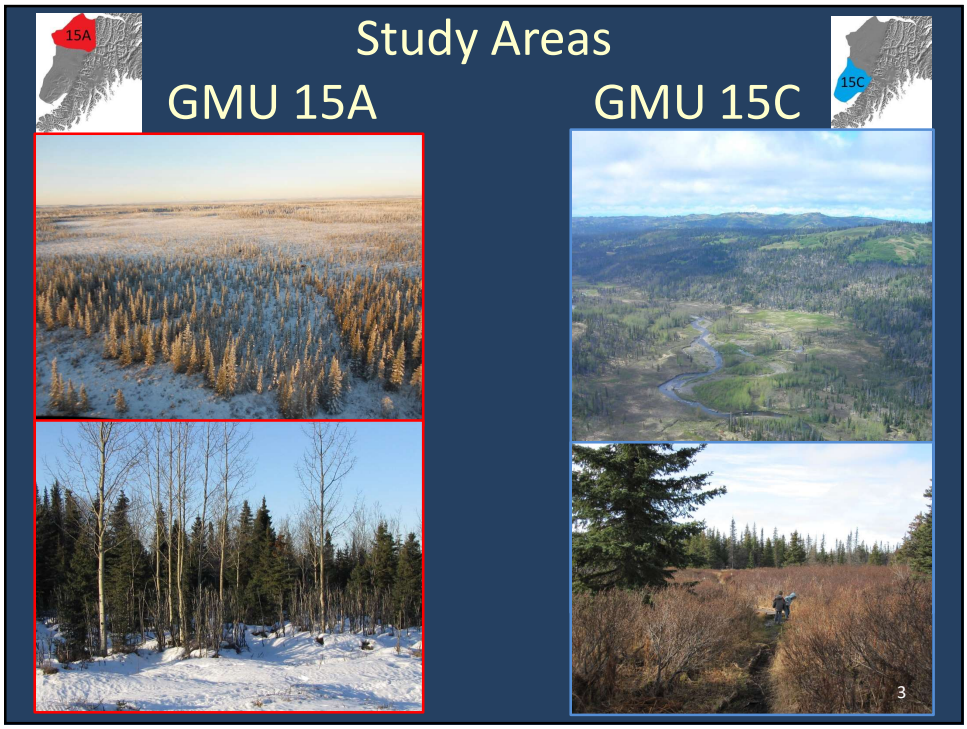
1

Talking points

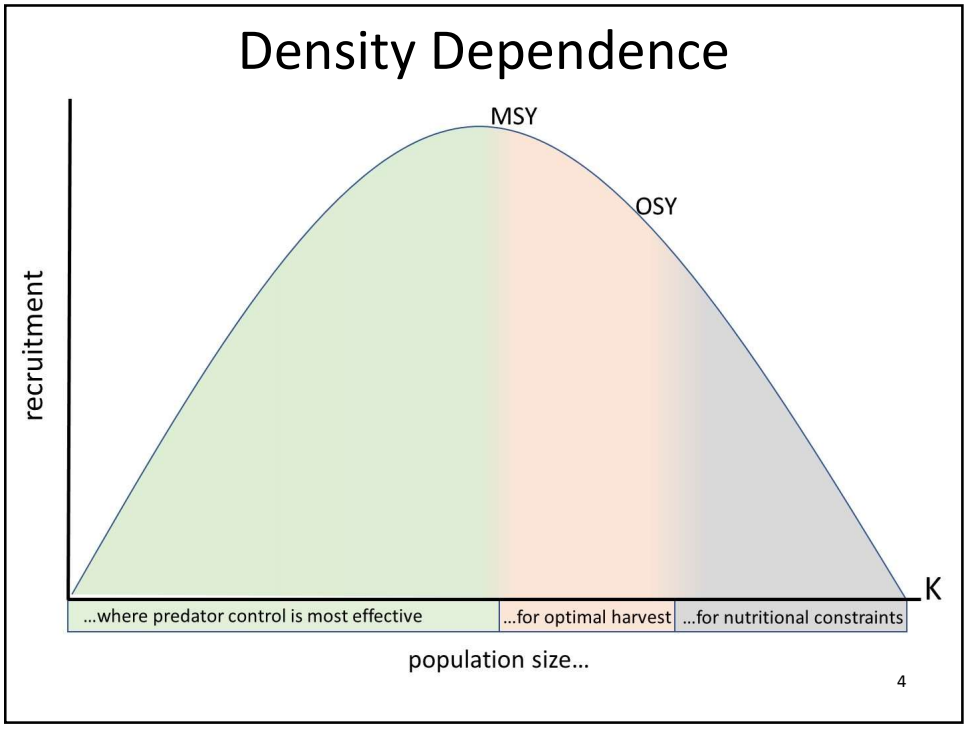
- 10 years of data on nutritional condition, productivity, and survival of moose, the relationship of these measures to density dependence, and why that is important
- Preliminary data on determining type and strength of wolf limitation on moose: quantifying compensatory vs. additive mortality

