

Supporting Information. What drives interaction strengths in complex food webs?
A test with feeding rates of a generalist stream predator. Daniel L. Preston, Jeremy S. Henderson, Landon P. Falke, Leah M. Segui, Tamara J. Layden, Mark Novak. *Ecology*. 2018.

Appendix S1

Estimating prey identification times

Detailed methods and analyses for estimating prey identification times are provided in Preston et al. 2017. In the following section we provide an overview of the approach.

We collected reticulate sculpin from Oak, Berry, and Soap Creeks and housed them individually in aquaria within a temperature-controlled environmental chamber. After an acclimation period without food, we fed each individual sculpin one to seven prey items, recording the exact time of prey consumption. After subsequent time periods varying in length from 10 min to 100 hours post-feeding, we used gastric lavage to recover remaining prey items which were examined under a dissecting microscope. We varied the size of the prey item (Table S3), the size of the sculpin, and the water temperature of the feeding trials in a randomized manner, reflecting the treatment of all predictors as continuous variables in our analysis. Sculpin ranged in size from 32 mm to 86 mm and water temperature ranged from 10°C to 20°C for each trial, corresponding to the natural variation in stream temperatures observed at our study sites over the course of a year. We defined prey identification times as the time at which a prey item from the gut of the predator was no longer identifiable to the family level using microscopy. We typically determined whether a prey item was identifiable based on the persistence of the head, but occasionally also the thorax or abdomen when these parts contained identifying features (see Preston et al. 2017 for additional details).

To generate functions for estimating prey identification times, we fit survival models to laboratory data on prey status (identifiable or not) over time. Survival analysis can accommodate censored data to estimate an unobserved event (here the 'true' identification time based on data collected either before or after the event had occurred) (Klein and Moeschberger 2005, Kleinbaum and Klein 2006). Survival functions describe the probability that a prey item will remain identifiable beyond a given time. They have a corresponding probability density function that describes the probability of the prey item becoming unidentifiable at a given time instant. We compared the fit of multiple parametric survival functions and found that Weibull models typically provided the best fit to the prey identification time data (see Preston et al. 2017).

We estimated individual prey identification times for each prey item in our field dataset as the mean of the probability density function of a Weibull model,

$$\lambda\Gamma(1/\alpha + 1),$$

where λ is a scale parameter and α is a shape parameter. We used the accelerated failure time extension of the Weibull model, which 'accelerates' or 'decelerates' the prey identification times by adjusting the scale parameter (λ) by

$$\lambda = \exp(\beta_1 X_1 + \beta_2 X_2 + \dots \beta_p X_p),$$

where the β terms are regression coefficients associated with each of p different covariates. The covariates that we used in the present paper included water temperature, prey body size and predator body size. Note that in Preston et al. 2017 we also incorporated prey count.

The intercepts, shape parameters, and coefficients for each covariate were estimated from the laboratory data for each prey taxon separately. Our approach therefore incorporated differences in taxonomic identity (e.g., prey traits) that affect rates of prey digestion. We used the field data on the observed covariate values for each individual prey item (i.e., prey size, predator size, and water temperature) to estimate the prey identification times. Water temperature was incorporated as a 24 hr. mean value from the time period preceding the end of the field surveys (see abiotic variable below).

For conspecific sculpin prey, of which seven were observed in stomach contents from the field, the survival model did not converge (likely due to a small sample size; $n = 33$). We therefore applied a constant prey identification times for sculpin prey based on the raw laboratory data (12.5 hrs). For prey taxa that were not included in laboratory trials, we applied functions from morphologically similar taxa (Table S1).

Our analysis utilized the 'Survival' package in R (Therneau 2015). Note that there are several different parameterizations of the Weibull distribution, and the above functions use a shape and scale parameter that differs from the output of the 'Survival' package (see the R help file for the 'Survival' package for additional discussion).

We provide the coefficients for each covariate and each prey taxon, as well as the shape parameters and mean laboratory prey identification times in Table S4. Weibull probability density functions using mean covariate values from the laboratory data are provided in Figure S1. The estimated prey identification times from the prey items recovered from sculpin in the field surveys are provided in Figure S6.

Measurement of abiotic stream variables

At each site we quantified stream discharge, mean canopy cover, mean substrate size, mean water temperature, and mean stream width (Table S5). We measured stream discharge at each reach on the date of sampling using a handheld water flow meter (OTT MF Pro by OTT Hydromet). We measured canopy cover every 5 m along the reach using a spherical densiometer. We estimated the embeddedness of substrate cobble on a scale of 1 to 5 within each habitat unit (pools and riffles). Water temperature was recorded as the 24 hr mean value from data loggers deployed at each site (TidbiT loggers by HOBO). The means represent the 24 hrs prior to the conclusion of a survey (roughly corresponding to the time period over which sculpin were feeding and digesting prey

prior to capture). Lastly, we recorded stream widths every 5 m along the length of the reach using a tape measure.

Mark-recapture surveys

To determine the electrofishing catch efficiency of reticulate sculpin, we conducted mark-recapture surveys at three sites, one each at Oak, Soap, and Berry Creeks. Mark-recapture surveys were conducted separately from our surveys of sculpin diets but at three of the same sites after the main surveys were completed. We set up block nets at the ends of each reach and in between habitat units (pools and riffles) to minimize sculpin movement between units. This approach allowed us to calculate habitat-specific catch efficiencies for pools and riffles. We visited each site on consecutive days. On the first day we used three-pass electrofishing to capture sculpin with a four-person crew (using a backpack electroshocker, block nets, and dip nets, as described in the main text). Each captured sculpin was anesthetized with Aqui-S and then marked with a small clip on the tail fin using sterilized scissors. After marking, the individuals were given time to recover in aerated stream water prior to release in the same habitat unit where they were collected. We then re-surveyed the same sites 24 hrs later using single-pass electroshocking. We followed Krebs (1989) to estimate sculpin abundance within each habitat unit based on the number of fish marked on the first visit, the total caught on the second visit, and the number marked on the second visit. Mark-recapture analyses were conducted with the 'FSA' package in R (Ogle 2017). Based on this analysis, the mean capture efficiencies were 31% for pools and 36% for riffles. The total numbers of sculpin captured per habitat at each site during our surveys for sculpin diets were adjusted by these catch efficiencies. Those values were then divided by the area of the reach to estimate sculpin density. Reach areas were calculated using the length and mean width, based on width measurements taken every 5 m along the reach.

