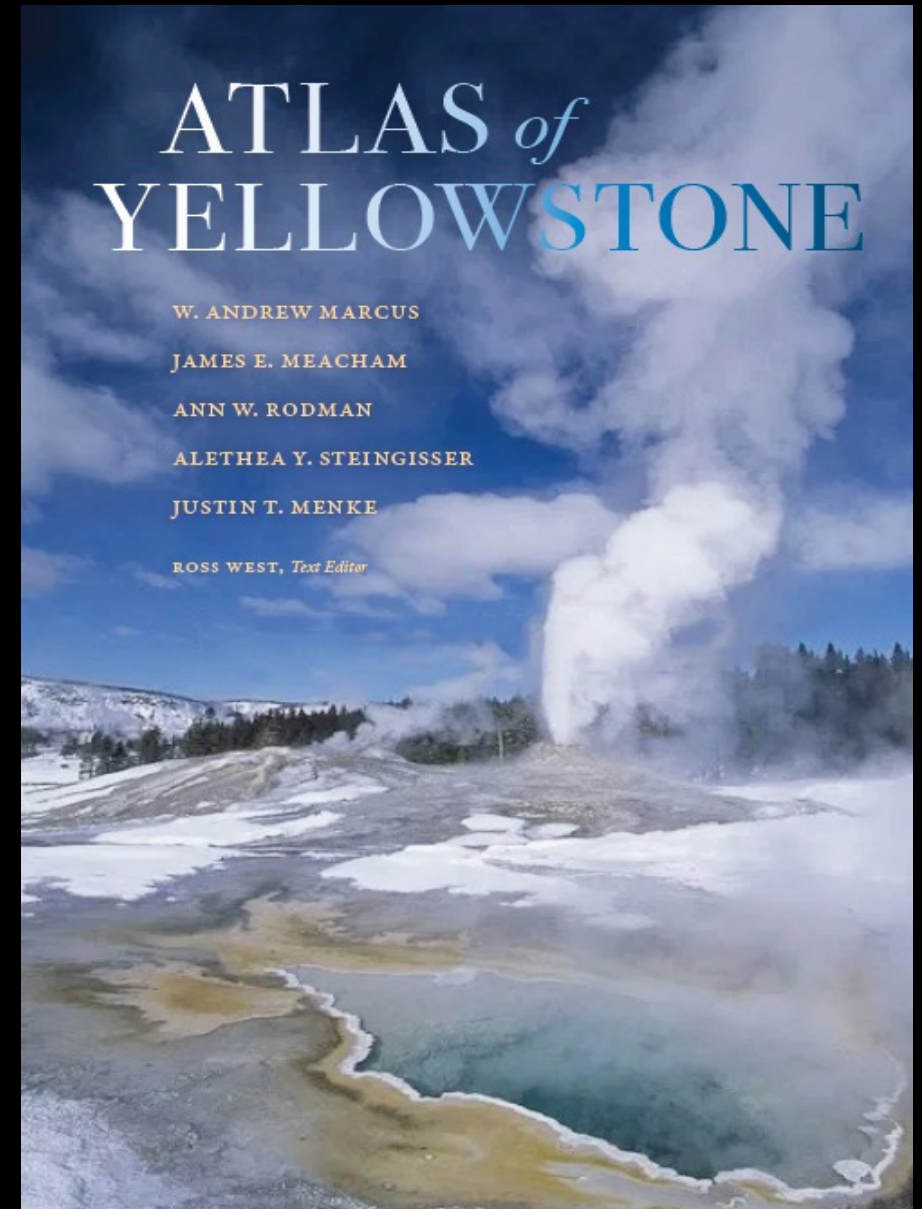


Mapping Carnivore Movement and Interactions in the Greater Yellowstone Ecosystem

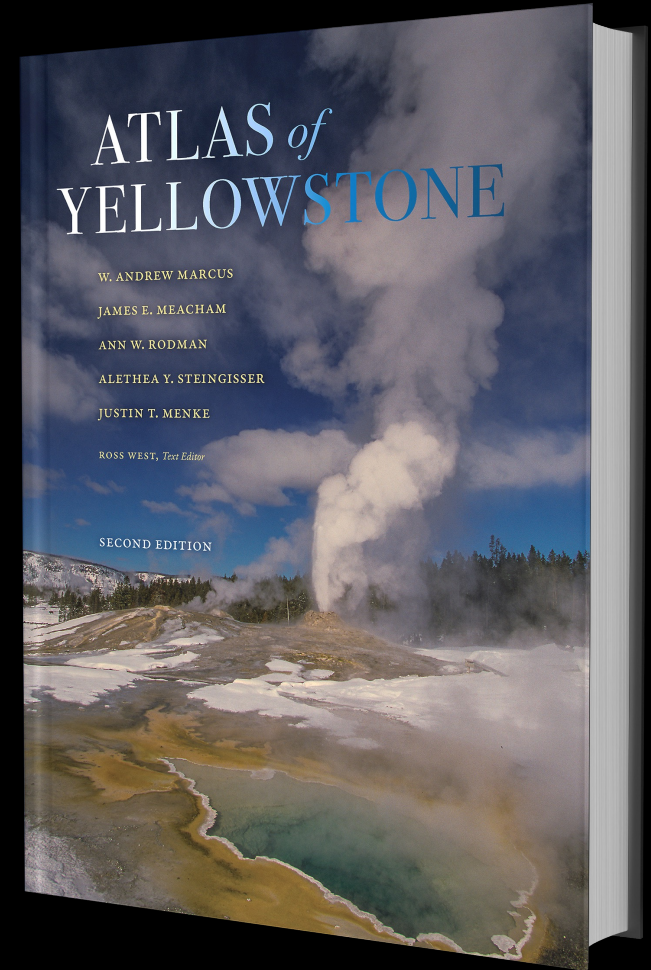
Stories from the
Atlas of Yellowstone, 2nd Edition

Jim Meacham
InfoGraphics Lab
University of Oregon

*ICA Mountain Cartography Workshop
Snow Mountain Ranch, Colorado
April 14, 2023*



Atlas Team



Ann W. Rodman



Ross West

Left to right: Justin T. Menke, W. Andrew Marcus, James E. Meacham, and Alethea Y. Steingisser at Norris Geyser Basin

PHOTO OF ANN W. RODMAN BY NPS; PHOTO OF ROSS WEST BY KRISTIN HIATT; GROUP PHOTO COURTESY OF J. MEACHAM, TAKEN BY UNKNOWN COUPLE ON TRAIL

W. Andrew Marcus, Senior Editor
James E. Meacham, Cartographic Editor
Ann W. Rodman, Yellowstone Editor

Alethea Y. Steingisser, Production Manager
Justin T. Menke, Research Cartographer
Ross West, Text Editor

...and many student
cartographers!

Expert Contributors



Lauren Walker: birds NPS



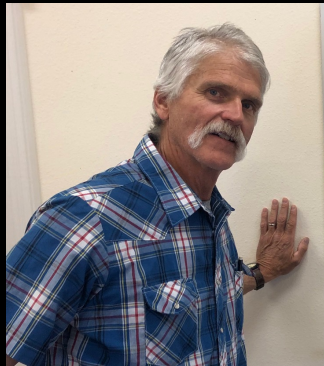
Beth Horton: archaeology NPS



Dan Stahler: elk, cougar



Jeff Hungerford: geology NPS



Doug Smith: wolves, birds



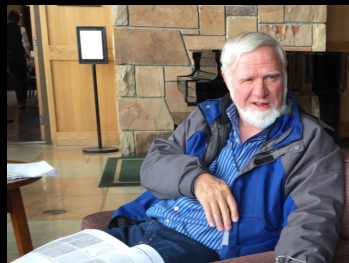
Kerry Gunther: grizzly bear



Zehra Osman:
architecture



Matt Kauffman: migration
Rick Wallen: bison



Lee Whittlesey: history

...and another 100+ experts
contributing to 150 topics.

