

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

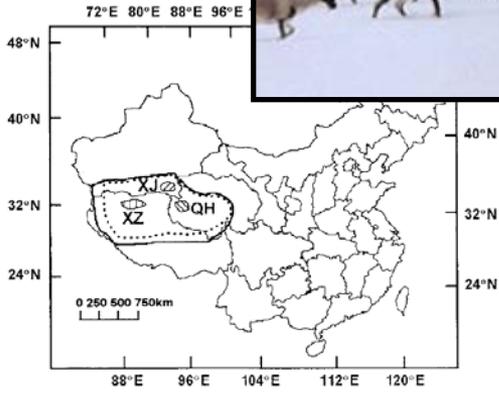
Pre-reading: Monday Oct 26 = Pauli and Buskirk. 2007.

Wednesday Oct 28 = Ford et al. 2014.

Terms:

**ideal free distribution, partial migration, life history polymorphism,
phenology**

1500 km

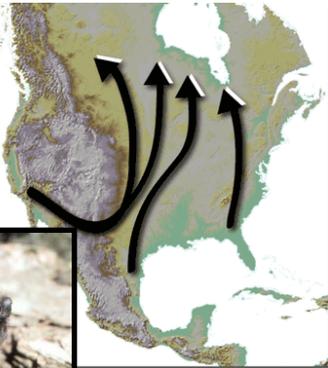


800 km



11,000 km

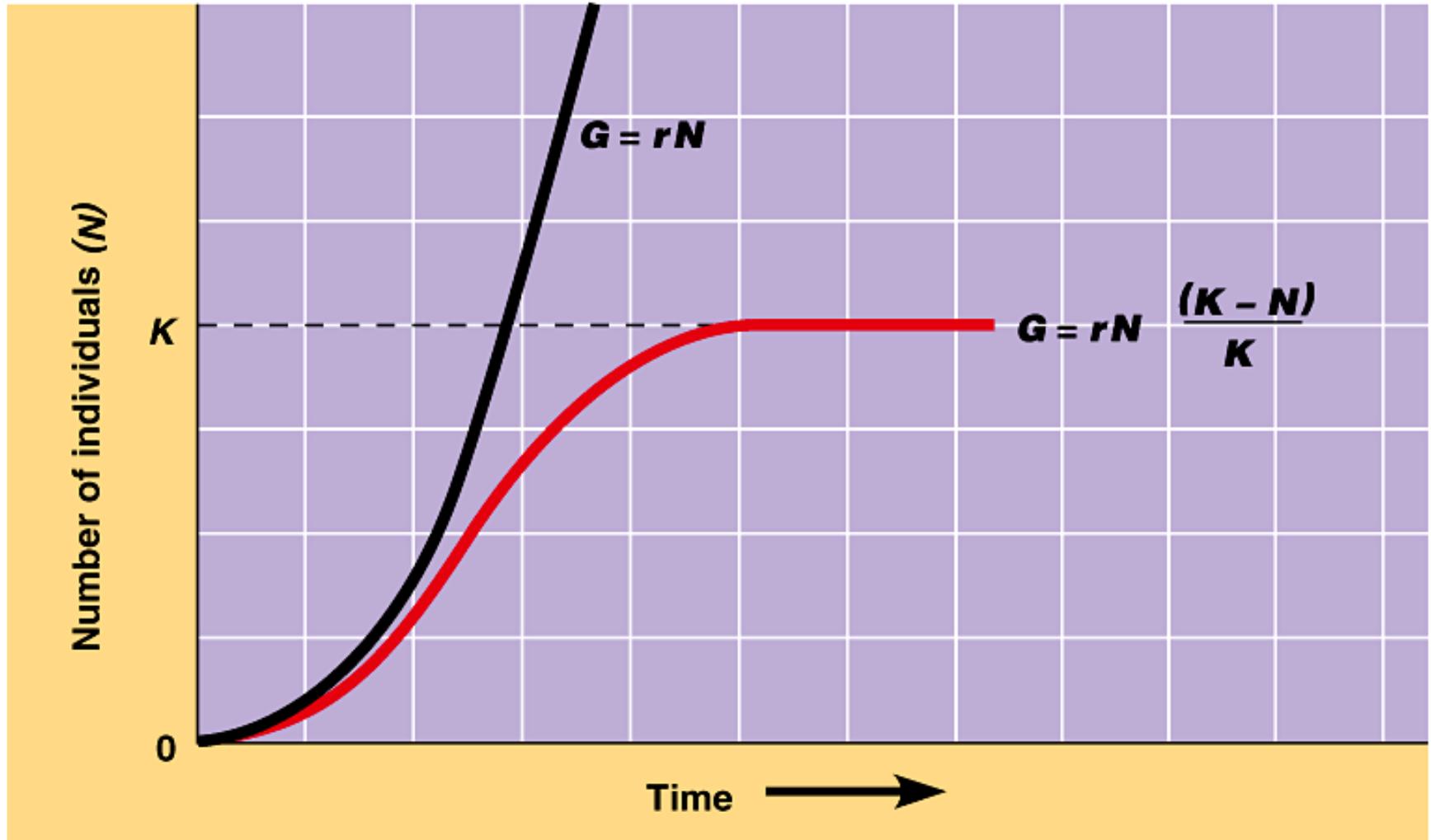
2000 km



1300 km



Population growth review

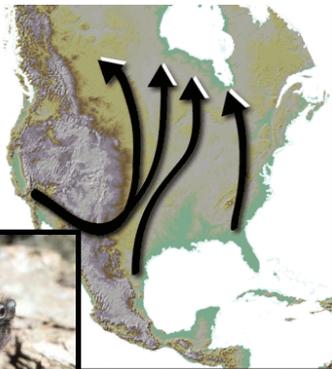


Convergent evolution of migration

Common attributes of migratory systems:

- 1) resource is sufficiently attractive to warrant moving such distances

2000 km



800 km

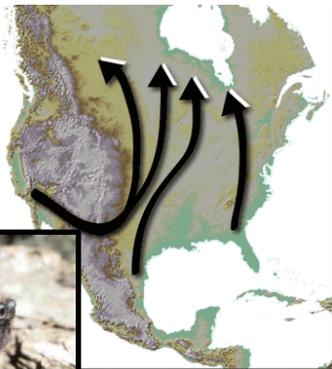


Convergent evolution of migration

Common attributes of migratory systems:

- 1) resource is sufficiently attractive to warrant moving such distances
- 2) return movement is initiated by the depletion of the periodic resource

2000 km



800 km

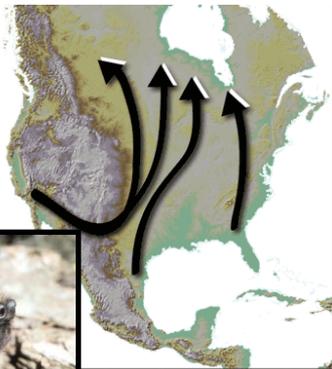


Convergent evolution of migration

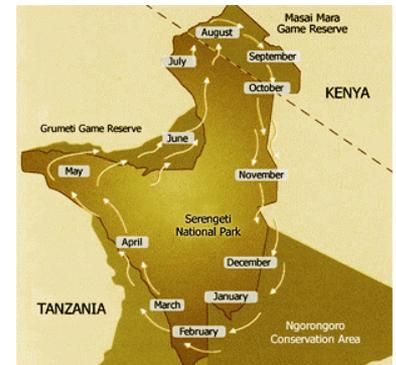
Common attributes of migratory systems:

- 1) resource is sufficiently attractive to warrant moving such distances
- 2) return movement is initiated by the depletion of the periodic resource
- 3) no physical barriers to movement

