**PLANKTON GROUP Research Question for Diving Deeper**

**Introduction:** This is the research question and method we are proposing for your Diving Deeper experience at Inland Seas. You are invited to make changes or modifications, as long as the changes can be done with our equipment and time constraints. We recommend looking at the data from previous years to inform the design of your study. This is your research experience; make it meaningful for you!

**Background:**
At Inland Seas we have been collecting zooplankton for more than 25 years. Each time we take a sample, our plankton net is lowered off the side of the boat to about 50-60 feet, and then pulled straight up. We note all of the species we find in the sample and how abundant each species is. With this data, we can see how species abundance and community composition change from spring to fall and from year to year, but what we don't know is, **How does species abundance or community composition vary at different depths in the water column?**

**ISEA Method:**

**First we need to collect plankton from the lake. There are choices:**

- **A.** Deploy the plankton net at different depths: 0-10 feet, 0-30 feet, and 0-60 ft.
- **B.** Deploy the plankton trap at different depths: 10 feet, 30 feet, 50 feet, 70 feet. The plankton trap collects water only from a select depth.
- **C.** Use some combination of these:
    a. Deploy the plankton net at 0-20 feet and 0-60 feet AND
    b. Deploy the plankton trap at 20 feet and 60 feet

**Second, we need to examine the samples. This is what we recommend:**

1. Thoroughly mix the sample. Examine five drops from the sample and record all of the species found in each drop.
2. Abundance for a single species can be calculated from the percentage of drops that contained the species in question.
3. Compare samples to one another to determine differences in plankton community composition at different depths.

**Your choice:**

- Modify the collection method to make it interesting and meaningful to you.
    - You may sample at any depth. What depths do you want to repeat from previous years? Can you fill in gaps in the data from previous years?
    - We have a plankton net and a plankton trap, and you may use either or both.
    - Be aware: the more samples you collect the more you will have to examine. Choose a number of samples that can be easily examined on board the ship (2-4 is probably best).
    - Feel free to take additional samples if your class wants to do follow-up studies with plankton in the classroom. Bring your own collection jars if you want to bring samples off the ship.
- The ISEA method for examining the samples is easy to use, but can be modified. Please let us know at least 5 days in advance of your trip if you would like to modify this procedure.

## FISH GROUP Research Questions for Diving Deeper

**Introduction:** This is the research question and suggested method you will be exploring during your Diving Deeper experience at Inland Seas. You may modify the ISEA method as long as it can be done with our equipment and time constraints. We recommend looking at the data from previous years to inform the design of your study. This is your research experience; make it meaningful for you!

**Background:** The round goby is an invasive species in the Great Lakes. It arrived in 1990 and has since grown to epic numbers in many regions. It is particularly common in shallow water, and then particularly abundant on rocky substrates. Yet, we don't quite know *how* abundant it actually is because most of the official surveys for fish happen in deeper waters. At Inland Seas we are assisting the DNR is learning about goby population numbers, but first we need to learn the best way to catch a goby.

Round gobies hang out right on the bottom of the lake and are relatively easy to catch with minnow traps, but trap success varies widely. **What is the best way to bait a minnow trap to catch round gobies?**

**ISEA Method:**
You will use 15 minnow traps and bait them in different ways to test bait success. Create 5 different treatments with three 3 traps for each treatment. These are some possible treatments:

| | | |
|---|---|---|
| Nothing* | Fish eggs | Dog food* |
| Substrate (gravel)* | Live goby* | Bread* |

* Provided by Inland Seas
Bait that is small in size, such as fish eggs, can be enclosed in bait bags to prevent it from falling through the holes in the trap.

The traps will be dropped onto rocky substrate and left for about 2 hours. When you haul them back in the fish in the traps will be identified, counted, and measured.

**Your choice:**

- You may test any bait that interests you: What baits do you want to retest from previous years? What baits have never been tested that you want to try?
- If you vary the ISEA method **use at least two treatments** and **be sure to create enough replicates so the data is meaningful** (not more than 5 treatments).
- If you are considering two ingredients per trap, make sure there are also traps with each ingredient alone.
- We will do everything we can to have at least 10 live gobies available on the day of your trip, but there could be fewer if conditions were unfavorable for collecting them prior to your trip. If you will need more than 10 live gobies, please contact us at least 5 days in advance.
- You will need to bring any materials that extend beyond those listed above.

## MICROPLASTICS GROUP Research Questions for Diving Deeper

**Introduction:** These are the research questions and method we will use for your Diving Deeper experience at Inland Seas. This procedure does not have room for modification, but we recommend coming with questions and thoughts about microplastics, their abundance in the ecosystem, how they get into the lake, how they affect the ecosystem, and what can be done about it. This is your research experience; make it meaningful for you!

**Background:**
Dr. Sheri Mason at the State University of New York Fredonia was the first person to look for microplastics in the Great Lakes, in 2012. What she found was shocking – microplastic concentrations several times greater than concentrations found in ocean waters, particularly for very small plastic particles.

Today, we know microplastics are present in the Great Lakes and we know a little bit about how abundant they are, but we don't know is, **How does microplastic abundance change over the course of a year, and how does microplastic abundance change in one place from year to year?** At Inland Seas we are working with Dr. Mason to answer those questions by regularly trawling for microplastics in Suttons Bay.

**ISEA Method:**
We collect water samples with a manta trawl, which floats on the surface of the water and can be hauled by the boat while we sail. Attached to the trawl is a long, fine mesh net, which filters the water and traps particles that are present in the surface waters. The net is towed for 30 minutes in a straight line.

