DRAFT

STATE OF WASHINGTON December 2015

Periodic Status Review for the Streaked Horned Lark

Derek W. Stinson

Washington Department of
FISH AND WILDLIFE
Wildlife Program

The Washington Department of Fish and Wildlife maintains a list of endangered, threatened, and sensitive species (Washington Administrative Codes 232-12-014 and 232-12-011). In 1990, the Washington Wildlife Commission adopted listing procedures developed by a group of citizens, interest groups, and state and federal agencies (Washington Administrative Code 232-12-297). The procedures include how species listings will be initiated, criteria for listing and delisting, a requirement for public review, the development of recovery or management plans, and the periodic review of listed species.

The Washington Department of Fish and Wildlife is directed to conduct reviews of each endangered, threatened, or sensitive wildlife species at least every five years after the date of its listing by the Washington Fish and Wildlife Commission. The periodic status reviews are designed to include an update of the species status report to determine whether the status of the species warrants its current listing status or deserves reclassification. The agency notifies the general public and specific parties who have expressed their interest to the Department of the periodic status review at least one year prior to the five-year period so that they may submit new scientific data to be included in the review. The agency notifies the public of its recommendation at least 30 days prior to presenting the findings to the Fish and Wildlife Commission. In addition, if the agency determines that new information suggests that the classification of a species should be changed from its present state, the agency prepares documents to determine the environmental consequences of adopting the recommendations pursuant to requirements of the State Environmental Policy Act.

This document is the Draft Periodic Status Review for the Streaked Horned Lark It contains a review of information pertaining to the status of the lark in Washington. It was reviewed by species experts and will be available for a 90-day public comment period. All comments received will be considered during the preparation of the final periodic status review. The Department intends to present the results of this periodic status review to the Fish and Wildlife Commission at an upcoming meeting.

Submit written comments on this report by e-mail by 27 March 2016 to:
T&Epubliccom@dfw.wa.gov

Or by mail to:

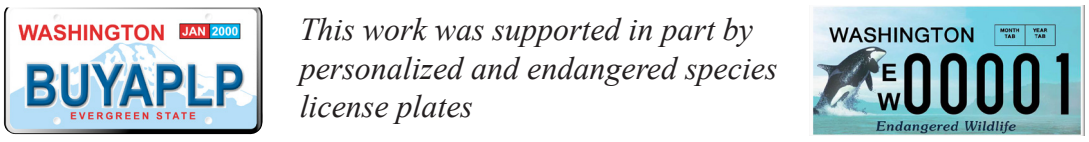
Listing and Recovery Section Manager, Wildlife Program
Washington Department of Fish and Wildlife
600 Capitol Way North, Olympia, Washington 98501-1091

This report should be cited as:

Stinson, D. W. 2015. Draft periodic status review for the Streaked Horned Lark in Washington. Washington Department of Fish and Wildlife, Olympia, Washington. 18 + iii pp.

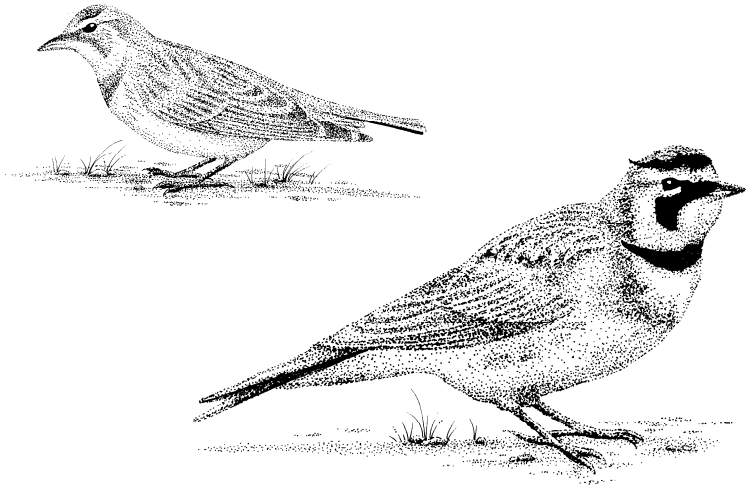
On the cover: Photo of banded male Streaked Horned Lark by David Maloney; background of Range 74/76 on JBLM by D. Stinson. Black and white illustration on title page by Darrell Pruett

This work was supported in part by personalized and endangered species license plates



DRAFT

Periodic Status Review for the Streaked Horned Lark in Washington



Prepared by
Derek W. Stinson

Washington Department of Fish and Wildlife
Wildlife Program
600 Capitol Way North
Olympia, WA 98501-1091

December 2015

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

ACKNOWLEDGEMENTS

The draft was improved by contributions and reviews by Scott Pearson, Hannah Anderson, Adrian Wolf, Gary Wiles, Michelle Tirhi, Brock Hoenes, Mary Linders, Stefanie Bergh, Penny Becker, Gerry Hayes, Cat Brown, and Kevin Kalasz.

EXECUTIVE SUMMARY

The Streaked Horned Lark (*Eremophila alpestris strigata*) is a rare endemic subspecies found only in western Washington and Oregon. It is perhaps the most distinct subspecies of the Horned Lark, a common ground-dwelling passerine of open grassland habitat. The Streaked Horned Lark was listed as endangered by the State of Washington in 2006, and as threatened under the federal Endangered Species Act by the U.S. Fish and Wildlife Service in 2013 (USFWS 2013).

The Streaked Horned Lark was once more abundant and widespread, but has become increasingly rare with habitat declines and is now restricted to a few large open grassland and sparsely vegetated sites, including airports, sandy islands, and coastal spits. The Streaked Horned Lark is currently known to breed at up to17 locations in Washington; 8 in the southern Puget Sound region; 6 sites on the outer coast; and 4 on islands and shore sites along the lower Columbia River. Oregon breeding areas include up to 11 along the lower Columbia, as well as airports and agricultural fields in the Willamette Valley.

Approximately 147 pairs were present at known Washington sites in 2015, based on detections of singing males during standardized surveys. Density trends from standardized transect data for 2010-2014 suggested that the populations at most sites were stable. However, the male population appears to be increasing and the female population appears to be decreasing on some Puget lowland sites resulting in a skewed sex ratio. This could result from sex ratios at hatching, or if females were subject to higher mortality rates. Numerous factors affect larks including predation of nests and fledglings, human-related disturbance and mortalities (at airports, army training areas, and nesting beaches), and likely low genetic diversity caused by inbreeding in small populations with high site fidelity. In addition, toxic substances including zinc phosphide, used to control rodents, and seeds treated with pesticides to control pests and fungus, may present a hazard to Streaked Horned Larks.

