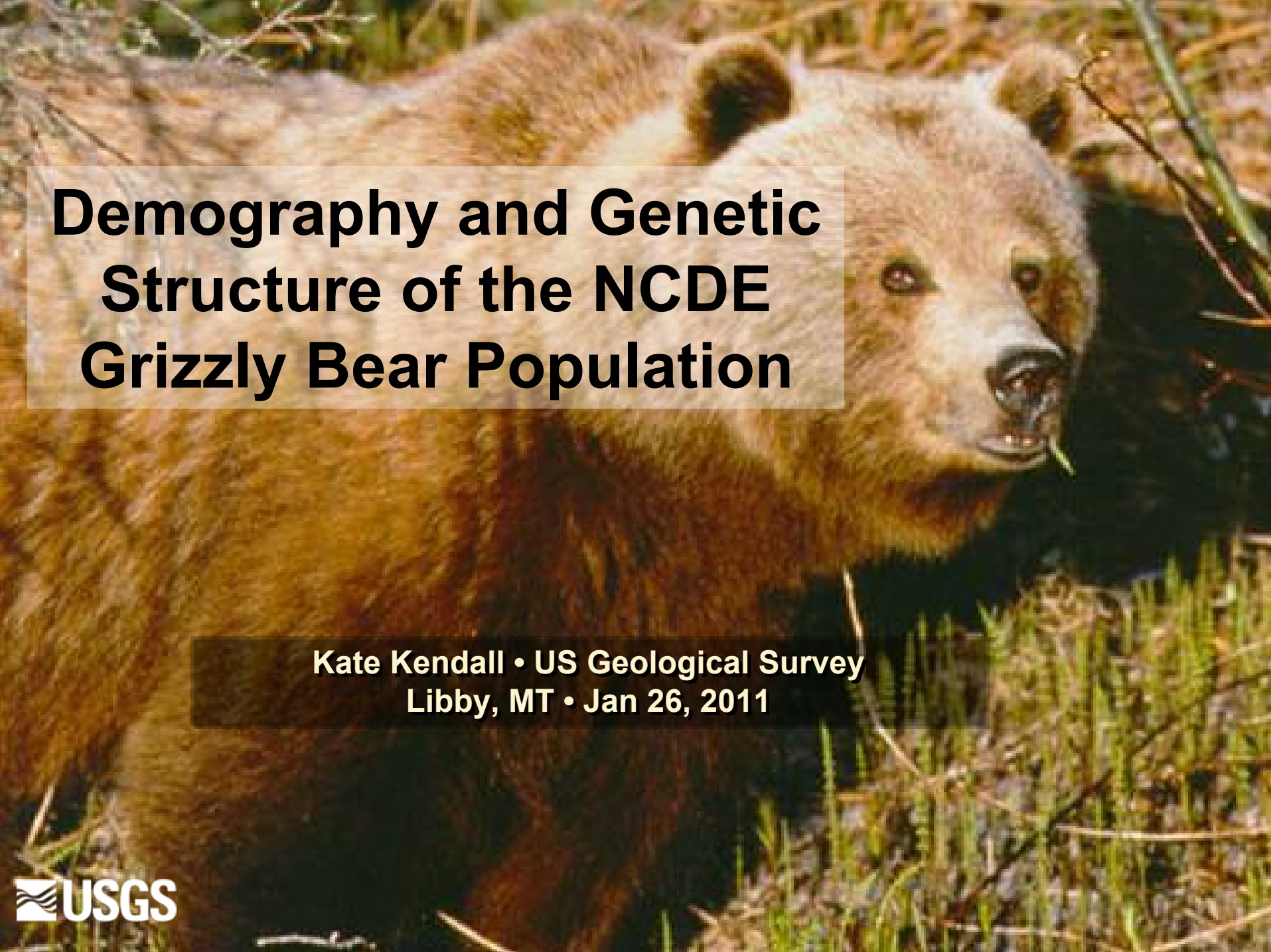
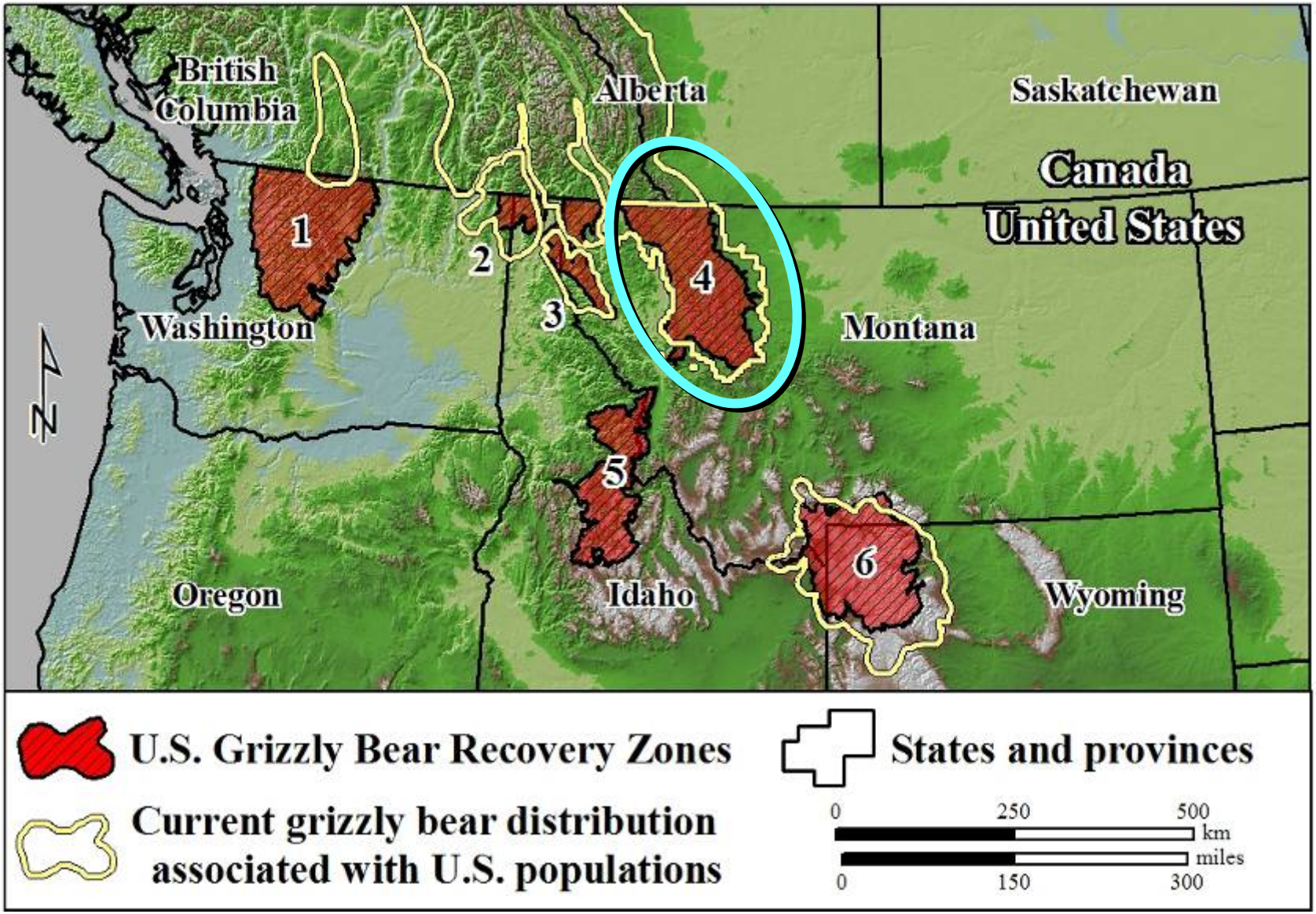


Demography and Genetic Structure of the NCDE Grizzly Bear Population

Kate Kendall • US Geological Survey
Libby, MT • Jan 26, 2011

USGS

GRIZZLY BEAR RECOVERY ZONES



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NEED FOR INFORMATION

- No baseline data
- Range appeared to have expanded
- Mortality thresholds exceeded
- Status unclear

OBJECTIVES

- Population size
- Distribution
- Genetic structure

APPROACH

- Hair snaring
- Genetic analysis
- Mark-recapture modeling

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NORTHERN DIVIDE PROJECT STUDY AREA

- **Size = 31,400 km^2**
  = 80% Switzerland

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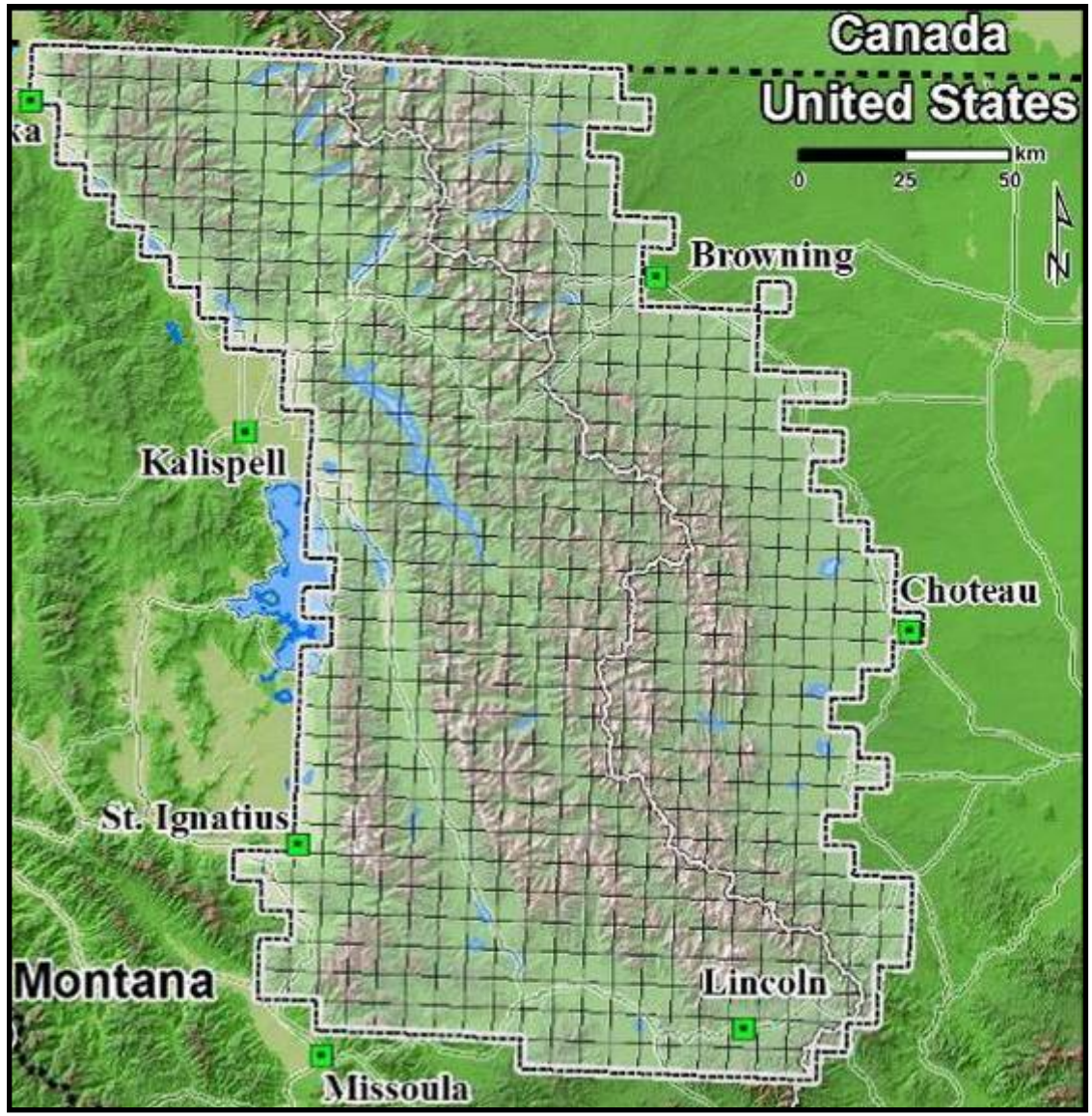
HAIR TRAP SAMPLING

