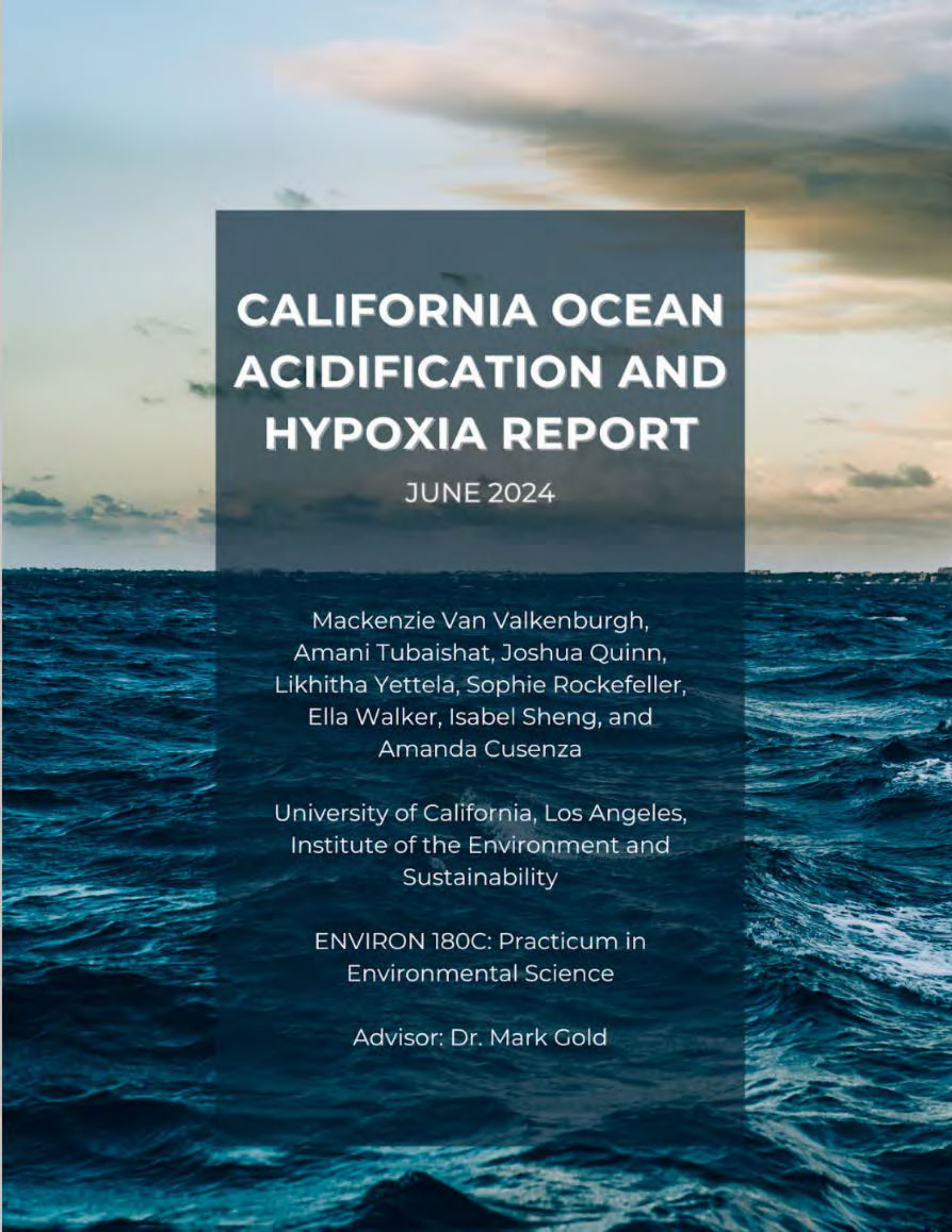
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CALIFORNIA OCEAN ACIDIFICATION AND HYPOXIA REPORT

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Appendix 1.

Introduction

In recent decades, ocean water masses around the world have experienced a reduction in dissolved oxygen concentrations and pH conditions. These processes are known as ocean acidification and hypoxia (OAH). Ocean acidification is the process in which the pH levels in the ocean are reduced due to uptake of the excess carbon dioxide (CO₂) in the atmosphere. Hypoxia refers to a state in which waters have low levels of dissolved oxygen, often leading to oxygen minimum zones or even uninhabitable regions in the ocean (referred to as ‘dead zones’). Both processes cause biological and ecosystem impacts to marine regions, which affect coastal economies and communities. Furthermore, over the past three decades, surface pH of the ocean has been decreasing (Lauvset et al., 2015; Ma et al., 2023; Global ocean acidification, N.D.), though research has also shown that there is a lot of spatial variability. The United Nations Educational, Scientific and Cultural Organization has reported that there has been a 26% increase in acidity since the start of the industrial era (Isensee, 2019). Simultaneously, the Intergovernmental Panel on Climate Change reported that from 1970-2010, oxygen availability has decreased by 0.5-3.3% and oxygen minimum zones increased by 3-8% (Special report, 2019).

The California Coastal Ecosystem is home to a wide range of species that are supported by the California current and seasonal dynamics. The current itself is a complex system that extends from the northern Washington State coast to Baja California in Mexico, bringing cold, nutrient-rich waters from the northern Pacific Ocean down south (NOAA Fisheries, 2024). In conjunction with the California current, seasonal upwelling—exacerbated by natural climate events such as El Niño— and submesoscale eddies also supply nutrient-rich waters to the coastal ecosystems. Eddy formation occurs when wind interacts with objects, such as an island, and is

redirected over the water causing movement among water masses. Although supplying the region with nutrients, these processes bring oxygen-poor and acidic water to the coast, which is partially mitigated through the mixing of water masses (Kessouri et al., 2022).

Along with the contribution from natural processes to ocean acidification and hypoxia, anthropogenic activities have been exacerbating these conditions. It is widely accepted that increasing global carbon emissions have influenced acidification and hypoxia. Atmospheric CO₂ is absorbed by the ocean and is transformed to bicarbonate ions (HCO₃⁻) and hydrogen ions (H⁺). Increasing ocean acidity influences the amount of certain carbon species present, often decreasing carbonate ions and increasing bicarbonate ions (Barker & Ridgwell, 2014). In regards to hypoxia, low oxygen concentrations have been linked to increased algal blooms that form in the right conditions with respect to nutrients, temperature, and sunlight (Sandoval-Belmar et al., 2023). Although increased algal biomass initially increases oxygen in marine waters, algae utilize oxygen and other nutrient chemicals in respiration and growth (US EPA, 2013). Post bloom, dissolved oxygen can decrease dramatically in the local ecosystem (US EPA, 2013).

California has been experiencing rapid changes in acidification, dissolved oxygen concentrations, and increases in phytoplankton biomass that cannot be attributed solely to natural processes (Booth et al., 2014). Booth et. al hypothesized that anthropogenic nutrient addition from wastewater treatment plants could be responsible for increases in acidification and hypoxic coastal conditions. In fact, although upwelling still dominates total nutrient input along the California coast, effluent sources from more populated coastal regions such as along Santa Monica Bay and San Diego can have an equal effect on nutrient flux (Meredith D.A. Howard et al., 2014; Sutula et al., 2021). On a local scale, these anthropogenic sources contribute significantly to changes in water chemistry and lead to algal blooms that reduce oxygen and pH

(McLaughlin et al., 2021). To expand, a recent model analyzed OAH conditions from wastewater effluent inputs that had varying levels of nitrogen reduction and water recycling; the study found significant increases in aerobic habitat space, available oxygen, and pH with 85% nitrogen reduction (Ho et al. 2023). Ultimately, this illustrates that wastewater effluent plays a role in ocean acidification and hypoxia on a regional scale in conjunction with upwelling and global CO₂ emissions. With coastal populations increasing, wastewater effluent nitrogen loads are expected to increase and further impact marine life. Due to their particular vulnerability to OAH, California and other Pacific states serve as a model to better understand its impacts and test solutions that other global regions could utilize in mitigation (Chan, 2016).

Furthermore, the State Water Resources Control Board (SWRCB) marked the issue of OAH as a top five high priority project in the 2019 Ocean Plan Review and set a goal of producing an amendment to the Ocean Plan for ocean acidification and hypoxia (SWRCB, 2019b; SWRCB, n.d.-b). In addition, the SWRCB included ocean acidification and hypoxia in both the 2022 and 2024 strategic working plans (SWRCB, 2022; 2024a). The strategic plans state their goal to address ocean acidification and hypoxia issues along with their relationship to anthropogenic sources (SWRCB, 2024a). Currently, the SWRCB has a goal adoption date for the amendment of December 15, 2026, with the amendment set to be opened for public comment by December 30, 2025 (SWRCB, n.d.-b). The goal of this report is to compile existing data on OAH and wastewater inputs across five areas– biological impacts, technology options, wastewater plant data, spatial data, and policy– to provide guidance to the State Water Resources Control Board on OAH regulations in California.

Biological and Ecosystem Impacts

I. Biological Impacts

Biological effects of ocean acidification and hypoxia have been examined under different thresholds. Common analysis for ocean acidification utilizes aragonite saturation state (Ω_{ar}), pH, or partial pressure of carbon dioxide (pCO_2) as metrics to determine the effects on taxonomic groups of interest. Aragonite saturation state refers to the ratio of individual calcium (Ca^{2+}) and carbonate (CO_3^{2-}) ions to the amount of calcium carbonate molecules ($CaCO_3$). Values of pH can influence reactions and biological processes in water, making it a direct marker of ocean acidification. Increasing ocean acidification tends to reduce the aragonite saturation value as more carbonate ions will form carbonic acid (H_2CO_3) and bicarbonate (HCO_3^-) rather than calcium carbonate. Hypoxia, on the other hand, is commonly analyzed using concentrations of dissolved oxygen (DO). More recent studies have highlighted the temperature-dependence of oxygen thresholds and switched to metabolic index (Φ) and hypoxia tolerance (Deutsch et al., 2020). The metabolic index is a species-specific measure of the environment's capacity to meet temperature-dependent organismal oxygen demand; the index uses environmental temperature, partial pressure of oxygen (pO_2), and hypoxia tolerance. Hypoxia tolerance provides an idea of an organisms' need for oxygen to perform metabolic or ecological functions. Outlined below are determined thresholds and effects on a variety of taxonomic groups and California species.

I.A. Taxonomic Groups

I.A.I. Pteropod

Pteropods, planktonic gastropods, are highly vulnerable to ocean acidification and serve as an important bioindicator for OA-impaired waters. Pteropods risk assessments for ocean

acidification are based on exposure to various Ω_{ar} values rather than pH and CO₂ values.

Saturation state values provide a more holistic analysis of the effects of ocean acidification on pteropod behavior, growth, physiology, mortality, and development (Bednaršek et al., 2019).

Exposure to 1.5 Ω_{ar} has been associated with effects on behavior and mild dissolution in pteropod species (Bednaršek et al., 2019). To expand, at this value, pteropod swimming capacity decreases by 10% (Bednaršek et al., 2019). Salinity also plays a critical role on swimming behavior and capacity as lower salinity environments of around 23.66 ppt combined with a low pH of 7.6 exacerbated these impacts as well as vertical migration ability (Manno et al., 2012). Effects on swimming ability in pteropods can influence their ability to escape predators. Beyond behavioral impacts on swimming, mild dissolution of pteropod shells also occurs at 1.5 Ω_{ar} exposure for five days (Bednaršek et al., 2019). This may have moderate effects on defensive capabilities as the shell becomes thinner and weaker, exposing the animal to predators.

Exposure to 1.2 Ω_{ar} is strongly linked to severe dissolution, decreased calcification, and impacts on larvae growth. Bednaršek et al. (2019) found severe dissolution of pteropod shells occurs at 1.2 Ω_{ar} exposure for 14 days. This threshold has been observed in cruises across the Pacific Ocean with severe dissolution occurring at a range of 1.4–1.2 Ω_{ar} at high rates among pteropod populations (Feely et al., 2024). In addition, 1.25 Ω_a also results in reductions in calcification (Bednaršek et al., 2019). Calcification may be more critical as Mekkes et al. (2021) found that calcification contributes more to thinning than dissolution; as seen in Figure 1. Nonetheless, thinning from severe dissolution and reduced calcification results in increased consumption by predatory species, ultimately impacting species interactions throughout the trophic web (Kroeker et al., 2014; Jellison et al., 2022). Finally, growth impairments in larval stage pteropods are also seen slightly below 1.2 Ω_{ar} at 1.15 Ω_{ar} (Bednaršek et al., 2019).

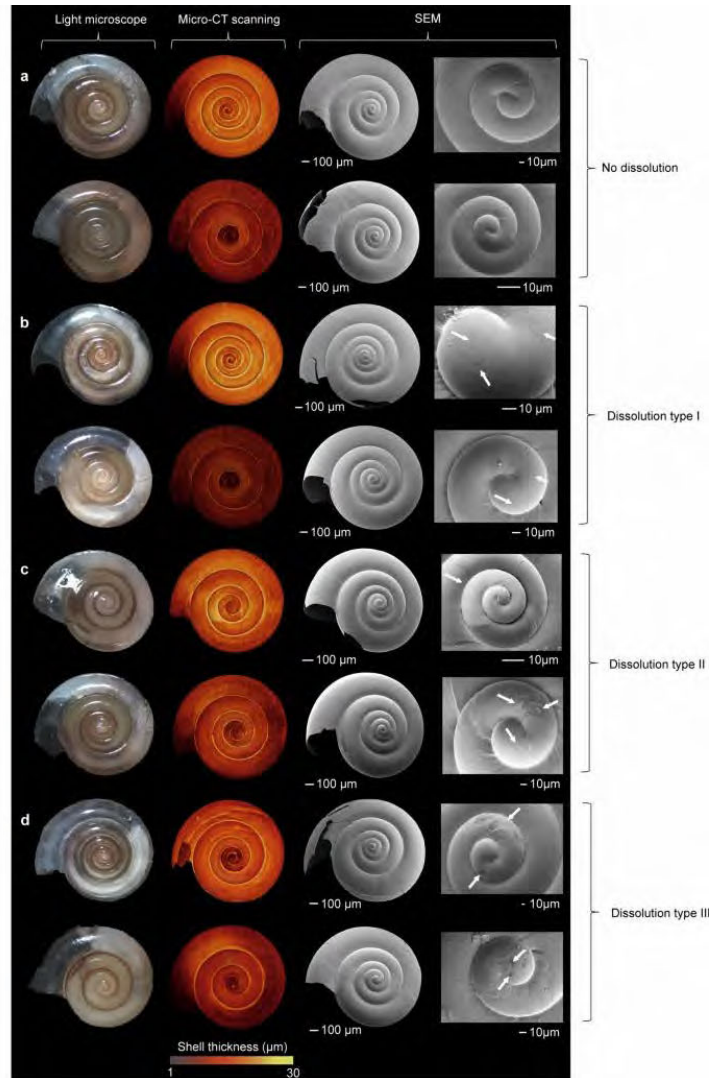


Figure 1. Shell images obtained by light microscopy, micro-CT, and scanning electron microscopy of *Limacina helicina* specimens. (a) Specimens with a thick shell (upper row) and a thin shell (lower row) without dissolution. (b) Specimens showing Type I dissolution, with pitting at the inner whorl (indicated by arrows). (c) Specimens showing Type II dissolution (d) Specimens showing Type III dissolution. Figure taken from Mekkes et al., (2021).

Recent monitoring efforts of ocean acidification and hypoxia have utilized the above threshold values as a biological indicator for acidification. Oregon has implemented sampling of pteropods to indicate regions with acidic and hypoxic conditions at a threshold of $1.2 \pm 0.2 \Omega_{ar}$ (Oregon DEQ, 2024). Oregon has also included 40% of pteropods must exhibit shell dissolution for waters to be listed as impaired, with their 40% threshold based on a calculation of percent pteropod individuals with severe shell dissolution in the pre-industrial period (Oregon DEQ,

2024). However, this percentage is far too high of a threshold, as recent studies have indicated on average 23.5% to 18% of pteropods experienced shell dissolution during the preindustrial period (Bednaršek et al., 2014; Feely et al., 2016). These values may be better indicators of anthropogenic related shell dissolution. Studies examining habitat compression from ocean acidification utilize values ranging from 1.0–1.4 Ω_{ar} based on the thresholds above (Feely et al. 2024; Frieder et al., 2023). Furthermore, the Southern California Coastal Water Research Project (SCCWRP) has active projects working to further expand on the development of proper methodologies for pteropod monitoring of OAH (Kimball, 2021).

I.A.II. Echinoderms

Echinoderms are one of the most abundant marine taxonomic groups, spanning from shallow coastal ecosystems to the bathyal zonation, which is around 200 m to 2,000 m in depth. The taxonomic group has important ecological roles such as being ecosystem engineers, macroalgal grazers, and keystone predators. Studies on the impact of ocean acidification on echinoderms are often conducted analyzing pH values rather than aragonite saturation state and CO₂ values.

Under lab exposure to 7.75–7.70 pH, echinoderms experience impacts on respiration and swimming behavior. Respiration rates at thresholds of around pH 7.75 increase by 35% in adults and 25% in juveniles (Bednaršek et al., 2021b). Wood et al. (2008) hypothesized that this increase in respiration occurs because of increased demands to survive and continue calcification and bodily processes under a low pH. However, this increase in respiration can lead to further stress which may influence other biological functions and lead to other harms. At a pH of 7.70, larval and young echinoderms have a 43% decrease in swimming speed resulting from efforts to

maintain stability under morphological changes from low pH exposure (Bednaršek et al., 2021b). Adult echinoderms have a lower threshold at 7.38 pH prior to seeing impacts on swimming behavior (Bednaršek et al., 2021b).

At lower pH values, more severe effects are seen. For example, exposure to 7.62 pH has severe implications on larval growth in echinoderms (Bednaršek et al., 2021b). Reductions of larval growth rate, total body length, and morphological development by 35%, 46%, and 35% respectively are seen at 7.62 pH (Bednaršek et al., 2021b). Lower growth rates and body length can affect movement as well as other processes important to echinoderm survival due to a change in energy allocation (Yu, 2012). Studies on adults exposed to this pH found increased rates of regeneration at a higher pH of 7.63, but due to lack of evidence and relative similarities between life stages, the threshold and impacts for adults was dismissed (Bednaršek et al., 2021b).

Bednaršek et al., (2021b) found additional impacts at 7.20 and 7.38 pH corresponding to decreases in correcting position after being flipped and reduction in feeding rates. However, growth and developmental effects seen at 7.62–7.63 pH may have more significant implications on a population and ecosystem level. As a result, preventing ocean pH dropping below 7.63 would better protect this taxonomic group.

In regards to hypoxic conditions, a study exposing various taxa groups to 1.0–3.5 mg L⁻¹ found echinoderms and mollusks experienced an approximate 25% and 15% reduction in metabolism and growth respectively (Sampaio et al., 2021). Additionally, echinoderms and mollusks experienced a decrease in survivability around 5–10% (Sampaio et al., 2021). Due to the significant impact on metabolism, a DO threshold above 3.5 mg L⁻¹ is recommended to protect this taxa group. However, Penn & Deutsch (2024) found that echinoderm hypoxia

thresholds are partially dependent on temperature. Therefore, a higher threshold may be required to better protect echinoderms with changes in temperature.

I.A.III. Decapod

Decapod crustaceans are ecologically important organisms and serve as indicators, especially for the food web. This taxonomic group includes species such as lobsters, crabs, and shrimp, making their conservation and success important to the commercial and recreational fishing economies (Florko et al., 2021). These species are not only important for industry, but also for cultural traditions and land-based identities such as those associated with indigenous marine cultural practices. Thus, evidence of ocean acidification affecting decapods could signal broader consequences across trophic levels, negatively impact decapod fisheries, and lead to cultural losses. Decapods and crustaceans in general are significant marine organisms of concern when studying ocean acidification due to their mineralized chitinous exoskeleton that is susceptible to the decrease in available carbonate ions (Whiteley, 2011).

When exposed to a pH around 7.70–7.75 in a laboratory setting, decapod growth rate, metabolism, and hypercapnia were impacted. For growth rate specifically, an expert panel determined a pH threshold of 7.75 for adult and juvenile decapods at this pH, reductions in growth rates are seen (Bednaršek et al., 2021a). Variations in species and geographic distributions of decapods can impact the pH threshold at which significant growth reduction is seen. For example, species such as porcelain crabs found in intertidal zones are acclimated to harsh environments with a constantly changing pH. Meanwhile, juvenile crab or lobster species found in cold and temperate habitats had significant reductions in growth at the lower pH level since their habitats have much more stable pH levels (Bednaršek et al., 2021a). Furthermore,

decapod metabolic rate and respiration rates show a decrease at a pH of 7.74. This number was only determined for adults due to the lack of significant correlation between studies in juveniles (Bednaršek et al., 2021a). Finally, while the species were able to control their interior pH levels, they were eventually compromised at extremely low environmental pH levels indicating hypercapnia; the agreed upon threshold by an expert panel is a pH of 7.70 (Bednaršek et al., 2021a; Davenport, 2019).

I.B Specific Species

I.B.I Dungeness Crabs

Dungeness crabs support the most valuable fishery in the U.S. West Coast, with its landings valued at \$220.9 million in 2019, and are an important part of regional food webs (National Marine Fisheries Service, 2021). A field study examined 1-month exposure to calcite saturation between the surface and a depth of 60 m (Bednaršek et al., 2020). Aragonite saturation, calcite saturation, and pH were collected on- and offshore. The average for aragonite saturation at 60 m was $1.72 \Omega_{ar}$ with a range from 0.88–2.08. Within the ranges of aragonite saturation, the main findings showed severe internal and external carapace dissolution, destabilized mechanoreceptors with important sensory and behavioral functions, and that dissolution is negatively related to the growth (Bednaršek et al., 2020). Figure 2 visualizes the impacts on Dungeness crabs external carapace and pereopod exoskeleton. These effects were found more frequently in regions where saturation state values changed the most. Although no direct threshold can be extrapolated from the study, it is evident that a threshold around $1.4 \Omega_{ar}$, based on studies of other calcifying species, or higher has the potential benefit to protect Dungeness crabs given the range and average of observed aragonite saturation state values.

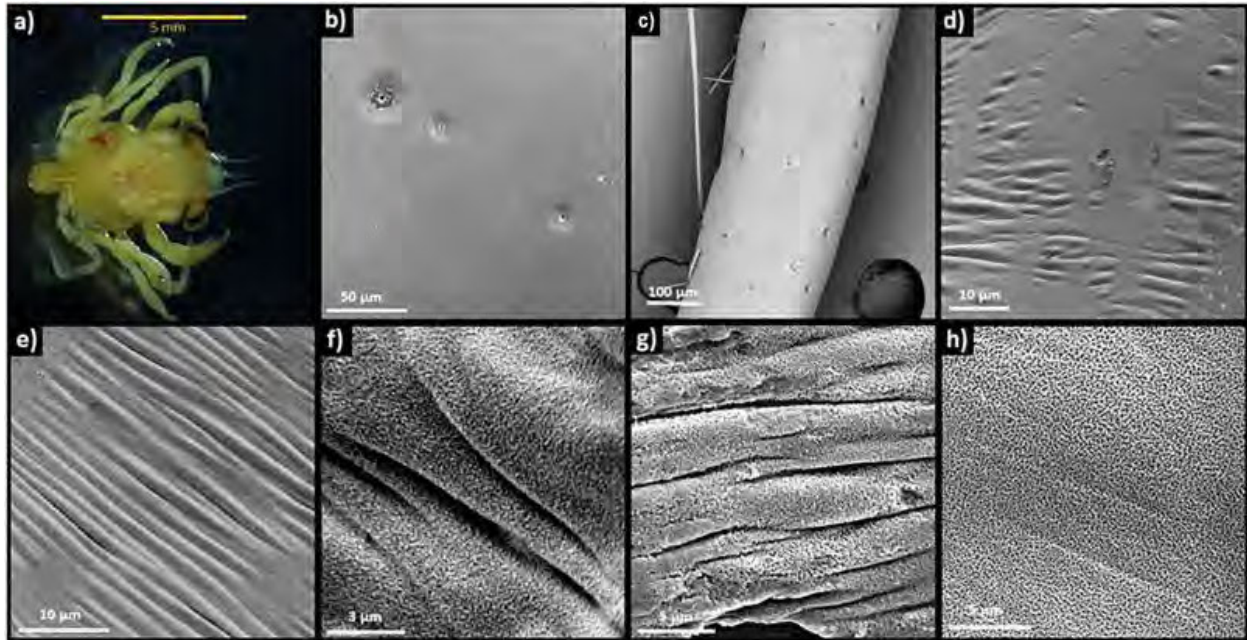


Figure 2. External carapace and pereopod exoskeleton of the Dungeness crab megalopae (a) in its undamaged form (b, c) and with dissolution presence ranging from mild (Stage 1; d) to severe (Stage 2; e, f) patterns showing similarity in the structural damages (g) or exposed crystals (h). Figure taken from Bednaršek et al., (2020).

A lab study revealed that Dungeness crab olfactory-related cues were also found to be negatively impacted at 7.74 ± 0.04 pH (Durant et al., 2023). The species within the experimental tanks had reduced olfactory-related antennular flicking responses to a food cue, which poses a major issue as they rely on their sensory system for vital biological and behavioral processes.

Interestingly, a lab study examining OAH impacts on Dungeness crabs found metabolite abundance, a marker for metabolism, decreased when exposed to 3.0 mg L^{-1} DO compared to ambient conditions of 8.9 mg L^{-1} ; however, under both low pH and DO treatment, pH had little effect on metabolism with low DO being dominant (Wanamaker et al., 2019). Moreover, although not directly Dungeness crabs, a meta-analysis study hypoxic threshold found that a threshold of 5.0 mg L^{-1} DO would prevent sublethal effects across 90% of crustacean species; which is the subphylum Dungeness crabs are under (Vaquer-Sunyer & Duarte, 2008).

I.B.II Pacific Oysters

The Pacific oyster is an important aquaculture species, with commercial oyster farming being a large cultural and economic part of coastal communities in the Pacific Northwest (Barton et al., 2015). They also provide many ecosystem benefits as they help improve water quality through feeding, provide habitats for other species, and stabilize sediment. A lab study conducting two replicated experiments, in the years 2015 and 2016, found that at $0.9\text{--}1.2 \Omega_{\text{ar}}$, larval development was inhibited and timing was impacted (Durland et al., 2019). Another lab study showed impacts on early larval shell development and growth as acute responses began to occur at roughly $1.2\text{--}1.5 \Omega_{\text{ar}}$ (Waldbusser et al., 2014).

Interestingly, a lab study comparing different carbonate chemistry condition effects on early embryonic development, found that developmental success and growth rates were not directly affected by changes in aragonite saturation state (Gazeau et al., 2011). Rather impacts were more correlated to the availability of carbonate ions, as tanks with lower aragonite saturation values (i.e. $0.8 \pm 0.1 \Omega_{\text{ar}}$ and $1.5 \pm 0.1 \Omega_{\text{ar}}$) had no significant difference in impacts in relation to the control treatment of $2.8 \pm 0.1 \Omega_{\text{ar}}$). However, the tank with an aragonite saturation of 1.6 and smaller amounts of carbonate ions, had significantly lower values of shell length and area as well as viable larvae. A field study using values from a 2009 water quality monitoring program of a hatchery found a correlation between water chemistry and Pacific oyster larval development (Barton et al., 2012). Results showed that during first-shell development the value of aragonite saturation was critical to the ultimate survival and growth of larval groups. Impacts on larvae were observed at $2 \Omega_{\text{ar}}$, however $\Omega_{\text{ar}} > 1.7$ represented the “break-even” point for commercial production. Given the range of aragonite saturation values that impact on Pacific oysters, maintaining a threshold greater than $1.2 \Omega_{\text{ar}}$ is crucial to protect the species for continued ecosystem benefits and commercial use.

I.B.III Anchovies

Northern anchovies are a key species along the Pacific west coast due to their role in ecosystem health and the fishing economy sector. Studies examining northern anchovies utilize the metabolic index and hypoxia tolerance due to their temperature sensitivity (Howard et al., 2020). The thresholds determined with this metric utilize monthly data for calculations (Deutsch et al., 2020; Howard et al., 2020). Howard et al. (2020) determined that northern anchovies have an ecological hypoxia tolerance of 5.4 atm^{-1} which corresponds to a pO_2 of 0.185 atm at 15°C , or 7.03 mg L^{-1} DO (Howard et al., 2020; Frieder, personal communication, May 2024). As oxygen thresholds are dependent on temperature, the pO_2 threshold changes to ~ 0.140 atm, or 5.86 mg L^{-1} DO, at 10°C and ~ 0.120 atm, or 5.35 mg L^{-1} DO, at 7.5°C (Howard et al., 2020; Frieder, personal communication, May 2024). This ecological hypoxia tolerance is similar to average tolerances of a variety of taxonomic groups determined in Penn & Deutsch (2024). Recent studies have modeled habitat compression based on northern anchovies' temperature dependent thresholds (Howard et al. 2020; Frieder et al. 2023). More information on these studies is provided in the modeling section.

I.B.IV Rockfish

Rockfish live from intertidal waters to more than 460 m depth and are one of the longest-living fishes. Many rockfish species are currently species of concern in California due to depleted stock populations (CDFW 2021). To start, in a lab setting under an exposure of 4.0 mg L^{-1} DO, copper rockfish had a $\sim 26\%$ reduction in critical swimming speed while black rockfish had a reduction of $\sim 9\%$ (Flannery & Bjorkstedt, 2024). When exposed to both a low pH of 7.5 and 4.0 mg L^{-1} of DO, black rockfish saw a reduction in swimming speed by 21% whereas

copper rockfish reduced by 21% (Flannery & Bjorkstedt, 2024). Otolith growth, an organ used for sensing gravity and changes in movement, in juvenile copper and blue rockfish from the central California coast were also found to be impacted by OAH. Both species showed a steep decline in otolith growth rates between 4.1 and 2.0 mg L⁻¹ DO (Hamilton et al., 2019). Another experiment done on the same fish resulted in declines in physiological and behavioral conditions within the similar DO range of 4.1 and 2.2 mg L⁻¹ (Mattiasen et al., 2020). Mattiasen et al (2020) also found decreased oxygen levels resulted in lower aerobic scope and metabolic rates. Given that declines within the range of 4.1 to 2.2 mg L⁻¹ occurred in both studies, it indicates that 4.1 mg L⁻¹ DO may be the tipping point for rockfish before negative impacts begin to occur.

I.B.V Salmonid

Salmonid species play a critical role in California and other states' fisheries along the pacific coast. Salmonid species are already experiencing population issues as through the rest of 2024, California has recommended the closure of both commercial and recreational salmon fisheries due to overfishing, harmful algal blooms, severe wildfires, and recent multi-year droughts (*Ocean Salmon Fishery Information*, 2024; CDFW News, 2024). Several studies have also indicated that certain salmonid species are sensitive to low oxygen levels (Vaquer-Sunyer & Duarte, 2008; Barnes et al., 2011; Del Rio et al. 2019). Vaquer-Sunyer & Duarte (2008) found salmon-related species have sublethal effects at a range of 4.5–8.85 mg L⁻¹ DO with Atlantic salmon at the lower range and sockeye salmon at the upper range. Barnes et al. (2011), found consistent DO thresholds for Atlantic salmon at 3.42 ± 0.42 mg L⁻¹; however, the study notes this might be slightly lower than required since it does not consider oxygen demands for active fish. Salmon species such as Chinook salmon that are relevant to California have DO thresholds of 5.5

mg L⁻¹ at 10°C and 5.9 mg L⁻¹ at 14°C (Del Rio et al. 2019). Effects seen at these thresholds include ~10% decrease in hatching success as well as reductions in growth and development (Del Rio et al. 2019). Furthermore, Washington Puget Sound lists water quality DO limits of fair, good, excellent, and extraordinary quality at 4.0 mg L⁻¹, 5.0 mg L⁻¹, 6.0 mg L⁻¹ and 7.0 mg L⁻¹ respectively (PSNGP Fact Sheet, n.d.). All four thresholds are based on effects seen on salmonid species (PSNGP Fact Sheet, n.d.). Due to the Chinook's importance to California, the 5.5–5.9 mg L⁻¹ range is more applicable for setting a dissolved oxygen threshold across the California coast.

I.B.VI Sea Urchins

Sea urchins, part of the echinoderm taxa group, are a key kelp grazer species in the California Current System due to their role in helping to preserve marine biodiversity by controlling the abundance of dominating species. In a lab study, within 5.5 and 4.5 mg L⁻¹ DO, purple and red sea urchins from the California Current System had a 39 to 47% reduction in kelp consumption and grazing (Low & Micheli, 2018). This was further tested and similarly found that sea urchin kelp consumption decreased under exposure to 5.5 mg L⁻¹ DO and a fluctuation between 8.5 to 5.5 mg L⁻¹ DO (Low & Micheli, 2020). More importantly, this study identified that other key biological processes such as gonad development, calcification, and spine regrowth rates decreased as a result of exposure to DO concentrations of 5.5 mg L⁻¹ (Low & Micheli, 2020). Spine regrowth and calcification specifically in lower DO treatments effect was found to be marginally significant after 35 days and statistically significant after 64 days when compared to the ambient treatment.

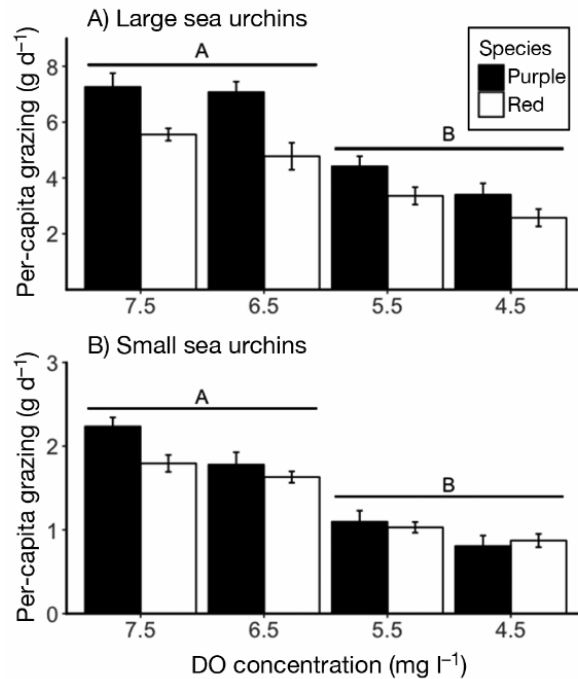


Figure 3. Per-capita kelp grazing for (A) large and (B) small individuals of purple sea urchins (filled bars) and red sea urchins (open bars) under dissolved oxygen (DO) concentrations. Letters indicate differences in kelp grazing between DO treatments, based on Tukey's HSD tests. Figure taken from (Low & Micheli, 2018).

I.B.VII Krill

Krill are amongst the largest and most ecologically important zooplankton species due to their importance in marine food webs, providing a link between phytoplankton and fish and cetacean species that directly feed on them. Antarctic krill embryonic development and larval behavior under a pCO₂ range up to 1,000 µatm in a lab study were unaffected (Kawaguchi et al., 2010; Kawaguchi et al., 2013). However, in pCO₂ levels of 1,250 µatm, hatch rates are significantly lowered and by pCO₂ of 2,000 µatm development is almost entirely inhibited (Kawaguchi et al., 2010; Kawaguchi et al., 2013). In the adult life stage, krill have been found to be highly resilient to 1,000–2,000 µatm pCO₂ as they were able to survive, grow, store fat, mature, and maintain respiration rates when exposed to conditions for one year (Ericson et al., 2018). Moreover, when tested for behavioral responses to different levels of pCO₂, ranging from

400–4,000 μatm , krill had no significant preference for different levels of CO_2 in the sea water (Yang et al., 2018)

North pacific krill similarly have a resistance to increases in OA during the adult stage while early life stages are shown to be more sensitive. Adult krill had the similar rates of survival and molting in both 380 (8.01 pH_T) and 1,200 μatm (7.60 pH_T), however at 1,200 μatm growth in all size classes was slowed (Cooper et al., 2016). At 7.69 pH (956 μatm pCO_2) larvae krill had developmental delays during the hatching and development, as well as slower molting process during the first feeding stage (McLaskey et al., 2016). Lastly, a paper examining both DO and pH levels in the field and lab found krill metabolism and growth to be generally tolerant to a wide range of seawater of 8.0 to 7.2 pH and 3.0 to 9.0 mg L^{-1} DO (McLaskey et al., 2021). However, the field observations within the study showed that as oxygen decreased, respiratory potential declined by 9%.

The resilience of krill under low pH waters, and to an extent low DO, could be a result of their natural exposure to different pCO_2 levels due to their well-developed acid–base regulation systems; which is perhaps an adaptation related to their seasonal and ontogenetic vertical migrations from the surface to the deep sea trough (Kawaguchi et al., 2010; Cooper et al., 2016). Still this could be an issue as reduced respiratory potential in low oxygen areas could limit the ability of krill to cope with their acid–base regulation (McLaskey et al., 2021). Based on the literature, 7.70–7.60 pH is the range at which negative impacts begin to occur.

I.B.VIII Coccolithophores

Coccolithophores are unicellular calcareous algae that play a dual role in global carbon cycling due to their ability to photosynthesize and need to calcify. This role creates an interesting

dynamic under the conditions of OA and excess nutrients. Numerous field and laboratory studies on coccolithophores found that OA leads to unaffected or stimulated photosynthesis, impaired or unaffected calcification and growth, and typically leads to decreased particulate inorganic carbon to particulate organic carbon ratio (Raven & Crawford, 2012; Kroeker et al., 2013; Meyer & Riebesell, 2015). A model study projects that under 900 atm CO₂, in comparison to pre-industrial CO₂ levels, global annual calcification is lowered by 11% (Krumhardt et al, 2019). Relative to growth, calcification in coccolithophores is greatly decreased, implying that while coccolithophores become more abundant they are overall less calcified as CO₂ increases.

At 7.85 pH low-light acclimated coccolithophores overcompensate the loss of HCO₃⁻ by increasing their CO₂ uptake (Kottmeier et al., 2016a). By contrast, high-light acclimated coccolithophores became carbon-limited as they could not increase CO₂ uptake and photosynthetic O₂ evolution due to their reliance on higher proportions of HCO₃⁻ uptake. A similar study examined longer term impacts of this regulation pattern and found that under 7.83 ± 0.04 and 7.79 pH, photosynthesis remained constant while calcification and cell growth decreased (Kottmeier et al., 2016b). Similar to the previous study, responses toward high [H⁺], CO₂ uptake significantly increased, but HCO₃⁻ uptake decreased. These regulations methods indicate that OA responses in photosynthesis are caused by [H⁺] rather than by [CO₂] and that coccolithophores in OA conditions often benefits their photosynthesis as they can use both CO₂ and HCO₃⁻, but calcification often decreases as it is dependent solely on HCO₃⁻.

II. Ecosystem Impacts

Ocean acidification and hypoxic events have also been linked to ecosystem and population wide effects. Although there have been few field studies on OAH impacts at the

ecosystem, community, or population scale, recent research has found exposure to low pH and dissolved oxygen concentrations can impact ecosystem function in several ways. These include (1) habitat compression and (2) trophic structure alteration (Sato et al., 2017; Feely et al. 2024; Kroeker et al., 2011, 2012, 2014; Núria Teixidó et al., 2024; Sunday et al., 2016; Jellison et al., 2022).

II.A. Habitat Compression

Habitat compression occurs when there is a reduction in available space in which organisms are able to sustain life. Recent studies have found that acidification and hypoxic events have profound impacts on benthic species habitat space off the California coast. To start, a study analyzing past trends in observations made from 1994-2013 in dissolved oxygen, pH, and sea urchins off the California coast found that a reduction from 7.8 pH and 150 $\mu\text{mol kg}^{-1}$ DO in 1994 to 7.75 pH and 120 $\mu\text{mol kg}^{-1}$ DO in 2013 led to decreased habitat capacity for sea urchins in shallow coastal waters (upper 100m) (Sato et al., 2017). More recent work has investigated the role of anthropogenic activities in causing OAH related habitat compression. When looking at attributions from anthropogenic carbon levels from 2007–2021, Feely et. al. (2024) observed declining rates of 0.002 pH per year and 0.006–0.011 aragonite saturation state per year. Corresponding to these reductions, there was notable loss in available habitat in regions containing aragonite saturation greater than 1.0 and oxygen levels high enough to sustain life (Feely et al. 2024). To expand, the study found that since the industrial area, the depth at which aragonite saturation reaches 1.0 has risen by about 30-50 m from anthropogenic activities alone. Feely et. al. (2024) also observed that at locations with 1.2–1.5 aragonite saturation, the frequency of severe shell dissolution in pteropods was 40–50% of the sampled population. These

observed conditions highlight the urgency to mitigate ocean acidification and hypoxia as current parts of the California current are already seeing significant impacts. Modeling studies have also been utilized to analyze habitat compression associated with increasing ocean acidification and hypoxia. Further information regarding these studies can be found in the modeling section.

II.B. Trophic Structure and Biodiversity Alterations

Ocean acidification and hypoxia can also impact entire marine ecosystems through changes in biodiversity and trophic structure. Several studies have concluded that across regions, low pH conditions cause shifts from longer living species to shorter living species (Kroeker et al., 2011; Núria Teixidó et al., 2024). In other words, under low pH conditions, algae and shorter lived species thrive and occur at a higher presence than calcifiers and fish. For example, in a study examining deep, shallow, and cave habitats in Italy with pH ranges of 7.70–7.90, there was a general decrease in calcifiers, organisms with medium growth rates, and filter feeders. At the same time, there were increases in filamentous organisms, photosynthetic activity, and shifts favoring organisms with faster growth rates (Núria Teixidó et al., 2024). This was further confirmed by several studies on the impacts of decreased pH on algal, seagrass, and mussel cover (Sunday et al., 2016). Sunday et. al. (2016) illustrates a general trend that as pH decreases, macroalgal and seaweed cover increases, whereas mussel and coral cover decrease. At low dissolved oxygen concentrations with values ranging from 1.0–3.5 mg L⁻¹, the abundance of organisms decreased by 65% on average (Sampaio et al., 2021). Significant decreases in species abundance can alter food webs and decrease the ecosystem services they provide, highlighting a potential community and trophic level effect. Sampaio et al. (2021) also found that with decreases in abundance, there were 50% and 60% decreases in reproduction and development

across species and life stages (Sampaio et al., 2021). Combined with population loss, these reductions can significantly impact ecosystem services and trophic structure. These studies provide a baseline for the impacts that will be seen at or below pH levels of 7.70 and 3.5 mg L⁻¹; however, more research is needed to confirm the applicability to the California coast.