2

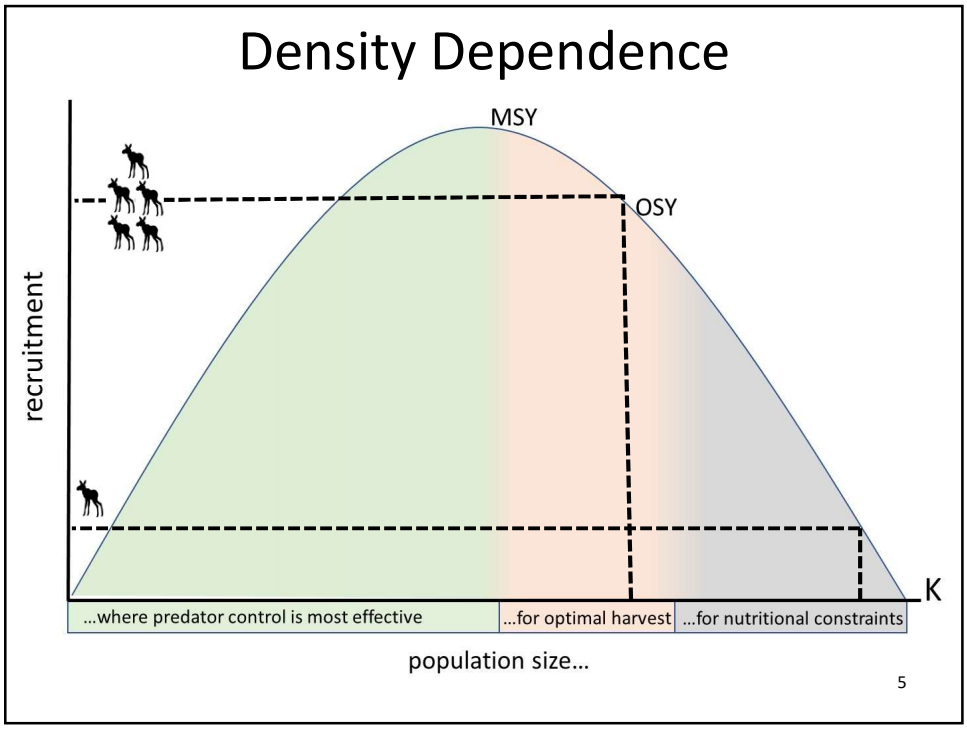
2


Study Areas
15A
GMU 15A
15C
GMU 15C
3

3


Density Dependence
MSY
OSY
recruitment
K
...where predator control is most effective
...for optimal harvest
...for nutritional constraints
population size...
4

4



5

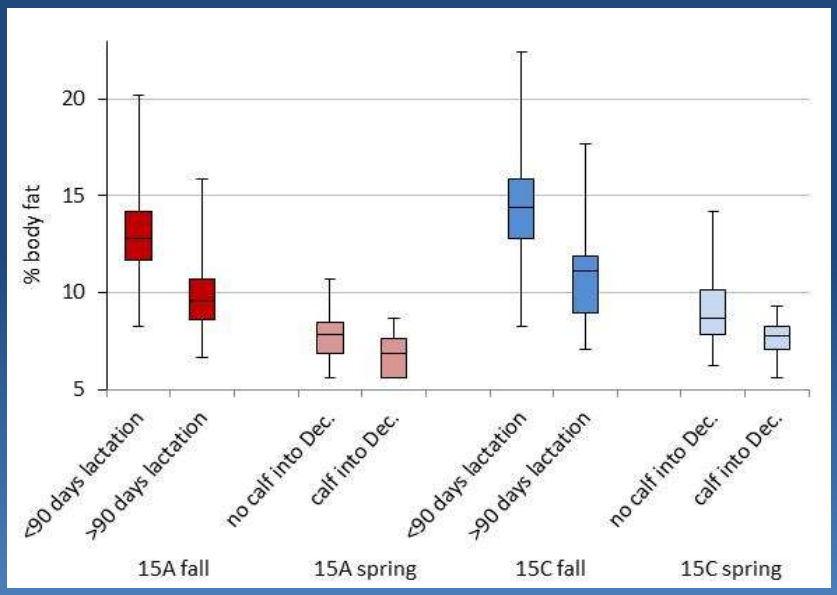
Measures of nutritional condition of moose

- Parturition
  - age at first reproduction
  - twinning
  - 3-year old twinning
  - >3-year old parturition
  - prime age parturition
  - age specific fecundity
  - onset of senescence
- Diet
  - mineral deficiencies
  - plant selection
  - fecal nitrogen
- Body condition
  - short yearling mass
  - neonate birth mass
  - lean mass in spring
  - lean mass in fall
  - body fat in spring
  - body fat in fall
  - bone marrow fat
  - body size
  - growth rate
  - tooth development
  - prevalence of malnutrition
- Cow and calf survival

6

6

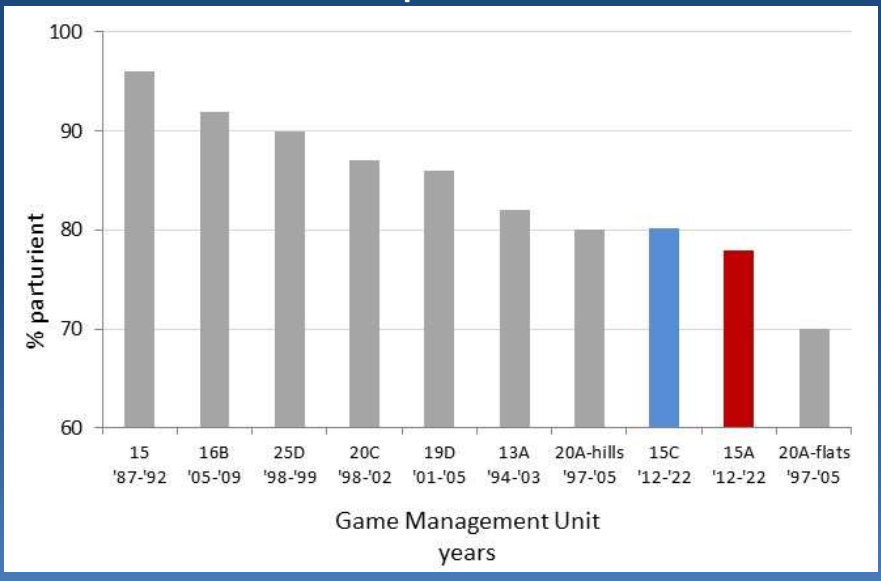
Moose body fat (2012-18)



7

7

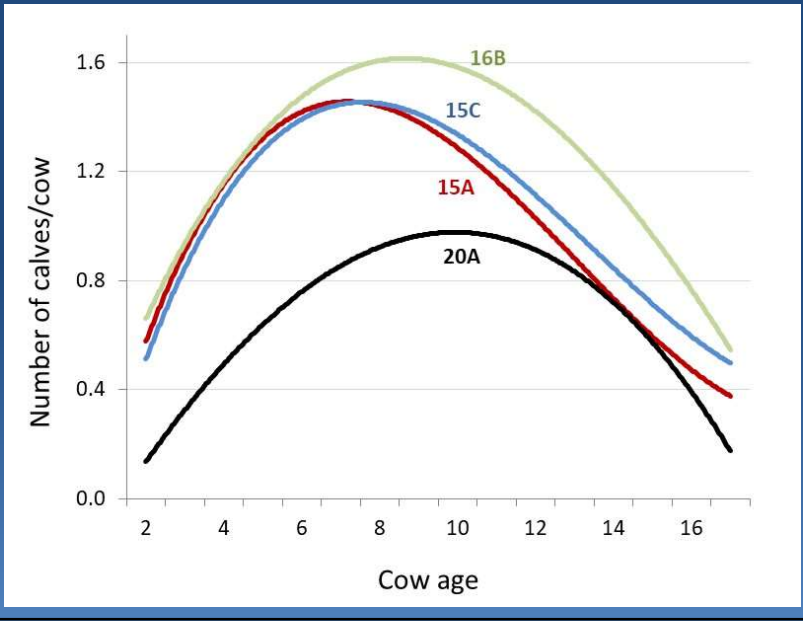
Moose parturition



8

8

Moose age-specific fecundity



9

9

Moose survival (2012-2021)