- 100 ft (30 m) barbed wire
- Baited w/ scent lure

DISTRIBUTION OF HAIR SAMPLING

- Grid : 7 x 7 km
- Cells: 641
- 4 14-day sample sessions



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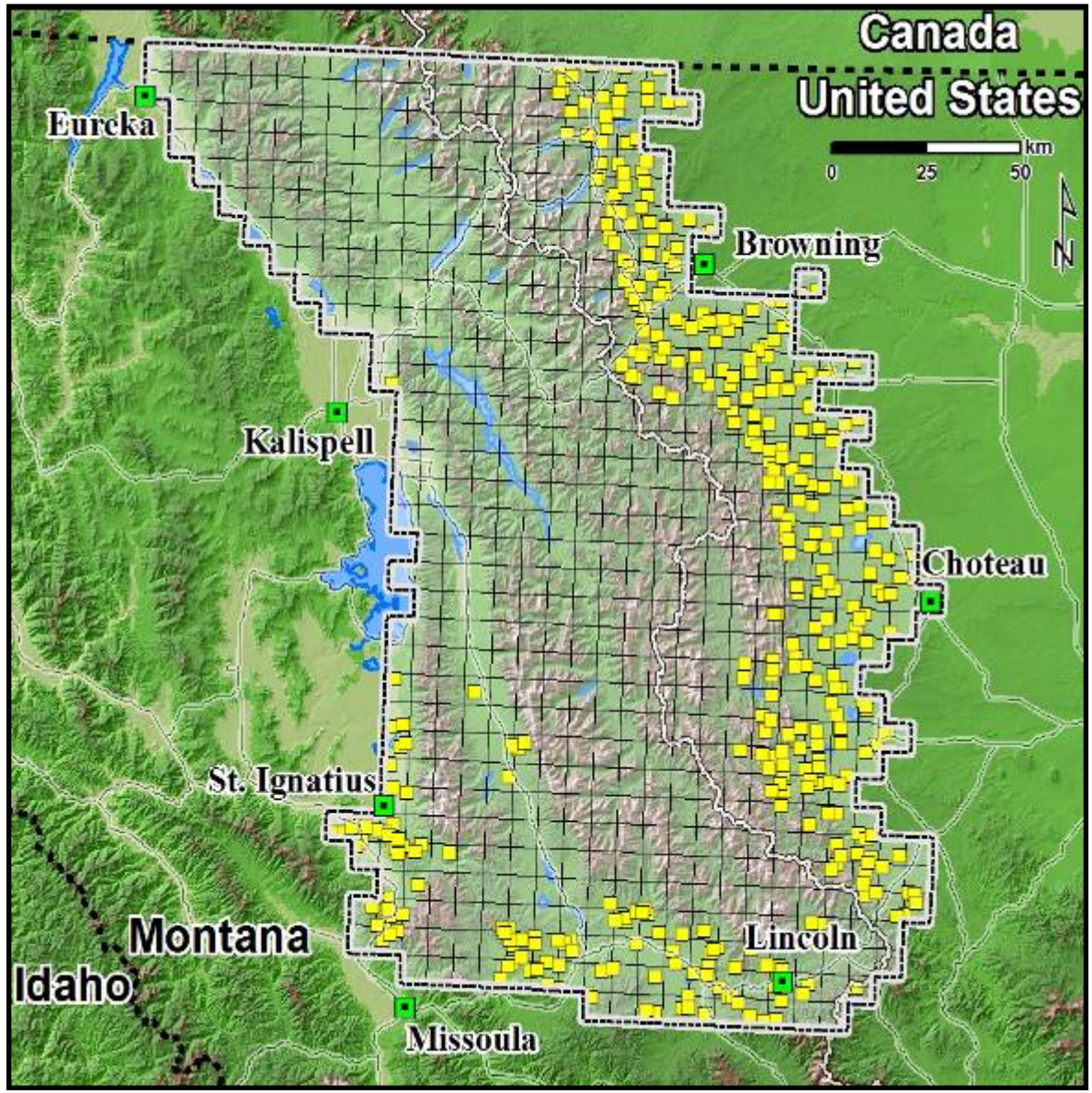
CATTLE EXCLUSION FENCES

- 440 fences built around hair traps



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BEAR RUB SURVEYS

- Trees, power poles, sign posts
- Natural rubs; no bait
- Barbed wire used for better hair samples

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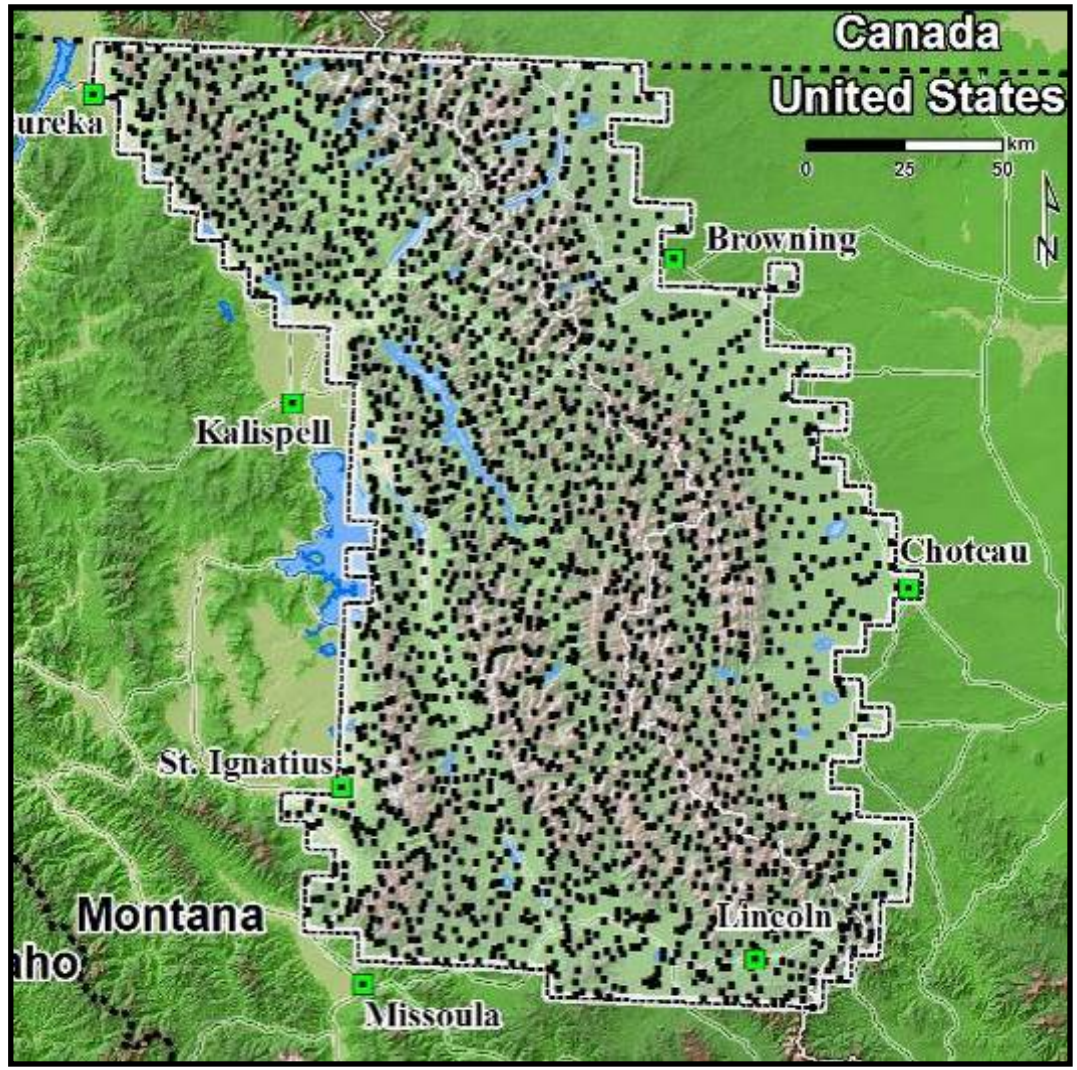
HAIR TRAP RESULTS

During 14-weeks

- **Hair traps: 2,558**
- **Bear hair samples: 20,785**



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BEAR RUB RESULTS

- **Rubs sampled: 4,795**
- **Each visited *x* = 3.8**
- **Bear hair samples: 12,956**

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2004 FIELD RESULTS

Total Bear Hair Samples:
~34,000

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GENETIC ANALYSIS QUALITY CONTROL

- Positive and negative controls on all runs
- All gender tests run 2x
- Reanalyze similar genotypes
  - All 1 and 2 MM pairs
  - 3 MM pairs consistent with allelic dropout

GENETIC ANALYSIS: BLIND SAMPLE TEST

Samples analyzed: 861
Genotypes correct: 100%

- Samples from 32 individual grizzlies
- From NCDE mgmt & research bears
- Closely related groups
- Mixed samples: hair from ≥ 1 bear

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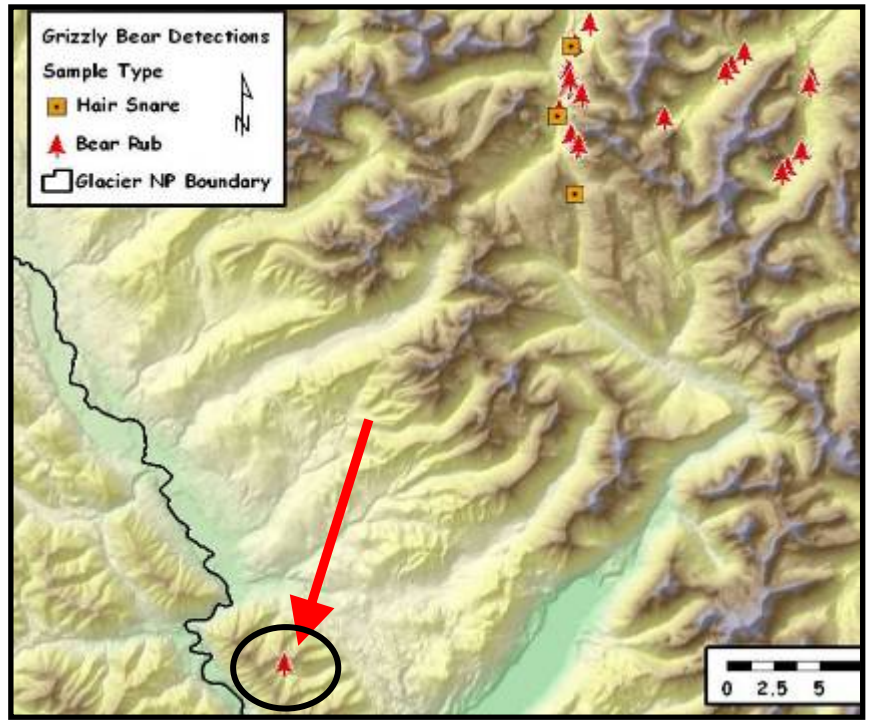
GENETIC ANALYSIS QUALITY CONTROL

- Scrutinize data spatially to identify outliers for reanalysis
- Add genetic results directly to field database via scanned bar code
- Confirm all 7-locus genotypes with independent 9-locus genotypes***



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GENETIC ANALYSIS QUALITY CONTROL

- Independent review:
  - Design
  - Field
  - Genetic analysis
  - Data entry/exchange

- Concluded that study represents the state-of-the-art for NGS wildlife research
- No potential for systematic error
- Conservative <1% individual ID error rate

GRIZZLY BEARS DETECTED

DNA minimum count	**545**
Mgmt bears not detected in DNA	**18**
TOTAL minimum on grid Jun 15–Sep 15	**563**

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Population Modeling

- Consulted with experts on modeling
- Huggins-Pledger mixture closed estimation model permits use of individual, group, temporal covariates
- Use handled/mgmt bear data to extend encounter histories
  - Bears on grid during sampling period
  - Histories include bears handled due to conflicts, research, mortalities
  - Increase minimum count, sample coverage, estimate precision

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2004 GRIZZLY BEAR POPULATION SIZE

	Estimate	SE	CV	95% Confidence Interval	
				Lower	Upper
Male	294.6	12.01	4.1%	276	324
Female	470.6	26.16	5.6%	427	531
TOTAL	**765.2**	**29.27**	**3.8%**	**715**	**831**

Factors Contributing to Estimate Precision

- Multiple data sources increased sample coverage
  - hair trap sessions
  - bear rub surveys
  - handled bears
- Models that include individual, group and temporal covariates and ≥ 2 capture probabilities (mixture model)
- Large scale of project → larger sample sizes

BEAR DETECTION RATE BY AGE-CLASS

	Total # Available (% Caught DNA)	# Females Available (% Caught DNA)	# Males Available (% Caught DNA)
Cub	16 (44%)	11 (36%)	5 (60%)
Yearling	15 (80%)	7 (100%)	8 (63%)
Subadult	31 (68%)	11 (55%)	20 (75%)
Adult	214 (91%)	118 (89%)	96 (94%)
Total	276 (85%)	147 (83%)	129 (88%)

- Based on known age bears from mgmt records
- Sampled with: Hair corral wire at 50 cm
  Rub tree wire ≥ 70 cm

