Expanding Coast Guard Credible Data Collection

Final Report: February 2013
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Abstract

Since 2009, we have collaborated with USCGC *NEAH BAY* (WTGB 105) to investigate winter limnology in Lake Erie. Adopting guidelines of the Ohio EPA, this collaboration offers potential to support water quality monitoring for which data are contributed to the Ohio Credible Data Program. Collaborative efforts such as this increase monitoring capacity despite continuing federal- and state-government budgetary restraints. The present award expanded our Lake Erie winter monitoring program while maintaining compliance with Ohio's "credible data law". Activities were focused on our continuing collaboration with *NEAH BAY* (Cleveland, OH) and its new Commanding Officer, LT Molly Waters. We expanded the program through engagement with CGC *BISCAYNE BAY* (WTGB 104; St. Ignace, MI) and CGC *THUNDER BAY* (WTGB 108; Rockland, ME), an icebreaking tug tasked to Cleveland for the winter season. Sampling on Lake Erie was augmented by participation on a 5 day survey aboard the Canadian Coast Guard icebreaker *GRIFFON* in mid-February 2012. Coordinating data collection with Coast Guard icebreakers has offered valuable insights into the winter limnology of Lake Erie. In particular, surveys over the period 2010-12 captured extremes in ice cover which may offer a window to future climate change scenarios calling for large-scale declines in lake ice.

Introduction

Winter research and monitoring of icebound rivers, lakes, and coastal seas to date has usually involved seagoing civilian scientists leading survey efforts. However, because of poor weather conditions and a lack of safe research platforms, scientists collecting data during winter face some difficult and often insurmountable problems. To solve these problems and to further research and environmental monitoring goals, new partnerships can be formed through integrating efforts of the U.S. Coast Guard (USCG) with citizen science initiatives.

USCG and our research group at Bowling Green State University are entering the fourth year of such a partnership, in which icebreaking operations in Lake Erie involving USCG cutters support volunteer data collection. With two additional USCG vessels having joined the program during 2012, the partnership serves as a timely and useful model for worldwide environmental research and monitoring through citizen science and government collaboration.

Icebreaking for Commerce and Research

Coast Guard icebreaking is an important winter operation supporting maritime commerce and flood control in inland and coastal waters. The North American Great Lakes, for instance, have a dedicated fleet of eight USCG and two Canadian Coast Guard icebreaking vessels. The Baltic Sea, as another example, had at least 40 state-owned or state-leased icebreaking vessels operating during the 2009–10 winter season (http://portal.liikennevirasto.fi/sivu/www/baltice/). Icebreaking operations are critical in rivers, lakes, and coastal seas where the demand for commercial ship traffic exists.

Scientists have long recognized that icebreakers travel areas of significant human activity and economic value, evidenced by the fact that they are needed to support such activity and

commerce. Thus, it is also important to monitor water quality, habitat degradation, and pollution related to human activity and industry in these areas.

Operations by coast guards have a long history of association with scientific research and monitoring, including on icebound waters. In North America, the Canadian Coast Guard, with its Icebreaking Program [*Canadian Coast Guard*, 1999], is charged with the operation of a federal civilian fleet of 18 icebreakers and has supported science missions from the high Arctic [*Cressey*, 2011] to the Great Lakes [*Twiss et al.*, 2012]. Likewise, the USCG has long been involved in oceanographic research [*Capelotti*, 1996], a mandate prescribed in Title 14 of U.S. Code, Section 94, which states that the Coast Guard "shall conduct such oceanographic research, use such equipment or instruments, and collect and analyze such oceanographic data, in cooperation with other agencies of the Government, or not, as may be in the national interest." Through a partnership with the National Science Foundation, USCG operates three polar class icebreakers in Arctic and Antarctic waters and has additionally supported winter research efforts in the Great Lakes [*Nghiem and Leshkevich*, 2007].

However, logistical considerations often prevent researchers from embedding on USCG vessels during icebreaking operations. Citizen science programs involving USCG personnel offer an alternative approach. The U.S. Environmental Protection Agency's (EPA) National Directory of Volunteer Monitoring Programs (http://yosemite.epa.gov/water/volmon.nsf/Home?readform) lists more than a thousand programs operating within the United States alone. With well-defined sampling procedures and good quality-assurance practices, citizen science programs that partner with USCG collect credible and defensible scientific data for research, monitoring, and policy efforts.

Monitoring Lake Erie

USCG service personnel are dedicated and motivated citizen stakeholders living and working in the marine and freshwater regions where they serve. Thus, they are well suited to citizen science initiatives that seek to learn more about the environment in which they live. The collaboration between USCG and Bowling Green State University to monitor Lake Erie exemplifies this - USCG service personnel have been eager to learn how to collect the data needed for winter environmental monitoring.

The collaboration has provided chemical and biological data on the ecosystem in winter that otherwise would have been very challenging to collect [*McKay et al.*, 2011; Oyserman *et al*., 2012]. These data are collected using the citizen science mechanism of the Ohio Credible Data Program, which provides a means to standardize and streamline surface water monitoring performed by non-governmental groups (http://www.epa.state.oh.us/Default.aspx?tabid=4566). As a result, not only are the data useful for research into the winter limnology of the North American Great Lakes but they also meet the requirements for use for regulatory applications, including the setting of water quality standards and evaluating the attainment of those standards. Thus, collaboration between Bowling Green State University and the USCG is not only furthering the university's research but is also providing the Ohio EPA with new data on the water quality of an important body of water during a virtually unstudied seasonal period.

A Model for Partnerships Between Government and Academia

The combination of icebreaking operations and a citizen science environmental monitoring program has been invaluable for work studying the winter limnology of the Laurentian Great Lakes. But more important, this model of enlisting the Coast Guard or other

groups with specialized equipment and all weather access could be replicable in other regions. Whether enlisted personnel or commissioned officers, the personnel on board icebreakers and other vessels are citizen stakeholders who place great value on the waterways on which they work, and these citizens offer an untapped resource for collecting high-quality and, until now, scarce information on nearshore environments.

Materials and Methods

Study Sites and Sampling:

The sampling protocol was designed to capture the spatial and temporal distribution of size fractionated chlorophyll (chl)-*a* phytoplankton biomass with accompanying nutrient concentrations from surface waters during winter 2012. Sampling in Lake Erie was conducted by personnel of the USCGC *NEAH BAY* from January through April, 2012. Samples from 26 sites were collected and processed on board *NEAH BAY* by USCG personnel following protocols detailed in the attached approved Study Plan (Appendix I). As with previous collaborations with *NEAH BAY* (winters 2009, 2010), the monitoring program was integrated into a BGSU general education course – in this case, BIOL 1090 (Life in Extreme Environments). Upon successful completion of the course, the Coast Guard students who participated earned 3 h of general education credit at BGSU with tuition covered through the Navy, Marine Corps, and Coast Guard Tuition Assistance Program.

We augmented our collection of winter data on Lake Erie by direct participation on a 5-day survey aboard CCGS *GRIFFON* in mid-February 2012 (55 sites surveyed) and on a late December 2012 transect from Cleveland to Detroit aboard USCGC *THUNDER BAY* (5 sites surveyed). While we engaged personnel from USCGC BISCAYNE BAY to participate in the

project, the lack of ice during winter 2012 resulted in *BISCAYNE BAY* not being tasked to Lake Erie to assist with icebreaking. As a result, sample collection provided by them was limited to the northern Great Lakes.

In total, over the winter season, samples from >85 sites (Fig. 1) were collected and analyzed in compliance with the Ohio EPA Surface Water Credible Data Program thus extending our spatial and temporal resolution of sampling during this important, but undersampled season.

Chl* a *phytoplankton biomass:

Analysis of size-fractionated chl-*a* was conducted at each station sampled over the winter period. Size-fractions included total chl-*a* and the microplankton size fraction. Total chl was processed using glass fiber filters (GF/F) and polycarbonate (PCTE) filters of 0.2 µm pore-size whereas the microplankton was fractionated using 20 µm PCTE membranes. Following vacuum filtration, filters were wrapped in a foil pouch and stored at -20 °C prior to transport to BGSU for extraction and analysis. Extraction of samples collected on glass fiber filters followed protocol LG405, developed by the EPA's Great Lakes National Program Office (GLNPO) for water quality surveys of the Great Lakes (Appendix I). Chl contained on seston collected on polycarbonate filters was extracted in 90% acetone overnight at -20°C prior to fluorometric analysis (Welschmeyer 1994). Size-fractionated chl data collected by USCGC *NEAH BAY* are available in Appendix II.

