

US EPA ARCHIVE DOCUMENT

*Sorting shoreline skin picks:
What odonates want from their
lakeshores.*

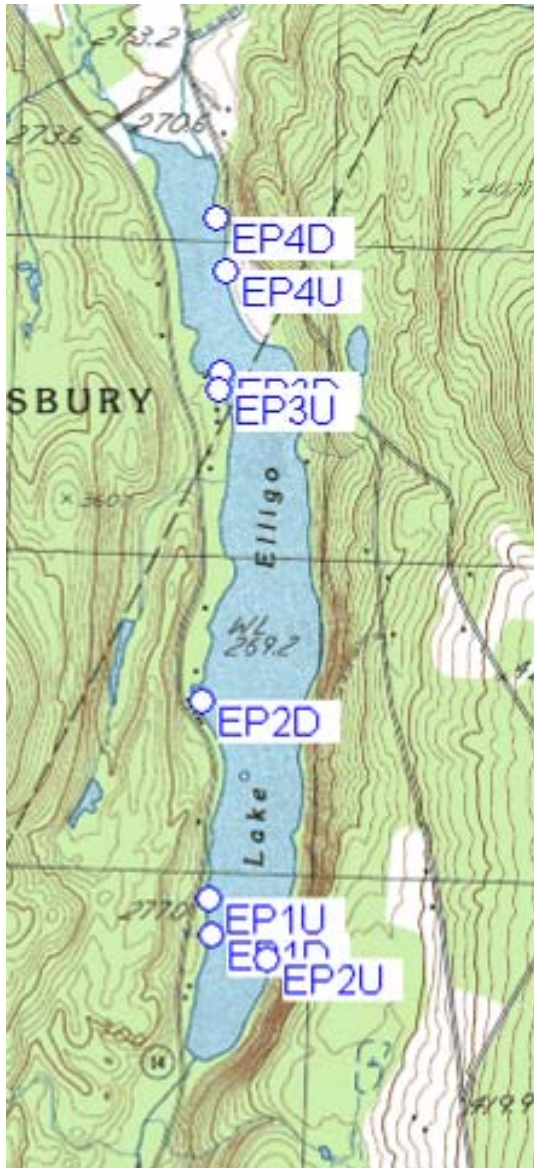
*Doug Burnham, Eric Howe, Kellie
Merrell*

2005-2008 VT DEC Study

- Examined effects of unbuffered lakeshore development on littoral habitat
- 40 lakes (data from 34 presented here)
- 5 lake classes
 - Oligotrophic: small & large lakes
 - Mesotrophic small & large lakes
 - Dystrophic: small
- 151 unbuffered developed sites
- 234 reference sites