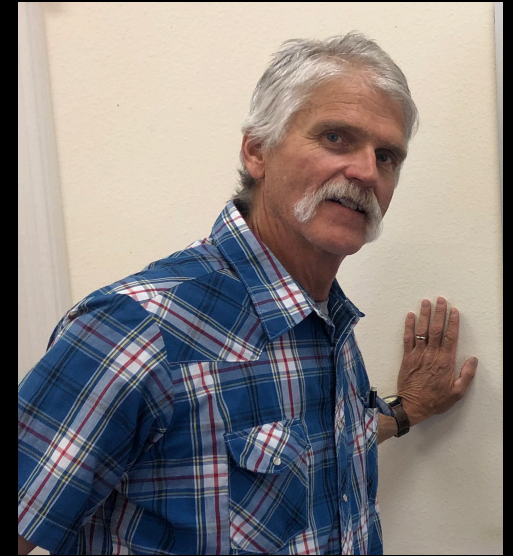
The Expert Contributors



Kerry Gunther: grizzly bear



Dan Stahler: elk, cougar

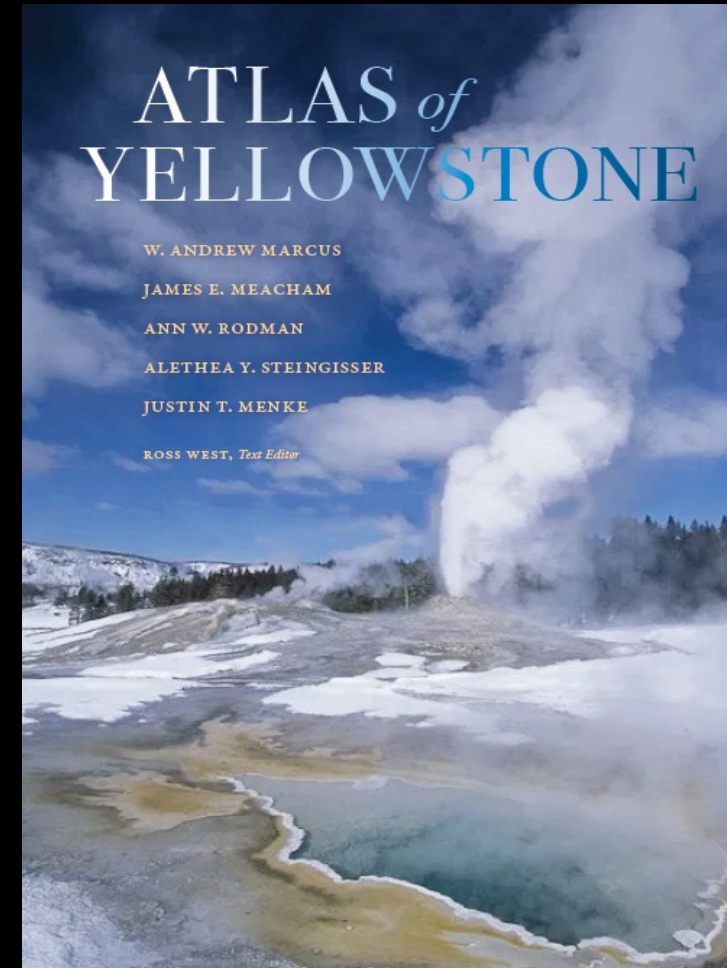
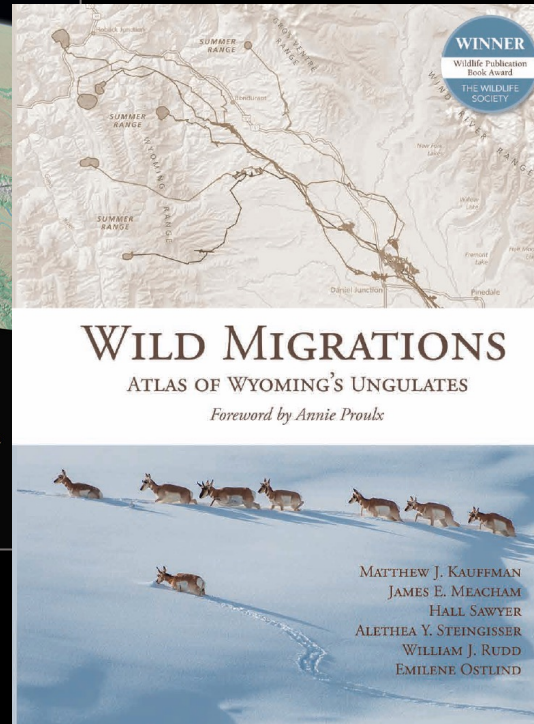
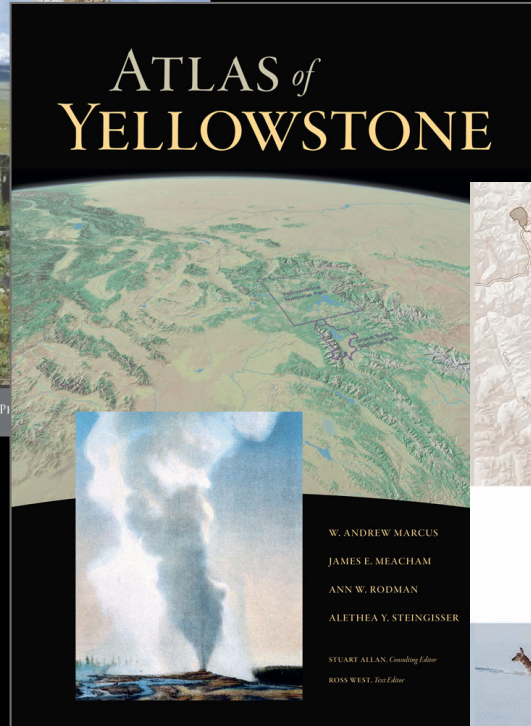
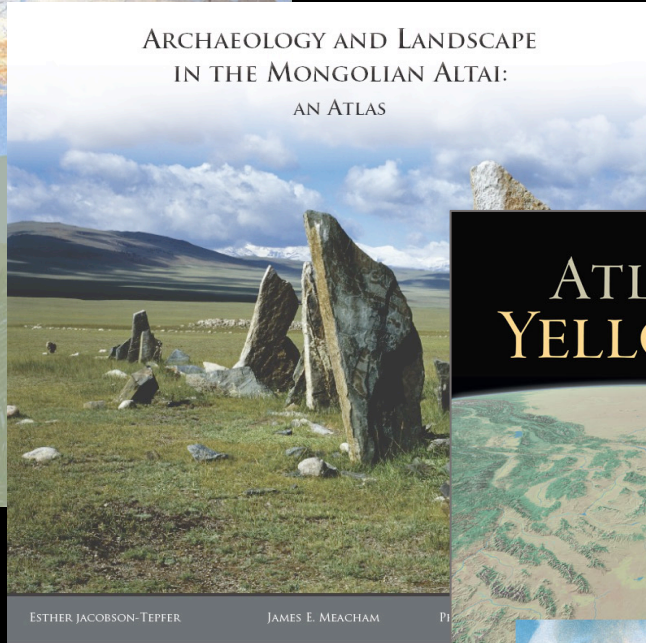
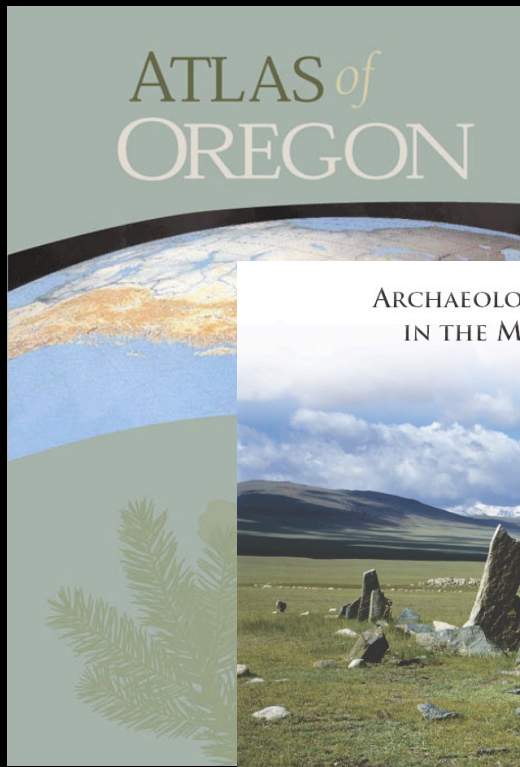


Doug Smith: wolves, birds

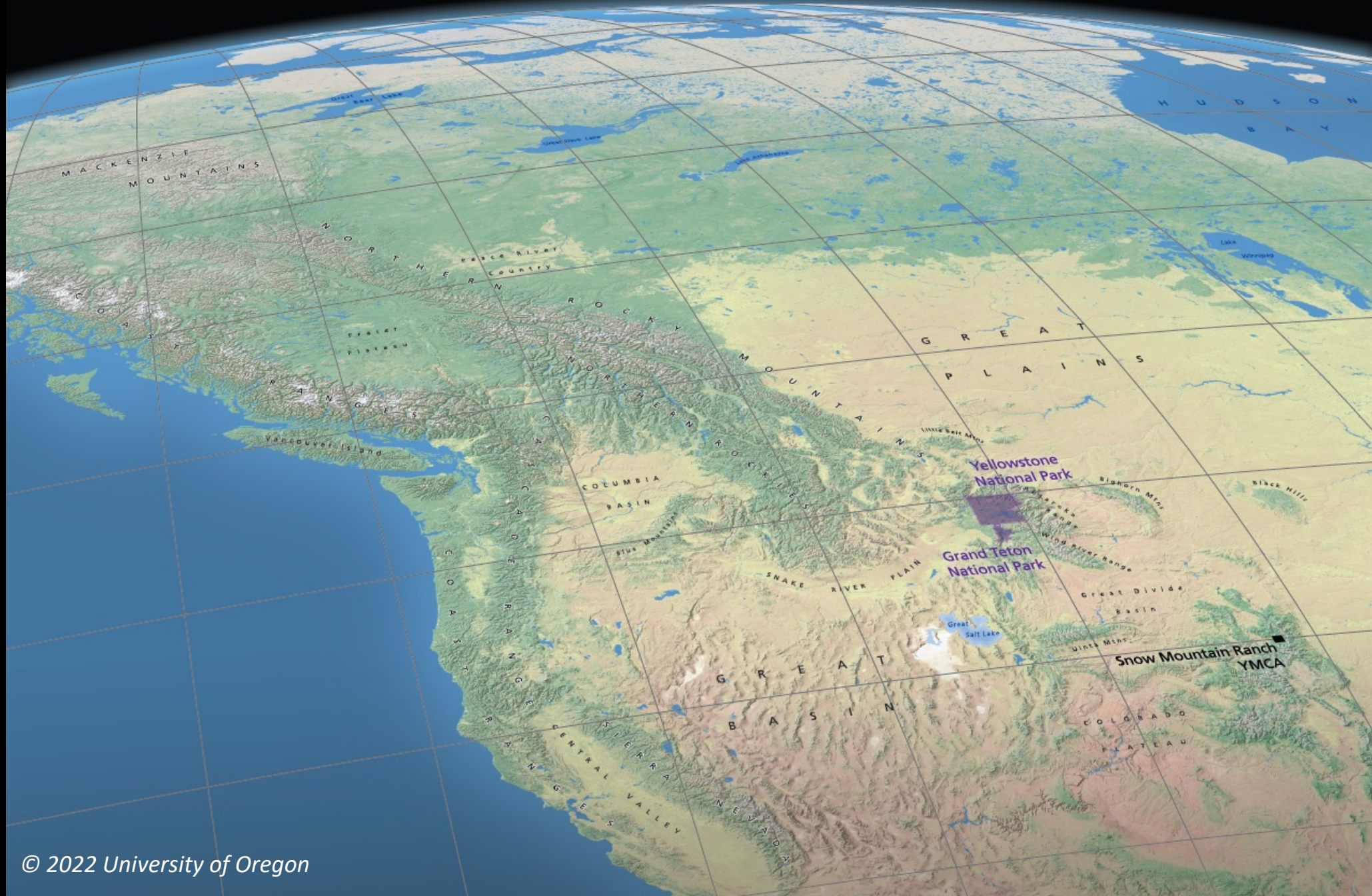
Atlas Cartography Background

InfoGraphics Lab

University of Oregon



Yellowstone - Western North America





**Yellowstone
National Park**

**Grand Teton
National Park**

**Snow Mountain Ranch
YMCA**

Carnivore Mapping Examples

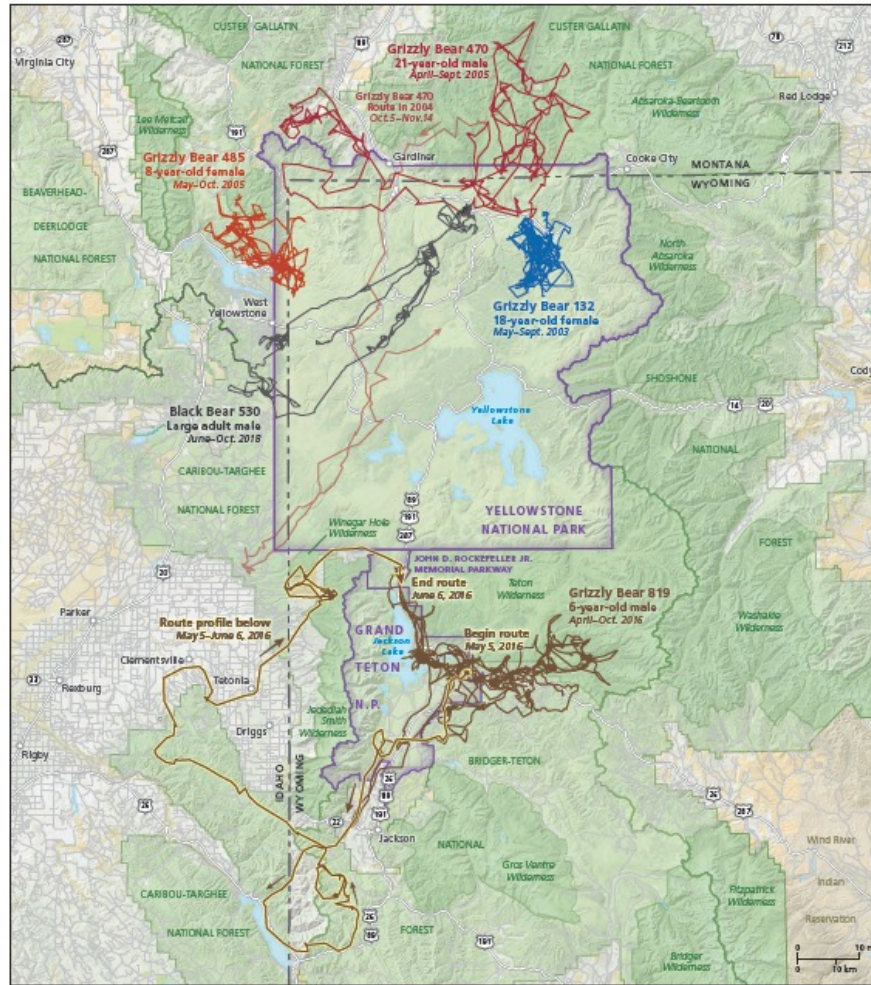
- Grizzly Bear Movement
- Cougar Movement
- Cougar Interaction with Grizzly Bears and Wolves
- Wolf Movement and Wolf 911M Story

Mapping Yellowstone Grizzly Bear

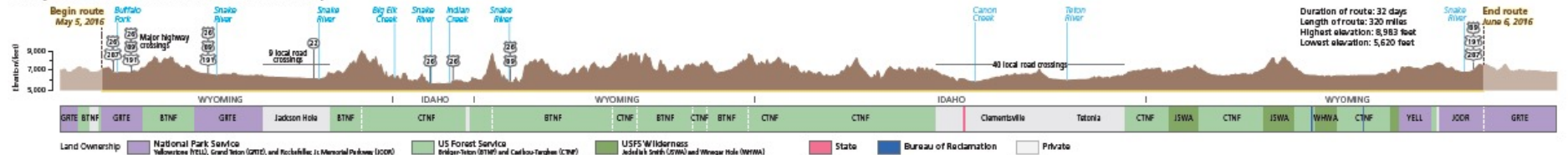


Jim Peaco, NPS

Bear Movement



Grizzly Bear 819 Route, Elevation and Land Ownership



Grizzly bears move around the Greater Yellowstone Ecosystem in ways that can vary daily, seasonally, annually, and throughout their lifetimes. Individual bears may travel long distances to find seasonally available food and mates for breeding, to avoid threats from humans and more dominant bears, and to make use of unexploited habitats.