Nutrients:

For nutrient analysis, samples were processed for analysis by Heidelberg University (National Center for Water Quality Research; USCG surveys) or by Environment Canada

(CCGS *GRIFFON* survey). Samples for dissolved nutrient analysis at Heidelberg were filtered (< 0.22 µm) into acid-cleaned HDPE bottles prior to freezing. Samples were analyzed within one month of collection at the Heidelberg facility. Nutrient data collected by USCGC *NEAH BAY* are available in Appendix II.

Results and Discussion

The effects of climate change have been especially pronounced in the Great Lakes where winter ice cover has declined by 71% over the past 4 decades (Wang et al 2012). The decline is not constant; rather it is driven by high interannual variability combined with an increase in the frequency of years with low ice cover (Wang et al. 2012). Mid-winter surveys conducted in 2011 and 2012 captured extremes in ice cover (Fig. 2). At 21%, Lake Erie possesses the highest median Total Accumulated Ice Coverage (TAC) of the Laurentian Great Lakes (Canadian Ice Service, 2010), a distinction consistent with its relatively shallow bathymetry. Ice conditions during 2010-11 were more severe than normal (30% TAC) with total ice concentration exceeding nine-tenths coverage across much of the lake with the majority of this ice characterized as medium lake ice of 15-30 cm thickness. In contrast, winter 2011-12 (1.3% TAC) was nearly ice-free. Despite markedly different ice conditions between years, physicochemical parameters varied only slightly (Fig. 3). Water column profiles taken at process stations occupied in mid-February aboard CCGS *GRIFFON* portrayed near isothermal conditions with temperatures ranging between 0.5-1.5°C and dissolved oxygen near saturation, conditions representative of annual February surveys conducted from 2007-10 (Twiss et al, 2012).

The ecological integrity of aquatic systems is ultimately tied to the activities of microbial populations and consortia. Whereas we possess a baseline knowledge of microbial diversity and

community structure in the Great Lakes (e.g. Wilhelm et al 2006), we know little about how these communities respond to the manifestations of climate change. Winter surveys conducted on Lake Erie over two years demonstrated tight coupling between microplankton chl biomass (dominated by filamentous diatoms) and total chl during winter 2010-11 (Fig. 4; blue- and green symbols), a year of expansive ice cover. A warm positive Arctic Oscillation resulted in negligible ice cover on Lake Erie in 2011-12. Coincident with the ice-free conditions, a strong departure from a microplankton-dominated system was documented (Fig. 4; red- and yellow symbols). Results obtained by assay of size-fractionated chl were reinforced by flow cytometry showing that cell abundance in the fraction containing large nanoplankton (6-20 µm) and smaller microplankton (20-30 µm) declined by >50% whereas small nanoplankton (2-6 µm) increased (Fig. 5). There were also pronounced declines in phycoerythrin (PE)-containing phytoplankton of both size categories (Fig. 5). This coincided with results of iTAG sequencing showing >60% decrease in operational taxonomic units (OTU's) of 16S chloroplast rDNA sequences aligning with the PE-rich cryptomonad *Guillardia theta* between winters with high ice cover (2010 and 2011) and the low ice winter of 2012 (one-tailed *t*-test, $p < 0.01$; Fig. 6). Whereas winter 2012 saw a large decline in microplankton-sized diatoms, diatom OTU's varied little between "high ice" and "low ice" years (Fig. 6) meaning more diatoms were likely present in the nanoplankton (2-20 µm) fraction in 2012. Despite the functional shift in size-resolved diatom community structure, our preliminary analysis of iTAG data indicates negligible change in the taxonomic status of the diatoms. One explanation is that the low ice conditions of 2012 resulted in the truncation of diatom filaments. This explanation is consistent with the higher turbulence encountered during winter with low ice cover. It is likewise possible that prolonged exposure to low light, consistent with wind-aided deep mixing, will affect filament length of these diatoms.

Regardless of the mechanism responsible, a change in size-resolved diatom community structure will likely have implications for the Lake Erie food web, a feature we plan to investigate this winter as 2013 shapes up to be another low ice year for Lake Erie.

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Figure Captions

Fig. 1. Sampling locations for winters 2011 and 2012.

Fig. 2. Moderate Resolution Imaging Spectroradiometer (MODIS) images taken on A) February 3, 2011 and B) February 6, 2012 showing the extremes of ice extent captured between the two years. Whereas Lake Erie is typically ice-covered (>80%) by mid-February, the lake was mainly ice free in 2012 (credit: Great Lakes CoastWatch, NOAA-GLERL).

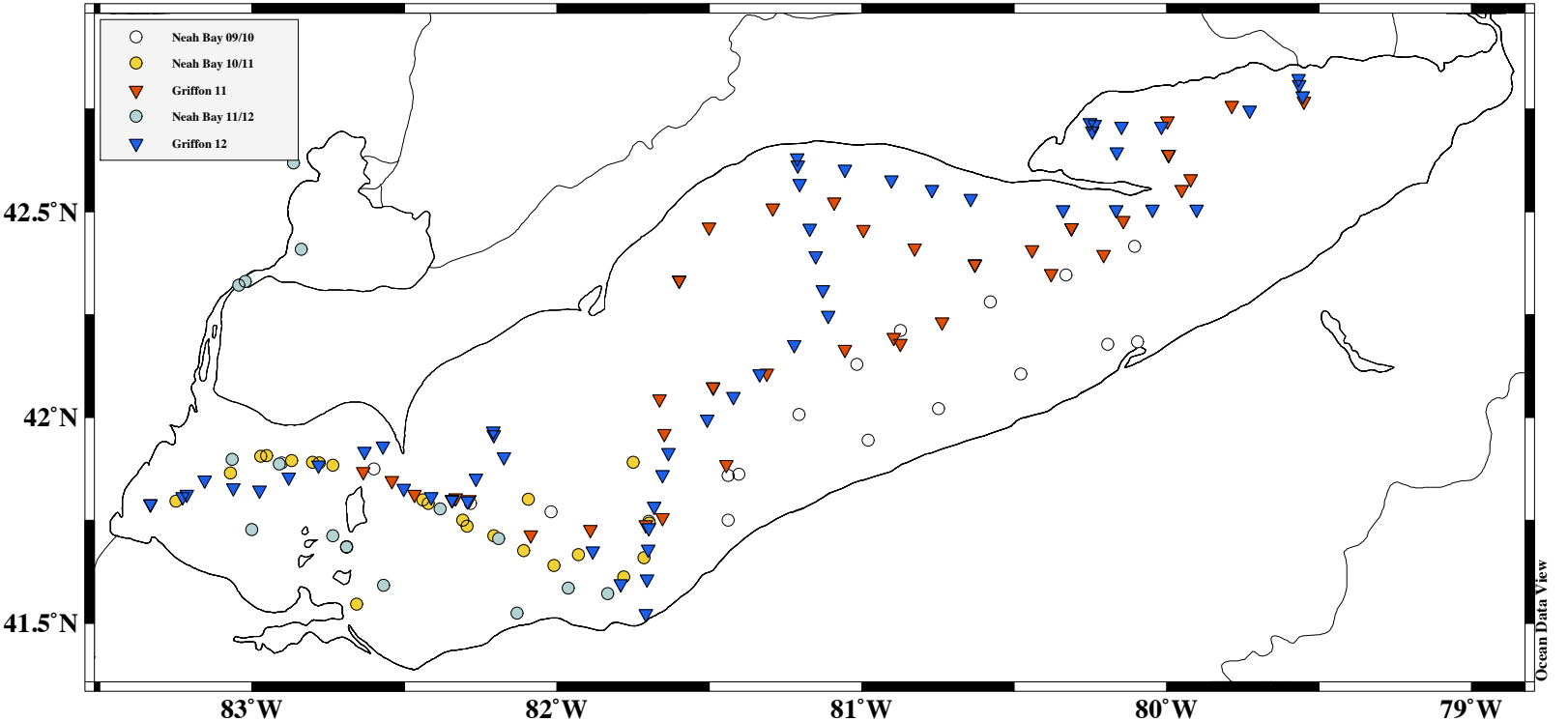
Fig. 3. Vertical water quality profiles for central basin sites occupied during winter surveys of Lake Erie. Water column profiles of temperature, dissolved oxygen (DO) and conductivity were recorded during the February 2011 and 2012 surveys using a Model 660 Sonde (YSI Inc.) lowered at approximately 0.1 m s^{-1}. A) During the February 2011 survey, total ice concentration exceeded nine-tenths coverage across much of the lake with the majority of this ice characterized as medium lake ice of 15-30 cm thickness. Water column profiles taken at Environment Canada (EC) station 1326 (17 February, 2011) which was freed of ice cover by the icebreaker portrayed a near isothermal water column with temperatures <0.5 °C and dissolved oxygen near saturation. B) Likewise, a mid-April survey conducted in 2011 was representative of thorough vernal mixing consistent with the warm monomictic character of Lake Erie during most years. At US EPA central basin master station 78 (12 April, 2011), water temperatures were cold (2 °C) with saturating dissolved oxygen throughout the water column. C) Water column profile at Environment Canada (EC) station 1326 (15 February, 2012). Whereas most sites surveyed during February 2012 were ice-free, the water column shared similar characteristics to the