GAMM analyses using sample size cutoff for prey identity groups

For the analysis in the main text, we grouped feeding rates into 15 prey taxonomic orders that varied in sample size from 1 to 69 feeding rates. Because a small sample size within a categorical variable can possibly lead to model overfitting, we conducted the same analysis on a smaller dataset containing eight prey orders that each contained > 5 individual feeding rate estimates (Annelida, Coleoptera, Diptera, Ephemeroptera, Hydracarina, Plecoptera, Gastropoda, and Trichoptera). This reduced the number of feeding rates in the dataset from 219 to 204. The results of this analysis were qualitatively similar to the analysis of the full dataset, with the relative importance of each variable being the same in terms of changes in AIC values. These results are presented in Table S5.

References

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Table S1. The distances separating reaches within a stream in meters.

Upstream Reach	Downstream Reach	Distance (m)
Oak Reach 1	Oak Reach 2	356
Oak Reach 2	Oak Reach 3	349
Soap Reach 1	Soap Reach 2	950
Soap Reach 2	Soap Reach 3	98
Berry Reach 1	Berry Reach 2	87
Berry Reach 2	Berry Reach 3	173

Table S2. Prey taxa found in the stomach contents of sculpin in the field. The order column corresponds to the categorical prey identity variable in the model comparisons. Prey count indicates the total number of that prey type found in all sculpin across the nine stream sites. The ‘Diets’ column indicates the number of sites at which a prey type was found and a feeding rate was calculated. The ‘Surbers’ column indicates the number of site in which that prey type was found in surber samples, allowing the estimation of a prey density. Lastly, the prey identification times were calculated from one of ten taxon-specific functions determined from laboratory data. The taxon-specific function used for each prey type is indicated in the last column labeled ‘Prey ID Time Source’.

Order	Family	Life Stage	Prey Count	Diets (Sites)	Surbers (Sites)	Prey ID Time Source
Achatinoidea	Semisulcospiridae	Juvenile	72	7	7	Snails
Achatinoidea	Semisulcospiridae	Egg	29	2	0	Sculpin Eggs
Annelida			8	5	5	Worms
Araneae			7	4	3	Snails
Bivalve			1	1	0	Mayflies
Coleoptera		Adult	2	1	1	Beetles
Coleoptera	Elmidae	Adult	143	7	7	Beetles
Coleoptera	Elmidae	Larvae	73	8	8	Beetles
Collembola			1	1	0	Mayflies
Copepod			83	4	1	Mayflies
Decapoda	Astacidae		8	4	2	Crayfish
Diptera		Adult	23	7	7	Flies
Diptera	Athericidae	Larvae	22	4	4	Flies
Diptera	Cecidomyiidae	Larvae	30	3	0	Flies
Diptera	Ceratopogonidae	Larvae	42	7	6	Flies
Diptera	Chironomidae	Larvae	1947	9	9	Flies
Diptera	D023	Adult	7	4	1	Flies
Diptera	Dixidae	Larvae	42	7	5	Flies
Diptera	Empididae	Larvae	39	8	6	Flies
Diptera		Larvae	3	3	2	Flies
Diptera	Pelecorhynchidae	Larvae	1	1	0	Flies
Diptera	Psychodidae	Larvae	13	7	5	Flies
Diptera	Ptychopteridae	Larvae	12	3	3	Flies
Diptera		Pupae	13	6	6	Flies
Diptera	Simuliidae	Larvae	69	8	7	Flies
Diptera	Tipulidae	Larvae	67	8	8	Flies
Ephemeroptera		Adult	12	4	1	Mayflies
Ephemeroptera	Ameletidae	Larvae	3	2	0	Mayflies

Ephemeroptera	Baetidae	Larvae	2830	9	9	Mayflies
Ephemeroptera	Ephemerellidae	Larvae	12	5	4	Mayflies
Ephemeroptera	Heptageniidae	Larvae	146	9	9	Mayflies
Ephemeroptera	Leptophlebiidae	Larvae	124	9	9	Mayflies
Hemiptera			9	5	2	Caddisflies
Hemiptera	Veliidae		2	2	1	Caddisflies
Hydracharina			52	8	8	Mayflies
Isopoda			11	4	0	Mayflies
Lepidoptera			6	2	0	Flies
Megaloptera	Sialidae	Larvae	4	3	2	Caddisflies
Neuroptera		Larvae	1	1	0	Caddisflies
Ostracoda			42	7	0	Caddisflies
Plecoptera		Adult	1	1	0	Stoneflies
Plecoptera	Chloroperlidae	Larvae	29	8	8	Stoneflies
Plecoptera		Larvae	8	5	1	Stoneflies
Plecoptera	Nemouridae	Larvae	146	9	9	Stoneflies
Plecoptera	Peltoperlidae	Larvae	1	1	0	Stoneflies
Plecoptera	Perlidae	Larvae	68	9	9	Stoneflies
Plecoptera	Perlodidae	Larvae	1	1	0	Stoneflies
Plecoptera	Pteronarcyidae	Larvae	1	1	1	Stoneflies
Scorpaeniformes	Cottidae	Juvenile	7	3	2	Sculpin
Thysanoptera		Adult	28	6	2	Mayflies
Trichoptera	Calamoceratidae	Larvae	4	3	3	Caddisflies
Trichoptera	Glossosomatidae	Larvae	278	9	9	Caddisflies
Trichoptera	Hydropsychidae	Larvae	113	9	8	Caddisflies
Trichoptera		Larvae	6	4	2	Caddisflies
Trichoptera	Lepidostomatidae	Larvae	188	9	8	Caddisflies
Trichoptera	Polycentropodidae	Larvae	45	4	1	Caddisflies
Trichoptera	Rhyacophilidae	Larvae	47	8	8	Caddisflies

Table S3. Length-to-mass regression equations and sources for the prey types observed in the stomach contents of reticulate sculpin. The column labeled ‘Regression’ indicates the taxonomic resolution (and taxon) of the corresponding equation that was applied.

