# The Carbon Stocks of Peatlands under Forestry in the Republic of Ireland.

**Michael Wellock[1] , Christina LaPerle[1] , Ger Kiely[1] , B. Reidy[2] & T. Bolger[2].**

(1). *Centre for Hydrology, Micrometeorology and Climate Change, Department of Civil and Environmental Engineering, University College Cork, Ireland.*

(2). *Department of Zoology, School of Biological and Environmental Science, University College Dublin, Belfield, Dublin 4, Ireland*

**Contact information: m.wellock@student.ucc.ie | t: +353-21-4903025 | f: +353-21-4276648 | http://www.hydromet.org/**

## Abstract

**As part of it's commitments to the UNFCCC, Ireland must publish inventories for greenhouse gas emissions (GHG) for both sources and removals by sinks. Forestry is one of a number of sectors that must report a GHG inventory. Within Ireland there has been work undertaken to estimate the C stored within the biomass of the national stock, but there has been little work on the C stocks of the forest floor and soils under forestry. This is especially true for peatlands. To assess the C stocks of peatlands under forestry, 20 afforested peat sites will be selected from the National Forest Inventory List (NFI, 2007) , covering both blanket and basin peats. At each site the peat will be sampled every 50 cm down the entire depth of the profile to determine the C content and the bulk density. Along with the soil sampling the forest floor will be sampled for fine woody debris, litter and humus layers for analysis of the C content and volume. This data will be combined with similar work that is being undertaken on afforested mineral and peaty mineral soils within Ireland, and with this information new default estimates for C stocks s in Irish forest soils (including the litter layer) will be developed. These estimates will substantiate reporting to the United Nations Framework Convention on Climate Change (UNFCCC). Also, with this data, total soil C stock in Irish forest soils can be computed. All soil samples will be archived for possible further analysis.**

## Background.

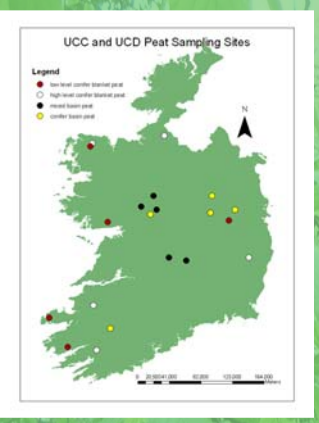


**Figure 1 – Map of Ireland showing the sites selected for sampling.**

**For centuries Irish forests had been over exploited and at the beginning of the twentieth century the national forest stock only accounted for 1% of the total land cover (Pilcher & Mac an tSaoir, 1995). However, it has been an important issue within government for a number of decades to increase forest cover within Ireland, and in 2007 the forest area was reported to be 10% (NFI, 2007). Peatlands became an attractive option for planting in Ireland as competition with agriculture meant that forestry was forced onto land that was marginal and submarginal for agriculture (Byrne & Milne, 2006). This has led to peat being the largest soil type of Irish forests with 42.2% of the total Irish forest cover (NFI, 2007). The main species that were planted on peatlands were Sitka spruce (*Picea sitchensis* (Bong.) Carr.) and lodgepole pine (*Pinus contorta* Dougl.). These forests were planted in large monocultured stands. This afforestation of peatlands began in the early 1950s and while still continuing, afforestation rates have decreased from 56% in 1990 to 29% in 2003 (Black et al., 2009).**

**There are two major types of peatland in Ireland, fens and bogs. Bogs are the most common type of peat to be forested with 42.2% of the total forest cover while fens only represent 1% of the total forest cover (NFI, 2007). Bogs are ombrotrophic which means that there water supply is from the mineral-poor rainwater. Bogs can be divided into two types, blanket and basin.**

**Blanket Bogs.**
**Globally, blanket bogs are a small part of the total peatland area, accounting for ca. 3% of the global peatland area (Foss et al, 2001). However, blanket bogs are an important form of peatland in Ireland as they comprise approximately 18% of the total peat area of Ireland (Hammond, 1981). In an undrained state blanket bogs can be between 1 and 6 m deep. Blanket bogs are found predominantly on the western seaboard and on the higher altitudes of mountains. And represent 0.196 Mha or 31.5% of the total forest area within Ireland.**

**Basin (or raised) Bogs.**
**Basin bogs in an undrained state can be found to be from 3 to 12 m deep and are predominantly found in the midlands of Ireland and represent 0.066 Mha or 10.7% of the total national forest area.**

**This work aims to provide much needed data on not only the depth of peat under forestry, but also important physical and chemical properties such as bulk density and C content. This data is severely lacking in Ireland (Tomlinson, 2005) and will be a large asset for modelling soil C stocks.**

## Methods

**Site Selection.**

**To determine the carbon stocks of forested Irish peat 20 sites around Ireland have been randomly selected from the NFI (National Forest Inventory, 2007). The NFI list was screened so that those sites that were of the wrong soil type, reforested, younger than 15 years or had poor access were removed from selection. The 20 sampling sites comprise**
**5 conifer, low level blanket peat sites (peats located at elevations lower than 150 m), 5 conifer, high level blanket peat sites (peats located at elevations greater than 150 m), 5 conifer basin peats and 5 mixed conifer and broadleaf (both conifer and broadleaf afforested) basin peats. If any peat site is not appropriate for sampling, then a back up site from the same category, i.e. mixed conifer basin peat, will be randomly chosen to replace it.**