The size of a bear's home range is affected by a number of factors. Bears living in highly productive landscapes often have much smaller ranges than those in harsher habitats. Grizzly bear population density can also influence a bear's selection of range. Given habitats of similar quality, female bears in areas of high population density tend to have smaller home ranges than those in less populated areas, likely due to competition for space and avoidance of dominant males at foraging sites.

Male grizzly bears typically have larger home ranges than females and make longer passages. Annual home ranges (which vary year to year) of adult males average around 150 square miles and often overlap those of several female bears, thereby enhancing their breeding opportunities. Females' annual home ranges are typically around 60 square miles; subadult females have the smallest

ranges at about 60 square miles. Mothers with cubs tend to have smaller ranges than those accompanied by yearlings. Subadult males have the largest home ranges, averaging nearly 200 square miles—a likely reason for such a large range is to avoid dominant adult males, which sometimes kill subadults.

The size of a female's annual home range usually plateaus at around age six and reaches a lifetime aggregate of nearly 200 square miles. A male's annual home range continues to increase over time and may reach a lifetime total of more than 1,500 square miles.

The movements of four radio-collared grizzly bears in the Greater Yellowstone Ecosystem illustrate these patterns. Female 132 was 18 years old and spent an entire summer within a relatively small portion of Yellowstone National Park, rarely crossing any roads. Eight-year-old female 485 had a summer range of similar size, but it overlapped the boundary between Yellowstone and the Custer Gallatin National Forest; her movements necessitated crossing two major highways.

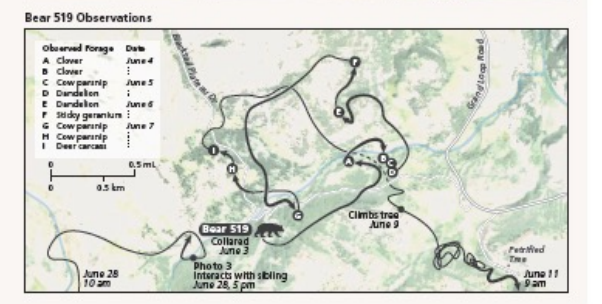
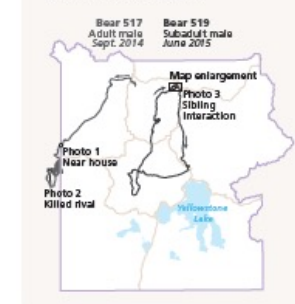
In contrast, 21-year-old male 470, and 6-year-old male 819 traveled considerably farther. Male 470 journeyed across multiple

roads, into three states, and onto habitat managed by various agencies. Male 819 embarked on an even longer odyssey—between May 5 and June 6 he covered approximately 320 miles, crossed 49 local roads and several major highways, and spent time in habitat managed by the Bureau of Reclamation, Bridger-Teton National Forest, and Caribou-Targhee National Forest, as well as by Grand Teton and Yellowstone National Parks.

Because grizzly bears often cover such long distances, and habitat in the Greater Yellowstone Ecosystem is managed by many different state and federal agencies, bears often cross multiple jurisdictional boundaries to procure the food and other resources they need to survive and reproduce. Consequently, these agencies must cooperate for the long-term conservation of grizzly bears, a task made even more challenging in the face of uncertainties such as climate change and expanding human occupation within the Greater Yellowstone Ecosystem.

Black Bear Collar Camera Study

Researchers are using a new tool, GPS camera collars, to document the daily movements and behaviors of black bears in Yellowstone. A camera collar records adult black bear 517 feeding on clover in a residential backyard (photo 1) and later killing and feeding on a rival black bear (photo 2). Subadult black bear 519 interacts with a sibling (photo 3) and navigates the natural hazards of the Greater Yellowstone Ecosystem (grizzly bears, wolves, and dominant adult male black bears) by riding in trees when not on the ground foraging.



Bear Movement



Grizzly and Black Bear Movement

Grizzly bears move around the Greater Yellowstone Ecosystem in ways that can vary daily, seasonally, annually, and throughout their lifetimes. Individual bears may travel long distances to find seasonably available food and mates for breeding, to avoid threats from humans and more dominant bears, and to make use of unexploited habitats.

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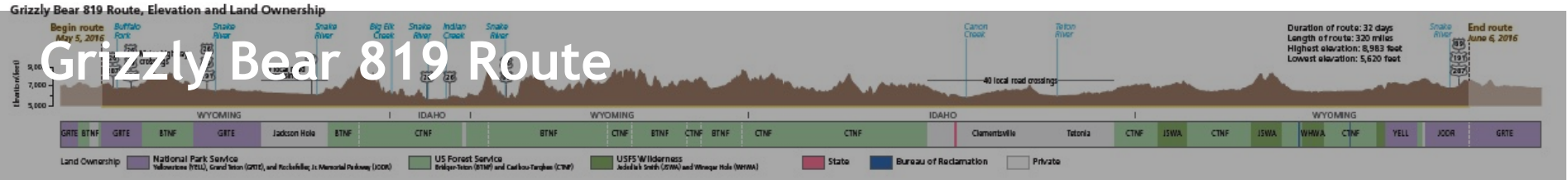
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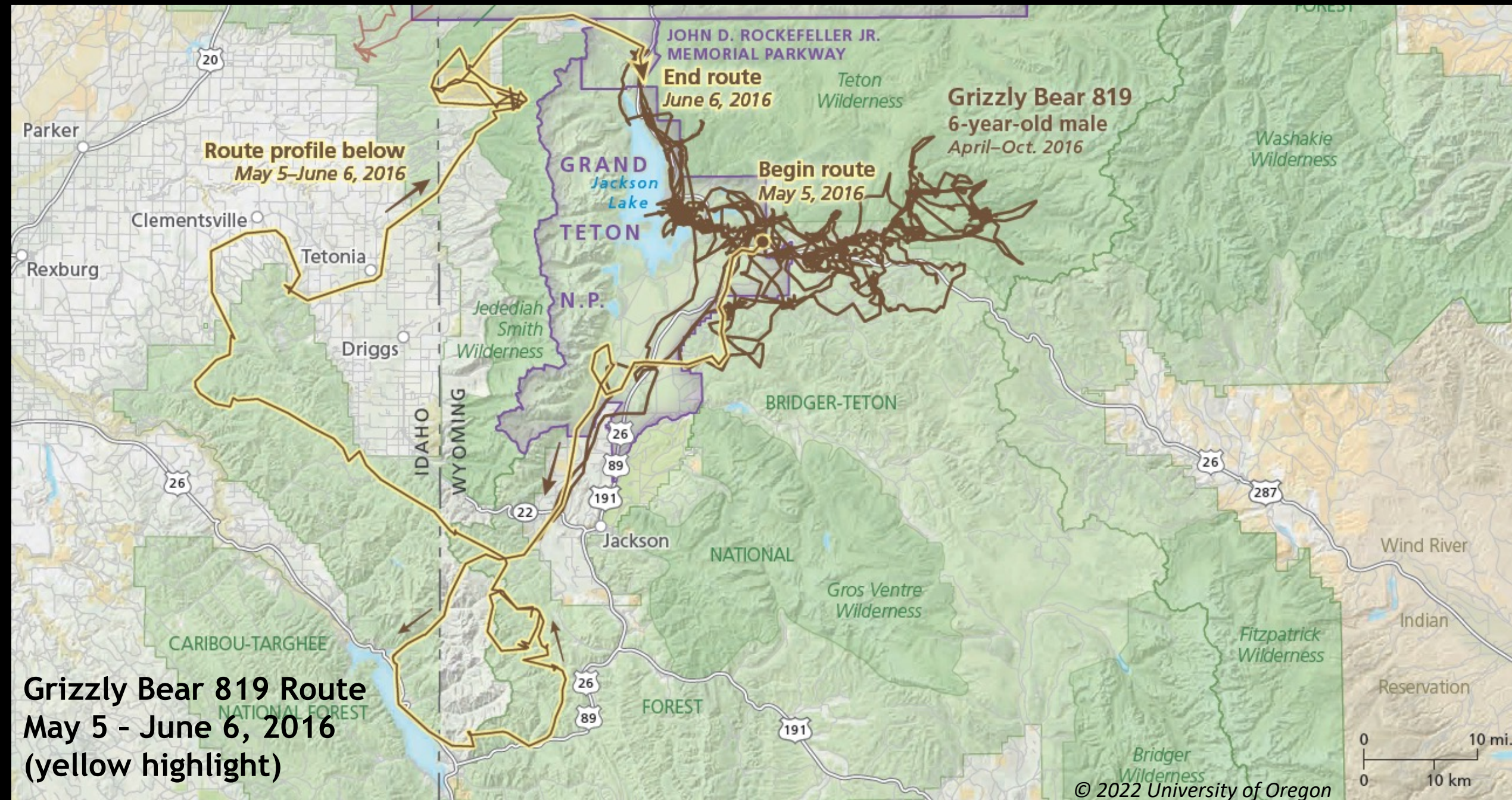
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Grizzly Bear 819 Route



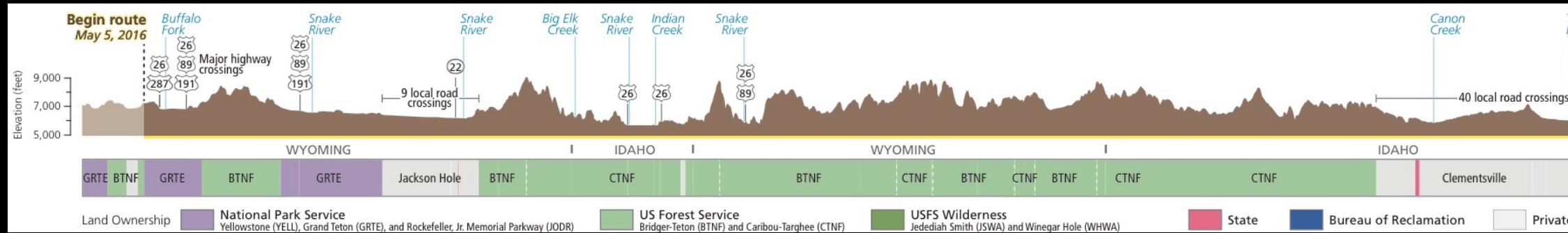
Grizzly Bear 819 Route
May 5 - June 6, 2016
(yellow highlight)

