Alpine Glacier Stream Ecology

Presenter: Morgan Freestone
Mentors: Professor Craig Thompson and Dr. Christopher Robinson

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slopes of the Continental Divide. He interested his friend E. H. Fourt of Lander, who, imbued with the spirit of the true

...expedition, ... guide—an old timer of Wyoming's Ro... up Days at their best—Glen St... a Geologi... whom mountain ...cursions scientific ... Dr. C. T. J... superinte... of Wyo... State Ho... who prov... mettle i... intrepi... with the party to the glaci... S. P. Vi... New Y... world t... and le... who w... official ... rapher party, colleagu...

Fourt Glacier flanked by the Peaks of the Continental Divide.

...l often irreverent multitude. ...mong our younger generation ...a growing appreciation of the

explorer and wishing to make known to the world at large the beauties of the Wyoming Mountains, organized a party ...

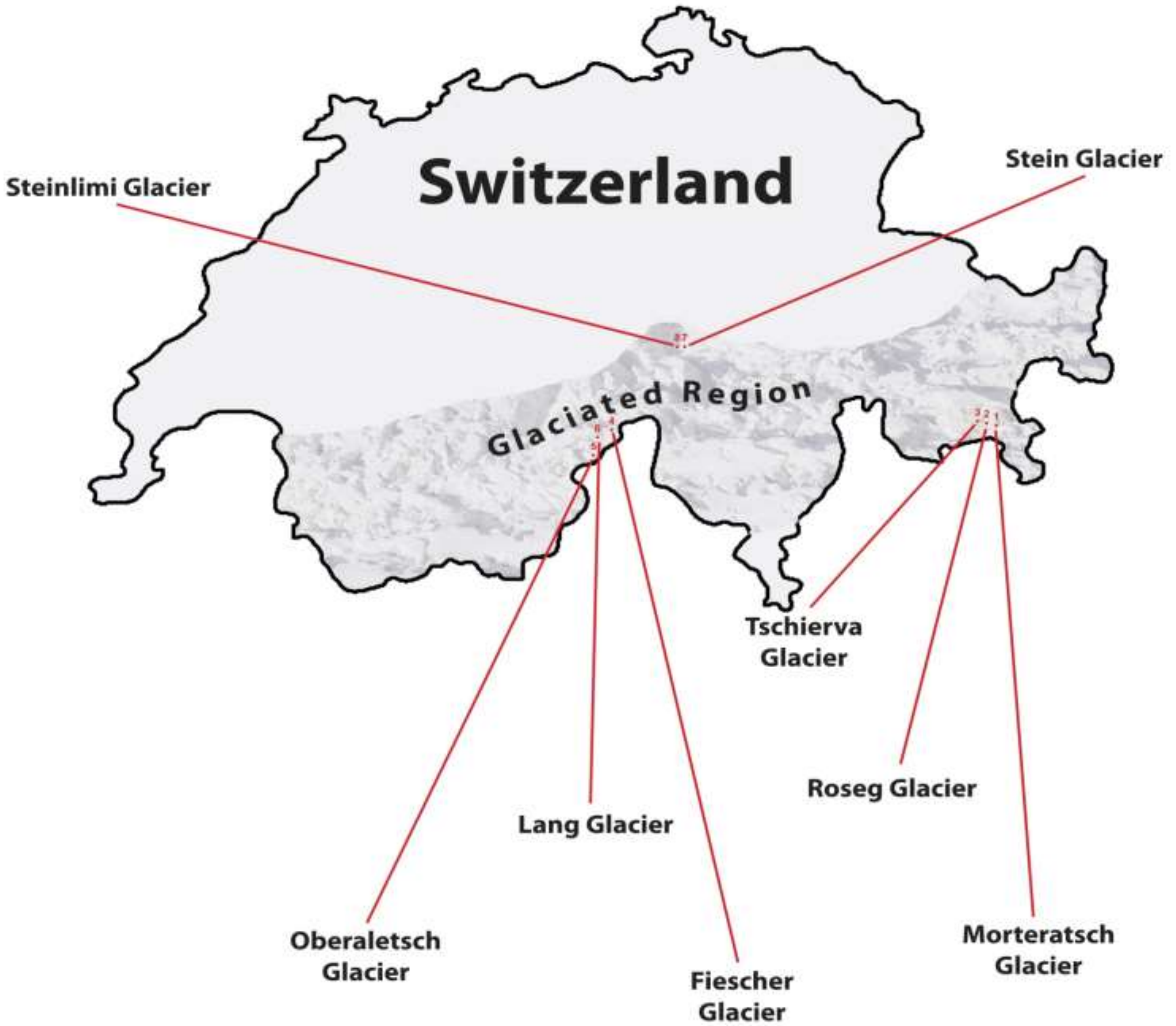
...ert A. Dohl; there were Sandy... State Game Warden, and Hans K... the U. S. Forest Service, who ... masters in woodcraft and mountai...

