Report as of FY2009 for 2009KY131B: "Impacts of Bush honeysuckle on ephemeral aquatic ecosystems"

Publications

- Conference Proceedings:
    - Wallace, Andrew and Richard Durtsche, 2010, The Effects of the Invasive Amur Honeysuckle Leaf Consumption on Green Frog Tadpoles, in Proceedings Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, Kentucky, p 85-86.
    - Boyce, Richard and S. Lincoln Fugal, 2010, Impact of the Invasive Amur Honeysuckle (Lonicera maackii) on Stand Transpiration in a Wetland Forest, in Proceedings Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, Kentucky, p 87-88.

Report Follows

Impacts of Bush Honeysuckle on Ephemeral Aquatic Ecosystems

Problem and Research Objectives

This study addresses two aspects of the impact of the exotic invasive Bush honeysuckle (*Lonicera maackii*) on ephemeral aquatic ecosystems. Our previous investigations have indicated a high abundance of these shrubs surrounding ponds and streams in the Northern Kentucky area and decomposition rates of its leaves in water significantly faster than native tree leaves. We also found reduced digestive capacity, fitness, and survival of frog tadpoles raised in leaf teas of this invasive shrub. As teas may affect these tadpoles both internally and externally, one of the focuses of the current study is to determine whether or not *L. maackii* leaves utilized as a food source negatively impact digestion efficiency in frog tadpoles. With the encroachment of these shrubs along the waters edge of ponds and streams, our second focus is to determine if *L. maackii* has higher evapotranspiration rates than other riparian trees or shrubs, thereby providing evidence for potential reduction of water available in these ephemeral water systems.

Methodology

The tadpole digestion study consisted of a feeding experiment where four different concentrations of plant leaves (*L. maackii* or mixture of native riparian plants – sycamore, boxelder, silver maple) were added to an algae food base. These foods, and a no leaf control were fed to green frog tadpoles (*Lithobates clamitans*) over several weeks, and the fecal output collected. Dried food and feces were then analyzed for assimilation by the tadpoles through energy and nutrient extraction. Our initial collections of frog egg clutches and developing tadpoles in a field enclosure were vandalized by either animals or people visiting the pond. We subsequently hand collected enough tadpoles to carry out the feeding experiment in the laboratory over a four week period.

Evapotranspiration rates were monitored by measuring water movement (sap flow rates) in shrubs and trees at the St. Anne Wetlands Research and Educational Center in Melborne, KY. Sap flow was measured in trees and shrubs with thermal dissipation or Granier probes. We initially purchased eight of these probes (from Dynamax), but working with our undergraduates we developed and fabricated 12 additional Granier probes and two heat balance probes (for small shrubs) that function as well or better than the purchased probes. We also set out 20m x 30m quadrats to assess overall tree and shrub composition. These plots were established in both an old growth beech forest with few encroaching shrubs, and a secondary forest heavily invaded by *L. maackii*. Trees were cored to determine sapwood area for estimation of transpiration rates. Shrub stems were considered to be all sapwood. By doing so, we were able to assess transpiration on an areal basis for both shrubs and trees. Prior to leaf flushing at the beginning of the year we established a soil water content reflectometer at the site to measure soil moisture levels.

By using the information from the Kentucky Hydrology website, we were able to obtain stream flow rates through the wetland, and the catchment area. This information along with our evaluation of transpiration rates, vapor pressure depression, and soil water potential have been used in regression analyses to model water loss from the wetland due to evapotranspiration by *L. maackii*. As we accumulate additional data on these parameters, we will eventually be able to model the impact of *L. maackii* on this wetland system with STELLA. As yet, our database is not large enough to carry out these models, but it is the next step in our on-going study.

Principal Findings and Significance

When fed diets that included leaf matter in an algae based food, tadpoles of the green frog (*Lithobates clamitans*) consumed significantly less caloric content than an algae diet alone (Fig. 1). Significantly less caloric content of *L. maackii* was consumed in comparison to native plant leaf matter. However, while caloric assimilation effiencies were best on an algae diet (Fig. 2), more energy was extracted from *L. maackii* than native plant leaf diets, presumably offsetting the balance of calories consumed of these two foods. Nitrogen (protein) assimilation was slightly better from *L. maackii* than native plant leaf diets, yet still best from the algae diet (Fig. 3). More potassium was extracted from either leaf diet than the algae diet (Fig. 4), and calcium assimilation was stronger from the algae and honeysuckle leaf diet than it was from the native leaf diet (Fig. 5). Evaluation of neutral detergent fiber content found that native plant leaves (74.5%) was greater than twice that of *L. maackii* (32.15%). Overall, this suggests that consumption of *L. maackii* leaf matter does not impact the digestive capacity any more than native plant leaves. However, the maximum concentrations of leaf matter in the food (10%) may not have been adequate for a definitive response.

