Resource Subsidies to Arthropod Food Webs at a Pond-Forest Boundary

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Abstract: Resources that move across ecosystem boundaries have been shown to subsidize recipient consumers and have complex consequences for recipient food webs. Emergence of aquatic insects onto land and accidental input of terrestrial arthropods into water are two important pathways by which protein-rich resources move between freshwater and terrestrial habitats. In this dissertation, I used field observations, conceptual modeling, field experiments and stable isotopes to understand the role of arthropod prey moving between a pond and forest habitat in generating the temporal and spatial patterns of predator abundance, size, reproduction and diet seen on land and in the water. The wolf spiders, dragonfly larvae, newts and crayfish living in and around two small permanent ponds in the southern Appalachians are a well-defined system within which to examine these ideas.

Aquatic insect movement to land was predictable only at the whole pond level, whereas terrestrial arthropods falling into the water could be manipulated locally within ponds. Wolf spider per capita mass and the proportion that were reproductive declined within enclosures where aquatic insects had been reduced by 50%. Wolf spiders at the edge of the pond consumed aquatic resources as demonstrated by a temporal shift in isotopic signatures which paralleled the change in isotope enrichment in aquatic insects emerging from the pond after the enclosures had been isotopically labeled with ^{13}C. Furthermore, the response of wolf spiders to aquatic insect prey differed among ponds and species life histories. Dragonfly larvae seemed to consume more terrestrial resources when more were available, as evidenced by isotopic data, but their abundances were not influenced by a reduction in terrestrial input. The reduced input also appeared to influence the intraguild interactions between newts and dragonfly larvae, as well as between crayfish and dragonfly larvae.

A conceptual model of donor and recipient food web productivity and types of effects of subsidies suggested that two-way movement should be important at the pond-forest interface. Results of this dissertation lend some support to this hypothesis but emphasize that the influence of subsidies on predators varies by taxa, the size and productivity of the aquatic habitat and the spatial scale of the subsidy.

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Chapter 1

Spatially subsidized food webs: predicting qualitative shifts in the impacts of resource movement across habitat boundaries

Abstract. The subsidization of food webs by externally derived resources has complex and far-reaching consequences for food web dynamics in natural and managed systems. These consequences include augmentation of consumer populations, depression of *in situ* resources and linked food web dynamics across ecosystem boundaries. I predicted a qualitative shift in the relative importance of different types of effects and patterns of resource subsidies at habitat interfaces based on the ratio of donor to recipient resource productivity (D/R) in that system. I expect direct effects on consumers, apparent competition and trophic cascades to be more important in high D/R systems, while reciprocal subsidies, recipient control and indirect competition between consumers in different habitats to be more important when D/R is closer to 1. I apply this predictive framework to previously published data on subsidy effects for eight types of interfaces between aquatic and terrestrial food webs that span a subsidy/recipient resource gradient (S/R, a proxy for D/R) in prey abundance, productivity, or mass from 4.59 (marine upwelling/desert) to 0.08 (stream/deciduous forest). There is a positive relationship between S/R and the magnitude of the effect of a subsidy on a predator's abundance. Reciprocal subsidies were only measured in one system and recipient control in none, making evaluation in these areas premature. Variation in response of taxa to a subsidy within a system and differences in effect magnitude among systems with similar S/R ratios point to the important contribution of factors such as taxon life history, habitat permeability, and temporal variability to the response of a particular consumer or food web to a subsidy. This perspective provides a simple framework for understanding the consequences of resource subsidies to food webs at interfaces between habitats of varying productivity.

Keywords: Reciprocal subsidies, D/R ratio, productivity, apparent competition, allochthonous input.

Introduction

The movement of resources across boundaries between aquatic and terrestrial ecosystems is ubiquitous in nature. Over the last fifteen years, attention to the consequences of the subsidization of recipient food webs by allochthonous resources has shown that these resources can increase consumer density (direct effects) and decouple consumers from *in situ* food webs (Polis and Hurd 1996a,b, Nakano and Murakami 2001, Sabo and Power 2002a,b). Thus, resource subsidies at times allow consumers to grow and reproduce independently of *in situ* prey availability. This effect can indirectly impact other resources as many as two trophic levels removed from the original consumer through apparent competition and trophic cascades (Polis and Hurd 1996b, Henschel et al. 2001, Murakami and Nakano 2002, Baxter et al. 2004). Furthermore, the bi-directional movement of resources (reciprocal subsidies) that may occur between habitats can cause feed-back loops that intertwine food web dynamics in apparently disparate systems (Nakano and Murakami 2001, Helfield and Naiman 2002, Baxter et al. 2005, Paetzold and Tockner 2005).

A current challenge to understanding the role of resource subsidies in driving the abundance and distribution of species is predicting when and where each of these types of effects and patterns of subsidies may most influence food web dynamics. Relative productivity of donor (D) and recipient (R) food webs, measured as a ratio (D/R), has been invoked as one of the underlying determinants of the magnitude of effects of subsidies on recipient food webs (Polis and Hurd 1996a,b, Huxel and McCann 1998, Witman et al. 2004, Polis et al. 2004). The index D/R may thus provide a good general framework for predicting the types of consequences expected to be important at a given interface.

Productivity, units of organic matter or energy generated per area per time, has a long history of use as an explanatory variable in food webs. The primary productivity of a habitat has been linked to secondary productivity (McNaughton et al. 1989, Power 1992), food chain length (Fretwell 1977, 1987, Power 1992) and output of resource subsidies from that system (Nakano and Murakami 2001, Huxel et al. 2004). Food webs with seasonally or consistently low levels of primary productivity, therefore, can be greatly affected by the input of resources (at any trophic level) from a more highly productive system (Takimoto et al. 2002, Huxel et al. 2004). In this type of system I would expect direct effects of subsidies and the consequences of these effects in the recipient system (apparent competition and trophic cascades) to be relatively more important than two-way interactions between donor and recipient food webs. On the other hand, in systems where productivity of donor and recipient food webs are more similar, I propose that reciprocal subsidies and regulation of the allochthonous resource by a recipient predator ('recipient control') will be more important at interfaces between habitats that are similar in productivity than in systems with high D/R.

The purposes of this study are 1) to offer a conceptual perspective that relates the effects of resource subsidies in a recipient habitat to the ratio of donor to recipient resource productivity (D/R); 2) to illustrate this idea with empirical examples from published studies of food webs; 3) to discuss variation not explained by this perspective; and 4) to recommend measurements needed to support a meta-analytical approach of studying patterns of resource subsidies to food webs. To provide background for the perspective, I outline the effects of subsidies on recipient food webs in a range of well-studied aquatic-terrestrial interfaces. This work provides a common currency (D/R) for predicting the mechanisms by which subsidies may affect a food web at a given interface. This idea is novel because it considers how the types of effects of subsidies might shift qualitatively across interface types and attempts to fit this pattern into a common, predictive framework. Understanding how both the types of effects and the patterns of subsidization vary at an interface illuminates food web processes at the landscape level.

Mechanisms and patterns of food web effects of subsidies

The response of species to resource subsidies is regulated by properties of the donor food web, the recipient food web, habitat structure and the species. The quantity of subsidy, which is influenced by the productivity of the donor food web (Kawaguchi and Nakano 2001) and permeability of the habitat boundary (Witman et al. 2004), can influence the stability of the recipient food web (Huxel and McCann 1998). In particular, high levels of subsidy can decouple the dynamics of consumers from that of its *in situ* prey. Furthermore, the preference of the consumer for the subsidy has a similar effect: increase preference increases the decoupling of the consumer from *in situ* prey (Huxel and McCann 1998). It is the behaviors and life-histories of the recipient species (Stapp and Polis 2003, Power et al. 2004, Baxter et al. 2005) that alters the use of and preference for the subsidy.

Resource subsidies can affect consumer populations directly by increasing abundance, growth, and biomass, and changing diet and foraging time of the consumer.

These responses, which have been recorded in spiders, scorpions, beetles, grasshoppers, lizards, bats, mice, birds, fish, foxes, and coyotes, have been found at the boundaries between desert and arctic-marine upwelling systems, desert-stream systems, deciduous forest-stream systems, and cobble bar-river systems (Roth 2003, Power et al. 2004, Baxter et al. 2005, for review see Polis et al. 2004). In some cases, this increase in abundance or shift in diet of consumers causes an indirect impact on *in situ* prey or resources (Fig. 1). In a mainland desert-marine interface, Polis and Hurd (1996b) found that apparent competition and trophic cascades caused by large increases in predator density (generalist spiders) reduced the number of herbivores and decreased herbivory. Henschel (2004) found an indirect effect of aquatic insects on thistle herbivory, mediated through the increased spider densities on thistle near the 70-m wide Main River in Bavaria, Germany. Alternatively, allochthonous resources may have a positive effect on *in situ* prey if predators shift their diet away from these resources in the presence of subsidies, such as in salmonid fish shifting from aquatic macroinvertebrates to terrestrial arthropod drift (reviewed by Baxter et al. 2005) and caged riparian lizards shifting from terrestrial wolf spiders to adults of emergent aquatic insects (Sabo and Power 2002a).

Although one-way movement of subsidies across a habitat boundary has been the most studied, in reality two-way or ‘reciprocal’ subsidies may be important at many boundaries (Fig. 1). Nakano, Murakami, and colleagues found that arthropods falling into a second-order stream greatly influenced the stream food web by providing important resources for salmonid fish (Kawaguchi and Nakano 2001, Nakano et al. 1999a,b, Baxter et al. 2005), while insects emerging from the stream played a similarly important role as a food source to some birds and spiders living near the stream (Nakano and Murakami 2001, Murakami and Nakano 2002, Kato et al. 2003). Two-way or reciprocal subsidies at the aquatic-terrestrial interface has thus far been studied in only this and one other system (J. M. Kraus, Chapter 3), but likely occurs in some form at most interfaces. Increased importance of reciprocal subsidies is likely to increase feedback between habitats and likely change the types of responses to subsidies by recipient consumers.

In particular, the two-way linkages between recipient and donor food webs may lead to the two food webs acting more as one. Most studies of resource subsidies at aquatic-terrestrial boundaries define subsidies and their effects as donor-controlled, i.e. the populations are regulated by food availability not by predators (Fretwell 1977, Polis and Strong 1996). There is no or minimal feedback from recipient to donor habitats when subsidies are controlled by resources in the donor environment and not by predation in the recipient environment. Donor control and minimal feedback appears to occur mainly with large detrital subsidies and from pulsed insect emergences where predators have little effect on resource availability or flux (Ostfeld and Keesing 2000, Polis et al. 2004). Recipient control, on the other hand, is top-down control of allochthonous resources (Fig.1). Although there is little mention in the literature of resource subsidies being controlled by their consumers (but see Paetzold and Tockner 2005), I suggest this is possible when the subsidies are living prey and mainly in systems where D/R is small (< or ≈ 1).

A perspective on subsidy effects

I offer a perspective on the roles that donor and recipient productivity play in determining the types of effects of subsidies (Fig. 1) on food webs in a two-habitat framework. I make the prediction that as the ratio of donor to recipient productivity (D/R) increases, the importance of direct and indirect effects of subsidies within a habitat increases and the importance of the direct and indirect effects of subsidies between habitats decrease (Fig. 2). In other words, consumer density, apparent competition and trophic cascades in the recipient habitat increase with increased D/R. Furthermore, reciprocal subsidies, indirect effect of consumers across boundaries and consumer regulation of subsidies (recipient-control) will be most important at habitat interfaces with small (< or ≈ 1) D/R. The fact that subsidized food web studies traditionally focused on large productivity gradients (e.g. desert-upwelling ocean, Polis et al. 2004) may explain why these later phenomena have not frequently been measured or reported.

An application

Methods

In order to examine whether there is a qualitative shift in the relative importance of direct effects, apparent competition, trophic cascades, reciprocal subsidies, indirect effect of consumers across boundaries, and recipient control of subsidies over a gradient of D/R, I selected studies of aquatic-terrestrial boundaries in which the subsidization of higher-level consumers were reported (Table 1). I only used papers that reported the response variables in areas of both high and low subsidy within the recipient habitat. This allowed presentation of effect sizes standardized by the magnitude of difference in subsidy between reduced and control treatments within each paper. I could not use standard effect size such as Cohen's d (Gurevitch and Hedges 2001) because sample size was not reported in all papers. Instead I constructed an index, referred to as effect magnitude, which is the ratio of means of the dependent variable of interest in high versus low subsidy sites. Effects are calculated as a ratio of means at the high to low subsidy sites, except in the case of apparent competition and trophic cascades where the larger mean was placed in the numerator regardless of treatment. Effect magnitudes for direct effect (DE) of a subsidy on consumer diet was initially found to have a positive linear relationship to the percent change in subsidy between the high and low subsidy areas across all studies (Linear regression, DE on diet, $r^2 = 0.42$, $N = 18$, *slope* = 115.7 ± 33.3, $F = 12.06$, $P = 0.003$, DE on abundance, $r^2 = 0.12$, $N = 16$, *slope* = 5.8 ± 4.1, $F = 1.98$, $P = 0.18$). This relationship did not hold for direct effects on abundance or apparent competition (AC) with herbivores (AC on herbivore biomass, $r^2 = 0.01$, $N = 36$, *slope* = -0.48 ± 0.71, $F = 0.45$, $P = 0.51$, AC on herbivore abundance, $r^2 = 0.04$, $N = 19$, *slope* = 0.52 ± 0.6, $F = 0.74$, $P = 0.40$). Effect magnitudes for direct effects on diet only were thus standardized by dividing the raw magnitude by the percent difference in subsidy between the high and low subsidy areas for all effects. Traditional effect size (Cohen's d, adjusted for low sample size, Gurevitch and Hedges 2001) was calculated when possible (i.e. when standard errors and sample sizes were reported) and showed similar trends to the effect magnitude ratio, but the lack of reported standard errors for several of the measurements made it an impractical choice for this analysis and is not reported.

Papers included in the meta-analysis also included some part of the following information: predator abundance or diet, consumer abundance or biomass, any measure of resource change and incidence or magnitude of reciprocal subsidy. Recipient control was not reported in any of the selected papers and so could not be included in the final analysis. When the same results were published in more than one paper they were only recorded once. Review papers were only included if they contained unpublished or more clearly presented data than original reports.

Only one paper that met the criteria for inclusion reported an estimate of donor and recipient productivity (Polis and Hurd 1996b). For this reason, I use the ratio of subsidy to recipient resource availability (S/R) as a proxy for D/R. Using this proxy assumes that S is proportional to D across all systems studied. Although it has been shown that factors affecting permeability of a boundary to subsidy may vary even within a system (Witman et al. 2004), the studies included in the analysis focus on unobstructed shore-line. Subsidy and recipient resource availability were measured as abundance, mass or productivity of terrestrial and aquatic arthropod prey (Table 2). One exception is in the desert island-marine system (Polis et al. 2004), where detrital input over time was compared with annual net primary productivity.

Effect magnitude for each taxon was averaged by and plotted against type of habitat boundary. Because studies of only four of the eight types of habitat boundaries reported enough information to calculate mean S/R, I use this graphical procedure to present all possible results. A linear regression was used to calculate the relationship between effect magnitude and S/R when reported. Standard errors are reported to illustrate variation among taxa within a study system. All analyses were performed using SAS (SAS 8.2, © 1999-2001, SAS Institute Inc., NC).

Results

The ratio of subsidy to *in situ* resource (S/R) was highest in the desert shore and island-marine upwelling systems (Polis and Hurd 1996b) and lowest in the Japanese stream-forest system (Fig. 4), suggesting that allochthonous resources provide more resources to consumers relative to *in situ* resources on desert islands than in second-order streams. The desert shore and island-marine upwelling systems also showed a higher magnitude of direct effects on consumer abundance and biomass than in other systems examined (Figs. 4 and 5). The ratio of donor to recipient productivity increased direct effects of subsidy on abundance of consumers (linear regression: $r^2 = 1.00$, $N = 3$, $slope = 1.0 \pm 0.02$, $F_{1,1} = 4709.94$, $P = 0.009$). This relationship was driven by differences in response between desert-upwelling ocean systems (S/R = 4.59) and all other interfaces examined here ($0.23 \leq S/R \leq 0.73$). The effect of apparent competition with resource subsidies on the biomass of *in situ* recipient resources did not vary with S/R (linear regression: $r^2 = 0.47$, $N = 3$, $slope = -0.87 \pm 0.93$, $F_{1,1} = 0.89$, $P = 0.51$). All other relationships could not be tested because of lack of data. Reciprocal subsidies were only studied in the Horonai Stream in Tomakomai Experimental Forest, Japan, both on land and in the stream (Table 3). There was variation in response to subsidy based on species identity for direct effects (Figs. 3 and 4), apparent competition and trophic cascades (not shown).

Discussion

Resource subsidies have been shown to influence food web dynamics through a variety of mechanisms. I suggest that the mechanisms by which subsidies influence food webs will change over a gradient of donor to recipient productivity, so that the direct and some indirect effects of subsidies (e.g. apparent competition and trophic cascades) will typically predominate in systems where energy is more externally than internally derived, such as in caves, headwater streams, and some marine islands (Huxel and McCann 1998). Evidence from published work supports the idea that direct effects of subsidies on consumers may be influenced by D/R, but there is currently no evidence to support the idea that this pattern holds true for apparent competition or trophic cascades within the recipient habitat. I also suggest that as the donor and recipient productivity become more similar, other mechanisms and patterns of food web dynamics (reciprocal subsidies and recipient feedback) become common. Because reciprocal subsidies have only been measured entering and exiting the stream in the Horonai Stream-deciduous forest system (Nakano and Murakami 2001, Baxter et al. 2004) and in this work (Chapter 3), it is impossible to confirm whether the pattern is generalizable. There were not enough appropriate studies to confirm predicted patterns. Published accounts of simultaneously measured subsidies and donor and recipient productivity using the same units were rare. It is important to note, however, that it is in a system with lower S/R and high intra-annual variability in subsidy movement that reciprocal subsidies and feedback between aquatic and terrestrial food webs are important to local consumers (Nakano and Murakami 2001, Baxter et al. 2004). However, it is still unclear whether apparent competition between *in situ* and allochthonous subsidies and trophic cascades are more important in recipient food webs that are much lower in productivity than their donors. The presence of both trophic cascades and apparent competition in systems with low D/R suggest this prediction might not hold in nature.

In general, data available to test my idea were limited and patterns were strongly influenced by one system with high S/R ratio. Desert-marine upwelling systems drive the relationship between the strength of direct effects and S/R ratio. This pattern should not be ignored since much of the theory has been developed with systems with large productivity gradients, especially the desert island-upwelling ocean in mind. However, the inability to test my idea against a true gradient highlights the need to measure subsidies and the interconnected nature of food webs across boundaries in additional systems.

Other factors besides D/R clearly influence the response of consumers, prey and resources to resource subsidies. When multiple taxa were measured within a system, they often varied in their response to resource subsidies. The departure of taxa from the predicted relationship provides an opportunity to examine whether other processes, such as boundary permeability (Fagan et al. 1999, Witman et al. 2004), recipient food web topology (Polis et al. 1997, Huxel et al. 2004), or taxa life histories (Baxter et al. 2005) may influence the pattern.

The ideas presented here provide a common framework for understanding food web patterns from different interfaces. I suggest that processes determining food web dynamics and patterns may be qualitatively different depending on the relative productivity of the surrounding habitats. This relative measurement of productivity acknowledges that properties of both donor and recipient food webs influence the importation of subsidies in these systems. As a result this perspective encourages study of both donor and recipient food webs when examining consequences of spatial subsidies at habitats with similar D/R.

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Table 1. Papers cited in meta-analysis. Taxa include the species or groups of species analyzed in the recipient habitat. Habitat is type of interface where the study took place, recipient is listed first.

Habitat	Taxa	Citation
Cobble Bar-River (CA)	lizards, spiders, beetles	Sabo and Power 2002b
Desert island-Marine (CA)	Coyotes	Rose and Polis 1998
Desert island-Marine (CA)	Spiders, lizards, scorpions	Polis and Hurd 1996b
Desert island-Marine (CA)	Beetles	Sánchez-Piñero and Polis 2000
Desert island-Marine (CA)	2 spp. mice	Stapp and Polis 2003
Desert island-Marine (CA)	Lizards	Barrett *et al.* 2005
Desert shore-Marine (Namibia)	Spiders, herbivores, plants	Polis and Hurd 1996b
Forest-stream (Japan)	3 taxa bird, 3 spp. herbivorous insect	Murakami and Nakano 2002
Forest-stream (Japan)	3 taxa bird	Iwata et al. 2003
Forest-stream (Japan)	3 taxa spiders	Kato et al. 2003
Stream-forest (Japan)	Fish, macro-inverts, periphyton	Nakano et al. 1999a,b
Stream-forest (Japan)	Fish, macro-invertebrates	Kawaguchi and Nakano 2001
Stream-forest (Japan)	2 spp. fish, macro-invertebrates, spiders	Baxter et al. 2004
Thistle-River (Germany)	Spiders	Henschel et al. 1996
Thistle-River (Germany)	Spiders, herbivores, nettles	Henschel et al. 2001
Stream-Forest (VA)	Fish	Cloe and Garman 1996
Alpine shore-River (Germany)	Beetles	Hering and Platcher 1997

Table 2. Taxa and currency of subsidy and *in situ* productivity of recipient food web where reported. Note the four cases in which subsidy and recipient productivity were not measured using the same currency. S/R is likely biased for these estimates: too small for the Stream-forest (Japan) system and unknown for the Desert island-Marine system.

Habitat	**Subsidy**	**Recipient productivity**	**Currency**	**Citation**
Cobble Bar-River (CA)	Aquatic insect adults	Terrestrial insects, wolf spiders and ground beetles	Mg dry mass/ trap	Sabo and Power 2002b
Desert island-Marine (CA)	Marine detritus	Estimated total plant NPP	g/m/yr (detritus) and g/m^2/yr (NPP)	Polis and Hurd 1996b
Desert island-Marine (CA)	Marine insects	Herbivorous insects	% of total insect prey sampled	Polis and Hurd 1996b
Forest-stream (Japan)	Aquatic insect adults	Aerial terrestrial insects	mg/trap/day	Iwata et al. 2003
Forest-stream (Japan)	Aquatic insect adults	Aerial terrestrial insects	mg/trap/day	Kato et al. 2003
Stream-forest (Japan)	Terrestrial arthropod fall	Aquatic insect larvae	mg/trap/day (terr) and mg/trap (aq)	Kawaguchi and Nakano 2001
Stream-forest (Japan)	Terrestrial arthropod fall and drift	Aquatic insect larvae	mg/trap/day (terr) and mg/trap (aq)	Baxter et al. 2004
Thistle-River (Germany)	Aquatic insects	Herbivorous arthropods	Mg/dm^2 sticky trap (aq) and thistle (terr)	Henschel et al. 2001

Table 3. Frequency of effect type reported in each system. Denominator is the number of papers included in the meta-analysis for each system. Numerator is the number of papers that reported a significant effect. DE= direct effect, AC=apparent competition, TC= trophic cascade, RS= reciprocal subsidy, RC= recipient control, IEP= indirect effect of aquatic and terrestrial predators on each other.

System	DE	AC	TC	RS	RC	IEP
Cobble Bar-river	1/1	1/1	0/1	0/1	0/1	0/1
Desert island-marine	5/5	0/5	0/5	0/5	0/5	0/5
Desert shore-marine	1/1	1/1	1/1	0/1	0/1	0/1
Forest-Japanese stream	4/4	3/4	0/4	1/4	0/4	1/4
Stream-Japanese forest	6/6	2/6	2/6	2/6	0/6	0/6
Thistle-River	1/1	1/1	1/1	0/1	0/1	0/1
Stream-VA Forest	1/1	0/1	0/1	0/1	0/1	0/1
Alpine shore-river	1/1	0/1	0/1	0/1	0/1	0/1

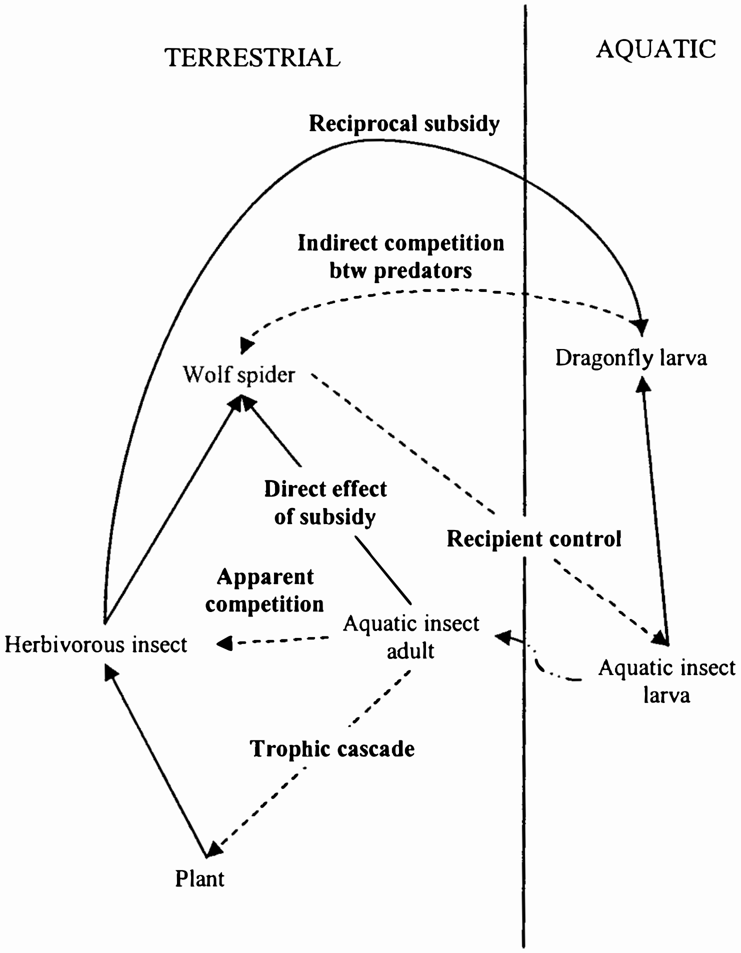

Figure 1. Illustration of the types of effects of subsidies that are discussed in this study. The example used is part of a food web at an aquatic-terrestrial boundary where aquatic insects are the subsidy. Effects are emboldened. Solid lines represent direct effects and arrows are in the direction of trophic flow. Dotted lines represent the indirect effects that result from the direct trophic interactions. Arrows are in the direction of the effect. The broken line between aquatic larva and adults represents the emergence of these insects from aquatic to terrestrial habitats.

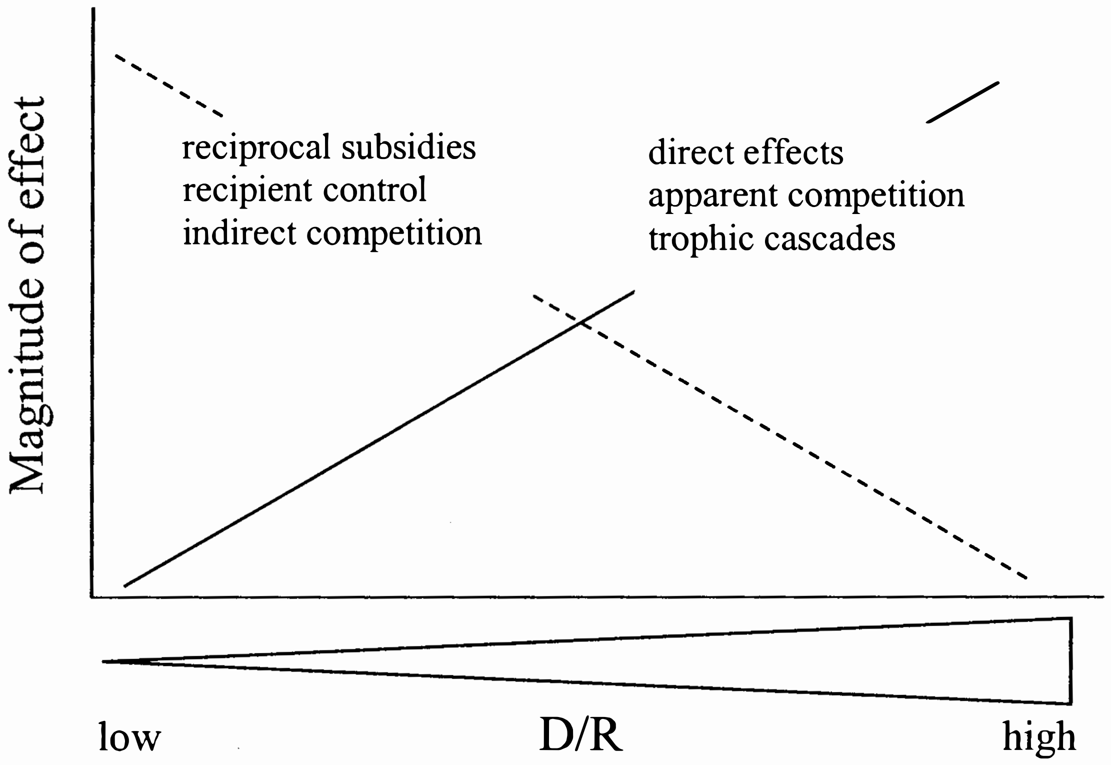

Figure 2. Diagram of the predicted relationship between types of effects and patterns of subsidies in systems with varying donor to recipient productivity ratios (D/R).

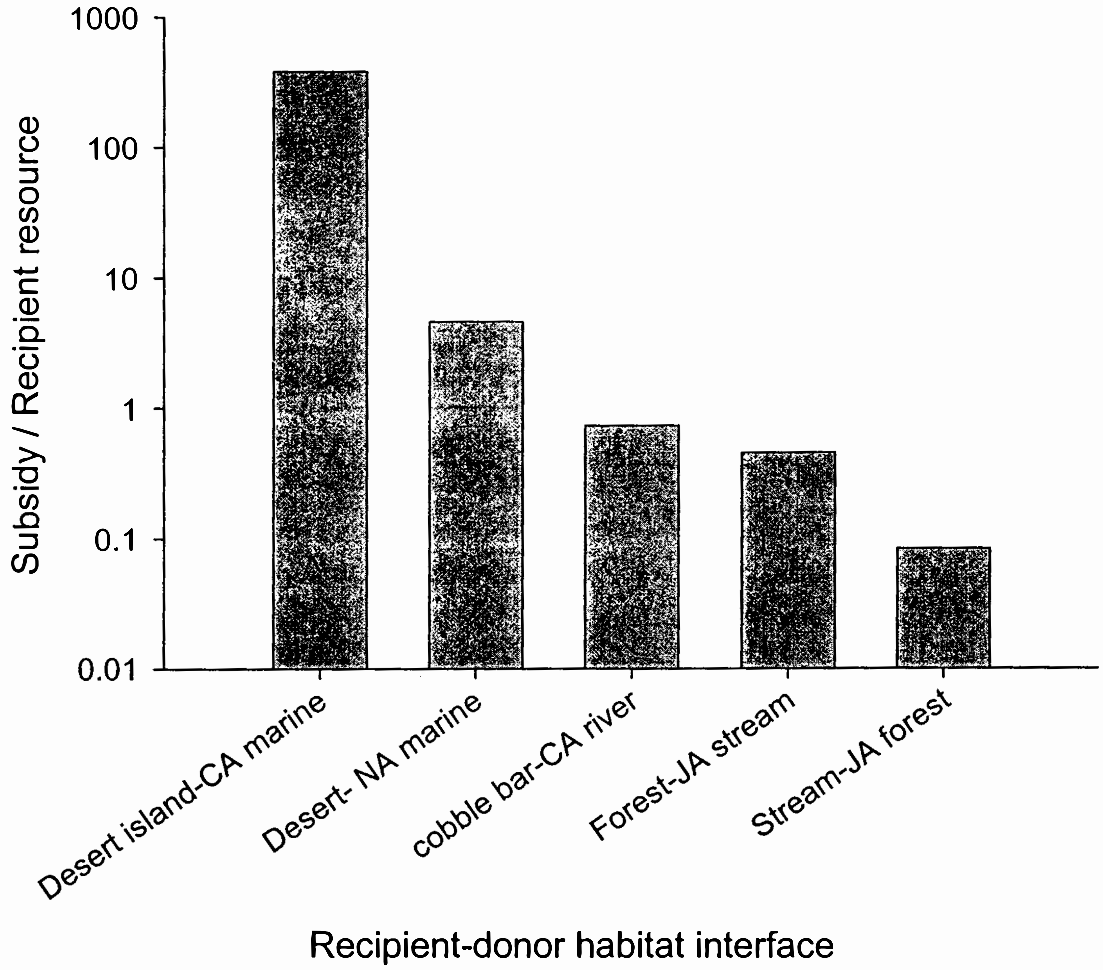

Figure 3. Ratio of subsidy to *in situ* resources. Measured as standing biomass, abundance or productivity. The S/R ratio reported is mean of all values reported for system, except Desert island-Marine system where the median is reported. All S/R are for arthropod prey except the Desert island- Marine system which reported detrital subsidy vs. primary productivity on the islands. The interfaces are the same as those

noted in Table 1. The capitalized abbreviation in the name refers to study location: NA = Namibia, CA = California, JA = Japan. Note that y-axis is log-scale.

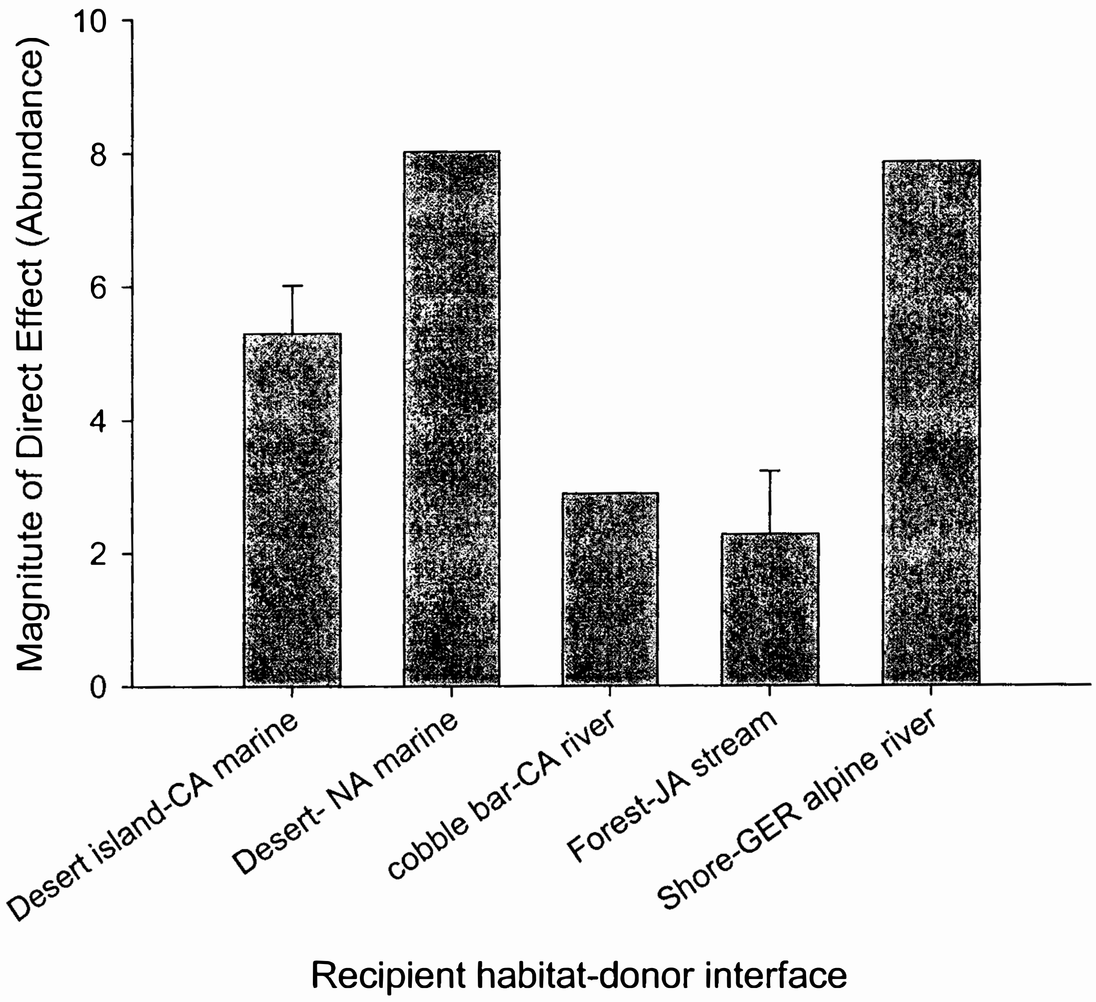

Figure 4. Direct effect of subsidy on predator abundance. Mean response of taxa in the system ± 1 S.E.M. Abundance is density or count. Magnitude of effect is relative to low or reduced subsidy area, and is standardized by % subsidy removed. Interface is ordered the same as in Figure 3 where there is overlap. S/R for Shore-GER alpine river is not known.

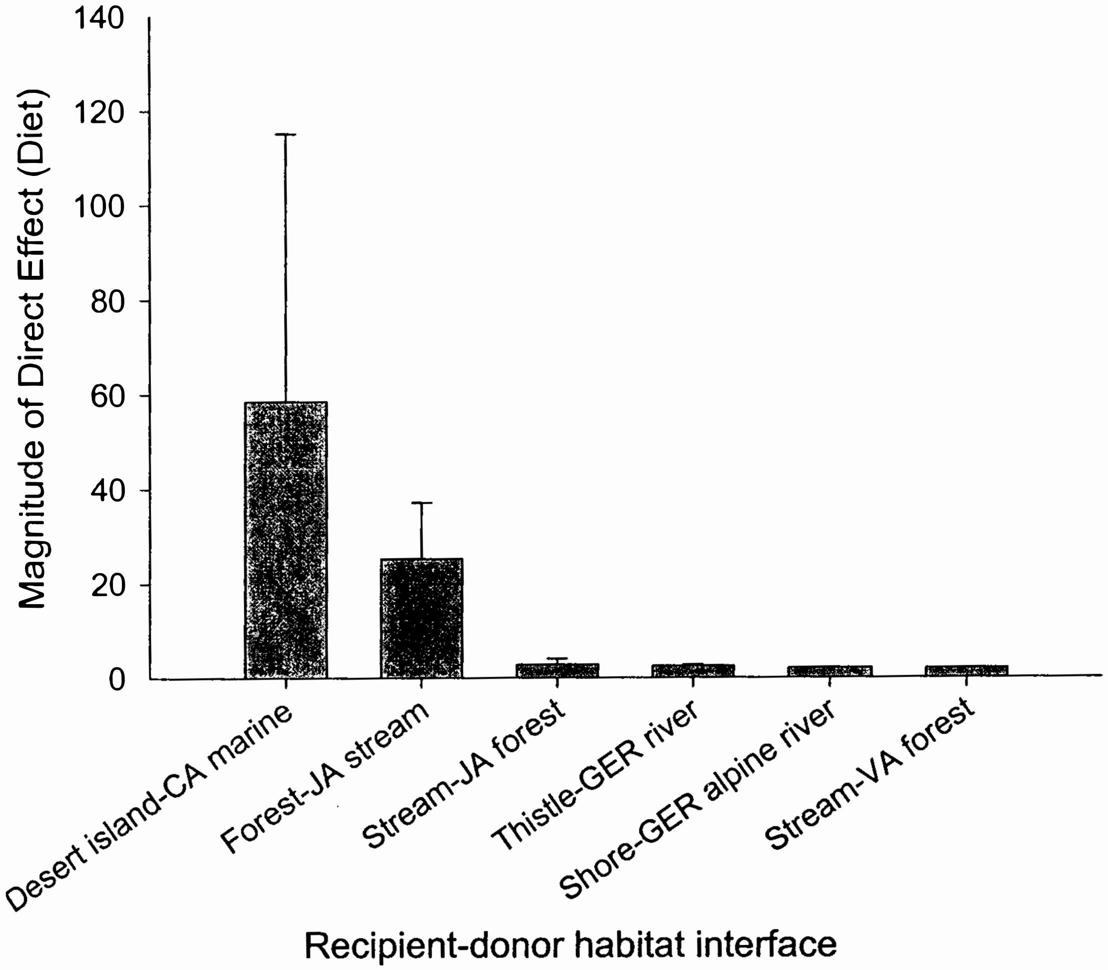

Figure 5. Direct effect of subsidy on predator diet. Mean response of taxa in the system ± 1 S.E.M. Diet is % allochthonous material in diet. Magnitude of effect is relative to low or reduced subsidy area, and is standardized by % subsidy removed. Interface is ordered the same as Figure 3 where S/R is known.

Chapter 2

Aquatic insect subsidies at a pond-forest boundary: patterns of prey availability and predator abundance

ABSTRACT:

1. The emergence of insects from aquatic larvae to terrestrial adults can create a resource subsidy for terrestrial predators. I used pitfall, sticky and emergence traps to examine to what extent and scale aquatic insects influence the distribution and abundance of common predatory arthropods near two small ponds and how pond attributes impact the movement of these resources to shore.
2. Aquatic and terrestrial insect prey were less abundant further from ponds. Predatory wolf spiders (Aranea: Lycosidae) also declined in abundance weakly over the same gradient. Predatory ground beetles (Coleoptera: Carabidae), on the other hand, were most abundant further from ponds.
3. Wolf spider but not ground beetle counts increased with aquatic prey abundance (number trap^{-1} 2 days^{-1}). Pond identity affected this relationship: aquatic prey seemed to influence wolf spider abundance only at the larger, less productive pond. Terrestrial prey did not influence the abundance of either predator.

4. A novel finding of this study is that aquatic prey availability on land (number trap^{-1} 2 days^{-1}) was not influenced by the abundance of aquatic prey emerging from an adjacent transect in the pond. Emergence at the whole-pond scale, however, mirrored aquatic prey availability on land. This pattern implies that small-scale attributes of ponds may not influence the distribution of aquatic insects on land.
5. Perimeter to area ratio (P/A) and rate of aquatic insects emerging from water to air (emergence) at each pond explained the majority of the difference in rate of aquatic insect movement from water to land (flux) at the two study ponds.
6. In summary, results of this study extend the hypothesis that aquatic insects may subsidize terrestrial predators living near freshwater to include lentic-terrestrial boundaries; however, the influence of this subsidy on predator distribution varies by taxa and the size and secondary production of the aquatic habitat. In contrast to better studied river- and stream-terrestrial boundaries, subsidy rates near these small lentic habitats appear to be less associated with small-scale variation in emergence, but further research on lentic-terrestrial interfaces is needed to confirm these patterns.

Keywords: allochthonous, aquatic insects, emergence, Lycosidae, food webs

Introduction

The emergence of insects from aquatic larvae to terrestrial adults is an important mechanism of resource movement between aquatic and terrestrial environments. Emergence of aquatic insects can provide from 1.5 to 23.1 g dry mass/m^2 of prey annually to land adjacent to streams (Jackson & Fisher, 1986; Nakano & Murakami, 2001; Baxter *et al.*, 2005) and is an important source of food to a wide variety of terrestrial predators, including spiders (Henschel, Mahsberg & Stumpf, 2001; Kato *et al.*, 2003; Sanzone *et al.*, 2003), beetles (Hering & Plachter, 1997), lizards (Sabo & Power, 2002a,b), birds (Murakami & Nakano, 2002) and bats (Power *et al.*, 2004).

The spatial distribution of aquatic insects on land may be affected by distance from the aquatic habitat (Henschel *et al.*, 2001; Power & Rainey, 2002), local shifts in aquatic productivity (e.g. algal mats increase insect emergence, Power *et al.*, 2004) and regional productivity differences among water bodies (Hering & Plachter, 1997). Terrestrial consumers of aquatic insects respond to all aspects of this variation by changes in their diet (Murakami & Nakano, 2002), growth (Sabo & Power, 2002a) and density (Henschel *et al.,* 2001; Sabo and Power, 2002b; Power *et al.*, 2004). Aquatic insects can increase predator abundance near riverine habitats from 1.5 to 4 fold, as compared with similar upland habitat (Henschel *et al.*, 2001; Sanzone *et al.*, 2003), areas of experimentally reduced input (Sabo & Power, 2002b; Kato *et al.*, 2003) or lower productivity streams (Hering & Plachter, 1997; Power *et al.*, 2004). Temporal variation in emergence over the year is caused by the developmental phenology of aquatic insects (Jackson & Fisher, 1986; Nakano & Murakami, 2001).

A key to predicting the terrestrial distribution of aquatic insects is understanding how attributes of the aquatic habitat influence movement of these insects to land. Increased insect emergence increases aquatic insect flux to land in river systems, both on a local (within a water body, Power *et al.*, 2004) and regional level (between water bodies, Hering & Plachter, 1997). Much less investigation has focused on terrestrial-lentic habitat boundaries, and it is unclear whether this pattern also applies in such systems.

Other attributes such as habitat shape have also been suggested to influence the movement or flux of aquatic resources to land (Witman, Ellis & Anderson, 2004). A decrease in the perimeter to area ratio (P/A) of a recipient habitat has been predicted to decrease the effect of subsidy on that habitat (e.g. desert islands of differing size, Polis & Hurd, 1996; Witman *et al.*, 2004). Conversely, a decrease in the P/A ratio of a donor habitat has been predicted to increase the movement of resources from that habitat, due to the higher quantity of resources crossing a smaller perimeter (e.g. lower and higher order rivers, Power & Rainey, 2002; Iwata *et al.*, 2003; Henschel, 2004). The different shape of ponds and streams could drive disparities in the scale and magnitude of the effect of aquatic insects on terrestrial consumers near these habitats. Understanding the relationship between aquatic flux to land and characteristics of the donor habitat such as productivity and P/A has profound implications for predicting the effect of these characteristics on recipient food webs (Polis *et al.*, 1997; Henschel, 2004; Witman *et al.*, 2004), especially in lentic systems where little is known about these processes (Schindler and Scheuerelle, 2002).

In this study, I sought to understand the influence of aquatic insect subsidies on the distribution of predaceous, terrestrial arthropods near two ponds in the Appalachian mountains of southwestern Virginia. Specifically, I asked: 1) How do predator and prey abundance vary spatially both away from and around the ponds? 2) How do predator and prey abundance and distribution change during two months of the growing season? 3) What is the relationship between predator distribution and aquatic and terrestrial prey abundance on land? 4) How are pond productivity (i.e. insect emergence above the ponds) and aquatic insect availability on land related at two spatial scales: around each pond, and between ponds? and 5) Does perimeter/area ratio influence the movement of aquatic insects to shore? Specifically, how might these movements differ at terrestrial-lentic habitat boundaries compared with the more frequently studied terrestrial-lotic boundaries.

Study site

This study was performed at Mountain Lake Biological Station in the Allegheny Mountains of southwestern Virginia, USA (elevation 1160 m). The station is about 2 km from Mountain Lake, the only natural lake in the unglaciated Appalachians. The two shallow ponds at the study site, Sylvatica Pond (86.1 m perimeter, 353.5 m^2 area, 0.95 m deep) and Horton Pond (65.9 m perimeter, 223.3 m^2 area, 1.3 m deep), are fishless. They were man-made in 1965 and are filled by rain and surface flow. Leaf litter from the surrounding trees and silt predominate the bottom cover, except for a patch of cattail (*Typha latifolia* Linnaeus) near the center of Sylvatica Pond. During most of the summer season the ponds have well-defined edges. There is an open vegetated area surrounding the ponds (ca. 1-5 m wide) that contains grasses, sedges, rushes, sphagnum moss

(*Sphagnum spp.*), ferns (*Thelypteris noveboracensis* Linnaeus, *Dennstaedtia punctilobula* Michxaux, *Osmunda cinnamomea* Linnaeus), blueberry (*Vaccinium spp.*), large oaks (*Quercus alba* Linnaeus, *Q. rubra* Linnaeus), serviceberry (*Amelanchier arborea* Michxaux) and pines (*Pinus rigida* Miller). The surrounding forest is mixed deciduous. The two ponds are approximately 500 m from each other.

A preliminary census of Sylvatica Pond in 2001 revealed that wolf spiders (Araneae: Lycosidae) and ground beetles (Coleoptera: Carabidae) were common arthropod predators around the pond edge (Appendix A).

Methods

I measured the distribution and abundance of predaceous terrestrial arthropods and their potential prey along 12 transects (6 at each pond) that radiated from the ponds, perpendicular to the edges of the ponds. Samples were taken at 0, 1 and 2 m from the pond edge. I trapped predators weekly from 13 June–11 July and biweekly from 11 July–8 August, 2002, while I trapped prey weekly from 13 June–4 July and three weeks later on 25 July, 2002. Trapping intervals varied because of constraints imposed by another experiment. All traps were deployed for 48 hrs. I placed the transects using a stratified random design. The strata were habitat types based on vegetation and topography. I estimated predator distribution using pitfall traps, which were nested 571-mL plastic cups with white interiors. Several small punctures perforated the cup bottoms for drainage. An elevated wooden cover was placed over each trap to prevent trap inundation by rain. Crushed leaf litter was placed in the bottom of the traps to reduce cannibalism and predation. Upon collection, traps were emptied into plastic bags and frozen. In a few rare cases at the beginning of the census, I identified and released trapped arthropods (5 Lycosidae and 2 Carabidae). I later sorted the frozen samples into morphological species, identified them to species (all wolf spiders and 1 ground beetle), tribe (remaining ground beetles), family or order and stored them in 70% ethanol.

I estimated aquatic and terrestrial prey distributions using 12.8 cm x 7.6 cm sticky traps (Bioquip). Traps were oriented parallel to the pond edge. The traps fit on wire holders that kept the traps erect and elevated approximately 10–15 cm off the ground. Trap placement matched that of pitfall traps. I sealed trap contents (or the trap itself) in plastic bags 2 days after deployment. The bags were frozen until contents were identified to a level that allowed discernment of prey origin (i.e. family and order, Sabo & Power 2002a, Nakano & Murakami 2001). I counted specimens under 12 to 25 times magnification and categorized them as potential aquatic prey, terrestrial prey or "other". Specimens were considered aquatic prey only if they belonged to completely aquatic families or orders found at the ponds, including: Diptera: Chironomidae, Ceratopogonidae, Chaoboridae, Culicidae, Dixidae, Simuliidae, Tipulidae; Neuroptera; Odonata (all Zygoptera); Plecoptera; Ephemeroptera; and Trichoptera. Terrestrial prey consisted of Hemiptera, Homoptera, Diptera not included above, Lepidoptera and Thysanoptera. Wasps (Hymenoptera), many of which were parasitoids, and spiders (Araneae) captured on the sticky traps were not included as potential prey.

To measure the spatial and temporal relationship between aquatic emergence from the ponds and aquatic prey flux to land, I set emergence traps on the surface of the ponds adjacent to the transects used on land, anchored at 0, 1 and 2 m from the land edge.

Sticky traps have been previously used to measure movement of aquatic insects to land over time (Sabo and Power 2002a,b). In my system aquatic insects were trapped more frequently on the pond-side of the traps (Chapter 3). Emergence traps were set simultaneously with sticky traps. The emergence traps were pyramid shaped (0.063 m^2 base, 0.25 m height) and were made from insect netting (approx. 965 x 804 μm opening) over a plastic pipe and wire framework. Styrofoam provided floatation and weights anchored the traps at the appropriate distances. Insects were collected by aspiration 2 days after traps were deployed. They were stored frozen in plastic bags until sorted, stored in 70% ethanol and identified to family or order.

Analysis

A Generalized Linear Mixed Model (GLMM) was used to test a repeated measure ANOVA-like mixed model design of the effects of the fixed factor of distance, regression variable of collection date, and random effect of transect (block) on the abundance of common predators, aquatic and terrestrial prey on land and emerging aquatic prey (SAS 8.2, © 1999-2001, SAS Institute Inc., NC; Littel *et al.*, 1996). The error and link functions (Poisson and logistic, respectively) were specified because the dependent variables were counts. Raw data were plotted for clarity, although this may have caused some small discrepancies between analytical and graphical results. Pond was not included as a factor in the original analysis but a two-fold difference in emergence rates between the two ponds warranted its inclusion as a fixed effect in the final model. Date was included as either a linear or second order regressor depending on significance.

Time was modeled as either autoregressive or compound symmetric depending on which model had a lower AIC_c value (Littel *et al.*, 1996). The same criterion was used to justify retaining the transect effect in each final model. Although there was previous evidence that wolf spider and ground beetle morpho-species differed in their distribution with respect to pond edge (Appendix A), individual species numbers were too low to warrant individual analysis.

GLMM analysis was also used to perform a multiple regression-like analysis of the simultaneous repeated measurements of terrestrial and aquatic prey counts on wolf spiders and ground beetle counts at the two ponds together and separately. R^2 values are not reported because they are not calculated using this pseudo-likelihood method. A similar regression analysis tested the relationship between aquatic insect emergence counts summed per transect and aquatic insect flux at the shore along the same transect. This second analysis was performed to test whether predators responded numerically to the distribution of prey around the pond. This analysis complimented the ANOVA-like evaluation of the effect of distance from pond on both predators and prey. A type III sum of squares-like procedure was used for all hypothesis tests (Littel *et al.*, 1996).

To evaluate the influence of pond perimeter to area ratio on flux of aquatic insects across the boundary, the actual fluxes based on sticky trap measurements were compared to predicted flux based on emergence and P/A (Table 4). Calculating the predicted lateral flux rates based on emergence rates and P/A ratio required several assumptions: 1. Emergence rates were constant across the water surface, and sufficient measurements had been taken to calculate a reasonable weighted average; 2. The trapping efficiencies of emergence traps were the same and the efficiencies of all sticky traps were the same in all habitats being compared; 3. A constant proportion of emerging insects made it to land at each habitat; and 4. The vertical distribution of emerging insects above the water was uniform. In general, all four assumptions could be tested. In my system, assumptions 3 and 4 were least likely to hold, since species-specific differences in life history, distance to land from the aquatic habitat, vegetation and wind would change the probability of an individual emerging insect making it to shore and the population's vertical distribution above the water (Witman *et al.*, 2004; Briers *et al.*, 2005). However, the contribution of these factors as a whole to lateral flux could be estimated by the lack of fit of P/A and emergence rates to the data.

Predicted values for lateral flux were calculated as:

$$\mathrm{Flux}_{\mathrm{pred}} = (ea)/(ph) \qquad (1)$$

where e is emergence rates in individuals $\mathrm{m}^{-2}\ \mathrm{day}^{-1}$, a is area of the pond in m^2, p is the perimeter of the pond in meters and h is the height of the upper limit of the vertical movement of the emerging insects in meters. The relative importance of P/A and emergence on lateral flux in this system was estimated by comparing the ratio of predicted flux if the two ponds had the same P/A or emergence to the actual lateral flux ratio.

To evaluate how habitat shape might affect aquatic flux at pond versus better-studied stream habitats, P/A for idealized pond and stream habitats were calculated. Assuming a circular pond and a linear stream reach:

$$\mathrm{P/A}_{\mathrm{pond}} = 2\pi \mathrm{r}/\ \pi \mathrm{r}^2 \qquad (2a)$$

$$= 2/\mathrm{r} \qquad (2b)$$

where r is the radius of the pond in meters, and

$$P/A_{stream} = 2l/lw \qquad (3a)$$

$$= 2/w \qquad (3b)$$

where *l* is the length of the shoreline of the stream reach in meters and *w* is the channel width in meters.

Results

Counts and proportions for all traps over the entire census are summarized by taxon (Table 1). On the sticky traps, 19.8% of the prey captured were of aquatic origin and 80.2% were of terrestrial origin. In the pitfall traps, the most common predators were beetles (54% of the captures) and spiders (28%). The majority of beetles were ground beetles (Carabidae, 83%) and the majority of spiders were wolf spiders (Lycosidae, 61%). I restrict further analysis of these predators to the family level to reduce the probability of grouping taxa with large differences in resource use and foraging behavior. The majority of aquatic insects captured were flies; of these flies the vast majority were midges (Chironomidae).

Counts of aquatic insects on land, terrestrial prey on land and wolf spiders declined with distance from the edge of the pond (GLMM, $P = 0.001, 0.02, 0.08$, Table 2, Fig. 1). The effect of distance on wolf spider counts was marginally influenced by pond identity (GLMM, $P = 0.06$, Fig. 2): counts at Sylvatica Pond but not at Horton Pond clearly declined with distance from the edge. Ground beetle counts were also affected by distance from the edge of the pond, but mean counts were higher 2m from edge than at the edge (GLMM, $P = 0.04$, Fig. 1, Table 2). Counts of terrestrial prey and wolf spiders differed by date (Fig. 2). However, terrestrial prey varied non-linearly with time, while wolf spiders varied linearly (Table 2). Ground beetle counts were affected by distance from pond differently at different dates of collection: abundance at 1 m peaked in mid-July while abundance at other distances remained relatively constant. Models that included transect fit the data better than those that did not for all taxa. Emerging aquatic insects were not influenced by distance from edge of the pond or date (Fig. 1, Table 2).

Pond identity did not significantly influence wolf spider, ground beetle, terrestrial prey or aquatic prey counts on land, but emergence was 3 times higher at Horton Pond than Sylvatica Pond ($P < 0.01$, Fig. 2). The effect of date on aquatic and terrestrial prey counts on land varied between ponds: counts at Horton Pond showed an increase relative to Sylvatica Pond in mid to late June (GLMM, date x pond, $P < 0.05$, Fig. 2, Table 2). Due to small sample size, the full GLMM model could not be evaluated at the species or morpho-species level, but there was variation among the distributions of the three most commonly sampled wolf spider species (Fig. 4) and the four most commonly sampled ground beetle morpho-species (Fig. 5). Furthermore, the distribution of one of the most common wolf spider species (*Pardosa moesta* Banks) appeared to differ between ponds. The commonly sampled wolf spiders were *Pardosa milvina* Hentz , *Pardosa moesta*, and *Pirata cantralli* Wallace and Exline. The common ground beetle species and morphological species sampled were *Pterostichus coracinus* Newman and Pterostichine sp. 1, sp. 2 and sp. 3.

There was a significant but small positive relationship between aquatic prey and wolf spider counts over both ponds (Table 3). At Sylvatica Pond, there was a significant positive relationship between aquatic but not terrestrial prey and wolf spiders (Table 3). This relationship was mirrored by a positive association between aquatic insect and wolf spider counts at each transect at Sylvatica Pond only (Table 3). At Horton Pond, there was no relationship between either type of prey and wolf spider abundance (Table 3). There was no relationship between prey abundance and ground beetle counts at either pond analyzed separately or together (GLMM, $P > 0.05$).

There was no relationship between the counts of aquatic insects emerging from each transect and the counts of aquatic insects on land when both ponds were analyzed together (GLMM, slope = -0.02, $n = 60$, $F_{1,47} = 2.1$, $P = 0.15$). Additional analysis confirmed that this pattern held even when only chironomids larger than the smallest captured by the emergence traps were included (Appendix B). There was a significant but small negative relationship between insects emerging and arriving on land at both Horton and Sylvatica Ponds when they were analyzed separately (Horton: slope = -0.03, $n = 30$, $F = 5.11$, $P = 0.03$; Sylvatica: slope = -0.05, $n = 30$, $F = 6.12$, $P = 0.02$; Fig. 6). On the whole-pond scale, the three-fold difference in aquatic insects emerging from Horton and Sylvatica Ponds was mirrored by an almost two-fold (but not statistically significant) difference in the lateral movement (or flux, insects m^{-2} d^{-1}) of aquatic insects to the shore of each pond (Fig. 2 – Aquatic Prey, Table 2). This doubling of aquatic resources apparently did not increase counts of wolf spiders or ground beetles at Horton Pond.

In the Horton-Sylvatica Pond complex the pond with the larger P/A (Horton Pond) had higher insect emergence and higher aquatic insect flux at the shoreline (Table 4). I restricted my analysis to flux at the shoreline because aquatic insect distribution with respect to edge was different at the two ponds (see above). The predicted flux of aquatic insects to land at Horton and Sylvatica Ponds based on emergence rates and P/A (19.4 and 7.8 insects m^{-2} day^{-1}, respectively) was lower than the actual (Table 4), suggesting that sticky traps were more efficient than the emergence traps. This difference might have been due to the potentially attractive yellow color of the sticky traps (Blumthal *et al.*, 2005) or the ability of the sticky traps to retain smaller animals than the emergence traps. The predicted relationship between the aquatic flux at Horton Pond and the aquatic flux at Sylvatica Pond was also larger than the actual relationship: the ratio of the aquatic flux predicted at Horton Pond to that predicted at Sylvatica Pond was 38% larger than the ratio of actual fluxes. If emergence alone were responsible for lateral flux differences between Horton and Sylvatica Ponds, the predicted ratio of aquatic flux at Horton Pond to aquatic flux at Sylvatica Pond would be 67% larger than the actual ratio. If P/A alone were responsible for lateral flux differences between Horton and Sylvatica Ponds, predicted ratio of aquatic prey flux at Horton Pond to aquatic prey flux at Sylvatica Pond would be 47% smaller than the actual ratio.

Discussion

The major finding of this study is that aquatic prey influenced the distribution of predatory wolf spiders around and over a distance from one of the two ponds studied. Ground beetles as a whole did not seem to be influenced by aquatic or terrestrial prey distribution. Furthermore, local emergence rates did not seem to influence the distribution of aquatic prey on land, and so must be disconnected from influencing local wolf spider abundance.

Abundance and distribution of aquatic and terrestrial prey

Aquatic prey densities decreased with distance from the pond edge: at Horton Pond, aquatic insects were reduced on average by 58% at 2 m from the pond, and at Sylvatica Pond, aquatic insects were reduced on average by 40% by 2 m. Other studies have found a similar decrease in aquatic insect flux from freshwater habitats but usually over a larger spatial scale (Power & Rainey, 2002; Power *et al.*, 2004). Power & Rainey (2002) and Power *et al.* (2004) reported an exponential decrease in aquatic insect abundance on land with respect to the river shore: insects were reduced by 50% within 10 m of the river's edge. The slower decline in aquatic insect counts away from river shores compared with my study ponds implies that proportionately more of the insects from rivers move longer distances, perhaps due to differences in wind and aquatic insect life history (Power *et al.*, 2004; Witman *et al.*, 2004; Briers *et al.*, 2005).

Terrestrial prey at Horton and Sylvatica Ponds decreased with distance from the ponds as a whole, coinciding with a decrease in vegetation height and moisture in the open areas (*personal observation*; L. Ahrens & J.M. Kraus, Appendix C) and a decrease in alternate aquatic prey. Terrestrial herbivores alone showed the same decline in abundance away from the ponds as terrestrial prey as a whole, suggesting that the pattern was not driven by the inclusion of partially aquatic families in the terrestrial prey category (Appendix D).

Sylvatica (160 insects m^{-2} day^{-1}) and Horton (340 insects m^{-2} day^{-1}) Ponds differed in their lateral flux of aquatic insects. The trend towards increased aquatic flux at Horton Pond was probably driven by the almost 3 fold increase in aquatic insect emergence compared with Sylvatica Pond, as suggested in other systems (Hering & Plachter, 1997; Power *et al.*, 2004). The disparity in aquatic insect emergence between Horton and Sylvatica Ponds may be explained by the greater depth and leaf bottom cover at Horton Pond providing a superior habitat for detritivorous chironomid larvae (*personal observation*). Data from an additional 2003 experiment (Appendix E) support this observation, as chironomid larvae were 6 times as dense at Horton Pond than at Sylvatica Pond.

A novel finding of this study was that aquatic prey abundance on land did not mirror local variation in rates of emergence from the adjacent pond habitat. Although evidence from other systems suggests that local emergence can positively influence local flux rates of aquatic insects to land (as suggested by predator distribution on land, Power *et al.*, 2004), small-scale variation in flux of aquatic insects at Horton and Sylvatica Ponds appears to be influenced by factors other than local emergence rates. These factors may include vegetation structure on land, wind, light and presence of conspecifics (Polis *et al.*, 1997; Witman *et al.*, 2004; Briers *et al.*, 2005). This finding is important because the decoupling of emergence of aquatic insects and their availability on land at a small scale limits the ability to predict changes in terrestrial food webs based on local changes in the aquatic food web in this system.

Although studies that include estimates of aquatic prey availability during June–August found temporal change over this period (Hering & Plachter, 1997; Henschel *et* *al.*, 2001; Nakano & Murakami, 2001), I found that only wolf spiders and terrestrial prey showed temporal changes in abundances. The lack of change in aquatic prey availability over the two month census may be due to over-lapping emergence phenology of different common species of aquatic insects in the ponds.

Effect of prey on wolf spiders and ground beetles

Overall patterns from this study suggest that aquatic insects play a medium to small role in determining the abundance and distribution of wolf spiders at the pond edge. Recent studies of stream-terrestrial boundaries suggest that aquatic insects are an important resource to wolf spiders and may strongly influence their distribution at stream edges (Sanzone *et al.*, 2003; Power *et al.*, 2004; Briers *et al.*, 2005). The differences in the importance of aquatic flux to land could be related to the P/A ratio of the two habitat types (Iwata *et al.*, 2003).

The decreased abundance of wolf spiders further from the ponds with decreased aquatic insect abundance fits patterns seen in both river and pond systems (DeVito *et al.*, 2004; Graham, Buddle & Spence, 2003; Power *et al.*, 2004; Kraus & Morse, 2005). Sanzone *et al.* (2003) suggested the decline in wolf spider abundance away from Sonoran desert stream was related to high reliance on aquatic insect prey: wolf spiders near shore received almost 68% of their carbon from aquatic insects. In addition, low response to terrestrial prey and high use of aquatic prey has been observed near temperate streams (Wenninger & Fagan, 2000; Collier, Burg & Gibbs, 2002). Because of the similar response of wolf spiders to aquatic resources in such disparate systems, I did not expect that the effect of aquatic insects on wolf spiders would differ between ponds in the same study system.

The magnitude and scale of the impact of aquatic insects on wolf spider distribution were different at each pond. These differences were most likely due to variation in the response of different wolf spiders species and also to trapping protocol. At Sylvatica Pond, there was a significant positive relationship between counts of aquatic prey and wolf spiders per trap (slope = 0.7) and per transect (slope = 0.04). At Horton Pond, however, where insect emergence rates were nearly 3 times those at Sylvatica Pond, there was no relationship between wolf spider and aquatic insect counts. The lack of a detectable increase in abundance of wolf spiders with increased aquatic prey at Horton Pond may result from a sampling artifact associated with decreased activity of satiated wolf spiders (Morse & Fritz, 1982; Kreiter & Wise, 2001). Because pitfall traps measure activity and density, any differences in movement rates would influence the relative abundance measures (Dinter, 1995; Buddle, 2000). Estimates from hand searched plots in 2003 support this hypothesis: the hand counts of wolf spiders 0–1.5 m from the pond edge, mostly *Pirata cantralli*, were 1.5 to 3 times as abundant at Horton Pond than at Sylvatica Pond in the subsequent years (2003 near edge and 2004 up to 17 m from edge, Appendix C and E) suggesting that lack of response in this study, at least by *P. cantralli,* a sedentary species (less than a 10% chance of moving between 1 cm and 1 m per day; L. Ahrens & J.M. Kraus, Appendix C), might be a sampling artifact. However, there may be some interaction between year and trapping method as well, since in 2004 there was no difference between hand-searched plots at Horton and Sylvatica ponds (Chapter 3), but a more than 3 fold higher abundance in wolf spiders at Horton Pond was detected using pitfall traps along transects (Appendix C).

The scale of the response of wolf spiders at Horton and Sylvatica Ponds may have differed for another reason. Wolf spider counts did not differ from 0-1 m from the ponds, but by 2 m numbers at Horton Pond had increased again (73% of count at edge), whereas at Sylvatica Pond numbers continued to drop (12% of count at edge). The higher proportion of the habitat generalist and forest dweller *Pardosa moesta* trapped at Horton Pond (as opposed to shoreline and open habitat specialists *Pirata cantralli* and *Pardosa milvina*) could account for the different response of wolf spiders as a whole at the two ponds.

The distribution of ground beetles as a family was not explained by aquatic or terrestrial prey density per sticky trap. The four common morpho-species showed differences in their distribution: one appeared to be a specialist of the shoreline, and the other three were apparent habitat generalists or preferred non-shoreline. Ground beetles are mainly predaceous and omnivorous, often feeding on dead or dying insects (White, 1983; Lövei & Sutherland, 1996; Hering & Plachter, 1997). Hering & Plachter (1997) found that aquatic insects that were washed up on shore and aquatic insects that emerge on land (i.e. stoneflies) formed a high proportion of the diet of several species of riparian ground beetles (73% for *Bembidion* spp., 51% for *Nebria picicornis*) near a large productive river. Those ground beetles preferring non-shoreline habitats, however, effectively consumed no aquatic insects (1 chironomid larva identified from 180 beetle guts). Furthermore, the abundance of shore drift at Horton and Sylvatica Ponds is most likely small compared to the larger riverine habitats of Hering & Plachter's (1997) study.

For these reasons, the consumption of aquatic insects by ground beetles at small ponds might be expected to be low in general despite the evidence of shoreline specialization in one common morpho-species.

Perimeter/area ratio, emergence and aquatic insect flux to land

Lateral flux of aquatic insects to land has been predicted to increase with surface area and decreased perimeter of the aquatic habitat. For example, Henschel (2004) suggested that an increase in stream order (correlated with surface area) should increase the concentration of aquatic insects moving onto land across a fixed distance of shoreline. Baxter *et al.* (2005) concluded that this pattern should occur because higher order streams have increased area for emergence and the increased potential for wind to advect prey onto land (Power & Rainey, 2002). Finally, Iwata *et al.* (2003) reported that stream meanders, which increase the perimeter to area ratio of stream in an area, increase the availability of aquatic insects on land. Perimeter to area ratio (P/A) of an aquatic habitat should thus negatively affect magnitude of lateral flux of aquatic insects to land and the emergence rate of insects from the aquatic habitat should positively affect lateral flux of aquatic insects to land.

In this study, the model including both P/A and emergence rates made the best prediction of the magnitude of change between the aquatic insect flux at Horton and Sylvatica Ponds. Perimeter to area ratio predicted a flux magnitude closer to the true values for each pond, but the higher flux at Horton Pond than at Sylvatica Pond was correctly predicted by emergence rates and not P/A. I was interested in extending this comparison of emergence, P/A and aquatic insect flux to studies of other freshwater habitats, however there is a dearth of published, simultaneously measured data on emergence rates and aquatic insect flux to land in a system.

This study aimed to make the connection between aquatic habitat shape, emergence rates of aquatic insects, flux of aquatic insects to land and terrestrial predator response, as well as touching on the variability of these connections both in magnitude and scale. Although emergence rates of aquatic insects may be influenced by local habitat quality, in this study system this influence did not translate to local variation within ponds in flux rates across space and time. A whole-pond relationship between emergence and flux, however, is suggested by the increased mean emergence and flux at Horton Pond compared with Sylvatica Pond, despite the smaller P/A of Horton Pond. The magnitude and scale of predator response to aquatic flux appears to differ by taxa and by pond, but trapping bias may confound these pond differences. A clear next step for studies of cross-habitat or ecosystem food web processes is to truly integrate knowledge about both donor and recipient systems by focusing on endogenous and exogenous processes governing input from donor systems, in addition to the response of the recipient food web. This more integrated approach will facilitate understanding of the factors that govern subsidies as well as their effect on recipient food webs.

