Extended Data Figures and Tables for “Observations of Elemental Composition of Enceladus  
Consistent with Generalized Models of Theoretical Ecosystems”

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Extended Data Figure 1. Analysis of derived biomass turnover times to facilitate population stability for given steady state nutrient concentrations. For all chemostat model simulations, steady state dissolved phosphate concentrations are set by calculating the cell turnover time (chemostat washout rate) that corresponds to that phosphate concentration. Cell turnover time is shown on the y-axis while steady state biomass in cells/mL is shown on the x-axis. Point color indicates the steady state phosphate concentration set for that model simulation.

Extended Data Table 1. Simulation results from chemostat model. Simulations searched for steady state biomass in cells/mL by varying the relative energy efficiency of phosphate conversion into biomass (first column), the steady state dissolved phosphate concentration (second column), and using those two parameters, calculating the necessary chemostat outflow/cell turnover rate to allow ecosystem stability (fourth column). The steady state biomass for each simulation is in the third column.

Extended Data Table 2. Power law parameters for macromolecular allometric scaling models. Macromolecules calculated include total genome, total proteins, total ribosomes, total lipids, and total carbohydrates to represent the largest pools of intracellular C, N, and P. Parameters are presented in the form of a log-log relationship, i.e., $log\_{10}(\textnormal{picograms macromolecule})=b+alog\_{10}(\textnormal{cell volume})$. The slope parameter, $a$, is in the power-law slope column, while the imntercept parameter, $b$ is in the power-law intercept column. References for each scaling are provided.

Extended Data Table 3. Results from scaling parameter grid search analysis. Each row represents one of 497,699 simulated ecosystem N:P ratios (first column) based on the model described in Methods. The parameters used for these calculations are the cellular allometric scaling exponent for N:P ratio as a function of cell volume (second column), the intercept for the N:P-volume relationship (third column), which is determined by setting a “Redfield-like” average N:P stoichiometry for a cell with a 1micron radius (fourth column). That scaling is integrated over a power-law cell size distribution governed by a scaling exponent (fifth column), where the cell volume distribution on Earth is characterized on average by an exponent of -1 and an exponent of 0 refers to an ecosystem with equal abundances of all cell volumes.

Extended Data Table 4. Data compiled from Moore et al. (see Methods) on average phytoplankton cell quotas and average dissolved seawater concentrations of 17 different bioactive elements (see Methods for enumerated list). Elements are presented as ratios, with the more abundant element in phytoplankton biomass always as the numerator. The columns show the ratio (first column), the numerator element (second column), the denominator element (third column), the average phytoplankton biomass stoichiometry (fourth column), and the average dissolved seawater stoichiometry (fifth column). Rows are ordered by the most abundant element in phytoplankton for the ratio numerator, then denominator.

Extended Data Table 5. Scaling-based estimates of ratios from major elemental pairs highlighted in main text figure 4. Columns show the elemental ratio (first column), the dissolved seawater ratio (second column), the scaling-model based estimate of the phytoplankton biomass stoichiometry with 95% confidence intervals in parentheses (third column), and then the observed phytoplankton biomass ratio from Extended Data Table 4 (fourth column). For Enceladus-based estimated, the observed biomass ratios are listed as NA.