New Hampshire Department of Environmental Services

RESPONSE TO PUBLIC COMMENT ON THE DRAFT 2010 CONSOLIDATED ASSESSMENT AND LISTING METHODOLOGY (CALM)

2/19/2010

On September 3, 2009, the New Hampshire Department of Environmental Services (DES) requested comments on the 2008 Consolidated Assessment and Listing Methodology (CALM) which served as a draft of the CALM for the 2010 Section 305(b) and 303(d) Surface Water Quality Report (i.e., the 2010 CALM). Downloadable copies of the 2008 CALM and a list of possible revisions were made available on the DES website for review (http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm). In addition, the following organizations/agencies were notified by email:

Appalachian Mountain Club
Audubon Society
Connecticut River Joint Commissions
Conservation Law Foundation
County Conservation Districts
Lake and River Local Management Advisory Committees
Maine Department of Environmental Protection
Manchester Conservation Commission
Massachusetts Department of Environmental Protection
Merrimack River Watershed Council
National Park Service
New England Interstate Water Pollution Control Commission
NH Department of Health and Human Services
NH Coastal Program
NH Rivers Council
North Country Council
Regional Planning Commissions
Society for the Protection of National Forests
Natural Resources Conservation Service
The Nature Conservancy
Upper Merrimack River Local Advisory Committee
US Environmental Protection Agency
US Geological Survey
US Fish and Wildlife Service
US Forest Service
University of New Hampshire
Vermont Department of Environmental Conservation
Volunteer Lakes Assessment Program
Volunteer Rivers Assessment Program
Water Quality Standards Advisory Committee

The public comment period ended on October 2, 2009. The following represents the Department's response to public comments received during this period. Each comment is numbered and preceded by a general description of the subject matter. The Department's response immediately follows each comment (in bold font).

A. RESPONSE TO PUBLIC COMMENTS

Mark Hemmerlein, Water Quality Program Manager, Bureau of the Environment, NH Department of transportation (full text attached at the end of this document)

COMMENT (1):

The New Hampshire Department of Transportation (NHDOT) recommends that section c. on page 62 of the CALM be revised to require some ambient chloride sampling before a waterbody is declared impaired for chloride because there can be many other ions which can affect specific conductivity.

DES RESPONSE:

DES DISAGREES – NO CHANGES NECESSARY: As stated in the Consolidated Assessment and Listing Methodology (CALM), DES *prefers*, but does *not require*, collection of chloride samples each time the chloride/specific conductance relationship is used to confirm a site fits the statewide specific conductance chloride relationship. DES does *not require* collection of chloride samples each time specific conductance is used to predict chloride for the following reasons:

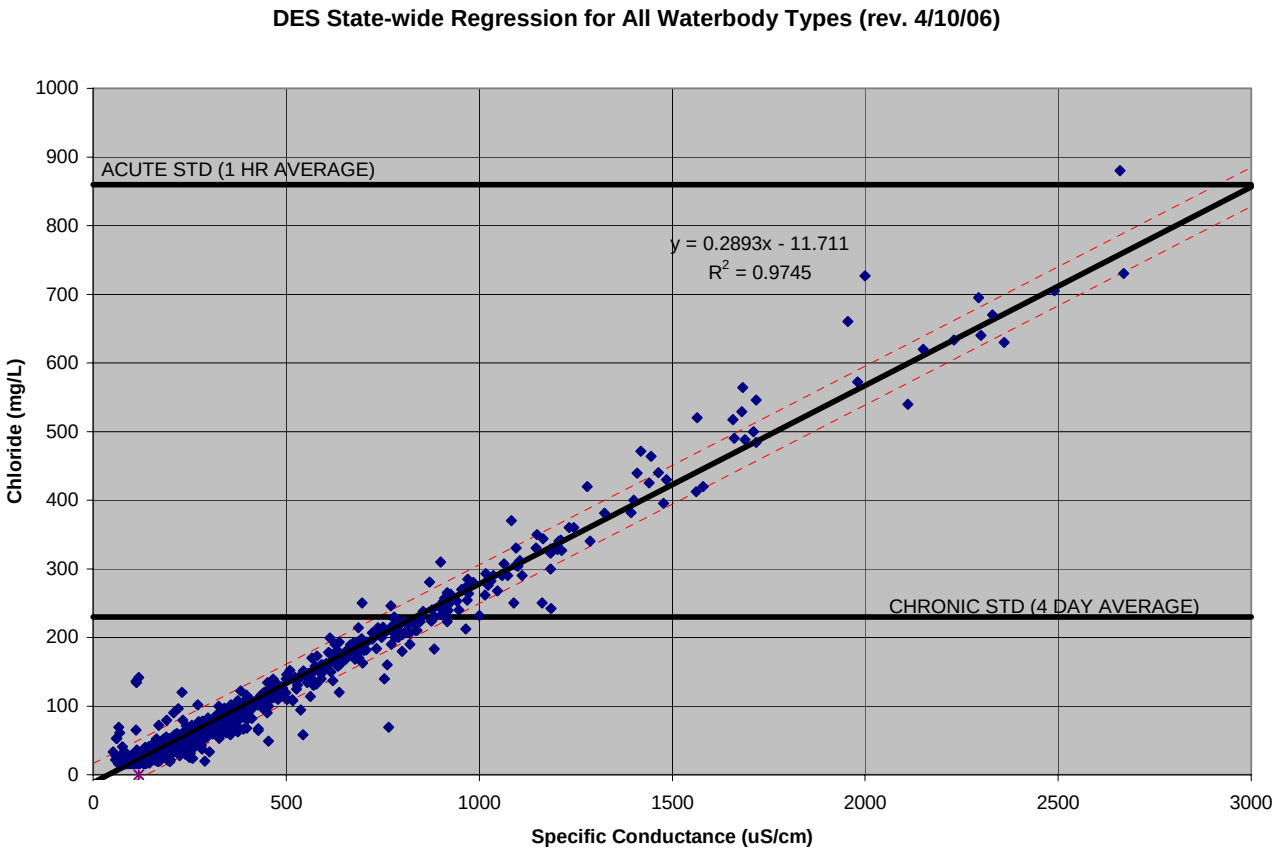
The regression used to predict ambient chloride concentrations based on ambient specific conductance is shown in the figure below. This is the same regression used to develop the 2006 and 2008 Clean Water Act (CWA) section 303(d) lists. It is based on 1860 data pairs from approximately 850 surface waters throughout the state that were approximately equally divided between lakes and rivers. As shown, the coefficient of determination (R^2) is equal to 0.97 (1 is the highest possible value) which means 97 percent of the variability in chloride is explained by the regression equation. This represents a very strong relationship which is further expressed by the relatively low 95th percentile confidence limit for each prediction of +/- 28 mg/L. This means that for daily average or four day average values, the error in the average chloride value would be only +/- 28/ ($n^{1/2}$), where n is the number of readings used in the average. This is very small and represents less than 10 percent when determining chronic chloride impairment (> 230 mg/L) and less than 4% error for determining acute chloride (> 860 mg/L). Consequently, the chances of incorrectly impairing a water for chloride based on specific conductance are quite minimal.