Although the above changes in trophic structure can be due to declined presence of organisms from direct causes such as habitat compression, indirect effects in interaction between species also contribute to trophic changes. To expand, the biological impacts discussed prior may impact defense, feeding rates, and other interactions that impact the entire ecosystem. For example, Kroeker et. al. (2012), which found similar trends in decreases of calcareous species and increases in algal and seagrass species at 7.71 pH, indicates these shifts to algal-organism cover is driven by alteration in grazers' feeding rates and competitive interaction between calcareous and algal species (Kroeker et al 2012). The idea of interaction-based changes causing ecosystem and trophic structure effects was also confirmed in a 2014 metastudy that found predatory species increased the rate of consumption on mussels and oysters under low pH conditions (Kroeker et al., 2014). Specifically, there were decreases in time spent breaking through shells, predator avoidance, and energy transfer across trophic levels to predators (Kroeker et al., 2014). This was confirmed in a later study conducted in Bodega Bay, California, which found decreased pH conditions of 7.1–7.6 resulted in snail anti-predatory gene suppression, leading to increased grazing and mussel consumption (Jellison et al., 2022). Increased mussel consumption can have cascading effects on trophic structure as well as ecosystem stability due to the benefits of mussel species.

III. Modeling Studies

Since the early 2000s, ocean scientists have used the Regional Oceanic Model System (ROMS) to solve the equations governing fluid motion for a high-resolution, free-surface, terrain-following physical oceanographic model. (Shchepetkin and McWilliams, 2005). Researchers at UCLA then coupled the physical model (ROMS) with another model called the Biogeochemical Elemental Cycling (BEC) model that simulates biogeochemical processes like nutrient cycling, phytoplankton and zooplankton functional roles, and the decomposition of organic detritus (Moore et al., 2004). The BEC equations include four nutrient cycles (nitrogen, silicic acid, phosphate, and iron) and four phytoplankton functional groups (picoplankton, diatoms, coccolithophores, and diazotrophs) characterized by their respective functions (nutrient recycling, silicification, calcification, and N₂ fixation) (Deutsch et al., 2021). Coupled together, the California Current ROMS-BEC model links the physical motion of currents with biogeochemical processes at an ecosystem scale.

The ROMS-BEC model represents a significant advancement in understanding the complex dynamics of the U.S. Pacific Coast because it strikes a balance between large-scale phenomena and fine-scale features like chaotic, submesoscale circulation, enabling simulations that effectively capture interannual ocean variability (Kessouri et al., 2021b). It can be tailored to simulate specific regions, revealing complicated site-specific coastal dynamics at the submesoscale (Kessouri et al., 2021b). The ROMS-BEC model is unique in offering high-resolution spatial coverage in three dimensions. It has recently been configured for the California Current System (CCS) to a 4 km resolution grid spanning the entire CCS, to a 1 km grid closer to the coastline, and a 0.3 km grid in the Southern California Bight. The model has been validated against observed data from various regions and seasons and reliably reproduces mean values and variability of observed ocean parameters (Kessouri et al., 2021b). Moreover, the ROMS-BEC

model has reliably responded to the disruptions in circulation caused by El Niño (Kessouri et al., 2021b). Many studies cited by Kessouri et al. (2021b) prove its reliable track record, supported by over 90 peer reviewed papers utilizing extensive data from dischargers and coastal monitoring efforts. Additionally, the model is undergoing current evaluation from a review panel of oceanographic experts to further validate the model for the use of policy application. For these reasons the ROMS-BEC model is widely regarded as one of the most effective tools for analyzing OAH within the California Current System (CCS) (Kessouri et al., 2021b).

The ROMS model has been utilized to simulate ocean conditions under different RCPs (Representative Concentration Pathways) used in climate modeling to represent future emission scenarios and concentrations of greenhouse gases in the year 2100. For example, RCP 8.5 represents a high emissions scenario characterized by limited mitigation efforts where atmospheric CO₂ reaches 910 µatm in the year 2100, up from 415 µatm in the present day. The model simulated OAH conditions projected under RCP 8.5 in 2100 to analyze their effects on Dungeness crabs. In this high emissions scenario, the model forecasted carbonate, pH and oxygen parameters falling below the species stress threshold range and increasing population-level vulnerability (Berger et al., 2021; Alin et al., 2023). Another study incorporated the model to understand aerobic habitat compression under RCP 8.5. The study found a 30–50% reduction in aerobic habitat capacity based on northern anchovy thresholds by 2100 with complete elimination of aerobic habitat capacity in the southern portion of the California current (Howard et al., 2020). Based on these results, it is critical and urgent to reduce anthropogenic contributions to hypoxic conditions to mitigate these predicted scenarios. Additionally, these studies demonstrate an important application of the model: the ability to analyze future scenarios at a relatively high resolution and spatial scale.

More recent analyses in the CCS utilizing ROMS-BEC have been concentrated on understanding how anthropogenic activities affect coastal ocean health. There has been extensive research done utilizing this model to understand oceanic processes such as nutrient fluxes, ocean circulation, and oxygen loss (Deutsch et al., 2021; Kessouri et al., 2022; 2024; Ho et al., 2023). By adding and removing certain variables, Kessouri et al. (2021a) linked wastewater discharges in the Southern California Bight to decreases in pH and oxygen levels. Current work on high resolution modeling of the central coast of California is expected to be completed by Fall 2024 (Kessouri, personal communication, April 2024). To expand on these findings, subsequent modeling efforts have analyzed the significance of wastewater discharge on California's marine habitats and biology. For instance, a recent study utilized the ROMS-BEC model to determine whether nutrient inputs have the potential to depress aragonite saturation state and metabolic index values below thresholds of two calcifying and aerobic key species: pteropods and northern anchovies (Frieder et al., 2023). **At an aragonite saturation of 1.4 and metabolic index ≥ 1 for northern anchovies, or 7.03 mg L^{-1} DO,** nutrient discharge contributed 25% on average to reduction in habitat capacity for aerobic and calcifier species with a maximum of 60% when compared to natural nutrient cycling (Frieder et al., 2023). Reductions were seen across the Southern California Bight with a hot spot southeast of Santa Catalina island and a potential hotspot forming off of Point Conception (Frieder et al., 2023). This finding highlights the influence of discharges in relation to habitat compression and ecosystem impacts. Additionally, it illustrates a key advantage of the model: its use in understanding various scenarios and impacts at a wide array of temporal and spatial scales that would otherwise prove difficult with observations alone.

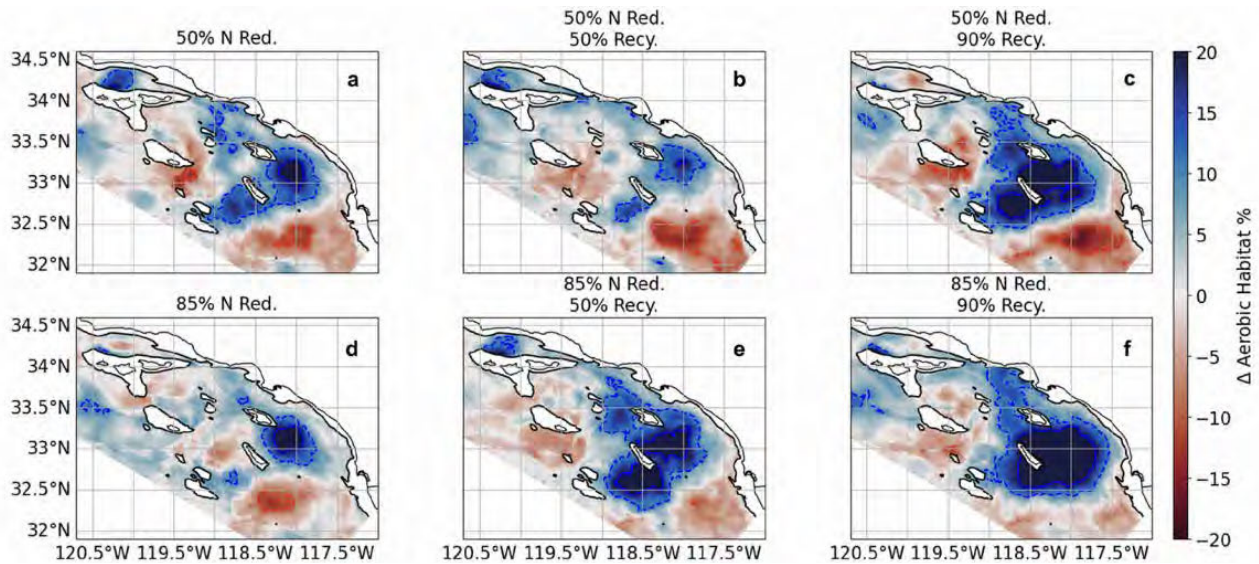


Figure 4. Change in aerobic habitat availability under different nutrient management scenarios from Ho et al. (2023)

The model can also be used to analyze the effectiveness of various nutrient management scenarios and strategies such as reducing a percentage of nutrients, at one specific plant or across the board. Ho et al. (2023) used this model to simulate different levels of nitrogen reduction and water recycling across wastewater treatment plants and the corresponding impact on OAH conditions off the Southern California coast. The study relied on near-shore data from point-source dischargers and offshore monitoring data from other sources (Ho et al., 2023). Scenarios of 0%, 50%, and 85% nitrogen reduction as well as 0%, 50%, and 90% water recycling were examined and are shown in Figure 4. The study found with increasing percent nitrogen reduction and water recycling, there are significant increases in habitat space, available oxygen, and pH (Ho et. al 2023). Specifically, under the scenarios of 85% nitrogen reduction and 50% water recycling or 50% nitrogen reduction and 90% water recycling, habitat expansion is predicted to be around 3,000 km² (Ho et al., 2023). Under 85% nitrogen reduction and 90% water recycling, habitat expansion for aerobic and calcifier species increases to 5,500 km² with more impact on aerobic habitats (Ho et al., 2023). Current work is being done to incorporate climate scenarios

into this model to give a more holistic view of the impact that nitrogen reduction will have (Kessouri, personal communication, April 2024). Regardless, this model indicates that nutrient management of wastewater treatment plants can greatly protect California ecosystems from the harmful effects of ocean acidification and hypoxia. Importantly, the study by Ho et. al (2023) demonstrates a significant advantage with the model is the ability to repeat simulations with the removal and modification of a certain source or variable to analyze potential impacts and management strategies.

IV. Final Remarks on Protective Thresholds

IV.A. Acidification Threshold

Based on the impacts to pteropods, a key indicator species, and other ecologically and socio-economically important species, a recommended threshold value for acidification is an aragonite saturation state value of 1.4. Although many studies have used pH as a metric for thresholds, aragonite saturation state has been utilized more recently due to its ability to better encompass carbonate chemistry in the ocean (Bednaršek et al., 2019). Aragonite saturation state thresholds have already been implemented in Oregon's monitoring plan and utilized in the 2024 California Integrated Report (Oregon DEQ, 2024; California State Water, 2024b). Moreover, an expert panel from Bednaršek et al. (2019) agreed upon a laboratory-based threshold for pteropods at $1.2 \Omega_{ar}$, validated by in-situ observations of this threshold by Feely et al. (2024). The value of 1.2 aragonite saturation was increased to 1.4 aragonite saturation state due to a $0.2 \Omega_{ar}$ uncertainty in measurement as well as observed effects at this threshold (McLaughlin et al., 2015; Feely et al. 2024). As a result, a threshold of $1.4 \Omega_{ar}$ is highly recommended.

This threshold is further supported by calculating the corresponding aragonite saturation state values from a determined pH threshold based on the studies presented above. First, to determine this threshold, we utilized Dungeness crabs, krill, echinoderms, and coccolithophores due to their importance on California fisheries and ecosystems. Significant impacts to coccolithophores, Dungeness crabs, krill, and echinoderms are observed at pH values of 7.83, 7.75, 7.70, and 7.63 respectively as mentioned above. Moreover, a recent commission meeting from Southern California Coastal Water Research Project (SCCWRP) noted a protective pH threshold range of 7.6–7.9 based on effects on pteropods, decapods, and echinoderms (State of Science, 2021). Thus, to protect important and sensitive California species, the upper bound threshold of 7.8–7.9 is recommended. In order to find corresponding aragonite saturation state values, conversions were extrapolated from an R-script, provided by Karen McLaughlin, with the seacarb package that calculated pH and aragonite saturation state values from salinity, temperature, pressure, dissolved inorganic carbon, and total alkalinity measurements; these measurements were taken from NOAA West Coast Ocean Acidification Cruises in 2011, 2012, and 2013 (*R: The R Project for Statistical Computing*, 2024; “Seawater Carbonate Chemistry [R Package Seacarb Version 3.3.3],” 2024; *OCADS - NOAA West Coast Ocean Acidification Cruises*, 2011, 2012, 2013; McLaughlin, personal communication, April 2024). Various pressure ranges were also considered due to the variability of aragonite saturation caused from pressure differences. Shown in Table 1 are the corresponding aragonite saturation state values to the pH threshold recommended above. Aragonite saturation state values range from ~ 1.20 to 1.35 ± 0.02 to $0.10 \Omega_{ar}$ for pH values between 7.8–7.9. Thus, the recommended threshold of $1.4 \Omega_{ar}$ would likely protect Dungeness crabs, krill, and other critical species in addition to pteropods. However, it is important to note that this threshold may not be protective for Pacific oysters,

which began seeing impacts at 1.5–2.0 Ω_{ar} (Gazeau et al., 2011; Barton et al., 2012; Waldbusser et al., 2014).

Overall, the determined threshold of 1.4 Ω_{ar} is recommended as a monthly geometric mean threshold. Effects at this threshold occur after 14 days of exposure (Bednaršek et al., 2019). Longer monthly exposure may require a higher threshold value; however, no current information is available for a threshold of 30 days of exposure specifically. Therefore, 1.4 Ω_{ar} for 14 days was utilized for the determination of a monthly geometric mean threshold. The maximum single day threshold value should be considered at 0.90–1.0 Ω_{ar} . At and below this range impacts such as external carapace dissolution, destabilized mechanoreceptors, and dissolution in Dungeness crabs as well as inhibited larval development in Pacific oysters occur (Durland et al., 2019; Bednaršek et al., 2020) Also at this range, pteropods egg development is significantly reduced in just two days of exposure (Bednaršek et al., 2019).

Pressure Range (dbar)	pH Range (total scale)	Average Aragonite Saturation State (Ω_{ar})
0-10	7.80 - 7.90	$\sim 1.35 \pm 0.10$
10-20	7.80 - 7.90	$\sim 1.25 \pm 0.10$
20-50	7.80 - 7.90	$\sim 1.25 \pm 0.10$
50-70	7.80 - 7.90	$\sim 1.20 \pm 0.02$

Table 1. Average aragonite saturation state to the given pH range. Extrapolated observed measurements from WCOA cruises from 2011 to 2013. Given at various pressure ranges due to the high variability across different pressures.

IV.B. Hypoxic Threshold

Generally, hypoxic events are defined when dissolved oxygen concentration reaches less than 2 mg L⁻¹ (Vaquer-Sunyer & Duarte, 2008; Roman et al., 2019; Hypoxia, 2023). However, it has been argued that this single threshold is below lethal effects for many species and is an

inadequate measurement of hypoxia that should be raised to better protect the marine environment (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021).

In order to determine a threshold for dissolved oxygen concentrations, studies on rockfish, sea urchins, anchovies, and a meta analysis on multiple taxonomic groups including crustaceans were reviewed. These studies provide significant evidence of the concentrations of dissolved oxygen at which California-relevant species and taxonomic groups experience impacts. Rockfish exhibited lower growth and swimming speed at DO of 4.1 mg L⁻¹ (Flannery & Bjorkstedt, 2024, Hamilton et al., 2019). A meta-analysis study determined an oxygen concentration of 5.0 mg L⁻¹ to prevent sublethal effects across 90% of crustacean species (Vaquer-Sunyer & Duarte, 2008). Sea urchins, as previously discussed, experienced significant declines in calcification and spine regrowth rates at an exposure of 5.5 mg L⁻¹ after 35 and 64 days (Low & Micheli, 2018; 2020). California salmonid species exhibit a DO threshold of 5.5 mg L⁻¹ to 5.9 mg L⁻¹ (Del Rio et al. 2019). Lastly, anchovy thresholds varied based on temperature, with impacts seen at a monthly exposure to 7.03, 5.86, and 5.35 mg L⁻¹ under 15, 10, and 7.5 °C respectively (Howard et al. 2020). .

Based on crustaceans, sea urchins, salmonid species, and northern anchovies, a threshold between 5.0 and 5.5 mg L⁻¹ is optimal. To extract a specific DO threshold within this range, northern anchovies were chosen as the main indicator species due to their importance in the economy and ecosystem as well as expert consensus (Howard et al. 2020; Ho et al. 2023). Additionally, northern anchovies as an indicator species would allow for a temperature dependent threshold approach, a concept emphasized by Vaquer-Sunyer & Duarte (2010) and Penn & Deutsch (2024) because of the critical influence of temperature on dissolved oxygen

levels. Thresholds based on temperature intervals of 2.5 °C are listed in Table 2. These threshold determinations would prevent significant sublethal effects on rockfish and other taxonomic groups discussed above (Vaquer-Sunyer & Duarte, 2008; Flannery & Bjorkstedt, 2024; Hamilton et al., 2019). This method would be better suited to protect ecosystems due to it adjusting for the significant influence of temperature. However, if taking a single-threshold approach, a threshold at 5.35 mg L⁻¹ DO will be adequately protective in nearly all situations for nearly all marine species.

The decided threshold is also recommended as a monthly geometric mean. This recommendation is based on the longer term impacts on sea urchins as well as northern anchovy thresholds corresponding to monthly exposure (Low & Micheli, 2020; Deutsch et al. 2020, Howard et al., 2020). A maximum single day threshold value was not determined within this report; however, one should still be considered to protect marine species. Based on the literature reviewed in this report, a possible range could be from 2.0–3.0 mg L⁻¹ DO given that it is below lethal effects for the majority of marine species (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021).

Temperature Range (°C)	Recommended Threshold (mg L ⁻¹ DO)
≤ 7.5 °C	5.35 mg L ⁻¹
10.0-7.5 °C	5.86 mg L ⁻¹
12.5-10.0 °C	6.42 mg L ⁻¹
15.0-12.5 °C	7.03 mg L ⁻¹

Table 2. Dissolved oxygen thresholds at temperature intervals of 2.5°C

V. Harmful Algal Blooms

Harmful algal blooms, otherwise known as HABs, are a naturally occurring phenomenon in which certain algal species produce toxins such as domoic acid (DA), a neurotoxin. The formation of harmful algal blooms depends upon a variety of conditions including salinity, temperature, imbalances in nutrient stoichiometry, and residence times of the water mass (Sandoval-Belmar et al., 2023; Ryan et al., 2017). Algal toxins have the potential to bioaccumulate and impact both aquatic organisms and humans on a biological level. In recent years, HAB events have impacted key species in the California ecosystem and fisheries. For example, in the 2015 and early 2016 fishing season, various fisheries were closed due to high domoic acid exposure amongst Dungeness crabs and shellfish (Moore et al. 2019). Exposure also led to sea lion and seal mortality events.

Although naturally occurring, HABs frequency and occurrences have recently been linked to wastewater treatment plant discharges. For example, a recent study that analyzed thousands of HAB sample data points dating back to 2000 found that certain hotspots of HAB events are correlated to nutrient releases from wastewater treatment plants, similar to OAH (Sandoval-Belmar et al., 2023). Three sites were examined with two out of the three showing strong positive correlations to wastewater discharge; these two sites were both located in Southern California, specifically the Santa Barbara and San Pedro channels (Sandoval-Belmar et al., 2023). The correlation between wastewater and HAB occurrences may arise from the tendency of these blooms to release toxins (like domoic acid) when limited by silica concentrations; moreover, high nitrogen inputs from wastewater discharge may cause water masses to be silica-limited rather than nitrogen-limited, potentially triggering the release of domoic acid (Sandoval-Belmar et al., 2023; Ryan et al. 2017). There has not been adequate research to demonstrate the impacts of specific nutrient loads on the temporal and spatial

distribution of HABs or the types of HABs, especially not in a predictable manner. Future research is needed to better understand the quantifiable relationship between nitrogen loading and HABs' spatial and temporal distribution. Regardless, it is evident that a potential benefit to managing wastewater nutrient discharges would be a decrease in HAB occurrence and frequency in coastal regions. This would reduce fishery closures, marine mammal morbidity, and public health consequences from DA toxin exposure as previously discussed.

Beyond future research, improvements in HAB monitoring are needed. Most data on DA and HAB occurrence is based on nearshore locations with significant gaps in offshore HAB data (Sandoval-Belmar et al., 2023). A current project by SCCWRP is testing methods to not only monitor HABs, but co-monitor coastal waters for OAH parameters (Kimball 2021). The project's goal is to examine the use of eDNA to monitor HABs. Another monitoring network lead by the Southern California Coastal Ocean Observing System (SCCOOS) and the Central and Northern California Coastal Ocean Observing System (CeNCOOS) is the California Imaging FlowCytobot Network which captures particles in the water and identifies present species (SCCOOS, 2024). The imaging network is frequently located by coastal shore stations that also monitor other parameters such as pH and DO in real time. Nonetheless, future research and funding is needed to expand these and other current monitoring efforts further offshore to fully understand the quantitative relationship between HABs and nutrient influxes from coastal wastewater discharges.

VI. Restoration Methods

Two commonly discussed restoration methods in California to mitigate OAH impacts are eelgrass and kelp restoration. Eelgrass restoration is mainly limited to enclosed bays and

estuaries and cannot be applied to offshore areas due to the conditions needed for growth; however, it is included for review due to its significant potential to ameliorate acidification. Kelp, on the other hand, is a near and offshore restoration method that can be applied more appropriately towards the focus of this project, the coastal ocean. Both of these restoration strategies are discussed within this section to provide potential local mitigation methods.

To start, the environmental benefits of eelgrass restoration include raising pH levels, providing a biogenic habitat for at-risk organisms, and increasing ecosystem diversity. In fact, eelgrass restoration is already implemented across California on a small, local scale with a current goal of establishing 15,000 acres of eelgrass by 2025 (OPC 2021). Furthermore, a study analyzed seven current eelgrass restoration locations: five in Northern California and two in Southern California (Ricart et al., 2021a). The study identified the following four trends seen in Figure 5 with pH across all sites: (a) positive increase at all times of day, (b) increases at daytime with no effect at night, (c) negative at all times of day, and finally (d) increases at daytime and decreases at night (Ricart et al., 2021a). Trends (c) and (d) were the least common while (a) and (b) were the most common. Nonetheless, all study sites showed an average increase in pH with the spring and summer season showing higher change in pH from eelgrass (Ricart et al., 2021a). Overall, expanding the implementation of current eelgrass restoration sites is a promising solution to mitigate harmful effects from acidification and hypoxic events within estuaries and bays. Important to note is that Ricart et. al. (2021a) found that, although both northern and southern sites had increases in pH, sites in Northern California had a more significant effect. This was hypothesized to be due to the longer leaves of eelgrass in northern California and thus higher rates of photosynthesis and pH amelioration (Ricart et al., 2021a). Based on the results of

this study, eelgrass restoration may be more beneficial in northern ecosystems threatened from ocean acidification.

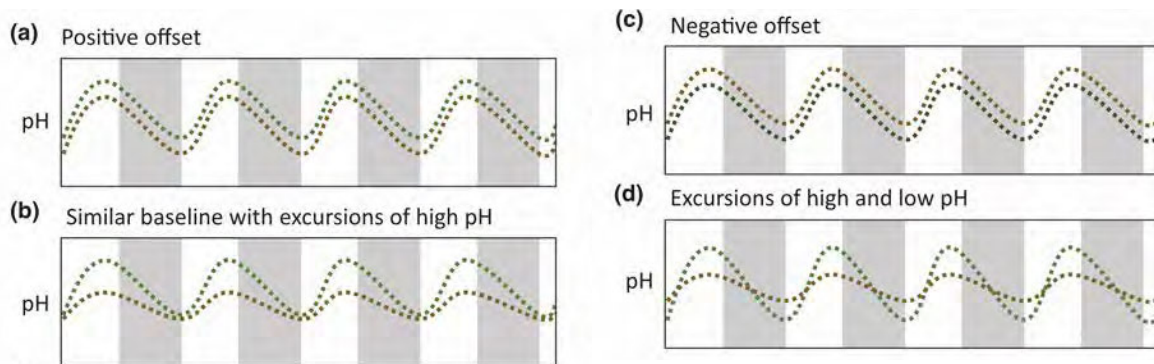


Figure 5. Observed restoration and mitigation scenarios of ocean acidification during the day (white) and night (gray/shaded) in eelgrass bioremediation sites (green) versus control sites (brown). Figure taken from Ricart et al., (2021)

The remediation in pH provided from planting eelgrass meadows positively benefits calcifying organisms that rely on specific pH for the creation of shells. For example, oysters in eelgrass meadows experienced increased shell growth when compared to standard pH conditions. Juvenile oysters experienced a maximum of 40% increase whereas adults experienced closer to 5% increase (Ricart et al. 2021b), suggesting that eelgrass restoration can not only prevent ocean acidification, but the impacts that come with it. As a result, eelgrass restoration can be a sufficient method of reducing anthropogenic and natural impacts of increased ocean acidity.

Additional benefits for eelgrass restoration include the associated carbon uptake and increases in biodiversity. Many studies have documented the significant ability of eelgrass to sequester carbon (Ryder et al. 2023 ; Greiner et al., 2013). A recent study has also determined the importance of eelgrass in upholding unique biodiverse ecosystems in California (Waters et al. 2023).

In regards to kelp restoration, there are few studies within California ecosystems that have observed the effects on acidification and hypoxia impacts; however, one study found that

kelp forests increased pH conditions at the surface near the canopy (Hirsh et al., 2020).

Importantly, the study found little to no effect on pH and acidification at lower depths where at-risk calcifying and benthic organisms reside (Hirsh et al., 2020). Based on current literature, kelp forests as a restoration strategy does not seem promising to mitigate the impacts on key species and ecosystems from acidification and hypoxia. Extensive research regarding other potential benefits of kelp such as CO₂ uptake were not part of the project's scope. Therefore, kelp restoration may provide significant benefits for issues other than ocean acidification and hypoxia.

In conclusion, cultivating eelgrass is the most promising way to mitigate acidification and hypoxia specifically through restoration. Due to the inability of eelgrass to be located in near and offshore environments, eelgrass is not suitable to be co-located next to coastal discharge plants; the authors are unaware of any restoration strategies that appear suitable for mitigating significant ocean acidification and hypoxic conditions along the coastal ocean. Ultimately, based on existing research, restoration is not an effective method to mitigate OAH impacts, underscoring coastal sewage treatment plant nitrogen reduction strategies as the key to reducing OAH impacts in coastal waters. Possible sewage treatment plant nitrogen reduction approaches and technologies are discussed in following sections.

Data Collection and Analysis

I. Goals and Criteria

I.A. Goals

Recent studies have linked OAH and HABs to wastewater discharges off the coast of California in more populated regions with larger plants (Booth et al., 2014; Meredith D.A. Howard et al., 2014; Sutula et al., 2021; Ho et al, 2023; Sandoval-Belmar et al., 2023). To

investigate further, effluent concentrations and loadings of discharged nitrogen species by coastal wastewater treatment plants were analyzed over a seven-year timescale. The goal of this section is to identify publicly available data sources for wastewater treatment facilities, use this data to conduct independent analysis pertaining to OAH, and provide recommendations regarding the data collection process.

I.B. Criteria for Wastewater Treatment Plants

The criteria for the plants analyzed in California include their proximity to the coast, volume capacity, and the region in which they are located. All of the plants selected for data collection and analysis are found within one mile from the coast, and the treated wastewater emitted from the plants is discharged into the coastal waterway. All plants had a flow rate capacity of at least one million gallons of water per day (1 MGD), also classified as “major” plants by the California State Water Resource Board (SWRCB). Major status refers to plants with a capacity over 1 MGD and minor status refers to plants with a capacity under 1 MGD. Lastly, the plants analyzed are located in regions 1, 3, 4, 8, and 9 of California. The state is broken up accordingly: Region 1: North Coast, Region 2: San Francisco Bay, Region 3: Central Coast, Region 4: Los Angeles, Region 5: Central Valley, Region 6: Lahontan, Region 7: Colorado River Basin, Region 8: Santa Ana, and Region 9: San Diego, as seen in Figure 6 below. Regions 1, 3, 4, 8, and 9 were selected due to their location on the coast of California and the plants’ status as coastal dischargers. The San Francisco Bay region (Region 2) was excluded from data collection because it is regulated under the Inland Surface Waters and Enclosed Bays and Estuaries (ISWEBE) Plan and Bay-Delta Plan, not the California Ocean Plan, and the nature of this project encompasses analyses of OAH conditions and impacts in the state’s coastal ocean waters.



Figure 6. Map of California and the State Water Resource Control Board Regional Water Board split (California State Water Resources Control Board, 2024).

Considering this criteria, 30 plants within California were considered for data analysis; five within Region 1, eleven within Region 3, seven within Region 4, two within Region 8, and five within Region 9. Seven years of influent and effluent water volumes, nitrate, nitrite, and ammonia concentration data was obtained from each plant. After data collection, average annual flow rates were calculated from 2017 to 2023 using daily or monthly average data available and all final values were reported in MGD. Average concentrations of nitrate, nitrite, and ammonia were calculated from 2017 to 2023, using daily or monthly averages available. All final values were reported in mg/L. The loading of nitrogen species, which refers to the efflux of nitrogen into coastal waters, was calculated by multiplying the nitrogen concentration by the effluent flow rate and the annual average loadings were recorded for each plant from 2017 to 2023 in kg/day (see calculation in **II. Data Collection Process** section). Due to a lack of average nitrate and

nitrite data reported, the team estimated these concentrations by referring to an average ratio of nitrate:ammonia and nitrite:ammonia calculated by using the only available real data values from the Hyperion and A.K. Warren treatment plants. These plants were two of the top four largest wastewater treatment plants investigated, making their data values notable and reliable as monthly averages of ammonia, nitrate, and nitrite were recorded for the seven-year time scale. Furthermore, Hyperion and A.K. Warren treatment plants are full secondary facilities with no nitrogen removal treatment, which is typical of most coastal sewage treatment plants. Values from Orange County Sanitation District (OCSD), another plant of the four largest investigated, were also available however not used to calculate the average ratios applied to the other treatment plants as OCSD utilizes nitrogen removal processes, making their nitrate and nitrite to ammonia ratios atypical compared to the other coastal, full secondary treatment plants with no nitrogen removal treatment. The result of averaging the ratios between Hyperion and A.K. Warren was 0.0031 for nitrate/ammonia and 0.0059 nitrite/ammonia. These values were then applied to the other plants that only had ammonia data available or only provided maximum daily concentrations of nitrate and nitrite. Estimated average nitrate and nitrite values were calculated using the Hyperion and A.K. Warren average ratio and the given plant's annual average ammonia data available.

II. Data Collection Process

The first database that was used for data collection was California Integrated Water Quality System Project (CIWQS). This database is used by the SWRCB to track information regarding permits and collect mandated data such as nutrient levels from permit holders (*California Integrated Water Quality System Project (CIWQS), n.d.-a*). In the context of wastewater treatment plants, data managers at each plant upload annual and monthly reports with

required data such as their effluent nutrient concentrations. For this project, CIWQS was used to create the initial list of wastewater treatment plants above 1 MGD (listed as “major”) in the target regions. This database also contained National Pollutant Discharge Elimination System (NPDES) permits for each of the wastewater treatment plants.

The NPDES program, authorized by the Clean Water Act, regulates sources that discharge pollutants into United States waters. In California, NPDES permits include waste discharge requirements (WDRs) that control discharges into water bodies in California. NPDES reports are constructed for each individual plant outlining the maximum concentrations of nitrogen species, among other biological and chemical elements, permitted for release into the ocean. The report relays the concentration of species allowed to be discharged (measured in mg/L or lbs/day), the minimum sampling frequency (quarterly, daily, monthly, etc.), sample type (24-hr composite, grab, calculated, etc.), among other parameters (California State Water Resources Control Board, 2024).

The NPDES permit states the body of water into which the plant discharges treated wastewater, including which plants discharge into the Pacific Ocean. All of the information collected from CIWQS and the NPDES permits were used to make the final list of 30 plants. While CIWQS is expected to have the nutrient concentration, flow rate, and other sought-after data, the public-facing CIWQS database is more limited. This version of CIWQS only provides information regarding design flow, major/minor status, Threat to Water Quality (TTWQ), and number of enforcement actions and violations within 5 years. While this information may be useful to the public regarding the safety and impacts of each plant, it does not provide much environmental data that can be analyzed to determine the efficacy of technology in reducing target nutrients to manage OAH impacts.

The next databases that were explored were California Environmental Data Network (CEDEN) and the Surface Water Ambient Monitoring Program (SWAMP). CEDEN is a comprehensive data system of all the state's data, including research and volunteer organizations, for surface water quality (*California Environmental Data Exchange Network*. 2021). SWAMP focuses on monitoring receiving water quality and is one of the data supporters of CEDEN (*SWAMP - Mission* 2018). While these databases are often used by environmental experts in California regarding water quality and environmental data, they did not contain the information that was required for the project. The CEDEN database did not include data regarding specific wastewater treatment facilities, but it provided a central location to access information on surface water in California including streams, lakes, rivers, and the coastal ocean. SWAMP reported concentration data collected from surface water monitoring programs that wastewater treatment plants discharged into, but not the specific concentrations and loadings the plants contributed.

Due to these obstacles, the team then reached out to the onsite manager of each target plant to directly receive the data from them. This was largely unsuccessful due to the lack of resources available to respond to queries at many of these facilities. However, the Hyperion, OCSD, A.K. Warren, McKinleyville, Point Loma, and South San Luis Obispo SD wastewater treatment plants agreed to share their data. Furthermore, many of them agreed to meet and talk through their data collection and upload process. Through these informational interviews, the team was introduced to the EPA's Enforcement and Compliance History Online (ECHO) and the Electronic Self-Monitoring Report (eSMR) databases. ECHO is an EPA database federally run with information on regulated facilities such as wastewater treatment facilities which receives its wastewater treatment plant data from CIWQS (Lapatra, M., & Barnett, P., 2021). The CIWQS module, eSMR, collects data reports directly from dischargers regarding their monitoring results

of various parameters, including effluent nitrogen species. During the data collection process, concentrations and flow rate data was obtained from multiple sources. The ideal source of information was directly from the wastewater treatment facilities, as this is the primary source of collection. If data were not available, ECHO was used as the secondary source and if data gaps still existed eSMR was used.

Despite utilizing multiple sources, these datasets were not complete and lacked many crucial data points such as monthly/annual averages of nutrient concentration (often only in daily maximum, instantaneous maximum, or 6 month median) and effluent nutrient loading. Due to the lack of available data, many of the concentrations were also averaged using the 6 month median to have an approximation for data analysis. The team was able to obtain the flow rates for the facilities through eSMR and calculate the loading using the following equation:

Furthermore, total inorganic nitrogen (TIN) concentrations were calculated using the following equation:

TIN was used in this part of the study instead of total nitrogen because effluent total organic nitrogen concentrations and loadings were not reported from a majority of the plants. Lastly, the average ratio from Hyperion and A.K. Warren was used to find the average annual nitrate and nitrite concentrations for each plant using the following equation:

III. Analysis

As previously mentioned, the gaps in data made it difficult to achieve the original data analysis goal. The original goal was to collect ten years of data, however, consecutive data for all plants was only available from 2017 through 2023 in the eSMR database, therefore, the team pivoted to a seven-year timescale. From the data collected, general trends and patterns were observed. When looking at data availability from region to region, some similarities and differences can be discerned. One commonality observed across the regions was the disproportionately available data between nitrogen species. Much of the monthly/annual average concentration data that was collected was only available for ammonia, with only four plants, Hyperion, A.K. Warren, OCSD, and Ventura, providing average concentrations for nitrate and nitrite spanning the seven-year time scale. Additionally, the data was spread out between databases. For example, some years of data were recorded in eSMR reports but not in the ECHO database. In general, there was a lesser amount of data available for region 1 and 3 in ECHO, as there were several gaps within the seven-year range and many of the plants did not report in the preferred monthly or annual average values. Regions 4, 8, and 9 had more available data across the seven-year span, with regions 4 and 8 submitting their data in annual averages. However, the majority of the data obtained from region 9 was calculated by the plants in 6 month medians, making it difficult to properly statistically analyze.

The available data was extrapolated to calculate estimated values of nitrate and nitrite (as shown in **II. Data Collection Process**). Table 3 includes a summary of the average estimates for each region, including ammonia, nitrate, nitrite, and TIN concentrations, along with their respective loadings. This table illustrates that region 9 has the highest average ammonia concentration at 38.77 mg/L. Meanwhile, region 8 has the highest average nitrate and nitrite concentrations, at 20.59 mg/L and 4.49 mg/L respectively. Overall, the region with the highest

TIN concentration was region 8 at 52.20 mg/L. The region with the highest ammonia loading was region 4 at 11,498.10 kg/d whereas the region with the highest nitrate and nitrite loadings was region 8 at 7,373.0 kg/d and 1,547.7 kg/d. Lastly, the region with the highest TIN loading was region 8 at 18,896.11 kg/d. As displayed in Table 5, region 4 has two of the four wastewater treatment plants with the largest water capacities. However, the highest TIN concentrations and loadings of nitrogen species did not occur in this region.

Region	Size (mgd)	Ammonia Concentration (mg/L)	Nitrate Concentration (mg/L)	Nitrite Concentration (mg/L)	Total Inorganic Nitrogen (TIN) Concentration (mg/L)	Flow Rate (MGD)	Ammonia Loading (kg/d)	Nitrate Loading (kg/d)	Nitrite Loading (kg/d)	Total Inorganic Nitrogen (TIN) Loading (kg/d)
1	2	8.09	0.03	0.05	8.17	1.99	72.26	0.23	0.43	72.91
3	9	8.51	0.03	0.05	8.59	3.13	118.42	0.37	0.70	119.50
4	136	18.67	0.06	0.11	18.84	74.06	11,506.02	47.24	111.45	11,566.87
8	179	27.20	20.59	4.42	52.20	95.62	9,753.18	7,373.02	1,547.79	18,896.11
9	59	38.77	0.10	0.50	39.73	34.18	5,216.80	17.41	32.98	5,603.22

Table 3. Average nutrient concentration and respective loading for region 1, 3, 4, 8, and 9 from 2017-2023. Nitrate and nitrite concentrations and loadings are estimates based on the A.K. Warren and Hyperion average ratio.

Table 4 focuses on the four largest wastewater treatment plants within the study. This includes, Hyperion Wastewater Treatment Plant, A.K. Warren Water Resource Facility (previously known as the Joint Water Pollution Control Plant), Orange County Sanitation District (OCSD) Treatment Plant Outfall 1, and Point Loma Wastewater Treatment Plant. The Hyperion Wastewater Treatment Plant and A.K. Warren Water Resource Facility are both located in region 4 and run by the Los Angeles County Sanitation District. The Hyperion Wastewater Treatment Plant is the largest plant in California, with a capacity of 450 MGD (Hyperion, n.d.). The Orange County Sanitation District plant is located in region 8, serving central and northwest Orange County (History, n.d.). Outfall 1 of OCSD is a combination of the ocean discharge from both Plant 1 and Plant 2. Point Loma Wastewater Treatment Plant is located in region 9 and serves the city of San Diego (City of San Diego, n.d.). Of these four

plants, Hyperion is estimated to have the highest average ammonia concentration of 43.80 mg/L but OCSD has the highest nitrate, nitrite and TIN concentrations at 20.59 mg/L, 4.42 mg/L, and 52.20 mg/L. However, out of the four plants, the average ammonia loading and TIN loading is the greatest for the A.K. Warren facility at 41,476.25 kg/d and 41,866.63 kg/d. It is important to note that there is variability in the sourcing of the data within the four largest wastewater treatments. For example, data for Hyperion and A.K. Warren was received directly from the plants. However, much of Hyperion’s nitrate and nitrite data was under the method of detection limit (MDL). Therefore, experts for this plant recommended dividing the MDL by 2 to get an approximation. Additionally, experts at OCSD pointed the team towards ECHO for their data. They also clarified that for their plant, though the labels said “daily maximum”, these values were indeed averages but labeled them as “daily maximum” since they were quarterly averages. Although OCSD has nitrogen removal processes in place that aim to lower ammonia concentrations, they still have the highest nitrate and nitrite concentrations and loadings of the four plants. To put these numbers into perspective, according to informational interviews with ocean modeling experts, high concentrations of nutrients contribute to more intense areas of OAH. Additionally, when considering the impact of wastewater treatment facilities on OAH, it is hypothesized that larger facilities (such as the aforementioned four) are responsible for 85 percent of the impact whereas smaller facilities only make up 15 percent (SCCWRPR Pers. Comm., 2024).

