Methods for macroalgal photosynthetic parameters and biomass relationships

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The following methods overcome the logistical challenges to measuring NPP of diverse macroalgal assemblages in shallow marine habitats off the coast of Santa Barbara, CA.

A. Non-destructive methods for estimating taxon-specific biomass from abundance measurements of 19 taxa of macroalgae common to kelp forests near Santa Barbara, CA.

B. Determination of physiological parameters (Pmax, alpha, dark respiration) for the same taxa that can be coupled with measures of biomass and seafloor irradiance to estimate taxon-specific primary production.

A. Macroalgal Abundance and Standing Biomass

Linear relationships were generated from field estimates of abundance and laboratory measurements of biomass for 19 common taxa that accounted for 97% of the standing biomass of understory macroalgae averaged across Santa Barbara Coastal Long Term Ecological Research (SBC LTER) sites from 2008-2011. Different measures of abundance were related to field estimates of biomass for macroalgae of different sizes and morphologies.

Percent cover was related to biomass for crustose forms, low lying turfs and foliose algae. The following taxa were included in this group: *Bossiella orbigniana* Decaisne, *Callophyllis flabellulata* Harvey, *Chondracanthus corymbiferus* Kützing, *Corallina chilensis* Decaisne, large *Cystoseira osmundacea* Turner (defined as individuals of diameter > 10 cm), *Desmarestia ligulata* Stackhouse, *Laurencia spectabalis* Postels & Ruprecht, *Polyneura latissima* Harvey, *Rhodymenia californica* Kylin, *Dictyota* spp., family Ectocarpaceae, *Polysiphonia* spp., *Pterosiphonia* spp., *Halymenia* spp., and crustose coralline algae consisting primarily of *Pseudolithophyllum neofarlowii* Setchell & Mason. Taxon-specific linear relationships between percent cover and biomass were established using data collected from within 20 to 30 replicate 100 cm^2 quadrats strategically placed on the bottom at SBC LTER sites. Percent cover was estimated by divers using SCUBA as a proportion of 20 uniformly spaced points within the 100 cm^2 quadrat that contacted any foliage of the target taxon. Once points were recorded, all tissue of the targeted taxon within the quadrat was carefully collected, placed in a labeled plastic bag and returned to the laboratory for determination of biomass in units of dry mass. In the laboratory, each sample was weighed damp, dried at 60^oC for three days and then re-weighed. *C. chilensis, B. orbigniana* and crustose coralline algae were de-calcified using a 10% HCL bath prior to drying to obtain measurements of de-calcified dry mass.

Measurements of individual size were related to biomass for the understory kelps *Laminaria farlowii* Setchell and *Pterygophora californica* Ruprecht and small individuals of the fucoid *Stephanocystis osmundacea*. For large individuals of *L. farlowii* (defined as having a blade width > 15cm) and *P. californica* (defined as having a stipe length $\geq$ 20cm and a stipe diameter > 7mm), relationships were developed using individuals collected in the field and measured and weighed in the laboratory. Dry mass of large *L. farlowii* was related to total blade length, while dry mass of large *P. californica* was related to the total number of blades > 30 cm in length. Small individuals of these species can be extremely abundant and mean size calculated from a subsample of individuals was used to estimate the biomass of individuals of these species that were smaller than the sizes noted above.

B. Measurements of Photosynthesis-Irradiance

We used the methods of Miller et al. (2012) to measure photosynthesis versus irradiance and respiration by the 19 common macroalgal taxa described above. We incubated whole thalli (minus the woody stipe and holdfast in the case of the kelp *Pterygophora californica*) in clear acrylic tanks and measured oxygen evolution at nine levels of irradiance (19, 36, 60, 103, 178, 198, 344, 392, and 700 μmol m^{-2} sec^{-1}: n = 10 to 20 whole thalli per taxon). This range of instantaneous irradiances encompassed the entire range of values that we observed on the seafloor at SBC sampling locations from 2008-2011. The initial slope of the relationship between photosynthesis and irradiance at non-saturating irradiance (α) was determined using linear regression of non-saturating irradiance values for each taxon (Jassby and Platt 1976). Photosynthesis at saturating irradiance (P_{max}) was estimated for each thallus by fitting the hyperbolic tangent function of Jassby and Platt (1976) using SAS (SAS Institute Inc., North Carolina version 9.1.3). Estimates of P_{max} and α were averaged across replicate thalli to obtain mean estimates for each species or taxonomic group. Units of oxygen were converted to carbon using a photosynthetic quotient of 1.0 (following Rosenberg et al. 1995) and respiration and production rates were standardized to the dry mass of photosynthetic tissue. P_{max} and Respiration are given in units of mg C hr^{-1} (g dry mass)$^{-1}$, α is in units of mg C hr^{-1} (g dry mass)$^{-1}$ (μmol m^{-2} sec^{-1}) $^{-1}$.

References

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