Comparison Of Benthic Invertebrate Community Structure And Diet Composition Of Steelhead (*Oncorhynchus mykiss*) In Dry Creek, California

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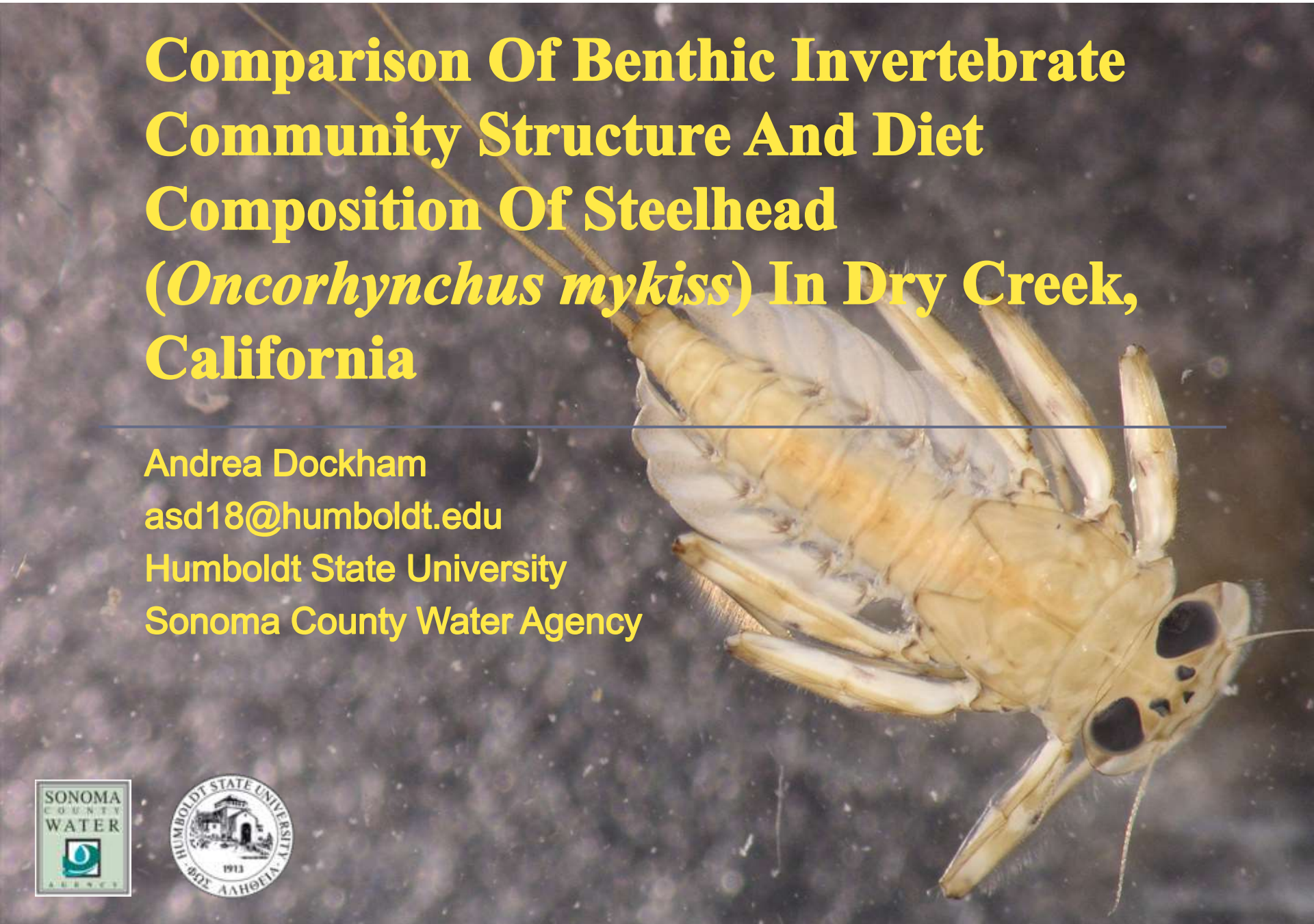