10-year average of annual cow survival:

- 89% in 15A
- 90% in 15C

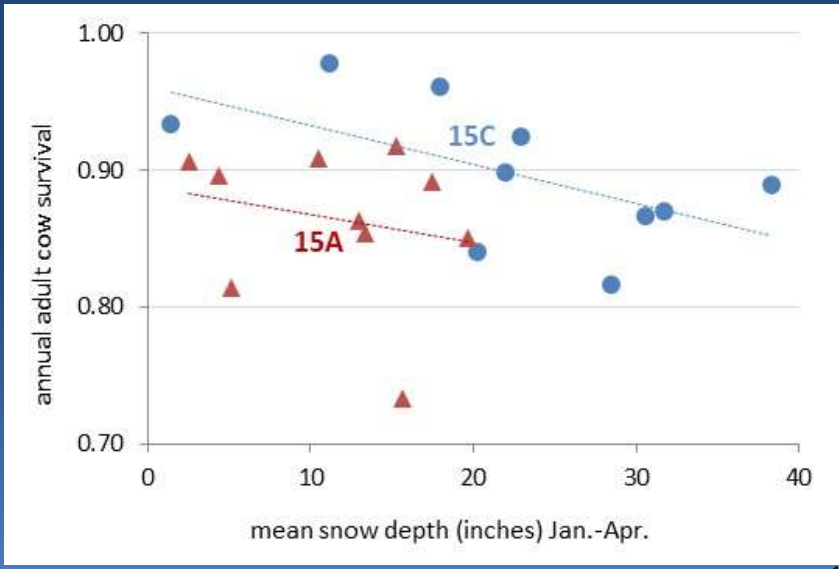
10-year average of 10-month calf survival:

- 15% in 15A
- 26% in 15C

10

10

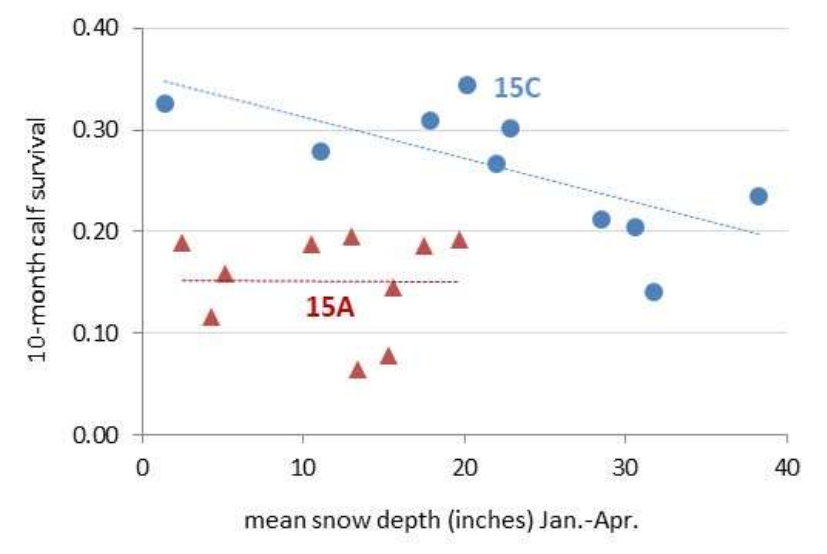
Snow depth and adult cow survival 2012-2021



11

11

Snow depth and short-yearling survival 2012-2021



12

12

Ranking of moose nutritional condition

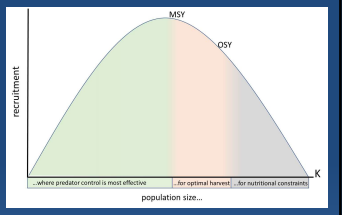
Using >30 studies: Bertram and Vivion 2002, Ballard et al. 1981, 1987, 1991, Ballard and Whitman 1987, Boer 1992 (16 studies), Boertje et al. 2000, 2007, 2009, 2018, Cook et al. 2021, Crouse unpublished data, Fong 1981, Gasaway et al. 1992, Jensen et al. 2018, Keech et al. 2011, Rinaldi and Peltier 2016, Schwartz and Hundertmark 1993, Sand et al. 2012, Snider 1980, Spears et al. 2003

15A

- Below K
  - twinning
  - short-yearling mass
- Below-near K
  - age at first reproduction
  - body fat-spring
  - body fat-fall
  - Franzmann score-fall
  - Franzmann score-spring
- Near carrying capacity
  - prevalence of malnutrition
  - 3-year old twinning
  - adult parturition
  - prime age parturition
  - fecundity
  - bone marrow- adult cows
- At carrying capacity
  - bone marrow- calves

15C

- Below K
  - twinning
  - body fat-spring
  - body fat-fall
  - Franzmann score-fall
  - Franzmann score-spring
- Below-near K
  - short-yearling mass
  - age at first reproduction
- Near carrying capacity
  - prevalence of malnutrition
  - 3-year old twinning
  - adult parturition
  - prime age parturition
  - fecundity
  - bone marrow- adult cows
  - neonate birth mass
- At carrying capacity
  - bone marrow- calves



