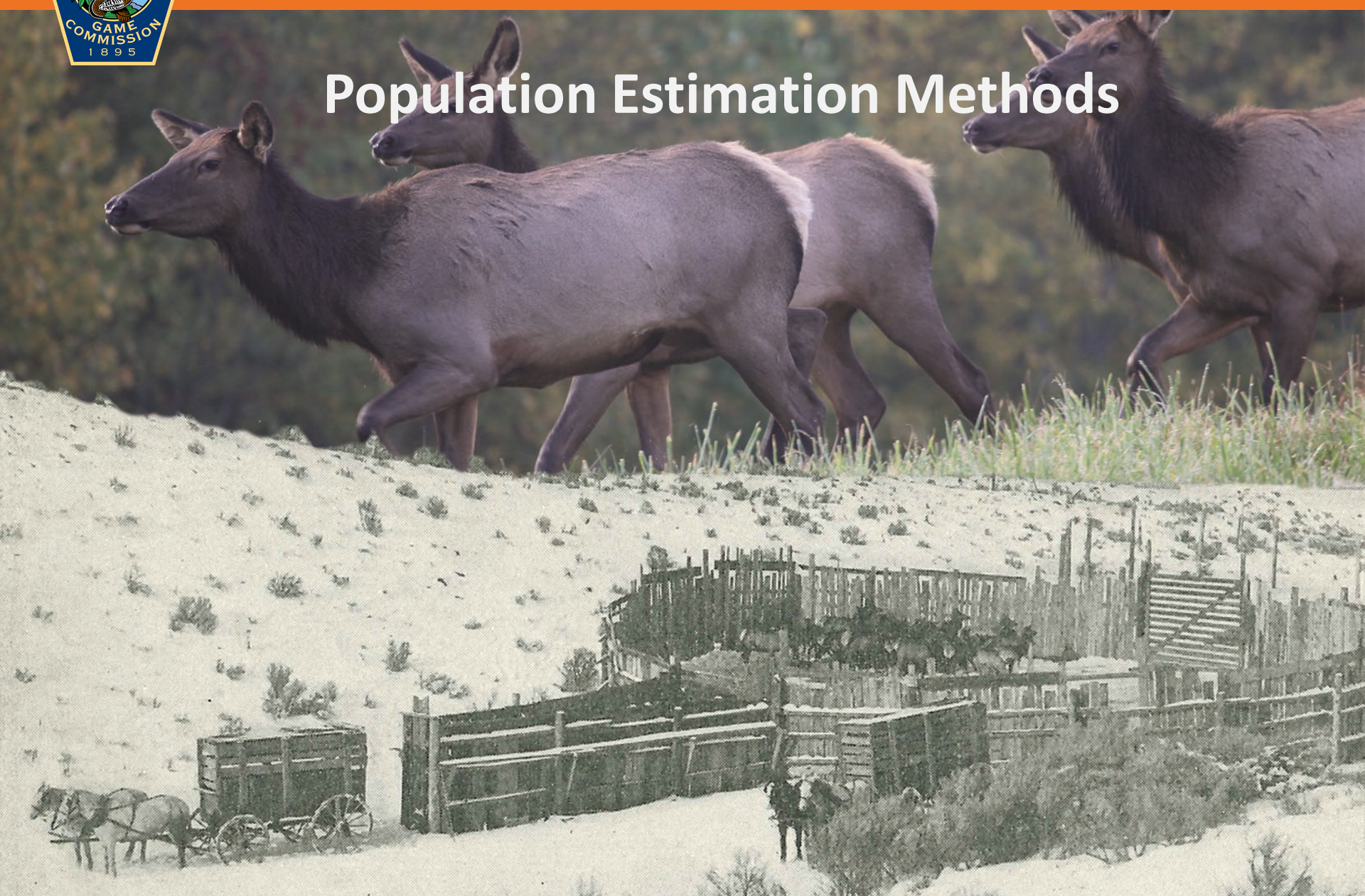




PENNSYLVANIA ELK

Population Estimation Methods





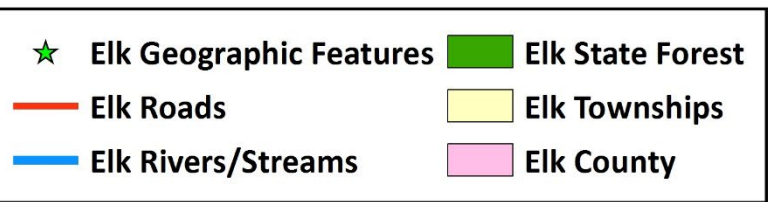
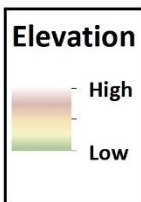
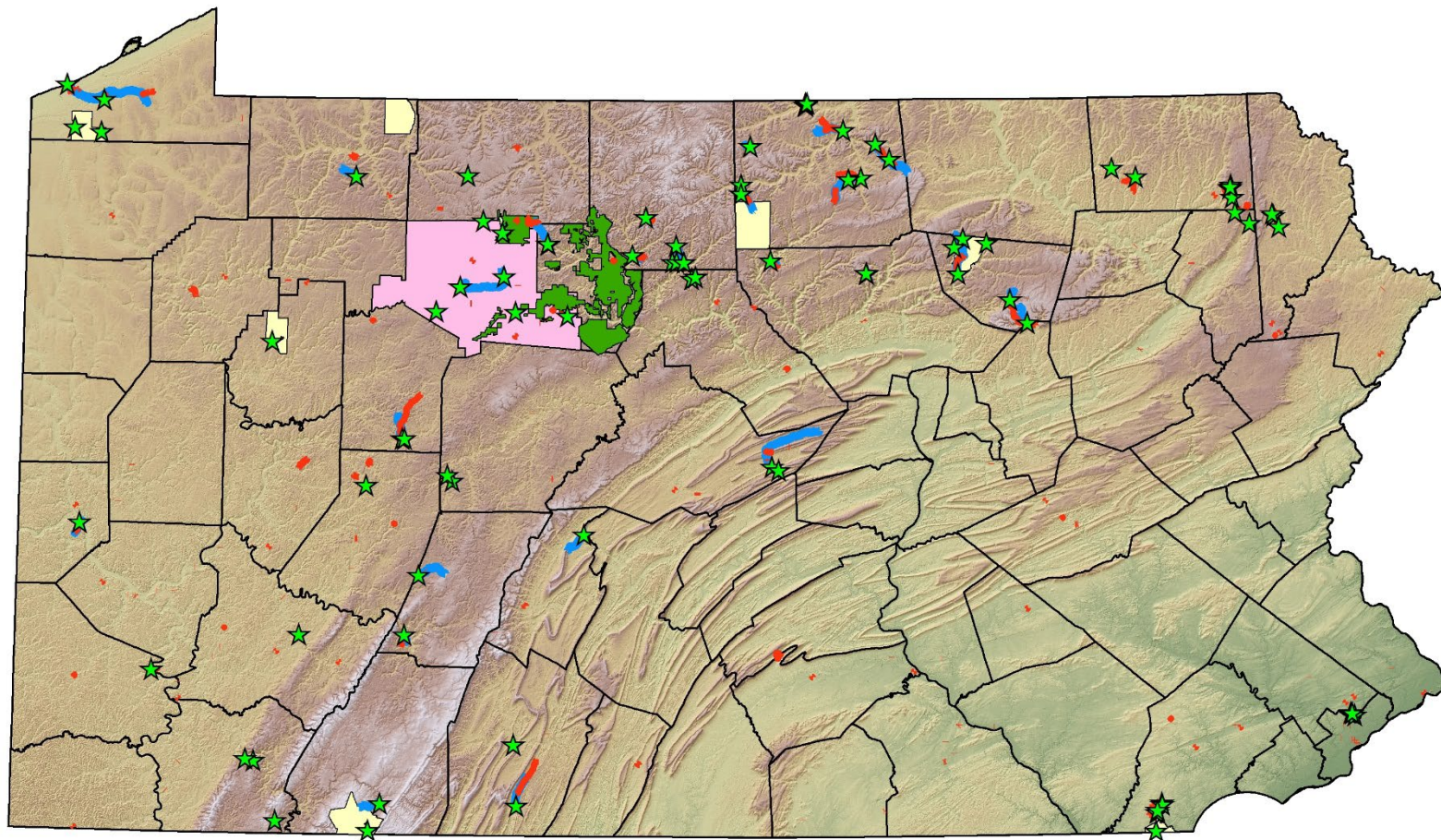
OUTLINE

- ELK REINTRODUCTION
- PA's ELK MANAGEMENT AREA
- POPULATION ESTIMATION METHODS
 - Aerial Survey
 - Radio Collared Elk
 - Mark-Recapture Estimate
 - Associated Challenges





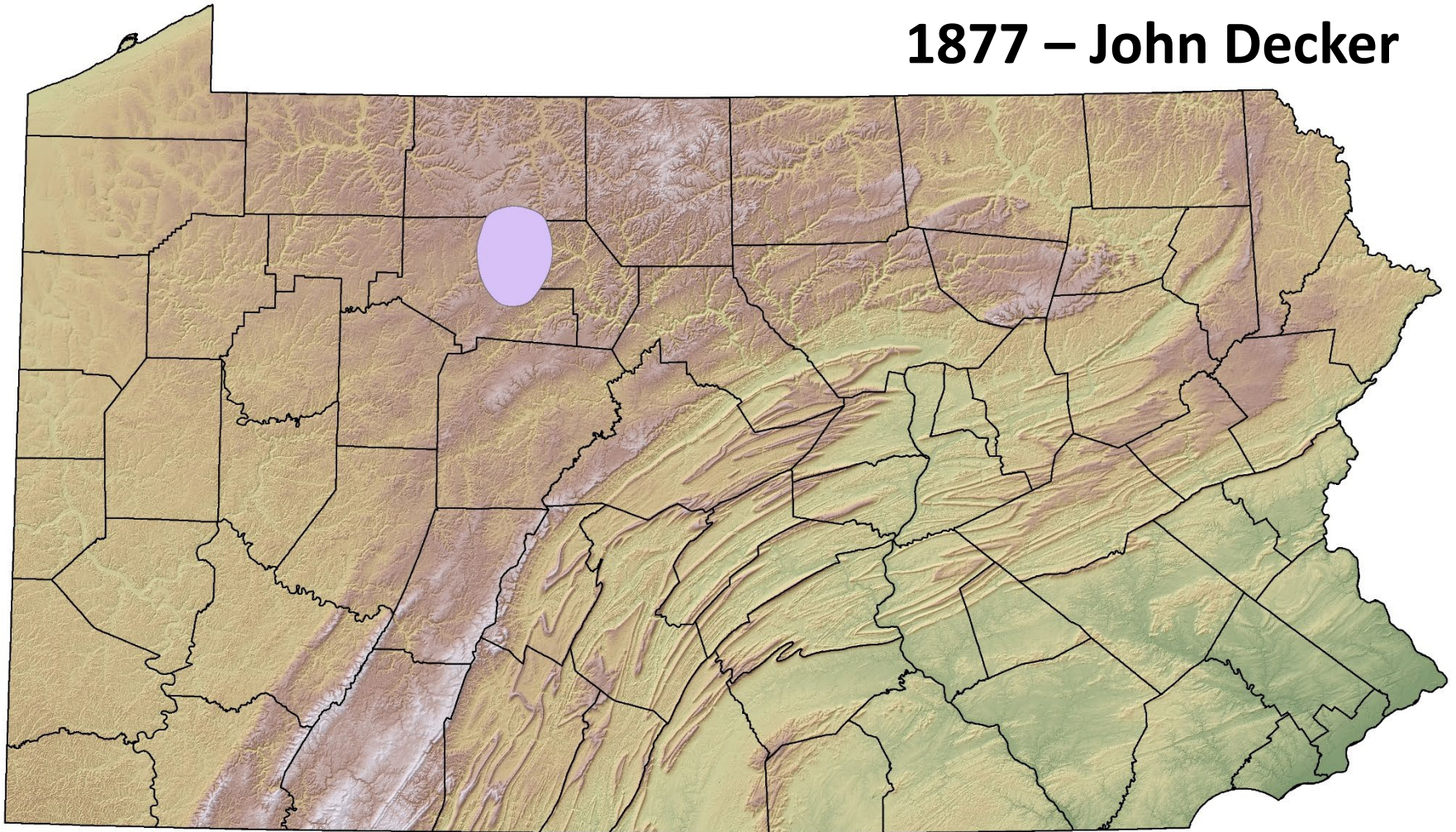
HISTORICAL DISTRIBUTIONS





EXTIRPATION

1867 – Jim Jacobs
1877 – John Decker





REINTRODUCTIONS...