2000 km



800 km

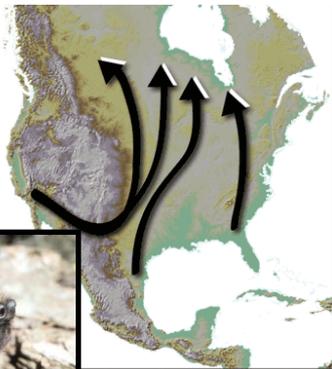


Convergent evolution of migration

Common attributes of migratory systems:

- 1) resource is sufficiently attractive to warrant moving such distances
- 2) return movement is initiated by the depletion of the periodic resource
- 3) no physical barriers to movement
- 4) cycle of available resources must be predictable based on external cues

2000 km



800 km

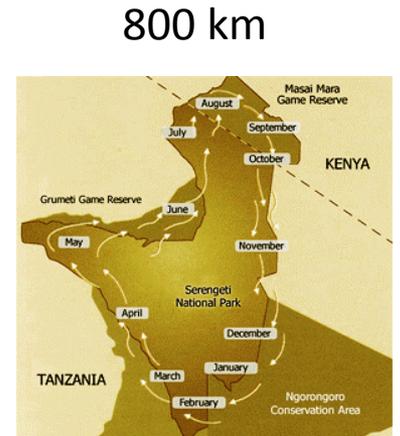
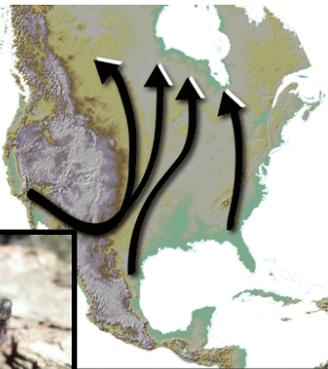


Convergent evolution of migration

Common attributes of migratory systems:

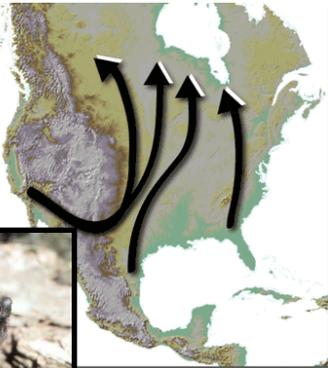
- 1) resource is sufficiently attractive to warrant moving such distances
- 2) return movement is initiated by the depletion of the periodic resource
- 3) no physical barriers to movement
- 4) cycle of available resources must be predictable based on external cues
- 5) movement of population is directional

2000 km

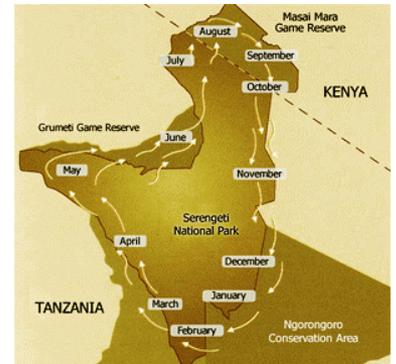


Discussion Q: what environmental variables would you expect to go hand-in-hand with migratory systems?

