Lentic Biomonitoring: Littoral Macroinvertebrate Response to Lakeshore Development

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Overview

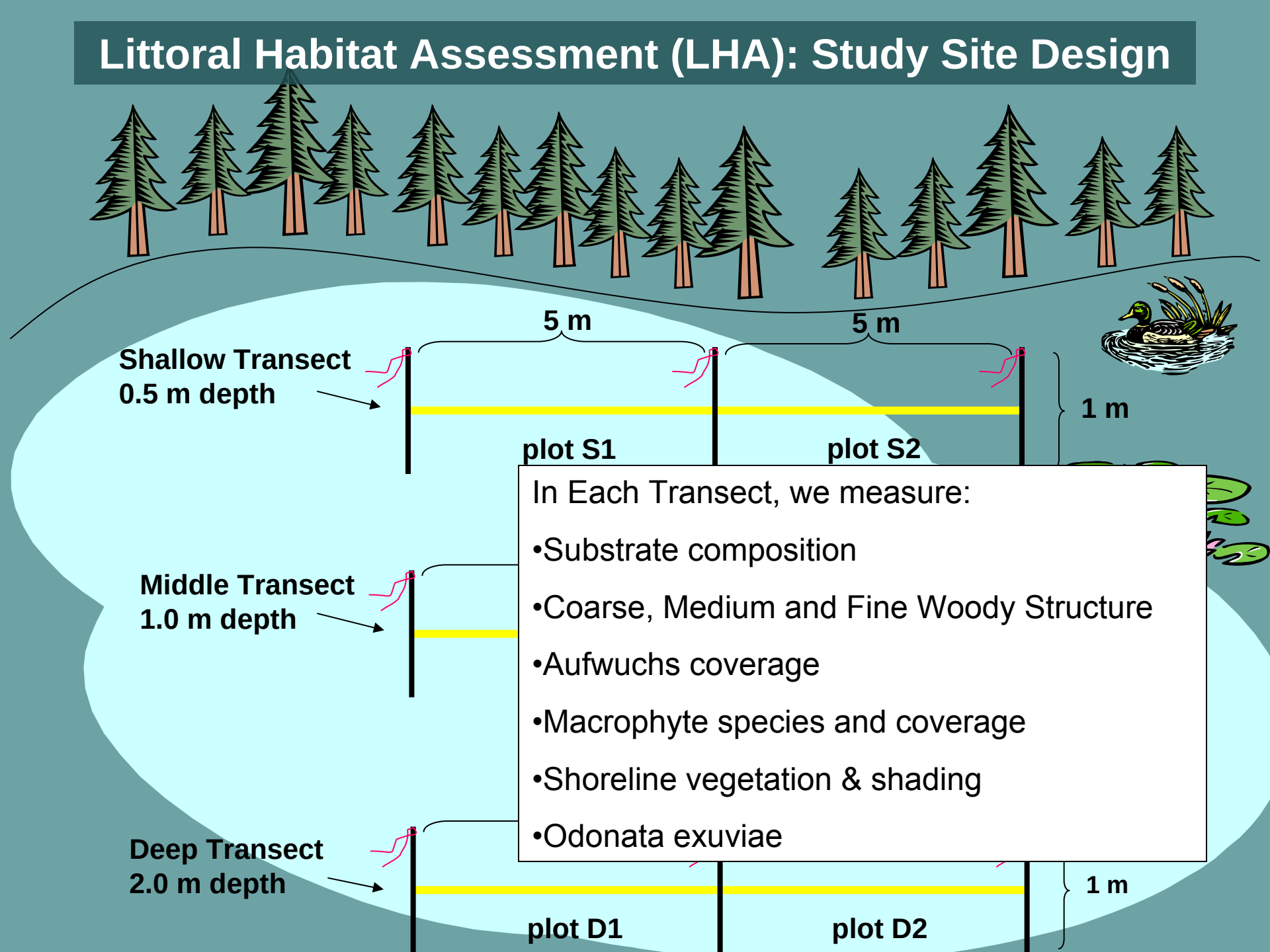
- VT Dept. Environmental Conservation pilot study on Littoral Macroinvertebrates
  - In relation to development of the immediate shoreline
- First year of data collection – 2009
- Preliminary Results, hot off the lab bench

Background

- Vermont has no Statewide buffer law in place
  - 9% of towns have regulations regarding shoreline development

- VT Water Quality Standards
  - Water Quality Criteria for Class B waters (Section 3-04 B)
    - **No change from the reference condition** that would prevent the full support of aquatic biota, wildlife, or aquatic habitat uses….
    - All life-cycle functions, including overwintering and reproductive requirements are maintained and protected.

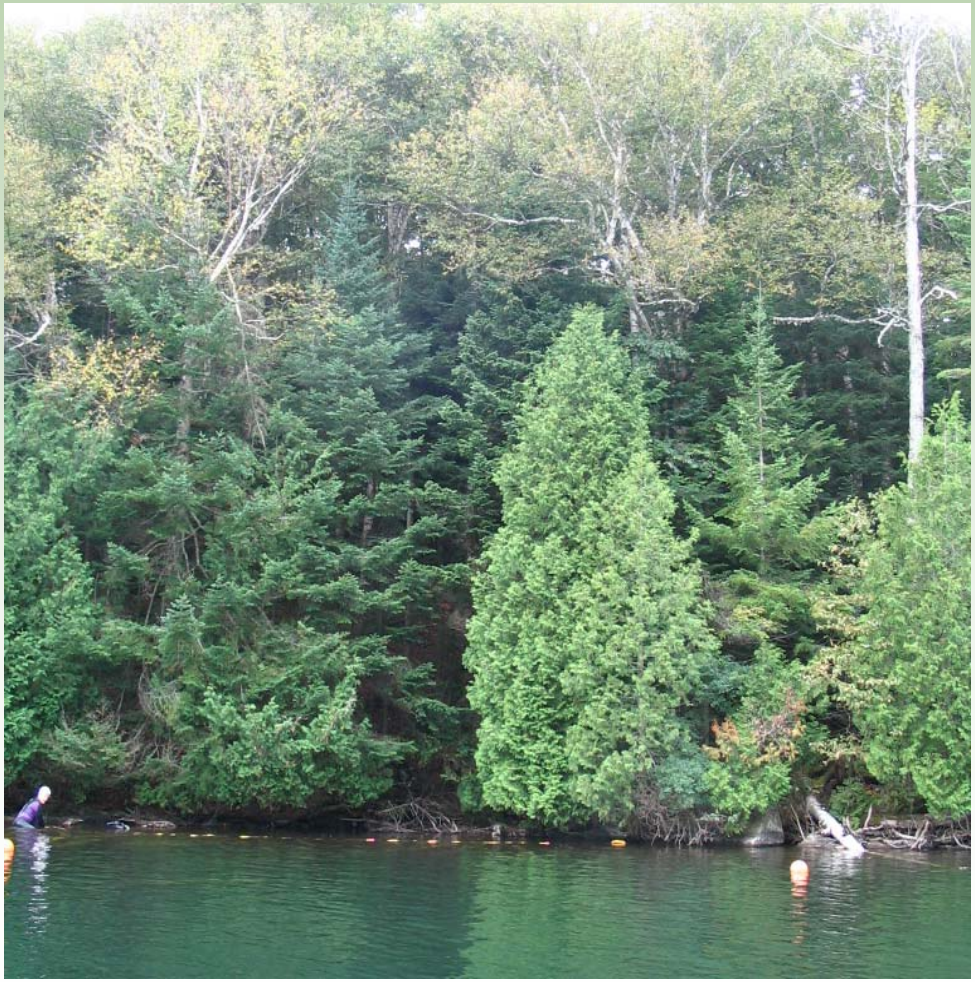
Littoral Habitat Assessment (LHA): Study Site Design



