

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

AOS PROTOCOL AND PROCEDURE: ZOOPLANKTON SAMPLING IN LAKES

PREPARED BY	ORGANIZATION	DATE
Stephanie Parker	AQU	11/13/2015
Charlotte Roehm	AQU	11/14/2012

APPROVALS	ORGANIZATION	APPROVAL DATE
Andrea Thorpe	SCI	01/20/2016
Mike Stewart	PSE	12/30/2015

RELEASED BY	ORGANIZATION	RELEASE DATE
Jennifer DeNicholas	CM	01/21/2016

See configuration management system for approval history.

© 2016 NEON Inc. All rights reserved.

The National Ecological Observatory Network is a project solely funded by the National Science Foundation and managed under cooperative agreement by NEON, Inc. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	05/28/2014	ECO-01127	Initial release
B	08/29/2014	ECO-02210	Minor updates based on feedback from the field
C	11/14/2014	ECO-02467	Migration to new protocol template
D	05/15/2015	ECO-02666	Minor updates including changes to the number of integrated samples taken, concentration of ethanol, updates to sample shipping and labeling, and the addition of sampling dates to appendix.
E	01/21/2016	ECO-03448	Removed Secchi/depth profile sampling, updates to Schindler sampling depth.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

TABLE OF CONTENTS

1 OVERVIEW1

1.1 Background 1

1.2 Scope..... 3

1.2.1 NEON Science Requirements and Data Products 3

1.3 Acknowledgments..... 3

2 RELATED DOCUMENTS AND ACRONYMS4

2.1 Applicable Documents 4

2.2 Reference Documents..... 4

2.3 Acronyms 4

2.4 Definitions..... 5

3 METHOD5

4 SAMPLING SCHEDULE7

4.1 Sampling Frequency and Timing 7

4.2 Criteria for Determining Onset and Cessation of Sampling 7

4.3 Timing for Laboratory Processing and Analysis 7

4.4 Sample Timing Contingencies 8

4.5 Sampling-specific Concerns 8

5 SAFETY9

6 PERSONNEL AND EQUIPMENT.....10

6.1 Equipment..... 10

6.2 Training Requirements..... 14

6.3 Specialized Skills..... 14

6.4 Estimated Time 14

7 STANDARD OPERATING PROCEDURES15

SOP A PREPARING FOR SAMPLING15

SOP B FIELD SAMPLING15

SOP C DATA ENTRY AND VERIFICATION21

SOP D SAMPLE SHIPMENT22

8 REFERENCES24

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

APPENDIX A	DATASHEETS	25
APPENDIX B	QUICK REFERENCES	26
APPENDIX C	REMINDERS	27
APPENDIX D	ESTIMATED DATES FOR ONSET AND CESSATION OF SAMPLING	28
APPENDIX E	SITE-SPECIFIC INFORMATION: SAMPLER RECOMMENDATIONS	29

LIST OF TABLES AND FIGURES

Table 1.	Contingent decisions.....	8
Table 2.	Equipment list – General equipment.....	10
Table 3.	Equipment list – Sampling equipment.....	11
Table 4.	Equipment list – Shipping supplies	13
Table 5.	Datasheets associated with this protocol.....	25
Figure 1.	Classes of zooplankton (from Tharp).....	2
Figure 2.	Zones of a lake.	3
Figure 3.	A generic lake site layout with zooplankton sampling locations.....	6
Figure 4.	Example of adhesive field labels for zooplankton sampling.....	15
Figure 5.	Example of a Schindler-Patalas sampler with Dolphin bucket.	16
Figure 6.	Schindler-Patalas sampling depths.....	17
Figure 7.	Zooplankton tow net with bottom tubing and clamp.	19
Figure 8.	Tow net configuration.	20
Figure 9.	Example field sheet for zooplankton collection (RD[05]).	20

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

1 OVERVIEW

1.1 Background

Zooplankton inhabit all layers of a water body and constitute a major link between primary production and higher trophic levels in aquatic ecosystems. Unlike algae or phytoplankton, zooplankton are microscopic animals that do not produce their own food (Figure 1). These small invertebrates float freely in the water column of lakes and oceans. They are important as both prey and consumers in the aquatic food web. Zooplankton are often filter feeders (sometimes predators) that feed primarily on algae while also being the main food source for planktivorous fish. The zooplankton assemblage responds to environmental stressors such as nutrients, and such effects can be detected through changes in species composition, abundance, and body size distribution (USEPA, 2012).

Many zooplankton are capable of strong swimming movements and may migrate vertically from tens to hundreds of meters; others have limited mobility and depend more on water turbulence to stay afloat. Zooplankton can be classified according both to developmental stages: meroplankton and holoplankton; and to size (Sanders and Porter, 1990). Meroplankton spend only part of their life cycles as plankton, while holoplankton spend essentially their whole existence in the water column. Freshwater zooplankton are dominated by six major groups of animals: protozoa, rotifers, two subclasses of the Crustacea, the cladocerans and copepods, and *Mysis* and *Chaoborus* (Figure 1 a-d). The planktonic protozoa in particular have limited locomotion and are dominated by the meroplanktonic pelagic zooplankton (5 – 300 µm), characterized by a summer planktonic lifecycle, spending the rest of their life cycle in the sediments. Several non-planktonic rotifers (150 µm – 1 mm) are sessile (lower mobility) and mostly associated with the littoral zone (Figure 2). Most rotifers are non-predatory, and omnivorously feed on bacteria, small algae, and detrital particulate organic matter. The majority of Cladocera are small (0.2 to 3.0 mm) and have a distinct head and bivalve carapace covering the body. Locomotion is accomplished mainly by means of the large secondary antennae. Planktonic copepods (2-4 mm) consist of two major groups, the calanoids (*Diatomus*) and the cycloids, distinguished by their body structure and length of antennae.