Grizzly Bear 819 Route

May 5 - June 6, 2016

Days: 32 Days
Distance: 320 Miles

Elevation High: 8,983 ft
Elevation Low: 5,620 ft



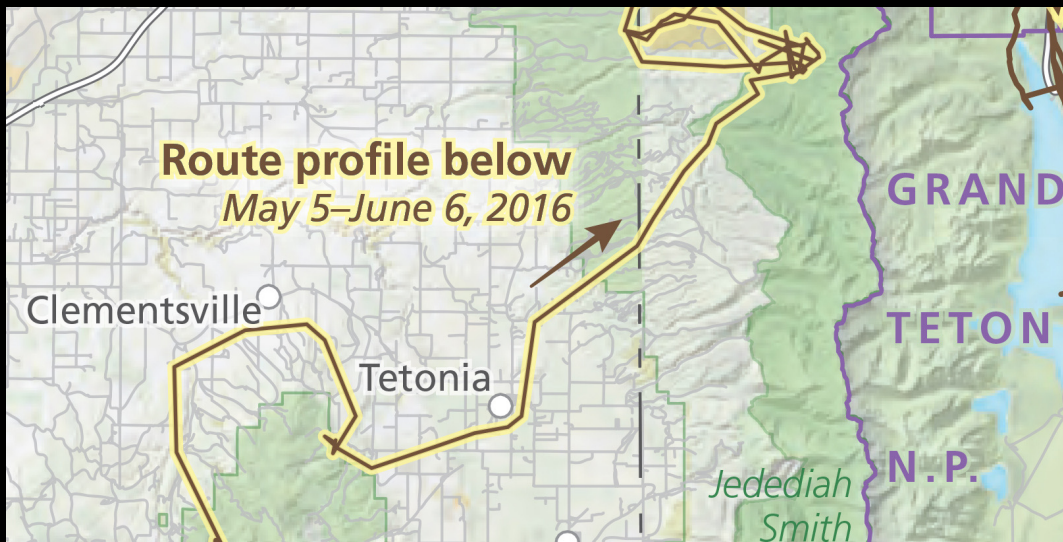
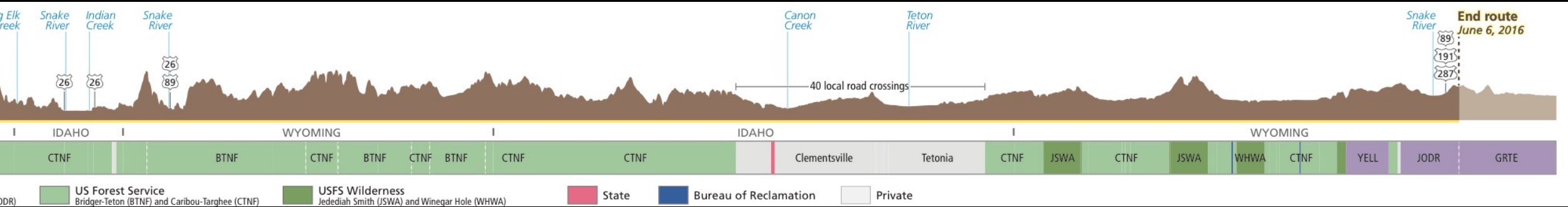
Neil Herbert, NPS

Grizzly Bear 819 Route

May 5 - June 6, 2016

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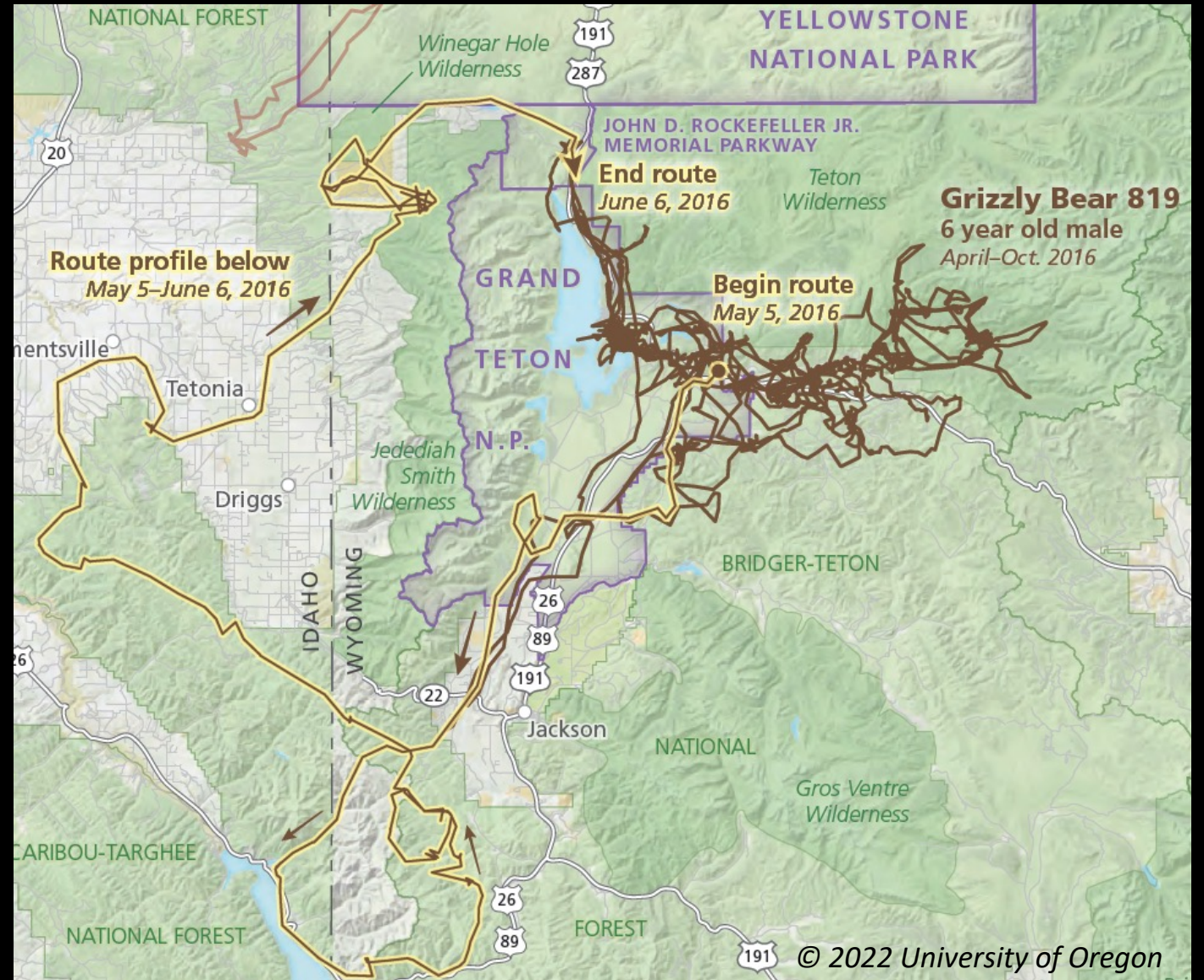
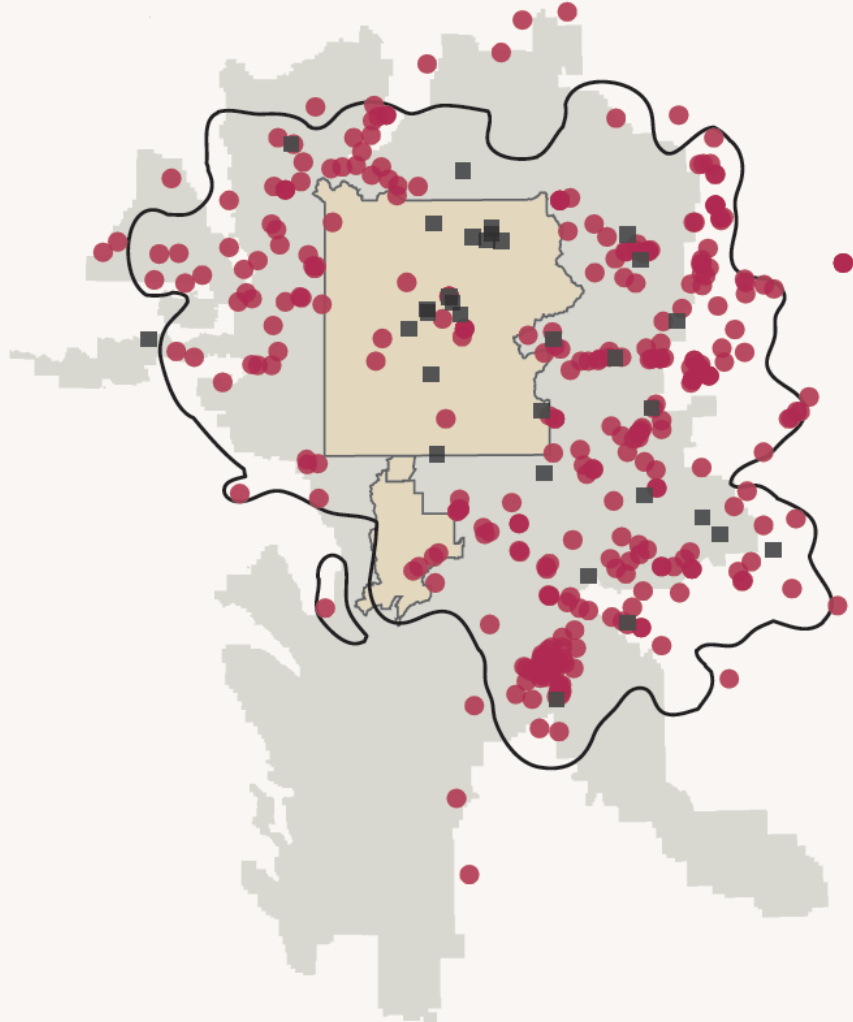
Elevation High: 8,983 ft
Elevation Low: 5,620 ft



Grizzly Bear Mortality

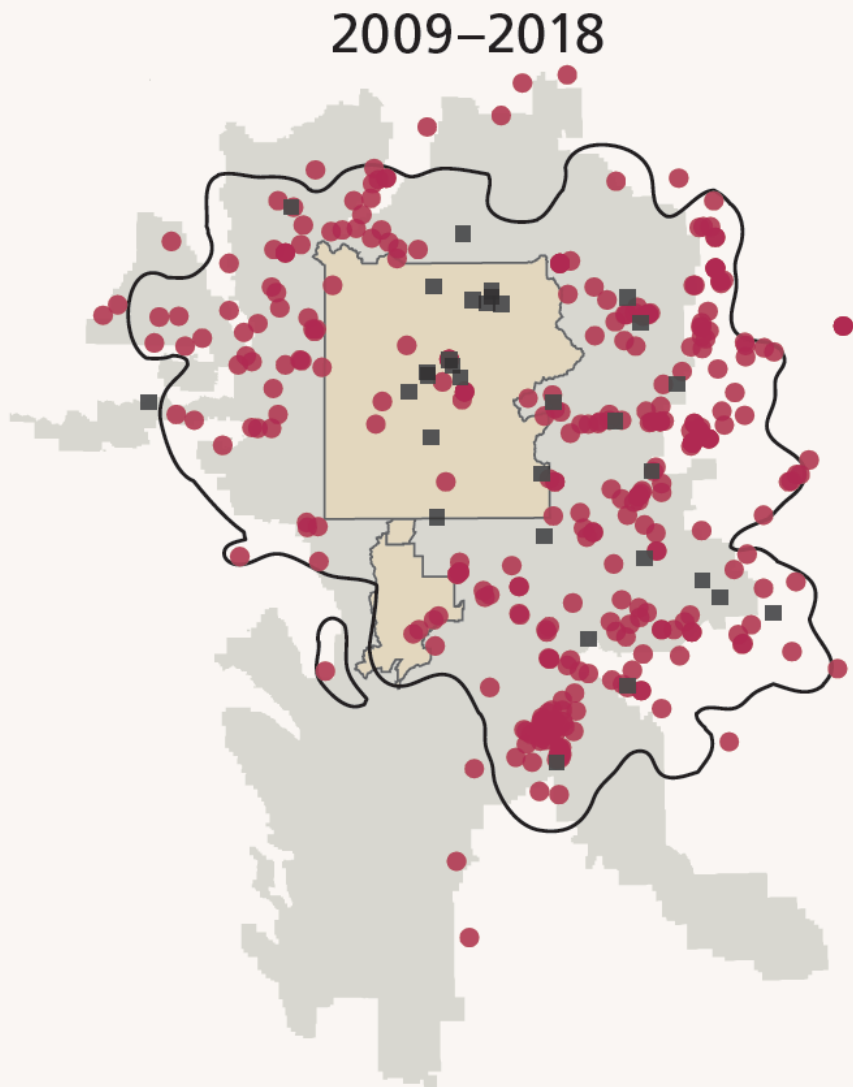
- Natural deaths
- Human-related deaths
- Bear range