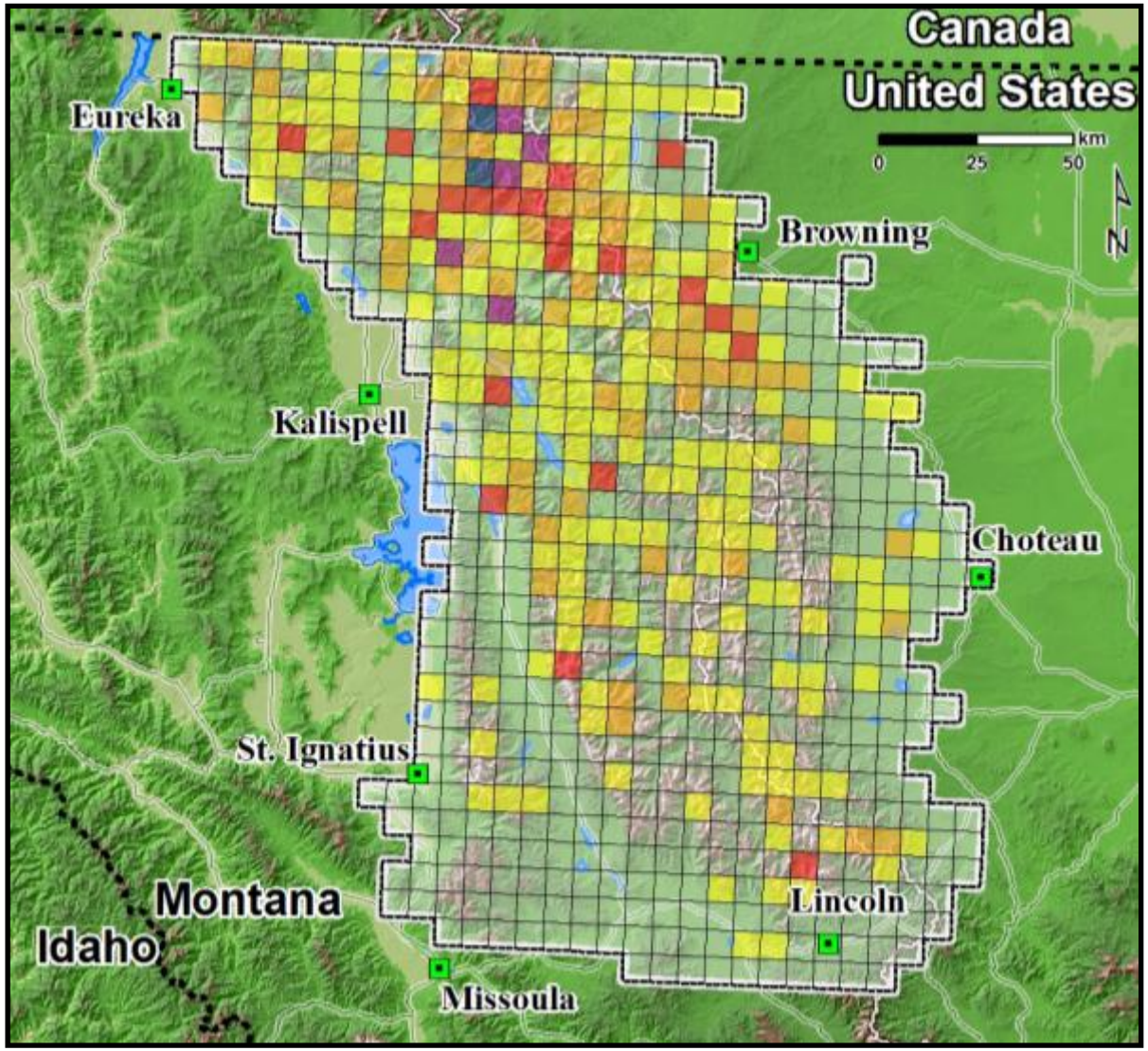
RELATIVE BEAR DENSITY

- **Based on hair trap detections only**

Average number of grizzly bears

per hair trap, per 7x7km cell

0	1.25 - 1.75
0.17 - 0.5	2.00 - 2.5
0.60 - 1.0	2.75 - 3.0



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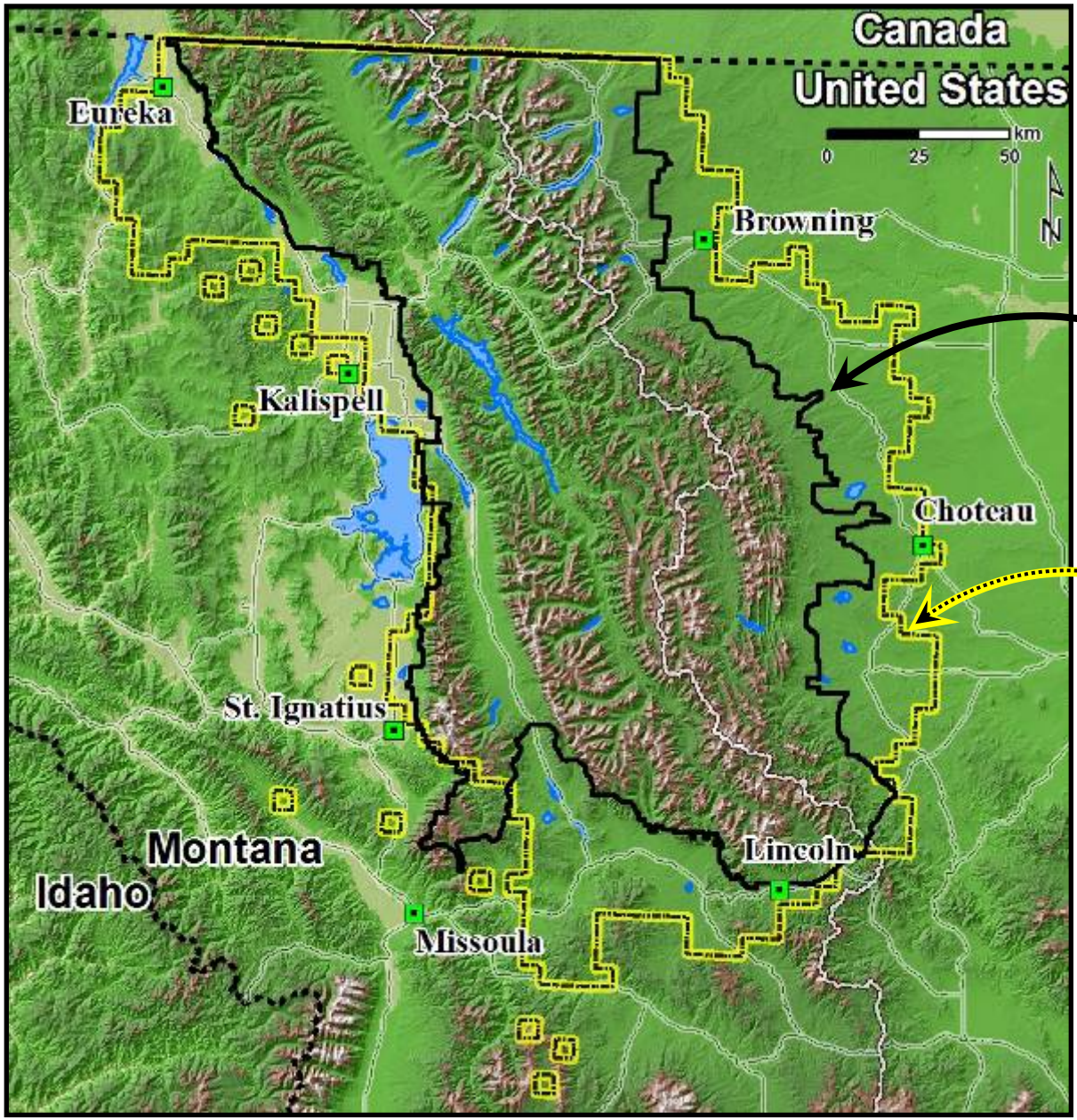
OCCUPIED RANGE

