**Project Title:** Decomposition of Aquatic and Terrestrial Invasive Species (DATIS)

**Lead Scientists:** Tracy Gartner, Carolyn Thomas

**Main Ecological Question:**

* What is the threshhold abundance of invasive species necessary to affect ecosystem processes?

**Secondary Ecological Questions:**

* What is the relationship between aquatic and terrestrial decomposition?
* How does geographic variation affect these patterns?

**Ecological Concepts:** nutrient cycling, aquatic and terrestrial ecology, invasive species, litterbag techniques, decomposition rates

**Ecological Framework and Background:**

In most forests and forest streams the major source of nutrients for trees and aquatic ecosystems is the process of decomposition. **Decomposition** refers to the processes that convert dead organic matter into smaller and simpler compounds. The products of complete decomposition are carbon dioxide, water, and inorganic ions (like ammonium, nitrate, phosphate, and sulfate). Decomposition is mainly a biological process carried out by insects, worms, bacteria, and fungi on the soil surface, in the soil, and in the water of the stream.

The rate of decomposition is influenced by many factors. Because decomposition is a biological process carried out primarily by bacteria and fungi, its speed will be affected by air and water temperature and soil moisture. Generally decomposition increases exponentially with temperature; that is, for every 10 degree rise in temperature, decomposition increases by a factor of 2 in terrestrial ecosystems (reference). Nevertheless, leaf decomposition does occur at a low rate during the winter months even under deep snow and in cold water (Taylor and Jones 1990).

Soil moisture effects are a little more complicated. Decomposition is inhibited in very dry soils because bacteria and fungi dry out. Decomposition is also slow in very wet soils because anaerobic conditions develop in saturated soils. Anaerobic decomposition is less efficient than aerobic and as a result is slower. Decomposition proceeds fastest at intermediate soil water contents and even faster in the stream ecosystem.

The quality of the leaves as a food source for microbial decomposers is another important factor. Substrate quality has been defined in many different ways - as the nitrogen concentration (N), as the lignin content, and as the C:N ratio (Moorhead et al. 1999). Researchers have found that decomposition of terrestrial and aquatic leaf litter can be predicted by the C:N ratio (Taylor et al. 1989), by the lignin content (Meentemeyer 1978), or by the lignin:nitrogen ratio (Melillo et al. 1982). Basically, high quality leaves (like nutrient-rich alder leaves) will decompose faster than low quality leaves (like nutrient-poor conifer needles). Many studies have shown striking differences in decomposition rates among species (for example, Adams and Angradi 1996; Cornelissen 1996). Invasive plant species (typically, non-native organisms that dominate and often adversely affect areas that they invade) frequently have higher N, lower C:N, and faster decay rates than their native counterparts (Ehrenfeld 2010). However, while past research has adequately demonstrated that invaded and uninvaded systems usually differ in decomposition rates (Ehrenfeld 2010), there is little information on how abundant the invasive needs to be before these changes are induced – to determine this will be one of the goals of this experiment.

In the initial stages (0 to 3 months) of leaf breakdown small soluble carbon molecules, like starches and amino acids, are lost first leaving behind the more recalcitrant molecules like lignin (Berg and Staaf 1980; McClaugherty and Berg 1987). Decomposition during this first phase is rapid because these molecules are easy to break down and energy rich. The second stage of decomposition - the break down of lignin - is much slower because lignin consists of very large and complex molecules. This rapid initial breakdown followed by a longer period of slow decomposition results in a mass loss curve that resembles an exponential decay curve. The decomposition rate constant, k, can be calculated from the decay curve using the following equation: ln ( M0 / Mt ) = k \* t

where

 M0 = mass of litter at time 0,
 Mt = mass of litter at time t,
 t = time of incubation,
 k = decomposition rate constant.

Leaf litter decomposition is most commonly measured using the litterbag technique. A known quantity of leaf litter is placed into a mesh bag, which is then inserted into the litter layer of a forest floor or attached to the stream bottom. Bags are harvested at periodic intervals, dried and reweighed to determine the amount of mass lost. By incubating the leaves *in situ*, they are exposed to the normal fluctuations in temperature and moisture. The mesh bags allow insects as well as microorganisms’ access to the leaves. **In this experiment you will use the litterbag technique to compare the decomposition rates of leaves incubated in aquatic and terrestrial environments**. While many experiments have examined decomposition in aquatic or terrestrial systems, methods tend to vary between these two types of ecosystems and there have been few attempts to link these interacting environments.

