There’s No Place Like Home: Litter Decomposition is Modulated by Species Diversity and Familiarity of Environment

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Abstract

Litter decomposition is controlled through biological, chemical, and physical factors. Biological control of decomposition is witnessed through home-field advantage: where lead litter decomposes faster in its home environment than in other environments. Although observed in terrestrial environments, home field advantage has never been studied for decomposition in aquatic environments. The goal of this study was to test effects of location, species mixing, and non-native plant litter on the decomposition of terrestrial leaves in aquatic environments. Leaves were collected from bog and lake plants, as well as Morrow's honeysuckle, and put into litter bags as single species and in litter mixes (combining 2 or 3 species). Litter bags were left to decompose over a month in both the bog and lake environments. Results show that litter decomposed faster in its own environment than in the away environment. This effect was confounded by a difference based on the source of the species. This interaction supports the idea that the microbial community acts as a gate to other controls on litter decomposition. Secondly, results show that litter decomposition was slowed in mixed species bags compared to single species bags. Mixing species together created non-additive properties not present when species decompose alone. There was no effect of the invasive plant litter on the overall decomposition. Future work is needed to separate out biological and environmental effects in controlling the home-field advantage.

Many different factors affect the decomposition of leaf litter. Previous studies have focused on how chemical and physical properties of the litter and site affect decomposition rates (Pérez-Harguindeguy et al., 2000; Talbot et al., 2012; Meentemeyer, 1978; See Prescott, 2010). In terrestrial environments, multi-site studies have shown that litter decomposition speeds up as average temperature increases and that large concentrations of lignin in the litter can halt decomposition (Prescott, 2010). In aquatic systems, litter quality has been shown to be the driving factor behind varying decomposition rates, with most variance explained as chemical differences between species (Leroy & Marks, 2006). These physical factors explain much of the variation across differing decomposition rates; however, rates can be modulated by characteristics outside of the physical environment.

Leaf litter has also been shown to decompose different based on the biological community present in the environment that the leaf litter is decomposing in (Hunt et al., 1988; Veen, Sundqvist, & Wardle, 2015; Bezemer et al., 2010). For example, some plants decompose faster in the vicinity of other members of their own species (termed Home-Field Advantage or HFA). Additionally, specialized decomposer communities may associate with a particular species or litter type, aiding in the decomposition when the litter is in its home environment (Veen, Sundqvist, & Wardle, 2015; de Toledo Castanho & de Oliveira, 2008; Ayres et al., 2008). However, HFA is not consistent across litter decomposition studies (e.g. Prescott et al, 2000), and may be species specific and also dependent on the environmental and physical variables to modulate the effect of HFA. Most studies on HFA have focused on terrestrial litter decomposition and it is unclear how this effect will play out in aquatic systems.

Typically, leaf litter does not decompose in clumps of single species but rather as mixtures of multiple leaf types. Previous studies have shown litter bags containing multiple species experience non-additive effects in decomposition compared to the expected decomposition rate (e.g. Gartner and Cardon, 2004). Increased litter diversity may lead to faster decomposition rates (Santischi et al., 2018; See also Lacerf et al,. 2007), but this effect can be species and site dependent (Leroy & Marks, 2006). Plant invasion introduces a new type of litter to the native mixtures. The addition of non-native leaf litter has been shown to accelerate (Ashton et al., 2005) or halt (Godoy et al., 2010) leaf litter decomposition in terrestrial environments. The native microbiota may not as efficient in processing invasive litter, slowing the process. Alternatively, invasive litter may provide different nutrients to the system, aiding in the overall decomposition process and accelerating the decomposition rate.

The goal of this study is to test both HFA and species mixing effects on the litter decomposition in aquatic environments. Furthermore, this study will look for interactions between species mixing effects and invasive species. I will test how the decomposition of native and invasive plant species vary between two functionally distinct aquatic ecosystems: lakes and bogs. Litter decomposition will also be compared between 1-species litter bags, 2- species litter bags, and bags containing both a native and invasive species to determine the effect of the invasive plant material on litter decomposition.

Based on the previous literature, I have developed the following hypotheses:

1. Plants will decompose faster in the environment where they originate from - e.g. bog plants will decompose faster in the bog than the lake.
2. Litter bags containing multiple leaf types will decompose faster than their predictive additive effect.
3. The presence of invasive plant litter will change the decomposition rates of native species plants.

Methods

Species descriptions. I collected leaves from 2 species on the sphagnum mat at tender bog. Bog Labrador tea (*Rhododendron groenlandicum*) is a common bush found on Sphagnum mats in northern bags (Hébert & Thiffault 2011). Leatherleaf (*Chamaedaphne calyculata*) is another common bog plant. It is one of the first bushes to establish on a sphagnum mat, and it is also found in nutrient poor bodies of water (Damman & French 1987). I collected leaves from 2 species on the shore directly adjacent to the location of the litter bag site in Tenderfoot Lake. Sugar maple (*Acer saccharum*) and paper birch (*Betula papyefera*) are both common overstory trees in the northern hardwoods forest. I collected leaves from Morrow's honeysuckle (*Lonicera morrowii*) in the forest between Tenderfoot Lake and Tender Bog. Morrow's Honeysuckle is originally from Japan and South Korea, but it is now commonly found across the eastern United States. It is found commonly in both forest interiors and forest edges, and can for dense monoculture thickets (Alien Plant Working Group, 2010).

Site descriptions. I placed litter bags at both Tender Bog and Tenderfoot Lake, both located at the University of Notre Dame Environmental Research Center in Land O' Lakes, Wisconsin. Tender Bog is a small open water bog with a large floating mat of sphagnum moss. During the sampling period, the water at the edge of the sphagnum mat had a temperature of 20.1˚C, Dissolved oxygen of 4.98 mg/L, and a pH of 4.4. Tenderfoot lake is a large lake with an average temperature of 22.7˚C, Dissolved oxygen of 9.40 mg/L, and pH of 6.8 in the littoral zone during the sampling period.

