Maine Casco Bay:

Summary of State Narrative Nutrient Criteria and Consolidated Listing and Assessment Methods

February 2021

Version 2.0

Contents

1 OVERVIEW

This document provides a brief review of existing nutrient regulatory thresholds in Maine. This starts with a description of existing criteria and then expands to discuss other state programs that have defined or identified nutrient thresholds for water quality programs (e.g., assessment and listing, permitting, TMDLs). Frequently where states have narrative criteria, they have interpreted those narratives in numeric terms. This allows NSTEPS a peek into a variety of important elements for this support work including: assessment endpoints that have been implemented (indicating valued nutrient responsive ecological attributes linked to management goals), the range of numeric values considered protective or restorative (even if only for a single water), and the general approach to nutrient effects management the state has employed.

2 STANDARDS

Maine statute does not have specific numeric nutrient criteria. The state is in the process of proposing these for freshwaters (see section 3.2b below).

2.1 Standards Language

General criteria are included in MRS 38 Subchapter 3.1 (4-A) Section 464.4

> *"464.4 General Provisions*
>
> *A. Notwithstanding section 414-A, the department may not issue a water discharge license for any of the following discharges:*
>
> *…*
>
> *(4) Discharge of pollutants to waters of the State that imparts color, taste, turbidity, toxicity, radioactivity or other properties that cause those waters to be unsuitable for the designated uses and characteristics ascribed to their class;*
>
> *(5) Discharge of pollutants to any water of the State that violates sections 465, 465-A and 465-B, except as provided in section 451; causes the "pH" of fresh waters to fall outside of the 6.0 to 8.5 range; or causes the "pH" of estuarine and marine waters to fall outside of the 7.0 to 8.5 range;*
>
> *…*
>
> *B. All surface waters of the State shall be free of settled substances which alter the physical or chemical nature of bottom material and of floating substances, except as naturally occur, which impair the characteristics and designated uses ascribed to their class.*
>
> *C. Where natural conditions, including, but not limited to, marshes, bogs and abnormal concentrations of wildlife cause the dissolved oxygen or other water quality criteria to fall below the minimum standards specified in sections 465, 465-A and 465-B, those waters shall not be considered to be failing to attain their classification because of those natural conditions.*

Section 465-B includes the specific classes of estuarine and marine waters, below we highlight sections relevant to nutrient impacts

> "*465-B. Standards for classification of estuarine and marine waters*

1. Class SA waters. Class SA shall be the highest classification and shall be applied to waters which are outstanding natural resources and which should be preserved because of their ecological, social, scenic, economic or recreational importance.

A. Class SA waters must be of such quality that they are suitable for the designated uses of recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, navigation and as habitat for fish and other estuarine and marine life. ***The habitat must be characterized as free-flowing and natural****.*

B. The ***estuarine and marine life, dissolved oxygen and bacteria content of Class SA waters must be as naturally occurs****,…*

…

2. Class SB waters. Class SB waters shall be the 2nd highest classification.

A. Class SB waters must be of such quality that they are suitable for the designated uses of recreation in and on the water, fishing, aquaculture, propagation and harvesting of shellfish, industrial process and cooling water supply, hydroelectric power generation, navigation and as habitat for fish and other estuarine and marine life. ***The habitat must be characterized as unimpaired.***

B. The dissolved oxygen content of Class SB waters may not be less than 85% of saturation…

C. Discharges to Class SB waters may not cause adverse impact to estuarine and marine life in that the ***receiving waters must be of sufficient quality to support all estuarine and marine species indigenous to the receiving water without detrimental changes in the resident biological community****. …*

3. Class SC waters. Class SC waters shall be the 3rd highest classification.

A. Class SC waters must be of such quality that they are suitable for recreation in and on the water, fishing, aquaculture, propagation and restricted harvesting of shellfish, industrial process and cooling water supply, hydroelectric power generation, navigation and as a habitat for fish and other estuarine and marine life.

