Strychnine alternatives for Richardson's ground squirrel control

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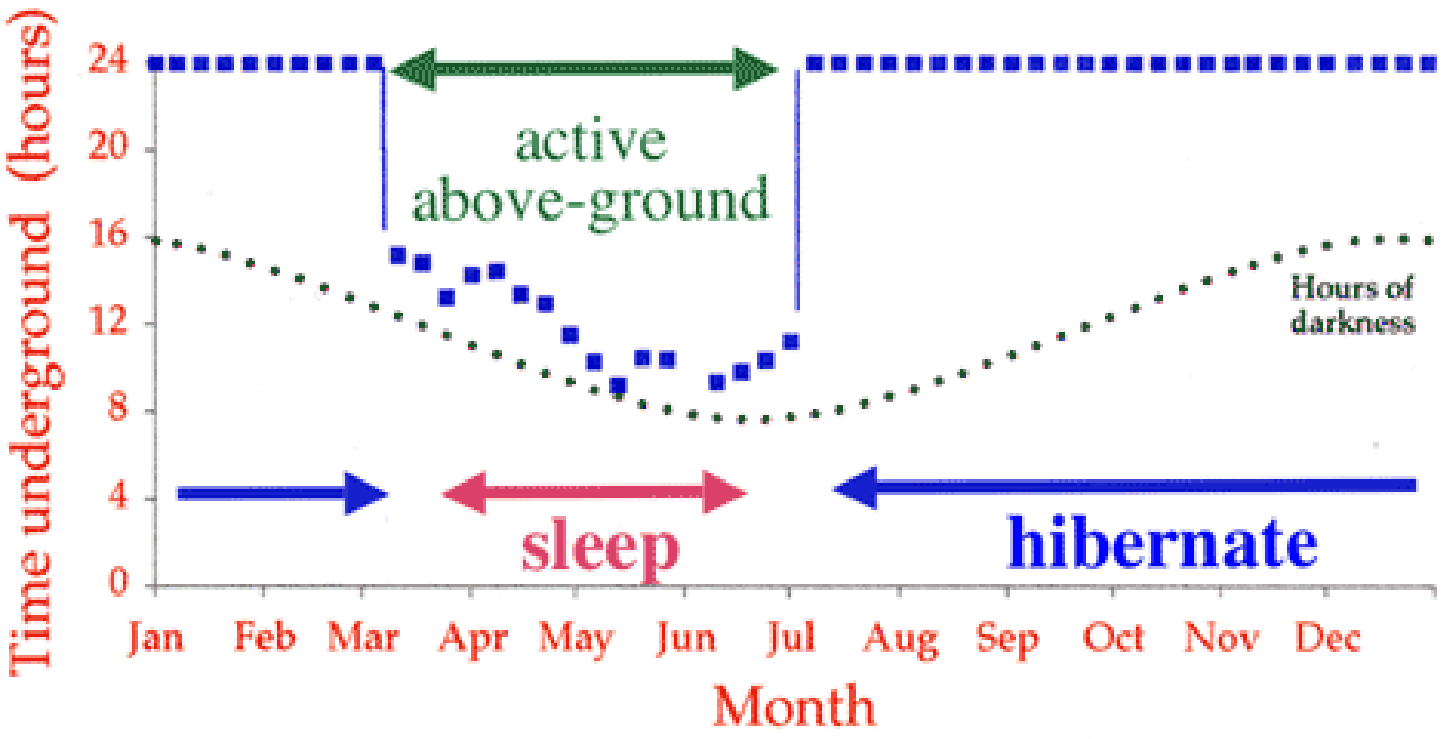
Richardson's Ground Squirrel (RGS)

- *Urocitellus richardsonii* (Sciuridae)
  - Formerly *Spermophilus richardsonii*
  - Semi-fossorial, semi-social
  - Native to western North American shortgrass prairie
  - Also called the dakrat (Dakota rat) and flickertail

RGS Life History

- Adults above ground for about 4 months per year
- Spring emergence
  - Correlated with warming surface and air temperatures
  - Ambient temps regularly stay above freezing
    - Soil temp still near 0°C
  - Males appear 2 wks before females
    - Preceded by a period of testicular recrudescence and build up fat reserves (assuming cache is large enough)
  - Females terminate torpor the day before they appear

