Alaska Field Guide to Duff Moisture Sampling

*This method has been modified from the **Fuel Moisture Sampling in Boreal Forest Duff** manual (by Brenda Wilmore) for field use. For more information on volumetric or TDR (time domain reflectometry) probe sampling procedures, please refer to the full sampling manual*.

The destructive sampling technique described below is designed to help you quickly collect, measure, and process duff moisture samples in order to calculate percent moisture content and the CFFDRS Fuel Moisture Codes (i.e., FFMC, DMC and DC). This technique is gravimetric, meaning that the moisture content is calculated by weight as opposed to volumetric, where moisture is calculated by volume. An **equipment list** is provided on page 6.

Site Selection

Sample sites are typically upland or lowland spruce with an understory of Labrador Tea (*Ledum*) and feathermoss (*Hylocomium* and/or *Pleurozium*) (Canadian Fuel Model C-2) (Figure 1). Be sure to select a site that is representative of the fuel model or vegetation composition for your project. Ideally, the sampling area will be near a RAWS or other representative weather station calculating the FWI (Fire Weather Index) and Fuel Moisture Codes. All reporting stations can be found in the FWI Database on the AICC webpage (http://fire.ak.blm.gov) under Fuels/Fire Danger.

Avoid

- Areas under canopy cover
- Areas that are not feathermoss ***(NO Sphagnum!)***
- Obvious game or foot trails
- Low hummocks
- High pillows (or mounds)
- Areas that have been recently disturbed or compressed (where you just stepped)

Figure 1. Example of a typical feathermoss/Labrador tea/low bush cranberry sampling site. Photo from J. Barnes (NPS).

Sampling Technique

The moisture regime in feathermoss is highly variable. Try to collect at least **4 samples** at each site.
Very Important: Do not compress the moss where you are going to sample!

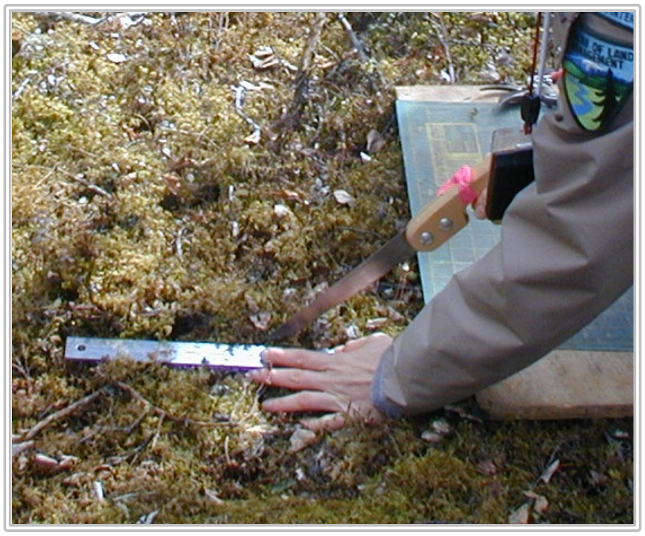

Figure 2. Cutting a duff plug with a keyhole saw. Photo from E. Miller (BLM).

1. Clip any herbs or other stems from the top of the feather moss. Remove any excess leaf or needle litter.
2. Use a keyhole saw, bread knife, or similar tool with a long serrated edge to cut a square in the moss (Figure 2). Cut down to mineral soil or frozen ground, whichever comes first.
3. Carefully pull away the moss and duff from the sides of the plug. Use your hands to reach down to the bottom and 'pop' the plug out. **Do not compress the sample!** You may need to use the clippers or saw to cut through roots before you can 'pop' the plug.
4. Place the plug on your mat board or other solid surface.
5. Identify the four moss/duff layers: ***Live Moss (LM), Dead Moss (DM), Upper Duff (UD) and Lower Duff (LD)*** (optional) (Figure 3). Insert a toothpick at each layer transition. Some layers may be very shallow or not present.

Identifying Duff Layers:

Live Moss (LM): The live moss layer includes the green, live portion of the moss. This layer is represented by the FFMC (Fine Fuel Moisture Code).

Dead Moss (DM): The dead moss layer is brown and "dead" but not yet starting to decompose. Moss stems and leaves should be fully intact and still mostly oriented vertically. The dead moss layer is best represented by the DMC (Duff Moisture Code).

Upper Duff (UD): Upper duff material has started to decompose and is made up of compacted, fine stems (or pieces of moss). The organic material is randomly oriented rather than upright. Fungal hyphae (white, very fine hair-like strands) are often present in the upper duff layer and are an indicator of decomposition. The upper duff layer is best represented by the DC (Drought Code).

