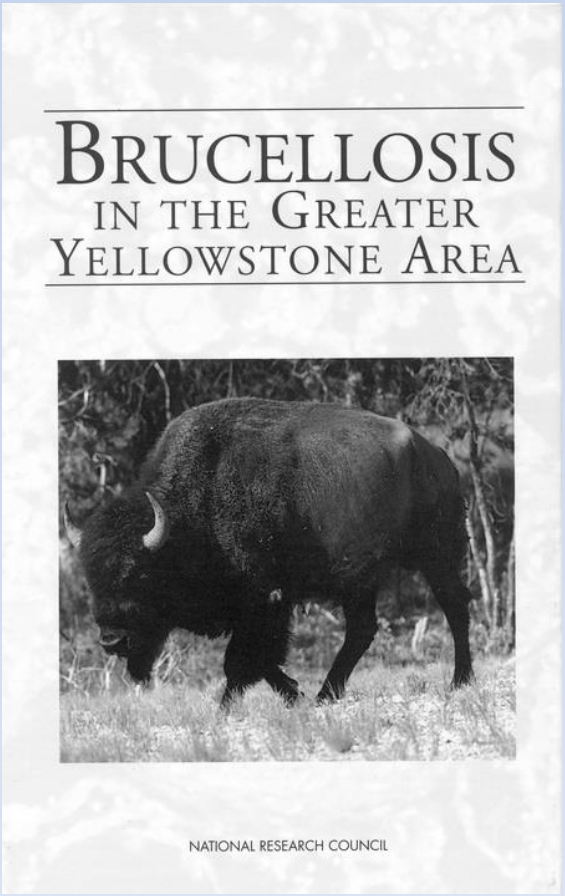
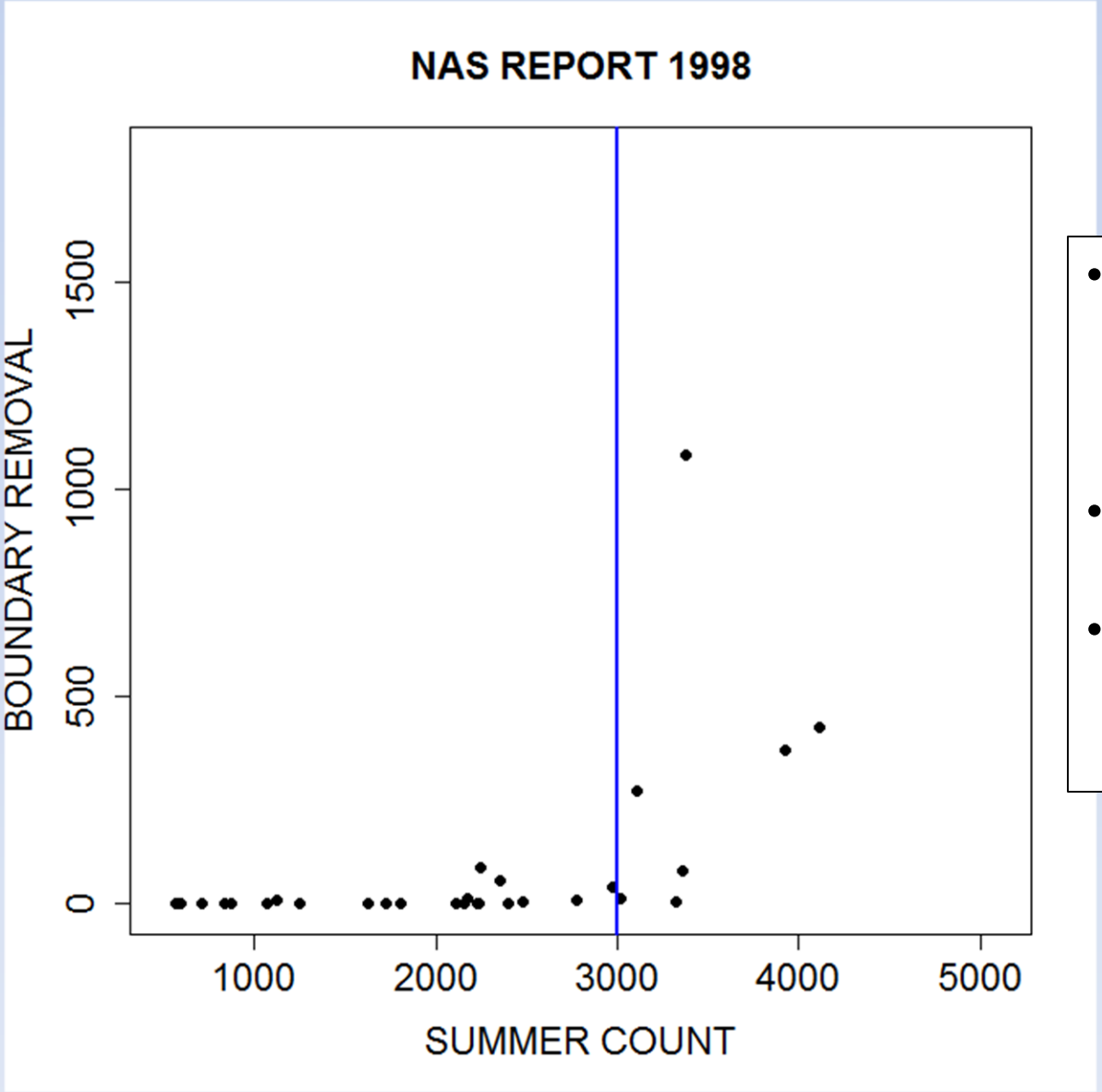
Methods for Forecasting the Timing and Extent of Bison Migrations to the North and West Boundaries of Yellowstone National Park