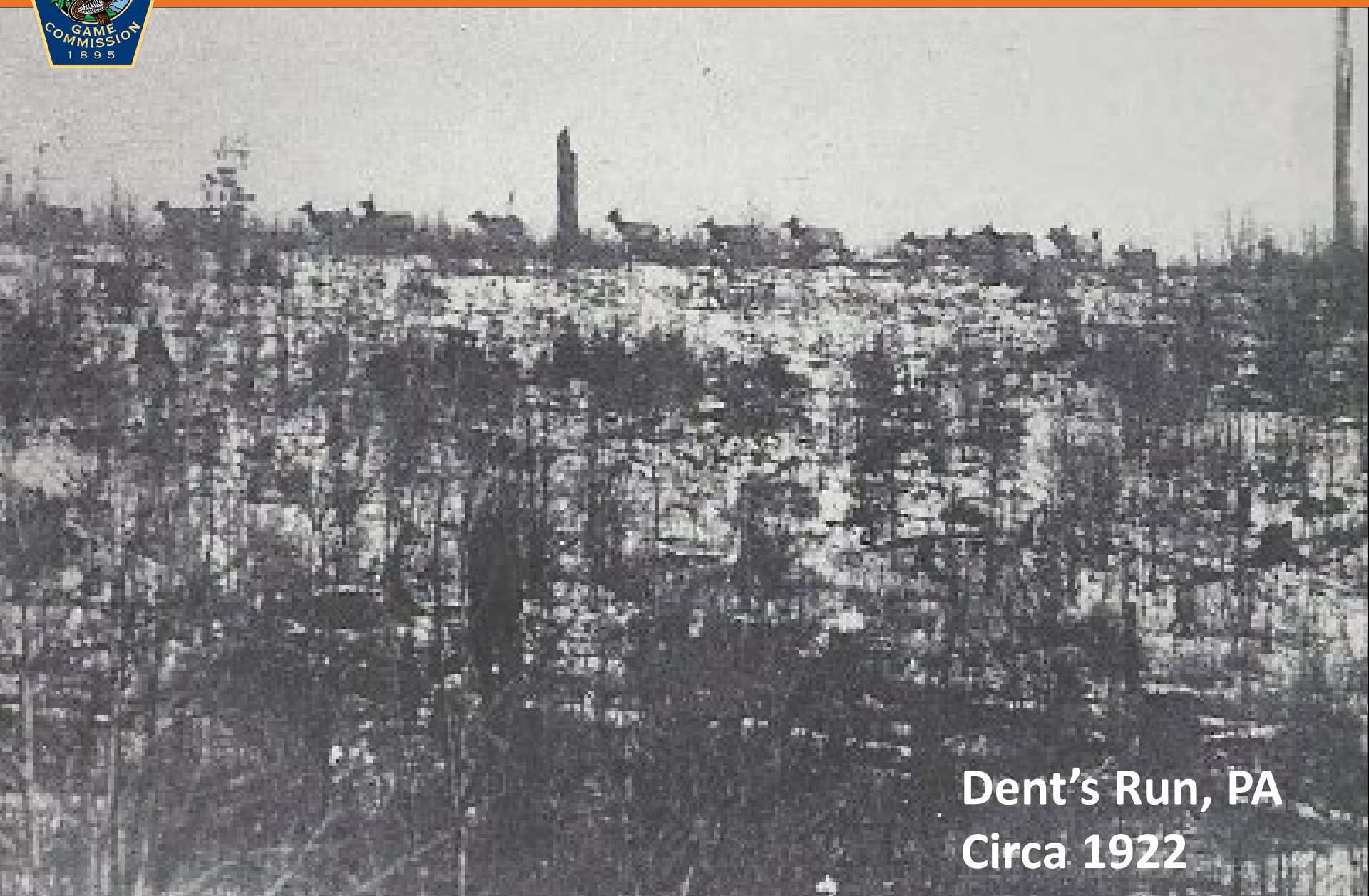


Year	Source	Number of Elk	County of Release	Comments
1913	Yellowstone National Park, WY/MT	50	Clearfield (25) & Clinton (25)	All 50 survived transit
1913	Monroe County, Pennsylvania	22	Monroe (12) & Centre (10)	Private reserve
1915	Yellowstone National Park, WY/MT	95	Potter (24), Cameron (24), Carbon (24), Forest (10), Blair (7), & Monroe (6)	100 captured, 5 lost in transit
1924	Wind Cave National Park, South Dakota	6	Elk County (6)	All bulls
1926	Wind Cave National Park, South Dakota	4	Elk County (4)	All bulls





REGENERATION (1915-1928)



Dent's Run, PA
Circa 1922



ELK HUNTING (1923-1931)

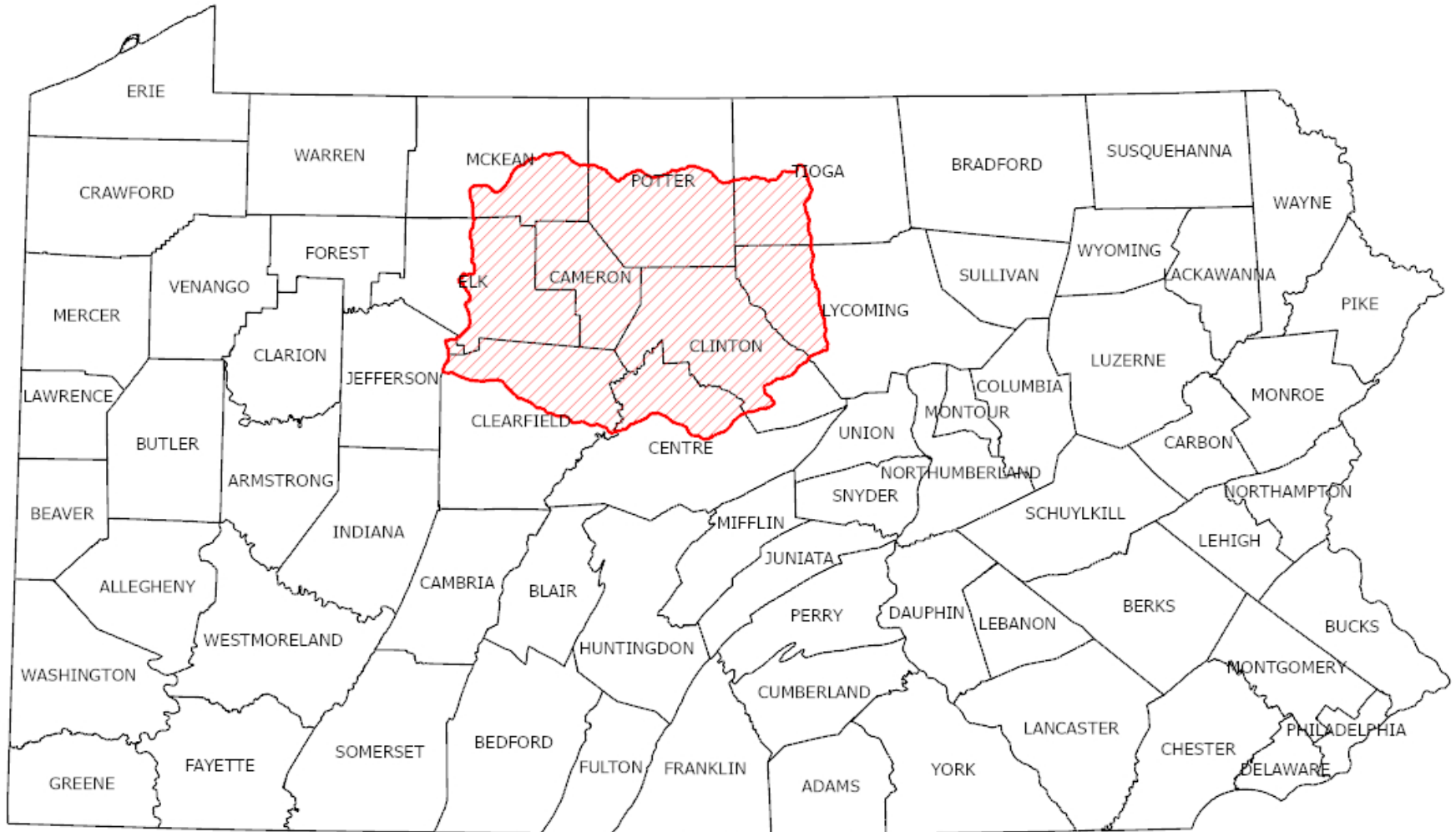


Year/ Season	Bull Harvest
1923	23
1924	10*
1925	6
1926	9*
1927	26
1928	6
1929	12
1930	5
1931	1
Total	98

* Years of additional reintroductions

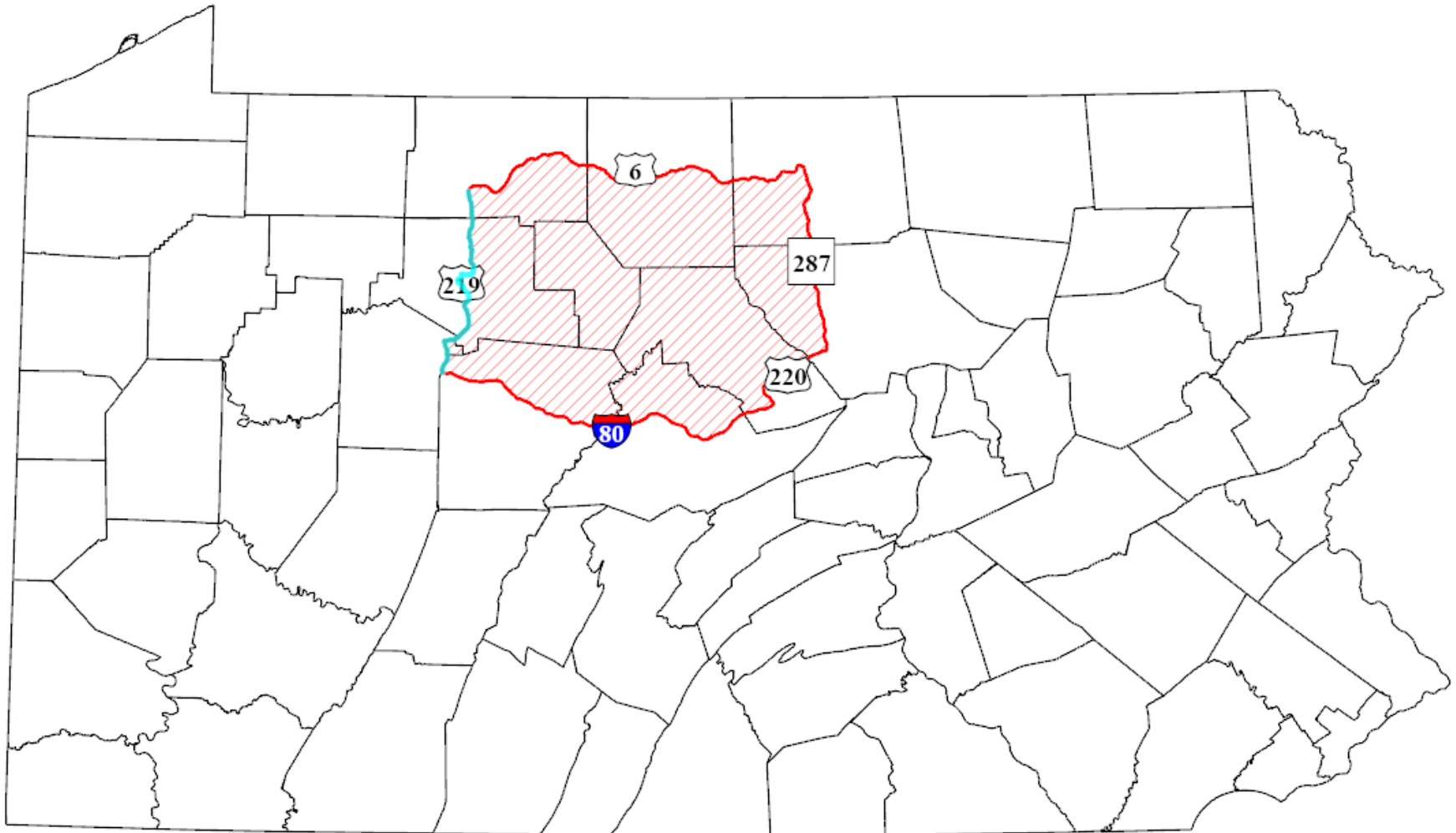


ELK MANAGEMENT AREA (EMA)