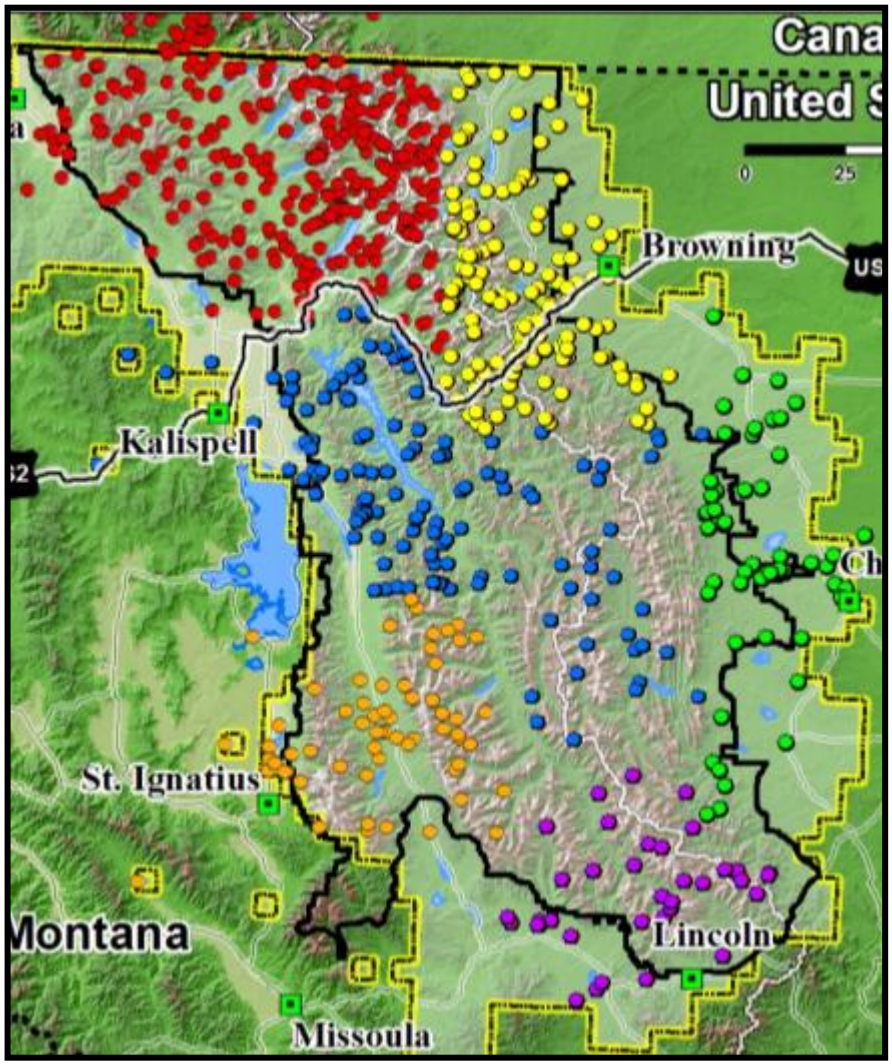


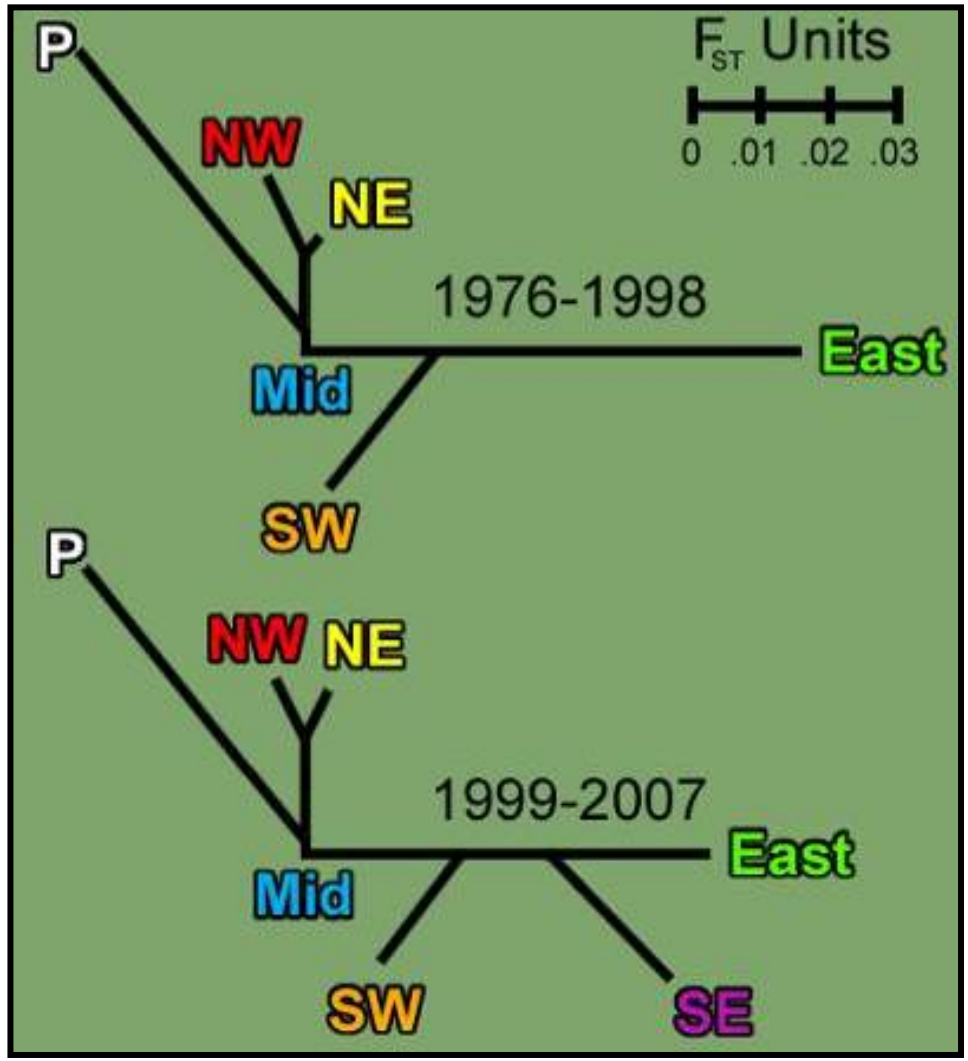
Recovery Zone = 23,000 km^2

1994 - 2007

Occupied Range = 36,000 km^2

CHANGE IN GENETIC STRUCTURE
1976-1998 vs 1999-2007





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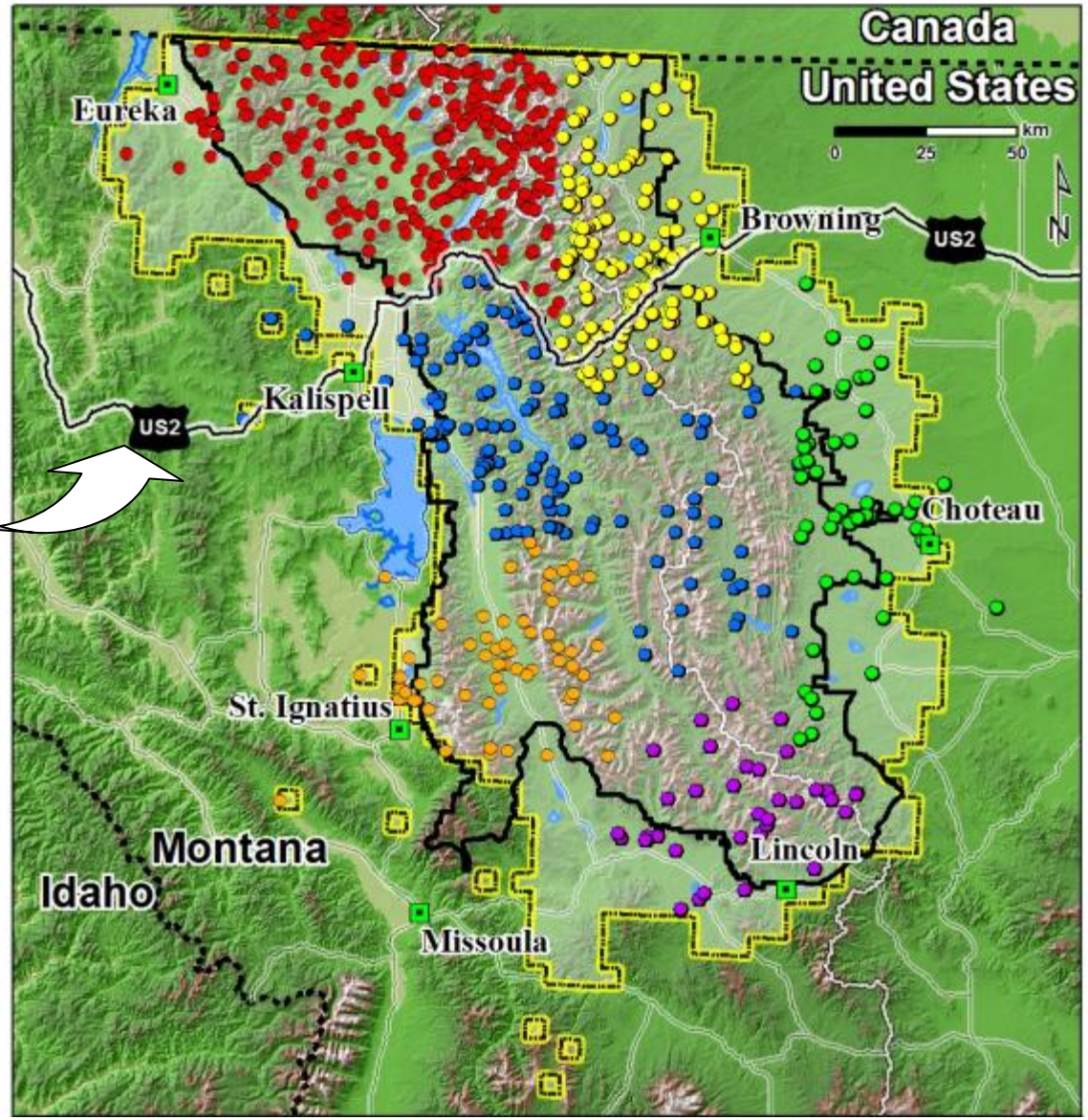
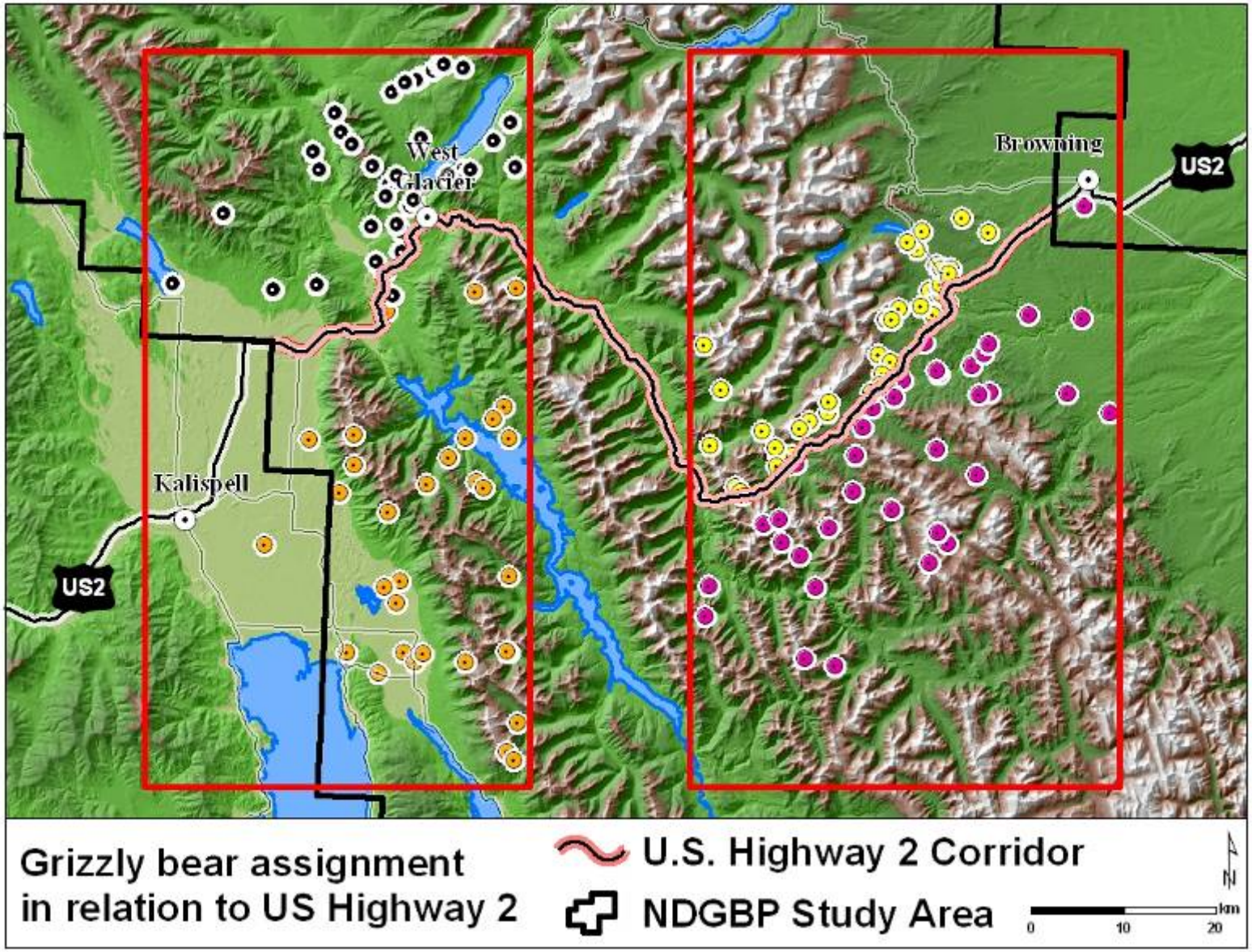
ARE THERE BARRIERS TO GENE FLOW?

Primary highway and rail line in study area



ARE THERE BARRIERS TO GENE FLOW?



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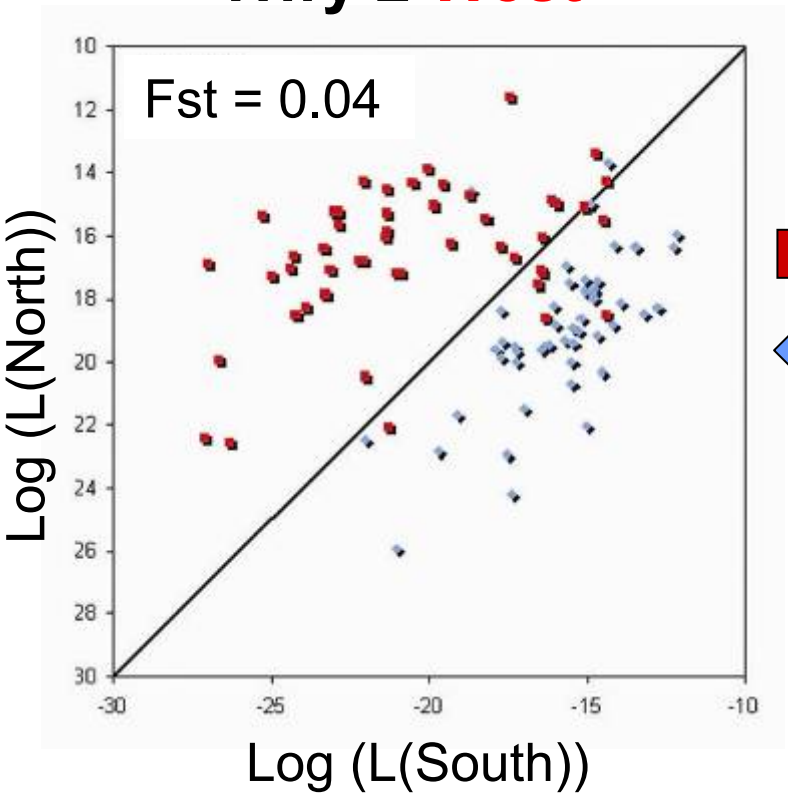
DEMOGRAPHIC LINKAGE

Hwy 2 West

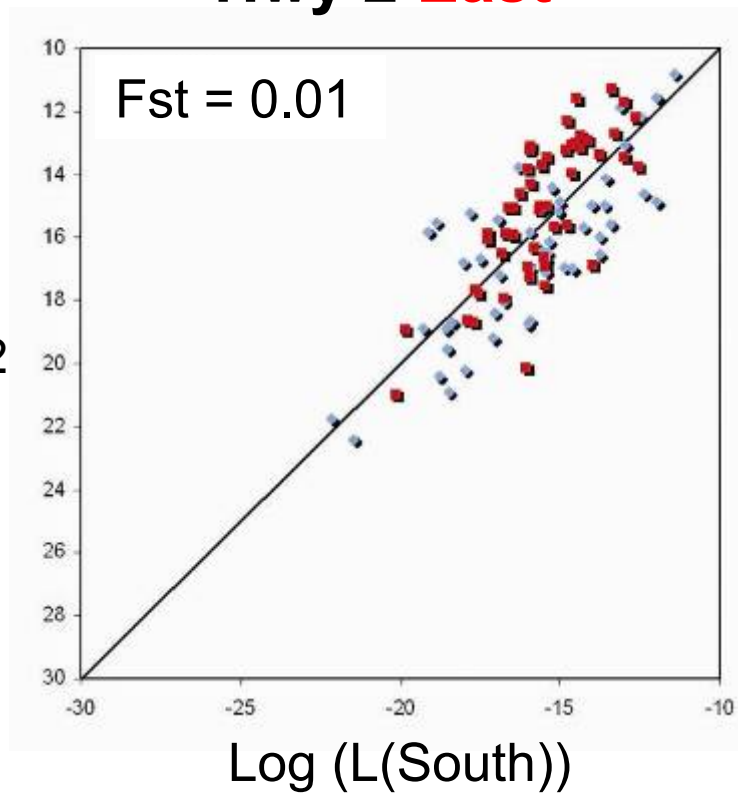


Bears located:

