Department of Defense
Legacy Resource Management Program

PROJECT 12-612
(AGREEMENT N0. W9132T-12-2-0050)

Monitoring Species of Concern Using Noninvasive Genetic Sampling and Capture-Recapture Methods: Pilot Demonstration With Coyote, a Predator to Species at Risk and Game Species on DoD Lands

LISETTE WAITS

Oral Presentation for Integrated Natural Resource Management Plan Meeting
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Monitoring Species of Concern Using Noninvasive Genetic Sampling

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- Dr. Eric Rickart, University of Utah

Unofficial Consultation:

- Dr. Jon Horne, Idaho Department of Fish & Game

Funding & Support

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DEPARTMENT OF DEFENSE LEGACY PROGRAM

T & E Inc.

Support:

DPG

UTAH DNR WILDLIFE RESOURCES

UtahState University Wildland Resources

NATURAL HISTORY MUSEUM OF UTAH

Outline

1. Introduction and Background
2. Overall Goal
3. General Methods
4. Overview of Primary Objectives
5. Preliminary Results
6. Next Steps

Introduction & Background

Land managers worldwide are challenged to protect sensitive flora and fauna

Photo Credit: DPG

DoD is challenged to conserved sensitive species *while* adhering to the military mission and supporting military readiness

- Requires compliance with Sikes Act, ESA, NEPA

BLM is challenged to conserve sensitive species *while* managing landscapes for multiple usages such as agriculture, recreation, and energy development

- Requires compliance with FLPMA, ESA, NEPA

Photo Credit: blm.gov

Introduction & Background

Effective management and conservation requires reliable and accurate estimates of:

- Population parameters (e.g., abundance, survival, reproduction, and trends)
- Occurrence, interspecific interactions, and habitat associations

Many species are notoriously difficult to monitor:

- Rare or elusive
- Wide-ranging
- Low density

Introduction & Background

Common approaches to estimate population parameters:

- Direct observation (e.g., aerial surveys, mark-resight)
- Physical capture (e.g., capture-recapture, telemetry)

- May put sensitive species at risk from capture trauma or stress
- Can be cost-prohibitive at extended spatial and temporal scales

Introduction & Background

Other indirect and more affordable approaches:

- Provide only indices of relative abundance
- The relationship between relative and absolute abundance may be unknown
- Suffer from potential misidentification of sign
- Do not provide information on survival, reproduction, etc.

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Introduction & Background

Conservation funding:

- Demands exceed available financial resources
- Both needs and costs are increasing
- Economic downturn and uncertainty in funding sources (e.g., federal appropriations) further complicate allocation of funds

Overall Goal

Develop an effective <u>and</u> cost-efficient monitoring approach for sensitive species by combining noninvasive genetic sampling (NGS) with capture-recapture (CR) and occupancy modeling (OM)

Population parameters of key interest include:

- Abundance
- Survival
- Reproduction
- Connectivity
- Genetic Diversity
- Effective Pop. Size
- Occupancy
- Species Interactions
- Habitat Associations