The subspecies is the focus of concerted conservation efforts with several key partners involved, including Joint Base Lewis-McChord, Center for Natural Land Management, U.S. Army Corps of Engineers, civilian airports (e.g. Corvallis, Olympia, and Shelton), Oregon State University, U.S. Fish and Wildlife Service, American Bird Conservancy, Port of Portland, and The Evergreen State College. Conservation actions include protecting nests and fledglings at nesting areas, restoring habitat, genetic augmentation of an at-risk population, and experiments to attract larks to new locations.

Joint Base Lewis-McChord has collaborated with Center for Natural Lands Management to monitor lark nests to help minimize impacts of mowing and training activities on nesting, and lark reproductive success improved in 2014 and 2015. The Army Corps of Engineers recently committed to maintain and increase lark habitat at Columbia River dredged material deposition sites. These actions have improved the outlook for lark recovery. However, with a range-wide population estimated at 1,170–1,610 individuals, including fewer than 150 pairs in Washington, it is recommended that the Streaked Horned Lark remain listed as an endangered species in Washington.

TAXONOMY, DESCRIPTION & LEGAL STATUS

The Streaked Horned Lark (*Eremophila alpestris strigata;* Fig. 1) is a rare subspecies found only in western Washington and Oregon. The subspecies was derived from a Pacific Coast lineage that included southern California coastal and Channel Island populations (Mason et al. 2014). It is perhaps the most distinct subspecies of the Horned Lark, a small common ground-dwelling passerine that prefers open grassland habitat (Beason 1995, Rogers 2000, Stinson 2005). Genetic data indicate that the subspecies is unique, isolated, and has little genetic diversity (Drovetski et al. 2005, Mason et al. 2014). The Streaked Horned Lark was listed as endangered by the State of Washington in 2006, and federally threatened by the U.S. Fish and Wildlife Service in 2013 (USFWS 2013). It is also listed as endangered under the Species at Risk Act in Canada (Beauchesne and Cooper 2003).

Figure 1. Streaked Horned Lark at Damon Point (*photo by Rod Gilbert*).

DISTRIBUTION

The Streaked Horned Lark was once more common and widespread, but has become increasingly rare with the decline in habitat, including south Puget Sound prairies. It is now restricted to a few large open grasslands and sparsely vegetated areas, including airports, sandy islands, and coastal spits. Historically, Streaked Horned Larks bred from southern British Columbia, through the Puget trough in Washington and in the Willamette and Rogue River Valleys in Oregon (Fig. 2; Rogers 2000, Stinson 2005, Altman 2011). It is considered extirpated in British Columbia (Beauchesne and Cooper 2003), and absent from former breeding sites in the northern Puget trough, the Washington coast north of Grays Harbor, and the Rogue River Valley of Oregon (Rogers 2000, Stinson 2005).

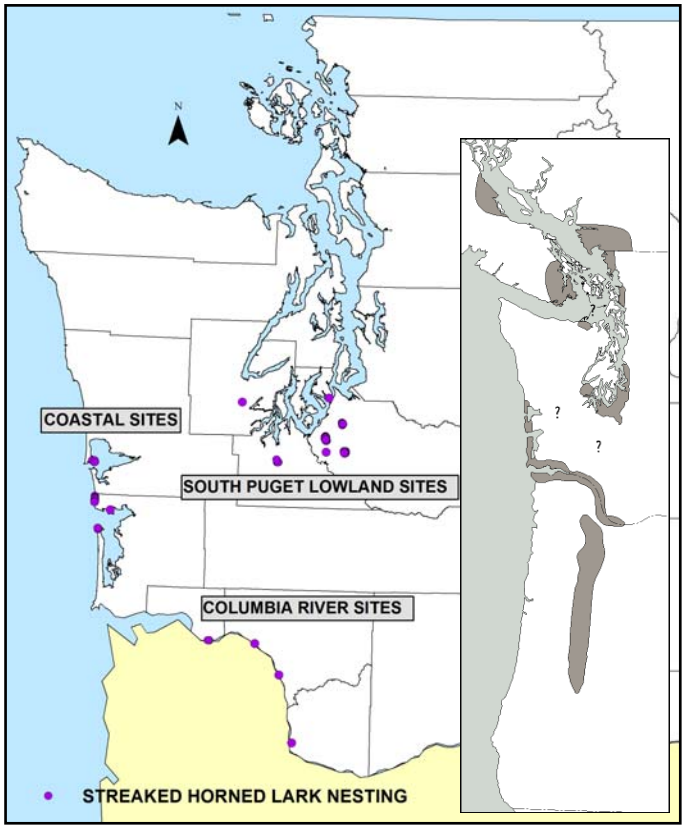


Figure 2. Current breeding locations of the Streaked Horned Lark in Washington, and (inset) hypothesized historical breeding range (Stinson 2005).

NATURAL HISTORY

Habitat requirements. Streaked Horned Larks inhabit relatively sparsely vegetated

grasslands, beaches, islands, and agricultural fields. They use sparsely vegetated sites dominated by relatively short grasses and they strongly prefer bare ground to vegetation that is more than several inches tall (Altman 1999, Rogers 2000, Pearson and Hopey 2005, Anderson and Pearson 2015). When establishing territories, males generally avoid areas dominated by shrubs, non-native sod-forming grasses, and non-native perennial forbs (Pearson 2003, Pearson and Hopey 2004, 2005). At the nest-site scale, female larks selected sites within territories with higher vegetation density and more perennial forbs (Pearson and Knapp 2015).

Areas historically used by Streaked Horned Larks may have had sparse vegetation because they burned frequently, had poorly developed soil horizons, had high gravel/cobble content, or combinations of these factors (Pearson and Hopey 2004). In the south Puget lowlands, where most of the historical grasslands have been lost to development or the incursion of trees (Chappell et al. 2001, Foster and Shaff 2003), mowed fields adjacent to airport runways and taxiways currently provide some of the most important remaining nesting areas for Streaked Horned Larks.

