Main Points

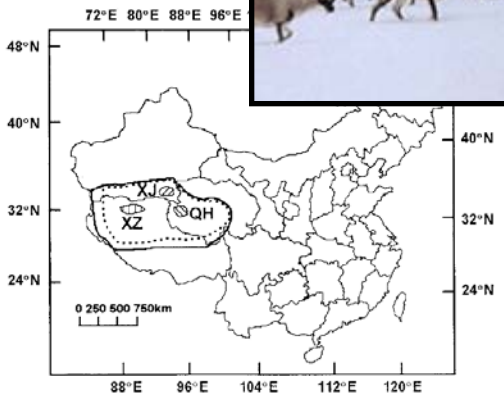
1) **The biology of migration**
   - **-- convergent evolution of migratory systems**
   - **-- biogeography of migratory systems**
   - **-- resident and migrant strategies**
   - **-- example: ideal free muskrats**

2) **The conservation of migrations**
   - **-- human disturbance, movement barriers, and climate change**
   - **-- example: functionality of migration routes (Sawyer et al reading)**
   - **-- example: shifting phenologies, predator reintroduction, and the costs and benefits of migrating**

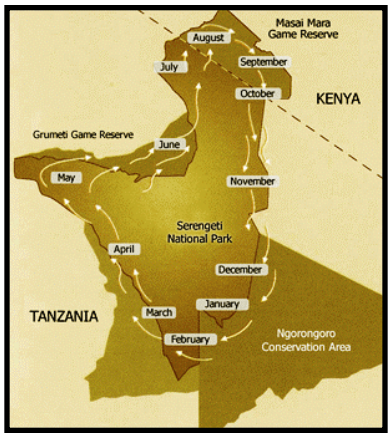
Pre-reading: Monday Oct 26 = Pauli and Buskirk. 2007.
Wednesday Oct 28 = Ford et al. 2014.

<u>Terms:</u>
ideal free distribution, partial migration, life history polymorphism, phenology

1500 km

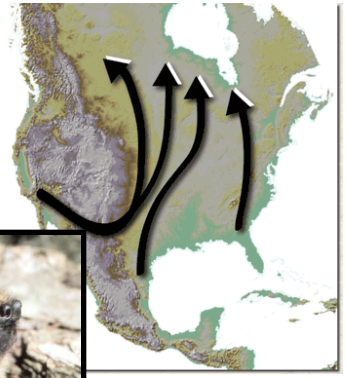


800 km



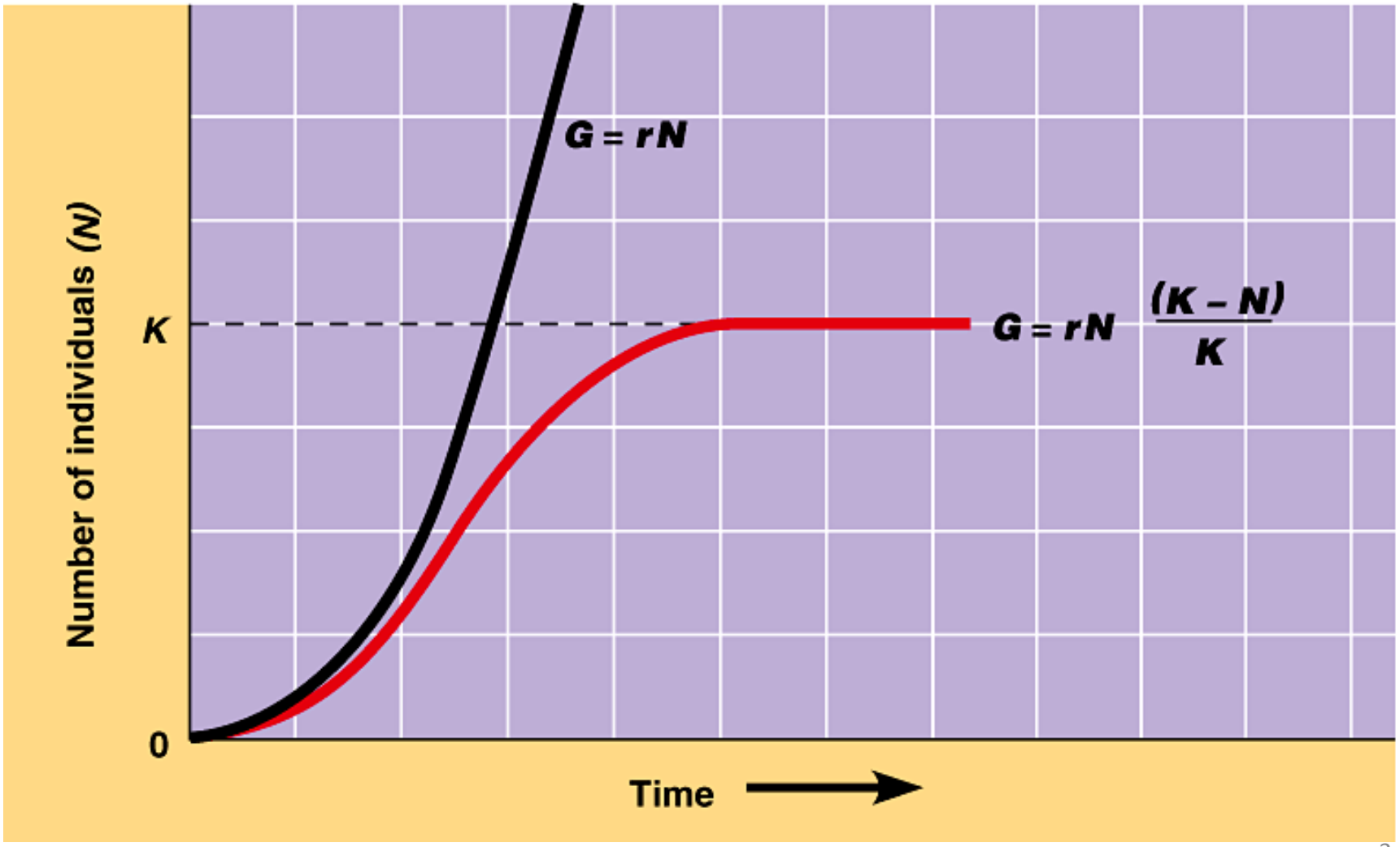
11,000 km

2000 km



1300 km

Population growth review



Convergent evolution of migration

Common attributes of migratory systems:
1) resource is sufficiently attractive to warrant moving such distances

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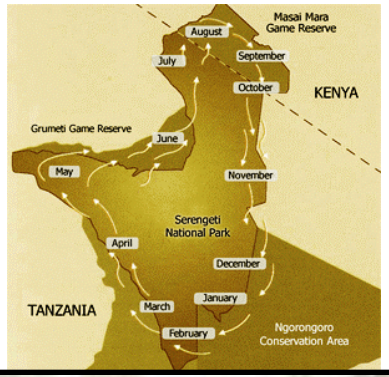

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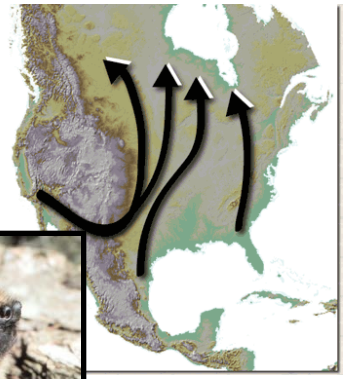

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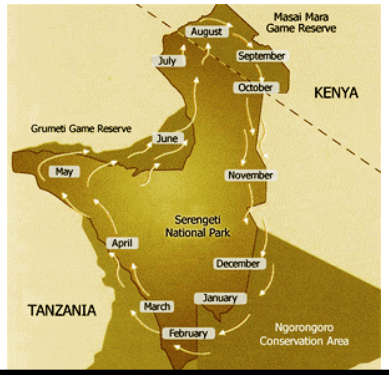

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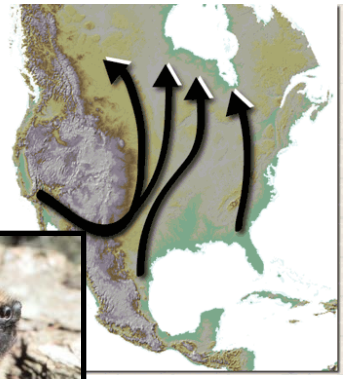