In Each Transect, we measure:

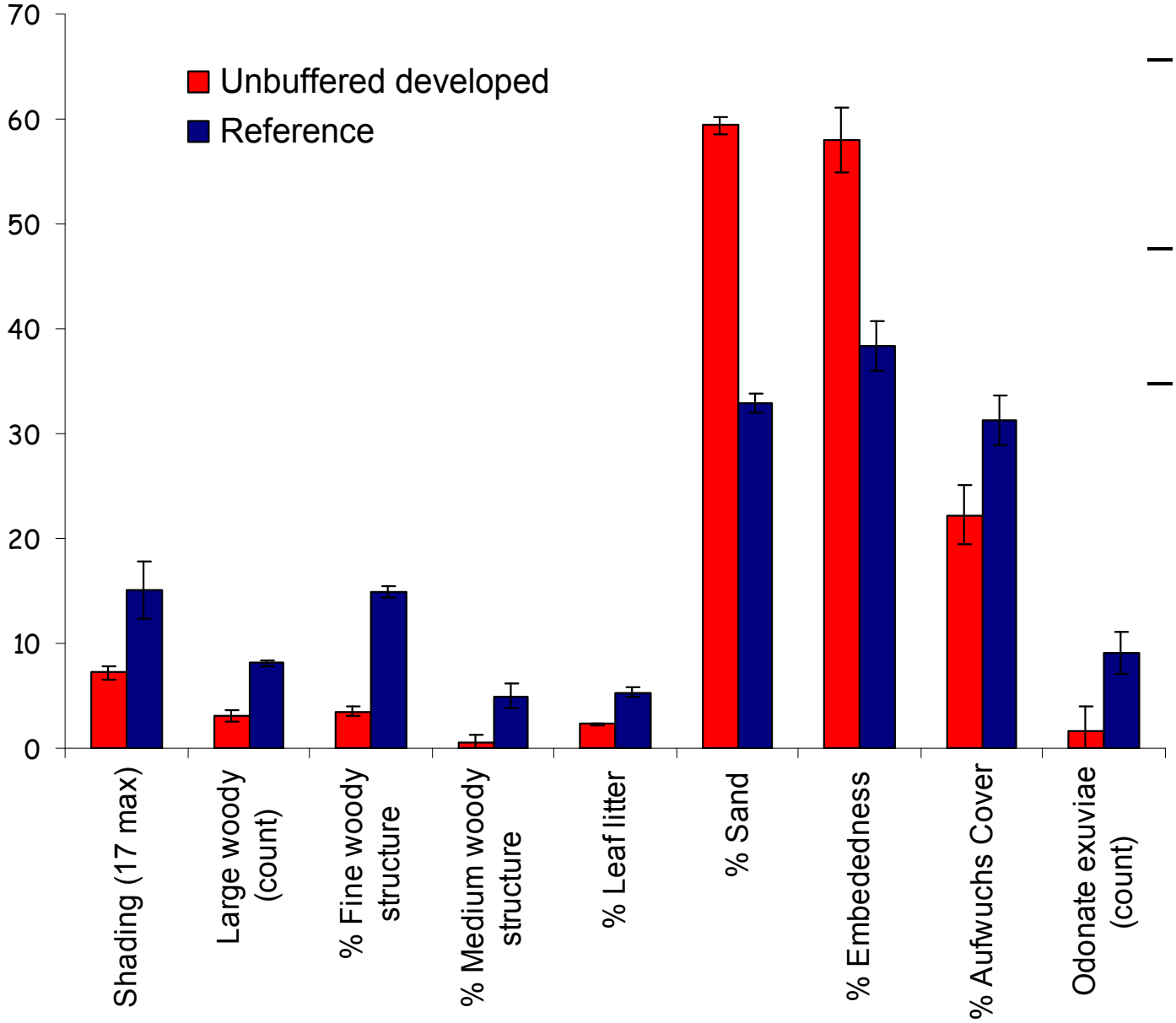
- Substrate composition
- Coarse, Medium and Fine Woody Structure
- Aufwuchs coverage
- Macrophyte species and coverage
- Shoreline vegetation & shading
- Odonata exuviae

Reference Sites (Undeveloped)



Unbuffered Developed

Previous Littoral Habitat Assessment Results



- Data from all lake classes, 2005-2008
- Reference Sites *n* = 234
- Unbuffered Developed Sites *n* = 151

…But what about the bugs???

