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How to calculate the benefits of planting trees to help meet carbon reduction goals

By Jen Vanderhoof

In 2013, the King County Department of Natural Resources and Parks (DNRP) made a commitment to go "Beyond Carbon Neutral" by setting an ambitious target to meet and even exceed zero net greenhouse gas emissions for all of its operations. To determine the progress at reaching this goal, greenhouse gas emissions (measured in terms of metric tons of carbon dioxide equivalent, or MT CO2e) generated by the department's various operations are added together and compared to the amount of carbon taken from the atmosphere ("sequestered") by various off-setting activities, such planting trees. Although the department has many projects that involve tree planting, a big question remained: how do you calculate the amount of carbon sequestered by newly planted trees in order to help assess whether or not you are meeting the goal?

The amount of carbon sequestered depends upon the age of the tree. It is not practical to physically measure the amount of carbon sequestered from fully mature, individual trees – the timescale is too long. Likewise, newly planted trees are very small and far below their eventual sequestration capacity. Therefore, calculating sequestration relies on coming up with a model or formula that involves a series of steps and assumptions.

A first step in determining a carbon sequestration calculation formula is to choose a time frame over which carbon sequestration would be calculated. After considering several options, we selected the relatively simple approach of calculating the carbon sequestered over the lifetime of trees planted during a given calendar year. Then we needed to decide how long a tree "lifetime" lasts. A review of the

literature suggested that a leveling-off for the rate of sequestration occurs at about 100 years, so we selected 100 years as the lifetime for trees planted each year.

The next decision was which data source to use for carbon-sequestration estimates for individual trees. Several lookup tables are available that provide default estimates of carbon sequestration that represent average forest conditions by region, ownership class, forest type, and productivity class. These tables are very general and created from data collected in geographic areas that may or may not be similar to where we plant trees. We ultimately selected a set of individual-tree based look-up tables, created by US Department of Energy (USDOE). Although the authors warn that these tables are intended to be used for trees in urban settings, these tables appeared to be most appropriate for our situation, where we often only have the total number of trees and not the size of area planted. Because these tables only went to year 60, data in the tables were extrapolated to year 100. We chose USDOE's sequestration rates for Fast-growing Hardwood and Moderate-growing Conifer for 2013 and 2014 calculations based on the predominant species planted in those years. Based on the approximate proportions planted of those two tree types, the average amount of carbon sequestered over the lifetime of each tree planted in 2013 and 2014, provided it lives to 100 years, is estimated to be 13.88 MT CO2e.

The final step in estimating carbon sequestered from tree planting activities was to determine tree survival rate. After reviewing forestry data and comparing results to other studies, we settled on relatively conservative survival rate of 20 percent.

The final formula for calculating the total carbon sequestered from a year's tree planting activities is:

MT CO2e x S x T

where:

MT CO2e is the lifetime equivalent of metric tons of CO2 for each tree, derived from modified USDOE tables;
S is the tree survival rate (we assumed 0.2, or 20 percent); and
T = number of trees planted in a given year (by surveying King County projects, we estimated that King County projects included planting 67,213 trees in 2013, and 83,255 in 2014).

After applying this formula (and rounding to the nearest 1,000), we estimate that carbon sequestration from the department's tree planting activities in 2013 and 2014 amounts to approximately 187,000 and 231,000 MTCO2e, respectively, over their lifetime.

As more research is done in this field, we may refine our calculation methods. Further, trees planted this year won't reach these sequestration levels for another 100 years. But as we plant more trees each year, and King County's proposed Strategic Climate Action Plan increasingly relies on promoting tree planting as a tool to address climate change, it is clear that the department's tree-planting activities help meet our carbon reduction goals.

More information on King County Climate change efforts is found here:
www.kingcounty.gov/environment/climate.aspx

Contributor to King County's SciFYI

Jen Vanderhoof

Jen is a Senior Ecologist in the Science and Technical Support Section. Her work often focuses on issues related to wildlife, biodiversity, and climate change. Jen frequently contributes to interdisciplinary projects involving the Parks Division, Roads Services Division, the Director's Office, and the Floodplain Management Section. Jen's hobbies include photography, and she brings this talent to bear at work whenever possible.

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Section Manager: Dave White
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Send questions, comments and future story ideas to:

Kate O'Laughlin - kate.olaughlin@kingcounty.gov, 206-477-4789

Jim Simmonds - jim.simmonds@kingcounty.gov, 206-477-4825

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