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## **Appendix I. Vital rates and demographic parameters for McCown's Longspur.**

Vital rates, demographic information, and effects of habitat and landscape on abundance and density for McCown's Longspur.

Population Parameter	Life Cycle Phase / Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Abundance	Breeding - Ad	Occurrence	CO, KS, MT, NE, OK	Occurrence where 75% of grass <15 cm	Vegetation height	+	McLachlan (2007)
				Male occurrence with increasing percentage grass within 800 m	Landscape: Grassland cover	+	Greer (2009)
				Minimum patch size for occupancy, 25 ha	Landscape: Patch size	NA	Davis (2003a), (2004)
Abundance	Breeding - Ad	Abundance	BBS	Increasing edge-to-area ratio	Landscape: Edge effects	-	
				Increased annual precipitation	Precipitation	+	Conrey et al. (2016)
				Decreasing distance from wells and access roads (nearly absent within 300 m)	Energy development: Gas wells, Roads	-	Linnen (2008)
				Reduced near roads vs. off-road (0.12 vs. 0.29 birds per point count, respectively)	Roads: Roadside, Off-road	-	Wellcome et al. (2014)
				Increasing proximity to prairie dog colonies	Proximity to prairie dog colonies	+	Augustine and Baker (2013)
				Decreasing soil productivity	Soil productivity	+	Lipsey and Naugle (2017)
				Increasing percentage grass near Permanent Cover Program (PCP) lands	Landscape: Grassland cover	+	McMaster and Davis (1998)
				Effect of amount of crop and wetlands within 1.6 km on number of pairs	Landscape: Crop, Wetland	0	McMaster et al. (1999)
				Increasing litter and percentage of grass coverage	Vegetation structure	-	White (2009)
				Effect <600 m from gas wells	Energy development: Gas wells	-	Kalyn Bogard (2011), Kalyn Bogard and Davis (2014)
Effect of increasing number of gas wells from no wells to more than one	Energy development: Gas wells	-					

Population Parameter	Life Cycle Phase / Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference	
Abundance	Breeding - Ad	Abundance	SK	Effect of reduced grass cover and low litter cover	Vegetation structure	+	Kalyn Bogard and Davis (2014)	
				Effect of increasing grass cover within 400 m	Landscape: Grassland cover	+	Davis et al. (2016)	
Abundance	Migration	Abundance	-	None				
				Abundance				
				Abundance				
Abundance	Wintering	Abundance	-	None				
				Abundance				
				Abundance				
Abundance	Breeding - Ad	Territory Size	CO	Territory size range 1.1-1.4 ha (n=14)	NA	NA	Wiens (1970, 1971)	
				Territory size average 0.93 ha (n=20)	NA	NA	With (2010)	
				Territory size range 0.5-1.0 ha	NA	NA	Felske (1971)	
Abundance	Breeding - Ad	Territory Size	WY	Territory size average 0.6 ha (n=74)	NA	NA	Greer (1988), Greer and Anderson (1989)	
Abundance	Breeding - Ad	Density	BCR 17 (Badlands and Prairies)	0.57 and 0.96 birds per 100 ha (2013 and 2016, respectively)	NA	NA	Bird Conservancy of the Rockies (2018)	
				CO	41 and 46 pairs per 100 ha, heavy grazing, short grass	Grazing intensity: Heavy	+	Giezentanner (1970)
					13.6 and 40.8 pairs per 100 ha, light grazing, short grass	Grazing intensity: Light	-	
					12-14 pairs per 100 ha average across all plots in study; 82-94 birds per 100 ha	NA	NA	
				76 birds per 100 ha, heavy grazing, short grass	Grazing intensity: Heavy	+	Wiens (1970)	
81.5 birds per 100 ha	NA	NA	Porter and Ryder (1974)					

