Marine Plan Partnership for the North Pacific Coast (MaPP)

KELP MONITORING METHODS

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Disclaimers:

The MaPP Partners and contractors or anyone else connected with MaPP, in any way whatsoever, are not responsible for use of the information contained in this document.

Please note that users of this document should review and implement their organizational safety protocols as required prior to conducting monitoring in the field.

The purpose of this document is to:

- support the MaPP Partners to conduct kelp monitoring training, field work and data collection
- provide guidance and examples for other organizations or practitioners wishing to conduct kelp monitoring

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CANOPY KELP MONITORING OVERVIEW

Canopy kelp monitoring requires a blend of Tier 1 (p.4) and Tier 2 (p.5) survey methods and supporting environmental and biological data, depending on your question of interest:

- Tier 1 methods can be used to map multiple kelp beds across a larger area. They are designed for the first field season of surveying to efficiently collect baseline information (kelp location and extent) over large coastal areas. Observations from Tier 1 surveys build local ecological knowledge and provide the information required to map and select ecologically important kelp beds for subsequent Tier 2 surveys. Tier 1 surveys can also be used to ground-truth Satellite data.
- Tier 2 methods collect detailed observations from preselected kelp beds, including measures of spatial coverage and kelp density, kelp health (bryozoan cover), and high-resolution drone images.
- Where time allows, Tier 1/Tier 2 methods can be paired with additional measurements of environmental conditions and observations of kelp associated species (see Figure 1 below).

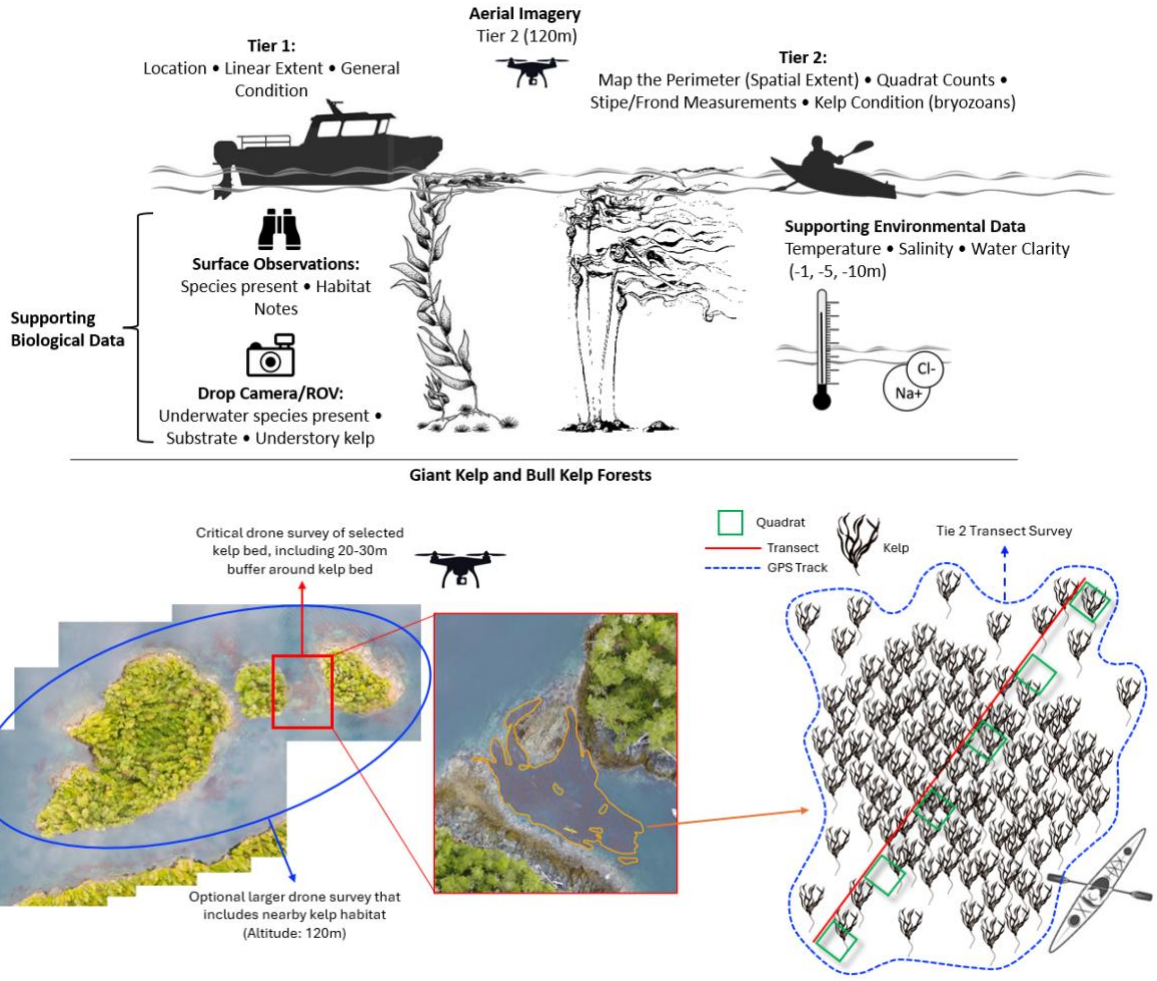


Figure 1: Surface view (top) and aerial view (bottom) examples of Tier 1 and 2 canopy kelp surveys

TIER 1 KELP MONITORING METHODS

Tier 1 Step 1: Kelp reference information

- Location mapping using Tier 1 methods should target the seasonal timing of peak biomass for kelp (June to August, depending on your location) and be completed at tides below 2.5m.
- Kelp bed definition guidelines:
  - A cluster of bull kelp or giant kelp spanning ~3 metres or more in any direction.
  - Gaps greater than 10 metres between plants separate individual kelp clusters / beds.
- Use a data collection app (e.g.: Avenza, Device Magic, Coast Tracker) or the datasheet to record reference information:
  - Date, Time, and Tide.
  - Kelp species (bull kelp, giant kelp, or mixed kelp bed).
  - Guardian crew, and names of Guardians collecting data.
  - Site location: name of the island, bay, or other nearby identifiable location.
  - Site Identification: provide a unique identification number for each site. For example, the first Tlowitsis kelp survey could be identified as TL–K01 (Tlowitsis – Kelp Bed number 1).
  - Site GPS coordinate: position the boat to record a UTM coordinate that can be used to find the kelp bed again. Set the GPS to NAD 83, UTM, and decimal degrees. Record the coordinates using a data collection app or the datasheet. If you are using Navionics or another GPS App on your phone, you will need to convert GPS coordinates to decimal degrees during data entry. For example: 50.589038, -126.863560.

