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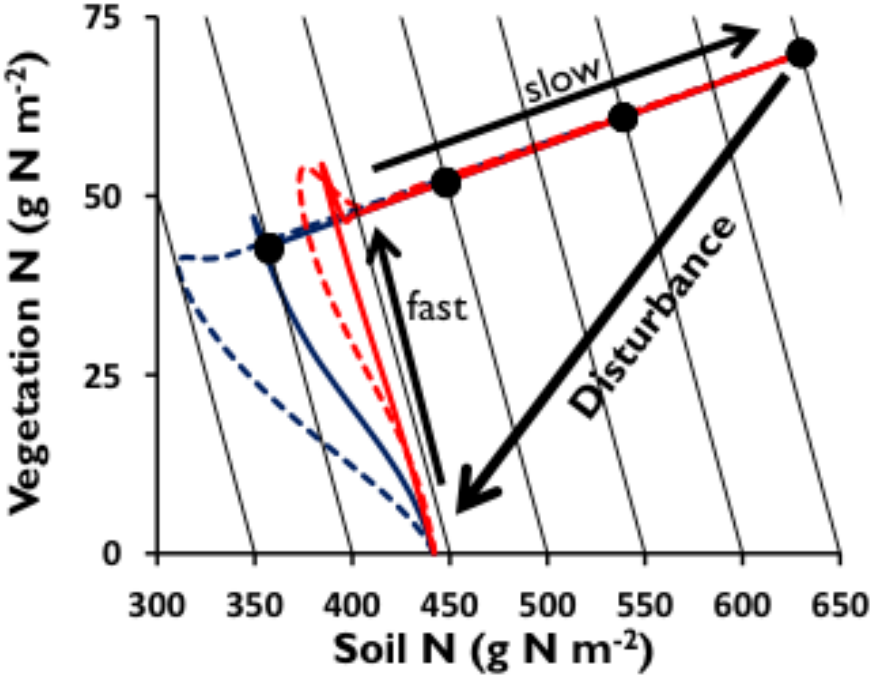
LTER NETWORK
LONG TERM ECOLOGICAL RESEARCH

TITLE SLIDE: It is not clear if we will be able to get into the field this year

Openness of ecosystem nutrient cycles influence response to disturbance



Because internal N cycle is fast relative to external nutrient supply, initial recovery is toward the quasi-steady state (trajectory defined by the dots).

Ecosystems with more open N cycles (dashed lines) have larger post-disturbance N losses than ecosystems with more closed N cycles (solid lines).

Ecosystems with mostly organic N losses (red) retain N better that ecosystems with mostly inorganic N losses (blue)

Initial recovery is fast and driven by a redistribution of N between soils and vegetation

Once soils and vegetation come into a quasi-steady state, long-term recovery to the true steady state is slow

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You are looking at simulated recovery trajectories for four ecosystems with vegetation N plotted against soil N.

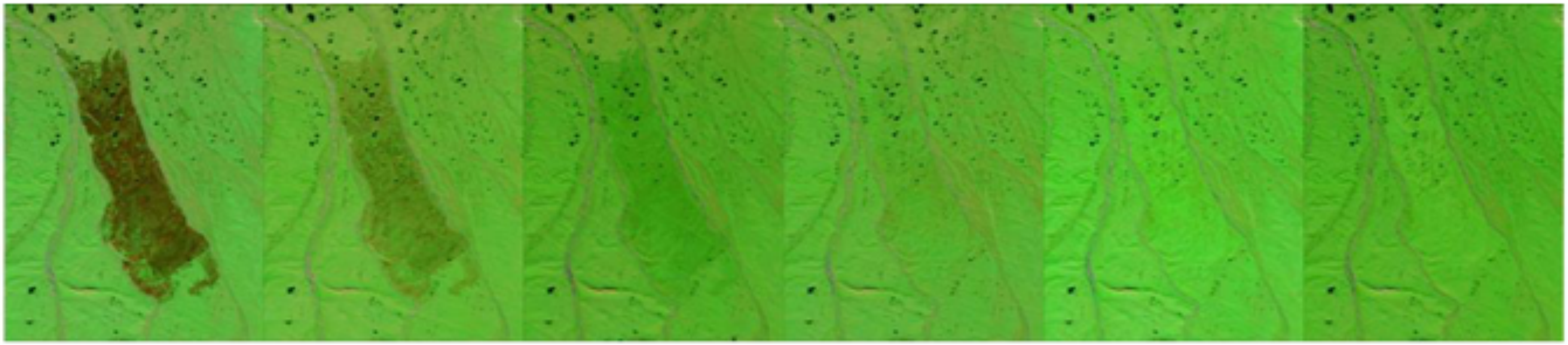
The thin diagonal black lines are isopleths of constant total ecosystem N.

The 4 ecosystems differ in the openness of the N cycle, defined as the ratio of inputs to internal cycling rates, and in the proportion of organic v inorganic N losses

The black dots are quasi-steady states that I generated by (1) setting the total ecosystem N to 400, 500, 600, & 700 g N m^{-2}; (2) closing the N cycle by forcing ecosystem N inputs to equal losses so there can be no net increase or decrease in total N; and (3) allowing the vegetation and soil to come into a balanced steady state under the closed N cycle.