RGS Activity– adult females



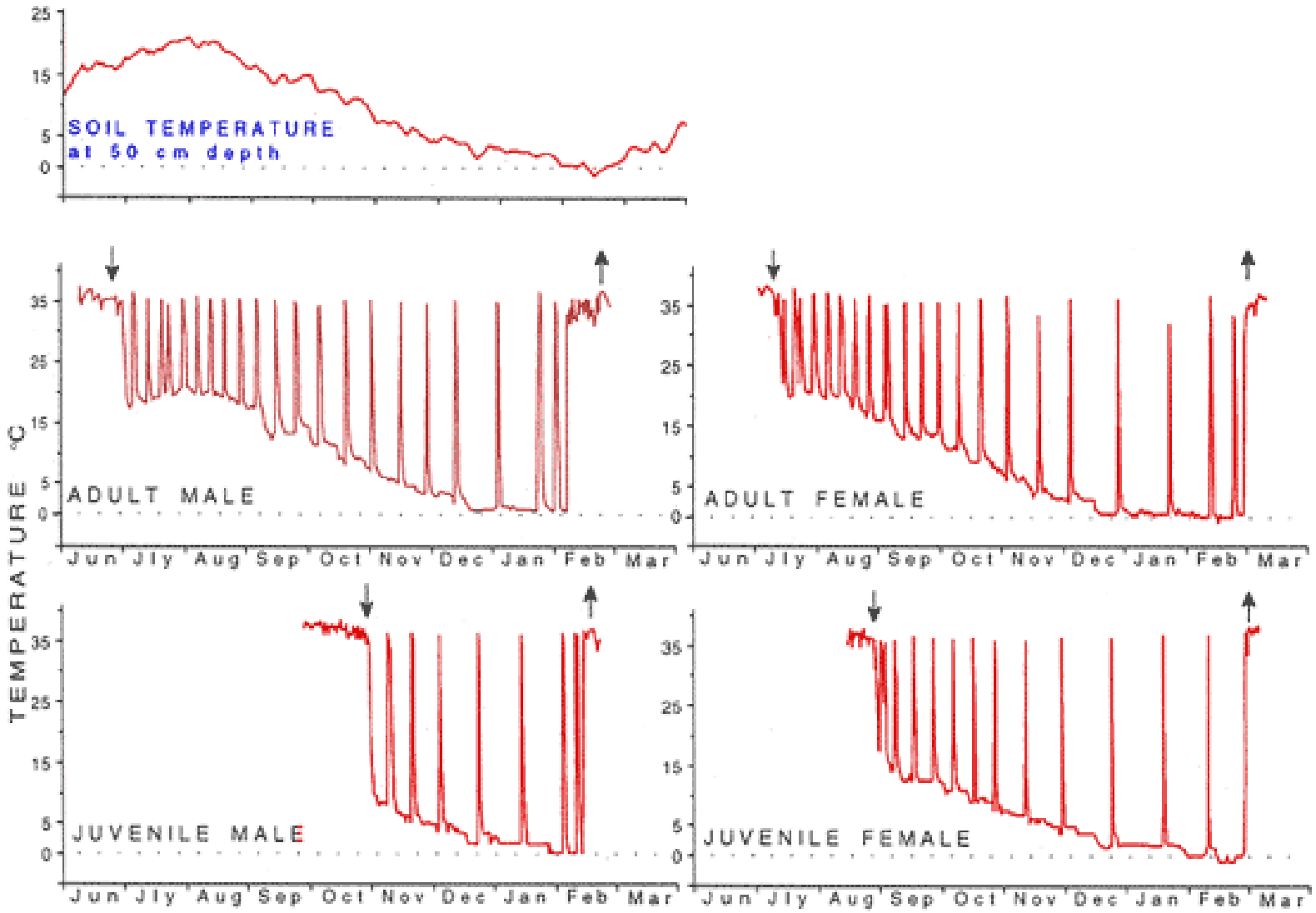
RGS Reproduction

- The young
  - One litter/year: 5-8
  - Gestation 23 d
  - Lactation 5 wks – weaned shortly after emergence
  - Young within mother's territory
    - Claim a part of it for their own as they mature
    - Young females move short distance from mother's territory when populations high
    - Males move long distances from mother if populations high
      - June/July
      - Seek other colonies
      - May move many km away
      - Do not mate with relatives if they stay close