Experimental manipulation. I created 9 different types of litter bags. 5 single species bags using bog Labrador tea, leatherleaf, sugar maple, paper birch, and Morrow's honeysuckle, 2 mixed bags combining leaf litter from the same location (bog Labrador tea with leather leaf, and sugar maple with paper birch), and 2 mixed bags that include the leaf litter from the same location plus the invasive plant litter from Morrow's honeysuckle. Each type of bag was placed in the lake and bog locations, creating 18 different treatments. 9 replicates of each treatment were placed at each location for a total of 162 litter bags.

Litter bag processing. I collected leaves from both tender bog and tenderfoot lake directly adjacent to where the litter bags would be set up for the decomposition. Leaves were collected directly after leaf out in the first week of June. Leaves were spread out and air dried for two days before being put in a drying oven set at 30˚C for 2 days. After drying, I measured out approximately 3 grams of dried leaf litter for each bag. I set the litter bags in each location on June 14th, 2019. 3 replicates of each treatment were collected after 10, 20 and 30 days. I rinsed each litter bag with warm water to remove algae and macroinvertebrates and dried each sample for 2 days at 50˚C before weighing for final mass. After weighing, single species samples were ashed in the muffle furnace at 600˚C for 90 minutes in order to obtain the ash-free dry mass. 3 samples of each species were also ashed in the muffle furnace in order to obtain the initial ash free dry mass of the litter bags. In order to obtain the ash-free dry mass for the mixed species bags, I multiplied the averages from the single species bags by the proportion of each species in the mixed bags. All samples were corrected for ass-free dry mass before analysis.

Data analysis. Replicates were collapsed within each timepoint to create an average per treatment. In order to compare across litter types, the z-score of the percent-remaining was calculated from the treatment averages in reference to the litter bag type. The z-score then represents the relative percent-mass remaining in each treatment based from the average for the litter bag type. 4 of the 48 averages were missing because there were no data points available for the treatment. In these cases, the timepoint was predicted using exponential decay functions derived from the unaveraged data. Decay functions were created by fitting data from all timepoints for each treatment to the formula $Y=b*e^{(-kt)}$, Where b is the y intercept, k is the decay constant, and t is time. To complete each curve estimation, the initial mass remaining (100%) was also included in the model. For mixed species bags, I calculated a predicted additive percent-remaining for each mixed bag by multiplying the proportion of each species in the bag with the average percent-remaining for that individual species in the same condition and timepoint. The difference between the actual percent remaining and the predicted amount represents any non-additive effect from species mixing.

Results

Decay rates. Decay constants for each treatment can be found in table 1, with the scatterplots of each treatment in Figure 1. Larger decay constants indicate faster decay. Overall, decay constants were larger in the home condition than in the away condition (home average: 0.678, away average: 0.127) , single species bags had larger decay constants than mixed species bags (single average: 0.579, mixed average: 0.226) , and lake species had larger decay constants than bog species (lake average: 0.751, bog average: 0.072)

Relative decomposition. A fractional 4-way ANOVA was conducted on the averaged z-scores to determine the influence of Condition (Home or Away), timepoint, litter mixing (single species or mixed species), and litter source (bog or lake) on the relative decomposition of leaf litter (as described using the z-score). The model included Condition and timepoint as main effects, and Condition x litter mixing, condition x timepoint, condition x litter source, and mixing x timepoint as interaction effects. The main effect of Condition was significant with an F-value of $F(1, 36) = 19.672$, $p<0.001$ $\eta_p^2= 0.353$ with litter bags in the away condition decomposing less than litter bags in the home condition, and the main effect of time was marginally significant at F(2,36)= 3.020, p=0.061 η_p^2= 0.144. Post-Hoc analysis with the Bonferroni analysis showed no significant difference between any two timepoints. There was a significant interaction between condition and source litter, with an F value of F (2,36) = 7.091, p=0.003, η_p^2= 0.283, with a larger difference between conditions for lake species compared to bog species. There was no interaction between Condition and litter mixing (F (1,36) =2.537, p=0.120), Condition and timepoint (F (2,36) =2.374, p=0.107), or Species mixing and timepoint (F (2,36) = 0.692, p=0.507). z-score averages are given in table 2, and figures 2 and 3.

Mixed leaf litter decomposition. The data from the difference between predicted and actual percent mass remaining was not normal using a shapiro-wilk test for normality (p<0.001). The average predicted percent remaining across all treatments and timepoints was 48.3%, while the actual average percent remaining for mixed bags was 60.9% (figure 3). A one sample Wilcoxon signed rank test on the difference between actual and predicted showed that there was a decrease in decomposition in mixed species litter bags (p<0.001), as mixed bags had a larger mass remaining then expected (Figure 4).

3 Independent sample Man-Whitney tests were used to determine if there were main effects from the condition (home or away), the presence of the invasive honeysuckle, and the source of the leaf litter. There was a significant effect for source of the litter (p=0.002), but no effect from the honeysuckle (p=0.454) or from the condition (p=0.173). An independent samples Kruskal-Wallace test showed a marginally significant effect of time on the decomposition of leaf litter mixes (p=0.05), with the difference between actual and predicted values increasing between timepoints 1 and 3 and between 2 and 3 (Figure 5).

In order to understand the interaction between source of leaf litter and condition on leaf mixture decomposition, I computed the difference between home and away conditions for each bag type at each timepoint. An independent samples Mann-Whitney test showed that there was a difference in the relationship between home and away conditions based on the two leaf litter sources ($p=0.004$), as shown in figure 5.

Discussion

Overall Decomposition. Overall, the decay constants showed that litter decomposition occurred faster in the lake then in the bog. This is consistent with previous research showing that decomposition slows with lower levels of system nutrients (Gulis & Suberkropp, 2003; Qualls & Richardson 2000). Percent mass remaining also changed over time as expected, with the main effect being marginally significant over time. Most treatments fit well to a decay curve (see figure 1), indicating the decrease in mass over time. However, both of the mixed bog bag types increased in percent mass remaining over time when placed in the lake. This is probably an artifact of the Ash-free dry mass (AFDM) correction. The Labrador tea leaves added a lot of mineral weight while in the lake. While the AFDM correction adequately corrected and normalized the single-species bags, it may have underestimated the correction for the mixed bags, resulting in the apparent increase in percent mass remaining to over 100%.

