WASHINGTON FISH AND WILDLIFE COMMISSION BEAR & COUGAR SCIENCE PANEL: COUGAR

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COUGAR ECOLOGICAL ROLE

QUESTIONS

- The primary ecological relationships and what quantitative information we have on cougar?
- Briefly describe the ecological function and/or niche of Washington's cougars.
- What is the role of cougar in the ecosystem and the potential impacts to their ecological role from regulation changes?
- List cougar food items. Do cougars scavenge or consume carrion?

ECOLOGICAL ROLE

- **Apex predator**
- **Ecosystem composition and function** (e.g., Ray et al. 2005)

-Alter ungulate behavior and distribution

-Energy flow, nutrient cycles -> ecosystem services

-Greater biodiversity, resilience

Ecological Benefits of Cougar Presence

Cougars provide food and habitat for a diversity of species, contributing to healthy ecosystems:

1. **Carnivores such as bears, coyotes, foxes, and skunks** eat once the cougar has its fill.
2. **Eagles, ravens, crows, jays, vultures, and other foraging birds** are drawn to carcasses to feed.
3. **Beetles and other insects** forage on the remains and even reproduce there, breaking down the carcass into soil nutrients.
4. **Soils are enriched** which encourages vigorous growth of plants.
5. **Cougars keep their prey naturally wary** and help keep populations healthy.

Western Wildlife Outreach/WDFW

COUGARS AS PREDATORS

- Stalking predator
- Ungulates – deer & elk
- Opportunistic and adaptable (Murphy and Ruth 2010)
- Domestic uncommon (Kertson et al. 2011)
- Kill rates vary (Murphy and Ruth 2010):

  -Cougar sex

  -Cougar reproductive status (females)

  -Prey killed and amount consumed

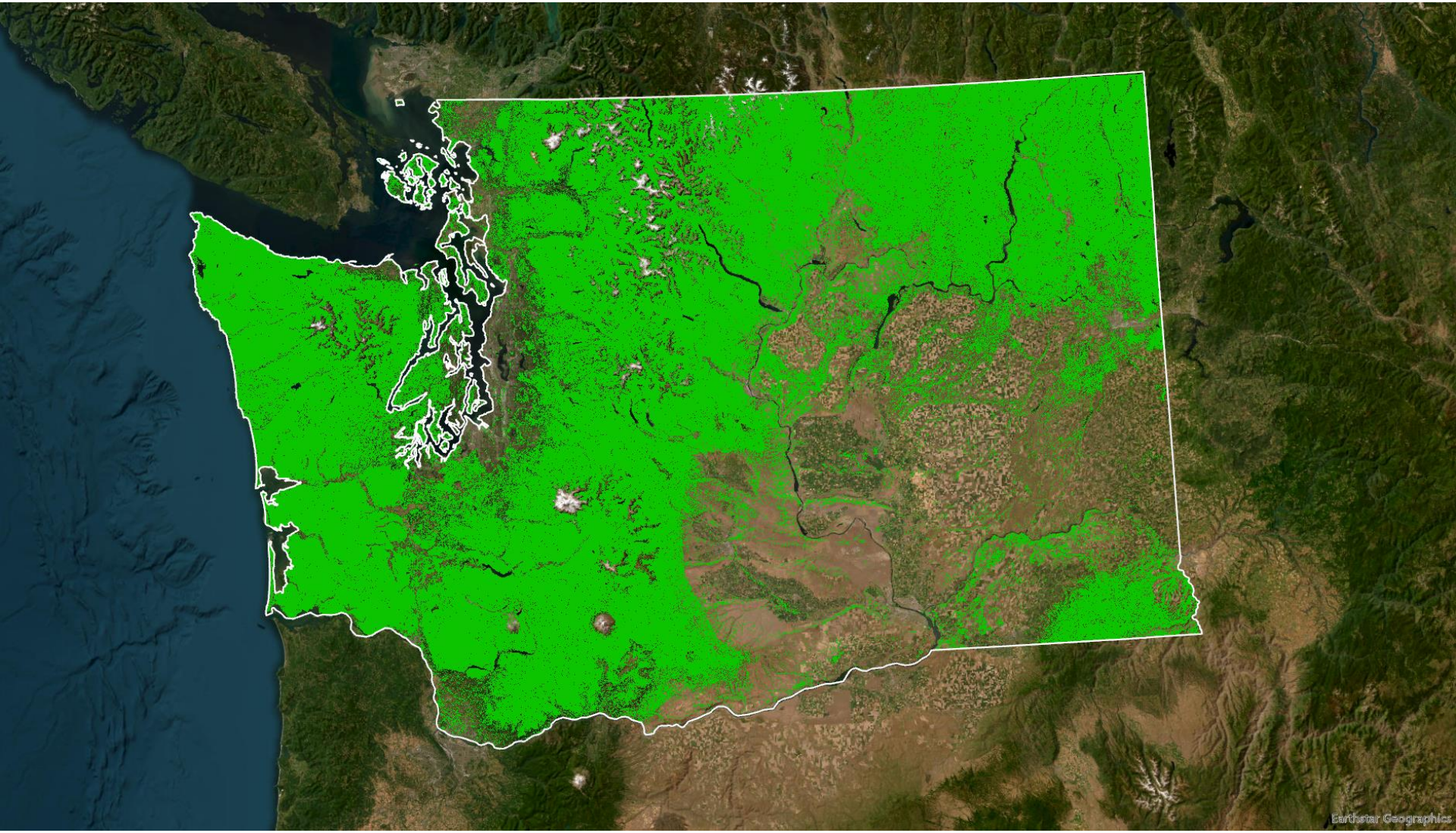
COUGAR DISTRIBUTION & HABITAT

QUESTIONS

- Cougar distribution?

DISTRIBUTION

WASHINGTON DISTRIBUTION



COUGAR POPULATION DEMOGRAPHY

QUESTIONS

- Where are cougar on the mammalian reproductive rate continuum?
- Cougar vital rates (survival and reproduction by age) and their propensity for emigration or immigration?
- Cougar age and sex structure?
- Is cougar population growth driven in part by nutritional quality, and if so, how? Does this impact reproductive rates and populations growth?
- Are cougar populations in Washington experiencing unrestricted or exponential growth that some members of the public have stated is occurring? Why or why not?

POPULATION DEMOGRAPHY: REPRODUCTION

- **Relatively high reproductive rate for carnivores**
  - **-2 to 3.5 years of age**
  - **-2 or 3 kittens per litter**
  - **-1.0 to 1.6 kittens/F/yr**
  - **-Dispersal: ~16-18 months**
  - **-18 to 24 mo. generation time**

POPULATION DEMOGRAPHY: SURVIVAL

- **Natural mortality**
  - -Intraspecifc strife, injuries, starvation, disease
- **Human mortality**
  - -Hunting, conflict, motor vehicles
  - -Significant, reduces population growth
- **Survival**
  - -Kitten: 50% - 60%
  - -Adult > subadult
  - -Subadult male lowest
  - -Adult females: 85% – 90% (Natural)

POPULATION DEMOGRAPHY: AGE STRUCTURE

- **Age classes** (Kertson, WDFW unpublished data)
  - -Adults: ~40%
  - -Subadults: ~30%
  - -Kittens: ~30%
- **Increased human mortality**
  - -Skews adults younger, more subadults

(Anderson and Lindzey 2005; Robinson and DeSimone 2011; Logan and Runge 2021)

