USGS
science for a changing world

UPDATE ON SCIENCE AND TOOLS AVAILABLE FOR ADDRESSING RAVEN ABUNDANCE AND REDUCING THEIR IMPACTS ON GREATER SAGE-GROUSE IN NEVADA

Peter S. Coates Ph.D.
U.S. Geological Survey
Western Ecological Research Center

Special Issue: Raven Management

22 peer-reviewed papers on raven science and management

Topics include:

- Population growth of ravens
- Synthesis of anthropogenic effects on raven demographics
- Synthesis of predation by ravens to sensitive avian species
- Expanding abundance of ravens in sage-grouse habitats
- Occupancy and density mapping
- Raven adverse impacts to snowy plovers
- Efficacy of lethal and non-lethal techniques
- Estimating raven take
- Population management strategies with software
- Rapid survey assessment
- Science-based Management of Ravens Tool (SMaRT)

All articles will be published by end of year 2022

Overview

Problem

Expansion of raven distribution and abundance

↓

Anthropogenic resource subsidies

↓

Predation effects on sensitive species

Solution

Science-based tiered framework

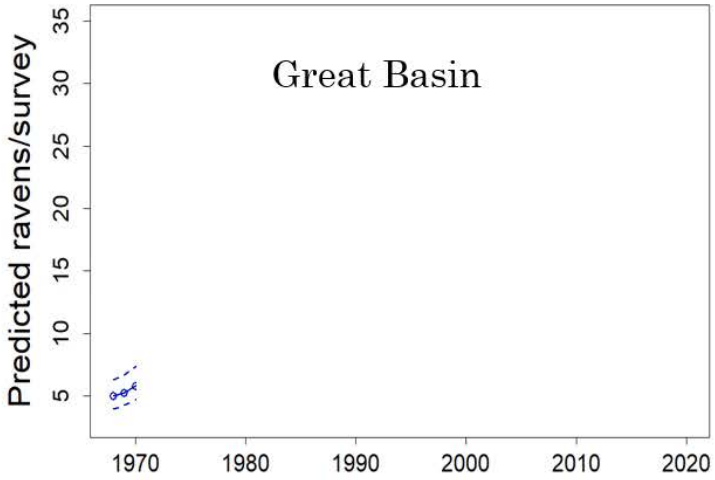
↓

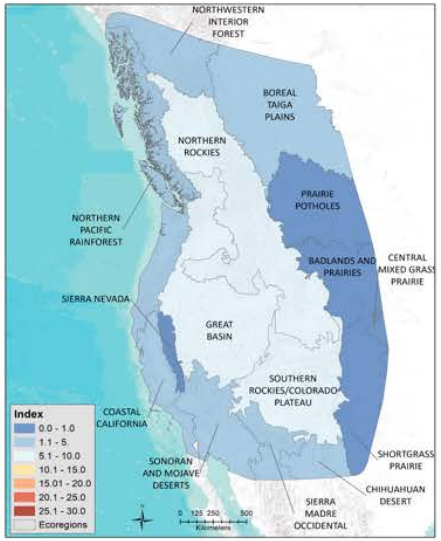
Decision support tools - SMaRT

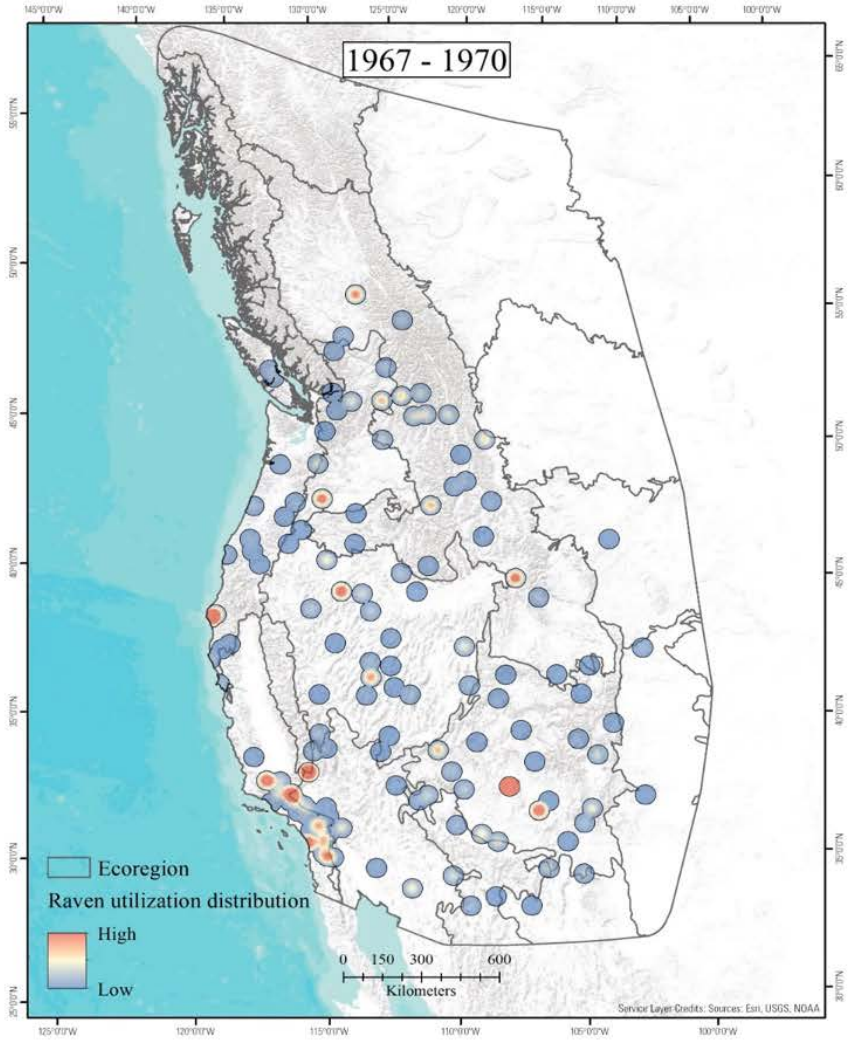
Overview

USGS science for a changing world

Raven expansion in the Great Basin region of the western U.S.

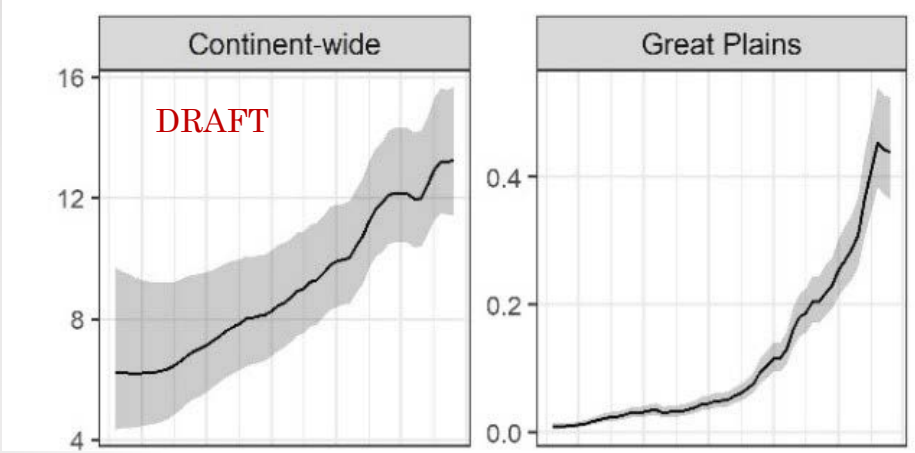


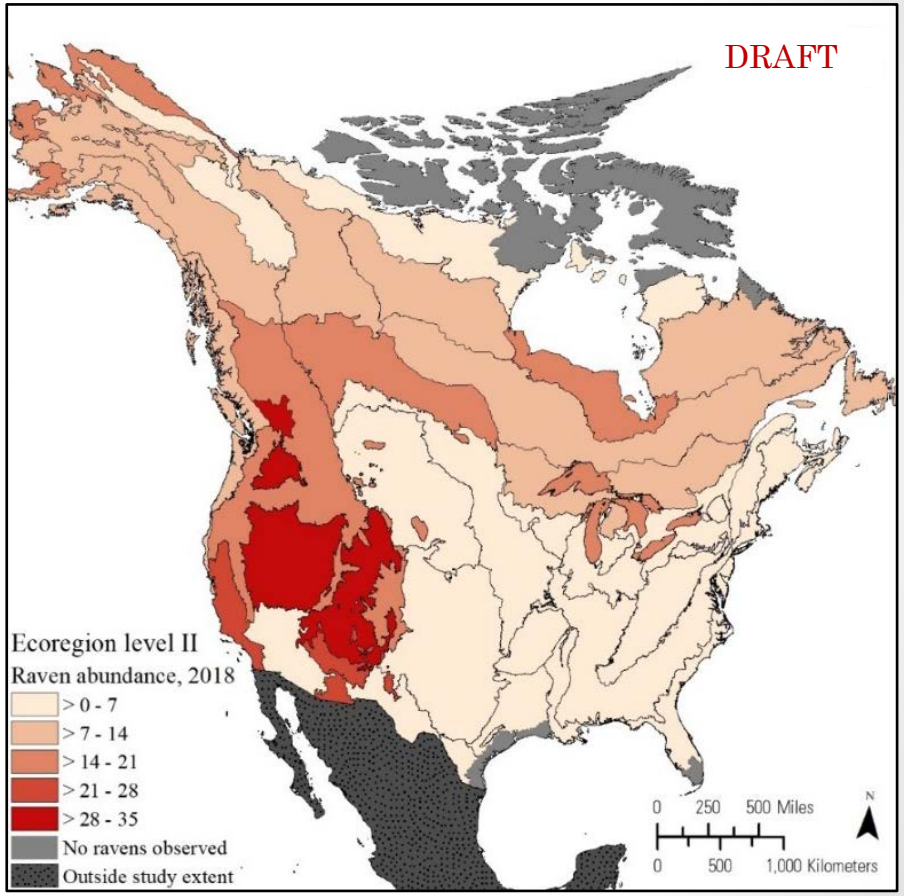




Harju, S.M., et al. (2021). Estimating trends of common raven populations in North America 1966 – 2018. *Human-Wildlife Interactions 15:5.*

Raven numbers have increased 4.6 times since 1966 in Cold Deserts





Harju, SM; Coates, PS; Dinkins, JB; Jackson, P; Chenaille, MP. *In press*. Estimating trends of common raven populations in North America, 1988 – 2018. *Human-Wildlife Interactions*.

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USGS science for a changing world

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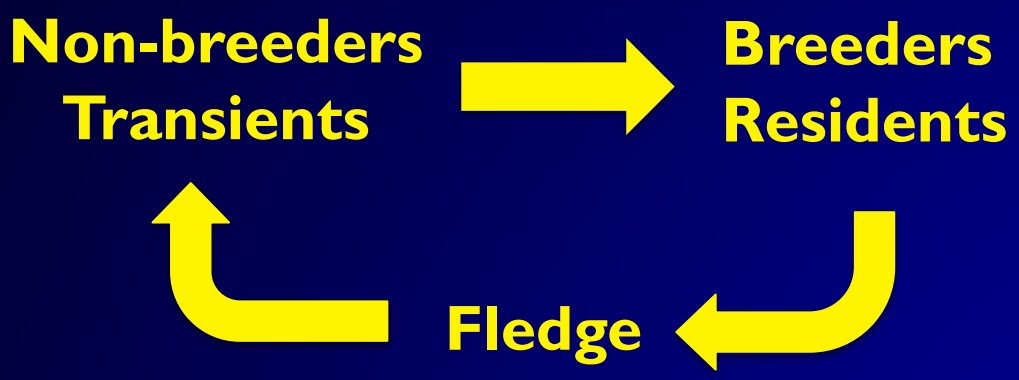
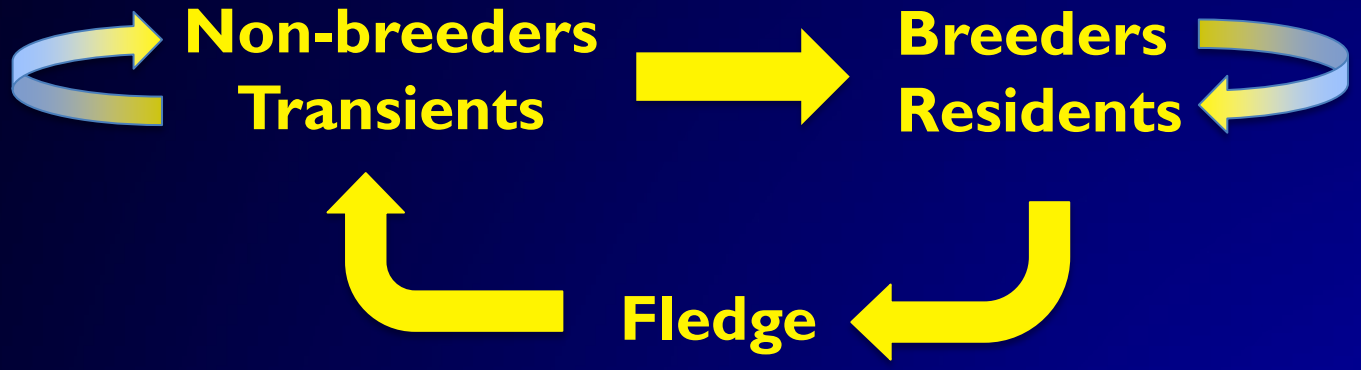
Conceptual Model



Conceptual Model



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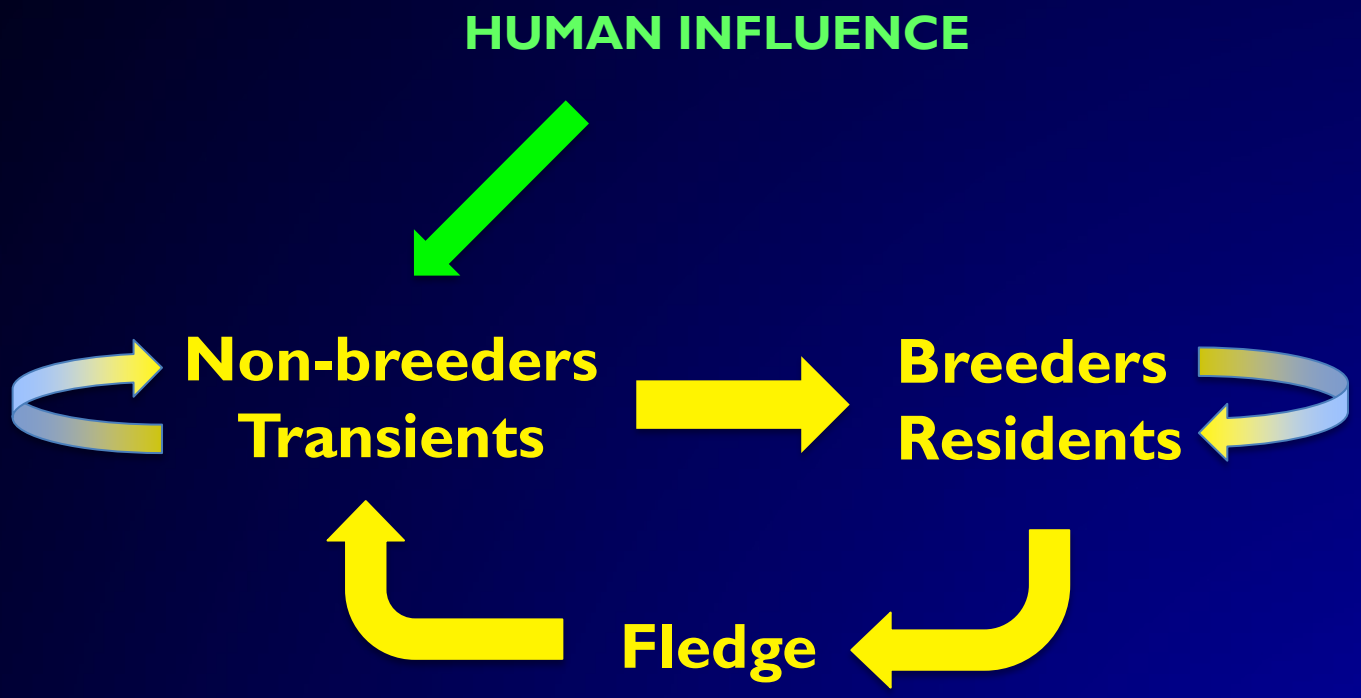
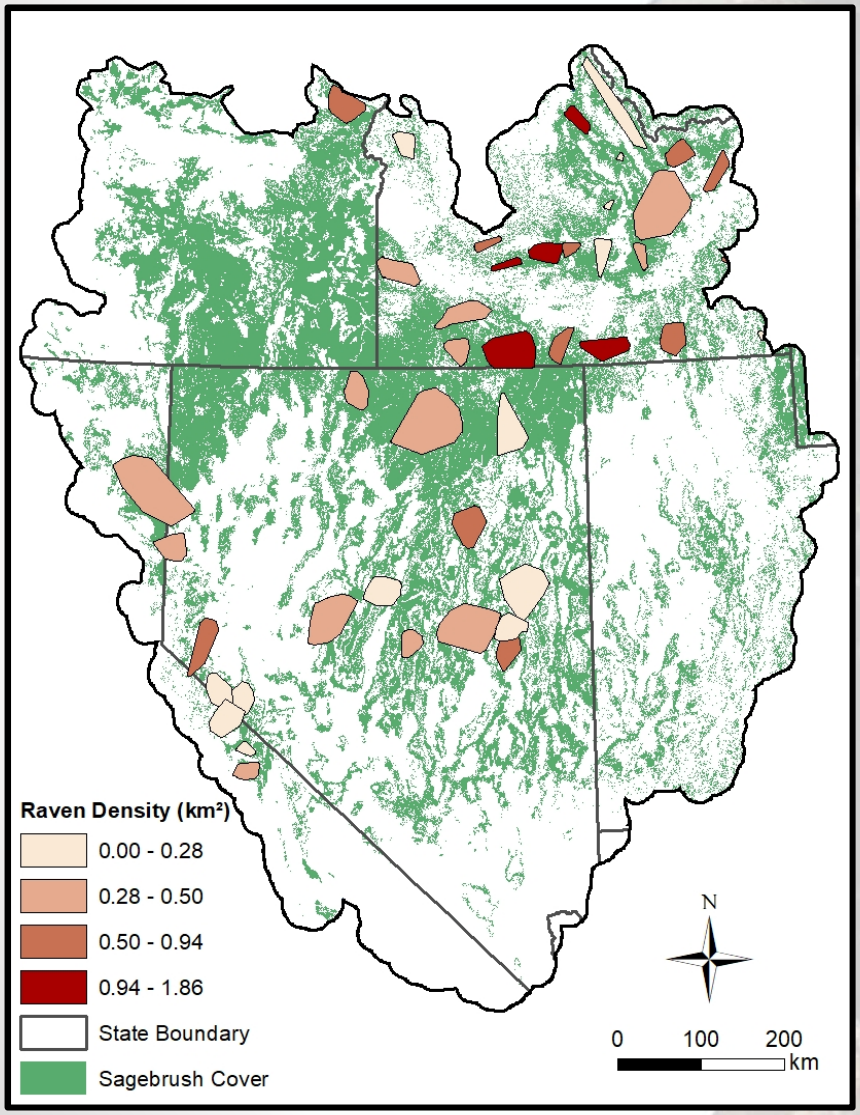


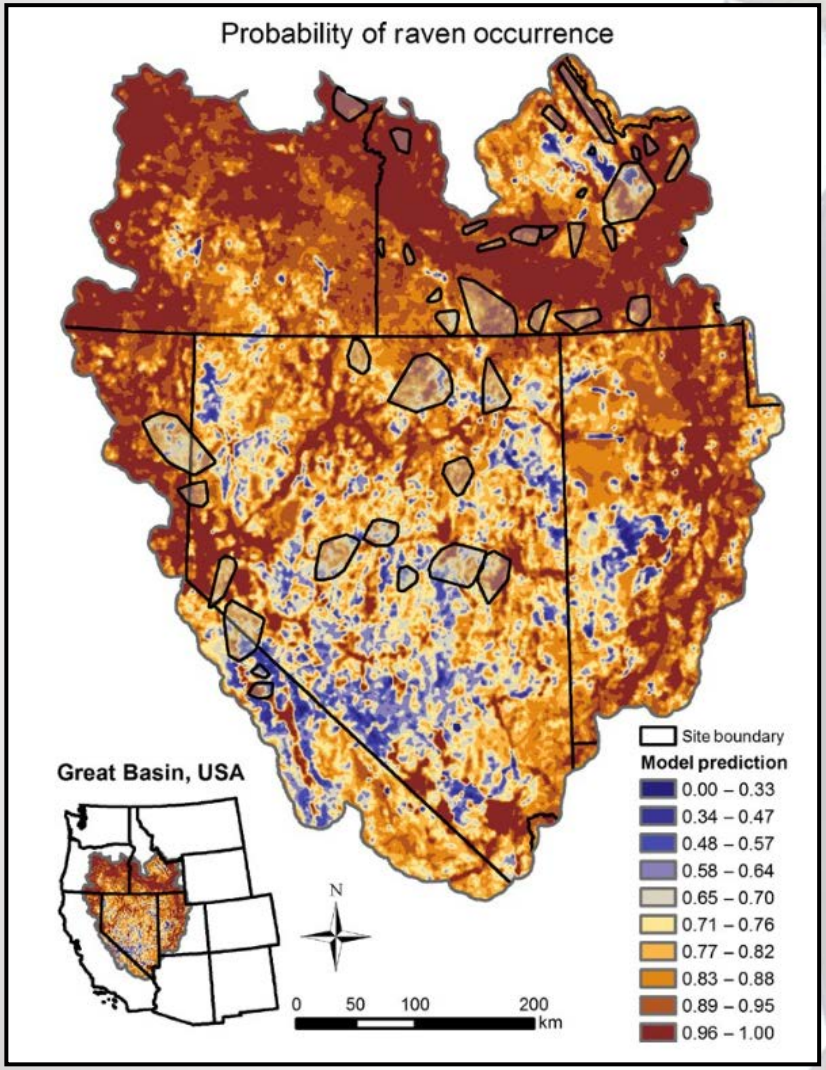
Raven Density Effects on Sage-Grouse Nest Survival



Models of occupancy and density of ravens in relation to environmental covariates

- **Standardized point count surveys**
- **>15,000 raven surveys at nearly 50 study sites**

Anthropogenic subsides impact occupancy



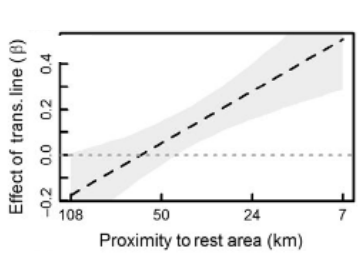
RESEARCH ARTICLE

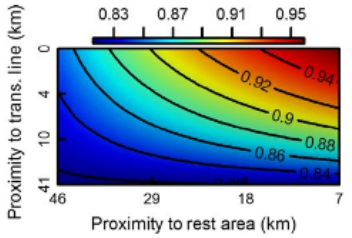
Journal of Applied Ecology

Broad-scale occurrence of a subsidized avian predator: Reducing impacts of ravens on sage-grouse and other sensitive prey

