

A one year survey of seagrass primary productivity using the diving-PAM technique

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Introduction

Posidonia oceanica (L.) Delile, the main Mediterranean seagrass species, has high foliar and belowground biomass production (Fig. 1). Several methods have been used to measure its growth and primary productivity (incubation bells, optodes, biomass and elementary content measurements etc.). A less used method relies on chlorophyll fluorescence measurements with the Pulse Amplitude Modulated fluorometry (PAM) technique. Underwater fluorometers, designed for studying *in situ* photosynthesis of primary producers, allow performing Rapid Light Curves (RLCs) that provide a reasonable approximation of the photosynthesis-irradiance relationship. The major parameter associated with RLCs is the maximum relative electron transport rate ($rETR_{max}$). The electron transport rate is considered as a good proxy of the plant photosynthetic activity. In the framework of the STARECAPMED project, the objective of this work was to assess the seasonal variation of *P. oceanica* photosynthetic production using the PAM technique.



Fig.1. *P. oceanica* vertical edge.



Figs. 2. Underwater use of a diving-PAM.

Material and methods

We measured weekly to bimonthly over a one-year period the photosynthetic production of *P. oceanica* using RLCs generated with a Diving-PAM (Walz Inc., Germany; Figs. 2). The survey was performed at 10 m depth in a pristine meadow (Calvi, France). To obtain reliable and comparable data, the protocol was standardized. Measurements were performed :

- on the convex middle part of the 3rd leaf,
- at zenith,
- during shiny and calm weather days.

Environmental parameters were measured using PAR sensors and light-temperature probes. RLC parameters were calculated using the Platt, Gallegos and Harrison (1980) or Webb (1974) models (with or without photoinhibition, respectively). Statistical analyses were done in R.

Results and discussion

PAR displayed a well marked seasonality with large differences between winter and summer regimes. Temperature, doubling between the two periods, followed that seasonal pattern with a time lag of about two to three months (Figs. 4). *P. oceanica* $rETR_{max}$, modeled from RLCs (Fig. 3), more than tripled in a year (Figs. 4). The seagrass photosynthetic activity, depending on light intensity and temperature, followed the seasonal trend of the ambient conditions.