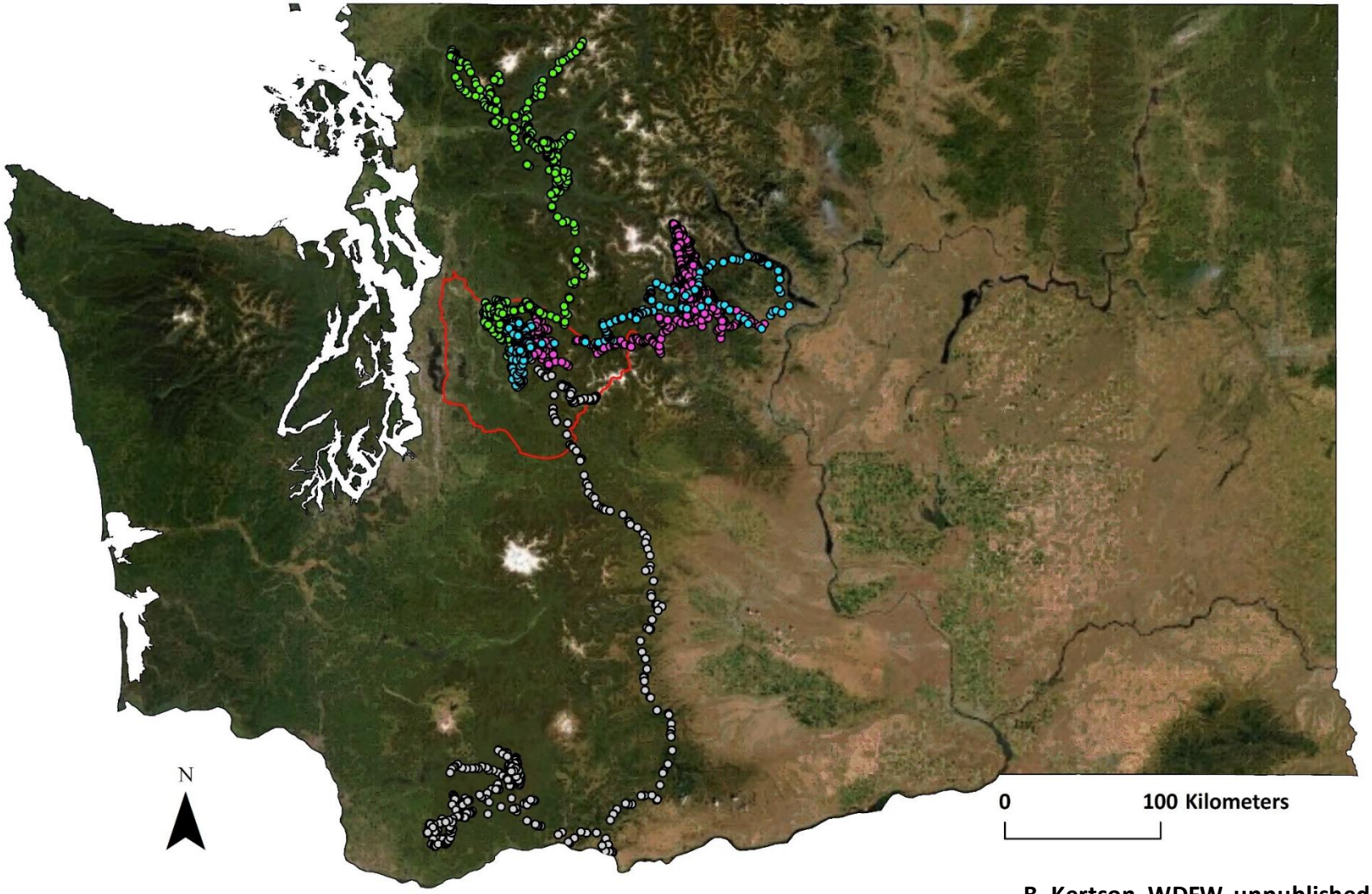
POPULATION DEMOGRAPHY: POPULATION GROWTH

- Maximum growth rate is unknown
- Intrinsic growth rates
  - WA: λ=14% without hunting (Wielgus et al. 2013)
  - MT: λ= 17% without hunting (Robinson and DeSimone 2011)
  - CO: Local decline at ≥ 15% harvest rate (Logan and Runge 2021)
- Open populations (source – sink)
  - Year-round breeding, emigration, immigration

POPULATION DYNAMICS: EMIGRATION & IMMIGRATION

- **Emigration (dispersal)**
  - -16 to 18 months
  - -Males: almost always (avoid inbreeding)
  - -Females: local recruitment, shorter distances
- **Effects of hunting**
  - -Reduced emigration (Newby et al. 2013, Robinson et al. 2014)
  - -Increased immigration (Newby et al. 2013, Cooley et al. 2009)
  - -Reduced dispersal distance & success (Newby et al. 2013)

WASHINGTON DISPERSAL EXAMPLES



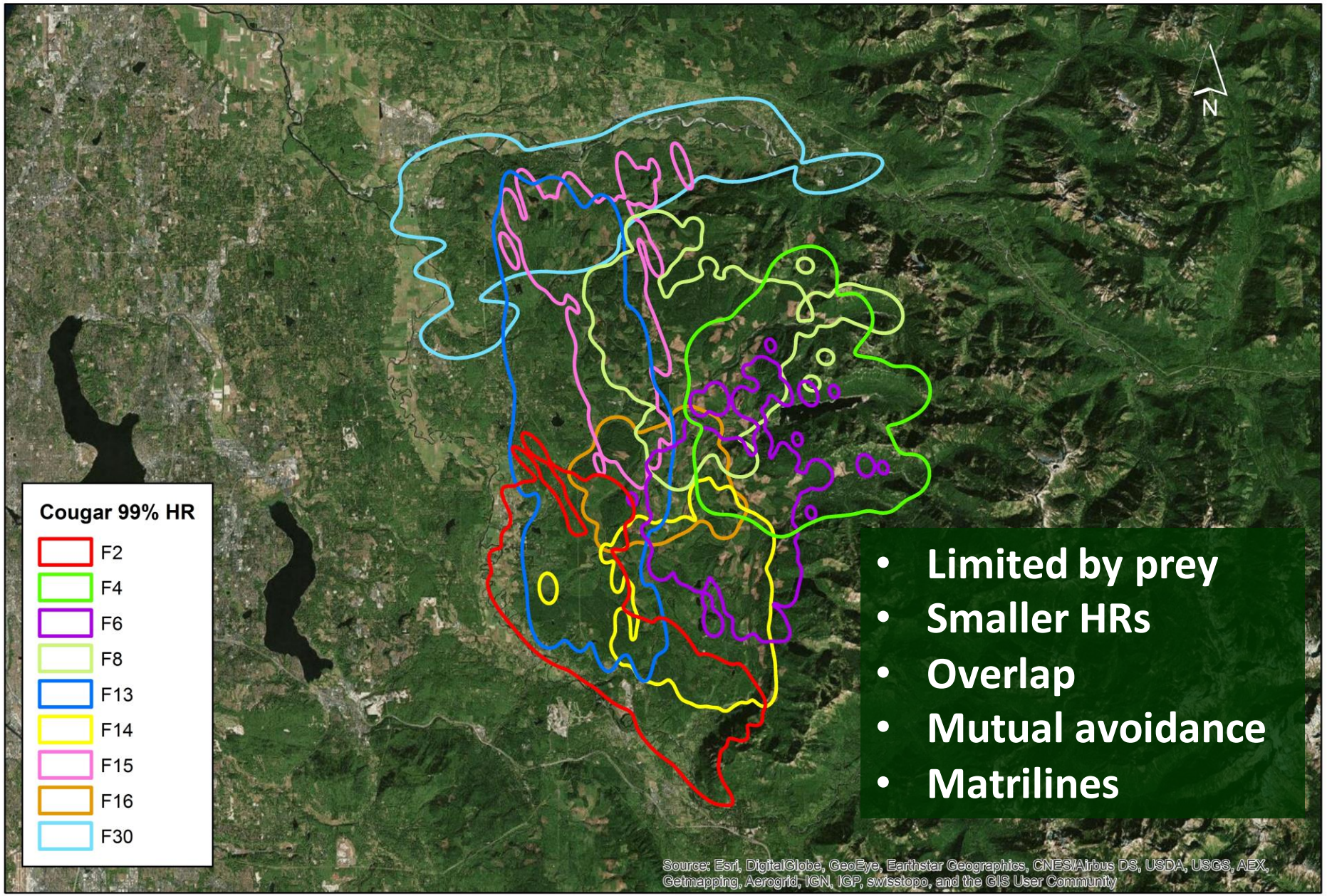
B. Kertson, WDFW, unpublished data

COUGAR SOCIAL ORGANIZATION

QUESTIONS

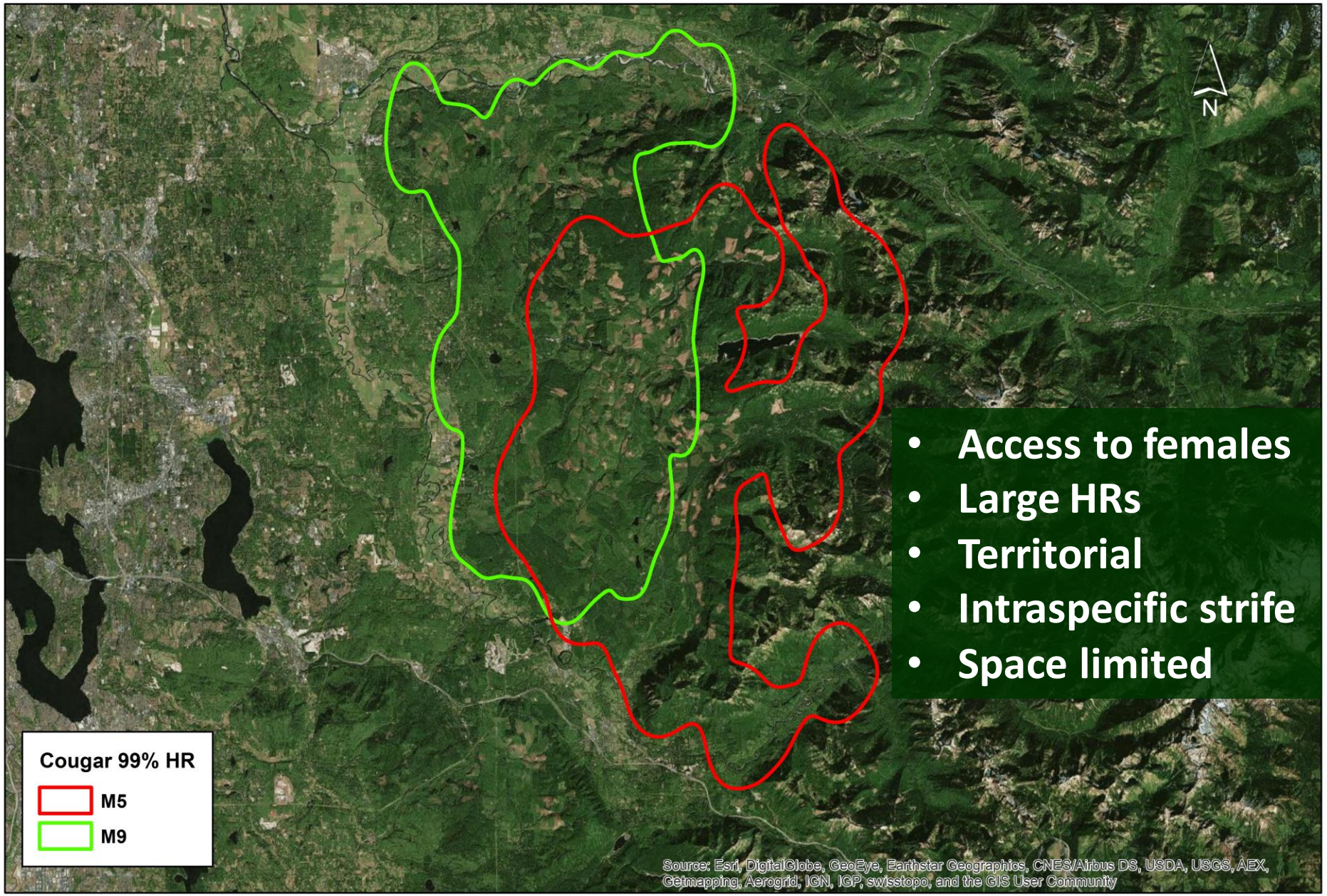
- If cougar populations self-regulate, how does hunting affect self-regulation and social structure?
- Can you discuss the cougar social regulatory theory? What are the competing theories?
- Briefly describe any self-regulation and social structure of cougar populations.
- Cougar movement patterns?