As shown in the figure, most of the data points lie above the regression line at concentrations above the chronic chloride water quality criterion of 230 mg/L. This implies that the regression equation usually underpredicts the actual ambient chloride concentration which further reduces the chances of incorrectly impairing a water for chloride based solely on specific conductance measurements.

With regards to the effect of ions other than chloride on specific conductance readings, the excellent fit of the statewide regression discussed above, which is based on data pairs from numerous (850) waterbodies throughout the state, and which undoubtedly contained different concentrations of ions, indicates that the impact of the other ions on the chloride / specific

conductance relationship is relatively insignificant. This is especially true at the higher concentrations. It is worth noting that "natural" levels of specific conductance and chlorides in ambient waters are typically less than 30 uS/cm and 10 mg/L respectively. To assess a water as impaired for chloride based on chronic water quality criterion, the specific conductance must be greater than 835 us/cm which is almost 30 times higher than natural background. With the exception of few rare instances where a surface water is obviously polluted (foam, scum etc.) by other sources, DES is not aware of any ambient surface water sample collected in the past decade with such high specific conductance that wasn't primarily attributable to chlorides. Consequently, based on DES experience to date, and the statewide regression, the potential for ions other than chloride to result in a waterbody being incorrectly assessed as impaired for chloride is considered to be very low.

In summary, DES is confident with making assessments using specific conductivity as a surrogate for chloride. That being said, samples collected by DES typically include both chloride and specific conductance. DES intends to continue this practice to continue testing the relationship and certainly encourages others to do the same. This is especially important in the rare instances where a water is obviously polluted by other sources. However, for the many reasons mentioned above, and for the vast majority of surface waters, DES does not feel it is necessary or protective of surface water quality to exclude data based solely on specific conductance measurements for assessing chloride impairment. Consequently, the wording in the CALM will remain unchanged.



<u>COMMENT (2)</u>:

With regards to use of specific conductance to determine chloride impairment, NHDOT further recommends that the following sentence in section c. on page 62 of the CALM be revised to define what is meant by "adequately fit" and to include minimum requirements for the strength of the relationship (perhaps in terms of a regression coefficient):

"In the event that the confirmation samples do not adequately fit the relationship, a site specific relationship must be developed."

DES AGREES – CHANGES MADE: The following revisions have been made to this section.

"Specific conductivity may be used as a surrogate for chloride. It is preferred but not required to collect at least 2 chloride samples within each time period that the specific conductance to chloride relationship is to be used. These samples will be used to confirm that the site fits the statewide specific conductance to chloride relationship developed in 2006 (see regression equation and statistics below)

Chloride (in mg/L) = 0.289 * Specific Conductance (in uS/cm) – 11.7.
95th percentile confidence limit for each prediction = +/- 28 mg/L.
R^2 = 0.97.

In the event that the confirmation samples do not adequately fit the relationship a site specific relationship may be developed. Criteria for determining what adequately fits the statewide relationship and for determining a site specific relationship shall be in accordance with the April 12, 2006, DES Policy on the Use of the DES State-Wide Chloride Regression for Other Datasets prepared by Philip Trowbridge. If no site specific samples are collected and there is no evidence to suggest that a site specific curve is needed, the statewide chloride to specific conductance curve will be used."

A copy of the April 12, 2006 guidance document is provided at the end of this document.

William H. McDowell, Professor of Water Resources Management, Department of Natural Resources and the Environment, Presidential Chair, Director - NH Water Resources Research Center, University of New Hampshire

COMMENT (1):

Overall, I think the DES has done a good job outlining changes and the rationale for these changes. Data requirements for TN (first described on p. 4) are appropriate. Requiring data within the last 5 years, 15 or more samples, and data taken over the four seasons are all necessary to get a robust picture of TN levels in a water body. I support inclusion of those criteria, and the overall approach that is taken in this document.

DES RESPONSE:

DES AGREES – NO CHANGES NECESSARY: The department appreciates the encouragement and agrees that use support determinations should be based on sound science and robust datasets.

Miyoko Sakashita, Oceans Director, Staff Attorney, Center for Biological Diversity (full text attached at the end of this document)

COMMENT (1):

Based on the scientific evidence provided by the Center for Biological Diversity (CBD), New Hampshire should list all ocean assessment units as impaired or threatened due to ocean acidification (i.e., the decrease in ocean pH caused by the uptake of atmospheric carbon dioxide) and create a TMDL under section 303(d) of the Clean Water Act.

New Hampshire's marine pH standards included in Env-Wq 1703.18 are inadequate to protect aquatic life.

(A CD with 82 reference documents was attached with the request.. The full text attached at the end of this document contains a list of the documents on the CD.)