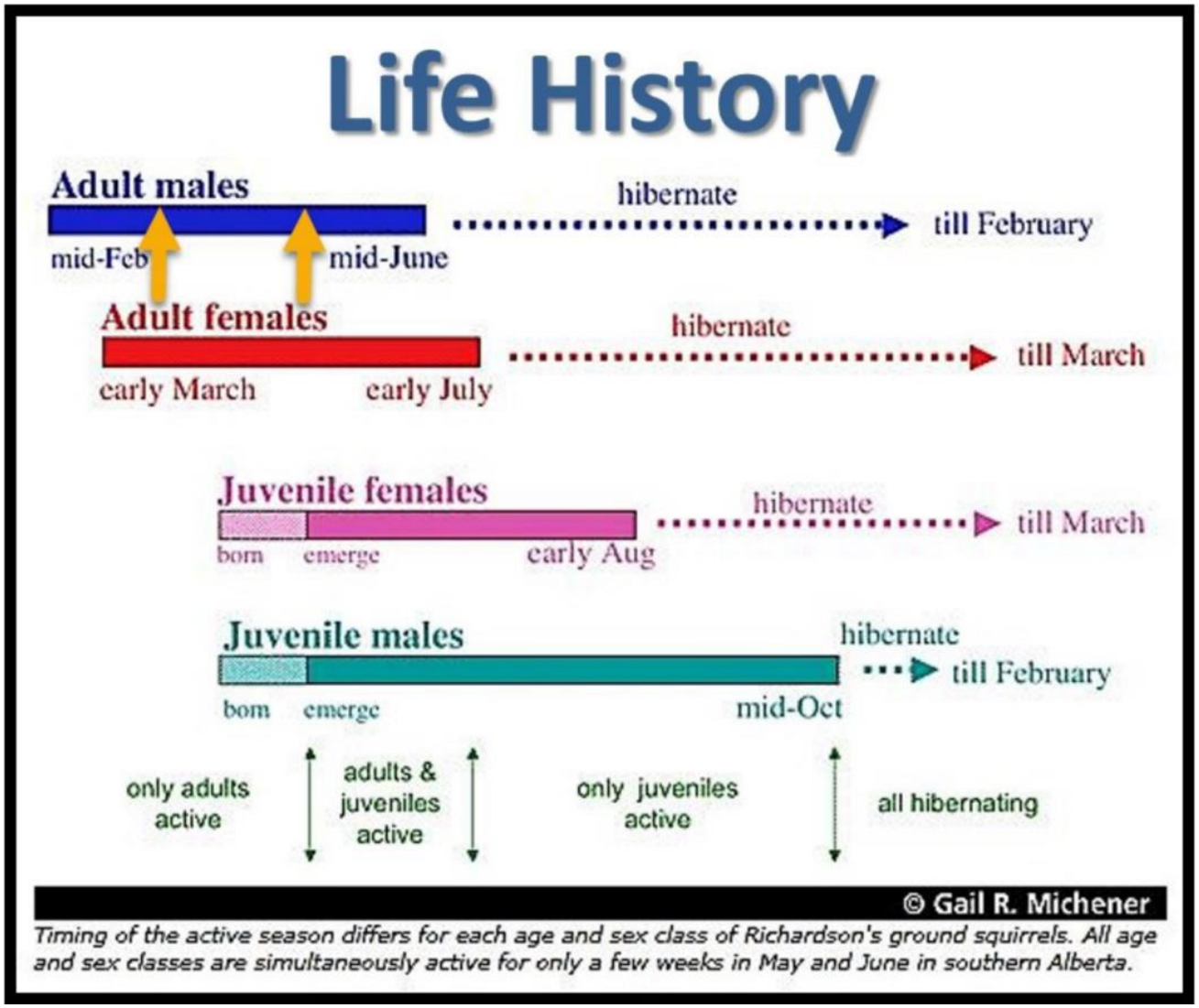
RGS 'Hibernation'

- State of torpor alone in a special grass-lined chamber
  - Begin in bouts in late summer
    - Bouts increase in duration as soil temps cool
    - Interrupted by <24 hr re-warming to normal temp of 37°C
    - Body temp is approx the same as surrounding soil
      - 4-6 days July and August
      - In January, 20-25 consecutive days in torpor, with body temp 0°C
      - Heart rate, respiration, and metabolism slow dramatically
  - Conserve energy
    - Fat reserves

Torpor by gender and age

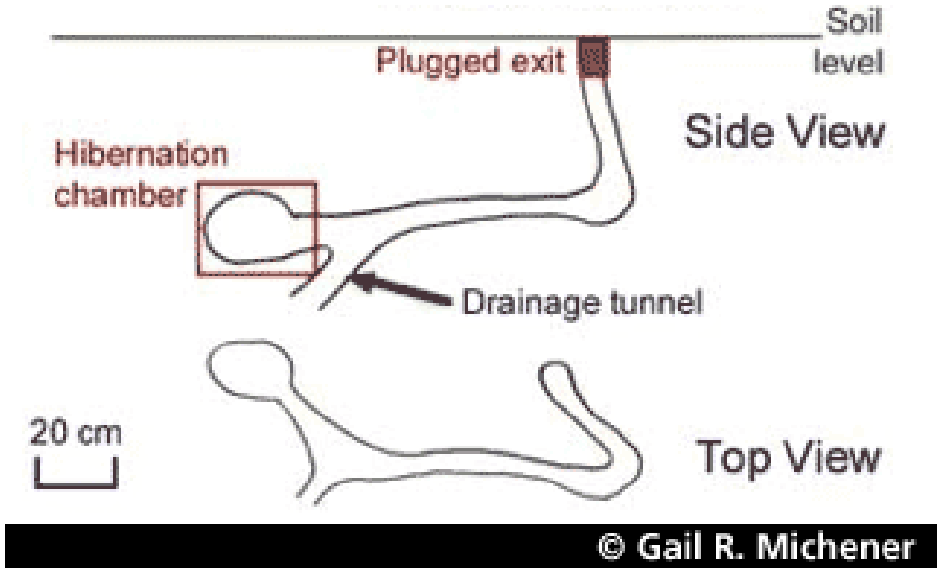


March 15 to April 30 is the best time to manage RGS



RGS Hibernation

- Seal themselves off, dig a new exit in the spring
- Timing and duration of torpor by age and sex
  - Adults active for about 110 days
  - Adult males active mid-Feb through mid-June
  - Adult females come out 2 weeks later
  - Mid-July onwards, only juveniles born that spring are active
  - Juvenile females dormant much earlier



