Greater Sage-grouse Dynamics in the Bighorn Basin, Wyoming

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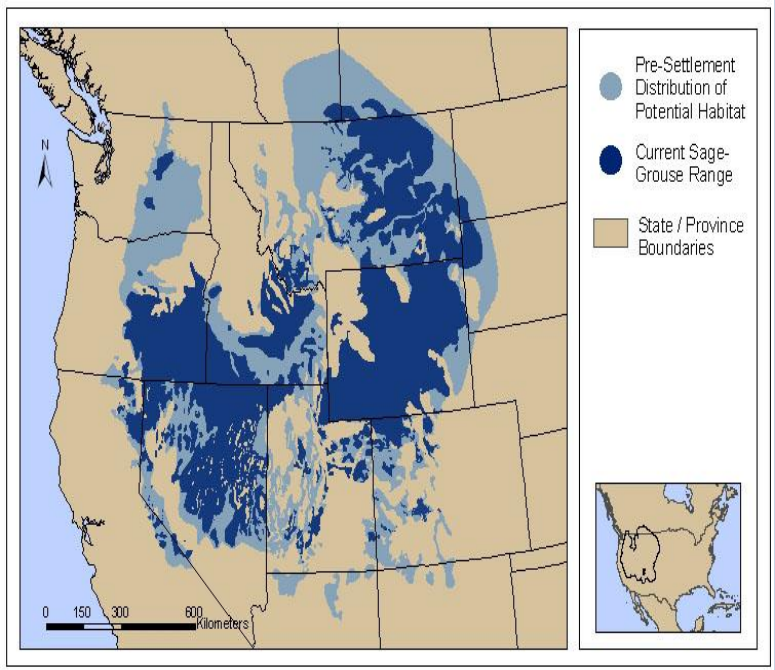
Background

- GRSG estimated to occupy 56% of historic range
- U.S. Fish and Wildlife Service concluded listing was “warranted but precluded” (2010), but later “not warranted” (2015)
- 37% of current occupied range (64% of the eastern population) found within Wyoming



Source: USGS Sage-grouse Local Working Group Locator

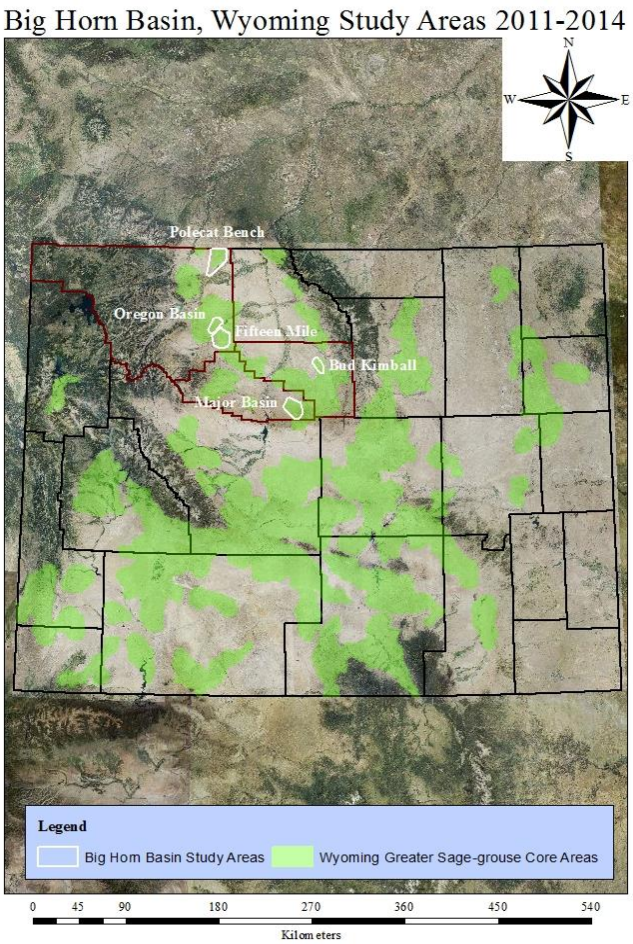
Study Objectives

- Estimate demographic parameters at 5 study sites in the Big Horn Basin
  - Breeding bird seasonal and annual survival
  - Nest survival
  - Chick survival

- Use estimates of vital rates to build population viability analysis (PVA) models