Home Field Advantage. The z-score calculations showed a main effect of condition on the litter decomposition. This is the first evidence for a home-field advantage in aquatic systems, showing that aquatic ecosystems are specific to the type of litter that they decompose. The home field advantage effect also showed a significant interaction with the source of the leaf litter. There was a larger difference between the home and away conditions for the lake litter bags than the bog litter bags. This indicates that both the physical environment and litter quality interact with the biological communities to determine decomposition rates. In this case, the bog is a bad environment for decomposition (acidic with low dissolved oxygen and few nutrients), while the lake is a good environment (neutral pH with higher dissolved oxygen and more nutrients). Both bog and lake species decomposed slow in the bog, but the better characteristics of the lake only benefited species taken from near the lake. Contrary to previous results that give a large directing role to physical characteristics of leaf and environment (Prescott, 2010), these results posit the biological component of litter decomposition as a threshold determining the effect of leaf litter and environment on decomposition.

Diversity Effects. Litter bags containing multiple types of litter decomposed slower than predicted. There is currently no consensus on the presence or direction of a non-additive species mixing effect, as about 30% of studies find decomposition rates increase, while 30% find that decomposition rates decrease – as in the current study (Gartner and Cardon, 2004). The inhibition of decay seen here contrasts against synergistic effects seen in other aquatic litter mixing studies (e.g. Laceref et al., 2007; Leroy and Marks, 2006).

There was a significant interaction between condition (Home or away) and source litter on the strength of the non-additive mixing effects (Figure 5). Bog plants showed a larger non-additive litter mixing effect in the away condition, while lake plants showed a larger non-additive effect in the home condition. This indicates that the lake environment created a larger antagonistic decomposition effect on mixtures than the bog environment.

There are multiple potential reasons for the patterning in mixing effects. First, mixing effects are thought to come about by increasing the diversity of microsites for microbes to grow on, thereby increasing the diversity of microbes in the litter (Hector et al., 2003). This could play a more important role in lakes than in the bog because bogs support a more specific and less diverse community of microbes. Increased microbe diversity could lead to increased mass remaining because the diversity prohibits one type of bacteria from efficiently decomposing the litter. Alternatively, the patterning in mixing effects may be caused from differences in physical environments. On the first day of the experiment, a large storm system caused waves on the normally quiet Tenderfoot Lake. If the mixed species bags provided more protection from physical weathering and decomposition from the waves, then I would expect to see a larger non-additive effect in the lake environment than the bog environment.

Effects of non-native species. There was no significant effect of the addition of honeysuckle on the antagonistic species mixing effect. In the lake environment, all of the single species honeysuckle bags had completely decomposed before the first time point. If the honeysuckle decomposed just as fast in the mixed bags, then it may have not stayed around long enough to cause any significant effect. Alternatively, there could be no net effect of the honeysuckle on decomposition because it creates canceling positive and negative non-additive effects. If the honeysuckle provides different nutrients to the system, then it could speed decomposition. However, since it is not a natural component of the ecosystem, the microbial decomposing community may be less adapted to it, causing a halting of the decomposition process.

Study limitations. By far, the largest limitation of this study was the use of spring leaves over senesced leaves. Leaf litter quality is very important in controlling litter decomposition (Prescott, 2010) and spring leaves may have different litter chemistry then fall senesced leaves. Specifically, spring leaves may have higher nutrient concentrations. The results here may not be applicable to normal decomposition of fall leaves because of differences in litter quality over time. The second limitation of this study was the spacing of time points. In the lake condition, decomposition of the honeysuckle and sugar maple occurred too rapidly to be accurately accounted for by sampling once every 10 days. More time points are needed to accurately capture the decomposition rates of these species.

Future directions. This experiment showed how litter decomposition is modulated by the relationship between leaf litter and the environment. However, it is still unclear if this modulation is primarily driven by specificity in the decomposing community or by some interaction between litter quality and physical environment. The next step of this project would be to isolate the biological community from the physical environmental effects through a laboratory experiment. If lake and bog water samples are held to have the same pH and dissolved oxygen, then any home-field advantage seen in the litter decomposition would stem from difference in the microbial community.

The second extension of this project is to test for a home-field advantage effect on a smaller scale. This experiment is the first support for HFA in an aquatic system, but it tested litter decomposition across two very different environments. This project should be repeated between two more similar habitats to test the extent and specificity of HFA.

Conclusion

This study is the first example of home field advantage of terrestrial litter decomposition in aquatic systems. Although traditionally thought to be least variable of litter decomposition, the effects shown here indicate the biotic component as a determining factor of litter decomposition. There was a difference in the effect of HFA based on the location of the decomposition, showing that the biological community can act as a limit to other variables in decomposition. More work is needed to separate effects of community specialization from physical environment as the driving force behind home field advantage.

Tables

Table 1: Summaries of estimated decay functions for each treatment. Data points from both the lake and the bog are grouped together for the honeysuckle bag type because it is not native in either environment.

Type	Condition	Equation Constants		Model Summary				
		Predicted Intercept	Decay Constant	R^2	F	df1	df2	Sig.
Labrador Tea	Away	0.919	0.048	0.170	2.657	1	13	0.127
	Home	0.974	0.095	0.760	22.189	1	7	0.002
Leather Leaf	Away	0.952	0.141	0.859	79.507	1	13	0.000
	Home	0.973	0.135	0.876	49.390	1	7	0.000
Bog Mix	Away	0.900	-0.008	0.006	0.057	1	10	0.817
	Home	0.951	0.079	0.754	30.694	1	10	0.000
Bog mix + Honeysuckle	Away	0.831	-0.029	0.014	0.147	1	10	0.710
	Home	0.911	0.116	0.680	21.232	1	10	0.001
Paper Birch	Away	0.863	0.205	0.701	30.406	1	13	0.000
	Home	1.004	1.151	0.986	488.550	1	7	0.000
Sugar Maple	Away	0.755	0.223	0.421	9.436	1	13	0.009
	Home	0.072	2.632	0.571	9.333	1	7	0.018
Lake Mix	Away	0.878	0.204	0.722	25.990	1	10	0.000
	Home	0.660	0.679	0.276	3.810	1	10	0.079
Lake Mix+ Honeysuckle	Away	0.918	0.231	0.853	58.200	1	10	0.000
	Home	0.684	0.534	0.654	18.865	1	10	0.001
Honeysuckle	NA	0.224	1.446	0.151	3.907	1	22	0.061

Table 2: Average z-scores (representing relative decomposition) based on condition, species mixing and time-point.