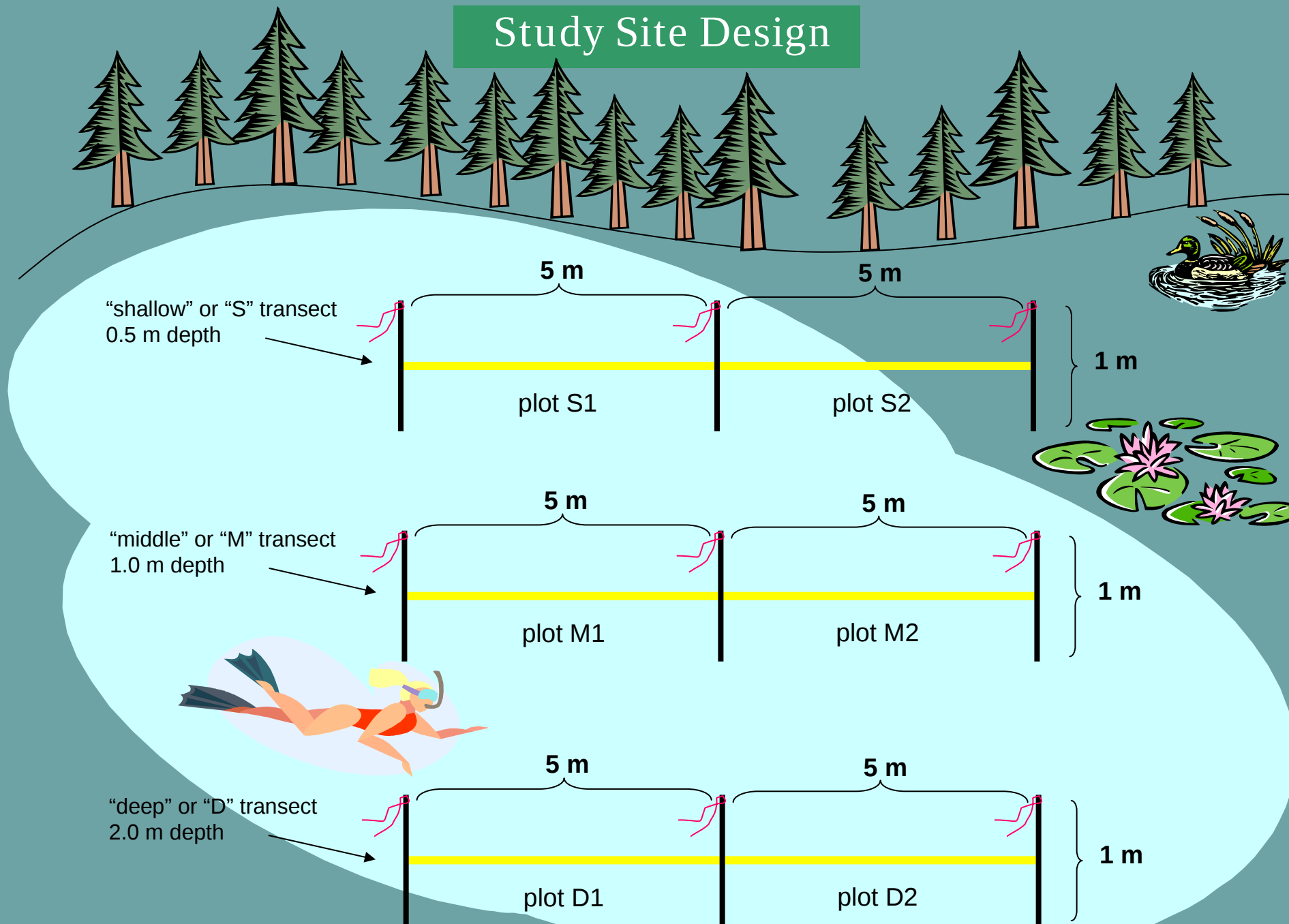
Lake Elligo



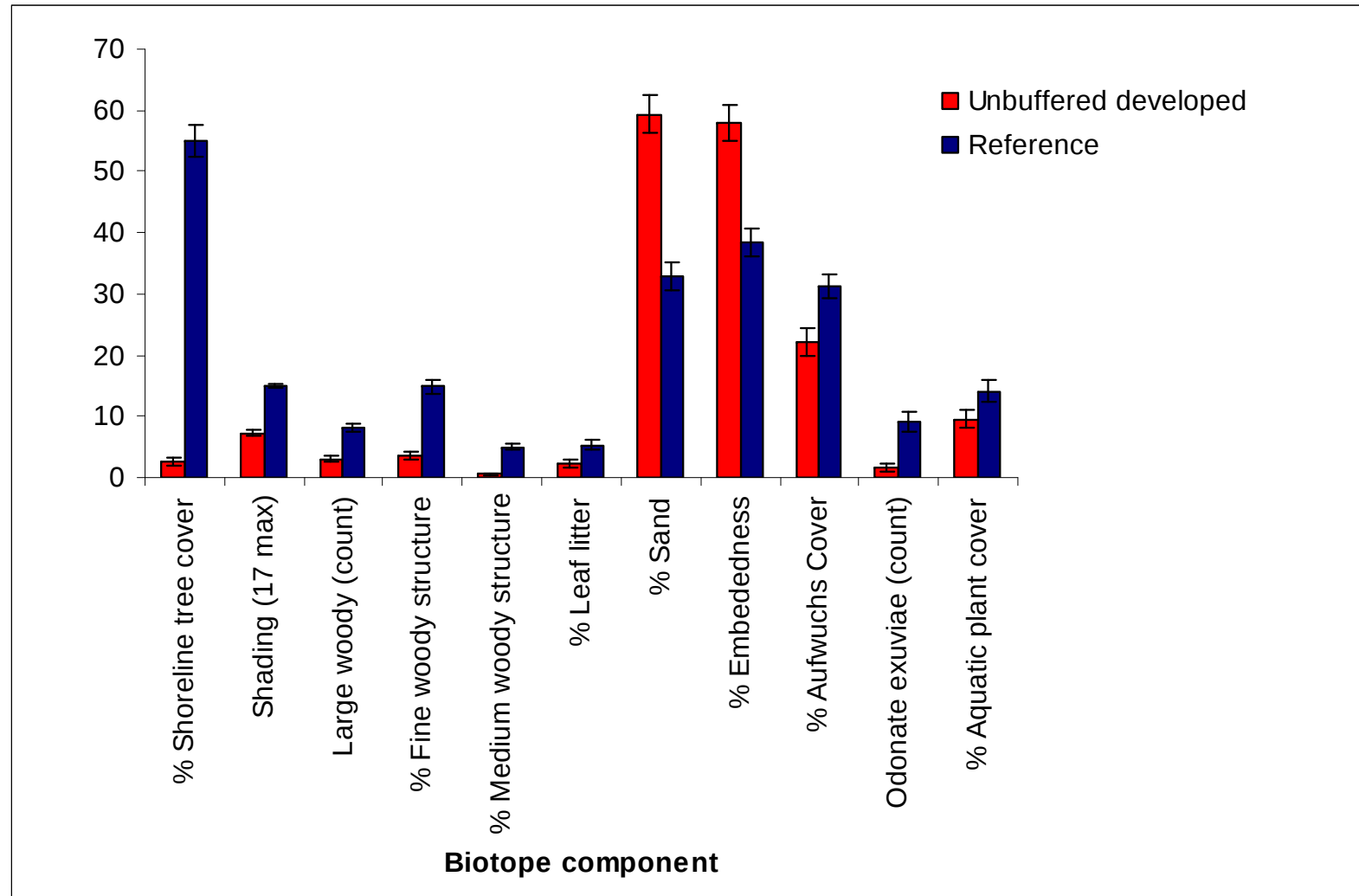
Site Selection

- Paired developed and undeveloped
 - Similar exposure
 - Similar slope
 - Similar sediments
- Selected sites throughout lake

