

Irrigation ditches are novel agricultural streams that contribute to aquatic insect emergence in Gallatin Valley, MT



Nate Heili & Wyatt Cross

Department of Ecology, Montana
State University



Acknowledgements

Committee:

Wyatt Cross, Advisor
Lindsey Albertson
Rob Payn
Scott Powell

Cross Lab Members:

Jose Sanchez-Ruiz
Eric Scholl
Russel Conti
Albertson Lab members



Technicians:

Lilly Strong
Ian Uland
Dakota Rygh
Kieran Wilder
Charles Miller



Rivers and their adjacent floodplain are one of the most diverse ecosystems on Earth



Humans use and develop near rivers

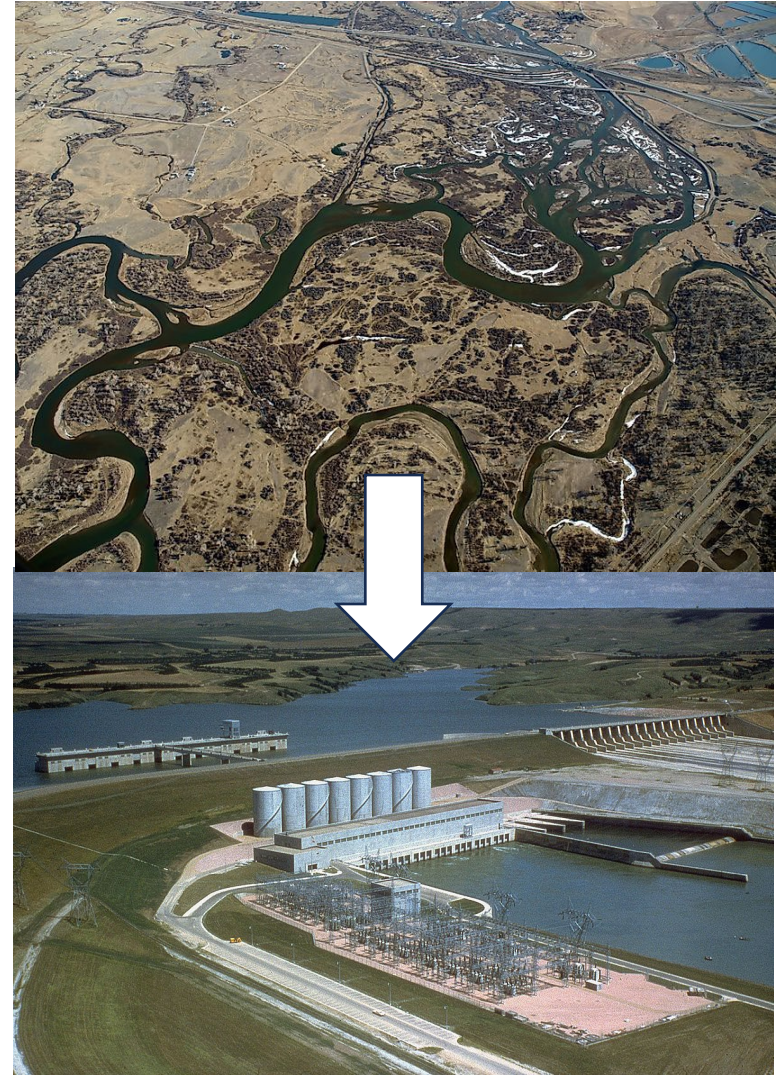
Proximity to water,
fertile soil



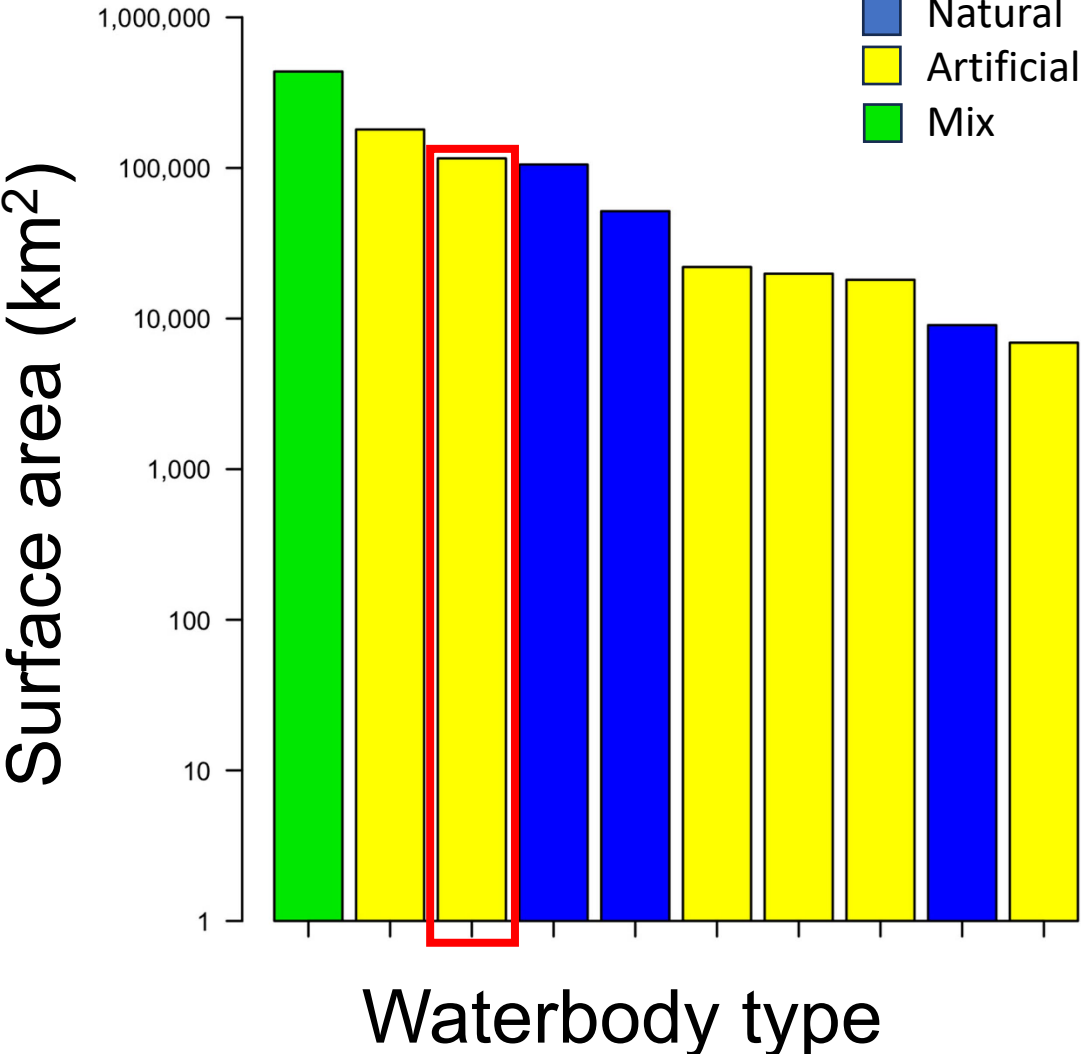
Control complexity



Engineered ecosystem



Artificial waterways are ubiquitous

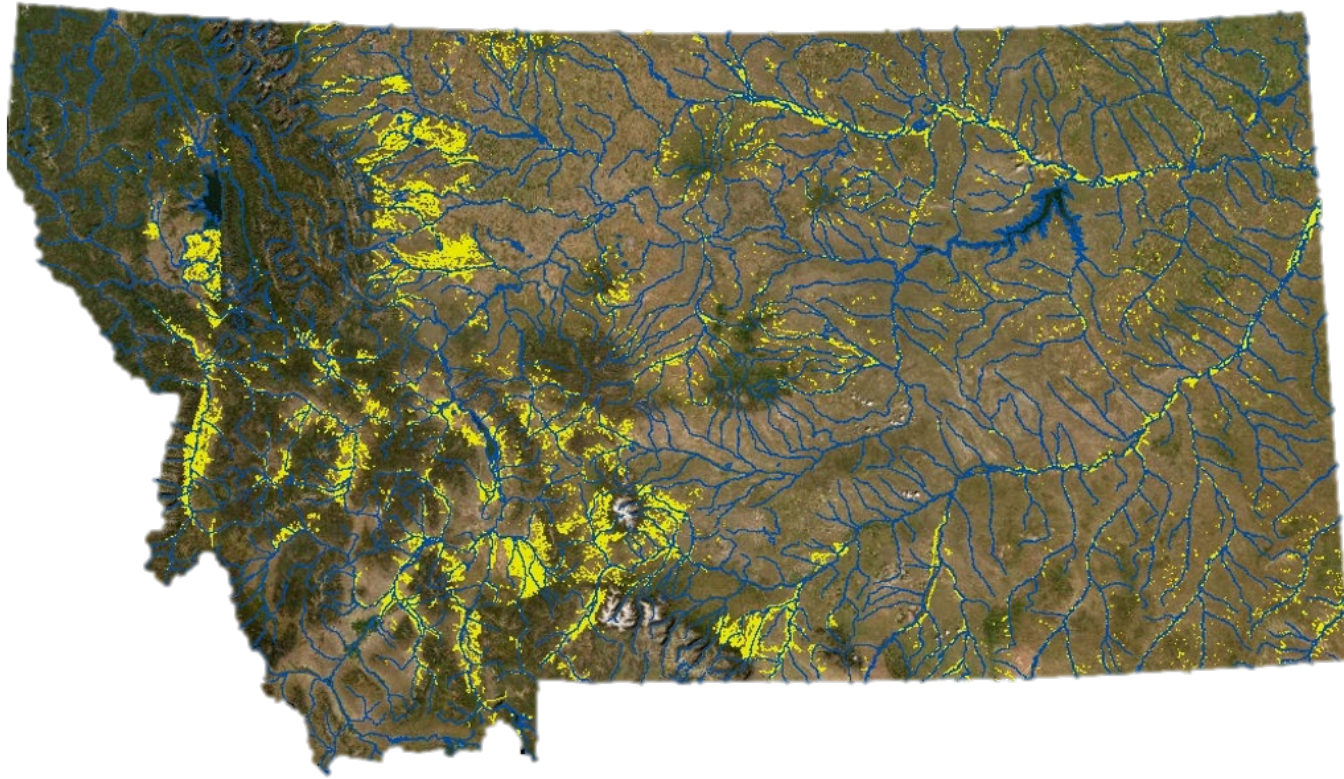


12% of total surface area is 'Ditches from agriculture'