Adult Female Cougars - Snoqualmie Forest



- Limited by prey
- Smaller HRs
- Overlap
- Mutual avoidance
- Matrilines

Resident, Adult Male Cougars - GMU 460



- Access to females
- Large HRs
- Territorial
- Intraspecific strife
- Space limited

COUGAR ABUNDANCE, TRENDS, AND RISKS

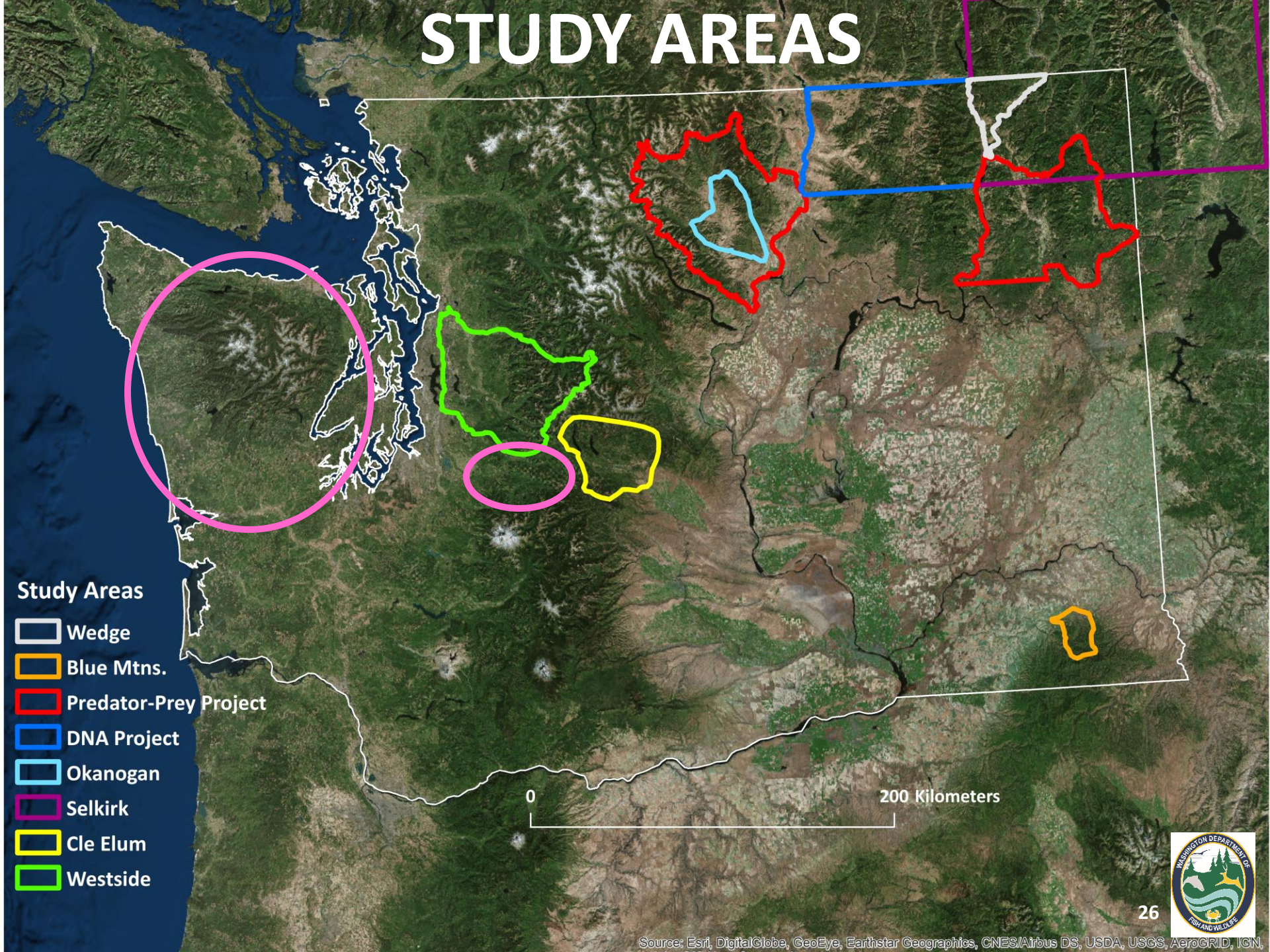
QUESTIONS

- Cougar abundances and trends?
- Are cougar populations in Washington experiencing unrestricted or exponential growth that some members of the public have stated is occurring? Why or why not?
- The full extent of human-related mortality for cougar?
- How do natural events like wildfire affect habitat over time? How does climate change affect the cougar population?
- Cougar vulnerability to climate change and human growth and development?
- Are cougar subject to known disease concerns?
- Describe the infanticide theory. Do each of you support this theory?

ABUNDANCE & TRENDS

- Solitary, secretive, & far-ranging
- Open populations
  -Residents and transients
- Local abundance frequently unknown
  -Fundamental challenge of cougar management
- Trends difficult -> lack of precision in estimates
  -Other fundamental challenge
  -No evidence of unconstrained growth (e.g., densities)
- Both logistically difficult and cost prohibitive
- Fortunately, lots of WA research….

STUDY AREAS


Study Areas
Wedge
Blue Mtns.
Predator-Prey Project
DNA Project
Okanogan
Selkirk
Cle Elum
Westside
0
200 Kilometers
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN,

POPULATION DYNAMICS: ANNUAL INDEPENDENT DENSITY (per 100 km^2)

Study Area	Years	Mean Density (SD)
Northeast	2002-2006	1.96 (0.20)
Cle Elum	2002-2006	2.37 (0.56)
Okanogan	2008-2012	1.55 (0.44)
Blues	2009-2013	2.79 (0.35)
Westside	2013-2016	2.34 (0.08)

- Home range modeling
- Cougars ≥ 18 months of age
- Accurate sex and age determination
- Proportional contributions (open population)
- Can miss individuals, no detection probability

Beausoleil et al. 2021

RISKS

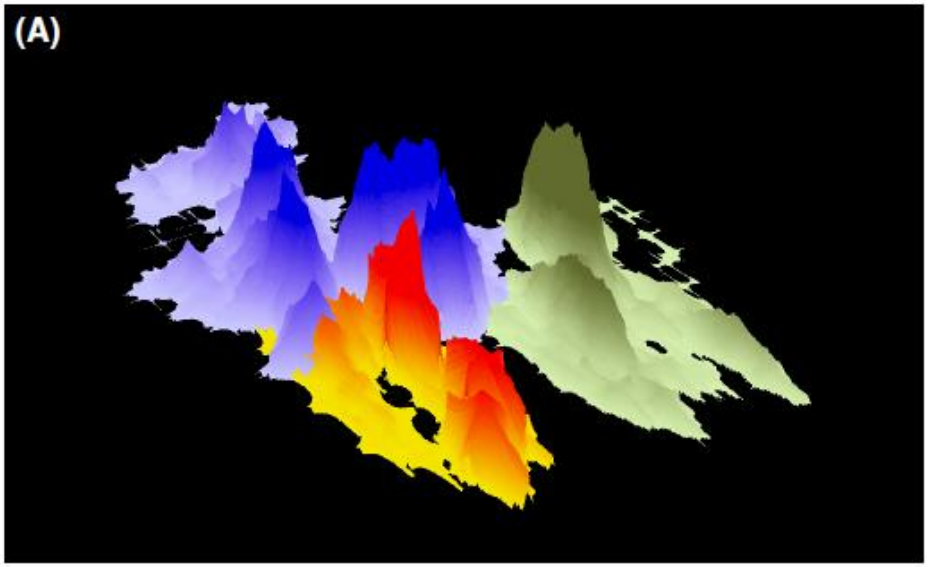
- **IUCN: Least Concern**
- **Anthropogenic landscape conversion** (Nielsen et al. 2017)
  - -Direct habitat loss -> reduced population capacity
  - -Fragmentation
    - -> Reduced genetic diversity (e.g., Dellinger et al. 2020)
    - -> Increased direct and indirect mortality (e.g., Benson et al. 2020)
- **Resilient to effects of climate change**
  - -Landscape-level stand replacement wildfire (Jennings et al. 2016)
- **Currently no major disease concerns** (Carver et al. 2015)

HUNTER HARVEST RISK TO POPULATION

- **Resilient** (e.g., bounty period pre-1965, Proffitt et al. 2020)
- **Modern cougar management ~1966**
- **Harvest can cause local population declines**
  (e.g., Stoner et al. 2006, Robinson et al. 2014, Logan and Runge 2021)
- **Scale and intensity of removals critical**
  - Source-sink dynamics (e.g., Stoner et al. 2006)
  - Recruitment success (Newby et al. 2013)