2009–2018

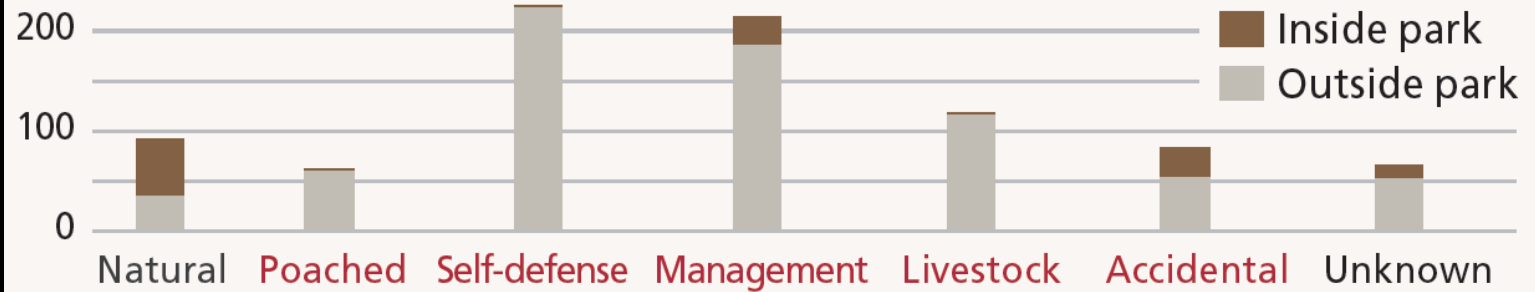


Grizzly Bear Mortality

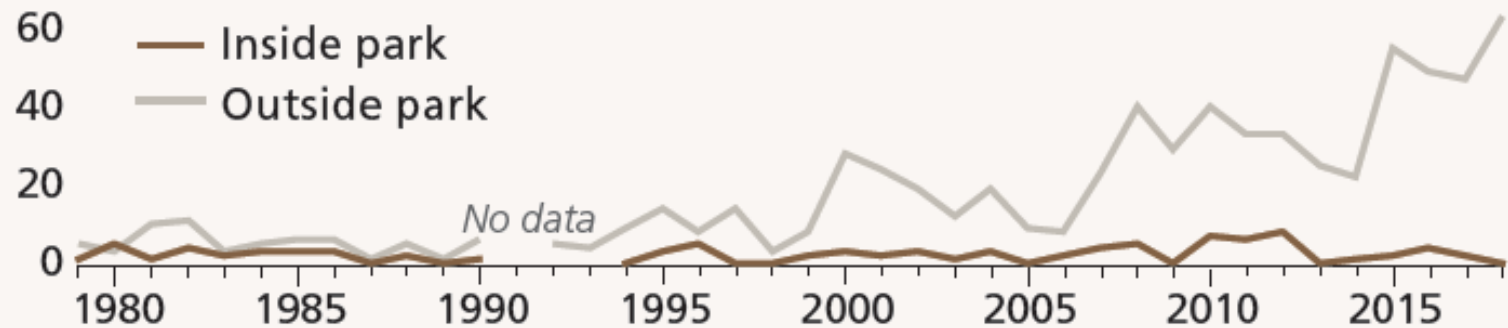
■ Natural deaths ● Human-related deaths ○ Bear range



Cause of Death



Mortality by Year

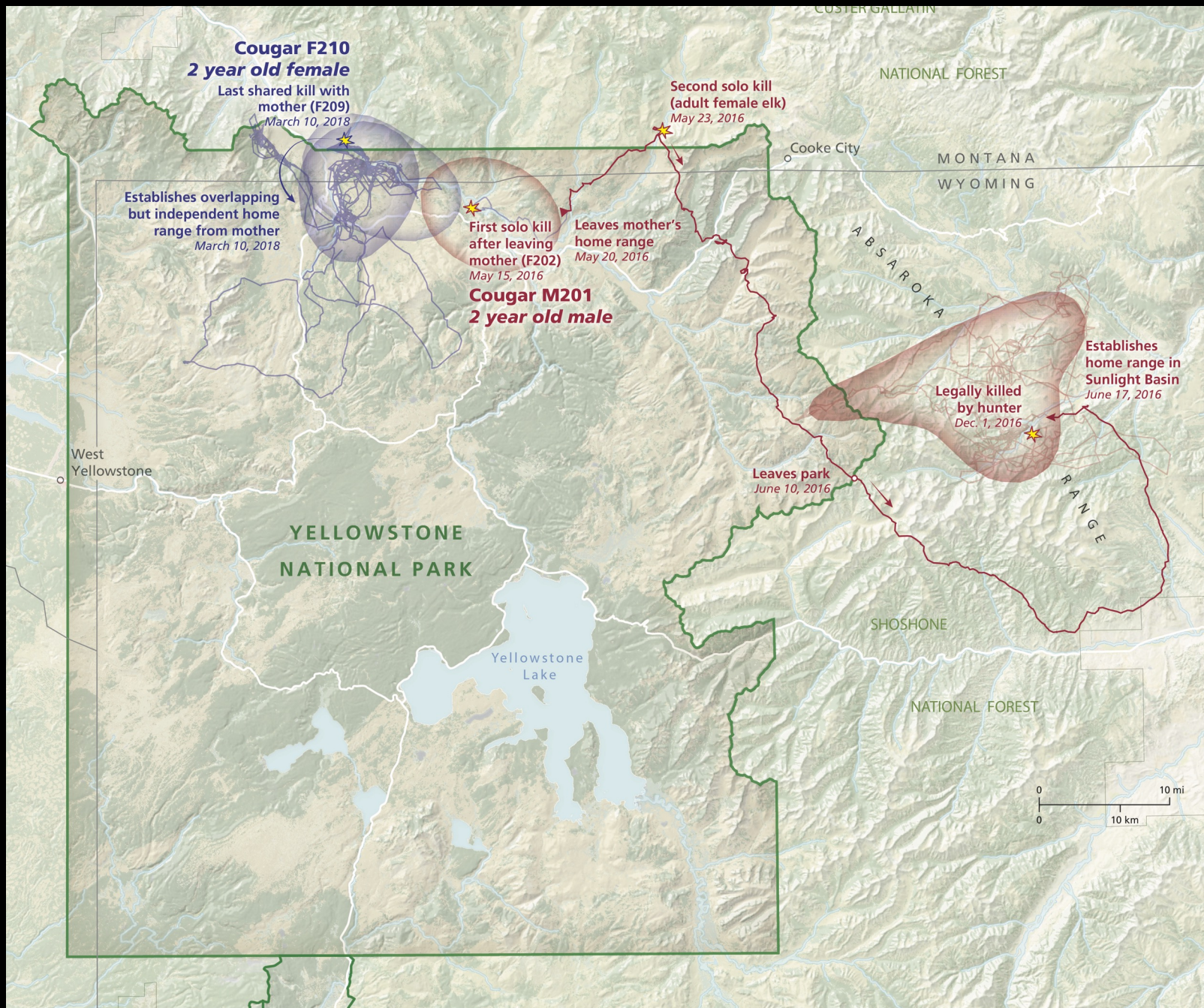


Mapping Yellowstone Cougar



A male cougar stares down from a tree

NPS / Connor Meyer



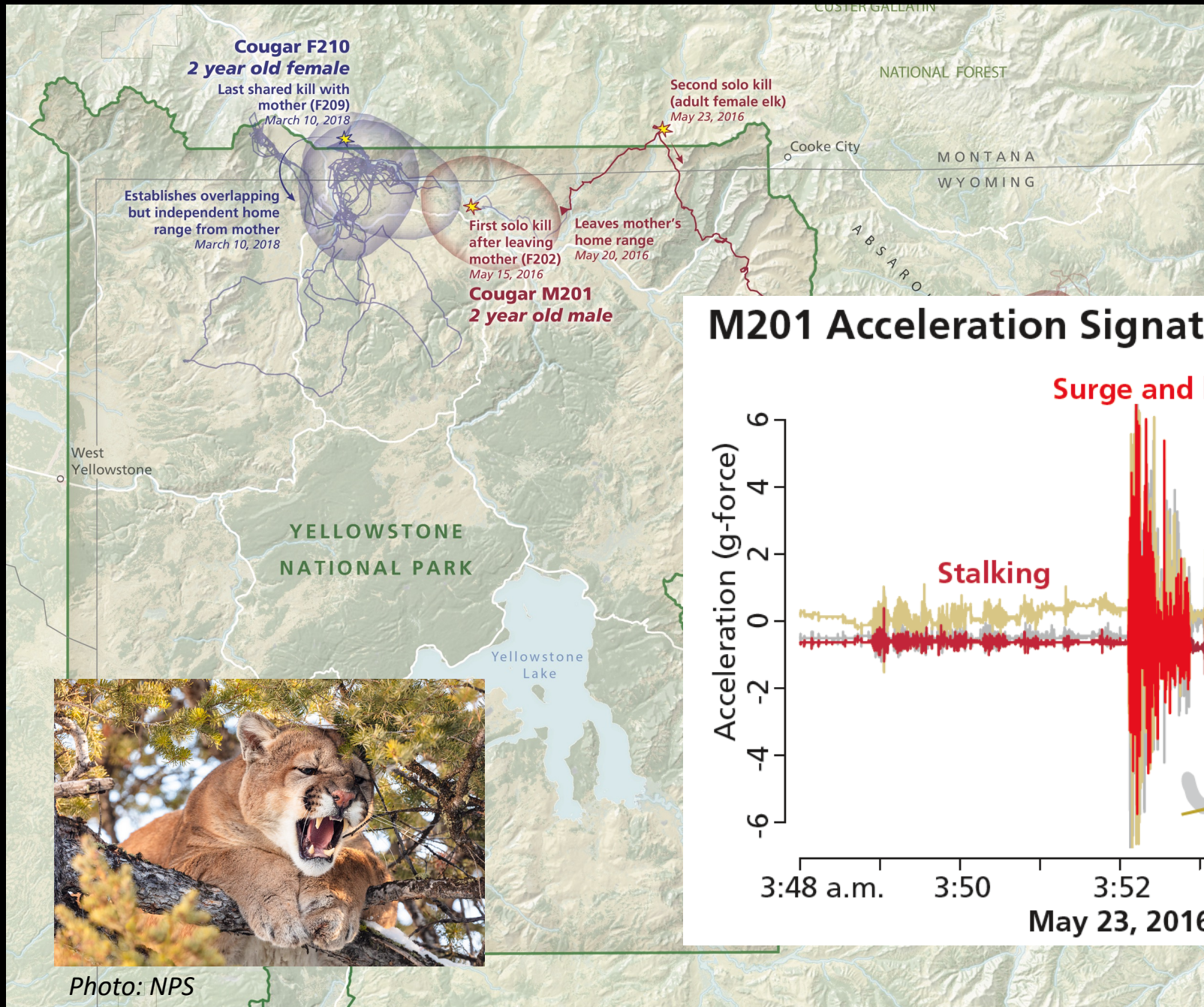
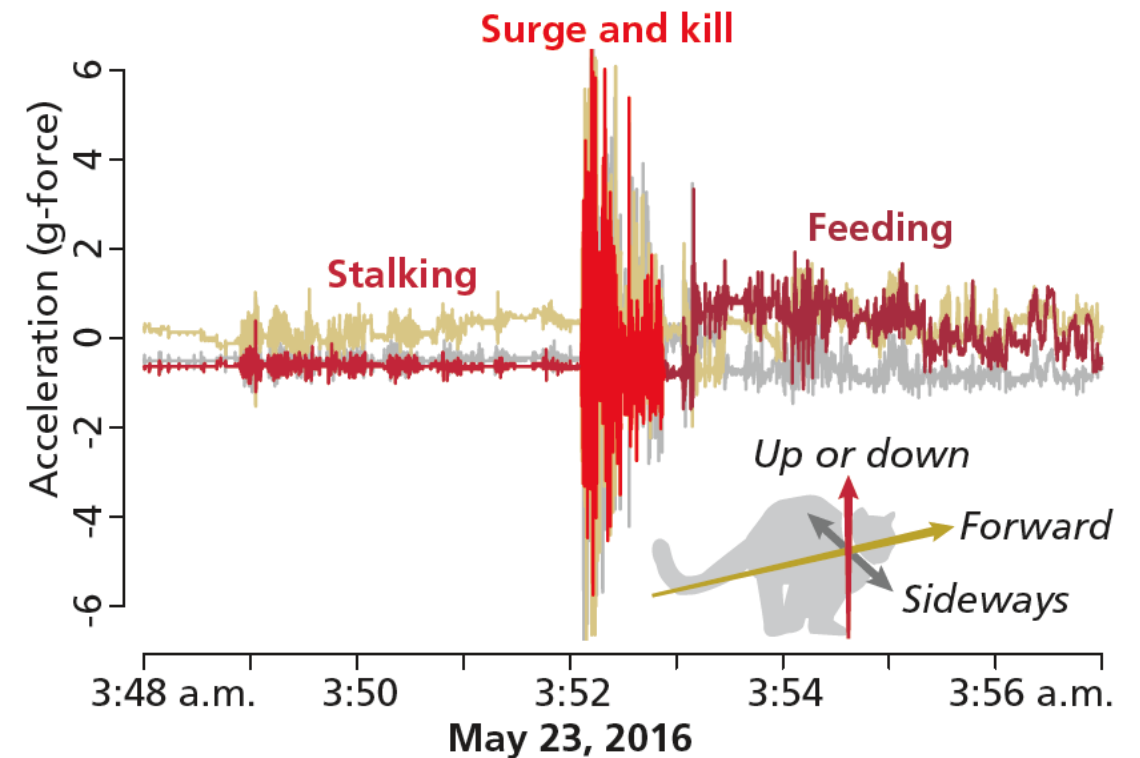


