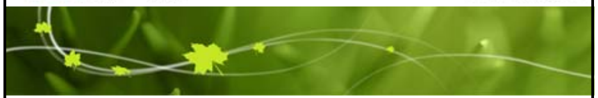
Environment Canada Environnement Canada

Canada



Spatial modelling exposure of non-target mammals to anticoagulant rodenticides can inform mitigation options for mammalian predators inhabiting areas impacted by oil and gas development

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I smell a rat!

- Different types of rodent pests in Canada, most notably
  - Norway rat (*Rattus norvegicus*)
  - Roof rat (*Rattus rattus*)
  - Deer mouse (*Peromyscus maniculatus*)
  - House mouse (*Mus musculus*)
  - White-footed mouse (*Peromyscus leucopus*)
  - Meadow voles (*Microtus pennsylvanicus*)

Most troublesome and economically detrimental in AB
(Government of Alberta – Agriculture and Forestry, 2002)

Rodent Control

- Why???
  - Damage
  - Disease

Rodent Control - Damage

Estimated at $19 BILLION in the USA alone! – Pimentel et al. 2005

Rodent Control - Measures

- IPM approach is favored

Rodent Control - Measures

- Exclusion, including sanitation





Rodent Control - Measures

- Mechanical




Rodent Control - Measures

- Chemical
  - Metal phosphides
    - Ex: zinc phosphide – produces phosphine gas
  - Hypercalcemia
    - Fat soluble vitamins – disrupts calcium and phosphate homeostasis
    - Vitamin D family (D, D_2 and D_3) – death by hypervitaminosis
  - Anticoagulant Rodenticides
    - First generation compounds (AKA - multiple dose compounds)
    - Second generation compounds (AKA – single dose compounds)

First Generation Anticoagulant Rodenticides

- Introduced in 1940s
- Derivatives of 4-hydroxycoumarin
- Requires multiple-feedings
- Subject to “bait shyness” and subsequent resistance
- AI: warfarin and coumatetralyl

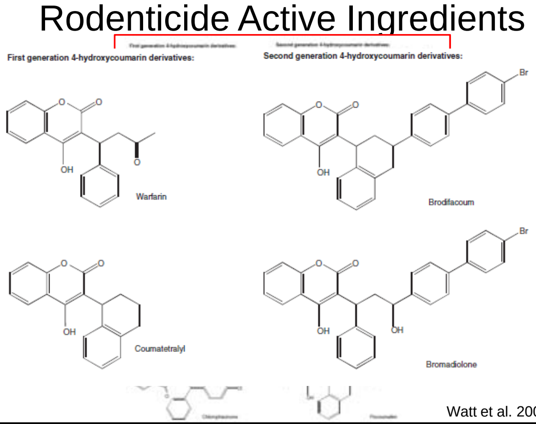
Watt et al. 2005

Second Generation Anticoagulant Rodenticides

- Introduced in 1970s after first reported cases of warfarin resistance in Norway rats (1958)
- Derivatives of 4-hydroxycoumarin
- Requires single feeding
- AI: brodifacoum, bromadiolone and difenacoum

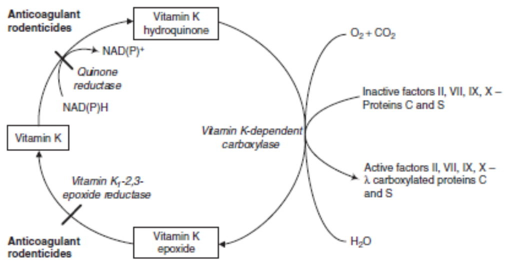
Buckle et al 1994

Rodenticide Active Ingredients



Watt et al. 2005

Rodenticides – Mode of Action



Park et al. 1979; Watt et al.. 2005

SGARs

- Greater potency attributed to:
  1. Greater affinity for vitamin K1-2,3-epoxide reductase
  2. Ability to disrupt the vitamin K1-epoxide cycle at more than one point
  3. Hepatic accumulation
  4. Unusually long half-lives due to high lipid solubility and enterohepatic circulation (up to 350 days for some SGARS - Erickson and Urban, 2002)

Watt et al.. 2005; Vandenbroucke et al. 2008

The Problem

- Death does not occur right away
- More time spent in the open (vs edges)
- More time spent foraging during the day
- Higher incidence of rodents dying above-ground (or in the open)

Cox and Smith 1992

The Problem

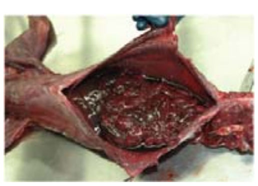
- With higher probability of poisoned rodents appearing in the light, in open areas, and sitting motionless for considerable lengths of time, it could increase rodents' liability to predation, or scavenging

