

Jefferson County Marine Resources Committee 2023 Bull Kelp Monitoring Project Summary Report

Project Overview

Bull kelp (*Nereocystis luetkeana*) is a large brown algae that is native to Washington's Outer Coast, Straits of Juan de Fuca, and Puget Sound. It often grows in dense "forests" in the rocky intertidal and subtidal zones and provides vital habitat and food to a variety of species, including forage fish, salmon, and rockfish. Concerns of decline in parts of southern and central Puget Sound have compelled efforts to assess kelp abundance and distribution statewide to better inform protection, stewardship and restoration plans. The Jefferson MRC continues to collect data for the Northwest Straits Commission's (NWSC) regional bull kelp monitoring project, with 2023 marking its eighth year of monitoring (since July 2016). This data helps to inform regional kelp planning and conservation efforts. The MRC also conducted a drone survey of the east bed at North Beach simultaneously with a paddle-based survey, to develop a basic citizen science drone-based survey, and conducted a linear extent survey of much of the northern areas of East Jefferson County to document bull kelp in areas where there are data gaps.

Project Lead: Solenne Walker

Subcommittee Members: Brenda Johnson, Betsy Carlson, Bryan DeCaterina, Nam Siu, Brent Vadopalas, Neil Harrington

Volunteer Participants 2023: Solenne Walker, Declan Westcott, Yewah Lau, Jon Waggoner, Amelia Kalagher, Betsy Carlson, Emily Bishop

October 2022 – September 2023 Bull Kelp Monitoring Project Activities

- January 10 – DNR Floating Kelp Vital Sign Indicator for Washington Workshop 3 attended by Solenne.
- January 19 – NWSC-MRC Kelp Kayak Monitoring Data Review Workshop attended by two MRC members, Solenne and Betsy.
- January 31 – DNR Virtual Kick-Off Workshop for providing background on the Kelp and Eelgrass Health and Conservation Plan and gathering input on values and priorities to help inform the development of a draft prioritization framework, attended by Betsy.
- February 10 – Puget Sound Restoration Fund (PSRF) Overview of Kelp Projects presentation attended by Solenne.
- March 14 – DNR Kelp Forest and Eelgrass Meadow Regional Workshop attended by two MRC members, Solenne and Troy.
- April 20 – MRC Kelp Monitoring Season Kickoff meeting attended by two MRC members, Solenne and Bryan.
- May 16 – NWSC Kelp Monitoring Discussion regarding North Beach attended by Solenne and Emily.

May 15 – Kelp project lead Solenne received a site-specific animation of currents near "North Beach" from Tarang Khangaonkar, Ph.D, Director [Salish Sea Modeling Center](#), University of Washington, Tacoma, Center for Urban Waters.

June 17 – The MRC attempted its first survey of the season with five volunteers (Solenne, Declan, Emily, Amelia and Jon) having to cancel the survey on site. The wind conditions were unfavorable and would have made it unsafe to paddle and conduct the survey.

July 15 – The MRC conducted its first survey of the season with one MRC member (Solenne), three community volunteers (Declan, Yewah, Jon) and the MRC Coordinator. A drone survey was also conducted simultaneously with photographer John Gussman to develop a basic protocol for drone surveying kelp beds with citizen science volunteers.

July 18 – The MRC conducted a Linear Extent Survey (LES) with two MRC members, Solenne and Betsy, an MRC intern (Amelia), and the MRC Coordinator. This was the first LES of bull kelp across East Jefferson County, covering Beckett Point to Point Wilson, the north and east sides of Marrowstone Island, and through the Port Townsend Ship Canal. The MRC partnered with Stewart Pugh, who lent his 35-foot vessel, Patience (see LES notes below).

August 12 – The MRC conducted its second survey of the season with the help of one MRC member (Solenne), two community volunteers (Declan and Yewah) and the MRC Coordinator.

August-September – Process GPX data files, compile data sheets and upload data and documents to KoboToolbox, draft project summary report, pack away field gear and organize photos.

A total of 91 volunteer hours were contributed by MRC members and community volunteers to the bull kelp monitoring project at North Beach in the Oct 2022 – Sept 2023 grant year.

General Observations 2022-2023

The North Beach east bull kelp bed was paddle-based surveyed twice this year (July and August). The June survey was cancelled due to adverse weather conditions. Concurrent with the July paddle-based survey, a drone survey was conducted by John Gussman, photographer (see Drone survey notes). Some key takeaways in 2023:

- North Beach kelp bed appears somewhat smaller in size with less density
- Extensive underwater kelp was observed, particularly in drone photos
- Other bull kelp beds nearby appear to be robust in size and density

Shifts in Shape and Density

The Jefferson MRC kelp team has noted that the bed continues to shift in shape and density, particularly since 2020. The MRC had similar observations in the past two years, with the densest areas of the bed growing offshore at the northwest edges of the bed and along the shoreline. The kelp bed grew and expanded in July and August, yet there persists a central

area “gap” with isolated bulbs scattered across the “gap”. Since patchy kelp beds extend beyond both the east and west North Beach boundaries surveyed, it is challenging to survey a definitive kelp bed boundary, particularly towards the northeast and east edges. Observations of the seafloor indicate a distinct sandy patch now exists within the bed, potentially increasing in size over the past several years. Erosion of the feeder bluffs at North Beach may be increasing with higher sea levels and storm surges depositing more sand into the nearshore environment. From drone photos, it is evident there is extensive understory kelp beneath the floating kelp bed surveyed.

Annual comparisons indicate that the kelp bed size is somewhat smaller and less dense with a distinct central area “gap”. However, bull kelp has a high interannual variation (up to 30%) and some changes in the bed footprint may also be due to the density threshold used to determine bed extent. Based on Puget Sound Restoration Fund (PSRF) data, North Beach is one of the most diverse kelp beds monitored in the region, when understory kelp is included. According to Helen Berry, Department of Natural Resources (DNR) Kelp Ecologist, North Beach kelp exists within a relatively stable sub-basin of Puget Sound and bull kelp may be a primary colonizing species that establishes the habitat and diversity for successional species, such as understory kelp. Since 30% of Puget Sound shorelines have understory kelp and 10% of Puget Sound shorelines have floating kelp, it may become equally important to assess the presence of understory kelp, as it is to assess the variable, annual floating kelp canopy along the shorelines. In 2024-2025, PSRF and DNR plan to install a scientific monitoring buoy at North Beach to collect water quality data year-round.

Results and Data Sheets

Field data sheets are submitted electronically to NWSC via KoboToolbox, copies of which are included at the end of this report along with photos from the monitoring season. An Addendum (pp. 29-34) to this report provides tips and recommendations for future kelp bed tracking by five different floating kelp canopy survey methods, as well as other potential bull kelp bed areas of East Jefferson County that can be surveyed by any of these methods in the future.

Figures 1 and 2 show that the North Beach bull kelp bed is variable in area and footprint, with an area decrease between 2016 and 2018 before increasing to 10.2 ha (25.2 acres) in 2021 and decreasing to 7.6 ha (18.78 acres) in 2022. Figure 3. provides a representative image from the Salish Sea Model’s [surface current simulation around North Beach](#) from Dr. Tarang Khangaonkar, Director of the [Salish Sea Modeling Center](#). The currents near North Beach are relatively fast, predicted to reach and exceed 1 meter/second based on the model. Figure 4 shows the LES Track (in purple) and the floating kelp bed areas observed during the survey (in green).