Dry Creek

- Located in Sonoma County
  - Average precipitation 110cm per year
  - Fourth order tributary of the Russian River
  - Alluvial bed mostly gravel Riffle-pool sequence
  - Home to federally threatened steelhead and Chinook Salmon and endangered Coho Salmon (Central California Coastal ESU)

Dry Creek

- Warm Springs Dam
- River conditions
  - Historical
    - Intermittent stream
    - Disconnected pools in the summer and fall
    - Peak discharge 3 orders higher in magnitude in winter
  - Current
    - Perennial stream
    - Loss of habitat heterogeneity
    - Less seasonal variability in flow

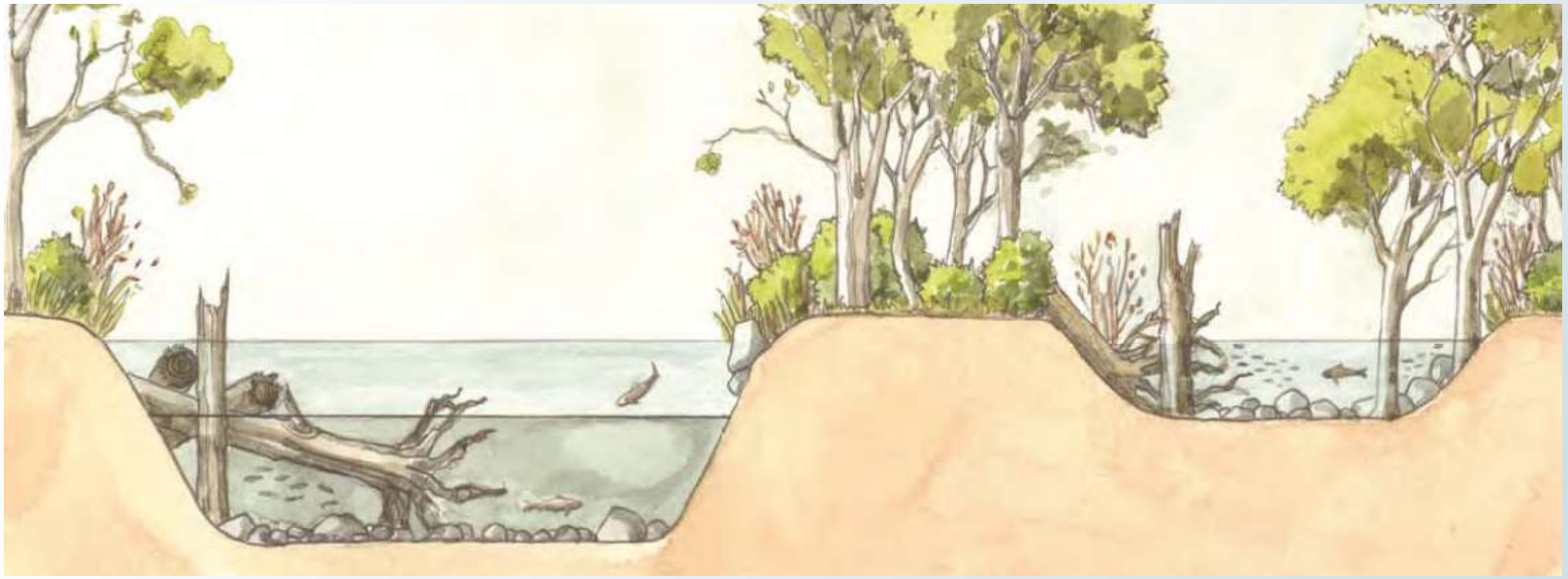
Russian River Biological Opinion

- Warms Springs Dam
  - Affected sediment transport and altered riparian vegetation.
  - Highly incised, narrow river that lacks natural sinuosity and quality habitat.

- Municipal water demands
  - summer flow rate of 30.5 to 53.3 m^3/s
- Lack of winter and summer rearing habitat and high velocities are negatively affecting steelhead and Coho.

