



# EVANS-HAMILTON, INC.

APPLIED OCEANOGRAPHY AND MARINE INSTRUMENTATION

Seattle

Houston

Vicksburg

Charleston

May 2, 2008

Diane Cooper  
Taylor Shellfish Company, Inc.  
130 Lunch Road  
Shelton, WA 98584

**RE: TOTTEN INLET MUSSEL FARM  
Additional Drogue Studies**

Dear Ms Cooper:

The original drogue measurements within Totten Inlet appear insufficient to answer questions concerning circulation and flushing rates of the Inlet. On 10 April, 2008, a conference call was held between Dr. Mitsuhiro Kawase (University of Washington), Dr. Jack Rensel (Rensel Associates Aquatic Sciences) and Carol Coomes (Evans-Hamilton, Inc.), to discuss aspects for a new drogue survey. Within this letter is a brief outline of the conference call dialogue concerning the drogue survey needs, a proposed scope of work, anticipated deliverables, schedule, and our assumptions. The budget is under separate cover.

## **CONFERENCE CALL RESULTS**

Drs. Kawase and Rensel felt the size of the drogues used during the original survey (panels measuring 60 cm x 60 cm; ~2 ft x 2 ft) was too small and potentially subject to interference from near surface currents acting on the float and support cord which could reduce the desired effect of the currents at drogue depth. In addition concern was noted regarding potential drag on the wire connecting the drogue and surface float. Jack suggested the use of seine twine (tarred) that is very thin with little drag.

Conditions for the new drogue study were outlined. The ideal scenario would be drogue releases during four (4) tidal phases: slack prior to the beginning of an ebb, maximum ebb, slack between ebb and flood, and maximum flood. Tracking of the drogues would be over a 24-48 hour period.

The final agreed measurement conditions were during spring tides on a big flood to measure a large tidal excursion. Measurements during a similar amplitude ebb tide would also be ideal. Together, the data from these tides and times will indicate the probable maximum extent of any influence of the proposed mussel raft, in terms of phytoplankton and seston removal as well as excretion of nitrogenous wastes and their incorporation into phytoplankton. Drogues would be released during the four phases mentioned above and tracked over a 2-day period in an effort to measure conditions during a large tidal range. Drogue depths would be at 2m and at a depth half way between surface and bottom at the proposed farm sites (~16.9 m bottom depth; drogue depth would be 8 m). However, both depths may be altered at the commencement of the study depending on the degree and depth of temperature and salinity stratification, if any.

## PROPOSED SCOPE OF WORK

There are several upcoming tidal windows that will allow drogue tracking during a large ebb and large flood occurring on the same day. These periods include the weeks of May 5-9, May 19-23, and June 3-5 (Figures 1 and 2). Since EHI will have to manufacture additional drogues, the week of May 5-9 will not be feasible for a measurement period. During the week of May 19<sup>th</sup>, the ebb tidal range is 14.6-14.8 ft and the flood tidal range is 16.6-17.0 ft. During the week of June 2<sup>nd</sup>, the ebb tidal range is 19.2-19.8 ft and the flood tidal range is 20.2-21.0 ft. For comparison, the mean tidal range for Totten Inlet is 11.0 ft, the average tidal height is 8.5 ft, and the average MHHW is 15.0 ft.

During one of these periods of large tidal ranges, EHI proposes to deploy two (2) drogues during each of the four tidal stages (slack, maximum ebb, slack, maximum flood) for a total of eight (8) drogues. All drogues will be instrumented with GPS units to record the position every 5 minutes. Drogue positions following release will also be tracked via boat and on-board GPS. This is accomplished by pulling the boat next to each drogue and logging the latitude and longitude via the boat's GPS. The drogue GPS, the drogue GPS will be downloaded as well to avoid loss of data should the drogue become lost during the course of the study.