2000 km

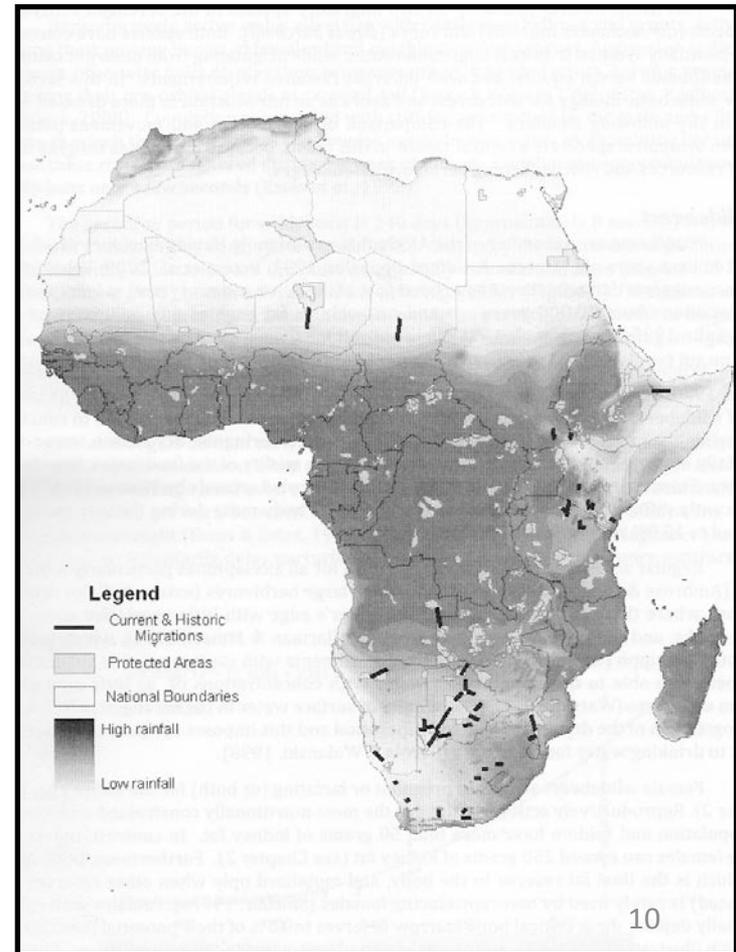


800 km



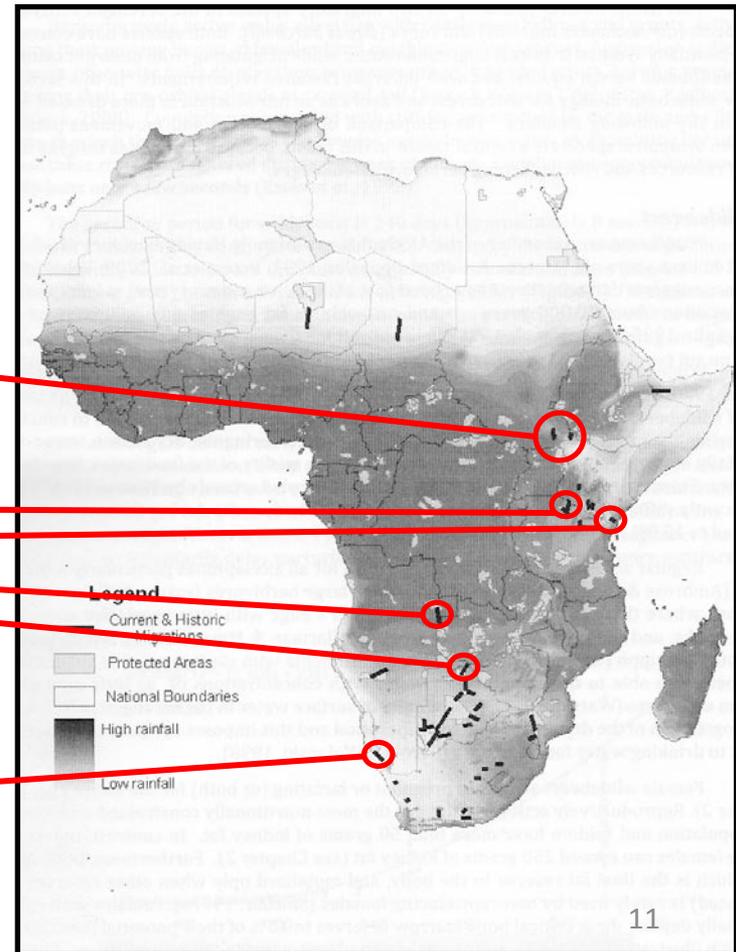
The biogeography of migratory systems

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

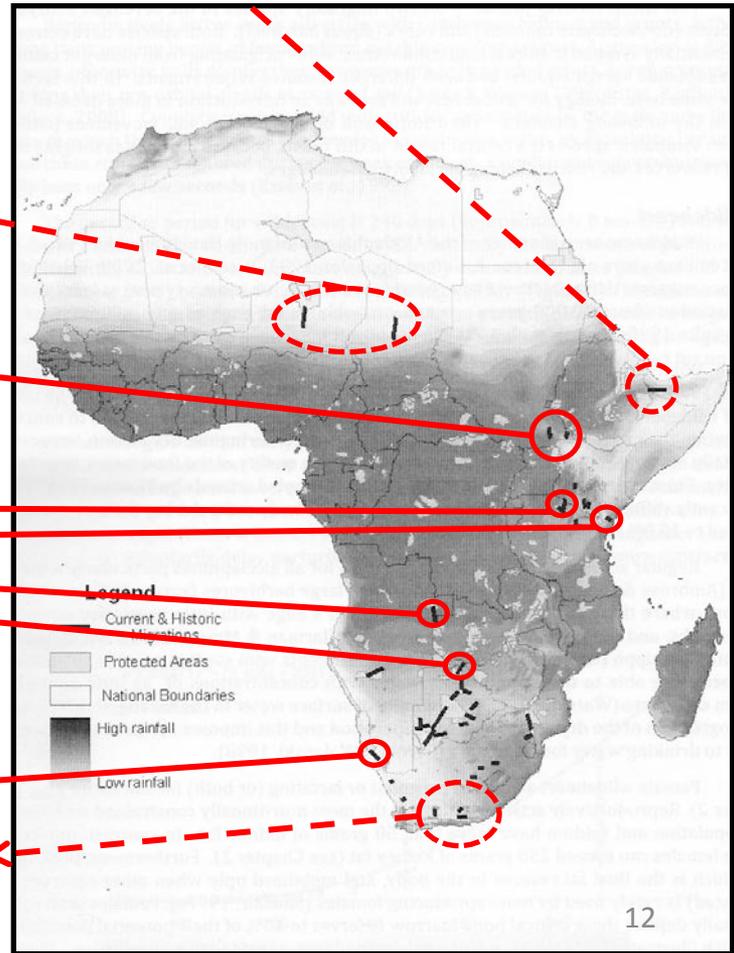


The biogeography of migratory systems

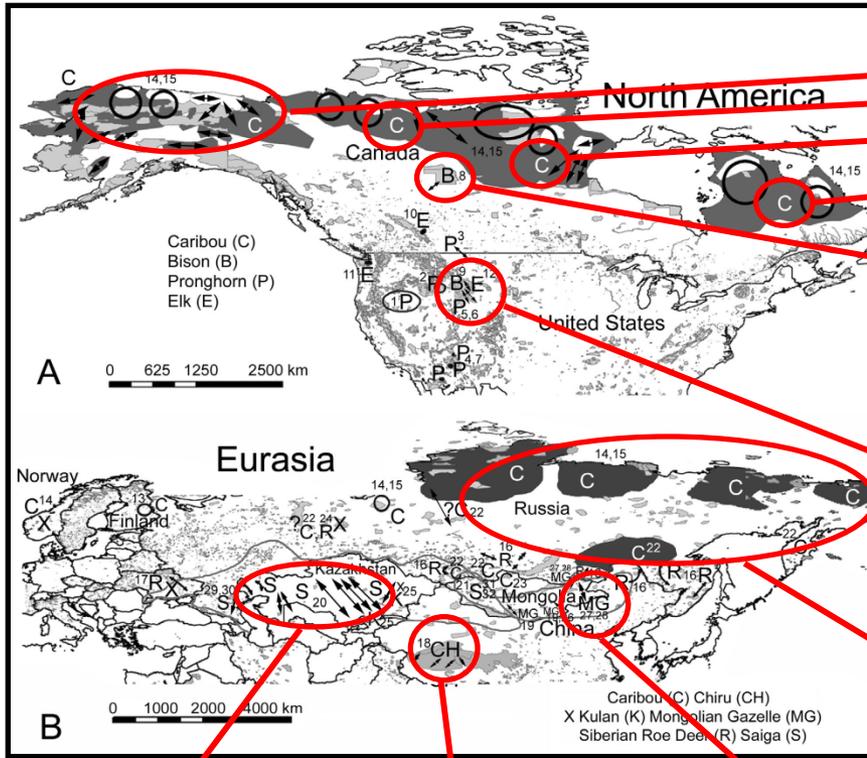
- Seasonal resource gradients (particularly rainfall or snowmelt) typify migratory systems.
- ~30 historic migrations of 14 species in Africa (of which 6 migrations of 9 species are extant).



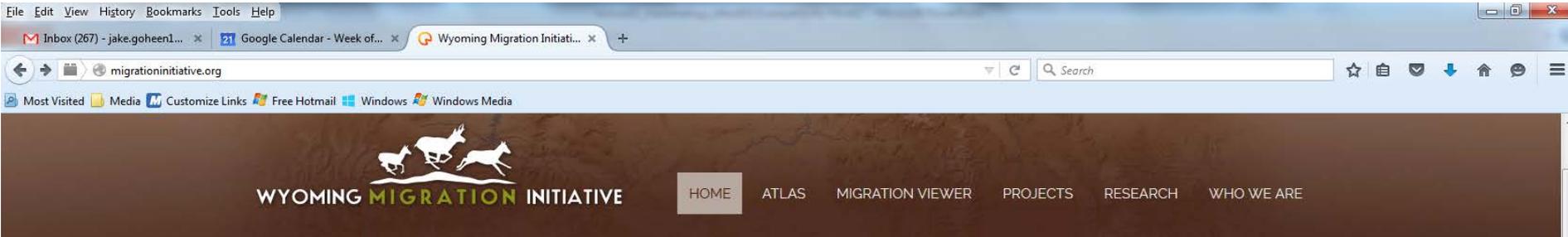
The biogeography of migratory systems



The biogeography of migratory systems



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



FEATURES

SUSTAINING BIG GAME MIGRATIONS IN THE WEST: SCIENCE, POLICY, AND PEOPLE

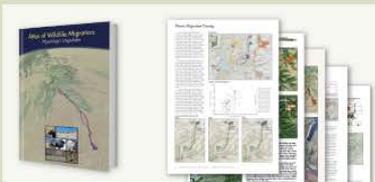


Nov 9 & 10, 2015: Come explore the science of big game migration and discuss what it means for policy and people. [Learn more >](#) Photo credit Joe Riis

Advancing the understanding, appreciation, and conservation of Wyoming's migratory ungulates by conducting innovative research and sharing scientific information through public outreach.

FOLLOW US:  

