Factors affecting intensity of insect harassment during summer: A case study of the Bathurst barren-ground caribou herd

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Background

- Current decline of the Bathurst barren-ground (*Rangifer tarandus groenlandicus*) herd in the Northwest Territories[1]:
  - 1986: 472 000 ± 72 000 (SE)
  - 2006: 128 000 ± 27 300 (SE)
- Conditions on the post-calving/summer range may be contributing to the decline.
- Summer is a critical time for caribou to support calves & replenish protein & energy reserves.
- One factor that may preclude the ability of caribou to obtain adequate forage is harassment by biting & parasitic insects, including oestrid flies, mosquitoes, & black flies.
- Insect harassment alters habitat use & activity budgets of caribou, potentially leading to reduced forage intake & elevated energy expenditures.

Objectives

- Measure abundance/activity of biting & parasitic insects in conjunction with weather & temporal parameters.
- Develop predictive indices of insect abundance/activity.

Methods

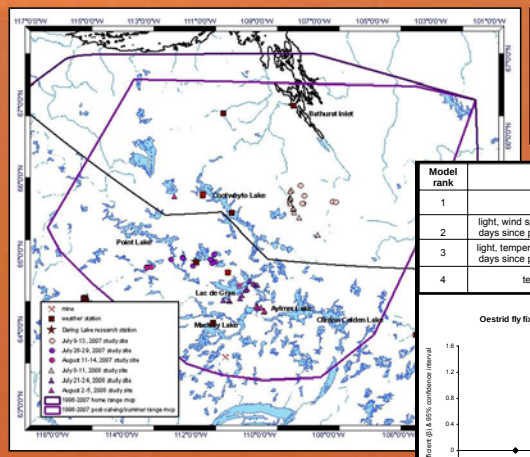
- Data collection during six sampling sessions July-August 2007 & 2008.
- CO_2-baited Malaise traps[2] to collect insects at 2-hr intervals; portable weather station & light meter to record weather variables at 10-min intervals.
- Count models (generalized linear model framework) to analyze activity/abundance of mosquitoes & black flies relative to weather & temporal variables; logistic regression to model presence/absence of oestrid flies. Akaike's Information Criteria (AIC) to identify the most parsimonious model from predefined model set[3].

[1] GNWT ENR. 2008. Bathurst caribou: population [online]. Available from http://www.nwtwildlife.com/NWTwildlife/caribou/bathurstpop.htm [Accessed 23 March 2008].

[2] Anderson, J. R., Nilssen, A. C., and Hemmingsen, W. 2001. Use of host-mimicking trap catches to determine which parasitic flies attack reindeer, *Rangifer tarandus*, under different climatic conditions. The Canadian Field-Naturalist 115: 274.

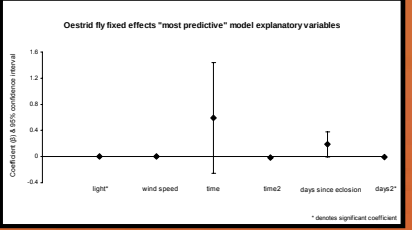
[3] Burnham, K. P. and Anderson, D. R. 1998. Model selection and inference: a practical information-theoretic approach. Springer. New York.

Study area & results



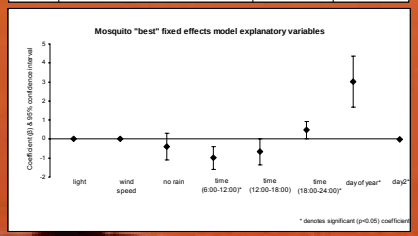
Bathurst post-calving/summer range & 2007-2008 study site locations.