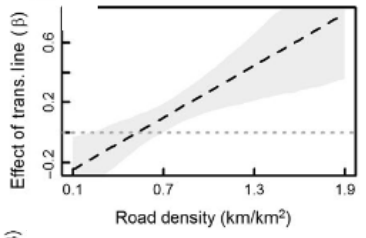
Shawn T. O'Neil[1] | Peter S. Coates[1] | Brianne E. Brussee[1] | Pat J. Jackson[2] | Kristy B. Howe[3] | Ann M. Moser[4] | Lee J. Foster[5] | David J. Delehanty[6]

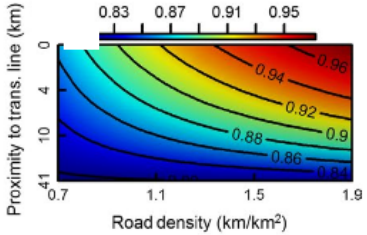
[1]U.S. Geological Survey, Western Ecological Research Center, Dixon, California; [2]Nevada Department of Wildlife, Reno, Nevada; [3]Nevada Natural Heritage Program, Carson City, Nevada; [4]Idaho Department of Fish and Game, Boise, Idaho; [5]Oregon Department of Fish and Wildlife, Hines, Oregon and [6]Department of Biological Sciences, Idaho State University, Pocatello, Idaho



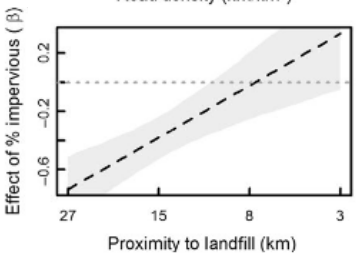


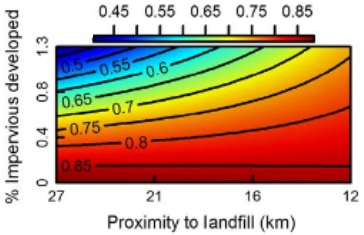
Transmission line
Rest area





Transmission line
Road density



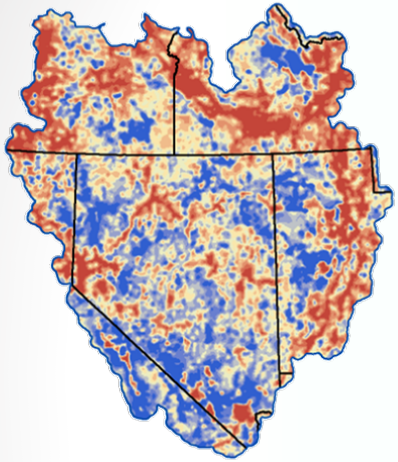


Imperviousness
Landfills

Preliminary Information—Subject to Revision. Not for Citation or Distribution

Effects of anthropogenic subsides are Great Basin wide –most recent study

A) Anthropogenic Effects Model



Predicted Occurrence

- 0.11 - 0.76
- 0.77 - 0.79
- 0.80 - 0.81
- 0.82 - 0.83
- 0.84 - 0.85
- 0.86 - 0.87
- 0.88 - 0.90
- 0.91 - 0.93
- 0.94 - 0.97
- 0.98 - 1.00

RESEARCH ARTICLE

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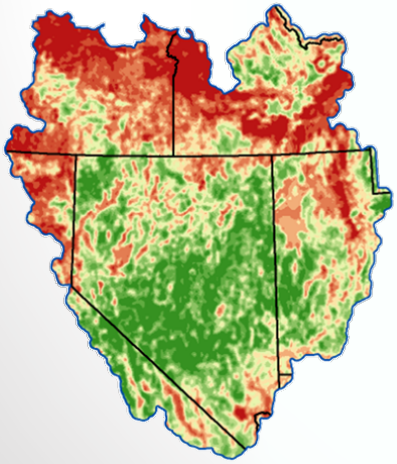
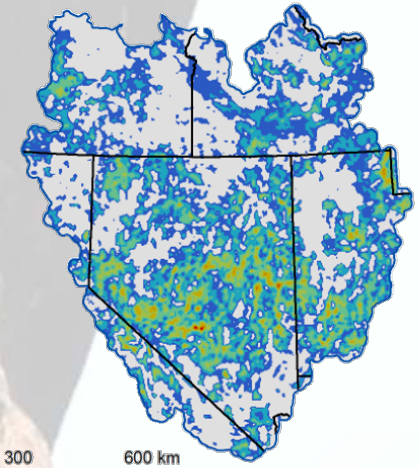
B) Natural Effects Model



Predicted Occurrence

- 0.56 - 0.74
- 0.75 - 0.78
- 0.79 - 0.8
- 0.81 - 0.83
- 0.84 - 0.85
- 0.86 - 0.87
- 0.88 - 0.89
- 0.9 - 0.91
- 0.92 - 0.94
- 0.95 - 0.99

C) Anthropogenic Influence Index



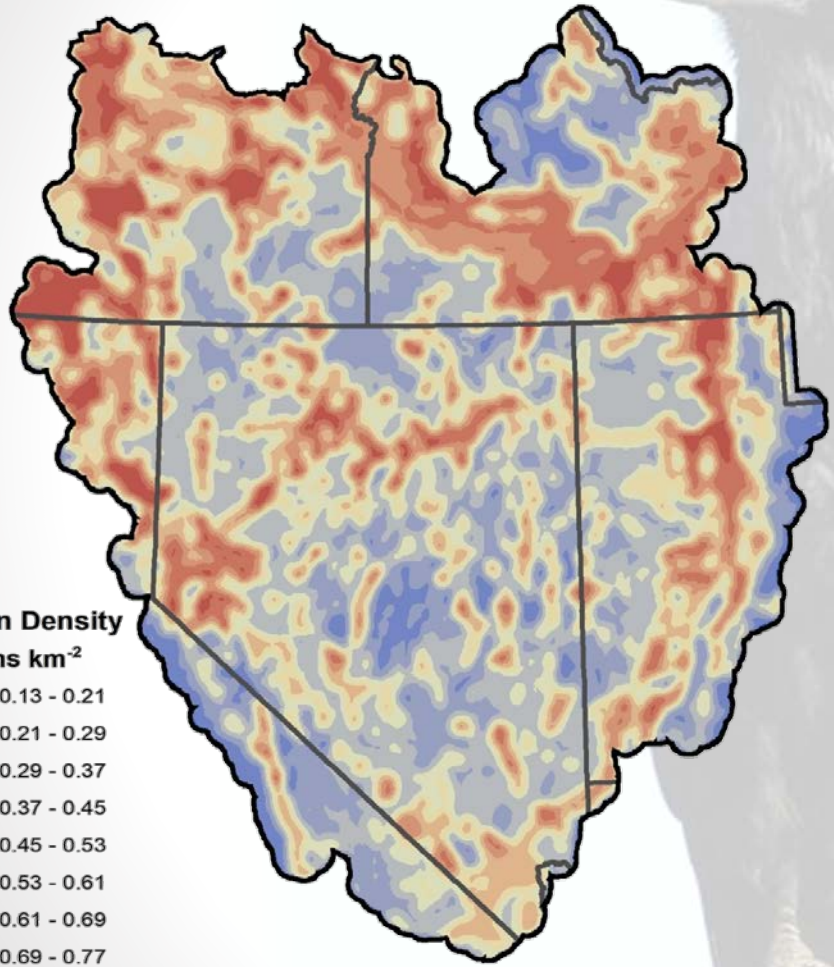
Change in occurrence

- 0.00
- 0.01 - 0.05
- 0.06 - 0.10
- 0.11 - 0.15
- 0.16 - 0.20
- 0.21 - 0.25
- 0.26 - 0.30
- > 0.30

0 300 600 km

N W E S

Raven Density Effects on Sage-Grouse Nest Survival



Biological Conservation
Volume 243, March 2020, 108409

Broad-scale impacts of an invasive native predator on a sensitive native prey species within the shifting avian community of the North American Great Basin

Peter S. Coates [a], Shawn T. O'Neil [a], Brianne E. Brussee [a], Mark A. Ricca [a], Pat J. Jackson [b], Jonathan B. Dinkins [c], Kristy B. Howe [d], Ann M. Moser [e], Lee J. Foster [f], David J. Delehanty [g]

Average raven density

0.54 ravens km^{-2} (95% CI = 0.42–0.70)

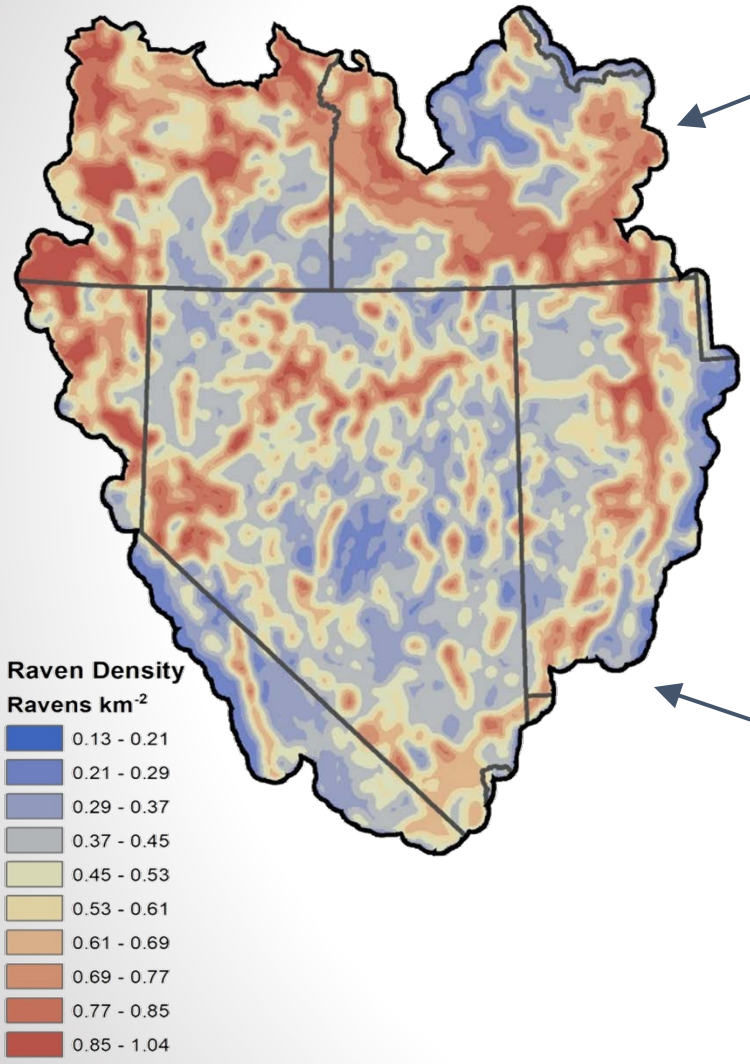
Total abundance Great Basin

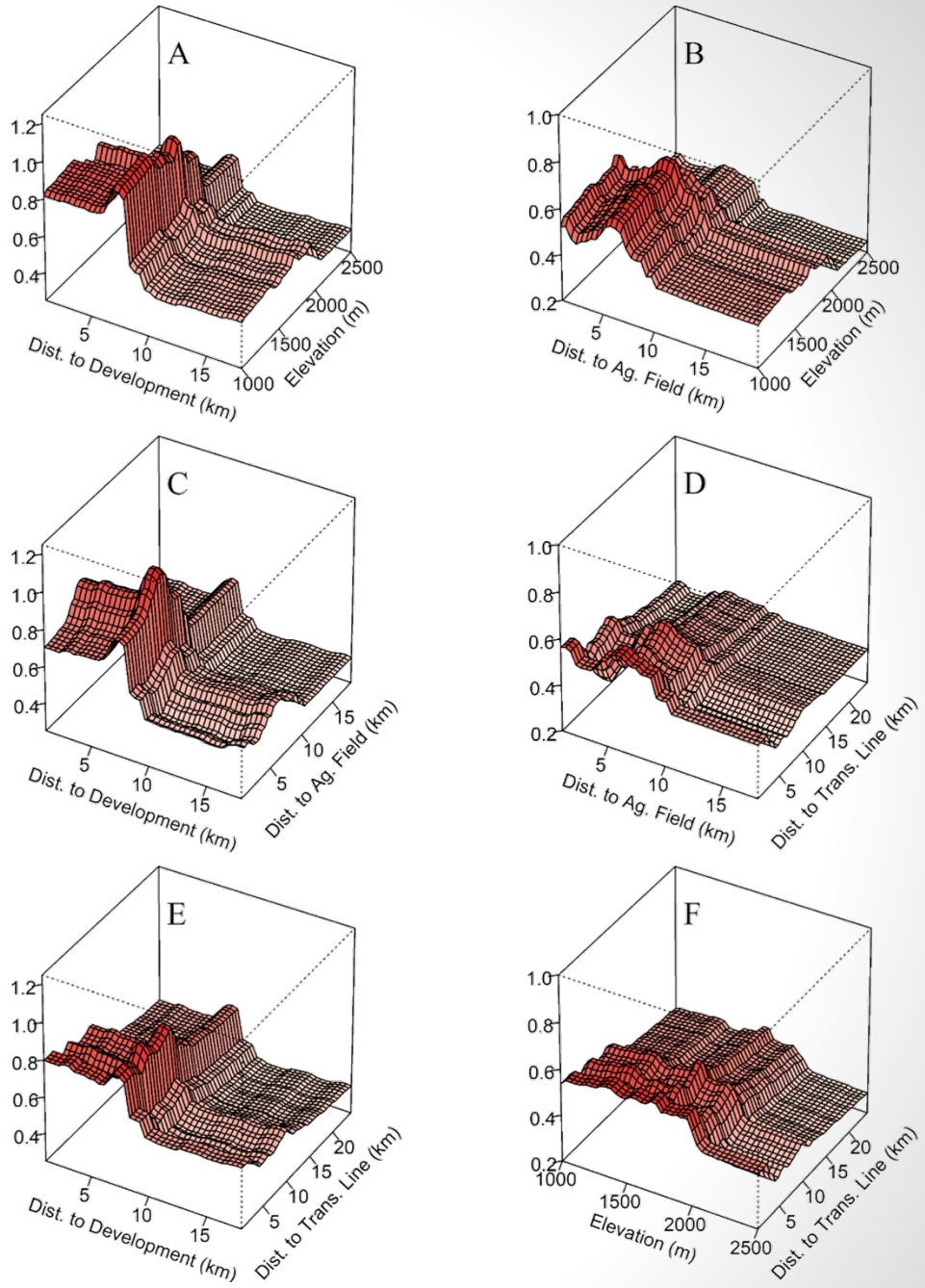
403,346 (95% CI = 310,783–522,803)

Total abundance sagebrush

165,186 (136,874–201,581)

Interaction effects of density

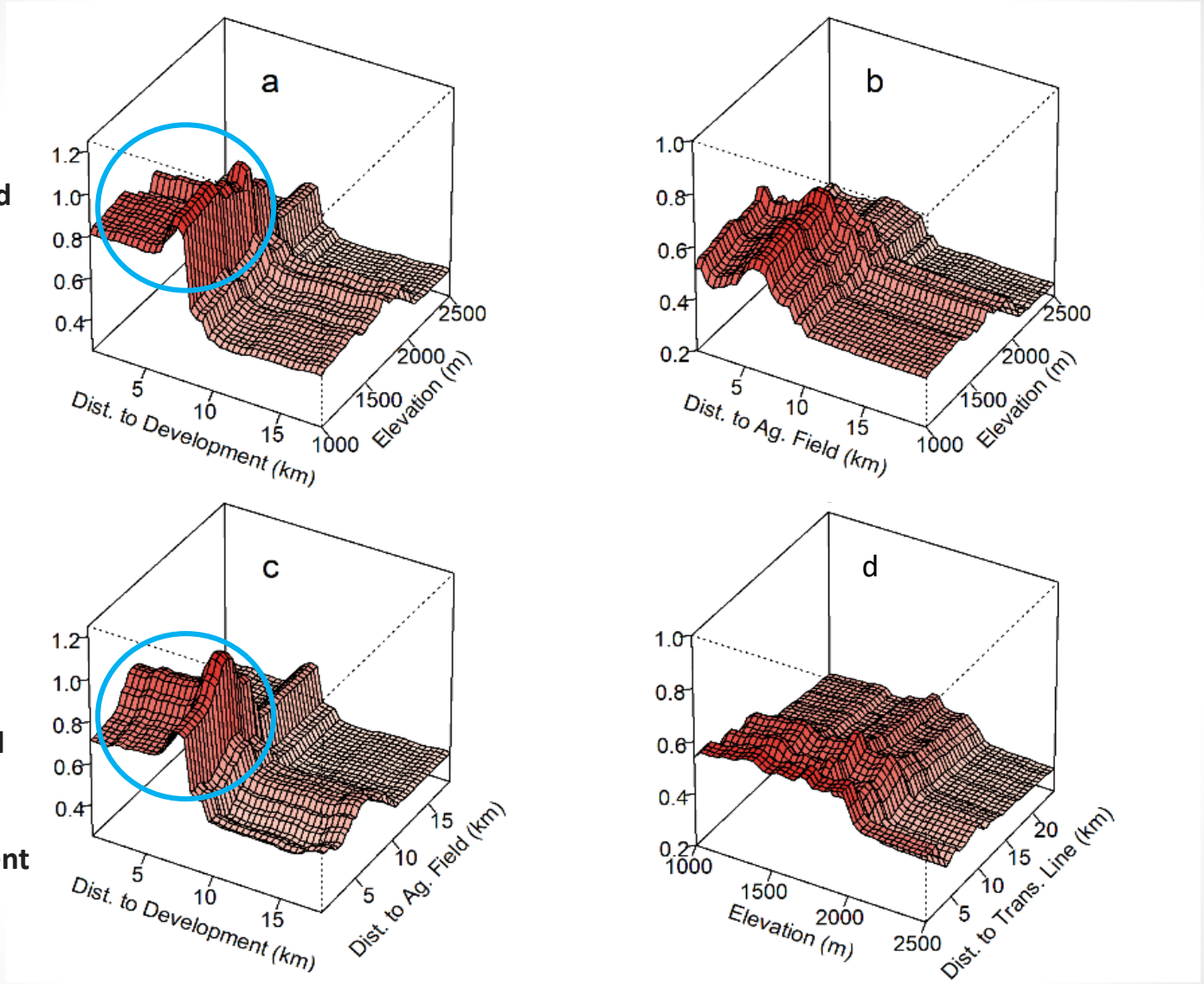




Coates et al. (2020) *Biol. Conservation 242*
https://doi.org/10.1016/j.biocon.2020.108409

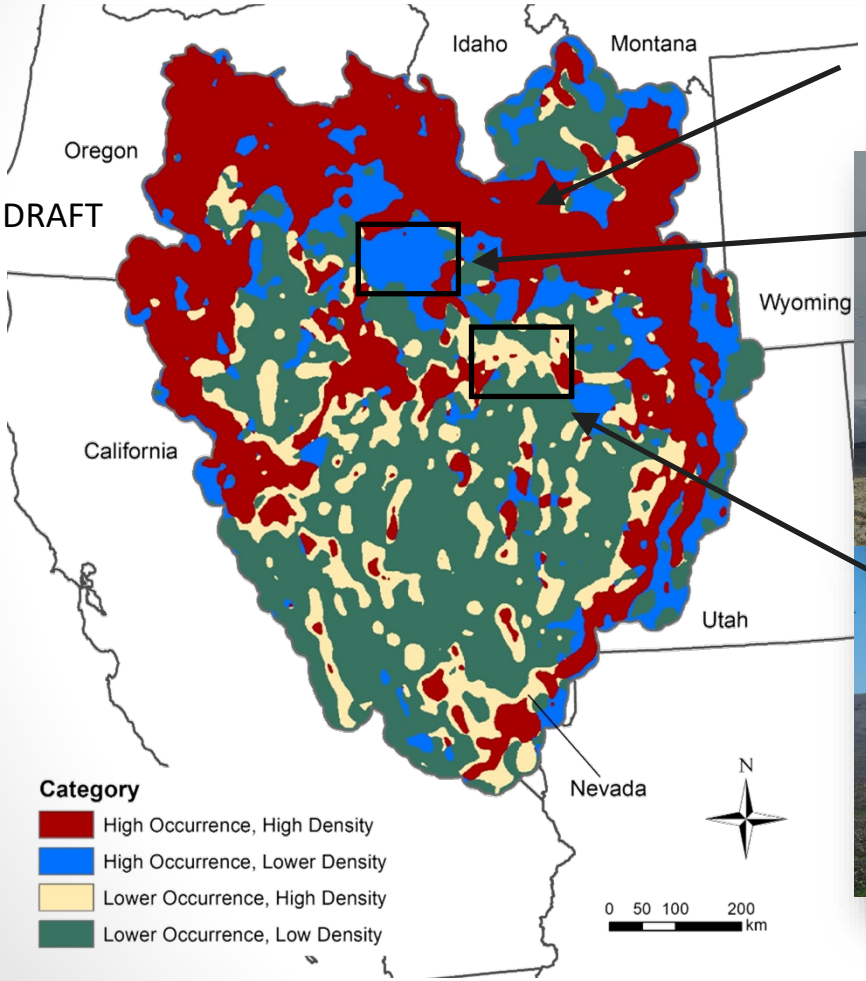
Near developed areas at lower elevation

Near agricultural fields and closer to development

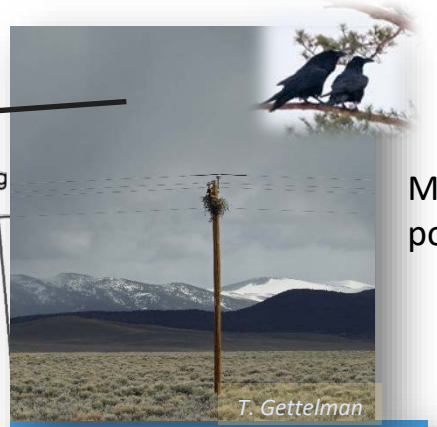


Ongoing & future research – Exploring resident vs. transient populations and impacts