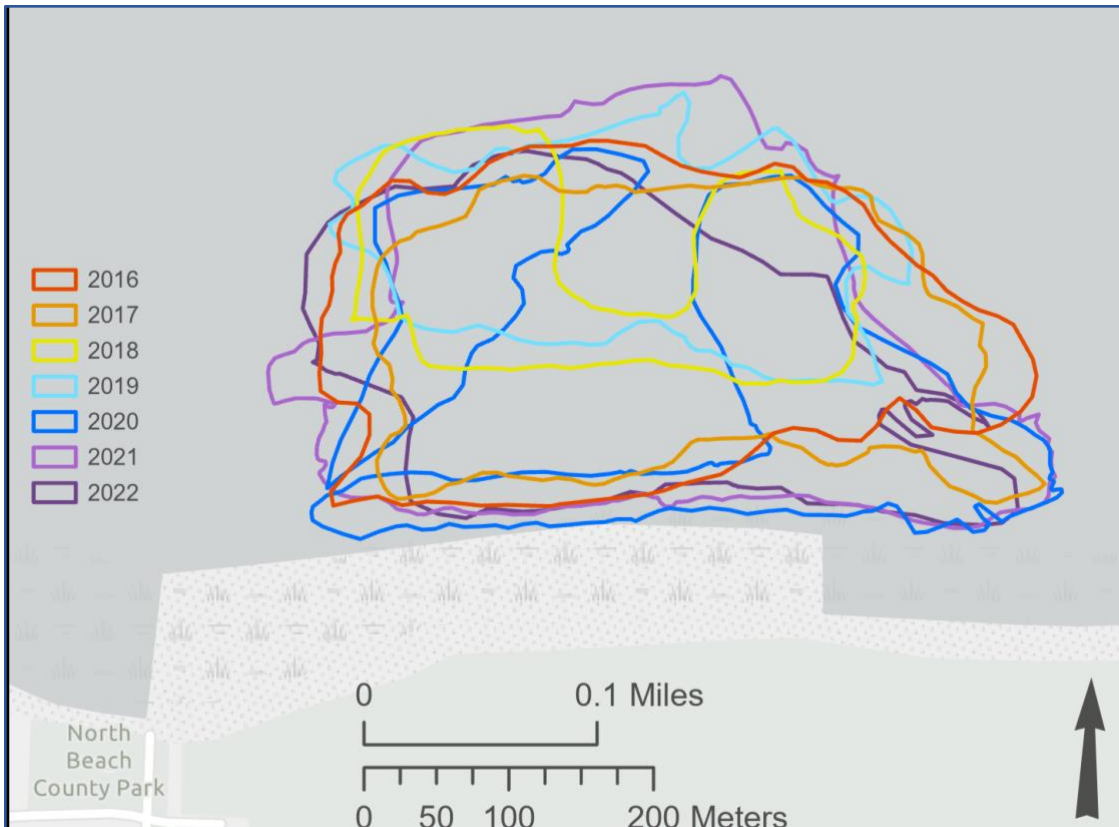


Figure 1. Map showing the maximum extent of the North Beach annual bull kelp bed perimeter as surveyed by the MRC, 2016-2022. Map created by NWSC, Jeff Whitty.

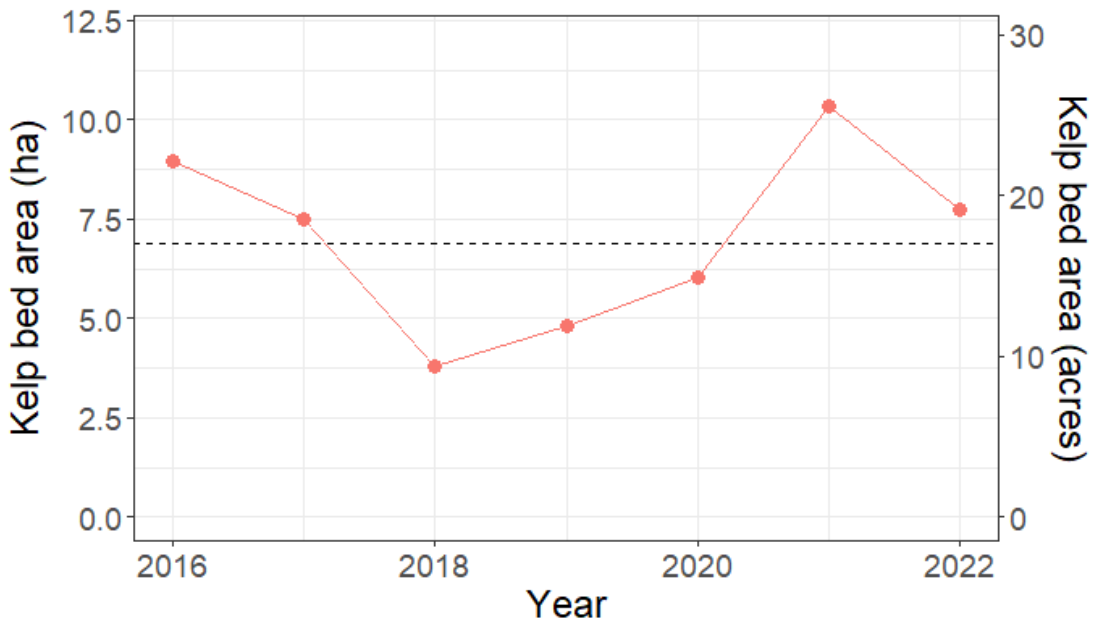


Figure 2. Graph of the maximum bed area per year in hectares and acres (2016-2022) of the North Beach East Bull Kelp Bed monitored by the MRC. The horizontal dashed line shows the long term (2016-2022) mean bed area. Graph created by NWSC, Jeff Whitty.

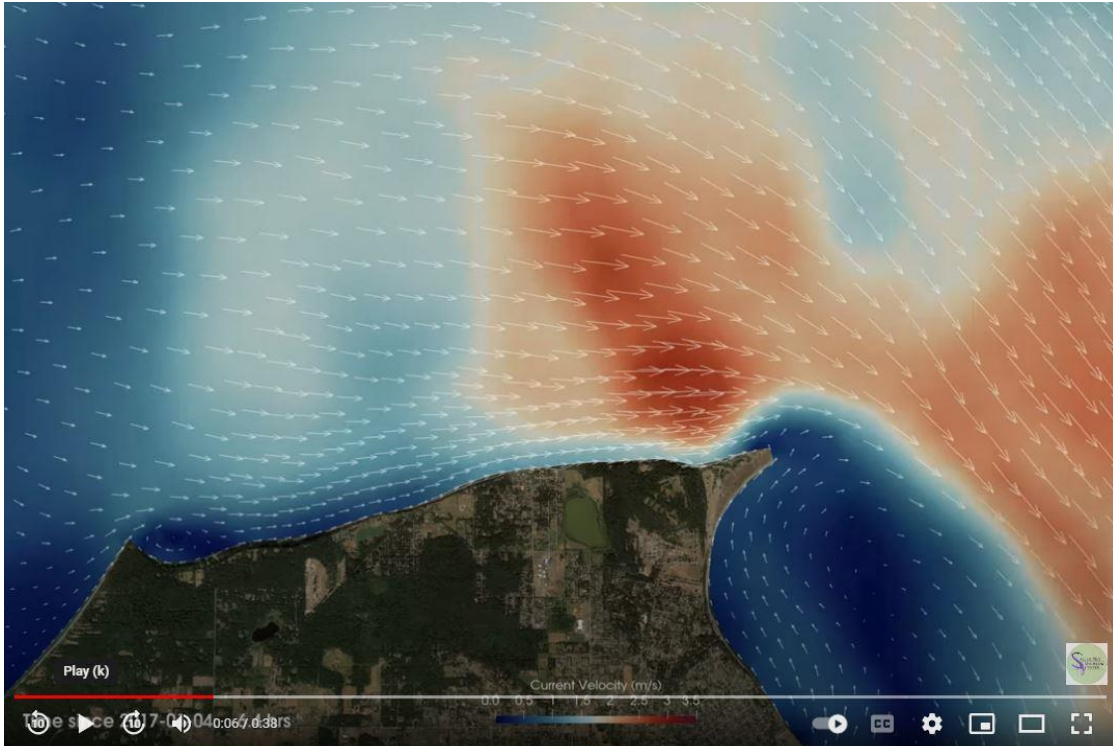


Figure 3. Representative image of the Salish Sea Model surface currents at North Beach.