- Summer of 2009: Littoral Macroinvertebrate Pilot Study
- 8 “Large Oligotrophic” Vermont lakes
  - >300 acres
  - TP, Chlorophyll, Secchi Depth
- Two Habitat Types
  - Sandy Littoral
  - Rocky Littoral

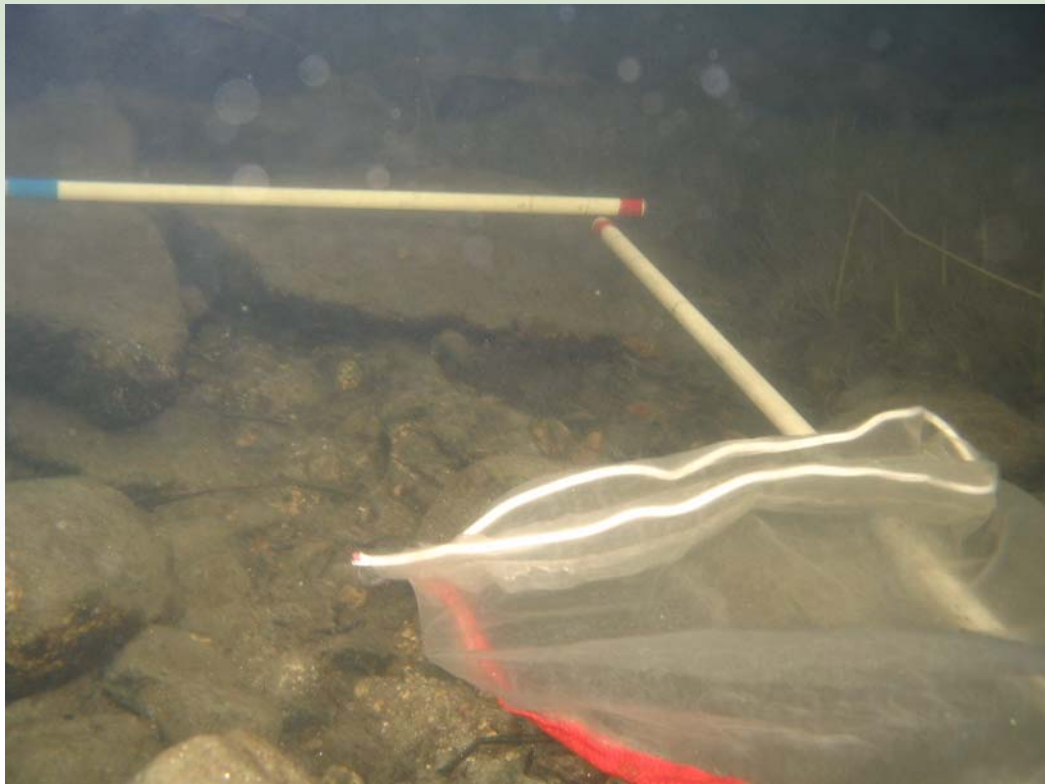
- **Main Question: Do the macroinvertebrates show a change from reference condition?**

Sandy Littoral - Methods

- Debunked method: Eckman Dredge
  - Too much sand: 5 full quart jars in three dredges
- Sediment Cores (*sensu* De Sousa et al. 2008)
  - 6.5 cm diameter x top 10 cm sediments
  - 5 replicates along 0.5m depth contour
    - Sampled 0.0166 m^2 of littoral zone
  - Composited in 500µm sieve bucket
- Sampling logistics
  - Each site took about 10 minutes to sample
  - Usually filled 1-2 quart jars of sand
- 52 SL sites
  - 17 Reference
  - 35 Unbuffered Developed

Rocky Littoral - Methods

- Debunked Method: Picking rocks out of water, washing into sieve bucket along transect
  - Quick, didn't retain much material
- Three 1m^2 quadrats along 0.5m depth transect
  - Washed rocks into 500µm mesh bags while snorkeling
  - 3m^2 total substrate sampled
  - Composited sample
- Logistics
  - Samples took roughly one hour to collect per site
  - Debris fit in 1 quart jar or less
- 35 RL Sites
  - 24 Reference
  - 11 Unbuffered Developed



