



A kayak-based survey protocol for Bull Kelp in Puget Sound

Prepared for the Northwest
Straits Commission

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Cover photo: Bull kelp bed in San Juan County; Emily Bishop

Background:

Large brown algae in the order Laminariales, commonly known as ‘kelp,’ provide habitat to a variety of species in Puget Sound and are considered critical habitat warranting protection via Critical Area Ordinances, Shoreline Master Plan updates, and NOAA Fisheries provisions for endangered rockfish. Kelp, like eelgrass, also contributes other valuable ecosystem services - food for many creatures, protection from coastal wave energy, and more.

Conspicuous declines in the abundance of bull kelp (*Nereocystis luetkeana*), the prominent canopy-forming species in Puget Sound, have been observed in many areas. The causes of decline are likely due to a combination of factors. An annual inventory conducted since 1989, by the Washington Department of Natural Resources (WDNR) through aerial and dive surveys, has focused on the floating kelps - including *Macrocystis pyrifera* - of the outer coast and Strait of Juan de Fuca. There, kelp abundance has increased.

In 2023, WDNR developed a [Floating Kelp Indicator](#) for the Puget Sound Partnership’s [Vital Sign Program](#). Using kayak monitoring, aerial photography, and historical documents the indicator documented significant declines of bull kelp in southern Puget Sound, but was unable to quantify trends in northern Puget Sound due to insufficient data.

This survey protocol has been prepared as a reliable and relatively simple tool for Northwest Straits Marine Resources Committee (MRC) volunteers and other community-scientists monitoring bull kelp toward its protection and recovery.

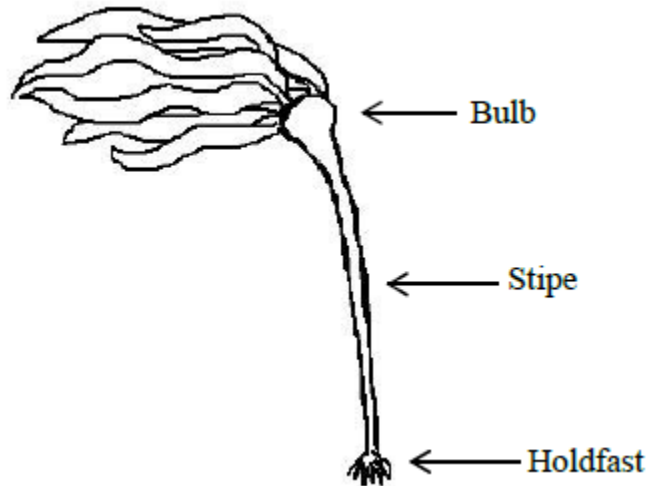
Our question: Can current distributions and patterns of change in bull kelp populations be accurately and repeatedly surveyed by community science volunteers, from the surface?

Northwest Straits Kayak-based Survey Protocol for Floating Bull Kelp Beds

A field guide to track presence of bull kelp, *Nereocystis luetkeana*, in Puget Sound

1. Materials

- Kayak and paddle
- Safety equipment (see checklist, Appendix C)
- Aerial photo, map, or chart of area
- Handheld GPS unit
- Datasheets (attached)
- Weighted line (marked in feet)
- Temperature sensor (marked in °C)
- Camera
- *Plankton net
- *Bucket/graduated cylinder
- *Labeled Falcon tube with approx.
- *10mL of ethanol



*Only used if comparing zooplankton communities in and outside of kelp

2. Safety Considerations

This protocol is designed for participants with a minimum of basic kayak skills and the ability to maneuver around kelp beds using forward and maneuver strokes. Participant roles, responsibilities, and skill sets include but are not limited to:

All Participants

- Must have the demonstrated ability to self-rescue if the kayak flips and the ability to assist others in a T-rescue and side by side rescue.
- Are responsible for their own safety. If you feel unsafe, notify the group and trip leader, discuss options, and take action either by returning to shore, or positioning yourself in a safe location. Always communicate with the others in the group.
- Must be aware of the environmental conditions and continually assess if it is safe to carry out the survey as conditions on the water can change quickly.
- Are responsible for bringing the required safety gear, kayak, paddle, PFD, and proper clothing (dress for the water, not the weather).

Trip Leader

- Is responsible for scheduling surveys based on the desired tide and current conditions and has familiarity with the site.

- Must have experience and ability to use weather forecasts, tide and current tables, and knowledge of the area to be paddled, to assess ocean conditions for group safety.
- Is responsible for making the assessment of weather conditions on the day of the survey as well as during the survey. If conditions are unsafe, the trip leader will postpone the survey.
- Is responsible for confirming that participants have required safety equipment and leading the group through the safety checklist on shore before starting each survey.

A. Training:

- Participants and trip leaders must meet required safety training standards or coordinate with the Northwest Straits Commission and Foundation on alternate safety skills demonstrations.

