Final Report

Measuring the impact of invasive browser management on carbon storage in forests. Phase 1 – Technical feasibility

No. SS2/03/03

20 June 2024

Does a 'healthy' native forest **absorb more carbon** from the atmosphere than one that is stressed or degraded by introduced animal pests?

Can we **measure** carbon sequestration with **enough** precision, to prove that intensive pest management results in a significant increase in carbon stocks in native forests?

If we can, then could this help Aotearoa New Zealand meet our international greenhouse gas emissions obligations and **save billions** of dollars that would otherwise be spent on overseas carbon credits, as well as increase our **resilience to climate change** and **restore biodiversity**?

These are the questions that ZIP, in collaboration with key partners and stakeholders, has set out to answer. Since we first began exploring the answers to these questions late last year, we have: established a small, dedicated carbon team within ZIP, and a group of external experts who work alongside us; begun measurements at our proof-of-concept trial in South Westland; and begun investigating additional study designs and locations to help build the evidence base.

Project Aims

ZIP's wider carbon programme aims to address this critical need for empirical evidence to inform on whether or not reducing invasive browsing mammals (including possums) to low levels, maintains or increases carbon stocks (and/or rate of storage) in New Zealand forests. PF2050 Ltd provided co-funding for the first year of the initial study to prove technical feasibility, based on one set of paired treatment and non-treatment sites, where the 'treatment' is the level of pest management.

Progress

The proof-of-concept paired site trial is well underway and all PF2050 Ltd. milestones have been achieved.

The research programme has been developed in collaboration with researchers from SCION and NIWA. It involves comparing carbon stocks and sequestration rates of two forests in South Westland, one which has no history of aerial pest management and one where pests are managed to extremely low levels.

The programme uses novel carbon measurement technologies that are sensitive to tiny changes over short time periods. These include monitoring stations that precisely measure atmospheric carbon dioxide concentrations before and after the air has passed over the forest, as well as point dendrometers that measure tiny changes in the diameter of individual trees. The data from these instruments will enable us to report small changes in carbon sequestration rates and stocks over short periods of time.

Assessing the forest's uptake of carbon dioxide from the atmosphere

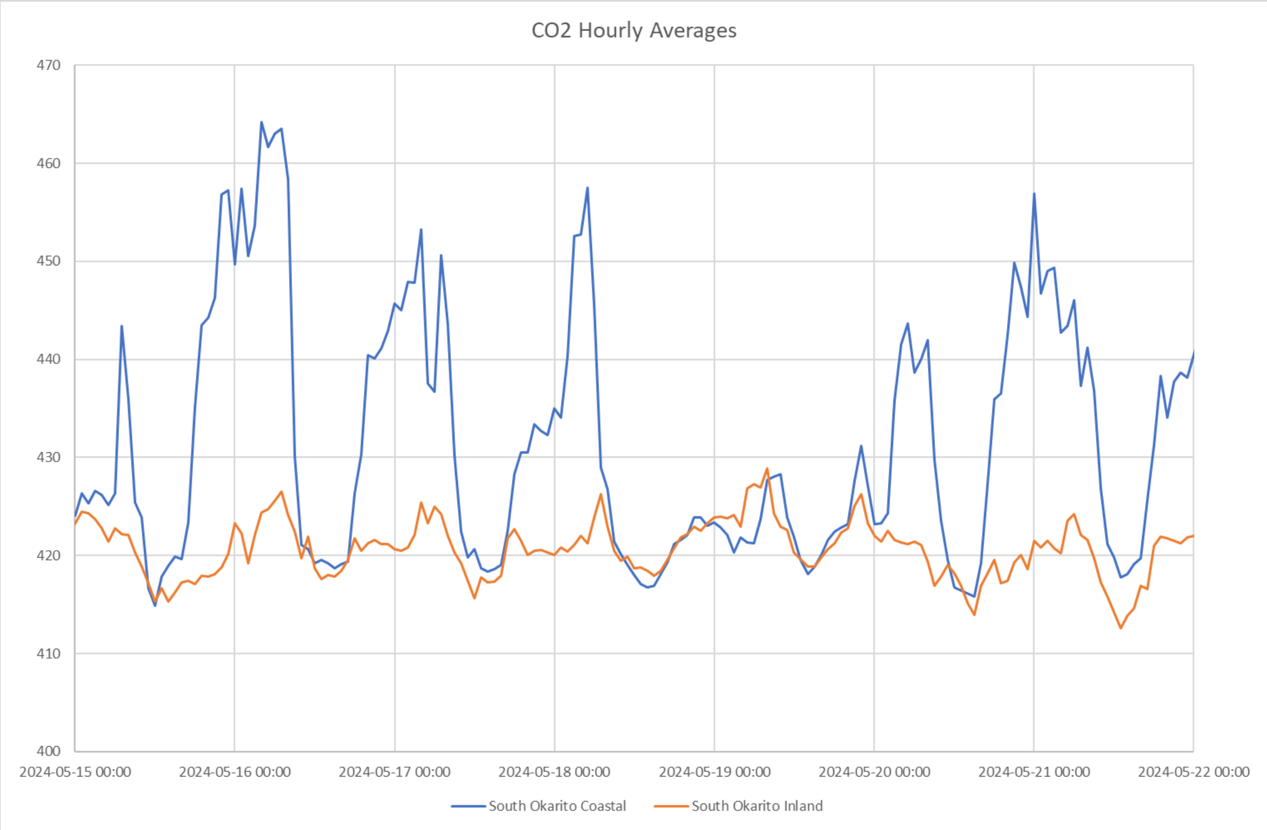
We are working with NIWA to see if the forest ecosystem within the treatment site removes more carbon dioxide (CO2) from the air, than in the non-treatment site. At both sites, we will measure CO2 in the air at two locations; the coast and inland. Firstly, at the coast we measure the clean air as it comes off the ocean. This air then travels across the forest where CO2 is taken up by trees through photosynthesis and released through respiration and decomposition. Remeasuring the air at the inland site, after it has blown over the forest, shows us how much CO2 has been taken up by the trees, soils and other parts of the forest ecosystem.