previous year being fully mixed although water temperatures in the central basin were elevated slightly to 1.5 °C.

Fig. 4. Microphytoplankton chl biomass plotted against total chl. Surveys conducted in 2011 showed microphytoplankton to dominate the algal assemblage, much as this fraction did during surveys conducted between 2007-2010 when the lake exhibited expansive ice cover (Twiss et al. 2012). Analysis of size-fractionated chl in 2012 showed a deviation from this trend with only ~25% of the phytoplankton belonging to the microphytoplankton size class.

Fig. 5. Analysis of phytoplankton cells by flow cytometry. Substantial reductions in large nanoplankton including phycoerythrin (PE)-rich nanoplankton were offset in part by increases in small nanoplankton (2-6 µm) between 2011-2012.

Fig. 6. Heat map showing relative abundance of taxa during winter at 3 sites in Lake Erie from 2010-2012. Data are derived from iTAG analysis conducted by the Department of Energy Joint Genome Institute as part of a Community Sequencing Program award to R.M. McKay. Like 2011, winter 2010 was characterized as having expansive ice cover. For comparison, taxonomic composition during summer 2012 is included for two central basin sites (EC 1326: epilimnion; EC 880: epi- and hypolimnion). Diatoms (thus classified due to their identity to 16S ribosomal sequences of diatom [*Thalassiosira*] chloroplasts) were the dominant taxa at all sites sampled during winter, even during the ice-free winter of 2012. By contrats, diatoms comprise only a minor component of microbial taxa during summer.