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Table 1: Total number and percent of individuals by taxon captured by pitfall, sticky and emergence traps at the edge of two small ponds in southwestern Virginia, USA, from 13 June – 2 August, 2002.

	Pitfall		Sticky		Emergence	
Taxa	count	percent	count	percent	count	percent
Amphibia	1	0.1	--	--	1	0.1
Arachnida	--	--	200	1.5	--	--
Acarina	158	17.7	--	--	3	0.2
Araneae	131	14.7	--	--	25	2.0
Opiliones	28	3.1	--	--	35	2.8
Annelida	1	0.1	--	--	--	--
Chilopoda	1	0.1	--	--	--	--
Diplopoda	38	4.3	--	--	--	--
Gastropoda	2	0.2	--	--	--	--
Insecta	7	0.8	--	--	1	0.1
Coleoptera	251	28.2	334	2.5	21	1.7
Collembola	172	19.3	--	--	2	0.2
Diptera aquatic	--	--	1860	14.0	861	68.9
Diptera other	16	1.8	3722	28.0	160	12.8
Ephemeroptera	--	--	4	0.0	54	4.3
Hemiptera	7	0.8	32	0.2	30	2.4
Homoptera	5	0.6	1678	12.6	5	0.4
Hymenoptera	39	4.4	2951	22.2	3	0.2
Lepidoptera	3	0.3	61	0.5	1	0.1
Mecoptera	1	0.1	--	--	--	--
Neuroptera	--	--	74	0.6	5	0.4
Odonata -adult	--	--	20	0.2	13	1.0
Odonata -nymph	--	--	--	--	20	1.6
Orthoptera	19	2.1	--	--	--	--
Plecoptera	--	--	5	0.0	--	--
Psocoptera	--	--	1	0.0	--	--
Thysanoptera	1	0.1	2170	16.3	3	0.2
Trichoptera	--	--	--	--	5	0.4
Isopoda	2	0.2	--	--	--	--
Mammalia	1	0.1	--	--	--	--
Unknown/other	7	0.8	194	1.5	1	0.1

Table 2. ANOVA-like table for response of wolf spiders and ground beetles to aquatic and terrestrial prey using generalized linear mixed model. Main effects include the fixed effects of distance from pond (DIST and DI) and pond identity (POND and PO), and the repeated measure of date (DATE and DA). Date by date (DA*DA) tests the significance of a second order regression of time. Emboldened values were significant at the $P < 0.05$ level, with the exception of the distance and distance x pond interaction for wolf spiders, which are weakly significant at the $P < 0.1$ level. DNC = the model did not converge when the factors indicated were included; hence those factors were not included in the analysis. All models included the random effect of transect.

		Wolf spider		Gr. beetle		Aq. prey		Terr. Prey		Aq. emerge	
Factor	df	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
DIST	2	2.5	**0.08**	3.4	**0.04**	7.3	**<0.001**	4.1	**0.02**	0.7	0.53
DATE	1	16.7	**<0.001**	1.3	0.25	1.7	0.20	4.5	**0.04**	1.1	0.35
POND	1	0.2	0.65	0.3	0.61	1.7	0.19	1.9	0.17	10.8	**0.001**
DI*PO	2	2.9	**0.06**	0.5	0.60	0.2	0.81	1.2	0.32	0.8	0.49
DA*PO	1	0.0	0.84	1.6	0.20	6.2	**0.01**	13.8	**<0.001**	0.8	0.37
DI*DA	2	0.1	0.87	3.3	**0.04**	1.6	0.20	0.7	0.49	1.5	0.23
DI*DA*PO	2	dnc	dnc	0.1	0.88	0.7	0.51	0.2	0.83	1.1	0.35
DA*DA	1	dnc	dnc	0.0	1.00	0.5	0.50	19.1	**<0.001**	1.7	0.21

Table 3. Multiple regression-like table for response of wolf spiders to aquatic and terrestrial prey using generalized linear mixed model. Analyses were of all traps per date at both ponds and of all traps per date and of each transect per date at each pond. Emboldened values were significant at the $P < 0.05$ level, except Sylvatica by transect, which is weakly significant at the $P < 0.1$ level for terrestrial prey.

			Aquatic Prey			Terrestrial Prey	
Model	N	*slope*	*F*	*P*	*Slope*	*F*	*P*
By trap							
Both ponds	180	0.04	11.95	**< 0.001**	-0.004	0.55	0.46
Sylvatica	90	0.70	17.34	**< 0.001**	0.01	0.99	0.32
Horton	90	0.03	2.19	0.14	-0.01	1.28	0.26
By transect							
Sylvatica	30	0.04	29.62	**< 0.001**	0.008	3.77	**0.07**
Horton	30	0.007	0.86	0.36	-0.004	1.35	0.25

Table 4. Pond dimensions, emergence rates and lateral flux of aquatic insects at Horton Pond and Sylvatica Ponds. Emergence traps have 625-cm^2 base. Sticky trap is ca. 219 cm^2.

Pond	Perimeter (m)	Area (m)	P/A	Emerge (#/trap/2 d)	Emerge (#/m^2/d)	Sticky (0m) (#/trap/2 d)	Sticky (0m) (#/m^2/d)
HORT	65.9	223.3	0.30	1.4 ± 0.2	11.4	16.0	365.3
SYL	86.1	353.5	0.24	0.5 ± 0.1	3.8	9.0	205.5

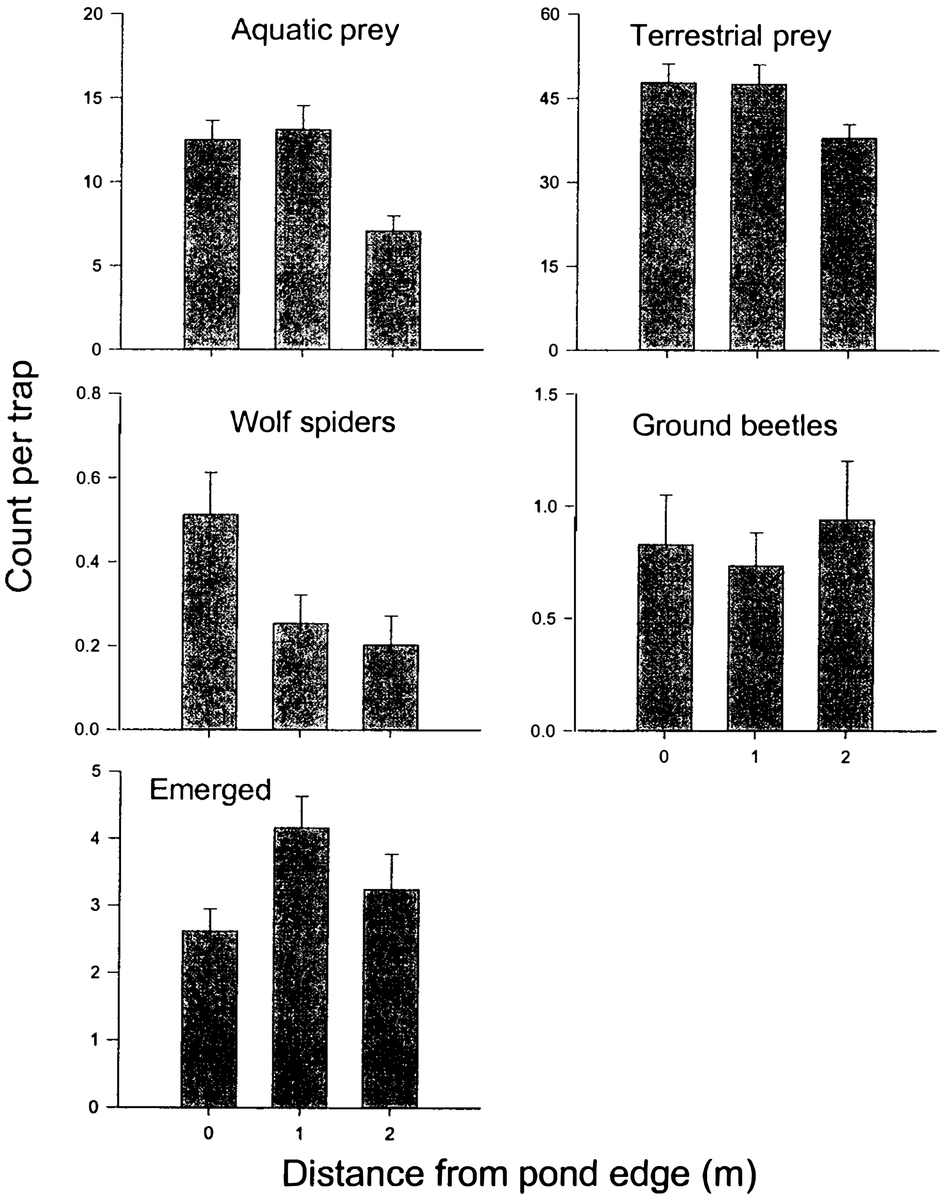

Figure 1. Temporal and spatial patterns in arthropod distribution at pond-forest interface. Average (mean ± 1 SE) counts (per trap) of emerging aquatic insects, aquatic prey, terrestrial prey, wolf spiders and ground beetles 0-2 m from the pond-forest edge, measured passively for 48 hours at 12 transects (n = 12).

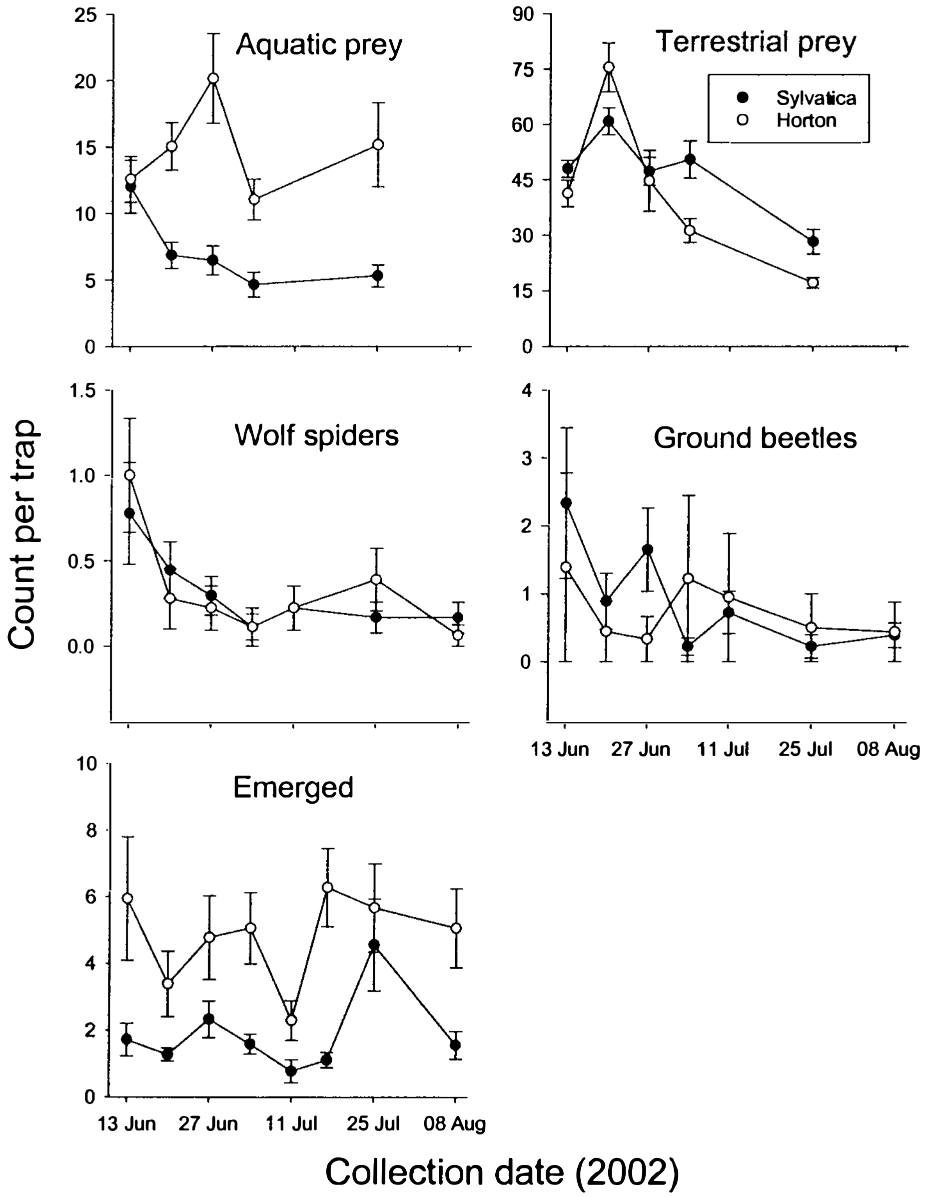

Figure 2. Temporal patterns of in arthropod abundance near and emerging from two small ponds. Average (mean ± 1 SE) counts (per trap) of emerging aquatic insects, aquatic prey, terrestrial prey, wolf spiders and ground beetles, measured passively for 48 hours at 6 transects per pond (n = 6).

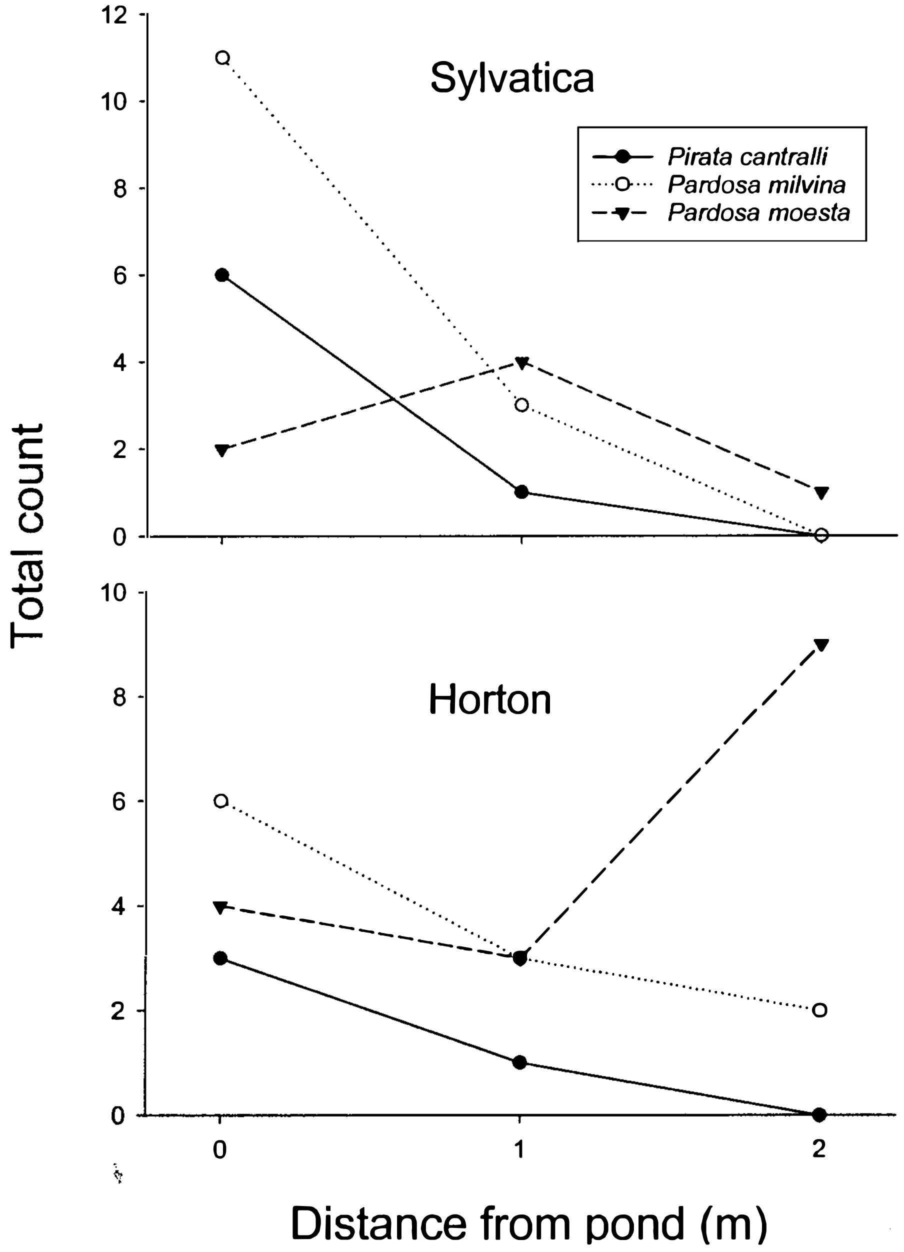

Figure 3. Spatial patterns in three common wolf spider species near two small ponds. Total counts summed over two-month census of *P. cantralli*, *P. milvina* and *P. moesta* 0-2 m from each pond.

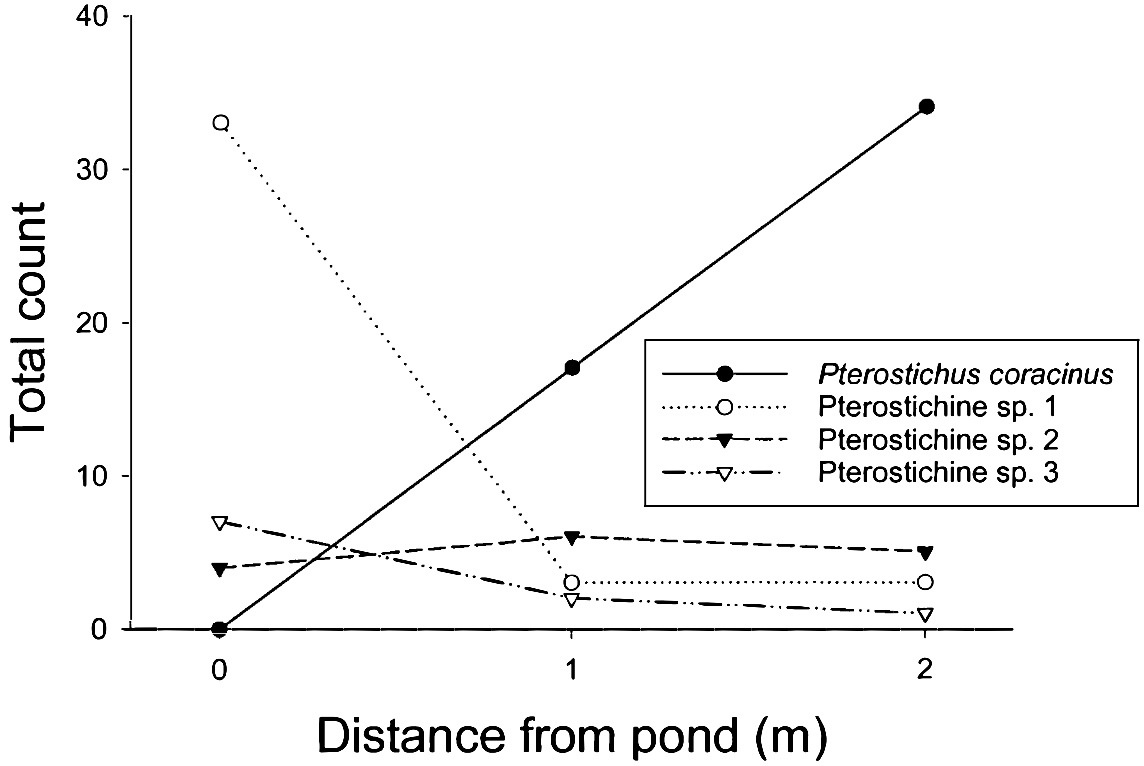

Figure 4. Spatial patterns in a common species and 3 common morpho-species of ground beetle. Total counts summed over the two-month census and over both ponds, 0-2m from the pond edge.

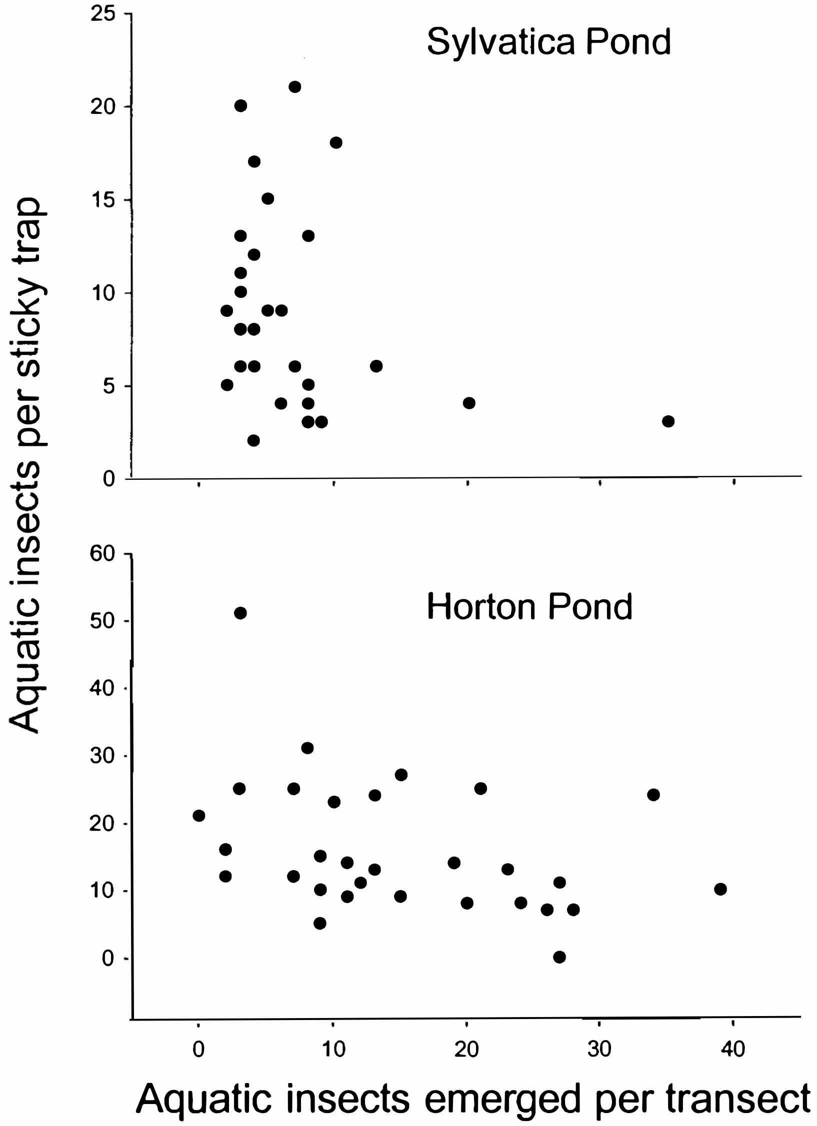

Figure 5. Relationship between aquatic insects emerging and moving to land on a local scale. Counts of emerging insects are totals per transect at each sample date. Counts of aquatic insects on land are from 0 m traps at each sample date. Figure presents raw data, slopes of regression lines from repeated measure analysis on Poisson distributed data are presented in text. The slope of both regression lines are significantly different from 0 at the $P < 0.05$ level.

Chapter 3

Reciprocal subsidies to arthropod food webs at a pond-forest boundary

Abstract.

Reciprocal movement of resources across habitat boundaries can have important consequences for food webs in adjacent habitats. These resources subsidize consumer populations, alter use of *in situ* resources and allow for indirect interactions among consumers inhabiting distinct ecosystems. This study examines how reciprocal subsidies crossing the boundary between forest and two small ponds in the southern Appalachians influence aquatic and terrestrial food webs near the edge of the ponds. Reported here are the responses of wolf spiders, dragonfly larvae, newts and crayfish to aquatic insects and terrestrial arthropods in terms of their abundance, mass, reproduction and diet. The *per capita* mass and the proportion of reproductive female wolf spiders declined within enclosures where aquatic insects had been reduced by 50% (season average) compared with open plots. Wolf spiders near the edge of the pond consumed aquatic resources as demonstrated by a temporal shift in isotopic signatures that paralleled a natural decrease in enrichment in aquatic insects emerging from the pond. The wolf spider *Pirata cantralli* (Araneae: Lycosidae), a water-edge specialist that desiccates easily tended to

show decreased mass and reproductive status in enclosures where a shield attempted to block the movement of aquatic resources to land, even though there was no evidence that the shield actually reduced aquatic subsidies to land. On the other hand, the wolf spider *Pardosa milvina* (Araneae: Lycosidae), a good colonizer of early-successional habitats that can tolerate drier conditions, increased numerically over the season in enclosures without the subsidy shield. Dragonfly larvae consumed more terrestrial resources in cages with ambient levels versus reduced terrestrial input, as evidenced by isotopic data. However, a 33% reduction in terrestrial input to subsidy enclosures did not influence the abundance or mass of dragonfly larvae, or the abundance and length of newts or crayfish. The reduced input did appear to influence the intraguild interactions between newts and dragonfly larvae, and between crayfish and dragonfly larvae. This result contrasts with data from a stream system where terrestrial arthropod input into streams can affect consumer abundance. Although there was no temporal difference in the peak availability of terrestrial and aquatic arthropod subsidies during the experiment, the inputs functioned on two spatial scales. Aquatic insect movement to land could be predicted only at the whole pond level, whereas terrestrial arthropods falling into the water could be manipulated locally within ponds. These results suggest that these reciprocal subsidies could link food web dynamics in and around the ponds. However, the direct effect of each type of subsidy is species specific and may be determined by desiccation tolerance on land and intraguild interactions in the water.

Keywords: Reciprocal subsidies, Lycosidae, Odonata, emergence, food web

INTRODUCTION

Ecologists have long understood that ecosystems are connected by the movement of energy and nutrients. The implications of such movement on food webs, however, have only begun to be thoroughly investigated over only the last 20 years (Polis and Winemiller 1996, Polis et al. 1997, Polis et al. 2004, Power et al. 2004, Baxter et al. 2005). Initially most research was conducted at boundaries with large resource gradients such as between high productivity and low productivity habitats like the upwelling ocean or rivers and either coral cays or desert (Heatwole 1970, Jackson and Fisher 1986, Polis et al. 2004). As research has expanded to interfaces between habitats with similar productivity like forests and streams, rivers or ponds (Cloe and Garman 1996, Nakano and Murakami 2001, Power et al. 2004, Knight et al. 2005, Paetzold and Tockner 2005), it seems that there may be a qualitative shift in the types of effects of subsidies on food webs (Chapter 1). Specifically, subsidies moving both ways between habitats (reciprocal subsidies, *sensu* Nakano and Murakami 2001) and indirect interactions between food webs (recipient feedback *sensu* Polis and Strong 1996) may be more ubiquitous determinants of food web dynamics than currently thought (e.g. Baxter et al. 2004, Baxter et al. 2005, Knight et al. 2005). However, reciprocal subsidies and their implications for food webs have been studied in only one other system (river-stream in Japan, Baxter et al. 2005).

Arthropods moving between water and land are important sources of protein for aquatic and terrestrial predators (Nakano and Murakami 2001, Power et al. 2004, Baxter et al. 2005). These resources may affect the growth, distribution and abundance of birds, fish, macroinvertebrates, spiders, beetles and herbivorous insects in and around streams and rivers (Cloe and Garman 1996, Kawaguchi and Nakano 2001, Sanzone et al. 2003, Henschel 2004, Power et al. 2004, Akamatsu et al. 2005, Baxter et al. 2005, Briers et al. 2005). In the deciduous forest- 2nd order stream system in Japan where the reciprocal movements of these resources have been simultaneously examined, these resources have also been shown to influence community structure in adjacent habitats (Baxter et al. 2004, Baxter et al. 2005).

Although movement of resources into and out of streams and rivers is important to consumers and community structure, little is known about the role of allochthonous subsidies at lentic-terrestrial interfaces. In this study, I used a manipulative experiment to examine the role of reciprocal subsidies at a lentic-terrestrial interface. Specifically, I investigated the response of wolf spiders to the input of aquatic insect prey to land and of dragonfly larvae to the input of aquatic insect prey into the water at a pond-forest interface. I examined how wolf spiders might be indirectly affected by aquatic predators competing for the same food source in a different life stage. Finally, I asked whether terrestrial input to the pond could influence the assemblage of predators in the ponds by affecting intraguild interactions among dragonfly larvae, crayfish and newts. I used census techniques and stable isotopes (Hall 1995, Hamilton et al. 2004, Pace et al. 2004) to monitor responses of consumer abundance, mass, reproductive condition and diet to the change in availability of allochthonous resources.

STUDY SITE

The experiment was performed at two ponds at Mountain Lake Biological Station in the Allegheny Mountains of southwestern Virginia, USA (elevation 1160 m). The two shallow ponds are approximately 500-m apart. Sylvatica (86.1 m perimeter, 353.5 m^2 area, 0.95 m deep) and Horton (65.9 m perimeter, 223.3 m^2 area, 1.3 m deep) are fishless and permanent. They are kept full by rain and surface flow. The ponds were constructed in 1965 along an old trail and Horton Pond is downstream of Sylvatica Pond. Leaf litter from the surrounding trees, silt and the pondweed *Elodea* sp. are the predominant bottom cover. During most of the summer season the ponds have a well-defined edge. There is a vegetated area surrounding the ponds (ca. 1-5 m wide) containing grasses, sedges and mosses. The surrounding forest is mixed deciduous, dominated by northern red oak (*Quercus rubra*), several of which overhang the pond.

The common wolf spiders around the ponds are *Pirata cantralli* Wallace & Exline 1978, *Pirata montanus* Emerton 1885, *Pirata sedentarius* Montgomery 1904, *Pardosa milvina* Hentz 1844 and *Pardosa moesta* Banks 1892. *Pirata cantralli* and *P. sedentarius* are both habitat specialists whose occasional movements are somewhat restricted to the water's edge (DeVito et al. 2004, Appendix C), whereas *P. milvina*, *P. moesta* and *P. montanus* have either more open or general affinities including forested and wet areas (Buddle 2000). Common dragonflies locally include *Libelulla lydia* Drury 1770, *Libellula pulchella* Drury 1773, *Somatochlora elongata* Scudder 1866, *Cordulia shurtleffi* Scudder 1866, *Aeshna umbrosa* Walker 1908, and *Sympetrum rubicundulum* Say 1839. There is one species of crayfish (*Orconectes spinosus*) and one species of newt (adults and larvae of *Notopthalamus viredescens*) in the pond. Voucher specimens of both the wolf spider and dragonfly species have been deposited at the Smithsonian National Museum of Natural History, Washington D.C., USA.

Aquatic flux onto land declines rapidly (58% at Horton, 40% at Sylvatica) within 2 m of the ponds (Chapter 2). The majority of aquatic insects available to ground arthropods on land (i.e. slow flying and close to the ground) are flies (90%) of which 80% are midges (Diptera: Chironomidae, Chapter 2). Wolf spiders also decrease over this gradient, but there appear to be species-specific differences in distribution. The flux of aquatic insects to land is influenced by the emergence rates from the pond, but local differences in emergence around each pond do not reflect the local flux (Chapter 2).

An initial bulk isotopic survey of arthropods in and around the three ponds at MLBS (including the larger, deeper Riopel Pond) revealed that terrestrial and aquatic insect prey overlapped in $\delta^{13}C$ signatures (terrestrial, -26.1 ± 0.23 vs. aquatic -27.4 ± 2.7, mean ± 1 SEM, n = 2, 3, respectively). Thus, differentiation between allochthonous versus autochthonous resources using natural abundances of the stable isotopes was not possible. In retrospect the difference between terrestrial and aquatic prey (midge larvae and leafhoppers) at just Horton and Sylvatica Ponds appeared more distinct (terrestrial, -25.8 vs. aquatic -29.6 ± 0.5, mean ± 1 SEM, n = 1, 2, respectively). A larger isotopic difference between food sources was still desirable to increase the probability of detecting changes in diet. A pilot experiment (Appendix F) examined the possibility of separating aquatic and terrestrial source signatures by enriching the pond food web by 20‰ $\delta^{13}C$ and 4‰ $\delta^{15}N$ with a small amount of isotopically labeled sodium acetate ($Na^{13}CH_40_2$) and ammonium chloride ($^{15}NH_4Cl$) added in a one-time pulse (Hall 1995, Briers et al. 2005, Carpenter et al. 2005). Enriched signals of $\delta^{13}C$ and $\delta^{15}N$ were detected in pond detritus and ^{15}N in aquatic macrophytes within a week of additions. Midge larvae (Diptera: Chironomidae) showed uptake of the ^{13}C by at most four weeks after the addition (Appendix F). Neither dragonfly larvae nor wolf spiders showed any sign of uptake after four weeks when the experiment was terminated (Appendix F). Lack of uptake in dragonfly larvae and wolf spiders likely was the result of time lag in the turnover of carbon and nitrogen to higher levels of the food chain. The lack of uptake in wolf spiders was also possibly the result of the life history of the midges: larvae that had consumed the heavy isotopes may not have emerged from the ponds before the experiment was terminated.

METHODS

Experimental design

The experiment consisted of reduced aquatic and terrestrial subsidies (– subsidy), ambient subsidy (+ subsidy) (*sensu* Sabo and Power 2002a,b) and aquatic predator removal treatments (predator removal). Unmanipulated open plots (open) were monitored as a control for the enclosures. Treatments were applied to cages using a randomized block design. I replicated the – subsidy and + subsidy treatments once in each of seven sections of pond-forest edge (blocks), whereas the predator removal (also in blocks) and open plot controls were replicated 4 times each (Fig. 1). Enclosures and plots were 3 m long (perpendicular to shore line) by 2 m wide with approximately 1.5 m x 2 m on land and 1.5 m x 2 m in the water. The plot on land included approximately 0.1 m x 2 m of water, so that emigration from terrestrial enclosures in – subsidy plots would not be attributed to lack of water (*sensu* Sabo and Power 2002 a,b).

In the year preceding this experiment, I conducted a similar study investigating the impact of resource subsidies on terrestrial and aquatic arthropod predators, but with fewer replicates, revealed that predatory wolf spiders were found in higher mean abundance in the + subsidy (7.2 ± 2.2, n = 3) compared to the – subsidy treatments (6.1 ± 0.6, n = 3) over the experiment, although this finding was not significant (GLMM: $F_{1,2} = 0.47$, $P = 0.57$; Appendix E). Although the experiment was not constructed to examine whether food web dynamics differed between the two ponds in the study, wolf spiders were found in more than double the density at Horton Pond than Sylvatica Pond (12.7 ± 2.2 vs. 4.9 ± 0.9, mean ± SE, n = 4, 6; Appendix E), where the density of dipteran larvae in the sediment averaged from August – October (22.0 ± 10.2 vs. 3.1 ± 1.2, n = 4, 6) was 7 times higher than in Sylvatica Pond (Appendix E). Data from the 2003 experiment were used to conduct a power analysis and set replicate numbers for 2004.

For the current experiment (May – August, 2004), I enclosed standing densities of focal predators in 2 m x 3 m x 1.5 m open-bottomed cages (Fig. 1). The enclosures were a polyvinyl chloride (PVC) pipe frame on a wood base with a plastic flange sunk into substrate. Tops and ends of cages were covered with plastic hardware cloth (opening 1.27 x 1.91 cm) to allow immigration and emigration of focal organisms while excluding larger predators such as birds and bullfrogs that may have used the enclosures as feeding troughs. Grey fiberglass window screening covered the sides of cages and 0.25 m white plastic sheeting was erected to further prevent migration between cages. I erected the cages in May before the first sample period (Table 1) so that pre-treatment measurements could be taken from within enclosures. After the May sampling, I erected a double screen wall between land and water, and a window screen roof to reduce aquatic arthropod flux to land and terrestrial flux to the pond in – subsidy treatments. Aquatic predators (newts, crayfish and dragonfly larvae) captured during sampling were removed from the predator removal treatments and window screen was layered over the hardware cloth on the bottom section of the wall that was immersed in the water. This partial wall was erected to prevent immigration of predators while allowing immigrating aquatic insects to oviposit and fly through.

I took repeated samples from the enclosures and control plots at the end of June, July and August. I sampled the enclosures for wolf spiders (timed searches), dragonfly larvae, crayfish and newts (box sampler), aquatic prey on land (sticky traps), terrestrial prey in the water (pan traps) and aquatic insects emerging from the water (emergence traps). I maintained predator removal treatments by box sampling and hand searching cages between the June and July sampling dates. All predators sampled for the experiment were counted and measured or weighed (mass for wolf spiders and dragonfly larvae and carapace length plus tail to last segment for crayfish, snout-vent length for newts). I identified wolf spiders to species and dragonfly larvae to family or species. I sexed adult and near adult wolf spiders and assessed the reproductive state of females (carrying egg case, carrying spiderlings, gravid or non-reproductive).

Stable isotope additions

I added heavy stable isotopes of carbon and nitrogen to the pond water in experimental plots to trace the relative resource use (allochthonous vs. autochthonous) of dragonfly larvae and wolf spiders under the different treatment conditions and over time (Hall 1995, Collier et al. 2002, Sanzone et al. 2003, Akamatsu et al. 2005). The aim was to treat isotopic signature as another dependent variable to evaluate treatment effects in the experiment. This use is novel and does not require knowing all food sources, as calculating % diet does, since this assumption is difficult to meet unless there are only two or three food sources with distinct signatures. I used the dissolved carbon and nitrate concentration in the ponds (Table 2) to calculate the level of isotopically enriched sodium acetate ($Na^{13}CH_4O_2$) and ammonium chloride ($^{15}NH_4Cl$) needed to increase the $\delta^{15}N$ and $\delta^{13}C$ of the organic carbon and nitrogen source in the pond enclosures and control plots by approximately 500‰ in one pulse. The enriched solutions were added to each plot by hand once in late June after the June census (Fig.1). The actual change in signal of the focal organisms was not attributable in most cases to this pulse enrichment because of diffusion and water currents from the enclosures most likely diluted any effect the enrichment pulse had. In fact, the isotopic signatures of most of the study taxa became less enriched after addition, suggesting that natural shifts in $\delta^{13}C$ and $\delta^{15}N$ over the season overwhelmed any residual effect of the artificial pulse. I removed the invasive pond weed *Elodea* sp. once from the enclosures before the isotope solution was added so that the enclosures would more closely resemble open plots that were grazed by deer. One wolf spider and one dragonfly larva were collected from each enclosure during each sample period and frozen until later isotopic analysis. I randomly chose the aquatic insects from emergence trap samples during each sample period and froze them for future analysis. I thawed frozen specimens in May 2005 and dried them at 45-50 °C for 2 to 5 d prior to sample preparation. Dried samples (thorax and legs) were weighed into tin capsules. Abdomens were excluded to prevent analysis of unassimilated gut contents. Terrestrial prey (Homoptera: Cicadellidae) were scraped from sticky traps to examine if N uptake from the ponds by land plants provided an alternative conduit of enriched N to land (Appendix F). Isotopic analysis was performed using a Carlo Erba elemental analyzer coupled to a Micromass Optima isotope ratio mass spectrometer (GV, Manchester, UK). The stable isotope ratio is reported as δX (‰) = $[R_{sample}/R_{standard} - 1] \times 1000$, where $X = {}^{13}C$ or ${}^{15}N$ and $R = {}^{13}C/{}^{12}C$ or ${}^{15}N/{}^{14}N$. Atmospheric N_2 served as the standard for ${}^{15}N$ and Peedee Belemnite (PDB) served as the standard for ${}^{13}C$. I analyzed open plot samples for June and July to test the hypothesis that the isotope addition caused an enriched signature, especially for the aquatic organisms (Appendix F). I analyzed samples for July and August, 1 and 2 months after the addition, respectively to test the effect of time and treatment on the enrichment of predators and aquatic insects. I expected that wolf spiders might not show enrichment until this second time period (see above, Oelbermann and Scheu 2002, Sanzone et al. 2003).

Aquatic and terrestrial prey availability on land

I estimated relative abundance of aquatic insects moving to land and terrestrial prey on land using yellow 12.7 x 17.8 cm sticky cards elevated approximately 10 cm above the ground with a wire card-holder. I ran sticky traps in enclosures and no cage plots for 48 hrs on four dates betweens 17 May and 13 August 2005 (Table 1). I collected the traps, stored them in small plastic bags and froze them until analysis. I identified arthropods under a dissecting microscope to family (aquatic flies) or order (all others), assigned an origin (aquatic or terrestrial) and counted them as being captured on the pond facing or forest facing side of the trap. Emergent aquatic insects included Diptera (Chironomidae, Chaoboridae, Ceratopogonidae, Culicidae, Lonchopteridae, Tipulidae), Ephemeroptera, Odonata, Trichoptera. Terrestrial orders were grouped as other Diptera (including semi-aquatic families such as Dolichopodidae), Homptera, Thysanoptera, and other (including Hymenoptera and Araneae).

Terrestrial and aquatic prey fluxes into the water

I measured the abundance of terrestrial and aquatic insects falling into the ponds using pan traps (43 cm x 33.5 cm x 11.4 cm grey plastic bins) with plastic foam tied to their sides to help them float. I filled the pans with 4 to 5 liters of filtered pond water and 30 ml of diluted dish soap as a surfactant (similar to Nakano and Murakami 2001). Two pan traps were anchored to the pond floor of each enclosure or open plot once a month from May through August. The single trap that drifted from an open plot was removed from analysis. I set pan traps simultaneously with sticky traps and collected them after 48 hrs. I sieved pan contents (# 35 U.S.A. Standard Testing Sieve, opening 500 μm), and the filtrate was rinsed into plastic bags and frozen for later identification. Previous analysis revealed that pans within plots were as similar as pans sampled among plots (GLMM, $F_{1,27} = 0.28$, $P = 0.60$), so one of the two pan traps was randomly selected for analysis. I thawed frozen samples and poured the contents onto filter paper for identification under a dissecting scope. I identified arthropods to family or order as above and assigned to habitat of origin. Only aerial aquatic insects were tallied as aquatic input. Terrestrial arthropods included Collembola, Acarina, Araneae, Lepidoptera, Homoptera, Hemiptera, Thysanoptera, Hymenoptera, Diptera (Cecidomyiidae, Sciaridae, and others, i.e. not from one of the aquatic fly families found previously emerging from the ponds; Chapter 2), and other terrestrial (Coleoptera, Psocoptera, Opiliones). Aquatic insects were grouped as aquatic Diptera (Chironomidae, Chaoboridae, Ceratopogonidae, Culicidae, Lonchopteridae, Tipulidae), other aquatic (Ephemeroptera), and Odonates.

Response of wolf spiders

I measured the abundance and per capita mass for all wolf spiders captured in enclosures. I also measured the reproductive status of adult (and near adult) females and bulk isotopic $\delta^{13}C$ and $\delta^{15}N$ ratios of one spider per enclosure (Appendix G and H). Spiders were weighed to the nearest 0.1 mg. All wolf spider species were analyzed as a group but the two most common species, *P. cantralli* and *P. milvina*, were also analyzed separately for abundance, proportion females reproductive and per capita mass.

Aquatic predator response

I measured abundances of dragonfly larvae, crayfish and newts and the per capita masses of dragonfly larvae at each of the four sample periods using a box sampler (Harris et al. 1988) in each sample plot. The box was dropped quickly over a randomly selected section of the plot then swept three times using a square net. This method of sampling without replacement was used to estimate density within the box sampler (Zippin 1956). However, due to violated assumptions for some samples (e.g. when count increased with each sweep), I summed the total number caught for all three sweeps for each predator and considered this the relative abundance estimate. Detritus and animals were returned to the enclosures after body lengths were measured, except for dragonfly larvae, which were removed temporarily for weighing (wet mass, Appendix G).

Detection probabilities

I sampled four enclosures without replacement to estimate the accuracy and repeatability of my relative measures of abundance for both aquatic and terrestrial predators. I sampled wolf spiders for 20 minutes 3 or 4 times successively per cage on 22 June and 29 June (from 2 – subsidy and 2 + subsidy enclosures). Dragonfly larvae, crayfish and newts were removed from predator removal enclosures (using three sweeps as above) from each box sample, which were taken 4 times from randomly selected portions of the enclosure over 4 days (5 – 8 June). Time was left between box samples to allow the predators to re-equilibrate their distribution. I extrapolated the estimated population per enclosure (Zippin 1956) using a linear regression in which the relationship between estimated population sizes and the first samples from three or four enclosures represented the relationship between the estimate of relative abundance in the enclosure and the estimate of actual abundance for each focal organism (Appendix I).

Data analysis

All analyses were completed using SAS statistical software (SAS 9.1, © 1999-2001, SAS Institute Inc., NC; Littel et al. 1996). The analyses of the enclosure experiments employed the repeated measures ANOVA-like designs using a pseudo-likelihood method (glimmix macro, Wolfinger and O'Connell 1993, Littel et al. 1996). Analyses were performed to examine the main effects of treatment, time and the treatment by time interaction for each predator separately as well as for aquatic and terrestrial prey items caught in pan and sticky traps. I used May data to test for initial differences among cages before treatments were applied. If there were initial differences among enclosures assigned to different treatments, I subtracted the initial values from subsequent values and the analysis was performed on the remaining three months.

Three planned post-comparison contrasts tested for cage, subsidy reduction and aquatic predator removal effects if a test showed omnibus significance. Significance for these comparisons were tested against a Bonferroni adjusted α of 0.017 ($k = 3$) since the contrasts were non-orthogonal. Specifically the comparisons examined whether responses of any focal group were different in + subsidy enclosures vs. open plots, + subsidy vs. – subsidy and + subsidy vs. predator removal. The cage effect (+ vs. open) was tested using data from all months, since the cages were erected before the first sample period. The subsidy reduction (- subsidy vs. + subsidy) and predator removal (+ subsidy vs. remove) effects were tested only using data from June-August to reflect differences after treatments were instated.

Response variables analyzed included a subset of the following: count per enclosure, average per capita mass per enclosure, average per capita body length per enclosure, average proportion of females that were reproductive (gravid, with egg sac or carrying spiderlings), and $\delta^{13}C$ and $\delta^{15}N$. Link functions were specific to the expected distribution of each dependent variable (McCullagh and Nelder 1989): count data were expected to be Poisson distributed (log link function) and length, mass and isotopic signature were expected to be normally distributed (identity link function, Littel et al. 1996). Data on proportion of individuals in reproductive condition were arcsin-square root transformed and then treated as normally distributed. With the exception of a few analyses of data sets with small sample sizes, final models were not over dispersed (extra-dispersion scale parameter ≈ 1), supporting the conclusion that the expected distributions matched the data (Littel et al. 1996). I modeled time as autoregressive and compound symmetric for each model, and selected the model with the lowest AICc (Burnham and Anderson 2002). For aquatic predators water volume per box sampler was used as a covariate in all analyses.

Linear regression using repeated measures was used to examine the linear relationship between prey availability on land and in the water and predator abundance, mass or size over time and space. Regression was also used to test if newts, crayfish and dragonfly larvae influenced each other's size or mass, and whether that relationship changed with treatment.

Block effect in the analysis included possible pond-level differences in predator abundance or response. The experiment was not designed to examine differences among ponds but because of differences in number of aquatic prey at the two ponds in 2003, I checked for a similar pond effect on aquatic prey on land in 2004 that might warrant additional pond level analyses, but found none.

RESULTS

Aquatic and terrestrial prey and treatment efficacy

Aquatic prey counts on land were reduced by almost 50% inside + subsidy enclosures (8.1 ± 1.3 $\text{trap}^{-1}2\ \text{d}^{-1}$, *n* = 7, mean ± SEM per treatment) when compared with no cage plots (15.9 ± 2.9, *n* = 4) (cage effect: GLMM, $F_{1,135} = 9.26$, $P = 0.003$) averaged over the length of experiment. Aquatic prey counts dropped 75% in all treatments from May (29.3 ± 4.0, mean ± 1 SEM, *n* = 15) to July (7.2 ± 1.0, *n* = 22) (Table 3, Fig. 2). The – subsidy and aquatic predator removal treatments had no effect on the relative flux of aquatic insects to land when compared with + subsidy enclosures (Table 3, Fig. 2). Aquatic prey that did arrive on land appeared to mainly be coming directly from the pond as counts were marginally higher on the side of the trap facing the pond (Table 3), and there was no interaction between side of trap and treatment. This supports the conclusion that aquatic insects were moving directly from the ponds and not another source such as moist soil in the forest. The numbers of aquatic prey captured on sticky traps did not differ initially among treatments in May. Emerged aquatic prey were not enriched in ^{13}C or ^{15}N by the addition of heavy carbon and nitrogen to pond enclosures (Fig. 3, Table 3, Appendix H). In fact, aquatic prey became less enriched in ^{13}C over time from July to August, likely due to natural changes in the $\delta^{13}C$ of available carbon (Fig. 3, Table 3, Appendix H). There was no effect of time on $\delta^{15}N$ or treatment on $\delta^{13}C$ or $\delta^{15}N$ of prey.

Terrestrial prey counts on land were reduced by 39% in + subsidy compared to open plots (42.1 ± 2.8, $n = 7$; 69.2 ± 11.0, $n = 4$, respectively; cage effect: $F_{1,135} = 9.26$, $P = 0.003$). The – subsidy and aquatic predator removal had no effect on the relative number of terrestrial insects captured on land when compared with + subsidy enclosures. Terrestrial prey counts were highest in May and July (58.5 ± 6.2, $n = 15$ and 56.1 ± 4.6, $n = 22$ respectively) (Table 3, Fig. 2). Counts of terrestrial prey captured on sticky traps on land did not initially differ within enclosures. Terrestrial prey (Cicadellidae) were not significantly enriched in ^{15}N by the addition of heavy carbon and nitrogen to pond enclosures (Fig. 3, Table 3, Appendix H), even though there was an increase in the mean $\delta^{15}N$ of the animals sampled from June to July by almost 2 ‰ (Fig. 3). There was no effect of time on $\delta^{15}N$ from July to August although the trend of increasing $\delta^{15}N$

continued (Fig. 3, Table 3, Appendix H). Thus there was no statistical evidence that terrestrial prey were enriched by ^{15}N additions to the pond.

Counts of terrestrial prey that fell into pan traps were reduced 36% in the – subsidy treatment (9.7 ± 1.0 trap^{-1}2 d^{-1}, n = 7, mean ± SEM per treatment) as compared to the + subsidy treatment (15.2 ± 1.1, n = 7; GLMM, $F_{1,45} = 13.04$, $P < 0.001$; Fig. 2) when averaged over the season. There was no cage effect. Terrestrial counts in pan traps dropped monotonically from May to August, quite different from the pattern of mid-season peak in terrestrial prey abundance simultaneously measured on land (Fig. 2). Counts of aquatic prey that fell into the pan traps were reduced 46% in – subsidy (2.1 ± 0.4 trap^{-1}2 d^{-1}, n = 7) as compared to enclosures with + subsidy (3.9 ± 0.4, n = 7) (Fig. 2) when averaged over the season. Mean counts of aquatic prey decreased almost 6-fold between May (30.6 ± 3.7, n = 15) and June (5.6 ± 0.7, n = 22), reflecting the pattern for aquatic prey counts on land. The majority of arthropods falling into the water within 1.5 m of the pond edge were small herbivorous insects (45% Homoptera, Hemiptera and Thysanoptera).

The removal of aquatic predators from enclosures significantly reduced the density of crayfish but not of dragonfly larvae or newts over the span of the experiment (Table 3).

Counts of wolf spiders, dragonfly larvae, newts and crayfish from the first samples for each enclosure did not vary significantly with the estimated sample size for that cage based on multiple sampling without replacement (Linear regression: wolf spiders, n = 4, $F_{1,2} = 0.07$, $P = 0.82$; dragonfly larvae, n = 3, $F_{1,1} = 0.06$, $P = 0.84$; newts, n = 4, $F_{1,2} = 0.75$, $P = 0.48$; crayfish, n = 3, $F_{1,1} = 0.57$, $P = 0.59$). There was no evidence, therefore, that 20 minute counts or box sampling gave a relative measure of abundance of predators in the enclosures. However, since this conclusion is based on a relatively small sample size, I cautiously interpret significant patterns in abundance when they relate to treatment differences.

Wolf spiders

Initial wolf spider counts varied by treatment assignment before treatments had been instituted within cages in May (Fig. 4), but the per capita mass of spiders per cage and the proportion of females that were reproductive did not. For proportion of females that were reproductive and mean per capita mass per cage (Appendix G), wolf spiders showed an effect of treatment (Table 3) and a marginal cage effect (GLMM, proportion reproductive, $F_{1,62} = 5.70$, $P = 0.020$; mass, $F_{1,63} = 5.79$, $P = 0.019$). Although there was no effect of – subsidy, mean proportion reproductive and mean per capita mass appeared at least twice as large in the + subsidy than in the – subsidy treatments in August (for proportion reproductive) or July (for per capita mass) (Fig. 4). Removal of aquatic predators from enclosures had no effect on any measure of wolf spider response over the course of the experiment. Wolf spider count per cage and the proportion of females that were reproductive changed over time (Table 3, Fig. 4). Wolf spiders did not show a change in isotopic enrichment after the addition of the heavy carbon and nitrogen to the pond (Fig. 4, Table 3). The δC^{13} of the wolf spiders measured however did become less enriched between the July and August sample periods (Table 3, Fig. 4). The δC^{13} and δN^{15} signatures of the wolf spiders did not vary by treatment (Appendix H). Arcsin-square-root transformed proportions of reproductive female wolf spiders increased with an increase in terrestrial prey on land in an enclosure (GLMM, n = 80, slope = 0.005 ±

0.001, $F_{1,67} = 25.37$, $P < 0.001$). This pattern is most likely attributable to changes in wolf spider reproduction and terrestrial prey availability over time, not space (Fig. 4). Aquatic prey counts on land did not show a direct relationship with wolf spider counts, per capita mass, proportion of females that were reproductive or δC^{13} or δN^{15} signature.

Counts, per capita mass and proportion of females of the water-edge specialist *P. cantralli* that were reproductive all changed over time (Fig. 5). Proportion of reproductive females varied marginally by treatment, and although there was no – subsidy or cage effect, the proportion of reproductive females at the end of the experiment was reduced two-fold when compared with other treatments (Fig. 5). Average per capita mass of *P. cantralli*, proportion of reproductive females, and abundance did not show differences in pretreatment conditions.

Counts of *P. milvina*, the open-habitat specialist, changed over time and were higher in open plots than in + subsidy (GLMM, $F_{1,63} = 6.79$, $P = 0.012$; does not include May values as noted in methods). Proportion of *P. milvina* females per enclosure that are reproductive increased over the season (Fig. 5), but did not differ by treatment. Per capita mass differed among treatments but there was no effect of – subsidy, cage or aquatic predator removal. *Pardosa milvina* count and mass showed variation by treatment assignment in May ($P < 0.01$). Neither standardized count nor mass differences (when compared to May values) differed by treatment or time.

Aquatic predators

Counts of dragonfly larvae and their per capita mass (Appendix G) changed over the season (Fig. 7). In May, larvae were large and few and had most likely over-wintered as larvae. As the season progressed, new larvae hatched in or immigrated into the enclosures. The seasonal change in per capita mass of dragonfly larvae differed marginally by treatment: open plots maintained larger larvae into June while mean per capita mass of the dragonfly larvae in the + subsidy enclosure plots dropped. There was no effect of cage, – subsidy or aquatic predator removal on dragonfly counts or per capita mass. Dragonfly larvae did not show a change in enrichment due to the addition of heavy carbon and nitrogen to the ponds. If anything there was a slight decrease in enrichment from June to July (Fig. 7, Table 3, Appendix H). The $\delta^{13}C$ signature of sampled dragonfly larvae varied by treatment from July to August: larvae in + subsidy enclosures were more enriched than in – subsidy enclosures (GLMM, $F_{1,20} = 16.14$, $P < 0.001$, Fig. 7). There was no effect of cage on the $\delta^{13}C$ of larvae (Table 3, Appendix H). There was no effect of cage or treatment on the $\delta^{15}N$ of larvae (Fig. 7, Table 3, Appendix H). Initial counts of dragonfly larvae and per capita mass in May did not differ by treatment assignments. Water volume per box sample contributed positively to variance in counts of dragonfly larvae but not in other dragonfly responses. Dragonfly larval counts increased with increasing aquatic prey counts on sticky traps and decreasing aquatic prey in pan traps (GLMM, Aquatic sticky, n = 80, slope = 0.023 ± 0.010, $F_{1,54} = 5.25$, $P = 0.026$; Aquatic pan: n = 80, slope = -0.063 ± 0.019, $F_{1,54} = 11.74$, $P = 0.001$). Per capita mass of dragonfly larvae increased with decreasing terrestrial counts on land and increasing aquatic prey counts in the water (GLMM, Terrestrial sticky trap, n = 71, slope = -0.002 ± 0.001, $F_{1,45} = 5.15$, $P = 0.027$; Aquatic pan: n = 71, slope = 0.008 ± 0.003, $F_{1,45} = 7.61$, $P = 0.007$). Fewer larger dragonfly larvae were present earlier in the season when more aquatic insects were falling into the water.

Mean length of crayfish increased and count per enclosure decreased over the season (Fig. 8). Count varied with treatment: open plots showed higher counts than in + subsidy enclosures (GLMM, $F_{1,61} = 7.42$, $P = 0.008$) and aquatic predator removal plots showed a significant decrease in density of crayfish compared with + subsidy treatments (GLMM, no pred vs. + subsidy, $F_{1,43} = 9.12$, $P = 0.004$; Fig. 8). Volume of water per box sampler did not contribute to variation in counts or average length of crayfish per enclosure. Initial counts and mean length of crayfish per enclosure were not influenced by treatment designations in May. Crayfish counts increased with increasing aquatic prey counts on land (GLMM, $n = 80$, slope = 0.021 ± 0.008, $F_{1,65} = 7.24$, $P = 0.009$).

Counts or snout-vent lengths of newts did not vary over time or by treatment; however, counts over time varied among treatments (Table 3). Initial counts of newts were not affected by treatment designations in May. Newt counts were not related to prey counts on land or in the water, potentially because of interactions with other predators in the enclosures.

The counts of dragonfly larvae in a box sampler increased with newt counts (GLMM, n = 86, slope = 0.11 ± 0.04, $F_{1,66} = 9.85$, $P = 0.003$), but this effect differed by treatment and subsidy: the – subsidy plots showed increased dragonfly larvae with increased newt counts, while + subsidy plots showed decreased dragonfly counts with increased newt counts (GLMM, by treatment, $F_{3,66} = 5.47$, $P = 0.002$; – subsidy vs. + subsidy, $F_{1,43} = 5.12$, $P = 0.03$). Dragonfly counts also varied with crayfish counts by treatment and marginally by subsidy. In this case + subsidy plots showed increased counts of dragonfly larva with increased number of crayfish captured per box sample, while there appeared to be only a weak relationship between the dragonflies and crayfish inside – subsidy enclosures (GLMM, $F_{3,66} = 6.90, P < 0.001$; – subsidy vs. + subsidy, $F_{1,43} = 3.60, P = 0.07$; Fig. 9). The mass of dragonfly larvae and the length of newts and crayfish were not related, nor were the capita mass of dragonfly larvae and wolf spiders.

DISCUSSION

Treatment efficacy

This experiment examined the direct effects of aquatic insects and terrestrial arthropods on aquatic and terrestrial predators, the indirect effect of aquatic predators on terrestrial predators mediated through aerial aquatic insects and the indirect effects of terrestrial input on intraguild interactions among three classes of predators in the ponds (Fig. 10). The interpretation of predator responses relies on the efficacy of the intended subsidy manipulation. Only terrestrial input moving into the ponds was successfully manipulated in the intended manner (i.e. by subsidy shields within enclosures). Aquatic input was reduced by enclosures but not by shields within enclosures. Aquatic predator removal successfully removed crayfish but did not translate into an increase in aquatic insect movement to land.

The shields that were erected to reduce ambient levels of allochthonous input from land to water and water to land successfully reduced the input of terrestrial arthropods to the water by 39%, on average. The shields did not reduce the flux of aquatic insects compared to enclosures without shields. Enclosures, however, reduced the flux of aquatic insects towards land by almost 50% without regard to whether the enclosures had shields. It is unlikely that aquatic insects coming through the terrestrial side of the cages explain this pattern, since a greater number of aquatic, but not terrestrial, arthropods were found on the side of the sticky traps facing the pond in all treatments. It is possible that many insects emerging within the cages flew straight up, since they were partially sheltered from wind that might have swept them to land. Enclosures prevented whole pond processes, as emergence and flux of aquatic insects to land has proven to be (Chapter 2), from affecting plots inside enclosures. On the other hand, arthropod input to the ponds occurs to some extent on a local scale, i.e. arthropods hitting the water surface are originating from above or adjacent to that part of the pond. Thus shields were successful in this case.

The predator removal treatments had equally mixed results. Only crayfish showed decreased abundance over the season in predator removal enclosures, pointing to a lack of success in removing dragonfly larvae and newts or a lack of ability to adequately detect these species. Ultimately the reduction in the numbers of crayfish, which in laboratory mesocosms have been shown to be efficient predators of aquatic midge larvae (Diptera: Chironomidae, Appendix J) was not enough to alter the flux of aquatic insects to land.

Direct effects of reciprocal subsidies

In light of the large negative impact of enclosures on aquatic insect abundance on land, the patterns in wolf spider response to aquatic resources may be better understood by comparing ambient subsidy to open plot treatments than to reduced subsidy treatments. These comparisons are made with caution since other factors such as terrestrial prey reduction and abiotic changes are confounded with aquatic prey availability in this comparison. Over the season, the reduction of subsidies and *in situ* prey by enclosures appeared to reduce the *per capita* mass of wolf spiders by about 27% and proportion of females that were reproductive by about 17%. However, the relative importance of aquatic resources in wolf spider diet did not appear to be related to the abundance of these resources. Wolf spiders were not less enriched in enclosures, which had fewer aquatic insects than in open plots, even thought wolf spiders appeared to consume at least some aquatic resources based on the parallel $\delta^{13}C$ enrichment patterns between wolf spiders and emerged insects and the potentially quick isotopic turnover rate of molting wolf spiders (< 12 d, Appendix K). This type of pattern is often seen when the population of a predator is being regulated by a factor other than resource abundance, such as predation, cannibalism or competition (Gaymer et al. 2002). All three of these factors were likely functioning, although the exclusion of larger predators by the enclosures may have reduced predation.

Besides variation in type of response of wolf spiders to subsidy, there were interspecific differences in response, perhaps related to desiccation tolerance. Two of the most common wolf spiders sampled at the edge of the pond were the aquatic specialist *P. cantralli* and the open habitat specialist *P. milvina. Pirata cantralli* appeared to be responding to subsidy by increased reprodutive output, while *P. milvina* appeared to be responding numerically. *Pirata cantralli* desiccate relatively quickly when compared with other pond edge spiders (DeVito et al. 2004); this appears to constrain them physiologically to living close to aquatic habitats (Graham et al. 2003). Furthermore, a study of wolf spider movement around Horton and Sylvatica Ponds suggests that marked spiders, the majority of which were the two common *Pirata* species living near the pond edge, showed a much greater probability of movement along the edge of ponds than away from ponds (0-54% vs. 0-2% chance of moving into an adjacent 1 m^2 plot/day, Appendix C). *Pardosa milvina*, on the other hand, is a good colonizer of early successional habitat (Marshall et al. 2000). There is anecdotal evidence from my study that *Pardosa* are able to move > 7 m around the ponds over the course of a month, where as *P. cantralli* was not observed moving more than 2 meters over that same period (Appendix C).

Pirata cantralli did not appear to respond in abundance, per capita mass, or proportion reproductive to the decreased prey availability within cages. However, there was a trend of reduced per capita mass and reduced proportion of reproductive females in the reduced subsidy treatments during the last sample period in mid-August. Aquatic resources were at their lowest during this period, and in addition terrestrial resource availability began to drop. It is possible, therefore, that *P. cantralli* in enclosures with shields were experiencing a cumulative effect of a small, undetected reduction in subsidy in reduced treatments compared to natural subsidy enclosures. It is not surprising that *P. cantralli* would only show these trends in the individual response measures, since it is unlikely that *P. cantralli* often moved far enough from the water to exit the cages.

Pardosa milvina was found in slightly higher abundance in natural subsidy treatments, even though subsidy was not necessarily increased in these enclosures. Per capita mass also appeared to respond to aquatic resource availability, in that open plots showed the highest per capita mass of *P. milvina*. Owing to their mobility, *P. milvina* was more likely to respond to differences in resource abundance numerically through immigration and emigration. Numerical responses could have been either through migration or reproduction because the experiment spanned the reproductive period of these spiders. However, the response of the spider depended on the physiological ability of the species to respond to changes in prey availability.

A species-specific response to the presence of subsidy appears to be a general phenomenon related to the physiology and feeding preference (Hering and Plachter 1997, Nakano and Murakami 2001, Polis et al. 2004, Power et al. 2004). On desert islands, two species of mice exhibit differences in diet that lead to only one being affected by distance from shore (Stapp and Polis 2003). Near a river, a non-mobile spider increases in mass near the river, and decreases when it is far away (Power et al. 2004). In the same system, wolf spiders are able to respond numerically to aquatic insects by moving along the shoreline (Power et al. 2004).

Finally, dragonfly larvae did not respond to terrestrial input either through changes in abundance or per capita biomass. However, the larvae incorporated more heavy carbon in the enclosures with a natural level of subsidy than in reduced subsidy enclosures. Given that the isotope enrichment in the pond enclosures did not work and terrestrial herbivores were naturally more enriched than aquatic insects (Appendix F), this pattern implies that dragonfly larvae were eating proportionately more terrestrial resources when proportionately more were available. There is evidence that larvae that typically live on stems in the water column (Aeshnidae) consume floating moth adults in laboratory experiments (Appendix J), which supports the pattern of allochthonous consumption by dragonfly larvae.

Resource subsidies and intraguild interactions

Neither newts nor crayfish responded to changes in terrestrial resource availability. The effect of both taxa on dragonfly abundance, however, did appear to change with the availability of terrestrial resources. So although individual taxa may not have shown a response, the interactions among taxa may have changed when subsidies were reduced. Allochthonous input has been shown to influence intraguild interactions in other systems (Sabo and Power 2002a, Baxter et al. 2004). At a deciduous forest-2nd order stream boundary, introduced salmonids heavily use terrestrial resources that fall into the stream and cause native fish to shift to benthic macroinvertebrates (Baxter et al. 2004). Although not explicitly stated by the authors, removing terrestrial resources might then be expected to cause more direct competition for resources between native and introduced fish. In a cobble bar-river system, wolf spiders are able to persist in higher numbers in the presence of lizards when aquatic insects are available because of the alternate food source for the lizard and not just because of additional food for the spiders (Sabo and Power 2002a, Power et al. 2004).

Competition between aquatic and terrestrial predators

It is unlikely that aquatic predators in the water could indirectly influence the distribution of terrestrial predators on land around a pond given the lack of relationship between aquatic emergence and aquatic flux at Horton and Sylvatica Ponds (Chapter 2). On the whole pond scale, however, it is conceivable that aquatic predators regulating the abundance of aquatic insect larvae could regulate the movement of insect prey to land. Two recent studies comparing fish and fishless ponds in Florida (Knight et al. 2005) and comparing stream reaches with introduced fish plus native fish to reaches with only native fish (Baxter et al. 2004) have found indirect effects across aquatic-terrestrial boundaries to occur at a local scale. Knight et al. (2005) showed significantly fewer dragonfly larvae emerging from ponds with fish than from ponds without fish. Streams with introduced fish showed a shift in diet of the native fish to aquatic macroinvertebrates and a reduction in emerging aquatic insects. In both of these studies, the reduction in emergent aquatic insects had implications for terrestrial food web processes. The reduction in emergent dragonfly larvae decreased predation on pollinators around the ponds and increased plant fecundity (Knight et al. 2005). The reduction in emerging aquatic insects decreased the abundance of web-building spiders at the edge of the pond (Baxter et al. 2004). Given that dragonfly larvae, crayfish and newts are the top predators in Horton and Sylvatica Ponds, it is likely that a similar regulation of their prey and influence of terrestrial food webs could occur at the pond level.

Reciprocal subsidies, productivity and spatial scale

Much of the original work on the effects of resource subsidies to food webs focused on input from high productivity to low productivity habitats (Polis and Hurd 1996a,b, Polis et al. 2004). It is now clear, however, that resource movement between habitats of similar productivity, or even from a low to high productivity environment can be important to consumers in recipient food webs (Power et al. 2004, Baxter et al. 2005). Temporal differences in reciprocal subsidies are a source of these strong direct effects (Nakano and Murakami 2001), while consumer preference is another (Baxter et al. 2004).

The present study suggests that movement of resource between a pond-forest interface occurs bi-directionally, similar to the Japanese stream system studied by

Nakano, Murakami and colleagues (see Baxter et al. 2005 for review). Unlike the Nakano and Murakami (2001) study, there was no evidence that the terrestrial and aquatic fluxes moving between the ponds and land temporally complemented each other. The present study only spanned 4 months, however, and this complementarity may have occurred later in the fall. Another difference between Nakano and Murakami's (2001) and the present system is that allochthonous resources in the pond system seemed to influence predators on land more clearly than those in the water. The reduced perimeter to area ratio of the pond compared to a similar area of stream reach might explain this pattern, especially compared to wooded streams (Kawaguchi and Nakano 2001).

A final difference between the ponds and the Japanese stream is that the fluxes and food web effects caused by them appeared to function at two spatial scales. In general, terrestrial input appears to be a local process; what was falling in over a caged area came from overhead or adjacent land probably could be reduced by shields. Interactions between terrestrial and aquatic predators through these resources are therefore possible. Terrestrial insects are an important source of carbon for dragonfly larvae and the input of terrestrial insects appeared to influence their interactions with other predators in the ponds. On the other hand aquatic input to land was more of a whole-pond process, i.e. what is emerging tends to influence what is getting to land only at the whole-pond scale, not within ponds. Thus, local interactions between aquatic and terrestrial predators are unlikely, although this might happen regionally. Aquatic insects appear to be a source of carbon for wolf spiders, but it is unclear from the current data how important a source they are. Aquatic insects may influence wolf spider distribution and reproduction but the response appears species-specific, influenced by physiological constraints of each species. The structure of food webs within ponds may explain differences in adjacent terrestrial arthropod assemblages among ponds, but only in some years, and local differences in the prey that fall into ponds may influence food web interactions within ponds.

This study extends the research of reciprocal subsidies to a lentic-terrestrial interface by examining the role of arthropod resource movement in and around ponds. My finding that the reciprocal subsidies may be functioning at two different spatial scales in this system is novel. Understanding the spatial and temporal scale over which productivity of a food web translates to resource flux to another habitat, and the relationship between the types of connections between food webs and their productivity is crucial to predicting how the effects of resource subsidies on consumers may cascade within and between food webs.

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Table 1. Schedule of sampling and additions (2004). Pan and sticky traps sampled aquatic input to land and terrestrial input to water. Spider search was the 20-minute hand search for wolf spiders in experimental plots. Box sampler was used to measure abundance of dragonfly larvae, newts and crayfish in the pond plots.

