Understanding Water Circulation using Bucket Drifters: Technical Brief

Completed in collaboration from the Maine Shellfish Learning Network

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I. Introduction

The Maine Shellfish Learning Network (MSLN) has compiled this document to inform municipalities and others looking to deploy bucket drifters. Bucket drifters are a technology used to understand how water moves around an estuary or other shallow coastal system. The basic principle is that these buckets will float in different currents around clam flats or other areas, and be able to give high resolution data around how water (and anything in the water such as seed or pollution) would move.

Aim
To provide a map of water currents near clams flats, which can influence ways how clam committees and others think of seeding, pollution, and other water traversed issues.

Deliverable
A comprehensive document outlining how to build, deploy, and analyze bucket drifters.

II. Building a Bucket Drifter

In order to build your own bucket drifter (rather than borrow one from the University of Maine), follow the steps below, using the materials highlighted. Some of these materials could be easily substituted. The final product **must be neutrally buoyant**. This means that when placed completely in water it does not sink, and is not floating too high (meaning too much is exposed at the top). The photos below show how the bucket drifters should float.

Materials

- 5 gallon bucket
- 7" acorn buoy labeled with the project name
- 22cm stainless hose clamps to secure the transmitter & ballast on acorn buoy
- Garmin Etrex 10 GPS
- small white toggle buoy to be tethered horizontally to increase visibility
- Small red flags for added visibility
- Plastic baggies

Procedure

- Cut holes on sides or bottom of bucket to allow for water to pass through it.

- Attach float to handle of bucket as shown above, using metal hose clamp.
- In a pool, or smaller body of water, float bucket, adding counter weight until the bottom of the float is above the water line as shown above and bucket is completely submerged.
- Firmly attach counterweights.
- Add any extra visibility measures as necessary (orange flags, small float, etc.)
- Place Garmin GPS in baggie, and attach under the metal hose clamp as shown above.
- Add counter strung ropes to secure GPS in place above the water.

III. Deploying a Bucket Drifter

Deciding on the Area

There are many different ways to choose deployment areas or field sites for the bucket drifter. Generally, you want to start by asking this guiding question: What areas are important to the community? Bucket drifters, as discussed before, are able to highlight how water moves around clam flats. This can give you a better idea of how seed or pollution can work, so deployment should be near those areas. In terms of timing, it is best to deploy at different tidal stages, in order to get a better sense of how incoming tidal currents and outgoing tidal currents change the water movement in an area. Start with a small number of deployment areas, 1-3, deploy at high tide (to see outgoing currents) and at low tide (to see incoming currents). Make sure that you keep track of the drifters as you don't want to lose a bucket! For those interested in pollution, you may want to deploy near conditionally closed areas during storms (or the day after). For those interested in seed movement, you may want to use satellite trackers or others that can track remotely (meaning you could pull up the drifter's location on a computer or phone) and deploy

for closer to 2 weeks. Finally, it is important to deploy more than one bucket at a time (ideally 3) in order to see if there is a great deal of spread in terms of water currents or not.

Basic Steps

The basic principle of the bucket drifter, is turn on the GPS, let it float around for anywhere from 6-48 hours (depending on how fast the currents are), and then retrieve them. Below, we have broken down the steps into simple bullet points based on the use of a Garmin ETrex Hiking GPS.

- Setup the GPS
    - From top menu, go to setup -> Tracks -> Record and select: Track Log: Record, Show on Map, Record Method: Time, and Recording Interval: 00:00:30.
    - Test by turning on GPS and walking around for a few minutes. Then check from top menu current track, to see if it is matching your location.
- Record Time, Location, and any weather factors before depositing a bucket in the water.
- Before placing bucket in the water turn Garmin GPS on and make sure the baggie is sealed around the GPS
- Place bucket in water
- If you do not have a satellite GPS, you will need to follow the buckets, either in boat or canoe, kayak etc.
    - This is not necessary if you are releasing in a small cove or area that will not open into spaces you cannot find the drifters in.
- After a period of time (a few hours or tidal cycle) retrieve drifters.
- Turn GPS off after placing bucket in boat before heading to shore

Analysis

General analysis of drifter tracks is first just seeing where they went. To do this, you have to upload data from the GPS to a mapping software (like Google maps) to see where the bucket drifters went. It can also tell you basic information about how long they traveled for and how far they travelled. Below, we have simplified how to upload the data (again from a Garmin ETrex GPS) to Google Maps.

- Mapping- Google Maps
    - You can set up an account with Google to create your own maps.
    - https://www.google.com/maps/about/mymaps/
    - From here, create new map
    - Add Layer
    - Insert Data from file

- With GPS connected via USB cord (it comes with the GPS) find the currenttrack.gpx file, and upload it into Google Maps
- This will then plot the data to show you where your drifter went.