North of Hwy 2

South of Hwy 2

Hwy 2 East



- **Population fragmentation likely with unmitigated future development**

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RECOVERY THRESHOLDS

- 6 recovery thresholds related to mortality rates and distribution of females
- USFWS monitoring program based on sightings of unmarked females with young

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ABUNDANCE AND MORTALITY

- Our estimate 2.5 times higher than estimate based on sightings of females with cubs
- Mortality rate overestimated by same amount
- Female mortality rate in 2004 was still 2x allowable rate

FEMALE GRIZZLY BEARS PER BEAR MANAGEMENT UNIT

- Females detected: 311
- Total females: 470
- Good distribution: 2 - 56 females per BMU
- Good reproductive potential

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SUMMARY

- Population faring better than sightings-based monitoring suggests
- Female mortality rate remains a concern
- High genetic diversity and possible recent increases in gene flow
- Early signs that human development starting to fragment population

DEMOGRAPHY AND GENETIC STRUCTURE OF A RECOVERING GRIZZLY BEAR POPULATION

Kate Kendall• US Geological Survey
Jeff Stetz • University of Montana
John Boulanger • Integrated Ecological Research
Amy Macleod • University of Montana
David Paetkau • Wildlife Genetics International
Gary White • Colorado State University

Journal of Wildlife Management • 2009

BLACK BEAR ABUNDANCE in GLACIER NP

- No information exists on black bear population status in GNP
- 1,496 black bears harvested statewide in 2004, 40% from northwestern Montana
- Sampled black bears during 2004 grizzly bear study
- USGS grant received for completing genetic analysis on black bears in GNP and surrounding area

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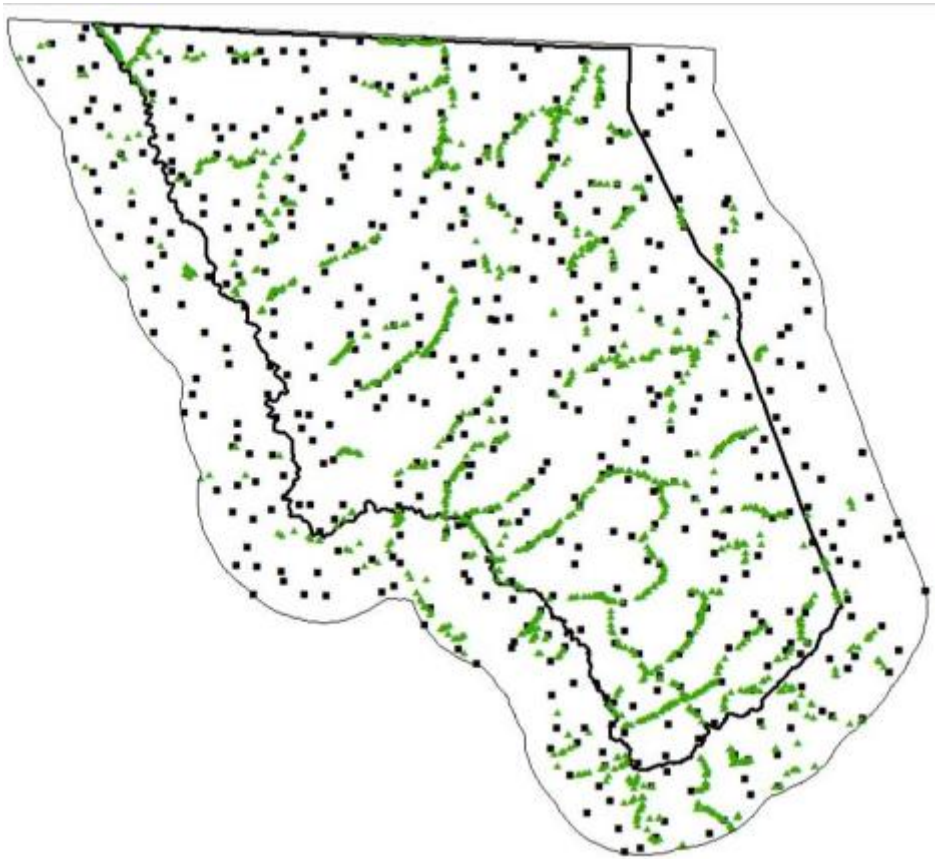
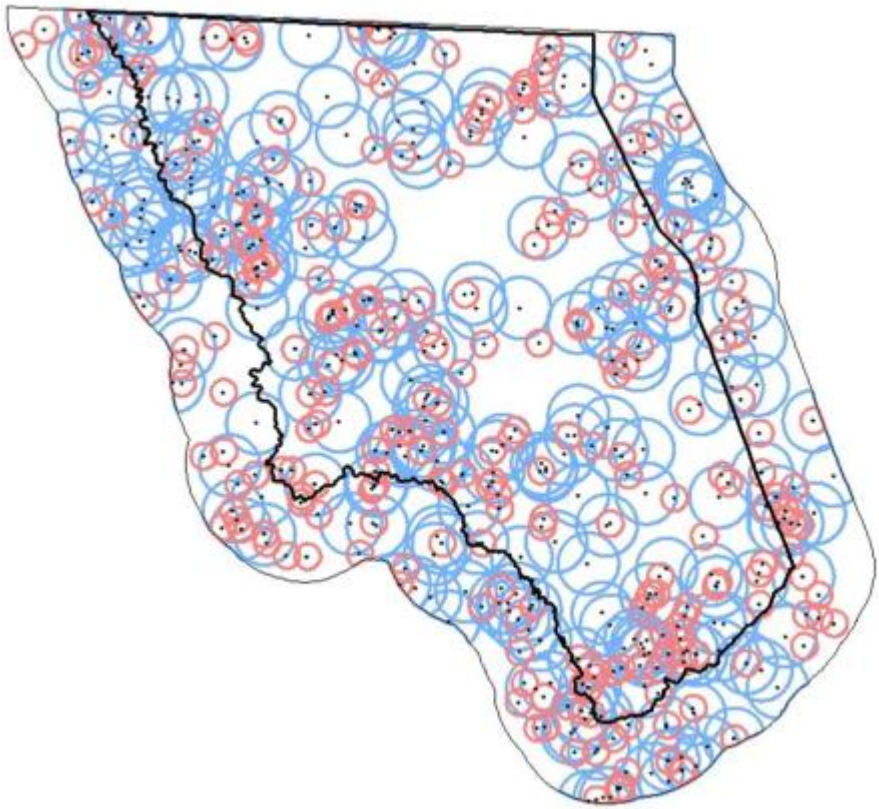
UNIQUE BLACK BEAR DETECTIONS





■ No. of Hair Traps = 550

▲ No. of Bear Rubs = 1542

Males: 295

Females: 305

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BLACK BEAR ABUNDANCE in GLACIER NP

			95 % CI	
	N	CV	Lower	Upper
Males	570	8.0%	480	660
Females	615	9.4%	502	728
TOTAL	1,185	6.2%	1,040	1,329

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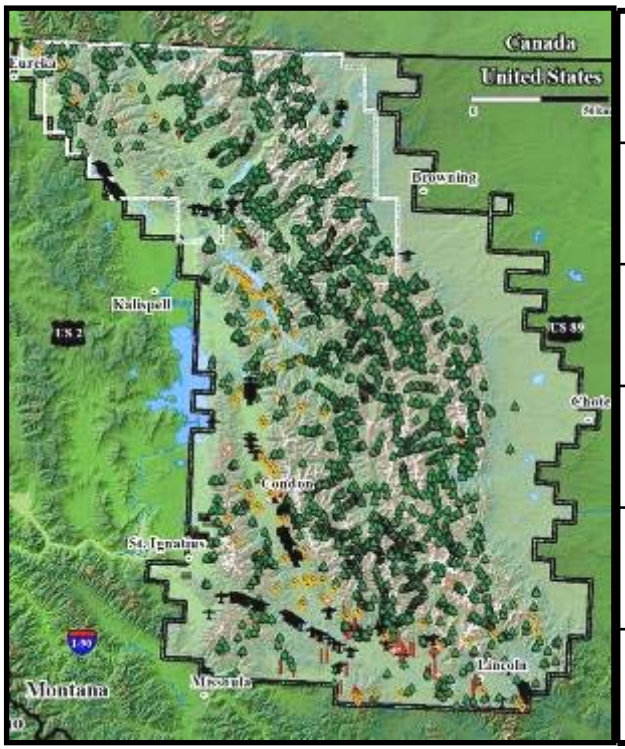
Noninvasive Methods to Monitor Bear Population Trends

History of Bear Rub Surveys

- Bear rub trees were identified and surveyed annually in Glacier NP 1983-1997
- Surveys intensified 1998-2000 and extended outside GNP in 2000.
- Surveys extended ecosystem-wide in 2004 as secondary sampling method.

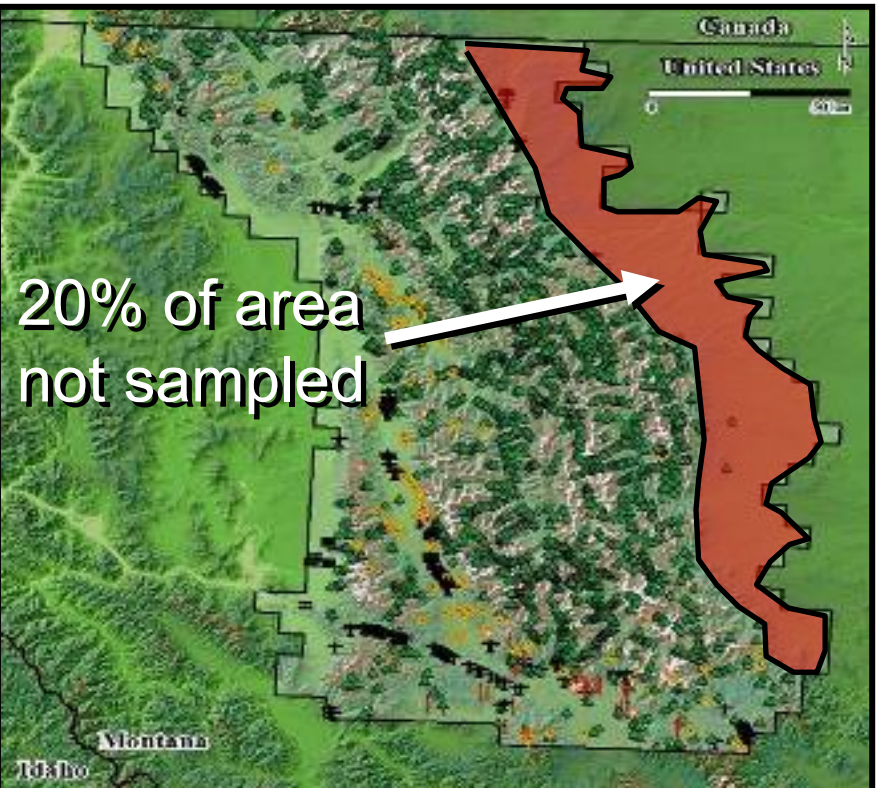


Year / Area	No. Rubs Surveyed	No. Grizzlies Detected		
		Male	Female	TOTAL
1998 GGA	576	43	22	**65**
1999 GGA	740	99	51	**150**
2000 GGA	790	90	44	**134**
2004 NCDE	4,795	155	120	**275**

GGA = Greater Glacier NP area (2 M acres)
NCDE = Northern Continental Divide Ecosystem (7.8 M acres)

GRIZZLY BEARS DETECTED AT RUBS

Number of bears	Female	120
	Male	155
% population detected	Female	26%
	Male	53%



Advantages of Monitoring with Bear Rub Surveys

- Large number of bears and both sexes sampled
- Concurrently samples grizzly and black bears
- On trails/roads – logistically easier than live capture or hair trap grids
- Field crews require little training
- Safe for bears and biologists
- No bait: bear behavior unaffected
- Potential to use existing personnel, volunteers to reduce costs

Monitoring Population Trend

- Traditional approach: live-capture and telemetry
- Only females monitored: 25-60 bears / yr
- Density distributed sample: ~ 50% in GNP
- One estimate for entire ecosystem
- Typically, 1st trend estimate after 6-8 years

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MONITORING TREND USING DNA DETECTIONS

- **Bear hair data can be used to estimate:**
  - ***population growth rates (trend)***
  - ***survival rates***
  - ***annual population size (for portion sampled by rubs)***
- **Large annual sample: ≥ 300 individuals/yr**
- **Gender-specific estimates can detect different trends among males and females**
- **Area-specific trends: changes in relative density**

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QUESTION:

Can bear rub data be used in Pradel models to estimate trend given observed detection rates?

