

---

## **Appendix H. Vital rates and demographic parameters for Chestnut-collared Longspur.**

Vital rates, demographic information, and effects of habitat and landscape on abundance and density for Chestnut-collared 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, NE, OK	Occurrence in dryland agriculture or Conservation Reserve Program (CRP)	Habitat Type: Dryland Agriculture, CRP	- (absent) - (absent)	McLachlan (2017)
				Increase of shrub cover to 10%	Vegetation Structure: Shrub/Woodland Cover	- (-90%)	Grant et al. (2004)
Abundance	Breeding - Ad	Abundance	SD	Increase of shrub cover to 50%, Increase of shrub cover to 3.5%	Vegetation Structure: Shrub/Woodland Cover to 50% To 3.5%	- (99%) - (90%)	Greer et al. (2016)
				Effect of percentage grass within 3.2 km	Landscape: Grassland Cover	0	Greer et al. (2016)
				Minimum patch size for occupancy, 39 ha	Landscape: Patch size	NA	Davis (2004)
				Increasing distance from gas well, Increasing distance from roads (>150 m)	Energy Development: Gas wells, Roads	+	Linnen (2008)
				Effect of high or low gas well density	Energy development: Gas wells	0	Hamilton et al. (2011)
				Within 1.95 km of cropland edges, Within 1.05 km of wetland edges, Effect of roads	Landscape: Cropland, Wetlands, Roads	- (-25%) - (-25%) 0	Shiwinski and Koper (2012)
				Effect of shallow gas wells	Energy Development: Gas wells	0	Rodgers (2013)
				Reduced near roads vs. off-road (0.84 vs. 1.48 birds per point count, respectively)	Roads: Roadside, Off-road	- +	Wellcome et al. (2014)
				Effect of reduced aspen cover within 500 m	Vegetation Structure: Shrub/Woodland Cover	+	Grant et al. (2004)
				Effect of distance from oil drilling (<550 m), Effect of roads	Energy development: Oil wells, Roads	- 0	Thompson et al. (2015)
Effect of wind turbine development: Immediate vs. delayed effect post-development	Energy Development: Wind turbines	-	Shaffer and Buhl (2016)				

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 1 year post burn, Effect 2 years post burn	Fire: 1 yr post-burn 2 yrs post-burn	- +	Maher (1973)
				Effect of roads: Reduced distance from two tracks vs. paved roads	Roads: Two tracks, Paved roads	+ -	Sutter et al. (2000)
				Effect of grazing: Grazed vs. ungrazed	Grazing: Grazed, Ungrazed	+(3x) -	Bleho (2009), Lusk (2009)
				Effect of increasing gas well infrastructure	Energy Development: Gas well density, Distance from wells	+ +	Kalyn Bogard (2011)
				Effect of altered vegetation structure and gas wells	Energy Development: Gas wells, Vegetation Structure	0 0	
				Effect of distance (>200 m) from gas wells	Energy Development: Gas wells	+	Kalyn Bogard and Davis (2014)
				Effect of increased gas well density	Energy Development: Gas wells	+	
				Effect of increased hayland in landscape	Landscape: Percentage hayland	-	Davis et al. (2016)
Abundance	Migration	Abundance	-	None			
Abundance	Wintering - Ad	Abundance	Chihuahua, Mexico	Abundance on prairie dog colonies vs. away from prairie dog colonies	Presence of prairie dogs	+	Desmond (2004)
				Effect of grazing intensity	Grazing: Overgrazing	-	
				Effect of vegetation structure where grass is <0.5 m tall and <1% shrub cover	Vegetation Structure: Shrub/Woodland Cover	+	Macias- Duarte et al. (2009)
Abundance	Breeding - Ad	Territory Size	AB	Territory size average 1.0 ha	NA	NA	Bleho et al. (2015)
			MB	Territory size range 0.2-0.4 ha	NA	NA	Harris (1944)
			SK	Territory size 0.4-0.8 ha, max 4.0 ha in marginal habitat	Grassland condition: Reduced condition	+	Fairfield (1968)

