1. Dendrochronology Module
    a. Background: In temperature environments (with summer/winter seasons), woody plants (trees and shrubs) grow more in the summers than in the winters. This can be seen in their outward stem or trunk growth as dark rings of cells and lighter rings of cells. Measuring the number of these, and the width between is called dendrochronology (dendro meaning tree limb and chronology meaning time sequence). Historical events such as fire, nutrient inputs (fertilization), climate, herbivory (animal browse), and pest abundance can be observed based on tree ring-width analysis. This makes dendrochronology a useful tool with a wide variety of applications.
        i. Intro to Dendrochronology
        ii. Addresses how plants grow and the opportunity to form questions (ie. do trees grow bigger with age? Taller and wider? Does this growth rate level off at a certain age like with people?)
        iii. Forests are easily visited and viewed, and learning how trees experience seasons will shed light on why each tree is a different size/shape.
        iv. References
            1. deer abundance via dendrochronology (Vila, B. and F. Guibal. 2001. Assessing browsing influence in forest understory using dendrochronology on Haida Gwaii archipelago (British Columbia, Canada). Dendrochronologia 19:130-151.
            2. Yukon, white spruce (Boonstra, R., L. Desantis, C.J. Krebs, and D.S. Hik. 2008. Climate and nutrient influences on the growth of white spruce trees in the boreal forests of the Yukon. Climate Research 36: 123-130.
    b. Materials (List)
        i. List of materials:
            1. Tree cookies (if available; borrowed from Beatty Biodiversity Museum – contact: Nicole Balsdon (nicole.balsdon@ubc.ca), or photos of tree cookies to count; example:

2. pencils
3. optional: forest nearby to walk in (or a couple trees/branches to observe)

c. Procedure
   i. **Pre-Assessment**
      1. How do we tell how old a tree is?
   ii. **Participatory Learning**
      1. Activity 1: outside walk in forest near University Hill school; observing differences between trees (trunk size, height, number branches..)
      2. Activity 2: in class, counting # growth rings on a tree/photo of cookie and finding out how old tree is, measuring diameter
   iii. **Post-Test**
      1. What does a tree experience in a year? (in the BC environment): looking for seasons, different temperatures and how this effects growth (connected with what they saw in the age rings)
      2. Summarizing tree age and diameter data and making scatter plot (answering the questions about trees getting bigger with age – are the oldest trees the biggest?)
   iv. **Summary**
      1. Some trees in cold climate don't grow very much and take a long time to grow; good management is to let some of them grow to a big enough size that they are good habitat to animals

d. Make it your own
   i. Include 1 way to advance the module
      1. This module could be advanced by having students measure ring widths in addition to counting (high school) and discussing what abiotic conditions result in different ring widths (ie. cold or drought

resulting in smaller tree rings and warm seasonal climates or precipitation resulting in larger tree rings)
2. Students could pool the class data and complete statistical analysis on average age and distribution of ring widths

ii. Include 1 way to adjust module for younger groups
1. Students could complete the 'tree structure' activity (so many individuals form cambium, xylem, phloem etc) [link: http://lnr.cambridge.gov.uk/uploads/build_a_tree_game.pdf]
2. Rather than tree cookies or photos of, simplified versions could be drawn/photocopied where rings are more clear and distinct

2. Plant Distribution and Abundance Module [modified from UBC BIOL 140]
   a. Background: Where plants grow (distribution) and how many there are (abundance) are two important questions of plant ecology. In the field, this is often assessed via a sample of plots (example: quadrats, or four-sided plots) to extrapolate to the larger area. Within these plots species can be identified (plant guide or dichotomous key) and counted in some way (example: percent cover or number of stems).
      i. Intro to Field Biology
      ii. To introduce what field work can entail for plant assessment.
      iii. Enables students to look at specific plant species and think about where they are occurring (different forest types? close to the ground or tall?) and why.
      iv. References
         1. UBC Biology 140 field trip [more info at http://www.zoology.ubc.ca/bio1/]
         2. Kluane Monitoring Program [http://www.zoology.ubc.ca/~krebs/kluane.html] see handbook and annual reports for examples
   b. Materials (List)
      i. List of materials:
         1. Quadrat (or four sided frame)
         2. Practice paper with plants drawn on (for quadrats to be placed on indoors, practice percent cover)
         3. Plant ID guide
         4. forested space to ID and place quadrats
   c. Procedure
      i. **Pre-Assessment**
         1. How do we identify plants?
      ii. **Participatory Learning**
         1. Activity 1: practice determining percent cover indoors on paper [review 1% rule: fist = approx. 1% in a 1m by 1m quadrat]
         2. Activity 2: outdoors, place quadrats and rotate groups to determine percent cover of different plant species.
      iii. **Post-Test**
         1. Did each quadrat have the same plants? Do some plants grow together? Which plants were tall and which grew close to the ground? [general observation questions]

iv. **Summary**
1. Learning where plants grow and if there are lots or just a few is important for understanding available habitats for different animal species. Additionally, plant distribution/abundance can also be an indicator of ecosystem health.

d. Make it your own
i. Include 1 way to advance the module
1. This module could be advanced by having students use a transect (or line) and a random number table to randomly assign quadrat locations; discuss the difference between systematic and random sampling.
2. Students could pool the class data and complete statistical analysis on distribution and abundance of different species in the forest near their school; could use this to identify which plants are invasive vs. native, or rare vs. common.

ii. Include 1 way to adjust module for younger groups
1. Students could be taught only 2 or 3 species they are looking for/identifying in the quadrats
2. Rather than using quadrats/plots, younger students could go for a short forest walk and be asked to find and draw one thing from the forest (ie. a cone or a plant); follow-up questions could be sharing the object you found and figuring out what plant it could be (could use more basic functional categories like ground plant [herb or forb], lichen, moss, shrub, tree)