Quality Assurance Project Plan

for

Zooplankton Monitoring Program

NJDEP QAPP Number:
FY25-34

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Bureau of Freshwater and Biological Monitoring
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Period of Applicability:
QAPP approval date 2025 through 2030, 5 years

My signature below indicates my approval of the plan and my commitment to follow the procedures noted herein. I understand that changes to this plan shall not be made without approval/signature by all below signatories.

Project Manager	Emily Mayer Emily Mayer	4/24/25 Date
Project QA Manager	Chris Kunz Chris Kunz	4/21/2025 Date
Project QA/QC Manager	Alice Belskis Alice Belskis	4/16/25 Date
Field Manager	Johannus Franken Johannus Franken	4/16/25 Date
NJDEP QA Manager	Megan Rutkowski Megan Rutkowski	4/24/2025 Date

QAPP Approval Date*: 4/24/2025

*Any environmental information operations conducted prior to the OQA approval date may not be in compliance with the final approved version of the QAPP.

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A4 Project Purpose, Problem Definition, and Background

Title of Document	Date of Document	Pertinence to this QAPP
NJDEP's Quality Management Plan (QMP)	7/1/2020 – 6/30/2025	This QAPP was developed in accordance with the NJDEP's QMP.
BFBM's Lake Monitoring Network QAPP (Approved 3/1/2022)	2022-2024	Zooplankton surveys will be performed at Lake Monitoring network sites,

Project Purpose and Problem Definition

a. Provide research driven monitoring by initiating the identification and enumeration of zooplankton assemblages. This has been a missing component of the lakes monitoring program and is an important community to assess when it comes to the food web. The EPA's multimeric index for New Jersey is divided into the Eastern Highlands and Coastal Plains, however the Eastern Highlands multimetric indices (MMI) has not been applied to any sites within NJ and requires testing to prove its efficacy.

b. Assessment of zooplankton assemblages, both microzooplankton (known as smaller zooplankton under 20 and 200 µm) and mesozooplankton (known as larger zooplankton 0.2mm - 20mm define zooplankton and types etc) will provide more insight into a potential contributing factor of the cause of HABs (Harmful Algal Blooms). According to EPA, zooplankton MMI appear to respond more strongly to increased nutrient concentrations than to shoreline habitat conditions. The EPA's multimeric index for New Jersey is divided into the Eastern Highlands and Coastal Plains, however the Eastern Highlands MMI has not

been applied to any sites within NJ and requires testing to prove its efficacy. The Coastal Plains MMI has only been applied to one 'least disturbed' site in southern NJ and requires further analysis to determine its efficacy. Improving our understanding of how zooplankton assemblages respond to increased human disturbance, and obtaining more information for zooplankton taxa would likely improve MMIs development for future assessments.

c. To characterize the composition, and abundance of zooplankton assemblages at specified list of lakes which may vary from year to year (this may include Targeted, Probabilistic, Reference, etc.) and potentially other lakes in the future. To establish baseline database that will allow for future evaluations of trophic interactions, indicator development, future model applications, trend analyses, to compare into the relating spatial patterns in zooplankton assemblages to changes in water quality and to further define the zooplankton MMI.

d. Information could also be used in the generation of the biennial New Jersey Integrated Water Quality and Assessment Report [305(b) and 303(d)].

Project Background

The Bureau of Freshwater and Biological Monitoring has maintained the Lake Monitoring Network Program since 2005. While this long-term monitoring program has been valuable in assessing water quality, HABs, and other conditions over time, there is an understanding that an evaluation of the health of the system and of the effects of any management actions is not complete without an evaluation of processes and trends in the living communities.

An understanding of the zooplankton community, which is an essential link in the food web, will allow scientists and managers complete comprehension of the system and its responses to environmental factors. With continued zooplankton monitoring over time, patterns may provide information through which the health of the ecosystem may be evaluated. With this information along with information regarding the relationships to water quality will allow a more complete understanding of the processes and responses in freshwater resources. Zooplankton that inhabit lakes are susceptible to environmental change, but our understanding about how biological communities react to simultaneous changes in geochemistry, and ways to evaluate this are incomplete. This research would investigate how zooplankton communities respond on both long-term and seasonal scales. These small organisms are sensitive to changes in physical lake conditions, and variation within zooplankton communities could indicate larger ecosystem shifts with potential insights related to nutrient criteria.

A5 Project Task Description

Table 1: Task / Deliverable Schedule			
Task/Deliverable	Responsible Individual	Anticipated Start Date	Anticipated End Date
QAPP development	Emily Mayer	January 2025	April 2025
Zooplankton Monitoring *	Lakes Team: Johannus Franken, Carly Conticchio, Brian Taylor, John Abatemarco, Kelly Krolik, Emily Mayer	April 2025	November 2025
Zooplankton Analysis / Final Report - Reporting – Annual review & annual final report *	Alice Belskis, Emily Mayer	October 2025	April 2025
Generation of integrated report	BEARS Staff	TBD	TBD

**Recurring each year for five years, ending 4/2030*

A6 Information/Data Quality Objectives and Performance/Acceptance Criteria

One sampling event will take place at each lake selected per year from the list of lakes selected that year. The list of sites may change from year to year based on the capacity of staff to complete the work. A potential list of these sites is in Appendix A. A pre-season meeting will occur between staff to determine the number of sites, and which sites will be sampled per year. Zooplankton monitoring conducted at each lake will help gain a baseline of the composition and assemblage of that plankton community. The following objectives will be captured:

- To characterize the composition, and abundance of zooplankton assemblages at specified list of lakes.
- To establish a baseline database that will allow for future evaluations of trophic interactions, indicator development, future model applications, and to compare the relating spatial patterns in zooplankton to changes in water quality.

Precision

To ensure precision is accounted for during the sampling collections, the same equipment will be used for repeatability purposes. Methods to determine precision during zooplankton monitoring will include:

- Utilizing two Plankton net samplers one fine mesh sampler (50 μm) and one coarse mesh sampler (150 μm), will capture the microzooplankton and larger zooplankton from the

water column at vertical tows as recommended by the National Lakes Assessment standards (USEPA, 2022).

- Sampling depth will vary based on the morphology and thermocline of each lake. Sampling will take place at the deepest lake station 1x per year.
- Utilizing a compound microscope to identify and enumerate zooplankton samples (20x - 63x magnification).
- Microscope will be calibrated 1x every year to ensure efficiency and accuracy.
- Three replicates will be examined from the same sample to determine an average count of the zooplankton composition and assemblage. If time allows, biovolume measurements of 20 individuals from the following groups: cladocera, and copepods as outlined in Appendix B will be recorded. Measurements and pictures will be taken utilizing the image capturing software Pax-it or equivalent.
- Of the sites sampled, a total of 1 duplicate per 5 - 20 samples will be collected and examined by another trained BFBM staff member for quality assurance purposes.