Dry Creek Habitat Enhancement

- Increase the availability of high quality summer rearing and winter refugia habitat
- 6 miles of Dry Creek
- Various habitats include:
  - Channels
  - Backwaters



Validation Monitoring

- 2011 RRBO Status Report-
  - Growth rates of steelhead in were lower in the upper reach than in the lower reaches
- Low growth rates may be caused by altered stream geomorphology and hydrology.

- While physical attributes of a river are often identified as key factors limiting salmonid growth and survival…

Biological factors are important as well

Abundant food resources are required to support high growth, even when physical habitat and water quality are favorable (Dill et al. 1981).

- Extensive data set of physical characteristics of Dry Creek

However…

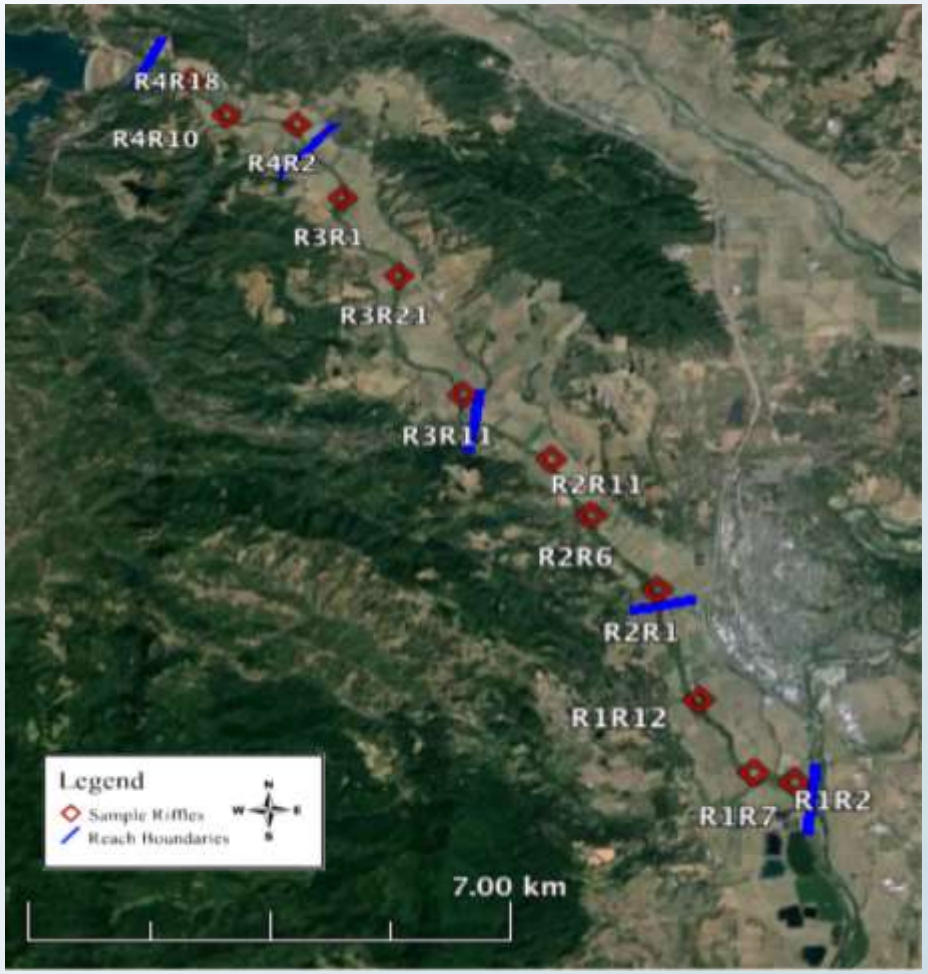
- Little is known about structure of aquatic invertebrate assemblages and diet composition of salmonids in Dry Creek

Objectives

- Characterize and compare the structure of benthic invertebrate communities in contiguous reaches of Dry Creek.
- Evaluate reach-specific prey selection by young of the year (≥60 mm) steelhead.
- Evaluate reach-specific correspondence of diet composition with condition of juvenile steelhead trout.