B. Liability:

- Trip leaders will coordinate with Marine Resources Committees to confirm and coordinate liability coverage through the County or Northwest Straits Foundation.

3. Methods

A. Identifying kelp beds

Bull kelp beds will be defined as a cluster of *Nereocystis* plants greater than 5 meters (16.5ft) across. Individual kelp bulbs greater than 8m (26ft, about 1.5x the length of a typical sea kayak) apart will be considered part of a separate bed (see Figure 1).

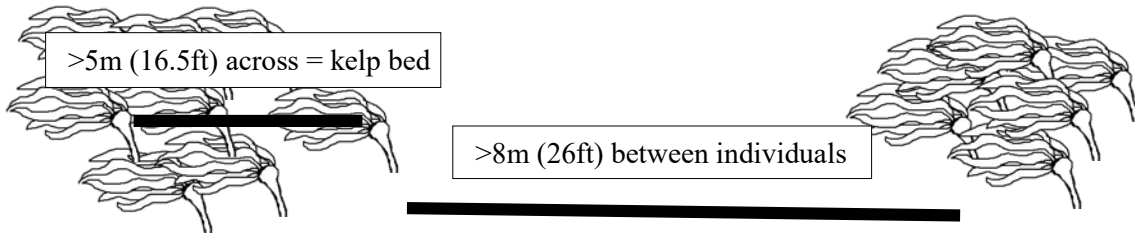


Figure 1. Measurements for identifying distinct kelp beds

B. General guidelines for selecting areas to map:

Choose a known location along a stretch of shoreline that will be easily identifiable in future years. During initial testing of protocol, it is advised that beds less than 1000m (~0.5mi) in length be selected¹.

Consider a pre-survey scouting trip to your selected kelp bed before attempting a full survey.

C. Survey Site – Shoreline Segments *NEW*****

The natural variability of bull kelp beds can make returning to the same bed each year challenging. Additionally, a bed may split or merge with adjacent beds, making the perimeter track subject to large changes year to year that does not reflect seasonal changes. To provide more consistency to surveys, shoreline segments are being added as a planning step before going into the field. All sites will have shoreline segments except for offshore sites (e.g., Coffin Rocks, Skagit County).

¹ Alternatively, one large bed could be surveyed using multiple GPS units and multiple surveyors paddling around the bed simultaneously.

- Each site will establish shoreline segments that are perpendicular to the shoreline using either a visible landmark on the shore, or GPS lines that can be loaded into the handheld units during the survey that bound the kelp area to be surveyed (see Figure 2).
- The shoreline segments establish spatial boundaries that are used as guidance for volunteers to return to each year to keep surveys comparable between years. When surveying, survey all kelp beds, OR cluster of bulbs (i.e., ≤ 10 bulbs) if no bed is present, which are within the two shoreline segment boundaries.
- Within the shoreline segments, participants will use the perimeter and points protocols to record the position, and where applicable, the perimeter of all (within reason) visible kelp beds OR clusters of bulbs (i.e., ≤ 10 bulbs). Bulb clusters should not be mapped unless the kelp bed disappears.
- Participants will also use the survey endpoints protocol to record the endpoint locations of the survey area to confirm the length of shoreline surveyed (see Figure 2). These two waypoints will be compared to the pre-defined shoreline segments to ensure the survey is comparable to previous surveys. Ideally, the survey endpoints should encompass and may extend beyond the entire defined shoreline segment.
- Shoreline segment boundaries should be set where breaks in kelp beds typically occur when possible. Or be based on a segment of interest. For existing sites, set segments based on historical surveys unless surveying a new bed.
- Northwest Straits Commission staff can assist with creating shoreline segments.



Figure 2. Blue lines indicate the shoreline segment, and the red dots represent the survey endpoints at Possession Point. The yellow line represents the surveyed kelp bed perimeter which includes all the kelp present within the shoreline segment. The red survey endpoints, taken during the survey, confirm that the entire shoreline segment was surveyed.

D. Choosing appropriate time to perform surveys

Surveys will be conducted:

- At low tide, when the water level is less than 0.0ft Mean Lower Low Water (MLLW)².
 - Choose to survey at a consistent tidal height year to year for maximum consistency. Choosing an intermediate low tidal height (as opposed to a very low tidal height) will increase the number of potential sampling days to choose from.
 - Use a tide chart (available online from sources such as www.tidesandcurrents.noaa.gov, tides.mobilegeographics.com, www.deepzoom.com, or on smart phone apps such as “Ayetides” or “MultiTide”) to determine the exact length of time during which the water will be below 0.0ft MLLW during late July through mid-September³ each year.
 - Base the number of surveys on your organization’s goals and objectives. If you survey once a year, try to survey when your bed typically hits its peak size.
- Around slack current, when kelp is most visible on the surface. Slack current can often be offset from low tide and is different at each site.
- Each site should choose the best time to survey based on local knowledge and participant observations of site-specific tide and current behavior.
- Within one week of the previous year’s survey date, for comparison of data between years.