HUNTER HARVEST & RISKS TO SOCIAL ORGANIZATION

- Demographic and behavioral consequences
- 35% observed harvest of collared males*
  - -Breakdown in territoriality (Maletzke et al. 2014)
  - -Increased immigration (Cooley et al. 2009)
  - -Increased infanticide (Packer et al. 2009)
    - -> Not always (Robinson et al. 2014; starvation)



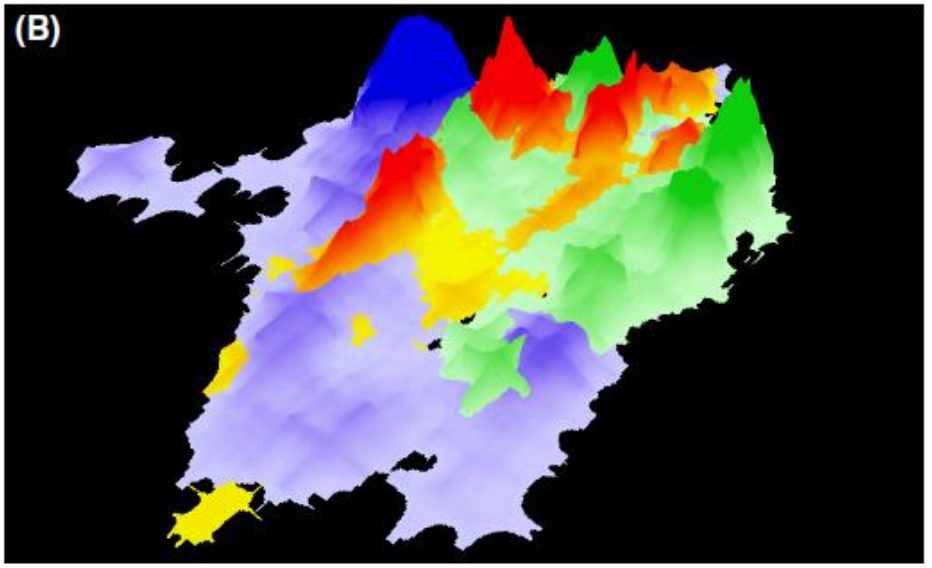
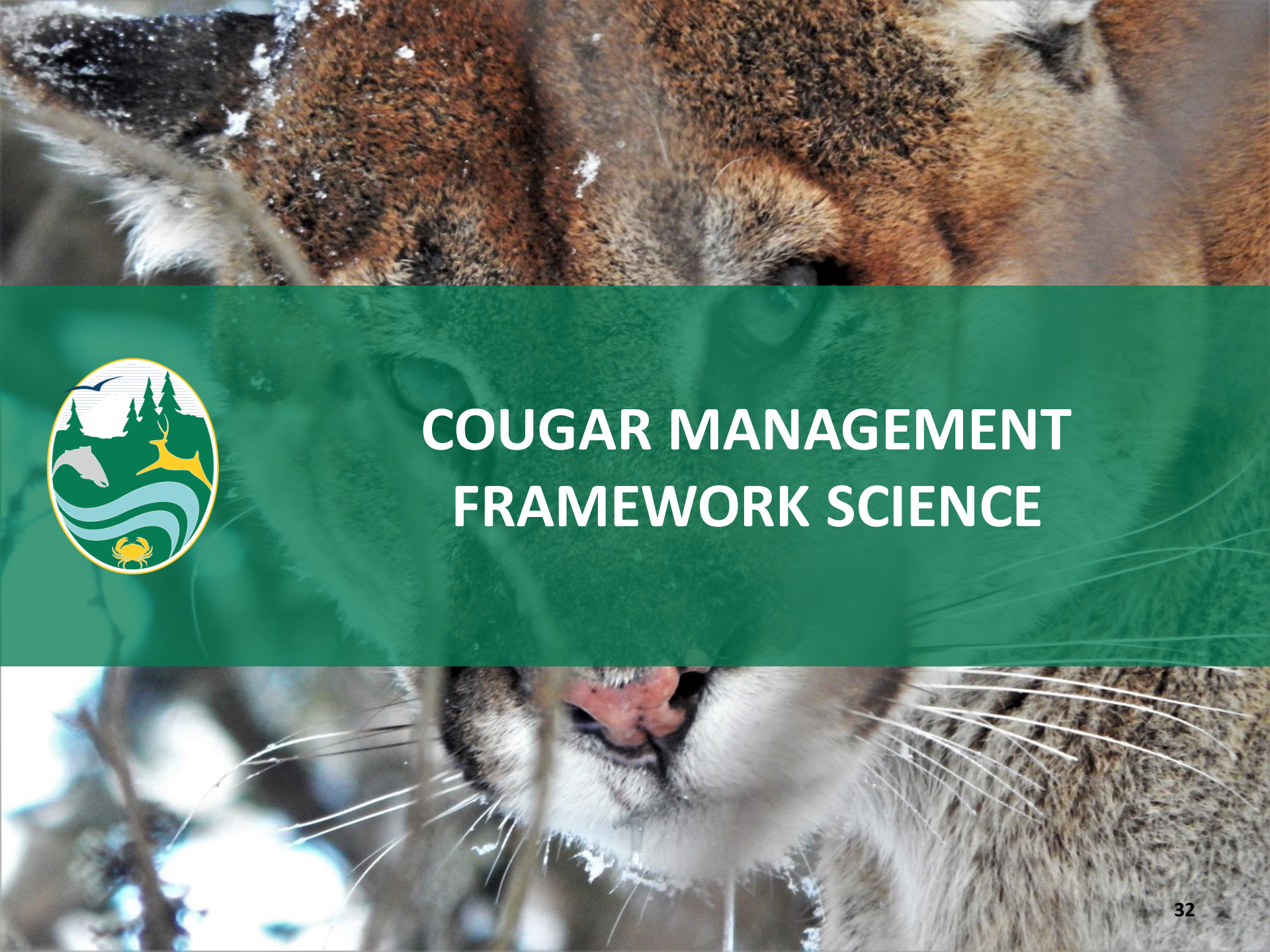


Figure 3. Home range utilization distributions for six male cougars: three (A) in the lightly hunted area near Cle Elum, 2008 and three (B) in the heavily hunted area near Kettle Falls, Washington, 2007. The color ramps represent individual cougars, and the peaks represent areas of high probability of use.

Maletzke et al. 2014



COUGAR MANAGEMENT FRAMEWORK SCIENCE

QUESTIONS

- In the vain that "All models are wrong, but some are useful," can the panel briefly describe our current cougar and management models? Shortcomings and strength? What will it take to develop or refine these models? Regional or statewide? Timeframes? Costs? Competing priorities?
- We utilize models with the data we have, or the data we hope to collect, or utilize various research from elsewhere. But weoften don't have critical information. Without an actual tally, we develop predictive relationships. For cougar, we utilize densities and habitat, among other things. How confident are we of the density information? The habitat information? Is all habitat the same or are there degrees of good/fair/poor habitat?
- How useful is the Population Management Unit designation/areas? Does new science suggest these to be useful, outdated or need adjustments?
- What will it take to develop or refine these models? Regional or statewide? Timeframes? Costs? Competing priorities?
- What are we learning from longitudinal studies on cougar? Why are we doing that work?
- How well does the cougar populations tolerate the current level of take?
- Are we confident the population can handle the current level without a role-back to past harvest levels?
- What is the role of cougar in the ecosystem and the potential impacts to their ecological role from regulation changes?
- Can dispersing subadult numbers be managed by hunter harvest, and if so, how?

COUGAR MANAGEMENT FRAMEWORK

- Evolution, ecology, and recreation
- Two primary objectives
  1) Maintain population stability ($\lambda = 1.00$)
  2) Maintain social organization (i.e., territoriality)
- Additional objectives/considerations
  -Smaller management units -> avoid large closures
  -Redistribute hunter harvest
  -Quality animals (e.g., older, larger)
  -Scale relevant to predator and prey management
  -Aesthetic and cultural values

(Beausoleil et al. 2013)