The smallest area of open land (dominated by sparse vegetation of grasses and forbs) used for nesting by Streaked Horned Larks in the Puget lowlands is ~194 ac (Tacoma Narrows Airport, includes pavement), although a singing male was observed at another site of <90 ac, no nesting was confirmed. On the coast and lower Columbia River, the water and beaches create much larger open areas free of tall vegetation and obstructions despite having small land area. On the Washington coast, Streaked Horned Larks nest on open dune areas of unstable substrate with little to no vegetation, such as sand spits and dune-backed beaches where Snowy Plovers (*Charadrius nivosus*) also nest (Richardson 1995, Stinson 2005).

Migration and winter habitat. The Puget lowland population of Streaked Horned Lark is migratory, but some coast and Columbia River birds overwinter on or near their breeding areas (Pearson et al. 2005). Winter habitats occupied by Streaked Horned Larks are large treeless and shrubless expanses with a high percentage of bare ground (Robinson and Moore 2004). Most birds occur on fallow ryegrass fields in the Willamette Valley and on islands in the lower Columbia River, with smaller numbers found at the sandy Washington coastal areas (Robinson and Moore 2004, Pearson et al. 2005).

Diet and foraging habitat. Horned Larks are largely granivorous, both in winter (80–100% seeds), and in the breeding season (up to 73% seeds), while nestlings are fed insects exclusively (Beason 1995, Moore 2007). They forage on the ground, usually in short vegetation or bare agricultural fields. Streaked Horned Larks on Joint Base Lewis-McChord (JBLM) prairies selected foraging sites that contained a large percentage of bare ground (>40% of 1 m radius plots; included occasional mosses) and low vegetation (<30 cm) (Rogers 2000).

Reproduction. Horned Larks breed when one year old, and attempt to rear 2–3 broods annually. Horned Larks are socially monogamous for at least the breeding season, but there have been no long-term studies of pair bonds (Beason 1995). In the south Puget Sound lowland, males begin to sing and establish territories in Washington in the latter half of February and early March (Bowles 1900, Rogers 2000, Pearson 2003). Bowles (1898) reported that some locations had high densities of nests, while large expanses of habitat were vacant, suggesting that Streaked Horned Larks are semi-colonial nesters. Territorial males sing from the ground, and in flight as part of an elaborate courtship display (Beason 1995).

Female Streaked Horned Larks build a compact cup of dead plant material placed in a depression excavated on the ground. Nest building in the southern Puget lowland is initiated from mid-April to early May and nesting is concluded by mid-August, with the last few chicks becoming independent by mid-

September (Wolf and Anderson 2014). There are two or three peaks of clutch initiation (Pearson 2003, Pearson and Hopey 2005, Wolf et al. 2015). The clutch size of Streaked Horned Larks is most often 3, but clutches of 1-5 have been observed (Pearson and Hopey 2005, Camfield et al. 2010, Wolf et al. 2015). Horned Lark chicks can flutter and hop at departure from the nest at 7–10 days, and are mostly independent at 4 weeks (Beason 1995, Campbell et al. 1997).

Survival and sources of mortality. Data on sources and timing of mortality for Streaked Horned Lark are needed in order to improve survival and population growth rate. Predation and nest abandonment are the most frequent causes of nest failure in Washington. Predation, mostly during the incubation stage, caused 69% of nest failures at sites in the south Puget lowland and 46% of failures at 1 river and 2 coastal sites in 2004 (n = 198; Pearson and Hopey 2005). Anderson (2010) observed no difference on 13th Division Prairie in nest predation rates between Streaked Horned Larks and the grassland bird guild (larks = 33%, vs. guild = 32%). On JBLM, causes of failure in 2013 (24 nests) and 2014 (11), were predation (8, 3), abandonment (7, 2), human activity (4, 2), and unknown (5, 4) (Wolf and Anderson 2014, Wolf et al. 2015).

American Crows (*Corvus brachyrhynchos*) are likely the most important nest predator of Streaked Horned Lark nests in Washington (Bent 1963: 358, Pearson 2003). Crows, Northern Harriers (*Circus cyaneus*), Western Meadowlarks, Red-tailed Hawks (*Buteo jamaicensis*), American Kestrels (*Falco sparverius*) Great Horned Owls (*Bubo virginianus*), Striped Skunks (*Mephitis mephitis*), and garter snakes (*Thamnophis* sp.) depredate Streaked Horned Lark nests (Pearson and Hopey 2008, Pearson et al. 2012, Moore 2013); harriers are the most frequent predator at the Corvallis Airport (Moore 2013). Other potential nest predators include domestic cats and dogs, Coyotes (*Canis latrans*), Raccoons (*Procyon lotor*), Long-tailed Weasels (*Mustela frenata*), and Opossums (*Didelphis virginiana*) (Creighton and Porter 1974, Bent 1963, Beason 1995, Pearson 2003).

A total of 219 larks have been banded on JBLM since 2010 (Wolf et al. 2015); 17.1% of these were observed in subsequent years, a juvenile return rate within the range reported by Verner et al. (2000) for other granivorous land birds (range = 8–42%). The cumulative survival probability for the entire 10-week post-fledging period was 32%, which is similar to some other studies of post-fledging survival (Wolf et al. 2015). Data is needed on survival during the migration and overwintering periods.

For banded birds, annual return rate of adults since 2011 was 72% (n = 16; Wolf et al. 2015). Camfield et al. (2010) reported apparent survival of adult Streaked Horned Larks at Washington sites during 2002-2005 was 0.51±0.07 (n = 58), compared to 0.69±0.04 (117) for Pallid Horned Larks at an alpine site in British Columbia. Apparent juvenile survival (φ) in Washington was 0.095±0.04 (n = 80; including dispersal was 0.17±0.06, n = 88), compared to 0.20±0.05 (n = 175) for Pallid Horned Larks.