Condition			
Species-mix	Time-point	Home	Away
	1	0.1305	0.4595
	2	-0.2406	-0.0657
single-Species	3	-0.5526	0.4527
	1	-0.2406	0.5484
	2	-0.8444	-0.0220
mixed-species	3	-0.7102	1.2688

<u>Figures</u>

Figure 1: Scatter plots of percent mass remaining over type for each condition.

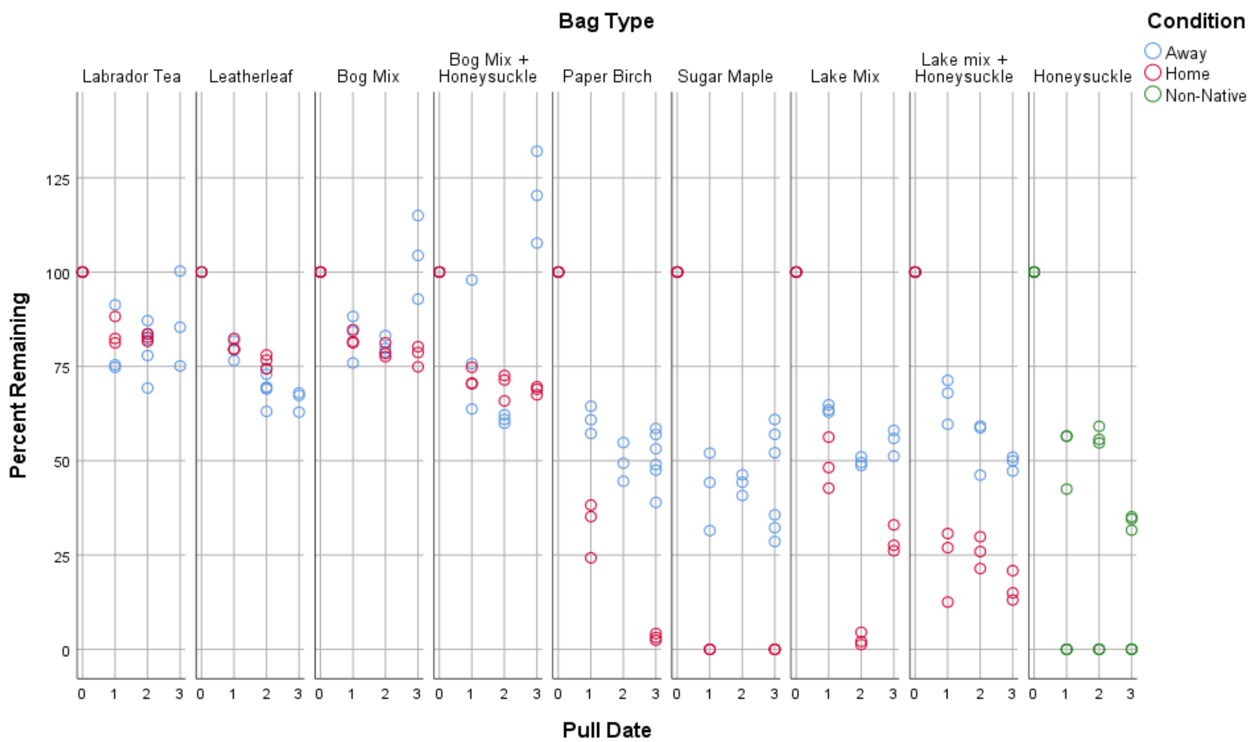


Figure 2: Average z-scores (representing relative decomposition) based on condition, species mixing and time-point.