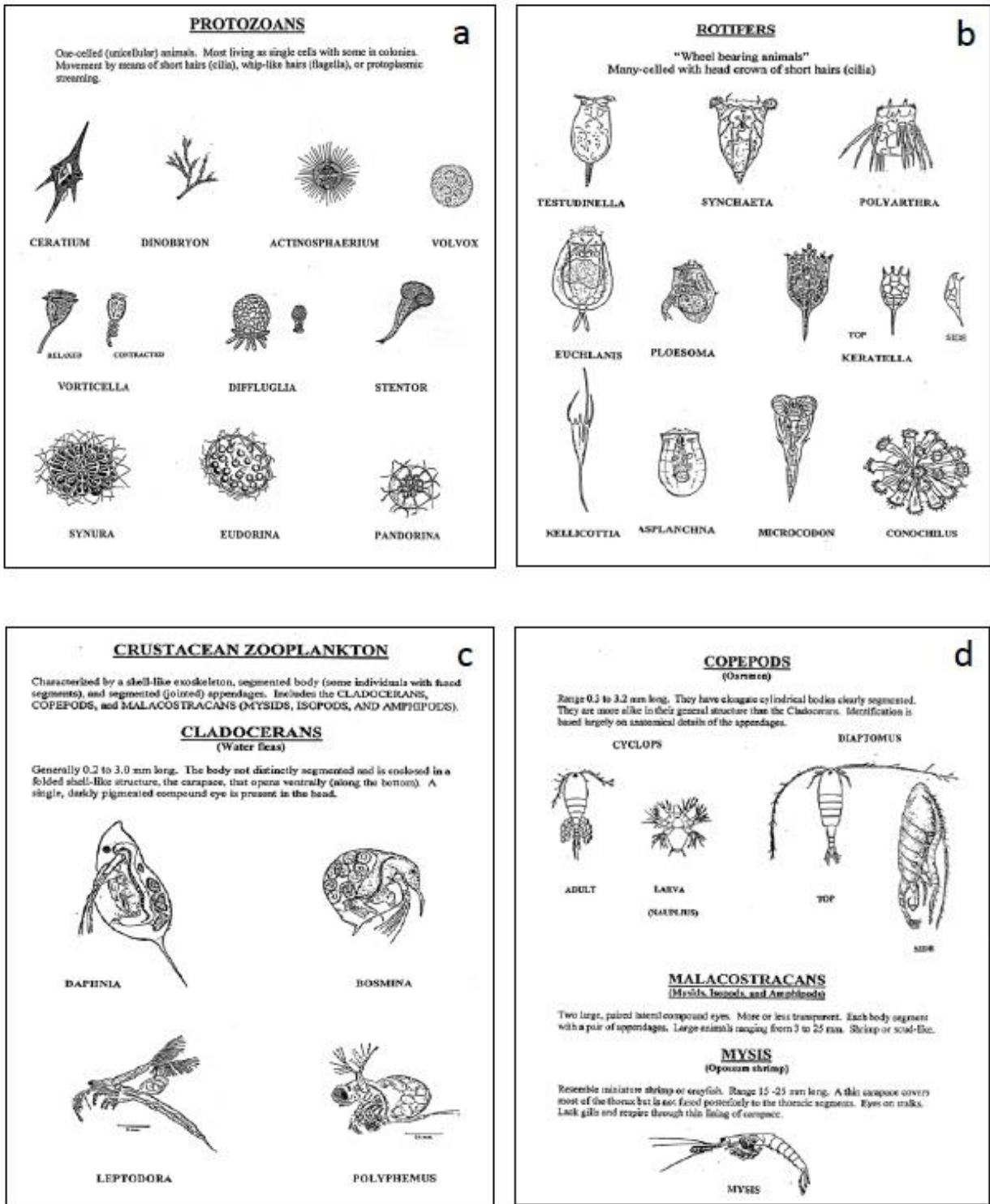


Figure 1. Classes of zooplankton (from Tharp).

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

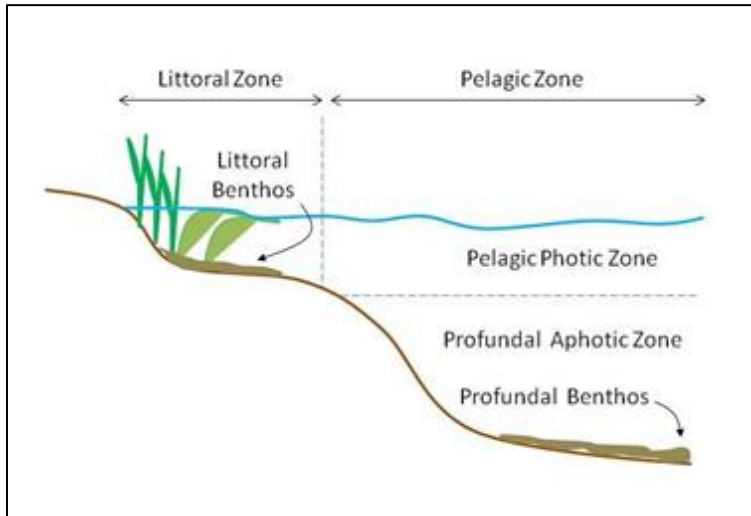


Figure 2. Zones of a lake.

Seasonality plays an important role in zooplankton species presence and abundance, with cyclopoid and calanoid copepods dominating the community in the winter months, with large cladocera peaking in mid-summer and small cladocera in later summer early autumn (Gerten and Adrian, 2002). A change in lake trophic conditions from oligotrophic to eutrophic has been shown to result in size-selective predation that potentially contributes to the decline of larger zooplankton, with ciliated protozoans and rotifers becoming more important (Wetzel, 2001).

1.2 Scope

This document provides a change-controlled version of Observatory protocols and procedures. Documentation of content changes (i.e. changes in particular tasks or safety practices) will occur via this change-controlled document, not through field manuals or training materials.

1.2.1 NEON Science Requirements and Data Products

This protocol fulfills Observatory science requirements that reside in NEON’s Dynamic Object-Oriented Requirements System (DOORS). Copies of approved science requirements have been exported from DOORS and are available in NEON’s document repository, or upon request.

Execution of this protocol procures samples and/or generates raw data satisfying NEON Observatory scientific requirements. These data and samples are used to create NEON data products, and are documented in the NEON Scientific Data Products Catalog (RD[03]).

1.3 Acknowledgments

This protocol is based on modified version of USEPA (2012a, b), Baker et al. (1997), and USEPA (2009).

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain higher-level information that is implemented in the current document. Examples include designs, plans, or standards.

AD[01]	NEON.DOC.004300	EHS Safety Policy and Program Manual
AD[02]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD[03]	NEON.DOC.000724	Domain Chemical Hygiene Plan and Biosafety Manual
AD[04]	NEON.DOC.050005	Field Operations Job Instruction Training Plan

2.2 Reference Documents

Reference documents contain information that supports or complements the current document. Examples include related protocols, datasheets, or general-information references.