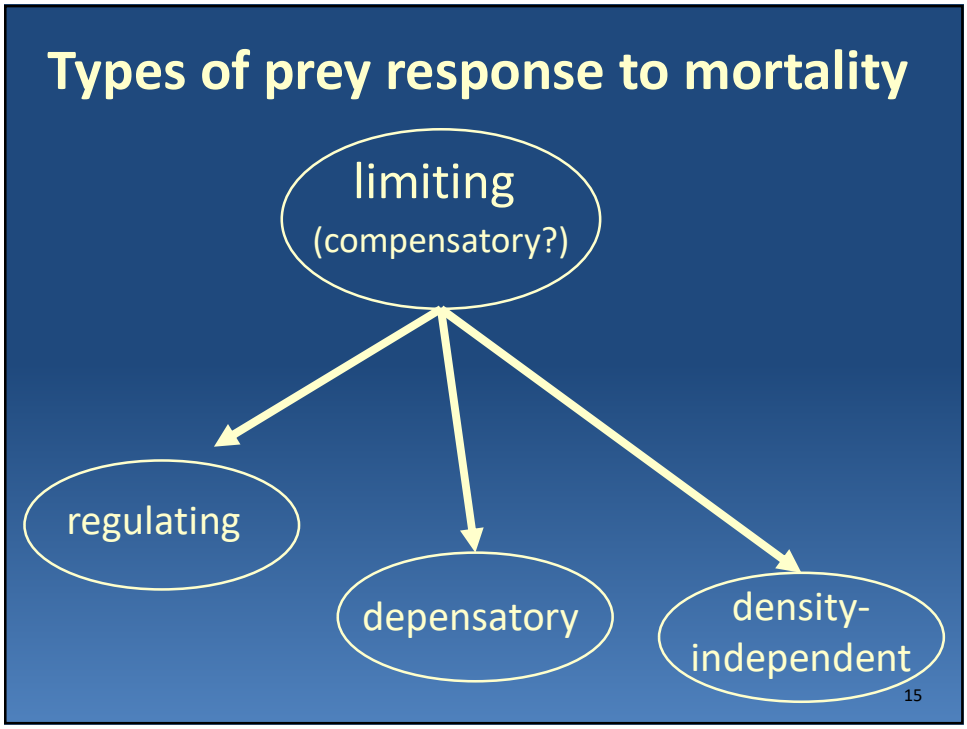
13

13

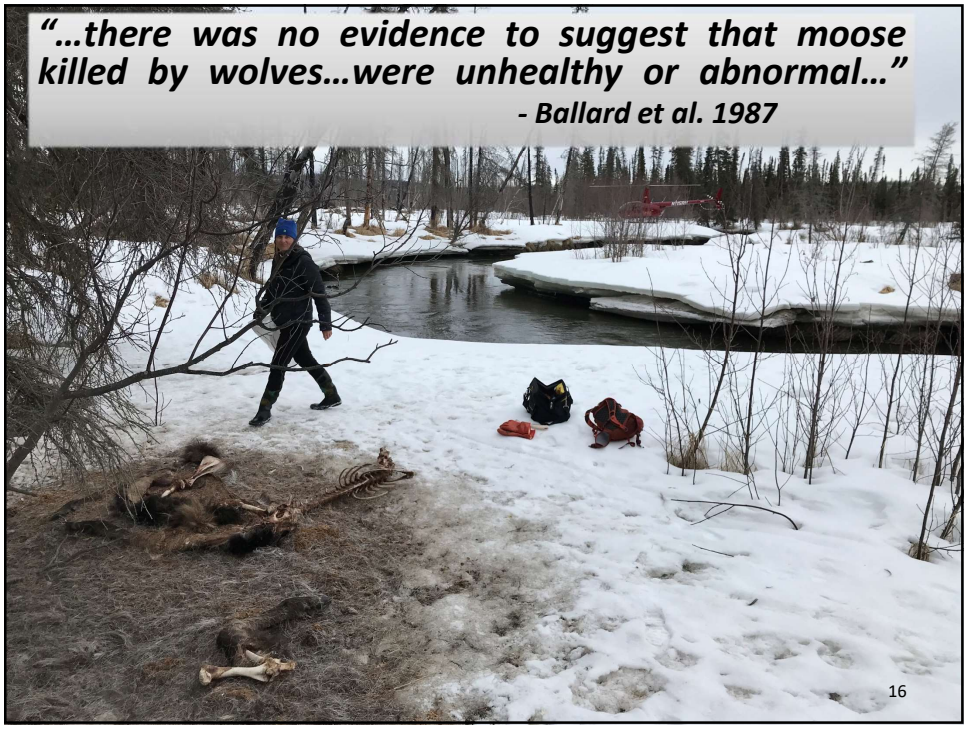
Wolf limitation on moose

14

14


Types of prey response to mortality
limiting
(compensatory?)
regulating
depensatory
density-
independent
15

15


"…there was no evidence to suggest that moose killed by wolves…were unhealthy or abnormal…"
- Ballard et al. 1987
16