B. The dissolved oxygen content of Class SC waters may not be less than 70% of saturation. …

C. Discharges to Class SC waters ***may cause some changes to estuarine and marine life*** *provided that the receiving waters are of sufficient quality to* ***support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community****.*

The following table from the 2016 Integrated Report[1] summarizes these classifications:"

[1] https://www.maine.gov/dep/water/monitoring/305b/2016/28-Feb-2018_2016-ME-IntegratedREPORT.pdf

Table 4-28 Maine's Estuarine and Marine Waters Classification Standards

Class	Designated Uses	Dissolved Oxygen	Bacteria	Aquatic Life
SA	Recreation in and on the water Fishing Aquaculture (excludes finfish) Propagation and harvesting of shellfish Navigation Habitat for fish and estuarine and marine life	As naturally occurs	As naturally occurs	As naturally occurs
SB	Recreation in and on the water Fishing Aquaculture Propagation and harvesting of shellfish Industrial process and cooling water supply Hydroelectric power generation Navigation Habitat for fish and estuarine and marine life	Not less than 85% of saturation	Enterococcus of human and domestic animal origin not higher than geometric mean of 8/100ml or instantaneous level of 54/100ml from 5/15 to 9/30 May not exceed National Shellfish Sanitation Program criteria for shellfish harvesting	Support all indigenous estuarine and marine species Discharge not to cause closure of shellfish beds
SC	Recreation in and on the water Fishing Aquaculture Propagation and restricted harvesting of shellfish Industrial process and cooling water supply Hydroelectric power generation Navigation Habitat for fish and estuarine and marine life	Not less than 70% of saturation	Enterococcus of human and domestic animal origin not higher than geometric mean of 14/100ml or instantaneous level of 94/100ml from 5/15 to 9/30 May not exceed National Shellfish Sanitation Program criteria for restricted shellfish harvesting	Maintain structure and function of the resident biological community Support all indigenous fish species

An important question for SC waters is what "maintain the structure and function" means and whether the support for indigenous fish species extends to seagrass or only fish? Would it extend to seagrass dependent fishes?

The definitions in Section 466 offer some insight:

"*466 Definitions*

1. Aquatic life. "Aquatic life" means any plants or animals which live at least part of their life cycle in fresh water.

2. As naturally occurs. "As naturally occurs" means conditions with essentially the same physical, chemical and biological characteristics as found in situations with similar habitats free of measurable effects of human activity.

3. Community function. "Community function" means mechanisms of uptake, storage and transfer of life-sustaining materials available to a biological community which determines the efficiency of use and the amount of export of the materials from the community.

> *4. Community structure. "Community structure" means the organization of a biological community based on numbers of individuals within different taxonomic groups and the proportion each taxonomic group represents of the total community.*
>
> *…*
>
> *10. Resident biological community. "Resident biological community" means aquatic life expected to exist in a habitat which is free from the influence of the discharge of any pollutant. This shall be established by accepted biomonitoring techniques*.
>
> *…*
>
> *12. Without detrimental changes in the resident biological community. "Without detrimental changes in the resident biological community" means no significant loss of species or excessive dominance by any species or group of species attributable to human activity."*

Additional insight into the state's consideration of valuable aquatic life attributes to be protected come from the freshwater provisions. For Great Ponds and natural lakes and ponds less than 10 acres (GPA class) the Statute states in Section 465-A that:

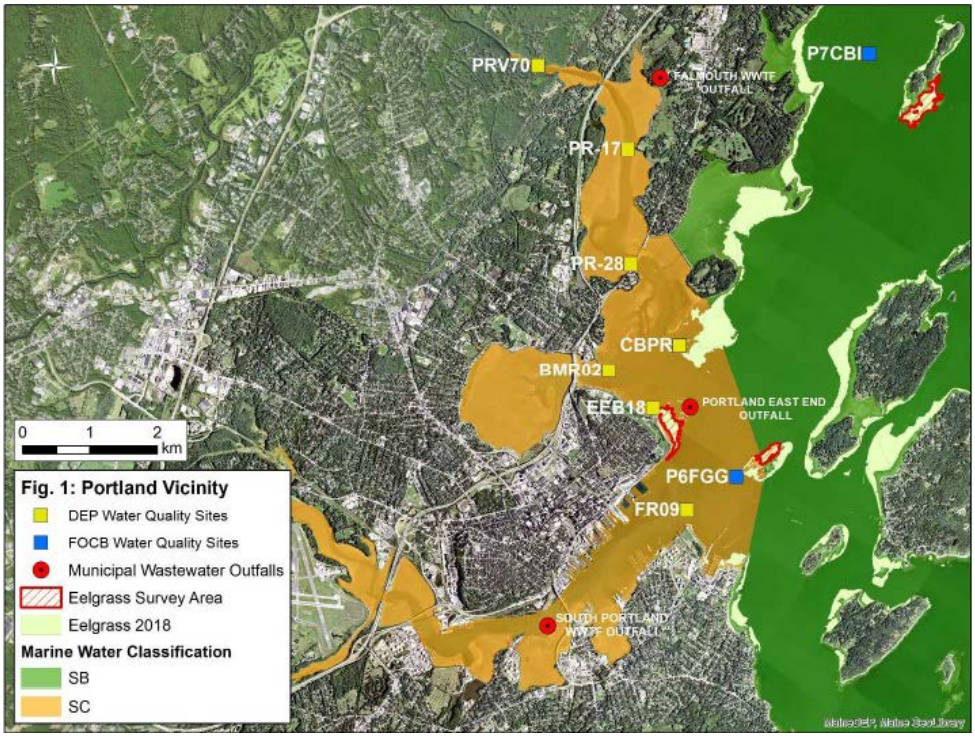
> "*Section 465-A. Standards for classification of lakes and ponds*
>
> *…*
>
> *B. Class GPA waters must be described by their trophic state based on measures of the chlorophyll "a" content, Secchi disk transparency, total phosphorus content and other appropriate criteria. Class GPA waters* ***must have a stable or decreasing trophic state, subject only to natural fluctuations, and must be free of culturally induced algal blooms that impair their use and enjoyment****.*