Intersection between raven occurrence and density



Likely saturated (red) high occurrence & density

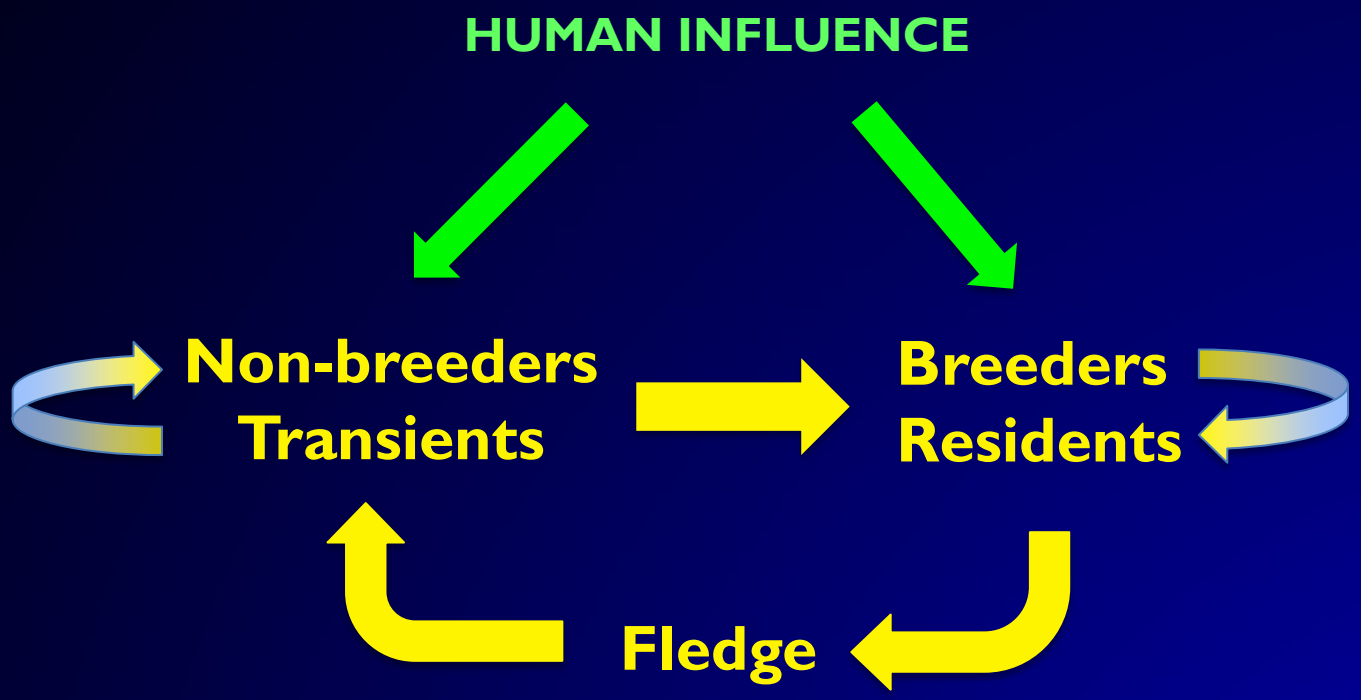


More resident populations (blue)

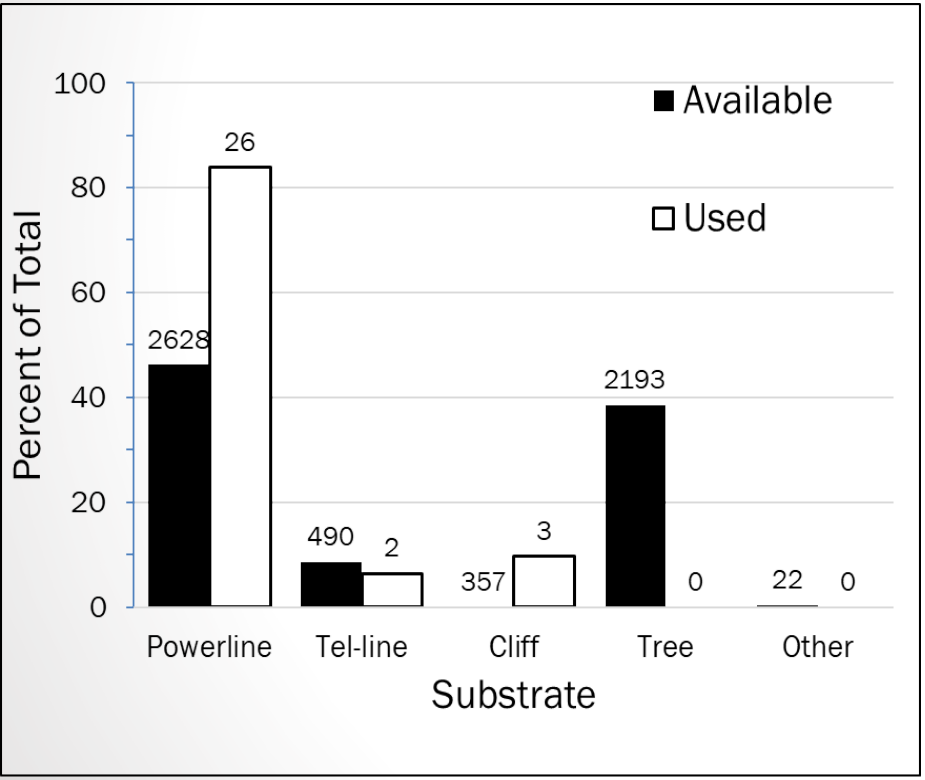
More transient populations (yellow)

Webster et al., In Press, Human Wildlife Interactions

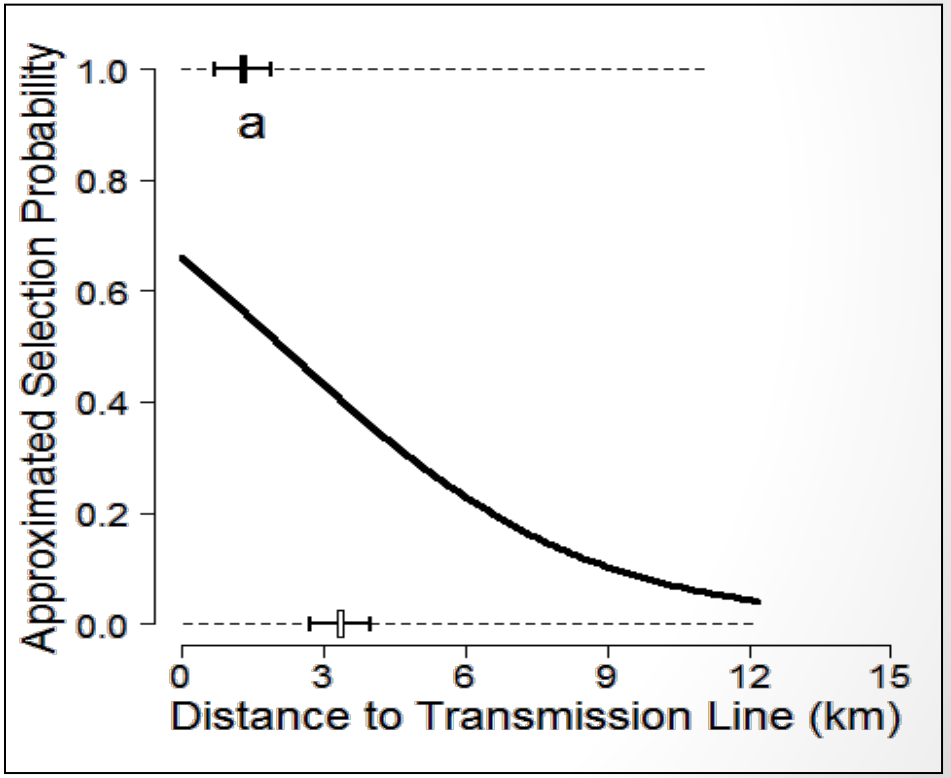
Conceptual Model



Nesting ravens select powerlines



Knight and Kawashima. 1993. Responses of raven and red-tailed hawks to linear right-of-ways. *Journal of Wildlife Management* 57(2):266-271



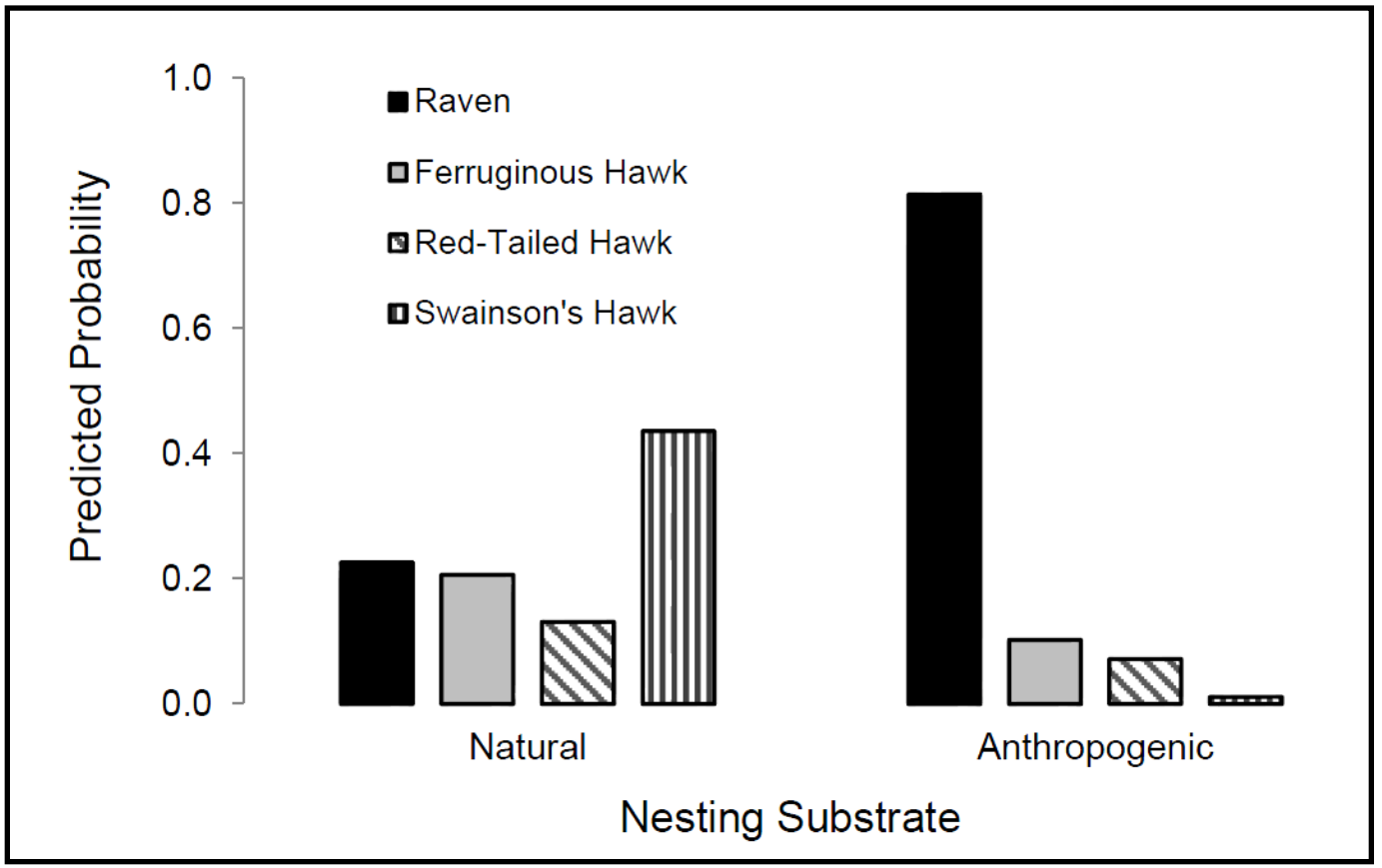
Howe et al. 2014. Selection of anthropogenic features and vegetation characteristics be nesting common ravens in the sagebrush ecosystem. *The Condor: Ornithological Applications* 116:35-49

THE CONDOR
Ornithological Applications
www.cooper.org
Volume 116, 2014, pp. 341–356
DOI: 10.1650/CONDOR-13-126.1

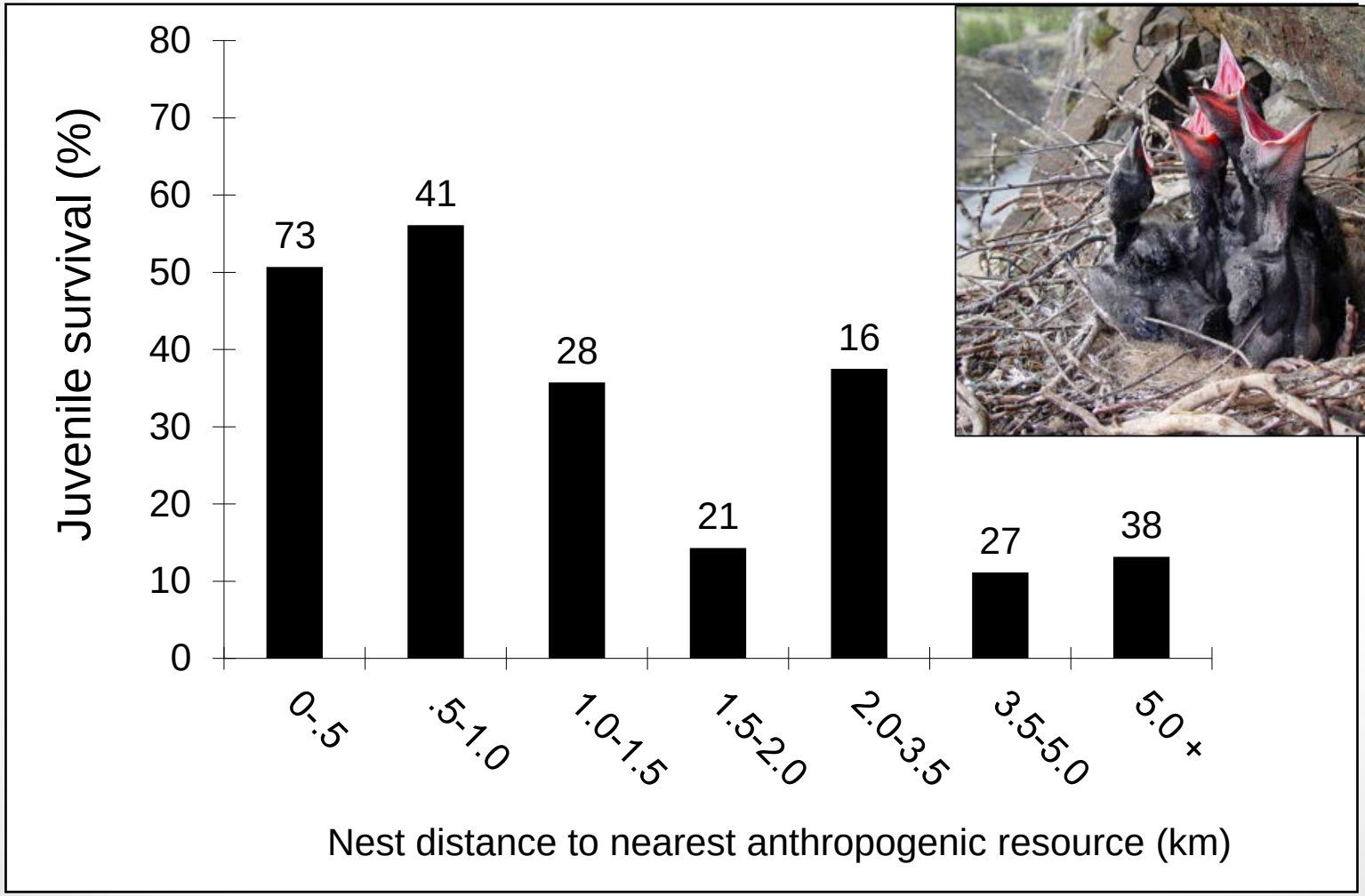
RESEARCH ARTICLE

Landscape alterations influence differential habitat use of nesting buteos and ravens within sagebrush ecosystem: Implications for transmission line development

Peter S. Coates,[1]* Kristy B. Howe,[1,2,3] Michael L. Casazza,[1] and David J. Delehanty[3]



Benefits of anthropogenic resources



Webb et al. 2004 Condor 106:517-528

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science for a changing world

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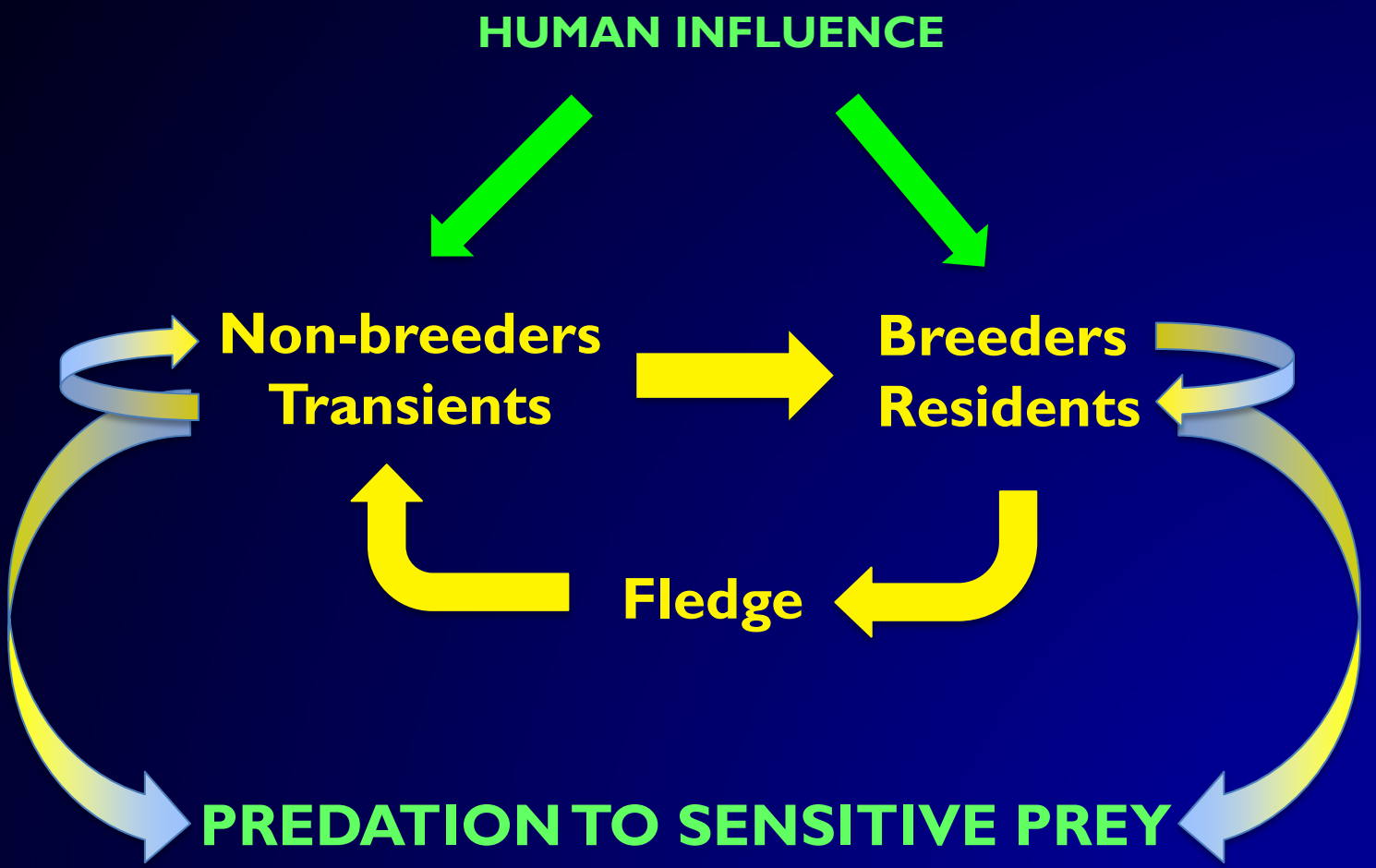
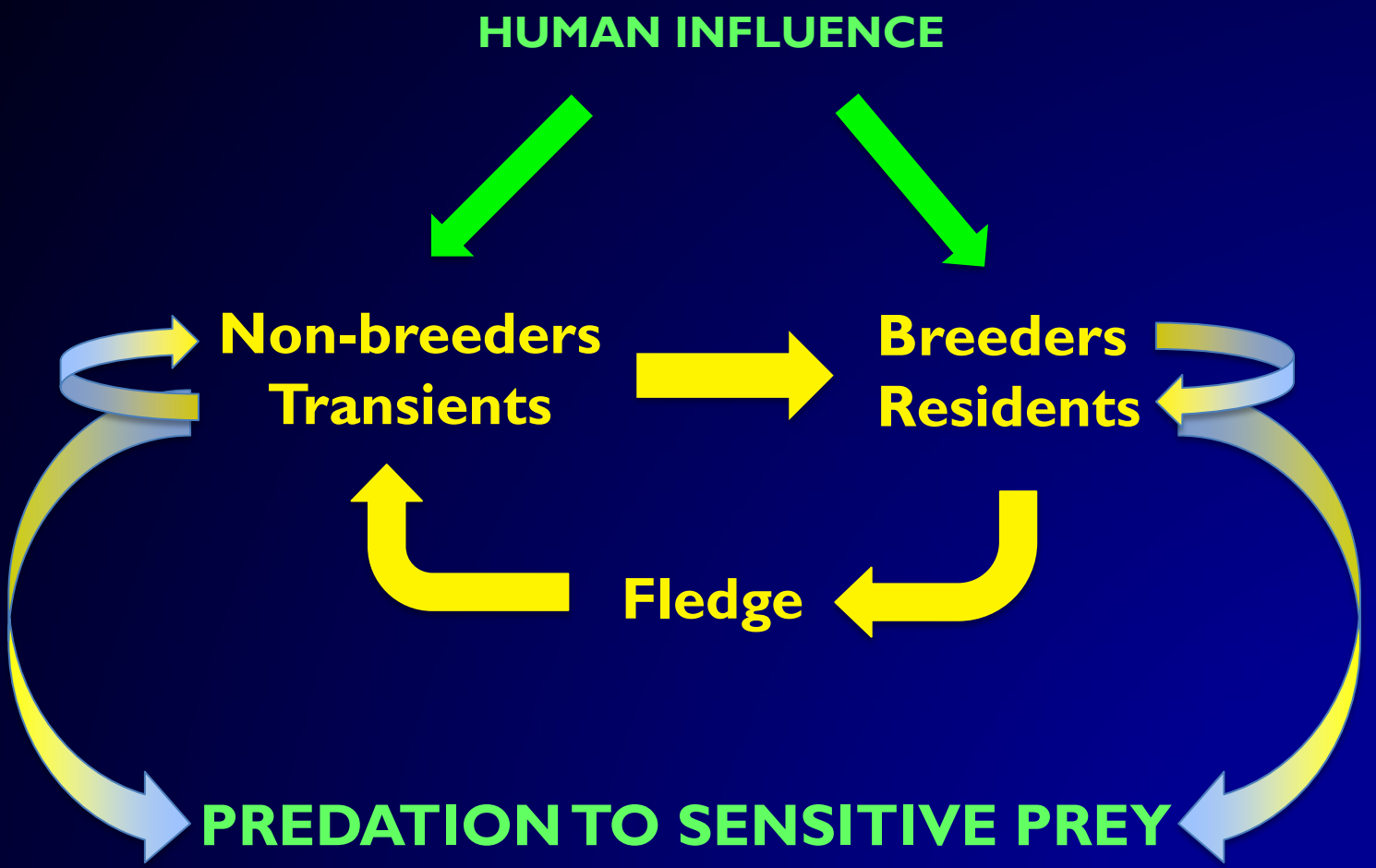


