Lake microbial communities are not resistant or resilient to repeated large-scale natural pulse disturbances

Katie Brasell\textsuperscript{1,2}, Jamie Howarth\textsuperscript{3}, John Pearman\textsuperscript{1}, Sean Fitzsimons\textsuperscript{4}, Xavier Pochon\textsuperscript{1,2}, Anastasija Zaiko\textsuperscript{1,2}, Kevin Simon\textsuperscript{2}, Marcus Vandergoes\textsuperscript{5}, and Susanna Wood\textsuperscript{1}

\textsuperscript{1}Cawthron Institute, Nelson, New Zealand
\textsuperscript{2}University of Auckland, Auckland, New Zealand
\textsuperscript{3}Victoria University of Wellington, Wellington, New Zealand
\textsuperscript{4}University of Otago, Dunedin, New Zealand
\textsuperscript{5}GNS Science, Lower Hutt, New Zealand

Opportunities to study and understand community level responses to extreme natural pulse disturbances in unaltered ecosystems are rare. Lake sediment records that span thousands of years can contain well resolved sediment pulses, triggered by earthquakes. These paleo-records provide a means to study repeated pulse disturbance and the processes of resistance (insensitivity to disturbance) and ecological resilience (capacity to regain structure, function and process). In this study, DNA preserved in lake sediment layers was extracted from a sediment core from a lake in a near-natural catchment. Metabarcoding and inferred functions were used to assess the lake microbial community over the past 1,100 years – a period that included four major earthquakes. Microbial community composition and function differed significantly between highly perturbed (postseismic, c. 50 yrs) phases directly after the earthquakes and more stable (interseismic, c. 260 yr) phases, indicating a lack of community resistance to natural pulse disturbances. A decoupling between community structure and function in successive postseismic phases suggest potential functional redundancy in the community. Significant differences in composition and function in successive interseismic phases demonstrates the communities are not resilient to large scale natural pulse disturbances. The clear difference in structure and function, and high number of indicator taxa in the fourth interseismic phase likely represents a regime shift, possibly due to the two-fold increase in sediment and terrestrial biospheric organic carbon fluxes recorded following the fourth earthquake. Large pulse disturbances that enhance sediment inputs into lake systems may produce an underappreciated mechanism that destabilises lake ecosystem processes.