The Study

- Alpine Glaciers world wide are retreating rapidly every year
- Retreating Glaciers cause new stream systems to form
- Algae and Macroinvertebrates are the first organisms to colonize these new streams

Why Are We Interested in Macroinvertebrates?

- Aquatic insects are sensitive to environmental change like temperature, water, pH, nutrient & food availability, toxins, population, community dynamics
- Aquatic insects quickly reproduce succeeding generations
- Excellent Indicators of Environmental Change


Switzerland
Glaciated Region
Steinlimi Glacier
Stein Glacier
Tschierva Glacier
Roseg Glacier
Lang Glacier
Oberaletsch Glacier
Fiescher Glacier
Morteratsch Glacier

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Roseg Glacier

Tschievera Glacier

Fiescher Glacier

Oberaletsch Glacier

Lang Glacier

Stein Glacier

Steinlimi Glacier

Why Switzerland ?

- Wyoming - the rooftop of our the USA. The headwaters of the Snake/Columbia, the Green/Colorado and the Wind River into Missouri/Mississippi are fed in part from receding glaciers in the Teton and Wind River Ranges.
- Switzerland - - the rooftop Europe. The headwaters of the Rhone river (F), the Rhine river (D, NL), and the Inn/Danube (A, D, H, BL, and Po are fed in part from receding glaciers in the Alps (CH, A) .

Why Switzerland?

- ETH – Swiss Federal Polytechnic University at Zurich
- EAWAG – the Swiss Federal Institute for Water Science and Technology
- Dr. Christopher Robinson

Methods

- Samples were taken from 8 different glaciers.
- Glacial streams were located on the N. and S. side of the Alps.
- Measurements included: Water quality parameters, dissolved nutrient concentrations, biomass, benthic macroinvertebrates, physical parameters, and suspended parameters.

Water Quality and Physical Parameters

- Conductivity- amount of ionic material dissolved in water
- Water Temperature
- PH
- Turbidity
- Velocity

Dissolved Nutrient Concentrations

- **1** l. water sample collected and analyzed for:
- Nitrate (NO3)
- Phosphorous (PO3)
- Particulate Phosphorous
- Dissolved Organic matter.
- Nutrient concentrations are critical

Suspended Parameters

- Seston sampling: to determine the concentration and composition of particulates
- Macroinvertebrates in water column
- Inorganic and organic matter
- 1-m long
- 100 micrometer mesh
- Aperture Diameter: 11 cm

Periphyton Biomass

- Sampled by scraping, using a metal brush and a known area of five stones randomly selected within a 20 meter study reach at each site.
- The collected periphyton was filtered onto Whatman GFF filters and frozen until analyzed.
- Measures productivity of a stream

Benthic Macroinvertebrates

- Collected using Hess Sampler
- Collected from 3 spots in the stream at each site
- Preserved in the field with 70% ethanol
- Laboratory: all macroinvertebrates were handpicked, identified and counted

Results

- Despite low temperatures and very dilute nutrient concentrations aquatic ecosystems exist in melt-water streams at the toe of alpine glaciers in Switzerland and in Wyoming.
- Most recorded temperatures : < 2°C
- Nutrient concentrations ranged from < 5 µg/l for ortho phosphate and particulate phosphate values slightly higher
- Nitrate concentrations were twenty times higher

Results

- Dissolved and particulate organic matter : < 2 mg/l
- Periphyton biomass: ranged from 2.0 – 90. g/m^2
- Macroinvertebrate density varied widely : 20 – 4200 $individuals/m^2$
- Macroinvertebrate biodiversity was low with 11 taxa identified from all sites
- alpine specialists colonized at the glacier toe