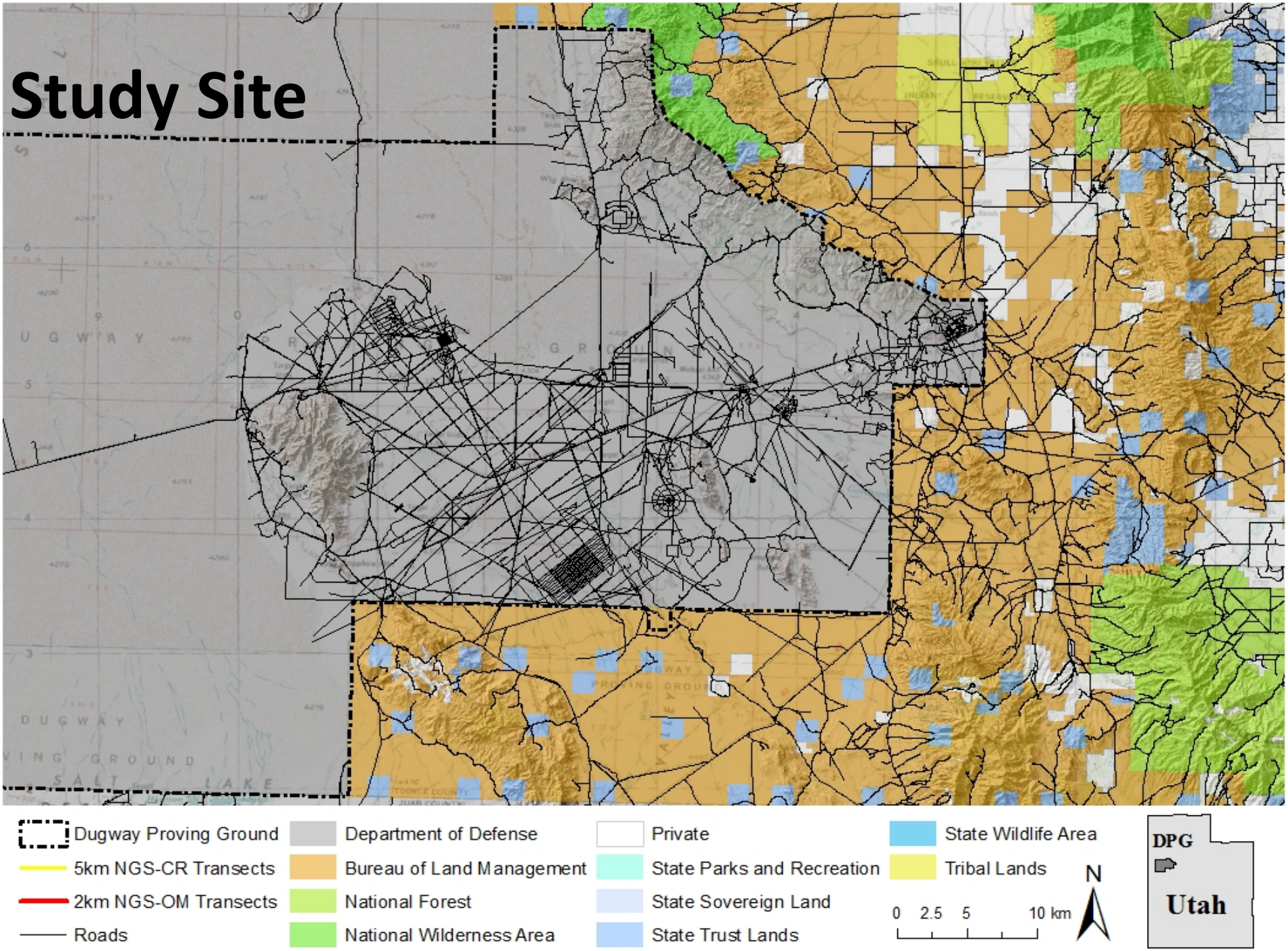
Target Sensitive Species

Kit fox *(Vulpes macrotis)*

- DoD and BLM: Sensitive Species
- UDNR: Species of Concern
- NatureServe: Vulnerable (UT)

Coyote *(Canis latrans)*

- Populations have increased in abundance and distribution over the last 50 years
- Influences kit foxes through intraguild predation and competition
- Can be surveyed simultaneously


Study Site
Dugway Proving Ground
5km NGS-CR Transects
2km NGS-OM Transects
Roads
Department of Defense
Bureau of Land Management
National Forest
National Wilderness Area
Private
State Parks and Recreation
State Sovereign Land
State Trust Lands
State Wildlife Area
Tribal Lands
N
0 2.5 5 10 km
DPG
Utah

General Methods

Noninvasive Genetic Sampling (NGS):

- Inventory and monitor species by collecting feces, hair, feathers, saliva, etc. (Taberlet et al. 1999)
- Eliminates need to disturb individuals (↓stress, trauma, risk)

General Methods

Sampling Methods:

- Many carnivores utilize linear features for regular movements (Kohn et al. 1999)
- Detection can be maximized by surveying along roads

Transect Surveys:

- Two surveyors, each survey ½ of the transect
- Search the transect for all carnivore scats

General Methods

Fecal DNA Collection:

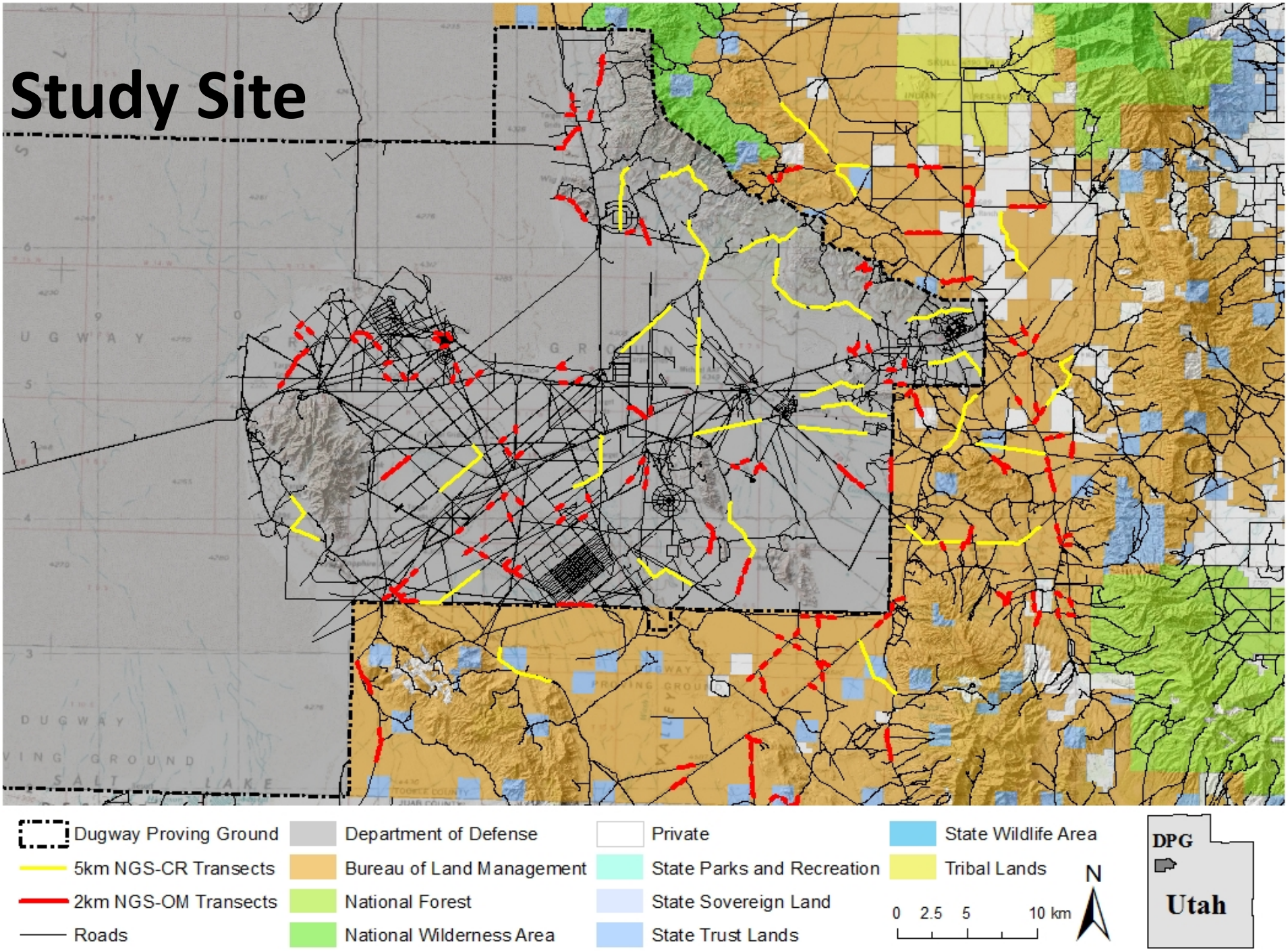
- When a carnivore scat is detected, a genetic sample is collected, along with covariate data (e.g., measurements, habitat, position)

General Methods

Spatio-Temporal Sampling Strategies:

1. Capture-Recapture (5km transects)
   - 15 historic transects to compare to current methods
   - 15 random transects to extend spatial extent
   - 30 transects = 150km of transects
   - Temporal replication (4 replicates/season ~14 days apart)

2. Occupancy Modeling (Four 500m transects)
   - 60 sites (2.5km x 2.5km) randomly selected
   - 60 sites = 120km of transects
   - Spatial replication (4 replicates surveyed once each/season)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0 2.5 5 10 km
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Utah

General Methods

Laboratory Analyses:

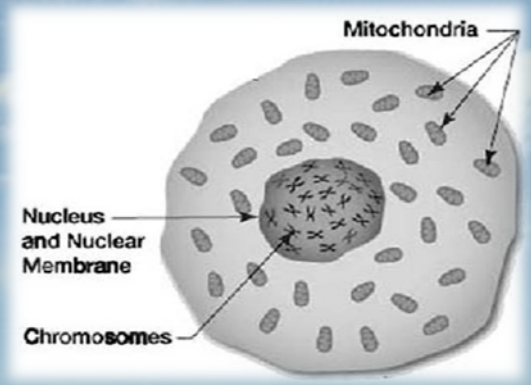
- Laboratory for Ecological, Evolutionary, & Conservation Genetics
- Lab dedicated to low quantity and low quality DNA such as NGS

Species Identification Test:

- Mitochondrial DNA (mtDNA)
- mtDNA is maternally inherited; abundant in a cell
- Kit fox vs. coyotes vs. other carnivores

Individual Identification Test:

- Nuclear DNA (nDNA)
- nDNA is bi-parentally inherited
- 6 – 9 microsatellite loci for kit fox and coyote



Six Primary Research Objectives

I. **Pilot Study**: Evaluate the interaction of scat deposition and DNA degradation for each species

II. **NGS-CR**: Evaluate as an effective and cost-efficient method for population monitoring of each species

III. **NGS-OM**: Estimate occupancy for each species and test hypotheses of competitive exclusion and habitat associations

