West Nile Virus, Mosquito Control, and Aquatic Invertebrates: Implications for Wetlands in Western Washington

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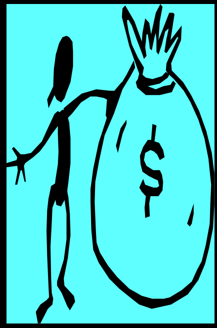
Acknowledgments



- **US Fish & Wildlife Service - Division of Refuge Operations Support Region 1**
- **US Geological Survey - Biological Resources Division**
- **Cooperative Research Units Program**
- **University of Washington - College of Forest Resources**

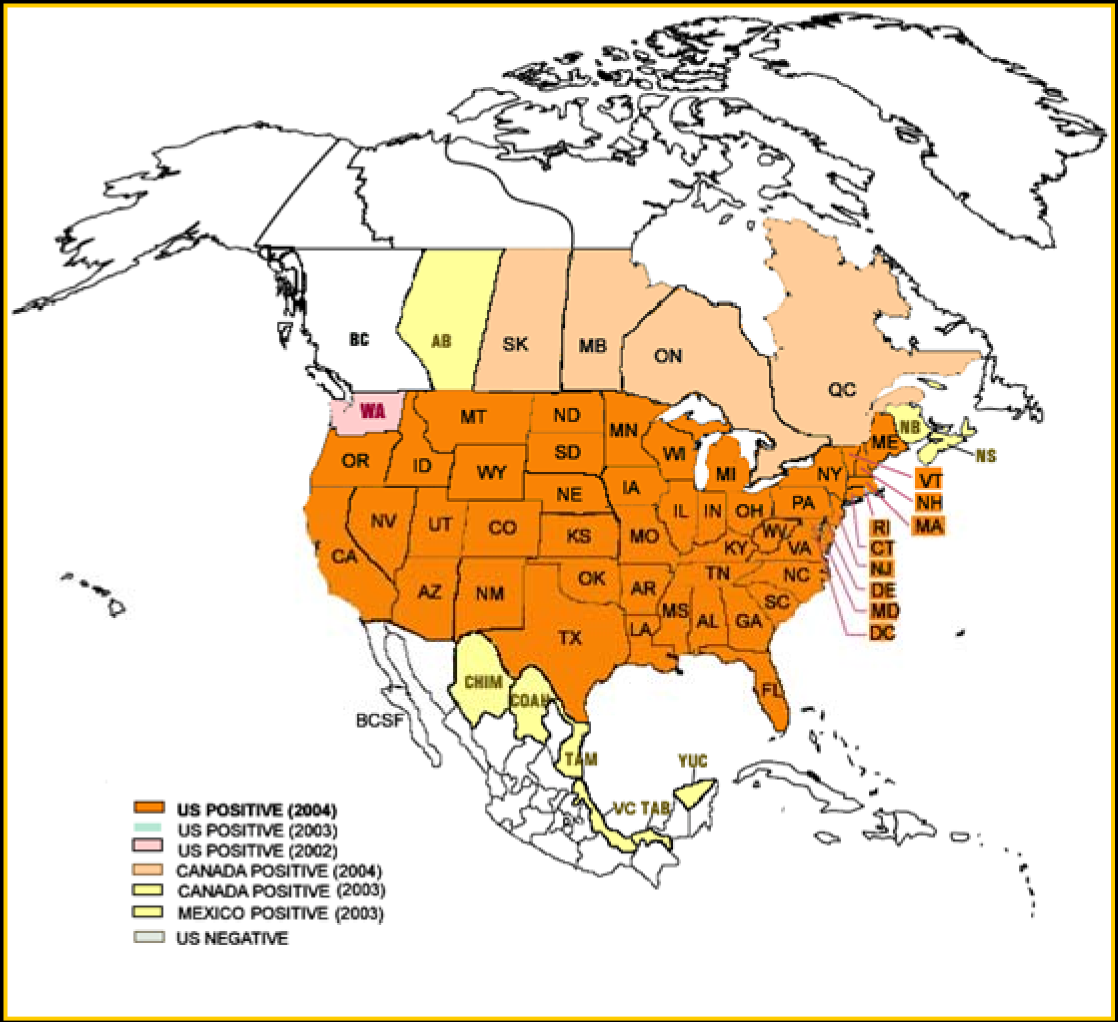
USFWS - Jim Clapp, Joe Engler, Sam Johnson, Sam Lohr, Kevin Kilbride, and Fred Paveglio. USGS - Sue Haseltine and Anne Kinsinger. CRU - Jim Fleming. UW Lab and Field Crew - Verna Blackhurst, Jenifer Cabarrus, Cat Curran, Martin Grassley, Kerensa King, Trevor King, Walter Major, Anna Ritchie, and Max Rogers. Skamania County Mosquito Control District - Nels Madsen and Bill Williams.