Monthly Paddle-based Kelp Survey Notes 2023

June: Bull kelp was observed from the shore one week prior to the survey. However, the survey was cancelled. Volunteers met on June 17 to survey, yet 10 mph west winds stirred up waves, making it difficult to see the floating kelp beds and conduct the survey safely.

July: Bull kelp was paddle-based surveyed, and the kelp bed appeared to increase in size from initial June observations. More bulbs had surfaced, yet there were still some bulbs that had not. The overall bed began inside the western boundary towards the east and there was a distinct central area “gap” with patchy areas or individual bulbs across the “gap”. Density of the bed increased towards the northwestern edge and along the shoreline, with “fringing bed” along the shoreline. Bull kelp with sori (reproductive blades) were present. Volunteers observed a few kelp crabs, schools of juvenile fish, a seal, jellyfish, fucus (rockweed), costaria and feather boa along the shoreline. Other kelp beds to the east, closer to the Point Wilson lighthouse appeared to be very dense and much more extensive than the North Beach kelp bed that the MRC monitors.

August: Bull kelp bed extent and density had increased, with the densest growth offshore at the northwest edges of the bed and a central “patchy” area still present. Overall, the kelp bed appeared to be less dense than in previous years, with more distance between individual bulbs located within the central “gap” area of the bed. The deepest extent of the kelp bed was at shallower depths than prior years (@3-5 ft). Understory kelp was present

across much of the floating kelp, except for sandy zones near the central “gap” area. The kelp grew close to the shoreline, yet it co-exists or may be displaced by feather boa and other underwater kelp species. Overall, the kelp bed still takes the shape of a lopsided “dumb bell” with the densest growth on the deep northwest edge and along nearshore portions. Volunteers observed flocks of geese, blue herons, a few kelp crabs, a seal and small schools of juvenile fish. Patchy areas of bull kelp were observed, east and west, beyond the kelp bed that the MRC monitors. Summer 2023 had warm and dry conditions with expectations that the kelp will continue to grow into September.

Note: The Jefferson MRC does not typically survey during September, yet may consider it for future years, especially with drone surveys or boat surveys to qualitatively assess late season growth.

Photos from the Shore and Kelp Paddle-based Surveys – June through August 2023



6/11/2023 Bull kelp bulbs arise one week before the survey planned for June. Photo by Solenne Walker.



6/17/2023 East kelp bed as observed from the beach. Strong winds led the team to cancel the first planned survey. Photo by Solenne Walker.



7/15/2023 First survey with calm seas and blue skies view east (BeR). Photo by Solenne Walker.



7/15/2023 First survey panorama of kelp beds facing south (ToBe). Photo by Yewah Lau.



7/15/2023 First survey at mid-survey slack tide view southwest (BeL). Photo by Yewah Lau.



7/15/2023 First survey with feather boa kelp covered in epiphytic/diatomaceous growth along the nearshore (BeL). Photo by Yewah Lau.



8/12/2023 Second survey with calm seas at west boundary view east (BeR). Photo by Solenne Walker.



8/12/2023 Second survey at east boundary view north (ToWa). Photo by Solenne Walker.

Drone Survey Notes 2023

See drone photos below and the Addendum (pp. 29-34) for drone survey tips.

- MRC's drone survey was designed to develop an initial protocol for citizen science drone monitoring of floating kelp beds in Jefferson County.
- This drone survey is not "survey-grade". The drone was not programmed to fly a specific-grid pattern for continuous, overlapping image representation to be georeferenced into a GIS-based orthomosaic map. This is due to the extended timeframe and costs for a "survey-grade" image.
- The MRC's drone survey was conducted at the same time as the paddle-based survey and was defined by the GPS survey boundaries, kelp bed depths and fixed-terrestrial markers.
- Drone images were taken from varying heights and angles to provide overviews of kelp bed shape, size and density, as well as presence of understory kelp and other shoreline conditions.

Drone images are useful for photo-documenting overall kelp bed shape, size and density. Taken at varying heights, drone images can illustrate distinct changes in the bed shape, density and size, as well as the presence of understory kelp, seafloor and other shoreline features. There are distinct advantages to conducting a drone survey at the same time of paddle-based surveys, particularly for data comparison purposes. However, each type of survey can be conducted separately for a comparative analysis depending on dates, weather and tides. Drone surveys can cover much larger segments of shoreline than paddle-based surveys within the same timeframe. The optimal drone surveys would be

“survey-grade”, yet a drone survey that collects images in a systematic pattern within a defined area and is repeated annually during similar monthly tides can provide valuable tracking information for specific kelp beds or a series of kelp beds.

Photos from Kelp Drone Survey – July 15, 2023



Paddle-based “starfish” taken at ~30 ft altitude above sea level with Declan, Jonathan, and Solenne on kayaks and Yewah and Monica on paddleboards. Photo by John Gussman.



Volunteers at start of the west boundary of the North Beach bull kelp bed, view west ~275 ft altitude above sea level. Photo by John Gussman.