Provided a **BASELINE OF UNDERSTANDING** about bison movements out of Yellowstone

Analyzed culls during 1968-1997

Important in negotiating the 2000 ROD



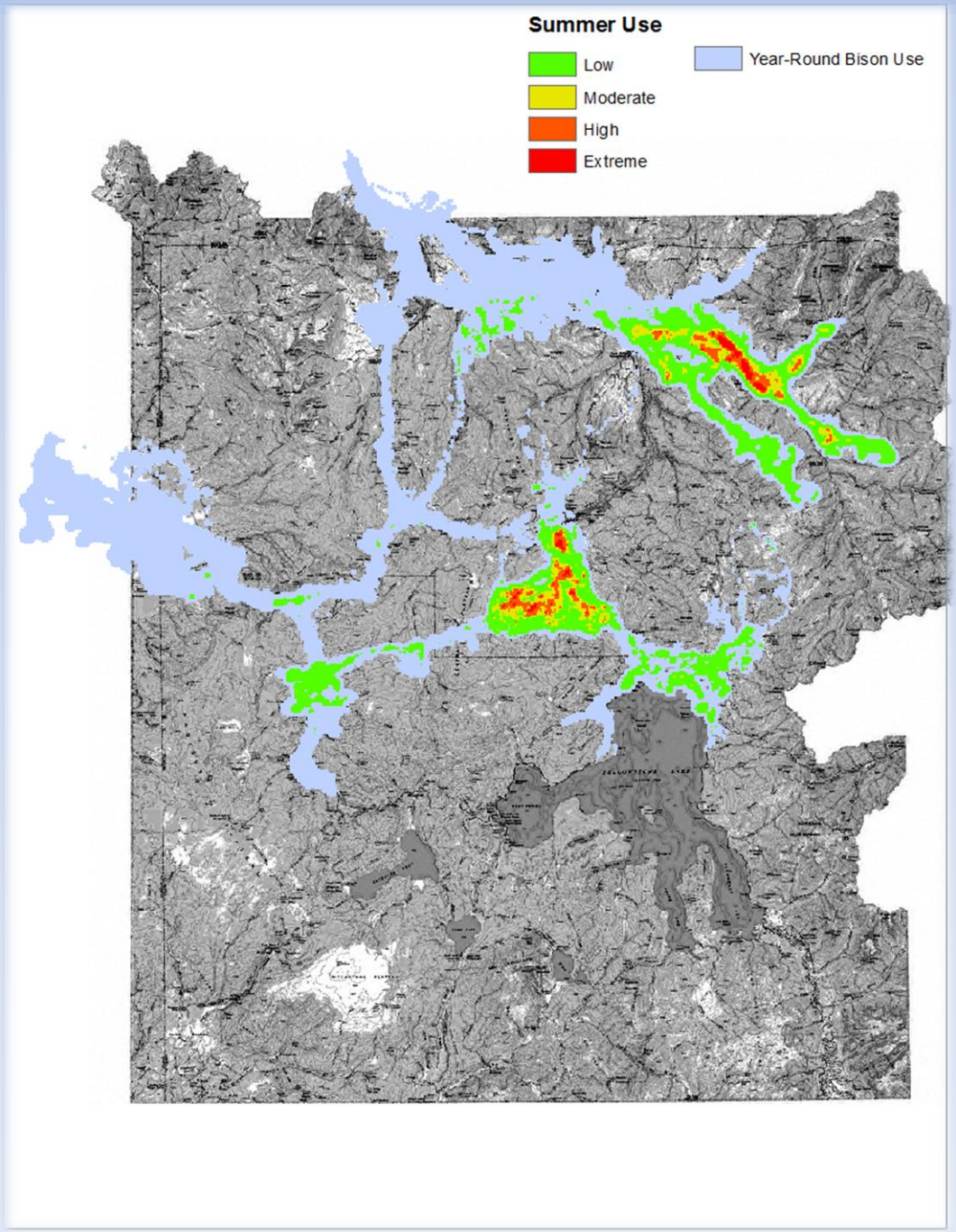
- Nonlinear relationship – best described as a threshold
- Little Removal below 3,000
- Snow related to removals above 3,000

Breeding Season Distribution:

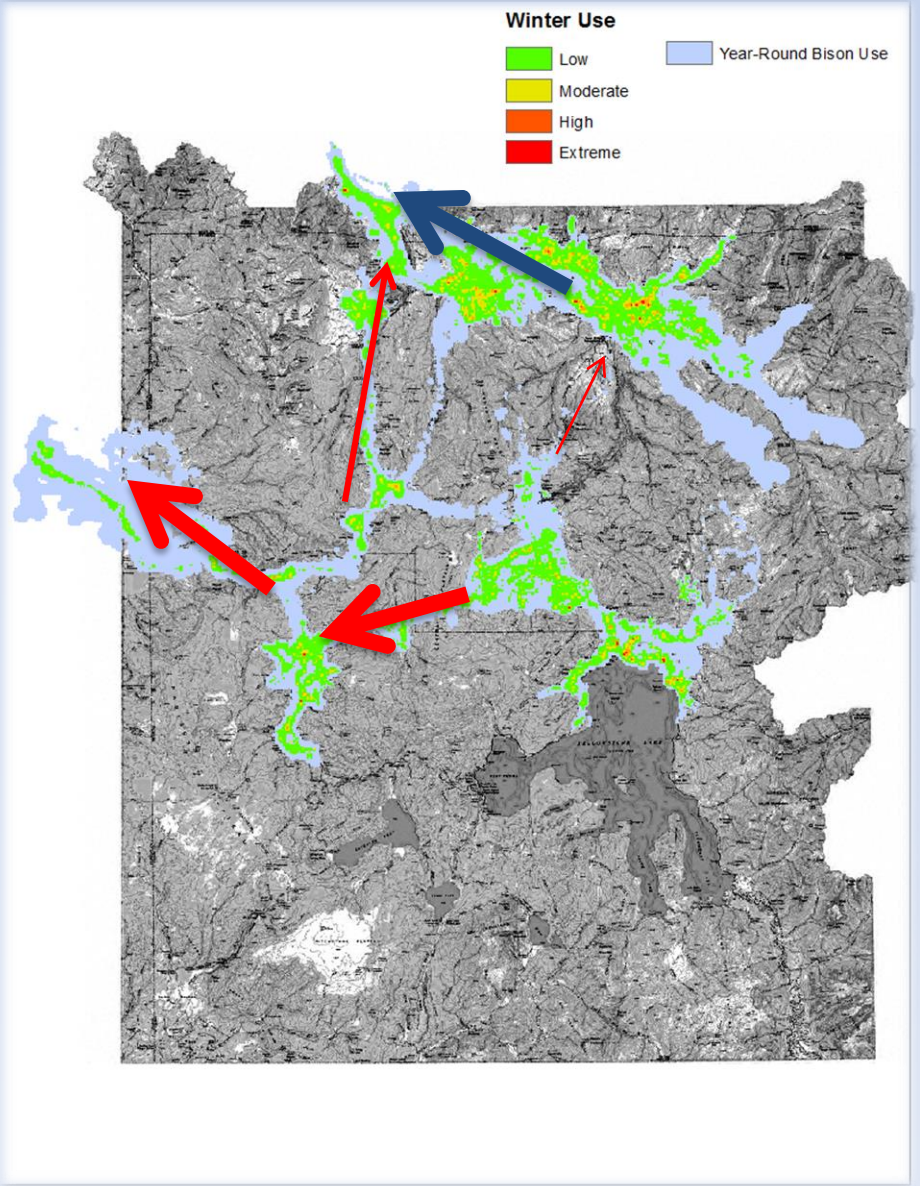
Yellowstone Bison Population Segregated in two breeding herds during summer

Central = Hayden Valley

Northern = Lamar Valley



Winter Migration:



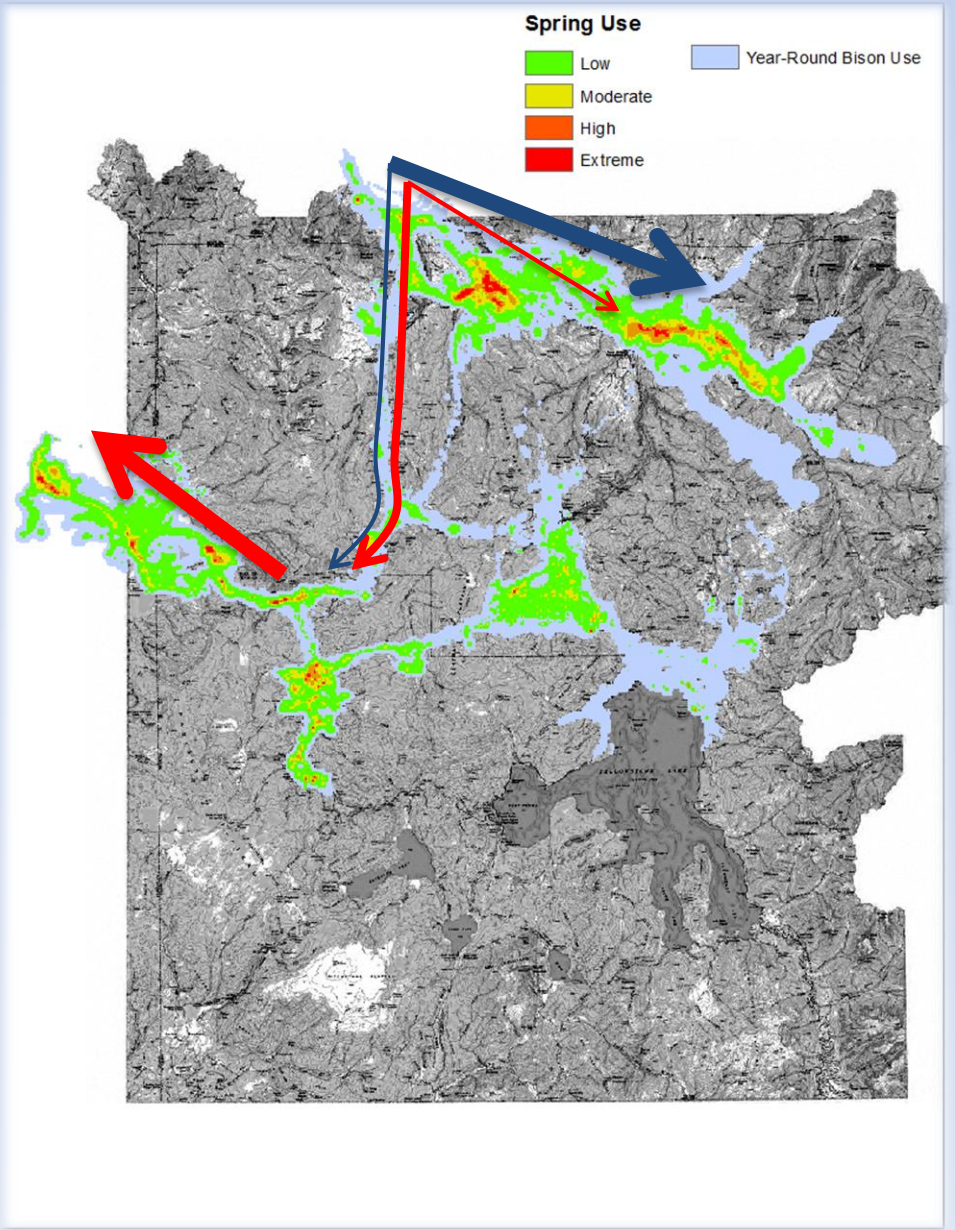
Northern Herd:

Moves towards Northern Management Area

Central Herd:

Moves towards Northern Range or Western Management Area

Spring Migration:

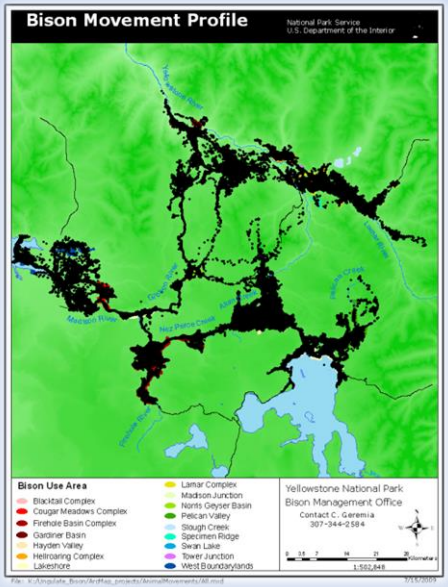


Northern Herd: Moves towards Lamar valley

Central Herd: Moves towards Western Management Area or Lamar Valley

Research Objective:

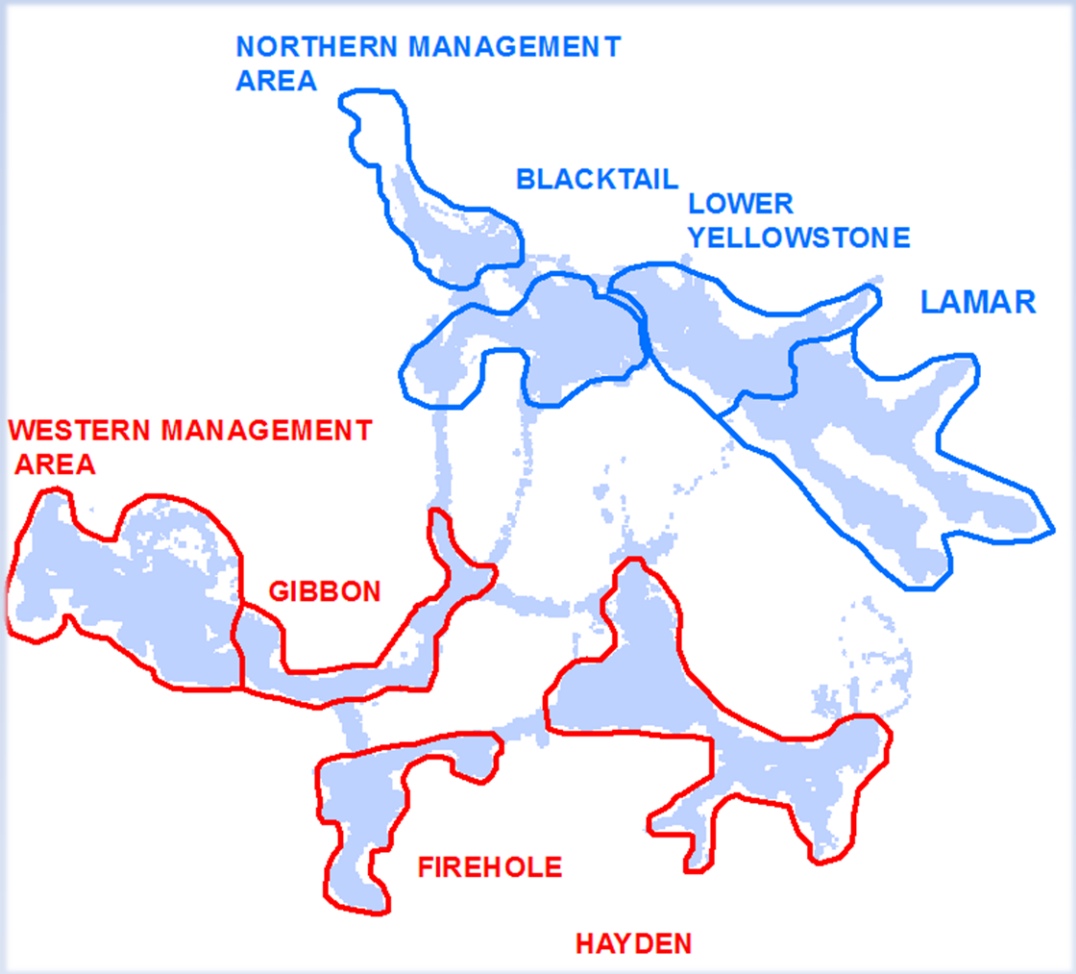
Predict numbers of bison in each wintering area at any time during the year based on conditions (snow, green vegetation)



Geremia, C., PJ White, JA Hoeting, RL Wallen, FGR Watson & NT Hobbs. 2014. Integrating individual and population level data in a movement model of Yellowstone bison. Ecological Applications 24:346-362.

