

# **CANOPY-TRAITS: A global initiative on the functional traits and diversity of canopy-forming macroalgae**

## **Overview**



**October 2025**

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## Overview

Functional traits, measured at the individual level, influence both organismal fitness and ecosystem functioning. Determining trait variation can elucidate species' ecological strategies and the functional consequences of species loss or replacement. Regional studies provide proof-of-concept for applying multiple quantitative traits to large brown macroalgae (Fig. 1), but global variation in these species remains unexamined. **In CANOPY-TRAITS we aim to form a global network conducting standardised trait-screening to shed new light on the functional traits and diversity of these ecologically important species.**

## Questions:

1. How is the global trait space of canopy-forming large brown seaweed species (primarily Fucales and Laminariales) defined?

*We anticipate a primary axis related to resource acquisition and lifespan, like in vascular plants; additional axes may include size and relative investment in holdfasts and other structural materials.*

2. How much redundancy is there in the global assemblage and where is it lowest, leaving ecosystem services highly vulnerable?

*Functional redundancy is expected to be lowest for the largest-sized species and in regions with low overall richness.*

3. How can variation in species' trait attributes be explained? What are the relative contributions of environmental factors, scales, and phylogeny?

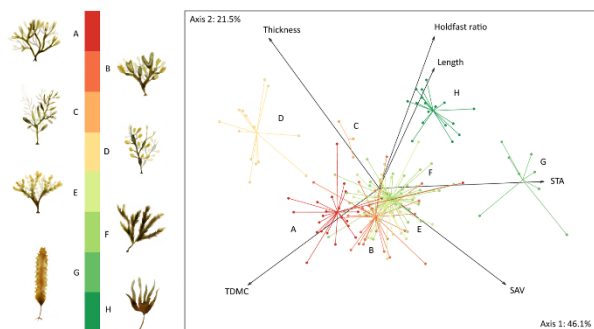
*We expect traits to be explained by depth and wave exposure (small-scales), water temperature and nutrient supply (larger-scales), biogeography, and phylogeny (all scales).*

4. What is the relative contribution of intraspecific vs. interspecific variability, across scales?

*Although interspecific will generally exceed intraspecific variation, the latter may be substantial where species span wide environmental gradients and should be explicitly accounted for across habitats and regions.*

## Participants and Timeline

As of October 2025, over [40 research groups worldwide](#) have expressed interest in participating in Canopy Traits (Fig. 2 overleaf). CANOPY-TRAITS is now running, with the window for data collection and submission to the coordinating team open until the end of July 2027. We do encourage people to sample and submit data as soon as possible,



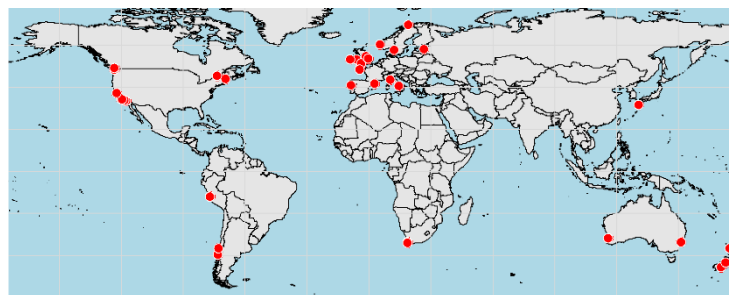
**Fig. 1.** Functional space of large brown macroalgae (UK). Cappelatti, Mauffrey, & Griffin, *Mar. Biol.* 2020.

however, with the hope of being in a position to begin analyses and write-up before the **end of July 2027**.

### Rationale behind trait selection

Traits have been selected that are relatively easy to measure, can be applied across contrasting species -- from massive flat-bladed kelps to small intricately branched wracks -- and hold significance for a suite of individual and ecosystem-level functions. For instance, specific thallus area (STA), can be measured in a standardised way across large brown seaweeds and beyond, and is related to the efficiency of photosynthesis and primary productivity. **The list of selected traits and their individual and ecosystem-level functions can be found [here](#).**

The selected traits vary in important ways from previous sets (Mauffrey et al. 2020, Cappelatti et al. 2019) because they are not being applied across such varied groups; we can focus more explicitly on the different parts of the individual due to a higher degree of differentiation in large browns. One example is STA, which is now explicitly applied to the most important tissues for photosynthesis. At the same time, we have decided to leave some traits out of the protocol, such as carbon and nitrogen %, due to labour and cost implications.