Study Site Design



Statistically Significant Changes to Littoral Habitat



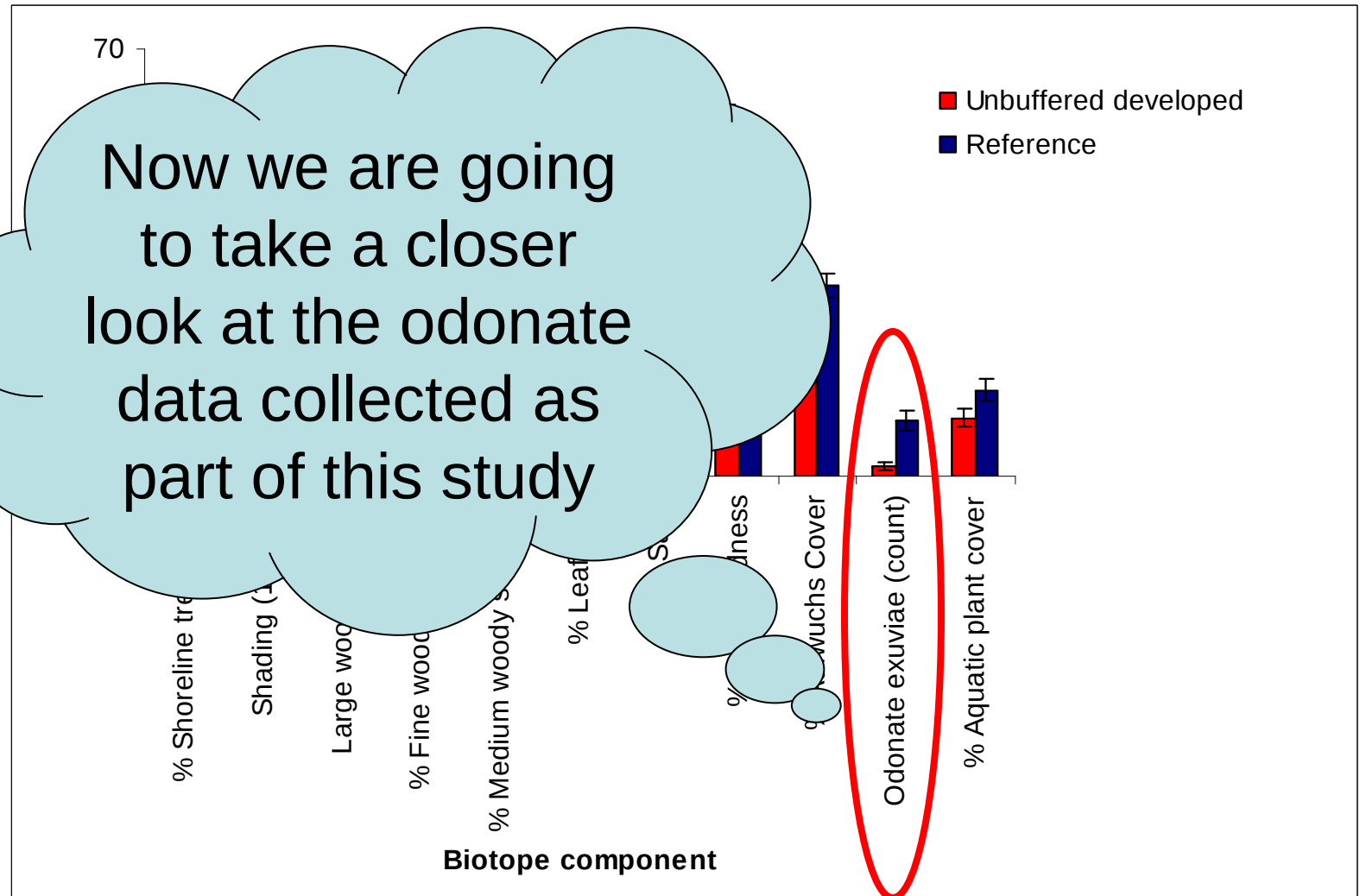


Parameter	Difference btw Reference & Developed site averages (RPD)
Large woody debris	-90%
% Tree cover	-182%
Shading 1 m from shore	-71%
% Fine woody debris	-124%
% Medium woody debris	-159%
% Sediment embeddedness	41%
% Leaf litter	-80%
% Aufwuchs*	-34%
% Sand	57%
% Macrophyte cover*	-33%
# Dragonfly exuviae*	-139%

*Aquatic Biota, rest are Aquatic Habitat parameters

Less odonates at unbuffered developed sites

Now we are going to take a closer look at the odonate data collected as part of this study



Odonate 101

- Odonates are dragonflies and damselflies
- Spend 1-4 yrs as nymphs in aquatic phase
- Crawl out of water to emerge and fly out into adult stage, leaving exuviae (skins) behind
- In lakes, have requirements of both the littoral and riparian habitats

Hunting Skins Method



How Successful Were We?

- Sampling success was variable and ranged from 0-41 mean exuvia per site.
- 10% of lakes greater than 10 ex/site
- 33% of lakes 1-10 ex/site
- 57% of lakes less than 1 ex/site



Where we found them

- On trees/stumps
- On ferns
- In tall grasses
- Under overhanging banks
- In duff
- On emergent plants
- On docks and decks
- On rock walls