Geremia, C. PJ White, RL Wallen, FGR Watson, JJ Treanor, J Borkowski, CS Potter & R Crabtree. 2011. Predicting bison migration out of Yellowstone National Park using Bayesian models. PLoSONE e16848.doi10.1371.pone.0016848

Bison Resource Selection Choices:



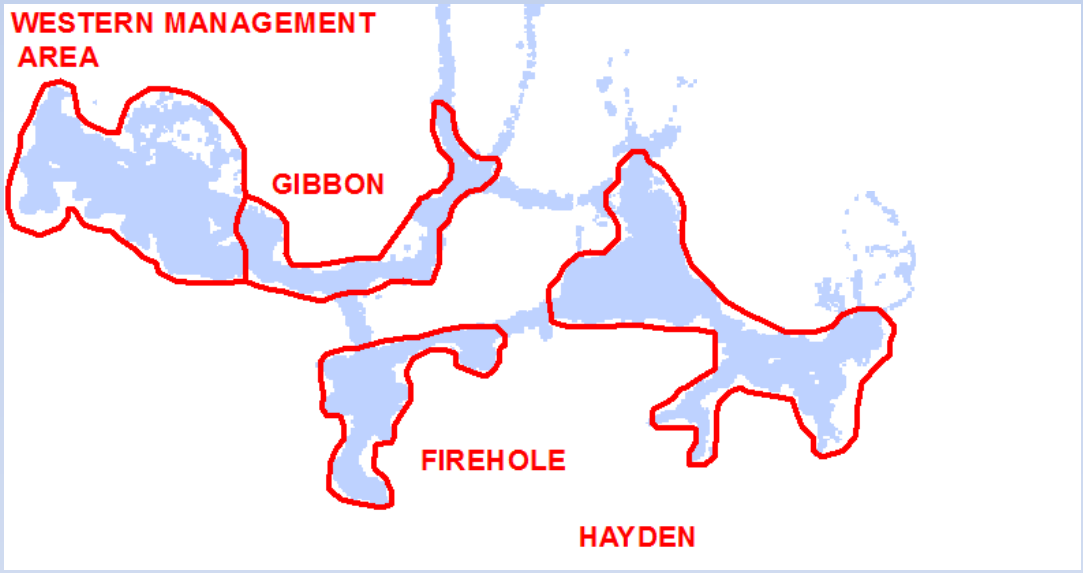
Choosing Northern vs. Central Ranges:

Proportion using Northern Range during the year increases:

a. As the central herd increases in size, particularly above 2,000 animals
b. When winter is severe in Hayden Valley
c. Increasing trend since 2005 - a winter with max central herd size and heavy snow

Implications in the Northern Management Area:

a. Inadvertent removal of Central Herd Animals
b. Large and **Pulsed** increases in numbers of migrants



Common to all Central Range Wintering Areas:

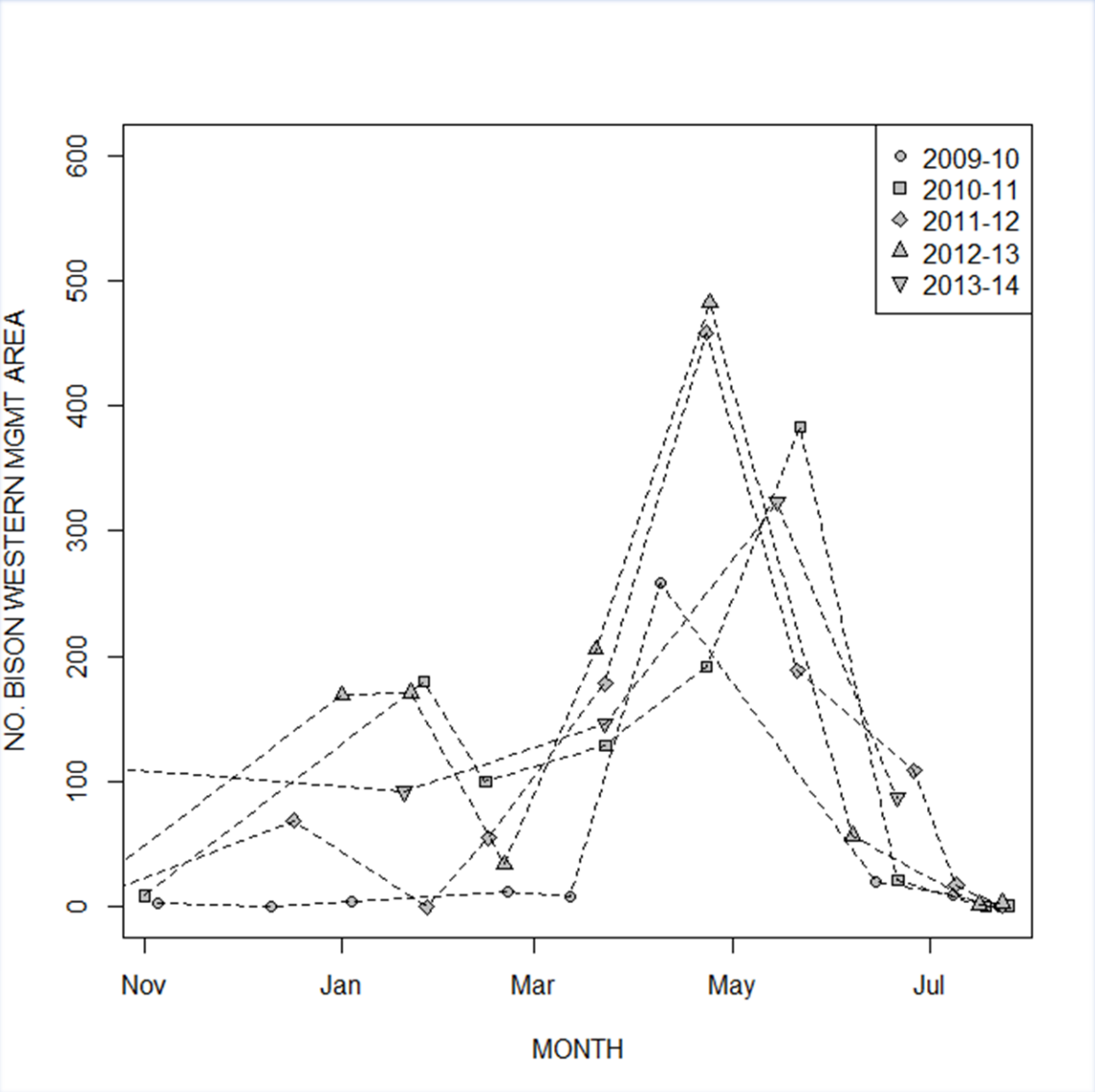
Movements coordinated – big numbers at same time… that's how bison move