**Fig. 2.** Distribution of groups expressing interest in or committed to joining Canopy Traits.

### Research group contribution and authorship

Overall, we are aiming to cover 30+ species of kelp and 30+ species of fucoid, with each species represented in multiple sites per region, and multiple regions. We hope that each research group will collect traits from **40+ individuals spanning 3+ species**. See *Sampling design* section below for further details.

Trait screening should take **20-30 minutes per sample** for a team of two. However, the first 5-10 samples are likely to take longer (>1 hr) while people are familiarising themselves with the protocol. In fact, we recommend spending half a day running through the protocol with some spare samples to get used to it before jumping in to screening fresh samples. The protocol is quite complex as it has to accommodate such varied species, so **experienced researchers or research group leads will need to oversee at least the initial run-throughs**. Note that there is one image-analysis step to undertake as part of the research group contribution, but this will be quick following the provided image-J steps or macro. If samples are especially time-consuming to screen, due to size or complex morphologies, discuss with the coordinating team; our aim is that each group invests as close to the same overall data gathering effort.

Research group leads or experienced researchers should do some **quality control checks** on the dataset before it is submitted to the coordinating team and are responsible for the quality of the data.

People will be entitled to authorship where they have made a “substantial contribution”, defined as undertaking **two or more** of the following: i) planning, coordination, or activity of sampling; ii) trait screening in the lab; iii) data management and curation; iv) quality control and assurance of final submitted data set. Once listed as authors on a draft manuscript, contributors would then be required to comment on/edit and approve the manuscript prior to submission.

We anticipate that this will usually be around **two authors per 40 samples**. If other researchers have been involved in an important part of the process, such as sample collection, but do not meet the above criteria, there should still be an opportunity to name them as an author on one of the overview products, such as a data paper. If a research group is able to gather more data (e.g., through a postdoc leading sampling in a new region) then additional authors would then be justified proportionally to the new samples (one per 15 additional samples). Again, if a team is dealing with especially challenging sites or species, there will be flexibility. We trust people will embrace the spirit of the authorship guidelines.

### **Sampling design**

There are only two rigid requirements: 1) species are replicated within a site, **n = 3-5+** per species per site; and 2) the same species is sampled from **multiple (2-3) sites per region**.

Beyond these restrictions, how the 40+ individuals per research group are divided across species, sites, and regions will vary among research groups depending on local circumstances, and discussion with the coordinating team, with the aim of maximising species coverage across the network. For example, this may be 4 species x 5 individuals x 2 sites within 1 region, or 2 species x 5 individuals x 2 sites x 2 regions.

**Species** to be selected are large brown canopy-forming seaweeds. The set of target species is at each research group's discretion, but take into consideration these points: i) prioritise species that reach high abundances and are the **most ecologically relevant** in your region; ii) **do not avoid** selecting **species with unusual traits**, as we are aiming to collectively capture the functional diversity of canopy formers; and iii) **discuss with coordinators** and/or other groups in your region to **ensure complementarity**, as we are aiming to maximise species coverage across the network.

**Sites** are to be chosen at the research group's discretion based on local knowledge of where suitable conditions for the target species occur. Sites are defined as distinct intertidal or subtidal reefs >2km apart.

**Region** is defined as a stretch of coastline that lies within a single marine biogeographic unit and shares a coherent thermal and oceanographic regime (i.e., broadly similar annual temperature range and seasonality, current/upwelling context), while still allowing site-level variation in local conditions such as wave exposure.

Feel free to discuss your sampling plan with the coordinating team prior to sampling to ensure that we are collectively optimising species/regional coverage. Guidelines for field sampling are provided in the protocol.

The *Canopy Traits Protocol* is provided in a separate document.

**Any questions?** Email coordinators: John Griffin [j.n.griffin@swansea.ac.uk](mailto:j.n.griffin@swansea.ac.uk); Robin Fales: [rfales@soka.edu](mailto:rfales@soka.edu); Matthew Bracken: [m.bracken@uci.edu](mailto:m.bracken@uci.edu)