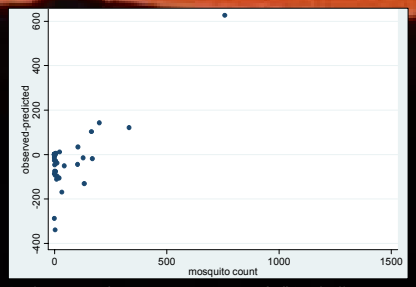
Model rank	Covariates	Log-likelihood	ΔAIC$_c$	ROC
1	light	- 36.862	0	0.864
2	light, wind speed, time of day (quadratic), days since predicted eclosion (quadratic)	-31.726	0.0169	0.912
3	light, temperature, time of day (quadratic), days since predicted eclosion (quadratic)	-31.729	0.0231	0.912
4	temperature, light	-36.760	1.8240	0.862



Top ranked models of oestrid fly presence/absence; ROC scores are indicative of predictive ability (1=perfect prediction) (top). Coefficients & 95% confidence intervals for explanatory variables included in the "most predictive" oestrid fly model (bottom).

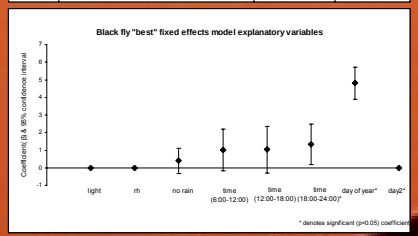
Model rank	Covariates	Log-likelihood	ΔAIC$_c$
1	light, rh, precipitation, time of day (categorical), day of year (quadratic)	-10318.715	0
2	light, rh, time of day (categorical), day of year (quadratic)	-10378.683	117.868
13	light, temperature	-15243.187	9836.664

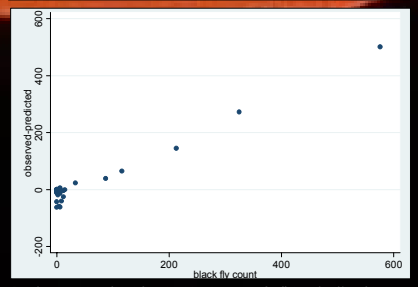




Best & worst models of mosquito activity/abundance (top). Coefficients & 95% confidence intervals for explanatory variables included in the "best" mosquito model; CI's that overlap zero indicate lack of statistical significance (middle). Difference between observed mosquito counts & counts predicted by the best model; negative values indicate over-prediction & positive values indicate under-prediction (bottom).

Model rank	Covariates	Log-likelihood	ΔAIC$_c$
1	light, wind speed, precipitation, time of day (categorical), day of year (quadratic)	-20540.634	0
2	light, temperature, precipitation, time of day (categorical), day of year (quadratic)	-20542.289	3.311
12	wind speed, day of year (quadratic)	-23486.826	5882.131





Best & worst models of black fly activity/abundance (top). Coefficients & 95% confidence intervals for explanatory variables included in the "best" black fly model (middle). Difference between observed black fly counts & counts predicted by the best model (bottom).

Summary

- Insect abundance/activity strongly influenced by temporal variables:
  - Time of day
    - Mosquitoes less active during midday; most active 18:00-24:00 hrs.
    - Black flies least active 0:00-6:00 hrs.
    - Potentially important for oestrids, however, low sample size & high degree of variability make interpretation difficult.
  - Date
    - Mosquito activity peak early July; negligible mid/late July.
    - Black fly activity peak mid July to early August.
    - Probability of oestrid presence significantly related to number of days since predicted emergence; likely present until 25 days post-emergence (late August for yrs studied).
- Weather appeared to be less important than temporal variables in explaining insect activity/abundance levels.
  - In the future, a two-stage modeling approach will be explored to separate factors affecting insect presence/absence from those important in determining insect activity levels given presence.
  - Better understanding of weather variables will help illuminate potential effects of climate change on insect activity/abundance levels.
- Additional field data collection and model improvement are planned.
  - Current models over-predict mosquito and black fly numbers at low insect activity; under-predict at high activity levels.
  - Models of oestrid presence are highly predictive (ROC scores 0.8-0.9), however, utility is questionable due to low number of trapping periods (11 of 285) when oestrid flies were caught.
- Future work will define fine-scale relationships between caribou behaviour & insect activity/abundance; identify landscape-scale patterns of caribou movement as related to forage quality/availability, vegetative phenology, & insect indices; quantify energetic costs of insect avoidance & examine implications for caribou population productivity.

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