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms
RD[03]	NEON.DOC.002652	NEON Level 1-4 Data Products Catalog
RD[04]	NEON.DOC.001271	NEON Protocol and Procedure: Manual Data Transcription
RD[05]	NEON.DOC.002302	Datasheets for AOS Protocol and Procedure: Zooplankton Sampling in Lakes
RD[06]	NEON.DOC.001646	General AQU Field Metadata Sheet
RD[07]	NEON.DOC.002191	Datasheets for Secchi Depth and Depth Profile Sampling
RD[08]	NEON.DOC.001152	NEON Aquatic Sample Strategy Document
RD[09]	NEON.DOC.001154	AOS Protocol and Procedure: Aquatic Decontamination
RD[10]	NEON.DOC.001197	AOS Protocol and Procedure: Bathymetry and Morphology of Lakes and Non-Wadeable Streams
RD[11]	NEON.DOC.002494	Datasheets for AOS Sample Shipping Inventory
RD[12]	NEON.DOC.002792	AOS Protocol and Procedure: Secchi Depth and Depth Profile Sampling

2.3 Acronyms

Acronym	Definition
DI	Deionized
EMAP	Environmental Monitoring and Assessment Program (USEPA)
mL	milliliter
NLA	National Lakes Assessment (USEPA)
PFD	Personal Flotation Device
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

2.4 Definitions

Epilimnion: Top layer of water of a stratified lake, denoted by highest temperatures and least dense water. Typically occurs in the summer.

Euphotic zone (or “Photic zone”): The upper layer of lake water where sunlight penetrates and photosynthesis can occur. Specifically, the depth to which 1% of surface light penetrates.

Eutrophic: An ecosystem with high nutrient concentration. In lakes, this often equates to algal proliferation or algal blooms.

Hypolimnion: The dense bottom layer of a stratified lake that sits below the thermocline. This layer is cooler than the surface water and has less circulation.

Metalimnion: The layer of water in a stratified lake that sits between the hypolimnion and the epilimnion. Often equated with the thermocline.

Oligotrophic: An ecosystem with low nutrient content. In lakes, this often equates to very clear water and little algal production.

Pelagic: The part of the lake that is not near shore or close to the bottom.

Stratified: Layers within the system (e.g., warm and cold water layers indicate thermal stratification in a lake).

Thermocline: A distinct layer in a body of water where the change in temperature is more rapid than increasing depth - usually a change of more than 1 °C per meter. The denser and cooler layer below the thermocline is the hypolimnion, the warmer upper layer is termed the epilimnion.

3 METHOD

The goals of the Zooplankton Sampling in Lakes Protocol are to quantify biodiversity, number of species present, and biomass (or biovolume) at each lake site. These variables will be used to build a database over time, in order to track changes in zooplankton community structure and function, and introduction of invasive species.

Samples shall be collected as an integrated water column sample at the central location of the lake. Two additional samples are taken at the inlet and outlet of the lake or a location downwind of the predominant wind direction. Samples are collected 3 times per year in order to capture differences in community composition, abundance, diversity, and biomass.

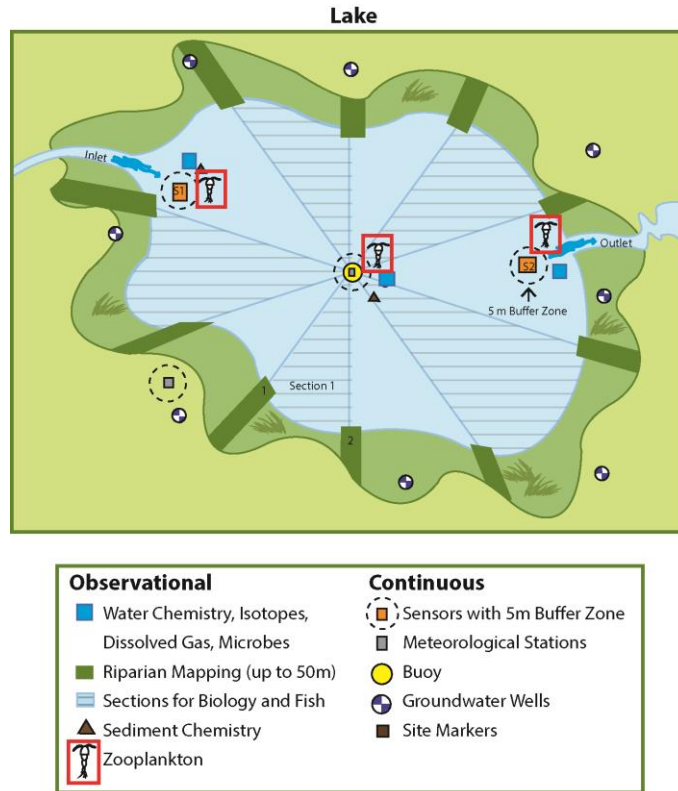


Figure 3. A generic lake site layout with zooplankton sampling locations

Standard Operating Procedures (SOPs), in Section 7 of this document, provide detailed step-by-step directions, contingency plans, sampling tips, and best practices for implementing this sampling procedure. To properly collect and process samples, field technicians **must** follow the protocol and associated SOPs. Use NEON’s problem reporting system to resolve any field issues associated with implementing this protocol.

The value of NEON data hinges on consistent implementation of this protocol across all NEON domains, for the life of the project. It is therefore essential that field personnel carry out this protocol as outlined in this document. In the event that local conditions create uncertainty about carrying out these steps, it is critical that technicians document the problem and enter it in NEON’s problem tracking system.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

4 SAMPLING SCHEDULE

4.1 Sampling Frequency and Timing

Lake zooplankton sampling occurs three times per year at each lake site, roughly spring, summer, and autumn. Sampling must be scheduled within the first 21 days of the 1 month window specified in Appendix D with a minimum of two weeks between sampling dates. Accommodations for local weather conditions (e.g., late ice-off) may be made that cause the sample date to fall outside of the pre-determined window. Use NEON’s problem reporting system to report sampling efforts that take place outside of the defined sampling window.

4.2 Criteria for Determining Onset and Cessation of Sampling

A range of dates for each site were determined *a priori*, based on historical data including ice on/ice off, the accumulation of degree days, weather, and riparian phenology (Appendix D).

4.3 Timing for Laboratory Processing and Analysis

Though samples should ideally be shipped to external processing facilities within 7 days of collection, they may be held for up to 30 days at the domain support facility if necessary.