Summer, Transitional & Winter Areas separated by narrow corridors and large gradients

Similar timing and magnitude of movements among years

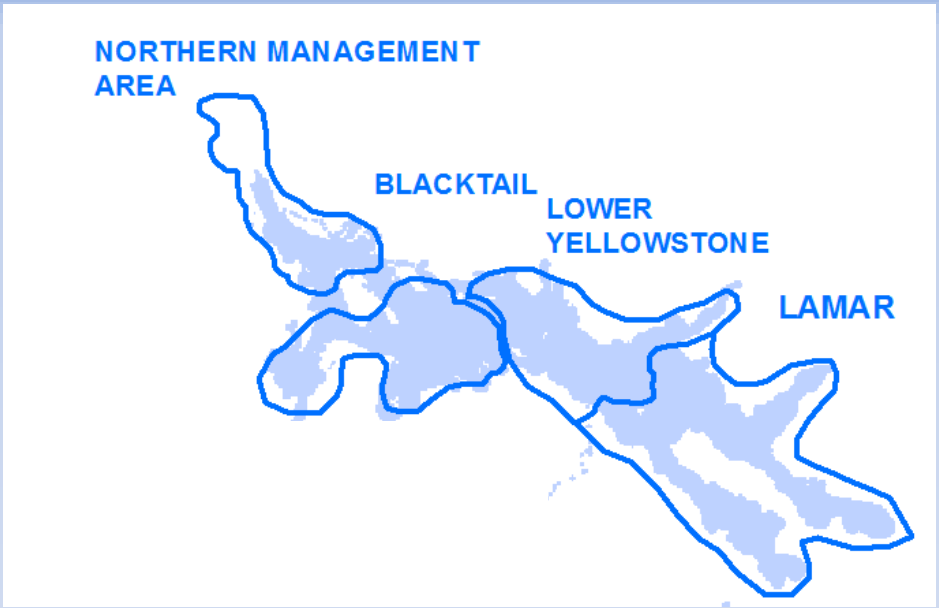
Strong indication of Learning

Western Management Area (WEST OF COUGAR MEADOW):



Movement Drivers TO/FROM Western Management Area

- Snow (SWE) Hayden Valley = Bison at West ↑
- Green Vegetation (NDVI) Hayden Valley = Bison at West ↓
- Peak Green Vegetation West = Bison at West ↑
- After the 2006 Adaptive Management Change to reduce hazing and allow hunting



Common to all Northern Wintering Areas:

Movements coordinated

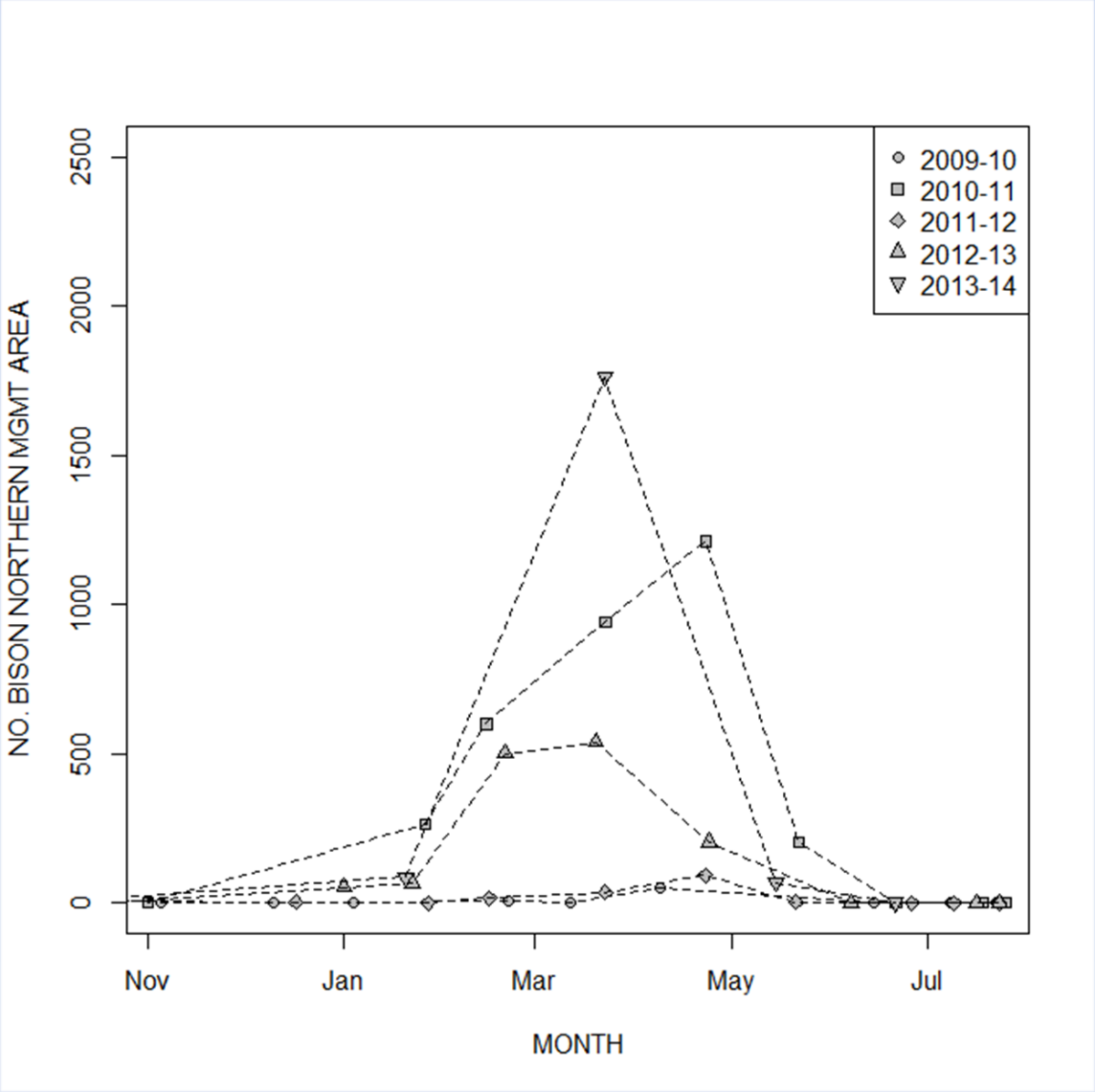
Smooth ‘environmental’ gradient among wintering areas allows back-and-forth movements