Study Areas

- 5 study sites in 3 northwestern Wyoming counties
  - Polecat Bench (2011-2014)
  - Oregon Basin (2011-2014)
  - Fifteen Mile (2012-2014)
  - Major Basin (2012-2014)
  - Bud Kimball (2014)



Methods

- Captured females on leks during spring using rocket nets
- Fitted with VHF or GPS transmitters
- Monitored birds ≥ 3 days/week
- Inspected hens that remained in same location with live signal for 3 days to identify nest locations
- Estimated breeding bird and nest survival using the nest survival model in Program MARK
- Estimated chick survival using young survival from marked adults model in Program MARK

Results

Captured 202 female sage-grouse

20 VHF, 5 GPS-marked females per study area

Study Site	Year				TOTAL
	2011	2012	2013	2014	
Polecat Bench	14	14	12	10	50
Oregon Basin	19	13	18	6	56
Major Basin	N/A	13	15	12	40
Fifteen Mile	N/A	17	14	10	41
Bud Kimball	N/A	N/A	N/A	15	15
TOTAL	33	57	59	53	202

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Survival Models

Defined 3 Seasons

1. Breeding and Nesting
   1 March-30 June
2. Brood Rearing
   1 July-31 October
3. Over-winter
   1 November-last day of February

1 & 2 pooled were classified as Breeding Season

Results

Survival Models

Model	AIC_c	ΔAIC_c	ω	Model Likelihood	# Parameters	Deviance
S_{winter}	1099.58	0.00	0.36	1.00	2	1095.58
$S_{year + winter}$	1099.58	0.00	0.36	1.00	7	1085.58
S_{season}	1101.54	1.96	0.13	0.37	3	1095.54
S_{year}	1103.20	3.63	0.06	0.16	4	1095.20
$S_{transmitter\ type}$	1104.51	4.93	0.03	0.08	2	1100.51
S_{age}	1104.76	5.19	0.03	0.07	2	1100.76
$S_{year + season}$	1106.63	7.05	0.01	0.03	11	1084.62
$S_{intercept\ only}$	1106.79	7.21	0.01	0.03	1	1104.79
$S_{year + study\ site}$	1108.75	9.17	0.00	0.01	15	1078.74
$S_{study\ site + winter}$	1108.92	9.34	0.00	0.01	9	1090.92
$S_{study\ site}$	1110.90	11.32	0.00	< 0.01	5	1100.90
$S_{study\ site + season}$	1115.75	16.17	0.00	< 0.01	14	1087.74

Breeding Season Survival = 0.62 (SE = 0.03)

Over-winter Survival 0.92 (SE = 0.03)

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Results

Nest Survival Models

Model	AIC_c	Δ AIC_c	AIC_c Weights	Model Likelihood	# Parameters	Deviance
$S_{\text{Study Site}}$	941.70	0.00	0.96	1.00	5	931.68
$S_{\text{Study Site + Year}}$	949.46	7.76	0.02	0.02	15	919.31
$S_{\cdot\ \text{(Intercept Only)}}$	951.11	9.42	0.01	0.01	1	949.11
$S_{\text{Within Year Quadratic Trend (tt)}}$	953.01	11.31	0.00	< 0.01	2	949.00
$S_{\text{Within Year Linear Trend (t)}}$	953.06	11.37	0.00	< 0.01	2	949.06
S_{Year}	953.60	11.90	0.00	< 0.01	4	945.58

Study Site	Daily Survival Rate	SE	LCI	UCI
Bud Kimball	0.963	0.015	0.920	0.983
Fifteen Mile	0.979	0.005	0.967	0.987
Major Basin	0.961	0.009	0.939	0.975
Oregon Basin	0.972	0.005	0.961	0.980
Polecat Bench	0.943	0.008	0.926	0.957

Study Site	Nest Survival Rate	SE	LCI	UCI
Bud Kimball	0.348	0.054	0.241	0.454
Fifteen Mile	0.558	0.046	0.467	0.649
Major Basin	0.328	0.029	0.270	0.385
Oregon Basin	0.452	0.030	0.393	0.511
Polecat Bench	0.196	0.010	0.177	0.214

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Benefits of Using Nest Cameras