Movements and dispersal. In late summer, young Horned Larks gather into small flocks of 10–25 birds, and may be joined by adults in the fall (Beason 1995). In winter, small flocks aggregate at foraging areas into larger nomadic foraging flocks that includes other subspecies of Horned Lark and other species like American Pipits (*Anthus rubescens*). Adult Streaked Horned Larks in Washington have relatively high site fidelity to nesting areas. First year breeding birds are more likely to disperse to other sites than adults, but adults are more likely to return to the site where they bred the previous year. Adult birds banded in 2002-2005 were only resighted nesting in the region where they were banded (Pearson et al. 2008); juveniles dispersed from the Puget lowlands to breed on the Washington coast, Columbia River, or Willamette Valley, but there was no natal or breeding dispersal into the Puget lowlands, and many birds on the coast and lower Columbia seem to be resident (Pearson et al. 2005, Pearson et al. 2008). In 2015, observers resighted 17 color-banded larks that were first year breeding birds (banded as nestlings in

2014); of these 10 (59%) had dispersed to breeding locations that were not their natal sites (A. Wolf, pers. comm.). One male on JBLM returned to his natal site in 2015 for a sixth season.

POPULATION AND HABITAT STATUS

Range-wide trends in Horned Larks. Horned Larks, like many other grassland bird species, have declined >2%/year since the 1960s (Sauer et al. 2014; Fig. 3). Reasons include the loss of native grassland habitats; for example, about 23 million acres of grasslands, shrublands, and wetlands were converted to crop production between 2008 and 2011(Faber et al. 2012). Pesticides may also be a factor (Mineau and Whiteside 2013, Hallman et al. 2014).

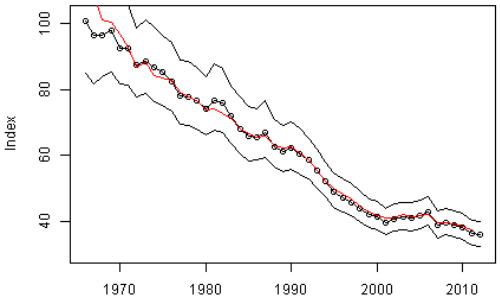


Figure 3. Survey-wide trend in Horned Lark detections during Breeding Bird Surveys, 1966-2012 (Sauer et al. 2014).

Streaked Horned Lark. There were an estimated 147 pairs of Streaked Horned Lark in Washington in 2015 (Table 1). This estimate is based on the high count of singing males detected during a single visit of 3 surveys at each known site during the breeding season. Experienced observers indicate that most singing males are paired (S. Pearson, H. Anderson, pers. comm.), so the number of males detected gives a reasonably accurate estimate of pairs present on a site. However, recent intensive nest monitoring at JBLM suggested that some males were remaining unpaired, so this method may slightly overestimate the number of pairs (H. Anderson, per. comm.). Standardization of surveys began in 2010, and additional sites have been added since. Altman (2011) provided an estimate of 1,170-1,610 for the subspecies, based on 2008-2010 data from all known breeding sites in Washington, and accessible breeding sites and roadside point counts in Oregon.

Reproductive success. Measures of productivity have sometimes been low and inconsistent in Washington populations. Camfield et al. (2010) reported that for 2002-2005, 23% of eggs laid (n = 123) produced a fledgling, and nest success (Mayfield method; the percent of nests that produced at least 1 fledgling) was 23% of 257 nests. Nest success for 2002-2004 varied from 7% at 13th Division Prairie to 66% at Damon Point (Pearson and Hopey 2005), and averaged 38%, 34%, 37%, and 71% in 2011, 2012, 2013, 2014 respectively, for three sites on JBLM (13th Div.; Gray Army AF, and McChord AF; using Program MARK; Wolf et al. 2015). Annual fecundity at several study areas during 2002-2005 averaged 0.91 female fledglings per female (Camfield et al. 2010). Annual fecundity on 13th Division Prairie during 2007 and 2009 averaged 0.99 female fledglings per female, compared to 3.25 for Savanah Sparrows (*Passerculus sandwichensis*) at the same location (Anderson 2010), and 3.4 for Horned Larks in Kansas (Ricklefs and Bloom 1977), and 1.75 for Pallid Horned Larks (*E. a. articola*) in British Columbia (Camfield et al. 2010).

Anderson (2010) compared nesting and fecundity data from 2007 and 2009 on 13th Division Prairie for Streaked Horned Larks, Savannah Sparrows (*Passerculus sandwichensis*), and the entire ground-nesting guild, which included larks, Savannah Sparrow, Vesper Sparrow (*Pooecetes gramineus*), Western Meadowlarks (*Sturnella neglecta*), and Common Nighthawks (*Chordeiles minor*). Larks had significantly lower values in all measures of reproductive success. Egg hatch rates for the guild (91%) and Savannah Sparrows (96%) were typical of most passerines (~91%; Koenig 1982), but the lark hatch rate was only 44% (n = 66). This compared to a hatch rate of 76% and 86% at 13th Division in 2013 and

Table 1. Estimated number of breeding pairs[a] of Streaked Horned Larks during May-August surveys in Washington, and the Oregon side of the Columbia River, 2010–2015.

Region/ Location	County	2010	2011	2012	2013	2014	2015
South Puget Sound							
Olympia Airport	Thurston	36	26	31	30	37	48
Shelton Airport	Mason	9	7	11	12	13	13
13th Division Prairie, JBLM[b]	Pierce	1	4	11	11	12	10
Gray Army Airfield, JBLM[b]	Pierce	15	15	12	12	16	22
91st Div. Prairie, Range 76, JBLM[b]	Pierce	10	5	-	5	9	6
91st Div. Prairie, Range 50, JBLM[b]	Pierce	-	-	-	-	3	3
McChord Air Force Base, JBLM[b]	Pierce	13	11	8	17	9	15
Tacoma Narrows Airport	Pierce	-	-	-	-	2	2
Washington coast							
Leadbetter Point	Pacific	-	17	12	6	11	11
Graveyard Spit	Pacific	-	-	-	1(3)[c]	0	0
Midway Beach	Pacific	-	-	2	1	1	0
Damon Point	Grays Harbor	-	2	3	2	0	0
Oyhut Spit	Grays Harbor		0	2	0	0	0
Johns River Island		-	-	2	0	0	0
Columbia River–Washington							
Brown Island	Wahkiakum	15	14	18	23	21	17
North Port (Kalama)	Cowlitz	-	-	1	3	2	-[d]
Port of Longview (Wasser and Winters)	Cowlitz	-	-	-	1	2	-
Columbia Gateway (Port of Vancouver)	Clark	-	-	-	-	1-2	-[d]
Washington total (pairs)[e]			**101**	**113**	**124**	**139**	**147**
Columbia River–Oregon							
Rice Island[f]	Clatsop / Wahkiakum	7	22	14	23	18	14
Miller Sands	Clatsop	3	4	2	5	8	12
Pillar Rock	Clatsop	3	4	3	2	4	2
Welch Island	Clatsop	1	0	-	-	-	0
Tenasillahe Island	Clatsop	-	2	2	0	2	2
Wallace Island	Columbia	-	-	1	-	1	0
Crims Island	Columbia	0	7	4	2	5	6
Dibblee Point	Columbia	-	-	-	-	1	1
Sandy Island	Columbia	1	1	1	4	6	3
Lower Deer Island	Columbia	-	-	-	-	1	0
Sand Island	Columbia	-	-	-	-	3	2

[a]Based on the high count of males detected; data from surveys by CNLM, USFWS Willapa National Wildlife Refuge, and WDFW (Linders 2011, 2012; WDFW data).