Neah Bay 09/10
Neah Bay 10/11
Griffon 11
Neah Bay 11/12
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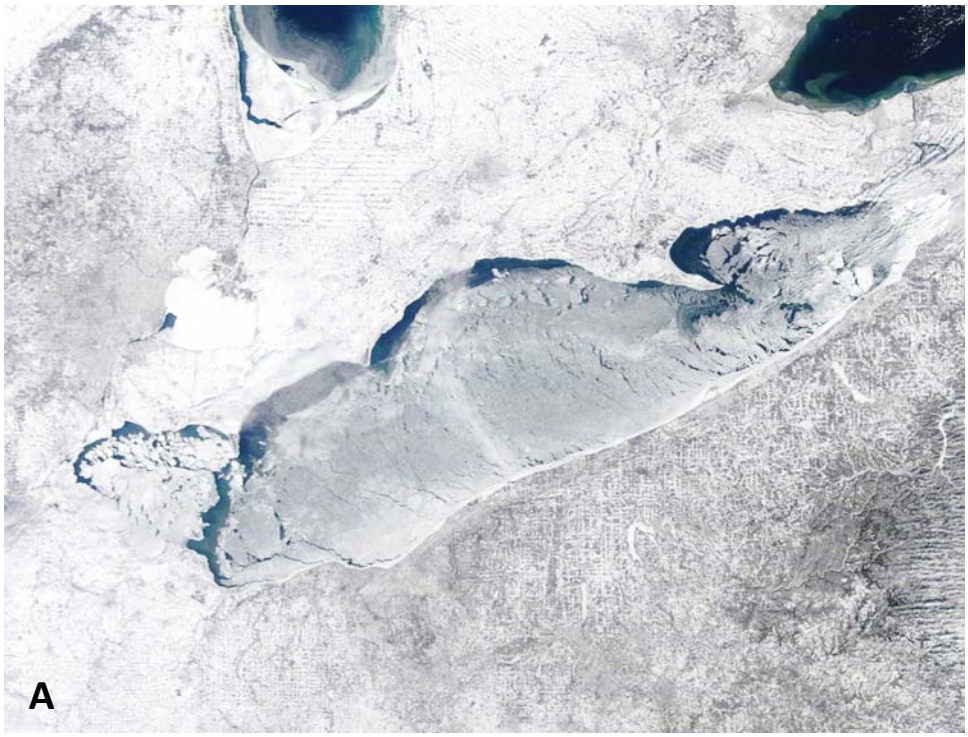
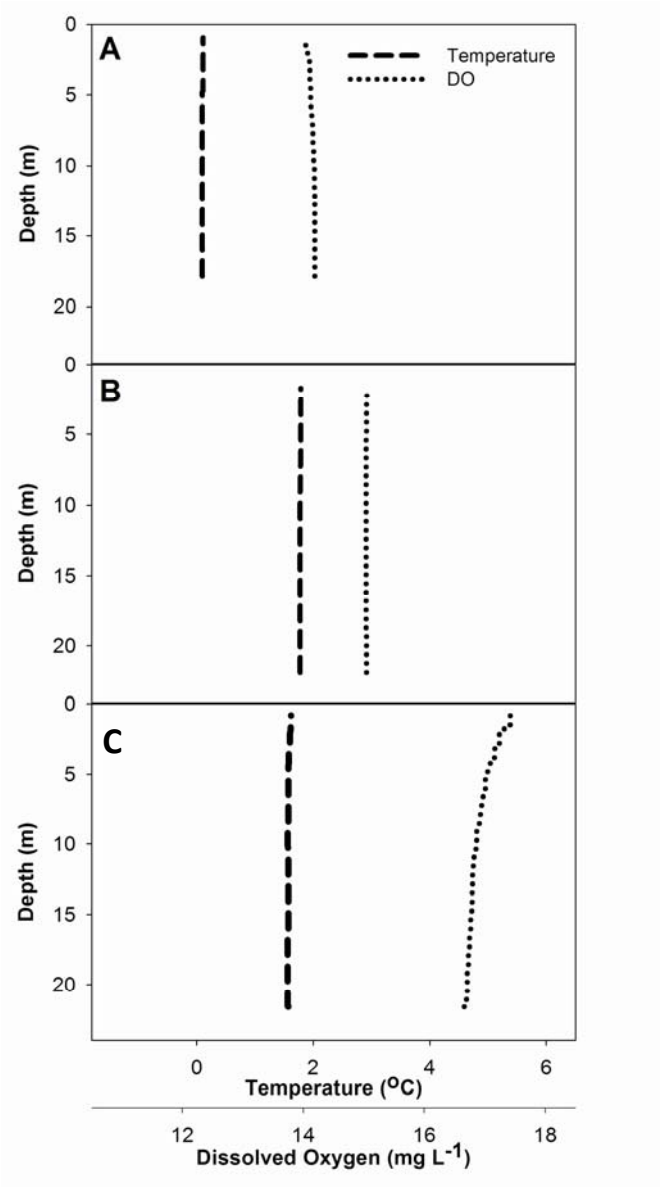
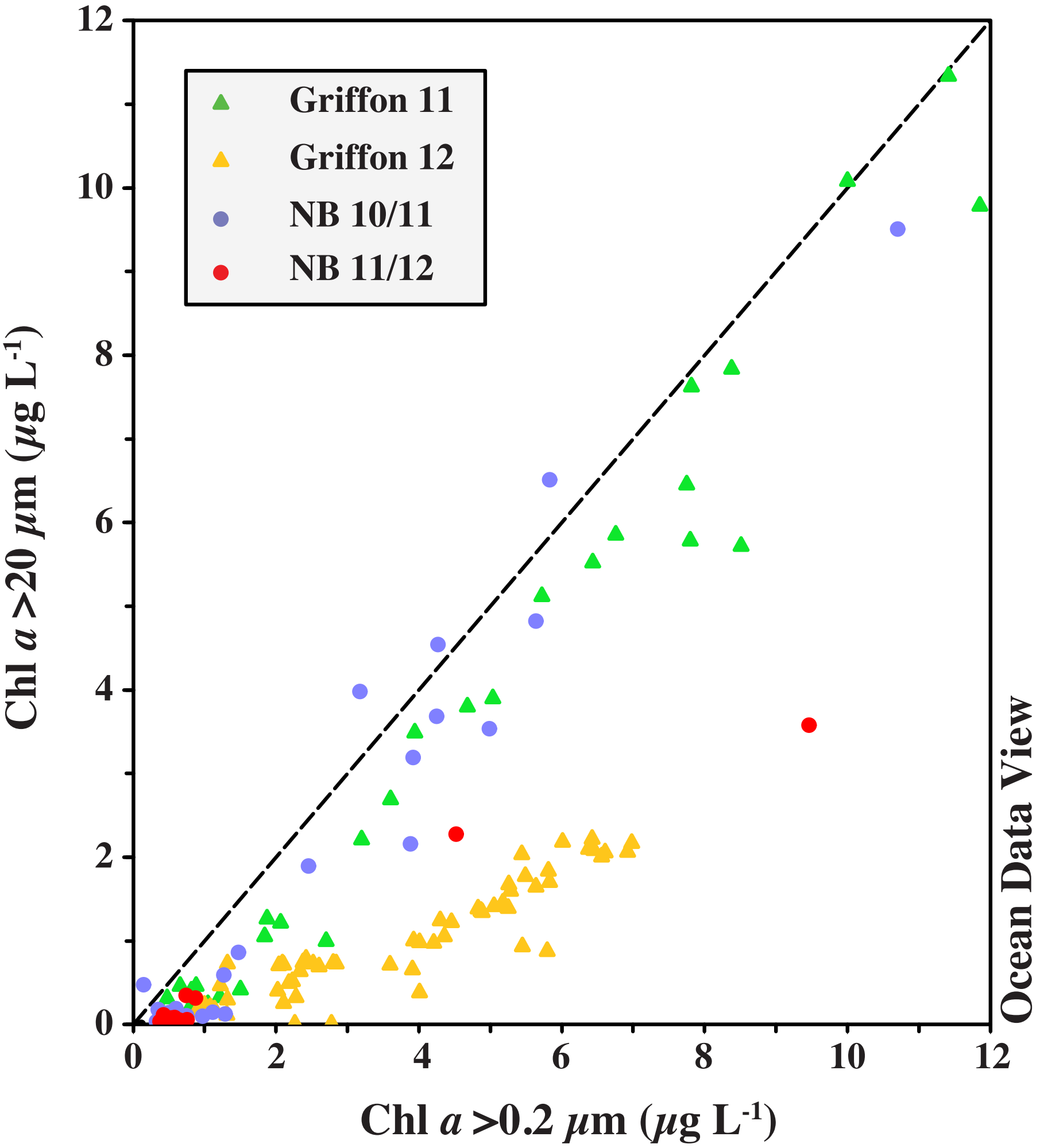
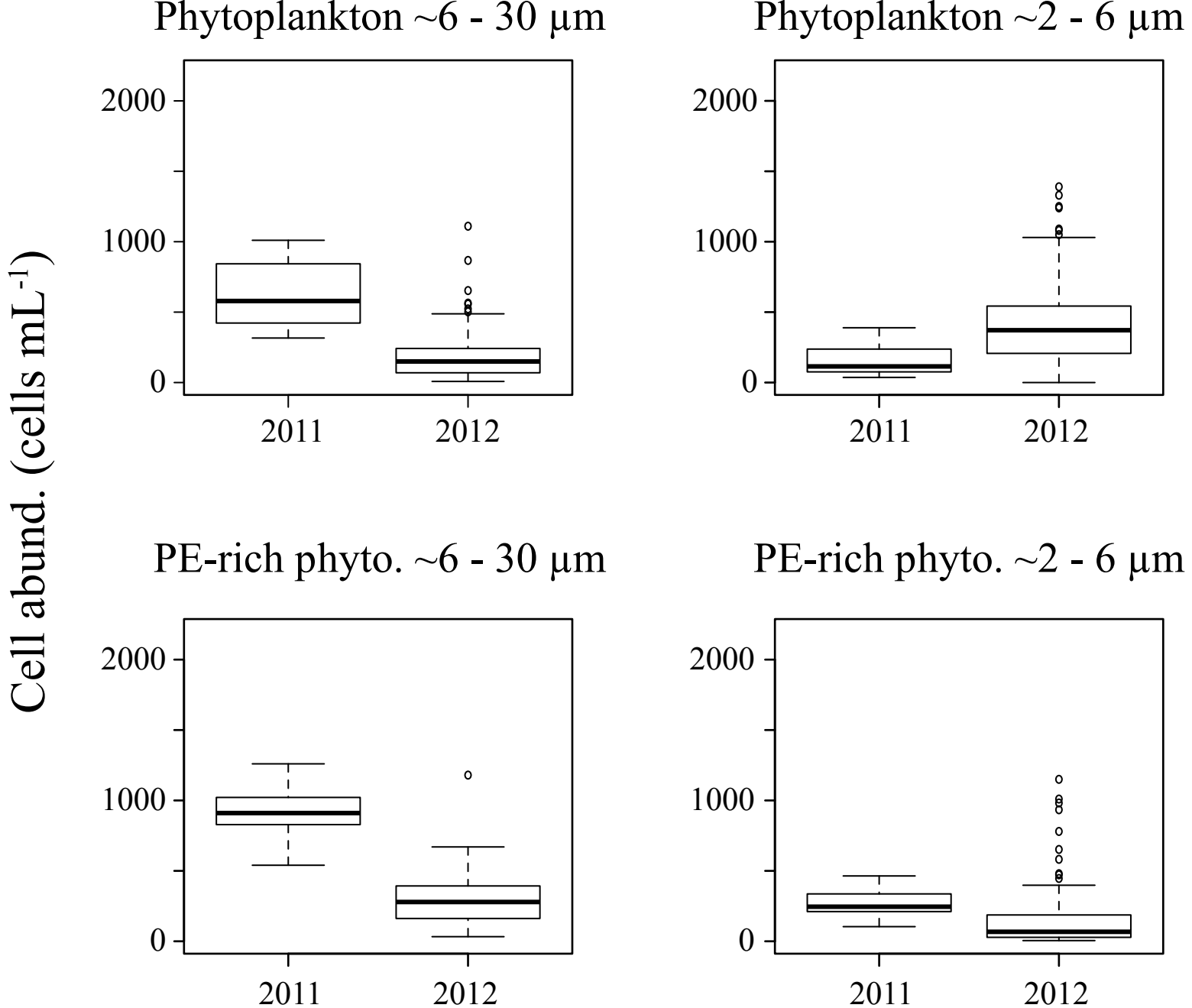
42.5°N
42°N
41.5°N
83°W
82°W
81°W
80°W
79°W
Ocean Data View