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RGS Control

- Populations increase during extended periods of warm and dry weather
- Several control strategies have been investigated to control RGS populations
  - Tolerance of predators
  - Shooting, trapping, drowning
  - Poisoning
    - Chlorophacinone (Rozol, Ground Force, Gopher Doom)
    - Diphacinone (Ramik)
    - Aluminum phosphide (Gastoxin)
    - Zinc phosphide
    - White Mustard Seed Powder + Sodium Alpha-olefin sulfonate (RoCon)
    - **2% liquid strychnine is by far the most widely used in SK**

Strychnine

- Toxic, intensely bitter terpene indole alkaloid
- Refined from seeds of the venom orange, *Strychnos nux-vomica* (Loganiaceae), native to India and Southeast Asia
- Inhalation, absorption through the eyes or mouth or oral consumption results in toxic effects
- Neurotoxin
  - High affinity, low specificity antagonist of acetocholine receptors and glycine
  - Symptoms of poisoning include spastic muscle contraction
  - Death is by respiratory arrest

Strychnine (a recent history)

- PMRA final decision to de-register March 2020
  - Manufacture permitted until March 2021; sales continued to March 2022; use allowed until March 2023
  - SK and AB submitted letters of objection to the final decision April 2020
  - Strychnine manufacturer Agromax experienced supply chain issues with COVID
  - Shortage reduced strychnine availability and limited intended use in the phase-out
  - SK and AB specialists requested delay of implementation of manufacture and sales deadlines by one year (to March 2022 and March 2023, respectively) and permitted use by one year and six months to September 2024

RGS Control

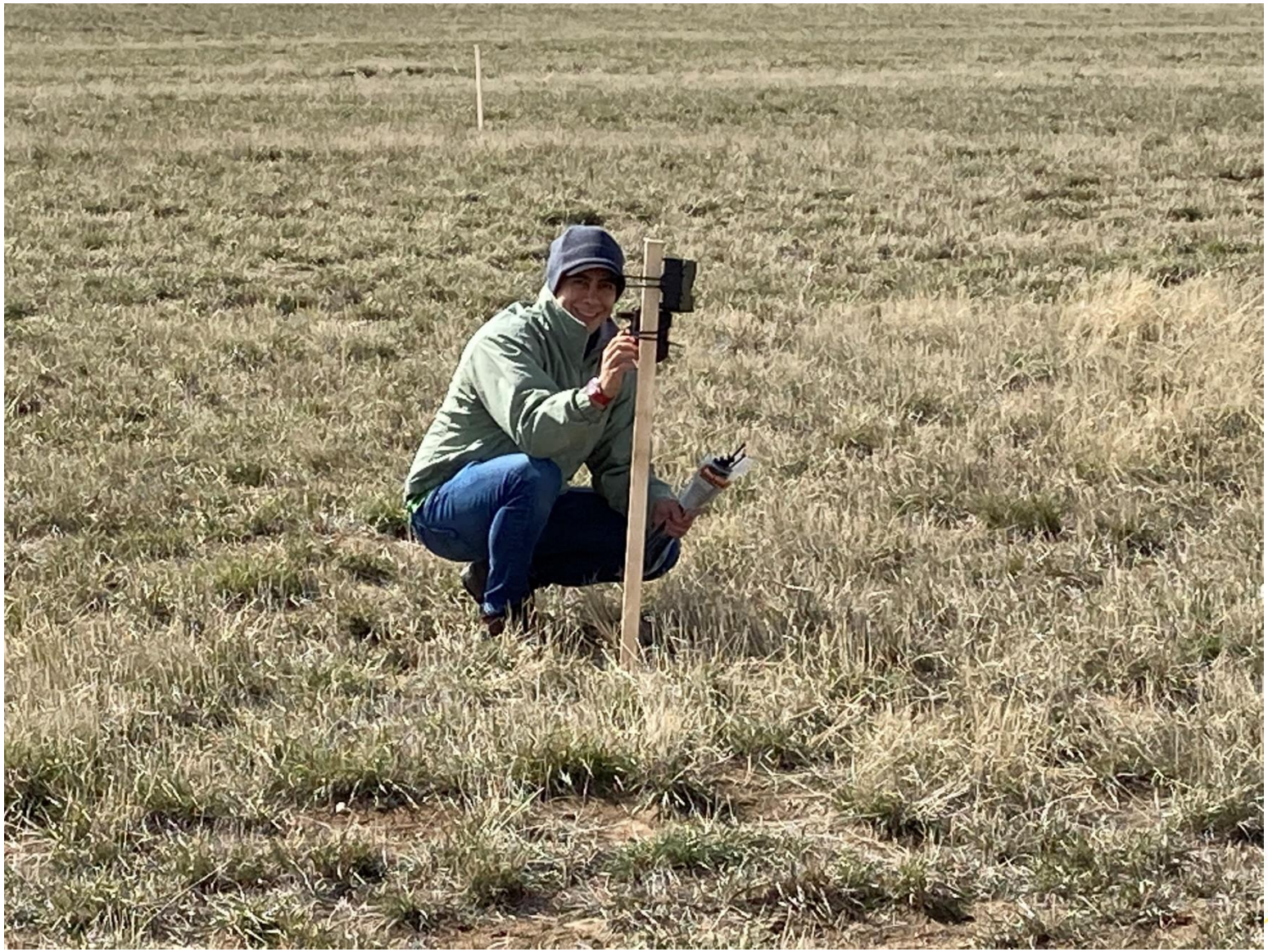
- RGS Stewardship Program
  - The SK Ministry of Agriculture has been operated since 2011 to 2021
    - 81 Rural Municipalities participate
  - This program was an integrated approach to managing RGS
    - includes proper use of fresh-mixed strychnine bait, and non-chemical practices
    - Maintaining predator habitat
    - Raptor platforms, nest boxes
    - Maintaining veg >15 cm
    - Monitoring and proactive management
  - Compliance with this program was good
    - 70 + per cent adoption of at least one IPM measure
    - 20 RMs, ca. 150 sites visited in 2019