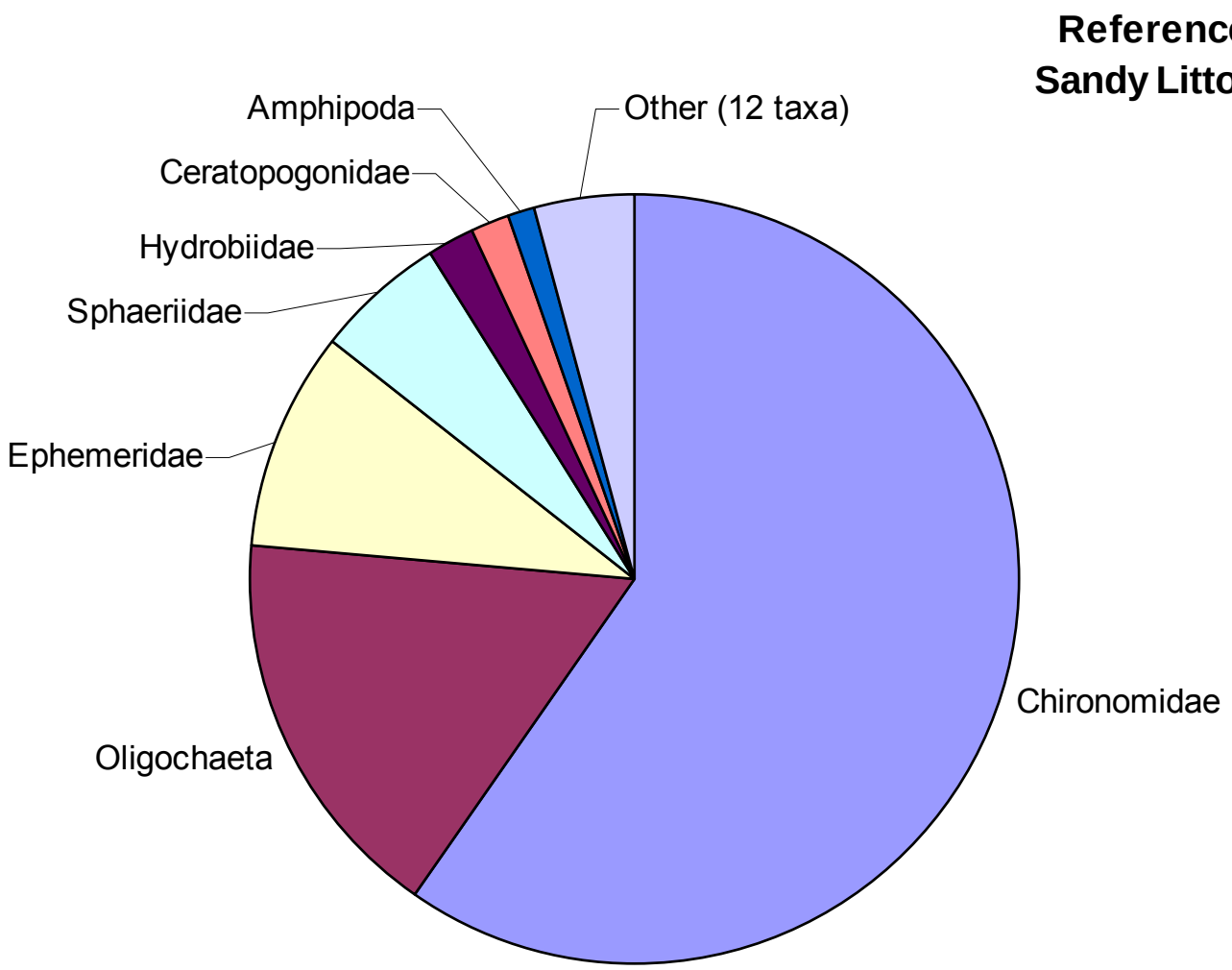
Lab Methods

- Total pick of sample for estimates of density
- Followed Vermont State Biomonitoring lab protocol for sample picking
  - Every sample pick checked
- Preliminary ID to family while sorting
- Metrics:
  - Density, Richness, EPT, ECT, Functional Feeding Groups, Habits, LHA Data

General Results - SL

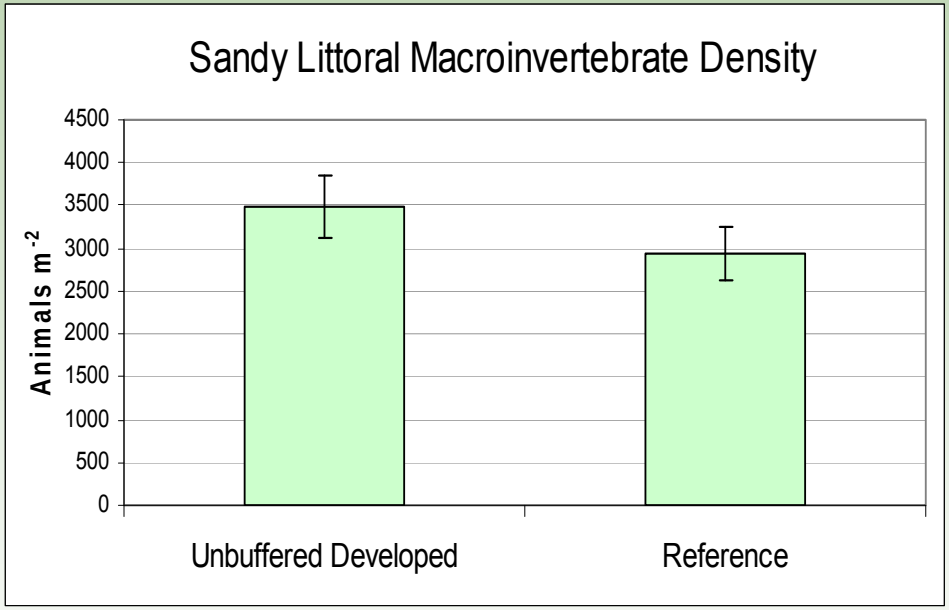
- Sandy Littoral Samples:
  - Densities of animals: 723 – 9880 m^{-2}
    - (mean = 3306.3 ± 272.1 m^{-2})
    - Actual Numbers in Samples: 12-164 (54.8 ± 4.5)
  - Most Common Taxa
    - Chironomidae (2042.4 ± 210.6 m^{-2})
    - Oligochaeta (614.0 ± 109.5 m^{-2})
    - Ephemeridae (199.3 ± 45.8 m^{-2})
    - Sphaeriidae (126.7 ± 26.0 m^{-2})

What does a reference Sandy Littoral macroinvertebrate community look like?