Results

- **Chironomidae** dominated the ecosystems : 50 % – 100%
- We found the following:
- **<u>Midges</u>**: Chironomidae Diamesa – 5 species
- **<u>Mayflies:</u>** Rhithrogena loyolae and Betis alpinus
- **<u>Stoneflies</u>**: genera Nemoura, Leutra, Protnemoura
- **<u>Caddisflies</u>**: Tricopterans
- Macroinvertebrate density and diversity increased from glacier toe downstream

Results-Long Term Predictions

- Increased elevation of streams over time due to receding glaciers may limit aquatic insect colonization due to physiological restraints.
- Smaller glaciers= less hydrological buffering capacity
- Loss in glaciers will alter alpine systems and significantly impact biota colonizing these systems.

WWCC and ETH team

Special thanks to ETH, EAWAG, the National Science Foundation EpSCOR program, Wyoming NASA Space Grant Consortium, WWCC and Dr. Chris Robinson – an amazingly energetic and world-class scientist

We sincerely thank the following people who played a critical role in our project.

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- Emily Stewart, NASA WSGC
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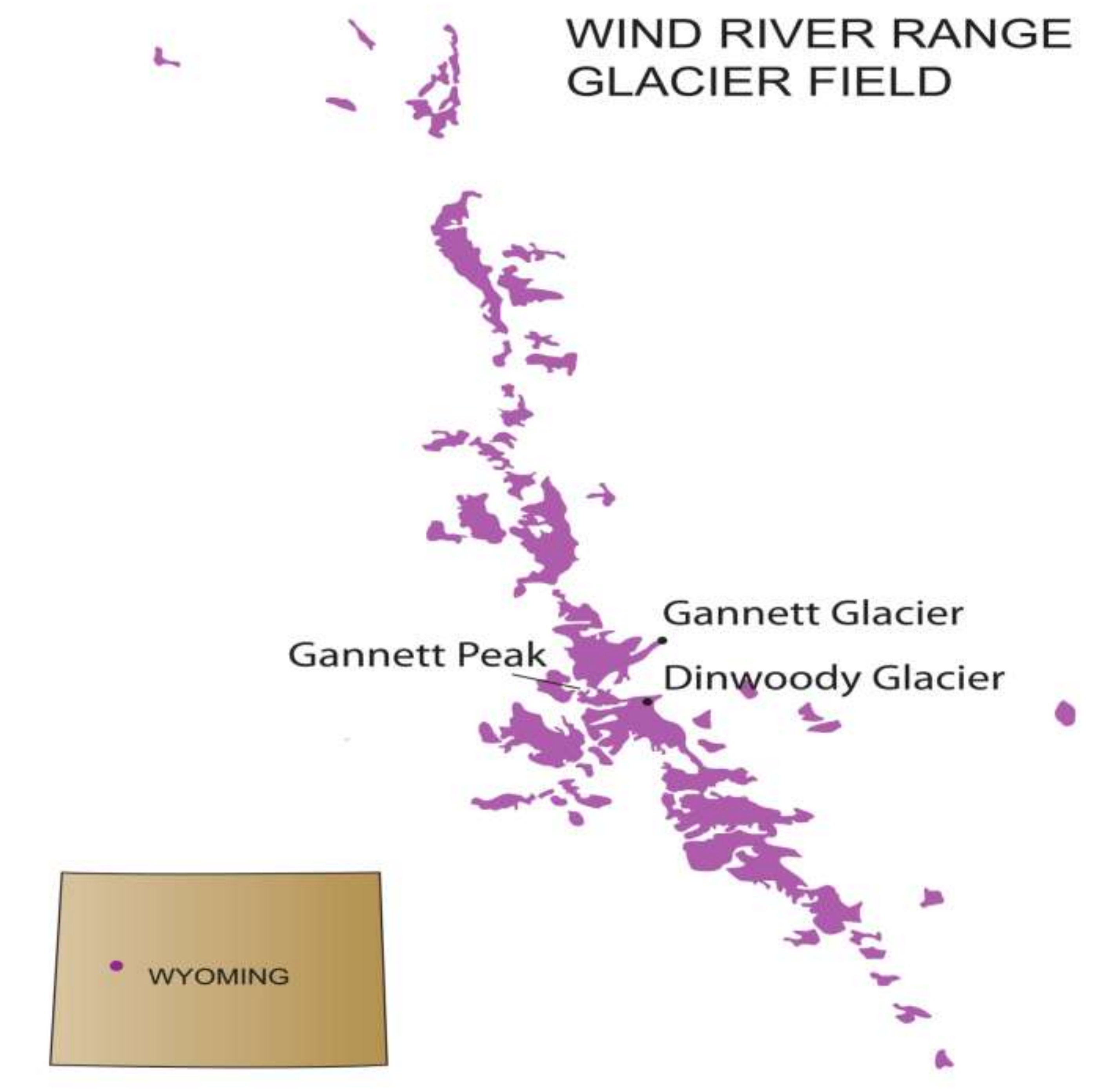
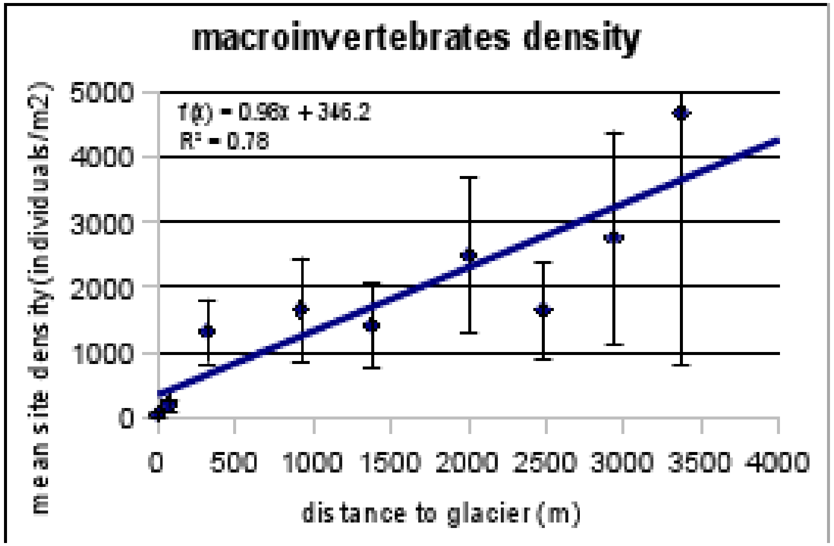
- The Swiss Federal Polytechnic University
- Jocelyn Moore, field data scribe
- Christiana Rapin-Nusbaumer, logistics
- EAWAG AuA, water chemistry data
- Krista Jolidon and B Lods-Crozet, macroinvertebrate and chironomid identification
- Western Wyoming Community College, Karla Leach, President