Modified figure from Clifford and Heffernan 2018

Ditches are essential in Montana



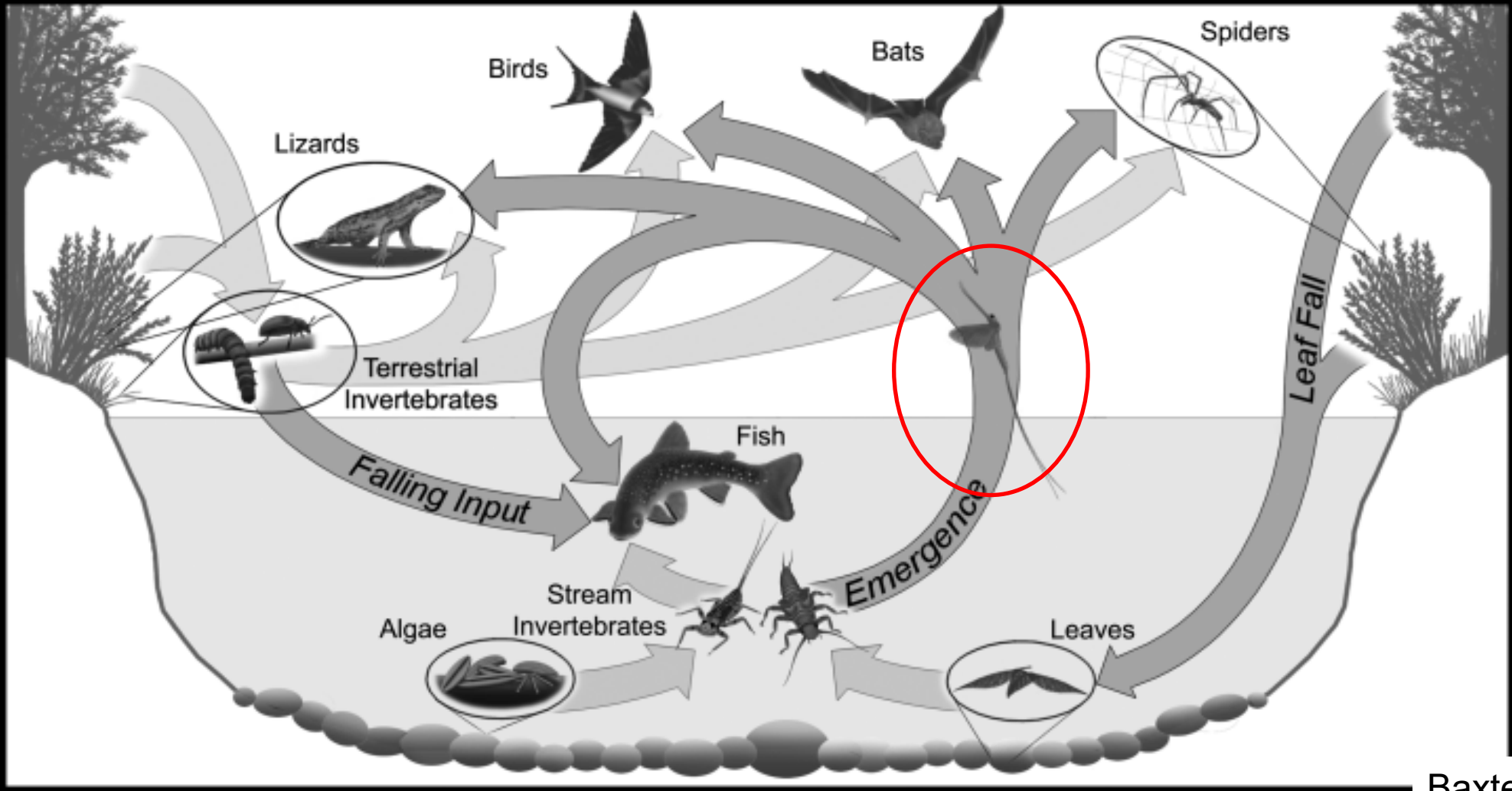
- Natural stream
- Irrigation ditch



What is the contribution of ditches to ecological processes?



Potential for water-to-land energy transfer via aquatic insect emergence



Gallatin Valley, MT



Research Questions:

What is the spatial extent of the irrigation ditch network in Gallatin Valley, MT?

What is the magnitude and taxonomic composition of aquatic insect emergence in irrigation ditches in Gallatin Valley, MT?

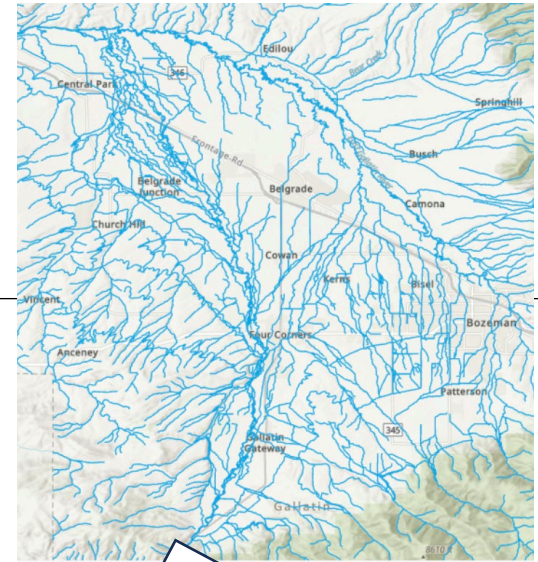
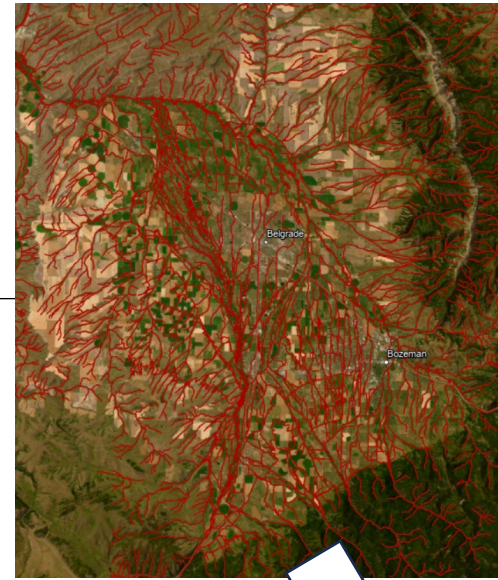
Mapping

Data sources: Gallatin County waterways, previous mapping efforts

Lower Gallatin Watershed boundary (MT DEQ)