COUGAR MANAGEMENT FRAMEWORK

- Management strategy

  -Harvest guidelines

  -Ecologically and logistically relevant scale

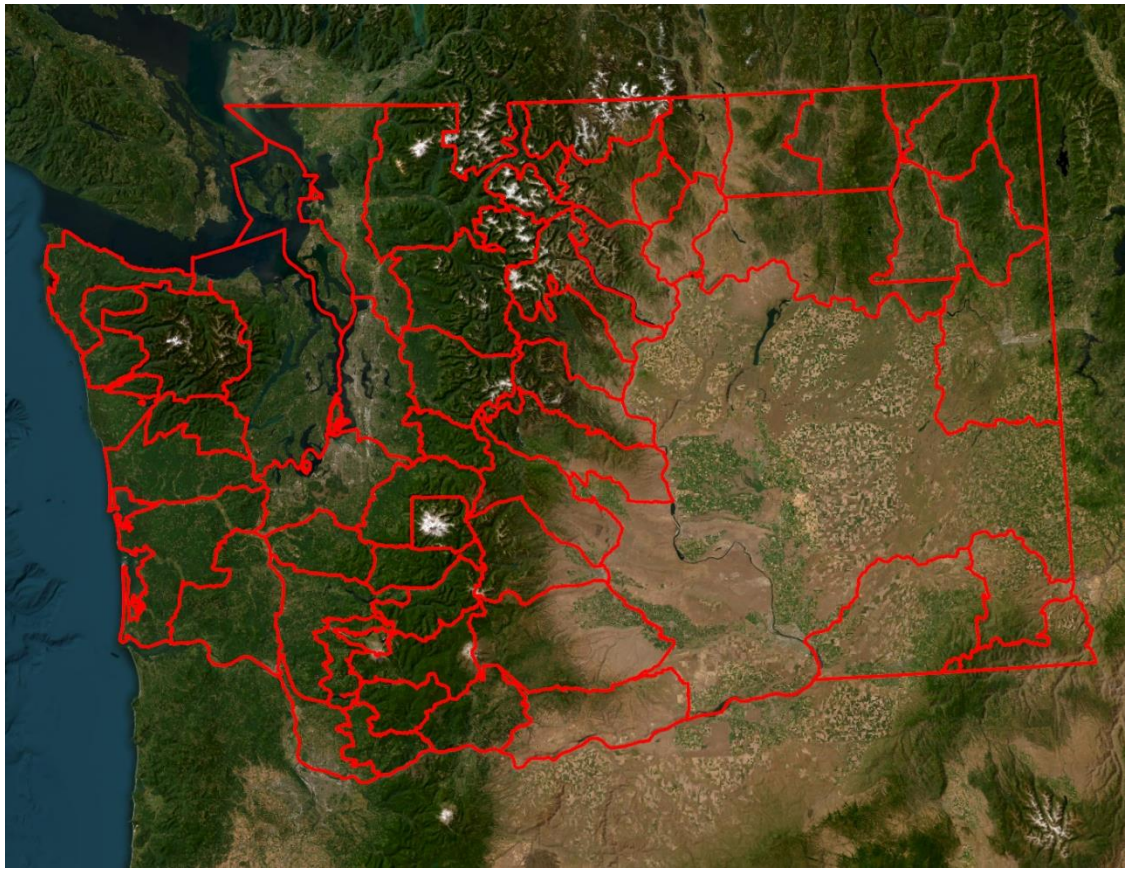
- Three key elements

  1) Population management units (PMUs)

  2) Population estimates

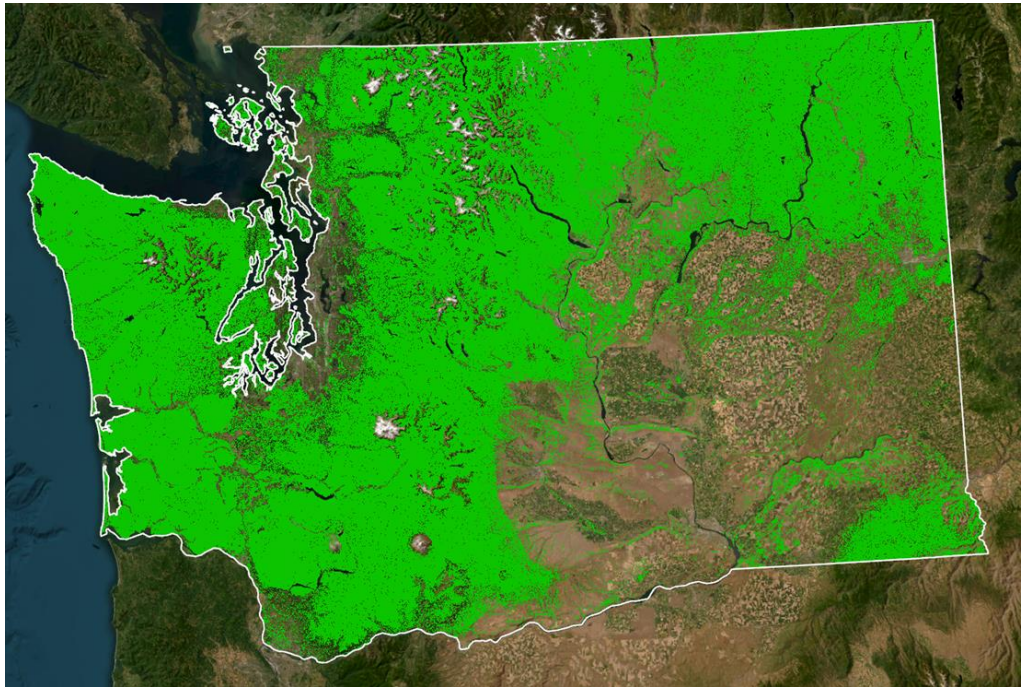
  3) Target harvest rate

COUGAR MANAGEMENT FRAMEWORK: PMUs

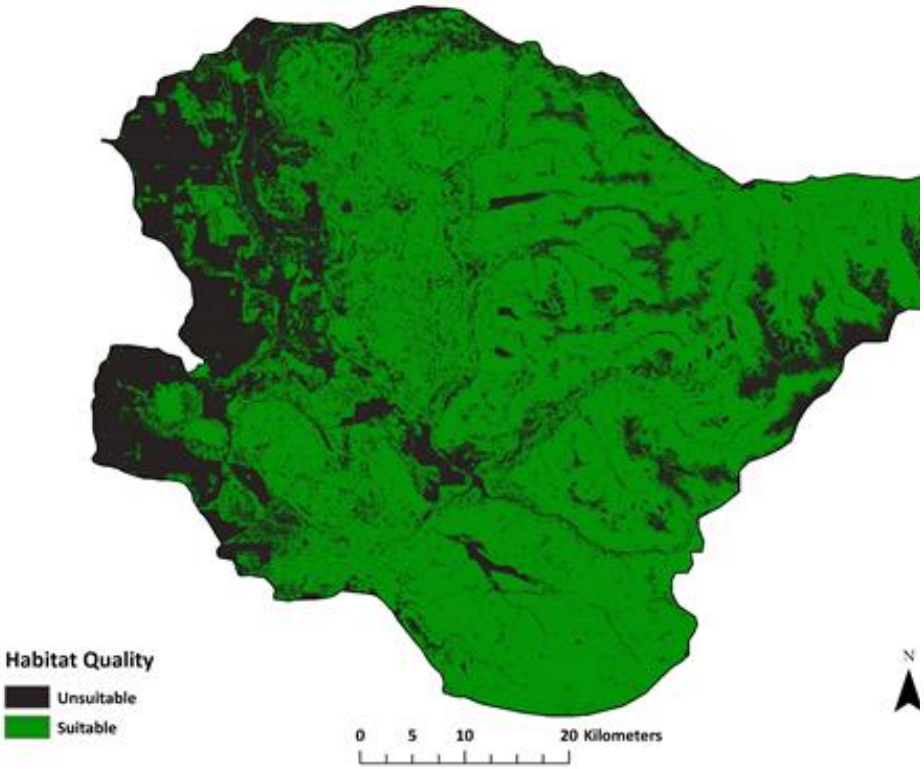


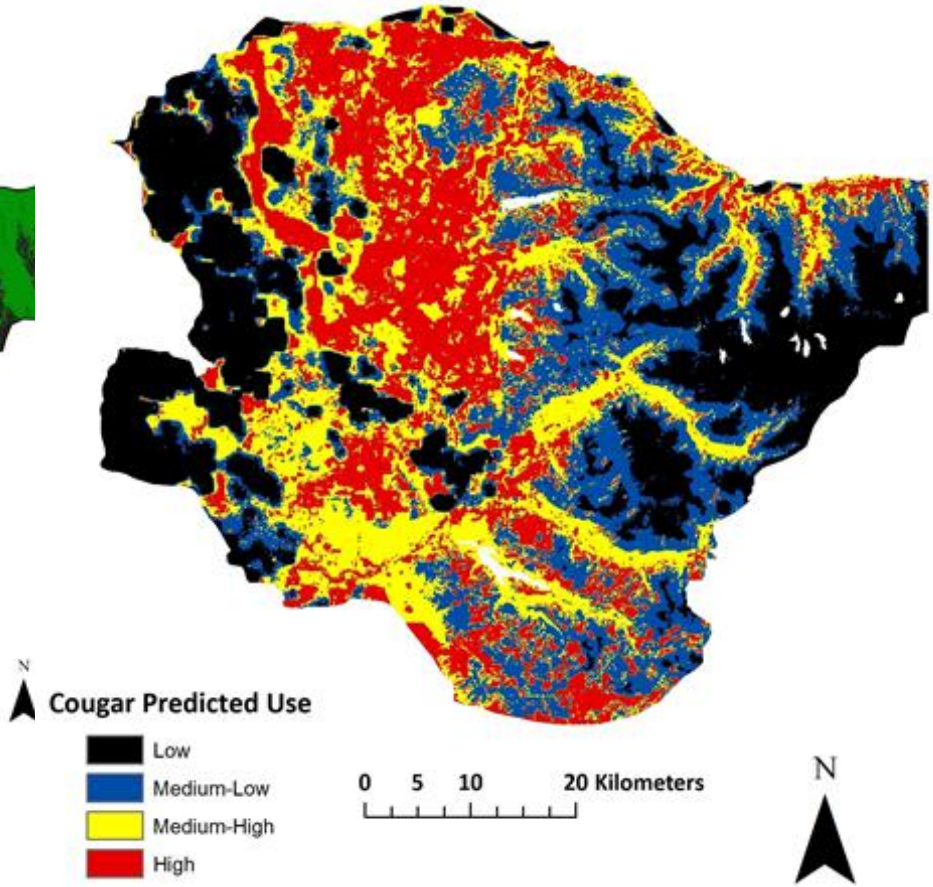
- GMUs foundation
- -Ungulate herds
- -Natural barriers
- ~Local cougar pop
- District Bio input
- 50 PMUs
- Effective scale