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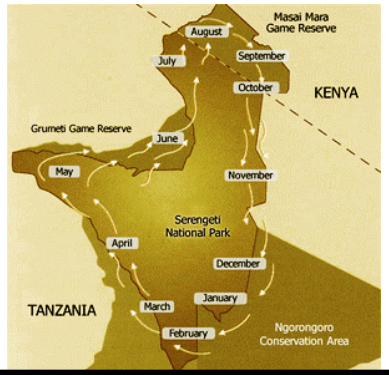

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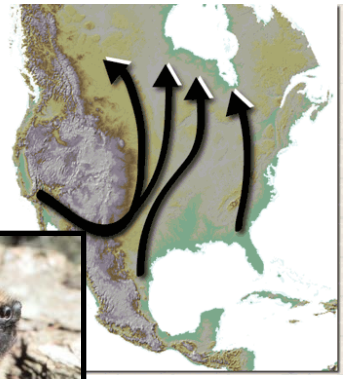

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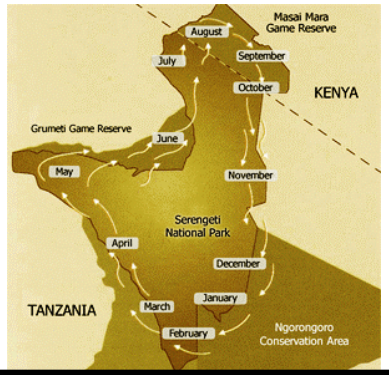

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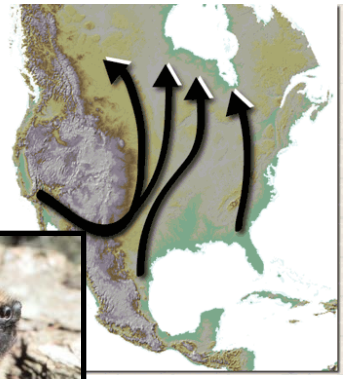

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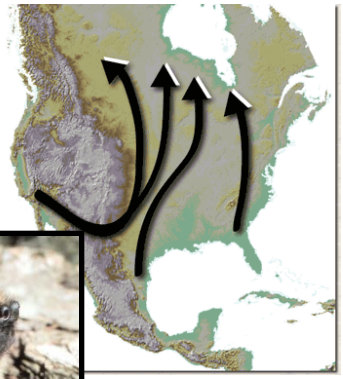
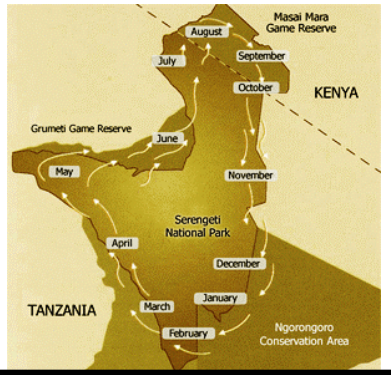
5) movement of population is directional

2000 km

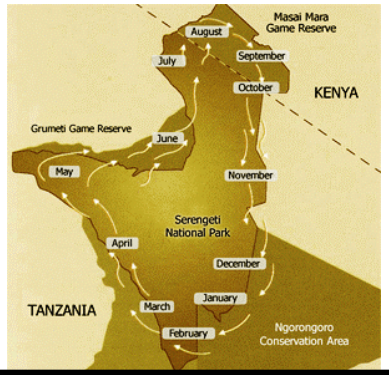


800 km



Discussion Q: what environmental variables would you expect to go hand-in-hand with migratory systems?

800 km



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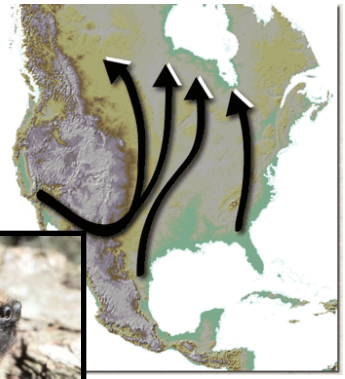
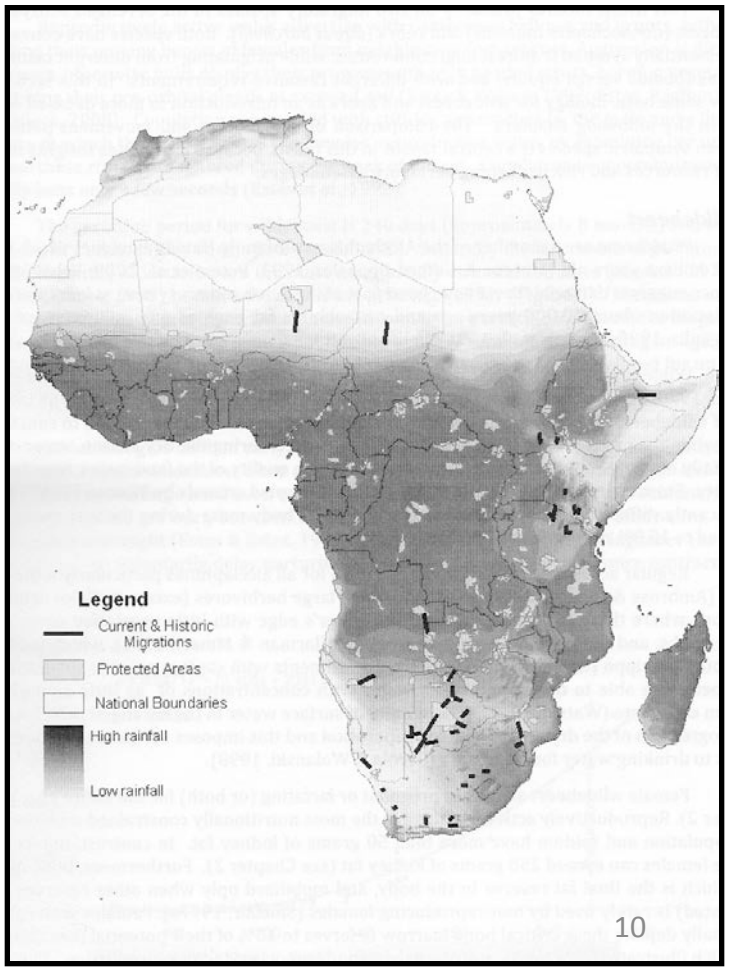


The biogeography of migratory systems

- **Seasonal resource gradients (particularly rainfall or snowmelt) typify migratory systems.**



Thirgood et al. 2010.

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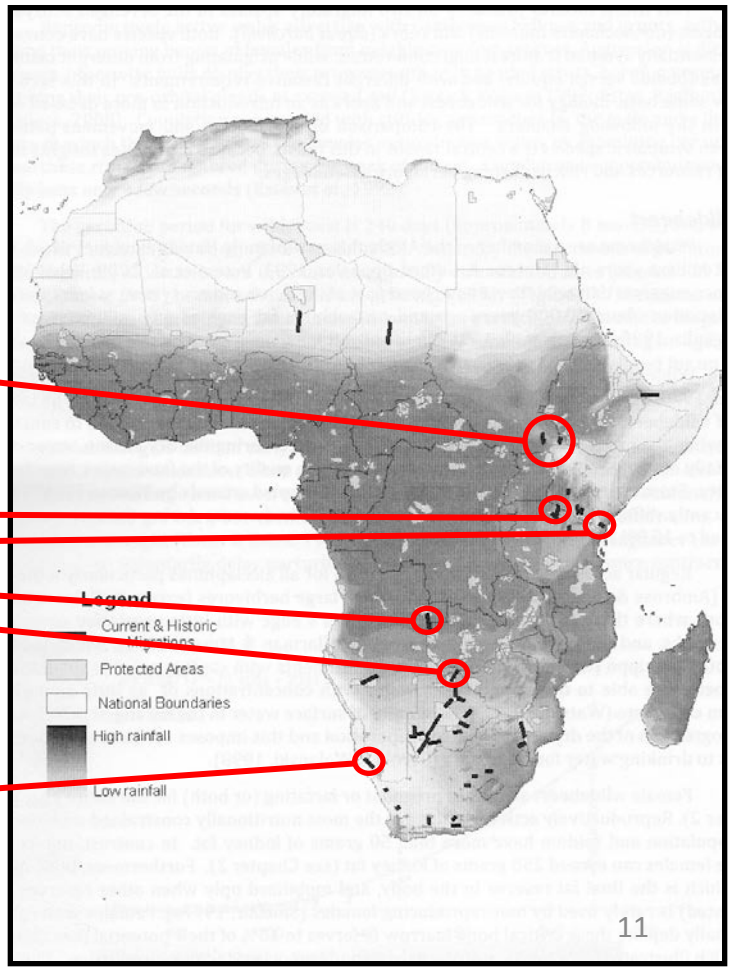
- **~30 historic migrations of 14 species in Africa (of which 6 migrations of 9 species are extant).**