ATLAS OF WILDLIFE MIGRATION



MIGRATION DATABASE AND VIEWER

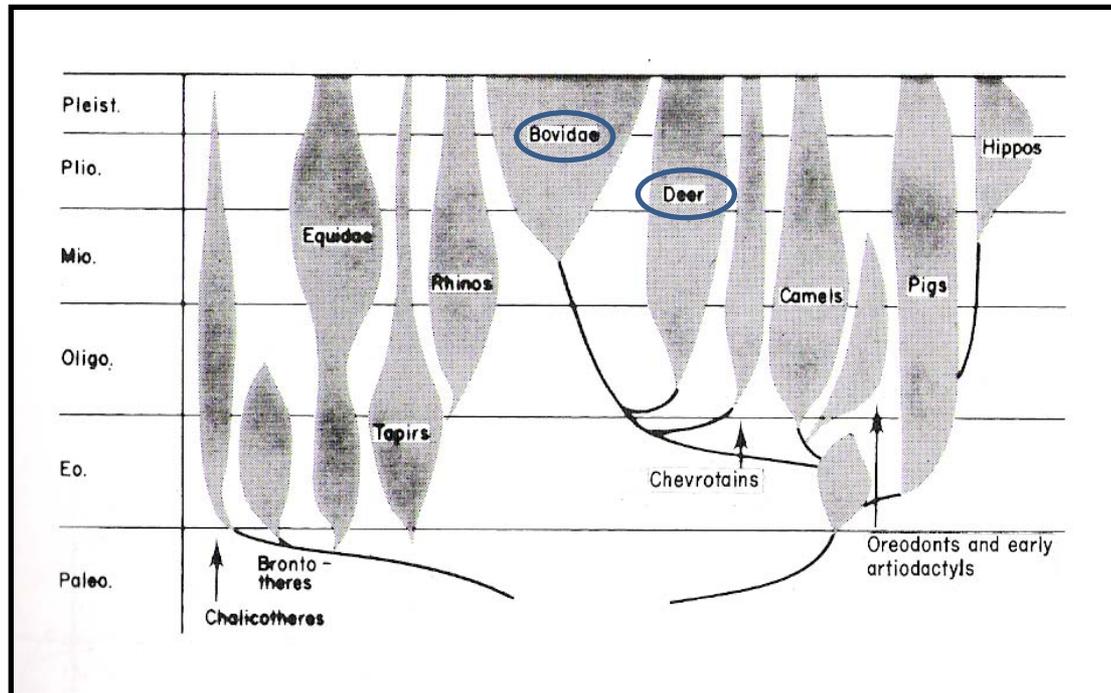


RED DESERT TO HOBACK MIGRATION ASSESSMENT



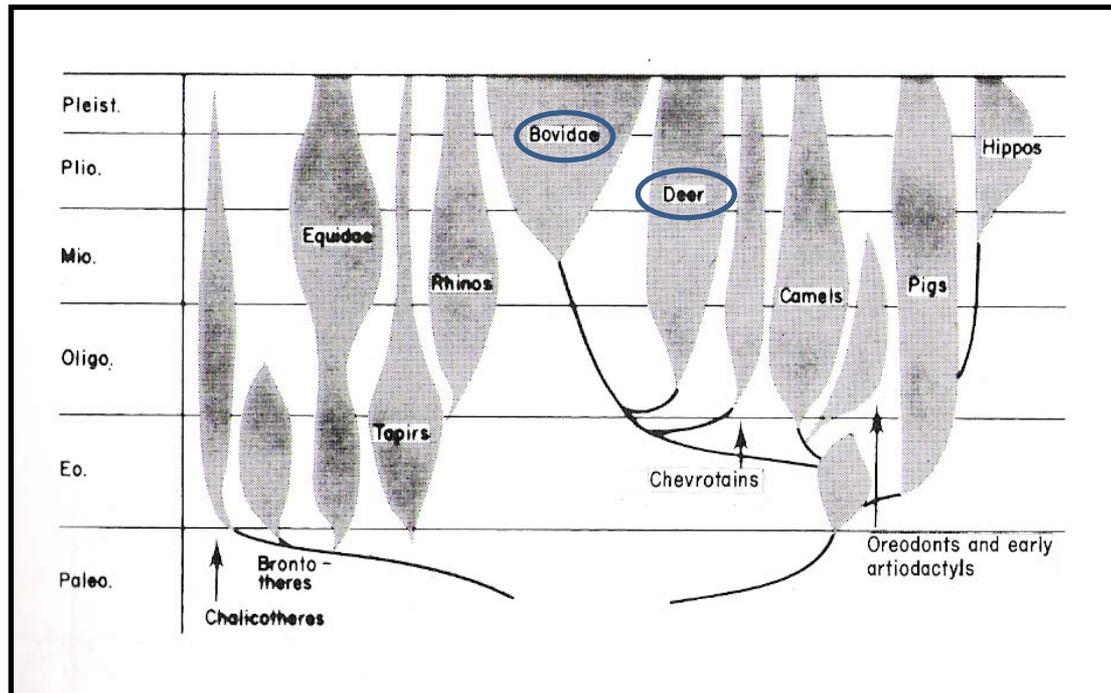
The evolution of novelty

- 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



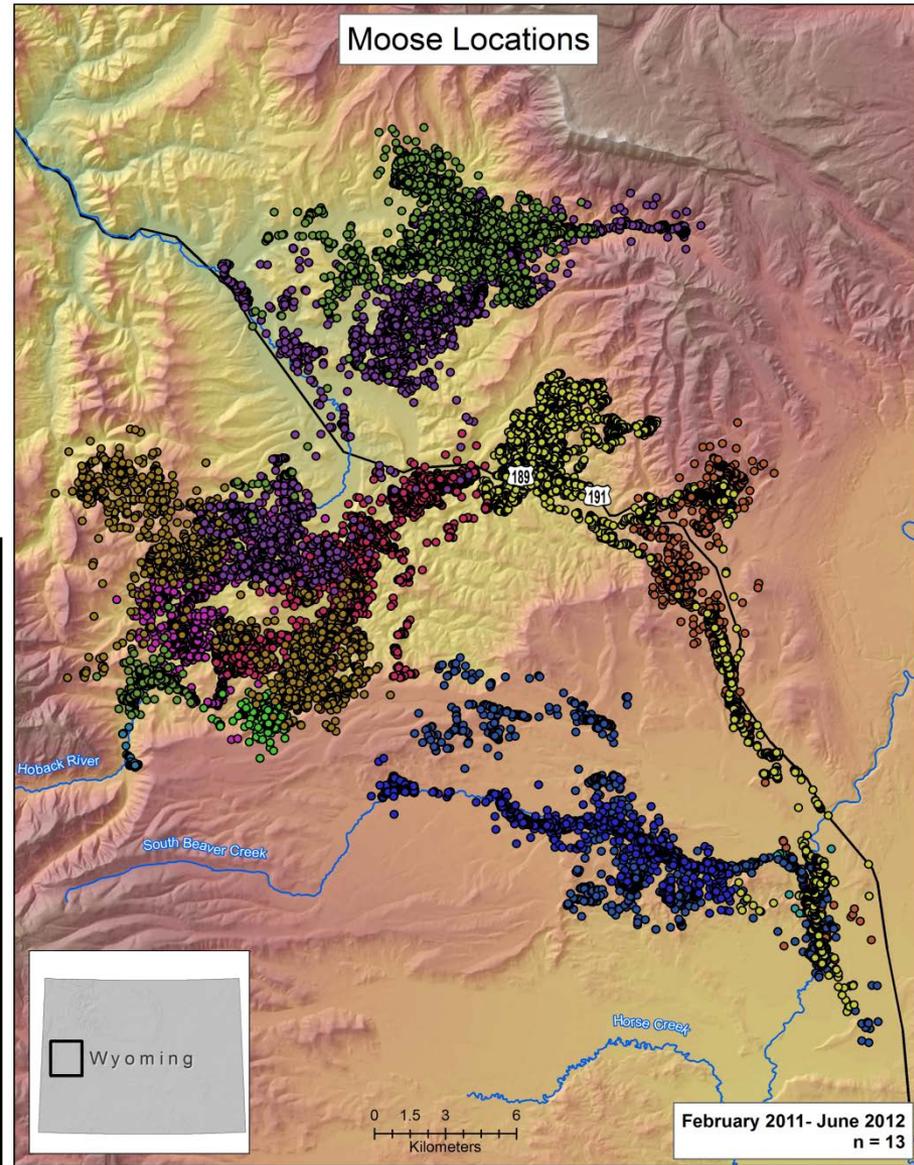
The evolution of novelty

- 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)