Results

Causes of Nest Failure

Causes of Nest Failure as a Proportion of All Nests						
Study Site	Abandoned	Hen Mortality	Raven	Coyote	Unidentified	Other [1]
Bud Kimball	0.30	0.10	0.10	0.10	-	-
Fifteen Mile	0.05	0.05	0.03	0.20	0.08	-
Major Basin	0.09	0.03	0.03	0.09	0.06	0.25
Oregon Basin	0.03	0.08	0.10	0.13	0.13	0.03
Polecat Bench	0.10	0.06	0.19	0.21	0.18	0.03

[1] Major Basin: 6 Badger Depredations, 1 Snake Depredation, 1 Pronghorn Depredation (ate eggs in active nest)
Oregon Basin: 1 Fox Depredation, 1 Skunk Depredation
Polecat Bench: 2 Badger Depredations

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Results

Chick Survival

36 Bi-weekly Flush Counts

14-56 days post-hatch

Overall Chick Survival

0.54 (SE = 0.03)

Objectives

- Develop a female only, pre-breeding census Population Viability Analysis model.
- Estimate risk of quasi-extinction (< 10 females remaining in the population) within 50 years.
- Conduct any reasonable exploratory analyses to help inform management decisions.

Methods

Estimates of Lambda

Calculated 10,000 values of population growth (λ) using PVA model and randomly selecting vital rate values from distributions estimated from data collected in field.

Risk of Quasi-extinction (within 50 years)