E. Pre-survey preparation

1. Be familiar with GPS operation⁴.
2. Designate a trip leader who will be responsible for the following:
 - Check GPS battery level. Bring spare batteries.
 - Set the GPS to record its position every 10 seconds, about every 2m.
 - Assure that safe weather and maritime conditions are projected. Confirm conditions from the beach for your safety. See “current speed” below.
 - Bring a simple pool thermometer, a weighted line, and a GPS to survey.

Current speed

Survey days should be selected with current speed in mind, both for the safety of boaters and to prevent excessive pull on bull kelp during surveys. **Your personal safety is the priority.** Record current speed on datasheet using a source such as www.tides.mobilegeographics.com.

F. Conducting the survey

3. On the beach, turn on the GPS unit and situate it pointing towards the sky while it warms up.
4. Fill out the Pre-Survey section of the Data Sheet.
5. **If there are multiple kelp beds in your shoreline segment section, name or number each bed you wish to survey on the data sheets. Each bed should have its own “on the water” data sheet. Refer to previous years data sheets if beds were previously surveyed.** If you are collecting waypoint for kelp clusters of ≤ 10 bulbs, please include all waypoint numbers and descriptions on one “on the water” data sheet.

² Some beds may be exposed on the beach during a 0.0ft tide. In this case, kayak around as much of the bed as possible and note on the data sheet that the shoreward perimeter was too shallow to paddle around.

³ Likely once per month. One goal is to determine how much perimeters change between months.

⁴ If feasible, conduct preliminary surveys with multiple GPS units to compare variation in perimeters using different units and multiple surveyors.

6. Bring the thermometer, weighted line, GPS, camera, and paddle out to the kelp bed.

Survey endpoints *NEW*

7. **Take a waypoint at the two survey endpoints of the area that you are actively looking for kelp** (whether or not kelp is present) and record point names on the datasheet. The survey endpoints are the two points farthest from each other, which are located between the shallow and deep edge of your survey area (this may vary if monitoring offshore locations like Coffin Rocks; Figure 2). If you start looking for kelp at one endpoint of a site, these points will include your starting point and the furthest point paddled to before turning around. These survey endpoints should reach or extend beyond the shoreline segments. Even if a perimeter is cut short due to conditions, take survey endpoints as it provides important data on how much of the site was surveyed.

Perimeter

8. **Take a waypoint, start recording a track** and paddle around the perimeter of a bed. Stay within 1m (3ft) of the outermost plant. Paddle the deep edge of the bed at the most optimal conditions (i.e., slack current) to capture the most accurate perimeter.
9. Once the perimeter is completed, **stop recording tracks and take the final waypoint**.

Points (for sites where ≤ 10 bulbs are present) *NEW*

10. **Take a waypoint** in instances where there are ≤ 10 kelp bulbs present in your survey area but do not constitute a kelp bed. Note the number of individual bulbs on the datasheet along with waypoint number. Take a single depth measurement and temperature measurement with the waypoint. Please be sure to survey from shoreline segment to shoreline segment when collecting points of kelp clusters or individual bulbs. **Taking points for kelp bulbs is unnecessary at sites where mapped kelp beds are present.**

Depth

11. For each bed, **at two locations** along the bed perimeter closest to shore (shallow edge), lower a weighted line into the water until there is slack. Pull back the line slightly and then lower again for a precise measurement. Pull back the entire line and **measure the amount that was underwater**. If multiple beds are present and surveyed in one shoreline segment, only take one depth reading along the bed perimeter closest to shore for each bed.
12. Record a GPS point where each shallow bed depth was measured and the time of the measurement.
13. Repeat Step 11-12 at two locations on the bed perimeter opposite from shore (deep edge).
14. Record a GPS point where each deep edge depth measurement was taken and the time of the measurement.

Temperature

15. **Take the surface temperature** of the kelp bed with the thermometer, within the top 0.5m (1.6ft) of water at each depth measurement location.

Photos

16. Take **one picture**⁵ of the kelp bed (Appendix A) on the water side facing shore (Towards beach: ToBe). The angle of the photo should try to capture as much of the bed as possible,

⁵ Photos will not be used to calculate the density of beds surveyed. The goal is to have photo documentation of changes in the bed over the course of the season, and between years. Surveyors should decide during their first survey, or possibly during a pre-survey scouting trip, a specific location for the photo point that will be easiest to replicate (picking a nearby landmark for the background is a great way to ensure the pictures are replicable).

while still including the horizon or a land feature. Take additional pictures of volunteers in action and any interesting observations or views.