IV. **Classification**: Evaluate objective characteristics for scat field ID

V. **Population Genetics**: Evaluate genetic diversity and population genetic structure for each species

VI. **Effective Population Size (N_e)**: Assess temporal changes in genetic diversity and N_e for kit foxes

Pilot Study

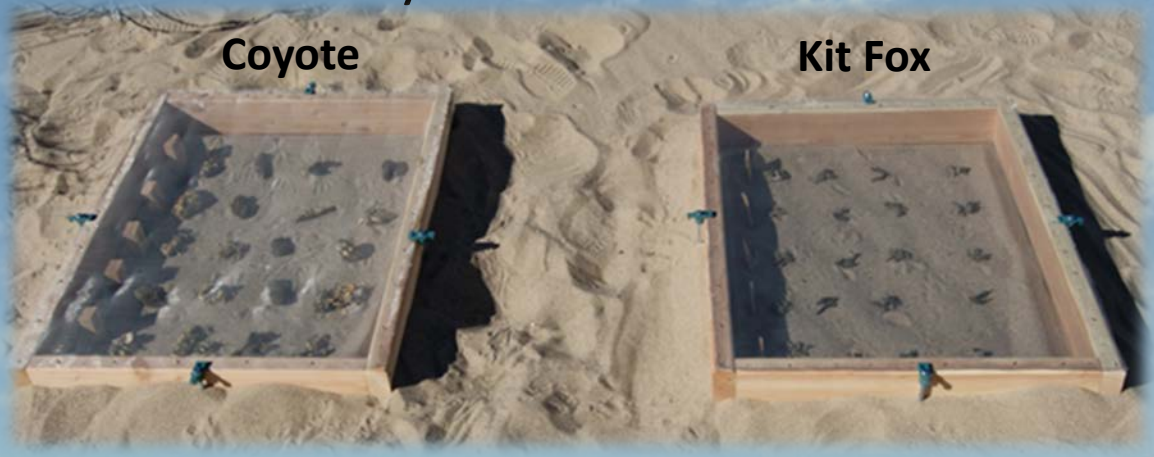
Objective: Evaluate summer and winter scat deposition and fecal DNA degradation rates under natural field conditions to inform sampling design, minimize costs, and maximize laboratory success

Deposition: Data provided by collaborators; collected summer 2012

DNA Degradation: 20 samples from each species evaluated in each season at time points from <1 – 112 days

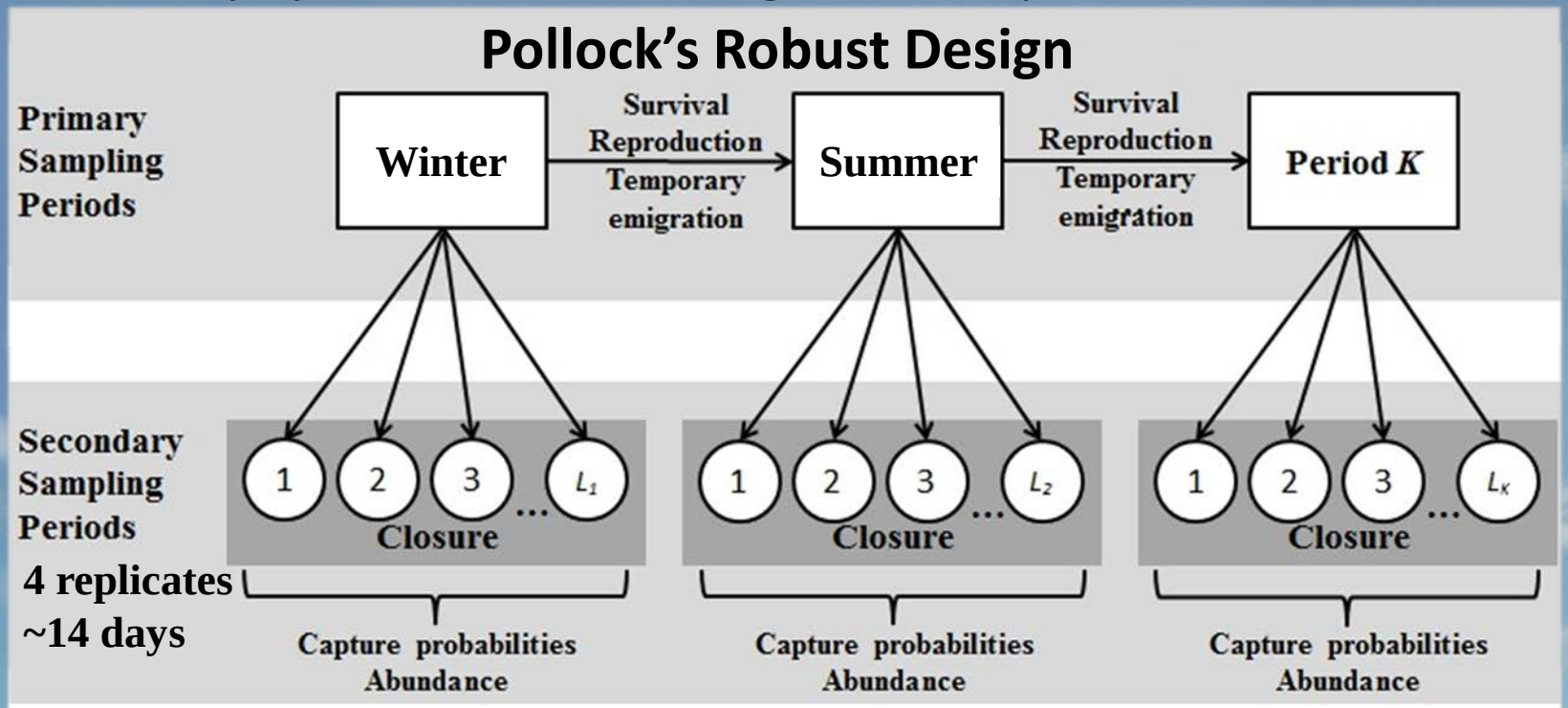
Genetic Analyses:

- Species ID (mtDNA)
- Individual ID (nDNA)



NGS-CR

Objective: Evaluate NGS-CR as an effective and cost-efficient method for population monitoring of each species



Competing models will be evaluated using and AIC approach within MARK

NGS-OM

Objective: Expand spatial sampling, estimate occupancy for each species, and test hypotheses of habitat associations and competitive exclusion

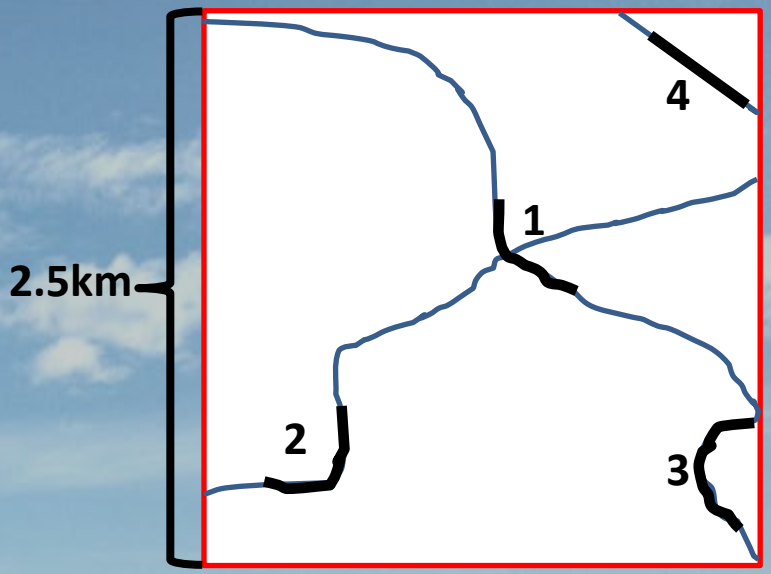
Sampling: NGS, 4 – 500m transects at each random site (60)

Spatio-Temporal Design:

- Winter & Summer seasons
- Spatial replication
- "Modified" removal
- Species Identification (mtDNA)

Habitat Associations: Covariates

Competitive Exclusion: Co-occurrence



Classification

Objective: Identify objective characteristics of scats (e.g., morphometric, covariates) which optimize successful field classification and further reduce costs associated with NGS-OM

Sampling: Morphometric measurements collected on NGS
Species identification determined via mtDNA

Measurements: Length, Width, Length/Width, #Segments

Classification: 1. Distribution of measurements
2. Discriminant Function Analysis
3. Classification and Regression Tree Analysis (CART)

Preliminary Results

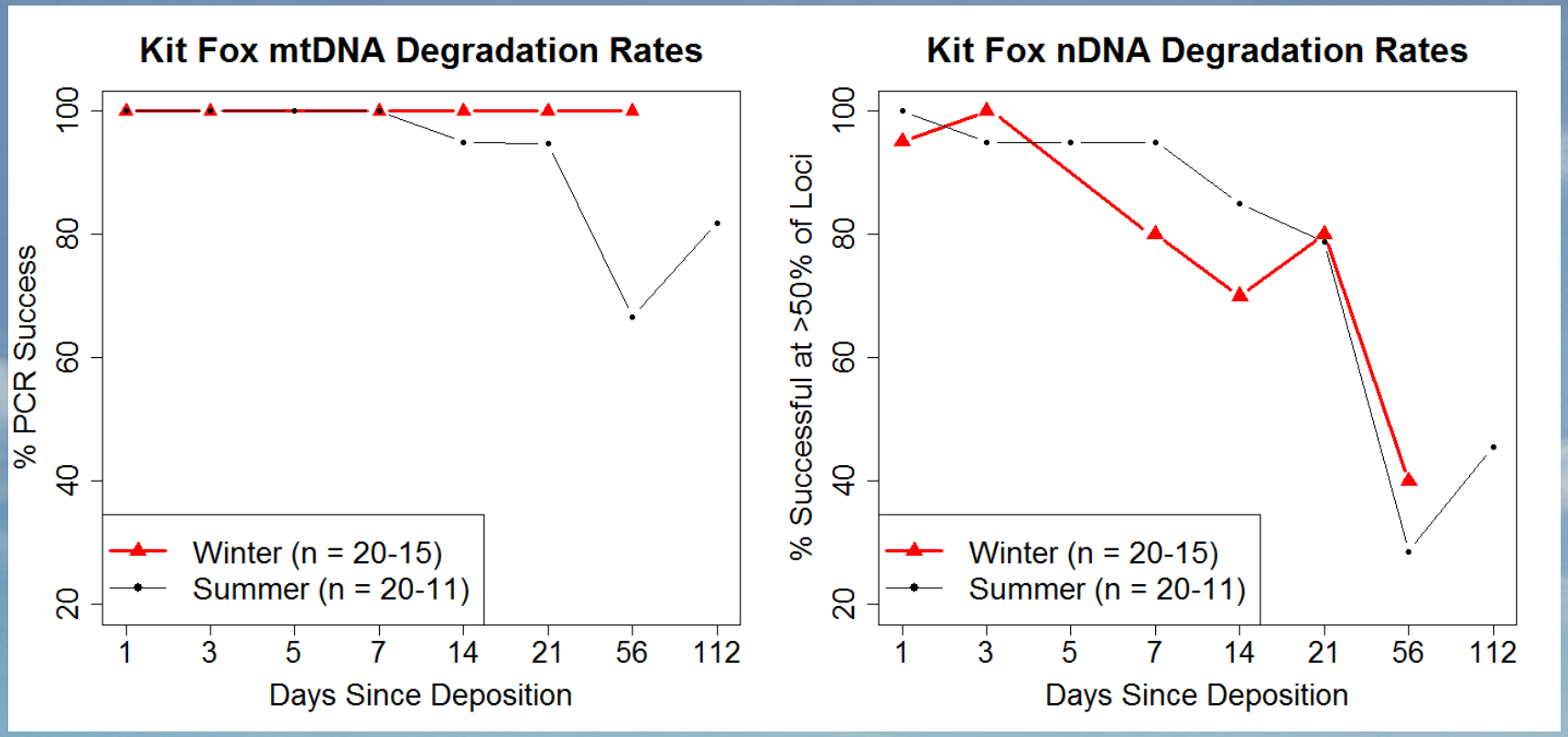
Pilot Study: Evaluate the interaction of scat deposition and DNA degradation for each species

