Next-Gen Schoolship Instructor Manual

Inland Seas EDUCATION ASSOCIATION

Although all of our programs emphasize the power of small-group learning, the Next Gen Schoolship Program takes it to the next level. Students work in teams to collect creatures and water samples from the lake, then teach each other what they learned in an upbeat, low-stakes round robin. Hands-on learning stations explore fish, plankton, the bottom of the lake, and water quality. An additional fifth station explores either Seamanship or Microplastic pollution. A microplastics tow involves students in current Great Lakes research, while the seamanship station connects students to history and geography. In addition, teams of students raise the sails and haul up the anchor so we can sail the Bay throughout the program.

Here is a brief summary:

1. Welcome, board the ship
2. Sampling:
    a. **Otter trawl** to collect fish in large group

    b. **Sample collection** (Benthos, Plankton, Weather, Water) takes place in small groups:
        i. All groups sample at the same time from different places on the ship.
        ii. Group instructors introduce their group to the subject, teach students how the sampling device works, and collect the sample.
            - Water quality VanDorn bottle and introduction to pH and DO
            - Plankton Plankton net and introduction to plankton
            - Benthos PONAR Dredge and introduction to benthos
            - Fish Weather station, especially water clarity
            - Microplastics Manta trawl and introduction to microplastics
            - Seamanship Introduce wheel/rudder and steering commands

    c. **Peer-teaching** to learn how others collected a sample
        i. Students regroup so one person from each sampling station is in each new group.
        ii. Instructors stay put while student groups rotate to every sampling device and teach each other how the devices work and what they learned.

    d. **Secchi depth** measurements in original station groups and discuss impacts of mussels on water clarity.
3. Raise anchor and hoist the sails
4. Analysis
    a. Students rotate to different stations to analyze the samples, starting at their original sampling station
    b. Manta trawl for microplastics occurs during the first three rotations. Rotation groups 4 and 5 will analyze the sample for microplastics.
    c. Group instructors will do a stewardship wrap-up with their original small group.

5. Disembark, farewell

TABLE OF CONTENTS

NEXT GEN SCHOOLSHIP SCHEDULE 3
ALTERNATIVE NEXT GEN SCHOOLSHIP SCHEDULE 4
NEXT-GEN STATION SETUP 5
SAMPLING & SAILING STATIONS 6
ASSEMBLE, WELCOME, BOARD, & CAST OFF 8
SAMPLING 9
Water Quality Group 10
Plankton Group 13
Benthos Group 16
Fish Group (doing the weather station) 19
Microplastics Group 21
Seamanship Group 24
REGROUP AND STUDENT PEER TEACHING ROTATION 25
SECCHI DISK AND WATER CLARITY 31
RAISING SAILS, ANCHOR AND QUIET TIME 33
LEARNING STATIONS 34
STEWARDSHIP WRAP-UP 34
CLOSING BEFORE DOCKING 37

NEXT GEN SCHOOLSHIP SCHEDULE

Time: AM	PM	Activity
8:00-8:30 *30 min*	12:45-1:15	Instructors arrive / Set-up stations
8:30-9:00 *30 min*	1:15-1:45	Welcome / Form small groups / Write student names on index cards / Safety talk / Board the ship
9:00-9:23 *23 min*	1:45-2:08	Departure / Fish trawl (launched by fish group)
9:23-9:40 *17 min*	2:08-2:25	Limnology sampling in small groups: Van Dorn bottle, Plankton net, PONAR dredge, Weather, and Manta trawl or Steering commands
9:40-9:45 *5 min*	2:25-2:30	Regroup to form student teaching stations
9:45-10:00 *15 min*	2:30-2:45	Peer teaching rotation (2 min at each station, 1 min rotation*)*
10:00-10:10 *10 min*	2:45-2:55	Secchi disk observation and discussion of water clarity
10:10-10:38 *28 min*	2:55-3:23	Hoist anchor / Raise sails
10:38-10:43 *5 min*	3:23-3:28	Quiet time
10:43-12:08 *85 min*	3:28-4:53	Learning station rotations (16 min each, 1 min rotation)
12:08-12:20 *12 min*	4:53-5:05	Stewardship discussion in small groups with original instructor
12:20-12:30 *10 min*	5:05-5:15	Docking / Thank-you / Class Picture
		Students disembark / Pass back belongings
		Instructors cleanup / Organize station materials / Record data

ALTERNATIVE NEXT GEN SCHOOLSHIP SCHEDULE

(Minnow trap and no Otter trawl)

Time: AM	**PM**	**Activity**
8:00-8:30 *30 min*	12:45-1:15	Instructors arrive / Set-up stations
8:30-9:00 *30 min*	1:15-1:45	Welcome / Form small groups / Write student names on index cards / Safety talk / Board the ship Pull up minnow trap and bring on board (fish group) / Board the ship
9:00-9:19 *19 min*	1:45-2:04	Limnology sampling in small groups: Van Dorn bottle, Plankton net, PONAR dredge, Weather, and Manta trawl or Steering commands
9:19-9:24 *5 min*	2:04-2:09	Regroup to form student teaching stations
9:24-9:39 *15 min*	2:09-2:24	Peer teaching rotation (2 min at each station, 1 min rotation*)*
9:39-9:49 *10 min*	2:24-2:34	Secchi disk observation and discussion of water clarity
9:49-10:17 *28 min*	2:34-3:02	Hoist anchor / Raise sails
10:17-10:22 *5 min*	3:02-3:07	Quiet time
10:22-12:08 *106 min*	3:07-4:53	Learning station rotations (20 min each, 1 min rotation)
12:08-12:20 *12 min*	4:53-5:05	Stewardship discussion in small groups with original instructor
12:20-12:30 *10 min*	5:05-5:15	Docking / Thank-yous / Class Picture
		Students disembark / Pass back belongings
		Instructors cleanup / Organize station materials / Record data

NEXT-GEN STATION SETUP

Get to the ship at least 30 minutes before the students are scheduled to arrive. This provides time to set-up your station, get acquainted with your fellow instructors, and troubleshoot anything unexpected.

A. Sign into the Volunteer Logbook to record your hours

B. Assemble materials on deck. Although each person is ultimately responsible for setting up their own station, we all help each other.

1. Work together to get station bins, sediment wash station, and weather materials on deck.
2. Put each bin at its respective station. Weather packets, anemometers, and thermometers are only needed by the Fish Group.
3. Distribute one weather bucket to every station.
4. Place the Pre-trip kit midship where all instructors can find it. The Pre-trip kit contains nametags, logbooks, pencils, index cards, markers and related materials.

C. Bring up or locate limnology equipment and the associated lines and place near the needed location**.**

1. Plankton Net and 1 acrylic sample cup
2. PONAR dredge (stored on deck)
3. Van Dorn bottle and Limnology kit (Limnology kit contains: the VanDorn messenger, 1 acrylic cup, thermometer, glass sample bottles with stoppers and wooden rack, DO chemicals #1 and #2, scissors and 3 pairs of goggles. Some of these materials may be in the Water Quality bin.

D. Set up individual stations:

1. **Write your name, the date, and the location on the data sheet.** Review instructions that explain how to fill in the data sheet. Ask the lead instructor if you need help.
2. **Check that all of the needed equipment is in the bin**, if not ask the lead instructor to help you locate it – the sooner the better!
    a. **Plankton:** Check that the microscope and screen are working properly. Make sure there is an acrylic sampling cup on deck with net. Verify the plankton net and line are present and in good condition.
    b. **Water quality:** Lay out the tablecloth to protect the surface and set up materials. Make sure the limnology kit is on deck. Verify the Van Dorn bottle and line are present and in good condition.
    c. **Benthos:** Bring up benthos bin and sediment wash station. Wait to set up until stations rotation begins. Verify the PONAR dredge and line are present and in good condition.
    d. **Fish:** Set up the aquarium: Put a non-stick mat under the aquarium. Fill with 4-8 inches of water from the lake (use the hose) and turn on the bubbler. Cover the aquarium with a towel. (Avoid using the big black bins as aquarium covers if possible since these heat up a lot on a sunny day and can quickly make the water uncomfortable for fish.)
    e. **Microplastics:** Make sure you have all of your equipment, including: bucket ½ full of water, pressure sprayer filled, check that cod end is on manta trawl. Trawl stays lashed to the cabin top (students will take it down).
    f. **Seamanship:** Set up bin at stern, have a bucket ½ full with lake water.