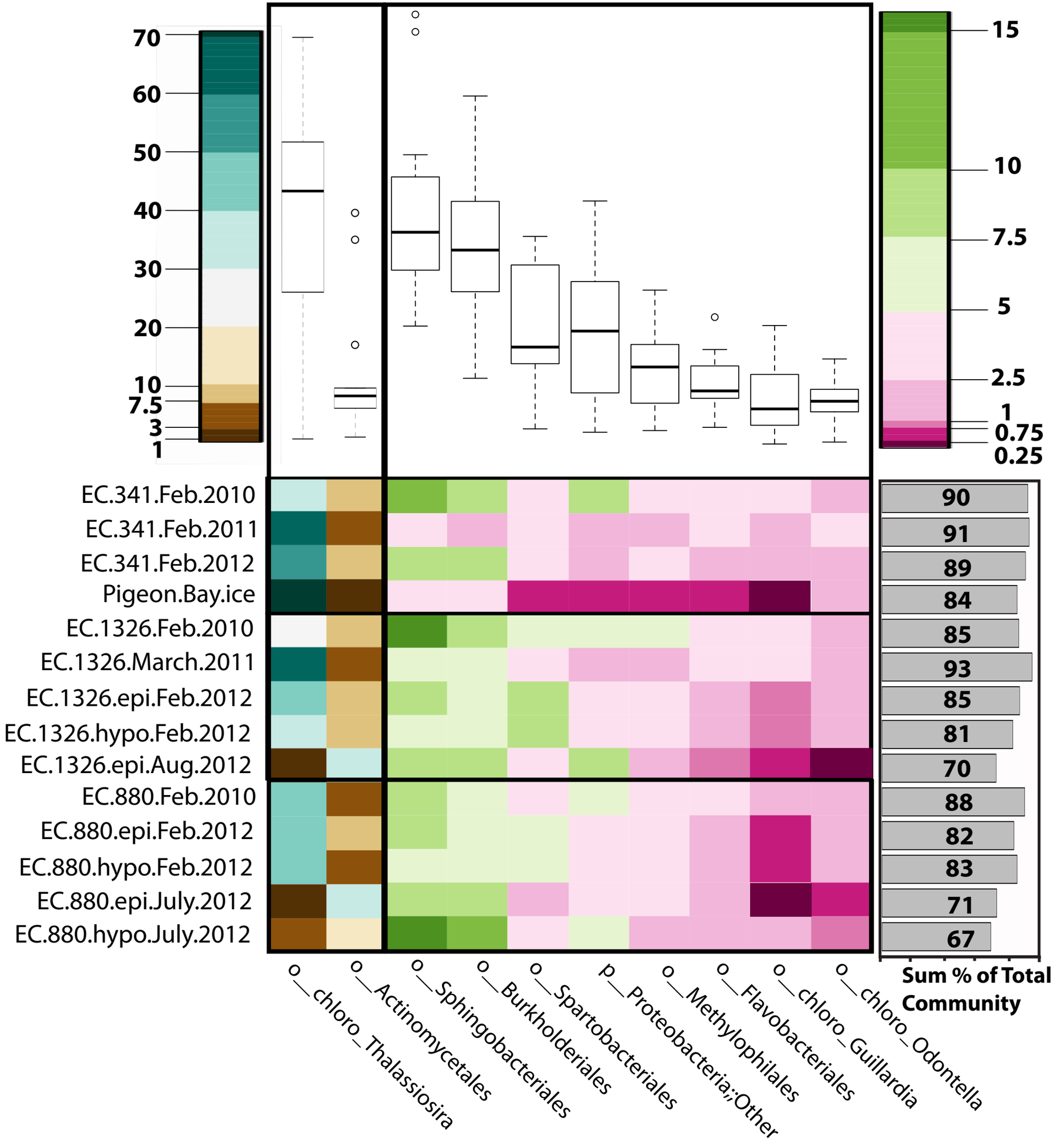

A

B


A
B
C
Temperature
DO
Depth (m)
0
5
10
15
20
Temperature (°C)
0
2
4
6
Dissolved Oxygen (mg L-1)
12
14
16
18


Griffon 11
Griffon 12
NB 10/11
NB 11/12
Chl a >20 μm (μg L-1)
Chl a >0.2 μm (μg L-1)
0
2
4
6
8
10
12
Ocean Data View


Phytoplankton ~6 - 30 µm
Phytoplankton ~2 - 6 µm
PE-rich phyto. ~6 - 30 µm
PE-rich phyto. ~2 - 6 µm
Cell abund. (cells mL-1)
2000
1000
0
2011
2012


70
60
50
40
30
20
10
7.5
3
1
15
10
7.5
5
2.5
1
0.75
0.25
EC.341.Feb.2010
EC.341.Feb.2011
EC.341.Feb.2012
Pigeon.Bay.ice
EC.1326.Feb.2010
EC.1326.March.2011
EC.1326.epi.Feb.2012
EC.1326.hypo.Feb.2012
EC.1326.epi.Aug.2012
EC.880.Feb.2010
EC.880.epi.Feb.2012
EC.880.hypo.Feb.2012
EC.880.epi.July.2012
EC.880.hypo.July.2012
90
91
89
84
85
93
85
81
70
88
82
83
71
67
Sum % of Total Community
o__chloro_Thalassiosira
o__Actinomycetales
o__Sphingobacteriales
o__Burkholderiales
o__Spartobacteriales
p__Proteobacteria;;Other
o__Methylophilales
o__Flavobacteriales
o__chloro_Guillardia
o__chloro_Odontella

Ohio | Environmental Protection Agency
John R. Kasich, Governor
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Scott J. Nally, Director

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Effective Date: February 24, 2012

CERTIFIED MAIL

Dr. Robert Michael McKay (QDC #519)
Bowling Green State University
Department of Biological Sciences
217 Life Sciences Building
Bowling Green, OH 43403

Re: Project Study Plan Approval, Surface Water Credible Data Program

Dear Dr. McKay:

The Division of Surface Water Volunteer Monitoring (Credible Data) Program has reviewed your Project Study Plan, "U.S. Coast Guard Survey of Lake Erie in Winter 2011- 2012." Pursuant to Ohio Revised Code (ORC) 6111.53 and Ohio Administrative Code (OAC) 3745-4-05, your plan is approved for the following level and specialty:

Specialty/Level: Chemical Water Quality / Level 3

As a reminder, the credible data rules specify that "QDCs choosing to submit their data to Ohio EPA must submit all collected data. Submission of data may be done at any time, but must be done no later than one year after completion of the study identified in the project study plan."

Our review did note that sampling will be conducted by non-QDC personnel which you will train prior to sampling commencement, monitor for thoroughness throughout the life of the project and re-train as often as necessary in the event of data anomalies detected.

You are hereby notified that this action of the Director is final and may be appealed to the Environmental Review Appeals Commission pursuant to Section 3745.04 of the Ohio Revised Code. The appeal must be in writing and set forth the action complained of and the grounds upon which the appeal is based. The appeal must be filed with the Commission within thirty (30) days after notice of the Directors action. The appeal must be accompanied by a filing fee of $70.00, made payable to "Ohio Treasurer Josh Mandel", which the Commission, in its discretion, may reduce if by affidavit you demonstrate that payment of the full amount of the fee would cause extreme hardship.

Notice of the filing of the appeal must be filed with the Director within three (3) days of filing with the Commission. Ohio EPA requests that a copy of the appeal be served upon the Ohio Attorney General's Office, Environmental Enforcement Section. An appeal may be filed with the

I certify this to be a true and accurate copy of the official documents as filed in the records of the Ohio Environmental Protection Agency.

By: Tonya Lassiter Date: 2/29/12

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Environmental Review Appeals Commission at the following address: Environmental Review Appeals Commission, 309 South Fourth Street, Room 222, Columbus, Ohio 43215.

Sincerely,

Scott J. Nally
Director

Study Plan for the U.S. Coast Guard Survey of Lake Erie in Winter 2011-12

1. Project Objective

The biogeochemical processes of Lake Erie during the winter are relatively unknown and represent an important uncertainty in our understanding of this Great Lake. U.S. Coast Guard operations on the Lake during the winter offer a valuable opportunity for data collection to fill this gap in our knowledge. This project uses current USCG operations as a sampling platform to measure the distribution of phytoplankton biomass and dissolved nutrients through Lake Erie in the winter. Collectively, these data will contribute to the credible chemical data repository maintained by Ohio EPA.

2. Project Design

The project consists of synoptic sampling of the near-surface waters of Lake Erie during normal operations of the USGC *NEAH BAY*. The cutter *NEAH BAY* operates throughout Lake Erie during the winter season and offers an unparalleled platform for sampling. With the support and leadership of LT Molly Waters, the Commanding Officer of *NEAH BAY*, water samples will be collected when mission permits to provide a spatial and temporal survey of the Lake for the concentrations of particulate chlorophyll *a* and dissolved nutrients.

