Summary of Public Comments and Responses

2014 Draft Wisconsin Consolidated Assessment and Listing Methodology (WisCALM)

The draft 2014 WisCALM was vetted by the public from May 30, 2013 to June 30, 2013. Five entities commented on the changes to the WisCALM guidance and the following is a summary of comments and DNR responses indicating any changes to WisCALM. Copies of the original comment documents submitted to DNR are included at the end of this response to comments document.

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PUBLIC NOTICE OF THE COMMENT PERIOD

Posted on DNR's website at: **http://dnr.wi.gov/news/input/Guidance.html**

Proposed DNR program guidance

- Subscribe to emails announcing when new guidance is available for comment.

The Wisconsin DNR creates and revises program guidance to aid in the consistent implementation of statutes and codes.

State lawmakers and the Natural Resources Board may grant the DNR authority to define the specific implementation details of regulations and programs. This is often described as broad decision-making authority. To help consistently implement broad decision-making authority, DNR programs often develop "program guidance."

Program guidance is formal written direction to DNR staff that explains how to approach making decisions when there are not specific details in the law. Department programs use different formats to document guidance including operational handbooks, manual codes and written directives from managers to staff. Program guidance can include recommended actions or suggested permit conditions when certain factors or criteria are present. Program guidance may also clarify implementation of legal authority or guide decision-making where legal authority allows discretion in decisions.

Opportunities for participation

We welcome your input on new and revised program guidance. Here are some key facts about this public input process.

- The comment period is 21 days unless modified for cause.
- Notice of proposed guidance will be posted on this site. You may sign up to be automatically notified.
- All comments received will be considered and a comment response summary will be shared on this page. Please be aware that the comment response summary will include all of the submitted comments in the format they were received.
- Final guidance will be posted on this page for 21 days once it is completed. We strive to post the final guidance within 45 days of the expiration of the comment period.
- If you would like to request that the department consider updating an existing guidance, please contact the appropriate DNR program directly or email the DNR Secretary's Office.

Proposed program guidance

[Posted on May 30, 2013]

Program Area	Subject	Status	Documents	Staff Contact	Comments
Water Quality Assessment	Updates to Wisconsin's Consolidated Assessment and Listing Methods (WisCALM) guidance for assessing water quality and listing impaired waters for surface waters of the state	Open for comment until **June 30, 2013**	Proposed guidance document [PDF]	Aaron Larson	Email your comments to Aaron Larson

GovDelivery Email Notification of Comment Period

From: Wisconsin Department of Natural Resources <widnr@service.govdelivery.com>

Date: Thu, May 30, 2013 at 4:24 PM

Subject: New DNR Proposed Program Guidance Available for Public Comment

To:

Thank you for subscribing to Wisconsin DNR's Proposed Program Guidance Updates.

New DNR Proposed Program Guidance Available for Public Comment

A new, draft document regarding updates to Wisconsin's Consolidated Assessment and Listing Methods (WisCALM) guidance for assessing water quality and listing impaired waters for surface waters of the state is now available for review and comment on the Proposed DNR Program Guidance Web page. This document is open for comment until **June 30, 2013**.

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DNR Response to Comments

Comments were received from five entities during the public comment period: U.S. Environmental Protection Agency, Midwest Environmental Advocates, Midwest Environmental Group – Wastewater Division, Alliance for the Great Lakes, and Fisheries Bio-Technology Prescriptions. Below are DNR's responses to their comments. Any changes made to the guidance document to address comments are noted in the response.

Responses to EPA Comments

1) Bio-monitoring and assessment program
    a. **Baseline monitoring strategy and assessment data requirements**
    DNR will continue evaluating minimum data requirements outlined in WisCALM to ensure that these requirements can be practicably met within the current baseline monitoring framework in order to make attainment decisions. DNR is currently evaluating our monitoring strategy with the goal of better aligning our monitoring design and assessment methodology in order to meet Clean Water Act (CWA) assessment requirements.
    b. **Biological assessment thresholds**
    DNR is working with EPA to address their concern regarding impairment thresholds and how to suitably manage marginally impaired waters or those with declining water quality. DNR is further assessing options for managing these waters and collaborating with EPA and their contractor, Midwest Biodiversity Institute, to better define and understand the department's uses of monitoring and assessment information and to determine the opportunities and barriers to the fuller use of this information in support of water quality management programs. DNR plans to examine the intersections of our bio-monitoring and assessment programs with designated aquatic life uses and water quality criteria as we prepare to update associated administrative rules with revised designated use classifications and biological criteria. In the process, DNR plans to plot our biological assessment thresholds along a biological condition gradient in order to link these thresholds to the appropriate level of aquatic life use protection.

2) Public Water Supply (PWS) waters and Public Health and Welfare (PHW) use assessments
    a. **PHW use assessments and associated water quality criteria**
    While public water drinking supply and non-public drinking water supply are defined in NR 102 Wis. Admin. Code, the definition does not imply an official designated use category. These definitions were designed to implement standards for toxic pollutants in NR 105 of Wis. Admin. Code. WDNR acknowledges that the current standards specify that all surface waters shall be suitable for supporting public health and welfare. DNR applies the human health criteria in NR 105.08 Wis. Admin. Code (thresholds in Table 8) for the protection of this use, where data that meet minimum data quantity and quality requirements are readily available.
    b. **PWS waters monitoring strategy and assessment methods**
    EPA recommends that DNR develop an assessment methodology for PWS waters and incorporate routine monitoring for these waters in our statewide WQ monitoring

program to include parameters from the newly developed assessment methodology for the 2016 assessment cycle. DNR's monitoring and assessment teams will work collaboratively with EPA to explore options for incorporating additional monitoring of key parameters at PWS waters and assessment methods that complement those data. DNR may then begin to more formally assess the PHW use for PWS waters in the future once assessment methods, including listing thresholds, are developed for supplemental indicators.

3) Extreme weather and representative data

   a. **Excluding data on a categorical basis (versus a case-by-case basis) is not appropriate for 303(d)/305(b) assessments.**

   DNR does not intend to exclude water quality data on a categorical basis. In cases where proper sampling protocols are not followed or other quality assurance issues are discovered, DNR will collect supplemental, representative data to meet minimum data requirements. DNR will record all case-by-case decisions to require additional data in the 303(d) listing documentation for affected waterbodies. This procedure was followed when DNR provided documentation in the 2012 list submittal to US EPA for each of six stream segments that were not listed as impaired because sufficient representative data were unavailable due to samples collected during flood conditions. DNR is collecting additional phosphorus data for these streams in the 2013 sampling season.

   Clarifying language was added on Page 9 and 25 of the final 2014 WisCALM guidance that describes how DNR will resolve data gaps left when samples were collected during extreme weather conditions, including additional sampling and consideration of data from outside of standard period of record.

4) Phosphorus assessment methods

   a. **TMDL priority for Category 5P Waters**

   DNR recognizes that all Category 5 waters require Total Maximum Daily Load (TMDL) evaluations. Clarification was provided on pages 33 and 47 of the final 2014 WisCALM guidance that explains all Category 5P waters require TMDLs, but will be given a low priority for TMDL development. The statement that "DNR does not intend to conduct TMDLs for Category 5P waters until biological impairment is confirmed..." will be removed from DNR's website.

   b. **Terminology related to biological confirmation of impairment**

   EPA interprets the term "bioconfirmation" as being inconsistent with our water quality standards. Per EPA's recommendation, DNR has replaced the term "bioconfirmation" with "biological information" in the context of phosphorus assessment methods in the final 2014 WisCALM guidance.

   c. **Phosphorus assessment methods and water quality standards consistency**

   EPA requests an explanation of the rationale supporting the use of confidence intervals as proposed in the TP assessment method and how this approach is consistent with Wisconsin's water quality standards. EPA is concerned that using a lower confidence limit (LCL), such as the 90% LCL, approach in our TP assessment methods would result in

DNR not listing some waterbodies that exceed criteria. While this could occur in a few cases, the most likely outcome is that these waters would be targeted for additional monitoring and some would be eventually listed as impaired as more data tighten the confidence intervals. On the other hand, using a sample mean or median with no measure of confidence would result in higher numbers of incorrect listing decisions. Therefore, in order to yield the highest number of correct assessment decisions with the least amount of sampling effort, DNR has adopted the confidence interval approach for assessing waters against the applicable statewide total phosphorus criteria. DNR will continue to work with EPA to demonstrate that the confidence interval approach is protective of water quality and consistent with standards.

DNR also wishes to better define some potentially confusing terminology. The term "90% lower confidence limit" in this proposed revision means that we can be 90% confident that the true mean TP concentration exceeds the specified value. It does not refer to the lower 90^{th} percentile of sample concentrations. In addition, while the 90% LCL is always less than the sample mean, it will be greater than the true mean in 10% of cases. Furthermore, the upper 90% confidence limit on the mean TP concentration will be used to make delisting decisions, so taken as a whole, this methodology is not biased toward or away from listing waterbodies whose mean TP concentrations actually exceed applicable criteria.

5) Temperature assessment methods

a. Minimum data requirements

EPA agrees that 10 and 20 sample minimums are reasonable temperature data requirements for streams and lakes, respectfully. However, they request that DNR consider smaller datasets, where needed. DNR agrees that smaller temperature datasets may be considered in certain cases, such as incidences of a high magnitude of exceedance, and will exercise best professional judgment in making a decision to use datasets smaller than the minimum specified in WisCALM. This clarification was added as a footnote in Tables 5 and 14 of the final 2014 WisCALM guidance.

b. Applicable criteria and frequency and duration of exceedance

EPA requests clarification that the weekly average temperature values are calculated using the daily max values rather than daily mean values (or continuous data) when comparing data against applicable sub-lethal criterion. This clarification was added to Tables 5 and 14 of the final 2014 WisCALM guidance. Table 5 was also updated to reference NR 102.25(4) of Wis. Admin. Code, which contains the temperature criteria applicable to surface waters for the protection of the fish and aquatic life use for inland lakes and impoundments. The final 2014 WisCALM guidance uses a 10% exceedance rate of the acute criterion to assess impairment; however, EPA is reevaluating the "10% rule" and may provide further explanation of this in the 2016 IR guidance. DNR will reexamine the use of a 10% exceedance allowance when new EPA guidance on this issue becomes available.

RESPONSES TO PUBLIC COMMENTS

Midwest Environmental Advocates (MEA)

1. **"DNR must incorporate all existing and readily available water quality-related data into impairment assessment protocols and must actively solicit such data when water quality issues have been reported."**
   Data was solicited from the public from October 1 through December 31, 2010. To enable efficient processing of these data, DNR required data to be submitted electronically and in a specific Excel spreadsheet format, along with quality assurance documentation. It was noted that data received as PDF files or in other hard copy formats may not be used. Guidance on minimum data requirements and methods DNR used to evaluate the data were made available in the 2010 Wisconsin Consolidated Assessment and Listing Methodology (WisCALM) document. Instructions for data file preparation were posted on our website. Required data submittal elements included:
   - A quality assurance plan
   - Data in specified Excel spreadsheet format (template provided)
   - Locational information in specified spreadsheet format (template provided)
   - General information about the submitter, entered in an online form

   All "readily available" data meeting minimum data and quality control requirements were used in the development of the 2012 list of impaired waters. Data that were not provided in the above specified format were not considered "readily available." Given DNR's existing financial and staff resources for compiling and organizing external data, DNR has limited ability to use data that are not provided in the specified format for impairment assessments.

2. **"Biological impairment requirements unlawfully prevent impaired waters from being listed and must be removed from the WisCALM."**
   The lack of biological information does not preclude DNR from listing a waterbody as impaired under the final 2014 WisCALM guidance. WisCALM includes a biological assessment component for determining the appropriate reporting category to assist DNR in water resources management prioritization and decision-making. Category 5 waters are those that are not attaining water quality standards *and require a TMDL*; this category constitutes Wisconsin's impaired waters list. The final 2014 WisCALM maintains the use of Category 5P, a subcategory of the Category 5 impaired waters, which includes those waters that exceed the applicable total phosphorus criteria in NR 102.06 of Wis. Adm. Code, but available biological data do not indicate impairment. DNR is required to develop TMDLs for Category 5P waters, but has assigned these waters a "low" priority for TMDL development in the current list. One reason for identifying these waters as a lower priority for TMDL development is to allow time for DNR to evaluate the suitability of the applicable statewide criterion and to consider the need for a site-specific criterion before initiating a TMDL study for these waters.

3. **"WisCALM must be revised to comply with codified state water quality standards at NR 102.06."**
   DNR has developed WisCALM guidance in accordance with administrative rules, including NR 102.06. The listing thresholds corresponding to the total phosphorus criteria in NR 102.06 can be

found in Tables 6 and 14 in the final 2014 WisCALM guidance document. Waters meeting minimum data requirements and exceeding listing thresholds in WisCALM are considered impaired and proposed for listing.

4. **"DNR must eliminate category 5P to ensure that the 303(d) list will actually function to improve water quality in Wisconsin waterbodies as the CWA intends."**
   DNR's use of Category 5P for integrated reporting and listing purposes is in accordance with state and federal policies and regulations. Category 5P waters will be evaluated for future management actions that may include, but are not limited to, further monitoring to collect needed biological data, studies to determine site-specific phosphorus criteria, use attainability analyses, Total Maximum Daily Load development, or implementation of best management practices to meet current water quality criteria.

5. **"DNR reliance on confidence intervals will result in an inadequate list and should be replaced with a more representative and scientifically sound methodology that reflects a protective approach to assessment decisions."**
   See response to EPA comment 4c above.

6. **"DNR must revise the protocol for assessing chlorophyll *a* exceedances to ensure that impairment decisions are representative of actual conditions, based on scientifically sound methodologies, and sufficiently protective of public health."**
   As defined in WisCALM, 20 ug/L is considered a nuisance condition and is to be assessed in the "deepest spot" of a waterbody. DNR acknowledges that chlorophyll concentrations are often spatially variable in lakes and may often be higher in near-shore areas. The use of the deepest spot as representative of the lake as a whole standardizes the assessment process among lakes. The 20 ug/L threshold is a conservative estimate of when lakes become impaired for recreational use. For example, when sampling a lake with 20 ug/L of chlorophyll, 50% of citizen lake monitors judged it to either have "very minor aesthetic problems," or be "beautiful, could not be nicer." Therefore, while the "deepest spot" may not be representative of every part of the lake, sampling at this location in most lakes makes assessment consistent, and the use of a conservative impairment threshold makes this method protective of recreational uses of lakes.

   The minimum number of samples for estimating chlorophyll exceedance frequency is six. The statistical procedure described on page 34 of WisCALM can provide an estimate of this frequency, and a confidence interval, which indicates the precision of the estimate. As with any summary statistic, the confidence interval will generally narrow as more data are collected. If the confidence interval overlaps the impairment threshold, the waterbody will be placed on the Watch Waters list, and targeted for additional sampling.

   The World Health Organization predicts a moderate risk of adverse health effects at >50 ug/L of chlorophyll if cyanobacteria dominate, so a 20 ug/L chlorophyll standard is expected to be protective of public health.

7. **"DNR should incorporate third party data from the USGS in addition to SWIMS when conducting assessments to ensure that impaired waters are recognized and listed."**

As discussed in the response to MEA's comment #1 above, all "readily available" data meeting minimum data and quality control requirements were used in the development of the 2012 list of impaired waters. Generally, data that were not provided in the required format were not considered "readily available." Given DNR's existing financial and staff resources for compiling and organizing external data, DNR has limited ability to use data that are not provided in the specified format for impairment assessments.

8. **"DNR's data requirements for dissolved oxygen are too stringent and must be revised to adequately identify and list waters that are in fact impaired."**
   For lakes, WisCALM guidance requires ten discrete dissolved oxygen (DO) measurements collected from the epilimnion on separate calendar days during ice-free periods. For streams, the proposed 2014 WisCALM guidance required three days of continuous measurements (no less than one sample per hour) in July or August collected from each of three separate calendar years. In the final 2014 WisCALM guidance, the number of separate years from which DO data are required was reduced from three to two years. This change better aligns our minimum data requirements for DO with our requirements for biological data of a minimum of two years. These minimum data requirements can be reasonable met under DNR's baseline monitoring program.

9. **"DNR should list waters as impaired for fish consumption based on human health risks regardless of whether that water is or is not subject to a specific advisory."**
   The listing methods for impairments related to fish tissue contaminants (i.e. fish consumption advisories) are unchanged. WDNR's current methods for making impaired waters listing updates related to mercury impairments are primarily based on updated fish tissue consumption advisories, issued jointly by WDNR and Wisconsin Department of Health Services. Waters for which fish consumption advisories are in effect are added to the 303(d) list. When an advisory is removed (based on new fish tissue contaminant concentrations), the associated waters are removed from the 303(d) list during the biennial listing update. DNR believes that consistency in listing methods for the fish consumption advisory waters and impaired waters provides mutual support for each respective list and maximizes public understanding and credence of our mercury-related listing procedures.

   The number of samples needed and time frame considered for issuing an advisory on a particular water is determined case-by-case based on the professional judgment of WDNR toxicologists and Department of Health Services staff.

Midwest Environmental Group – Wastewater Division (MEG)

1. **"The Department has revised WisCALM to provide that if a waterbody is exceeding the numeric water quality standard, it will be listed as impaired regardless of whether the biological indicators show an impairment. We encourage the Department to retain the current guidance that provides where natural background levels may be higher than impairment thresholds or uncontrollable factors may cause an exceedance of water quality standard, the**

Department will determine whether the criteria exceedance is reasonably expected to be due to natural or uncontrollable factors."

In their February 17, 2012 letter to DNR, the U.S. Environmental Protection Agency (EPA) stated that "waters that meet minimum data requirements and exceed numeric total phosphorus criteria must be placed on the 303(d) list in order to implement Wisconsin water quality standards as written and to meet Clean Water Act (CWA) goals." In response, WDNR has begun developing an administrative rule revision proposal to modify our assessment and impaired waters listing processes and more formally incorporate biological confirmation of impairment into these processes.

If the proposed rule revisions are adopted, WDNR would make assessment and listing decisions in accordance with the revised rule. Under the proposed rule revisions, waters that exceed applicable phosphorus concentration thresholds and are biologically impaired would be included on the Impaired Waters List. Whereas, waters that exceeded applicable phosphorus concentration thresholds only and are not biologically impaired would be delisted from the Impaired Waters List.

In the interim, assessments and listing decisions will follow current WisCALM guidance, which implements the existing phosphorus criteria in Wis. Adm. Code NR 102.06 by including such waters in the 5P category.

2. **"The Department states that for water bodies that exceed the numeric water quality standard they will list the water body in Category 5P but that these waters will have a low priority for the development of a TMDL. This will cause significant problems for those communities that discharge to Category 5P waters - they will be discharging to an impaired water and subject to the regulatory burdens associated with discharges to impaired waters, with no timeline for an individual assessment of the waterbody or plan to get the water into attainment. We respectfully request that the Department use the 5P Category in very limited situations."**

   As stated in a previous response, while a low TMDL priority is a default status for Category 5P waters, they will be evaluated for future management actions. These activities may include, but are not limited to, further monitoring to collect needed biological data, studies to determine site-specific phosphorus criteria, use attainability analyses, Total Maximum Daily Load development, or implementation of best management practices to meet current water quality criteria.

3. **"…the Department should adopt a broader approach [that] determines all the evidence of impairment in the water body and apportions the proper weight to that evidence provides for a proper review of a complex system to determine whether the water body's function is truly impaired. For instance, Ohio EPA has proposed a process that integrates the stressor variables (nitrogen and phosphorus concentrations) that potentially cause stream degradation with "response" data collected through measurements of biologically important stream attributes when determining whether a water body should be listed as impaired."**

   DNR is currently evaluating other states' nutrient criteria and bearing in mind Ohio's nutrient index approach, which integrates nutrient stressor and response variables, as a possible option to consider for revisions to Wisconsin's water quality standards and listing methods.

4. **"…[MEG] recommend[s] that the Department create a process that provides for recognition of waterbodies that may exceed the numeric water quality criterion but that are apart of a larger watershed initiative such as an adaptive management project or are effluent dominated water bodies. For instance, the updated 303(d) impaired waters list includes Badfish Creek which is the point of discharge for the Madison Metropolitan Sewerage District (MMSD)."**
   In response to comments received on the proposed Badfish Creek phosphorus impairment listing, DNR revised the 2014 WisCALM guidance and draft 2012 impaired waters list to include Badfish Creek in a new category for impaired waters within watershed project areas, where DNR expects those programs to result in attainment of water quality standards and, therefore, TMDL development would be a low priority. Below is the definition of the new listing category, 5W, which was included in the final 2014 WisCALM guidance document:

   > Category 5W: Available information indicates that water quality standards are not met; however, the development of a TMDL for the pollutant of concern is a low priority because the impaired water is included in a watershed area addressed by at least one of the following WDNR-approved watershed plans: adaptive management plan, adaptive management pilot project, lake management plan, or Clean Water Act Section 319-funded watershed plan (i.e. nine key elements plan).

   Note that waters placed in any subcategory of Category 5, including 5W, are considered impaired, and require the development of a TMDL. One reason for establishing the new subcategory 5W is to identify these waters as a lower priority for TMDL development and allow time to evaluate the effectiveness of a watershed management plan before embarking on a TMDL study.

   EPA regulations acknowledge other pollution control requirements that may obviate the need to develop a TMDL for listed waters, including technology-based effluent limitations, more stringent effluent limitations, or other pollution control requirements (e.g. best management practices) that are stringent enough to achieve water quality standards within a reasonable period of time (see 40 CFR 130.7(b)(1)). These are impaired waters, where a TMDL is not required because they are expected to meet standards due to other pollution control requirements, are commonly referred to as "Category 4B" waters. DNR considered Category 4B as an option for Badfish Creek, but have come to the conclusion that EPA requirements for this category are not currently met.

Alliance for the Great Lakes

1. **"WDNR must evaluate and list all Great Lakes nearshore areas for recreational use impairments caused by excessive phosphorus."**
   "WDNR must develop methods for determining support of recreational use within the context of aesthetics at the Great Lakes beaches."
   As stated in previous responses to similar comments, DNR does not have an established assessment protocol for assessment of Great Lake nearshore waters or a clear means to delineate an area of impact. However, recreation use impairments to Lake Michigan and Superior caused by excessive phosphorus may be addressed, in part, through implementation of the statewide phosphorous criteria by reducing nutrient loading. DNR has also incorporated

aquatic macrophyte metrics in impairment assessments of inland waters, and some of this assessment methodology may be applied to Great Lake beaches in the future. Because Lakes Michigan and Superior are large, intra-jurisdictional waters, DNR will strive to collaborate with other state water quality agencies and the USEPA to develop mutually agreed upon impairment assessment protocols for excessive algae on Great Lake beaches.

2. **"WDNR should incorporate the recent 2012 EPA Recreational Water Quality Criteria ("RWQC") for the assessment and listing of Great Lakes for bacteria and make use of sanitary surveys for evaluating recreational use impairments."**
   As the commenter notes, Wisconsin has not yet adopted the EPA's 2012 RWCQ. Recreation use assessments are currently based on the recreational use criteria in NR102(6) of Wisconsin Administrative Code applicable to all surface waters of the state. For the Great Lakes system waters, we are also implementing the federally-promulgated Bacteria Rule for Coastal and Great Lakes Recreation Waters. Based on these criteria and for Integrated Reporting to EPA, we currently use the Beach Act *E. coli* geometric mean criterion of 126 CFU/100ml to assess the recreation use of Great Lakes and inland beaches, as well as tributaries to the Great Lakes. The Beach Act criteria do not supersede the existing state fecal coliform criteria in NR 102; currently, they both apply. If DNR were to adopt the criteria proposed in EPA's 2012 RWCQ guidance, we would likely replace our current fecal coliform bacteria criteria to use one or both of the indicators currently preferred by the EPA: *E. coli* or *Enterococci*.

Fisheries Bio-Technology Prescriptions (FBP)

1. **Professional judgment and value of local teams**
   The development of WisCALM guidance has been a collaborative, cross-program effort, including DNR staff from multiple Water Division programs, as well as stakeholder groups. DNR will continue to involve our partners through our current public participation process and will strive to expand our collaboration within the agency in future updates of WisCALM guidance.

2. **Two-story lakes**
   The two-story fishery lake classification is described on page 16 of the final 2014 WisCALM guidance, and phosphorus criteria for this lake class, as noted by the commenter, are 15 ppb total phosphorus. Site-specific criteria (SSC) for total phosphorus may be appropriate for two-story lakes with ambient phosphorus concentrations that are lower than the applicable statewide criterion, such as cases where more stringent criteria are needed to protect their designated uses. As noted in NR 102.06(7) of Wisconsin Administrative Code, "Reservoirs, two−story fishery lakes and water bodies with high natural background phosphorus concentrations are the most appropriate water bodies for site−specific criteria." Parties interested in pursuing phosphorus SSC for a particular water are encouraged to contact DNR.

3. **Onus of proof**
   By establishing minimum data requirements and impairment thresholds for assessment purposes, DNR collects representative data as efficiently as possible with limited staff and fiscal resources and uses those data in a manner that minimizes the chance of incorrectly characterizing the attainment status of a particular water.

COMMENT DOCUMENTS

The following comments documents were received during the May 30, 2013 to June 30, 2013 public comment period.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUL 31 2013

REPLY TO THE ATTENTION OF:
WW-16J

Kristi Minahan, Acting Section Chief
Water Evaluation Section (WT/3)
Wisconsin Department of Natural Resources
101 S. Webster Street
Madison, Wisconsin 53701

Dear Ms. Minahan:

The U.S. Environmental Protection Agency has conducted a review of Wisconsin's 2014 draft Consolidated Assessment and Listing Methodology (2014 draft WisCALM), which the State uses for assessing data for 303(d) list development. EPA's comments on the 2014 draft WisCALM are enclosed.

Thank you for the opportunity to review the 2014 draft WisCALM. We look forward to working with you as you finalize the methodology for use in Wisconsin's 303(d) listing process.

Sincerely,

for Peter Swenson, Chief
Watersheds and Wetlands Branch

Enclosure

cc: Aaron Larson, WDNR

U.S. Environmental Protection Agency Comments on
Wisconsin's 2014 Draft Assessment Methodology (WisCALM)
On public notice May 30 to June 30

It is EPA's understanding that the 2014 draft WisCALM, dated May 2013, is being used for making assessments of phosphorus waters for Wisconsin's 2012 303(d) list, and that the State intends to use the full methodology in its development of the 2014 list. Please confirm that our understanding is correct.

I. Issues raised in past Assessment Methodology comments (See August 25, 2011 and February 20, 2012 letters)

1. Tiered Uses and Biological Thresholds

   Region 5 remains concerned about issues that were raised in regard to the 2012 WisCALM and which remain unresolved in the 2014 draft WisCALM. These include questions about the State's ability to produce sufficient data to make routine attainment determinations using the tiered monitoring approach, and concerns about the biological thresholds used for assessing attainment. Region 5 would like to continue working with the State to resolve these issues and appreciates the work done recently on reviewing the biological assessment program, as well as other efforts.

2. Drinking Water

   The draft WisCALM states (p. 8, note 2) that WDNR will include a drinking water assessment methodology in a future WisCALM document. The Region would like to see more specific timelines set for development of this methodology and ideally the initiation of monitoring in anticipation of the 2016 listing cycle. The Public Health and Welfare Designated Use (PWS) at NR 102.04(7) applies to all surface waters and includes those waterbodies that are used by public water supplies. While the full list of human health criteria that apply to PWS waters are part of the State's WQS rules, EPA recommends that WDNR develop a methodology with specific components that can be used to assess attainment in PWS waters. EPA would be interested in participating in this effort. EPA also recommends that WDNR prioritize and incorporate all PWS waters into its routine surface water monitoring, and that this monitoring include the specific components that will comprise the PWS assessment methodology in addition to the parameters that are normally part of the routine sample analysis.