Scat Deposition Rates		
Time Frame	**Kit Fox # Scats/km/2 weeks**	**Coyote # Scats/km/2 weeks**
Summer (2010-2012)	0.635	1.733
Winter (2010-2012)	0.378	1.160
Spring (2010-2011)	0.196	0.837
Average	**0.461**	**1.366**

Based on combined data collected by collaborators at USU and pilot surveys

Preliminary Results

Pilot Study: Evaluate the interaction of scat deposition and DNA degradation for each species



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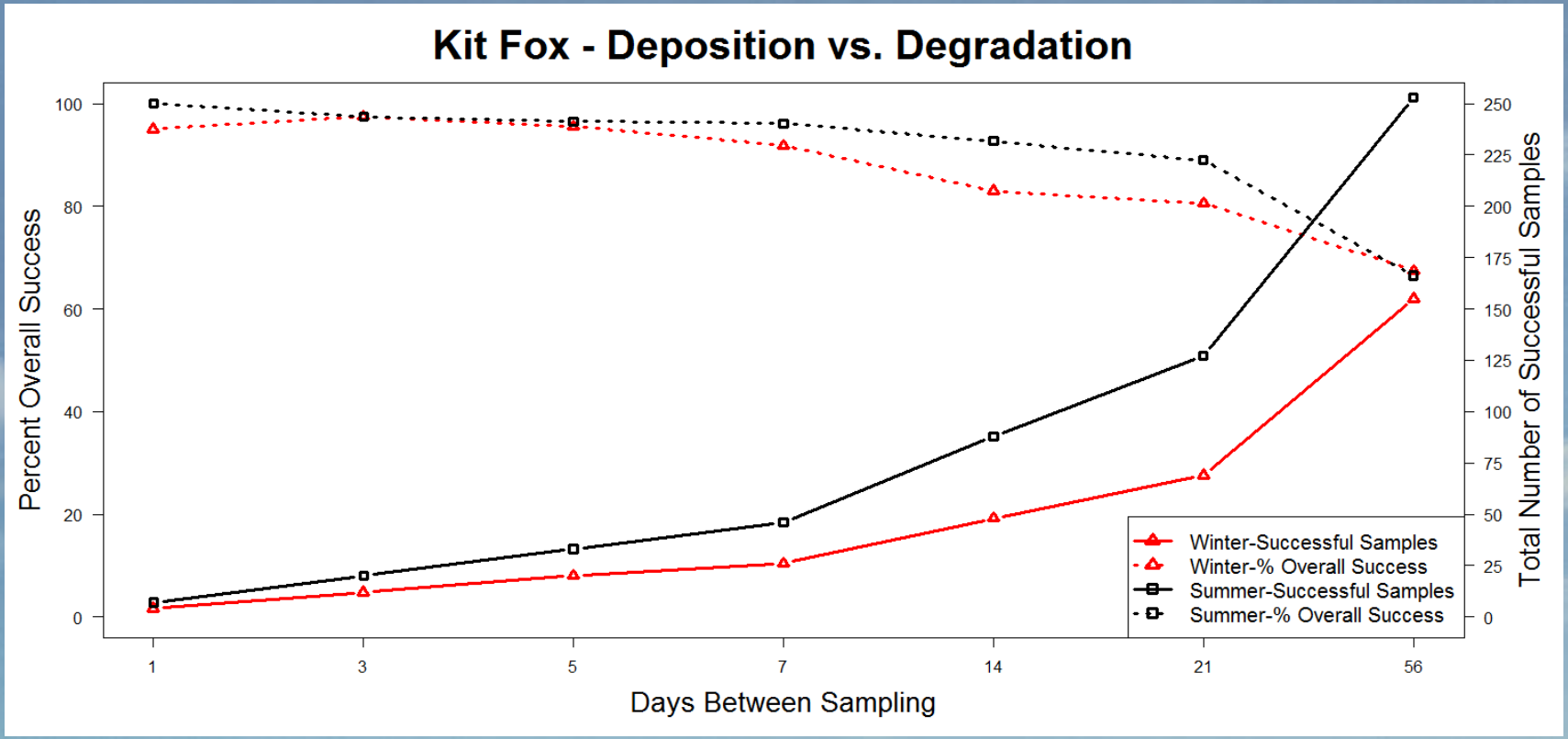