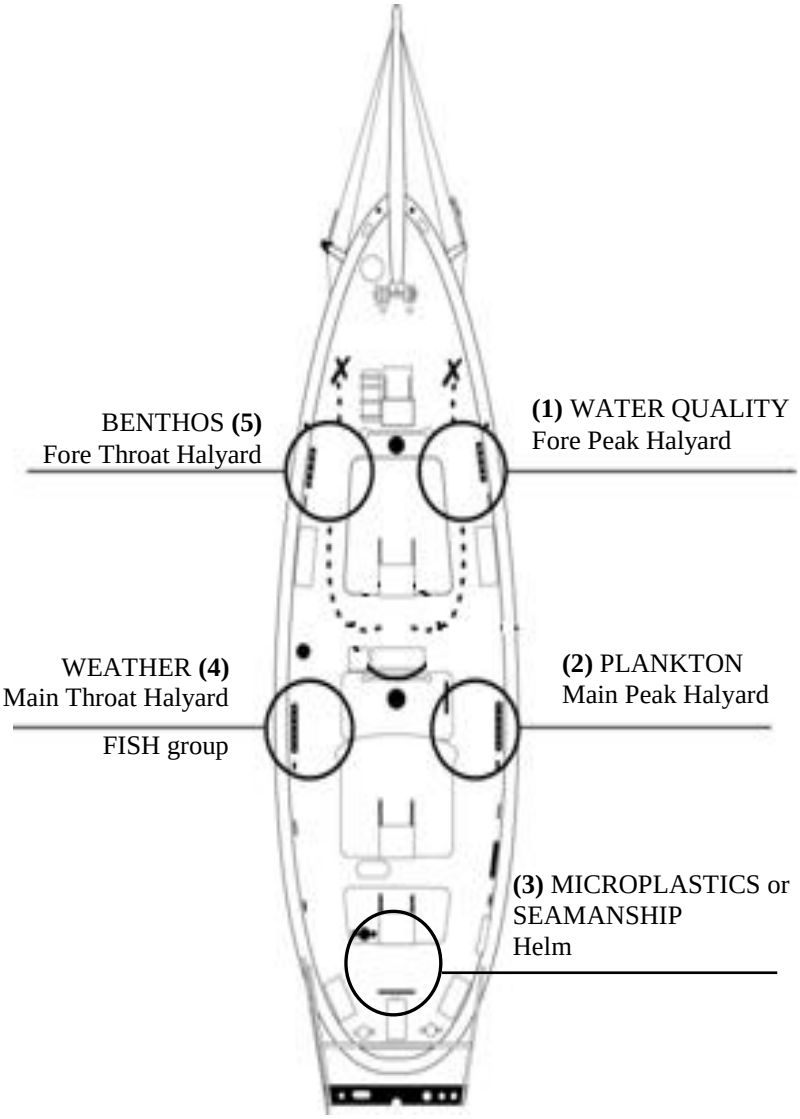
E. Be ready for student arrival:

1. Gather an index card, 5 or more logbooks, and 5 or more pencils

2. Don your layers, or have them handy
3. Review your notes
4. Down that final cup or coffee or snack to keep you fueled throughout the program
5. Smile!

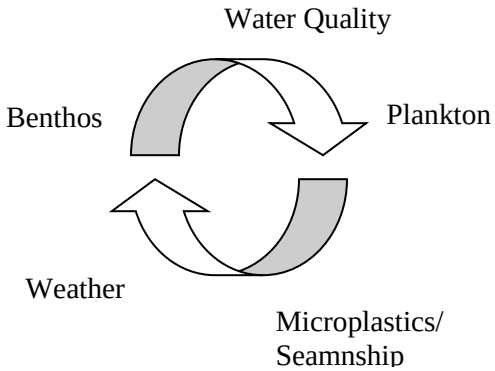
SAMPLING & SAILING STATIONS

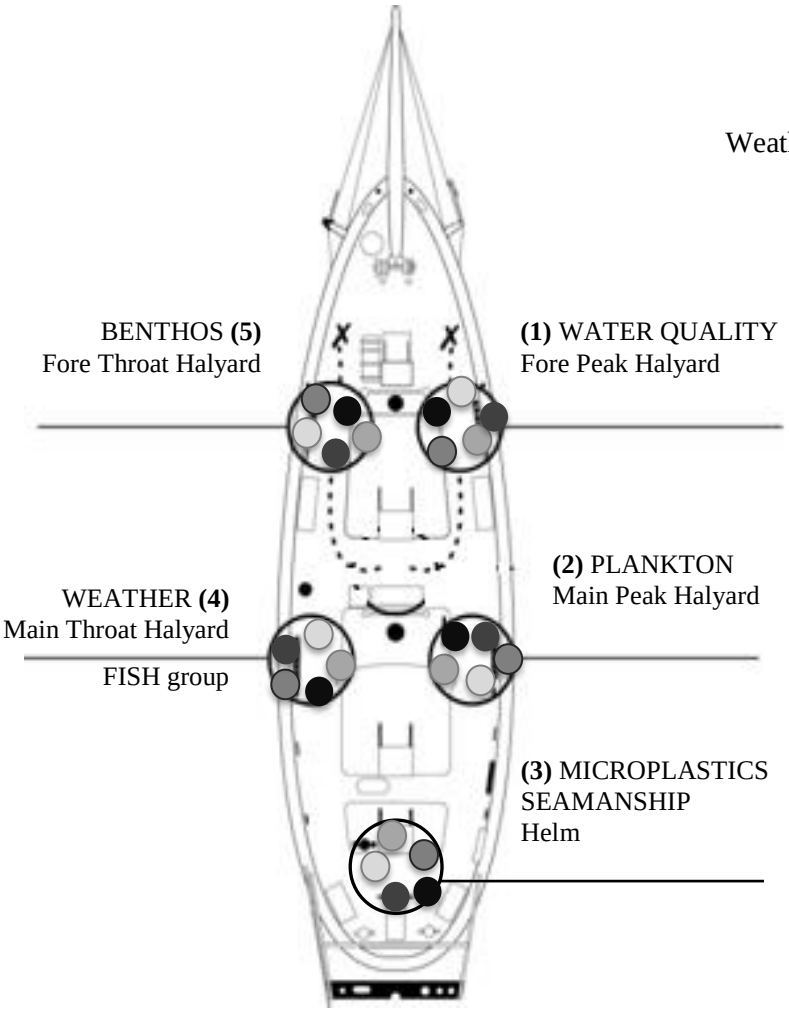
INLAND SEAS Sample collection stations and Sail stations
MANITOU Sample locations may be slightly different
(Microplastics/ Seamanship group sits at mid-ship and raises the headsails when sails are raised)



Peer Teaching

Students re-group,and rotate to teach each other:





ASSEMBLE, WELCOME, BOARD, & CAST OFF

Lead Instructor

1. Greet group at the bus
2. Introduce day's activities
3. Offer opportunity to use bathrooms at the center
4. Verify the Manifest
5. Lead group to the dock
6. At the dock:
    a. Give manifest to Captain
    b. Introduce instructors
    c. Form small groups
    d. Introduce captain
    e. Follow instructors on board & cast off by 9 AM

Group Instructors

1. Greet your group and welcome them.
2. Create index cards with names of group members – one for you, one for a group member.
3. Establish a group identity
    a. Let group know they will be responsible for collecting a certain sample for the whole group. (Ex. Plankton group will collect the Plankton sample.)
    b. Create a group name based on station assignment. (Ex. Fish group can come up with a "fishy" name.)
4. Listen to the safety talk (presented by the Captain and Crew)
5. Board with your group. Instructors lead the group and show them where to sit. Students pass belongings to crew to be stored below deck.
6. While waiting for the crew to cast off, engage your group. Here are some ideas:
    a. Learn the names of the students in your group. Try a name game. For example, each student tells you their name and something they brought on board that starts with the first letter of their name. It can be imaginary! For example, Jeanie brought jellybeans, and Lindsey brought a llama.
    b. Observer weather conditions at the dock: cloud cover, wave height, air temperature, wind speed. Teach how to use thermometer and anemometer. The front of the logbook has a place to record data, which later can be compared to information collected off shore.
    c. Teach the parts of the ship: stern, bow, starboard, port, main mast, fore mast. Practice with a Simon Says game, "Simon Says point to the bow."
    d. Play I Spy or another observation game, which gets students to look around and observe the different parts of the ship. "I Spy something with my little eye that is shaggy like a sheep."

SAMPLING

Fish Sampling

1. Lead Instructor introduces the Otter trawl to the whole group.
2. Fish group launches and hauls in fish trawl with help from the Crew.
3. Lead Instructor transfers fish to aquarium.

Limnology Sampling

Lead Instructor:
During limnology sampling, the Lead will oversee groups, be an extra set of hands when necessary, and keep track of time. A five minute warning is important so group instructors can give students time to practice teaching each other.

Group Instructors:
All limnology samples are collected in small groups at the same time *(See descriptions for each group).* Some important notes:

- BEFORE collection begins, group instructors should explain that students will be responsible for teaching material to fellow students. This means students must and fill out their logbooks so they have the information they need to teach others. This also means instructors must help all students learn everything.
- It will take a few minutes to get the anchor set so be prepared to discuss the device and give background on the topic before doing the actual sampling if necessary. Let students practice using the device on deck.
- In the last 3-5 minutes of the station, make sure log books are filled out, and make a plan for teaching the material. Let students practice explaining different aspects of what you just did together.
- *Lead role is to oversee groups, be an extra set of hands if necessary, as well as keep track of time*.

