# Temporal and Vertical Dynamics of Unicellular Cyanobacterial Diazotrophs in the North Pacific Subtropical Gyre

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## ABSTRACT

Dinitrogen ($N_2$) fixation – a prokaryotic process important to ecology, biogeochemistry, and Earth's climate – supports approximately half of the carbon export at the North Pacific Subtropical Gyre site, Station ALOHA (A Long-term Oligotrophic Habitat Assessment, 23.75º N, 158.00º W) (Karl et al 1997, Dore et al. 2002). This process, also referred to as *diazotrophy*, facilitates the fixation of inorganic carbon into organic matter, and partially fuels the biological carbon pump (BCP), which sequesters carbon from the atmosphere and surface waters to the deep sea. While the filamentous marine diazotroph, *Trichodesmium spp.,* has historically been viewed as the dominant organism controlling $N_2$-fixation in the open ocean, size-fractionated $N_2$-fixation rate measurements at Station ALOHA indicate that smaller (<10 μm) microorganisms, including unicellular diazotrophs, contribute nearly three quarters of the bulk annual $N_2$-fixation. The apparent importance of the <10 μm diazotrophs begs an understanding of their population dynamics.

A molecular-based time-series of phylotype-specific *nifH* gene abundances was carried out over 24 near-monthly time points between September 2009 and March 2012, to assess population dynamics of three genera of unicellular cyanobacterial diazotrophs: *Atelocyanobacterium* (termed UCYN-A), *Crocosphaera,* and *Cyanothece*. On average, UCYN-A dominated the unicellular cyanobacterial diazotroph community throughout the water column, with greatest abundances occurring in the upper 75 m ($2 \times 10^5$ *nifH* gene copies $L^{-1}$). *Crocosphaera*, which exhibited intermediate abundance, was the most temporally dynamic, while *Cyanothece* was consistently the least abundant phylotype,

averaging between 10- and 1000-fold fewer *nifH* gene copies $m^{-2}$ than the other phylotypes studied. Both *Crocosphaera* and *Cyanothece* exhibited statistically significant seasonality in depth-integrated (0-125 m) abundances, with *Crocosphaera* exhibiting higher abundances in the summer (May – Oct.) (ANOVA, $p = 0.02$), and greater abundances of *Cyanothece* occurring in the winter (Nov. - Apr.) ($p = 0.04$).