II. Other Comments on 2014 draft WisCALM

1. Extreme weather and representative data

The 2014 draft WisCALM discusses special considerations for data collected during extreme weather years in two contexts:

A. Special studies - Page 14 of the 2014 draft WisCALM states "Prescheduled sampling designs are often used for 305(b)/303(d)-related monitoring in order to randomly capture the range of conditions. In these cases, targeted samples that are collected for other purposes (e.g. monitoring targeted during runoff events) should not be incorporated into the 305(b)/303(d) assessment datasets."

EPA believes that it is not appropriate to make decisions about excluding data on a categorical basis (with exception of data with quality assurance issues). EPA's guidance cautions against excluding data when making impairment assessments since both short term events and long-term average conditions can have potential adverse effects (2006 IR guidance, pp. 34-36). EPA Data Quality guidance also states that outliers should not be discarded based solely on a statistical test, "Instead, the decision to discard an outlier should be based on some scientific or quality assurance basis" (EPA/600/R-96/084, pp. 4-26). Where a case-by-case decision is made to exclude data, EPA believes this decision should be documented in the 303(d) decision process.

B. 305(b) and 303(d) prescribed sampling- For most parameters, Wisconsin uses the most recent 10 years of data to make assessment decisions. For phosphorus, the State's standard practice is to use the most recent 5 years of data, but the state will consider data on a case-by-case basis "if insufficient data are available from the most recent 5-year period" (See p. 14, footnote 4.)

According to the 2014 draft WisCALM, a qualifying year for data involving total phosphorus and chlorophyll-a would be "one that has at least 2 daily means that are in different months of the appropriate date range and that are at least 15 days apart. Whether or not a year is a qualifying year is indicated by the assessment package output." Footnote 15 in this section discusses "Extreme weather years" and states that "if the biologist feels the extreme weather year resulted in data that would make the assessment result unrepresentative, the biologist may manually check to determine that at least one "normal year" was included in the assessment before making impairment decisions." (See p. 30).

EPA interprets these discussions to mean that where 305b/303d sampling coincides with extreme weather conditions, WDNR may supplement the data either by collecting additional new data, or by considering data collected outside the period of record normally used for making assessment decisions. EPA recommends that this point be clarified in the 2014 WisCALM.

2. Total Phosphorus methodology

A. EPA appreciates the state's establishment of subcategory 5P in order to list impaired waters based on phosphorus data alone. The 2014 draft WisCALM, however, is unclear with regard to whether the state plans to develop TMDLs for these waters. Based on the public notice information for the 2012 list, WDNR indicates that it does

not intend to develop TMDLs for Category 5P waters until biological impairment is confirmed. EPA recommends that public notice information available on the WDNR website and the 2014 draft WisCALM (at page 33) for Lakes and (at pp. 54-55) for rivers be revised to clarify that Category 5P waters are given a lower priority for TMDL development. While states have discretion in how impaired waters are prioritized for TMDL development, states are obligated to establish TMDLs for impaired waters (40 CFR 130.7(c)(1). EPA guidance recommends that TMDLs be established within 8-13 years from the time of initial listing (2004 IR guidance, p. 9).

B. The 2014 draft WisCALM indicates WDNR will be using "bioconfirmation" in determining into which subcategory the waterbody will be placed (5A or 5P) for phosphorus listings. EPA suggests using different terminology in place of "bioconfirmation," such as "biological information," for example. EPA is concerned that the state's use of the term "bioconfirmation" is misleading in this context because the state's phosphorous standard does not include biological confirmation as a listing factor, i.e. to list a waterbody in subcategory 5P.

C. Region 5 notes that changes were made regarding confidence intervals in the draft WisCALM methods for phosphorus assessment. Region 5 would like to continue to work with the State regarding the use of confidence intervals. EPA recommends that WDNR explain the rationale for using the lower 90^{th} percent confidence interval for Lakes and Streams/Rivers and explain how this approach is consistent with the phosphorus criteria.

Rivers and Streams Assessment

i. The confidence interval equation on Page 54 includes a variable; 'K.' The text identifies 'K' as a tolerance limit factor and refers the reader to Gibbons (2003). EPA recommends that more information be provided in the text about how 'K' was derived.

ii. EPA is reserving comment on the fish IBI and macroinvertebrate IBI thresholds in Table 14A (page 55) until such time as such criteria may be incorporated into an EPA-approved water quality standard.

Lakes Assessment

i. Please clarify which response variables are used in identifying biological causes of impairment due to TP for aquatic life uses in lakes to determine whether a lake would be listed in subcategory 5A or 5P.

ii. Page 31. Is the equation supposed to be *ln* CI?

iii. EPA is reserving comment on the chlorophyll-a thresholds in Table 6 (page 43) until such time as such a criterion may be incorporated into an EPA-approved water quality standard.

3. Temperature Assessment Methodology

Region 5 identified the following concerns with WDNR's approach for assessing against the temperature standard, as written in the 2012 WisCALM, dated April 2012:

1) Mean daily temperatures rather than maximum daily temperatures were used to assess streams for acute temperature impacts; and
2) sub-lethal temperature impacts were not being assessed.

WDNR has addressed both of these concerns in the 2014 draft WisCALM document, dated May 2013. However Region 5 would like to continue to work with WDNR to further improve the consistency between the methodology and the temperature criteria for lakes and rivers/streams.

*For reference, the key provisions for temperature in Wis. Admin. Code NR 102 are provided (**with emphasis added in bold**):*

- *NR 102.25(c): Acute water quality criteria are to be applied as daily maximum temperatures.*
- *NR 102.25(b): Sub-lethal water quality criteria are to be applied as maximum weekly average temperatures.*
- *NR 102.22(6), "Maximum weekly average temperature" means the highest allowed arithmetic mean of all **daily maximum** temperatures during a calendar week, outside mixing zone allowed in this subchapter.*
- *NR 102.22(4): "Daily maximum temperature" means the **highest** allowed water temperature for a calendar day, outside a mixing zone allowed in this subchapter.*
- *NR 102.25(e): Final acute and sub-lethal water quality criteria for temperature specified in or developed pursuant to §§ NR 102.24-26 **shall not be exceeded** at any point outside the mixing zone.*

Rivers and Streams Assessment (Refer to Table 14A):

i. The methodology requires 10 discrete daily values collected on separate calendar days for acute assessment and 10 days of continuous hourly temperature data for sub-lethal assessment for rivers and streams. Because the state has an acute "shall not exceed" criterion, a single daily maximum value that is above the acute criterion is technically sufficient to trigger a nonattainment determination. Our concern is that data requirements for 10 daily values might prevent assessment on a subset of waters. While a *goal* of collecting 10 daily values is reasonable, EPA recommends that the assessment methodology be revised to allow WDNR to make assessment determinations using fewer than 10 daily values, where necessary.

ii. The methodology appears to evaluate impairment in streams by calculating a 24 hour average for the daily temperature and comparing this average to the sub-lethal criteria. The Wisconsin sub-lethal criteria are implemented by calculating

the weekly average of the daily maximum temperatures and then comparing the results to the criterion. EPA recommends that the methodology should be clarified that the state is using the daily maxima for each 24 hour period collected over the week and averaging these values to compare to the criterion for impairment determination.

Lakes Assessment (Refer to Table 5A):

i. The methodology requires 20 discrete daily values collected on separate calendar days for acute and sub-lethal assessment of inland lakes. For an acute "shall not exceed" criterion, a single daily maximum value that is above the acute criterion is technically sufficient to trigger a nonattainment determination. Our concern is that data requirements for 20 daily values might prevent assessment on a subset of waters. While a *goal* of collecting 20 daily values is reasonable, EPA recommends that the assessment methodology be revised to allow WDNR to make assessment determinations using fewer than 20 daily values, where necessary.

ii. The impairment threshold in Table 5A of the draft methodology does not include the actual acute and sub-lethal criteria applicable to inland lakes that are included in Wisconsin's thermal rule. The temperature criteria applicable to inland lakes are listed in Wis. Admin. Code NR 102.25(4), Table 4. EPA recommends that this table be referenced in Table 5A of the 2014 draft WisCALM and the language in the current draft table 5A be deleted as it is no longer applicable.

Acute and sub-lethal temperature criteria

i. EPA recommends that the 2014 draft WisCALM clarify that acute and sub-lethal criteria are to be applied as described above under 3.A and B for rivers and streams.

ii. Wisconsin's thermal rule, Wis. Admin. Code NR 102.25(e), states that acute and sub-lethal temperature criteria "shall not be exceeded." The acute and sub-lethal criteria are defined as daily maximum and weekly average (of daily maximum) temperatures, respectively. The acute and sub-lethal criteria, as these terms are defined by the rule, represent endpoints that WDNR derived based on an extensive review of fish data. Please note that EPA is currently reevaluating its guidance on the use of a 10% exceedance rate, and plans to explain it further in guidance for the 2016 listing cycle and beyond.

Following development of this new guidance and its application for criteria that are expressed in the state's WQS as "never to be exceeded," EPA may wish to discuss changes to WDNR's methodology for 2016 to address the "never to exceed" temperature standards so that the methodology is consistent with both the approved WQS and future EPA guidance.

4. Review of Assessment Methodology and 2014 list

EPA Region 5 appreciates the opportunity to review Wisconsin's Draft 2014 methodology. The Region will review the 2014 WisCALM methodology in conjunction with its review of the draft and final 2014 303(d) lists.

5. Summary of revisions to the Methodology

EPA recommends that WDNR consider adding a section to the methodology in a summary section which identifies significant changes made from the previous methodology. Although some changes were identified (for example, draft methodology, p. 28), consolidating a summary of these changes would allow the reader to focus more specifically on these revisions.

ALLIANCE FOR THE GREAT LAKES

ENSURING A LIVING RESOURCE FOR ALL GENERATIONS

June 28, 2013

VIA EMAIL: DNRImpairedwaters@wisconsin.gov

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Re: Additional comments on Wisconsin's draft 2012 impaired waters list and WisCALM for the 2014 assessment cycle

Dear Mr. Larson:

Thank you for the opportunity to submit additional comments on Wisconsin's draft 2012 impaired waters list and the Wisconsin Consolidated Assessment and Listing Methodology ("WisCALM") to be used for the 2014 assessment cycle. The Alliance for the Great Lakes is the oldest non-profit organization committed to protecting and restoring the Great Lakes. We do so through policy, education, and local outreach efforts. We appreciate you accepting our input on this critical issue for Wisconsin and the Great Lakes.

The Great Lakes provide recreation and drinking water for millions of people in the region. An important component of ensuring the health of the Great Lakes into the future is protecting their water quality by the reducing biological, physical, and chemical contamination of Great Lakes waters, beaches and tributaries. Unfortunately, many of Wisconsin's Great Lakes beaches, especially along Lake Michigan, are threatened by bacterial contamination and algal blooms that negatively affect recreational opportunities in those communities. Algal blooms also contribute to depletion of oxygen in the water column affecting fish and wildlife. Such algae growth is driven by excessive nutrient loading and exacerbated by invasive mussels and climate change.

The Alliance greatly applauds Wisconsin Department of Natural Resources' ("WDNR") continual efforts in developing improved methods for evaluating Wisconsin's Great Lakes and inland beaches. However, Wisconsin should understand that the Great Lakes shorelines are distinct coastal water body types and different methods for evaluating aesthetic, phosphorus and algae impairments are needed for

recreational use at Great Lakes beaches. Therefore, it is imperative that WDNR use appropriate assessment and listing protocol for Wisconsin's list and WisCALM to reflect the unique nature of Great Lakes shorelines and nearshore waters.

Our comments today call on WDNR to ensure that: (1) WDNR evaluates and lists all Great Lakes nearshore areas for recreational use impairments caused by excessive phosphorus; (2) WDNR improves its methods for determining support of recreational use within the context of aesthetics at Great Lakes beaches; and (3) WDNR should incorporate the recent 2012 EPA Recreational Water Quality Criteria ("RWQC") for the assessment and listing of Great Lakes beaches for bacteria and make use of sanitary surveys for evaluating recreational use impairments. Please find our comments in more detail below.

I. WDNR must evaluate and list all Great Lakes nearshore areas for recreational use impairments caused by excessive phosphorus.

While the 2014 WisCALM includes a new phosphorus assessment methodology for listing lakes, rivers and streams for Fish & Aquatic Life and Recreational impairments, the WDNR still fails to address the issue of developing and implementing a protocol for recreational use impairment listing of nearshore areas on the Great Lakes that have excessive phosphorus levels. In our previous comments[1] to WDNR on the impaired waters lists, the Alliance has repeatedly requested WDNR to add nearshore Lake Michigan waters with excessive phosphorus levels to the impaired water list. While we welcome WDNR's decision to add the 5P category to the list last year to address phosphorus-impaired waters, WDNR must develop and implement a protocol to list impaired coastline areas of the Great Lakes for recreational purposes where there are data confirming violation of Wisconsin's numeric phosphorus water quality criteria (7 ug/L in Lake Michigan and 5 ug/L in Lake Superior). NR102.06, part 5(a), (b). For the past several years, WDNR has continually chosen to ignore readily available data showing excess phosphorus in Lake Michigan nearshore waters and not included these Great Lakes nearshore zones on the impaired list for not supporting recreational uses stating that WDNR does not have an established assessment protocol for listing. For the 2014 WisCALM, WDNR should develop a protocol for assessing the exceedence of acceptable total phosphorus levels in these nearshore coastal waters. Moreover, Wisconsin must place all Great Lakes nearshore areas on the impaired list where phosphorus levels routinely exceed Wisconsin's numeric phosphorus standards for nearshore Lake Michigan to ensure that proper TMDLs are developed to correct these impairments.

[1] Public comments on Wisconsin's proposed 303(d) list for 2008, 2010 & 2012 and Additional comment on Wisconsin's draft 2012 impaired waters list and new "5P" category

II. WDNR must develop methods for determining support of recreational use within the context of aesthetics at the Great Lakes beaches.

Although the WDNR acknowledges[2] that large accumulations of algae, predominantly *Cladophora* sp., have been fouling Wisconsin´s Lake Michigan shoreline for the past several years, it still has not initiated or developed a recreational use impairment listing protocol for nuisance algae for Great Lakes shorelines. Presence of nuisance algae at Great Lakes beaches presents aesthetic and odor problems, impairing recreational use and decreasing lakefront property values. These algae also promote bacterial retention and growth causing much higher bacterial counts, which is a huge public health concern. Therefore, we request that WDNR develop and implement a protocol to list recreational use impairments in the Great Lakes not only within the context of human health but also within the context of aesthetics and presence of nuisance algae.

Extensive research[3] and monitoring data have linked the reemerging problem of *Cladophora* blooms on Wisconsin's Lake Michigan coastlines to high amounts of phosphorus in the nearshore waters. Therefore, it is imperative for the WDNR to develop metrics for assessing recreational impairments due to nuisance algae buildup and excessive phosphorus levels on Great Lakes coastlines.

While the inclusion of the protocol for assessing metrics that correlate to elevated phosphorus levels and eutrophication impairments within the context of fish and aquatic life uses in the 2014 WisCALM is a significant step forward, WDNR must also incorporate these standards for assessing recreational use impairments of the Great Lakes waters and beaches. Minnesota already uses ecoregion-based eutrophication standards[4] as primary basis for aquatic recreational use support in their lakes. Therefore, in addition to measuring total phosphorus, chlorophyll-a, and Secchi depth in the Great Lakes[5], which the WDNR already monitors, the Alliance urges Wisconsin to embrace Minnesota's approach of incorporating eutrophication standards specific to ecoregion and lake depth for assessing recreational use impairments of the lakes including the Great Lakes.

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[2] *Cladophora* and Water Quality of Lake Michigan: A Systematic Survey of Wisconsin Nearshore Areas http://dnr.wi.gov/topic/greatlakes/documents/DNR_ResearchSummary2004.pdf

[3] Nuisance algae (*Cladophora*) in Lake Michigan http://dnr.wi.gov/topic/GreatLakes/cladophora.html

[4] Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List http://www.pca.state.mn.us/index.php/view-document.html?gid=16988

[5] Wisconsin 2012 Consolidated Assessment and Listing Methodology (WisCALM). Clean Water Act Section 305(b), 314, and. 303(d) Integrated Reporting http://dnr.wi.gov/topic/surfacewater/documents/FINAL_2012_WisCALM_04-02-12.pdf

III. WDNR should incorporate the recent 2012 EPA Recreational Water Quality Criteria ("RWQC") for the assessment and listing of Great Lakes for bacteria and make use of sanitary surveys for evaluating recreational use impairments.

We understand that WDNR has historically relied on the 1986 EPA RWQC and the 2002 BEACH Act to determine if a beach should be included on the Impaired Waters List within the recreational use context. However, WDNR should now incorporate the 2012 RWQC for the assessment and impaired listing of Great Lakes for recreational use into the 2014 WisCALM. In the 2012 RWQC[6], EPA recommends that states adopt the geometric mean ("GM") along with the statistical threshold value ("STV"), intended to supplement the geometric mean with a frequency of exceedance component, into their Water Quality Standards ("WQS") for all primary contact recreation waters. Using both a GM and an STV together provides a more accurate picture of the overall health of the water body. Previous RWQC utilized the concept of "use intensity" as a basis for recommending multiple Single Sample Maximum ("SSM") criteria in conjunction with the long term (monthly) GM. Wisconsin must update its water quality standards to reflect these new EPA criteria. The Alliance would be happy to participate in the WDNR's process for updating these standards.

In the 2012 RWQC, the EPA has also provided information on tools for assessing and managing recreational waters, such as predictive modeling and sanitary surveys. EPA's Great Lakes Sanitary Survey is a protocol tailored specifically for the assessment of the Great Lakes and Great Lakes beaches. Wisconsin should adopt a protocol such as these sanitary surveys that are unique to the Great Lakes water and beaches to evaluate and manage their impairments. EPA[7] believes that these sanitary surveys would be a great tool for site-specific assessment and management of the Great Lakes waters and nearshore impairments. These sanitary surveys can be successfully used to develop predictive or forecast models to estimate beach water quality and to track sources of pollution affecting beaches around the Great Lakes. Furthermore, they can also be used to collect information on the types of mitigation measures being implemented at Great Lakes beaches to reduce or eliminate the pollution sources identified, and to measure the success of the mitigation measures through improvements in water quality. For example, sanitary surveys can be an effective tool to develop techniques for shaping beaches where *Cladophora* is deposited in confined areas and can be more easily removed. The WDNR

[6] USEPA 2012 Recreational Water Quality Criteria
http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/RWQC2012.pdf

[7] 2007 Beach Sanitary Survey Great Lakes Pilot Project
http://water.epa.gov/type/oceb/beaches/upload/2008_05_29_beaches_sanitarysurvey_pilot-summary.pdf

has also previously stated[8] that they believe these sanitary surveys may be an extremely valuable tool to identify and control pollution sources that contribute to potentially unsafe beach conditions. However, in the past WDNR has continually ignored EPA's effort to incorporate data from these sanitary surveys[9] into the assessment and listing methodology for recreational use impairments. The Alliance raised this issue in comments on the proposed impaired waters lists in 2010 and 2012 along with advocating the use of Alliance's Adopt-a-Beach™ data as a reliable source to assess the conditions of Great Lakes beaches for recreational purposes. WDNR should utilize these beach surveys because EPA has repeatedly endorsed beach sanitary surveys as an effective tool for site-specific assessment and management of recreational waters.

Thank you for the opportunity to submit these additional comments on the draft 2012 impaired waters list and on the revisions to the Wisconsin's Consolidated Assessment and Listing Methodology ("WisCALM") to be used for the 2014 assessment cycle. If you have any questions concerning our comments, please contact me at (312) 445-9739 or email: lwelch@greatlakes.org

Sincerely,

Lyman Welch
Water Quality Program Director

Abhilasha Shrestha
Dale Bryson Water Quality Intern

[8] Wisconsin's Great Lakes Beach Sanitary Survey Report Beach Season 2007 http://cdm16119.contentdm.oclc.org/cdm/singleitem/collection/p267601coll4/id/1610/rec/2

[9] US Beach Sanitary Survey http://water.epa.gov/type/oceb/beaches/sanitarysurvey_index.cfm#great

Midwest Environmental Advocates

June 30, 2013

VIA ELECTRONIC MAIL
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Re: Comments of Proposed 2012 Section 303(d) List of Impaired Waters

Dear Mr. Larson,

Thank you for the opportunity to submit comments on the proposed 2012 section 303(d) list of impaired waters.

We are pleased to acknowledge the positive steps that DNR has taken to improve the transparency of the listing process. DNR has significantly improved the availability of data underlying its 303(d) listing decisions. We hope that the agency continues to move toward a transparent, qualitative, comprehensive listing process.

The quality of Wisconsin waters depends on the creation of a comprehensive 303(d) list. The Clean Water Act ("CWA") requires that Wisconsin set water quality standards for existing and attainable uses and set numeric and narrative criteria that are protective of human and aquatic health. DNR is required to use water quality data to determine whether the set water quality standards are met, and when they are not met, to identify such waters as impaired.[1] Impaired waters must then be listed and prioritized for clean-up based on the severity of the impairment.[2]

These impaired waters constitute the 303(d) list.[3] Inclusion on Wisconsin's 303(d) triggers CWA mechanisms to address impairments, including the development of Total Maximum Daily Loads ("TMDL"). A TMDL enables cleanup of Wisconsin waters by establishing a basis to restrict pollution from point and non-point sources into an impaired waterbody. When impaired

[1] *See* 40 C.F.R. § 131.11; 40 C.F.R. § 131.3(f); and 33 U.S.C. § 1313(d).
[2] 33 U.S.C. § 131(d)(1).
[3] 33. U.S.C. § 1313(d).

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waters are not properly included in the 303(d) list the purpose and intent of the CWA are undermined and the state fails to meet its obligations under the CWA.While commendable progress has been made, the following comments identify areas where the draft methodology is inadequately protectively and thereby violates federal law. We encourage the DNR to continue to improve its listing methodology by implementing the changes discussed below as well as the changes discussed in the comments by JoAnn Burkholder, Ph.D, attached as Appendix A.

I. Summary of Comments

First, DNR's data policy fails to meet the federal requirement that DNR consider "all existing and readily available water-quality related data and information" when making the 303(d) list.[4] Additionally, with respect to water bodies with reported pollution, DNR is required to actively solicit third-party data. The DNR must amend its data policy to conform to these requirements and must amend the 303(d) list to include impaired water bodies based on all available data.

Second, the biological impairment rule violates state and federal law. DNR's continued unlawful reliance on the rule results in a failure to adequately respond to known chemical impairments. At a minimum, the rule must be revised so that it no longer allows DNR to disregard valid, representative data of a water quality impairment when supporting biological data is unavailable.

Third, DNR impairment assessment protocols must be consistent with Wisconsin's codified water quality criteria. The 2014 WisCALM must be amended to include phosphorus criteria that are at least as stringent as those required under state law by NR 102.06 for all uses.

Fourth, the development of the 303(d) is meant to trigger actual water quality improvements and is not merely a paper exercise. The creation and continued reliance on category 5P impermissibly delays the development of federally required processes designed to correct documented impairments in these waters. DNR must eliminate Category 5P and revise the 303(d) to ensure that waters with concentrations of phosphorus that exceed water quality standards are correctly listed and prioritized for clean-up.

Fifth, DNR cannot skirt its obligations under the CWA by adopting methods that distort available reliable data to make recognition of known impairments considerably less likely. The 2014 WisCALM must be amended to eliminate reliance on confidence intervals to determine exceedances of phosphorus and chlorophyll *a*.

Sixth, DNR must revise its chlorophyll *a* protocols to include sampling methods that will effectively identify impairments and to establish exceedance thresholds that are consistent with the required sampling frequencies.

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[4] 40 C.F.R. § 130.7(b)(5).

Seventh, DNR must consider USGS data and SWIMS data and must list those waters with phosphorus impairments under the criteria set by NR 102.06.

Eighth, given the agency's limited resources, DNR's dissolved oxygen data requirements are too stringent and will result in waters that are in fact impaired not being listed. These requirements should be revised to ensure that such waters are listed as required by the Clean Water Act.

Ninth, in order to meet the goals of the Clean Water Act, DNR must list waters that have mercury levels that are a threat to public health if fish from those waters are consumed. The state's general fish advisory does not satisfy the federal requirement to list these waters. Additionally, WisCALM should include guidance on the specific procedures that DNR will use for fish listing decisions.

II. Comments

1. **DNR must incorporate all existing and readily available water quality-related data into impairment assessment protocols and must actively solicit such data when water quality issues have been reported.**

DNR has necessarily limited resources, and therefore as a practical matter, the agency should be particularly receptive to third-party data. The University of Wisconsin, Public Health Departments, and other private institutions collect high-quality data that should be systematically incorporated by DNR to improve the quality of its assessments without expending additional resources. While DNR has taken some steps to improve its incorporation of third-party data, DNR continues to avoid utilizing a majority of the available data in making its assessment decisions. This approach is unlawful insofar as it results in an inadequate list.

Federal law requires that DNR adopt an expansive approach to data. The requirement is designed to ensure that impaired waters are actually included in the list. The applicable regulation states:

> Each State shall assemble and evaluate *all existing and readily available water quality-related data and information* . . . [which] includes but is not limited to all of the existing and readily available data and information about the following categories of waters:
> . . .
> (iii) Waters for which water quality problems have been reported by local, state, or federal agencies; members of the public; or academic institutions. *These organizations and groups should be actively solicited for research they may be conducting or reporting*. For example, university researchers, the United States Department of Agriculture, the National Oceanic and

> Atmospheric Administration, the United States Geological Survey, and the United States Fish and Wildlife Service are good sources of field data;[5]

DNR has not met this plain regulatory requirement because it only requires reliance on the Surface Water Integrated Monitoring System (SWIMS) data,[6] Water Assessment, Tracking and Electronic Reporting System (WATERS) data,[7] and a 90-day window for public submission of third party data.[8]

Third-party data are readily available from a number of sources—including some specifically named in 40 C.F.R. § 130.7(b)(5)(iii)—and DNR must actively solicit and use such data. The UW-Madison Long Term Ecological Research Project (LTER),[9] County Public Health Departments, and other governmental and academic sources have valuable data that DNR must use to supplement its own limited sampling data.

As expressed in our previous comments, the Madison area lakes provide an example of where DNR fails to follow 40 C.F.R. § 130.7(b)(5). High quality data are available from LTER for Trout Lake, Allequash Lake, Big Muskellunge Lake, Sparkling Lake, and Crystal Lake in northern Wisconsin and Fish Lake, Lake Mendota, Lake Wingra, and Lake Monona in the Madison area.[10] The Madison lakes fit the description of "[w]aters for which water quality problems have been reported by local, state, or federal agencies; members of the public; or academic institutions."[11] For example, the Department of Public Health for Madison & Dane County issues report cards on local conditions, including data on surface waters. The 2008 report card states that Dane County surface waters have high levels of phosphorus, which is leading to harmful algal blooms.[12] It reports that phosphorus levels in Lake Mendota and Lake Monona have consistently increased. This report also states that chloride is an increasing problem, especially in Lake Wingra. The report card, and other reports like it, are readily available and must be considered by DNR. In addition, this public report triggers the active solicitation requirement of 40 C.F.R. § 130.7(b)(5)(iii).[13]

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[5] 40 C.F.R. § 130.7(b)(5) (emphasis added).

[6] *See* Wisconsin Department of Natural Resources, Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM 2014), 13.

[7] *Id.*

[8] Wisconsin Department of Natural Resources, Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM 2012), 11-12 (though DNR allowed a 90 day period from October 1, 2010 – December 31, 2010 for public submission of third-party data for consideration in the 2012 lising, this already truncated window has been shortened to only 60 days, from January 2, 2013 – March 1, 2013, for the 2014 listing. Available at http://dnr.wi.gov/topic/surfacewater/assessments.html).