Water Quality Group

Overview: The instructor demonstrates the Van Dorn bottle and introduces pH and dissolved oxygen (DO). The bottom water temperature is taken, and pH and DO samples are collected from the Van Dorn bottle. At this time also explain why we take a sample from a consistent depth. Students add two chemicals to the DO sample to fix the amount of dissolved oxygen in the sample. When the precipitate in the bottle settles, add the third chemical and shake. The pH and DO samples are set aside for later examination at the Water Quality Station. Instructor helps students practice explaining the use of the Van Dorn bottle and information they gathered.

Objectives: At the end of the station students will be able to:

a. Describe how the Van Dorn bottle works and use it to collect a water sample.
b. Report the measured water temperature.
c. Identify the sample we will use to measure the dissolved oxygen and say why it is amber colored
d. (If time) discuss why pH and dissolved oxygen are important measures of water quality.

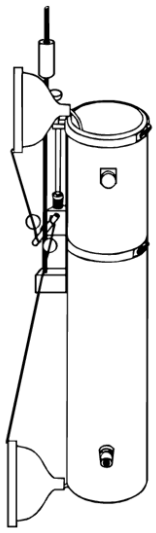


Figure 1.

1. Pre-sampling discussion (1 min)
   At this station we are going to collect a sample from deep in the lake. We always sample from about the same depth (if possible) so we can compare different samples to one another. (50-60 feet on Inland Seas, 60-70 feet on Manitou). Students can choose a depth in the range that is appropriate for the current conditions.
   Note: It is fine if a different depth is sampled, we just won't use that data point when analyzing the data.
2. Demonstration and Practice (4 min)
   a. How does this device work to collect water from any depth in the lake? Allow students to examine the Van Dorn bottle and see if they can figure out how it works.
   b. Show students how the Van Dorn bottle functions. A properly assembled Van Dorn bottle should look like Figure 1. *Van Dorn Sampler Illustration from Standard Methods for Examination of Water and Wastewater, 20th Edition. Copyright 1992 by the American Public Health Association, the American Water Works Association and the Water Environment Federation*
      i. Attach the line (BLACK END) to the bottle using a bowline.
      ii. Attach bitter end (BLUE END) to the ship using a bowline.
      iii. Set the plungers on the trigger mechanism, the top plunger first. Be sure the top plunger is clear of the path for messenger.
      iv. Make sure the valves on either end of the bottle are closed, which means the handles are perpendicular to their spouts. If the valves are not closed water will leak out of the bottle when it is raised.
      v. Hold the line for the Van Dorn Bottle and have a student place the messenger on the line. Student releases the messenger to trigger the Van Dorn.
   c. Let students practice using the device if there is time.
2. Student sampling (5 min)

Inland Seas: use the small davit on starboard side. Manitou: no davit, lower over the side.

a. Re-assemble the Van Dorn bottle. Very capable students might be able to do this on their own. Be mindful of time.
b. Students work together to collect the sample. Important tasks:
    i. Read the depth meter (remember to add 4 feet)
    ii. Decide on an appropriate depth to lower Van Dorn bottle (50-60 feet on Inland Seas, 60-70 feet on Manitou)
    iii. Attach and drop the messenger. Always attach the messenger **over the boat** (not over the water).
    iv. Lower and raise the Van Dorn bottle to depth. (2-3 students)
    v. Count the number of marks to be sure the device is lowered to the appropriate depth. There are marks on the line every five feet.
c. While the bottle is on its way to the bottom, hand out a cup with a thermometer to one student, the pH sample bottle to another, the DO sample bottle to another and pairs of goggles to two others.
d. When bottle is retrieved, place the bottle in the stand and open the valve that is up (turn the handle parallel to the spout.) The lower valve can be opened when you are ready to transfer the water to another container.

3. Measure temperature and prepare samples (4 min)
    a. What will we do with this water sample? Look at water quality. Temperature, pH and DO are important measures of water quality. They help us know if the water is a comfortable place for living things, or if it is a stressful place for living things.
    b. **Temperature at depth**:
        i. Another group is taking the water temperature at the surface of the lake. Will the bottom of the lake be warmer or colder than the top of the lake?
        ii. One student can fill the cup and take the water temperature. It should only take a few seconds for the thermometer to respond, but wait until the reading is steady before recording the temperature.
        iii. Alert students to compare this temperature to the surface water temperature taken at the Weather Station (by the fish group). Which do they think will be colder?
    c. **pH**:
        i. What is pH? pH is a measure of how acidic or basic the water is. pH determines how well substances can dissolve in water, and influences how easy it is for living things to acquire nutrients and toxins. A change in pH over time can suggest pollutants are entering the water.
        ii. Fill the pH sample bottle at least halfway. The glass stopper only needs to be placed in the mouth of the bottle; no pressing or twisting is needed.

    d. Dissolved Oxygen (DO):
        i. What is Dissolved Oxygen? Fish and plants and all organisms in the water need oxygen just like humans do. If there is not enough oxygen in the water, the lake (and the organisms in it) will die.
        ii. The water should be poured so that hits the side of the bottle and then runs down into the bottle. We don't want the water to splash or be forced into the bottle because this could add additional oxygen.

iii. Overfill the DO bottle to ensure no air bubbles.
iv. Add chemicals to the DO bottle. *Students adding chemicals and student holding bottle should wear goggles.* Cut chemical packets open; do your best to keep track of all plastic. Students add the contents of chemical #1 (manganous sulfate) then chemical #2 (lithium hydroxide and potassium iodide) to the DO sample bottle.
v. Explain that chemical #2 contains iodide, and if there is oxygen in the water, the sample will turn amber. *If it does not turn amber something went wrong and a new sample will need to be collected and fixed.*
vi. Put lid on the bottle and invert several times to mix the chemicals. It is OK if all of the powder does not seem to dissolve. There is more reagent in the pillows than is necessary to perform the reaction.
vii. Let the bottle sit in the bottle rack for several minutes until the precipitate begins to settle. Then add chemical #3 (sulfamic acid) and invert several times to mix. This will dissolve the precipitate and make a transparent yellow fluid. *Instructor may need to do this step after the sampling station. Sample is stable for a few hours before adding #3.*

4. Prepare for the presentation. Ask students to plan what they want to share with other groups, review the material, and answer questions. (3 min)
    a. **Logbook**: Make sure all students have the information recorded in the box on the water quality page. Tell students they can begin their presentation by sharing the information in the logbook and ask a student to practice presenting this part. Other students can listen and jump in with corrections and additions.
        i. Name of the device (The Van Dorn bottle is designed to collect water at any depth.)
        ii. Depth of the sample
        iii. Water temp at that depth
    b. **The device:** Let the students explain how it works. As the instructor you can say, "*I'll set up the Van Dorn bottle and hold it. One of you can drop the messenger and explain how it works."* Aim for participation by many.
        i. Plungers are set on a trigger mechanism.
        ii. Bottle is lowered.
        iii. Messenger triggers bottle to close, trapping water at any depth.
    c. **The sample:** Ask a student to show the samples and tell what we will be doing with them.
        i. One sample will be used to determine pH
        ii. The amber-colored sample will be used to determine dissolved oxygen
    d. **More:** If there is time and your group understands this part, ask students to share why we are collecting water and measuring temperature, pH and DO.
        i. Temp, pH, and DO are indicators of water quality. They tell us if the water is comfortable for living things, or uncomfortable.
        ii. pH is a measure of how acidic or basic the water is and it influences how easy it is for organisms to acquire nutrients and toxins.
        iii. DO is dissolved oxygen - the oxygen source for fish and all organisms in the lake.

Plankton Group

Overview: The instructor introduces the different types of plankton (zoo- vs phyto-) and where they are located in water column. This helps students understand why we sample to 50 feet – so we can get a diversity of plankton species. Students lower the plankton net and raise it vertically to the surface in order to collect plankton. Students rinse net and transfer samples to cup for later examination at the Plankton Station. Instructor helps students practice explaining the use of the plankton net and information they gathered.

Objectives: At the end of the station students will be able to:

a. Describe how a plankton net works and use it to collect a plankton sample.
b. Describe the difference between zooplankton and phytoplankton.
c. (if time) Explain why we do a vertical plankton tow.

1. Pre-sampling discussion (5 min)
    a. Show students the plankton net, make sure each student gets the opportunity to examine the net and feel the mesh. The holes in this net are 153 μm wide, which is big enough to put two of your hairs through one hole. (μm stands for microns. A micron is $1/1000^{th}$ of a millimeter, so the holes in this net are 0.153 mm wide.)
    b. What do you think we can catch with this net? *Tiny things, Plankton*
    c. What words describe plankton? *Free-floating organisms living in the water.*
    d. Do you think plankton are plants or animals?
    e. We classify plankton into two groups based on where they get their energy:
        i. **Phytoplankton** = get their energy from the sun through photosynthesis. They are very small; many, <u>but not all</u>, are too small to get caught in the net. The prefix "phyto" refers to plants, and phytoplankton are plant-like, but they are not plants; they are Protista or Bacteria. Some phytoplankton are called "algae" when they grow to large numbers and sometimes large masses. These algae are also either Protista or Bacteria.
        ii. **Zooplankton** = get their energy by eating other things. They are often larger than phytoplankton and we expect to catch a bunch of them in the net. This net is designed to capture zooplankton. The prefix "zoo" means animal and zooplankton are animal-like. Some are animals, such as copepods which are crustaceans like shrimp. Others are Protista, such as the rotifers.
    f. Sometimes a plankton net is towed behind a boat to get a horizontal plankton tow. We are going to lower the net straight down into the water then pull it straight up. What might be the advantage of doing a vertical plankton tow? *Different kinds of plankton live at different depths in the lake.*
        i. Phytoplankton – near the surface so they can absorb sunlight
        ii. Zooplankton – lower, they avoid light to hide from predators. At night they may come up to feed on the phytoplankton. Different zooplankton species prefer different depths.