Four monitoring stations have been installed (at a coastal and inland location at both sites). First the instruments that measure the CO2 needed to be supplied with power and protected from the elements (including inquisitive kea!). Two of the locations are also very boggy which meant keeping the instruments dry and in place was also going to be a challenge. Our engineers did a great job modifying four small shipping containers to meet these needs, including building two floating pontoons.

The instruments that measure the CO_2 were assembled, calibrated and tested by NIWA in Wellington, before being shipped to South Westland and installed in April. After some initial teething issues with two of the monitoring stations, all four stations are now reporting data reliably. NIWA has begun to provide us with reports on their operations, including preliminary assessments of differences between coastal and inland sites for the two study areas.

Left: Container being helicoptered into position. Right: container with floatation pontoon, solar panels and air sampling tube. Photos by John Wilks.

Above: ZIP Engineer John Wilks inspects CO_2 monitoring instruments inside a station. Photo by Bradley Sheilds



Above: A week of atmospheric CO2 data from the treatment site showing preliminary differences between the coastal (blue) and inland (orange) sites.

Assessing how much carbon is stored by the forest

While the atmospheric CO2 measurements will help us understand how the forest ecosystems are sequestering carbon over time, they can't tell us where that carbon is going. For this we need to measure how much carbon is being stored in the forest. We are using a range of methods to measure characteristics of interest that, together, we expect will help to determine the carbon pools (where it is stored) and stocks (the amount of carbon stored) at both sites.

Above: Setting up a vegetation plot. Photo by Hamish Foxwell.

We sampled vegetation at 30 plots, spread throughout the sites. This involved intensive identification, measurement and counting of the trees, saplings and seedlings within each plot. Allometric models are then used to calculate the carbon stored above and below ground (in roots of vegetation). While this method is not sensitive enough to detect very small differences in carbon storage over our short timeframes (less than 3 years), it may, in time (10 years +) provide additional evidence for differences in carbon storage. The data collected will also help correlate carbon stock estimates with other measurement techniques.


Above: A point dendrometer measuring the growth of a miro tree. Photo by John Wilks.

To detect small changes in the amount of carbon being stored by trees, we need a more sensitive technique. Point dendrometers may be the answer. These instruments measure how a tree grows over time, from which we can determine how much atmospheric carbon has been converted into wood.

A point dendrometer is essentially a small piston attached to the bark of the tree. A sensor rod sits against the trunk and measures tiny (microscopic) changes in the tree's girth. Those changes are recorded by a data logger, and the information is sent out via the cellular network, every 10 minutes.

In collaboration with SCION, in January we began a pilot study using 10 dendrometers to understand how well these devices work in our wet and remote forests. The dendrometers are holding up well and already providing some very interesting insights into the growth of our native trees.

Future Work

Within the proof-of-concept study, we will continue to collect data on atmospheric CO2 levels. To analyse this data, NIWA will need to further develop and increase the resolution of their models. Two years of data (to mid-2026) will be required to allow for any anomalies in weather patterns. We plan to expand the use of dendrometers across the sites and are developing our own dendrometer (which is expected to be much cheaper and better suited to local conditions than those currently available commercially). We will soon measure soil fertility at both sites. Throughout the study we will continue to monitor possum and ungulate densities to ensure they remain at the expected levels. We are also investigating other methodologies for example, hyperspectral camera imaging. Hyperspectral imagery could be used to examine forest canopy health including damage from possum browsing and potentially be useful for scaling results across other forests.

To help build the evidence base, we will begin work at a new site, where we will look to understand carbon stocks and sequestration before and after pest animals are reduced to extremely low levels. 'Before' measurements will begin in FY25.

We are also interested to see whether we can retrospectively understand the long-term (decadal) recovery of trees after animal pests are removed. Our hypothesis that possum browsing limits a trees' ability to photosynthesise and therefore maximise carbon sequestration through radial tree growth. To test this, we would like to take cores from trees in an area where possums were eradicated a long time ago, to investigate the history of tree growth through annual growth rings. These rings reflect each season of a tree's growth and allow us to look back in time to understand what the growing conditions were like and how much carbon the tree was able to store during certain periods i.e. before and after possums were removed.

Thanks to PF2050 Ltd!

We are grateful for the support of this work shown by PF2050 Ltd and other forward-thinking early investors.