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference		
Abundance	Breeding - Ad	Density	AB	Effect of increasing percentage of grass in landscape	Landscape: Grass coverage	+	Koper and Schmiegelow (2006)		
				Effect of increasing length of wetland edges	Landscape: Wetland size	+			
				Effect of increasing distance from water, crops, roads	Landscape: Wetlands, Crops, Roads	+	+	+	
				Effect of increasing distance to water, crops and roads	Landscape: Wetlands, Crops, Roads	+	+	0	
					BCR 17 (Prairies and Badlands)	5.2-40.3 birds per 100 ha (2009-2017)	NA	Bird Conservancy of the Rockies (2018)	
					MT	Effect of crested wheatgrass vs. native prairie	Grassland Type: Native, Crested Wheatgrass	0	Lloyd and Martin (2005)
						Range 170-190 (mean 180) pairs per 100 ha in native prairie;	Grassland Type: Native, Tame	+	
						Range 60-180 (mean 120) pairs per 100 ha in tame grassland		0	
						Predicted abundance:	Grazing: Rest-rotation vs. Season-long	0	Golding and Dreitz (2017)
						Rest-rotation: 9.0 (2013) and 5.8 (2014) birds per 100 ha;			
				Season-long: 8.0 (2013) and 5.2 (2014) birds per 100 ha					
				140 birds per 100 ha mean (867 pts), 620 birds per 100 ha maximum	NA	NA	Lipsey (unpubl. data)		

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference	
Abundance	Breeding - Ad	Density	MT	1.7-9.5 birds per 100 ha (2010-2015); 4.3-41.9 birds per 100 ha (2011-12, 2014-2017) in BCR 11; 14.6-96.9 birds per 100 ha (2010-12, 2014-17) on BLM land in BCR 11	NA	NA	Bird Conservancy of the Rockies (2018)	
				Effect of distance to cattle water structures	Cattle water structures	0	Fontaine et al. (2004)	
			ND	4.4-49.9 birds per 100 ha (2011-17) in BCR17 in ND	NA	NA	NA	Bird Conservancy of the Rockies (2018)
				Effect of increasing woody cover	Vegetation Structure: Shrub/Woodland Cover	-	Greer et al. (2006)	
			SD	Effect of patch size: large (>100 ha) vs. small (<50 ha) patches	Landscape/ Patch Size: >100 ha, <50 ha	+	Berman (2007)	
				Effect of wind turbines	Energy Development: Wind turbines	-	Shaffer and Johnson (2008)	
				2.3-56.2 birds per 100 ha (2010-2017) in BCR17	NA	NA	Bird Conservancy of the Rockies (2018)	
			SK	70-120 (mean 90) pairs per 100 ha, grazed native prairie; 0-20 (mean 10) pairs per 100 ha, ungrazed native prairie	Grazing: Grazed, native, Ungrazed, native	+	Maheer (1973)	
				Effect of increased disturbance, Effect of increasing vegetation height and volume	Vegetation structure: Vegetation height Vegetation volume, Disturbance	-	Gaudet (2013)	

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Abundance	Breeding - Ad	Density	MN, MT, ND, SD	0.50 pairs per 100 ha (range 0-1.38 pairs per 100 ha)	NA	NA	Igl (2009)
Abundance	Migration	Density	-	None			
Abundance	Wintering - Ad	Density	Sonoita, AZ	Average 92.4 birds per 100 ha (2008-12)	NA	NA	CEC (2013)
			Sulfur Springs, AZ	Average 6.5 birds per 100 ha (2011-12)	NA	NA	
			Boothel, NM	Average 141.6 birds per 100 ha (2011-12)	NA	NA	
			Otero Mesa, NM	Average 138.2 birds per 100 ha (2011-12)	NA	NA	
			Armendaris, NM	Average 73.4 birds per 100 ha (2011-12)	NA	NA	
			OK	Average densities on different study plots per year: 5 and 37 birds per 100 ha (1978, 1979, respectively); 69 birds per 100 ha (1977); 41 and 46 birds per 100 ha (1976, 1978, respectively); 46 birds per 100 ha (1977); 83 birds per 100 ha (1976); 166 birds per 100 ha (1978)	NA	NA	Gryzbowski (1982)
			Marfa, TX	Average 130.9 birds per 100 ha (2009-11); Range 67.8-117.0 birds per 100 ha (2014-17)	NA	NA	CEC (2013), Bird Conservancy of the Rockies (unpubl. data)
			w. TX	Average densities on different study plots per year: 16, 5, and 30 birds per 100 ha (1977, 1978, 1979, respectively); 14, 3 birds per 100 ha (1977, 1979, respectively); 22, 35, and 122 birds per 100 ha (1977, 1978, 1979, respectively)	NA	NA	Grzybowski (1980)

