NIRB: Online Public Registry for SU's " Testing the impact of early land plants on the Earth system " Project Proposal

Public Registry - Project Proposals

NPC 151082: Testing the impact of early land plants on the Earth system

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Proposal Status: Conformity Determination Issued

Overview Documents

Project Overview

Type of application: New

Proponent name:

Erik Sperling

Proponent company:

Stanford University

Project Description:

The diversification and geographic spread of plants on land is one of the most profound changes in the history of our planet. Modern Earth is covered by lush tropical forests, seemingly endless grasslands, and soaring redwoods—in striking contrast to Precambrian landscapes that consisted largely of bare rock and microbial mats. Today ~55% of primary productivity occurs on land and animals have co-evolved with plants in terrestrial ecosystems for ~450 million years. Plants have altered the landscape; for example, the emergence of plants transformed river morphologies and the distribution of mud in sedimentary systems. They also affect Earth's climate and the global hydrologic cycle through evapotranspiration and by altering planetary albedo. Climatic changes, especially in the Devonian, have long been linked to plant evolution. While early land plants in the Ordovician and Silurian were small and morphologically simple, the Late Silurian through Devonian was characterized by the explosive diversification of vascular plants, including lycophytes, ferns, gymnosperms, and angiosperms. The mid-Silurian to Early Devonian (~430-393 Ma) was a particularly critical interval in land plant evolutionary and ecological history, during which plant body fossils show a dramatic diversification in taxonomic richness, body size, anatomical and physiological specialization, and reproductive diversity. Nevertheless, there are few robust constraints on the net impact of changes mediated by the emergence of land plants or the tempo with which these occurred. Two of the most fundamental—and most debated—aspects of how plants transformed our planet concern potential changes in long-term nutrient cycling and oxygen levels, both on land and in the oceans. It has been argued that plants increased nutrient input to the oceans, which drove increased primary productivity that both pushed anoxic and ferruginous (ferrous iron present; sulfide limited) water

masses towards euxinia (sulfide present; iron limited) and oxygenated the planet. However, it has also been argued that plants had no long-term effect. Previous hypotheses linking land plant evolution and marine geochemistry have been put forward primarily on the basis of modeling and summary figures of fossil and geochemical change from disparate paleogeographic areas. Here, we will directly test these hypotheses in a coherent stratigraphic framework based in Nunavut. Our work will be grounded in new observations and field work that feed into Earth-system modeling. These ambitious goals will be accomplished by a diverse team of paleontologists, sedimentologists, geobiologists, isotope geochemists, and biogeochemical and climate modelers. In 2023, our research team studied the Cape Phillips and Bathurst Island Formations at Grant Point, Bathurst Island, Nunavut (in Qausuittuq National Park). We collected samples for geochemistry and biostratigraphy and are currently in the process of preparing a paper on the geological framework for publication. Our overall goal (across the 2023 and 2026 field seasons) is to study both shallow- and deep-water depositional settings through the Silurian-Devonian transition in the southern Queen Elizabeth Islands. Specifically, in 2026 we will study the shallow-water carbonate formations (Allen Bay, Cape Storm, Douro, Barlow Inlet, Sophia Lake, Snowblind Bay, and Disappointment Bay formations) on Cornwallis Island (primary field area), Somerset Island, and potentially Truro Island. We will also study the shallow-water Blue Fiord and Bird Fiord formations, and the deeper-water Eids formation, in the Twilight Creek area, Bathurst Island, Qausuittuq National Park (we are applying for a separate Parks Canda research permit for this work and it is not described here in detail.) Overall, this fieldwork will result in a complete record spanning all depositional environments through this critical interval of Earth history. Our primary research camp for this work will be near Read Bay on Cornwallis Island. This represents the type section for the Barlow Inlet, Sophia Lake, and Snowblind Bay formations (Thorsteinsson and Uyeno, 1980). It also represents good exposures of the Allen Bay, Cape Storm, and Douro formations (Sodero and Hobson, 1979; Thorsteinsson, 1958). The strata are low maturity and a relatively short helicopter flight from the PCSP base in Resolute Bay. Finally, team member Dr. Martin Brazeau has previously worked in this area and is personally familiar with the stratigraphy. We are also planning a research camp at Twilight Creek, Bathurst Island, and we have submitted a separate Parks Canada application. The field team led by PIs Sperling and Tarhan, along with Inuit wildlife monitor Devon Manik and several graduate student team members and/or collaborators, will travel by commercial airline to the Polar Continental Shelf Project (PCSP) base in Resolute Bay and then by chartered PCSP helicopter to the vicinity of Read Bay, Cornwallis Island. We will measure the stratigraphic section through the Silurian-Devonian Allen Bay, Cape Storm, Douro, Barlow Inlet, Sophia Lake and Snowblind Bay formations in the Read Bay vicinity by Jacobs staff, collecting geochemical samples every ~2-5 meters and graptolite, brachiopod and conodont biostratigraphic samples from appropriate lithologies. Early plant and vertebrate fossils will also be sampled to understand the evolution of those groups. Samples will then be analyzed in our laboratories for sedimentary geochemistry (iron speciation, Total Organic Carbon contents and isotopes, carbonate carbon isotopes, redox sensitive trace metal abundances, biomarkers, phosphorous speciation, and lithium isotopes and cap17O isotopes in brachiopods) by graduate students and project partners at Stanford, Yale, and the University of California, Riverside. This work will be carried out between 7/15/2026 and 8/15/206. Our primary camps will be for ten days (Read Bay) and six days (Twilight Creek), exact dates determined based on aircraft availability. We are requesting permission to work in three additional areas (that may or may not be studied depending on logistics and permissions). First, we request to study the Cape Storm Formation exposed on Signal Hill and Cape Martyr near Resolute Bay. This would overlap with the study in Read Bay and would only be completed if we have extra days at the Polar Continental