Date	Protocol	Sampling
May		
29 April-5	install enclosure	
20-2 June	**1**	box
20-3 June		spider search
25-3 June		pan, sticky
	install treatments	
June		
5-8	predator removal	
18-29	**2**	box
22-29		spider search
20-25		pan, sticky
14-29	isotope addition	
July		
14-21	**3**	box
22- Aug 1		spider search
20-25		pan, sticky
August		
6-28	**4**	box

Table 2. Chemistry of the two study ponds. Samples were taken in June and July, 2002, at 10 cm, 1m and 2m from the pond edge at random transects around the ponds. Ammonium was determined by fluorimetry, nitrate by automated cadmium reduction and organic carbon by wet oxidation. Units for carbon are ppm (mg/L), for nitrogen ppb (μg/L). The value for DIC at Sylvatica surpassed the range of detection of the analyzer. Analyses were run in the Stream Team shared facility at Virginia Polytechnic Institute courtesy of Dr. Jack Webster. The difference in chemistry between Horton and Sylvatica Ponds may be partially attributable to dust from a limestone gravel driveway rinsing into Sylvatica Pond, but not reaching downstream Horton Pond.

	DOC	DIC	NO_2^-/NO_3^-	NH_4^-
Horton	7.5 ± 0.8	1.3 ± 0.3	11.2 ± 2.1	39.4 ± 8.9
Sylvatica	6.1 ± 0.6	>>11.9 ± 0.3	20.1 ± 5.0	168.9 ± 38.3

Table 3. Results from generalized linear mixed model analyses on counts, per capita mass, proportion reproductive or isotopic signature of aquatic and terrestrial arthropods on land, aquatic and terrestrial arthropods fallen into the pond, wolf spiders, dragonfly larvae, crayfish, newts and emergent aquatic insects.

Source	df	*F*	*P*	*Cov. est.*
SUBSIDIES and PREY				
Aquatic flux to land				
Treatment –fixed	3, 132	4.68	**0.004**	
Time –fixed, repeated	3, 132	31.29	**<0.001**	0.03
Treat x Time –fixed	9, 132	0.68	0.73	
Side –fixed	2, 132	0.13	0.13	
Treat x Side –fixed	3, 132	0.69	0.69	
Block –random				0.06
Error –random				2.97
Emergent insects - δ^{13}C				
Enrichment	1,3	5.32	0.10	0.66, E=1.13
July-Aug				
Treatment	3, 18	0.24	0.87	
Time	1, 16	9.85	**0.006**	3.32
Treat x Time	3, 16	1.85	0.18	
Error				2.75
Emergent insects - δ^{15}N				
Enrichment	1,3	2.56	0.21	-0.31, E=0.75
July-Aug				
Treatment	3, 18	1.11	0.37	
Time	1, 15	0.03	0.87	0.51
Treat x Time	3, 15	0.50	0.69	
Error				1.8
Terrestrial prey on land				
Treatment	3, 132	6.17	**<0.001**	
Time	3, 132	6.20	**<0.001**	0.46
Treat x Time	9, 132	0.35	0.95	
Side –fixed	2, 132	0.71	0.49	
Treat x Side –fixed	3, 132	1.03	0.38	
Block				0.018
Error				4.15
Terrestrial Homopterans-δ^{15}N				
Enrichment	1,3	3.45	0.16	0.8, E=2.2
July-Aug				
Time	1,2	3.45	0.21	0.19
Error				1.44
Aquatic flux to water				
Treatment	3, 56	3.31	**0.03**	
Time	3, 56	149.62	**<0.001**	-0.16

Treat x Time	9, 56	2.33	**0.03**	
Block				0.09
Error				1.36
Terrestrial flux to water				
Treatment	3, 56	5.41	**0.002**	
Time	3, 56	61.48	**<0.001**	-0.25
Treat x Time	9, 56	1.02	0.43	
Block				
Error				
WOLF SPIDERS				
Wolf spider – count				
Treatment	3, 63	0.66	0.58	
Time	3, 63	2.97	**0.04**	0.47
Treat x Time	9, 63	1.03	0.43	
Block				0.17
Error				1.65
Wolf spider – mass				
Treatment	3, 63	2.75	**0.05**	
Time	3, 63	0.34	0.80	-0.12
Treat x Time	9, 63	1.62	0.13	
Block				3.3×10^{-6}
Error				3.2×10^{-5}
Wolf spider – prop. repro.				
Treatment	3, 62	4.76	**0.005**	
Time	3, 62	3.22	0.29	-0.01
Treat x Time	9, 62	1.11	0.37	
Block				0.001
Error				0.09
Wolf spider – $\delta^{13}C$				
Enrichment	1,3	0.04	0.85	0.4, E=0.30
July-Aug				
Treatment	3, 22	0.78	0.52	
Time	1, 22	7.46	**0.01**	0.07
Treat x Time	3, 22	0.31	0.82	
Block				0.36
Error				0.35
Wolf spider – $\delta^{15}N$				
Enrichment	1,3	0.05	0.84	0.10, E=2.4
July-Aug				
Treatment	3, 22	0.43	0.73	
Time	1, 22	0.27	0.61	0.03
Treat x Time	3, 22	0.48	0.70	
Block				0.97
Error				0.45
Pirata cantralli– count				
Treatment	3, 63	0.2	0.83	
Time	3, 63	3.15	**0.03**	1.06
Treat x Time	9, 63	0.42	0.92	
Block				0.02

Error				2.08
Pirata cantralli – mass				
Treatment	3, 18	1.84	0.18	
Time	3, 54	3.75	**0.02**	0.35
Treat x Time	9, 54	1.66	0.12	
Block				0
Error				8.9×10^{-6}
Pirata cantralli – prop. repro.				
Treatment	3, 18	3.00	0.06	
Time	3, 52	3.50	**0.02**	-0.02
Treat x Time	9, 52	0.86	0.65	
Block				0
Error				0.12
Pardosa milvina– count				
Treatment	3, 63	4.51	**0.006**	
Time	3, 63	4.55	**0.006**	0.44
Treat x Time	9, 63	0.67	0.73	
Block				0.22
Error				1.26
Pardosa milvina – mass				
Treatment	3, 18	3.88	**0.03**	
Time	3, 54	1.95	0.13	2.7×10^{-5}
Treat x Time	9, 54	0.43	0.92	
Block				0
Error				0.45
Pardosa milvina– prop. repro.				
Treatment	3, 22	2.15	0.12	
Time	3, 22	5.29	**0.007**	-0.14
Treat x Time	9, 22	1.23	0.33	
Block				0.04
Error				0.28
AQUATIC PREDATORS				
Dragonfly larvae – count				
Treatment	3, 61	1.06	0.37	
Time	3, 61	7.40	**< 0.001**	-1.13
Treat x Time	9, 61	0.49	0.88	
Block				0.06
Water volume				7.99
Error				5.64
Dragonfly larvae – mass				
Treatment	3, 18	0.49	0.69	
Time	3, 44	17.63	**<0.001**	0.0006
Treat x Time	9, 44	1.85	0.09	
Block				0
Water volume				0
Error				0.01
Dragonfly larvae – $\delta^{13}C$				
Enrichment	1,1	57.13	**0.08**	6.62, E=0.01

July-Aug				
Treatment	3, 20	6.37	**0.003**	
Time	1, 20	1.91	0.18	-0.12
Treat x Time	3, 20	0.79	0.51	
Block				3.62
Water volume				0
Error				.45
Dragonfly larvae – $\delta^{15}N$				
Enrichment	1,1	0.67	0.56	0.03, E=0.32
July-Aug				
Treatment	3, 20	1.05	0.39	
Time	1, 20	0.83	0.37	0.06
Treat x Time	3, 20	0.56	0.65	
Block				0.02
Water volume				4.52
Error				3.53
Newt – count				
Treatment	3, 61	1.23	0.31	
Time	3, 61	0.77	0.51	0.11
Treat x Time	9, 61	2.18	**0.04**	
Block				0.49
Water volume				0
Error				1.39
Newt– length				
Treatment	3, 63	1.32	0.28	
Time	3, 63	0.63	0.60	-.0.11
Treat x Time	9, 63	1.39	0.21	
Block				0.74
Water volume				0
Error				3.30
Crayfish – count.				
Treatment	3, 61	4.62	**0.006**	
Time	3, 61	4.92	**0.004**	-0.14
Treat x Time	9, 61	1.75	0.10	
Block				0.60
Water volume				0
Error				1.41
Crayfish - length				
Treatment	3, 35	1.70	0.18	
Time	3, 35	5.27	**0.004**	-0.38
Treat x Time	9, 35	1.10	0.38	
Block				0.44
Water volume				7.7×10^{-33}
Error				0.21

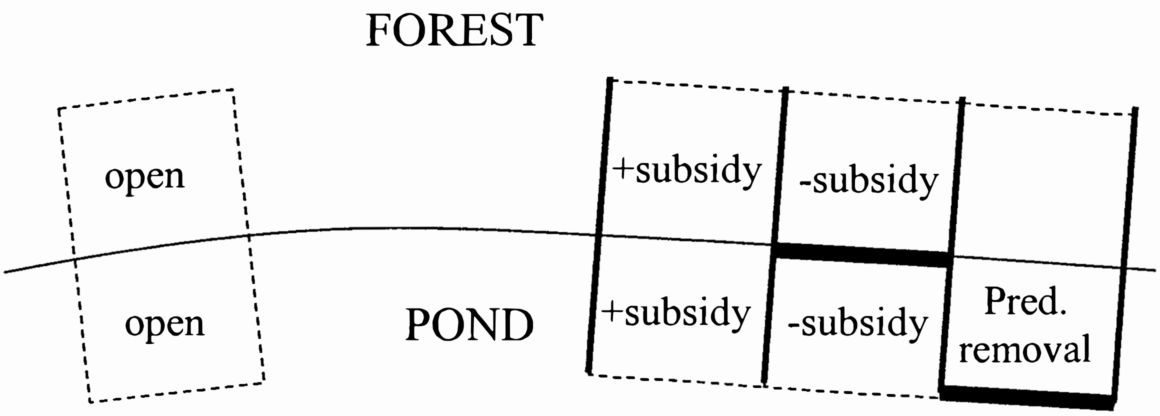

Figure 1. Design of subsidy alteration experiment. Shield between water and land planned to reduce aquatic insect flux to land and terrestrial arthropods falling into water. Aquatic predators were removed to test indirect effects of aquatic predators on terrestrial wolf spiders mediated by the ontogenetic niche shift of a shared prey (aquatic insects). Open plots were monitored as a control. Movement of predators was allowed in and out of the ends of the cages but not in between.

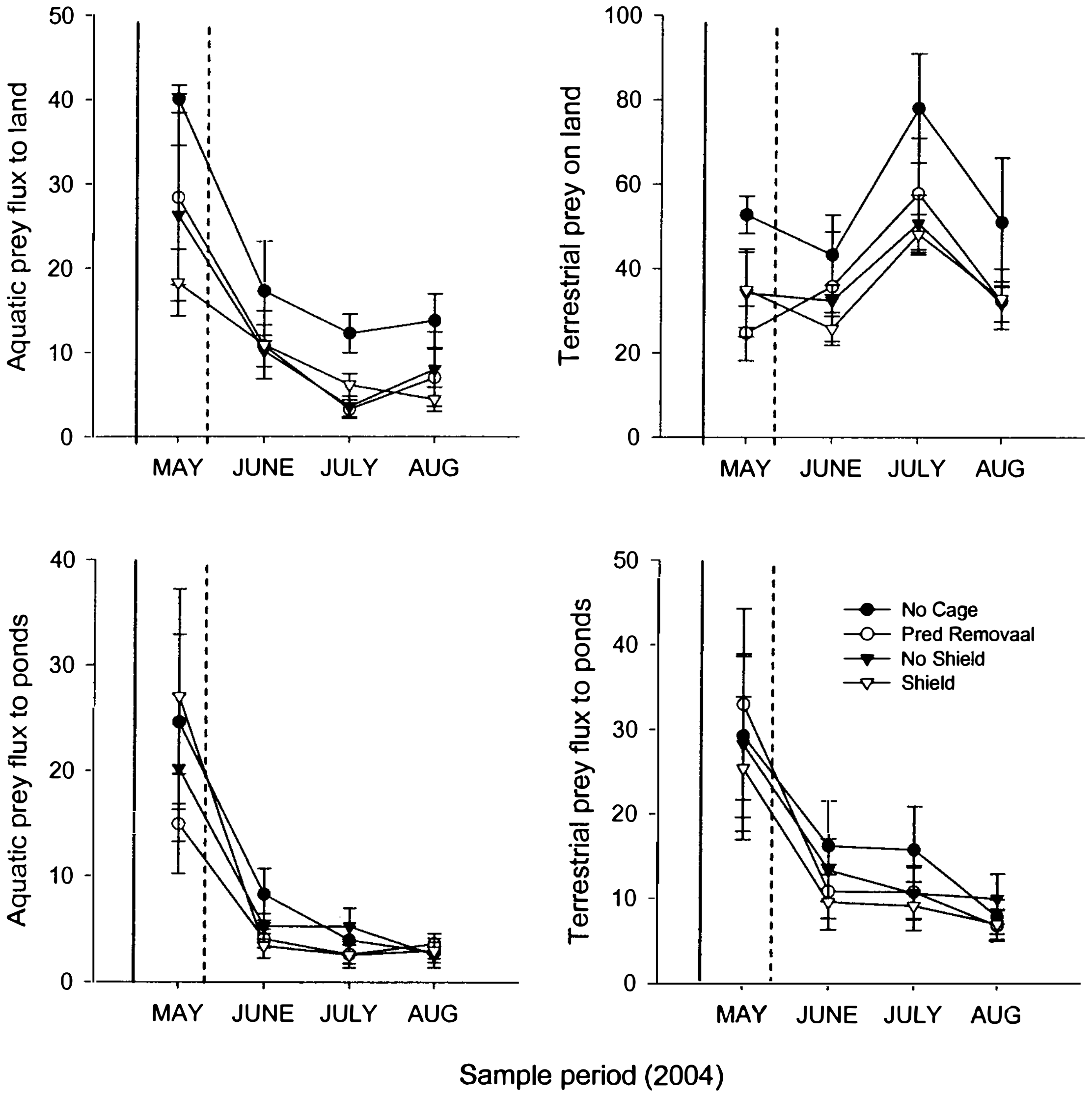

Figure 2. Treatment effects and temporal changes in resource abundance on land and in water. Pan and sticky traps were used to trap arthropods moving from air to pond surface and across the land over two days. Flux is mean counts per 2 days per trap surface. Errors are ± 1 S.E.M. Dashed line indicates when treatments were applied or for isotopes, where isotopes were added. Solid line indicates installation of enclosures.

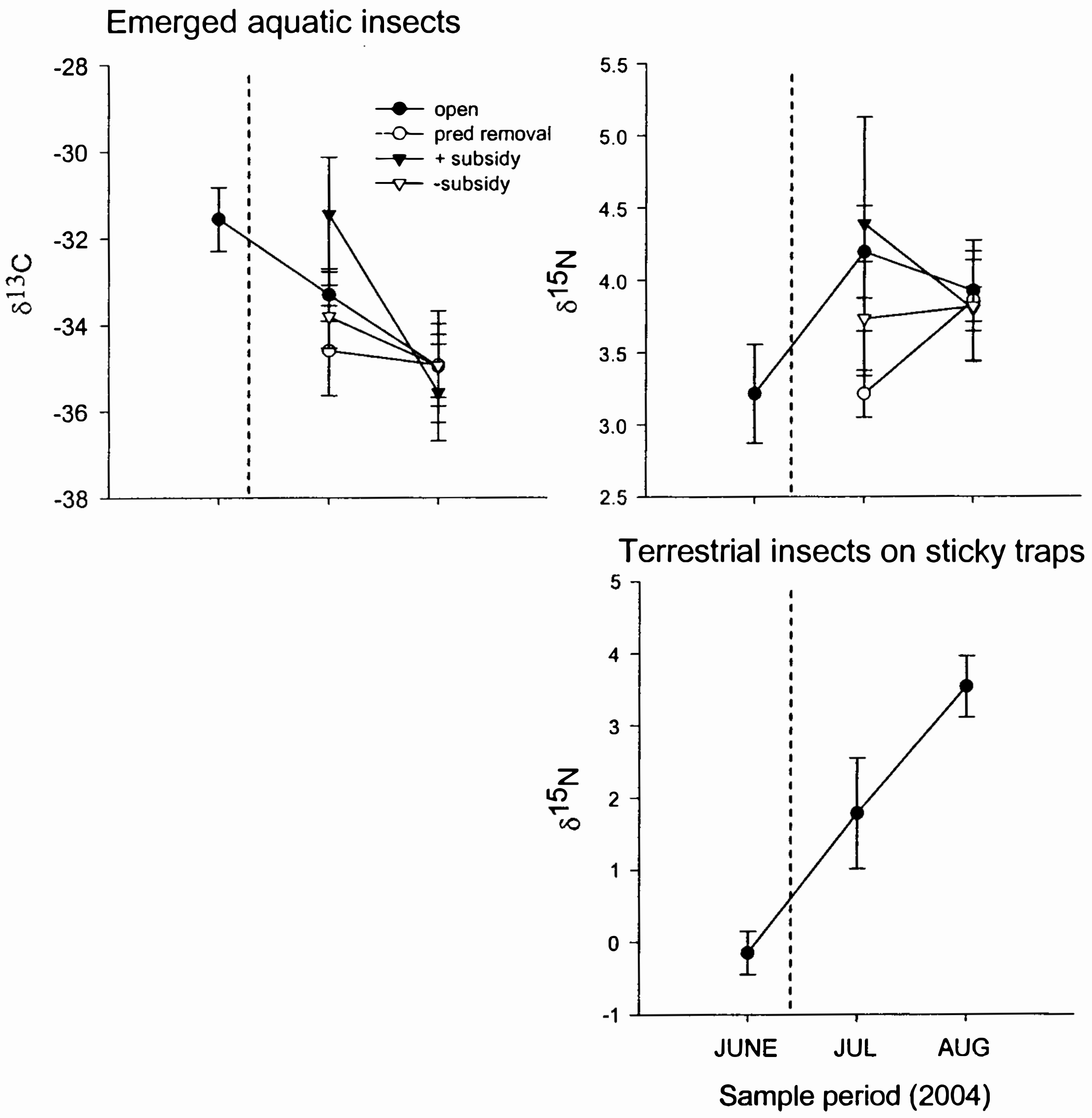

Figure 3. Isotopic signatures of terrestrial and aquatic prey at the edges of the ponds. Aquatic prey are chironomids and mayflies. Terrestrial prey analyzed are homopterans, almost exclusively leaf hoppers (Homptera: Cicadellidae). Treatment effects were examined in July and August. Efficacy of isotopic enrichment was examined between June and July for open treatments only. Dashed line indicates where isotopes were added.

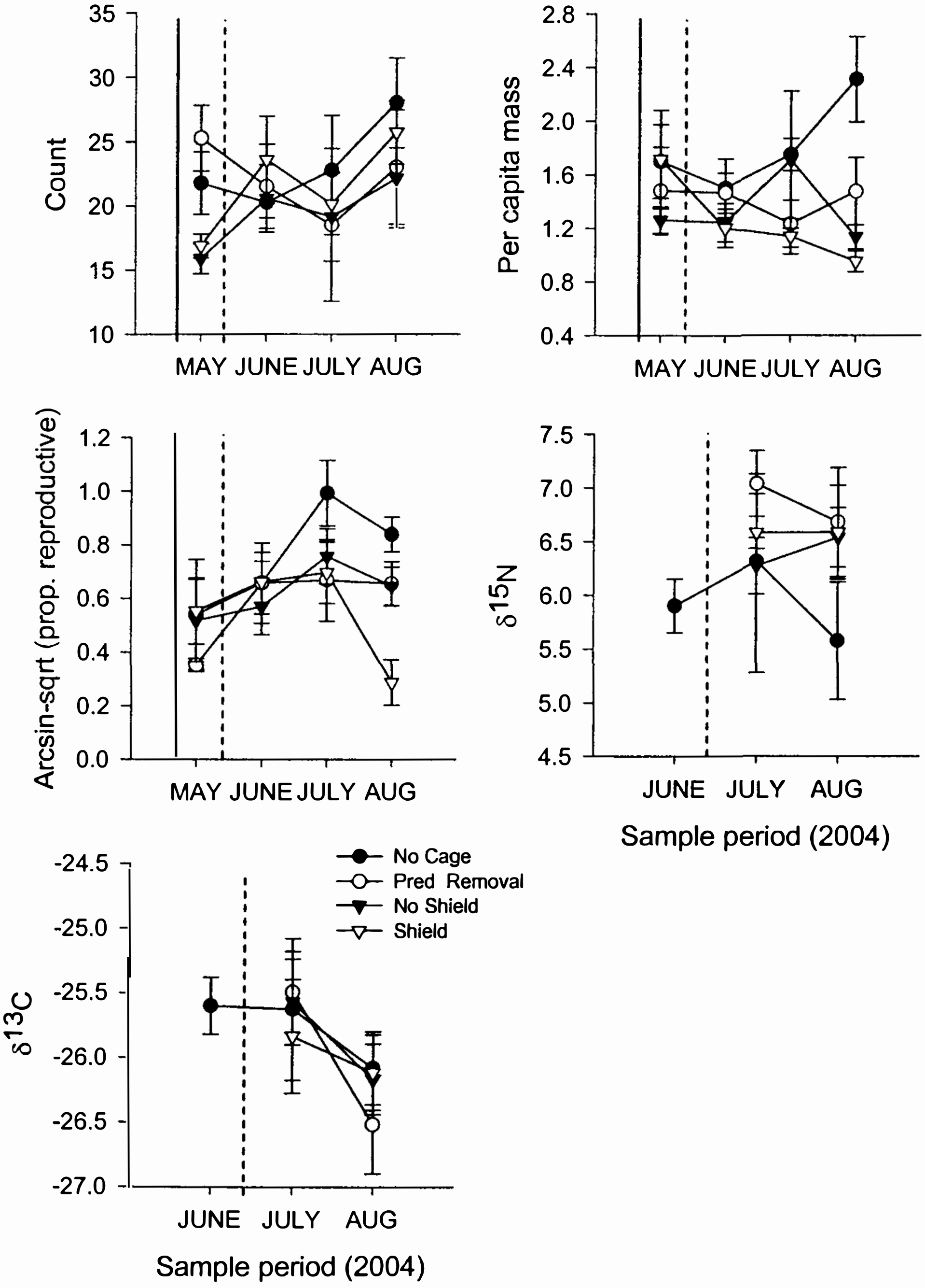

Figure 4. Treatment effects and temporal changes in wolf spider response. Counts are based on number of wolf spiders sampled per 20-minute sampling period and only include individuals captured on the terrestrial side of the enclosure. Per capita mass is the

average per enclosure in mg. Proportion reproductive is the proportion of females captured per enclosure that were carrying spiderlings, an egg case or were gravid. Enclosures with no females were not scored. The $\delta^{13}C$ value is based on signature (‰) of one individual sampled per enclosure. Errors are ± 1 S.E.M. Dashed line indicates when treatments were applied or for isotopes, where isotopes were added. Solid line indicates installation of enclosures.

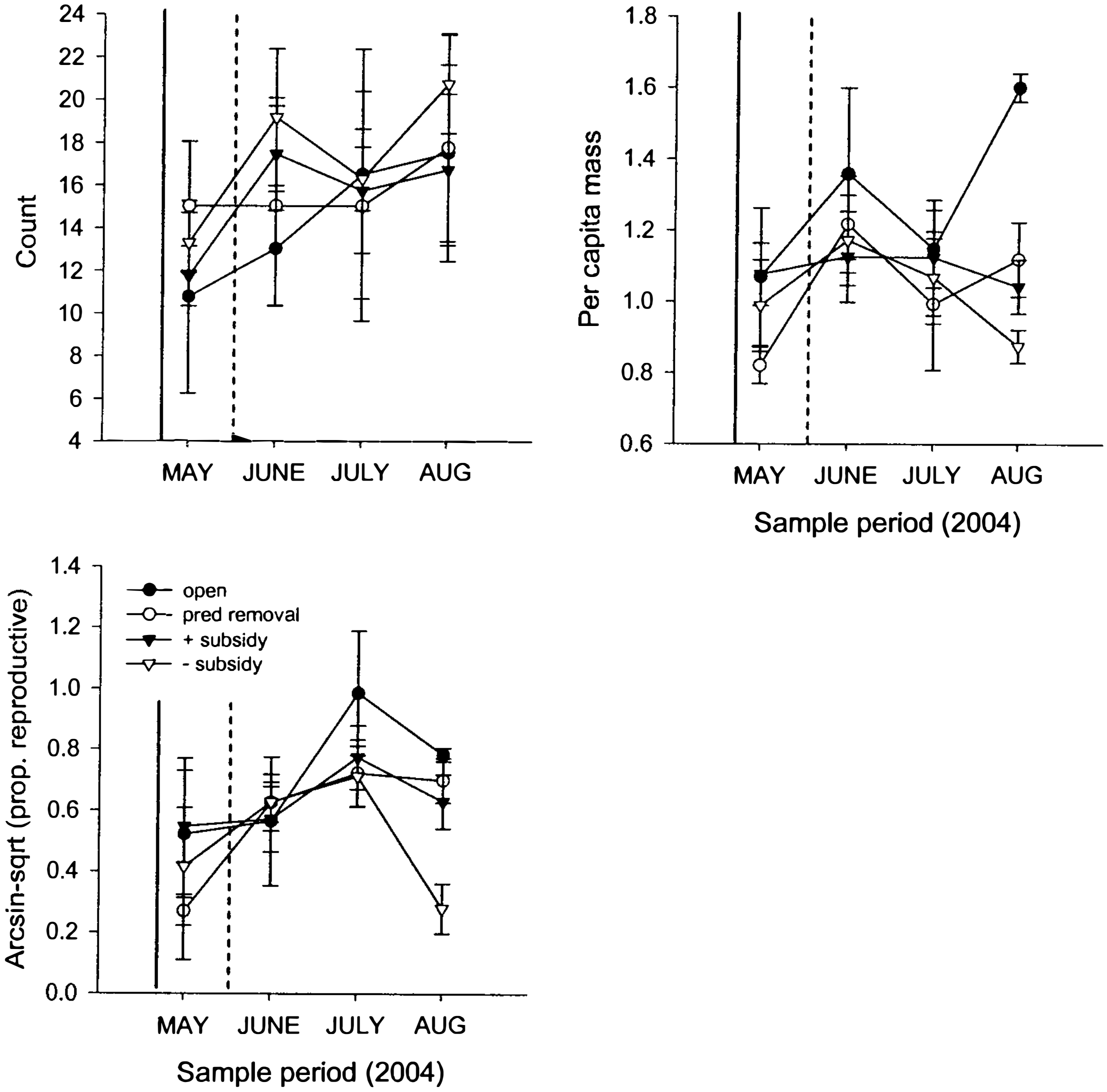

Figure 5. Treatment effects and temporal changes in *Pirata cantralli* response. Counts are based on number of wolf spiders sampled per 20-minute sampling period and only include individuals captured on the terrestrial side of the enclosure. Per capita mass is the average per enclosure in mg. Proportion reproductive is the proportion of females captured per enclosure that were carrying spiderlings, an egg case or were gravid. Enclosures with no females were not scored. Errors are ± 1 S.E.M. Dashed line indicates when treatments were applied. Solid line indicates installation of enclosures.

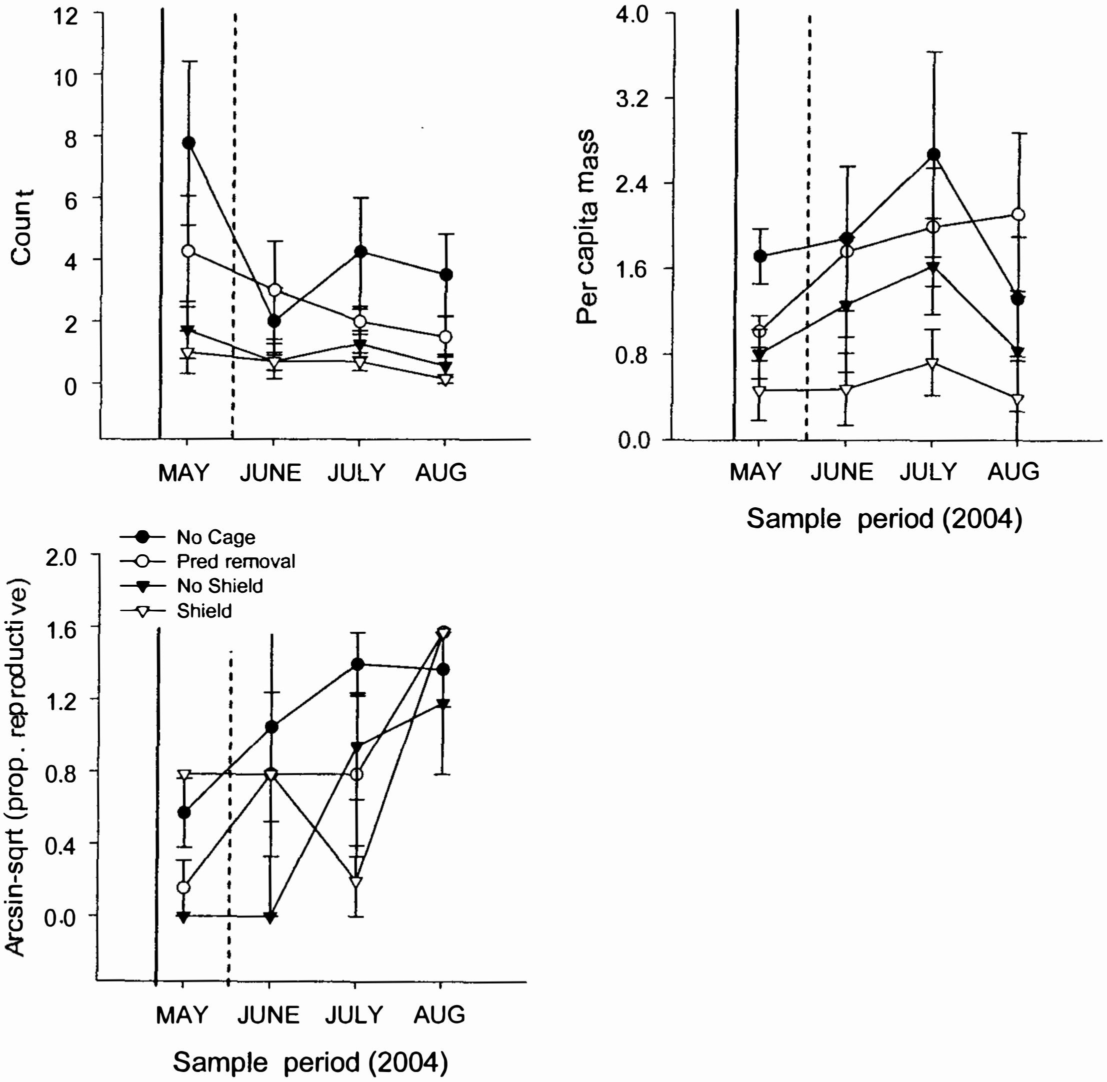

Figure 6. Treatment effects and temporal changes in *Pardosa milvina* response. Counts are based on number of wolf spiders sampled per 20-minute sampling period and only include individuals captured on the terrestrial side of the enclosure. Per capita mass is the average per enclosure in mg. Proportion reproductive is the proportion of females captured per enclosure that were carrying spiderlings, an egg case or were gravid. Enclosures with no females were not scored. Errors are ± 1 S.E.M. Dashed line indicates when treatments were applied. Solid line indicates installation of enclosures.

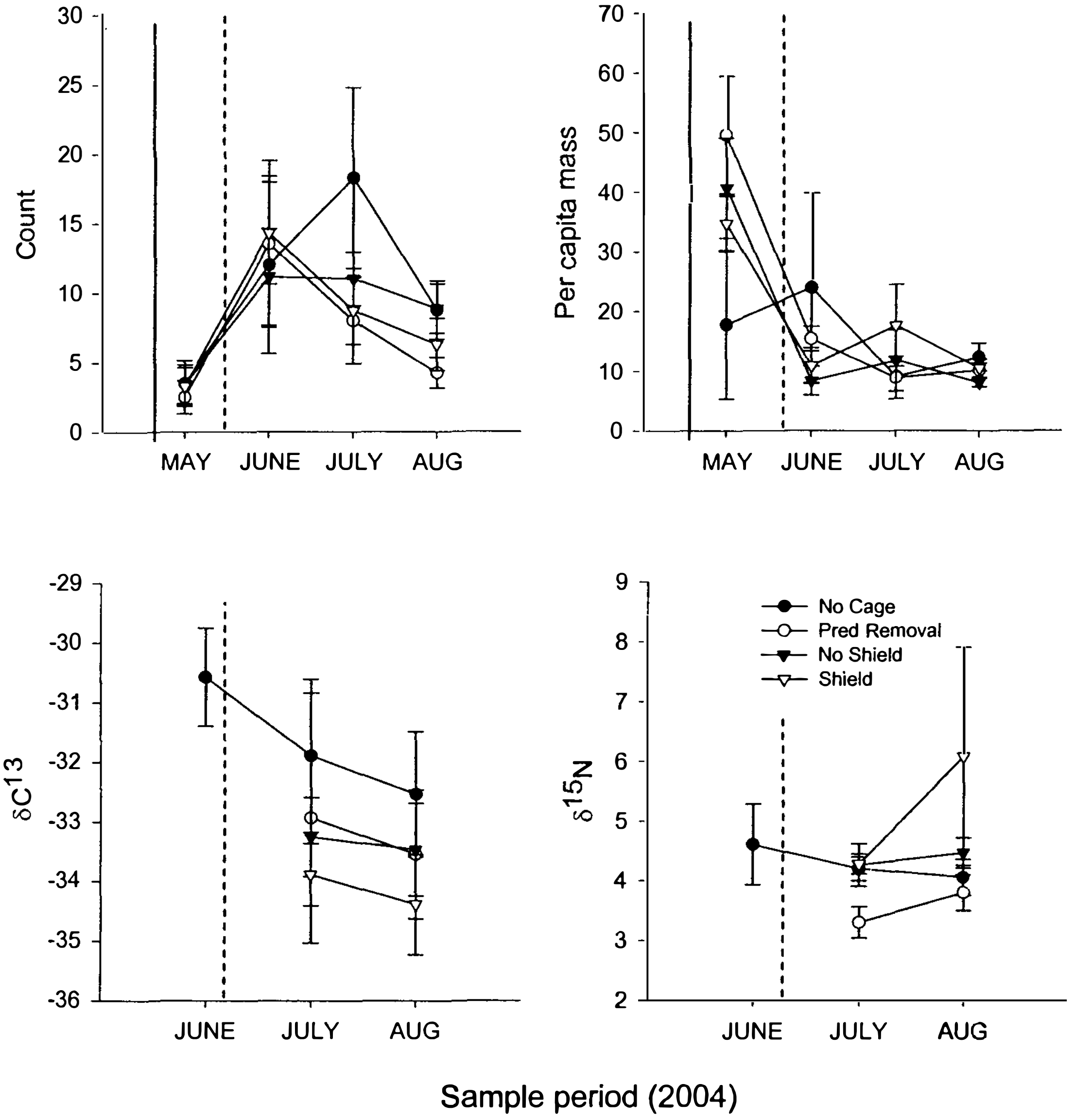

Figure 7. Treatment effects and temporal changes in dragonfly larvae response. Counts are total number of larvae sampled per enclosure using a box sampler. Per capita mass is the average per enclosure in mg. The δ^{13}C value is based on signature (‰) of one individual sampled per enclosure. Errors are ± 1 S.E.M. Dashed line indicates when treatments were applied or for isotopes, where isotopes were added. Solid line indicates installation of enclosures.

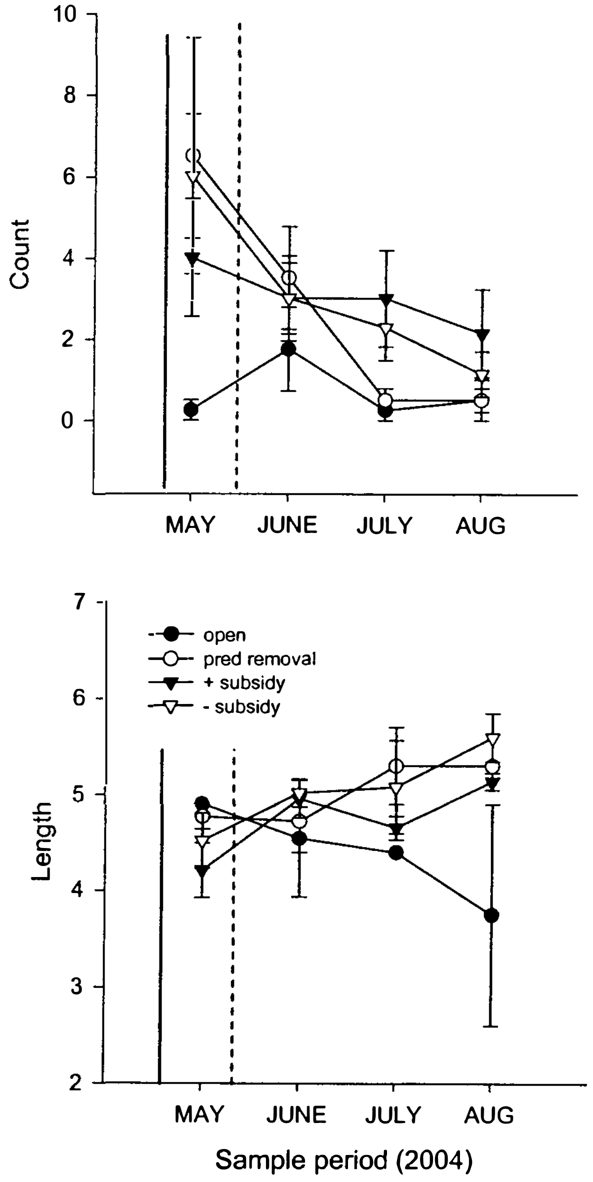

Figure 8. Treatment effects and temporal changes in crayfish response. Counts are total number of crayfish sampled per enclosure using a box sampler. Length is the total body length from tip of head to base of last tail segment. Dashed line indicates when treatments were applied. Solid line indicates installation of enclosures.

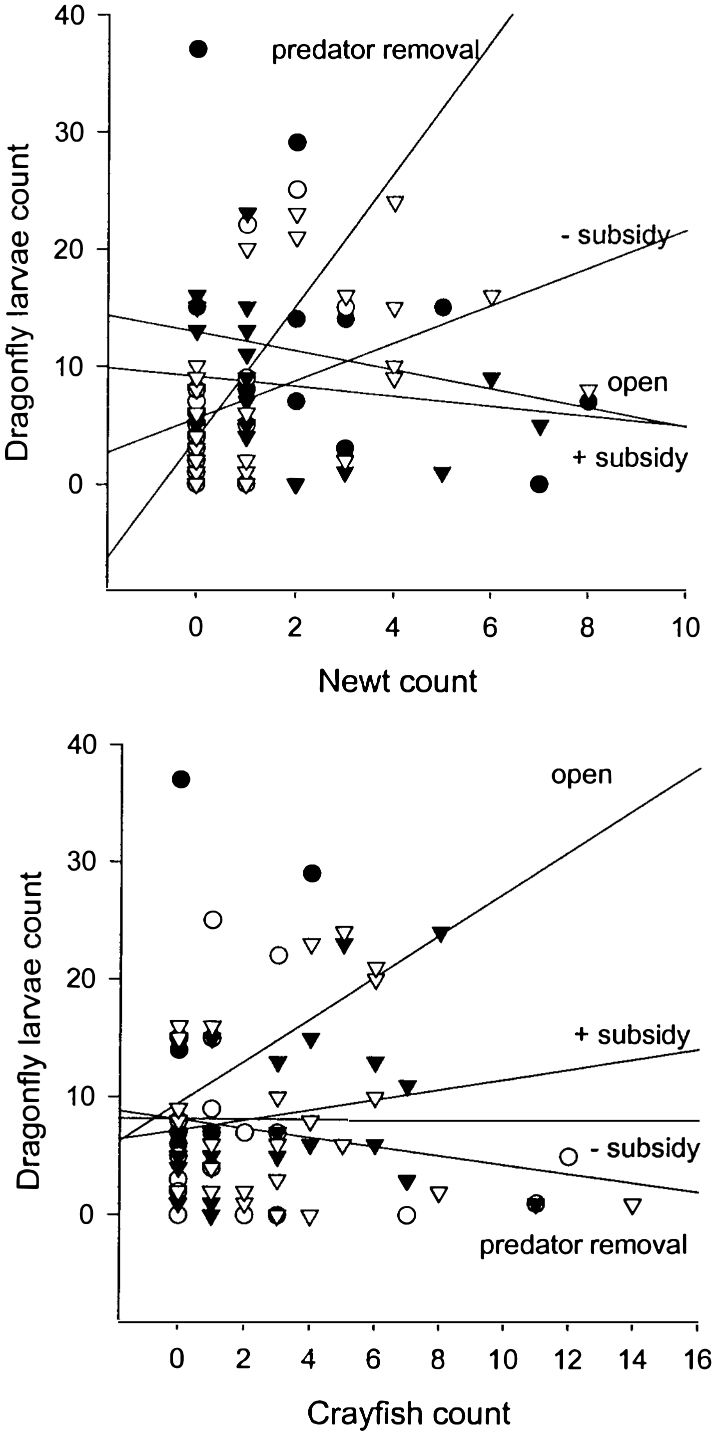

Figure 9. Relationships between counts of dragonfly larvae and crayfish or newts. Regression lines are labeled by treatment.

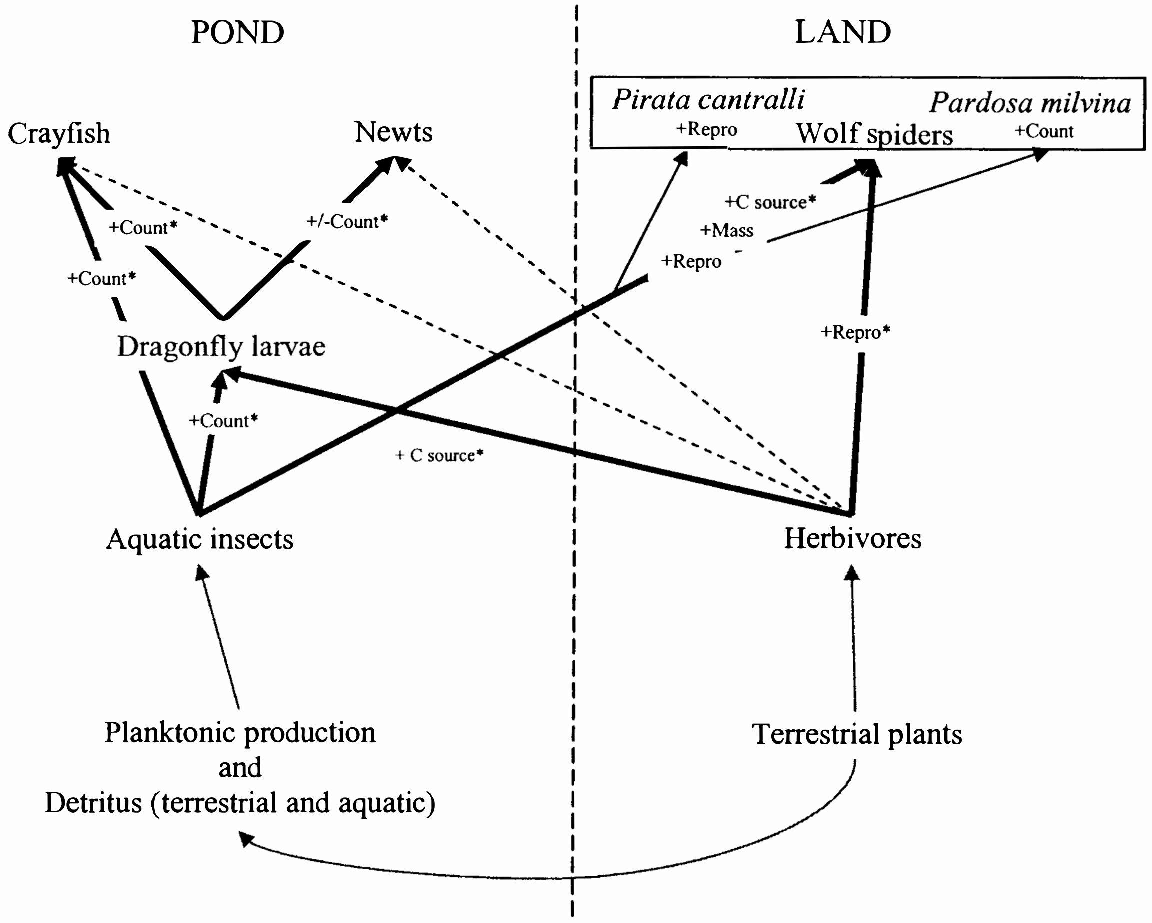

Figure 10. The food web at a pond-forest boundary. Major findings are summarized by arrows in the direction of energy flow. Significant results have an asterisk and heavy black line, others have a thin line and are trends supported by the data. Grey arrows were not examined in this study. Dashed arrows are implied by the significant effect of subsidy on intraguild interactions in the ponds.

Appendix A. 2001 Pitfall trap data for wolf spider and ground beetle counts with respect to pond edge based on species or morpho-species.

DATE	POND	TRAP	DIST	NUM	ORDER	FAMILY	SPECIES
09JUN01	SYL	4	0.1m	1	araneae	lycosidae	lycosidae
13JUN01	SYL	3	0.1	1	araneae	lycosidae	Lycosa spp. (?)
13JUN01	SYL	4	0.1	1	araneae	lycosidae	Pardosa spp. (?)
15JUN01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
15JUN01	SYL	1 top	0.1	1	araneae	lycosidae	lycosidae
15JUN01	SYL	4 top	0.1	1	araneae	lycosidae	Pardosa milvina
15JUN01	SYL	4 top	0.1	1	araneae	lycosidae	Pardosa milvina
17JUN01	SYL	4 top	0.1	1	araneae	lycosidae	Pardosa milvina
18JUN01	SYL	3 top	0.1	1	araneae	lycosidae	Pardosa milvina
19JUN01	SYL	2	0.1	1	araneae	lycosidae	lycosidae
19JUN01	SYL	3	0.1	1	araneae	lycosidae	lycosidae
19JUN01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
21JUN01	SYL	1 top	0.1	1	araneae	lycosidae	lycosidae
21JUN01	SYL	1	0.1	1	araneae	lycosidae	lycosidae
21JUN01	HOR	2	0.1	1	araneae	lycosidae	Pardosa moesta
21JUN01	SYL	3	0.1	1	araneae	lycosidae	Pardosa moesta
21JUN01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
21JUN01	HOR	4	0.1	1	araneae	lycosidae	lycosidae
22JUN01	HOR	2	0.1	1	araneae	lycosidae	lycosidae
22JUN01	SYL	2 top	0.1	1	araneae	lycosidae	lycosidae
25JUN01	HOR	2	0.1	1	araneae	lycosidae	lycosidae
25JUN01	HOR	2	0.1	1	araneae	lycosidae	lycosidae
25JUN01	HOR	2	0.1	1	araneae	lycosidae	lycosidae
25JUN01	HOR	2	0.1	1	araneae	lycosidae	lycosidae
25JUN01	HOR	2	0.1	1	araneae	lycosidae	Pardosa moesta
25JUN01	SYL	3	0.1	1	araneae	lycosidae	lycosidae
25JUN01	SYL	2 top	0.1	1	araneae	lycosidae	lycosidae
03JUL01	HOR	2	0.1	1	araneae	lycosidae	Pardosa moesta
03JUL01	HOR	3	0.1	1	araneae	lycosidae	Pardosa moesta
03JUL01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
03JUL01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
04JUL01	SYL	3	0.1	1	araneae	lycosidae	lycosidae
05JUL01	HOR	3	0.1	1	araneae	lycosidae	Pardosa moesta
06JUL01	HOR	1	0.1	1	araneae	lycosidae	Pardosa moesta
06JUL01	SYL	2	0.1	1	araneae	lycosidae	Pardosa moesta
07JUL01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
08JUL01	HOR	4	0.1	1	araneae	lycosidae	Pardosa moesta
09JUL01	SYL	3	0.1	1	araneae	lycosidae	lycosidae
10JUL01	SYL	2	0.1	1	araneae	lycosidae	lycosidae
10JUL01	SYL	3	0.1	1	araneae	lycosidae	Pardosa moesta
10JUL01	HOR	4	0.1	1	araneae	lycosidae	Pardosa moesta
10JUL01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
10JUL01	HOR	1 top	0.1	1	araneae	lycosidae	lycosidae

11JUL01	SYL	1	0.1	1	araneae	lycosidae	Pardosa moesta
11JUL01	HOR	2	0.1	1	araneae	lycosidae	lycosidae
11JUL01	SYL	4 top	0.1	1	araneae	lycosidae	lycosidae
12JUL01	HOR	3	0.1	1	araneae	lycosidae	Pardosa moesta
12JUL01	SYL	2 top	0.1	1	araneae	lycosidae	lycosidae
14JUL01	SYL	1	0.1	1	araneae	lycosidae	Pardosa moesta
14JUL01	SYL	4	0.1	1	araneae	lycosidae	Pardosa moesta
16JUL01	HOR	2	0.1	1	araneae	lycosidae	Pardosa moesta
16JUL01	SYL	2 top	0.1	1	araneae	lycosidae	lycosidae
16JUL01	SYL	2 top	0.1	1	araneae	lycosidae	Pardosa moesta
17JUL01	SYL	1	0.1	1	araneae	lycosidae	Pardosa moesta
17JUL01	HOR	2	0.1	1	araneae	lycosidae	lycosidae
17JUL01	SYL	2	0.1	1	araneae	lycosidae	Pardosa moesta
17JUL01	SYL	2	0.1	1	araneae	lycosidae	Pardosa moesta
17JUL01	HOR	3 top	0.1	1	araneae	lycosidae	lycosidae
17JUL01	HOR	3 top	0.1	1	araneae	lycosidae	lycosidae
19JUL01	SYL	4	0.1	1	araneae	lycosidae	lycosidae
09JUN01	SYL	13	1	1	araneae	lycosidae	lycosidae
09JUN01	SYL	16	1	1	araneae	lycosidae	lycosidae
15JUN01	SYL	14	1	1	araneae	lycosidae	lycosidae
15JUN01	SYL	16	1	1	araneae	lycosidae	Lycosa spp. 1?
18JUN01	SYL	13	1	1	araneae	lycosidae	Pardosa spp. (?)
18JUN01	SYL	14	1	1	araneae	lycosidae	Pardosa spp. (?)
18JUN01	SYL	16	1	1	araneae	lycosidae	Pardosa spp. (?)
18JUN01	SYL	16	1	1	araneae	lycosidae	Pardosa spp. (?)
19JUN01	SYL	14	1	1	araneae	lycosidae	lycosidae
19JUN01	SYL	15	1	1	araneae	lycosidae	lycosidae
21JUN01	SYL	15	1	1	araneae	lycosidae	Pardosa moesta
22JUN01	SYL	14	1	1	araneae	lycosidae	Pardosa moesta
22JUN01	SYL	14	1	1	araneae	lycosidae	Pardosa moesta
25JUN01	HOR	8	1	1	araneae	lycosidae	Pardosa moesta
25JUN01	HOR	8	1	1	araneae	lycosidae	Pardosa moesta
03JUL01	HOR	6	1	1	araneae	lycosidae	Pardosa moesta
03JUL01	HOR	8	1	1	araneae	lycosidae	Pardosa moesta
03JUL01	SYL	15	1	1	araneae	lycosidae	lycosidae
03JUL01	SYL	16	1	1	araneae	lycosidae	Pardosa moesta
05JUL01	HOR	6	1	1	araneae	lycosidae	Pardosa moesta
05JUL01	HOR	6	1	1	araneae	lycosidae	Pardosa moesta
06JUL01	HOR	5	1	1	araneae	lycosidae	Pardosa moesta
06JUL01	HOR	6	1	1	araneae	lycosidae	Pardosa moesta
06JUL01	SYL	14	1	1	araneae	lycosidae	lycosidae
07JUL01	HOR	6	1	1	araneae	lycosidae	Pardosa moesta
07JUL01	SYL	15	1	1	araneae	lycosidae	lycosidae
08JUL01	HOR	6	1	1	araneae	lycosidae	Pardosa moesta
08JUL01	HOR	7	1	1	araneae	lycosidae	juvenile
08JUL01	SYL	15	1	1	araneae	lycosidae	lycosidae
09JUL01	SYL	16	1	1	araneae	lycosidae	Pardosa moesta
10JUL01	HOR	7	1	1	araneae	lycosidae	Pardosa moesta
10JUL01	SYL	16	1	1	araneae	lycosidae	Pardosa moesta
11JUL01	HOR	7	1	1	araneae	lycosidae	Pardosa moesta

12JUL01	SYL	14	1	1	araneae	lycosidae	Pardosa moesta
14JUL01	SYL	14	1	1	araneae	lycosidae	lycosidae
16JUL01	HOR	7	1	1	araneae	lycosidae	Pardosa moesta
16JUL01	SYL	13	1	1	araneae	lycosidae	lycosidae
17JUL01	HOR	5	1	1	araneae	lycosidae	Pardosa moesta
17JUL01	HOR	7	1	1	araneae	lycosidae	Pardosa moesta
17JUL01	SYL	15	1	1	araneae	lycosidae	lycosidae
19JUL01	SYL	13	1	1	araneae	lycosidae	Pardosa moesta
09JUN01	SYL	6	2	1	araneae	lycosidae	lycosidae
09JUN01	SYL	8	2	1	araneae	lycosidae	lycosidae
18JUN01	SYL	5	2	1	araneae	lycosidae	lycosidae
21JUN01	SYL	7	2	1	araneae	lycosidae	lycosidae
21JUN01	SYL	8	2	1	araneae	lycosidae	Pardosa ?
21JUN01	HOR	9	2	1	araneae	lycosidae	Pardosa moesta
21JUN01	HOR	11	2	1	araneae	lycosidae	Pardosa moesta
22JUN01	HOR	11	2	1	araneae	lycosidae	lycosidae
25JUN01	HOR	10	2	1	araneae	lycosidae	Pardosa moesta
25JUN01	HOR	11	2	1	araneae	lycosidae	pardosa
25JUN01	HOR	11	2	1	araneae	lycosidae	pardosa
25JUN01	HOR	12	2	1	araneae	lycosidae	Pardosa moesta
25JUN01	HOR	12	2	1	araneae	lycosidae	Pardosa moesta
03JUL01	SYL	7	2	1	araneae	lycosidae	lycosidae
05JUL01	SYL	8	2	1	araneae	lycosidae	lycosidae
06JUL01	HOR	12	2	1	araneae	lycosidae	Pardosa moesta
07JUL01	HOR	9	2	1	araneae	lycosidae	Pardosa moesta
07JUL01	HOR	10	2	1	araneae	lycosidae	Pardosa moesta
07JUL01	HOR	11 top	2	1	araneae	lycosidae	Pardosa moesta
07JUL01	SYL	7	2	1	araneae	lycosidae	lycosidae
09JUL01	HOR	9	2	1	araneae	lycosidae	Pardosa moesta
09JUL01	HOR	12	2	1	araneae	lycosidae	Pardosa moesta
09JUL01	HOR	12 top	2	1	araneae	lycosidae	Pardosa moesta
10JUL01	SYL	8	2	1	araneae	lycosidae	Pardosa moesta
10JUL01	HOR	10	2	1	araneae	lycosidae	Pardosa moesta
11JUL01	HOR	11	2	1	araneae	lycosidae	Pardosa moesta
11JUL01	HOR	11	2	1	araneae	lycosidae	lycosidae
14JUL01	HOR	11	2	1	araneae	lycosidae	Pardosa moesta
17JUL01	SYL	7	2	1	araneae	lycosidae	Pardosa moesta
17JUL01	HOR	11	2	1	araneae	lycosidae	Pardosa moesta
09JUN01	SYL	12	4	1	araneae	lycosidae	lycosidae
13JUN01	SYL	10	4	1	araneae	lycosidae	Lycosa spp. 1
13JUN01	SYL	12	4	1	araneae	lycosidae	Lycosa spp. 1
15JUN01	SYL	10	4	1	araneae	lycosidae	Lycosa spp 1
18JUN01	SYL	10	4	1	araneae	lycosidae	lycosidae
21JUN01	HOR	14	4	1	araneae	lycosidae	Pardosa moesta
25JUN01	HOR	14	4	1	araneae	lycosidae	Pardosa moesta
25JUN01	HOR	16	4	1	araneae	lycosidae	Pardosa moesta
25JUN01	HOR	16	4	1	araneae	lycosidae	Pardosa moesta
03JUL01	SYL	11	4	1	araneae	lycosidae	lycosidae
06JUL01	HOR	13	4	1	araneae	lycosidae	lycosidae
06JUL01	HOR	15	4	1	araneae	lycosidae	Pardosa moesta

07JUL01	HOR	16	4	1	araneae	lycosidae	Pardosa moesta
11JUL01	SYL	11	4	1	araneae	lycosidae	Pardosa moesta
14JUL01	SYL	11	4	1	araneae	lycosidae	Pardosa moesta
14JUL01	HOR	15	4	1	araneae	lycosidae	lycosidae
14JUL01	HOR	15 top	4	1	araneae	lycosidae	lycosidae
17JUL01	SYL	11	4	1	araneae	lycosidae	Pardosa moesta
17JUN01	SYL	13	4	1	araneae	lycosidae ?	lycosidae ?
18JUN01	SYL	9	4	1	araneae	lycosidae ?	lycosidae ?
19JUN01	SYL			1	coleoptera	carabidae	Carabus limbatus
13JUN01	SYL	2	0.1	1	coleoptera	carabidae	Platynus spp.
13JUN01	SYL	2	0.1	1	coleoptera	carabidae	csp 11
13JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
14JUN01	SYL	1	0.1	1	coleoptera	carabidae	csp 12
14JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
14JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
15JUN01	SYL	2	0.1	1	coleoptera	carabidae	Platynus spp.
15JUN01	SYL	2	0.1	1	coleoptera	carabidae	Platynus spp.
15JUN01	SYL	2	0.1	1	coleoptera	carabidae	Platynus spp.
15JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
15JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
17JUN01	SYL	1	0.1	1	coleoptera	carabidae	Carabus limbatus
17JUN01	SYL	1	0.1	1	coleoptera	carabidae	csp 12
17JUN01	SYL	1	0.1	1	coleoptera	carabidae	csp 12
17JUN01	SYL	3	0.1	1	coleoptera	carabidae	csp 3
18JUN01	SYL	1	0.1	1	coleoptera	carabidae	Platynus spp.
19JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	SYL	1	0.1	1	coleoptera	carabidae	Dysidius mutus
21JUN01	SYL	1	0.1	1	coleoptera	carabidae	Dysidius mutus
21JUN01	SYL	1	0.1	1	coleoptera	carabidae	Dysidius mutus
21JUN01	HOR	1	0.1	1	coleoptera	carabidae	carabidae
21JUN01	HOR	1	0.1	1	coleoptera	carabidae	Dysidius mutus ?
21JUN01	HOR	2	0.1	1	coleoptera	carabidae	carabidae
21JUN01	HOR	2	0.1	1	coleoptera	carabidae	carabidae
21JUN01	HOR	2	0.1	1	coleoptera	carabidae	carabidae
21JUN01	HOR	2	0.1	1	coleoptera	carabidae	carabidae
21JUN01	HOR	2	0.1	1	coleoptera	carabidae	carabidae
21JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	HOR	3	0.1	1	coleoptera	carabidae	csp 6
21JUN01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
21JUN01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
22JUN01	SYL	1	0.1	1	coleoptera	carabidae	Platynus spp.
22JUN01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
22JUN01	SYL	2	0.1	1	coleoptera	carabidae	Platynus spp.
22JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.

22JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	SYL	1	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	SYL	2	0.1	1	coleoptera	carabidae	carabidae
25JUN01	SYL	2	0.1	1	coleoptera	carabidae	carabidae
25JUN01	SYL	2	0.1	1	coleoptera	carabidae	carabidae
25JUN01	HOR	2	0.1	1	coleoptera	carabidae	csp 6
25JUN01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
25JUN01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
25JUN01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
03JUL01	HOR	1	0.1	1	coleoptera	carabidae	Platynus spp.
03JUL01	HOR	2	0.1	1	coleoptera	carabidae	carabidae
03JUL01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
03JUL01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
03JUL01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
05JUL01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
05JUL01	SYL	4	0.1	1	coleoptera	carabidae	csp 19
06JUL01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
06JUL01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
08JUL01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
09JUL01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
10JUL01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
10JUL01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
11JUL01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
11JUL01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
11JUL01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
11JUL01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
12JUL01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
12JUL01	HOR	3	0.1	1	coleoptera	carabidae	Platynus spp.
12JUL01	HOR	4	0.1	1	coleoptera	carabidae	carabidae
14JUL01	HOR	1	0.1	1	coleoptera	carabidae	Dysidius mutus
14JUL01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
14JUL01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
14JUL01	HOR	2	0.1	1	coleoptera	carabidae	Platynus spp.
16JUL01	SYL	1	0.1	1	coleoptera	carabidae	Platynus spp.
16JUL01	SYL	1	0.1	1	coleoptera	carabidae	Platynus spp.
16JUL01	SYL	1	0.1	1	coleoptera	carabidae	Platynus spp.

16JUL01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
16JUL01	HOR	4	0.1	1	coleoptera	carabidae	Platynus spp.
17JUL01	SYL	1	0.1	1	coleoptera	carabidae	Platynus spp.
17JUL01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
17JUL01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
19JUL01	SYL	3	0.1	1	coleoptera	carabidae	Platynus spp.
19JUL01	SYL	4	0.1	1	coleoptera	carabidae	Dysidius mutus
17JUN01	SYL	14	1	1	coleoptera	carabidae	csp 2
20JUN01	SYL	16	1	1	coleoptera	carabidae	csp 4
21JUN01	HOR	6	1	1	coleoptera	carabidae	csp 2
22JUN01	HOR	5	1	1	coleoptera	carabidae	csp 6
25JUN01	SYL	15	1	1	coleoptera	carabidae	csp 8
03JUL01	HOR	8	1	1	coleoptera	carabidae	carabidae
05JUL01	SYL	16	1	1	coleoptera	carabidae	csp 2
10JUL01	HOR	7	1	1	coleoptera	carabidae	csp 16
10JUL01	SYL	15	1	1	coleoptera	carabidae	csp 20
11JUL01	HOR	7	1	1	coleoptera	carabidae	carabidae
19JUL01	SYL	13	1	1	coleoptera	carabidae	? csp 2
09JUN01	SYL	5	2	1	coleoptera	carabidae	Carabus limbatus
09JUN01	SYL	7	2	1	coleoptera	carabidae	Carabus limbatus
09JUN01	SYL	8	2	1	coleoptera	carabidae	csp 3
13JUN01	SYL	5	2	1	coleoptera	carabidae	Platynus spp.
13JUN01	SYL	7	2	1	coleoptera	carabidae	csp 2
17JUN01	SYL	5	2	1	coleoptera	carabidae	csp 6
17JUN01	SYL	6	2	1	coleoptera	carabidae	csp 6
17JUN01	SYL	8	2	1	coleoptera	carabidae	csp 4
20JUN01	SYL	6	2	1	coleoptera	carabidae	csp 4
20JUN01	SYL	8	2	1	coleoptera	carabidae	csp 2
20JUN01	SYL	8	2	1	coleoptera	carabidae	Dysidius mutus
21JUN01	HOR	9	2	1	coleoptera	carabidae	Dysidius mutus
21JUN01	HOR	9	2	1	coleoptera	carabidae	Dysidius mutus
21JUN01	HOR	9	2	1	coleoptera	carabidae	csp 17
21JUN01	HOR	10	2	1	coleoptera	carabidae	Carabus limbatus
21JUN01	HOR	11	2	1	coleoptera	carabidae	Dysidius mutus
21JUN01	HOR	12	2	1	coleoptera	carabidae	csp 2
25JUN01	SYL	5	2	1	coleoptera	carabidae	Dysidius mutus
25JUN01	SYL	7	2	1	coleoptera	carabidae	carabidae
25JUN01	HOR	9	2	1	coleoptera	carabidae	Dysidius mutus
03JUL01	SYL	5	2	1	coleoptera	carabidae	csp 13
05JUL01	HOR	9	2	1	coleoptera	carabidae	csp 4
06JUL01	HOR	11	2	1	coleoptera	carabidae	csp 17
07JUL01	HOR	10	2	1	coleoptera	carabidae	csp 16
07JUL01	HOR	12	2	1	coleoptera	carabidae	csp 14
08JUL01	HOR	10	2	1	coleoptera	carabidae	csp 16
08JUL01	HOR	10	2	1	coleoptera	carabidae	cap 18
10JUL01	HOR	12	2	1	coleoptera	carabidae	carabidae
11JUL01	HOR	9	2	1	coleoptera	carabidae	Platynus spp.
14JUL01	SYL	6	2	1	coleoptera	carabidae	csp 2
14JUL01	HOR	11	2	1	coleoptera	carabidae	csp 2
14JUL01	HOR	12	2	1	coleoptera	carabidae	Dysidius mutus

14JUL01	HOR	12	2	1	coleoptera	carabidae	csp 2
16JUL01	SYL	7	2	1	coleoptera	carabidae	csp 2
16JUL01	SYL	8	2	1	coleoptera	carabidae	csp 7
16JUL01	HOR	10	2	1	coleoptera	carabidae	csp 2
17JUL01	HOR	9	2	1	coleoptera	carabidae	Dysidius mutus
17JUL01	HOR	11	2	1	coleoptera	carabidae	csp 2
19JUL01	SYL	5	2	1	coleoptera	carabidae	csp 16
09JUN01	SYL	9	4	2	coleoptera	carabidae	Carabus limbatus
09JUN01	SYL	9	4	1	coleoptera	carabidae	csp 2
09JUN01	SYL	10	4	1	coleoptera	carabidae	csp 3
09JUN01	SYL	11	4	1	coleoptera	carabidae	csp 4
13JUN01	SYL	9	4	2	coleoptera	carabidae	Platynus spp.
13JUN01	SYL	9	4	1	coleoptera	carabidae	?
13JUN01	SYL	10	4	1	coleoptera	carabidae	csp 8
13JUN01	SYL	10	4	1	coleoptera	carabidae	?
13JUN01	SYL	12	4	1	coleoptera	carabidae	csp 10
13JUN01	SYL	12	4	1	coleoptera	carabidae	csp 20
13JUN01	SYL	12	4	1	coleoptera	carabidae	csp 10
14JUN01	SYL	9	4	1	coleoptera	carabidae	csp 4
14JUN01	SYL	12	4	1	coleoptera	carabidae	csp 7
14JUN01	SYL	12	4	1	coleoptera	carabidae	csp 7
14JUN01	SYL	12	4	1	coleoptera	carabidae	csp 2
14JUN01	SYL	12	4	1	coleoptera	carabidae	?
15JUN01	SYL	9	4	1	coleoptera	carabidae	Dysidius mutus
15JUN01	SYL	12	4	1	coleoptera	carabidae	Carabus limbatus
15JUN01	SYL	12	4	1	coleoptera	carabidae	csp 2
15JUN01	SYL	12	4	1	coleoptera	carabidae	csp 8
17JUN01	SYL	9	4	1	coleoptera	carabidae	Carabus limbatus
17JUN01	SYL	9	4	1	coleoptera	carabidae	Anisodactylus ?
17JUN01	SYL	9	4	1	coleoptera	carabidae	Anisodactylus ?
17JUN01	SYL	10	4	1	coleoptera	carabidae	csp 13
17JUN01	SYL	10	4	1	coleoptera	carabidae	csp 13
17JUN01	SYL	12	4	1	coleoptera	carabidae	Dysidius mutus
18JUN01	SYL	10	4	1	coleoptera	carabidae	csp 8
18JUN01	SYL	11	4	1	coleoptera	carabidae	csp 4
18JUN01	SYL	12	4	1	coleoptera	carabidae	Dysidius mutus
19JUN01	SYL	9	4	1	coleoptera	carabidae	Dysidius mutus
19JUN01	SYL	11	4	1	coleoptera	carabidae	csp 2
20JUN01	SYL	12	4	1	coleoptera	carabidae	csp 2
21JUN01	HOR	13	4	1	coleoptera	carabidae	carabidae
21JUN01	HOR	15	4	1	coleoptera	carabidae	Carabus limbatus
21JUN01	HOR	15	4	1	coleoptera	carabidae	csp 18
22JUN01	HOR	13	4	1	coleoptera	carabidae	Carabus limbatus
25JUN01	SYL	9	4	1	coleoptera	carabidae	csp 13
25JUN01	SYL	12	4	1	coleoptera	carabidae	Dysidius mutus
25JUN01	SYL	12	4	1	coleoptera	carabidae	Dysidius mutus
25JUN01	HOR	13	4	1	coleoptera	carabidae	csp 2
25JUN01	HOR	13	4	1	coleoptera	carabidae	csp 2
25JUN01	HOR	13	4	1	coleoptera	carabidae	Dysidius mutus
25JUN01	HOR	14	4	1	coleoptera	carabidae	Carabus limbatus

25JUN01	HOR	14	4	1	coleoptera	carabidae	csp 15
03JUL01	SYL	9	4	1	coleoptera	carabidae	Carabus limbatus
03JUL01	SYL	11	4	1	coleoptera	carabidae	csp 13
03JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
03JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
03JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
03JUL01	SYL	12	4	1	coleoptera	carabidae	Dysidius mutus
03JUL01	HOR	14	4	1	coleoptera	carabidae	Carabus limbatus3
03JUL01	HOR	15	4	1	coleoptera	carabidae	csp 18
03JUL01	HOR	15	4	1	coleoptera	carabidae	csp 18
04JUL01	SYL	10	4	1	coleoptera	carabidae	csp 2
05JUL01	SYL	10	4	1	coleoptera	carabidae	csp 2
05JUL01	SYL	11	4	1	coleoptera	carabidae	carabidae
05JUL01	HOR	14	4	1	coleoptera	carabidae	Carabus limbatus
06JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
06JUL01	HOR	16	4	1	coleoptera	carabidae	Carabus limbatus
07JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
07JUL01	HOR	15	4	1	coleoptera	carabidae	csp 18
08JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
08JUL01	HOR	15	4	1	coleoptera	carabidae	carabidae
09JUL01	SYL	10	4	1	coleoptera	carabidae	Carabus limbatus
09JUL01	HOR	16	4	1	coleoptera	carabidae	Dysidius mutus
10JUL01	HOR	13	4	1	coleoptera	carabidae	Dysidius mutus
11JUL01	HOR	13	4	1	coleoptera	carabidae	Dysidius mutus
11JUL01	HOR	14	4	1	coleoptera	carabidae	Dysidius mutus
11JUL01	HOR	14	4	1	coleoptera	carabidae	csp 2
12JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
12JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
12JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
14JUL01	HOR	16	4	1	coleoptera	carabidae	csp 2
16JUL01	SYL	11	4	1	coleoptera	carabidae	csp 2
16JUL01	SYL	11	4	1	coleoptera	carabidae	carabidae
16JUL01	HOR	14	4	1	coleoptera	carabidae	csp 2
17JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2 ?
17JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
17JUL01	SYL	12	4	1	coleoptera	carabidae	csp 2
17JUL01	HOR	15	4	1	coleoptera	carabidae	csp 2
17JUL01	HOR	16	4	1	coleoptera	carabidae	csp 2
19JUL01	HOR	13	4	1	coleoptera	carabidae	Carabus limbatus
19JUL01	HOR	13	4	1	coleoptera	carabidae	Dysidius mutus

Appendix B. 2002 data on emerging aquatic insects and aquatic insects stuck to sticky traps at 10 cm from the pond edge. These data are limited to individuals who are larger than the smallest individual captured in the emergence trap. POND-TRAN is the pond and transect at which the aquatic insects were captured. DATE is the date the traps were collected. Each trap was set for 48 hours. AQ = aquatic insect, ST = sticky trap, EM= emergence trap, CH = Chironomidae. AQ ST is the number of aquatic insects captured on sticky traps at 10 cm from the pond edge. AQ EM is the total number of aquatic insects captured along the adjacent transect in the water (total of 3 traps). CH > 1.8mm is chironomids greater than 1.8 mm long (the smallest chironomid captured in the emergence traps). CH 1-1.5mm are chironomids and ceratopogonids that are 1-1.5mm long.