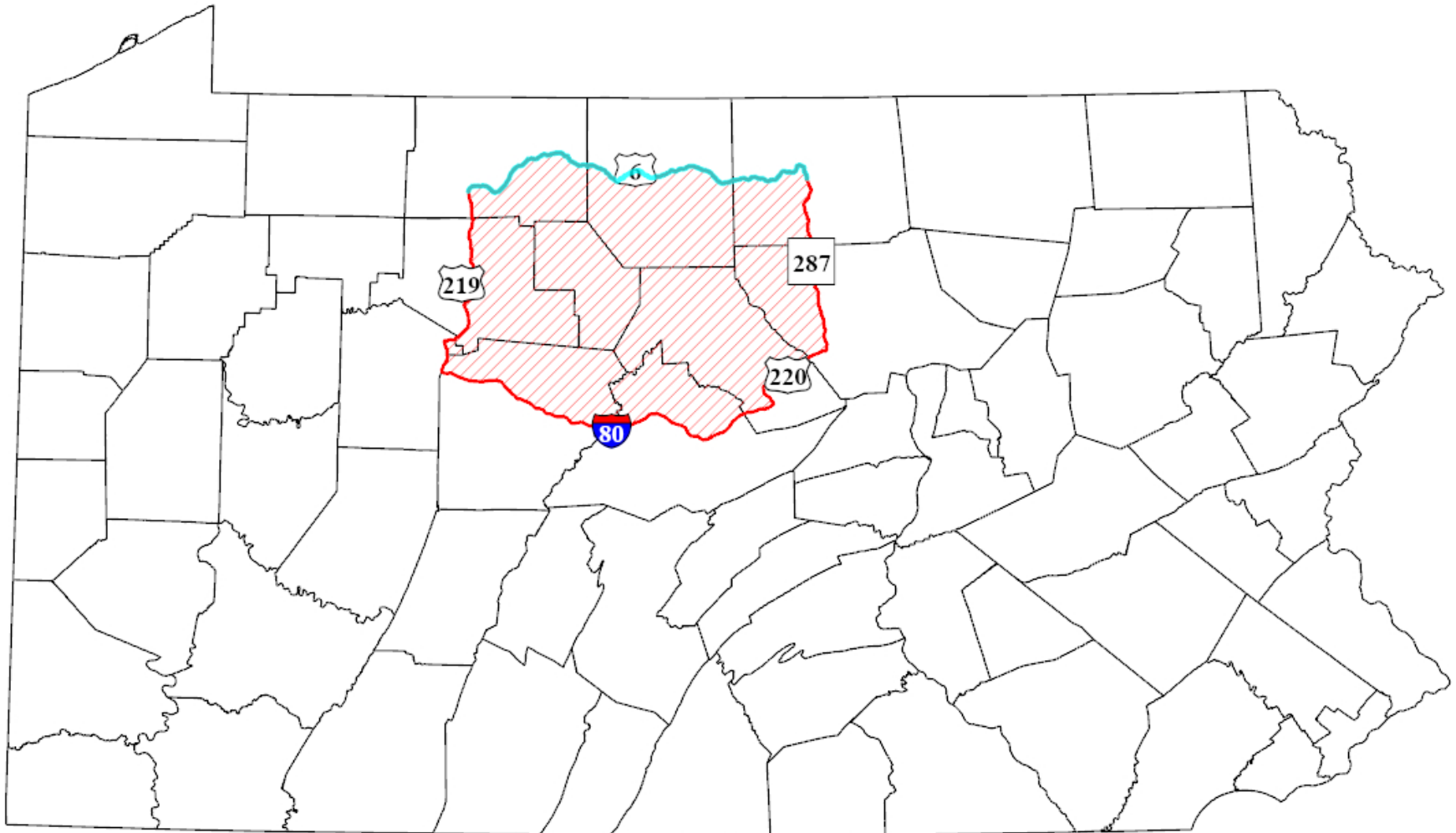


ELK MANAGEMENT AREA (EMA)



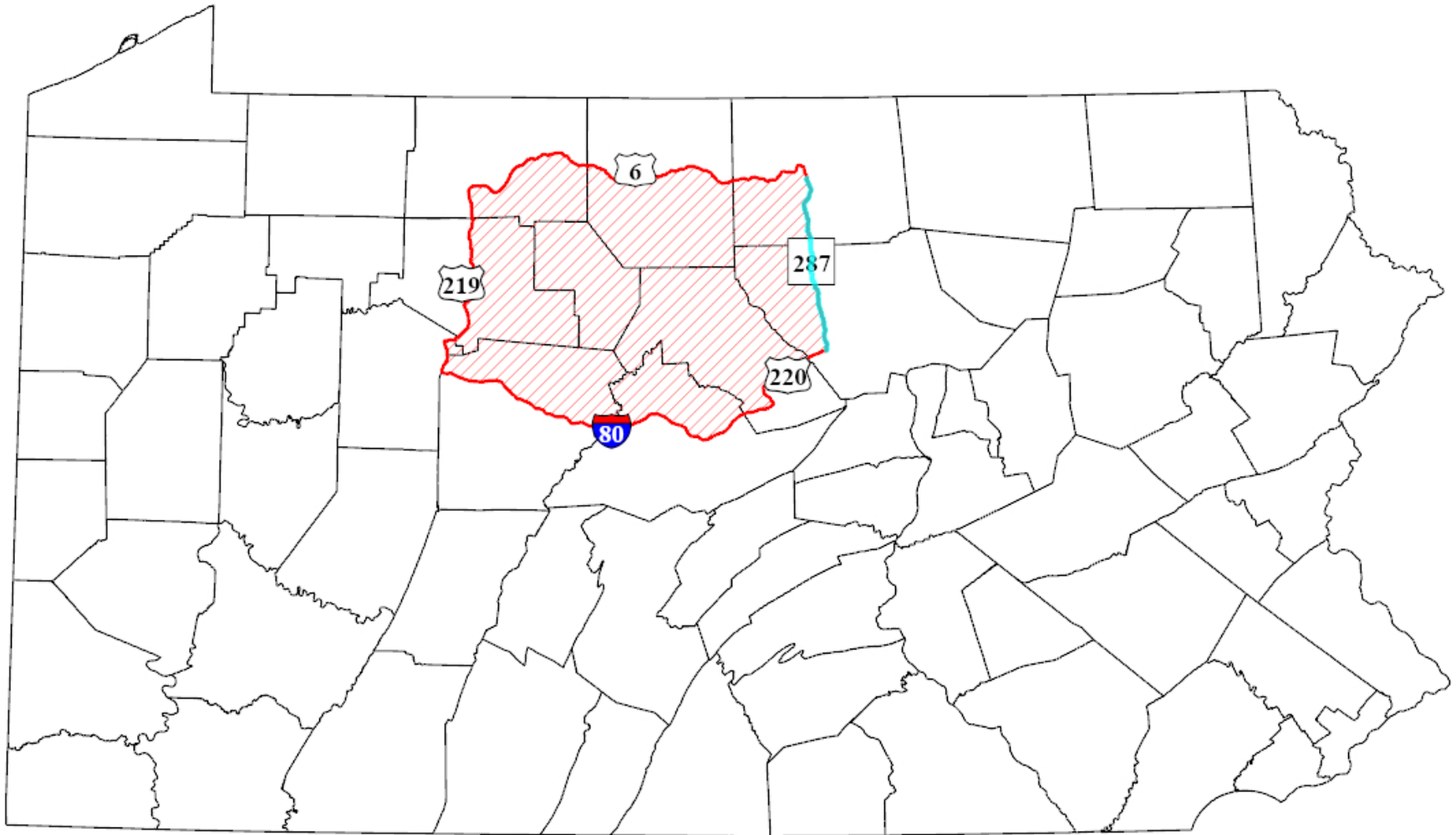


ELK MANAGEMENT AREA (EMA)



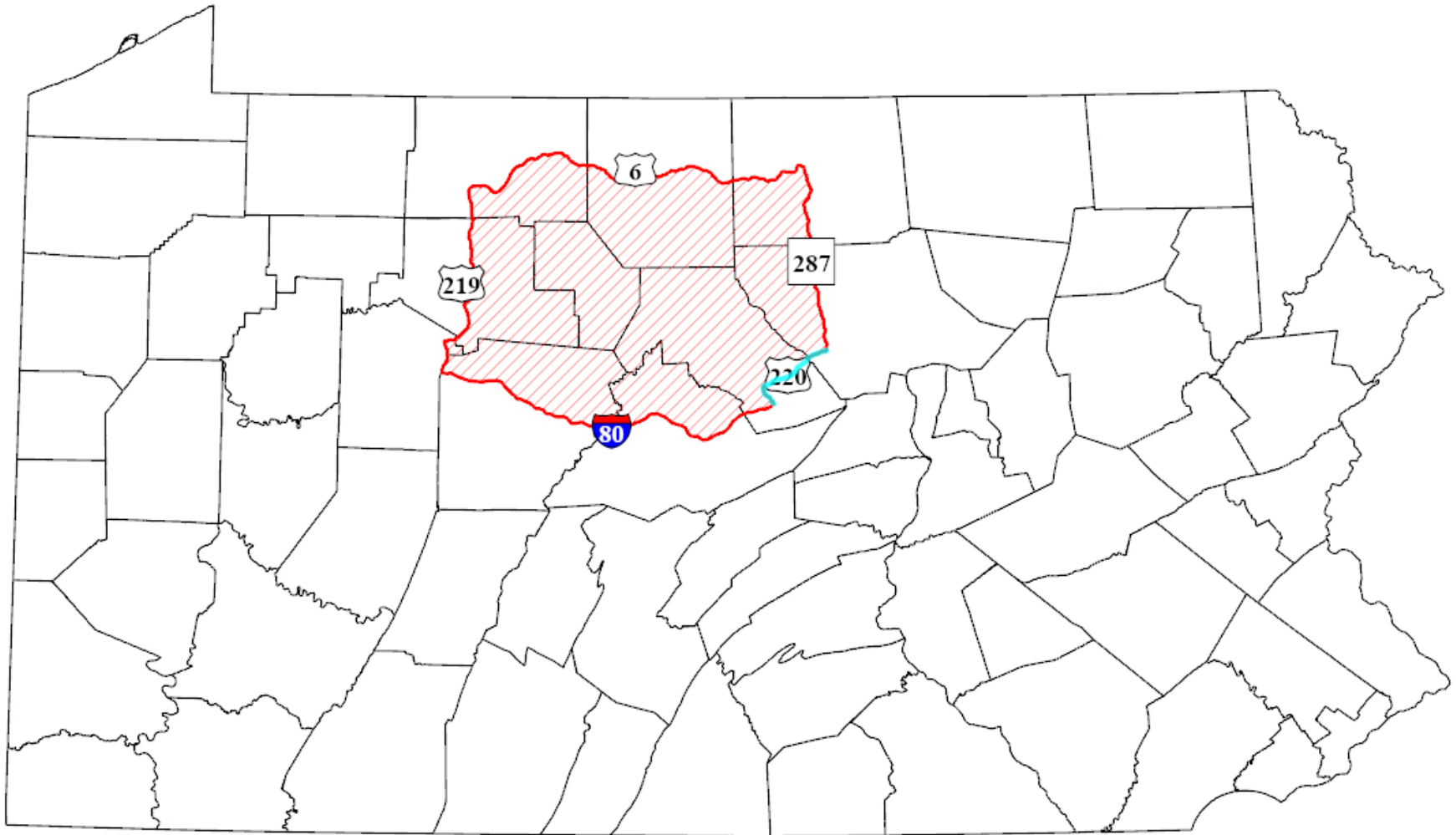


ELK MANAGEMENT AREA (EMA)