COUGAR MANAGEMENT FRAMEWORK: HABITAT



- LandFire GIS
- Binary
- Validated w/ GPS
- 104,000 km^2
- 90,783 km^2 - WDFW

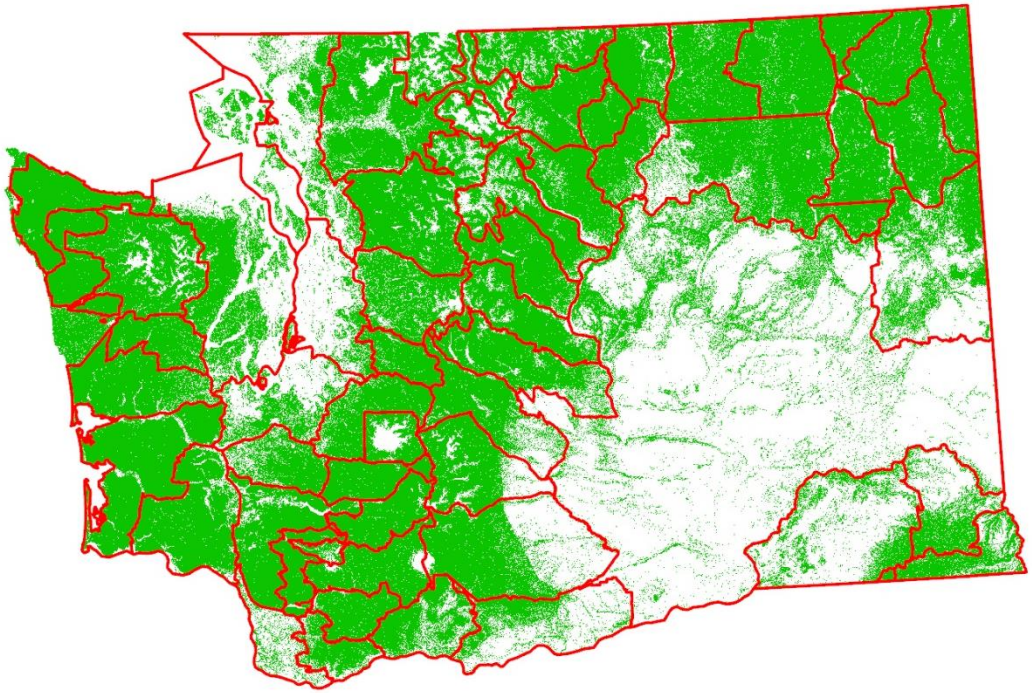




- Elevation
- Residential density
- Distance to residential
- % Forest
- % Regenerating forest
- % Conifer forest
- Slope
- Distance to road
- Distance to water
- Forest edge ratio

Kertson et al. 2011

COUGAR MANAGEMENT FRAMEWORK: PMU ABUNDANCE



- Density (2.2/100 km^2)
- Habitat area
- Solve for x (abundance)

COUGAR MANAGEMENT FRAMEWORK: HARVEST RATE

- Wielgus et al. 2013
- Cle Elum & "The Wedge" (GMU 105)
- Leslie matrix in RAMAS GIS
- Right-censored hunting mortalities
- 2 conflict mortalities over a 5-year period
- Cle Elum: $\lambda = 1.14$, SD = 0.03
- Wedge: $\lambda = 1.14$, SD = 0.01

COUGAR MANAGEMENT FRAMEWORK: HARVEST GUIDELINES

2015 WDFW Hunting Pamphlet

General Cougar Seasons ATTENTION - A 2016 cougar tag is required to hunt cougar in April 2016.

Hunt Area	Harvest Guideline	Hunt Area	Harvest Guideline	Hunt Area	Harvest Guideline	Hunt Area	Harvest Guideline
GMU 101	10-12	GMUs 218, 231	6-7	GMU 454	N/A[a]	GMUs 607, 615	4-5
GMU 105	2-3	GMU 224	2-3	GMU 460	5-7	GMUs 618, 636, 638	4-5
GMUs 108, 111	7-8	GMUs 233, 239	3-4	GMUs 466, 485[b], 490	2-3	GMUs 621, 624, 627, 633	N/A[a]
GMU 113	6-8	GMUs 242, 243	6-7	GMUs 501, 504, 506, 530	7-10	GMUs 642, 648, 651	6-8
GMU 117	8-10	GMUs 244, 246, 247	5-6	GMUs 503, 505, 520, 550	6-8	GMUs 652, 666	N/A[a]
GMU 121	6-8	GMUs 245, 250	5-6	GMUs 510, 513	3-4	GMUs 653, 654	4-6
GMUs 124, 127, 130	7-9	GMUs 249, 251	7-8	GMU 516	3-5	GMUs 658, 660, 663, 672, 673, 681, 684, 699	9-12
GMUs 133, 136, 139, 142, 248, 254, 260, 262, 266, 269, 272, 278, 284, 290, 330, 334, 371, 372, 373, 379, 381	N/A[a]	GMUs 328, 329, 335	8-10	GMUs 524, 554, 556	3-4	GMU 667	3-4
GMUs 145, 166, 175, 178	5-6	GMUs 336, 340, 342, 346	5-7	GMU 560	5-6	Check on Cougar Hunt Area Closures 1-866-364-4868 or go online at wdfw.wa.gov/hunting/cougar	
GMUs 149, 154, 162, 163	6-7	GMUs 352, 356, 360, 364, 368	5-7	GMU 564	2-3		
GMUs 169, 172, 181, 186	4-5	GMUs 382, 388	3-4	GMU 568	2-3	**Hunt Notes:** a Season open from Sept. 1, 2015 to April 30, 2016 with no harvest guideline. b Only those hunters who have been drawn for a quality deer or elk permit in GMU 485 can hunt cougar in this unit.	
GMU 203	4-6	GMU 407	N/A[a]	GMU 572	3-4		
GMU 204	9-11	GMUs 418, 426, 437	11-15	GMUs 574, 578	3-5		
GMUs 209, 215	4-5	GMUs 448, 450	9-13	GMUs 601, 602, 603, 612	5-7		

- **Guideline:**

- 12-16% of independent population

-Does not include conflict removals -> flexibility

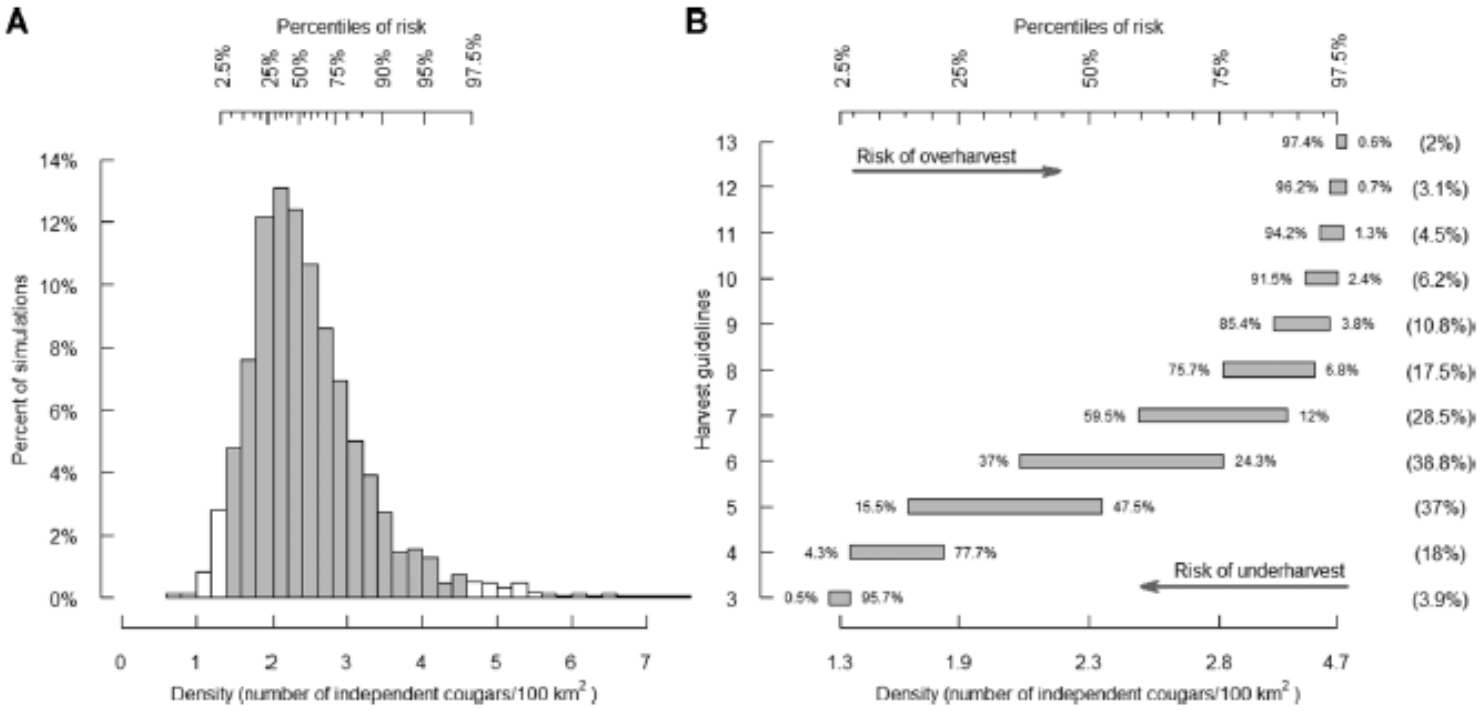
-Regional discretion

COUGAR MANAGEMENT FRAMEWORK: IMPLEMENTATION

- **A history of adjustments**
  - 2012-13: implemented, with split season
  - 2015-16: April added, 24 hr. closure ended
  - 2019-20: Increased guidelines in 19 PMUs, adults only guideline
  - 2021: Blues bag limit 2
- **Potential revisions for upcoming GMP**
  - -Incorporating additional research findings
    - -> West Cascades, Blues, Okanogan, PPP
  - -Improved accounting of human mortality
  - -Revisiting the habitat map

