Abstract

The aim of this study was to develop a simple and robust methodology for the routine estimation of primary production in coastal water bodies, such as the sea loughs of Northern Ireland. Primary production estimates are a key element in assessing the trophic status of a water body as well as in defining its carrying capacity. The traditional methods for deriving production, although sensitive and reliable, are time consuming and not suitable for routine monitoring programme. To achieve the aim of this study, high frequency sampling was carried out for two years (April 2006 - March 2008) in Carlingford Lough (NI), to characterise the main environmental properties of the Lough, and to run incubations to derive primary production and microplankton community respiration.

From the observations and analyses carried out, it is evident that run off from the River Clanrye strongly influenced the physical, chemical and biological characteristics of the Lough. Phytoplankton biomass showed the typical seasonal cycle observed in temperate coastal waters. Microalgal growth was light limited during winter, and potentially nutrient limited (silicate and nitrogen), during spring and summer respectively. Diatoms dominated the phytoplankton population during the year, due to the high nutrient concentration in the Lough and mixed/stratified water column conditions. The sub-surface light climate was considered to be the main factor controlling the timing of the phytoplankton spring bloom, and suspended solids were the optically active constituent that explained the higher proportion of variability in K_d (30%).

The ^{14}C technique was chosen for estimating primary production due to its high sensitivity. A standard operating procedure was developed for deriving estimates of production of the Lough that involved the use of a photosynthetron and short term incubations. The photosynthesis-irradiance curves derived from incubations were fitted by light-saturation models and the hyperbolic tangent of Jassby and Platt (1976) consistently produced a good fit to the data sets. α^B and P^B_{max} showed seasonal variability and significant relationships with some environmental variables (e.g. ammonium, incubation temperature). Single daily values of chlorophyll concentration, K_d and photosynthetic parameters were used to derive daily column production for a given sampling event. The range of estimates of daily

gross column production of Carlingford Lough (3.2 – 1210 mgC m^{-2} d^{-1}) was comparable to the ranges derived for other temperate estuaries and coastal areas. The seasonal trend in gross production in Carlingford Lough showed 2 main peaks (one in spring and one at the end of the summer). Chlorophyll standing stock explained 71% of the variability in daily production. This increased to 89% when irradiance during the sampling and K_d were included in the relationship.

A model to implement a truncated Fourier series (TFS) was applied to daily estimates of production to derive annual production that was estimated as 116 gC m^{-2} y^{-1} with 90% confidence interval of 98-141 gC m^{-2} y^{-1}. Annual microplankton community respiration was estimated as 117 gC m^{-2} y^{-1} (90% confidence interval 105-134 gC m^{-2} y^{-1}). It was concluded that within the Lough there were periods of net production but these episodes were not cyclical and that on an annual balance, Carlingford Lough was a heterotrophic system.

This study confirmed that chlorophyll standing stock can be used to derive estimates of daily gross production. The TFS analysis also appears to be a useful method for estimating annual production and quantifying the associated error to provide confidence intervals that could be used to assess long-term change. A preliminary test using Belfast Lough data suggests that the relationship chlorophyll stock/production and the TFS can be used in other Northern Ireland sea loughs. The empirical relationship with chlorophyll standing stock, together with the TFS analysis, shows promise as a method for estimating annual production in estuarine and coastal waters, and merits further validation and testing.