Accuracy (Bias)

When utilizing a compound microscope for zooplankton monitoring, accuracy of requirements is crucial to ensure proper identification and analysis. Below is an outline of the following accuracy requirements:

- Magnification: typically, 20x – 63x to examine finer details for identification.
- High resolution lenses (i.e. plan achromatic or apochromatic) to reduce optical distortions.
- Higher numerical aperture to help improve resolution and light-gathering ability.
- Lighting and contrast enhancement as an option on the microscope, to help enhance visibility of structural details if needed without having to stain the zooplankton (i.e. brightfield illumination, phase contrast, darkfield/differential interference contrast).
- Measurement and imaging accuracy to ensure accurate size estimation and improve documentation of image analysis by ensuring during the annual microscope calibration process. During analysis of the samples, pictures will be taken of the organisms as part of the documentation process.

With many samplers, variables such as the speed, depth and duration of tows can affect resulting catches. Repeated training and utilization of the same sampling equipment can influence the consistency of captured organisms.

Representativeness

The study is designed to gain baseline data of the zooplankton community. The sample collection is designed to capture snapshots of the community at two different time periods to represent general conditions between May 1 through September 30. At one deep lake station per lake, two samples will be collected via vertical tows. Site selection of the list of lakes that are selected that year which aligns well with the current set up of the lake monitoring network and would provide more information to further develop the MMI. Note a list of lakes for the 2025 season has been selected (Appendix A). Keeping in mind, samplers should avoid sampling during precipitation events. Utilizing

the standard zooplankton analysis (EPA, 2016) three replicate sub-samples from a sample will be identified and enumerated through a gridded sedgewick-rafter counting cell. Samples will be viewed under a compound microscope and each entire replicate slide will be evaluated.

Comparability

Maintaining consistency in procedures as referred to in the representativeness section of this document, nationally recognized sampling procedures will be utilized as referenced in the zooplankton sampling procedures. Two zooplankton nets will be utilized, one net will be made of a fine mesh (50μm) and the other net will be made from 150μm mesh as outlined in the National Lakes Assessment 2017 Field Operations Manual (USEPA, 2017). This is to ensure the capturing of both microzooplankton and mesozooplankton from the water column. Data will be used to gain baseline information, trends over time, and further define the MMI for NJ.

Completeness

The study is designed to meet completeness requirements by ensuring that tow collections are conducted properly based on depth of the lake as guided by the procedure developed by the National Lakes Assessment. If accessibility or a safety issue arises during the study, that site will not be included that year. If a Harmful Algal Bloom (HAB) is occurring during the site visit, this may provide sampling complications, such as slower processing time, debris and filamentous algae getting inside the net contaminating the sample, etc. If this occurs, the samplers will avoid sampling that day and will come back to collect the sample at a later date. If these standards are not met, then the results for that site will not be accounted for.

Sensitivity

Not applicable to this project. This study entails more biological procedures in comparison to analytical testing procedures.

A7 Distribution List

Table 2: Distribution List			
Name	Organization	Title	E-mail Address
Emily Mayer	NJDEP, BFBM	Project Manager	Emily.Mayer@dep.nj.gov
Chris Kunz	NJDEP, BFBM	Project QA Manager	Chris.Kunz@dep.nj.gov
Dean Bryson	NJDEP, BFBM	Supervisor	Dean.Bryson@dep.nj.gov
Johannus Franken	NJDEP, BFBM	Field Manager	Johannus.Franken@dep.nj.gov
Alice Belskis	NJDEP, BFBM	QA Officer	Alice.Belskis@dep.nj.gov
Brian Taylor	NJDEP, BFBM	Environmental Specialist 4	Brian.Taylor@dep.nj.gov
Megan Rutkowski	NJDEP – Office of Quality Assurance	NJDEP QA Manager	Megan.Rutkowski@dep.nj.gov
Frank Klapinski	NJDEP, BEARS	Environmental Scientist	Frank.Klapinski@dep.nj.gov
Leigh Lager	NJDEP, BFBM	Geographic Information Specialist 1	Leigh.Lager@dep.nj.gov

A8 Project Organization

Name	Organization	Project Role	Project Duties
Emily Mayer	NJDEP, BFBM	Project Manager	Principal investigator, overall responsibility for the project, maintaining and distributing QAPP, from planning through reporting.
Chris Kunz	NJDEP, BFBM	Project QAM*	Planning, documenting, coordinating, and assessing effectiveness of the QAPP
Megan Rutkowski	NJDEP – Office of Quality Assurance	NJDEP QAM**	QAPP review and approval
Johannus Franken	NJDEP, BFBM	Field Supervisor	Coordinates scheduling with field crews to ensure sampling collection is completed. Serves as lead Trainor.
Alice Belskis	NJDEP, BFBM	QA/QC Officer	Detection of any data entry errors, revision, correction and reporting of errors to PM for guidance, digitizing and compiling all documentation.

* *The project QAM has the authority to access and discuss quality-related issues with senior management outside of their direct supervisory chain as necessary.*

** *The assistant QAM from the NJDEP OQA has been delegated QAPP signature authority from the EPA as described in the Department's Quality Management Plan (QMP).*