When the N cycle is opened, the quasi-steady states define a continuous trajectory where soil and vegetation processes are in balance relative to one another and along which the ecosystem will slowly approach the true steady state.

Rapid recovery of greenness following Anaktuvuk fire: Falsification of slow-recovery hypothesis for less-open systems?



Aug 23 2008 | Aug 7 2009 | Aug 25 2010 | Aug 22 2011 | Aug 23 2012 | Aug 26 2013

The Anaktuvuk fire was set by lightning and burned 1000 km^2 of tundra (Mack et al 2011).
Sediments in nearby lakes have no charcoal back at least 5000 years (Hu et al. 2010).
Thunderstorms were rare 30 years ago, but are now common (climate change is real).
With the very slow rate of N input, we were surprised at this fast recovery of greenness.
However, the recovery is only skin deep, representing a quasi-steady state.
Recovery of lost carbon and nutrients will take millennia (if ever).

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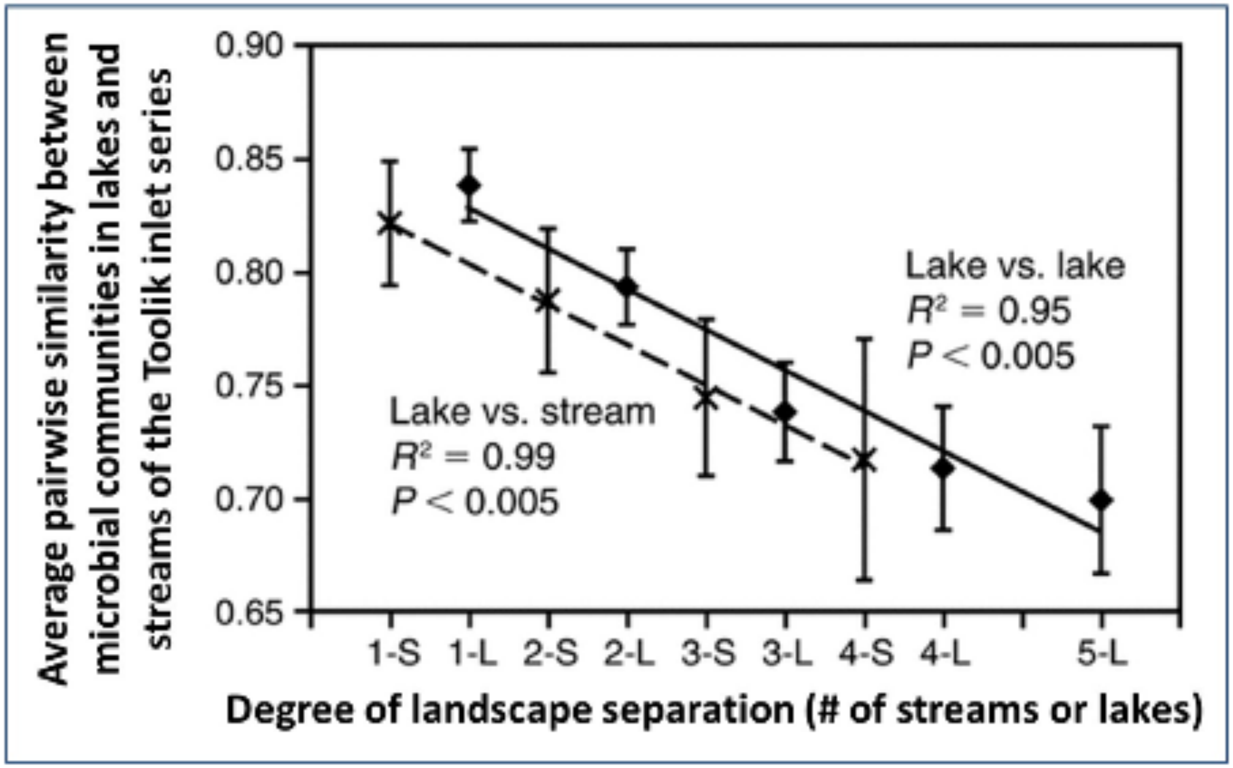
These are satellite images showing 6 years of recovery from the Anaktuvuk fire on the North Slope.

Connectivity across landscape facilitates propagation of disturbance responses



Microbial community in streams and lakes also seasonally connected to soil microbial communities in surrounding catchment during spring runoff.

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Crump et al 2007

Openness allows for connectivity across the landscape. Our microbial communities are seasonally open and highly connected from hillslopes, to streams, to lakes.

You are looking at a plot of the pairwise similarity in the microbial communities along a series of alternating streams and lakes feeding into Toolik Lake. Communities are more similar the closer they are in the series, but even well separated streams and lakes have a high degree of similarity.

Each spring the microbial communities in streams and lakes get a large input of terrestrially derived bacteria that then undergo sorting and selection through population and community processes, resulting in a repeating seasonal cycle in the microbial community structure in Toolik Lake.

Can we quantify the openness of nutrient cycles across the LTER network and test if and how it affects ecosystem responses to disturbances like wildfire, land-use change, and climate change?

Can openness serve as a metric to compare responses among very different types of ecosystem (terrestrial v. aquatic, fresh-water v. marine, &c.)?

Is there an analogous, widely applicable, metric for community openness that could serve as the basis for analyzing responses to disturbance and comparing responses among different types of ecosystem?

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