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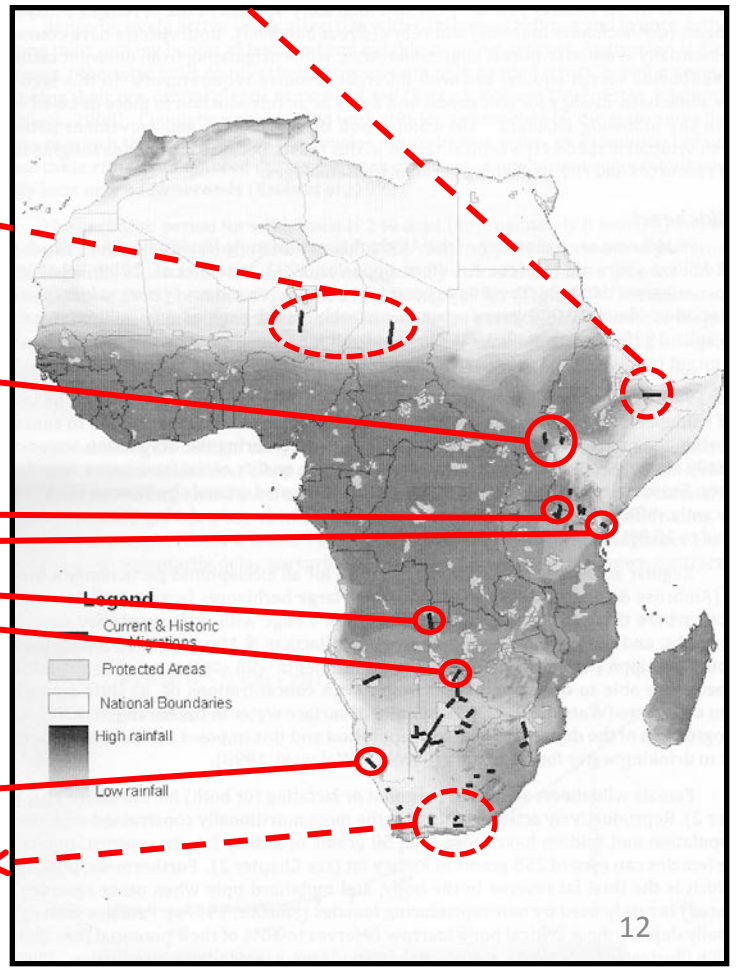

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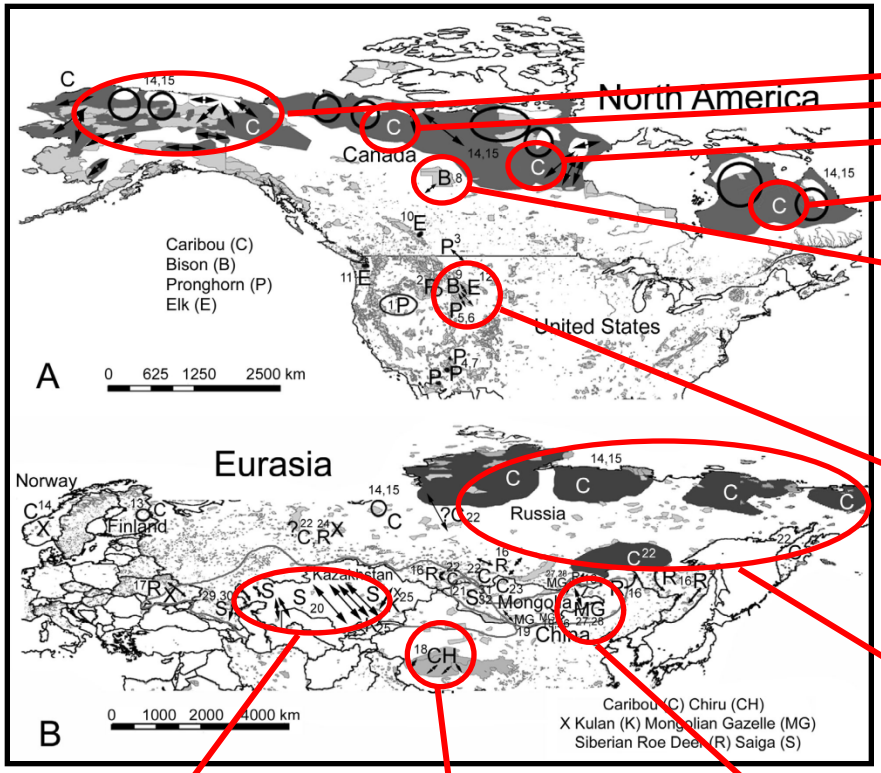
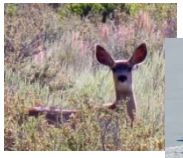
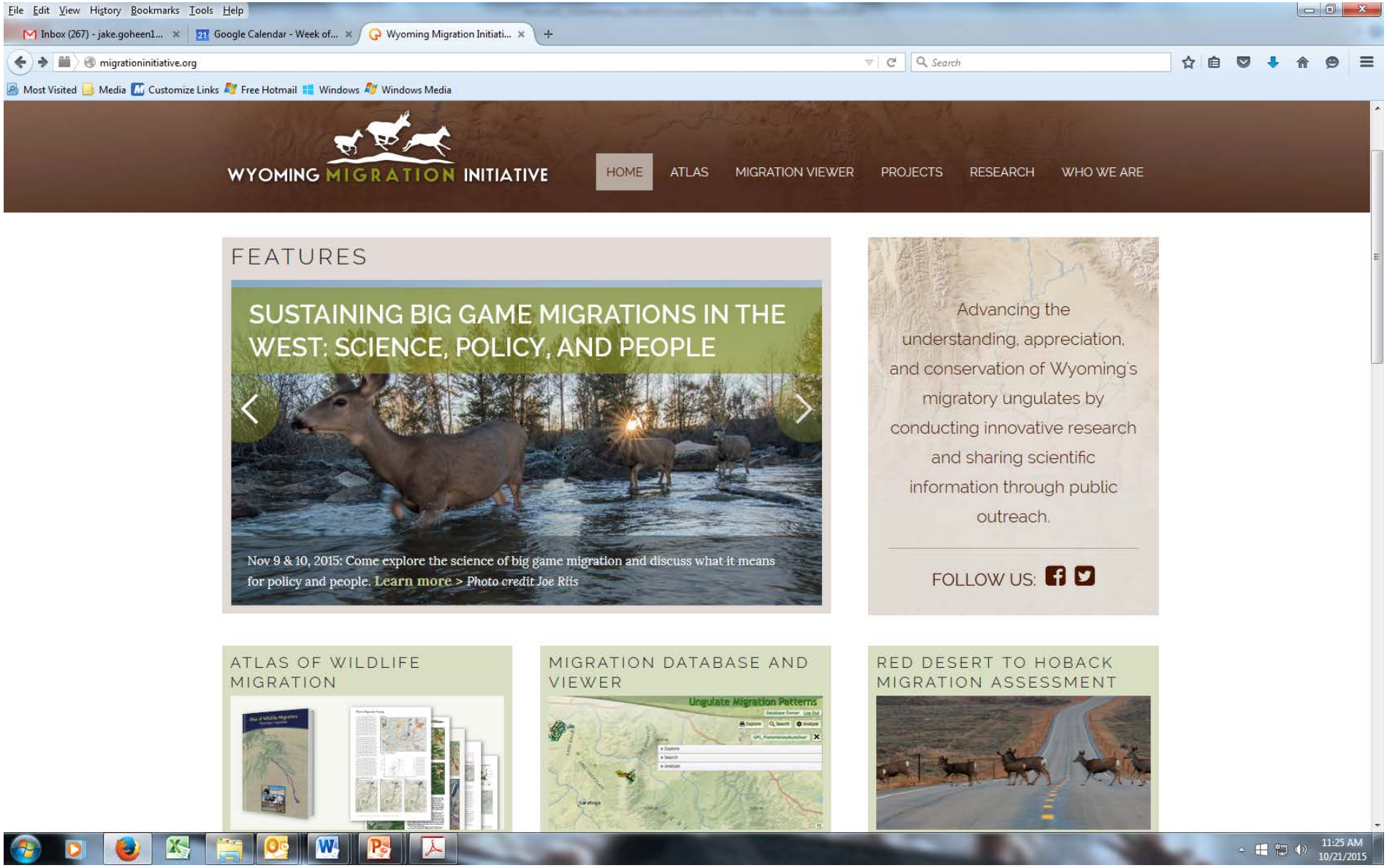