[9] The North Temperate Lakes Long-Term Ecological Research study includes seven northern Wisconsin lakes and four southern Wisconsin lakes and can be accessed at http://lter.limnology.wisc.edu.

[10] *See* North Temperate Lakes Long Term Ecological Research, Lake Characteristics, *available at* http://www.lternet.edu/sites/ntl.

[11] *See* 40 C.F.R. § 130.7(b)(5)(iii).

[12] Department of Public Health for Madison & Dane County, Madison and Dane County Environmental Health Report Card 2008, p. 21-22, *available at* http://www.publichealthmdc.com/publications/documents/2010RptCard.pdf.

[13] In fact, DNR has joined a Memorandum of Understanding acknowledging the need to address the pollution problems in the Yahara lakes. *See* Yahara CLEAN, Memorandum of Understanding, Feb. 13, 2008, *available at* http://danedocs.countyofdane.com/webdocs/pdf/lwrd/lakes/clean_MOU.pdf.

Moreover, DNR's limited use of citizen data for status and trends monitoring is legally insufficient.[14] Where citizen data satisfy the rigorous quality assurance requirements set by DNR, federal law requires that DNR use those data to make listing decisions.

The Clean Water Act requires that states "shall identify those waters within its boundaries for which the effluent limitations . . . are not stringent enough to implement any water quality standard applicable to such waters."[15]

Comment: DNR's current approach of using SWIMS data, WATERS data, and undefined public comment opportunities does not meet the broad federal requirement that DNR systematically consider "all existing and readily available water quality-related data and information." DNR should change WisCALM to systematically incorporate readily available data and amend the 303(d) list accordingly. If DNR feels it satisfies this requirement, it should provide an explanation of how it does so.

Comment: When water quality problems have been reported, DNR must also actively solicit organizations that have data regarding these water bodies.[16] The Madison area lakes are an example of water bodies reported as polluted by local agencies. DNR should change WisCALM consistent with this mandate and amend the 303(d) list accordingly. If DNR feels it meets this requirement it should provide an explanation of how it does so.

2. Biological impairment requirements unlawfully prevent impaired waters from being listed and must be removed from the WisCALM.

DNR implemented a biological impairment requirement in the 2012 WisCALM and continues to rely on the unlawful requirement in the 2014 WisCALM.[17] The requirement prevents waterways that exceed applicable water quality standards for phosphorus from being listed and receiving a TMDL. In so doing, the requirement fails to comply with state law requiring attainment of set phosphorus standards.[18] In turn, the biological impairment requirement violates the Clean Water Act mandate that states identify and address waters that do not meet "any water quality standard applicable to such waters.[19]

Through the biological impairment requirement, DNR elects to wait until water quality criteria are overwhelmingly exceeded or have shown excessive biological impairments before taking action. This approach ensures that DNR may only identify impairments and propose clean-up plans after water bodies are so polluted that remediation is extremely

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[14] WisCALM 2014 at 12 ("Citizen data are currently used for general water quality assessments, including broad-scale statewide assessments. If these data indicate a potential water quality problem at a specific site, additional data may be collected by Department staff to verify the extent of the problem and determine if a waterbody should be placed on the Impaired Waters List.").
[15] 33 U.S.C. § 1313(d)(1)(A).
[16] 40 C.F.R. § 130.7(b)(5)(iii).
[17] WisCALM 2014 at 33.
[18] Wis. Adm. Code NR 102.06 (2013).
[19] 33 U.S.C.A. § 1313(d)(1)(A).

costly and complicated, if it is possible at all. In the previous listing, the invention of the biological impairment requirement resulted in DNR not listing 99 waters with adequate sampling data showing exceedances of phosphorus standard in Category 5A as required by state and federal law. We commend the DNR for moving 42 of those waters into category 5A after reassessing available data under the 2014 WisCALM. Nonetheless, the 2014 WisCALM must be refined further to address the 48 waters that continue to be listed in the unlawful category 5P. The failure to properly list and address the exceedance in those 48 waters continues to be unlawful and threatens to result in considerable harm to the waters of the state.

Continued reliance on the biological impairment requirement will result in many more inadequate listings of legally impaired waters. Rather than prompting DNR to act when valid, reliable chemical data shows impairment of a waterbody, DNR will only reactively address gross impairments of multiple assessment criteria. This is too little, too late. The CWA requires that Wisconsin list waters that are *threatened or* impaired.[20] Despite that requirement, DNR's proposed approach to listing decisions will not list threatened waters or waters that are actually impaired until the impairment is extreme enough to affect multiple lines of evidence.

Moreover, DNR's biological impairment requirement violates the EPA's well-established independent applicability rule. This rule provides that "a demonstration of water quality standards nonattainment using one assessment method does not necessarily require confirmation with a second method; *nor can the failure of a second method to confirm impact, by itself, negate the results of the initial assessment.*"[21] The independent applicability rule is intended to prevent states from disregarding valid and representative data when making listing determinations.[22] Rather than allowing biological indicators to trump exceedances of chemical standards, the EPA would recommend that DNR instead *resolve* discrepancies between assessment methods rather than ignore valid data.[23]

Finally, as already made clear to DNR by the EPA, the WisCALM cannot rely on a categorical rule "where biological metrics 'trump' water chemistry metrics when making an impairment decision."[24] Yet DNR continues to propose to allow biological metrics to

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[20] *See* 40 C.F.R. § 130.2; 40 C.F.R. § 130.7(b)(5)(i).

[21] Memorandum from Tudor T. Davies, Director Office of Science and Technology, to Water Management Division Directors Regions I-X (June 19, 1991) (emphasis added). Available at http://www.epa.gov/npdes/pubs/owm0232.pdf.

[22] U.S. Environmental Protection Agency, Consolidated Assessment and Listing Methodology: Toward a Compendium of Best Practices, First Edition at 3-9 (July 2002) (available at http://water.epa.gov/type/watersheds/monitoring/upload/2003_07_24_monitoring_calm_calm_ch3.pdf) ("EPA's policy on independent application is based on the premise that any valid, representative dataset indicating an actual or projected water quality impairment should not be ignored when one is determining the appropriate action to be taken.").

[23] U.S. Environmental Protection Agency, Consolidated Assessment and Listing Methodology: Toward a Compendium of Best Practices, First Edition at 3-9 (July 2002) (available at http://water.epa.gov/type/watersheds/monitoring/upload/2003_07_24_monitoring_calm_calm_ch3.pdf).

[24] Issue Brief from Bob Masando, Water Evaluation Section, on Impairment Decision Protocol for Total Phosphorus in Lakes, Rivers, and Streams to Watershed Board (Feb. 09, 2011).

do exactly that.[25] Under the 2014 WisCALM, it continues to be the case that an impairment may be based on of biological data alone, but chemical impairment in excess of the state water quality standards for phosphorus will not result in an impairment listing without accompanying biological confirmation, unless there is an "overwhelming exceedance" of the chemical (TP) data.[26] Not only does WisCALM allow biological impairment to trump chemical data in this regard, but the WisCALM goes so far as to suggest that less stringent, site specific phosphorus standards be developed in such circumstances.[27]

Comment: DNR should remove the biological impairment rule from the WisCALM because it prevents waters already impaired by total phosphorus levels from being listed and appropriately prioritized, and therefore is in violation of state and federal law.

Comment: Not only will the biological impairment rule result in an inadequate list, but WisCALM's data requirements will further increase the incidence of waters not being listed for want of sufficient collaborating biological data despite clear exceedances of phosphorus standards.

Comment: The biological impairment rule should be removed or amended because it violates both the independent applicability rule and specific guidance provided by the EPA. DNR may not ignore valid, representative data showing impairment of one assessment method only for want of a second method confirming that result.

Comment: WisCALM fails to include specific guidance on how the agency will identify and resolve discrepancies across assessment methods.

Comments: WisCALM fails to require DNR to submit evidence of a discrepancy between biological and chemical metrics to EPA for further analysis.

3. WisCALM must be revised to comply with codified state water quality standards at NR 102.06.

Federal law requires states to establish water quality standards that are protective of designated and attainable uses.[28] Pursuant to federal requirements, Wisconsin has codified water quality standards intended to protect Wisconsin's surface waters and to "serve as a basis for developing and implementing control strategies to achieve legislative policies and goals."[29] These standards include the concentration limits for phosphorus found at NR 102.06 and are designed to protect fish and aquatic life uses and recreational uses (in lakes).[30] NR 102.06 "identifies the water quality criteria for total phosphorus that

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[25] *See* WisCALM 2014 at 33.
[26] *Id.*
[27] *Id.*
[28] 40 C.F.R. 131.11
[29] Wis. Adm. Code NR 102.01 (2013).
[30] *See* Wis. Adm. Code NR 102.06 (2013).

shall be met in surface waters."[31] These standards are based on years of studies regarding scientific thresholds that cause negative impacts to fish and aquatic life and recreation.[32] The plain language of the rule applies one set of phosphorus standards as protective of all uses in Wisconsin surface waters, and DNR is obliged to follow the law as written. DNR cannot ignore this science, and it must not revise the acceptable threshold for phosphorus pollution through the WisCALM. By changing the thresholds for listing waters as impaired through the WisCALM guidance, DNR is, in effect, changing the EPA approved phosphorus criteria and thresholds adopted in NR 102.06 and approved by EPA – but DNR has failed to follow procedures for properly amending its water quality criteria and obtaining EPA approval of that criteria change.

The CWA requires EPA approval of state water quality criteria.[33] As explained in the federal regulations, "[a]pplicable water quality standards for purposes of the Act are the *minimum standards which must be used* in identifying impaired waters and calculating TMDLs under section 303(d)."[34] On DNR's submission, the EPA approved the phosphorus criteria in NR 102.06 as the applicable water quality standard for purposes of the CWA.[35] DNR policies and methodologies must be consistent with the minimum applicable standard such that waters are recognized as impaired when phosphorus levels exceed the criteria defined by NR 102.06. DNR may not avoid meeting these minimum standards through the WisCALM.

Despite the clarity of the rule, the standards adopted in the 2014 WisCALM are not consistent with the codified phosphorus standards of NR 102.06.[36] For instance, NR 102.06 sets the phosphorus criteria for drainage lakes at 40 ug/L.[37] The 2014 WisCALM, however, sets the Fish & Aquatic Life Use impairment threshold for deep drainage lakes and shallow drainage lakes at 60 ug/L and 100 ug/L, respectively.[38] The 2014 WisCALM further departs from state requirements by requiring as much as two times the impairment thresholds before a waterway is listed in category 5A. In combination with the already less stringent concentration levels, this means that a shallow drainage lake, for example, would be required to reach nearly four times the concentration of phosphorus required by NR 102.06 before being listed as impaired.[39]

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[31] Wis. Adm. Code NR 102.06(1) (2013) (emphasis added).
[32] DNR Report to Legislature: Revisions to Chapters NR 102 and 217 Wis. Adm. Code, Board Order No. WT-25-08, CR10-035, *available at* https://docs.legis.wisconsin.gov/code/chr/related/2010/cr_10_035/cr_10_035_agency_report_to_legislature_part_1.pdf; *see* U.S. Geological Survey, Professional Paper 1754, Nutrient Concentrations and Their Relations to the Biotic Integrity of Nonwadeable Rivers in Wisconsin, Appendix 1, p. 76, *available at* http://pubs.usgs.gov/pp/1754; U.S. Geological Survey, Professional Paper 1722, Nutrient Concentrations and Their Relations to the Biotic Integrity of Wadeable Streams in Wisconsin, p. 96-109, *available at* http://pubs.usgs.gov/pp/pp1722.
[33] *See* 40 C.F.R. §§ 131.5, 131.6, 131.21.
[34] 40 C.F.R. § 131.21(d) (emphasis added).
[35] 40 C.F.R. § 131.21(c).
[36] *Compare* Wis. Adm. Code NR 102.06(3)-(5) *to* WisCALM 2014 at 33.
[37] Wis. Adm. Code NR 102.06(4)(b).
[38] WisCALM 2014 at 37.
[39] *See* WisCALM 2014 at 33, 37.

If a waterway fails to meet the phosphorus criteria prescribed by NR 102.06, DNR is required by law to list that waterway as impaired. As already explained by the EPA, "waters that meet minimum data requirements and exceed numeric total phosphorus criteria must be placed on the 303(d) list in order to implement Wisconsin water quality standards as written and to meet Clean Water Act (CWA) goals."[40] The 2014 WisCALM must be amended so that it relies on total phosphorus criteria that are at least as stringent as those required by state law.

Comment: In development the 303(d) list, DNR must set water quality criteria that are at least as stringent as those required under state law by NR 102.06. The 2014 WisCALM impairment thresholds for all uses must be revised accordingly. If it does not, DNR should explain what provisions of the state or federal law allow it to ignore the state's codified water quality criteria.

4. **DNR must eliminate category 5P to ensure that the 303(d) list will actually function to improve water quality in Wisconsin waterbodies as the CWA intends.**

Category 5P must be eliminated as it violates federal policy and does not prompt sufficient action to improve Wisconsin water quality as required by federal law. In the previous Wisconsin 303(d) list, DNR introduced Category 5P. Category 5P is explained by DNR as "a special category" for waters where reliable data reflect an exceedance of TP criteria under WisCALM, but without bioconfirmation of that impairment.[41] As admitted by DNR, placement in Category 5P did not and does not trigger development of a TMDL.

Previously, DNR included 98 surface waters in Category 5P. That means that there was evidence showing exceedances of Wisconsin's phosphorus criteria in each of these 98 waterbodies. These exceedances were as much as four times greater than the applicable state water quality criteria. The revised list has reconsidered the waters originally placed in Category 5P, moving 42—or nearly half—of those waters into Category 5A, and thereby triggering the TMDLs that evidence had long indicated as necessary.[42] Forty-eight waterbodies remain in Category 5P, and thus despite reliable evidence of phosphorus impairment, DNR will not be developing TMDLs for these 48 potentially grossly impaired waterbodies for want of biological confirmation.

The objective of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[43] In order to meet that goal, Congress set a "national policy that programs for the control of nonpoint sources of pollution be developed and *implemented in an expeditious manner* so as to enable the goals of this

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[40] February 17, 2012 letter to WDNR.
[41] WisCALM 2014 at 33.
[42] Of the remaining waterbodies, two were moved into Category 2 and six were moved into Category 3.
[43] 33 § 1251(a).

chapter to be met through the control of both point and nonpoint sources of pollution."[44] The 303(d) listing process and the development of TMDLs are critical programs in meeting the goals of the CWA. The listing process is significant not as an informational exercise, but as one designed to trigger remediation.[45] Category 5P avoids correctly listing waterbodies that are in fact impaired for phosphorus as such and delays prioritization for and development of TMDL's as required by federal law.

Furthermore, as already discussed, DNR is obliged to follow EPA's rule of independent applicability making it unlawful to ignore evidence of water quality impairment for want of an additional line of evidence.[46] On that basis alone DNR must eliminate Category 5P and move phosphorus impaired waters into the category with practical effect, Category 5A.

Comment: DNR must eliminate Category 5P. The 48 waterbodies presently listed in Category 5P must be reassessed and all waterbodies showing exceedances of the applicable state water quality criteria for phosphorus as codied in NR 102.06 must be moved into Category 5A.

5. **DNR reliance on confidence intervals will result in an inadequate list and should be replaced with a more representative and scientifically sound methodology that reflects a protective approach to assessment decisions.**

The CWA requires DNR to make listing decisions according to all readily available data in order to ensure that impairments are identified and addressed. DNR cannot avoid this obligation by analyzing available data in a manner that will conceal observed impairments. DNR reliance on confidence intervals to determine phosphorus and chlorophyll *a* impairments unnecessarily distorts available data and will prevent waters with actual evidence of impairment from being listed as impaired.

DNR's revised guidance replaces the use of annual averages to determine exceedance frequencies for phosphorus and chlorophyll *a* with reliance on 90% confidence intervals.[47] In the case of phosphorus, DNR will only acknowledge an impairment based on phosphorus levels if the lower bound of the 90% confidence interval exceeds the set impairment threshold by 1.5 times for lakes and 2 times for rivers and streams.[48] The lower bound of the confidence interval will be lower than the actual average, thereby making it less likely to meet the already inflated thresholds. Even more problematic, DNR will accept as few as two samples in its assessments. As the number of samples relied on decreases, the confidence interval around the average grows wider, pushing the lower bound further from the average and thereby making it *even less likely* that a

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[44] 33 U.S.C.A. § 1251(a)(7) (emphasis added).
[45] *See* 40 C.F.R. § 130.7(c).
[46] *See* Memorandum from Tudor T. Davies, Director Office of Science and Technology, to Water Management Division Directors Regions I-X (June 19, 1991). Available at http://www.epa.gov/npdes/pubs/owm0232.pdf.
[47] WisCALM 2014 at 37, 45.
[48] *Id.* at .33, 54-55.

waterbody will meet the inflated thresholds, despite data showing a threatened or actual impairment.

As already discussed, requiring extreme exceedances of the applicable water quality standards is an unlawful approach standing alone and will prevent DNR from adequately identifying impaired waters and ensuring that those waters benefit from CWA remediation processes.[49] By also layering reliance on confidence intervals onto an already unlawful approach, DNR not only distorts the standard, it also manipulates reliable, available data to avoid listing known impairments. The result will be a failure to list waters that suffer even extreme exceedances according to available data. This unrepresentative approach to the data must be revised to ensure that DNR adequately lists waters where data shows impaired conditions.

We recognize that limited resources prevent DNR from collecting sufficient data on all of the state's waterbodies to make impairment decisions with scientific certainty. However, where DNR is unable to collect enough of the right data, it must take a protective approach to assessing water quality to ensure that existing and attainable uses are protected or restored. For instance, if the DNR must depart from reliance on annual averages, it should rely on the upper bound of the 90% confidence interval to determine exceedances. In contrast to the current approach which eschews legal requirements, reliance on the upper bound of the 90 % confidence would ensure that DNR lists impaired *and threatened* waters as required by the CWA.[50] Furthermore, reliance on the upper bound of the 90% confidence interval would encourage DNR to obtain larger samples sets whenever possible, including soliciting and incorporating available third-party data as already required under the CWA.[51] In contrast, retaining the current approach to use of confidence intervals would create a perverse incentive to base listing decisions on as little data as possible despite clear federal requirements to base listing decisions on all available data.[52]

Comment: WisCALM must be revised to remove reliance on confidence intervals to determine exceedances. Where reliable available data shows pollution levels above the applicable water quality standard those waterbodies must be listed. Reliance on confidence intervals impermissibly distorts actual sampling results, particularly when DNR is forced to make judgments based on minimum sample requirements, as is often the case.

Comment: If DNR continues to statistically distort actual and reliable data, it must only do so in a manner that is protective of Wisconsin water quality. For instance, if the *upper bound* of the 90% confidence interval exceeds applicable water quality standards, then that is a sufficient indication that the water body is impaired. Alternate uses of confidence intervals are inconsistent with the goals and purposes of the CWA and must be removed from WisCALM.

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[49] *See* 40 C.F.R. §§ 130.7(b)(3), 131.21(c), (d); NR 102.06.
[50] *See* 40 C.F.R. § 130.2; 40 C.F.R. § 130.7(b)(5)(i).
[51] 40 C.F.R. § 130.7(b)(5)
[52] *Id.*

6. **DNR must revise the protocol for assessing chlorophyll *a* exceedances to ensure that impairment decisions are representative of actual conditions, based on scientifically sound methodologies, and sufficiently protective of public health.**

The chlorophyll *a* assessment protocols in the draft WisCALM must be significantly revised to ensure that DNR collects representative data, bases decisions on scientifically defensible assessments of that data, and judges impairment against a concentration threshold that is sufficiently protective of designated uses and public health.

With respect to data requirements, DNR has provided that whichever sample method is relied upon, "the selection of the values should result in using the most representative data available."[53] This commitment logically obliges DNR to select sample sites that ensure collection of the most representative data available. As presently defined, however, the sampling protocols for chlorophyll *a* will result in samples that are not representative of actual conditions. Phytoplankton blooms are typically small in open water areas of lakes relative to nearshore areas. Despite this scientific reality, DNR's guidance requires sampling in most lakes to be conducted at only a single "deepest spot" site.[54] Similarly, mid-channel sections of rivers and streams typically have low algal growth relative to nearshore sections, and yet DNR proposes to rely on mid-channel sampling locations.[55] In practice, "deepest spot" and mid-channel sampling sites will minimize the likelihood of identifying high chlorophyll *a* even where such conditions do in fact exist, thereby biasing the data against identification of actual impairments.

Lake Menomin provides a clear example of the problem with DNR's current sampling site selection protocols. Lake Menomin has been listed as nutrient impaired since 1998. A review of DNR sampling data shows that samples taken from sites recognized as "deep holes" have rarely returned chlorophyll values above 100 µg/L.[56] Samples taken from the shallower, relatively nearshore Wolske Bay have returned chlorophyll values as high as 588 µg/L,[57] nearly six times the highest concentration levels observed in deeper portions of the lake. DNR must identify impairments while remediation is still biologically and economically possible, and that requires selecting sampling sites that will be early indicators of impairments.

Not only are the sampling protocols not likely to be representative, the impairment threshold for chlorophyll *a* is fundamentally inconsistent with that data, and requires the DNR to make impairment decisions on the basis of percentages that will not be

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[53] WisCALM 2014 at 15.

[54] *Id.* at 25 ("By default, the TP and chl *a* Packages use those sites that are designated as "Deepest Spot" for assessments.").

[55] *Id.*

[56] The reviewed DNR sampling sites with fewer than five collective exceedances of 100 µg/L recorded in sampling from 1996 – 2003 include: "S. Basin Deep Hole"; "Lake Menomin – Deep Hole"; and E. Basin Deep Hole."

[57] DNR data from the "Lake Menomin at Wolske Bay" site, recorded on 8/4/2011.

representative of actual conditions. This will result in impairment decisions that cannot be scientifically defended, and more likely than not, inadequately recognize waters that are in fact impaired.

As revised, DNR guidance has replaced simple concentration thresholds for assessing exceedances of chlorophyll *a* with a standard that requires calculation of the percentage of days in the growing season with chlorophyll *a* concentrations in excess of 20 µg/L, a concentration representing a "nuisance algal bloom."[58] DNR proposes to determine the percentage of days a given water body suffers nuisance algal blooms based on as few as two samples in a single year.[59] Simply as a matter of common sense, it is not possible to reliably extrapolate the percentage of days with nuisance algal blooms based on as few as two samples. DNR's method for recognizing an impairment is therefore fundamentally inconsistent with sampling protocols and will result in impairment decisions that are not representative of actual conditions.

Finally, in addition to reliance on unrepresentative and insufficient data, DNR has proposed impairment thresholds that are not sufficiently protective of existing uses and amount to a serious threat to public health. Stated differently, even with the correct data, the draft guidance would allow waters with exceedances to avoid being actually listed as impaired. In so doing, the state will fail to adequately identify and remediate impaired waters.

DNR's proposed guidance would not recognize a lake as impaired for recreational uses until nuisance algal blooms are assumed to occur for greater than 30% of the sampling season for two years.[60] "Nuisance algal blooms" are defined as having chlorophyll *a* concentrations greater than 20 µg/L.[61] As acknowledged in WisCALM:

> "excessive nutrient loading (particularly phosphorus) can cause algae populations to grow rapidly under certain environmental conditions and form 'blooms' that can impact water quality and pose health risks to people, pets, and livestock. Blue-green algae pose the greatest nuisance and risk to those recreating."[62]

Wisconsin is notorious for these cyanobacteria blooms, including being reported as having among the highest microcystin toxins reported worldwide.[63] Cyanotoxins pose serious health risks including, but not limited to, respiratory illnesses, gastrointestinal illnesses, neurological diseases, liver failure, malignant tumors, and severe skin rashes.

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[58] *Compare* WisCALM 2012, Table 4A at 32 *against* WisCALM 2014, Table 5A at 37; *Compare* WisCALM 2012, Table 5 at 37, *to* WisCALM 2014, Table 6 at 43.
[59] WisCALM 2014 at 30.
[60] *Id.* at 43.
[61] *Id.* at 41.
[62] *Id.* at 41.
[63] Hedman, Curtis J., William R. Krick, Dawn A. Karner Perkins, Elisabeth A. Harrahy, and William C. Sonzogni, New Measurements of Cyanobacterial Toxins in Natural Waters Using High Performance Liquid Chromatography Coupled to Tandem Mass spectrometry, Journal of Environmental Quality, Vol. 37 (Sept. – Oct. 2008).

These impacts have already been documented among recreational users of Wisconsin lakes and rivers.[64]

Beyond public health threats, nuisance algal blooms also have negative impacts economic impacts. Lakes with nutrient impairments can depress property values in the surrounding area and clean-up can impose significant costs. The algal blooms in Wolske Bay, for instance, are already so extreme this summer to trigger proposals for authorization to dredge the bay in an attempt to slow algal growth, at an estimated expense of over $225,000.[65]

In light of these serious risks, DNR should revise the exceedance threshold to protect public health adequately listing impaired waters and guaranteeing that these waters are appropriately prioritized for clean-up. Under the present standard, dangerous algal blooms could be present for as much as a third of the summer season—creating a great risk of exposing recreational users to considerable harm—but the waterbody would not be identified as impaired and prioritized for a clean-up plan. DNR must instead take an approach that would identify impaired waters before such waters pose a serious threat to public health.

Comment: DNR must revise WisCALM to require sampling locations that will ensure representative data is collected for each parameter. With respect to chlorophyll *a*, sampling must be required at nearshore sites to ensure that data capture conditions in areas most susceptible to algal growth and that therefore pose the greatest risk to public health.

Comment: DNR must set impairment thresholds in terms that are consistent with sampling protocols. WisCALM must be revised to remove reliance on the percentage of days in sampling season with nuisance algal blooms as such a percentage cannot possibly be determined with scientific certainty based on the paucity of required data. Alternatively, if DNR elects to retain that impairment standard, additional samples must be required such that something approaching a daily sampling frequency is required.

Comment: DNR must revise the chlorophyll *a* exceedance threshold to a level that is protective of recreational uses and public health. Allowing dangerous concentrations of chlorophyll *a* for as much as a third of the peak recreational season is insufficiently protective and inconsistent with the purposes and goals of the CWA.

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[64] *See* B. Novak, Blue-green algae blooming all over Wisconsin, DNR says, *The Capital Times* (August 3, 2011); Lisa Gaumnitz, Less P is key: Controlling phosphorus remains a key to improving health and water quality, *Wisconsin Natural Resources* (August 2010) (available at http://dnr.wi.gov/wnrmag/2010/08/phos.htm); A. Rathbun, Blue-green Algae Sickening Lakes' Residents – Blooms' Effects Can Range from Sore Throat to Liver Damage, *Pioneer Press* (Sept. 18, 2011).

[65] Barabara Lyon, Council: Let's hear from experts about Wolske Bay dredging, *The Dunn County News* (June 22, 2013). Available at http://chippewa.com/dunnconnect/news/local/council-let-s-hear-from-experts-about-wolske-bay-dredging/article_44a05936-db5d-11e2-967d-001a4bcf887a.html.

7. **DNR should incorporate third party data from the USGS in addition to SWIMS when conducting assessments to ensure that impaired waters are recognized and listed.**

As discussed above, federal law requires DNR to consider all readily available data when making impairment assessments.[66] Federal regulations specifically name the USGS as a good source of field data.[67] The USGS continually collects readily available public data on Wisconsin waterbodies, [68] and the DNR must incorporate these data into its assessments to assure adequate listing of impaired waters.

