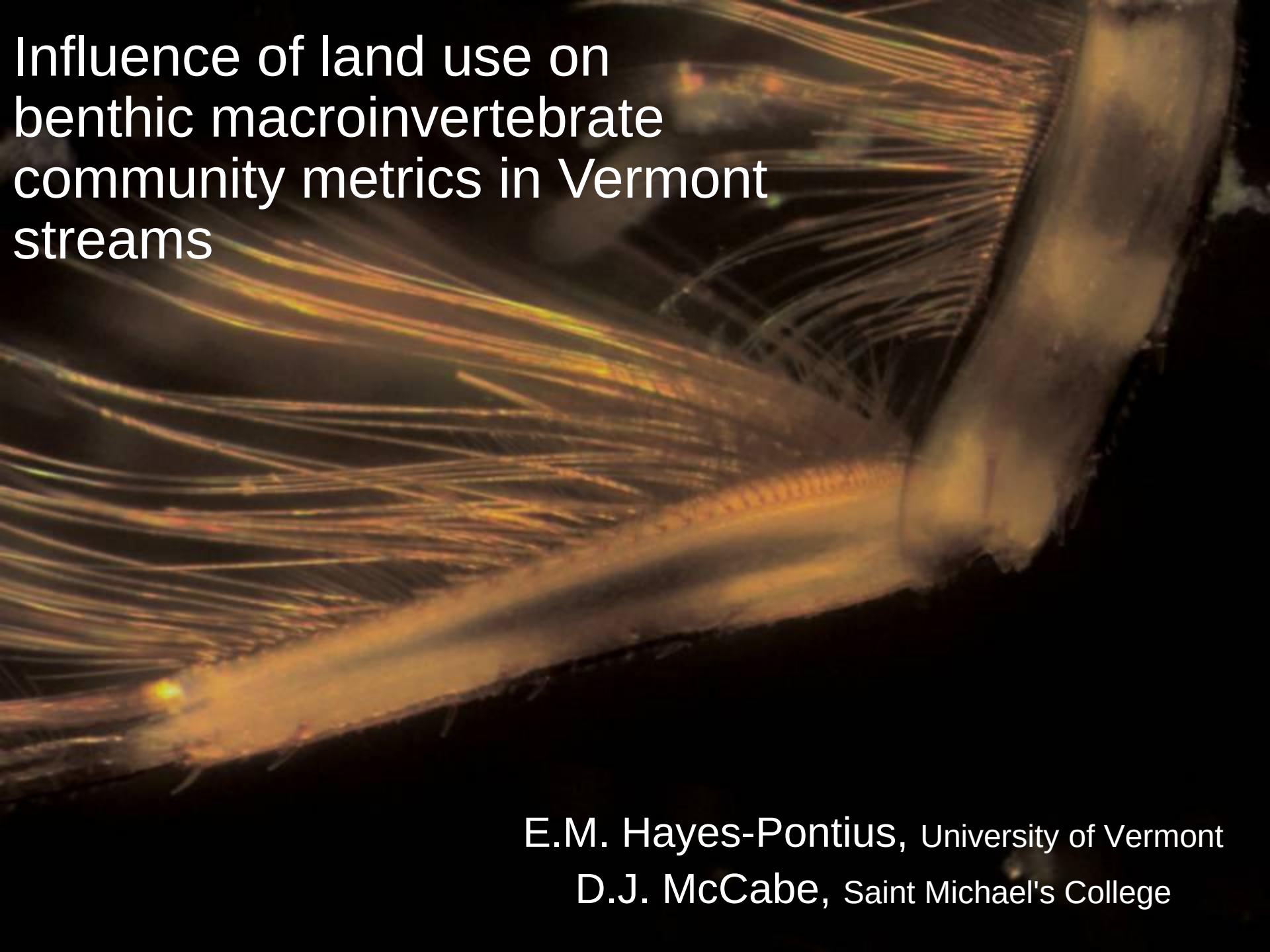




Influence of land use on benthic macroinvertebrate community metrics in Vermont streams

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Introduction

- Macroinvertebrate communities are frequently used as indicators of stream health (Merritt et al 2008).
- Agricultural landscapes load sediments, phosphorous, and nitrogen into streams (Palmer-Felgate et al. 2009).
- From the gradient of forested headwaters to agricultural areas to urban areas, abundance is expected to increase while richness and EPT richness are expected to decrease (Hepp and Santos 2009).



Image courtesy of noaa.gov

Methods- Field

- EPA RBP



Methods- Lab

- Samples rinsed through 600 micron sieve
- Sieve contents rinsed and dispersed evenly on numbered and gridded tray
- At least $\frac{1}{4}$ of randomly-selected squares and at least 80 macroinvertebrates were sub-sampled



Sample Sizes

- Urban: $n = 25$ samples from six sites
- Agricultural: $n = 20$ samples from four sites
- Forested: $n = 45$ samples from seven sites