16

Competing hypotheses

- Predator regulation

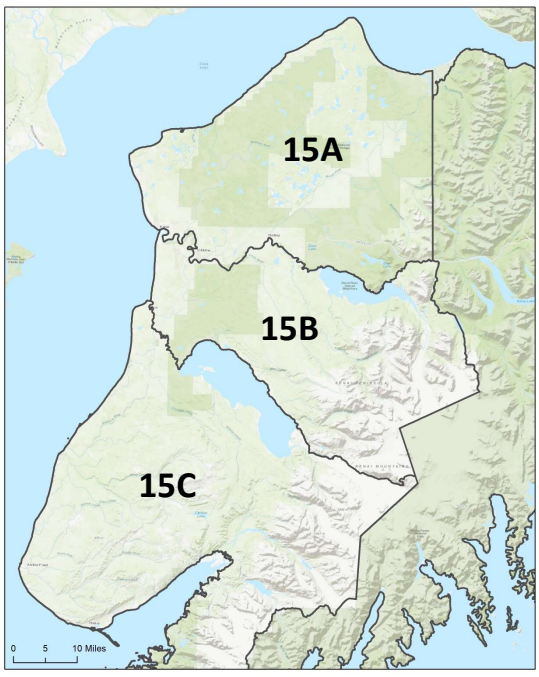
  Condition of wolf kills = control

- Surplus predation

  Condition of wolf kills < control

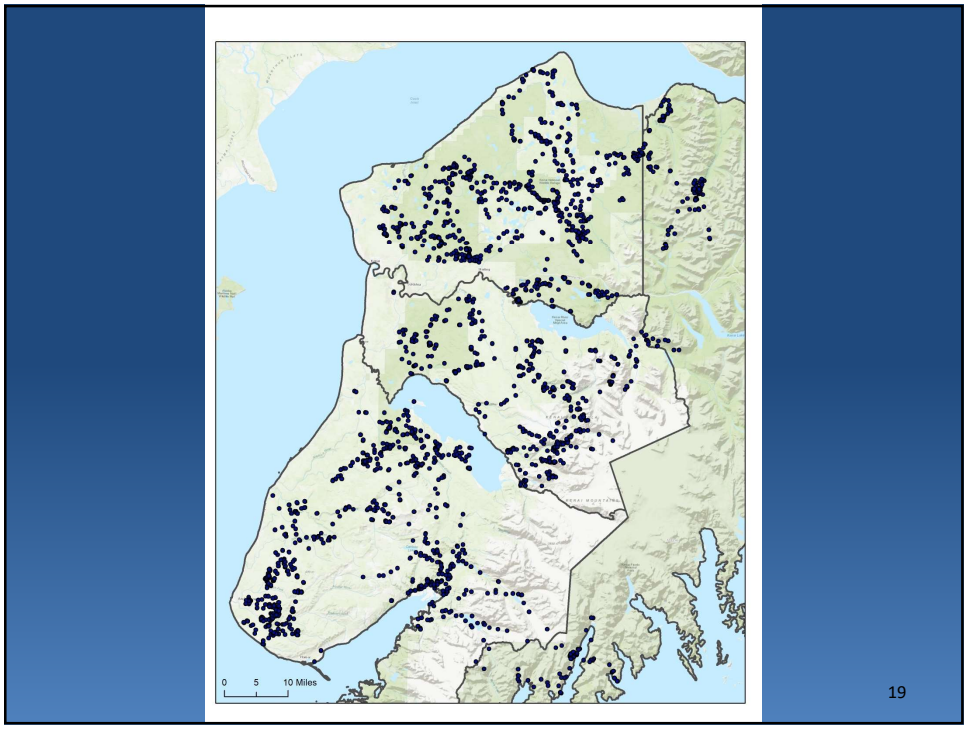
17

17

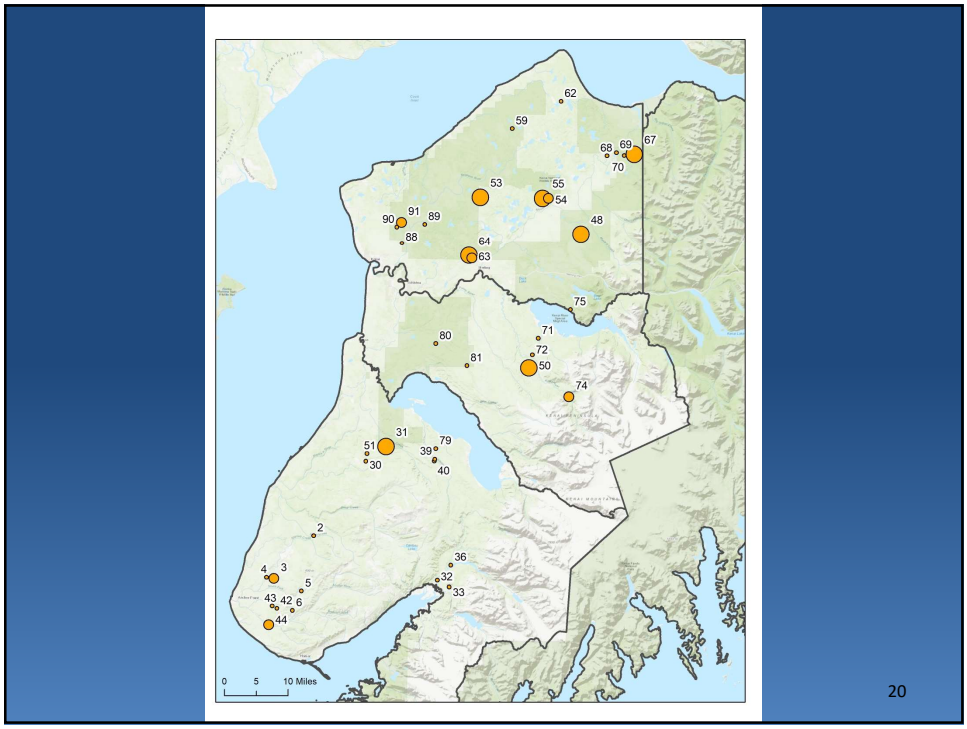


18

18


0 5 10 Miles
19

19


62
59
68
69
67
70
53
55
54
90
91
89
48
88
64
63
75
80
71
72
81
50
74
31
51
79
39
30
40
2
36
4
3
32
5
33
43
42
6
44
0 5 10 Miles
20

20

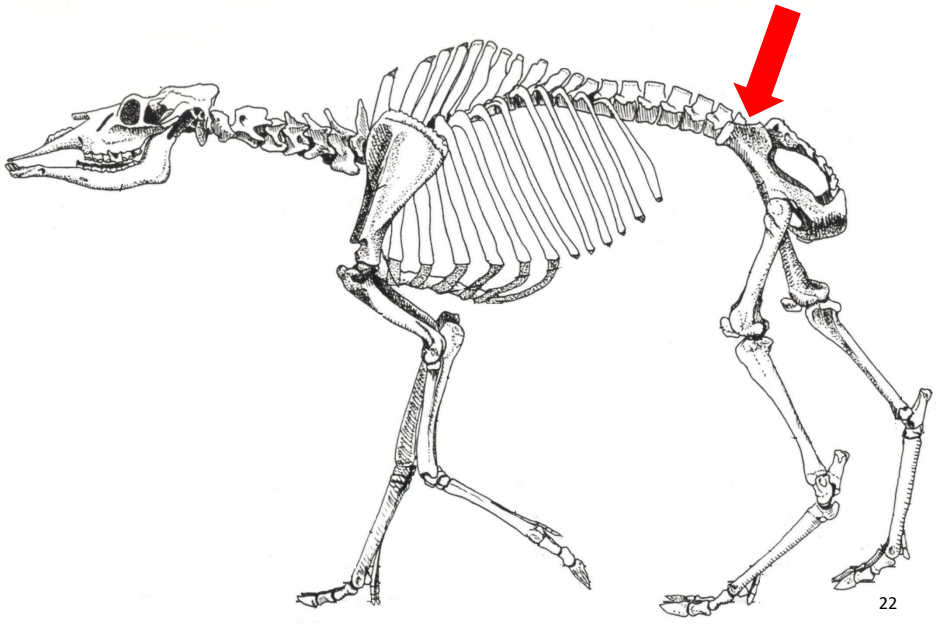
Measures of moose condition: wolf kills vs. control

- age
- bull vs cow
- bone marrow fat
- osteoarthritis
- tooth wear and pathology