[b]Joint Base Lewis-McChord.

[c]There were 3 detections, but all were believed to be the same male lark, and no female or nest was detected.

[d]North Port was not surveyed because access was denied; no larks detected during survey on dredge site at Columbia Gateway, but 2 flushed from adjacent agricultural field (H. Anderson, pers. comm.).

[e]2010 was not totaled due to lack of coast data; some of the apparent increase from 2010-2015 may reflect improved skills of surveyors.

[f]A small portion of Rice Island is in Wahkiakum County, Washington, but all recent lark nesting has been on the Oregon portion.

2014 (n = 66, 60; Wolf and Anderson 2014, Wolf et al. 2015) and 83% (n = 61) during the study by Camfield et al. (2010). It isn't clear why hatch rate was so low in 2007 and 2009, but low hatchability can be symptomatic of inbreeding (Briskie and Mackintosh 2004, Pearson and Stinson 2010).

Population trend and viability. From apparent survival rates (φ) and fecundity, Camfield et al. (2010) predicted a rapidly declining Streaked Horned Lark population in Washington. Compared to an alpine population of Pallid Horned Larks, Streaked Horned Larks had longer re-nesting intervals, smaller clutches, lower hatchability of eggs, lower fledging success, and high clutch depredation rates. Pallid Horned Larks produced 12% more fledglings per egg, and had higher annual fecundity (1.75 female fledglings per adult female), compared to Streaked Horned Larks (0.91). Their estimate of lambda (λ) suggested serious decline in the Washington population and that local breeding sites are not sustainable without immigration (Camfield et al. 2010).

More recent data and analyses suggest that most populations are now relatively stable or increasing, as suggested by high counts of males (Fig. 4). Productivity at JBLM was much higher in 2013 and 2014, compared to 2007 and 2009 (Anderson 2010, Wolf et al 2015). However, there seems to be diverging trends for males and females on South Puget sites with male numbers stable or increasing, but female numbers declining (Keren and Pearson, in prep.). Observations on 13th Division Prairie indicated that some males went unpaired, which was very rare in earlier studies (S. Pearson, pers. comm.). Similar observations were made in Oregon at Corvallis Airport in 2014 (R. Moore, pers. comm.). A male-skewed adult sex ratio may be due to higher mortality rates of females, possibly while nesting or during dispersal or migration (Donald 2007). A skewed sex ratio affects the effective population size, and bird species identified by IUCN as Globally Threatened more often exhibit male-biased sex ratios, and the skew toward males tends to increase with increasing threat status (Donald 2007).

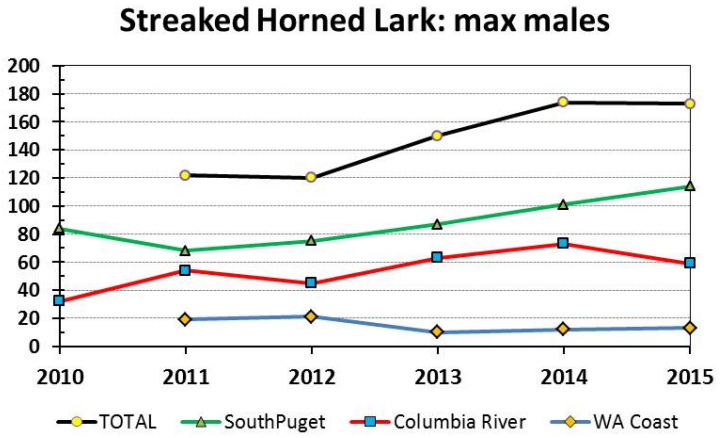


Figure 4. Maximum count of males in three regions, 2010-2015 (Columbia River includes Washington and Oregon river sites).

Prior to the recent improvement in productivity, there were two population modeling efforts. Schapaugh (2009) conducted a viability analysis of the three Streaked Horned Lark regions in Washington, using stage- and spatially explicit stochastic and deterministic models. Both models predicted that, without immigration from the Willamette population, the Washington populations in all three regions would decline to extinction within 25 years. Sensitivity analyses suggested that adult survival rates need to improve to stabilize and recover the populations, and that improving fecundity alone may not result in recovery. Camfield et al. (2011) conducted a life-stage simulation analysis (LSA) which indicated that adult survival had the greatest influence on λ, followed by juvenile survival and fecundity. Increases in vital rates led to a stable population (λ = 1) only when survival was raised from 0.47 to 0.85 for adults, from 0.17 to 0.58 for juveniles, and fecundity from 0.91 to 3.09 female fledglings per adult female, which may be unrealistic expectations. They concluded that conservation activities need to target multiple vital rates to be successful (Camfield et al. 2011).

Occupied habitat. In 2015, Streaked Horned Larks bred (or attempted to breed) at 10-12 locations in Washington: 8 inland sites, 1 coastal site, and 1-3 Columbia River sites. All of these sites are in public ownership. A few sites with a few larks have been discovered in recent years, but nearly all large suitable areas have been surveyed. Most of the 'new' sites are on Columbia River islands where habitat conditions change due to succession of vegetation and deposition of dredged material, and are used by small numbers of larks intermittently. Three new breeding sites were identified on the lower Columbia in 2014: Dibblee Point and Lower Deer Island in Oregon, and Columbia Gateway in Washington (Anderson and Slater 2015). Two new sites, Tacoma Narrows Airport and Range 50 on JBLM, were discovered in Pierce County in 2014.