- 53% of all males
  26% of all females
- 4,795 bear rubs surveyed
- 275 bears detected
- >800 detection events

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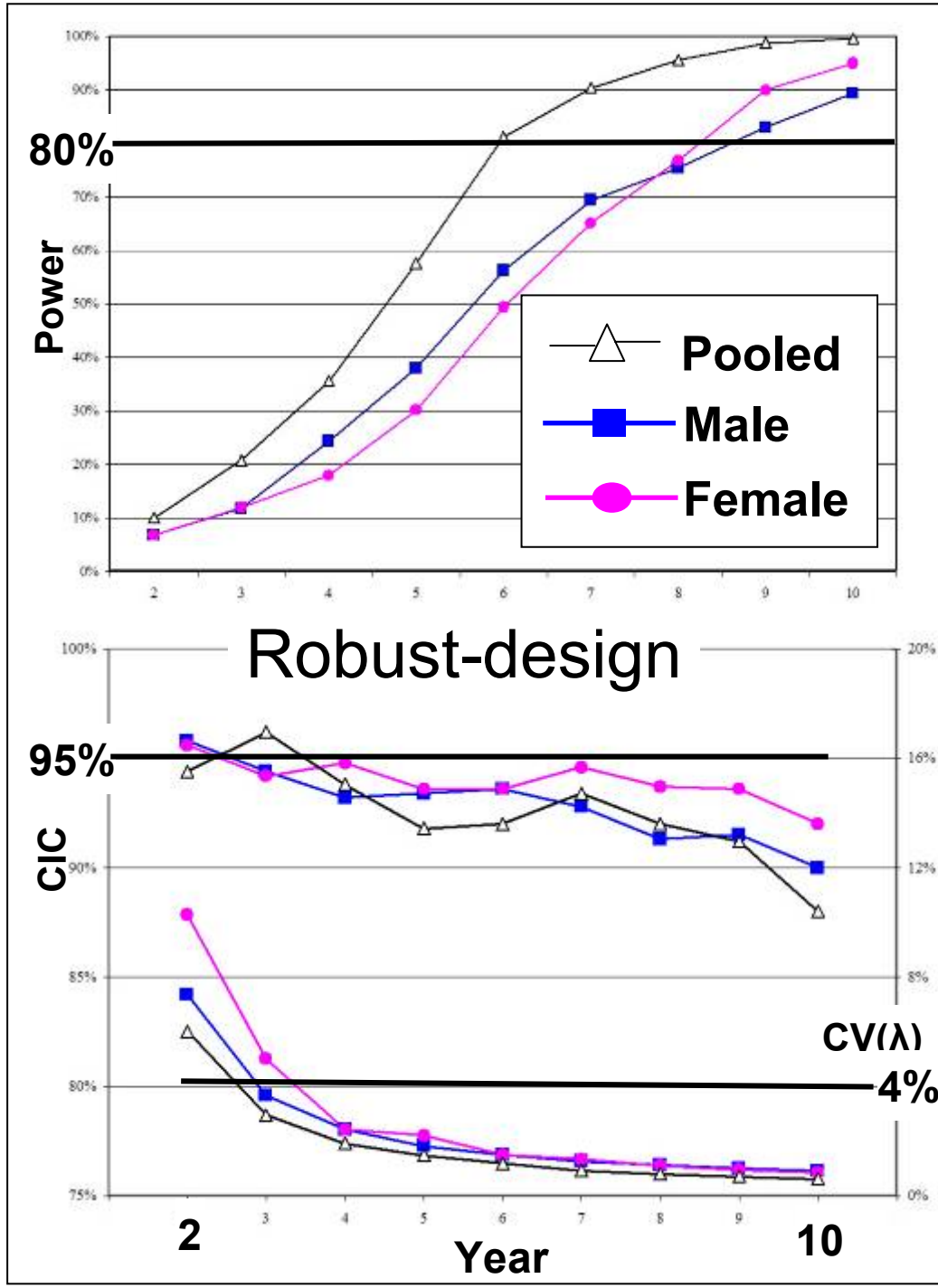
Used 2004 NCDE data to evaluate:

- **Precision & bias of population growth rate estimates**
- **Level of survey effort required to detect trend given:**
  - Various rates of population decline, increase
  - Various capture probabilities for males & females
  - Changing growth rates over time
  - Gender- specific vs pooled estimates

SIMULATION RESULTS
Population decline

- λ = 0.97
- 80% power by year 9
- CV (λ) < 4% by:
  year 3 (males)
  year 4 (females)
- Similar results for 1- and 2-session designs



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Conclusions

- In all cases, trend estimates had excellent precision with 3-4 years' data
- This work suggests adequate power to detect even slight declines in bear numbers with high degree of precision
- Can rapidly obtain precise estimates of several measures of population status
- Can monitor changes in relative density and source/sink dynamics

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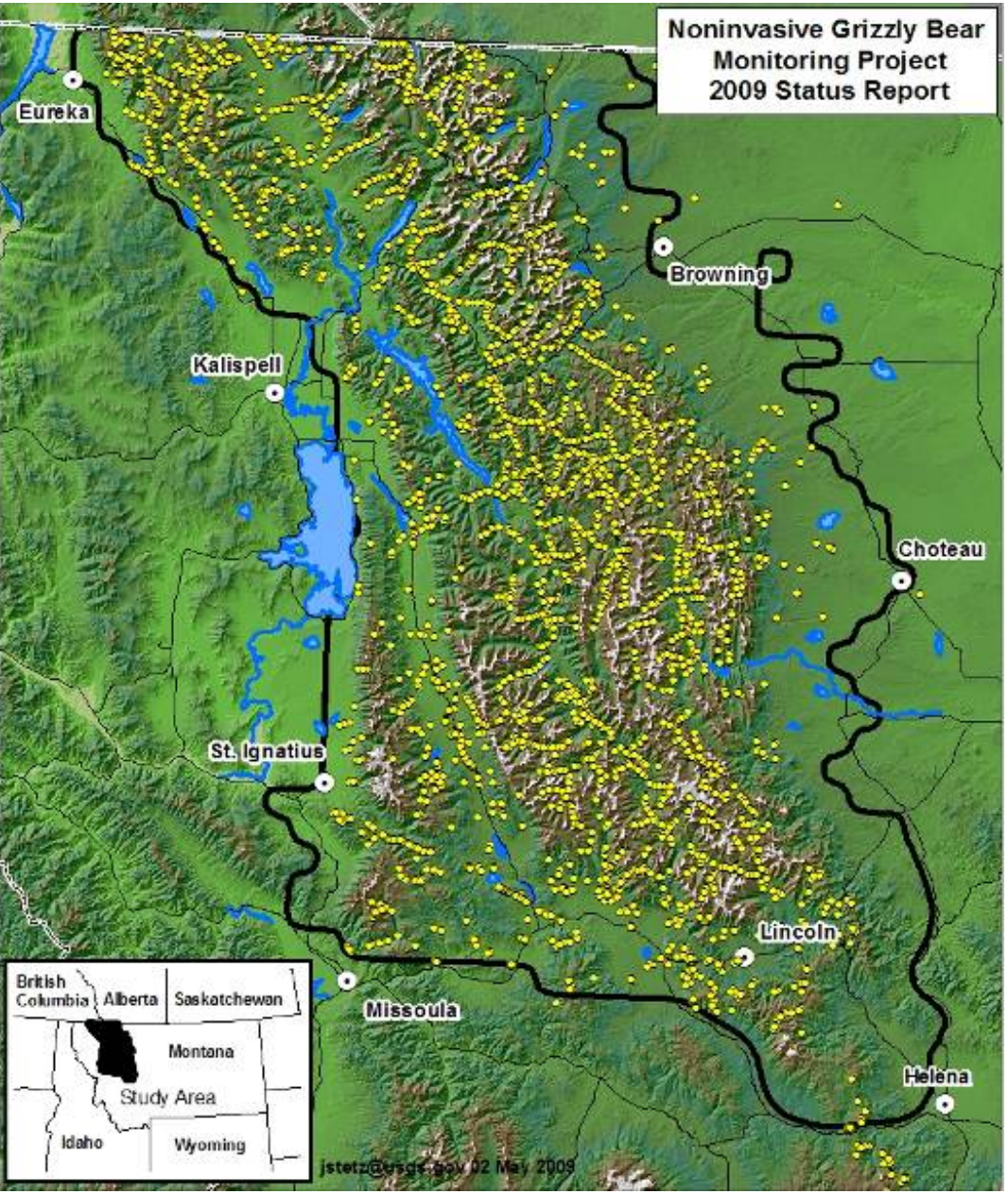
EVALUATION OF BEAR RUB SURVEYS TO MONITOR GRIZZLY BEAR POPULATION TRENDS

Jeff Stetz • University of Montana
Kate Kendall • US Geological Survey
Chris Servheen • US Fish & Wildlife Service

***Journal of Wildlife Management*: May 2010**

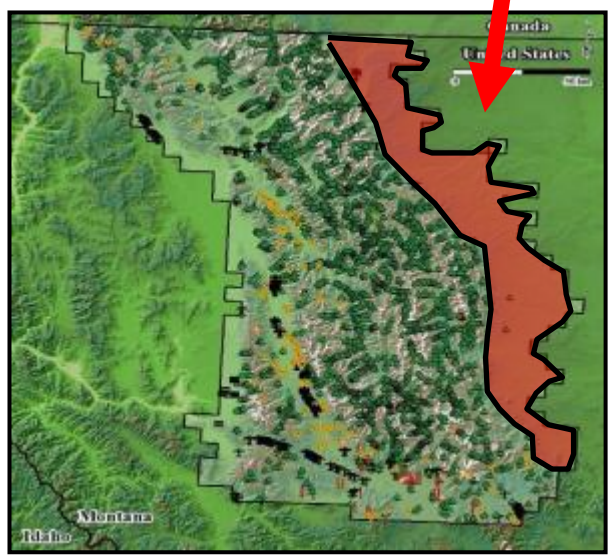
STUDY OBJECTIVES

- Evaluate bear rub surveys to estimate population:
  - Annual growth and survival rates
  - Annual abundance
  - Distribution
  - Genetic structure
- Provide area-specific information needed for forest management on grizzly bear:
  - Occurrence
  - Relative density
  - Minimum counts
- Evaluate ways to optimize these methods.



STUDY AREA

- Lands estimated to be occupied by grizzlies
- Essentially the same as 2004 DNA study
- Increase area sampled with bear rubs by ~20% over 2004 season



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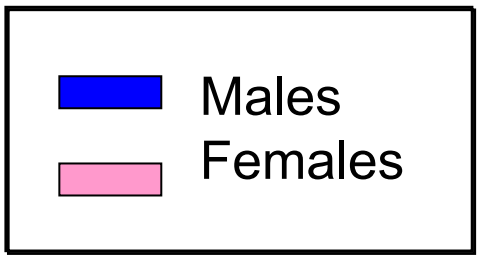
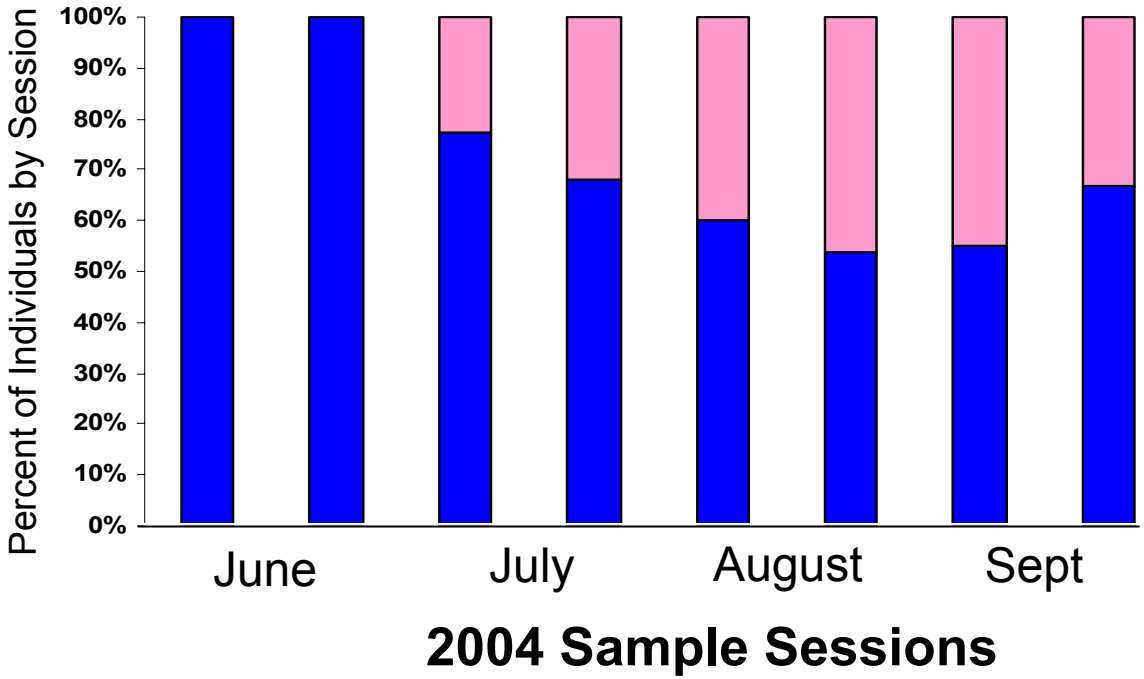
SAMPLING SEASON