The varied and unpredictable nature of USCG operations on Lake Erie in the winter season necessitates a flexible sampling strategy to maximize the spatial and temporal coverage of the survey. A pilot study conducted in the winter of the 2009-2010 showed sampling at regular time intervals, hourly in the case of ship transits between duty stations, provided ample spatial resolution. This project will use a similar strategy of hourly samples, or regularly spaced stations on the discretion of the Commanding Officer of *NEAH BAY*, to provide adequate spatial resolution for the survey. The project will continue throughout the winter operations season of *NEAH BAY* and will thus provide temporal resolution for the survey.

3. Project Parameters

a) Sampling location, time, and local conditions

The latitude, longitude (decimal degree format with 4 decimal minimum) and time will be recorded from the ship's navigational suite at every sampling location. Local environmental conditions, including air and water temperature, wind direction and strength, cloud cover, ice cover, and ice thickness will also be recorded.

b) Particulate chlorophyll a concentration

Near-surface water (1 m depth) will be collected using a stainless steel sampling bottle and processed using the chlorophyll *a* standard operating procedure (Appendix A). We have adopted this approach rather than use of Go-Flo bottles to accommodate working in ice. These bottles were custom made (welded stainless steel) by Fletcher

Manufacturing, Bowling Green, OH).

Since the sampling bottle is re-used, it is subject to a cleaning regimen including washing with tap water and phosphate-free detergent followed by rinsing with tap water and de-ionized water.

Equipment blanks will be processed at a frequency of 5% (1 of 20 samples). For these blanks, the sampling bottle is rinsed and filled with reagent water and then treated as a normal sample. This is done to verify that cross contamination does not occur between samples. The reagent water used will be de-ionized water.

c) Dissolved nutrient concentrations
Near-surface water (1 m depth) will be collected using a stainless steel sampling bottle and processed using the dissolved nutrient standard operating procedure (Appendix B).

4. Sampling Design

a. The ship will come to a stop at the sampling station, chosen at regular time intervals or by the discretion of the Commanding Officer. Stations will not be biased on the basis of ice conditions or location. The location and time of the sampling station will be recorded along with the environmental conditions.

b. Designated crew members of *NEAH BAY*, trained in sampling and supervised by LT Waters, will deploy the stainless steel sampling bottle to a depth of 1 m and collect the water grab sample. On occasion where BGSU QDC-3 approved personnel have joined the vessel, they will conduct this operation.

c. Sub-samples for particulate chlorophyll *a* and dissolved nutrient concentrations will be processed by LT Waters according to the Standard Operating Procedures and stored under the appropriate conditions until collection by BGSU personnel for shipping and analysis.

i. Triplicate replicates of particulate chlorophyll *a* will be prepared from each water grab sample.

ii. Duplicate replicates of dissolved nutrients will be prepared from each water grab sample.

d. Particulate chlorophyll *a* samples will be transported back to BGSU with dry ice and processed according to the EPA standard 445.0 method for chlorophyll *a* analysis. Analysis will be completed prior to the 3.5 week hold time allowed under this procedure.

e. Dissolved nutrient samples will be transported back to BGSU following which they will be shipped to the Division of Environmental Services at Ohio EPA (Reynoldsburg, OH). Samples will be acidified and cooled as detailed in section 5c below. The holding time for total phosphorus (non filtered and preserved with H_2SO_4 to a pH < 2) and dissolved phosphorus (filtered and preserved with H_2SO_4 to a pH < 2) is 28 days. The holding time for orthophosphate (filtered and non preserved) is 48

hours. As a result, logistics associated with sampling and retrieval of samples from the vessel will prevent measurement of orthophosphate as part of this project.

5. Quality Assurance & Quality Control

Sampling, sample preparation and analysis will follow the methods in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 2009) and the Inland Lakes Sampling Procedure Manual (Ohio EPA, 2010).

a. Particulate chlorophyll a concentration

i. Triplicate laboratory replicates will be prepared from each water grab sample.

ii. Replicate field blanks will be prepared daily from de-ionized water.

iii. Samples will be handled under low light conditions and frozen immediately. Samples will be kept at -20°C or under dry ice (transport) until analysis at BGSU.

b. Dissolved nutrients

i. Duplicate laboratory replicates will be prepared from each water grab sample.

ii. QA/QC procedures are conducted by Ohio EPA, the contract laboratory conducting the analyses for dissolved nutrients.

iii. Samples will be immediately filtered using 0.22-µm membrane filters and preserved using sulfuric acid to a pH < 2.

6. Credible Data Collection

Supervisory and analytical personnel (Dr. McKay, Dr. Bullerjahn, and Dr. Beall) submitted credentials for consideration to be certified Level 3 Qualified Data Collectors and were approved by Ohio EPA in fall 2010. A training session led by Dr. McKay was held on 21 November, 2011 and again on 8 December, 2011 for LT Waters to establish sample collection methods and quality criteria. Mr. Dan Glomski (Ohio EPA) oversaw the December training session.

USCG servicemen, under the direct supervision of LT Waters will be responsible for sample collection. LT Waters will be responsible for sample processing and storage until which time samples are collected by BGSU personnel for delivery to Bowling Green. During the winter months, the project manager (Dr. McKay) or one of the BGSU QDC 3-certified personnel will visit *NEAH BAY* fortnightly to meet with LT Waters and retrieve samples collected. During these meetings, BGSU personnel will monitor sampling techniques, discuss data quality performance, and ensure the sampling efforts by the USCG meet the requirements of the study plan and standard operating procedures.

7. Project Deliverables to the Ohio Credible Data Program

This project will provide synoptic data on the concentration of chlorophyll *a*, and dissolved and particulate nutrients concentrations in near-surface waters at stations throughout Lake Erie during the winter season.

8. Qualified Personnel

Project Manager
Level 3 Certification: Chemical Water Quality Assessment
Effective: 11/15/2010
QDC # 00519

Dr. Robert Michael L. McKay
Department of Biological Sciences
Bowling Green State University
Bowling Green, OH, 43403
Phone: (419) 372-6873
Email: rmmckay@bgsu.edu

BGSU Personnel (Level 3 Certified)

Dr. George S. Bullerjahn

Department of Biological Sciences
Bowling Green State University
Bowling Green, OH, 43403
Phone: (419) 372-8527
Email: bullerj@bgsu.edu

Level 3 Certification: Chemical Water Quality Assessment
Effective: 11/15/2010
QDC # 00517

Dr. Benjamin F. N. Beall

Department of Biological Sciences
Bowling Green State University
Bowling Green, OH, 43403
Phone: (419) 372-4209
Email: bbeall@bgsu.edu

Level 3 Certification: Chemical Water Quality Assessment
Effective: 11/15/2010
QDC # 00518

Sampling will be conducted by USCG personnel on *NEAH BAY* under the direct supervision of LT Waters or one of the BGSU QDC 3-certified scientists. Sample processing will be conducted by LT Waters, following which she will store samples for pick-up by BGSU personnel. A training session led by Dr. McKay was held on 21 November, 2011 and again on 8 December, 2011 for LT Waters to establish sample

collection methods and quality criteria. Agency Advisor Dan Glomski attended the training on Dec. 8 and offered advice where necessary.

Sample analysis, data processing, and data analysis will be conducted at BGSU by Drs. McKay, Bullerjahn and Beall.

During the study period, the project manager (Dr. McKay) or one of the BGSU QDC 3-certified personnel will visit *NEAH BAY* fortnightly to meet with LT Waters and retrieve samples collected. During these meetings, BGSU personnel will monitor sampling techniques, discuss data quality performance, and ensure the sampling efforts by the USCG meet the requirements of the study plan and standard operating procedures.

Should our Quality Assurance & Quality Control procedures detect anomalies over the course of the study, we will re-visit the training regimen for sample collection, processing and storage with LT Waters.

9. Contract Laboratory

Chemical analysis for dissolved nutrient concentrations will be conducted by the Division of Environmental Services, Ohio EPA.