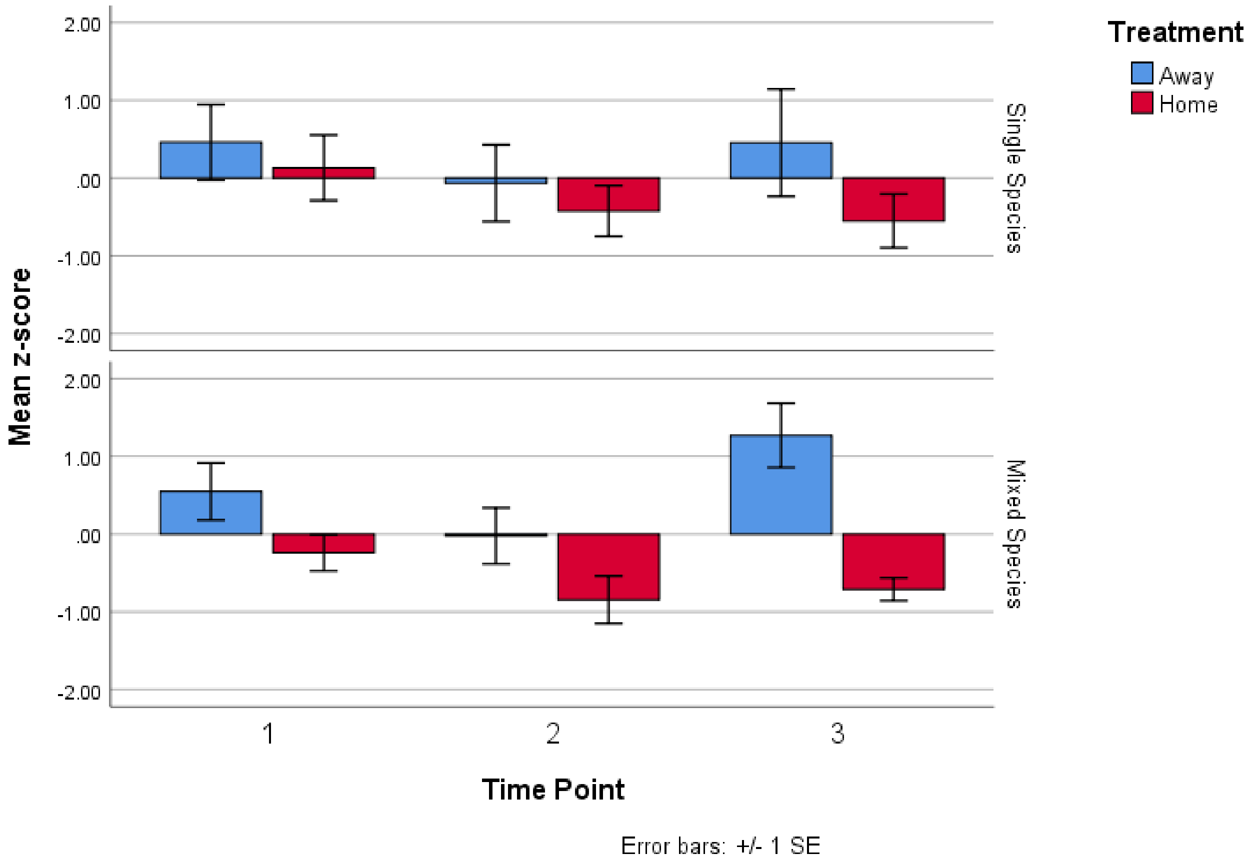


Figure 3: Average z-scores (representing relative decomposition) based on condition and litter source.

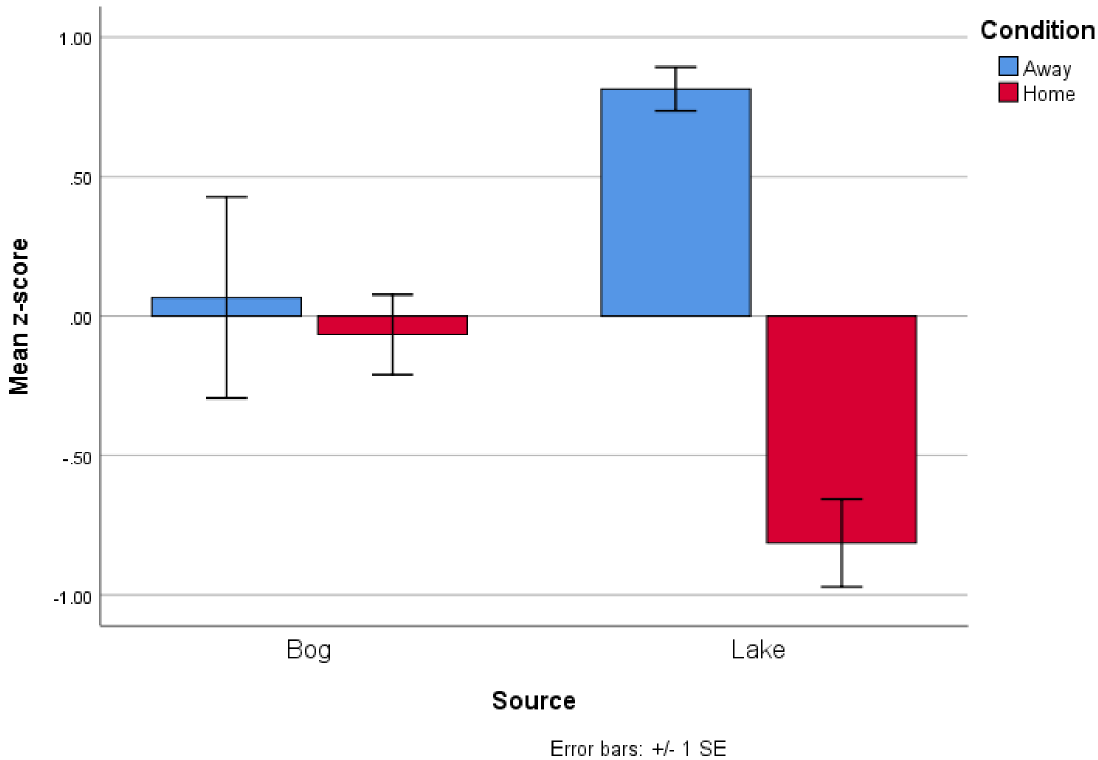


Figure 4: Actual vs Predicted leaf litter mass remaining for mixed-species bags in home and away conditions.