West Nile Virus

- **Isolated in 1937**
- **Family Flaviviridae**
  (St. Louis Encephalitis, Equine Encephalitises, Yellow Fever, Dengue Fever)
- **Humans - Asymptomatic infection & fevers in Africa, West Asia, Middle East**
- **No infections documented in Western Hemisphere until 1999**

CDC-USGS

West Nile Virus - September 2004



Also detected in:

- El Salvador
- Jamaica
- Dominican Republic
- Guadeloupe
- Puerto Rico

USGS-NWHC

Birds and West Nile Virus

- WNV primarily an avian virus
- 284 bird species from at least 51 families infected

- Corvids (American Crows, Blue Jays) very susceptible
- 1999-2002 - >57,000 dead crows collected

CDC-AUDUBON

Other Animals and West Nile Virus

~ 29 mammal spp.

2 reptile spp.

CDC-AUDUBON

Vectors of West Nile Virus

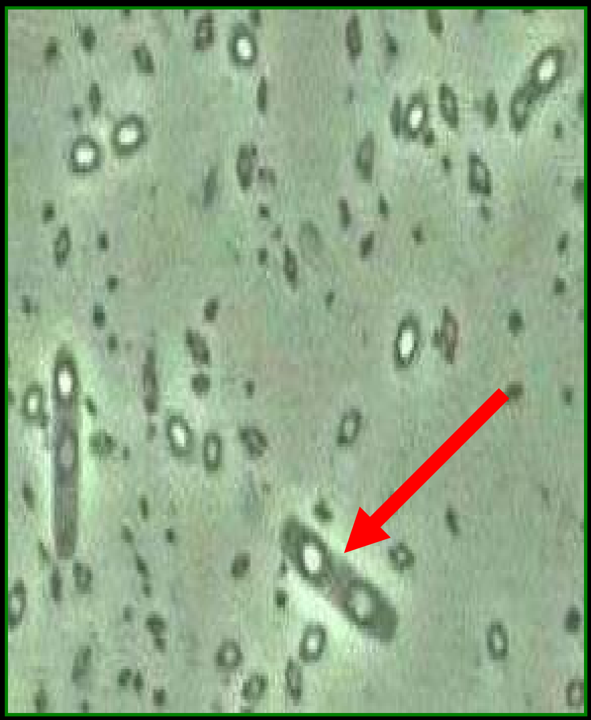
- 60 mosquito species linked to WNV
- Genus *Culex* - likely main vector of WNV

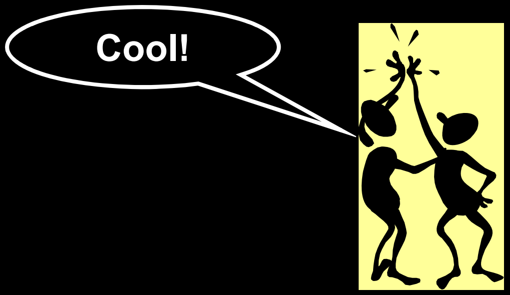
- Many *Culex* spp prefer birds over mammals
- *Culex* spp - active dawn and dusk

CDC-AUDUBON

Vector Control

Bti





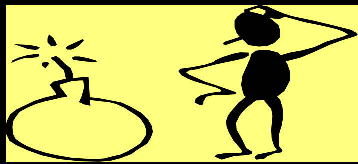
- **Bti (*Bacillus thuringiensis israelensis*)**
- **Discovered in Israel in 1976**
- **Aerobic bacteria**
- **Protein crystal endotoxin**
- **Active only if ingested & solubilized in the high pH of the midgut of certain insect larvae**