DES RESPONSE:

DES DISAGREES - NO CHANGES NECESSARY: While the New Hampshire Department of Environmental Services (DES) agrees that ocean acidification is a global, long-term issue that warrants continued vigilance, DES does not believe it is appropriate at this time to list ocean water assessment units within New Hampshire's jurisdiction as either impaired or threatened due to ocean acidification per Section 303(d) of the Clean Water Act for the following reasons:

Surface water assessments are based on New Hampshire's water quality standards which are included in State statute (RSA 485-A:8) and regulation (Env-Wq 1700). New Hampshire's water quality standards have been approved by the US EPA (EPA). In New Hampshire, surface waters are classified as A or B with all marine waters being Class B. According to Env-Wq 1703.18 (b), "the pH for class B waters shall be 6.5 to 8.0, unless due to natural causes". Consequently, Class B surface waters are currently considered "acidic" if the pH falls below 6.5 unless naturally occurring. There are currently no ocean assessment units within the State's jurisdiction that are listed as impaired for low pH.

With regards to the adequacy of pH standards for marine waters, EPA is currently reviewing its aquatic life criterion for marine pH to determine if revisions are warranted. Their review is based on scientific information and data related to ocean acidification received in response to the Notice of Data Availability (NODA) included in the Federal Register notice of April 15, 2009 (Vol. 74, No. 71, page 17484). The public comment period for the NODA ended on June 15, 2009. It is DES' understanding that EPA will make a final decision by June 15, 2010. DES will review EPA's final decision and, if deemed appropriate, will then recommend changes to its marine pH water quality standards in the future.

DES reviewed the information submitted by the CBD and is not aware of any evidence demonstrating local impairment of aquatic life due to ocean acidification in ocean waters under the jurisdiction of New Hampshire. With regards to listing these waters as threatened, the Consolidated Assessment and Listing Methodology (CALM) defines threatened waters as:

- **Waters which are expected to exceed water quality standards by the next listing cycle (every two years) and/or,**
- **Waters that do not have any measured in-stream violations but other data indicate the potential for water quality violations (such as calibrated predictive models or violations of NPDES permit effluent limits).**

Based on a DES' review of available information, including that submitted by the CBD, DES is not aware of any data or calibrated predictive models which indicates that New Hampshire's jurisdictional ocean water assessment units will violate New Hampshire's marine pH standards by the next listing cycle (every two years). Consequently, DES does not believe it is appropriate to list the New Hampshire's jurisdictional ocean water assessment units as threatened due to ocean acidification at this time.

Policy on the Use of the DES State-Wide Chloride Regression for Other Datasets

Revised: April 12, 2006

Objective

To determine under which circumstances it is appropriate for an organization or researcher to use the DES state-wide regression equation between specific conductance and chloride concentrations.

DES State-wide Chloride Regression

The DES state-wide chloride regression equation is the most recent correlation of specific conductance and chloride concentrations for samples collected from all water body types in the state during a mixture of seasons. The regression uses all of the valid data pairs in the DES Environmental Monitoring Database, excluding:

- Censored results
- Pairs with chloride concentrations less than 15 mg/L or greater than 1,000 mg/L
- Pairs with specific conductance measurements less than 50 uS/cm or greater than 3,000 uS/cm
- Data without an assigned HUC code
- Pairs from stations with known pollution sources or salt water influences: 00-SPB, 00J-PRB, 06-CCH, 05-SAG.

The regression is updated periodically based on newer data. The current regression equation is based on 1,860 data pairs, approximately divided between lakes and rivers. The equation for predicting chloride concentrations from specific conductance measurements is:

*Chloride (in mg/L) = 0.289 * Specific Conductance (in uS/cm) – 11.7.*

The 95th percentile confidence limit for each prediction is +/- 28 mg/L. For daily average or four day average values, the error in the average value would be +/- $28/(n^{1/2})$, where n is the number of readings used in the average. A graph of the current regression is shown in the attached figure.

The DES state-wide regression equation is only slightly different from the predicted relationship between specific conductance and chloride in pure water from Standard Methods (*Chloride = 0.310*Specific Conductance - 0.0843*). The predicted chloride concentration for a given specific conductance measurements is lower with the DES state-wide regression equation than with the Standard Methods regression. This difference reflects the presence of other ions that add to the conductance in natural waters besides chloride.

Criteria for Using the DES State-Wide Chloride Regression

Organizations and Researchers Without a Site-Specific Chloride Regression

If the organization/researcher has not developed a site-specific chloride regression that is equal to or better than the DES state-wide chloride regression, the organization/researcher should use the DES state-wide chloride regression. The organization/researcher should follow the steps listed below to verify that the state-wide regression is acceptable for their study area.

1. The organization/researcher should collect at least 2 data pairs of chloride concentration and specific conductivity on water samples collected from the study area. If possible, the data pairs should be collected during different flow conditions and seasons.

2. For each data pair, the chloride concentration should be predicted from the conductivity reading using the DES regression equation and then be compared to the measured chloride concentration. If the difference between the predicted and measured chloride concentration is greater than the 95th percentile confidence interval for the regression, then the pair should be rejected.

3. If the data pairs consistently fall outside the confidence limits of the regression, then the organization/researcher should question whether the DES state-wide regression is appropriate for their study area. The regression will not be appropriate for sites with large pollution sources or salt water influences.

Organizations and Researchers with Site-Specific Chloride Regressions

If the organization/researcher has developed a site-specific chloride regression that is equal to or better than the DES state-wide chloride regression, the organization/researcher should use the site-specific regression. The following guidance should be used to determine if the site-specific regression is superior to the state-wide regression. The guidance listed below applies to both outside organizations and DES site-specific studies.