Sandy Littoral Results

- No Significant Changes From Reference Condition

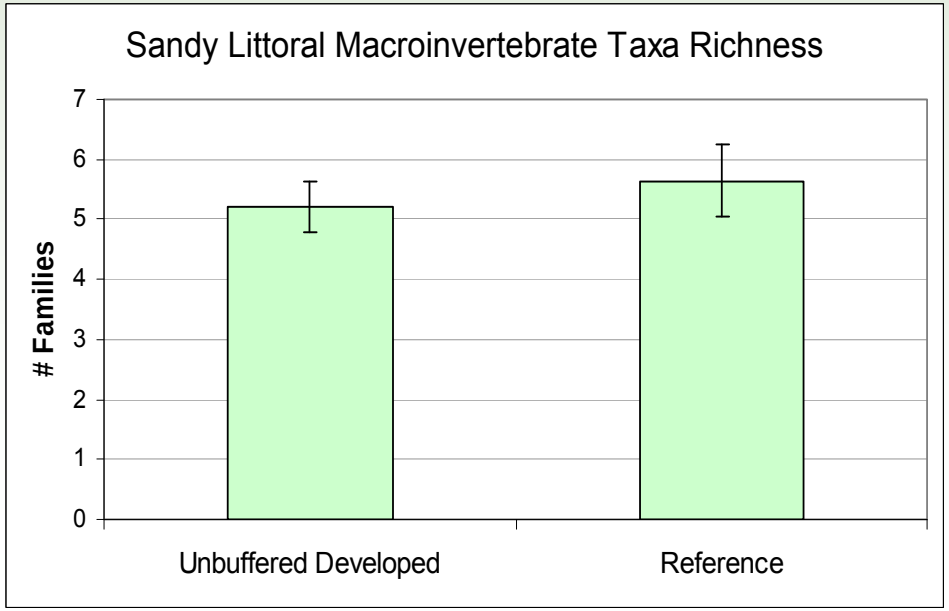


– Macroinvertebrate Density

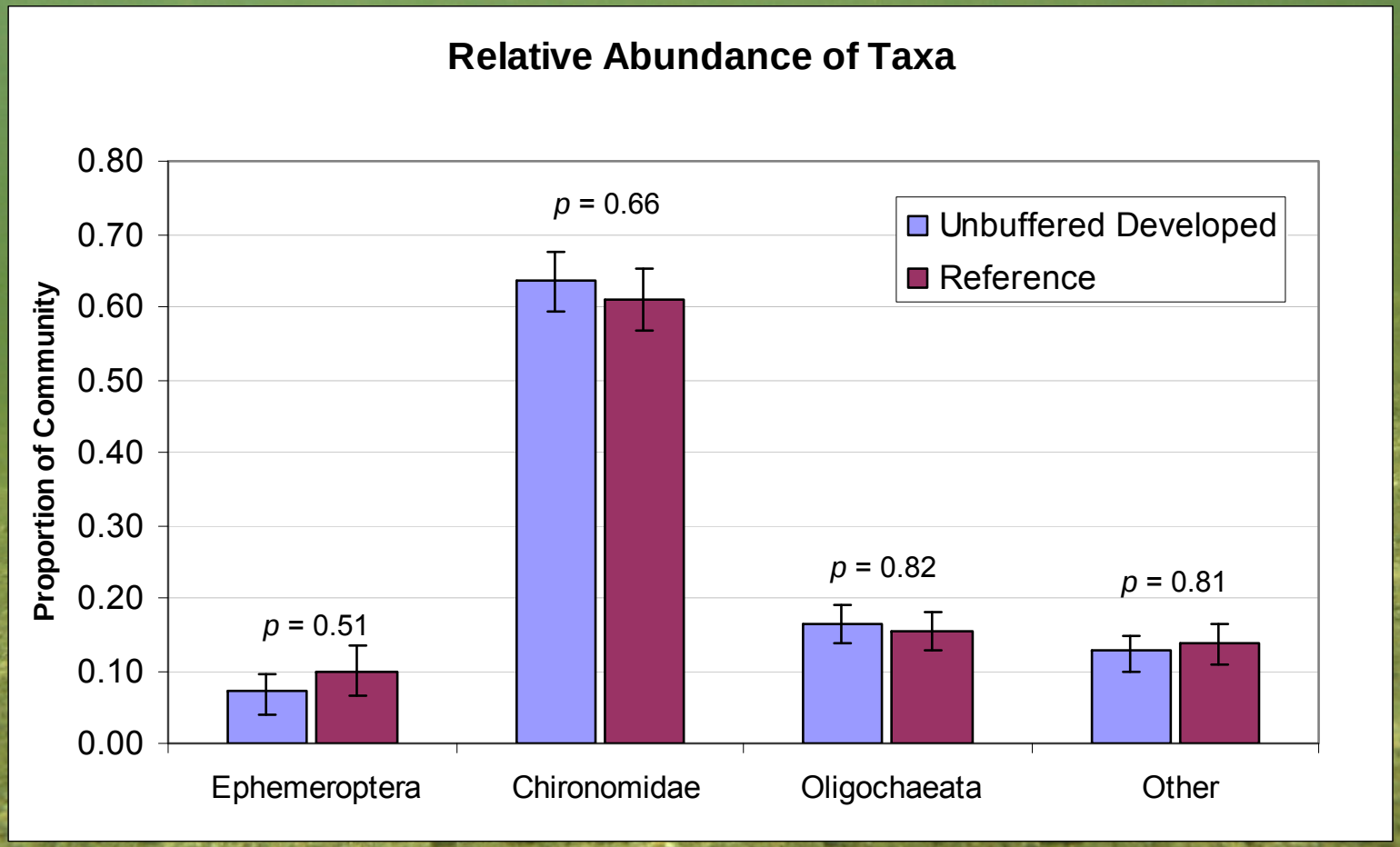
– t-test: $p = 0.28$

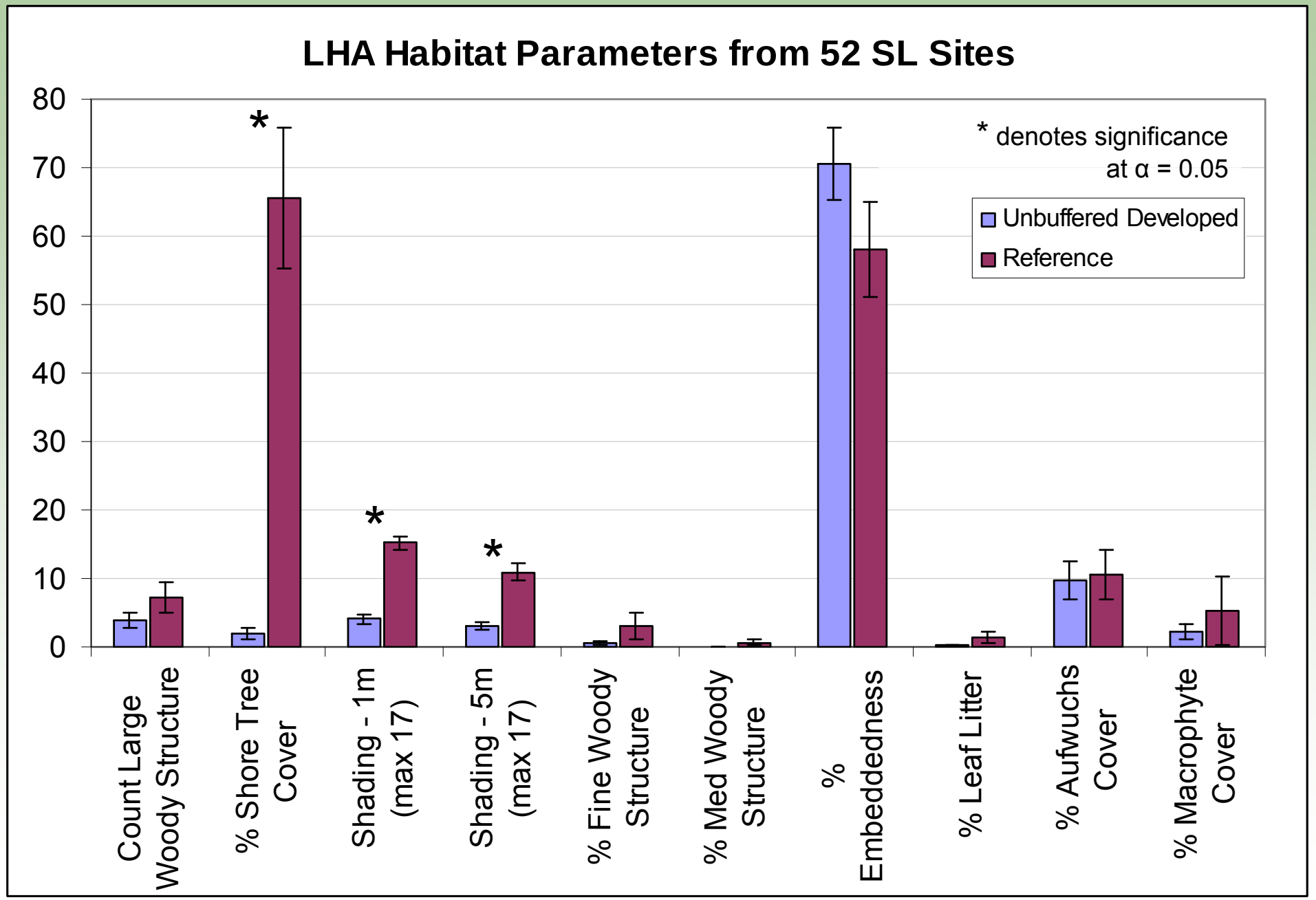
– Taxa Richness

– t-test: $p = 0.54$



Sandy Littoral Results




LHA Habitat Parameters from 52 SL Sites
80
70
60
50
40
30
20
10
0
* denotes significance at α = 0.05
Unbuffered Developed
Reference
*
*
*
Count Large Woody Structure
% Shore Tree Cover
Shading - 1m (max 17)
Shading - 5m (max 17)
% Fine Woody Structure
