**Ecosystem Respiration Radiocarbon Protocol**

Purpose: To measure the 14C of soil or ecosystem respiration *in situ*.

Note: Ideally, the air should be still while sampling. A slight breeze is OK, but too much wind causes atmospheric air to intrude the sampling chamber. Through experience, I have come up with a wind speed cutoff of about 7 to 8 mph.

Supplies: 4 Trapping Systems (the ones that have pumps with air flows less than 1 liter per minute) –*You should always have a spare trapping system because it’s common for trapping systems to malfunction during the week of intense sampling- EFP*

4 Dark chambers and collars

LiCor with palm pilot or other data viewer attached. *Recently we have used a laptop—make sure battery is fully charged!!- EFP*

1/4” Gas tubing (Bev A Line)

Molecular Sieve Traps

9 Volt batteries

Digital Watch

***Note****: Generators should NOT be running while sampling radiocarbon! EFP*

1. Collars will need to be installed in the ground. The collars are 10cm slices of large PVC tubing. To install them, cut into the soil with a knife using the collar like a stencil and push the collar into the soil. Some roots may have to be cut. It is recommended that you take your measurement immediately and then wait about two weeks before taking any other measurements so the decay of newly dead roots do not affect your results. Collars are left in the ground for as long as the sampling needs to occur.

2. When you are ready to sample, attach the tubing (~1 meter long) from the chambers to the “In/Out” connections on the trapping systems, and set the trapping system valves to “Scrub”. Attach the 9 volt battery to the wiring inside the trapping system. One can sample from four collars at a time, so set up four trapping systems like this.

3. Place the chamber onto the collar*. Make sure no plants get caught between the chamber and collar to ensure an airtight seal. Use care to not to breathe into or near the chamber while attaching it to the collar*—you do not want CO2 from your breath to get into the chamber as, unlike for atmospheric air, one cannot correct for that contamination.

4. Turn on the trapping systems and adjust the flow rate. Initially set the flow rate to between 0.4 and 0.5 lpm if you are sampling at the height of the growing season. If it is cold out or in September or May, set the flow rate to between 0.2 and 0.3 lpm. Write down the starting time and the trapping system number. Each chamber gets scrubbed for 45 minutes.

5. Set up the next three sampling collars as in steps 3 and 4.

6. After 10 minutes of scrubbing, you will need to sample the concentration of CO­2 in the chambers. The point of this is to make sure you are not scrubbing too slowly or too quickly, thereby creating an unnatural concentration gradient (like a CO2 vacuum that pulls CO2 out of the soil.) The ideal range is around ambient (350 to 450 ppm). To sample the CO2 concentration, hook up a line of gas tubing from the “To” on the trapping system to the “In” on the LiCor case, turn on the LiCor pump low so that it is flowing at about the same rate as the trapping system pump, and turn the valves on the trapping systems to “Trap.” Wait a few seconds and then write down the CO2­ concentration and the time.

7. Turn the valves back to “Scrub” and remove the tubing from the trapping system. If the concentration was too high or low, adjust the flow rate. Unless it is really high (>550) or really low (<250), only change the flow by 0.05 to 0.15 lpm.

*Note: There are some big tussocks in some of the collars. In those chambers, it is almost impossible to get the concentration to 350-450ppm. Even after performing 3 checks and adjusting the flow rate, you will have to settle for higher concentrations depending on the type of vegetation present in the collar.* ***Make notes of these plots*** *and rationalize whether the concentration makes—EFP.*

8. Repeat with the remaining chambers. Wait another 10 minutes and repeat steps 6 and 7 for each collar. If they are still not in the correct range, or if the concentration is fluctuating a lot, you should repeat the concentration check a third time. (It is good to always check it 3 times for each collar until you get the hang of it).

9. Next prepare the traps. Attach the trap connector tubing (with the ferrules on the end) to the “To/From” on the trapping systems and then attach the traps to the connectors. Avoid breathing while connecting the traps. You can do this while the systems are scrubbing but only after you are done checking the concentration.

10. When 45 minutes of scrubbing is done, you can start trapping. If the traps have valves, open them. Then turn off the trapping system, set the valves to “Trap” and turn the system back on. Record the start time, the end time, and the trap number. Trap for 15 minutes (20 for flow rates <0.25 lpm).

11. While trapping, you can go around and mark the traps with tape to signify them as filled. It is also a good idea to check that the flow rates have not changed, which can occur as the batteries discharge. *Pay close attention during sampling time to make sure trapping system is running. Have spare batteries with you and walk around in case batteries die- EFP*

12. When trapping is done, remove the traps from the trapping systems and screw the caps onto the trap, again without breathing. You have now successfully taken a CO2 sample for radiocarbon.

13. You should trap ambient air at least once during the sampling period (definitely more than once if there’s smoke in the air from nearby fires). Run bev-a-line from a remote location (far from the brains and people. Make sure tubing is raised above the vegetation) to the ‘inlet’ of the trapping system. There shouldn’t be anything attached to the outlet. Attach a trap to the trapping system. Scrub the tubing for a couple of seconds, then switch ‘trap’ and sample ambient air for 10 minutes at a flow rate of 1 lpm. -EFP

14. During the time of sampling, you should collect a couple of Pineapple weeds (Matricaria matricaioides) along Stampede Rd. (the farther from the road the better). I usually collect some close to the Gradient, CiPEHR, and close to the cabin. Collect about 5 flower heads in ~5 different locations. Label envelope with location and date. If possible, dry envelope + weeds in food desiccator the same day. -EFP



*Tip*:

A new battery is good for two rounds of trapping. It will still have some juice left after two rounds but will inevitably run out during the third round while you are busy with another sample. Save yourself the headache and only use them twice.

*Trapping System Maintenance*:

After 2-3 rounds of sampling, always change out the Magnesium Perchlorate in the trapping systems. You only have to remove and change out the part that is cakey which is usually only the top centimeter (unless it is really wet.) Failure to do so will result in wet traps (shortens their life) and clogged trapping system valves.

Check the soda lime to see of it is changing color, indicating it is time to replace it (though the soda lime has the potential to last a full sampling season.)

Prior to sampling, make sure the trapping systems are airtight. To do this attach a short tubing to the “To/From” creating a loop and attach a piece of tubing closed off by a valve to the “In.” Attach a hand vacuum pump to the “Out” and create a vacuum. Check to see if the vacuum holds in both “Trap” and “Scrub” modes. If not, there is a leak. Common places to check for leaks are the chemical containers—check to see if their O-rings need to be replaced or if there are chemical particles preventing a tight seal. Another place to check is to make sure all the lines are far enough into the quick connectors and the valve connections are quite *hand* tight. If these fail, then the leak is likely in the valves themselves, which can happen if the magnesium perchlorate gets too wet and travels to the valves. Putting the valves in vinegar for a couple hours before rinsing and drying usually does the trick. Lastly, you most likely do not have to worry about very slow leaks as the trapping systems are used under positive pressure.

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