- **Later season than 2004 to increase detection rate of females**
- **Visit each rub at least 3X each year**





Bear Rub Setup

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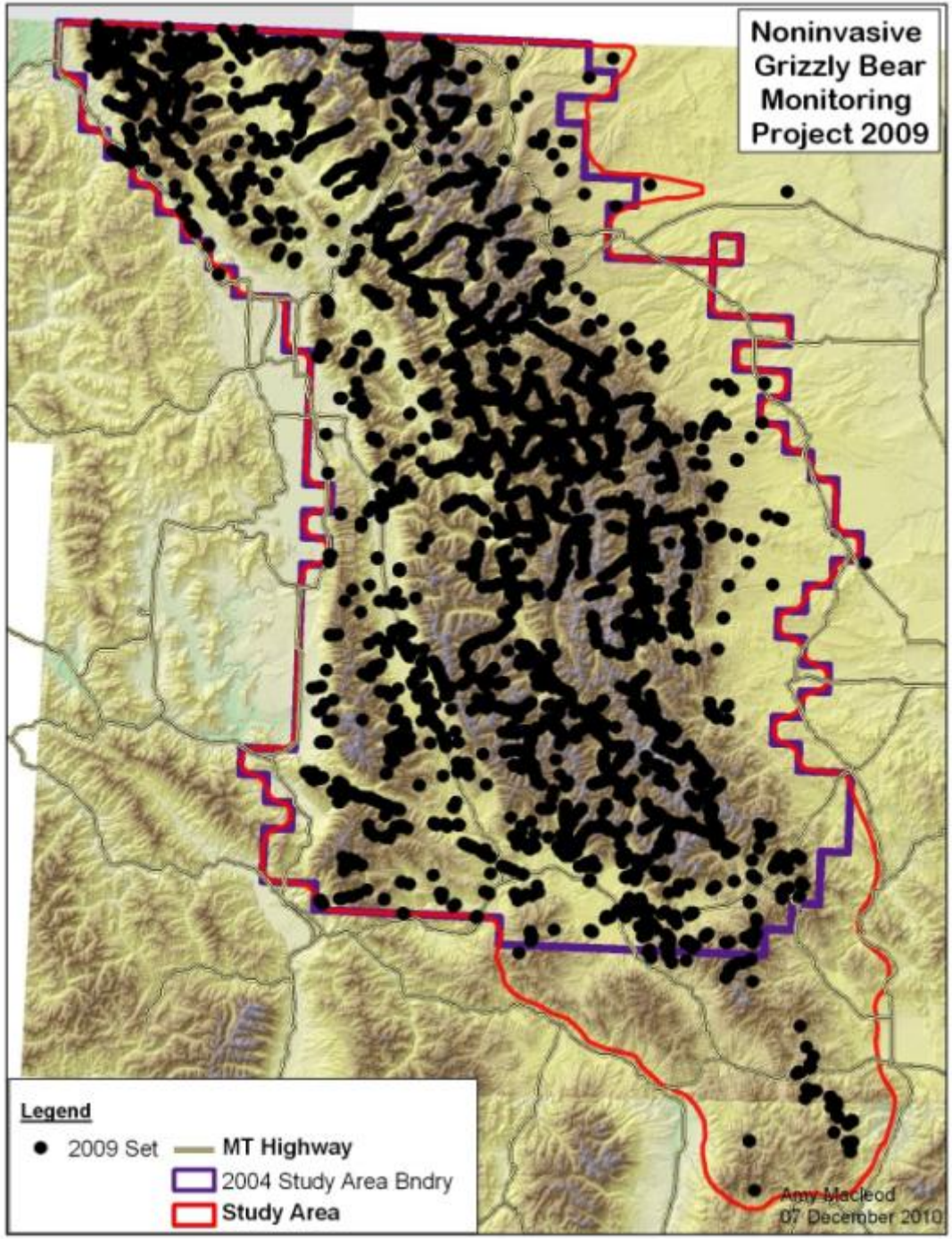
2009 RESULTS

- Rubs occur throughout 32,000 km^2 study area
- Timing maximizes female detections
- 4,912 bear rubs set up



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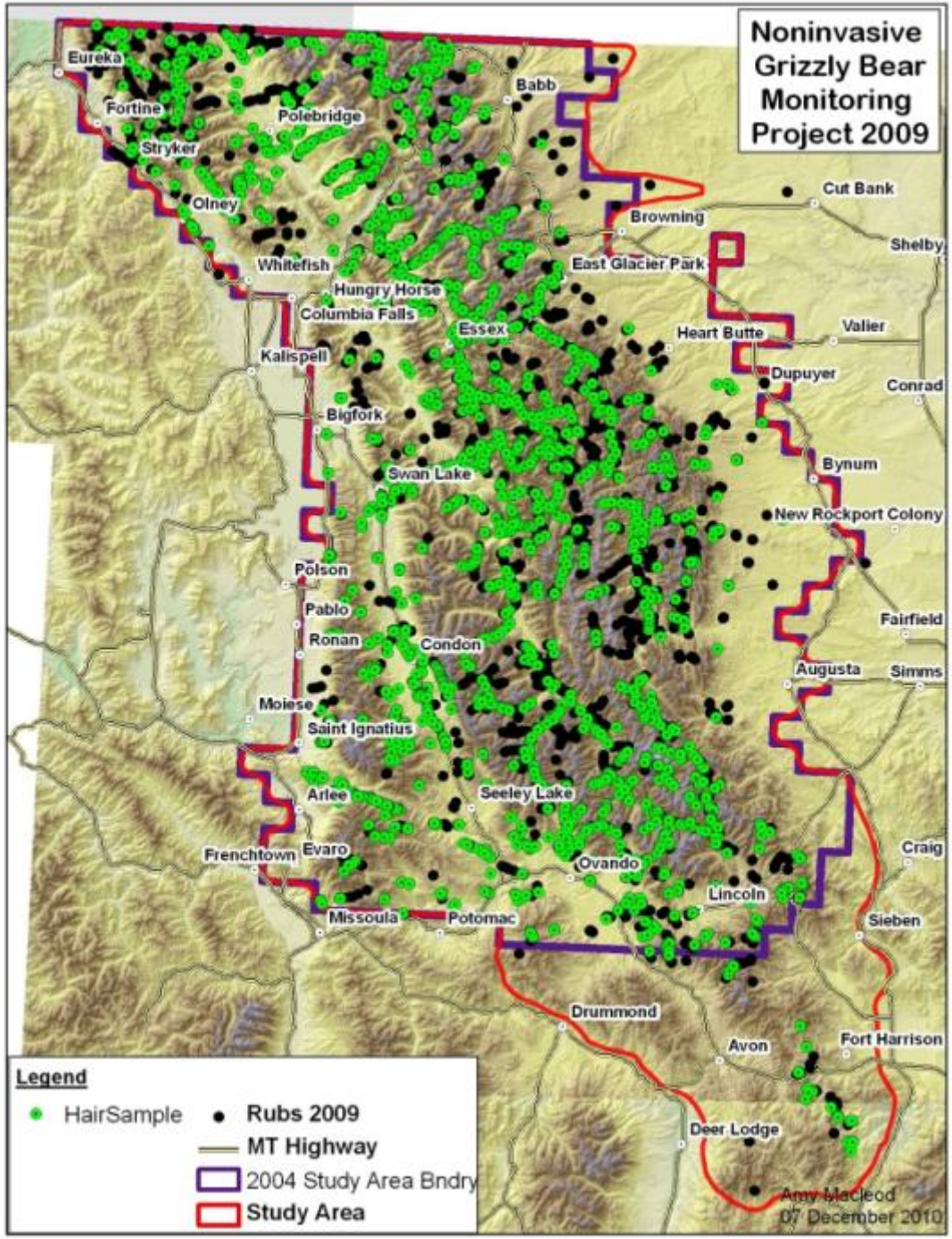
2009 Season

- 9,240 bear hair samples
- Rubs with no samples



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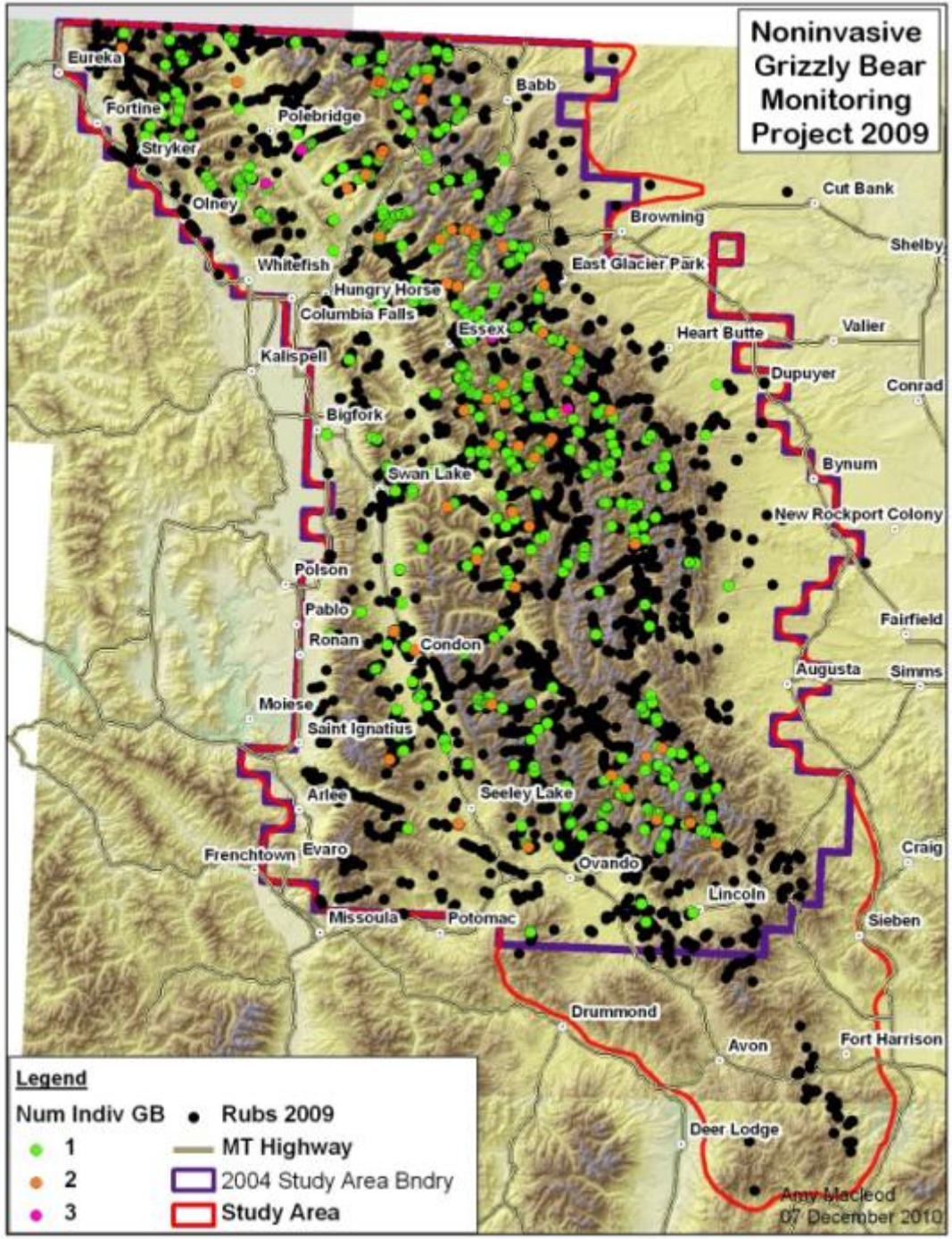
2009 Results