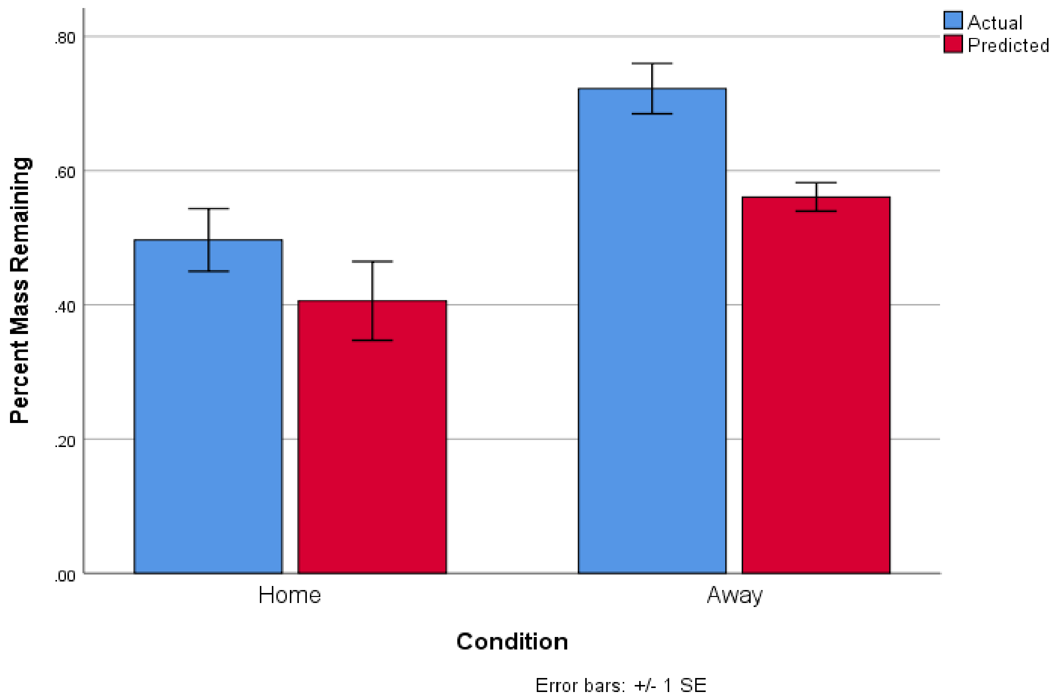
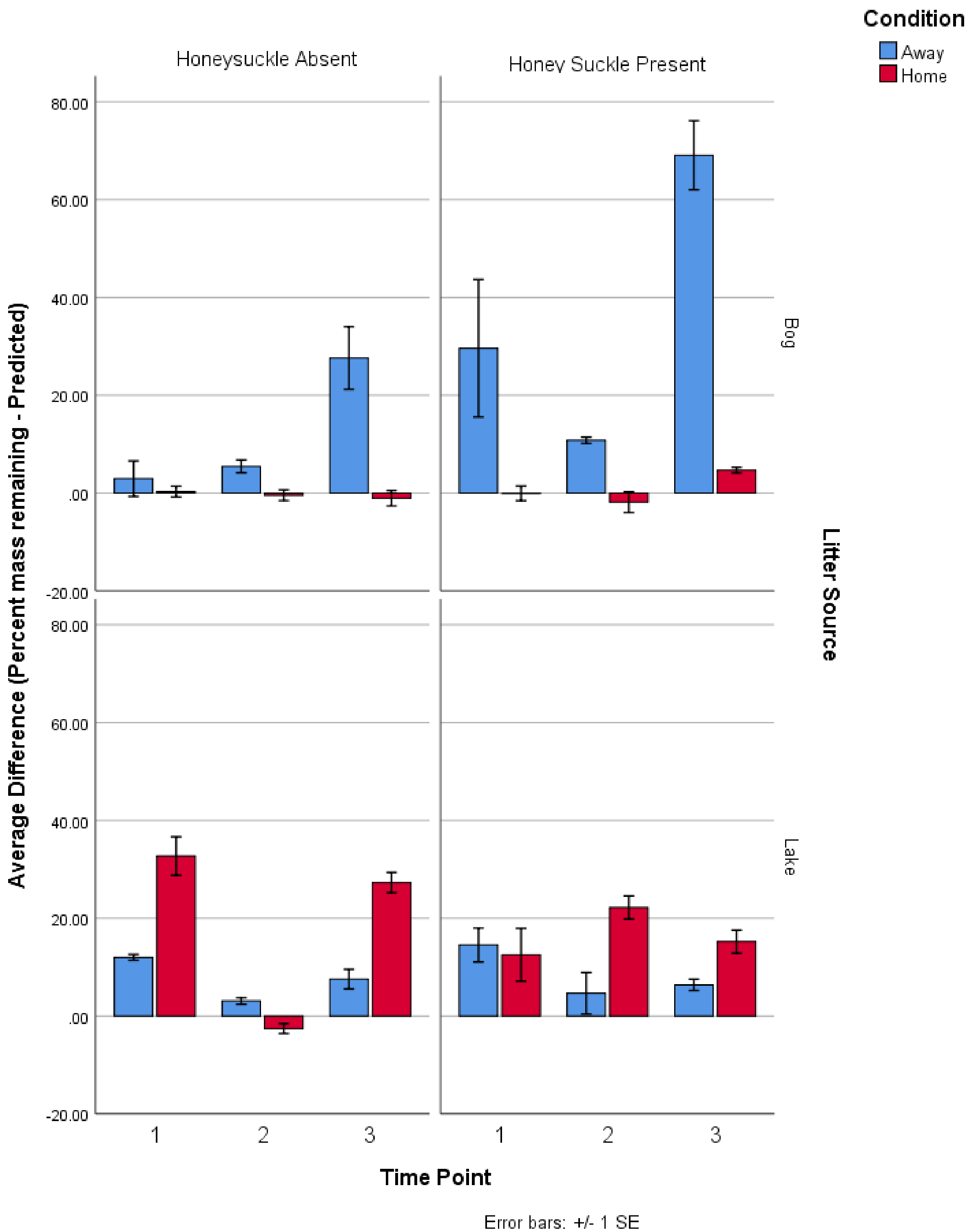


Figure 5: Average difference between actual and predicted leaf litter remaining for mixed-species bags.



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Appendix 1: Finalized data. All percent remaining and predicted values are corrected for ash-free dry mass.

Number	Species 1	Species 2	Species 3	Type	Location	Time Point	Condition	percent_remaining_corrected	corrected_prediction	macroinvertebrate_morphospecies_richness
1	honeysuckle	none	none	9	Bog	1	NA	0.4249		0
2	honeysuckle	none	none	9	Bog	1	NA	0.5646		0
3	honeysuckle	none	none	9	Bog	1	NA	0.5655		0
4	labrador tea	none	none	1	Bog	1	Home	0.8239		0
5	labrador tea	none	none	1	Bog	1	Home	0.8123		0
6	labrador tea	none	none	1	Bog	1	Home	0.8825		0
7	leatherleaf	Labrador Tea	Honeysuckle	4	Bog	1	Home	0.7478	0.7186	0
8	leatherleaf	Labrador Tea	Honeysuckle	4	Bog	1	Home	0.7058	0.7181	1
9	leatherleaf	Labrador Tea	Honeysuckle	4	bog	1	Home	0.7037	0.7228	0
10	leatherleaf	Labrador Tea	none	3	Bog	1	Home	0.8474	0.8222	3
11	leatherleaf	Labrador Tea	none	3	Bog	1	Home	0.8124	0.8222	1
12	leatherleaf	Labrador Tea	none	3	Bog	1	Home	0.8157	0.8222	4
13	leatherleaf	none	none	2	Bog	1	Home	0.7961		3
14	leatherleaf	none	none	2	Bog	1	Home	0.8239		0
15	leatherleaf	none	none	2	Bog	1	Home	0.7952		0
16	paper birch	none	none	5	bog	1	Away	0.6086		1
17	paper birch	none	none	5	bog	1	Away	0.5718		0
18	paper birch	none	none	5	Bog	1	Away	0.6444		0
19	sugar maple	none	none	6	Bog	1	Away	0.5205		0
20	sugar maple	none	none	6	Bog	1	Away	0.3149		0
21	sugar maple	none	none	6	Bog	1	Away	0.4424		3
22	sugar maple	paper birch	honeysuckle	8	Bog	1	Away	0.7131	0.5175	0
23	sugar maple	paper birch	honeysuckle	8	Bog	1	Away	0.6792	0.5176	0
24	sugar maple	paper birch	honeysuckle	8	bog	1	Away	0.5966	0.5176	1
25	sugar maple	paper birch	none	7	Bog	1	Away	0.6485	0.5176	0
26	sugar maple	paper birch	none	7	Bog	1	Away	0.6288	0.5186	0
27	sugar maple	paper birch	none	7	Bog	1	Away	0.6346	0.5159	0
28	honeysuckle	none	none	9	Lake	1	NA	0		5
29	honeysuckle	none	none	9	Lake	1	NA	0		7
30	honeysuckle	none	none	9	Lake	1	NA	0		9
31	labrador tea	none	none	1	Lake	1	Away	0.7477		9
32	labrador tea	none	none	1	Lake	1	Away	0.9131		6