Order	Family	Life Stage	Regression	Equation	Source
Achatinoidea	Semisulcospiridae	Juvenile	Species (<i>Juga plicifera</i>)	$0.0182 \cdot L^{2.6534}$	This study
Annelida			Family (Lumbriculidae)	$\exp(-9.19 + 3.25 \cdot \log(L))$	Miserendino 2001
Araneae			Family (Elmidae)	$0.0074 \cdot L^{2.879}$	Benke et al. 1999
Bivalve			Species (<i>Juga plicifera</i>)	$0.02 \cdot L^{2.6534}$	This study
Coleoptera		Adult	Order (Coleoptera)	$\exp(-2.0076 + 3.2271 \cdot \log(L))$	Towers et al. 1994
Coleoptera	Elmidae	Adult	Family (Elmidae)	$\exp(-2.0076 + 3.2271 \cdot \log(L))$	Towers et al. 1994
Coleoptera	Elmidae	Larvae	Family (Elmidae)	$0.0074 \cdot L^{2.879}$	Benke et al. 1999
Collembola			Order (Collembola)	$\exp(-1.8749 + 2.3002 \cdot \log(L))$	Ganihar 1997
Copepod			Order (Amphipoda)	$0.0058 \cdot L^{3.015}$	Benke et al. 1999
Decapoda	Astacidae		Order (Decapoda)	$0.0147 \cdot L^{3.626}$	Benke et al. 1999
Diptera		Adult	Order (Diptera)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera	Athericidae	Larvae	Family (Athericidae)	$0.004 \cdot L^{2.586}$	Benke et al. 1999
Diptera	Cecidomyiidae	Larvae	Order (Diptera)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera	Ceratopogonidae	Larvae	Family (Ceratopogonidae)	$0.0025 \cdot L^{2.469}$	Benke et al. 1999
Diptera	Chironomidae	Larvae	Family (Chironomidae)	$0.0018 \cdot L^{2.617}$	Benke et al. 1999
Diptera	D023	Adult	Order (Diptera)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera	Dixidae	Larvae	Family (Dixidae)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera	Empididae	Larvae	Family (Empididae)	$0.0054 \cdot L^{2.546}$	Benke et al. 1999
Diptera		Larvae	Order (Diptera)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera	Pelecorhynchidae	Larvae	Family (Pelecorhynchidae)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera	Psychodidae	Larvae	Family (Psychodidae)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera	Ptychopteridae	Larvae	Family (Ptychopteridae)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999
Diptera		Pupae	Order (Diptera)	$0.0025 \cdot L^{2.692}$	Benke et al. 1999

Diptera	Simuliidae	Larvae	Family (Simuliidae)	$0.002 * L^{3.011}$	Benke et al. 1999
Diptera	Tipulidae	Larvae	Family (Tipulidae)	$0.0029 * L^{2.681}$	Benke et al. 1999
Ephemeroptera		Adult	Order (Ephemeroptera)	$0.0071 * L^{2.832}$	Benke et al. 1999
Ephemeroptera	Ameletidae	Larvae	Family (Ameletidae)	$0.0077 * L^{2.588}$	Benke et al. 1999
Ephemeroptera	Baetidae	Larvae	Family (Baetidae)	$0.0053 * L^{2.875}$	Benke et al. 1999
Ephemeroptera	Ephemerellidae	Larvae	Family (Ephemerellidae)	$0.0103 * L^{2.676}$	Benke et al. 1999
Ephemeroptera	Heptageniidae	Larvae	Family (Heptageniidae)	$0.0108 * L^{2.754}$	Benke et al. 1999
Ephemeroptera	Leptophlebiidae	Larvae	Family (Leptophlebiidae)	$0.0047 * L^{2.686}$	Benke et al. 1999
Hemiptera			Order (Hemiptera)	$0.0108 * L^{2.734}$	Benke et al. 1999
Hemiptera	Veliidae		Family (Veliidae)	$0.0126 * L^{2.719}$	Benke et al. 1999
Hydracharina			Order (Hydracharina)	$\exp(-2.02 + 1.66 * \log(L))$	Baumgartner and Rothhaupt 2003
Isopoda			Order (Amphipoda)	$0.0058 * L^{3.015}$	Benke et al. 1999
Lepidoptera			Order (Diptera)	$0.0025 * L^{2.692}$	Benke et al. 1999
Megaloptera	Sialidae	Larvae	Order (Megaloptera)	$0.0037 * L^{2.838}$	Benke et al. 1999
Neuroptera		Larvae	Order (Megaloptera)	$0.0037 * L^{2.838}$	Benke et al. 1999
Ostracoda			Order (Amphipoda)	$0.0058 * L^{3.015}$	Benke et al. 1999
Plecoptera		Adult	Order (Plecoptera)	$0.0094 * L^{2.754}$	Benke et al. 1999
Plecoptera	Chloroperlidae	Larvae	Family (Chloroperlidae)	$0.0065 * L^{2.724}$	Benke et al. 1999
Plecoptera		Larvae	Order (Plecoptera)	$0.0094 * L^{2.754}$	Benke et al. 1999
Plecoptera	Nemouridae	Larvae	Family (Nemouridae)	$0.0056 * L^{2.762}$	Benke et al. 1999
Plecoptera	Peltoperlidae	Larvae	Family (Peltoperlidae)	$0.0170 * L^{2.737}$	Benke et al. 1999
Plecoptera	Perlidae	Larvae	Family (Perlidae)	$0.0099 * L^{2.879}$	Benke et al. 1999
Plecoptera	Perlodidae	Larvae	Family (Perlodidae)	$0.0196 * L^{2.742}$	Benke et al. 1999
Plecoptera	Pteronarcyidae	Larvae	Family (Pteronarcyidae)	$0.0324 * L^{2.573}$	Benke et al. 1999
Scorpaeniformes	Cottidae	Juvenile	Species (<i>Cottus perplexus</i>)	$0.0026 * L^{3.0234}$	This study
Thysanoptera		Adult	Order (Diptera)	$0.0025 * L^{2.692}$	Benke et al. 1999