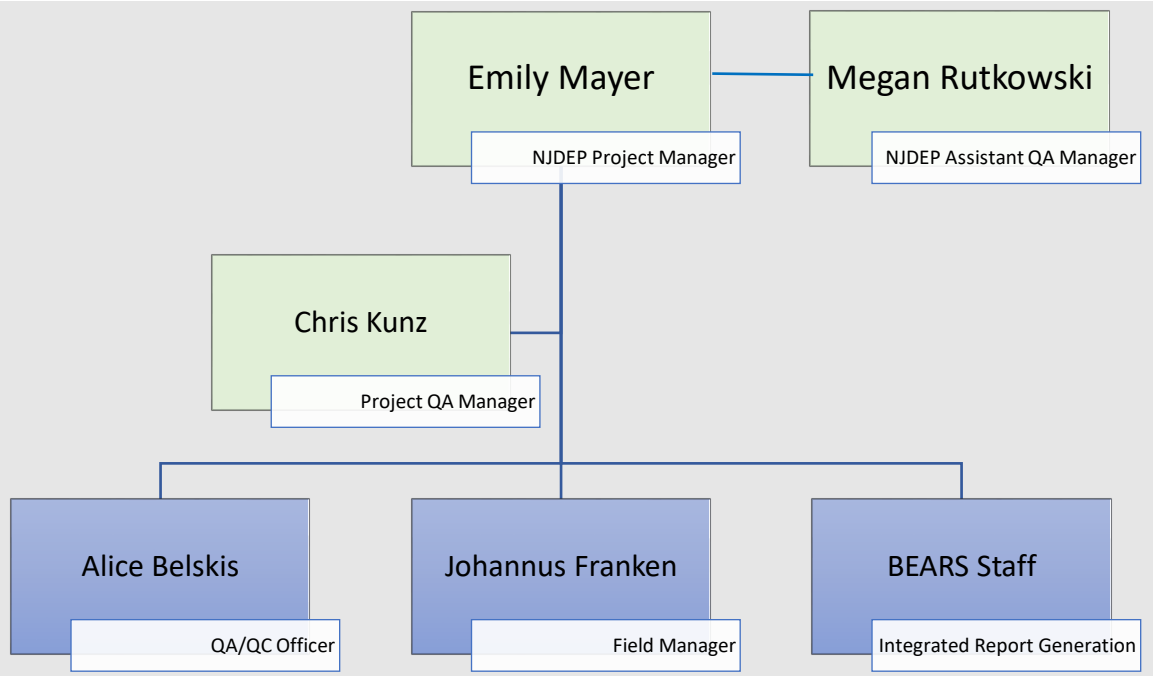
A9 Project QAM Independence

The Project QAM is a separate individual from the Project Manager. The Project QAM and their role in this project relates to planning, documenting, and assessing the effectiveness of this QAPP. The Project QAM will not perform data collection activities during this project.

A10 Project Organizational Chart and Communications

Listed below are staff and resources to accomplish the zooplankton monitoring component of the projects. Figure 1 illustrates an organizational chart for the QAPP.

Figure 1: Organizational Chart



A11 Personnel Training / Certification

All field samplers who are collecting the samples will be trained by experienced staff who have conducted zooplankton sampling previously for National Lakes Assessment (USEPA, 2017). Staff will have access to a training video located on BFBM's server to review prior to field training. Led by staff who are experienced in zooplankton sampling, training events will be held on-site in the field prior to initial sampling. This field training will go over how to operate both zooplankton nets, be prepared to determine what depths deployment will be at, to properly rinse the net and process to collect sample at each station. Overview of training and ensuring completeness will be the responsibility of the Project Manager. The Project Manager will be responsible for the identification and enumeration of zooplankton as she is the only one on staff who is trained. If needed, other staff will be trained by the Project Manager in identification and enumeration of zooplankton.

A12 Documents and Records

Sample collection data will be recorded on the sample label (date, time, sample number, sample station, lake name, depth sample was collected, volume of sample, etc.) (Appendix C). A checklist will be available to field crews to ensure all are following procedures and completeness (Appendix D). Samples will be preserved on site with 95% Ethanol or equivalent preservative and placed in a cooler for transportation to the BFBM's Biomonitoring Laboratory for identification and enumeration. All sample identification and enumeration will be completed by the end of December of the sampling year.

During the identification and enumeration process, photographs will be taken and stored on the server. Records will be transcribed onto a microscopic examination sheet (Appendix B) which will include information such as genus names (species if possible) and the number of organisms observed. A total of three microscopic examination sheets, each of which represents a replicate (i.e. A, B, C), will accompany each sample. Once identification and enumeration are completed, data will be entered into a Microsoft Excel document and be checked for accuracy or any errors by QA/QC Officer, in preparation for export into the Water Quality Exchange (WQX), USEPA's water monitoring data warehouse. The following data to be submitted to WQX is the taxonomic information, assemblage counts, and index scores. The QA/QC Officer will be responsible for scanning all documents onto the computer and organizing them into the appropriate folders on the BFBM server. All physical documentation will be stored in an organized cabinet in BFBM.

B1 Identification of Project Environmental Information Operations

Environmental Information	x	direct measurements of environmental parameters or processes.
	x	analytical testing results of environmental conditions (e.g., geophysical or hydrological conditions).
		information on physical parameters or processes collected using environmental technologies.
	x	calculations or analyses of environmental information.
		information provided by models.
	x	information compiled or obtained from databases, software applications, decision support tools, websites, existing literature, and other sources.
		development of environmental software, tools, models, methods, applications;
Environmental Technology		systems, devices, and their components applicable to both hardware and methods or techniques that measure and/or remove pollutants or contaminants and/or prevent them from entering the environment
		pollution prevention: measurement, monitoring, reduction, control, and/or treatment processes, such as wet scrubbers (air), granulated activated carbon unit (water), filtration (air, water).
		Contamination: containment to prevent further movement of the contaminants, such as capping, and solidification or vitrification, and biological treatment.
		Storage containers, methods, or facilities, such as drums, tanks, and ponds or lagoons.
		Design, construction, and operation or application of environmental technology.
		Remediation processes and their components, and/or technologies, such as soil washing (soil), pump and treatment, soil vapor extraction (soil), land farming and other bioremediation processes.

Other		

B2 Methods for Environmental Information Acquisition

Field Activities

The site selection process is based on field staff availability and capacity, and prioritizing lakes that can be sampled within the designated field season. Sites will be chosen from either the list of Targeted, Reference or Probabilistic list of lakes from the Lake Monitoring Program (Appendix A). Additional specialty sites may be incorporated as opportunities arise. For example, if a particular lake requires extensive accessibility planning, zooplankton sampling may be conducted due to limited visit opportunities. Sampling will be conducted on a yearly basis and the number of sites sampled per year will vary based on the criteria of field and lab staff availability and capacity. For consistency purposes, the sampling station at each lake will be the same station utilized in the Lakes Monitoring Program and the deepest point of the lake (via GPS coordinates).

The following zooplankton sampling and sample collection procedures described below were developed by the EPA as part of the National Lakes Assessment 2022 located in the Field Operations Manual (USEPA 2022). While hold times may vary based on preservation methods, for preservation in 95% Ethanol, this study shows that there was no evidence that Daphnia (Cladocera) were brittle or fragile even after 18 months of storage in 95% Ethanol. Instead, they were resilient to becoming distorted. Be sure prior to collection operations all sample bottles are labeled properly in preparation for collection. Field crews will collect two samples at the deepest area of a lake as their station which will be referenced via GPS coordinates. Two nets, one with a mesh size of 50 µm and another net with a mesh size of 150µm will be utilized at each specific lake. The total tow length will be 5 meters, with the number of tows depending on the site depth.

Table 3. EPA Tow and Depth Reference Table
Source: National Lakes Assessment 2022 Field Operations Manual (USEPA 2022)

Depth of Lake (m)	Length of Tow (m)	Number of Tows
7 or more	5	1
4 - 6	2.5	2
2 – 3	1	5
Less than 2	0.5	10

Source: National Lakes Assessment Field Operations Manual (USEPA 2022).

At lakes deeper than 7 meters, a single 5-meter vertical tow will be conducted. At lakes between 4 and 6 meters deep, two 2.5-meter vertical tows will be conducted. At lakes between two to three meters deep, five 1-meter vertical tows will occur. At lakes less than 2 meters deep, ten 0.5 m vertical tows will be collected. EPA's study suggests that a total tow length of 5 meters would provide enough taxa and organisms to develop multimeric indices from lakes. When tows are being conducted samplers will be mindful to ensure that the bottom of the net will not come into contact with the

bottom of the lake, to prevent contamination of the sample. If the bottom of the net meets the bottom of the lake, the sampler will retrieve the net and thoroughly rinse the net, bucket, and other components of the net with lake water to ensure there is no sediment or benthic filamentous algae on it. When deploying the net, be sure to lower the net carefully and vertically over the side of the boat. Afterwards, the sampler will redeploy the tow again to collect the samples.

