Step By Step Field Methods

Preparation Before Field Work

Boat

Considerations regarding the boat used for the work include workspace, maneuverability, and cost. This study used a 23' center console boat with a large space behind the console. A sturdy davit, preferably with a weight capacity of several hundred pounds, is absolutely necessary to deploy and retrieve the lander. Some provision for shading during summer deployments is very helpful. The heavy gear is best loaded in the boat prior to arriving at the launch.

Pumps and Batteries

The submersible water pumps should be tested prior to deployment and a spare pump can be helpful in case of failure. The peristaltic pump used for sampling should be tested and the tubing replaced on a routine basis. The lithium batteries used for the submersible and sampling pumps need to be fully charged and an extra battery should be brought as a backup. The amperage draw of the submersible pumps used for mixing the chamber should be monitored during deployment. A drop in the amperage draw of the pump indicates a possible pump failure.

Water Quality Sonde

The battery charge on the sonde should be determined prior to deployment and normal calibration checks should be carried out as specified in the manual.

Reagents

There are generally two reagents used for operation and sampling. In a salinity of ~10, we used 60 mL of 5.3 molar NaBr for determination of dilution rate. The samples for mass spectrometry need to be preserved to inhibit microbial processes within the vial; 10 μl of 0.11 M $HgCl_2$ or 100 μl of 7 M $ZnCL_2$ are typically added to a 10 mL sample vial.