The second stage of analysis would include using a model to calculate residence time, or how long water stays in an area. If that is of interest, you will most likely need to contact the University of Maine or a similar institution with modelling expertise. In the later section "Contact List" we have highlighted who to contact.

IV. Cost

The major cost of bucket drifter experiments is very flexible depending on the avenue taken in terms of building your own or renting bucket drifters. If borrowing from the University of Maine, the cost in the Appendix will be a great starting point in terms of understanding cost of operation. If you are building your own, generally the cost would be time spent deploying (anywhere from 2-6 hours for each test), and the cost of materials. The materials range anywhere from $100- $300 per bucket drifter. The major cost comes from the GPS, which is $80.00 (although that cost may vary). The buckets and other materials can be found at various stores, but they can also come from recycling companies or other thrift areas that could have buckets, acorn buoys or others.

V. Where to Go From Here?

After deploying bucket drifters, there are a lot of different directions a shellfish committee or community group could go. Generally, these are thought of a first step in a larger effort to understand seeding or pollution. With datasets from bucket drifters, shellfish committees can make more informed decisions about where to pursue either pollution sources or set up seeding experiments. If used with a model, these bucket drifters can further inform water quality efforts, highlighting areas that have a lower residence time, and therefore could be resolved more easily.

VI. Contact List

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Appendix: Example Field Plan

This field plan is one developed by Gabrielle Hillyer during her work with Thomaston, this should serve as an example for how bucket drifter projects should be conducted, although there are many possibilities. In this example, Gabrielle Hillyer was conducting the research, and using her own bucket drifters, rather than building them, so the cost breakdown does include her time.

Field Plan Objectives

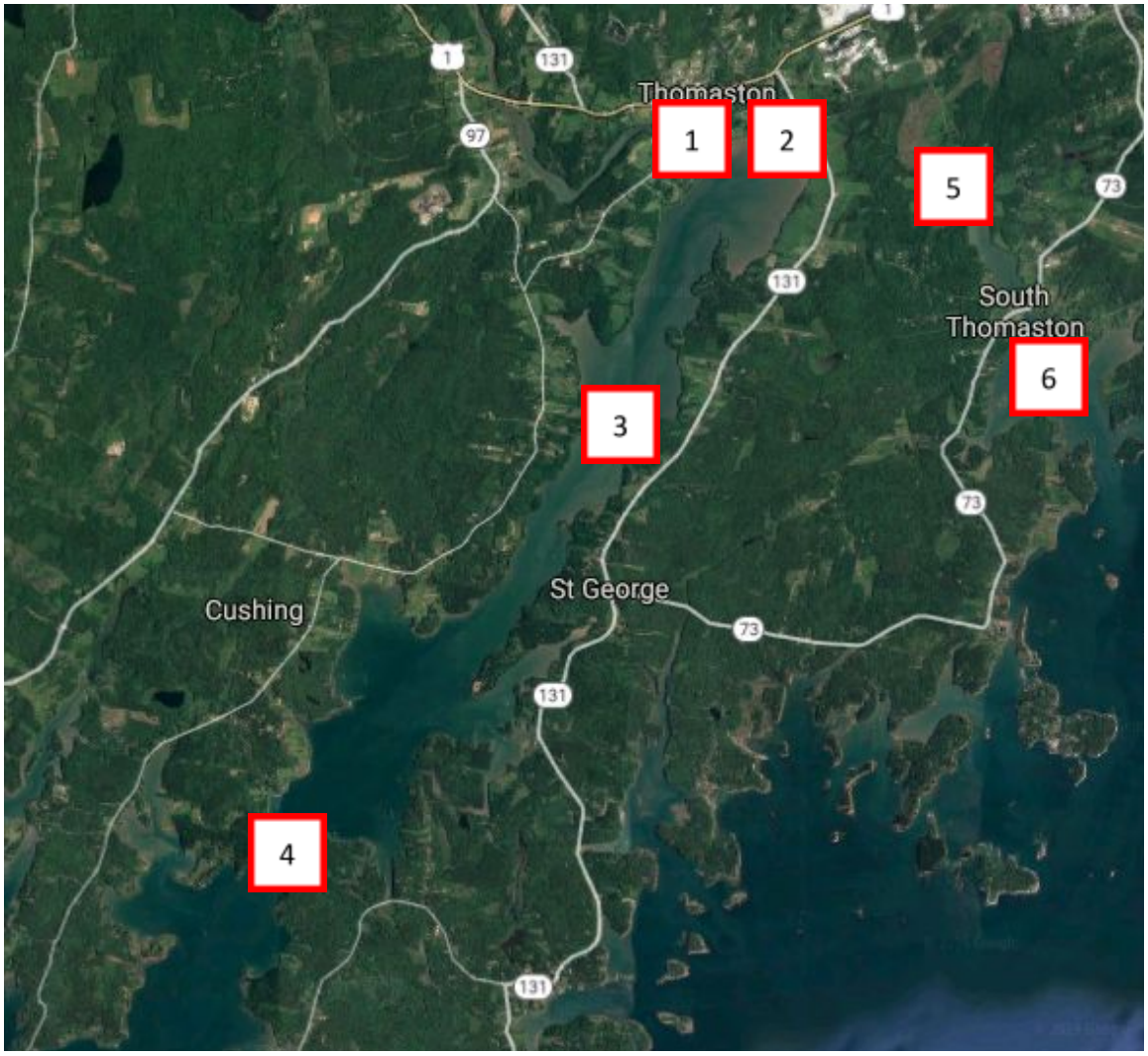
- Collect data on current speed and direction in multiple areas identified by the Thomaston Shellfish Committee as areas of importance in the St. George River

