

## Nutrient Limitation of the Macroalga *Enteromorpha intestinalis* Collected along a Resource Gradient in a Highly Eutrophic Estuary

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### ABSTRACT

We conducted a laboratory experiment to quantify nutrient (nitrogen and phosphorus) limitation of macroalgae collected along a gradient in water column nutrient availability in Upper Newport Bay estuary, a relatively nutrient-rich system in southern California, United States. We collected *Enteromorpha intestinalis* and water for use in the experiment from five sites ranging from the lower end of the estuary to the head. Initial algal tissue N and P concentration and molar N:P ratios—as well as water column NO<sub>3</sub> and total Kjeldahl nitrogen (TKN)—increased along a spatial gradient from the lower end toward the head. Water column soluble reactive phosphorus (SRP) varied among sites as well but did not follow a pattern of increasing from the seaward end toward the head. Algae from each site were assigned to one of four experimental treatments: control (C), nitrogen enrichment (+N), phosphorus enrichment (+P), and nitrogen and phosphorus enrichment (+N+P). Each week for 3 wk we replaced the water in each unit with appropriate treatment water to mimic a poorly flushed estuary. Growth of *E. intestinalis* collected from several sites increased with N enrichment alone and increased further when P was added in combination with N. This indicated that N was limiting and that when N was sufficient, P became limiting. Sites from which *E. intestinalis* exhibited nutrient limitation spanned the range of background water column NO<sub>3</sub> (12.9± 0.4 to 55.2 ± 2.1 μM) and SRP (0.8 ± 0.0 to 2.9 ± 0.2 μM) concentrations. Algae that were N limited had initial tissue N levels ranging from 1.18 ± 0.03 to 2.81 ± 0.08% dry weight and molar N:P ratios ranging from 16.75 ± 0.39 to 26.40 ± 1.98.

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