Bti activity mostly restricted to Nematocera (Diptera)

Most susceptible:

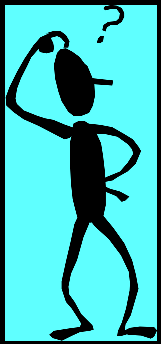
Culicidae	Simuliidae	Chironomidae
		

Bti - little direct or indirect effects on non-target benthic invertebrates (Lacey & Merritt 2003) BUT……

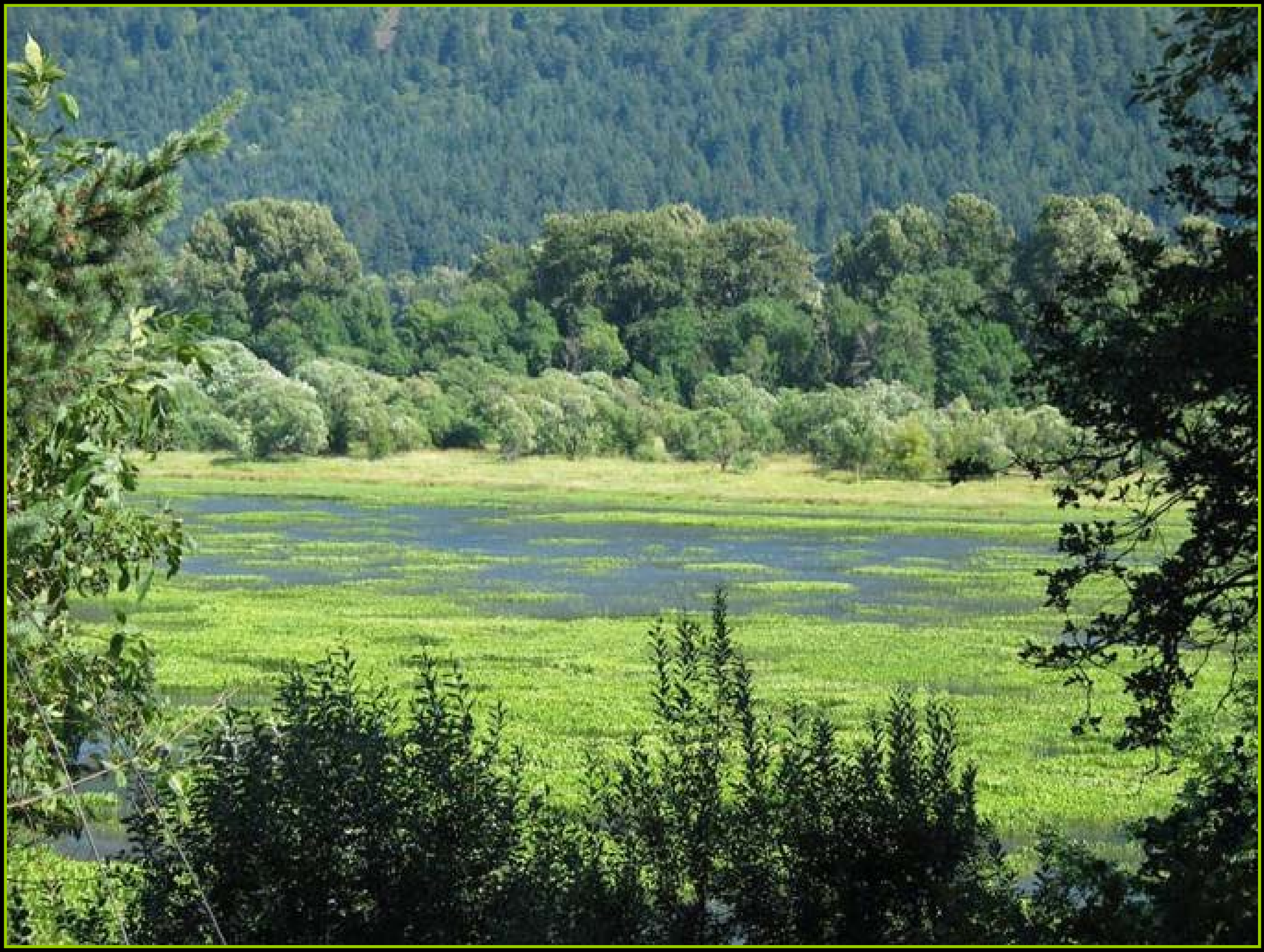


The Issues……

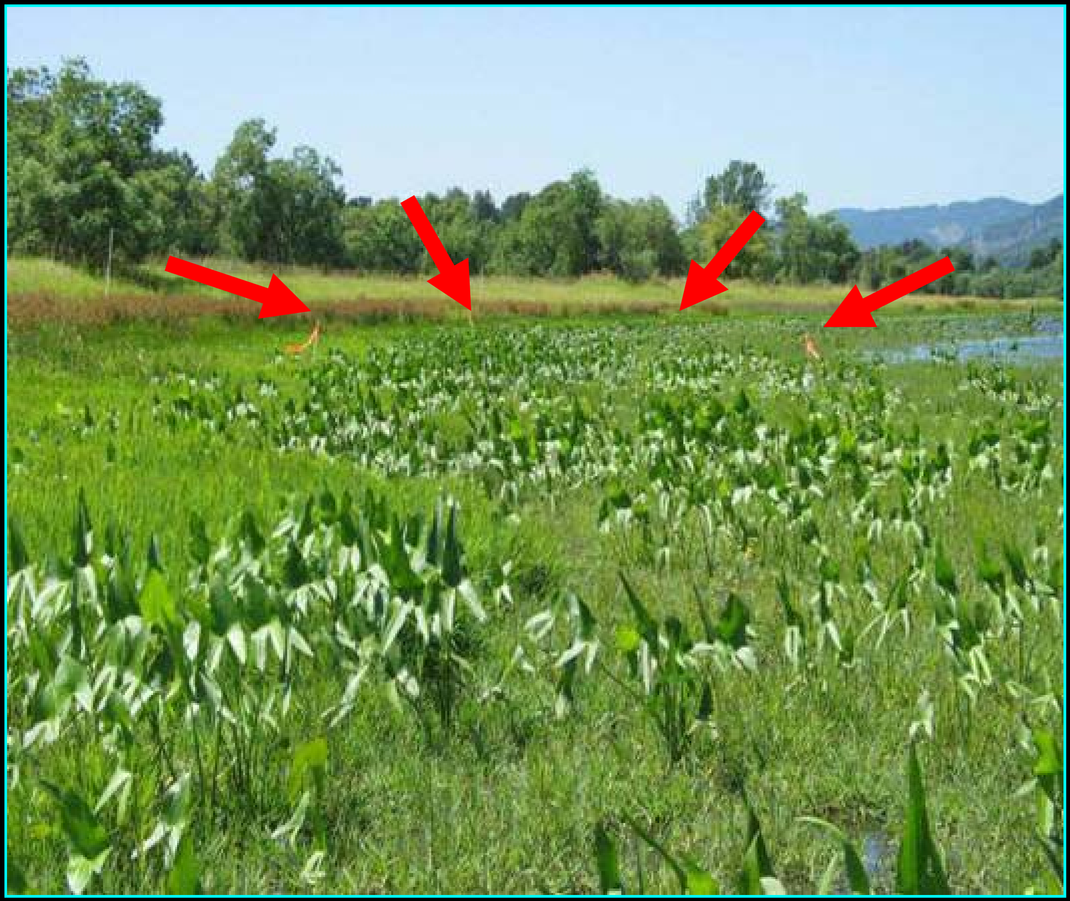
- Food web disruption - loss of prey biomass
- Minnesota wetland study - 3 yrs of Bti treatments
  1^{st} yr - minimal effects on non-target organisms
  2^{nd} yr - significant reductions in several insect groups
  3^{rd} yr - communities depauperate in most insects
  (Hershey et al. 1998)
- NWRS Improvement Act (1997)
  conservation plans & compatibility