Prior to deploying the net during towing operations, samplers will make sure the clip is closed on the tubing on the net, if it is not closed the sample will be lost and will need to re-sample. When deploying the net, follow the marked lines on the rope but be sure to account for the length of the net for the correct depth. Lower the net in an upright position vertically over the side of the vessel. If more than one tow is needed, be sure to take samples from other sides of the vessel. Start to retrieve the net by pulling the rope back up as a consistent rate of approximately 0.3 to 1 ft/s without stopping. Before the net is hoisted into the vessel, raise, and lower the net half-way into the water to assist with moving zooplankton that may be stuck on the inside of the net to flow into the container then hoist the net into the vessel. Next, using a squirt bottle and lake water begin to rinse the outside of the net starting from the top and working your way down all around the net. This will help flush organisms into the container at the bottom of the net to ensure they all get captured. Be sure no "rinse lake water" enters the inside of the net as this could add organisms into the sample unintentionally.

Once rinsing has been completed, the container at the bottom of the net will be placed into a pail that is filled halfway with lake water with two CO_2 tablets (i.e. Alka-Seltzer or equivalent product) added. Tablets need to be fully dissolved prior to submerging the container of the organisms into the pail. This process narcotizes the organisms to help relax their internal structures before preservation occurs, which facilitates the taxonomic identification process. Wait until zooplankton movement has stopped, which usually takes one minute.

Using deionized (DI) water from another squirt bottle, (note not the same squirt bottle as the one that contained the lake water), rinse the outside of the net, and concentrate on the container part and hold it over the sterile plastic 125mL bottle or equivalent sized bottle. Rinse the collection container with DI water three to four times or until most zooplankton has been removed without allowing the bottle to fill more than half full. Once the bottle is half full of sample, fill the remaining half to the shoulder of the bottle with 95% ethanol. As this study shows, the majority of Cladocera will be effective on the preservation and that after reviewing this method only approximately 2% of other taxa were distorted and that relaxing the taxa prior to preservation (CO_2 method) would likely enhance the preservation of the internal components of the taxa. In some cases, there may be more sample volume, do not try to fill the bottle all the way to the top as room will be needed for the preservative, so be sure to have extra bottle for overflow if needed. Therefore, samplers should be prepared with two bottles per collection per net for a total of four bottles. If a QC sample is being taken at that site, additional bottles would be needed. Note this entire process is repeated using the other net (either the 50 or 150) not used on the first round. Once samples have been collected, they are put in a cooler and brought back to the lab. Samples are placed in the fridge for further processing. Samples are preserved for up to 18 months in the fridge. For more information on sampling design, refer to the National Lakes Assessment 2022 Field Operations Manual (USEPA 2022). All sampling equipment will be decontaminated after each use; samplers will strictly adhere to the following

decontamination protocols outlined in the *Decontamination Protocol: Recommendations for Research and Monitoring Activities in and around New Jersey Waters* developed by the New Jersey Water Monitoring Council (New Jersey Water Monitoring Council, 2024).

Laboratory Analyses

In preparation for sample analysis, samples will be removed from the fridge, and the biologist will make sure the lid is on tightly. The biologist will gently invert the sample bottle 3 – 4 times to resuspend the organisms that have settled to the bottom. Utilizing EPA's SOP for Zooplankton Analysis (EPA, 2017) using a calibrated Hensen-Stempel pipette or equivalent pipette/syringe, 1 mL of sample will be extracted from the bottle and evenly distributed through the gridded Sedgewick-rafter counting cell. As an alternative, after inverting the bottle 3 – 4 times the sample can be poured into a sterile 500ml beaker for ease of extraction from the sample, if desired. A coverslip will be placed overtop; no bubbles should appear in the slide. If this occurs, the biologist will discard the sample on the slide and repeat the process as described. This sample process will occur for a total of three times to represent three replicates. To ensure there is no cross contamination in between samples, the slide and syringe will be cleaned using DI water prior to analyzing the next sample.

During the identification and enumeration process, photographs will be taken and stored on the server. Records will be transcribed onto a microscopic examination sheet (Appendix B) which will include information such as bottle number, lake name, station, date, replicate letter, genus names (species if possible), volume of water sampled, and the number of organisms observed. A total of three microscopic examination sheets, each which represents a replicate (i.e. A, B, C), will accompany each sample.

Samples will be viewed under a compound microscope or equivalent microscope. Magnification levels will vary based on the scientist conducting the counts to help distinguish identifiable features of the zooplankton. All groups of zooplankton Rotifera, Copepoda, and Cladocera will be accounted for if present in the samples being analyzed. Any damaged zooplankton organisms that are unidentifiable will not be counted in the results. Individual zooplankton organisms will be counted and reported as organisms per mL (orgs/mL). A regionally appropriate taxonomic resource will be utilized throughout the identification process, as needed (University of New Hampshire, 2013). If any issues arise during this process, the Project Manager will be informed and will make the revisions as needed.

After all replicates are completed, the totals for each genus are tabulated and divided by three, which provides the number of per mL. This result is then multiplied by 1,000 mL which equals one liter. This number is then divided by the volume of water sampled to get the result of organisms per L of each genus. An additional calculation may need to be made based on how many tows were conducted as each site and should be taken into account. Each genus can be categorized into the appropriate groups of rotifera, cladocera, and copepods to get a total number of organisms per group.

Existing Information

Utilization of the information with the intent to contribute to the biennial New Jersey Integrated Water Quality and Assessment Report [305(b) and 303(d)] by utilizing the MMI and any other appropriate models. To gain a better understanding of the composition, abundance, and distribution in the zooplankton community as this has been a missing component of the lakes monitoring program. If historical lake records are available from lake associations or State records where previous zooplankton monitoring may have been conducted may be referenced in the final report as a contribution for trend analysis, if possible. Other sources that may be identified in the future may include scientific journals, R-Studio packages available through contributing organizations through non-profit organization databases, or through a general web search. If found to be necessary, meteorological data may be included in the review of the data to account for potential explanations of variables that may impact those populations.

BFBM will follow the USEPA multimeric indices as part of the generated data from the adopted approach described by Stoddard et al. (2008) to transform metric responses into a metric score that ranged between 0 and 10. The final MMI score for each region by summing the six component metric scores, and then multiplying by 10/6 which will result in an MMI score ranging between 0 and 100. As mentioned earlier, New Jersey is divided between Eastern Highlands and Coastal Plains, following metric types for both: abundance/size, cladoceran, copepod, richness/diversity, rotifer, and trophic state. More information regarding the multimetric indices and the USEPA's approach can be found in the National Lakes Assessment 2022: Technical Support Document.bio.