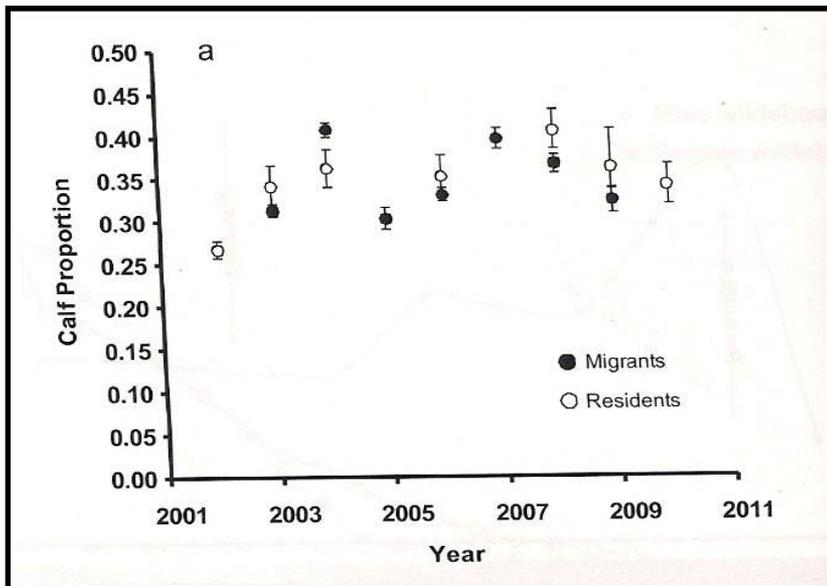
Partial migration

- populations of most species of mammals that migrate are partially migratory, composed of a mix of migrants and residents



Partial migration

- in most partially migratory populations, migrants outnumber residents
- life history polymorphism = multiple strategies within a population, often resulting in equivalent fitness



Ideal Free Distribution

- **IFD** = a hypothesis about how animals distribute themselves among habitats to maximize individual gains (for example, energy intake)
- **Assumptions:**
 - 1) animals are **ideal** (i.e., perfect) in assessing the distribution of **resources** among habitats or patches

Ideal Free Distribution

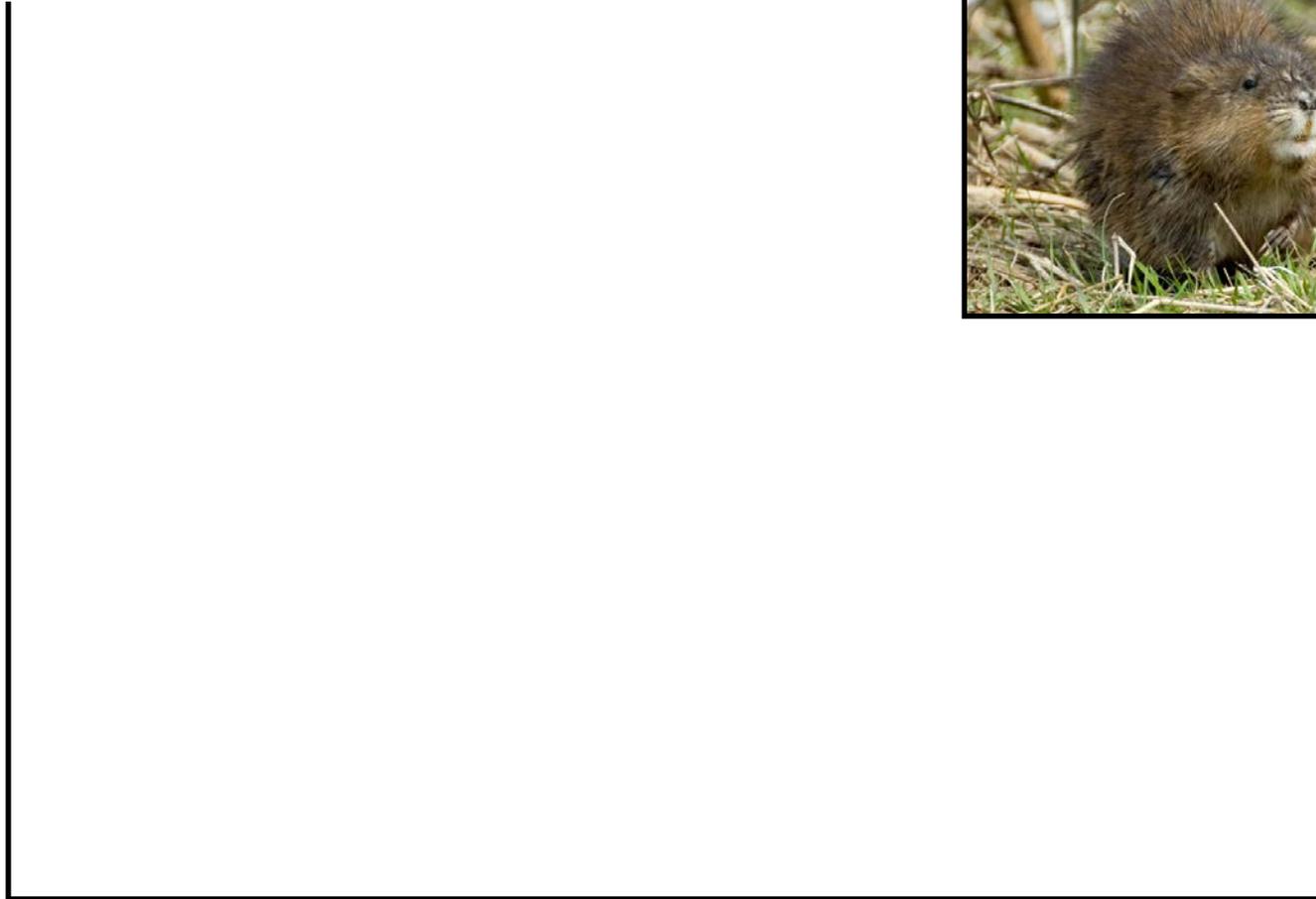
- **IFD = a hypothesis about how animals distribute themselves among habitats to maximize individual gains (for example, energy intake)**
- **Assumptions:**
 - 1) animals are ideal (i.e., perfect) in assessing the distribution of resources among habitats or patches**
 - 2) animals are free to distribute themselves among habitats or patches**

Ideal Free Distribution

- **IFD** = a hypothesis about how animals distribute themselves among habitats to maximize individual gains (for example, energy intake)
- **Assumptions:**
 - 1) animals are **ideal** (i.e., perfect) in assessing the distribution of **resources** among habitats or patches
 - 2) animals are **free** to **distribute** themselves among habitats or patches
 - 3) first arrivals get “first dibs”