ESRI aerial imagery for 'new' ditches

Geoprocessing tools for waterway length estimates



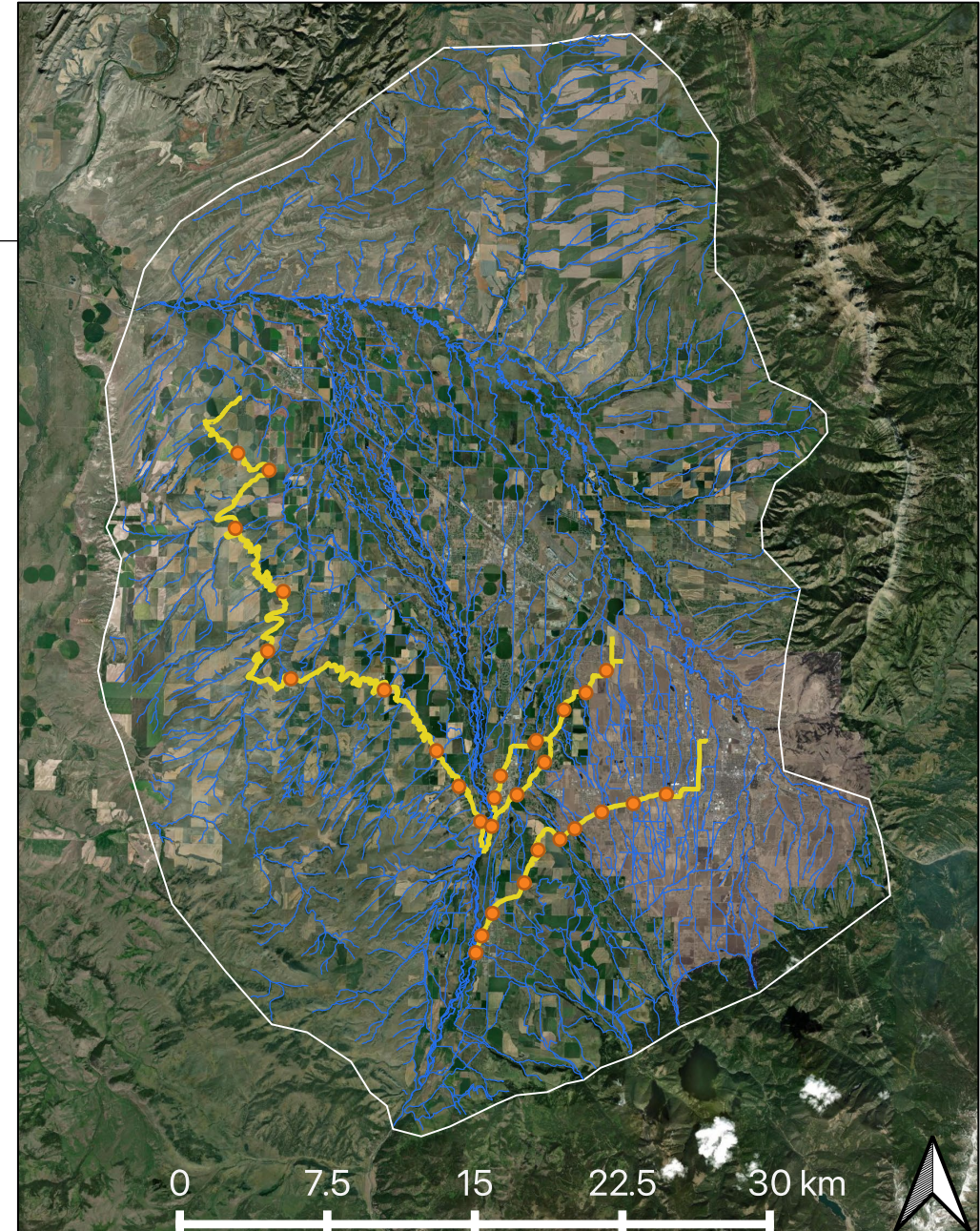
Insect emergence

4 ditches, 30 total sites, 3 replicates / site

Sampled weekly from June - November 2022

Image-J for identification and length measurements

Converted to flux estimate



Insect emergence

4 ditches, 30 total sites, 3 replicates / site

Sampled weekly from June - November 2022

Image-J for identification and length measurements

Converted to flux estimate



Insect emergence

4 ditches, 30 total sites, 3 replicates / site

Sampled weekly from June - November 2022

Image-J for identification and length measurements

Converted to flux estimate



Insect emergence

4 ditches, 30 total sites, 3 replicates / site

Sampled weekly from June - November 2022

Image-J for identification and length measurements

Converted to flux estimate



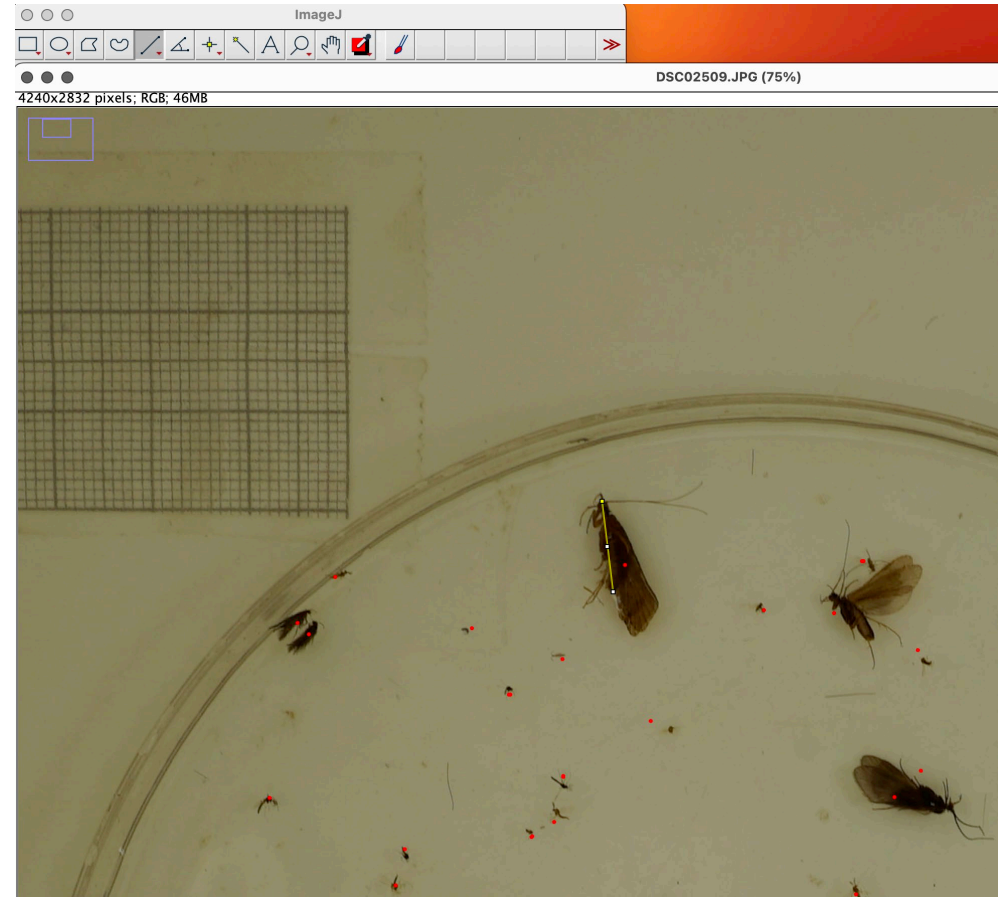
Insect emergence

4 ditches, 30 total sites, 3 replicates / site

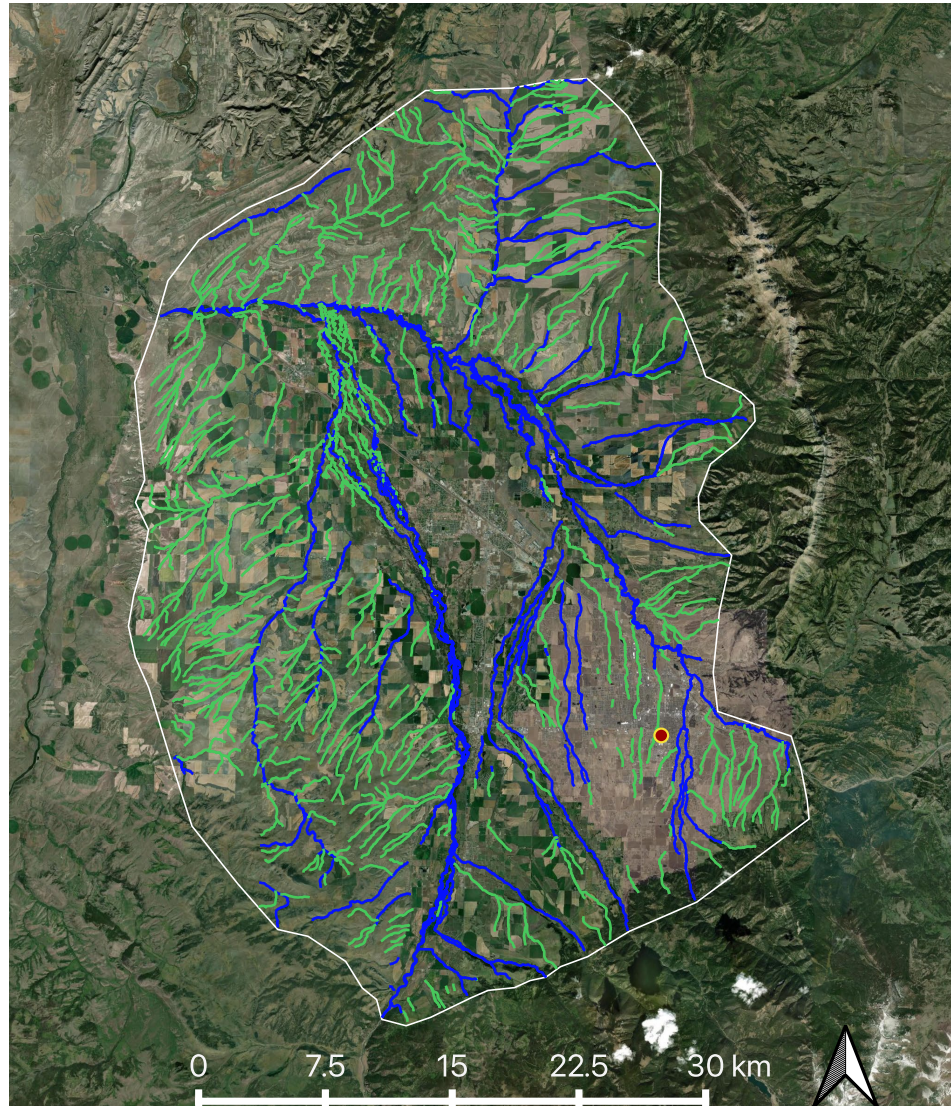
Sampled weekly from June - November 2022

Image-J for identification and length measurements

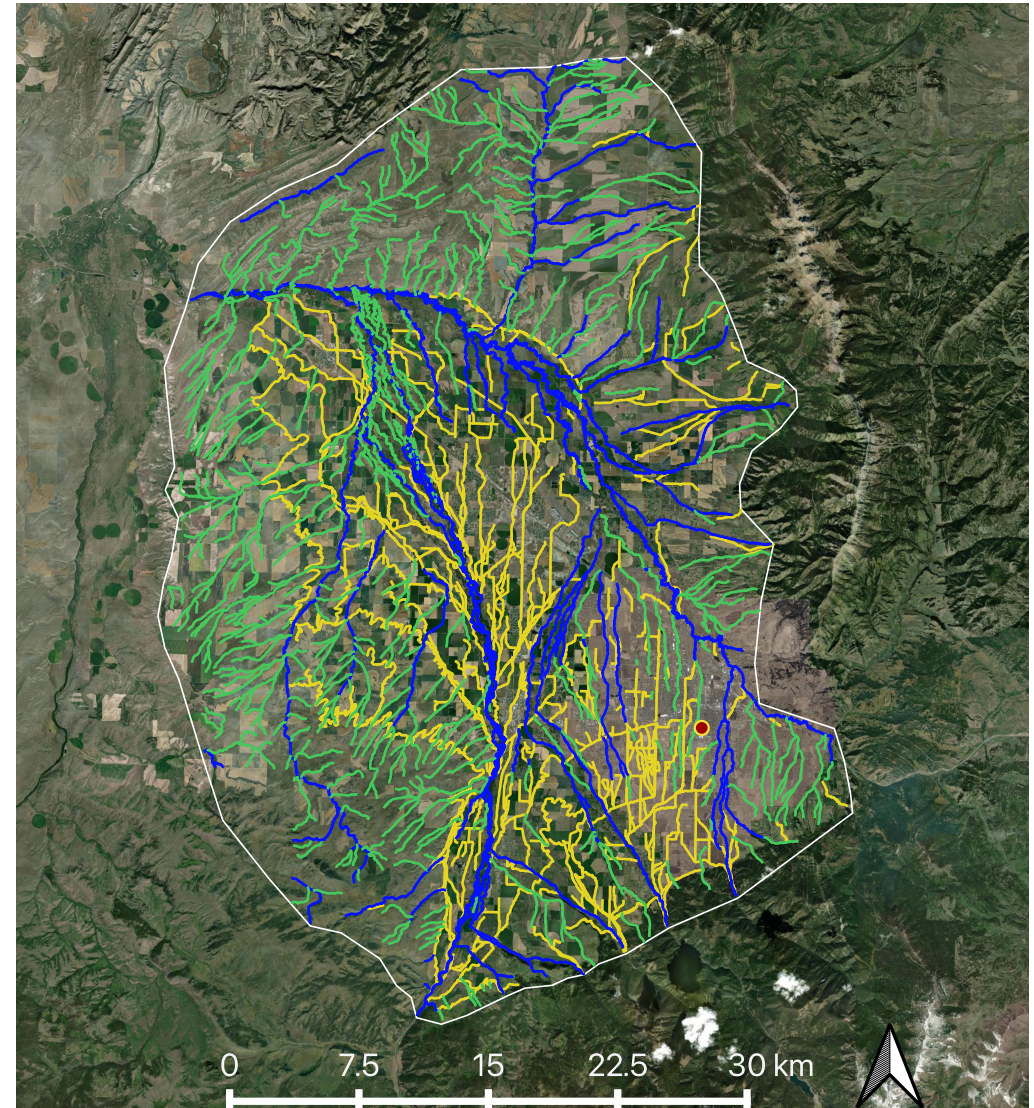
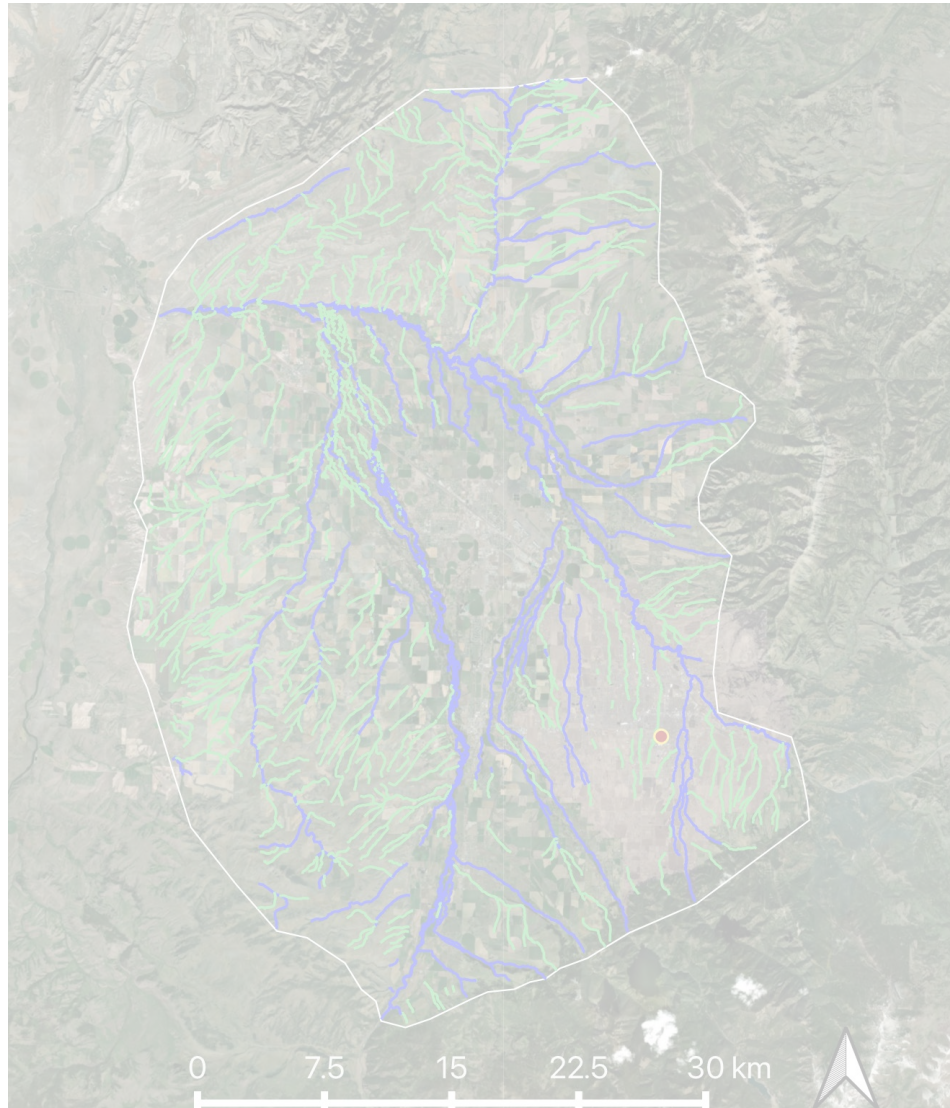
Converted to flux estimate