4.4 Sample Timing Contingencies

All samples from one sampling bout must be collected within one day (i.e., all samples per lake/non-wadeable stream as detailed in this protocol). A minimum of 2 weeks between sample periods shall be observed.

Table 1. Contingent decisions

Delay/ Situation	Action	Outcome for Data Products
Hours	If weather conditions deteriorate and the lake becomes unsafe (e.g., approaching thunderstorm) or becomes too windy (>32 km hr ⁻¹) and has unsafe wave heights (>1 m) so that the boat cannot be held stationary over a sampling point while at anchor, return to shore and wait in a safe location for 30 minutes. If conditions improve, resume sampling, if not, return to the Domain Support Facility and sample at another time.	None as long as samples are collected within the pre-determined sampling window. If waiting for favorable conditions causes sampling to occur outside of the sampling window, data must be flagged.
	If you are able to return to the site to sample within 24 hours, you may keep samples from the previous day. If you are not able to return within 24 hours, discard any previously collected samples in the water or at the Domain Support Facility and start over.	None as long as samples are collected within the pre-determined sampling window. If waiting for favorable conditions causes sampling to occur outside of the sampling window, data must be flagged.
6 Months	Preserved zooplankton samples may be held for up to 6 months at 4 °C in the domain support facility if circumstances do not allow shipping to the external laboratory.	Holding samples >30 days affects external lab schedules, staffing, and budgets and delays data release on the NEON portal. However, sample integrity is not affected and samples do not need to be flagged if held for ≤ 6 months.

4.5 Sampling-specific Concerns

1. Zooplankton often become trapped in the folds of the nets (near the stitching). Check net seams between samples to ensure that specimens are added to the correct samples, and do not remain in the net between sites.
2. Samples must be preserved within 30 minutes in the field.
3. Use only deionized water rinse inside zooplankton sampling nets to prevent introduction of additional zooplankton to the samples.

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

5 SAFETY

This document identifies procedure-specific safety hazards and associated safety requirements. It does not describe general safety practices or site-specific safety practices.

Personnel working at a NEON site must be compliant with safe field work practices as outlined in the Operations Field Safety and Security Plan (AD[02]) and EHS Safety Policy and Program Manual (AD[01]). Additional safety issues associated with this field procedure are outlined below. The Field Operations Manager and the Lead Field Technician have primary authority to stop work activities based on unsafe field conditions; however, all employees have the responsibility and right to stop their work in unsafe conditions.

Safety Data Sheets (SDS) shall be readily available and reviewed for all chemicals (ethanol) used during this task. Whenever chemicals are used, follow requirements of the site-specific Chemical Hygiene and Biosafety Plan (AD[03]) for Laboratory Safety and NEON EHS Safety Policy and Program Manual (AD[01]), Section HC-03, Hazard Communication.

See Section 10 in the NEON Operations Field Safety and Security Plan (AD [01]) for aquatic-specific field safety requirements. In addition, the following safety requirement must be followed:

1. In **lakes**, site-specific hazards may be encountered that cause technicians to conduct sampling from the boat, without dismounting from the vessel. In addition, technicians are required to use extra caution in waters where alligators are present and to make sure a safe distance from hazards is maintained.
2. All personnel must be wearing a personal flotation device (PFD) prior to entering the boat.
3. All employees shall have access to a form of communication with other team members such as a two-way radio.
4. Technicians should be aware of any site-specific hazards and to the waters of that particular location (i.e. current status, tidal charts, etc.).

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

6 PERSONNEL AND EQUIPMENT

6.1 Equipment

The following equipment is needed to implement the procedures in this document. Equipment lists are organized by task. They do not include standard field and laboratory supplies such as charging stations, first aid kits, drying ovens, ultra-low refrigerators, etc.

Table 2. Equipment list – General equipment

Item No.	R/S	Description	Purpose	Quantity	Special Handling
Durable items					
RD[10]	R	Site-specific Bathymetry Map	Determining sampling locations	1	N
	S	Work gloves	Used with the samplers for safe handling of the rope	1 pair	N
	R	Cooler with ice packs	Keeping samples cool	1	N
Consumable items					
RD[06]	R	Aquatic Field Metadata Sheet (all-weather paper)	Recording metadata	1	N
RD[05], RD[07]	R	Field data sheets (all-weather paper,)	Recording data	2	N
	R	Pre-printed adhesive labels	Labeling sample bottles	1 sheet	N

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

Item No.	R/S	Description	Purpose	Quantity	Special Handling
	S	Laboratory nitrile gloves	Preventing preservative contact with skin	3 pair	N
	R	Pencils	Recording data	4	N
	R	Permanent markers	Labeling samples	4	N

R/S=Required/Suggested

Table 3. Equipment list – Sampling equipment

Item No.	R/S	Description	Purpose	Conditions Used	Quantity	Special Handling
Durable items						
MX100397	R	Plankton tow net, 12" mouth, 63 µm mesh	Collecting samples	Water depth >4 m	1	N
	R	Nylon safety line (10-50 m)	Used with tow net and Schindler-Patalas	Water depth >4 m	1	N
MX105580	R	Schindler-Patalas sampler, 12 L, 63 µm mesh size	Collecting samples	Water depth ≤4 m	1	N
MX107128	R	500 mL Wash bottle	Rinsing the sampler net	All	1	N

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

Item No.	R/S	Description	Purpose	Conditions Used	Quantity	Special Handling
	S	Plastic sampling tray	Removing debris from the sample	All	1	N
	S	Forceps	Removing debris from the sample	All	1	N
MX109276	S	Depth finder	Determining depth at sampling location	All	1	N
Consumable items						
MX100652	R	500 mL Nalgene sample bottles	Sample container	All	3	N
MX100665	S	1 L Nalgene sample bottles	Sample container for large samples	Large samples	3	N
	R	95% Ethanol	Preservative	All	1	Y
	R	DI water	Rinsing	All	2L	N
MX104844	S	Resealable bags (gallon)	Organizing sample bottles	All	3	N

R/S=Required/Suggested

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

Table 4. Equipment list – Shipping supplies

Item No.	R/S	Description	Purpose	Quantity	Special Handling
Durable Items					
(None)					
Consumable Items					
	R	Cardboard box, UN-rated, Group II	Shipping samples to taxonomist	1	N
MX109205	R	Vermiculite, Grade 2	Absorbing liquid leaks and cushioning shipment	TBD	N
	R	Heavy duty plastic trash bag	Lining the shipping container	1	N
	R	Appropriate labels and forms for limited quantity ground shipments (see AD[03])	Shipping paperwork and external shipping labels	TBD	N
	R	Shipping inventory (RD[11])	Provides sample information to external lab	1	N

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

6.2 Training Requirements

Technicians must complete protocol-specific training for safety and implementation of this protocol as required in Field Operations Job Instruction Training Plan (AD[04]).