Past USGS reports have included data showing that a large number of waterbodies exceed the phosphorus impairment thresholds established in NR 102.06(3).[69] In addition, the datasets currently available through the USGS website similarly indicate that a significant number of Wisconsin waters have phosphorus levels in excess of the NR 102.06(3) threshold.[70] On the basis of that data, DNR should actively solicit the USGS for all available water quality data currently on record with the agency, and that data should be relied upon in making impairment assessments of Wisconsin's water.

If DNR finds the available data insufficient for listing, DNR must actively solicit additional data and explain the basis for its finding that USGS data are insufficient as required by federal regulation.[71]

Comment: DNR must consider all readily available water quality data, including the extensive readily available data collected by USGS. All waters that exceed the state phosphorus standards set by NR 102.06 on the basis of readily available data must be listed as impaired. If DNR finds USGS data insufficient, it should explain its basis for that judgment.

Comment: DNR must list waters from the SWIMS database showing an exceedance of the phosphorus standards of NR 102.06. If DNR finds SWIMS data insufficient, it should explain its basis for that judgment.

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[66] 40 C.F.R. § 130.7(b)(5).
[67] *Id.*
[68] *See* United States Geological Survey, USGS Water Data for the Nation, available at http://waterdata.usgs.gov/nwis.
[69] U.S. Geological Survey, Professional Paper 1754, Nutrient Concentrations and Their Relations to the Biotic Integrity of Nonwadeable Rivers in Wisconsin, Appendix 1, p. 76, *available at* http://pubs.usgs.gov/pp/1754; U.S. Geological Survey, Professional Paper 1722, Nutrient Concentrations and Their Relations to the Biotic Integrity of Wadeable Streams in Wisconsin, p. 96-109, *available at* http://pubs.usgs.gov/pp/pp1722.
[70] *See U.S. Geological Survey*, USGS Water Data for the Nation, *available at* http://waterdata.usgs.gov/nwis.
[71] 40 C.F.R. § 130.7(b)(6)(iii).

8. **DNR's data requirements for dissolved oxygen are too stringent and must be revised to adequately identify and list waters that are in fact impaired.**

Wisconsin waters with dissolved oxygen ("DO") impairments should be placed on the 303(d) list.[72] However, because of overly strict data requirements, many waters that do in fact suffer from DO impairments have again not been properly listed.

Accordingly, DNR should alter the DO minimum data requirements. DNR currently requires three or more days of continuous DO measurements in July or August, over a minimum of three years, and showing an exceedance frequency of at least 10%.[73] Actually collecting such data would require use of prohibitively expensive automatic sonde devices. The DNR thus is unable to even consider DO impairments where it is unable to afford these automatic sampling devices.

Though DNR guidance does allow waters to be listed in spite of not meeting minimum data requirements, this allowance is only triggered where available data show "overwhelming evidence of impairment."[74] Given the practical reality of DNR's limited monitoring resources, the overly stringent DO data requirement functions to prevent the listing of legitimately impaired waters unless such waters are so unreasonably impaired as to be characterized as "overwhelming." These data requirements must be revised in light of practical limitations to ensure that impaired waters are listed as required by the CWA.

Comment: DNR's DO sample requirements should conform to practical restraints. This could be accomplished by reducing the listing threshold to one year, thereby allowing DNR to make more effective use of a limited number of sonde devices.

9. **DNR should list waters as impaired for fish consumption based on human health risks regardless of whether that water is or is not subject to a specific advisory.**

States are required to adopt water quality standards that will provide for fishable waters.[75] The narrative water quality standards in NR 102.04 reflect Wisconsin's commitment to meet the federally required goal of providing for fishable waters.

A general fish advisory applies to all waters in Wisconsin.[76] DNR continues to follow the policy of only listing waters as impaired where a specific advisory has been issued for a waterbody.[77] These specific advisories required that have "specific contaminant data for game and panfish species that require advice more stringent than the statewide general

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[72] *See* 33 U.S.C. § 1313(d).
[73] WisCALM 2014, Table 14A at 56.
[74] WisCALM 2014, at 15.
[75] *See* 33 U.S.C.A. § 1251(a)(2); 40 C.F.R. § 131.10.
[76] WisCALM 2014 at 61.
[77] *Id.* at 61.

advice based on examination of data in conjunction with WDNR of Health Services."[78] For PCBs to trigger listing, a water body must have a specific advisory of one meal per month or less for gamefish and one meal per week or less for panfish.[79] Stated differently, DNR will only list a waterbody as impaired if contamination levels are so great that it is never safe to eat gamefish.

By not listing waters according to a more protective standard, DNR is violating the CWA and NR 102.04 requirements designed to protect the fishability of our waters. Instead, DNR must list waters as impaired when contamination levels would create a public health risk if the fish are relied upon as a food source.[80] Where waters under a general advisory pose such a health risk those waters must be listed as impaired.

Appropriately including mercury-impaired waters on the 303(d) and thereby making the TMDL process possible would enable the DNR to assess the source and severity of mercury pollution. That assessment may include identification of out of state sources that might be addressed through the EPA's Mercury and Air Toxics Standards.[81]

Finally, DNR's methodology for issuing specific advisories is relative undefined and discretionary. The basis for judgments of whether or not to add particular species to a specific advisory should be clearly articulated in WisCALM. Implementing standardized protocols in place of ad hoc judgments, largely contingent on individual professional judgment will ensure that fish assessments are as consistent and correct as is possible.

Comment: DNR must list waters as impaired if they contain mercury levels that may injure public health if the fish are consumed. By listing these waters, DNR will be able to identify and remediate mercury contamination through the TMDL process.

Comment: DNR's current listing threshold is insufficiently protective to ensure the fishability of Wisconsin waters as required by the Clean Water Act and NR 102.04. DNR should revise the threshold to list waters where the recommended fish consumption frequency is less than one meal per week for any member of the population.

Comment: WisCALM should be revised to provide specific guidance on how impairment assessments in fish will be made. This guidance should include provisions addressing sample size, length of time to gather samples, and a procedure for determining the source of impairment.

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[78] *Id.* at 62.
[79] *Id.* at 80.
[80] *See* NR 102.04(1)(d) ("Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance.").
[81] *See* 40 CFR Parts 60 and 63.

We look forward to your responses to these comments. We applaud DNRs longstanding commitment to realizing the goals of the CWA and ensuring that Wisconsin's valuable surface water resources are adequately protected and restored.

Sincerely,

Cassandra R. McCrae, Law Clerk

Betsy Lawton, Supervising Attorney

Appendix A

Comments on the Draft "Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM) for Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting" (WDNR 2013)

Prepared for Midwest Environmental Advocates

by

JoAnn Burkholder, Ph.D., 29 June 2013

Overall Assessment

The Wisconsin Department of Natural Resources (WDNR) (2013) has proposed a radical departure from the State's total phosphorus (TP) standards for assessing surface water bodies as impaired. As background, waters evaluated as impaired are added to the state's annual 303(d) List of Impaired Waters, prepared for the U.S. Environmental Protection Agency (EPA) as a requirement of the Clean Water Act. Impairment status is supposed to trigger cleanup and enhance water quality protection.

The following comments address WDNR protocols for assessing impairment of Wisconsin surface waters, specifically in regard to TP, suspended algal biomass as corrected chlorophyll *a* (chl*a*), and dissolved oxygen (DO). WDNR asserts (p.28) that a major reason for the radical changes is "to more appropriately assess water quality." This vague assertion is false. The proposed procedures are not science-based; they are also biased to find acceptable conditions in lakes that are actually impaired; and they are reactive to such an extreme that they do not find impairment unless and until a surface water body has become highly degraded by nutrient pollution, rendering cleanup difficult or logistically/economically impossible.

My overall assessment is that WDNR's proposed protocols to evaluate lake impairment will fail to protect the designated use of Wisconsin surface waters for fish and other aquatic life (FAL). Adoption of these protocols would result in widespread, highly degraded conditions and loss of desirable fish communities in Wisconsin waters. The protocols would also allow substantial damage for recreational uses (REC) by promoting fish kills that discourage fishing and major algal blooms whose slimy growths discourage swimming, and by clogging waterways to impede boating. More seriously for the state's citizens and visitors, these protocols would miss impairment in many Wisconsin waters that are already sustaining highly toxic cyanobacteria blooms. Incorrect evaluation of such water bodies as "not impaired" would mean that these waters would not receive the cleanup and improved protection from pollution they critically need. The net result would be sustained major risk for the health safety of many people in the summer season every year. WDNR's proposed protocols to evaluate lake impairment will fail to protect the designated use of Wisconsin lakes for recreation (REC) to such an extreme that these protocols pose a direct, serious threat to human health.

Summary: WDNR Protocols to Assess Impairment Greatly Weaken Protection of Wisconsin Surface Waters

The Wisconsin TP standards are based on rigorous analysis of phosphorus levels that directly or indirectly promote unacceptable adverse impacts on fish and other beneficial aquatic life, and unacceptable adverse impacts on recreational uses. *The strong science foundation that was used*

to develop the Wisconsin total phosphorus (TP) standards is ignored by WDNR in its protocols to assess impairment. Excessive TP thresholds are set much higher than the TP standards to assess a water body as impaired; even these excessive thresholds are then abandoned for much higher thresholds; data requirements are greatly weakened; and other steps in the protocols bias the evaluation against finding impairment. The net result is that a water body must become highly degraded before it can be assessed as impaired.

- *Excessive TP and chl*a *impairment concentration thresholds for lakes that will "miss" impairment* - For all but 1 of 7 designated lake types, WDNR has set "impairment TP concentration thresholds" for FAL waters to be much higher than the TP standards, and much higher than the level of the response variable, chl*a*, that the TP standards target. Thus, waters can be assessed as impaired only after the nutrient pollution is *greatly in excess* of the Wisconsin TP standards.

- *Extremely sparse, antiquated data* - only six samples collected over ten years - would be considered adequate to assess a water body's present status, although science has shown that such data would not allow accurate assessment.

- *Elimination of clear impairment thresholds* - Clear concentration thresholds for TP and chl*a* set to indicate impairment would be replaced by 90% confidence intervals (CIs) around a non-science-based mean developed from extremely sparse data. The 90% CIs would be highly changeable from year to year, thus eliminating a clear impairment target.

- *Further misuse of 90% CIs to require extremely high TP concentrations for impairment* - The 90% CIs would be wrongly used by WDNR to require even higher TP concentration thresholds before a water body could be assessed as impaired: "Clear exceedance" of the already-excessive impairment thresholds would require that the lower 90% CI, a value that was substantially lower than the mean, was 1.5-times *higher* than the impairment threshold in lakes, and double the impairment threshold in rivers and streams. Absent this "overwhelming exceedence" (WDNR's wording), the water body could not be assessed as impaired based on TP alone, despite the fact that the water body's TP concentrations were already far higher than the Wisconsin State standards.

- *Misuse of 90% CIs to require extremely high chl*a *concentrations for impairment* - A similar approach would be imposed for use of the response variable chl*a* in assessing Wisconsin waters. Absent extreme exceedence, the water body could not be evaluated as impaired based on chl*a* alone, despite the fact that the water body's chl*a* concentrations were already far higher than targeted by the Wisconsin State standards.

- *High concentrations of TP and chl*a*, used together, to indicate impairment* - Excessive concentrations of TP and chl*a* used together, although lower than the "overwhelming exceedence" required for use of TP or chl*a* alone, would be required in order for a water body to be assessed as impaired.

- *False claims to be able to accurately predict the percentage of days with nuisance algal blooms to protect recreational uses, based on highly inadequate information* - Only 2 chl*a* samples that were collected over an entire 4- to 5-month growing season would be used to "guesstimate" the percentage of days when a water body would be impaired by

noxious algal blooms. This approach is non-science-based in the extreme and will not protect the designated use of Wisconsin waters for recreation.

- *A required sampling location that biases against finding impairment* - The main sampling location required by WDNR, in the deep-water or deepest part of a lake, biases against finding impairment because deeper water generally coincides with the open-water area of the lake where algal blooms are minimal in comparison to conditions in nearshore areas.

- *Non-science-based use of DO concentrations to indicate impairment* - The WDNR protocols for use of DO to indicate impairment allow data from cool months to be considered rather than only data from the warmest months when DO deficits occur. These protocols also require extremely sparse data (10 samples collected over multiple years), and fail to consider pre-dawn sags and diel variation.

Specific Comments

The new automated assessment protocols ("Packages") for TP and chl*a* use whatever qualifying data are available, going back an entire decade. Readers are falsely assured (p.28) that "the automated assessment packages will indicate which stations do or do not meet the minimum data requirements for impairment assessment, and only those that do meet assessment requirements will be used for official assessment reporting" (see ** on the next page of these comments). The reality is that WDNR's stipulations render the minimal data useless for accurately assessing water body status. The combination of these non-science-based "Packages," together with the sparse data requirements and the newly devised "Assessment Paths" (below), make it easy to assess an impaired lake as "acceptable" in water quality, difficult to list the lake as impaired, and impossible to accurately assess the lake's TP, chl*a*, and DO status.

*The protocols require excessive TP and chl*a *impairment concentration thresholds that ignore the Wisconsin state TP standards and will commonly "miss" impairment, so that affected water bodies do not receive protection and instead continue to degrade* -

The table on the next page of these comments compares impairment threshold concentrations set by WDNR to evaluate whether lakes are impaired. It is modified from WDNR (2013) to include the Wisconsin State TP standards and targeted chl*a* concentrations (both in blue) according to lake type. The TP impairment threshold concentrations at set at 100 µg/L for shallow lakes, whereas the State Standards are set at 40 µg/L. The TP thresholds for impairment of all deep lake types except two-story lakes are set at 60 µg/L, versus a level of less than 20 µg/L for at least 95% of the growing season as targeted by the Wisconsin State TP standards. These impairment thresholds, much higher than the State TP standards and the chl*a* level they were designed to target, are used by WDNR to evaluate many lakes that clearly violate the State standards as "not impaired" but, rather, acceptable in water quality. Lacking impairment status, these water bodies are allowed to continue to degrade until the impairment becomes extreme.

The proposed protocols to assess impairment so weaken data requirements that acceptable assessment of "present" impairment can be based on extremely sparse, antiquated TP data -

The draft document (p.30) states that WDNR's automated software program to evaluate lake impairment will now use <u>any</u> [WDNR's emphasis] qualifying data *from within the past decade*,

Indicators	Min. Data Requirement (see text for details)	Exceedance Frequency (see text for details)	Impairment Threshold - LAKES - Fish & Aquatic Life Use						
			Shallow			Deep			
			Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Two-story fishery lake
Biological indicators									
chl a	3 monthly values from each of two years[3] from the period July 15 – Sept. 15	Lower bound 90%CI of the mean exceeds threshold	≥60 ug/L (≥71 TSI)	≥60 ug/L (≥71 TSI)	≥60 ug/L (≥71 TSI)	≥27 ug/L (≥63 TSI)	≥27 ug/L (≥63 TSI)	≥27 ug/L (≥63 TSI)	≥10 ug/L (≥53 TSI)
			← Target: < 20 µg/L for ≥ 95% of the growing season →						< 10 µg/L
Conventional physico-chemical indicators									
TP	3 monthly values from the period June 1 –Sept. 15	Lower bound 90%CI of the mean exceeds threshold	≥100 ug/L Std ≤ 40	≥100 ug/L Std ≤ 40	≥100 ug/L Std ≤ 40	≥60 ug/L Std ≤ 30	≥60 ug/L Std ≤ 30	≥60 ug/L Std ≤ 20	≥15 ug/L Std ≤ 15

"whether or not the quantity of data meets the assessment requirements." WDNR (p.30) defines an acceptable "qualifying year" as having a minimum of ***only two samples***, misleadingly called "daily means," in different months, with the two samples taken at least 15 days apart (e.g. in the latter half of June, versus the first half of July). WDNR then informs readers that a "daily mean" does not have to be a mean (!). *Science defines a mean as the average of two or more data points* (Sokal and Rolff 2012). WDNR eliminates the scientific definition and redefines the "daily mean" to be *one* data point, that is, one sample. WDNR further states that the "daily mean" can "represent" (read, be considered equal to) a "monthly mean" as well. There is also no mention of any replication requirement.

WDNR's explanation (p.28) for this procedure is that "including datasets that do not meet minimum requirements [for data collection] will allow biologists to review the available data and determine future monitoring needs." Yet, biologists would easily be able to discern data gaps (as dashed lines, or n.a. = not available, etc.) in the dataset indicating "no data," and the present logical procedure makes it straightforward to review the existing data needs.

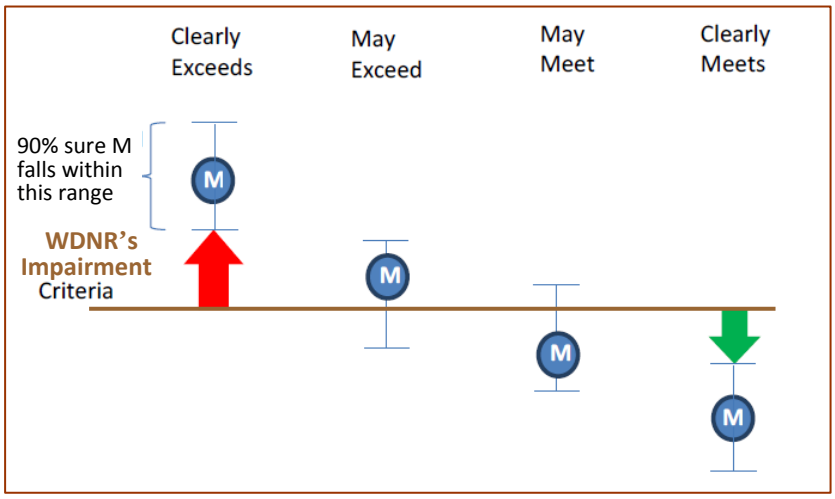
The draft document describes a preference of WDNR that data from in the past 5 years are used to assess impairment but, as mentioned, data as old as a decade would be considered "acceptable." In the proposed protocols, A "Biology Only" impairment listing (based, at present, on chl*a*) would require at least 6 monthly means over at least 2 qualifying years; and a "Chl*a* Bioconfirmation" impairment listing would require at least 3 "monthly means" (actually not means, as explained above) collected from at least 1 qualifying year. WDNR then further weakens the data requirements so that assessment of Wisconsin surface waters as "presently" impaired becomes completely meaningless: If 3 chl*a* "monthly means" (not means, just 3 samples in total, collected 15 days apart in different months) are *not* available during a year, then multiple years dating back an entire decade can be used to "assemble the minimum number of data points" - in other words, for example, 1 sample from 2004, 1 sample from 2007, 2 samples from 2009, 1 sample from 2010, and 1 sample from 2012 could be used to reach the designated total sample number of 6. Those samples were used to assess "present" impairment. ***Only if there are fewer than 6 data points (read, 6 samples) taken within the past entire 10 years is the station "flagged" as not meeting assessment requirements.* Thus, WDNR's new protocols allow use of **extremely** sparse samples collected as long as 10 years ago to assess whether the lake is [presently] impaired.

This approach ignores a body of science publications showing that means or medians based on data collected at least monthly during the same growing season (same year, then repeated the next year, and so on) are needed to accurately assess nutrient status (e.g. U.S. EPA 2000a,b,

Hollabaugh and Harris 2004). WDNR's proposed adequacy of samples is also illogical considering that conditions affecting surface waters across the country, including Wisconsin, have dramatically changed over the past decade as watershed development has advanced with rapidly increasing human and livestock (swine, poultry, cattle) populations (e.g. U.S. EPA 2010, WDNR 2010).

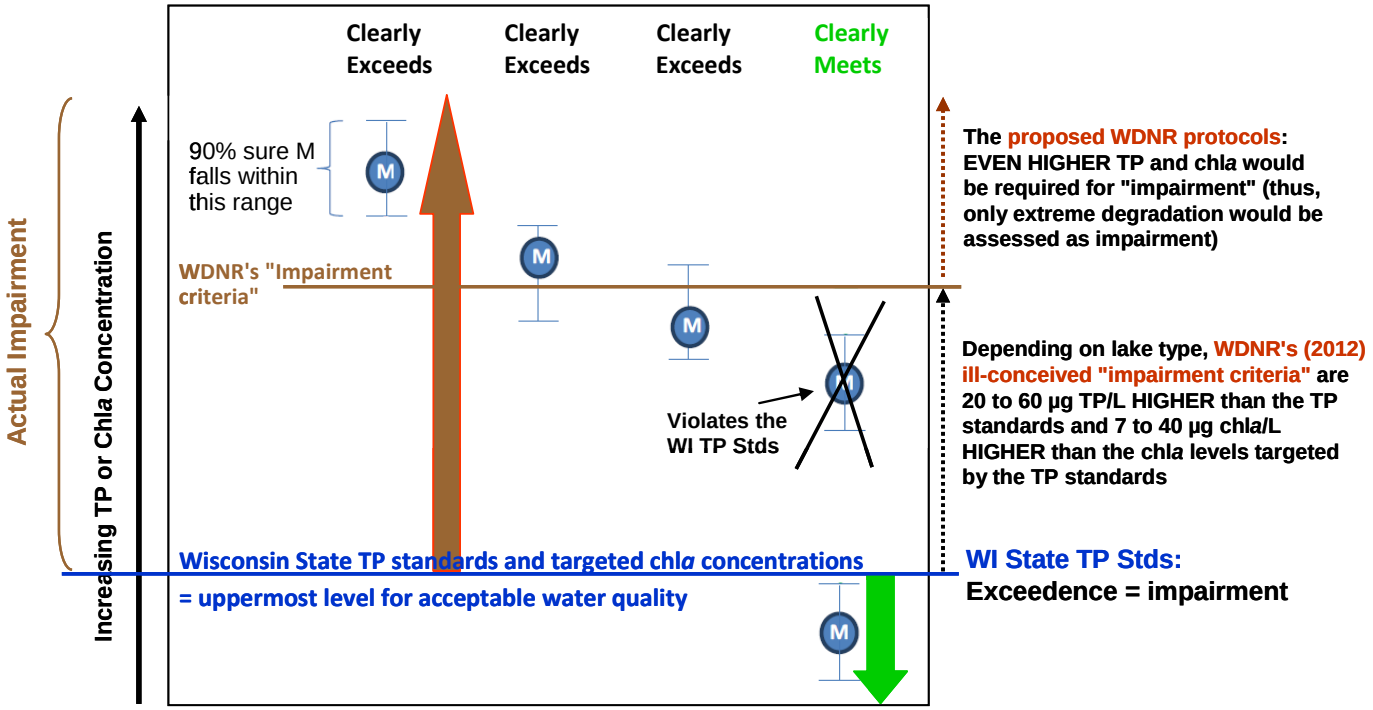
The new protocols de-emphasize clear impairment thresholds in favor of 90% confidence intervals (CIs) for a poorly conceived, non-science-based 'grand mean' -

The new protocols would de-emphasize the TP impairment thresholds (60 to 100 µg/L for most lake types to protect the designated use for fish and other aquatic life, FAL). Yet, as shown above - and see WDNR's figure below, versus the modified figure on the next page of these comments - the impairment thresholds have been set at already-substantially-higher levels than the Wisconsin TP standards (15 to 40 µg TP/L for various lake types as an average growing season average). The new protocols would also ignore the actual data; instead, 90% CIs would be used, which are much wider than the 95% CIs usually applied to averages for nutrient data. A 5% probability (chance) of being wrong in estimating the average is generally accepted for water quality data (see Sokal and Rolff 2012). WDNR proposes to reduce the number of required samples from 3 to 2 per year (summer growing season), which would increase the uncertainty (error) in estimating the average TP and chl*a*. Compounding the broader uncertainty, WDNR then proposes to use unusually wide CIs, which would "move" the analysis farther and farther away from the actual data.



WDNR's (2013 draft) proposed protocols take "impairment," already set at levels far in exceedance of the Wisconsin State TP Standards, even higher. Here, the words "WDNR's Impairment" have been added to the above misleading figure because without it readers would infer, erroneously, that "criteria" refers to the Wisconsin State TP standards. WDNR has set "impairment" at much higher levels than the Wisconsin State TP Standards, despite the fact that exceedance of the Wisconsin State TP Standards violates the standards and should mean impairment. This figure provides a clear illustration of WDNR's attempt to simply ignore the actual TP Standards. Compare this figure with the figure on the next page of these comments.

The extremely sparse data considered "acceptable" by WDNR (2 samples per year for 1 to 2 years, used to "represent" as much as an entire decade) would be combined into a 'grand' mean for a given station. This mean, based on very few samples, with wide CIs, would then be



Modified figure from WDNR (2013 draft) **to include comparison with the Wisconsin State TP standards, and to show where exceedance should occur** - at TP concentrations higher than the State TP standards and at chl*a* levels higher than the chl*a* levels targeted by the State TP standards.

subjected to analysis by a gauntlet of reactive "Assessment Paths," each designed to reach a "not impaired" conclusion unless and until there was "overwhelming" exceedance - that is, extreme water quality degradation:

Assessment Path 1, TP Only ("overwhelming TP exceedance" over at least 1 year) - The lower 90% CI must ***overwhelmingly exceed*** [WDNR's wording] the impairment threshold criterion, ***by a factor of at least 1.5x in lakes, and at least 2 in flowing waters*** (see the first figure on the next page of these comments). *This will allow substantial degradation by phosphorus pollution* before the lake can be assessed as impaired and, therefore, in need of improved water quality protection. Such "overwhelming exceedance" would mean that a *much higher TP concentration would be required* than the presently used method before it would be possible to assess a lake or stream as impaired.

Assessment Path 2, Biology Only (at present, phytoplankton chl*a* indicating impairment of uses; Wis. Adm. Code NR 102.01 2013), which were based on attempting to limit the risk of nuisance algae conditions (defined as 20 µg chl*a*/L or higher) to occurrence no more than 5% of the time. The chl*a* concentrations at the impairment thresholds set by WDNR are *much higher*, ranging from 27 to 60 µg chl*a*/L for most lake types. The WDNR figure (first figure on the next page of these comments) applies to chl*a* as well as TP; thus, the reactive new protocols will allow substantial degradation as indicated by very (i.e., "overwhelmingly") high chl*a* concentrations before the lake can be assessed as impaired and in need of improved water quality protection.

Assessment Path 3 - TP & Biology in Combination (basis: TP exceedance + "bioconfirmation") - Lakes fitting this proposed "Assessment Path" would have a 'grand mean' TP that exceeds the impairment threshold criterion, but not by at least 1.5-fold (this writing in the draft document is inferred to refer to the lower 90% CI, although that was not explicitly stated). In addition:

a) Chl*a* must clearly be "poor" [WDNR wording] for at least 1 year (Category 5A lake = TP indicates impairment but there are insufficient chl*a* data for bioconfirmation); or,
b) Insufficient chl*a* data are available, or the chl*a* data do not indicate impairment (Category 5P lake = impaired for now; more monitoring is needed to re-assess).

The TP and chl*a* impairment thresholds set for streams and rivers fitting this "Assessment Path" would have to have lower 90% CIs that were twice as high as the impairment threshold criterion, or they would be wrongly evaluated as having acceptable water quality.

The requirement of "poor" concentrations [WDNR's wording] of ***both*** TP and chl*a* is the opposite of what has been stated as U.S. EPA's position on how exceedance should be evaluated:

> It is U.S. EPA's current position that exceedence of a causal water quality criterion, such as nitrogen or phosphorus, would require a determination of non-attainment regardless of whether the water is meeting a different water quality criterion, such as chlorophyll-*a* or other biological response criteria.

Accordingly, these criteria should each "stand alone" to protect Wisconsin's lakes. That is, if any one of the three parameters causal/response variables is exceeded, the system should be characterized as in violation of these proposed nutrient water quality standards (Silva 2010). The criteria will only be sufficiently protective of Wisconsin lakes if excess of one parameter – TP *or* chl*a* – is sufficient for a lake to be assessed as impaired.