**Table 1 – Showing the Sites to be sampled as part of the project..**

| | Number of sites to be sampled. | | |
|---|---|---|---|
| Forest Type | High Level Blanket Peat | Low Level Blanket Peat | Basin Peat |
| Conifer | 5 | 5 | 5 |
| Mixed | - | - | 5 |

**Sampling Methodology.**

**Plot Layout.**

**Within each forest site a 20m x 20m plot is laid out. Within this plot 2 types of samples will be taken, soil and forest floor samples. For the soil sampling the plot is to be split into sixteen, 5m x 5m squares, while for the forest floor sampling the 20 x 20 m plot is split into four 10 x 10 m squares.**

**Soil Sampling.**

**Within each square a point is chosen at random and at this point the litter layer is removed and using a peat sampler (Eijlelkamp, NL) the peat soil is sampled for the 0 – 50 cm depth. To sample the next interval the sampling point is moved 10 cm west of the initial sampling point and sampled for 50 – 100 cm so as to reduce the impact of compaction from the previous sampling. The next sampling point is again moved 10 cm west of the previous point to sample the next interval at 100 – 150 cm. For the next sample it is taken back to the original sampling point to sample for the 150 – 200 cm. The entire profile is sampled every 50 cm down the profile upto a maximum of 10 m. This is repeated for each of the 16 sampling points within the 20 x 20 m plot.**

**Figure 2 – Picture of the 50 cm peat core taken during sampling.**

**Forest Floor Sampling.**

**Within each 5 x 5 m square a random point is selected for litter sampling. A 0.1 m2 quadrat is placed and all dead material underneath is collected. The material is split into three separate samples, Fine Woody Debris (all dead material with diameter > 2.5 cm and < 7.5 cm), Litter (all dead, undecomposed material <2.5 cm in diameter) and F/H horizons (all dead material in a state of decomposition under the litter layer). Where soil is mixed with the F/H horizons the material is classed as soil. The forest floor is sampled twice more, one sample 1 m to the east of the original sample and the second 1 m west of the original sampled the same way as the original.**

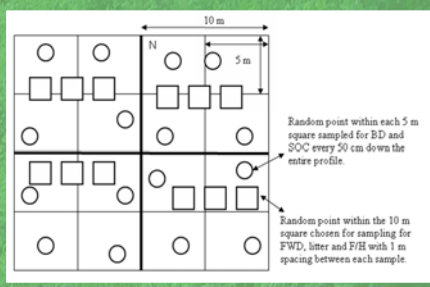


**Figure 3 - Showing the soil and forest floor sampling design of the forested peatland.**

**Sample Analysis.**

**The samples are stored at 4 OC before being dried at 55 OC until they achieve a constant dry weight. The dried peat samples will be sieved to <2 mm and will be used to determine the sample's bulk density. The <2 mm fraction will then be ground to a fine powder for combustion in a C/N analyser (Elementar – Vario Max CN) to determine SOC. The dried forest floor samples are also ground to a powder for combustion in a C/N analyser (Elementar – Vario Max CN) to determine TOC.**

## Results

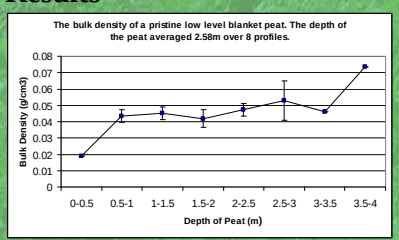


**Figure 4 – Showing the bulk density results of a low level blanket peat down the entire profile**

**Figure 4 shows that bulk density increases with depth but there is a lot of variation, believed to be due to the influence of piping on the samples taken. The 0 – 0.5 m sample is less than half that of the other samples and this is due to the problems of the peat sampler. The peat sampler has difficulties taking samples in the top 50 cm due to the thick rooting of the plant cover that the sampler is unable to cut keeping the peat intact and not taking a full sample. If this is found to be a continuing problem in the field then normal bulk density rings will be used in the top 50 cm to gain a value for bulk density.**

## References

Black, K., Byrne, K.A., Mencuccini, M., Tobin, B., Nieuwenhuis, M., Reidy, B., Bolger, T., Saiz, G., Green, C., Farrell, T. & Osborne, B. (2009). Carbon stock and stock changes across a Sitka spruce chronosequence on surface-water gleys. *Forestry*, (In Press).

Byrne, K.A. & Milne, R. (2006). Carbon stocks and sequestration in plantation forests in the Republic of Ireland. *Forestry*, 79; 361-369.

Foss, P. J., O'Connell, C.A. & Crushell, P.A. (2001). Bogs and fens of Ireland, in Conservation Plan 2005, 144 pp., Intergovernmental Panel of Climate Change, Dublin, Ireland.

Hammond, R. F. (1981). *The Peatlands of Ireland*. An Foras Talu´ntais, Dublin, Ireland.

National Forest Inventory: NFI Methodology. (2007). *Forest Service, The Department of Agriculture, Fisheries, and Food, Wexford, Ireland.*

Pilcher, J.R.., & Mac an tSaoir, S. (1995). *Wood, Trees Forests in Ireland.* (Royal Irish Academy, Dublin).

Tomlinson, R.W. (2005). Soil carbon stocks and changes in the Republic of Ireland. *Journal of Environmental Management*, 76: 77–93.

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