When the trawl comes in, all the debris it collected is rinsed from the net and washed through sieves, which sort the material by particle size. Next the sample is placed in salt water, which will cause many of the plastic particles to float. The floating particles are skimmed off the surface and examined under a microscope to classify the particles into types: fiber, pellet, foam, fragment, or film.

The collected particles samples are preserved in labeled vials. All of the remaining debris (including any plastic particles we did not find) is also preserved and sent to Dr. Mason's lab in Fredonia, NY to be processed with a hydrogen peroxide wash, which dissolves organic material and reveals plastic bits. Those plastic bits are sorted by size and classified by type.

**Your choice:**
- The manta trawl collects everything that is on the surface of the water. Your group could identify the other things that come in with the trawl, and count or otherwise quantify the material that is collected.
- Microplastics plastics float when they are less dense than water. Bring different plastic materials on board and test how their ability to float changes in salt or fresh water.
- What else can you do to learn more about microplastics or the water surface?
- If you want to try any of these things, contact us at least 5 days before your trip.

**WATER QUALITY GROUP Research Questions for Diving Deeper**

**Introduction:** This is the research question and method we are proposing for your Diving Deeper experience at Inland Seas. You may modify or change them if you like, as long as the changes can be done with our equipment and time constraints. We recommend looking at the data from previous years to inform the design of your study. This is your research experience; make it meaningful for you!

**Background:**
The Great Lakes, like all bodies of water, are constantly changing. They change from week to week as seasons progress, and from year to year. Conditions also change as one moves from one place in the lake to another. For example, in late summer water is warmer at the surface of the lake than at the bottom.

At Inland Seas we have tracked temperature, pH, dissolved oxygen, and water clarity in Suttons Bay for more than 15 years. These parameters help us understand water quality and habitat conditions for living things. However we have only taken these readings in one place in the lake, at the bottom (surface water temperature is also recorded.) What we don't know is, **How do temperature, pH, and dissolved oxygen vary throughout the water column, and how does this water profile change throughout the year?**

**ISEA Method:**
We have two tools for measuring water quality parameters at different depths. First, is the VanDorn bottle, which acts like a water trap, enabling us to collect a water sample from any depth and bring it to the surface without it being contaminated with water from other depths. Once the water is on board we can subject it to any number of tests.

Second, is a sonde, which is an electronic device on a cable and attached to a meter that contains multiple water quality probes. This device can collect real-time data on temperature and dissolved oxygen, and makes it easy to get lots of data quickly.

We will use both methods:

A. With the sonde record **temperature and dissolved oxygen** every few feet until the bottom is reached or you run out of cable, which ever comes first!
B. With the VanDorn bottle, collect water samples at 3 or more depths - either the depths that cannot be reached by the sonde, or at various depths in the water column (surface, middle, and bottom). On deck, measure temperature and pH of the water. Dissolved oxygen can also be measured with the sonde or with a chemical test (a modified Winkler test).

**Your choice:**

- The exact depths you measure and frequency of collecting data with the sonde (every 2 feet, every 5 feet, every 10 feet) is up to you.
- Bring your own water quality tests! FYI: Nutrient levels (N and P) are very low in Suttons Bay (and Lake Michigan) so need quite sensitive tests, and might not register at all even then. We have a Nitrogen test if you would like to try it. Please let us know at least 5 days before your trip.

**BENTHOS GROUP Research Questions for Diving Deeper**

**Introduction:** This is the research question and method we are proposing for your Diving Deeper experience at Inland Seas. You may modify or change them if you like, as long as the changes can be done with our equipment and time constraints. We recommend looking at the data from previous years to inform the design of your study. This is your research experience; make it meaningful for you!

**Background:** In 1995 researchers at the NOAA Great Lakes Environmental Research Lab in Ann Arbor started examining the bottom of Lake Michigan for zebra mussels and a small shrimp-like crustacean called *Diporeia.* Since then quagga mussels have been added to the list and the survey of Lake Michigan has occurred every five years. We now have striking maps that show changes in abundance for all three creatures over the past 20 years.

Yet, Grand Traverse Bay was conspicuously absent from these studies in 2010 (it was sampled in 1995, 2000, and 2005), and Suttons Bay was never a sample location during any year of the study. **What do zebra, quagga, and *Diporeia* abundances look like in Suttons Bay?**

**ISEA Method:**
This method is adapted from the method the researchers themselves used.

1. Collect three samples from the lake using a PONAR grab. The PONAR grab is a heavy piece of equipment and requires some muscle to haul up. Any of you can do it, but it takes a little stamina, and caution so your fingers do not get pinched.
2. Wash the samples through a sieve to remove the sediment and leave the organisms behind.
3. Identify, sort, measure, and weigh the organisms found. We are particularly interested in the mussels, but we will record everything we find.
4. Calculate ratios such as zebra : quagga; dead : alive; dead zebra : dead quagga; etc.
5. Calculate density (number per $m^2$) for each species. Each sampling area = 0.023 $m^2$

Bonus: It is also possible (and recommended) to collect a sample or two from a shallow location - where we drop the minnow traps - in addition to the three samples taken in deep water. Process these samples in the same way.

**Your choice:**

- You might want to or need to collect a different number of samples.
- If you have studied soil or sedimentation, you may want know more about the sediment in Suttons Bay. If so, there are a couple of options.
    - We have stacked sieve sets that allow you to sort the sediment by particle size and analyze the composition of the sediment.
    - We also have a gravity corer, which can take a core sample and allow you to see sediment layers in Suttons Bay.
    - If either of these are interesting to you, please contact us at least 5 days in advance so we can have this equipment on board.