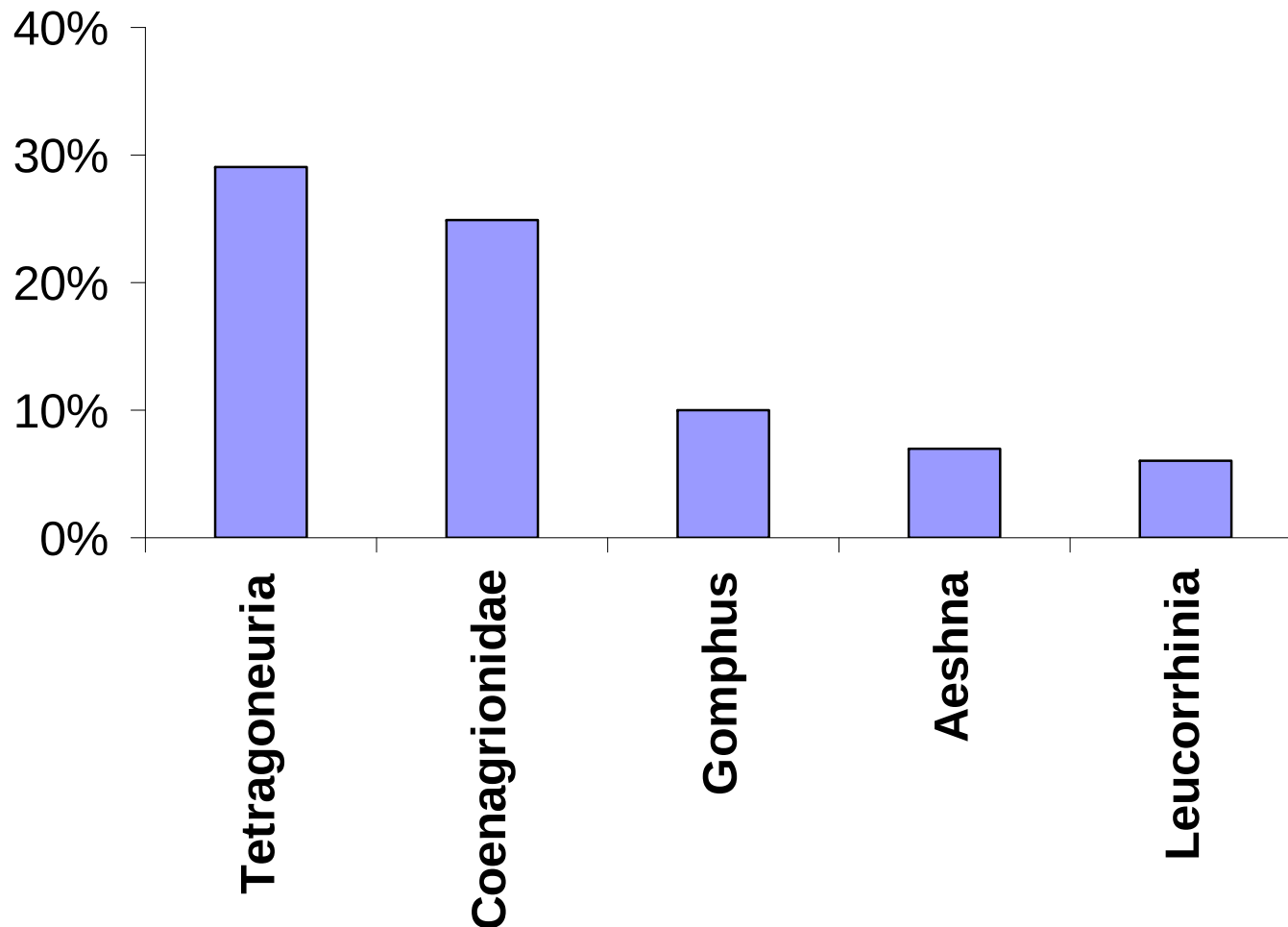
Where we didn't find them

- On bushes, both emergent and terrestrial
- On smooth sea walls
- On sandy beaches
- On lawns



What was most abundant?

- 6 taxa made up 82% of the total exuvia collected

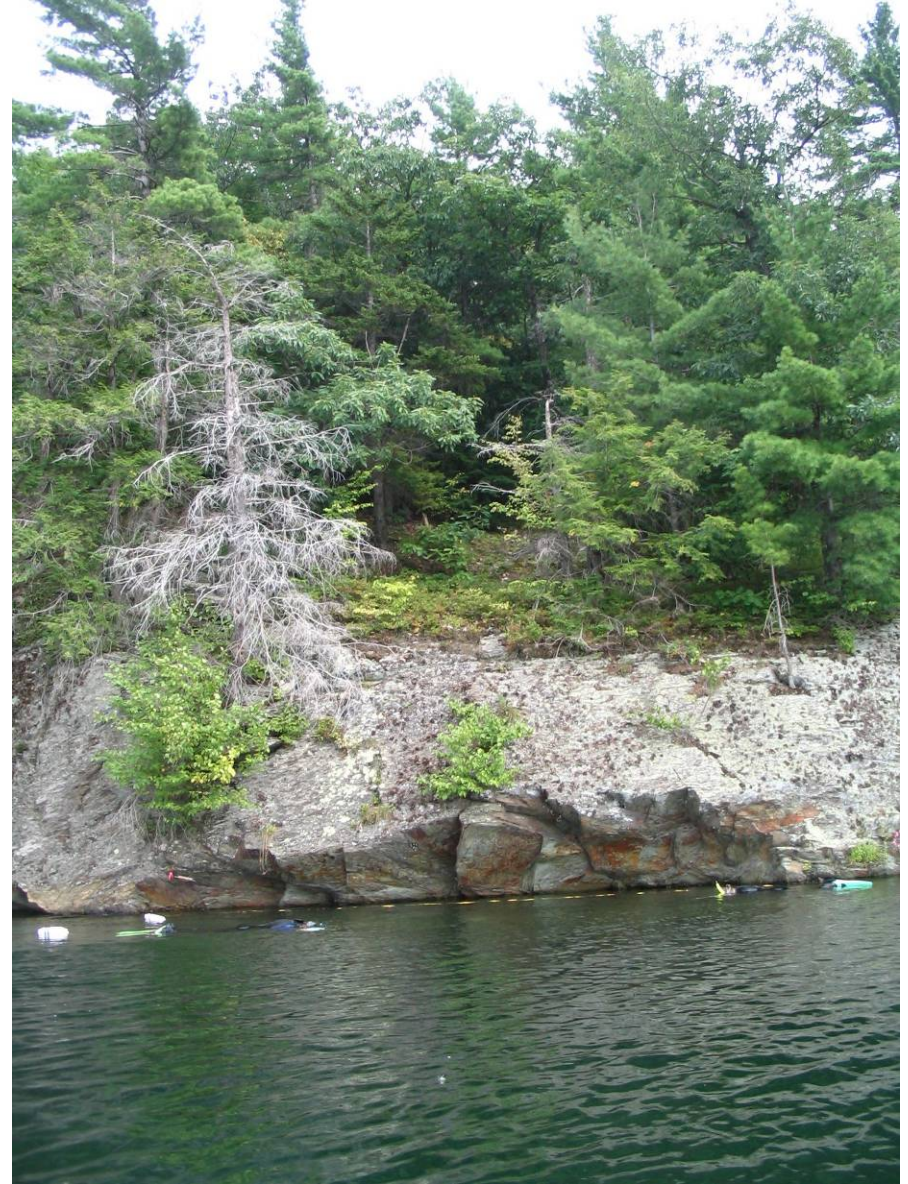


What was least abundant?

- 6 taxa were represented by fewer than 10 specimens
- *Ladona julia*
- *Helocordulia uhleri*
- *Anax junius*
- *Libellula* sp.
- *Macromia* sp.
- *Hagenius brevistylus*