Photo: NPS

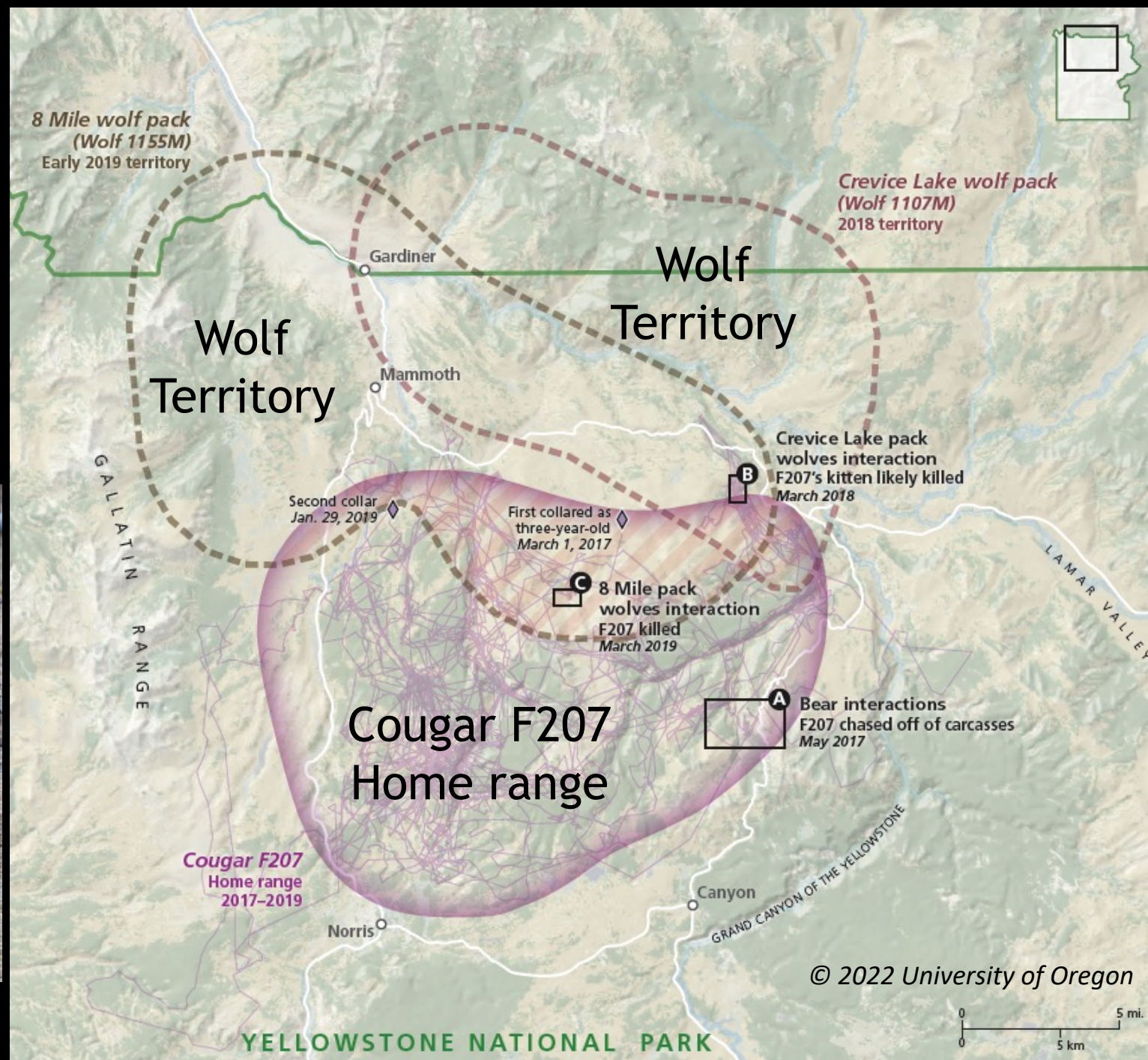
M201 Acceleration Signature During Elk Kill



Cougar F207 Carnivore Interactions



NPS



Cougar Interaction Events Data

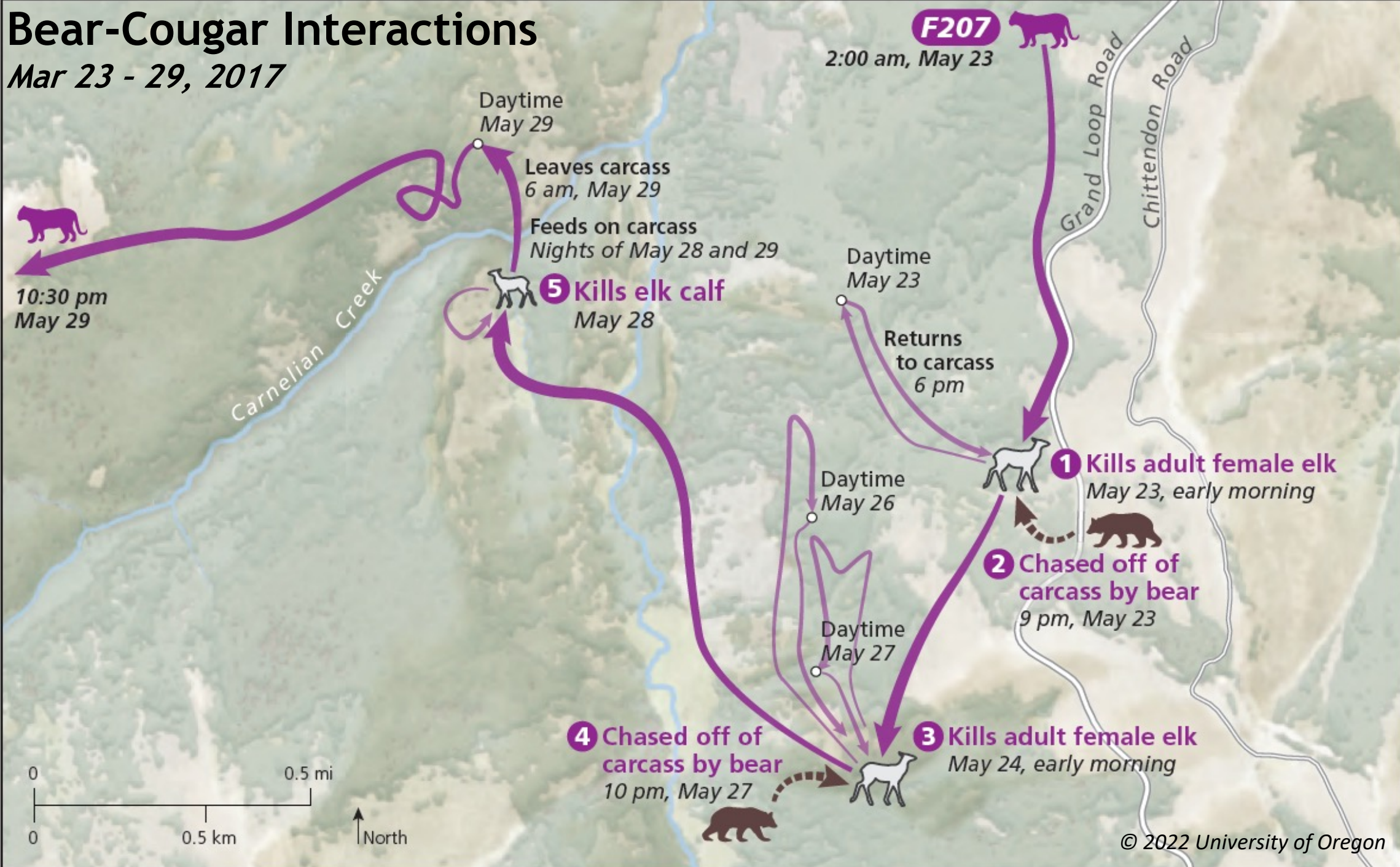


Photo: NPS

B	C	D	E	F	G	H	I	J
Species 1	Species 2	Easting	Northing	Date	Description			
cougar	N/A	536451	4973685	3/1/17	F207 capture location 1			
elk	bear	543463	4963267	5/22/17	kill adult female elk chased off by black bear			
elk	bear	543066	4962345	5/24/17	kill adult female elk chased off by unknown bear species			
elk	N/A	542003	4963783	5/28/17	kill elk calf allowed to feed undisturbed			
elk	wolf	542613	4975381	3/20/18	kill unknown age and sex chased off by wolves killed kitten			
elk	wolf	542405	4975142	3/23/18	kill of yearling male elk chased off by wolves killed kitten			
cougar	N/A	524629	4974187	1/29/19	F207 capture location 2			
elk	wolf	533829	4969485	2/28/19	kill bull elk chased off by wolves 1105M and 1155M of 8 m			
porcupine	wolf	533376	4969691	3/2/19	kill			
cougar	wolf	533695	4969612	3/14/19	death killed by wolves 1105M and 1155M of 8 mile pack			