2. Demonstration (3 min)
    a. Attach the line (BLACK END) to the bridle using a bowline.
    b. Attach bitter end (BLUE END) to the ship using a bowline.
    c. Point out the parts of the net:

i. Bridle - the part we attach to the line
ii. Mesh – the part that filters the water

d. Cod end – the part where the plankton collectAsk students how we will be using the net to catch plankton. If they are unsure, explain that we will be lowering the net over the edge and pulling it back up.
e. To make it easier to compare samples, follow this protocol. On Inland Seas get the plankton sample from between 50 and 60 feet. On Manitou get the sample from between 60 and 70 feet. Be sure the depth you chose leaves **at least 10 feet** between the bottom of the lake and the sample depth so the net does not touch the bottom. *It is OK if you choose to sample at a different depth, we just won't use this data in our regular analysis.*

3. Student sampling (6 min)
    a. Students work together to collect the sample. Important tasks:
        i. Read the depth meter (remember to add 4 feet).
        ii. Confirm the depth to which you will lower plankton net.
        iii. Lower and raise the plankton net.
            1. Give the net time to sink before hauling it back in.
            2. There are marks on the line every 5 feet. There are different (color, or two marks) every 25 feet, measured from the BLACK end.
        iv. Rinse the net with the hose on the "shower" setting so plankton are not damaged. Hold the net over the water and spray from the top of the net down, being sure to rinse well near the cod end. You may need to walk the net to the other side of the boat, or stretch the hose across the deck.
        v. Unscrew the cod end and pour into cup (one student can hold the cup).
            1. The cod end is weighted so the pourer needs to focus on maintaining control of it while pouring (kids seem to be naturally good at this)
            2. Pour out the solid side of the cod end, rather than through the screen, to keep the water in the sample.
        vi. Rinse the cod end with the hose to remove any stray plankton and keep the screen clean for the next program. Rinse water can be poured into the lake.
    b. Examine the sample visually. Note:
        i. Cloudiness and color of the water
        ii. Any moving creatures in the water
    c. With students who are not handling the net, and while the tow is underway, calculate the number of gallons filtered to get the sample. Encourage mental math. Every foot of line corresponds to 16 gallons of water filtered. If the net is lowered to 50 feet (50 feet × 16 gallons/foot), 800 gallons of water are sampled.
4. Prepare for the presentation. Ask students to plan what they want to share with other groups, review the material, and answer questions. (3 min)
    a. **Logbook**: Make sure all students have the information recorded in the box on the plankton page. Tell students they can begin their presentation by sharing the information in the logbook and ask a student to practice presenting this part. Other students can listen and jump in with corrections and additions.
        i. Name of the device (it is used to filter plankton out of the water)
        ii. Depth of the sample
        iii. Volume of water filtered

b. **The device:** Let the students explain how it works. As the instructor you can say, "I'll hold the plankton net while you explain how it works."
    i. Lower the net down, bring back up.
    ii. The net filters plankton out of the water.
    iii. Plankton collects in the cod end.
c. **The sample:** Ask a student to show the samples and tell what we will be doing with it.
    i. Note how tiny the organisms are in the cup.
    ii. We will identify them with a microscope.
d. **More:** If there is time and your group understands this part, ask students to share the different types of plankton and why we do a vertical plankton tow.
    i. Phytoplankton do photosynthesis and are smaller.
    ii. Zooplankton eat other things and are bigger.
    iii. We do a vertical tow because plankton live at different depths. A vertical tow allows us to get lots of different species. Also, zooplankton are more likely to be found deeper in the water during the day; phytoplankton prefer the surface so they can access to the sun.

Benthos Group

Overview: Instructor introduces benthos. Students hypothesize about what sediment is like in deep water. Instructor demonstrates use of the PONAR dredge. Students, doing as much work as safety allows, collect 2 samples of the lake bottom and set aside for later examination at the Sediment & Benthos Station. Instructor helps students practice explaining the use of the dredge and information they gathered.

Objectives: At the end of the station students will be able to:

a. Describe how a PONAR dredge works and use it to collect a benthic sample.
b. Describe the benthic zone and define benthic organism.

1. Pre-sampling discussion (4 min)
    a. Introduce the term benthos. Ask the group if they have heard that term before and what it means.
        i. The bottom of the lake is called the benthic zone. When light penetrates all the way to the bottom, plants grow on the bottom. If the water is deep enough the benthic zone will be too dark for plants to grow. Decomposition occurs in the benthic zone.
        ii. Benthic organisms live in, on, or near the bottom of the lake.
    b. Remind students that this is the second benthos sample they are collecting today. Ask, what was the first?
        i. Otter trawl – dragged across the bottom, and collected what was living at the bottom at that depth.
        ii. Ask them at what depth the otter trawl was towed.
    c. Explain that the group will collect another sample of the benthos in deeper water, this time getting some sediment. Ask a student to read the depth meter if we have reached our anchor spot so you can compare the two depths.
    d. Ask what they think they will find in deeper water. What will the sediment look like? Any predictions are fine. You might want to ask students to give reasons for their predictions.
2. Demonstration (2 min)
    a. Display and name the PONAR dredge. It weights about 25 pounds and will sample 0.25 ft^2. The dredge is heavy and can easily pinch fingers. Use caution.
    b. Attach the line to the dredge using a bowline.
    c. With solid pin already through hole, and PONAR dredge open, pull up on rope to show that pin keeps the dredge open. Ask, how do we make the dredge close?
    d. Instructor should demonstrate the PONAR dredge. <u>Keep student fingers safe.</u>
        i. Put in spring-loaded pin (it takes practice to make this happen; the most important thing is to be so so patient and calm) – pull up on dredge to keep the pin in place.
        ii. Lift the dredge and explain that the pressure on the pin keeps it in place.
        iii. Lower dredge onto a surface and explain that once the tension is released (when the rope goes slack as it hits the bottom) the pin pops out due to the spring.
        iv. Lift the dredge to show how it closes and scoops into the sediment.
3. Student sampling (8 min)

a. Record the water depth (remember to add 4 feet to the depth meter reading). This is the sample depth.
b. For most groups, the instructor will insert the spring-loaded pin. Only the most capable students groups should be allowed to do this.
c. Instructor will put the dredge on the davit. To do this, hold the line just above the dredge with one hand. With the other hand take a length of line above the dredge and loop it over the davit. Give yourself plenty of slack, so you can lasso the line on to the davit
d. Students work in pairs to collect the sample. Follow these steps:
    i. Let line out until the dredge hits the bottom. The line needs to go out smoothly – no jerks – but it does not need to go out quickly. Go gradually.
    ii. Feed additional line into the lake to ensure the line goes slack so the pin can pop out.
    iii. Haul on the line SLOWLY. It should very hard to pull for a moment as the dredge scoops into the sediment.
    iv. Pull dredge to surface (haul away). Stop when dredge gets close to davit (avast). When instructor has a hold of the line have students let go (up behind). *This is a good opportunity to practice sailing commands.*
    v. As line comes is, another student can coil it in the bin to keep it contained.
    vi. Instructor removes dredge from davit and places it in a sample bin. With a flat hand press straight down on the arms of the dredge to open the dredge and the release sample into the bin. Insert the solid pin.
    vii. Use the hose (on the shower setting) to rinse the dredge, especially around the screen. Small organisms can cling to the inside of the dredge.
    viii. Replace spring-loaded pin and repeat above for sample #2 but with different students.
    ix. If these steps are followed sampling should be successful. If the pin does not pop out, it is usually best to haul in the dredge, reset the spring-loaded pin, and try again. Above all maintain humor and just keep trying until there are 5 minutes left (to give time for students to practice teaching each other). If necessary, the lead instructor can try getting a sample while group instructor reviews with the students.
e. When sampling is complete, insert solid pin to lock the dredge open and dunk the dredge into the lake a few times to rinse and clean the dredge.
f. Ask students to compare their predictions to the sample.
    i. Is this what you expected?
    ii. If the sample doesn't look like the prediction, does that mean your prediction is wrong? The only way to know for sure if a prediction is wrong, is to look at all parts of the benthic zone. Remember we are looking at 0.25 ft^2, which is a tiny window into the bottom of the lake. Imagine an alien taking one sample from the earth's surface, how much would that one sample able to tell them about the surface of the earth?