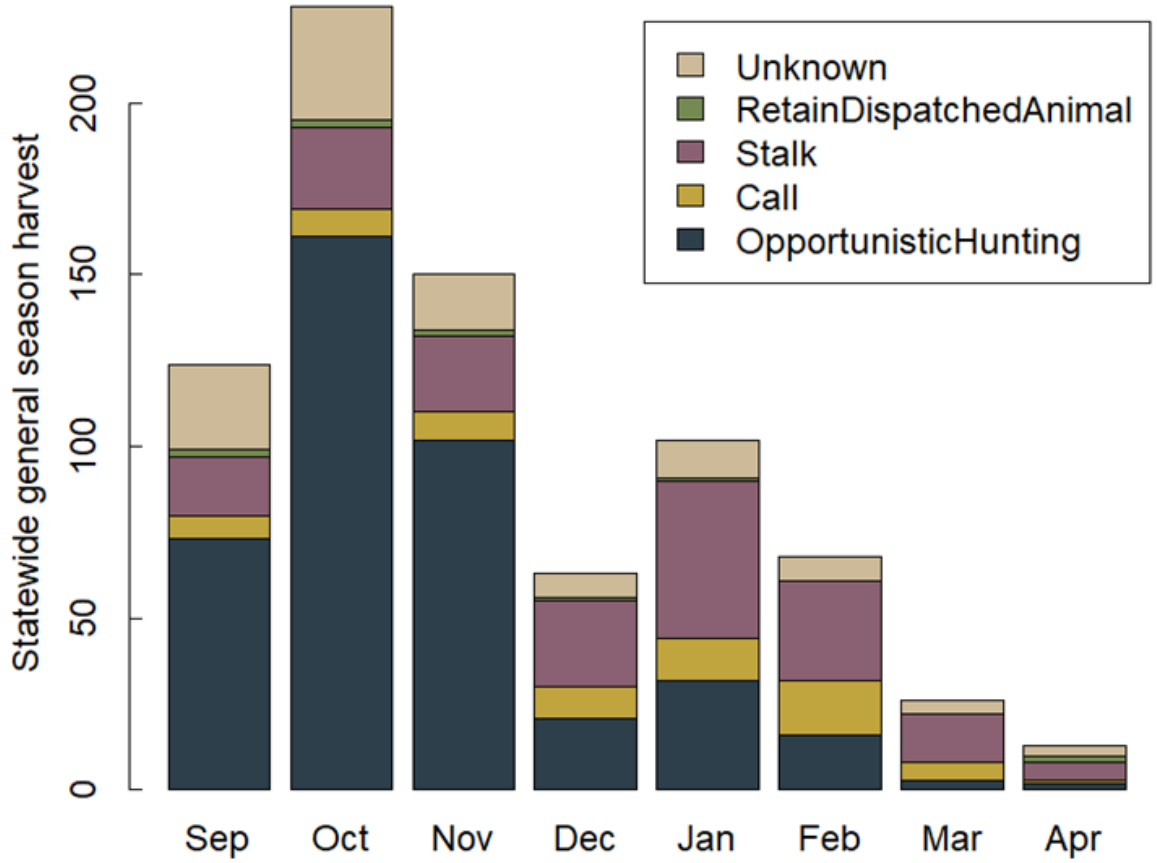
HUNTER HARVEST RISK FOR THE MANAGEMENT OBJECTIVE

- **Not the statistical risk of population decline; it is the risk of not meeting the 12%-16% harvest rate**



Beausoleil et al. 2021

OPPORTUNISTIC VS. TARGETED HUNTING



SEASON HARVEST DEMOGRAPHICS

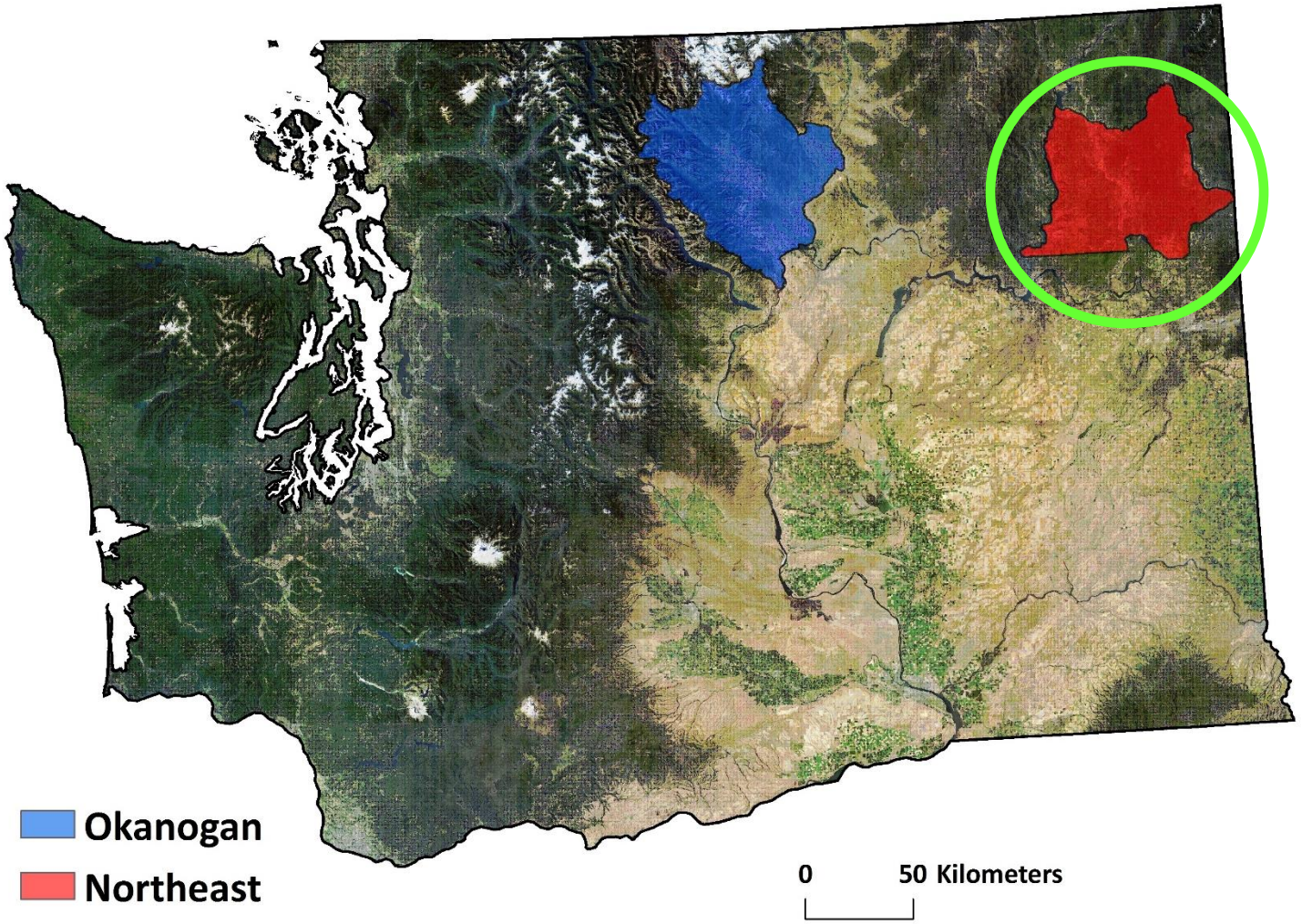
2013 – 2022 Harvest

	12-24 mo	24+ mo	Prop. Subadults
Early	432	882	32.9
Late	64	258	19.9

χ-squared = 20.081, df = 1, p-value < 0.001

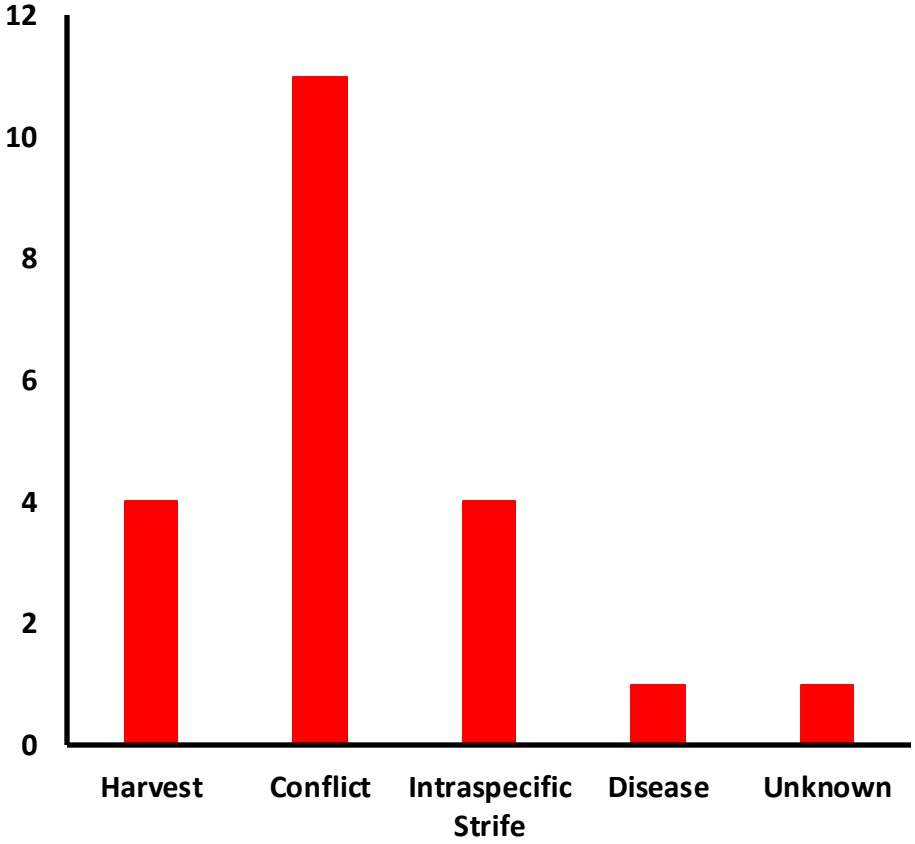
- **More subadults taken during the opportunistic Early season**
- **More adults relative to subadults taken in Late season**