Ecological Consequences

- Hyperpredation
- Spillover predation

Conceptual Model



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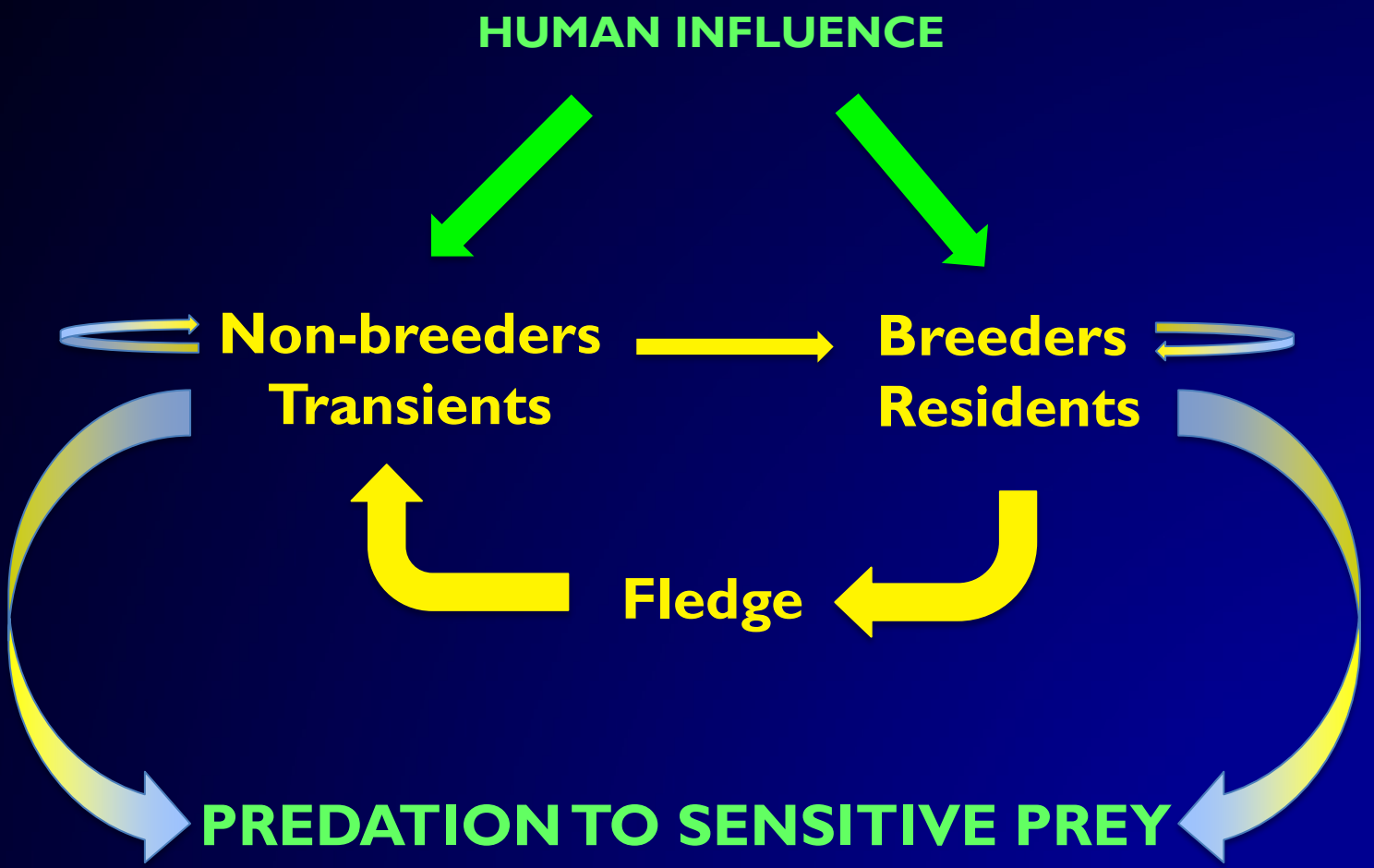

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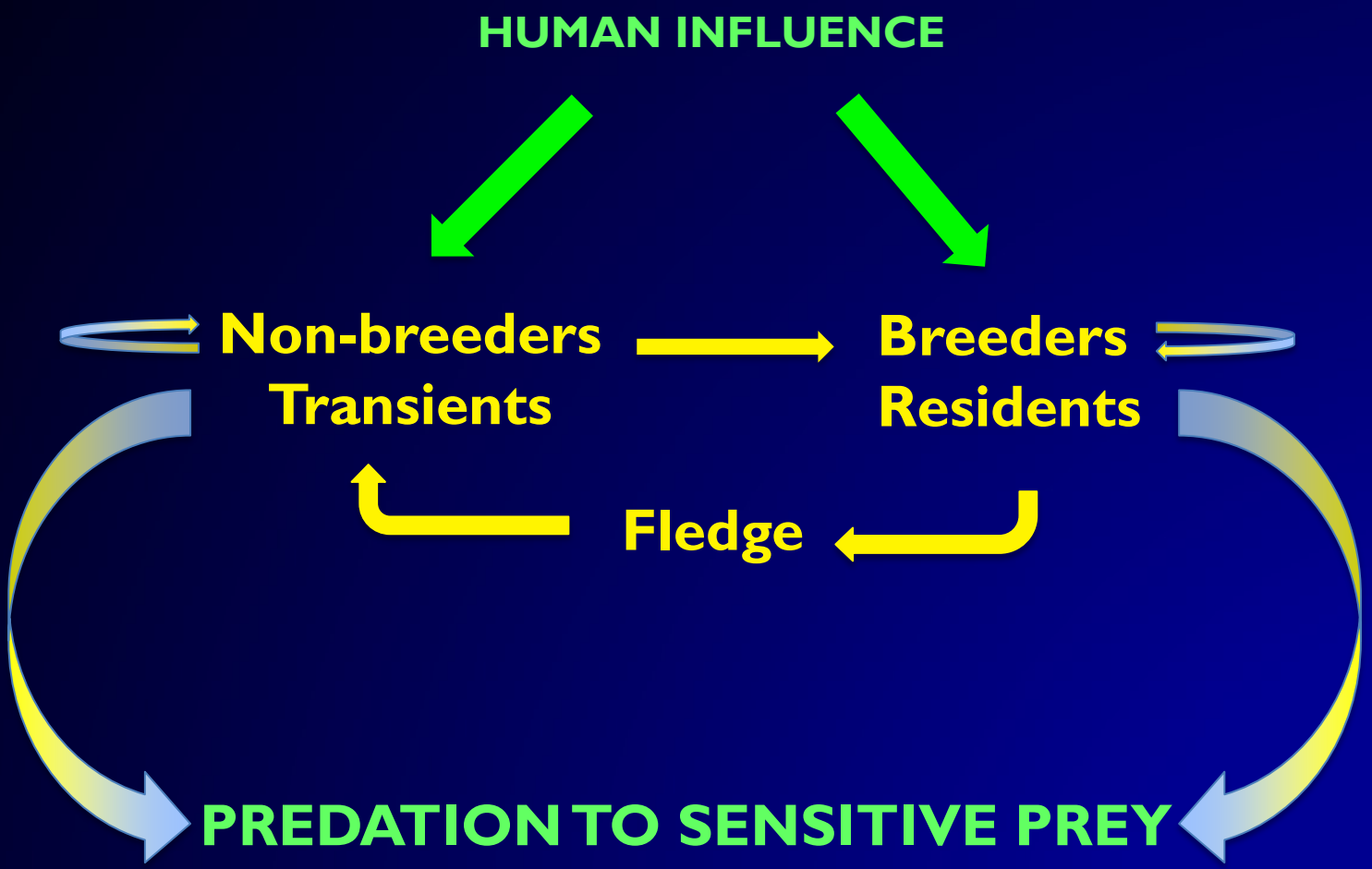

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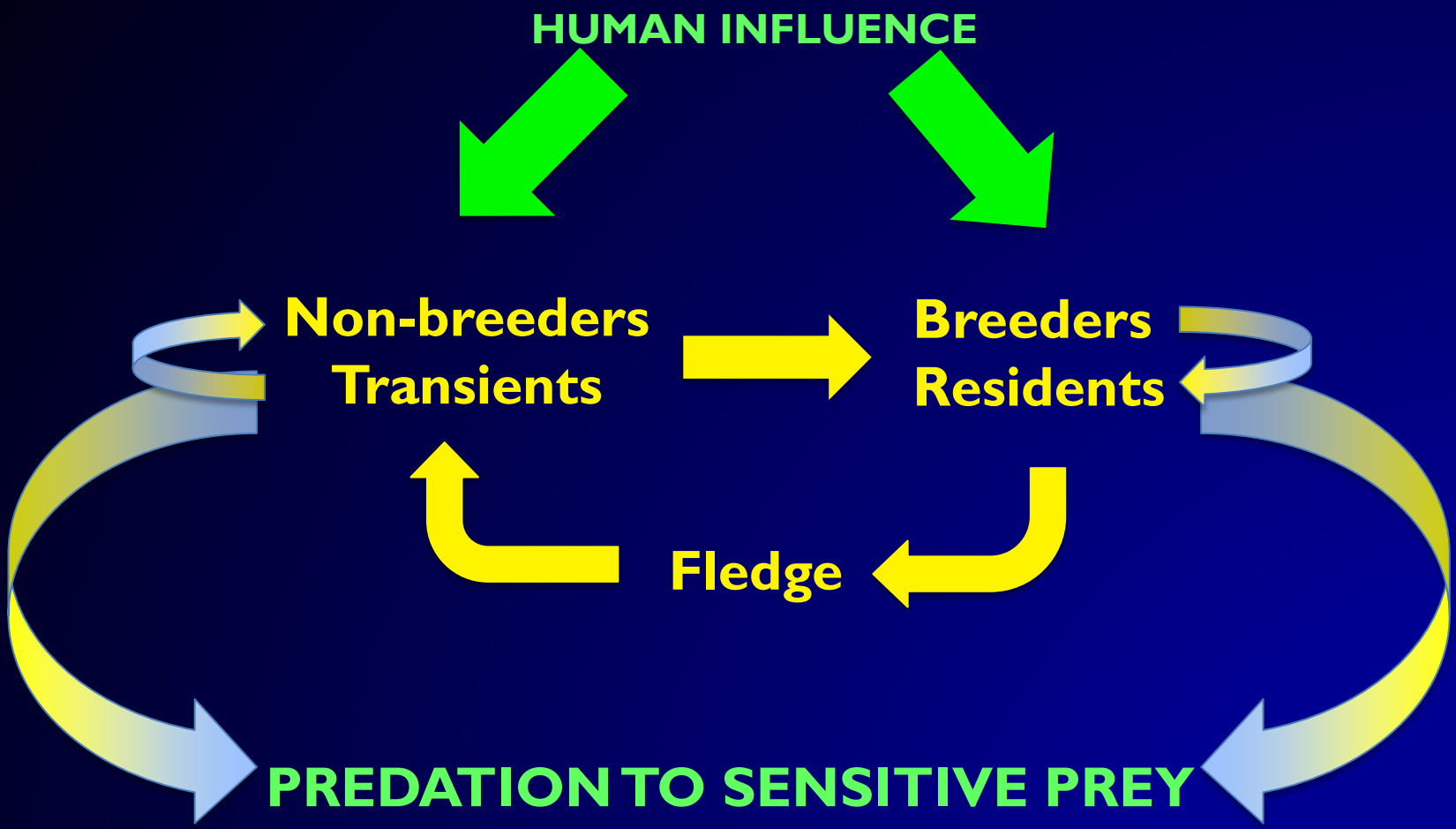
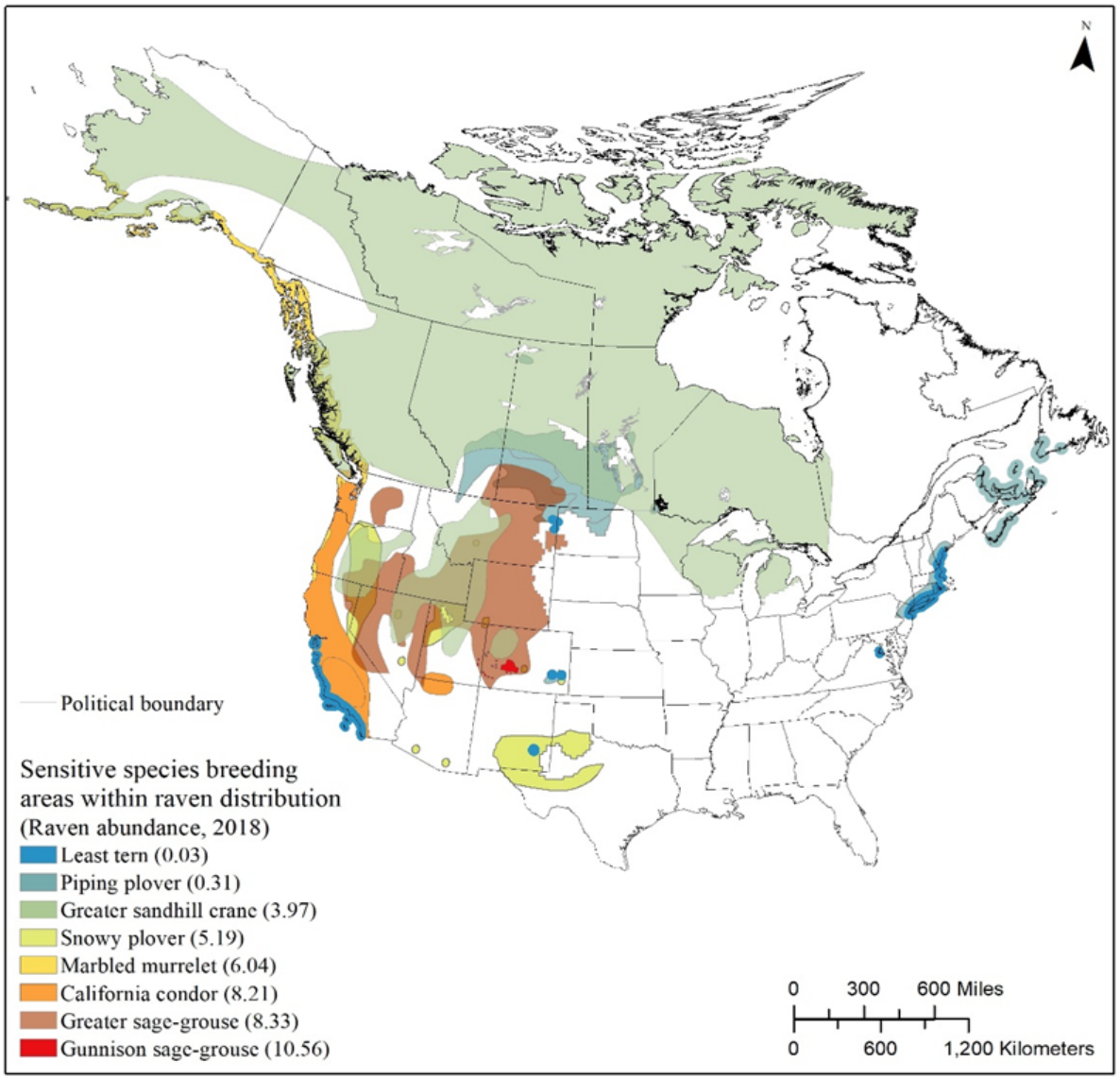
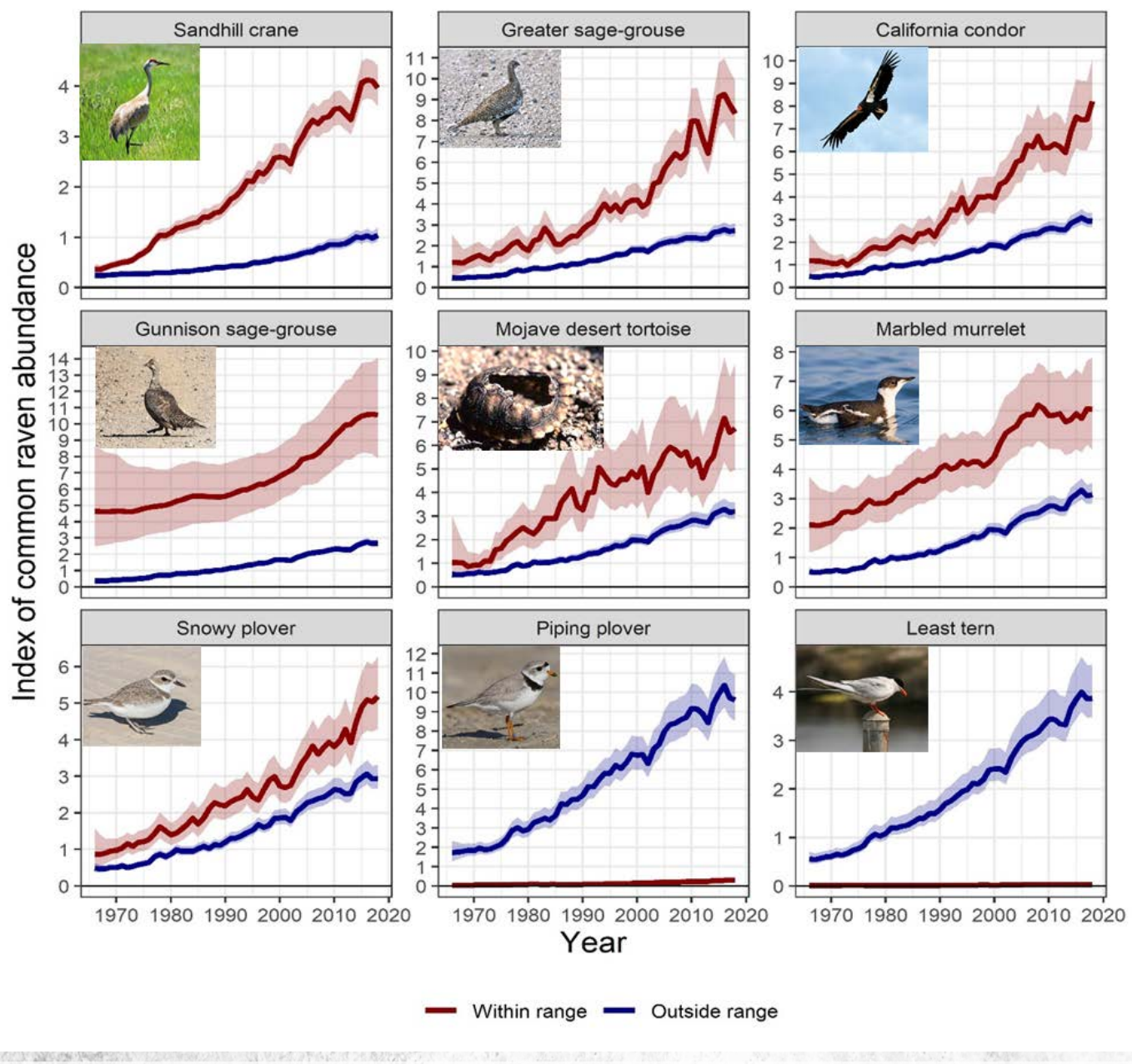


Ravens impact sensitive avian populations



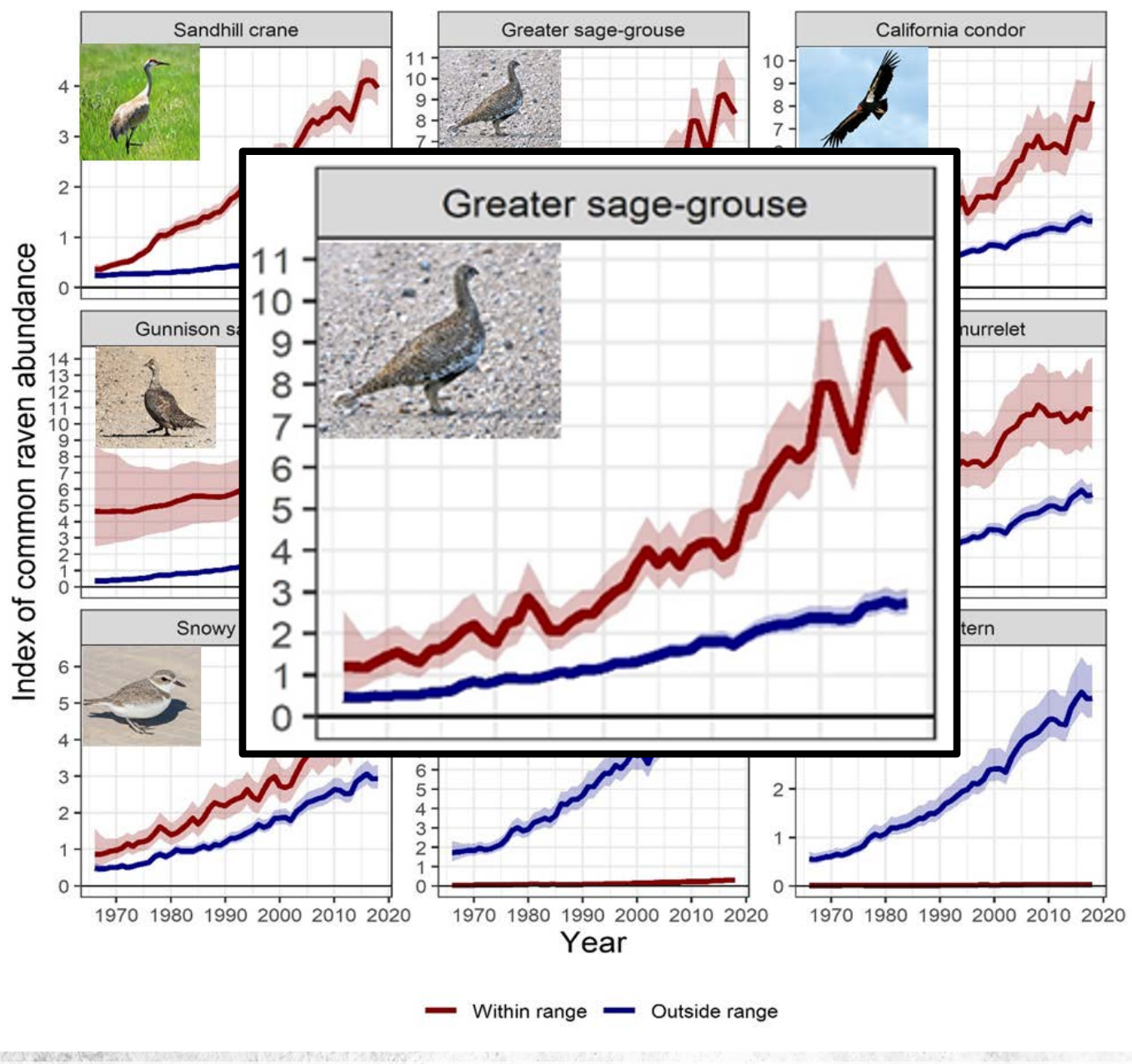
Coates et al. *In press*. Synthesis of nest predation impacts of common ravens on sensitive avian species. *Human-Wildlife Interactions*.