WIND RIVER RANGE
GLACIER FIELD
Gannett Glacier
Gannett Peak
Dinwoody Glacier
WYOMING

Results: Macro invertebrate Richness and Abundance



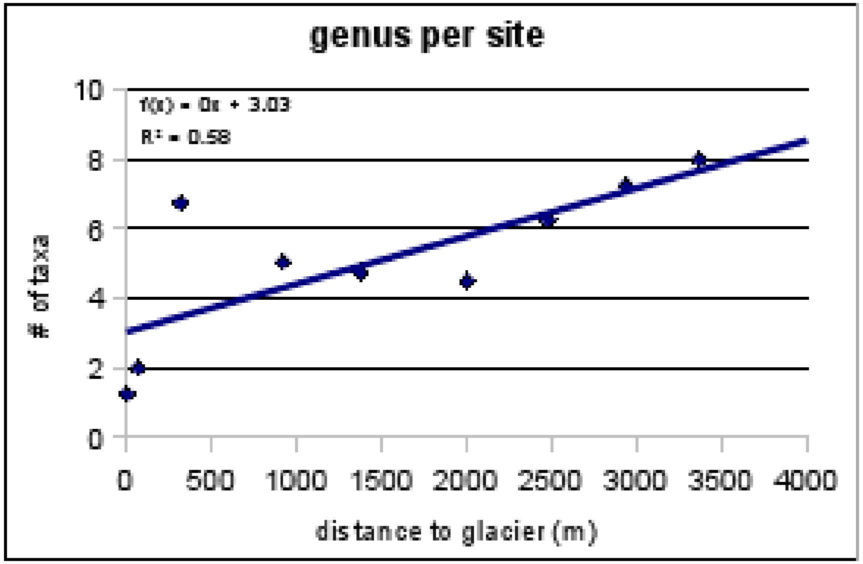


Figure 2. To the left, it shows the increase of macroinvertebrates' density when increasing distance to glacier. To the right, it shows the increase of the number of taxa present in the site when increasing distance to glacier.