B3 Integrity of Environmental Information

Once identification and enumeration are completed, data will be entered into a Microsoft Excel document and be checked for accuracy or any errors by QA/QC Officer, in preparation for import into the WQX database. The QA/QC Officer and assisting seasonal staff at that time will be responsible for scanning all documents onto the computer and organizing them into the appropriate folders on the BFBM server. All physical documentation will be stored in an organized cabinet in BFBM.

Sticker labels will be used to attach to the sample bottles. Sharpies and/or waterproof ink pens will be used to write-in the information on the sample bottles. The following information on the labels will be date, time, samplers, lake name, site ID, tow (i.e. 2 tows x lake depth), checked preservation, marked net size, and number of samples (i.e. 1 of 2, 2 of 2). *(Appendix C)*

Samples will be analyzed starting in October with completion by the end of March the following year. Currently, there is no known defined hold time for zooplankton samples. However, as noted in the National Lakes Assessment 2017 Field Operations Manual, recommends that as soon as sampling is completed samples will be stored in a refrigerator until extraction.

B4 Quality Control

Quality control (QC) procedures ensure the accuracy, precision, and reliability of zooplankton monitoring data. This section outlines the QC measures applied to sample collection, laboratory analysis, data recording, and reporting.

- All field personnel will be trained in standardized sampling techniques to ensure consistency. As described earlier, once samplers are trained will be utilizing the same nets and will try to maintain similar tow speed to minimize variability.
- Rinse procedures will be followed to prevent cross-contamination between sites.
- Sampling nets will be inspected for damage prior and after each use.
- GPS unit will be checked for accuracy to confirm sampling locations.
- Samples will be preserved in 95% Ethanol immediately after collection to prevent degradation.
- Sample containers will be properly labeled and stored in a secure location to prevent contamination during transport.
- 10% of total samples will be analyzed by another trained BFBM staff member to conduct a quality check.
- Zooplankton identification will follow standard taxonomic keys, and a reference collection will be maintained.
- Compound microscope will be calibrated annually (1x per year).
- Counting chambers (slides, and cover slips) will be inspected for debris or damage before each use.

- Data Quality Indicators:

Parameter	Measure	QC Check	Acceptance of Criteria
Precision	Field duplicates	10% of total samples for QAQC	Variability $\leq$ 20%
Accuracy	Taxonomic verification	10% of samples re-identified (QAQC)	Agreement of $\geq$ 90%
Completeness	Sample collection	100% of planned samples collected	$\geq$ 95% completeness
Comparability	Standardized methods	Adherence to QAPP	Full compliance
Representativeness	Sampling coverage	Representative of study areas / lakes	Meets study design

Table 4. Data Quality Indicators

- If precision, accuracy, or completeness fall below acceptance criteria, corrective actions will include re-sampling, retraining of analysts, or recalibrating equipment if needed.
- Any major QC deviations will be documented in a corrective action report and reviewed by the project manager.

B5 Instrument / Equipment Calibration, Testing, Inspection and Maintenance

Calibration is not applicable to the plankton net, other than ensuring the quality and integrity of the equipment is up to manufacturer's standard. Spare parts will be purchased prior to the sampling season such as tubing, screws, and zip ties will be in the field sampler's truck and a backup net will be at the office with the same specifications in case the net is beyond repair. A maintenance logbook which will be stored in the BFBM lab, which will include information such as date, time, net number, and notes indicating what was replaced or repaired on the net.

B6 Inspection/Acceptance of Supplies and Services

Reference section B2, for more details on how supplies will be inspected. Inventory on the number of sterile bottles will be accounted for by Project Manager to ensure enough bottles are needed for field samplers. An area of BFBM's lab will be designated for zooplankton supplies such as extra parts, screws, tubing, zip ties, labels, sterile bottles, etc.

B7 Environmental Information Management

The sampling paperwork will be dropped off in a file tray in the BFBM lab. After data entry and QC processes occur the paperwork will be filed in an organized cabinet and the virtual data will go into the Water Quality Exchange (WQX), USEPA's water monitoring data warehouse. Reference section B2 for more details on processing the data. Further investigation is needed on the potential use of statistical software called R Studio may be useful during the analysis process as far as predicting trends etc. Other water quality data collected from the lakes monitoring program may be used to help correlate biomass results and population abundance (I.e. as chlorophyll increases so does zooplankton biomass) (USEPA, 2023).

C1 Assessments and Response Actions

Prior to sampling occurring a yearly meeting will take place before the sampling season begins (sometime between January and March) we will identify the number of sites and sampling events that will take place each year. Review of zooplankton results, sample collection methodologies, and record keeping occurring in the field to ensure activities will be discussed to ensure everyone is within compliance of this QAPP.

<u>Field Oversight</u>

- *Readiness review of the field team prior to starting field efforts*

Sampling personnel will be properly trained by qualified personnel before any sampling begins. Equipment maintenance records will be checked to ensure all field instruments are in proper working order and any required field calibrations will be performed. Adequate supplies of all preservatives and bottles will be obtained and stored appropriately before heading to the field. All equipment will be kept in a designated "Zoop" bin for ease of travel with the equipment and crews will double check all equipment is in there. Sampling equipment will be checked to ensure that it is properly cleaned

(per the decontamination protocol mentioned earlier in QAPP). The Field Manager will review all field equipment, instruments, containers, and paperwork to ensure that all is ready prior to each sampling event. Any problems observed will be corrected before the sampling team departs for the sampling event.

- Field activity audits

During at least one annual sampling event, the Project Manager will assess the sample collection methodologies, and record keeping of the field team to ensure activities are being conducted as described in this QAPP. Any deviations noted will be corrected immediately to ensure all subsequent samples and field measurements and observations are valid. If any deviations are associated with technical changes and/or improvements made to the procedures, the Project Manager will verify that the changes have been documented and addressed in an amendment to this QAPP. The project manager may stop any field activity that could potentially compromise data quality.

- Post-field activity reviews

Following each field event, the Field Manager will review field datasheets and records to ensure that all information is complete and any deviations from planned methodologies are documented. This review will be conducted in the office, not in the field.

Laboratory Oversight

Following receipt of the laboratory results for each sampling event, the QA/QC Manager will review the data for completeness, as well as to ensure that all planned methodologies were followed and that project data quality objectives were met. The results of the review will be mentioned in the report saying all results met QAPP standards. The Project Manager has the authority to request re-testing (if the samples are still present), if not then the data will be excluded from the report as part of the results. This will also be part of the process when it comes to reviewing the data

The field crew will be conducting the sampling, the lab staff will conduct the enumeration, identification, and calculations, and the QA/QC Manager will be the one interpreting the data/ assessment will be part of the report by conducting a general overview of the zooplankton assemblage (by the QA/QC Manager and/or Project Manager). Any deviations noted will be corrected immediately to ensure all subsequent samples, field measurements and observations are valid. Depending upon the type of deviation, will be noted as a note on the lab paperwork or a note will be added during the data review process. Notes will be kept on the site-specific information on SharePoint: (DEP BFBM Lake Monitoring> Documents>Zoops and Aquatic Plants>Zooplankton Monitoring).