Ideal Free Muskrats

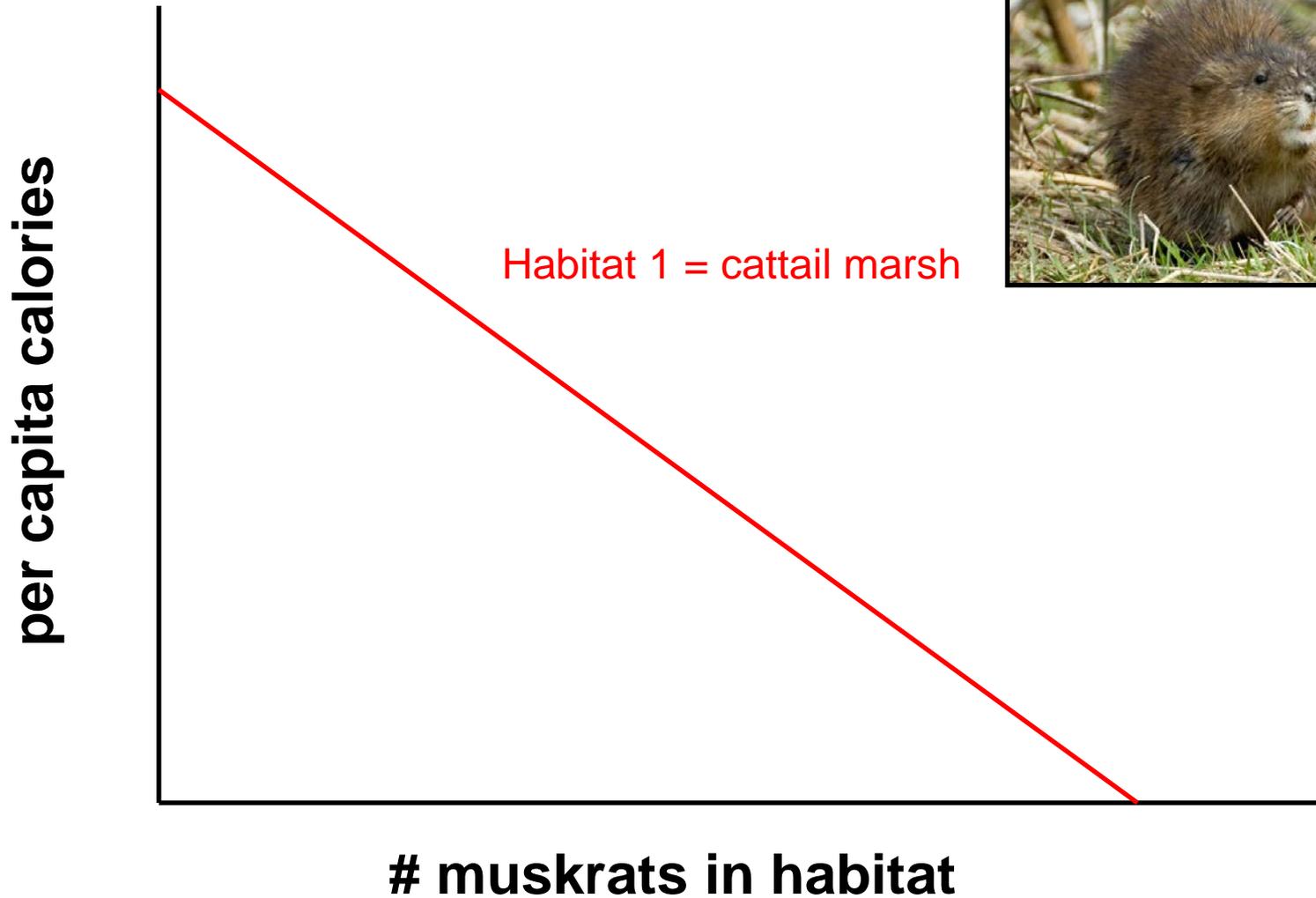
per capita calories



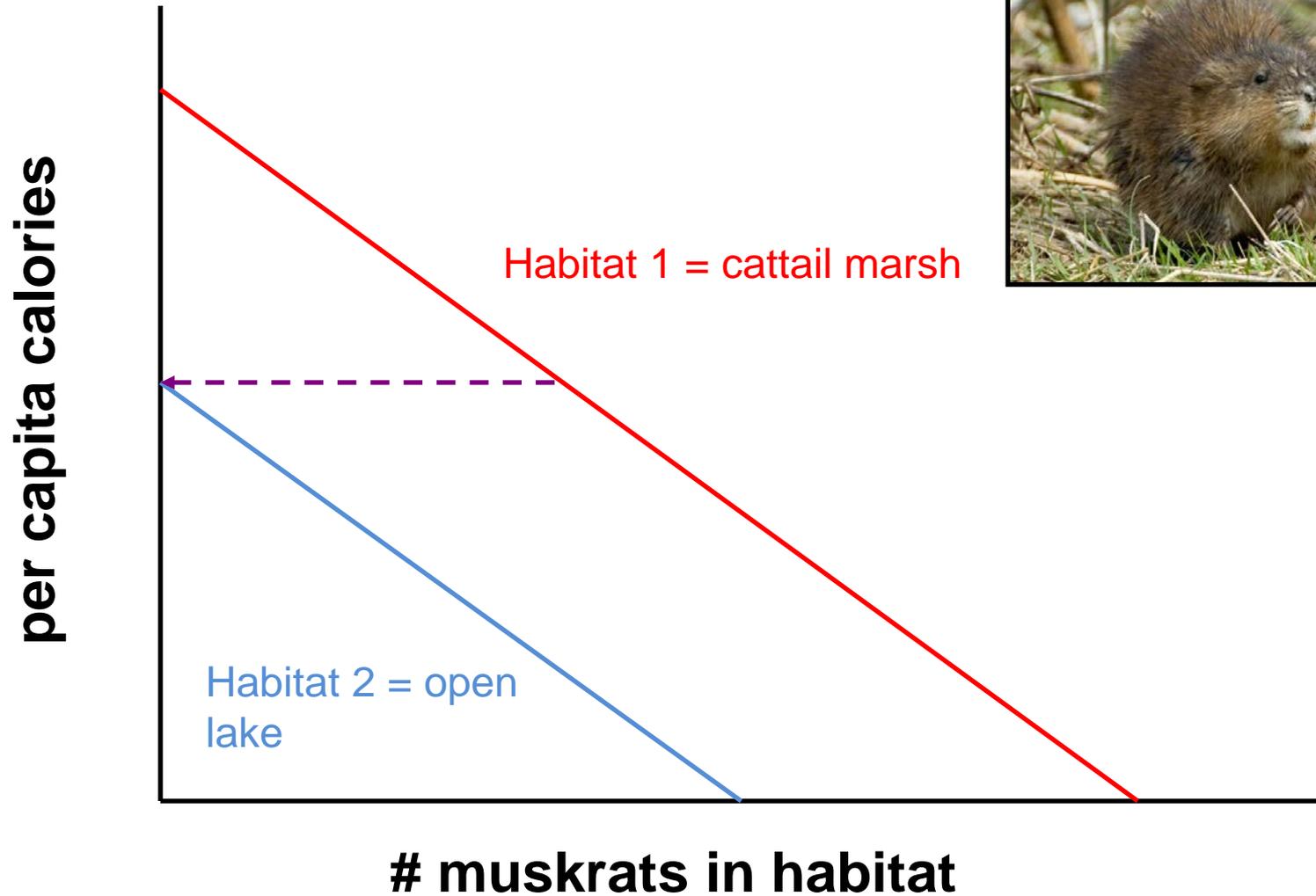
muskrats in habitat



Ideal Free Muskrats



Ideal Free Muskrats



The conservation of migrations

- **Migrations are jeopardized with the fitness costs of migration override the benefits**

The conservation of migrations

- **Migrations are jeopardized with the fitness costs of migration override the benefits**

Common attributes of migratory systems:

- 1) resource is sufficiently attractive to warrant moving such distances**
- 2) return movement is initiated by the depletion of the periodic resource**
- 3) no physical barriers to movement**
- 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