Ravens impact sensitive avian populations



Harju et al. In Press. Human-Wildlife Interactions

Ravens impact sensitive avian populations



Harju et al. In Press. Human-Wildlife Interactions

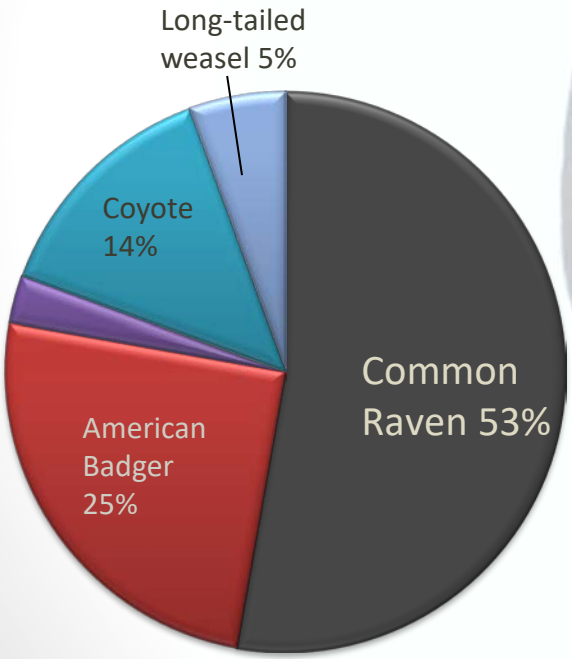
Ravens as effective sage-grouse egg predator

Journal of Wildlife Management 74(2):240–248; 2010; DOI: 10.2193/2009-047

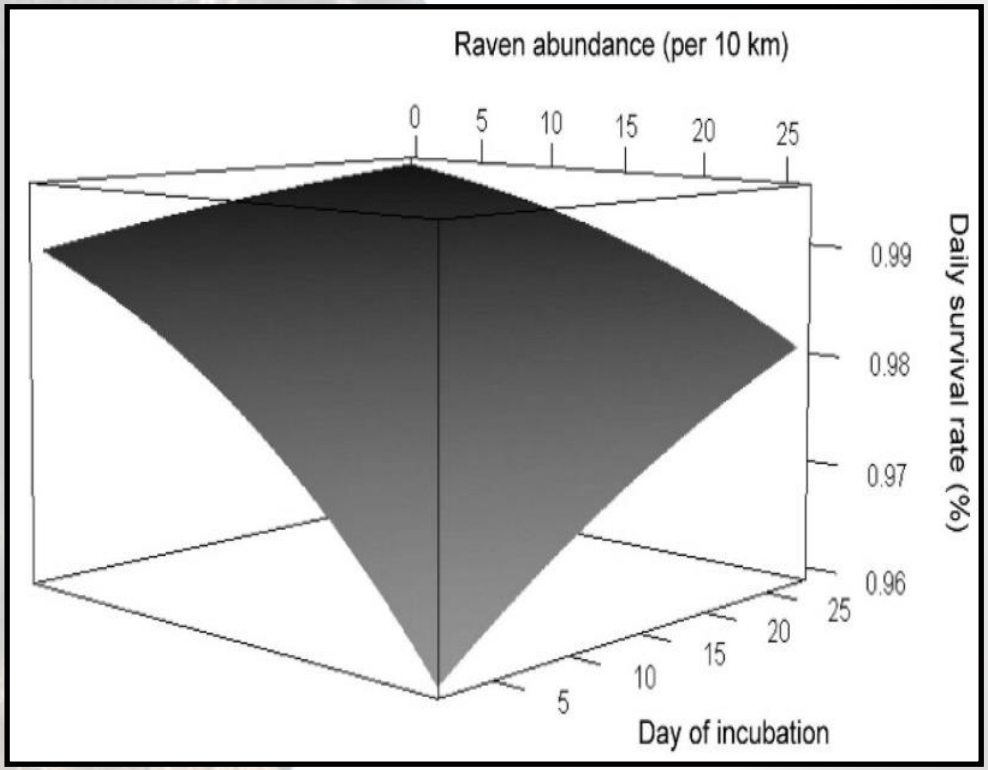
Management and Conservation Article

Nest Predation of Greater Sage-Grouse in Relation to Microhabitat Factors and Predators

PETER S. COATES,[1] *Department of Biological Sciences, Idaho State University, Pocatello, ID 83209-8007, USA*
DAVID J. DELEHANTY, *Department of Biological Sciences, Idaho State University, Pocatello, ID 83209-8007, USA*



Predation on sage-grouse nests (9 years of video data; Idaho State University)



Coates and Delehanty (2010). Journal of Wildlife Management 74:240–248.

Shrub cover influences predation by ravens

Journal of Wildlife Management 74(2):240–248; 2010; DOI: 10.2193/2009-047

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Nest Predation of Greater Sage-Grouse in Relation to Microhabitat Factors and Predators

PETER S. COATES,[1] *Department of Biological Sciences, Idaho State University, Pocatello, ID 83209-8007, USA*
DAVID J. DELEHANTY, *Department of Biological Sciences, Idaho State University, Pocatello, ID 83209-8007, USA*

Resp.	Covariate	Estimate	95% CI lower	95% CI upper
Raven	raven	0.23	0.11	0.41*
	shrub cover	-0.08	-0.15	-0.02*
	grass	0.17	-0.63	0.41
	forb	0.16	-0.40	0.70
	understory	0.02	-0.04	0.08
	shrub height	0.00	-0.06	0.06
Badger	understory	0.10	0.03	0.12*
	forb	0.70	0.13	1.43*
	grass	0.23	-0.02	0.49
	shrub cover	0.02	-0.02	0.06
	shrub height	0.01	-0.01	0.42

1% decrease in shrub cover increased the odds of raven predation by 7.5%

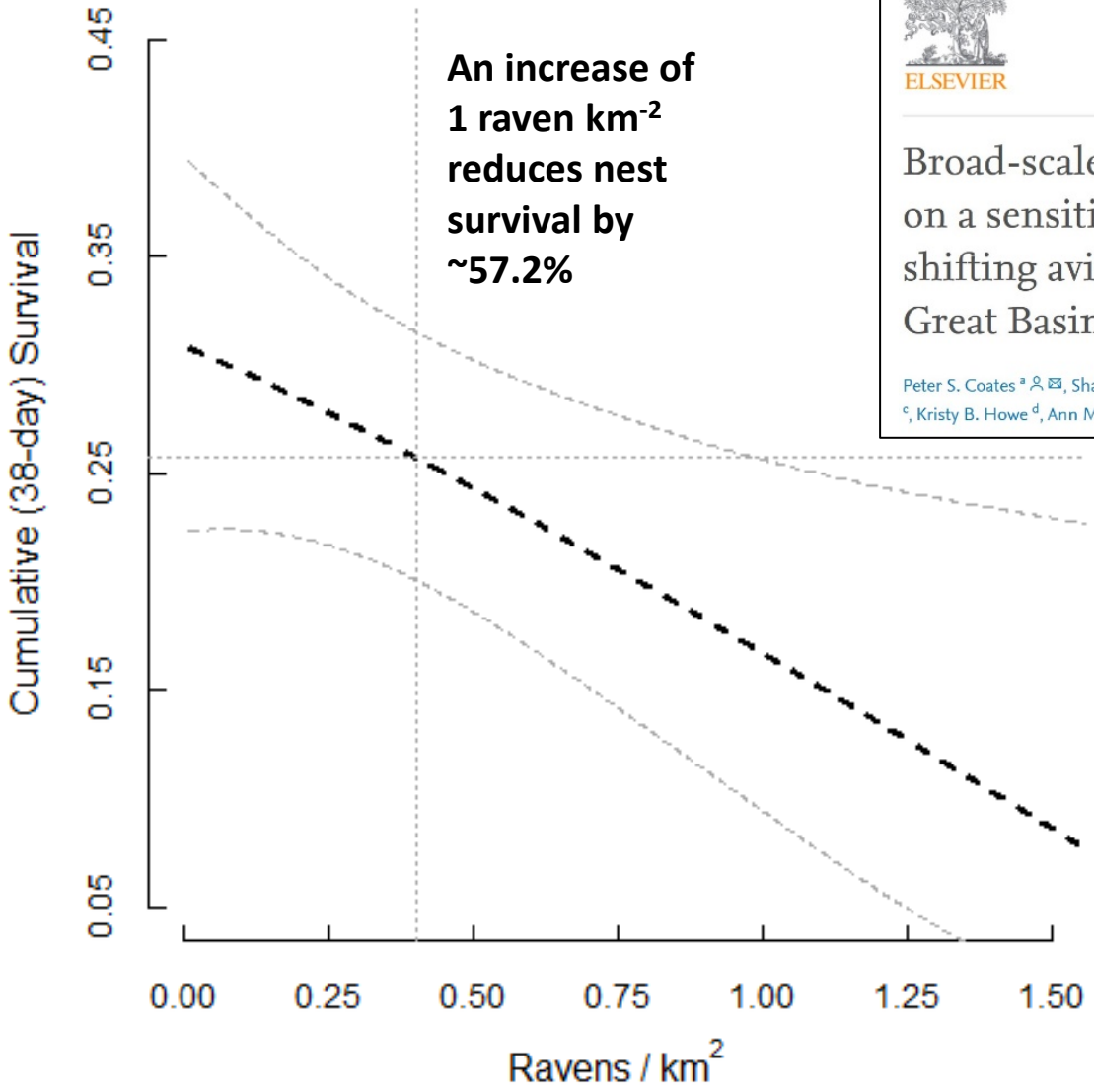
20–30% sagebrush cover and >40% total shrub cover

Photo: BLM

Loss of Habitat

Photo: Matt Lavin

Raven density influences nest survival



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Biological Conservation
Volume 243, March 2020, 108409

Broad-scale impacts of an invasive native predator on a sensitive native prey species within the shifting avian community of the North American Great Basin

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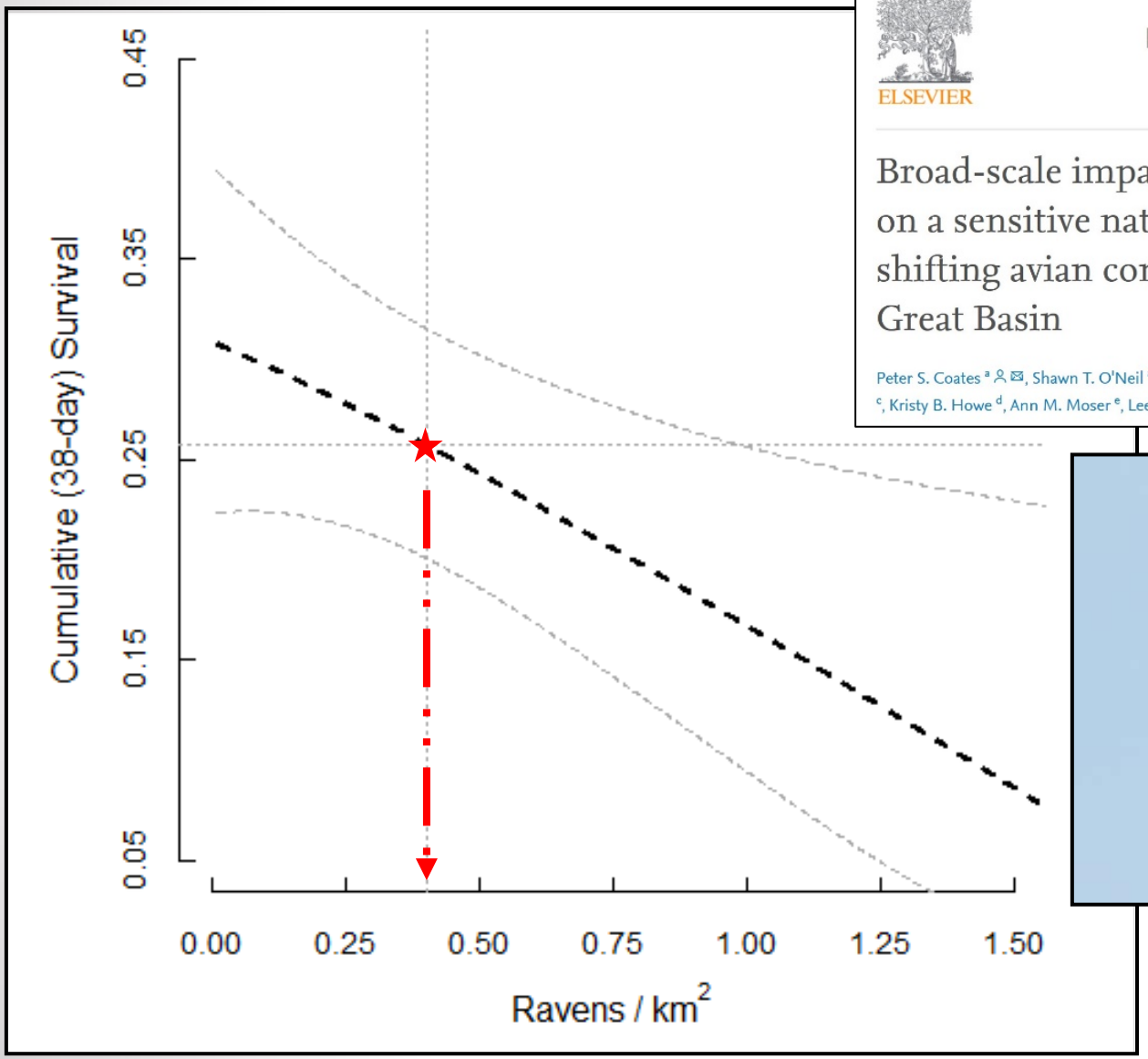
Ecological threshold of 0.4 ravens km^{-2}



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Broad scale impacts of ravens on sage-grouse nest success

USGS science for a changing world

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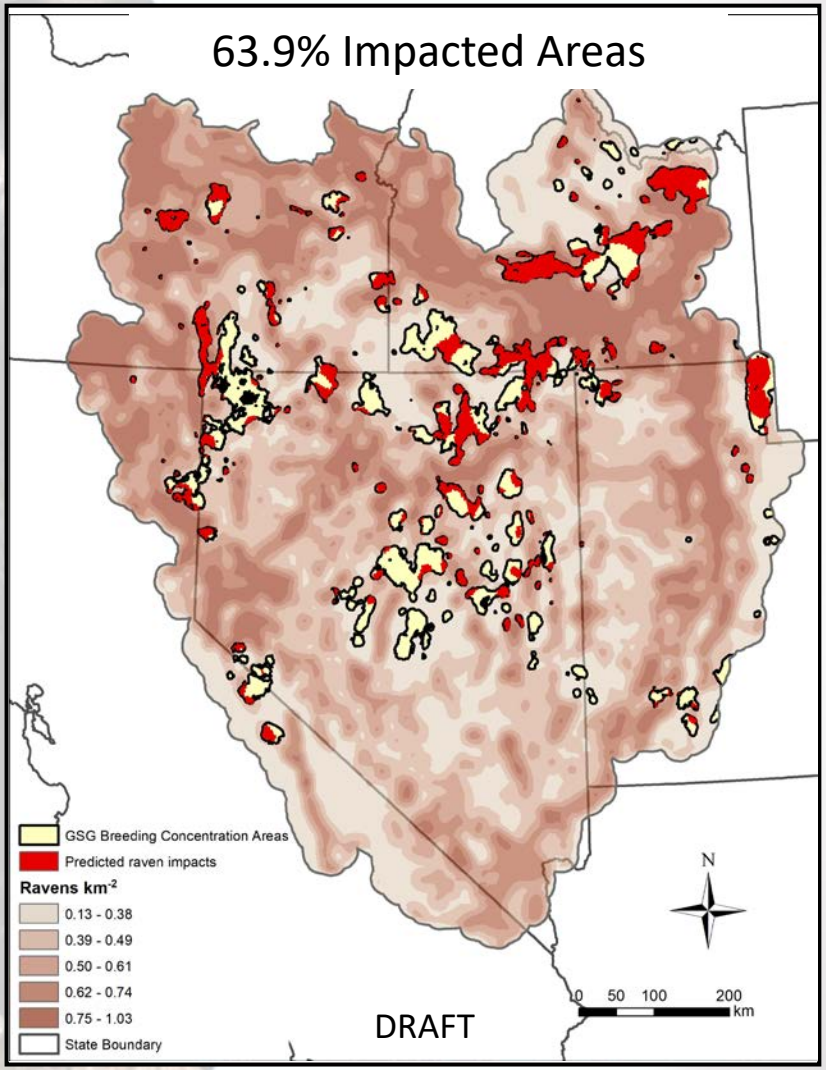


Coates, O'Neil, Brussee et al. 2020. Biological Conservation

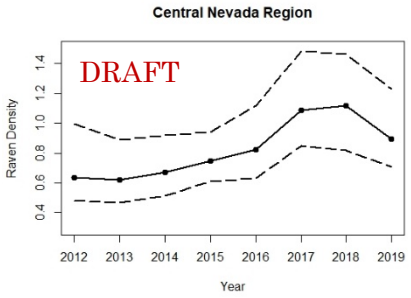
Fine scale impacts of ravens on sage-grouse nest success

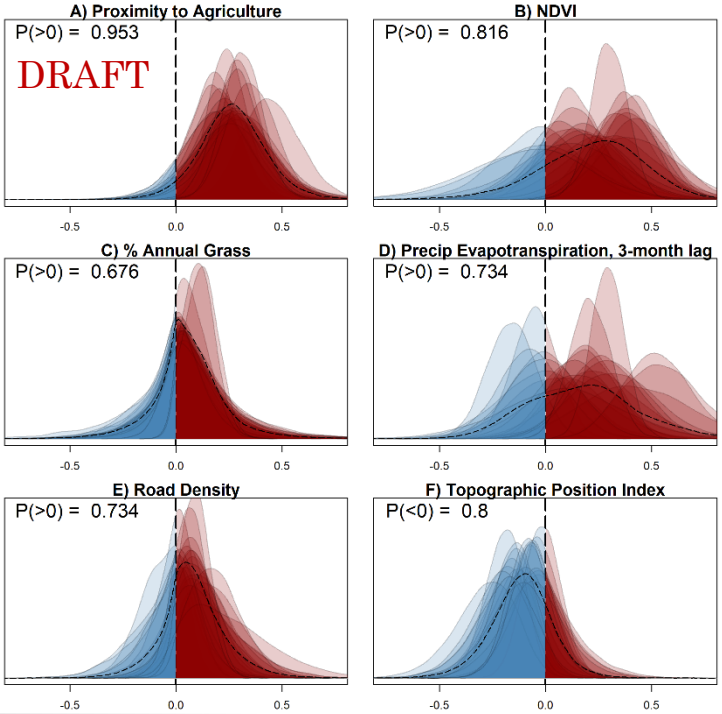
USGS science for a changing world

Fine-scale density surface modeling

Local applications to support raven management efforts

Example: Central Nevada





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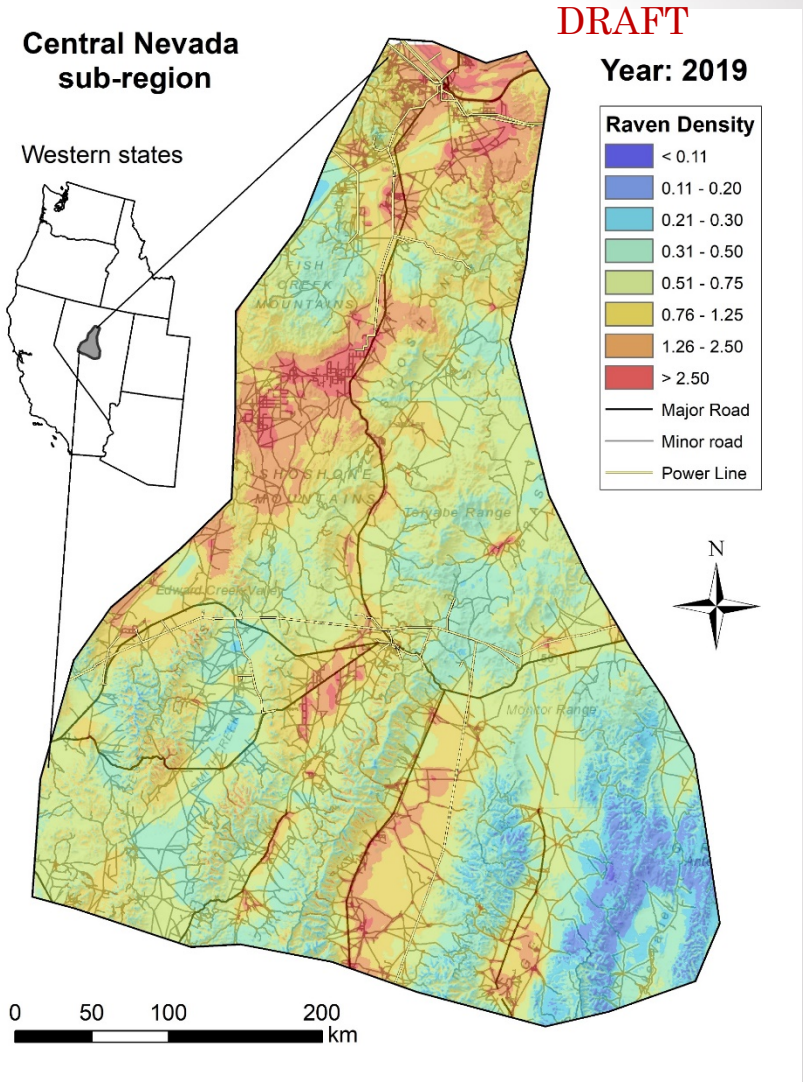


Fine scale impacts of ravens on sage-grouse nest success

USGS science for a changing world

Where to reduce raven impacts?

