

**Fellow:** Jeffery A Hatten

**OECD Theme:** Managing Natural Capital for the Future

**Project Title:** Long-term effects of forest management on soil carbon: Understanding the mechanisms of soil carbon vulnerability and resilience to harvest

**Host Institution:** New Zealand Forest Research Institute (trading as Scion)

**Host Collaborator:** Dr. Peter Clinton

**Dates of Fellowship:** 28 June 2019 to 30 Aug 2019

**Consent to my report being posted on the Co-operative Research Programme's website:**

Yes

## **1. What were the objectives of the research project? Why is the research project important?**

Soil organic carbon (SOC) is a critical component of soils and central to soils' function to provide ecosystem services (e.g., plant productivity, hydrologic process). Furthermore, soils comprise the largest pool of terrestrial organic carbon. Forests cover about 30% of the earth's terrestrial surface, and forest soils account for a similar proportion of the global terrestrial pool of soil organic carbon. Disturbances such as harvesting can remove substantial portions of a forest's aboveground C stores and mineral associated SOC pools can change in response. The overall objective of this proposal is to illuminate the mechanisms that result in vulnerability or impart resilience to forest SOC after extreme disturbances. Our central hypothesis is that organo-mineral complexes are resistant to disturbance-induced degradation and that decaying roots left after harvest readily replace any SOC vulnerable to loss after harvesting. By meeting our objectives, we will be able to understand which soils are most vulnerable to losses and degradation and develop management strategies that maintain or enhance forest SOC in managed settings. This work was guided by 2 specific objectives:

Objective #1: Determine the mechanisms of resistance in SOC to forest harvesting across a gradient in SOC stabilization mechanisms.

Forest soil can resist SOC loss due to severe disturbances as a result of stabilization mechanisms that have recently elucidated. We will examine the dynamics of SOC stabilization across archives of soils collected from a widely applied biomass removal study. This study encompasses a broad spectrum of soils and climates and will allow us to determine if the mechanisms of stabilization and resistance to change are different by soil or forest type.

Objective #2: Determine the source of SOC in harvested and unharvested forest soils across a gradient in SOC stabilization mechanisms.

Forest soils can be resilient against C losses by recovering C within stabilized pools within a short period. The mechanisms of resilience could be a result of 1) increased inputs of residual roots created as a result of forest harvesting. Using a biomarker approach, we will determine the quantity and source (belowground or aboveground and fresh versus degraded) of C contributing to the resilience of SOC.

## **2. Were the objectives of the fellowship achieved?**

The objectives of this work are on the way to being achieved. We were able to locate and subsample 34 years of archived soils from four different sites in New Zealand that had been collected from pre-harvest (1985-1994) through end of rotation (2014-2017) of radiata pine plantations in New Zealand. After Over 950 samples were shipped from Scion to Oregon State University in early October. While in New Zealand I was able to visit many sites or nearby sites

similar to the study sites where soils were archived from. The timing of the arrival of samples did not allow us to complete the lab work initially proposed. However, while in New Zealand we received funding from the USDA AFRI program to expand on this work. This set of New Zealand samples will be combined with samples from other long-term soil productivity experiments around the world. Currently we have agreements with collaborators in the northwest and southeast US and have reached out to several groups in Canada and Europe to determine if any samples are available from those areas. Currently a PhD student is overseeing the sample acquisition and analyses.

### **3. What were the major achievements of the fellowship? (up to three)**

- Improved networking, communication, and collaboration between home institution and host agency.
- Sample acquisition
- Initiation of larger project

### **4. Will there be any follow-up work?**

**Is a publication envisaged? Will this be in a journal or a publication? When will it appear? Is your fellowship likely to be the start of collaboration between your home institution and your host? Is your research likely to result in protected intellectual property, novel products or processes?**

Given that this project has been given a major expansion with the funding from USDA-AFRI, follow-up work will be completed over the next 3 years and includes:

1. Acquiring samples from other long-term soil productivity studies
2. Analysis of sample set for carbon stabilization mechanisms (biomarkers, mineralogy,  $^{14}\text{C}$ , density fractions, etc.)
3. Publication of a dissertation and several manuscripts (OECD Co-operative Research Programme will be notified and acknowledged for their funding contribution)

### **5. How might the results of your research project be important for helping develop regional, national or international agro-food, fisheries or forestry policies and, or practices, or be beneficial for society?**

By understanding the mechanisms that impart resilience to forest SOC stocks after harvesting induced disturbances, we will be able to understand which soils are most vulnerable to losses and degradation and develop management strategies that maintain or enhance forest SOC resistance and/or resilience in all managed settings. The current New Zealand government has set an aggressive environmental and sustainability agenda. The expansion of this project will allow us to generalize our findings well beyond New Zealand so that this research will help most

forested countries meet carbon and forest targets by facilitating the planting of managed forests on those lands that are most resilient against harvesting impacts. Using this knowledge, we will inform forest managers of the soils, sites, and situations that 1) require special care to maintain SOC or reduce SOC losses, and 2) are particularly resilient to the activity they are proposing (e.g. prescribed fire, timber harvest), and then 3) begin to develop strategies that enhance SOC storage in forest soils.

## **6. How was this research relevant to:**

The goal of this proposal was to improve our ability to predict the response of SOC in managed forest and ultimately develop management strategies to improve SOC stocks. The focus on sustainable management and intensification at the stand- and landscape-scales to improve soil carbon stocks while maintaining or increasing the economic vitality of the forestry sector.

## **7. Satisfaction**

The fellowship was a complete success and helped me develop a new network of collaborators that would have been nearly impossible without the funding assistance. Through this fellowship I have connected many other colleagues from my home institution to those at Scion, thereby further extending the impact of this fellowship. This experience has furthered my career the expansion of my network, initiating a new and unique sample- and data-set, and establishment of new lines of research not part of my OECD fellowship proposal (e.g. sediment source tracking).

## **8. Advertising the Co-operative Research Programme**

I learned about the Co-operative Research Programme through my collaborators, Drs. Peter Clinton and Brian Strahm. I had not heard of the fellowship opportunity prior to that opportunity. Past fellows may be able to share announcements for current funding calls to their scientific communities.