Contact:

Roman Khidekel, Manager
Division of Environmental Services
Ohio EPA
8955 E Main Street, BLDG 22
Reynoldsburg, OH 43068-3342
Tel: (614)644-4234
Email: roman.khidekel@epa.state.oh.us

10. Statement

The persons conducting data collection have not been convicted of or have pleaded guilty to a violation of section 2911.21 of the Revised Code (criminal trespass) or a substantially similar municipal ordinance within the previous five years.

Appendix A
Standard Operating Procedure for Chlorophyll-*a* Sampling Method: Field Procedure for Use by U.S. Coast Guard

1.0 Scope and Application
This method is used to filter chlorophyll-*a* samples from the Great Lakes and Tributary streams.

2.0 Summary of Method
A grab lake water sample is collected from a stainless steel sampling bottle at various depths and filtered by vacuum filtration in dim light. The filter is then placed in a screw cap polyethylene culture tube in the dark. The tube is stored in the dark at sub-freezing temperatures and transported to the BGSU laboratory for extraction and analysis. The BGSU laboratory will follow protocol LG405, developed by the EPA's Great Lakes National Program Office (GLNPO) for water quality surveys of the Great Lakes (appended).

3.0 Apparatus
Plastic filter funnel, Pall Filtron (250 mL capacity)
Vacuum manifold system to accommodate 3 filter funnels
Vacuum system (3-4 psi)
GF/F filters, Whatman (25 mm)
Screw cap polyethylene tubes
Graduated polystyrene pipettes (25 mL; disposable)
Pasteur short disposable pipets
Rubber bulb
Plastic wash bottle, 500 mL
Plastic wash bottle, 500 mL, for MgCO3
Filter forceps
Opaque sample bottles, 1000 mL (Nalgene or equivalent)

4.0 Reagents
Saturated Magnesium Carbonate Solution Add 10 grams magnesium carbonate to 1000 mL of deionized water. The solution is settled for a minimum of 48 hours. Decant the clear solution into a new container for subsequent use. *Only the clear "powder free" solution is used during subsequent steps.*

5.0 Sample Handling and Preservation
Sample collection and preservation will follow the procedures described in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 2009) and the Inland Lakes Sampling Procedure Manual (Ohio EPA, 2010). The entire procedure should be carried out as much as is possible in subdued light to prevent photodecomposition. The frozen samples should also be protected from light during storage for the same reason. During the filtration process, the samples are treated with $MgCO_3$ solution (section 4) to eliminate acid induced transformation of chlorophyll to its degradation product, pheophytin. Samples are stored by station in aluminum foil and transported to the BGSU laboratory in a cooler with dry ice. Analysis should be performed as soon as possible following sampling.

6.0 Field Procedure
6.1 Following sample collection with the stainless steel sampling bottle, samples are transferred to 1000 mL opaque Nalgene bottles, labeled with the station, sample depth, *eg.* Surface, representing a surface sample
6.2 Place filters, using forceps, textured side up. Assemble the filtration apparatus just prior to filtration.
6.3 Due to differing trophic levels among the Great Lakes, the volume of water filtered varies. For

Lake Erie, 25 mLs of sample are filtered. After inverting the sample bottle several times to create a uniform mixture, carefully draw 25 mL into a pipette and distribute contents into filtration funnel.
6.4 Turn vacuum pressure on, not exceeding 3 psi. Our plans call for use of a hand pump.
Check Frequently During Filtration to Insure Pressure Does Not Go Above 3 PSI!!!
6.5 When approximately 10 mL of sample remains on the filter, add 10 drops of the $MgCO_3$ (section 4.1) solution using a disposable pipet. Thoroughly rinse the filter apparatus and graduated cylinder, using a squirt bottle, with deionized water. Turn off vacuum pressure as soon as the liquid disappears to prevent the breakage of cells.
6.6 Using the forceps, fold and remove the filter and carefully place it into the bottom portion of the prelabeled culture tube (see section 10) and close tightly. Lay all tubes flat and completely wrap in aluminum foil. Clearly label the Lake, station and date on masking tape and attach to above mentioned aluminum foil package. Immediately freeze. All the above procedures should be completed in subdued light.

7.0 Quality Control
7.1 Each of the following audits is collected once per lake transect.
7.2 Field duplicates are taken from a second stainless steel sampling bottle collected at about the same time and location as the regular field sample. It is transported from the Niskin bottle to the onboard biology laboratory in an opaque bottle marked as duplicate sample.
7.3 Laboratory duplicates are filtered from the same opaque sample bottle as their corresponding regular field samples.
7.4 Field blanks, consisting of reagent water are carried by an opaque sample bottle from the onboard reagent water supply to the filtration apparatus. The bottle is used only for field blanks and is permanently marked as such.

8.0 Waste Disposal
Follow all laboratory waste disposal guidelines regarding the disposal of $MgCO_3$ solutions.

9.0 Shipping
Once a transect has been completed or a batch of 35 samples has been completed, wrap all samples into one complete batch and clearly label with date. Pack tightly in a medium sized cooler and fill all spaces with enough dry ice to last 24 hours. Dry ice is considered a hazardous chemical by most shipping companies and has to be accompanied by authorizing paperwork. Once transported to BGSU, the samples should be immediately placed in the freezer.

10.0 Labeling
Sample identification information is provided on printed labels both prior to and during the survey. The labels are affixed to the side of the 16 × 100 mm chlorophyll tube. The sample identification number is covered with clear tape in case the tube becomes wet.

Appendix B
Standard Operating Procedure for Dissolved Nutrient Sampling Method: Field Procedure for Use by U.S. Coast Guard

1.0 Scope and Application
This method is used to prepare dissolved nutrient samples from the Great Lakes and Tributary streams.

2.0 Summary of Method
A representative lake water sample is collected from a stainless steel sampling bottle at various depths and pre-filtered by syringe filtration then preserved with sulfuric acid for subsequent analysis at the Division of Environmental Services at Ohio EPA (Reynoldsburg, OH). Sample collection and preservation will follow the procedures described in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 2009) and the Inland Lakes Sampling Procedure Manual (Ohio EPA, 2010).

3.0 Apparatus
Opaque sample bottles, 500 mL (Nalgene or equivalent)
Go-Flo sampling bottle
60 mL propylene syringes
0.22-µm syringe filters (Acrodisk™ or equivalent)
60 mL polyethylene bottles (Nalgene™ or equivalent)
Pasteur pipettes

4.0 Reagents
12.5% H_2SO_4 solution Sulfuric acid solution used for sample preservation.

5.0 Sample Handling and Preservation
Samples are pre-filtered with 0.22-µm syringe filters into acid-cleaned HDPE bottles. One filtered sample is then preserved with 10 drops of 12.5% sulfuric acid.

6.0 Field Procedure
6.1 Following sample collection with the stainless steel sampling bottle, samples are transferred to 500 mL opaque Nalgene bottles, labeled with the station, sample depth, *eg.* Surface, representing a surface sample
6.2 50 mL samples are syringe-filtered into 60 mL HDPE bottles.
6.3 The sample is fixed with 10 drops of 12.5% sulfuric acid and stored at 4°C until shipment to the Division of Environmental Services at Ohio EPA (Reynoldsburg, OH) for analysis.

7.0 Quality Control and Assurance
7.1 Each of the following audits is collected once per lake transect.
7.2 Field duplicates are taken from a second stainless steel sampling bottle closed at about the same time and location as the regular field sample. It is transported from the Niskin bottle to the onboard biology laboratory in an opaque bottle marked as duplicate sample.
7.3 Laboratory duplicates are filtered from the same opaque sample bottle as their corresponding regular field samples.

7.4 Field blanks, consisting of reagent water are carried by an opaque sample bottle from the onboard reagent water supply to the filtration apparatus. The bottle is used only for field blanks and is permanently marked as such.

8.0 Waste Disposal

Follow all laboratory waste disposal guidelines regarding the disposal of H_2SO_4 solutions.

9.0 Shipping

Once a transect has been completed or a batch of 15 samples has been completed, bottles will be loaded into bags and clearly label with the date. Samples will be stored at 4°C until loaded into a cooler with blue ice for transport to Division of Environmental Services at Ohio EPA (Reynoldsburg, OH).