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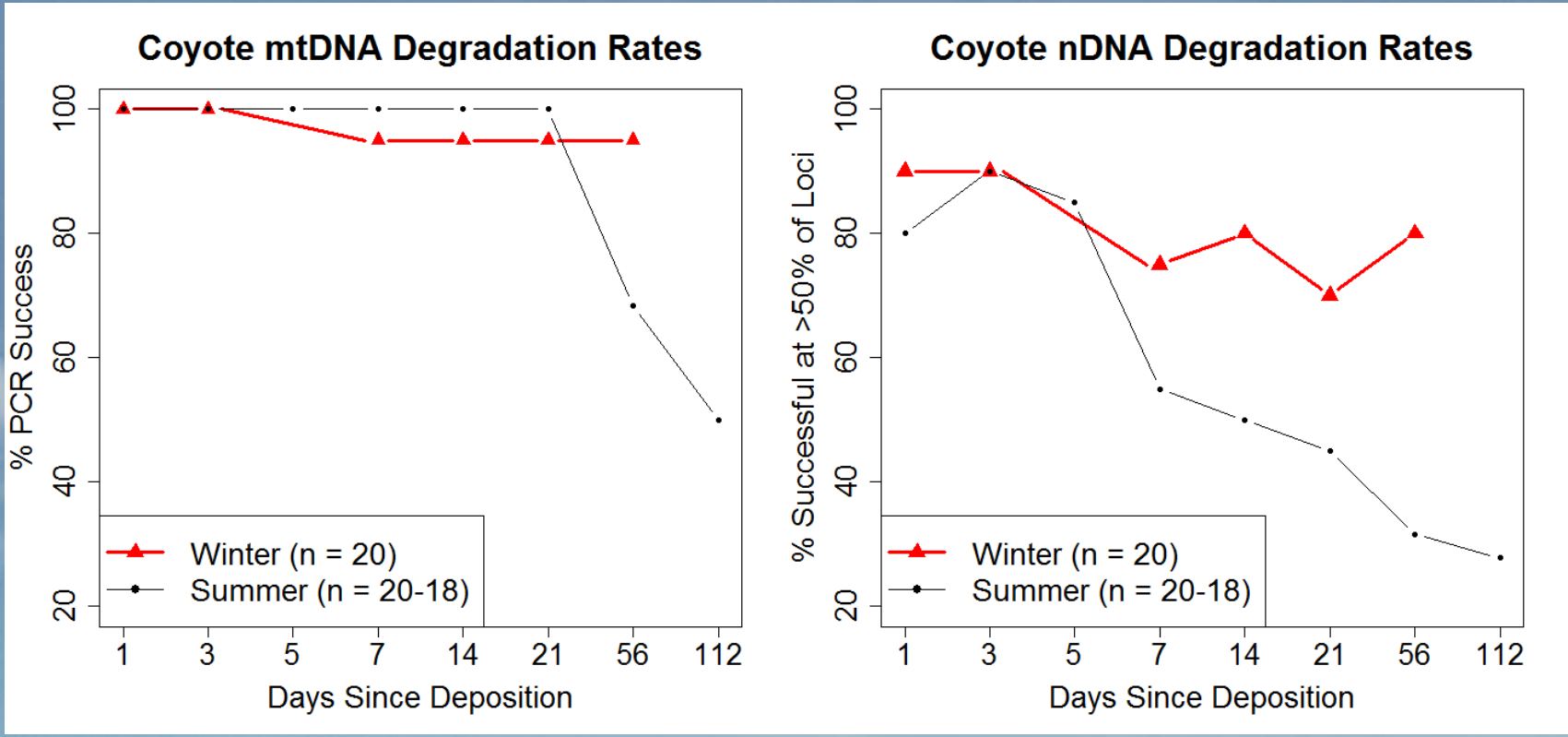