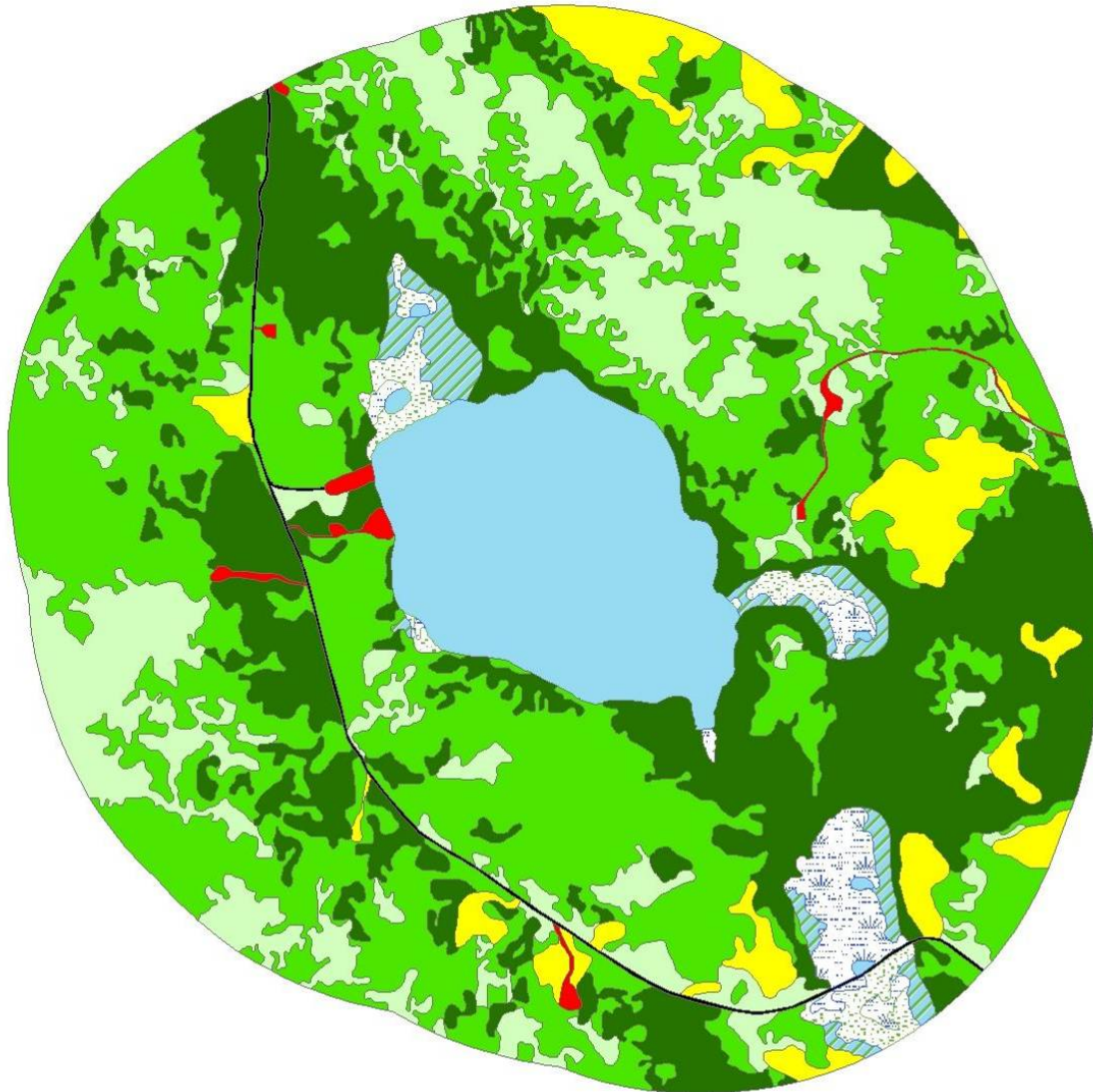
Where were they most abundant?

- 70% of all exuvia were collected from 3 lakes;
- Little or no development on 3 lakes;



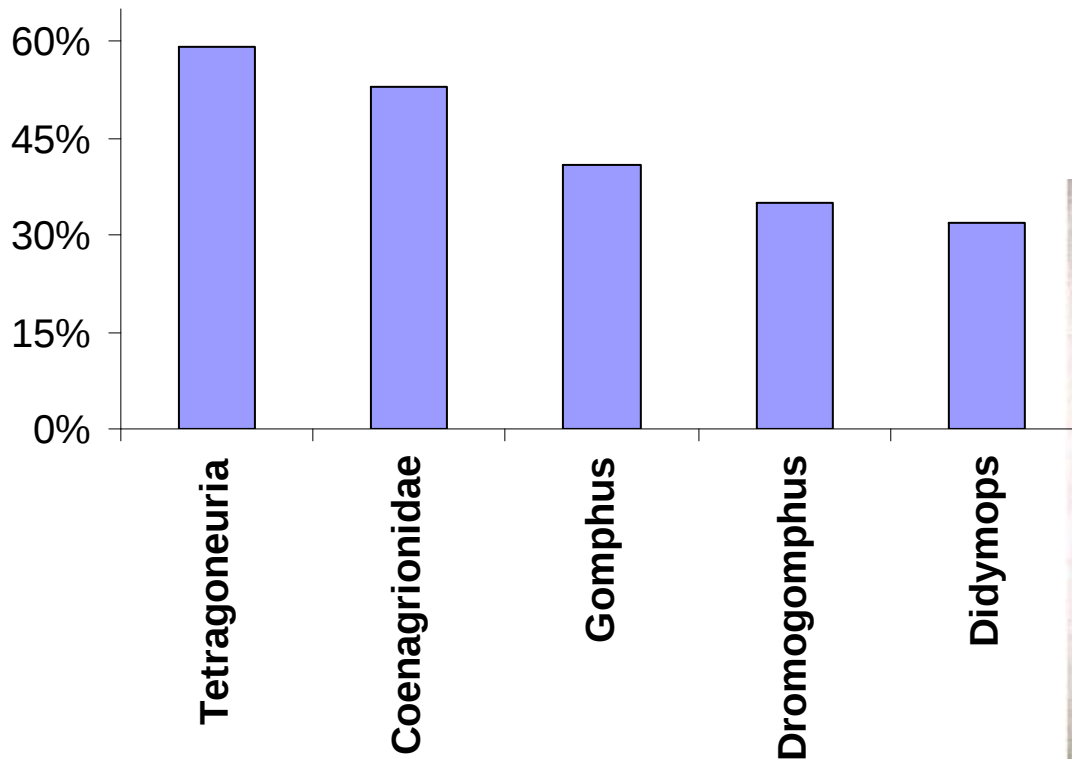
Foster's Pond Land use/land cover map

Primarily undeveloped;
Most abundant and diverse Odonate fauna collected



What taxa were the most/least common?

- 5 taxa found in more than 30% of the lakes
- 17 taxa occurred in only 1 or 2 lakes
- 7 taxa only in 1 lake



Where were they most/least diverse?