Bear-Cougar Interactions

Mar 23 - 29, 2017



Wolf-Cougar Interaction

Feb 28 - Mar 14, 2019

Wolf Pack

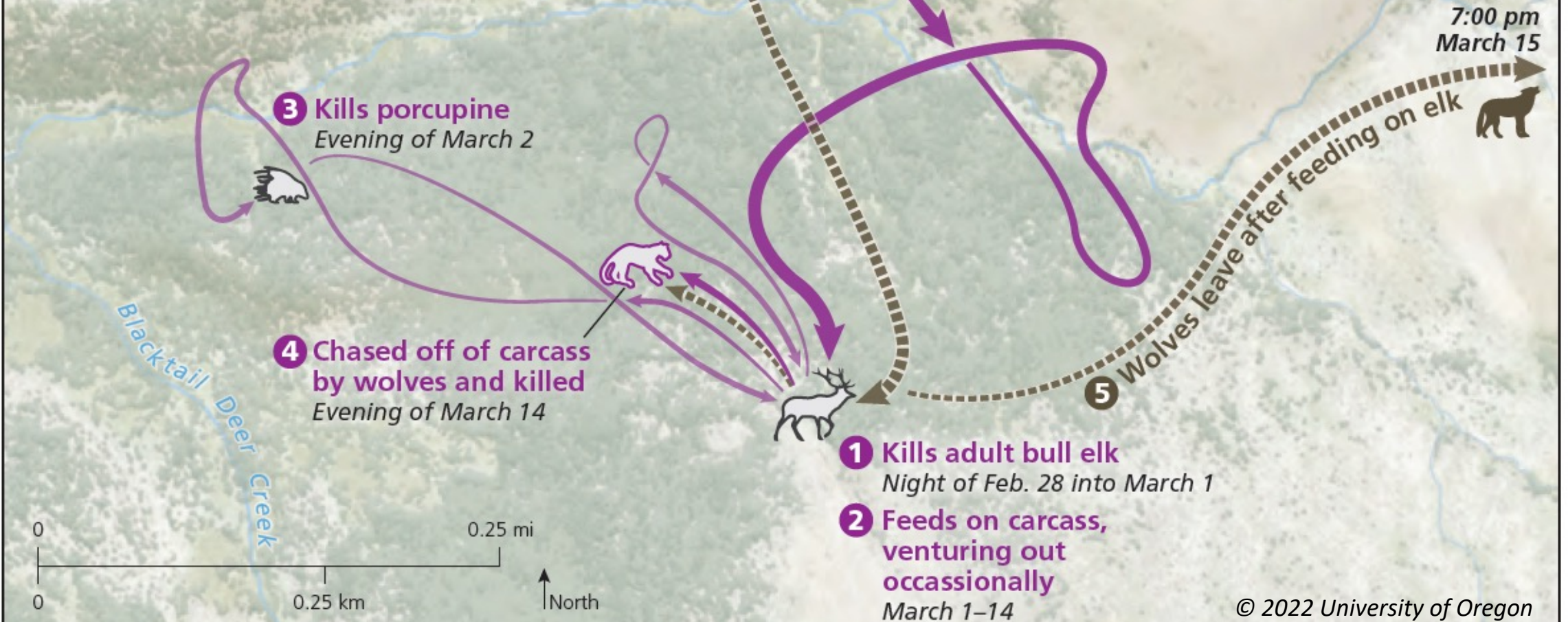


6:30 pm, March 14



F207

7:00 pm, February 28



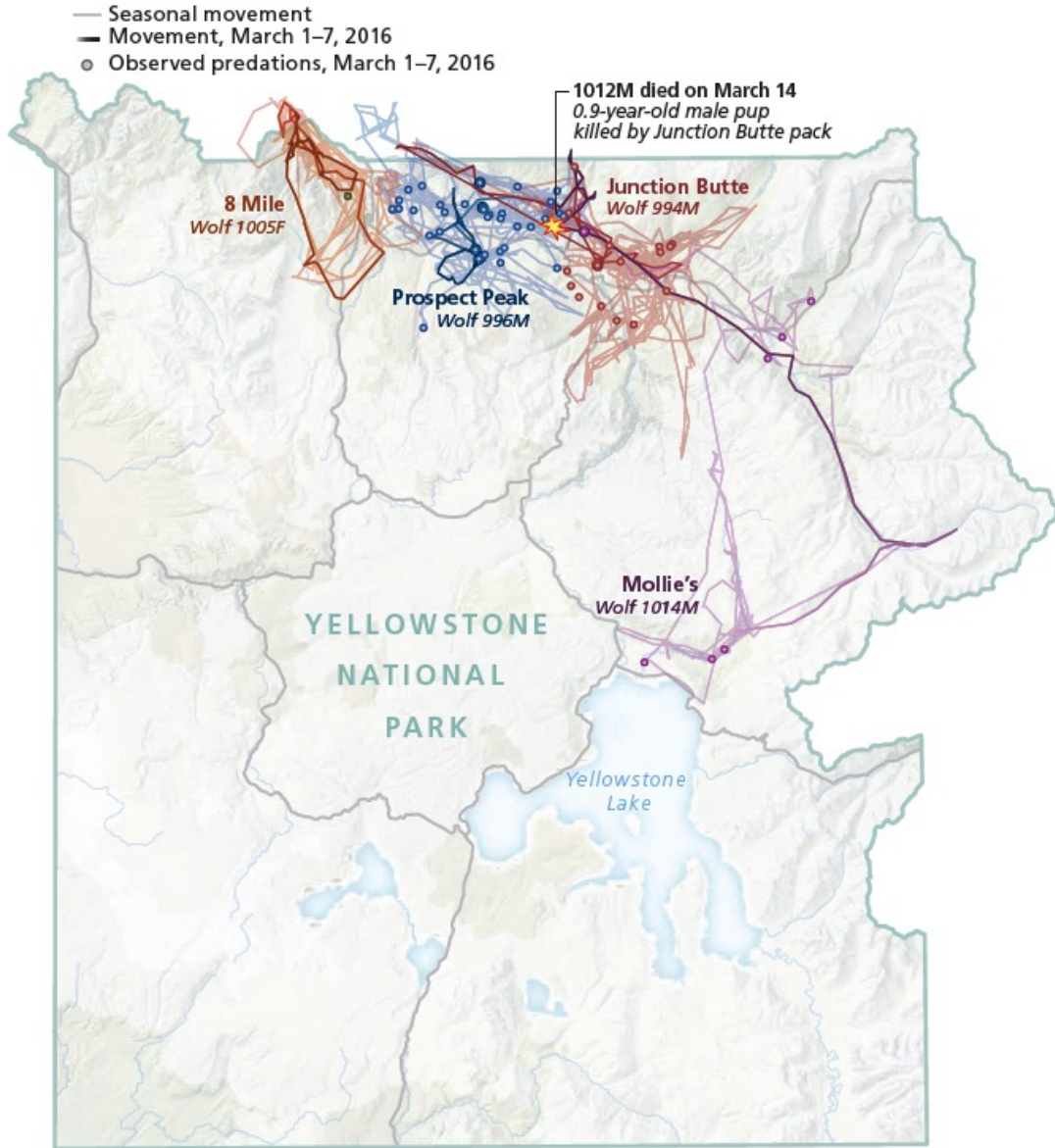
Mapping Yellowstone Wolves

NPS PHOTO - D. STAHLER

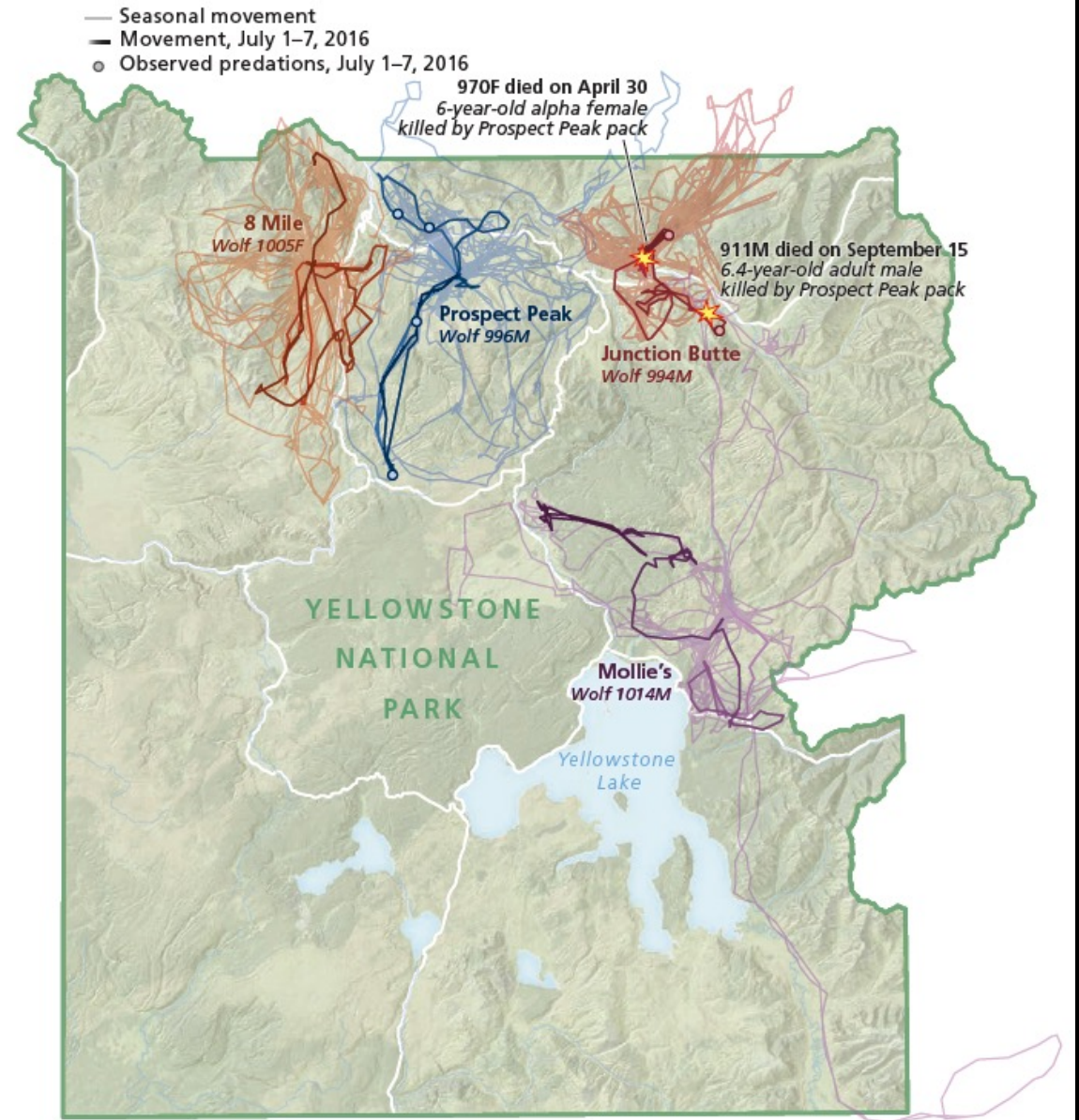


Seasonal Wolf Movement: intraspecies conflict

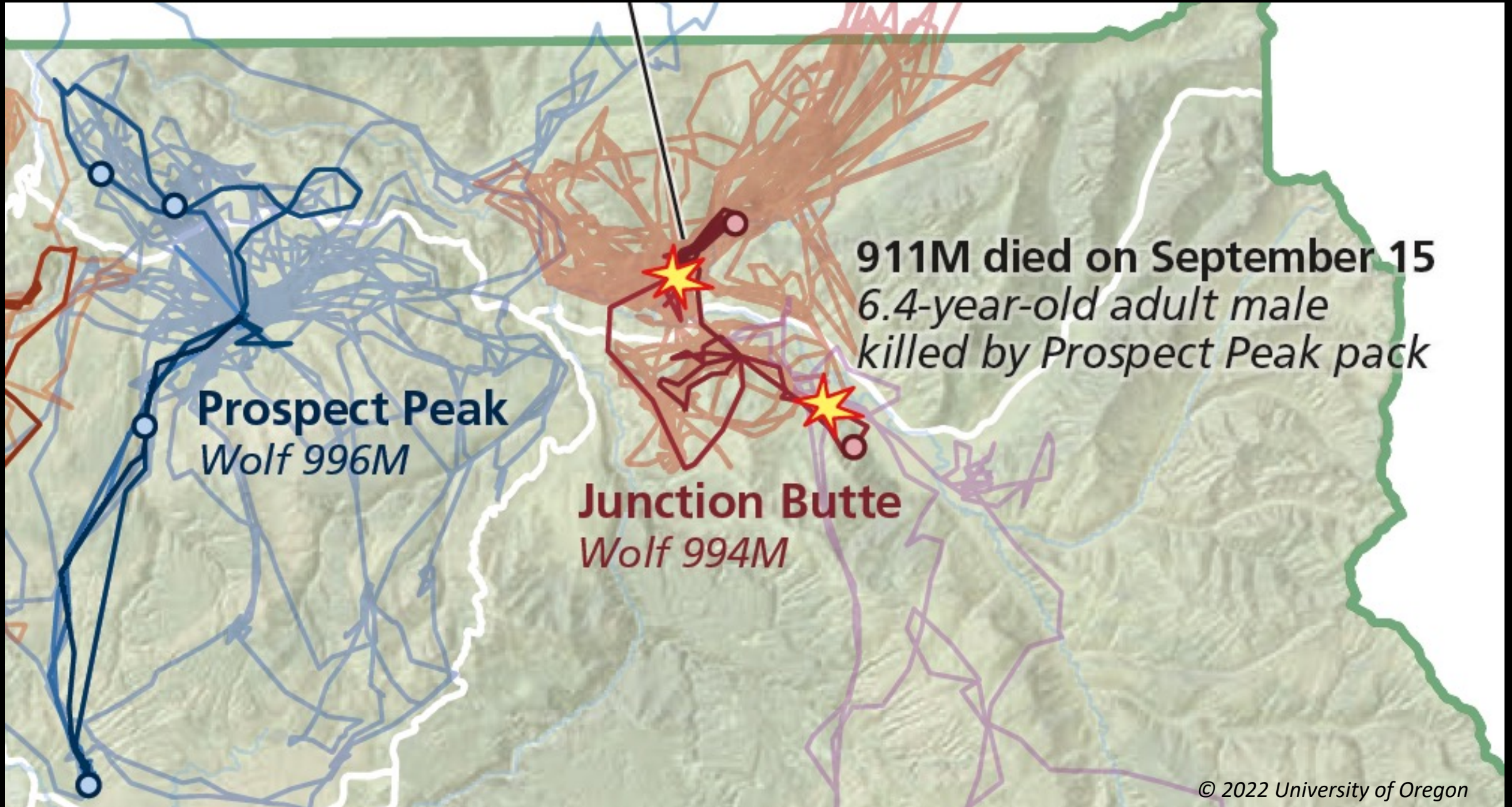
Pack Movements, Winter 2015–2016



Pack Movements, Summer 2016



Intraspecies Conflict - Death of Wolf 911M



Life Story Wolf 911M

Wolf 911M

Every year I sit alone with a wolf. The wolf doesn't agree to this as I catch it as part of a research program on wolves in Yellowstone National Park. The wolf is sedated, but we still sit together, alone, looking out at the great park. The incessant, drowning-out noise of humanity gets turned off. I cherish these moments—the quiet beauty all around, the wolf's presence. It almost seems as if the wolf is talking to me. A look into wolf eyes will make you think very deeply about life.