Results: Feeding Groups

- Taxa classified by feeding groups
  - Collectors and Filterers (C/F)
  - Collectors (C)
  - Gatherers and Scrapers (G/S)
  - Predators (P)
  - Shredders detritivours (S/D)
  - Shredders herbivores (S/H)
- (C/F) classification dominant at all sites
- Taxa in top glacier rivers can be omnivorous to survive extremes

Results: Feeding Groups

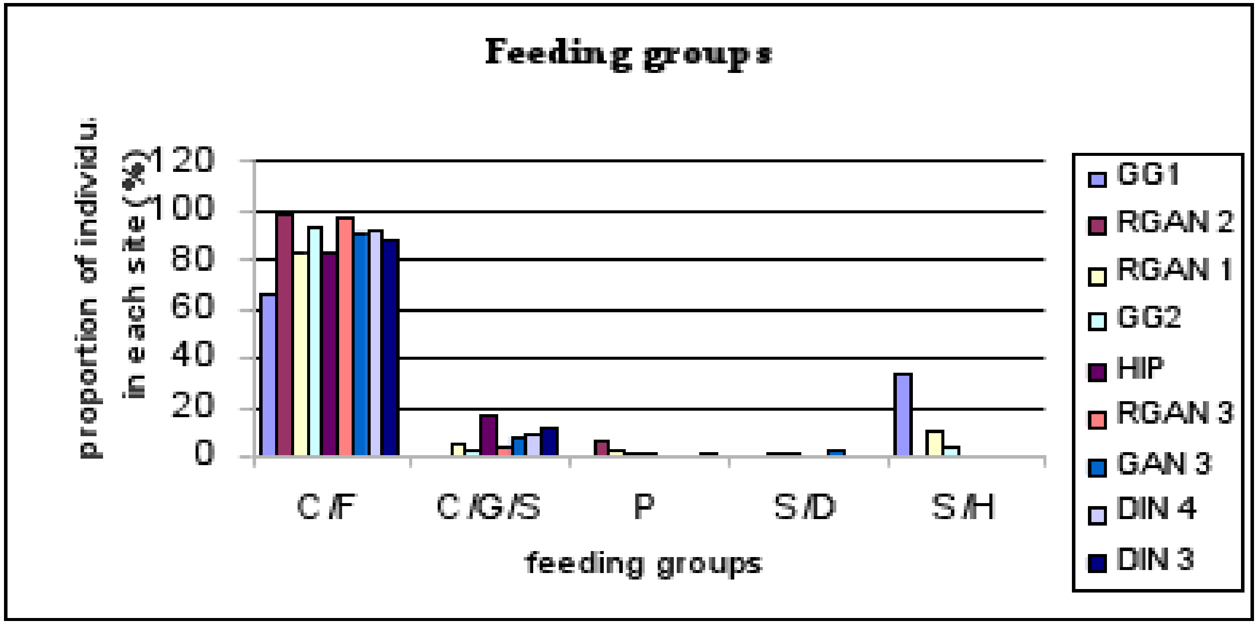


Figure 4. Distribution of the abundance of individuals in each feeding group. collectors and filterers (C/F), collectors (C), gatherers and scrapers (G/S), predators (P), shredders detritivorous (S/D) and shredders herbivores (S/H).

Results: Environmental Characteristics

- Temperature: Mean <3.5 degrees C, ranged from 1.3 to 5.4 degrees C
- Turbidity: Low turbidity exhibited, ranged from 3.4 to 43 NTUs
- pH: Mean 6.31, ranged from 5.86 to 6.89
- Low conductivity, low phosphorus and nitrogen levels
- No Seston and Peripyton organic matter trend with distance
- Organic matter on benthic samples did correlate with increased distance to glacier

Results: Macro invertebrate Richness and Abundance

- Average density differed markedly (61 to 4680 indiv/m^2)
- Density increased significantly with increased distance
- 6 orders, 13 families, 17 genus found
- One taxon, Chironomidae, Diptera found at all sites
- Number of taxa and Simpsons diversity index increased with distance
- Chironomidae, when present, were most abundant
  - Subfamily Orthocladinae increased abundance with distance
  - Subfamily Diamesine decreased with increasing distance