- 34 taxa were identified
- 0-18 taxa per lake
- 10 or more taxa in 5 lakes
- 0-1 taxa in 12 lakes



Behavioral Distribution

Taxa classified as:

- Burrowers (9%) - primarily Gomphidae;
- Claspers (32%) - primarily Aeshnidae and Coenagrionidae;
- Sprawlers (58%) - primarily Corduliidae and Libellulidae;

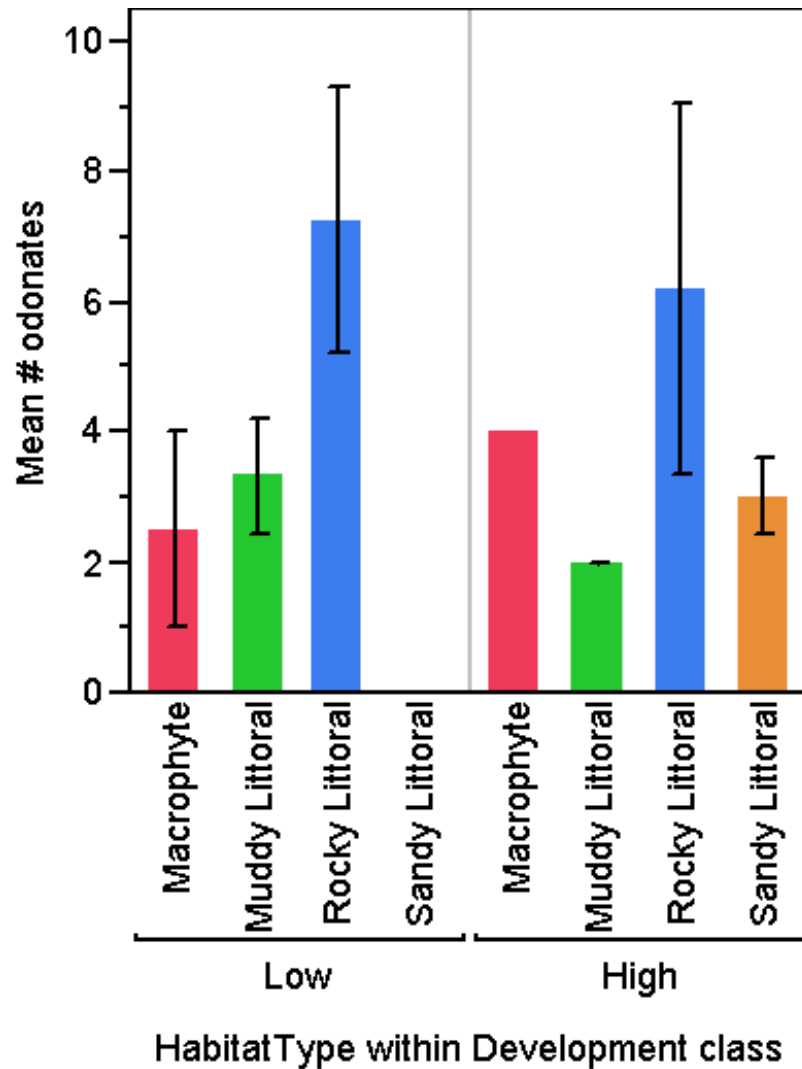


Behavioral Classifications

Lakes classified by dominant behavioral characteristics

- Burrower Lakes $>40\%$ - 6 lakes
- Sprawler Lakes $>50\%$ - 6 lakes
- Clasper Lakes $>75\%$ - 10 lakes
- Generalist Lakes all $>20\%$ - 5 lakes

Habitat Specialists?



“Riverine” species habitat preferences:

- *Dromogomphus spinosus*
- *Boyeria* sp.
- *Basiaeschna janata*
- *Hagenius brevistylus*
- *Helocordulia uhleri*
- associated with flowing waters
- found most frequently at hard bottom “rocky littoral” sites

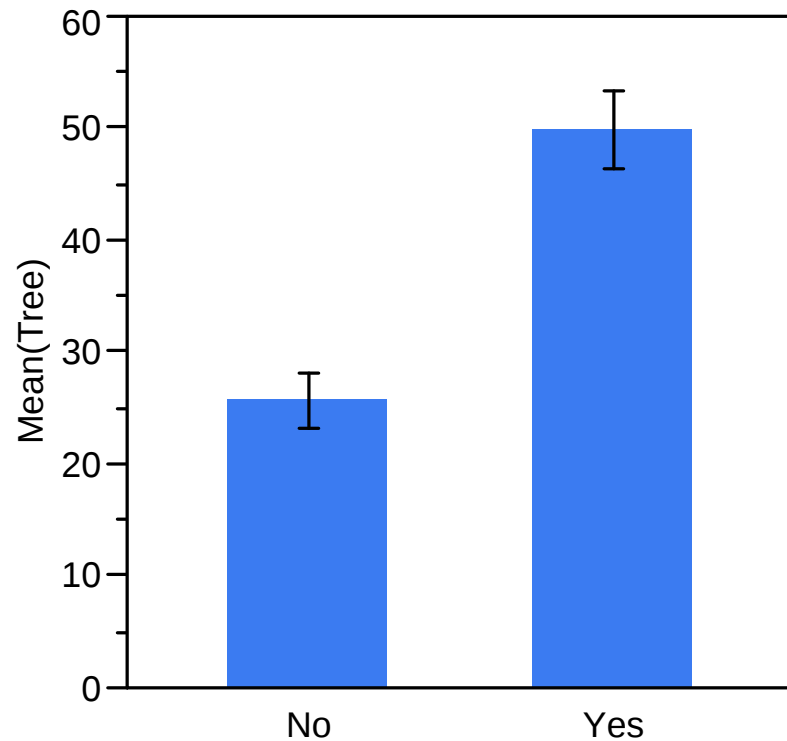


No apparent difference between “high” and “low” development class.

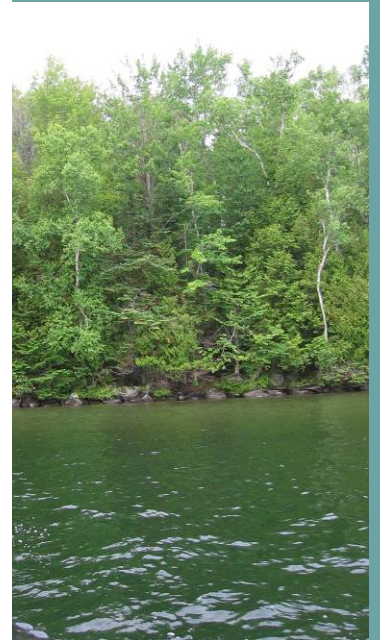
What do odonates want from their
lakeshores?