(Note: If the deviations are associated with technical changes and/or improvements made to the procedures, the project manager will verify that the changes have been documented by the quality assurance officer in the field notes and will be addressed in an amendment to this QA Project Plan.) The field staff may stop any field activity that could potentially compromise data quality.

If activities and analyses are found to be inconsistent with the QAPP, and do not meet Data Quality Objectives requirements, or if some other unforeseen problem arises, corrective actions (response actions) which may include the following, will be taken:

- Reanalysis of samples that do not meet quality control criteria.
- Convening project personnel to decide on next steps that may be needed to improve performance.
- Any response actions will be documented pertaining to the specific samples or sites in a project folder on SharePoint (DEP BFBM Lake Monitoring> Documents>Zoops and Aquatic Plants>Zooplankton Monitoring).

C2 Oversight and Reports to Management

- An annual final report would be generated from the data collected conducted in combination with efforts from both the QA/QC Manager and Project Manager. In the report, the following information will be provided: a basic overview of zooplankton and their role in the environment, outlining zooplankton abundance, calculations, raw data, and processed data. If available, biovolume calculations will also be reported. If any, description of QA problems, and analysis of findings. As more monitoring continues, we hope this will help provide more information related to developing the MMI will become more defined. Final report will be submitted to the BEARS and BFBM programs.
- Data obtained during the project cannot be used for regulatory purposes.

D1 + D2 Environmental Information Review / Useability Determination

Establishing procedures for environmental information review helps to ensure that project data are evaluated in an objective and consistent manner. The review will consist of verification, validation and data quality assessment. The Project Manager is responsible for determining usability of data by conducting a final review of all information in general, from the raw data to the annual report. Documentation of useability process will be reiterated in the annual report through the completion of the table.

Data will be verified by the QA/QC Officer reviewing how the data was recorded, analyzed, and transformed. Verification is the process of evaluating the completeness, correctness, and compliance of a specific data set to method, procedural, or contractual requirements (e.g., ensuring that method requirements were met during analytical procedures). Verification will include the following: calculations will be double checked for correctness. The verification will include confirming whether all sites were sampled as planned. The verification process will be performed by the QA/QC Manager. The results of the process, including any observed deviations, will be recorded and sent via email to the Project Manager. If there is a validation issue with the data, decisions on whether to accept, reject, or qualify data during validation will be made based on the nature of any identified deviation by the Project Manager. Validation involves determining whether the requirements for a specific intended use or application have been fulfilled (e.g., were the project-specific data quality objectives presented in this QAPP met?). Data may also be validated through statistic models built in excel,

potentially through R studio and by the QA/QC Officer. The table below will be used to help evaluate the usability of the data collected from the season (Table 4 and Table 5.) The validation process will be performed by QA/QC Manager. The results of the process, including any observed deviations, will be recorded QA/QC Manager or Project Manager.

Project Manager is responsible for determining usability of data by conducting a final review of all information in general, from the raw data to the annual reports. Documentation of useability process will be reiterated in the annual report through the completion of the table in (Table 5) below to determine if the information is useable.
Below outlines the quality assurance measures to enhance the creditability and validity of results:

- Data Collection Protocols:
    - Before commencing the sample collection all field personnel will undergo comprehensive training on data collection protocols specific to sample collection methodologies.
    - Field Verification: Stations are pre-selected based on the bathymetry mapping and/or current lake monitoring station (deepest location in lake) for consistency and accuracy of data collected.
    - Discrepancies between original and verified data will be documented and resolved through consensus among team members.
- Data Entry Validation:
    - All collected data will be entered into a centralized database using standardized data entry procedures to minimize transcription errors.
    - Double checking the data entry will be performed independently by different personnel to identify and rectify any discrepancies.
    - Data validation checks will be conducted to ensure consistency and integrity against identification of reference guides.

- Quality Control Review:

    - Data Manager and Project Manager will conduct reviews of the data to identify any anomalies or inconsistencies.

    - Any data outliers or discrepancies will be thoroughly investigated, and corrective actions will be implemented as necessary.

    - Regular meetings will be held to discuss findings and ensure continuous improvement in data quality throughout the sample collection duration.

- Reporting and Documentation:

    - A comprehensive report summarizing the results of the data quality assessment will be prepared, highlighting key findings, and challenges encountered.

    - Documentation of all QA/QC procedures, including field protocols, data entry guidelines, and quality control measures will be maintained for transparency and auditability.

Note that it will be considered that the data as a result of the study is considered a "snapshot in time" as far as presence of zooplankton. Note that new introductions may occur or change the assemblage after these sample collections and assessments are completed. These limitations will be noted in the annual report. The following table below will be used to assess the data to ensure we are covering all information pertaining to the approved QAPP. Reference sections B7 and D1 of this document for further details.

Determining whether environmental information may be used for the project purpose is the culmination of the entire QA process. Only data that has been verified and validated as described in D1, above, shall be considered usable. The QA/QC Manager will determine whether project data is usable by recording answers to the questions in the "Useability Determination" table that is listed below (Table 5). The useability determination will occur during the review of the data process before the creation of the report begins. If the useability determination reveals any limitations on the use of the data, these limitations will be subjected to re-test the sample (if the sample is still present). If the sample is no longer available, then that data in question will be excluded from the report.

Project Name:	*Date:*	
Name of Person Completing Form:	*QAPP#:*	
Item	*Assessment Activity*	*Useability Review Results*
Data Deliverables	*Was all necessary information (e.g., results and reports) performed/provided, including validation and verification of results?*	
Deviations from QAPP (e.g., sampling sites, sample handling (preservatives, holding times, etc.), analytical methods, QC sample failures)	*Were there any deviations from the QAPP? If so, what impact do these deviations have on usability?*	
Metrological effects/site conditions	*Were there any weather or site conditions that may have affected results?*	
DQI: Precision	*Were precision criteria met for all samples? If not, what percent of samples had precision issues? Is there enough data that met criteria for use in decision making?*	
DQI: Accuracy (Bias)	*Were accuracy criteria met for all QC samples? Is there enough data that met criteria for use in decision making?*	
DQI: Representativeness	*Was the data collected in a manner that ensured representativeness (e.g., if it was planned that samples would be taken every month to ensure seasonal differences were captured, but three samples were missed, can you confirm that the 3 samples that were missed were not all from the winter months?)*	

DQI: Completeness	*Was any planned data collection omitted? Is there enough data that met criteria for use in decision making?*	
DQI: Comparability	*Did results from different environmental information operations agree in an expected manner?*	
DQI: Sensitivity	*Were the quantitation/ reporting limits specified in the QAPP met?*	
Usability decision	*Based on an evaluation of all criteria tabulated above, is there enough usable data to make a specific decision?*	

Table 5. Usability Table

E1 References

Black, A. R., & Dodson, S. (2003). Ethanol: a better preservation technique for Daphnia *American Society of Limnology and Oceanography*, *15415856*(1), 45-50.