Facility	Size (mgd)	Ammonia Concentration (mg/L)	Nitrate Concentration (mg/L)	Nitrite Concentration (mg/L)	Total Inorganic Nitrogen (TIN) Concentration (mg/L)	Ammonia Loading (kg/d)	Nitrate Loading (kg/d)	Nitrite Loading (kg/d)	Total Inorganic Nitrogen (TIN) Loading (kg/d)
Hyperion Wastewater Treatment Plant	450	43.80	0.0705	0.309	44.18	37,282.81	133.05	571.19	37,302.23
Orange	179	27.20	20.59	4.42	52.20	9,753.18	7,373.02	1,547.79	18,896.11

County Sanitation District Outfall 1									
A.K. Warren Water Resource Facility	400	43.15	0.20	0.21	43.56	41,476.25	192.05	198.34	41,866.63
Point Loma	240	40.656	0.00	1.88	44.66	21,714.41	74.40	140.94	23,945.95

Table 4. Average nutrient concentration and respective loading for the four largest wastewater treatment plants within the criteria from 2017-2023. Nitrate and nitrate concentrations and loadings are estimates based on the A.K. Warren and Hyperion average ratio.

Region	Size (MGD)	Facility	Ammonia Concentration (mg/L)	Nitrate Concentration (mg/L)	Nitrite Concentration (mg/L)	Nitrate+Nitrite Concentration (mg/L)	Total Inorganic Nitrogen (TIN) Concentration (mg/L)	Flow Rate (MGD)	Ammonia Loading (kg/d)	Nitrate Loading (kg/d)	Nitrite Loading (kg/d)	Nitrate+Nitrite Loading (kg/d)	Total Inorganic Nitrogen (TIN) Loading (kg/d)
1	2	Arcata City WWTF	11.17	0.04	0.07	0.10	11.27	2.00	84.57	0.27	0.50	0.77	85.33
1	5	Eureka City Elk River WWTP	11.80	0.04	0.07	0.11	11.91	4.71	210.38	0.66	1.25	1.91	212.29
1	2	Crescent City WWTP	3.87	0.01	0.02	0.04	3.91	1.38	20.22	0.06	0.12	0.18	20.40
1	1	Fort Bragg City WWTP	9.29	0.03	0.06	0.08	9.37	0.83	29.19	0.09	0.17	0.26	29.45
1	2	McKinleyville WWTP	4.34	0.01	0.03	0.04	4.38	1.03	16.92	0.05	0.10	0.15	17.08
3	3	Carmel Area WWTP	22.47	0.07	0.13	0.20	22.67	0.68	57.84	0.18	0.34	0.52	58.36
3	3	Carpinteria SD WWTP	0.24	0.00	0.00	0.00	0.24	1.18	1.07	0.00	0.01	0.01	1.08
3	2	City of Morro Bay Water Reclamation Facility	0.20	0.00	0.00	0.00	0.20	0.84	0.64	0.00	0.00	0.01	0.64
3	8	Goleta SD WWTP	16.98	0.05	0.10	0.15	17.13	4.72	303.38	0.95	1.80	2.75	306.14
3	2	Montecito SD WWTP	0.17	0.00	0.00	0.00	0.17	0.70	0.45	0.00	0.00	0.00	0.45
3	30	Monterey One Water Regional WWTP	4.61	0.01	0.03	0.04	4.65	7.10	123.90	0.39	0.74	1.12	125.02
3	2	Pismo Beach WWTP	0.23	0.00	0.00	0.00	0.23	2.07	1.80	0.01	0.01	0.02	1.82
3	11	El Estero Water Resource Center NPDES	12.42	0.04	0.07	0.11	12.53	7.79	366.24	1.15	2.18	3.32	369.57
3	17	Santa Cruz WWTP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	5	South San Luis Obispo SD WWTP	11.23	0.04	0.07	0.10	11.33	2.88	122.43	0.38	0.73	1.11	123.54
3	12	Watsonville WWTP	16.53	0.05	0.10	0.15	16.68	3.30	206.49	0.65	1.23	1.87	208.36
4	1	Avalon WWTF	2.93	0.01	0.02	0.03	2.96	0.38	4.21	0.01	0.03	0.04	4.25
4	25	Long Beach WRP	1.85	0.01	0.01	0.02	1.87	10.54	73.81	0.23	0.44	0.67	74.48
4	450	Hyperion WWTP	43.80	0.0705	0.309	0.38	44.18	223.05	37,282.81	133.05	571.19	320.42	37,302.23
4	30	Terminal Island Water Reclamation Plant	2.08	0.01	0.01	0.02	2.10	11.90	93.70	0.29	0.56	0.85	94.55
4	32	Oxnard WWTP	36.13	0.11	0.21	0.33	36.46	11.64	1,591.96	4.99	9.45	14.45	1,606.41
4	14	Ventura WRF	0.73	0.00	0.00	0.01	0.74	7.01	19.37	0.06	0.12	0.18	19.55
4	400	A.K. Warren Water Resource Facility	43.15	0.20	0.21	0.41	43.56	253.90	41,476.25	192.05	198.34	390.39	41,866.63
8	179	OCSO Outfall 1	27.20	20.59	4.42	25.01	52.20	95.62	9,753.18	7,373.02	1,547.79	9,051.32	18,896.11
9	48	Encina Ocean Outfall/Carlsbad WRF	40.44	0.13	0.24	0.37	40.81	43.30	6,628.43	20.78	39.37	60.15	6,688.58
9	6	La Salina WWTP, Oceanside Ocean Outfall	30.25	0.09	0.18	0.27	30.52	3.20	366.43	1.15	2.18	3.32	369.75
9	13	Latham WWP	39.91	0.13	0.24	0.36	40.27	6.70	1,012.20	3.17	6.01	9.18	1,021.39
9	39	City of San Clemente WRP	39.91	0.13	0.24	0.36	40.27	5.00	755.38	2.37	4.49	6.85	762.23
9	5	San Elijo Water Campus	41.46	0.13	0.25	0.38	41.84	5.25	823.95	2.58	4.89	7.48	831.43
9	240	Point Loma	40.65	0.00	1.88	1.88	42.53	141.64	21,714.41	0.00	1,007.99	1,007.99	22,803.06

Table 5. Average nutrient concentration and respective loadings for all 30 wastewater treatment plants within the criteria from 2017-2023. Nitrate and nitrate concentrations and loadings are estimates based on the A.K. Warren and Hyperion average ratio. Size is based on facility design capacity.

Figure 7 portrays the average annual effluent concentrations of ammonia discharged from the largest four plants over the past seven years in mg/L. All plants discharged relatively constant concentrations of ammonia over the timescale analyzed, excluding OCSD's values which fluctuate. OCSD currently discharges higher average concentrations of ammonia compared to past years whereas Hyperion, A.K. Warren, and Point Loma discharge lower average concentrations of ammonia in 2023 compared to past years. Additionally, Figure 7 displays that the A. K. Warren Water Resource Facility discharges the highest effluent ammonia concentration as of 2023, with minimal variation in annual average ammonia concentration over the timescale. Figure 8 portrays the average annual effluent loadings of ammonia discharged from the largest four plants over the past seven years in kg/day. When comparing the loadings, the A. K. Warren Water Resource Facility also has the largest effluent loading of ammonia. Despite having the greatest ammonia loading values, the A.K. Warren plant has reduced its discharge over the past seven years. Alternatively, Hyperion and Point Loma's 2023 discharged loading is greater than the volume reported from 2017, despite having maintained relatively constant values over the seven-year timescale. From these figures it can be concluded that the A.K. Warren plant and the Hyperion wastewater treatment plant currently have the highest average ammonia concentration and loading discharges, making them possible plants of interest for analyzing OAH impacts.

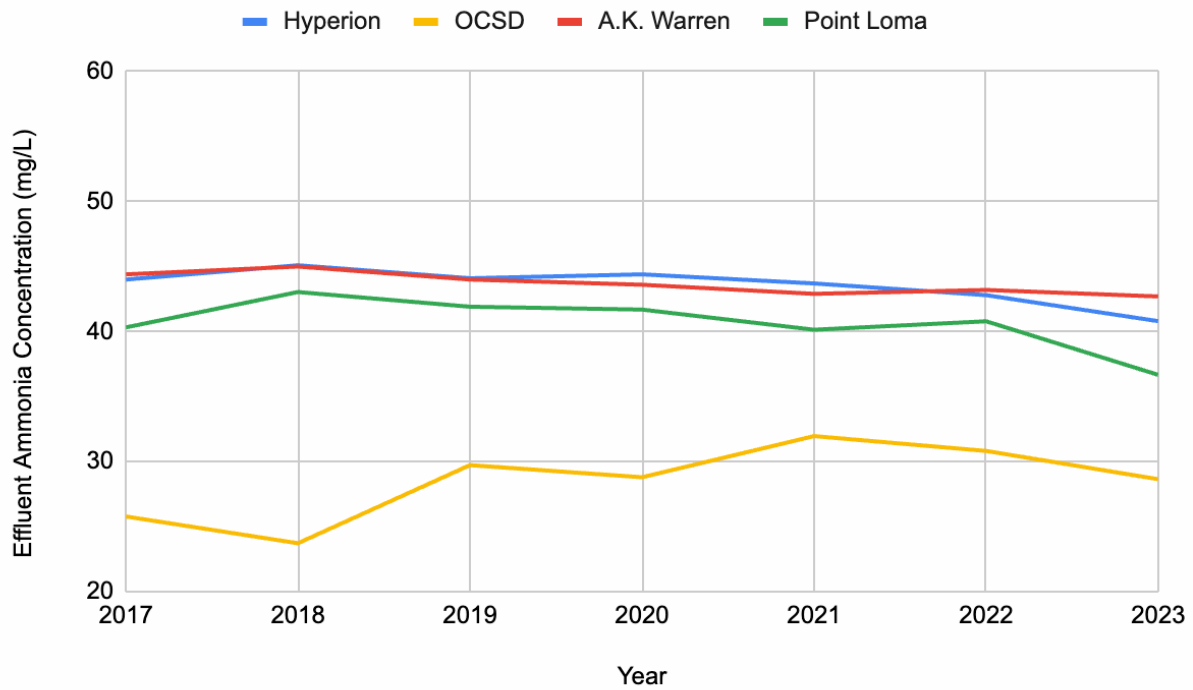


Figure 7. Average effluent ammonia concentration from 2017-2023 at the four largest wastewater treatment plants within the criteria.

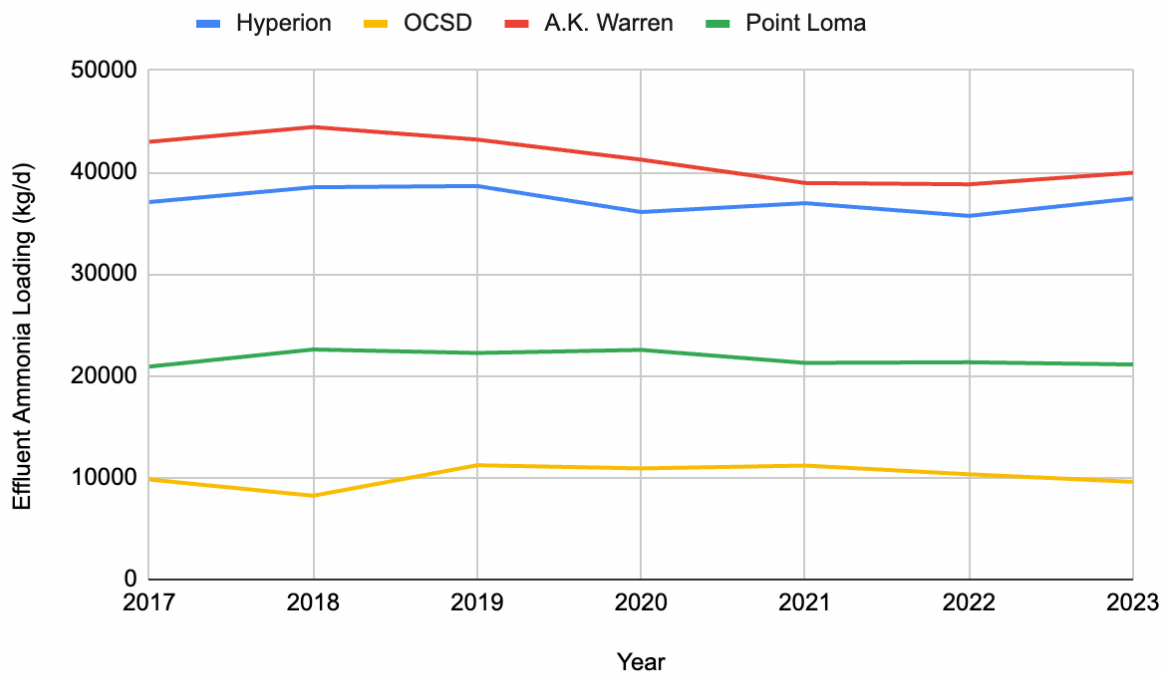


Figure 8. Average effluent ammonia loading volume from 2017-2023 at the four largest wastewater treatment plants within the criteria.

Additional comparison reveals the loading volumes from different plant size capacities. From the 30 treatment plants analyzed three categories were formed, 1-5 MGD, 6-20 MGD, and 20+ MGD. In the 1-5 MGD category, there were 13 wastewater treatment facilities. Of these 13, five were from region 1, six were from region 3, one was from region 4, and one was from region 9. If the 1-5 MGD category is to be labeled as “small” wastewater treatment facilities for this study, the majority of the small wastewater facilities are in region 1. The 6-20 MGD category includes seven plants, of these four were from region 3, one was from region 4, and two were from region 9. The 20+ MGD category includes ten plants, of which one was from region 3 at 30 MGD, five were from region 4 ranging from 25 to 450 MGD, one was from region 8 at 179 MGD, and three were from region 9 ranging from 39 to 240 MGD. Figure 9 and Table 6 portray the significant differences in effluent discharge from larger plant capacities compared to those of smaller size. This information can be used to understand the recommendations provided in the Technologies Section. From the figures below it is evident that plants of smaller size, specifically in the 6-20 MGD category, still contribute significant concentrations of ammonia into the ocean outfalls. However, size still remains a defining factor in determining the amount of nitrogen species emitted, with the largest capacity plants contributing the most for both average loadings and concentrations.

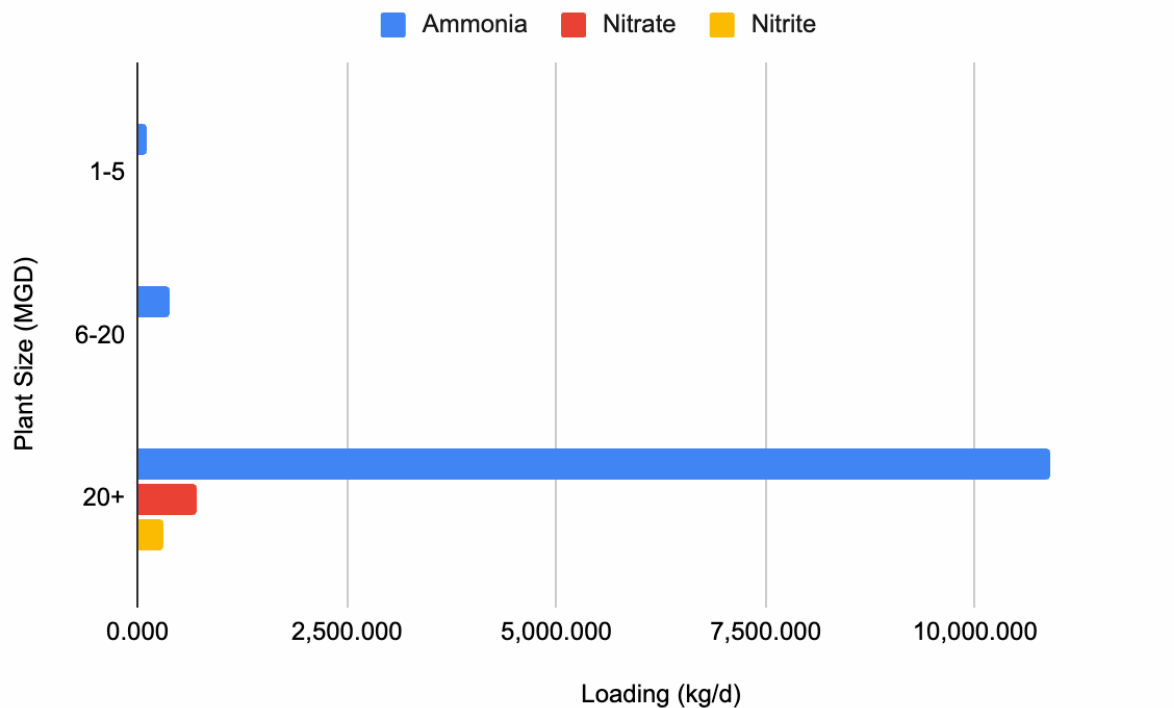


Figure 9. Annual average effluent loading volumes (kg/d) from 2017-2023 at treatment plants with capacities of 1-5 MGD, 6-20 MGD, and 20+ MGD.

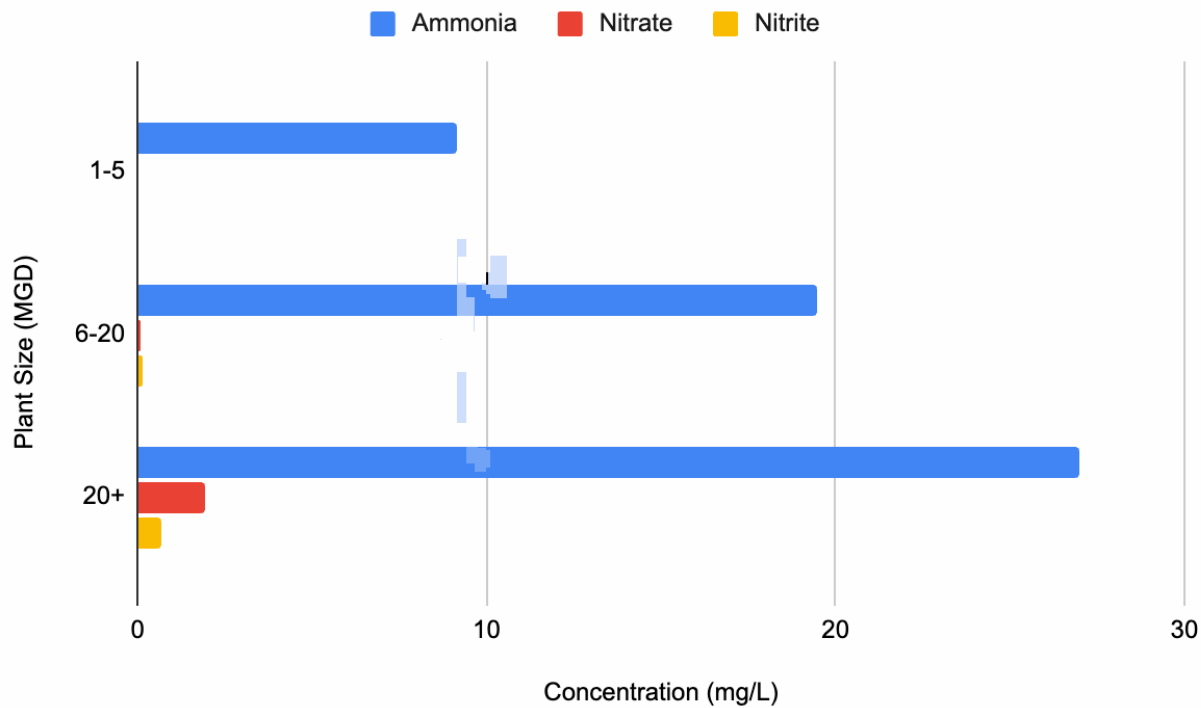


Figure 10. Annual average effluent concentrations (mg/L) from 2017-2023 at treatment plants with capacities of 1-5 MGD, 6-20 MGD, and 20+ MGD.

Size (mgd)	Ammonia Concentration (mg/L)	Nitrate Concentration (mg/L)	Nitrite Concentration (mg/L)	Total Inorganic Nitrogen (TIN) Concentration (mg/L)	Ammonia Loading (kg/d)	Nitrate Loading (kg/d)	Nitrite Loading (kg/d)	Total Inorganic Nitrogen (TIN) Loading (kg/d)
1-5	9.18	0.03	0.05	9.27	105.67	0.33	0.63	106.63
6-20	19.47	0.06	0.12	19.65	379.02	1.19	2.25	382.46
20+	26.98	1.94	0.70	29.61	10,890.66	702.56	307.47	11,865.95

Table 6. Annual average effluent loading volumes (kg/d) from 2017-2023 at treatment plants with capacities of 1-5 MGD, 6-20 MGD, and 20+ MGD.

IV. Recommendations

As outlined in the data collection process, the current data distribution methods do not allow for independent analysis and study of wastewater treatment plants. A lack of standardization across the state's wastewater treatment plants' data submissions makes data both difficult to locate and challenging, if not impossible, to compare and analyze. When reaching out to plants individually, only some responded with full data sets of daily and monthly averages of flow rate and nutrient concentrations such as McKinleyville Wastewater Treatment Plant and San Elijo Water Campus. Additionally, when speaking to these plants, they mentioned that they labeled their data as daily maximum even if it was an average as it wasn't an annual or monthly average. Furthermore, these plants' data were still not accessible to the public through databases such as ECHO, CIWQS, CEDEN, SWAMP, etc. This raises many obstacles for data collection as information is not readily available and is extremely time consuming to locate due to a lack of centralization. Another challenge is that the data is highly inconsistent due to the lack of standardized requirements for data recording or submission. Inconsistencies include the time interval at which parameters are measured and submitted, calculation methodology, units of parameter, and even parameter measured. The original goal for this project was to analyze data from the past ten years from each plant, from 2013 to 2023. However, not all plants had data from all these years. In fact the eSMR analytical data report in the California Open Data Portal,

from which flow rate data was retrieved, includes no flow rate data for all of 2016. Furthermore, access to data from the past ten years is critical when considering climate change impacts that have plagued California, specifically from 2012 to 2016, and their effects on water quality. Droughts alter influent and effluent flow rate of water at wastewater treatment plants, altering the concentration of nitrogen species and other nutrients being discharged. Reduced effluent water volume most likely increases the concentration of nitrogen species being discharged into coastal waters due to the lack of dilution.

The next inconsistency among the data was the calculation method. The goal of this project was to analyze the annual averages of the variables in question over the past ten years. To do so, daily, monthly, or annual averages of concentrations or flow rates are required. However, the calculation methods listed in these databases were often “Daily Maximum”, “Instantaneous Maximum”, or “6 month median”. These derived data cannot be converted into an annual average as the maximum rates and concentrations are not representative of the mean rates and concentrations for each plant. Considering the majority of nitrate and nitrite concentrations were reported as maximum values, total loadings for these nitrogen species were estimated using a ratio.

Lastly, the parameters measured and the units of such parameters were also not standard across the state. While most plants recorded ammonia concentrations, nitrate and nitrite levels were underreported and absent from many reports. Additionally, some plants record total organic nitrogen and total inorganic nitrogen concentrations rather than the individual nitrogen species. The concentrations were also reported in different units, including mg/L, $\mu\text{g/L}$, lbs/day, and mmol/m^3 for nitrogen species and MGD or m^3/second for flow rate.

To avoid these obstacles in the future, it is recommended to increase transparency between regulator interface and public interface in databases such as CIWQS. As it is found that many of these plants already collect the necessary data, it should be made available to the public on databases including CIWQS and ECHO. Additionally, the SWRCB and all regional boards should require the use of a standardized data collection and submission format so that data is comparable within and between regions. Parameters such as average flows, monthly mean nitrate, nitrite, and ammonia concentrations should be submitted by all wastewater treatment plants. For future studies this will increase transparency and allow researchers to utilize data, reducing the burden on regulators to upload to multiple databases or individually provide this information. As more research is conducted on ocean acidification and anthropogenic effects, these queries will become more frequent and improving data accessibility will encourage accurate research and benefit the scientific community. Data availability will also benefit regulators and policymakers in making more informed decisions regarding plants and technology by analyzing established trends and patterns.

Technologies

Utilizing technology-based solutions will be key to mitigating the impacts of ocean acidification and hypoxia on ocean health. Our goal is to provide considerations and perspectives on how ocean-discharging wastewater treatment plants across the California coast can achieve more stringent standards of effluent quality based on an examination of current technologies and their cost and feasibility.

I. Nutrient Reduction Technologies

I.A. Conventional Biological Nitrogen Removal

The most common, and generally the most easily-adaptable method of nitrogen removal utilizes biological processes led by microorganism activity to consume and remove nutrients. Conventional biological nitrogen removal (BNR) technology has been used widely since the 1970s, largely in treating wastewater up to a secondary level and includes both bioreactors and secondary clarifiers. After undergoing primary solids treatment, wastewater can begin the BNR process and undergo nitrification and denitrification (NDN). During nitrification, ammonium (NH_4^+) present in the influent is converted to nitrite (NO_2^-) and nitrate (NO_3^{2-}) in an aeration basin:

Once a sufficient amount of nitrifying bacteria is generated, ammonia oxidizers convert ammonium to nitrite. At the same time, nitrite oxidizers convert nitrite to nitrate. Both of these conversions require an adequate amount of dissolved oxygen as well as specific conditions with pH and temperature (Zhou et al., 2023). Denitrification is the process by which nitrate formed during nitrification is converted to nitrogen gas in an anoxic zone. The anoxic conditions ensure that denitrifying bacteria consume nitrate instead of oxygen for this reaction to occur:

The solid retention time must meet a minimum threshold to enable nitrification. (Leu et al., 2012). Generally, a retention time greater than 10 days—to ensure complete nitrification—and less than 30 days—to ensure efficient denitrification without an excess nitrifier population—should be maintained (Li & Wu, 2014). The specific solids retention time should be determined on a case-by-case basis depending on the amount of biomass in influent and treatment plant limitations. Increasing the precision of the solids retention time based on site-specific and influent water quality conditions positively influences the efficacy of the nitrification and

denitrification process. Experiments conducted by Leu et al. suggest that increasing retention time comes with added benefits including lower N_2O emissions, reduced biosolids production, and greater reduction in other contaminants and pharmaceuticals in effluent.

The carbon already present in wastewater influent is generally enough to reach a total nitrogen effluent concentration of 10 to 15 mg/L after BNR. To reach a lower effluent concentration, the addition of external carbon is necessary to facilitate the reaction since heterotrophic denitrification requires a high carbon-to-nitrogen ratio. Methanol is the most common form of external carbon source because it is inexpensive and requires a lower amount for successful BNR than other carbon sources, such as acetic acid or ethanol (*Carbon Augmentation for Biological Nitrogen Removal*, n.d.).

While BNR provides an effective method of nitrogen removal, its implementation is accompanied by certain constraints. The higher the level of nitrogen reduction, the more resources, energy, and space BNR demands. Space constraints in treatment facilities can present a challenge when retrofitting to full BNR and contribute to higher capital costs. Increasing the solids retention time means more dissolved oxygen is required for nitrification during aeration, resulting in an increase of energy consumption by 30-50% (Leu et al., 2012) to produce additional O_2 . Ensuring an optimal pH, C/N ratio, dissolved oxygen content, and solids retention time will also lead to higher operational and maintenance costs and require a higher level of operator competence (Zhou et al., 2023). Operators should also take precaution regarding the emission of nitrous oxide generated from the activated sludge process. Valkova et al. determined a negative linear relationship between the amount of emitted N_2O and higher nutrient removal. This provides another incentive for advanced removal, considering nitrous oxide pollution from wastewater treatment currently accounts for 5.6% of global anthropogenic N_2O emissions and

26% of greenhouse gas originating from the water sector (Kemmu & Amanatidou, 2023). Even when advanced nitrogen removal is implemented, it is recommended that local N₂O emissions are consistently monitored to mitigate any contribution to the greenhouse warming effect, whether on a local or larger scale. This is important to consider because N₂O has a global warming potential 273 times more potent than that of carbon dioxide (US EPA).

Despite these caveats, it is indisputable that BNR is highly effective at removing nitrogen content in wastewater effluent when ideal conditions are met. Under proper environmental conditions, BNR alone can accomplish between 70 to 99.9% total nitrogen removal (Zhou et al., 2023). The technology can be easily retrofitted to existing wastewater treatment plants, does not require complicated configurations, and is tolerant to various weather conditions.

I.B. Membrane Bioreactors

Membrane bioreactors (MBRs) are an adaptation of the nitrification and denitrification system described above. It couples the traditional bioreactor chambers followed by a membrane filtration system to purify wastewater to higher degrees than what can be achieved with conventional activated sludge systems—however, it should be noted that conventional BNR and tertiary filtration can obtain similar results as MBRs. Additionally, the pore size of the membrane allows suspended solids to be filtered out simultaneously to the biological processes, avoiding the need for secondary clarifiers (Mao et. al, 2020).

The main advantage of MBRs is that they can purify wastewater with a much smaller land footprint than nitrification and denitrification systems. This makes MBRs ideal for POTWs in an area where land is very expensive or unavailable. MBRs often produce higher-quality water effluent and operate with a longer solid retention time (SRT), reducing sludge production.

However, the main caveat to MBRs is the price. Operational and maintenance costs are high for MBRs to keep the membranes in working order. Air scouring, a necessary process to prevent microbial growth on the membranes, is extremely energy-intensive and increases the plant's environmental and monetary costs (EPA, 2007).

I.C. System Enhancement with Anammox

The anaerobic ammonium oxidation (anammox) system modifies biological nutrient removal processes by enriching the microbes traditionally used with anammox bacteria. The chemical pathways used by anammox bacteria directly produce nitrogen gas under anoxic conditions by using ammonium as an electron donor and nitrite as an electron acceptor. The reaction conditions bypass many of the caveats of traditional biological nutrient removal, including the need for additional carbon sources and dissolved oxygen, and therefore lowers the operational and maintenance costs of the plant (Ren et al., 2022). Additionally, these reactions bypass the formation of nitrous oxide, a potent greenhouse gas, which is a byproduct of traditional biological nutrient removal. The reduced environmental footprint is contributing to the growing interest in anammox technology (Chen, Guo, & Li, 2022). In recent years, a variation of mainstream anammox has been developed known as partial denitrification-anammox (PdNA). Denitrification generates nitrite to be used as a substrate for anammox bacteria. Then, partial denitrification consumes dissolved oxygen (DO) to provide the low-oxygen environment for anammox. Finally, anammox bacteria consumes nitrite and converts it to nitrogen gas (Yo et al., 2020).

However, anammox implementation has been fairly limited. Most commonly, anammox bacteria are used to remove nitrogen from liquid return streams generated from anaerobic digestion that are highly concentrated in ammonia. While side stream channels are most

commonly recycled and mixed with influent to provide microbes for nitrification and denitrification, recent research has focused on treating return streams to decrease loading on the main nutrient removal system. While this indirectly decreases effluent concentrations of nitrogen, sidestream treatments often cannot impact the bulk volume of wastewater (EPA 2007). While anammox treatment in mainstream nutrient removal has been a growing emphasis in the environmental engineering industry, it has been incredibly difficult for the industry to achieve. There has only been success in a few places, namely at the District of Columbia Water and Sewer Authority (DC Water), the Hampton Roads Sanitation District (HRSD), and multiple plants in South Korea. Locally, the Los Angeles County Sanitation District (LACSD) has begun preliminary pilot testing and bench studies to evaluate the viability. These sites have also shifted towards PdNA rather than a full anammox system, and they are characterized by extremely site specific conditions and resources that justified the use of innovative technologies. Without more widespread implementation and knowledge of anammox systems, it is difficult for smaller plants who lack the sufficient expertise, trained personnel, and funds to implement this technology.

II. Nutrient Reduction Cost Analysis

These cost curves were developed through communication with industry representatives. The curves were originally developed in the early 2010s based on installed upgrades—new or retrofit—observed around the country. Then, the costs were escalated to 2024 dollars and adjusted for the higher market costs in southern California.

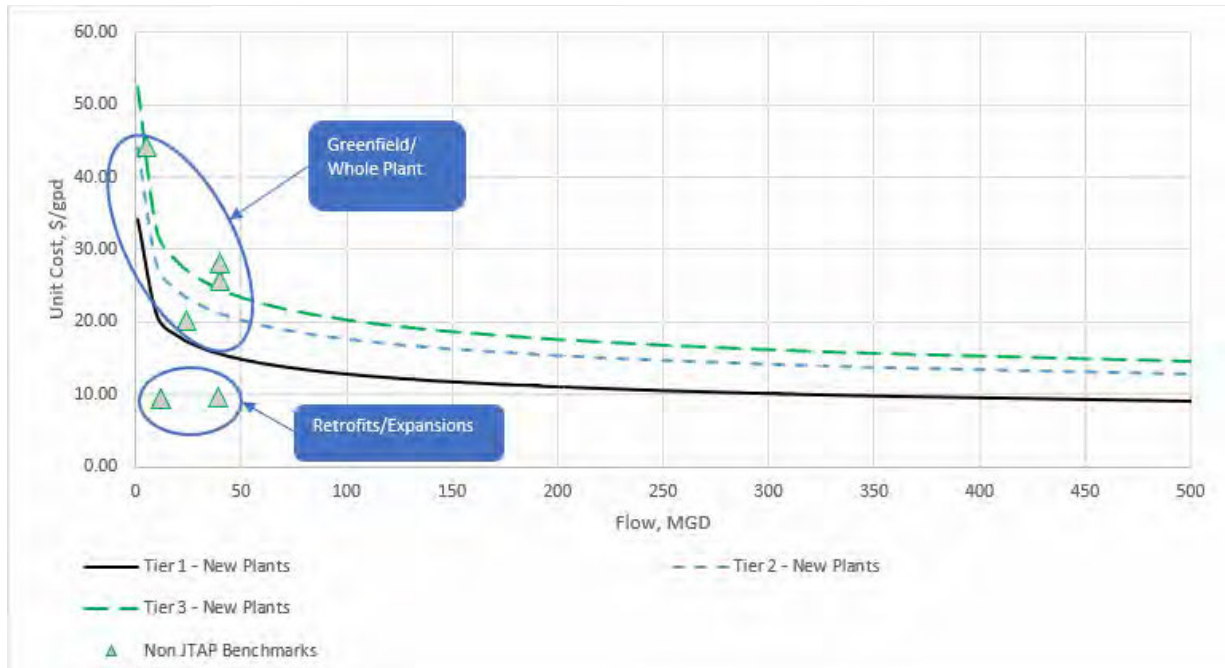


Figure 11: Cost Curves for Wastewater Treatment Plant Retrofits to Enhance Nitrogen Removal

Flow (MGD)	Tier 1 (\$/gpd)	Tier 2 (\$/gpd)	Tier 3 (\$/gpd)
1	34.24	44.10	52.50
10	21.01	27.92	32.60
50	14.94	20.27	23.40
100	12.90	17.66	20.22

Table 7. Snapshot of cost per gallon per day at Tier 1 (8 mg/L TN), Tier 2 (5 mg/L), and Tier 3 (3 mg/L) at various flow rates.

The curves represent the cost to treat a gallon of wastewater per day to reach different effluent levels for any wastewater treatment facility ranging from 0 to 500 MGD. Each of the three tiers represent both different total nitrogen (TN) effluent concentrations and technologies used to reach them for wastewater treatment plants ranging from 0-500 MGD of rated plant capacity. Tier 1 portrays TN levels of 8 mg/L achieved only with nitrification/denitrification from biological nitrogen removal. Tier 2 depicts TN levels of 5 mg/L attained by a combination of improved biological nitrogen removal and simple tertiary technologies, mainly filters. Finally, tier 3 represents TN levels of 3 mg/L obtained through advanced biological nitrogen removal and

combined advanced tertiary technologies including membrane bioreactors, advanced flocculation, sedimentation, and filtration, and membrane filtration. Since resources are often scaleable for larger projects, the cost per unit of wastewater decreases dramatically for plants with capacities larger than 20 MGD and again for plants with capacities than 50 MGD. It should also be noted that while the figures draw estimates for “new plants,” most of the existing wastewater treatment plants targeted in this report were constructed without any capacity for nutrient removal. Therefore, the necessary upgrades to equip these facilities will likely mirror many of the construction needs of a new plant. True retrofits have been plotted as well, and their costs fall below all three curves but inherently assumes sufficient site space was available for the upgrade.

While this model offers crucial insight into the implementation of nutrient removal at existing coastal wastewater treatment plants it is important to scrutinize the limitations of these curves as well. To begin, given the extreme site specificity of each plant that draws from this model, each curve should be considered as a range that aligns with the Association for the Advancement of Cost Engineering (AACE) Class 5, which has a -50% to 100% margin of error. Figures 12 and 13 expand the cost curves for tiers 1 and 2 and include AACE Class 5 boundaries.

Furthermore, while tier 3 provides the most stringent nutrient removal outcomes, they also carry the highest financial cost. The curves do not portray the potential repercussions and impacts. Plants should be cautious about the financial burden and negative externalities for the surrounding community and ratepayers that are associated with intensive infrastructure projects. Finally, these curves only reflect capital costs, not operational and maintenance costs; the final costs of long-term use of upgraded wastewater treatment plants will be higher. Increased variable

costs associated with more advanced nutrient removal—including cost of energy, added chemicals, and hauling—may also put additional strain on utilities, which was also not included in this cost analysis.

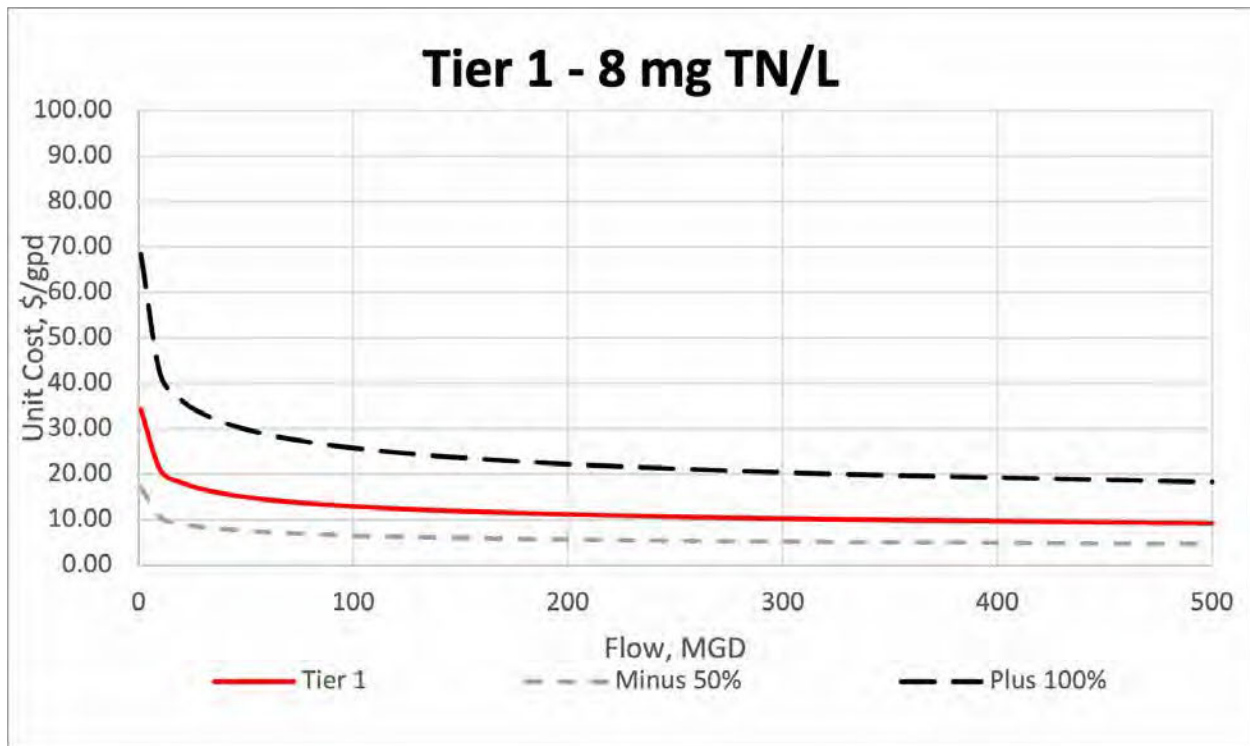


Figure 12. Tier 1 (8 mg/L TN) Cost Curve with AACE Class 5 Margins of Error

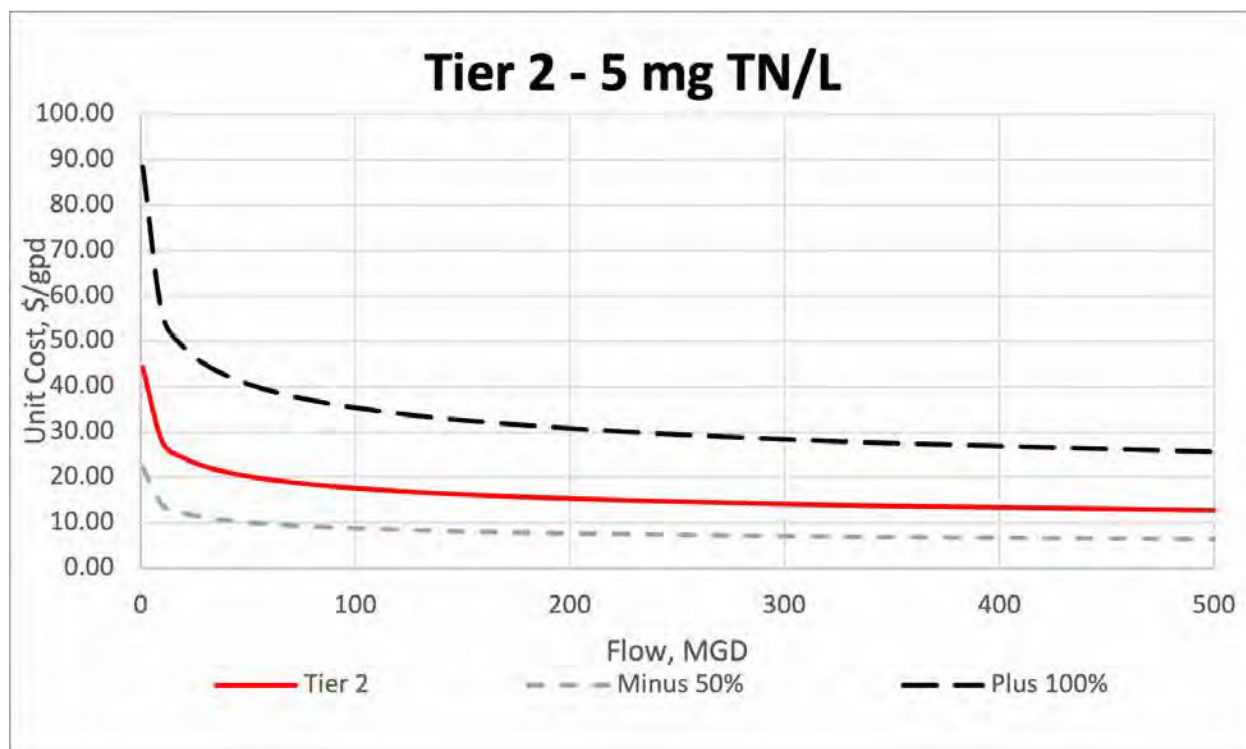


Figure 13. Tier 2 (5 mg/L TN) Cost Curve with AACE Class 5 Margins of Error

III. Alternative Programs: Brine and Sludge Disposal

III.A. Deep Well Injection

As discussed, reducing the ammonia concentration in wastewater effluent before it is discharged into coastal waters is imperative to protecting marine ecosystem health. Alternative measures can be taken in order to reduce the volume of waste that reaches the ocean, including the deep well injection of highly concentrated brine and bioslurry.