Shelf Project (PCSP) research base in Resolute Bay due to aircraft or weather delays. Second, we hope to travel down to the Aston Bay Holdings/American West Metals mineral exploration camp on Somerset Island to study previously collected drill core through the Cape Storm and Allen Bay formations. Permission to visit this exploration camp and sample their drillcore is currently being negotiated with these companies and may or may not happen, but the scientific value of fresh drill core material would add greatly to our study. Finally, we have listed Truro Island as a possible backup site for our work in Qausuittuq National Park. The PCSP staff have been unable to confirm the landing strip near our site at Twilight Creek. In the event that we cannot land there, on the way home we would be flying back over the established strip on Truro Island. Truro Island hosts nice exposures of the Cape Phillips, Disappointment Bay, and Blue Fiord formations, and so we request permission to work there so that we do not waste researcher time, PCSP logistics, research budgets, and carbon dioxide costs of travel. We scouted the Twilight Creek strip from the air in 2023 and are confident we will be able to land and work in Qausuittuq National Park, and primarily list Truro Island as a backup out of an abundance of caution. Additional details are provided in the uploaded detailed project description.

Project Schedule

Start Date:

2026-07-15

End Date:

2026-08-15

Project Map

List of project geometries:

Id

Geometry

Location Name

20271

polygon

Read Bay--primary research camp locality

20272

polygon

Cape Martyr--possible research locality if extra days at PCSP base

20273

polygon

Signal Hill--possible research locality if extra days at PCSP base

20274

polygon

Twilight Creek--primary research camp locality

20275

polygon

Storm exploration camp--work on existing drill cores

20276

polygon

Truro Island--backup site if we cannot land at Twilight Creek

NPC Planning regions:

North Baffin

Project Land Use and Authorizations

Project Land Use:

Scientific Research

Scientific Research

Licensing Agencies:

Government of Canada - Parks Canada

Nunavut Impact Review Board

Nunavut Research Institute

Nunavut Water Board

Qikiqtani Inuit Association

Government of Nunavut - Department of Culture and Heritage

Material Use

Equipment:

Type

Quantity

Type

Use

Helicopter

1

36 feet

A helicopter will be used for transport to and from the Polar Continental Shelf base in Resolute Bay to our research camp in Read Bay

Twin Otter plane

1

50

A Twin Otter will be used for transport to and from the Polar Continental Shelf base in Resolute Bay to our research camp at Twilight Creek (or our backup site on Truro Island)

Fuel Use:

Type

Container

Capacity

Use

No data found

Hazardous Material and Chemical Use:

Type

Container

Capacity

Use

No data found

Water Consumption:

Daily Amount (m^2)

Retrieval Method

Retrieval Location

0

Unnamed streams near our camp location

Bucket or water bottles

Waste and Impacts

Environmental Impacts:

Impact: rock sampling. We will be collecting geological specimens for laboratory analysis. Mitigation: We will be collecting geological rock samples collected via hand or geological hammer. We will not be making any holes or excavations or using any mechanized equipment. All rock samples to be collected are normal rock samples with no aesthetic or commercial value. We will attempt to minimize the amount of sample being removed and use our rock hammers as little as possible and we will target easily accessible broken or fractured outcrops to avoid excessive hammer use. Impact: Small research camp (<10 people) Mitigation: We operate on the philosophy of no (or at least minimal) impact. Multiple members of our team have had over a decade of experience carrying out fieldwork in the Arctic. We will leave no rubbish or other trace of our base camps or sampling locations. No campfires are allowed in camp and we only use small, gas-powered stoves. Dr. Sperling and Dr. Tarhan have worked and camped in many remote areas during previous field seasons throughout northwestern Canada (and elsewhere in the Arctic) during previous field seasons, and have left campsite areas essentially indistinguishable from before arriving, in keeping with the wild character of these field areas. Our team previously did fieldwork in Qausuittuq National Park in 2023 at Grant Point, and our camp area was essentially unchanged (photos available on request). In fact we left it ‘cleaner than we found it’ by hauling out some minor trash apparently left by an older and less careful field party (the previous geological work at that site was in the late 1980s). All human waste will be collected and returned to the PCSP base in Resolute Bay.

Waste Management:

Waste Type

Quantity Generated

Treatement Method

Disposal Method

Sewage (human waste)

144 people-days

None.

Collection and return to PCSP base in Resolute Bay for disposal.