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University of New Hampshire. (2013). An Image-Based Key To The Zooplankton Of North America Version 5.0. Center of Freshwater Biology - University of New Hampshire. Retrieved February 5, 2023, from http://cfb.unh.edu/cfbkey/html/

USEPA. 2022. National Lakes Assessment 2022. Field Operations Manual. EPA 841-B-16-002. U.S. Environmental Protection Agency, Washington, DC.

[USEPA] United States Environmental Protection Agency. 2023.NSTEPS New Jersey Lakes Analysis. Draft version 2. Office of Science and Technology.

E2 Appendices

Appendix A: Potential Site List
Appendix B: Examples of Microscopic Examination Sheets and Biovolume Measurements
Appendix C: Label Example
Appendix D: Zooplankton Checklist

Appendix A: Potential Site List

SiteID	GNIS_NAME	County	Acres	Lake Type
NJW04459-097	Great Gorge Lake	SUSSEX	19.8	Reference
NJLM-0028	Green Turtle Lake	PASSAIC	44.7	Reference
NJW04459-352	Hands Mill Pond	CUMBERLAND	32.9	Reference
NJW04459-339	Mashipacong Pond	SUSSEX	49.0	Reference
NJW04459-058	Mt. Misery Lake	BURLINGTON	8.9	Reference
NJW04459-134	Silver Lake	SUSSEX	23.8	Reference
NJW04459-233	Watchu Pond	SUSSEX	26.5	Reference
NJLM-1224	Newton Lake	CAMDEN	90.5	Targeted
NJLM-0626	Big Pine Lake	BURLINGTON	16.3	Targeted
NJLM-0985	Malaga Lake	GLOUCESTER	99.4	Targeted
NJLM-1279	Shaws Mill Pond	CUMBERLAND	28.3	Targeted
NJLM-0285	Elmer Lake	SALEM	43.1	Targeted
NJLM-0086	Country Lake	BURLINGTON	42.7	Targeted & Probabilistic
NJW04459-430	Grenloch Lake	GLOUCESTER	19.1	Targeted & Probilistic
NJLM-0456	Gropp Lake	MERCER	30.6	Targeted
NJW04459-120	Sunset Lake	CUMBERLAND	89.1	Targeted
NJW04459-378	Almonesson Lake	GLOUCESTER	19.2	Targeted
NJW04459-109	Green Pond	MORRIS	506.8	Probabilistic
NJLM-0705	“Strawberry Lake”	ATLANTIC	19.8	Probabilistic
NJLM04459-116	Hainsville Pond	SUSSEX	35.18	Probabilistic
NJW04459-064	Lake Saginaw	SUSSEX	16.2	Probabilistic
NJLM-1359	Marshall Pond “Laurel Pond”	SUSSEX	9.7	Probabilistic
NJW04459-231	Conines Millpond (Allentown Lake)	MONMOUTH	24.0	Probabilistic

NJW04459-151	Lower Aetna Lake	BURLINGTON	18.0	Probabilistic
NJLM-0416	“Mirror Lake”	MORRIS	15.7	Probabilistic
NJW04459-254	“Overpeck Creek”	BERGEN	137.9	Probabilistic
NJW04459-331	Camp Inawendiwin Lake	BURLINGTON	16.9	Probabilistic
NJLM-0198	“Batona Trail”	BURLINGTON	13.2	Probabilistic

Note: Other lakes may also be included in future that are not listed here.

2025 Site List				
SiteID	**GNIS_NAME**	**County**	**Acres**	**Lake Type**
NJLM-0626	Big Pine Lake	BURLINGTON	16.3	Targeted
NJLM-1279	Shaws Mill Pond	CUMBERLAND	28.3	Targeted
NJLM-0285	Elmer Lake	SALEM	43.1	Targeted
NJW04459-430	Grenloch Lake	GLOUCESTER	19.1	Targeted
NJW04459-378	Almonesson Lake	GLOUCESTER	19.2	Targeted

Appendix B: Examples of Microscopic Examination Sheets and Biovolume Measurements

Final Microscopic Examination Results

Lake Name:	Site:	Sample		Replicate						
Group	**Order**	**Family**	**Genus**	**A**	**B**	**C**	**Total/3**	**x1000ml**	**Water sampled**	**# orgs/ml**
Rotifera	Plioma	Brachionidae	Kellicotta longispina	10	4		4.67	4667	68.8	68
			Keratella crassa				0.00	0		#DIV/0!
			Keratella quadrata				0.00	0		#DIV/0!
							0.00	0		#DIV/0!
		Trichocercidae	Trichocerca cylindrica				0.00	0		#DIV/0!
			Trichocerca multicrinis				0.00	0		#DIV/0!
		Gastropidae	Ascomorpha				0.00	0		#DIV/0!
							0.00	0		#DIV/0!
		Synchaetidae	Polyarthra				0.00	0		#DIV/0!
			Synchaeta				0.00	0		#DIV/0!
	Floscullariacea	Conochilidae	Conochilus				0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
Cladocera		Bosminidae	Bosmina				0.00	0		#DIV/0!
		Daphniidae	Ceriodaphnia				0.00	0		#DIV/0!
			Daphina				0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
Copepoda			Calanoid napluii				0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!
							0.00	0		#DIV/0!

Total Orgs/ml	*Rotifera*	*Caldocerca*	*Copepoda*
	%	%	%

Microscopic Examination Sheet

Lake Name: Site: Date: Sample ID #:

Circle Replicate: A B C

Group Indication (R, C, CO)	*Genus*	*Count*	*Total*

Legend: Zooplankton Groups

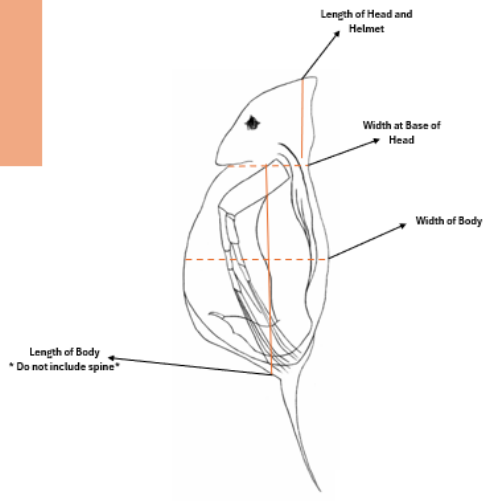
R= Rotifers

C = Cladocera

CO = Copepods

Length of Body*	Width of Body	Width at Base of Head	Length of Head & Helmet

Biovolume (μm^3/mL)	0

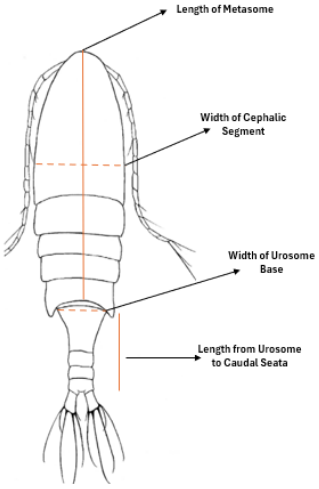


Calculations Source
SUNY, 2011

Picture Source
SUNY, 2004

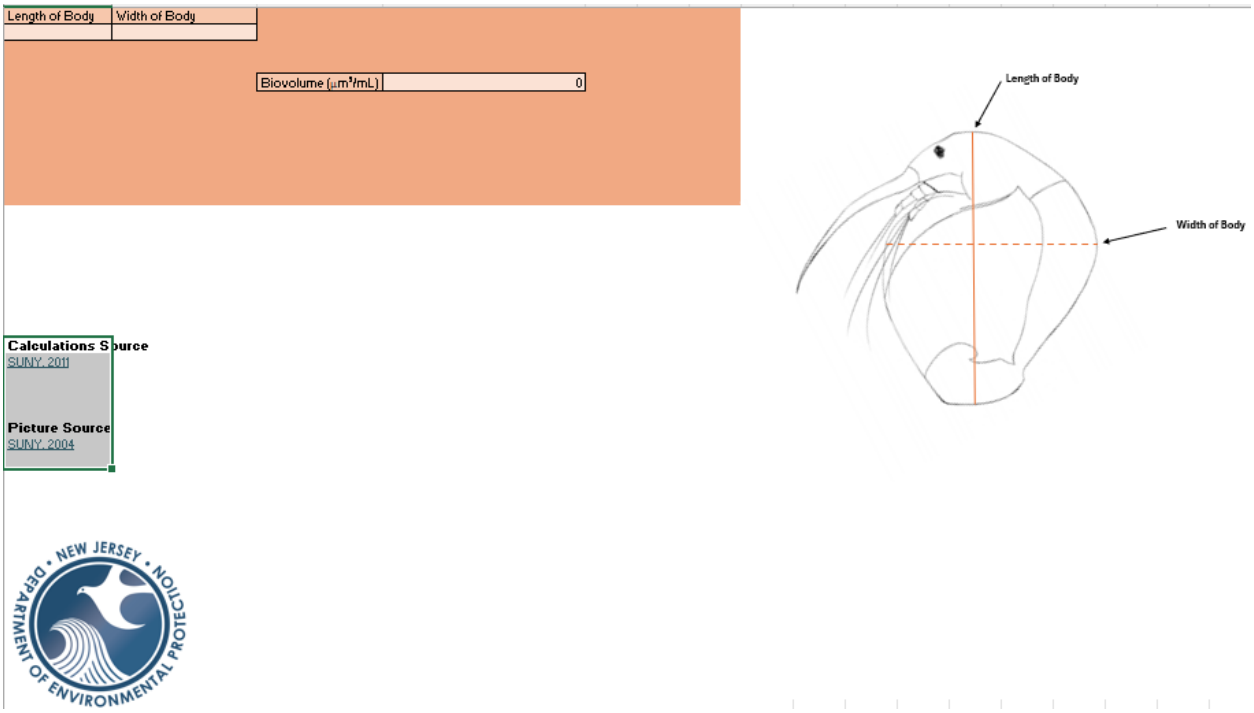
Length of Metasome	Width of Cephalic Segment	Width of Urosome Base	Length from Urosome to Caudal Setae

Biovolume (μm^3/mL)	0



Calculations Source
SUNY, 2011

Picture Source
SUNY, 2004



Appendix C: Label Example

Date: Time: Samplers:

Lake Name:
Site ID:
Tow:

Preserved: Y / N ____ of ___

Net size: 150 / 50

Appendix D: Zooplankton Check List

ZOOPLANKTON FIELD SAMPLING CHECK LIST

EQUIPMENT CHECKLIST:

- ZOOPLANKTON NETs (150um and 50um)
- ROPE WITH CLIP / HARD CARRYING CASE
- DISTILLED WATER IN NOZZLE BOTTLE
- EMPTY SQUIRT BOTTLES (2)
- 250ML SAMPLE BOTTLEs (4 total) (- 2 are considered backups)
- BUCKETS (2)
- ALKASELTZER TABLETS (OR EQUILVALENT)
- LABELS
- PRESERATIVE (ETHANOL OR EQUILVALENT)
- LABEL
- SHARPIE/PENCIL
- GPS
- Anchor

CHECK OFF EACH TASK AS THEY ARE COMPLETED

Table 5.8 Lengths and numbers of zooplankton tows based on Index Site depth

Depth of lake (m)	Length of Tow	Number of Tows
7 or more	5 m	1
4 - 6	2.5 m	2
2 - 3	1 m	5
less than 2	0.5 m	10

(Source: NLA, FOM)

1. ☐Make sure all equipment has been thoroughly cleaned/ sterilized prior to sampling.
2. ☐Verify you're at the correct location via GPS
3. ☐Launch and navigate to the deepest point of the waterbody (this should already be an established station).
4. ☐Slowly lower the anchor to secure the vessel in the sampling location.
5. ☐Prior to each use, carefully clean and thoroughly rinse the interior of the plankton nets and buckets with DI water.
6. ☐Carefully and slowly lower the first net in a constant upright position (vertical) over the side of the boat
7. ☐Continue lowering the net to the correct depth (remember to account for the length of the bridle). If more than one tow is needed, be sure to take additional tows from different locations around the boat. Retrieve the net by pulling back to the surface at a steady rate (0.3 m or 1 ft/s) without stopping.

8. ☐Once at the surface, slowly dip the net up and down in the water without submersing the net mouth to rinse contents into the collection bucket. Complete the rinsing of the net contents by spraying lake water against the outside of the net with a squirt bottle or similar tool. Be careful not to splash or squirt lake water into the net mouth, or additional organisms may be collected.with a squirt bottle or similar tool. Be careful not to splash or squirt lake water into the net mouth, or additional organisms may be collected.
9. ☐Once all organisms have been rinsed into the collection bucket, hold the collection bucket in a vertical position, and carefully remove the bucket from the net.
10. ☐Follow Alka seltzer procedure as outlined in the NLA FOM, prior to preservation.
11. ☐Preserve sample with 95% ethanol or equivalent preservative.
12. ☐Add label to bottle and fill out appropriate information (I.e. date, time, site name, etc.)