1. The chloride-specific conductance data pairs should be representative of the study area in terms of station types, seasons and flow conditions. In particular, the data pairs should have the following characteristics:

- The data pairs should be collected from at least three different stations in the study area.
- If the organization/researcher collects specific conductance data during the winter season (Nov-Mar), the data pairs should be collected during the winter season. If the organization collects specific conductance data during the summer season (Jul-Sept), the data pairs should be collected during the summer season. If the organization collects specific conductance data in both seasons, the data pairs should be collected from each season.
- Some of the data pairs should be collected during low flow conditions and some from high flow conditions in each season.
- Some of the data pairs should be for water samples with “high” conductance readings relative to the maximum specific conductance measured in the study area. The maximum conductance in a

calibration data pair should not be less than 75% of the maximum conductance measured in the study area.

2. The 95th percentile confidence limit for predictions should be less than the error in the DES state-wide chloride regression. The error can be approximated by multiplying the standard error of the regression by the value of the t distribution for the number of samples in the regression.

New Hampshire DOT
Department of Transportation

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

GEORGE N. CAMPBELL, JR.
COMMISSIONER

JEFF BRILLHART, P.E.
ASSISTANT COMMISSIONER

September 11, 2009

Water Quality Data
NHDES Watershed Management Bureau
29 Hazen Drive, P.O. Box 95
Concord, NH 03302-0095

Dear ~~Sirs~~:
Ken

RE: Comments to the 2010 Comprehensive Assessment and Listing Methodology

The Department has a concern with the section involving listing of water bodies for chloride impairments. Currently the CALM reads as follows on page 62:

> c. Specific conductivity may be used as a surrogate for chloride. It is preferred but not required to collect at least 2 chloride samples within each time period that the specific conductance to chloride relationship is to be used. These samples will be used to confirm that the site fits the statewide specific conductance to chloride relationship. In the event that the confirmation samples do not adequately fit the relationship a site specific relationship may be developed. If no site specific samples are collected and there is no evidence to suggest that a site specific curve is needed, the state wide chloride to specific conductance curve will be used.

The Department would like this language to be strengthened to require some actual chloride sampling before a waterbody is declared impaired for chloride. There are many ions that will increase specific conductance and without some ion specific verification that it is actually the chloride ion that is causing the increase in specific conductance, the waterbody could be misdiagnosed. We offer the following to replace the current language:

> c. Specific conductivity may be used as a surrogate for chloride if at least one chloride sample is collected within each time period that the specific conductance to chloride relationship is to be used. The sample will be used to confirm that the site fits the statewide specific conductance to chloride relationship. In the event that the confirmation sample does not adequately fit the relationship (Note: need to define fit, maybe the TMDL standard would work), a site specific relationship (Note: the strength of this relationship should also be defined with a regression coefficient) must be developed. If no site specific sample is collected then the state wide chloride to specific conductance curve cannot be used.

Thank you for your consideration and if you have any question please contact me.

Sincerely,

Mark Hemmerlein
Water Quality Program Manager
Bureau of Environment
(603) 271-1550

MTH:mth
c.c. C. Hood
Bill Cass
S:\WaterQuality\CALM\Commentsto2010CALM.doc

For DES Use:	AU:	Record #:

Surface Water Data / Information Submittal Form

Please fill in all blank boxes below and attach any supporting documentation or information. The more complete your submittal, the more useful it will be in our surface water assessment. Thank you.

Today's Date:	October 29, 2009		
CONTACT INFORMATION			
Your Name:	Miyoko Sakashita	**Organization:**	Center for Biological Diversity
Phone Number:	415-436-9682 x 308	**E-Mail:**	miyoko@biologicaldiversity.org
P.O. Box or Street:	351 California Street, Suite 600	**City or Town:**	San Francisco
State:	CA	**Zip Code:**	94104

LOCATION WHERE SURFACE WATER DATA / INFORMATION WAS COLLECTED	
Name of Waterbody:	All Atlantic Ocean Assessment Units
City or Town:	
Description of, and a plan or sketch showing, the area of interest or concern, including sampling locations, if applicable. If included in another document, please reference and submit the document.	All Atlantic Ocean Assessment Units
Is a plan or sketch attached?	No, but the description is explanatory.
Directions to the site(s):	
SURFACE WATER DATA / INFORMATION	
Actual data or information including dates and time of collection, measurement results, pictures, etc. If included in another document, please reference and submit the document.	Please see the attached letter and compact disc containing supporting data and information.
Summary of what you think the data or information indicates about water quality. If summarized in another document, please reference and submit the document.	The data and information indicates that New Hampshire's ocean water assessment units are threatened or impaired by ocean acidification and warrant listing under section 303(d) of the CWA.
Documentation of quality assurance methods used in collecting, analyzing and reporting data. If included in another document, please reference and submit the document.	The information submitted herein is from high-quality, credible scientific journals and most of these are peer-reviewed articles that specifically report their methods and analysis.

HOW TO SUBMIT SURFACE WATER DATA / INFORMATION TO DES

By Fax	By E-Mail	By Mail	Questions?
Water Quality Data 603-271-7894	wqdata@des.state.nh.us or visit our website at http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm	Water Quality Data NHDES Watershed Management Bureau P.O. Box 95 29 Hazen Drive Concord, NH 03302-0095	603-271-2457

NOV 03 2009

DEPARTMENT OF ENVIRONMENTAL SERVICES

Sent via electronic and certified mail (with CD enclosed)

October 26, 2009

Water Quality Data
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive
P.O. Box 95
Concord, New Hampshire 03302-0095
wqdata@des.state.nh.us

RE: REQUEST TO ADD OCEAN WATERS TO NEW HAMPSHIRE'S LIST OF IMPAIRED WATERS UNDER SECTION 303(D) OF THE CLEAN WATER ACT DUE TO OCEAN ACIDIFICATION

On behalf of the Center for Biological Diversity, I am writing to request that the New Hampshire Department of Environmental Services:

> **List all ocean assessment units as threatened or impaired due to ocean acidification under section 303(d) of the Clean Water Act.**

The ocean absorbs carbon dioxide causing seawater to become more acidic. Among various adverse impacts to marine life, this process—termed ocean acidification—impairs the ability of calcifying organisms to build their protective structures. Nearly all marine animals studied to date from corals to shellfish have had adverse reactions to ocean acidification. Already ocean pH has changed significantly due to human sources of carbon dioxide. On the current trajectory, ocean ecosystems are likely to become severely degraded from absorption of carbon dioxide and corresponding acidification.