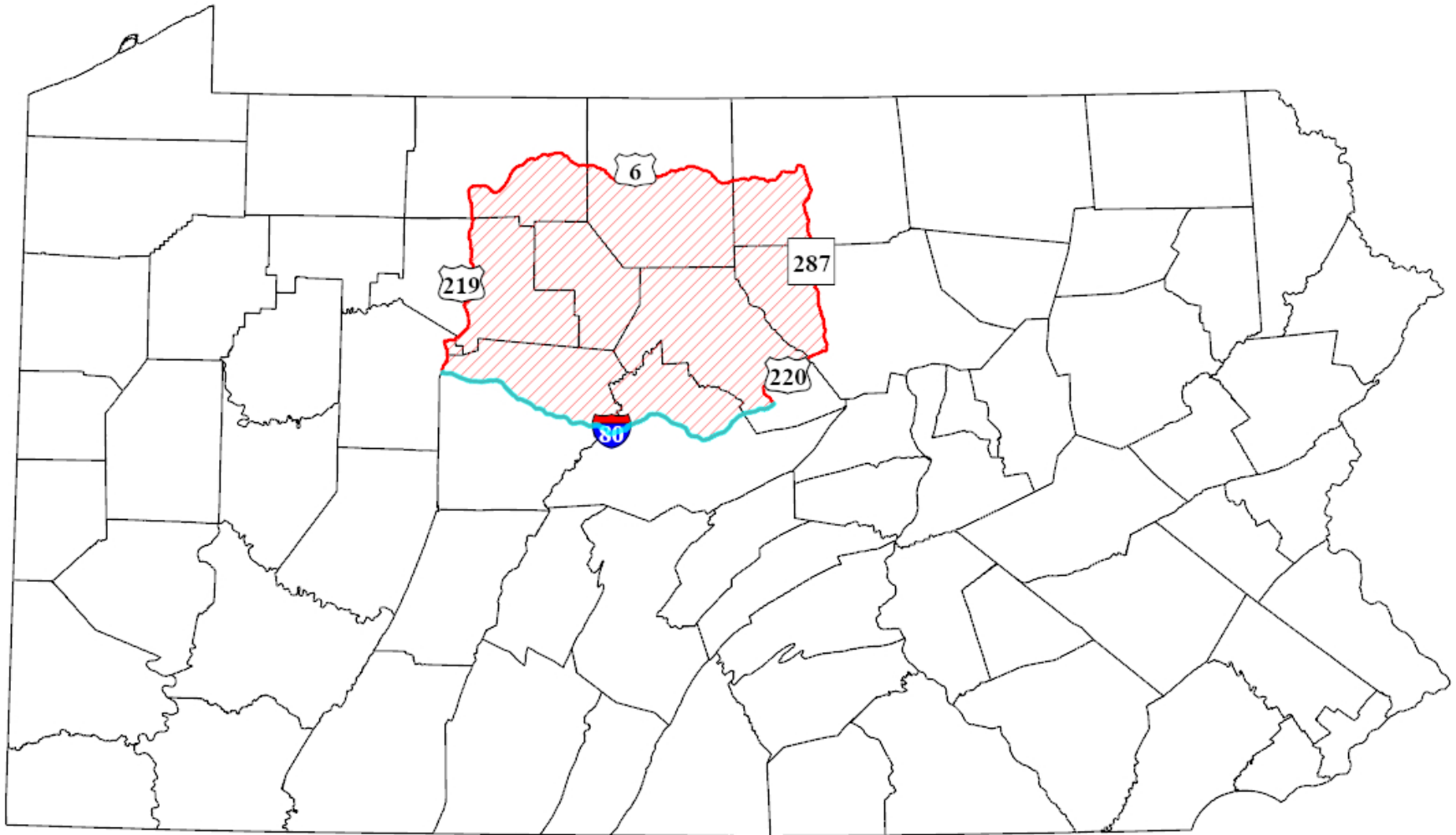


ELK MANAGEMENT AREA (EMA)



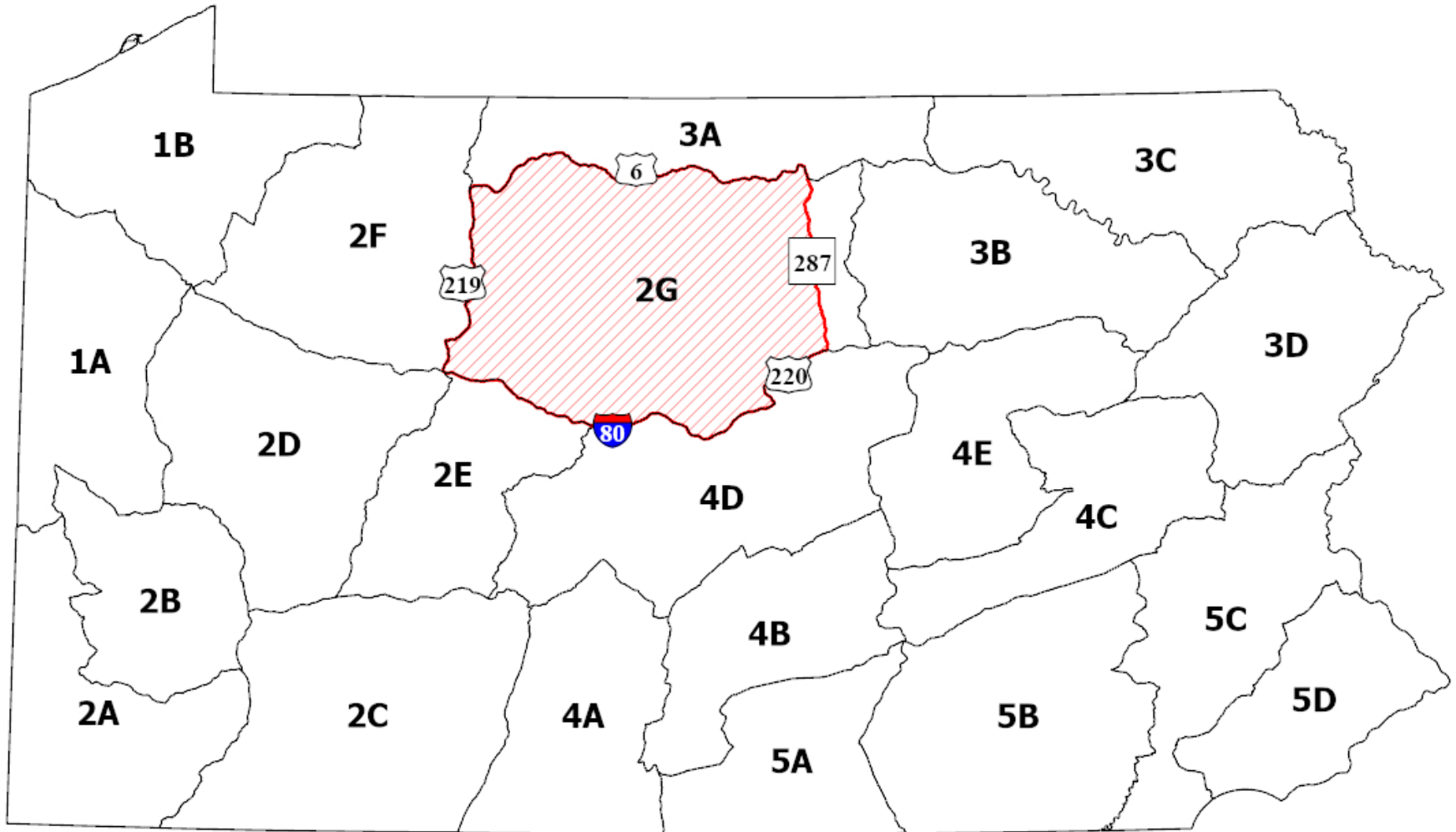


ELK MANAGEMENT AREA (EMA)





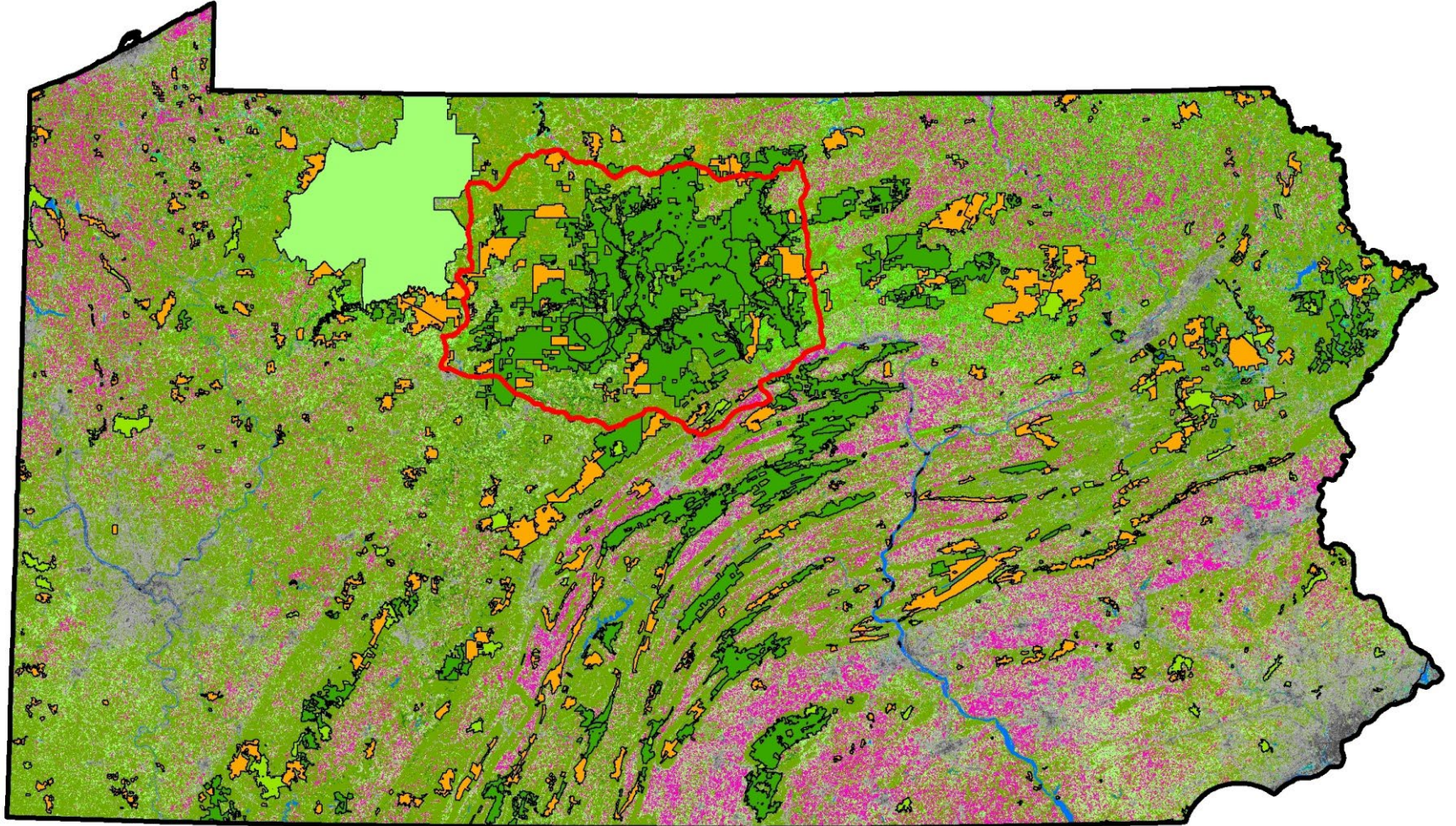
ELK MANAGEMENT AREA (EMA)