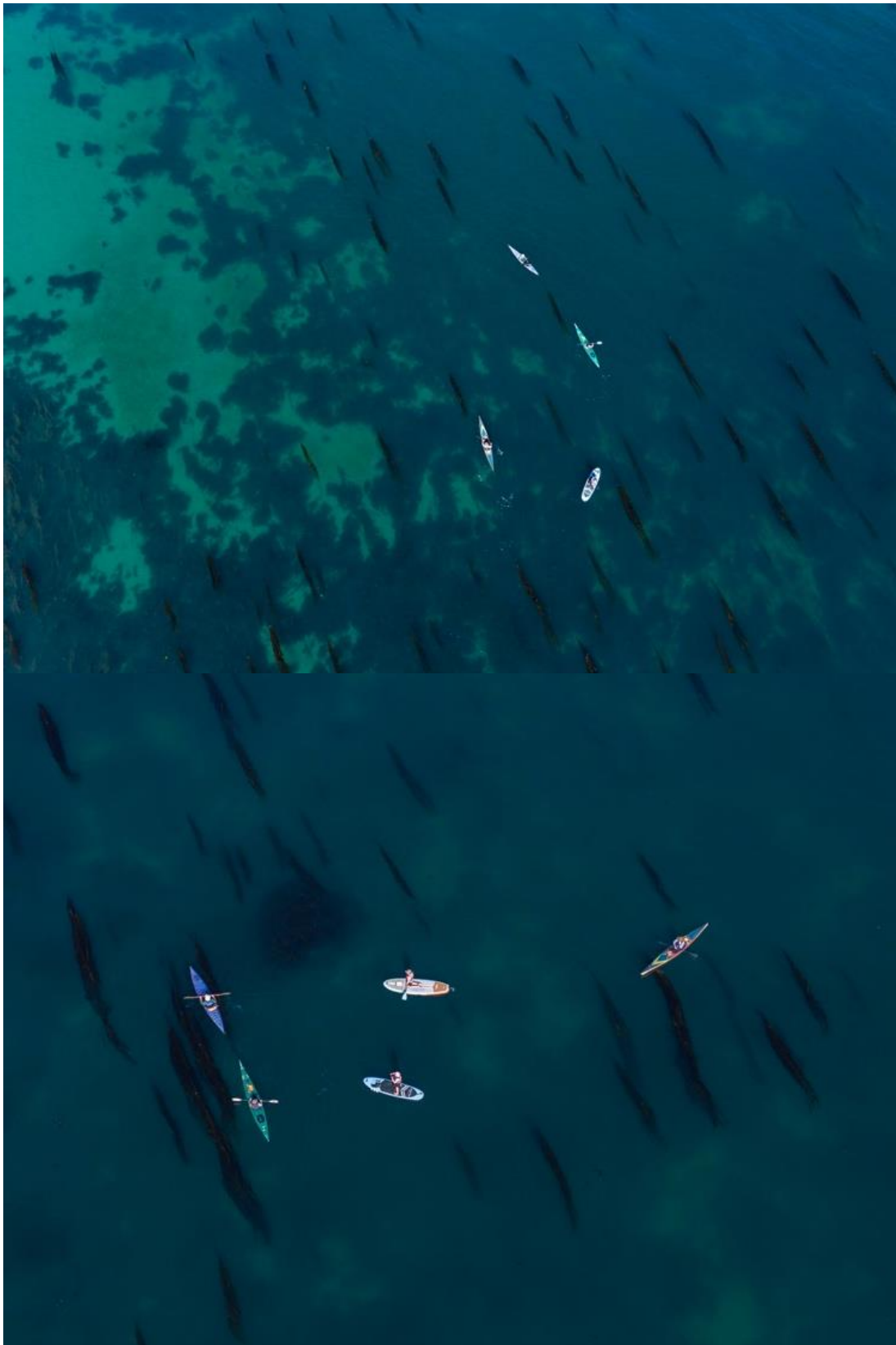


Overviews of the North Beach bull kelp bed taken ~ 275 ft altitude above sea level. Photo by John Gussman.



Overviews of bull kelp and understory kelp ~162 ft altitude above sea level @ 48 8'40" -122 46'40".

Photos by John Gussman.



Overview of bull kelp bed ~ 62-68 ft altitude above sea level @ 48° 8' 40" - 122° 46' 32".

Photos by John Gussman.



*Overviews at eastern boundary ~160 and 215 ft altitude above sea level @48 8'40" -122 46'19".
Photos by John Gussman.*



Photo by John Gussman.

Linear Extent Survey (LES) Notes 2023

See LES photos below and the Addendum (pp. 29-34) for LES tips.

- An initial LES was planned on a 24-ft vessel in June, however adverse weather pushed the survey until July 18th when only a 34-ft vessel was available.
- Volunteers followed the LES protocol provided by NWSC-DNR.
- The first LES was nearly 20 miles in length and took approximately 6-7 hours from:
 - Beckett Point to McCurdy Point
 - McCurdy Point to Point Wilson
 - Marrowstone Point to Kinney Point
 - Port Townsend Ship Canal west-side of the “cut”
- GPX data was provided to the MRC, yet not mapped in GIS due to time and data constraints.

Near-continuous bull kelp beds were observed from Beckett Point to McCurdy Point and from McCurdy Point to Point Wilson, except for a few, short segments where kelp beds were absent. The presence of near-continuous bull kelp beds from Beckett Point to Point Wilson made it difficult to precisely follow survey protocol. Kelp beds can begin and end in transitional patterns which make it difficult to define the overlapping “start and end” points. For areas of near-continuous kelp beds, marking distinct areas of “little to no kelp” first from Beckett Point to Point Wilson would have been more useful. Kelp beds varied from small, fringing shoreline beds to medium and large size beds. The largest, densest kelp

beds were also observed in this area to the north of Cape George, at and around McCurdy Point, and just west of Point Wilson.

Smaller fringing kelp beds were observed at Point Hudson, yet no kelp was observed, or has ever been documented, across the entrance of Port Townsend Bay or within Port Townsend Bay. Fringing kelp beds were observed west of and around Marrowstone Point. Small floating kelp beds were observed approaching Liplip Point, yet little to no floating kelp was observed at Kinney Point, or anywhere along the southern shoreline of Marrowstone Island. Floating kelp beds were observed again along the west side of the Port Townsend Ship Canal.

Due to the size and type of vessel, this survey was not able to navigate closer to areas of fringing shoreline beds to obtain a better visual estimate of bed size and density. In addition, most of the shoreline segments of eastern Marrowstone Island were not closely surveyed to ensure that the 34-foot vessel would not run aground and would also be able to return through Port Townsend Ship Canal before encountering adverse tide and current conditions.

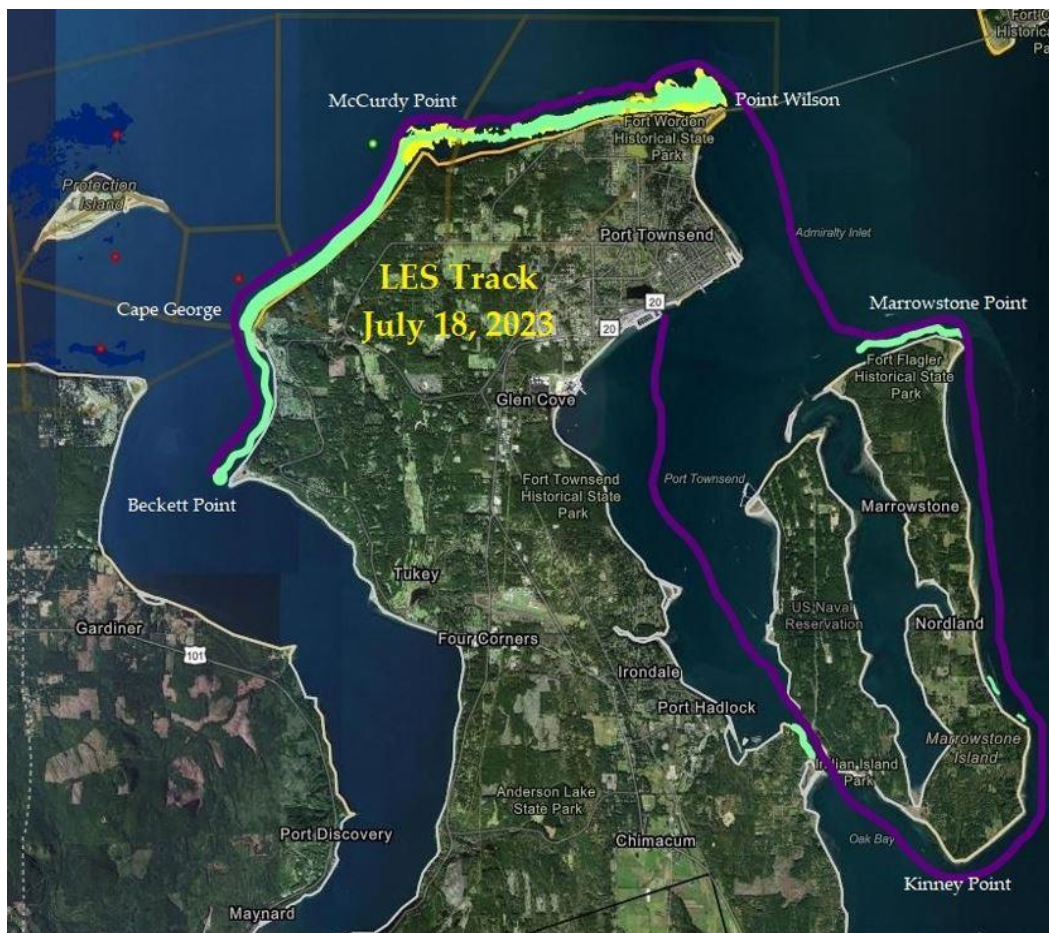


Figure 4. Map showing LES Track (purple) and bull kelp beds (green) observed July 18, 2023.