The concept of protecting the trophic state of a system is an intriguing one. This may lack parallels in estuarine waters in general (i.e., there may be no comparable trophic categorization), but there are measures that can be used and, for example, trends of estuarine trophic condition have been applied nationally[2,3]. The second of these studies concluded that there was little evidence of adverse conditions in Casco Bay, except maybe in populated areas such as the Portland Region, and that the 12-year trend was generally positive, with some exceptions (e.g., Yarmouth/Freeport region and the NE Casco Bay.

2.2 Casco Bay Applicable Standards

Casco Bay includes Class SA, SB, and SC waters. The Portland region including the Fore River and Back Bay areas are class SC (orange area in figure below).

[2] Bricker, S. B., J. G. Ferreira, and T. Simas (2003). "An integrated methodology for assessment of estuarine trophic status." *Ecological modelling* 169, no. 1: 39-60.
[3] Bricker, S., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks, and J. Woerner. 2007. Effects of Nutrient Enrichment In the Nation's Estuaries: A Decade of Change. NOAA Technical Memorandum NOS NCCOS Coastal Ocean Program Decision Analysis Series 26. Silver Spring, MD. 328 pp.



3 MAINE ASSESSMENT AND LISTING INFORMATION

This section describes the assessment and listing methods applied by Maine in recent Integrated Reports that provide insight into the assessment endpoints/measures and potential thresholds used by the state to assess against nutrient related water quality standards.

3.1 2016 Integrated Report

Maine's latest online available integrated report[4] (IR) lists the methods used for conducting assessments of designated uses. This was used to review methods and applications for marine waters.

3.1.1 Assessment Methods, Criteria and Data Interpretation

In the Assessment Criteria section, Table 4-3 lists standard sections that apply for each use in marine waters. Note that ambient numeric criteria are generally more straightforward to apply (dissolved oxygen, pH, etc.). Narrative criteria (e.g., narrative biological standards and general provision "free from" narrative criteria, many of which are applicable to the effects of nutrients) are, however, dependent upon interpretation. The state provides general indications of this in the Data Interpretation section of Chapter 4 (pp 45-47).

It is unclear from this Data Interpretation section how the narrative biological standards are interpreted for marine waters. The biological criteria section describes methods for rivers, streams and wetlands using macroinvertebrates and algae. For lakes, description is made of trophic state indicators used. There is then a section related to support of indigenous species including the following language:

[4] https://www.maine.gov/dep/water/monitoring/305b/2016/28-Feb-2018_2016-ME-IntegratedREPORT.pdf

"*Assessment based on the known absence of a species previously documented as indigenous to a waterbody in historical records collected by state or federal agencies or through published scientific literature; or based on non-attainment of water quality criteria, absence of critical habitat necessary to support indigenous species, or presence of conditions known to prevent support of indigenous species*."

This language could clearly be extended to marine waters and applied to, for example, eelgrass beds which have been surveyed and mapped in Casco Bay and include beds near and around the Portland area. There is also an established literature on their sensitivity to nutrient pollution, even to the extent of known nutrient loads/concentrations considered protective of these species. Indeed, the RP values used by Maine reflect this use.