MORE TREES ALONG THE SHORE

Mean tree cover along the shore

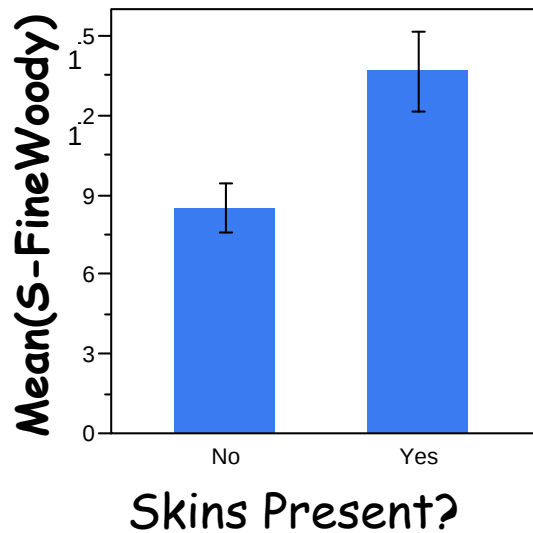


Exuviae present?
 $\text{Prob} > Z = 0.001^*$



More underwater woody habitat

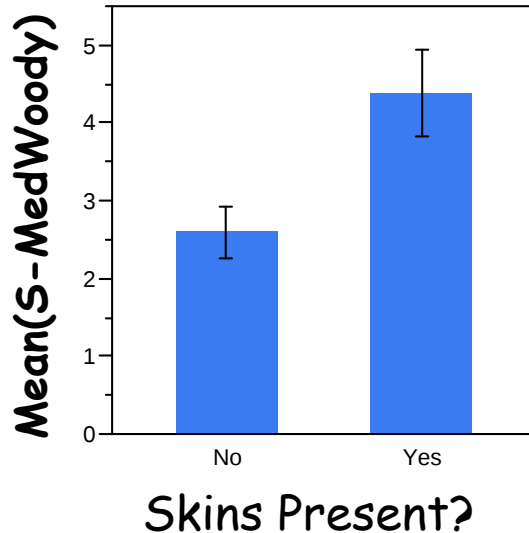
Prob>Z = 0.0009*



Fine

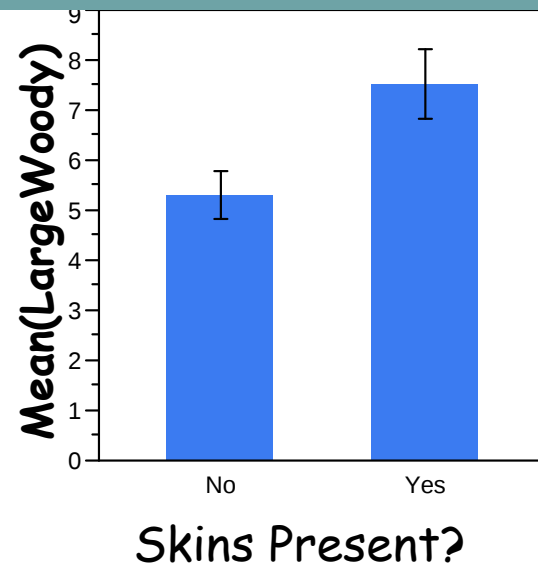


Prob>Z = 0.0013*



Medium

Prob>Z = 0.0012*

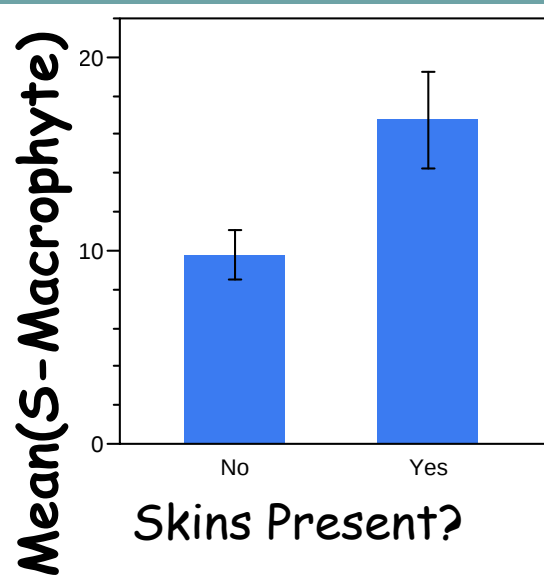


Coarse

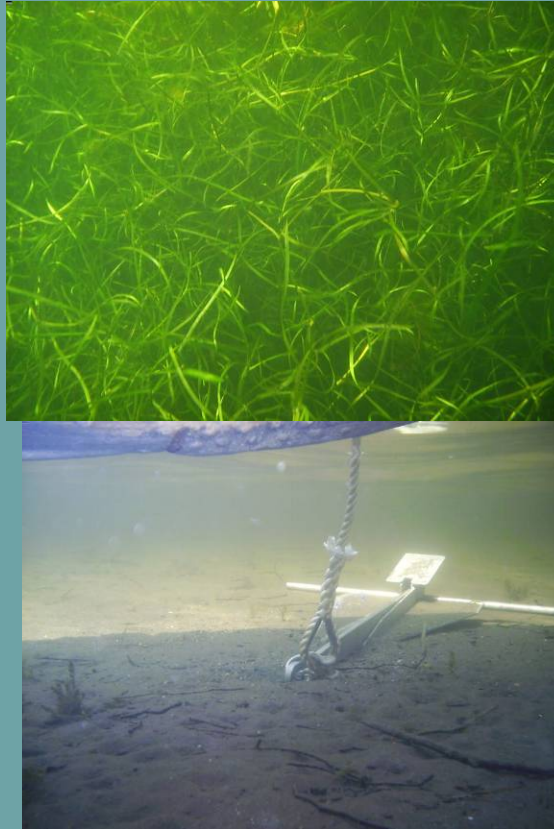


More Plants and Less Sand

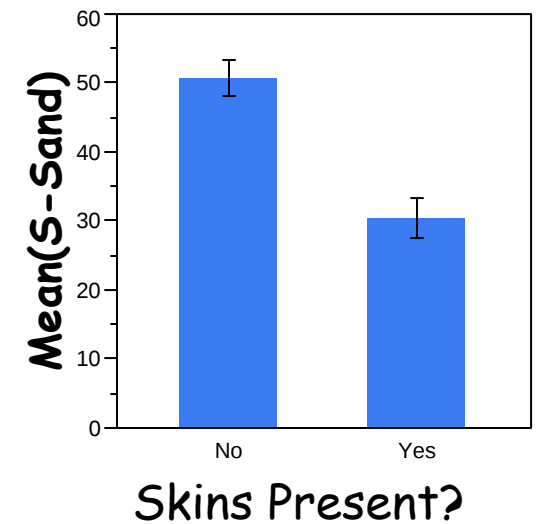
Prob>Z = 0.0009*



More aquatic
plants



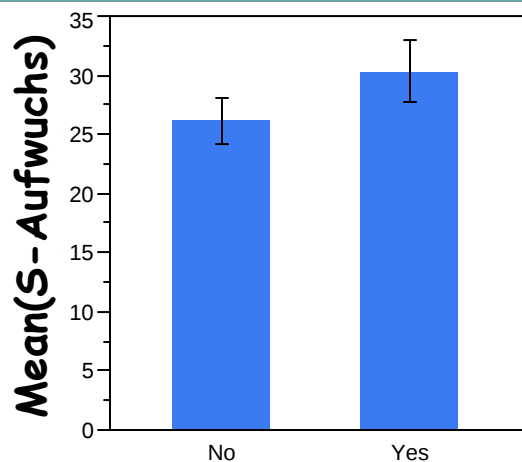
Prob>Z = 0.0001*



Less sand

What odonates are neutral about

Prob>Z = 0.0557

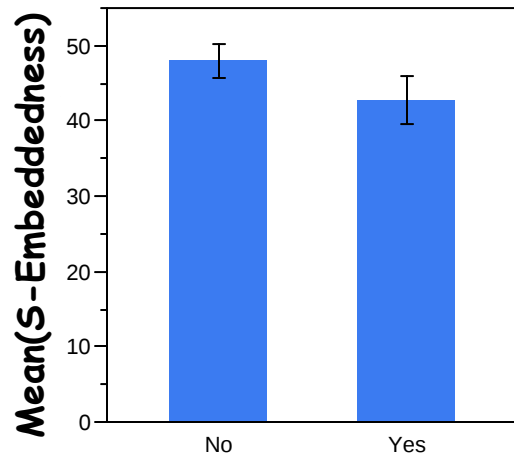
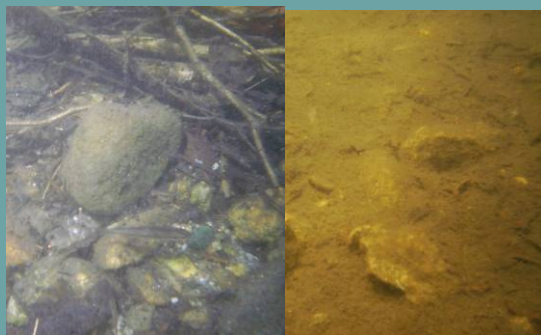


Skins Present?

Aufwuchs



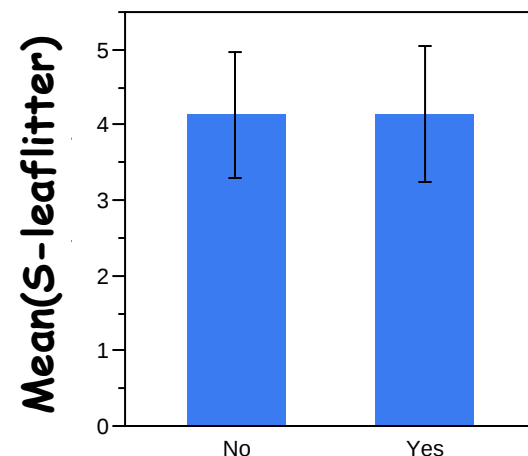
Prob>Z = 0.1102



Skins Present?

Embeddedness

Prob>Z = 0.5158



Skins Present?

Leaf Litter



Information-Theoretic Framework (AIC)

- Linear models estimated through generalized linear model function in JMP
- Estimates $-\log$ likelihood of model
- AIC calculates plausibility of each model in candidate set of models
 - Doesn't rely on arbitrary "p-value" to determine which model(s) are significant
 - Provides "weight" for each candidate model

What combinations of these variables are important to odonate species richness?

- Created 5 linear models using these habitat parameters:
 - % macrophytes
 - % fine woody
 - % medium woody
 - # coarse woody
 - % sand
 - % tree cover
 - % low shrub