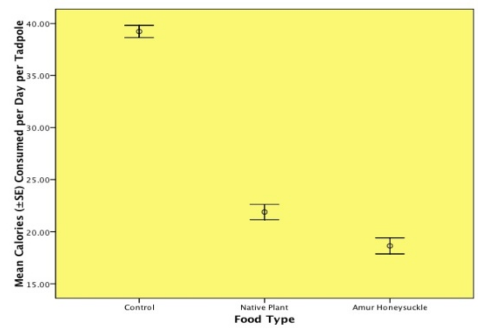

Fig. 1. Per day calorie consumption per tadpole of *L. clamitans* on two diets including leaf matter, and a control algae diet

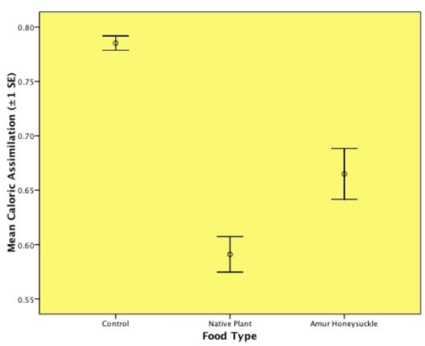

Fig. 2. *Lithobates clamitans* tadpole caloric assimilation over a four week period.

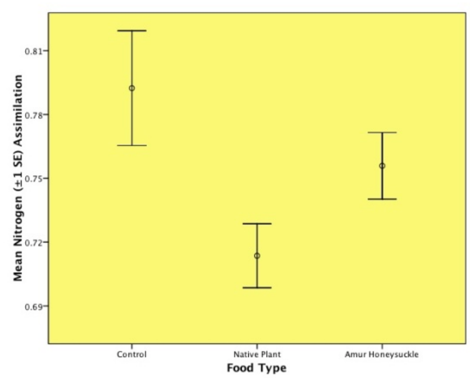

Fig. 3. Nitrogen (a measure of protein) assimilation was similar to the pattern found with caloric assimilation.

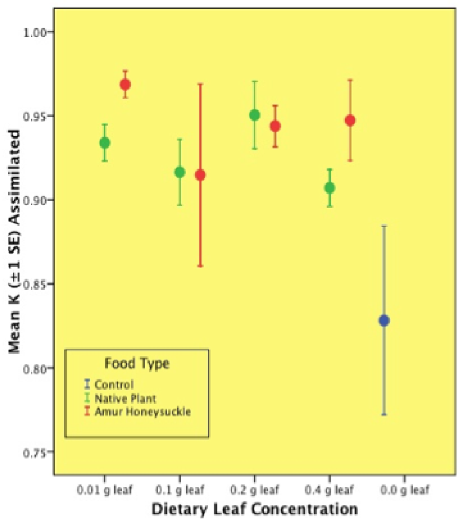

Fig. 4. The uptake of potassium was significantly greater from either dietary leaf type than the algae control food.

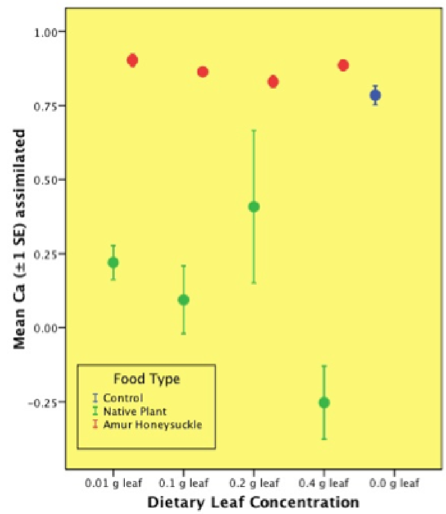

Fig. 5. Calcium assimilation from the control algae and from the *L. maackii* leaf foods were significantly higher than that taken up from riparian leaves.

In the evapotranspiration study, the two stands differ greatly in structure; the old growth forest has both a lower coverage of trees and of shrubs (Table 1). The *L. maackii* cover is more than 5 times greater at the secondary forest.

Table 1. Basal areas of trees, shrubs and *L. maackii* at the old growth and secondary forests at St. Anne Wetlands. Tree basal area also includes grape vines (*Vitis labrusca*), which account for ~1% total basal area.

Basal Area ($m^2\ ha^{-1}$)	**Old Growth Forest**	**Secondary Forest**
Trees	20.3	38.9
Shrubs	0.45	2.05
L. maackii (% shrubs)	0.34 (75.5%)	1.76 (85.9%)

Our findings suggest that transpiration from the tree stratum is slightly higher from the old growth forest (Fig. 6), even though it has a substantially lower basal area.