The historical population and range reduction in south Puget Sound prairies is reviewed in Stinson (2005). Streaked Horned Lark habitat has remained relatively stable in recent years, though with some incremental losses. The airports, army training areas, and Columbia River sites have largely been maintained in suitable condition but with some losses as facilities expand. The currently occupied South Puget lowland nesting areas include 3 civilian airports, and 5 sites on JBLM (2 military airfields, and 3 training areas). Washington coast nesting areas include: Damon Point, a sand spit Natural Area owned by Washington Dept. of Natural Resources; Midway Beach, managed by Washington State Parks; and Leadbetter Point, part of the Willapa National Wildlife Refuge. Additional possible coastal locations where single males were observed in recent years include Johns River Island, part of the WDFW Johns River Wildlife Area, and Graveyard Spit. Graveyard Spit, owned by the Shoalwater Bay Indian Tribe and private landowners, was formerly used for nesting by larks (Stinson 2005), and a single male was observed there in 2013. Brown Island (also called White's Island, at the eastern end of Puget Island), is the largest lower Columbia River nesting area in Washington, 1-2 pairs have nested at three shore sites owned by the ports of Kalama (Northport), Longview, and Vancouver (Columbia Gateway). Additional islands that have hosted nesting larks in the recent past include Welch and Coffeepot (Pearson and Hopey 2005, WDFW and CNLM data). Larks also nest on several islands on the Oregon side of the river.

FACTORS AFFECTING CONTINUED EXISTENCE

Adequacy of Regulatory Protection

Federal listing. The Streaked Horned Lark was federally listed as threatened, effective 4 November 2013 (USFWS 2013). The listing included designation of critical habitat and a special rule pursuant to section 4(d). The listing prohibits take, critical habitat limits federal actions on specified lands, and the 4(d) rule exempts certain activities on specified types of land from the 'take' prohibition.

Recovery to a viable population of Streaked Horned Larks could not be achieved through efforts in Washington alone. Most of the larks that breed in Washington winter in Oregon. Federal listing and the previous status as a 'candidate' for listing has been instrumental in getting the needed attention from federal entities, such as the Department of Defense, Army Corps of Engineers, and the Federal Aviation Administration (FAA). FAA permitting and funding of airport improvements provide a federal nexus that means airports where larks are present must consult with the USFWS as required by Section 7 of the Endangered Species Act.

Critical habitat. Critical habitat was designated at four sites on the Washington coast, nine islands in the lower Columbia River, and three national wildlife refuge sites in the Willamette Valley. Critical habitat was exempted or excluded at occupied sites on the tribal portion of Shoalwater (Graveyard) Spit, civilian

airports, and JBLM, which has an approved Integrated Natural Resources Management Plan and associated Endangered Species Management Plan (JBLM Public Works, Environmental Division 2013). Critical habitat designation affects actions that have a federal nexus (federal entity funds, authorizes, or carries out an action) occurring on designated lands.

4(d) Rule. Specified activities associated with airport management, agriculture and noxious weed control on non-federal lands are not considered 'take' under this rule, which recognizes that while there may be adverse effects, the overall effect is a benefit to the species (USFWS 2013:61502-3).

State, county, and city protections. The Streaked Horned Lark is protected from 'take' as an endangered species in state law (RCW 77.12.020, RCW 77.15.130). Their habitat receives protection through county or municipal critical area ordinances. Critical area ordinances require environmental review and habitat management plans for development proposals that affect state-listed species. Washington's Growth Management Act requires counties to develop critical area ordinances that address development impacts to important wildlife habitats. The specifics and implementation of critical area ordinances vary somewhat by county. The Streaked Horned Lark is recognized as a species of local importance in the critical area ordinances of counties where they are found. This generally means that when development activities are proposed where larks are likely to be present, the applicant must determine if larks are present, assess the impacts to larks, and submit a habitat plan. Counties consult with WDFW, and the permit issued may impose conditions on the development to avoid, minimize, and mitigate impacts to the lark population.

Thurston County HCP. Thurston County is completing a Habitat Conservation Plan (HCP) for prairie habitats. The HCP will address the most common activities that the County typically permits. The HCP will outline a predictable, organized process for land use applications that may affect endangered or threatened species, including Streaked Horned Lark. The HCP would quantify the impacts that proposed land use actions might have, outlining mitigation and other conservation strategies. If approved by the U.S. Fish and Wildlife Service USFWS, they will issue an incidental take permit under Section 10 of the Endangered Species Act.

Other Factors Affecting Larks

Habitat loss, fragmentation, and degradation. Habitat fragmentation has been identified as an important factor in the decline of grassland birds (Peterjohn and Sauer 1999). Additional loss of large open habitat required by larks may occur at currently occupied sites. For example, Gray Army Airfield recently expanded the paved area to accommodate additional helicopters, and civilian airports plan to develop significant portions of the land surrounding runways for port related development.

The lark's selection of sites with sparse vegetative cover means that large open sites with tall or thick vegetation (e.g., pastures) go unused. Succession to shrubs (particularly Scotch Broom, *Cytisus scoparius*) and trees, and planting or invasion by turf-forming grasses eliminates the short, open structure that larks need. All the current nesting sites in the south Puget lowland have a disturbance regime that controls invasion by woody or tall and dense vegetation. For example, fires, whether from exploding ordnance or prescribed burns, reduce the spread of Scotch Broom, and Douglas-fir (*Pseudotsuga menziesii*) on JBLM prairie training areas, while regular maintenance activities (e.g. mowing) maintains the suitability of nesting sites on JBLM airfields and civilian airports. Scotch Broom, horsetails (*Equisetum* spp.), beachgrasses, and other weedy plants are also invading some coastal (e.g. Damon Point) and lower Columbia River sites (Anderson 2011). Most remaining prairie sites are degraded to some extent by exotic forbs and grasses, creating conditions that are not compatible with lark use.

Recently habitat at Shelton Airport has become entirely covered by moss and is no longer used for nesting (J. Skriletz, pers. comm.).

On coastal sites, tall perennial beachgrasses can eliminate sparsely vegetated sand used for nesting by Streaked Horned Larks. Two species, American Beachgrass (*Ammophila breviligulata* Fern.) from eastern North America, and European Beachgrass (*Ammophila arenaria* (L.) Link) from Europe, have become naturalized along the west coast of North America and have replaced much of the native vegetation that comprised foredune habitat (Wiedemann 1987, Seabloom and Wiedemann 1994). Beachgrass is also becoming a problem on some of the Columbia River islands (Anderson 2011). Beachgrass control has been ongoing at Willapa NWR to restore nesting areas for Snowy Plovers, and the restoration sites have also been used by larks.