Lower Duff (LD) - Optional: The lower duff is very compact and nearly completely decomposed. Moss parts (stems and leaves) are no longer identifiable. This layer is usually thin and very dark in color. Collecting lower duff is ***optional*** as it generally does not correlate well with the FWI fuel moisture codes. If lower duff is collected, **DO NOT** include mineral soil in the sample. Mineral soil is generally lighter in color and when rubbed between your fingers, it smears easily and fills in the lines on your fingertips.

Tips:

- When in doubt, poke the plug. There should be a noticeable difference in density between the dead moss, upper duff, and lower duff layers.
- Don't separate your upper and lower duff layers based on color alone. The upper duff layer can be fairly deep. A darker color towards the bottom of the upper duff layer may just be the moisture gradient. Don't let moisture fool you!
- Discard any samples with a mineral soil layer or rotten log within the plug and find another sampling location.

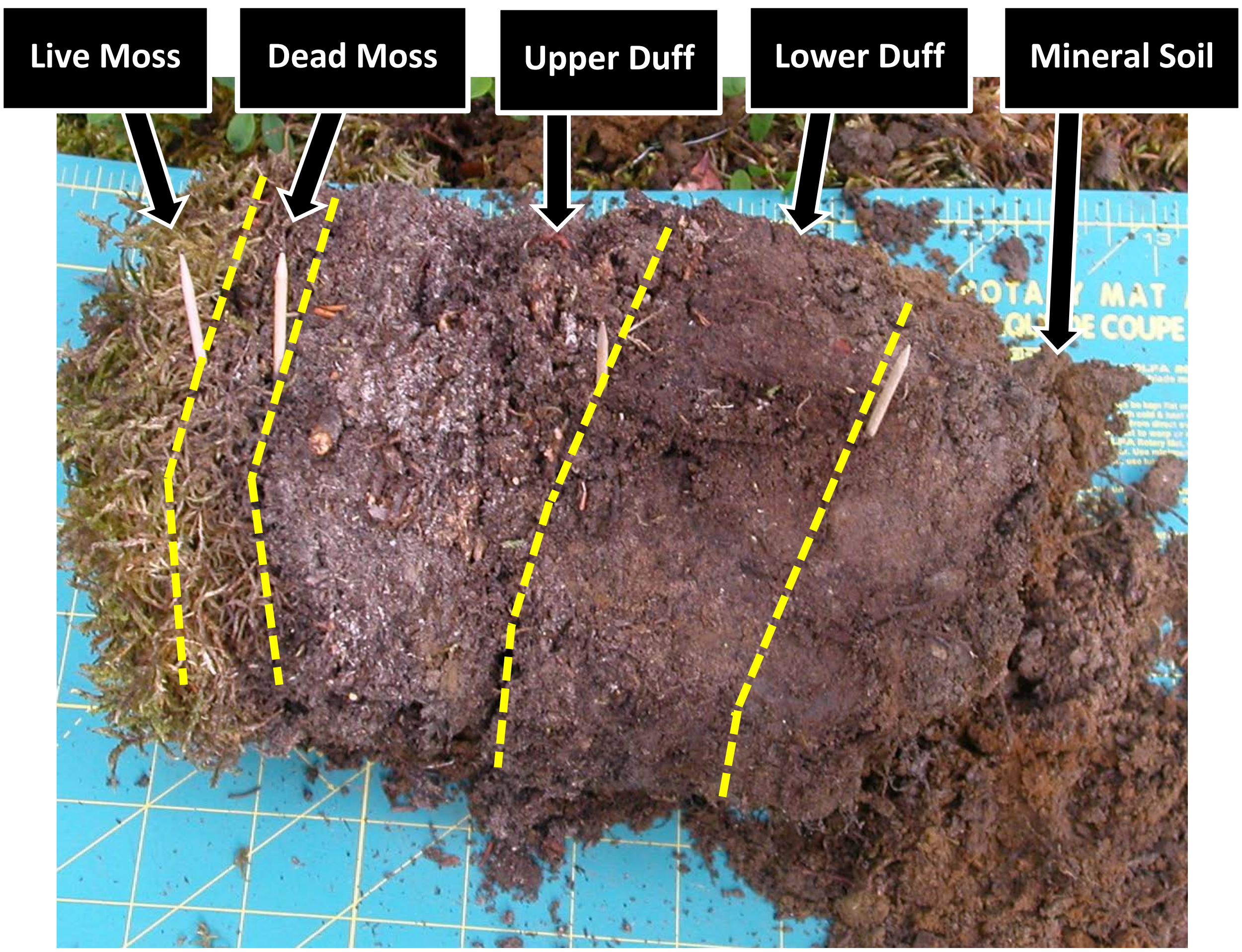

Figure 3. Duff plug sectioned into live moss (LM), dead moss (DM), upper duff (UP), lower duff (LD), and mineral soil layers.