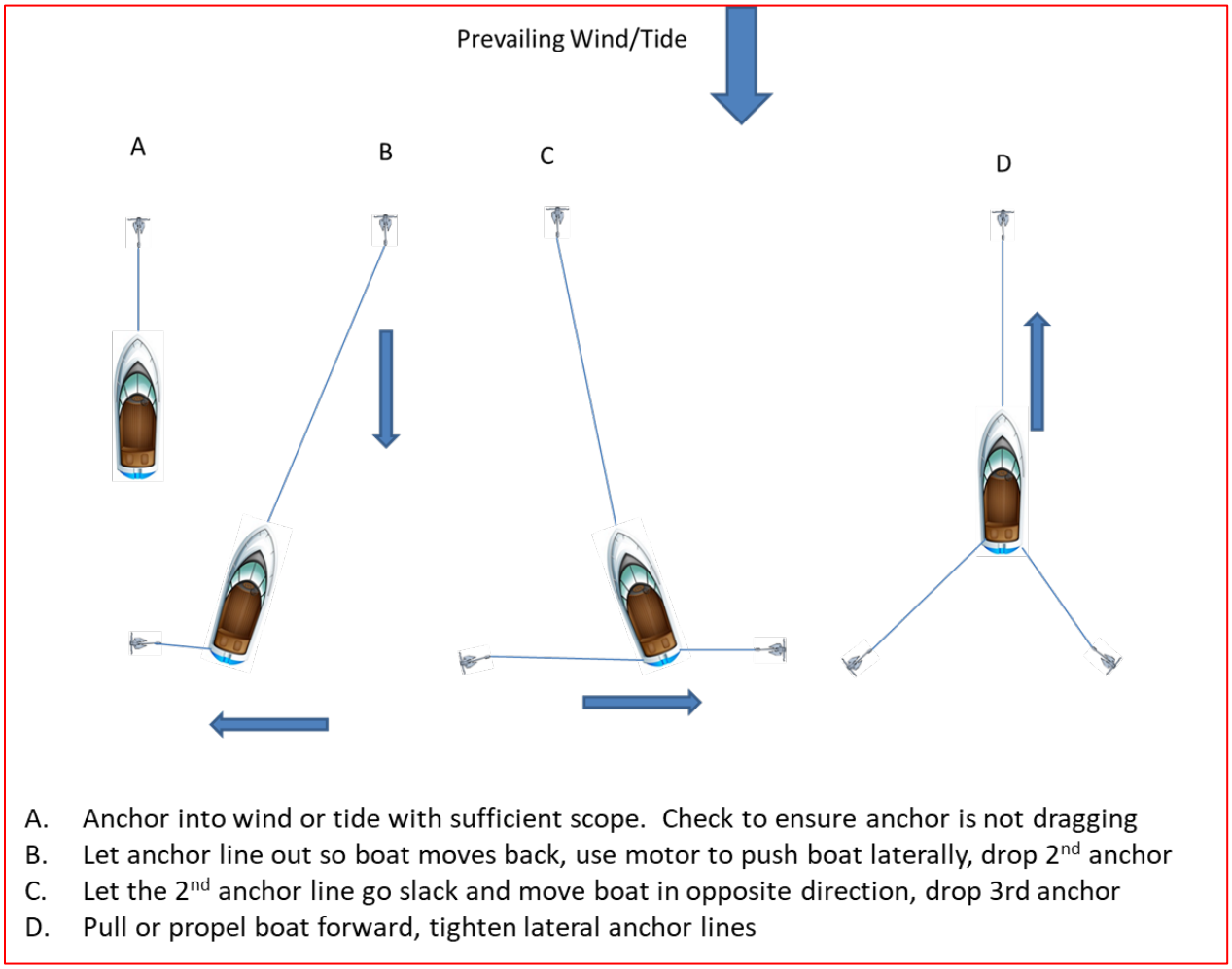
Safety Considerations

There is a presumption of proficiency with standard boating operation and safety procedures. There are some specific concerns with lander operation:

- The lander, as currently constructed is both heavy and awkward to deal with. Moving it on and off the boat requires at least two people. On board, its footprint can be large, especially on a smaller boat and moving it around can take a bit of effort and organization. The other gear is relatively light.
- The 3 point anchoring procedure can result in a loose rear anchor line and it can be easy to wrap a line around the propeller.
- Most agencies specify use of a PFD on boats; there is a considerable amount of time spent leaning out beyond the boat and flotation is an essential requirement. Experience with overboard personnel recovery is helpful.
- The operators should be prepared to rapidly retrieve the lander with any large increase in wind.
- Deployments required a considerable amount of time in the sun. Shading of personnel and gear is essential; we lash a large patio umbrella for this purpose.
- A proper watch should be maintained to ensure that other boats are aware of your presence. At anchor, with gear deployed, the sampling vessel will have very limited maneuverability.

Boat Anchoring

Anchoring the boat so that the boat does not swing can be difficult depending on wind, tide and bottom conditions. Three fluke-style anchors can be deployed in a triangle as shown in the figure below. Grapnel type anchors may work better on more developed oyster reefs. Sudden shifts in wind or tide can present a challenge; operators need to vigilant to ensure that if the anchors break loose, the lander can be rapidly retrieved.



A. Anchor into wind or tide with sufficient scope. Check to ensure anchor is not dragging
B. Let anchor line out so boat moves back, use motor to push boat laterally, drop 2nd anchor
C. Let the 2nd anchor line go slack and move boat in opposite direction, drop 3rd anchor
D. Pull or propel boat forward, tighten lateral anchor lines

Deployment

After anchoring, the deployment of the lander requires a careful sequence of operations.

Preparation

1. Attach the lander to the davit (example to right), ensure that all 3 connection points are secure.
2. Position the a) 12 v pump wire, b) water quality sonde, c) water sampling tubing and d) bromide tracer tubing are attached to the lander.
3. The lifting line is strung through the block on the davit and using a hand winch attached to the davit, lift the lander to the level of the boat's gunnel (side). Pivot the davit so the lander is over the water.

Lowering and Setup Operation

1. Lower the lander into the water, while leaning over the side turn the lander on its side to let all of the air out of it. Tilt the lander back to vertical. Lower it during this process, turn it so it is in its original upright position, and lower the lander slowly to the bottom. Put at least 1-2 m of slack in the lowering lines to ensure it is not tilted with mall movements of the boat.
2. Ensure the water quality sonde is measuring oxygen.
3. Add the bromide to the tracer addition tubing after opening its two way luer valve. Push 60 mL of bromide solution through the tube, close the valve, and add 60 mL of site water to flush the tubing. The bromide is well-mixed in the chamber in ~1 minute or less.
4. <u>The sampling pump is turned on and pumps continuously</u>, depleting a trivial proportion of the volume of water in the chamber. This minimizes the sample water time in the sampling line.

