The Application of Fluorescent Optode to Oxygen Dynamics in the Rhizosphere of *Vallisneria spirals*

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Abstract Oxygen (O_2) availability within the sediment–root interface is critical to the survival of macrophytes in O_2-deficient sediment; however, our knowledge of the fine-scale impact of macrophyte roots upon the spatiotemporal dynamics of O_2 is relatively limited. In this study, a non-invasive imaging technology was utilized to map O_2 micro-distribution around *Vallisneria spirals*. Long-term imaging results gathered during a 36 day-period revealed an abundance of O_2 spatiotemporal patterns ranging from 0 to 250 μmol L^{-1}. The root-induced O_2 leakage and consequent oxygenated area were stronger in the vicinity of the basal root compared to that found in the root tip. The O_2 images revealed *Vallisneria spirals* exhibited radial O_2 loss (ROL) along the entire root, and the O_2 distribution along the root length showed a high degree of small-scale spatial heterogeneity decreasing from 80% at the basal root surface to 10% at the tip root. The oxygenated zone area around the roots increased as O_2 levels increased with root growth and irradiance intensities ranging from 0 to 216 μmol photos m^{-2} s^{-1}. A weak ROL measuring less than 20% air saturation around the basal root surface was maintained in darkness, which was presumably attributed to the O_2 supply from overlying water via plant aerenchyma. The estimated total O_2 release to the rhizosphere of *Vallisneria spirals* was determined to range from 8.80 ± 7.32 to 30.34 ± 17.71 nmol m^{-2} s^{-1}, which was much higher than many other macrophyte species. This may contribute importantly to the high-capacity of *Vallisneria spirals* for quickly colonizing the anaerobic sediment.