Table 4-3 Maine Designated Uses and Attainment Criteria for Estuarine and Marine Waters

Designated Use	Criteria for Attainment
Marine life use support	• Ambient Water Quality Criteria (DEP Chapters 530 and 584) • Dissolved oxygen (38 M.R.S. § 465-B) • Narrative biological standards (38 M.R.S. § 465-B) • General provisions: floating/settleable solids, pH, radioactive substances [38 M.R.S. § 464(4)(A)]
Shellfish propagation and harvest [1]	• National Shellfish Sanitation Program (as assessed by DMR) • No shellfish consumption advisory (instituted by Maine CDC) • General provisions: floating/settleable solids, pH, radioactive substances [38 M.R.S. § 464(4)(A)]
Aquaculture	• General provisions: floating/settleable solids, pH, radioactive substances [38 M.R.S. § 464(4)(A)]
Fishing/Fish Consumption	• Support of indigenous fish species • No fish consumption advisory (instituted by Maine CDC) • General provisions: floating/settleable solids, pH, radioactive substances [38 M.R.S. § 464(4)(A)]
Recreation in and on the water	• Enterococcus bacteria (38 M.R.S. § 465-B, geometric mean) • General provisions: floating/settleable solids, pH, radioactive substances [38 M.R.S. § 464(4)(A)]
Navigation, hydropower, industrial supply	• General provisions: floating/settleable solids, pH, radioactive substances [38 M.R.S. § 464(4)(A)]

[1] Applies to estuarine/marine waters with high enough salinity to naturally support shellfish propagation and harvest

The Data Interpretation then has a section on Nutrient/Eutrophication biological indicators. This section begins with the following text indicating the range of indicators/assessment endpoints the state has identified at least conceptually for the focus of interpreting nutrient criteria:

"*Excessive nutrient enrichment (eutrophication) can cause negative environmental impacts to surface waters, such as blooms of algae or bacteria in the water or on the substrate, low DO concentrations, fish kills, generation of cyanotoxins, and alteration of community structure."*

It then ends with the following language that also indicates additional indicators/assessment endpoints of importance to the state:

"*Non-numeric listing criteria for this cause of Aquatic Life Use (ALU) impairment consist of documentation of abnormal biological findings that indicate nutrient enrichment in rivers and streams as well as marine waters. Excess nutrients impair ALU through alteration of habitat, creation of diurnal DO*

sags caused by excessive plant and algae growth, abundant epiphytic growth resulting in decreased light availability to submerged vegetation, and alteration of benthic macroinvertebrate assemblage structure."

Important elements of note include a focus on "blooms", low DO/diurnal DO sags, toxins, excessive plant/algae growths, abnormal epiphyte growth on submerged vegetation, altered habitat and shifts in community structure.

The IR indicates that the state is in the process of developing rules (Chapter 583) for nutrient criteria in freshwater (see section 3.2 below) and will eventually include nutrient criteria for marine waters which will "include thresholds for total nitrogen (TN) as well as environmental response indicators to determine attainment of designated uses in estuarine and coastal waters". This combination of both nutrient and response indicators, commonly known as "combined criteria" or "confirmatory criteria" is embodied in Maine's approach to the proposed freshwater criteria (see section 3.2 below) and could have an implementation construct similar to that in the proposed Chapter 583 rule language.

3.1.2 Estuaries/Coastal Waters 2016 Assessment

From pp. 74-83, the IR discusses the results for coastal waters and provided additional insights. The section on Causes and Sources of Impairment to estuaries and coastal waters discusses dissolved oxygen impairments, but in none of them does it explicitly call out nutrient enrichment or eutrophication, suggesting that the state presumably does not see nutrient enrichment causing DO issues. This should be discussed.

Following oxygen is an extensive section on nutrient/eutrophication biological indicators. It starts by saying there are instances of elevated nutrient conditions and corresponding biological responses. The state states that typical biological indicators of nutrient enrichment effects include primary producers such as phytoplankton, macroalgae, and eelgrass (*Zostera marina)*. Phytoplankton blooms are called out specifically as being observed more in tidal waters with ample nutrients, light, and less turbulent mixing. For macroalgae, they note that opportunistic growth occurs when temperature, light, and nutrient availability coincide and that anthropogenic N has been shown to fuel nuisance macroalgal (e.g., *Ulva*) growths, typically on protected shorelines with shallow slopes (e.g., mudflats) but also elsewhere, importantly among eelgrass. They state that macroalgal growth is a natural occurrence, but widespread and dense blooms can smother organisms and release toxic hydrogen sulfide. Lastly, the state discusses the well-established dependence of eelgrass on light which can be reduced by nutrient mediated epiphyte and water column turbidity from CDOM, sediments and phytoplankton. They note that use of eelgrass as a eutrophication indicator has occurred mostly in Great Bay, NH so, presumably, not yet in Maine.