Franz Lake NWR Study



Methods - Study Plots



- Each Plot = 40 m x 6 m
- 4 Control Plots
- 4 Treatment Plots
- Control & Treatment Plots Alternated
- 50 m buffer between plots

Mosquito Monitoring & Sampling

Bti Treatments (7.8 kg/ha)

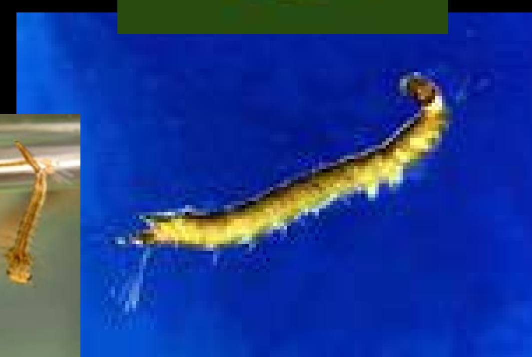
Results - Franz Lake Study

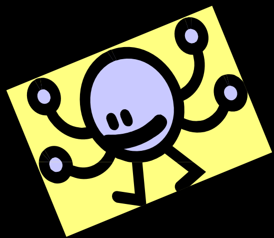
- Diverse community - >40 taxa
- Oligochaeta and Cyclopoida most common taxa
- 23-42% Oligochaeta and 20-22% Cyclopoida

- Insect families (28) represented >50% of the total number taxa
- Most were Coleoptera (6) and Diptera (11)
- 5% Coleoptera and 14-16% Diptera

More Results - Franz Lake Study

- Diptera families - 6 Nematocera
- Ceratopogonidae (biting midges)
- Chironomidae (non-biting midges)
- Dixidae (dixid midges)
- Culicidae (mosquitoes)
- Psychodidae (moth flies)
- Tipulidae (crane flies)





More Results – Within Spray Events

Before Spray 1

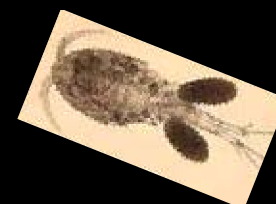
- Taxa richness & abundance (most taxa) similar in control and treatment plots.
- Control Plots – Water samples: < Ceratopogonidae, Tabanidae, Harpacticoida, and Oligochaeta. Benthic samples: < Stygothrombidiidae and Chydoridae. BUT all (except Oligochaeta) had < 1 individual / L ($p \leq 0.03$, $t \leq -2.3$, d.f.=31- 42)

Spray 1

- Taxa richness & abundance NOT significantly different between control and treatment plots