- Analyze this data to provide a basis of other projects including seeding experiments, conservation closures, as well as possible mussel retreat studies

Methods

This project is centered around sustainable shellfish management. The drifters are designed to characterize general circulation patterns in complex estuaries. These drifters have been used nearby in the Medomak River. This project will occur in two different phases, one focused on the St. George River, and another focused on Weskeag River, in April and November 2020. Below, I describe the deployment timing. I will be referencing a map below, where I highlight the launch sites based on discussions with the Thomaston Shellfish Committee.

Field Site Map



Spring Drifter Releases

This phase will focus on spring drifter release sites shown on the field site map. Initially, each site will have one release of three drifters for 24 hours. Afterwards, depending on results, drifters may be released for shorter or longer periods of time to further explore any specific currents or eddies of interest to the shellfish committee. Eventually, we plan on 6-10 drifter releases, from March 19 – April 10. I have added a calendar below with a tentative schedule for drifter releases.

Tentative Calendar Phase I

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				March 19 Release Sites 1 and 2	**20** Pick Up Sites 1 and 2, Release Site 3	**21** Pick Up Site 3
22	**23**	**24**	**25** Release Site 4 and 5	**26** Pick up Site 4 and 5	**27**	**28**
29	**30**	**31**	**April 1** Release Site 6 **Possible other release	**2** Pick up Site 6	**3**	**4**
5	**6**	**7**	**8** Alternate Release Day	**9** Alternate Release Day	**10**	**11**

Fall Drifter Releases

This phase will focus on fall drifter release sites shown on the field site map. Initially, each site will have one release of three drifters for 24 hours. Afterwards, depending on results, drifters may be released for shorter or longer periods of time to further explore any specific currents or eddies of interest to the shellfish committee. Eventually, we plan on 6-10 drifter releases, from March 26- November 13. I have added a calendar below with a tentative schedule for drifter releases.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	October 26	**27**	**28** Release Sites 1 and 2	**29** Pick up Sites 1 and 2, Release Site 3	**30** Pick Up Site 3	**31**
1	**2**	**3**	**4** Release Sites 4 and 5	**5** Pick Up Sites 4 and 5	**6**	**7**
8	**9**	**10**	**11** Release Site 6 **Possible other release	**12** Pick up Site 6	**13**	**14**
15	**16**	**17**	**18** Alternate Release Day	**19** Alternate Release Day	**20**	**21**

Cost Breakdown

I have broken down the cost in a few different ways. We discussed 10 deployments in two different areas, in April and November. I've put in a table to show the cost of one deployment, 3 buckets, for both 12 and 24 hours. I've also added a second table below where I've completed the entire cost, of 20 deployments in total, including my own cost without mileage.

Item	Cost Per Bucket	12 Hours Cost	24 Hours Cost
Satellite Tracker	$0.15 / 45 min	$5.85	$11.70
GH	$20.00 / hour	$60.00	$60.00
TOTAL		**$65.85**	**$71.70**

Type of Deployment	Number of Deployments	April Deployments	November Deployment	TOTAL

12 Hour	10	$658.50	$658.50	**$1317.00**
24 Hour	10	$717.00	$717.00	**$1434.00**

Based on these calculations, the entire project should cost around $1,500.00 with some caveats. I believe we could get away with more deployments, and depending on scheduling. I want to keep the overall project to cost $1,500.00. So, this is my final table, showing the methods that were described above, with all costs including my mileage and payment.

Item	Cost	Number	April	November	TOTAL
Mileage	$0.20/miles	800 miles*	$160.00	$160.00	**$1443.80****
24 Hour Release	$71.70	6	$430.20	$430.20	
12 Hour Release	$65.85	2**	$131.70	$131.70	
GH Hours	$20.00/hour	36-48***	Included in release cost		

*This mileage is based on calendar for both phases, including Thomaston – Umaine Orono roundtrip 4 times for each month, this may change depending on number of releases

**This releases are exploratory, other releases may be added or removed depending upon further consultation with municipal shellfish management and myself

***These hours also change depending on release number, and I may add ~10-20 hours depending on analysis extent

****THIS TOTAL DOES NOT INCLUDE ANY INSURANCE ON EQUIPMENT USED