Fine-scale spatially explicit impact tool

Derived prediction of nest survival under current raven densities (S_0)

- Current, site-specific density projected from HDSM

Simulate reduced raven density across the site

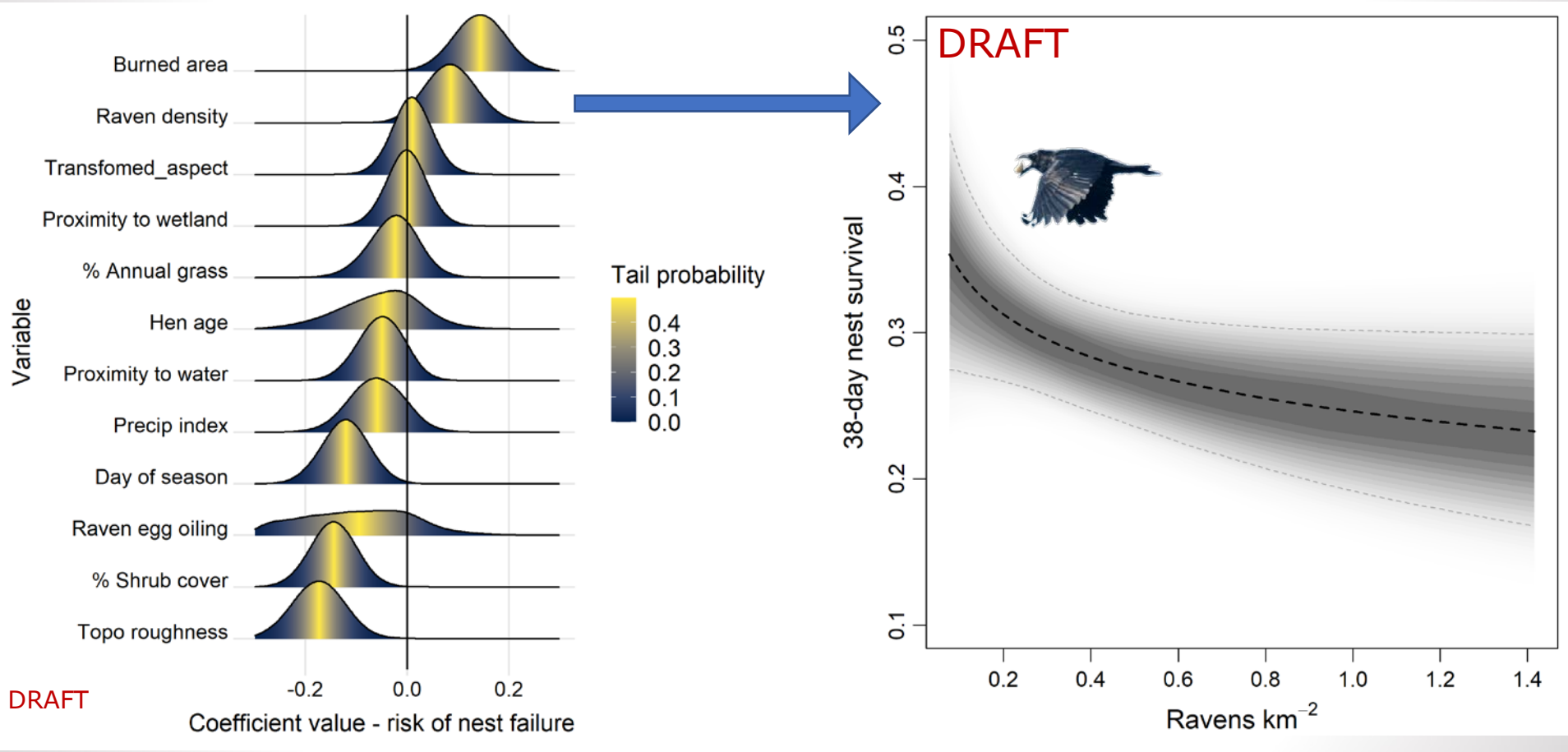
- E.g., constant 0.2 ravens km^{-2}, based on remote study areas

New derived prediction of potential nest survival (S_P)

Subtract current from 'potential' to derive raven impact surface

Fine scale impacts of ravens on sage-grouse nest success

Modeled raven density effect



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Fine scale impacts of ravens on sage-grouse nest success

USGS science for a changing world

Decision support tool – Susanville site, CA & NV

Derived prediction of nest survival under current raven densities (S_0)

↓

Simulate reduced raven density across the site

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Subtract current from 'potential' to derive raven impact surface

▲ SG Nest

★ SG Lek

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km

T. Gettelma

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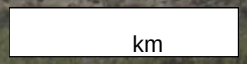

T. Gettelma

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Fine scale impacts of ravens on sage-grouse nest success

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Decision support tool – Desatoya Mountains, NV

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Subtract current from 'potential' to derive raven impact surface

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★ SG Lek

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Impacts on population growth

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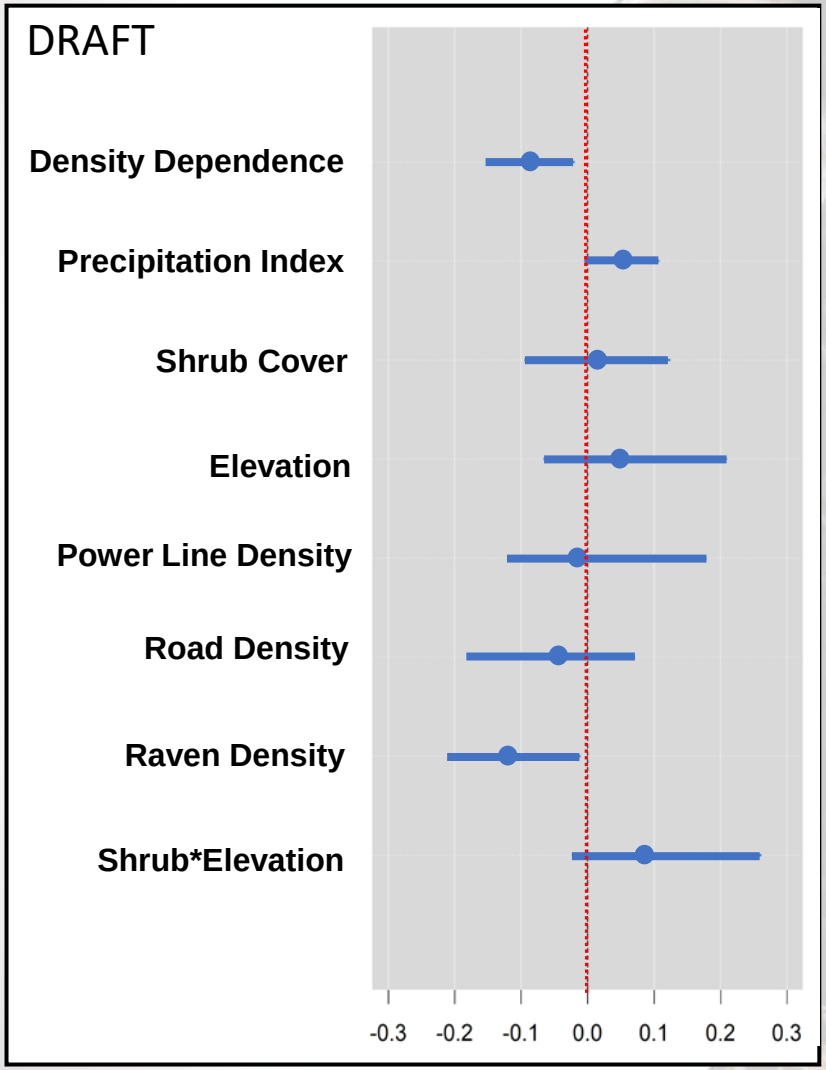

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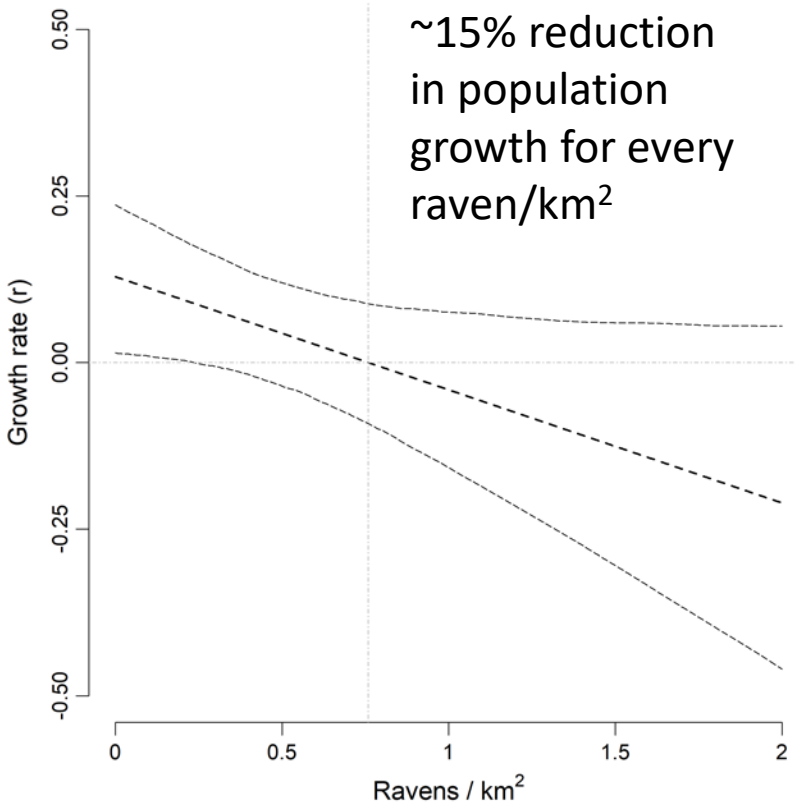

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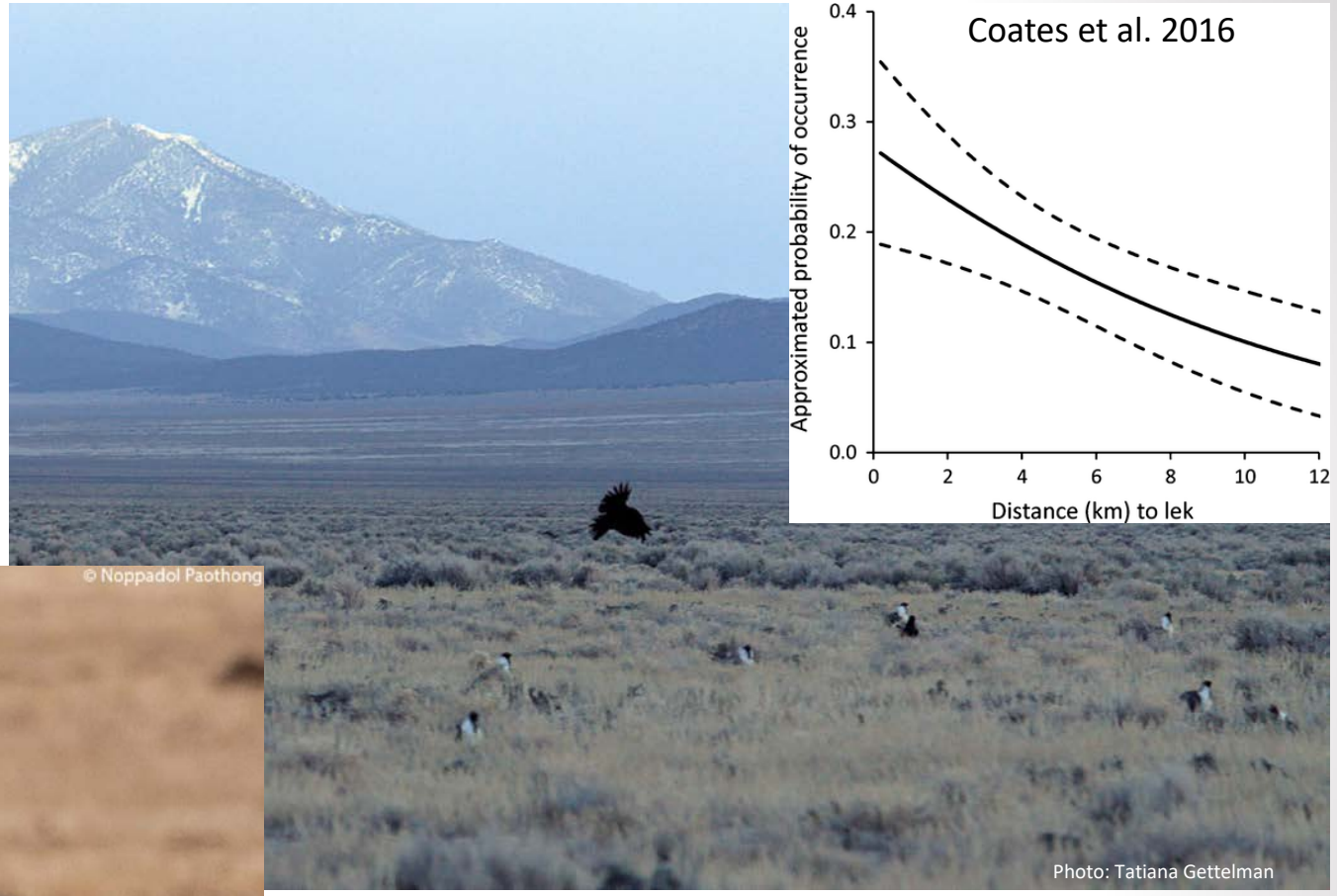
Attraction to leks and harassment

Raven attacks greater sage-grouse (NV)



Raven attacks Gunnison sage-grouse (CO)

Overview

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Problem

Expansion of raven distribution and abundance

↓

Anthropogenic resource subsidies

↓

Predation effects on sensitive species

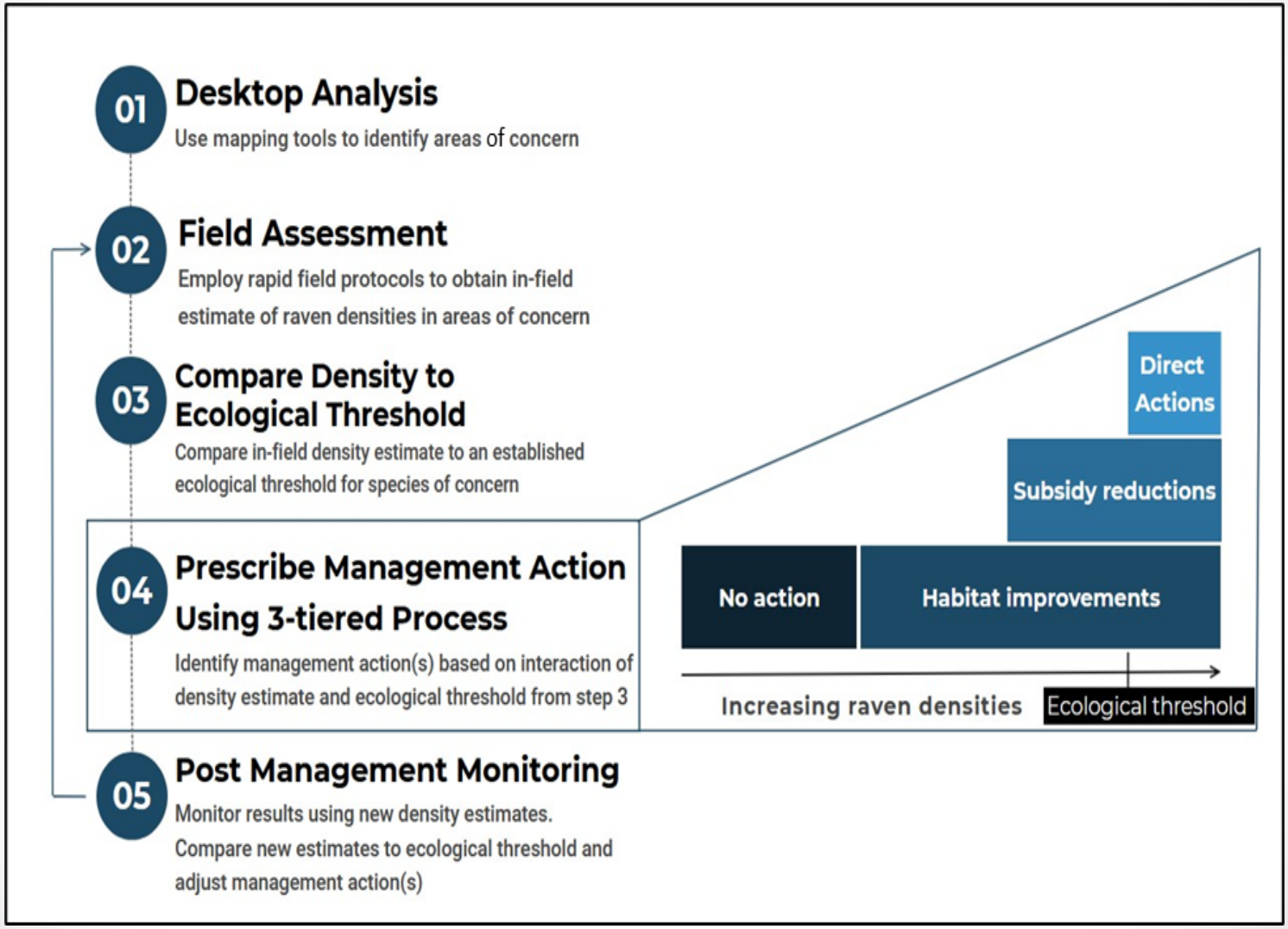
Solution

Science-based tiered framework

↓

Decision support tools - SMaRT

Science-based framework – Raven Core Team

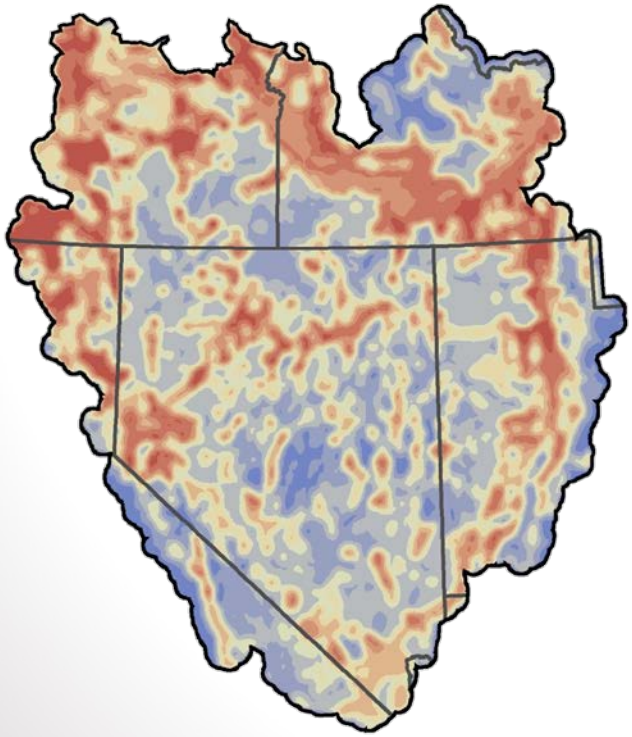


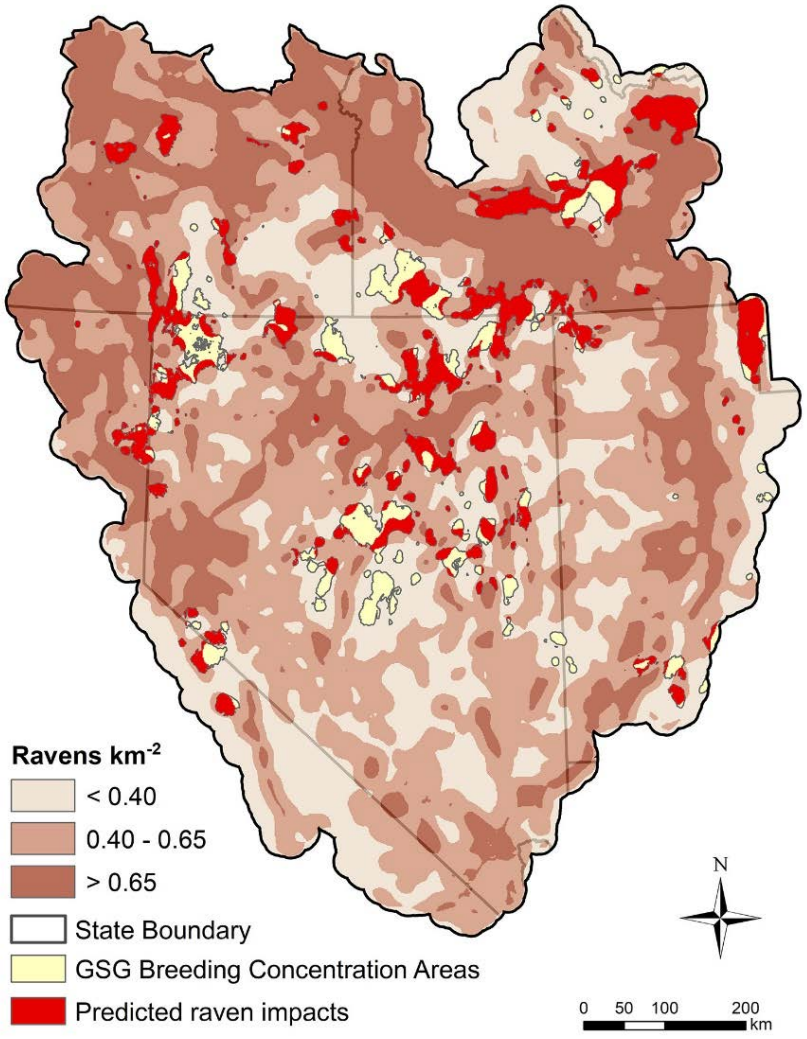
Dettenmaier et al. In Press. Human Wildlife Interactions.