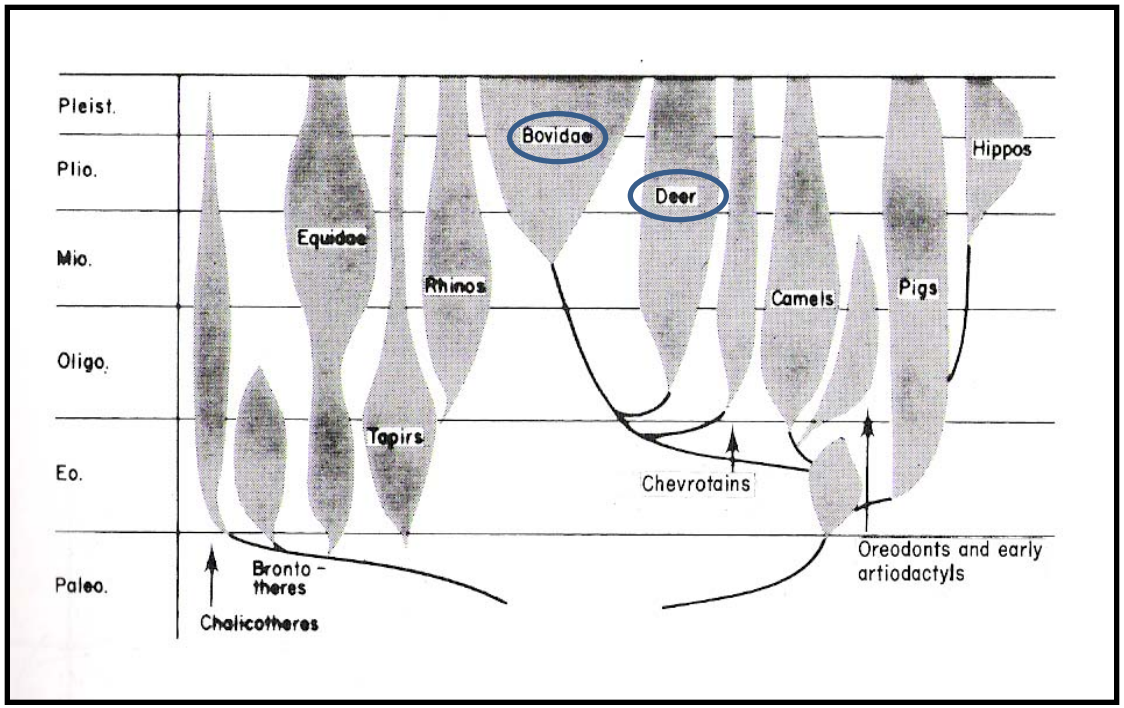
Thirgood et al. 2010.

Right here in your own backyard! (migrationinitiative.org)



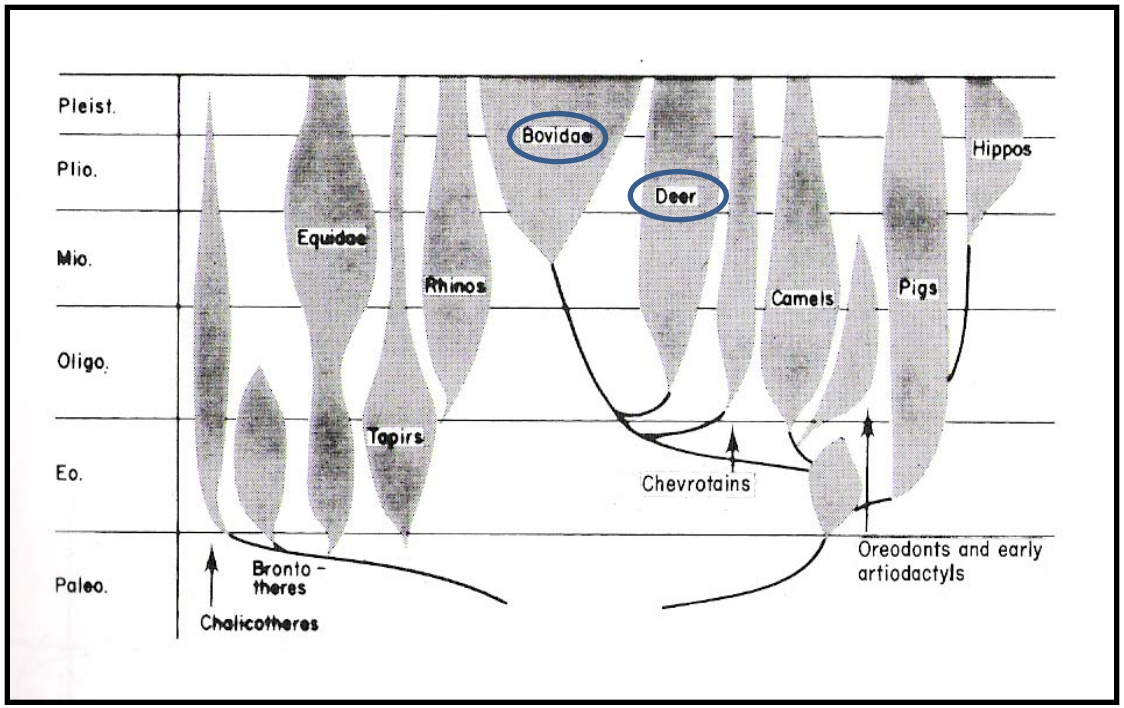
The evolution of novelty

- **the evolution of a ruminant stomach is thought to have resulted in the radiation of bovids (cattle, goats, sheep, antelopes) and cervids (deer) ~50-100,000 years ago**