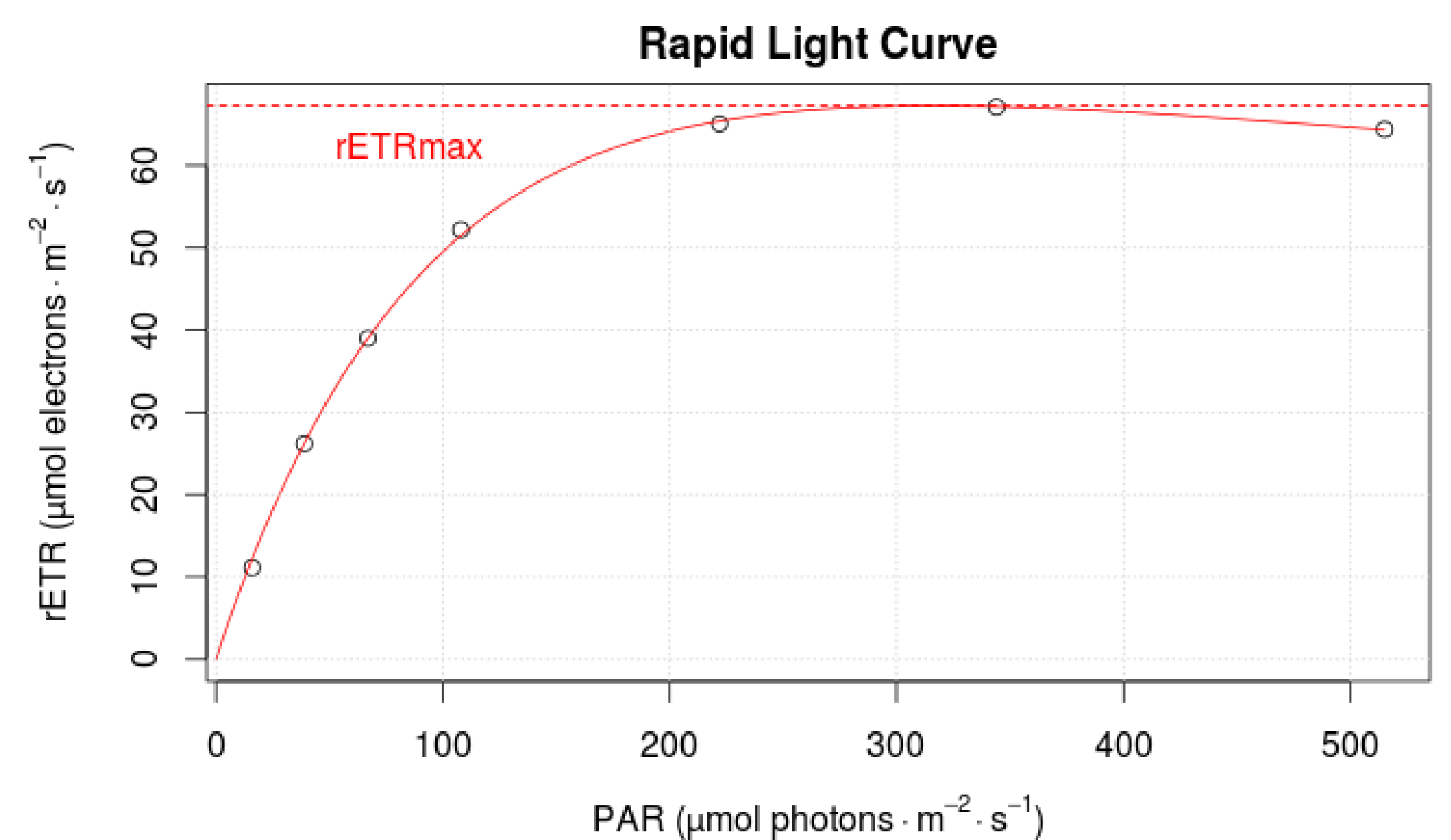
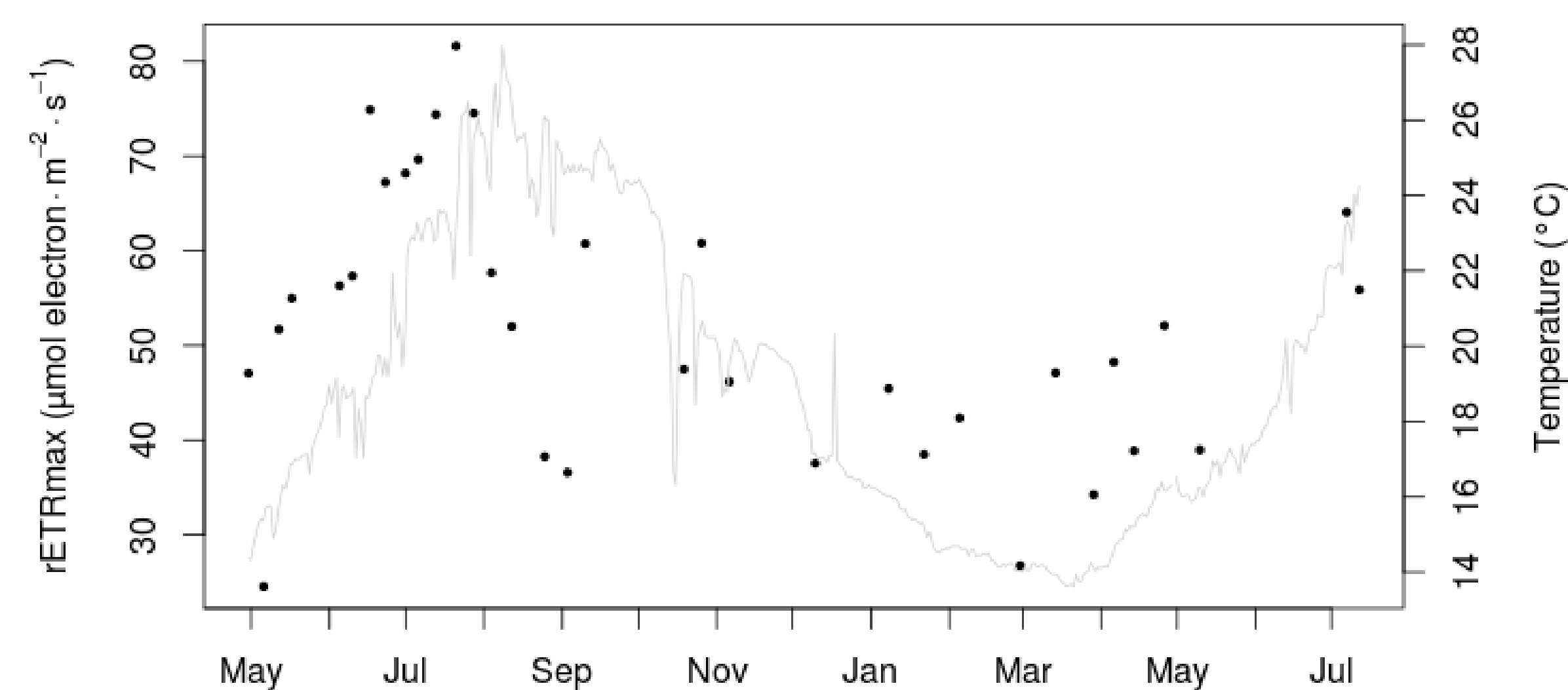


Fig. 3. Example of one RLC modeled with the PGH model.