Trichoptera	Calamoceratidae	Larvae	Family (Calamoceratidae)	$0.0056 * L^{2.839}$	Benke et al. 1999
Trichoptera	Glossosomatidae	Larvae	Family (Glossosomatidae)	$0.0082 * L^{2.958}$	Benke et al. 1999
Trichoptera	Hydropsychidae	Larvae	Family (Hydropsychidae)	$0.0046 * L^{2.926}$	Benke et al. 1999
Trichoptera		Larvae	Order (Trichoptera)	$0.0056 * L^{2.839}$	Benke et al. 1999
Trichoptera	Lepidostomatidae	Larvae	Family (Lepidostomatidae)	$0.0079 * L^{2.649}$	Benke et al. 1999
Trichoptera	Polycentropodidae	Larvae	Family (Polycentropodidae)	$0.0047 * L^{2.705}$	Benke et al. 1999
Trichoptera	Rhyacophilidae	Larvae	Family (Rhyacophilidae)	$0.0099 * L^{2.48}$	Benke et al. 1999

Table S4. Sample sizes and body length information for ten prey types that were fed to reticulate sculpin in laboratory feeding trials. Lengths are presented in millimeters. Multiple families of insect were included within some orders as follows: mayflies (Ameletidae, Baetidae, Heptageniidae, Leptophlebiidae), caddisflies (Calamoceratidae, Glossosomatidae, Hydropsychidae, Rhyacophilidae), stoneflies (Perlidae, Perlodidae, Nemouridae, Chloroperlidae), flies (Chironomidae, Simuliidae, Athericidae, Ceratopogonidae, Tipulidae), worms (Lumbriculidae), beetles (Elmidae), eggs (*Cottus perplexus*), sculpin (*Cottus perplexus*), crayfish (*Pacifascatus leniusculus*), and snails (*Juga plicifera*).

Prey Identity	Sample Size	Min Length	Max Length	Mean Length (SD)
Mayflies	141	0.5	9.0	5.35 (1.59)
Caddisflies	116	2.0	15.0	5.75 (2.46)
Stoneflies	106	2.0	22.0	8.2 (3.20)
Flies	148	2.0	26.0	6.06 (4.07)
Worms	74	4.0	52.0	25.4 (8.27)
Beetles	51	1.5	4.0	2.87 (0.66)
Eggs	57	3.0	3.0	3.0 (NA)
Sculpin	33	8.0	31.0	14.12 (4.43)
Crayfish	66	10.0	15.0	12.1 (0.58)
Snails	86	3.0	15.0	4.7 (1.5)

Table S5. Mean abiotic variables at the nine stream reaches. Stream discharge is in cubic meters per second. The cobble rating is a relative estimate of stream embeddedness ranging from 1 (highly embedded with a small cobble size) to 5 (minimally embedded with a large cobble size).

Site	Mean Width (m)	Mean Temp (°C)	Discharge (CMS)	Mean Canopy Cover (%)	Mean Cobble Rating
Berry Reach 1	1.92	14.17	0.005	92	1.3
Berry Reach 2	1.78	15.07	0.006	97	4.0
Berry Reach 3	1.42	15.01	0.012	83	4.6
Oak Reach 1	2.10	16.43	0.010	100	4.5
Oak Reach 2	2.62	17.36	0.013	99	3.8
Oak Reach 3	2.29	12.99	0.010	97	4.0
Soap Reach 1	2.47	16.54	0.007	95	5.0
Soap Reach 2	2.66	15.84	0.011	97	3.4
Soap Reach 3	3.55	13.72	0.016	97	4.2

Table S6. Intercepts, covariate coefficients (prey length, predator length, temperature), shape parameters, and mean prey identification times for different prey taxa fed to reticulate sculpin in the laboratory. The values below correspond to Weibull survival functions that were fit to the observed prey statuses (identifiable or not). Sculpin egg size, crayfish size, and temperature for annelid worms did not exhibit sufficient variation to be retained in the models. Sculpin are omitted as a prey item because the survival models did not converge.

Prey Identity	Intercept	Prey Length	Predator Length	Temp	Shape Parameter (α)	Mean ID Time
Mayflies	2.307	0.147	-0.011	-0.042	3.458	5.886
Caddisflies	3.914	0.150	-0.004	-0.112	2.751	15.676
Stoneflies	4.016	0.177	-0.026	-0.103	3.644	11.336
Flies	3.667	0.030	-0.016	-0.038	1.512	10.286
Worms	-0.861	0.077	-0.027	-	0.719	0.851
Beetles	1.872	-0.022	0.018	-0.018	1.730	8.410
Eggs	3.891	-	-0.006	-0.093	5.796	9.613
Crayfish	5.548	-	-0.011	-0.094	3.857	29.609
Snails	5.269	-0.014	-0.002	-0.057	2.331	56.225

Table S7. Generalized additive mixed model results from a dataset omitting prey orders that contained less than five feeding rates. Models used for this analysis were the same as those described in the main text.

Model	Log Likelihood	AIC	Δ AIC	GCV	Adjusted R^2
Full Model	-284.6	610.5	0.0	1.168	0.606
Full Model Without PC1	-285.1	609.9	-0.7	1.163	0.606
Full Model Without Predator Density	-284.0	611.4	0.9	1.174	0.606
Full Model Without Mass Ratios	-292.6	619.5	8.9	1.216	0.582
Full Model Without Prey Order	-312.6	661.3	50.7	1.494	0.489
Full Model Without Prey Density	-336.4	705.2	94.7	1.850	0.360
Intercept Only Model	-417.1	841.6	231.1	2.708	0.010