Ocean acidification is perhaps the greatest threat to marine water quality. The U.S. Environmental Protection Agency ("EPA") has acknowledged the threat of ocean acidification and the reach of the Clean Water Act to address this problem. New Hampshire has the duty and authority to list ocean waters as impaired under section 303(d) of the Clean Water Act because ocean acidification is causing seawaters to violate the state's water quality standards. The designated uses protecting New Hampshire's ocean water segments for shellfish, aquatic life, and wildlife are not attained because human sources of carbon dioxide are changing marine pH, which is negatively affecting marine life. New Hampshire should list its ocean waters as threatened or impaired for ocean acidification and develop and implement total maximum daily loads for carbon dioxide pollution.

1. Clean Water Act Background

Congress enacted the Clean Water Act, 33 U.S.C. §§ 1251 et seq., with the express purpose of "restor[ing] and maintain[ing] the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a) (2008). The goals of the Clean Water Act are to guarantee "water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation" and to promptly eliminate water pollution. 33 U.S.C. § 1251(a).

Toward those goals, the Clean Water Act requires states to establish water quality standards that serve as a basis for regulation of water pollution. 33 U.S.C. § 1313(a)-(c); 40 C.F.R. § 130.3. These standards set out water quality goals for each water body by designating uses and setting criteria necessary to protect those uses. 40 C.F.R. § 130.3. Water quality standards should "provide water quality for the protection and propagation of fish, shellfish and wildlife and for recreation." 40 C.F.R. § 130.3.

In turn, section 303(d) of the Clean Water Act requires states to establish a list of impaired water bodies within their boundaries for which existing pollution controls "are not stringent enough to implement any water quality standard applicable to such waters." 33 U.S.C. § 1313(d). Water quality standards include all numeric criteria, narrative criteria, waterbody uses, and antidegradation requirements. 40 C.F.R. § 130.7(b)(3).

Once a state develops its impaired waters list, EPA provides oversight and must either approve, disapprove, or partially disapprove the impaired waters list. 33 U.S.C. § 1313(d)(2). EPA regulations mandate that a list shall be approved only if it meets the requirements that existing pollution control requirements are stringent enough to ensure waters meet all water quality standards. 40 C.F.R. § 130.7(b)(1) & (d)(2). If EPA does not approve a state's list, then it must identify those waters that should be included. 33 U.S.C. § 1313(d)(2); 40 C.F.R. § 130.7(d)(2).

Once a water body is listed as impaired pursuant to Clean Water Act § 303(d), the state has the authority and duty to control pollutants from all sources that are causing the impairment. Specifically, the state or EPA must establish total maximum daily loads of pollutants that a water body can receive and still attain water quality standards. 33 U.S.C. § 1313(d). States then implement the maximum loads by controlling pollution from point sources and nonpoint sources. The goal of section 303(d) is to ensure that our nation's waters attain water quality standards whatever the source of pollution.

2. New Hampshire Should List Ocean Waters as Impaired or Threatened

New Hampshire should list its coastal waters as impaired or threatened water bodies as required by section 303(d) of the Clean Water Act because existing pollution controls are insufficient for ocean waters to meet the state's water quality standards. 33 U.S.C. § 1313(d). Moreover, pH is already considered a conventional pollutant under the Clean Water Act, and accordingly, an unacceptable change in pH constitutes a basis for regulation.

Recent actions of EPA underscore the authority that states have to address ocean acidification pursuant to the Clean Water Act. EPA announced that it will review the aquatic life criterion for marine pH under the Clean Water Act to determine if a revision is necessary to protect designated uses from the threat of ocean acidification (EPA 2009). On April 15, 2009, EPA issued a notice of data availability in the Federal Register that calls for information and data on ocean acidification that the agency will use to evaluate water-quality criteria under the Clean Water Act. In the notice, EPA acknowledged the threat that ocean acidification poses to marine ecosystems:

> Preliminary projections indicate that oceans will become more acidic over time and overall, the net effect is likely to disrupt the normal functioning of many marine and coastal ecosystems.

(EPA 2009: 17485). Despite the approach EPA ultimately decides to take on ocean acidification, New Hampshire has an independent obligation under the Clean Water Act to list is ocean waters as impaired and establish a total maximum daily load.

New Hampshire must list ocean waters as impaired for ocean acidification because designated uses for shellfish, aquatic life, and wildlife are not being attained. To support aquatic life uses, the waters must "provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms." N.H. Water Quality Report at 44-45. Waters designated for wildlife uses must "provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life." Id. These uses are not being attained and are threatened due to ocean acidification as described in this letter and supporting documents.

Moreover, it is New Hampshire's antidegradation policy that "where the quality of the surface waters exceeds levels necessary to support propagation of fish, shellfish, and wildlife, and recreation in and on the water, that quality shall be maintained and protected." ENV-WQ 1708.01. Absent a finding by the Department that allowing lower water quality is necessary to accommodate important economic or social development following public notice and comment, such degradation of water quality shall not be allowed.

New Hampshire's numeric water quality standard for pH requires that waters between pH of 6.5 to 8.0, unless due to natural causes. ENV-WQ 1703.18 PH. These standards, however, are woefully inadequate to protect marine fauna and flora and the designated uses of waters. Zeebe et al. (2008) highlighted the importance of addressing ocean acidification before seawater pH change exceeds the 0.2 unit water quality criterion recommended by the EPA, and far more stringent than New Hampshire's standards:

> Thus, although the response of different organisms is expected to be inhomogeneous (*9*), current evidence suggests that large and rapid changes in ocean pH will have adverse effects on a number of marine organisms. Yet,

> environmental standards for tolerable pH changes have not been updated in decades. For example, the seawater quality criteria of the U.S. Environmental Protection Agency date back to 1976 and state that for marine aquatic life, pH should not be changed by more than 0.2 units outside of the normally occurring range (*10*). These standards must be reevaluated based on the latest research on pH effects on marine organisms. Once new ranges of tolerable pH are adopted, CO_2 emission targets must be established to meet those requirements in terms of future seawater chemistry changes (Zeebe et al. 2008: 52).