Observations:

17. List any observations to describe the kelp community or factors that may be impacting it⁶. Record visible damage to plants, kelp crabs eating things, birds, fish, mammals present. Does it look healthy? Any obvious bulbs left over from previous season? Do they look like they're persisting – huge, blades ratty, epiphytes present? Is it a thin bed, thick bed? If there is no floating kelp visible at the site, record what you find instead. Is it barren? Is there understory kelp? Are there any human related influences on the bed? Do you see fishing activity in or near the kelp bed? Also consider taking photos of your observations. Record photo label in the observations section.

REPEAT FOR EACH KELP BED

G. Post survey process back on shore

Fill out Post-Survey section of the data sheet when back on shore. If survey conditions changed during the survey, record wind, wave and/or current conditions in the “Survey condition notes” area of the pre-survey section. The trip leader should fill out the post-survey checklist. The trip leader should confirm that all data sheets are completely filled out and that photo points were recorded. Upload photos and save photo points with file names that include the bed name, date, and photo point name (i.e., “NorthBeach5.24.16ToBe.JPG”). Add data to KoboToolBox (see Appendix E for more detail)

Each MRC should file and store datasheets and photos for floating kelp beds within their county. GIS mapping and uploading of data to SoundIQ will be coordinated by the Northwest Straits Commission.

4. Acknowledgement of Contributors and Reviewers

Brian Allen, Puget Sound Restoration Fund
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Thomas Mumford, Retired, Washington State Department of Natural Resources
Dana Oster, Northwest Straits Commission
Leah Robison, Northwest Straits Commission
Suzanne Shull, Padilla Bay National Estuarine Research Reserve

⁶ Surveyors should not feel limited to the suggestions provided here. Any qualitative notes may be useful in future analyses.

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Special thanks to Leanna Boyer and the Mayne Island Conservancy Society for providing, at the outset of this project, the kayak-based mapping methodology developed for the Seagrass Conservation Working Group.

Thanks to the Northwest Straits Foundation for the safety checklist and continually improving our culture of safety.

5. Glossary of Acronyms

GPS: Global Positioning System
MLLW: Mean Lower Low Water
MRC: Marine Resources Committee
NOAA: National Oceanic and Atmospheric Administration

6. Appendices (included below)

- A. Bull kelp survey datasheet ***UPDATED***
- B. Sample datasheet for reference
- C. Safety Checklist
- D. How to Deep Zoom-Updated from Solenne Walker
- E. How to upload data- KoboToolBox
- F. Zooplankton sampling protocol – Julie Keister
- G. Zooplankton ID card – Washington Sea Grant (attachment)

7. Bibliography

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Appendix A: Bull Kelp Survey Data Sheet (on shore)

Pre-Survey Section (on the beach)

Trip Leader: _____ Date: _____

Name of surveyors: _____

Location (Shoreline Segment): _____

Name of GPS unit or phone app _____ Accuracy of GPS: +/- _____ ft

Weather conditions (circle one)

Clear Haze Clouds Fog/mist Light rain Heavy rain

Tide height (ft): Start _____ Tide station: _____

Current (knots): _____ Station/source: _____

Survey condition notes (wind/wave condition, current behavior, sparse kelp outside of perimeter?):

Proceed to page 2 to conduct survey. Following your survey, fill out Post-Survey section below.

Post-Survey Section (back on the beach after the survey)
 Provide a sketch of the area surveyed, including approximate location of kelp bed boundary line, temperature, depth measurements, and locations of photo points.

- Post-survey checklist:
- Kelp bed perimeter track is saved in one or more GPS units
 - GPS units are collected for storage until next survey
 - Data sheets are completely filled out and legible.
 - Photo points have been taken (and are later uploaded with properly labeled names)



Bull Kelp Survey Data Sheet (on the water)

Kelp Bed Number or Name _____ **Survey start time:** _____

Survey Endpoints: 1 = first recorded survey endpoint, 2 = second recorded survey endpoint

Survey Endpoint 1 GPS point name: _____ Survey Endpoint 2 GPS point name: _____

Perimeter: GPS perimeter track name: _____

GPS point name at Start: _____ End of paddle around bed: _____

Points (If there is no bed, take a waypoint for kelp clusters with ≤ 10 bulbs within shoreline segment):

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

Kelp Bed Water Temperature and Depth (ft):

Edge closest to shore GPS Point name: _____ Depth: _____ ft, Temp: _____ Time: _____

Edge closest to shore GPS Point name: _____ Depth: _____ ft, Temp: _____ Time: _____

Edge farthest to shore GPS Point name: _____ Depth: _____ ft, Temp: _____ Time: _____

Edge farthest to shore GPS Point name: _____ Depth: _____ ft, Temp: _____ Time: _____

Photo points: (take first photo, then take a photo of this data sheet with the corresponding box checked)

- ToBe** **Interesting kelp bed photos** **Photos of Volunteers**

Observations (consider density, animals present, overall health of blades, presence of understory kelp, human impacts, fishing activity, etc.): _____

End time (time of last measurement or observation before returning to shore): _____

Appendix B: Bull Kelp Survey Data Sheet (on shore)