POND - TRAN	**DATE**	**AQ ST**	**AQ EM**	**CH EM**	**CH >1.8mm ST**	**CH 1-1.5mm ST**
HORT1	a6/13/02	10	39	35	0	4
HORT3	b6/20/02	10	9	9	0	6
HORT6	g7/25/02	13	23	23	0	10
SYL5	c6/27/02	5	8	1	0	3
SYL6	d7/04/02	5	2	1	0	5
SYL5	d7/04/02	4	8	4	1	1
HORT4	c6/27/02	25	7	6	2	13
HORT4	g7/25/02	15	9	9	2	12
HORT4	d7/04/02	23	10	10	3	15
SYL1	c6/27/02	9	5	1	3	3
SYL3	a6/13/02	15	5	1	3	6
HORT3	c6/27/02	51	3	3	4	17
HORT6	a6/13/02	21	0	0	4	11
HORT5	b6/20/02	24	13	12	5	13
SYL1	a6/13/02	20	3	1	5	7
HORT6	b6/20/02	16	2	1	7	8
SYL5	a6/13/02	21	7	3	7	8
SYL1	b6/20/02	11	3	1		
HORT1	b6/20/02	11	27	25		
HORT1	c6/27/02	25	21	19		
HORT1	d7/04/02	7	28	28		
HORT1	g7/25/02	7	26	24		
HORT2	a6/13/02	14	11	11		
HORT2	b6/20/02	12	2	2		
HORT2	c6/27/02	13	13	9		

HORT2	d7/04/02	9	15	15
HORT2	g7/25/02	5	9	9
HORT3	a6/13/02	8	20	16
HORT3	d7/04/02	11	12	11
HORT3	g7/25/02	9	11	11
HORT4	a6/13/02	25	3	3
HORT4	b6/20/02	31	8	8
HORT5	a6/13/02	24	34	34
HORT5	c6/27/02	27	15	14
HORT5	d7/04/02	12	7	6
HORT5	g7/25/02	8	24	24
HORT6	c6/27/02	0	27	26
HORT6	d7/04/02	14	19	17
SYL1	d7/04/02	6	4	1
SYL1	g7/25/02	9	2	0
SYL2	a6/13/02	11	3	2
SYL2	b6/20/02	8	4	2
SYL2	c6/27/02	6	13	12
SYL2	d7/04/02	4	6	5
SYL2	g7/25/02	3	35	33
SYL3	b6/20/02	6	3	3
SYL3	c6/27/02	13	3	0
SYL3	d7/04/02	8	3	0
SYL3	g7/25/02	4	20	18
SYL4	a6/13/02	6	7	5
SYL4	b6/20/02	9	5	4
SYL4	c6/27/02	10	3	0
SYL4	d7/04/02	2	4	2
SYL4	g7/25/02	13	8	6
SYL5	b6/20/02	17	4	3
SYL5	g7/25/02	3	9	8
SYL6	a6/13/02	9	6	5
SYL6	b6/20/02	12	4	3
SYL6	c6/27/02	18	10	5
SYL6	g7/25/02	3	8	7

Appendix C. i. Manuscript "Wolf spider (Araneae: Lycosidae) movement along a pond edge" by L. Ahrens and J. M. Kraus submitted to the Journal of Arachnology (December 2005) examining movement of wolf spiders living near pond edge. ii. Wolf spiders captured at Horton and Sylvatica in 2004 at transects erected by L. Ahrens to examine the distribution of wolf spiders and their aquatic and terrestrial prey up to 17-m from the pond edges.

i. Wolf spider (Araneae: Lycosidae) movement along a pond edge

ABSTRACT. Movement of organisms plays an important role in population and predator-prey dynamics. Wolf spiders (Araneae: Lycosidae) are important predators at freshwater-forest ecotones where their distribution may be determined by their ability to respond to moisture and prey levels. The purpose of this study was to examine the movement of wolf spiders along a pond-forest boundary at Mountain Lake Biological Station, VA. We performed two mark-recapture studies at two temporal and spatial scales (4 hours to 20 days and 1 meter to about 20 meters, respectively) to determine the probability of movement by the spiders. The mark-recapture studies showed the spiders moved very little over the temporal and spatial scale used: 0-54% per day chance of moving to the adjacent 1-m^2 plot around the pond and 0-2% per day chance of moving to the adjacent 1-m^2 plot to and from the pond. This finding is in contrast to other studies that have shown wolf spiders to completely exit a 900-m2 quadrant within several days. We discuss possible causes of this low mobility and its implications for wolf spider distribution and abundance at the pond edge.

Keywords: Lycosidae, movement, mark-recapture, freshwater ecotone

INTRODUCTION

Individual choices about movement have population level consequences (Kareiva 1990). Animals move to find favorable physical conditions, food and mates and to avoid predation (Jones 1977, Henschel 2002, Ramos et al. 2004). Both empirical and theoretical studies have long recognized that the strength of an abiotic or biotic factor's influence on the distribution of an organism is greatly influenced by the scale over which that organism moves (Cain 1985, Hanski 1998, Weins 2001). Understanding the ability and propensity for individuals to move is, therefore, a prerequisite for predicting the response of a species to changing resources and physiological conditions (Morse 2000, DeVito et al. 2004).

Habitat boundaries are common in nature. These boundaries or interfaces offer a large amount of variation in biotic and abiotic factors. At the freshwater-terrestrial interface, moisture and food have been shown to vary and may influence the distribution of various consumers (spiders, Graham et al. 2003, Power et al. 2004; beetles, Hering & Platcher 1997; birds, Murakami & Nakano 2002). For example, numerical response has been observed in lizard populations near a river's edge when the inputs of aquatic insect prey are experimentally reduced (Sabo and Power 2002). At a freshwater pond edge, moisture had a positive association with 3 of the 4 spider species measured (Graham et al. 2003). Information about movement gives insight into the relative importance of these factors in driving the abundance and distribution of consumers at freshwater-terrestrial interfaces.

Spiders are found in high densities in most terrestrial habitats (Moulder & Reichle 1972), and many live near aquatic-terrestrial interfaces (Norgaard 1951, Kato et al. 2003, Kraus & Morse 2005). At this interface moisture and desiccation tolerance are important factors influencing wolf spider distribution (DeVito & Formanowicz 2003, Graham et al. 2003). Some wolf spiders, including a couple in the genus *Pirata*, which are found in our study area, can walk and therefore hunt on water as easily as on land (Foelix 1996).

Aquatic insects can also influence the distribution of wolf spiders near the water's edge (Henschel et al. 2001, Power et al. 2004, Kraus, *unpublished*). The life history and physiological constraints of the spider, however, strongly affect its ability to respond to changes in prey availability (DeVito et al. 2004, Power et al. 2004).

The purpose of this study was to monitor the movement wolf spiders (Araneae: Lycosidae) in the area surrounding two small ponds in the southern Appalachians to determine the scale of their response to changes in the biotic and abiotic environment. We used mark-recapture to track cohorts 1-3m from and 1-20m around the pond perimeter. We hypothesized that the spiders would move laterally around the pond, but not much away from or towards the pond due to their close association with water.

METHODS

Study site and sampling design.--- The study was conducted around two ponds at the Mountain Lake Biological Station in the Allegheny Mountains of southwestern Virginia (elev. 1,160 m). The two shallow ponds in our study site, Sylvatica (70 meter perimeter) and Horton (40 meter perimeter), are fishless. The edge of the pond is fairly well defined. There is a grassy area directly surrounding the pond and beyond that is forest, with mainly oaks (*Quercus alba, Q. rubra*) and pines (*Pinus rigida*). The common wolf spider species found at these study sites include *Pirata cantralli* Wallace & Exline

1978, *Pirata montanus* Emerton 1885, *Pirata sedentarius* Montgomery 1904, *Pardosa milvina* Hentz 1844 and *Pardosa moesta* Banks 1892. Voucher specimen have been deposited at the Smithsonian National Museum of Natural History, Washington, D.C., U.S.A. *Pirata cantralli* and *sedentarius* both appear to be water specialists (this study, DeVito & Formanowicz 2003), while *Pardosa milvina* inhabits open habitats (Marshall et al. 2000) and *Pardosa moesta* has more general affinities including forested and wet areas (Buddle 2000). *Pirata montanus* lives in leaf litter (Pearce et al. 2004), and in this study was constrained to one area of the pond where the slope aspect was steep and trees and shrubs grew closer than 3 m from the water's edge. Wolf spiders prey on flies and other small invertebrates in the riparian zone including aquatic insects that emerge onto land (Henschel et al. 2001).

We performed an initial mark-recapture analysis to find the approximate detection probability. In each of two 1m^2 plots, LA visually searched for wolf spiders for 20 minutes, marked, released and waited one hour before searching again. We found a 15% detection probability in one plot and 26% in the other. While this was low, it is comparable to the recapture rate found by Kiss and Samu (2000; 5-19% recapture rate), and is high enough to estimate movement probability with sufficient accuracy. To test that the plot remained a closed system during the one hour before recapture, LA visually monitored three spiders (one female with egg sac, one adult male, and one juvenile) for half an hour and found that each moved 8 cm or less.

We estimated movement rates of wolf spider cohorts using two randomly placed grids that were comprised of nine plots located around Sylvatica Pond. "Dispersed Grid" (L1-L3 on Figure 1, begun 14 June 2004), at the northeast side of the pond, had the nine plots split into three separate sections. Each section consisted of three 1 x 3-m plots located adjacent and parallel to the pond edge. Each plot was between 8 m and 11 m apart. They were equidistant from existing structures from another study (J.M. Kraus, *unpublished*). "Adjacent Grid" (L4 on Fig. 1, begun 28 July 2004), on the northwest side of Sylvatica Pond, consisted of nine adjacent 1 x 1-m plots, set in a square formation. The Adjacent Grid mark-recapture was done after the entire mark-recapture study for Dispersed Grid was completed. Dispersed Grid had very little movement of spiders, so we decided to arrange the Adjacent Grid plots in a close adjacent pattern to determine if there was movement at that scale.

We used Pollock's (1982) Robust mark-recapture sampling design with three primary sampling periods (for Dispersed Grid: day 1, 5 and 25; for Adjacent Grid: day 1, 4 and 8), each containing two secondary sampling periods (morning and afternoon of each primary sample date), to estimate movement probability while taking into account variation in detection probability at different samples times. Due to the abundance of spiders in the study area and the difficulty in uniquely marking individuals of such small size (< 1cm in length), we performed our study on spatial cohorts of animals, which limited the number of colored marks to 5 per animal. In the morning of day one of sampling for Dispersed Grid we visually searched each of the nine sections for 20 minutes, collecting as many wolf spiders as possible. Spiders from each section were marked with a different color of non-toxic Testers© paint on their abdomen so we were able to estimate cohort movement rates. The spot was made with the blunt end of a dissecting needle so it would be small enough to not impede their movement or increase predation on the spider. We have some evidence that we were fairly successful achieving these objectives although survival rates increased by about 10% after the first primary period, indicating some mortality may have been caused by the marking process (see Results). The spiders were released around 12 noon. That afternoon the plots were searched again, 20 minutes in each section. These spiders were recorded, marked a different color and released. We repeated the procedure on day five and day twenty-five. Each spider received a maximum of five spots, with each sampling period and section having a different color. For Adjacent Grid, we used the same Pollock's Robust design but LA searched alone for 10 minutes instead of 20 in each plot, because of the smaller size of the plots and the relatively good capture probability (12-74%).

Data analyses. --- Mark-recapture data were analyzed using the program Mark (White and Burnham 1999). Due to small sample movement rates among plots, which disallowed individual estimates of movements between each plot, each grid was condensed laterally such that vertical (away from and towards the ponds) movement rates of spiders could be estimated and condensed vertically such that lateral (around the perimeter of the ponds) movement rates of spiders could be estimated (Fig. 2). We used the Multistrata recapture setting in Mark, because on a few occasions there was movement within a primary period, which violates an assumption of Pollocks Robust design. All analyses are therefore performed within the Multistrata framework; the language used to describe sampling intervals in the results section reflects this switch. Species are not analysed separately, since the majority of spiders marked appeared to be *Pirata cantralli*. Evidence from a census conducted simulatenously with the current study indicate this observation is true, since within 4.5 m of the pond 64% of 100 individuals sampled along random transects were *Pirata cantralli*, 18% were *Pirata* *sedentarius*, 9% were *Pirata montanus* and 9% were *Pardosa milvina* (J. M. Kraus and L. Ahrens, *unpublished data*). Survival (*s*) is the probability of survival from one recapture event to the next, capture probability (*p*) is the probability of capturing an individual given that the individual is in the plot and transition probability (ψ) is the probability of moving from one sample plot to the next. The variable "*t*" refers to the time between recapture events in days and "*d*" refers to the linear distance in meters between sample plots.

Our most fully specified model, $p(.)s(.)$, made the simplifying assumption that survival and recapture probabilities would be constant across short sampling intervals (S2 and C2) and across long sampling intervals (S1 and C1) within each grid type (dispersed vs. adjacent, see above). We predicted that these assumptions would be valid if 1. movements were small and 2. if survival was similar over the month of sampling. We did not expect movements of all species to be small based on another movement study (Kiss and Samu 2000). However, data on dessication rates did suggest that *Pirata* species might be constrained to living near the pond edge (Devito et al. 2004), which could limit movement. It seemed probable that survival would be similar over the study since the number of reproductive adults at this site are still increasing in numbers at this point in the season (J.M. Kraus, *unpublished*).

From that model we made four additional models, which constrained movement probabilities in different ways. We varied the parameters in this way to determine the role time and distance played in modeling spider movement. We predicted that distance and time would play a role, but only if movement were limited. First, we constrained movement to be constant by both time and distance, $p(.)s(.)\psi(.)$, essentially saying that the distance between plots did not make a difference to the probability that a spider would move that distance and that the length of time a spider had to move did not affect the probability it would move.

The second model constrained movement to be constant by distance but not time, $p(.)s(.)\psi(., t)$, so the probability of movement between the longer distances was constrained to be the same as the probability of movement between shorter distances, but the probability of movement was different for shorter periods of time (3 hrs) than longer periods of time (5 or 25 days). In the third model movement was constrained to be constant by time, but not distance, $p(.)s(.)\psi(d, .)$, meaning that the length of time a spider had to move did not affect the probability it would move, but the distance a spider had to move did affect the probability that it would move that distance. In the fourth model movement was not constrained by time nor distance: the probability of moving was allowed to be different for long versus short distances and long versus short sampling intervals, $p(.)s(.)\psi(d, t)$.

We tested the assumption that capture probabilities were constant between sampling periods (i.e. not time variable) with a final model that constrained movement and survival, but not capture probability, $p(t)s(.)\psi(.)$. These models were each applied to the four sets of condensed data (Dispersed Grid vertically condensed, Dispersed Grid laterally condensed, Adjacent Grid vertically condensed, and Adjacent Grid laterally condensed), and then we used Akaike's Information Criterion corrected for small sample size (AICc) to choose the best-fit model.

RESULTS

A total number of 499 spiders with 105 different capture histories were found and marked in Dispersed Grid. When the data were condensed laterally the number of different capture histories observed decreased to 70 and when condensed vertically it decreased to 62. Adjacent Grid had 147 spiders with 74 capture histories. The laterally condensed data for Adjacent Grid had 62 different capture histories and the vertically condensed data had 43.

The four data sets had different best-fit models. For Dispersed Grid examining movement around the pond (condensed vertically), the best model was "Ψs constrained". This showed the probability of movement to be 0 m per day and high average survival probabilities (survival probability across shorter sampling intervals= 0.77 ± 0.09 and survival probability across longer sampling intervals= 0.93 ± 0.01 mean + 1 SEM). The capture probability was unconstrained in this model and ranged from 12-74% for all sample period-plot combinations (Table 1). For Dispersed Grid examining movement to and from the pond (condensed laterally), the best fit model was $p(t)s(.)\psi(d,t)$, which let the movement across short sampling intervals be different from movement across long sampling intervals and also let movement between adjacent plots be different from movement between nonadjacent plots. The probability of movement was small (<0.06) for all four possibilities (Table 2). The best-fit model for Adjacent Grid examining movement around the pond (vertically condensed) was $p(.)s(.)\psi(.)$. This model constrained capture probabilities and survival to be constant across short and long sampling intervals. The survival was high across short sampling intervals (0.77 ± 0.10) and across long sampling intervals (0.88 ± 0.04). The capture probability across short sampling intervals was 0.50 ± 0.07 and across long sampling intervals was 0.34 ± 0.07.

The probability of movement for this model was higher than all other grids (Table 3). For Adjacent Grid examining movement to and from the pond (condensed laterally), two models were equally well fit, $p(.)s(.)\psi(.)$ and $p(.)s(.)\psi(d,.)$, with AICc values only 0.04 apart. For both models survival, capture probability and movement were constrained to be constant across short sampling intervals and constant across long sampling intervals. However, the probability of movement between adjacent plots was allowed to be different from the probability of movement between nonadjacent plots for one but not the other model. For both models the survival was high and the same; the capture probability (p) was the same for both as well, and the probability of movement was between 0.01 and 0.02 (Table 4).

DISCUSSION

In this study, we made two independent estimates of wolf spider movement near Sylvatica Pond. The first, taken from Dispersed Grid in mid-June, estimated movement 0 – 3 m to and from the pond, and 8 – 28 m around the pond edge 3 hrs, 5 days and 25 days after marking. The second, taken from Adjacent Grid at the end of July, estimated movement 0 – 3 m to and from the pond and 0 – 3 m around the pond edge at 3 hrs and 4 days after marking. The first estimate suggests spiders had a 0% chance of moving 8 – 28 m around the pond at all of the time scales over which the study was performed (< 25 days). On the other hand, spiders had a 5% chance of moving 1 – 2 m to and from the pond over 5 or 25 days (but 0% chance of doing so in 3 hours). The second estimate suggests that spiders had a 4% chance of moving 0 – 2 m to and from the ponds over 3 hours or 4 days. Chances of moving around the ponds between 0 – 2 m, however, averaged 5% over 3 hrs, and 18% over 4 days.

We assumed that lateral movement around the ponds would be much greater for these spiders than movement to and from the ponds due to moisture constraints (DeVito and Formanowicz 2003, Graham et al. 2003). We discovered that movement around the ponds was more probable than movement to or from the ponds (up to 18% vs. 4%), but that movements of over 3m were rare enough to be undetected within the study. Higher movement around than to and from the ponds fits what is known about the high desiccation rates of wolf spiders that specialize in habitats near water (e.g. *Pirata sedentarius*, DeVito et al. 2004), and the importance of aquatic prey to spiders living near freshwater (Kato et al. 2003, Power et al. 2004). However, even taking these limitations into account, the probability of moving distances as short as 0 – 2 m around the pond edge was relatively small compared to previous estimates of wolf spider movement (Morse 1997, Kiss and Samu 2000). For example, Kiss & Samu (2000) found that marked wolf spiders had completely exited a 900 m^2 quadrant over several days of trapping near Hungarian alfalfa fields. Morse (1997) also found that intertidal wolf spiders (*Pardosa lapidicina*) migrating with the tide could move the width of the beach (up to 25m) in one tidal cycle. However, those spiders that remained in the supratidal on the high beach moved infrequently, employing a sit-and-wait hunting strategy.

Wolf spiders are generally thought of as active hunters; they do not construct webs to catch prey. Our data show that the spiders in this study, the majority of which were water specialist *P. cantralli*, apparently hunt in a small (less than 1 meter) region. However, there was some anecdotal evidence that another common species at the ponds is capable of larger scale movement. On one occasion, a marked *P. milvina* was found to have moved at least 7 m around the pond perimeter over a five week time period.

Pardosa milvina, which is found in early successional habitats and is a good colonizer (Marshall et al. 2000), appears to move more than *P. cantralli* and may be able to track resources over a larger spatial scale around the pond.

Several abiotic and biotic factors including moisture and prey distribution can influence the ability or propensity of wolf spiders to move (Norgaard 1951, Humphreys 1975). Desiccation tolerance and moisture levels limit the distribution of wolf spiders around ponds (DeVito & Formanowicz 2003, Graham et al. 2003). Furthermore, Kreiter and Wise (2001) found that adult female fishing spiders that have been fed move less frequently than those who have not received a meal. Perhaps those spiders living near the pond edge receive sufficient prey from aquatic resources and therefore may not need to roam. There are differences in the soil moisture and prey abundance in areas around the pond (J.M. Kraus, *in review*, L. Ahrens & J.M. Kraus, *unpublished*). Such differences may dictate where the spiders are able to hunt for food as well as their abundance within those limits. Movement of wolf spiders is most likely affected, therefore, by a combination of biotic and abiotic factors that pose constraints on the distribution and abundance of wolf spiders at the pond edge.

The spatial scale chosen for this study may have had a large impact on the findings from the model. A scale too large or too small can miss important movement and community interactions (Kareiva 1990). Our study on wolf spiders was done to determine movement at the scale of meters during the summer months, fitting the size of the ponds and the active period of the spiders. Study done over a longer time period or a smaller scale may reveal seasonal or more local movement patterns.

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Table 1. Capture probability for Dispersed Grid examining movement around the ponds (condensed vertically) data. Means ± SEM given. The sample size is 499 spiders. The AICC score was 850.44, the next best fit was 854.56.

Sampling interval	Plot 1	Plot 2	Plot 3
1 (3 hrs)	0.38 ± 0.10	0.72 ± 0.16	0.19 ± 0.07
2 (5 days)	0.12 ± 0.05	0.24 ± 0.09	0.14 ± 0.06
3 (3 hrs)	0.22 ± 0.07	0.42 ± 0.11	0.19 ± 0.06
4 (25 days)	0.60 ± 0.21	0.64 ± 0.15	0.34 ± 0.14
5 (3 hrs)	0.39 ± 0.11	0.51 ± 0.11	0.34 ± 0.08

Table 2. Survival, capture and movement probabilities over entire sampling for Dispersed Grid examining movement to and from the ponds (condensed laterally) with a sample size of 499 spiders. Means ± SEM given. The AICC score is 980.61, the next best model has an AICC score of 983.35.

	Short sample intervals (3 hrs)	Long sample intervals (5 days and 25 days)
Survival	0.69 ± 0.08	0.95 ± 0.01
Capture probability	0.36 ± 0.05	0.24 ± 0.04
Probability of movement between adjacent plots	0.05 ± 0.02	0.06 ± 0.03
Probability of movement between nonadjacent plots	0.00 ± 0.00	0.05 ± 0.03

Table 3. Probability of movement for Adjacent Grid examining movement around the ponds (condensed vertically) with a sample size of 147 spiders. Means ± SEM given. The AICC score is 492.54, the next best model had a score of 498.28.

Sampling interval	1 to 2	1 to 3	2 to 1	2 to 3	3 to 1	3 to 2
1 (3 hrs)	0	0	0	0.11±0.10	0	0
2 (4 days)	0.17±0.15	0	0.22±0.21	0	0	0.14±0.13
3 (3 hrs)	0	0	0	0	0	0
4 (4 days)	0.35±0.20	0	0	0.54±0.21	0	0
5 (3 hrs)	0	0	0.15±0.14	0.28±0.16	0	0.10±0.09

Table 4. Survival, Capture probability and Probability of wolf spider movement for Adjacent Grid examining movement to and from the pond (condensed laterally) with a sample size of 147 spiders. Means ± SEM given. The AICC score for the first model is 459.35, the second model's AICC score is 459.39, the third best fit model is 461.28.

$p(.)s(.)\psi(.)$:

	Short sample intervals (3 hrs)	Long sample intervals (4 days)
Survival	0.77 ± 0.10	0.88 ± 0.04
Capture probability	0.50 ± 0.07	0.34 ± 0.07
Probability of movement	0.02 ± 0.01	0.02 ± 0.01

$p(.)s(.)\psi(d, .)$:

	Short sample intervals	Long sample intervals
Survival	0.77 ± 0.10	0.88 ± 0.04
Capture probability	0.50 ± 0.07	0.34 ± 0.07
Probability of movement between adjacent plots	0.04 ± 0.02	0.04 ± 0.02
Probability of movement between nonadjacent plots	0.01 ± 0.01	0.01 ± 0.01

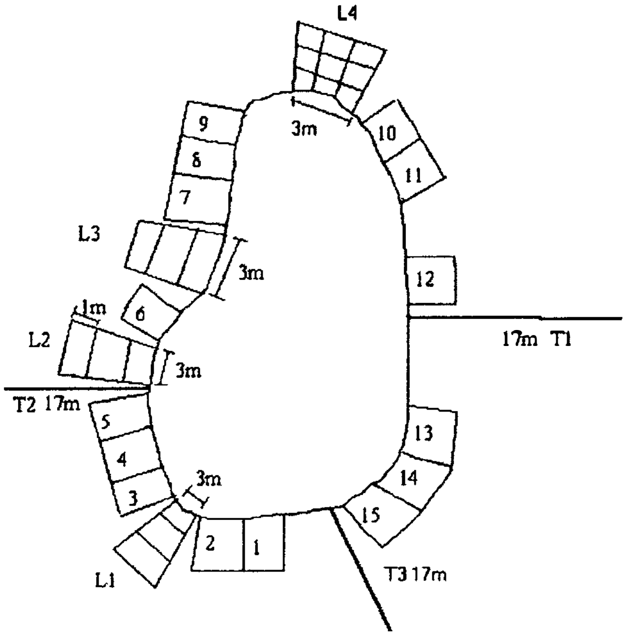


Figure 1. Map of Sylvatica Pond. The four grids, each 3x3 m represent the plots used for the mark recapure of this study (L1-L4). Transects for another study are marked by solid lines and identified by transect number (T1-T3) and length. The numbered squares represent enclosures used in an experiment not reported here.

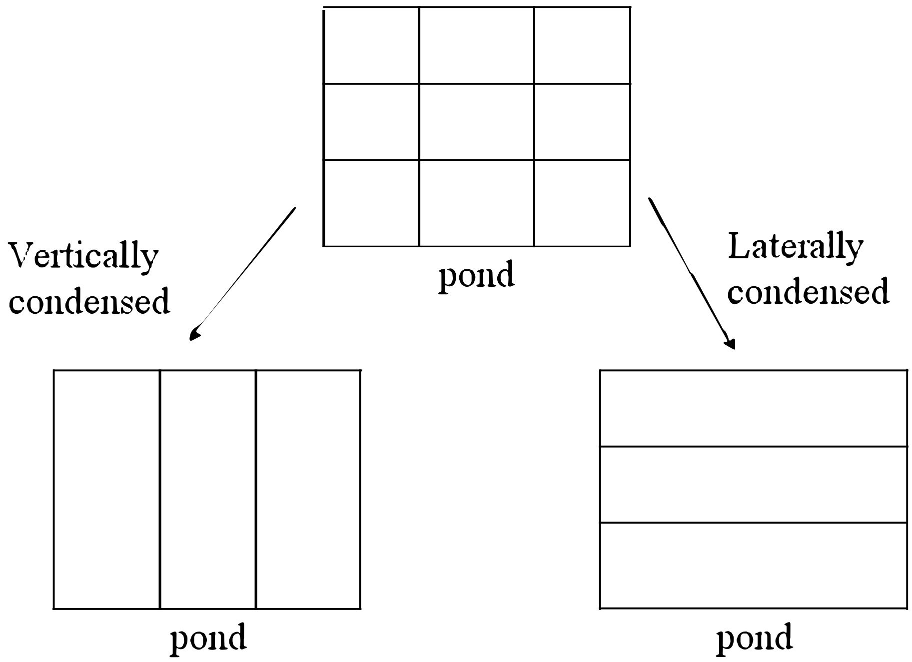


Figure 2. Data from the two nine-plot systems were condensed to allow for analysis of lateral movement around the pond and vertical movement away from and towards the pond. This figure shows how each condensation was organized.

ii. **Transect Data 2004.** Counts of the five common species of wolf spiders during June and July of 2004. Nine 1 m^2 plots along each transect were hand searched for 15 minutes once each between June 24 and July 30, 2004. Three transects per pond were set randomly and perpendicular to the edge of Horton and Sylvatica Ponds. Sample points along the transects were 0.5 m to 17 m from the pond edge (DIST). Species are abbreviated as follows: *P. mil* = *Pardosa milvina*, *P. mo* = *Pardosa moesta*, *P. can* = *Pirata cantralli*, *P. mon* = *Pirata montanus* and *P. sed* = *Pirata sedenarius.* A point estimate of prey availability along the entire 17 m gradient was determined at three transects randomly selected from the six (2 at Horton and 1 at Sylvatica) using yellow sticky traps (5x7" cards) that were set for a 2-day period at the beginning of August. CHIR, AQ PREY and HOM are the number of chironomids, aquatic prey (Chironomidae, Chaoboridae, Culicidae, Ephemeroptera) and terrestrial prey (Homptera) captured on sticky traps. Percent soil moisture of each plot was estimated by taking the wet and dry mass of a soil sample collected from the middle of the plot between July 7 and August 2, 2004, after the plot had been searched.

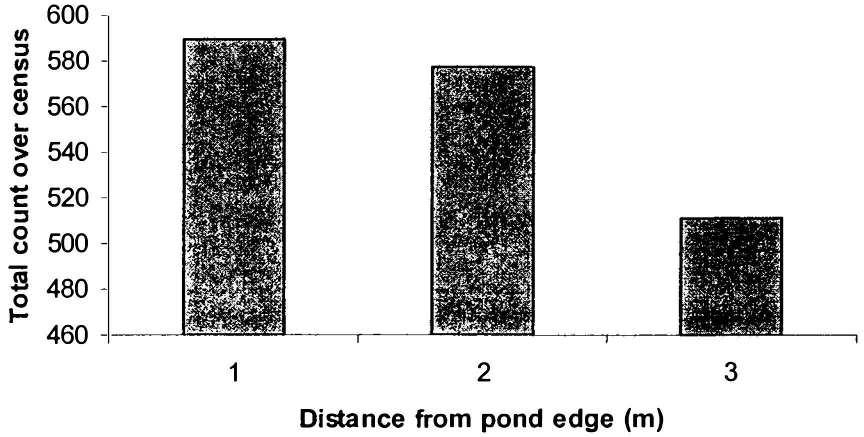
POND-TRAN	**DIST**	**% water**	***P. mil***	***P. mo***	***P. can***	***P. mon***	***P. sed***	**CHIR**	**AQ PREY**	**HOM**
H1	0.5	78.93	1	0	12	0	0	8	8	8
H1	2.5	70.36	0	0	0	0	0	3	3	14
H1	4.5	73.53	0	0	0	0	0	24	24	10
H1	6.5	61.29	0	0	0	1	1	7	7	10
H1	8.5	48.11	0	0	0	1	1	20	20	11
H1	10.5	46.74	0	0	0	0	0	2	2	2
H1	12.5	63.83	0	0	0	3	0	11	12	10
H1	14.5	59.01	0	0	0	5	0	3	4	7
H1	16.5	64.71	0	0	0	3	0	0	0	3
H2	0.5	83.93	2	0	13	0	4	4	6	23
H2	2.5	54.21	0	0	1	2	0	1	1	6

H2	4.5	64.96	0	0	0	5	0	14	14	7
H2	6.5	71.18	0	0	0	3	0	0	0	6
H2	8.5	73.64	0	0	0	2	0	2	2	8
H2	10.5	63.02	0	0	0	5	0	5	5	8
H2	12.5	70.44	0	0	0	7	0	4	4	7
H2	14.5	62.63	0	0	0	3	0	8	9	3
H2	16.5	56.49	0	0	0	0	0	12	12	8
H3	0.5	71.16	0	0	13	0	12			
H3	2.5	45.78	0	0	1	0	2			
H3	4.5	45.58	0	0	0	2	0			
H3	6.5	60.22	0	0	0	2	0			
H3	8.5	65.12	0	0	0	1	0			
H3	10.5	62.42	0	0	0	1	0			
H3	12.5	53.36	0	0	0	0	0			
H3	14.5	60.67	0	0	0	0	0			
H3	16.5	61.07	0	0	0	0	0			
S1	0.5	55.69	2	0	10	0	0			
S1	2.5	24.66	0	1	0	0	0			
S1	4.5	38.33	0	0	0	0	0			
S1	6.5	44.32	0	0	0	0	0			
S1	8.5	51.37	0	0	0	0	0			
S1	10.5	55.15	0	0	0	0	0			
S1	12.5	46.26	0	0	0	0	0			
S1	14.5	55.76	0	0	0	0	0			
S1	16.5	59.08	0	0	0	0	0			
S2	0.5	43.26	1	0	6	0	0			
S2	2.5	33.09	0	0	0	0	0			
S2	4.5	27.13	0	0	0	0	0			
S2	6.5	25.09	0	0	0	0	0			
S2	8.5	48.00	0	0	0	0	0			
S2	10.5	54.71	0	0	0	0	0			
S2	12.5	52.47	0	0	0	0	0			
S2	14.5	58.70	0	0	0	0	0			
S2	16.5	42.48	0	0	0	0	0			
S3	0.5	36.45	1	0	8	0	0	10	11	36
S3	2.5	36.29	0	0	0	0	0	9	9	15
S3	4.5	31.70	0	1	0	0	0	11	12	8
S3	6.5	54.84	0	0	0	0	0	2	2	12
S3	8.5	52.01	0	0	0	0	0	3	3	11
S3	10.5	45.55	0	0	0	0	0	2	2	12
S3	12.5	37.24	0	0	0	0	0	1	1	1
S3	14.5	49.66	0	0	0	1	0	3	3	10
S3	16.5	43.61	0	0	0	0	0	1	1	7

Result summary. Wolf spiders were three times more abundant at Horton Pond (35.7 ± 5.0 individuals captured per transect, mean ± SE) than at Sylvatica Pond (10.3 ± 1.6).

The total number of spiders found was highest from 0 to 1 m from the pond edge. Only two species, *Pirata montanus* and *Pardosa moesta*, peaked in abundance farther than 1 m from the pond (*P. montanus* 12-13 m, *P. moesta* 4-5 m. *Pirata cantralli* had the highest abundance overall and was never found farther than 3 m from the pond edge. The highest average soil moisture measured was 0.5 m from the pond, with an average percent soil moisture over the 17 m gradient of 61.56%. The plots two to four meters away from the pond had lower percent soil moistures than did the forest plots, which remained steadily between 53 and 58%. Terrestrial and aquatic prey density per trap decreased with distance from the pond.

Appendix D. Patterns of terrestrial herbivore abundance away from pond edge and raw counts per sticky trap for 2002.



DATE	POND	TRAN	DIST (m)	ORDER	TOTAL
06/13/02	hort	1	0	HOMOPTERA	3
06/13/02	hort	1	0	HOMOPTERA	8
06/13/02	hort	1	1	HOMOPTERA	6
06/13/02	hort	1	1	HOMOPTERA	4
06/13/02	hort	1	2	HOMOPTERA	3
06/13/02	hort	1	2	HOMOPTERA	5
06/13/02	hort	2	0	HOMOPTERA	7
06/13/02	hort	2	0	HOMOPTERA	5
06/13/02	hort	2	1	HOMOPTERA	4
06/13/02	hort	2	1	HOMOPTERA	6
06/13/02	hort	2	2	HOMOPTERA	1
06/13/02	hort	2	2	HOMOPTERA	12
06/13/02	hort	3	0	HOMOPTERA	3
06/13/02	hort	3	0	HOMOPTERA	5
06/13/02	hort	3	1	HOMOPTERA	2
06/13/02	hort	3	1	HOMOPTERA	4
06/13/02	hort	3	2	HOMOPTERA	5
06/13/02	hort	3	2	HOMOPTERA	5
06/13/02	hort	4	0	HOMOPTERA	2
06/13/02	hort	4	0	HOMOPTERA	4
06/13/02	hort	4	1	HOMOPTERA	2
06/13/02	hort	4	1	HOMOPTERA	2
06/13/02	hort	4	2	HOMOPTERA	0
06/13/02	hort	4	2	HOMOPTERA	3
06/13/02	hort	5	0	HOMOPTERA	1
06/13/02	hort	5	0	HOMOPTERA	3
06/13/02	hort	5	1	HOMOPTERA	3
06/13/02	hort	5	1	HOMOPTERA	3
06/13/02	hort	5	2	HOMOPTERA	0
06/13/02	hort	5	2	HOMOPTERA	3

06/13/02	hort	6	0	HOMOPTERA	13
06/13/02	hort	6	0	HOMOPTERA	6
06/13/02	hort	6	1	HOMOPTERA	3
06/13/02	hort	6	1	HOMOPTERA	2
06/13/02	hort	6	2	HOMOPTERA	2
06/13/02	hort	6	2	HOMOPTERA	3
06/13/02	syl	1	0	HOMOPTERA	6
06/13/02	syl	1	0	HOMOPTERA	11
06/13/02	syl	1	1	HOMOPTERA	7
06/13/02	syl	1	1	HOMOPTERA	9
06/13/02	syl	1	2	HOMOPTERA	10
06/13/02	syl	1	2	HOMOPTERA	3
06/13/02	syl	2	0	HOMOPTERA	8
06/13/02	syl	2	0	HOMOPTERA	5
06/13/02	syl	2	1	HOMOPTERA	12
06/13/02	syl	2	1	HOMOPTERA	6
06/13/02	syl	2	2	HOMOPTERA	4
06/13/02	syl	2	2	HOMOPTERA	7
06/13/02	syl	3	0	HOMOPTERA	10
06/13/02	syl	3	0	HOMOPTERA	11
06/13/02	syl	3	1	HOMOPTERA	12
06/13/02	syl	3	1	HOMOPTERA	9
06/13/02	syl	3	2	HOMOPTERA	4
06/13/02	syl	3	2	HOMOPTERA	8
06/13/02	syl	4	0	HOMOPTERA	4
06/13/02	syl	4	0	HOMOPTERA	14
06/13/02	syl	4	1	HOMOPTERA	8
06/13/02	syl	4	1	HOMOPTERA	9
06/13/02	syl	4	2	HOMOPTERA	8
06/13/02	syl	4	2	HOMOPTERA	1
06/13/02	syl	5	0	HOMOPTERA	9
06/13/02	syl	5	0	HOMOPTERA	8
06/13/02	syl	5	1	HOMOPTERA	2
06/13/02	syl	5	1	HOMOPTERA	12
06/13/02	syl	5	2	HOMOPTERA	3
06/13/02	syl	5	2	HOMOPTERA	8
06/13/02	syl	6	0	HOMOPTERA	10
06/13/02	syl	6	0	HOMOPTERA	12
06/13/02	syl	6	1	HOMOPTERA	5
06/13/02	syl	6	1	HOMOPTERA	10
06/13/02	syl	6	2	HOMOPTERA	10
06/13/02	syl	6	2	HOMOPTERA	6
06/20/02	syl	1	0	HOMOPTERA	7
06/20/02	syl	1	0	HOMOPTERA	9
06/20/02	syl	1	1	HOMOPTERA	4
06/20/02	syl	1	1	HOMOPTERA	6
06/20/02	syl	1	2	HOMOPTERA	5
06/20/02	syl	1	2	HOMOPTERA	12
06/20/02	syl	2	0	HOMOPTERA	8
06/20/02	syl	2	0	HOMOPTERA	3

06/20/02	syl	2	1	HOMOPTERA	5
06/20/02	syl	2	1	HOMOPTERA	6
06/20/02	syl	2	2	HOMOPTERA	2
06/20/02	syl	2	2	HOMOPTERA	3
06/20/02	syl	3	0	HOMOPTERA	1
06/20/02	syl	3	0	HOMOPTERA	12
06/20/02	syl	3	1	HOMOPTERA	3
06/20/02	syl	3	1	HOMOPTERA	5
06/20/02	syl	3	2	HOMOPTERA	11
06/20/02	syl	3	2	HOMOPTERA	3
06/20/02	syl	4	0	HOMOPTERA	5
06/20/02	syl	4	0	HOMOPTERA	10
06/20/02	syl	4	1	HOMOPTERA	10
06/20/02	syl	4	1	HOMOPTERA	1
06/20/02	syl	4	2	HOMOPTERA	1
06/20/02	syl	4	2	HOMOPTERA	2
06/20/02	syl	5	0	HOMOPTERA	5
06/20/02	syl	5	0	HOMOPTERA	0
06/20/02	syl	5	1	HOMOPTERA	2
06/20/02	syl	5	1	HOMOPTERA	4
06/20/02	syl	5	2	HOMOPTERA	6
06/20/02	syl	5	2	HOMOPTERA	6
06/20/02	syl	6	0	HOMOPTERA	5
06/20/02	syl	6	0	HOMOPTERA	5
06/20/02	syl	6	1	HOMOPTERA	3
06/20/02	syl	6	1	HOMOPTERA	5
06/20/02	syl	6	2	HOMOPTERA	0
06/20/02	syl	6	2	HOMOPTERA	5
06/20/02	hort	1	0	HOMOPTERA	6
06/20/02	hort	1	0	HOMOPTERA	0
06/20/02	hort	1	1	HOMOPTERA	2
06/20/02	hort	1	1	HOMOPTERA	3
06/20/02	hort	1	2	HOMOPTERA	4
06/20/02	hort	1	2	HOMOPTERA	3
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06/20/02	hort	2	1	HOMOPTERA	3
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06/20/02	hort	2	2	HOMOPTERA	1
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06/20/02	hort	3	0	HOMOPTERA	4
06/20/02	hort	3	0	HOMOPTERA	6
06/20/02	hort	3	1	HOMOPTERA	1
06/20/02	hort	3	1	HOMOPTERA	3
06/20/02	hort	3	2	HOMOPTERA	2
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06/20/02	hort	4	0	HOMOPTERA	6
06/20/02	hort	4	1	HOMOPTERA	5
06/20/02	hort	4	1	HOMOPTERA	5

06/20/02	hort	4	2	HOMOPTERA	1
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06/20/02	hort	5	2	HOMOPTERA	0
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06/20/02	hort	6	0	HOMOPTERA	3
06/20/02	hort	6	1	HOMOPTERA	0
06/20/02	hort	6	1	HOMOPTERA	5
06/20/02	hort	6	2	HOMOPTERA	1
06/20/02	hort	6	2	HOMOPTERA	5
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06/27/02	hort	3	0	HOMOPTERA	5
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06/27/02	hort	3	1	HOMOPTERA	2
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06/27/02	hort	4	1	HOMOPTERA	2
06/27/02	hort	4	1	HOMOPTERA	1
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06/27/02	hort	5	0	HOMOPTERA	2
06/27/02	hort	5	1	HOMOPTERA	0
06/27/02	hort	5	1	HOMOPTERA	2
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06/27/02	hort	5	2	HOMOPTERA	4
06/27/02	hort	1	0	HOMOPTERA	7
06/27/02	hort	1	0	HOMOPTERA	6
06/27/02	hort	1	1	HOMOPTERA	1
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06/27/02	hort	1	2	HOMOPTERA	2
06/27/02	hort	1	2	HOMOPTERA	2
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06/27/02	hort	3	0	HOMOPTERA	1
06/27/02	hort	3	1	HOMOPTERA	2
06/27/02	hort	3	1	HOMOPTERA	5
06/27/02	hort	3	2	HOMOPTERA	1
06/27/02	hort	3	2	HOMOPTERA	1

06/27/02	syl	1	0	HOMOPTERA	4
06/27/02	syl	1	0	HOMOPTERA	8
06/27/02	syl	1	1	HOMOPTERA	5
06/27/02	syl	1	1	HOMOPTERA	6
06/27/02	syl	1	2	HOMOPTERA	3
06/27/02	syl	1	2	HOMOPTERA	3
06/27/02	syl	2	0	HOMOPTERA	5
06/27/02	syl	2	0	HOMOPTERA	2
06/27/02	syl	2	1	HOMOPTERA	0
06/27/02	syl	2	1	HOMOPTERA	4
06/27/02	syl	2	2	HOMOPTERA	2
06/27/02	syl	2	2	HOMOPTERA	2
06/27/02	syl	3	0	HOMOPTERA	7
06/27/02	syl	3	0	HOMOPTERA	9
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06/27/02	syl	4	0	HOMOPTERA	0
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06/27/02	syl	6	2	HOMOPTERA	7
06/27/02	syl	6	2	HOMOPTERA	7
07/04/02	syl	3	0	HOMOPTERA	1
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07/04/02	syl	3	1	HOMOPTERA	8
07/04/02	syl	3	1	HOMOPTERA	8
07/04/02	syl	3	2	HOMOPTERA	10
07/04/02	syl	3	2	HOMOPTERA	4
07/04/02	syl	6	0	HOMOPTERA	5
07/04/02	syl	6	0	HOMOPTERA	8
07/04/02	syl	6	1	HOMOPTERA	0
07/04/02	syl	6	1	HOMOPTERA	0
07/04/02	syl	6	2	HOMOPTERA	11
07/04/02	syl	6	2	HOMOPTERA	7
07/04/02	syl	2	0	HOMOPTERA	4
07/04/02	syl	2	0	HOMOPTERA	29

07/04/02	syl	2	1	HOMOPTERA	10
07/04/02	syl	2	1	HOMOPTERA	43
07/04/02	syl	2	2	HOMOPTERA	22
07/04/02	syl	2	2	HOMOPTERA	33
07/04/02	syl	1	0	HOMOPTERA	3
07/04/02	syl	1	0	HOMOPTERA	5
07/04/02	syl	1	1	HOMOPTERA	8
07/04/02	syl	1	1	HOMOPTERA	5
07/04/02	syl	1	2	HOMOPTERA	3
07/04/02	syl	1	2	HOMOPTERA	3
07/04/02	syl	5	0	HOMOPTERA	3
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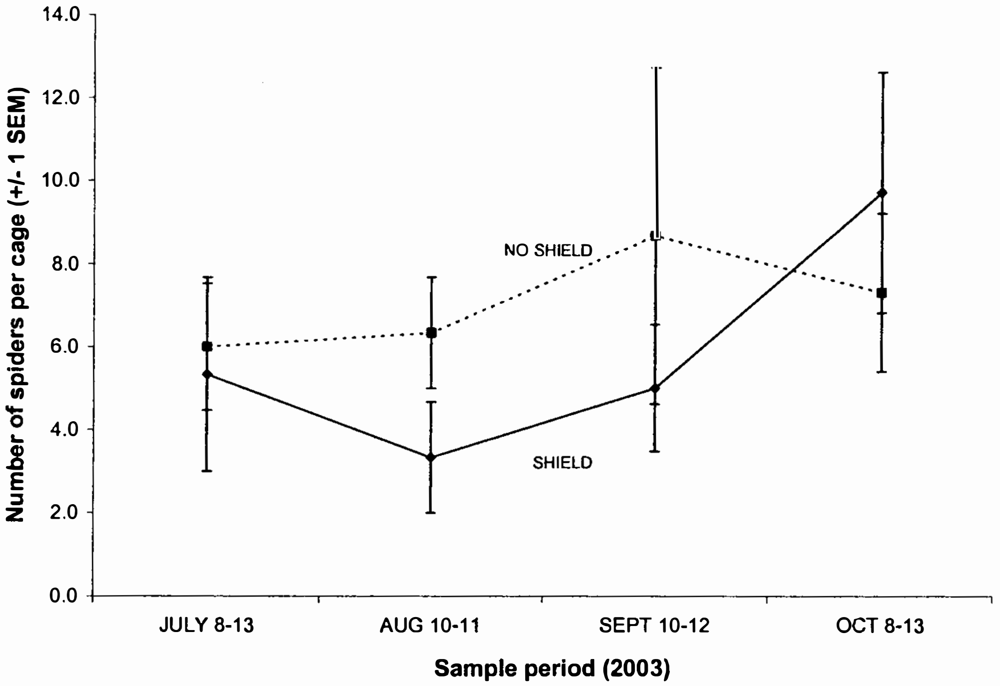
07/04/02	syl	5	1	HOMOPTERA	3
07/04/02	syl	5	1	HOMOPTERA	9
07/04/02	syl	5	2	HOMOPTERA	9
07/04/02	syl	5	2	HOMOPTERA	5
07/04/02	syl	4	0	HOMOPTERA	7
07/04/02	syl	4	0	HOMOPTERA	7
07/04/02	syl	4	1	HOMOPTERA	3
07/04/02	syl	4	1	HOMOPTERA	9
07/04/02	syl	4	2	HOMOPTERA	0
07/04/02	syl	4	2	HOMOPTERA	1
07/04/02	hort	3	0	HOMOPTERA	4
07/04/02	hort	3	0	HOMOPTERA	2
07/04/02	hort	3	1	HOMOPTERA	3
07/04/02	hort	3	1	HOMOPTERA	3
07/04/02	hort	3	2	HOMOPTERA	3
07/04/02	hort	3	2	HOMOPTERA	2
07/04/02	hort	1	0	HOMOPTERA	0
07/04/02	hort	1	0	HOMOPTERA	8
07/04/02	hort	1	1	HOMOPTERA	2
07/04/02	hort	1	1	HOMOPTERA	1
07/04/02	hort	1	2	HOMOPTERA	1
07/04/02	hort	1	2	HOMOPTERA	5
07/04/02	hort	2	0	HOMOPTERA	2
07/04/02	hort	2	0	HOMOPTERA	3
07/04/02	hort	2	1	HOMOPTERA	4
07/04/02	hort	2	1	HOMOPTERA	1
07/04/02	hort	2	2	HOMOPTERA	1
07/04/02	hort	2	2	HOMOPTERA	2
07/04/02	hort	6	0	HOMOPTERA	0
07/04/02	hort	6	0	HOMOPTERA	7
07/04/02	hort	6	1	HOMOPTERA	5
07/04/02	hort	6	1	HOMOPTERA	3
07/04/02	hort	6	2	HOMOPTERA	4
07/04/02	hort	6	2	HOMOPTERA	4
07/04/02	hort	4	0	HOMOPTERA	5
07/04/02	hort	4	0	HOMOPTERA	10
07/04/02	hort	4	1	HOMOPTERA	2
07/04/02	hort	4	1	HOMOPTERA	0

07/04/02	hort	4	2	HOMOPTERA	3
07/04/02	hort	4	2	HOMOPTERA	2
07/04/02	hort	5	0	HOMOPTERA	0
07/04/02	hort	5	0	HOMOPTERA	0
07/04/02	hort	5	1	HOMOPTERA	1
07/04/02	hort	5	1	HOMOPTERA	1
07/04/02	hort	5	2	HOMOPTERA	1
07/04/02	hort	5	2	HOMOPTERA	2
07/25/02	syl	1	0	HOMOPTERA	8
07/25/02	syl	1	0	HOMOPTERA	0
07/25/02	syl	1	1	HOMOPTERA	17
07/25/02	syl	1	1	HOMOPTERA	41
07/25/02	syl	1	2	HOMOPTERA	20
07/25/02	syl	1	2	HOMOPTERA	22
07/25/02	syl	2	0	HOMOPTERA	5
07/25/02	syl	2	0	HOMOPTERA	5
07/25/02	syl	2	1	HOMOPTERA	1
07/25/02	syl	2	1	HOMOPTERA	1
07/25/02	syl	2	2	HOMOPTERA	6
07/25/02	syl	2	2	HOMOPTERA	1
07/25/02	syl	3	0	HOMOPTERA	6
07/25/02	syl	3	0	HOMOPTERA	8
07/25/02	syl	3	1	HOMOPTERA	2
07/25/02	syl	3	1	HOMOPTERA	2
07/25/02	syl	3	2	HOMOPTERA	2
07/25/02	syl	3	2	HOMOPTERA	1
07/25/02	syl	4	0	HOMOPTERA	2
07/25/02	syl	4	0	HOMOPTERA	0
07/25/02	syl	4	1	HOMOPTERA	1
07/25/02	syl	4	1	HOMOPTERA	2
07/25/02	syl	4	2	HOMOPTERA	4
07/25/02	syl	4	2	HOMOPTERA	1
07/25/02	syl	5	0	HOMOPTERA	5
07/25/02	syl	5	0	HOMOPTERA	4
07/25/02	syl	5	1	HOMOPTERA	4
07/25/02	syl	5	1	HOMOPTERA	3
07/25/02	syl	5	2	HOMOPTERA	4
07/25/02	syl	5	2	HOMOPTERA	2
07/25/02	syl	6	0	HOMOPTERA	9
07/25/02	syl	6	0	HOMOPTERA	1
07/25/02	syl	6	1	HOMOPTERA	0
07/25/02	syl	6	1	HOMOPTERA	5
07/25/02	syl	6	2	HOMOPTERA	2
07/25/02	syl	6	2	HOMOPTERA	4
07/25/02	hort	1	0	HOMOPTERA	4
07/25/02	hort	1	0	HOMOPTERA	0
07/25/02	hort	1	1	HOMOPTERA	0
07/25/02	hort	1	1	HOMOPTERA	5
07/25/02	hort	1	2	HOMOPTERA	1
07/25/02	hort	1	2	HOMOPTERA	1

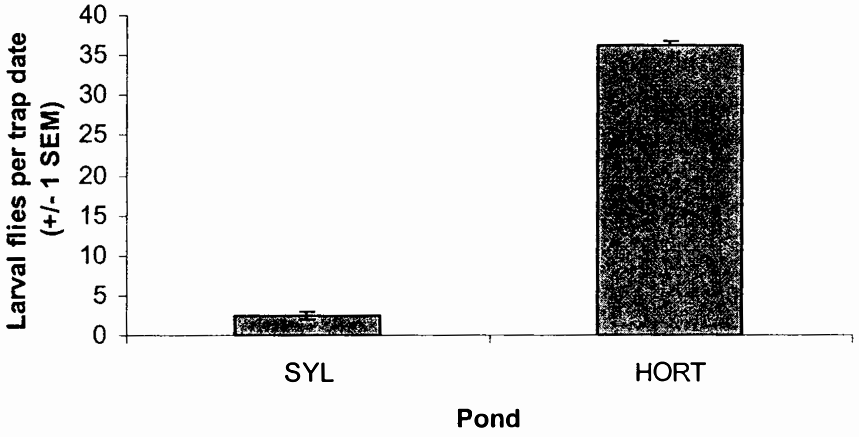
07/25/02	hort	2	0	HOMOPTERA	1
07/25/02	hort	2	0	HOMOPTERA	1
07/25/02	hort	2	1	HOMOPTERA	2
07/25/02	hort	2	1	HOMOPTERA	4
07/25/02	hort	2	2	HOMOPTERA	0
07/25/02	hort	2	2	HOMOPTERA	4
07/25/02	hort	3	0	HOMOPTERA	2
07/25/02	hort	3	0	HOMOPTERA	3
07/25/02	hort	3	1	HOMOPTERA	4
07/25/02	hort	3	1	HOMOPTERA	1
07/25/02	hort	3	2	HOMOPTERA	1
07/25/02	hort	3	2	HOMOPTERA	0
07/25/02	hort	4	0	HOMOPTERA	2
07/25/02	hort	4	0	HOMOPTERA	0
07/25/02	hort	4	1	HOMOPTERA	0
07/25/02	hort	4	1	HOMOPTERA	2
07/25/02	hort	4	2	HOMOPTERA	4
07/25/02	hort	4	2	HOMOPTERA	2
07/25/02	hort	5	0	HOMOPTERA	1
07/25/02	hort	5	0	HOMOPTERA	5
07/25/02	hort	5	1	HOMOPTERA	3
07/25/02	hort	5	1	HOMOPTERA	6
07/25/02	hort	5	2	HOMOPTERA	0
07/25/02	hort	5	2	HOMOPTERA	0
07/25/02	hort	6	0	HOMOPTERA	3
07/25/02	hort	6	0	HOMOPTERA	4
07/25/02	hort	6	1	HOMOPTERA	5
07/25/02	hort	6	1	HOMOPTERA	13
07/25/02	hort	6	2	HOMOPTERA	6
07/25/02	hort	6	2	HOMOPTERA	5

Appendix E. 2003 Enclosure Experiment: i. Dipteran (mostly Chironomid) larval densities per pond; Replicate in the graph is the trap catch in an enclosure each date. The raw data is presented below the figure. ii. Density of wolf spiders per pond.

i. Wolf spider response to subsidy shield (- subsidy treatment) compared to ambient subsidy (+ subsidy treatment) over time, 2003.



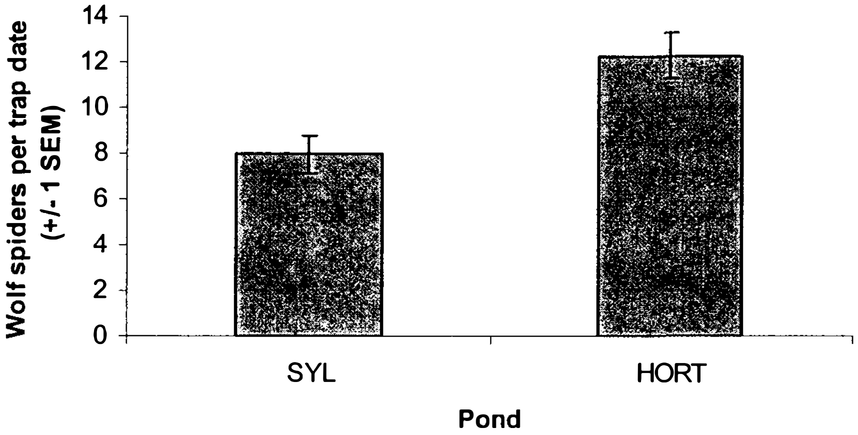
ii. Aquatic diptera larval densities per pond, 2003.



DATE	CAGE	POND	TREAT	DIPT
AUG	1	SYL	NS	0
OCT	1	SYL	NS	0
SEPT	1	SYL	NS	6
AUG	2	SYL	S	3
OCT	2	SYL	S	0
SEPT	2	SYL	S	12
AUG	3	SYL	W	1
OCT	3	SYL	W	5
SEPT	3	SYL	W	2
AUG	4	SYL	D	6
OCT	4	SYL	D	7
SEPT	4	SYL	D	14
AUG	5	SYL	N	0
OCT	5	SYL	N	2
SEPT	5	SYL	N	4
AUG	6	SYL	C	5
OCT	6	SYL	C	11
SEPT	6	SYL	C	
AUG	7	SYL	N	0
OCT	7	SYL	N	2
SEPT	7	SYL	N	1
AUG	8	SYL	W	0
OCT	8	SYL	W	0
SEPT	8	SYL	W	1
AUG	9	SYL	D	0
OCT	9	SYL	D	0
SEPT	9	SYL	D	2
AUG	10	SYL	S	2
OCT	10	SYL	S	0
SEPT	10	SYL	S	0
AUG	11	SYL	NS	1

OCT	11	SYL	NS	3
SEPT	11	SYL	NS	
AUG	12	SYL	C	0
OCT	12	SYL	C	3
SEPT	12	SYL	C	0
AUG	13	SYL	W	2
OCT	13	SYL	W	
SEPT	13	SYL	W	
AUG	14	SYL	D	0
OCT	14	SYL	D	2
SEPT	14	SYL	D	
AUG	15	SYL	N	0
OCT	15	SYL	N	0
SEPT	15	SYL	N	
AUG	16	SYL	C	3
OCT	16	HORT	C	
SEPT	16	HORT	C	3
AUG	17	HORT	C	28
OCT	17	HORT	C	29
SEPT	17	HORT	C	48
AUG	18	HORT	W	23
OCT	18	HORT	W	
SEPT	18	HORT	W	39
AUG	19	HORT	N	115
OCT	19	HORT	N	
SEPT	19	HORT	N	102
AUG	20	HORT	D	1
OCT	20	HORT	D	
SEPT	20	HORT	D	38
AUG	21	HORT	NS	3
OCT	21	HORT	NS	9
SEPT	21	HORT	NS	10
AUG	22	HORT	S	11
OCT	22	HORT	S	8
SEPT	22	HORT	S	112

iii. Wolf spider density per pond, 2003



DATE	CAGE	POND	TREAT	COUNT	INDIV BIOM
AUG	16	HORT	CC	17	0.0212
SEPT	16	HORT	CC	26	0.0199
JULY	16	HORT	CC	11	0.0230
AUG	17	HORT	CC	12	0.0243
SEPT	17	HORT	CC	22	0.0193
JULY	17	HORT	CC	7	0.0198
AUG	18	HORT	WA	17	0.0187
SEPT	18	HORT	WA	12	0.0385
OCT	18	HORT	WA	13	0.0088
JULY	18	HORT	WA	7	0.0273
AUG	19	HORT	NA	11	0.0194
SEPT	19	HORT	NA	11	0.0141
OCT	19	HORT	NA	11	0.0098
JULY	19	HORT	NA	8	0.0089
AUG	20	HORT	DA	13	0.0213
SEPT	20	HORT	DA	12	0.0127
OCT	20	HORT	DA	14	0.0117
JULY	20	HORT	DA	14	0.0236
AUG	21	HORT	NS	9	0.0166
SEPT	21	HORT	NS	16	0.0171
JULY	21	HORT	NS	9	0.0119
AUG	22	HORT	S	6	0.0252
SEPT	22	HORT	S	8	0.0204
JULY	22	HORT	S	9	0.0206
AUG	1	SYL	NS	5	0.0226
SEPT	1	SYL	NS	2	0.0031
JULY	1	SYL	NS	4	0.0257
AUG	2	SYL	S	2	0.0148
SEPT	2	SYL	S	3	0.0086
JULY	2	SYL	S	1	0.0288

AUG		3	SYL	WA	15	0.0152
SEPT		3	SYL	WA	17	0.0134
OCT		3	SYL	WA	13	0.0133
JULY		3	SYL	WA	5	0.0276
AUG		4	SYL	DA	5	0.0616
SEPT		4	SYL	DA	10	0.0765
OCT		4	SYL	DA	10	0.0059
JULY		4	SYL	DA	4	0.0186
AUG		5	SYL	NA	4	0.0202
SEPT		5	SYL	NA	18	0.0108
OCT		5	SYL	NA	20	0.0091
JULY		5	SYL	NA	4	0.0347
AUG		6	SYL	CC	7	0.0213
SEPT		6	SYL	CC	9	0.0121
JULY		6	SYL	CC	0	
AUG		7	SYL	NA	5	0.0219
SEPT		7	SYL	NA	5	0.0116
JULY		7	SYL	NA	9	0.0137
AUG		8	SYL	WA	4	0.0209
SEPT		8	SYL	WA	20	0.0085
JULY		8	SYL	WA	28	0.0208
AUG		9	SYL	DA	7	0.0166
SEPT		9	SYL	DA	11	0.0100
OCT		9	SYL	DA	16	0.0111
JULY		9	SYL	DA	10	0.0190
AUG		10	SYL	S	2	0.0085
SEPT		10	SYL	S	4	0.0088
JULY		10	SYL	S	6	0.0132
AUG		11	SYL	NS	5	0.0176
SEPT		11	SYL	NS	8	0.0084
JULY		11	SYL	NS	5	0.0099
AUG		12	SYL	CC	7	0.0265
SEPT		12	SYL	CC	13	0.0202
JULY		12	SYL	CC	5	0.0242
AUG		13	SYL	WA	1	0.0178
SEPT		13	SYL	WA	12	0.0111
OCT		13	SYL	WA	14	0.0072
JULY		13	SYL	WA	2	0.0391
AUG		14	SYL	DA	2	0.0190
SEPT		14	SYL	DA	7	0.0114
OCT		14	SYL	DA	5	0.0063
JULY		14	SYL	DA	2	0.0308
AUG		15	SYL	NA	6	0.0155
SEPT		15	SYL	NA	10	0.0134
OCT		15	SYL	NA	4	0.0047
JULY		15	SYL	NA	5	0.0466
OCT	?7		SYL	NA	21	0.0081
OCT	?8		SYL	WA	11	0.0094

Appendix F. Methods and results for 2002 Isotope Addition Experiment, including information on diffusion rates from enclosures.

Diffusion rates. The movement rate of water through enclosures in Riopel Pond was measured by monitoring the diffusion of salt solution out of the enclosures. Three enclosures (3 m long x 1 m wide) constructed from aluminum flashing were installed so that 1 m x 1.5 m of the enclosure was in the water and the other half was on land. Two of the enclosures had two mesh vents made from window screening while the third had no vent. A control plot of the same size as the enclosures was used to calculate the reduction in flow caused by the enclosures. Approximately 60 ml of NaCl was added to 1 L of pond water and then mixed into the enclosures. The conductivity probe was then swirled slowly under the surface of the water until the reading was stable. Conductivity, pH and temperature were measured within all enclosures and outside one of the vented enclosures before salt was added at 11am, at 1pm on the first day, at 8 am on the second day and at 8 am and 5 pm on the third day. The enclosures with vents lost from 20 to 200 ppm of conductivity in the first 15 minutes. Over the next 18 hours they lost another 200 ppm. The enclosure with no vent lost conductivity at the same rate but maintained the original salt content at a higher level. The area with no enclosure only increased approximately 20ppm immediately but was back to ambient (~10 ppm) for the next three days. This study indicated that diffusion rates in Riopel Pond were fast and could affect local isotopic uptake if water flow through cages was not restricted.

Isotope addition experiment. Enriched nitrogen and carbon was added to the pond communities to measure how ^{13}C and ^{15}N moved through the aquatic and eventually terrestrial food webs. Sodium acetate (^{13}C) was added to enter the detrital food web through the bacteria that break down the leaves (Hall, 1995) and are consumed by aquatic fly larvae. Ammonium chloride (^{15}N) was added to enter the primary productivity web. I hypothesized that by increasing the signature of algae and detritivorous bacteria herbivores and detritivores in the water and the carnivores that preyed on them would become enriched over time. Three enclosures (1 m x 3 m) made from aluminum flashing were erected at Sylvatica Pond to examine the movement of nitrogen and carbon across the pond-terrestrial boundary in the form of insect prey movement. The flashing was solid around the bottom with two plankton netting windows installed for some water flow during the experiment. Windows were covered while enriched solutions were added to the pond side of the enclosures. The bottoms of the aquatic sides of the cages were of aluminum flashing topped with mud and leaves. The terrestrial sides were sunk into the soil and had open bottoms.

Beginning August 24, I collected aquatic plants, zooplankton/phytoplankton, terrestrial plants (near and far from water), leaf hoppers, a terrestrial predator (preferably a wolf spider), midge larvae, dragonfly larvae or other aquatic predator every week. The carbon and nitrogen isotopes in solution were added to the aquatic side after the first collection. The additions were added to increase the δ^{13}C signature of the pond animals by 20 ‰ but the nitrogen was only added enough to increase the δ^{15}N by 4 ‰. The enrichment was seen in aquatic organisms over time (Fig. 1), but not in the higher aquatic trophic levels (Fig. 2). The enriched C and N did not reach the terrestrial consumers within the span of the experiment probably because of the combined times for turnover and emergence exceeded a month (Fig. 3). Plants near the pond edge showed an increased enrichment in ^{15}N over time, probably caused by the uptake of labeled water from the pond (Fig. 4). Terrestrial herbivorous insects did not reflect this change in enrichment (Fig. 5).

References:

Hall RO. 1995. Use of a stable carbon-isotope addition to trace bacterial carbon through a stream food-web. Journal of the North American Benthological Society 14: 269-277.

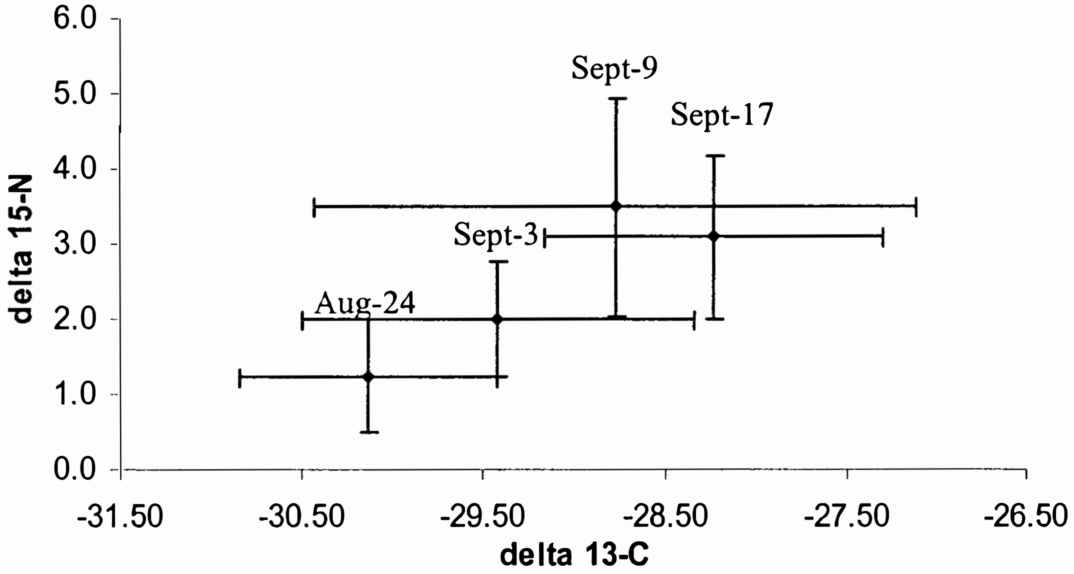


Figure 1. Isotopic enrichment of aquatic organisms sampled over time. Enclosure is unit of replication.