Drogues will be tracked during daylight hours only. Any drogues that leave the Inlet will be tracked through the day but pulled from the water at the end of the survey day. However, if a drogue is headed into Pickering or Dana Passage following completion of the ebb tide it will be pulled. Once the drogues reach these two passages they are difficult to recover. Drogues within the Inlet will be left out over night to obtain at least a full 36-hour (1.5 days) release period. The 1.5 days is the probable doubling time of the types of algae likely to be present during nutrient sensitive periods of the summer and early fall. The following morning the position of each drogue will be logged and the GPS downloaded. A limited search will be made for any missing drogues not found within Totten Inlet. This will be within the nearby inlets (Eld, Budd, and Hammersley) and around Squaxin Island.

## Task Overview

This project will involve the following management and technical steps, listed below in the approximate order they will occur. These steps are then detailed in the specific tasks below.

1. Manufacture Drogues
2. Mobilize Equipment
3. Deploy Drogues
4. Track Drogues
5. Retrieve Drogues

6. Demobilize Equipment

7. Produce Report and Plots

### **Task 1: Manufacture Drogues**

The drogues will be an X-shaped panel drifter (see Photo 1). Each large panel measures 1 meter square of rip-stop nylon. Two of these panels are sewn together at their centers to construct the X-shape. The panels are held open by PVC pipes both at the top and bottom of the drogue. A tension rod runs down the center of the drogue where the two panels connect to add stability and weight to the panels and prevent them from folding. The bottom PVC pipes contain additional weight and the top PVC pipes contain foam for buoyancy to keep the drogue at the deployed depth.

The drogues are tethered to a surface float via 1/8<sup>th</sup> inch parachute cord. If a thinner tether line is desired, a 1/16<sup>th</sup> inch SS aircraft cable can be used instead of the 1/8<sup>th</sup> inch parachute cord. Each drogue tether line has a clip at both ends to facilitate a quick attachment/release of the drogue and surface assembly. Two lengths of tethers will be made, a set of 4 tethers at 2 m and a set of 4 at 8 m. The surface float is typically a bullet or trawl (10") float on a weighted PVC pipe. A marker flag with a unique number (different for each drogue) is attached to the PVC/float assembly.

The drogues are equipped with a Garmin Geko 201 GPS placed in a water tight PVC compartment and attached to the PVC/float assembly. A download cable is plugged into each unit within the water tight compartment. This allows the GPS data to be downloaded while the vessel is along side the drogue assembly without pulling the drogue assembly from the water.

### **Task 2: Mobilize Equipment**

All equipment will be mobilized at the EHI Seattle office. This will involve assembly of the drogue components and bench testing all GPS units. Field log sheets will be prepared in both electronic and hardcopy formats. Log sheets will contain pertinent information for each drogue as it is deployed and tracked throughout the field effort. Deployment times will be estimated from tidal prediction tables for each of the four tidal phases for the selected deployment date. These times will be posted on the log sheets for reference by the field crew.

The GPS units will be programmed with a preset list of instructions downloaded from a laptop computer. All GPS units will be powered down following testing. An extra set of batteries for each unit will be packed with the field gear.

Following testing and confirmation of equipment status, all drogues will be packed for transport to Totten Inlet. This will involve loosening the center tension rod so all drogues can be lay flat and stacked for transport within the field van.

The day before the scheduled deployments, the field crew will travel to Totten Inlet. All drogues, tethers, and surface float assemblies will be loaded aboard the boat. All GPS systems, both drogue and boat, will be tested.

### **Task 3: Deploy Drogues**

A set of two drogues will be deployed during each of four tidal phases at the proposed mussel farm in Gallagher Cove. Figure 3 shows an example tidal curve with a dot marking the four tidal phases the sets of drogues would be deployed. During the first slack before the ebb, one drogue with a 2 m tether and one drogue with an 8 m tether will be deployed. Both drogues will be instrumented with GPS units. As the boat holds position the drogues will be deployed in the following manner:

1. One end of the tether will be clipped to the top center of the drogue and the other end to the base of the surface float while still aboard the boat (rings are provided on both the drogue and float for tether clips)
2. Drogue and float assembly will be lowered into the water ensuring that the tether line is free of snags and tangles.
3. Time, GPS position, drogue depth, and drogue number will be logged to the field sheet prior to setting the drogue adrift. Ancillary data will be noted on the log sheets (e.g., weather conditions, vessel traffic, etc).
4. Repeat steps 1 through 3 for remaining drogue spacing deployments approximately 1 minute apart.