6. Measure the thickness (cm) of each layer and record it on the data sheet along with the corresponding sample number and fuel code (LM, DM, UD, and LD - *optional*).

7. Clip or slice the plug at each layer transition, starting with the live moss. Remove any litter, roots, lichen, and other non-moss plant parts from the live moss layer.

8. Place the entire live moss layer into a numbered airtight sampling container (plastic autoclavable nalgene® or tin). If using tin containers, tape the lid closed to eliminate any air leaks. Do not tightly pack or "stuff" organic materials into the container. They may not completely dry in the oven. Refer to the ***Thick Layers and Small Containers*** section when duff layers will not fit into one container.

9. Repeat steps 7 and 8 for the dead moss, upper duff, and lower duff *(optional)* layers.

Thick Layers and Small Containers

Duff depths can be highly variable. It is common to have a 10-20cm thick upper duff layer, which will not easily fit into one sampling container. It is important to collect the entire profile of each duff layer to capture the full moisture gradient. After the plug has been sectioned, clip the section (or layer) vertically so the entire profile will fit in one container (Figure 4). Discard the unused portion of the section.

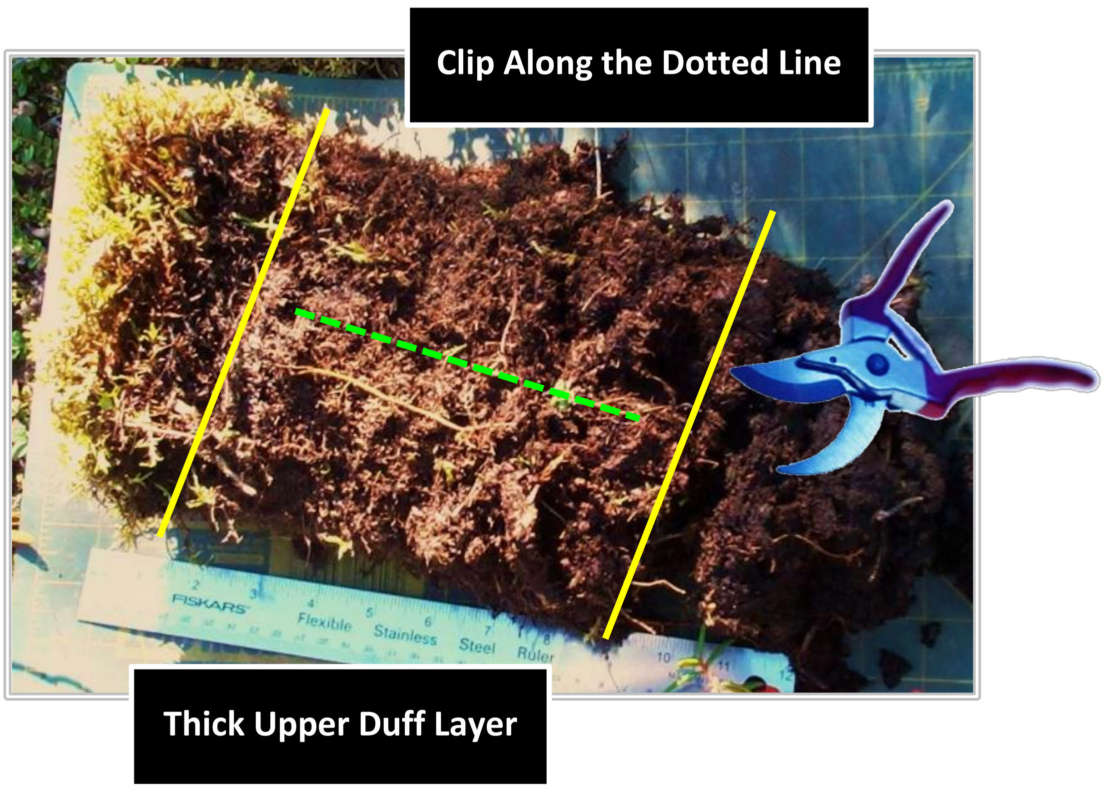

Figure 4. A thick upper duff layer is present between the yellow lines. Clip the upper duff section vertically (along the dotted line) to collect the full layer profile.