21

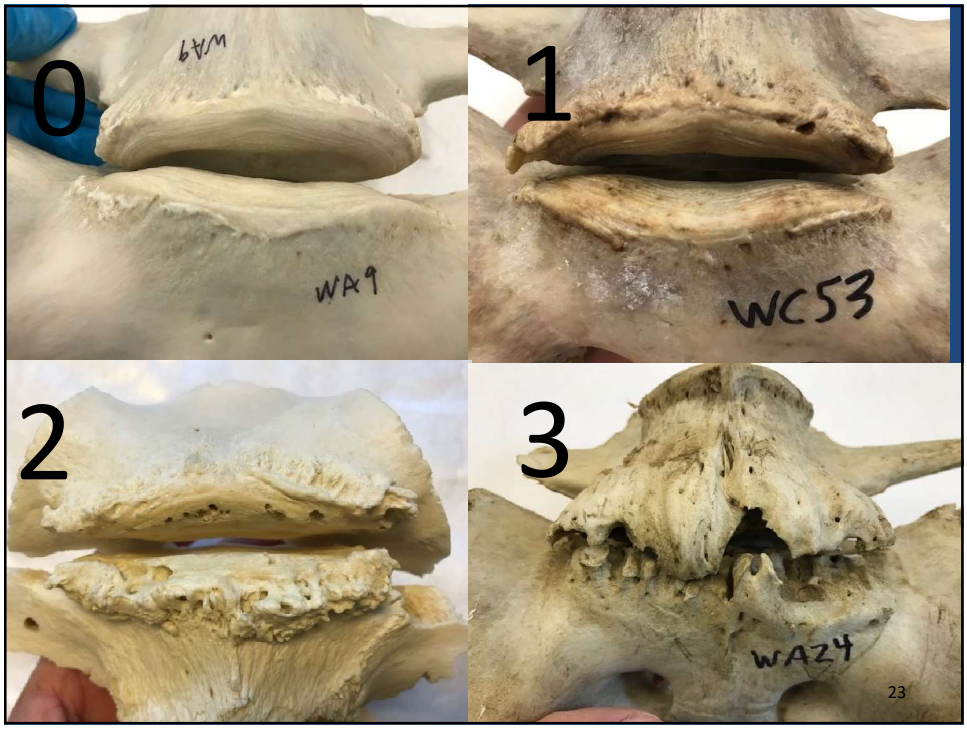
21

Where to look for osteoarthritis

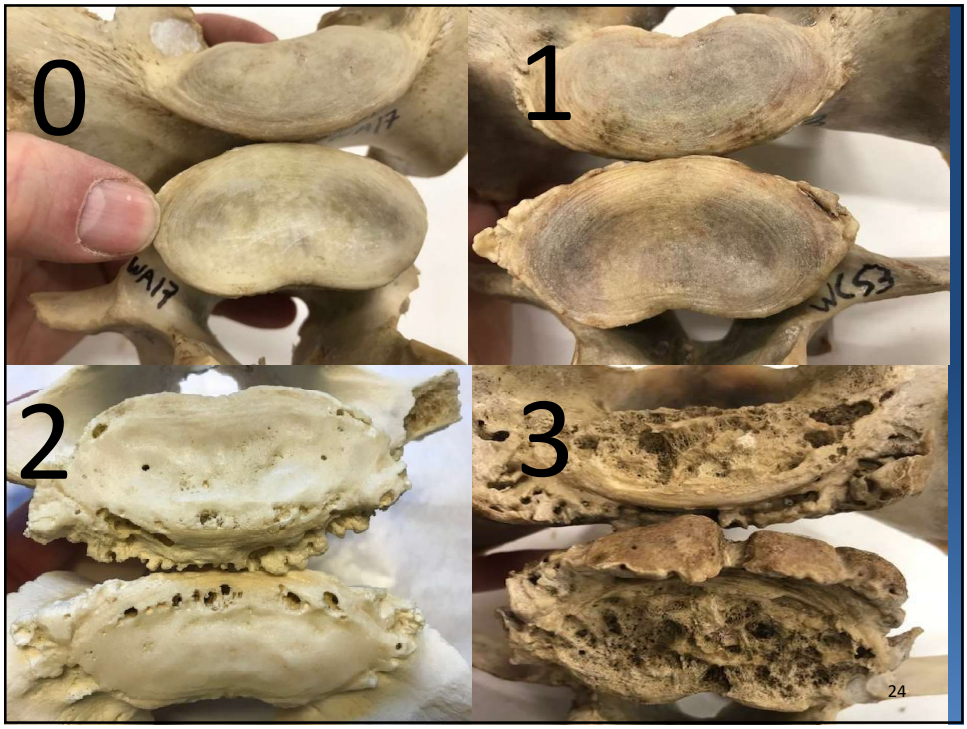


22

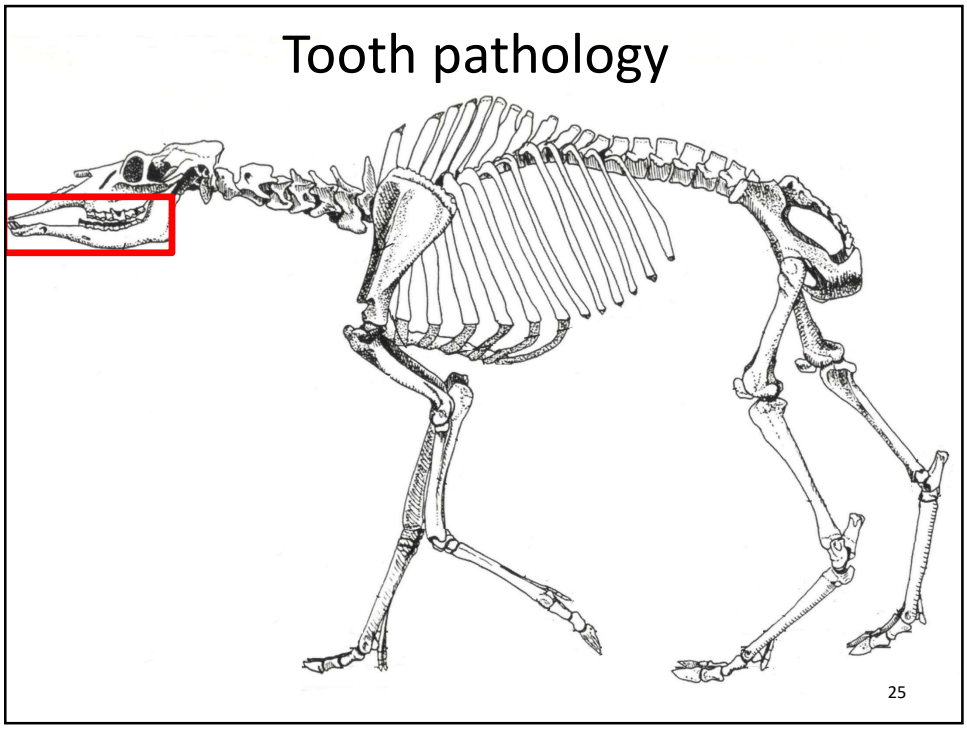
22



23

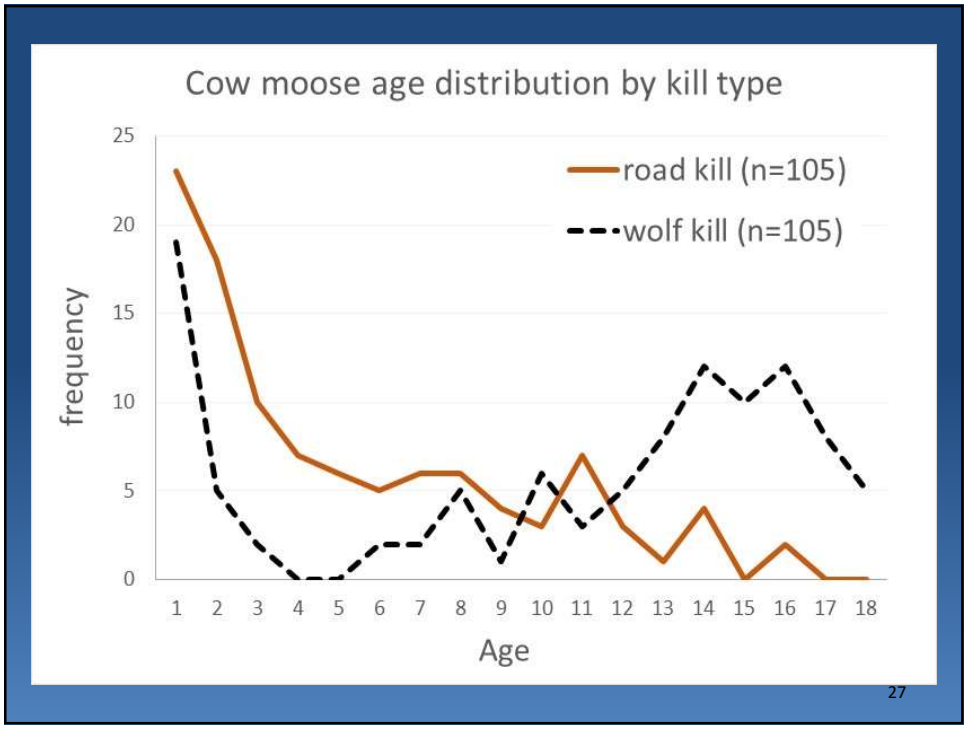


24

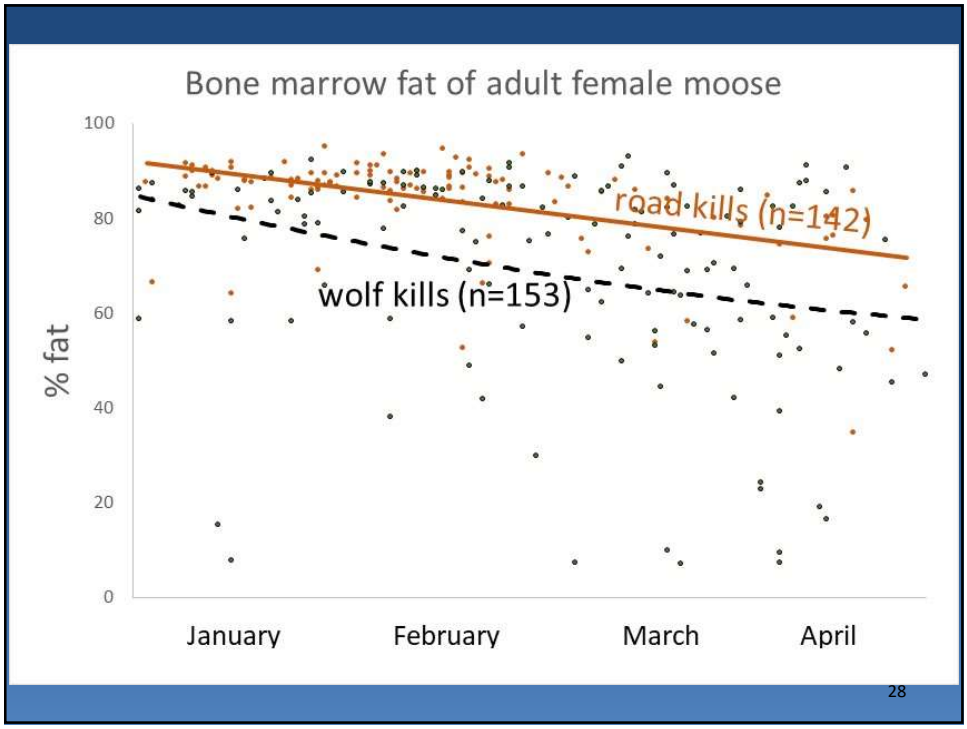


25

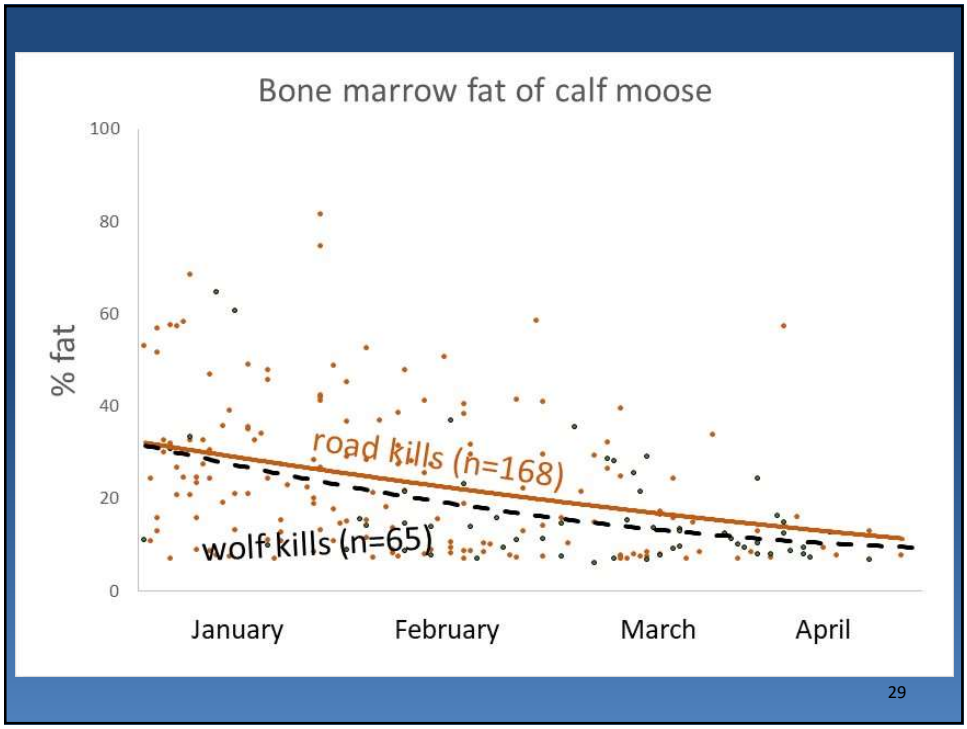
26


Cow moose age distribution by kill type
road kill (n=105)
wolf kill (n=105)
frequency
0
5
10
15
20
25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Age
27

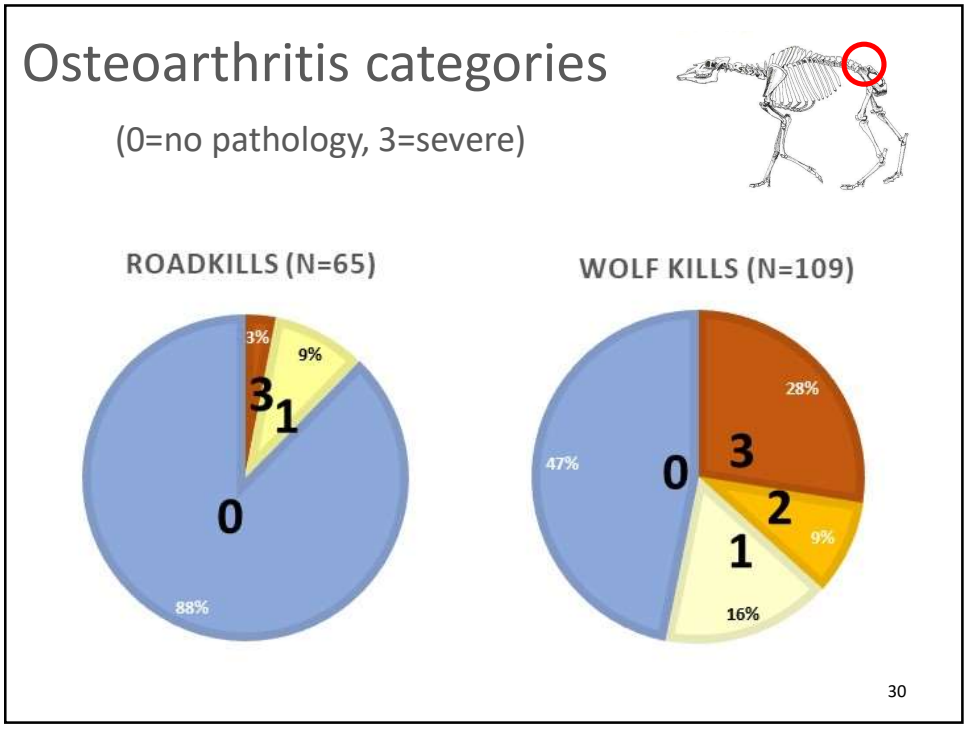
27


Bone marrow fat of adult female moose
road kills (n=142)
wolf kills (n=153)
% fat
0
20
40
60
80
100
January
February
March
April
28

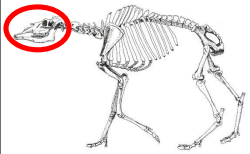
28


Bone marrow fat of calf moose