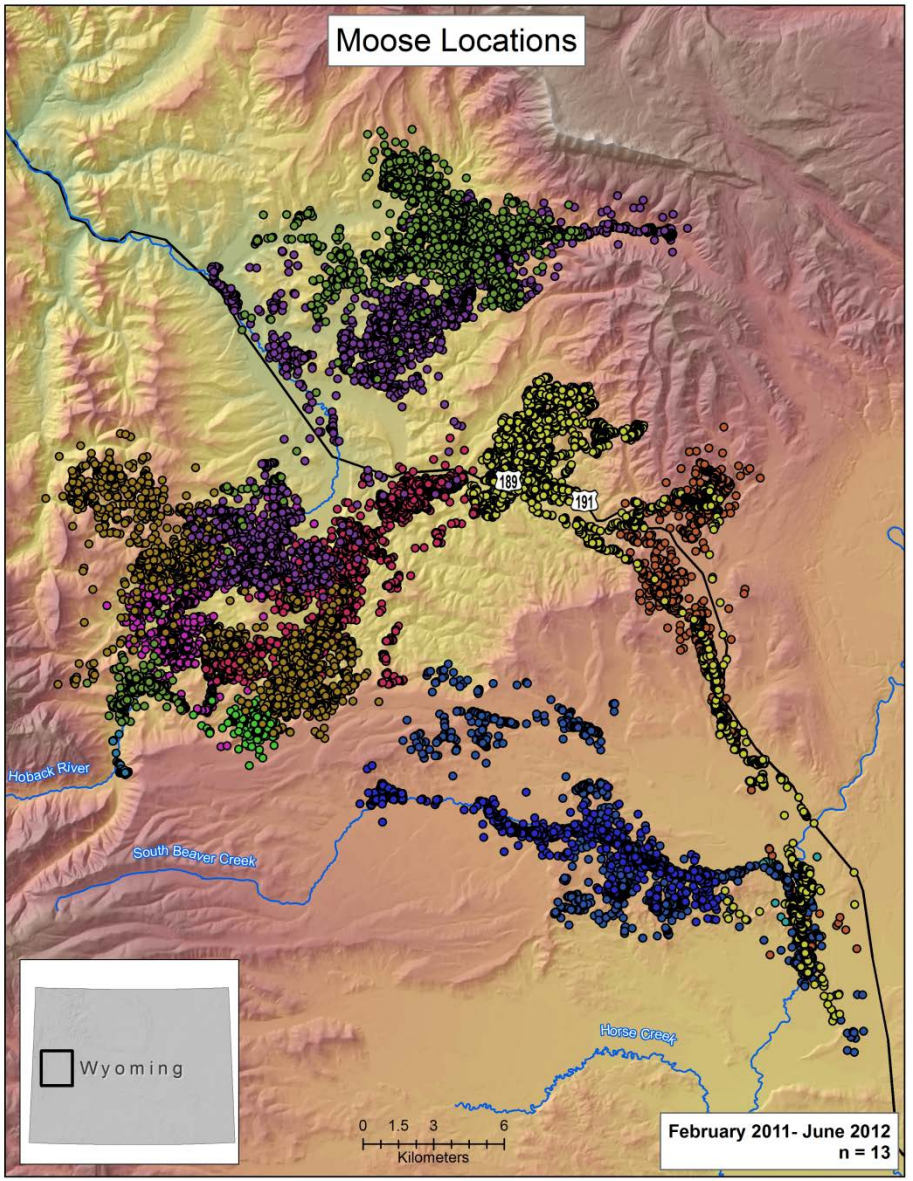
The evolution of novelty

- **this "novelty" probably facilitated the capacity to migrate over long distances, thereby increasing carrying capacities by permitting the exploitation of a previously-underutilized resource (i.e., seasonally-available forage)**



Partial migration

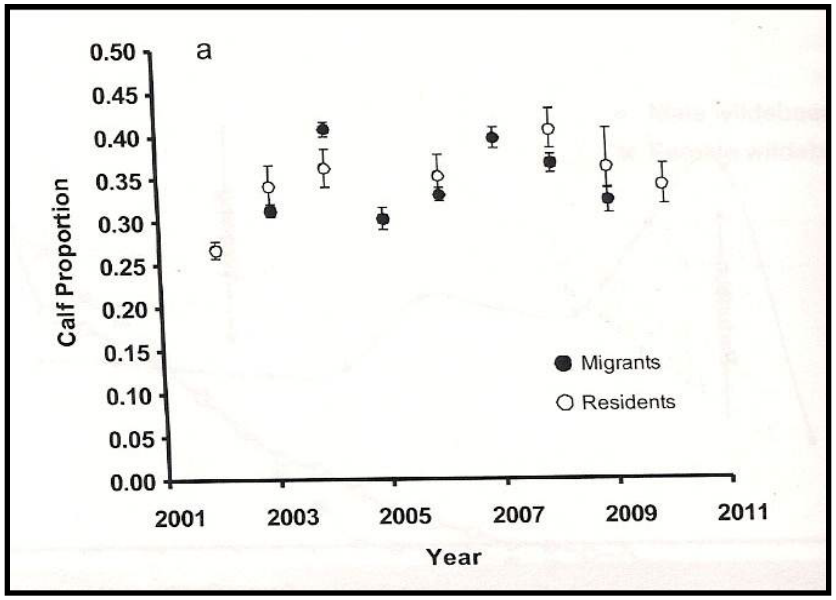
- **populations of most species of mammals that migrate are <u>partially migratory</u>, composed of a mix of migrants and residents**



Partial migration

- **in most partially migratory populations, migrants outnumber residents**

- **<u>life history polymorphism</u> = multiple strategies within a population, often resulting in equivalent fitness**



Ideal Free Distribution

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- **Assumptions:**
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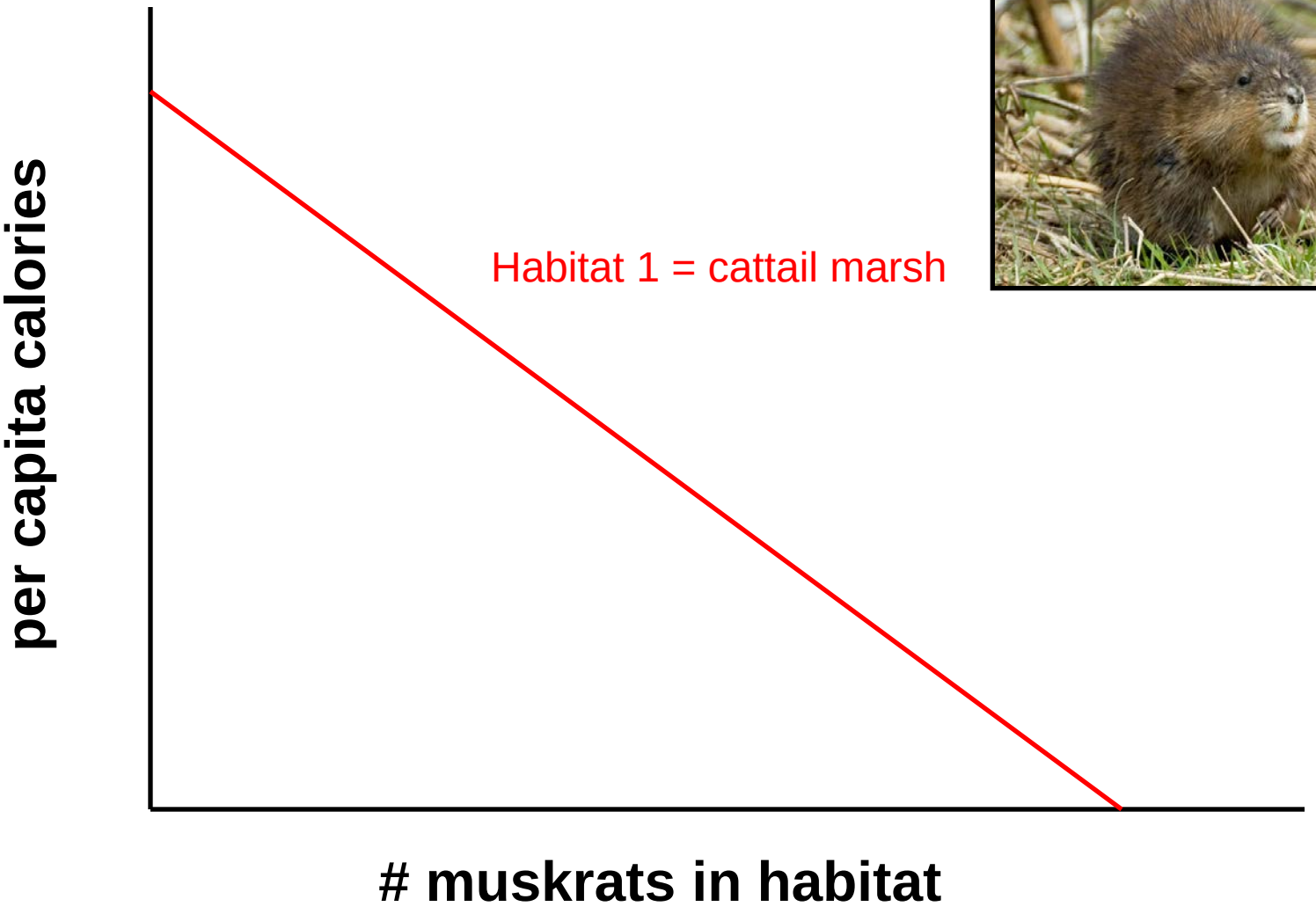
  3) first arrivals get "first dibs"