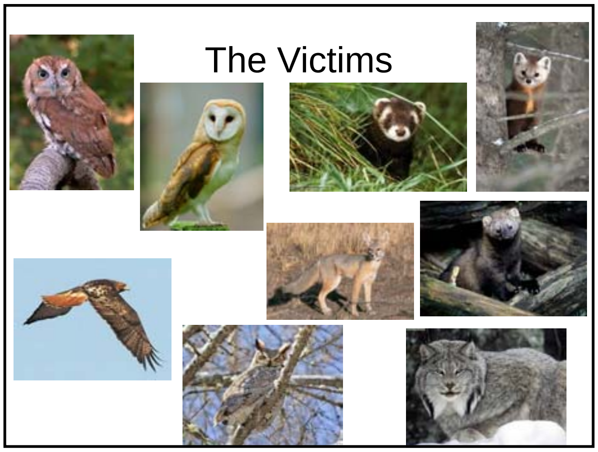

The Problem

- Greater persistence and toxicity of SGAR compounds has resulted in increased incidence of exposure and poisoning of non-target wildlife, primarily predatory birds and mammals (Hegdal and Colvin 1988; Newton et al. 1990; Shore et al 1996; Tobin et al. 1996; Newton et al. 1999, 2000; Stone et al. 1999, 2003; Howald et al. 1999; Eason et al. 2002; Lambert et al. 2007; Riley et al. 2007; Walker et al. 2008; Albert et al. 2010, Lima and Salmon 2010; Murray 2011; Thomas et al. 2011; Christensen et al. 2012; Gabriel et al. 2012)

Elliott et al. 2013

The Problem

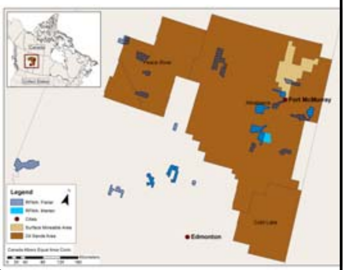




The Victims

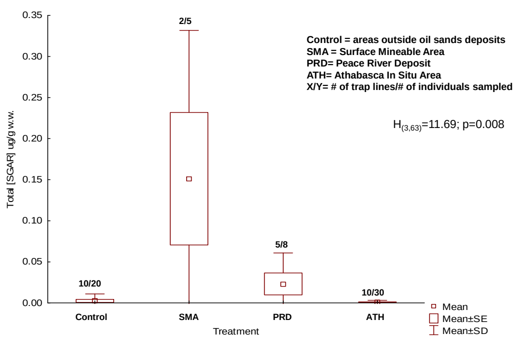

WHY???
CAUTION
READ
INSTRUCTIONS
BEFORE USING


OPEN ACCESS Freely available online
PLoS one
Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore
Mourad W. Gabriel, Leslie W. Woods, Robert Poppenga, Rick A. Sweitzer, Craig Thompson, Sean M. Matthews, J. Mark Higley, Stefan M. Keller, Kathryn Purcell, Reginald H. Barrett, Greta M. Wengert, Benjamin N. Sacks, Deana L. Clifford

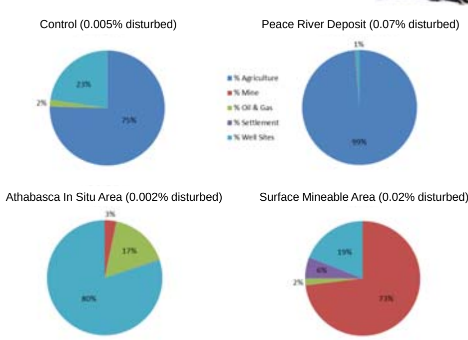
A New Context: Alberta's Oil and Gas Industry



SGARs Exposure in Northern Alberta Fishers

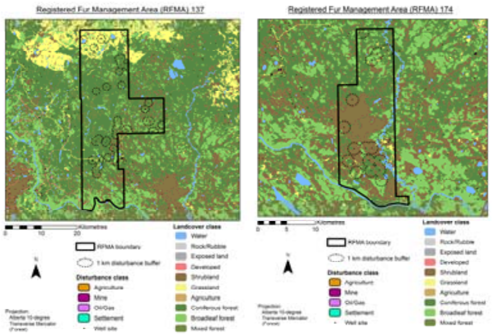


Spatial Analysis of Polygonal Anthropogenic Disturbance Features

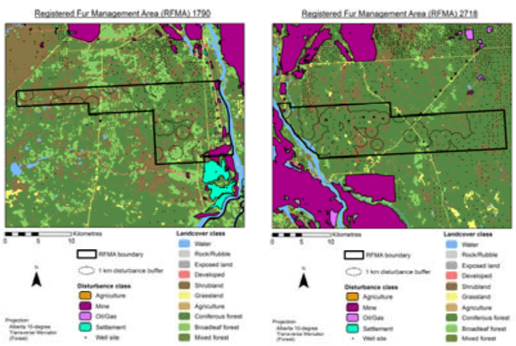


n = 25 trap lines

Spatial Analysis of Polygonal Anthropogenic Disturbance Features



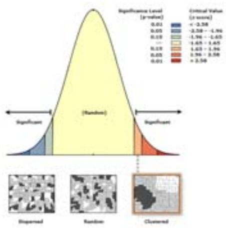
Spatial Analysis of Polygonal Anthropogenic Disturbance Features