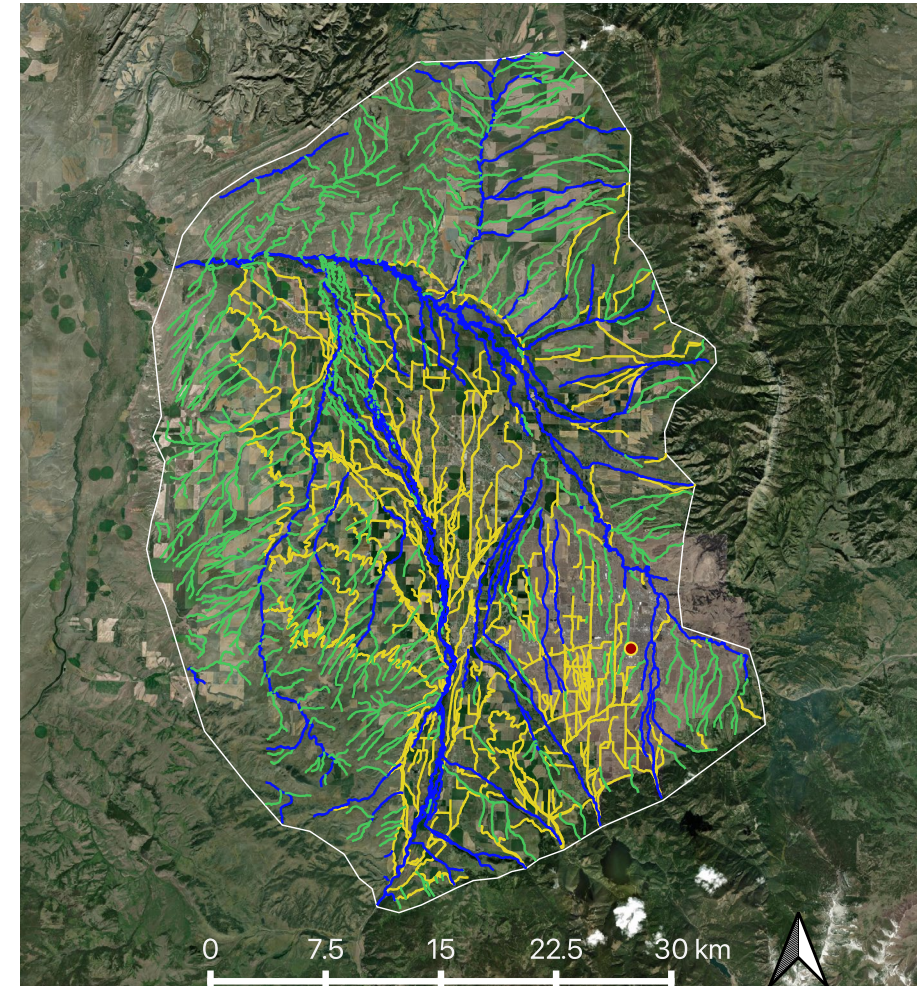
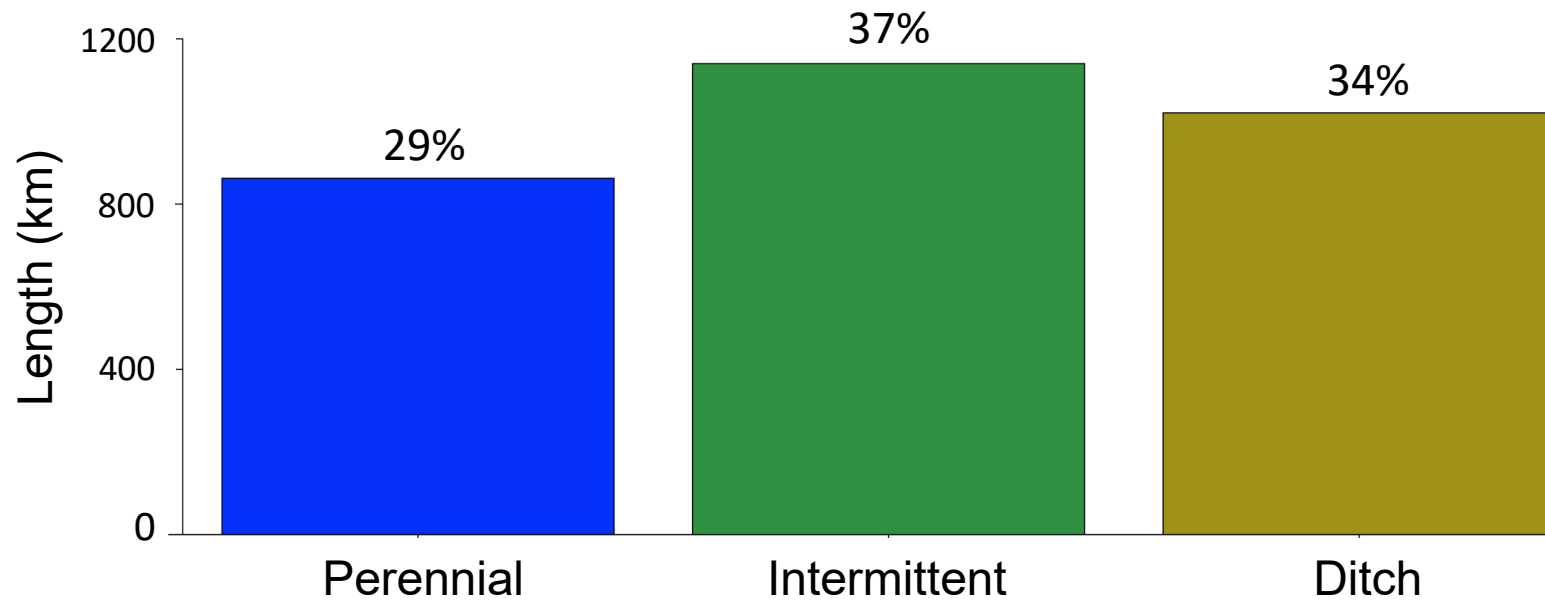
Results: Map



Results: Map



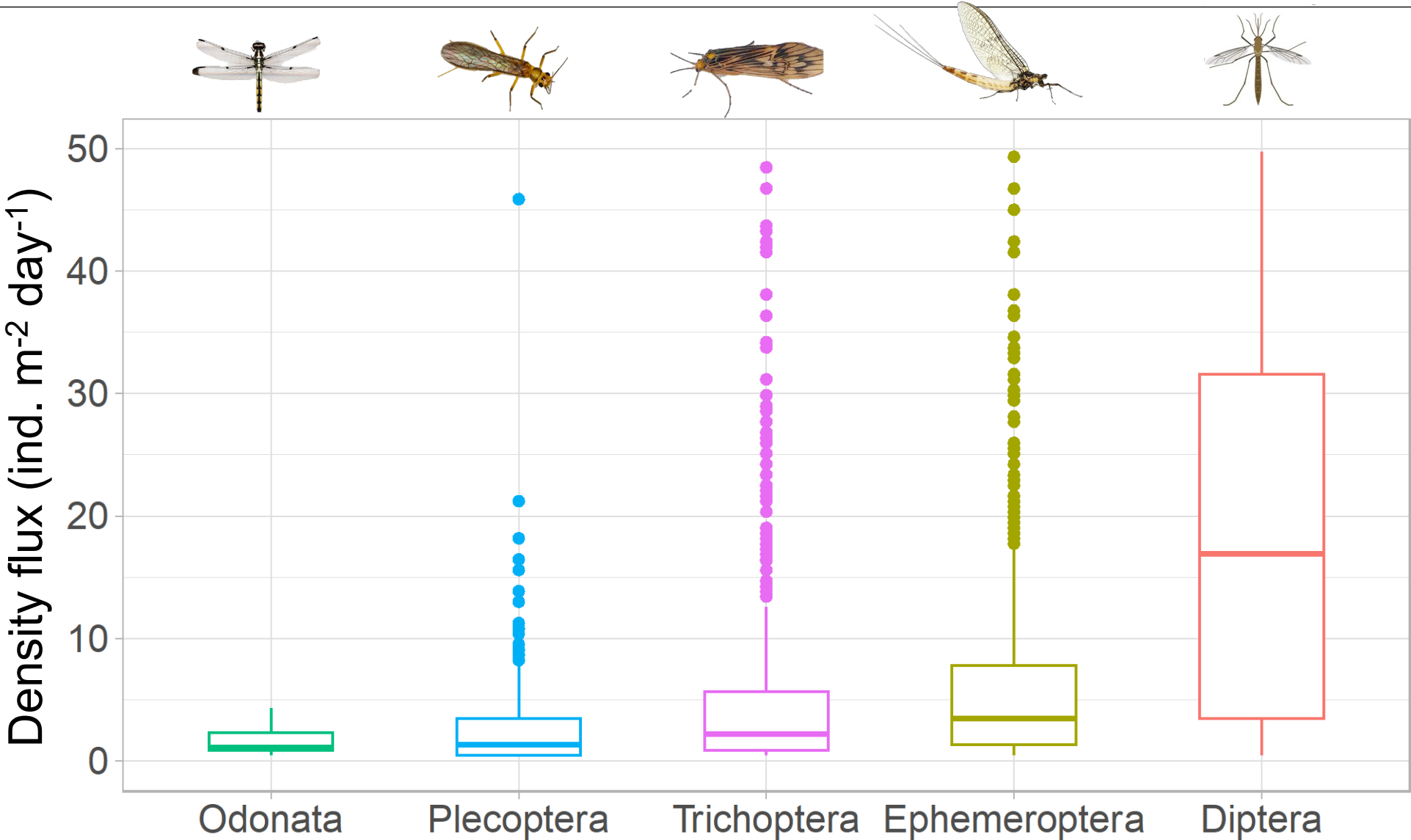
Ditches constitute 34% of total waterway length



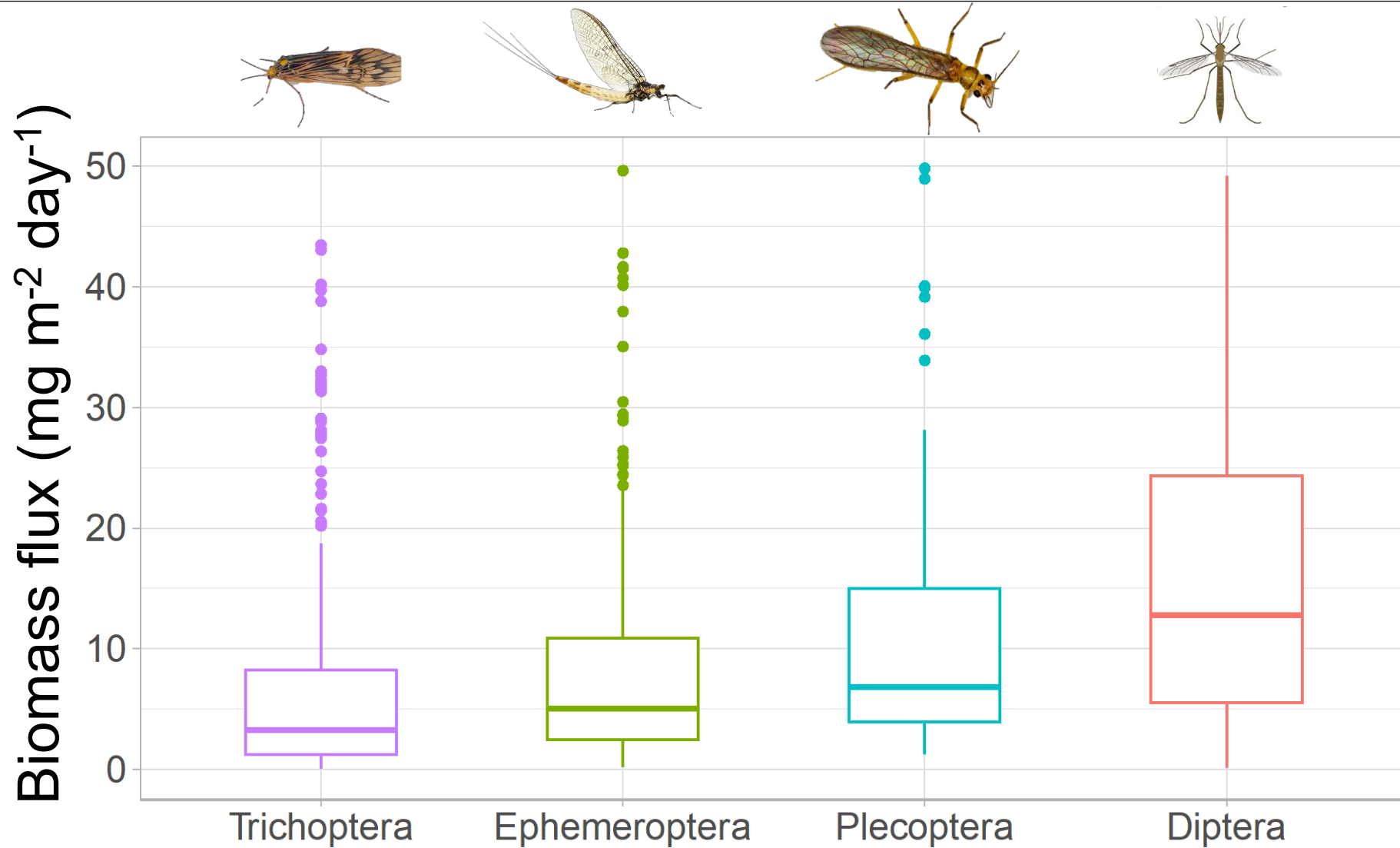
Ditches have aquatic life in them!