Tier 1 Step 2, Option A: Map the extent or perimeter of the kelp bed

- Use a data collection app or the datasheet to map the location of kelp with GPS points:
- For kelp fringing the shoreline: map the offshore edge with GPS points (enough to connect the dots and show the edge on a map) and record width (distance across the kelp to the shoreline) at each GPS point.
  - Example: map the kelp along a curving coastline by placing a GPS point at each location where the shoreline curves (e.g.: along an S shaped coastline record GPS points on the inside and outside of each curve, this will allow you to connect the dots on a map, retracing the kelp).
- For kelp bed reefs map the perimeter with enough GPS points to record the general shape.
  - Example: map a circular bed with 4 GPS points – inshore, offshore, left and right sides. Irregularly shaped beds should include additional points to record the general shape (width measurements are not required here as we can later measure the width with the GPS points).
- Optional: Estimate the density (percent coverage) of the kelp bed observed at each GPS point using a score from 1 to 5 (very low to very high):
  - Very low density: less than 20 percent coverage. Patchy and fragmented.
  - Low density: 20-40 percent coverage.
  - Medium density: 40-60 percent coverage
  - High density: 60-80 percent coverage
  - Very high density: 80-100 percent coverage. Continuous and unbroken.

Tier 1 Step 3: Comments and photographs.

- Use a data collection app or the datasheet to provide informative comments.
    - Brief description: informative details not included in steps 1 and 2 (fringe or reef; proximity to human activities; exposed or sheltered; notable impacts).
    - Substrate – bedrock, boulder, cobbles, gravel, shell, sand, mud (note primary and secondary).
    - Bryozoans (present / absent). Sea urchins (species, present / absent).
    - Other species observed – schools of fish, predators (sea lions, otters, etc.).

TIER 2 KELP MONITORING METHODS

Tier 2 Step 1: Kelp reference information.

- Spatial mapping and data collection using Tier 2 methods should target the seasonal timing of peak biomass for kelp (June to August, depending on your location) and be completed at tides below 1.5m. It's important that annual Tier 2 surveys are conducted in the same season to compare change in kelp over time.
- Kelp bed selection: While Tier 1 methods can be used to map the location of smaller kelp beds and ground-truth satellite imagery, the selected kelp bed for more detailed data collection using Tier 2 methods should be large enough to complete at least 20 quadrats (approximately ~200m2). If the selected kelp bed is not adequate in size, move to the nearest adequate kelp bed.
    - If the entire kelp bed cannot be surveyed due to size, select a representative area that includes similar proportions (areas of high and low density) of kelp when compared to the entire bed and that can be surveyed within the 2-hour tide window (1 hour before and 1 hour after the low tide). Ideally, you should aim to survey 40 or more quadrats for these large beds to ensure you're capturing the variability (patchiness) in kelp density throughout the bed.
- Use a data collection app (e.g.: Avenza, Device Magic, Coast Tracker) or the datasheet to record reference information:
    - Date
    - Kelp species (bull kelp, giant kelp, or mixed kelp bed).
    - Guardian crew, and names of Guardians collecting data.F
    - Site location: name of the island, bay, or other nearby identifiable location.
    - Site Identification: provide a unique identification number for each site. For example, the first Tlowitsis kelp survey could be identified as TL–K01 (Tlowitsis – Kelp Bed number 1).
    - Site GPS coordinate: position the boat to record a UTM coordinate that can be used to find the kelp bed again. Set the GPS to NAD 83, UTM, and decimal degrees. Record the coordinates using a data collection app or the datasheet. If you are using Navionics or another GPS App on your phone, you will need to convert GPS coordinates to decimal degrees during data entry. For example: 50.589038, -126.863560.
    - Weather: record relevant weather conditions (cloud cover, sea state, etc.).
    - Time, Tide, and Current: Importantly, record the time when you start and when you complete the survey. Record the tide and, if possible/relevant, the current at the star and end of your survey,

Tier 2 Step 2: Map the areal extent (Option A) or perimeter (Option B) of the kelp bed

Option A: Drone survey

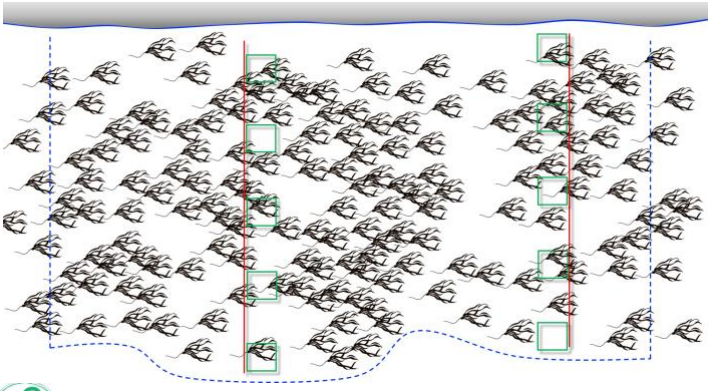
- Use your drone to record survey images of the entire kelp bed (areal extent).
    - It is very important to be sure the entire kelp bed has been surveyed.
    - Use DJI Pilot 2 to review the areas selected for the survey (this area should be planned and selected before you leave for the field). It is important to survey the same area each year. If it is the first time you are conducting a drone survey of this kelp bed, create a flight plan that includes some extra space (minimum of 20-30m) around the surveyed kelp bed to allow for an increase in the extent or a shift in the location of the kelp bed in subsequent years (see Figure 1).
    - Fly the survey at 120m elevation.
- Check that the controller and drone batteries are charged and the SD card is installed.
- Check the drone frame, props, and gimbal for any signs of damage.
- Keep clear communication with your assistant – communicate when you are powering the drone on, taking off, and the moment you are landing.
- Note tree heights, wildlife and human activity, private property, and any other activity, boundaries, or obstacles that could affect your flight.
- Check weather, light, and tide elevation to ensure you have suitable conditions.
- Complete your flight log, including start and end times, weather conditions, and crew.
- Refer to the Drone Mapping Guide for detailed instructions.