Pre-Survey Section (on the beach)

Trip Leader: Kelly Kelp Date: 7/15/23

Name of surveyors: Peter Plankton, Amy Anemone

Location (Shoreline Segment): North Beach

Name of GPS unit or phone app Garmin 62s Accuracy of GPS: +/- 9 ft

Weather conditions (circle one)

Clear Haze Clouds Fog/mist Light rain Heavy rain

Tide height (ft): Start -0.5 Tide station: Port Townsend

Current (knots): 0.3kts Station/source: tidemobilegeographics.com

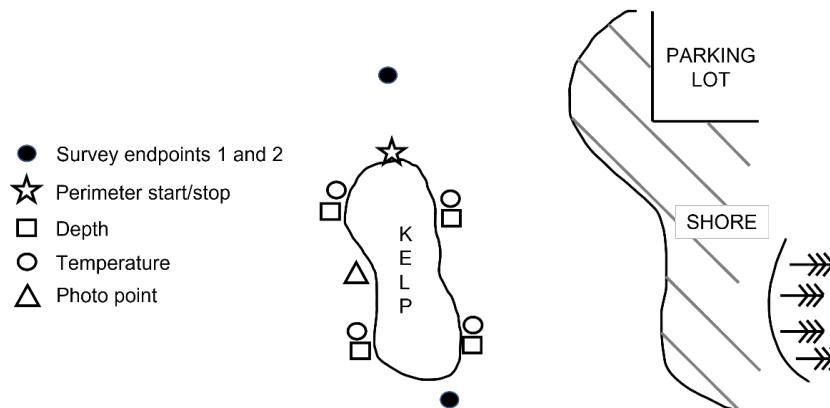
Survey condition notes (wind/wave condition, current behavior, sparse kelp outside of perimeter?):

Slight wind but no wind waves. No significant current when on the deep edge of the bed, no kelp noticeably pulled under. Sparse kelp outside deep edge of mapped perimeter but doesn't reach the threshold distance to be included.

Proceed to page 2 to conduct survey. Following your survey, fill out Post-Survey section below.

Post-Survey Section (back on the beach after the survey)

Provide a sketch of the area surveyed, including approximate location of kelp bed boundary line, temperature, depth measurements, and locations of photo points.



Post-survey checklist:

- Kelp bed perimeter track is saved in one or more GPS units
- GPS units are collected for storage until next survey
- Data sheets are completely filled out and legible.
- Photo points have been taken (and will be uploaded with labeled names)



Bull Kelp Survey Data Sheet (on the water)

Kelp Bed number or name North Beach East Survey start time: 14:15

Survey Endpoints: (start = when first looking for kelp on water, end = farthest point before turning around)

Start survey GPS point name: 102 End survey GPS point name: 109

Perimeter: GPS perimeter track name: 20230715_nb

GPS point name at Start: 103 End of paddle around bed: 108

Points (If there is no bed, take a waypoint for kelp clusters with ≤ 10 bulbs within shoreline segment):

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

GPS Point name: _____ Depth: _____ ft, Temp: _____ Observations: _____

Kelp Bed Water Temperature and Depth (ft):

Edge farthest to shore GPS Point name: 104 Depth: 25 ft, Temp: 12.5 C Time: 14:37

Edge farthest to shore GPS Point name: 105 Depth: 31.5 ft, Temp: 12.6 C Time: 14:55

Edge closest to shore GPS Point name: 106, Depth: 6.0 ft, Temp: 12.3 C Time: 15:15

Edge closest to shore GPS Point name: 107, Depth: 5.5 ft, Temp: 12.4 C Time: 15:30

Photo points: (take first photo, then take a photo of this data sheet with the corresponding box checked)

ToBe

Interesting kelp bed photos

Photos of Volunteers

Observations (consider density, animals present, overall health of blades, presence of understory kelp, human

impacts, fishing activity, etc.): Healthy blades with minimal epifauna. Some boat damage to

NW edge of bed. Understory kelp present closer to shore. Perch and small schooling fish

visible. SE edge of bed looks more dense since last survey (~10 bulbs/m). Some small

fishing boats trolling near the seaward edge of the kelp bed

End time (time of last measurement or observation before returning to shore): 15:30

Appendix C: Safety Checklist



Bull Kelp Kayaking Checklist

This checklist is designed to help create a unified safety culture every time we go out on the water to conduct kayak-based bull kelp monitoring. Please take the time to check this list together, as a group.

Required gear for all:

- Kayak that is suitable for the environment
- Paddle
- Personal Floatation Device (PFD)
- Proper clothing and shoes (Dress for the water)

Recommended gear:

- Paddle float
- Whistle
- Tow belt

Additional required gear for Lead:

- (Can be disbursed within group)
- Bilge pump
 - VHF Radio
 - Extra paddle
 - Cell phone with service
 - Basic First Aid Kit*

Skills Check:

- What if you flipped your kayak today? Are you prepared to help if someone else flips their kayak? Where would you return to shore? Would all the gear (cell phone, GPS unit, first aid kit) be okay if submerged?