Overall, in each designed step, the three "Assessment Paths" are *consistently reactive, not protective*, with the net effect of making it much more difficult for a lake (that would have been evaluated as impaired if adequate sampling had been conducted and science-based protocols had been used, to be assessed as impaired prior to sustaining extreme degradation with ("overwhelmingly") high TP concentrations and/or high chl*a*. In addition as mentioned, WDNR proposes to reduce the number of "acceptable" samples from 3 to 2 per year (summer growing season). The CIs around the average for 2 samples would very likely be wider than those around the average of 3 samples; the lowermost value of the CI would be less. The yet-lower CI would make it even more difficult for a water body to be assessed as "clearly impaired" (see figure on p.5 of these comments).

The new protocols for assessing Wisconsin lakes as impaired for recreational use are claimed to be based on the percentage of days with nuisance algal blooms based on only 2 samples per growing season, which is grossly insufficient; moreover, the critically important procedure for determining this percentage is excluded from the document -

As shown by comparison of the two tables on the next page of these comments, the impairment threshold for REC in a given lake type presently is a clearly interpreted chl*a* concentration. That concentration was comparable to or lower than the chl*a* concentration targeted by the TP Standards

in the Wisconsin state statutes (Wis. Adm. Code NR 102.01 2013 - see the previous page of these comments). *WDNR now proposes to replace these clear criteria with percentage of days in the sampling season that have nuisance algal blooms* (> 20 µg chla/L) - *despite the fact that the agency requires only 2 days of sampling for the entire year*. Moreover, the draft document describes nothing about how this guesstimated percentage is "derived" from only 2 days of data (1 sample per date) generally taken at one location to represent the entire lake. The procedure for deriving the complete guesstimates is vaguely described on p.42, and tells readers nothing because key table(s) are not included:

Present recreational impairment thresholds for natural communities in Wisconsin lakes (WDNR 2012).

Note: Data are evaluated from within the most recent 10 year period for all parameters. For TP and chl *a*, data from within the most recent 5 year period are used for impairment assessments.

Indicators	Min. Data Requirement (see text for details)	Exceedance Frequency (see text for details)	Impairment Threshold - LAKES - Recreational Use						
			Shallow			Deep			
			Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Two-story fishery lake
Conventional physico-chemical indicators									
TP	3 values from each of 2 years from June 1 - Sept. 15	Annual Average exceeds for at least 2 years (or majority of yrs of data)	≥40 ug/l	≥40 ug/l	≥40 ug/L	≥30 ug/L	≥30 ug/L	≥20 ug/L	≥15 ug/L
Biological indicators (to be used as supporting data only; these thresholds are rough guidance)									
chl *a**	3 values from each of 2 yrs (or 2values/3yrs) from July 15 - Sept. 15	Annual Average exceeds for at least 2 years (or majority of yrs of data)	≥25 ug/L	≥25 ug/L	≥17 ug/L	≥14 ug/L	≥12 ug/L	≥10 ug/L	≥6 ug/L
AMCI plant metrics* (Abundance of low light tolerant spp.)	Baseline aquatic plant survey within last 5 yrs	NA (one survey)	*(reserved until sufficient data available)*						

* NOTE: While the TP impairment thresholds for Recreational Uses are based on codified criteria and are based on clear breakpoints in water quality corresponding to Recreational Uses, the chl *a* threshold for impairment is not based on a clear scientific breakpoint in water quality and is meant to be used only as loose guidance to provide supporting information in listing decisions. WDNR does not recommend listing for Recreational Use Impairment based solely on the chl *a* thresholds; rather, other corroborating evidence for listing would be needed. Similarly, biologists may consult research staff in Science Services to assess macrophyte data in the AMCI, but this should be used as supporting data rather than as a sole source for impairment listing.

Recreational impairment thresholds **proposed** for Wisconsin lakes (WDNR 2014 draft).

Note: For all parameters, the assessment period is the most recent 10 year period. For TP and chl *a*, data from within the most recent 5 year period are prioritized for impairment assessments.

Indicators	Min. Data Requirement (see text for details)	Exceedance Frequency (see text for details)	Impairment Threshold - LAKES - Recreational Use						
			Shallow			Deep			
			Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Headwater Drainage Lake	Lowland Drainage Lake	Seepage Lake	Two-story fishery lake
Conventional physico-chemical indicators									
TP	3 monthly values from the period June 1 –Sept. 15	Lower bound 90%CI of the mean exceeds threshold	≥40 ug/l	≥40 ug/l	≥40 ug/L	≥30 ug/L	≥30 ug/L	≥20 ug/L	≥15 ug/L
Biological indicators									
chlorophyll *a* (1)	3 monthly values from each of two years(2) from the period July 15 –Sept. 15	Lower bound 90%CI of the mean exceeds threshold	> 30% of days in sampling season have "nuisance algal blooms (> 20 ug/L)			> 5% of days in sampling season have "nuisance algal blooms" (> 20 ug/L)			
Aquatic plant metrics*	Baseline aquatic plant survey	N/A (one survey)	*(reserved until guidance available)*						

(1) While the TP impairment thresholds for the Recreational Use are based on codified criteria, the chlorophyll *a* thresholds for impairment and plant metrics assessments protocols are not codified.

(2) For bio-confirmation of TP criteria exceedance, chlorophyll data from only one year is required.

> Using the T table provided by the department (The department can provide the appropriate T table file upon request as a CSV file (Ttable.csv)), for each CI (lower 90%, Tlow; median, Tmed; and upper 90%, Thigh), and for the appropriate value of n (number of samples), find the value of T that is closest to the one calculated in step 1.

The instructions in the draft document are unclear; the tables are not provided; and the procedure cannot be evaluated. Regardless, it is non-science-based in the extreme for WDNR to assert that ***two*** data points for an entire year can be used, with any semblance of accuracy, to "predict" the percentage of days in the sampling season that would have chl*a* concentrations higher than 20 µg/L. Scientists have worked carefully for decades in attempts to use major datasets to make more general predictions, and have had some success only in well-studies systems (Burkholder 2002, 2009, and references therein; Burkholder et al. 2010 and references therein). WDNR misinforms the general citizenry that accurate predictions about a serious public health issue can be based on 2 samples. This is science fiction; there is no scientific basis to the agency's assertion or its protocol.

The new protocols for assessing impairment in the most productive Wisconsin lakes will seriously jeopardize public health by allowing people of all ages to be exposed to toxic cyanobacteria blooms in shallow water bodies for an entire month or more -

The new protocols would not evaluate a lake as impaired for REC until nuisance algal blooms occur throughout nearly one-third (30%) of the entire growing season, for at least 2 years (i.e., two summer growing seasons). Such conditions will directly expose recreationists to highly toxic blooms of cyanobacteria (blue-green algae). The most common routes of human exposure to these cyanotoxins are by ingesting contaminated water (e.g., during swimming) or inhaling air-borne toxins over and near cyanobacteria blooms (Chorus and Bartram 1999). As acknowledged by WDNR (p.41),

> Blue-green algae pose the greatest nuisance and risk to those recreating. Most species… are buoyant and when populations reach bloom densities, they float to the surface where they form scum layers or floating mats. In Wisconsin, blue-green alga[l] blooms generally occur between mid-June and late September.

The agency's professed rationale for this change is that the new protocol "better reflects actual impairments of recreational uses," and "better captures the variability of chlorophyll in lakes." The reality is that it does neither; instead it seriously threaten the people of Wisconsin with respiratory illnesses, liver failure, malignant tumors, and other impacts from toxic cyanobacteria blooms (Burkholder 2002, 2009, and references therein).

Wisconsin is renowned for extremely toxic cyanobacteria blooms. Cyanotoxins have caused serious human disease and death throughout the world, including Wisconsin (Hedman et al. 2008). Cyanobacteria are capable of making a wide array of other toxins that cause human gastrointestinal illnesses, neurological diseases, skin diseases, and other illness (Burkholder et al. 2009 and references therein). They can cause diarrhea, vomiting, weakness, and death from liver hemorrhaging. They are also known to damage kidney and lung tissues. About 10% of mice exposed to microcystin toxins developed brain (hippocampus) injury and reduced brain size. These toxins also can cause increased gene damage (breakage of chromosomes in human

lymphocytes). Microcystin toxins, a group of common cyanotoxins, are known to cause liver failure and promote malignant tumors (Burkholder 2009, and references therein). Thus, along with the obvious but relatively mild symptoms of illness such as diarrhea and other gastrointestinal problems, severe skin rashes, and difficulty breathing, more insidious impacts are known from cyanotoxins which cannot be detected immediately after exposure, such as promotion of malignant tumors and liver damage.

Such serious, long-term risks to health safety increase substantially from chronic exposure to the high levels of cyanotoxins (Hedman et al. 2008) for several months each summer (Chorus and Bartram 1999, WHO 2003). Notably, ***Wisconsin lakes had among the highest concentrations of microcystin-LR (up to 7,600 µg/L) reported worldwide.*** By comparison, the World Health Organization (WHO) guideline for microcystin-LR in drinking water is 1 µg/L (WHO 2003). Recreationists who swim in such lakes are at high risk for serious health impacts (Chorus and Bartram 1999). Working in nearby Minnesota lakes, Lindon and Heiskary (2008, p.9; also see Lindon and Heiskary 2009, p.247) found that as blooms exceed 30 µg chl*a*/L ("severe" cyanobacteria blooms), the frequency of moderate to high risk of microcystin exposure increases to 12%; and that all high-risk microcystin concentrations were associated with chl*a* concentrations above 30 µg/L. Such cyanotoxin concentrations can also affect rivers, run-of-river impoundments, and reservoirs (Whitton 2000, and references therein).

Cyanobacteria toxins increase the risk for serious human health impacts throughout the summer recreational season, considering both cyanotoxins in the water column and – for severe blooms that would continue to be supported by the proposed WDNR protocols to assess lake impairment – cyanotoxins concentrated in *cyanobacterial scums* (Chorus and Bartram 1999, WHO 2003). Chorus and Bartram (1999, pp.167, 169) wrote:

> "These [cyanobacterial] scums may increase local cell density and thus toxin concentration,… rapidly changing the risk from moderate to high…for bathers and others involved in body-contact water sports....Abundant evidence exists for potentially severe health hazards associated with scums caused by toxic cyanobacteria…. Cyanobacterial scums can represent a thousand-fold to million-fold concentration of cyanobacterial cell populations. It has been calculated that a child playing in a scum [of toxic cyanobacteria] for a protracted period and ingesting a significant volume could receive a lethal exposure ….The presence of scums cause by cyanobacteria is a readily detected indicator of a high risk of adverse health effects for those bathers who come into contact with the scum."

Chorus and Bartram (1999, Section 1.3) stated that estimates indicate that a fatal dose is possible for humans, if scum material is swallowed; and that "The combination of available knowledge on chronic toxicity mechanisms (such as cumulative liver damage and tumour promotion by microcystins) with that on ambient concentrations occurring under some environmental conditions, shows that chronic human injury from some cyanotoxins is likely, particularly if exposure is frequent or prolonged at high concentrations.

The WHO (2003, p.105) similarly reported "high probability of adverse health effects" from cyanobacterial scum formation "in areas where whole-body contact and/or risk of ingestion/ aspiration occur." The adverse health effects listed included the "potential for acute poisoning, potential for long-term illness with some cyanobacterial species, and short-term adverse health

outcomes, e.g. skin irritations [and] gastrointestinal illness." And, in a study of microcystin cyanotoxins in Minnesota lakes, Lindon and Heiskary (2008, p.5) wrote,

> "…sites with surface scums exhibited higher and more variable MC [microcystin cyanotoxin] concentrations compared to sites without scums….the likelihood of moderate to very high risk MC [microcystin cyanotoxin] concentrations was found to be greater at sites with a distinct surface scum. These results are consistent with observations by Graham et al. (2004)…that MC in [nearshore] scums may be much greater than at pelagic [open-water] locations…."

Given this wealth of scientific and medical information about the impacts of cyanotoxins, known worldwide for many years, and the dangers posed especially by cyanotoxin scums, the draft document conveys a compelling disregard for the health safety of the citizens and visitors of Wisconsin by pointedly excluding consideration of cyanotoxin scums, and by presenting troubling misinformation-by-omission. Consider the following table (Table 7) from p.46 of the draft document:

Summary Table of WHO Guidelines for Cyanobacteria Levels in Water:

Risk Category	Cell Density (cells/mL)	Action Recommended
Low Risk	20,000 – 100,000	None
Moderate Risk	>100,000	Advisory & Possible Closure
High Risk	Visible Scum Layer	Closure

The above brief summary table mentions "high risk" to human health from visible scum layers, yet the proposed protocols ignore them entirely. The table on the next page of these comments is from Chorus and Bartram (1999). The WDNR protocols require sampling at a depth that avoids surface scums. Yet, according to the Minnesota authorities mentioned in the draft document,

> "…sites with surface scums exhibited higher and more variable MC [microcystin cyanotoxin] concentrations compared to sites without scums... the likelihood of moderate to very high risk MC [microcystin cyanotoxin] concentrations was found to be greater at sites with a distinct surface scum. These results are consistent with observations by Graham et al. (2004)…that MC in [nearshore] scums may be much greater than at pelagic [open-water] locations…." (Lindon and Heiskary 2008, p.5).

The proposed protocols are also troubling in their lack of clear steps that should be taken to protect public health from exposure to cyanotoxins in the water. Nuisance algal blooms are defined as having more than 20 µg chl*a*/L, described by WDNR as based on user perception surveys from Minnesota. The survey participants, who were not scientists, would not have known that chl*a* concentrations above 30 µg chl*a*/L are not only aesthetically undesirable, but also are associated with increasing risk of cyanotoxin exposure (explained above). No "ceiling" or maximum chl*a* level is mentioned by WDNR as a threshold indicating the need for additional management actions to protect public health. Instead, only this is stated:

> If minimum data requirements cannot be met (e.g. shallow stations available but not deep station)], the professional judgment of the Regional Biologist should be used (p.42)….Biologists should use best professional judgment in

Guidelines for safe practice in managing bathing waters which may produce or contain cyanobacterial cells and/or toxins

Guidance level or situation	How guidance level derived	Health risks	Recommended action
Cyanobacterial scum formation in bathing areas	Inference from oral animal lethal poisonings Actual human illness case histories	Potential for acute poisoning Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g. skin irritations, gastrointestinal illness	Immediate action to prevent contact with scums; possible prohibition of swimming and other water-contact activities Public health follow-up investigation Inform relevant authorities
100,000 cells cyanobacteria per ml *or* 50 µg chlorophyll *a* per litre with dominance of cyanobacteria	From provisional drinking water guideline for microcystin-LR, and data concerning other cyanotoxins	Potential for long-term illness with some cyanobacterial species Short-term adverse health outcomes, e.g. skin irritations, gastrointestinal illness	Watch for scums Restrict bathing and further investigate hazard Post on-site risk advisory signs Inform relevant health authorities
20,000 cells cyanobacteria per ml *or* 10 µg chlorophyll *a* per litre with dominance of cyanobacteria	From human bathing epidemiological study	Short-term adverse health outcomes, e.g. skin irritations, gastrointestinal illness, probably at low frequency	Post on-site risk advisory signs Inform relevant authorities

determining whether High Risk thresholds in Table 7 are exceeded on a regular basis. When a waterbody is proposed to be included on the Impaired Waters List due to frequent and elevated blue-green alga[l] counts or toxins, and data are available suggesting high TP concentrations, the Impairment should be identified as "Public Health-Harmful Algal Blooms" (p.45).

The above protocol for biologists to use their best professional judgment to "determine" whether high risk thresholds are exceeded is especially noteworthy considering that WDNR protocols require no documentation or even qualitative assessment of the cyanobacterial scums that cause such "high risk" (see WDNR's abbreviated table on p.11 of these comments, and the full table from the original reference on this page). The above wording about a Wisconsin lake being in such poor condition that it is sustaining "frequent and elevated" cyanobacteria cell numbers **or toxins** (emphasis added) is also very troubling. It shows that, *as proposed by WDNR, such lakes must become a direct, serious threat to human health before they are assessed as impaired*.

Such protocols do a major disservice to the people and visitors of Wisconsin by allowing them to be exposed to this serious health threat as an "acceptable" situation, for 30% of the entire summer growing season in shallow lakes over at least two summers, before the need for improved protection of water quality is acknowledged by WDNR. Contrast such protocols with those of other states such as Minnesota (above) or Maine:

> …. conditions vary greatly, even within the same lake and from day to day. High concentrations of toxins are probably confined to lakes with intense algae blooms, but are probably detectable at low levels in many lakes that grow noticeable algae in the summer. **Whenever surface accumulations of algae and scums occur, suspect a problem** (emphasis added)" (see http://www.maine.gov/dep/water/lakes/cynobacteria.htm).

Beyond the *potential* risk of serious health impacts from cyanotoxin exposure, *such impacts are a reality that is increasingly documented in the state of Wisconsin*. People who live along the shores of affected lakes and reservoirs, and who attempt to recreate in them, are getting sick from toxic cyanobacteria blooms as a past, present, and ongoing serious problem. For example, Novak (2011) stated that 22 illnesses related to algae [cyanobacteria blooms] were reported during 2009-2010 in Dunn County. Residents near Tainter Lake have likened it to "a toxic waste dump," and have expressed serious concern for their health, and for the health of their children: "The stench is unbearable, and if you have health problems, it can be very dangerous….We don't want our children getting sick just by being near a lake" (Gaumnitz 2010). They describe being unable to be outside during four months of the year (June - Sept.), and economic impacts such as being unable to sell their homes so that they can leave. Lakefront property is considered "a curse" (Rathbun 2009). In recent years, the Wisconsin Department of Health Services is reported to have received "an upswing in reports that the lakes' algae blooms are causing health problems among those living nearby…." (Rathbun 2011).

Thus, these WDNR protocols pose a direct, serious threat to human health. A much more protective approach is needed than waiting until a water body sustains toxic algal blooms for at least 30% of the entire summer growing season, for at least two summers, before impairment is acknowledged and management actions are taken to attempt to restore the designated uses of these systems for REC.

The required main sampling location biases against finding excessive algal biomass -

As another serious problem with WDNR's protocols for sampling to assess lake impairment from P pollution, the agency would continue to require most lakes to have only a single, "deepest spot" site that was sampled, despite the fact that the "deepest spot" typically coincides with open waters where phytoplankton blooms are small in comparison to nearshore phytoplankton biomass. Thus, the approach minimizes finding biological impairment indicated by high chl*a*. Analogously, rivers and streams must be sampled mid-channel, where mixing and dilution are highest and algal growth is discouraged relative to growth in quieter, nearshore waters (Whitton 1975).

The dissolved oxygen protocols described in the draft document will not protect the designated uses of Wisconsin surface waters for FAL -

WDNR's protocols (Section 5.3) allow low DO can be considered as an impairment indicator, consistent with what is known about the science of eutrophication (Wetzel 2001, Burkholder and Glibert 2013, and references therein). The draft writing explains that the intent of the Wisconsin DO standards (at least 5 mg/L in surface waters, and at least 6 mg/L in the hypolimnion of lakes containing coldwater species) is to prevent an activity that causes a change in DO above and

beyond natural variability (undefined) or some uncontrollable factor such as a drought. However, the minimum data requirement is at least 10 discrete values taken in the surface waters or, in stratified lakes, in both the epilimnion and hypolimnion (bottom water layer, stratified by temperature) on separate calendar days over 5 years in the ice-free period (which, for many Wisconsin lakes and reservoirs, occurs from April through October).

There are serious problems with the minimum data requirement from a scientific perspective. Fish and other beneficial aquatic life do not have trouble with low DO in surface waters unless a water body is seriously degraded by nutrient pollution, with major cyanobacteria blooms that remove all of the oxygen even from surface waters when the algae have to breathe during the night (Wetzel 2001, Mallin et al. 2006). Ten discrete values over five years, any time during the ice-free period, is illogical considering that DO solubility is much higher at cold temperatures (Wetzel 2001), and that a five-year span with only 10 sample points would (extremely) easily miss low DO stress in a given water body (e.g. see Heiskary and Markus 2003, Morgan et al. 2006, Heatherly et al. 2007). The lack of focus by WDNR on the critical warmest-temperatures season allows inclusion of cool months such as April and October in the dataset to assess impairment. Such an approach likely will yield no evidence of DO stress, even in highly impacted systems, because the noxious bloom-forming species generally do not grow well during those months. Other serious problems with WDNR's protocols for using low DO to indicate impairment from nutrient pollution are that there is no mention of the importance of sampling pre-dawn to capture oxygen sags, when aquatic organisms are most vulnerable to stress and death from low DO (Hynes 1980, Morgan et al. 2006, Miltner 2010).

The draft protocols state that individual stations in the same lake should be assessed separately for DO concentration. *However, the protocols then abandon consideration of lakes by separate stations or areas*: A given lake can only be evaluated as impaired if 10% or more of all DO values, from all assessment sites considered collectively, and cumulatively over the most recent five-year period, are below the Wisconsin standard values. This requirement will effectively obscure or minimize severe conditions of hypoxia and/or anoxia that may be occurring in a major portion of the lake. The requirement is reactive because it downplays lakes that have low DO stress as a chronic summer condition in part, but not all, of the water body. WDNR requires the entire system to be averaged together over both space and time, including samples taken in cool seasons when low DO stress typically does not occur.

Recommendations

The following corrective actions should be taken by WDNR to develop science-based protocols to assess impairment of Wisconsin surface waters by nutrient pollution:

- Impairment threshold concentrations for TP and chl*a* should be consistent with Wisconsin's TP standards and targeted chl*a* levels for lakes, reservoirs, impoundments, and rivers, and with the derivation of these values as true means over the same growing season. Impairment should be assessed as exceedance of the Wisconsin State TP standards or the chl*a* levels targeted by those standards.
- These means should be based on data collected at least monthly during the same growing season ($n \geq 3$ per year), each year for 3 years. Citizens' monitoring data and observations

(e.g. photographic documentation) should be acceptable data for inclusion. Data older than three years should not be used.

- "Overwhelming exceedences," that is, extremely high TP and chl*a* concentrations, should *not* be required, and 90% CIs as well as guesstimates of the percentage of days when nuisance algal blooms occur in a given water body, should *not* be used to assess impairment of Wisconsin surface waters.
- Exceedance of the Wisconsin State TP standards *or* exceedance of the chl*a* levels targeted by those standards should be sufficient to assess a given water body as impaired.
- Sampling locations should include emphasis on nearshore stations to more accurately assess the status of a given water body with respect to nutrient pollution.
- DO data collection should be restricted to the warmest months when low DO stress generally occurs.
- DO protocols should pre-dawn DO sags during the warmest season.

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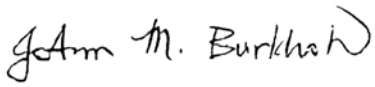

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Curriculum Vitae

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Education

Undergraduate:	Iowa State University	Zoology	B.S., 1975
Graduate:	University of Rhode Island	Aquatic Botany	M.S., 1981
	Michigan State University	Botanical Limnology	Ph.D., 1986

Research Interests

Algal nutritional physiology and algal culturing, spanning the salinity gradient from freshwater to marine species; and chronic effects of eutrophication (nutrient over-enrichment and associated pollutants) on aquatic ecosystems, especially impacts and mitigation of harmful algal blooms (eukaryotes, cyanobacteria)

Professional Experience

1999 - present	Director, CAAE, Department of Plant Biology (formerly Botany), NCSU, Raleigh, NC
1998 - present	Professor, Department of Plant Biology, NCSU
1993 - 1997	Associate Professor, Department of Botany, NCSU
1993 - present	Adjunct Professor, Department of Marine, Earth and Atmospheric Sciences (MEAS), NCSU
1986 - 1992	Assistant Professor, Department of Botany, NCSU
1982 - 1986	Graduate Research Assistant, Michigan State University (W.K. Kellogg Biological Station), Hickory Corners, MI
1981 (fall)	Instructor, *Introductory Chemistry* (for science majors), Quinebaug Valley Community College, Danielson, CT
1979 - 1980	Instructor of *Marine Botany,* summers, St. Georges College Prep. School, Newport, RI
1978 - 1981	Graduate Research Assistant and Graduate Teaching Assistant, Department of Botany, University of Rhode Island, Kingston, RI
1976 - 1977	Environmental Scientist, EcolSciences, Inc., Rockaway, NJ
1974 - 1975	Undergraduate Research Assistant, Limnology Laboratory, Department of Zoology, Iowa State University, Ames, IA

Awards and Distinctions

2009	Borlaug Joint Award for Service to the Environment and Society, College of Agriculture and Life Sciences/ College of Natural Resources, NCSU
2008	William Neal Reynolds Distinguished Professor, College of Agriculture and Life Sciences, NCSU, for excellence in research
2008	J. Compton River Achievement Award, River Network, lifetime achievement for leadership in research to advance water quality protection

2007	Darbaker Prize, Botanical Society of America, for excellence in research
2004	Fellow, American Association for the Advancement of Science (AAAS)
2003	Honorary Doctorate, Knox College, Galesburg, IL
2003	Provasoli Award, best paper of 2002, *Journal of Phycology*
2001	Honorary Doctorate, Southampton College - Long Island University
2000	Fellow, Aldo Leopold Leadership Program, Ecological Society of America
1999	Hutner Award, Society of Protozoologists, for excellence in microalgal research
1998	Scientific Freedom and Responsibility Award, AAAS
1998	Distinguished Service in Environmental Education Award, Environmental Educators of North Carolina
1998	Distinguished Scholarly Achievement Award, NCSU Honors Convocation
1998	Conservationist of the Year Award, National Wildlife Federation
1998	Conservationist of the Year Award, Governor of North Carolina and the North Carolina Wildlife Federation
1998	Jack Bayless Award – outstanding presentation of the year, South Carolina Fishery Workers Association, and the North and South Carolina chapters of the American Fisheries Society
1997	Admiral of the Chesapeake Award, Federal and State Leadership Summit, Washington, DC
1997	Outstanding Achievement Award, Society of Business and Professional Women of North Carolina
1997-2000	Pew Fellow in Marine Conservation, the Pew Foundation
1994	Outstanding Research Award, NCSU Alumni Association

Other Honors

2013	Invited presentation, Capital Hill Briefing, representing the Coastal and Estuarine Research Federation
2007	Theodore L. Jahn and Eugene C. Bovee Award, International Society of Protozoologists, for best graduate student research paper, to doctoral candidate Hayley Skelton (coauthors of the paper, Burkholder and Parrow)
2001	Elected member, Alumni Hall of Fame, Rock Valley College, Rockford, Illinois
2001	Convocation speaker, Appalachian State University
2001	Convocation speaker, Southampton College - Long Island University
1998	Special recognition for excellence in research, Phi Kappa Phi
1998	Invited testimony, Congressional Hearing on the Value of Estuaries, US Senate, Senate Environment and Public Works Committee
1998	Invited testimony, Congressional Hearing on Harmful Algal Blooms, US Senate, Committee on Commerce, Science and Transportation
1997	Invited testimony, Congressional Hearing on Fisheries Conservation, Wildlife and Oceans, US House of Representatives – Committee on Resources
1997	Invited testimony, Congressional Hearing on Harmful Algae and Human Health, US House of Representatives – Committee on Government Reform and Oversight
1997-1999	Science Advisor, Governor's Commission on *Pfiesteria*, Maryland
1993-1994	Member, North Carolina Coastal Futures Committee (governor-appointed)
1993-1995	Member, Board of Directors, Partnership for the Sounds (directive, environmental education for eastern North Carolina)
1992-1997	Member-at-large, North Carolina Marine Fisheries Commission (governor-appointed)
1985	Elected member, Phi Kappa Phi, Michigan State University
1984-1986	Graduate fellow, Department of Botany and Plant Pathology, Michigan State University

Selected Research Accomplishments

(with thanks to my graduate students, postdoctoral research associates and other research associates, and collaborators)

Freshwater Ecosystems

- First to maintain automated platform stations with depth profiling capability for advanced research and monitoring of North Carolina reservoirs; the real-time data from these stations is also helping to safeguard drinking water supplies depended upon by more than half a million people
- Documented adverse effects from confined swine feed operations on surface waters in the Southeast
- Experimentally quantified interactions between nutrient and sediment loadings in controlling noxious algal blooms in turbid reservoirs
- First to document widespread occurrence, at low levels, of cyanotoxins in major potable water supplies in North Carolina
- Documented novel nutritional and physical adaptations of a cryptic group of dinoflagellates in reservoirs affected by episodic suspended sediment loading

Estuarine and Marine Ecosystems

- Discovered that water-column nitrate enrichment from sewage and other sources inhibits *Zostera marina*, the dominant seagrass of north temperate U.S. waters, as a direct physiological effect
- Co-discovered the toxic dinoflagellates, *Pfiesteria piscicida* and *P. shumwayae*, as causative agents of major estuarine fish kills; this research also led to colleagues' discovery of a group of *Pfiesteria* toxins, new to science, that may be helpful in understanding human memory disorders
- First to design and maintain a series of automated platform stations for advanced research and monitoring of a North Carolina estuary; coauthor of a patent for an automated depth profiler
- Discovered a striking increase in ammonium concentrations in the Neuse and Cape Fear estuaries over the past decade, linked to increased nonpoint source pollution from confined swine feed operations and other sources, and related the ammonium increase to stimulation of harmful algae
- Helped to develop a model for water mass transport to the Neuse Estuary; used the model and a detailed dataset for improved quantification of nutrient loads, including decadal trend analysis
- First to show that shallow lagoonal estuarine ecosystems are resilient to the adverse effects of hurricanes, recovering within 4-5 years

Publications (Peer-reviewed, in scientific journals, books and symposia volumes)

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134) Touchette BW, Burkholder JM, Allen EH, Alexander JL, Kinder CA, James J, Britton CH (2007) Eutrophication and cyanobacteria blooms in run-of-river impoundments in North Carolina, U.S.A. *Lake and Reservoir Management* 23: 179-192.