300 female initial population size

juveniles = 120

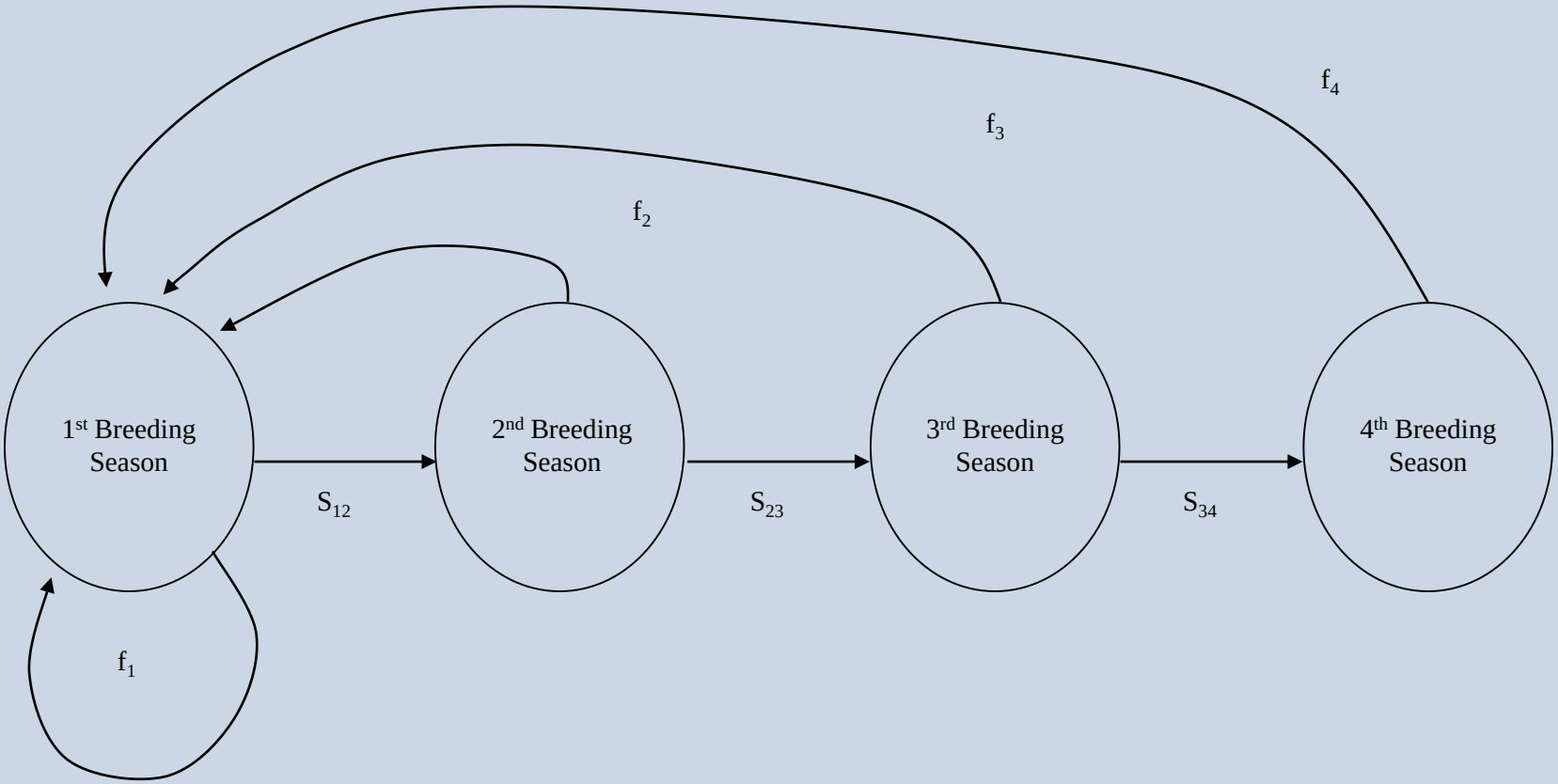
1st year adults = 90

2nd year adults = 60

3rd year adults = 30

Population Viability Analysis Model

Model



Population Viability Analysis Model

Model

$$\lambda = \begin{bmatrix} f_1 & f_2 & f_3 & f_4 \\ s_{12} & 0 & 0 & 0 \\ 0 & s_{23} & 0 & 0 \\ 0 & 0 & s_{34} & 0 \end{bmatrix}$$

f_1 = recruitment from 1st breeding year birds
f_2 = recruitment from 2nd breeding year birds
f_3 = recruitment from 3rd breeding year birds
f_4 = recruitment from 4th breeding year birds
s_{12} = survival of birds from the beginning of the 1st breeding year to the beginning of the 2nd breeding year
s_{23} = survival of birds from the beginning of the 2nd breeding year to the beginning of the 3rd breeding year
s_{34} = survival of birds from the beginning of the 3rd breeding year to the beginning of the 4th breeding year

Results

Mean Site-specific Lambda Values
(10,000 simulations per site)

Fifteen Mile = 1.52 (SE = 0.0006)

Oregon Basin = 1.32 (SE = 0.0004)

Major Basin = 1.10 (SE = 0.0002)

Polecat Bench = 0.84 (SE = 0.0001)

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Results

Mean Estimated Time to Quasi-extinction (<10 females)
(10,000 simulations per site)

Fifteen Mile = > 50 years

Oregon Basin = > 50 years

Major Basin = > 50 years

Polecat Bench = 20 years (SE = 0.10)

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Results

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Results

Mean Polecat Bench Lambda Values and Time to Quasi-extinction Under Raven Reduction Management (10,000 simulations)

50% Reduction of Sage-grouse Nest Loss due to Raven Depredation

λ = 0.90 (SE = 0.0001) Time to Quasi-extinction = 33 years (SE = 0.43)

75% Reduction of Sage-grouse Nest Loss due to Raven Depredation

λ = 0.97 (SE = 0.0001) Time to Quasi-extinction = 50 years (SE = 0.07)

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Conclusions

- Overall, sage-grouse demographic parameters across our study areas in the Big Horn Basin are between average and above average
  - BHB Annual Survival = 0.57
  - Range-wide Annual Survival = 0.65 (juvenile) and 0.58 (adult)

Conclusions

- Overall, sage-grouse demographic parameters across our study areas in the Big Horn Basin are between average and above average
  - BHB Nest Survival = 0.20-0.56
  - Range-wide Nest Survival = 0.22-0.53

Conclusions

- Overall, sage-grouse demographic parameters across our study areas in the Big Horn Basin are between average and above average
  - BHB Chick Survival (hatch-56 days post-hatch)= 0.54
  - Range-wide Chick Survival = 0.41 (35 days)

    0.50 (45 days in Utah)

Conclusions

- If raven depredation of sage-grouse nests on Polecat Bench is additive, management to control the raven population on this site might benefit sage-grouse
  - 50% reduction in losses due to ravens = 0.23 nest survival rate
  - 75% reduction = 0.26 nest survival rate

Conclusions

- Results of PVA modeling suggest that under current management conditions 3 of 4 study sites are increasing and not as risk of extinction within 50 years
- Reduction of additive nest loss due to raven depredation on Polecat Bench could stabilize population

Acknowledgements

- Wyoming Wildlife and Natural Resources Trust Fund
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