NH listed the Piscataqua River Estuary as impaired due to seagrass loss (up to 98% in one segment). Maine DEP also discussed extensive survey work in that estuary, including aerial and in situ visual surveys. DEP decided that that for one segment "*sufficient data existed to assign a Category 5 listing for a Marine Life Use Support impairment with cause of "nutrient/eutrophication biological indicators*"" and that a second segment was listed for cause unknown. The nutrient impairment was justified based on epiphyte growth and benthic macroalgal growth. The state noted, however, that TN concentrations and chlorophyll levels were not at those suggested to cause adverse effects to eelgrass, and that neither diel DO or light attenuation levels were indicative of significant productivity or enrichment. More data collection was proposed.

3.2 Draft nutrient Standards and Consolidated Assessment Method for Streams

As referenced earlier, Maine have just posted a report describing their nutrient criteria rule (Nov 2020[5]) as well as working drafts of their proposed numeric nutrient criteria rules (Jan 2021[6]). These are a combined-criteria construct for streams, but the structure is informative of how they have done nutrient assessments to date against their narrative as their Integrated Report ostensibly mentions this is their approach – response based- and presumably reflects approaches that may be developed for marine waters. For stream responses and for each tier of their ALU, they have numeric thresholds for percent nuisance algal cover, patches of bacteria/'fungi, their pH, DO and aquatic life criteria. Then they have numeric TP thresholds. A site is impaired for nutrients if one or more response indicator thresholds is exceeded or one or more response thresholds and TP are exceeded.

Maine also really values aquatic life. That language permeates their standards, they have a very effective biomonitoring program, tiered aquatic life uses, and explicit promulgated numeric biological criteria for streams (Class AA, A, B and C waters).

3.2.1 Assessment Approach/Draft Numeric Criteria

Maine's stream assessment approach ostensibly reflects their proposed draft criteria. These criteria consist of the following [Water Column Chl a and Secchi transparency apply to streams unless they determine a stream is too swift to support phytoplankton or the Secchi disk (most streams)]:

[5] https://www.maine.gov/dep/water/nutrient-criteria/description-of-nutrient-criteria2020.11.03.pdf
[6] https://www.maine.gov/dep/water/nutrient-criteria/chapter583-2021.01.13.pdf

		Statutory Class		
		AA & A	B	C
Nutrient criteria		≤18.0 µg/L (ppb) TP[a] *and* if the waterbody has a site-specific value for another nutrient, the mean concentration of that nutrient is less than or equal to the site-specific value *and* all applicable response indicator[b] values in this column *OR* all applicable response indicator[b] values in this column	≤30.0 µg/L (ppb) TP[a] *and* if the waterbody has a site-specific value for another nutrient, the mean concentration of that nutrient is less than or equal to the site-specific value *and* all applicable response indicator[b] values in this column *OR* all applicable response indicator[b] values in this column	≤40.0 µg/L (ppb) TP[a] *and* if the waterbody has a site-specific value for another nutrient, the mean concentration of that nutrient is less than or equal to the site-specific value *and* all applicable response indicator[b] values in this column *OR* all applicable response indicator[b] values in this column
	Percent Nuisance Algal Cover	≤ 18.0	≤ 24.0	≤ 35.0
	Water Column Chl *a* (µg/L, ppb)	≤ 3.5 (≤ 5.0 for low gradient streams with velocity < 2.0 cm/sec or impoundments)	≤ 8.0 (impoundments must have spatial mean ≤ 8.0 and no value > 10.0)	≤ 8.0 (impoundments must have spatial mean ≤ 8.0 and no value > 10.0)
	Secchi Disk Transparency (m)	≥ 2.0		
	Patches of Bacteria and Fungi	None observed		
	pH	6.5 – 9.0		
	Dissolved Oxygen (mg/L, ppm)	In accordance with 38 M.R.S. § 465 (2020)[c]		
	Aquatic Life	In accordance with 38 M.R.S. §§ 464 and 465 (2020)[c] , and where applicable *Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams,* 06-096 C.M.R. ch. 579 (effective May 27, 2003)		