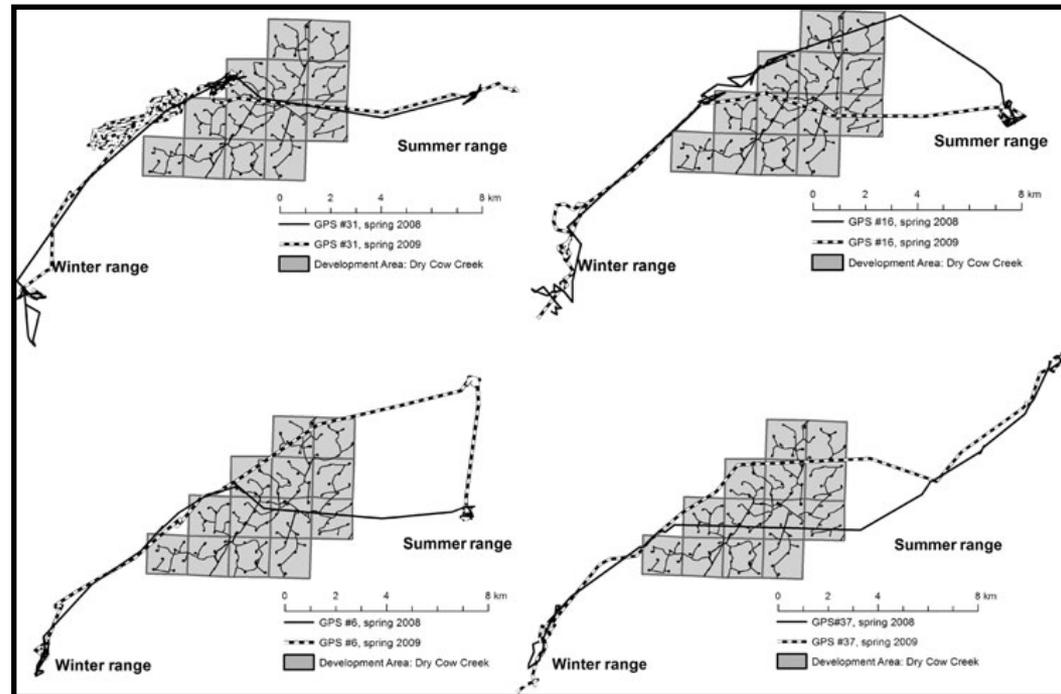
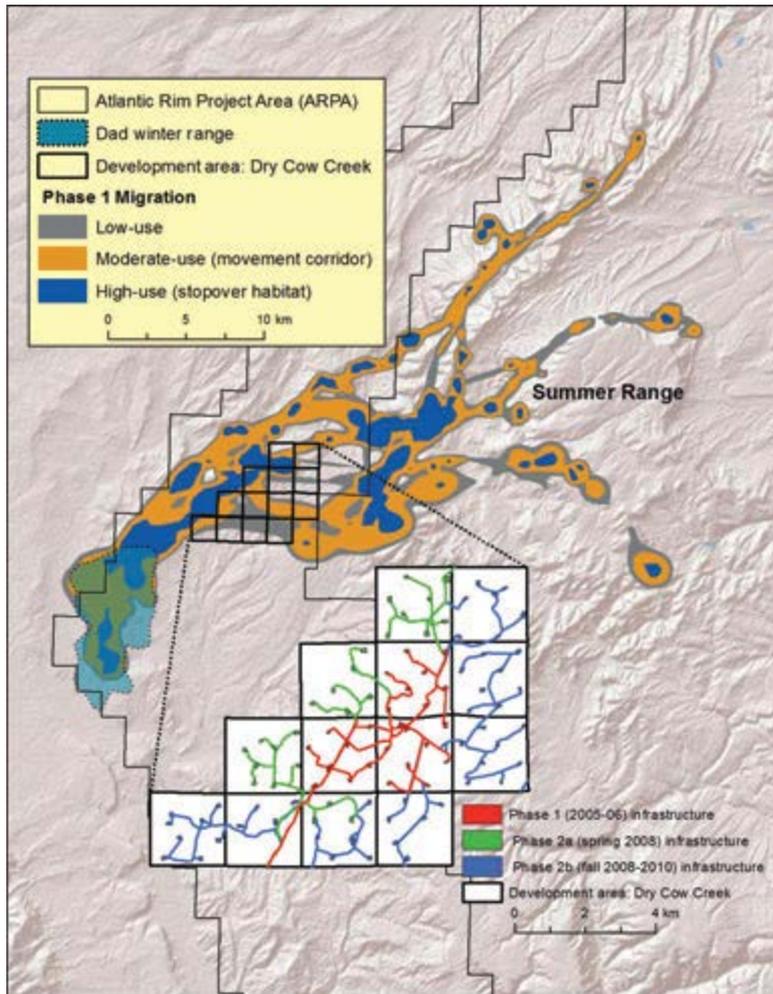
The conservation of migrations

- 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?



The conservation of migrations

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

3) Shifting phenologies reduce the profitability of migration

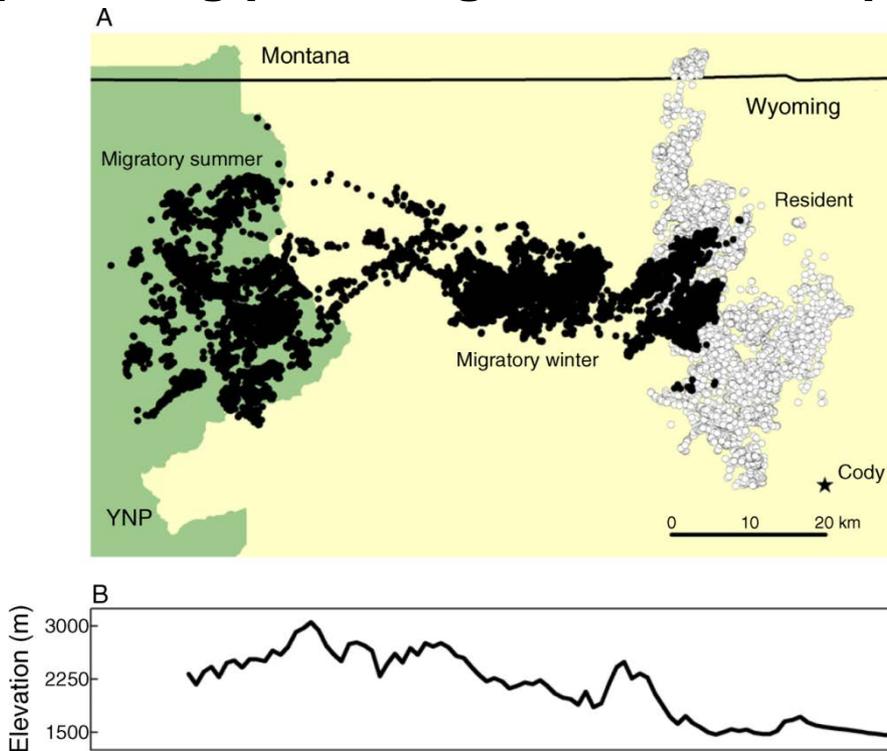


Middleton et al. 2013.

The conservation of migrations

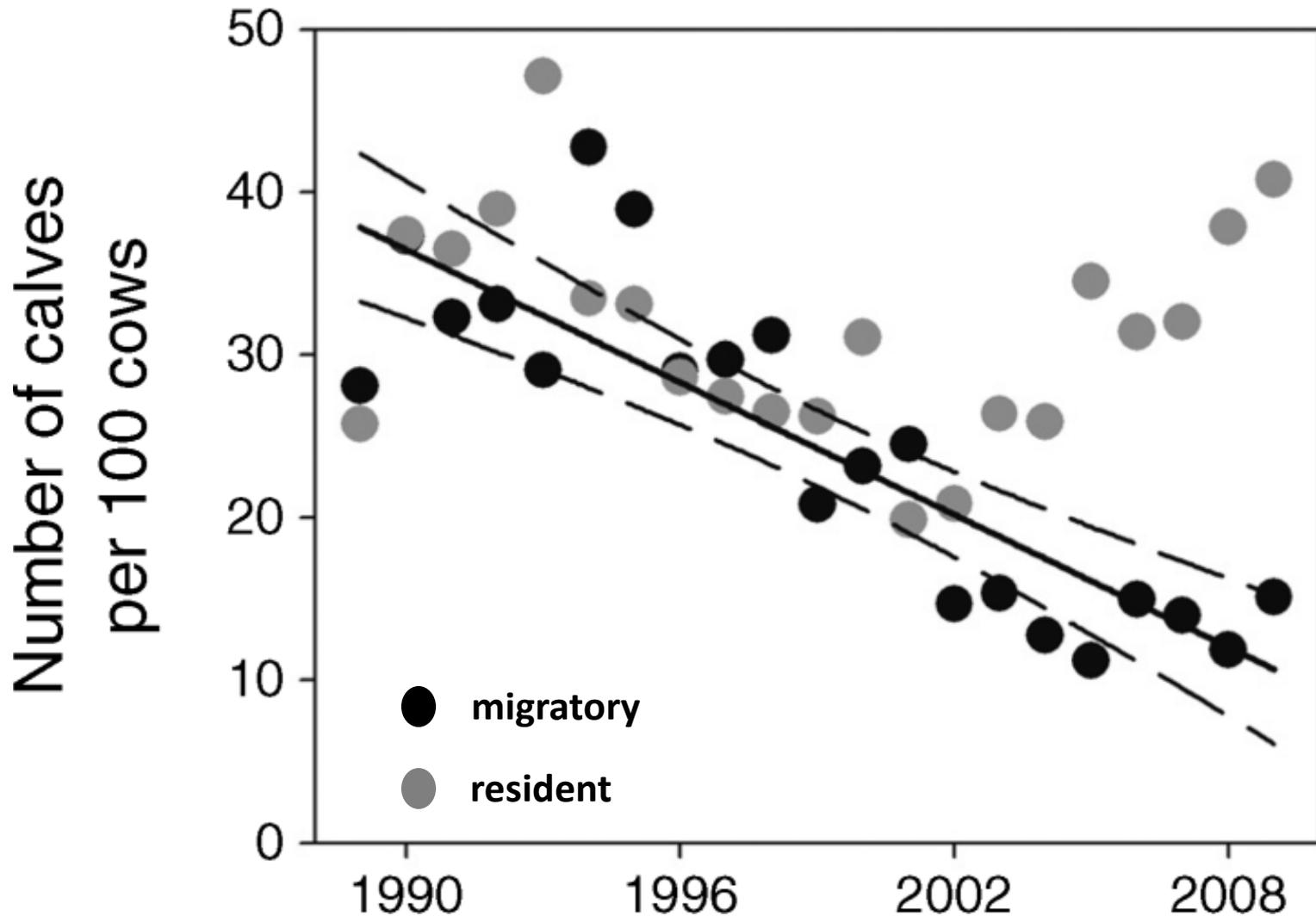
- Factors causing the decline of migrations (and migratory species):