Ideal Free Muskrats

per capita calories

muskrats in habitat

Ideal Free Muskrats



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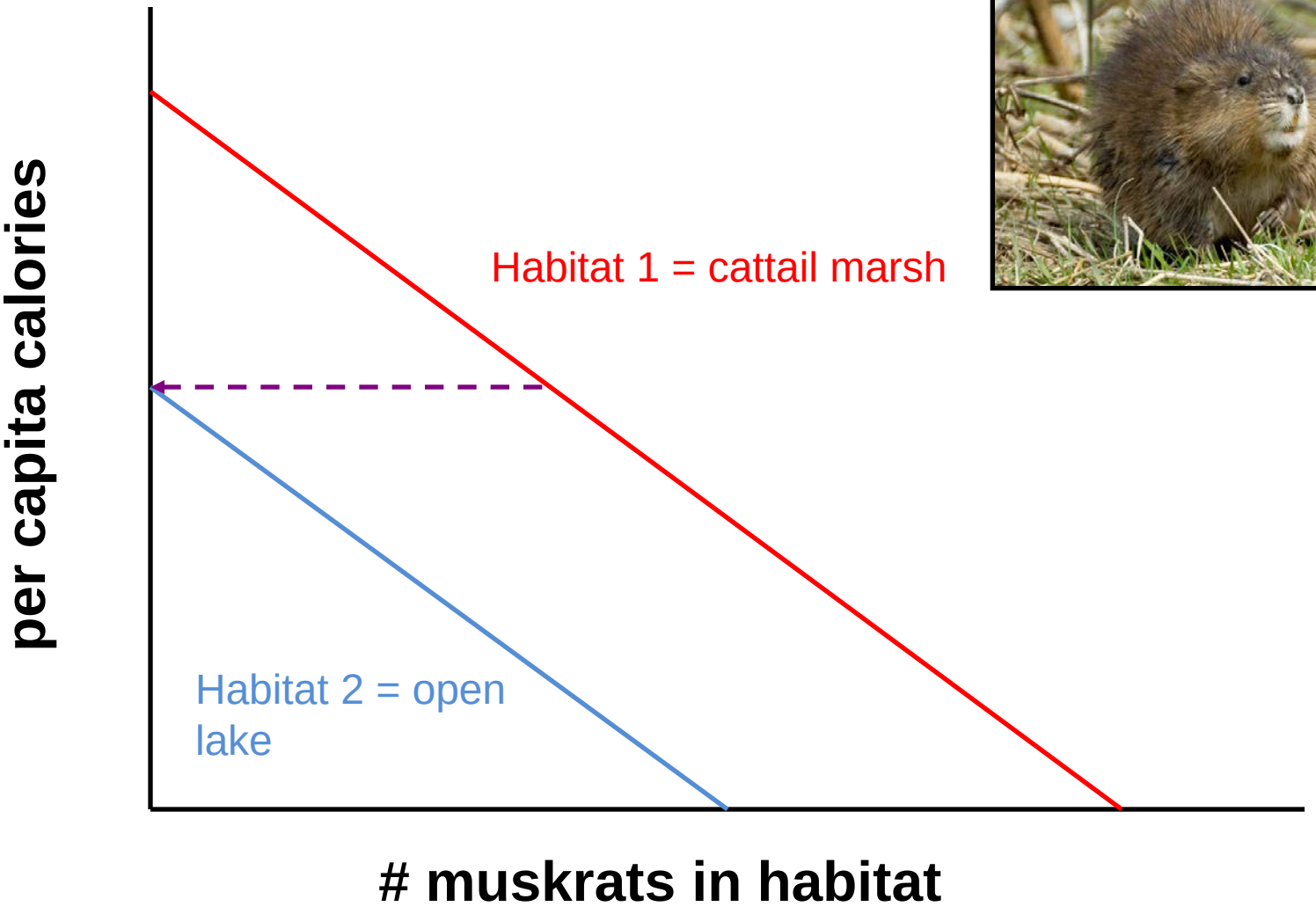

The conservation of migrations

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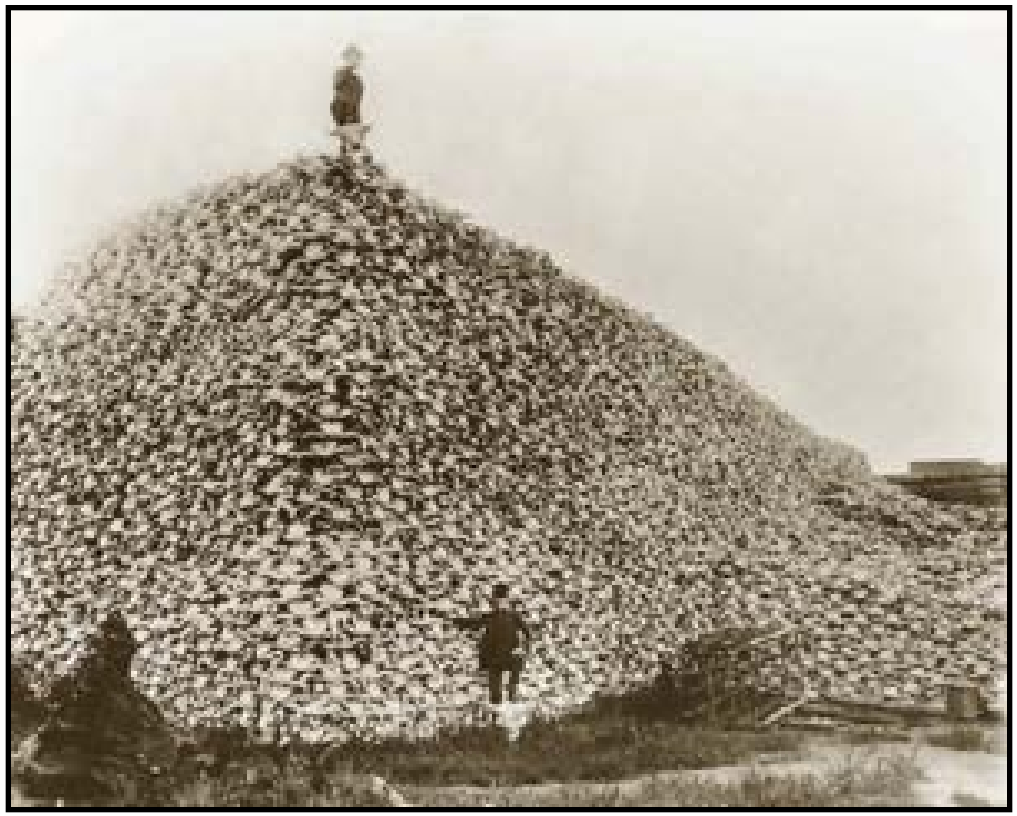
4) cycle of available resources must be predictable based on external cues

5) movement is directional (i.e., not dispersal)