Deep well injection provides a cost-effective and convenient method of nutrient-dense waste disposal. The process is environmentally safe as long as the injection well is properly sited, constructed, installed, and monitored. Effective injection technology is able to accurately predict the capacity of rocks to contain the waste material in order to prevent leakage (Shammas et al., 2016). Basic injection well design consists of an injection pipe lined with inner casing and protected with an outer casing of cement that delivers waste to the designated injection zone, and

includes pressure gauges for monitoring. Extra layers of cement casing encompass sections of the injection pipe that pass through depths that contain drinking water aquifers. Deep well injection sites can reach depths anywhere from 3,500 to 10,000 feet below the ground surface (Markley, 2019). A range of waste material can be injected, including dewatered wetcake (biosolids), high pressure effluent, secondary-treated effluent, digested sludge, thickened waste activated sludge, and salty nutrient-rich brine (EPA Quarterly Report, 2023). The contents and proportions of the cumulative bioslurry are dependent on the geological structure of the injection site and the type of well used for injection (US EPA).

The Los Angeles Bureau of Sanitation has been implementing deep well injection at the Terminal Island Water Reclamation Plant since 2008. The Terminal Island Renewable Energy (TIRE) Project is located along San Pedro Bay in an area with extensive oil extraction. The TIRE project injects about 1,050 tons of bioslurry at a depth of 4,900 feet below the ground's surface each month with a secondary goal of generating methane for energy production with naturally-occurring subsurface heat (EPA Quarterly Report, 2023). While methane production has been minimal to none, injection for storage purposes has proven successful thus far (EPA Quarterly Report, 2023). The capital cost of injection construction was about \$7.9 million, and operational costs are \$70,000 monthly (Attai et al., 2008). This monthly cost is based on a flat rate of \$71.21 per ton of slurry injected.

To ensure successful and safe operation, TIRE conducts step-rate tests to monitor the presence and severity of possible fractures and utilizes modeling to watch for the vertical migration of fluids from within the containing geologic formations (EPA Quarterly Report, 2023). To date, no seismic anomalies have been associated with TIRE's injection activities, and there have been no issues with limited geological capacity so far.

The TIRE project is a testament that deep well injection can be a successful and cost-effective (minimal to no BNR needed) method of storing byproducts of wastewater treatment and reducing effluent loading into coastal waters. Since a capacity has not yet been identified for Terminal Island, it is recommended that deep well injection be utilized as a partial solution in conjunction with other nutrient removal technologies already discussed.

III.B. Zero Liquid Discharge

Zero liquid discharge (ZLD) offers a method of handling brine that releases minimal to no waste byproduct into surface waters. The process generates both a clean freshwater-quality output and a solid salt product (Panagopoulos & Haralambous, 2020). As a result, no contaminants of any kind—including nitrogen—are discharged into receiving waters. ZLD usually utilizes enhanced biological nutrient removal methods to remove nitrogen from the water. Following pretreatment—the removal of organic matter and other contaminants—a variety of technologies can be used to treat the remaining brine and separate salts from the freshwater product. The techniques that produce the lowest amount of waste are forward osmosis, brine crystallization, and eutectic freeze crystallization, each associated with a 98-99% freshwater recovery rate (Panagopoulos & Haralambous, 2020). Higher recovery rates are largely associated with higher energy intensity and cost. Cost of forward osmosis is estimated to be \$0.63 per cubic meter of fluid, and brine crystallization and eutectic freeze crystallization range between \$1.11 to \$1.42 per cubic meter (Panagopoulos & Haralambous, 2020).

Due to such high energy demand and cost, ZLD is not widely adopted for use in municipal wastewater treatment facilities. More research should be dedicated to increasing efficiency of ZLD technologies and large-scale feasibility.

IV. Recommendations

While it is difficult to recommend a blanket approach to dealing with nutrient removal across all coastal wastewater treatment plants in California due to site-specific variations, we can provide some guidance on the technologies discussed above.

Due to their excellent space-efficiency, membrane bioreactors can be used where land availability poses a constraint, including densely populated urban areas. BNR retrofits are ideal in treatment plants that already utilize BNR as a form of nutrient removal to some extent and would require minimal retrofitting and capital cost. Otherwise, BNR retrofits are also fitting for treatment facilities that have the available space and are working with a lower cost of land. Additionally, due to its successful operation at the Terminal Island Water Reclamation Plant, we can recommend the use of deep well injection as an aid to handling brine and sludge generated from advanced treatment, only when there is complete geological compatibility and no proposed environmental and public health risks. More research should be dedicated to comparing operational and maintenance costs when adopting a balance of multiple technologies.

Nutrient reduction standards can be achieved by adopting a percent reduction standard or establishing specific effluent concentration benchmarks for wastewater treatment plants to adhere to. A percent reduction approach would result in the discharge of different effluent concentrations depending on the plant. The percent reduction approach ultimately puts less pressure on the largest plants that are discharging the most highly concentrated effluent. Implementing a high percent reduction may still result in an effluent nitrogen concentration that is not sufficient to protect marine ecosystems for these plants. Implementing a concentration-based limitation assigns an appropriate amount of urgency to large wastewater treatment plants in adopting advanced nitrogen reduction measures that will mitigate OAH impacts in receiving waters.

Plant capacity and size should be noted and taken into account for policymaking with regards to setting nutrient reduction standards. Upon examining the cost curves above (Figures 11-13), it is evident that facilities with a rated treatment capacity of 20 MGD or less experience a disproportionately higher cost per gallon per day of wastewater treated. Considering plants within this capacity range may have a substantially lower effect on OAH impacts, it is logical to set more stringent standards for treatment plants above this size threshold.

Due to the urgency of ocean acidification and hypoxia and its growing impacts on marine ecosystems, a precautionary technology-based standard is strongly recommended as a means to mitigate the contribution of wastewater treatment plants to this issue as soon as possible. This report recommends coastal wastewater treatment plants in California with a rated plant capacity larger than 20 MGD reduce the total nitrogen concentration in effluent to 5 mg/L. As stated, site-specific conditions can prevent smaller plants from reaching effluent thresholds without a major socioeconomic impact to the surrounding community. Taking the cost disparity into account, treatment plants with a rated plant capacity smaller than 20 MGD should reduce their total nitrogen concentration to 10 mg/L. This maximum benchmark of 10 mg/L is ideal because it invites opportunity for treatment plants to implement water recycling, based on the current water reclamation standard in California requiring 10 mg/L for non-potable reuse. Additionally, reaching an effluent concentration of 10 mg/L has been proven feasible and executed in a number of inland wastewater treatment plants in California.

Coastal treatment plants should begin planning retrofits and adjustments to accomplish these effluent limitations as soon as possible. It is crucial to continue to refine research that can provide accurate correlations between a particular effluent concentration and the resulting OAH biological impact. Ultimately, the goal of this endeavor is to address wastewater treatment plants

that inflict a detrimental impact on marine health. Recommendations can be adjusted based on the results of this research. This may be accomplished through modeling efforts that can demonstrate various ecosystem impacts at different intervals of TN concentration in discharged effluent.

Spatial Data

I. Summary of Monitoring and Modeling Efforts to Date

I.A. Monitoring Efforts

For decades, a host of public and private actors have been monitoring ocean parameters along the Pacific western coastline. Among the most thorough monitoring efforts, NOAA's Pacific Marine Environmental Laboratory (PMEL) has been running West Coast Ocean Acidification (WCOA) cruises since 2007. WCOA cruise ships gather data from buoys and moorings along 13 transects that run orthogonally to the coastline from the Canadian border to the tip of Baja California in Mexico. Cruise survey results provide coastwide information on ocean conditions for the entire California Current, including underway measurements of $p\text{CO}_2$, dissolved oxygen content, and pteropod abundance and shell dissolution over time. Since these measurements are affected in predictable ways by ocean acidification, WCOA surveys allow for accurate and ongoing assessments of OAH impacts off the Pacific coast. Adding to the state-wide repository of coastal monitoring data, the California Ocean Observing System (CalOOS) Automated Shore Station network is made up of automated sensors attached to several piers up and down California's coast. Shore stations take stationary measurements at frequent intervals of temperature, salinity, chlorophyll, and water level in the nearshore ocean. All of these data can be accessed through the CalOOS Data Portal.

Specific to the region of Southern California, the Southern California Bight (SCB) hosts a suite of regular monitoring efforts that make it one of the best-observed coastal ecosystems in the world (Kessouri et al., 2021b). The longest-running effort to measure and monitor ocean parameters in Southern California is the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program, a collaboration between Scripps Institute of Oceanography, NOAA Fisheries, and the California Department of Fish & Wildlife (CDFW). Established in 1949, CalCOFI is a seasonal sampling effort that collects physical and biogeochemical ocean parameters, including carbonate chemistry and zooplankton data, four times annually along the coast between Point Conception in Santa Barbara County and the U.S.-Mexico border. In 2023, Scripps researchers published a multi-decade times series of ocean data, revealing an unambiguous trend towards acidification. The 37 years of dissolved carbon dioxide measurements were taken at CalCOFI station 90.90 (located 450 km off the coast of San Diego) and illustrate an observed decrease in pH of 0.0015 per year, in agreement with the global average (Wolfe et al., 2023).

The Southern California Coastal Water Research Project (SCCWRP) also collects ocean data in the Southern California Bight as part of its SCB Regional Monitoring Program. Across 1,500 square miles of Southern California coastal waters, data come from over 100 organizations and have been posted approximately every 5 years since 1994 in the Bight Program Portal. Presently, ocean acidification data (formerly known as water quality data) are missing in the Bight Program portal due to a processing issue that is delaying the publication of OA data (Bight Regional Monitoring, SCCWRP).

As for North-central California, the Central and Northern California Ocean Observing System (CeNCOOS) is part of the larger U.S. Integrated Ocean Observing System (IOOS)

within NOAA. The organization's mission is to produce, source, and deliver high-quality oceanographic data, including ocean circulation models, for the central California coast, including Monterey Bay. Their data catalog is expanding to include over 1,000 observational and model data sets for the region. This effort is the main driver of improving public access to biogeochemical and biological ocean data for research and decision making across California.

Some other key datasets for the north-central coast come from Point Blue Conservation Science, a conservation-focused non-profit, specifically through their Applied California Current Ecosystems Studies (ACCESS) cruises. Funded through a joint public-private partnership, ACCESS began in 2004 to observe ocean conditions during upwelling season and assess how ecosystems are responding to multi-year climate shifts. ACCESS' biological datasets include the presence and distribution of seabirds, zooplankton, and marine mammals, as well as of various macronutrients that aid in the growth of primary producers like algae. This information, combined with CTD (conductivity, temperature, and depth) data and dissolved oxygen measurements, can inform ocean managers about ocean conditions along the north-central coast.

Complementary to the CalCOFI effort, the California Underwater Glider Network (CUGN) comprises autonomous gliders situated on four of the CalCOFI lines orthogonal the California coast, from Bodega Bay in the north to Dana Point in the south, and one alongshore line parallel to the coast between Point Conception and Dana Point. Since 2005, CUGN has regularly deployed gliders 500 m beneath the surface and back up along transects, collecting observations of temperature, salinity, chlorophyll, and DO. Glider data can be used to assess environmental conditions like ocean heat waves and algal blooms, as well as to inform responses to mitigate their impact on fisheries and other marine operations.

California benefits from unparalleled access to long-term oceanographic data collected from several stationary moorings along its coast, such as PMEL's California Current Ecosystem (CCE) moorings and MBARI's M1 mooring. CCE-1 is located in the core flow of the California Current, west of Point Conception, and CCE-2 is positioned at the shelf-break to capture near-shore upwelling processes. Each consists of a buoy anchored to the seafloor by a mooring line, where sensors attached to the mooring line collect data at different depths within the water column, providing continuous observations of chemical, physical, and biological parameters. The MBARI M1 mooring is located near the mouth of Monterey Bay, where sensors on the mooring have been collecting measurements including water temperature, salinity, dissolved oxygen, chlorophyll fluorescence, pH, and pCO₂ since the early 1990s. These long-term monitoring efforts and biogeochemical time-series clarify linkages between changing ocean chemistry and the responses of ocean biota with respect to anthropogenic climate change.

As for nearshore waters, dischargers are required to monitor receiving waters and conduct bioassessments in compliance with NPDES Discharge Monitoring Reports (DMR) requirements. The General Permit requires effluent water quality monitoring at all sites and receiving water monitoring at some Risk Level 3 sites (SWRCB, Discharge Monitoring Reports). These complementary efforts in nearshore and offshore coastal waters thoroughly capture both past and present ocean conditions in the California Current System, allowing for accurate analysis of ongoing OAH impacts.

I.B. Modeling Efforts

In concert with observational data, models have been used to isolate certain variables and project how the environment is expected to change over time. As previously discussed in Section III. Modeling Studies, the main advantage of the coupled physical-biogeochemical numerical

approach of ROMS-BEC has been the ability to generate various scenarios at spatial and temporal scales that surpass the limitations of observations alone.

The ROMS-BEC model has proven successful in disentangling various drivers of eutrophication by removing and altering certain sources to evaluate their isolated impacts (Kessouri et al., 2021b). This process is known as source attribution. For instance, repeated simulations with varying degrees of nitrogen reduction from wastewater discharges reveal how much reductions have the potential to improve ocean pH and oxygen levels (Ho et al., 2023). Source attribution experiments allow researchers to predict the effectiveness of hypothetical nutrient management scenarios by forecasting the OAH impacts of each. These two studies emphasize the continued need for high-resolution models to discern natural upwelling effects from anthropogenic nutrient loading.

Models can also simulate future changes in ocean chemistry under varying concentrations of atmospheric CO₂. In a study by Feely et al. (2018), it was found that under the RCP 8.5 emissions scenario, surface and subsurface sea waters along the US West Coast will experience reductions in both pH and aragonite saturation state. The study revealed an expected 0.3 reduction in pH units (from 8.04 to 7.72) and a reduction of 1.0 in Ω_{ar} (from 2.00 to 1.03) in surface waters from the present day to the year 2100 (Feely et al., 2018). Another study by Pozo Buil et al. (2021) modeled future projections of the California Current System. They downscaled three earth system models to force a regional ocean model and generate climate projections for the CCS based on the high emission scenario, RCP 8.5. All of the model outputs agreed on future conditions in offshore waters: an overall surface warming, higher concentrations of nitrate, and a corresponding decrease in DO in the subsurface layer. Furthermore, two of the models project a rise in surface chlorophyll levels in the northern CCS (Pozo Buil et al., 2021).

There is some pending ocean modeling work for the San Francisco Bay and north-central coastal ocean. The San Francisco Bay Ocean Forecast System (SFBOFS) puts out short-term predictions for water levels, currents, temperature, and salinity at over 50 locations within its domain. SFBOFS provides both real-time and forecasted measurements out to 48 hours, four times per day. The Monterey Bay Aquarium Research Institute (MBARI) is also conducting modeling studies related to regional ocean circulation and ecosystem dynamics. However, better, more precise climate simulations are still needed for the north-central coast of California.

In conclusion, complementary efforts to forecast OAH conditions and isolate the drivers of eutrophication have allowed modelers to assess the combined effects of future nutrient management decisions and anticipated climate change impacts.

I.B.I. The California OAH Portal

In cataloging ocean monitoring and modeling efforts, it was clear that the most comprehensive tools for analyzing OAH impacts off the coast of California are being developed through the California Ocean Acidification and Hypoxia (Cal OAH) Portal. With funding from the Ocean Protection Council and NOAA's California Sea Grant, the Central & Northern California Ocean Observing System (CeNCOOS) is spearheading this effort in collaboration with networked OOS (Ocean Observing Systems) partners. Its cyberinfrastructure is managed by Axiom Data Science, an informatics firm that specializes in making tools for visualizing ecological, geological and ocean data. The Cal OAH Portal is a subset of the CalOOS Data Management and Cyberinfrastructure (DMAC) system that is tailored to OAH stakeholders, including resource managers, researchers, and industry partners (e.g. shellfish growers). It will serve as a repository for state-wide OAH ocean data to synthesize status and apparent trends and integrate quality-assured observations from ongoing monitoring programs into a single, user-

friendly OAH hub for scientific and public uses, including management applications (CASG Project Focus). Data scientists at CeNCOOS are actively collaborating with SWRCB to identify and build useful deliverables within the portal (Harper, personal communication, February 2024). While the team at CeNCOOS is preparing for its public launch, the beta version of the portal is up and running and they are prepared to demonstrate its capabilities, including by hosting a workshop catered towards end-users. Descriptions of the portal's functionality and screenshots are included below in Section II.C.I. *Data Products of the Cal OAH Portal*.

II. Contents of the California Ocean Acidification and Hypoxia Portal

II.A. Current Contents of the Cal OAH Portal

At the time of writing this report, the CeNCOOS team is approaching its third year of developing the Cal OAH Portal. Already, the portal includes biological and chemical observations from a range of sources and platforms, including the aforementioned WCOA cruise data, state-wide buoys and sensor stations, as well as the ACCESS and CalCOFI datasets. WCOA data come from NOAA's National Centers for Environmental Information (NCEI) Ocean Carbon and Acidification Data System (OCADS), a nation-wide data portal. OCADS houses WCOA cruise data, from pteropod abundance and dissolution metrics obtained between 2011 and 2016, to chemical measurements like underway $p\text{CO}_2$, temperature, salinity, pH, dissolved inorganic carbon, carbonate ions, dissolved oxygen, and nutrient concentrations, as well as full-depth CTD casts up to 2021. All of this ocean and carbon data has been integrated into the Cal OAH Portal. In addition, CalCOFI and ACCESS datasets supplement the portal with zooplankton biomass estimates and more carbonate chemistry and CTD measurements. The beta version of the portal also includes real-time OAH measurements from a variety of providers—government entities, universities, and publicly funded partners—resulting in an amalgamation of

ocean data that is unparalleled in both size and scope. The beta version of the portal is live and usable and features a catalog that can be used to search and access all of the datasets that have been uploaded so far.

Underpinning its observational datasets, the portal serves a version of the ROMS model called ROMS-NEMURO, a regional version of the ROMS ocean circulation model developed for the North Pacific. It was recently adapted for the West Coast at a resolution of 10 km. The NEMURO model reproduces biogeochemical cycles; however, it does not include OAH parameters (Kishi et al., 2007).

II.B. Future Contents of the Cal OAH Portal and Timeline for Integration

II.B.I. Integrating Observational Data

In the coming months, the CeNCOOS team will integrate more key observational datasets. The list includes long-term CalCOFI zooplankton datasets, time-series data from Monterey Bay Aquarium Research Institute (MBARI) assets (e.g. wavegliders, OA moorings), the Multistressor Observations of Coastal Hypoxia and Acidification (MOCHA) synthesis dataset, and pteropod and crab shell dissolution from other state-wide programs, including ACCESS and SCCWRP (Lebrec, personal communication, February 2024). The plan is to continue adding new data as it becomes available.

II.B.II. Integrating Oceanographic Models

The CeNCOOS team is in the process of integrating regional model outputs into the Cal OAH Portal. According to Marine Lebrec, chief data specialist on this project, there are two model outputs that her team plans to have integrated in the near future: the aforementioned California Current ROMS-BEC model outputs and those of a different version of ROMS developed by Jerome Fietcher at UCSC. The UCSC ROMS model outputs will include OAH

parameters for the full water column up to 2020, and its delivery to the portal is anticipated within the next 2-4 months (Lebrec, personal communication, February 2024). The ROMS-BEC product includes priority parameters like potential temperature, salinity, macronutrients (phosphate, nitrate, silicate, ammonium, and iron), oxygen, dissolved inorganic and organic carbon, alkalinity, surface water pCO₂, air-sea flux of CO₂, as well as derived products such as calcite saturation state, aragonite saturation state, pH, pCO₂, and chlorophyll-a. The CeNCOOS team plans to integrate ROMS-BEC model outputs and associated parameters into the portal in the next 1-2 months (Lebrec, personal communication, February 2024). Several 1-year ROMS-BEC model outputs are included in the Key Visualizations section of this chapter.

II.C. Utilizing Spatial Data to Inform Regulatory Decisions

Maps and models can assist in assessing impaired waters and beneficial uses and regulatory priorities based on the configured values of environmental parameters and their known impacts on species and ecosystem health. Because California's coastline is so extensively observed and expertly modeled, water quality managers have access to a wealth of observational data, real-time modeled data, and projected ocean conditions for regulatory decision-making. For instance, models can produce hindcast simulations of ocean chemical levels from the pre-industrial period, providing the historical baseline necessary for demonstrating water quality impairment. Water quality managers and regulators can use this information to perform accurate water quality assessments and develop standards.

II.C.I. Data Products of the Cal OAH Portal

The OAH Portal serves multiple functionalities within a single, user-friendly interface. Datasets within this portal are downloadable in various formats and shareable for a variety of state and federal efforts, including for OAH management (CASG Project Focus).

II.C.I.A. Dashboards, Map View, and Data Views

Spatial data products within the OAH Portal include dashboards, maps (including model outputs), and data views. Firstly, dashboards are a quick snapshot of current conditions available at a glance for users requiring real-time information. OAH dashboard data typically span the last two weeks and are taken at shore stations along the California coastline. They offer short-term insights into OAH conditions along the coast and in different aquaculture areas. In addition, data are quality-controlled following Quality Assurance of Real-Time Oceanographic Data (QARTOD) standards. Within the portal, time-series measurements containing green bins represent data that have passed through quality checks, while orange and red colors signify suspect and failed data quality, respectively, and may require closer scrutiny.

The map view allows users to search for a desired layer and add it to the map for customized visualizations. For example, users can add layers of sensor data (e.g. California Real-time Sensors and California OAH Sensors) which take discrete or "in situ" measurements of different parameters at fixed monitoring locations. Points are color-coded to indicate recent measurements; white denotes sites where data hasn't been collected for some time. Users can generate a time series for a specific period by clicking on a site, selecting the desired measurement, and adjusting the timescale slider at the bottom of the interface. Turning off seasonal statistics will reduce chart background noise. As another example, users can search for WCOA pteropod data and toggle between different parameters, including levels of pteropod abundance, percentage of type II or type III shell dissolution damage, and average aragonite saturation state (see Figure 14). Three-dimensional visualizations are also available for some parameters, such as dissolved oxygen (see Figure 15). These in situ measurements are crucial for assessing acidification impacts. It should be noted that WCOA pteropod data after 2016 are not

yet included in the beta version of the portal because WCOA pteropod data after 2016 have not yet been published in OCADS.-

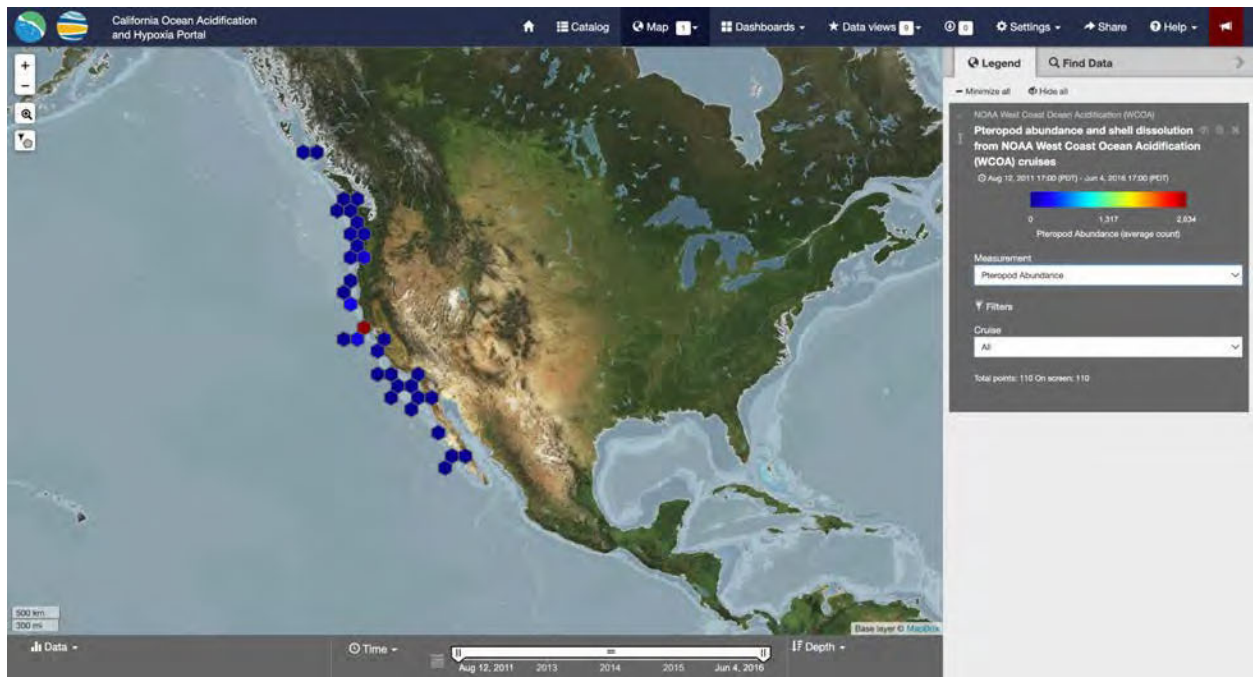


Figure 14. A screenshot of the California OAH Portal map view showing pteropod abundance data obtained from NOAA West Coast Ocean Acidification (WCOA) cruises from 2011–2016.

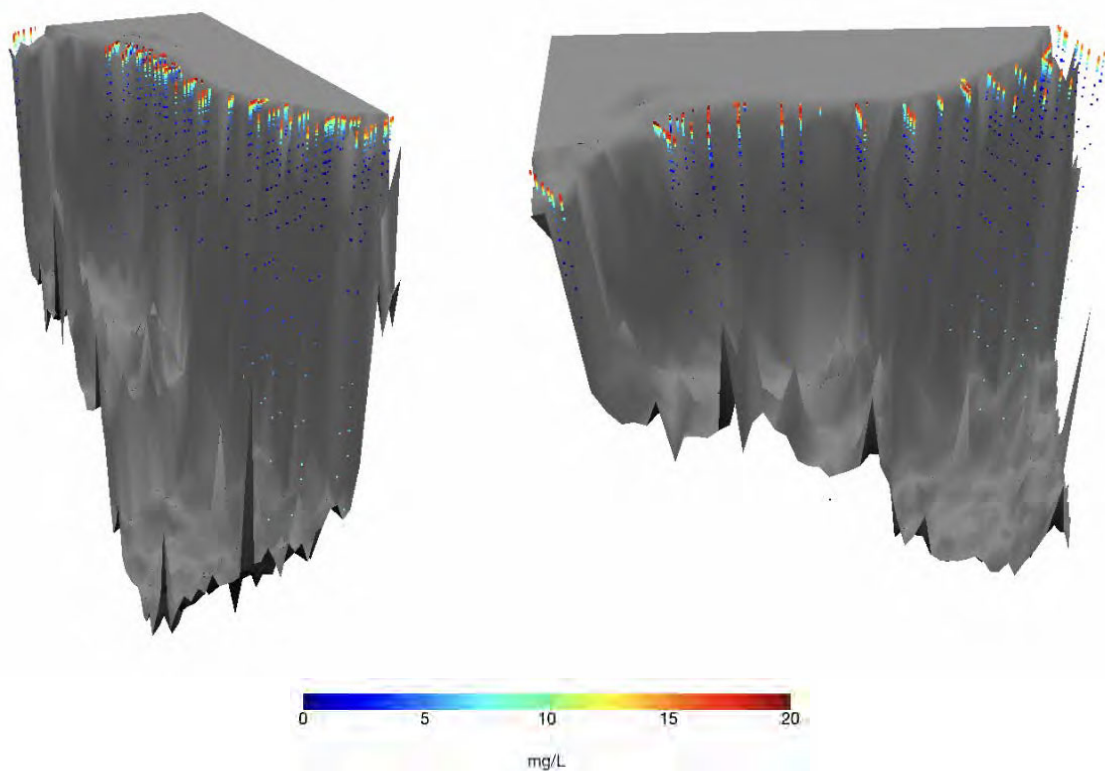


Figure 15. Two screenshots of three-dimensional renderings from the California OAH Portal showing in situ dissolved oxygen measurements taken during NOAA West Coast Ocean Acidification (WCOA) cruises in June–July 2021. The rendering can be rotated to view from different angles.

In contrast to discrete observations depicted in Figures 14 and 15, model outputs can also be added to the map, where each variable simulated by the model is represented as a single layer. Model simulations result in comprehensive coverage rather than discrete observations. Hovering over a grid cell reveals the modeled value of the variable at that cell. Users can select the depth of the model’s output in the legend at the right hand side. Once the ROMS-BEC model is integrated in the portal, comprehensive coverage of its OAH simulations will be available. The ROMS-BEC model outputs will assist water quality managers in determining water quality impacts at various spatial and temporal scales. For instance, the acidification threshold value recommended in this report is an aragonite saturation state of 1.4 (Biological and Ecosystem Impacts, *Section III.A.*). When CeNCOOS’ portal includes the ROMS-BEC model output, users

will be able to observe at which depths aragonite is saturated at or above 1.4, providing context for OAH management. The latest OPC Annual Coast and Ocean Report includes a time series for aragonite saturation state from the ROMS-BEC model, generated for OPC externally, below.

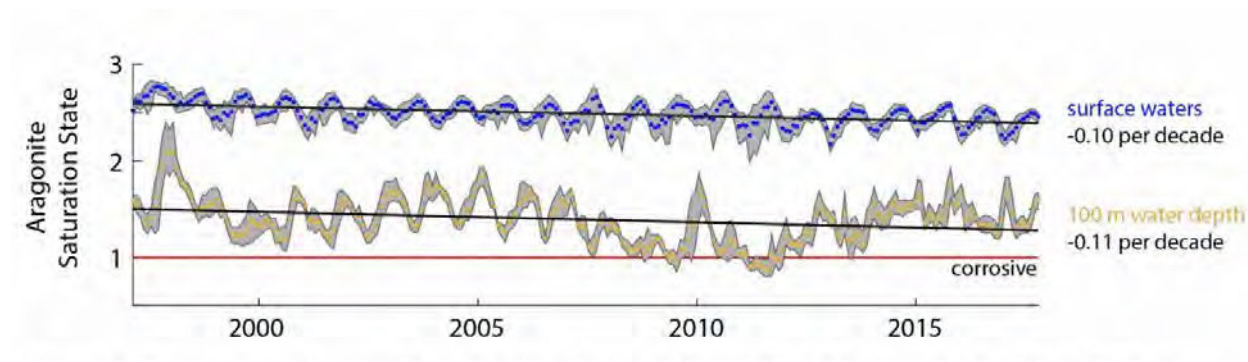


Figure 16. Time series of aragonite saturation state at the surface (blue) and at 100 m depth (yellow) in Southern California waters (2022 Annual Coast and Ocean Report, OPC). Plotted is a ROMS-BEC model output synthesized as monthly averages (circles) with average conditions in gray shading. Black lines represent long term trends and red line indicates corrosive conditions with respect to aragonite.

II.C.II.B. Advanced and Evolving Data Products

The portal offers an advanced feature called "Data Views" which allows users to create an overlay of time series from different sources to explore scientific questions or relationships. The CeNCOOS team is presently developing an OAH-specific data view that is tailored to OAH research and management needs. It overlays time series from two different CCE moorings, comparing levels of atmospheric or seawater pCO₂ between near-shore and off-shore moorings in the same plot. Users can create their own data views by selecting specific time series and saving them for comparison. For purposes of setting OAH thresholds, it is recommended that default data views are created that overlay time series for pH, temperature, and DO at near-shore and off-shore locations, or at the same location at different depths in the water column. It is also recommended to develop default data views that overlay seasonal comparisons of aragonite saturation values. The depths at which we see Ω_{ar} of 1.0, 1.2, and 1.4 could be compared, for

instance, in spring and fall to highlight seasonal discrepancies associated with upwelling. This and other visualizations are included in the Key Visualizations section of this chapter.

Finally, the portal is evolving to include a virtual sensor feature that would generate time series plots of modeled data for any variable at any location on the model domain (Lebrec, personal communication, February 2024). By clicking on a specific point, users can generate a plot representing fluctuations in parameter levels over time, from the pre-industrial period to the present day, revealing apparent trends. This proposed functionality is intended to meet the state's requirements for documentation of status and change over time.

The beta version of the portal is operational already, and team members at CeNCOOS are willing to host walk-through demonstrations of its capabilities. In fact, they plan to host a workshop catered towards end-users in Fall 2024, where they will be seeking feedback to improve the portal's usability (Lebrec, personal communication, April 2024). It is recommended that California decision-makers and researchers take full advantage of this state-of-the-art resource that is soon to be launched publicly.

III. California State Water Board's Current Data Submission Procedure

The sheer quantity and complexity of data within the Cal OAH Portal ironically present a problem for regulators because of the state's rigid requirements for uploading scientific data. In order for data to be assessed for the 2028 Integrated Report, which is used to identify impaired waters, the State Water Board must receive data individually from each data generator. The two avenues for uploading data to the State are the California Environmental Data Exchange Network (CEDEN) or, for all non-CEDEN compatible data, the Integrated Report Upload Portal (Data Solicitation, SWRCB). In conversations with SWRCB's Office of Information

Management and Analysis (OIMA), it was determined that CeNCOOS datasets must be uploaded in the CEDEN framework in order to be included in the 2028 Integrated Report assessment (Fojut, personal communication, April 2024). At the time of writing this report, CeNCOOS data specialists and OIMA staff are collaborating to reformat Cal OAH datasets within CEDEN data structure and vocabulary (Martorano, personal communication, April 2024). It is expected that, within the coming months, Cal OAH datasets will be at least partially uploaded to CEDEN for the 2028 Data Solicitation.

IV. Recommendations for an Alternative Data Submission Procedure

CEDEN was built to streamline the exchange of water quality data between state agencies and other government, discharger, NGO, and private partners, yet its framework is limited in both scope and capacity. It is organized by templates with controlled vocabulary for each type of field data. The template formats are not compatible with a platform as complex and non-homogeneous as the California OAH Portal, nor is it designed to manage big data. Therefore, it is recommended that the state implement a workaround of sorts, whereby federal data generators (e.g. NOAA, EPA) can submit data to an open repository using machine-readable pathways. Machine-readable pathways enable data transfers through standardized formats that can easily be interpreted by software, such as APIs (Application Programming Interfaces). These pathways ensure efficient communication and exchange between different data sources. Presently, it is not possible to submit data to CEDEN using machine-readable pathways (Fojut, personal communication, April 2024). Another option would be for the SWRCB to link directly to federal government monitoring partners' data sources. In this case, the CeNCOOS OAH data portal is funded by the state and the state is the client for the effort.

Furthermore, it would be ideal for the SWRCB and the state of California to accept other widely-accepted standardized formats into their system. For example, the Climate-Forecast standard is the best practice for NOAA IOOS observations, which come from a nation-wide network of satellites, buoys, tide gauges, radar stations, and underwater vehicles; this format should be accepted by the state. Also, NOAA IOOS has extensive QA/QC data requirements that need to be met to utilize and analyze the data. Government-funded entities like CeNCOOS should not have to convert a standard format into a new one in order to meet the state's CEDEN submission criteria. Tight constraints on time and capacity make it nearly impossible to comply with these outdated criteria.

The SWRCB and the state of California should institute a policy that makes data sharing acceptable through a link to the federal data manager. Linking data directly onto an open data platform via API could streamline data management and regulatory applications without compromising the portal's capacity for high-quality visualizations. This same approach would be important for the use of remote sensing data from federal agencies such as NASA, NOAA, USDA and USGS. Doing so would not only remove the burden of manually transferring and formatting data, but it would also enhance the portal's regulatory applications.

In conclusion, given that the California OAH Portal is a state-funded project with the explicit goal of compiling relevant, quality-assured OAH data for state-wide applications, it is in the state's interest to modernize the data submission process to accommodate the Cal OAH Portal data without undermining its ability to generate useful data products. Instead, it is recommended that the state accept data submissions via machine-readable pathways or a link directly to federal partners' data sources. It is also recommended that the state accept other

widely-accepted standardized formats. These updates would speed up the data sharing process and promote access to high-quality scientific information and model outputs.

V. Key Visualizations

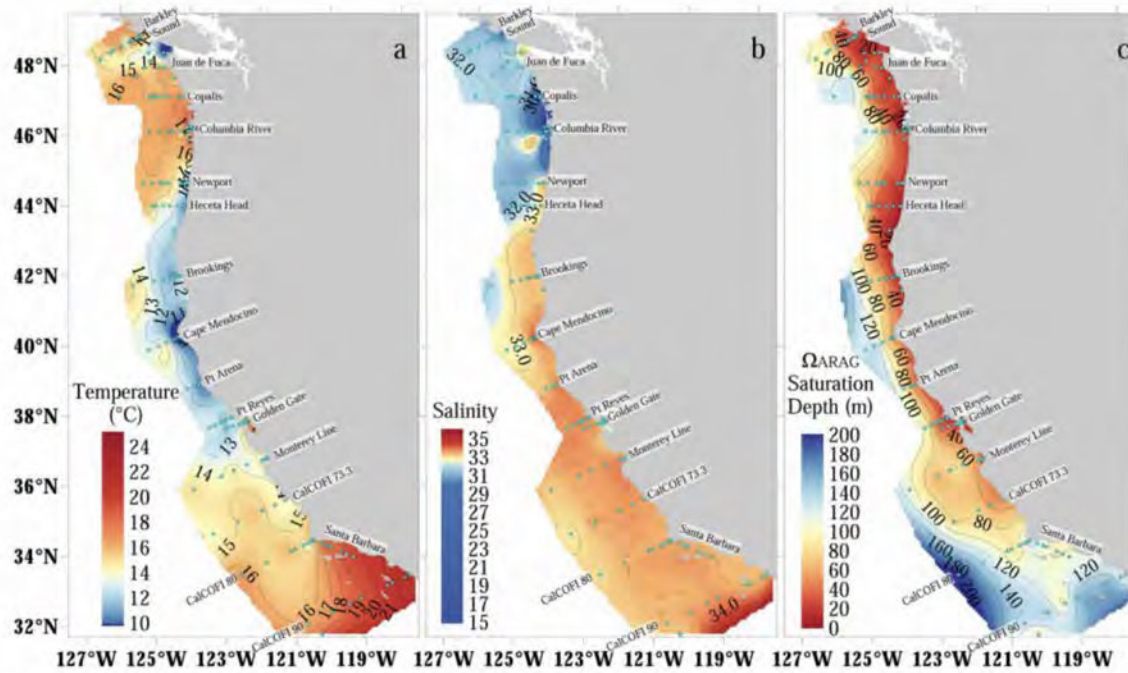


Figure 17. (c) Distribution of depth at which aragonite saturation reaches 1.0 along the coastal margin of the California Current Ecosystem (Feely et al., 2024). Data taken from WCOA cruises in June–July 2021. The depth where $\Omega_{ar} = 1.0$ occurs at 20–40 m near the coast in the northern part of the study region, compared with 50–160 m near the coast in the southern half of the study region.

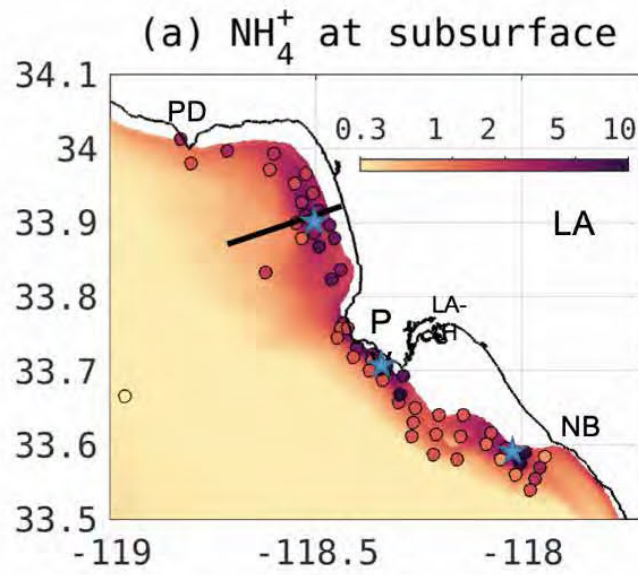
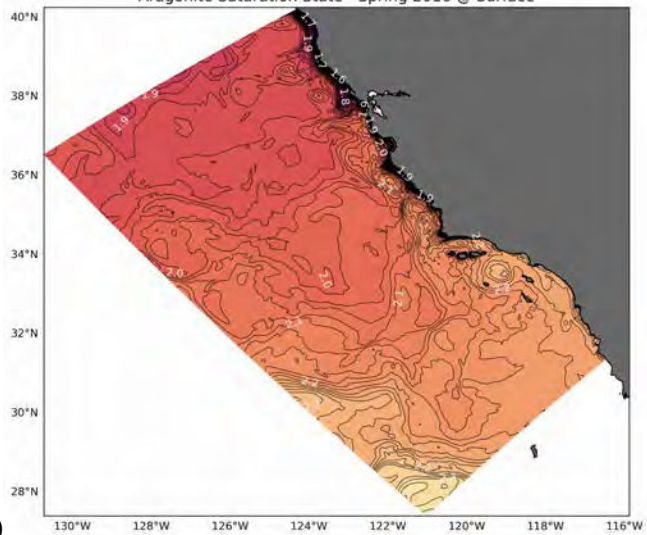


Figure 18. Subsurface (30–45 m) ammonium (NH_4^+) concentration averaged during summer (June to August between 1997 and 2000) from the ANTH simulation (background color contours) and in situ observations (colored dots), showing the location and dispersal of ammonium enriched wastewater plumes near the coast. Blue stars show the location of three large POTW outfalls. (Kessouri et al., 2021a).