In light of this insufficiency and EPA's current review and possible revision of its marine pH criterion, New Hampshire should gauge the need to list waters due to ocean acidification on the 303(d) list by the impacts on water quality and marine life. It should also revise its water quality standards in light of the most recent information on ocean acidification.

Information included herein and the enclosed scientific information demonstrate that the water quality standards described above are not being attained by New Hampshire's ocean waters due to ocean acidification. Specifically, ocean acidification impairs the use of coastal waters for aquatic life and wildlife habitat because it changes ocean chemistry with adverse effects on calcifying species and other marine animals.

3. The Scientific Background of Ocean Acidification

The ocean absorbs carbon dioxide from the atmosphere, which alters seawater chemistry causing slightly alkaline waters to become more acidic. This process, ocean acidification, is advancing rapidly as humans release carbon dioxide into the atmosphere, and the changes in ocean chemistry are unlike anything experienced for millions of years.

The current atmospheric carbon dioxide concentration is at 386 ppm (parts per million) and it continues to increase by 2 ppm annually (EPA 2009). This is a 38 percent increase from preindustrial levels, which is almost all attributable to anthropogenic sources (EPA 2009). Three-quarters of carbon dioxide pollution is from fossil fuel use, with most emitted from electricity generation followed by the transportation sector (Denman et al. 2007; EPA 2009). Most of the remaining emissions are from land use changes, primarily deforestation (Denman et al. 2007).

About half of the carbon dioxide released into the atmosphere from human activities will be absorbed by the ocean (EPA 2009). Right now the ocean absorbs about 22 million tons of carbon dioxide each day (Feely et al. 2006).

Carbon dioxide reacts with seawater to form carbonic acid, which dissociates to form bicarbonate and releases hydrogen ions. This reaction reduces the amount of carbonate ions and decreases pH.[1] Ocean acidification has caused seawater pH to decrease by 0.11 units on average,

[1] Acidity is the concentration of H^+ ions, and it is measured in pH units. A pH decrease of 1 unit means a 10-fold increase in the concentration of H+, or acidity.

which is equivalent to a 30 percent change in acidity and a decrease in carbonate concentration of 10 percent (Caldeira & Wickett 2003; Orr et al. 2005; Caldeira et al. 2007; Feely et al. 2008). By the end of this century, carbon dioxide is predicted to reach 788 ppm and the pH of the ocean will to drop by another 0.3 or 0.4 units, amounting to a 100–150 percent change in acidity (Orr et al. 2005, Meehl et al. 2007). A pH change of this magnitude has not occurred for more than 20 million years (Feely et al. 2004). Scientists tell us that carbon dioxide emissions will need to be stabilized below 350 ppm to avoid perilous biological consequences of ocean acidification (McNeil & Matear 2008; Steinacher et al. 2009; Hansen et al. 2008; Cao & Caldeira 2008).

Changing marine pH and carbonate concentrations are fundamentally altering ocean chemistry. Carbonate is an important constituent of seawater because many organisms form their shells and skeletons by complexing calcium and carbonate. Calcium carbonate is present in the ocean in two common forms, calcite and aragonite. When seawaters become undersaturated with respect to calcium carbonate they are corrosive to organisms that produce calcium carbonate shells, liths, and skeletons. Modeling predicts that by the end of the century global aragonite production will be reduced by 29% and total calcium carbonate production by 19% relative to preindustrial levels (Ganstø et al. 2008).

A recent survey of the Pacific Coast revealed that the effects of ocean acidification are occurring more rapidly there than predicted (Feely et al. 2008). Researchers found seawater undersaturated with respect to aragonite upwelling onto large portions of the continental shelf, reaching shallow depths of 40 to 120 meters (Feely et al. 2008). As a result, marine organisms in surface waters, in the water column, and on the sea floor along the West Coast are already being exposed to corrosive water during the upwelling season. Although the East Coast has different oceanographic conditions than the West Coast, monitoring of the Atlantic Ocean reveals that pH is declining in step with rising carbon dioxide in the atmosphere.