For each of the remaining 3 deployment times (maximum ebb, slack, maximum flood) two drogues will be deployed (one at 2 m and one at 8 m depth both with GPS units). Deployments will follow the same procedure as outlined above.

### **Task 4: Track Drogues**

After the last drogue for the first deployment set is released, the boat will motor to the first released drogue for a new time and GPS position (logged to field notes). The boat will continue motoring to each released drogue for a new time and GPS position. Each drogue should be logged once per hour at a minimum. Tracking of the drogues will continue in this manner until time of the deployment of the maximum ebb drogue set.

The GPS unit will be accessed and the position data stored on the unit downloaded to a laptop aboard the boat. The battery power indicator on each GPS unit will be checked and if determined to be less than 50% the batteries will be replaced.

The boat will be equipped with a Hypack® navigation system. As time allows during field efforts, the drogue positions will be transferred to electronic format and the positions overlaid on an electronic nautical chart.

If a drogue travels outside Totten Inlet (into Pickering and Dana Passages) it will be retrieved. One exception to this is during an ebb tide. The drogue will be allowed to drift and then will be retrieved at the end of the ebb tide.

As each set of drogues are deployed the boat will continue to motor to all released drogues for a new time and GPS position (logged to field notes). Each drogue should be logged once per hour at a minimum. Sunset is expected to occur approximately 30-45 minutes following the last drogue deployment (maximum flood). Drogues will be tracked until daylight is no longer available. Drogues will be left in the water over night.

### **Task 5: Retrieve Drogues**

At daylight the following morning, the boat and field crew will search for all drogues. As each drogue is found, the time and GPS position will be logged and the drogue GPS downloaded. If not all the drogues were retrieved within Totten Inlet a search will be conducted by boat outside the inlet to locate missing drogues. As the drogues are found they will also have the time and GPS location noted and then pulled from the water. Comments on the log sheets will note which drogues have run aground and the location. All drogues will be retrieved at the end of the second day 36 hours after the initial deployment (approximately 5:30pm).

### **Task 6: Demobilize Equipment**

All drogues will be rinsed in freshwater and the tension released from the center rod so the drogues can be stacked flat for transport. The tether lines and surface float assemblies will also be rinsed in freshwater. All GPS units will be downloaded to a laptop and backup copy placed on a data stick of all data files. Following download the batteries and download cable will be removed prior to packing the units for transport. All equipment will be transported back to the EHI Seattle facility.

### **Task 7: Produce Report and Plots**

A report will be produced containing the methodology and results from the drogue study. Plots of the drogue paths will be produced for individual drogues, tidal groups, and similar depth groups. Data will include measured or calculated velocity for appropriate time periods of the measurements. In addition, local wind records, if available, will be included with estimated recorded by staff using a hand held meter. An appendix will contain the field log sheets and observations of weather during the field survey, at the end of the first day, and prior to boarding the vessels the second day.

**DELIVERABLES**

In addition to the data report and plots, EHI will provide the processed data files in ASCII format. Raw data files will be kept on file and can be obtained by request.

**Assumptions**

This proposal is based on the following assumptions:

1. The proposed costs are valid for 60 days from the date of this proposal.
2. Taylor Shellfish Company, Inc. will provide the following services during the field effort:
  - Vessel and operator.
  - Differential GPS for the vessel (if this is not available EHI will provide a system).

**AUTHORIZATION TO PROCEED**

We appreciate the opportunity to provide this proposal and look forward to working with Taylor Shellfish Company, Inc. Notice to proceed (NTP) can be given via email or phone call. Confirmation of NTP will be via return email. If you have any questions or need additional information, please don't hesitate to contact me at the phone number or e-mail listed on page 1 of this letter.