ELK MANAGEMENT AREA (EMA)

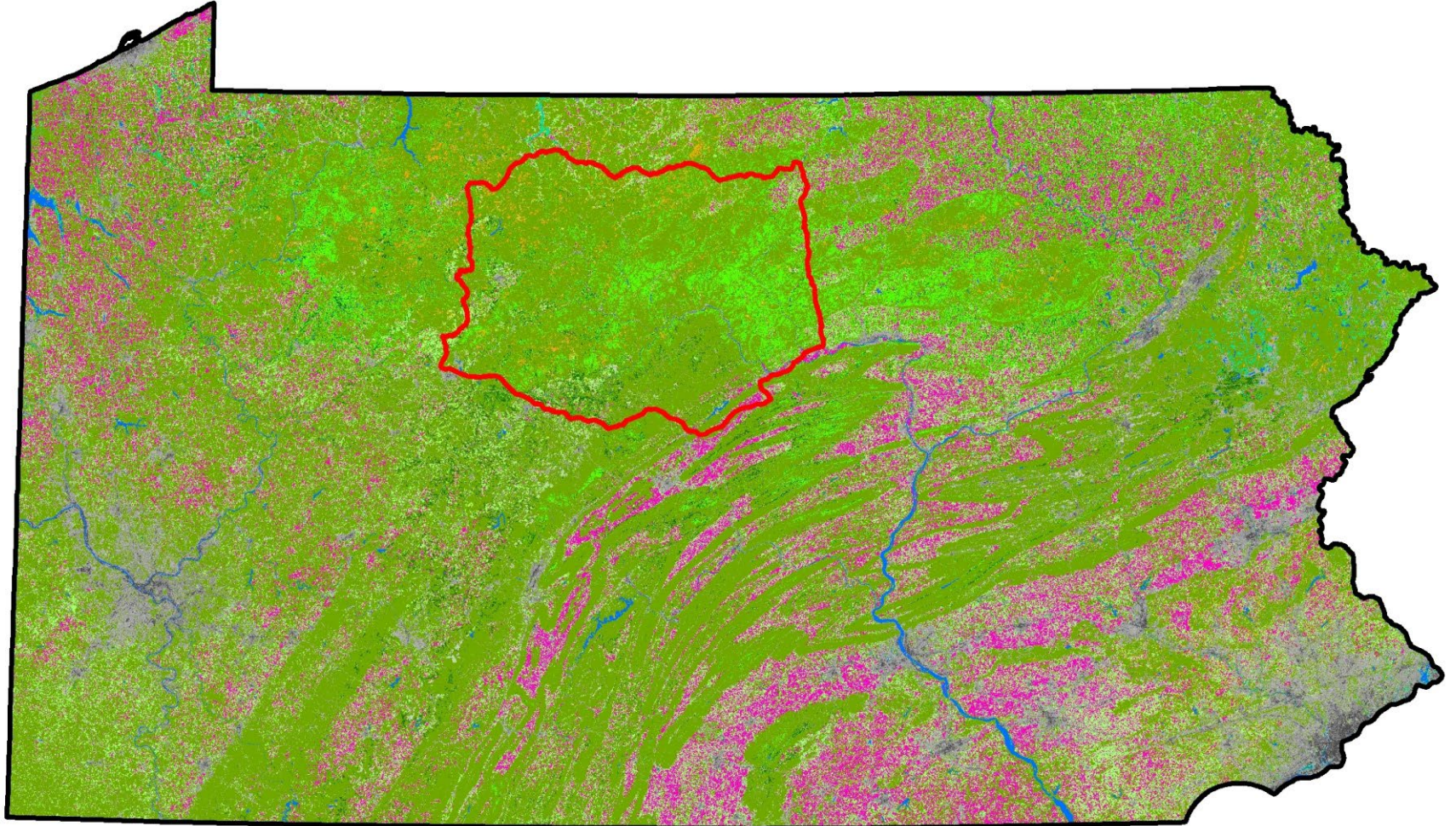
Public Land Base >70%





ELK MANAGEMENT AREA (EMA)

Avoid Agriculture





HOW MANY ELK?



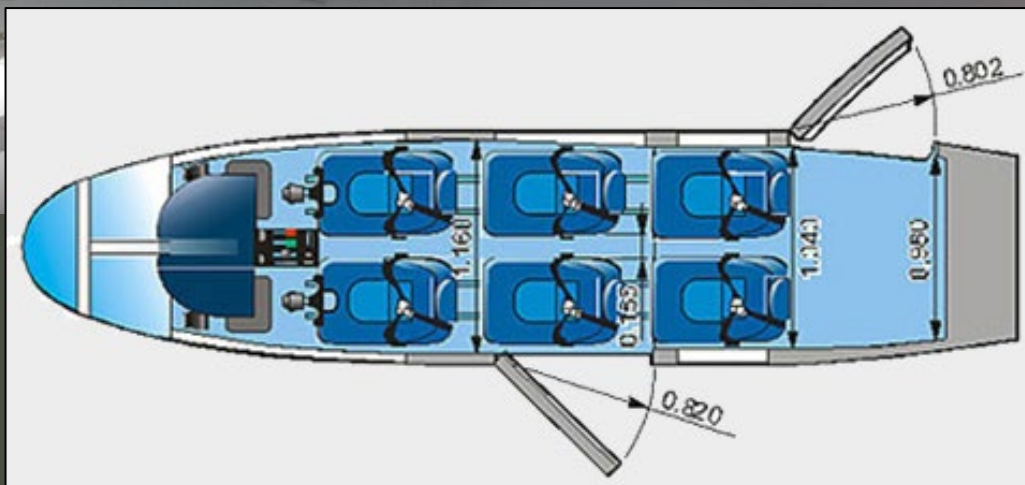
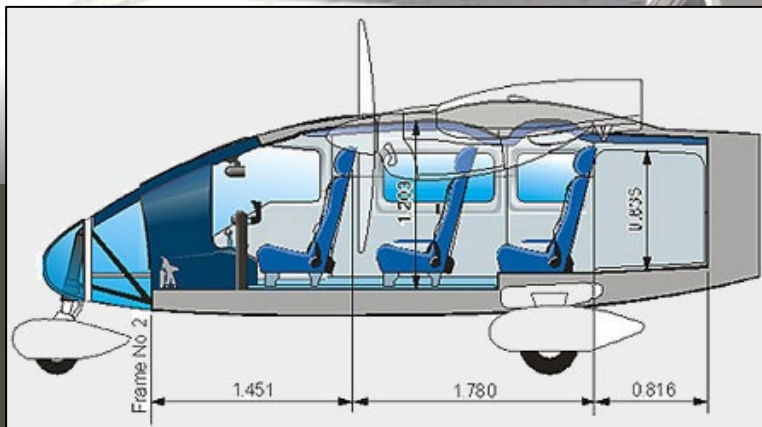


AERIAL SURVEY





P68 OBSERVER: Vulcanair





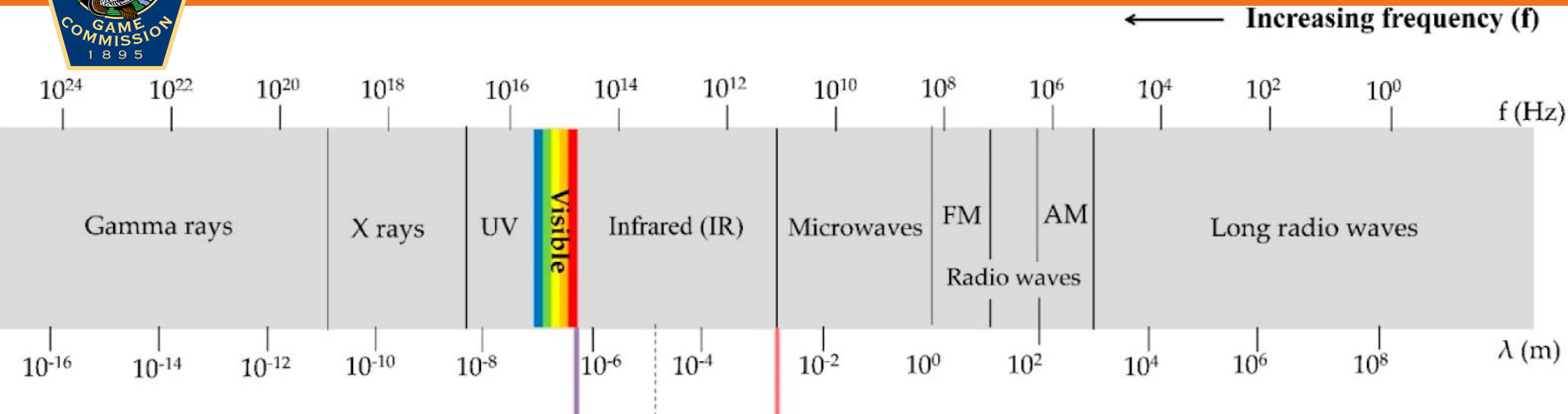
CAMERAS & SENSORS: MX-10



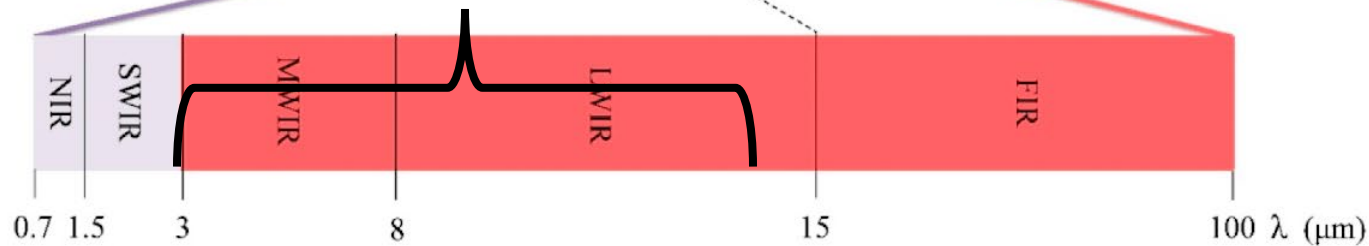
- Liquid-cooled IR imaging
- On-board augmented reality/integrated GIS mapping
- Electro-optical zoom
- 4-axis gimbal with image stabilization
- Laser rangefinder



CAMERAS & SENSORS: MX-10



Most thermal imagers operate in this range (3-14)



Near infrared (NIR):	0.7-1.5 μm
Short-wave infrared (SWIR):	1.5-3 μm
Mid-wave infrared (MWIR):	3-8 μm
Long wave infrared (LWIR):	8-15 μm
Far infrared (FIR):	15-100 μm