3) Shifting phenologies reduce the profitability of migration



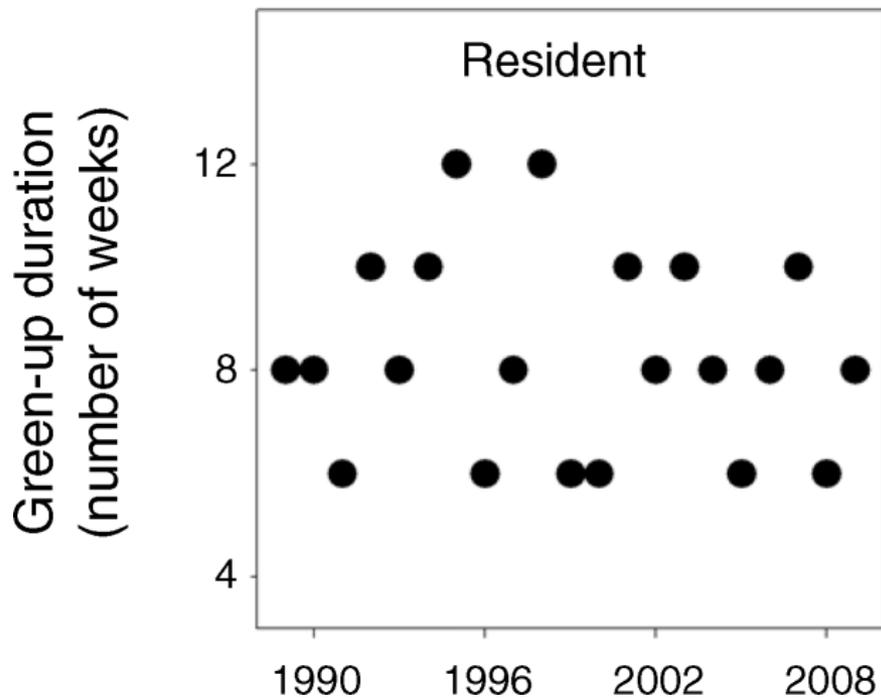
Middleton et al. 2013.

Declines in migratory, but not resident elk in the GYE



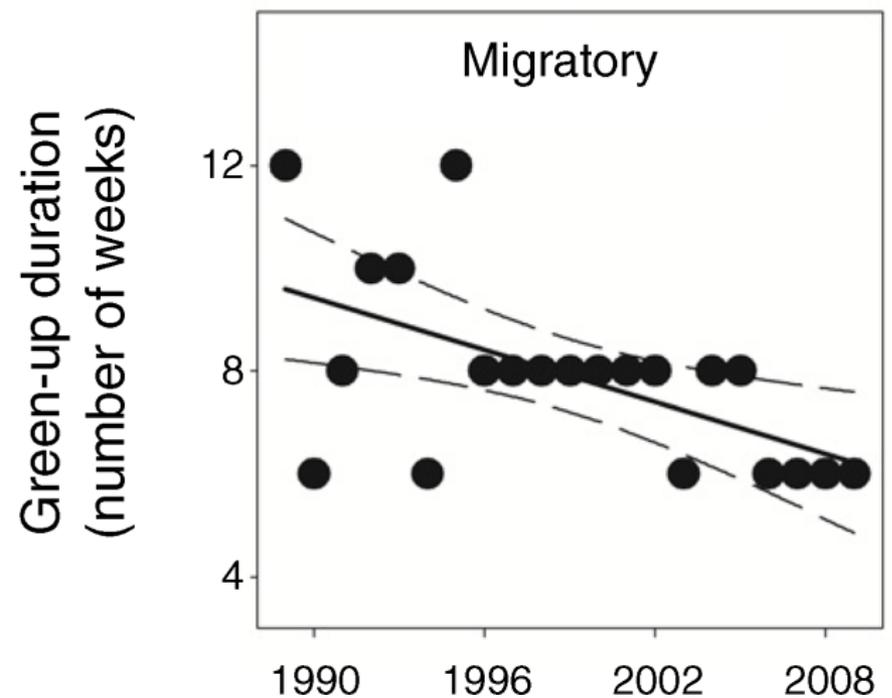
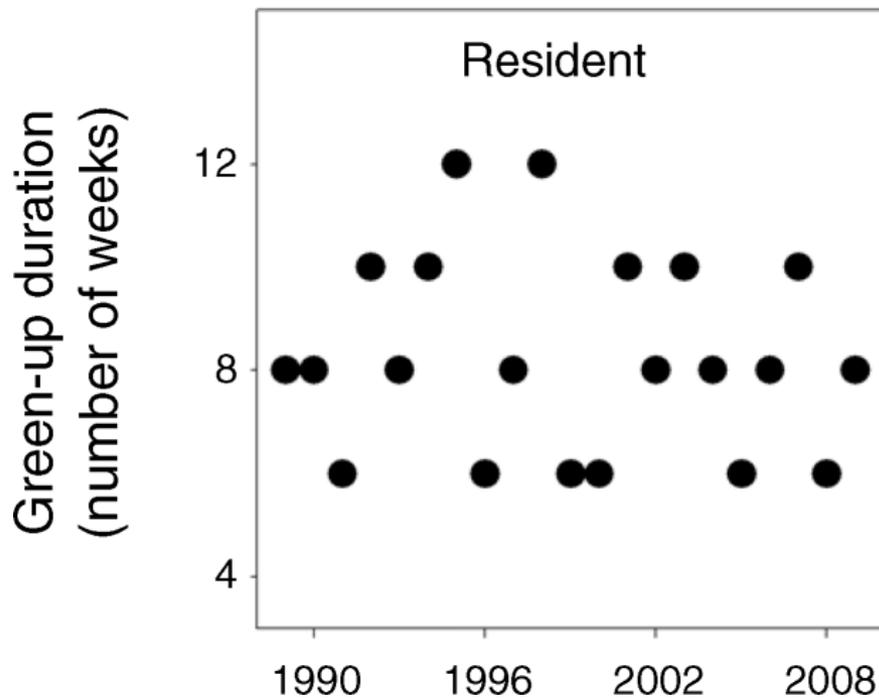
Declines in migratory, but not resident elk in the GYE

- **Shifting phenology (the timing of plant growth) resulted in reduced food quality for migratory elk as time progressed. This coincided with warmer, drier springs.**



Declines in migratory, but not resident elk in the GYE

- **Shifting phenology (the timing of plant growth) resulted in reduced food quality for migratory elk as time progressed. This coincided with warmer, drier springs.**



Declines in migratory, but not resident elk in the GYE

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