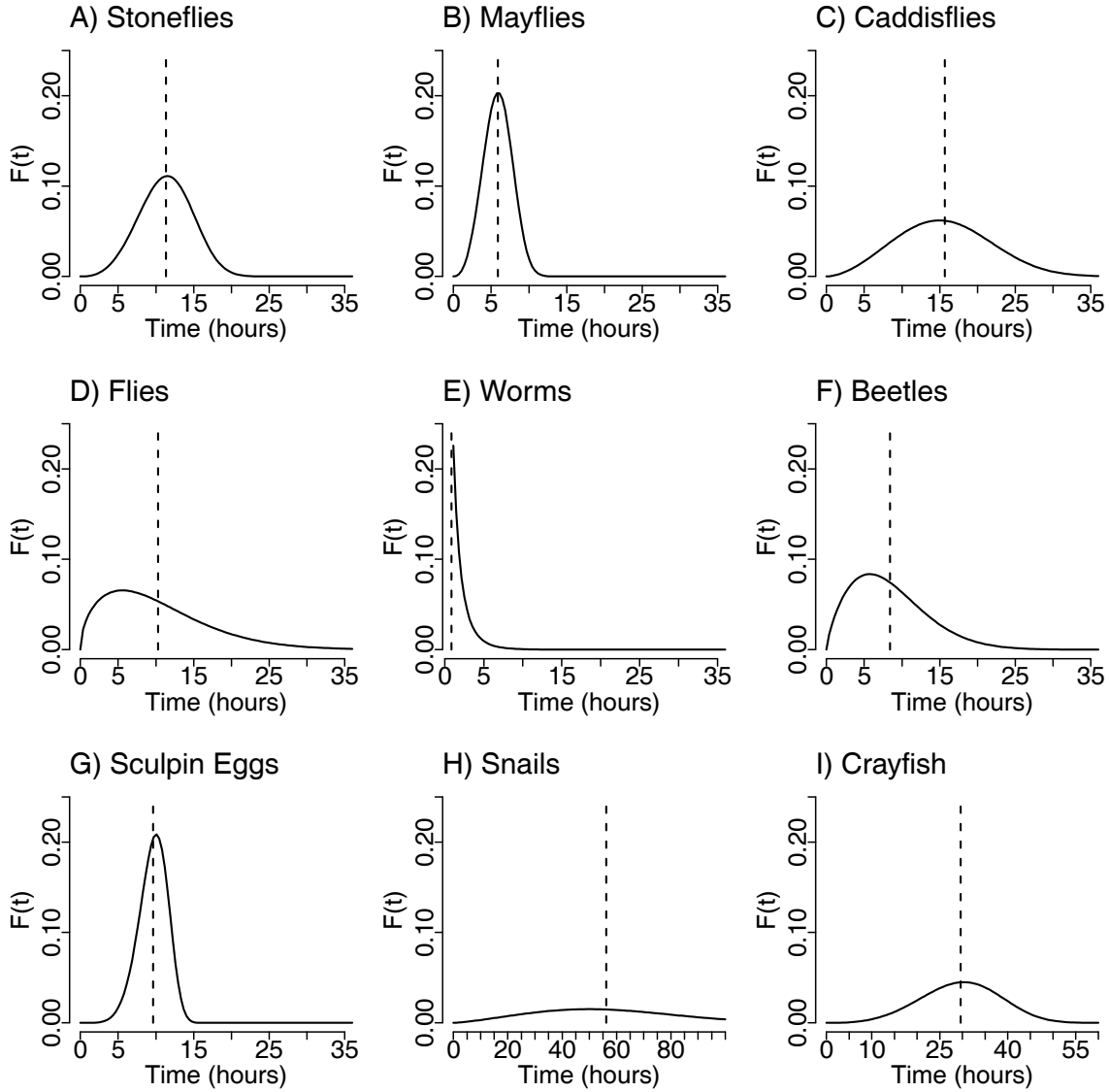


Figure S1. Probability density functions for prey identification times of nine prey taxa that were fed to sculpin in the laboratory. All functions correspond to Weibull models with mean mean values of covariates (prey size, predator size, and water temperature) within a prey group. The dashed vertical lines indicate the mean of the probability density functions, which corresponds to the average prey identification time for each taxon in the laboratory. Sample size information is provided in Table S1.