Step 1. Desktop Analysis

Mapping products

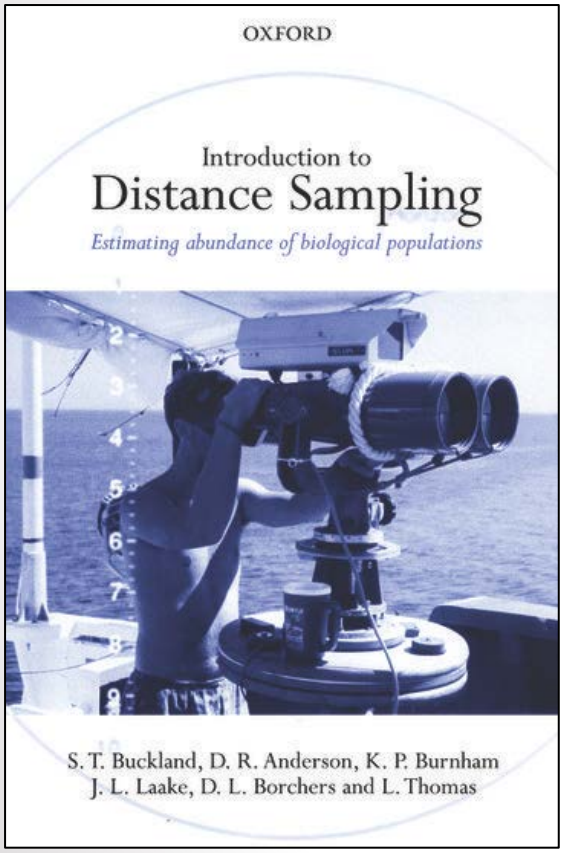
- Raven probability of occurrence/density
- Sensitive species probability of occurrence/breeding habitat



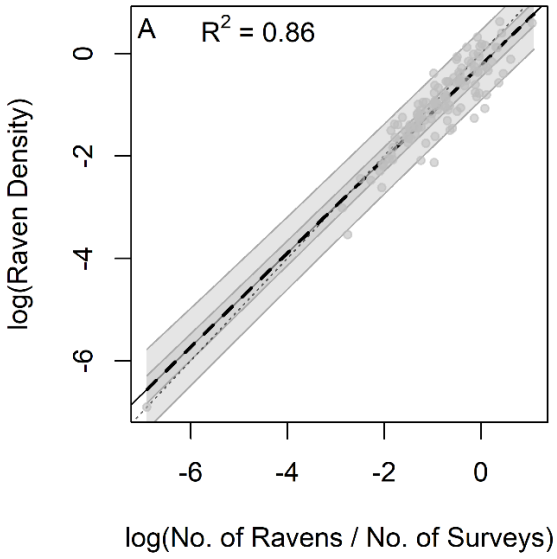


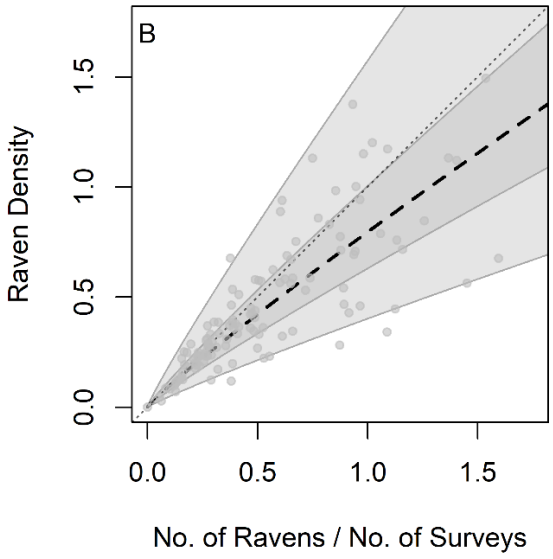
Coates, O'Neil, Brussee et al. 2020. Biological Conservation

Step 2. Estimate site-level raven density



Rapid assessment function





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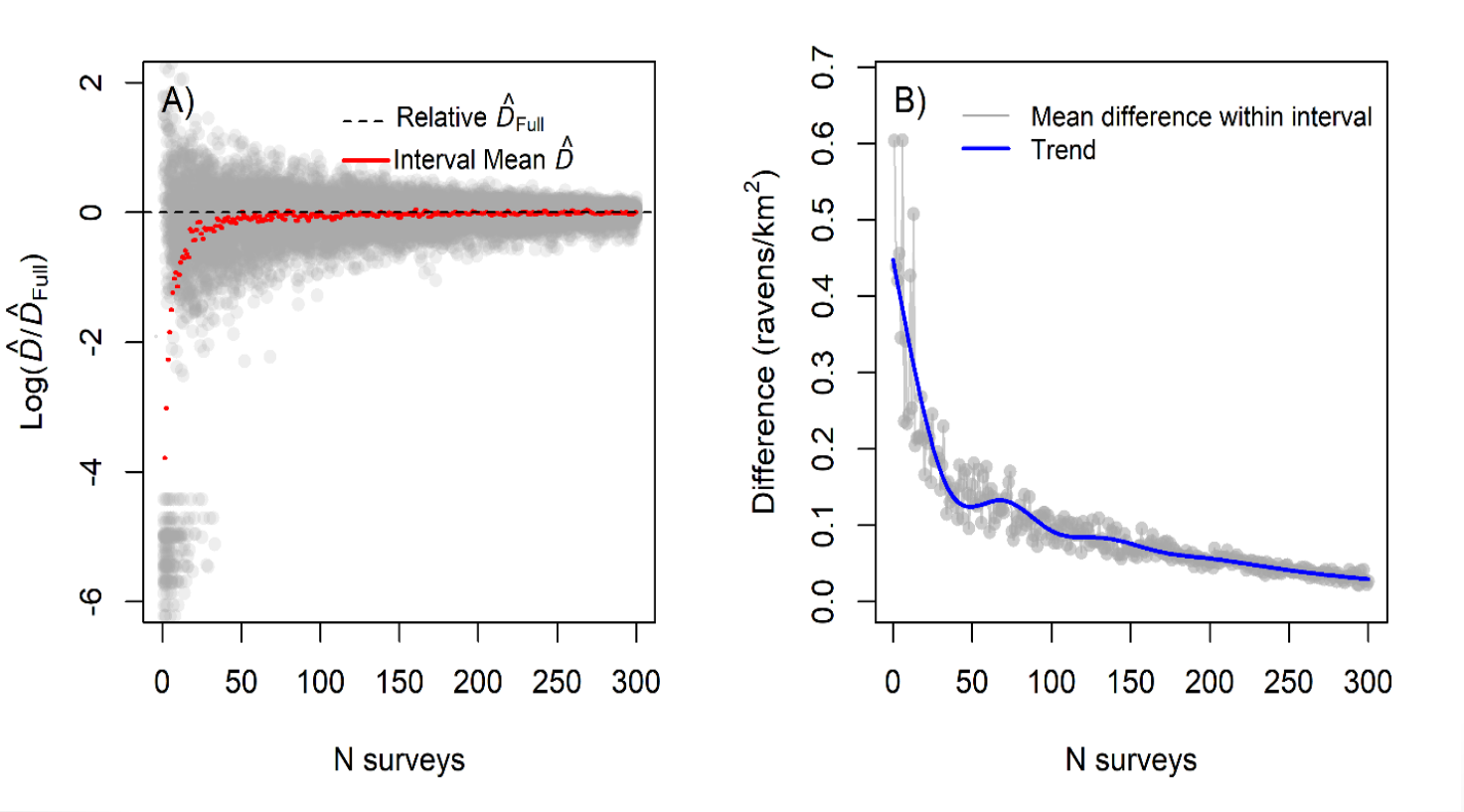

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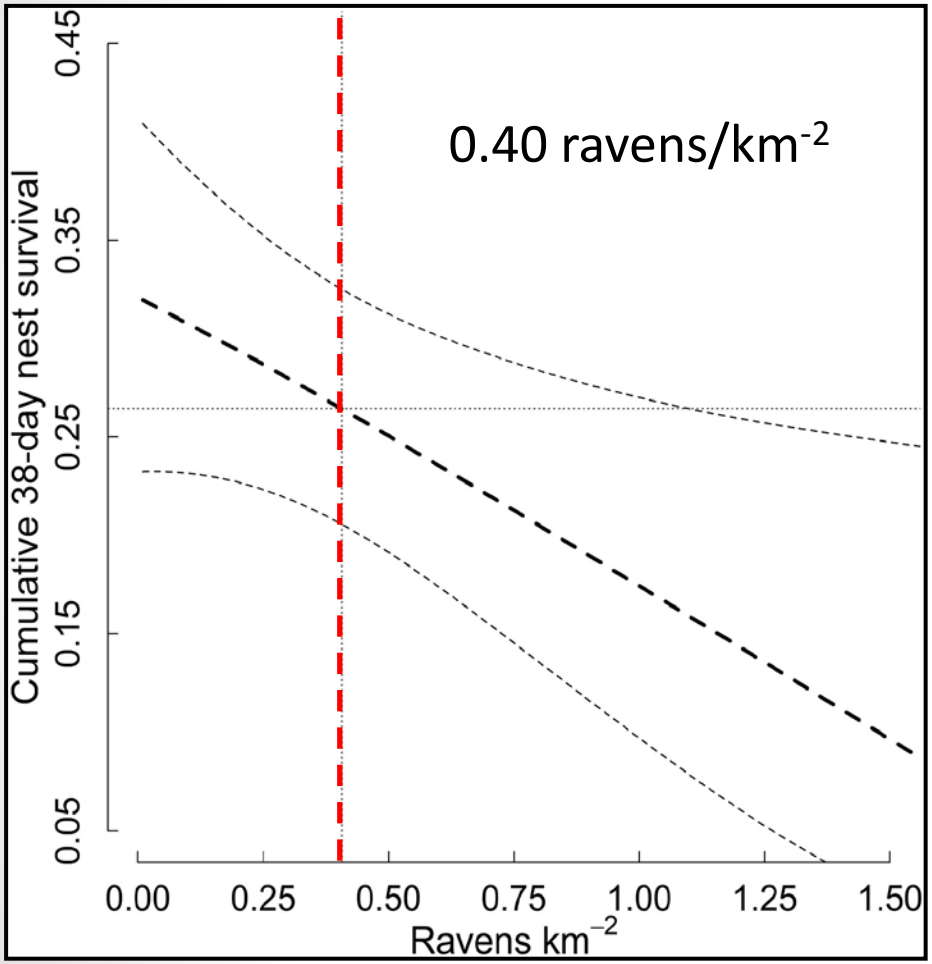
Step 3. Compare density estimate to threshold



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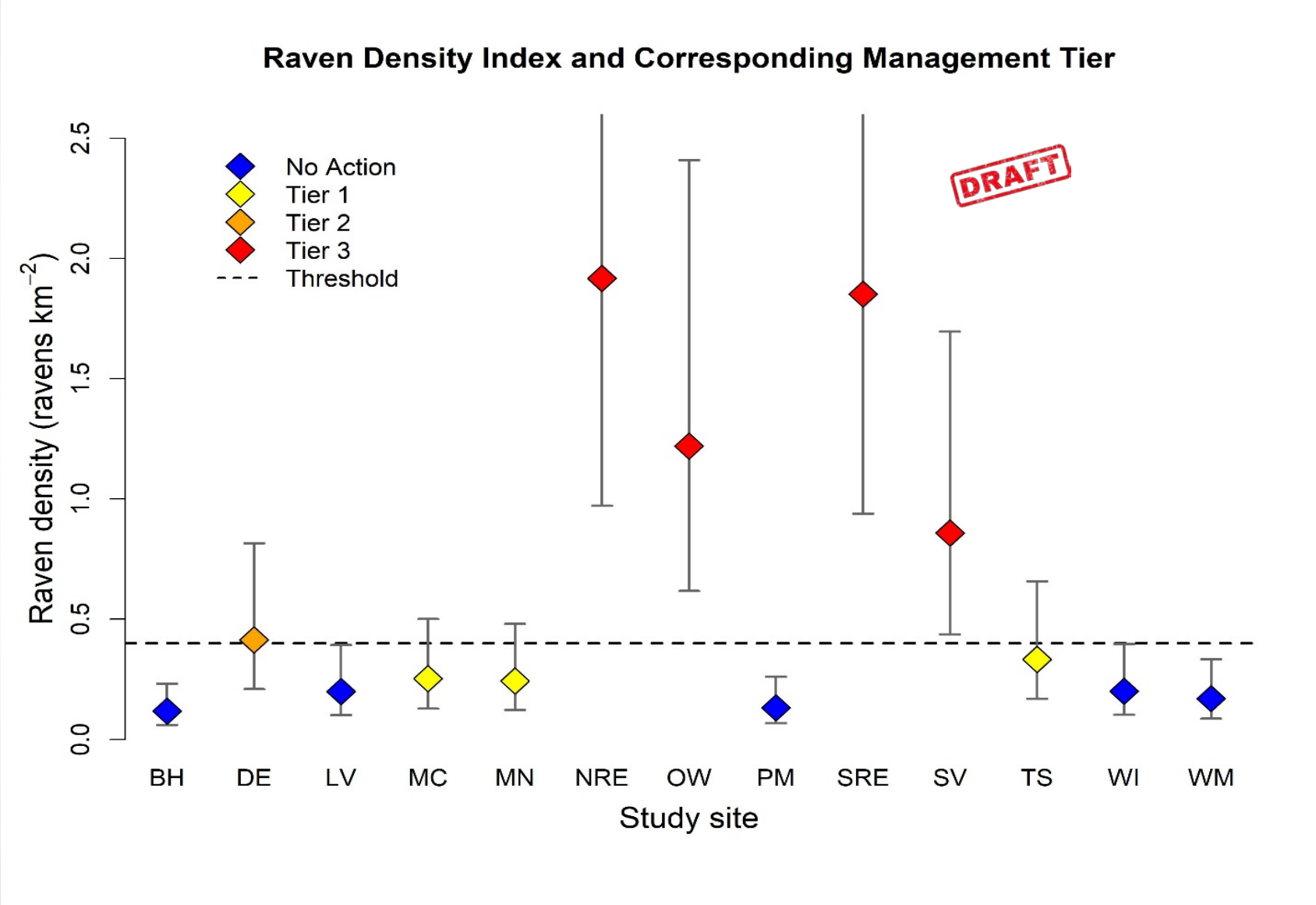
↑ 1 raven/km^{-2}

=

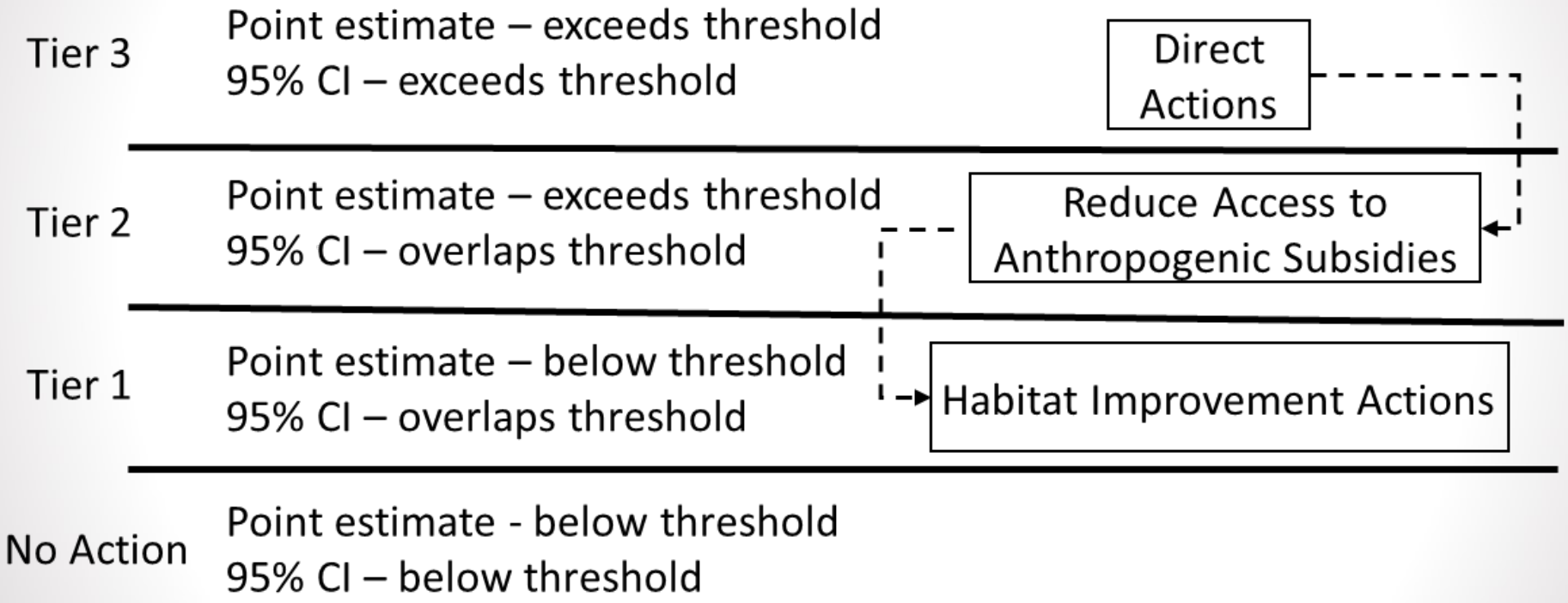
↓ nest survival ~57.2%

Step 3. Compare density estimate to threshold



Dettenmaier et al. In Press. Human Wildlife Interactions.

Step 4. Identify management options



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Step 5. Post-Management Monitoring

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Overview

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Problem

Expansion of raven distribution and abundance

↓

Anthropogenic resource subsidies

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Predation effects on sensitive species

Solution

Science-based tiered framework

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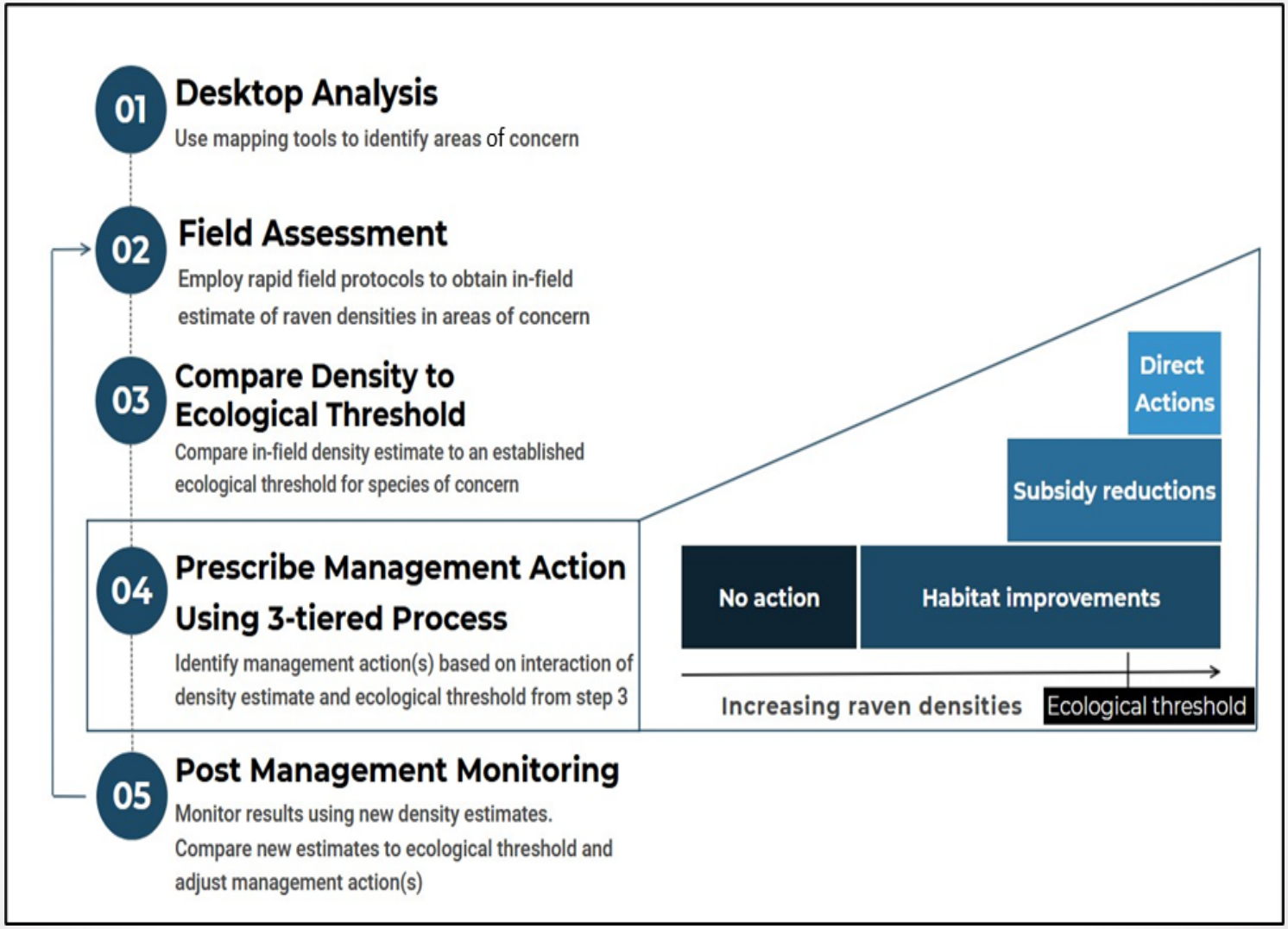
Decision support tools - SMaRT

Science-based framework – Raven Core Team



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Science-based framework – Raven Core Team

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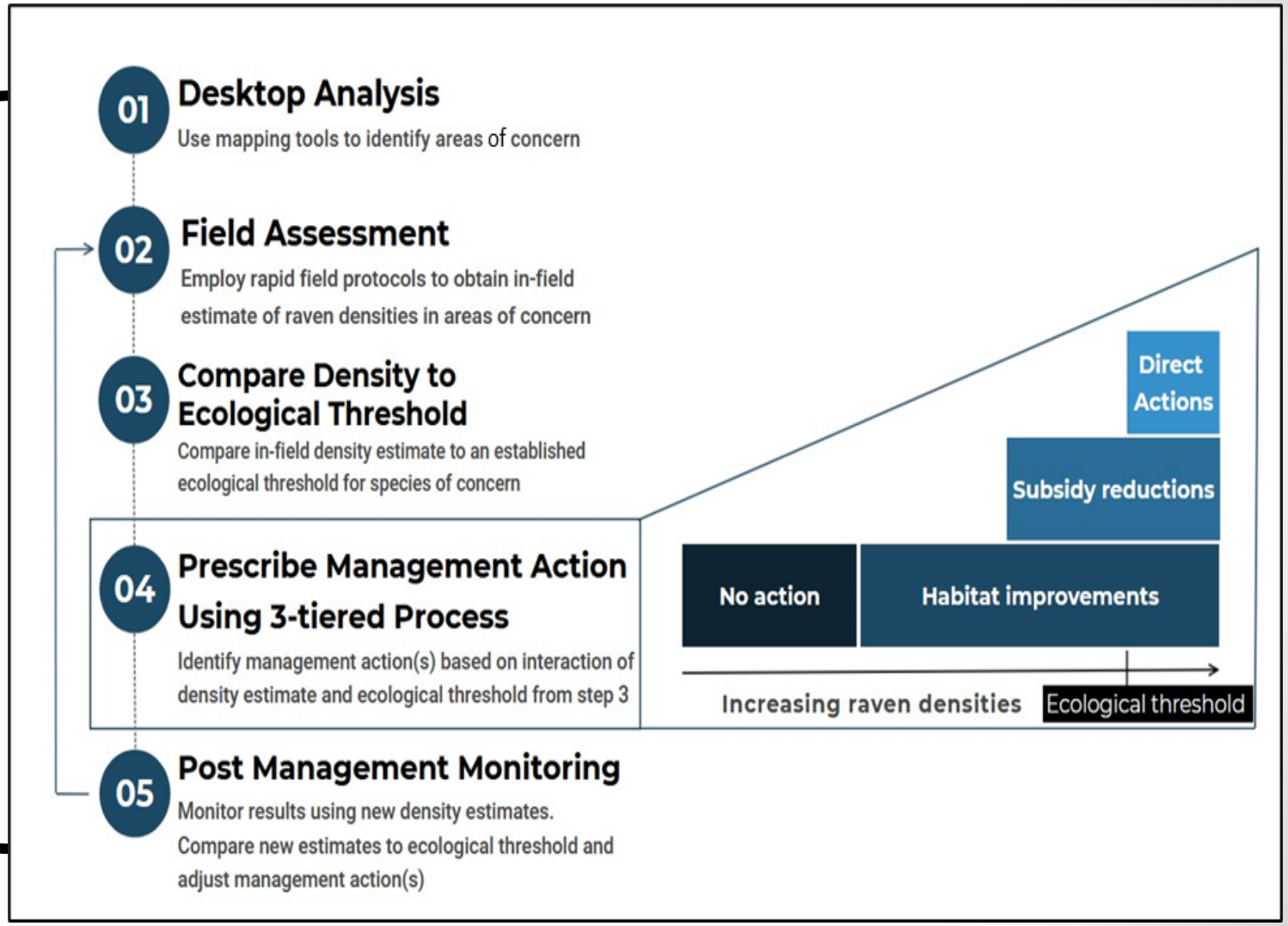
SMaRT