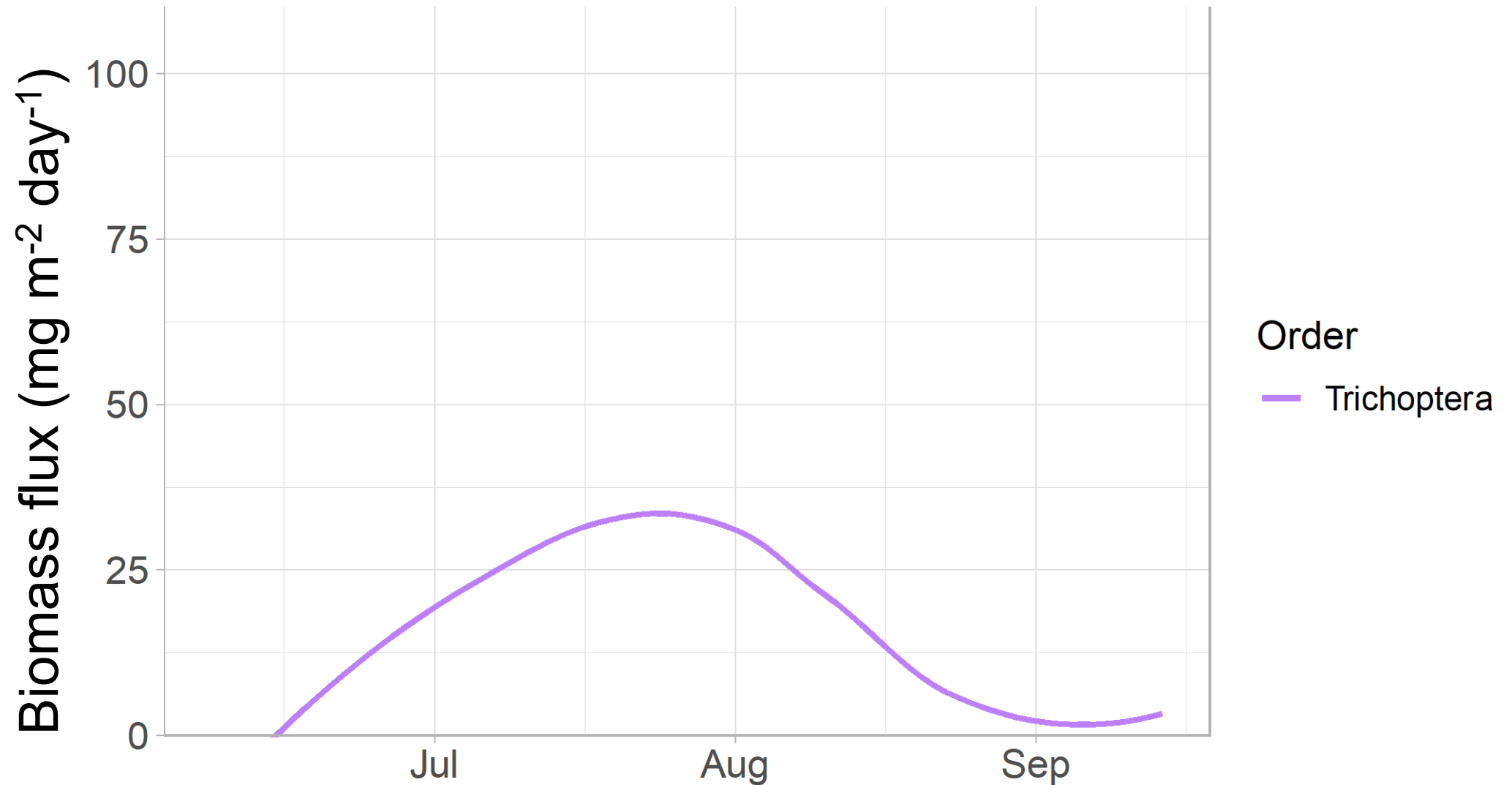
Diptera dominated abundance, but sensitive taxa present



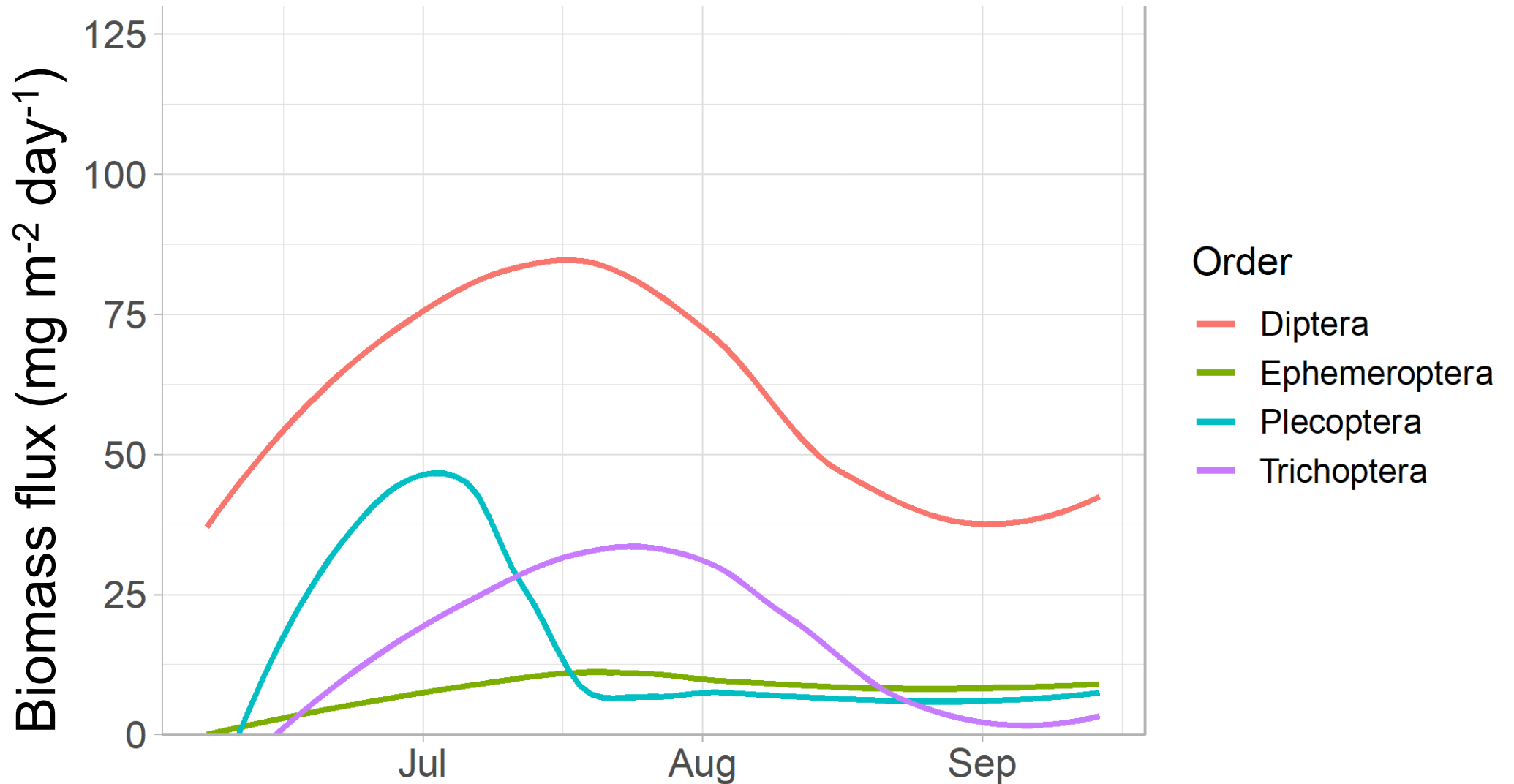
Less abundant taxa are an important proportion of biomass



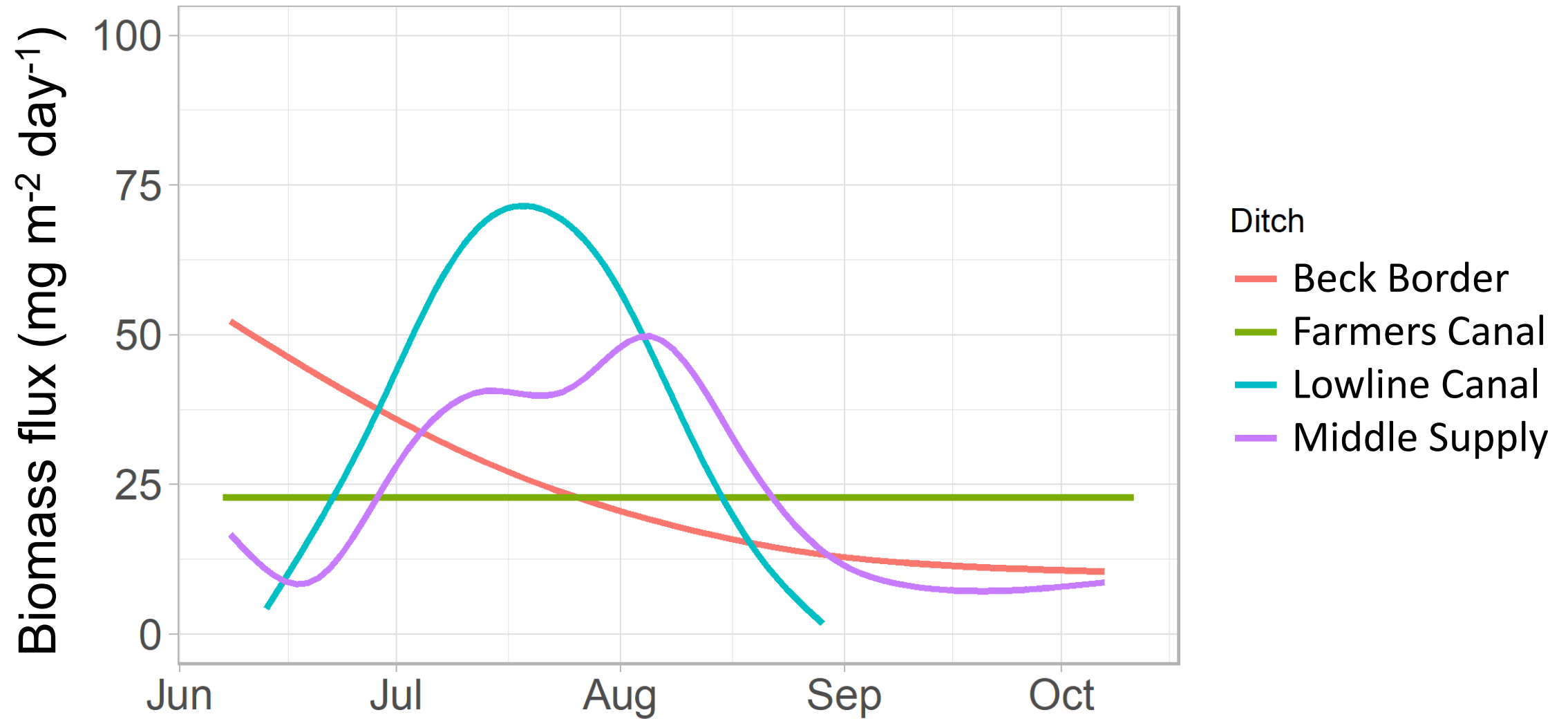
Timing and magnitude of emergence varied by taxa