All personnel required to operate a boat shall be trained through an approved program. All others shall be aware of boating safety procedures.

Personnel will be trained in field protocols associated with this document, and trained in safe working practices for aquatic field work. Technicians must also be trained in safe handling of ethanol (AD[03]).

6.3 Specialized Skills

Where applicable, personnel will be licensed to operate a boat and able to safely handle a motor and drive a boat safely.

6.4 Estimated Time

The time required to implement a protocol will vary depending on a number of factors, such as skill level, system diversity, environmental conditions, and distance between sample plots. The timeframe provided below is an estimate based on completion of a task by a skilled two-person team (i.e., not the time it takes at the beginning of the field season). Use this estimate as framework for assessing progress. If a task is taking significantly longer than the estimated time, a problem ticket should be submitted.

Field sampling requires two technicians for four hours per site plus travel to and from the site. There is no domain lab processing associated with this protocol.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

7 STANDARD OPERATING PROCEDURES

SOP A Preparing for Sampling

1. Collect and prepare all equipment, including sample bottles and labels.
 - a. Load GPS sampling coordinates in GPS (accuracy ± 4 m).
2. Pre-print adhesive labels (Figure 4) for sample bottles and data sheets on all-weather paper.
 - a. Labels must be filled out using pencil or ethanol-safe pen in the field.

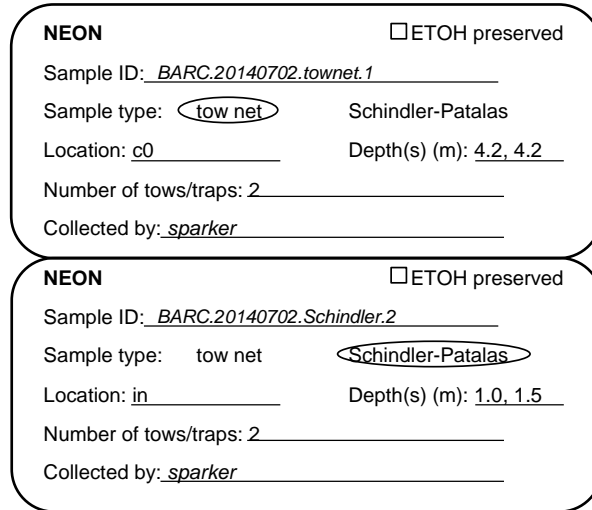


Figure 4 shows two examples of adhesive field labels for zooplankton sampling. Each label is a rounded rectangle with a border and contains the following information:

- NEON** (top left) and ETOH preserved (top right)
- Sample ID: BARC.20140702.townet.1
- Sample type: tow net (circled) Schindler-Patalas
- Location: c0 Depth(s) (m): 4.2, 4.2
- Number of tows/traps: 2
- Collected by: sparker

The second label has the following information:

- NEON** (top left) and ETOH preserved (top right)
- Sample ID: BARC.20140702.Schindler.2
- Sample type: tow net Schindler-Patalas (circled)
- Location: in Depth(s) (m): 1.0, 1.5
- Number of tows/traps: 2
- Collected by: sparker

Figure 4. Example of adhesive field labels for zooplankton sampling.

3. Check for holes in nets, assure that nets are clean and free of debris and organic matter and have been decontaminated (RD[09]) since last use.
4. Have ice or ice packs frozen and ready for cooler.
5. Check that all equipment is in good condition and all batteries are charged.
6. Fill out general aquatic field metadata sheet (RD[06]) and Secchi and depth profile data sheet (RD[07]) upon every field visit.


SOP B Field Sampling

B.1 Locating Sampling Locations

1. In the deepest point in the lake (near buoy), determined by site map and pre-loaded GPS coordinates, 1 integrated sample.
 - a. Location ID = "c0"
2. Near the major inlet in the littoral zone, 1 integrated sample.
 - a. Location ID = "in"
3. Near the outlet in the littoral zone, 1 integrated sample.
 - a. Location ID = "ot"

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

B.2 Collecting Samples

1. Navigate to within 5 m of the sampling location.
2. Gently lower anchors at the bow and allow boat to float back with wind or current to sampling location. Drop a second anchor at the stern to hold boat in place.
 - a. Allow ~5 minutes for sediments to settle after lowering the anchor; you can use this time to prepare the sampling equipment.
 - b. Using a bow anchor rope 2 times the water depth will minimize disturbance of the sediment at the sampling location.
 - c. The boat must be anchored at the bow and stern so that the boat doesn't rotate, in order to collect representative water column samples.
-  3. Always sample near the bow of the boat to minimize the effects of the motor on the water column. When anchored, the bow of the boat tends to orient itself with the bow into the wind or current.
4. Determine the total water depth from depth finder readings or a weighted rope.
 - a. If depth is ≤ 4 m, use a Schindler-Patalas sampler and proceed to Step 5.
 - b. If depth is >4 m, use the tow net and proceed to Step 7.
5. **Schindler-Patalas sampler** (Figure 5): Integrate 2 to 3 Schindler traps to equal 1 sample. Measure to the bottom of the Schindler trap box (Figure 6), Note sample type, sample depths, and number of traps collected on field data sheet (Figure 9, RD[05]).
 - a. If depth is 2-4 m, integrate the following (3 traps):
 - i. 0.5 m below surface (measure to bottom of Schindler trap)
 - ii. Middle of water column
 - iii. 0.5 m above lake bottom
 - b. If depth is 1-2 m, integrate the following (2 traps):
 - i. 0.5 m below surface
 - ii. 0.5 m above lake bottom
 - c. If depth is <1 m, integrate the following (2 traps):
 - i. 2 Schindler traps at 0.5 m below surface

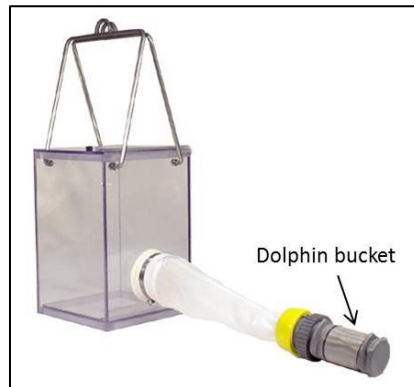


Figure 5. Example of a Schindler-Patalas sampler with Dolphin bucket.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