PREDATOR-PREY PROJECT
2017-2021



PREDATOR-PREY PROJECT MORTALITY AND SURVIVAL

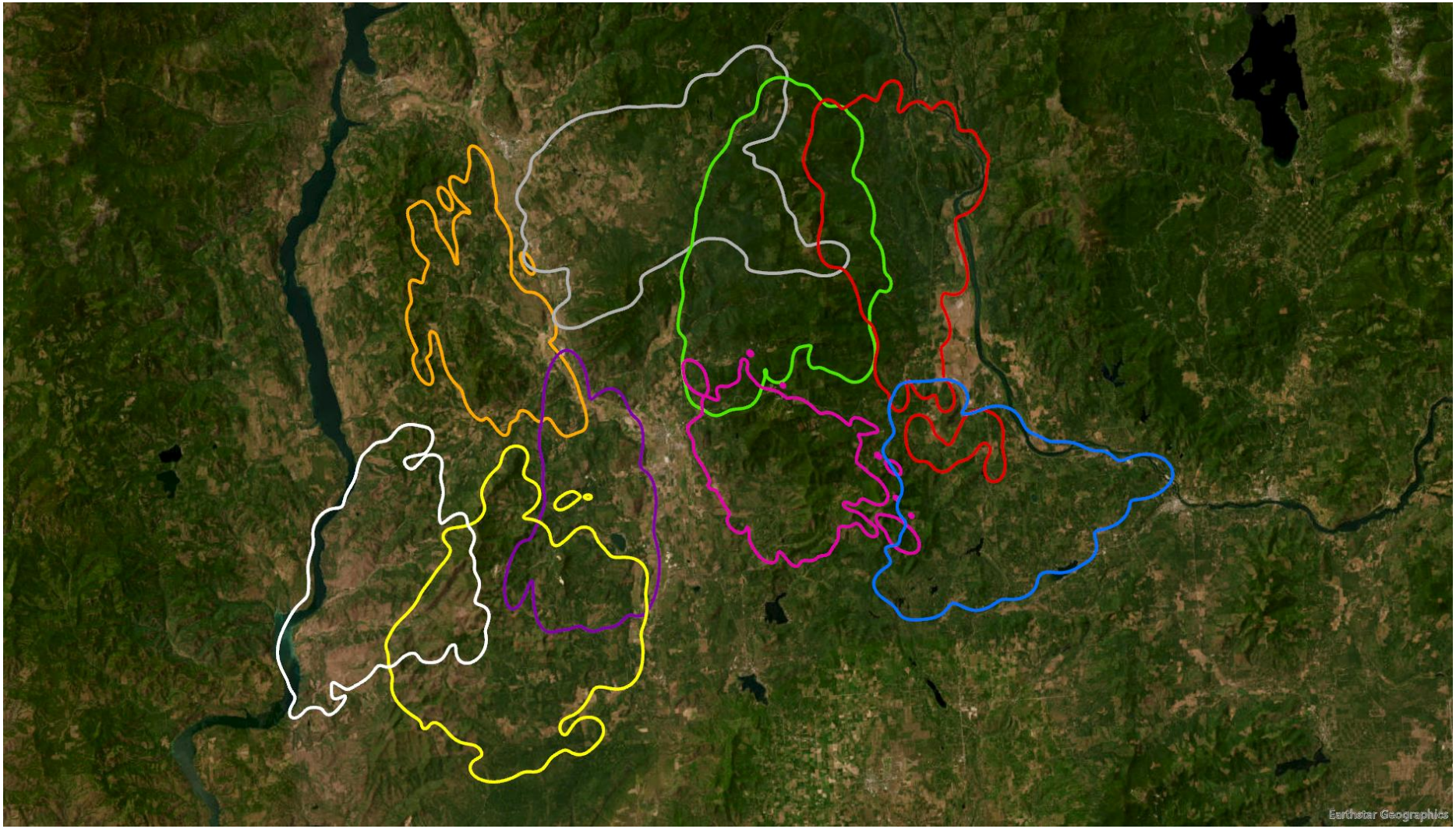
Northeast (n = 21)



Demographic Class	n	$\widehat{S}$	SE
Sex			
Female	18	77.2	6.3
Male	16	63.1	8.8
Age			
Adult	26	72.3	5.7
Subadult	11	65.4	14.1
Sex & Age			
Adult Female	14	78.9	6.6
Subadult Female	6	66.7	19.2
Adult Male	12	63.4	9.7
Subadult Male	5	62.5	21.3

Preliminary Results

PREDATOR-PREY PROJECT
SOCIAL ORGANIZATION



COUGAR INTERSPECIFIC RELATIONSHIPS

QUESTIONS

- **Discuss the interrelationship of cougars and bears (and wolves) on the landscape and how this might or might not affect prey populations.**

INTERSPECIFIC COMPETITION

- **Black Bears**
  - -Overlap is common
  - -Kleptoparasitism (i.e., stealing kills)
  - -Some evidence of increased kill rates (Allen et al. 2021)
- **Wolves**
  - -Overlap common, but also avoidance (Wirsing et al., in prep)
  - -Interference competition (e.g., Elbroch et al. 2020, WDFW unpublished)
  - -Kleptoparasitism
  - -Forthcoming research findings from PPP
- **Griffin et al. 2011**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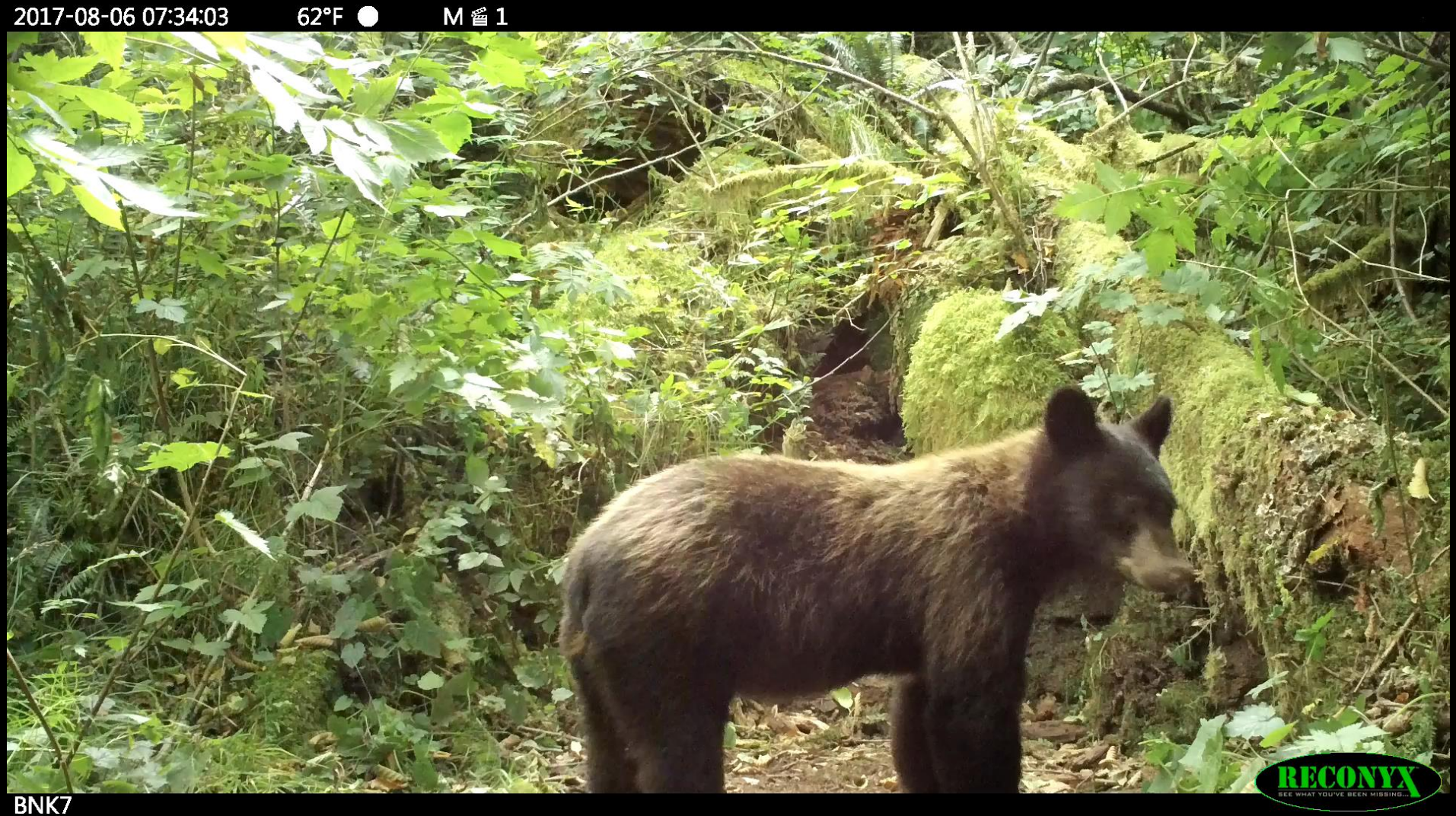
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BNK7

QUESTIONS?

CITATIONS

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