SURVEY USES AIRCRAFT MOUNTED CAMERA TO DETECT ELK

04F 13
09:44:10
UTC-5.0

AUTO

DV3
COR-A

SPA

IR

78

HIGH

17.5
25

Date/Time



-012°



180°



Aircraft

Camera

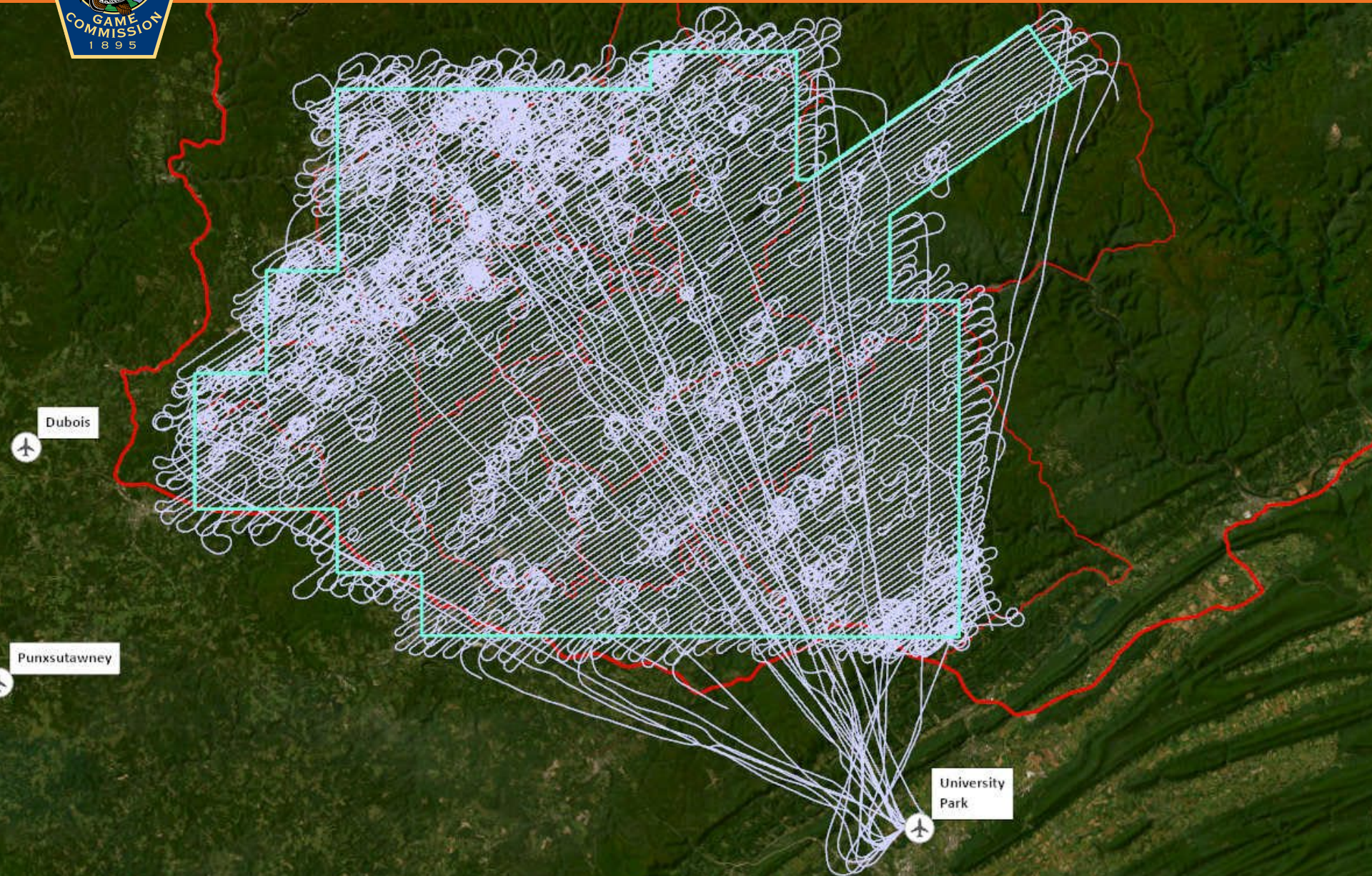
ACFT
41.45801N 056°
78.23562W 3548F

Obs. 19
Bulls:2 Others:28 Collars:3 1524FT

1.2MI 236° 41.44
LOS 78.25

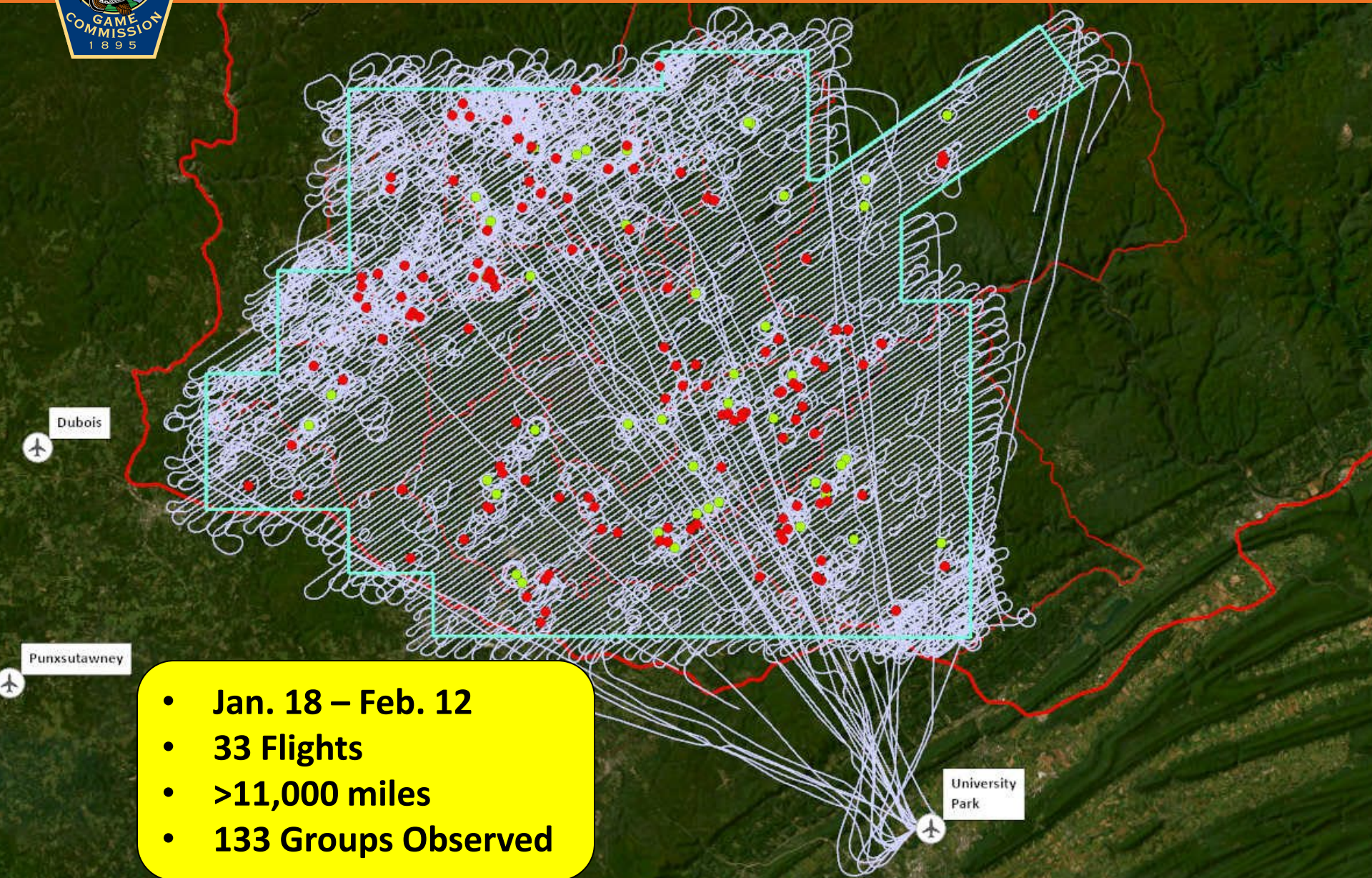


SURVEY PROVIDES NEAR COMPLETE COVERAGE





MARK RECAPTURE ESTIMATOR





LINCOLN PETERSON / MARK RECAPTURE ESTIMATOR

Marked (M)

Marked Observed (m)

Population (N)

Total Observed (n)

=





LINCOLN PETERSON / MARK RECAPTURE ESTIMATOR

July 1, 2024

25 (M)

Marked Recap (m)

Population (N)

Total Observed (n)





LINCOLN PETERSON / MARK RECAPTURE ESTIMATOR

July 1, 2024

25 (M)

Population (N)

July 15, 2024

Marked Recap (m)

50 (n)

=





LINCOLN PETERSON / MARK RECAPTURE ESTIMATOR

July 1, 2024

25 (M)

Population (N)

=

July 15, 2024

10 (m)

50 (n)





LINCOLN PETERSON / MARK RECAPTURE ESTIMATOR

Population (N)

=

25 (M)

×

50 (n)

10 (m)

N ≈ 125





Radio collared elk are used in a mark recapture estimator.





MARK RECAPTURE ESTIMATOR

MARK OBSERVED

Obs 33:
2/2/2024 @22:47





MARK RECAPTURE ESTIMATOR

MARK OBSERVED

Obs 33:
2/2/2024 @22:47

Collar	Period	Date/Time	Time from Obs	Dist. to Obs
83814	-1	2/2/2024@22:00	+0:47	49m
83814	0	2/2/2024@23:00	<u>-0:13</u>	20m
83814	+1	2/3/2024@00:00	-1:13	94m