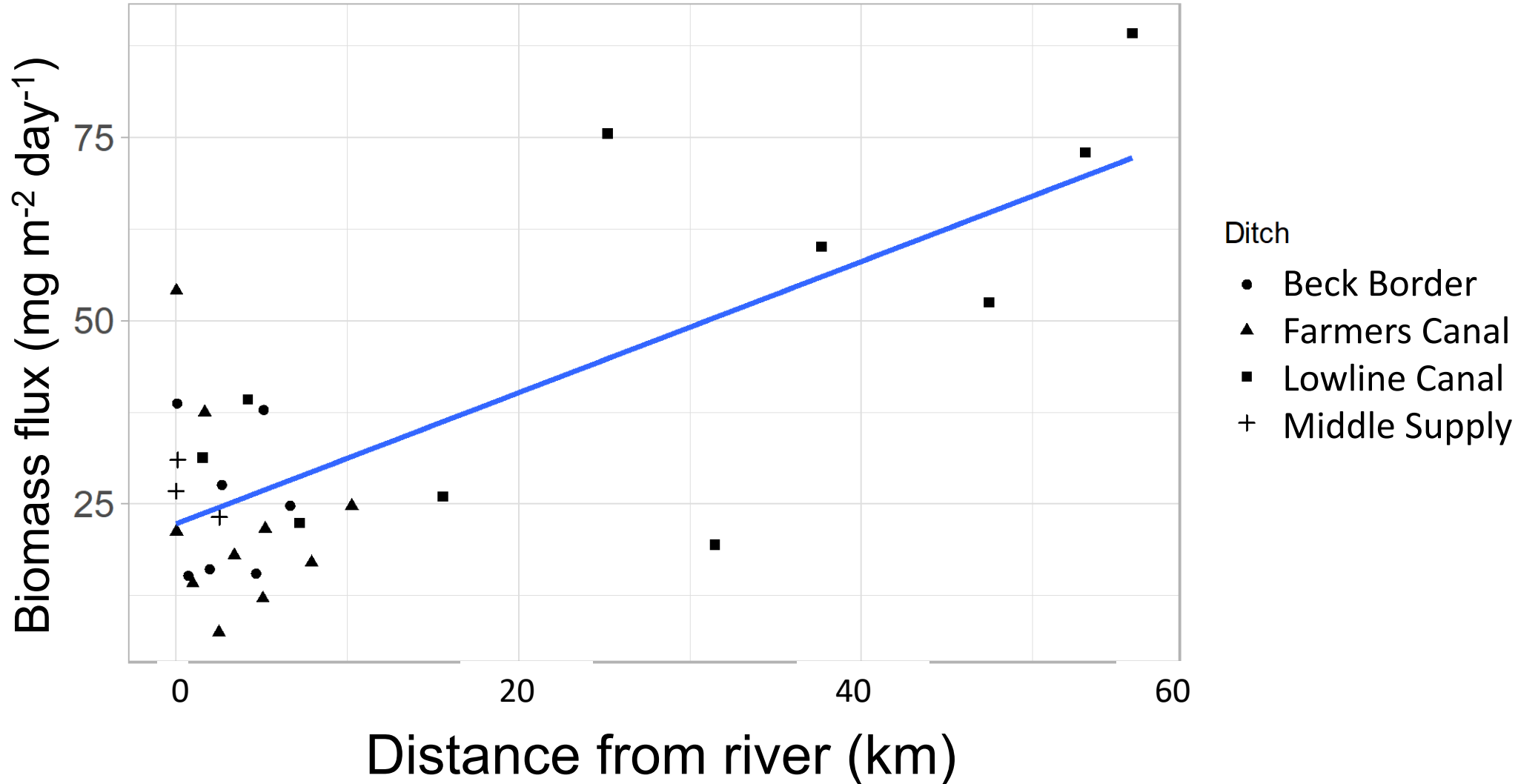
Timing and magnitude of emergence varied by taxa



Variation in emergence production across ditch

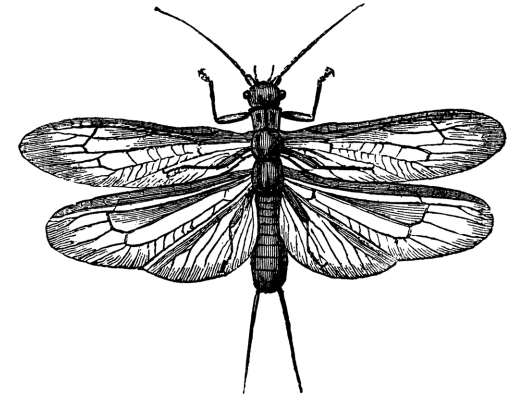


Relationship between distance from river and biomass flux not clear



Back of the envelope for perspective...

- 38 mg m⁻² day⁻¹
- 90 days of inundation
- 5,000,000 m² of ditch
- 17,000,000 grams of insect material
- 40,000 pounds
- 50 bull elk





Questions?



Main takeaways

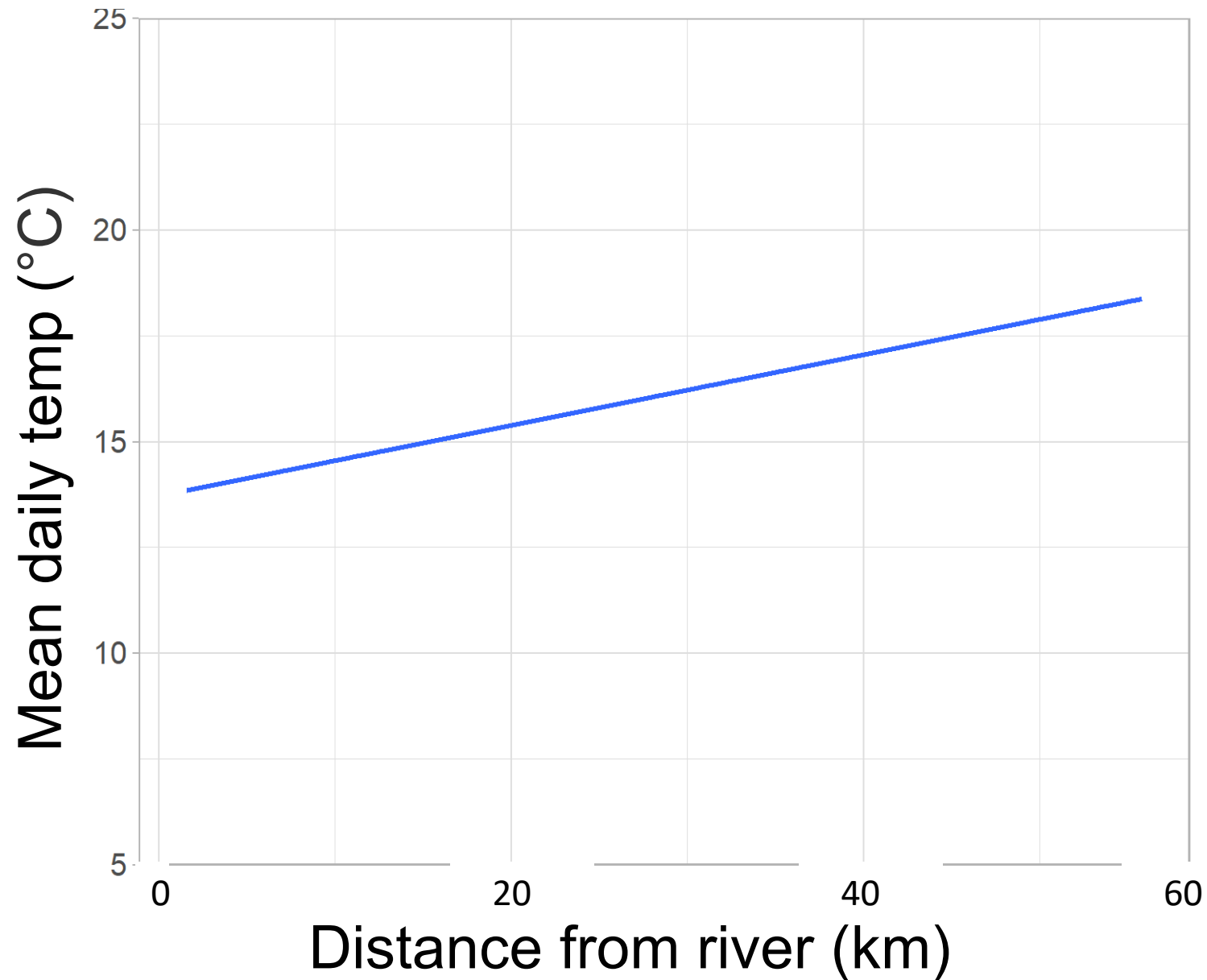
Ditches are an extension of the river that provide water-to-land energy transfer through aquatic insect emergence

Variation in emergence timing across ditches suggests a mosaic of subsidy for terrestrial predators

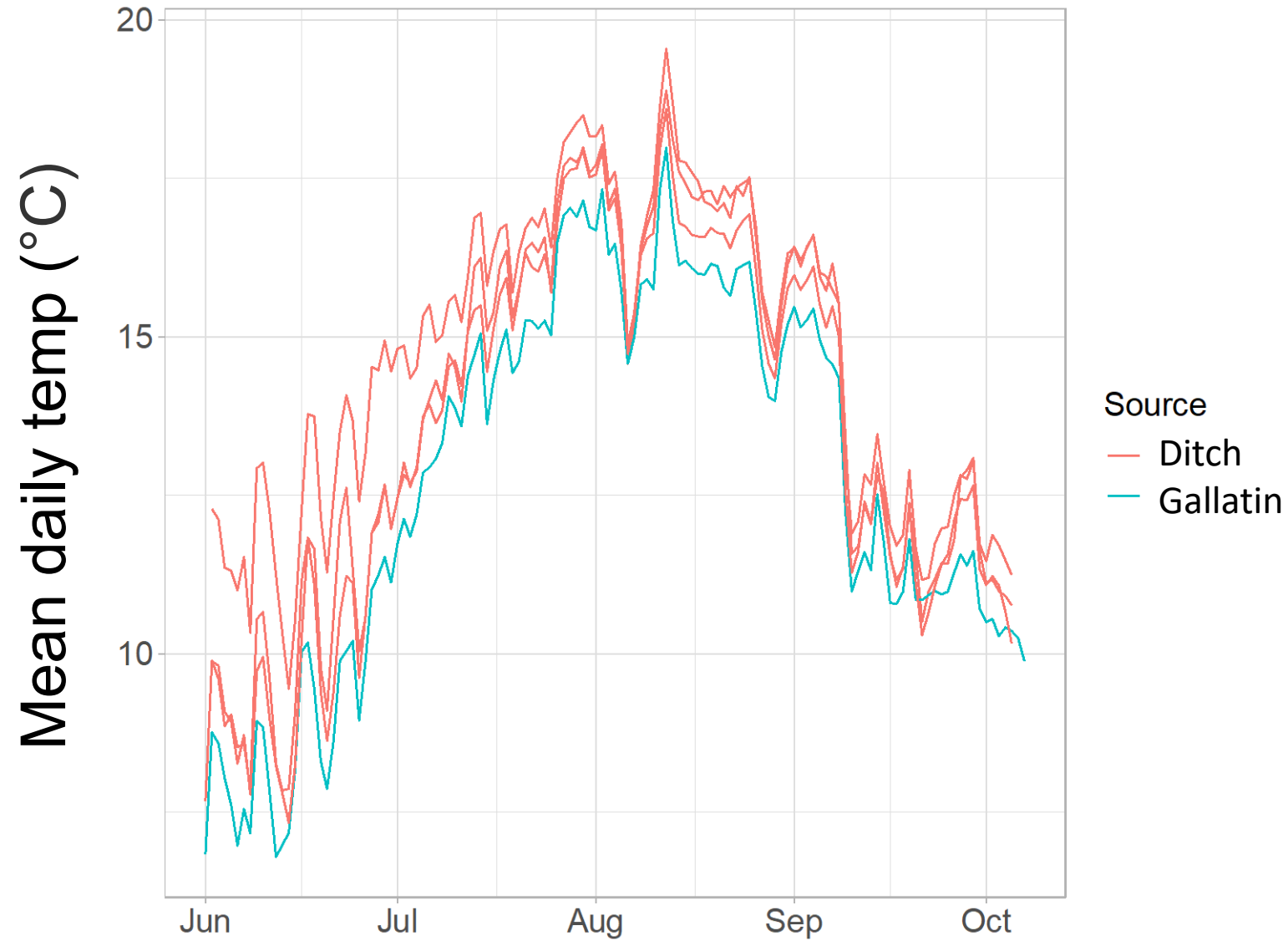
Ditches are common across arid western landscapes and represent a new area of ecological research