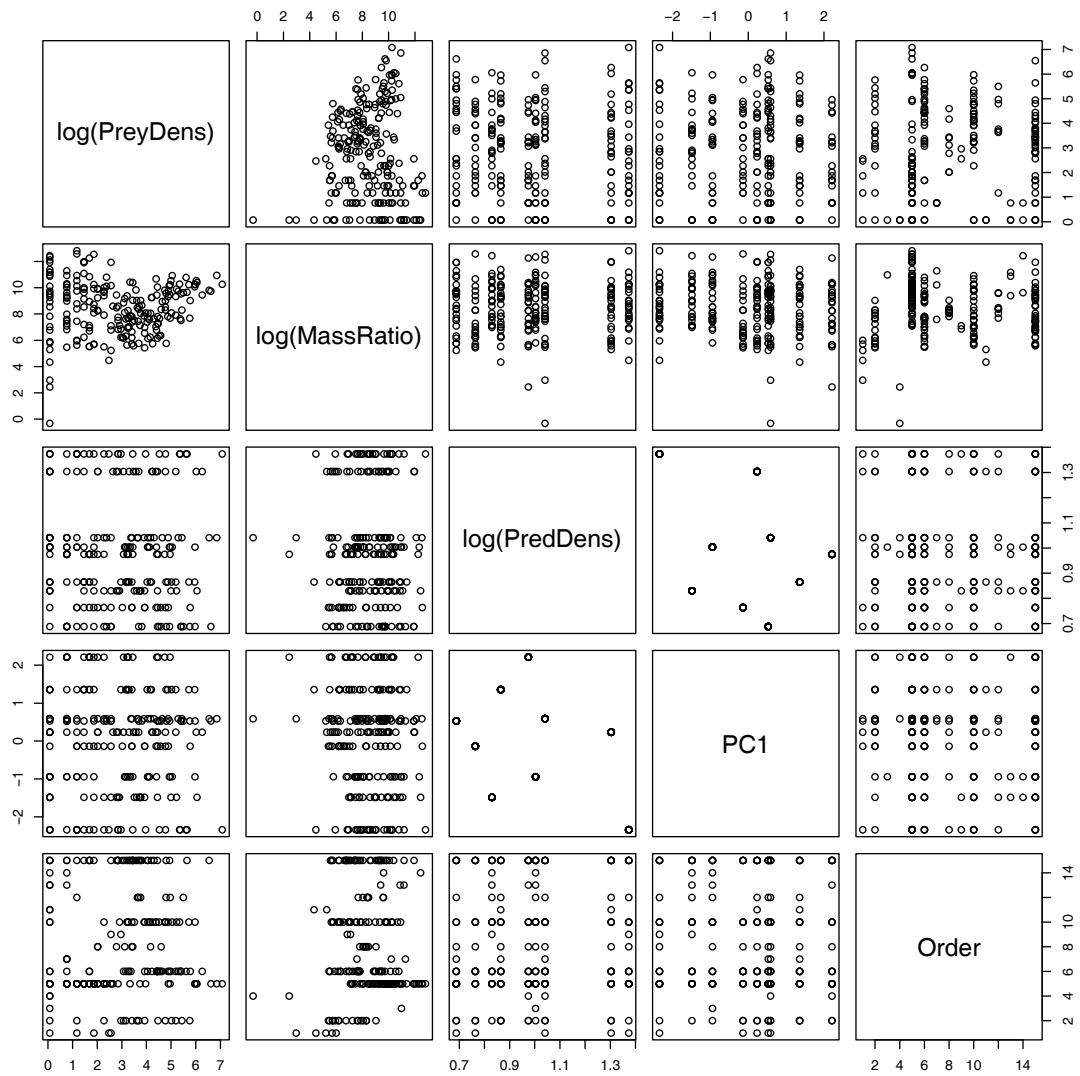


Figure S2. Correlations among predictor variables of the sculpin feeding rate model, including log-transformed prey density, log-transformed predator-prey mass ratios, predator density, the first principal component from the PCA of abiotic variables, and prey order.

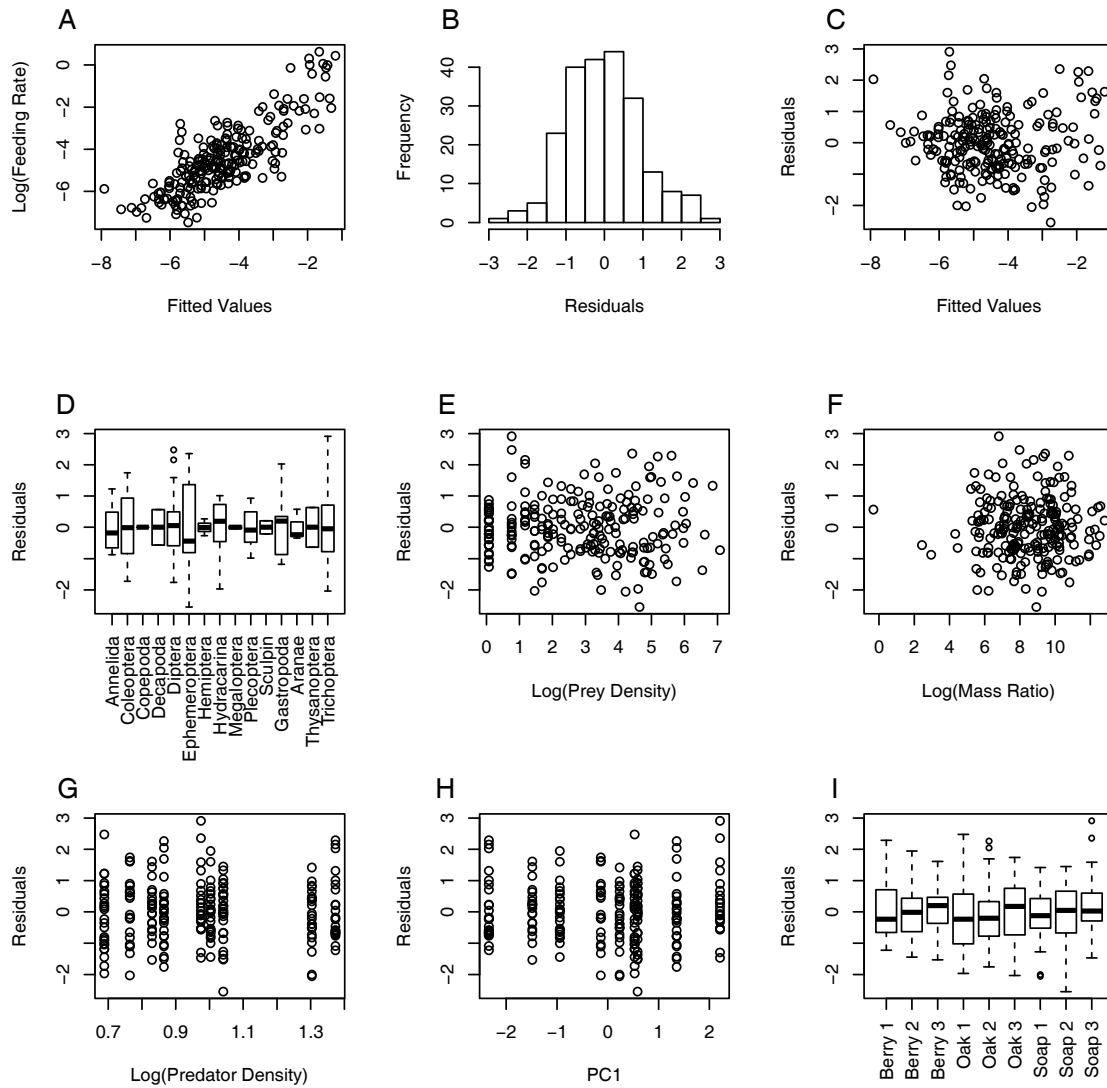


Figure S3. Model diagnostics from the generalized additive mixed model predicting sculpin feeding rates. Plots show the log-transformed feeding rates plotted against the predicted values (a), the frequency distribution of model residuals (b), the residuals plotted against the predicted values (c), the residuals plotted against each of the five predictor variables (d,e,f,g,h), and the residuals for each of the nine stream sites (i).