6. When using the Schindler-Patalas trap:

- a. Ensure the dolphin bucket is attached (Figure 5)
- b. Lower sampler to appropriate depth at a consistent speed so trap doors do not close prematurely.
 - i. When the depth is reached and the sampler stops descending, the trap doors will close automatically.
- c. Bring the sampler to the surface. The water will drain through the net.
 - i. When filled with water, this sampler is heavy. Work gloves may be worn to protect hands when pulling in the rope.
 - ii. Lift the sampler slowly to allow water to drain through the net and dolphin bucket.
- d. Inspect the sample for organic and inorganic debris. If sediments were captured, discard sample and start again. If organic debris (e.g., leaves, plants) is noted accounting for >25% of sample, discard sample and start again. Smaller amounts of organic debris can be removed by hand.
 - i. Discard sample away from where you intend to collect the next sample.
- e. Rinse the sampler and net until the entire sample is in the dolphin bucket.
 - i. Lake water can be used on the outside of the net
 - ii. DI must be used if rinsing the inside of the trap or net to ensure that no additional zooplankton are added to the sample.
- f. Carefully remove the dolphin bucket and transfer sample to a 500 mL sample bottle. Rinse dolphin bucket into collection bottle. Samples volume may be significantly less than 500 mL.
- g. Repeat steps above to integrate Schindler-Patalas samplers.
- h. Preserve according to Sample Preservation (Section B.3) and place sample bottle in cooler.
- i. Proceed to next sampling location, rinse trap, net, and dolphin bucket well with lake water, and repeat steps above.

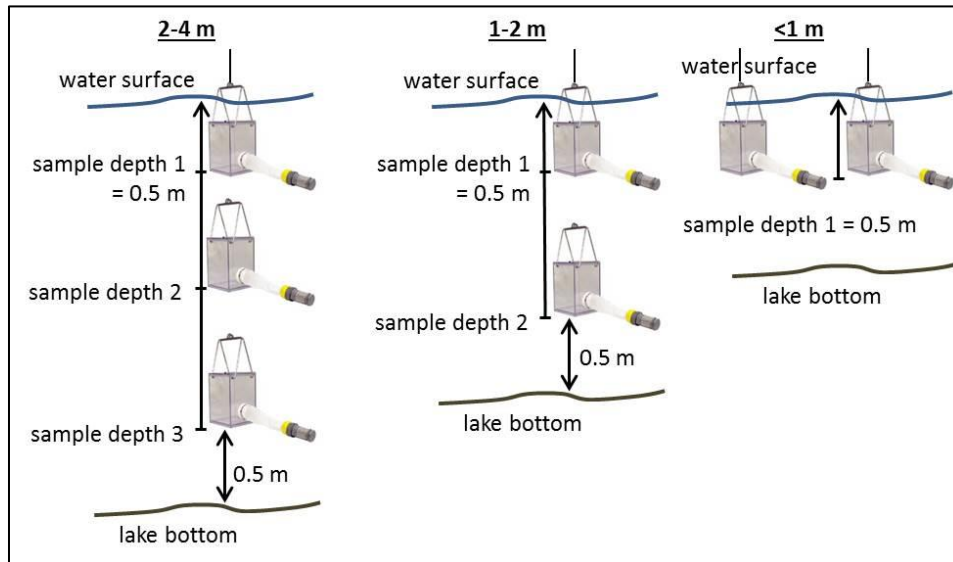


Figure 6. Schindler-Patalas sampling depths.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

7. **Tow net sampler** (Figure 7): integrate at least 2 tow nets to equal 1 sample. Measure depth to the top of the tow net mouth. Note sample type, sample depths, and number of tows collected on the field data sheet (RD[05]).
- a. Ensure that the tubing end is firmly attached and clamp is closed over tubing prior to sampling. The tubing end comes loose easily.
 - b. Lower the net to where the bottom tubing is 0.5 m above the bottom of the lake. If conditions are windy, add a small weight at the bottom of the net to help lower the tow net.
 - c. Pull the nylon rope vertically at a rate of 0.5 m/s until top of net is out of the water.
 - d. Inspect the sample for organic and inorganic debris. If sediments were captured, discard sample and start again. If organic debris (e.g., leaves, plants) is noted accounting for >25% of sample, discard sample and start again. Smaller amounts of organic debris can be removed by hand.
 - i. Discard sample away from where you intend to collect the next sample.
 - e. If algae clog the net, rinse the sides of the net down with the 500 mL wash bottle. If water cannot drain through the net, consider using the Schindler-Patalas sampler at this location.
 - i. Lake water can be used on the outside of the net
 - ii. DI must be used if rinsing the inside of the trap or net to ensure that no additional zooplankton are added to the sample.
 - f. After the inspection, slowly lower the net into the lake to within inches of the net opening above the water surface and abruptly pull upwards out of the water to collect the contents of the net at the bottom. *Take care not to submerge the top of the net opening below the water surface and introduce more sample water.* Repeat several times until the net is fully rinsed.



Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E



Figure 7. Zooplankton tow net with bottom tubing and clamp.

- g. Complete the rinsing of the net contents by spraying water against the **outside** of the net with a wash bottle filled with lake water. If rinsing the inside of the net, use DI water. Be sure to inspect and rinse the net seams carefully for trapped zooplankton.
- h. Holding the net in a vertical position, carefully open the spigot on the hose and pour into the 500 mL sample bottle.
 - i. If large organic debris is present, remove the large debris with forceps.
- i. Rinse the concentrated zooplankton into the collection bottle using a squirt bottle filled with DI.
- j. Note the tow depth (distance in meters of water column through which the collecting unit was retrieved) on the field data sheet (Figure 8, RD[05]) so sample volume can be calculated.
- k. Collect two or more tows following the steps above to increase the number of organisms in the sample.
 - i. Leave space in bottle for preservative (bottle should be no more than ~1/2 full).
- l. Preserve according to Sample Preservation (Section B.3) and place sample bottle in cooler.
- m. Proceed to the next sample location, and rinse the net, collection cup and retrieval rope thoroughly (2 to 3 times) with water from the site on the downwind side of the sampling location and repeat above steps.