The conservation of migrations

- **Factors causing the decline of migrations (and migratory species):**

1) Overexploitation made possible by aggregations

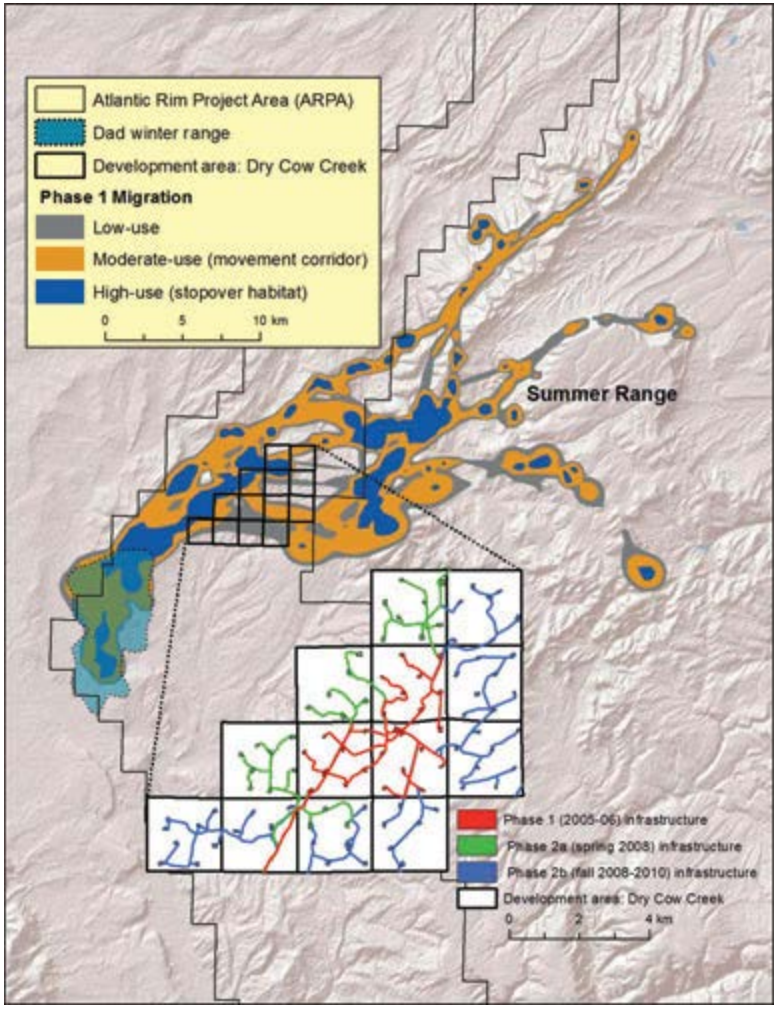


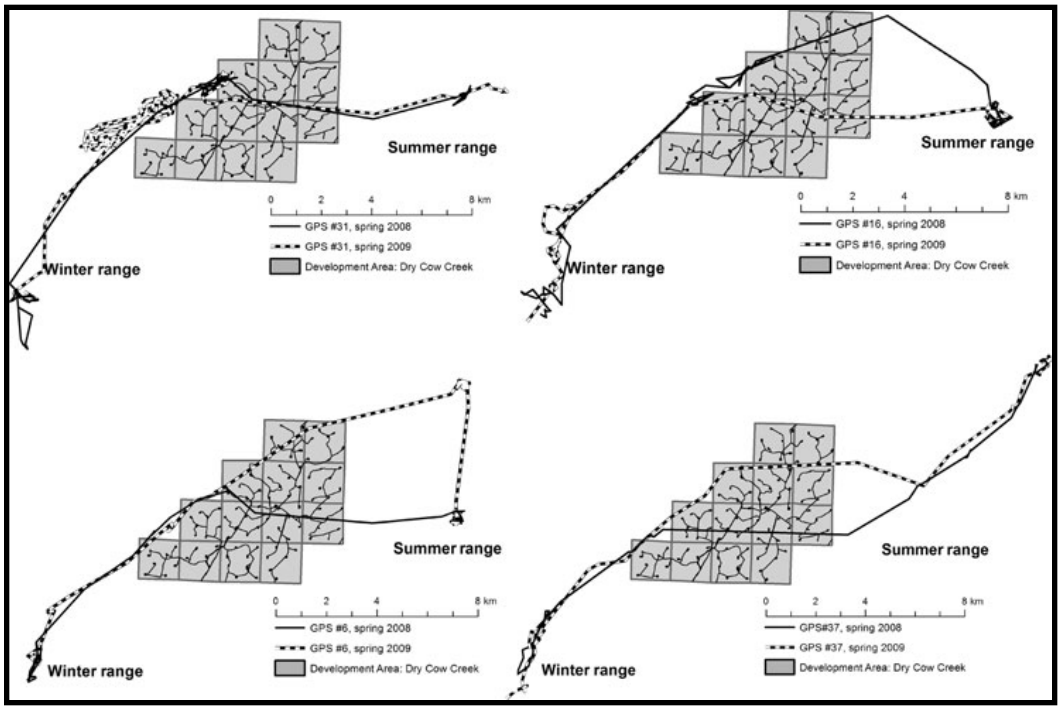
The conservation of migrations

- **Factors causing the decline of migrations (and migratory species):**

2) Barriers and/or bottlenecks to migration

Discussion Q: Sawyer et al discuss a framework for understand functionality of migration corridors. What did they mean by "functionality", and what were some examples of functionality that they used? Do you think there were any advantages of this approach compared to just focusing on barriers to migration?



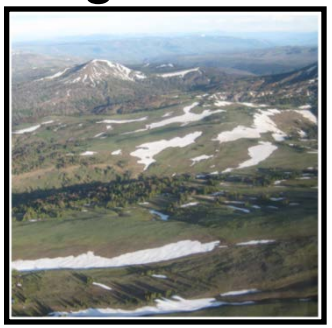


Sawyer et al. 2013.

The conservation of migrations

- **Factors causing the decline of migrations (and migratory species):**

3) Shifting phenologies reduce the profitability of migration



Middleton et al. 2013.

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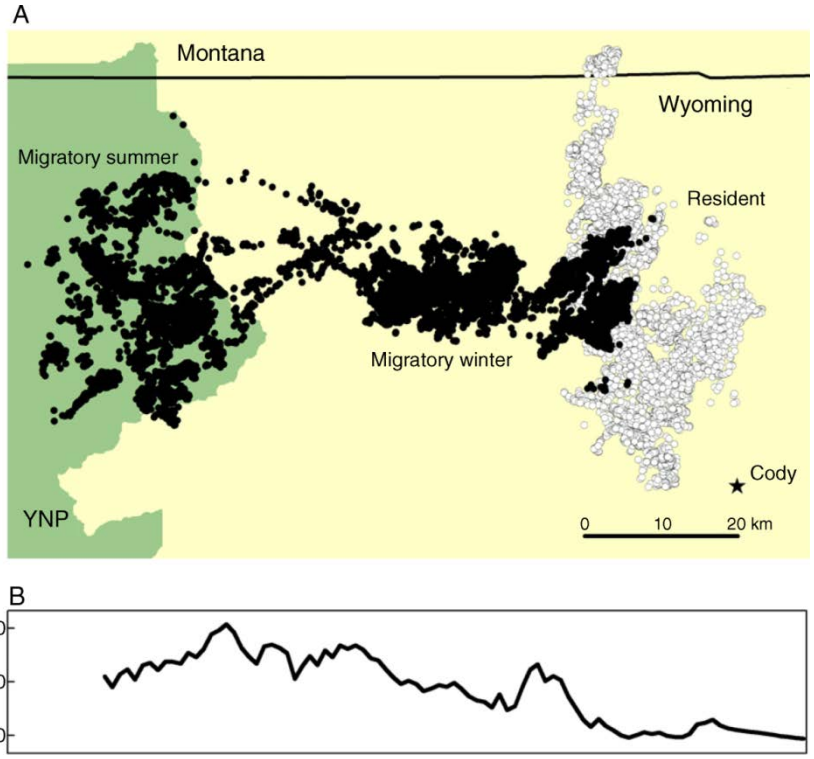
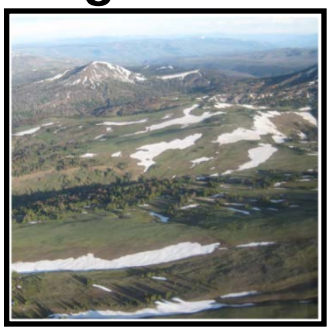
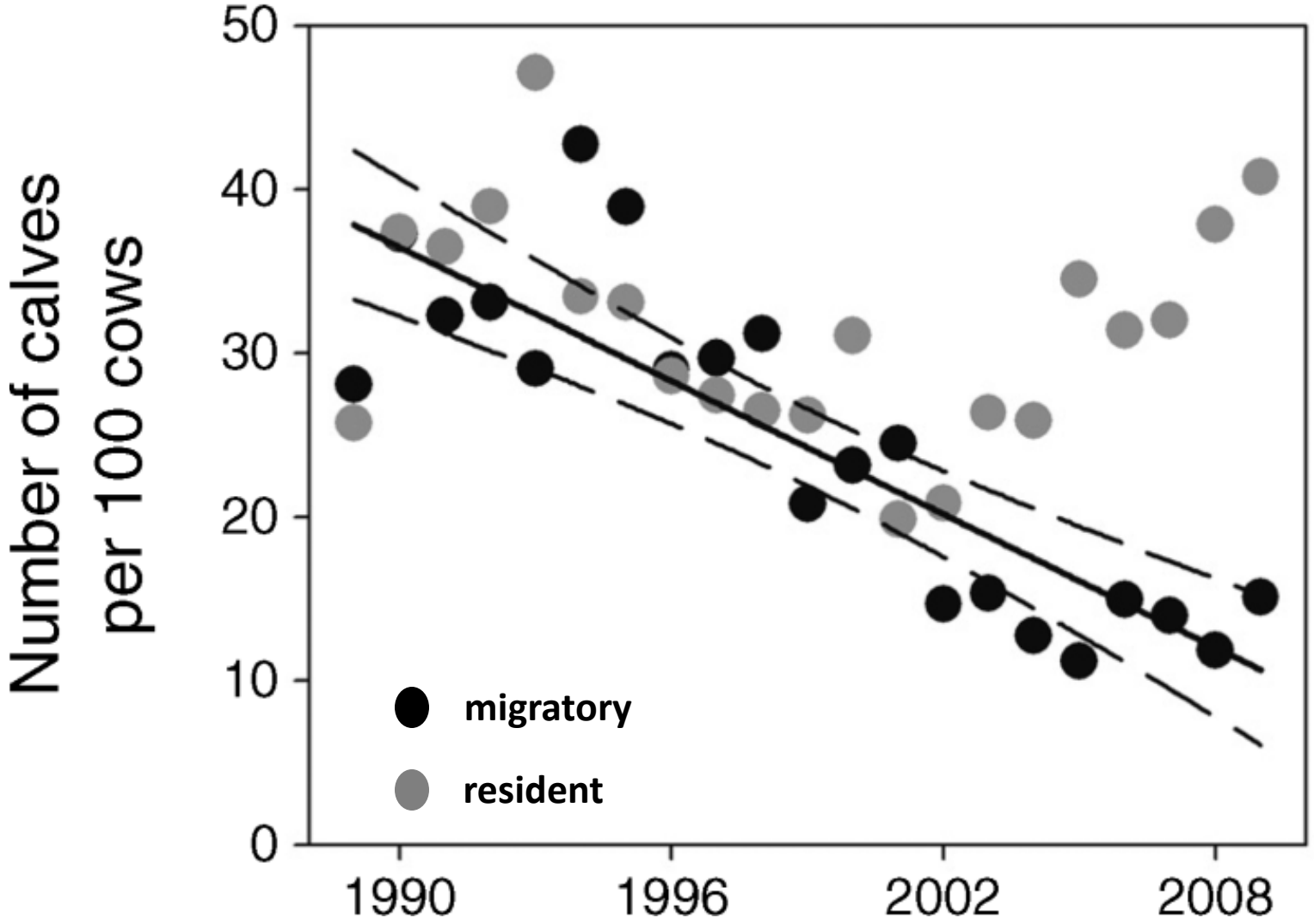