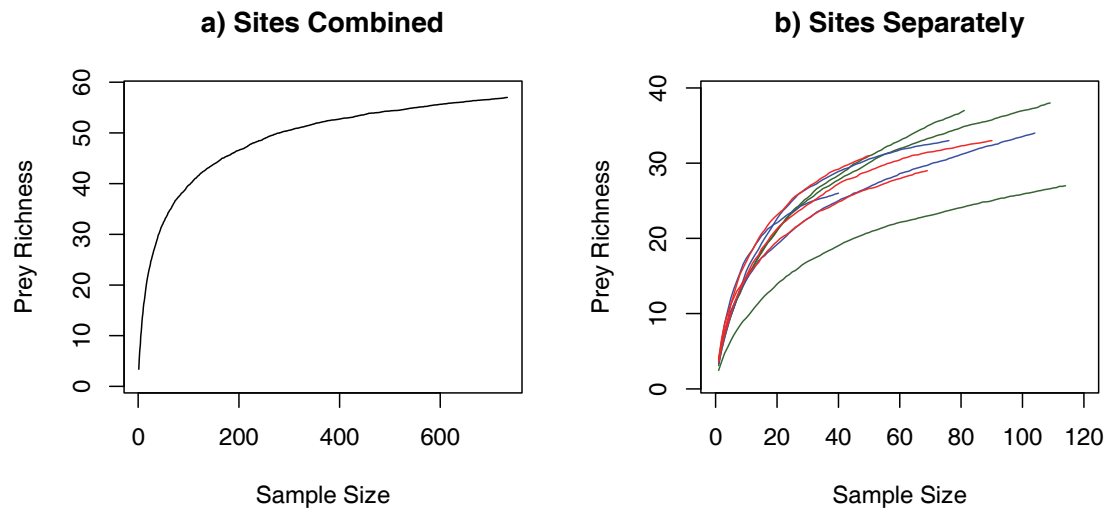


Figure S4. Species accumulation curves for all sites combined (a) and each of the nine sites separately (b). In the plot with each site separately, the three streams are color coded (red = Oak Creek , green = Soap Creek, blue = Berry Creek). The sample size (x-axis) on both figures represents the number of individual sculpin stomachs sampled.

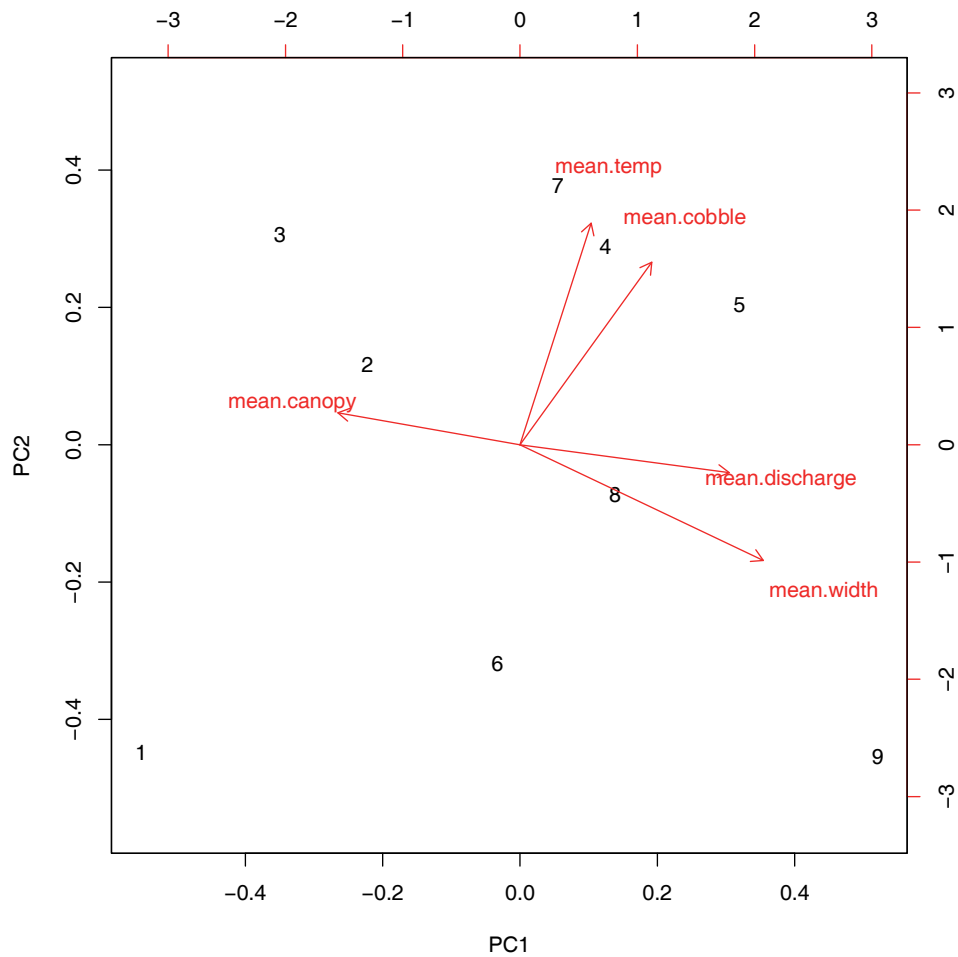


Figure S5. Biplot showing the principal components analysis on stream width, stream discharge, cobble size, water temperature, and canopy cover. The first principal component explained 40% of the variation and was used as a linear predictor in the GAMMs.

