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Research papers

Seasonal variability of primary production in a fjord ecosystem of the Chilean Patagonia: Implications for the transfer of carbon within pelagic food webs

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ABSTRACT

We characterized the seasonal cycle of productivity in Reloncaví Fjord (41°30'S), Chilean Patagonia. Seasonal surveys that included measurements of gross primary production, community respiration, bacterioplankton secondary production, and sedimentation rates along the fjord were combined with continuous records of water-column temperature variability and wind forcing, as well as satellite-derived data on regional patterns of wind stress, sea surface temperatures, and surface chlorophyll concentrations. The hydrography and perhaps fjord productivity respond to the timing and intensity of wind forcing over a larger region. Seasonal changes in the direction and intensity of winds, along with a late-winter improvement in light conditions, may determine the timing of phytoplankton blooms and potentially modulate productivity cycles in the region.

Depth-integrated gross primary production estimates were higher (0.4–3.8 g C m⁻² d⁻¹) in the productive season (October, February, and May), and lower (0.1–0.2 g C m⁻² d⁻¹) in the non-productive season (August). These seasonal changes were also reflected in community respiration and bacterioplankton production rates, which ranged, respectively, from 0.3 to 4.8 g C m⁻² d⁻¹ and 0.05 to 0.4 g C m⁻² d⁻¹ during the productive and non-productive seasons and from 0.05 to 0.6 g C m⁻² d⁻¹ and 0.05 to 0.2 g C m⁻² d⁻¹ during the same two periods. We found a strong, significant correlation between gross primary production and community respiration (Spearman, $r=0.95$; $p < 0.001$; $n=12$), which suggests a high degree of coupling between the synthesis of organic matter and its usage by the planktonic community. Similarly, strong correlations were found between bacterioplankton secondary production and both gross primary production (Spearman, $r=0.7$, $p < 0.05$, $n=9$) and community respiration (Spearman, $r=0.8$, $p < 0.05$, $n=9$), indicating that bacterioplankton may be processing an important fraction (8–59%) of the organic matter produced by phytoplankton in Reloncaví Fjord. In winter, bacterial carbon utilization as a percentage of gross primary production was > 100%, suggesting the use of allochthonous carbon sources by bacterioplankton when the levels of gross primary production are low. Low primary production rates were associated with a greater contribution of small cells to autotrophic biomass, highlighting the importance of small-sized plankton and bacteria for carbon cycling and fluxes during the less productive winter months. Fecal pellet sedimentation was minimal during this period, also suggesting that most of the locally produced organic carbon is recycled within the microbial loop. During the productive season, on the other hand, the area exhibited a great potential to export organic matter, be it to higher trophic levels or vertically towards the bottom.

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1. Introduction

Fjords and estuaries play an important role in biological productivity and carbon cycling within aquatic ecosystems (Burrell, 1988; González et al., this issue). These systems receive large contributions of particulate and dissolved organic matter

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