Modelling Exposure Frequencies to Rodenticides in Northern Alberta Fishers

- Large number of independent variables…
  - Initial selection made using Pearson's moment correlation (criteria > 0.7 or < -0.7 => one variable removed)
  - Exposure frequency weighted by population sampled at each trap line
  - Non-normal data was log10 transformed
  - Due to low sample size – forward variable selection method was used entering those with highest correlation coefficient first
  - Remaining variables added one at a time until none of the remaining variables added were significant
  - Model forced through zero – RODs are not naturally occurring compounds
  - AICc used to select best model
  - Residuals tested for homoscedasticity, normality, linearity, and no serial autocorrelation: passed all test

Modelling Exposure Frequencies to Rodenticides in Northern Alberta Fishers



Global Spatial Autocorrelation
Moran's Index: 0.152881
Expected Index: -0.038462
Variance: 0.012531
z-score: 1.709298
p-value: 0.087396

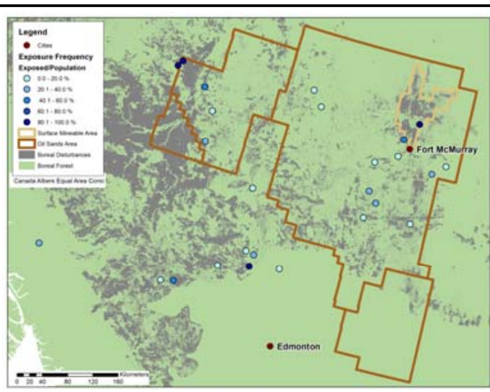
Local Spatial Autocorrelation
Observed General G: 0.000007
Expected General G: 0.000005
Variance: 0.000000
z-score: 1.907404
p-value: 0.056468

Summary of global (Moran's I) and local (Getis and Ord's G*) spatial autocorrelation results indicate clustering at both the global and local level at the 90% CI.

Modelling Exposure Frequencies to Rodenticides in Northern Alberta Fishers

Table 1: Final linear regression model, where the dependent variable is the frequency of fishers exposed to SGAR. Significance threshold relaxed to 10% as supported by Suter (1996)

	Estimate	Std. Error	T value	Pr(>|t|)	Partial R^2
D_tot_perc	0.222	0.082	2.7	0.013	0.248
D_Mine_n	0.125	0.067	1.88	0.073	0.138
LC_BrdFor_perc	0.034	0.018	1.96	0.063	0.148
Residual Standard Error	0.209	**R^2**	0.66	**Model AICc**	-0.51
Degrees of freedom	22	**Adj R^2**	0.61	**Null AICc**	6.7
$F_{(3,22)}$	13.92	**P-value**	2.63e-05		



Exposure frequency of fishers on trap lines (centroid represented by blue circles) in relation to oil sands deposits and Northern Alberta Boreal forest disturbances.

Company Surveys – Targeted Mitigation Options

Table 2: Survey on rodent control measures employed by Northern Alberta companies who operate in oil and gas impacted areas. 25 companies (n) answered the survey.

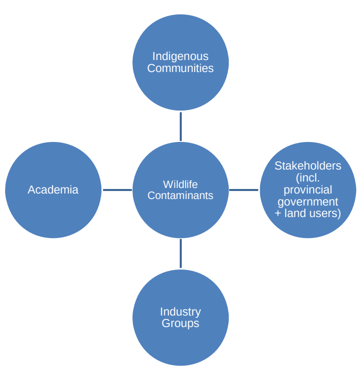
Rodent Control Measure	Number of companies reporting use
Companies employing more than 1 rodent control strategy	10/25
Companies employing more than 1 chemical strategy	2/10
Chemical Strategies that include Bromadiolone	17/21
Strategies that include outdoor use	4/8
<u>Rodent Control Measures:</u>	
First Generation Compounds	
Warfarin	2
Diphacinone	1
Chlorphacinone	1
Second Generation Compounds	
Bromadiolone	17
Brodifacoum	1
Difethialone	2
Others	
Zinc Phosphide	1
Snap Traps	7
Live Traps	4
Sticky traps	1
Tin cans	1
Cats	1

Jeff Wendorff Wildlife Photography (2016)

<u>Conclusions:</u>

- First time fishers are reported exposed to rodenticides in Canada; first time marten are reported exposed globally
- GIS tools can help answer relevant ecotoxicological questions on spatial & temporal trends of exposure
- Data can be used in formulating localized intervention/mitigative efforts

Our Purpose



THANK YOU TO:

- Fort McKay First Nation, Mikisew-Cree First Nation, Athabasca Chipewyan First Nation, and all Métis Locals, Bruce Maclean and CBMP crew, Alberta Trappers Association
- ECCC partners (including Parks Canada!) and the NWRC (support), the province of Alberta, Saskatchewan and the Northwest Territories (including provincial, territorial and federal health authorities)
- Canadian Wildlife Health Cooperative
- University of Alberta – Dr. Margo Pybus, Barb Maile (Fish and Wildlife)

Joint Canada | Alberta Implementation Plan for Oil Sands Monitoring

Questions?

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