Photo courtesy SARM

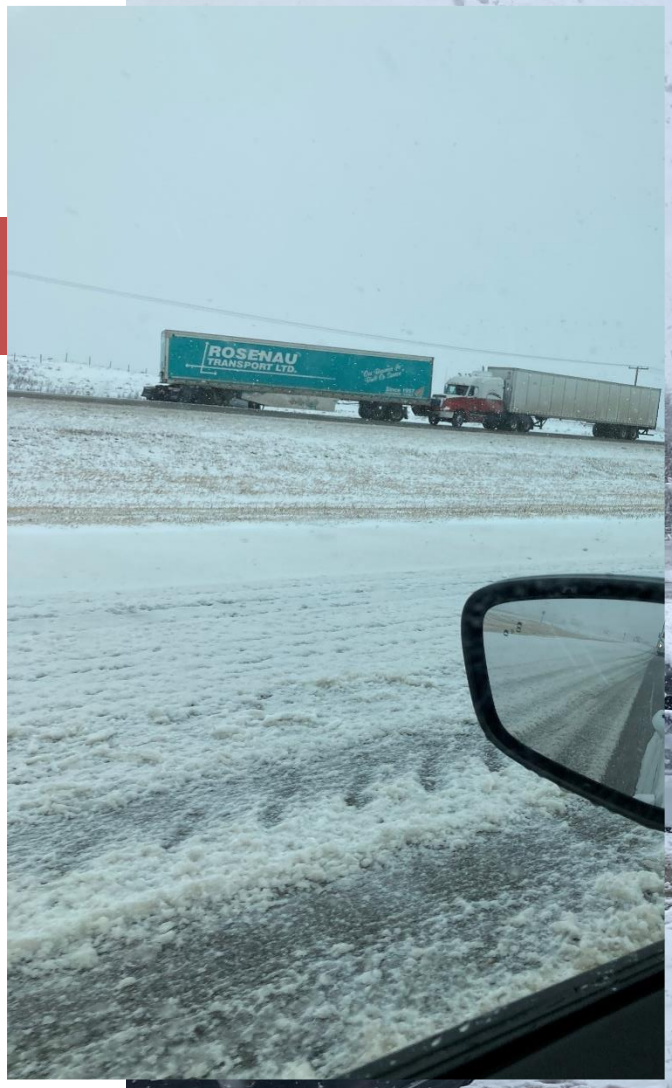
Strychnine alternatives

- Comparative efficacy/non-target mortality trial 2022
  - Early April…Mid April…Late April!
  - Several products evaluated in SK (RM 111) and AB (Cypress County)
    - Strychnine
    - ZP Burrow oat bait
    - ZP Rodent oat bait
    - Rozol RTU
    - Ramik Green
  - Each replicated three times on different sites
  - 40 n x 40 m plot separated by >1km from other treatments, >250 m same treatment
  - Two game cams on central post
  - Two days pre-treatment baseline RGS counts, application, one week of observation counts