Photos from the Kelp Linear Extent Survey (LES) - July 18, 2023



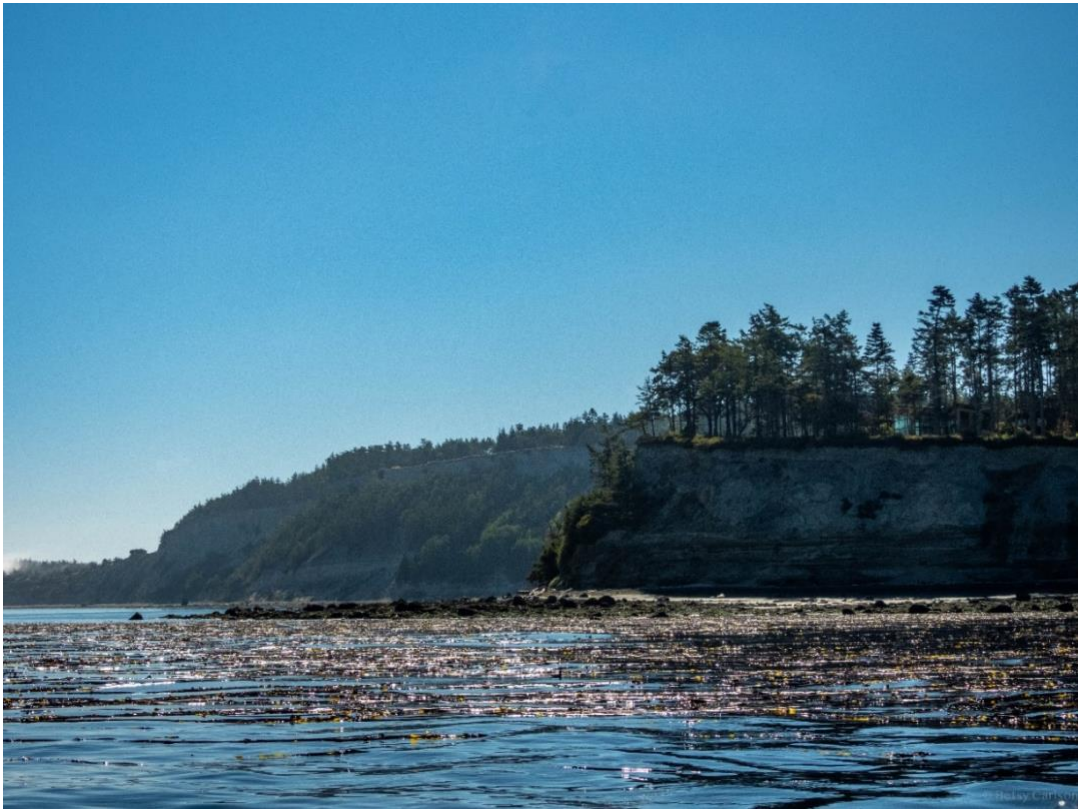
Kelp beds north of Cape George. Photo by Monica Montgomery.



Kelp beds along the shoreline north of Cape George. Photo by Betsy Carlson.



Bull kelp on the northwest side of the Quimper Peninsula. Photo by Betsy Carlson.



Extensive bull kelp beds at McCurdy Point. Photo by Betsy Carlson.



Kelp beds along shoreline east of McCurdy Point. Photo by Monica Montgomery.



Kelp beds along shoreline east of McCurdy Point. Photo by Monica Montgomery.



Extensive kelp beds at Fort Worden State Park east of North Beach. Photo by Betsy Carlson.



Extensive kelp beds east of North Beach approaching Point Wilson. Photo by Betsy Carlson.



Kelp beds to the west of Point Wilson lighthouse. Photo by Betsy Carlson.



Kelp beds to the west of Point Wilson lighthouse. Photo by Monica Montgomery.



No floating kelp was observed at Kinney Point State Park, or along the south end of Marrowstone Island. Photo by Monica Montgomery.



Kelp beds observed on west side of Port Townsend Ship Canal. Photo by Monica Montgomery.



Betsy guiding the boat captain, Stewart, around the bull kelp beds. Photo by Monica Montgomery.



Solenne, Betsy and Amelia conducting the MRC's first LES for bull kelp. Photo by Monica Montgomery.

Field Data Sheets – July and August 2023



Bull Kelp Data Sheets (on shore)

Pre-Survey Section (on the beach)

Trip Leader: Solenne Walker Date: July 15, 2023
 Name of surveyors: Monica Montgomery, Declan Westcott, Yewah Lau, JON Waggoner
 Location (Shoreline Segment): North Beach (east), Port Townsend
 Name of GPS unit or phone app: Garmin G4 SX Accuracy of GPS: +/- ft 10
 Weather conditions (circle one)
Clear Sun Haze Clouds Fog/mist Light rain Heavy rain

Tide height (ft): At Start -1.06 at 0915 Tide station: Port Townsend

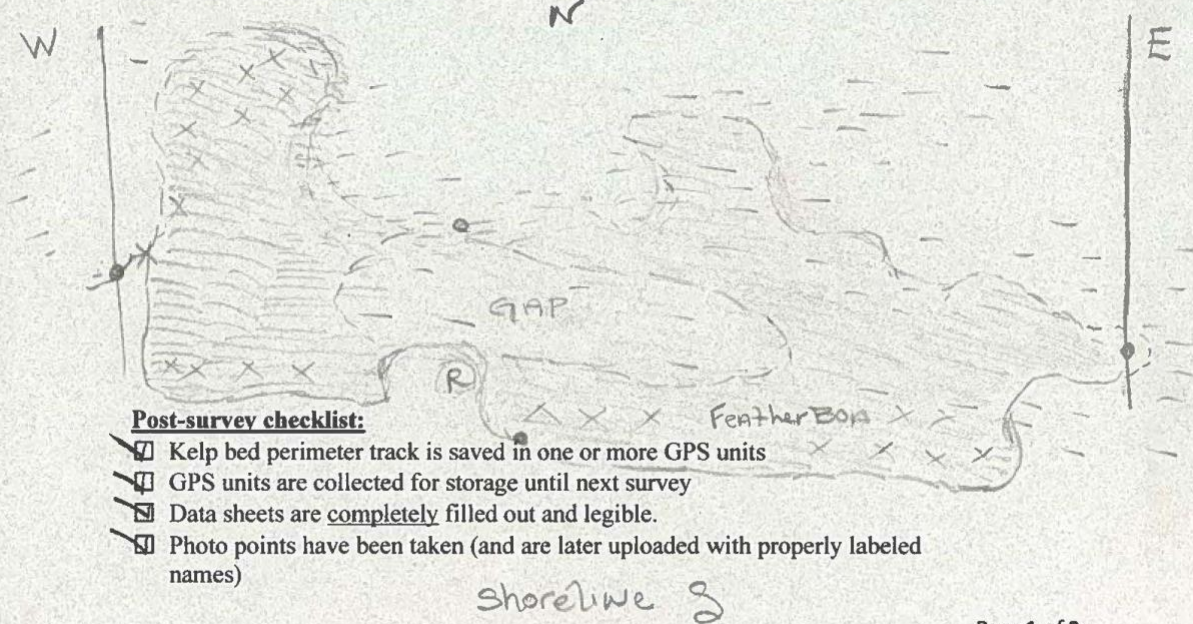
Current (knots): 2 Knots ESE Station/source: Deep Zoom
Slack @ 1030 + (Δ's direction)