Weather, Currents, and Tides:

- What does the weather forecast say for the next three hours? Are you using a reliable source?
- What does the weather look like right now?
- When is slack current for the survey site? What will happen if you're out a little longer than expected?
- When is the ideal time to be out there (tides) and does that line up with the safest time to be out there (currents)?

Plan for the Day:

- What is the plan for the day?
- Does everyone understand the plan?
- Any questions or concerns?

Waivers:

- Has everyone signed a waiver?

Materials for data collection:







- Aerial photo, map, or chart of area
- Handheld GPS unit
- Datasheets
- Weighted line (marked in feet)
- Temperature sensor (marked in °C)
- Camera
- *Plankton net
- *Bucket/graduated cylinder
- *Labeled Falcon tube with approx.
- *10mL of ethanol

*Only used if comparing zooplankton communities in and outside of kelp

Appendix D: How to use Deep Zoom

DeepZoom ~ displays animated **Current flows and Tidal heights** superimposed on NOAA Nautical Charts (<http://www.deepzoom.com>)

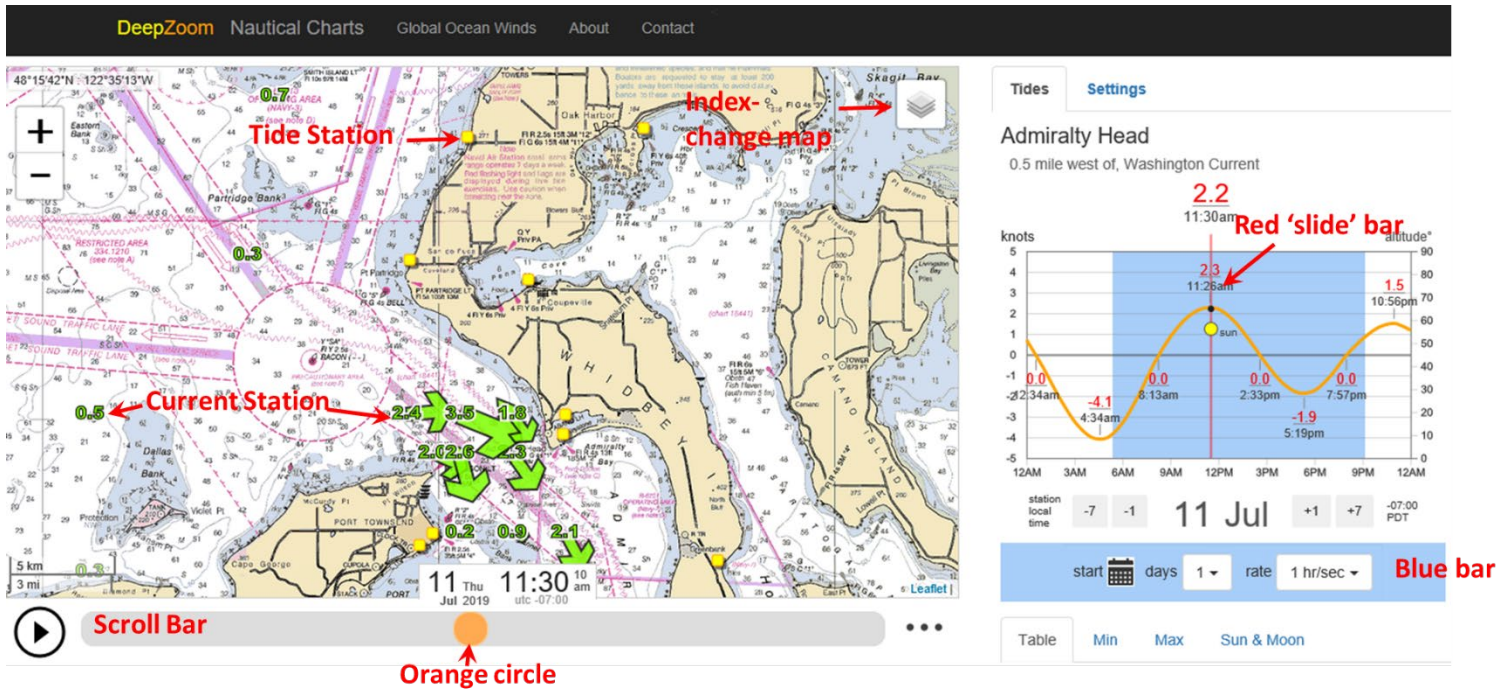
Steps

- On **DeepZoom Nautical Chart** map link, scroll and zoom the map to region of interest
 - **Map Viewing Options:**
 - i. **Satellite image** or **Street view** – click on **Index** squares in map upper right corner
 - Make sure NOAA is checked if you want view the **Nautical Chart**.
 - ii. **Settings** on right column is where you can change **Opacity** from Nautical Chart to Satellite or Street view; or view both
 - View Lat/Long in decimal minutes seconds or decimal degrees (*GPS displayed in map upper left corner*)
 - View standard time or military time
 - Make sure both tide stations and current stations are checked
- **Tides** – Click on a yellow square for the closest tidal station 
 - **Tide Chart** under **Tides** on right column shows a **Daily Tide Graph** with a red “slide” bar
 - i. Select start **Date and Time** or a **Range of Dates** within the blue bar below the graph
 - ii. Select **Now** or a “slideshow” **Rate** to view daily tidal changes on the map and the graph
 - *1 min/sec is good and slow for one day; 1 hr/sec is faster when viewing changes over several days...*
 - iii. See **Scroll Bar** with orange circle and play button at bottom of map to play “slideshow” at rate selected or manually move the orange circle to change date and time
 - iv. See **Table Min - Max Sun & Moon** to view:
 - **High and low tides of day; sun and moon rise and set**
 - **Minimum and maximum tides for month**
 - **Visual image of sun and moon position**  
- **Currents** – Click on a yellow or green number or arrow in the water 
 - **Current Direction:** Positive speed values indicate that the current is flowing in the direction of the mean flood direction. Negative speed values indicate that the current is flowing in the direction of the mean ebb direction. When current numbers and arrows are green, the current is flooding (flowing towards the mainland), and when it is yellow, the current is ebbing (flowing away from the mainland).
 - **Flow Chart** under Tides on right column shows the **Current in Knots** with a red “slide” bar
 - i. Select start **Date and Time** or a **Range of Dates** within the blue bar below the graph
 - ii. Select **Now** or a “slideshow” **Rate** to view daily current changes on the map and the graph (*as described above*)
 - iii. See **Scroll Bar** at bottom of map to play “slideshow” at rate selected or manually move the button to change date and time
 - iv. See **Table Min-Max Sun & Moon** to view:
 - **Max flow and ebb times of day; slack before flow and slack before ebb times of day**
 - **Minimum and maximum currents for month**
 - **Visual image of sun and moon position**  

Key Features

- **Red “slide” bar** = presents one point of view in time or plays a red bar “slideshow” of changing tides and currents throughout the day based on a rate
- **Blue Bar** = between graph and table on right column allows you to view one day and time of tides and currents or a select a range of dates
- **Scroll Bar** = bottom of page. Scroll button to date and time you want to view on map or graph or select “play” to view changes based on a rate

Note: Not all areas have good current data



Appendix E: How to enter kelp data into KoboToolbox

For an instructional video, please see:

<https://vimeo.com/user862642/review/334546598/7174906d14>

1. In a web browser (not internet explorer), go to <https://www.kobotoolbox.org>
2. Select 'Sign Up' in the top right corner
3. Under Researchers, Aid Workers & Everyone Else
 - a. Select "Create an account" if you have not set one up (you will need to confirm sign-up in email that will be sent to you), or
 - b. Login, if you have a username and password already set up
4. Email your username to sv.dreamtime@gmail.com (Richard Austin) to receive access to the current year's database
5. Go to the Kelp Data project link for the current year
6. On the homepage select **FORM** at the top of the page, or **Collect Data** in the Quick links tab.

The screenshot shows the KoboToolbox interface for the 'Kelp Data 2019' project. The 'SUMMARY' tab is selected and highlighted with a red box. The 'Collect data' link in the 'Quick Links' section is also highlighted with a red box. The interface displays the following information:

- Project Details:** Project country: United States; Sector: Environment.
- Submissions:** A bar chart showing 2 submissions on July 4, 2019, and 0 submissions from July 3, 2019, to June 27, 2019. The total number of submissions is 2.
- Quick Links:** Collect data, Preview form, Reports, Table, Gallery, Downloads, Map.
- Team members:** R, D, K, B.

7. Under collect data, select Online-Offline (multiple submissions) – open

The screenshot shows the 'Collect data' dialog box in KoboToolbox. The 'Online-Offline (multiple submission)' option is selected in the dropdown menu. The 'OPEN' button is highlighted with a red box. Below the dropdown menu, there is a text box that reads: "This allows online and offline submissions and is the best option for collecting data in the field."

8. Enter Pre-Survey and Survey information (fields may vary from that shown below)

The screenshot shows the KoBoToolbox interface for a form titled "Kelp Data 2019". The form is divided into a "Pre-Survey" section. The fields are as follows:





Name of Surveyors	
Location	Survey Date yyyy-mm-dd
County <input type="radio"/> Clallam <input type="radio"/> Island <input type="radio"/> Jefferson <input type="radio"/> San Juan <input type="radio"/> Skagit <input type="radio"/> Snohomish <input type="radio"/> Whatcom	
Weather <input type="radio"/> Clear <input type="radio"/> Clouds <input type="radio"/> Heavy rain <input type="radio"/> Light rain <input type="radio"/> Fog/mist <input type="radio"/> Other	
Tidal height (ft): Start	Tide Station
Current (knots)	Station/source
Name of GPS unit or phone app	Accuracy of GPS (ft) <i>Leave blank if N/A or unknown</i>

9. The orange symbol in the top left corner allows for you to load and save offline forms in the queue, or to prepare multiple submissions.