Site establishment



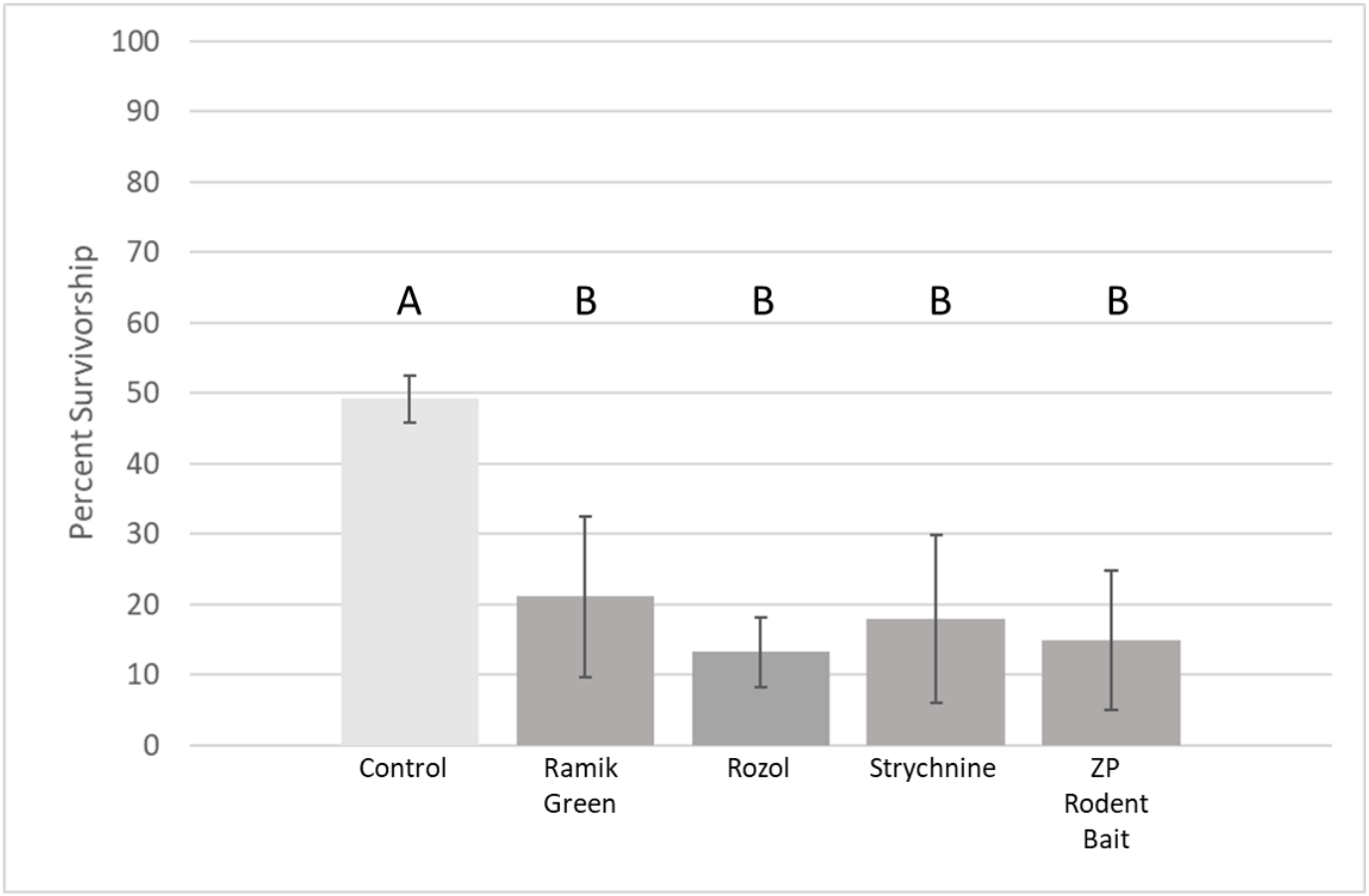
Delays…



Baits applied!