Ditch temperature got warmer farther away from diversion point



In general, ditch was warmer than Gallatin at point of diversion





Farmer's Canal



Beck Border Ditch

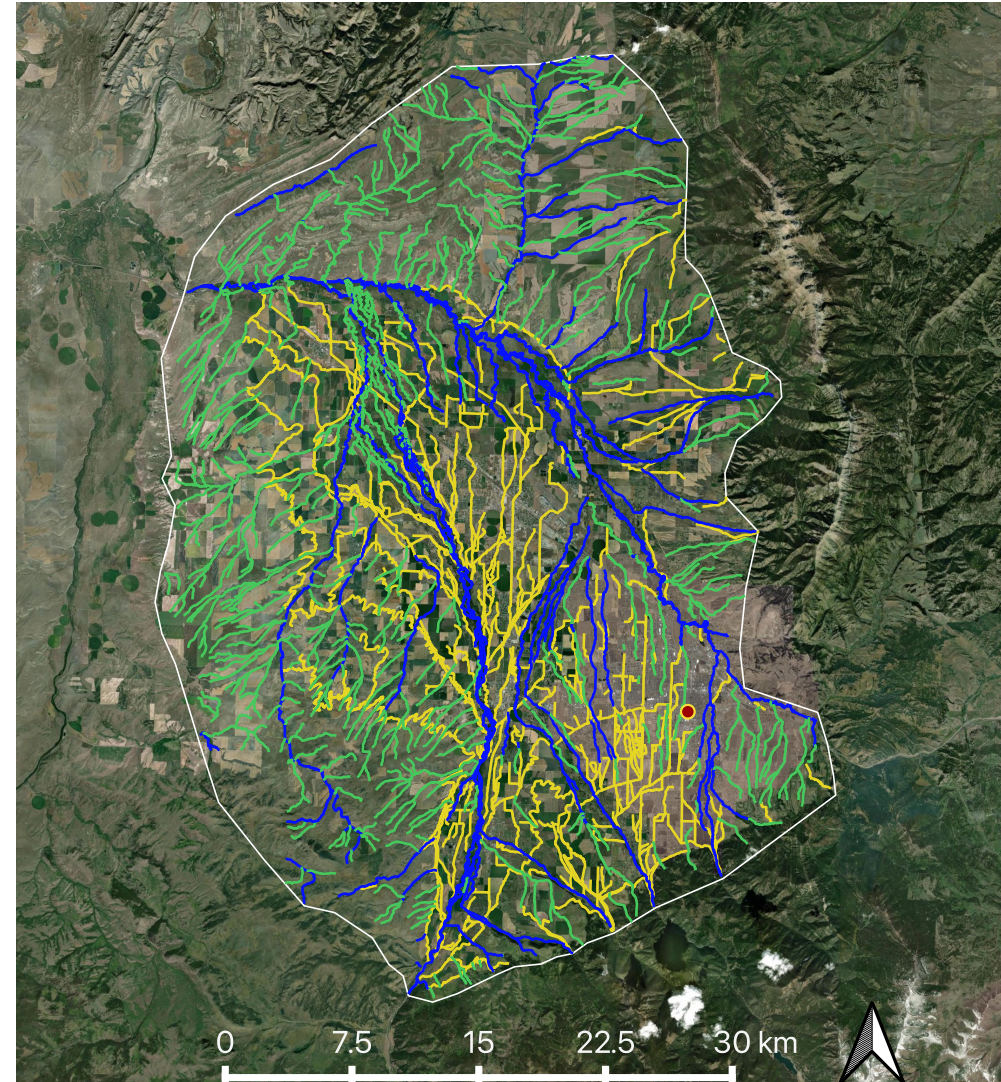
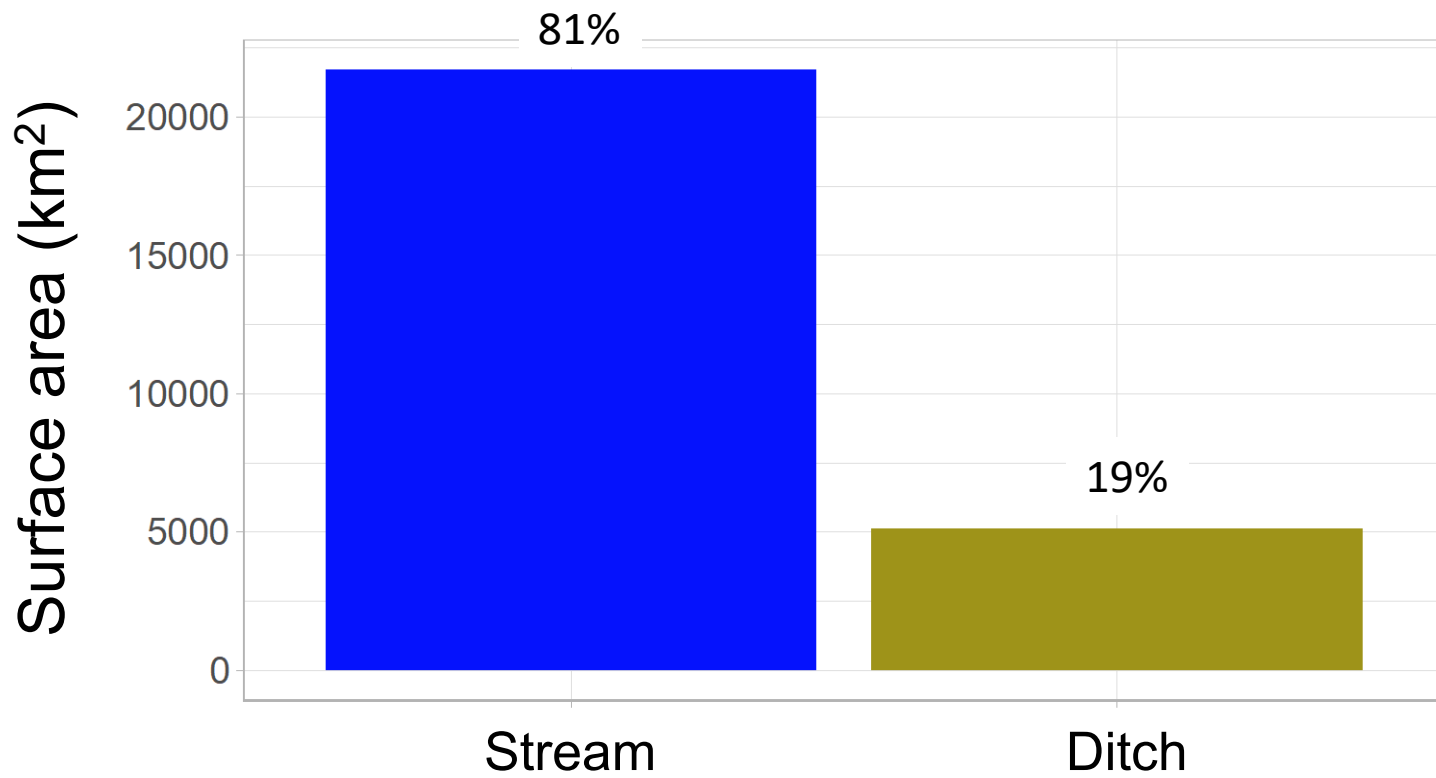