Sampling

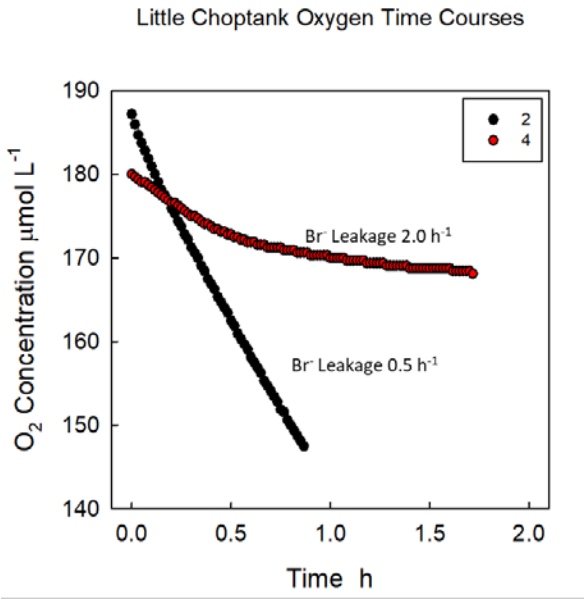
1. It is essential that the time each sample is collected is put into a notebook. Recording the oxygen data from the sonde at each sample time point is essential to determine 1) if the experiment is working – i.e. the chamber is not over-diluted with leakage and 2) there is a 10-20% drop in dissolved oxygen indicating that gas and nutrient changes will be sufficient to make flux calculations.
2. Since denitrification is the key purpose of measurement, rapid sampling for dissolved gases is the top sampling priority. Samples are unfiltered and need to be preserved either with mercuric chloride or zinc chloride. UMCES/HPL uses 7 mL glass vials with a glass stopper to collect the gas samples. The sampling procedure involves placing the sample tube (with continuous pumping) in the bottom of the vial, allowing it to overflow for 10-15 seconds. The tube is slowly removed,

the preservative added, and the vial capped. It is essential that the vial stays at temperatures similar to the water body and we submerge the vials (in a rack) in a cooler of site water. The cooler is placed in the shade.

3. Samples for dissolved nutrients and bromide are collected in a 20 mL plastic syringe barrel (without plunger) to which a 25mm 0.4 µm syringe filter is attached. After filling the barrel, the plunger is inserted and 2-3 ml of water is expelled to rinse the filter. UMCES/HPL fills 4 vials with 5 mL of sample for each manual nutrient analysis and an extra sample for bromide analysis; automated analyses generally could use a single 5 mL vial. Samples should be kept on ice in a cooler and put in a freezer upon return from the field.
4. The recommended time interval for sampling is ~5 minutes. Our experience has shown that almost all the key information is derived in 30-40 minutes; in general, there is little value for information generated with longer incubations.

Field Criteria For Abandoning An Incubation

If the chamber is set on a "high spot" on the bottom and seals very poorly, the time course will not be valuable for estimating rates. The oxygen data are the only field data available in real time and if oxygen concentrations are not decreasing sufficiently the estimation of denitrification and nutrient flux rates will not be possible. In the figure below, we show oxygen profiles with high and low leakage. In the example below the red line shows a time course change that was insufficient to reliably estimate nutrient and N_2-N fluxes. A small oxygen decrease over < 0.5 hour is problematic, whereas the low leakage time course yields much more useful rates.



Chamber Retrieval

Upon completion of sampling, the chamber is lifted from the bottom above the sea surface. If the next site for sampling is close, the chamber can be suspended above the water, in position for a rapid re-deployment.