Site Name	Urban	Urban-Open	Urban sum	Agricultural	Forest	Designation	F>A?	F>U?	A>U?
WR_MillBrk_940	0.000	0.000	0.000	0.000	0.998	Forest	TRUE	TRUE	FALSE
French Hill F	0.000	0.000	0.000	0.000	0.991	Forest	TRUE	TRUE	FALSE
WR_SlBrk_714	0.000	0.000	0.000	0.012	0.987	Forest	TRUE	TRUE	TRUE
WHR_LcstCrk_1116	0.000	0.001	0.001	0.027	0.969	Forest	TRUE	TRUE	TRUE
PSR_MRTribA_1232	0.001	0.000	0.001	0.024	0.965	Forest	TRUE	TRUE	TRUE
WR_CrstBrk_467	0.003	0.000	0.003	0.039	0.947	Forest	TRUE	TRUE	TRUE
WHR_CmpBrk_687	0.002	0.002	0.004	0.047	0.938	Forest	TRUE	TRUE	TRUE
WR_MillBrk_754	0.001	0.000	0.001	0.082	0.905	Forest	TRUE	TRUE	TRUE
Brewster-F	0.016	0.000	0.016	0.069	0.896	Forest	TRUE	TRUE	TRUE
Brewster-Jeff-IMP	0.016	0.000	0.016	0.074	0.891	Forest	TRUE	TRUE	TRUE
PSR_SWBrnch_703	0.015	0.001	0.017	0.107	0.830	Forest	TRUE	TRUE	TRUE
LCD_SktBrk_981	0.122	0.000	0.122	0.005	0.811	Forest	TRUE	TRUE	FALSE
LCD_MltsCrk_350	0.008	0.000	0.008	0.206	0.772	Forest	TRUE	TRUE	TRUE
PSR_SlpRv_746	0.017	0.001	0.018	0.200	0.756	Forest	TRUE	TRUE	TRUE
PSR_ShldBrk_649	0.012	0.000	0.012	0.195	0.753	Forest	TRUE	TRUE	TRUE
LCD_MillRiv_149	0.018	0.000	0.018	0.210	0.710	Forest	TRUE	TRUE	TRUE
LCD_SktBrk_53	0.001	0.000	0.001	0.281	0.653	Forest	TRUE	TRUE	TRUE
Mill-AG	0.022	.000	0.022	0.326	0.628	Forest	TRUE	TRUE	TRUE
Mill-IMP	0.024	0.000	0.024	0.329	0.627	Forest	TRUE	TRUE	TRUE
LR_MillBrk_343	0.027	0.001	0.028	0.332	0.625	Forest	TRUE	TRUE	TRUE
LCD_MillRiv_142	0.097	0.000	0.097	0.226	0.582	Forest	TRUE	TRUE	TRUE
LCD_SABTrib_48	0.070	0.000	0.070	0.338	0.563	Forest	TRUE	TRUE	TRUE
MR_HngldBrk_307	0.037	0.000	0.037	0.381	0.563	Forest	TRUE	TRUE	TRUE
LCD_IndBrk_318	0.150	0.051	0.201	0.199	0.553	Forest	TRUE	TRUE	FALSE
LCD_SktBrk_154	0.278	0.000	0.278	0.049	0.469	Forest	TRUE	TRUE	FALSE
WR_AllnBrk_361	0.059	0.042	0.101	0.398	0.445	Forest	TRUE	TRUE	TRUE
LCD_SktBrk_118	0.285	0.000	0.285	0.115	0.417	Forest	TRUE	TRUE	FALSE
LCD_SktBrk_117	0.306	0.000	0.306	0.110	0.397	Forest	TRUE	TRUE	FALSE
LCD_RugBrk_139	0.186	0.000	0.186	0.358	0.389	Forest	TRUE	TRUE	TRUE
LCD_SktBrk_132	0.316	0.000	0.316	0.107	0.387	Forest	TRUE	TRUE	FALSE
LCD_RugBrk_119	0.241	0.000	0.241	0.340	0.327	Agricultural	FALSE	TRUE	TRUE
LCD_SktBrk_137	0.443	0.000	0.443	0.079	0.314	Urban	TRUE	FALSE	FALSE
WR_CeBrk_259	0.511	0.000	0.511	0.009	0.313	Urban	TRUE	FALSE	FALSE
LCD_RugBrk_157	0.045	0.000	0.045	0.625	0.306	Agricultural	FALSE	TRUE	TRUE
LCD_RugBrk_142	0.274	0.000	0.274	0.312	0.297	Agricultural	FALSE	TRUE	TRUE
LCD_SktBrk_59	0.326	0.000	0.326	0.264	0.250	Urban	FALSE	FALSE	FALSE
TI-4	0.029	0.000	0.029	0.611	0.250	Agricultural	FALSE	TRUE	TRUE
LCD_BrtltBrk_124	0.342	0.106	0.448	0.301	0.241	Urban	FALSE	FALSE	FALSE
M-4	0.015	0.000	0.015	0.615	0.198	Agricultural	FALSE	TRUE	TRUE
LR_TribA_374	0.538	0.201	0.739	0.007	0.195	Urban	TRUE	FALSE	FALSE
LCD_PoBrk_133	0.382	0.000	0.382	0.235	0.183	Urban	FALSE	FALSE	FALSE
LCD_EngBrk_117	0.479	0.291	0.770	0.047	0.180	Urban	TRUE	FALSE	FALSE

Site Selection

Site Name	Urban	Agricultural	Forest	Designation	F>A?	F>U?	A>U?
LCD_EngBrk_117	0.770	0.047	0.180	Urban	-	FALSE	FALSE
WR_CeBrk_259	0.511	0.009	0.313	Urban	-	FALSE	FALSE
LCD_BrtltBrk_124	0.448	0.301	0.241	Urban	-	FALSE	FALSE
LCD_StvBrk_137	0.443	0.079	0.314	Urban	-	FALSE	FALSE
LCD_PoBrk_133	0.382	0.235	0.183	Urban	-	FALSE	FALSE
LCD_StvBrk_59	0.326	0.264	0.250	Urban	-	FALSE	FALSE
LCD_RugBrk_157	0.045	0.625	0.306	Agricultural	FALSE	-	TRUE
M-4	0.015	0.615	0.198	Agricultural	FALSE	-	TRUE
TI-4	0.029	0.611	0.250	Agricultural	FALSE	-	TRUE
LCD_RugBrk_119	0.241	0.340	0.327	Agricultural	FALSE	-	TRUE
WR_MillBrk_940	0.000	0.000	0.998	Forest	TRUE	TRUE	-
French Hill F	0.000	0.000	0.991	Forest	TRUE	TRUE	-
WR_SlBrk_714	0.000	0.012	0.987	Forest	TRUE	TRUE	-
WhR_LcstCrk_1116	0.001	0.027	0.969	Forest	TRUE	TRUE	-
PSR_MRtribA_1232	0.001	0.024	0.965	Forest	TRUE	TRUE	-
WR_CrstBrk_467	0.003	0.039	0.947	Forest	TRUE	TRUE	-
WhR_CmpBrk_687	0.004	0.047	0.938	Forest	TRUE	TRUE	-

Metrics Chosen

- Composition Measures
 - % EPT
 - % *Hydropsychidae*
 - % *Hydropsychidae* of Trichoptera
 - % Diptera
 - % *Chironomidae*
 - % Dominant Taxon
 - % Top Two Dominant Taxa
 - % Top Three Dominant Taxa
- Richness Measures
 - EPT
 - Overall
- Evenness
 - Probability of Interspecific Encounter