4. Prepare for the presentation. Ask students to plan what they want to share with other groups, review the material, and answer questions. (3 min)
    a. **Logbook**: Make sure all students have the information recorded in the box on the benthos page. Tell students they can begin their presentation by sharing the

information in the logbook and ask a student to practice presenting this part. Other students can listen and jump in with corrections and additions.

i. Name of the device (it collects sediment from the bottom of the lake)
ii. Depth of the sample
iii. Number of samples collected

b. **The device:** Let the students explain how it works. As the instructor you can say, "*I'll demonstrate the dredge while you explain how it works."* Aim for participation by many.
    i. Spring loaded pin keeps dredge open until it hits the bottom.
    ii. When tension on the pin is released, the pin pops out.
    iii. Pulling on the line causes the dredge to close and grab sediment.
c. **The sample:** Ask a student to show the samples and tell what we will be doing with it.
    i. This is what is looks like at the bottom of the lake: it is dark in color and there are no plants
    ii. We will examine it more closely later.
d. **More:** If there is time and your group understands this part, ask students to define benthos and explain why the sample is dark and does not include plants.
    i. The benthic zone refers to the bottom of the lake. Benthos are the organisms that live in, on, or near the bottom of the lake.
    ii. The sediment dark is dark because decomposition occurs at the bottom of the lake.
    iii. We didn't get any plants because at this depth the benthic zone is too dark for plants to grow.

Fish Group (doing the weather station)
Overview: This is a typical weather station with an emphasis on using the equipment. Students determine air and water temperatures, wind direction and wind speed. Wave height, visibility, cloud types, and cloud cover are included when there is time to do so. Instructor helps students practice explaining the use of the wind meter and data they gathered.

Objectives: At the end of the station students will be able to:

a. Describe how sampling devices work (wind gauge, thermometer) and use them to collect observations.
b. Report on weather and sea conditions.
c. (if time) Explain why scientists and sailors need to pay attention to the weather.

1. Pre-sampling discussion (1 min)
    a. Why might a scientist want to pay attention to weather conditions? *Measurements and observations can change with the weather because nature responds to weather conditions.*
    b. Why might a sailor want to pay attention to weather conditions? *Sailing conditions are determined by the weather*.
2. Collect weather station data. (10 min)
   There may be less time that usual, so focus on the information in the top box on the logbook page. Since nothing can be sampled over the side until the anchor is set, begin with an orientation to the equipment.
    a. Ask a student to take the air temperature and tell students that it can take several minutes for the thermometer to respond completely, so be patient.
    b. When the boat is anchored, students can use a bucket to collect a water sample so we can find the temp of the water. *Digital thermometers should respond within several seconds, but wait for reading to stabilize before recording temperature.*
    c. Demonstrate how to use the anemometer and tell students that we will collect the wind speed once the boat stops moving.
    d. By the time demonstrations are finished the boat should be anchored and students can collect data independently. There will be enough equipment for several students to collect the same data (2 or more thermometers, anemometers, etc.). This will allow an opportunity to discuss the sources of variation in data and that an average can be taken
3. Alert students to compare the surface water temperature to the temperature taken at depth by the Water Quality group. Which do they think will be colder?
4. Continue making weather observations or clouds, waves, and visibility as time permits.
5. Prepare for the presentation. Ask students to plan what they want to share with other groups, review the material, and answer questions. (3 min)
    a. **Logbook**: Make sure all students have the information recorded in the box on the weather and sea conditions page. Tell students they can begin their presentation by sharing the information in the logbook and ask a student to practice presenting this part. Other students can listen and jump in with corrections and additions.
        i. Wind direction and wind speed
        ii. Surface water and air temperatures

b. **The devices:** Let the students explain how each one works. Students might find it easiest to describe how the anemometer works if they hold it themselves. Allow the audience to try it out if time permits.
    i. Anemometer: Point the back of the gauge into the wind and read the wind speed on the front.
    ii. Thermometer: Make sure thermometer is in a measurement mode. Keep hands off the probe. Wait for reading to stabilize.
c. **Why:** If there is time and your group understands this part, ask students to explain why the weather is important for scientists and sailors.
    i. Measurements and observations can change with weather
    ii. Sailors rely on the weather for good sailing conditions.

Microplastics Group

Overview: Students assemble and set up Manta Trawl and learn about how a Manta Trawl works. Discussion begins on what microplastics are and possible impacts of microplastics on the Great Lakes. The Manta Trawl will not be launched until the learning stations begin. Instructor helps students practice explaining the use of the Manta Trawl and information they gathered about microplastics.

Objectives: At the end of the station students will be able to:

a. Describe how the Manta Trawl works.
b. Define and describe microplastics.
c. Say that Inland Seas is part of a research project that is monitoring microplastics in the Great Lakes
d. (if time) Discuss possible sources of microplastics found in the water and possible impacts of microplastics on the lake.

1. How the Manta Trawl works (5 min)
    a. Students can unlash the trawl and move it to the cabin top in the stern so everyone can get a good look at it.
    a. Name the trawl (Manta Trawl). Named this because it looks like a manta ray.
    b. Tell students that the purpose of the Manta Trawl is to skim the surface of the water. Ask them to figure out how it works, and what they think we will catch.
        i. How is it oriented in the water? *Open end is the bottom*
        ii. What are the wings for? *Buoyant, keeps mouth of net at the surface*
        iii. What does the hood do? *Hood deflects wave crests into the net*
        iv. What is the mesh for? *To contain material of a certain size*
        v. Where does the sample collect? *In the cod-end of the trawl*
        vi. Does the size of the holes in the mesh impact what we will get? Explain. *Yes, anything smaller than holes will go through mesh, anything larger will be caught in the net.*
        vii. What do you think it will capture? *Let students come up with ideas, there are no "right" answer here, we are hypothesizing!*
2. Set-up the Manta Trawl (2 min)
    a. Attach the towline to the bridle with a bowline
    b. Move the trawl to the port side of the boat with the net and cod-end extended in preparation for launching.
3. Describe microplastics (7 min)
    a. What we are looking for with the trawl are microplastics. *Instructors can ask students to guess at the definition of microplastics.* Microplastics are bits of plastic that are less than 5mm in every dimension. Show a sample that was captured in a mantra trawl from the Great Lakes.
    b. How do you think plastics get into the lake? *Students should be able to propose sources. Let their ideas guide the discussion.*
        i. Microplastics are usually the remains of a larger plastic item. Through abrasion, wave action, and break-down from the sun the larger pieces are broken down into smaller pieces. Plastics can get into the water from rivers, beach-goers, boaters, and wind blowing trash around. There is research underway to find out where plastics originate.

ii. Another source is microbeads from body products. Show a body product that contains microbeads and the electron micrograph image that shows the similarity between the microbead and the microplastic collected in the manta trawl. Microbeads probably come from wastewater treatment plants, which cannot filter microbeads out of sewage water. There is legislation proposed to ban microbeads in Michigan by 2019.

c. How do you think microplastics affect the lake? *Students should be able to come up with most of these possibilities; it is not necessary to cover all of this information:*

i. Plastics are eaten by fish and plankton. The plastic may stay in the animal's stomach, unable to be digested or egested (pooped out). If the stomach fills up there won't be space for food and the animal will starve. But even if the animal is able to eliminate it, the animal wasted energy eating useless food. Data has been collected to show that perch do eat plastic. We don't know for sure if plankton eat plastic particles, but observations suggest this is probably happening.

ii. Larger animals can ingest plastic by eating smaller animals that have plastic in their stomachs. This means that larger animals may actually eat more plastic than smaller animals. Data has been collected to show that cormorants (who eat perch) contain much more plastic in their stomachs that perch do.

iii. Plastics can absorb chemicals in the water, such as DDT and PCBs which can make the chemicals more available to animals when they eat the plastic. There is evidence of this occurring in the ocean, and scientists are looking into how this happens in a fresh water system.

iv. Filter feeding organisms like mussels and snails might also eat microplastics. We suspect they do, but don't know the effects just yet. More research is needed.

v. The manta trawl skims water at the surface. There is probably also plastic at the bottom of the lake (many plastics sink). Research is underway to find out if this is happening and the quantity of plastic there.

d. We know very little about microplastics in the Great Lakes. Scientists are currently investigating all sorts of questions and you are part of that team. At Inland Seas we are also collecting data to answer questions about how microplastics interact with the lakes.

i. The data we collect will help us understand if there are seasonal differences in microplastic abundance. Is it more common in spring or summer or fall?

ii. Our data will also give data nearshore, whereas most of the data collected so far are from the main basins of the lakes. *Show map of where data has been collected so far.*