I have caught so many wolves I cannot remember if I sat alone with 911. For the purposes of this story I will say I did. I also can't remember what those eyes said to me, but I do remember what happened afterward.

He was born in April 2010 to the Blacktail pack with five other pups. If it was a typical litter, several of these pups would have died that first summer. 911 made it though and matured quickly as most wolves do. He left his natal pack, as most males do.

Leaving is risky because dispersing wolves die at a higher rate, but the payoff can be worth it. He found a female and started a new pack called the Junction Butte pack. He led his pack for several years. By all appearances he was a strong leader. He did not lead alone, however, his mate, female 970, co-lead with him, and he likely deferred to her, as most male wolves do.

He bred and lived with 970 for a couple of years. Then she died and their pups did too. This was the beginning of his troubles. Suddenly he began looking bad. It was clear something was wrong.

In poor shape, he still had to hunt for his pack, and he found an elk and attacked it. Why 911, alone and injured, decided to attack this elk, is unknown. Driven by something cons old, he only knew forward—keep fighting. Survive.

Some saw the battle. It was painful to watch. A classic confrontation between predator and prey. Surprisingly, he prevailed.

Then the unthinkable. A rival pack wandered in, eight wolves, they saw the meal, and they saw that only one wolf defended it. They claimed the dead elk then attacked him. Sixty-six minutes after killing the elk alone, he was dead.

As we always do, we hiked in to necropsy his body. It was in terrible shape. The jaw was broken in two and it had been like that for months. I surmised he was kicked by an elk or bison, and that was what led to his decline and death. What would it have been like to live with such an injury? The pain must have been awful. How did he carry on?

So each year I wait, wait for that time I get to sit alone with a wolf. I strain to understand what this life might be like. Those eyes. I have looked into a lot of wolf eyes and think I know some of their stories. When I remember 911, I wonder what story his eyes would have told if I had looked into them on his last day.

Douglas W. Smith
Senior Wildlife Biologist
Yellowstone National Park

911M Movements

Leaving His Birth Pack



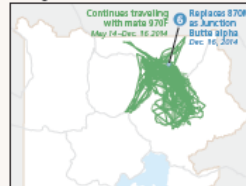
Finding a Group



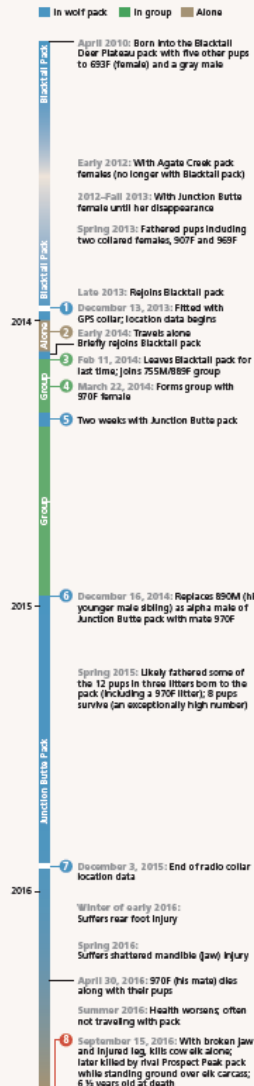
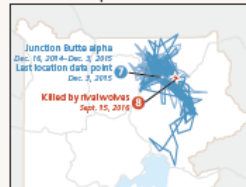
Forming a Group



Finding a Pack

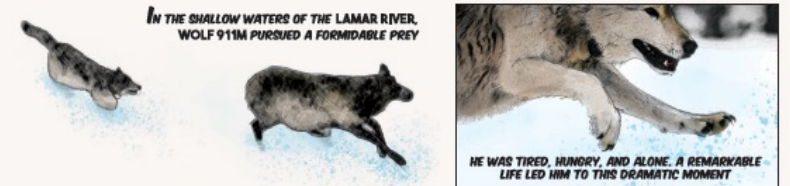


Rise and Fall as Alpha



THE SAGA OF WOLF 911M

IN THE SHALLOW WATERS OF THE LAMAR RIVER, WOLF 911M PURSUED A FORMIDABLE PREY



SIX AND A HALF YEARS PRIOR, 911M WAS BORN INTO A LITTER OF 6 PUPS



HE BEAT THE ODDS TO SURVIVE AND, LIKE MOST MALES, LEFT HIS BIRTH PACK TO STRIKE OUT ON HIS OWN...



EVENTUALLY HE FORMED A BOND WITH 970F THEY LED THE PROMINENT JUNCTION BUTTE PACK TOGETHER FOR SEVERAL SUCCESSFUL YEARS...



THEN HIS MATE, 970F, DIED LEAVING THEIR YOUNG PUPS TO PERISH... THIS MARKED THE BEGINNING OF THE END FOR 911M...



ENDURING MULTIPLE INJURIES INCLUDING A SHATTERED JAW... DROVE HIM TO THE DESPERATE STANDOFF WITH A HEALTHY ADULT ELK



WOLF 911M DISPLAYED UNBELIEVABLE SKILL AND GRIT... UNBELIEVABLY HE SUCCEEDED!



HIS WET FUR REVEALED HIS STARVED, BROKEN CONDITION



BUT THERE WOULD BE NO REST FOR THE WEARY WOLF THE RIVAL PROSPECT PEAK PACK LOOKED ON—IMPRESSED, BUT UNSYMPATHETIC, THEY SAW A MEAL...

IN AN ACT OF DEFIANT COURAGE, 911M STOOD BETWEEN THE PACK AND HIS KILL—HE DIDN'T HAVE A CHANCE...



SUCH IS THE UNFORGIVING LIFE OF A WOLF—ONE OF PAIN AND HARDSHIP, ONE HARD-FOUGHT AND OF SHORT-LIVED TRIUMPHS BUT, ABOVE ALL, ONE WILD AND FREE



Illustrations and text by Justin Menke. Source photos for illustrations (in story order): 1. NPS / Doug Smith, 2. NPS / Barry O'Neill, 3. NPS / Dan Stahler, 4. Bradley Orsted, 5. Doug McLaughlin, 6. NPS / Dan Stahler, 7. Craig Whitman, 8. NPS / Dan Stahler, 9. Doug McLaughlin, 10. NPS / Jacob W. Frank, 11. NPS / Jacob W. Frank.

Doug Smith, NPS Biologist



NPS

**SIX AND A HALF YEARS PRIOR, 911M
WAS BORN INTO A LITTER OF 6 PUPS**



Leaving His Birth Pack



■ In wolf pack
 ■ In group
 ■ Alone

April 2010: Born into the Blacktail Deer Plateau pack with five other pups to 693F (female) and a gray male

Early 2012: With Agate Creek pack females (no longer with Blacktail pack)

2012–Fall 2013: With Junction Butte female until her disappearance

Spring 2013: Fathered pups including two collared females, 907F and 969F

Late 2013: Rejoins Blacktail pack

2014 — **1** **December 13, 2013:** Fitted with GPS collar; location data begins
 — **2** **Early 2014:** Travels alone Briefly rejoins Blacktail pack

**HE BEAT THE ODDS TO SURVIVE
AND, LIKE MOST MALES, LEFT HIS BIRTH PACK TO STRIKE OUT ON HIS OWN...**



**EVENTUALLY HE FORMED A BOND WITH 97 OF
THEY LED THE PROMINENT JUNCTION BUTTE PACK
TOGETHER FOR SEVERAL
SUCCESSFUL YEARS...**



HIS WET FUR REVEALED HIS STARVED, BROKEN CONDITION



2016

7 December 3, 2015: End of radio collar location data

Winter of early 2016:
Suffers rear foot injury

Spring 2016:
Suffers shattered mandible (jaw) injury

April 30, 2016: 970F (his mate) dies
along with their pups

Summer 2016: Health worsens; often
not traveling with pack

***IN THE SHALLOW WATERS OF THE LAMAR RIVER,
WOLF 911M PURSUED A FORMIDABLE PREY***

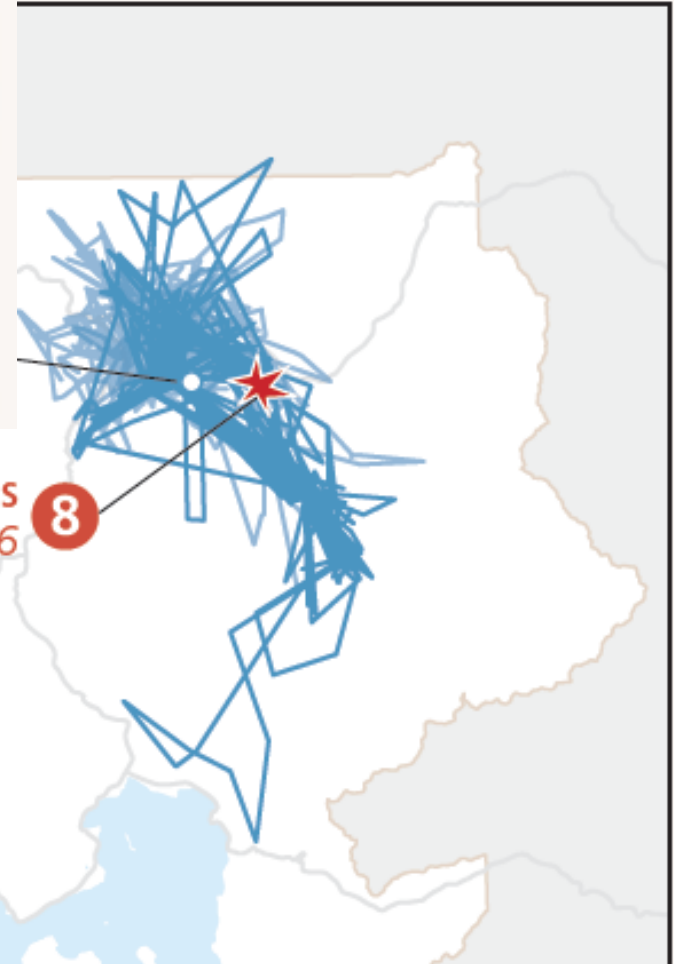


**WOLF 911M DISPLAYED
INCREDIBLE SKILL AND GRIT...**

**UNBELIEVABLY HE
SUCCEEDED!**



THIS WAS HIS FINAL STAND



Thank you



Jim Meacham
jmeacham@uoregon.edu