SBC-LTER

Estimating NPP in giant kelp

NPP of giant kelp is estimated from changes in plant allometry and stoichiometry and measurements of plant and frond loss. The methodology consists of estimating the density and length of all fronds > 1 m tall along fixed transects each month at three sites (Mohawk Reef, Arroyo Burro, Arroyo Quemado). Data obtained from laboratory dissections of whole plants collected from the field allow us to reliably estimate weight-length relationships of the water column and surface portions of fronds, and to determine the water and chemical composition (C, N) of different tissue types. At each site we also measure the average rate of frond loss between sampling dates by tracking fronds on marked individuals, and estimate the rate of plant loss at the site based on changes in plant density. We use the above information to calculate the mean growth rate of kelp in each month at each site based on the change in biomass and our estimates of plant tissue loss. Net primary production (NPP) is calculated as the integral of mean growth rate (g) multiplied by biomass (B_t), plus the biomass of plants recruiting during that period (R).

$$NPP = \int_0^t gB_t dt + R$$

Sampling methods

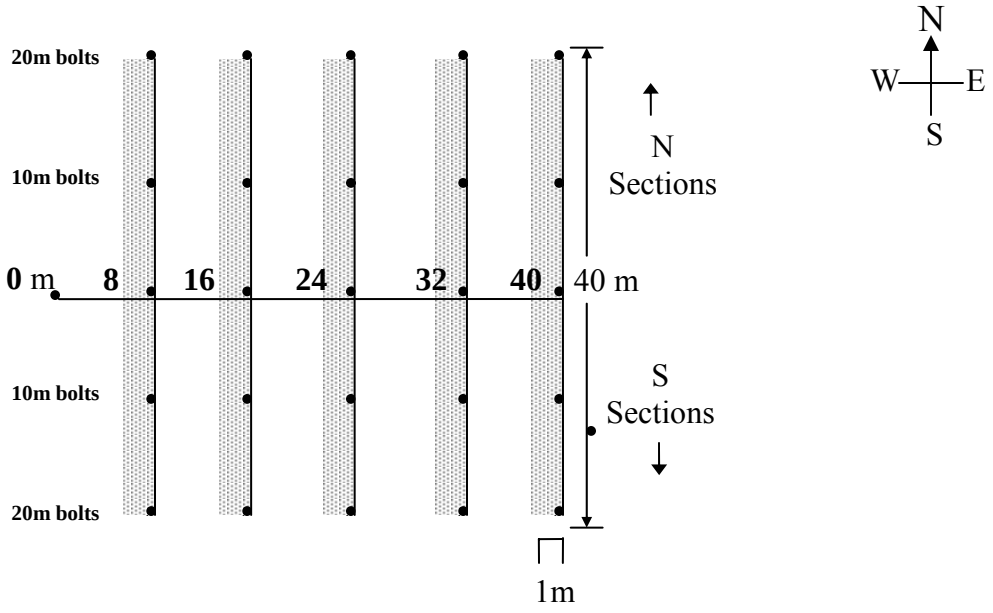
I. Estimating Kelp Biomass

Study sites and sampling areas

1. Mohawk and Arroyo Quemado

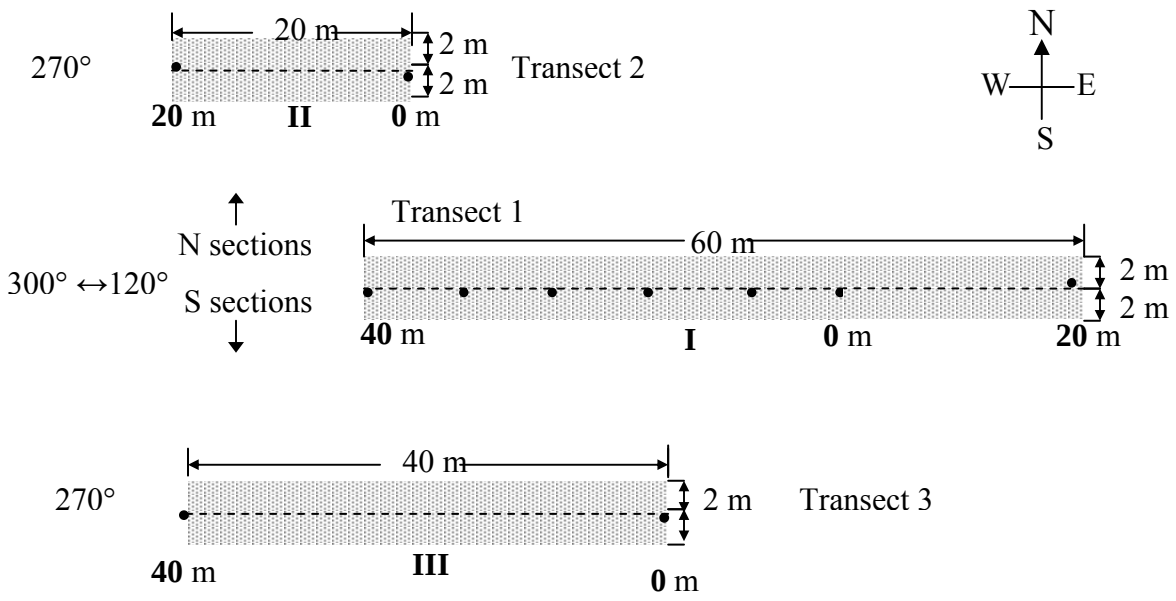
Kelp biomass is measured in five parallel 40 m x 1 m sampling areas that lie west of the perpendicular line that intersects SBC LTER benthic monitoring transect #1 at the 8, 16, 24, 32 and 40 m bolts at each of the two study sites. Each of the five sampling areas is divided into two sections: a 20 m x 1 m section that extends to the north (0^o) and a 20 m x 1 m section that extends to the south (180^o). The area sampled in each 20 m section of transect is a 1 m swath to the west of each transect line. Both sites have either re-bar or stainless steel eye bolts delineating the 20m end points, with intermediate (10 m) re-bar or eye bolts marking the half-way point to help ensure that the transect tape is placed in the same position each sampling period.. (Figure 1.)