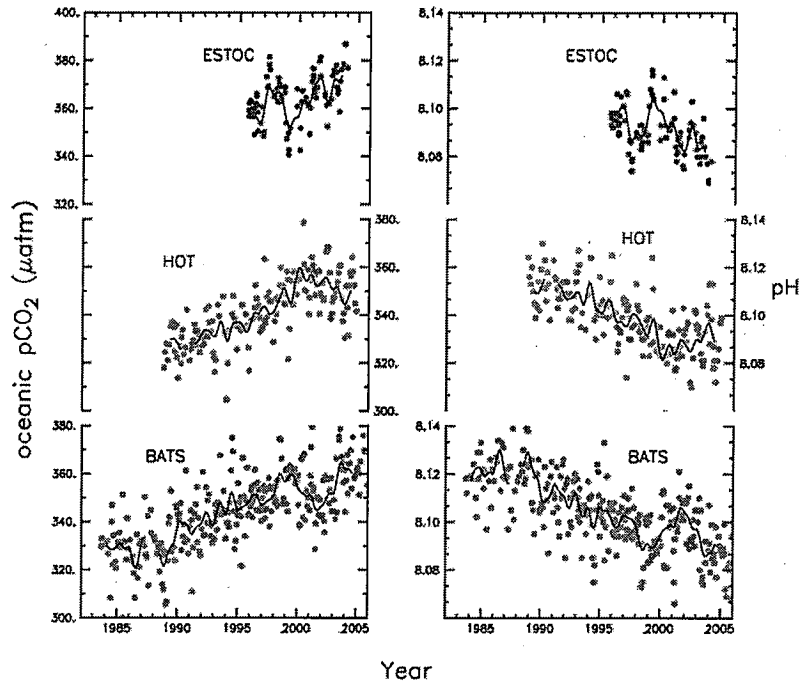


Figure 1. Changes in surface oceanic pCO2 (left; in μatm) and pH (right) from three time series stations: Blue: European Station for Time-series in the Ocean (ESTOC, 29°N, 15°W; Gonzalez-Dávila et al., 2003); green: Hawaii Ocean Time-Series (HOT, 23°N, 158°W; Dore et al., 2003); red: Bermuda Atlantic Time-series Study (BATS, 31/32°N, 64°W; Bates et al., 2002; Gruber et al., 2002). Values of pCO2 and pH were calculated from DIC and alkalinity at HOT and BATS; pH was directly measured at ESTOC and pCO2 was calculated from pH and alkalinity. The mean seasonal cycle was removed from all data. The thick black line is smoothed and does not contain variability less than 0.5 years period (Bindoff et al. 2007).

At present, the effects of ocean acidification are greatest in surface waters (< 1000 m) where carbon dioxide exchange occurs with the air, but the decline in aragonite and calcite saturation will extend throughout the water column in the foreseeable future (Orr et al. 2005). This is important because calcifying organisms form their shells from calcium carbonate, and can not do so when carbonate is not available to complex with calcium. Consequently, ocean acidification threatens the biological, chemical, and physical integrity of marine waters and impairs the ability of ocean waters to sustain the health and vitality of aquatic life.

4. Ocean Acidification Impairs Fish and Wildlife Habitat

The science is undisputable that carbon dioxide is causing our oceans to become more acidic. The key question remaining is whether we will be able to reduce carbon dioxide emissions quickly enough to avoid the worst consequences of ocean acidification on marine ecosystems.

One of the major impacts of ocean acidification is that it impairs the ability of marine organisms to build protective shells and skeletons. The uptake of carbon dioxide by the ocean impairs calcification in animals because carbonate minerals, calcite and aragonite, become unavailable in seawater. Nearly all calcifying organisms studied, including species from the major marine calcifying groups, have shown an adverse response of reduced calcification in response to elevated carbon dioxide. According to the EPA:

> As more CO2 dissolves in the ocean, it reduces ocean pH, which changes the chemistry of water. These changes present potential risks across a broad spectrum of marine ecosystems...For instance, ocean acidification related reductions in pH is forecast to reduce calcification rates in corals and may affect economically important shellfish species including oysters, scallops, mussels, clams, sea urchins, and lobsters...Impacts to shellfish and other calcifying organisms that represent the base of the food web may have implications for larger organisms that depend on shellfish and other calcifying organisms for prey.

(EPA 2009: 17485)

Plankton, which comprise the basis of the marine food web, are among the calcifying organisms likely to be adversely affected by ocean acidification. Studies of coccolithophorids showed that carbon dioxide related changes to seawater caused reduced calcification, resulting in malformed and incomplete shells (Riebesell 2000). Pteropods similarly experience reduced calcification under elevated carbon dioxide levels (Comeau et al. 2009). Experiments also show that the shells of pteropods dissolve as seawater becomes undersaturated with aragonite (Orr et al. 2005). Elevated carbon dioxide concentrations also reduce the shell mass of foraminifera (Kleypas et al. 2006). Modern shell weights of foraminifera in the Southern Ocean are 30–35 percent lower than those from preindustrial sediments, which is consistent with reduced calcification induced by ocean acidification (Moy et al. 2009). While some species of plankton react differently under high concentrations of carbon dioxide, most calcareous plankton studied thus far exhibit reduced calcification (Guinotte & Fabry 2008). Ocean acidification's impact on calcifying plankton is especially troublesome because most of the ocean's primary production is from such plankton and effects will extend up the entire food chain.

Ocean acidification also decreases the calcification of corals, including cold-water corals found in the Atlantic Ocean. Calcification rates of reef-building corals are expected to decrease 30-40 percent with a doubling of atmospheric carbon dioxide (Kleypas et al. 2006; Hoegh-Guldberg et al. 2007; Guinotte and Fabry 2008). Scientists predict that ocean acidification coupled with increasing ocean temperatures will destroy the world's reefs by mid-century (Hoegh-Guldberg et al. 2007). Within the past decade, scientists have observed a significant decrease in the saturation state of a calcium carbonate mineral, aragonite, in the greater Caribbean region (Gledhill et al. 2008). In the Australian Great Barrier Reef, scientists investigated 328 colonies of massive Porites corals and found that calcification has declined by 14.2% since 1990, predominantly because linear extension has declined by 13.3%. (De'ath et al. 2009; Cooper 2008). Ocean acidification also causes a decrease in crustose coralline algae, an

important plant for coral reef building. Experiments at pH levels expected within the century caused crustose coralline algae to decrease by 92 percent (Kuffner et al. 2008). Cold-water corals may be even more sensitive to reduced carbonate saturation because they already live in conditions less favorable to calcification, and 70 percent of scleractinian cold-water corals could be in water undersaturated with respect to aragonite by the end of the century (Royal Society 2005; Guinotte & Fabry 2008).

Scientists predict that ocean acidification will also decrease calcification in shellfish significantly by the end of the century (Gazeau et al. 2007). For example, a recent study found that the calcification rates of the edible mussel and Pacific oyster decrease with increases in carbon dioxide (Gazeau et al. 2007). Experiments revealed that moderate increases in atmospheric carbon dioxide had significant effects on the survival and growth of sea urchins and snails (Shirayama 2005).