* Survey condition notes (wind/wave condition, current behavior, sparse kelp outside of perimeter?):
 • Winds - W-NW 6-10 mph
 • Temp - 60-65° am; 75 in afternoons
 • Waning-Crescent Moon

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 sketch of area surveyed, ~ location of kelp bed boundary lines and 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)

shoreline 3

7/15/2023



Northwest Straits INITIATIVE

Bull Kelp Survey Data Sheet (on the water)

Kelp Bed Number or Name NORTH BEACH Survey Start Time 7:10

Survey Endpoints: 1 = first recorded survey endpoint, 2 = second recorded survey endpoint
Survey Endpoint 1 GPS point name: _____ Survey Endpoint 2 GPS point name: _____

GPS point at Start of Paddle: _____ GPS point at End of Paddle @ bed: _____

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

GPS Point: 2 Time: 9:23 Depth: 11.5 Temp at Surface: 7.6 Temp at Depth: 11.4^{find bottom right above}

DO(mg/L): 7.9 DO(%): 86 Sal(ppt): 30.7 TDS(mg/L): 30700

GPS Point: 3 Time: 9:44 Depth: 13.5 Temp at Surface: 11.5 Temp at Depth: 11.4

DO(mg/L): 7.8 DO(%): 86 Sal(ppt): 30.7 TDS(mg/L): 30800

GPS Point: 4 Time: 10:00 Depth: 10'11" Temp at Surface: 11.5 Temp at Depth: 11.4

DO(mg/L): 7.7 DO(%): 86 Sal(ppt): 30.8 TDS(mg/L): 30800

GPS Point: 5 Time: 10:17 Depth: 2'8" Temp at Surface: 12.1 Temp at Depth: 12.0

DO(mg/L): 10.4 DO(%): 117 Sal(ppt): 30.8 TDS(mg/L): 30800

GPS Point: _____ Time: _____ Depth: _____ Temp at Surface: _____ Temp at Depth: _____

DO(mg/L): _____ DO(%): _____ Sal(ppt): _____ TDS(mg/L): _____

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

- BeR ToBE BeL ToWa Volunteers/Other photos

Observations (consider bed density, animals, health of blades, understory kelp, human impacts, activity, etc.):

- eelgrass, ^{4-5" length} school of fish, fucus, jelly, seal, feather boa along shore ^{3 kelp}
- bed patchy (evenly distr. bulbs) w/ denser outer edge (toward water), in center and closer to shore; large gap after #2 and tapers into shore ^{right facing beach}
- sori on blades
- dense feather boa & kelp along shore: dense but blades "stunted"? ^{patomaceous growth?} #34

Survey End time: (time of last measurement or observation before returning to shore): 10:45 #35



Measuring clusters: 28

Pre-Survey Section (on the beach)

Trip Leader: Solenne Walker Date: 8/12/2023
 Name of surveyors: Monica Montgomery, Dedan Westcott, Yewah Lau
 Location (Shoreline Segment): North Beach - East
 Name of GPS unit or phone app: Garmin 645x Accuracy of GPS: +/- ft 10 ft

Weather conditions (circle one)

Clear Sun Haze light Clouds Fog/mist Light rain Heavy rain

Tide height (ft): At Start -0.75 @ 0812 Tide station: Port Townsend
 (NOAA)
 Current (knots): 2.5 knots Station/source: Deep Zoom - Pt. Wilson
slack at 0940

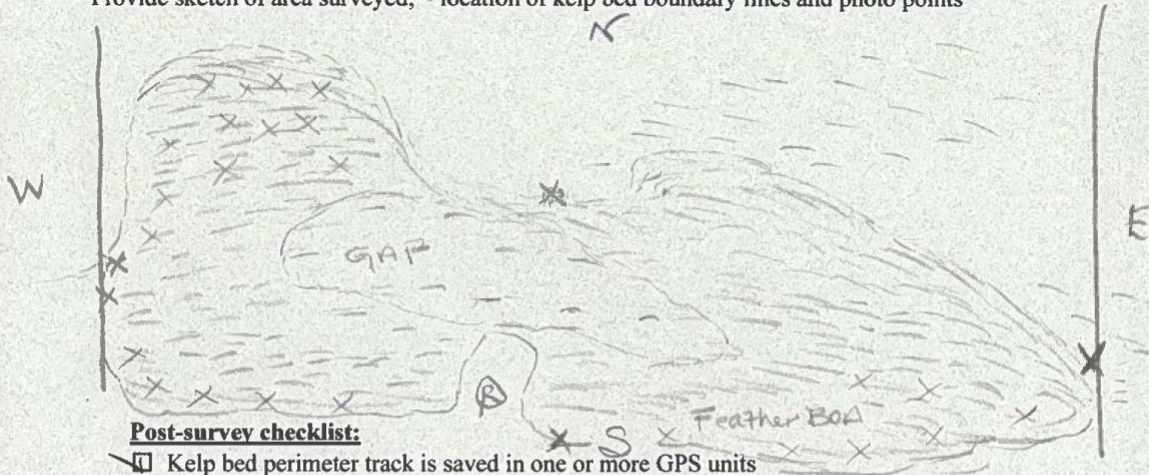
Survey condition notes (wind/wave condition, current behavior, sparse kelp outside of perimeter?):

Temp - 26.5°
Wind - WNW 7-8 mph
Waning Crescent Moon (New Moon 8/16)

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 sketch of area surveyed, ~ location of kelp bed boundary lines and 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)

9/12/202



Northwest Straits INITIATIVE

Bull Kelp Survey Data Sheet (on the water)

Kelp Bed Number or Name North Beach East Survey Start Time 830

Survey Endpoints: 1 = first recorded survey endpoint, 2 = second recorded survey endpoint
Survey Endpoint 1 GPS point name: _____ Survey Endpoint 2 GPS point name: _____

GPS point at Start of Paddle: _____ GPS point at End of Paddle @ bed: 125

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

GPS Point: 118 Time: 850 Depth: 13' 10" Temp at Surface: 11.8 Temp at Depth: X

DO(mg/L): 8.25 DO(%): 90.6 Sal(ppt): 31 TDS(mg/L): 30900

GPS Point: 119 Time: 905 Depth: 22' 6" Temp at Surface: 11.8 Temp at Depth: 11.5

DO(mg/L): 8.2 DO(%): 90.3 Sal(ppt): 31 TDS(mg/L): 31060

GPS Point: 121 Time: 917 Depth: 14' 2" Temp at Surface: 11.8 Temp at Depth: 11.7

DO(mg/L): 8.6 DO(%): 95 Sal(ppt): 31.1 TDS(mg/L): 31100

GPS Point: 123 Time: 930 Depth: 4' 2" Temp at Surface: 12.3 Temp at Depth: 12.2

DO(mg/L): 8.22 DO(%): 93.6 Sal(ppt): 31 TDS(mg/L): 30970

GPS Point: 124 Time: 10 Depth: 5' 8" Temp at Surface: 12.5 Temp at Depth: 12.4

DO(mg/L): 8.81 DO(%): 100.5 Sal(ppt): 30.9 TDS(mg/L): 30080

Western boundary

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

- BeR ToBE BeL ToWa Volunteers/Other photos

Observations (consider bed density, animals, health of blades, understory kelp, human impacts, activity, etc.):

strong currents!