100
80
60
40
20
0
% fat
road kills (n=168)
wolf kills (n=65)
January
February
March
April
29

29

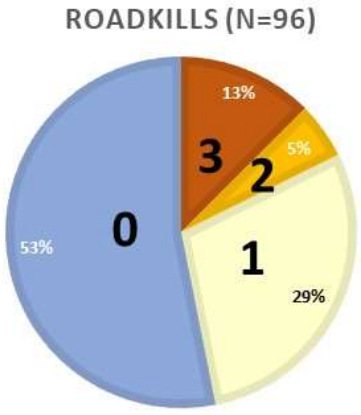

Osteoarthritis categories
(0=no pathology, 3=severe)
ROADKILLS (N=65)
3%
9%
3
1
0
88%
WOLF KILLS (N=109)
28%
47%
0
3
2
9%
1
16%
30

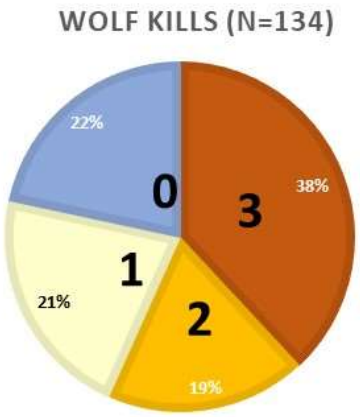
30



Tooth pathology categories

(0=no pathology, 3=severe)





31

31

Estimating compensatory mortality of short-yearling moose

Those with <20% bone marrow fat divided by all the moose sampled:

73% of wolf kills would be compensatory (43/59)

48% of roadkills would be compensatory (76/158)

32

32

Estimating compensatory mortality of adult cow moose

Those with <50% bone marrow fat, and/or category 3 osteoarthritis/tooth pathology divided by all the moose sampled:

51% of wolf kills would be compensatory (76/149)

11% of road kills would be compensatory (13/117)

33

33

Summary

- Nutritional constraints we measured in moose in subunits 15A and 15C support that these populations are influenced by density dependent effects. Therefore, management actions to increase densities would likely have a negative impact on recruitment.
- Preliminary data indicate wolves are not greatly regulating moose in GMU 15 and a majority of the wolf predation is likely compensatory.

34

34


Ori Badajos
Nick Fowler
John Crouse
Jeff Selinger
Dan Thompson
Dave Saalfeld

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