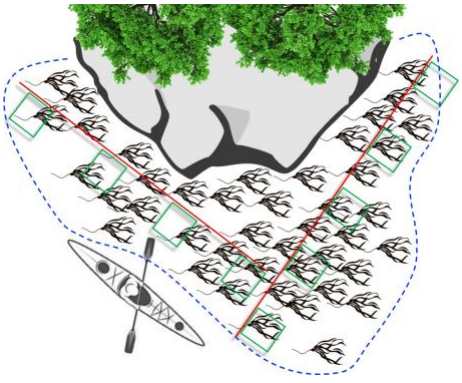
Option B: GPS survey (when a drone survey is not possible)

- If you cannot complete a drone survey, map the kelp bed perimeter using GPS.
    - Use a kayak, inflatable, or punt to move around the kelp bed while recording a GPS track or GPS points. Stay within 1m of the kelp bed edge (see Figure 1).

Tier 2 Step 3: Set-up transects

- Identify representative transects (an imaginary line spanning the kelp) through the kelp bed. Set one or more straight lines (transects) across the kelp bed that include similar proportions (areas of high and low density) of kelp when compared to the entire bed (see below and Figure 2).
- Multiple transects should be used when necessary. If more than 1 transect is needed, additional transects must be separated by a minimum of 3m for Bull Kelp and 6m for Giant Kelp.
- For large kelp beds, complete as many quadrats as time will allow (while the tide is below 1.5m). Ideally, you should aim to survey 40 or more quadrats for a given kelp bed to ensure you're capturing the variability (patchiness) in kelp density throughout the bed.





Tier 2 Step 4: Collect quadrat data along the transect

Bull kelp (Nereocystis luetkeana)

- Use a 1 m^2 quadrat to count and measure kelp bulbs along the transect. Use a small inflatable boat, punt, or kayak to get into the kelp bed, if needed.
    - Count all of the kelp bulbs found inside the quadrat on the water surface.
    - Estimate bryozoan coverage observed on the kelp in each quadrat using a score from 0.5 to 5 (note the added 0.5 category) (if bryozoan data were not taken, write N/A on the data sheet):
        - Rare: less than 5 percent coverage. Few and far between.
        - Very low density: less than 20 percent coverage. Patchy and fragmented.
        - Low density: 20-40 percent coverage.
        - Medium density: 40-60 percent coverage
        - High density: 60-80 percent coverage
        - Very high density: 80-100 percent coverage. Continuous and unbroken.
- Measure the width (diameter) of up to 10 kelp stipes at their widest point (typically found ~10cm below the bulb) below the bulb using calipers (e.g.: 28 mm; see Tier 2 Surveys – Example Field Photos below). Only measure stipes that are attached to bulbs on the water surface inside the quadrat.
- Flip the quadrat 3 times to move 3 meters along the transect to reach the next quadrat location.

Giant kelp (Macrocystis tenuifolia, formerly pyrifera)

- Use a 1 m2 quadrat to count kelp fronds along the transect. Use a small inflatable boat, punt, or kayak to get into the kelp bed if needed.
    - Whenever possible, place the transect perpendicular to the direction fronds are sitting in the current to ensure you don't count the same individual fronds again in multiple quadrat locations (if your transect points in the same direction as the kelp fronds, the same fronds may be counted 2 or 3 times).
    - If more than 1 transect is needed, additional transects must be separated by a minimum of 6m.
    - Count kelp fronds (one frond = a single branch, including all attached floats and blades) that are inside the quadrat, on the surface (counts will vary from 0 to 60+).
    - Estimate bryozoan coverage observed on the kelp in each quadrat using a score from 0.5 to 5 (note the added 0.5 category) (if bryozoan data were not taken, write N/A on the data sheet):
        - Rare: less than 5 percent coverage. Few and far between.
        - Very low density: less than 20 percent coverage. Patchy and fragmented.
        - Low density: 20-40 percent coverage.
        - Medium density: 40-60 percent coverage
        - High density: 60-80 percent coverage
        - Very high density: 80-100 percent coverage. Continuous and unbroken.
- Flip the quadrat 3 to 6 times to move 3 to 6 meters along the transect to reach the next quadrat location. Choose the number of times you flip the quadrat (3-6) to ensure you are not counting the same fronds more than once. This decision will depend on how long your kelp fronds are and the orientation of your transect relative to the direction the fronds are lying.

Mixed (giant kelp + bull kelp)

- Complete quadrat counts (Step 4) separately for each species.

If you are returning to monitoring a site that once had a kelp bed, but that kelp bed is no longer there or has shifted its location

- Use the pre-existing flight plan for that site to repeat survey the same area as where the kelp bed was present previously
- Deploy a drop cam or ROV to record underwater observations at the site
- If time and battery power allow, you might consider using your drone to record survey images of potential kelp habitat surrounding the survey area from a height of 120m, in case the kelp bed has shifted to nearby kelp habitat (see Figure 1).

SUPPORTING ENVIRONMENTAL AND BIOLOGICAL DATA

Step 1: Oceanographic data.