33	labrador tea	none	none	1	Lake	1	Away	0.754		4
34	leatherleaf	Labrador Tea	Honeysuckle	4	lake	1	Away	0.757	0.5339	4
35	leatherleaf	Labrador Tea	Honeysuckle	4	Lake	1	Away	0.637	0.5393	7
36	leatherleaf	Labrador Tea	Honeysuckle	4	Lake	1	Away	0.9793	0.412	11
37	leatherleaf	Labrador Tea	none	3	Lake	1	Away	0.8423	0.7987	10
38	leatherleaf	Labrador Tea	none	3	Lake	1	Away	0.759	0.7984	4
39	leatherleaf	Labrador Tea	none	3	Lake	1	Away	0.8826	0.7986	12
40	leatherleaf	none	none	2	Lake	1	Away	0.8176		5
41	leatherleaf	none	none	2	Lake	1	Away	0.7937		4
42	leatherleaf	none	none	2	Lake	1	Away	0.7654		8
43	paper birch	none	none	5	Lake	1	home	0.3826		12
44	paper birch	none	none	5	Lake	1	home	0.2425		12
45	paper birch	none	none	5	Lake	1	home	0.3518		8
46	sugar maple	none	none	6	Lake	1	home	0		4
47	sugar maple	none	none	6	Lake	1	home	0		8
48	sugar maple	none	none	6	Lake	1	home	0		3
49	sugar maple	paper birch	honeysuckle	8	Lake	1	home	0.1254	0.1058	8
50	sugar maple	paper birch	honeysuckle	8	Lake	1	home	0.307	0.1096	6
51	sugar maple	paper birch	honeysuckle	8	Lake	1	home	0.2693	0.11	6
52	sugar maple	paper birch	none	7	Lake	1	home	0.4273	0.1632	8
53	sugar maple	paper birch	none	7	Lake	1	home	0.4818	0.1632	7
54	sugar maple	paper birch	none	7	Lake	1	home	0.5624	0.1628	6
55	honeysuckle	none	none	9	Bog	2	NA	0.5472		
56	honeysuckle	none	none	9	Bog	2	NA	0.5913		
57	honeysuckle	none	none	9	Bog	2	NA	0.5564		
58	labrador tea	none	none	1	Bog	2	Home	0.8165		
59	labrador tea	none	none	1	Bog	2	Home	0.8368		
60	labrador tea	none	none	1	Bog	2	Home	0.8268		
61	leatherleaf	Labrador Tea	Honeysuckle	4	bog	2	Home	0.6584	0.7187	
62	leatherleaf	Labrador Tea	Honeysuckle	4	bog	2	Home	0.7138	0.7171	
63	leatherleaf	Labrador Tea	Honeysuckle	4	bog	2	Home	0.7259	0.718	
64	leatherleaf	Labrador Tea	none	3	Bog	2	Home	0.8126	0.7956	
65	leatherleaf	Labrador Tea	none	3	bog	2	Home	0.7757	0.7951	
66	leatherleaf	Labrador Tea	none	3	bog	2	Home	0.7845	0.7955	
67	leatherleaf	none	none	2	bog	2	Home	0.7434		
68	leatherleaf	none	none	2	Bog	2	Home	0.7666		
69	leatherleaf	none	none	2	bog	2	Home	0.7807		
70	paper birch	none	none	5	Bog	2	Away	0.4932		
71	paper birch	none	none	5	Bog	2	Away	0.4458		
72	paper birch	none	none	5	Bog	2	Away	0.548		
73	sugar maple	none	none	6	Bog	2	Away	0.443		
74	sugar maple	none	none	6	Bog	2	Away	0.4075		
75	sugar maple	none	none	6	Bog	2	Away	0.4626		