% Med Woody Structure
% Embeddedness
% Leaf Litter
% Aufwuchs Cover
% Macrophyte Cover

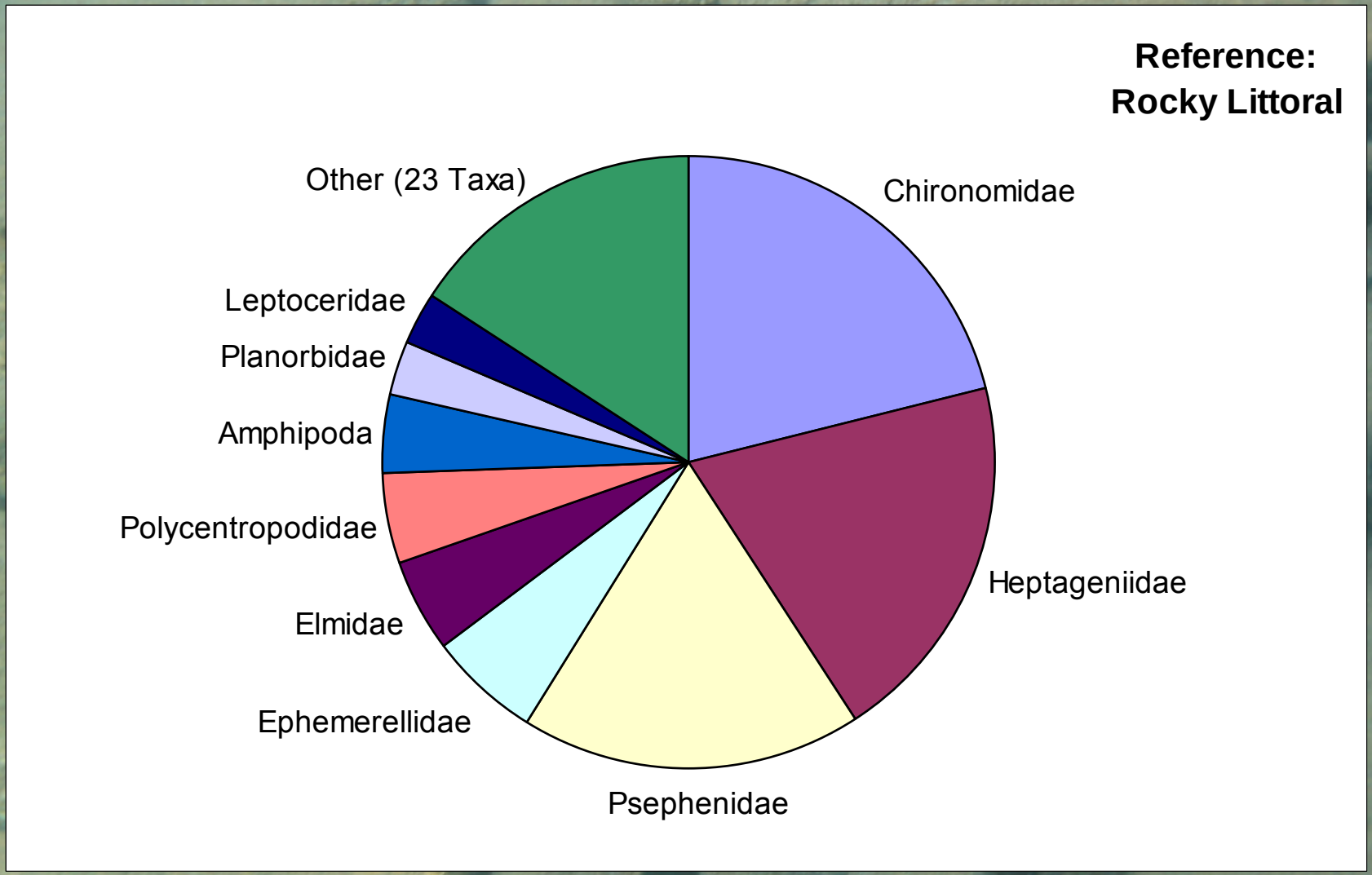
General Results - RL

- Rocky Littoral Samples:
  - Densities of animals:

    21 – 279 m^{-2} (mean = 88.7 ± 11.3 m^{-2})
    - Actual Numbers in Samples:

      64 - 836 (266.2 ± 33.8)
  - Most Common Taxa
    - Heptageniidae (19.7 ± 3.7)
    - Psephenidae (17.4 ± 4.2)
    - Chironomidae (15.6 ± 2.3)
    - Ephemerellidae (6.8 ± 2.4)

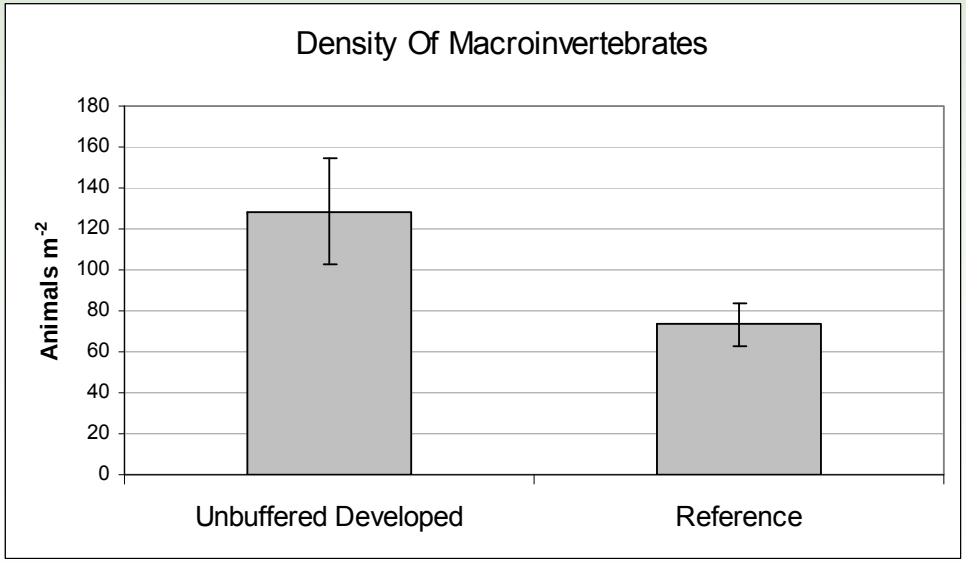
What does a reference Rocky Littoral macroinvertebrate community look like?