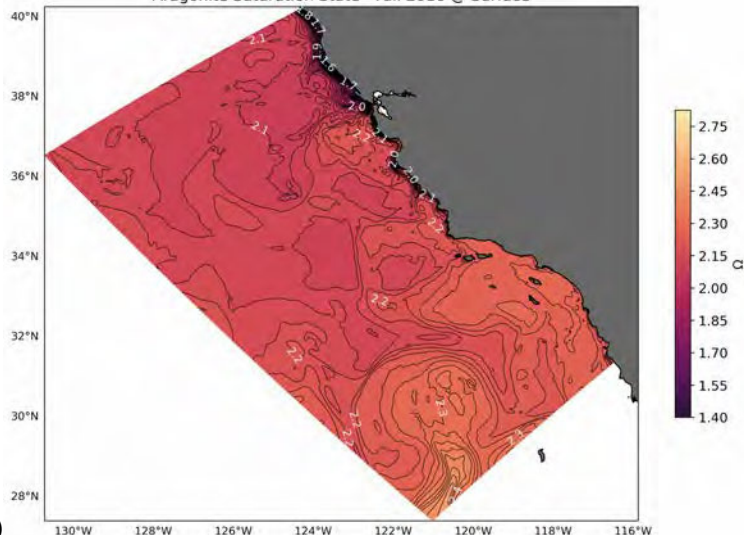
The figures below were generated by the CeNCOOS data team in advance of the public launching of the Cal OAH Portal. In June 2024, data scientists at CeNCOOS received 1 year of ROMS-BEC files from 2016 and generated the static maps below in order to enhance this report's usability in decision-making. Plots were generated for worst-case scenario months, when geometric monthly means for pH, DO, and aragonite saturation reach annual lows. The plots are further described below.

Aragonite Saturation State - Spring 2016 @ Surface



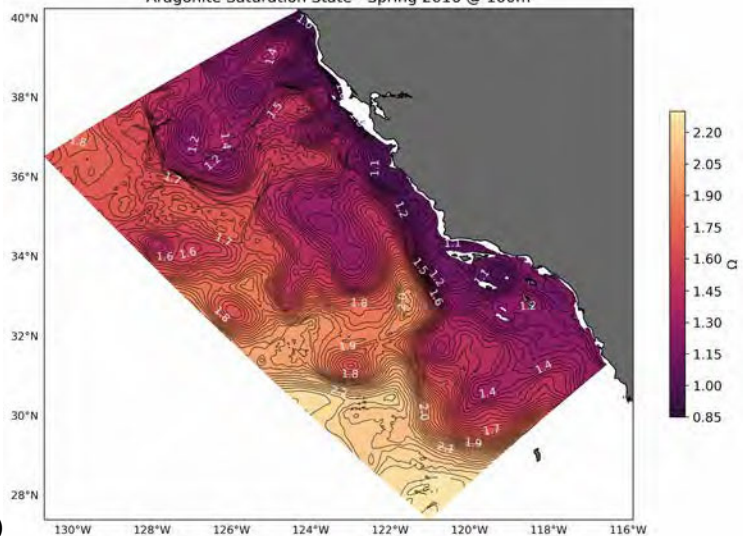
(a)

Aragonite Saturation State - Fall 2016 @ Surface



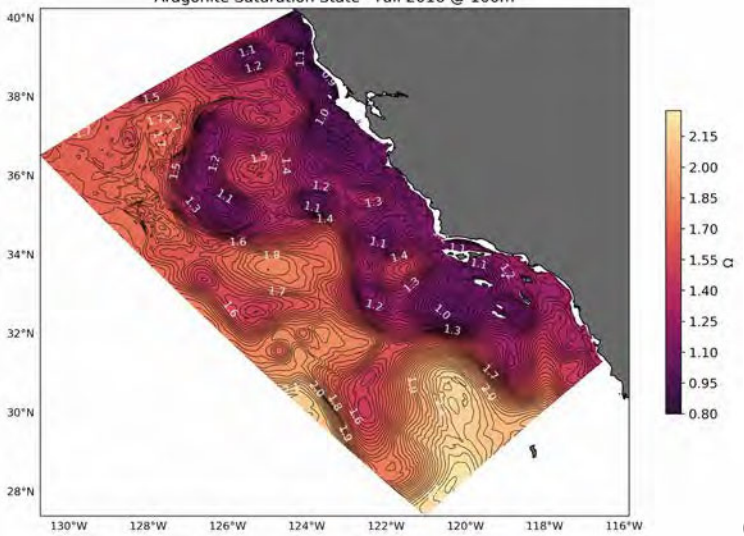
(b)

Aragonite Saturation State - Spring 2016 @ 100m



(c)

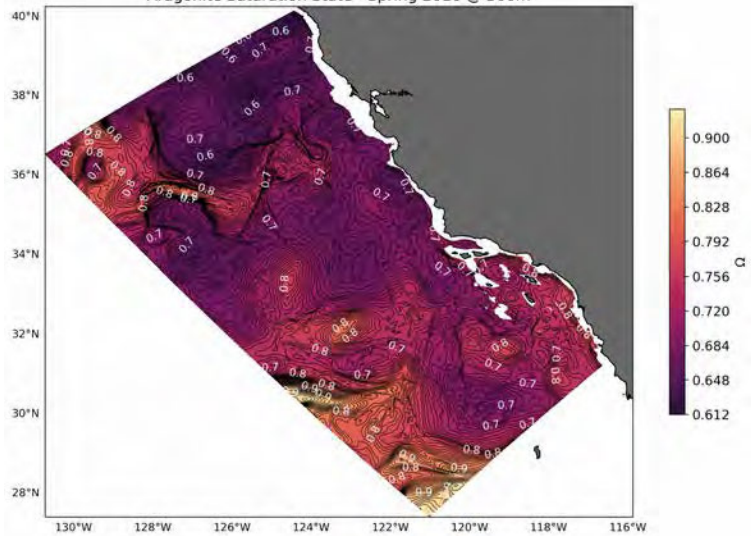
Aragonite Saturation State - Fall 2016 @ 100m



(d)

(e)

Aragonite Saturation State - Spring 2016 @ 300m



(f)

Aragonite Saturation State - Fall 2016 @ 300m

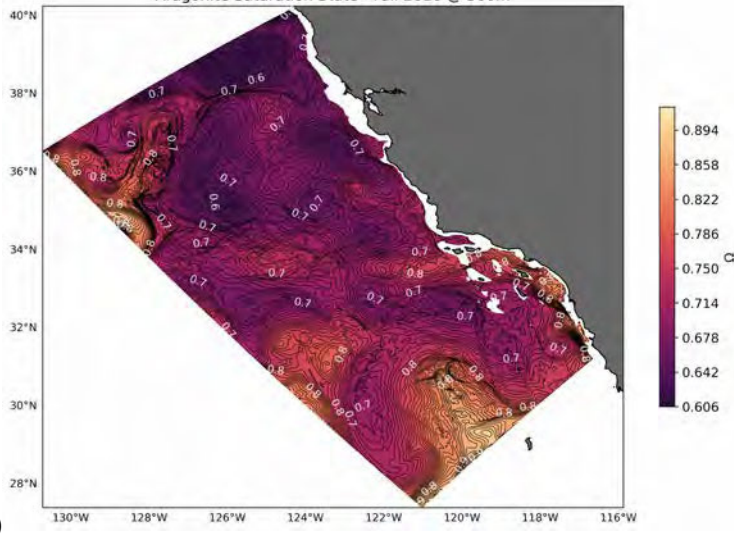


Figure 19. (a-f) Heat maps showing seasonal differential in aragonite saturation state (Ω_{ar}) at different depths along the coastal margin of the California Current Ecosystem. Omega aragonite values averaged for spring (Apr–May 2016) on the left (a, c, e) compared to fall (Aug–Sept 2016) on the right (b, d, f). Values averaged at the surface and at depths of 100 m and 300 m include Ω_{ar} values ranging from 0.6 at depth to 2.2 at the surface. Darker shading indicates problematic areas with lower Ω_{ar} values. Deeper and nearshore waters are shown to have lower aragonite saturation states, especially in the spring months which are dominated by natural upwelling processes that bring acidic, low-oxygen waters closer to the surface and to shore. Monthly averages of Ω_{ar} in nearshore waters at depths of 100 m and 300 m are shown to decrease below the recommended threshold of 1.4 in both spring and fall.

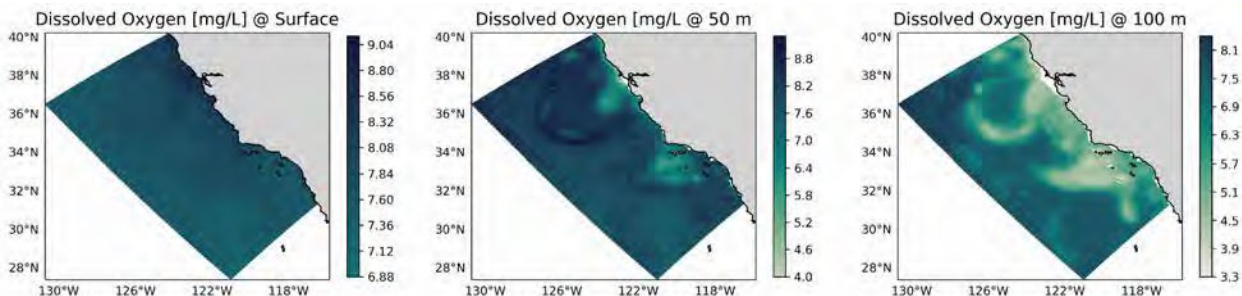


Figure 20. Heat maps of dissolved oxygen levels in milligrams per liter at various depths along the coastal margin of the CCE. Values are monthly averages from September 2016, highlighting the lack of dissolved oxygen during late summer when the problem is exacerbated by natural processes. Values averaged at the surface and at depths of 50 m and 100 m. Lighter shading indicates lower available oxygen. Deeper and nearshore waters are shown to have lower available oxygen. DO is shown to drop below 6.0 mg/L in nearshore waters at 50 m depth and decrease further to 4.0 mg/L at 100 m depth. In September, nearshore waters are $\sim \leq 15.0^{\circ}\text{C}$ at 50 m and $\sim \leq 12.5^{\circ}\text{C}$ at 100 m (see Figure 22.) corresponding to a DO threshold of 7.03 mg/L and 6.42 mg/L, respectively. The figure shows DO breaching that temperature-dependent threshold in September.

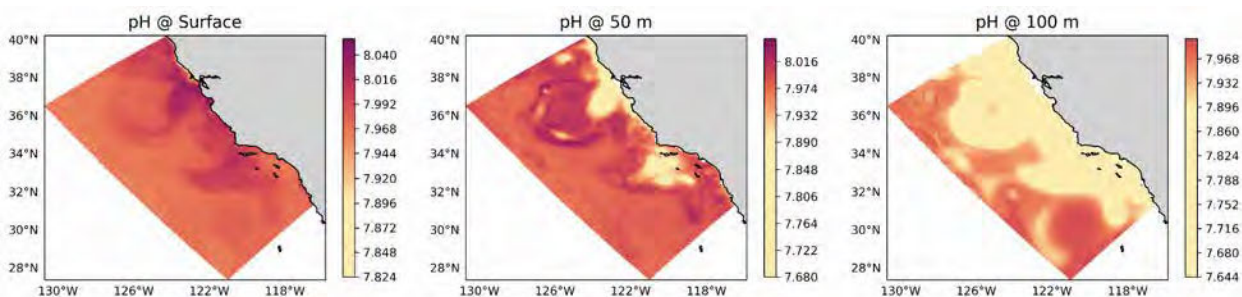


Figure 21. Heat maps of pH at various depths along the coastal margin of the CCE. Values are monthly averages from September 2016 when pH is lowest due to natural processes. Plots depict pH at the surface and at depths of 50 m and 100 m. Lighter shading indicates areas with a lower pH, corresponding to more acidic waters. Deeper and nearshore waters are shown to be more acidic. The upper bound pH threshold given in this report of 7.8–7.9 is breached at 50 m along the coast and over a larger area at 100 m.

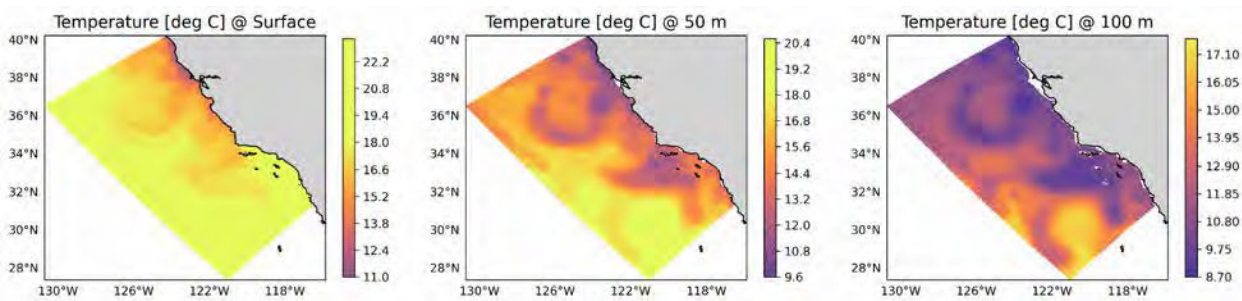


Figure 22. Heat maps of temperature at various depths along the coastal margin of the CCE. Temperature values averaged at the surface and at depths of 50 m and 100 m. Values are monthly averages from September 2016, when ocean waters are warmer than usual. Darker shading indicates colder waters. Visualizing temperatures is helpful for applying the temperature-dependent dissolved oxygen thresholds outlined in this report. Water temperature of 12.5–15.0°C corresponds to dark orange shading, where the recommended DO threshold in this report is 7.03 mg/L. Purple regions, ranging from 7.5–12.5°C, suggest a minimum recommended dissolved oxygen threshold between 5.86–6.42 mg/L. For ocean waters colder than 7.5°C, a dissolved oxygen threshold of 5.35 mg/L is advised, although it's not depicted on these maps due to elevated ocean temperatures in late summer.

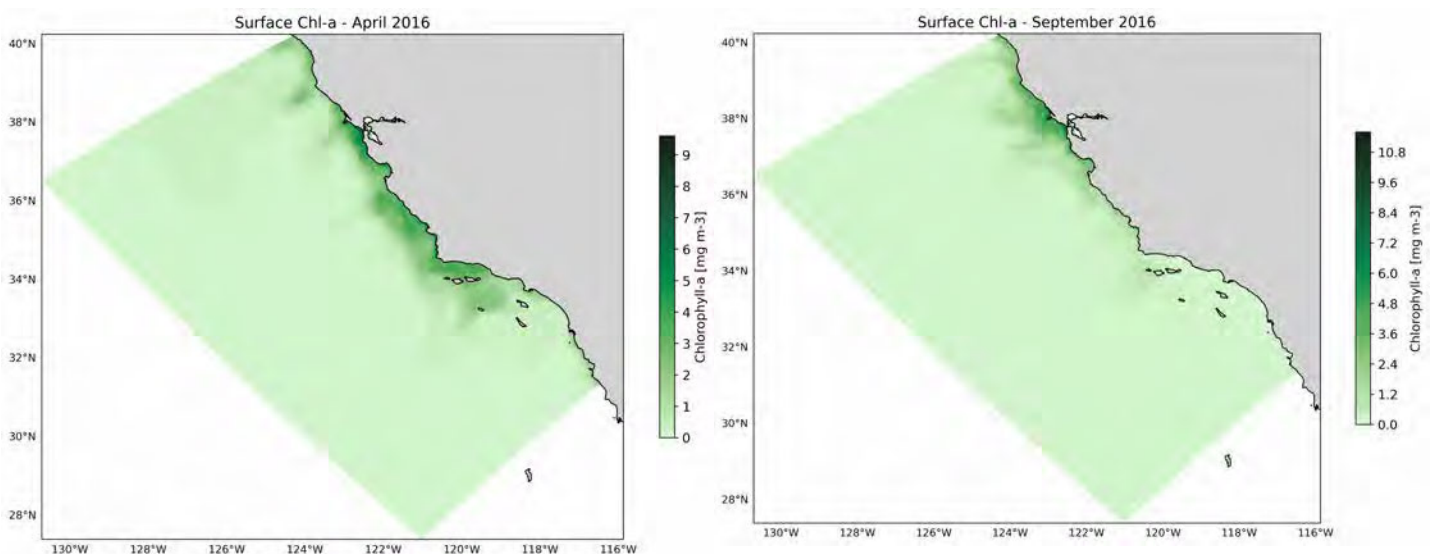


Figure 23. Heat maps showing surface chl-a averaged during April and September 2016 showing seasonal differential in primary productivity. Land based nutrient inputs fuel algal growth which contributes to acidification and oxygen loss.

Policy

I. California Policy

I.A. History of OAH Policy in California

Foundational OAH policy in California includes Senate Bill 1363 (Monning), entitled “Ocean Protection Council: Ocean Acidification and Hypoxia Reduction Program” (2016). This

bill built upon the existing California Ocean Protection act that established the California Ocean Protection Council (OPC) and the California Ocean Protection Trust Fund to fund projects related to the protection of ocean waters and ecosystems. SB 1363 required that OPC, consulting with the State Coastal Conservancy and other relevant entities, “establish and administer the Ocean Acidification and Hypoxia Reduction Program” and propose “authorization of funding for grants or loans for projects or activities that further public purposes consistent with the Ocean Acidification and Hypoxia Reduction Program” (OPC & California Ocean Science Trust, 2018). Thus far, SB 1363 has been utilized for OPC to invest in OA monitoring in seagrass beds, as well as the creation of an OPC Science Advisory Team working group which explores the use of seagrass as a tool to manage ocean acidification in California (OPC & California Ocean Science Trust, 2018). The bill authorizes OPC to fund projects that are consistent with the findings of the bill, including ocean acidification, hypoxia, and the benefits of eelgrass, and requires OPC to “ensure that ocean and coastal policy and management reflects the best science on ocean acidification and hypoxia” (SB 1363, 2016).

Assembly Bill 2139 (Williams) is the other major piece of OAH legislation in California. This 2016 bill, titled “Ocean Protection Council: ocean acidification and hypoxia”, authorized OPC to create an OAH task force designed to support council decision-making with the best available science (AB 2139, 2016). This bill also requires OPC to take task force-specified actions to address OAH and adopt annual recommendations for further actions to address OAH, beginning with recommendation in 2018 (AB 2139, 2016). Furthermore, the bill requires OPC to implement measures to mitigate climate change in the ocean, work with other agencies to research and coordinate standards for coastal water health, and to work with national, federal,

state, regional, and academic entities towards the advancement of OAH research priorities and OAH management gaps and needs (AB 2139, 2016).

The West Coast Ocean Acidification and Hypoxia Science Panel released a report in April of 2016 detailing its major findings regarding OAH in California and including recommendations and actions to take on behalf of these findings. Key findings included that global carbon emissions are the main driver of OAH processes, that there are actions we can take to lower the exposure to OA, and that the growth and acceleration of OA science will expand the number of effective, fiscally reasonable management strategies for OA (Chan et al., 2016). The panel's first of three themes in this report is "Address Local Factors That Can Reduce OAH Exposure", with the recommendations under this section including "Reduce local pollutant inputs that exacerbate OAH" and "Revise water quality criteria" (Chan et al., 2016). These recommendations demonstrate that expanding OAH policy, specifically in the realm of local nutrient inputs like WWTPs, has been a growing focus of the state for many years.

In collaboration with California Ocean Science Trust, OPC released California's Ocean Acidification Action Plan in October of 2018. The CA Ocean Acidification Action Plan states that "California has identified OA as a priority issue for over 10 years", and builds upon this growing momentum to establish six strategies, each with a five year timeline, to address OA in California (OPC & California Ocean Science Trust, 2018). These six strategies are: prepare for the full range of OA risks and impacts, which encourages investment into a monitoring and observation system for OA; activate responsible elements of state government, which includes two actions to "Fully integrate OA into California state government policies, planning, and operations"; reduce the pollution that causes OA, which calls for increased incentives for "coastal infrastructure upgrades that are designed to simultaneously reduce or eliminate nutrient-

and carbon-laden ocean discharges that exacerbate local acidification”; deploy living systems to slow OA and store carbon; build resilience of affected communities, industries, and interests; and engage beyond state boundaries, especially by establishing strong regional partnerships to address OA along the West Coast (OPC & California Ocean Science Trust, 2018). This report was developed within the framework of the International Alliance to Combat Ocean Acidification (OA Alliance) of which California is a member. Today, the OA Alliance is made up of over 60 member organizations, including the United States, that have “joined together to elevate the visibility of OA in public discourse and policy development and to push for the inclusion of strong ocean protection provisions in international climate agreements” (OPC & California Ocean Science Trust, 2018). Its foundational goals include advancing the collective scientific understanding of OAH, taking meaningful actions to reduce its regional causes, and protecting coastal communities by improving their resilience to increasing acidity. California published its 2018 Action Plan in pursuit of fulfilling these goals and obligations, emphasizing once again the growing focus on OA action within California.

In February of 2020, the OPC published its Strategic Plan to Protect California’s Coast and Ocean 2020-2025 (OPC, 2020). Objective 1.2 “Minimize Causes and Impacts of Ocean Acidification and Hypoxia” outlines four targets for OPC and the numerous state agency partners they name to pursue in order to minimize OAH harms. The plan also outlines four actions to promote completion of two of these targets. One action under Target 1.2.1 highlights the necessity of updated science to inform policy. In this action, the OPC calls for scientific guidance to be provided to the SWRCB by 2022 in order to “inform new nutrient loading standards that minimize biological and chemical impacts including ocean acidification, hypoxia, and harmful algal blooms” (OPC, 2020). A following 2021 staff recommendation from OPC

proposed funding for the SCCWRP to carry out action towards completing this action (Kimball, 2021). Despite the deadline for this goal having passed, no updated nutrient loading information is currently available. In a similar vein, Target 1.2.4 is “Ensure implementation of California’s Ocean Acidification Action Plan’s Goals by 2023” (OPC, 2020). This goal is still a work in progress, despite the deadline having passed. SWRCB has begun the implementation process of all targets noted in the Strategic Plan, but continues to work with OPC and SCCWRP to utilize relevant research in order to achieve this goal.

The California Ocean Acidification and Hypoxia Task Force (Task Force) released a report entitled “Enhancing California’s Ocean Acidification and Hypoxia Monitoring Network” in June of 2020 with recommendations for gaps to close which will allow for the aforementioned Strategic Plan and Action Plan to be implemented. The three recommendations developed by the Task Force were designed with “the extent of likely improvement in the management decision, the cost-effectiveness of the investment, and the applicability of the investment for supporting multiple management actions” as guiding factors and focus largely on the expansion of monitoring systems to provide a basis for management strategy development (Weisberg et al., 2020). First, the Task Force recommended better connecting biological and chemical monitoring, which it states will remove barriers to developing OAH water quality criteria as outlined in the Strategic Plan and Action Plan (Weisberg et al., 2020). Their second recommendation is to “Continuously improve OAH models as decision-support tools via collection of additional monitoring data”, which will aid in assessing the potential effectiveness of reducing local nutrient inputs to mitigate OAH (Weisberg et al., 2020). Third, the Task Forces recommends strengthening the continuity of OAH monitoring programs across California’s coast, which

would help address the spatial disparity of monitoring efforts across CA and allow for better management of California's diverse coastal expanses (Weisberg et al., 2020).

I.B. Ocean Plan (2019)

The California Ocean Plan, or Water Quality Control Plan for Ocean Waters of California, has established water quality standards and implementation provisions to protect beneficial uses of California's marine waters since 1972, with intermittent amendments to the Ocean Plan implemented to enhance its protection of California ocean water. The most recently amended version of the Ocean Plan took effect in 2019. In the 2019 Ocean Plan, ocean acidification is not discussed, and hypoxia is only explicitly discussed thrice, all three times of which fall under the regulation of desalination plants (SWRCB, 2019a). Dissolved oxygen and pH, metrics which can be utilized for OAH assessment, are included as chemical characteristics in the 2019 Ocean Plan under section II. Water Quality Objectives. Nonetheless, specific OAH regulations are not included, which are the focus of this report's research and policy recommendations.

In the 2019 Ocean Plan Triennial Review, SWRCB marked the issue of OAH as a top five high priority project (SWRCB, 2019b). Further discussion of the Ocean Plan and Ocean Plan amendment goals and recommendations are found in sections I.D. Goals for California OAH Policy and V. Policy Recommendations.

I.C. 2024 Integrated Report

The 2024 California Integrated Report (IR), which was submitted to the EPA on March 26, 2024, introduces methodologies for assessment of ocean acidification in section 3.10 of the

IR. Assessment of OA under the 2024 IR is assessment of beneficial use attainment rather than objective attainment, as “no current objective in the Ocean Plan is applicable for aragonite saturation data” (SWRCB, 2024b). The IR notes that a biological characteristic water quality objective for the degradation of marine species indicates that the degradation is caused by discharges; because OA degradation is not proven to be caused solely by discharges, the IR states that this kind of objective is incompatible with OA assessment and aragonite saturation data (SWRCB, 2024b). The data included in the 2024 IR was used to recommend placement of a water body into Category 3, which denotes insufficient data and/or possible concern, rather than listing the water body on the 303(d) list; this indicates that the SWRCB believed that there was insufficient data to make a biological impact determination, but that the data does suggest that beneficial uses could be potentially threatened by ocean acidification.

California’s 2024 IR explores a number of studies on aragonite saturation states, also referred to as omega aragonite values in the IR assessments, to discuss its potential threshold for this value. Crucially, the IR includes that $1.4 \Omega_{ar}$ is the threshold which provides a most accurate assessment of potential OA impairment, which is based on the $1.2 \pm 0.2 \Omega_{ar}$ threshold and uncertainty range defined in McLaughlin et al. (2015) (SWRCB, 2024b). The IR also lists that continuous studies have demonstrated dissolution at various stages of the pteropod life cycle at thresholds of 1.0, 1.2, 1.25, and $1.5 \Omega_{ar}$, and notes that water bodies with $<1.0 \Omega_{ar}$ aragonite saturation state are undersaturated and may have severe dissolution (SWRCB, 2024b). Despite noting that 1.4 is a “more accurate reflection of OA impairment”, California’s 2024 IR leaves the future thresholds open to change for determining likely versus potential impairment in water bodies, explaining that “defining thresholds for likely impairment versus potential impairment with the varying aragonite saturation states will be considered” (SWRCB, 2024b). Although this

data framework is not yet being used for full listing and assessment, a 1.4 Ω_a threshold is a strong recommendation which should be further developed and included in the next possible IR.

Oregon's 2024 Integrated Report (see IV.B.) provides a policy basis for the pursuit of 1.4 Ω_a as a benchmark for beneficial use attainment and protection of marine species.

The 2024 California IR does not provide assessment methodologies for hypoxia. Hypoxia is only mentioned in a brief description about the ROMS-BEC model's capabilities to improve understanding of hypoxia-impacted water body conditions (SWRCB, 2024b).

I.D. Goals for California OAH Policy

In its 2022 Strategic Work Plan, the SWRCB stated its goal of scoping an Ocean Plan amendment including water quality objectives and a program of implementation to address OAH for the first time, with a specific focus on the effects of anthropogenic sources of nutrients in ocean waters (SWRCB, 2022). This goal was labeled 2.2.3 under the broader scope of section "2.2. Ensure surface water quality and management protects fish, wildlife, recreation, and other beneficial uses" (SWRCB, 2022). In the 2023 Strategic Work Plan, this goal was updated to include that SWRCB will update the Clean Water State Revolving Fund Policy "to incentivize nutrient removal for projects that discharge to the ocean" and the Water Recycling Funding Program Guidelines "to incentivize elimination of ocean discharges" (SWRCB, 2023b). In the 2024 Draft Strategic Work Plan, this goal is carried over under section "2: Protect and restore watersheds, marine waters, and ecosystems" (SWRCB, 2024a). The language about updating funding programs to incentivize nutrient removal is removed; instead, the 2024 Work Plan includes the goal of initiating an "investigation of feasibility of nutrient removal at wastewater

treatment plants that discharge to the ocean” on top of the initial 2022 Work Plan goal (SWRCB, 2024a).

SWRCB marked the issue of OAH as a top five high priority project in the 2019 Ocean Plan Triennial Review (SWRCB, 2019b). The estimated resources required to achieve this goal as listed in the Review would be 0.5 personnel years to participate in the ongoing research into OAH and 3 personnel years to develop an Ocean Plan amendment (SWRCB, 2019b).

The timeline for this goal of developing an Ocean Plan amendment was last updated on May 23, 2024 on SWRCB’s website. SWRCB currently lists a goal adoption date for the amendment of December 15, 2026, with the amendment set to be opened for public comment by December 30, 2025 (SWRCB, n.d.-b). It is important to note that prior to the two most recent updates to this timeline, the previous goal for this amendment (as outlined in the November 7, 2023 update to the SWRCB website) was to have an amendment adopted by December 16, 2025, and a public comment release date at the end of 2024.

II. Clean Water Act

II.A. NPDES and Secondary Treatment Standards

The Clean Water Act (CWA) acts as the foundation from which OAH policy has been built in the United States. The CWA outlines a goal of water quality “which provides for the protection and propagation of fish, shellfish, and wildlife” (Clean Water Act, 1972). Upon its passage into law in 1972, the Clean Water Act established a National Pollutant Discharge Elimination System (NPDES) permitting program that mitigates water pollution by enforcing the regulation and monitoring of point source discharges into the waterways of the United States. Sewage treatment plants, or Publicly Owned Treatment Works (POTWs), are point sources that

discharge wastewater from commercial, residential, and industrial facilities, including municipal sewage, and are required to have a NPDES permit to do so. The NPDES permit writer's manual lays out "Effluent Guidelines" that generally place upper limit bounds on the amount (mass or concentration) of a pollutant that can be discharged into Waters of the United States.

Technology-based effluent limitations (TBELs) for POTWs require secondary treatment standards for all municipal wastewater treatment plants under CWA section 301(b)(1)(B) (EPA, 2010). Secondary treatment couples physical (primary) and biological (secondary) processes to remove impurities from wastewater via filtration, settling, and aeration. Secondary treatment standards remain critical to maintaining water quality necessary to protect beneficial uses.

It is important to note that secondary treatment standards do not include requirements for nutrients. Thus, any effluent limitations on nutrients enacted by states in NPDES permits for POTWs would be based on water quality standards or state performance standards rather than Clean Water Act technology standards. The CWA and NPDES regulations include provisions for developing case-by-case technology-based effluent limitations in situations where EPA's effluent guidelines are inapplicable; in such cases, states have the ability to develop requirements in addition to or that go beyond the Clean Water Act standards. One scenario in which EPA's promulgated effluent guidelines are inapplicable is when EPA did not consider the specific pollutant of concern in its secondary treatment standards. Given that EPA did not consider nutrients in its secondary treatment standards, states are allowed to determine TBELs for nutrients that cause OAH processes on a case-by-case basis without preempting the Clean Water Act by doing so.

II.B. The Gold Book and pH Criteria

In 1986, the EPA published its updated Quality Criteria for Water, also known as the “Gold Book”, which includes pH criteria for oceans; since 1986, no updates have been made to this criteria (Arce, 2016). The current criteria as established in the Gold Book outline a range of 6.5-8.5 pH for marine aquatic life. The Gold Book specifies that for open ocean waters with a depth substantially greater than that of the euphotic zone, the pH should not be changed more than 0.2 units outside of the naturally occurring variation in that region, and in any case should be outside of the range of 6.5 to 8.5 (Office of Water Regulations and Standards, 1986).

However, shallow, productive coastal and estuarine waters are regulated under the criteria set for freshwater, and thus are allowed a broader 6.5 to 9.0 pH range. In addition, coastal and estuarine waters are not held to less than 0.2 units of variation, as there is more naturally occurring variation of pH in coastal waters that often exceeds this 0.2 unit limit (Office of Water Regulations and Standards, 1986). For treatment plant and sewage discharge regulation, the Gold Book states that “rapid pH fluctuations that are caused by waste discharges should be avoided” in coastal waters (Office of Water Regulations and Standards, 1986). These water quality standards for marine aquatic life and coastal waters are currently the only federal basis for pH levels in ocean waters.

There is strong evidence that the water quality standards established by the Gold Book are far too broad to prevent the effects of ocean acidification from harming marine life. Many marine species including decapods and echinoderms, experience negative effects of ocean acidification within the broad range of 6.5-8.5 pH outlined in the Gold Book. As explained in the Biological Impacts section of this report, coccolithophores, Dungeness crabs, krill, and echinoderms start to see significant impacts at pH values of 7.83, 7.75, 7.70, and 7.63 respectively. SCCWRP reports that a protective pH threshold range of 7.6-7.9, based on

pteropods, decapods, and echinoderms, is ideal for most species (State of Science, 2021). Thus, the pH ranges outlined by EPA for both open waters and coastal waters are too broad to prevent biological harms from occurring to many species.

II.C. Limitations and Litigation of the Clean Water Act

The limitations of this pH quality range has resulted in legal action, the outcomes of which have implications for policy moving forward. In 2007, the Center for Biological Diversity (CBD) formally petitioned the EPA to strengthen the national recommended water quality criterion for ocean pH and provide guidance for states regarding ocean acidification. The EPA eventually decided against doing so, stating that there is insufficient data regarding ocean acidification and “normal” marine pH values vary across the nation (Craig, 2015). Nevertheless, the CBD readjusted their ocean acidification litigatory efforts onto Section 303(d) of the Clean Water Act, which identifies impaired waters and beneficial uses in receiving waters which can lead to the development of total maximum daily loads (TMDLs), the maximum amount of a pollutant allowed to enter a body of water whilst continuing to meet water quality standards . Under this section, each state must develop TMDLs for all of the water bodies on their EPA-approved list of impaired waters (EPA, 2023).

In *Center for Biological Diversity v. EPA* (2009), the CBD argued against the EPA's approvable of Washington state's list of impaired waters. The main argument for this case was that Washington had failed to list their ocean waters as impaired despite ocean acidification causing the pH to drop below permitted water quality standards. As part of the case settlement, the EPA determined that “waters impaired by ocean acidification should be identified on the list as required by Section 303(d) of the Clean Water Act” by states (Arce, 2016). *CBD v. EPA* is the

most emblematic case of ocean acidification litigation within the United States, yet it still falls short of strong federal regulation against ocean acidification. This litigation opened the door for the TMDL program to be used by states as an abatement tool against OA. However, because the EPA recognizes that most states do not have the proper data or monitoring resources to determine their “normal” ocean pH, it has been unable or unwilling to develop a TMDL for ocean acidification (Craig, 2015). This limitation is reflected in current 303(d) listings for ocean acidification. For example, in Oregon’s 2024 303(d) listings, OA-impaired waters are categorized under Sub-Category 5C (impaired by climate change) and Category 3 and 3B (insufficient data and/or possible concern), and the 303(d) methodology does not identify a pollutant to be mitigated through TMDLs (Oregon DEQ, 2024). Despite the progress legal action has made in expanding 303(d) listings and the TMDL program to include OA, the EPA’s guidelines for including OA in 303(d) listings do not provide strong enough support for mitigation of ocean acidification.

II.D. 303(d) and 305(b) Listing

303(d) listings and 305(b) listings, pursuant to Section 303(d) and Section 305(b) of the Clean Water Act, serve as the basis for the Integrated Reports released by states to obtain water quality standards. EPA requires states to provide 303(d) listings, or “a list of impaired and threatened waters still requiring TMDLs” with identification of the impairing pollutant(s) and a priority ranking of these waters, “including waters targeted for TMDL development within the next two years”, by April 1 of every even-numbered year (US EPA, 2006). In addition, states must submit by April 1 of every even-numbered year “the water quality of all waters of the state” under Section 305(b), which includes the water quality of ocean waters (US EPA, 2006).

The EPA advocates for a five-category system of 303(d) and 305(b) listing of state waters. Under EPA's categorization system, only placement into Category 5, which indicates that "available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed", means that a water body is 303(d) listed; other categories serve to provide descriptions of water quality as required by Section 305(b) of the Clean Water Act (US EPA, 2006).

States produce categorizations which are based on the five recommended categories provided by EPA. However, they are not required to make their categorizations identical to that of EPA. For example, in California, placement into Categories 4A and 4B—categories which indicate that a water body is impaired but have a TMDL or other regulatory program in place that is expected to get the water body to full attainment of standards—denotes that water bodies will be 303(d) listed in addition to water bodies in Category 5 (SWRCB, 2024b). However, the US EPA will only consider those water bodies which are impaired and need a TMDL, or Category 5 waters, when approving California's 303(d) listings. Further individual state categorizations with variation from the EPA recommendations are described in their respective policy sections as needed.

As explained above, Category 5, which constitutes the 303(d) list, is the category for water bodies which are impaired or threatened and are in need of a TMDL. The remaining four categories under the EPA categorization system are as follows. Category 1 indicates that all designated uses are supported, and no use is threatened within a water body (US EPA, 2006). Placement into Category 2 means that available data and/or information for a water body indicate that some, but not all of the designated uses of that water are supported (US EPA, 2006). Category 3 placement indicates that there is insufficient available data for a water body to make

a use support determination (US EPA, 2006). Category 4 designation means that available data and/or information indicate that “at least one designated use is not being supported or is threatened, but a TMDL is not needed” (US EPA, 2006). As explained in section III.B. of this report, this category can mean that a TMDL is not needed because EPA already approved a TMDL for the pollutant (Washington State Department of Ecology, 2023). Therefore, water bodies can be moved from Category 5 (impaired and in need of a TMDL) to Category 4 (impaired but does not need a TMDL) once a TMDL has been developed and approved by EPA for the impairing pollutant(s).

III. Washington State Policies

III.A. Expansive Regulatory Efforts

Washington State followed a similar path to Oregon in its steps to measure and mitigate OAH. Washington’s authoritative voice on ocean acidification, called the Blue Ribbon Panel, published its flagship report titled “Ocean Acidification: From Knowledge to Action” in 2012. This document was a first-of-its-kind strategic response to OAH, and has since been updated with an addendum by the Washington Marine Resources Advisory council in 2017. The report lists 42 actions, including 18 Key Early Actions, aimed at “[increasing] Washington’s capacity to understand, reduce, remediate, and where possible adapt to the consequences of ocean acidification” (Blue Ribbon Panel, 2012). These recommendations go deeper than Oregon’s Action Plan into land-based contributions to ocean acidification. Specifically, Chapter 5 of Washington’s 2012 Plan highlights two strategies: first, “strengthen and augment existing pollutant reduction actions to reduce nutrients and organic carbon” and second, “impose stringent controls to reduce and limit nutrients and organic carbon from sources that are

contributing significantly to acidification of Washington's marine waters" (Blue Ribbon Panel, 2012). This verbiage crucially mentions contributions from land-based point sources, making it the strongest lever in any state OAH Plan discussed heretofore for targeting outflow from water treatment plants.

Washington State has made substantial headway towards its goal of limiting nutrients that are causing acidification and harmful algal blooms. Most notably, the Puget Sound Nutrient Source Reduction Project is a collaborative effort between Tribes and Puget Sound stakeholders who are "using the latest science to find the right solutions for regional investments to control nutrients from point and non-point sources" (Department of Ecology, n.d.). The project utilizes decades of water quality monitoring data and modeling tools to analyze relationships between observed poor water quality and nutrient sources both near and far away. Specifically, the Puget Sound Nutrient Source Reduction Project utilizes the Salish Sea Model to guide its analysis of the impacts of anthropogenic nutrient inputs on Washington waters. The Salish Sea Model found that increased dissolved inorganic nitrogen (DIN) and phytoplankton biomass "caused by regional anthropogenic nutrient sources can significantly contribute to acidification in the Salish Sea", and projects that nitrogen inputs from marine point sources and watershed inflows would cause increased dissolved oxygen depletion through 2070 (Pelletier et al., 2017; Roberts et al., 2014). The model incorporates nutrient inputs from 99 point sources, mostly municipal wastewater treatment plants (WWTPs), in the United States and Canada. According to the Washington State Department of Ecology, "modeling results have confirmed that human sources of nutrients are leading to dissolved oxygen problems in many parts of Puget Sound" (Puget Sound Nutrient General Permit). This powerful tool allows scientists and policymakers to prioritize OAH actions in order of maximum nutrient reduction.

III.B. Washington State 303(d) Listing

Washington addresses dissolved oxygen concentrations and pH thresholds in its Water Quality Assessment Listing Methodology to Meet Clean Water Act Requirements, which was finalized by the Washington State Department of Ecology in March 2023.