Appendix E

10. Upload photos, data sheet, and gpx files. If you have additional volunteer photos, select Add volunteer photos 'OK'. The datasheet can be uploaded as an image or pdf file. There is capacity for two GPX files to be uploaded.

▼ Photos

To beach photo Click here to upload file. (< 10MB)	
To water photo Click here to upload file. (< 10MB)	
Beach to the left photo Click here to upload file. (< 10MB)	
Beach to the right photo Click here to upload file. (< 10MB)	
Add volunteer photos <input type="radio"/> OK	

▼ Data Sheets & GPX Files


Data Sheet Format <input type="radio"/> Image <input type="radio"/> PDF	
Track data file <i>.gpx suffix</i> Click here to upload file. (< 10MB)	
Second data file <i>.gpx suffix</i> Click here to upload file. (< 10MB)	
Second file description	

11. If you have additional water quality data, additional water temperatures, bed depths, etc. Those can be uploaded as additional Spreadsheet data in .csv file format.


▼ **Spreadsheet Data**

Useful for uploading sets of custom data, such as a series of temperatures and depths

Spreadsheet1 data description

Spreadsheet data file 1
.csv suffix
Click here to upload file. (< 10MB) 

Spreadsheet2 data description

Spreadsheet data file 2
.csv suffix
Click here to upload file. (< 10MB) 

12. The final option is to add perimeter data in the form of kml text file. This allows you to plot the GPS track in a map and calculate area. This is not required!

▼ **Perimeter Data**

Add perimeter data
Requires data in KML format

OK

13. Next you save, either as a draft to come back to later, or to submit. You will be prompted to log in again to verify identity and complete the submission.

Appendix F: Optional Zooplankton Sampling Methods*

This component is included for those who aim to document zooplankton-kelp associations. Zooplankton monitoring is a regional priority as identified by the Puget Sound Ecosystem Monitoring Program, Salish Sea Survival Project, and others. Kelp surveyors can participate in the growing effort to track community assemblages of zooplankton in Puget Sound.

* Priority taxa for zooplankton-kelp surveys should be specified ahead of time by the MRC. A comprehensive zooplankton survey protocol and zooplankton ID card are available (see appendices F and G).

Plankton nets can be constructed with simple materials to reduce expense. Cut 2 inch PVC pipe into 25cm segments, and cut 200 μ m Nitex bolting cloth into 3.5 inch diameter circles. Pinch the Nitex circle between two segments of PVC pipe, and secure with a coupler (Figure 4).

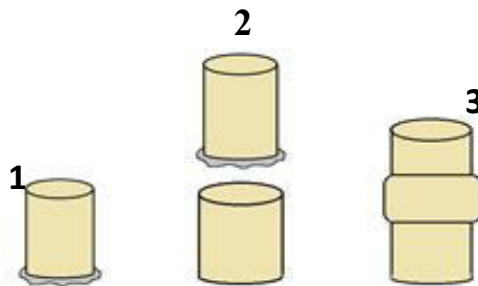


Figure 4. Plankton net construction.

Before collecting a sample, rinse out a small bucket or graduated cylinder three times with water at the collection site. Collect 500mL of surface water (within the top 0.5m or 1.6ft) from the center of the kelp bed (pre-measure and mark a fill line, or use a graduated cylinder) and pour through the plankton net (Figure 5). When finished, remove the Nitex circle containing the sample, making sure to only touch the edges. Store the sample in a labeled Falcon tube pre-filled with ethanol. Repeat the process 15 meters away from the offshore edge of the bed.

Identify taxa under a microscope, or refrigerate samples for later comparison of plankton communities inside and outside of surveyed kelp beds.

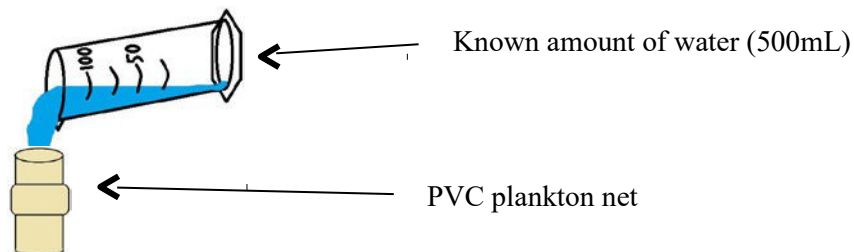


Figure 5. Zooplankton sample collection