And they propose the following straightforward decision framework

	Seasonal mean TP concentration is less than or equal to the applicable value in Table 1 or an established site-specific value *AND* If the waterbody has a site-specific value for a non-TP nutrient pursuant Section 5(C)(3)(b), the seasonal mean concentration of the non-TP nutrient is less than or equal to the site-specific value for the non-TP nutrient	Seasonal mean TP concentration is greater than the applicable value in Table 1 or an established site-specific value *OR* If the waterbody has a site-specific value for a non-TP nutrient pursuant Section 5(C)(3)(b), the seasonal mean concentration of the non-TP nutrient is greater than the site-specific value for the non-TP nutrient
All applicable response indicators meet the values in Table 1	A. **Not Impaired.** Nutrient criteria attained	B. **Not Impaired.** Department may conduct a study to develop a site-specific TP value as described in Section 5(B)
One or more of the applicable response indicators do not meet the values in Table 1	C. **Impaired.** Department conducts weight-of-evidence analysis to determine cause of impairment as described in Section 5(C)	D. **Impaired.** Nutrient criteria not attained.

For element B, the state may establish site specific TP values (the value of which would then be used in the framework moving forward) based on additional study, during which, if it is found response indicators are not met, it may impair said site.

For element C, their decision framework allows has a flexible relief clause to establish nutrient impairments based on a weight of evidence: "*The Department may, by considering relevant evidence and through use of a weight-of-evidence approach, determine if TP, another nutrient, or a non-nutrient factor caused or contributed to impairment…"*. This may result for a site that is simply more sensitive to nutrients than allowed for by their TP values.

This weight of evidence is not clearly defined.

3.2.2 Other Relevant Information

3.2.2.1 Derivation

The values used in this assessment procedure/draft criteria were derived using statistical models, reference-based distributions. This is all detailed in a comprehensive set of technical support documents and peer reviewed papers[7]. They reference the MT aesthetics-based work as a support for their percent nuisance cover value.

[7] Danielson, T. J. 2006. Protocols for Sampling Algae in Wadeable Streams, Rivers, and Freshwater Wetlands (DEPLW0634). Maine Department of Environmental Protection, Augusta, ME.
Danielson, T.J., Loftin, C.S., Tsomides, L., DiFranco, J.L. and Connors, B., 2011. Algal bioassessment metrics for wadeable streams and rivers of Maine, USA. *Journal of the North American Benthological Society*, *30*(4), pp.1033-1048.
Danielson, T.J., Loftin, C.S., Tsomides, L., DiFranco, J.L., Connors, B., Courtemanch, D.L., Drummond, F. and Davies, S.P., 2012. An algal model for predicting attainment of tiered biological criteria of Maine's streams and rivers. *Freshwater Science*, *31*(2), pp.318-340.

4 PERMITTING

To date, Maine has incorporated nutrient thresholds that apply to ambient waters in the vicinity of outfalls for purposes of reasonable potential[8] (RP) analyses for wastewater discharge permitting. Maine has used two total nitrogen (TN) thresholds:

1) 0.32 mg/L for protection of eelgrass, when historically mapped as present within close proximity (defined by state as within 0.5km or based on professional judgment based on eelgrass resources) to the discharge in question and

2) 0.45 mg/L for protection of dissolved oxygen, when eelgrass has not been historically mapped within close proximity to the discharge in question.

The first value has been applied by EPA Region 1 permit staff and is midpoint between concentrations deemed protective of eelgrass by the Massachusetts Estuary Project[9] and 0.30 mg/L, an average concentration from the lower Piscataqua River where Maine DEP observed epiphytic growth on eelgrass that resulted in a 2012 impaired waters listing due to eelgrass loss.

5 TMDLS

We could not locate any marine/coastal TMDLs for nutrients/eutrophication on the list of approved TMDLs or Draft TMDLs[10].

Danielson, Thomas John. "Assessing the biological condition of Maine streams and rivers using benthic algal communities." (2010). Dissertation. University of Maine, Orono, ME. https://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1367&context=etd

[8] CWA regulations at 40 CFR 122.44(d)(1)(i) state: "Limitations must be established in permits to control all pollutants or pollutant parameters that are or may be discharged at a level that will cause, ***have the reasonable potential to cause***, or contribute to an excursion above any state water quality standard." A reasonable potential analysis is conducted as part of permitting process to identify which pollutants may require a limit in the discharge in order to protect the water quality standard.

[9] https://yosemite.epa.gov/OA/EAB_WEB_Docket.nsf/Verity%20View/DE93FF445FFADF1285257527005AD4A9/$File/Memorandum%20in%20Opposition%20...89.pdf

[10] https://www.maine.gov/dep/water/monitoring/tmdl/index.html