4. We send a subset of our samples to a scientist in Pennsylvania whose lab will count and classify any plastic particles we collect. *Dr. Sheri "Sam" Mason at Penn State. She is the research scientist who first sampled for microplastics on the Great Lakes in 2012.* Prepare for the presentation. Ask students to plan what they want to share with other groups, review the material, and answer questions. (3 min)

a. **Logbook**: Make sure all students have the information recorded in the box on the microplastics page.
    i. Name of the device (skims the surface to filter particles out of the water.)
    ii. Size of microplastics
    iii. How much we know about microplastic in fresh water systems
    iv. The research question we are exploring
b. **The device:** Let the students explain how it works. Aim for participation by many.
    i. Wings help the trawl float.
    ii. Scoop deflects waves into the trawl.
    iii. Net filters the water.
    iv. Cod end collects the sample.
c. **The sample:** Ask a student to explain what we are looking for with the trawl and to show an example of a sample.
    i. We are looking for tiny bits of plastic in the water, called microplastics.
    ii. This is a sample that was collected in Lake Ontario (Inland Seas) / St Lawrence River (Manitou) during a 30 min trawl.
    iii. Our sample will go to a university in New York to be analyzed.
    iv. We are trying to find out how the amount of plastic in the lake varies seasonally and annually.
d. **More:** If there is time and your group understands this part, ask students to describe how plastic gets into the lake and to share some ideas we have about how microplastics might impact the lake.
    i. Rivers, beach-goers, boaters and wind can bring plastic of all sizes to the lake. Wave action breaks-down larger plastics. Wastewater treatment plants may release microbeads from body care products and lint from synthetic fabrics.
    ii. Animals can eat it and clog their digestive systems, plastics absorb toxins from water which might enter the food chain, filter feeding organisms may ingest it, there might be plastic on the bottom of the lake, etc.

Seamanship Group

Overview: This is adapted from the Traditional Schoolship program. Students will learn how to steer the ship. This includes learning about the rudder and the wheel. Integral to this station is learning the commands given in order to steer the ship, listening only to commands given by the captain, and why we repeat a command before acting on it. Instructor helps students practice explaining how the wheel and rudder are connected, and what to do when it is the student's turn to steer the ship.

Objectives: At the end of the station students will be able to:

a. Describe how the rudder turns the ship and how the wheel is connected to the rudder.
b. Explain what is expected of him/her when it is their turn to steer the ship.
c. What the commands mean, and why we repeat commands before acting.

1. "Sampling" discussion (5 min)
    a. How does this ship move through the water? *Sailing vessels need wind, but we can also use our engine. We will have to steer it through the water in much the same way that a fish uses its body to push water one way or the other. We use a rudder, like the tail fin of a fish.*
    b. What steers the ship? *The ship's wheel is connected to the rudder.*
    c. How will we steer the ship? *Two at a time students will stand on either side of the wheel, looking forward. Students are "on duty", no sitting down, listen to directions, and work together.*
2. Learning Commands (5 min)
    a. As a helmsman, it's important to pay attention. Only the captain can change the course we are heading.
    b. When the captain gives a command, the crew always repeats it back **before** acting.
    c. Why do we repeat all the commands? *Wait for responses. Some reasons are that it's loud, windy on the ship and the captain needs to know that it was heard correctly.*
    d. Describe the spokes on wheel. Go through example commands: "Three spokes to port", or "Three spokes left", have students practice repeating them.
3. If there is time, introduce the navigation screen and ask students to record current location in Lat/Long in their logbooks.
4. Prepare for the presentation. Ask students to plan what they want to share with other groups, review the material, and answer questions. (3 min)
    a. **Logbook**: Make sure all students have the information recorded in the box on the Seamanship page. Tell students they can begin their presentation by sharing the information in the logbook and ask a student to practice presenting this part. Other students can listen and jump in with corrections and additions.
        i. Wheel and Rudder
        ii. Repeat commands
    b. **The Steering:** Let the students explain how steering works. Students might find it helpful to use the laminated pictures describing the rudder and a fish tail.
        i. Spokes on the wheel
        ii. Where to stand, what to do when "on duty"
        iii. Repeat commands

REGROUP AND STUDENT PEER TEACHING ROTATION

Regroup

Lead Instructor

1. When it is time to regroup, give very clear instructions on what to do next. Inform students they will next all move to different groups and will get a chance to teach their classmates what they learned. They will also learn about all of the other sampling stations. Orient students to the sampling locations. They are arranged clockwise, starting at the fore peak halyards (starboard):
    a. #1 – Water Quality
    b. #2 – Plankton
    c. #3 – Microplastics/ Seamanship (helm)
    d. #4 – Weather
    e. #5 – Benthos
2. Count off students so everyone gets a number 1-5. To prevent very lopsided group sizes during the student presentation rotation, we need to keep special situations in mind. The lead instructor will decide on the appropriate numbering scheme:
    a. If there are **more than 5 students per group**, repeat numbers starting with your station number or partner a more hesitant student with another student. For example, if I am leading the fish group at the weather sampling station (sampling station #4) and I have 7 students, I will number students this way: 1, 2, 3, 4, 5, 4, 5. We must be systematic in the way we repeat numbers else one group could have 10 students, while the rest have only 5.
    b. If there are **less than 5 students in all groups, and all groups have the same number of students**, then just count to the number you have; 1-4, for example. This will create four student presentation groups, and during the rotation there will always be a sampling station without any students.
    c. If there are **less than 5 students in some but not all groups**, assign numbers in a way that skips your station number. For example, if I am leading the plankton sampling (sampling station #2) and I have 4 students, I will number students this way: 1, 3, 4, 5. We must be systematic about skipping numbers when group sizes are uneven else a group could have only 1 student.
3. Students are to hold up their number using their fingers so they don't forget their number.
4. Help students go to their new stations.
5. Help rearrange students if student presentation groups end up overly lopsided. But, sometimes lopsidedness will happen. Just relax and work with it.

Group Instructors

1. Count off students according to the numbering scheme given by the lead instructor and reinforce directions given by the Lead.
2. Group instructors are to hold up their group number using their fingers until all members of their group have arrived. There may be a different number of students than you started with. In some case there may be less than five groups, in which case you may not have a group at first.

Student Peer Teaching Rotations

Lead Instructor

Ring the bell every three minutes. This gives time to rotate to the next station and a couple minutes for the students to teach before the next bell.

Group Instructors

When students have moved to their new locations, each group should contain an "expert" on each sampling station. The expert for your station is the one you trained. This expert should explain the purpose of the sample device, how it works, and other pertinent information learned at the station.

To make this work, instructors may need to scaffold the presentation for the students. Here are some important points:

1. First, tell the group to get out their logbooks and fill in the information in the box while the student presents. This will tell the audience they need to use active listening.
2. Throughout the presentation, instructors can prompt student presenters with what to talk about next. Some students may be able to put together a meaningful presentation on the fly, but some will need help. Example scripts are below.
3. Instructors will demonstrate for students how limnology equipment works. Since it takes practice to fluidly set up and use the equipment, there is not time for students to demonstrate how the devices work. Please demonstrate on deck, do not put anything over the side.
4. Instructors will allow students to do all of the explaining. When necessary, prompt students with a question rather than giving an answer. Fill in answers only if students are truly stuck (it is OK for a student to be uncomfortable for a moment while he or she searches for what they want to say).

If there is not a student expert in the group, the group instructor will teach the sampling station.

Instructors stay at their stations while students move from instructor to instructor. For example, if I am at the benthos sampling station, each time the groups rotate one student I trained on benthos will be in the new group. My benthos students will present only when they are with me.

Example scripts for facilitating the student presentations

You might find that after the first rotation or two, students get the hang of it and present without any help at all! Use this scaffolding only if students need it.

1. **Water Quality** (the student expert for this example is Devon)
   You might start like this. *"Turn to page 4 and fill in the information in the box when Devon gives it to you. Devon, why don't you start by explaining what this device is called and how it works? I will hold the device and demonstrate how it works while you tell everyone what is happening. Feel free to refer to your logbook whenever you need to."*
   Devon will tell the group that this is called a Van Dorn bottle and will describe how it works while the instructor demonstrates. The instructor may need to prompt Devon if a step is missed. *How are these plungers held open?*

"Now, Devon, tell us about the collection information recorded in the log book."
Devon will give the sample depth and the water temperature at that depth.

"Good, now tell us about these bottles. How did we prepare these and what will we do with them?"
Devon will tell us that one bottle will be used to determine the pH of the water; we didn't put anything but water in this bottle. In the other bottle we put a bunch of chemicals to trap the oxygen in the water, which is why it is yellow. We will use that one to measure how much oxygen is in the water.

If you have time and a group that understood prompt, *"Devon, wrap up by telling everyone why temperature, pH and DO are important measures of water quality."*
Devon will explain:

a. Temperature, pH and DO all help us understand if the water is comfortable or uncomfortable for the organisms that live in in.
b. pH is a measure of how acidic or basic the water is and influences how easy it is for organisms to acquire nutrients and toxins.
c. DO is dissolved oxygen - the oxygen source for fish and all organisms in the lake.

→ If there is time, ask the weather station student to report the surface water temperature to compare to the temperature at depth.

2. **Plankton** (the student expert for this example is June)

You might start like this. *"Turn to page 6 and fill in the information in the box when June gives it to you. June, why don't you start by explaining what this device is called and what we wanted to collect with it."*
June will tell the group that this is called a plankton net and we used it to collect a plankton sample.