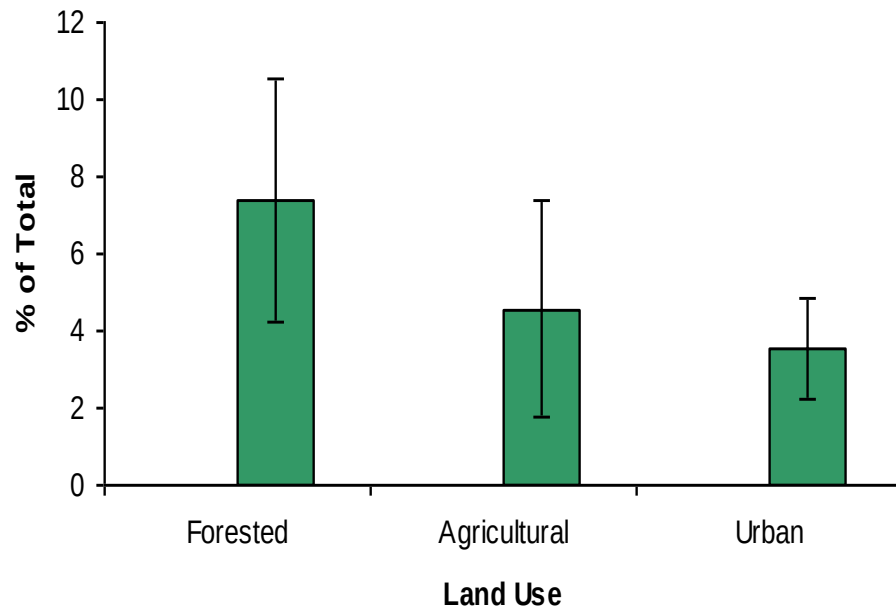
Hydropsychidae



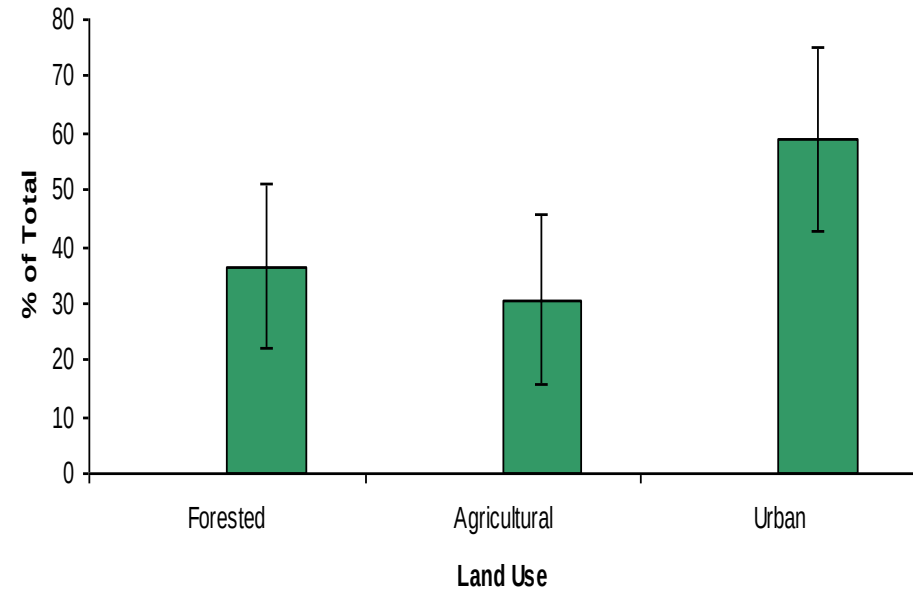
- Tolerant of pollution
- Filter feeders
- Thrive on particles in streams
- Agricultural and urban land uses load particles

Results: *Hydropsychidae*

% *Hydropsychidae*

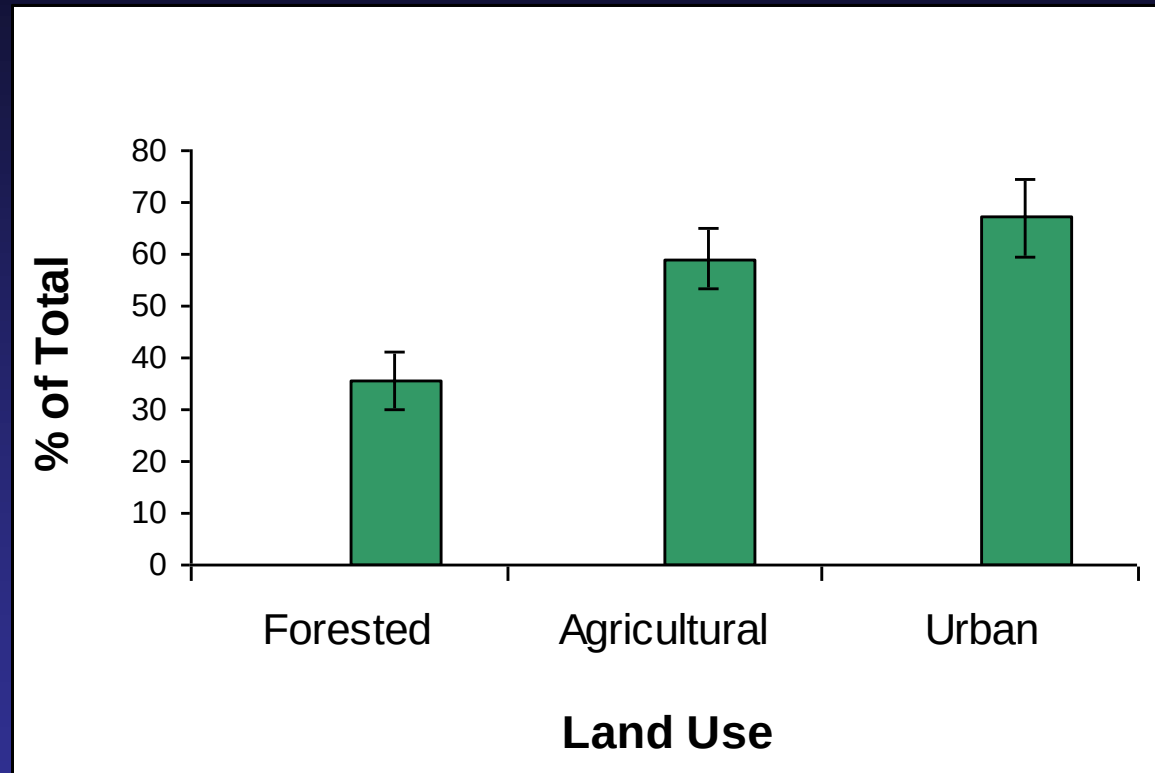


% *Hydropsychidae* of Trichoptera



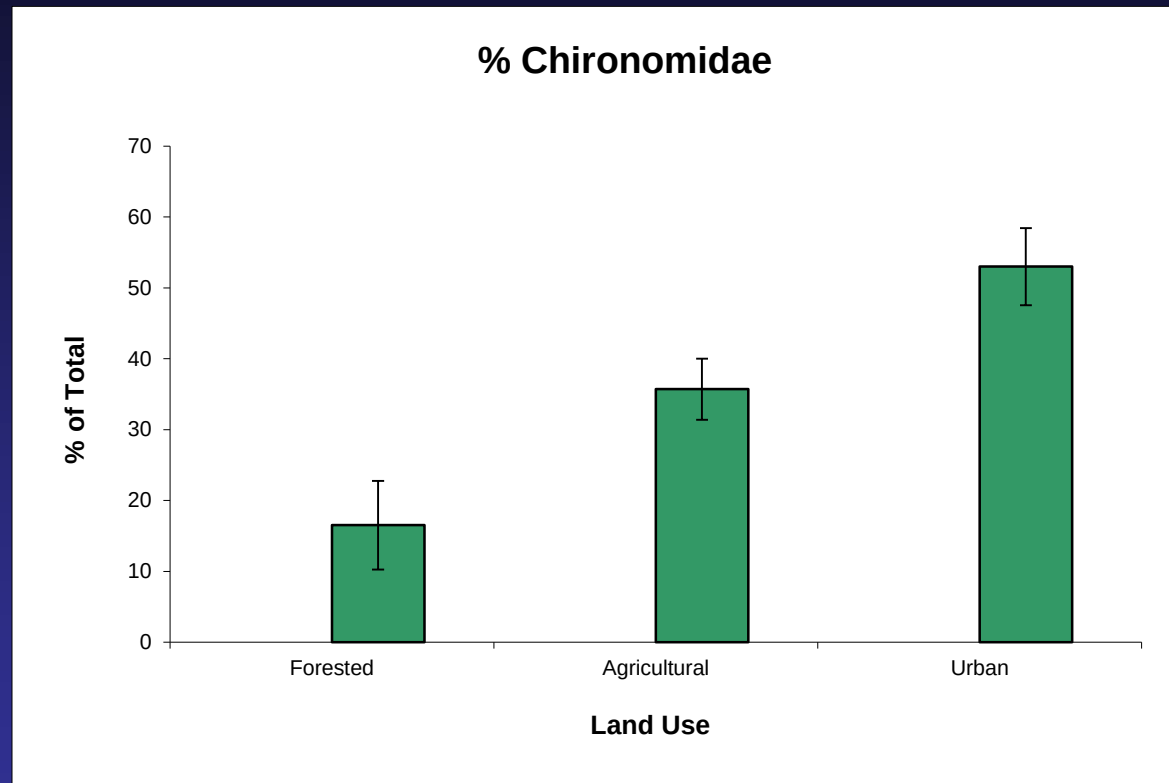
All differences were non-significant ($p > 0.05$)