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136) Burkholder JM, Glibert PM, Skelton HM (2008) Mixotrophy, a major mode of nutrition for harmful algal species in eutrophic waters. *Harmful Algae* 8: 77-93.

137) Glibert P, Azanza R, Burford M, Furuya K, Abal E, Al-Azri A, Al-Yamani F, Andersen P, Anderson DM, Beardall J, Berg GM, Brand L, Bronk D, Brookes J, Burkholder JM, Cembella A, Cochlan WP, Collier J, Collos Y, Diaz R, Doblin M, Drennen T, Dyhrman S, Fukuyo Y, Furnas M, Galloway J, Granéli E, Ha DV, Hallegraeff G, Harrison J, Harrison PJ, Heil CA, Heimann K, Howarth R, Jauzein C, Kana AA, Kana TM, Kim H, Kudela R, Legrand C, Mallin M, Mulholland M, Murray S, O'Neill J, Pitcher G, Qi Y, Rabalais N, Raine R, Seitzinger S, Salomon P, Solomon C, Stoecker DK, Usup G, Wilson J, Yin K, Zhou M, Zhu M (2008) Ocean urea fertilization for carbon credits poses high ecological risks. *Marine Pollution Bulletin* 56: 1049-1056.

138) Hégaret H, Shumway SE, Wikfors GH, Pate S, Burkholder JM (2008) Potential transport of harmful algae via relocation of bivalve molluscs. *Marine Ecology Progress Series* 361: 169-179.

139) Heisler J, Glibert P, Burkholder J, Anderson D, Cochlan W, Dennison W, Gobler C, Dortch Q, Heil C, Humphries E, Lewitus A, Magnien R, Marshall H, Stockwell D, Suddleson M. (2008) Eutrophication and harmful algal blooms: A scientific consensus. *Harmful Algae* 8: 3-13.

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141) Skelton HM, Burkholder JM, Parrow MW (2008) Axenic cultivation of the heterotrophic dinoflagellate *Pfiesteria shumwayae* and observations of feeding behavior. *Journal of Phycology* 44: 1614-1624.

142) Reed RE, Dickey DA, Burkholder JM, Kinder CA, Brownie C (2008) Water level variations in the Neuse and Pamlico Estuaries, North Carolina, due to local and non-local forcing. *Estuarine, Coastal and Shelf Science* 76: 431-446.

143) Burkholder JM (2009) Harmful algal blooms, pp. 264-285. In: *Encyclopedia of Inland Waters*, *Volume 1*, by Likens GE (ed.) Elsevier, Oxford, UK.

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145) Skelton HM, Burkholder JM, Parrow MW (2009) Axenic cultivation of the heterotrophic dinoflagellate *Pfiesteria shumwayae* in a semi-defined medium. *Journal of Eukaryotic Microbiology* 56: 73-82.

146) Rothenberger M, Burkholder JM, Wentworth T (2009) Multivariate analysis of phytoplankton and environmental factors in a eutrophic estuary. *Limnology and Oceanography* 54: 2107-2127.

147) Rothenberger M, Burkholder JM, Brownie C (2009) Long-term effects of changing land use practices on surface water quality in a coastal river and lagoonal estuary. *Environmental Management* 44: 505-523.

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149) Burkholder JM, Frazier W, Rothenberger MB (2010) Source water assessment and treatment strategies for harmful and noxious algae, pp. 299-328. In: *Algae Manual*, AWWA Manual 57, by the American Water Works Association, Denver, CO.

150) Reed RE, Burkholder JM, Allen EH (2010) Current online monitoring technology for surveillance of algal blooms, potential toxicity, and physical/chemical structure in rivers, reservoirs, and lakes, pp. 3-24. In: *Algae Manual*, AWWA Manual 57, by the American Water Works Association, Denver, CO.

151) Burkholder JM, Shumway SE (2011) Bivalve shellfish aquaculture and eutrophication, pp. 155-215. In: *Shellfish and the Environment*, by Shumway SE (ed.). Wiley, New York.

152) Glibert PM, Burkholder JM (2011) Harmful algal blooms and eutrophication: Strategies for nutrient uptake and growth outside the Redfield comfort zone. *Chinese Journal of Oceanography* 29: 724-738.

153) Glibert PM, Fullerton D, Burkholder JM, Cornwell JC, Kana TM (2011) Ecological stoichiometry, biogeochemical cycling, invasive species and aquatic food webs: San Francisco Estuary and comparative systems. *Reviews in Fisheries Science* 19: 358-417.

154) Null KA, Corbett DR, DeMaster DJ, Burkholder JM, Thomas CJ, Reed RE (2011) ^{222}Rn-based advection of ammonium into the Neuse River Estuary, North Carolina, USA. *Estuarine, Coastal and Shelf Science* 95: 314-325.

155) Burkholder JM, Marshall HG (2012) Toxigenic *Pfiesteria* species - updates on biology, ecology,

toxins, and impacts. *Harmful Algae* 14: 196-230.

156) Flynn, KJ, Mitra A, Stoecker DK, Raven JA, Granéli E, Glibert PM, Hansen PJ, Burkholder JM G. (2012) An ocean of mixotrophs – a new paradigm for marine ecology. *Journal of Plankton Research* 35: 3-11.

157) Glibert PM, Burkholder JM, Kana TM (2012) Recent insights about relationships between nutrient availability, forms, and stoichiometry, and the distribution, ecophysiology, and food web effects of pelagic and benthic *Prorocentrum* species. *Harmful Algae* 14: 231-259.

158) Hathaway JM, Moore TLC, Burkholder JM, Hunt WF (2012)Temporal analysis of stormwater SCM effluent based on harmful algal bloom (HAB) sensitivity in surface waters: Are annual nutrient EMCs appropriate during HAB-sensitive seasons? *Ecological Engineering* 49: 41-47.

159) Burkholder JM, Glibert PM (2013) Eutrophication and oligotrophication. In: *Encyclopedia of Biodiversity*, 2nd edition, Volume 3, by Levin S (ed.). Academic Press, Waltham, MA.

Technical Reports (peer-reviewed)

United States Department of Environmental Protection (U.S. EPA) (2011) *Efficacy of Ballast Water Treatment Systems: A Report by the EPA Science Advisory Board (SAB)*. U.S. EPA SAB Ecological Processes and Effects Committee Augmented for the Ballast Water Advisory. Report #EPA-SAB-11-009. U.S. EPA, Washington, DC, ~150 pp. Burkholder was an Augmented Panel Member and a coauthor of this report.

Burkholder JM, Allen EH, Kinder CA, Morris E (2010) *Assessment of Water Resources and Watershed Conditions in the Chattahoochee River National Recreation Area, Georgia*. Draft Report to the Southeast Coast Inventory and Monitoring Network of the National Park Service, Southeast Regional Office, Atlanta, GA, 202 pp.

Burkholder JM, Rothenberger MB (2010) *Assessment of Water Resources and Watershed Conditions in Horseshoe Bend National Military Park, Alabama.* Draft Report to the Southeast Coast Inventory and Monitoring Network of the National Park Service, Southeast Regional Office, Atlanta, GA, 51 pp.

Burkholder JM (2010) *Assessment of Water Resources and Watershed Conditions in the Kennesaw Mountain National Battlefield Park, Georgia.* Draft Report to the Southeast Coast Inventory and Monitoring Network of the National Park Service, Southeast Regional Office, Atlanta, GA, 71 pp.

Burkholder JM, Allen EH, Kinder CA (2010) *Assessment of Water Resources and Watershed Conditions in the Ocmulgee National Monument, Georgia.* Draft Report to the Southeast Coast Inventory and Monitoring Network of the National Park Service, Southeast Regional Office, Atlanta, GA, 81 pp.

Burkholder J, Glasgow H, Deamer N, Melia G, Litzenberger T (2003) *Response of* Pfiesteria piscicida, *Microbial Predators and Prey, and Fish to Common Dithiocarbamate Fungicides and Heavy Metals*. Final Report to the U.S. EPA, Research Triangle Park, NC, 26 pp. + appendix.

Burkholder JM, Glasgow HB, Rublee PA, Shumway SE (2001) *The Toxic Dinoflagellate,* Pfiesteria, *as a Potential Biosensor of Estuarine Stress.* Final Report to the U.S. EPA, Washington, DC, 108 pp.

van der Schalie WH, Shedd T, Widder M, Kane AS, Reimschussel R, Sarabun J, Burkholder J, Glasgow H (2001) *Real-Time Monitoring for Toxicity Caused by Harmful Algal Blooms and Other Water Quality Perturbations*. Report EPA/600/R-01/103, U.S. EPA, Washington, DC.

Touchette BW, Burkholder JM, Glasgow HB (2001) *Distribution of American Water Willow (*Justicia americana *L.) in the Narrows Reservoir.* Final Report to Alcoa Power Generating Inc., Badin, NC, 51 pp.

Burkholder JM, Glasgow HB (1999) *Neuse Estuary Biomonitoring Study, with Additional Information on Overall Nutrient Loading to the Mesohaline Estuary.* Final Report to the U.S. Marine Air Station – Cherry Point. Department of Botany, NCSU, Raleigh, 134 pp.

Burkholder JM (1999) *The Role of Toxic* Dinoflagellates *in Fish Lesions.* Issue paper prepared for the U.S. Army. Office, Assistant Secretary of the Army - Installations, Logistics and Environment. Pentagon, Washington, DC.

Burkholder JM (1998) *The Toxic* Pfiesteria *Complex: A Scientific Discussion of its History, Ethology, and Impacts on Human Health.* Office, Assistant Secretary of the Army - Installations, Logistics and Environment. Pentagon, Washington, DC.

Burkholder JM, Glasgow HB, Deamer-Melia N (1998) *Neuse Estuary Biomonitoring Study – Physical, Chemical, and Biological Characteristics of Water Samples Collected from the Neuse Estuary in the Vicinity of Cherry Point, North Carolina, May 1993 - April 1998.* Final Report of a five-year study, to the U.S. Marine Air Station, Cherry Point, NC. Aquatic Botany Laboratory, NCSU, Raleigh, 110 pp.

Burkholder JM, Glasgow HB, Fensin E (1996) *Neuse Estuary Biomonitoring Study – May 1993 – December 1995.* Report of the first three years of a five-year study, to the U.S. Marine Air Station – Cherry Point, Cherry Point, NC. Aquatic Botany Laboratory, NCSU, Raleigh, 86 pp.

Burkholder JM, Parsons JE (1993) *Sediment and Phosphorus Loading: Predicting Water Quality in Urban Piedmont Reservoirs.* Report No. 274. UNC Water Resources Research Institute, Raleigh, NC, 194 pp.

Non-Referred and Popular Press Articles

Burkholder JM (2006) A major potable water supply reservoir poised for increased cyanobacteria blooms. *LakeLine* (summer), pp. 49-51.

Burkholder JM (2003) Science and the press. On-line modules (editor, N. Kriesberg), NCSU, Raleigh.

Schmechel DE, Burkholder JM, Attix DK, Glasgow HB (2002) Toxic *Pfiesteria*. Microbiology No. MB 02-5 (MB-036). *Check Sample, American Society for Clinical Pathology* 45:65-88.

Burkholder JM (2000) Brushstrokes from Floyd, pp. 72-79. In: *Eye of the Storm – Essays in the Aftermath*, by E.W. Rickert (ed.). Coastal Carolina Press, Wilmington.

President's Committee of Advisors on Science and Technology (PCAST) (1998) *Teaming with Life: Investing in Science to Understand and Use America's Living Capital.* Section I: Make Use of Current Knowledge in Managing Biodiversity and Ecosystems of the U.S., p.27. PCAST Panel on Biodiversity and Ecosystems, Washington, DC.

Burkholder JM (1997) *Pfiesteria* and Nutrient Pollution. Requested by Maryland's Governor Glendening for a summit meeting of five governors of states in the Chesapeake Bay watershed, Annapolis, pp. 1-5.

Burkholder JM (1995) Fish kills' message: Get serious about reducing nutrient over-enrichment to our estuaries, pp.1-3. In: *WaterWise*, by Doll B (Ed.). Vol. 1, 2nd Quarter. NC Sea Grant News Letter, Raleigh.

Coastal Futures Committee (1994) *Charting a Course for our Coast - A Report to the Governor of North Carolina.* L.R. Preyer, Chair. NC Department of Environment, Health and Natural Resources, Raleigh, 106 pp. [As the only scientist on the 15-member committee, I contributed substantially to all sections related to water quality, habitat, and fisheries in the document, and to the executive summary of prioritized recommendations.]

Burkholder JM (1993) Vital grasses need clean water to grow. In: *Currents*, News Letter of the Pamlico-Tar River Foundation, Vol. 13, Fall, p.7, Washington (NC).

Burkholder JM (1993) A newly discovered toxic alga and its relationship to fish kills, pp.48-58. In: *Proceedings from the Second North Carolina Marine Recreational Fishing Forum.* NC Sea Grant Report UNC-SG-93-06. UNC Sea Grant, NCSU, Raleigh, 61 pp.

Burkholder JM (1993) Golf course runoff: View from below the water surface, pp. 18-23. In: *Is Golfing Green? The Impact of Golf Courses on the Coastal Environment*. Symposium Proceedings (sponsored by the NC Coastal Federation and the NCSU Cooperative Extension Service through the NC Sea Grant College Program), Wilmington.

Patent

U.S. Patent #7,040,157. "Variable depth automated dynamic water profiler", Reed, Glasgow, Burkholder, Toms, May 2006 (NCSU; patent sold to YSI, Inc.).

Professional Activities

Editorial

Guest Co-Editor, special issue, *Harmful Algae* (Intraspecific Variation, 2009)
Guest Co-Editor, special issue, *Harmful Algae* (Harmful Algae and Eutrophication), 2007
Guest Co-Editor, special issue, *Harmful Algae* (Ecology of *Pfiesteria*), 2006
Editorial Board, *Journal of Experimental Marine Biology and Ecology*, 2005 - present
Editorial Board, *Harmful Algae*, 2002 - present
Editorial Board, *Journal of Eukaryotic Microbiology*, 1996-1999
Editorial Board, *Journal of Phycology*, 1995-1997

Other Society Service

Member, Organizing Committee, International Symposium on Harmful Algae, 2009-2010
Member, Organizing Committee, National Symposium on Harmful Algae, 2000, 2002, 2003
Member, Ethics Committee, American Society of Limnology and Oceanography, 1996-1997
Member, Harmful Algae Technical Advisory Committee, Maryland Department of Natural Resources, 1998-2001
Session Chair, Ecology of Aquatic Protozoa session, XIth Meeting of the International Congress of Protozoology, 2001
Session Chair, New Harmful Algae, 10th International Conference on Harmful Algal Blooms, 2000
Session Chair, *Pfiesteria* in the Southeast, 1st National Symposium on Harmful Algae, 2000
Session Chair, Harmful Algae, 15th Biennial International Conference of the Estuarine Research Federation, 1999
Session Co-Chair, Harmful Algal Blooms, Annual Summer Meeting of the American Society of Limnology and Oceanography, 1998
Session Co-Chair, Harmful Algal Blooms, Joint Meeting of the American Society of Limnology and Oceanography and the American Geophysical Union, 1997
Chair, Hutchinson Award Committee, American Society of Limnology and Oceanography, 1996
Board of Directors, American Society of Limnology and Oceanography, 1994-1997
Session Chair, Ecology of Freshwater Algae, Joint Meeting of the International Phycological Congress and the Phycological Society of America, 1991
Session Chair, Phytoplankton, Annual Meeting of the American Society of Limnology and Oceanography, 1988

External Panels and Reviews

Member, panel review of the South Florida Environmental Report for the South Florida Water Management District, 2006, 2007, 2008, 2009, 2010, 2011

Examiner ("Opponent") of doctoral candidate Johannes Hagström, Kalmar University, 2006

Member, review team for the Department of Botany, Miami University of Ohio, 2005

Member, review team for the Marine Sciences Programs, Institut für Meereskunde, Salzau, Germany, 1998

National Science Foundation, Biological Oceanography Panel, 1995

UNC Water Resources Research Institute Panel, 1991-1993

Member, review team, Lake Okeechobee Ecosystem Project, South Florida Water Management District, 1991

Workshops (Invited Participant)

The Importance of Algal Mixotrophy in Trophic Models of the Oceans – participant and invited speaker of an international workshop sponsored by the Leverhume Foundation, University of Maryland - Horn Point, Cambridge, MD, 2013

Taxonomy and Ecology of Algae in the Southeast – co-organizer of a workshop for members of the North Carolina Lake Management Society (NALMS – Southeast Chapter), sponsored by NALMS, 2009, 2010, 2011, 2012

Falls Lake Symposium: Christian Creation Stewardship – keynote speaker of a workshop attended by scientists and theologians, to encourage church memberships to become involved in environmental stewardship of the Falls Lake potable water supply, sponsored by the concerned citizens group, Wake Up Wake County, and organized by Drs. Bob George (editor, Theoecology Journal online) and Bruce Little (Center for Faith and Culture, Southeastern Theological Seminary), 2012

Algae Affecting Potable Water Supplies – AWWA, Savannah, GA, 2010

Identifying Harmful Cyanobacteria in North Carolina Potable Water Supplies – Organizer; two workshops for potable water treatment plant operators, sponsored by the NC Department of Health and Human Services, 2006

Occurrence of Toxigenic Cyanobacteria in the USA, International Symposium on Harmful Cyanobacterial Blooms, US Environmental Protection Agency (EPA), 2005

National Plan for Harmful Algal Research, Ecological Society of America and the National Oceanic and Atmospheric Administration (NOAA), 2004

Social and Environmental Impacts of Concentrated Animal Feed Operations, The University of Iowa and the National Institute of Environmental Health Sciences (NIEHS), 2004

Conflicted Science / Integrity in Science Conference and Workshop, Center for Science in the Public Interest, Washington, DC, 2003

Estuarine Fish Disease, Delaware Department of Natural Resources & Environmental Control, 2000

Harmful Algae Technical Advisory Committee Workshop, Maryland Department of Natural Resources (MD DNR) and Maryland Department of Environment (MD DE), 2000, 2001, 2002

Re-evaluation of Microbial Water Quality: Powerful New Tools for Detection and Risk Assessment, American Academy of Microbiology, 2000

Conservation Medicine Workshop, Center for Conservation Medicine of Tufts University, 1999

Harmful Algal Blooms: Research and Monitoring Programs, US EPA - Region IV, 1998

Pfiesteria Workshops - Sampling and Identification (organizer), NCSU, 1998

Pfiesteria Sampling and Identification Protocols, Centers for Disease Control & Prevention, 1998

European Harmful Algal Blooms (EUROHAB) Science Initiative, Marine Science and Technology Programme of the European Commission, 1998

Pfiesteria and Water Quality Monitoring Standards Workshop, NOAA, 1998

Pfiesteria and Human Health Workshop, Maryland Department of Health and Mental Hygiene and the Maryland Medical Team, University of Maryland and Johns Hopkins, 1998

State/Federal *Pfiesteria* Working Group - Monitoring Protocols, U.S EPA and NOAA, 1998
Maryland Technical Advisory Committee Workshop on *Pfiesteria*, Fish Kills and Water Quality Monitoring, MD DNR, Baltimore, MD, 1998
Pfiesteria Workshop, 14th Biennial International Conference of the Estuarine Research Federation, Providence, RI, 1997
The Cambridge *Pfiesteria*/Nutrients Workshop, convened by Governor Glendening of Maryland, 1997. The final report, *The Cambridge Consensus,* was used by the governor and the Maryland legislature to change policy about non-point water pollution control in tributaries to Chesapeake Bay and led to passage of the Maryland Water Quality Act of 1998.
Impacts of Toxic *Pfiesteria*/*Pfiesteria*-like Dinoflagellates on Fisheries and Human Health, US EPA (Philadelphia, PA; Washington, DC; Pensacola, FL), 1997; Delaware Department of Environment and Water Resources, 1997
Harmful Algal Blooms and Human Health, NIEHS, 1997
Pocomoke River Fish Disease, MD DNR, 1997
Climate Variability and Human Health, American Society of Microbiology, 1997
Developing an Environmental Education Video on Water Resource Issues in North Carolina, Z. Smith Reynolds Foundation, 1997
Control of Blue-Green Algae in Rainbow Springs, Florida, Department of Fisheries and Aquaculture, University of Florida, 1996
Sustainable Marine Fisheries, National Academy of Sciences Ocean Studies Board, 1996
Disease Events and Meteorology along the US Atlantic Coast, Harvard Medical School, 1995
National Nutrient Assessment Workshop – Estuaries, US EPA, Washington, DC, 1995
Harmful Algal Blooms - Research Initiative Development, NSF / NOAA, 1994
Seagrasses and Eutrophication Impacts, US EPA / Sarasota Bay National Estuary Program, 1993
Techniques in Sampling and Identification of *Pfiesteria* – NOAA, 1992; Florida Department of Environmental Protection - Florida Marine Research Institute, 1992; MD DNR, 1993; MD DE, 1993; Delaware Division of Water Quality, 1993
Target Issues: Development of RFP guidelines for a New NOAA Coastal Ocean Program Initiative on Harmful Algal Blooms, NOAA, 1992
Phytoplankton of the Southeastern United States, North Carolina Department of Environment, Health and Natural Resources (NC DEHNR) and Duke Power Company, 1992
Target Issues for Funding Support of Research on Toxic Phytoplankton, NOAA, 1992
Improved Data Base and Optimal Approaches for Modeling Water Quality in the Albemarle-Pamlico Estuarine System, US EPA and NC DEHNR, 1992
Water Quality Regulations for Protection of Seagrass Habitat on the Gulf Coast, US EPA, 1992
Improved Standards for Protecting Water Quality in the Albemarle-Pamlico Estuarine System, US EPA, 1991
Teaching Aquatic Botany to High School Students (organizer), NCSU, 1987, 1988
Light Microscope-Autoradiography of Microalgae (organizer), Bowling Green State University, Bowling Green, OH, 1987

Grants and Contracts

Support for research and education outreach in aquatic sciences has been obtained from the National Science Foundation, the National Park Service, the U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the U.S. Department of Defense, the Park Foundation, the Z. Smith Reynolds Foundation, the Centers for Disease Control and Prevention via the North Carolina Department of Health and Human Services, the North Carolina General Assembly, the UNC General Administration, the UNC Water Resources Research Institute, the North Carolina Clean Water Management Trust Fund, the Cities of Raleigh and High Point, GlaxoSmith Kline, and private donors.

Professional Consulting

1989	Phytoplankton Analyst - Duke Power and Light Company, Charlotte, NC (samples from local reservoirs: species identifications, quantification of cell numbers and biovolumes)
1990-1992	Phytoplankton Analyst - consulting firm of Dr. J. Beaver (samples from central Florida lakes with major cyanobacteria blooms: species identifications, quantification of cell numbers and biovolumes)
2004	Expert Witness - requested by several concerned citizens groups to review impacts of Georgia Pacific, Inc. on marine coastal ecosystems on the west Florida shelf
2005	External Reviewer (1 of 2) – contracted by the higher administration at Miami University of Ohio to review the academic and research programs of the Department of Botany. Our review resulted in new positions, a strengthened Bioinformatics Facility, and other significant support for the department.
2005	External Reviewer – contracted by the Harris Chain of Lakes Restoration Council in Florida to review the sampling protocols and two annual environmental reports from a commercial laboratory/consulting firm on water quality and cyanobacteria blooms in the Harris Lake Chain. Included a presentation at a public Council meeting.
2006 -2011	Panelist on a review team of the *South Florida Environmental Report* (*SFER*) for the South Florida Water Management District. Formally critique the annual draft report (selected chapters, ~1,200 pages), emphasizing water quality sampling/ compliance and water quality programs/ restoration in the Kissimmee River basin, Lake Okeechobee, the Everglades, estuarine ecosystems; and environmental education outreach programs
2006	Coauthor of the report, *Indicators for Restoration*, for the South Florida Ecosystem Restoration Task Force
2009	Panel Representative who presented key findings of review of the draft 2010 *SFER* to the the Board of Governors of the South Florida Water Management District, Key Largo, FL
2009 - present	Consultant on eutrophication issues in lakes and streams for PEER (Public Employees for Environmental Responsibility - Mississippi River Collaborative) and the Minnesota Center for Environmental Advocacy
2010 - 2011	Consultant on the U.S. Environmental Protection Agency's Science Advisory Board - Ecological Process and Effects Committee Augmented for the Ballast Water Advisory
2011 - present	Expert Witness - as requested by Earthjustice, Tallahassee, FL regarding draft nutrient criteria rules proposed by the Florida Department of Environmental Protection
2012	Reviewer for the U.S. Environmental Protection Agency - document about chlorophyll *a* and cyanotoxins
2012	Reviewer for the U.S. Environmental Protection Agency - Science to Achieve Results (STAR) Graduate Fellowship Program

Research Presentations

Water Quality (Eutrophication, Seagrasses, etc.)

2012

UNC Water Resources Research Institute, Raleigh, NC ("The NCSU Center for Applied Aquatic Ecology Falls Lake Monitoring and Research Program," by J. Burkholder, R. Reed, C. Kinder, E. Allen, J.