For pH, outlined in section 2E of their Assessment Listing Methodology, Washington utilizes a hypergeometric test which assesses whether a water body is impaired based on exceedances of the pH criteria. Under this hypergeometric test, the “allowable” criterion exceedance rate is 5%—in other words, for a given year, if 5% of the days with recorded pH measurements exceed the pH criterion, then Washington assumes that this indicates aquatic life use is impaired (Washington State Department of Ecology, 2023). The actual number of exceedances allowed varies based on the number of samples collected given this 5% rule. Washington places water bodies in Category 5 (indicating impairment) for pH if the hypergeometric test is failed in “one or more calendar years based on time series data or two or more calendar years based on discrete data”, where time series data is “continuous” monitoring data that is preferred for assessment because it demonstrates how pH changes throughout the day, and discrete measurements are single, instantaneous measurements (Washington State Department of Ecology, 2023). Washington will also place a water body into Category 5 if the hypergeometric test requirements are not met but large deviations from the pH criterion magnitude are observed, and when two or more days have pH values below 6.5 or above 9.0 for marine waters (Washington State Department of Ecology, 2023). The Department of Ecology states that they prioritize and schedule water bodies “placed in Category 5 for TMDL studies or other cleanup plans to address the impairment” (Washington State Department of Ecology,

2023). A TMDL has not yet been approved by the EPA for pH, which means that pH-impaired waters cannot currently be moved into Category 4A (which is the category indicating that there is a TMDL approved by EPA to address the impairment). However, Washington states that they will move pH-impaired waters from Category 5 to Category 4A if and when the EPA approves a TMDL to address pH (Washington State Department of Ecology, 2023). While Washington utilizing pH for ocean acidification assessment is acceptable given that the Salish Sea is shallower and better suited for pH measurement as a result, California's coast, which is extremely varied in depth, is better suited for 303(d) listing assessment based off of aragonite saturation state, a framework for which exists in Oregon's 2024 Integrated Report draft methodology (see section IV.B of the Policy section of this report for an extensive explanation of this framework).

Dissolved oxygen is similarly assessed under Washington's methodologies, with the hypergeometric test with an allowance of 5% criterion exceedance rate used to assess impairment (Washington State Department of Ecology, 2023). Water bodies are placed into Category 5 (impairment) when they exceed DO criteria based on time series/monitoring data during one calendar year or if they exceed the criteria based on discrete data for two calendar years. Water bodies will also be placed into Category 5 if marine waters are measured to have two or more days with a verifiable DO value below 4.0 mg L, which is the Fair Quality, or least stringent, marine DO criterion under Washington's water quality standards (Washington State Department of Ecology, 2023). As is true for pH-impaired waters, DO-impaired waters cannot be placed under Category 4A because the EPA has not yet approved a TMDL for DO; thus, until the EPA approves a TMDL for dissolved oxygen, these thresholds will not have an accompanying TMDL and remain only 303(d) listed under Category 5 (impairment).

III.C. Puget Sound Nutrient General Permit

Washington's key action to mitigate nutrient inputs from point sources was establishing a new general permit, called the Puget Sound Nutrient General Permit (PSNGP), which regulates discharges from WWTPs to marine and estuarine waters in Washington. The first permit under this new general permit, which works in conjunction with existing NPDES permits for the WWTPs and is issued by the Department of Ecology, was issued on December 1, 2021, and took effect on January 1, 2022 (Washington State Department of Ecology, n.d.). The PSNGP applies to 58 facilities which discharge into the Puget Sound, including seven major dischargers which contribute 80% of the nutrients discharged there (Washington State Department of Ecology, n.d.). The PSNGP is a function of Washington State's authority under the United States EPA's NPDES permitting program to administer NPDES permits to point sources. According to the fact sheet for the new permit, wastewater discharged into the greater Puget Sound is treated as a point source in 40 Code of Federal Register 122.2, meaning the state can impose more stringent controls if it so chooses. Washington's PSNGP limits the discharge of nutrient pollution from WWTPs into receiving waters. The PSNGP targets total inorganic nitrogen and supersedes any requirements relating to inorganic nitrogen in the existing individual NPDES permits. .

The PSNGP issues 2 types of standards: technology-based standards and surface water quality standards, which include criteria for the protection of aquatic ecosystems and human health (PSNGP Fact Sheet, n.d.). The technology-based standards included in the PSNGP follow the approach of an all known, available and reasonable treatment (AKART) analysis. This approach necessitates that all permittees who must complete a Nutrient Reduction Evaluation (NRE) include an AKART analysis in said NRE to evaluate all "reasonable treatment

alternatives capable of reducing total inorganic nitrogen”, and must present one alternative that represents “the greatest TIN reduction that is reasonably feasible on an annual basis” (Puget Sound Nutrient General Permit, n.d.). Furthermore, the AKART analysis must be sufficiently thorough for an engineering report to be developed for the chosen alternative treatment (Puget Sound Nutrient General Permit, n.d.).

In addition, the NRE analysis must include a selected alternative for achieving an effluent concentration of 3 mg/L TIN. The NRE must also construct viable implementation timelines including funding, design, and construction for both the selected AKART technology and the selected alternative for achieving 3 mg/L TIN (Puget Sound Nutrient General Permit, n.d.). The effluent concentration 3 mg/L TIN represents the “lower limit” of technology in TIN reduction (Puget Sound Nutrient General Permit, n.d.). Washington allows for alternative effluent management strategies, such as reclaimed water being identified for beneficial use, to work as alternative strategies to meet this lower limit requirement (Puget Sound Nutrient General Permit, n.d.). Washington’s requirement for permittees completing NREs to find alternatives that achieve this lower limit of technology for reductions represents an important step in technology-forcing policy regulating the impacts of WWTPs on OAH.

The PSNGP also establishes surface water quality standards for ocean acidification and hypoxia. The PSNGP enacts non-numeric effluent limits for surface water quality standards, citing an EPA regulation which states that non-numeric effluent limits are permitted when “[n]umeric effluent limitations are infeasible” (Puget Sound Nutrient General Permit, n.d.). Washington states that numeric water quality based effluent limits (WQBELs) are not currently possible for nutrient inputs because additional modeling work is necessary to establish numeric WQBELs (PSNGP Fact Sheet, n.d.). In place of a numeric WQBEL, this permit sets forth

requirements for the “optimization of current treatment processes to abate nutrient loads through the permit term”, the use of an action level and treatment performance metrics to “serve as an indicator for optimization success”, and a requirement for dominant nutrient loaders to “pursue additional nutrient reduction actions if the action level is exceeded” (PSNGP Fact Sheet, n.d.). Washington expects that the second iteration of the PSNGP will come after a WQBEL is able to be established, and thus will shift its requirements to working towards compliance with numeric limits (PSNGP Fact Sheet, n.d.).

Washington’s surface water quality criteria is divided into four primary categories, each of which is designed to protect both indigenous fish and non-fish aquatic species in Washington State waters (PSNGP Fact Sheet, n.d.). Waters designated for extraordinary, excellent, and good quality, the highest three categories, account for salmonid and other fish migration and rearing, as well as clam, oyster, mussel, crustaceans, and other shellfish rearing and spawning; poor quality waters must only provide for salmonid and other fish migration (PSNGP Fact Sheet, n.d.). The standards for hypoxia/dissolved oxygen are listed as a lowest 1-day minimum DO criteria for each of the four categories, with a provision to account for natural conditions (PSNGP Fact Sheet, n.d.). For dissolved oxygen 1-day minimums criteria, waters designated for extraordinary quality use have a threshold of 7.0 mg/L DO; waters designated for excellent quality use have a threshold of 6.0 mg/L DO; waters designated for good quality use have a threshold of 5.0 mg/L; and waters designated for fair quality use have a threshold of 4.0 mg/L (PSNGP Fact Sheet, n.d.).

Designated Use	DO Criteria, 1 day min
Extraordinary Quality	7.0 mg/L
Excellent Quality	6.0 mg/L
Good Quality	5.0 mg/L
Fair Quality	4.0 mg/L

Table 8. Marine aquatic life uses and corresponding lowest 1-day minimum DO criteria from Washington State Department of Ecology’s Puget Sound Nutrient General Permit Fact Sheet (PSNGP Fact Sheet, n.d.).

Ultimately, Washington’s state-level permitting program strengthens the federal requirements for treatment of wastewater effluent. This legislation goes beyond the Clean Water Act to protect Washington’s marine habitat from point sources of organic nitrogen. The PSNGP applies to 58 facilities that discharge into the Puget Sound.

The PSNGP is the first permitting stage in the Puget Sound Nutrient Source Reduction Project, an ongoing phased restoration plan which Washington intends to improve water quality in the Salish Sea. The PSNGP is planned to involve numeric effluent limits (WQBELs) during the second permitting stage. The first permit issuance of the PSNGP discussed in this report works to cap existing total nitrogen loads, establish planning and monitoring requirements, and will optimize existing treatment processes for nutrient removal; this phase will end once current permits expire on December 31, 2026 (Bilhimer, 2022). The second permit issuance, which Washington expects during the the range of 2027-2031, will include total nitrogen load targets

and WQBELs for specific WWTPs as well as watershed WWTP actions to be met (Bilhimer, 2022; Keltz, 2024). The third permitting stage, from 2032-2036, will continue to refine the permit, and will possibly incorporate a Nutrient Trading Framework as part of its nitrogen reduction requirements (Keltz, 2024).

As of May 2, 2024, the Department of Ecology reports that the 58 facilities covered by the PSNGP are “now reporting their nitrogen discharges and optimizing their treatment systems”, and notes that while there are some legal challenges to the permit work, “the vast majority of the permit is in effect” (Keltz, 2024). By the end of 2025, all permittees are required to submit a Financial Capability Assessment to the Department of Ecology; the Department is releasing new guidance available summer 2024 to aid in this process (Keltz, 2024). From there, permittees will use the results of their Financial Capability Assessments “to move forward with their facility plans to reduce their nitrogen discharge” (Keltz, 2024). The permit also includes an environmental justice analysis requirement which will be submitted in addition to the Financial Capability Assessment in order to aid in mitigating rate impacts related to nutrient reduction investments at wastewater treatment plants serving environmentally vulnerable communities (Keltz, 2024). However, this requirement only encourages permittees to use the results of the analysis to “consider more equitable approaches to address affordability concerns”, and does not require consideration of these factors (Keltz, 2024). Continual progress updates on the Financial Capability Assessment and environmental justice analysis process as well as nutrient reductions will be shared as the Puget Sound Nutrient Source Reduction Project progresses.

IV. Oregon Policy

IV.A. OAH Council

Oregon's OAH Council, established in 2017, is a critical entity in providing science and policy guidance for Oregon. OAH Council developed Oregon's OAH Action Plan, which is modeled on the same themes as the OA Alliance Action Plan and is updated every six years with key actions that urge state leadership to address and mitigate OAH (Oregon Coordinating Committee, n.d.). The Council also releases a biennial report on OAH conditions, which has been instrumental in informing the state's ocean policy priorities. These frequent reports recently led the Oregon legislature to pass House Bill (HB) 3114, "representing a historic investment in Oregon's efforts to combat ocean acidification and hypoxia", which sets aside \$1.9 million to be distributed by the Ocean Science Trust's grant program for research and monitoring of OAH along Oregon's coasts and estuaries (Juranek et al., 2022; Oregon Department of Fish and Wildlife, 2021).

Oregon's OAH Council has been productive in advancing scientific understanding of changing ocean conditions through monitoring, specifically in two of the state's most important bays: Tillamook Bay and Yaquina Bay. Supported by grant funding, these sites now have a solid foundation in place for a long-term monitoring program that will provide crucial information about ecosystem-level changes in OAH impacted waters (Oregon Council on OAH, Third Biennial Report, 2022). Furthermore, these long-term monitoring programs provide crucial data for the historic baselines necessary for impact assessments of OAH. Observational data of background conditions, which can be provided by monitoring programs, are an important factor in the assessment of dissolved oxygen concentrations and hypoxia impacts under Oregon's 2024 Integrated Report (see IV.B.).

IV.B. 2024 Integrated Report: Ocean Acidification

Oregon's Department of Environmental Quality (DEQ) released its draft assessment methodologies for its 2024 Integrated Report on April 18, 2024, which includes both ocean acidification and hypoxia for the first time. According to the Fact Sheet for the 2024 IR, this assessment methodology will be used to list an ocean area for impairment due to ocean acidification (Oregon DEQ, n.d.). Aragonite/pteropod shell dissolution is the parameter and fish and aquatic life in marine waters is the beneficial use by which OA is assessed for the IR. Ocean acidification methodology in the 2024 IR is based on a hybrid marine biocriteria framework which allows for the individual or combined assessment of biological and chemical metrics depending on data availability, with biologically relevant assessment data used to evaluate impacts (Oregon DEQ, 2024). Within each data type, two benchmarks are utilized for IR categorization: an independently applicable (IA) benchmark, which is a value for which experts have confidence in biological impacts based off of a single data value, and a combined line of evidence (CLOE) benchmark, in which one value indicates biological impact, but must be confirmed through multiple lines of evidence (Oregon DEQ, 2024). DEQ establishes that both biological and chemical data must be collected within the critical period, designated as April-September, in order to be used for assessment.

Aragonite saturation state (Ω_{ar}) is utilized as the basis for the chemical metrics of OA assessment. Oregon utilizes the threshold of $1.2 \Omega_a$ with an uncertainty range of ± 0.2 , as established in McLaughlin et al. (2015), to determine its benchmarks for assessment (Oregon DEQ, 2024). In line with this threshold and uncertainty range, DEQ established its chemical metrics benchmarks at $1.0 \Omega_{ar}$ ($1.2 - 0.2$) for the IA benchmark and $1.4 \Omega_a$ ($1.2 + 0.2$) for the CLOE benchmark.

The biological metric utilized for impairment assessment is the percentage of individuals within a pteropod sample of *L. helicina* with severe shell damage, which is damage that falls under Type II/III dissolution as outlined in Bednaršek et al. (2012) (Oregon DEQ, 2024). DEQ selected 62% individuals with Type II/III dissolution as the IA benchmark and 40% individuals with Type II/III dissolution as its CLOE benchmark. The IA benchmark represents a severe effects/lethality threshold, with about 50% mean survival probability under these conditions (Bednaršek et al., 2012; Oregon DEQ, 2024). To establish its CLOE benchmark, DEQ adapted research from Feely et al. (2016) in which 36-39% Type II/III dissolution was the estimated pre-industrial natural background average dissolution of nearshore waters. Thus, Oregon reasons the CLOE benchmark of 40%, which is slightly higher than the high end of background dissolution, both accounts for variability in natural response and could indicate impairment when combined with chemical metrics (Oregon DEQ, 2024).

However, Feely et al. (2016) found that the average pre-industrial value for dissolution was 23.5%, calculated from the 36-39% cited above found in nearshore waters and 8-12% individuals with severe dissolution in offshore waters. A study by Bednaršek et al. (2014) found that the pre-industrial average for *L. helicina* pteropods with severe shell dissolution along the California-Oregon-Washington coast was 18%, which correlates with the 23.5% average found in Feely et al. (2016) more so than the 40% pre-industrial value utilized by DEQ. Under DEQ's current 40% CLOE benchmark, offshore waters, which increased from 8% and 12% severe dissolution to 34% and 37% in 2011 and 2013, would not be marked as Category 3B/potentially concerning despite the increased potential for species-specific and ecological harms associated with such a stark increase in dissolution (Feely et al., 2016). Furthermore, the 40% Type II/Type

III dissolution standard allows for a percentage of individuals with severe shell dissolution that is nearly double the 23.5% average found in Feely et al. (2016).

In addition, Oregon's 62% Type II/Type III IA dissolution threshold allows for significant increases in high dissolution levels without indicating impairment. Feely et al. (2016) indicates a 19% increase across all nearshore waters in percent individuals with severe shell dissolution from pre-industrial time to 2011 and 2013. Even after these significant increases in percent individuals with severe shell dissolution in nearshore waters, from 36 and 39% pre-industrial to 56 and 58% in 2013 and 2011 respectively, nearshore waters with 56-58% dissolution would still fall below Oregon's 62% IA threshold (Feely et al., 2016). This indicated a significant limitation in the assessment methodology's ability to assess severe dissolution increases since pre-industrial times. Therefore, Oregon's thresholds fail to prevent harms and dissolution increases caused by anthropogenic acidification and dissolution. At minimum, the CLOE benchmark must be strengthened in accordance with the findings of Feely et al. (2016) to a threshold of 23.5% in order to serve as an impactful benchmark for OA assessment.

Oregon's DEQ will be categorizing water bodies into Category 3 (insufficient data), Category 3B (insufficient data; potential concern) and Category 5C (impaired; climate change related) for OA assessment from its 2024 IR methodologies. Oregon notes that it will not determine biocriteria attainment (Category 2) from its 2024 IR methodologies due to "uncertainty in the level of protection provided by the current CLOE benchmarks" (Oregon DEQ, 2024). Under current methodologies, water bodies with $\leq 1.0 \Omega_{ar}$ and $\geq 62\%$ pteropods with severe shell dissolution, or $\leq 1.4 \Omega_{ar}$ and $\geq 40\%$ pteropods with

severe shell dissolution are categorized under Category 5. Water bodies with $\leq 1.4 \Omega_a$ and water bodies with $\geq 40\%$ pteropods with shell dissolution are categorized under Category 3B (potential concern) if the necessary biological or chemical metrics data is not available to meet a CLOE benchmark (Oregon DEQ, 2024).

		Aragonite Saturation State (Ω_{ar})			
		No data	> 1.4	≤ 1.4 (CLOE)	≤ 1.0 (IA)
	No data	No assessment	Category 3 (insufficient data)	Category 3B (potential concern)	Category 5 (IA - Chem)
% pteropods with severe shell dissolution	< 40	Category 3 (insufficient data)	Category 3 (insufficient data)		
	≥ 40 (CLOE)	Category 3B (potential concern)		Category 5 (CLOE)	
	≥ 62 (IA)	Category 5 (IA – Bio)			

Table 9. Marine biocriteria hybrid assessment framework for ocean acidification outlining category assignments based on biological and/or chemical data. From the Oregon Department of Environmental Quality, Assessment Methodology for Oregon’s 2024 Integrated Report (Oregon DEQ, 2024).

A weakness of Oregon’s IR methodology for OA is that it does not identify a specific pollutant which should be addressed by a TMDL or other point and nonpoint source controls, making enforcement of water body recovery from OA impacts difficult to pursue. Furthermore, Oregon acknowledges that broader approaches than the traditional TMDL approach or restricting permitted discharges may be necessary to find effective solutions to increasing ocean acidification, but does not provide concrete actions which will be used to mitigate OA further than 303(d) listing (Oregon DEQ, 2024). 303(d) listing of ocean acidification alone will not

combat OA impacts, making Oregon's overall approach to OA mitigation through IR assessment and 303(d) listing weak without implementation methods for mitigation. Identifying specific pollutants and creating a TMDL for dischargers of those pollutants which contribute to OA would be a crucial step in Oregon actually mitigating OA inputs and impacts. Strategies for producing TMDLs may be added to Oregon's finalized assessment methodology for the 2024 IR; the finalized methodology will be released sometime after June 17, 2024, when the commentary period on the current draft methodology closes.

IV.C. 2024 Integrated Report: Hypoxia

To assess hypoxia impacts, DEQ introduced a methodology in the 2024 IR utilizing dissolved oxygen as a parameter and fish and aquatic life in marine waters as the beneficial use for marine dissolved oxygen assessments. DEQ proposes a hybrid framework using two lines of evidence to assess beneficial use support, where one line of evidence quantifies reasonable measurable reduction in DO by comparing observational data with background conditions and the second uses established DO biological thresholds to determine if biological harms are occurring due to measurable DO reductions.

DEQ sets the biological numeric benchmark at 1.4 ml L⁻¹ or 2.0 mg L⁻¹ DO (Oregon DEQ, 2024). While it is true that severe biological harms occur under these hypoxic conditions, and 2.0 mg L⁻¹ is the defined DO concentration at which hypoxic events occur, there are numerous of studies that indicate that this threshold is far too low to prevent lethal and sublethal impacts across marine species (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021). For example, biological harms occur at as high as 5.5 mg L⁻¹ DO for sea urchins, 4.1 mg L⁻¹ DO for rockfish, and 3.5 mg L⁻¹ DO for echinoderms,

demonstrating the weakness of 2.0 mg L⁻¹ DO as a numeric benchmark to protect fish and aquatic life (Flannery & Bjorkstedt, 2024, Hamilton et al., 2019, Low & Micheli, 2018; 2020, Sampaio et al., 2021). More information on the range of sublethal and lethal harms experienced by various species and taxa is explained in the Biological Impacts section of this report.

Similar to the categorization for ocean acidification assessment, hypoxia-impaired water bodies will also be categorized under Categories 3, 3B and 5, specifically Sub-Category 5C, through the application of these methodologies. Water bodies with ≤ 1.4 ml L⁻¹ (2.0 mg L⁻¹) DO and either an observational or modeled deviation from the background conditions will be categorized under Sub-Category 5C, indicating that these are water bodies impaired by climate change. Waters with ≤ 1.4 ml L⁻¹ (2.0 mg L⁻¹) DO and no observed deviation from background, and waters with > 1.4 ml L⁻¹ (2.0 mg L⁻¹) DO and a modeled or observed deviation from background will be categorized as Category 3B, denoting potential concern. Extensive research that indicates lethal and sublethal harms occur at DO concentrations higher than 2.0 mg L⁻¹, and argues that this threshold should be raised to better protect marine life (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021). As a result, the assessment methodology proposed by Oregon DEQ will likely not accurately portray or, when used to regulate, prevent harms across marine life, thus impairing the beneficial use which this methodology attempts to protect. Therefore, a threshold of 2.0 mg L⁻¹ would not be appropriate for OAH mitigation in California, as there is extensive data demonstrating that marine species have sensitivity at values far above this threshold (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021).

V. Policy Recommendations

This report strongly recommends the implementation of technology-based effluent limitations (TBELs) in order to regulate nutrient inputs contributing to OAH impacts. This TBEL, implemented as an amendment to California's Ocean Plan in 2025 or 2026 at the latest, should require total nitrogen outputs to be reduced to an effluent concentration of 5 mg L⁻¹ total nitrogen for coastal treatment plants with a rated plant capacity larger than 20 MGD and effluent concentrations of 10 mg L⁻¹ TN for treatment plants with a rated plant capacity of 20 MGD and smaller. This report recommends the TBEL approach based on the success of the Clean Water Act's standardization of full secondary treatment in 1972, and the success of once through cooling technology based standards for California's coastal power plants (SWRCB, 2023a). All WWTPs must reduce their discharge effluent concentration to 10 mg L⁻¹ or less of TN to ensure protection of marine waters, and must pursue tertiary treatment if necessary to treat wastewater to this level of reductions.

20 MGD rated plant capacity was selected as the cutoff for large versus small plant thresholds because there are disproportionately high cost impacts per gallon of water treated on WWTPs with capacities less than 20 MGD, which may impact the strategies necessary to ensure these technologies can be implemented. These price discrepancies for smaller plants are depicted in the cost curves in Figures 11, 12, and 13 in the Technologies section of this report. The differing thresholds are also due to the greater impact that discharge from higher-volume WWTPs have on ocean acidification and hypoxia processes, which necessitates a more strict reduction goal to combat the urgent and growing issues of OAH. Recognizing the challenges facing smaller WWTPs, this report recommends including site-specific and community

economic considerations be taken into account when developing policy for regulating WWTPs with a rated plant capacity of 20 MGD or less.

Furthermore, our strong recommendation for a TBEL was based on economic analyses of engineering performance and technology capabilities which utilized TN and volume treated as the nitrogen metrics for examining economic feasibility. As such, this report recommends TN as the nitrogen parameter for TBEL development. The thorough research and background information which informed these recommendations, is available in the Technologies section of this report, including technological information based on TN values, recommended technologies, explanations of plant size benchmarks, and descriptions of different technology capabilities.

V.A. Ocean Acidification

V.A.I. Biological Metrics

This report recommends pteropods be used as an indicator species for ocean acidification regulation and thresholds. The best available research on ocean acidification impacts is available for pteropods, as there is extensive literature and research investigating the impacts of ocean acidification on pteropods and thresholds at which pteropods are impacted by OAH (Bednaršek et al., 2019; Feely et al., 2024). We recommend utilizing Dungeness crab larvae as an additional indicator species, particularly because Dungeness crabs are a highly popular fishery species in California and because their larvae are sensitive to the impacts of OA (Bednaršek et al., 2020). Thus, Dungeness crab larvae serve as an excellent indicator for both the economic and biological productivity of the California coast.

V.A.II. Chemical Metrics

This report strongly recommends an aragonite saturation state of 1.4 ($1.4 \Omega_{\text{ar}}$) as the benchmark for biological impact assessment when determining beneficial uses in ocean waters. In Bednaršek et al. (2019), an expert panel agreed upon a set laboratory-based threshold for pteropods at $1.2 \Omega_{\text{ar}}$, with $1.5 \Omega_{\text{ar}}$ serving as an early warning for OA impacts. At minimum, a $1.4 \Omega_{\text{ar}}$ threshold is necessary to ensure protection for marine life; this benchmark is based on an established $1.2 \Omega_{\text{ar}}$ threshold at which impacts occur to marine life, including the ± 0.2 uncertainty range as determined by McLaughlin et al. (2015) and has policy basis, as it is included in California's 2024 Integrated Report as the potential threshold for OA assessment.

The $1.4 \Omega_{\text{ar}}$ threshold should be implemented as a geometric monthly mean threshold. Effects at this threshold have been demonstrated to occur after 14 days of exposure (Bednaršek et al., 2019). Longer monthly exposure may require a higher threshold value; however, no current information is available for a threshold of 30 days of exposure specifically. Therefore, the demonstrated threshold of $1.4 \Omega_{\text{ar}}$ for 14 days was utilized for the determination of the recommended monthly geometric mean threshold. In order to prevent acute impacts, a maximum single day threshold value of $0.90\text{--}1.0 \Omega_{\text{ar}}$ should be considered. A threshold of $1.0 \Omega_{\text{ar}}$ as an indicator for impairment in conjunction with a $1.4 \Omega_{\text{ar}}$ impairment threshold has policy precedent in Oregon's 2024 Draft IR, where $1.0 \Omega_{\text{ar}}$ is utilized as the independently applicable benchmark to indicate OA impairment of beneficial uses.

Utilizing aragonite saturation state instead of pH as a benchmark for OA thresholds serves as a better indicator and thus protector of the health of marine life (Bednaršek et al., 2019). However, it is important to note that the vast majority of information and studies concerned with OA impacts are conducted using pH. Nonetheless, research conducted for OA thresholds in pH values can be converted to aragonite saturation state for further support for

these recommendations. Extensive explanation of biological and chemical metric recommendations, including conversions of pH into aragonite saturation states which support a 1.4 Ω_{ar} benchmark, are included in the Biological and Ecosystem Impacts section of this report.

V.B. Hypoxia

In order to mitigate hypoxic impacts and protect beneficial uses in California waters, this report recommends a temperature dependent threshold for dissolved oxygen due to the critical impact of temperature on dissolved oxygen, as determined by Vaquer-Sunyer & Duarte (2010) and Penn & Deutsch (2024). As explained in the Biological and Ecosystem Impacts section of this report, hypoxia tolerance values calculated for key indicator species across a set of temperature ranges can be converted to DO concentrations, which produces thresholds corresponding to the set water temperatures; methodology for calculating hypoxia tolerance is explained in Deutsch et al. (2020). This method of threshold determination would provide better protection for ecosystems and marine life, as it considers the significant impact that temperature has on dissolved oxygen and organism metabolic rate.

This report utilizes sea urchins, crustaceans, and northern anchovies to best establish a protective DO threshold for California. The species and taxa above provided an initial range of 5.5 mg L⁻¹ to 5.0 mg L⁻¹ DO thresholds (Howard et al., 2020; Ho et al., 2023). This range was then specified with a focus on the indicator species of northern anchovies due to northern anchovies' importance in the California economy and ecosystem as well as expert consensus about the importance of northern anchovies in DO thresholds (Howard et al., 2020; Ho et al., 2023). Utilizing northern anchovies could allow for a temperature-dependent threshold in line with the findings of Vaquer-Sunyer & Duarte (2010) and Penn & Deutsch (2024). Thresholds

based on temperature intervals of 2.5 °C are listed in Table 2 of the Biological and Ecosystem Impacts section of this report, and are as follows: a threshold of 5.35 mg L⁻¹ at ≤ 7.5 °C, 5.86 mg L⁻¹ at 10.0-7.5 °C, 6.42 mg L⁻¹ at 12.5-10.0 °C, and 7.03 mg L⁻¹ at 15.0-12.5 °C. These thresholds will also prevent significant sublethal effects on rockfish, sea urchins, and other taxonomic groups of California marine species as discussed in the Biological and Ecosystem Impacts section of this report, which is important given that the policy language should be written in a way that protects both a broad range of species and particularly the most sensitive taxa (Vaquer-Sunyer & Duarte, 2008, Flannery & Bjorkstedt, 2024, Hamilton et al., 2019). This temperature-dependent method would be better suited to protect ecosystems due to it encompassing the significant impacts of temperature.

Recognizing that non-temperature dependent thresholds are the current normal in hypoxia policy, this report recommends utilizing the lower bound of the temperature-dependent thresholds listed above, 5.35 mg L⁻¹ DO concentration, if a non-temperature dependent threshold is pursued. This general threshold based on temperature-dependent calculations would provide protection against critical sublethal and lethal effects in nearly every situation for most marine species.

The DO threshold should be implemented as a geometric monthly mean threshold. This time scale recommendation is based on the longer term impacts of low DO concentrations on sea urchins, as well as previously discussed northern anchovy thresholds which correspond to monthly exposure (Low & Micheli, 2020; Deutsch et al. 2020, Howard et al., 2020). A maximum single day threshold value was not determined within this report; however, one should still be considered to protect marine species. Based on the literature reviewed in this report, a possible range for the single day threshold could be 2.0–3.0 mg L⁻¹ DO, given that these values

are below lethal effects for the majority of marine species and fall into the widely accepted range of what constitutes hypoxia events (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021). Extensive detail on the research on and determination of hypoxia thresholds as well as the impacts on marine life at various DO concentrations and temperatures can be found in the Biological and Ecosystem Impacts section of this report.

V.C. 303(d) Listing and TMDLs

Though the TMDL program and 303(d) listings are important tools in leveraging the Clean Water Act to mitigate OAH, the slow pace of TMDL compliance demonstrates the necessity of technology-based standards in order to mitigate OAH within the coming decade. As acknowledged by the EPA, the process of TMDL development, TMDL implementation, and impaired waters recovery often takes many years (Impaired Waters Restoration Process 2023). Given the SWRCB's near-future goals for an Ocean Plan Amendment to address OAH and the pressing urgency of mitigating climate change impacts, a technology-forcing policy which would enact change more quickly than a TMDL approach is in line with the State's goals, and would prevent harms from OAH sooner than a TMDL approach. OAH processes are accelerating given increasing atmospheric greenhouse gas concentrations and the worsening of climate change around the world, making the issue of addressing OAH along California's coast a matter of urgency and necessity. To address this issue with the urgency it necessitates, this report strongly recommend a technology-based effluent limitations amendment to the Ocean Plan to be the primary focus of OAH policy in California

However, acknowledging that the TMDL approach is still a useful component in upholding water quality standards and a necessary backstop to ensure attainment of the Ocean Plan's beneficial uses, recommendations for pursuing a TMDL approach are as follows. Oregon's approach to ocean acidification assessment as explained in their 2024 Integrated Report, if modified, will serve as the framework for OA assessment in California. Oregon produced a strong framework for aragonite saturation assessment for OA in its 2024 Integrated Report. Oregon established an aragonite saturation state benchmark of $1.2 \pm 0.2 \Omega_{ar}$ to determine OA impairment, with the lower bound of $1.0 \Omega_{ar}$ designating the independently applicable benchmark for categorization as impaired (under Sub-Category 5) and the upper bound of $1.4 \Omega_{ar}$ indicating potential concern (Category 3B) if alone and impairment (Sub-Category 5C) if combined lines of evidence with dissolution metrics indicate impairment (Oregon DEQ, 2024). This style of framework could be replicated in California's assessment methodologies, especially given that California's 2024 IR already set a threshold of $1.4 \Omega_{ar}$ as categorizing waters under Category 3, which indicates potential concern (SWRCB, 2024b). However, enough research has been done on pteropods and aragonite saturation states alone that aragonite saturation states should act as an independent indicator of impairment; the percent of individuals with severe shell dissolution should not have to be utilized alongside this data as proof of impairment. Furthermore, California should maintain pursuit of the $1.4 \Omega_{ar}$ as its threshold, and, if pursuing upper and lower bound thresholds as seen in Oregon, should maintain $1.2 \Omega_{ar}$ as the lower bound at which water bodies are automatically qualified as impaired.

If California determines to pursue pteropod dissolution standards as part of the assessment process, the state should pursue stronger dissolution standards than Oregon includes in its 2024 IR. Oregon's draft assessment methodology sets its lower bound benchmark at 40%

individuals of pteropods with severe (Type II/Type III) shell dissolution; however, research indicates that this is far above the pre-industrial average, and thus will allow major increases in individuals with severe shell dissolution which could be prevented with a lower, more protective benchmark. Thus, this report recommends a protective pteropod dissolution threshold based on the demonstrated pre-industrial average of 23.5% individuals with severe dissolution that was found in Feely et al. (2016).

California should also implement stronger assessment methodologies for hypoxia than Oregon. Oregon's current benchmark of a 2.0 mg L⁻¹ DO concentration is significantly lower than levels at which many species experience lethal impacts and sub-lethal impacts; as a result, several studies argue that 2.0 mg L⁻¹ DO threshold is an inadequate measurement of hypoxia, and that this threshold should be raised to better protect the marine environment (Vaquer-Sunyer & Duarte, 2008; Steckbauer et al., 2011; Breitburg et al., 2018; Sampaio et al., 2021). Based on this latest research, this report recommends raising the DO threshold to 5.35 mg L⁻¹ DO, a threshold calculated based on northern anchovies, a species of economic and environmental importance to the California Coast.

California's approach to assessment of OA impairment must go beyond Oregon's methodologies, particularly in terms of solutions beyond 303(d) listing. Given the urgency of addressing climate change impacts, including ocean acidification, solutions to address OA impairment, such as TMDLs, must be included in order to make 303(d) listing effective in protecting marine waters. California must notate a pollutant to be restricted by TMDLs, which is a step towards water quality attainment that Oregon fails to take. This report finds that the pollutant to be regulated should be TN inputs from WWTPs. Furthermore, due to the growing spatial and temporal impacts of OAH, California must act fast towards mitigating OAH, which

means the development of regulations, policy and potentially legislation beyond that of the 303(d) list and TMDLs. Technology-based effluent limitations, established as an amendment to the Ocean Plan, would prevent the lack of implementation strategies that befall water bodies that have only been 303(d) listed and thus would expedite the process of remedying anthropogenic inputs which are causing ocean acidification and hypoxia.

VI. Priority Recommendations

Outlined below are recommendations for priority items that this report finds necessary to address ocean acidification and hypoxia in California in a swift, strong manner which matches the expansion and urgency of the OAH issue. The priorities identified by this report are as follows:

- Further research on the differing impacts on marine life, ocean acidity, and dissolved oxygen concentrations of varied total nitrogen effluent concentrations, specifically of 3, 5, 8, and 10 mg L⁻¹ TN and of 85% or greater nitrogen reduction values at varied discharge volumes.
- Implementation of a precautionary 5 mg L⁻¹ TN effluent discharge concentration at WWTPs with a rated plant capacity larger than 20 MGD and 10 mg L⁻¹ TN for WWTPs with a rated plant capacity of 20 MGD and smaller.
- Development of an Ocean Plan amendment with technology-based effluent limitations following the effluent discharge limitations explained in the priority above, with the amendment added to the Ocean Plan by 2026 at the latest.
- Centralize, standardize, and make publicly available the flow and effluent concentration data from WWTPs, which can be done using an interface such as CIWQS or ECHO.

- Development of a method for better uploading to and utilizing spatial data for SWRCB, such as a direct partnership with federal organizations with whom SWRCB already has a working relationship that will allow for easier and less compressed submission of crucial spatial data.
- Integration of new data sources that are in the California OAH Portal and near-completed studies on Central Coast OAH into SWRCB decision-making.
- Further research on how OAH along the CA coast will change over time under various potential climate scenarios.
- Further research on the impacts of small coastal sewage treatment plants on OAH processes.

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Appendix 1.

Region	Sewage Plant	Variable	Effluent/Influent	Calculation Method	Source	2017	2018	2019	2020	2021	2022	2023 Average Ammonia
1	Arcata City WWTP	Ammonia Concentration (mg/L)	Effluent	Monthly Average	ECHO/eSMR	10.10	5.55	21.00	12.86	8.37	10.94	8.25
1	Crescent City WWTP	Ammonia Concentration (mg/L)	Effluent	12-Month Average	Keam's Data	7.80	11.20	11.10	8.22	13.30	15.30	14.67
1	Fureka City Elb River WWTP	Ammonia Concentration (mg/L)	Effluent	Monthly Average	ECHO/eSMR	4.80	3.95	4.53	2.94	3.57	2.26	3.02
1	Fort Bragg City WWTP	Ammonia Concentration (mg/L)	Effluent	n/a and 6 Month Median	eSMR	18.55	20.17	16.21	8.38	0.14	0.27	0.33
1	McKinleyville WWTP	Ammonia Concentration (mg/L)	Effluent	Monthly Average	Plant/eSMR	17.01	0.67	0.43	6.10	1.94	1.43	1.22
3	Carmel Area WWTP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO/eSMR	13.03	27.92	16.62	23.66	21.69	30.39	23.98
3	Carpinteria SD WWTP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	eSMR	0.39	0.05	0.89	0.32	0.01	0.00	0.00
3	City of Mono Bay Water Reclamation Facility	Ammonia Concentration (mg/L)	Effluent	Monthly Average	eSMR	n/a	n/a	n/a	n/a	n/a	0.29	0.11
3	Goleta SD WWTP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	eSMR	n/a	n/a	25.00	14.00	12.00	3.90	21.00
3	Monterey SD WWTP	Ammonia Concentration (mg/L)	Effluent	Daily Average	eSMR	0.17	0.17	0.17	0.17	0.17	0.17	0.17
3	Monterey One Water Regional WWTP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO/eSMR	n/a	28.18	0.18	0.25	0.37	0.37	0.34
3	Pismo Beach WWTP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO/eSMR	n/a	0.12	n/a	0.24	0.25	0.36	0.20
3	El Estero Water Resource Center NPDES	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO/eSMR	26.80	26.00	11.80	2.60	3.12323	2.69	2.62
3	Sanita Cruz WWTP	Ammonia Concentration (mg/L)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3	South San Luis Obispo SD WWTP	Ammonia Concentration (mg/L)	Effluent	Monthly Average	Plant/eSMR	20.00	41.00	2.35	2.36	2.32	2.18	2.38
3	Watsonville WWTP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	Plant	13.51	14.63	13.36	16.46	17.04	20.83	16.53
4	Avalon WWTP	Ammonia Concentration (mg/L)	Effluent	12-Month Average	eSMR	1.30	3.93	0.43	0.14	0.09	4.79	9.84
4	Long Beach WRP	Ammonia Concentration (mg/L)	Effluent	12-Month Average	eSMR	1.29	1.98	1.48	1.47	2.03	2.67	2.15
4	Hyattson WWTP	Ammonia Concentration (mg/L)	Effluent	12-Month Average	Plant	44.00	45.10	44.10	44.40	43.70	42.80	43.74
4	Terminal Island Water Reclamation Plant	Ammonia Concentration (mg/L)	Effluent	12-Month Average	ECHO	2.26	1.18	1.88	4.63	0.74	1.83	2.25
4	Quarant WWTP	Ammonia Concentration (mg/L)	Effluent	12-Month Average	ECHO	34.33	45.80	37.33	32.73	33.38	34.65	34.70
4	Ventura WRF	Ammonia Concentration (mg/L)	Effluent	12-Month Average/6 Month Median	ECHO/eSMR	0.53	0.68	0.68	0.91	0.98	0.78	0.34
4	A.K. Warren Water Resource Facility	Ammonia Concentration (mg/L)	Effluent	12-Month Average	Plant	44.4	45.00	44.00	43.60	42.90	43.20	42.70
6	OCSO Outfall Number 1	Ammonia Concentration (mg/L)	Effluent	Monthly Average	ECHO	25.78	23.72	29.73	28.79	31.96	30.82	28.64
9	Enviña Ocean Outfall/Carlsbad WRF	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO	36.80	44.06	n/a	n/a	n/a	n/a	40.44
9	La Salina WWTP/ Oceanwide Ocean Outfall	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO	43.73	38.66	38.38	38.27	33.81	6.48	12.39
9	Latham WWP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO	33.08	38.01	40.03	42.46	45.23	40.63	38.91
9	City of San Clemente WRP	Ammonia Concentration (mg/L)	Effluent	6 Month Median	ECHO	33.08	38.01	40.03	42.46	45.23	40.63	38.91
9	San Elito Water Campus	Ammonia Concentration (mg/L)	Effluent	12-Month Average/6 Month Median	ECHO	42.16	46.43	30.33	38.42	44.92	44.17	43.83
9	Point Loma Water Treatment Plant	Ammonia Concentration (mg/L)	Effluent	12-Month Average	Plant	40.32	43.04	41.91	41.69	40.14	40.75	36.67

Table 10. Ammonia concentrations from 30 plants within California from 2017-2023.

Comments from Willamette Riverkeepers:



1210 Center St.
Oregon City, OR
97045

July 1, 2024

Submitted via email to IntegratedReport@deq.oregon.gov

Re: Comments on Oregon's 2024 Draft Integrated Report

To Whom It May Concern:

Please consider the following comments from Willamette Riverkeeper regarding the Department of Environmental Quality's 2024 Draft Integrated Report.

In fall 2023, Willamette Riverkeeper submitted five years of trash collection data to DEQ showing the trash crisis in the Willamette River Basin as well as a narrative explanation of how the trash has negatively affected all the Willamette River's beneficial uses. In response, DEQ listed three sections of the Willamette River as impaired for trash and found that trash impairs two beneficial uses of the river: aesthetics and recreation. While Willamette Riverkeeper thanks DEQ for this listing and recognizing the problem, DEQ still needs to go further.