Population Parameter	Life Cycle Phase / Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Abundance	Breeding - Ad	Density	CO	2.1-4.1 birds per 100 ha (2008-09, 2015); 5.1-9.5 birds per 100 ha (2008-09, 2015) in BCR 18	NA	NA	Bird Conservancy of the Rockies (2018)
			MT	2 birds per 100 ha mean (867 pts), 36 birds per 100 ha maximum  Predicted abundance: 132.4 (2013) and 144.4 (2014) birds per 100 ha, rest-rotation; 53.2 (2013) and 58.0 (2014) birds per 100 ha, season-long  1.3-3.5 birds per 100 ha (2010-12, 2014); 4.7-15.8 birds per 100 ha (2010-12, 2014) in BCR 11	Grazing: Rest-rotation, Season-long	+ -	Lipsey (unpubl. data)  Golding and Dreitz (2017)
Abundance	Migration Wintering - Ad	Density	SD	Male density with increasing percentage of grass within 800 m	Landscape: Grassland cover	+	Greer (2009)
			SK	79 birds per 100 ha	NA	NA	MAher (1973)
			WY	77 and 126 pairs per 100 ha average, 38 and 65 birds per 100 ha  1.4-4.1 birds per 100 ha (2012-13, 2015-16); 1.9-3.2 birds per 100 ha (2012-13, 2015-16) in BCR 10; 4.3-7.4 birds per 100 ha (2012-13, 2016) on BLM land	NA	NA	Finzel (1964)
Reproduction	Breeding - Ad	Nest Success	-	None			
			w. TX	Average densities on different study plots: 62 birds per 100 ha (1979), 13 and 17 birds per 100 ha (1978, 1979, respectively)	NA	NA	Grzybowski (1980, 1982)
			CO	Fledging success: 75% (n=53) <sup>c</sup>  Fledging success: 42% (n=34) <sup>d</sup>  Fledging success: 38% (n=76) <sup>d</sup>	Predation	-	Strong (1971)
					Predation	-	Creighton and Baldwin (1974)
					Predation	-	With (1994), With (2010)

Population Parameter	Life Cycle Phase / Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Reproduction	Breeding - Ad	Nest Success	CO	22% nests by shrubs fledged 1+ young, 40-60% nests fledged 1+ young away from shrubs	Nest site: Near shrub Away from shrubs	- +	With (1994)
				77% nest failure near shrubs or cactus	Nest site: Near shrubs/cactus	-	
				Nesting success: Mayfield estimate, 42.3% (1997, n=16 nests), 27.0% (1998, n=23 nests), 28.3% (1999, n=10 nests), 75.0% (2001, n=8 nests)	Predation	-	Skagen unpubl. data in Sedgwick (2004)
				Overall nest survival: 0.202 ± 0.027 (SE)	NA	NA	Conrey et al. (2016)
				Increasing drought and storms	- -		
				Nesting success: 17.3% (2011, n=69 nests), 7.5% (2012, n=64 nests, drought year)	Climate: Drought, Storms	- -	Skagen et al. (2018)
				Apparent nest success: 100% (2017, n=1), 33% (2018, n=15)	NA	NA	Pulliam and USFWS (unpubl. data)
				Fledging success: 45-54% (n=unknown) <sup>d</sup>	Not reported	NA	Felske (1971)
				Nesting success: 20% (n=5) <sup>e</sup>	Predation	-	Pipher (2011)
				Fledging success: 77% (n=45) <sup>c</sup>	Predation	-	Mickey (1943)
Reproduction	Breeding - Ad	Productivity	CO	Nest predation 50-75% in heavy grazed pasture; Nest predation 42-60% in moderate grazed pasture	Grazing intensity: Heavy, Moderate	- +	With (1994)
				1.3 young fledged per nest (n=53 nests), 2.4 young fledged per successful nest (n=unknown) <sup>e</sup>	NA	NA	Strong (1971), Porter and Ryder (1974)
				1.1 young fledged per nest (n=77 nests), 2.7 young fledged per successful nest (n=31 nests) <sup>e</sup>	NA	NA	With (1994), Sedgwick (2004)
				Number of young fledged per successful nest: 2.6 (n=86)	Predation, Weather	- -	Conrey et al. (2016)