Results: Percent Diptera



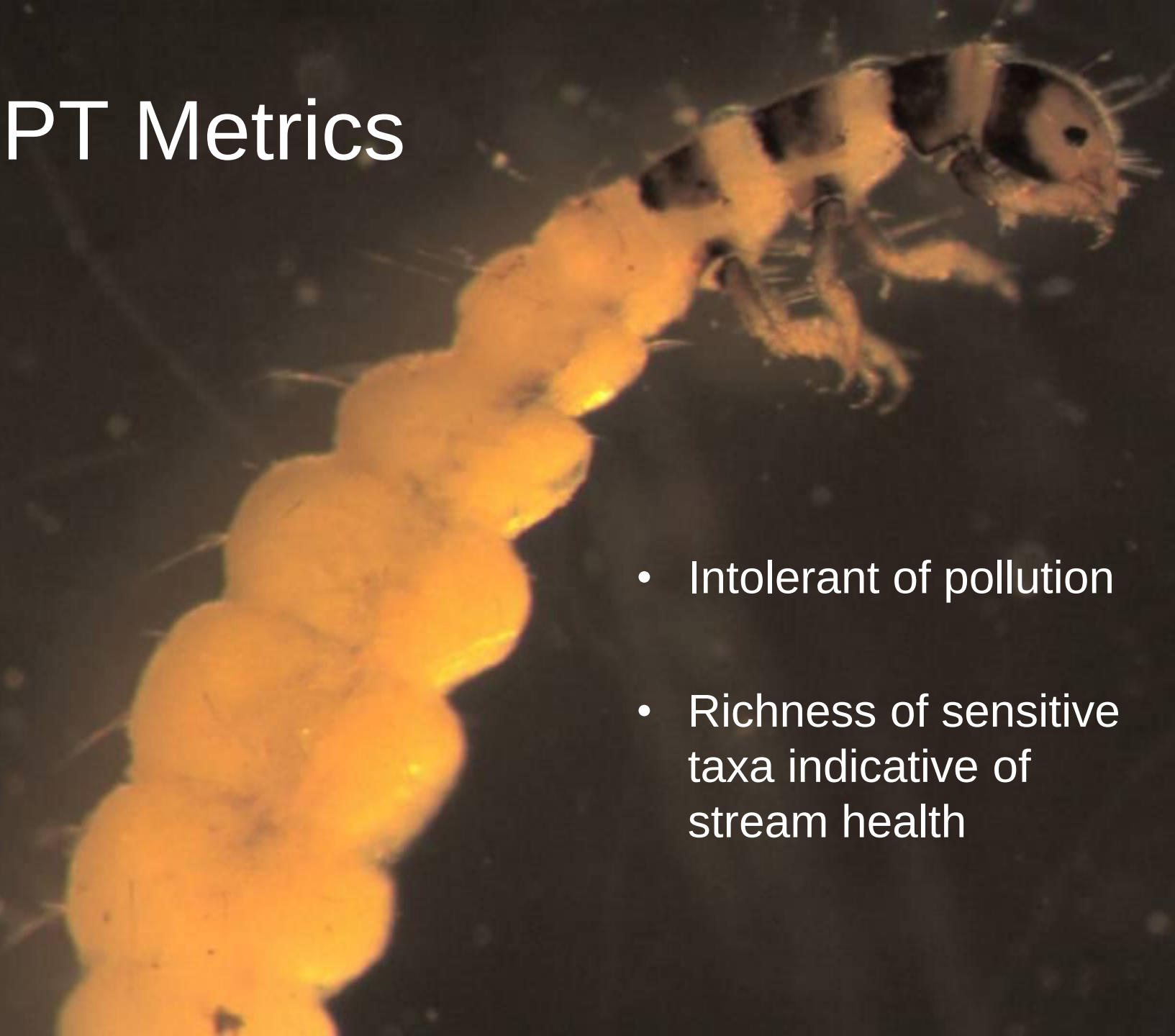
Samples from forested streams had a significantly lower percentage of Dipterans comprising their samples ($p < 0.05$)

Results- Percent *Chironomidae*



Samples from forested streams had a significantly lower percentage of *Chironomidae* comprising their samples ($p < 0.05$)

EPT Metrics

- 
- Intolerant of pollution
 - Richness of sensitive taxa indicative of stream health