- I. DEQ needs to change the priority ranking for aquatic trash pollution to high or, at the bare minimum, medium priority.

Trash accumulates. The Willamette River has a long history of being treated as a dump, as early as 1907, the Oregon Health Board was describing the Willamette River as "an open sewer" and continuing in to the 1930s, "industries continued to dump indiscriminately into the river."¹ It wasn't until the 1960s that Willamette River cleanup efforts started being taken seriously by the state. However, over recent years, the Willamette River water quality has begun to decline yet again. This is in part due to the trash crisis in and around the river, only mitigated by different entities holding their own independent cleanups. Willamette Riverkeeper volunteers have returned to areas that have already been cleaned to find even more piles of trash. Without these entities prioritizing trash cleanups, the river would become a garbage dump once more. As the trash in the river will only begin to dissipate when there is a cohesive trash collection plan throughout the watershed, DEQ needs to make aquatic trash a higher priority. Until aquatic trash becomes a higher priority to DEQ, the trash crisis will continue to grow, and the problem will be even more difficult to combat once DEQ does deem it a priority.

¹ William G. Robbins, *This Land, Oregon*, Oregon History Project (2002), <https://www.oregonhistoryproject.org/narratives/this-land-oregon/people-politics-and-environment-since-1945/pollution-in-paradise/>.

- a. DEQ should include the creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

When listing a water as impaired, “the state assigns a priority for development of Total Maximum Daily Loads (TMDL) based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors.”²

As trash is a pollutant that can only break down into smaller pieces, not disappear completely without being removed by a human or machine, over the course of many years, it should be considered a more severe pollutant. Especially as much of the trash found in the Willamette River is various forms of plastic, a material that can take “anywhere from 20 to 500 years to decompose, and even then, it never fully disappears; it just gets smaller and smaller.”³

As much of the trash that enters the Willamette River is a form of nonpoint source pollution, the methods to remove the trash will likely have to be implemented through a wide variety of programs, including incentive-based approaches. As only part of the solution will come from regulatory measures, and likely much of the cleanup efforts will require voluntary efforts, removing trash from the Willamette will be significantly more complex than removing pollutants that stem from point sources. The longer DEQ takes to create a TMDL for aquatic trash in the Willamette River, the longer it will take for these programs to get off the ground, and the more garbage, chemicals, and biohazards will deteriorate water quality, wildlife habitat, and river recreation experiences.

Willamette Riverkeeper requests DEQ to give aquatic trash in the Willamette River a higher priority ranking and to include the creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule that outlines DEQ’s TMDL plans through 2030. Willamette Riverkeeper is ready to assist DEQ in the creation of this TMDL and is attaching an example aquatic trash TMDL for the Willamette River, using impairment of all beneficial uses, to this comment letter as exhibit A. Creating an aquatic trash TMDL will take time and effort, especially as there are so few in the nation to base one off, but the longer it takes to create a TMDL, the longer it will take to remedy the problem as the trash continues to accumulate and the Willamette River becomes more and more degraded.

- II. DEQ should list the three sections of the Willamette River as impaired for more beneficial uses than aesthetics and recreation.

While Willamette Riverkeeper does not expect DEQ to find aquatic trash to impair all thirteen beneficial uses of the Willamette River, DEQ should find trash to impair more than

² *Overview of Listing Impaired Waters under CWA Section 303(d)*, U.S. EPA, [https://www.epa.gov/tmdl/overview-listing-impaired-waters-under-cwa-section-303d#:~:text=For%20each%20water%20on%20the,among%20other%20factors%20\(40%20C.F.R.; See 40 C.F.R. §130.7\(b\)\(4\).](https://www.epa.gov/tmdl/overview-listing-impaired-waters-under-cwa-section-303d#:~:text=For%20each%20water%20on%20the,among%20other%20factors%20(40%20C.F.R.; See 40 C.F.R. §130.7(b)(4).)

³ *In Images: Plastic is Forever*, United Nations, <https://www.un.org/en/exhibits/exhibit/in-images-plastic-forever#:~:text=But%20when%20does%20plastic's%20life,just%20gets%20smaller%20and%20smaller..>

two beneficial uses. The two impairments DEQ found, impairments to aesthetics and recreation, are obviously issues that stem from aquatic trash. Those two impairments visually evident, with trash making the river area look degraded and that aesthetic impairment making people afraid to recreate in the river, and some of the trash making it more dangerous to recreate in the river. However, trash clearly impairs more than just those two beneficial uses.

Much of the trash found in the Willamette River is made from plastic. This plastic then breaks down into microplastics which are then ingested by aquatic life, including fish, and terrestrial animals. In aquatic invertebrates, species which show water quality and provide food for fish and birds, “microplastics cause a decline in feeding behavior and fertility, slow down larval growth and development, increase oxygen consumption, and stimulate the production of reactive oxygen species.”⁴ In fish species, “the microplastics may cause structural damage to the intestine, liver, gills, and brain, while affecting metabolic balance, behavior, and fertility.”⁵ As there are Endangered Species Act-listed fish species in the Willamette River, including the Upper Willamette River Chinook salmon and steelhead, the effects of aquatic trash on fish are extremely worrying and will increase the rate of decline for these species. While there are far fewer studies on the effects of microplastics on terrestrial animals, “the studies demonstrate that in mice and rats microplastics may also cause biochemical and structural damage with noticeable dysfunctions of the intestine, liver, and excretory and reproductive systems.”⁶ As terrestrial animals eat the fish and macroinvertebrates found in the river, it is very probable that they have ingested microplastics both by eating the aquatic species and by drinking the river water.

Not only do plastics break down into microplastics, but they also cause a risk of harming aquatic and terrestrial wildlife when still in one piece. Fish and other species can easily ingest larger pieces of plastic thinking that they are a food source, and those larger pieces can “block the gastrointestinal tract (GI) of small birds and fish and can also cause physical damage internally such as lacerations or irritation to sensitive GI tissues.”⁷ Additionally, ingesting plastics can “lead to a false feeling of satiety” even though there is no nutritional value in plastic.⁸ Species can also become entangled on larger pieces of plastic and that can then lead to death in the animal. For these reasons, DEQ must find that the beneficial use impairments caused by aquatic trash include impairments to fish and aquatic life and wildlife. In addition, these impairments to aquatic and terrestrial species can then impair fishing and hunting, so it would be logical for DEQ to also list those uses as impaired.

Finally, DEQ should find that there is an impairment to the beneficial use of boating. Willamette Riverkeeper submitted many photos to DEQ during the data submission stage of drafting the 2024 Integrated Report. Those pictures included numerous examples of

⁴ Natalia Zolotova et al., *Harmful effects of the microplastic pollution on animal health: a literature review*, PeerJ (June 14, 2022), <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9205308/>.

⁵ *Id.*

⁶ *Id.*

⁷ *Wildlife Ingestion of Microplastics*, Canadian Wildlife Health Cooperative, https://www.cwhc-rcsf.ca/docs/fact_sheets/Wildlife%20ingestion%20of%20microplastics.pdf.

⁸ *Id.*

large pieces of aquatic trash in the river. However, it isn't only the large pieces of trash that harm boating, as plastic bags and similar trash have been known to frequently get caught in boat propellers.⁹ These trash hazards, both large and small, are extremely detrimental to boating and can cause paddlecrafts and motorboats to get trapped in an area and can break different mechanisms on motorboats. Just by the nature of there being enough trash in the water to be considered an impairment, boating is negatively affected and becomes more hazardous. Because of this, DEQ should list boating as another impairment caused by aquatic trash.

Conclusion

Willamette Riverkeeper urges to increase the priority ranking of aquatic trash in the Willamette River to high or, at the very least, medium. With this increase in priority ranking, we also request that DEQ adds the creation of an aquatic trash TMDL to the 2024 Priorities and Schedule document, with the goal of creating this TMDL by 2030. To assist in this, Willamette Riverkeeper is attaching an example of a draft aquatic trash TMDL for the Willamette River. Finally, Willamette Riverkeeper believes that there is more than enough evidence that aquatic trash harms the beneficial uses of fish and aquatic life, wildlife, fishing, hunting, and boating. As such, we request DEQ to expand the impairments caused by trash beyond the current aesthetic and recreation impairments.

Thank you for taking this matter seriously and listing segments of the Willamette River as impaired for trash. Willamette Riverkeeper looks forward to continued collaboration on this issue and is ready to assist DEQ in these efforts in any way we can.

Sincerely,

Bob Sallinger
Executive Director
bob@willametteriverkeeper.org

Lindsey Hutchison
Staff Attorney
lindsey@willametteriverkeeper.org

⁹ See *Plastic bag in the propeller*, Kavas Yachting, <https://www.kavas.com/sailors-guide/troubleshooting/plastic-bag-in-the-propeller.html#:~:text=Plastic%20bag%20in%20the%20propeller&text=This%20problem%20is%20not%20uncommon,requires%20diving%20into%20the%20water..>

EXHIBIT A

Example of a Trash TMDL for the Willamette River Basin

DRAFT

- I. Introduction – Legal Background
- II. Problem Statement
 - a. Description of the Basin
 - b. Beneficial Uses of the Basin
 - c. Water Quality Objectives
 - d. Impairment of Beneficial Uses
 - e. Extent of the Trash Problem in the Willamette River Basin
 - i. Transport Mechanisms
 - ii. Current Data
 - iii. Costs of Trash Clean-Ups
- III. Numeric Target
- IV. Source Analysis
- V. Total Maximum Daily Loads and Load Allocations
 - a. Development of Loading Rates and Baseline Loads
 - i. Nonpoint Source Loading Rates
 - b. TMDL Allocations
 - i. Load Allocations
 - ii. Wasteload Allocations
 - c. Margin of Safety
- VI. Monitoring
- VII. Implementation

I. INTRODUCTION – LEGAL BACKGROUND

Willamette Riverkeeper has developed this draft total maximum daily load (TMDL) designed to attain the water quality standards for trash in the Willamette River Basin. This draft TMDL has been prepared pursuant to OAR 137-001-0070(1)(a) to preserve and enhance water quality in the Willamette River Basin.

The OAR 340-041-0340 Table 340A designates beneficial uses for the Willamette River Basin. Oregon DEQ plans to list the Willamette River Basin as impaired for trash in its 2024 303(d) list, as required pursuant to the federal Clean Water Act (CWA), and this draft Trash TMDL should be used to assist with the listing and the drafting of the final Trash TMDL.

Section 303(d)(1)(A) of the CWA mandates biennial assessment of the nation's water resources, and these water quality assessments are used to identify and list impaired waters. The resulting list is referred to as the 303(d) list. The CWA also requires states to establish a priority ranking for impaired waters and to develop and implement TMDLs. A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and allocates pollutant loading to point and non-point sources. Water quality standards include designated beneficial uses, numeric and narrative water quality objectives, and DEQ's antidegradation policy.

The United States Environmental Protection Agency (EPA) has oversight authority for the 303(d) program and must approve or disapprove DEQ's 303(d) lists and each specific TMDL. EPA is ultimately responsible for issuing a TMDL if DEQ fails to do so in a timely manner.

This draft Trash TMDL is based on Willamette Riverkeeper's existing, readily available information concerning the conditions in the Willamette River Basin, as well as previously developed TMDLs.

II. PROBLEM STATEMENT

a. Willamette River Basin Description

The Willamette River is of vital importance to the state and people of Oregon. Nearly 70 percent of Oregon's population lives within 20 miles of the Willamette River, and the population in the Willamette Valley continues to grow.¹ The Willamette River runs through Oregon's most populous cities, including Eugene, Corvallis, Salem, and Portland. Many fish and other wildlife species can be found in the Willamette River Basin, including the threatened Upper Willamette River Steelhead, Upper Willamette River Chinook Salmon, freshwater mussels, kingfisher, and

¹ See *Willamette River Recreation Guide*, Oregon State Parks & Oregon State Marine Board (Dec 2007), at 1, <https://www.oregon.gov/osmb/forms-library/Documents/Publications/WillametteRiverGuide07.pdf>; Jamie Goldberg, *New Census Data Shows Where Oregon's Population Grew Fastest in the 2010s*, Oregon Live (Aug. 12, 2021), <https://www.oregonlive.com/business/2021/08/new-census-data-show-where-oregons-population-grew-fastest-in-the-2010s.html>.

native bull trout to name a few.² DEQ considers aquatic species found in the Willamette Basin to be culturally and economically significant to the Basin, including native populations of Chinook salmon, steelhead trout, and bull trout.³

The Willamette River runs over 187 miles from its headwaters near Waldo Lake to the confluence with the Columbia River in Portland. The Willamette River Basin is the largest watershed in the state, covering almost 11,500 square miles.⁴ The Willamette River Basin is comprised of 12 subbasins.⁵

b. Beneficial Uses of the Willamette River Basin

The designated beneficial uses for the Willamette River Basin are: public, private, and industrial water supply; irrigation; livestock watering; fish and aquatic life; wildlife and hunting; fishing; boating; water contact recreation; aesthetic quality; hydropower; and commercial navigation and transportation.⁶

² See NOAA Fisheries, *Upper Willamette River Chinook Salmon*, <https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/upper-willamette-river-chinook-salmon>; NOAA Fisheries, *Upper Willamette River Steelhead*, <https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/upper-willamette-river-steelhead#:~:text=Species%20Recovery&text=It%20encompasses%20the%20Willamette%20River,Upper%20Willamette%20River%20steelhead>; Oregon DEQ, *TMDL Program: Willamette Basin*, <https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Willamette-Basin.aspx> [hereinafter *WRB TMDL Program*].

³ *WRB TMDL Program*.

⁴ *Willamette Watershed*, City of Portland, <https://www.portlandoregon.gov/bes/30938>.

⁵ The 12 subbasins are: Lower Willamette, Tualatin, Molalla-Pudding, Yamhill, Clackamas, South Santiam, North Santiam, Middle Willamette, McKenzie, Coast Fork Willamette, Middle Fork Willamette, and Upper Willamette. *WRB TMDL Program*.

⁶ OAR 340-041-0340, Table 340A.

 OAR 340-041-0340 Table 340A Designated Beneficial Uses Willamette Basin										
Beneficial Uses	Willamette River Tributaries						Main Stem Willamette River			
	Clackamas River	Molalla River	Santiam River	McKenzie River	Tualatin River	All Other Streams & Tributaries	Mouth to Willamette Falls, Including Multnomah Channel	Willamette Falls to Newberg	Newberg to Salem	Salem to Coast Fork
Public Domestic Water Supply ¹	X	X	X	X	X	X	X	X	X	X
Private Domestic Water Supply ¹	X	X	X	X	X	X	X	X	X	X
Industrial Water Supply	X	X	X	X	X	X	X	X	X	X
Irrigation	X	X	X	X	X	X	X	X	X	X
Livestock Watering	X	X	X	X	X	X	X	X	X	X
Fish & Aquatic Life ²	X	X	X	X	X	X	X	X	X	X
Wildlife & Hunting	X	X	X	X	X	X	X	X	X	X
Fishing	X	X	X	X	X	X	X	X	X	X
Boating	X	X	X	X	X	X	X	X	X	X
Water Contact Recreation	X	X	X	X	X	X	X ³	X	X	X
Aesthetic Quality	X	X	X	X	X	X	X	X	X	X
Hydro Power	X	X	X	X	X	X	X	X		
Commercial Navigation & Transportation							X	X	X	
¹ With adequate pretreatment and natural quality that meets drinking water standards. ² See also Figures 340A and 340B for fish use designations for this basin. ³ Not to conflict with commercial activities in Portland Harbor. Table produced August, 2005										

c. Water Quality Objectives

The CWA requires states to develop water quality standards.⁷ The established water quality standards must “protect the public health or welfare, enhance the quality of water and serve the purposes” of the CWA.⁸ Water quality standards must include designated beneficial uses of the waterway, criteria specifying water quality conditions, and an antidegradation policy.⁹ States “are required to set water quality standards for *all* waters within their boundaries regardless of the sources of the pollution entering the waters.”¹⁰

The statewide narrative criteria applicable for this TMLD is OAR 340-041-0007(12) which states “objectionable discoloration, scum, oily sheen, or floating solids... may not be allowed.”

⁷ 33 U.S.C. §1313(a).

⁸ 33 U.S.C. §1313(c)(2)(a).

⁹ 33 U.S.C. §§ 1313(c)(2), (d)(4)(B)

¹⁰ *Pronsolino v. Nastri*, 291 F.3d 1123, 1127 (9th Cir. 2002) (emphasis in original).

River Recreation

Aquatic trash can negatively impact water contact recreation by both making the water look unappealing and also by creating physical risks. Trash such as needles, broken glass, metal, and sharp plastic can cause physical harm to humans who come into contact with it. These types of trash are extremely common along the Willamette River, and if someone is recreating in or on the river they can easily come into contact with these objects and be injured. In the Upper Willamette alone, Willamette Riverkeeper removed over 952 needles in 2018, 796 in 2019, 894 in 2020, and 1,057 in 2021. As stated previously, removing needles requires special training, and not all volunteers, let alone members of the public, are qualified to touch the needles found along the Willamette River. If injuries from aquatic trash become more common, it will be less likely that people will be willing to recreate in and on the river and its tributaries. In some instances, such as the Marys River confluence with the Willamette River in Corvallis, there have also been reports of recreationists being affected by sickness and fungal and staph infections.²⁶



Needles collected during a cleanup effort on the west bank of the Willamette River along an urban segment in Eugene in 2019.

The State of Oregon has invested significant time and funds into the Willamette River Water Trail. The Willamette River Water Trail is a National Water Trail, designated in 2012 by the National Park Service. With a host of public lands along the river, the opportunity to canoe, kayak, drift boat and otherwise travel the river is significant, from day long trips, to week-long excursions of over 150 miles. Over the years DEQ, as well as organizations like WRK, have spent significant funds, and time establishing new access points, camp sites, and related amenities to facilitate river travel. Further, websites have been designed, and maps have been created and printed to help enable low impact river use.

²⁶ Erica Van Ess, *OSU Study: neighborhood swimming holes may not be all that safe*, Oregon State University (Aug. 7, 2009), <https://today.oregonstate.edu/archives/1997/jun/osu-study-neighborhood-swimming-holes-may-not-be-all-safe>.

In 2019, the Willamette Valley Visitors Association began putting emphasis on the Water Trail, helping to promote the Willamette as a vacation destination for people in Oregon, and beyond. WRK has mailed thousands of Water Trail guides over the past 10 years, and many of these are to people from outside of Oregon. The potential impact on the regional economy is significant, and use of the Water Trail can benefit a range of businesses in the Willamette Valley.

When one travels to a river like the Willamette to paddle and camp along it for a day or a week, the experience is diminished by trash and debris along the shoreline and in the water. This reality decreases the desire to return to such a river, which in turn can limit the economic impact for local communities. Further, such conditions along the river decrease the desire by locals and visitors alike to travel the river, thus limiting what should be a significant recreational opportunity and economic driver. This inadvertently affects rural communities located between urban areas where some of the worst garbage is located as the trash travels downstream into these communities.

The same can be said for those seeking to fish the river, or seek riverside greenway properties out for birding and other pass times. Trash diminishes these experiences.

Aesthetic Quality

Trash in the Willamette River Basin is making these naturally beautiful waterways a visual blight to those who come across it. Trash harms perception of the waterways and makes it unlikely that anyone will want to go near it. This harms tourism as well as the health of those around the area who would normally recreate along the waterways. Willamette Riverkeeper has substantial evidence of the visual blight that trash causes along the Willamette River.



Trash found along an ephemeral seasonal draw into the Willamette River; photo taken in Corvallis in 2017.



(Willamette River, Eugene, Oregon, 2020)

i) Transport Mechanisms

Trash enters the river system in 6 ways:

- (1) Storm drains: trash is deposited throughout the Basin and is carried to the various reaches of the river and its tributaries during and after rain through storm drains;
- (2) Wind action: trash can also blow into the waterways directly;
- (3) Tidal action;
- (4) Direct disposal: direct littering and dumping from land and watercraft occurs;
- (5) Materials left behind on river adjacent lands by anthropogenic activities such as camping;
- (6) Flood events: when water rises it often carries with it terrestrial trash from floodplains and beyond into the river and redeposits into either the sediment or terrestrial areas downstream. flooding can carry materials from floodplains and beyond into the river.

ii) Current Data

Willamette Riverkeeper is the only entity known to have data on the trash issue in the Willamette River Basin. This makes the data incomplete and sporadic, as the organization currently collecting data does not have the resources to conduct regular and constant studies throughout the Basin and is only able to do so when holding trash cleanups. While other agencies, organizations, and cities may have their own data on trash collected, there is not a single place where this data is collected and compiled.

What is known is that the amount of trash found in the waterways is excessive, and that trash is found in all reaches of the river, from Waldo Lake to the Columbia River, and its tributaries. Willamette Riverkeeper's data shows that quantities of trash have grown every year. On the Upper Willamette River alone, Willamette Riverkeeper removed 144 cubic yards of trash in 2018, 197.5 cubic yards in 2019, 216 cubic yards in 2020, and 293 cubic yards in 2021.

Trash is regularly observed in the waterways and nonprofits regularly organize volunteer cleanups and document the amount of trash removed on such days. While some of the data can

indicate how long trash has been accumulating at sites, such as when organizations return to sites that have previously been cleaned, this information is not always known.

For the past two decades, Willamette Riverkeeper has partnered with municipalities, land managers, nonprofits agencies, and private property owners along the river to address the challenges of trash on and in the river. Partners include: the cities of Portland, Salem, Albany, Corvallis, Eugene, Springfield, Westfir, and Oakridge; Willamalane Parks and Recreation District; River House Outdoor Program; Benton Soil & Water Conservation District; Middle Fork Willamette Watershed Council; Twin Rivers Rotary Club; Lane Migrant Education Program; Willamette Kayak & Canoe Club; and Oregon Paddle Sports. Despite the overwhelming support and interest in a clean river, without a unified approach, the Willamette River will continue to be riddled with trash.

iii) Costs of Trash Clean-ups

Cleaning up the river and its tributaries is a costly endeavor. Willamette Riverkeeper alone spends over \$100,000 on trash monitoring and cleanup each year. Willamette Riverkeeper conducts hundreds of cleanup efforts annually throughout the Basin.

While many organizations, entities, and cities work to clean up trash throughout the Willamette River Basin, those costs are not shared publicly so the true yearly trash cleanup cost is not known. There is an additional unquantified economic loss to the region from reduction in tourism due to dirty waterways.

III. Numeric Target

The numeric target is zero trash in the river. A numeric target of zero means that ultimately, at the end of the implementation period, there must be no trash in the river. The goal has been set at zero because no amount of trash can be deemed as acceptable to protect the beneficial uses of the river and there is no justification for anything larger than a numeric target of zero.

The implementation will be phased: load allocations will be decreased gradually over ten years. A possible review of the numeric target would have to be based on the findings of future studies on appropriate threshold levels for protecting beneficial uses. However, significant trash reductions must be achieved before the numeric target may be reconsidered.

IV. Source Analysis

Trash generation rates are dependent on land uses. For purposes of this TMDL, load allocations will be based on the average amount of trash generated by specific land uses to the extent that supporting data are available. We have divided the urban population of the Willamette River Basin into seven types of land uses: (1) residential, (2) commercial, (3) industrial, (4) transportation and utilities, (5) mixed urban, (6) open space and recreation, (7) agriculture, and (8) will be our rural marker.

In the absence of such data, a default value of 64 gallons per 1 square mile will be assigned. Due to a lack of data, this Draft Trash TMDL is unable to estimate average trash generation for each land use to allocate a maximum quantity to each city or land use type. Once that data is collected, DEQ will be able to estimate the average trash generation for each land use to allocate a maximum quantity to each area. The load allocations/reductions will be based on the amount of trash estimated to be produced by each type of land use, and the amount will be the sum of the products of given land uses in each city by the allocation for the specific land use.

Using the estimate of 64 gallons of trash per 1 square mile, and estimating the Willamette River Basin to be 11,500 square miles, generation of trash for a typical year for the entire Basin would be 736,000 gallons.

V. Total Maximum Daily Loads and Load Allocations

a. Development of Loading Rates and Baseline Loads

Once DEQ has conducted monitoring from May 2024 – April 2025 and more data becomes available, baseline point source and nonpoint source loads will be established. To differentiate between the point source and nonpoint source loads, items that are generally considered too large to move through the storm drain system will be considered part of the baseline point source load. The baseline loads do not include natural debris, such as sticks and leaves.

DEQ's monitoring will provide data allowing DEQ to be able to assume the amount of trash currently generated for each type of land use and each city. Cities and unincorporated areas will be given 90% of this baseline for the first year of implementation, and the allocation will be reduced from this baseline by approximately 10% through every year of implementation. Cities will be deemed in compliance with their allocation loads for the first two years after the implementation of this TMDL, provided that the cities remove and properly dispose of the trash collected pursuant to the baseline monitoring program.

Allocations will be uncompressed in volume. The volumes will be shown in cubic feet. Uncompressed volume means that no mechanical devices should be used to compress volumes inventories for purposes of monitoring the amount produced at select locations. Until there is data to characterize different land uses, the same generation factor will be assigned to every land use. However, allocations may be assigned in dry weight and a different load factor may be assigned to the various land uses if we obtain enough data to do so. The current allocation is the default allocation and is based upon data proved by Willamette Riverkeeper during the drafting of this TMDL. The current default allocations may be revised if reliable data is provided to DEQ by the end of the baseline monitoring season, which will close so as to include data from the current year's storm season.

i. Nonpoint Source Loading Rates

In establishing the nonpoint source baseline loading rate, only items considered too large to enter the stormwater system through street-level storm drains should be counted. It should be

assumed that these larger items have been intentionally and illegally dumped into the Basin. While it is easily understood how small items enter the storm sewer via street level storm drains and are transferred to the impaired riverbanks and waterways, it may not be as clear as to how larger dumped items are transported. While dumping is generally considered a land-based problem, these items all have the potential to be transferred into the stream system by rainfall or other means. Therefore, for the purpose of this TMDL, all dumped or nonpoint source loads are considered to have the potential to impact the impaired riverbanks and waterways.

While conducting monitoring, DEQ will collect nonpoint source trash data and determine how many sampling sites are impaired by nonpoint source trash. To calculate the baseline loading rate for each sampling event, the drainage acreage, start and end dates, and total weight for each sample event will be taken from the collected monitoring data. The total weight will be divided by total acreage and the total number of days to get a normalized unit loading rate, expressed in units of lbs/ac/day. The nonpoint source loading rate should be normalized to days, as opposed to inches of rain because it is not assumed that dumping activities are associated with rainfall.

b. TMDL Allocations

A TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody while still achieving water quality standards or goals. It is composed of the sum of individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background levels. In addition, the TMDL includes a margin of safety, either implicitly or explicitly, to account for any uncertainty in the relationship between the pollutant loads and the quality of the receiving waterbody. TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. In this TMDL, the endpoint is equal to 100 percent removal of the baseline load, calculated as an average of the measured or estimated removal rate. This is because of high seasonal and annual variability. The baseline load is defined as the annual trash load calculated from monitoring data obtained through storm drain and in-stream sampling, the baseline load represents an average annual load. The numeric target is derived from the narrative water quality criteria and includes both an explicit and implicit margin of safety.

This TMDL is expressed as the quantity of trash that must be captured or removed for the waterbody to achieve the water quality standards, rather than as the amount of trash that can be added to the waterbody without being objectionable, unsightly, or constituting a nuisance. A TMDL target equal to 100 percent removal of the baseline load is not the same as zero trash in the waterway, but should result in compliance with the narrative standards. This target provides an objective and measurable basis for compliance, as no water quality standards exist that are zero, even for extremely toxic substances. Removal of 100 percent of the baseline load would achieve water quality standards and avoid interference with the Basin's designated uses.

i. Load Allocations

The load allocation is the portion of the TMDL that is allocated to nonpoint source and background levels. The target of the load allocation for trash in the Willamette River Basin is

100 percent removal of the baseline load, calculated as an average. The endpoint will be sufficient to no longer violate water quality standards. The TMDL is expressed in terms of quantity removed, rather than quantity added to the waterbody.

ii. Wasteload Allocations

TMDLs must include individual wasteload allocations for each point source. Wasteload allocations will be developed for the MS4s and other point sources. NPDES regulated MS4 discharges will be included in the wasteload allocation component of the TMDL. Other point sources include industrial facilities and private properties.

c. Margin of Safety

TMDLs must incorporate a margin of safety to account for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. An explicit margin of safety of 5 percent will be incorporated into this TMDL due to the variability present in all trash collection data. This means the margin of safety will be incorporated as an additional 5 percent of the total baseline load that must be removed.

Conservative assumptions were incorporated into both the load allocations and wasteload allocations and represent an implicit margin of safety. The wasteload allocations are conservative estimates of actual loads because they were calculated under the assumption that all land in the watershed contributes to the point source trash load, even if they come from nonpoint source lands not regulated under NPDES MS4 permits. The load allocations are conservative estimates of actual loads because although dumping of large items into the watershed occurs on a site specific basis, the nonpoint source loading rate was applied to all acres in the Basin.

LOAD ALLOCATIONS AS A PERCENTAGE OF BASELINE:

Year of Implementation	Watershed Wide Load Allocation (urbanized areas only) in cubic feet
Monitoring and Disposal of Trash Collected (May 2024 – April 2025)	No allocation specified. Baseline Monitoring Program. Trash will be reduced by levels collected during the baseline monitoring program.
Monitoring and Disposal of Trash Collected (May 2025 – April 2026)	No allocation specified. Baseline Monitoring Program. Trash will be reduced by levels collected during the baseline monitoring program.
Total Allocation – First Year (May 2026 – April 2027)	90% of baseline load as determined from baseline monitoring program.
Total Allocation – Second Year (May 2027 – April 2028)	75% of baseline load as determined from baseline monitoring program.
Total Allocation – Third Year (May 2028 – April 2029)	60% of baseline load as determined from baseline monitoring program.

Total Allocation – Fourth Year (May 2029 – April 2030)	50% of baseline load as determined from baseline monitoring program.
Total Allocation – Fifth Year (May 2030 – April 2031)	40% of baseline load as determined from baseline monitoring program.
Total Allocation – Sixth Year (May 2031 – April 2032)	30% of baseline load as determined from baseline monitoring program.
Total Allocation – Seventh Year (May 2032 – April 2033)	20% of baseline load as determined from baseline monitoring program.
Total Allocation – Eighth Year (May 2033 – April 2034)	10% of baseline load as determined from baseline monitoring program.
Total Allocation – Ninth Year (May 2034 – April 2035)	5% of baseline load as determined from baseline monitoring program.
Total Allocation – Tenth Year (May 2035 – April 2036)	0

VI. Monitoring

This section will address two types of monitoring: (a) baseline monitoring and (b) compliance monitoring to be conducted throughout the implementation period.

(a) Baseline Monitoring

This refers to collection of baseline data on the sites that are representative of each land use. Collection of baseline data is compulsory and will be used as appropriate to refine the default allocations per land use. Cities are strongly encouraged to team up and work collectively.

Baseline data will be collected from May 2023 through April 2025 and an attempt will be made to represent all land uses that drain to the Willamette River Basin. Although the amount of trash deposited into the waterways through conveyance of a storm drain and from the land surrounding the waterways is dependent on rainfall patterns, and larger amounts of trash are typically deposited into the waterways as a result of the first major rain event of the season, monitoring will include dates in both the rainy season and the dry season. The rainy season typically takes place between October and May.

During the first year of baseline monitoring, a city or group of cities is required to capture and quantify trash from an area of not less than 10% of the total land area that drains into the Willamette River Basin. The surface areas chosen by the cities or groups of cities must represent their land uses equitably. Trash captured during the monitoring program must be disposed of in accordance with all applicable laws and regulations.

A list consisting of a minimum of three monitoring locations for each land use per city, or group of cities and/or unincorporated areas, must be proposed to DEQ by April 1, 2023. The list shall include, for each proposed monitoring location, a map showing the drainage to the Willamette River or tributary outlet, or to a location that will eventually drain to the river or one of its tributaries. The monitoring sites will be structured for full capture of trash and the sampling devices will be emptied and analyzed after every precipitation event of 0.25 inch or more or after

be allowed flexibility in how to reduce trash generation rates as long as they achieve the required reductions. For example, one city or group of cities may find that a reduction of the amount of trash generated by residential areas can be achieved more quickly than that produced by commercial areas. In this example, the city or group of cities may choose to reduce the commercial load by less than would be required on a per land use reduction, still achieving the overall reduction that is mandated. It is up to the cities to decide the exact set of strategies to be used to reduce the amount of trash discharged to the Willamette River Basin, including city ordinances prohibiting trash litter.

Each city, or group of cities, must develop and implement strategies which may include a combination of Structural Control Best Management Practices (BMPs) (e.g., continuous deflective separation systems, appropriate storm drain capture technologies, enforcement of illicit dumping laws, and trash nets), Treatment Control BMPs (e.g., catch-basin inserts, storm drain inserts, floating debris traps, side entry pit traps), and Source Control BMPs (e.g., efficient street cleaning, increased enforcement of existing litter laws, providing dumpsters to known houseless camps). While each city, and county for non-incorporated areas, will receive an allocation based on the trash generation factors for its land uses, the area not regulated under industrial stormwater permits will be permitted separately. Each city must provide DEQ with a list of entities located within their boundaries which are outside of their jurisdiction, including state and federal lands and facilities, within 120 days of the adoption of this Trash TMDL. DEQ will review the lists of state and federal entities and issue permits as warranted.

Dates, Deadlines, and Requirements for the Willamette River Basin Trash TMDL

	Collection of Baseline Data
	List of baseline monitoring locations due to DEQ
120 days after the adoption of this Trash TMDL	Submission by each city of a list of facilities that are within their boundaries but under state or federal jurisdiction
Wet weather: after every rain event over 0.25 inches	Collection and analysis of trash at monitoring location
Dry weather: every two months from the last rain event	Collection and analysis of trash at monitoring location

Appendix I

The following table (Table 1) shows the estimated waste generation, disposal, and recovery in 2021 for all wastesheds located along the Willamette River.

Table 1:

Wasteshed Recovery Rates, 2021 ²⁹					
Wasteshed	Tons Disposed	Tons Recovered	Tons Generated	Calculated Recovery Rate	SB 263 Goal 2025
Benton	60,957	39,466	100,433	39.30%	44%
Lane	283,634	331,183	614,817	53.90%	63%
Linn	109,434	93,426	303,860	46.10%	45%
Marion	287,947	270,824	558,771	48.50%	46%
Metro	1,357,591	1,179,812	2,537,404	46.50%	64%
Polk	51,685	44,596	96,281	46.30%	48%
Yamhill	86,938	49,561	136,499	36.20%	45%
Oregon Totals	3,452,854	2,507,951	5,960,805	42.10%	

²⁹ 2021 Oregon Material Recovery and Waste Generation Rates Report – Tables 1-9 Only By: Materials Management Program Land Quality Division Oregon Department of Environmental Quality.

The following table (Table 2) shows the estimated waste recovery per capita in 2021 for all wastesheds located along the Willamette River.

Table 2:

Amount Recovered in 2021 by Wasteshed ³⁰			
Wasteshed	Tons Recovered	Pounds Per Capita	Wasteshed Population
Benton	39,466	914	86,365
Lane	331,183	1,737	381,365
Linn	93,426	1,376	135,820
Marion	270,824	1,552	348,920
Metro	1,179,812	1,258	1,876,155
Polk	44,596	1,076	82,910
Yamhill	49,561	905	109,500
Oregon Totals	2,507,951	1,175	4,268,055

The following table (Table 3) shows the estimated total waste recovery rates in Oregon from 1992 until present.

Table 3:

Oregon State Recovered Tons and Recovery Rates ³¹			
Year	Tons Recovered	Tons Disposed	Calculated Rate¹⁰
1992	839,679	2,263,099	27.1
1993	974,685	2,280,513	29.9

³⁰ 2021 Oregon Material Recovery and Waste Generation Rates Report – Tables 1-9 Only By: Materials Management Program Land Quality Division Oregon Department of Environmental Quality.

³¹ 2021 Oregon Material Recovery and Waste Generation Rates Report, Materials Management Program Land Quality Division Oregon Department of Environmental Quality at 15

1994	1,118,912	2,312,669	32.6
1995	1,257,204	2,362,146	34.7
1996	1,338,259	2,497,170	34.9
1997	1,462,114	2,633,017	35.7
1998	1,604,985	2,695,903	37.3
1999	1,626,271	2,788,699	36.8
2000	1,765,817	2,778,463	38.9
2001	1,999,085	2,635,072	43.1
2002	2,029,261	2,723,365	42.7
2003	2,116,880	2,796,787	43.1
2004	2,317,064	2,923,462	44.2
2005	2,523,367	3,026,457	45.5
2006	2,494,050	3,235,828	43.5
2007	2,437,569	3,248,126	42.9
2008	2,326,146	2,890,503	44.6
2009	2,082,631	2,586,721	44.6
2010	2,163,957	2,523,808	46.2
2011	2,306,124	2,437,767	48.6
2012	2,391,490	2,424,833	49.7
2013	2,390,859	2,513,404	49.5
2014	2,307,269	2,634,653	47.2
2015	2,369,080	2,784,467	46.0
2016	2,225,9501	3,059,7451	42.11

2017	2,286,969	3,237,2141	41.41
2018	2,307,5451	3,295,4681	41.21
2019	2,403,3931	3,286,3081	42.21
2020	2,507,951	3,452,854	42.1

|

Comments from Bill O'Brien

SCHICK Daniel * DEQ

From: bill obrien <obrienmurphy@yahoo.com>
Sent: Saturday, June 1, 2024 23:33
To: IntegratedReport * DEQ
Subject: TMDL aquatic trash problem

You don't often get email from obrienmurphy@yahoo.com. [Learn why this is important](#)

This is a serious issue on the Willamette and Mary's River in the Corvallis area where I live. I grew up near the Willamette River and have recreated on it for 60 years, fishing as a kid and kayaking now. I have been on around a dozen clean-ups along its shore focused on homeless trash. Though they are not the only problem groups, they are the most impactful by far.

These sites in all but one case included tents and sleeping bags that have been abandoned, bed mattresses are common, too. They get these free for the asking, so when late fall arrives and the river rises the occupants simply walk away. Tarps, clothing, rugs, propane tanks, bike parts, spoiled food, and nearly always used needles, many times uncapped remain.

It's a race against time to get these sites cleaned up. Often there is so much trash that the ground is covered. Then the tress drop leaves covering much of the trash. Rain arrives and the river rises. People leave just prior to flooding. We get some sites cleaned in this short window, but the river claims other sites resulting in a debris field.

Several times, I contacted friends to help as the rising water is already flooding sites. On several occasions I don a dry suit and have literally swum in flood waters to move the trash to higher ground to get later. I was on a fire department's swiftwater and dive rescue teams for nearly thirty years and upon retiring have kayaked from Alaska to Mexico camping along the way, so I know what I'm doing in my flood swimming adventures. In one of these instances I literally recovered 100 used syringes with about 90 of these found underwater, as they floated when sunken fabric was carefully pulled up. This was in Avery park! Another time I swam out and retrieved a large yard debris container from under a railroad bridge. Another time I tied a floating couch to a tree and came back later with a portable winch and winched it to the top of the embankment. Another time I swam out in light current with a safety rope and grabbed a mattress that was hung up in the last tree branch farthest from shore. I came back later and winched it up to the sidewalk under the Van Buren Bridge.

One time I was with Willamette Riverkeepers on a clean up along another Corvallis park and a volunteer stepped on an uncapped syringe that was covered with mud from a recent flood with only the needle sticking up out of the mud. He ended up getting two preventative medications which he took for a month and paid out of pocket \$500 over insurance costs. He became hugely frustrated largely because local government does next next to nothing and these sites that we clean become occupied again and again. He and I feel like maid service to these few homeless people. I say few because out of around 400 homeless people in Corvallis less than two dozen are the ones that trash the river. It shouldn't be hard to keep them off the river, especially since nearly every other homeless person in Corvallis is not camping along the river.

Last summer, when the water level was extremely low, I kayaked a short distance up the Mary's River and saw a bit of black tarp sticking out of the gravel. I tried to remove it only to discover that it crossed nearly the entire river and only a bit stuck out here and there. It's probably still there. One site that we never got to before flooding had five tents, several tarps, sleeping bags and miscellaneous trash covering the ground. It is along a quarry owned by Knife River, so we couldn't clean it without trespassing and other sites kept us busy anyway. Leaves fell and floods came leaving a layer of silt to cover most of the trash. The same thing happened the following year and the year after that. The trash is still there, mostly out of site.

As you know, plastic breaks down into tinier and tinier peaces and enters the food chain. Estimates of microplastic volume in the ocean at this point in time shockingly roughly equals the volume of plankton! Microplastic is in all of our bodies now, in human milk, and in our brains. The rate of plastic pollution in our waterways is rapidly increasing. This won't be the end of the world, but it clearly is one of the major environmental issues of modern times as well as a public health issue needing much more research. Needless to say, this issue needs to be addressed on several fronts, and in this case, plastic pollution in our waterways is low hanging fruit.

It's crazy not to move TMDL for aquatic trash near the top of the list of priorities. Please do so!

Bill O'Brien

Comments from Charles Loos:

SCHICK Daniel * DEQ

From: MERRICK Lesley * DEQ
Sent: Tuesday, April 23, 2024 09:16
To: IntegratedReport * DEQ
Subject: Fw: Comment on 2024 Integrated Report: Aquatic Trash

From: Charles Loos <charles@theoceancoach.com>
Sent: Tuesday, April 23, 2024 9:12 AM
To: MERRICK Lesley * DEQ <Lesley.MERRICK@deq.oregon.gov>
Subject: Comment on 2024 Integrated Report: Aquatic Trash

You don't often get email from charles@theoceancoach.com. [Learn why this is important](#)

Hello Lesley,

The public comment link on your web page does not work, so I'm taking the liberty of sending you my comments directly. I hope you don't mind.