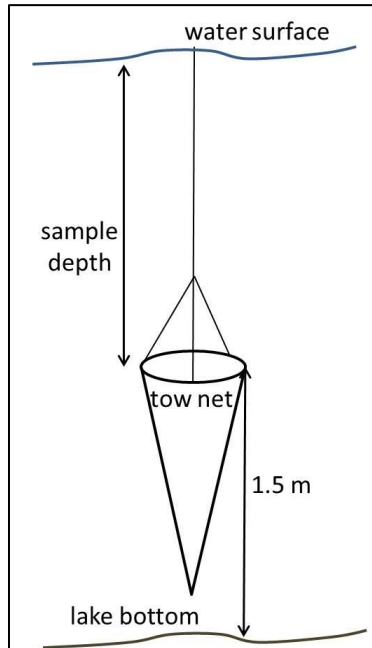


Figure 8. Tow net configuration.

NEON Zooplankton Collection							
Lakes							
Site (4-letter code): <i>SUGG</i>				Recorded by: <i>sparker@neoninc.org</i>			
Date (YYYY-MM-DD): <i>2014-07-02</i>				Collected by: <i>jstewart@Field-ops.org</i>			
Local time (HH:MM): <i>10:30</i>				Sampling protocol: <i>NEON.DOC.001194</i>		Rev: <i>C</i>	
Location ID	Sample type	Replicate	Sample ID	Sample depth 1 (m)	Sample depth 2 (m)	Sample depth 3 (m)	Number of tows/traps
<i>c0</i>	<i>tow net</i>	1	<i>SUGG.20140702.townet.1</i>	<i>3.6</i>	<i>3.6</i>	<i>NA</i>	<i>2</i>
<i>in</i>	<i>Schindler</i>	2	<i>SUGG.20140702.schindler.2</i>	<i>0.5</i>	<i>1.1</i>	<i>NA</i>	<i>2</i>
<i>ot</i>	<i>Schindler</i>	3	<i>SUGG.20140702.schindler.3</i>	<i>0.5</i>	<i>1.3</i>	<i>NA</i>	<i>2</i>

Figure 9. Example field sheet for zooplankton collection (RD[05]).

B.3 Sample Preservation



All processing must be completed in the field. Should conditions not allow for this step to be undertaken in the field within 5 minutes of sampling, all preservatives shall be added within 30 minutes of collecting the sample in the field and noted in the comments section.

1. Add enough 95% ETOH solution to the 500 mL sample bottle within 5 minutes of collection to reach a final concentration of ~30-40% ETOH.
 - a. The sample can be <500 mL.
 - b. Consider using a larger sample bottle (1 L) if there is not enough room to add ethanol to reach a final preservative concentration of 30-40%.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

- c. Use $C1V1=C2V2$ to calculate preservative volume, where:
 - i. **C1=concentration** of ETOH before adding to sample (95%)
 - ii. **V1=volume** of ETOH before adding to sample
 - iii. **C2=concentration** of ETOH in final sample (30-40%)
 - iv. **V2= volume** of final sample
- d. As a rule of thumb, add enough 95% ETOH to slightly less than double the sample volume (i.e., <50% ETOH in final sample).
2. Carefully re-cap bottle, ensuring that no sample escapes, and gently invert bottle to mix.
3. Store in a cooler (~4 °C) to return to Domain Support Facility.

B.4 Ending the Sampling Day

1. Refresh the sampling kit
 - a. Replace sample bottles.
 - b. Print new field labels and field data sheets.
 - c. Refill/restock preservative containers.
2. Equipment maintenance, cleaning and storage
 - a. Decontaminate all equipment that has come in contact with lake/non-wadeable stream water according to the NEON Aquatic Decontamination Protocol (RD 08)].
 - b. Dry all equipment thoroughly before storage.
 - c. Check all nets for holes and patch if necessary.

SOP C Data Entry and Verification

As a best practice, field data collected on paper datasheets should be digitally transcribed within 7 days of collection or the end of a sampling bout (where applicable). However, given logistical constraints, the maximum timeline for entering data is within 14 days of collection or the end of a sampling bout (where applicable). See RD[04] for complete instructions regarding manual data transcription. Enter all data from the field datasheets into AOS database, PDA, or Web UI if available.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

SOP D Sample Shipment

Information included in this SOP conveys science-based packaging, shipping, and handling requirements, not lab-specific or logistical demands. For that information, reference the CLA shipping document on NEON's CLA intranet site.

Shipments are to include a hardcopy of the "per sample" tab of the shipping inventory (RD[11]) as well as an electronic shipping inventory that is emailed to the receiving laboratory and to the contact in NEON Collections and Laboratory Analysis at the time of shipment. The shipment tracking number (shipment ID) must be included in the electronic version of the shipping inventory as well as the email, but is not necessary on the hard copy.

D.1 Zooplankton Sample Shipping

1. Place sealed sample bottles into one or several gallon-sized resealable zip-top bags, grouped by site. Sample jars are acceptable "inner containers" required for shipping.
2. Line a Group II cardboard box with a heavy-duty trash bag.
3. Place all sample bottles right-side up inside the trash bag, inside the Group II cardboard shipping box. Add Grade 2 Vermiculite in the trash bag liner as needed to take up excess space in container and cushion samples.
4. Include shipping inventory/manifest in an additional zip-top bag.
5. Follow instructions for shipping ETOH in limited quantity ground shipments in AD[03].

D.2 Handling Hazardous Material

Follow procedures for shipping ethanol in limited quantity ground shipments in AD[03].

D.3 Supplies/Containers

See section D.1 and Table 4 for specific shipping materials.

D.4 Timelines and Conditions

Shipping should occur within one week of sampling if possible, however samples may be held for up to 30 days at the domain support facility if necessary. Samples may be stored at the domain support facility at 4 °C until shipping. Ship samples at ambient temperature.

D.5 Grouping/Splitting Samples

Group samples by site per bout. Samples from multiple sites may be sent in the same shipment. Zooplankton samples may be shipped with macroinvertebrate samples if going to the same external lab.

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

D.6 Return of Materials or Containers

Include return shipping label with WBS code if any shipping materials need to be returned to the domain support facility (e.g., cooler).

D.7 Shipping Inventory

Shipments are to have a hardcopy of the per sample tab of the shipping inventory (RD[11]) sent in each box as well as an electronic shipping inventory that is emailed to the receiving laboratory and to the contact in NEON Collections and Laboratory Analysis at the time of shipment. Also include the shipment tracking number in the email.