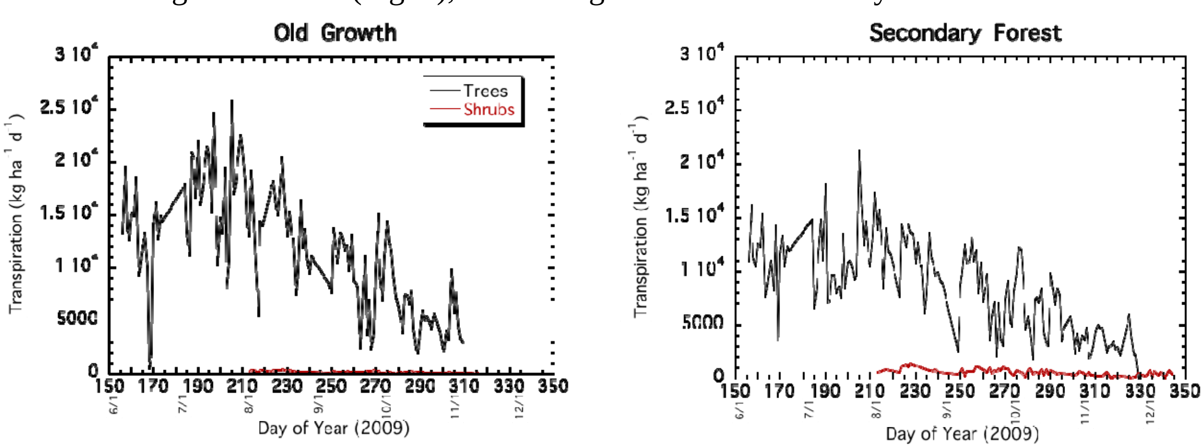

Fig. 6. Transpiration rates for trees and for shrubs at St. Anne Wetland. Distributions based on hourly sapflow measurements, summed for each day.

However, shrub transpiration is 3-4 times greater from the secondary forest (Fig. 7).

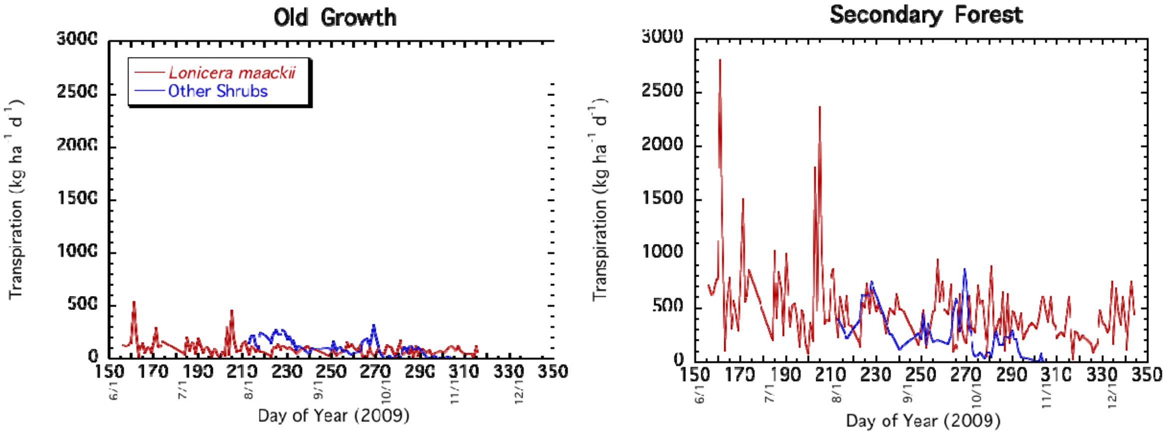

Fig. 7. Transpiration rates for shrubs at St. Anne Wetland. Distributions based on hourly sapflow measurements, summed for each day.

Shrub transpiration adds only a small amount to the total from the old growth forest (~1.4% of tree transpiration; Fig. 7). The amount added by the shrub layer at the secondary forest is much greater (~7.3% of tree transpiration). Since almost all of the shrub basal area is *L. maackii* (Table 1), over 4x the transpiration is coming from that species in comparison with the other shrubs in the secondary forests (Fig. 8).

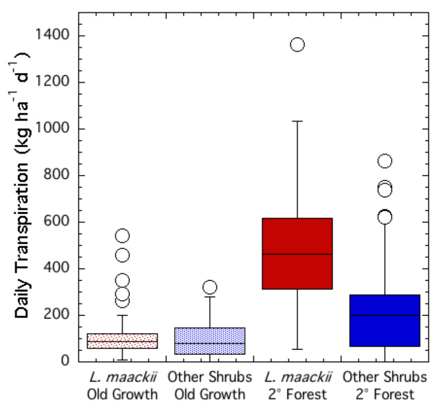

Fig. 8. Boxplots of % transpiration for shrubs vs. trees at old growth and secondary forest stands at St. Anne Wetland, based on data in Fig. 1.

With a catchment area of 325,800 m^2 from the St. Anne Wetlands, and a stream flow rate of 26,790 m^3/yr, the rainfall equivalent drainage to this area is 75.94 mm/yr. Based on the sap flow measurements, *L. maackii* has a transpiration equivalent of 7 mm/yr for this area. This suggests that Amur honeysuckle potentially reduces drainage from this wetland by approximately 9.2%. While these calculations represent average estimates across the season, the impact to ephemeral water sources in the wetland could be more extreme. This impact could drastically reduce the persistence of these ephemeral water sources and shorten the time to metamorphosis for larval amphibians.