Columbia River islands and dredged material management. Pearson and Altman (2005) identified the dredged material islands along the Columbia River as critical to the persistence and recovery of this subspecies. To deepen and maintain the Columbia River shipping channel, the Army Corps of Engineers removes sediment from the bottom of the shipping channel and deposits it on islands in the river, on the shore, or at in-water locations. Larks breeding on these islands have higher reproductive success than at other breeding sites, perhaps due to lower numbers of predators. The periodic deposition of new material helps maintain the presence of bare ground and sparsely vegetated areas, but habitat is lost through succession to more dense vegetation. It is also temporarily lost when dredged material is deposited on top of suitable habitat, and depending on the timing, larks can be disturbed and nests destroyed if material is deposited on occupied sites during the breeding season. Consequently, areas are intermittently used for nesting by larks as new habitat is either created or destroyed.

A biological assessment for the maintenance dredging program was recently completed for the Section 7 consultation with the USFWS required by the Endangered Species Act (ACOE 2014). The assessment describes the potential adverse and beneficial effects to Streaked Horned Lark and its critical habitat of operations to meet current and projected dredged material placement needs in the lower Columbia River during 2014– 2018. Dredging operations over the next five years are expected to have some short-term negative effects, including disturbance, but the proposed action effectively doubles the acreage of suitable lark nesting habitat across the network of dredge placement sites. During 2014–2018, suitable habitat ranges from a low of 241 acres in 2015 to a high of 643 acres (35% of network acreages) by 2018 (104% increase over 2014 acreage), the final year of the current plan.

Human disturbance. Human activities may result directly and indirectly in significant mortality of eggs and chicks by contributing to nest abandonment and predation when adults are kept away from the nest. Larks are sometimes affected by Army training activities when they coincide with lark nesting (Pearson and Hopey 2004, Wolf and Anderson 2014). Mowing and special events during breeding season disturbs nesting larks at airports and can cause abandonment or direct mortality; at the same time, mowing benefits larks by keeping the vegetation short (Pearson and Hopey 2004, Wolf and Anderson 2014). Airports with nesting populations have modified mowing schedules and adjusted blade height to minimize impacts during peak nesting times, but fledglings are vulnerable between these peaks. Despite these efforts, nests in mowed vegetation at JBLM had 57% lower probability of fledging young in 2013, than those in unmowed vegetation (Wolf and Anderson 2014). CNLM has been working closely with Gray Army Airfield and McChord Air Field (AF) monitoring nests and providing weekly maps of areas to avoid. Mowing incidences were down and lark productivity improved in 2014 and 2015, likely as a result of this communication and coordination (Wolf et al. 2015).

Horned Larks do not seem to be overly disturbed by the routine comings and goings of the large military cargo aircraft at McChord AF (S. Pearson, pers. comm.), but past special training and civilian events likely affected larks (Pearson and Altman 2005, D. Stinson, pers. obs.). In recent years, Gray Army Airfield expanded operations to accommodate Apache helicopters, which produce a hot downdraft that may make some of the habitat unusable for lark nesting (Pearson and Altman 2005).

Rogers (2000) noted frequent disturbance of nesting larks by recreational activities on south Puget prairies. Since that time, JBLM has restricted some recreation uses on important prairie sites, including 13th Division Prairie (Pearson 2003, JBLM Public Works, Environmental Division 2013). Recreational disturbance occurred on 15% of lark survey days in 2013 and 2014 (Wolf and Anderson 2014, Wolf et al. 2015). Disturbances included people walking dogs (daily during August), and motorcycles. Recreational disturbances at coastal sites include foot traffic, dogs off leash, vehicles, bicycling, and horseback riding, all of which occur despite seasonal postings intended to restrict human presence (Richardson 1995; C. Sundstrom, pers. comm.).

Predation. Predation caused 69% of nest failures at sites in south Puget Sound and 46% of failures at one river island and two coastal sites in 2004 (Pearson and Hopey 2005), although Anderson (2010) observed no difference in nest predation rates between Streaked Horned Larks and other grassland birds (larks = 33% vs. guild = 32%). Birds on prairie remnants within a matrix of suburbs may be subject to high rates of predation. Rogers (2000) observed cats and crows preying on larks or other bird species at airport nesting sites, and crow populations are high in urban habitats due to human associated food sources.

Small population size, potential inbreeding, and skewed sex ratio. Anderson (2010) reported that Streaked Horned Larks at 13th Division Prairie on JBLM had significantly lower reproductive success when compared to either Savannah Sparrows or the entire guild of ground nesting birds. Streaked Horned Lark's low egg hatching rate (44%) suggested that inbreeding depression was playing a role in the decline of larks at 13th Division Prairie. Briskie and Mackintosh (2004) reported low hatching rates in 11 species of New Zealand birds that had gone through population bottlenecks of <150 individuals. The south Puget lowland population of larks may be <250 birds, and of these, perhaps 10 pairs nest on 13th Division (Table 1). The recent data indicating a male-skewed adult sex ratio at Puget lowland sites, and territorial males going unpaired adds another concern that will affect effective population size (N_e). Larks show high site fidelity to nesting areas, which would also contribute to negative effects of small population size.

Pesticides. Although thorough studies on the effects of pesticides on Horned Larks have not been conducted to date, anecdotal evidence suggests that further exploration of this issue may be warranted. During 2014, a sample combined from 4 dead Streaked Horned Larks found at Corvallis Airport in Oregon tested positive for exposure to zinc phosphide, indicating at least one of the birds probably ingested treated grain. Grain treated with zinc phosphide is used to control rodent populations at some airports to reduce collision hazard posed by raptors, and it is used by farmers when Gray-tailed Vole (*Microtus canicaudus*) populations are extraordinarily high. The test suggested at least one lark had ingested the treated grain. Reducing or eliminating the hazard to larks may entail using a seed drill to insert the grain underground, or using a larger pelletized form too large for larks to ingest (N. Atwell, pers. comm.). In Washington, Gray-tailed Voles are only found in Clark County and the use of zinc phosphide has not been reported to be an issue at occupied sites.