Study Area

- Warm Springs Dam to confluence with Russian River (22.4 RKm)
- Reaches based on sediment input
- Sample riffles chosen randomly



Methods- Benthic Invertebrate Sampling

Sampling:

- Spring and Fall 2013
- Three samples per riffle
  - 36 samples per sampling event
  - 72 samples total
- Samples:
  - Collected with a kicknet
  - Preserved in 70% ethanol
- Habitat data

Methods- Benthic Invertebrate Sampling

- Each sample was subsampled:
  - Approximately 300 individuals per sample
  - Gridded tray, random number table
- Individuals from each subsample:
  - Identified
    - Insecta: Genus
    - Non-Insecta: Order or lower
  - Measured (mm)
  - Enumerated

Methods- Steelhead Diet Sampling

Sampling

- Occurred fall 2013
- At least 20 steelhead per reach
  - 86 diet samples total
- From each steelhead:
  - Length (mm) and weight (g)
  - Gut samples were taken using gastric lavage
- Samples preserved in 70% ethanol

Lab Work-up

- Individuals from each samples were:
  - Identified
    - taxonomic level coarser then benthic samples
  - Measured (mm)
  - Enumerated

Statistical Methods

Benthic Invertebrate Data

- Non-metric multidimensional scaling (NMDS) ordination plots
  - Covariate vectors
- Community metrics
- Permutation MANOVA
  - Categorical data:
    - Season, reach ID

Fish and Diet data

- Multiple response permutation procedure (MRPP)
  - Bray-Curtis dissimilarity
- Relative abundance
- Relative condition
  - L/W regression
- Linear regression?

  ANOVA

Results- Benthic Invertebrates

- 71 taxa were identified
  - Mostly Insecta
- Taxonomic richness per riffle
  - Highest: 39 (riffle R4R18, fall 2013)
  - Lowest: 21 taxa (riffle R1R7, spring 2013)
- Dominant three taxa