Ephemeroptera

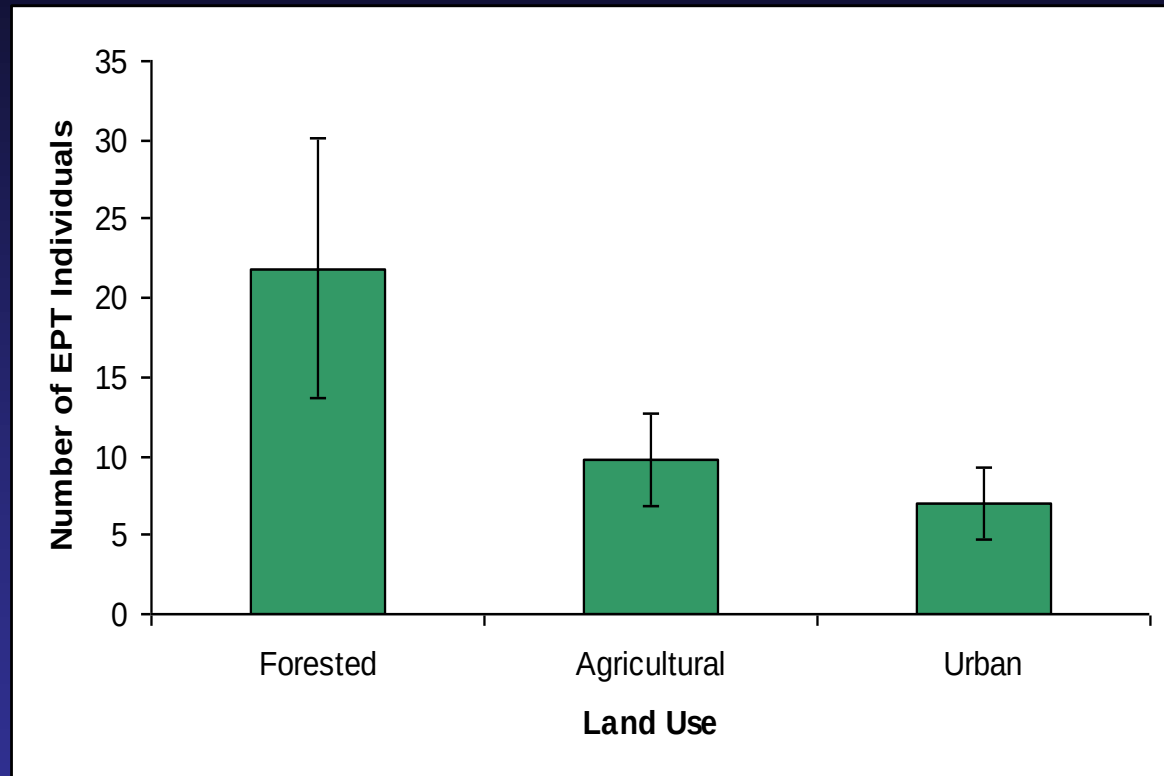


Plecoptera



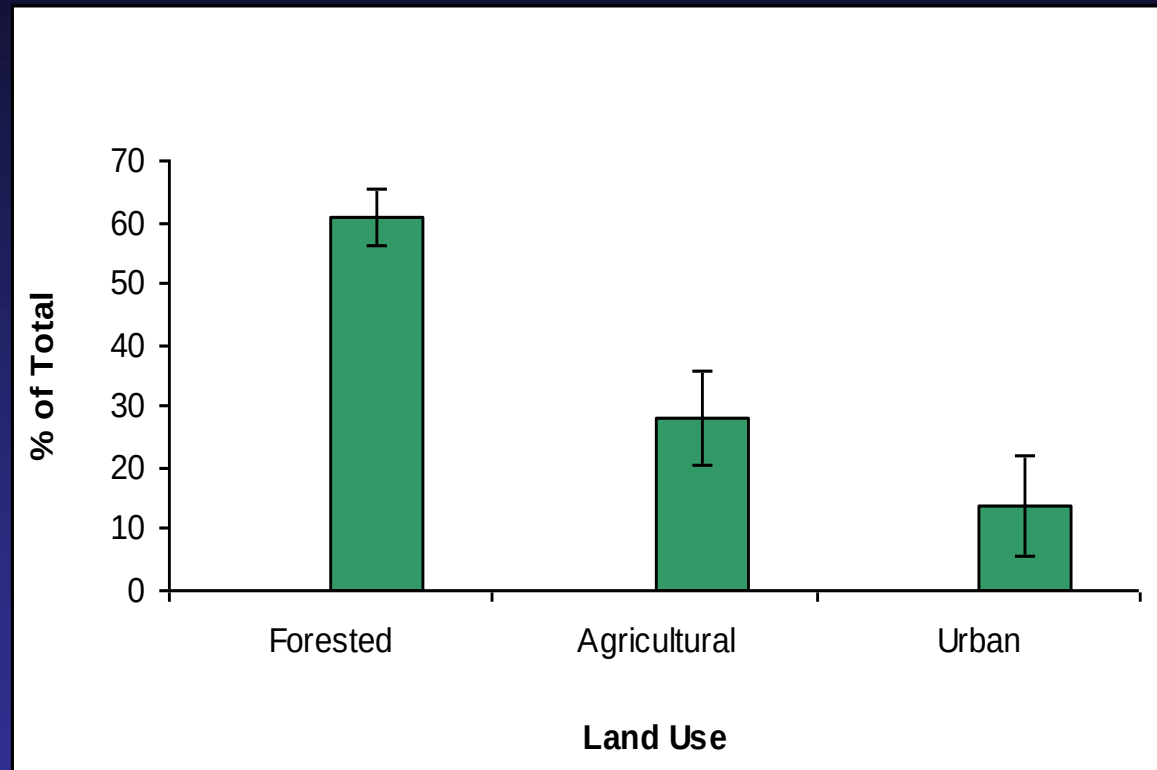
Trichoptera

Results- EPT Richness



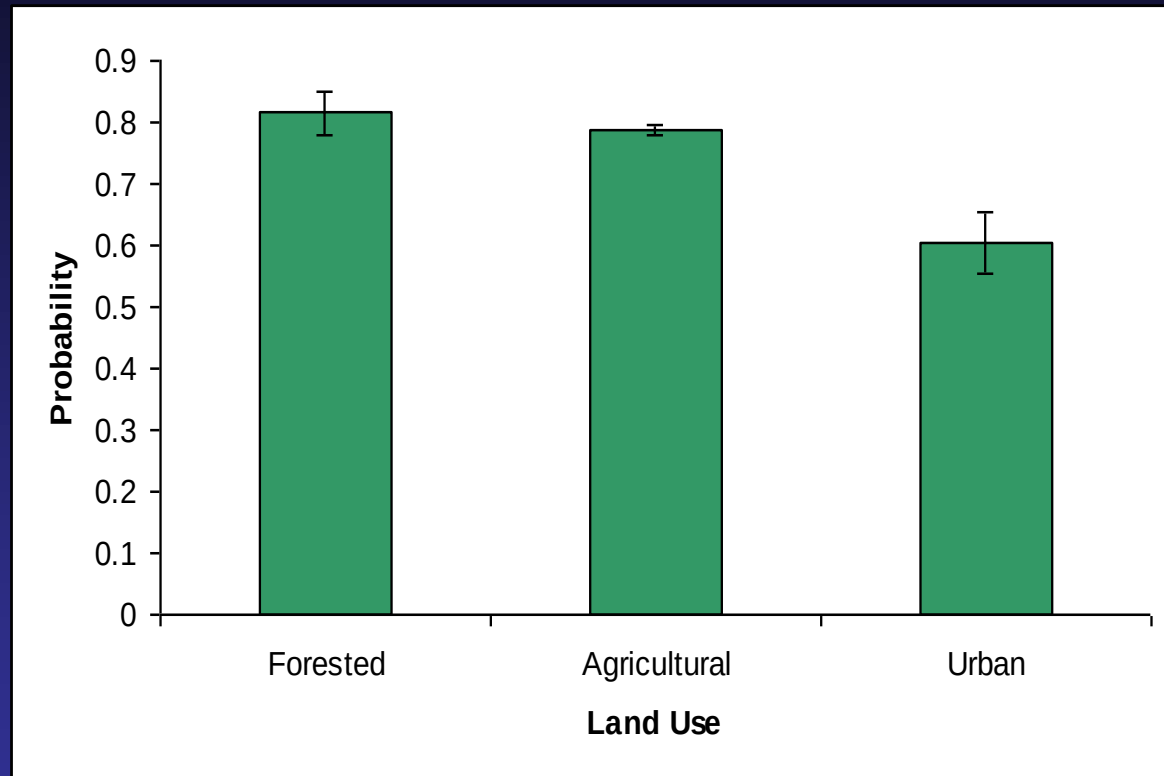
No statistically significant difference among any of the land usages. ($P > 0.05$)

Results- Percent EPT



Forested sites had a significantly higher percentage of EPT than agricultural or urban sites ($p < 0.05$)