**Application**:

* The data generated from this activity can be used in your curriculum without additional sources of data.
* The data generated from this activity will be able to be uploaded to EREN’s website and add a significant contribution to the decomposition database.
* The data from this activity will work with data from other EREN sites.

**Methodology:**

* Minimum number of three-hour labs required for this activity is \_\_\_1\_\_
* The optimal number of three-hour labs for fully implementing this activity is \_\_\_4\_\_
* Faculty time pre-lab preparation and trips to field that might be needed: \_\_\_1-3\_\_

Note: The tasks can be divided between the faculty member and the student lab. If there is more than one lab section, different labs sections could divide the tasks among them.

* Lab 1: 3 hours
	+ Construction of mesh bags – 20 hours for 1 individual, may be divided among students as first or last hour of 3-hour lab.
	+ Fall collection of leaves and leaf preparation
* Lab 2: 3 hours
	+ Weighing leaves and filling litter bags
* Lab 3: 2-3 hours
	+ Installing, collecting, and drying litter bags
* Lab 4: 3 hours
	+ Process litterbags: weigh litterbags, record data and make calculations

**Students’ Skills:**

**What scientific background is needed for students to participate in this activity?**

* Basic familiarity with scientific method

**What analytical, instrumental, etc skills are needed for students to participate in this activity?**

Existing

* Knowledge of the scientific method
* Basic lab skills (i.e., use of balances)

Acquired

* Familiarity with spread sheets
* Construction, deployment, and processing of litterbags
* Identification of plant species
* Management of data through data entry and proofreading

**Outcomes (TBD)**

Assessment type

 Skills and learning

 Other measurable outcomes

**Transferability** **(TBD)**

(Links between research and teaching). Research data can use one-lab time versus more lab times and the education piece can use data from the EREN dataset.

**Create matrix linking students activities in labs with learning, concepts and skills? (TBD)**

**Student Instructions**

Students and faculty should use the research protocols available on the EREN website[[1]](#footnote-1). For non-field activities such as data analysis and reporting, faculty are encouraged to develop their own set of instructions to fit their individual courses.

**Faculty Notes**

Here, we will provide tips and strategies learned from faculty who have completed this protocol in efforts to anticipate student responses, misunderstandings, and misconceptions, and to provide suggestions for making the process proceed more smoothly. We encourage you to submit your feedback to the Lead Scientists.

**Challenges to anticipate and solve:**

Here, we will provide a list of the principal challenges that faculty and students encounter as they implement this experiment. We will provide potential solutions to common challenges. This section will be modified as we continue to receive feedback from our users. We encourage you to submit your feedback to the Lead Scientists.

* Time commitment
* Phased-nature of the project (biggest issue for year 1)

**DATA AVAILABILITY** - short and long te**rm**

**Bibliography and Links**

Adams, M.B. and T.R. Angradi. 1996. Decomposition and nutrient dynamics of hardwood leaf litter in the Fernow whole-watershed acidification experiment. Forest Ecology and Management 83:61-69.

Berg, B., and H. Staaf. 1980. Decomposition rate and chemical changes in decomposing needle litter in Scots pine. *In* T. Persson, (ed.) Structure and function of northern coniferous forests. Ecological Bulletins-NFR 32:373-390.

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McClaugherty, C.A. and B. Berg. 1987. Celluolose, lignin and nitrogen concentrations as rate regulating factors in late stages of forest litter decomposition. Pedobiologia 30:101-112.

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Melillo, J.M., J.D. Aber, and J.F. Muratore.1982. Nitrogen and lignin control of hardwood leaf litter decomposition dynamics. Ecology 63:621-626.

Moorhead, D.L., W.S. Currie, E.B. Rastetter, W.J. Parton, and M.E. Harmon. 1999. Climate and litter quality controls on decomposition: An analysis of modeling approaches. Global Biogeochemical Cycles 13(2):575-589.

Taylor, B.R., and H.G. Jones. 1990. Litter decomposition under snow cover in a balsam fir forest. Canadian Journal of Forest Research 68:112-120.

1. To be posted soon! Currently available via email by request. [↑](#footnote-ref-1)