Middleton et al. 2013.

Declines in migratory, but not resident elk in the GYE



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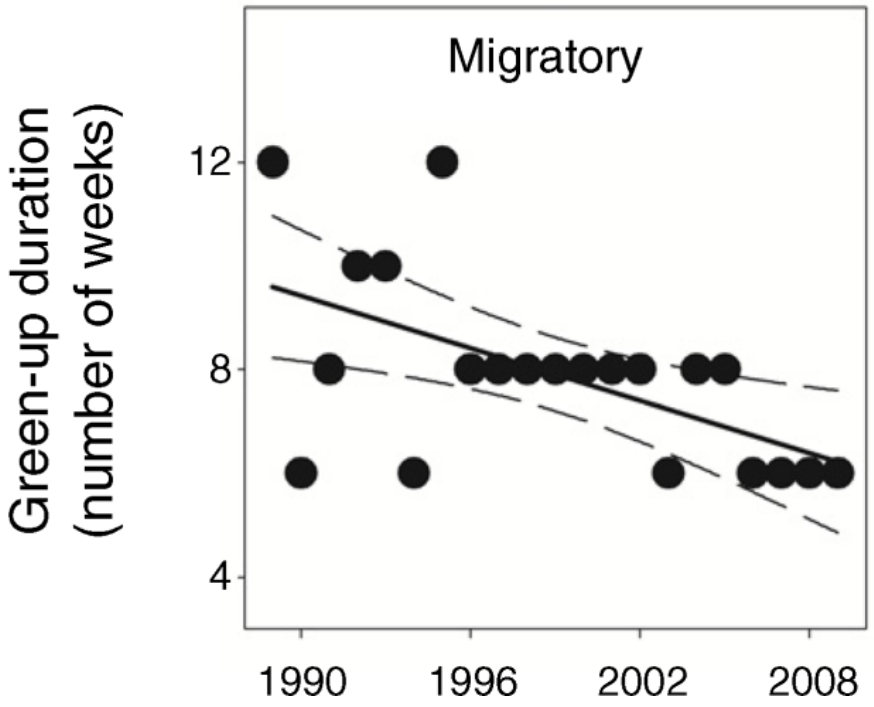
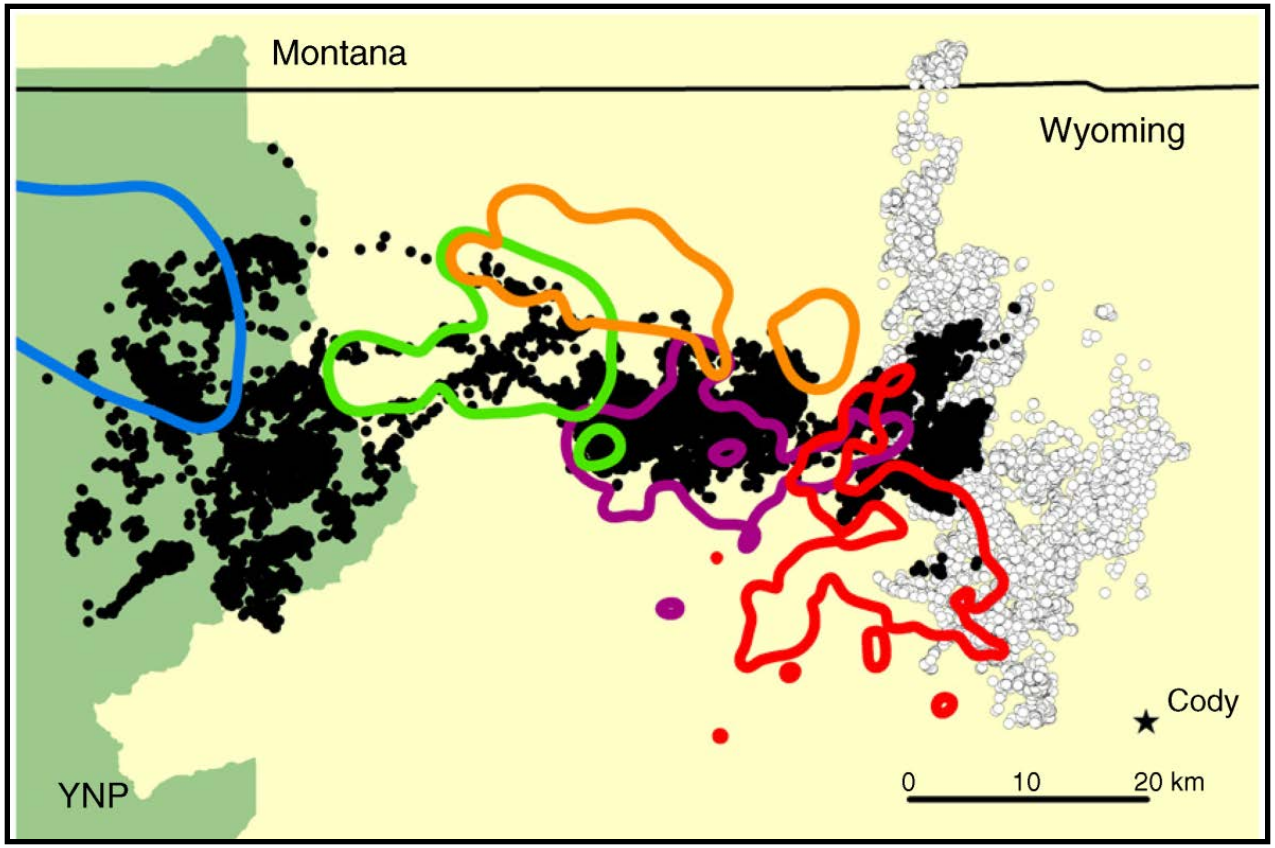
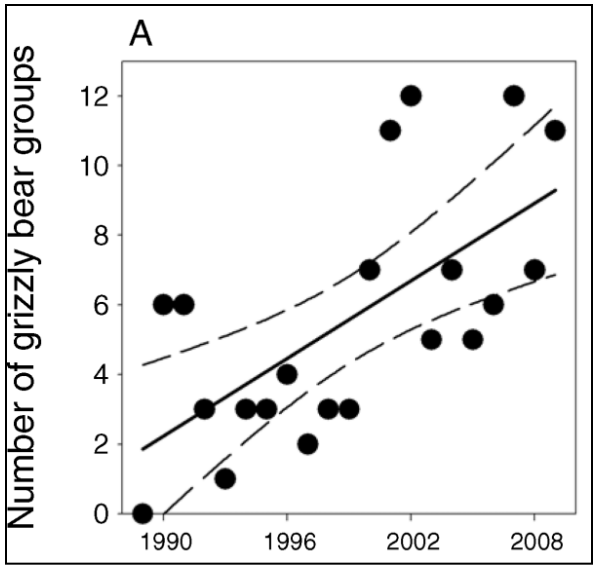


Declines in migratory, but not resident elk in the GYE

- **Reintroduction of wolves and increased numbers of grizzly bears coincided with elk declines.**





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