D.8 Laboratory Contact Information and Shipping/Receipt Days

See the Shipping Information for External Facilities on NEON’s CLA intranet site.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

8 REFERENCES

- Baker, J.R., D.V. Peck, and D.W. Sutton (Eds.) 1997. Environmental Monitoring and Assessment Program Surface Waters: Field Operations Manual for Lakes. EPA/620/R-97/001. U.S. Environmental Protection Agency, Washington, D.C.
- Gerten, D. and Adrian, R. 2002. Species-specific changes in the phenology and peak abundance of freshwater copepods in response to warm summers. *Freshwater Biology* 47, 2163–2173.
- Sanders, R.W. and K.G. Porter. 1990. Bacterivorous flagellates as food resources for the freshwater crustacean zooplankter *Daphnia ambigua*. *Limnol. Oceanogr.* 35: 188-191.
- Tharp, R. <http://gvsu.edu/wri/education/instructor-s-manual-appendix-d-44.htm>.
- USEPA. 2005. Standard Operating Procedure for Zooplankton, Revision 10, (http://www.epa.gov/glnpo/monitoring/sop/chapter_4/LG402.pdf).
- USEPA. Minnesota. 2009. National Lake Assessment (NLA) protocol. National Lakes Assessment: a collaborative survey of the Nation's lakes. EPA 841/R-09/001, U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C.
- USEPA. 2012a. National Lakes Assessment Program, Field Operations Manual.
- USEPA. 2012b. Sampling Procedures for the Great Lakes.
- Wetzel R G. *Limnology*. Philadelphia: Saunders, 2001.

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

APPENDIX A DATASHEETS

The following datasheets are associated with this protocol:

Table 5. Datasheets associated with this protocol

NEON Doc. #	Title
NEON.DOC. 002302	Datasheets for AOS Protocol and Procedure: Zooplankton Sampling in Lakes
NEON.DOC.001646	General AQU Field Metadata Sheet
NEON.DOC.002191	Datasheets for Secchi Depth and Depth Profile Sampling
NEON.DOC.002494	Datasheets for AOS Shipping Inventory

These datasheets can be found in Agile or the NEON Document Warehouse.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

APPENDIX B QUICK REFERENCES

Step 1 – Check the zooplankton field sampling kit to make sure all supplies are packed.

Step 2 – Prepare labels (2" x 4").

Step 3 – Ensure the General AQU Field Metadata Sheet (RD[06]) is completed per field site visit.

Step 5 – Determine which sampler to use based on water depth.

1. If water depth is ≤ 4 m use a Schindler-Patalas sampler.
 - a. If 2-4 m collect samples at 0.5 m, mid-water column, and 0.5 m above the lake bottom and integrate.
 - b. If 1-2 m collect sample from 0.5 m and 0.5 m above the lake bottom and integrate.
 - c. If water is < 1 m collect 2 Schindler traps 0.5 m below water surface and integrate.
2. If water depth is > 4 m, use the tow net and integrate at least 2 tows.

Step 6 – Collect 1 integrated sample at:

1. In the deepest point in the lake (buoy), determined by site map and pre-loaded GPS coordinates
 - a. Location ID = "c0"
2. Near the major inlet in the littoral zone
 - a. Location ID = "in"
3. Near the outlet in the littoral zone
 - a. Location ID = "ot"

Step 7 – Preserve samples in the field with ethanol (final concentration 30-40%).

Step 8 – Ship samples to zooplankton taxonomy lab.

Title: AOS Protocol and Procedure: Zooplankton Sampling in Lakes		Date: 01/21/2016
NEON Doc. #: NEON.DOC.001194	Author: S. Parker	Revision: E

APPENDIX C REMINDERS

Before heading into the field: Make sure you...

- Collect and prepare all equipment including labels.
- Pre-print adhesive labels.
- Check for holes in nets, assure that nets are clean and free of debris and organic matter and have been decontaminated (RD[09]) since last use.
- Check that all equipment is in good condition and all batteries are charged.

Sample collection: Be sure to...

- Choose the appropriate sampler.
- Always sample near the bow of the boat to minimize the effects of the motor on the water column. When anchored, the bow of the boat tends to orient itself with the bow into the wind or current.
- Take care not to submerge the top of the net opening below the water surface after collecting the sample, during rinsing.

Sample processing: Be sure to...

- Preserve samples in the field.
- Store at 4 °C until shipping to the external lab.

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

APPENDIX D ESTIMATED DATES FOR ONSET AND CESSATION OF SAMPLING

Preliminary date ranges for biological sampling bouts in lakes. Also see the Site Specific Sampling Strategy Document on NEON’s FOPS intranet site.

Domain	Site	Bout 1	Bout 2	Bout 3
D03	Lake Barco	9Feb-9Mar	27Jun-25Jul	29Oct-26Nov
D03	Lake Suggs	9Feb-9Mar	27Jun-25Jul	29Oct-26Nov
D05	Crampton Lake	20Apr-18May	5Jul-2Aug	13Sep-11Oct
D05	Round Lake	20Apr-18May	5Jul-2Aug	13Sep-11Oct
D09	Prairie Lake	18Apr-16May	5Jul-2Aug	11Sep-9Oct
D09	Prairie Pothole	20Apr-18May	5Jul-2Aug	11Sep-9Oct
D11	South Pond at Klemme	9Feb-9Mar	27Jun-25Jul	29Oct-26Nov
D18	Toolik Lake	21May-18Jun	29Jun-27Jul	6Aug-3Sep

<i>Title:</i> AOS Protocol and Procedure: Zooplankton Sampling in Lakes		<i>Date:</i> 01/21/2016
<i>NEON Doc. #:</i> NEON.DOC.001194	<i>Author:</i> S. Parker	<i>Revision:</i> E

APPENDIX E SITE-SPECIFIC INFORMATION: SAMPLER RECOMMENDATIONS

Domain	Site	c0	in	ot
D03	Lake Barco	tow net	Schindler	Schindler
D03	Lake Suggs	Schindler	Schindler	Schindler
D05	Crampton Lake	tow net	Schindler	Schindler
D05	Round Lake	tow net	Schindler	Schindler
D09	Prairie Lake	tow net	Schindler	Schindler
D09	Prairie Pothole	tow net	Schindler	Schindler
D11	South Pond at Klemme	Schindler	Schindler	Schindler
D18	Toolik Lake	tow net	Schindler	Schindler