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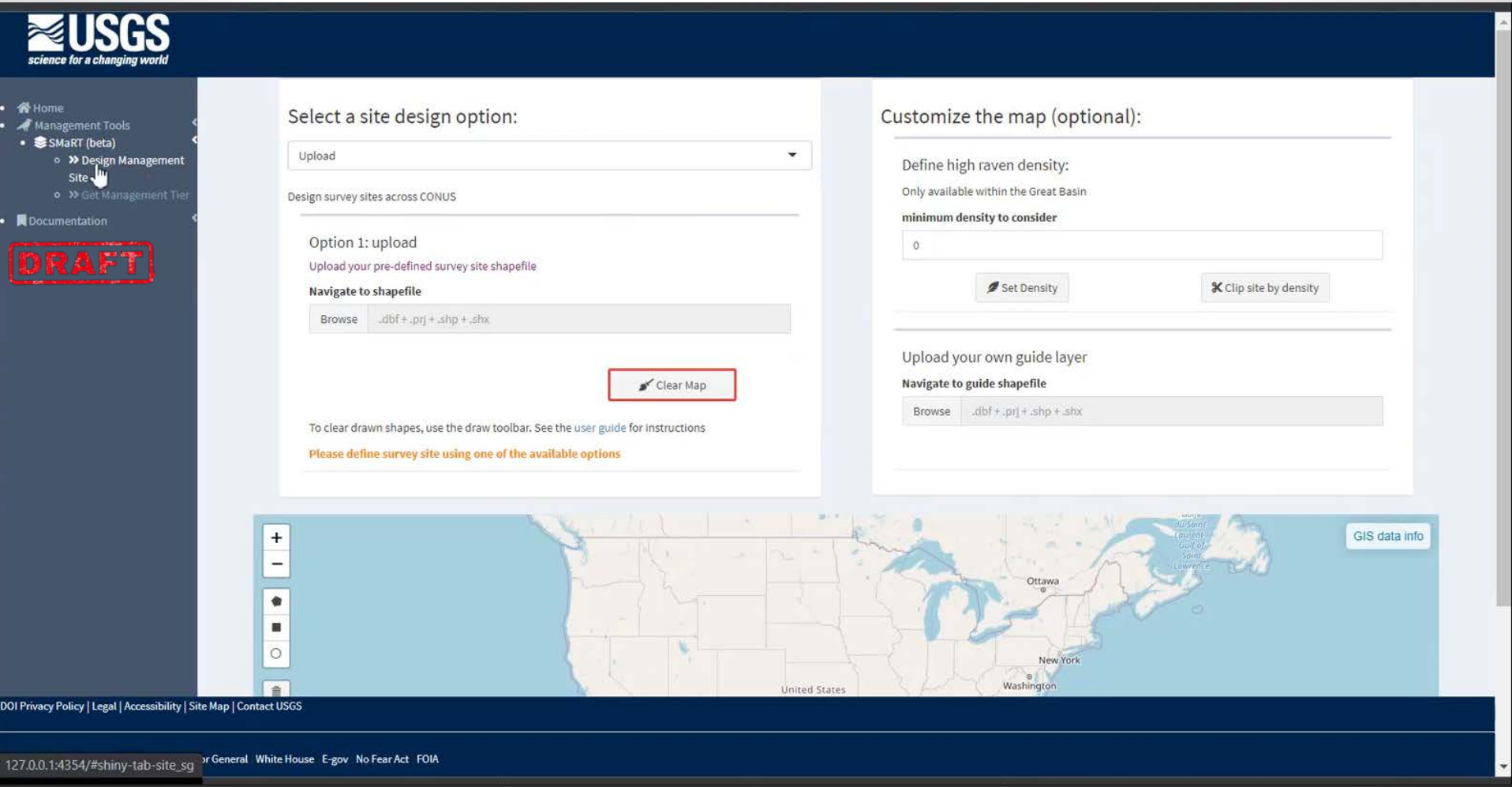
SMaRT – Science-based Management of Ravens Tool



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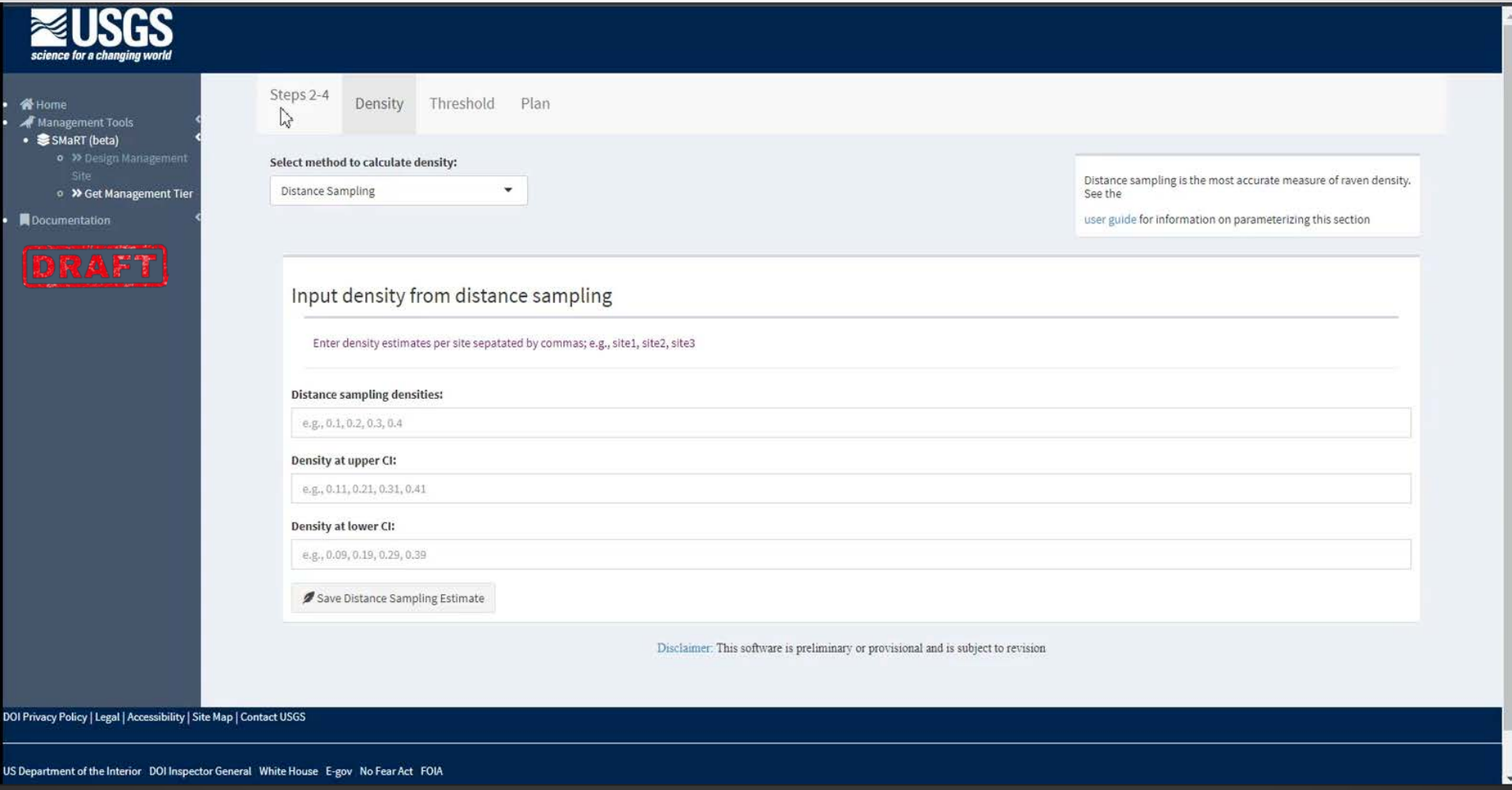

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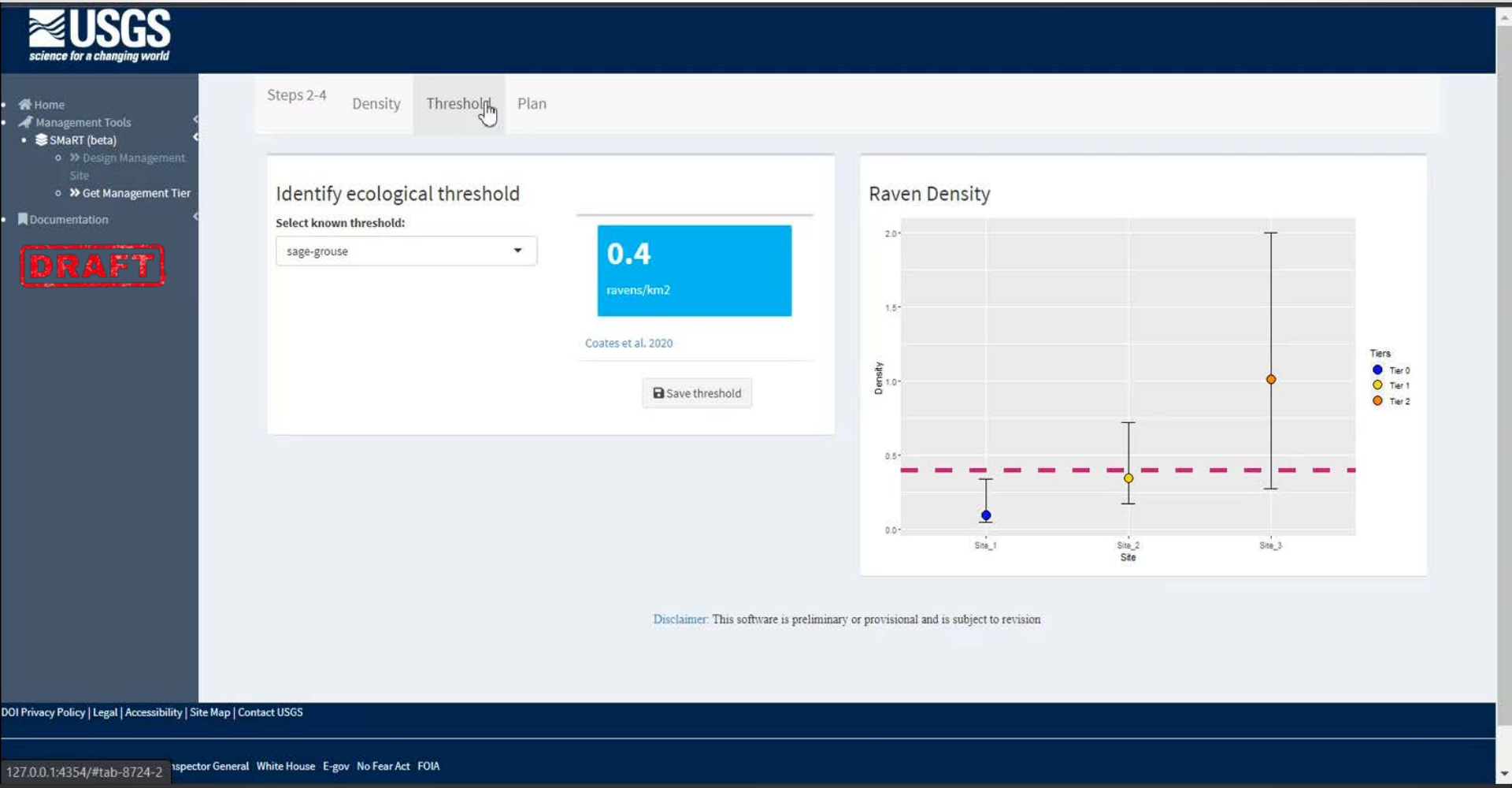
USGS
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Home
Management Tools
SMaRT (beta)
Design Management Site
Get Management Tier
Documentation
DRAFT
Steps 2-4
Density
Threshold
Plan
Identify ecological threshold
Select known threshold:
sage-grouse
0.4
ravens/km2
Coates et al. 2020
Save threshold
Raven Density
Density
Site
Site_1
Site_2
Site_3
Tiers
Tier 0
Tier 1
Tier 2
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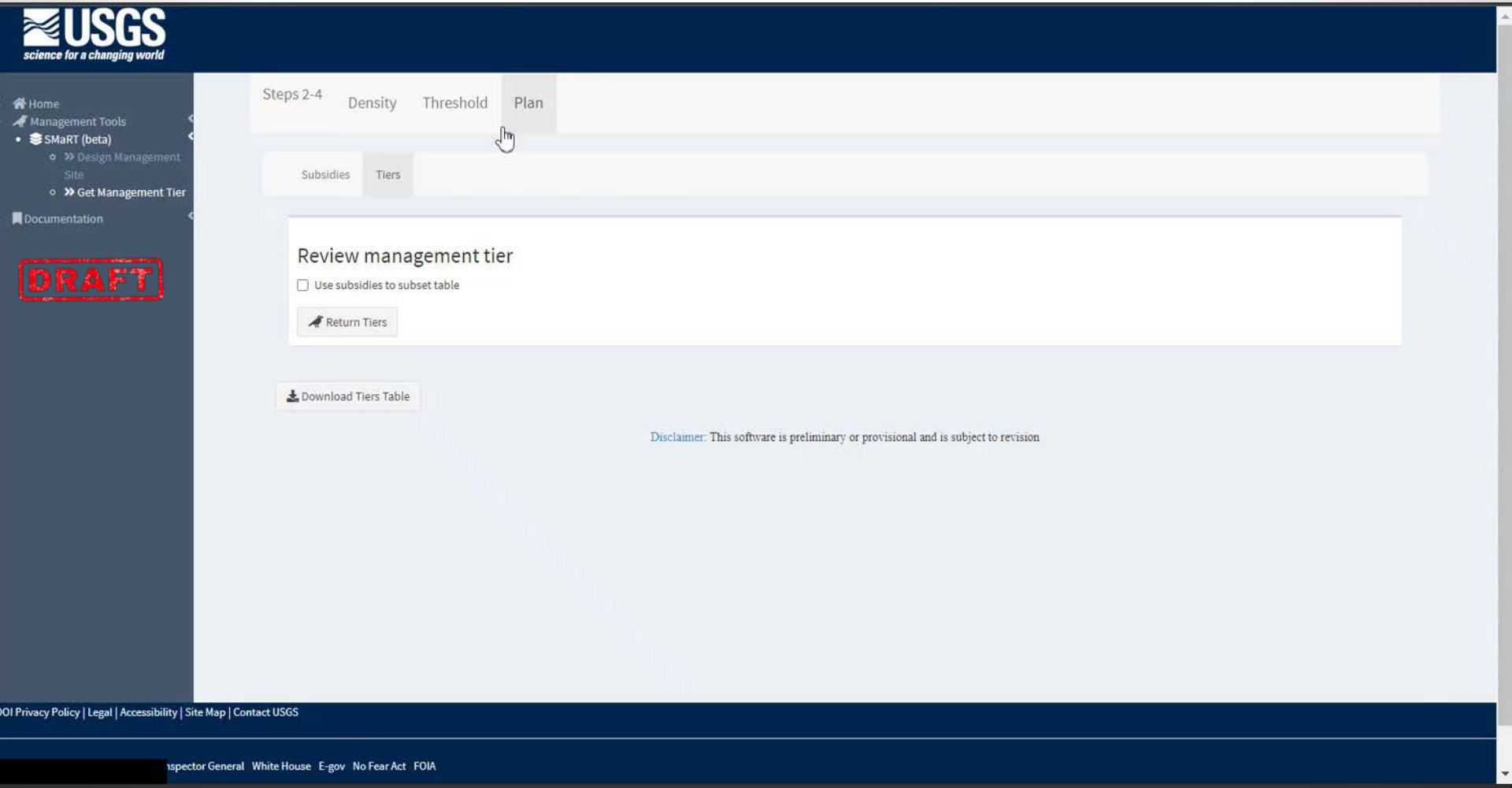

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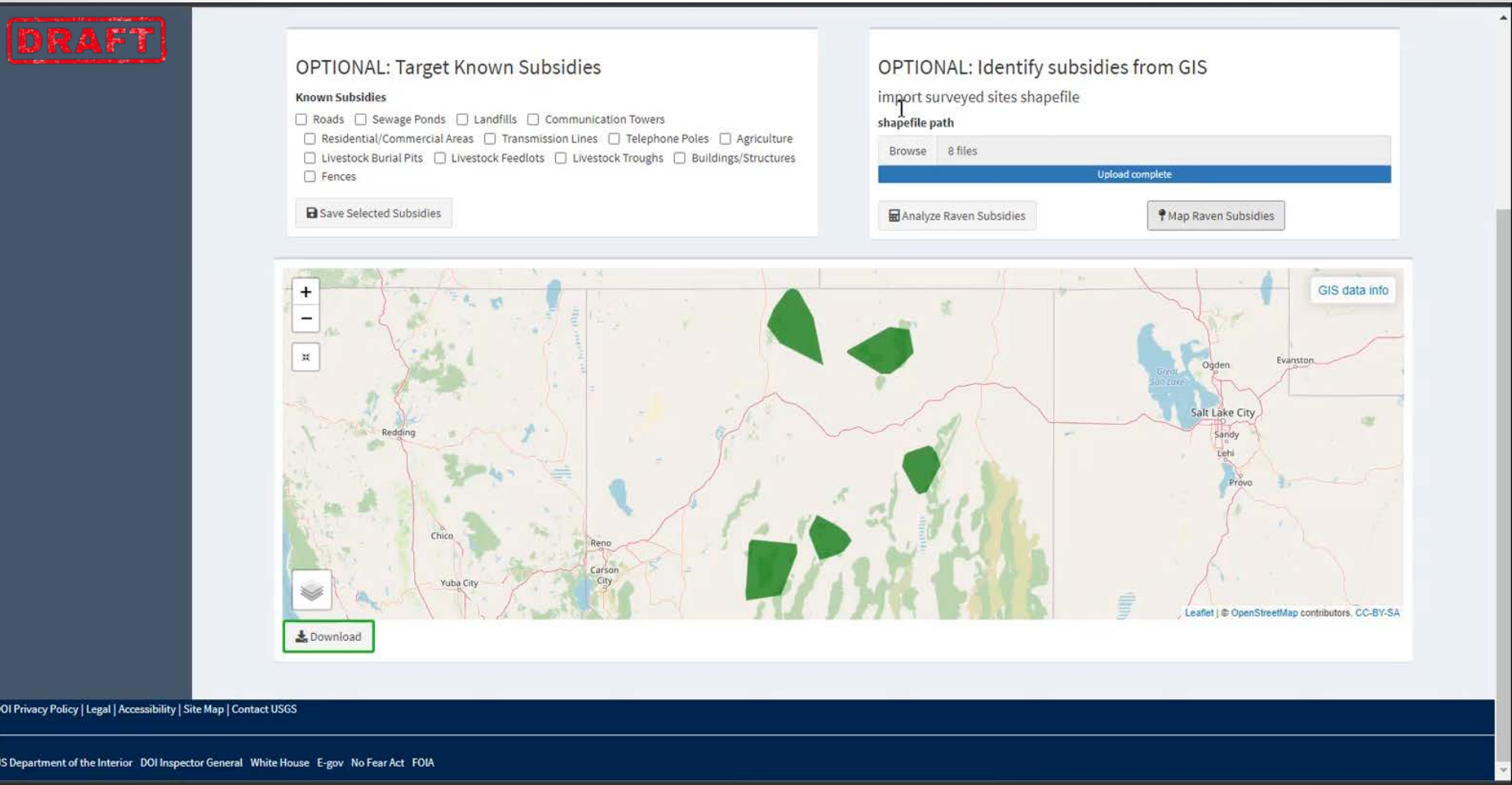

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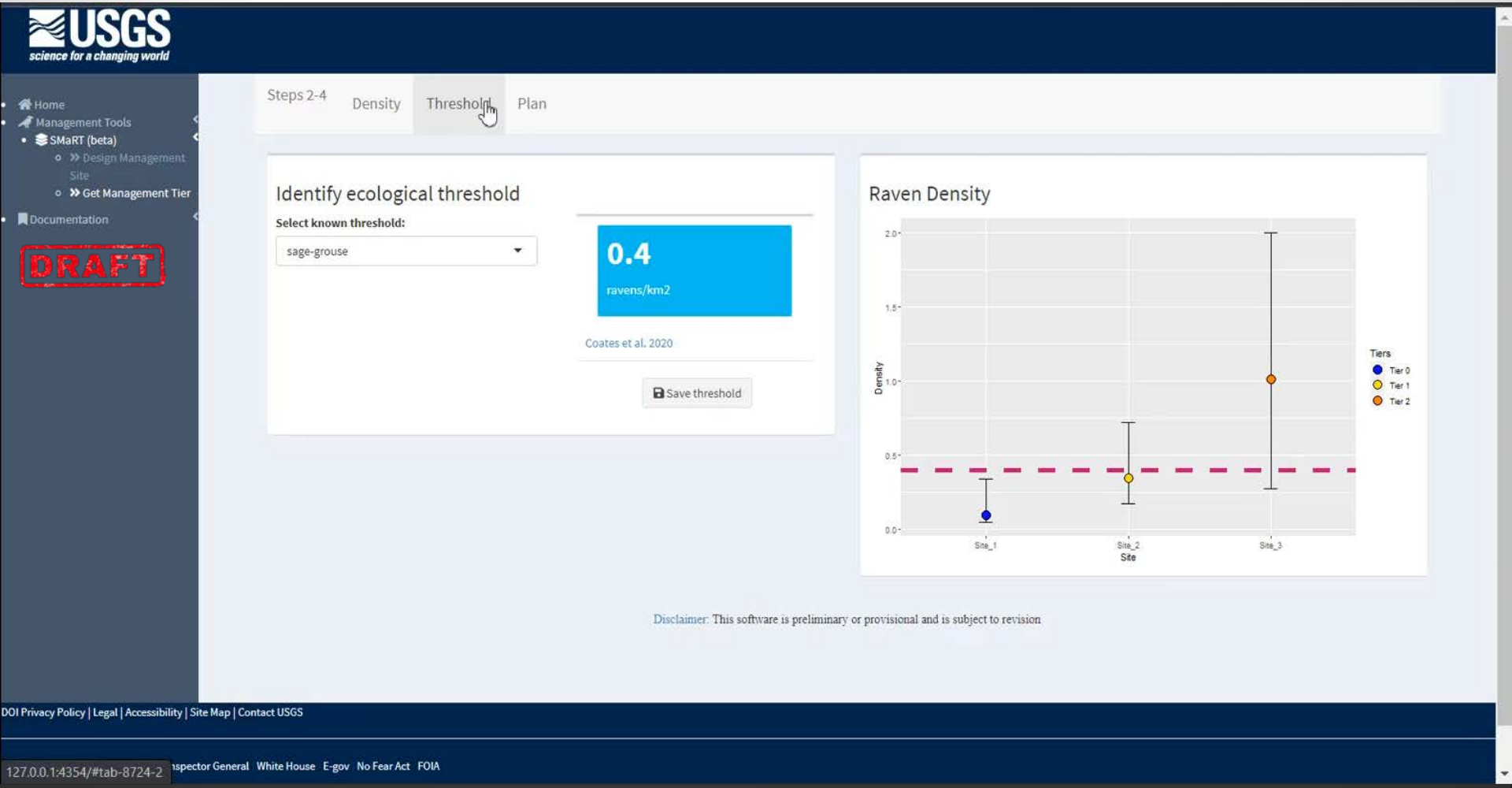
Science-based Management or Ravens Tool

USGS science for a changing world

Next Steps

- Simulate impact of subsidy reduction on raven demographics
- Simulate impacts of raven reductions on sage-grouse demographics
- Expand available guide layers to improve site design platform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Site_2
Site_3
Tiers
Tier 0
Tier 1
Tier 2
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