2 kelp crab; silty along shore; lots of growth on kelp along shore; "stunted" feather beds covered in growth along shore; 1 seal, 2 blue heron & 3 dozen geese flying overhead; Gap at center of bed; Healthier looking kelp furthest from shore

Survey End time: (time of last measurement or observation before returning to shore): 1005

YSI (Water Quality) Data Collected

Survey 1: Saturday, July 15, 2023

Waypoint #	Waypoint Coordinates		Depth (ft)	Surface temp (°C)	DO (mg/L)	DO (%)	Salinity (ppt)	TDS (mg/L)
1	-122.78063	48.14414	11.5	11.5	7.9	86	30.7	30700
2	-122.77625	48.14462	13.5	11.5	7.8	86	30.7	30800
3	-122.77304	48.14419	10.9	11.5	7.7	86	30.8	30800
4	-122.77617	48.14391	2.75	12.1	10.4	117	30.8	30800

Survey 2: Saturday, August 12, 2023

Waypoint #	Waypoint Coordinates		Depth (ft)	Surface temp (°C)	DO (mg/L)	DO (%)	Salinity (ppt)	TDS (mg/L)
1	- 122.78055	48.14424	13.8	11.8	8.25	90.6	31.0	30900
2	- 122.77759	48.14527	22.5	11.8	8.20	90.3	31.0	31060
3	- 122.77338	48.14449	14.2	11.8	8.6	95.0	31.1	31100
4	- 122.77599	48.14389	4.2	12.3	8.2	93.6	31.0	30910
5 – west boundary	- 122.78065	48.14360	5.75	12.5	8.81	100.5	30.9	30880

Key:

DO = Dissolved Oxygen

TDS = Total Dissolved Solids (Turbidity)

C = Centigrade

mg/L = milligrams/Liter

ppt = part per thousand

**ADDENDUM – BULL KELP SURVEY METHODS and
BULL KELP AREAS TO SURVEY in EAST JEFFERSON COUNTY**

Tips and recommendations for future kelp bed tracking
Project Summary Kelp 2023

PADDLE-BASED SURVEYS – *on the water, resolution 1-10 meters*

Annual field-based surveys conducted during the summer season via kayak or paddleboards directly connects volunteers to the seasonal growth of the floating kelp beds. These surveys are conducted monthly from June to August (September is a bonus month) at low tides (<0 MLLW) during slack tide, calm seas and little to no winds. Morning surveys (0800-1100) ensure less wind and more optimal conditions.

- Volunteers – 3 to 4 volunteers minimum for each monthly survey
- Approximately 3-4 hours for the field survey, only.
- Garmin 64sx skills to conduct perimeter survey to determine kelp bed size
- Garmin Basecamp skills to transfer, edit and process data
- Field Data Sheets to process and upload to Kobo Toolbox.
- YSI instrument calibration prior to each survey for field data collection
- Manage, clean and track all field gear
- Assist with Project Summary report on an annual basis

DRONE (UAV) SURVEYS – *from the shore; resolution 1-10 meters*

Skilled drone pilots with a license can conduct bull kelp surveys without getting wet! Drone surveys are best conducted within the same timeframe and field protocol as paddle-based surveys (i.e., << 0 MLLW, calm seas, slack tides, little to no winds). The best drone surveys are designed to be repeated on an annual basis and include survey boundaries defined by GPS coordinates and/or fixed terrestrial markers. Drone surveys can cover larger areas of bull kelp along the shoreline than paddle-based surveys, in the same amount of time. They can also help to assess the presence and extent of understory kelp, which is challenging to assess from paddle-based surveys, which are more focused on defining the floating kelp canopy.

Drone photos are a particularly useful tool for tracking kelp bed shape, size and density. Drone surveys conducted at the same time of paddle-based surveys can be very useful for providing a comparative analysis of kelp bed shape, density and size. However, unless the drone pilot programs the drone to fly a specific grid-pattern to collect overlapping images to create a geo-referenced, orthomosaic map in GIS (i.e., survey-grade), drone surveys may not be the best tool to precisely determine kelp bed size, depending on the data collected. See Figure 5 for an example of a survey-grade drone image.

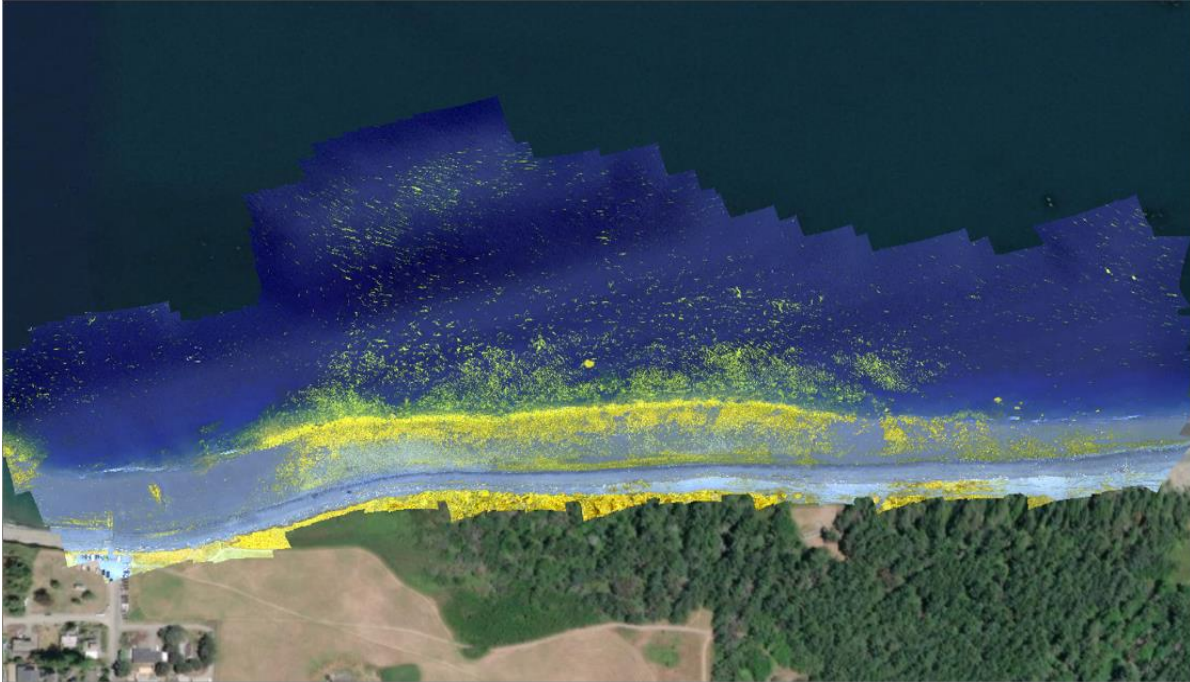


Figure 5. Example of a “survey-grade” drone image of North Beach bed (Phantom 4 Multispectral) by Tyler Cowdry, DNR on August 24, 2021. Bull kelp stripes are more visible than kelp blades.