Large Annual fluctuations in timing and extent of movements related to SNOW and HERD SIZES

Movement Drivers TO/FROM Northern Management Area

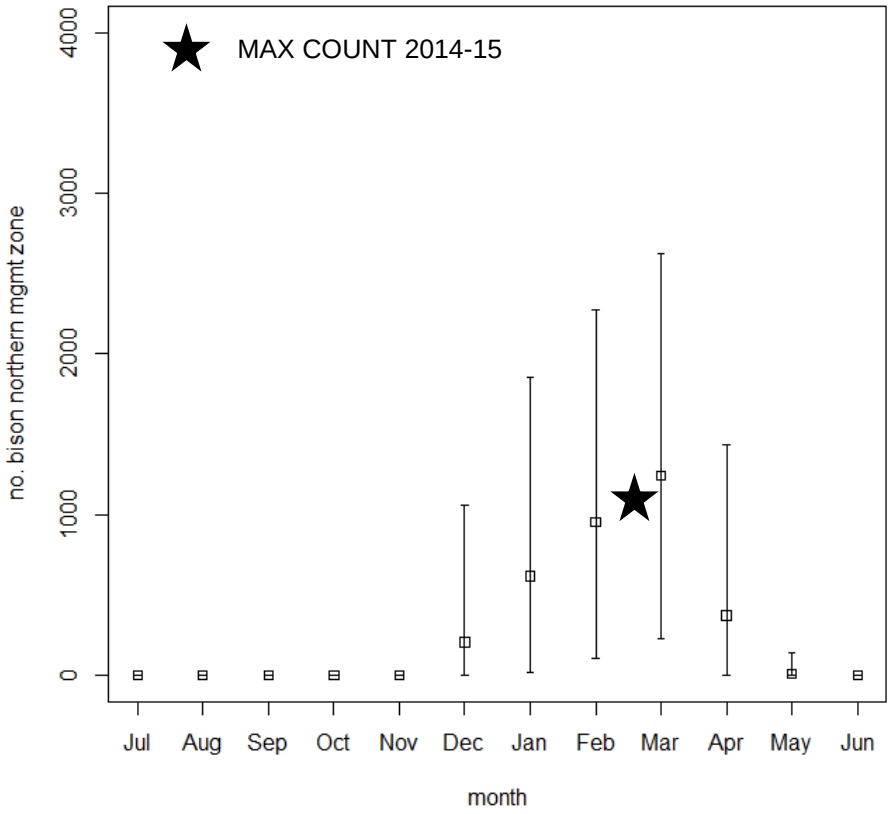
- Snow (SWE) Lamar Valley = Bison at North ↑
- Total Population Size = Bison at North ↑
- Snow covered Area Blacktail Deer Plateau = Bison at North ↑

Northern Management Area (North of Mammoth Hot Springs):