Results- Evenness

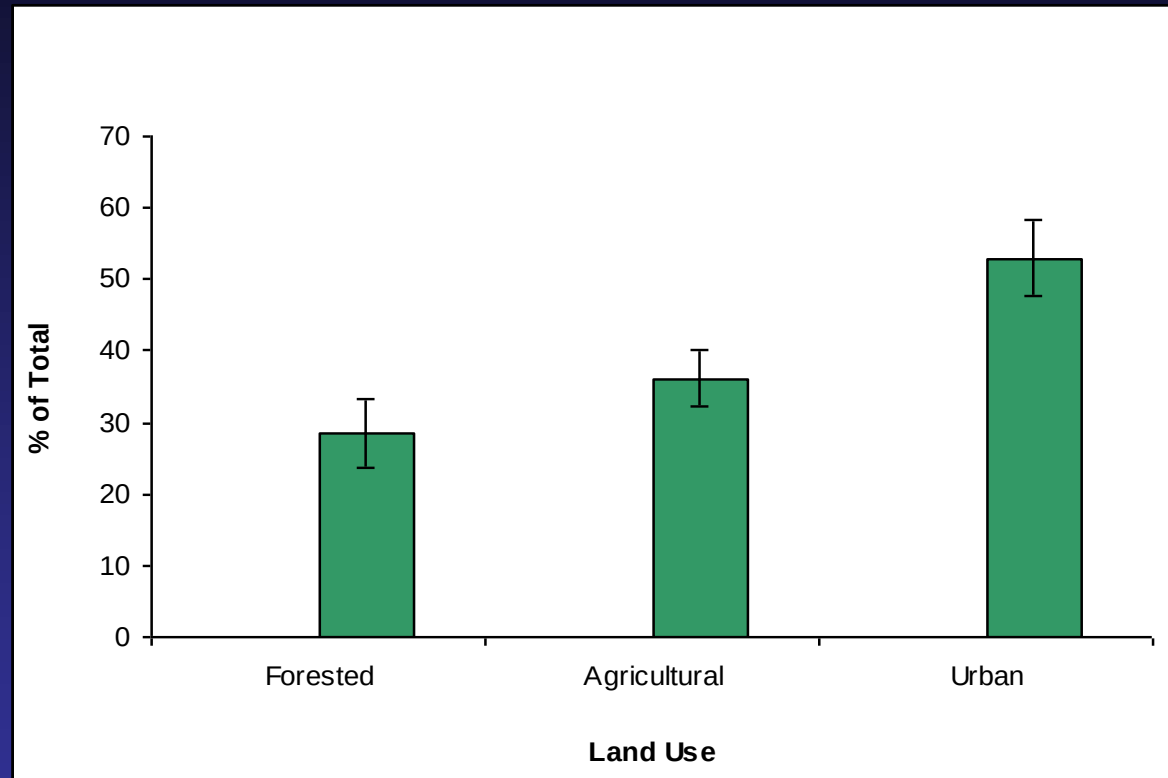


Urban sites had a significantly lower probability of interspecific encounter (PIE) than agricultural or forested sites. ($p < 0.05$)

Dominant Taxon/Taxa Determination

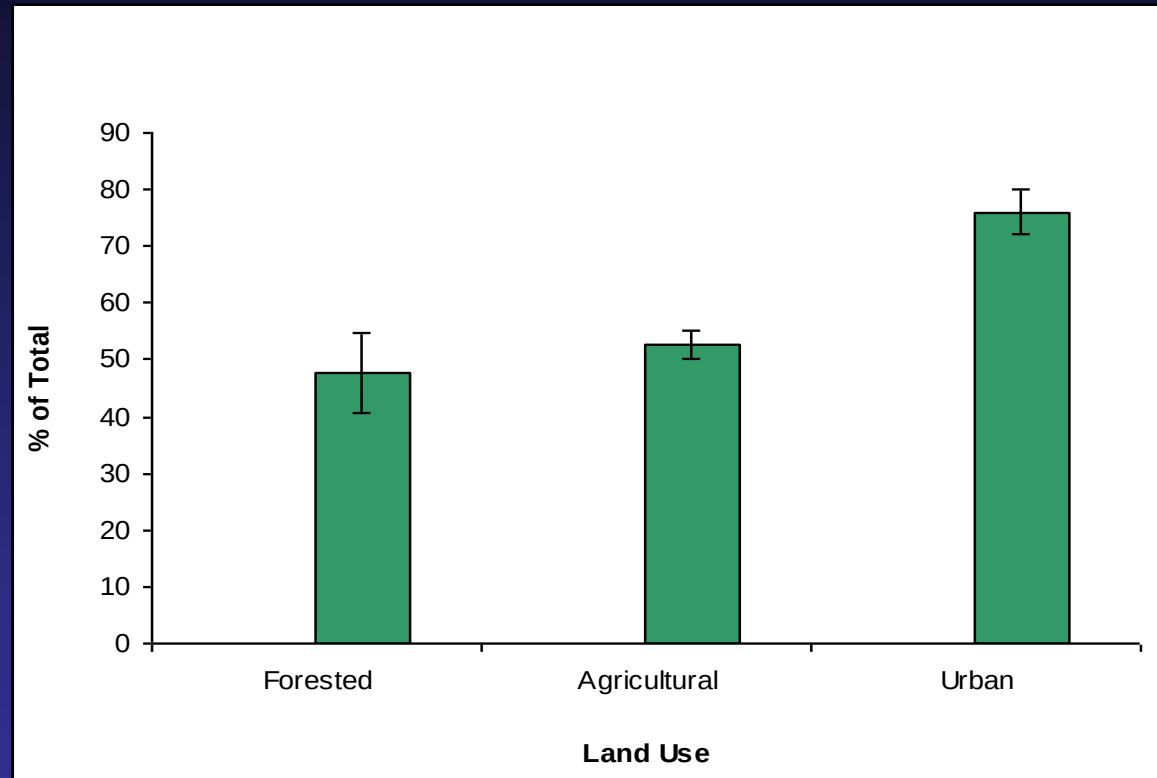
Phylum	Class	Order	Family	Genus	SUMS
Arthropoda	Insecta	Diptera	Chironomidae		155
Arthropoda	Branchiopoda	Cladocera			106
Arthropoda	Insecta	Diptera	Simuliidae		42
Arthropoda	Malacostraca	Amphipoda	Gammaridae		28
Arthropoda	Malacostraca	Isopoda	Asellidae		9
Annelida	Oligochaeta				8
Arthropoda	Insecta	Coleoptera	Elmidae	Stenelmis	8
Arthropoda	Insecta	Diptera	Tipulidae	Dicronata	4
Arthropoda	Insecta	Lepidoptera	Pyalidae		4
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	4
Arthropoda	Insecta	Coleoptera	Elmidae	Optioservus	2
Arthropoda	Insecta	Diptera	PUPAE		2
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Ceratopsyche	2
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	2
Arthropoda	Malacostraca	Amphipoda	Hyalellidae		2
Mollusca	Gastropoda	Pulmonata	Physidae		2
Arthropoda	Insecta	Diptera	Dolichopodidae		1
Arthropoda	Insecta	Diptera	Tipulidae		1
Arthropoda	Insecta	Diptera	Tipulidae	Antocha	1
Arthropoda	Insecta	Ephemeroptera			1
Arthropoda	Insecta	Hemiptera	Notonectidae		1
Arthropoda	Insecta	Hemiptera	Veliidae	Microvelia	1
Arthropoda	Insecta	Odonata	Gomphidae		1
Arthropoda	Insecta	PUPAE			1
Arthropoda	Insecta	Trichoptera	Hydroptilidae	Hydroptila	1