251 individuals from 580 grizzly samples

- 516 rubs with 1 grizzly
- 60 rubs with 2 grizzlies
- 4 rubs with 3 grizzlies



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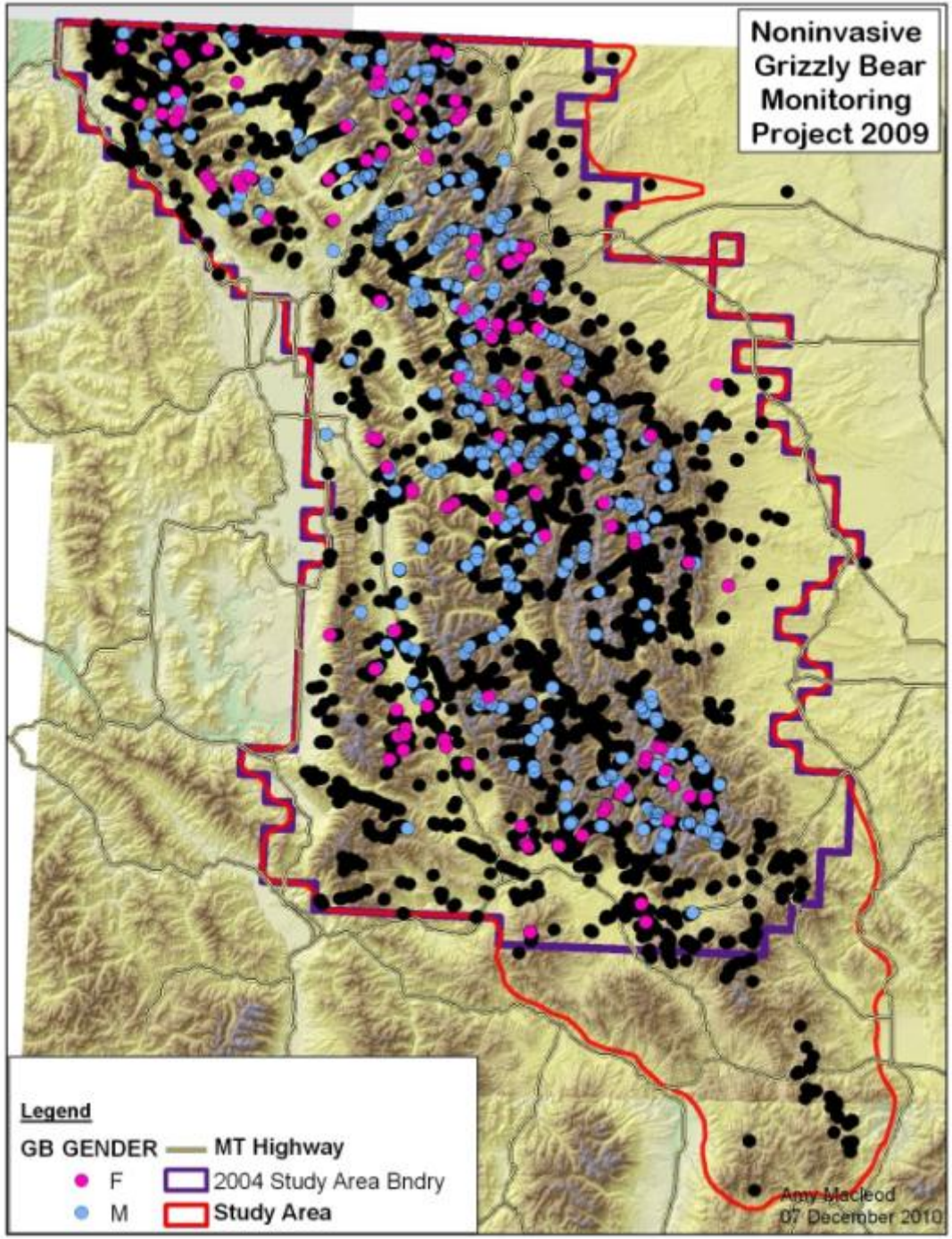
2009 Season

- Female grizzlies: 95
- Males grizzlies: 156



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2010 FIELD SEASON*

- **Rubs set up 2009: 4,907**
- **Rubs set up 2010: 792**
- **Rubs decommissioned: 123**
- **Active rubs: 5,576**

*preliminary results

Timeline

Tasks	2009	2010	2011	2012
Identify and setup bear rubs	•			
Conduct bear rub surveys	•	•	•	
Genetic analysis		•	•	•
Data analysis		•	•	•
Manuscript preparation				•

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ACKNOWLEDGEMENTS

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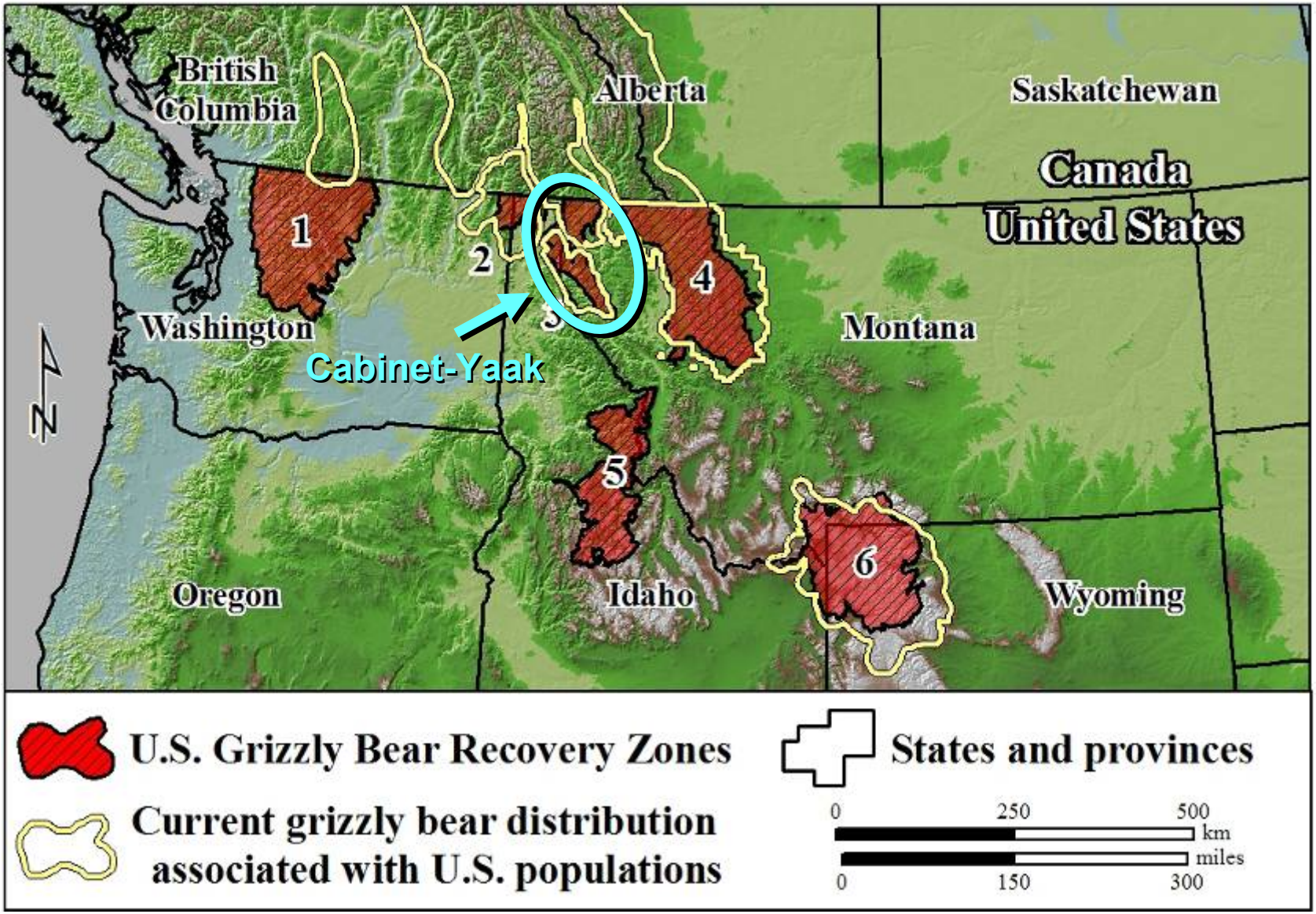
Forest Service
National Park Service
U.S. Fish & Wildlife Service
Montana Fish, Wildlife & Parks
Montana DNRC
Blackfeet Nation Fish & Wildlife
Northwest Connections
The University of Montana
Cooperative Ecosystem Studies Units Network

CABINET-YAAK RECOVERY ZONE



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Sampling Design

- Hair trap density: smaller grid increases capture probability, estimate precision.
- More detection sessions improve estimate precision
- Moving hair traps between sessions increases capture probability
- Small bear populations require more sample effort
- More sample effort = higher cost

Project	Popn. size	Precision (CV)	Capture prob.	Grid (km)	Sites moved	Sample sessions
Jumbo	45	15.8%	0.26	5 x 5	No	4
U. Columbia '97	55	17.3%	0.20	5 x 5	No	5
U. Columbia '98	92	32.4%	0.12	5 x 5	No	5
Granby Kettle	46	16.4%	0.13	8 x 8	Yes	5

ESTIMATED COST OF ESTIMATING CABINET-YAAK GRIZZLY BEAR POPULATION SIZE

Assumptions

- Year 1: Set up field work / planning; Year 2: Sample collection; Year 3: Genetic analysis , population modeling, report preparation
- Study area size: Cabinet-Yaak Recovery Zone = 6,734 km^2
- 5 x 5 km grid = 269 cells
- 5 hair trap sessions = 1,345 hair traps; 4,035 liters of scent lure
- Hair traps moved between sessions
- 19 2-person field crews
- Concurrent sampling at natural rub sites
- Year 1: Identify bear rubs, make lure, landowner permissions, hair trap site selection
- Year 2: Conduct field sampling at hair traps and bear rubs, enter filed data
- Year 3: Genetic analysis, population modeling, report preparation

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ESTIMATED COST OF ESTIMATING CABINET-YAAK GRIZZLY BEAR POPULATION SIZE (x$1,000)

	Year 1	Year 2	Year 3	TOTAL
Labor	115	450	70	635
Travel	7	40	5	52
Vehicle rental	30	132	5	167
Supplies & Equipment	18	82		100
Genetic analysis		50	50	100
Statistical consultation			15	15
Indirect	30	136	26	192
Total	200	890	171	1,261

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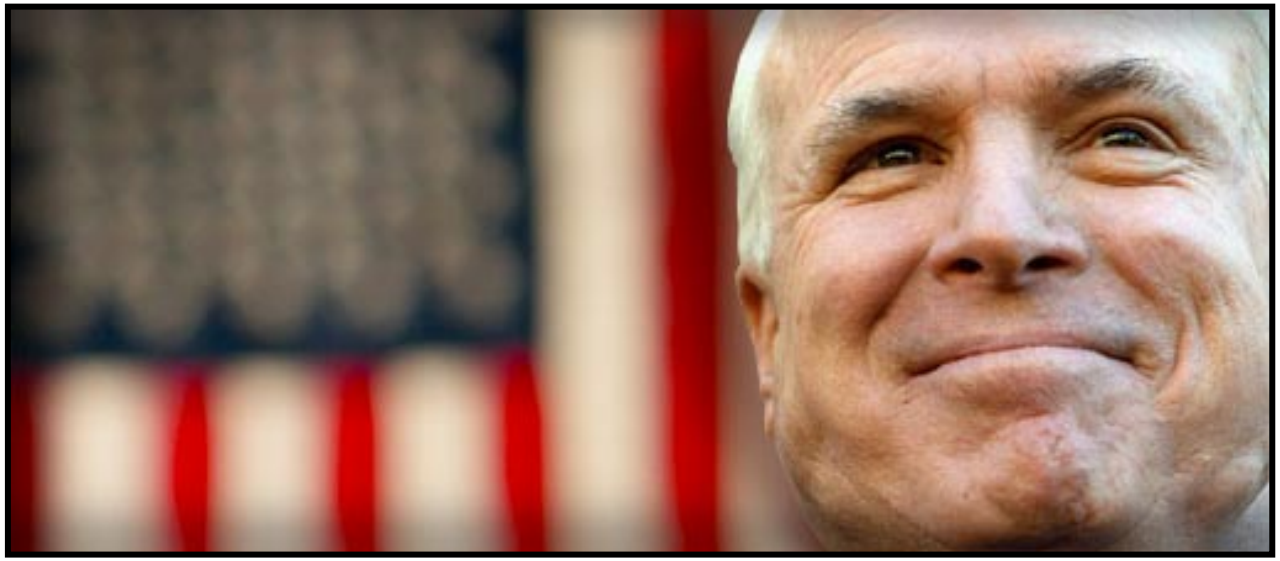

“I don’t know if it was a paternity or criminal issue but I do know it was a waste of money."

John McCain 2008
Presidential campaign

“One of the great breakthroughs in modern science”

John McCain 2010
Washington Post

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ADDITIONAL INFORMATION

Google: grizzly bear dna

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