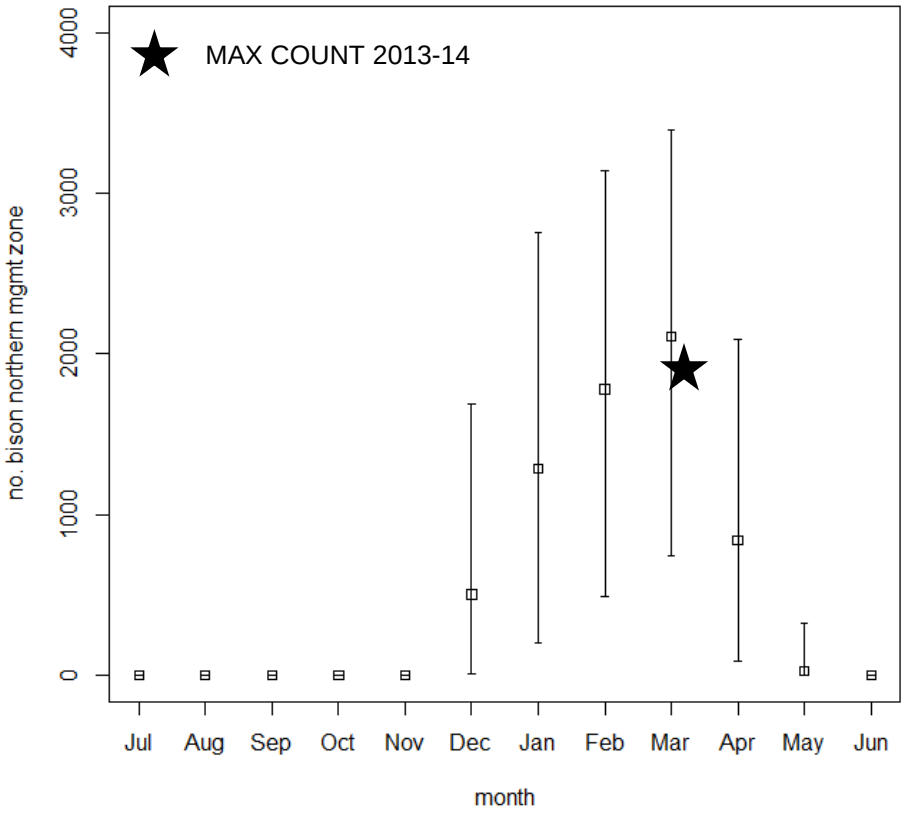


Predicted Migration: 3,600 Northern & 1,300 Central Herd

Conditions similar to Winter 2014-15



Conditions similar to Winter 2013-14



Take home message:

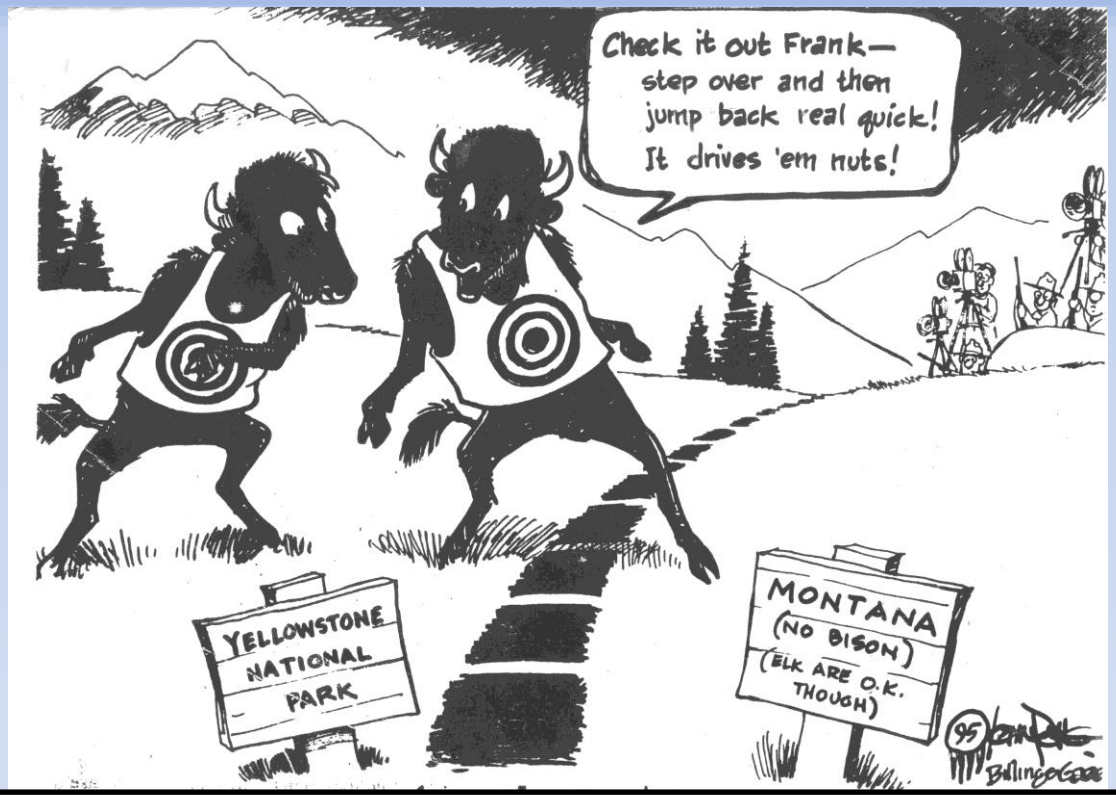
- EXPECT UP TO 1,000 BISON FLUCTUATING IN/AND OF THE NORTHERN MANAGEMENT ZONE WITH NUMBERS INCREASING DRAMATICALLY DURING FEBRUARY AND MARCH -- UNDER THE PREDICTED EL NINO CONDITIONS

- BE PREPARED FOR UP TO 2,000 BISON IF WINTER IS MORE SEVERE THAN ANTICIPATED AND NEAR AVERAGE

- EXPECT UP TO 500 BISON MOVING INTO THE WESTERN MANAGEMENT AREA DURING APRIL – JUNE

- LEARNING, EXPERIENCE & SPRING GREEN-UP ARE WHAT MATTERS IN PREDICTING THE TIMING/EXTENT OF MIGRATIONS TO THE WESTERN MANAGEMENT AREA

- SNOW & CENTRAL/NORTHERN HERD SIZES ARE WHAT MATTERS IN PREDICTING THE TIMING/EXTENT OF MIGRATIONS TO THE NORTHERN MANAGEMENT AREA



- There is not a reasonable population threshold below which bison would remain in the park – due to Expanded Tolerance, Learning, Hunting, High Population Abundance & Big Snow
- Current abundance supports annual hunts and some culling to maintain a relatively stable bison population
- Providing bison more access to areas outside Yellowstone would facilitate more learning and increased hunting opportunities