"Good. Can you tell us what plankton are?"
June will say that plankton are tiny organisms in the water. She might also explain the difference between zooplankton and phytoplankton if she understood this part. Feel free to prompt her for this information if there is time to share it and you covered it in your station, "*and how we can categorize plankton into different groups?"*

"Now, I will hold the device and demonstrate how it works while you tell everyone what is happening. Feel free to refer to your logbook whenever you need to."
June will describe how it works while the instructor demonstrates. The instructor may need to prompt June if she misses a step, although the plankton net is pretty straightforward.

"Now, June, tell us about the collection information recorded in the log book."
June will give the sample depth and amount of water filtered.

"Good, now show us the sample. What did we find?"

June will show the sample in the cup. Hopefully she will also point out the tiny creatures moving about everywhere.

→ If there is time, draw attention to the cloudiness of the water. Explain that plankton in the water will make it less clear. This will probably be meaningful to the student who collected the weather station data.

3. **Benthos** (the student expert for this example is Joe)

You might start like this. *"Turn to page 7 and fill in the information in the box when Joe gives it to you. Joe,* w*hy don't you start by explaining what this device is called and how it works. I will hold the device and demonstrate how it works while you tell everyone what is happening. Feel free to refer to your logbook whenever you need to."*

Joe will tell the group that this is called a PONAR dredge and will describe how it works while the instructor demonstrates. The instructor may need to prompt Joe if he misses a step. "*Why is there a spring on this pin?"*

"Now, Joe, tell us about the collection information recorded in the log book."

Joe will give the sample depth and the number of samples collected.

"Good, now show us what you collected. Is it what you expected to see?"

Joe will point out the bins of mud. If you formed hypotheses about what you would collect, Joe might be able to say what everyone thought they would see and then compare this to what the mud actually looks like.

"Joe, wrap up by defining benthos for everyone and explain what it is like at the bottom of the lake."

Joe will explain:

a. The benthic zone refers to the bottom of the lake. Benthos are organisms that live in, on, or near the bottom of the lake.
b. Dead things sink to the bottom of the lake and decompose in the benthic zone. Benthos often feed on dead things.
c. In the shallows there is lots of light in the benthic zone. In deep water, it is very dark at the bottom.

→ If there is time, remind students that we took a second benthos sample in shallow water. Students will get to compare the two in the Benthos station.

4. **Weather** (Fish group) (the student expert for this example is Anna)

You might start like this, *"Turn to page 3 and fill in the information in the box when Anna gives it to you. Anna,* w*hy don't you start by describing the wind conditions today and how you measured them? Feel free to refer to your logbook whenever you need to."*

Anna will tell the group the wind direction and speed. She may also mention that wind direction refers to the origin of the wind, if you covered that information. She will also demonstrate how the wind meter (or anemometer) works. The instructor may need to prompt Anna if she misses a step. "*Which way do you point the wind meter?"*

If it makes sense, allow the audience to try using the anemometers themselves. How does the wind speed now compare to the wind speed when Anna recorded it?

"Good, now compare the air temperature to the surface water temperature."
Anna will share the air and water temperatures and mention which one is colder.

"*Next, share the other weather information we collected. We can compare conditions now to what they were when we observed them originally."*
Anna will give the precipitation, cloud types, cloud cover, visibility, and wave height. The group can make these same observations of current conditions and discuss how things have changed (or not changed).

→ If you have time and a group that understood ask*, "Anna, wrap up by telling us why scientists and sailors pay a lot of attention to the weather."*
Anna will tell us that sailors use weather to determine sailing conditions and scientists record the weather because measurements and observations change based on the weather.

5. **Microplastics** (the student expert for this example is Sam)

You might start like this. *"Turn to page 4 and fill in the information in the box when Sam gives it to you. Sam,* w*hy don't you start by explaining what this device is called and how it works? Feel free to refer to your logbook whenever you need to."*
Sam will tell the group this is called a Manta Trawl, will describe how it works, and will mention that it skims the surface of the water. The instructor may need to prompt Sam if anything important is missed. "*What keeps the trawl on the surface?"*

"Now, Sam, what are we hoping to collect with this device?"
Sam will say that we are looking for microplastics. Pass around the sample for the group to observe.

"Good, can you explain what microplastics are and how they end up in the lake?"
Sam will give the size of microplastics and share some of sources of microplastics. Invite others to share ideas if they are eager or if Sam seems stuck.

"Let's end the presentation by explaining the research we will be doing at Inland Seas. First tell us how much is known about microplastics in the Great Lakes, and if you remember, the question we are trying to answer with our tow today."
Sam will explain:

1. Very little is know about microplastics in the Great Lakes, even though quite a bit is know about microplastics in the ocean.
2. Since Inland Seas visits the same location year after year we can help find out if plastic abundance varies seasonally or year to year.

→ Remind students that the trawl will be launched after we are under sail.
→If you have time and a group that understood ask*, "What are some ways microplastics might impact the lake ecosystem?"* Animals can eat it and clog their digestive systems, plastics absorb toxins from water, etc.

6. **Seamanship** (the student expert for this example is Lisa)
   You might start like this. *"Turn to page 5 and fill in the information in the box when Lisa gives it to you. Lisa,* w*hy don't you start by explaining what this is called and what we do with it." (Point to the wheel of the ship)*

   Lisa will tell the group that this is called wheel of the ship and we used it to steer the ship.

   "Good. Can you tell us what the wheel is connected to that helps us change direction?"

   Lisa will say that the wheel is connected to the rudder.

   "Yes, and what does the rudder of a ship act like? Is there an animal that moves this way?"

   Lisa will describe how the rudder of the ship acts much the same way that the tail of a fish does.

   "Now, Lisa, tell us about how we will be steering the ship today. What do we do?"

   Lisa will explain and show where to stand at the wheel and to wait for the captain to give a command. She should also explain that you need to repeat the command back before acting on it. The instructor may need to prompt Lisa if she misses a step.

   → If there is time, let the students know that they will each get a chance to steer the ship and also learn about how the ship works on the water.

SECCHI DISK AND WATER CLARITY

When peer teaching is done, students will return to their original groups.

Lead Instructor

Congratulate the students on their fabulous teaching and listening. Let them know they will be looking at all of those samples in more detail later in the program.
Instruct students to return to their original instructors to collect one more piece of data.

Group Instructors

1. Pre-sampling discussion (1 min)
    a. Welcome back your students
    b. The last reading we are going to get is the secchi depth. It is determined with a device called a Secchi Disk. This tool has been used by limnologists since 1865 because it is so easy to use and gives such valuable information.
2. Show how the secchi disk works and take the measurement (4 min)
    a. Explain that we lower the disk into the lake until we can't see it any more. That is the secchi depth.
    b. Have a student take the line and disk out of the bucket. One student holds onto the bitter end and does not let go (very important so the disk gets back on board).
    c. Another student lowers the disk into the water and watches for when it is no longer visible. Others count the line marks (one every meter) and make note of this depth. It is important to look intently for several seconds to make sure you really can't see the disk, not just that it is just really hard to see. Lots of eyes can be a benefit.
    d. Raise the disk until it is visible again, and average the two depths to obtain the secchi depth.
    e. It is a good idea to count line marks when the disk comes out of the water to verify your original count.
    f. Put the disk in the bucket first, then feed the line starting at the disk end into the bucket, so it piles nicely on top of the disk.
3. Discuss what secchi depth means (5 min)
    a. Show the graph of secchi depths in Suttons and/or Grand Traverse Bay. Have students point to where today's data point belongs on this graph.
    b. What is the trend on this graph? *Increasing secchi depth.* What was the depth when we first started collecting data? What is it now? How much of a change is this?
    c. What causes water to be cloudy? *Stuff dissolved or suspended in the water.*
        i. *Sediment makes water cloudy.* Think of a river after a rainstorm; it is brown and muddy from all of the runoff that entered from the land.
        ii. *Suspended organisms reduced light penetration.* Plankton in the water blocks some light. Remember I told you that Lake Erie secchi depths are often only a few inches? That's because there is so much phytoplankton (algae) in the water that the water is actually green and can't been seen through at all. Ask students to recall the cloudiness of plankton sample, as another example.
    d. Here the water is very clear, but is that a good thing?

i. If we are going to drink water, clear water is very important. We don't want to drink water that is clouded with too much dirt or too many organisms.
ii. What happens if there are no tiny organisms in the lake itself? *Then there is no plankton and no food for larger organisms. In fact, without phytoplankton there is almost no life at all since phytoplankton (and other photosynthesizers) are the gateway for almost all energy into the lake.*
iii. Looking at this graph, what do you think is happening to the amount of plankton in the water? *It is decreasing. Since the secchi depth is getting deeper, water must be getting clearer. One explanation for clearer water is less plankton.*
iv. What might be the cause of less plankton (there is a clue on the graph)? *Zebra mussels arrived in Suttons Bay in 1991, and quagga mussels in 2001. Both of these are filter feeders, which means they filter tiny particles out of the water to eat, especially plankton. They filter a lot of water (quagga mussels even more than zebra mussels) and are now present in very large numbers throughout Lake Michigan.*
v. Here are some maps that show the spread of zebra and quagga mussels in Lake Michigan (Show the maps). What patterns do you notice? *Zebra mussels are virtually extinct. Quagga mussels are more abundant than zebras ever were. No data was taken in Grand Travers Bay in 2010. The red dots show sampling locations.*
vi. How do you think the secchi graph will look next year? 10 years from now? *Students might predict the trend to continue and state that as long as mussels continue to be here they will continue to deplete plankton populations. OR they might realize that eventually there won't be enough plankton to feed the mussels. Mussel populations will decrease, and water clarity will probably stabilize at some minimum plankton. It will be fun to find out how students think about all of this, so ask them and listen!*

RAISING SAILS, ANCHOR AND QUIET TIME

Every program offered at Inland Seas offers the chance for participants to raise the sails, as well as raise the anchor if it was deployed.
After Secchi, the Lead instructor will gather everyone's attention. Seamanship and Microplastics group will be asked to join the rest of the group at mid-ships again. The lead will ask a student from every group to share their secchi disk depth out load. The Lead will record and ask the students to think about why we didn't all get the same depth measurement.