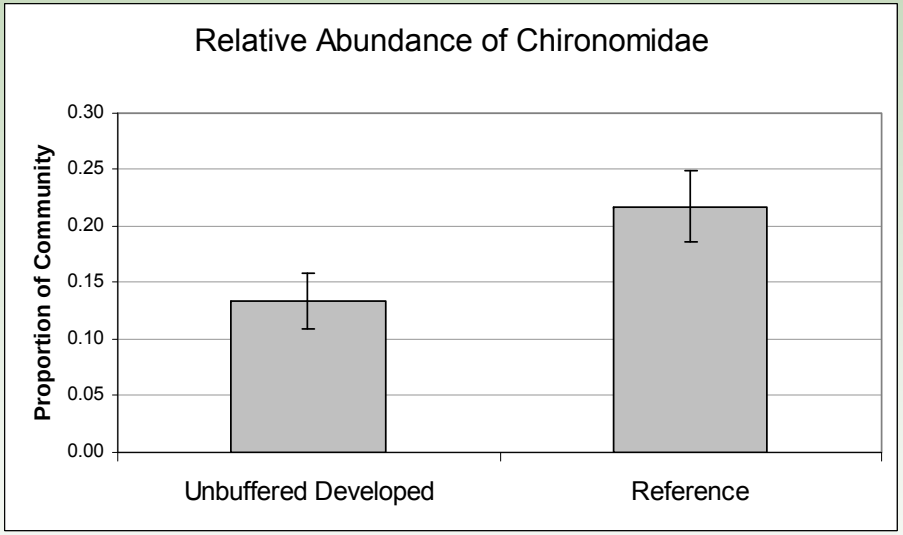


Rocky Littoral Results

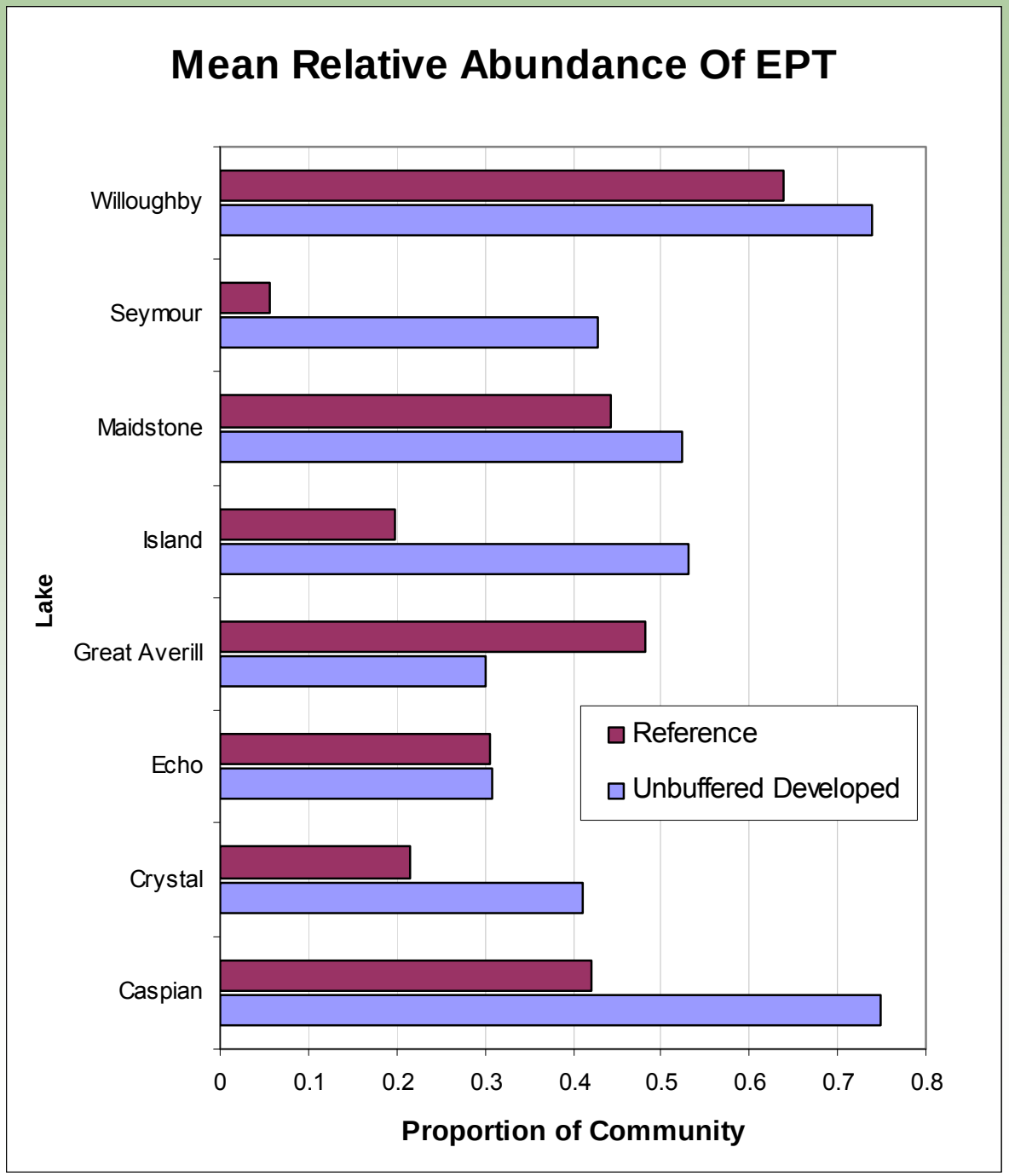
- Changes from Reference in some metrics