MARK RECAPTURE ESTIMATOR

MARK MISSED

McKinnon Branch

Obs 53: 
2/11/2024 @05:09

Mill Rd



MARK RECAPTURE ESTIMATOR

MARK MISSED

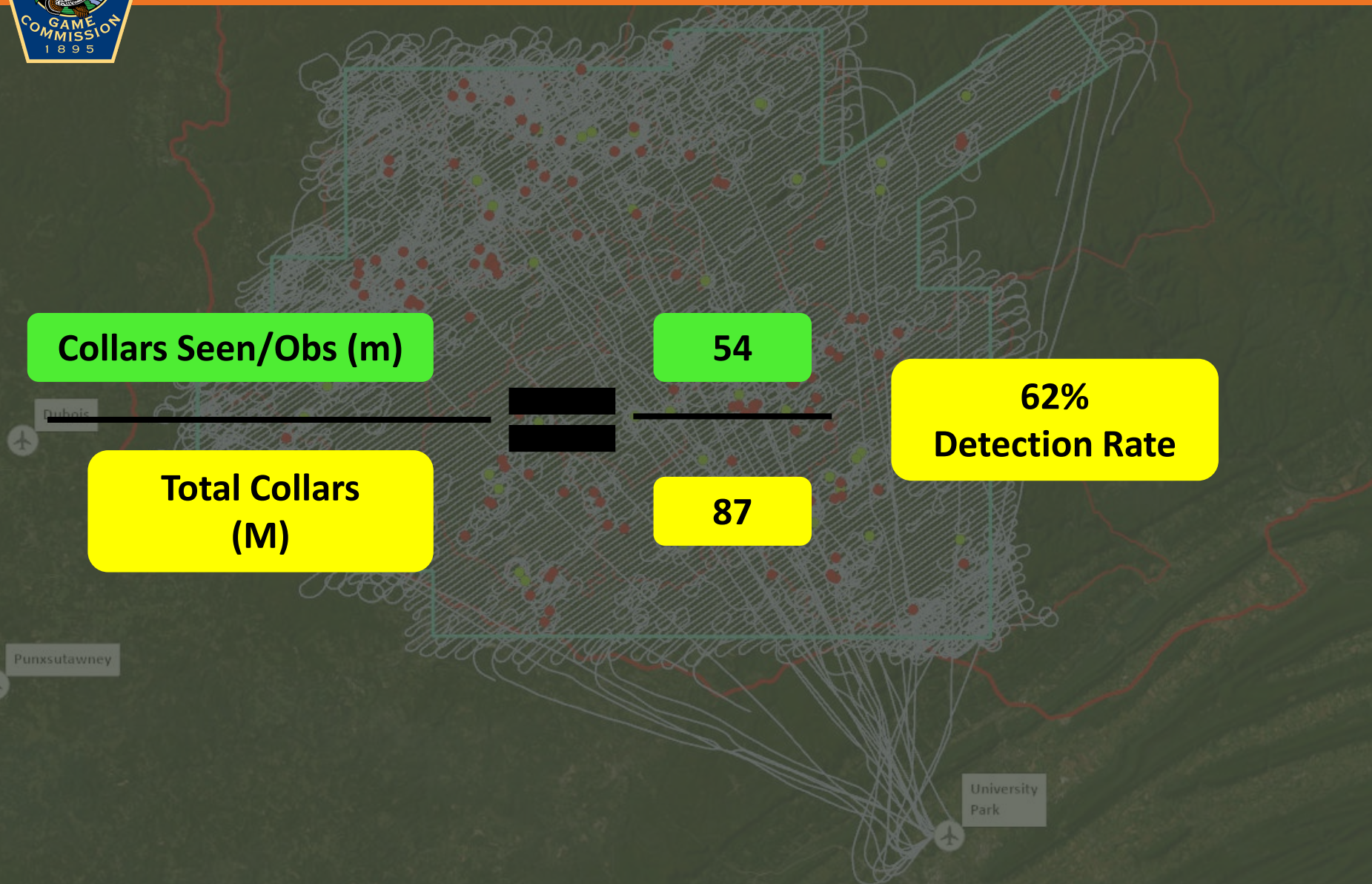


Collar	Period	Date/Time	Time from Obs	Dist. to Obs
83829	-1	2/11/2024@04:00	-1:09	1905m
83829	0	2/11/2024@05:00	<u>-0:09</u>	1962m
83829	+1	2/11/2024@06:00	+0:51	2018m

Obs 53: 
2/11/2024 @05:09



MARK RECAPTURE ESTIMATOR





MARK RECAPTURE ESTIMATOR



Marked (M)

Population (N)

=

Marked Observed (m)

Total Observed (n)



Dubois

Punxsutawney

University
Park



MARK RECAPTURE ESTIMATOR

Population (N)

=

87 (M)

×

935 (n)

54 (m)

$$\hat{N}_c = \frac{(M+1)(n+1)}{m+1} - 1$$

*Lincoln Peterson Estimator
(Chapman et al 1951)*

$$\widehat{varN} = \frac{(n+1)(M+1)(n-m)(M-m)}{(m+1)^2(m+2)}$$



Survey data across years are relatively consistent.