I'm excited about the prospect of including Willamette Trash in a Clean Water Act 303(d) listing. By way of background, I've rowed on the Willamette River in the Portland area, totaling several thousand miles. I also fish for Spring Chinook on the river. I offer two comments.

First, I no longer row or fish as much due to the despoiling of the Willamette. This despoiling comprises four parts; 1) unsightly squatter boats, 2) homeless camps along the river, 3) trash, needles and sewage in and along the river, and 4) feeling intimidated by boat squatters and bank-based homeless, since they are often mentally ill, acting erratically or in a threatening manner. I'm quite vulnerable alone in my 14 foot rowboat.

In other words, I now avoid using the river due to the trash, boat squatters and intimidation factors. For me, the river is no longer the urban treasure it once was. As much as the Big Pipe recovered the river for recreational use, the trash has once again dirtied and defiled the river.

Second, I am frustrated by the inability of the competing jurisdictions to solve the problem. The City, Sheriff, Coast Guard, Landowners (e.g. Ross Island) and Marine Board all claim they lack jurisdiction to do anything. They throw up their hands and nothing gets done.

I hope that a 303(d) listing can break the regulatory and enforcement logjam.

Let me know how I can help.

Best,
Charles Loos

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Comments from Celeste Wolf:

SCHICK Daniel * DEQ

From: Celeste Wolf <cpwolf@gmail.com>
Sent: Saturday, May 18, 2024 08:53
To: IntegratedReport * DEQ
Subject: Aquatic trash

You don't often get email from cewolf@gmail.com. [Learn why this is important](#)

1. DEQ should find aquatic trash pollution to be at least medium priority in their rankings.
2. The aquatic trash crisis gets worse every year.
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.
 - There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
 - Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.
 - Humans are consuming up to a credit card's size of microplastics a week.

Thank you for listing segments of the Willamette River as impaired for trash.

Comments from Chris Shults:

SCHICK Daniel * DEQ

From: Chris <cdshults321@gmail.com>
Sent: Sunday, May 19, 2024 11:34
To: IntegratedReport * DEQ
Subject: Willamette River - TMDL Priority

You don't often get email from cdshults321@gmail.com. [Learn why this is important](#)

Hello,

My name is Chris Shults. I live in Eugene and volunteer regularly for various outdoors-related organizations in town. I'm also a fisherman and often find myself on the banks of the Willamette at different points throughout the Valley.

First, I'd like to thank the DEQ for listing segments of the Willamette as impaired for trash, as this shows an understanding for the growing crisis that threatens the river. However, I do think that additional intervention is needed in the form of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

Despite the efforts of various organizations in the Valley, both volunteer and paid, I fear that our communities will be unable to hold the line against the accumulation of trash in the coming years without an aquatic trash TMDL on this year's Schedule. Trash piles along the banks continue to grow, adding more and more microplastics to the water and harming the wildlife that depends on the Willamette for survival.

As someone who frequently uses public parks and access points to reach the Willamette, I try to take personal responsibility for the health of the river by picking up trash whenever I see it and also volunteering regularly. I am asking the DEQ to also do as much as they can to prevent trash accumulation by including an aquatic trash TMDL on this year's Schedule.

Thank you for reading and for the work that you do.

Best,
Chris

Comments from Cory Starr:

SCHICK Daniel * DEQ

From: Cory Starr <Cory.Starr@EWEB.ORG>
Sent: Tuesday, May 21, 2024 15:51
To: IntegratedReport * DEQ
Subject: Waste on the Willamette and subsequent TMDL

You don't often get email from cory.starr@eweb.org. [Learn why this is important](#)

Hello,

I am reaching out not only as a fisheries biologist on the McKenzie, but also as a frequent recreationalist on the Willamette River and its forks. I am happy to see that the DEQ is aware of the issues we are facing with trash pollution in and along our waterways with the recent listing of "impaired" for trash. However, this is only a box check until further action is taken starting with the appropriate aquatic trash TMDL. I urge you to prioritize this project in future plans as it seems the problem has only gotten worse with time despite the heightened use from other recreationalists that want the best for our waterways and actively engage in river clean ups and reporting just to see it return to a worse state year after year.

Thank you,

Cory Starr

Fish Biologist
Eugene Water & Electric Board

Email: Cory.Starr@eweb.org

Comments from David Kenney

SCHICK Daniel * DEQ

From: David Kenney <dskenneypdx@gmail.com>
Sent: Tuesday, May 21, 2024 17:29
To: IntegratedReport * DEQ
Subject: Comments on 2024 draft Integrated Report

You don't often get email from dskenneypdx@gmail.com. [Learn why this is important](#)

Dear DEQ,

Please accept my comments on the 2024 draft Integrated Report. Thank you for listing segments of the Willamette river *impaired* for trash!

I am a kayaker, most frequently paddling on the Willamette River in a variety of locations between West Linn and the confluence with the Columbia River. I have been concerned with the increased amount of trash that I see in recent years. As a concerned citizen and paddler, I see plastics and large garbage obstructions very frequently along our shores and in the water.

The microplastics **negatively impact wildlife and fish habitat** which in turn can affect fishing and hunting. I am often afraid for boaters, jet skiers, and paddle boarders when I observe floating or hard to see **garbage that could be hazardous**. The DEQ should **create an aquatic trash TMDL** on the 2024 TMDL Priorities and Schedule. Pollution of aquatic trash **should be a high, or at least, medium priority** in your rankings.

I appreciate your consideration and for listing segments of our beloved Willamette impaired for trash - let's work together to make *cleaning it up and preventing trash a higher priority, now rather than later*.

Regards,
David Kenney
Portland, OR

Comments from Dennis Pennell

SCHICK Daniel * DEQ

From: Dennis Pennell <bluespaddler@gmail.com>
Sent: Saturday, May 18, 2024 07:42
To: IntegratedReport * DEQ
Subject: Willamette River Aquatic Trash

[You don't often get email from bluespaddler@gmail.com. Learn why this is important at <https://aka.ms/LearnAboutSenderIdentification>]

Thanks to Oregon DEQ for listing segments of the Willamette River as impaired for trash.

Please make the aquatic trash in the Willamette River a high priority for Oregon DEQ.

The aquatic trash crisis gets worse every year, especially with regard to plastic trash which breaks down into microtrash and gets into the food chain.

I suggest that DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.

Dennis Pennell
McMinnville, Oregon

Comments from Emily Platt

SCHICK Daniel * DEQ

From: Emily Platt <emilyplatt93@yahoo.com>
Sent: Saturday, May 18, 2024 10:35
To: IntegratedReport * DEQ
Subject: Willamette River trash

You don't often get email from emilyplatt93@yahoo.com. [Learn why this is important](#)

In the 2024 draft Integrated Report, DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings. As documented by Willamette Riverkeeper and others, the aquatic trash crisis gets worse every year. Therefore, DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule. In addition, DEQ should find aquatic trash pollution as an impairment to beneficial uses in addition to recreation and aesthetics. For example, there is much scientific literature on microplastics describing negative effects on fish, aquatic life and wildlife, which can affect fishing and hunting. Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Lastly, I wish to thank DEQ for listing segments of the Willamette River as impaired for trash.

Sincerely,
Emily Platt
Portland, OR

Comments from Glenn and Gison Creek Watershed Council



Glenn and Gibson Creeks Watershed Council 2308 Ptarmigan St. NW, Salem, OR 97304

May 22, 2024

Lesley Merrick
WQ Assessment Program Lead
Oregon Department of Environmental Quality
700 NE Multnomah Street, Suite 600
Portland, OR 97232-4100

RE: 2024 Integrated Report: Aquatic Trash

Dear Ms. Merrick:

The Glenn Gibson Creek Watershed Council is very pleased to see that aquatic trash has been identified as a pollutant in the Willamette River. The area of insufficient information through the Salem area includes a significant area of houseless occupancy on the west side of the river at the north end of Wallace Marine Park. It is estimated that more than 500 occupants are camping in the floodplain in this area. There are no waste facilities in the area and the significant potential for E. coli, debris, and other materials associated with houseless camping are observable and can be readily documented. The Council will contact the City of Salem to develop information necessary to document impairment.

The council believes strongly that aquatic trash should be at least a medium priority for the State and part of urban area stormwater permits. The council urges DEQ to elevate the priority and conduct a statewide survey on the magnitude of the issue. While Willamette Riverkeeper has done an excellent job of documenting the issue through their Willamette River clean up program, there are houseless encampments throughout the state in riparian and floodplain sites.

In conversation with City of Salem Public Works staff it is clear that aquatic trash has more than an aesthetic and recreational impact. There is a high likelihood that houseless encampments are sources of E. coli, and discarded batteries and other metals could have toxic residues as well. It is clear that the water quality issue is not solely aesthetics. The potential for toxic and bacterial contamination needs to be measured and evaluated to ensure Oregon's water quality standards are met.

Mission: to foster better understanding and stewardship of watershed resources

Purpose: to share information, reduce duplication of activities and to help address watershed management issues in the watershed and to provide a framework for coordination and cooperation among key interests

Vision: a balanced ecosystem that supports a healthy watershed and provides for an economic base and viable communities

GlennGibsonWC.org

The Glenn Gibson Creek Watershed Council is pleased that the Oregon Department of Environmental Quality has taken the bold step of identifying aquatic trash as a pollutant. The bold start should be followed by actions to both raise awareness and develop solutions to the problem.

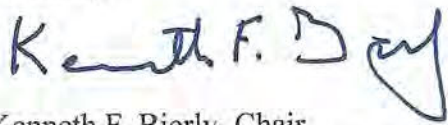
To that end the Glenn Gibson Creek Watershed Council encourages the agency to consider:

1. Upgrading the priority to at least a moderate priority for developing TMDLs.
2. Conducting a state-wide survey of at least urban areas on the potential for such issues throughout the waters of the state.
3. Cooperating with interested communities and community organizations to document both the occurrence of trash and water quality parameters associated with areas of trash occurrence (especially E. coli).

The council believes that by following up with these efforts, DEQ can schedule the development of a TMDL for streams in a consistent manner, starting with the Willamette.

Please feel free to call if you have any questions.

Sincerely,

A handwritten signature in dark ink, appearing to read "Kenneth F. Bierly". The signature is fluid and cursive, with a large, stylized "B" and "y".

Kenneth F. Bierly, Chair
Glenn Gibson Creek Watershed Council

- c. Jeff Johnson, Salem Public Works
Lindsey Hutchison, Staff Attorney, Willamette Riverkeeper

Comments from Inga Fisher Williams

SCHICK Daniel * DEQ

From: IntegratedReport * DEQ
Sent: Thursday, April 25, 2024 15:58
To: IntegratedReport * DEQ
Subject: Fwd: Trash from camps along the Willamette River

Sent via the Samsung Galaxy XCover Pro, an AT&T 4G LTE smartphone
Get [Outlook for Android](#)

From: Inga Fisher Williams <ifisherw@gmail.com>
Sent: Thursday, April 25, 2024 10:32:16 AM
To: IntegratedReport * DEQ <IntegratedReport@deq.oregon.gov>
Cc: Rep Nguyen D <Rep.DanielNguyen@oregonlegislature.gov>; Sen Wagner <sen.robwagner@oregonlegislature.gov>
Subject: Trash from camps along the Willamette River
[You don't often get email from ifisherw@gmail.com. Learn why this is important at <https://aka.ms/LearnAboutSenderIdentification>]

input to DEQ rule making re trash

It is pretty clear from visual inspections along the bank of the Willametter river that DEQ and other governmental entities are playing catch up when it comes to accumulated debris from homeless camps within the general Portland metro region.

In particular the East bank of the river from Ross Island bridge to Sellwood bridge has gotten a free ride where year round a flotilla of some 14 vessels are moored. Seemingly immune from recourse. Trash piles are growing. Is anyone checking whether these vessels even have holding tanks for urine and feces? How can the owner of the property that used to operate Ross Island Sand And Gravel be held to account for this multi year nuisance? The lagoon is predictably named annually for its toxic algae bloom . Aside from water quality itself, canoeists, paddle board and sail boat users (yes , there is a sailing club just North of Willamette Park) are affected. Parents bring their toddlers to play in the sand at waters edge. All this pollution upstream from OHSU, the Waterfront development, downtown riverwalk and areas where folks actually swim?

I guess it is nice that DEQ is thinking about updating its standards and rules but is a complex process of rule making really the BEST we can do immediately? This issue has been ignored for years, all along the river. Corvallis has been conducting periodic sweeps where known sites favored by homeless squatters have become a predictable nuisance. [Ditto along the Spring Water trail, Clackamas County.]

Not so long ago, the river was like a sewer, a dumping ground for industrial, commercial and residential effluent. It took Gov Tom McCall to inspire a Willamette clean up decades ago.

Who has the moxie to convene relevant governmental bodies which ought have a stake in water quality (Counties, Metro, cities, sheriff departments, boat licensing entities, water safety patrols, etc) in a joint task force to tackle homeless camp pollution whether from floating (potentially decrepit) vessels or shoreline garbage piles?

It is way past time to act.
Inga Fisher Williams
Portland, Johns Landing

Sent from my iPad

Comments from Ignacio Gonzalez

SCHICK Daniel * DEQ

From: Ignacio Gonzalez <ignacio927@hotmail.com>
Sent: Sunday, May 19, 2024 09:52
To: IntegratedReport * DEQ
Subject: Comments on DEQ's draft integrated report

You don't often get email from ignacio927@hotmail.com. [Learn why this is important](#)

To DEQ:

I am writing to request that DEQ create an aquatic trash TMDL that will be implemented at the local, state, and federal levels. As most aquatic trash is nonpoint source pollution, a TMDL will be implemented through a variety of programs that may be regulatory, non-regulatory, or incentive-based as opposed to the permits that are typically used for point source pollution. The longer DEQ takes to make a TMDL for aquatic trash in the Willamette, the longer it will take for these programs to get off the ground, and the more garbage, chemicals, and biohazards will deteriorate water quality, wildlife habitat, and river recreation experiences.

1. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.
2. The aquatic trash crisis gets worse every year.
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics. There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting. Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Thank you for listing segments of the Willamette River as impaired for trash.

Sincerely,
Stacie Hall
Oregon City, OR 97045

Comments from John Cluskey

SCHICK Daniel * DEQ

From: John Cluskey <clusk01@yahoo.com>
Sent: Sunday, May 19, 2024 07:30
To: IntegratedReport * DEQ
Subject: 2024 draft Integrated Report

You don't often get email from clusk01@yahoo.com. [Learn why this is important](#)

Hi,

Thanks for listing the Willamette River as impaired by trash, I truly appreciate the recognition.

The problem appears to be getting worse every year.

I request to make that cleanup a higher priority.

Sincerely,
John

Comments from Jamie Knight

SCHICK Daniel * DEQ

From: jamie knight <darkrider_64@yahoo.com>
Sent: Sunday, May 19, 2024 18:37
To: IntegratedReport * DEQ
Subject: Willamette River Trash

You don't often get email from darkrider_64@yahoo.com. [Learn why this is important](#)

Hi DEQ,

The Willamette River is trashy and getting worse each year, the microplastics are killing us and the wildlife. Us more slowly than the wildlife. The Riverkeepers showed the amount of trash and we should do something about it! Thank you for listing Willamette River as impaired for trash.

James Knight
Corvallis, Oregon

Comments from Judith Lienhard

SCHICK Daniel * DEQ

From: Judith Lienhard <judith.lienhard1956@gmail.com>
Sent: Saturday, May 18, 2024 06:15
To: IntegratedReport * DEQ
Subject: Our Willamette river is a priority!

You don't often get email from judith.lienhard1956@gmail.com. [Learn why this is important](#)

dear officials at DEQ:

DEQ, please find aquatic trash pollution to be a high or at least medium priority in your rankings.

The aquatic trash crisis gets worse every year.

DEQ, please include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

DEQ, please find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.

- There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
- Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

. Thank you for listing segments of the Willamette River as impaired for trash. Warmly,

Judith Lienhard, Portland Oregon retired nurse and military veteran

Comments from Jim Stuller

SCHICK Daniel * DEQ

From: Jim Stuller <stullerjim@gmail.com>
Sent: Saturday, May 18, 2024 08:14
To: IntegratedReport * DEQ

You don't often get email from stullerjim@gmail.com. [Learn why this is important](#)

Key Messages:

1. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.
2. The aquatic trash crisis gets worse every year.
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.
 - There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
 - Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Thank you
Jim Stuller


Comments from Jeff Malmquist

SCHICK Daniel * DEQ

From: Jeff Malmquist <jmalmquist6974@gmail.com>
Sent: Saturday, May 18, 2024 13:45
To: IntegratedReport * DEQ
Subject: 2024 Draft Integrated Report

You don't often get email from jmalmquist6974@gmail.com. [Learn why this is important](#)

Hello! I hope Oregon DEQ will create an aquatic trash TMDL, especially on the Willamette, and most especially on the Willamette near and in Portland.

Aquatic trash is a current and growing problem on the Willamette that we need to address.

Thank you!

Jeff Malmquist


SCHICK Daniel * DEQ

From: Jeff Malmquist <jmalmquist6974@gmail.com>
Sent: Wednesday, April 24, 2024 07:16
To: IntegratedReport * DEQ
Subject: 2024 Draft Integrated Report

You don't often get email from jmalmquist6974@gmail.com. [Learn why this is important](#)

Hi! I have volunteered at several cleanups on the banks of the Willamette in Portland organized by Willamette Riverkeeper. The amount of trash, feces and drug paraphernalia at just one of the many homeless camps we encountered is frightening.

Whatever we can do to greatly reduce this riverside trash will help all of us.

Thank you for your efforts!

Jeff Malmquist


Comments from John Maroney

SCHICK Daniel * DEQ

From: John Maroney <maroneyjo@yahoo.com>
Sent: Sunday, May 19, 2024 17:14
To: IntegratedReport * DEQ
Subject: Willamete Trash Pollution

You don't often get email from maroneyjo@yahoo.com. [Learn why this is important](#)

Dear DEQ,
Please prioritize trash pollution and create an aquatic trash TMDL on the 2024 TMDL Schedule.
DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics. Thank you for your attention in this regard.

Sincerely, John Maroney
Portland OR

Comments from Kristy Overton

SCHICK Daniel * DEQ

From: Kristy Overton <kristy@overton.club>
Sent: Saturday, May 18, 2024 10:01
To: IntegratedReport * DEQ
Subject: comments on draft integrated report

You don't often get email from kristy@overton.club. [Learn why this is important](#)

Hi! I am someone who lives and works near the Willamette River. Thank you for including parts of the river as impaired for trash - aquatic trash is a huge problem and only gets worse over time. It's not just a problem of looking gross, or scaring away would-be kayakers; there is a body of scientific literature demonstrating the harmful effects of microplastics on aquatic life and wildlife. It affects fishing and hunting as well as the ecosystem in general. And the "macro" trash is also both (a) extant and (b) a hazard for boats, among other things.

I hope to see DEQ find aquatic trash pollution to be a high or at least medium priority in their rankings, for the reasons above. I also hope to see DEQ include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

Thanks for your time, and all your efforts in this area.
Kristy Overton

Comments from Linda Leyva

SCHICK Daniel * DEQ

From: Linda Leyva <lindaomsi@gmail.com>
Sent: Saturday, May 18, 2024 07:07
To: IntegratedReport * DEQ
Subject: Aquatic Trash in our rivers

You don't often get email from lindaomsi@gmail.com. [Learn why this is important](#)

1. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.
2. The aquatic trash crisis gets worse every year.
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.
 - There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
 - Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Thank you for making aquatic trash control a priority!

Linda Leyva

Sent from my iPhone

Comments from Lucinda Pierpont

SCHICK Daniel * DEQ

From: Lucinda Pierpont <lucindapierpont@gmail.com>
Sent: Saturday, May 18, 2024 06:48
To: IntegratedReport * DEQ
Subject: Aquatic trash on the Willamette River

[You don't often get email from lucindapierpont@gmail.com. Learn why this is important at <https://aka.ms/LearnAboutSenderIdentification>]

Please make this issue a priority in all your upcoming legislations as we all know the Willamette River has been polluted for decades. In our beautiful state let's not continue to ignore the necessity for clean -up of the Willamette River and ongoing measures to maintain the riverbanks and eliminate the trash that persistently accumulates due to lax measures to keep Oregon, it's rivers, it's people and wildlife safe from pollutants now and evermore.

Respectfully,
Lucinda Lee Pierpont
Sent from my iPhone

Comments from Lydia Stivers

SCHICK Daniel * DEQ

From: Lee S. <leestivers9607@gmail.com>
Sent: Saturday, May 18, 2024 08:10
To: IntegratedReport * DEQ
Subject: the Willamette River is a Priority!

You don't often get email from leestivers9607@gmail.com. [Learn why this is important](#)

Good morning,

As a member of the Willamette River Keepers, I would like to provide comments to the draft integrated report.

Aquatic trash pollution remains a significant problem for the Willamette River, and worsens every year. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.

To help address this issue, DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

In its report, DEQ should also find that aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.

- There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
- Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Thank you for listing segments of the Willamette River as impaired for trash but I urge you to go further by making TMDL for aquatic trash a higher priority, to be implemented at local, state and federal levels.

Sincerely,
Lydia Stivers

[REDACTED]
[REDACTED]

Comments from Mariam Higgins

SCHICK Daniel * DEQ

From: Mariam Higgins <higgins.draws@gmail.com>
Sent: Tuesday, May 21, 2024 16:51
To: IntegratedReport * DEQ
Subject: Comments on 2024 draft Integrated Report

You don't often get email from higgins.draws@gmail.com. [Learn why this is important](#)

Dear DEQ,

Please accept my following comments on the 2024 draft Integrated Report. To begin, thank you for listing segments of the Willamette river *impaired* for trash! The amount of trash I encounter as a kayaker gets worse every year. As a concerned citizen and outdoorswoman I see plastics and large garbage obstructions very frequently along our shores and in the water. The microplastics **negatively impact wildlife and fish habitat** which in turn can affect fishing and hunting. I am often afraid for boaters, jet skiers, and paddle boarders when I observe floating or hard to see **garbage that could be hazardous**. The DEQ should **create an aquatic trash TMDL** on the 2024 TMDL Priorities and Schedule. Pollution of aquatic trash **should be a high, or at least, medium priority** in your rankings.

Again, I appreciate your consideration and for listing segments of our beloved Willamette impaired for trash - let's work together to make *cleaning it up and preventing trash a higher priority, now rather than later*.

Best,
Mariam Higgins

--

Mariam Higgins


Comments from Melody Long

SCHICK Daniel * DEQ

From: Melody Long <durgama07@gmail.com>
Sent: Saturday, May 18, 2024 08:13
To: IntegratedReport * DEQ
Subject: Draft Integrated Report

You don't often get email from durgama07@gmail.com. [Learn why this is important](#)

To Whom It May Concern at DEQ,

First of all, thank you for listing segments of the Willamette River as impaired for trash. But much more needs to be done.

As a Portlander who spends time on the rivers of our area kayaking, walking and hiking alongside them, and generally benefits from living near the beauty of the rivers, I am asking that for your Intergrated Report this agency makes trash pollution a high or at least medium priority in your rankings.

The trash situation in our area is horrible and next to the water it is getting worse every year and polluting our waterways.

DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.

DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.

- There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
- Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Sincerely,

Melody Long
Portland, 97202

Comments from Marilyn McWilliams

SCHICK Daniel * DEQ

From: Marilyn McWilliams <marilynamcwilliams@gmail.com>
Sent: Monday, May 20, 2024 06:55
To: IntegratedReport * DEQ
Subject: Need for a TNDL for trash on the Willamette River

[You don't often get email from marilynamcwilliams@gmail.com. Learn why this is important at <https://aka.ms/LearnAboutSenderIdentification>]

Sent from my iPhone

I have paddled and kayaked on the Willamette River, and found the increasing amount of trash a hazard for boating and use of the shoreline. Please institute a TMDL for trash to focus on the destruction of our beaches due to trash.

Comments from Michael Kipley

SCHICK Daniel * DEQ

From: sMheo2438 Kipley <mjkipley@gmail.com>
Sent: Sunday, May 19, 2024 14:06
To: IntegratedReport * DEQ
Subject: Willamette River Impairment

You don't often get email from mjkipley@gmail.com. [Learn why this is important](#)

Aquatic trash on and along the Willamette River continues to worsen every year. DEQ should declare aquatic trash pollution as an impairment to recreation and aesthetics on the Willamette River. DEQ should also raise the priority of this issue in their rankings. Further, DEQ should create an aquatic trash TMDL for the Willamette River in their TMDL Priorities and Schedule for 2024.

Thank you.

Michael Kipley

mjkipley@gmail.com

Comments from Michael Schilmoeller

From: Michael Schilmoeller <michaeljschilmoeller@gmail.com>
Sent: Monday, May 20, 2024 13:55
To: IntegratedReport * DEQ
Subject: Aquatic trash pollution

You don't often get email from michaeljschilmoeller@gmail.com. [Learn why this is important](#)

The Willamette River and the issue of aquatic trash remain a low priority for the State, and creating a Total Maximum Daily Load (TMDL) for aquatic trash is not on DEQ's schedule. The trash crisis keeps getting worse and will only continue to accumulate in the river and on our shores without prioritized action to move forward.

DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.

DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.

There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.

Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Thank you, nevertheless, for listing segments of the Willamette River that have been impaired for trash.

Michael Schilmoeller and
Katie Larsell

Northeast Portland,
Kayakers, and
Users of the Columbia Slough, the Columbia River, and
the Willamette River

Comments from Mark Scantlebury

SCHICK Daniel * DEQ

From: Mark Scantlebury <scantle@earthlink.net>
Sent: Tuesday, May 21, 2024 15:51
To: IntegratedReport * DEQ
Subject: Oregon's draft 2024 Integrated Report on Surface Water Quality and 303(d) List of Water Impaired Waters

You don't often get email from scantle@earthlink.net. [Learn why this is important](#)

I want to commend DEQ for listing the Willamette River as impaired for trash. This is an important step. But I also want to urge DEQ to make creating a TMDL for aquatic trash a higher priority. We need an aquatic trash TMDL that can be implemented at the local, state, and federal levels. We need one that brings aquatic trash pollution up to a high, or at the minimum, medium priority in DEQ rankings.

As most aquatic trash is nonpoint source pollution, a TMDL will enable implementation through a variety of programs that may be regulatory, non-regulatory, or incentive-based as opposed to the permits that are typically used for point source pollution. The longer DEQ takes to make a TMDL for aquatic trash in the Willamette, the longer it will take for these programs to get off the ground, and the more garbage, chemicals, and biohazards will deteriorate water quality, wildlife habitat, and river recreation experiences.

Now that DEQ has listed the Willamette as trash-impaired, let's take the next step.

Sincerely yours,
Mark Scantlebury
[Lower Columbia Canoe Club](#)

Comments from Nikki Dennis

SCHICK Daniel * DEQ

From: MERRICK Lesley * DEQ
Sent: Tuesday, May 7, 2024 13:29
To: IntegratedReport * DEQ
Subject: Fw: Regulate the Willamette River Under the Clean Water Act

From: LIFE2024 Aquatic * DEQ <Aquatic.Life2024@DEQ.oregon.gov>
Sent: Tuesday, May 7, 2024 10:17 AM
To: MERRICK Lesley * DEQ <Lesley.MERRICK@deq.oregon.gov>; MILLER-PIERCE Mailea * DEQ <Mailea.MILLER-PIERCE@deq.oregon.gov>
Cc: DOU Connie * DEQ <Connie.DOU@deq.oregon.gov>
Subject: FW: Regulate the Willamette River Under the Clean Water Act

Hi Lesley,

We received this public comment below to the Aquatic Life Toxics mailbox and it looked like it was meant to be an IR public comment. I let the commenter, Nikki, know and provided a link to the IR public comment information in case it was a mistake. I am forwarding her comment to you in case she did not submit a comment to you (she may have in which case this would be a duplicate).

-Mailea

From: Nikki Dennis <nmden1@hotmail.com>
Sent: Thursday, May 2, 2024 1:41 PM
To: LIFE2024 Aquatic * DEQ <Aquatic.Life2024@DEQ.oregon.gov>
Subject: Re: Regulate the Willamette River Under the Clean Water Act

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Thank you, Mailea, for taking the kind effort to ensure my comments were directed to the proper place.

Sincerely,

Nikki

From: LIFE2024 Aquatic * DEQ <Aquatic.Life2024@DEQ.oregon.gov>
Sent: Thursday, May 2, 2024 10:31 AM
To: Nikki Dennis <nmden1@hotmail.com>
Subject: RE: Regulate the Willamette River Under the Clean Water Act

Hi Nikki,

Thank you for your comment. Since your comment mentioned a few topics that seem related to another open Public Comment for DEQs [Draft 2024 Integrated Report](#), I wanted to make sure you commented on the rulemaking you intended to comment on. This comment you submitted is for the rulemaking on [Aquatic Life Toxics Criteria](#).

In any case, your comment will be included. I didn't want you to miss out on commenting on the Integrated Report if that was your intention.

Please let me know if you have any questions.

Thanks,

Mailea

From: Nikki Dennis <nmden1@hotmail.com>
Sent: Thursday, April 25, 2024 10:25 AM

To: LIFE2024 Aquatic * DEQ <Aquatic.Life2024@DEQ.oregon.gov>

Subject: Regulate the Willamette River Under the Clean Water Act

You don't often get email from nmden1@hotmail.com. [Learn why this is important](#)

Hello DEQ,

I strongly support having the Willamette River ([and other Oregon bodies of water such as the Columbia Slough/parts of Oregon Coast](#)) regulated under the Clean Water act and holding landowners accountable for preventing camping and/or cleaning up the trash that could further contaminate/pollute the river. For far too long, trash has accumulated in the river at the expense of water quality that affects people who use the river. It is disheartening that we are only the third river in the nation to seek this type of needed regulation and that it has been allowed to get to this level.

It is especially concerning to me in regards to the wildlife such as river otters, fish, waterfowl/birds, and other aquatic life who depend on the river for survival. We are in the midst of the [Sixth Mass Extinction](#) and every opportunity to undo harm to ecosystems and to the environment we all call home must be taken. I am thankful that Willamette Riverkeeper has brought this issue to the forefront and I hope you take advantage of that opportunity as it appears you will so there is more recourse for actions or inactions that harm the health of the river.

Thank you,
Nikki Dennis
Portland, OR

Comments from Nora Stern

SCHICK Daniel * DEQ

From: Nora Stern <norastern1@gmail.com>
Sent: Saturday, May 18, 2024 07:56
To: IntegratedReport * DEQ
Subject: Willamette River comments

You don't often get email from norastern1@gmail.com. [Learn why this is important](#)

I would like to submit comments for the integrated report on the Willamette River:

1. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings due to previous findings that indicate need for concern, and due to the impact of trash on fish health, water quality, and downstream global plastic accumulation in oceans.
2. The aquatic trash crisis gets worse every year locally and globally.
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule so that there is a systematized way of addressing this issue.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.
 - There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
 - Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

Thank you to DEQ for your prior important work on listing segments of the Willamette River as impaired for trash.

Nora Stern


Sent from my gadget, apologies for brevity and typos.

Comments from Joziedonaghey

SCHICK Daniel * DEQ

From: joziedonaghey <joziedonaghey@gmail.com>
Sent: Sunday, May 19, 2024 12:32
To: IntegratedReport * DEQ
Subject: Willamette River needs more action!

You don't often get email from joziedonaghey@gmail.com. [Learn why this is important](#)

I am leaving this comment to make sure that this beautiful and natural resource does not just get recognized as needing environmental intervention but receives action to make a difference!

We thank you for identifying the river as impaired by trash, but without action the trash is going nowhere. As a riverkeeper volunteer and paddle instructor, I see first hand how much trash pollutes our river. I also see how dangerous it makes it for our community to be in, on and around the river. Glass and needles and plastic washes up on our park shores where kids play. Shopping carts and mattresses create strainers and drowning hazards for floaters and boaters. This is not just an eye soar. This is not just bad for the environment. It's a health hazard and law suit waiting to happen especially now that it's been recognized as a hazard.

Please get the WR a TMDL so progress can be made. Please get law makers involved with helping to solve homelessness that creates so much trash in the river. And please start making moves that are actionable for your sake, ours and all the life that feeds in, on and around the river.

Thank you.

Sent via the Samsung Galaxy S10e, an AT&T 5G Evolution capable smartphone

Comments from Perpetuatetruth.proton.me

SCHICK Daniel * DEQ

From: perpetuatetruth@proton.me
Sent: Monday, April 22, 2024 23:42
To: IntegratedReport * DEQ
Subject: Public Comment Draft Integrated Report

You don't often get email from perpetuatetruth@proton.me. [Learn why this is important](#)

I don't think anyone is surprised by the information in this report. If anything the state has contributed to the aquatic trash pollution in our waterways by not acting more urgently to address this issue. Sadly citizens are seeing public waterways and precious habitats and environments being destroyed by unhoused populations existing in our public spaces.

Comments from Roger Kofler

SCHICK Daniel * DEQ

From: rkofler@aol.com
Sent: Saturday, May 18, 2024 07:33
To: IntegratedReport * DEQ
Subject: Willamette River trash

You don't often get email from rkofler@aol.com. [Learn why this is important](#)

Thank you for recognizing the very serious trash problem on the Willamette River by declaring parts of the river as Impaired For Trash. While this declaration is a step in the right direction, what is really needed is for DEQ to find time in its 2024 schedule to write an Aquatic Trash TMDL. Having a TMDL would aid the process of turning ideas into action.

While trash is everyone's problem, I feel I have a special stake in promoting the cleaning up of the Willamette River because I grew up along the Willamette, and now that I am eighty years old, I am still an avid paddler on the Willamette. It saddens me to see this beautiful asset to our state turned into a garbage dump. Having quantities of trash in the river is a serious health risk and poses a risk to boaters.

Thank you for reading these comments and please know that a whole heartily support the cleanup of the Willamette.

Respectfully:

Roger H. Kofler

[Redacted signature block]

rkofler@aol.com

Comments from Roberta Schwarz

SCHICK Daniel * DEQ

From: Roberta Schwarz <roberta.schwarz@comcast.net>
Sent: Sunday, May 26, 2024 08:38
To: IntegratedReport * DEQ
Subject: Comments of your Draft Integrated Report.

You don't often get email from roberta.schwarz@comcast.net. [Learn why this is important](#)

Dear DEQ,

We have lived in the Willamette Valley for twenty-two years. The Willamette River is the heart and soul of this beautiful place. But the river has a problem with aquatic trash. You have seen the photos and some of your staff have seen it up close.

We want to thank you for listing the Willamette as impaired for trash. Please make creating a TMDL for aquatic trash on the 2024 TMDL Priorities and Schedule a higher priority (high or at least medium in the priorities) and something that can be implemented at the state, local, and federal levels.

We have learned that as most aquatic trash is nonpoint source pollution, a TMDL will be implemented through a variety of programs that may be regulatory, non-regulatory, or incentive based as opposed to the permits that are typically used for point source pollution. The longer DEQ takes to make a TMDL for aquatic trash in the Willamette, the longer it will take for these programs to get off the ground, and the more garbage, chemicals, and biohazards will deteriorate water quality, wildlife habitat, and river recreation experiences.

- There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
- Large pieces of aquatic trash can cause instream hazards which will affect boating.

Thank you for listing segments of the Willamette River as impaired for trash please. Please give a higher priority to aquatic trash on the Willamette on the 2024 TMDL Priorities and Schedule.

Ed and Roberta Schwarz

[REDACTED]

[REDACTED]

Comments from Ray Thomas

SCHICK Daniel * DEQ

From: Ray Thomas <rthomas@tcnf.legal>
Sent: Tuesday, May 21, 2024 10:10
To: IntegratedReport * DEQ
Subject: DEQ Action on Aquatic Trash Pollution in Willamette River

You don't often get email from rthomas@tcnf.legal. [Learn why this is important](#)

I am writing to urge DEQ in its consideration project to please prioritize the current intolerable unhealthy and dangerous trash situation along the banks of the Willamette River.

Specifically, I request:

1. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.
2. Make a finding that the aquatic trash crisis gets worse every year.
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.
 - There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
 - Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.

I want to express my thanks to DEQ for listing segments of the Willamette River as impaired for trash.

Ray Thomas

THOMAS, COON, NEWTON & FROST

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F: 503-273-9175

Email: rthomas@tcnf.legal

www.tcnf.legal

Comments from Susan Huston

SCHICK Daniel * DEQ

From: Susan Huston <sasanqua@comcast.net>
Sent: Saturday, May 18, 2024 16:27
To: IntegratedReport * DEQ
Subject: Willamette River in Salem, Oregon

[You don't often get email from sasanqua@comcast.net. Learn why this is important at <https://aka.ms/LearnAboutSenderIdentification>]

I'd like to thank you for prioritizing the Willamette River as a crisis. THANK YOU for making this designation. I can't think of a more important problem to solve.

The Willamette River water quality is shameful. How can a national major natural resource become so polluted that the major NW salmon populations decline to nearly nothing, in less than ten years?

I implore you to make this water quality a priority.

Please provide for an aquatic trash TMDL, specifically in the NW Willamette River, that will be implemented at the state, local and federal levels.

PLEASE PRIORITIZE a TMDL, and include it in your 2024 calendar. Our major rivers have been a vital part of our lives in Oregon for 200 years. Enforce government to save our aquatic habitats. It's a desperate tragedy. Please help.

Best,
Susan Kay Huston



Comments from Sarah Wetjen

SCHICK Daniel * DEQ

From: sarah w <wetjensarah@gmail.com>
Sent: Saturday, May 18, 2024 09:40
To: IntegratedReport * DEQ
Subject: Willamette River Trash TMDL

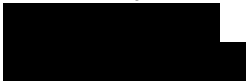
[You don't often get email from wetjensarah@gmail.com. Learn why this is important at <https://aka.ms/LearnAboutSenderIdentification>]

Hi DEQ,

Thanks for all you do to improve our environment. Recently DEQ listed Willamette River as impaired for trash and now I am asking DEQ to go a step further. Please assess the Willamette River a high priority aquatic trash TMDL on 2024 TMDL Priorities and Schedule that will be implemented at the local, state, and federal levels.

Much has been done to clean up the Willamette River and more work is needed to restore and maintain its biodiversity and beauty.

Thank you,
Sarah Wetjen



Comments from Tammie Bardowell

SCHICK Daniel * DEQ

From: t b <tbardowell@yahoo.com>
Sent: Sunday, May 19, 2024 20:15
To: IntegratedReport * DEQ
Subject: river debris

[You don't often get email from tbardowell@yahoo.com. Learn why this is important at <https://aka.ms/LearnAboutSenderIdentification>]

I just wanted to put in some of my input, of how i am sure, everyone feels.

I am highly concerned not only for the contamination, seeping in to our sacred earth, it will also effect the wildlife, water contamination, water species and plants will start to die. It will haunt us for years to come. It can cause diseases such as bacterial infections, to cancers.

Please, for the sake of our natural wonders of life. Its imperative that action takes place, all most immediately.

Thank you, for listening to my concerns.

Tammie L Bardowell
White Water Kayaker
River Lover
Earth Lover

Comments from Theo Cantalupo

SCHICK Daniel * DEQ

From: Theo <theocantalupo@gmail.com>
Sent: Monday, May 20, 2024 18:59
To: IntegratedReport * DEQ
Subject: Comments on draft integrated report

You don't often get email from theocantalupo@gmail.com. [Learn why this is important](#)

Hello,

I'm a Portlander concerned with water quality in the Willamette river. I'm troubled by some aspects of DEQ's draft report. I believe DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings. The aquatic trash crisis gets worse every year; therefore, DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.

Moreover, DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics; namely, there are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting; and large pieces of aquatic trash can cause instream hazards which will affect boating. Below is a photo provided by Willamette Riverkeeper showing evidence of examples of these large pieces of trash.

Thank you for listing segments of the Willamette River as impaired for trash. We appreciate your hard work to keep our waterways clean.



Best,
Theo Cantalupo

Comments from Tom Fawell

SCHICK Daniel * DEQ

From: Tom Fawell <tfawell@yahoo.com>
Sent: Saturday, May 18, 2024 07:35
To: IntegratedReport * DEQ
Subject: Trash

You don't often get email from tfawell@yahoo.com. [Learn why this is important](#)

Dear DEQ:

1. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.
2. The aquatic trash crisis gets worse every year.
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.
 - There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
 - Large pieces of aquatic trash can cause instream hazards which will affect boating. Willamette Riverkeeper provided photographic evidence of examples of these large pieces of trash.
5. Thank you for listing segments of the Willamette River as impaired for trash.
6. **DEQ needs to collaborate with and strongly advocate that local and state governments end the source of this pollution: unsanctioned camping. Other cities, municipalities and states do not allow this.**

Sincerely
Tom Fawell
Portland, OR

Comments from Teresa Frye

SCHICK Daniel * DEQ

From: Teresa Frye <tfrye5558@gmail.com>
Sent: Saturday, May 18, 2024 09:40
To: IntegratedReport * DEQ
Subject: Aquatic Trash TMDL 2024

You don't often get email from tfrye5558@gmail.com. [Learn why this is important](#)

Dear DEQ,

First, I would like to thank DEQ for listing segments of the Willamette River as impaired for trash. Your efforts are much appreciated! Further, I would like to submit my comments regarding prioritization of this listing, as this appears to be a remaining weak spot in the planning process. Please consider the following recommendations:

1. DEQ should find aquatic trash pollution to be a high or at least medium priority in their rankings.
2. The aquatic trash crisis gets worse every year—we need to stay ahead of it
3. DEQ should include creation of an aquatic trash TMDL on the 2024 TMDL Priorities and Schedule.
4. DEQ should find aquatic trash pollution as an impairment to more beneficial uses than recreation and aesthetics.
 - There are many pieces of scientific literature on microplastics negatively affecting fish and aquatic life and wildlife, both of which can affect fishing and hunting.
 - Large pieces of aquatic trash can cause instream hazards which will affect boating.

Many thanks for your kind attention to this.

Teresa Frye
Willamette River Property owner, west linn, or