Sincerely,

**CAROL COOMES**  
**OCEANOGRAPHER/VP**  
carol@evanshamilton.com

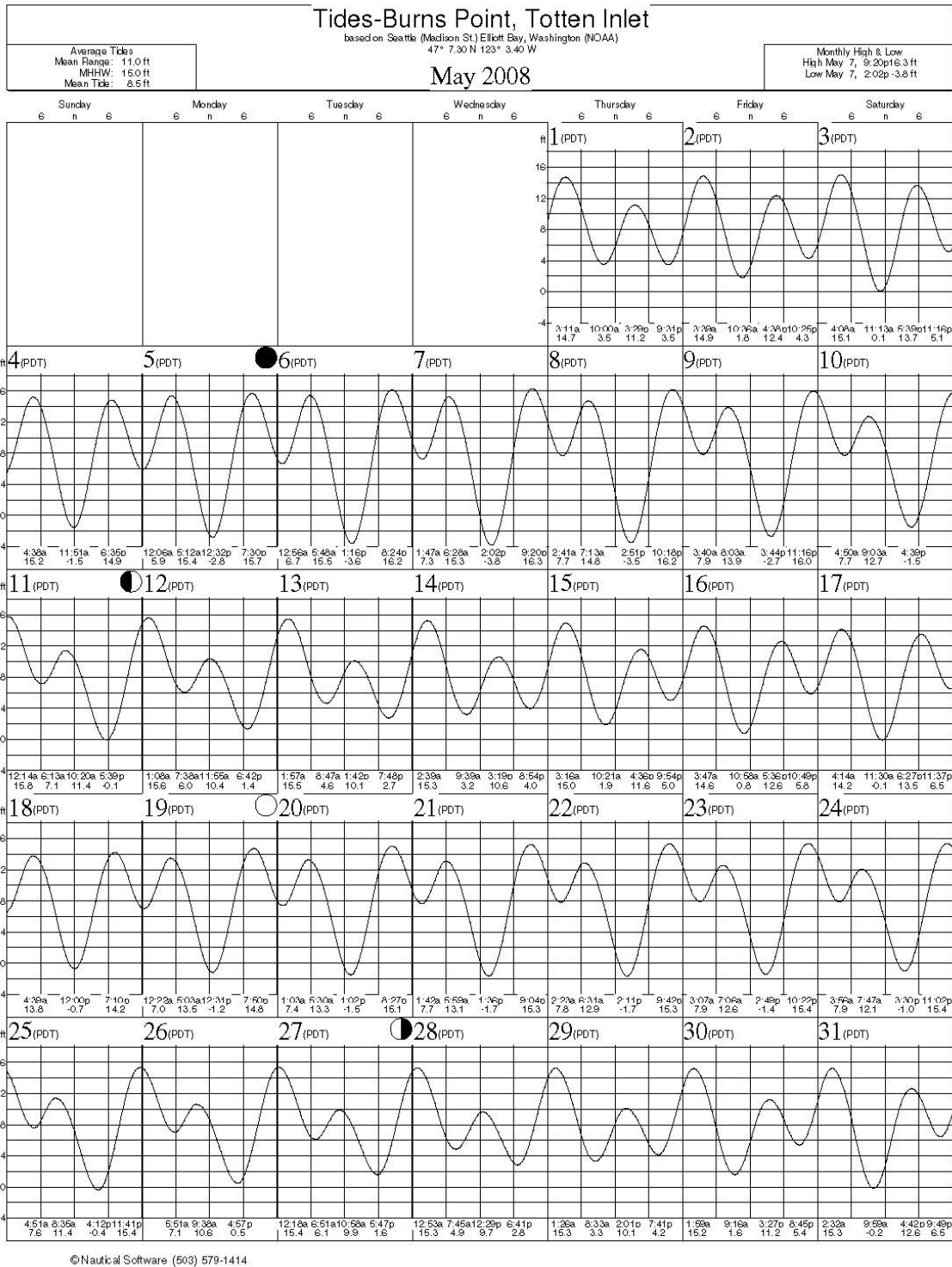


Figure 1. May 2008 tides for Totten Inlet.