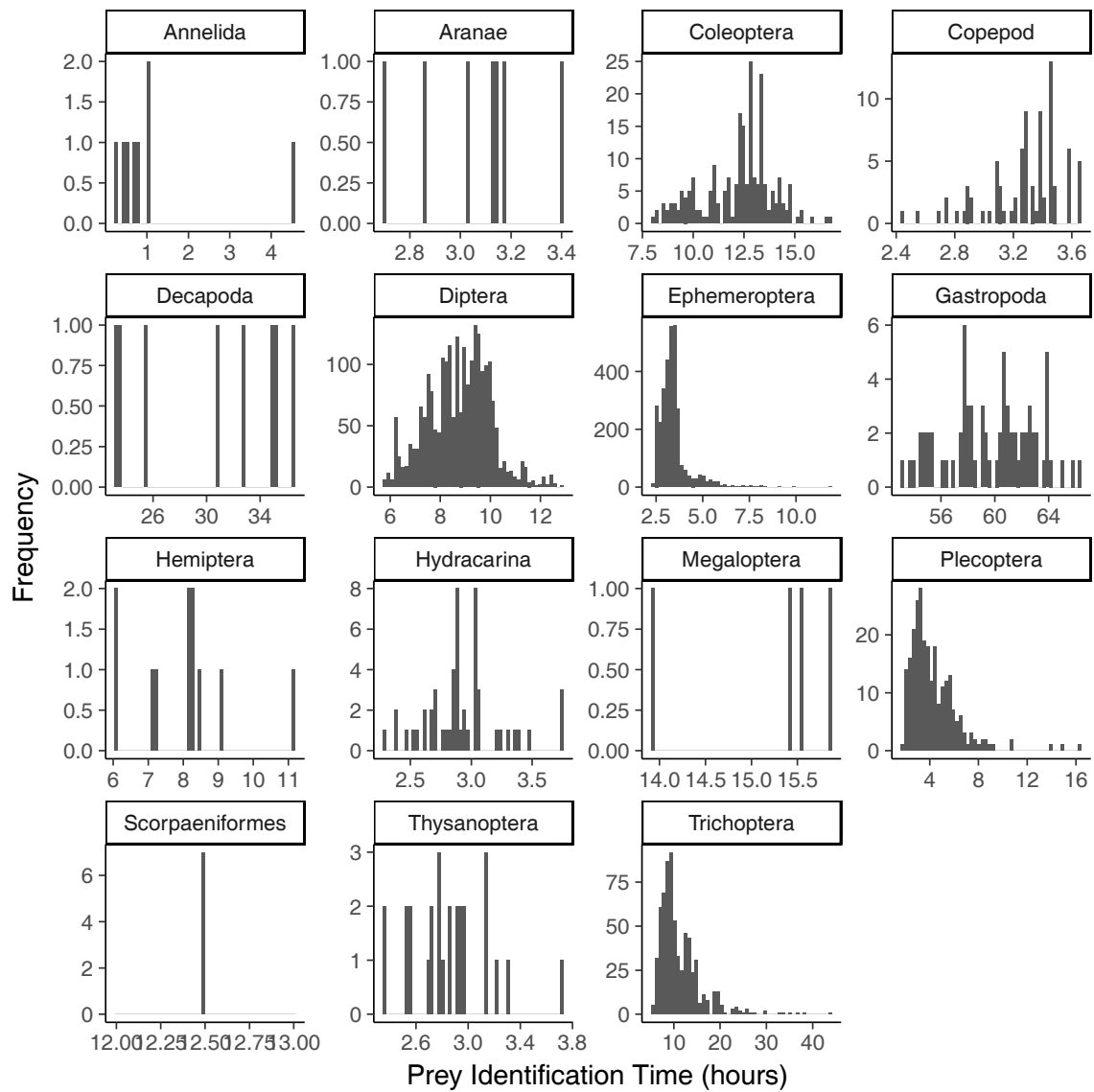


Figure S6. Estimated prey identification times for individual prey items recovered from sculpin during field surveys of nine stream sites.

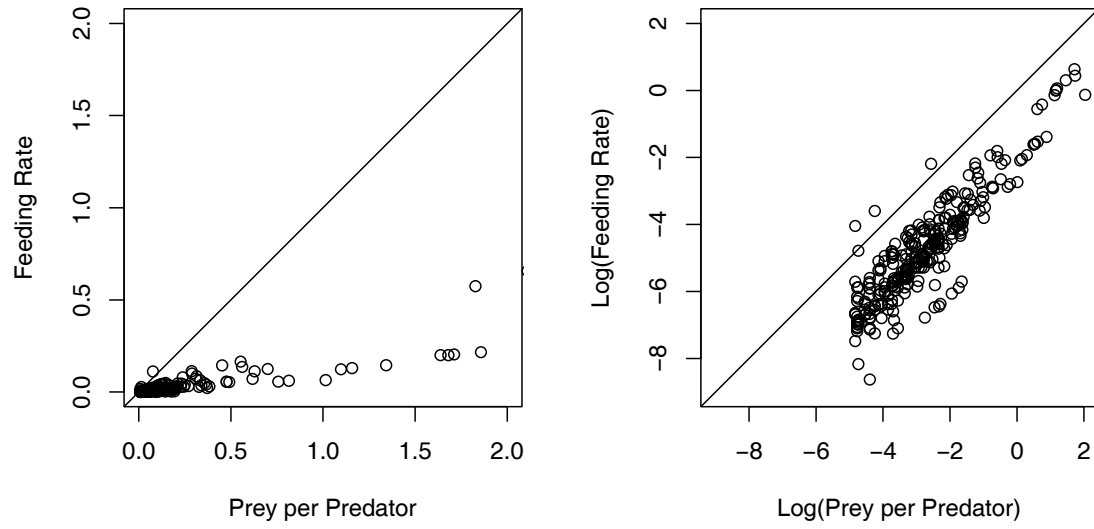


Figure S7. The relationship between feeding rates and the number of prey observed per predator. The left panel shows untransformed values and the right panel shows log-transformed values. The number of prey per predator is scaled by the prey identification times to estimate feeding rates (see eqn. 1 in the main text). The 1:1 line is shown on each panel.

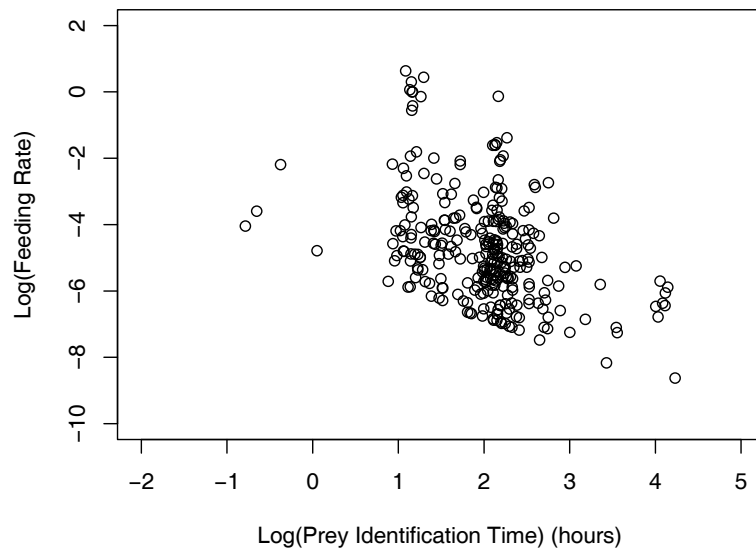


Figure S8. The relationship between log-transformed feeding rates and log-transformed prey identification times.