- Use a CTD water quality instrument to measure temperature and salinity at –1m, –5m, and –10m.
  - Measurements should be recorded near the center of the bed via kayak, if possible.
- Use the Secchi disk to measure water visibility.
  - Record the depth (marked on the Secchi line) where the disk is no longer visible.
- Record a GPS point where you measured oceanographic parameters using a GPS or data collection app.
- Ideally, CTD profiles taken during surveys (a single point in time) should be accompanied by continuous measurements of temperature and salinity collected using loggers fixed ~ 1 meter below the surface on moorings deployed just outside the kelp bed (see Example Mooring Diagram for Deploying Temperature and Salinity Loggers below). Setting loggers to record measurements every 30 minutes will capture daily and seasonal variation in temperature and salinity, while prolonging battery life

Step 2: Kelp bed observations

- Use a smart phone, tablet, or data collection app to record photographs and observations, including notable comments on kelp health/condition and the presence of wildlife. Record underwater observations from the boat, using a drop camera, mask and snorkel, or ROV (see Appendices: Guide for ROV Surveys, Drop Camera Methods).
  - Urchin species (red, purple, green) and abundance (high: > 10/m2, medium: 4-10/m2, low: 1-3/m^2, none: 0), see Table 1.
  - Fish and invertebrate species present (use an ID book for identification).
  - Understory kelp presence/absence and whether it is patchy or continuous cover
  - Substrate type: bedrock, boulder, cobbles, gravel, shell, sand, mud (note primary and secondary).
- Take wide angle photographs (above and below water) that show as much of the kelp bed as possible.

Table 1: Sea urchin abundance categories: associated site level observations and approximate densities per m2. Approximate densities are based on 1) urchin density targets for restoration that allow for kelp recovery (~2/m2), 2) urchin densities typical of patchy kelp forests or transitional states between kelp forests and urchin barrens (4-10/m^2), and 3) urchin densities that may be associated with persistent barrens (>10/m^2).

Category	**Site level abundance**	**Approx. density**
None	No urchins observed	0
Low	Urchins rare, kelp undisturbed	1-3/m^2
Medium	Urchins common but patchy, kelp thinning	4-10/m^2
High	Urchins continuous, kelp suppressed	>10/m^2

SURVEY DATA GUIDELINES AND CHECKLIST:

Guidelines:

- Record all measurements in metric (meters, centimeters, and millimeters).
    - Set all relevant equipment to metric: DJI Pilot 2, YSI, depth sounder, range finder, etc.
- Record all GPS points in Decimal Degrees (i.e.: 50.589038, -126.863560).
    - Set all relevant equipment to decimal degrees: Avenza, depth sounder, etc.
- All data from the same site must include the same Identification number (i.e.: TL-K001).
    - The site ID number must be recorded with each method used for data collection (Table 1).

Tier 1:

- ○ Fill in all kelp reference information
- ○ GPS points recorded in a data collection app or datasheet, including kelp bed width and density estimates
- ○ Notes recorded on species, habitat, and substrate (include photographs if needed)

Tier 2:

- ○ Fill in all kelp reference information
- ○ Quadrat counts and kelp measurements recorded on the data sheet
- ○ Drone survey of the entire kelp bed completed / flight log completed (Option A: drone survey)
- ○ Record kelp bed perimeter GPS points using a GPS unit or data collection app (Option B: GPS survey)
- ○ Survey start and end times recorded, including estimated tide elevations

Drone:

- ○ Survey is planned in DJI Pilot 2 before leaving for fieldwork
- ○ Before flight: batteries are fully charged + SD card has adequate space
- ○ After flight: photos are in focus + survey area has been covered

Supporting Environmental Data:

- ○ Oceanographic data (temperature and salinity) recorded at -1, -5, and -10m using the CTD
- ○ Visibility recorded using the Secchi Disk
- ○ Temperature and salinity loggers changed or data read out
- ○ Drop camera or ROV observations recorded, including substrate type, urchin presence and abundance, understory kelp presence/absence
- ○ Photographs (surface and drone) and notes on species and habitat recorded

