Effects of the Dempster Highway on Arthropod Assemblages

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Important Terms

• **Arthropod** = an invertebrate with jointed appendages

• **Hymenoptera** = Wasps, bees and ants

• **Collembola** = Springtails

• **Diptera** = Flies
Important Terms

- **Alpha Diversity** = the local diversity of different sites
- **Beta Diversity** = how different the sites are from each other
Arthropods in the Yukon

• The **Yukon** has unusually rich arthropod communities
  • Refugium during glaciation
  • Warmer than other other areas at the same latitude

• Perform vital ecosystem services
  • Pollination, decomposition, food for vertebrates, etc..

• Can be pests too

The Dempster

- 737 km long
- From near Dawson (YK) to Inuvik (NWT)
- Construction completed 1979
- Maintained twice between May and October
  - Coarse grained alluvial deposits
  - = Disturbance
- Cuts through Boreal and Tundra areas
Roads and Arthropods

• Roads can affect the ABUNDANCE and DIVERSITY of organisms
  • Fragmentation
  • Increased mortality
  • Edge effects

• Effects differ depending on:
  • The taxa
  • The type of road
  • The surrounding habitat
  • The number of vehicles using the road
  • Etc...
What About the Dempster Could Impact Arthropod Communities?

- Its construction & maintenance
- Road dust
- Hydrological effects
- Thermal effects
- Altered plant community
Construction & Maintenance

• Input of new material
• Heavy machinery
  • disturbs surrounding vegetation
  • Possibly compacts soil
• Maintenance ongoing...

Road Dust

- Increases soil pH
- Decreases moss cover
- Changes nutrient availability in soil
- Causes earlier melt of snow cover
- Dust fall reaches 300m from the road

https://www.reisestationen.de/der-dempster-highway-kanada/?lang=en
Hydrological & Thermal Effects

• Removal of vegetation = Erosion
• Changes in the flow of water through the system
• Permafrost thaw several meters below the road
  • Causes subsidence and embankment
  • Affects drainage
• Warmer microclimate near road
Vegetation

• Since construction, some plants more successful at recolonizing
  ✓ Alder shrubs
  ✓ Willow shrubs
  ✓ Graminoids (grass-like plants)

• Others less so...
  ✗ Mosses
  ✗ Lichens
  ✗ Forbs

• Where adjacent areas have subsided, water accumulation favours water tolerant vegetation

• Intentional and accidental introduction of non-natives along Dempster
Hypotheses

1. Arthropod **abundance** will be affected by road proximity and will vary among taxa or functional group.

2. Arthropod **diversity** will be affected by road proximity and will vary among taxa or functional group.
Methods
Methods

1m 10m 100m

Km 118 ...

Km 174
9 transects x 3 distances = 27 samples
Results

Overall, we collected **10 057** arthropods

- **12 orders**
  - Springtails **4322** and Flies **4421** were most abundant
  - Followed by Hymenopterans (**471**), Spiders (**287**) and Hemipterans (**289**)
  - Under **150** = Lepidoptera, Acarina, Coleoptera, Gastropoda, Plecoptera and Orthoptera
- Not a totally accurate representation of nature... (only pan traps)
Dempster Highway

Road dust

Hydrological alterations

Edge effects

Disturbance from initial construction

Vegetation

Arthropod assemblage

Trophic interactions
Contrary to our expectations, abundance was lowest at the intermediate distance.

Total arthropods = 10057

(GLM (poisson) ANOVA; $\chi^2 (2, N=27) = 1275.9; p < 0.0001$)
Arthropod communities were dominated by flies (Diptera) and springtails (Collembola).
Fly abundance was greater close to the road than far.

- Many flies have aquatic larval stage – pooling water beside road.
- Many flies are herbivorous or pollinators – many potentially useful plants prefer roadside

(GLM (neg. binom.) ANOVA; $\chi^2 (2, N=27) = 16.1; p < 0.0003$)
Springtail abundance was greater far from the road than close.

- Soil-dwelling, rather than gravel-dwelling
- Have strong associations with mosses and lichens

(GLM (poisson) ANOVA; $\chi^2 (2, N=27) = 2757.3; p < 0.0001$)
Another look…

(GLM (poisson) ANOVA; $\chi^2 (2, N=27) = 1275.9; p < 0.0001$)
Arthropod diversity was unaffected by road proximity.

**Alpha-diversity**

(Kruskal-Wallis; $\chi^2 (2, N=27) = 2.5079; p = 0.2854$)

**Beta-diversity**

(Kruskal-Wallis; $\chi^2 (2, N=27) = 0.067; p = 0.967$)
Hymenoptera abundance was greater close to the road than far.

Total Hymenoptera = 471

(GLM (neg. binom.) ANOVA; $\chi^2 (2, N=27) = 6.5617; p = 0.0376$)
Hymenoptera communities were diverse.

Hymenoptera Subfamilies/families = 34
Hymenoptera communities were dominated by parasitoid wasps.
• Parasitoids of gall midges (Diptera) – more Diptera close to road

Platygastridae abundance was greater close to the road than far.

(GLM (neg. binom.) ANOVA; $\chi^2 (2, N=27) = 17.863; p = 0.0001$)
Ceraphronidae abundance was greater close to the road than intermediate.

Parasitoids of many groups (including Diptera and Hemiptera)

(GLM (neg. binom.) ANOVA; $\chi^2 (2, N=27) = 10.189; p = 0.0061$)
The fly parasitoid group was the only abundant functional group to be affected by road proximity.

(GLM (neg. binom.) ANOVA; $\chi^2 (2, N=27) = 7.0001; p = 0.0302$)
Hymenoptera taxonomic diversity was unaffected by road proximity.

(LM ANOVA; $F(2, 24) = 2.2662; p = 0.1254$)

(Kruskal-Wallis; $\chi^2(2, N=27) = 3.3063; p = 0.1915$)

(Kruskal-Wallis; $\chi^2(2, N=27) = 4.222; p = 0.1211$)
Hymenoptera functional diversity was unaffected by road proximity.

(LM ANOVA; F(2, 24) = 1.9175; p = 0.1688)

(Kruskal-Wallis; χ²(2, N=27) = 0.29648; p = 0.8622)

(Kruskal-Wallis; χ²(2, N=27) = 3.4965; p = 0.1742)
Summary of Findings

Fly parasitoids (Hymenoptera) + Flies + Springtails

Vegetation + Dempster Highway -
What next?

• Large scale study
  • Repeat sampling
  • Multiple sampling techniques (passive + active)
  • Longer stretch of highway
  • Finer taxonomic scale (Genus level?)

• Parallel vegetation study

• Perhaps diversity patterns will become apparent
Relevance to the Yukon

- Traditional/wild-harvested foods
  - Pollinators
  - Pests

- Ecosystem health
  - Effects on food web

- Arthropods as indicators
Questions?
References