Spring Samples

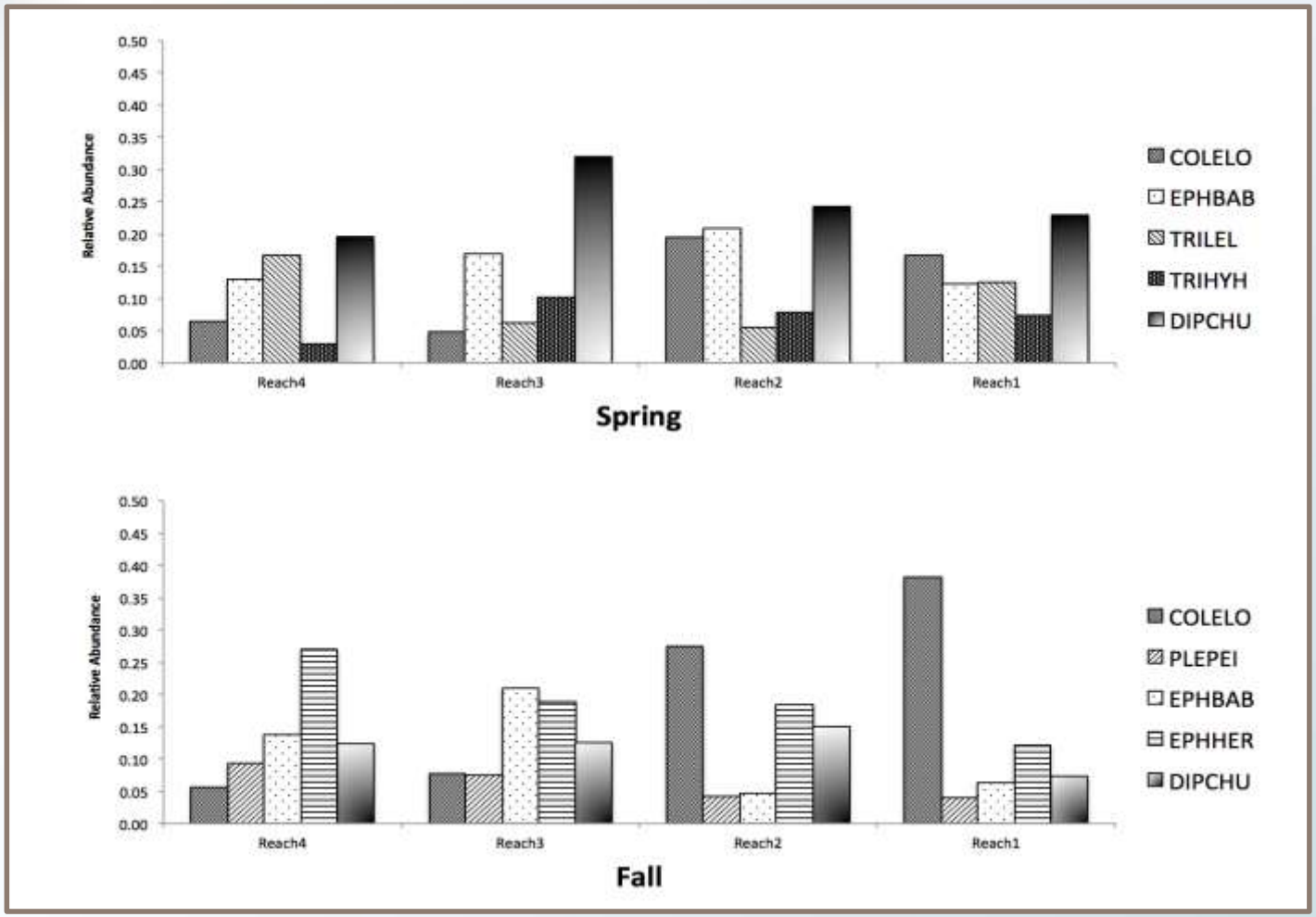
Optioservus *Baetis* Chironomidae

Fall Samples

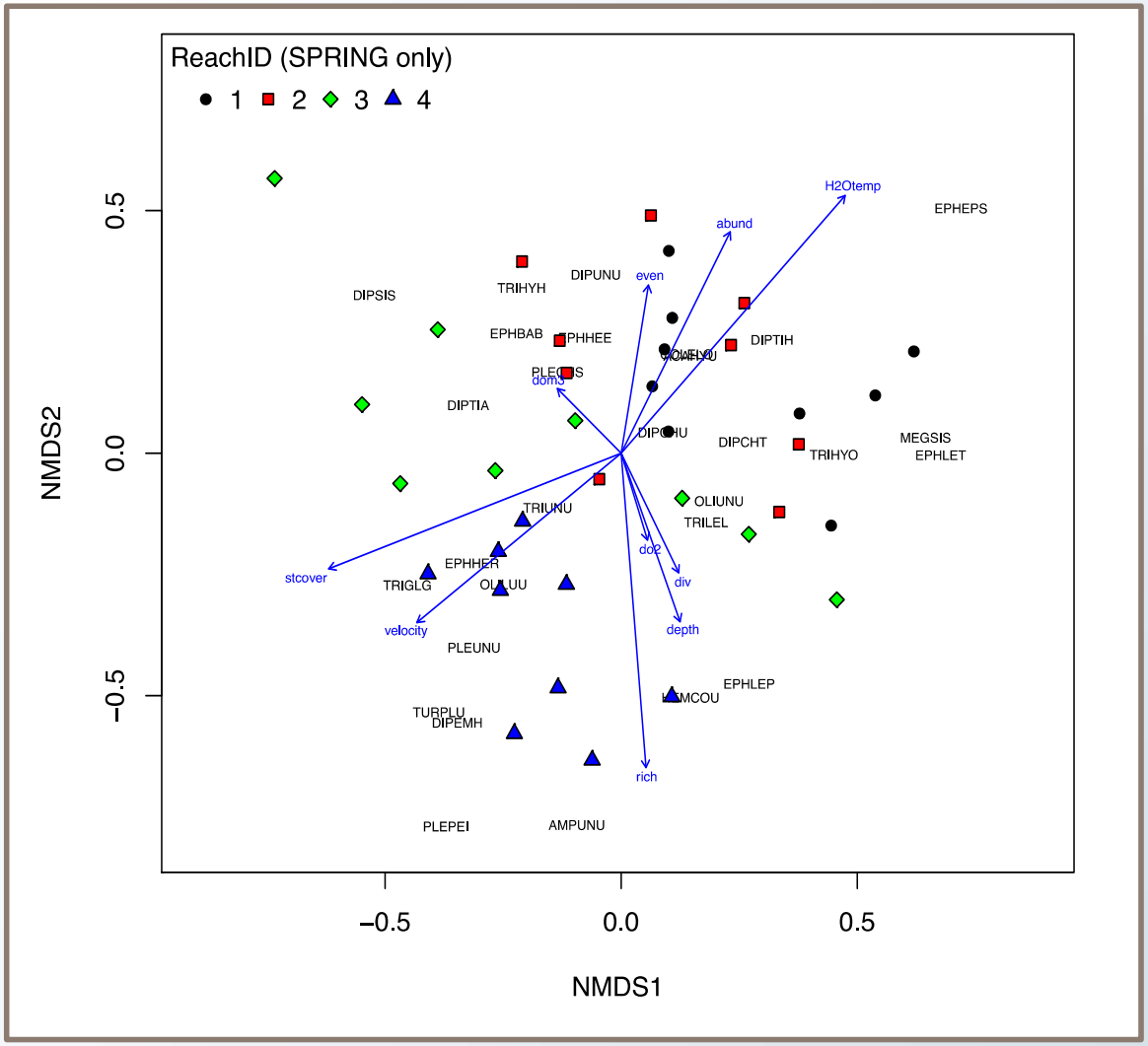
Optioservus *Rhithrogena* Chironomidae

- MANOVA- Variability: Season:18%, Reach: 12%

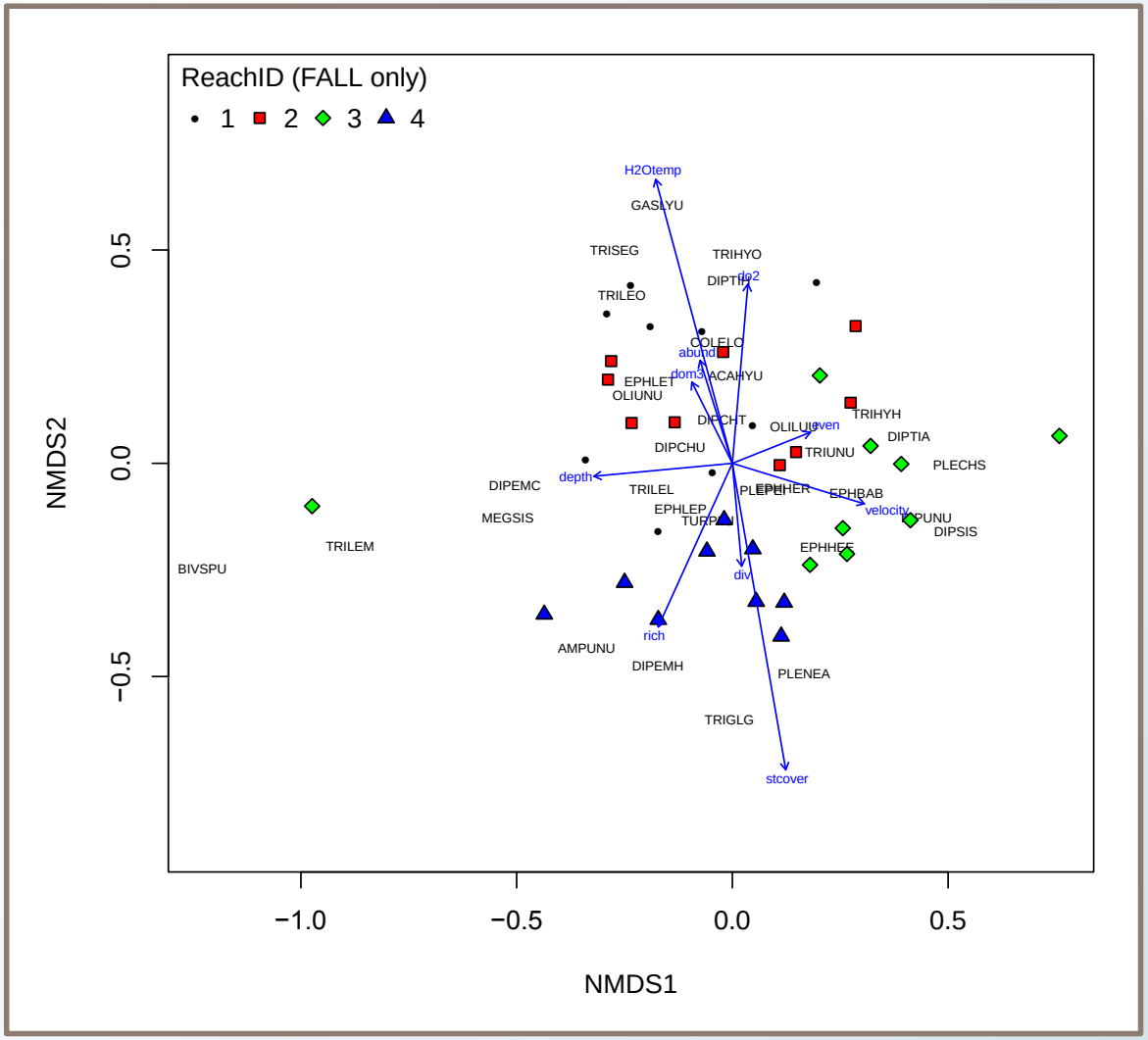
Results- Benthic Invertebrates



Results- Benthic Invertebrates



Results- Benthic Invertebrates



Discussion- Benthic Invertebrates

- Taxa more abundant in certain reaches:
  - Ex: *Optioservus*
- Gradient of relative abundances in fall samples.
  - Ex: *Rhrithrogena*
- Main factor causing sample to be grouped by reach may be stream temperature.
- Higher species richness in reach 4

Results- Diet and Fish Condition

Diet Composition

- 68 taxa were identified
  - 14 taxa were not found in benthic samples
    - 7 were strictly terrestrial
- MRPP: Diet composition differed among reaches ($p<0.05$)