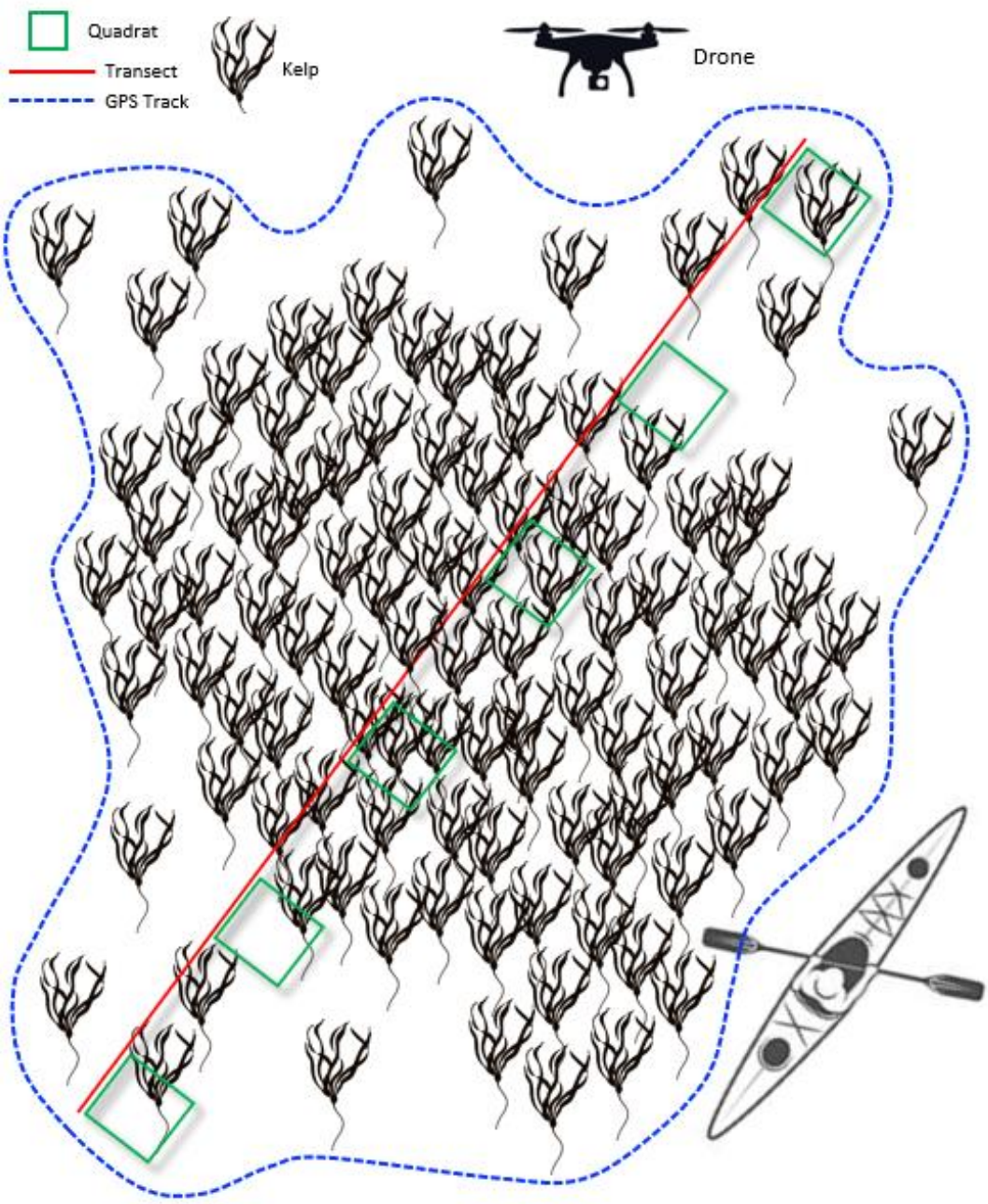


Figure 2: Tier 2 kelp bed mapping.
Step 1: record location and site ID. Step 2: complete an aerial extent survey using drone and DJI Pilot 2, or map the kelp bed perimeter with GPS. Steps 3 & 4: using transects and quadrats count and measure kelp stipes (bull kelp) or fronds (giant kelp) and estimate bryozoan percent cover. Step 5: use the CTD instrument to record temperature and salinity and change/read out temperature and salinity loggers. Step 6: record key observations, including substrate type, species presence/absence (urchins, understory kelp).

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Pfister, C. A., Berry, H. D., & Mumford, T. (2017). The dynamics of Kelp Forests in the Northeast Pacific Ocean and the relationship with environmental drivers. Journal of Ecology, (June), 1–14.

Springer, Y., Hays, C., Carr, M., Mackey, M., & Bloeser, J. (2006). Ecology and management of the bull kelp,
Nereocystis luetkeana: A synthesis with recommendations for future research. LenFest Ocean Program, 1–53.

RESOURCES:

- MaPP marine plan portal: www.seasketch.org
- B.C. marine conservation atlas: www.bcmca.ca
- ShoreZone coastal habitat mapping system: www.shorezone.org
- Global algae database: www.algaebase.org

EQUIPMENT LIST:

- Kelp field manual
- Waterproof notebooks, datasheets, and pencils
- Tablet / iPad equipped with a data collection app.
- Tide table (printed or electronic)
- Species ID book
- Binoculars
- 100 x 100 cm quadrats (1.0m2)
- Data collection boat (inflatable, punt, canoe, or kayak)
- Weighted tape or drop line for measuring depth
- CTD instrument (for temperature and salinity measurements)
- Temperature and salinity loggers (to swap with loggers on moorings)
- Drop Camera/ROV
- Survey Drone
- Rangefinder
- Secchi disk

APPENDIX 1: KELP OVERVIEW AND IDENTIFICATION

Canopy kelps are large seaweeds that form the canopies of dense marine kelp forests along British Columbia's coastline. Kelp forests are typically found in rocky subtidal areas along semi-exposed shorelines up to 10 m deep. These habitats are often composed of multiple species that form a three-dimensional community structure, including benthic, understory, and canopy layers. The dominant canopy species found in the North Vancouver Island region are bull kelp (Nereocystis luetkeana) and giant kelp (Macrocystis tenuifolia).

Bull kelp is an annual seaweed (growing from spore to maturity in a single year) that can reach over 20 m in length. Each plant is composed of a holdfast anchoring the plant to the seafloor, a long flexible stipe, a single gas-filled float, and long narrow blades that form the surface canopy. Reproduction in bull kelp occurs when patches of spores (sori) are released from reproductive blades, settling on nearby rocky substrate. Fully matured bull kelp is typically washed away in winter storms, creating space for the growth of new plants in the following year. Under optimal conditions kelp can grow up to 25 cm per day.