Strychnine alternatives

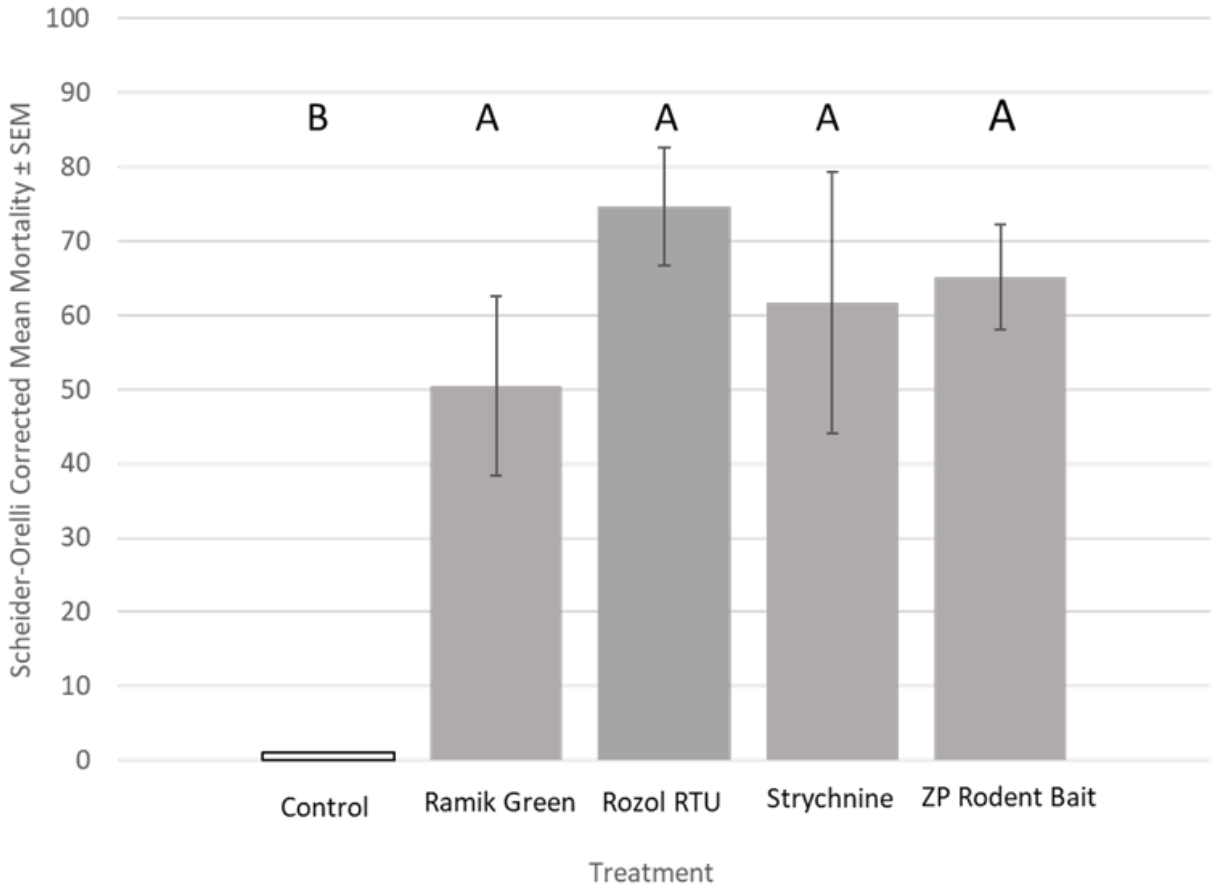
- Alberta 2022 data



No significant differences among like-lettered groups (Tukey HSD, $\alpha = 0.05$)

Strychnine alternatives

- Alberta 2022 data
  - Harsh weather drove RGS underground. Model needed correction



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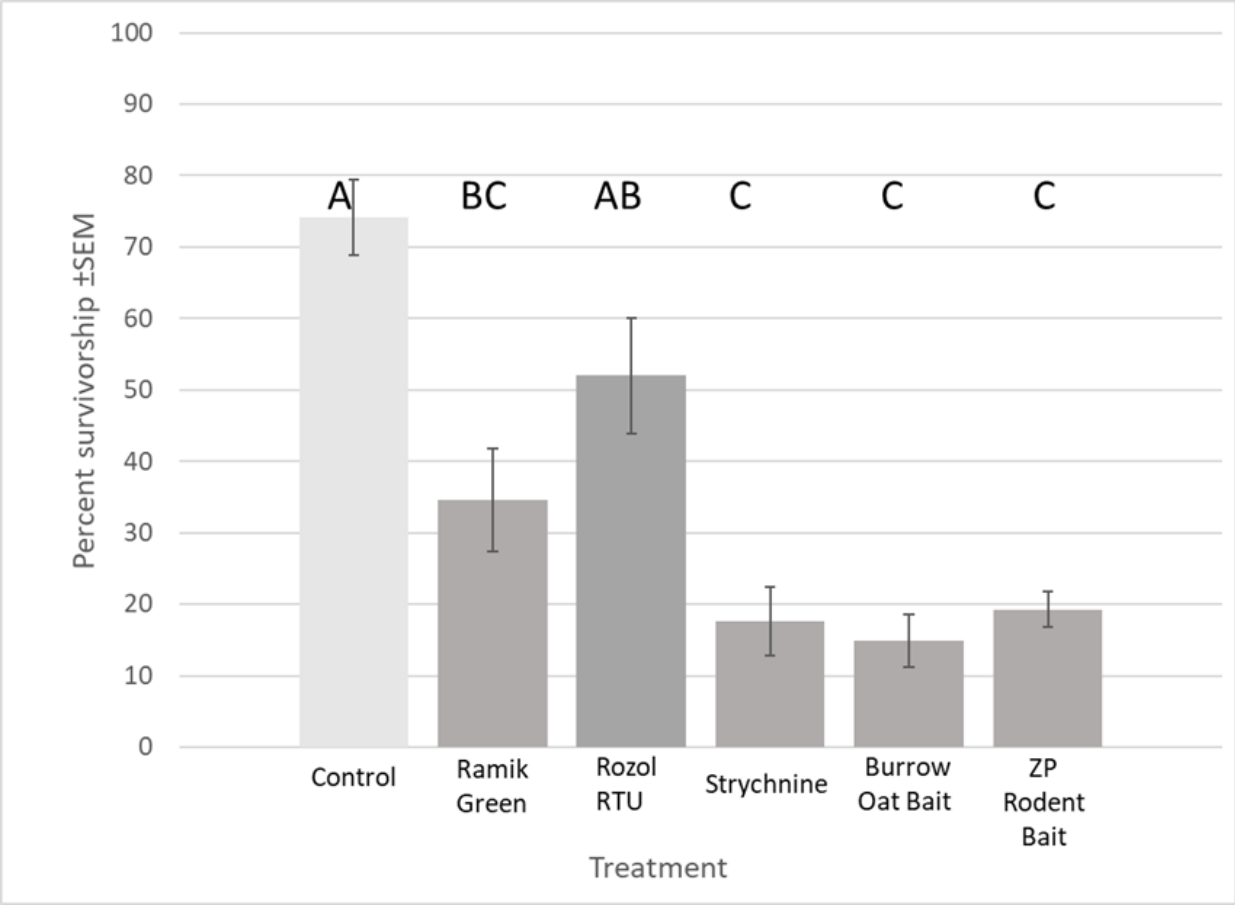
Strychnine alternatives