10.0 Labeling

Sample identification information is provided on printed labels both prior to and during the survey. The labels are affixed to the side of the 60 mL sample bottle. The sample identification number is covered with clear tape in case the tube becomes wet.

APPENDIX II: NEAH BAY Sampling Log												
						Coverage						
Stn	Date	Time	Lat	Long	Depth	Ice	Snow	Ice Type	Thickness (	Air Temp	Baro Press	
			(Deg/Min/Sec)		(ft)	(%)	(%)		(in)	(°F)	(in Hg)	
1	01/04/2012	19:00:00	41° 41.16	082° 41.33	27	0	0	N/A	N/A	29	29.95	
2	01/06/2012	08:45:00	41° 42.83	082° 43.99	35	0	0	N/A	N/A	40	29.74	
3	01/06/2012	12:00:00	41° 35.58	082° 34.00	34	0	0	N/A	N/A	40	29.8	
4	01/06/2012	13:45:00	41° 31.54	082° 07.74	39	0	0	N/A	N/A	51	29.8	
5	01/10/2012	14:10:00	41° 35.17	081° 57.75	48	0	0	N/A	N/A	38	30.04	
6	01/12/2012	10:45:00	41° 53.26	082° 54.58	40	0	0	N/A	N/A	38	29.34	
7	01/17/2012	09:10:00	41° 34.33	081° 49.97	48	0	0	N/A	N/A	44	29.66	
8	01/17/2012	10:30:00	41° 42.41	082° 11.48	66	0	0	N/A	N/A	42	29.53	
9	01/17/2012	11:20:00	41° 46.68	082° 22.88	69	0	0	N/A	N/A	42	29.53	
10	01/20/2012	12:30:00	42° 19.36	083° 02.58	shore	0	0	N/A	N/A	18	N.D.	
1	02/07/2012	07:40:00	41° 41.16	082° 41.33	26	0	0	N/A	N/A	31	30.2	
11	02/07/2012	09:30:00	41° 43.65	082° 59.92	35	0	0	N/A	N/A	31	30.25	
12	02/08/2012	18:45:00	42° 19.84	083° 01.27	36	0	0	N/A	N/A	38	30.2	
12	02/09/2012	07:30:00	42° 19.84	083° 01.27	36	0	0	N/A	N/A	39	30.22	
13	02/09/2012	11:00:00	42° 24.57	082° 50.24	31	0	0	N/A	N/A	42	30.2	
14	02/09/2012	13:15:00	42° 37.14	082° 51.76	20	0	0	N/A	N/A	39	30.22	
15	02/12/2012	11:50	41° 53.96	083° 03.90	35	0	0	N/A	N/A	35	30.16	
16	03/16/2012	19:15	46° 02.17	083° 58.51	27	90	0	plate	8	48	30.17	
17	03/20/2012	17:30	46° 03.13	083° 56.48	39	10	0	slush	1	60	30.09	
18	03/22/2012	19:30	46° 24.28	084° 14.68	32	0	0	N/A	N/A	50	30.27	
19	03/25/2012	15:00	41° 53.30	082° 55.28	39	0	0	N/A	N/A	66	30.05	
20	03/25/2012	17:20	41° 43.14	082° 17.47	47	0	0	N/A	N/A	60	30	
21	03/27/2012	15:50	41° 57.26	081° 09.91	66	0	0	N/A	N/A	40	30.3	
22	04/02/2012	14:40	42° 02.24	080° 42.20	61	0	0	N/A	N/A	50	30.11	
23	04/05/2012	12:20	42° 00.14	080° 48.64	59	0	0	N/A	N/A	50	30.09	
CCB-A	04/05/2012	N.D.	41° 44.89	081° 41.83	70	0	0	N/A	N/A	N.D.	N.D.	
CCB-B	04/05/2012	N.D.	41° 44.89	081° 41.83	70	0	0	N/A	N/A	N.D.	N.D.	
24	04/13/2012	11:45	41° 56.11	083° 02.22	32	0	0	N/A	N/A	48	30.32	
25	04/13/2012	12:40	41° 53.61	082° 48.62	40	0	0	N/A	N/A	50	30.33	

APPENDIX II: NEAH BAY Sampling Log												
Stn	Date	Wind	Wind	Weather	Chl	Chl	Chl	NH3	NO3	SIO2	SRP	TP
		(kt)	(°)		(0.2 µm)	(20 µm)	(GF/F)	mg L-1	mg L-1	mg L-1	mg L-1	mg L-1
1	01/04/2012	14	250	Clear	0.54	0.08	0.98	0.068	0.73	3.12	0.0097	0.056
2	01/06/2012	16	210	Clear	0.54	0.05	1.43	0.07	1.18	4.2	0.0238	0.0828
3	01/06/2012	11	237	Clear	0.58	0.09	1.15	0.074	0.73	3.76	0.0152	0.0594
4	01/06/2012	17	240	Clear	0.87	0.32	1.54	0.035	0.39	3.25	0.0067	0.0446
5	01/10/2012	6	290	Clear	4.52	2.28	6.25	0.045	0.3	2.6	0.0094	0.0401
6	01/12/2012	12	245	Clear	0.43	0.12	0.91	0.061	1	3.23	0.0077	0.0476
7	01/17/2012	12	130	overcast	9.46	3.58	15.64	0.042	0.3	2.27	0.0033	0.0386
8	01/17/2012	12	180	overcast	13.45	5.68	24.99	0.014	0.08	0.76	0.0021	0.0305
9	01/17/2012	18	185	overcast	0.74	0.35	1.47	0.088	0.66	3.55	0.0028	0.0286
10	01/20/2012	N.D.	N.D.	N.D.	0.42	0.07	1.91	0.043	0.4	2.58	0.0025	0.0265
1	02/07/2012	9	280	overcast	0.38	0.04	0.40	0.095	0.66	3.09	0.0093	0.0393
11	02/07/2012	7	292	overcast	0.65	0.05	0.84	0.114	0.36	2.29	0.0045	0.026
12	02/08/2012	12	260	Clear	0.18	0.02	0.21	0.03	0.18	1.93	0.0015	0.0109
12	02/09/2012	10	270	Clear	0.23	0.03	0.25	0.036	0.26	2.14	0.0012	0.0044
13	02/09/2012	14	240	Clear	0.23	0.04	0.27	0.023	0.38	2.13	0.0019	0.0034
14	02/09/2012	8	220	Clear	0.24	0.05	0.23	0.051	0.31	2.1	0.002	0.0029
15	02/12/2012	20	290	overcast	0.76	0.06	0.66	0.219	0.3	2.71	0.0086	0.0148
16	03/16/2012	N.D.	N.D.	Clear	1.06	0.21	0.81	0.045	0.33	1.76	0.0041	0.0124
17	03/20/2012	13	60	Clear	1.00	0.26	0.88	0.03	0.31	1.85	0.0034	0.0115
18	03/22/2012	0	N/A	Fog	1.14	0.31	1.14	0.042	0.34	1.98	0.0059	0.0109
19	03/25/2012	6	210	Clear	1.40	0.41	1.24	0.08	0.39	1.62	0.0041	0.0168
20	03/25/2012	6	230	Fog/Clear	1.32	0.16	1.59	0.047	0.04	0.01	0.0036	0.0156
21	03/27/2012	13	65	Clear	9.44	5.67	11.88	0.038	0.14	0.07	0.0032	0.0203
22	04/02/2012	4	316	Clear	6.73	2.17	4.40	0.042	0.3	0	0.0037	0.0189
23	04/05/2012	17	53	Clear	2.00	1.93	2.51	0.04	0.1	0.21	0.0045	0.0154
CCB-A	04/05/2012	N.D.	N.D.	N.D.	6.26	3.93	4.95	0.04	0.46	0.1	0.0044	0.0188
CCB-B	04/05/2012	N.D.	N.D.	N.D.	6.28	3.15	5.61	0.034	0.52	0.13	0.0054	0.0207
24	04/13/2012	5	119	Clear	0.80	0.04	0.68	0.107	0.26	1.9	0.0033	0.0297
25	04/13/2012	4	120	Clear	4.55	1.10	5.68	0.026	0.39	1.69	0.0036	0.0204