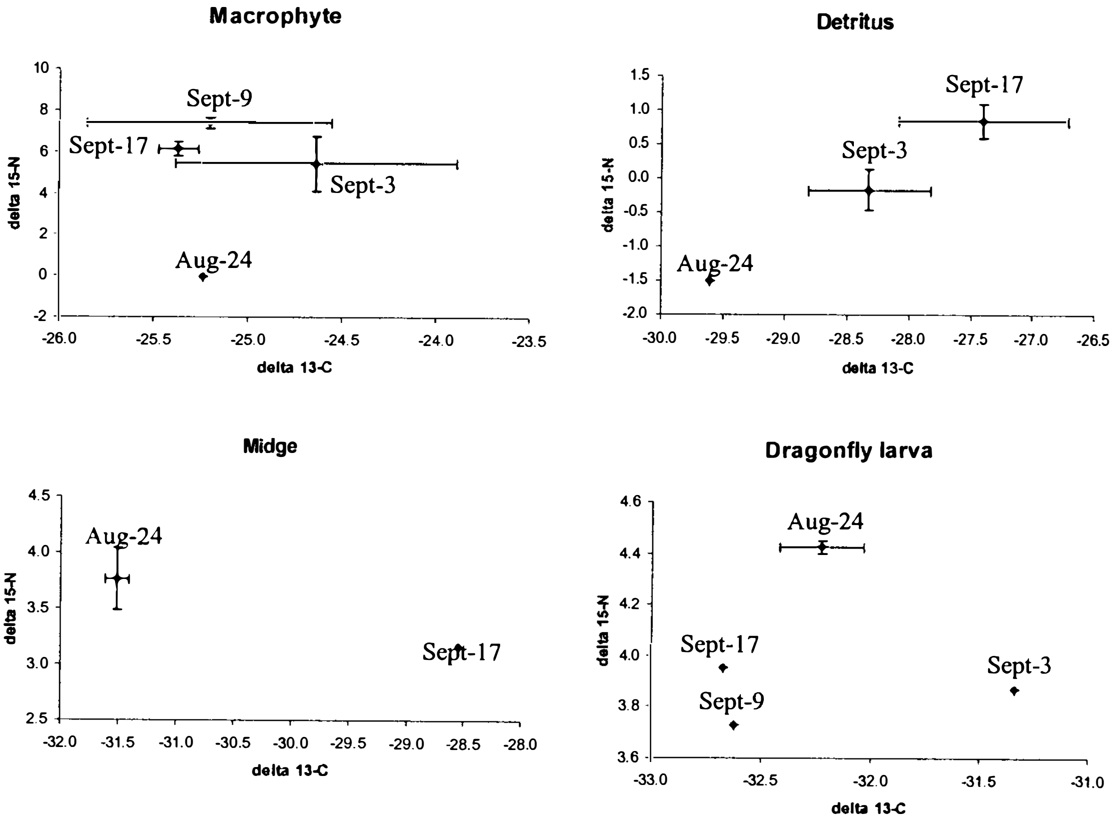


Figure 2. Isotopic enrichment of aquatic organisms sampled over time by taxa. Enclosure is unit of replication.

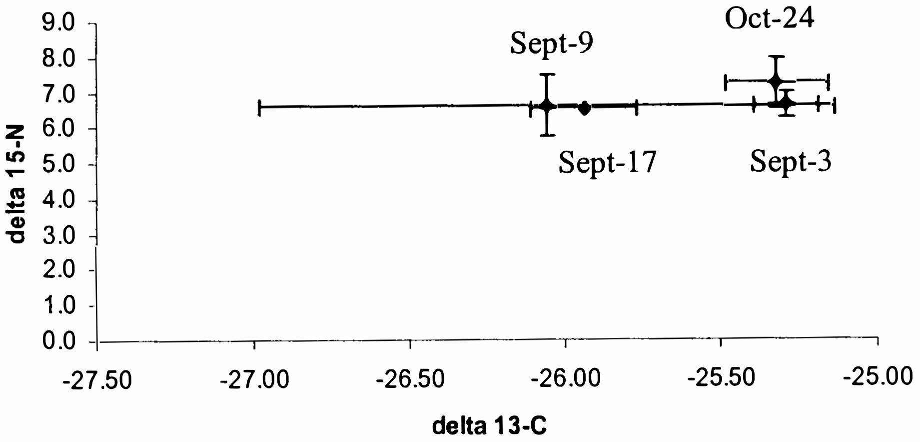


Figure 3. Isotopic enrichment of wolf spiders over time. Enclosure is unit of replication

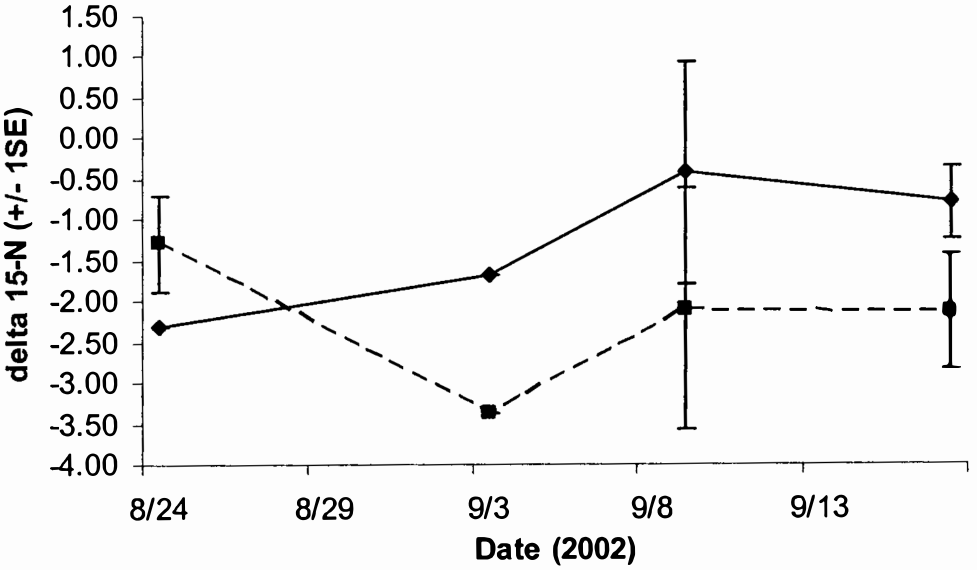


Figure 4. Terrestrial plant $\delta^{15}N$ over time. Near plants are approximately 10 cm from the edge of pond. Far plants are more than 50 cm from the edge of pond.

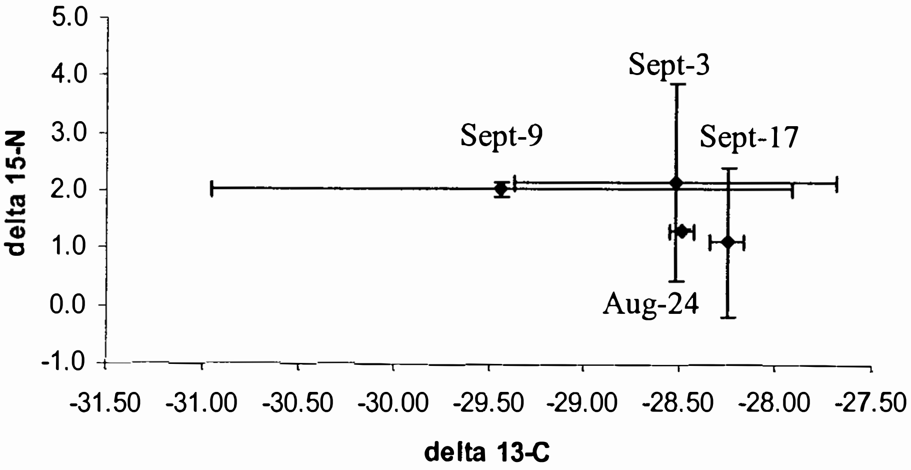


Figure 5. Isotopic enrichment of terrestrial prey (Homopterans) over time. Enclosure is unit of replication.

Raw data from 2002 Isotope Addition Experiment.

SAMPLE ID	δ^{15}N	δ^{13}C	CAGE	DATE
DRAGONFLY LARVAE48	3.99	-31.54	E1	8/24/2002
DRAGONFLY LARVAE49	4.80	-32.53	E1	8/24/2002
LEAFHOPPER51	1.29	-28.55	E1	8/24/2002
MIDGE55	3.49	-31.61	E1	8/24/2002
PERIDETRITUS42	-3.70	-30.70	E1	8/24/2002
PERIDETRITUS56	0.72	-28.51	E1	8/24/2002
PLANT TERR FAR44	-0.69	-31.17	E1	8/24/2002
PLANT TERR NEAR45	-2.31	-30.87	E1	8/24/2002
WOLFSPIDER47	6.54	-25.48	E1	8/24/2002
PHYTOE18-24	0.20	-30.25	E1	8/24/2002
ZOOE18-24	-0.49	-30.38	E1	8/24/2002
AQ PLANT64	-0.07	-25.23	E2	8/24/2002
DRAGONFLY LARVAE62.63	4.45	-32.42	E2	8/24/2002
LEAFHOPPER67. 68	2.47	-28.85	E2	8/24/2002
LEAFHOPPER69	0.23	-28.01	E2	8/24/2002
PLANT TERR FAR59	-2.16	-30.89	E2	8/24/2002
PLANT TERR FAR60	-1.59	-29.15	E2	8/24/2002
WOLFSPIDER65	8.00	-25.16	E2	8/24/2002
PHYTOE28-24	0.20	-30.46	E2	8/24/2002
ZOOE28-24	0.50	-29.25	E2	8/24/2002
PLANTST1RIO	5.29	-27.66	T1	8/24/2002
MIDGE61	4.05	-31.40	T1	8/24/2002
PHYTOT18-24	-1.55	-30.25	T1	8/24/2002
ZOOT18-24	1.54	-31.32	T1	8/24/2002
LEAFHOPPERT2RIO	6.60	-28.29	T2	8/24/2002
LEAFHOPPERT2RIO	6.56	-28.11	T2	8/24/2002
LEAFHOPPERT2RIO	0.85	-28.55	T2	8/24/2002
MIDGET2RIO	3.24	-25.35	T2	8/24/2002
AQ PLANT78	4.16	-25.39	E1	9/3/2002
LEAFHOPPER86	1.71	-28.13	E1	9/3/2002
LEAFHOPPER88	-0.89	-30.60	E1	9/3/2002
MAYFLY AND CRAYFISH96	0.35	-33.99	E1	9/3/2002
MIDGE71	1.93	-36.85	E1	9/3/2002
PLANT TERR FAR93	-3.37	-30.17	E1	9/3/2002
PLANT TERR NEAR89	-0.67	-29.97	E1	9/3/2002
PLANT TERR NEAR90	-0.21	-30.94	E1	9/3/2002
PLANT TERR NEAR92	-4.16	-29.46	E1	9/3/2002
WOLFSPIDER76	6.29	-25.18	E1	9/3/2002
PERIDETRITUS98	0.13	-27.84	E1	9/3/2002
PHYTOE19-3	1.92	-31.29	E1	9/3/2002
ZOOE19-3	1.73	-30.67	E1	9/3/2002
AQ PLANT82	6.79	-23.89	E2	9/3/2002
DRAGONFLY LARVAE80	3.87	-31.34	E2	9/3/2002
LEAFHOPPER85	3.86	-27.69	E2	9/3/2002
WOLFSPIDER84	7.01	-25.39	E2	9/3/2002
PERIDETRITUS99	-0.46	-28.82	E2	9/3/2002

ZOOE29-3	0.77	-29.24	E2	9/3/2002
PHYTOT19-3	0.51	-29.46	T1	9/3/2002
ZOOT19-3	1.31	-29.12	T1	9/3/2002
AQ PLANT15	4.77	-24.58	E1	9/9/2002
DRAGONFLY LARVAE32	3.73	-32.62	E1	9/9/2002
LEAFHOPPER38	2.16	-30.96	E1	9/9/2002
PLANT TERR FAR26	-3.57	-29.85	E1	9/9/2002
PLANT TERR NEAR16	-2.29	-30.62	E1	9/9/2002
PLANT TERR NEAR19	-1.26	-32.15	E1	9/9/2002
WOLFSPIDER35	7.48	-25.13	E1	9/9/2002
PHYTOE19-9	-0.35	-31.70	E1	9/9/2002
PHYTOE29-3	-0.07	-30.31	E1	9/9/2002
ZOOE19-9		-27.46	E1	9/9/2002
AQ PLANT13	10.04	-25.83	E2	9/9/2002
DRAGONFLY LARVAE1	4.20	-31.96	E2	9/9/2002
LEAFHOPPER7	1.89	-27.92	E2	9/9/2002
PLANT TERR FAR23	-2.08	-30.52	E2	9/9/2002
PLANT TERR FAR24	0.83	-31.80	E2	9/9/2002
PLANT TERR NEAR29	0.91	-30.96	E2	9/9/2002
PHYTOE29-9	1.48	-29.97	E2	9/9/2002
WOLFSPIDER10	5.75	-26.98	E2	9/9/2002
ZOOE29-9	1.25	-27.96	E2	9/9/2002
PHYTOT19-9	-2.25	-30.82	T1	9/9/2002
ZOOT19-9	-2.15	-30.35	T1	9/9/2002
AQ PLANT109	9.20	-27.16	E1	9/17/2002
DRAGONFLY LARVAE101	3.96	-32.67	E1	9/17/2002
LEAFHOPPER7	2.42	-28.17	E1	9/17/2002
MIDGE104-106	3.15	-28.54	E1	9/17/2002
PLANT TERR FAR113	-2.22	-31.22	E1	9/17/2002
PLANT TERR FAR114	-3.41	-31.44	E1	9/17/2002
PLANT TERR NEAR110	-1.78	-30.41	E1	9/17/2002
PLANT TERR NEAR112	-0.71	-31.32	E1	9/17/2002
WOLFSPIDER123.124	6.61	-25.77	E1	9/17/2002
PERIDETRITUS142	1.10	-26.72	E1	9/17/2002
PHYTOE19-17	1.32	-29.10	E1	9/17/2002
ZOOE19-17	5.21	-29.78	E1	9/17/2002
AQ PLANT108	3.10	-23.57	E2	9/17/2002
LEAFHOPPER127-131	-0.18	-28.34	E2	9/17/2002
MIDGE100		-31.49	E2	9/17/2002
PLANT TERR FAR133	-2.02	-29.97	E2	9/17/2002
PLANT TERR FAR135	-0.84	-29.46	E2	9/17/2002
PLANT TERR NEAR139	-0.37	-30.80	E2	9/17/2002
WOLFSPIDER126	6.55	-26.11	E2	9/17/2002
PERIDETRITUS143	0.59	-28.09	E2	9/17/2002
PHYTOE29-17		-28.91	E2	9/17/2002
ZOOE29-17	0.13	-28.44	E2	9/17/2002
PHYTOT19-17	0.96	-29.47	T1	9/17/2002
ZOOT19-17	0.48	-29.69	T1	9/17/2002

Appendix G. 2004 Experiment – Data for Terrestrial and Aquatic Predators. Count, mass, size, mass-size regressions, reproductive status, and species for i. wolf spiders, ii. dragonfly larvae, iii. and iv. crayfish, and v. newts.

i. Wolf spiders. Species are abbreviated as follows: *P. ca.* = *Pirata cantralli*, *P. mil.* = *Pardosa milvina*, *P. moe.* = *Pardosa moesta*, *P. mon.* = *Pirata montanus*, *P. sed.* = *Pirata sedentarius*, *H. hue.* = Hogna huello, *R. rab.* = *Rabidosa rabida*. Species labeled with descriptors instead of a latin binomial are unidentified morpho species.

DATE	ENCL	TREAT	MASS(g)	FAMILY	SPP.	SEX	REPRO
5/19/2004	E10	S	0.0258	lycosidae	*H. hue.*	juv/f	
5/19/2004	E10	S	0.0018	lycosidae	*P. ca.*	juv	
5/19/2004	E10	S	0.0017	lycosidae	*P. ca.*	juv	
5/19/2004	E10	S	0.0026	lycosidae	*P. ca.*	juv	
5/19/2004	E10	S	0.0027	lycosidae	*P. ca.*	juv	
5/19/2004	E10	S	0.0136	lycosidae	*P. ca.*	m	
5/19/2004	E10	S	0.001	lycosidae	*P. ca.*	juv	
5/19/2004	E10	S	0.0006	lycosidae	*P. ca.*	juv	
5/19/2004	E10	S	0.0017	lycosidae	*P. ca.*	juv	
5/19/2004	E10	S	0.0157	lycosidae	*P. ca.*	m	
5/19/2004	E10	S	0.0093	lycosidae	*P. mil.*	f	
5/19/2004	E10	S	0.0137	lycosidae	*P. mil.*	m	
5/19/2004	E10	S	0.0071	lycosidae	*P. mil.*	f/juv	
5/19/2004	E10	S	0.0259	lycosidae	*P. mil.*	f	egg
5/19/2004	E10	S	0.0332	lycosidae	*P. mil.*	f	egg
5/19/2004	E10	S	0.024	lycosidae	*P. moe.*	f	
5/19/2004	E11	NS	0.0041	lycosidae	*P. ca.*	m/juv	
5/19/2004	E11	NS	0.0255	lycosidae	*P. ca.*	f	
5/19/2004	E11	NS	0.0134	lycosidae	*P. ca.*	m	
5/19/2004	E11	NS	0.0135	lycosidae	*P. ca.*	m	
5/19/2004	E11	NS	0.04	lycosidae	*P. ca.*	juv/m	
5/19/2004	E11	NS	0.0086	lycosidae	*P. ca.*	m	
5/19/2004	E11	NS	0.0077	lycosidae	*P. ca.*	juv	
5/19/2004	E11	NS	0.0034	lycosidae	*P. ca.*	juv	
5/19/2004	E11	NS	0.0075	lycosidae	*P. ca.*	m/juv	
5/19/2004	E11	NS	0.0095	lycosidae	*P. mil.*	f	
5/19/2004	E12	NC	0.0013	lycosidae	*P. ca.*	juv	
5/19/2004	E12	NC	0.0106	lycosidae	*P. ca.*	f	
5/19/2004	E12	NC	0.0015	lycosidae	*P. ca.*	juv	
5/19/2004	E12	NC	0.0085	lycosidae	*P. ca.*	f	
5/19/2004	E12	NC	0.0153	lycosidae	*P. mil.*	f	
5/19/2004	E12	NC	0.0105	lycosidae	*P. mil.*	m	

5/19/2004	E12	NC	0.0115	lycosidae	*P. mil.*	f	
5/19/2004	E12	NC	0.0109	lycosidae	*P. mil.*	m	
5/19/2004	E12	NC	0.0064	lycosidae	*P. mil.*	m	
5/19/2004	E12	NC	0.0048	lycosidae	*P. mil.*	juv	
5/19/2004	E12	NC	0.0097	lycosidae	*P. mil.*	f	
5/19/2004	E12	NC	0.016	lycosidae	*P. mil.*	f	
5/19/2004	E12	NC	0.0088	lycosidae	*P. mil.*	m	
5/19/2004	E12	NC	0.0042	lycosidae	*P. mil.*	juv	
5/19/2004	E12	NC	0.0203	lycosidae	*P. mil.*	f	
5/19/2004	E12	NC	0.0045	lycosidae	*P. mil.*	juv	
5/19/2004	E12	NC	0.012	lycosidae	*P. mil.*	m	
5/19/2004	E12	NC	0.007	lycosidae	*P. mil.*	m	
5/19/2004	E12	NC	0.0075	lycosidae	*P. sed.*	f/juv	
5/19/2004	E13	S	0.2007	lycosidae	*H. hue.*	f	
5/19/2004	E13	S	0.0015	lycosidae	*P. ca.*	juv	
5/19/2004	E13	S	0.007	lycosidae	*P. ca.*	m/juv	
5/19/2004	E13	S	0.0125	lycosidae	*P. ca.*	f	
5/19/2004	E13	S	0.019	lycosidae	*P. ca.*	f	
5/19/2004	E13	S	0.0211	lycosidae	*P. ca.*	f	
5/19/2004	E13	S	0.0033	lycosidae	*P. ca.*	juv	
5/19/2004	E13	S	0.0116	lycosidae	*P. ca.*	f	
5/19/2004	E13	S	0.0182	lycosidae	*P. ca.*	f	
5/19/2004	E13	S	0.0016	lycosidae	*P. ca.*	juv	
5/19/2004	E13	S	0.0357	lycosidae	*P. moe.*	f	egg
5/19/2004	E13	S	0.013	lycosidae	*P. moe.*	f	
5/19/2004	E13	S	0.009	lycosidae	*P. moe.*	m	
5/19/2004	E13	S	0.0074	lycosidae	*P. moe.*	f/juv	
5/19/2004	E14	NS	0.0025	lycosidae	*? P. moe.*	juv	
5/19/2004	E14	NS	0.0194	lycosidae	*H. hue.*	f/juv	
5/19/2004	E14	NS	0.0144	lycosidae	*P. ca.*	f	
5/19/2004	E14	NS	0.0097	lycosidae	*P. ca.*	f	
5/19/2004	E14	NS	0.0024	lycosidae	*P. ca.*	juv	
5/19/2004	E14	NS	0.0015	lycosidae	*P. ca.*	juv	
5/19/2004	E14	NS	0.005	lycosidae	*P. ca.*	juv/m	
5/19/2004	E14	NS	0.0149	lycosidae	*P. ca.*	m	
5/19/2004	E14	NS	0.0049	lycosidae	*P. ca.*	juv	
5/19/2004	E14	NS	0.0124	lycosidae	*P. ca.*	m/juv	
5/19/2004	E14	NS	0.0061	lycosidae	*P. ca.*	f/juv	
5/19/2004	E14	NS	0.0065	lycosidae	*P. mil.*	juv	
5/19/2004	E14	NS	0.009	lycosidae	*P. mil.*	juv	
5/19/2004	E14	NS	0.0066	lycosidae	*P. mil.*	m	
5/19/2004	E14	NS	0.0173	lycosidae	*P. mil.*	m	
5/19/2004	E14	NS	0.0058	lycosidae	*P. mil.*	f/juv	
5/19/2004	E14	NS	0.0111	lycosidae	*P. mil.*	f	
5/19/2004	E14	NS	0.0091	lycosidae	*P. mil.*	m/juv	
5/19/2004	E15	PR	0.2233	lycosidae	*H. hue.*	f	
5/19/2004	E15	PR	0.0397	lycosidae	*H. hue.*	f/juv	
5/19/2004	E15	PR	0.0041	lycosidae	*P. ca.*	juv	
5/19/2004	E15	PR	0.0026	lycosidae	*P. ca.*	juv	
5/19/2004	E15	PR	0.0276	lycosidae	*P. ca.*	f	

5/19/2004	E15	PR	0.0051	lycosidae	*P. ca.*	juv/f	
5/19/2004	E15	PR	0.0045	lycosidae	*P. ca.*	juv	
5/19/2004	E15	PR	0.0068	lycosidae	*P. ca.*	f	
5/19/2004	E15	PR	0.0045	lycosidae	*P. mil.*	juv	
5/19/2004	E15	PR	0.0185	lycosidae	*P. mil.*	f	
5/19/2004	E15	PR	0.0112	lycosidae	*P. mil.*	f	
5/19/2004	E15	PR	0.0332	lycosidae	*P. mil.*	f	egg
5/19/2004	E15	PR	0.0056	lycosidae	*P. mil.*	juv	
5/19/2004	E15	PR	0.0051	lycosidae	*P. mil.*	juv/m	
5/19/2004	E15	PR	0.0157	lycosidae	*P. mil.*	m	
5/19/2004	E15	PR	0.0152	lycosidae	*P. mil.*	f	
5/19/2004	E15	PR	0.0111	lycosidae	*P. mil.*	f	
5/19/2004	E15	PR	0.012	lycosidae	*P. moe.*	f	
5/19/2004	E15	PR	0.0257	lycosidae	*P. moe.*	f	
5/19/2004	E15	PR	0.0172	lycosidae	*P. moe.*	f	
5/20/2004	E1	NS	0.0157	lycosidae	*P. ca.*	m	
5/20/2004	E1	NS	0.0203	lycosidae	*P. ca.*	f	
5/20/2004	E1	NS	0.0014	lycosidae	*P. ca.*	m	
5/20/2004	E1	NS	0.0079	lycosidae	*P. ca.*	f/juv	
5/20/2004	E1	NS	0.0029	lycosidae	*P. ca.*	juv	
5/20/2004	E1	NS	0.0185	lycosidae	*P. ca.*	f	
5/20/2004	E1	NS	0.0056	lycosidae	*P. ca.*	juv	
5/20/2004	E1	NS	0.0006	lycosidae	*P. ca.*	juv	
5/20/2004	E1	NS	0.0034	lycosidae	*P. ca.*	juv	
5/20/2004	E1	NS	0.0248	lycosidae	*P. ca.*	f	
5/20/2004	E1	NS	0.0115	lycosidae	*P. mil.*	juv/f	
5/20/2004	E1	NS	0.0094	lycosidae	*P. mil.*	f/juv	
5/20/2004	E1	NS	0.024	lycosidae	*P. moe.*	f	gravid
5/20/2004	E1	NS	0.0191	lycosidae	*P. moe.*	f	
5/20/2004	E1	NS	0.0382	lycosidae	*P. moe.*	f	gravid
5/20/2004	E1	NS	0.0144	lycosidae	*P. moe.*	m	gravid
5/20/2004	E2	S	0.0245	lycosidae	*?H. hue.*	f	
5/20/2004	E2	S	0.0216	lycosidae	*P. ca.*	f	
5/20/2004	E2	S	0.0163	lycosidae	*P. ca.*	f	
5/20/2004	E2	S	0.017	lycosidae	*P. ca.*	m	
5/20/2004	E2	S	0.0051	lycosidae	*P. ca.*	juv/f	
5/20/2004	E2	S	0.0155	lycosidae	*P. ca.*	m	
5/20/2004	E2	S	0.0118	lycosidae	*P. ca.*	m	
5/20/2004	E2	S	0.0042	lycosidae	*P. ca.*	juv	
5/20/2004	E2	S	0.0012	lycosidae	*P. ca.*	juv	
5/20/2004	E2	S	0.0171	lycosidae	*P. ca.*	f	
5/20/2004	E2	S	0.014	lycosidae	*P. ca.*	m	
5/20/2004	E2	S	0.0027	lycosidae	*P. ca.*	juv	
5/20/2004	E2	S	0.0265	lycosidae	*P. ca.*	f	
5/20/2004	E2	S	0.0249	lycosidae	*P. ca.*	f	
5/26/2004	E3	NS	0.0038	lycosidae	*P. ca.*	m/juv	
5/26/2004	E3	NS	0.0018	lycosidae	*P. ca.*	juv	
5/26/2004	E3	NS	0.0028	lycosidae	*P. ca.*	m/juv	
5/26/2004	E3	NS	0.0029	lycosidae	*P. ca.*	m/juv	
5/26/2004	E3	NS	0.0001	lycosidae	*P. ca.*	juv	

5/26/2004	E3	NS	0.0025	lycosidae	*P. ca.*	juv	
5/26/2004	E3	NS	0.0308	lycosidae	*P. ca.*	f	
5/26/2004	E3	NS	0.0049	lycosidae	*P. ca.*	m/juv	
5/26/2004	E3	NS	0.0425	lycosidae	*P. ca.*	f	egg
5/26/2004	E3	NS	0.0036	lycosidae	*P. ca.*	juv	
5/26/2004	E3	NS	0.0099	lycosidae	*P. mil.*	f	
5/26/2004	E3	NS	0.0163	lycosidae	*P. moe.*	f	
5/26/2004	E3	NS	0.0002	lycosidae	*pirata*	juv	
5/26/2004	E3	NS	0.0254	lycosidae	*R. rab.*	f	
5/26/2004	E5	PR	0.0011	lycosidae	.		
5/26/2004	E5	PR	0.0027	lycosidae	.		
5/26/2004	E5	PR	0.0064	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0057	lycosidae	*P. ca.*	m/juv	
5/26/2004	E5	PR	0.002	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0068	lycosidae	*P. ca.*	m/juv	
5/26/2004	E5	PR	0.0062	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0322	lycosidae	*P. ca.*	f	gravid
5/26/2004	E5	PR	0.0074	lycosidae	*P. ca.*	m/juv	
5/26/2004	E5	PR	0.0047	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0049	lycosidae	*P. ca.*	m	
5/26/2004	E5	PR	0.0084	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0112	lycosidae	*P. ca.*	m/juv	
5/26/2004	E5	PR	0.0271	lycosidae	*P. ca.*	f	
5/26/2004	E5	PR	0.0065	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0126	lycosidae	*P. ca.*	m	
5/26/2004	E5	PR	0.0005	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0042	lycosidae	*P. ca.*	m/juv	
5/26/2004	E5	PR	0.0089	lycosidae	*P. ca.*	f/juv	
5/26/2004	E5	PR	0.0021	lycosidae	*P. ca.*	juv	
5/26/2004	E5	PR	0.0087	lycosidae	*P. mil.*	f/juv	
5/26/2004	E5	PR	0.0041	lycosidae	*P. mil.*	m/juv	
5/26/2004	E5	PR	0.0417	lycosidae	*P. moe.*	f	
5/26/2004	E5	PR	0.0167	lycosidae	*P. moe.*	f	
5/26/2004	E5	PR	0.0221	lycosidae	*P. moe.*	f	
5/26/2004	E5	PR	0.0658	lycosidae	*R. rab.*	f	
5/26/2004	E6	NC	0.0865	lycosidae	*H. hue.*	m	
5/26/2004	E6	NC	0.006	lycosidae	*P. ca.*	m/juv	
5/26/2004	E6	NC	0.0159	lycosidae	*P. ca.*	m	
5/26/2004	E6	NC	0.0056	lycosidae	*P. ca.*	m/juv	
5/26/2004	E6	NC	0.0034	lycosidae	*P. ca.*	m/juv	
5/26/2004	E6	NC	0.0056	lycosidae	*P. ca.*	juv	
5/26/2004	E6	NC	0.0404	lycosidae	*P. ca.*	f	egg
5/26/2004	E6	NC	0.0374	lycosidae	*P. ca.*	f	egg
5/26/2004	E6	NC	0.0095	lycosidae	*P. ca.*	juv	
5/26/2004	E6	NC	0.0111	lycosidae	*P. ca.*	m	
5/26/2004	E6	NC	0.0297	lycosidae	*P. ca.*	f	egg
5/26/2004	E6	NC	0.0072	lycosidae	*P. ca.*	m/juv	
5/26/2004	E6	NC	0.002	lycosidae	*P. ca.*	juv	
5/26/2004	E6	NC	0.0091	lycosidae	*P. ca.*	m	
5/26/2004	E6	NC	0.0318	lycosidae	*P. ca.*	f	egg

5/26/2004	E6	NC	0.0052	lycosidae	*P. ca.*	m	
5/26/2004	E6	NC	0.0138	lycosidae	*P. ca.*	m	
5/26/2004	E6	NC	0.0043	lycosidae	*P. ca.*	juv	
5/26/2004	E6	NC	0.037	lycosidae	*P. ca.*	f	gravid?
5/26/2004	E6	NC	0.0134	lycosidae	*P. ca.*	m	
5/26/2004	E6	NC	0.0185	lycosidae	*P. ca.*	f	
5/26/2004	E6	NC	0.0088	lycosidae	*P. ca.*	m/juv	
5/26/2004	E6	NC	0.0141	lycosidae	*P. ca.*	juv	
5/26/2004	E6	NC	0.0084	lycosidae	*P. ca.*	f/juv	
5/26/2004	E6	NC	0.0043	lycosidae	*P. ca.*	juv	
5/26/2004	E6	NC	0.0094	lycosidae	*P. mil.*	f/juv	
5/26/2004	E6	NC	0.0308	lycosidae	*P. mil.*	f	egg
5/26/2004	E6	NC	0.0455	lycosidae	*P. moe.*	f	egg
5/27/2004	E4	S	0.0285	lycosidae	*?*	f	
5/27/2004	E4	S	0.4815	lycosidae	*lycosidae*	f	
5/27/2004	E4	S	0.0006	lycosidae	*lycosidae*		squished
5/27/2004	E4	S	0.0005	lycosidae	*P. ca.*	juv	
5/27/2004	E4	S	0.0212	lycosidae	*P. ca.*	f	
5/27/2004	E4	S	0.0136	lycosidae	*P. ca.*	m	
5/27/2004	E4	S	0.002	lycosidae	*P. ca.*	juv	
5/27/2004	E4	S	0.0074	lycosidae	*P. ca.*	juv	
5/27/2004	E4	S	0.0145	lycosidae	*P. ca.*	m	
5/27/2004	E4	S	0.0096	lycosidae	*P. ca.*	m/juv	
5/27/2004	E4	S	0.0081	lycosidae	*P. ca.*	m	
5/27/2004	E4	S	0.0054	lycosidae	*P. ca.*	f/juv	
5/27/2004	E4	S	0.009	lycosidae	*P. ca.*	m	
5/27/2004	E4	S	0.0021	lycosidae	*P. ca.*	juv	
5/27/2004	E4	S	0.0043	lycosidae	*P. ca.*	juv	
5/27/2004	E4	S	0.008	lycosidae	*P. ca.*	juv	
5/27/2004	E4	S	0.0021	lycosidae	*P. ca.*	juv	
5/27/2004	E4	S	0.0124	lycosidae	*P. mil.*	m	
5/27/2004	E4	S	0.0313	lycosidae	*P. moe.*	f	gravid
5/27/2004	E7	S	0.0153	lycosidae	*P. ca.*	m	
5/27/2004	E7	S	0.0053	lycosidae	*P. ca.*	j	
5/27/2004	E7	S	0.0057	lycosidae	*P. ca.*	j	
5/27/2004	E7	S	0.03	lycosidae	*P. ca.*	f	gravid
5/27/2004	E7	S	0.0097	lycosidae	*P. ca.*	m/juv	
5/27/2004	E7	S	0.0013	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0037	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0016	lycosidae	*P. ca.*	m/juv	
5/27/2004	E7	S	0.0024	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0037	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0278	lycosidae	*P. ca.*	f	
5/27/2004	E7	S	0.0106	lycosidae	*P. ca.*	m	
5/27/2004	E7	S	0.0019	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0034	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0029	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0018	lycosidae	*P. ca.*	juv	
5/27/2004	E7	S	0.0037	lycosidae	*P. ca.*	m/juv	
5/27/2004	E7	S	0.0031	lycosidae	*P. ca.*	juv	

5/27/2004	E7	S	0.0013	lycosidae	*pirata odd*	juv	
5/27/2004	E7	S	0.0016	lycosidae	*pirata odd*	juv	
5/27/2004	E8	PR	0.0038	lycosidae	*lycosidae*		squished
5/27/2004	E8	PR	0.0034	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0046	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0017	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0021	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0035	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0359	lycosidae	*P. ca.*	f	egg
5/27/2004	E8	PR	0.0042	lycosidae	*P. ca.*	f/juv	
5/27/2004	E8	PR	0.0017	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.007	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0033	lycosidae	*P. ca.*	m/juv	
5/27/2004	E8	PR	0.0021	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0085	lycosidae	*P. ca.*	f	
5/27/2004	E8	PR	0.0025	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.008	lycosidae	*P. ca.*	m/juv	
5/27/2004	E8	PR	0.025	lycosidae	*P. ca.*	f	
5/27/2004	E8	PR	0.034	lycosidae	*P. ca.*	f	
5/27/2004	E8	PR	0.0028	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0047	lycosidae	*P. ca.*	juv	
5/27/2004	E8	PR	0.0144	lycosidae	*P. ca.*	m	
5/27/2004	E8	PR	0.0093	lycosidae	*P. mil.*	m	
5/27/2004	E8	PR	0.019	lycosidae	*pirata odd*	f	
5/27/2004	E8	PR	0.0829	lycosidae	*R. rab.*	f	
5/27/2004	E9	NS	0.0375	lycosidae	*lycosidae*	f	
5/27/2004	E9	NS	0.0124	lycosidae	*P. ca.*	m/juv	
5/27/2004	E9	NS	0.0378	lycosidae	*P. ca.*	f	egg
5/27/2004	E9	NS	0.005	lycosidae	*P. ca.*	m/juv	
5/27/2004	E9	NS	0.0026	lycosidae	*P. ca.*	juv	
5/27/2004	E9	NS	0.0064	lycosidae	*P. ca.*	m/juv	
5/27/2004	E9	NS	0.0484	lycosidae	*P. ca.*	f	gravid
5/27/2004	E9	NS	0.0003	lycosidae	*P. ca.*	m/juv	
5/27/2004	E9	NS	0.0047	lycosidae	*P. ca.*	m/juv	
5/27/2004	E9	NS	0.0052	lycosidae	*P. ca.*	m	
5/27/2004	E9	NS	0.0139	lycosidae	*P. ca.*	m	
5/27/2004	E9	NS	0.0085	lycosidae	*P. ca.*	m	
5/27/2004	E9	NS	0.0372	lycosidae	*P. ca.*	f	gravid
5/27/2004	E9	NS	0.0025	lycosidae	*P. ca.*	juv	
5/27/2004	E9	NS	0.0021	lycosidae	*P. ca.*	juv	
5/27/2004	E9	NS	0.0362	lycosidae	*P. ca.*	f	egg
5/27/2004	E9	NS	0.0011	lycosidae	*P. ca.*	juv	
5/27/2004	E9	NS	0.0171	lycosidae	*P. mil.*	m	
5/27/2004	E9	NS	0.0113	lycosidae	*P. mon.*	m	
6/1/2004	E17	NC	0.0162	lycosidae	*P. ca.*	juv/f	
6/1/2004	E17	NC	0.0049	lycosidae	*P. ca.*	juv	
6/1/2004	E17	NC	0.0263	lycosidae	*P. ca.*	f	
6/1/2004	E17	NC	0.004	lycosidae	*P. ca.*	juv/f	
6/1/2004	E17	NC	0.0115	lycosidae	*P. ca.*	m/juv	
6/1/2004	E17	NC	0.0293	lycosidae	*P. ca.*	f	egg

6/1/2004	E17	NC	0.0072	lycosidae	*P. ca.*	juv/f	
6/1/2004	E17	NC	0.0034	lycosidae	*P. ca.*	juv	
6/1/2004	E17	NC	0.0123	lycosidae	*P. mil.*	f	
6/1/2004	E17	NC	0.0144	lycosidae	*P. mil.*	m	
6/1/2004	E17	NC	0.0221	lycosidae	*P. mil.*	f	
6/1/2004	E17	NC	0.0128	lycosidae	*P. mil.*	m	
6/1/2004	E17	NC	0.037	lycosidae	*P. mil.*	f	gravid
6/1/2004	E17	NC	0.0101	lycosidae	*P. mil.*	f	
6/1/2004	E17	NC	0.0413	lycosidae	*P. mil.*	f	egg
6/1/2004	E17	NC	0.0192	lycosidae	*P. mil.*	f	
6/1/2004	E17	NC	0.0057	lycosidae	*P. mil.*	juv	
6/1/2004	E17	NC	0.0429	lycosidae	*P. mil.*	f	egg
6/1/2004	E17	NC	0.0502	lycosidae	*P. moe.*	f	egg
6/1/2004	E17	NC	0.0338	lycosidae	*R. rab.*	f	
6/1/2004	E18	PR	0.0183	lycosidae	*H. hue.*	f	
6/1/2004	E18	PR	0.0146	lycosidae	*P. ca.*	m	
6/1/2004	E18	PR	0.0052	lycosidae	*P. ca.*	juv/m	
6/1/2004	E18	PR	0.0031	lycosidae	*P. ca.*	juv	
6/1/2004	E18	PR	0.0018	lycosidae	*P. ca.*	juv	
6/1/2004	E18	PR	0.0065	lycosidae	*P. ca.*	f/juv	
6/1/2004	E18	PR	0.0068	lycosidae	*P. ca.*	f/juv	
6/1/2004	E18	PR	0.013	lycosidae	*P. ca.*	f	
6/1/2004	E18	PR	0.0059	lycosidae	*P. ca.*	f/juv	
6/1/2004	E18	PR	0.0093	lycosidae	*P. ca.*	f/juv	
6/1/2004	E18	PR	0.0016	lycosidae	*P. ca.*	juv	
6/1/2004	E18	PR	0.0032	lycosidae	*P. ca.*	juv	
6/1/2004	E18	PR	0.0101	lycosidae	*P. ca.*	m	
6/1/2004	E18	PR	0.0017	lycosidae	*P. ca.*	juv	
6/1/2004	E18	PR	0.0081	lycosidae	*P. ca.*	m/juv	
6/1/2004	E18	PR	0.0049	lycosidae	*P. ca.*	juv	
6/1/2004	E18	PR	0.0046	lycosidae	*P. ca.*	juv	
6/1/2004	E18	PR	0.0134	lycosidae	*P. ca.*	f	
6/1/2004	E18	PR	0.0122	lycosidae	*P. mil.*	m	
6/1/2004	E18	PR	0.0053	lycosidae	*P. mil.*	juv/m	
6/1/2004	E18	PR	0.015	lycosidae	*P. mil.*	f	
6/1/2004	E18	PR	0.0172	lycosidae	*P. mil.*	f	
6/1/2004	E18	PR	0.0078	lycosidae	*P. mil.*	m	
6/1/2004	E18	PR	0.0032	lycosidae	*P. moe.*	juv	
6/1/2004	E18	PR	0.0388	lycosidae	*P. moe.*	f	egg
6/1/2004	E18	PR	0.0381	lycosidae	*P. moe.*	f	egg
6/1/2004	E18	PR	0.0317	lycosidae	*P. moe.*	f	
6/1/2004	E18	PR	0.0085	lycosidae	*P. sed.*	juv/f	
6/1/2004	E18	PR	0.0035	lycosidae	*P. sed.*	juv	
6/1/2004	E18	PR	0.003	lycosidae	*P. sed.*	juv/f	
6/1/2004	E18	PR	0.0048	lycosidae	*P. sed.*	juv/f	
6/1/2004	E18	PR	0.0019	lycosidae	*P. sed.*	juv	
6/1/2004	E19	S	0.0094	lycosidae	*P. ca.*	f	
6/1/2004	E19	S	0.0025	lycosidae	*P. ca.*	juv	
6/1/2004	E19	S	0.0028	lycosidae	*P. ca.*	juv	
6/1/2004	E19	S	0.002	lycosidae	*P. ca.*	juv	

6/1/2004	E19	S	0.0013	lycosidae	*P. ca.*	juv	
6/1/2004	E19	S	0.0376	lycosidae	*P. ca.*	f	gravid
6/1/2004	E19	S	0.0046	lycosidae	*P. ca.*	juv/f	
6/1/2004	E19	S	0.0033	lycosidae	*P. ca.*	juv/m	
6/1/2004	E19	S	0.0379	lycosidae	*P. ca.*	f	egg
6/1/2004	E19	S	0.0118	lycosidae	*P. ca.*	f	
6/1/2004	E19	S	0.0125	lycosidae	*P. ca.*	m	
6/1/2004	E19	S	0.0277	lycosidae	*P. ca.*	f	
6/1/2004	E19	S	0.0044	lycosidae	*P. ca.*	juv/m	
6/1/2004	E19	S	0.0015	lycosidae	*P. ca.*	juv	
6/1/2004	E19	S	0.0109	lycosidae	*P. ca.*	m	
6/1/2004	E19	S	0.0505	lycosidae	*P. ca.*	f	egg
6/1/2004	E19	S	0.0095	lycosidae	*P. ca.*	f	
6/1/2004	E19	S	0.0114	lycosidae	*P. ca.*	m/juv	
6/1/2004	E19	S	0.0022	lycosidae	*P. mil.*	juv	
6/1/2004	E20	NS	0.0015	lycosidae	*P. ca.*	baby	
6/1/2004	E20	NS	0.0019	lycosidae	*P. ca.*	juv	
6/1/2004	E20	NS	0.0151	lycosidae	*P. ca.*	m	
6/1/2004	E20	NS	0.0034	lycosidae	*P. ca.*	juv	
6/1/2004	E20	NS	0.0155	lycosidae	*P. ca.*	f	
6/1/2004	E20	NS	0.0047	lycosidae	*P. ca.*	juv/m	
6/1/2004	E20	NS	0.0021	lycosidae	*P. ca.*	juv	
6/1/2004	E20	NS	0.044	lycosidae	*P. ca.*	f	gravid
6/1/2004	E20	NS	0.0038	lycosidae	*P. ca.*	juv	
6/1/2004	E20	NS	0.0089	lycosidae	*P. ca.*	f/juv	
6/1/2004	E20	NS	0.0128	lycosidae	*P. ca.*	f	
6/1/2004	E20	NS	0.0022	lycosidae	*P. ca.*	juv	
6/1/2004	E20	NS	0.0455	lycosidae	*P. ca.*	f	egg
6/1/2004	E20	NS	0.004	lycosidae	*P. ca.*	m/juv	
6/1/2004	E20	NS	0.0084	lycosidae	*P. ca.*	m/juv	
6/1/2004	E20	NS	0.0043	lycosidae	*P. ca.*	juv/m	
6/1/2004	E20	NS	0.0142	lycosidae	*P. ca.*	m	
6/1/2004	E20	NS	0.0048	lycosidae	*P. ca.*	juv	
6/2/2004	E16	NC	0.0947	lycosidae	*lycosidae*	f	
6/2/2004	E16	NC	0.0175	lycosidae	*P. ca.*	m	
6/2/2004	E16	NC	0.0045	lycosidae	*P. ca.*	f/juv	
6/2/2004	E16	NC	0.0426	lycosidae	*P. ca.*	f	egg
6/2/2004	E16	NC	0.003	lycosidae	*P. ca.*	m/juv	
6/2/2004	E16	NC	0.0005	lycosidae	*P. ca.*	juv	
6/2/2004	E16	NC	0.0021	lycosidae	*P. ca.*	f/juv	
6/2/2004	E16	NC	0.0009	lycosidae	*P. ca.*	juv	
6/2/2004	E16	NC	0.0138	lycosidae	*P. mil.*	m	
6/2/2004	E16	NC	0.0089	lycosidae	*P. mil.*	f	
6/2/2004	E16	NC	0.0051	lycosidae	*P. mil.*	f/juv	
6/2/2004	E16	NC	0.0321	lycosidae	*P. mil.*	f	egg
6/2/2004	E16	NC	0.0233	lycosidae	*P. mil.*	f	egg
6/2/2004	E16	NC	0.0113	lycosidae	*pirata odd*	f	
6/2/2004	E16	NC	0.0003	lycosidae	*pirata odd*	juv	
6/2/2004	E16	NC	0.005	lycosidae	*pirata odd*	m/juv	
6/2/2004	E16	NC	0.0404	lycosidae	*R. rab.*	f	

6/2/2004	E16	NC	0.049	lycosidae	*R. rab.*	f	
6/2/2004	E16	NC	0.0429	lycosidae	*R. rab.*	f	
6/2/2004	E21	S	0.0135	lycosidae	*P. ca.*	m	
6/2/2004	E21	S	0.0223	lycosidae	*P. ca.*	f	gravid
6/2/2004	E21	S	0.006	lycosidae	*P. ca.*	m/juv	
6/2/2004	E21	S	0.0035	lycosidae	*P. ca.*	juv	
6/2/2004	E21	S	0.0072	lycosidae	*P. ca.*	m/juv	
6/2/2004	E21	S	0.0025	lycosidae	*P. ca.*	juv	
6/2/2004	E21	S	0.0153	lycosidae	*P. ca.*	m	
6/2/2004	E21	S	0.0288	lycosidae	*P. ca.*	f	gravid
6/2/2004	E21	S	0.0017	lycosidae	*P. ca.*	juv	
6/2/2004	E21	S	0.0059	lycosidae	*P. ca.*	juv/f	
6/2/2004	E21	S	0.0016	lycosidae	*P. ca.*	juv	
6/2/2004	E21	S	0.0317	lycosidae	*P. ca.*	f	egg
6/2/2004	E21	S	0.0112	lycosidae	*P. sed.*	f	
6/2/2004	E21	S	0.0075	lycosidae	*P. sed.*	m	
6/2/2004	E21	S	0.0325	lycosidae	*P. sed.*	f	egg
6/2/2004	E21	S	0.0314	lycosidae	*P. sed.*	f	gravid
6/2/2004	E22	NS	0.0045	lycosidae	*P. ca.*	juv/m	
6/2/2004	E22	NS	0.0105	lycosidae	*P. ca.*	m	
6/2/2004	E22	NS	0.0036	lycosidae	*P. ca.*	juv	
6/2/2004	E22	NS	0.0025	lycosidae	*P. ca.*	juv	
6/2/2004	E22	NS	0.0209	lycosidae	*P. ca.*	f	gravid
6/2/2004	E22	NS	0.0231	lycosidae	*P. ca.*	f	
6/2/2004	E22	NS	0.0021	lycosidae	*P. ca.*	juv	
6/2/2004	E22	NS	0.0143	lycosidae	*P. ca.*	m	
6/2/2004	E22	NS	0.0013	lycosidae	*P. ca.*	juv	
6/2/2004	E22	NS	0.0075	lycosidae	*P. ca.*	m/juv	
6/2/2004	E22	NS	0.0335	lycosidae	*P. sed.*	f	gravid
6/2/2004	E22	NS	0.0326	lycosidae	*P. sed.*	f	egg
6/2/2004	E22	NS	0.0119	lycosidae	*P. sed.*	f/juv	
6/2/2004	E22	NS	0.054	lycosidae	*P. sed.*	f	egg
6/2/2004	E22	NS	0.0077	lycosidae	*P. sed.*	f/juv	
6/2/2004	E22	NS	0.0241	lycosidae	*R. rab.*	f	
6/22/2004	E21	no	0.0078	lycosidae	*P. ca.*	f	.
6/22/2004	E21	no	0.0039	lycosidae	*P. ca.*	juv	.
6/22/2004	E21	no	0.0061	lycosidae	*P. ca.*	f	.
6/22/2004	E21	no	0.0039	lycosidae	*P. ca.*	juv	.
6/22/2004	E21	no	0.0287	lycosidae	*P. ca.*	f	egg
6/22/2004	E21	no	0.0046	lycosidae	*P. ca.*	f	.
6/22/2004	E21	no	0.0039	lycosidae	*P. ca.*	f	.
6/22/2004	E21	no	0.0158	lycosidae	*P. ca.*	m	.
6/22/2004	E21	no	0.0038	lycosidae	*P. ca.*	juv	.
6/22/2004	E21	no	0.0104	lycosidae	*P. ca.*	m	.
6/22/2004	E21	no	0.0063	lycosidae	*P. ca.*	f	.
6/22/2004	E21	no	0.0103	lycosidae	*P. ca.*	m	.
6/22/2004	E21	no	0.0048	lycosidae	*P. mon.*	f	.
6/22/2004	E21	no	0.0039	lycosidae	*P. sed.*	juv	.
6/22/2004	E21	no	0.0039	lycosidae	*P. sed.*	juv	.
6/22/2004	E21	no	0.0032	lycosidae	*P. sed.*	juv	.

6/22/2004	E21	no	0.0135	lycosidae	*P. sed.*	m	.
6/22/2004	E21	no	0.0061	lycosidae	*P. sed.*	f	.
6/22/2004	E22	no	0.0048	lycosidae	*P. ca.*	f	.
6/22/2004	E22	no	0.0016	lycosidae	*P. ca.*	f	egg
6/22/2004	E22	no	0.0226	lycosidae	*P. ca.*	f	.
6/22/2004	E22	no	0.0011	lycosidae	*P. ca.*	juv	.
6/22/2004	E22	no	0.0011	lycosidae	*P. ca.*	juv	.
6/22/2004	E22	no	0.0060	lycosidae	*P. ca.*	m	.
6/22/2004	E22	no	0.0084	lycosidae	*P. ca.*	f	.
6/22/2004	E22	no	0.0472	lycosidae	*P. ca.*	f	egg
6/22/2004	E22	no	0.0077	lycosidae	*P. ca.*	m	.
6/22/2004	E22	no	0.0042	lycosidae	*P. ca.*	juv/f	.
6/22/2004	E22	no	0.0038	lycosidae	*P. ca.*	juv	.
6/22/2004	E22	no	0.0039	lycosidae	*P. ca.*	juv	.
6/22/2004	E22	no	0.0083	lycosidae	*P. ca.*	f	.
6/22/2004	E22	no	0.0142	lycosidae	*P. ca.*	f	.
6/22/2004	E22	no	0.0043	lycosidae	*P. ca.*	juv	.
6/22/2004	E22	no	0.0033	lycosidae	*P. mon.*	juv	.
6/22/2004	E22	no	0.0316	lycosidae	*P. sed.*	f	egg
6/22/2004	E22	no	0.0128	lycosidae	*P. sed.*	m	.
6/22/2004	E22	no	0.0059	lycosidae	*pirata*	f	.
6/22/2004	E22	no	0.0144	lycosidae	*R. rab.*	f	.
6/22/2004	E22	no	0.0198	lycosidae	*R. rab.*	f	.
6/24/2004	E13	S	0.0021	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0337	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0287	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0065	lycosidae	*P. ca.*	juv/m	.
6/24/2004	E13	S	0.0088	lycosidae	*P. ca.*	m	.
6/24/2004	E13	S	0.0087	lycosidae	*P. ca.*	f	.
6/24/2004	E13	S	0.0036	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0037	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0331	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0486	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0021	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0077	lycosidae	*P. ca.*	m	.
6/24/2004	E13	S	0.0020	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0031	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0112	lycosidae	*P. ca.*	m	.
6/24/2004	E13	S	0.0080	lycosidae	*P. ca.*	m	.
6/24/2004	E13	S	0.0215	lycosidae	*P. ca.*	f	.
6/24/2004	E13	S	0.0040	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0366	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0333	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0360	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0119	lycosidae	*P. ca.*	f	.
6/24/2004	E13	S	0.0437	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0095	lycosidae	*P. ca.*	f	.
6/24/2004	E13	S	0.0303	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0171	lycosidae	*P. ca.*	f	.
6/24/2004	E13	S	0.0071	lycosidae	*P. ca.*	m	.

6/24/2004	E13	S	0.0084	lycosidae	*P. ca.*	m	.
6/24/2004	E13	S	0.0135	lycosidae	*P. ca.*	f	.
6/24/2004	E13	S	0.0056	lycosidae	*P. ca.*	juv	.
6/24/2004	E13	S	0.0097	lycosidae	*P. ca.*	f	.
6/24/2004	E13	S	0.0334	lycosidae	*P. ca.*	f	egg
6/24/2004	E13	S	0.0066	lycosidae	*P. ca.*	f/juv	.
6/24/2004	E13	S	0.0115	lycosidae	*P. ca.*	f	
6/24/2004	E13	S	0.0108	lycosidae	*P. mil.*	f	.
6/24/2004	E14	NS	0.0152	lycosidae	*?*	f	.
6/24/2004	E14	NS	0.0238	lycosidae	*P. ca.*	f	egg
6/24/2004	E14	NS	0.0356	lycosidae	*P. ca.*	f	egg
6/24/2004	E14	NS	0.0090	lycosidae	*P. ca.*	f	.
6/24/2004	E14	NS	0.0034	lycosidae	*P. ca.*	juv	.
6/24/2004	E14	NS	0.0013	lycosidae	*P. ca.*	juv	.
6/24/2004	E14	NS	0.0104	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0024	lycosidae	*P. ca.*	juv	.
6/24/2004	E14	NS	0.0078	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0071	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0066	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0359	lycosidae	*P. ca.*	f	.
6/24/2004	E14	NS	0.0063	lycosidae	*P. ca.*	f	.
6/24/2004	E14	NS	0.0061	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0019	lycosidae	*P. ca.*	juv	.
6/24/2004	E14	NS	0.0058	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0044	lycosidae	*P. ca.*	juv	.
6/24/2004	E14	NS	0.0074	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0045	lycosidae	*P. ca.*	juv/m	.
6/24/2004	E14	NS	0.0083	lycosidae	*P. ca.*	m	.
6/24/2004	E14	NS	0.0119	lycosidae	*P. ca.*	f	.
6/24/2004	E15	PR	0.0167	lycosidae	*P. ca.*	f	egg
6/24/2004	E15	PR	0.0109	lycosidae	*P. ca.*	m	.
6/24/2004	E15	PR	0.0031	lycosidae	*P. ca.*	juv	.
6/24/2004	E15	PR	0.0056	lycosidae	*P. ca.*	f	.
6/24/2004	E15	PR	0.0008	lycosidae	*P. mil.*	juv	.
6/24/2004	E15	PR	0.0105	lycosidae	*P. mil.*	m	.
6/24/2004	E15	PR	0.0128	lycosidae	*P. mil.*	f	.
6/24/2004	E15	PR	0.0351	lycosidae	*P. mil.*	f	egg
6/24/2004	E15	PR	0.0096	lycosidae	*pirata*	f	egg
6/24/2004	E15	PR	0.0062	lycosidae	*pirata*	f	.
6/24/2004	E15	PR	0.0116	lycosidae	*pirata*	f	egg
6/24/2004	E15	PR	0.0075	lycosidae	*pirata*	f	egg
6/24/2004	E15	PR	0.0023	lycosidae	*pirata*	m	.
6/24/2004	E15	PR	0.0098	lycosidae	*pirata*	f	egg
6/25/2004	E12	NC	0.0126	lycosidae	*fringe*	m/juv	
6/25/2004	E12	NC	0.0016	lycosidae	*fringe*	m	
6/25/2004	E12	NC	0.0157	lycosidae	*P. ca.*	m	
6/25/2004	E12	NC	0.0029	lycosidae	*P. ca.*	juv	
6/25/2004	E12	NC	0.0128	lycosidae	*P. ca.*	f	
6/25/2004	E12	NC	0.0092	lycosidae	*P. ca.*	f	
6/25/2004	E12	NC	0.0016	lycosidae	*P. ca.*	juv	

6/25/2004	E12	NC	0.0195	lycosidae	*P. ca.*	f	egg
6/25/2004	E12	NC	0.0039	lycosidae	*P. ca.*	juv	
6/25/2004	E12	NC	0.0137	lycosidae	*P. mil.*	m	
6/25/2004	E12	NC	0.0285	lycosidae	*P. mil.*	f	gravid
6/25/2004	E12	NC	0.0215	lycosidae	*P. mil.*	f	gravid
6/25/2004	E12	NC	0.0215	lycosidae	*P. mil.*	f	egg
6/25/2004	E12	NC	0.0284	lycosidae	*P. mil.*	f	egg
6/25/2004	E12	NC	0.0240	lycosidae	*P. sed.*	f	egg
6/25/2004	E12	NC	0.0064	lycosidae	*ysl*	f	
6/25/2004	E12	NC	0.0039	lycosidae	*ysl*	juv	
6/26/2004	E10	S	0.0075	lycosidae	*P. ca.*	m	.
6/26/2004	E10	S	0.0118	lycosidae	*P. ca.*	m	.
6/26/2004	E10	S	0.0126	lycosidae	*P. ca.*	f	.
6/26/2004	E10	S	0.0004	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0041	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0407	lycosidae	*P. ca.*	f	egg
6/26/2004	E10	S	0.0139	lycosidae	*P. ca.*	f	.
6/26/2004	E10	S	0.0039	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0105	lycosidae	*P. ca.*	m	.
6/26/2004	E10	S	0.0062	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0007	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0212	lycosidae	*P. ca.*	f	egg
6/26/2004	E10	S	0.0052	lycosidae	*P. ca.*	m	.
6/26/2004	E10	S	0.0104	lycosidae	*P. ca.*	f	.
6/26/2004	E10	S	0.0007	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0005	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0020	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0022	lycosidae	*P. ca.*	juv/f	.
6/26/2004	E10	S	0.0009	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0082	lycosidae	*P. ca.*	f	.
6/26/2004	E10	S	0.0025	lycosidae	*P. ca.*	juv	.
6/26/2004	E10	S	0.0310	lycosidae	*P. moe.*	f	egg
6/26/2004	E10	S	0.0017	lycosidae	*P. mon.*	juv	.
6/26/2004	E10	S	0.0030	lycosidae	*P. sed.*	juv/f	.
6/26/2004	E10	S	0.0025	lycosidae	*P. sed.*	f	egg
6/26/2004	E11	NS	0.0264	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0260	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0308	lycosidae	*P. ca.*	f	egg
6/26/2004	E11	NS	0.0239	lycosidae	*P. ca.*	m	.
6/26/2004	E11	NS	0.0350	lycosidae	*P. ca.*	m	.
6/26/2004	E11	NS	0.0133	lycosidae	*P. ca.*	juv	.
6/26/2004	E11	NS	0.0210	lycosidae	*P. ca.*	m	.
6/26/2004	E11	NS	0.0063	lycosidae	*P. ca.*	juv	.
6/26/2004	E11	NS	0.0072	lycosidae	*P. ca.*	m	.
6/26/2004	E11	NS	0.0079	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0011	lycosidae	*P. ca.*	juv	.
6/26/2004	E11	NS	0.0003	lycosidae	*P. ca.*	juv	.
6/26/2004	E11	NS	0.0062	lycosidae	*P. ca.*	m	.
6/26/2004	E11	NS	0.0290	lycosidae	*P. ca.*	f	egg
6/26/2004	E11	NS	0.0032	lycosidae	*P. ca.*	m	.

6/26/2004	E11	NS	0.0011	lycosidae	*P. ca.*	juv	.
6/26/2004	E11	NS	0.0109	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0079	lycosidae	*P. ca.*	m	.
6/26/2004	E11	NS	0.0332	lycosidae	*P. ca.*	f	egg
6/26/2004	E11	NS	0.0111	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0126	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0126	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0184	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0043	lycosidae	*P. ca.*	juv	.
6/26/2004	E11	NS	0.0056	lycosidae	*P. ca.*	juv	.
6/26/2004	E11	NS	0.0048	lycosidae	*P. ca.*	juv/f	.
6/26/2004	E11	NS	0.0327	lycosidae	*P. ca.*	f	egg
6/26/2004	E11	NS	0.0108	lycosidae	*P. ca.*	f	.
6/26/2004	E11	NS	0.0114	lycosidae	*P. mil.*	m	.
6/26/2004	E11	NS	0.0441	lycosidae	*P. moe.*	f	egg
6/26/2004	E11	NS	0.0370	lycosidae	*P. sed.*	f	egg
6/26/2004	E3	NS	0.0024	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0024	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0018	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0031	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0065	lycosidae	*P. ca.*	m/juv	
6/26/2004	E3	NS	0.0071	lycosidae	*P. ca.*	m	
6/26/2004	E3	NS	0.0351	lycosidae	*P. ca.*	f	egg
6/26/2004	E3	NS	0.0065	lycosidae	*P. ca.*	m	
6/26/2004	E3	NS	0.0042	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0022	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0079	lycosidae	*P. ca.*	f	
6/26/2004	E3	NS	0.0036	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0056	lycosidae	*P. ca.*	f/juv	
6/26/2004	E3	NS	0.0052	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0325	lycosidae	*P. ca.*	f	egg
6/26/2004	E3	NS	0.0203	lycosidae	*P. ca.*	f	egg
6/26/2004	E3	NS	0.0031	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0154	lycosidae	*P. ca.*	m	
6/26/2004	E3	NS	0.0066	lycosidae	*P. ca.*	m	
6/26/2004	E3	NS	0.0021	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0035	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0131	lycosidae	*P. ca.*	m	
6/26/2004	E3	NS	0.0025	lycosidae	*P. ca.*	juv	
6/26/2004	E3	NS	0.0098	lycosidae	*P. ca.*	f	
6/26/2004	E3	NS	0.0215	lycosidae	*P. mil.*	f	
6/26/2004	E3	NS	0.0109	lycosidae	*P. mil.*	f	
6/26/2004	E3	NS	0.0349	lycosidae	*P. moe.*	f	egg
6/26/2004	E3	NS	0.0298	lycosidae	*P. moe.*	f	egg
6/26/2004	E4	S	0.0122	lycosidae	*P. ca.*	f	.
6/26/2004	E4	S	0.0058	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0113	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0156	lycosidae	*P. ca.*	f	.
6/26/2004	E4	S	0.0274	lycosidae	*P. ca.*	m	.
6/26/2004	E4	S	0.0138	lycosidae	*P. ca.*	juv	.

6/26/2004	E4	S	0.0111	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0179	lycosidae	*P. ca.*	f	.
6/26/2004	E4	S	0.0101	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0215	lycosidae	*P. ca.*	f	.
6/26/2004	E4	S	0.0066	lycosidae	*P. ca.*	m	.
6/26/2004	E4	S	0.0045	lycosidae	*P. ca.*	m	.
6/26/2004	E4	S	0.0008	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0396	lycosidae	*P. ca.*	f	egg
6/26/2004	E4	S	0.0026	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0046	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0067	lycosidae	*P. ca.*	f	.
6/26/2004	E4	S	0.0095	lycosidae	*P. ca.*	f	.
6/26/2004	E4	S	0.0014	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0026	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0011	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0074	lycosidae	*P. ca.*	f	.
6/26/2004	E4	S	0.0038	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0164	lycosidae	*P. ca.*	f	egg
6/26/2004	E4	S	0.0012	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0025	lycosidae	*P. ca.*	juv	.
6/26/2004	E4	S	0.0304	lycosidae	*P. mil.*	f	egg
6/26/2004	E4	S	0.0207	lycosidae	*P. mil.*		.
6/26/2004	E4	S	0.0284	lycosidae	*P. mil.*	f	egg
6/26/2004	E4	S	0.0116	lycosidae	*P. mil.*	m	.
6/26/2004	E4	S	0.0448	lycosidae	*P. moe.*	f	egg
6/26/2004	E4	S	0.0446	lycosidae	*P. moe.*	f	egg
6/26/2004	E4	S	0.0217	lycosidae	*P. mon.*	f	.
6/26/2004	E4	S	0.0126	lycosidae	*P. sed.*	juv	.
6/26/2004	E4	S	0.0035	lycosidae	*P. sed.*	juv	.
6/26/2004	E5	PR	.	lycosidae	*dead*	juv	
6/26/2004	E5	PR	0.0199	lycosidae	*P. ca.*	m	.
6/26/2004	E5	PR	0.0189	lycosidae	*P. ca.*	f	.
6/26/2004	E5	PR	0.0081	lycosidae	*P. ca.*	juv	.
6/26/2004	E5	PR	0.0101	lycosidae	*P. ca.*	m	.
6/26/2004	E5	PR	0.0096	lycosidae	*P. ca.*	juv	.
6/26/2004	E5	PR	0.0073	lycosidae	*P. ca.*	juv	.
6/26/2004	E5	PR	0.0191	lycosidae	*P. ca.*	f	egg
6/26/2004	E5	PR	0.0374	lycosidae	*P. ca.*	f	egg
6/26/2004	E5	PR	0.0165	lycosidae	*P. ca.*	f	egg
6/26/2004	E5	PR	0.0029	lycosidae	*P. ca.*	juv	
6/26/2004	E5	PR	0.0152	lycosidae	*P. ca.*	m	
6/26/2004	E5	PR	0.0086	lycosidae	*P. ca.*	m	
6/26/2004	E5	PR	0.0066	lycosidae	*P. ca.*	m	
6/26/2004	E5	PR	0.0105	lycosidae	*P. ca.*	f	
6/26/2004	E5	PR	0.0112	lycosidae	*P. ca.*	m	
6/26/2004	E5	PR	0.0028	lycosidae	*P. ca.*	juv	
6/26/2004	E5	PR	0.0038	lycosidae	*P. ca.*	juv	
6/26/2004	E5	PR	0.0076	lycosidae	*P. ca.*	m	
6/26/2004	E5	PR	0.0085	lycosidae	*P. ca.*	f	
6/26/2004	E5	PR	0.0106	lycosidae	*P. ca.*	m	

6/26/2004	E5	PR	0.0049	lycosidae	*P. ca.*	juv	
6/26/2004	E5	PR	0.0127	lycosidae	*P. ca.*	f	
6/26/2004	E5	PR	0.0204	lycosidae	*P. ca.*	f	gravid
6/26/2004	E5	PR	0.0096	lycosidae	*P. ca.*	m	
6/26/2004	E5	PR	0.0045	lycosidae	*P. ca.*	juv	
6/26/2004	E5	PR	0.0389	lycosidae	*P. moe.*	f	.
6/26/2004	E5	PR	0.0357	lycosidae	*P. moe.*	f	egg
6/26/2004	E5	PR	0.0243	lycosidae	*P. sed.*	f	
6/26/2004	E5	PR	0.0714	lycosidae	*R. rab.*	f	
6/26/2004	E6	NC	.	lycosidae	*dead*	f	
6/26/2004	E6	NC	.	lycosidae	*dead P. ca.*	f/juv	
6/26/2004	E6	NC	0.0204	lycosidae	*P. ca.*	f	gravid
6/26/2004	E6	NC	0.0099	lycosidae	*P. ca.*	m	
6/26/2004	E6	NC	0.0362	lycosidae	*P. ca.*	f	egg
6/26/2004	E6	NC	0.0091	lycosidae	*P. ca.*	m	
6/26/2004	E6	NC	0.0222	lycosidae	*P. ca.*	f	egg
6/26/2004	E6	NC	0.0412	lycosidae	*P. ca.*	f	egg
6/26/2004	E6	NC	0.0138	lycosidae	*P. ca.*	f	
6/26/2004	E6	NC	0.0157	lycosidae	*P. ca.*	f	gravid
6/26/2004	E6	NC	0.0120	lycosidae	*P. ca.*	f	
6/26/2004	E6	NC	0.0160	lycosidae	*P. ca.*	f	
6/26/2004	E6	NC	0.0483	lycosidae	*P. ca.*	f	egg
6/26/2004	E6	NC	0.0059	lycosidae	*P. ca.*	juv	
6/26/2004	E6	NC	0.0032	lycosidae	*P. ca.*	juv	
6/26/2004	E6	NC	0.0035	lycosidae	*P. ca.*	juv	
6/26/2004	E6	NC	0.0391	lycosidae	*P. ca.*	f	egg
6/26/2004	E6	NC	0.0092	lycosidae	*P. ca.*	m	
6/26/2004	E6	NC	0.0264	lycosidae	*P. ca.*	f	egg
6/26/2004	E6	NC	0.0546	lycosidae	*R. rab.*	f	
6/26/2004	E7	S	0.0119	lycosidae	*P. ca.*	f	
6/26/2004	E7	S	0.0071	lycosidae	*P. ca.*	m	
6/26/2004	E7	S	0.0035	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0131	lycosidae	*P. ca.*	m	
6/26/2004	E7	S	0.0316	lycosidae	*P. ca.*	f	egg
6/26/2004	E7	S	0.0029	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0063	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0123	lycosidae	*P. ca.*	f	
6/26/2004	E7	S	0.0045	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0072	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0031	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0027	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0334	lycosidae	*P. ca.*	f	egg
6/26/2004	E7	S	0.0103	lycosidae	*P. ca.*	f	
6/26/2004	E7	S	0.0078	lycosidae	*P. ca.*	m	
6/26/2004	E7	S	0.0058	lycosidae	*P. ca.*	m/juv	
6/26/2004	E7	S	0.0046	lycosidae	*P. ca.*	juv	
6/26/2004	E7	S	0.0042	lycosidae	*P. sed.*	juv	
6/26/2004	E7	S	0.0045	lycosidae	*P. sed.*	juv	
6/26/2004	E7	S	0.0069	lycosidae	*P. sed.*	juv	
6/26/2004	E7	S	0.0037	lycosidae	*P. sed.*	juv	

6/26/2004	E7	S	0.0032	lycosidae	*P. sed.*	juv	
6/26/2004	E7	S	0.0052	lycosidae	*P. sed.*	juv	
6/26/2004	E7	S	0.0025	lycosidae	*P. sed.*	juv	
6/26/2004	E8	PR	0.0073	lycosidae	*P. ca.*	m	.
6/26/2004	E8	PR	0.0334	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0079	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0068	lycosidae	*P. ca.*	juv	.
6/26/2004	E8	PR	0.0191	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0135	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0046	lycosidae	*P. ca.*	juv	.
6/26/2004	E8	PR	0.0351	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0280	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0069	lycosidae	*P. ca.*	m	.
6/26/2004	E8	PR	0.0110	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0452	lycosidae	*P. ca.*	f	egg
6/26/2004	E8	PR	0.0235	lycosidae	*P. ca.*	f	egg
6/26/2004	E8	PR	0.0076	lycosidae	*P. ca.*	juv	.
6/26/2004	E8	PR	0.0117	lycosidae	*P. ca.*	f	.
6/26/2004	E8	PR	0.0142	lycosidae	*P. ca.*	m	.
6/26/2004	E8	PR	0.0081	lycosidae	*P. ca.*	juv	.
6/26/2004	E8	PR	0.0045	lycosidae	*P. ca.*	juv	.
6/26/2004	E8	PR	0.0056	lycosidae	*P. ca.*	juv	.
6/26/2004	E8	PR	0.0186	lycosidae	*P. ca.*	m	.
6/26/2004	E8	PR	0.0387	lycosidae	*P. mil.*	f	egg
6/26/2004	E9	NS	0.0093	lycosidae	*P. ca.*	m	.
6/26/2004	E9	NS	0.0137	lycosidae	*P. ca.*	m	.
6/26/2004	E9	NS	0.0106	lycosidae	*P. ca.*	m	.
6/26/2004	E9	NS	0.0088	lycosidae	*P. ca.*	m	.
6/26/2004	E9	NS	0.0055	lycosidae	*P. ca.*	juv	.
6/26/2004	E9	NS	0.0181	lycosidae	*P. ca.*	f	.
6/26/2004	E9	NS	0.0160	lycosidae	*P. ca.*	f	.
6/26/2004	E9	NS	0.0118	lycosidae	*P. ca.*	f	.
6/26/2004	E9	NS	0.0141	lycosidae	*P. mil.*	m	.
6/26/2004	E9	NS	0.0338	lycosidae	*P. mon.*	f	.
6/26/2004	E9	NS	0.0042	lycosidae	*P. mon.*	juv	.
6/26/2004	E9	NS	0.0040	lycosidae	*P. sed.*	juv	.
6/26/2004	E9	NS	0.0105	lycosidae	*P. sed.*	m	.
6/26/2004	E9	NS	0.0062	lycosidae	*P. sed.*	juv	.
6/26/2004	E9	NS	0.0207	lycosidae	*P. sed.*	f	.
6/29/2004	E1	no	0.0034	lycosidae	*P. ca.*	juv	.
6/29/2004	E1	no	0.0234	lycosidae	*P. ca.*	f	egg
6/29/2004	E1	no	0.0116	lycosidae	*P. ca.*	f	.
6/29/2004	E1	no	0.0313	lycosidae	*P. ca.*	f	egg
6/29/2004	E1	no	0.0326	lycosidae	*P. ca.*	f	egg
6/29/2004	E1	no	0.0046	lycosidae	*P. ca.*	m	.
6/29/2004	E1	no	0.0118	lycosidae	*P. ca.*	m	.
6/29/2004	E1	no	0.0080	lycosidae	*P. ca.*	f	.
6/29/2004	E1	no	0.0015	lycosidae	*P. ca.*	juv	.
6/29/2004	E1	no	0.0302	lycosidae	*P. ca.*	f	egg
6/29/2004	E1	no	0.0138	lycosidae	*P. ca.*	f	.