More Results – Within Spray Events

Spray 2

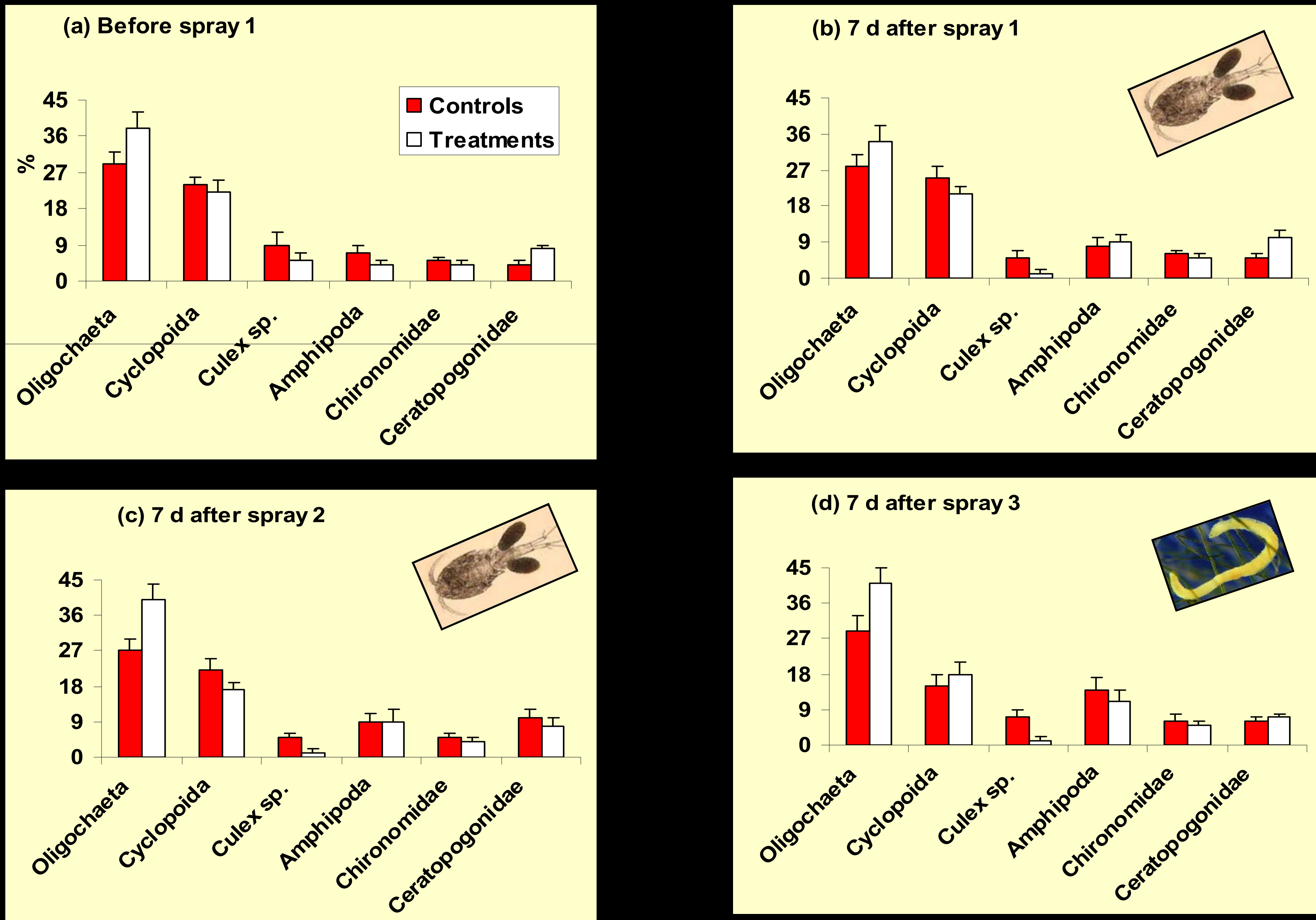


- **Taxa richness & abundance similar in control and treatment plots**
- **Control Plots – Benthic samples: > Cyclopoida (3 times more; p=0.03, t=2.3, d.f.=37)**

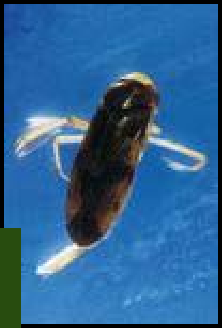
Spray 3

- **Taxa richness & abundance similar in control and treatment plots**
- **Control Plots – Water samples: > *Culex* spp. (1.5 *Culex* spp./L vs. 0.2 *Culex* spp./L, p=0.03, t=2.3, d.f.=33)**

More Results – Percent Relative Abundance



More Results – Across Spray Events



Taxa richness

- Same between control & treatment plots
- 12 taxa water column, 6 taxa benthos

Taxa abundance

- Similar between control & treatment plots
- Ceratopogonidae - Control plots < Treatment plots
  (1.0 Ceratopog./L vs. 2.0 Ceratopog./L, $p=0.01$, $t=-2.6$, $df=202$)
- *Culex* spp. – Control plots > Treatment plots
  (1.2 *Culex* spp./L vs. 0.6 *Culex* spp./L, $p=0.01$, $t=2.7$, $df=197$)

Conclusions

- **Franz Lake - Diverse community - >40 taxa**
- **Oligochaeta and Cyclopoida most common taxa**
- **Overall taxa richness and abundance similar between control and in treatment plots**
- **3 Bti spot treatments in one season had no significant effects on the invertebrate communities**
- **However, unclear if cumulative long-term effects will occur if multi-year treatments applied**


Done!