# Pre- to post-harvest net ecosystem productivity of a Douglas-fir forest: a comparison of a site-specific disturbance in a chronosequence study

**E. Paul-Limoges [1,2], T.A. Black [1], A. Christen [2], Z. Nesic [1], N.J. Grant [1], R.S. Jassal [1], T. Baker [1], R. Ketler [1,2]**

[1] Faculty of Land and Food Systems, University of British Columbia, [2] Dept. of Geography, University of British Columbia

**B31A-0387**
AGU Fall Meeting
Dec 3-7,2012
San Francisco, CA

## Introduction

Chronosequence studies, where current different-aged stands are used to reconstruct the development of an older stand, have been used to characterize the net ecosystem productivity (NEP) at different stand ages following disturbances. NEP is the balance between gross primary productivity (GPP) and ecosystem respiration (R). Almost no replicated observations have been made within the FLUXNET community comparing the NEP of similarly aged stands in a particular ecosystem. Chronosequence studies assume that all sites differ only in age, and have had the same history in their abiotic and biotic components; this main assumption has been shown to be invalid in several ecological studies using chronosequences and replications are needed to explain these differences.

### Objectives:

1) To quantify the NEP of a recently harvested West Coast Douglas-fir forest.
2) To compare this post-harvest NEP with that before harvest at the same site and with that of another clearcut 3 km away.

## Study Sites


**Pre-harvest stand** ➡ **Post-harvest stand** **The other clearcut**

**Fig. 1** The study sites (DF49, HDF11 and HDF00) are part of the Fluxnet-Canada Douglas-fir chronosequence on Vancouver Island.

**DF49:**
- Pre-harvest DF49 stand. DF49 was the most mature Douglas-fir stand of the chronosequence, planted in 1949. It was monitored from 1997 to 2010, when it reached harvesting age and was commercially harvested during the 2011 winter.

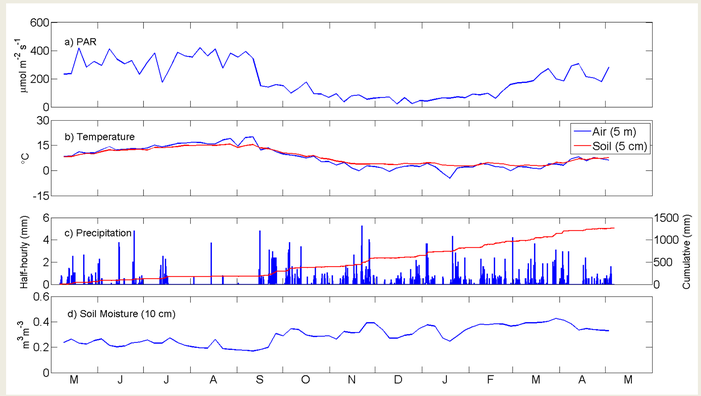
**HDF11:**
- Post-harvest DF49 stand. The site was replanted during the 2011 spring. It has been monitored since April 2011.

**HDF00:**
- Another clearcut harvested stand in the chronosequence. It was harvested and replanted in 2000. It was monitored from 2000 to 2011. HDF00 is 3 km southwest of DF49/HDF11.

## Climate and $CO_2$ Fluxes at HDF11

**Fig. 2** Closed-path eddy covariance system at a height of 4.5 m above the ground. Measurements are taken at a frequency of 20 Hz and calibrations are done daily.

**Fig. 3 Climate at HDF11 from May 2011 to 2012**




In Fig. 3 a, b and d show 5-day running means. During this first year of measurements from May 2011 to 2012, weather conditions were normal. Mean air temperature was 7.8 °C and annual precipitation was 1265.7 mm.