6/29/2004	E1	no	0.0360	lycosidae	*P. ca.*	f	egg
6/29/2004	E1	no	0.0041	lycosidae	*P. ca.*	f	.
6/29/2004	E1	no	0.0358	lycosidae	*P. ca.*	f	egg
6/29/2004	E1	no	0.0076	lycosidae	*P. ca.*	m	.
6/29/2004	E1	no	0.0469	lycosidae	*P. mil.*	f	.
6/29/2004	E16	NC	0.0083	lycosidae	*P. ca.*	m	.
6/29/2004	E16	NC	0.0044	lycosidae	*P. ca.*	juv	.
6/29/2004	E16	NC	0.0083	lycosidae	*P. ca.*	m	.
6/29/2004	E16	NC	0.0086	lycosidae	*P. ca.*	m	.
6/29/2004	E16	NC	0.0074	lycosidae	*P. ca.*	f	.
6/29/2004	E16	NC	0.0196	lycosidae	*P. ca.*	juv	.
6/29/2004	E16	NC	0.0178	lycosidae	*P. ca.*	juv	.
6/29/2004	E16	NC	0.0452	lycosidae	*P. ca.*	f	egg
6/29/2004	E16	NC	0.0197	lycosidae	*P. ca.*	m	.
6/29/2004	E16	NC	0.0150	lycosidae	*P. ca.*	f	.
6/29/2004	E16	NC	0.0063	lycosidae	*P. mil.*	juv	.
6/29/2004	E16	NC	0.0351	lycosidae	*P. mil.*	f	egg
6/29/2004	E16	NC	0.0342	lycosidae	*P. moe.*	f	.
6/29/2004	E16	NC	0.0062	lycosidae	*P. sed.*	f	.
6/29/2004	E16	NC	0.0044	lycosidae	*P. sed.*	juv	.
6/29/2004	E16	NC	0.0047	lycosidae	*P. sed.*	f	.
6/29/2004	E16	NC	0.0056	lycosidae	*P. sed.*	f	.
6/29/2004	E16	NC	0.0014	lycosidae	*P. sed.*	juv	.
6/29/2004	E16	NC	0.0031	lycosidae	*P. sed.*	juv	.
6/29/2004	E16	NC	0.0027	lycosidae	*P. sed.*	juv	.
6/29/2004	E16	NC	0.0033	lycosidae	*P. sed.*	f	.
6/29/2004	E16	NC	0.0307	lycosidae	*P. sed.*	m	.
6/29/2004	E17	NC	0.0088	lycosidae	*P. ca.*	m	.
6/29/2004	E17	NC	0.0076	lycosidae	*P. ca.*	m	.
6/29/2004	E17	NC	0.0201	lycosidae	*P. ca.*	f	.
6/29/2004	E17	NC	0.0248	lycosidae	*P. ca.*	f	.
6/29/2004	E17	NC	0.0024	lycosidae	*P. ca.*	juv	.
6/29/2004	E17	NC	0.0223	lycosidae	*P. ca.*	f	.
6/29/2004	E17	NC	0.0039	lycosidae	*P. ca.*	juv	.
6/29/2004	E17	NC	0.0143	lycosidae	*P. ca.*	m	.
6/29/2004	E17	NC	0.0137	lycosidae	*P. ca.*	f	.
6/29/2004	E17	NC	0.0055	lycosidae	*P. ca.*	juv	.
6/29/2004	E17	NC	0.0103	lycosidae	*P. ca.*	f	.
6/29/2004	E17	NC	0.0096	lycosidae	*P. ca.*	f	.
6/29/2004	E17	NC	0.0109	lycosidae	*P. ca.*	m	.
6/29/2004	E17	NC	0.0017	lycosidae	*P. ca.*	juv	.
6/29/2004	E17	NC	0.0011	lycosidae	*P. ca.*	juv	.
6/29/2004	E17	NC	0.0127	lycosidae	*P. ca.*	f	.
6/29/2004	E17	NC	0.0085	lycosidae	*P. ca.*	m	.
6/29/2004	E17	NC	0.0020	lycosidae	*P. ca.*	juv	.
6/29/2004	E17	NC	0.0321	lycosidae	*P. mil.*	f	.
6/29/2004	E17	NC	0.0357	lycosidae	*P. moe.*	f	egg
6/29/2004	E17	NC	0.0069	lycosidae	*P. sed.*	juv/f	.
6/29/2004	E17	NC	0.0067	lycosidae	*P. sed.*	juv	.
6/29/2004	E18	PR	0.0056	lycosidae	*P. ca.*	f	.

6/29/2004	E18	PR	0.0040	lycosidae	*P. ca.*	juv	.
6/29/2004	E18	PR	0.0142	lycosidae	*P. ca.*	f	.
6/29/2004	E18	PR	0.0085	lycosidae	*P. ca.*	f	.
6/29/2004	E18	PR	0.0081	lycosidae	*P. ca.*	f	.
6/29/2004	E18	PR	0.0065	lycosidae	*P. ca.*	juv	.
6/29/2004	E18	PR	0.0154	lycosidae	*P. ca.*	m	.
6/29/2004	E18	PR	0.0063	lycosidae	*P. ca.*	juv	.
6/29/2004	E18	PR	0.0046	lycosidae	*P. ca.*	juv	.
6/29/2004	E18	PR	0.0571	lycosidae	*P. ca.*	f	egg
6/29/2004	E18	PR	0.0069	lycosidae	*P. ca.*	m	.
6/29/2004	E18	PR	0.0237	lycosidae	*P. mil.*	f	.
6/29/2004	E18	PR	0.0265	lycosidae	*P. mil.*	f	.
6/29/2004	E18	PR	0.0149	lycosidae	*P. mil.*	m	.
6/29/2004	E18	PR	0.0191	lycosidae	*P. mil.*	m	.
6/29/2004	E18	PR	0.0081	lycosidae	*P. mil.*	f	.
6/29/2004	E18	PR	0.0121	lycosidae	*P. mil.*	f	.
6/29/2004	E18	PR	0.0149	lycosidae	*P. mil.*	m	.
6/29/2004	E18	PR	0.0357	lycosidae	*P. moe.*	f	egg
6/29/2004	E18	PR	0.0237	lycosidae	*P. moe.*	f	.
6/29/2004	E18	PR	0.0182	lycosidae	*P. sed.*	f	.
6/29/2004	E19	S	0.0089	lycosidae	*P. ca.*	m	
6/29/2004	E19	S	0.0110	lycosidae	*P. ca.*	f	
6/29/2004	E19	S	0.0080	lycosidae	*P. ca.*	f	
6/29/2004	E19	S	0.0011	lycosidae	*P. ca.*	juv	
6/29/2004	E19	S	0.0241	lycosidae	*P. ca.*	f	gravid
6/29/2004	E19	S	0.0064	lycosidae	*P. ca.*	m	
6/29/2004	E19	S	0.0026	lycosidae	*P. ca.*	juv	.
6/29/2004	E19	S	0.0095	lycosidae	*P. ca.*	m	.
6/29/2004	E19	S	0.0550	lycosidae	*P. ca.*	f	egg
6/29/2004	E19	S	0.0091	lycosidae	*P. ca.*	m	.
6/29/2004	E19	S	0.0370	lycosidae	*P. ca.*	f	egg
6/29/2004	E19	S	0.0082	lycosidae	*P. ca.*	m	.
6/29/2004	E19	S	0.0208	lycosidae	*P. sed.*	f	egg
6/29/2004	E2	no	0.0168	lycosidae	*P. ca.*	f	.
6/29/2004	E2	no	0.0077	lycosidae	*P. ca.*	m	.
6/29/2004	E2	no	0.0021	lycosidae	*P. ca.*	juv	.
6/29/2004	E2	no	0.0021	lycosidae	*P. ca.*	j	.
6/29/2004	E2	no	0.0094	lycosidae	*P. ca.*	f	.
6/29/2004	E2	no	0.0154	lycosidae	*P. ca.*	f	.
6/29/2004	E2	no	0.0143	lycosidae	*P. ca.*	f	.
6/29/2004	E2	no	0.0271	lycosidae	*P. ca.*	f	egg
6/29/2004	E2	no	0.0211	lycosidae	*P. ca.*	f	.
6/29/2004	E2	no	0.0036	lycosidae	*P. ca.*	juv	.
6/29/2004	E2	no	0.0369	lycosidae	*P. ca.*	f	egg
6/29/2004	E2	no	0.0145	lycosidae	*P. ca.*	f	.
6/29/2004	E2	no	0.0382	lycosidae	*P. moe.*	f	.
6/29/2004	E2	no	0.0053	lycosidae	*P. sed.*	f	.
6/29/2004	E2	no	0.0052	lycosidae	*P. sed.*	f	.
6/29/2004	E20	NS	0.0135	lycosidae	*P. ca.*	m	.
6/29/2004	E20	NS	0.0062	lycosidae	*P. ca.*	f	.

6/29/2004	E20	NS	0.0028	lycosidae	*P. ca.*	juv	.
6/29/2004	E20	NS	0.0082	lycosidae	*P. ca.*	m	.
6/29/2004	E20	NS	0.0033	lycosidae	*P. ca.*	juv	.
6/29/2004	E20	NS	0.0296	lycosidae	*P. ca.*	f	egg
6/29/2004	E20	NS	0.0030	lycosidae	*P. ca.*	juv	.
6/29/2004	E20	NS	0.0026	lycosidae	*P. ca.*	juv	.
6/29/2004	E20	NS	0.0016	lycosidae	*P. ca.*	juv	.
6/29/2004	E20	NS	0.0071	lycosidae	*P. ca.*	f	.
6/29/2004	E20	NS	0.0036	lycosidae	*P. ca.*	juv	.
6/29/2004	E20	NS	0.0133	lycosidae	*P. ca.*	m	.
7/21/2004	E1	NS	0.0041	lycosidae	*P. ca.*	juv	
7/21/2004	E1	NS	0.0064	lycosidae	*P. ca.*	f	
7/21/2004	E1	NS	0.0264	lycosidae	*P. ca.*	f	egg
7/21/2004	E1	NS	0.0157	lycosidae	*P. ca.*	f	
7/21/2004	E1	NS	0.0274	lycosidae	*P. ca.*	f	egg
7/21/2004	E1	NS	0.0188	lycosidae	*P. ca.*	f	egg
7/21/2004	E1	NS	0.0153	lycosidae	*P. ca.*	f	
7/21/2004	E1	NS	0.0221	lycosidae	*P. ca.*	f	egg
7/21/2004	E1	NS	0.0045	lycosidae	*P. ca.*	juv	
7/21/2004	E1	NS	0.0187	lycosidae	*P. ca.*	f	egg
7/21/2004	E1	NS	0.0249	lycosidae	*P. ca.*	f	spiderling
7/21/2004	E1	NS	0.0219	lycosidae	*P. ca.*	f	egg
7/21/2004	E1	NS	0.0041	lycosidae	*P. ca.*	juv	
7/21/2004	E1	NS	0.0149	lycosidae	*P. mil.*	f	
7/21/2004	E1	NS	0.0302	lycosidae	*P. moe.*	f	
7/21/2004	E16	NC	0.1306	lycosidae	*?*		
7/21/2004	E16	NC	0.0074	lycosidae	*P. ca.*	f	
7/21/2004	E16	NC	0.0387	lycosidae	*P. ca.*	f	egg
7/21/2004	E16	NC	0.0009	lycosidae	*P. ca.*	juv	
7/21/2004	E16	NC	0.0041	lycosidae	*P. ca.*	juv	
7/21/2004	E16	NC	0.0060	lycosidae	*P. ca.*	juv	
7/21/2004	E16	NC	0.0026	lycosidae	*P. ca.*	juv	
7/21/2004	E16	NC	0.0055	lycosidae	*P. ca.*	f	
7/21/2004	E16	NC	0.0020	lycosidae	*P. ca.*	juv	
7/21/2004	E16	NC	0.0165	lycosidae	*P. ca.*	f	egg
7/21/2004	E16	NC	0.0039	lycosidae	*P. ca.*	juv	
7/21/2004	E16	NC	0.0063	lycosidae	*P. ca.*	f/juv	
7/21/2004	E16	NC	0.0330	lycosidae	*P. mil.*	f	egg
7/21/2004	E16	NC	0.0453	lycosidae	*P. mil.*	f	gravid
7/21/2004	E16	NC	0.0507	lycosidae	*P. mil.*	f	egg
7/21/2004	E16	NC	0.0299	lycosidae	*P. moe.*	f	gravid
7/21/2004	E16	NC	0.0267	lycosidae	*P. moe.*	f	gravid
7/21/2004	E16	NC	0.0065	lycosidae	*P. sed.*	f/juv	
7/21/2004	E16	NC	0.0061	lycosidae	*pirata*	f/juv	
7/21/2004	E17	NC	0.0257	lycosidae	*P. ca.*	f	egg
7/21/2004	E17	NC	0.0071	lycosidae	*P. ca.*	m	
7/21/2004	E17	NC	0.0091	lycosidae	*P. ca.*	m	
7/21/2004	E17	NC	0.0138	lycosidae	*P. ca.*	f	egg
7/21/2004	E17	NC	0.0042	lycosidae	*P. ca.*	juv	
7/21/2004	E17	NC	0.0031	lycosidae	*P. ca.*	juv	

7/21/2004	E17	NC	0.0217	lycosidae	*P. ca.*	f	gravid
7/21/2004	E17	NC	0.0043	lycosidae	*P. ca.*	juv	
7/21/2004	E17	NC	0.0053	lycosidae	*P. ca.*	f	
7/21/2004	E17	NC	0.0225	lycosidae	*P. ca.*	f	egg
7/21/2004	E17	NC	0.0160	lycosidae	*P. ca.*	f	
7/21/2004	E17	NC	0.0259	lycosidae	*P. mil.*	f	egg
7/21/2004	E17	NC	0.0411	lycosidae	*P. mil.*	f	egg
7/21/2004	E17	NC	0.0274	lycosidae	*P. mil.*	f	egg
7/21/2004	E17	NC	0.0358	lycosidae	*P. mil.*	f	egg
7/21/2004	E17	NC	0.0466	lycosidae	*P. mil.*	f	egg
7/21/2004	E17	NC	0.0372	lycosidae	*P. mil.*	f	gravid
7/21/2004	E17	NC	0.0534	lycosidae	*P. mil.*	f	egg
7/21/2004	E17	NC	0.0388	lycosidae	*P. mil.*	f	egg
7/21/2004	E17	NC	0.0041	lycosidae	*P. sed.*	juv	
7/21/2004	E17	NC	0.0025	lycosidae	*P. sed.*	juv	
7/21/2004	E17	NC	0.0036	lycosidae	*P. sed.*	juv	
7/21/2004	E18	PR	0.0047	lycosidae	*P. ca.*	juv	
7/21/2004	E18	PR	0.0043	lycosidae	*P. ca.*	juv	
7/21/2004	E18	PR	0.0063	lycosidae	*P. ca.*	f	
7/21/2004	E18	PR	0.0044	lycosidae	*P. ca.*	juv	
7/21/2004	E18	PR	0.0043	lycosidae	*P. ca.*	juv	
7/21/2004	E18	PR	0.0040	lycosidae	*P. ca.*	juv	
7/21/2004	E18	PR	0.0051	lycosidae	*P. ca.*	f/juv	
7/21/2004	E18	PR	0.0025	lycosidae	*P. ca.*	juv	
7/21/2004	E18	PR	0.0202	lycosidae	*P. ca.*	f	egg
7/21/2004	E18	PR	0.0026	lycosidae	*P. ca.*	juv	
7/21/2004	E18	PR	0.0053	lycosidae	*P. mil.*	f/juv	
7/21/2004	E18	PR	0.0117	lycosidae	*P. mil.*	f	
7/21/2004	E18	PR	0.0217	lycosidae	*P. mil.*	f	
7/21/2004	E19	S	0.0013	lycosidae	*P. ca.*	juv	
7/21/2004	E19	S	0.0041	lycosidae	*P. ca.*	f	
7/21/2004	E19	S	0.0053	lycosidae	*P. ca.*	f	
7/21/2004	E19	S	0.0036	lycosidae	*P. ca.*	juv	
7/21/2004	E19	S	0.0055	lycosidae	*P. ca.*	f	
7/21/2004	E19	S	0.0037	lycosidae	*P. ca.*	juv	
7/21/2004	E19	S	0.0099	lycosidae	*P. ca.*	f	
7/21/2004	E19	S	0.0552	lycosidae	*P. ca.*	f	egg
7/21/2004	E19	S	0.0185	lycosidae	*P. ca.*	f	egg
7/21/2004	E19	S	0.0065	lycosidae	*P. ca.*	f/juv	
7/21/2004	E19	S	0.0066	lycosidae	*P. ca.*	f	
7/21/2004	E19	S	0.0066	lycosidae	*P. mil.*	f/juv	
7/21/2004	E20	NS	0.0079	lycosidae	*P. ca.*	f	
7/21/2004	E20	NS	0.0055	lycosidae	*P. ca.*	f	
7/21/2004	E20	NS	0.0052	lycosidae	*P. ca.*	f/juv	
7/21/2004	E20	NS	0.0050	lycosidae	*P. ca.*	f	
7/21/2004	E20	NS	0.0116	lycosidae	*P. ca.*	f	egg
7/21/2004	E20	NS	0.0059	lycosidae	*P. ca.*	f	
7/21/2004	E20	NS	0.0063	lycosidae	*P. ca.*	f/juv	
7/21/2004	E20	NS	0.0128	lycosidae	*P. ca.*	f	egg
7/21/2004	E20	NS	0.0035	lycosidae	*P. ca.*	juv	

7/21/2004	E20	NS	0.0041	lycosidae	*P. ca.*	juv	
7/21/2004	E20	NS	0.0090	lycosidae	*P. ca.*	f	
7/21/2004	E20	NS	0.0055	lycosidae	*P. ca.*	f/juv	
7/21/2004	E20	NS	0.0046	lycosidae	*pirata*	juv	
7/21/2004	E21	S	0.0245	lycosidae	*P. ca.*	f	egg
7/21/2004	E21	S	0.0520	lycosidae	*P. ca.*	f	egg
7/21/2004	E21	S	0.0030	lycosidae	*P. ca.*	juv	
7/21/2004	E21	S	0.0064	lycosidae	*P. ca.*	f/juv	
7/21/2004	E21	S	0.0039	lycosidae	*P. ca.*	juv	
7/21/2004	E21	S	0.0068	lycosidae	*P. ca.*	f	
7/21/2004	E21	S	0.0041	lycosidae	*P. ca.*	juv	
7/21/2004	E21	S	0.0075	lycosidae	*P. ca.*	f	
7/21/2004	E21	S	0.0035	lycosidae	*P. ca.*	juv	
7/21/2004	E21	S	0.0046	lycosidae	*P. ca.*	juv	
7/21/2004	E21	S	0.0167	lycosidae	*P. ca.*	f	egg
7/21/2004	E21	S	0.0062	lycosidae	*P. ca.*	f/juv	
7/21/2004	E21	S	0.0067	lycosidae	*P. ca.*	f	
7/21/2004	E21	S	0.0056	lycosidae	*P. ca.*	juv	
7/21/2004	E21	S	0.0060	lycosidae	*P. ca.*	f/juv	
7/21/2004	E21	S	0.0034	lycosidae	*P. ca.*	juv	
7/21/2004	E21	S	0.0385	lycosidae	*P. ca.*	f	
7/21/2004	E21	S	0.0311	lycosidae	*P. ca.*	f	egg
7/21/2004	E21	S	0.0082	lycosidae	*P. ca.*	f	
7/21/2004	E21	S	0.0052	lycosidae	*P. sed.*	f	
7/21/2004	E21	S	0.0079	lycosidae	*pirata*	f	
7/21/2004	E21	S	0.0214	lycosidae	*pirata*	f	egg
7/21/2004	E22	NS	0.0095	lycosidae	*P. ca.*	f	
7/21/2004	E22	NS	0.0047	lycosidae	*P. ca.*	juv	
7/21/2004	E22	NS	0.0091	lycosidae	*P. ca.*	f	
7/21/2004	E22	NS	0.0236	lycosidae	*P. ca.*	f	egg
7/21/2004	E22	NS	0.0052	lycosidae	*P. ca.*	juv	
7/21/2004	E22	NS	0.0047	lycosidae	*P. ca.*	juv	
7/21/2004	E22	NS	0.0030	lycosidae	*P. ca.*	juv	
7/21/2004	E22	NS	0.0060	lycosidae	*P. ca.*	f	
7/21/2004	E22	NS	0.0053	lycosidae	*P. ca.*	f/juv	
7/21/2004	E22	NS	0.0052	lycosidae	*P. ca.*	f/juv	
7/21/2004	E22	NS	0.0044	lycosidae	*P. ca.*	juv	
7/21/2004	E22	NS	0.0040	lycosidae	*P. ca.*	juv	
7/21/2004	E22	NS	0.0043	lycosidae	*P. ca.*	f/juv	
7/21/2004	E22	NS	0.0051	lycosidae	*P. ca.*	f/juv	
7/21/2004	E22	NS	0.0062	lycosidae	*P. ca.*	f	
7/21/2004	E22	NS	0.0171	lycosidae	*P. ca.*	f	
7/21/2004	E22	NS	0.0083	lycosidae	*P. ca.*	f	
7/21/2004	E22	NS	0.0065	lycosidae	*P. sed.*	f	
7/21/2004	E22	NS	0.0057	lycosidae	*P. sed.*	f	
7/22/2004	E10	S	0.0079	lycosidae	*P. ca.*	m	
7/22/2004	E10	S	0.0022	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0039	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0039	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0044	lycosidae	*P. ca.*	juv	

7/22/2004	E10	S	0.0040	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0053	lycosidae	*P. ca.*	f/juv	
7/22/2004	E10	S	0.0064	lycosidae	*P. ca.*	f/juv	
7/22/2004	E10	S	0.0053	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0042	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0028	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0041	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0030	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0043	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0054	lycosidae	*P. ca.*	f/juv	
7/22/2004	E10	S	0.0039	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0027	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0050	lycosidae	*P. ca.*	juv	
7/22/2004	E10	S	0.0167	lycosidae	*P. ca.*	f	egg
7/22/2004	E10	S	0.0193	lycosidae	*P. ca.*	f	egg
7/22/2004	E10	S	0.0049	lycosidae	*P. ca.*	f/juv	
7/22/2004	E10	S	0.0094	lycosidae	*P. mil.*	f	
7/22/2004	E10	S	0.0036	lycosidae	*P. sed.*	juv	
7/22/2004	E10	S	0.0065	lycosidae	*P. sed.*	f	
7/22/2004	E10	S	0.0040	lycosidae	*P. sed.*	f/juv	
7/22/2004	E11	NS	0.0212	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0047	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0119	lycosidae	*P. ca.*	m	
7/22/2004	E11	NS	0.0152	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0371	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0061	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0031	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0053	lycosidae	*P. ca.*	f/juv	
7/22/2004	E11	NS	0.0070	lycosidae	*P. ca.*	f	
7/22/2004	E11	NS	0.0060	lycosidae	*P. ca.*	f/juv	
7/22/2004	E11	NS	0.0268	lycosidae	*P. ca.*	f	spiderling
7/22/2004	E11	NS	0.0171	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0171	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0051	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0038	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0060	lycosidae	*P. ca.*	f/juv	
7/22/2004	E11	NS	0.0186	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0146	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0022	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0212	lycosidae	*P. ca.*	f	egg
7/22/2004	E11	NS	0.0054	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0034	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0040	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0022	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0063	lycosidae	*P. ca.*	f/juv	
7/22/2004	E11	NS	0.0043	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0024	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0047	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0041	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0179	lycosidae	*P. ca.*	f	egg

7/22/2004	E11	NS	0.0056	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0044	lycosidae	*P. ca.*	juv	
7/22/2004	E11	NS	0.0453	lycosidae	*P. mil.*	f	egg
7/22/2004	E11	NS	0.0069	lycosidae	*P. mil.*	f	
7/22/2004	E11	NS	0.0236	lycosidae	*P. moe.*	f	egg
7/22/2004	E11	NS	0.0074	lycosidae	*P. sed.*	f	
7/22/2004	E11	NS	0.0043	lycosidae	*pirata*	juv	
7/22/2004	E12	NC	0.0276	lycosidae	*P. ca.*	f	egg
7/22/2004	E12	NC	0.0058	lycosidae	*P. ca.*	juv	
7/22/2004	E12	NC	0.0215	lycosidae	*P. ca.*	f	egg
7/22/2004	E12	NC	0.0037	lycosidae	*P. ca.*	juv	
7/22/2004	E12	NC	0.0070	lycosidae	*P. ca.*	m	
7/22/2004	E12	NC	0.0073	lycosidae	*P. ca.*	m	
7/22/2004	E12	NC	0.0053	lycosidae	*P. ca.*	juv	
7/22/2004	E12	NC	0.0255	lycosidae	*P. ca.*	f	egg
7/22/2004	E12	NC	0.0087	lycosidae	*P. ca.*	m	
7/22/2004	E12	NC	0.0256	lycosidae	*P. ca.*	f	egg
7/22/2004	E12	NC	0.0402	lycosidae	*P. mil.*	f	egg
7/22/2004	E12	NC	0.0386	lycosidae	*P. mil.*	f	egg
7/22/2004	E12	NC	0.0309	lycosidae	*P. mil.*	f	egg
7/22/2004	E12	NC	0.0150	lycosidae	*P. mil.*		
7/22/2004	E12	NC	0.0236	lycosidae	*P. mil.*	f	
7/22/2004	E12	NC	0.0068	lycosidae	*P. mil.*	m	
7/22/2004	E13	S	0.0112	lycosidae	*P. ca.*	f	egg
7/22/2004	E13	S	0.0028	lycosidae	*P. ca.*	juv	
7/22/2004	E13	S	0.0213	lycosidae	*P. ca.*	f	
7/22/2004	E13	S	0.0145	lycosidae	*P. ca.*	f	egg
7/22/2004	E13	S	0.0193	lycosidae	*P. ca.*	f	egg
7/22/2004	E13	S	0.0169	lycosidae	*P. ca.*	f	egg
7/22/2004	E13	S	0.0201	lycosidae	*P. ca.*	f	egg
7/22/2004	E13	S	0.0079	lycosidae	*P. ca.*	f	
7/22/2004	E13	S	0.0053	lycosidae	*P. ca.*	juv	
7/22/2004	E13	S	0.0331	lycosidae	*P. ca.*	f	egg
7/22/2004	E13	S	0.0045	lycosidae	*P. ca.*	juv	
7/22/2004	E13	S	0.0063	lycosidae	*P. ca.*	f/juv	
7/22/2004	E13	S	0.0373	lycosidae	*P. ca.*	f	spiderling
7/22/2004	E13	S	0.0142	lycosidae	*P. mil.*	f	
7/22/2004	E14	NS	0.0109	lycosidae	*P. ca.*	m	
7/22/2004	E14	NS	0.0346	lycosidae	*P. ca.*	f	egg
7/22/2004	E14	NS	0.0033	lycosidae	*P. ca.*	juv	
7/22/2004	E14	NS	0.0232	lycosidae	*P. ca.*	f	egg
7/22/2004	E14	NS	0.0259	lycosidae	*P. ca.*	f	
7/22/2004	E14	NS	0.0060	lycosidae	*P. ca.*	f/juv	
7/22/2004	E14	NS	0.0133	lycosidae	*P. ca.*	f	egg
7/22/2004	E14	NS	0.0149	lycosidae	*P. ca.*	f	egg
7/22/2004	E14	NS	0.0260	lycosidae	*P. mil.*	f	egg
7/22/2004	E15	PR	0.0166	lycosidae	*P. ca.*	f	egg
7/22/2004	E15	PR	0.0069	lycosidae	*P. ca.*	f/juv	
7/22/2004	E15	PR	0.0104	lycosidae	*P. ca.*	f	egg
7/22/2004	E15	PR	0.0096	lycosidae	*P. ca.*	f	egg

7/22/2004	E15	PR	0.0361	lycosidae	*P. mil.*	f	egg
7/22/2004	E2	S	0.0204	lycosidae	*P. ca.*	f	egg
7/22/2004	E2	S	0.0044	lycosidae	*P. ca.*	juv	
7/22/2004	E2	S	0.0167	lycosidae	*P. ca.*	f	egg
7/22/2004	E2	S	0.0054	lycosidae	*P. ca.*	juv	
7/22/2004	E2	S	0.0063	lycosidae	*P. ca.*	f/juv	
7/22/2004	E2	S	0.0052	lycosidae	*P. ca.*	juv	
7/22/2004	E2	S	0.0066	lycosidae	*P. ca.*	juv	
7/22/2004	E2	S	0.0338	lycosidae	*P. ca.*	f	egg
7/22/2004	E2	S	0.0280	lycosidae	*P. ca.*	f	egg
7/22/2004	E2	S	0.0037	lycosidae	*P. ca.*	juv	
7/22/2004	E2	S	0.0336	lycosidae	*P. ca.*	f	egg
7/22/2004	E2	S	0.0033	lycosidae	*P. ca.*	juv	
7/22/2004	E2	S	0.0076	lycosidae	*P. ca.*	m	
7/22/2004	E2	S	0.0355	lycosidae	*P. moe.*	f	egg
7/22/2004	E2	S	0.0063	lycosidae	*P. sed.*	juv	
7/23/2004	E3	NS		lycosidae	*?pirata*	juv	
7/23/2004	E3	NS	0.0035	lycosidae	*fringe*	juv	
7/23/2004	E3	NS	0.1269	lycosidae	*H. hue.*	f	
7/23/2004	E3	NS	0.7156	lycosidae	*H. hue.*	f	egg
7/23/2004	E3	NS	0.0039	lycosidae	*P. ca.*	juv	
7/23/2004	E3	NS	0.0021	lycosidae	*P. ca.*	juv	
7/23/2004	E3	NS	0.0034	lycosidae	*P. ca.*	juv	
7/23/2004	E3	NS	0.0196	lycosidae	*P. ca.*	f	egg
7/23/2004	E3	NS	0.0165	lycosidae	*P. ca.*	f	gravid
7/23/2004	E3	NS	0.0039	lycosidae	*P. ca.*	juv	
7/23/2004	E3	NS	0.0061	lycosidae	*P. ca.*	juv/f	
7/23/2004	E3	NS	0.0133	lycosidae	*P. ca.*	f	egg
7/23/2004	E3	NS	0.0113	lycosidae	*P. ca.*	f	egg
7/23/2004	E3	NS	0.0061	lycosidae	*P. ca.*	juv	
7/23/2004	E3	NS	0.0070	lycosidae	*P. ca.*	f	
7/23/2004	E3	NS	0.0072	lycosidae	*P. ca.*	f	
7/23/2004	E3	NS	0.0026	lycosidae	*P. ca.*	juv	
7/23/2004	E3	NS	0.0071	lycosidae	*P. ca.*	f	
7/23/2004	E3	NS	0.0043	lycosidae	*P. ca.*	juv	
7/23/2004	E3	NS	0.0336	lycosidae	*P. mil.*	f	spiderling
7/23/2004	E3	NS	0.0359	lycosidae	*P. mil.*	f	egg
7/23/2004	E3	NS	0.0112	lycosidae	*P. mil.*	m	
7/23/2004	E3	NS	0.0148	lycosidae	*P. moe.*	f	egg
7/23/2004	E3	NS	0.0060	lycosidae	*P. mon.*	f	egg
7/23/2004	E4	S	0.0081	lycosidae	*P. ca.*	m	
7/23/2004	E4	S	0.0158	lycosidae	*P. ca.*	f	egg
7/23/2004	E4	S	0.0041	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0132	lycosidae	*P. ca.*	f	
7/23/2004	E4	S	0.0061	lycosidae	*P. ca.*	f/juv	
7/23/2004	E4	S	0.0026	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0049	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0094	lycosidae	*P. ca.*	m	
7/23/2004	E4	S	0.0059	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0033	lycosidae	*P. ca.*	juv	

7/23/2004	E4	S	0.0044	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0065	lycosidae	*P. ca.*	f/juv	
7/23/2004	E4	S	0.0346	lycosidae	*P. ca.*	f	
7/23/2004	E4	S	0.0060	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0045	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0167	lycosidae	*P. ca.*	f	spiderling
7/23/2004	E4	S	0.0046	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0077	lycosidae	*P. ca.*	f	
7/23/2004	E4	S	0.0105	lycosidae	*P. ca.*	f	egg
7/23/2004	E4	S	0.0062	lycosidae	*P. ca.*	juv	
7/23/2004	E4	S	0.0318	lycosidae	*P. mil.*	f	egg
7/23/2004	E4	S	0.0102	lycosidae	*P. mil.*	f	
7/23/2004	E4	S	0.0310	lycosidae	*P. moe.*	f	spiderling
7/23/2004	E4	S	0.0280	lycosidae	*P. moe.*	f	egg
7/23/2004	E4	S	0.0373	lycosidae	*P. moe.*	f	egg
7/23/2004	E4	S	0.0328	lycosidae	*P. sed.*	f	egg
7/23/2004	E5	PR	0.1385	lycosidae	*H. hue.*	m	
7/23/2004	E5	PR	0.0068	lycosidae	*P. ca.*	juv/f	
7/23/2004	E5	PR	0.0054	lycosidae	*P. ca.*	juv	
7/23/2004	E5	PR	0.0200	lycosidae	*P. ca.*	f	egg
7/23/2004	E5	PR	0.0131	lycosidae	*P. ca.*	f	spiderlings
7/23/2004	E5	PR	0.0056	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0051	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0122	lycosidae	*P. ca.*	f	egg
7/23/2004	E5	PR	0.0061	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0056	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0068	lycosidae	*P. ca.*	m	
7/23/2004	E5	PR	0.0066	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0057	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0044	lycosidae	*P. ca.*	juv	
7/23/2004	E5	PR	0.0054	lycosidae	*P. ca.*	juv/f	
7/23/2004	E5	PR	0.0070	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0088	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0046	lycosidae	*P. ca.*	juv	
7/23/2004	E5	PR	0.0180	lycosidae	*P. ca.*	f	spiderlings
7/23/2004	E5	PR	0.0007	lycosidae	*P. ca.*	2nd instar	
7/23/2004	E5	PR	0.0055	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0131	lycosidae	*P. ca.*	f	egg
7/23/2004	E5	PR	0.0124	lycosidae	*P. ca.*	f	egg
7/23/2004	E5	PR	0.0343	lycosidae	*P. ca.*	f	egg
7/23/2004	E5	PR	0.0061	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0070	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0041	lycosidae	*P. ca.*	juv	
7/23/2004	E5	PR	0.0065	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0054	lycosidae	*P. ca.*	f	
7/23/2004	E5	PR	0.0029	lycosidae	*P. ca.*	juv/f	
7/23/2004	E5	PR	0.0054	lycosidae	*P. mil.*	m	
7/23/2004	E5	PR	0.0310	lycosidae	*P. mil.*	f	egg
7/23/2004	E6	NC	0.1332	lycosidae	*H. hue.*	f	
7/23/2004	E6	NC	0.0058	lycosidae	*P. ca.*	f	

7/23/2004	E6	NC	0.0205	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0057	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0215	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0211	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0059	lycosidae	*P. ca.*	juv/f	
7/23/2004	E6	NC	0.0049	lycosidae	*P. ca.*	juv	
7/23/2004	E6	NC	0.0072	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0068	lycosidae	*P. ca.*	m	
7/23/2004	E6	NC	0.0075	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0051	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0235	lycosidae	*P. ca.*	f	spiderlings
7/23/2004	E6	NC	0.0225	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0068	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0057	lycosidae	*P. ca.*	juv/f	
7/23/2004	E6	NC	0.0191	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0156	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0077	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0192	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0062	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0127	lycosidae	*P. ca.*	m	
7/23/2004	E6	NC	0.0096	lycosidae	*P. ca.*	m	
7/23/2004	E6	NC	0.0079	lycosidae	*P. ca.*	m	
7/23/2004	E6	NC	0.0050	lycosidae	*P. ca.*	juv	
7/23/2004	E6	NC	0.0101	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0163	lycosidae	*P. ca.*	f	gravid
7/23/2004	E6	NC	0.0130	lycosidae	*P. ca.*	m	
7/23/2004	E6	NC	0.0055	lycosidae	*P. ca.*	juv	
7/23/2004	E6	NC	0.0079	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0217	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0069	lycosidae	*P. ca.*	f	
7/23/2004	E6	NC	0.0076	lycosidae	*P. ca.*	f	gravid
7/23/2004	E6	NC	0.0245	lycosidae	*P. ca.*	f	egg
7/23/2004	E6	NC	0.0043	lycosidae	*P. ca.*	?m	
7/23/2004	E7	S	0.0209	lycosidae	*P. ca.*	f	egg
7/23/2004	E7	S	0.0054	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0075	lycosidae	*P. ca.*	f	
7/23/2004	E7	S	0.0122	lycosidae	*P. ca.*	m	
7/23/2004	E7	S	0.0045	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0042	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0059	lycosidae	*P. ca.*	f/juv	
7/23/2004	E7	S	0.0055	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0053	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0023	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0048	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0046	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0059	lycosidae	*P. ca.*	f/juv	
7/23/2004	E7	S	0.0055	lycosidae	*P. ca.*	juv	
7/23/2004	E7	S	0.0058	lycosidae	*P. ca.*	f/juv	
7/23/2004	E7	S	0.0274	lycosidae	*P. ca.*	f	
7/23/2004	E7	S	0.0063	lycosidae	*P. ca.*	juv	

7/23/2004	E7	S	0.0297	lycosidae	*P. moe.*	f	
7/23/2004	E7	S	0.0051	lycosidae	*P. sed.*	juv	
7/23/2004	E7	S	0.0063	lycosidae	*P. sed.*	f/juv	
7/23/2004	E7	S	0.0072	lycosidae	*P. sed.*	f	
7/23/2004	E7	S	0.0062	lycosidae	*P. sed.*	f/juv	
7/23/2004	E7	S	0.0054	lycosidae	*P. sed.*	juv	
7/23/2004	E7	S	0.0042	lycosidae	*P. sed.*	juv	
7/23/2004	E7	S	0.0054	lycosidae	*P. sed.*	juv	
7/23/2004	E7	S	0.0043	lycosidae	*P. sed.*	juv	
7/23/2004	E7	S	0.0062	lycosidae	*P. sed.*	f/juv	
7/23/2004	E8	PR	0.0110	lycosidae	*P. ca.*	m	
7/23/2004	E8	PR	0.0224	lycosidae	*P. ca.*	f	egg
7/23/2004	E8	PR	0.0072	lycosidae	*P. ca.*	f	
7/23/2004	E8	PR	0.0280	lycosidae	*P. ca.*	f	
7/23/2004	E8	PR	0.0181	lycosidae	*P. ca.*	f	egg
7/23/2004	E8	PR	0.0286	lycosidae	*P. ca.*	f	egg
7/23/2004	E8	PR	0.0075	lycosidae	*P. ca.*	f/juv	
7/23/2004	E8	PR	0.0073	lycosidae	*P. ca.*	f	
7/23/2004	E8	PR	0.0034	lycosidae	*P. ca.*	juv	
7/23/2004	E8	PR	0.0053	lycosidae	*P. ca.*	f/juv	
7/23/2004	E8	PR	0.0097	lycosidae	*P. ca.*	f	
7/23/2004	E8	PR	0.0041	lycosidae	*P. ca.*	juv	
7/23/2004	E8	PR	0.0248	lycosidae	*P. ca.*	f	egg
7/23/2004	E8	PR	0.0167	lycosidae	*P. ca.*	f	
7/23/2004	E8	PR	0.0201	lycosidae	*P. ca.*	f	
7/23/2004	E8	PR	0.0255	lycosidae	*P. ca.*	f	egg
7/23/2004	E8	PR	0.0072	lycosidae	*P. ca.*	f	
7/23/2004	E8	PR	0.0050	lycosidae	*P. mil.*	f/juv	
7/23/2004	E8	PR	0.0202	lycosidae	*P. mil.*	f	
7/23/2004	E8	PR	0.0067	lycosidae	*P. sed.*	f/juv	
7/23/2004	E8	PR	0.0073	lycosidae	*P. sed.*	juv	
7/23/2004	E8	PR	0.0068	lycosidae	*P. sed.*	f	
7/23/2004	E8	PR	0.0059	lycosidae	*P. sed.*	f/juv	
7/23/2004	E8	PR	0.0073	lycosidae	*pirata*	f	
7/23/2004	E9	NS	0.0222	lycosidae	*P. ca.*	f	egg
7/23/2004	E9	NS	0.0055	lycosidae	*P. ca.*	juv	
7/23/2004	E9	NS	0.0081	lycosidae	*P. ca.*	f	
7/23/2004	E9	NS	0.0172	lycosidae	*P. ca.*	f	egg
7/23/2004	E9	NS	0.0250	lycosidae	*P. ca.*	f	egg
7/23/2004	E9	NS	0.0054	lycosidae	*P. ca.*	juv	
7/23/2004	E9	NS	0.0091	lycosidae	*P. ca.*	m	
7/23/2004	E9	NS	0.0068	lycosidae	*P. ca.*	f	
7/23/2004	E9	NS	0.0054	lycosidae	*P. ca.*	juv	
7/23/2004	E9	NS	0.0178	lycosidae	*P. ca.*	f	egg
7/23/2004	E9	NS	0.0054	lycosidae	*P. ca.*	f/juv	
7/23/2004	E9	NS	0.0248	lycosidae	*P. ca.*	f	gravid
7/23/2004	E9	NS	0.0323	lycosidae	*P. ca.*	f	egg
7/23/2004	E9	NS	0.0295	lycosidae	*P. mil.*	f	egg
7/23/2004	E9	NS	0.0107	lycosidae	*P. mil.*	f	
7/23/2004	E9	NS	0.0078	lycosidae	*P. sed.*	f	

7/23/2004	E9	NS	0.0067	lycosidae	*pirata*	f	
7/31/2004	E13	S	0.0079	lycosidae	*P. ca.*	f	
7/31/2004	E13	S	0.0171	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0051	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0052	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0162	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0262	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0197	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0182	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0064	lycosidae	*P. ca.*	f/juv	
7/31/2004	E13	S	0.0179	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0043	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0133	lycosidae	*P. ca.*	m	
7/31/2004	E13	S	0.0065	lycosidae	*P. ca.*	juv/f	
7/31/2004	E13	S	0.0224	lycosidae	*P. ca.*	f	gravid
7/31/2004	E13	S	0.0058	lycosidae	*P. ca.*	juv/f	
7/31/2004	E13	S	0.0041	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0050	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0045	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0172	lycosidae	*P. ca.*	f	
7/31/2004	E13	S	0.0058	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0073	lycosidae	*P. ca.*	f	
7/31/2004	E13	S	0.0192	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0146	lycosidae	*P. ca.*	f	egg
7/31/2004	E13	S	0.0087	lycosidae	*P. ca.*	f	
7/31/2004	E13	S	0.0065	lycosidae	*P. ca.*	m	
7/31/2004	E13	S	0.0115	lycosidae	*P. ca.*	f	gravid
7/31/2004	E13	S	0.0043	lycosidae	*P. ca.*	juv	
7/31/2004	E13	S	0.0077	lycosidae	*P. ca.*	f	
7/31/2004	E13	S	0.0020	lycosidae	*P. mon.*	juv	
7/31/2004	E13	S	0.0057	lycosidae	*P. sed.*	f/juv	
7/31/2004	E14	NS	0.0905	lycosidae	*H. hue.*	f	
7/31/2004	E14	NS		lycosidae	*lycosidae*		
7/31/2004	E14	NS	0.0086	lycosidae	*P. ca.*	f	
7/31/2004	E14	NS	0.0018	lycosidae	*P. ca.*	j	
7/31/2004	E14	NS	0.0104	lycosidae	*P. ca.*	m	
7/31/2004	E14	NS	0.0194	lycosidae	*P. ca.*	f	egg
7/31/2004	E14	NS	0.0122	lycosidae	*P. ca.*	f	egg
7/31/2004	E14	NS	0.0309	lycosidae	*P. ca.*	f	egg
7/31/2004	E14	NS	0.0079	lycosidae	*P. ca.*	f	
7/31/2004	E14	NS	0.0063	lycosidae	*P. ca.*	juv	
7/31/2004	E14	NS	0.0205	lycosidae	*P. ca.*	f	egg
7/31/2004	E14	NS	0.0186	lycosidae	*P. ca.*	f	egg
7/31/2004	E14	NS	0.0042	lycosidae	*P. ca.*	juv	
7/31/2004	E14	NS	0.0011	lycosidae	*P. ca.*	juv	
7/31/2004	E14	NS	0.0176	lycosidae	*P. ca.*	f	spiderlings
7/31/2004	E14	NS	0.0231	lycosidae	*P. ca.*	f	
7/31/2004	E14	NS	0.0068	lycosidae	*P. ca.*	f	
7/31/2004	E14	NS	0.0187	lycosidae	*P. ca.*	f	egg
7/31/2004	E14	NS	0.0159	lycosidae	*P. ca.*	f	egg

7/31/2004	E14	NS	0.0326	lycosidae	*P. mil.*	f	egg
7/31/2004	E14	NS	0.0262	lycosidae	*P. mil.*	f	spiderlings
7/31/2004	E14	NS	0.0048	lycosidae	*P. mon.*	f	
7/31/2004	E14	NS	0.0036	lycosidae	*ysl*	juv	
7/31/2004	E15	PR	0.0074	lycosidae	*fringe*	f	egg hatching
7/31/2004	E15	PR	0.0087	lycosidae	*P. ca.*	f	egg
7/31/2004	E15	PR	0.0166	lycosidae	*P. ca.*	f	egg
7/31/2004	E15	PR	0.0159	lycosidae	*P. ca.*	f	egg
7/31/2004	E15	PR	0.0125	lycosidae	*P. mil.*	f	
7/31/2004	E15	PR	0.0225	lycosidae	*P. mil.*	f	1 spiderling
7/31/2004	E15	PR	0.0300	lycosidae	*P. mil.*	f	egg
7/31/2004	E15	PR	0.0090	lycosidae	*P. mil.*	m	
7/31/2004	E15	PR	0.0357	lycosidae	*P. mil.*	f	egg
7/31/2004	E15	PR	0.0379	lycosidae	*P. mil.*	f	egg
7/31/2004	E15	PR	0.0248	lycosidae	*P. mil.*	f	egg
8/10/2004	E3	NS	0.0153	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0044	lycosidae	*P. ca.*	juv	
8/10/2004	E3	NS	0.0052	lycosidae	*P. ca.*	m/juv	
8/10/2004	E3	NS	0.0049	lycosidae	*P. ca.*	juv	
8/10/2004	E3	NS	0.0002	lycosidae	*P. ca.*	baby	
8/10/2004	E3	NS	0.0083	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0253	lycosidae	*P. ca.*	f	spiderlings
8/10/2004	E3	NS	0.0128	lycosidae	*P. ca.*	f	egg
8/10/2004	E3	NS	0.0050	lycosidae	*P. ca.*	juv	
8/10/2004	E3	NS	0.0063	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0144	lycosidae	*P. ca.*	f	egg
8/10/2004	E3	NS	0.0072	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0078	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0080	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0050	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0120	lycosidae	*P. ca.*	f	egg
8/10/2004	E3	NS	0.0045	lycosidae	*P. ca.*	juv	
8/10/2004	E3	NS	0.0105	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0068	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0007	lycosidae	*P. ca.*	baby	
8/10/2004	E3	NS	0.0073	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0087	lycosidae	*P. ca.*	f	
8/10/2004	E3	NS	0.0065	lycosidae	*P. ca.*	m	
8/10/2004	E3	NS	0.0063	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0010	lycosidae	*?P. mil.*	baby	
8/10/2004	E4	S	0.0012	lycosidae	*?yellow*	juv/baby	
8/10/2004	E4	S	0.0007	lycosidae	*?yellow*	baby	
8/10/2004	E4	S	0.0013	lycosidae	*?yellow*	baby/juv	
8/10/2004	E4	S	0.0016	lycosidae	*?yellow*	baby/juv	
8/10/2004	E4	S	0.0007	lycosidae	*?yellow*	baby/juv	
8/10/2004	E4	S	0.0040	lycosidae	*P. ca.*	juv	
8/10/2004	E4	S	0.0157	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0090	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0084	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0072	lycosidae	*P. ca.*	f	

8/10/2004	E4	S	0.0133	lycosidae	*P. ca.*	f	egg
8/10/2004	E4	S	0.0296	lycosidae	*P. ca.*	f	egg
8/10/2004	E4	S	0.0124	lycosidae	*P. ca.*	f	egg
8/10/2004	E4	S	0.0062	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0057	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0176	lycosidae	*P. ca.*	f	egg
8/10/2004	E4	S	0.0065	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0068	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0070	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0035	lycosidae	*P. ca.*	juv	
8/10/2004	E4	S	0.0058	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0063	lycosidae	*P. ca.*	f	
8/10/2004	E4	S	0.0233	lycosidae	*P. ca.*	f	egg
8/10/2004	E4	S	0.0275	lycosidae	*P. mil.*	f	gravid
8/10/2004	E4	S	0.0282	lycosidae	*P. moe.*	f	egg
8/10/2004	E4	S	0.0055	lycosidae	*P. sed.*	f	
8/10/2004	E4	S	0.0054	lycosidae	*P. sed.*	f	
8/10/2004	E4	S	0.0065	lycosidae	*P. sed.*	f	
8/10/2004	E4	S	0.1487	lycosidae	*R. rab.*	f	
8/10/2004	E5	PR	0.0023	lycosidae	*?yellow*	juv	
8/10/2004	E5	PR	0.0060	lycosidae	*P. ca.*	f	
8/10/2004	E5	PR	0.0172	lycosidae	*P. ca.*	f	egg
8/10/2004	E5	PR	0.0305	lycosidae	*P. ca.*	f	egg
8/10/2004	E5	PR	0.0067	lycosidae	*P. ca.*	f	
8/10/2004	E5	PR	0.0141	lycosidae	*P. ca.*	f	
8/10/2004	E5	PR	0.0064	lycosidae	*P. ca.*	f	
8/10/2004	E5	PR	0.0074	lycosidae	*P. ca.*	m	
8/10/2004	E5	PR	0.0063	lycosidae	*P. ca.*	f	
8/10/2004	E5	PR	0.0024	lycosidae	*P. ca.*	juv	
8/10/2004	E5	PR	0.0176	lycosidae	*P. ca.*	f	egg
8/10/2004	E5	PR	0.0239	lycosidae	*P. ca.*	f	egg
8/10/2004	E5	PR	0.0009	lycosidae	*P. ca.*	baby	
8/10/2004	E5	PR	0.0104	lycosidae	*P. ca.*	f	gravid
8/10/2004	E5	PR	0.0255	lycosidae	*P. ca.*	f	egg
8/10/2004	E5	PR	0.0078	lycosidae	*P. ca.*	m	
8/10/2004	E5	PR	0.0200	lycosidae	*P. ca.*	f	egg
8/10/2004	E5	PR	0.0076	lycosidae	*P. ca.*	f	
8/10/2004	E5	PR	0.0422	lycosidae	*P. mil.*	f	egg
8/10/2004	E5	PR	0.0309	lycosidae	*P. mil.*	f	egg
8/11/2004	E7	S	0.0081	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0115	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0086	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0065	lycosidae	*P. ca.*	f/juv	
8/11/2004	E7	S	0.0071	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0083	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0073	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0099	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0083	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0119	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0054	lycosidae	*P. ca.*	f	

8/11/2004	E7	S	0.0081	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0171	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0092	lycosidae	*P. ca.*	m	
8/11/2004	E7	S	0.0076	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0077	lycosidae	*P. ca.*	f	
8/11/2004	E7	S	0.0069	lycosidae	*P. ca.*	m	
8/11/2004	E7	S	0.0049	lycosidae	*P. mon.*	f/juv	
8/11/2004	E7	S	0.0065	lycosidae	*P. mon.*	f	
8/11/2004	E7	S	0.0058	lycosidae	*P. sed.*	f	
8/11/2004	E7	S	0.0089	lycosidae	*P. sed.*	f	
8/11/2004	E7	S	0.0061	lycosidae	*P. sed.*	f	
8/11/2004	E7	S		lycosidae	*P. sed.*	f	
8/11/2004	E7	S	0.0077	lycosidae	*P. sed.*	f	
8/11/2004	E7	S	0.0082	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0012	lycosidae	*?yellow*	baby/juv	
8/11/2004	E8	PR	0.0006	lycosidae	*?yellow*	baby	
8/11/2004	E8	PR	0.0234	lycosidae	*P. ca.*	f	spiderlings
8/11/2004	E8	PR	0.0322	lycosidae	*P. ca.*	f	egg
8/11/2004	E8	PR	0.0085	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0215	lycosidae	*P. ca.*	f	egg
8/11/2004	E8	PR	0.0061	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0066	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0010	lycosidae	*P. ca.*	baby	
8/11/2004	E8	PR	0.0098	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0084	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0214	lycosidae	*P. ca.*	f	egg
8/11/2004	E8	PR	0.0086	lycosidae	*P. ca.*	f	gravid
8/11/2004	E8	PR	0.0089	lycosidae	*P. ca.*	m	
8/11/2004	E8	PR	0.0103	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0085	lycosidae	*P. ca.*	f	gravid
8/11/2004	E8	PR	0.0073	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0172	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0091	lycosidae	*P. ca.*	f	
8/11/2004	E8	PR	0.0068	lycosidae	*P. ca.*	juv	
8/11/2004	E8	PR	0.0049	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0071	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0091	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0066	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0084	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0058	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0068	lycosidae	*P. sed.*	f	
8/11/2004	E8	PR	0.0177	lycosidae	*ysl*	f	
8/11/2004	E9	NS	0.0647	lycosidae	*H. hue.*	f	
8/11/2004	E9	NS	0.0101	lycosidae	*P. ca.*	f	
8/11/2004	E9	NS	0.0174	lycosidae	*P. ca.*	f	spiderlings
8/11/2004	E9	NS	0.0005	lycosidae	*P. ca.*	baby	
8/11/2004	E9	NS	0.0256	lycosidae	*P. ca.*	f	egg
8/11/2004	E9	NS	0.0192	lycosidae	*P. ca.*	f	
8/11/2004	E9	NS	0.0075	lycosidae	*P. mon.*	f	
8/11/2004	E9	NS	0.0156	lycosidae	*P. mon.*	f	

8/11/2004	E9	NS	0.0143	lycosidae	*P. mon.*	f	gravid
8/11/2004	E9	NS	0.0052	lycosidae	*P. sed.*	f/juv	
8/11/2004	E9	NS	0.0072	lycosidae	*P. sed.*	f	
8/11/2004	E9	NS	0.0128	lycosidae	*P. sed.*	f	
8/11/2004	E9	NS	0.0062	lycosidae	*P. sed.*	f	
8/11/2004	E9	NS	0.0052	lycosidae	*P. sed.*	f/juv	
8/11/2004	E9	NS	0.0067	lycosidae	*P. sed.*	f	
8/13/2004	E12	NC	0.1462	lycosidae	*H. hue.*	f	
8/13/2004	E12	NC	0.0226	lycosidae	*P. ca.*	f	egg
8/13/2004	E12	NC	0.0084	lycosidae	*P. ca.*	f	
8/13/2004	E12	NC	0.0248	lycosidae	*P. ca.*	f	spiderlings
8/13/2004	E12	NC	0.0071	lycosidae	*P. ca.*	f	
8/13/2004	E12	NC	0.0234	lycosidae	*P. ca.*	f	spiderlings
8/13/2004	E12	NC	0.0057	lycosidae	*P. ca.*	f	
8/13/2004	E12	NC	0.0114	lycosidae	*P. ca.*	m	
8/13/2004	E12	NC	0.0251	lycosidae	*P. ca.*	f	egg
8/13/2004	E12	NC	0.0124	lycosidae	*P. ca.*	f	
8/13/2004	E12	NC	0.0344	lycosidae	*P. mil.*	f	egg
8/13/2004	E12	NC	0.0164	lycosidae	*P. mil.*	f	
8/13/2004	E12	NC	0.0005	lycosidae	*P. mil.*	baby	
8/13/2004	E12	NC	0.0349	lycosidae	*P. mil.*	f	egg
8/13/2004	E12	NC	0.0023	lycosidae	*P. mil.*	juv	
8/13/2004	E12	NC		lycosidae	*P. mil.*	baby	
8/13/2004	E12	NC	0.0085	lycosidae	*P. sed.*	f	
8/13/2004	E12	NC	0.0258	lycosidae	*ysl*	f	
8/13/2004	E13	S	0.0036	lycosidae	*?yellow*	juv	
8/13/2004	E13	S	0.0103	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0058	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0077	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0077	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0121	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0223	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0060	lycosidae	*P. ca.*	f/juv	
8/13/2004	E13	S	0.0096	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0125	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0043	lycosidae	*P. ca.*	f/juv	
8/13/2004	E13	S	0.0101	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0082	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0041	lycosidae	*P. ca.*	juv	
8/13/2004	E13	S	0.0102	lycosidae	*P. ca.*	juv	
8/13/2004	E13	S	0.0123	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0093	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0055	lycosidae	*P. ca.*	juv	
8/13/2004	E13	S	0.0180	lycosidae	*P. ca.*	f	egg
8/13/2004	E13	S	0.0070	lycosidae	*P. ca.*	f/juv	
8/13/2004	E13	S	0.0051	lycosidae	*P. ca.*	juv	
8/13/2004	E13	S	0.0079	lycosidae	*P. ca.*	m	
8/13/2004	E13	S	0.0071	lycosidae	*P. ca.*	m	
8/13/2004	E13	S		lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0213	lycosidae	*P. ca.*	f	egg

8/13/2004	E13	S	0.0057	lycosidae	*P. ca.*	f/juv	
8/13/2004	E13	S	0.0060	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0064	lycosidae	*P. ca.*	m	
8/13/2004	E13	S	0.0069	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0088	lycosidae	*P. ca.*	m	
8/13/2004	E13	S	0.0084	lycosidae	*P. ca.*	f	
8/13/2004	E13	S	0.0118	lycosidae	*P. ca.*	m	
8/13/2004	E13	S	0.0067	lycosidae	*P. sed.*	juv	
8/13/2004	E13	S	0.0372	lycosidae	*ysl*	f	
8/13/2004	E14	NS	0.0025	lycosidae	*?*	juv	
8/13/2004	E14	NS	0.0005	lycosidae	*P. ca.*	baby	
8/13/2004	E14	NS	0.0044	lycosidae	*P. ca.*	juv/f	
8/13/2004	E14	NS	0.0110	lycosidae	*P. ca.*	f	egg
8/13/2004	E14	NS	0.0071	lycosidae	*P. ca.*	m	
8/13/2004	E14	NS	0.0076	lycosidae	*P. ca.*	m	
8/13/2004	E14	NS	0.0129	lycosidae	*P. ca.*	f	egg
8/13/2004	E14	NS	0.0092	lycosidae	*P. ca.*	m	
8/13/2004	E14	NS	0.0060	lycosidae	*P. ca.*	f	
8/13/2004	E14	NS	0.0059	lycosidae	*P. ca.*	f	
8/13/2004	E14	NS	0.0292	lycosidae	*P. ca.*	f	egg
8/13/2004	E14	NS	0.0019	lycosidae	*P. ca.*	juv	
8/13/2004	E14	NS	0.0246	lycosidae	*P. ca.*	f	
8/13/2004	E14	NS	0.0006	lycosidae	*P. ca.*	baby	
8/13/2004	E14	NS	0.0148	lycosidae	*P. ca.*	f	egg
8/13/2004	E14	NS	0.0006	lycosidae	*P. ca.*	baby	
8/13/2004	E14	NS	0.0057	lycosidae	*P. ca.*	f	egg
8/13/2004	E14	NS	0.0128	lycosidae	*P. ca.*	f	egg
8/13/2004	E14	NS	0.0060	lycosidae	*P. ca.*	f	
8/13/2004	E14	NS	0.0184	lycosidae	*P. ca.*	f	egg
8/13/2004	E14	NS	0.0203	lycosidae	*P. ca.*	f	gravid
8/13/2004	E14	NS	0.0054	lycosidae	*ysl*	juv	
8/13/2004	E15	PR	large	lycosidae	*H. hue.*	f	
8/13/2004	E15	PR	0.0027	lycosidae	*P. ca.*	juv	
8/13/2004	E15	PR	0.0077	lycosidae	*P. ca.*	m	
8/13/2004	E15	PR	0.0124	lycosidae	*P. ca.*	f	egg
8/13/2004	E15	PR	0.0082	lycosidae	*P. ca.*	f	
8/13/2004	E15	PR	0.0225	lycosidae	*P. ca.*	f	egg
8/13/2004	E15	PR	0.0073	lycosidae	*P. ca.*	m	
8/13/2004	E15	PR	0.0072	lycosidae	*P. ca.*	m	
8/13/2004	E15	PR	0.0049	lycosidae	*P. ca.*	juv	
8/13/2004	E15	PR	0.0077	lycosidae	*P. ca.*	m	
8/13/2004	E15	PR	0.0048	lycosidae	*P. ca.*	juv	
8/13/2004	E15	PR	0.0378	lycosidae	*P. mil.*	f	egg
8/13/2004	E15	PR	0.0324	lycosidae	*P. mil.*	f	spiderlings
8/13/2004	E15	PR	0.0002	lycosidae	*P. mil.*	baby	
8/13/2004	E15	PR	0.0064	lycosidae	*P. mon.*	f	
8/13/2004	E15	PR	0.0706	lycosidae	*R. rab.*	f	
8/13/2004	E15	PR	0.0527	lycosidae	*R. rab.*	f	
8/17/2004	E10	S	0.0067	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0035	lycosidae	*P. ca.*	juv	

8/17/2004	E10	S	0.0006	lycosidae	*P. ca.*	baby	
8/17/2004	E10	S	0.0057	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0213	lycosidae	*P. ca.*	f	egg
8/17/2004	E10	S	0.0062	lycosidae	*P. ca.*	juv	
8/17/2004	E10	S	0.0074	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0055	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0183	lycosidae	*P. ca.*	f	egg
8/17/2004	E10	S	0.0058	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0043	lycosidae	*P. ca.*	juv	
8/17/2004	E10	S	0.0061	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0064	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0022	lycosidae	*P. ca.*	juv	
8/17/2004	E10	S	0.0060	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0067	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0057	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0063	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0077	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0076	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0047	lycosidae	*P. ca.*	juv	
8/17/2004	E10	S	0.0071	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0067	lycosidae	*P. sed.*	f	
8/17/2004	E10	S	0.0280	lycosidae	*ysl*	f	
8/17/2004	E10	S	0.0055	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0064	lycosidae	*P. ca.*	f	
8/17/2004	E10	S	0.0046	lycosidae	*P. ca.*	juv	
8/17/2004	E10	S	0.0054	lycosidae	*P. ca.*	juv	
8/17/2004	E10	S	0.0056	lycosidae	*P. ca.*	juv/f	
8/17/2004	E10	S	0.0041	lycosidae	*P. ca.*	juv	
8/17/2004	E10	S	0.0292	lycosidae	*P. moe.*	f	egg
8/17/2004	E10	S	0.0078	lycosidae	*P. sed.*	m	
8/17/2004	E11	NS	0.0063	lycosidae	*P. ca.*	juv	
8/17/2004	E11	NS	0.0337	lycosidae	*P. ca.*	f	egg
8/17/2004	E11	NS	0.0119	lycosidae	*P. ca.*	f	gravid
8/17/2004	E11	NS	0.0092	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0078	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0076	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0212	lycosidae	*P. ca.*	f	egg
8/17/2004	E11	NS	0.005	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0087	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0127	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0065	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0089	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0071	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0069	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0077	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0092	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0053	lycosidae	*P. ca.*	juv	
8/17/2004	E11	NS	0.0104	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.009	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0072	lycosidae	*P. ca.*	m	

8/17/2004	E11	NS	0.015	lycosidae	*P. ca.*	f	egg
8/17/2004	E11	NS	0.0071	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0112	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0169	lycosidae	*P. ca.*	f	spiderlings
8/17/2004	E11	NS	0.0063	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0079	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0089	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0109	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0271	lycosidae	*P. ca.*	f	egg
8/17/2004	E11	NS	0.0053	lycosidae	*P. ca.*	juv	
8/17/2004	E11	NS	0.0081	lycosidae	*P. ca.*	f	
8/17/2004	E11	NS	0.0056	lycosidae	*P. mon.*	f	
8/17/2004	E11	NS	0.0062	lycosidae	*P. mon.*	f	
8/17/2004	E11	NS	0.0186	lycosidae	*P. sed.*	f	spiderlings
8/17/2004	E11	NS	0.053	lycosidae	*R. rab.*	f	
8/17/2004	E11	NS	0.0232	lycosidae	*ysl*	f	
8/17/2004	E6	NC	0.0006	lycosidae	*?P. mil.*	baby	
8/17/2004	E6	NC	0.0005	lycosidae	*?P. mil.*	baby	
8/17/2004	E6	NC	0.1776	lycosidae	*H. hue.*	f	
8/17/2004	E6	NC	0.0309	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0149	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0246	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0004	lycosidae	*P. ca.*	baby/juv	
8/17/2004	E6	NC	0.0073	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0073	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0110	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0093	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0185	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0284	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0110	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0100	lycosidae	*P. ca.*	m	
8/17/2004	E6	NC	0.0313	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0108	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0128	lycosidae	*P. ca.*	f	gravid
8/17/2004	E6	NC	0.0076	lycosidae	*P. ca.*	m	
8/17/2004	E6	NC	0.0007	lycosidae	*P. ca.*	baby/juv	
8/17/2004	E6	NC	0.0287	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0360	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0107	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0076	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0095	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0203	lycosidae	*P. ca.*	f	egg
8/17/2004	E6	NC	0.0135	lycosidae	*P. ca.*	m	
8/17/2004	E6	NC	0.0070	lycosidae	*P. ca.*	f	
8/17/2004	E6	NC	0.0297	lycosidae	*P. ca.*	f	egg
8/25/2004	E18	PR	0.0077	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0086	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0095	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0316	lycosidae	*P. ca.*	f	egg
8/25/2004	E18	PR	0.0048	lycosidae	*P. ca.*	f	

8/25/2004	E18	PR	0.007	lycosidae	*P. ca.*	m	
8/25/2004	E18	PR	.	lycosidae	*P. ca.*	.	
8/25/2004	E18	PR	0.0101	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0152	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.01	lycosidae	*P. ca.*	.	
8/25/2004	E18	PR	0.0088	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0212	lycosidae	*P. ca.*	f	spiderlings
8/25/2004	E18	PR	0.022	lycosidae	*P. ca.*	f	egg
8/25/2004	E18	PR	0.0082	lycosidae	*P. ca.*	m	
8/25/2004	E18	PR	0.0098	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0102	lycosidae	*P. ca.*	m	
8/25/2004	E18	PR	0.0117	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0073	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0073	lycosidae	*P. ca.*	m	
8/25/2004	E18	PR	0.0099	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0085	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0094	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0344	lycosidae	*P. ca.*	f	spiderlings
8/25/2004	E18	PR	0.0281	lycosidae	*P. ca.*	f	spiderlings
8/25/2004	E18	PR	0.0133	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0067	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0144	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0084	lycosidae	*P. ca.*	m	
8/25/2004	E18	PR	0.0108	lycosidae	*P. ca.*	m	
8/25/2004	E18	PR	0.0071	lycosidae	*P. ca.*	m	
8/25/2004	E18	PR	0.0073	lycosidae	*P. ca.*	f	
8/25/2004	E18	PR	0.0246	lycosidae	*P. mil.*	f	egg
8/25/2004	E19	S	0.0109	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0068	lycosidae	*P. ca.*	m	
8/25/2004	E19	S	0.0061	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0082	lycosidae	*P. ca.*	m	
8/25/2004	E19	S	0.0052	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0065	lycosidae	*P. ca.*	m	
8/25/2004	E19	S	0.0079	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0059	lycosidae	*P. ca.*	m	
8/25/2004	E19	S	0.0102	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0088	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0134	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0098	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0077	lycosidae	*P. ca.*	f	
8/25/2004	E19	S	0.0074	lycosidae	*P. ca.*	m	
8/25/2004	E19	S	0.0063	lycosidae	*P. ca.*	m	
8/25/2004	E19	S	0.0077	lycosidae	*P. ca.*	f	
8/25/2004	E20	NS	0.0094	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	0.0099	lycosidae	*P. ca.*	f	
8/25/2004	E20	NS	0.0152	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	0.0083	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	0.0089	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	0.007	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	.	lycosidae	*P. ca.*	.	