- Saskatchewan 2022 data



No significant differences among like-lettered groups (Tukey HSD, $\alpha = 0.05$)

Strychnine alternatives

- **An important consideration with all baits is timing**
  - **Best results are achieved if baits are applied as RGS are emerging from overwintering, before spring green-up**
  - This can be as early as late February in some regions
- Anti-coagulants
  - Fresh plant material, particularly legumes, provide RGS with vitamin K
  - This is the antidote
- Strychnine and zinc phosphide have no antidotes

Strychnine alternatives

- Economic analysis
  - Rozol and Ramik can require multiple applications
  - Costs are per application

Product	$ per acre
2% Liquid Strychnine Concentrate	12.97
Burrow oat bait	**4.54**
ZP Rodent oat bait AG	**8.80**
Rozol RTU Field Rodent Bait	14.73
Ramik Green	10.60

Non-target effects

- 2022 - no non-target mortality detected
- 2019 - small number of deer mice killed by strychnine
  - Most were buried in short order by carrion beetles

Invertebrate scavengers

- *Nicrophorus carolinus* (L.) are important scavengers in W Canada
  - Bury small carcasses for their larvae
  - Both male and female care for the developing young
  - Work quickly


Photo: Bugguide.com

Invertebrate scavengers

Invertebrate scavengers

Contributors to 2022 study

- SK
  - Rural Municipality of Maple Creek (RM111): Christine Hoffman, Shawn Kramer, ratepayer cooperators
  - Rural Municipality Edenwold (158)
  - Saskatchewan Ministry of Agriculture: Dr. James Tansey, Richard Wilkins, Raul Avila, Austin Baron, Jordan Johnson, and Brooke Fiala
  - SARM PHOs: Joanne Kwasnicki and Colleen Fennig
- AB
  - Alberta Agriculture, Forestry and Rural Economic Development: Dr. Karen Wickerson
  - Municipal District of Willow Creek: Carla Preachuk, Kirby Hugo and Gary Murray
  - Cypress County: Lisa Sulz

Consideration for various products

- Strychnine
  - 2% liquid strychnine concentrate to be mixed with farm available grain to formulate 0.4% strychnine bait
  - Grain can influence palatability and uptake
  - Environmental considerations
    - Do not scatter bait
    - No above-ground bait stations
    - Treated grain on soil surface and poisoned carcasses may be hazardous to birds and other wildlife
    - All treated grain and poisoned carcasses on soil surface must be collected and disposed of by incineration or burial at least 18 inches deep and then covered
    - Do not apply if SAR (burrowing owl, swift fox, etc) in the area

Consideration for various products

- Strychnine
  - Hazards
    - There is no antidote
      - Eating activated charcoal immediately can help
    - Liquid is very toxic to all life, baits and dust from baits also toxic
    - Central nervous system stimulant:
      - Causes convulsions: 5-10 minutes after consumption
      - Death by asphyxiation

Consideration for various products

- Zinc Phosphide
  - Hazards
    - There is no antidote
    - May be fatal or harmful if swallowed. Avoid skin contact. Avoid inhalation of dust
    - Avoid all acid contacts
    - Residues limited

Consideration for various products

- Ramik Green, Rozol RTU
  - Hazards
    - Anticoagulant
    - The use of anticoagulant bait can present a significant hazard to predatory mammals and birds through secondary poisoning
    - Residues can be significant

Questions?