James, and L. Mackenzie – poster, with published abstract)

Falls Lake Creation Care Symposium, Wake Forest, NC ("Status of Water Quality in Falls Lake", by J. Burkholder). The goal of this national symposium was for scientists to inform theologians about citizens' potential roles, including church congregations, in assisting with natural resource stewardship issues (keynote presentation, with published abstract)

2011

UNC Water Resources Research Institute, Raleigh, NC (excessive ammonium concentrations throughout the Falls Lake water column, and implications for the Falls Lake Rules - with published abstract)

American Water Works Association National Webinar, online technology used to monitor algae and associated environmental conditions (invited, with published abstract)

LOICZ Open Science Conference 2011 – Coastal Systems, Global Change and Sustainability, Yantai, China (Shumway SE, Burkholder JM: mitigating coastal eutrophication – are filter-feeding shellfish the answer?) (plenary, with published abstract)

2010

UNC Water Resources Research Institute, Raleigh, NC (status of water quality in the most important potable water supply in North Carolina - with published abstract)

2009

National Shellfisheries Association, Savannah, GA (bivalve shellfish aquaculture and eutrophication)

North Carolina Academy of Science, Warren Wilson College, Swannanoa, NC (documenting microbial changes in reservoirs using metagenomics – coauthor)

Department of Civil and Environmental Engineering, Northwestern University, Chicago, IL (decadal analysis of land use, water quality, and phytoplankton assemblages in a coastal watershed)

20th Biennial Conference of the Coastal and Estuarine Research Federation (increasing ammonium in eutrophic estuaries, and its potential importance in governing phytoplankton assemblages)

2008

Department of Occupational and Environmental Health, U IA (water quality and algal blooms in watersheds influenced by industrialized agriculture)

NOAA National Symposium on Shellfish and the Environment, Warwick, RI (chronic effects of eutrophication on shellfish)

American Society of Limnology and Oceanography, St. Johns, Newfoundland, Canada (microdynamics of physical/chemical structure in a lagoonal estuary - lead, R. Reed; with published abstract)

North Carolina Water Quality Monitoring Forum, Charlotte (recent advances in technology for tracking algal blooms and related environmental conditions; with published abstract)

2007

Horn Point Environmental Laboratory, U MD (chronic eutrophication of the Neuse Estuary)

UNC Water Resources Research Institute, Raleigh (CAAE's Falls Lake Monitoring and Research Program; with published abstract)

UNC Water Resources Research Institute, Raleigh (groundwater and benthic nitrogen flux in the Neuse Estuary - lead, K. Null; poster with published abstract)

UNC Water Resources Research Institute, Raleigh (long-term impacts of changing land use practices on water quality and phytoplankton assemblages in the Neuse River ecosystem - lead, M. Rothenberger; poster with published abstract)

Annual Conference of the North Carolina Academy of Science, Greenville (inorganic nitrogen flux across the sediment-water interface in the Neuse Estuary - lead, K. Null; poster with published abstract).

Conference, Water Initiatives: What's on the Horizon for Lake Users and Managers, Greensboro.

19th Biennial Conference of the Estuarine Research Federation, Norfolk, VA (temporal and spatial

variability in high-resolution, cross-estuarine physical/chemical structure in the Neuse Estuary – lead, R. Reed; poster with published abstract).

19th Biennial Conference of the Estuarine Research Federation, Norfolk, VA (multivariate analysis of phytoplankton and environmental factors in a eutrophic estuary - lead, M. Rothenberger; poster with published abstract).

2006

Department of Biology, Cornell University (water quality trends in the Neuse Estuary)

Department of Marine Sciences, U CONN (water quality trends in the Neuse Estuary)

2005

Department of Biology, UNC Greensboro (water quality trends in the Neuse Estuary)

Wilkes Community College, Wilkesboro, NC (honors seminar series - water quality issues)

2003

Center for Science in the Public Interest: Conflicted Science Conference, Washington, DC (water quality and confined animal feed operations [CAFOs] - with published abstract)

Yale University - Conference, The Chicken (environmental impacts of CAFOs - with published abstract)

2002

Medical School, Harvard University (marine diseases, anthropogenic influences)

Wilkes Community College, Wilkesboro (honors seminar series - water quality issues)

2001

Washington College (Chesterton, MD; environmental impacts of CAFOs)

Veterinary, Wildlife and Ecological Toxicology Department, Veterinary Biosciences College of Veterinary Medicine, U IL (national water quality issues)

School of Design, NCSU (environmental effects of CAFOs)

Wilkes Community College (honors seminar series - water quality issues)

American Society of Agronomy and the Soil Science Society of America (Northeast Branch) – annual meeting, URI (environmental effects of CAFOs; with published abstract)

2000

American Fisheries Society - annual meeting, St. Louis, MO (environmental effects of CAFOs – with published abstract).

American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America - joint meeting, Minneapolis, MN (nutrient management on CAFOs, and effects on surface water resources - with published abstract)

Association of Southeastern Biologists, Chattanooga, TN: Plenary Speaker (national water quality issues - with published abstract)

Rock Valley College - Natural Resources and Community Action Series, Rockford, IL: Plenary Speaker (national water quality issues)

U MASS, Amherst - Environmental Policy Seminar Series (invited; national water quality issues)

Yale University, School of Forestry (national and state water quality issues)

Department of Zoology, U WA - Seattle (national water quality issues)

American Fisheries Society (NC chapter), New Hill, NC (impacts of Hurricane Floyd on water quality in the Neuse River and Estuary, and Pamlico Sound - with published abstract)

1999

US Department of Agriculture - National Resources Conservation Service, Washington, DC (state water quality issues)

Simon Fraser University - Oceans Limited Conference, Vancouver, British Columbia, Canada (chronic

effects of eutrophication - with published abstract)
Department of Biology, University of Louisville, Louisville, KY (chronic effects of eutrophication)

1998
Society of Environmental Toxicology and Chemistry - annual meeting, Charlotte, NC: Keynote Speaker (effects of chronic eutrophication - with published abstract)

1997
Conference, Nutrients in the Neuse River: Working Toward Solutions (sponsor, UNC Water Resources Research Institute [WRRI]), NCSU (effects of chronic eutrophication - with published abstract)

1996
National Association of Biology Teachers - annual meeting, Charlotte, NC (effects of chronic eutrophication - with published abstract)
Texas A&M University, Corpus Christi (effects of pulsed nutrient enrichment on seagrass physiology)
Department of Zoology, Oregon State University (OSU), Corvallis (seagrasses and eutrophication)

1995
Statewide Nutrient Summit (sponsors, NC Sea Grant, NC DEHNR), NCSU (effects of chronic eutrophication - with published abstract)
Water Quality Research and Extension Overview, College of Agriculture and Life Sciences (CALS), NCSU (surface water quality research in CALS - with published abstract)

1994
NC Academy of Sciences - annual meeting, Manteo - Keynote Speaker (state water quality issues - with published abstract)

1993
UNC WRRI Seminar Series, Keynote Accomplishments in Research on Water Resources in NC, Raleigh (seagrasses and water-column nitrate enrichment - with published abstract)
Horn Point Environmental Laboratory, U MD (seagrasses and water-column nitrate enrichment)

1992
UNC WRRI Seminar Series, Keynote Accomplishments in Research on Water Resources in NC (sediment and phosphorus loading: predicting reservoir water quality – with published abstract)
American Society of Limnology and Oceanography - annual meeting, Edmonton, Alberta, Canada (seagrasses and eutrophication - with published abstract)

1990
Department of Zoology, U WI - Madison (algal phototrophy *vs.* heterotrophy in turbid reservoirs)
1987
Department of Biology, Bowling Green State University, Bowling Green, OH (biological interactions that structure stream plant communities)

1986 (nutrient interactions - macrophytes, epiphytes)
Department of Botany, NCSU
Department of Biology, Fordham University, Bronx, NY
Savannah River Ecology Laboratory, Aiken, SC
University of Michigan Biological Station, University of Michigan, Pellston, MI

1985
Department of Biology, West Virginia University, Morgantown, WV - importance of benthic microalgae in stream ecosystems

Massachusetts Audubon Society, Lincoln, MA - effects of acid deposition on aquatic ecosystems

Harmful Algal Research

2013

Leverhume Foundation International Workshop, U MD - Horn Point, Cambridge, MD (algal mixotrophy and water-column nutrients)

2010

North American Lake Management Society (NALMS), Winston-Salem, NC (climate change and harmful algal blooms in the Southeast - with published abstract)

Webinar Lecture Series, Northwestern University, given at the University of British Columbia, Vancouver, BC, Canada (overview on harmful algae)

2008

Burdick Lecture, Department of Biology, Alfred University, Alfred, NY (*Pfiesteria*, other harmful dinoflagellates - toxicity, impacts)

Annual Toxicology and Risk Assessment Conference, Cincinnati, OH (the toxins of inland algae - with published abstract)

2007

Joint meeting of the Phycological Society of America and the International Society of Protozoologists (cyanobacteria in eutrophic turbid impoundments of the North Carolina Piedmont - lead, J. Burkholder; poster with published abstract)

Joint meeting of the Phycological Society of America and the International Society of Protozoologists (axenic cultivation of a heterotrophic dinoflagellate - lead, H. Skelton; with published abstract)

4th National Symposium on Harmful Algae, Woods Hole, MA (axenic cultivation of *Pfiesteria shumwayae* on a semi-defined medium; poster with published abstract)

2006

Kalmar University, Kalmar, Sweden (*Pfiesteria*, other harmful dinoflagellates - toxicity, impacts)

American Society of Limnology and Oceanography - annual summer meeting: Plenary Speaker, Victoria, British Columbia, Canada (stimulation of harmful algae by eutrophication – with published abstract)

2005

North American Lake Management Society (NALMS) - National Meeting, U WI - Madison – Keynote Speaker (cyanobacteria in potable water supplies - with published abstract)

GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms) Symposium, Nutritional Ecology of Harmful Algae, Baltimore, MD (importance of intraspecific variation – with published abstract)

Medical School, Harvard University (harmful algae and seafood safety)

NALMS Southeast Chapter Meeting, Asheville, NC (cyanobacteria in potable water supplies - with published abstract)

American Water Works Association - Source Water Protection Symposium, West Palm Beach, FL (cyanobacteria in potable water supplies - with published abstract)

2004

XIth International Conference on Harmful Algae, Cape Town, South Africa: Plenary Speaker (intraspecific variation in toxicity, behavior and nutrition - with published abstract)

St. Johns Water Management District, Orlando, FL (effects of harmful algae on fish and mammalian health)

International EnviroVet Program, Harbor Branch Oceanographic Institute, Fort Pierce, FL (marine diseases)

Department of Oceanography, U WA - Seattle (science, policy)

Shannon Point Marine Laboratory, Western Washington University (science, policy)
NSF Undergraduate Education Honors Program, NCSU (science, policy)

2003

Elon University - Voices of Discovery Seminar Series: Keynote Speaker (*Pfiesteria*)
International EnviroVet Program, Harbor Branch Oceanographic Institute (toxic dinoflagellates)
Florida Institute of Technology (toxic dinoflagellates)
Conference on Emerging Waterborne Pathogens, NC Department of Health and Human Services (DHHS), Wilmington, NC: Two presentations - toxic dinoflagellates; toxic cyanobacteria)

2002

Hopkins Marine Laboratory, Stanford University, Monterey, CA (*Pfiesteria*, other toxic dinoflagellates - science, policy, science ethics)
National Ocean Service, NOAA, Charleston, SC (progress in *Pfiesteria* research)
Symposium, Climate Change and Fisheries in the Gulf of Maine (sponsor, NOAA), College of the Atlantic, Bar Harbor, ME (harmful algae and climate change)
Department of Biology, UNH, Durham (toxic dinoflagellates).
Department of Biology, Williams College, Williamston, MA (toxic dinoflagellates)
Department of Biology, Miami University of Ohio, Athens (toxic dinoflagellates)

2001

XIth International Congress of Protozoology, Salzburg, Austria (dinoflagellates - complex life histories and feeding behaviors – with published abstract)
George Clark Lecture Series, Wetlands Institute, Cape May, NJ (*Pfiesteria*, other dinoflagellates)
Society for Risk Analysis, Research Triangle Park (biomarkers for species and toxins)
Environmental Lecture Series, Ashland University, Ashland, OH (harmful algae and eutrophication)
Marine Conservation Biology Series, Wheaton College, Springfield, MA (chronic effects of harmful algae on fish and mammalian health)

2000

IXth International Conference on Harmful Algal Blooms, Hobart, Tasmania, Australia: Plenary Speaker (toxic *Pfiesteria* - with published abstract)
Elliott-Nowell-White Symposium, Delta State University, Delta State, MS: Keynote Speaker (chronic and sublethal impacts of harmful algae on mammalian health)
Society of Toxicology of Canada - annual meeting, Montreal, Quebec, Canada (toxic dinoflagellates - with published abstract)
Department of Biology, State University of NY - Syracuse (toxic dinoflagellates)
Brookhaven National Laboratory, Brookhaven, NY (toxic dinoflagellates)
State University of New York - Stony Brook (toxic dinoflagellates)
XIIIth World Congress of the International Society of Toxinology, Paris, France (toxic *Pfiesteria*)
Centers for Disease Control & Prevention, Atlanta - conference, ***Pfiesteria*: From Biology to Public Health** (ecology and conservative analysis of role in fish kills - with published abstract)
National Association of Biology Teachers - Biotechnology Conference. VPI, Blacksburg (harmful algal research)
University of Mississippi, Oxford - Conference, Sustainability of Wetlands and Water Resources (toxic dinoflagellates)
Department of Biology, University of Memphis (toxic dinoflagellates)
Society of Microbiology - Northeast Chapter, Sturbridge, MA (toxic dinoflagellates)
Society of Toxicology - annual meeting (sponsor, US EPA), Philadelphia (toxic dinoflagellates - with published abstract)
Southeastern Estuarine Research Society - annual meeting in conjunction with the 29th Benthic Ecology Meeting and the annual meeting of the Atlantic Estuarine Research Society, Wilmington, NC (toxic

dinoflagellates - with published abstract)

1999

National Academy of Sciences - Workshop on Critical Research Needs, Washington, DC (research needs to advance understanding about harmful algae)
Lake Biwa Research Institute, Forum on Water Quality, Kyoto, Japan: Keynote Speaker (*Pfiesteria*, other toxic dinoflagellates)
Woods Hole Oceanographic Institute, Falmouth, MA (toxic dinoflagellates)
Veterinary School, Tufts University, Grifton, MA (toxic dinoflagellates)
Department of Biology, Yale University (improved mitigation of harmful algal blooms)
Georgetown Conference on Policy and *Pfiesteria*, Georgetown University, Washington, DC: Keynote Speaker (science, policy of *Pfiesteria* - with published abstract)
American Association for the Advancement of Science (AAAS) - annual meeting, Anaheim, CA, session, "Human Health Risks in the Ocean" (chronic and sublethal impacts - with published abstract)
AAAS - annual meeting, Anaheim, CA, session "Harmful Algal Blooms" (toxic *Pfiesteria* - with published abstract)
Department of Geology, University of Oslo (Oslo, Norway) (toxic *Pfiesteria*)
Society of Protozoologists - annual meeting, Raleigh: Keynote Speaker (toxic *Pfiesteria* - with published abstract)
Department of Ecology Evolution and Behavior, U MN - Minneapolis (toxic dinoflagellates - with published abstract)
Phi Beta Kappa Seminar Series, Elon University (toxic *Pfiesteria*)
Honors Seminar Series, Southampton College, Southampton, NY (toxic dinoflagellates)
Department of Biology, Barton College, Wilson (toxic dinoflagellates)
Department of Biology, Davidson College, Davidson (toxic dinoflagellates)
Wilkes Community College, Wilkesboro (toxic dinoflagellates)
Department of Biology, NC A&T University, Greensboro (toxic dinoflagellates)
Department of Pathology, UNC Chapel Hill (toxic dinoflagellates)
Department of Biology, UNC Greensboro (toxic dinoflagellates)
Department of Biology, University of Louisville (toxic dinoflagellates)
Sigma Xi - NC Chapter meeting, Appalachian State University, Boone, NC (toxic *Pfiesteria*)

1998

AAAS - annual meeting, Philadelphia, session, "Management of Harmful Marine Microbes: When Science and Politics Don't Mix" (harmful algae - with published abstract)
Medical School, Harvard University (harmful algae)
Shallow Water Conference (sponsor, US EPA), Atlantic City, NJ: Keynote Speaker (effects of toxic *Pfiesteria* on fish and mammals - with published abstract)
Gordon Conference - annual meeting, Ventura, CA (acute/chronic effects of toxic dinoflagellates - with published abstract)
Department of Biology, Rutgers University (chronic effects of toxic dinoflagellates)
Department of Biology, URI (toxic dinoflagellates)
Department of Pharmacology, U GA - Athens (toxic dinoflagellates)
American Biological Safety Association - 41st Annual Biological Safety Conference, Lake Buena Vista, FL: Eagleston Lecture (*Pfiesteria*, other toxic dinoflagellates - with published abstract)
Wildlife Disease Association - 47th Annual Conference, U WI - Madison (toxic *Pfiesteria* - with published abstract)
Department of Biology, Purdue University (toxic dinoflagellates)
American Institute of Biological Sciences - 49th annual meeting (toxic dinoflagellates - with published abstract)

Microbiology Society of NC - annual meeting, Research Triangle Park: Keynote Speaker (*Pfiesteria*, other toxic dinoflagellates)
NC Water Resources Association - Conference on Water Pollution Issues in NC, Asheville: Keynote Speaker (*Pfiesteria*, other toxic dinoflagellates - with published abstract)
Northeast Algal Symposium - annual meeting, Plymouth, MA – Keynote Speaker (toxic *Pfiesteria* - with published abstract)
American Society of Limnology and Oceanography - joint summer meeting with the Ecological Society of America, Symposium Session Honoring Minority Students: Keynote Speaker (*Pfiesteria*, other harmful algae – with published abstract)
Stanford University, Institute of Ecosystem Ecology (toxic *Pfiesteria*)
NASA, Goddard Space Center, Baltimore, MD (*Pfiesteria*, other toxic dinoflagellates)
Keynote Seminar Series in Marine Sciences, Wilmington, DE (sponsors, U DE, DE Sea Grant): Presentation (*Pfiesteria*)
Friends of the Library, NCSU (*Pfiesteria*, other toxic dinoflagellates)
Department of Biology, Auburn University (toxic dinoflagellates)
Department of Environmental Sciences, Drexel University, Philadelphia (toxic *Pfiesteria*)
Department of Biology, Hampden Sydney College, Hampden-Sydney, VA (toxic dinoflagellates)
Department of Biology, UNC Charlotte (*Pfiesteria*, other toxic dinoflagellates)
Headquarters, US EPA, Washington, DC (toxic *Pfiesteria*)
Distinguished Lecturer Series, Old Dominion University, Norfolk, VA (*Pfiesteria*)

1997

Society for Conservation Biology - annual meeting, Victoria, British Columbia, Canada (harmful algae and eutrophication - with published abstract)
Department of Biology, University at Buffalo, Buffalo, NY (*Pfiesteria*, other toxic dinoflagellates)
Departments of Zoology and Oceanography, OSU (toxic algae)
3rd Annual Conference on Population-Level Effects of Marine and Estuarine Contamination, Charleston, SC (science, policy - with published abstract)
Wagner College, Staten Island, NY (special college-wide seminar, toxic *Pfiesteria*)
Department of Biological Science, Florida State University, Tallahassee (toxic dinoflagellates)
Department of Botany, Duke University (*Pfiesteria*, other toxic dinoflagellates)
Conference on Fisheries, Habitat and Pollution (sponsors, SC Sea Grant, TerrAqua Environmental Science and Policy Institute), Charleston, SC (chronic and sublethal effects of harmful algae - with published abstract)
Institute of Ecosystem Studies, Millbrook, NY (chronic and sublethal effects)
American Fisheries Society, NC Chapter - annual meeting, Lake Wylie, SC (*Pfiesteria* - with published abstract)

1996

AAAS - annual meeting, session Global Change and Emerging Infectious Diseases (effects of harmful algae on fish and mammalian health - with published abstract)
NATO Workshop, Physiological Ecology of Harmful Marine Phytoplankton, Bermuda Biological Station for Research (raptorial dinoflagellates - with published abstract)
Sigma Xi - UNC Greensboro and NCCU Chapters: Keynote Speaker (toxic *Pfiesteria*)
Department of Biology, Southampton College, Long Island University, Southampton, NY (toxic dinoflagellates)
Department of Biology, University of Cincinnati, Cincinnati (toxic dinoflagellates)
NIEHS, Research Triangle Park (toxic *Pfiesteria*)
Whitney Laboratory, U FL - St. Augustine (toxic dinoflagellates)
Department of Biology, Wake Forest University, Winston-Salem (toxic dinoflagellates)
Association of Women in Science, UNC Chapel Hill (*Pfiesteria*, other toxic dinoflagellates)
Texas A & M University, Corpus Christi, TX (*Pfiesteria*, other toxic dinoflagellates)

1995

Society of Protozoologists - annual meeting, U AL, Tuscaloosa, AL: Keynote Speaker (toxic *Pfiesteria* and its microbial, macroinvertebrate and vertebrate prey - with published abstract)

5th Pan American Symposium on Animal, Plant and Microbial Toxins, Baltimore, MD (*Pfiesteria* - with published abstract)

Department of Toxicology, NCSU (toxic dinoflagellates)

Department of Biology, U MD, Baltimore, MD (toxic *Pfiesteria*)

1994

First International Conference on Ecosystem Health and Medicine, Ottawa, Ontario, Canada (effects on human health - with published abstract)

E-MAP Monitoring Program, US EPA, Research Triangle Park (emerging toxic algae - effects on fisheries and public health)

Department of Biology, University of Richmond (emerging toxic algae)

Department of Environmental Health, Boston University (toxic dinoflagellates)

Department of Biology, SUNY - Stony Brook (toxic dinoflagellates)

International Society for Evolutionary Protistology - Biennial Meeting, Halifax, Nova Scotia, Canada: Keynote Speaker (*Pfiesteria* and its prey - with published abstract)

Institute of Ecology, U GA - Athens (harmful heterotrophic dinoflagellates)

Department of Fisheries and Aquaculture, U FL - Gainesville (toxic dinoflagellates)

1993

Fifth International Conference on Modern and Fossil Dinoflagellates (Zeist, the Netherlands): Keynote Speaker (toxic *Pfiesteria* - with published abstract)

Beta Beta Beta Biological Honors Society, Elon University: Keynote Speaker (effects of toxic *Pfiesteria* on estuarine food webs)

Chesapeake Biological Laboratory, Solomons, MD (toxic dinoflagellates)

Southeastern Fisheries Society, Reidsville, NC (toxic dinoflagellates and fish health)

Dauphin Island Marine Laboratory, Dauphin Island, AL (toxic dinoflagellates)

Department of MEAS, NCSU (*Pfiesteria*)

1992

Vth International Symposium on Toxic Algae, Newport, RI (toxic *Pfiesteria* - with published abstract)

Southeast Regional Directors of the Sea Grant College Program - annual meeting: Keynote Speaker (*Pfiesteria*)

Department of Zoology, NCSU (toxic *Pfiesteria*)

US Geological Survey, Raleigh (toxic *Pfiesteria*)

NC Statewide Phytoplankton Meeting, Duke Power Company (Huntersville, NC: Keynote Speaker (harmful dinoflagellates)

Department of Biology, UNC Wilmington (*Pfiesteria*, other toxic dinoflagellates)

Department of Biology, Appalachian State University, Boone, NC (toxic dinoflagellates)

Department of Biology, UNC Greensboro (toxic dinoflagellates)

US EPA, Narragansett, RI (*Pfiesteria*, other toxic dinoflagellates)

Department of Biology - Marine Sciences Group, UNC Chapel Hill (toxic dinoflagellates)

Bodega Marine Laboratory, U CA - Davis, Bodega Bay (toxic dinoflagellates)

Other Algae

2012

Phycological Society of America, Charleston, SC (Mixson, S. and J. Burkholder - enhancing lipid production in the marine microalga *Dunaliella* through environmental stressors - with published abstract)

2010
Webinar, Northwestern University special summer course for graduate students, given at the University of British Columbia, Vancouver, BC (the ecology of periphyton)

2007
Society of International Limnologists (SIL) - 30th Congress of the International Association of Theoretical and Applied Limnology, Montreal, Quebec, Canada (importance of benthic microalgae across freshwater, estuarine and marine ecosystems - with published abstract)

1999
Society for General Microbiology - Symposium, Microbial Signaling and Communication, University of Edinburgh, Edinburgh, Scotland (signaling in dinoflagellates - with published abstract)

1991
Department of Biology, VPI, Blacksburg, VA (phytoplankton survival of pulsed suspended sediment loading)

1990
Center for Reservoir Research, Hancock Biological Station, Murray State University, Paducah, KY (phytoplankton and periphyton dynamics in turbid, eutrophic reservoirs)
Department of Zoology, NCSU - Aquatic Ecology Seminar Series (mutualistic symbioses involving algae)
Department of MEAS, NCSU (role of benthic microalgae in eutrophication of freshwater and coastal marine habitats)

1989
Experimental Lakes Area (ELA), University of Manitoba, Winnepeg, Manitoba, Canada (relative importance of the water column and macrophytes as nutrient sources for epiphytes)
Hampton University, Hampton, VA (biotechnology in aquatic ecology)
Department of Biology, University of Louisville, Louisville, KY (use of autoradiography to examine nutrient dynamics of microalgal biofilms)
Duke Marine Laboratory, Beaufort (nutrients and epiphytes – unifying trends in freshwater and marine ecosystems)

1988
Department of Biology, UNC Chapel Hill - Marine Macroalgae Seminar Series (epiphytes)
Department of Biology, East Carolina University (phosphorus sources for epiphytic microalgae)
Department of Botany, Duke University (nutrient sources for epiphytic microalgae)
Environmental Section, Carolina Power and Light Company, New Hill, NC (epiphytic microalgae - role in nutrient cycling of lakes)

Science Ethics and Environmental Issues

2006, 2007, 2008, 2009, 2010, 2011
Park Scholars Program, NCSU (role of science ethics in environmental issues)

2005
Department of Epidemiology, UNC Chapel Hill, Forum "Funding, Academic Freedom, and Public Responsibility" (industry and water quality)

2004
Department of Biology, Cornell University (toxic algae)
Department of Civil Engineering, NCSU (water quality)
Department of Biology, UNC Asheville (water quality)

2003

New York Metropolitan Association of College and University Biologists – 36th Annual Conference, Wagner College, Staten Island: Keynote address (role of science ethics in natural resource issues)

NSF Environmental Education Program, NCSU (toxic algae, water quality)

1999

Department of Geology, University of Oslo, Oslo, Norway (toxic algae, water quality)

Park Foundation Lecture Series, College of Journalism, UNC Chapel Hill (critical role of journalists in environmental science education and ethics)

1998

Metcalf Institute for Marine and Environmental Journalism - annual board meeting, URI: Keynote Speaker (how environmental journalists could help to strengthen science ethics)

Academic Contributions

Courses Taught

- PB 595A, *Aquatic Plant Ecology* (4 credits; 1987 - present, fall alternate years)
- PB 595W, *Environmental Issues in Aquatic Ecology* (3 credits, 1990 - present, usually fall alternate years) - special topics/current events graduate course
- PB/MB 774, *Phycology* (3 credits including laboratories; 1987 - present, spring alternate years)
- BO 595E, *Ecology, Evolution and Diversity* – (2003; course coordinator, Jon Stuckey); mini-course: designed and taught one of eight modules on aquatic vascular plants as bioinvaders
- PB 824C, *Plant Biology Colloquium* (1 credit) – co-taught with Nina Allen (spring 2002, 2004, 2006) or Bill Thompson (spring 2009, 2011, 2013); graduate students receive training to give presentations, write grant proposals, and critique grant proposals)
- HON 398, *Honors Seminar on Aquatic Ecology* (1 credit, spring 2008) – seminar/discussion course for undergraduate honors students on aquatic natural resource issues in North Carolina
- EMS 496/622/822 or TDE 490/610 – STEM Education Seminar Course, *Environmental Issues in Estuarine Ecology and Pedagogical Applications* (1 credit, spring 2010), co-taught with P. Simmons and A. Clark.