Figure 1.



2. Arroyo Burro

Kelp biomass is measured in a 4 m wide swath centered along three distinct transects. Transect 1 is 60 m long that follows a heading of 120°. Parking lot bumpers at the 0 m and 40 m ends and either stainless steel eye bolts or re-bar located at 8, 16, 24, and 32m mark the SBC LTER benthic monitoring Transect 1. A sand anchor at 60 m from start bolt marks the end of the east section of Transect 1. Transect 2 is 20m long and is located 40m inshore of Transect 1 at a heading of 350°. The 0 m end is marked by a rebar stake with a subsurface buoy. The 20 m end is marked by rebar. Transect 3 lies offshore from Transect 1 approximately 60 m at a heading of 240°. It is 40 m long and follows a heading of 270°. The 0 m end of Transect 3 is marked by a parking lot bumper with a subsurface buoy, and the 40 m end is marked with a sand anchor. (Figure 2.)



Sampling protocol

1. Sampling gear required for each observer

a. Accurate depth gauge
b. Accurate compass
c. Meter stick
d. Fiberglass transect tape
e. Data slate
f. Current month's data sheet

2. Establishing sampling area

a. Transect tapes are laid out according to the headings indicated in the previous section.
b. After laying out the transect tape, the observer swims back along the transect to the 0 m mark and insures that the transect is laid out in a straight line at the proper compass heading prior to collecting any data.
c. Beginning at 0 m the observer carefully swims along the transect line and records all plants that fall within 1 m of the transect tape. The observer takes care not to tangle or dislodge any plants or fronds while sampling.
d. If only a portion of a plant falls within the 1 m wide swath, then the observer collects data on **only those fronds that fall within the transect**. Any such plant that falls partially in the transect is identified as such on the data sheet by **marking a "P" in the C or P (cut or partial) column**.

3. Plant measurements

The following measurements are recorded for each **subsurface canopy** plant that falls within the sampling area of the transect:

a. depth (m) as measured at the ***top*** of the holdfast of each plant
b. number of fronds 1 m above the holdfast
c. the mean length of all fronds on the plant

The following measurements are recorded for each **surface canopy** plant that falls within the sampling area of the transect:

a. Depth (m) as measured at the ***top*** of the holdfast of each plant
b. the number of fronds 1m above the holdfast (F_1m)
c. The number of fronds that reach the surface (F_sfc). This is done by pulling the fronds of the plant down a distance equal to the water depth at the holdfast and counting the number of fronds at that distance, or by the observer swimming up the water column to the surface and counting the fronds that reach the surface. If the plant that is being measured is tangled with adjacent plants or with detached plants that drift into the transect, then the observer must estimate the number of fronds that reach the surface to the best of his/her ability.
d. The surface length of longest surface canopy frond (sfc_long). If the plant that is being measured is tangled with adjacent plants or with detached plants that drift into the transect, then the observer must estimate the surface length of the longest surface frond to the best of his/her ability

***** If the fronds of a plant have been cut near the surface by a boat or kelp harvester, then the observer records the depth at the top of the holdfast, counts the number of fronds at 1m and records a "C" in the C or P (cut or partial) column.**

II. Estimating Frond Loss

Study sites and sampling areas

At each kelp NPP site, there are 15 adult plants marked with consecutive numbered tags that are used in estimating the birth and death rates of fronds. These plants are randomly distributed about the sampling area and are sampled each month. New plants are tagged when old plants are lost to maintain an adequate sample size (i.e. at least 15 plants). A map denoting the location of each plant is updated each sample period and is used by the observer underwater to locate the tagged plants.

Sampling protocol

1. Sampling gear required for each observer

a. Updated map of tagged plants
b. Current month's data sheet
c. Pre-labeled bags
d. At least 50 pink cable ties

2. Locating and sampling the plant

a. Using the site plant map on the side of the datasheet, locate one of the 10 to15 tagged kelp plants.
b. Verify plant number and location
c. Count all the fronds that are 1m in length or greater, record that number as **F_1m** on the datasheet.
d. Count the fronds that have been previously marked with a cable tie. This number gets recorded as **OLD.**
e. The difference between the **F_1m** and the **OLD** should be the **NEW** fronds. Verify this by counting the number of fronds without a cable tie tag.
f. Collect two blades ~1m from the growing end of an actively growing frond that reaches the canopy. Place the blades in a labeled zip-lock bag.
g. Record the bag label in the appropriate column on the data sheet.
h. Repeat steps a through g until all tagged plants have been sampled.
i. If a plant is found to be missing, then mark data sheet accordingly, and a new plant tagged.

3. Tagging New Plants

a. Check condition of all plant tags and replace with identical plant number if necessary
b. If the number of tagged plants falls below 15, then tag a new plant using a consecutive plant number.
c. Tag all fronds over 1m on each new tagged plant with **PINK** cable ties.
d. Record the number of fronds on each newly tagged plant.