Figs. 4. Seasonal evolution of *P. oceanica* $rETR_{max}$ (black dots), in relationship with PAR (above, grey line) and temperature (below, grey line) conditions.



In addition to the well marked plasticity of the seagrass photosynthetic apparatus to changing ambient conditions, the combined analysis of *P. oceanica* $rETR_{max}$ and leaf growth showed similar seasonal trends (Fig. 5). To greater photosynthetic activity between winter and summer corresponded faster leaf growth.

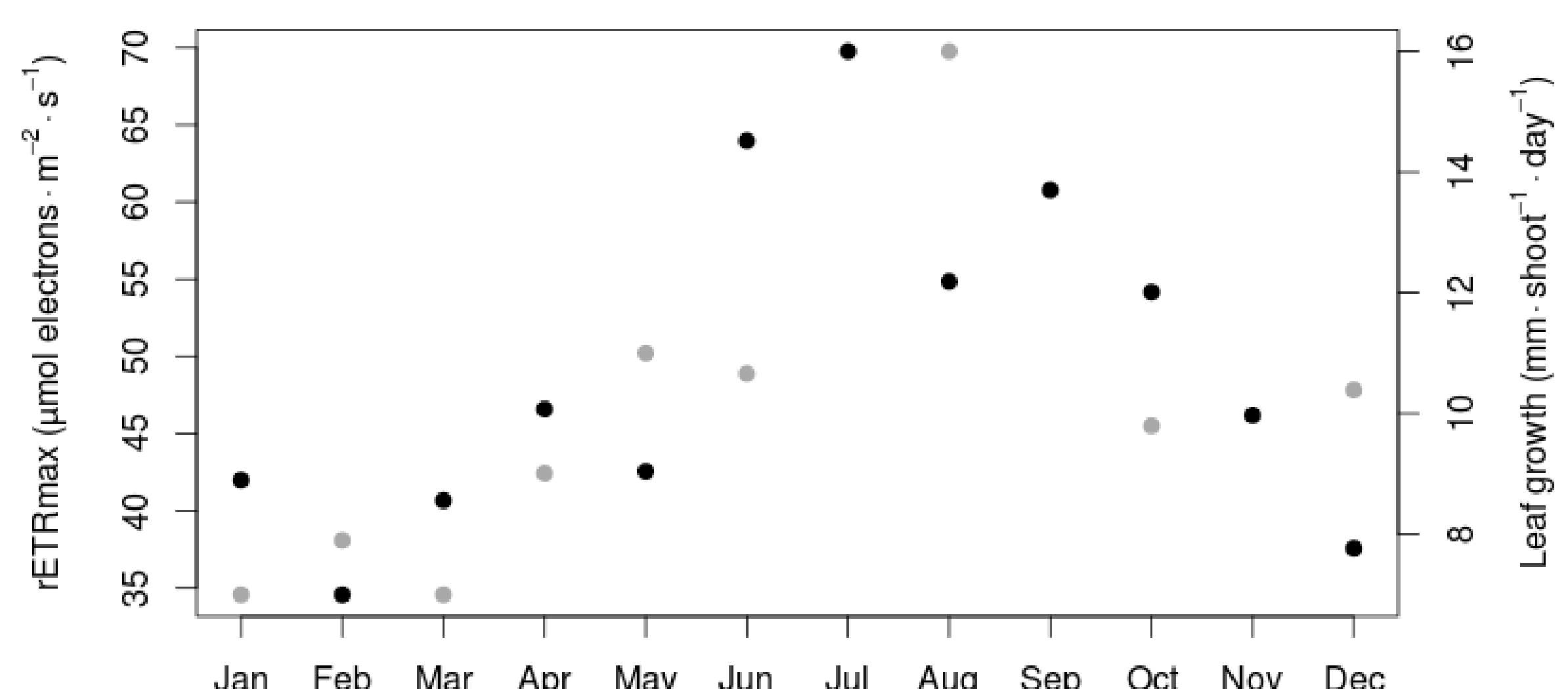


Fig. 5. Seasonal evolution of *P. oceanica* leaf growth (grey dots; data from Gobert, 2002) and $rETR_{max}$ (black dots).

Conclusion

Observations from this one-year survey demonstrated that *P. oceanica* photosynthetic production evolved following the seasonal light and temperature patterns. The similar trends between the plant photosynthesis and its leaf growth suggested that $rETR_{max}$ could be used as a proxy of growth. Confirmation of that hypothesis will require further studies.