76	sugar maple	paper birch	honeysuckle	8	Bog	2	Away	0.5921	0.5004	
77	sugar maple	paper birch	honeysuckle	8	bog	2	Away	0.587	0.5003	
78	sugar maple	paper birch	honeysuckle	8	Bog	2	Away	0.4618	0.5	
79	sugar maple	paper birch	none	7	bog	2	Away	0.495	0.4665	
80	sugar maple	paper birch	none	7	bog	2	Away	0.5104	0.4664	
81	sugar maple	paper birch	none	7	bog	2	Away	0.4871	0.4663	
82	honeysuckle	none	none	9	Lake	2	NA	0		
83	honeysuckle	none	none	9	Lake	2	NA	0		
84	honeysuckle	none	none	9	Lake	2	NA	0		
85	labrador tea	none	none	1	Lake	2	Away	0.8351		
86	labrador tea	none	none	1	Lake	2	Away	0.6927		
87	labrador tea	none	none	1	Lake	2	Away	0.8712		
88	labrador tea	none	none	1	Lake	2	Away	0.7787		
89	labrador tea	none	none	1	Lake	2	Away	0.8349		
90	labrador tea	none	none	1	Lake	2	Away	0.8204		
91	leatherleaf	Labrador Tea	Honeysuckle	4	Lake	2	Away	0.5993	0.5001	
92	leatherleaf	Labrador Tea	Honeysuckle	4	Lake	2	Away	0.6217	0.501	
93	leatherleaf	Labrador Tea	Honeysuckle	4	Lake	2	Away	0.6094	0.5055	
94	leatherleaf	Labrador Tea	none	3	Lake	2	Away	0.8318	0.7512	
95	leatherleaf	Labrador Tea	none	3	Lake	2	Away	0.7979	0.7515	
96	leatherleaf	Labrador Tea	none	3	Lake	2	Away	0.7887	0.7516	
97	leatherleaf	none	none	2	lake	2	Away	0.6947		
98	leatherleaf	none	none	2	lake	2	Away	0.6309		
99	leatherleaf	none	none	2	lake	2	Away	0.69		
100	leatherleaf	none	none	2	Lake	2	Away	0.6939		
101	leatherleaf	none	none	2	Lake	2	Away	0.7292		
102	leatherleaf	none	none	2	Lake	2	Away	0.7447		
103	sugar maple	paper birch	honeysuckle	8	Lake	2	home	0.2984	0.0369	
104	sugar maple	paper birch	honeysuckle	8	Lake	2	home	0.2142	0.0347	
105	sugar maple	paper birch	honeysuckle	8	Lake	2	home	0.2591	0.034	
106	sugar maple	paper birch	none	7	Lake	2	home	0.0129	0.0526	
107	sugar maple	paper birch	none	7	Lake	2	home	0.045	0.0509	
108	sugar maple	paper birch	none	7	Lake	2	home	0.021	0.0517	
109	honeysuckle	none	none	9	bog	3	NA	0.3158		

110	honeysuckle	none	none	9	bog	3	NA	0.3454		
111	honeysuckle	none	none	9	bog	3	NA	0.3514		
112	leatherleaf	Labrador Tea	Honeysuckle	4	bog	3	Home	0.696	0.6399	
113	leatherleaf	Labrador Tea	Honeysuckle	4	bog	3	Home	0.6896	0.6409	
114	leatherleaf	Labrador Tea	Honeysuckle	4	bog	3	Home	0.6748	0.639	
115	leatherleaf	Labrador Tea	none	3	bog	3	Home	0.8022	0.7902	
116	leatherleaf	Labrador Tea	none	3	bog	3	Home	0.7868	0.7896	
117	leatherleaf	Labrador Tea	none	3	bog	3	Home	0.749	0.79	
118	paper birch	none	none	5	bog	3	Away	0.532		
119	paper birch	none	none	5	bog	3	Away	0.5695		
120	paper birch	none	none	5	bog	3	Away	0.475		
121	paper birch	none	none	5	bog	3	Away	0.4896		
122	paper birch	none	none	5	bog	3	Away	0.3895		
123	paper birch	none	none	5	bog	3	Away	0.5854		
124	sugar maple	none	none	6	bog	3	Away	0.3225		
125	sugar maple	none	none	6	bog	3	Away	0.6093		
126	sugar maple	none	none	6	bog	3	Away	0.5213		
127	sugar maple	none	none	6	bog	3	Away	0.2855		
128	sugar maple	none	none	6	bog	3	Away	0.5698		

129	sugar maple	none	none	6	bog	3	Away	0.3565		
130	sugar maple	paper birch	honeysuckle	8	bog	3	Away	0.5098	0.4295	
131	sugar maple	paper birch	honeysuckle	8	bog	3	Away	0.4725	0.4307	
132	sugar maple	paper birch	honeysuckle	8	bog	3	Away	0.4999	0.4305	
133	sugar maple	paper birch	none	7	bog	3	Away	0.5123	0.475	
134	sugar maple	paper birch	none	7	bog	3	Away	0.559	0.4748	
135	sugar maple	paper birch	none	7	bog	3	Away	0.5805	0.4754	
136	honeysuckle	none	none	9	Lake	3	NA	0		
137	honeysuckle	none	none	9	lake	3	NA	0.0007		
138	honeysuckle	none	none	9	lake	3	NA	0		
139	labrador tea	none	none	1	lake	3	Away	0.7512		
140	labrador tea	none	none	1	lake	3	Away	0.8539		
141	labrador tea	none	none	1	lake	3	Away	1.0025		
142	leatherleaf	Labrador Tea	Honeysuckle	4	lake	3	Away	1.2033	0.5097	
143	leatherleaf	Labrador Tea	Honeysuckle	4	lake	3	Away	1.3203	0.5088	
144	leatherleaf	Labrador Tea	Honeysuckle	4	lake	3	Away	1.077	0.5101	
145	leatherleaf	Labrador Tea	none	3	lake	3	Away	1.044	0.7642	
146	leatherleaf	Labrador Tea	none	3	lake	3	Away	0.9286	0.7649	
147	leatherleaf	Labrador Tea	none	3	lake	3	Away	1.1498	0.7648	
148	leatherleaf	none	none	2	lake	3	Away	0.6288		
149	leatherleaf	none	none	2	lake	3	Away	0.6728		
150	leatherleaf	none	none	2	Lake	3	Away	0.6798		
151	paper birch	none	none	5	lake	3	home	0.0315		

152	paper birch	none	none	5	lake	3	home	0.0242		
153	paper birch	none	none	5	lake	3	home	0.0417		
154	sugar maple	none	none	6	lake	3	home	0		
155	sugar maple	none	none	6	lake	3	home	0		
156	sugar maple	none	none	6	lake	3	home	0.0006		
157	sugar maple	paper birch	honeysuckle	8	lake	3	home	0.1497	0.0112	
158	sugar maple	paper birch	honeysuckle	8	lake	3	home	0.1309	0.0105	
159	sugar maple	paper birch	honeysuckle	8	lake	3	home	0.2086	0.0105	
160	sugar maple	paper birch	none	7	lake	3	home	0.3299	0.0163	
161	sugar maple	paper birch	none	7	lake	3	home	0.2761	0.0162	
162	sugar maple	paper birch	none	7	lake	3	home	0.2612	0.016	