Ocean acidification also disrupts metabolism and other biological functions in marine life. Changes in the ocean's carbon dioxide concentration result in accumulation of carbon dioxide in the tissues and fluids of fish and other marine animals, called hypercapnia, and increased acidity in the body fluids, called acidosis. These impacts can cause a variety of problems for marine animals including difficulty with acid-base regulation, calcification, growth, respiration, energy turnover, and mode of metabolism (Pörtner et al.2004). Squid, for example, show a very high sensitivity to pH because of their energy intensive manner of swimming (Pörtner et al. 2004; Royal Society 2005). Because of their energy demand, even under a moderate 0.15 pH change squid have reduced capacity to carry oxygen and higher carbon dioxide pressures are likely to be lethal (Pörtner et al. 2004). Studies have shown that squid under elevated carbon dioxide have a slowed metabolic activity and impaired behaviors, and researchers say warming waters will mean that the oxygen-poor zones the squid inhabit at night will be shallower reducing squid habitat and increasing their vulnerability to predators (Rosa et al. 2008). In fish, high concentrations of carbon dioxide in seawater can lead to cardiac failure (Ishimatsu et al. 2004).

Some studies show that juvenile marine organisms are particularly susceptible to ocean acidification (Ishimatsu et al. 2004; Kurihara & Shirayama 2004). In conditions simulating future seawater with elevated carbon dioxide, larval clownfish lost their detection and homing abilities to find suitable habitat (Munday et al. 2009).

Ocean acidification can also decrease the sound absorption of seawater causing sounds to travel further with potential impacts on marine mammals and other marine life that may be sensitive to noise of vessel traffic, seismic surveys, and other noise pollution (Hester et al. 2008). Already sound travels 10-15 percent further with a change of 0.1 pH, and it is predicted to increase about 40 percent by mid century with corresponding ocean acidification (Hester et al. 2008). Moreover, ocean acidification may also enhance the mobility of mercury in the environment resulting in increased accumulation of mercury in fish, marine mammals, and humans (USGS 2000).

Entire ecosystems are likely to be altered by the changes caused by ocean acidification. Scientists have already observed changes in species distribution that are likely the result of ocean acidification. Calcifying organisms off the coast of Washington State exhibited increasing probabilities of replacement by other species as pH decreased substantially between 2000 and 2008 (Wootton et al. 2008).

The consequences of ocean acidification on marine life are complex, but they could disrupt the marine food web with potentially detrimental consequences. Already some of the biological effects of ocean acidification are occurring in our ocean waters (Moy et al. 2009). Additionally, ocean acidification coupled with other environmental changes such as global warming can have cumulative and synergistic adverse impacts on ocean biodiversity (Guinotte & Fabry 2008).

Pacific Coast oyster hatcheries are already experiencing difficulties associated with increasing ocean acidification. Two of the largest hatcheries report production rates down by as much as 80% (Miller et al. 2009). The oyster failures in recent years may foreshadow the widespread effects that increasingly acidic waters will have on the shellfishing and fishing industry. Assuming business as usual projections for carbon emissions and a corresponding decline in ocean pH and mollusk harvests, ocean acidification's broader economic losses for the United States would range from $1.5–6.4 billion through 2060 (Cooley et al. 2009).

5. Data Quality and Consideration

The regulations governing implementation of the Clean Water Act's section 303(d) *require* that New Hampshire "evaluate all existing and readily available water quality-related data and information to develop the list." 40 C.F.R. § 130.7(b)(5); *see also Sierra Club v. Leavitt*, 488 F.3d 904 (11th Cir. 2007)

The enclosed peer-reviewed scientific literature meets data quality standards. The data and information is of high quality and credibility using methods and parameters to control for errors. Moreover, EPA's guidance states that the "[l]ack of a State-approved QAPP should not, however, be used as the basis for summarily rejecting data and information submitted by such organizations, or assuming it is of low quality, regardless of the actual QA/QC protocols employed during the gathering, storage, and analysis of these data" (EPA, Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act at 33 (2005) ("EPA 2006")(EPA advised states to prepare their 2010 303(d) lists consistent with the 2006 Guidance).

EPA's guidance for listing of impaired waters emphasizes that states should evaluate all data, and that listings may be based on small data sets, data other than site specific monitoring, and data from the public (EPA 2006 Guidance). Here, the absence of site specific monitoring

should not obviate the need to list New Hampshire's ocean waters as impaired, rather it demonstrates a need for additional coastal monitoring. Recognizing the limited monitoring data available, EPA encourages states to consider a more expansive versus cautious approach to monitoring data (EPA 2006 Guidance). Site-specific monitoring data is not required for impaired water listing. EPA regulations require that "reports from dilution calculations and predictive modeling" be included in the data and information that a state considers in its assessment process for section 303(d) listing purposes. 40 CFR 130.7(b)(5)(ii)). EPA guides states to consider even very small sample sets to ascertain the attainment status of waters. Moreover, states should use information about observed effects, predictive modeling, and knowledge about pollutant sources and loadings when making its listing determinations (EPA 2006 Guidance).

Furthermore, EPA regulations and guidance require states to seek public participation in the impaired waters listing process. EPA regulations require that states actively solicit data and information from organizations and individuals, including conservation organizations. 40 C.F.R. 130.7(b)(5)(iii); EPA 2006 Guidance. Here, the Center for Biological Diversity presents well-documented and highly credible scientific evidence that New Hampshire ocean waters are impaired from ocean acidification.

6. Conclusion

In summary, New Hampshire has an obligation to list its ocean waters as impaired under section 303(d) of the Clean Water Act. The scientific evidence summarized here and enclosed with this letter documents that the addition of carbon dioxide to our coastal waters from human sources is significantly changing ocean chemistry and harming marine life. Ocean acidification is a threat to seawater quality, and the Clean Water Act requires the state to list waters and create a TMDL.

While the worst effects of ocean acidification are forecasted for the future, the adverse changes to New Hampshire's ocean waters from ocean acidification are already underway. These changes will, if not addressed, have serious, and likely catastrophic effects on ocean biodiversity, productivity, and ultimately, economy. The goals of the Clean Water Act can only be met by taking steps to slow ocean acidification, and action under the Clean Water Act can complement other efforts to regulate carbon dioxide emissions.

Sincerely,

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enclosure

Enclosed on compact disc:

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