8/25/2004	E20	NS	0.0088	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	0.0102	lycosidae	*P. ca.*	f	
8/25/2004	E20	NS	0.0114	lycosidae	*P. ca.*	f	
8/25/2004	E20	NS	0.0072	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	0.0084	lycosidae	*P. ca.*	m	
8/25/2004	E20	NS	0.0268	lycosidae	*P. ca.*	f	egg
8/25/2004	E20	NS	0.0189	lycosidae	*P. ca.*	f	egg
8/25/2004	E20	NS	0.0085	lycosidae	*P. ca.*	f	gravid
8/25/2004	E20	NS	0.0176	lycosidae	*P. sed.*	f	egg
8/26/2004	E1	NS	0.001	lycosidae	*?P. mil.*	baby	
8/26/2004	E1	NS	0.0013	lycosidae	*?P. mil.*	baby	
8/26/2004	E1	NS	0.0106	lycosidae	*P. ca.*	f	spiderlings
8/26/2004	E1	NS	0.0071	lycosidae	*P. ca.*	f	
8/26/2004	E1	NS	0.0224	lycosidae	*P. ca.*	f	egg
8/26/2004	E1	NS	0.0088	lycosidae	*P. ca.*	f	
8/26/2004	E1	NS	0.0076	lycosidae	*P. ca.*	m	
8/26/2004	E1	NS	0.0172	lycosidae	*P. ca.*	f	egg
8/26/2004	E1	NS	0.0091	lycosidae	*P. ca.*	f	spiderlings
8/26/2004	E1	NS	0.0072	lycosidae	*P. ca.*	f	
8/26/2004	E1	NS	0.0158	lycosidae	*P. ca.*	f	spiderlings
8/26/2004	E1	NS	0.0004	lycosidae	*P. ca.*	baby	
8/26/2004	E1	NS	0.0066	lycosidae	*P. ca.*	m	
8/26/2004	E1	NS	0.0081	lycosidae	*P. ca.*	f	
8/26/2004	E1	NS	0.0073	lycosidae	*P. ca.*	f	
8/26/2004	E1	NS	0.0087	lycosidae	*P. ca.*	f	
8/26/2004	E1	NS	0.039	lycosidae	*P. mil.*	f	egg
8/26/2004	E1	NS	0.0036	lycosidae	*P. mil.*	juv	
8/26/2004	E1	NS	0.0358	lycosidae	*P. moe.*	f	egg
8/26/2004	E1	NS	0.0046	lycosidae	*P. mon.*	f	
8/26/2004	E2	S	0.0014	lycosidae	*?P. mil.*	baby	
8/26/2004	E2	S	0.0128	lycosidae	*?P. mon.*	f	
8/26/2004	E2	S	0.0099	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0084	lycosidae	*P. ca.*	m	
8/26/2004	E2	S	0.0079	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0081	lycosidae	*P. ca.*	m	
8/26/2004	E2	S	0.0257	lycosidae	*P. ca.*	f	spiderlings
8/26/2004	E2	S	0.0054	lycosidae	*P. ca.*	juv	
8/26/2004	E2	S	0.0068	lycosidae	*P. ca.*	m	
8/26/2004	E2	S	0.0009	lycosidae	*P. ca.*	baby	
8/26/2004	E2	S	0.0009	lycosidae	*P. ca.*	baby	
8/26/2004	E2	S	0.0095	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0086	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0117	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.009	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0077	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0103	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0078	lycosidae	*P. ca.*	f	
8/26/2004	E2	S	0.0093	lycosidae	*P. ca.*	m	
8/26/2004	E2	S	0.0132	lycosidae	*P. mon.*	f	
8/26/2004	E2	S	0.0114	lycosidae	*P. sed.*	f	

8/26/2004	E2	S	0.0089	lycosidae	*ysl*	f	
8/27/2004	E21	S	0.0062	lycosidae	*P. ca.*	f/juv	
8/27/2004	E21	S	0.0094	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0095	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0067	lycosidae	*P. ca.*	f/juv	
8/27/2004	E21	S	0.0263	lycosidae	*P. ca.*	f	egg
8/27/2004	E21	S	0.01	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0112	lycosidae	*P. ca.*	m	
8/27/2004	E21	S	0.0081	lycosidae	*P. ca.*	m	
8/27/2004	E21	S	0.0081	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0076	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0066	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0005	lycosidae	*P. ca.*	baby	
8/27/2004	E21	S	0.0174	lycosidae	*P. ca.*	f	babies in clump
8/27/2004	E21	S	0.0125	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0074	lycosidae	*P. ca.*	m	
8/27/2004	E21	S	0.0082	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0062	lycosidae	*P. ca.*	m	
8/27/2004	E21	S	0.0073	lycosidae	*P. ca.*	f	
8/27/2004	E21	S	0.0176	lycosidae	*P. mon.*	f	egg
8/27/2004	E21	S	0.0078	lycosidae	*P. mon.*	m	
8/27/2004	E21	S	0.0089	lycosidae	*P. sed.*	f	
8/27/2004	E22	NS	0.0191	lycosidae	*?P. mon.*	f	egg
8/27/2004	E22	NS	0.0092	lycosidae	*P. ca.*	m	
8/27/2004	E22	NS	0.0097	lycosidae	*P. ca.*	m	
8/27/2004	E22	NS	0.0181	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.0103	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.011	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.0112	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.0089	lycosidae	*P. ca.*	m	
8/27/2004	E22	NS	0.0063	lycosidae	*P. ca.*	m	
8/27/2004	E22	NS	0.0057	lycosidae	*P. ca.*	m	
8/27/2004	E22	NS	0.006	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.0084	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.0085	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.0006	lycosidae	*P. ca.*	baby	
8/27/2004	E22	NS	0.0073	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.008	lycosidae	*P. ca.*	m	
8/27/2004	E22	NS	0.0098	lycosidae	*P. ca.*	f	
8/27/2004	E22	NS	0.0353	lycosidae	*P. ca.*	f	egg
8/27/2004	E22	NS	0.0618	lycosidae	*P. mil.*	f	gravid
8/27/2004	E22	NS	0.0123	lycosidae	*P. mil.*	f	
8/27/2004	E22	NS	0.018	lycosidae	*P. mon.*	f	egg
8/27/2004	E22	NS	0.0204	lycosidae	*P. mon.*	f	egg
8/27/2004	E22	NS	0.0128	lycosidae	*P. mon.*	f	egg
8/27/2004	E22	NS	0.0207	lycosidae	*P. mon.*	f	egg
8/27/2004	E22	NS	0.0177	lycosidae	*P. mon.*	f	egg
8/27/2004	E22	NS	0.0155	lycosidae	*P. mon.*	f	
8/27/2004	E22	NS	0.0152	lycosidae	*P. mon.*	f	
8/27/2004	E22	NS	0.0081	lycosidae	*P. mon.*	f	

8/27/2004	E22	NS	0.0056	lycosidae	*P. sed.*	f	
8/27/2004	E22	NS	0.0227	lycosidae	*P. sed.*	f	egg
8/27/2004	E22	NS	0.0262	lycosidae	*P. sed.*	f	egg
8/27/2004	E22	NS	0.0083	lycosidae	*P. sed.*	f	
8/27/2004	E22	NS	0.0086	lycosidae	*P. sed.*	m	
8/28/2004	E16	NC	0.4268	lycosidae	*H. hue.*	f	
8/28/2004	E16	NC	0.0062	lycosidae	*P. ca.*	f	
8/28/2004	E16	NC	0.0325	lycosidae	*P. ca.*	f	egg
8/28/2004	E16	NC	0.0075	lycosidae	*P. ca.*	m	
8/28/2004	E16	NC	0.0238	lycosidae	*P. ca.*	f	egg
8/28/2004	E16	NC	0.0121	lycosidae	*P. ca.*	f	
8/28/2004	E16	NC	0.031	lycosidae	*P. ca.*	f	egg
8/28/2004	E16	NC	0.0209	lycosidae	*P. ca.*	f	egg
8/28/2004	E16	NC	0.0086	lycosidae	*P. ca.*	f	
8/28/2004	E16	NC	0.0076	lycosidae	*P. ca.*	f	
8/28/2004	E16	NC	0.0112	lycosidae	*P. ca.*	f	
8/28/2004	E16	NC	0.0295	lycosidae	*P. ca.*	f	egg
8/28/2004	E16	NC	0.0149	lycosidae	*P. ca.*	f	
8/28/2004	E16	NC	0.0008	lycosidae	*P. mil.*	baby	
8/28/2004	E16	NC	0.0003	lycosidae	*P. mil.*	baby	
8/28/2004	E16	NC	0.0239	lycosidae	*P. mil.*	f	spiderlings
8/28/2004	E16	NC	0.0151	lycosidae	*P. mon.*	f	egg
8/28/2004	E16	NC	0.0154	lycosidae	*P. mon.*	f	gravid
8/28/2004	E16	NC	0.017	lycosidae	*P. mon.*	f	egg
8/28/2004	E16	NC	0.0207	lycosidae	*P. mon.*	f	egg
8/28/2004	E16	NC	0.0179	lycosidae	*P. mon.*	f	egg
8/28/2004	E16	NC	0.0178	lycosidae	*P. mon.*	f	
8/28/2004	E16	NC	0.0142	lycosidae	*P. mon.*	f	
8/28/2004	E16	NC	0.0202	lycosidae	*P. sed.*	f	egg
8/28/2004	E16	NC	0.007	lycosidae	*P. sed.*	f	
8/28/2004	E16	NC	0.027	lycosidae	*P. sed.*	f	egg
8/28/2004	E16	NC	0.0174	lycosidae	*P. sed.*	f	egg
8/28/2004	E16	NC	0.0359	lycosidae	*P. sed.*	f	egg
8/28/2004	E16	NC	0.033	lycosidae	*P. sed.*	f	egg
8/28/2004	E16	NC	0.0297	lycosidae	*P. sed.*	f	egg
8/28/2004	E16	NC	0.0309	lycosidae	*P. sed.*	f	egg
8/28/2004	E17	NC	0.0023	lycosidae	*?P. mil.*	baby	
8/28/2004	E17	NC	0.0053	lycosidae	*P. ca.*	juv	
8/28/2004	E17	NC	0.0088	lycosidae	*P. ca.*	m	
8/28/2004	E17	NC	0.0066	lycosidae	*P. ca.*	f	
8/28/2004	E17	NC	0.0211	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0271	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0097	lycosidae	*P. ca.*	m	
8/28/2004	E17	NC	0.0144	lycosidae	*P. ca.*	f	
8/28/2004	E17	NC	0.0229	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0287	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0334	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0136	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0128	lycosidae	*P. ca.*	f	
8/28/2004	E17	NC	0.0087	lycosidae	*P. ca.*	f	

8/28/2004	E17	NC	0.0134	lycosidae	*P. ca.*	f	
8/28/2004	E17	NC	0.01	lycosidae	*P. ca.*	f	
8/28/2004	E17	NC	0.0083	lycosidae	*P. ca.*	m	
8/28/2004	E17	NC	0.0215	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0309	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0063	lycosidae	*P. ca.*	m	
8/28/2004	E17	NC	0.0327	lycosidae	*P. ca.*	f	gravid
8/28/2004	E17	NC	0.0112	lycosidae	*P. ca.*	f	egg
8/28/2004	E17	NC	0.0098	lycosidae	*P. ca.*	f	
8/28/2004	E17	NC	0.0075	lycosidae	*P. ca.*	f	
8/28/2004	E17	NC	0.0355	lycosidae	*P. mil.*	f	egg
8/28/2004	E17	NC	0.0334	lycosidae	*P. mil.*	f	egg
8/28/2004	E17	NC	0.0319	lycosidae	*P. mil.*	f	egg
8/28/2004	E17	NC	0.0308	lycosidae	*P. mil.*	f	gravid
8/28/2004	E17	NC	0.0026	lycosidae	*P. mil.*	juv	
8/28/2004	E17	NC	0.0152	lycosidae	*P. moe.*	m	
8/28/2004	E17	NC	0.0021	lycosidae	*P. mon.*	juv	
8/28/2004	E17	NC	0.0164	lycosidae	*P. sed.*	f	egg
8/28/2004	E17	NC	0.0115	lycosidae	*P. sed.*	f	egg
8/28/2004	E17	NC	0.0264	lycosidae	*P. sed.*	f	egg

ii. Dragonfly larvae. L = length from front of head to tip of abdomen. W = width at widest point. Species abbreviations are as follows: *L. lyd.* = *Libellula lydia, S. rub.* = *Sympetrum rubicundulum, S. elo.* = *Somatochlora elgongata, C. shu.* = *Cordulia shurtleffi, A. umb.* = *Aeshna umbrosa, A. jun.* = *Anax junius*. Several of the *L. lydia* could be *Libelulla pulchella* (I did not know how to differentiate at the time), but the proportion would be low (V. Rudolf, *pers. comm.*).

DATE	ENCL	TREAT	L(cm)	W(cm)	MASS(g)	FAMILY	SPP.
5/18/2004	E12	NC	0.55	0.3	0.0116	libellulidae	*L. lyd.*
5/18/2004	E12	NC	0.7	0.3	0.0174	libellulidae	*L. lyd.*
5/18/2004	E12	NC	0.8	0.3	0.0176	libellulidae	*L. lyd.*
5/26/2004	E6	NC	0.3	0.15	0.0019	?cordullidae	?
5/26/2004	E6	NC	1	0.35	0.0313	libellulidae	*L. lyd.*
5/26/2004	E6	NC	0.9	0.4	0.0293	libellulidae	*L. lyd.*
5/26/2004	E6	NC	1	0.35	0.0304	libellulidae	*L. lyd.*
5/26/2004	E6	NC	0.9	0.4	0.0294	libellulidae	*L. lyd.*
5/26/2004	E6	NC	0.9	0.4	0.0283	libellulidae	*L. lyd.*
5/26/2004	E6	NC	2.1	0.7	0.3176	libellulidae	*L. lyd.*
5/26/2004	E6	NC	1.9	0.85	0.3036	cordullidae	*S. elo.*

5/31/2004	E16	NC	2.1	0.7	0.3684	libellulidae	*L. lyd.*
5/31/2004	E16	NC	1.9	1	0.4580	cordullidae	*S. elo.*
5/31/2004	E16	NC	2.2	0.85	0.4394	cordullidae	*S. elo.*
6/1/2004	E17	NC	0.95	0.45	0.0465	cordullidae	*C. shu.*
6/1/2004	E17	NC	1.2	0.55	0.0875	cordullidae	*C. shu.*
6/1/2004	E17	NC	1.1	0.5	0.0755	cordullidae	*C. shu.*
6/1/2004	E17	NC	1.1	0.55	0.0726	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.9	0.35	0.028	libellulidae	?
6/15/2004	E12	NC	0.75	0.2	0.01	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.9	0.3	0.017	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.9	0.25	0.017	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.8	0.25	0.01	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.8	0.2	0.014	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.8	0.2	0.013	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.85	0.25	0.012	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.8	0.2	0.012	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.75	0.25	0.01	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.35	0.7	0.587	aeshnidae	*A. umb.*
6/15/2004	E12	NC	0.5	0.3	0.0100	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.5	0.25	0.0060	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.55	0.25	0.0080	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.4	0.15	0.0040	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.7	0.35	0.0180	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.6	dead		cordullidae	*C. shu.*
6/15/2004	E12	NC	0.5	dead		cordullidae	*C. shu.*
6/15/2004	E12	NC		dead		cordullidae	*C. shu.*
6/15/2004	E12	NC	0.7	0.3	0.016	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.8	0.4	0.036	cordullidae	*C. shu.*
6/15/2004	E12	NC	0.4	0.2	0.0040	cordullidae	*S. elo.*
6/15/2004	E12	NC	0.5	0.25	0.0090	cordullidae	*S. elo.*
6/15/2004	E12	NC	0.5	0.25	0.0060	cordullidae	*S. elo.*
6/15/2004	E12	NC	0.5	0.25	0.0050	cordullidae	*S. elo.*
6/15/2004	E12	NC	0.55	0.25	0.009	cordullidae	*S. elo.*
6/15/2004	E12	NC	0.5	dead		cordullidae	*S. elo.*
6/15/2004	E12	NC	0.65	0.35	0.016	cordullidae	*S. elo.*
6/15/2004	E12	NC	0.5	dead		cordullidae	*S. elo.*
6/22/2004	E16	NC	3.8	0.8	0.698	aeshnidae	*A. umb.*
6/22/2004	E16	NC	4	0.9	0.762	aeshnidae	*A. umb.*
6/22/2004	E16	NC	3.35	0.75	0.440	aeshnidae	*A. umb.*
6/22/2004	E16	NC	3.9	0.7	0.850	aeshnidae	*A. umb.*
6/22/2004	E17	NC	3.7	0.8	0.750	aeshnidae	*A. umb.*
6/22/2004	E17	NC	0.8	0.25	0.012	aeshnidae	*A. umb.*
6/22/2004	E16	NC	0.5	0.25	0.005	cordullidae	*C. shu.*
6/22/2004	E17	NC	1.4	0.6	0.137	cordullidae	*C. shu.*
6/22/2004	E17	NC	1.35	0.55	0.121	cordullidae	*C. shu.*
6/22/2004	E17	NC	1.5	0.7	0.158	cordullidae	*C. shu.*
6/22/2004	E17	NC	0.6	0.2	0.011	cordullidae	*C. shu.*
6/22/2004	E17	NC	0.9	0.45	0.033	cordullidae	*C. shu.*
6/22/2004	E17	NC	1.1	0.7	0.173	cordullidae	*C. shu.*
6/22/2004	E17	NC	1.4	0.7	0.172	cordullidae	*C. shu.*

6/22/2004	E17	NC	1.1	0.55	0.071	cordullidae	*S. elo.*
7/14/2004	E12	NC	1.00	0.35	0.053	aeshnidae	*A. umb.*
7/14/2004	E12	NC	1.30	0.5	0.082	libellulidae	*L. lyd.*
7/14/2004	E12	NC	1.10	0.4	0.035	libellulidae	*L. lyd.*
7/14/2004	E12	NC	1.25	0.5	0.075	libellulidae	*L. lyd.*
7/14/2004	E12	NC	0.80	0.3	0.020	cordullidae	*S. elo.*
7/14/2004	E12	NC	0.60	0.35	0.015	cordullidae	*S. elo.*
7/14/2004	E12	NC	1.15	0.55	0.730	libellulidae	*S. rub.*
7/16/2004	E6	NC	1.15	0.5	0.068	libellulidae	*L. lyd.*
7/16/2004	E6	NC	1.30	0.55	0.114	libellulidae	*L. lyd.*
7/16/2004	E6	NC	1.40	0.5	0.119	libellulidae	*L. lyd.*
7/16/2004	E6	NC	1.15	0.5	0.066	libellulidae	*L. lyd.*
7/16/2004	E6	NC	1.50	0.6	0.137	libellulidae	*L. lyd.*
7/16/2004	E6	NC	0.80	0.4	0.034	cordullidae	*S. elo.*
7/16/2004	E6	NC	0.70	0.35	0.016	cordullidae	*S. elo.*
7/16/2004	E6	NC	1.30	0.5	0.098	libellulidae	*S. rub.*
7/16/2004	E6	NC	0.95	0.45	0.040	libellulidae	*S. rub.*
7/16/2004	E6	NC	1.20	0.5	0.082	libellulidae	*S. rub.*
7/16/2004	E6	NC	1.25	0.45	0.074	libellulidae	*S. rub.*
7/16/2004	E6	NC	0.70	0.3	0.020	libellulidae	*S. rub.*
7/16/2004	E6	NC	1.30	0.5	0.080	libellulidae	*S. rub.*
7/16/2004	E6	NC	1.15	0.5	0.065	libellulidae	*S. rub.*
7/16/2004	E6	NC	1.30	0.45	0.079	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.10	0.3	0.025	aeshnidae	*A. umb.*
7/20/2004	E17	NC	1.20	0.3	0.037	aeshnidae	*A. umb.*
7/20/2004	E17	NC	1.40	0.3	0.044	aeshnidae	*A. umb.*
7/20/2004	E17	NC	1.90	0.9	0.310	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.70	0.7	0.217	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.60	0.7	0.171	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.80	0.8	0.303	cordullidae	*C. shu.*
7/20/2004	E17	NC	2.00	0.9	0.312	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.70	0.8	0.191	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.60	0.7	0.218	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.10	0.6	0.073	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.20	0.6	0.069	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.60	0.8	0.187	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.20	0.6	0.085	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.90	0.9	0.317	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.50	0.7	0.165	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.60	0.7	0.171	cordullidae	*C. shu.*
7/20/2004	E17	NC	1.90	0.8	0.291	cordullidae	*S. elo.*
7/20/2004	E17	NC	1.40	0.7	0.145	cordullidae	*S. elo.*
7/20/2004	E17	NC	1.80	0.7	0.189	cordullidae	*S. elo.*
7/20/2004	E17	NC	0.80	0.4	0.021	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.10	0.45	0.055	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.10	0.5	0.061	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.20	0.5	0.057	libellulidae	*S. rub.*
7/20/2004	E17	NC	0.90	0.3	0.032	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.10	0.4	0.063	libellulidae	*S. rub.*
7/20/2004	E17	NC	0.80	0.3	0.027	libellulidae	*S. rub.*

7/20/2004	E17	NC	0.90	0.4	0.031	libellulidae	*S. rub.*
7/20/2004	E17	NC	0.90	0.4	0.036	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.10	0.5	0.054	libellulidae	*S. rub.*
7/20/2004	E17	NC	0.70	0.3	0.020	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.10	0.5	0.058	libellulidae	*S. rub.*
7/20/2004	E17	NC	0.90	0.4	0.032	libellulidae	*S. rub.*
7/20/2004	E17	NC	0.70	0.4	0.025	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.20	0.4	0.065	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.10	0.4	0.058	libellulidae	*S. rub.*
7/20/2004	E17	NC	1.00	0.4	0.051	libellulidae	*S. rub.*
7/21/2004	E16	NC	1.40	0.3	0.057	aeshnidae	*A. umb.*
7/21/2004	E16	NC	1.00	0.3	0.018	aeshnidae	*A. umb.*
7/21/2004	E16	NC	1.00	0.2	0.015	aeshnidae	*A. umb.*
7/21/2004	E16	NC	1.10	0.3	0.026	aeshnidae	*A. umb.*
7/21/2004	E16	NC	1.10	0.2	0.021	aeshnidae	*A. umb.*
7/21/2004	E16	NC	1.20	0.3	0.032	aeshnidae	*A. umb.*
7/21/2004	E16	NC	1.20	0.3	0.025	aeshnidae	*A. umb.*
7/21/2004	E16	NC	0.60	0.2	0.005	aeshnidae	*A. umb.*
7/21/2004	E16	NC	1.00	0.3	0.018	aeshnidae	*A. umb.*
7/21/2004	E16	NC	0.90	0.4	0.035	libellulidae	*S. rub.*
7/21/2004	E16	NC	1.00	0.4	0.035	libellulidae	*S. rub.*
7/21/2004	E16	NC	1.10	0.4	0.050	libellulidae	*S. rub.*
7/21/2004	E16	NC	1.00	0.5	0.045	libellulidae	*S. rub.*
7/21/2004	E16	NC	1.10	0.5	0.059	libellulidae	*S. rub.*
8/7/2004	E12	NC	1.90	0.45	0.095	aeshnidae	*A. umb.*
8/7/2004	E12	NC	0.65	0.3	0.016	libellulidae	*L. lyd.*
8/7/2004	E12	NC	1.45	0.55	0.121	libellulidae	*L. lyd.*
8/7/2004	E12	NC	1.40	0.5	0.097	libellulidae	*L. lyd.*
8/7/2004	E12	NC	1.40	0.65	0.128	libellulidae	*L. lyd.*
8/7/2004	E12	NC	0.75	0.35	0.025	cordullidae	*S. elo.*
8/18/2004	E6	NC	.	.	0.011	libellulidae	*L. lyd.*
8/18/2004	E6	NC	.	.	0.012	libellulidae	*L. lyd.*
8/18/2004	E6	NC	.	.	0.015	libellulidae	*L. lyd.*
8/18/2004	E6	NC	.	.	0.169	libellulidae	*L. lyd.*
8/18/2004	E6	NC	.	.	0.213	cordullidae	*S. elo.*
8/18/2004	E6	NC	.	.	0.053	cordullidae	*S. elo.*
8/18/2004	E6	NC	.	.	0.072	libellulidae	*S. rub.*
8/26/2004	E16	NC			0.096	aeshnidae	*A. umb.*
8/26/2004	E16	NC			0.060	aeshnidae	*A. umb.*
8/26/2004	E16	NC			0.023	aeshnidae	*A. umb.*
8/26/2004	E16	NC			0.273	cordullidae	*C. shu.*
8/26/2004	E16	NC			0.012	libellulidae	*L. lyd.*
8/26/2004	E16	NC			0.025	cordullidae	*S. elo.*
8/26/2004	E16	NC			0.068	libellulidae	*S. rub.*
8/27/2004	E17	NC			0.293	cordullidae	*C. shu.*
8/27/2004	E17	NC			0.302	cordullidae	*C. shu.*
8/27/2004	E17	NC			0.066	cordullidae	*C. shu.*
8/27/2004	E17	NC			0.321	cordullidae	*C. shu.*
8/27/2004	E17	NC			0.308	cordullidae	*C. shu.*
8/27/2004	E17	NC			0.314	cordullidae	*C. shu.*

8/27/2004	E17	NC			0.024	cordullidae	*S. elo.*
8/27/2004	E17	NC			0.022	cordullidae	*S. elo.*
8/27/2004	E17	NC			0.213	cordullidae	*S. elo.*
8/27/2004	E17	NC			0.229	cordullidae	*S. elo.*
8/27/2004	E17	NC			0.226	cordullidae	*S. elo.*
8/27/2004	E17	NC			0.028	cordullidae	*S. elo.*
8/27/2004	E17	NC			0.082	libellulidae	*S. rub.*
8/27/2004	E17	NC			0.070	libellulidae	*S. rub.*
8/27/2004	E17	NC			0.078	libellulidae	*S. rub.*
5/17/2004	E14	NS	4.2	0.8	0.8040	aeshnidae	*A. umb.*
5/18/2004	E11	NS	2.95	0.55	0.3031	aeshnidae	*A. umb.*
5/20/2004	E1	NS	2.2	0.7	0.2969	libellulidae	*L. lyd.*
5/20/2004	E1	NS	1.9	0.65	0.2528	libellulidae	*L. lyd.*
5/20/2004	E1	NS	2.2	0.75	0.3346	libellulidae	*L. lyd.*
5/20/2004	E1	NS	2.2	0.7	0.3746	libellulidae	*L. lyd.*
5/20/2004	E1	NS	1.9	0.7	0.3014	libellulidae	*L. lyd.*
5/20/2004	E1	NS	2	0.7	0.2832	libellulidae	*L. lyd.*
5/20/2004	E1	NS	2	0.7	0.3023	libellulidae	*L. lyd.*
5/20/2004	E1	NS	2	0.65	0.3132	libellulidae	*L. lyd.*
5/20/2004	E1	NS	2.05	0.75	0.3433	libellulidae	*L. lyd.*
5/20/2004	E1	NS	0.9	0.4	0.0357	libellulidae	*L. lyd.*
5/20/2004	E3	NS	2.2	0.7	0.3966	libellulidae	*L. lyd.*
5/20/2004	E3	NS	2.1	0.7	0.3573	libellulidae	*L. lyd.*
5/20/2004	E3	NS	2.1	0.65	0.2955	libellulidae	*L. lyd.*
5/20/2004	E3	NS	2.2	0.65	0.3674	libellulidae	*L. lyd.*
5/20/2004	E3	NS	0.9	0.35	0.0332	libellulidae	*L. lyd.*
5/20/2004	E3	NS	0.8	0.4	0.0263	libellulidae	*L. lyd.*
5/26/2004	E9	NS	3.3	0.65	0.4752	aeshnidae	*A. umb.*
5/26/2004	E9	NS	2.8	0.65	0.3204	aeshnidae	*A. umb.*
5/26/2004	E9	NS	3.6	0.75	0.6039	aeshnidae	*A. umb.*
5/26/2004	E9	NS	3.2	0.7	0.5129	aeshnidae	*A. umb.*
5/26/2004	E3-try2	NS	0.9	0.35	0.0288	libellulidae	*L. lyd.*
5/26/2004	E3-try2	NS	2.2	0.65	0.3431	libellulidae	*L. lyd.*
5/26/2004	E9	NS	1.05	0.4	0.0503	libellulidae	*L. lyd.*
6/1/2004	E20	NS	2.3	0.85	0.4118	cordullidae	*S. elo.*
6/15/2004	E14	NS	1.05	0.25	0.0210	aeshnidae	*A. jun.*
6/15/2004	E14	NS	0.8	0.25	0.0100	aeshnidae	*A. umb.*
6/15/2004	E14	NS	0.6	0.2	0.0060	aeshnidae	*A. umb.*
6/15/2004	E14	NS	3.3	0.6	0.4710	aeshnidae	*A. umb.*
6/15/2004	E14	NS	0.55	0.3	0.0110	cordullidae	*C. shu.*
6/15/2004	E14	NS	0.3	0.15	0.0030	cordullidae	*C. shu.*
6/15/2004	E14	NS	0.6	0.35	0.0180	cordullidae	*C. shu.*
6/15/2004	E14	NS	0.75	0.35	0.0260	cordullidae	*C. shu.*
6/15/2004	E14	NS	0.6	0.3	0.0150	cordullidae	*C. shu.*
6/15/2004	E14	NS	0.4	0.15	0.0030	cordullidae	*C. shu.*
6/15/2004	E14	NS	0.7	0.3	0.0180	cordullidae	*C. shu.*
6/15/2004	E14	NS	0.65	0.3	0.0140	cordullidae	*S. elo.*
6/15/2004	E14	NS	0.5	0.25	0.0060	cordullidae	*S. elo.*
6/16/2004	E11	NS	0.95	0.3	0.02	aeshnidae	*A. umb.*

6/16/2004	E11	NS	3.7	0.7	0.664	aeshnidae	*A. umb.*
6/16/2004	E11	NS	0.9	0.2	0.016	aeshnidae	*A. umb.*
6/16/2004	E11	NS	0.75	0.25	0.009	aeshnidae	*A. umb.*
6/16/2004	E11	NS	1.15	0.3	0.023	aeshnidae	*A. umb.*
6/16/2004	E11	NS	1	0.25	0.019	aeshnidae	*A. umb.*
6/16/2004	E1	NS	0.7	0.3	0.015	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.5	0.25	0.008	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.7	0.3	0.015	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.55	0.3	0.013	cordullidae	*C. shu.*
6/16/2004	E11	NS		dead		cordullidae	*C. shu.*
6/16/2004	E11	NS		dead		cordullidae	*C. shu.*
6/16/2004	E11	NS	0.9	0.4	0.038	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.8	0.4	0.031	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.9	0.4	0.034	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.7	0.3	0.015	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.75	0.3	0.018	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.55	0.2	0.008	cordullidae	*C. shu.*
6/16/2004	E11	NS	0.6	0.25	0.009	cordullidae	*C. shu.*
6/16/2004	E1	NS	1	0.4	0.039	libellulidae	*L. lyd.*
6/16/2004	E1	NS	1.2	0.5	0.076	libellulidae	*L. lyd.*
6/16/2004	E1	NS	2.2	0.6	0.381	libellulidae	*L. lyd.*
6/16/2004	E1	NS	1	0.35	0.043	libellulidae	*L. lyd.*
6/16/2004	E1	NS	0.8	0.35	0.033	libellulidae	*L. lyd.*
6/16/2004	E1	NS	2	0.85	0.368	cordullidae	*S. elo.*
6/16/2004	E11	NS	0.5	0.25	0.009	cordullidae	*S. elo.*
6/16/2004	E11	NS	0.5	0.2	0.006	cordullidae	*S. elo.*
6/16/2004	E11	NS	0.55	0.25	0.008	cordullidae	*S. elo.*
6/16/2004	E11	NS	0.5	0.3	0.008	cordullidae	*S. elo.*
6/16/2004	E11	NS	0.5	0.25	0.007	cordullidae	*S. elo.*
6/16/2004	E11	NS	0.55	0.3	0.009	cordullidae	*S. elo.*
6/17/2004	E3	NS	0.6	0.2	0.006	aeshnidae	?
6/17/2004	E3	NS	0.9	0.25	0.021	aeshnidae	*A. umb.*
6/17/2004	E9	NS	1.1	0.25	0.02	aeshnidae	*A. umb.*
6/17/2004	E9	NS	DEAD			aeshnidae	*A. umb.*
6/17/2004	E3	NS	0.9	0.35	0.034	cordullidae	*C. shu.*
6/17/2004	E3	NS	DEAD			cordullidae	*C. shu.*
6/17/2004	E3	NS	DEAD			cordullidae	*C. shu.*
6/17/2004	E3	NS	0.75	0.35	0.017	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.6	0.35	0.016	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.55	0.25	0.008	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.4	0.2	0.003	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.65	0.3	0.014	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.5	0.25	0.008	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.65	0.3	0.013	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.5	0.25	0.005	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.5	0.3	0.006	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.6	0.25	0.008	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.5	0.25	0.007	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.55	0.3	0.008	cordullidae	*C. shu.*
6/17/2004	E3	NS	0.3	0.2	0.001	cordullidae	*C. shu.*

6/17/2004	E9	NS	0.55	0.3	0.008	cordullidae	*C. shu.*
6/17/2004	E9	NS	0.9	0.4	0.027	cordullidae	*C. shu.*
6/17/2004	E9	NS	0.5	0.25	0.007	cordullidae	*C. shu.*
6/17/2004	E3	NS	2.25	0.65	0.422	libellulidae	*L. lyd.*
6/17/2004	E3	NS	1.2	0.7	0.194	cordullidae	*S. elo.*
6/17/2004	E3	NS	DEAD			cordullidae	*S. elo.*
6/17/2004	E3	NS	0.5	0.25	0.007	cordullidae	*S. elo.*
6/17/2004	E3	NS	0.55	0.3	0.013	cordullidae	*S. elo.*
6/21/2004	E22	NS	0.9	0.2	0.015	aeshnidae	?
6/21/2004	E22	NS	0.9	0.3	0.019	aeshnidae	?
6/21/2004	E20	NS	1.5	0.7	0.165	cordullidae	*C. shu.*
6/21/2004	E22	NS	1.2	0.5	0.081	cordullidae	*C. shu.*
6/21/2004	E22	NS	2.3	0.9	0.517	cordullidae	*S. elo.*
6/21/2004	E22	NS	1.2	0.5	0.113	cordullidae	*S. elo.*
7/13/2004	E14	NS	1.20	0.3	0.022	aeshnidae	*A. umb.*
7/13/2004	E14	NS	1.20	0.35	0.029	aeshnidae	*A. umb.*
7/13/2004	E14	NS	1.15	0.3	0.024	aeshnidae	*A. umb.*
7/13/2004	E14	NS	1.10	0.3	0.028	aeshnidae	*A. umb.*
7/13/2004	E14	NS	1.55	0.45	0.062	libellulidae	*L. lyd.*
7/13/2004	E14	NS	0.65	0.3	0.016	corduliidae	*S. elo.*
7/13/2004	E14	NS	1.30	0.5	0.071	libellulidae	*S. rub.*
7/13/2004	E14	NS	1.00	0.45	0.042	libellulidae	*S. rub.*
7/13/2004	E14	NS	0.75	0.35	0.023	libellulidae	*S. rub.*
7/13/2004	E14	NS	1.10	0.5	0.063	libellulidae	*S. rub.*
7/13/2004	E14	NS	1.20	0.5	0.066	libellulidae	*S. rub.*
7/13/2004	E14	NS	0.90	0.35	0.035	libellulidae	*S. rub.*
7/13/2004	E14	NS	1.10	0.4	0.045	libellulidae	*S. rub.*
7/15/2004	E11	NS	3.70	0.75	0.670	aeshnidae	*A. umb.*
7/15/2004	E11	NS	1.60	0.45	0.071	aeshnidae	*A. umb.*
7/15/2004	E11	NS	1.50	0.4	0.060	aeshnidae	*A. umb.*
7/15/2004	E11	NS	1.15	0.3	0.032	aeshnidae	*A. umb.*
7/15/2004	E11	NS	1.45	0.4	0.058	aeshnidae	*A. umb.*
7/15/2004	E11	NS	1.35	0.35	0.043	aeshnidae	*A. umb.*
7/15/2004	E9	NS	1.10	0.2	0.026	aeshnidae	*A. umb.*
7/15/2004	E9	NS	1.15	0.3	0.027	aeshnidae	*A. umb.*
7/15/2004	E9	NS	1.90	0.45	0.112	aeshnidae	*A. umb.*
7/15/2004	E11	NS	0.55	0.3	0.011	cordullidae	*S. elo.*
7/15/2004	E11	NS	0.85	0.4	0.030	cordullidae	*S. elo.*
7/15/2004	E11	NS	1.35	0.5	0.091	libellulidae	*S. rub.*
7/15/2004	E11	NS	1.25	0.45	0.069	libellulidae	*S. rub.*
7/15/2004	E11	NS	1.15	0.45	0.069	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.30	0.45	0.092	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.20	0.45	0.080	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.25	0.5	0.079	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.00	0.35	0.045	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.30	0.5	0.083	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.30	0.5	0.086	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.35	0.5	0.087	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.10	0.4	0.047	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.30	0.5	0.090	libellulidae	*S. rub.*

7/15/2004	E9	NS	1.25	0.5	0.088	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.15	0.45	0.068	libellulidae	*S. rub.*
7/15/2004	E9	NS	1.25	0.45	0.070	libellulidae	*S. rub.*
7/16/2004	E3	NS	1.00	0.25	0.017	aeshnidae	*A. umb.*
7/16/2004	E3	NS	1.00	0.3	0.022	aeshnidae	*A. umb.*
7/16/2004	E3	NS	1.15	0.3	0.025	aeshnidae	*A. umb.*
7/16/2004	E3	NS	1.15	0.3	0.025	aeshnidae	*A. umb.*
7/16/2004	E3	NS	1.85	0.4	0.099	aeshnidae	*A. umb.*
7/16/2004	E3	NS	1.20	0.5	0.069	libellulidae	*L. lyd.*
7/16/2004	E3	NS	1.00	0.4	0.035	libellulidae	*S. rub.*
7/17/2004	E1	NS	1.50	0.45	0.061	aeshnidae	*A. umb.*
7/17/2004	E1	NS	1.60	0.4	0.065	aeshnidae	*A. umb.*
7/17/2004	E1	NS	1.20	0.3	0.030	aeshnidae	*A. umb.*
7/17/2004	E1	NS	1.10	0.4	0.047	libellulidae	*L. lyd.*
7/17/2004	E1	NS	1.00	0.4	0.041	libellulidae	*L. lyd.*
7/17/2004	E1	NS	1.20	0.5	0.077	libellulidae	*L. lyd.*
7/17/2004	E1	NS	2.25	0.8	0.424	libellulidae	*L. lyd.*
7/17/2004	E1	NS	0.90	0.45	0.030	cordullidae	*S. elo.*
7/17/2004	E1	NS	0.90	0.4	0.029	libellulidae	*S. rub.*
7/17/2004	E1	NS	1.25	0.5	0.075	libellulidae	*S. rub.*
7/17/2004	E1	NS	1.20	0.5	0.070	libellulidae	*S. rub.*
7/17/2004	E1	NS	1.30	0.5	0.069	libellulidae	*S. rub.*
7/17/2004	E1	NS	1.25	0.5	0.075	libellulidae	*S. rub.*
7/17/2004	E1	NS	0.95	0.4	0.038	libellulidae	*S. rub.*
7/17/2004	E1	NS	1.20	0.5	0.072	libellulidae	*S. rub.*
7/17/2004	E1	NS	0.90	0.4	0.034	libellulidae	*S. rub.*
7/19/2004	E22	NS	4.00	0.8	0.955	aeshnidae	?
7/19/2004	E22	NS	1.60	0.7	0.207	cordullidae	*C. shu.*
7/19/2004	E22	NS	1.70	0.7	0.199	libellulidae	*S. rub.*
7/19/2004	E22	NS	1.40	0.5	0.118	libellulidae	*S. rub.*
8/6/2004	E14	NS	1.70	0.4	0.071	aeshnidae	*A. umb.*
8/6/2004	E14	NS	1.40	0.35	0.050	aeshnidae	*A. umb.*
8/6/2004	E14	NS	1.35	0.5	0.096	libellulidae	*S. rub.*
8/7/2004	E11	NS	1.65	0.4	0.075	aeshnidae	*A. umb.*
8/7/2004	E11	NS	1.40	0.4	0.046	aeshnidae	*A. umb.*
8/7/2004	E11	NS	1.60	0.4	0.057	aeshnidae	*A. umb.*
8/7/2004	E11	NS	1.45	0.6	0.125	libellulidae	*L. lyd.*
8/7/2004	E11	NS	0.65	0.3	0.021	cordullidae	*S. elo.*
8/7/2004	E11	NS	0.75	0.4	0.028	cordullidae	*S. elo.*
8/7/2004	E11	NS	1.00	0.55	0.063	cordullidae	*S. elo.*
8/7/2004	E11	NS	0.95	0.4	0.036	cordullidae	*S. elo.*
8/7/2004	E11	NS	0.65	0.4	0.020	cordullidae	*S. elo.*
8/7/2004	E11	NS	1.30	0.5	0.090	libellulidae	*S. rub.*
8/7/2004	E11	NS	1.30	0.5	0.093	libellulidae	*S. rub.*
8/7/2004	E11	NS	1.35	0.5	0.089	libellulidae	*S. rub.*
8/7/2004	E11	NS	1.45	0.55	0.010	libellulidae	*S. rub.*
8/7/2004	E11	NS	1.20	0.5	0.084	libellulidae	*S. rub.*
8/7/2004	E11	NS	1.35	0.55	0.094	libellulidae	*S. rub.*
8/10/2004	E9	NS	2.00	0.5	0.145	aeshnidae	*A. umb.*
8/10/2004	E9	NS	1.65	0.45	0.085	aeshnidae	*A. umb.*

8/10/2004	E9	NS	1.00	0.55	0.055	cordullidae	*S. elo.*
8/10/2004	E9	NS	1.30	0.55	0.101	libellulidae	*S. rub.*
8/10/2004	E9	NS	1.40	0.5	0.095	libellulidae	*S. rub.*
8/10/2004	E9	NS	1.35	0.5	0.104	libellulidae	*S. rub.*
8/18/2004	E3	NS			0.131	libellulidae	*L. lyd.*
8/18/2004	E3	NS			0.020	cordullidae	*S. elo.*
8/18/2004	E3	NS			0.080	cordullidae	*S. elo.*
8/18/2004	E3	NS			0.041	cordullidae	*S. elo.*
8/18/2004	E3	NS			0.032	cordullidae	*S. elo.*
8/19/2004	E20	NS			0.043	aeshnidae	*A. umb.*
8/19/2004	E20	NS			0.150	aeshnidae	*A. umb.*
8/19/2004	E20	NS			0.141	aeshnidae	*A. umb.*
8/19/2004	E20	NS			0.072	aeshnidae	*A. umb.*
8/19/2004	E20	NS			0.227	aeshnidae	*A. umb.*
8/19/2004	E20	NS			0.069	libellulidae	*S. rub.*
8/19/2004	E20	NS			0.085	libellulidae	*S. rub.*
8/19/2004	E20	NS			0.082	libellulidae	*S. rub.*
8/19/2004	E20	NS			0.080	libellulidae	*S. rub.*
8/26/2004	E1	NS			0.226	aeshnidae	*A. umb.*
8/26/2004	E1	NS			0.133	aeshnidae	*A. umb.*
8/26/2004	E1	NS			0.146	aeshnidae	*A. umb.*
8/26/2004	E1	NS			0.206	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.010	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.017	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.013	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.021	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.010	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.010	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.167	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.017	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.016	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.008	libellulidae	*L. lyd.*
8/26/2004	E1	NS			0.074	cordullidae	*S. elo.*
8/27/2004	E22	NS			0.036	aeshnidae	*A. umb.*
8/27/2004	E22	NS			0.041	aeshnidae	*A. umb.*
8/27/2004	E22	NS			0.369	cordullidae	*C. shu.*
8/27/2004	E22	NS			0.036	cordullidae	*S. elo.*
8/27/2004	E22	NS			0.090	libellulidae	*S. rub.*
8/27/2004	E22	NS			0.071	libellulidae	*S. rub.*
8/27/2004	E22	NS			0.084	libellulidae	*S. rub.*
8/27/2004	E22	NS			0.067	libellulidae	*S. rub.*
8/27/2004	E22	NS			0.067	libellulidae	*S. rub.*
5/17/2004	E15	PR	2.3	0.7	0.4539	aeshnidae	*A. umb.*
5/17/2004	E15	PR	2.1	0.7	0.3005	libellulidae	*L. lyd.*
5/17/2004	E15	PR	1.7	0.6	0.1806	libellulidae	*L. lyd.*
5/17/2004	E15	PR	0.9	0.4	0.2400	libellulidae	*L. lyd.*
5/17/2004	E15	PR	2	0.65	0.3244	libellulidae	*L. lyd.*
5/26/2004	E5	PR	3.9	0.7	0.6143	aeshnidae	*A. umb.*
5/26/2004	E8	PR	3.7	0.75	0.7051	aeshnidae	*A. umb.*
5/26/2004	E8	PR	3.75	0.75	0.7418	aeshnidae	*A. umb.*

5/26/2004	E8	PR	3.2	0.65	0.4115	aeshnidae	*A. umb.*
5/26/2004	E8	PR	2.1	0.95	0.4375	cordullidae	*S. elo.*
6/1/2004	E18	PR	3.45	0.6	0.5287	aeshnidae	?
6/1/2004	E18	PR	1.2	0.6	0.0906	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.25	0.55	0.0786	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.35	0.55	0.1097	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.25	0.55	0.0936	cordullidae	*C. shu.*
6/1/2004	E18	PR	0.95	0.4	0.4500	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.2	0.5	0.0862	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.25	0.6	0.0831	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.25	0.5	0.0767	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.15	0.5	0.0895	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.5	0.65	0.1398	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.25	0.55	0.0965	cordullidae	*C. shu.*
6/1/2004	E18	PR	1.55	0.65	0.1629	cordullidae	*C. shu.*
6/17/2004	E8	PR		dead		cordullidae	?
6/17/2004	E5	PR	4.3	1	1.009	aeshnidae	*A. jun.*
6/17/2004	E5	PR	1	0.25	0.14	aeshnidae	*A. umb.*
6/17/2004	E5	PR	0.8	0.25	0.011	aeshnidae	*A. umb.*
6/17/2004	E5	PR	0.95	0.25	0.015	aeshnidae	*A. umb.*
6/17/2004	E5	PR	0.9	0.25	0.014	aeshnidae	*A. umb.*
6/17/2004	E5	PR	4	0.8	0.851	aeshnidae	*A. umb.*
6/17/2004	E8	PR	3.6	0.8	0.714	aeshnidae	*A. umb.*
6/17/2004	E8	PR	3.75	0.7	0.591	aeshnidae	*A. umb.*
6/17/2004	E8	PR	0.9	dead		aeshnidae	*A. umb.*
6/17/2004	E5	PR	0.8	0.35	0.019	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.6	0.3	0.014	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.75	0.4	0.031	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.65	0.3	0.015	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.85	0.4	0.033	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.6	0.3	0.011	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.6	0.3	0.015	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.7	0.3	0.015	cordullidae	*C. shu.*
6/17/2004	E5	PR	0.6	0.25	0.009	cordullidae	*C. shu.*
6/17/2004	E8	PR	0.7	0.3	0.017	cordullidae	*C. shu.*
6/17/2004	E8	PR	0.65	0.3	0.011	cordullidae	*C. shu.*
6/17/2004	E8	PR	0.8	0.35	0.019	cordullidae	*C. shu.*
6/17/2004	E5	PR	1.2	0.45	0.058	libellulidae	*L. lyd.*
6/17/2004	E5	PR	1.2	0.45	0.065	libellulidae	*L. lyd.*
6/17/2004	E5	PR	0.95	0.4	0.04	libellulidae	*L. lyd.*
6/17/2004	E5	PR	1	0.4	0.04	libellulidae	*L. lyd.*
6/17/2004	E5	PR	1.1	0.45	0.05	libellulidae	*L. lyd.*
6/17/2004	E5	PR	1.1	0.45	0.057	libellulidae	*L. lyd.*
6/17/2004	E5	PR	1.6	0.8	0.176	cordullidae	*S. elo.*
6/21/2004	E18	PR	2.7	dead		?	?
6/21/2004	E18	PR	1.6	0.7	0.139	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.5	0.7	0.132	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.6	0.75	0.190	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.6	0.7	0.152	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.1	0.5	0.057	cordullidae	*C. shu.*

6/21/2004	E18	PR	1.45	0.7	0.144	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.5	0.7	0.158	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.6	0.65	0.153	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.1	0.5	0.064	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.55	0.7	0.156	cordullidae	*C. shu.*
6/21/2004	E18	PR	1.8	0.8	0.245	cordullidae	*S. elo.*
7/13/2004	E15	PR	1.25	0.5	0.064	libellulidae	*L. lyd.*
7/13/2004	E15	PR	0.85	0.44	0.033	cordullidae	*S. elo.*
7/13/2004	E15	PR	0.80	0.4	0.028	cordullidae	*S. elo.*
7/13/2004	E15	PR	0.80	0.4	0.028	cordullidae	*S. elo.*
7/13/2004	E15	PR	0.65	0.35	0.015	cordullidae	*S. elo.*
7/13/2004	E15	PR	0.80	0.35	0.031	libellulidae	*S. rub.*
7/13/2004	E15	PR	1.20	0.55	0.074	libellulidae	*S. rub.*
7/13/2004	E15	PR	0.90	0.4	0.038	libellulidae	*S. rub.*
7/16/2004	E5	PR	2.15	0.45	0.136	aeshnidae	*A. umb.*
7/16/2004	E5	PR	2.00	0.45	0.094	aeshnidae	*A. umb.*
7/16/2004	E5	PR	1.15	0.45	0.064	libellulidae	*L. lyd.*
7/16/2004	E5	PR	0.85	0.4	0.025	cordullidae	*S. elo.*
7/16/2004	E5	PR	1.20	0.45	0.066	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.15	0.45	0.060	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.20	0.5	0.068	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.35	0.5	0.093	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.35	0.45	0.077	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.30	0.5	0.078	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.40	0.55	0.085	libellulidae	*S. rub.*
7/16/2004	E5	PR	0.95	0.4	0.039	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.00	0.45	0.043	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.20	0.45	0.069	libellulidae	*S. rub.*
7/16/2004	E5	PR	1.20	0.45	0.064	libellulidae	*S. rub.*
7/20/2004	E18	PR	4.00	0.8	0.912	aeshnidae	*A. umb.*
7/20/2004	E18	PR	1.30	0.3	0.042	aeshnidae	*A. umb.*
7/20/2004	E18	PR	1.00	0.3	0.018	aeshnidae	*A. umb.*
7/20/2004	E18	PR	1.20	0.6	0.081	cordullidae	*C. shu.*
7/20/2004	E18	PR	1.60	0.8	0.184	cordullidae	*C. shu.*
7/20/2004	E18	PR	1.10	0.6	0.081	cordullidae	*C. shu.*
7/20/2004	E18	PR	0.80	0.4	0.031	libellulidae	*S. rub.*
7/20/2004	E18	PR	0.90	0.3	0.031	libellulidae	*S. rub.*
7/20/2004	E18	PR	1.00	0.4	0.036	libellulidae	*S. rub.*
8/5/2004	E15	PR	1.70	0.4	0.076	aeshnidae	*A. umb.*
8/5/2004	E15	PR	1.50	0.5	0.123	libellulidae	*L. lyd.*
8/5/2004	E15	PR	1.15	0.6	0.073	cordullidae	*S. elo.*
8/10/2004	E8	PR	1.70	0.4	0.074	aeshnidae	*A. umb.*
8/10/2004	E8	PR	1.40	0.4	0.044	aeshnidae	*A. umb.*
8/10/2004	E8	PR	1.00	0.55	0.051	cordullidae	*S. elo.*
8/10/2004	E8	PR	1.10	0.55	0.073	cordullidae	*S. elo.*
8/10/2004	E8	PR	1.30	0.5	0.089	libellulidae	*S. rub.*
8/10/2004	E8	PR	1.40	0.55	0.110	libellulidae	*S. rub.*
8/18/2004	E5	PR			0.218	aeshnidae	*A. umb.*
8/18/2004	E5	PR			0.035	cordullidae	*S. elo.*
8/18/2004	E8	PR			0.067	cordullidae	*S. elo.*

8/26/2004	E18	PR			0.088	aeshnidae	*A. umb.*
8/26/2004	E18	PR			0.306	cordullidae	*C. shu.*
8/26/2004	E18	PR			0.074	libellulidae	*S. rub.*
8/26/2004	E18	PR			0.059	libellulidae	*S. rub.*
8/26/2004	E18	PR			0.057	libellulidae	*S. rub.*
5/17/2004	E13	S	2.8	0.6	0.2786	aeshnidae	*A. umb.*
5/18/2004	E10	S	1.85	0.8	0.2978	cordullidae	?
5/18/2004	E10	S	2.7	0.55	0.2797	aeshnidae	*A. umb.*
5/20/2004	E2	S	2.1	0.75	0.3371	libellulidae	*L. lyd.*
5/20/2004	E2	S	2.3	0.65	0.4530	libellulidae	*L. lyd.*
5/20/2004	E2	S	2.2	0.7	0.3681	libellulidae	*L. lyd.*
5/20/2004	E2	S	2.2	0.65	0.3294	libellulidae	*L. lyd.*
5/20/2004	E2	S	2.15	0.7	0.3181	libellulidae	*L. lyd.*
5/20/2004	E2	S	0.7	0.35	0.0192	libellulidae	*L. lyd.*
5/20/2004	E2	S	0.9	0.4	0.0297	libellulidae	*L. lyd.*
5/20/2004	E2	S	1	0.35	0.0360	libellulidae	*L. lyd.*
5/20/2004	E2	S	0.8	0.25	0.0183	libellulidae	*L. lyd.*
5/20/2004	E2	S	0.7	0.3	0.0220	libellulidae	*L. lyd.*
5/26/2004	E7	S	2.5	0.6	0.2268	aeshnidae	?
5/26/2004	E4	S	3.5	0.8	0.5202	aeshnidae	*A. jun.*
5/26/2004	E4	S	3.15	0.9	0.5087	aeshnidae	*A. jun.*
5/26/2004	E4	S	3.45	0.7	0.4636	aeshnidae	*A. umb.*
5/26/2004	E4	S	3.3	0.7	0.4743	aeshnidae	*A. umb.*
5/26/2004	E4	S	3.2	0.7	0.4587	aeshnidae	*A. umb.*
5/26/2004	E7	S	3.7	0.55	0.5941	aeshnidae	*A. umb.*
5/26/2004	E7	S	3.1	0.65	0.4145	aeshnidae	*A. umb.*
5/26/2004	E4	S	0.45	0.2	0.0031	?libellulidae	*L. lyd.*
5/31/2004	E21	S	2.15	0.9	0.5062	cordullidae	*S. elo.*
6/1/2004	E19	S	1.4	0.7	0.1687	cordullidae	*C. shu.*
6/1/2004	E19	S	1.2	0.55	0.0873	cordullidae	*C. shu.*
6/1/2004	E19	S	1.3	0.6	0.0998	cordullidae	*C. shu.*
6/1/2004	E19	S	1.2	0.55	0.0911	cordullidae	*C. shu.*
6/1/2004	E19	S	1.7	0.7	0.1947	cordullidae	*C. shu.*
6/1/2004	E19	S	1.2	0.55	0.1004	cordullidae	*C. shu..*
6/16/2004	E10	S	0.5	dead		cordullidae	?
6/16/2004	E2	S	4.2	0.9	1.02	aeshnidae	*A. jun.*
6/16/2004	E2	S	4.9	0.95	1.622	aeshnidae	*A. jun.*
6/16/2004	E10	S	3.8	0.7	0.691	aeshnidae	*A. umb.*
6/16/2004	E10	S	3.6	0.7	0.543	aeshnidae	*A. umb.*
6/16/2004	E10	S	3.1	0.7	0.727	aeshnidae	*A. umb.*
6/16/2004	E10	S	3	0.7	0.409	aeshnidae	*A. umb.*
6/16/2004	E2	S	1.2	0.3	0.029	aeshnidae	*A. umb.*
6/16/2004	E10	S	0.65	0.35	0.016	cordullidae	*C. shu.*
6/16/2004	E10	S	0.8	0.4	0.025	cordullidae	*C. shu.*
6/16/2004	E10	S	0.6	0.3	0.019	cordullidae	*C. shu.*
6/16/2004	E10	S	0.7	0.35	0.021	cordullidae	*C. shu.*
6/16/2004	E10	S	0.7	0.3	0.015	cordullidae	*C. shu.*
6/16/2004	E10	S	0.5	0.25	0.01	cordullidae	*C. shu.*
6/16/2004	E10	S	0.5	0.25	0.007	cordullidae	*C. shu.*
6/16/2004	E2	S		dead		cordullidae	*C. shu.*

6/16/2004	E2	S	0.6	0.3	0.015	cordullidae	*C. shu.*
6/16/2004	E10	S	0.9	0.35	0.034	libellulidae	*L. lyd.*
6/16/2004	E10	S	1.1	0.5	0.058	libellulidae	*L. lyd.*
6/16/2004	E10	S	0.8	0.4	0.032	libellulidae	*L. lyd.*
6/16/2004	E2	S	1	0.4	0.043	libellulidae	*L. lyd.*
6/16/2004	E2	S	1.1	0.5	0.061	libellulidae	*L. lyd.*
6/16/2004	E2	S	1.05	0.4	0.048	libellulidae	*L. lyd.*
6/16/2004	E2	S	1.2	0.45	0.073	libellulidae	*L. lyd.*
6/16/2004	E2	S	1	0.4	0.045	libellulidae	*L. lyd.*
6/16/2004	E2	S	1.2	0.5	0.071	libellulidae	*L. lyd.*
6/16/2004	E10	S	0.6	0.4	0.018	cordullidae	*S. elo.*
6/16/2004	E10	S	0.5	0.25	0.007	cordullidae	*S. elo.*
6/16/2004	E10	S	0.8	0.3	0.014	cordullidae	*S. elo.*
6/16/2004	E10	S	0.5	0.25	0.006	cordullidae	*S. elo.*
6/16/2004	E10	S	0.45	0.25	0.007	cordullidae	*S. elo.*
6/16/2004	E2	S		dead		cordullidae	*S. elo.*
6/16/2004	E2	S		dead		cordullidae	*S. elo.*
6/16/2004	E2	S	0.6	0.35	0.015	cordullidae	*S. elo.*
6/16/2004	E2	S	0.6	0.35	0.014	cordullidae	*S. elo.*
6/17/2004	E4	S	4.2	0.8	0.898	aeshnidae	*A. jun.*
6/17/2004	E4	S	3.8	0.75	0.778	aeshnidae	*A. umb.*
6/17/2004	E4	S	3.8	0.8	0.74	aeshnidae	*A. umb.*
6/17/2004	E4	S	1.25	0.3	0.025	aeshnidae	*A. umb.*
6/17/2004	E4	S	0.95	0.25	0.015	aeshnidae	*A. umb.*
6/17/2004	E4	S	1.2	0.3	0.020	aeshnidae	*A. umb.*
6/17/2004	E4	S	1.25	0.35	0.036	aeshnidae	*A. umb.*
6/17/2004	E7	S	0.85	0.2	0.012	aeshnidae	*A. umb.*
6/17/2004	E7	S	0.9	0.25	0.016	aeshnidae	*A. umb.*
6/17/2004	E7	S	2.9	0.7	0.326	aeshnidae	*A. umb.*
6/17/2004	E4	S	0.9	0.45	0.034	cordullidae	*C. shu.*
6/17/2004	E4	S	0.65	0.3	0.013	cordullidae	*C. shu.*
6/17/2004	E4	S	dead	.	.	cordullidae	*C. shu.*
6/17/2004	E4	S	dead	.	.	cordullidae	*C. shu.*
6/17/2004	E4	S	dead	.	.	cordullidae	*C. shu.*
6/17/2004	E4	S	0.65	0.35	0.018	cordullidae	*C. shu.*
6/17/2004	E4	S	0.65	0.35	0.013	cordullidae	*C. shu.*
6/17/2004	E4	S	dead	.	.	cordullidae	*C. shu.*
6/17/2004	E4	S	dead	.	.	cordullidae	*C. shu.*
6/17/2004	E4	S	dead	.	.	cordullidae	*C. shu.*
6/17/2004	E4	S	0.6	0.35	0.014	cordullidae	*C. shu.*
6/17/2004	E4	S	0.95	0.4	0.028	cordullidae	*C. shu.*
6/17/2004	E4	S	0.95	0.4	0.029	cordullidae	*C. shu.*
6/17/2004	E4	S	0.95	0.45	0.035	cordullidae	*C. shu.*
6/17/2004	E7	S	0.5	0.35	0.008	cordullidae	*C. shu.*
6/17/2004	E7	S	DEAD			cordullidae	*C. shu.*
6/17/2004	E7	S	DEAD			cordullidae	*C. shu.*
6/17/2004	E7	S	DEAD			cordullidae	*C. shu.*
6/17/2004	E7	S	0.75	0.35	0.02	cordullidae	*C. shu.*
6/17/2004	E7	S	0.45	0.35	0.006	cordullidae	*C. shu.*
6/17/2004	E7	S	0.65	0.3	0.014	cordullidae	*C. shu.*

6/17/2004	E7	S	0.7	0.3	0.017	cordullidae	*C. shu.*
6/17/2004	E7	S	0.65	0.3	0.017	cordullidae	*C. shu.*
6/17/2004	E7	S	0.9	0.35	0.029	cordullidae	*C. shu.*
6/17/2004	E7	S			0.017	cordullidae	*C. shu.*
6/17/2004	E7	S	0.35	0.2	0.001	cordullidae	*C. shu.*
6/17/2004	E7	S	0.7	0.3	0.018	cordullidae	*C. shu.*
6/17/2004	E7	S	0.65	0.35	0.016	cordullidae	*C. shu.*
6/17/2004	E7	S	0.8	0.35	0.027	cordullidae	*C. shu.*
6/17/2004	E7	S	0.65	0.25	0.012	cordullidae	*C. shu.*
6/17/2004	E7	S	DEAD			cordullidae	*C. shu.*
6/17/2004	E4	S	2	0.8	0.34	cordullidae	*S. elo.*
6/17/2004	E4	S	2	0.85	0.414	cordullidae	*S. elo.*
6/17/2004	E7	S	0.55	0.3	0.013	cordullidae	*S. elo.*
6/17/2004	E7	S	0.5	0.3	0.009	cordullidae	*S. elo.*
6/17/2004	E7	S	0.5	0.25	0.008	cordullidae	*S. elo.*
6/17/2004	E7	S	0.6	0.3	0.017	cordullidae	*S. elo.*
6/21/2004	E19	S	dead			aeshnidae	?
6/21/2004	E19	S	dead			cordullidae	?
6/21/2004	E19	S	3.8	0.75	0.796	aeshnidae	*A. umb.*
6/21/2004	E19	S	0.6	0.2	0.006	aeshnidae	*A. umb.*
6/21/2004	E19	S	0.8	0.25	0.010	aeshnidae	*A. umb.*
6/21/2004	E19	S	0.6	0.3	0.012	cordullidae	*C. shu.*
6/21/2004	E19	S	1.15	0.5	0.069	cordullidae	*C. shu.*
6/21/2004	E19	S	1.5	0.7	0.132	cordullidae	*C. shu.*
6/21/2004	E21	S	0.6	0.3	0.018	cordullidae	*C. shu.*
6/21/2004	E21	S	0.5	0.3	0.013	cordullidae	*C. shu.*
6/21/2004	E19	S	1.2	0.7	0.126	cordullidae	*S. elo.*
6/21/2004	E19	S	0.9	0.75	0.151	cordullidae	*S. elo.*
7/14/2004	E13	S	1.20	0.35	0.035	aeshnidae	?
7/14/2004	E13	S	1.10	0.35	0.022	aeshnidae	?
7/14/2004	E13	S	1.00	0.25	0.016	aeshnidae	?
7/14/2004	E13	S	1.40	0.4	0.046	aeshnidae	*A. umb.*
7/14/2004	E13	S	1.15	0.4	0.027	aeshnidae	*A. umb.*
7/14/2004	E13	S	1.15	0.3	0.026	aeshnidae	*A. umb.*
7/14/2004	E13	S	0.85	0.3	0.014	aeshnidae	*A. umb.*
7/14/2004	E13	S	1.30	0.35	0.035	aeshnidae	*A. umb.*
7/14/2004	E13	S	1.20	0.3	0.059	aeshnidae	*A. umb.*
7/14/2004	E13	S	1.20	0.5	0.063	libellulidae	*L. lyd.*
7/14/2004	E13	S	1.10	0.45	0.060	libellulidae	*L. lyd.*
7/14/2004	E13	S	1.15	0.45	0.060	libellulidae	*L. lyd.*
7/14/2004	E13	S	1.10	0.45	0.054	libellulidae	*L. lyd.*
7/14/2004	E13	S	0.80	0.5	0.030	corduliidae	*S. elo.*
7/14/2004	E13	S	0.75	0.45	0.027	corduliidae	*S. elo.*
7/14/2004	E13	S	0.80	0.45	0.028	corduliidae	*S. elo.*
7/14/2004	E13	S	0.65	0.3	0.016	corduliidae	*S. elo.*
7/14/2004	E13	S	0.90	0.4	0.036	libellulidae	*S. rub.*
7/14/2004	E13	S	1.15	0.5	0.065	libellulidae	*S. rub.*
7/14/2004	E13	S	0.90	0.4	0.032	libellulidae	*S. rub.*
7/14/2004	E13	S	1.30	0.55	0.075	libellulidae	*S. rub.*
7/15/2004	E10	S	1.10	0.35	0.029	aeshnidae	*A. umb.*

7/15/2004	E10	S	1.10	0.45	0.062	libellulidae	*L. lyd.*
7/15/2004	E10	S	1.20	0.4	0.068	libellulidae	*L. lyd.*
7/15/2004	E10	S	0.80	0.4	0.030	cordullidae	*S. elo.*
7/15/2004	E10	S	1.25	0.5	0.085	libellulidae	*S. rub.*
7/15/2004	E10	S	1.00	0.45	0.044	libellulidae	*S. rub.*
7/16/2004	E4	S	4.10	0.8	0.910	aeshnidae	*A. umb.*
7/16/2004	E4	S	0.95	0.25	0.018	aeshnidae	*A. umb.*
7/16/2004	E4	S	2.40	0.7	0.401	libellulidae	*L. lyd.*
7/16/2004	E4	S	0.75	0.3	0.017	cordullidae	*S. elo.*
7/16/2004	E4	S	0.70	0.4	0.021	cordullidae	*S. elo.*
7/16/2004	E4	S	1.35	0.55	0.088	libellulidae	*S. rub.*
7/16/2004	E4	S	1.30	0.5	0.085	libellulidae	*S. rub.*
7/16/2004	E4	S	1.25	0.35	0.029	libellulidae	*S. rub.*
7/16/2004	E4	S	0.95	0.45	0.038	libellulidae	*S. rub.*
7/16/2004	E4	S	1.20	0.5	0.064	libellulidae	*S. rub.*
7/17/2004	E2	S	3.90	0.8	0.812	aeshnidae	*A. umb.*
7/17/2004	E2	S	3.80	0.8	0.870	aeshnidae	*A. umb.*
7/17/2004	E2	S	1.10	0.35	0.028	aeshnidae	*A. umb.*
7/17/2004	E2	S	1.20	0.4	0.069	libellulidae	*L. lyd.*
7/17/2004	E2	S	1.40	0.6	0.144	libellulidae	*L. lyd.*
7/17/2004	E2	S	1.40	0.55	0.118	libellulidae	*L. lyd.*
7/17/2004	E2	S	1.65	0.6	0.141	libellulidae	*L. lyd.*
7/17/2004	E2	S	1.25	0.55	0.081	libellulidae	*S. rub.*
7/17/2004	E2	S	1.25	0.55	0.073	libellulidae	*S. rub.*
7/19/2004	E21	S	3.90	0.8	0.933	aeshnidae	?
7/19/2004	E19	S	0.90	0.3	0.013	aeshnidae	*A. umb.*
7/19/2004	E19	S	1.00	0.3	0.020	aeshnidae	*A. umb.*
7/19/2004	E19	S	1.30	0.4	0.044	aeshnidae	*A. umb.*
7/19/2004	E19	S	1.40	0.4	0.059	aeshnidae	*A. umb.*
7/19/2004	E21	S	3.80	0.8	0.960	aeshnidae	*A. umb.*
7/19/2004	E21	S	3.70	0.9	0.798	aeshnidae	*A. umb.*
7/19/2004	E19	S	1.80	0.7	0.274	libellulidae	*S. rub.*
7/19/2004	E19	S	1.00	0.4	0.045	libellulidae	*S. rub.*
7/19/2004	E19	S	1.10	0.4	0.058	libellulidae	*S. rub.*
7/19/2004	E19	S	1.10	0.5	0.060	libellulidae	*S. rub.*
7/19/2004	E19	S	0.90	0.4	0.032	libellulidae	*S. rub.*
7/19/2004	E21	S	0.90	0.4	0.040	libellulidae	*S. rub.*
7/19/2004	E21	S	1.00	0.5	0.056	libellulidae	*S. rub.*
7/19/2004	E21	S	1.10	0.4	0.053	libellulidae	*S. rub.*
8/6/2004	E13	S	0.7	0.35	0.020	cordullidae	*S. elo.*
8/6/2004	E13	S	1.70	0.7	0.198	cordullidae	*S. elo.*
8/10/2004	E10	S	2.00	0.5	0.123	aeshnidae	*A. umb.*
8/10/2004	E10	S	1.80	0.45	0.086	aeshnidae	*A. umb.*
8/10/2004	E7	S	2.00	0.45	0.111	aeshnidae	*A. umb.*
8/10/2004	E7	S	1.40	0.35	0.043	aeshnidae	*A. umb.*
8/10/2004	E10	S	2.00	0.8	0.336	cordullidae	*S. elo.*
8/10/2004	E10	S	0.80	0.4	0.026	cordullidae	*S. elo.*
8/10/2004	E7	S	0.70	0.4	0.025	cordullidae	*S. elo.*
8/10/2004	E7	S	0.70	0.35	0.019	cordullidae	*S. elo.*
8/10/2004	E7	S	0.85	0.45	0.033	cordullidae	*S. elo.*

8/10/2004	E7	S	0.75	0.35	0.015	cordullidae	*S. elo.*
8/10/2004	E7	S	0.95	0.55	0.054	cordullidae	*S. elo.*
8/10/2004	E7	S	1.30	0.5	0.086	libellulidae	*S. rub.*
8/18/2004	E4	S			0.121	aeshnidae	*A. umb.*
8/18/2004	E4	S			0.206	cordullidae	*S. elo.*
8/19/2004	E19	S			0.064	aeshnidae	*A. umb.*
8/19/2004	E19	S			0.207	aeshnidae	*A. umb.*
8/19/2004	E19	S			0.114	aeshnidae	*A. umb.*
8/19/2004	E19	S			0.110	aeshnidae	*A. umb.*
8/19/2004	E19	S			0.190	cordullidae	*S. elo.*
8/19/2004	E19	S			0.044	cordullidae	*S. elo.*
8/19/2004	E19	S			0.089	libellulidae	*S. rub.*
8/19/2004	E19	S			0.086	libellulidae	*S. rub.*
8/26/2004	E2	S			0.135	aeshnidae	*A. umb.*
8/26/2004	E2	S			0.014	libellulidae	*L. lyd.*
8/26/2004	E2	S			0.041	cordullidae	*S. elo.*
8/26/2004	E2	S			0.085	cordullidae	*S. elo.*
8/27/2004	E21	S			0.057	aeshnidae	*A. umb.*
8/27/2004	E21	S			0.168	aeshnidae	*A. umb.*
8/27/2004	E21	S			0.071	aeshnidae	*A. umb.*
8/27/2004	E21	S			0.041	cordullidae	*S. elo.*
8/27/2004	E21	S			0.228	cordullidae	*S. elo.*
8/27/2004	E21	S			0.028	cordullidae	*S. elo.*
8/27/2004	E21	S			0.211	cordullidae	*S. elo.*
8/27/2004	E21	S			0.202	cordullidae	*S. elo.*
8/27/2004	E21	S			0.021	cordullidae	*S. elo.*
8/27/2004	E21	S			0.075	libellulidae	*S. rub.*
8/27/2004	E21	S			0.054	libellulidae	*S. rub.*
8/27/2004	E21	S			0.077	libellulidae	*S. rub.*
8/27/2004	E21	S			0.064	libellulidae	*S. rub.*
8/27/2004	E21	S			.	libellulidae	*S. rub.*
8/27/2004	E21	S			0.082	libellulidae	*S. rub.*
8/27/2004	E21	S			0.064	libellulidae	*S. rub.*
~6/18/2004	?		0.7	0.3	0.021	cordullidae	*C. shu.*

iii. Crayfish. All specimen are *Orconectes spinosus*. L = length in cm from tip of head to last tail segment before the uropods. W = linear carapace width at widest point in cm.

