Methods for determining macrolgal photosynthetic parameters and biomass relationships

S. Harrer, D. Reed and R. Miller

Macroalgal Standing Biomass

Linear relationships between macroalgal abundance and biomass were generated from field estimates of abundance and laboratory measurements of biomass. SBC uses different measures of abundance for macroalgae with different morphologies. Percent cover is used to measure the abundance of crustose forms, low lying turfs and foliose algae. The following taxa were included in this group:

- Bossiella orbigniana
- Callophyllis flabellulata
- Chondracanthus corymbiferus
- Corallina chilensis
- large Cystoseira osmundacea (defined as individuals having a total width > 10cm)
- Desmarestia ligulata
- Laurencia spectabalis
- Polyneura latissima
- Rhodymenia californica
- Dictyota spp.
- family Ectocarpaceae
- Polysiphonia spp.
- Pterosiphonia spp.
- Halymenia spp.
- crustose coralline algae consisting primarily of Pseudolithophyllum neofarlowii

For each of these taxa, a relationship between percent cover and biomass was established using data collected from within replicate 100 cm2 quadrats strategically placed on the bottom to obtain variation in percent cover for each taxon. Percent cover was estimated by SCUBA divers as a proportion of 20 uniformly spaced points within the 100 cm2 quadrat that contacted the target taxon. Once points were recorded, all tissue of the targeted taxon within the quadrat was 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 60oC 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.

SBC uses density (number of individuals m-2) to measure abundance of the understory kelps,

- Laminaria farlowii
- Pterygophora californica
- Cystoseira osmundacea

Biomass of these individuals was estimated with measurements of individual size that could be coupled with estimates of density. For large individuals of L. farlowii (defined as having a blade width > 15cm) and P. californica (defined as having a stipe length > 20cm and a stipe diameter > 7mm), biomass was estimated from allometric relationships generated from 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, including both vegetative and reproductive sporophylls greater than 30 cm in length. Small individuals of L. farlowii (defined as having a blade width of less than 15 cm), P. californica (defined as having a stipe diameter less than 7mm) and the fucoid, C.

osmundaceae (defined as having a total diameter measuring less than 10 cm) can be extremely abundant depending on time of year and location and additional methods were needed to accurately estimate biomass of these individuals. We observed that small P. californica varied considerably in size depending on the time of year; thus we used two size categories to estimate the biomass of small individuals of this species: stipe diameter less than 7 mm and stipe length less than 20 cm (hereafter referred to as small P. californica) and stipe diameter less than 7 mm and stipe length greater than 20 cm (hereafter referred to as medium P. californica). We used the mean size calculated from a subsample of individuals representative of each size class to estimate the biomass of small L. farlowii, small C. osmundaceae, and small to medium P. californica.

Physiological Measurements

To estimate production and respiration of each taxon we incubated whole thalli in clear acrylic tanks and measured oxygen evolution at 9 irradiance levels ranging from 0-700 μmol m-2 sec-1 using self-contained oxygen probes (D-Opto Log). The initial slope of the relationship between photosynthesis and irradiance at non-saturating irradiance (α, alpha) was determined using linear regression on data points below 300 μmol m-2 sec-1. Photosynthesis at saturating irradiance (Pmax) was estimated for each thallus using non-linear curve fitting procedures in SAS (SAS Institute Inc., North Carolina version 9.1.3). Estimates of Pmax 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 and respiration and production rates were standardized to the dry mass of photosynthetic tissue measured.