Lower Middle Creek Supply

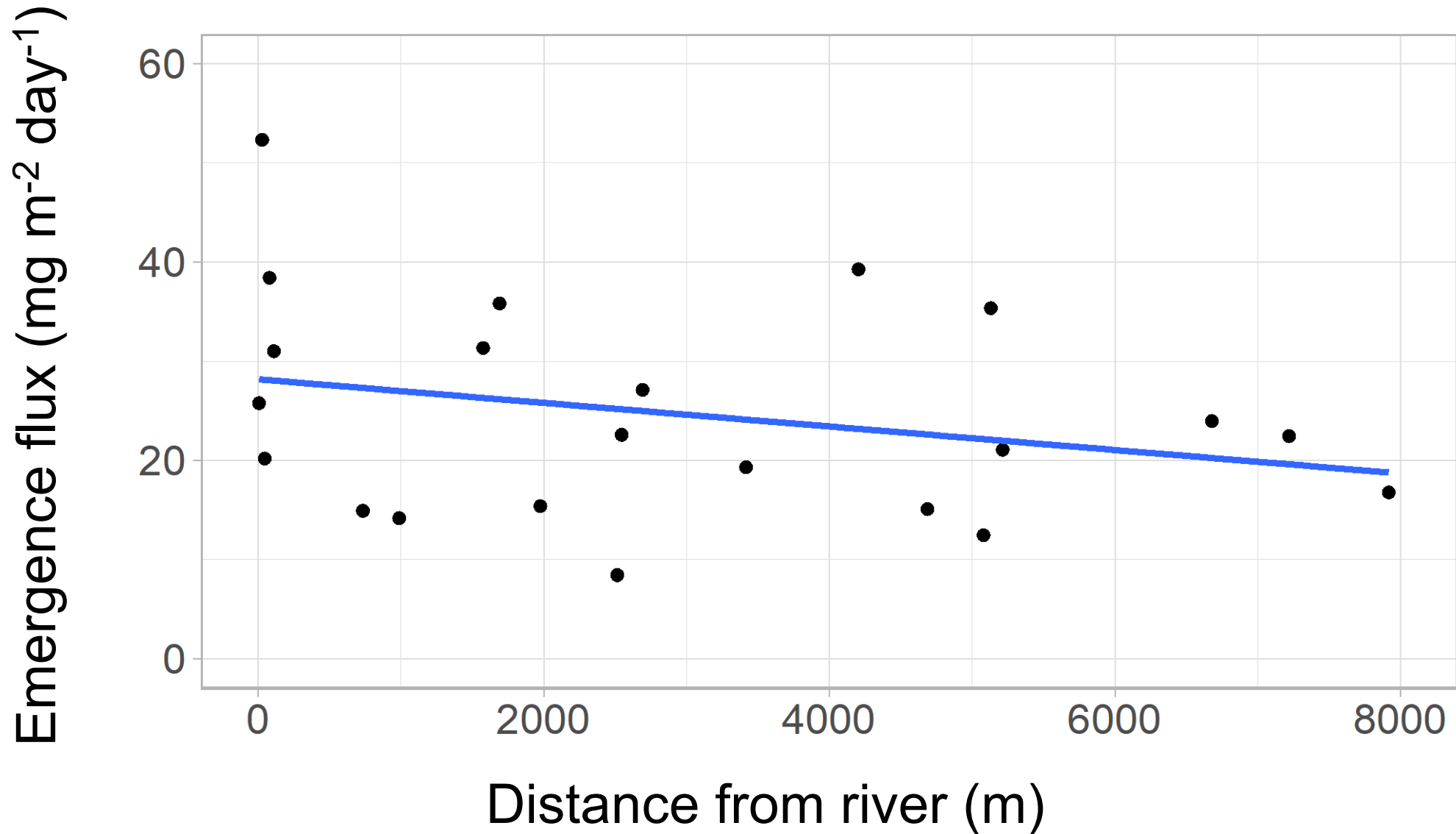


Lowline Canal

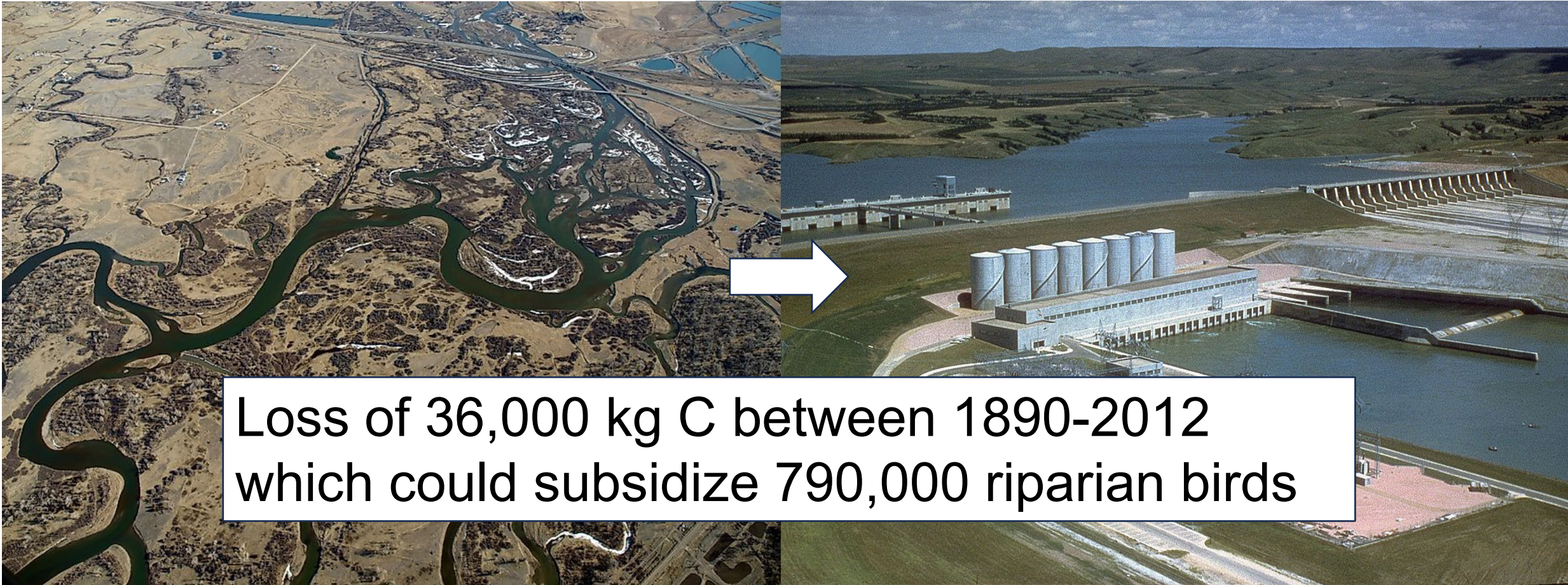
And about 20% of the surface area



Distance from river not a strong predictor of emergence flux

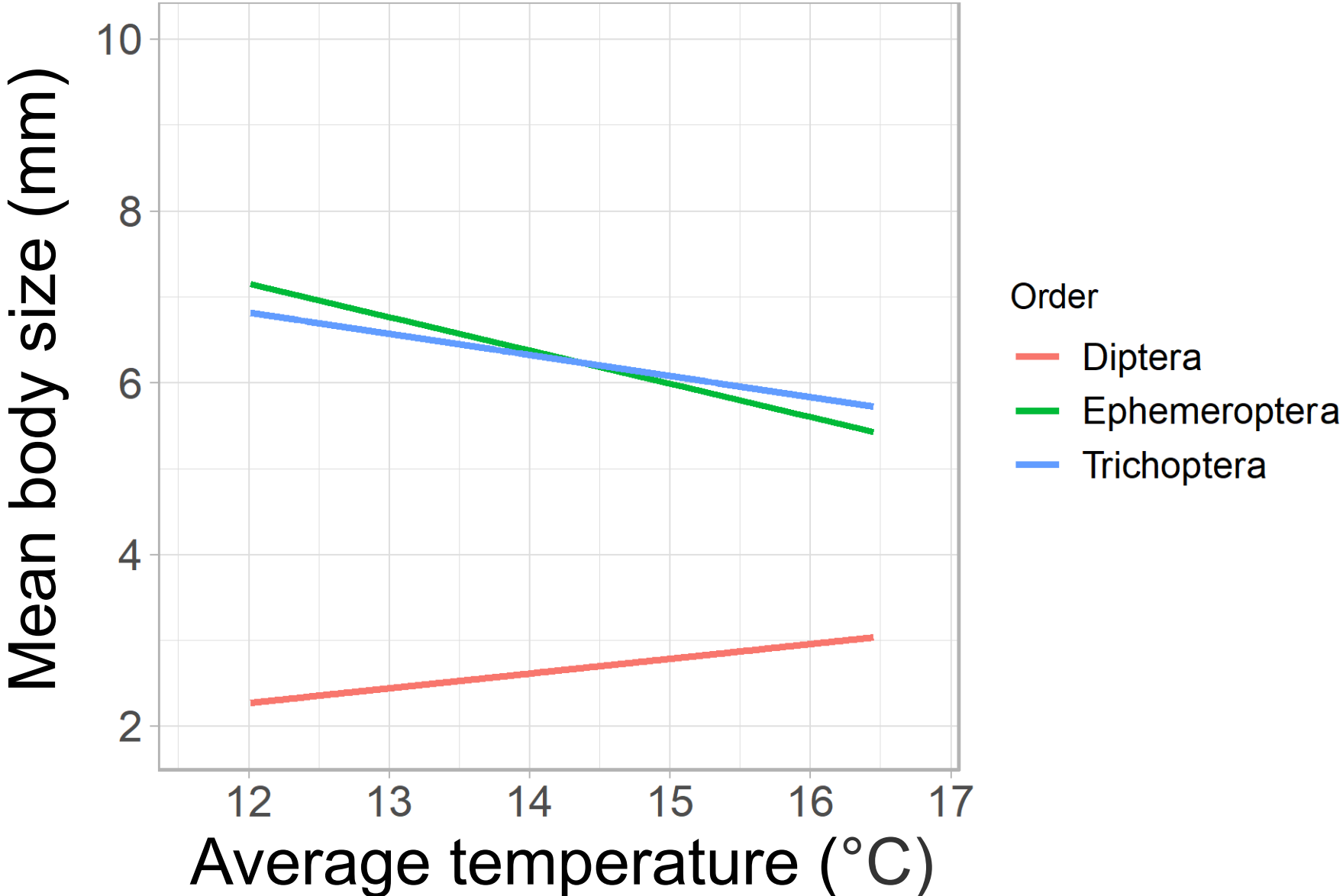


Homogenization reduces surface area

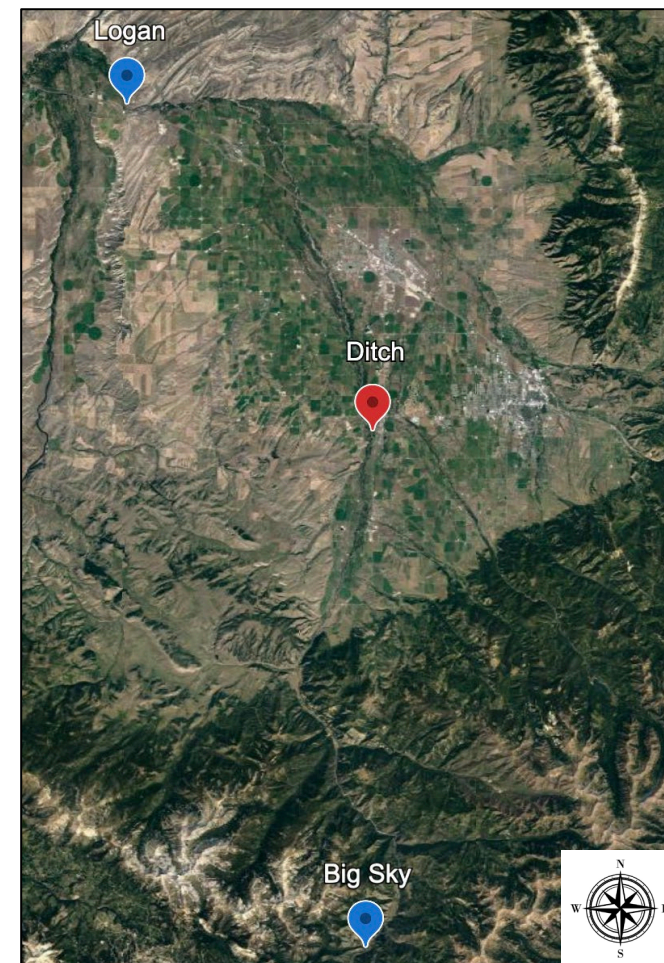
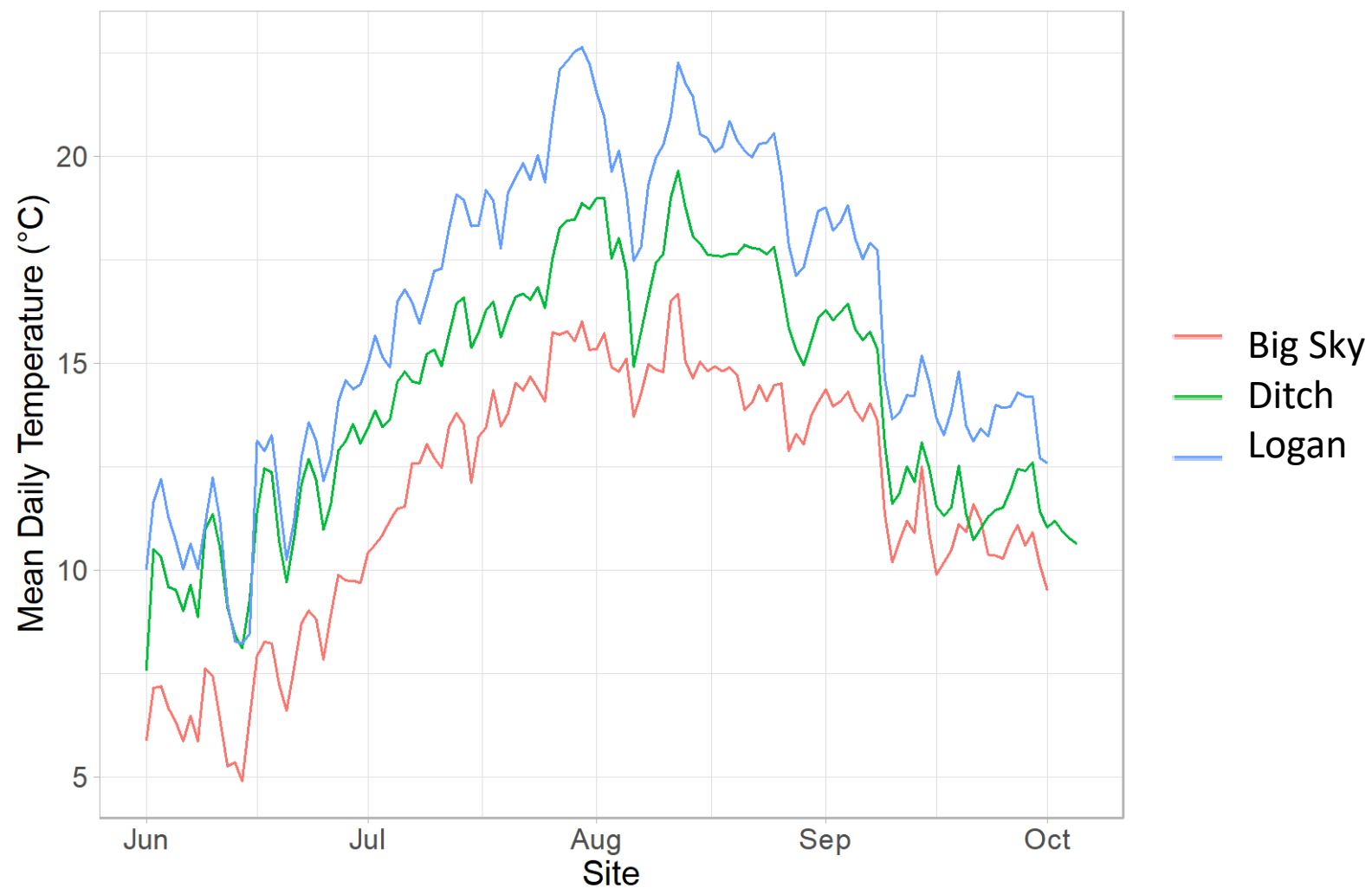


Loss of 36,000 kg C between 1890-2012
which could subsidize 790,000 riparian birds

Diptera body size increase with water temperature



Is ditch temp different than Gallatin River?



Backwater habitat supports high invertebrate diversity and biomass