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference			
Abundance	Wintering - Ad	Density	Alto Conchos, Chihuahua	Average 41.9 birds per 100 ha (2012-13)	NA	NA	CEC (2013)			
			Cuchillas de la Zarca, Durango	Average 145.4 birds per 100 ha (2007-2012)	NA	NA				
			Janos, Chihuahua	Average 161.1 birds per 100 ha (2007-2012)	NA	NA				
			Lagunas del Este, Chihuahua	Average 243.9 birds per 100 ha (2009-12)	NA	NA				
			Llano Las Amopolas, Chihuahua	Average 275.2 birds per 100 ha (2011-12)	NA	NA				
			Mapimi, Durango	Average 48.4 birds per 100 ha (2007-12)	NA	NA				
			El Tokio, primarily Coahuila	Average 0.11 birds per 100 ha (2007-13)	NA	NA				
			Valles Centrales, Chihuahua	Average 287.4 birds per 100 ha (2007-13)	NA	NA				
			Valle Colombia, Coahuila	Average 40.3 birds per 100 ha (2007-13)	NA	NA				
			Reproduction	Breeding - Ad	Nest Success	AB	Effect of gas wells on apparent nest success	Energy Development: Gas wells	0	Yoo (2014)
						Canada	Effect of grazing type in meta-analysis of nests across multiple studies (n=351)	Grazing	0	Bleho et al. (2014)
						CO	Overall nest survival: $0.254 \pm 0.069$ (SE); Effect of increased drought, average temperature, storms	Climate: Drought, Average temperature, Storms	- - -	Conrey et al. (2016)
						MB	Nesting success: 45% (n=57) <sup>c</sup>	NA	NA	Davis (1994)

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference	
Reproduction	Breeding - Ad	Nest Success	MT	Fledging success (number of young fledged per egg hatched): 48% (1997), 72% (1998)	Predation	-	Lynn and Wingfield (2003)	
				Nesting success (nests that fledged any young): 57% (1997, n=14), 74% (1998, n=19)	Predation	-		
				Nesting success: 47.9% in native grass (n=167) <sup>c</sup> , 41% in tame grass (n=134) <sup>c</sup>	Grassland Type: Native vs. Tame	0	Lloyd and Martin (2005)	
			MT and ND	Nesting success: 44% (n=770) <sup>c</sup>	Predation, Weather	-	Jones et al. (2010)	
				Apparent nest success: 40% (2017, n=102), 25% (2018, n=128)	NA	NA	Pulliam and USFWS (unpubl. data)	
				Nest survival: 36% (logistic exposure method)	Increasing temperature, Reduced grassland conditions	-	Bernath-Plaisted et al. (2018)	
			SD	Nesting success: 55% (n=42) <sup>c</sup> Mayfield: 29%	Predation	-	Berman (2007)	
				SK	Nesting success: 30% (n=474) <sup>c</sup>	Predation	-	Davis (2003)
			Effect of increasing distance from edges		Landscape: Edge effect	-	Davis (2004, 2006)	
			Effect of increasing patch size		Landscape: Patch size	+	Davis et al. (2006)	
			Effect of light or moderate grazing	Effect of light or moderate grazing	Effect of light or moderate grazing	Grazing Intensity: Light, Moderate	0	Lusk (2009)
							0	
							NA	Pipher (2011)
NA	Gaudet (2013)							
Effect of gas wells on apparent nest success	Effect of gas wells on apparent nest success	Energy Development: Gas wells	0					



Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Reproduction	Breeding - Ad	Nest Success	SK	Nesting success: 30% (n=57, grazed) <sup>c</sup> , 23% (n=14, ungrazed) <sup>c</sup>	Predation; Grazing Intensity: Grazed, Ungrazed	- 0 0	Lusk and Koper (2013)
				Effect of increasing percentage planted pasture within 400 m	Landscape: Percentage planted pasture	+	Davis et al. (2016)
Reproduction	Breeding - Ad	Productivity	AB	Effect of reduced distance to well pads on number of fledged young per nest	Energy Development: Gas wells	-	Yoo (2014)
				3.4 young fledged per successful nest (n=142)	NA	NA	Hill (1997)
			CO	Fewer young fledged per successful nests with decreasing distance to well pads	Energy Development: Gas wells	-	Yoo (2014)
				Number of young fledged per successful nest: 3.4 (n=10)	Predation, Weather	-	Conrey et al. (2016)
			MB	3.5 young fledged per successful nest (n=26)	NA	NA	Davis (1994)
				MT	Number of young fledged per successful nest: 3.6 (1997, n=14), 4.25 (1998, n=19)	Predation	-
			SD		1.5 young fledged per nest (n=770), 3.4 young fledged per successful nest (n=342)	NA	NA
				1.8 young fledged per nest (n=42)	NA	NA	Berman (2007)
			SK	0.9 host young fledged per nest (n=474), 3.0 host young fledged per successful nest (n=141)	Predation	-	Davis (2003b)
				1.4 young fledged per nest (n=40) <sup>d</sup> , 2.9 young fledged per successful nest on grazed sites (n=19) <sup>d</sup> , 1.0 young fledged per nest (n=8) <sup>d</sup> , 2.7 young fledged per successful nest on ungrazed sites (n=3) <sup>d</sup>	Grazing Intensity: Grazed, Ungrazed	+	Lusk (2009)
		Effect of reduced distance to well pads on number of fledged young per nest	Energy Development: Gas wells	+	Gaudet (2013)		

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Reproduction	Breeding - Ad	Productivity	SK	1.0 young fledged per nest (n=212); 3.2 young fledged per successful nest (n=64)	NA	NA	Gaudet (2013)
				Effect of reduced distance to well pads on number of fledged young per successful nest	Energy Development: Gas wells	+	
Reproduction	Breeding - Ad	Brown-headed Cowbird (BHCO) Parasitism	AB	0.6 more young fledged per nest in native prairie vs tame grass	Grassland Type: Native, Tame	+	Davis et al. (2016)
				Effect of distance to roads or gas wells	Energy Development: Roads, Gas wells	0 0	Ludlow et al. (2015)
				0% BHCO parasitism (n=254 nests)	NA	NA	Bleho et al. (2015)
				4% BHCO parasitism (n=23 nests)	Parasitism	-	Harris (1944)
				12% BHCO parasitism (n=26 nests)	Parasitism	-	De Smet (1992)
				14% BHCO parasitism (n=57 nests)	Parasitism	-	Davis (1994), Davis and Sealy (2000)
				8% BHCO parasitism (n=26 nests)	Parasitism	-	Igl and Johnson (2007)
				2% BHCO parasitism (n=134 nests) tame grassland	Parasitism	-	Lloyd and Martin (2005)
				2% BHCO parasitism (n=770 nests)	Parasitism	-	Jones et al. (2010)
				3% BHCO parasitism (n=167 nests) native grassland	Parasitism	-	Lloyd and Martin (2005)
0% BHCO parasitism (n=264 nests)	NA	NA	Pulliam and USFWS (unpubl. data)				
			ND	22% BHCO parasitism (n=37 nests)	Parasitism	-	R.E. Stewart in Friedmann et al. (1977)