DATE	ENCL	TREAT	L(cm)	W(cm)
5/17/2004	E14	NS		5 .
5/17/2004	E14	NS		4.2 .
5/17/2004	E14	NS		2.7 .
5/17/2004	E14	NS		5.7 .
5/17/2004	E14	NS		4.3 .
5/17/2004	E14	NS		4.7 .
5/17/2004	E14	NS		5.2 .

5/17/2004	E14	NS		4.2	.
5/17/2004	E14	NS		4.6	.
5/17/2004	E14	NS		4.2	.
5/17/2004	E14	NS		4.3	.
5/17/2004	E15	PR		5	.
5/17/2004	E15	PR		4.7	.
5/17/2004	E15	PR		5.6	.
5/17/2004	E15	PR		5.3	.
5/17/2004	E15	PR		4.7	.
5/17/2004	E15	PR		5.3	.
5/17/2004	E15	PR		3.4	.
5/17/2004	E15	PR		3	.
5/17/2004	E15	PR		4.7	.
5/17/2004	E15	PR		4.2	.
5/17/2004	E15	PR		4.1	.
5/17/2004	E15	PR		3	.
5/17/2004	E13	S		4.5	.
5/17/2004	E13	S		3.5	.
5/17/2004	E13	S		4.7	.
5/17/2004	E13	S		4.9	.
5/17/2004	E13	S		4.7	.
5/17/2004	E13	S		6.2	.
5/17/2004	E13	S		4.2	.
5/17/2004	E13	S		4.7	.
5/17/2004	E13	S		3	.
5/17/2004	E13	S		3.1	.
5/17/2004	E13	S		4.7	.
5/17/2004	E13	S		5.2	.
5/17/2004	E13	S		4.3	.
5/17/2004	E13	S		2.6	.
5/18/2004	E12	NC	.		.
5/18/2004	E12	NC	.		.
5/18/2004	E12	NC	.		.
5/18/2004	E11	NS		3.1	.
5/18/2004	E10	S		4.3	.
5/18/2004	E10	S		5.2	.
5/18/2004	E10	S		5.2	.
5/18/2004	E10	S		4.7	.
5/18/2004	E10	S		4.6	.
5/18/2004	E10	S		4.7	.
5/18/2004	E10	S		5.2	.
5/18/2004	E10	S		3.5	.
5/20/2004	E1	NS		5	1.4
5/20/2004	E1	NS		4.5	1.2
5/20/2004	E1	NS		4.6	1.1
5/20/2004	E1	NS		3.5	0.9
5/20/2004	E1	NS		3.7	0.9
5/20/2004	E1	NS		3.1	0.8
5/20/2004	E2	S		4.7	1.1
5/20/2004	E2	S		4.1	0.95
5/20/2004	E2	S		3	0.8
5/20/2004	E2	S		4.5	1

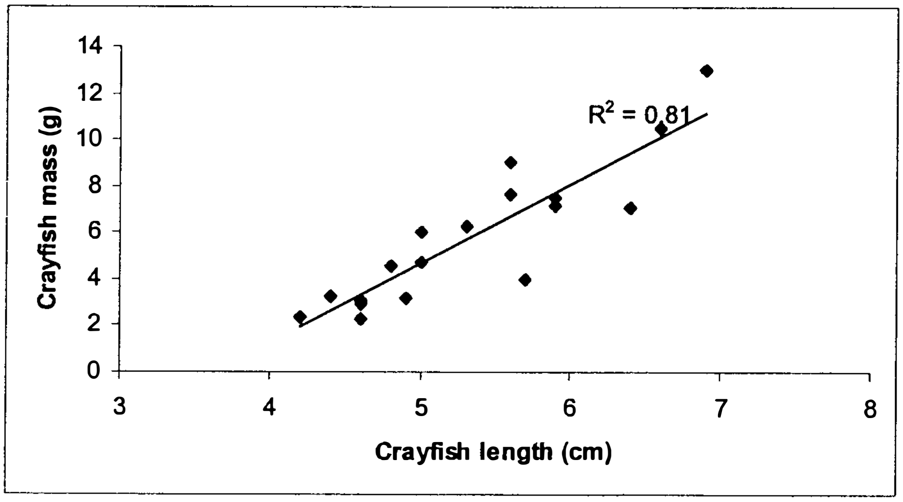
5/20/2004	E2	S	4.5	1
5/20/2004	E2	S	3.2	0.8
5/26/2004	E6	NC	4.9	1.25
5/26/2004	E3	NS	4.5	1.1
5/26/2004	E3	NS	4.8	1.15
5/26/2004	E3	NS	5.05	1.2
5/26/2004	E3	NS	4.8	1.2
5/26/2004	E3	NS	4.7	1.25
5/26/2004	E3	NS	5.1	1.35
5/26/2004	E5	PR	4.4	1.1
5/26/2004	E5	PR	4.8	1.1
5/26/2004	E5	PR	4.2	1.1
5/26/2004	E5	PR	4.6	1.15
5/26/2004	E5	PR	4.7	1.15
5/26/2004	E5	PR	5	1.15
5/26/2004	E5	PR	5.1	1.2
5/26/2004	E5	PR	4.8	1.2
5/26/2004	E5	PR	4.7	1.2
5/26/2004	E5	PR	5.2	1.3
5/26/2004	E5	PR	5.4	1.35
5/26/2004	E4	S	4.8	1.15
5/26/2004	E4	S	5	1.2
5/26/2004	E4	S	4.5	1.2
5/26/2004	E4	S	5.4	1.2
5/26/2004	E4	S	4.9	1.2
5/27/2004	E9	NS	3.5	0.9
5/27/2004	E8	PR	4.8	1.2
5/27/2004	E7	S	2.9	0.7
5/27/2004	E7	S	2.9	0.7
5/27/2004	E7	S	3.7	0.9
5/31/2004	E22	NS	4.2	1
5/31/2004	E21	S	5	1.3
5/31/2004	E21	S	5.6	1.4
6/1/2004	E20	NS	4.8	1.3
6/1/2004	E20	NS	5.8	1.5
6/1/2004	E18	PR	4.7	1.1
6/1/2004	E18	PR	5.4	1.4
6/1/2004	E19	S	5.2	1.3
6/1/2004	E19	S	5.5	1.3
6/1/2004	E19	S	5.1	1.3
6/1/2004	E19	S	5.2	1.3
6/15/2004	E14	NS	3.6	0.8
6/15/2004	E14	NS	5.1	1.3
6/15/2004	E14	NS	5.8	1.4
6/15/2004	E15	PR	3.8	0.8
6/15/2004	E15	PR	4.4	1
6/15/2004	E15	PR	4.8	1
6/15/2004	E15	PR	4.8	1.1
6/15/2004	E15	PR	4	1.1
6/15/2004	E15	PR	5.7	1.2
6/15/2004	E15	PR	5.3	1.2
6/15/2004	E13	S	5	1.3

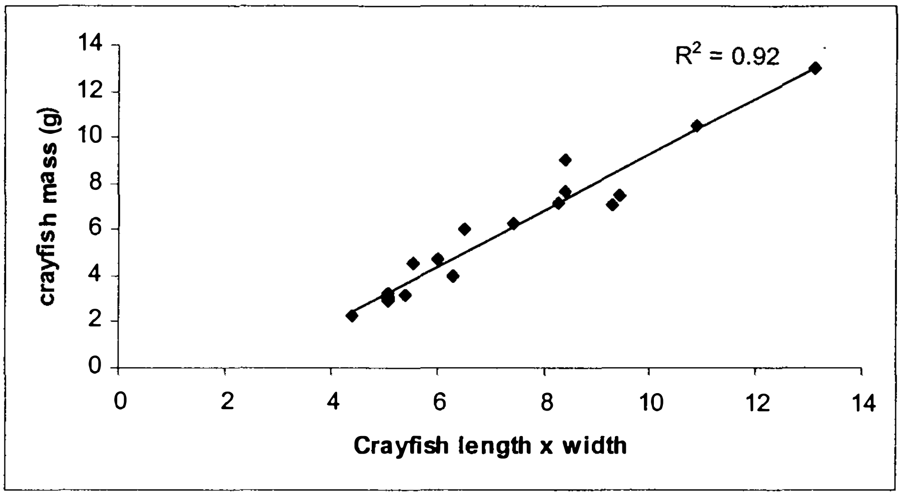
6/15/2004	E13	S	5.3	1.3
6/15/2004	E13	S	5.3	1.3
6/15/2004	E13	S	5.8	1.4
6/16/2004	E12	NC	4.5	1.1
6/16/2004	E12	NC	5.2	1.2
6/16/2004	E12	NC	5.4	1.3
6/16/2004	E12	NC	5.5	1.3
6/16/2004	E1	NS	4.8	1.1
6/16/2004	E11	NS	3.4	0.7
6/16/2004	E11	NS	3.8	0.8
6/16/2004	E11	NS	3.9	0.9
6/16/2004	E11	NS	4.4	1
6/16/2004	E11	NS	4.3	1
6/16/2004	E11	NS	4.9	1.3
6/16/2004	E11	NS	5.5	1.4
6/16/2004	E11	NS	5.4	1.4
6/16/2004	E10	S	3.7	0.8
6/16/2004	E10	S	4	0.8
6/16/2004	E10	S	4.1	0.9
6/16/2004	E10	S	4.2	0.9
6/16/2004	E10	S	5.4	1.2
6/16/2004	E10	S	6.3	1.5
6/16/2004	E2	S	.	.
6/17/2004	E6	NC	4.1	0.9
6/17/2004	E6	NC	3.5	0.9
6/17/2004	E6	NC	4.2	1.1
6/17/2004	E3	NS	4.7	1
6/17/2004	E3	NS	4.3	1
6/17/2004	E3	NS	4.5	1.1
6/17/2004	E3	NS	5.4	1.4
6/17/2004	E3	NS	5	1.4
6/17/2004	E9	NS	4.3	1.1
6/17/2004	E9	NS	5	1.3
6/17/2004	E9	NS	5.6	1.4
6/17/2004	E5	PR	4.4	1
6/17/2004	E5	PR	4.4	1.3
6/17/2004	E5	PR	4.9	1.3
6/17/2004	E8	PR	3.5	0.8
6/17/2004	E8	PR	4.2	0.9
6/17/2004	E8	PR	4.4	1.1
6/17/2004	E4	S	3.5	0.9
6/17/2004	E4	S	4.9	1.2
6/17/2004	E4	S	4.7	1.2
6/17/2004	E4	S	5.6	1.3
6/17/2004	E7	S	4.3	0.9
6/17/2004	E7	S	4.4	1
6/17/2004	E7	S	5.8	1.1
6/17/2004	E7	S	5	1.3
6/17/2004	E7	S	5.3	1.4
6/21/2004	E20	NS	.	.
6/21/2004	E22	NS	5.9	1.5
6/21/2004	E18	PR	5.6	1.2

6/21/2004	E21	S		5	1.2
6/22/2004	E16	NC	.	.	
6/22/2004	E17	NC	.	.	
7/13/2004	E14	NS		1.4	0.3
7/13/2004	E14	NS		4.4	1
7/13/2004	E14	NS		5.5	1.3
7/13/2004	E14	NS		5.5	1.4
7/13/2004	E14	NS		5.5	1.4
7/13/2004	E14	NS		5.8	1.5
7/13/2004	E15	PR	.	.	
7/13/2004	E13	S		3.9	1
7/13/2004	E13	S		4.3	1.2
7/13/2004	E13	S		5.4	1.4
7/13/2004	E13	S		5.3	1.4
7/13/2004	E13	S		5.4	1.4
7/13/2004	E13	S		3.9	3
7/15/2004	E6	NC		4.4	1.2
7/15/2004	E11	NS		4.4	1
7/15/2004	E11	NS		3.9	1
7/15/2004	E11	NS		4.4	1.1
7/15/2004	E11	NS		4.7	1.2
7/15/2004	E11	NS		4.9	1.3
7/15/2004	E11	NS		4.9	1.3
7/15/2004	E11	NS		5.4	1.5
7/15/2004	E3	NS		4.4	1.1
7/15/2004	E3	NS		4.9	1.3
7/15/2004	E3	NS		5.5	1.5
7/15/2004	E9	NS		4.8	1.2
7/15/2004	E5	PR		4.9	1.3
7/15/2004	E8	PR	.	.	
7/15/2004	E10	S		4.3	1
7/15/2004	E10	S		4.4	1.1
7/15/2004	E10	S		5	1.2
7/15/2004	E4	S		4.2	0.9
7/15/2004	E4	S		5.4	1.3
7/15/2004	E4	S		5.8	1.4
7/16/2004	E7	S		4.4	1.1
7/16/2004	E7	S		4.4	1.2
7/16/2004	E7	S		3.5	1
7/17/2004	E1	NS		4.2	1
7/17/2004	E20	NS	.	.	
7/17/2004	E22	NS	.	.	
7/17/2004	E19	S	.	.	
7/17/2004	E21	S		6.9	1.9
7/20/2004	E18	PR		5.7	1.5
7/21/2004	E16	NC	.	.	
8/5/2004	E15	PR	.	.	
8/6/2004	E14	NS		4.8	1
8/6/2004	E14	NS		4	1
8/6/2004	E14	NS		5	1.1
8/6/2004	E14	NS		5.3	1.15
8/6/2004	E14	NS		5.5	1.3

8/6/2004	E14	NS		5.5	1.4
8/6/2004	E14	NS		6	1.45
8/6/2004	E13	S		5.6	1.4
8/6/2004	E13	S		6.3	1.65
8/7/2004	E12	NC	.	.	
8/7/2004	E11	NS		4.6	1.1
8/7/2004	E11	NS		5.7	1.1
8/7/2004	E11	NS		4.4	1.15
8/7/2004	E11	NS		6.4	1.45
8/10/2004	E9	NS		4.70	1.1
8/10/2004	E9	NS		3.8	1.1
8/10/2004	E9	NS		5.6	1.25
8/10/2004	E9	NS		5.8	1.4
8/10/2004	E8	PR		5.1	1.25
8/10/2004	E8	PR		5.5	1.4
8/10/2004	E10	S		5.2	1.1
8/11/2004	E7	S		4.4	1.05
8/11/2004	E7	S		4.5	1.1
8/11/2004	E7	S		5.4	1.4
8/11/2004	E7	S		6.2	1.6
8/18/2004	E6	NC		4.9	1.2
8/18/2004	E20	NS	.	.	
8/18/2004	E3	NS	.	.	
8/18/2004	E5	PR	.	.	
8/18/2004	E19	S			
8/18/2004	E4	S	.	.	
8/26/2004	E16	NC		2.6	0.6
8/26/2004	E2	S		6.1	2

iv. Crayfish size-mass regression





DATE	ENCL	L(cm)	W(cm)	MASS(g)
7/16/2004	E3	5.00	1.2	4.71
7/16/2004	E3	5.6	1.5	7.62
7/16/2004	E3	4.6	1.1	3.022
7/17/2004	E17	5.9	1.6	7.52
7/19/2004	E21	6.9	1.9	13.05
7/20/2004	E1	4.2	1	2.345
8/6/2004	E13	5.9	1.4	7.16
8/6/2004	E13	6.6	1.65	10.53
8/6/2004	E14	5.3	1.4	6.296
8/6/2004	E14	4.6	0.95	2.277
8/6/2004	E14	4.9	1.1	3.194
8/6/2004	E14	4.8	1.15	4.531
8/6/2004	E14	4.6	1.1	2.94
8/6/2004	E14	5.6	1.5	9.063
8/6/2004	E14	5	1.3	6.023
8/7/2004	E11	4.4	1.15	3.291
8/7/2004	E11	4.6	1.1	3.115
8/7/2004	E11	5.7	1.1	3.954
8/7/2004	E11	6.4	1.45	7.06
8/10/2004	E10	5.5	1.4	6.258
8/10/2004	E10	5.1	1.25	4.135
8/10/2004	E7	4.6	1.15	3.286
8/10/2004	E7	4.2	1.05	3.225
8/10/2004	E7	5.8	1.45	8.654
8/10/2004	E7	5.2	1.45	6.568
8/10/2004	E9	4.70	1.1	3.124
8/10/2004	E9	5.8	1.4	7.348
8/10/2004	E9	3.8	1.1	3.044
8/10/2004	E9	5.6	1.25	4.758
8/25/2004	E16	2.9	0.55	0.513
8/25/2004	E2	6.2	1.4	7.630

v. Newts. All specimen are *Notopthalamus viredescens.* L = snout-vent length. W = width of body at widest point.

DATE	ENCL	L(cm)	W(cm)	STAGE
5/17/2004	E13	4.7		adult
5/18/2004	E11	4.7		adult
5/18/2004	E11	3.9		adult
5/18/2004	E11	4.7		adult
5/18/2004	E12	4.3		adult
5/18/2004	E12	4.5		adult
5/18/2004	E12	4		adult
5/26/2004	E6	4.5	1	adult
5/31/2004	E16			?juv
5/31/2004	E22	4.9		adult
5/31/2004	E22	4.1		adult
6/1/2004	E17	4.2	1	adult
6/1/2004	E17	4.5	0.9	adult
6/1/2004	E17	4.7	1.1	adult
6/1/2004	E17	4.6	0.8	adult
6/1/2004	E17	4.3	0.8	adult
6/1/2004	E17	4.7	0.9	adult
6/1/2004	E17	4.7	1	adult
6/1/2004	E18	4.8	0.8	adult
6/1/2004	E19	5.7	1.2	adult
6/1/2004	E20	4.3	1.1	adult
6/1/2004	E20	4.2	0.9	adult
6/1/2004	E20	4.3	0.9	adult
6/15/2004	E14	4.8	0.9	adult
6/16/2004	E1	1		larva
6/16/2004	E10	4.1	0.8	adult
6/16/2004	E11	1.9		larva
6/16/2004	E11			larva
6/16/2004	E11	1		larva
6/16/2004	E11	1		larva
6/16/2004	E12	4.8	1	adult
6/16/2004	E12	4	0.8	adult
6/16/2004	E2	4	0.9	adult
6/16/2004	E2	3.9	0.8	adult
6/16/2004	E2	4.5	0.9	adult
6/16/2004	E2	4.3	1	adult
6/17/2004	E3			larva
6/17/2004	E4	4.5	1.1	adult
6/17/2004	E4			?not newt
6/17/2004	E5	3.8	1.1	adult
6/17/2004	E7	4	0.7	adult
6/17/2004	E7	4.1	1	adult
6/17/2004	E7	3.9	0.8	adult
6/17/2004	E7	3.8	1.1	adult

6/17/2004	E9	4	1	adult
6/21/2004	E18	4.2	1.2	adult
6/21/2004	E18	4.3	0.9	adult
6/21/2004	E19	3.7	0.9	adult
6/21/2004	E19	4.1	1.1	adult
6/21/2004	E19	4	0.9	adult
6/21/2004	E20	4.2	1.1	adult
6/21/2004	E20	3.9	0.8	adult
6/21/2004	E20	3.5	0.8	adult
6/21/2004	E20	4.3	0.9	adult
6/21/2004	E20	4.4	1	adult
6/21/2004	E21	4.3	0.9	adult
6/21/2004	E21	4.5	1	adult
6/21/2004	E21			larva
6/21/2004	E22	5.9	1.5	adult
6/21/2004	E22	4.1	1	adult
6/21/2004	E22	4	0.8	adult
6/21/2004	E22	4.4	1	adult
6/21/2004	E22	4.5	1.1	adult
6/21/2004	E22	4.6	1	adult
6/21/2004	E22	4	0.8	adult
6/22/2004	E17	4.5	1.1	adult
6/22/2004	E17	4.1	1	adult
7/13/2004	E13	4.5	1	adult
7/13/2004	E13	4.8	1.2	adult
7/14/2004	E12	1.4	0.3	larva
7/14/2004	E12	4.1	1.2	adult
7/15/2004	E10	4.6	1.1	adult
7/15/2004	E11	4.5	1.2	adult
7/15/2004	E3	1.6	0.3	larva
7/15/2004	E4	4	0.9	adult
7/15/2004	E4	4.4	1	adult
7/15/2004	E4	4.5	1	adult
7/15/2004	E4	4.1	0.9	adult
7/15/2004	E5	1.9	0.3	larva
7/15/2004	E5	1.8	0.3	larva
7/15/2004	E5	1.5	0.2	larva
7/15/2004	E9	1.8	0.4	larva
7/17/2004	E19	0.9	0.2	larva
7/17/2004	E19	0.7	0.15	larva
7/17/2004	E19	1.2	0.3	larva
7/17/2004	E19	1.05	0.2	larva
7/17/2004	E22			larva
7/20/2004	E18	1.1	0.2	larva
7/21/2004	E16	1.4	0.25	larva
7/21/2004	E16	1.25	0.25	larva
7/21/2004	E16	1.1	0.25	larva
8/6/2004	E13	4.5	1.2	adult
8/19/2004	E19	1.5	0.5	larva
8/19/2004	E19	1.5	0.3	larva

8/19/2004	E19	1.1	0.3	larva
8/19/2004	E19	1.6	0.4	larva
8/19/2004	E19	1.6	0.4	larva
8/19/2004	E19	1.5	0.3	larva
8/19/2004	E19	1.3	0.2	larva
8/19/2004	E19	1.7	0.5	larva
8/19/2004	E20			larva
8/26/2004	E16	1.2	0.2	larva
8/26/2004	E16	1.7	0.3	larva
8/26/2004	E16	1.5	0.3	larva
8/26/2004	E16	1.8	0.3	larva
8/26/2004	E16	1.35		larva
8/26/2004	E16	1		larva
8/26/2004	E16	1.5		larva
8/26/2004	E16	1.2		larva
8/26/2004	E18	1.75		larva
8/27/2004	E17	1.7	0.4	larva
8/27/2004	E17	1.7		larva
8/27/2004	E17	1.5		larva
8/27/2004	E17	1.6		larva
8/27/2004	E17	1.2		larva
8/27/2004	E21	1.6		larva
8/27/2004	E21	1.7		larva
8/27/2004	E21	1.9		larva
8/27/2004	E21	1.8		larva
8/27/2004	E21	1.5		larva
8/27/2004	E21	1.7		larva
8/27/2004	E22	1.6		larva
8/27/2004	E22	1.7		larva
8/27/2004	E22	1.6		larva
8/27/2004	E22	1.7		larva
8/27/2004	E22	1.5		larva
8/27/2004	E22	1.4		larva

Appendix H. 2004 Experiment – δ^{13}C and δ^{15}N for wolf spiders, dragonfly larvae, aquatic and terrestrial prey. Species abbreviations are the same used in Appendix G.

Wolf spiders

MONTH	ENCL	TREAT	SPP.	PART	δ13C	δ15N
JUNE	E12	NC	*P. mil.*	leg and ceph	-26.2	6.11
JUNE	E16	NC	*P. can.*	leg and ceph	-25.2	5.49
JUNE	E17	NC	*?*	leg and ceph	-25.5	6.01
JUNE	E6	NC	*P. mil.*	leg and ceph	-26.0	6.72
JUL	E1	NS	*P. can.*	leg and ceph	-27.0	5.9
JUL	E10	S	*P. sed.*	leg and ceph	-26.5	6.4
JUL	E11	NS	*P. can.*	leg and ceph	-26.6	5.8
JUL	E12	NC	*P. can.*	leg and ceph	-26.0	3.9
JUL	E13	S	*P. can.*	leg and ceph		
JUL	E14	NS	*P. can.*	leg and ceph	-24.7	5.3
JUL	E15	PR	*P. mil.*	leg and ceph	-24.9	7.3
JUL	E16	NC	*P. moe.*	leg and ceph	-24.1	6.3
JUL	E17	NC	*P. mil.*	leg and ceph	-25.7	8.9
JUL	E18	PR	*P. can.*	leg and ceph	-25.1	7.0
JUL	E19	S	*P. can.*	leg and ceph	-24.3	7.3
JUL	E2	S	*P. can.*	leg and ceph	-26.1	6.3
JUL	E20	NS	*P. can.*	leg and ceph	-24.9	6.7
JUL	E21	S	*P. can.*	leg and ceph	-27.3	6.5
JUL	E22	NS	*P. can.*	leg and ceph	-25.5	7.4
JUL	E3	NS	*P. moe.*	leg and ceph	-25.3	6.2
JUL	E4	S	*P. mil.*	leg and ceph	-25.9	6.5
JUL	E5	PR	*P. can.*	leg and ceph	-25.8	6.9
JUL	E6	NC	*P. can.*	leg and ceph	-26.7	6.2
JUL	E7	S	*P. can.*	leg and ceph	-24.9	6.4
JUL	E8	PR	*P. sed.*	leg and ceph	-26.2	6.9
JUL	E9	NS	*P. can.*	leg and ceph	-25.0	6.6
AUG	E1	NS	*P. can.*	leg and ceph	-27.4	6.7
AUG	E10	S	*P. can.*	leg and ceph	-26.8	4.8
AUG	E11	NS	*H. hue.*	leg and ceph	-25.6	5.7
AUG	E12	NC	*P. sed.*	leg and ceph	-26.4	5.0
AUG	E13	S	*P. can.*	leg and ceph	-25.7	5.8
AUG	E14	NS	*P. can.*	leg and ceph	-26.1	6.3
AUG	E15	PR	*P. can.*	leg and ceph	-25.8	5.4
AUG	E18	PR	*P. can.*	leg and ceph	-27.6	6.4
AUG	E19	S	*P. can.*	leg and ceph	-25.7	8.4
AUG	E2	S	*?*	leg and ceph	-26.8	6.7
AUG	E20	NS	*P. can.*	leg and ceph	-25.1	7.3
AUG	E21	S	*P. can.*	leg and ceph	-26.8	6.9
AUG	E22	NS	*P. can.*	leg and ceph	-26.5	7.1
AUG	E3	NS	*P. can.*	leg and ceph	-26.3	5.5
AUG	E4	S	*P. sed.*	leg and ceph	-26.2	7.3

AUG	E5	PR	*P. can.*	leg and ceph	-26.3	7.1
AUG	E6 or 7	NC	*P. can.*	leg and ceph	-25.9	6.4
AUG	E6 or 7	NC	*P. can.*	leg and ceph	-27.2	6.2
AUG	E7 or 6	S	*P. can.*	legs	-24.8	6.1
AUG	E7 or 6	S	*P. can.*	leg and ceph	-26.2	7.0
AUG	E8	PR	*P. sed.*	leg and ceph	-26.4	7.8
AUG	E9	NS	*P. can.*	leg and ceph	-26.3	7.2

Dragonfly larvae

DATE	ENCL	TREAT	SPP.	PART	L(cm)	δ13C	δ15N
JUNE	E16	NC	*A. umb.*	eye/labia		-29.8	5.2
JUNE	E17	NC	*A. umb.*	eye/labia		-31.4	3.9
JUL	E1	NS	*S. rub.*	leg	1	-34.5	3.9
JUL	E10	S	*A. umb.*	leg	1.25	-33.7	4.7
JUL	E11	NS	*A. umb.*	leg	1.35	-33.6	4.9
JUL	E12	NC	*L. lyd.*	leg	1.2	-34.3	4.5
JUL	E13	S	*A. umb.*	leg	1.4	-35.4	4.7
JUL	E16	NC	*A. umb.*	leg/head	.7	-29.0	3.9
JUL	E17	NC	*C. shu.*	leg	1.5	-30.5	3.8
JUL	E18	PR	*C. shu.*	leg	1.25	-30.8	3.0
JUL	E19	S	*S. rub.*	leg		-32.6	4.0
JUL	E2	S	*A. umb.*	leg	1.2	-34.5	4.5
JUL	E21	S	*S. rub.*	leg	1.15	-32.3	4.1
JUL	E22	NS	*C. shu.*	leg	1.65	-30.7	3.8
JUL	E3	NS	*A. umb.*	leg	1.1	-33.8	5.3
JUL	E4	S	*S. rub.*	leg	.9	-35.0	3.7
JUL	E5	PR	*S. rub.*	leg	1.2	-35.0	3.6
JUL	E6	NC	*L. lyd.*	leg	1.3	-33.8	4.5
JUL	E9	NS	*S. rub.*	leg and part	1.15	-33.7	3.4
AUG	E1	NS	*S. elo.*	leg	1.15	-33.5	5.0
AUG	E10	S	*S. elo.*	leg	0.8	-35.5	4.0
AUG	E11	NS	*L. lyd.*	leg	2	-34.5	3.4
AUG	E12	NC	*S. elo.*	leg	0.8	-34.9	3.4
AUG	E14	NS	*S. rub.*	leg	1.35	-36.5	3.9
AUG	E15	PR	*S. rub.*	leg	1.3	-35.0	4.1
AUG	E16	NC	*S. rub.*	leg	1.15	-30.5	4.5
AUG	E17	NC	*C. shu.*	leg	2	-31.1	3.7
AUG	E18	PR	*A. umb.*	leg	2	-30.3	4.1
AUG	E19	S	*S. rub.*	leg	1.3	-31.4	3.5
AUG	E2	S	*S. elo.*	leg	1.15	-34.4	15.1
AUG	E20	NS	*A. umb.*	leg	2.56	-30.1	4.7
AUG	E21	S	*S. elo.*	leg	0.8	-32.7	4.1
AUG	E22	NS	*S. rub.*	leg	1.2	-31.9	4.3
AUG	E3	NS	*L. lyd.*	leg	1.9	-34.3	4.6
AUG	E4	S	*S. elo.*	leg	1.6	-37.0	5.1
AUG	E5	PR	*S. elo.*	leg	0.9	-34.6	2.9
AUG	E6	NC	*L. lyd.*	leg	1.65	-33.7	4.6
AUG	E7	S	*S. elo.*	leg	0.7	-35.4	4.5

AUG	E8	PR	*S. elo.*	leg	1	-34.3	4.1
AUG	E9	NS	*A. umb.*	leg	1.6	-33.6	5.4

Aquatic Prey

DATE	ENCL	TREAT	SPP	PART	δ13C	δ15N
JUNE	E12	NC	1 chironomid	whole	-32.5	3.9
JUNE	E16	NC	2 chironomid	whole	-31.1	3.5
JUNE	E17	NC	2 chironomid	whole	-29.7	2.3
JUNE	E6	NC	1 chironomid	whole	-33.0	3.2
JUL	E1	NS	1 chironomid	whole	-30.3	5.0
JUL	E10	S	1 mayfly. 1 chironomid	whole	-34.8	2.6
JUL	E11	NS	1 chaoborid. 1 chironomid	whole	-34.5	5.4
JUL	E12	NC	1 mayfly. 1 chironomid	whole	-35.1	3.5
JUL	E13	S	1 chironomid	whole	-33.9	
JUL	E14	NS	2 chironomid	whole	-34.6	4.7
JUL	E15	PR	2 mayfly	whole	-36.1	2.8
JUL	E16	NC	2 chironomid	whole	-32.4	3.9
JUL	E17	NC	2 chironomid	1 no abd	-33.0	4.6
JUL	E18	PR	2 chironomid	whole	-32.7	3.1
JUL	E19	S	2 chironomid	whole	-30.6	3.0
JUL	E2	S	1 mayfly. 1 chironomid	whole	-37.0	3.0
JUL	E20	NS	1 dolichopodid	whole	-24.3	8.0
JUL	E20	NS	1 chironomid	whole	-28.9	1.2
JUL	E21	S	2 chironomid	whole	-33.5	4.8
JUL	E22	NS	2 chironomid	whole	-36.0	4.8
JUL	E3	NS	2 chironomid	whole	-32.0	2.2
JUL	E4	S	2 chironomid	1 no abd	-33.0	4.3
JUL	E5	PR	1 mayfly. 1 chironomid	whole	-36.7	3.3
JUL	E6	NC	2 chironomid	whole	-32.8	4.9
JUL	E7	S	2 chironomid	whole	-33.8	4.6
JUL	E8	PR	2 chironomid	whole	-32.9	3.6
JUL	E9	NS	1 chironomid	whole	-31.0	3.9
AUG	E10	S	2 chironomid	whole	-36.1	3.5
AUG	E11	NS	2 chironomid	whole	-36.3	3.8
AUG	E12	NC	1 mayfly. 1 chironomid	whole	-38.2	3.9
AUG	E13	S	2 chironomid	whole	-34.3	4.5
AUG	E14	NS	1 mayfly	whole	-38.6	3.1
AUG	E15	PR	2 chironomid	whole	-35.1	3.6
AUG	E16	NC	2 chironomid	whole	-33.2	3.4
AUG	E17	NC	2 chironomid	whole	-32.6	4.4
AUG	E18	PR	2 chironomid	whole	-32.4	4.8
AUG	E19	S	2 chironomid	whole	-33.7	2.4
AUG	E2	S	1 mayfly	whole	-38.1	3.2
AUG	E20	NS	2 chironomid	whole	-32.1	4.2
AUG	E21	S	2 chironomid	whole	-33.7	4.5
AUG	E22	NS	2 chironomid	whole	-33.2	3.8

AUG	E3	NS	1 mayfly. 1 chironomid	1 no abd	-38.6	3.9
AUG	E4	S	2 chironomid	whole	-33.7	4.7
AUG	E5	PR	1 mayfly. 1 chironomid	whole	-37.1	2.9
AUG	E6	NC	2 chironomid	whole	-35.9	4.0
AUG	E7		2 chironomid	whole	.	.
AUG	E8	PR	2 chironomid	whole	-35.1	4.1
AUG	E9	NS	2 chironomid	whole	-34.5	4.0

Terrestrial Prey

DATE	ENCL	TREAT	SPP	PART	δ15N	TYPE
JUNE	E12	NC	3 leafhopper	whole	0.04	STICK
JUNE	E16	NC	2 leafhopper	whole	0.58	STICK
JUNE	E17	NC	3 leafhopper	whole	-0.41	STICK
JUNE	E6	NC	3 leafhopper	whole	-0.81	STICK
JUL	E12	NC	1 leafhopper	whole	0.33	STICK
JUL	E16	NC	1 leafhopper	whole	0.76	STICK
JUL	E17	NC	1 leafhopper	whole	2.37	STICK
JUL	E6	NC	1 leafhopper	whole	3.67	STICK
AUG	E12	NC	2 leafhopper	whole	3.08	STICK
AUG	E17	NC	2 leafhopper	whole	4.39	STICK
AUG	E6	NC	1 leafhopper	whole	3.14	STICK

Appendix I. Relationship between Zippin (1956) estimated and relative densities of aquatic and terrestrial predators in enclosures.

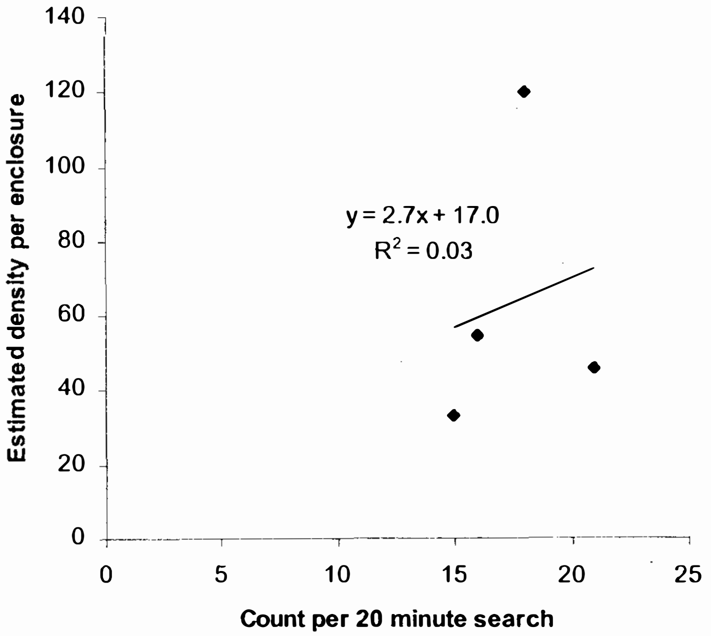


Figure 1. Wolf spiders counted in first 20 minute search compared with estimated density per enclosure. Estimates were made by using Zippin population estimates on data sampled with out replacement. See text for details. Linear regression reported in graph represents the best fit linear relationship (slope) between the measure of relative population density per enclosure and the estimated actual density per enclosure (N = 4). The R^2 value represents the explanatory power of relative population size in estimating actual density.

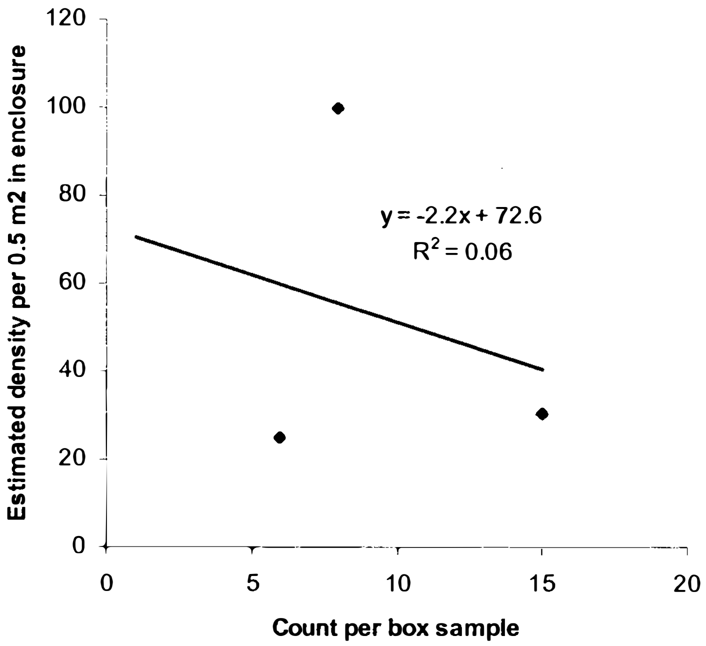


Figure 2. Dragonfly larvae count in first box sample (includes sum of 3 sweeps) compared with estimated density per area included in box sampler in each enclosure. Estimates were made by using Zippin population estimates on data sampled with out replacement. See text for details. Linear regression is reported in graph. . Linear regression reported in graph represents the best fit linear relationship (slope) between the measure of relative population density per enclosure and the estimated actual density per enclosure (N = 3). The R^2 value represents the explanatory power of relative population size in estimating actual density.

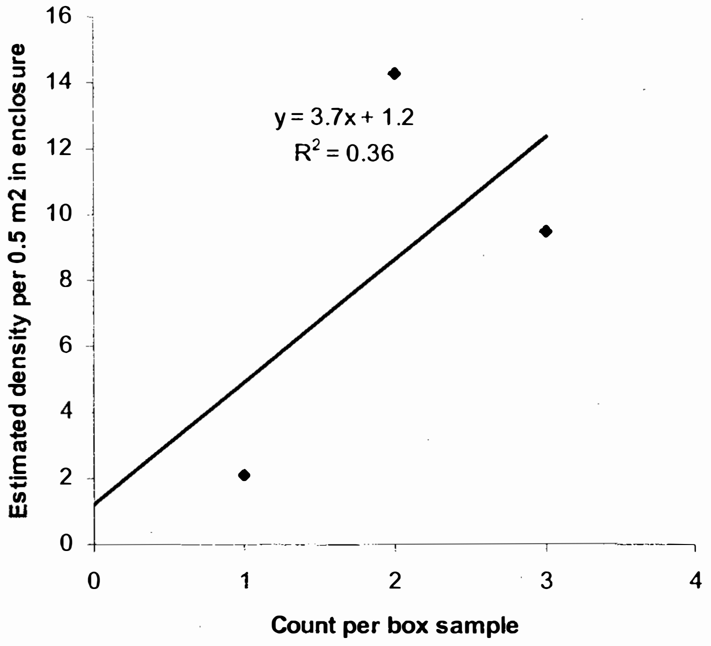


Figure 3. Crayfish count in first box sample (includes sum of 3 sweeps) compared with estimated density per area included in box sampler in each enclosure. Estimates were made by using Zippin population estimates on data sampled with out replacement. See text for details. Linear regression is reported in graph. . Linear regression reported in graph represents the best fit linear relationship (slope) between the measure of relative population density per enclosure and the estimated actual density per enclosure (N = 3). The R^2 value represents the explanatory power of relative population size in estimating actual density.

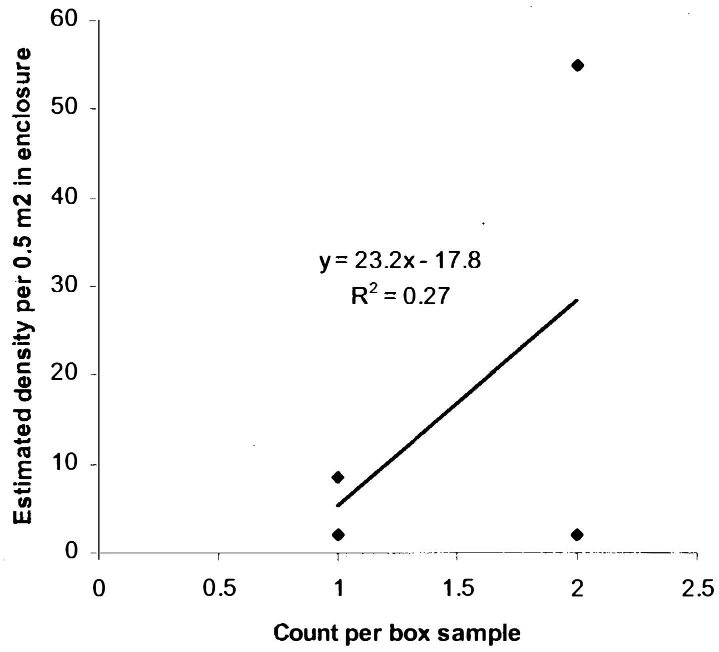


Figure 4. Newt adults and larvae count in first box sample (includes sum of 3 sweeps) compared with estimated density per area included in box sampler in each enclosure. Estimates were made by using Zippin population estimates on data sampled with out replacement. See text for details. Linear regression is reported in graph. Linear regression reported in graph represents the best fit linear relationship (slope) between the measure of relative population density per enclosure and the estimated actual density per enclosure (N = 3). The R^2 value represents the explanatory power of relative population size in estimating actual density.

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Appendix J. Allochthonous inputs and intraguild predation influencing the predation rate on larval midges (Diptera:Chironomidae). B. S. Williams and J. M. Kraus, 2003.

Abstract

Macroinvertebrates are crucial to the functioning of aquatic ecosystems. Elucidating the factors that affect their abundance and distribution within aquatic environments is of great importance to the study of freshwater ecosystems as well as to the study of ecosystem coupling. The purpose of this study is to examine the effects of terrestrial subsidy and intraguild predation on dragonfly (Odonata:anisoptera) and crayfish diet. We hypothesized that allochthonous input (terrestrial moths) and intraguild predation between the two predators would decrease the predation pressure on the midge population and that there would be a combined effect of inputs and intraguild predation on the midges. Our data did not support these hypotheses. The presence of allochthonous inputs had no significant effect ($P > 0.05$), and in treatments where the predators were predators were paired together there was significantly higher predation on midges. Further study and a larger sample size are needed for a more accurate comparison.

Keywords: allochthonous, intraguild predation, Odonate, crayfish, midge, Noctuid, microcosm, Chironomid

Introduction

Macroinvertebrates are crucial to the functioning of aquatic ecosystems. They are responsible for nutrient recycling between sediments and macrophyte root structure (Barko et al. 1991) and between the sediments and the water column (Devine and Vanni 2002); they directly link primary production to higher trophic levels in aquatic systems (Applegate and Mullen 1967; Vodopich and Cowell 1984; Nalepa et al. 1998; Svensson et al. 1999; and Lozano et al. 2001), provide subsidy for terrestrial predators (Henschel 2001; Nakano and Murakami 2001; Sabo and Power 2002), and are often used as indicators of ecological disturbance (Hellawell 1986; and Lewis et al. 2001). Identifying and understanding the factors that structure macroinvertebrate communities is essential if we are to understand the functioning of aquatic ecosystems as a whole (Shostell & Williams, in review) and if we are to further understand coupling between terrestrial and aquatic ecosystems.

Many biotic and abiotic habitat factors influence the abundance and distribution of macroinvertebrates within aquatic systems. Factors such as the availability of oxygen and depth of the water (Allen et al. 1999), pollution within the system (Allan and Flecker 1993), spatial heterogeneity (Thorp 1992), sediment type (Benke, 1984; Morrisey, 1992), the presence of macrophytes (Egglishaw 1964; Soszka 1975; Ságová 1992; France 1998; Ságová-Marecková 1999), and predation by fish (Specziár and Bíró, 1998; Svensson et al., 1999) all effect the benthic community. There is much controversy and little consensus however, on the interdependence of these factors and which, if any, of these is the foremost governing factor structuring benthic communities (Shostell and Williams, in review). The complex and heterogeneous nature of aquatic ecosystems likely excludes any one habitat factor from controlling community structure, but there is some agreement on the importance of predation in structuring communities (Sih et al. 1985) especially in freshwater ponds where numerous species of both arthropod and amphibian predators coexist (Van Buskirk 1989). In studies where organisms occupying higher trophic positions such as fish were removed from the system there was a dramatic increase in the abundance of macroinvertebrates (Svensson et al. 1999). In fishless ponds, organisms normally considered to be lower trophic level consumers, such as Odonate nymphs and crayfish likely assume the higher trophic status usually occupied by fish. Predation by dragonfly nymphs and crayfish in these ponds likely has a greater impact on macroinvertebrate communities than it would in areas with high fish biomass.

Dragonfly larva are polyphagous predators, consuming a diverse assemblage of prey items. Odonates have a sizeable daily consumption capacity and possess the numerical and physiological potential for regulating prey assemblages (Thorp 1984). Studies have shown that dragonfly larva can alter the ratio of several common benthic organisms through predation, and other discoveries have shown that Odonates have the feeding capacity to deplete common benthic prey species (Johnson et al. 1987). Crayfish also exert a strong influence on the benthic community through predation. The crayfish is omnivorous by nature but grows best on a diet of invertebrates or a mixed diet that includes macroinvertebrates (Hill et al. 1994).

Studies have shown how aquatic habitats donate allochthonous resources to surrounding terrestrial environments through predation across the aquatic terrestrial boundary (Henschel 2001) or marine terrestrial boundary (Polis and Hurd 1995), but to our knowledge few studies have specifically focused on terrestrial environments donating arthropod fall to aquatic arthropod predators across this boundary and little attention has been given to how intraguild predation influence benthic communities. If predation pressure on aquatic prey was decreased by the predator feeding on organisms which have fallen into water or if there were instances of intraguild predation between common predators then there could be subsequent increases in the abundance of benthic organisms such as aquatic dipterans. This subsidy would lead to a possible increase in available prey items for aquatic predators and could possibly reduce their dependence on *in situ* resources like the often dominant midge larva

The purpose of this study was to determine if allochthonous terrestrial arthropods that fall into ponds can stimulate a shift in the diet of two common predators the Odonate larva (Family: Aeshinidae) and the crayfish, and to see if this dietary change can effect larval midge (Family: Chironomidae) densities. This study also determined if instances of intraguild predation could decrease the predation pressure on the midge population, and to determine if there is interaction between instances of allochthonous inputs and intraguild predation.

We hypothesized that the presence of allochthonous arthropod prey (nocturnal moths) and instances of intraguild predation between crayfish and the dragonfly larva would decrease the predation pressure on benthic organisms from what would be expected by the presence of only one resource or by additive effects of predation. We also hypothesized that the presence of allochthonous prey and intraguild predation together will decrease predation to a greater degree than either two factors alone.

Methods

Description of sampling sites and field sampling

To evaluate our hypotheses we simulated natural conditions at the aquatic/terrestrial boundary in a laboratory setting. Experimental organisms were obtained from several small pond and streams located at the Mountain lake Biological Station (37.368° N, 80.522° W, elevation 1316 m). Larval midges (Diptera: Chironomidea) were obtained from Horton pond by dip netting the leaf litter near the aquatic terrestrial boundary. Dragonfly nymphs of the genus *Boyeria* (Anisoptera : Aeshnidae) and crayfish were obtained from Station Pond but due to low abundances of crayfish in late July, some specimen had to be obtained from nearby streams. Data gathered by Kraus (unpublished) indicate that Odonate densities are greater < 1 m from the aquatic terrestrial boundary (Fig 1). Dragonfly larva were obtained by dip netting and seining < 1 m from the aquatic terrestrial boundary. Dipteran larva accounted for roughly 90 percent of all organisms obtained in emergence traps from Horton and Sylvatica ponds and 77 percent of the dipterans were midges (Kraus unpbl. Data). Only larval Dipterans in the family Chironomidea were used in experimental trials. Common nocturnal moths of the family: Noctuidae served as the terrestrial input in our experiment. These are commonly found in forest vegetation as well as in the vegetation near the ponds edge. They have also been observed landing and then drowning in Horton and Sylvatica ponds in mid-June (Williams and Kraus personal observation). These organisms were obtained by scraping a large insect net through the vegetation surrounding the ponds and around light sources.

Experimental setup

All experimental trials were conducted in 16.5 cm x 30 cm x 9 cm clear plastic boxes. The bottom of each microcosm was completely covered with rinsed leaf litter obtained from Horton pond. The leaf litter was then covered with exactly 7 cm of filtered pond water. Natural densities of predators and prey (1 dragonfly, 1 crayfish, and 12 midge larva) were used in each treatment (Kraus unpbl. Data). Size and robustness of predators and prey were kept constant throughout experiment. The average area of the dragonfly larva used in the experiments was 2.53 ± 0.22 cm^2 and the average area of the crayfish used was 4.82 ± 0.33 cm^2. An attempt was made to match the sizes of the predators in order to keep the size ration close to one. Dragonfly larva displaying wing buds or those whose areas were greater than the average we not used in this experiment because final instar larva often does not actively feed. Moth size was approximated and kept constant through out the experiment. The moths wings were surgically altered before they we placed in the treatments to ensure that the were unable to escape. A piece of plastic window screening was placed over each microcosm in order to prevent emerged dragonflies or midges from being unaccounted for.

Experimental design was a 2 x 2 x 2 factorial with 2 levels of dragonfly treatments (presence and absence) two levels of crayfish treatments (presence and absence) and two levels of allochthonous treatments (presence and absence). The predation rate was determined as the number of midges consumed / treatment. Each treatment was allowed to run for 3 d when it was then destructively sampled. The water from the experiment was filtered through a sieve and each leaf used was individually rinsed to assure that all midges were recovered. The experiment was blocked by treatment where 5 reps of each treatment were conducted. The experiment was also blocked by time to determine if date that the experiments were run had an effect on the predation rate. The data was analyzed using a 3 way ANOVA model with the abundance number of midge larva consumed / treatment as the dependent and the presence of Odonates, crayfish, and allochthonous inputs as the independent variables. A Duncan's multiple comparison test was conducted. All statistical analyses were analyzed using SAS (Proc GLM, SAS Institute, 2001).

Results

Efficiency of recovery

The efficiency of recovery was rated as the number of midges recovered from the treatments excluding predators (M) and (M & All). The mean # of midges recovered from the midge treatment was 11 ± 0.45 midges / treatment and was 11.4 ± 0.4 midges / treatment (Fig 2). The combined average of the predator exclusion treatments was 11.2 ± 0.29 midges / treatment (Fig 2).

The effects of allochthonous input and intraguild predation.

In treatments where predators were exposed to allochthonous inputs the moth was consumed roughly 60% of the time. In the (M & All) treatment the proportion of moths consumed was 0/5, in the (M, O, All) treatment the dragonfly larva consumed the moth 3/5, in the (M, Cf, All) treatment the moth was consumed 3/4, and in the (M, O, Cf, All) treatment the moth was consumed 3/4. Because we destructively sampled the treatments at the end of the trial it was impossible for us to determine the time of death in the instances where the predators did not survive so these treatments were excluded.

The instances of intraguild predation between the dragonfly and the crayfish occurred much less than the instances where the allochthonous input was eaten. In the two treatments where this interaction was possible, intraguild predation by the crayfish on the Odonate occurred only 37% of the time. The proportion of Odonates eaten in the (M, O, Cf) treatment was 1/4 where the proportion of Odonates eaten was 2/4.

The two predators used in this experiment had distinctively different rates of consumption. The Odonate consumed and average of 4.5 ± 2.06 midges / treatment, where the crayfish consumed an average 7.2 ± 1.62 midges / treatment (Fig 3). The Crayfish consumed significantly higher numbers of midges ($P < 0.05$). In the (M, O, Cf) treatment the predators consumed a significantly higher number of midges than in all other treatments ($P < 0.05$) (Fig 3). In the treatments including both predators and allochthonous inputs the mean number of midges varied little across treatments. In the (M, O, All) treatment the Odonate consumed an average of 7.0 ± 1.26 midges / treatment in the (M, Cf, All) treatment, while the crayfish consumed and average of 8.0 ± 1.47 midges / treatment. In the (M, O, Cf, All) treatment the predators consumed an average of 6.75 ± 1.31 midges / treatment (Fig 3). The presence of allochthonous inputs and instances of intraguild predation had no significant effect on midge density ($P > 0.05$). Time the treatments were run, position, and the size of the predators also had no significant effect on midge density.

Discussion

The allochthonous input was consumed in 9/15 instances suggesting that predators generally consumed this prey item. However, there was no significant correlation between the presence of allochthonous input and the number of midges consumed / treatment. Perhaps the densities of allochthonous inputs used in this study were not high enough to satisfy the predators dietary needs. Our conclusions were reached based on a single density of moths being added to the treatments. Future study should focus on varying the densities of allochthonous input with varying densities of both predator and prey species. If the findings of such a study concurred with our own then it would be reasonable to assume that allochthonous inputs such as Noctuid moths do not alter the rate of predation on midges and that there would likely be a bottom up effect on the predators in the system as they deplete the *in situ* aquatic resources as observed by Johnson et al. (1987). If this were true then it would likely lead to a diminished subsidy to the surrounding terrestrial environment because of fewer emerging midges.

We also hypothesized that intraguild predation between the crayfish and the dragonfly larva would decrease the predation pressure on the midge population, however; our data do not support this hypothesis. Instances of intraguild predation only occurred 38% of the time when the predators were exposed to one another. Consumption of the moth and dragonfly larva in the (M, O, Cf, All) treatment occurred in 2/4 times. There was no significant interaction between allochthonous input and intraguild predation, but low sample size makes an accurate comparison difficult. A larger sample size would be needed in order to make a more robust comparison.

Few studies have used an experimental design to evaluate the influence of subsidies. Both Nakano and Murikami (2001) (in streams) and Sabo and Power (2002) (in rivers) found that allochthonous prey input influenced predator movement and biomass. It is possible that allochthonous prey provided was not enough to satiate the predators. Given the unnatural densities of the input used it is possible that the inputs used do not play a large role in the pond as they do in stream and river systems.

Our findings do show a significant difference in the amount of midges consumed by the predators in this experiment and that instances of intraguild predation do occur between the crayfish and the dragonfly larva. This would seem to suggest that there could be strong competition between these two predators. Instances of intraguild predation may occur more often if local prey species are depleted as observed by Johnson et al. (1987) or when there are higher densities of these predators. Further study would be needed in order to assess this possibility.

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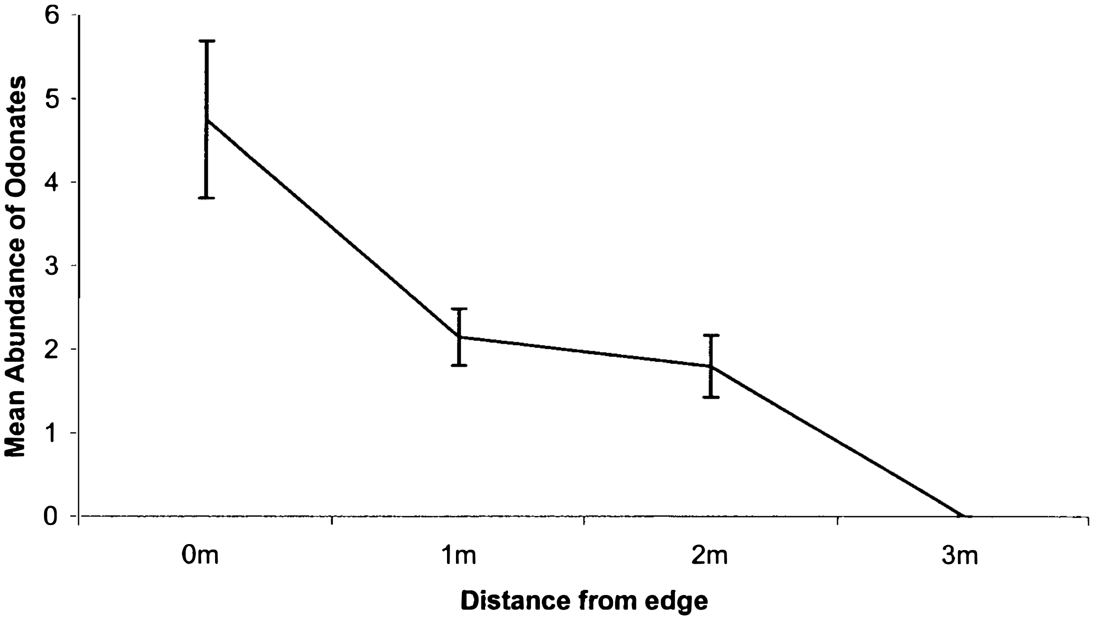

Figure 1. Mean abundance of odonates (± S.E.) at 0, 1, 2, and 3m from the aquatic terresterial boundary.

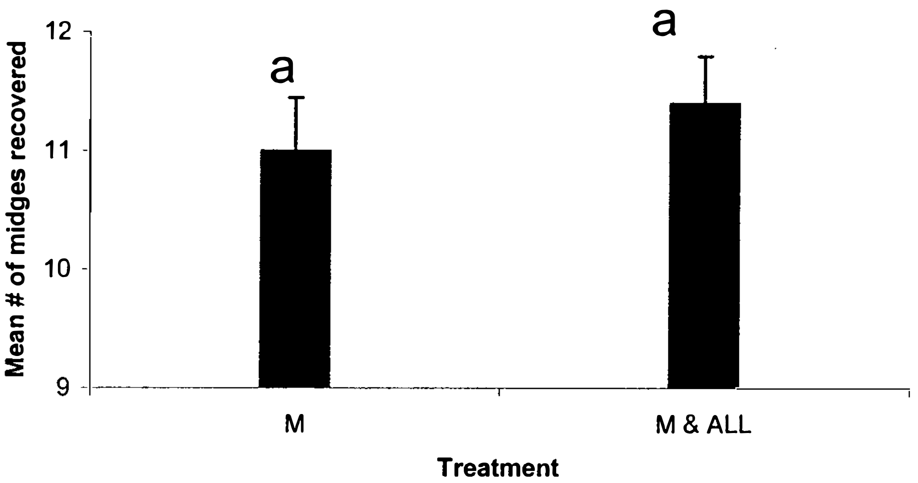

Figure 2. Recovery efficiency and the non-significant effect of allochthonous input alone in midge density. Mean amount of midges recovered from treatments excluding predators (M) and (M & ALL) ± S.E. Identical letters above the means indicate an insignificant difference (Duncan's correction test $P > 0.05$).

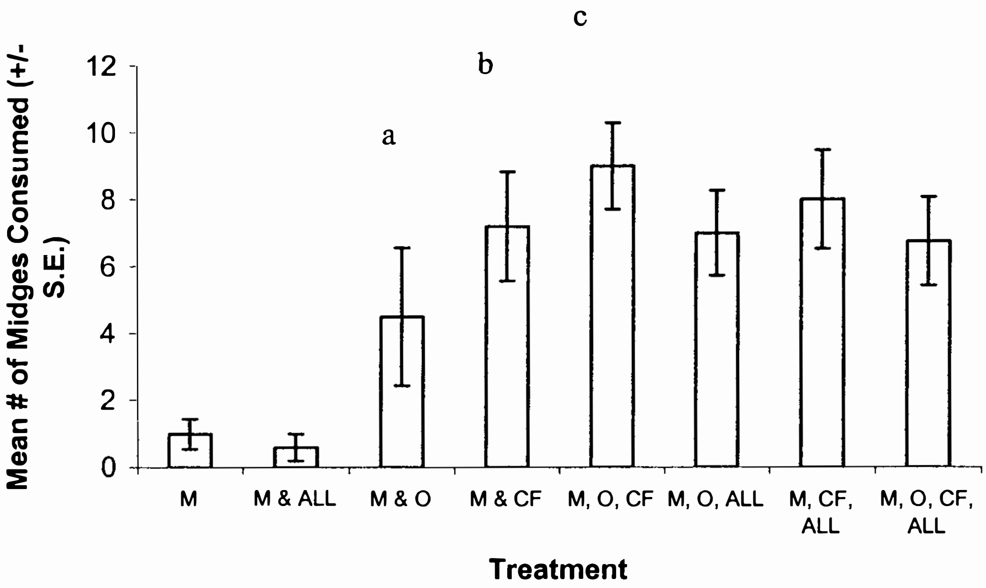

Figure 3. Mean number of midges consumed / treatment (± S.E.) for (M) midges n = 5, Midges & Odonate (M & O) n = 4, midges and a crayfish (M & CF) n = 5, midges, Odonates, and crayfish (M, O, CF) n = 4, midges and allochthonous inputs (M & All) n = 5, midges, Odonates, and allochthonous inputs (M, O, All) n = 5, midges, crayfish, and allochthonous inputs (M, CF, All) n = 4, and Midges, Odonates, Crayfish, and allochthonous inputs (M, O, CF, All) n = 4. Different letters over the means indicate the statistical significance (3-Way ANOVA and Duncan's corrections test $P < 0.05$).

Appendix K. Isotopic turnover in wolf spiders. Data summary from 2005 laboratory experiment. Wolf spiders (*Pardosa milvina*) collected December 17-18 near a man-made pond on the campus of the University of Virginia were maintained in vials and fed laboratory reared fruit flies (*Drosophila melanogaster*). Spiders were fed every other day beginning December 19, 2005. Three spiders were also frozen on those days without being fed. Since spiders usually consumed the flies within a couple of hours, approximately 48 hours were given for digestion and assimilation of gut contents (*sensu* Oelbermann and Scheu 2002). Legs and abdomens as well as molts when available were analyzed separately for ^{13}C and ^{15}N isotopes. Data is presented below for individuals not fed fruit flies, and those fed over 12, 24 and 36 days. Abdomens resembled the $\delta^{13}C$ of their fruit fly diet within 12 days (Fig. 1). Legs took longer to turnover, probably because exoskeleton produced on a natural diet comprised a large proportion of the sample (Fig. 1). The $\delta^{15}N$ signature of the wolf spiders was rather similar for abdomens and legs and over time (Fig. 2). This pattern suggests that the $\delta^{15}N$ of the fruit flies and that of the natural prey of the spiders were similar. Isotopic signatures of molts were very close to the original signature of the spiders. Only three individuals were observed to molt during the experiment, despite warm temperatures and ample food. Low molting incidence likely results from the physiological changes due to over-wintering adaptations in these spiders (Kraus and Morse, 2005).

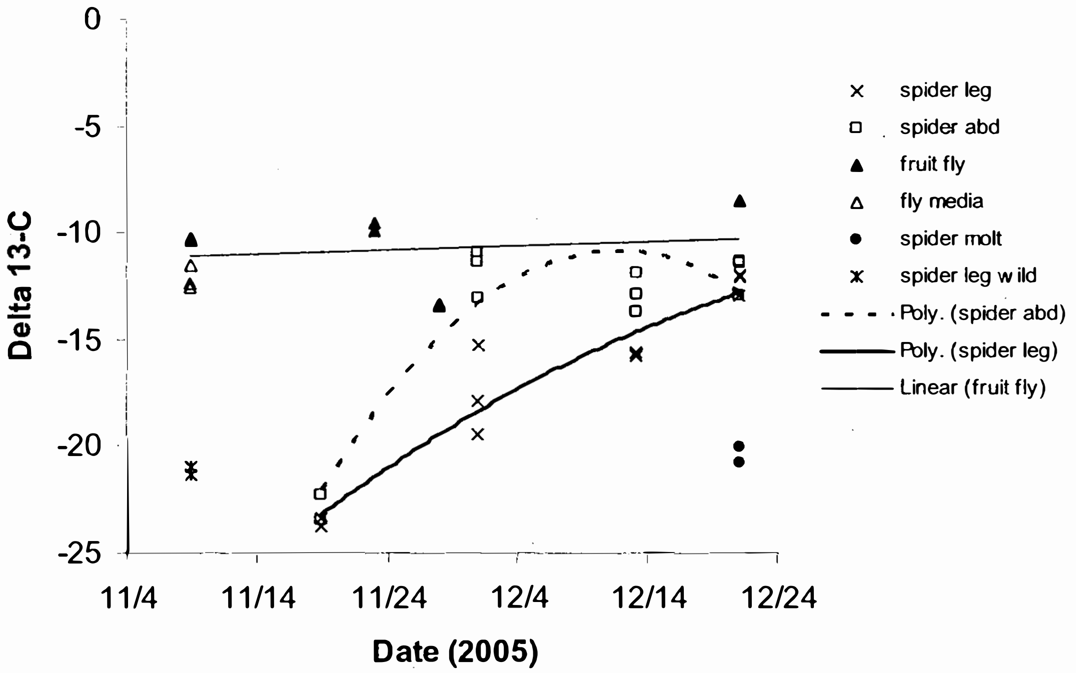

Figure 1. Change in $\delta^{13}C$ isotopic signature of wolf spiders fed on an artificial diet over time. Each point represents an independent sample. "Spider leg and "spider abd" are the legs and abdomens of the wolf spider *Pardosa milvina*. "Spider leg wild" are the legs of 2 spiders captured before the initiation of the turnover experiment. The first 3 points in the turnover experiment (where the regression lines for the spiders begin) also represent spiders that consumed a wild diet only. The regression lines for the spider turnover are quadratic, while the fruit fly regression is linear.

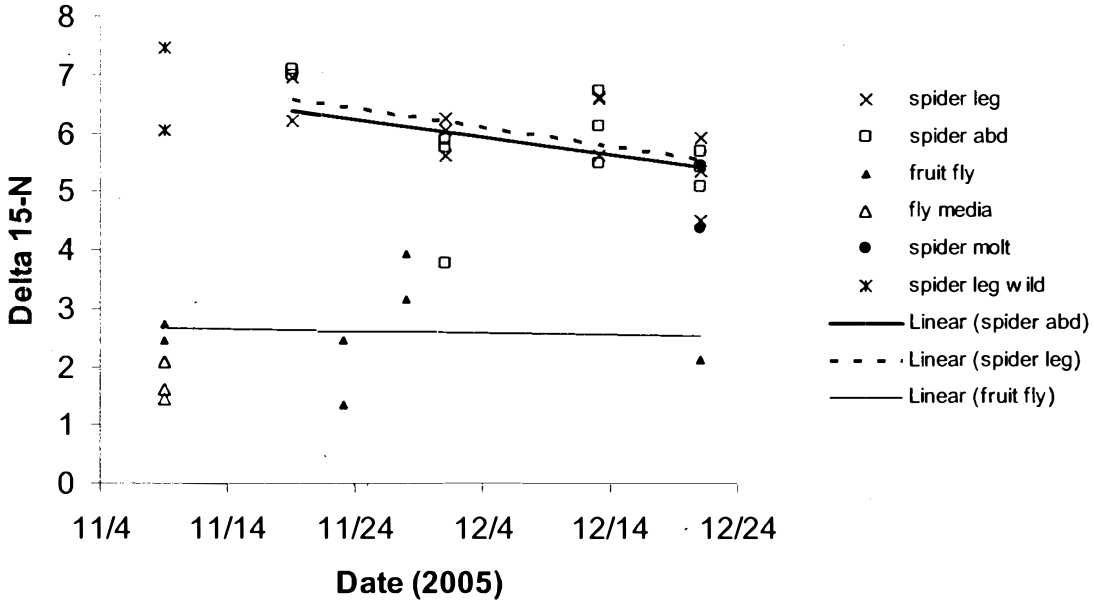

Figure 2. Change in $\delta^{15}N$ isotopic signature of wolf spiders fed on an artificial diet over time. Each point represents an independent sample. "Spider leg and "spider abd" are the legs and abdomens of the wolf spider *Pardosa milvina*. "Spider leg wild" are the legs of 2 spiders captured before the initiation of the turnover experiment. The first 3 points in the turnover experiment (where the regression lines for the spiders begin) also represent spiders that consumed a wild diet only. The regression lines for the spider turnover and fruit flies are linear.

References:

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