 - % high shrub
 - % shoreline development

What combinations of these variables are important to odonate species richness?

- Model 1: Full model (all parameters)
- Model 2: Mixed model (aquatic and terrestrial parameters)
- Model 3: Terrestrial model (% tree, % low shrub, %high shrub, development)
- Model 4: Terrestrial model – development
- Model 5: Aquatic model (% macrophytes, % fine, % med woody, # coarse woody, % sand)

The most plausible model explaining odonate species richness

- Model 4: Terrestrial model w/o development

Model	$-2\log(\ell)$	K	N	AICc	Δ_i	W_i
1	108.4	10	516	128.8	76.3	0.000
2	92.9	6	519	105.1	52.5	0.000
3	50.3	5	519	60.5	7.9	0.019
4	44.5	4	519	52.6	0.0	0.979
5	53.8	6	517	65.9	13.4	0.001

The most plausible model explaining odonate species richness

- Model 4: Terrestrial model w/o development
 - Why? Explains habitat availability for the life stage that was sampled (emergence)



The most plausible model explaining odonate species richness

- Model 4: Terrestrial model w/o development
 - Why? Explains habitat availability for the life stage that was sampled (exuviae)
 - Why no development? Could be due to strong correlation to other parameters already in model (trees & shrubs)

Conclusions

- Species diversity at emergence stage strongly tied to riparian characteristics
 - Tree % cover
- Aquatic habitat parameters important
 - Woody habitat, macrophytes
- Shoreline development strongly influences these parameters

Acknowledgements

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