After this the First Mate is introduced and will give all further directions to the entire group. Model good behavior for your group by giving all your attention to the Mate and crew.
The crew and Lead will help to get students set up in the correct spots to help raise the anchor, followed by raising the sails.

Special Note: While the students are being assembled to raise the anchor/ sails, this is an excellent time to **put your samples away in a safe spot**.

> **Water Quality**: take your water samples down below, set up your station materials, and add chemical #3. Return up top as soon as you can to re-join your group before the sails are done being raised.
> **Plankton:** take your sample down below and place it in a safe spot near the microscope. Prop things around it if needed, you don't want it to spill once the sails go up. Check that your microscope is working, if not you can alert the Lead.
> **Benthos:** move your basin with sample in it to a safe location. A crew member will let you know if it is in the way. In general, it is best to leave it on the cabin top, slightly in-board.

All instructors: make sure your devices and equipment are stowed and out of the way for the crew. Coil and stow all lines back into their bins and move them to a safe spot away from any working lines the crew might need for raising the sails or anchor.

LEARNING STATIONS

All stations follow the same format as the Traditional Schoolship program. The one exception is Seamanship is replaced by Microplastics. The outline for microplastics is in the microplastics manual.

Note to the Fish Group (on the Schooner Inland Seas): The Microplastics group will need the davit near your station to launch and haul in the Manta trawl. Launching will most likely occur at the beginning of the first rotation, and hauling in will most likely occur near the end of the third station rotation. You may need to move farther forward to begin rotation 1 and to wrap-up with rotation 3. Cooperate with the microplastics group so you all have space. (On Manitou there may not be interference with any group.)

STEWARDSHIP WRAP-UP

After the learning station rotations, students rotate one more time to return to their original instructors. At this time, instructors will lead students through a discussion to help them reflect on what they learned. Use the questions on the last page of the logbook to guide the discussion.

Objectives:

1. Students will reflect on their experience on the Schoolship.
2. Students will formulate a vision for what they want the Great Lakes to be, and consider steps to reach that vision.

Important: The goal is to listen to the students in order to learn what they discovered and what seemed important to them. The questions are open-ended so all answers are reasonable, yet resist the temptation to judge some ideas as better than others or to teach more information (it is OK to correct facts if it seems important).

1. You might want to begin by asking if students have any questions about anything they learned or experienced. Sometimes there is something burning a kid did not get a chance to ask. If there are questions the discussion might never get to the stewardship questions, and that is fine, but be sure the conversation is on topic and not about when they will leave the ship, get their bags, etc. You can answer these questions, but do so directly and simply then move on.

2. Remind students that there are no wrong answers here and everyone is invited to share whatever is true for them.

3. Try to involve everyone. Here are some tips:
    a. For the first question, go around the circle and have students say one word that was important today.
    b. Have students think quietly about one or more of the questions and/or write their answer on the logbook. Then go around the circle and have each person share. This might be especially good for the first or third question.
    c. In preparation for the second questions, ask student to show with a fist to five scale how much the learned on the ship. Show a fist if you learned nothing, and five fingers if you learned a ton.

d. Ask students to talk to a partner or in a trio. They may share more if they talk to their friend, than if they talk to the whole group. This might be especially good for the second question.
e. Make a group response to one of the questions. Go around the circle and have each student give one word that connects to the words said so far. The sentence is invented as it comes out. It might be really funny or it might be spot on. Either is fine. Maybe try it more than once.

Questions

What is the most important thing you learned today?

Rationale: This question helps students reflect on what happened. It uncovers what students remembered most, or what they thought was significant about their trip.

Tips:

- You can also prompt students to think about specific stations (What was the most important thing you learned at the fish station?), but wait for them to answer the overarching question first.
- Ask: What was the one message that was important (repeated) at every station?
- Can also ask: What surprised you today?

Compare how you thought about the Great Lakes before you got on the ship to how you think about them now.

Rationale: After students have reviewed what happened, this question allows students to reflect on its impact. How have I changed over the last 3.5 hours? It also helps us see what students didn't understand before, but do understand now.

Tips:

- Give them sentence starters:
  - I used to think….
  - But now I think….
- Ask what they learned or experienced to change their thinking

What do you want other people to know about the Great Lakes?

Rationale: This is another way of helping students figure out what was important about their experience. It helps them think about what might be meaningful to someone else.

Tips:

- Ask: Why do you want other people to know that?
- Ask: Who do you think should know that?
- Ask: Who should know about how to be responsible with the Great Lakes?
- Emphasize that we all must work together to keep the lakes healthy: scientists, citizens, lawmakers, students, and sailors.

What do you wish for the Great Lakes? What can be done to make your wish a reality?

Rationale: Stewardship is a lifestyle, a mindset that leads to actions on behalf the Great Lakes. A specific act can demonstrate stewardship and we want to share specific actions that can promote healthy Great Lakes. However, young people are limited in the actions they can take. They are unlikely to be in a position where they get to make a choice about what to do with motor oil or they may need to ask permission to pick up litter. Yet, their imaginations are unlimited. Young people can create a vision for what they want the world to be like, in fact it is absolutely critical that all of us imagine the world we want, otherwise we are likely to get more of the same, or worse.

The second question, what can be done, helps students consider the specific actions they can take as individuals, the actions their families can take, and actions communities, organizations, businesses, and governments can take. Sometimes when we see the larger picture, we begin to find ways we can insert ourselves into that picture. If we can help plant a seed for healthy Great Lakes, students can grow up with that vision in mind and can take stewardship actions as soon as they are able.

Tips:

- The wish might be something like: There is lots of plankton in the Great Lakes. Everyone can eat the fish that grow in the lakes. All of the beaches are safe for swimming. Everyone in Michigan loves the Great Lakes. The lake is totally healthy.
- Give students different stakeholders and have them imagine what each one could do to make the wish come true: kids, adults, businesses, schools, communities, governments, etc.
- It is OK to make a list of things we can do to do help the Great Lakes, but it is best to first make wishes, or create a vision. Here are some possible things we can do as individuals: Don't litter. Pick up trash. Don't buy products that will create garbage. Teach someone about what you learned. Volunteer. Conserve water at home (brushing teeth, taking a bath, washing). Dispose of toxins properly (paint, oil, chemicals). Write letters to people who make laws in your town, county, state or country. Vote.

All that said, it might be impossible to have a meaningful discussion with students about these topics. They might be too tired or too scattered. In that case, do your best to discuss whatever it is that interests them; get them talking.

When the bell rings send your students on deck to meet the lead instructor. It is OK to at your station to begin clean-up

CLOSING BEFORE DOCKING

1. The lead will suit the wrap up to the group and the time remaining.
   a. When everyone assembles on deck, a very short and simple wrap-up might help provide closure. The lead might want to ask one or two group-answer questions to maintain the energy of the program and end with a closing thought. Participants should be encouraged to respond out loud and all at once. Here are some questions:
      - Who tried something new today? *–I did!*
      - Who felt encouraged today? *–I did!*
      - Who encouraged someone else today? *–I did!*
      - Who felt part of a team today*? –I did!*
      - Who wants to have a healthy Great Lakes? *–I do!*
      - Who can contribute to making the Great Lakes healthy? *–I can!*
   b. Thank the group for their participation, cooperation, and enthusiasm today. The data they helped us collect will be used to help many people monitor the health of Suttons Bay. Scientists, schools, and everyday citizens use our data to learn about the lakes. We hope when you go home you realize you are part of the team that is stewarding the lakes. No one can opt out because we all live here; it takes everyone to protect and enhance this amazing resource. There is nothing like the Great Lakes anywhere else in the world.
   c. Lead the group in appreciation for: the volunteers, crew, teachers, each other, yourselves. Emphasize that each person played important roles and that the cooperation and good attitude of everyone on board is what made this a successful trip. Showing appreciation is an important part of working together.
2. Take a photograph of the group and send them off.