**Fig. 4 Carbon fluxes at HDF11 from May 2011 to 2012**

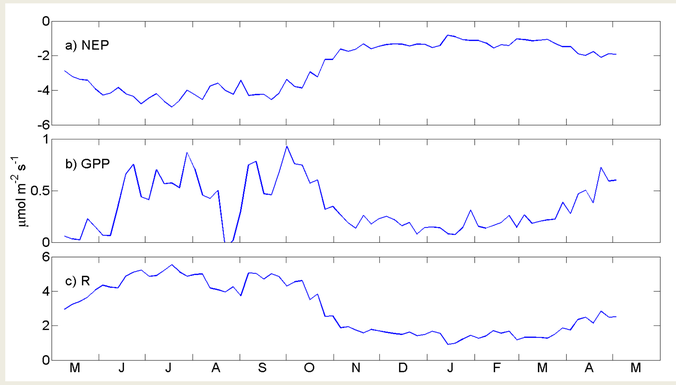
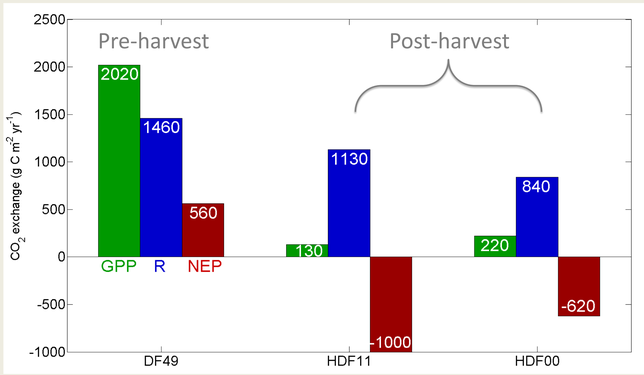



Fig. 4 shows 5-day running means. During the first post-harvest year, HDF11 was a source of carbon (negative NEP) all year, being a greater source in summer than in winter. R was much greater than GPP thus accounting for most of the measured NEP. GPP was relatively small even during the summer due to slow recovery of vegetation.

## Chronosequence Comparison

**Fig. 5 Comparison of $CO_2$ fluxes at DF49, HDF11 and HDF00**

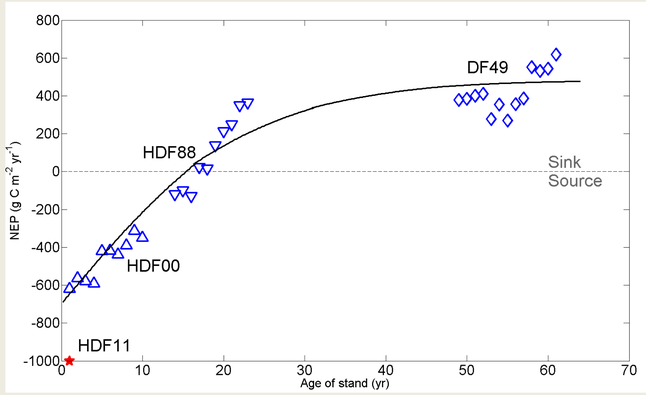



In Fig. 5, $CO_2$ fluxes represent the first year of measurements following harvesting at HDF11 and HDF00, and the average of the last 4 years of measurements at DF49.

From pre- to post-harvest, the stand transitioned from being a sink of 560 g C $m^{-2}$ $yr^{-1}$ (DF49) to being a strong source of 1000 g C $m^{-2}$ $yr^{-1}$ (HDF11).

In comparison, the previously harvested stand (HDF00) was a weaker source (620 g C $m^{-2}$ $yr^{-1}$) due to a lower R and a greater GPP.

**Fig. 6 NEP as a function of stand age for all sites in the chronosequence**




The line in Fig. 6 represents the fit for the Douglas-fir chronosequence before harvesting DF49[1]. As in most FLUXNET studies, this chronosequence was based on only one replicate for a particular stand age.

The difference in $CO_2$ fluxes in the first year after harvesting at HDF11 and HDF00 indicates there can be differences among same-age sites and suggests the need for more replications to characterize the NEP for an ecosystem-specific stand age following a disturbance.

[1]Results from previous studies, e.g., Humphreys et al. (2006) *Agric. For. Meteorol*. 140, 6-22 and Jassal et al. (2010) *Agric. For. Meteorol*. 150, 208-218. HDF88 was planted in 1988 and has been monitored from 2000 to 2012.

## Conclusions

- From pre- to post-harvest, the site transitioned from being a moderate sink to being a strong source of $CO_2$.
- Large differences in $CO_2$ fluxes were measured in the two clearcuts in the first year following harvesting.
- These differences are likely due to:
  - Vegetation recovery following harvesting
  - Site characteristics affecting respiration
- The results show the importance of replications to characterize the NEP for an ecosystem-specific stand age following a disturbance.

## Acknowledgements

This study was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery grants #342029-07 (Christen) and #6123-07 (Black). E. Paul-Limoges was supported by NSERC through an Alexander Graham Bell Postgraduate Scholarship and through the Canadian Meteorological and Oceanographic Society (CMOS) –Weather Research House NSERC Scholarship supplement.