Drone Survey Tips:

Type of Drone – There many good drone brands; these are the drone types used by DNR and local professional photographers/videographers:

- Drone photos/video: DJI Air 2 or Air 3 (yet, need smartphone for visuals) or DJI Mavic 3 Pro (controller with built-in screen)
- Survey-grade aerial mapping: DJI Mavic 3 Classic or Phantom 4 Multispectral
- Small drone: to stay under 250 g weight limit, with no need to register: DJI Mini 3 Pro (249 g; yet, won't work for survey grade)

Select new kelp bed(s) to survey - The following tools can help identify areas of floating kelp:

- [Washington Floating Kelp Indicator](#) (DNR) new interactive map to view kelp monitoring locations, trends and subbasin boundaries
- [Marine Vegetation Atlas](#) (DNR) next most informative on kelp, eelgrass and macroalgae. Presence/absence/extent with details in Attribute Table with reports/data to download
- [Coastal Atlas](#) (Ecology) general overview of kelp and eelgrass presence/absence and continuous/patchy. Great for aerial shoreline photos info, plus determining drift cells

Prep and Post-field Review

- Select kelp bed(s) and pre-determine boundary lines to survey within with GPS coordinates and/or fixed terrestrial markers
- Volunteers - Need 1-2 volunteers minimum to survey kelp beds
- Volunteers may spend 2-4 hrs. in field, depending on size of area selected to survey
- Photos need downloading, processing and review

Basic Field Protocol

- Take oblique angle overviews of kelp from 4 cardinal directions at high altitude (200-275 ft)
- Take downward overviews from 4 cardinal direction boundaries at high altitude (200-275 ft)
- Systematically photograph each ¼ area (NW, NE, SW, SE) of kelp bed from a mid-range altitude (60-100 ft) in a clockwise direction. Start at the same 1/4 location each year
- Photograph unique or defining features within each ¼ section of the kelp bed
- Systematically photograph kelp along the shoreline from mid-range altitude (60-100 ft)
- Document date, time, weather, tides, currents, wind speed and direction.

FIXED-WING AERIALS – *on an airplane, resolution centimeters to meters*

The Jefferson MRC has not conducted any aerial photo images from an airplane to date. Future potential exists for volunteer pilots to obtain floating kelp canopy aerial images. Aerial image surveys have been conducted by DNR for nearly 30 years along the north shore of Jefferson County along the Straits of Juan de Fuca, only. Aerial surveys have not been conducted south into Discovery Bay or Port Townsend Bay, or south of Point Wilson or Marrowstone Island. In August 2021, Island County MRC pilot Greg Ridder, in coordination with DNR, flew along the north shore from Point Wilson to McCurdy Point (including North Beach) to collect aerial images for comparison to other types of kelp surveys. See example of a fixed-wing aerial image North Beach in Figure 6.



Figure 6. Example of a fixed-wing aerial image of North Beach kelp bed by Greg Ridder/DNR on August 24, 2021. Near-infrared photography shows the blades more than stipes.

LINEAR EXTENT SURVEY (LES) – on a boat, a qualitative assessment along shorelines

A Linear Extent Survey (LES) is a bull kelp survey method conducted from motorized boats. LES take place during the same type of tide, current, time of year targets as paddle-based and drone surveys. The LES is conducted from a vessel navigating between depths of -6.5 ft to -20 ft MLLW. When floating kelp beds are present a GPS mark is made to track the beginning and the end of the kelp beds. The vessel must attempt to stay 3-10 ft waterward of the deepest kelp plants and slow down to ~2 knots in speed when bull kelp is present. Since the vessel is constantly moving, it is important to GPS mark the beginning and end of the kelp bed accurately, or the data can be off by one hundred of feet, thereby mapping kelp beds where none exist.

LES Survey Tips:

- Optimal vessel size is 18 to 24 ft, or smaller, especially when surveying fringing kelp beds. Smaller vessels tend to be more maneuverable to track the variable outer edges of the kelp bed and can navigate closer to fringing kelp beds that occur closer to the shoreline.
- A depth finder is needed to ensure navigation occurs within -6.5 ft to -20 ft MLLW.
- Surveys should be conducted in small segments, or 4-10 miles, or within a 3-4 hr timeframe.
- Data quality depends on the accuracy of marking the beginning and the end of the beds, so shorter segments in areas of near-continuous beds may ensure data is more precisely collected within a limited range of tides for reliable data that is transferable into a GIS map (i.e., the most time-consuming portion of the process).

SATELLITES – from an office, resolution varies depending on satellite program

Satellite monitoring of floating kelp canopy is a developing science. According to kelp researchers conducting satellite monitoring (DNR, Pete Dowty and Tyler Cowdry), satellite resources and resolutions are a rapidly changing market and expected to improve over the next several years. Future potential to monitor North Beach and other bull kelp beds around Jefferson County with satellite data imagery will depend on volunteers and their time and willingness to assess and track the data. Based on their current experience, DNR states that selecting, tracking and evaluating satellite data imagery for floating kelp is almost a full-time, year-round position.

Satellite imagery is not necessarily a complete substitute for field surveys since kelp bed appearances are directly affected by natural conditions which may obscure the ability to accurately assess kelp beds. Floating kelp canopy appearance is affected by tide height, sun height, currents, cloud cover and wind speed. When using satellite data, one must be sure to note weather and natural conditions which affect kelp appearance.

Satellite Recommendations (to date):

- [Landsat](#) – 30-meter resolution: Bands 9, Repeats 16 days, Free.
 - Landsat does not provide high enough resolution to accurately assess a floating kelp bed size or boundaries. To obtain resolution comparable to the 10 ft field data surveys, fee-based satellite image services below are recommend.
- [SPOT](#) – 10-meter resolution
- [Sentinel 2](#) - 10-meter resolution. Bands 12, Repeats 5 days, Multi-Spectrum, Free.
 - According to Jeff Taylor, MRC “May only get a handful of good images every year; need the right current, no clouds”.
- [Planet Labs](#) (Doves) 3-meter resolution, Bands RGB and IR, Repeats 1 each day, Free in CA.
 - According to Jeff Taylor, MRC “RGB wasn’t too hard, but you had to process the Near Infrared (NIR) image to get images useful for kelp”. Floating kelp reflects NIR, water absorbs NIR.
- [Digital Globe WorldView 3](#) - 1.5-2.0-meter resolution, Bands 28, Repeats “targeted”, pricey.
 - May become available custom with a 0.31-meter resolution.

BULL KELP AREAS TO SURVEY in EAST JEFFERSON COUNTY

In addition to the bull kelp-rich shorelines of the north Quimper Peninsula, the following floating kelp bed areas of East Jefferson County are worthy of future kayak, drone, LES, aerial, or satellite-based surveys. Spot checks may help to stay up-to-date on presence/absence of floating kelp beds around East Jefferson County, yet a more systematically conducted, repeat annual surveys provide the most valuable information.

Kelp beds in East Jefferson County not surveyed by MRC to date

- Colvos and Claus Rocks between Mats Mats Bay and Port Ludlow Bay
- Kelp Sisters rocks just south of the Hood Canal bridge on west side
- Hood Head and Shine
- All areas in Hood Canal south of the Hood Canal bridge
 - Dabob Bay to Quilcene Bay
 - Dungeness River to Triton Cove
- Gardiner, and marine areas south of Protection Island