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Reproduction	Breeding - Ad	Brown-headed Cowbird (BHCO) Parasitism	ND	23% BHCO parasitism (n=62 nests)	Parasitism	-	Stewart (1975)
				4% BHCO parasitism (n=71 nests)	Parasitism	-	Granfors et al. (2001)
			SD	7% BHCO parasitism (n=42 nests)	Parasitism	-	Berman (2007)
				4% BHCO parasitism (n=27 nests)	Parasitism	-	Smith and Smith (1966)
			SK	0% BHCO parasitism (n=36 nests)	NA	NA	Fairfield (1968)
				0% BHCO parasitism (n=38 nests)	NA	NA	Regina Museum of Natural History Nest Record Cards in Fairfield (1968)
				0% BHCO parasitism (n=111 nests)	NA	NA	Maier (1973)
				18% BHCO parasitism (n=22 nests)	Parasitism	-	Prairie Nest Records Scheme in Maier (1973)
				16% BHCO parasitism (n=490 nests)	Parasitism	-	Davis (2003)
				Effect on parasitism rates	Landscape: Patch size	0	Davis et al. (2006)
				5% BHCO parasitism (n=96 nests)	Parasitism	-	Klippertine and Sealy (2008)
				0% BHCO parasitism (n=54 nests)	NA	NA	Lusk (2009)
			0% BHCO parasitism (n=115 nests)	NA	NA	Pipher (2011)	
			<0.01% BHCO parasitism (n=212 nests)	Parasitism	NA	Gaudet (2013)	

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Reproduction	Breeding - Ad	Nest Placement	AB	Nesting within 100 m of roads or trails to gas wells	Energy Development: Gas wells	- (no nesting)	Ludlow et al. (2015)
			SK	Effect of increasing distance from gas wells on nest occurrence	Energy Development: Gas wells	+	Gaudet (2013)
				Effect of gas well noise, fences or roads	Energy Development: Gas well noise, Fences, Roads	0 0 0	
Reproduction	Breeding - Ad	Clutch Size	AB	Effect of increasing distance from gas wells	Energy Development: Gas wells	+	Yoo (2014)
			MT	Effect of high or low impact roads	Roads: High impact, Low impact	0 0	Lloyd and Martin (2005)
				Range 3.8-4.1 eggs per nest (n=212), effect of grassland type, i.e., native vs tame	Grassland Type: Native vs. Tame	0	
Reproduction	Breeding - Ad	Number of Clutches	SK	Effect of distance to gas wells	Energy Development: Gas wells	0	Gaudet (2013)
			SK	Often double brooded, possibly treble brooded. Frequently re-nests after failure with up to 4 nests per year after successive failures	NA	NA	Bleho et al. (2015)
			CO	$0.940 \pm 0.012$ (SE)	Predation, Climate	- -	Conrey et al. (2016)
Reproduction	Breeding - Ad	Daily Nest Survival	MT	Effect of grassland type, i.e., crested wheatgrass vs native prairie	Grassland Type: Native, Crested Wheatgrass	+	Lloyd and Martin (2005)
			SD	Effect of patch size: large (>100 ha) vs. small (<50 ha) patches	Landscape: Patch size >100 ha, <50 ha	+	Berman (2007)
				Effect of increasing litter depth	Vegetation Structure: Litter depth	-	
Survival	Breeding - Ad	Site Fidelity	AB	Male return rates: 67% (20 of 30), Female return rates: 32% (5 of 18)	NA	NA	Bleho et al. (2015)

Population Parameter	Life Cycle Phase/ Age Class <sup>a</sup>	Parameter	Region	Estimate	Covariate	Effect <sup>b</sup>	Reference
Survival	Breeding - Ad	Site Fidelity	SK	Male return rate: 35.9% (14 of 39), Female return rate: 32.3% (21 of 65)	NA	NA	K. Ellison in Bleho et al. (2015)
Survival	Breeding - FI	Natal Site Fidelity	AB	0% of 325 banded nestlings returned	NA	NA	Hill (1997)
Survival	Breeding - Ad	Survival	-	None			
Survival	Breeding - FI	Survival	-	None			
Survival	Migration	Survival	-	None			
Survival	Migration	Stopover Ecology	-	None			
Survival	Wintering	Site Fidelity	-	None			
Survival	Wintering	Survival	-	None			

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

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

<sup>c</sup> Nest success = raw % of nests that were successful

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