Population Parameter	Life Cycle Phase / Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Reproduction	Breeding - Ad	Productivity	CO	Number of young fledged per successful nest: 2.2 ± 0.88 (2011, n=26 nests), 2.2 ± 0.44 (2012, n=13 nests, drought year)	NA	NA	Skagen et al. (2018)
			SK	1.6 young fledged per nest (n=unknown), 2.0 young fledged per successful nest <sup>e</sup>	NA	NA	Felske (1971)
			WY	1.6 young fledged per nest (n=45 nests), 3.5 young fledged per successful nest (n=unknown) <sup>e</sup>	NA	NA	Mickey (1943)
Reproduction	Breeding - Ad	Brown-headed Cowbird (BHCO) Parasitism	ND	67% BHCO parasitism (n=3 nests)	Parasitism	-	Friedmann (1963)
			MT	0% BHCO parasitism (n=16 nests)	NA	NA	Pulliam and USFWS (unpubl. data)
			SK	0% BHCO parasitism (n=74 nests)	Parasitism	0	Maier (1973)
Reproduction	Breeding - Ad	No. of Clutches	WY	0% BHCO parasitism (n=5 nests)	Parasitism	0	Pipher (2011)
			CO	0% BHCO parasitism (n=71 nests)	Parasitism	0	Mahoney and Chalfoun (2016)
			SK	Frequently double brooded	NA	NA	With (2010)
Reproduction	Breeding - Ad	Clutch Size	CO	1.5-1.8 clutches per female per year	NA	NA	Maier (1973)
			SK	1.3-1.4 clutches per female per year	NA	NA	Felske (1971)
			WY	Average 3.1 eggs per clutch	NA	NA	Strong (1971), Porter and Ryder (1974), With (2010)
Reproduction	Breeding - Ad	Effect of wind turbines	MT, SK, WY	Average 3.4-3.6 eggs per clutch	NA	NA	DuBois (1935), Mickey (1943), Maier (1973)
			WY	Effect of wind turbines	Energy development: Wind turbines	0	Mahoney and Chalfoun (2016)

Population Parameter	Life Cycle Phase / Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Reproduction	Breeding - Ad	Daily Nest Survival	CO	0.930 ± 0.006 (n=339),	Climate	-	Conrey et al. (2016)
				0.923 ± 0.010 (SE) (2011), 0.889 ± 0.014 (SE) (2012, drought year)	Climate: Drought	-	Skagen et al. (2018)
			WY	Effect of wind turbines	Energy development: Wind turbines	0	Mahoney and Chalfoun (2016)
Reproduction	Breeding - Ad	Hatching Success	CO	54% (n=53 nests)	NA	NA	Strong (1971)
				70.9% (n=34 nests)	NA	NA	Creighton and Baldwin (1974)
			60.2% (n=36 nests) in heavily grazed pasture; 78% (n=25 nests) in moderate grazed pasture	Grazing intensity: Heavy Moderate	- +	With (1994)	
Survival	Breeding - Ad	Site Fidelity	SK	100% (2 of 2 adult males)	NA	NA	Ryder (1972)
Survival	Breeding - Fl	Natal Site Fidelity	CO	0% (0 of 74) returned	Unknown	NA	With (2010)
Survival	Breeding - Ad	Survival	-	None			
Survival	Breeding - Fl	Survival	-	None			
Survival	Migration	Survival	-	None			
Survival	Migration	Stopover Ecology	-	None			
Survival	Wintering	Site Fidelity	-	None			
Survival	Wintering	Survival	-	None			
Ad-Adult, Fl-Fledgling							

<sup>a</sup> Ad-Adult, Fl-Fledgling

<sup>b</sup> Effect: = positive response, - = negative response, 0 = no effect, NA = not applicable.

<sup>c</sup> Fledging success (number fledglings per number of hatchlings) calculated by taking proportion of total young fledged across all nests (successful and unsuccessful), rather than the average proportion of young that fledged per nest.

<sup>d</sup> Fledging success (number fledglings per number of hatchlings) calculated by using number of fledglings per number of nestlings, thus excluding nests that failed before hatching.

<sup>e</sup> Nest that fledged at least one host or cowbird chick