Guest Lectures (past five years)

- PB 101, *Introduction to Plant Biology*, Department of Plant Biology, NCSU (once per year, 2006-2011)
- PB 250, *Plant Biology*, Department of Plant Biology, NCSU (2010, 2011)
- PB 595E, *Plant Functional Ecology*, Department of Plant Biology, NCSU (spring 2007, 2008, 2009)
- ALS 103, *Introductory Topics in Agriculture and Life Sciences*, College of Agriculture and Life Sciences, NCSU (2004-2008)
- IDS 303, *Humans and the Environment*, Department of Plant Biology, NCSU (2006-2007)
- *Research Ethics Seminar Module*, Department of Crop Science, NCSU (2007)
- SSC/BAE 780, *Movement of Chemicals in Soils and Natural Waters*, Department of Crop Science, NCSU (2004, 2005)
- PP590A, *Agriculture, Ethics, and the Environment*, Department of Plant Pathology, NCSU (2006)
- ZO 512, *Symbiosis*, Department of Zoology, NCSU (2006-2009)
- *Park Scholars*, NCSU (once per year, 2006-2011)
- BIO 568, *River Ecology*, Department of Biology, University of North Carolina Wilmington (2006-2007)

- GEHP 152:121, *Global Environmental Health*, The University of Iowa (2006)
- BIOL 304, *Microbial Ecology*, Alfred University (Alfred, NY, 2008)
- BIOL 140 *Global Ecology*, Alfred University (Alfred, NY, 2008)
- Freshman Focus Program, "Science, Society, Uncertainty, and Conflicting Values" (Duke University, Durham, NC, 2010)

Major or Co-major Advisor of Graduate Students

Stephanie Mixson, Ph.D. (Plant and Microbial Biology - thesis defended 1 July 2013)
Thesis: *Dunaliella* spp. under environmental stress: Enhancing lipid production and optimizing harvest
Honors: Secured a grant to help support her dissertation research, from the Charles A. and Anne Morrow Lindbergh Foundation (2010)

Stacie Flood, Ph.D. (Plant and Microbial Biology [department name change]), in progress (expected, Dec. 2013)

Eva Ngulo, M.A. (Plant Biology, 2011)
Final paper: Influence of clay treatment on noxious planktonic cyanobacteria

Kimberly Null, Ph.D. (MEAS; co-advisor with Dr. Dave DeMaster), 2010
Thesis: Ammonium dynamics in a shallow lagoonal estuary
Honors: Secured two grants to help support her dissertation research, from the NC Academy of Science (2006) and the Geological Society of America (2006)
Post-Graduate Position: Post-Doctoral Research Associate, University of California - Santa Cruz

Hayley Skelton, Ph.D. (MEAS; co-advisor, Dr. Dan Kamykowski), 2008
Thesis: Nutritional features and feeding behavior of the heterotrophic dinoflagellate, *Pfiesteria shumwayae*
Honor: Won the Theodore L. Jahn and Eugene C. Bovee Award for best graduate student research paper, annual meeting of the International Society of Protozoologists, Providence, RI (2007)
Post-Graduate Position: Post-Doctoral Fellow, National Research Council, NOAA / University of Connecticut

Meghan Rothenberger, Ph.D. (Plant Biology), 2007
Thesis: Long-term impacts of changing land use practices on water quality and phytoplankton assemblages in the Neuse Estuary ecosystem, North Carolina
Honors: Won best graduate research presentation, Graduate Student Forum, Department of Plant Biology (2007)
Won best Ph.D. dissertation of the year (2007) at NCSU, from the NCSU Graduate School (2008)
Post-Graduate Positions: Post-Doctoral Associate, CAAE (Visiting Professor, UNC Greensboro; then assistant professor at Lafayette College, Easton, PA)

Susan Pate, M.S. (Botany), 2006
Thesis: Impacts of the toxic dinoflagellate *Alexandrium monilatum* on three ecologically important shellfish species
Post-Graduate Position: Laboratory Administrator (Biotechnology), Duke University

Matthew Parrow, Ph.D. (Botany), 2003
Thesis: Feeding, reproduction, and sexuality in *Pfiesteria* spp. and cryptoperidiniopsoid estuarine heterotrophic dinoflagellates
Honor: Won the Kellar Award for outstanding dissertation research (NCSU), 2004
Post-Graduate Positions: Post-Doctoral Associate, CAAE (now Assistant Professor, UNC Charlotte)

Paul Cancellieri, M.S. (Botany), 2001
Thesis: Chemosensory attraction of *Pfiesteria* spp. to fish secreta

Post-Graduate Position: Teacher, Durant Middle School, Raleigh

Howard Glasgow, Ph.D. (MEAS; co-advisor with Dr. Dan Kamykowski), 2000
Thesis: Biology and impacts of toxic *Pfiesteria* complex species
Post-Graduate Position: Researcher, CAAE (permanently disabled by a neurological illness)

Jeffrey Springer, M.S. (MEAS; co-advisor, Dr. Dave Eggleston), 2000
Thesis: Interactions between two commercially important species of bivalve molluscs and the toxic estuarine dinoflagellate, *Pfiesteria piscicida*
Honor: Won the Best Student Presentation Award at the Annual Meeting of the National Shellfish Association, Seattle, WA, 2002
Post-Graduate Position: Research Associate, CAAE

Naomi Tsurumi, M.A. (Botany), 2000
Thesis: Influence of Industrialized Swine Agriculture on Air Quality
Post-Graduate Position: Environmental Policy M.A. program, Duke University

Brant Touchette, Ph.D. (Botany), 1999
Thesis: Physiological and developmental responses of eelgrass (*Zostera marina* L.) to increases in water-column nitrate and temperature
Post-Graduate Position: Assistant Professor, Elon University (now associate professor)

Elizabeth Fensin, M.S. (Botany), 1997
Thesis: Population dynamics of *Pfiesteria*-like dinoflagellates, and environmental controls in the mesohaline Neuse Estuary, North Carolina, USA
Post-Graduate Position: Research Assistant, North Carolina Department of Environment and Natural Resources (then called the North Carolina Department of Environment, Health, and Natural Resources)

L. Michael Larsen, Ph.D. (Zoology; co-advisor with Dr. Sam Mosley), 1995
Thesis: Responses of *Diaphanosoma brachyurum* (Cladocera: Suicide) and other zooplankton to clay loading and algal food quality in a turbid southeastern reservoir.
Post-Graduate Position: Assistant Professor, Campbell University, Fayetteville, NC (now Professor and Department Chair, Biology)

Leslie (Taylor) Taggett, M.S. (Botany), 1995
Thesis: Nitrate reductase activity of two intertidal macroalgae across gradients of temperature, salinity and desiccation
Post-Graduate Position: Research Assistant – Analytical Chemistry Laboratory, NC DEHNR

Virginia Coleman, M.S. (Botany), 1993
Thesis: Community structure and productivity of epiphytic microalgae on eelgrass (*Zostera marina* L.) under water-column nitrate enrichment
Post-Graduate Position: Research Associate – Algal Laboratory, NC DEHNR

Phumelele Gama, M.S. (Botany), 1992
Thesis: Phytoplankton response to a sediment loading gradient in a mesotrophic reservoir
Post-Graduate Position: Lecturer of Botany, University of Zululand, South Africa

Deborah Everitt (Tan), M.S. (Botany), 1992
Thesis: Seasonal dynamics of macrophyte communities from a stream flowing over granite flatrock in North Carolina, USA
Post-Graduate Position: Stream Scientist, MD DNR

Other Graduate Student Committee Memberships

Ph.D.
Brett Hartis, Fisheries, Wildlife and Conservation Biology
Geoff Sinclair, MEAS
Diane Whitaker, Science Education
Katherine Galucci, Science Education
Daniel Dickerson, Science Education
Nancy White, Forestry
Louis Elsing, Forestry
Dennis Hazel, Forestry
Gary Kirkpatrick, Zoology
Francois Bergand, Biological and Agricultural Engineering
Leslie Dorworth, MEAS
Thomas Shahady, Zoology
Randall Jackson, Zoology
Elise Irwin, Zoology
Kimberly Jones, Chemistry (UNC Wilmington)
George Hess, Biomathematics
Ann Darrien, Zoology
Elizabeth Marschall, Zoology

M.S.
Susan Randolph, Science Education
John Grady, Plant Biology
Carolyn Foley, Botany
Chad Coley, Soil Science
Angela Poovey, Crop and Soil Science
Scott Thomas, Biological and Agricultural Engineering
Kristin Toffer, Biology, UNC Greensboro
Beth Buffington, Crop and Soil Science
Edward Walycz, MEAS
Lisa Hartley, Botany
Robert Clark, Zoology
Beth Walker, Zoology
Rose Ragnacci, MEAS
Karen Kracko, Zoology

Postdoctoral Associate Advisor

Meghan Rothenberger, 2007: Present position, Assistant Professor, Lafayette College
Matthew Parrow, 2004-2006: Present position, Assistant Professor, UNC Charlotte
Brant Touchette, 2000-2002: Present position, Associate Professor, Elon University
Cheng Zhang, 1999-2003: Present position, Research Scientist, North Carolina Department of Environment and Natural Resources

Visiting Fulbright Scholar

Allasanne Ouattara, Ivory Coast, 2008-2009: Professor from the University of Abobo-Adjamé

Activities in Other Academic Programs (past five years)

Kenan Fellows Program (for gifted K-12 teachers)

Mentor to Amanda Warren, 2008-2009
Mentor to Susan Randolph, 2008-2009

Mentor to Diane Whittaker, 2006-2007
Secondary mentor to Gayle Powell, 2005-2006
Panelist on selection committee for Kenan Fellows, 2004

Other NC State Service

Member, Radiation Safety Committee (university)
Member, College of Agriculture and Life Sciences Research Committee (college)
Member, Advisory Committee, Plant Biology (departmental)
Member, Green Committee, Plant Biology (departmental)
Chair, Plant Biology Post-Tenure Evaluation Committee (departmental)
Member, Selection Committee for Evolutionary Ecologist Position (departmental)
Member, Larry A. Whitford Botany Scholarship/Fellowship Award Committee (departmental)
Member, Plant Biology Mentoring Committee for Alexander Krings (departmental)
Member, Plant Biology Mentoring Committee for Bill Hoffmann (departmental)
Member, Plant Biology Undergraduate Curriculum Committee (departmental)
Member, Search Committee, Plant Biology - Evolutionary Ecologist (departmental)
Member, Water Quality Committee (university)
Member, Water Resources Curriculum Committee (university)
Member, Ad Hoc Committee on Marine Science (university)
Member, Advisory Committee for the NCSU publication, *Results: Research and Innovation at North Carolina State University* (university, 2011-)

Education Outreach (examples, past five years)

K-12 Students and Teachers

The CAAE's *Floating Classroom Program* aboard our research/education ship, *RV Humphries*: Provided hands-on education in aquatic science (1/2-day cruise on the Neuse Estuary for 345 9th graders and their teachers (2013), 360 9th graders and their teachers (2012), and 480 9th graders and their teachers (2011) from Wayne County schools in economically depressed areas; for 636 8th graders and their teachers from Craven County schools, 2009
Guilford County high school teachers' training – presentation to ~30 teachers on designing experiments, 2011
Cardinal Gibbons High School, Cary, NC – presentation to ~80 students on water quality issues nationally and in our State (senior-level courses, *Ecology* and *Environmental Issue*s), 2010
Randleman High School, Randleman, NC – presentation to ~70 students on water quality issues, 2010
Kenan Fellows Program: *Teaching Students to Think Outside the Book* - the CAAE's Floating Classroom Program was prominently featured in this video for helping to make the Kenan Fellows Program a major success, 2009
Water Quality Institute: Presentation to 35 high school teachers – state water quality issues (sponsored by the Office of Environmental Education, NC DENR), 2008, 2009
Wayne Early-/Middle College High School, Goldsboro, NC, 2008 – two presentations to ~60 students on water quality issues
NC Student Academy of Sciences - Student Statewide Research Competition, NC School of Science and Mathematics, Durham: Keynote address to ~600 6th to 12th grade students, parents and teachers - careers in aquatic ecology, 2007
Ethics and Leadership Conference, NC School of Science and Mathematics, Durham: Keynote address to ~450 high school students, teachers - importance of ethics in science leadership, 2007
NC School of Science and Mathematics; also teleconferenced to Brunswick Community College:

Presentation to senior biology and environmental sciences classes - influence of scientists' conduct on progress in natural resource issues, 2006

Fuquay-Varina High School, Fuquay-Varina: Presentation to the senior biology class - state water quality issues, 2007

Garner High School, Garner: Presentation to the senior biology class - water quality issues, 2007

Southwest Guilford High School, Greensboro, NC: Presentation to the honors science class - algae in NC streams), 2007; presentations to the honors science class - how to design a scientifically sound experiment, and to the junior and senior biology and chemistry classes - state water quality issues, 2006

Southwest Guilford High School: Guided a senior science project, together with chemistry teacher Ms. Diane Whittaker (student was 1 of 5 selected to present his/her science project in an international science forum in China for gifted young scientists), 2007

Kenan Fellows Program for High School Teachers, NCSU: Two presentations - algae for high school students; and approaches in teaching how to design scientifically sound experiments, 2006

Daniels Middle School, Raleigh: Two presentations to 7th grade and 8th grade science classes - state water quality issues, 2006

General Citizenry (invited presentations, other activities)

Status of Water Quality in Falls Lake (presentation to the concerned citizens group, Wake Up Wake County), 2010

Status of Water Quality in High Rock Lake (presentation to the Yadkin Riverkeeper Foundation), 2009

Forum on Falls Lake Water Quality: Science and Policy (1 of 3 panelists - sponsored by the Neuse Riverkeepers Foundation), 2009

North Carolina Water Works Association, Raleigh (Lab Tech Day) - advanced technology for monitoring environmental conditions in near-real time, 2008

FL Department of Environmental Protection (Secretary of the Environment, staff, and agency personnel), Tallahassee: Influence of fertilizer nutrients on the Florida red tide, 2006

Public seminar series (sponsor, TREE Foundation), Sarasota, FL: Emerging linkages between harmful algae and nutrient pollution, 2006

Other Service

Member, City of Raleigh Stormwater Commission, 2010-present

Society Memberships

American Association for the Advancement of Science, American Society of Limnology and Oceanography, Estuarine Research Federation, Society of International Limnologists, North American Lake Management Society, Phi Kappa Phi, Phycological Society of America, Sigma Xi

DeWitt
Ross & Stevens s.c. Law Firm

Please respond to: Capitol Square Office
Direct line: 608-252-9319
Email: tps@dewittross.com

June 28, 2013

VIA EMAIL (DNRImpairedwaters@wisconsin.gov; aaronlarson@wisconsin.gov)
AND FIRST CLASS MAIL
Mr. Aaron Larson
Wisconsin Dept. of Natural Resources
Water Evaluation Section (WT/3)
P.O. Box 7921
Madison, WI 53707-7921

RE: Comments on Third Reopened 2012 303(d) List of Impaired Waters

Dear Mr. Larson:

I am providing the following written comments on the third reopened 2012 303(d) list of impaired waters on behalf of the Wisconsin State Cranberry Growers Association ("WSCGA"). As a preliminary matter, WSCGA restates and incorporates herein its previous comments provided on May 18, 2012.

A. The 2012 List Should Not Be Based Upon An Evolving And Moving Methodology.

As noted in the public notice, this is the third reopened public comment period for the 2012 303(d) list. The first public comment period was opened December 20, 2011 and extended until February 20, 2012. WSCGA did not comment on the initial list because WDNR had appropriately applied existing law and guidance which resulted in no additions for phosphorus. The second reopened public comment began on April 17, 2012 and ran through May 18, 2012. WSCGA provided extensive comments on WDNR's 180° turn regarding the application of the phosphorus standard to the 2012 list. Now, over one year later, DNR has reopened for the third time its 2012 list, which again "changed the rules of the game" and utilized a methodology based upon a guidance document which is still draft and available for public comment. (*See* Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM) for Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting, May 2013, EGAD#3200-2013-01). While this guidance may be appropriate for WDNR's 2014 list, it should not be used for the 2012 list.

This is not how lists should be created; especially lists which are required to be updated every two years. There is no need for DNR to repeatedly move the goalposts during a listing period. DNR should simply return to its initial list which was based upon well-reasoned and established guidance.

B. Musky Bay, Sissabagama Lake and The Yellow River Should Not Be Switched From Category 5P to Category 5A.

As noted above, none of these water bodies appeared on WDNR's initial 303(d) list. Then they appeared as 5P waters. Now they are 5A waters. No data has changed – only WDNR's "view" of the data. Even using the 2014 guidance, WDNR's view should not have caused a switch from 5P to 5A. (See for example the attached memorandum regarding Sissabagama Lake.)

Very truly yours,

DeWitt Ross & Stevens s.c.

Timm P. Speerschneider

TPS:bmf

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July 1, 2013

Mr. Aaron Larson
Wisconsin Department of Natural Resources
101 South Webster Street – WT/3
P.O. Box 7921
Madison WI 53707-7921

Re: Comments on 2014 Consolidated Assessment and Listing Methodology and Updates to 2012 303(d) Impaired Waters List

Dear Mr. Larson:

I am writing on behalf of the Municipal Environmental Group Wastewater Division (MEG) which is an association of over 100 municipalities throughout the state of Wisconsin. Our members range in size from some of the smallest communities to cities the size of Green Bay. For almost 25 years, MEG has been an advocate for municipalities in regulatory matters and has been actively involved in the development of the recent phosphorus water quality standards. We submit these comments regarding the revisions to 2014 Wisconsin Consolidated Assessment and Listing Methodology (WisCALM), especially with respect to the determination of whether a waterbody is impaired for phosphorus.

Specifically, the Department had previously recognized the importance of assessing biological indicators in addition to in-stream numeric water quality data. We believe that this a reasonable approach to determine whether to list a waterbody as impaired. As you

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know, there are a number of regulatory burdens that are associated with a waterbody being listed as impaired especially for new or increased discharges, so it is important that the listing decision be supported by various types of information.

In further support of using biological data, the United States Geological Survey (USGS) Professional Papers 1722 and 1754 indicated relatively poor correlations between phosphorus concentrations and biological impairments on wadeable streams and large rivers in Wisconsin. This indicates the importance of using site-specific biological data and other information in addition to the instream phosphorus concentrations when assessing individual rivers and streams for phosphorus impairments.

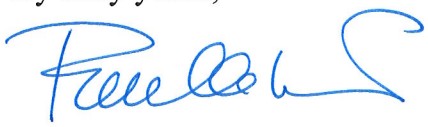
The Department has revised WisCALM to provide that if a waterbody is exceeding the numeric water quality standard, it will be listed as impaired regardless of whether the biological indicators show an impairment. We encourage the Department to retain the current guidance that provides where natural background levels may be higher than impairment thresholds or uncontrollable factors may cause an exceedance of water quality standard, the Department will determine whether the criteria exceedance is reasonably expected to be due to natural or uncontrollable factors. The Department states that for water bodies that exceed the numeric water quality standard they will list the water body in Category 5P but that these waters will have a low priority for the development of a TMDL. This will cause significant problems for those communities that discharge to Category 5P waters – they will be discharging to an impaired water and subject to the regulatory burdens associated with discharges to impaired waters, with no timeline for an individual assessment of the waterbody or plan to get the water into attainment. We respectfully request that the Department use the 5P Category in very limited situations.

As an alternative, the Department should adopt a broader approach determines all the evidence of impairment in the water body and apportions the proper weight to that evidence provides for a proper review of a complex system to determine whether the water body's function is truly impaired. For instance, Ohio EPA has proposed a process that integrates the stressor variables (nitrogen and phosphorus concentrations) that potentially cause stream degradation with "response" data collected through measurements of biologically important stream attributes when determining whether a water body should be listed as impaired. This approach acknowledges that water bodies are complex and the health of that water body is not determined by a sole factor. This approach is also consistent with the current approach Wisconsin has adopted. We recommend that Wisconsin adopt an approach similar to that of Ohio.

We are also writing to recommend that the Department create a process that provides for recognition of waterbodies that may exceed the numeric water quality criterion but that are a part of a larger watershed initiative such as an adaptive management project or are effluent dominated water bodies. For instance, the updated 303(d) impaired waters list includes Badfish Creek which is the point of discharge for the Madison Metropolitan Sewerage District (MMSD). MMSD has taken the lead in developing an adaptive management plan for the Yahara Watershed. The listing of Badfish Creek will at a minimum reduce the effectiveness of the adaptive management plan and at most will force MMSD to abandon the adaptive management plan altogether to focus on the discharge at Badfish Creek.

Thank you for the opportunity to provide our comments and please call at your convenience if you would like to discuss this letter.

Very truly yours,



Marney I. Hoefer
Paul G. Kent

PGK:mai
cc: Steering Committee

29 June, 2013

Fisheries Bio-Technology Prescriptions (FBP)

10783 Minnie Avenue

Hayward, Wisconsin 54843June 28, 2013

Aaron Larson

Wisconsin Department of Natural Resources (WDNR)

Water Evaluation Section (WY/3)

P.O. Box 7921

Madison WI, 53707-7921

RE: FBP Comments on Biological Impairment Listing and WisCALM, 2014

Dear Mr. Larson:

I thank you and WDNR staff for the opportunity to help improve the proposed draft of Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM, 2014), as well as the current Impaired Lakes listing. I congratulate the Department staff for a job well done: As a 38 year veteran of the WDNR Fisheries program, I share first- hand knowledge of how daunting the task of environmental protection really is. I know the political and administrative restraints which can conspire to frustrate the resource protection mission. So, I see a tremendous amount of hard work and dedication manifested in what you have accomplished, so far. Thank you- I am proud of you.

I contributed to, and totally concur with, comments forwarded to you separately by COLA. On WisCALM, 2014 I totally agree with COLA on the value of professional judgment via local teams, the inadequacy of the "reference lake" protocol for special waters, the need to acknowledge and address AIS and Climate Change , and misaligned onus of proof. I also concur completely on COLA's impairment concerns in Musky Bay- excessive organic production leading to winterkill, loss of muskellunge spawning habitat, and recreation, recognition of CLP as an impairment, and inappropriate application of the reference lake protocol. If WisCALM, 2014 and the 2014 Impairment List had been in place in 2006 , and in practice with the additional principles advanced by COLA, seven years of intense effort and a half million dollars of expense probably could have been avoided. I am also offering additional input to you on- 1. Professional judgment and the value of local teams; 2. Two-Story fisheries; 3. Onus of proof; and "Other" (unacknowledged gorillas).

1. Professional judgment and the value of local teams. I know first- hand that you have gigantic internal obstacles due to top-down central control. The cabinet form of government does not work in the favor of the resource. So, many of the critical resource issues become insular and fear-based. The "bubble-up", local level, collaborative team model which COLA is proposing for WisCALM 2014 will work. In fact it has already been field-truthed by COLA in their Musky Bay proceedings. WDNR has multi-program expertise and information available which it could be using to improve water quality management. I invite you to start reaching out to put that cross-program expertise to good use. I know for a fact that this has yet to be done. Water Quality has been attempting to go it alone- with disastrous results. Involve local Fisheries, Water Management, Wildlife, and other local functions in the decision making process, and you will, finally, put real "watershed" management in play. COLA's idea of a Watershed Quality Team is a radical and revolutionary idea for reinventing government at the local level. One whose time is come in is in perfect concert with other, like-minded, Department initiatives. Please use WisCALM, 2014 to make it happen. (To get the collaborative team concept up and running, the Department also needs to get back in the corner of the resource and its primary users.)

2. Two-Story Lakes: WisCALM, 2014 provides no protection for special category lakes like ORW and Two-Story. LCO is both. The reference lake protocol is especially weak in these instances. These type lakes are especially, and increasingly, subject to the synergistic effects of Climate change and AIS. The quoted TSI threshold of 48 and TP of 15 are both way too high. They should be 43 and 10-12, respectively, and those standards should be applied to all parts, and tributaries of the lake. Even now, LCO is down to less than 1% by volume lake whitefish habitat during worst case summer conditions. As additional documentation I have attached my Power Point presentation on cold-water fishes in LCO and cite Fang et. al. (2012) and Sharma et. al. (2011), which model the effects of Climate Change on two-story fisheries in the upper Mid-West. To paraphrase all three: "Two-story fisheries are ultra-threatened/ ultra-sensitive/ and merit the highest degree of protection". Lake cold-water fish are especially sensitive index of limnological change. They are the only lake class for which I see any hope for devising a usable and meaningful, lake, fish IBI. The current WDNR research initiative on lake cold-water fishes should be channeled in that direction.

3. Onus of proof: Why is the onus on the resource? Political expediency. Yet, if WDNR is not going to advocate for the lake who will? The developers already have many other advocates. Why would they even need the DNR doing their "jobs creation" dance? (And, yes, fishing, hunting, trapping, and silent sports ARE big business, anyway.) In all my years in resource management and protection I NEVER operated under the premise that the resource had to prove itself, or that environmental protection had to be reactionary. Yet, WisCALM, 2014 gives the polluter a virtual license to pollute-up until the point where an "overwhelming" body of evidence proves harm. The action thresholds are all way too high for the stated lake classes, and the range of frequency analysis requires a near 24/7 frequency of exceedance to even trigger further scrutiny. On top of that, a chemical exceedance means nothing unless paired with at least one biological impairment! Is the Department so focused on dogs dying from toxic algae, that it is blind to subtle tipping points, on lakes worthy of saving? Crazy. Crazy-Bad. For help in returning to the spirit of the WDNR mission, and for consistency with other WDNR functions, I recommend that Water Quality consult with the Bureau of Fisheries Management. Template how Safe

Harvest in the Treaty Fishery is regulated: conservative, risk-adverse, errs on the side of protecting the resource, court-mandated and -approved, too. Even Safe Harvest, subjects the fishery to some level of debatable risk. But the WisCALM, 2014 system subjects our lakes to a degree of risk which is unfounded and irresponsible. Every resource professional should read Silver's (2012). After reading it, I am very disturbed by the way WisCALM, 2014 seems to eerily parallel the world-wide, banking system collapse of 2009. Stick to the proof rules set forth in WisCALM, 2014- and our lakes are going to collapse, too.

The free ride for the polluter may be politically expedient but it is totally irresponsible environmental stewardship. The 1968 Clean Water Act delivered "fishable and swimmable", by putting the polluter on trial. Rather than waiting for dogs to die from cyano-toxin. "Jobs creation"?-Really? For whom? The Pet Cemetery? God bless the foresight of previous, visionary legislators and regulators. God help our children.

4.Other (Unacknowledged Gorillas): . I am really tempted to use a classic, Latin, debating trick developed by the famous Roman orator, Cicero. In his "Orations against Cataline ", this statesman said: "I need not mention, Cataline, BUT…."- Then he goes on, and on, and on, lambasting the Roman Senate with all Cataline's supposed transgressions. There are other lake water quality issues which need to be addressed. This is probably not the place, though. I do not want to expose you dedicated resource professionals to even more political pressure. (My section on onus of proof is pretty vicious, anyway.) So, I need not mention, WDNR….BUT... Here are just the titles of some more WisCALM, 2014 comments which I am cutting out: "The C Word"; "The Non-Point, Point Source?" and my favorite: "George Orwell trumps Webster's?" More ammo for later (- in the "Court of Public Opinion.")

These comments are my own private, personal, and professional views. They do not necessarily represent the views of COLA, or any other party. Thank you for the opportunity to be heard.

Frank Pratt

Fisheries Consultant-FBP; WDNR, Fisheries (retired); Aquatic Educator

Literature Cited

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Sharma, S., M.J. Vander Zanden, J.J. Magnuson, and J. Lyons 2011. Comparing climate change and species invasions as drivers of cold-water fish population extirpations. Public Library of Science, ONE (on-line serial), 6(8): e22906. DOI: 10.1371/journal.pone.0022906.

Silver, Nate 2012. The Signal From the Noise: Why So Many Predictions Fail-But Some Don't. Penguin Press, New York, N.Y. 531 pages, hard-copy.

Cc Tinka Hyde, Untied States Environmental Protection Agency