2000

1800

1600

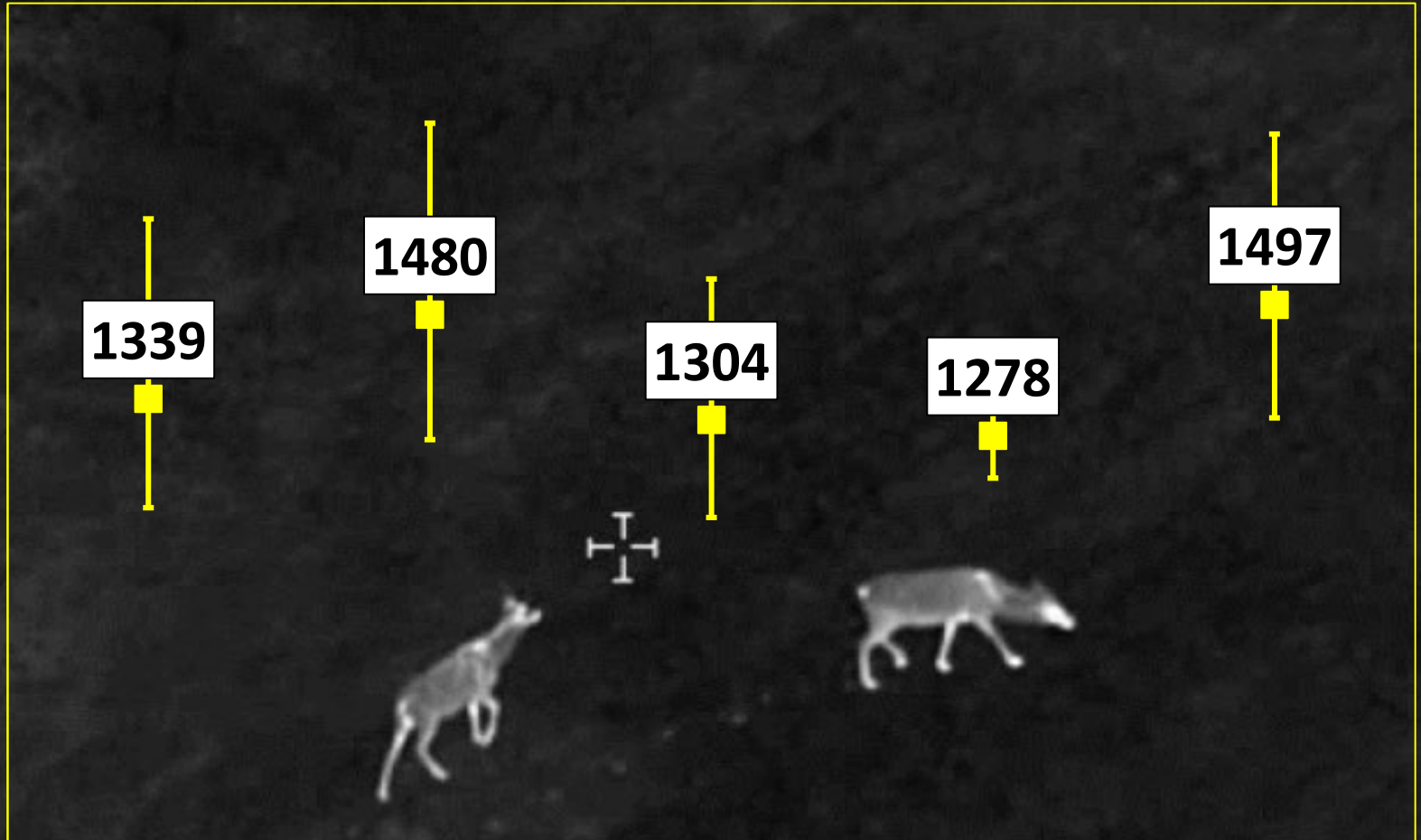
1400

1200

1000

800

600



2020

2021

2022

2023

2024



PA Elk Population Estimates

2000

1800

1600

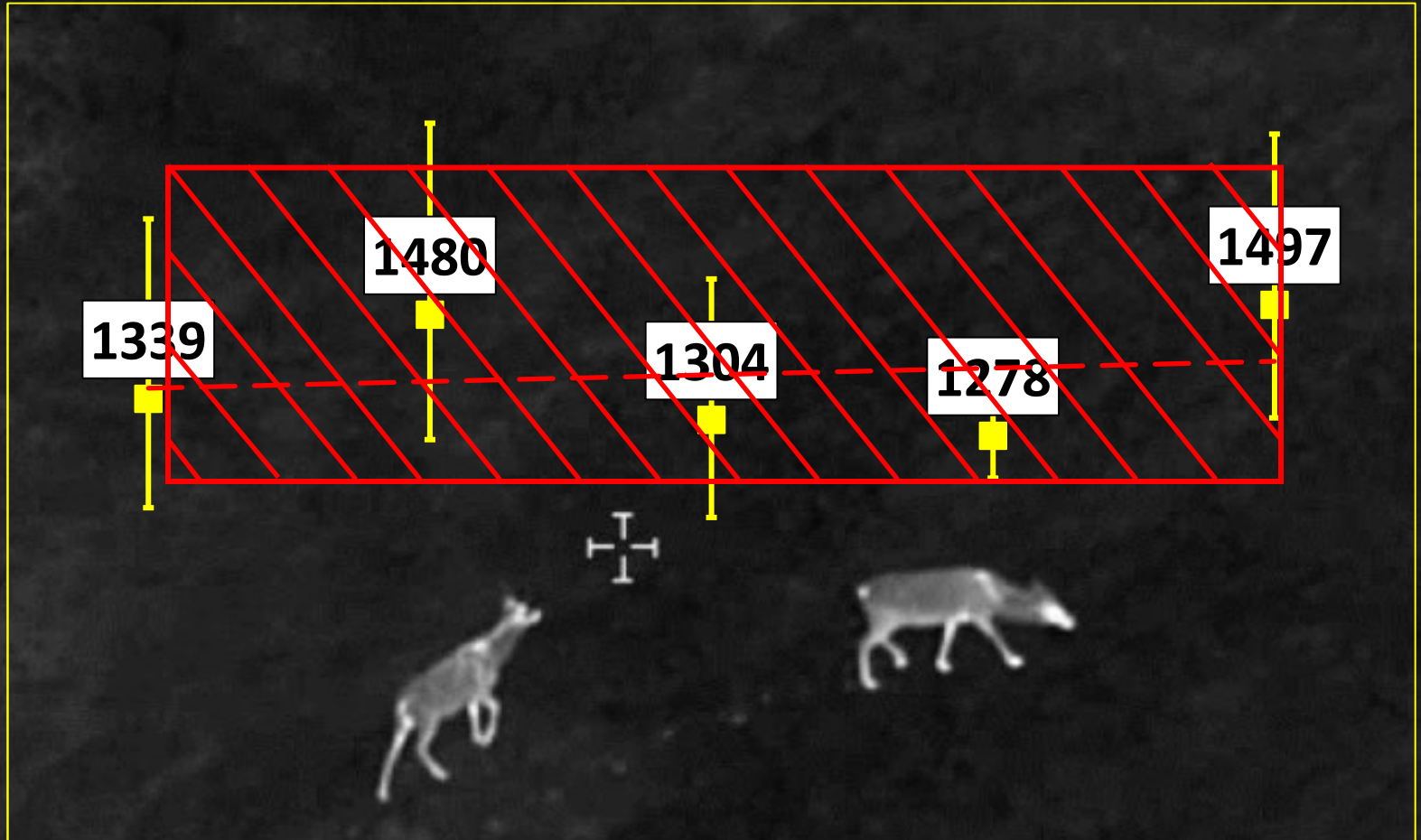
1400

1200

1000

800

600



2020

2021

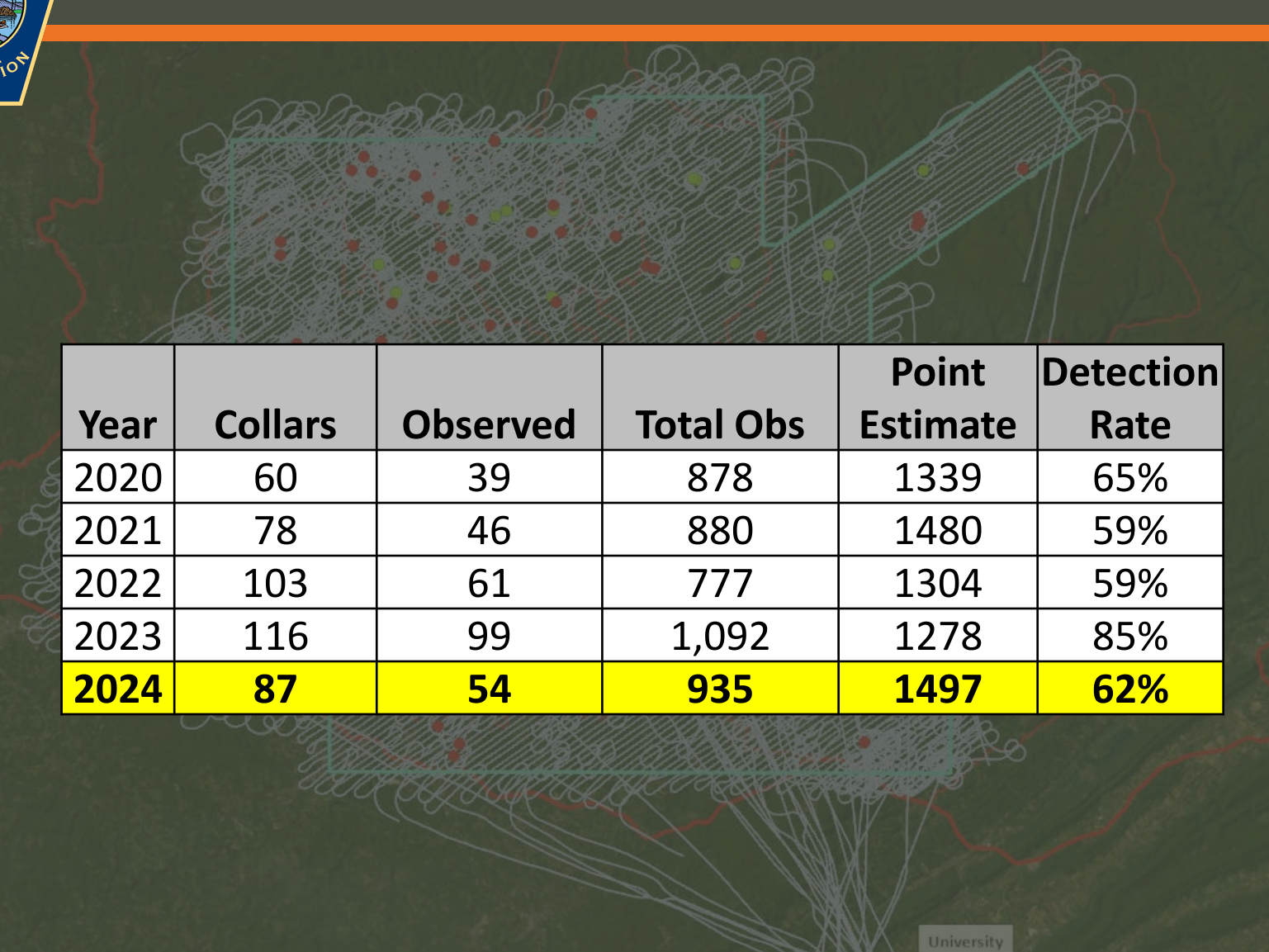
2022

2023

2024



MARK RECAPTURE ESTIMATOR



Year	Collars	Observed	Total Obs	Point Estimate	Detection Rate
2020	60	39	878	1339	65%
2021	78	46	880	1480	59%
2022	103	61	777	1304	59%
2023	116	99	1,092	1278	85%
2024	87	54	935	1497	62%



CHALLENGE #1:

DIFFERENTIATING DEER vs. ELK





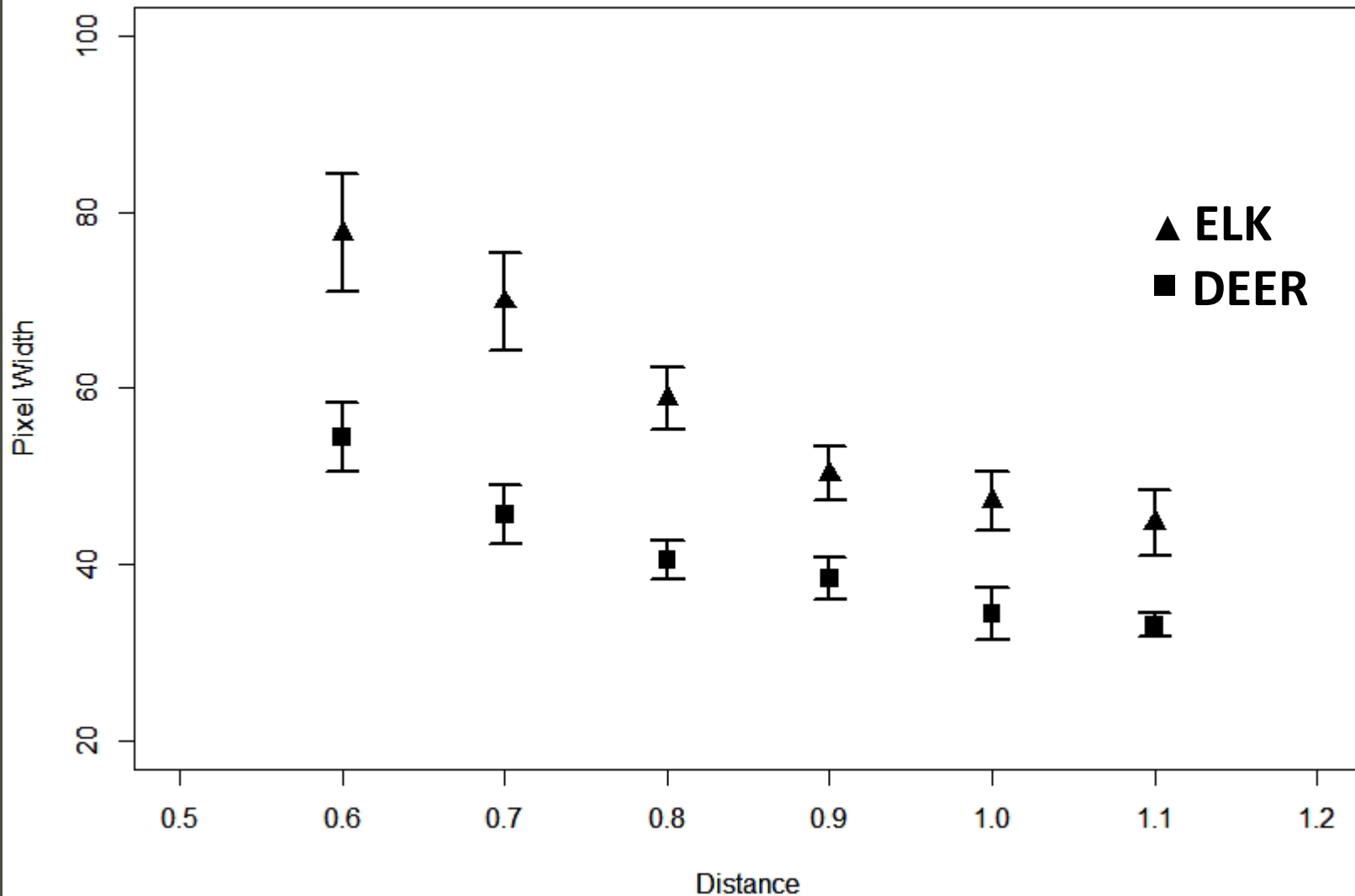
CHALLENGE #1:

DIFFERENTIATING DEER vs. ELK



CHALLENGE #1:

DIFFERENTIATING DEER vs. ELK



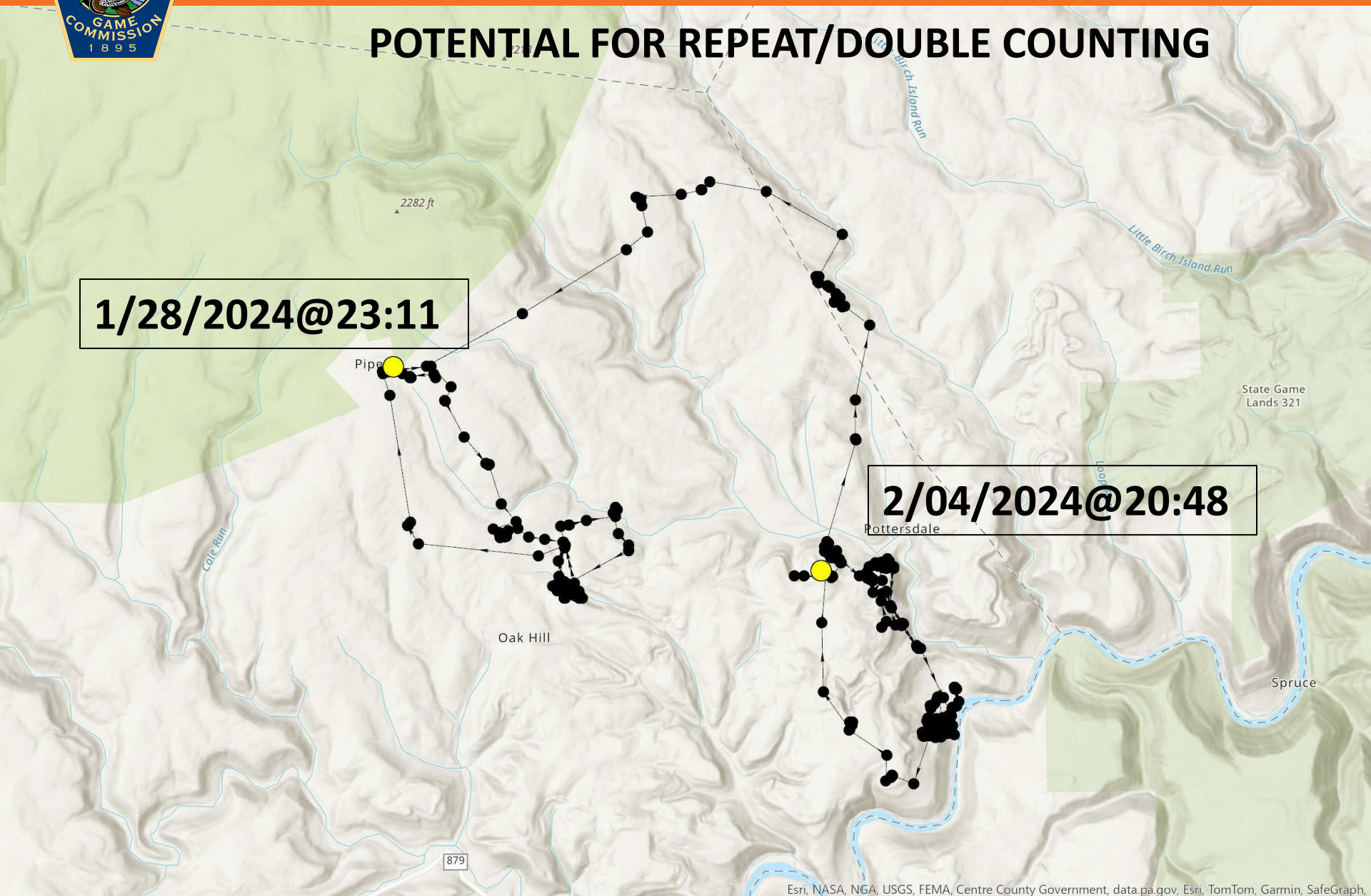


CHALLENGE #2:

POTENTIAL FOR REPEAT/DOUBLE COUNTING

1/28/2024@23:11

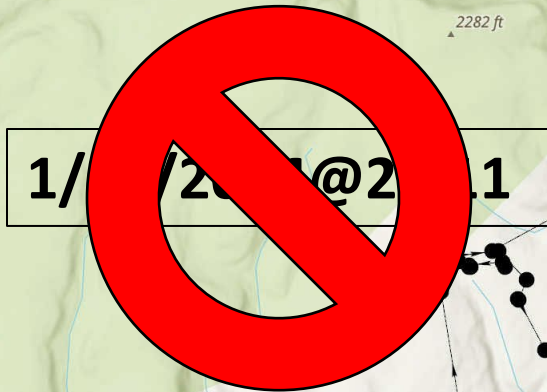
2/04/2024@20:48





CHALLENGE #2:

POTENTIAL FOR REPEAT/DOUBLE COUNTING



2/04/2024@20:48



QUESTIONS

Questions?



Jeremy Banfield
Pennsylvania Game Commission - Elk Biologist
www.pgc.pa.gov