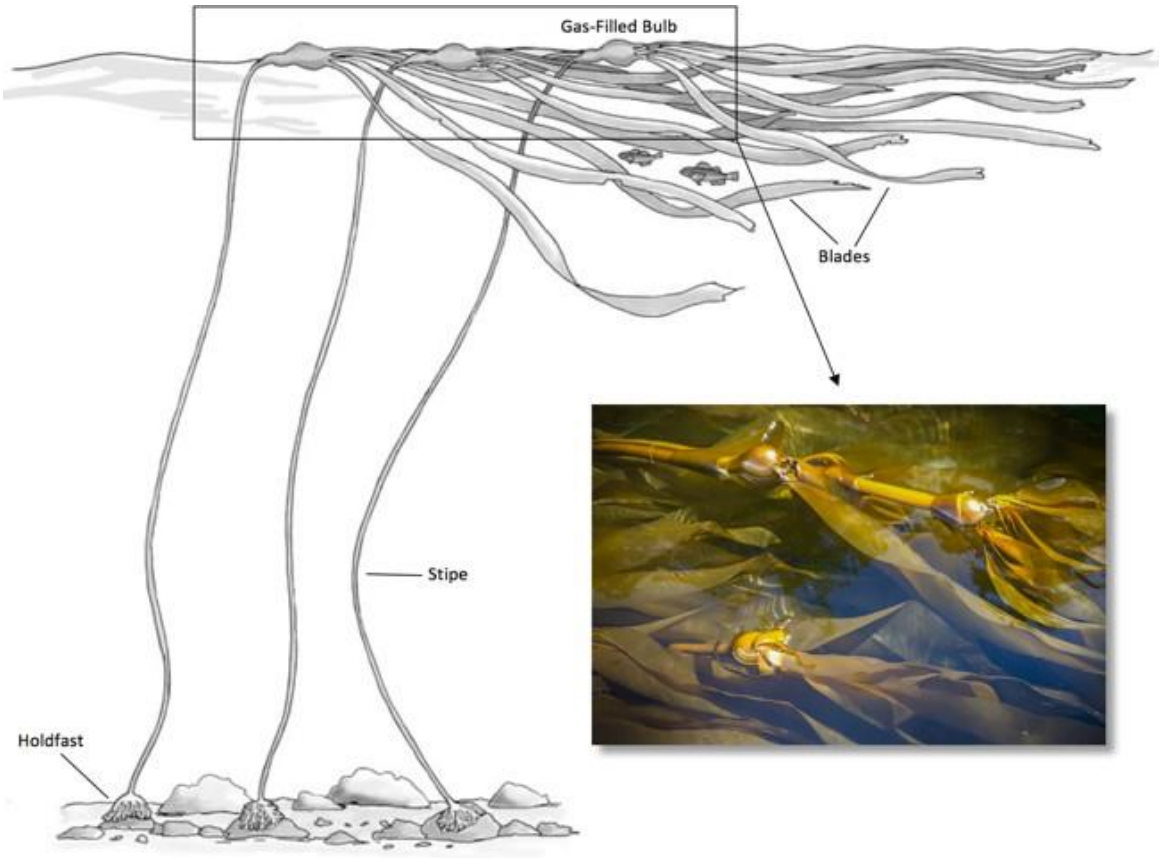


Figure A1: Bull kelp (Nereocystis luetkeana) identification.

Giant kelp is a perennial seaweed (persisting for multiple years) that can grow to 30 m in length. Each plant is composed of a cone-shaped mass of branching haptera (a holdfast) anchoring the plant to the seafloor, and multiple branching vine-like fronds; each frond includes a single stipe many gas-filled floats and blades, pulling the plant to the surface where it forms a dense canopy. Reproduction in giant kelp occurs when specialized blades (sporophylls) release spores that settle on rocky substrate. Under optimal conditions giant kelp can grow up to 35 cm per day.

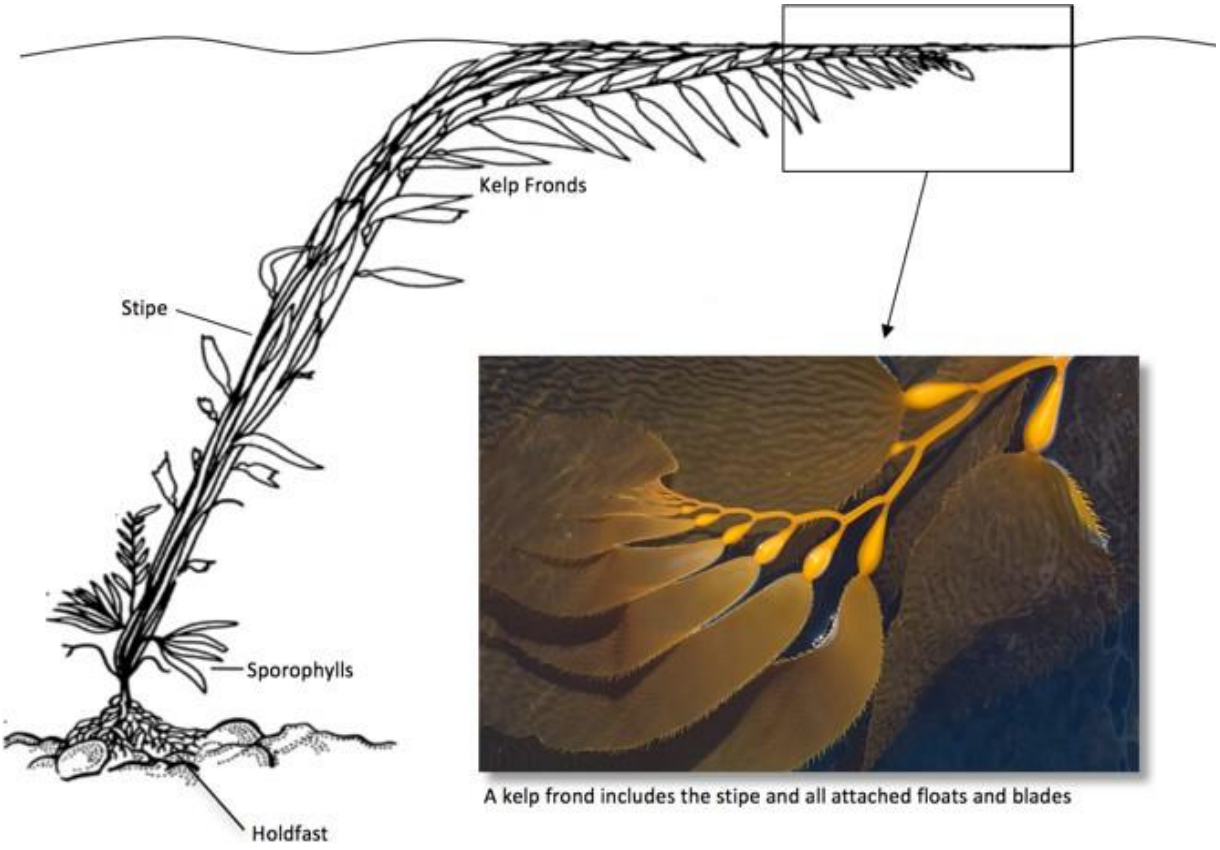


Figure A2: Giant kelp (Macrocystis tenuifolia) identification.