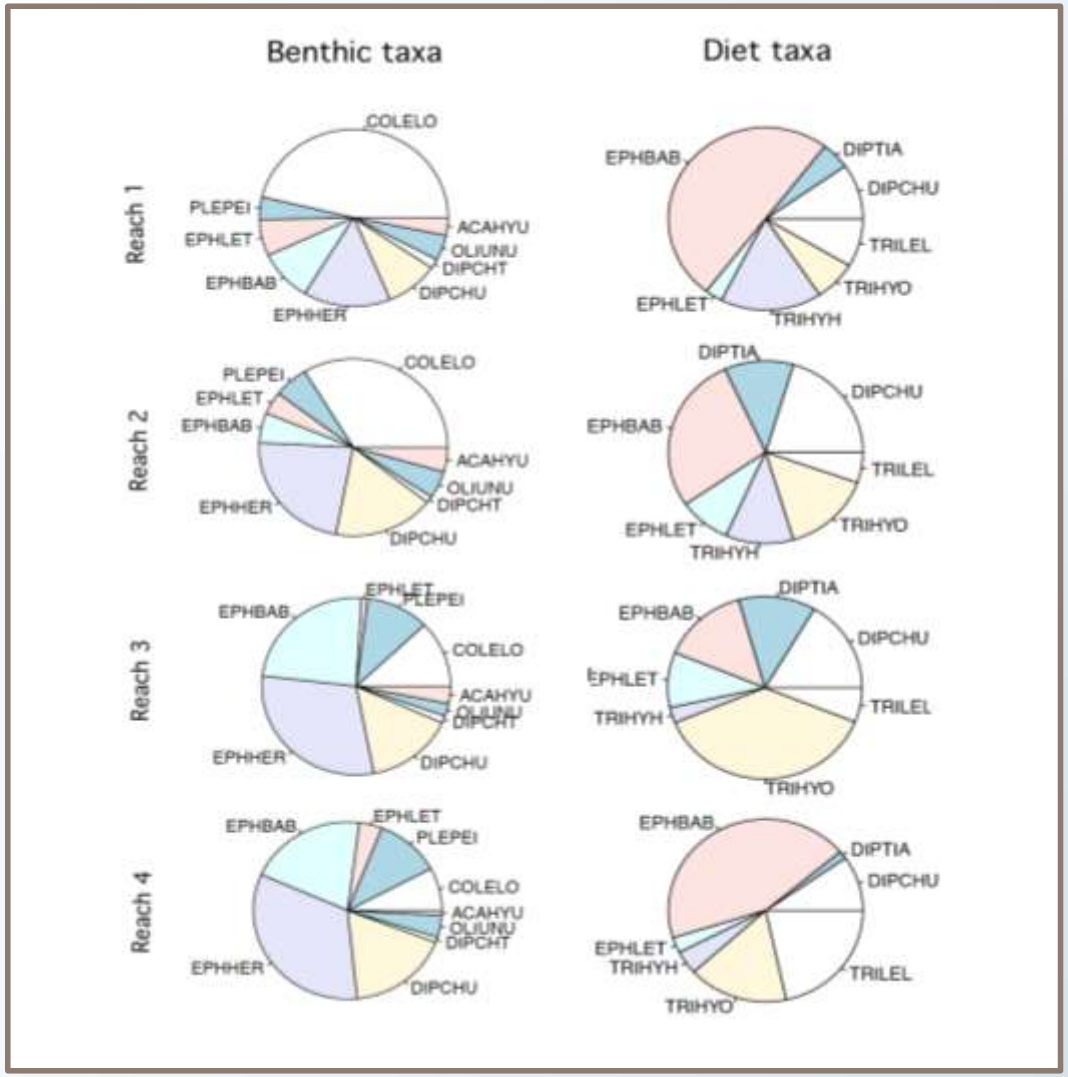
Relative Condition

- ANOVA:
  - Relative condition of fish differed between reaches ($p<0.05$)
  - Metrics of fish diets did not differ
  - Linear regression was not performed

Results- Prey Selection

Fall benthic samples		Fall diet sample	
Taxa	Relative abundance	Taxa	Relative abundance
Optioservus	0.20	*Baetis*	0.23
Rhithrogena	0.19	*Ochrotrichia*	0.11
CHIRONOMIDAE Sp.	0.12	CHIRONOMIDAE Sp.	0.09
Baetis	0.11	*Lepidostoma*	0.07
Isoperla	0.06	*Hydropsyche*	0.06
Lepidostoma	0.04	*Simulium*	0.05
OLIGOCHAETA Sp.	0.03	*Isoperla*	0.05
Tricorythodes	0.03	*Antocha*	0.05
Hydropsyche	0.02	*Tricorythodes*	0.04
ACARI Sp .	0.02	OLIGOCHAETA Sp.	0.03

Results- Prey Selection



Discussion- Diet and Fish Condition

- No obvious relationship between benthic invertebrate community structure and diet in fall or within reaches.
  - Fish mobility between reaches
  - Other sources of food (drift)
  - Fish eating selectively
- Relative condition of fish differed between reaches,
- However, metrics considered for linear regression were not.
  - Does not say that diet is not a factor affecting fish condition
  - Limitations to sampling events.

Conclusion

- Benthic invertebrate community structures were different among reaches and may be caused by dam related changes to Dry Creek.
- No strong evidence of benthic invertebrate assemblages influencing diets
- No strong evidence that food availability is affecting fish condition
  - However cannot draw hard conclusions from my study.

Further Research

- Sample drift and benthic and terrestrial sources of food to get a better picture of fish diet selectivity.
- Stand alone study of fish condition and diet that incorporates physical attributes of the study area.

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Questions?

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