Results- Dominant Taxon



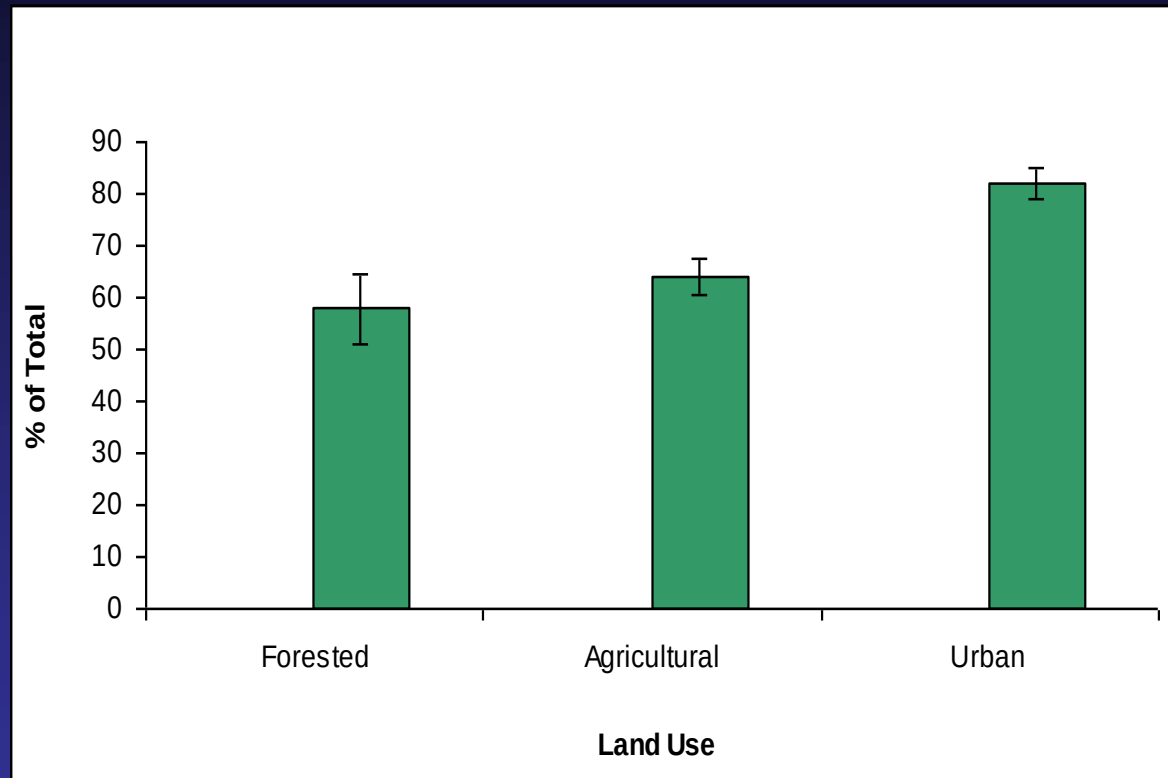
The dominant taxon at forested sites comprised a significantly lower percentage of samples than at urban sites. ($p < 0.05$)

Results- Top Two Dominant Taxa



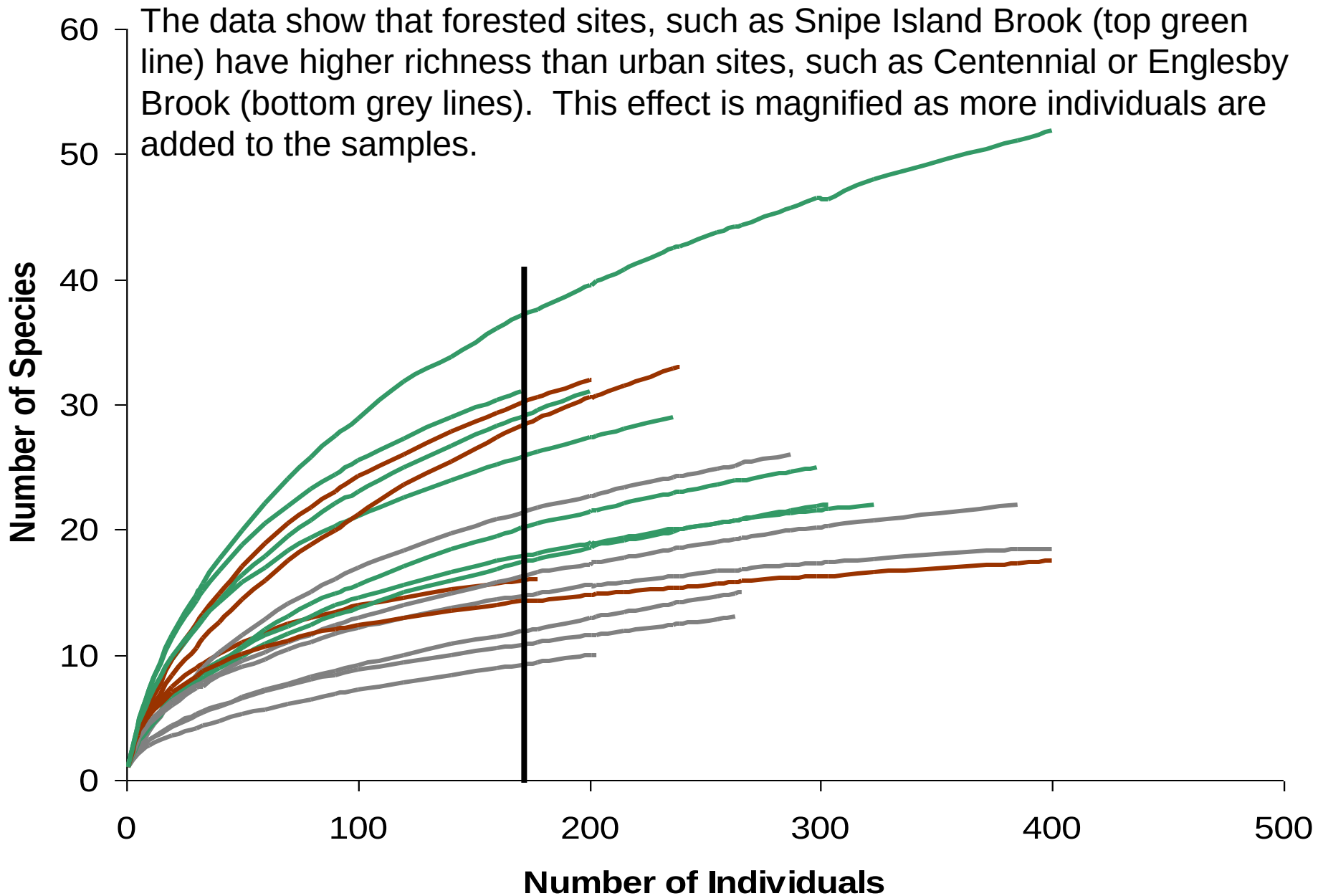
The two dominant taxa at urban sites comprised a significantly higher percentage of samples than at agricultural or forested sites. ($p < 0.05$)