Bull kelp is common throughout the entire North Vancouver Island region, from Quadra Island in the south to Cape Scott in the north; the distribution of giant kelp is restricted to the Queen Charlotte Strait, from Malcolm Island to Cape Scott.

Canopy kelps were selected as MaPP indicator species for their ecological value and sensitivity to shifts in oceanographic conditions and human pressures. Kelp forests provide food and shelter for an extensive range of marine life, including marine mammals, birds, and many species of commercially important fish and shellfish. Canopy kelps provide the architecture for these dynamic kelp forest habitats, shifting their distribution and density with changes in temperature, salinity, turbidity, marine weather, and grazing pressure. Sensitivity to oceanographic conditions also make canopy kelps an ideal indicator for tracking the effects of climate change.

APPENDIX 2: SUPPLEMENTAL FIGURES

Tier 1 Monitoring Datasheet – Kelp / Eelgrass (Circle One) Page Number: /

Date		Tide		Crew / Guardian	/
Time		Species		Site Location / Site ID	/

Perimeter	1	2	3	4	5
GPS Point					
Density					
Depth					
Width					

Notes: observations (kelp condition, bryozoan presence, habitat description, etc.), substrate (bedrock, boulder, cobble, sand), species observed (note urchin species / abundance)

Figure A3: Tier 1 Datasheet

Tier 2 – Bull Kelp (Nereocystis) Monitoring

Site ID + Location:		Date:		Survey:	Time	Tide	Current	Comments
Site GPS:		Crew:		Start				
				End				

Drone Survey

Flight Name:		Start time:		Area surveyed (m^2):		Cloud Cover	0% / >0-50% / >50-99% / 100%
Pilot Name:		End time:		Survey altitude (m):		Sea State	flat calm / ripples / chop / swell
		Flight time:		Comments:			

Field Survey

Substrate:	Bedrock / Boulder / Cobbles / Gravel / Shell / Sand / Mud	Understory kelp:	Present / Absent	Patchy / Continuous
		Water Clarity:	Clear / Med Vis / Low Vis / Suspended Sediment	
Urchins:	High / Medium / Low / None	Other Species Observed:	Kelp Crab / Otter / Forage fish / Sea Star / Salmon / Rockfish / Other	

Oceanographic Data

Depth	Temperature	Salinity	Secchi Disk:	
-1m			GPS:	
-5m				
-10m				

Quadrat Data

Quadrat	% Bryozoans	# Bulbs	Stipe Diameter (10)	Quadrat	% Bryozoans	# Bulbs	Stipe Diameter (10)
1				21			
2				22			
3				23			
4				24			
5				25			
6				26			
7				27			
8				28			
9				29			
10				30			
11				31			
12				32			
13				33			
14				34			
15				35			
16				36			
17				37			
18				38			
19				39			
20				40			

Figure A4: Tier 2 Datasheet, Bull Kelp

Tier 2 – Giant Kelp (Macrocystis) Monitoring

Site ID + Location:		Date:		Survey:	Time	Tide	Current	Comments
Site GPS:		Crew:		Start				
				End				

Drone Survey

Flight Name:		Start time:		Area surveyed (m^2):		Cloud Cover:	0% / >0-50% / >50-99% / 100%
Pilot Name:		End time:		Survey altitude (m):		Sea State:	flat calm / ripples / chop / swell
		Flight time:		Comments:			

Field Survey

Substrate:	Bedrock / Boulder / Cobbles / Gravel / Shell / Sand / Mud	Understory kelp:	Present / Absent Patchy / Continuous
		Water Clarity:	Clear / Med Vis / Low Vis / Suspended Sediment
Urchins:	High / Medium / Low / None	Other Species Observed:	Kelp Crab / Otter / Forage fish / Sea Star / Salmon / Rockfish / Other

Oceanographic Data

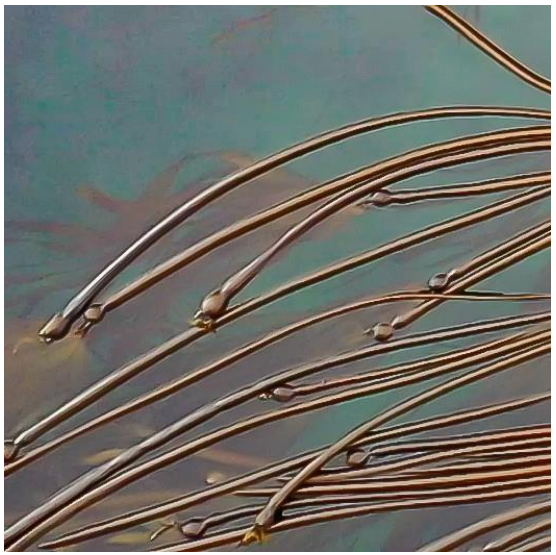
Depth	Temperature	Salinity	Secchi Disk:	
−1m			GPS:	
−5m				
−10m				

Quadrat Data

Quadrat	% Bryozoans	# Fronds	Quadrat	% Bryozoans	# Fronds	Quadrat	% Bryozoans	# Fronds
1			21			41		
2			22			42		
3			23			43		
4			24			44		
5			25			45		
6			26			46		
7			27			47		
8			28			48		
9			29			49		
10			30			50		
11			31			51		
12			32			52		
13			33			53		
14			34			54		
15			35			55		
16			36			56		
17			37			57		
18			38			58		
19			39			59		
20			40			60		