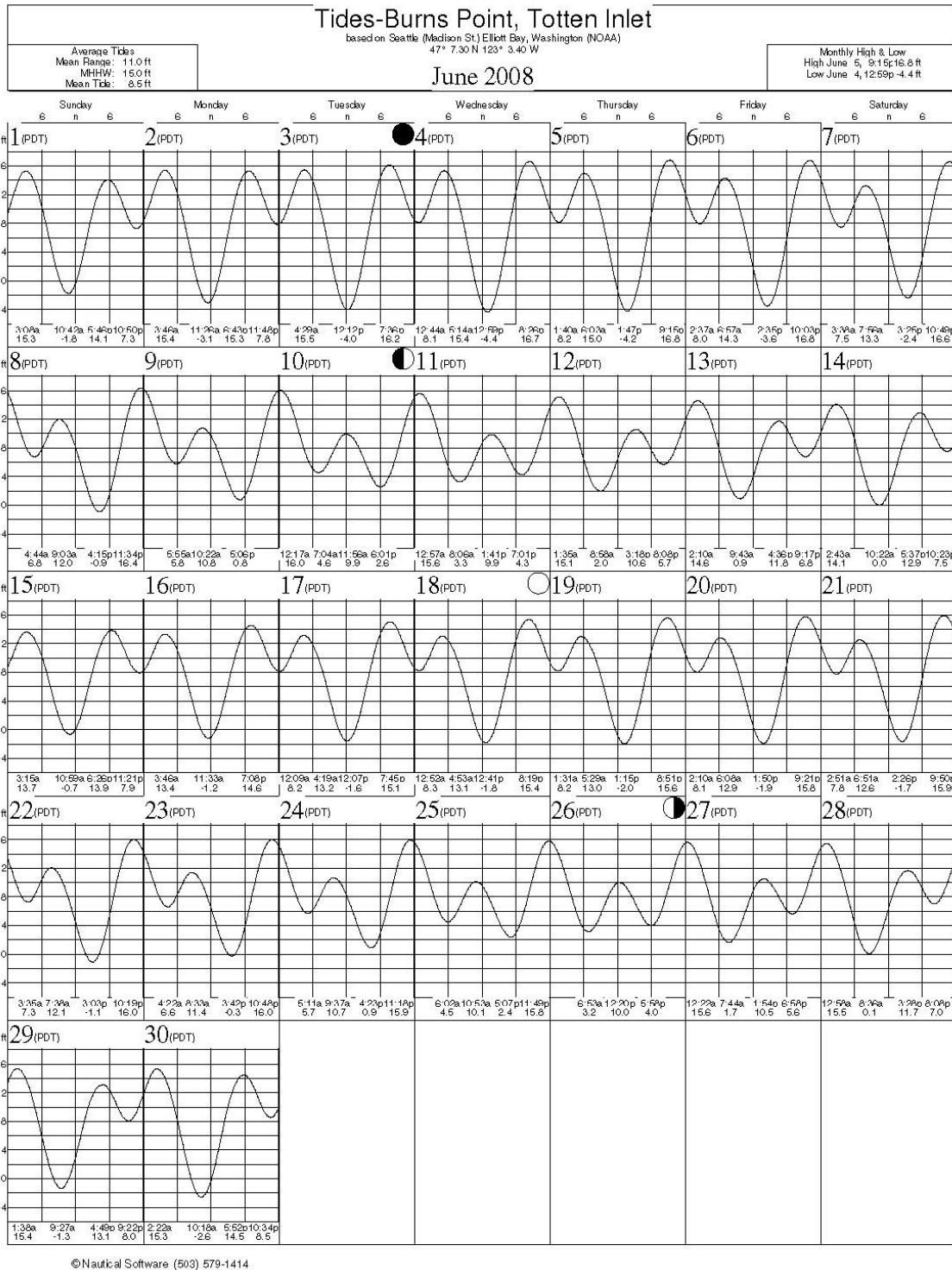


Figure 2. June 2008 tides for Totten Inlet.

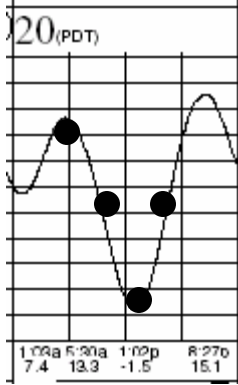


Figure 3. Example tide curve showing a dot at the four drogue deployments, slack, maximum ebb, slack, and maximum flood.



Photo 1. X-shaped drogue of rip-stop nylon.