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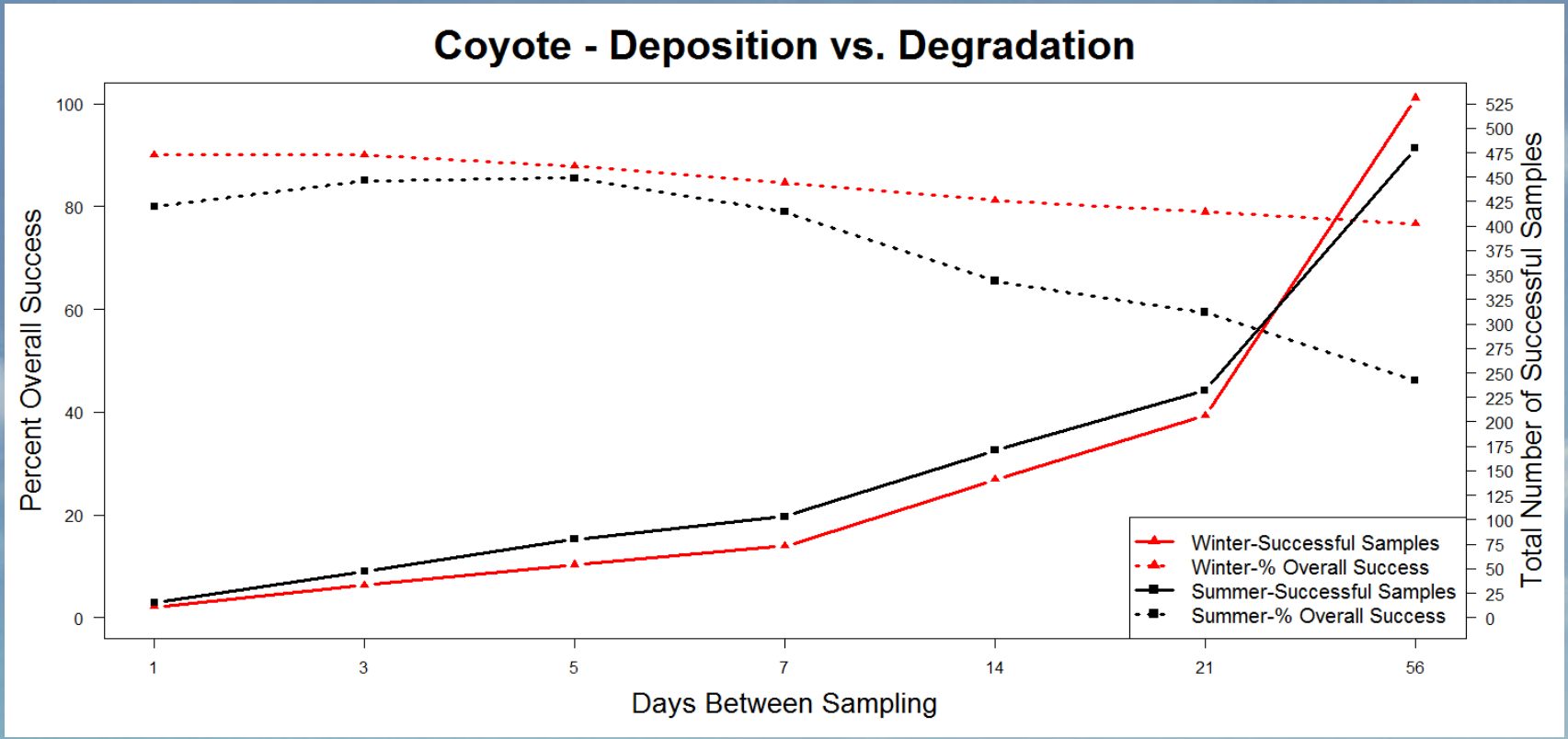

Preliminary Results

NGS-CR: Evaluate as an effective and cost-efficient method for population monitoring of each species

NGS-OM: Estimate occupancy for each species and test hypotheses of competitive exclusion and habitat associations

Winter 2013 Results						
Jan – Mar 2013	**Total**	**Kit Fox**	**Coyote**	**Other**	**Number of Transects**	**Total Distance (km)**
NGS-CR	451	125	319	7	30	600
NGS-OM	151	59	91	1	60	120
Total	**602**	**184**	**410**	**8**	90	720
%Misclassified (n)	12% (72)	23% (42)	6% (24)	75% (6)	-	-
%Failed (n)	10% (60)	3% (5)	13% (54)	13% (1)	-	-
Total (after mtDNA)	**542**	**151**	**379**	**12**	-	-

Preliminary Results

NGS-CR: Evaluate as an effective and cost-efficient method for population monitoring of each species

NGS-OM: Estimate occupancy for each species and test hypotheses of competitive exclusion and habitat associations

Winter 2013 Results Based on mtDNA Identification

Freshness Scores	Total	%Failed (n)
1	208	2.9% (6)
2	132	4.5% (6)
3	84	10.7% (9)
4	86	36.0% (31)
5	15	53.3% (8)

*May provide a subsampling strategy for reducing laboratory costs

Next Steps

Laboratory Analyses:

- Individual identification tests (nDNA) on winter samples

Field Sampling:

- Next field season scheduled for the summer of 2013

Data Analyses:

- Further explore the interaction between deposition and degradation
- Begin single season CR and OM
- Conduct power analyses to further evaluate optimal sampling design

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