Figure A5: Tier 2 Datasheet, Giant Kelp

5. Very high density: 80–100 percent coverage. Continuous and unbroken.



4. High density: 60-80 percent coverage.

3. Medium density: 40-60 percent coverage.

2. Low density: 20-40 percent coverage.

1. Very low density: < 20 percent coverage. Patchy and fragmented

Figure A6: Kelp Density Estimation Examples – Bull Kelp

5. Very high density: 80–100 percent coverage. Continuous and unbroken.

4. High density: 60–80 percent coverage.

3. Medium density: 40–60 percent coverage.

2. Low density: 20–40 percent coverage.

1. Very low density: <20 percent coverage. Patchy and fragmented.

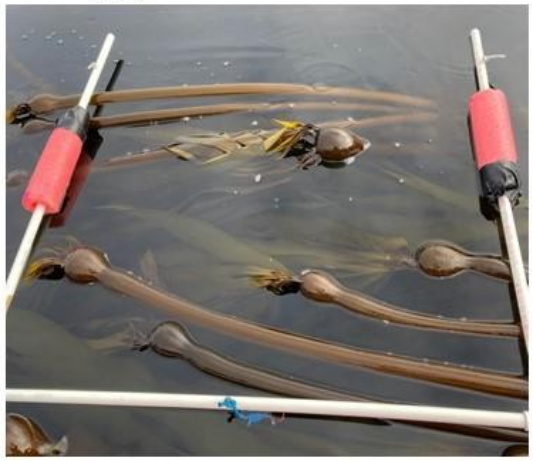
Kelp images: Sandie Hankewich

Figure A7: Kelp Density Estimation Examples – Giant Kelp

Three Giant Kelp fronds with no (0%) bryozoan cover

Giant Kelp fronds with very low (<5%) bryozoan cover

Giant Kelp fronds with low (>20-40%) bryozoan cover



Five Bull Kelp bulbs with no (0%) bryozoan cover.

Measuring Bull Kelp stipe diameter at the widest point below the bulb.

Figure A8: Tier 2 Surveys – Example Field Photos

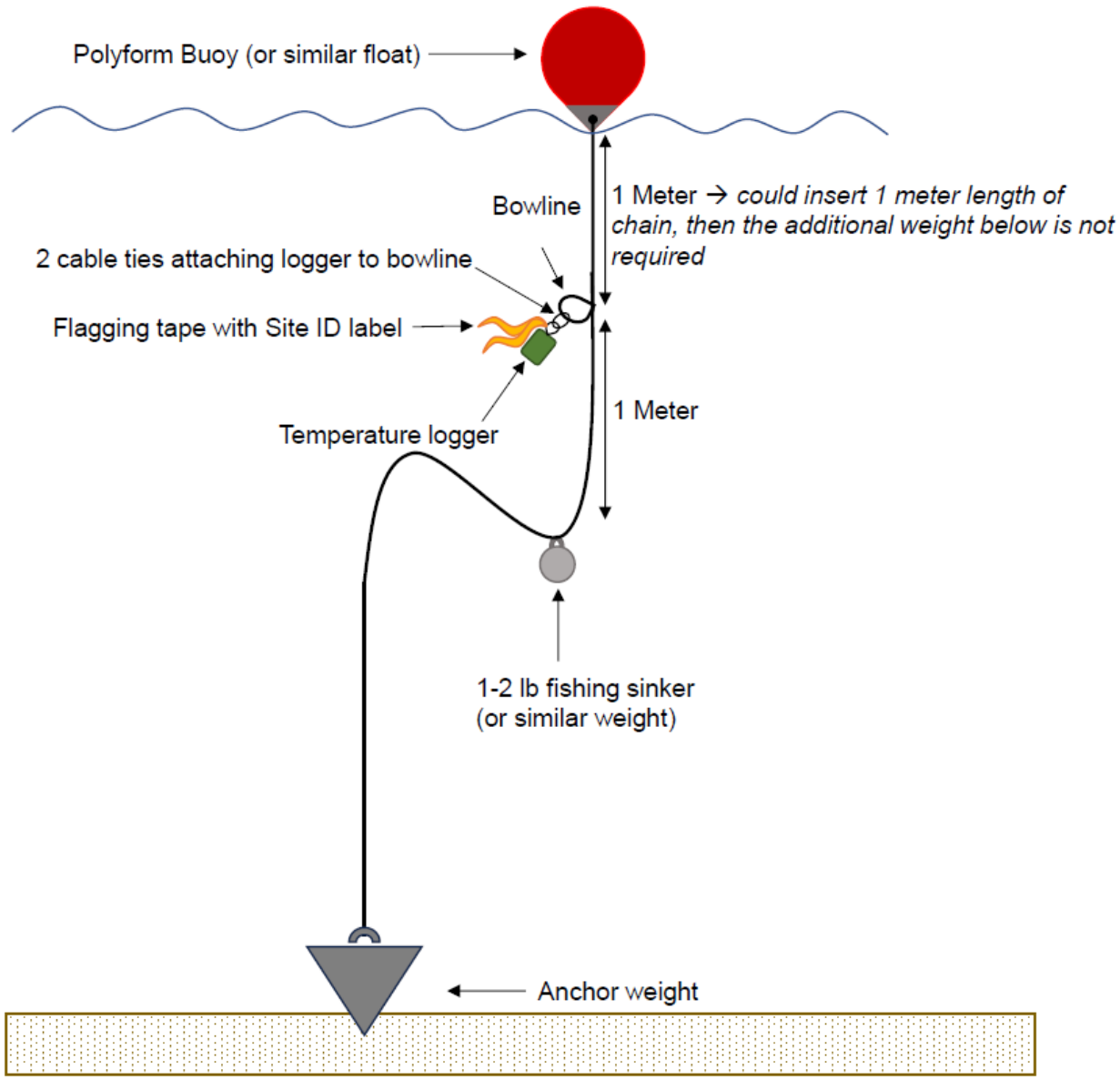


Figure A9: Example Mooring Diagram for Deploying Temperature and Salinity Loggers
At ~1 Meter Below the Surface. The entire length of the mooring should be ~1 meter longer than the depth at high tide at the site where it is being deployed.