  - Macroinvertebrate Density
  - t-test: $p = 0.07$



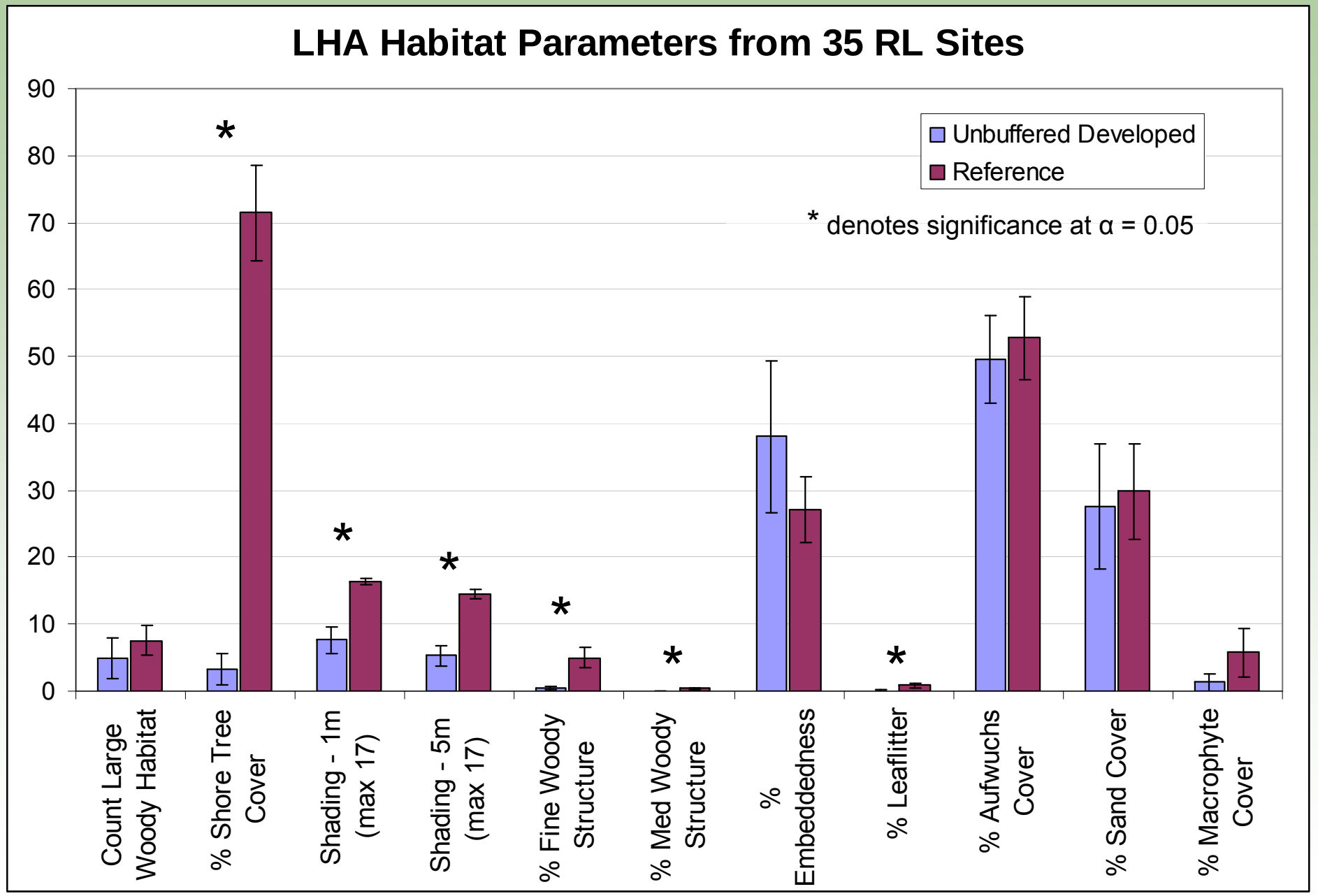


  - RA Chironomidae
    - t-test: $p = 0.04$
  - Densities roughly the same between development classes: ~15 m^{-2}



- Paired t-test, RA EPT:
  $p = 0.058$
- n = 1 for 6 Lakes
  - 5 Unbuffered Developed
- *Unbuffered Developed* consistently higher except for Great Averill Lake; Echo the same

LHA Habitat Parameters from 35 RL Sites



Discussion (*Beta Version*)

- **Main Question: Do the macroinvertebrates show a change from Reference Condition?**

- **Main Answer: Yeah, sort of…**

Discussion (*Beta Version*)

- RL/SL habitats similar across development classes
  - development class didn't appear to greatly influence community structure
  - Contrary to De Sousa et al. (2008), but they were looking at whole-lake variables
- Sandy littoral habitat poor for macroinvertebrates, regardless of development class
  - Especially in oligotrophic lakes
- Rocky littoral areas appear to have higher densities of macroinvertebrates near developed shorelines
  - Increased light, nutrients
    - Development may be enhancing primary production in otherwise nutrient poor habitat

Discussion (*Beta Version*)

- Rocky Littoral (cont.)
  - Unbuffered Developed sites generally showed higher EPT scores
    - Light, nutrients making habitat better for a variety of taxa
  - Greater RA of Chironomidae in reference RL Sites
    - Make up greater portion of the community in nutrient-poor "stressed" conditions
  - Other Studies:
    - De Sousa et al. (2008) – greater RL biomass in more developed lakes, but no change in community composition
    - Brauns et al. (2007) – greater densities in more developed lakes, but greater RA of Chironomidae with more development

Next Steps

- Finer taxonomy may elucidate some community/habitat relationships
- Use methodology developed here for further investigations:
  - More data for Large Oligotrophic, Rocky Unbuffered Developed sites
  - Sample littoral macroinvertebrates in different lake classes

Acknowledgements

- VT DEC Staff:
  - Eric Howe, Leslie Matthews, Susan Warren, Mark Mitchell, Neil Kamman, Steve Fiske, Rick Levey, Jim Kellogg, Heather Pembrook, Rich Langdon, Katie Chang, Aaron Moore, Jim Deshler
- Funding:
  - EPA Water Quality Monitoring Strategy and Performance Partnership Grants
  - Vermont Department of Environmental Conservation
  - USDA Forest Service Northeastern States Research Cooperative (NSRC)
  - Vermont Department of Fish and Wildlife - Wildlife Action Plan Grant