Results- Top Three Dominant Taxa

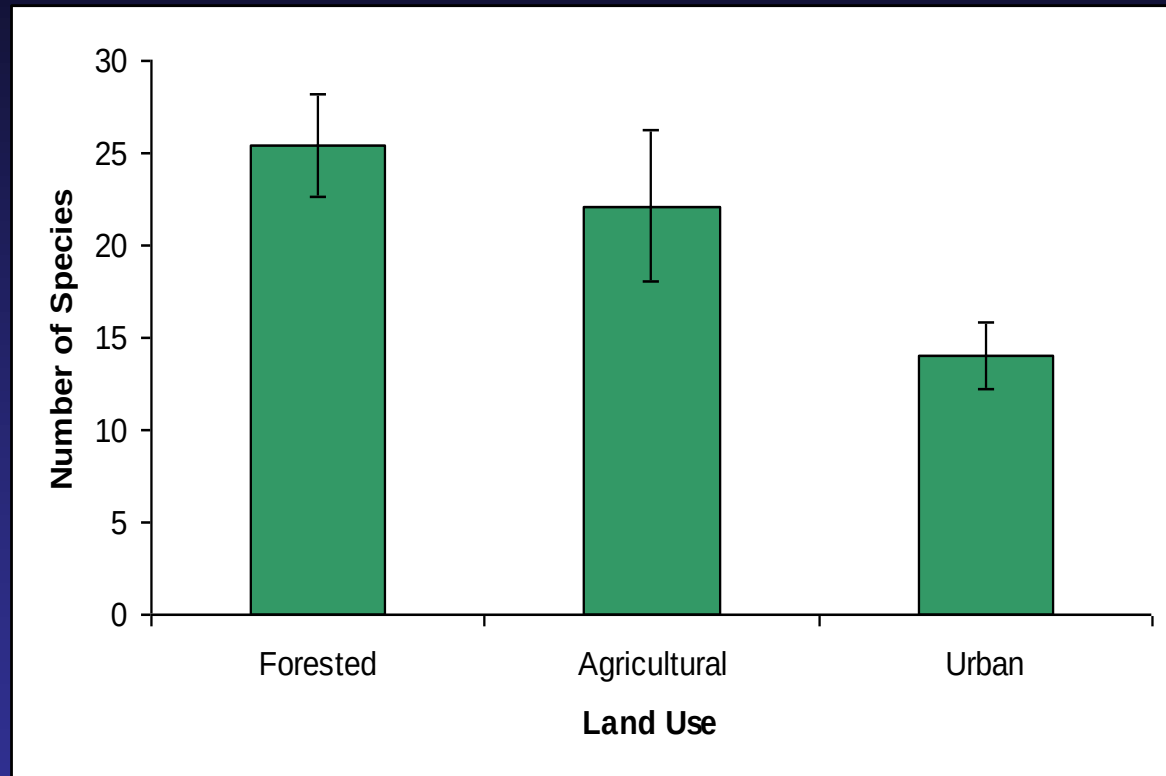


The three dominant taxa at forested sites comprised a significantly lower percentage of samples than at urban sites. ($p < 0.05$)

Results- Richness Rarefaction Curve



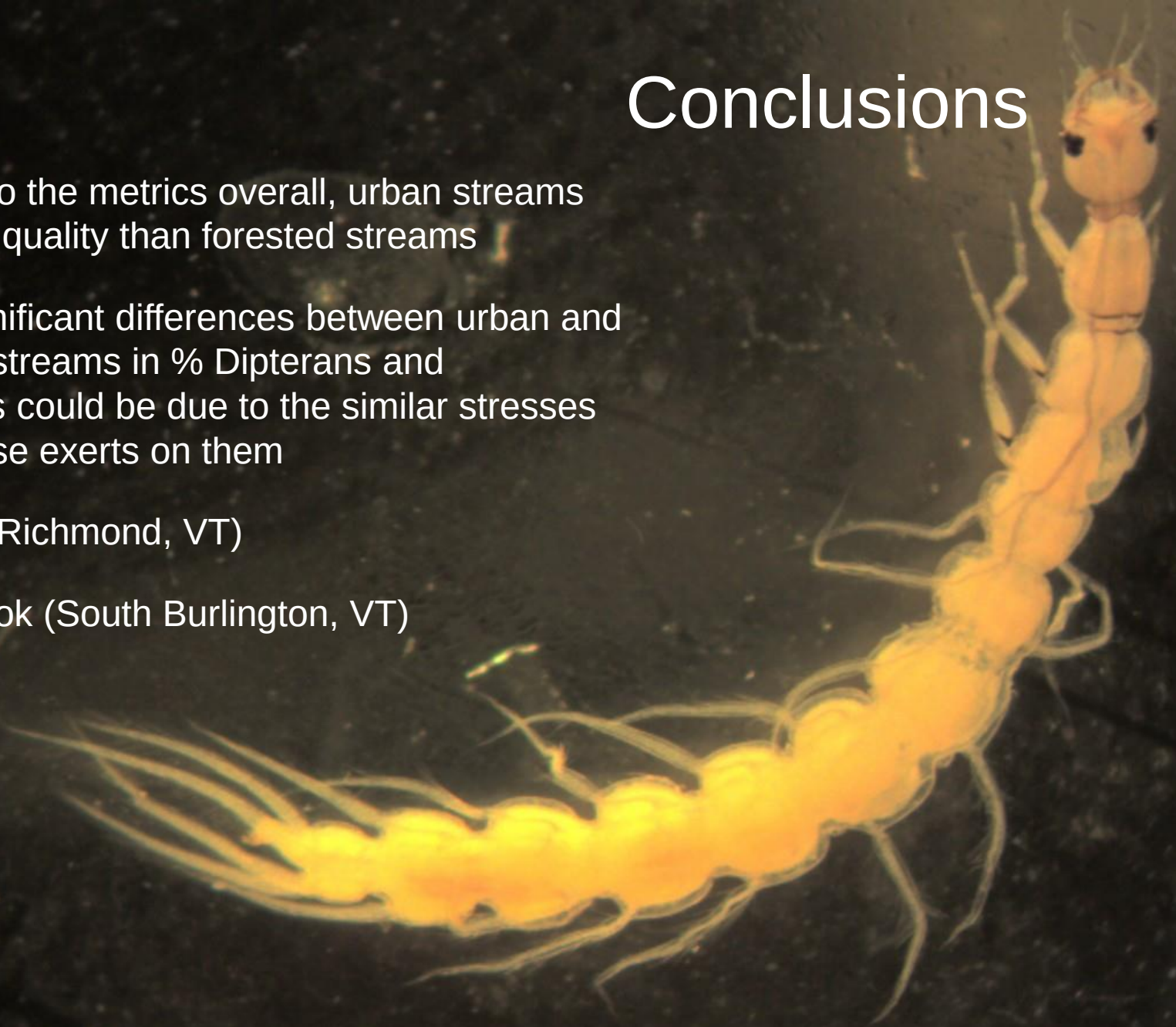
Results- Overall Richness



Forested sites had a significantly higher richness than urban sites. ($p < 0.05$)

Conclusions

- According to the metrics overall, urban streams are of lower quality than forested streams
- Lack of significant differences between urban and agricultural streams in % Dipterans and Chironomids could be due to the similar stresses each land use exerts on them
- Mill Brook (Richmond, VT)
- Potash Brook (South Burlington, VT)



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Questions?