Filling Out the Field Data Sheet

The general ***Fuel Moisture Data Sheet*** should also be used for duff plugs. Fill out the datasheet as completely as possible. Remember, there will be 3-4 entries on the data sheet per sample because each duff plug is broken down by fuel code (LM, DM, UD, LD). Each fuel code is recorded on a separate line. See the sample data sheet in the ***Fuels Drying and Data Entry Instructions Guide***.

Drying the Samples

Weigh and record the ***Wet Weight*** of each sample on the data sheet. After weighing, open the containers and place them in the drying oven (with the lids) for 48 hours at 100°C (212°F). Lower duff layers can take longer to dry than other layers. For very wet lower duff, weigh a few samples after 48 hours. Re-weigh them again an hour or two later. Keep re-weighing them periodically until the weight stabilizes. It's not unusual for lower duff layers to dry for more than 48 hours. Remember, collecting the lower duff layer is optional.

When the drying process is complete, replace the lid and weigh the container to obtain the ***Dry Weight***. Discard the container contents and weigh the empty container (with the lid) to get the ***Tare Weight***. Record the ***Wet Weight, Dry Weight,*** and ***Tare Weight*** on the paper ***Fuel Moisture Datasheet***.

For remote sampling (or sampling where there are long travel times), it is strongly recommended to weigh the samples in the field (or as soon as possible). If a scale is not accessible, make sure the container lids are on tight to avoid losing or gaining moisture. Samples can be stored in a cooler or similar container until they can be weighed.

Calculating Moisture Content & CFFRDS Fuel Moisture Codes

Basic fuel sampling procedures and gravimetric (dry weight based) moisture content calculations are discussed in detail in Norum and Miller (1984) and Lawson and Dalrymple (1996). The following equation can be used to calculate gravimetric moisture content.

$$\frac{\text{(wet weight of sample - dry weight of sample)}}{\text{(dry weight of sample - tare weight)}} \times 100 = \text{\% moisture content}$$

A pre-built spreadsheet is available to calculate moisture content and the CFFDRS Fuel Moisture Codes (FFMC, DMC, and DC) (FuelMoisture_DataEntry_Year_Site.xls). All of the Fuel Moisture Code equations are provided in the spreadsheet for reference. Refer to the ***Fuels Drying and Data Entry Instructions Guide*** for processing your data.

Duff Sampling Equipment List

- Drying Oven (Multiple racks, heats up to 100°C)
- Scale (Up to 300g, +/- 0.1g)
- Keyhole saw or bread knife with 12-14” serrated blade
- Clippers (Short handled pruners with curved sharp blade)
- Gridded mat board (or any solid surface approximately 12” x 18” or larger)
- Ruler
- Wooden toothpicks
- Data sheets
- Pencil
- Numbered sampling containers (at least 3 per sample). Plastic Nalgene containers (8-16 oz) are preferred though tins will work (with the lids taped).
- Masking tape (if using tin sampling containers)
- Clip board

Links

AICC Predictive Services – FWI Database: http://fire.ak.blm.gov/wx/wxstart.php?src=fwi&disp=geog
AICC Predictive Services – Fuels/Fire Danger: http://fire.ak.blm.gov/predsvcs/fuelfire.php
Alaska Fire Science Consortium – Library: http://www.frames.gov/partner-sites/afsc/library/afsc-newsletters-factsheets-and-summaries/
AWFCG Fire Research Development and Application Committee: http://www.frames.gov/frdac

References

Norum, R.A.; Miller, M. 1984. Measuring fuel moisture content in Alaska: Standard methods and procedures. Gen. Tech. Rep. PNW-171. USDA, Pacific Northwest Forest and Range Experiment Station. pp.1-34. http://www.fs.fed.us/pnw/pubs/pnw_gtr171.pdf

Lawson, B.D. and G.N. Dalrymple. 1996a. Ground-truthing the drought code: field verification of overwinter recharge of forest floor moisture. Can.-B.C. Partnership Agreement on Forest Resource Development: FRDA II. FRDA Rep. No. 268. Can. For. Serv., Victoria, B.C.
http://www.for.gov.bc.ca/hfd/pubs/docs/Frr/Frr268.pdf

Wilmore, B. Fuel Moisture Sampling in Boreal Forest Duff. Unpublished.
http://www.frames.gov/documents/alaska/docs/sampling_manual.pdf