Seeds treated with neonicotinoid pesticides are another potential factor that could affect Streaked Horned Larks. Seeds of canola, corn, wheat, and turf grasses are often treated with neonicotinoid insecticides and or fungicides, and some neonicotinoids are sufficiently toxic to small birds that ingestion of a few treated seeds can cause death or inhibit normal reproduction (Goulson 2013, Mineau and Palmer 2013, Gibbons

et al. 2015). Some recent studies suggest the widespread use of neonicotinoids was correlated with declines in grassland birds (Mineau and Palmer 2013, Mineau and Whiteside 2013, Hallmann et al. 2014).

Collisions with aircraft. Dead larks have been found along the runways at McChord AF and Gray Army AF (Pearson and Hopey 2005, Wolf and Anderson 2014). It is not known how significant a source of mortality aircraft collisions are for Streaked Horned Larks in Washington, but 5 of 14 known nesting populations are associated with airports, and they represent sites with the largest nesting populations. Nationwide data indicate that Horned Larks are particularly susceptible to being struck by aircraft, due to their affinity for the open, short-grass habitat surrounding runways. Between 1995 and 2013, Horned Larks accounted for 2,642 of reported bird strikes on U.S. Air Force aircraft, which was the highest number recorded for any species (BASH 2014). For civilian aircraft, Horned Larks accounted for 2,669 bird strikes reported to the Federal Aviation Administration (FAA) from 1990-2013 (Dolbeer et al. 2014), the sixth highest total for species reported. Only one of the strikes on civilian aircraft caused damage and many strikes not causing damage probably went unreported, particularly early in the reporting period (Cleary et al. 2003). Analysis by Camfield et al. (2011) suggested that improving adult survival will be necessary for the Washington population to be sustainable. An assessment may be needed to determine whether aircraft collisions are an important source of mortality of Streaked Horned Larks, particularly on JBLM, and if the number can be reduced by managing vegetation near runways to be less suitable, while maintaining mowed areas to attract larks to areas further from runways.

Disease. In August-September 2015, five larks, both adults and young of the year with pox-like lesions were observed on McChord AF, and veterinarians confirmed from photos and videos that it appeared to be avian pox (H. Anderson, K. Mansfield, pers. comm.). Avian pox is a viral disease spread naturally by mosquitoes; it is highly contagious and spread by bird-bird contact or if a food source such as a grasshopper is picked up and dropped by an infected bird and subsequently eaten by a healthy bird (Hansen 1999). Birds can recover from pox as long as the lesions do not inhibit their ability to obtain food, water, shelter, or avoid predators. Lesions can take several weeks to heal and fall off.

MANAGEMENT ACTIVITIES

Population monitoring. Monitoring populations of larks is a priority for WDFW and partners. Standardized site-occupancy and population monitoring protocols have been developed (Pearson et al. 2015), and occupied sites are surveyed regularly to monitor population trends.

Minimizing impacts on larks at airports and training areas. CNLM is working closely with JBLM to minimize disturbance and mortalities of larks on airfields and training areas. During 2013-2015, CNLM used the information collected during transect surveys and nest monitoring to guide minimization of direct impact to larks. They provided weekly or bi-weekly maps of each occupied area to airfield and training area managers showing the locations of nest sites, appropriate buffers, and vulnerability periods (Wolf and Anderson 2014, Wolf et al. 2015). This effort may be reflected in the improved reproductive success in 2014 and 2015.

JBLM Endangered Species Management Plan. JBLM recently completed an Endangered Species Management Plan for the Streaked Horned Lark (JBLM Public Works, Environmental Division 2013). Plan objectives include protecting and contributing to population recovery on and off JBLM, while incurring no net loss in meeting the military missions.

Research. Recent and ongoing studies (see Literature Cited) in Washington and Oregon have investigated nesting locations, nesting success, survival, predation, habitat use and management, survey methods, and genetics.

Nest exclosure trials. During 2009-2010, WDFW and Randy Moore at Oregon State University tested the efficacy of wire nest exclosures to reduce predation and improve fledging success. Lower rates of predation were offset by higher rates of nest abandonment caused by American Kestrels perching on the exclosure (Pearson et al. 2012). Exclosures may still be a useful tool to increase reproductive success at sites where perching by avian predators is not a problem, or if the exclosures are modified to limit perching by kestrels (Pearson et al. 2012).

Genetic augmentation on Joint Base Lewis-McChord. A project was initiated in 2011 to address the potential issue of inbreeding and low hatching rates, by moving eggs from the Willamette Valley in Oregon to nests on 13th Division. In 2011, 4 clutches of 3 eggs were moved; 11 of the 12 translocated eggs hatched, and 3 of 4, 3-egg clutches produced at least 5 (possibly 7) fledglings. One translocated Oregon nestling returned to 13th Division Prairie as an adult male in 2012, and then again in 2013, 2014, and 2015. In 2013, he and his mate produced two clutches and at least one of the fledglings was observed foraging independently (Wolf et al. 2013); in 2014, he and his mate produced 3 clutches, and at least 3 fledglings; one was observed several times on 13th Division in 2015 (Wolf et al. 2015, A. Wolf, pers. comm.). In 2015, 3 nesting attempts with a new mate failed, but a 4th produced two nestlings that were resighted later in the season (A. Wolf, pers. comm.).

In addition, two 3-egg clutches and one 2-egg clutch were translocated to 13th Division nests in 2013 (Wolf et al. 2013). Two of the nests with replaced clutches were successful to the fledgling stage, and one fledgling was observed foraging independently. Two of the clutches removed from 13th Division lark nests were cross-fostered by Savannah Sparrows, and one clutch successfully produced a lark fledgling. Continued monitoring and genetic data will be used to evaluate success of this effort.

Habitat restoration and management. Scotch broom control and prairie restoration has been an ongoing activity on south Puget prairies since the 1990s (Dunn and Ewing 1997). Programs on JBLM have worked to rehabilitate the impacts of army training, to maintain grassland on training areas, and more recently to restore habitat for larks and other grassland species. This work has included mowing and prescribed burns, control of invasive species, removal of conifers, and raising and planting of native vegetation (Wolf and Anderson 2014, Wolf et al. 2015).

CNLM and the U.S. Army Corps of Engineers conducted management experiments during 2009-2011 on dredged material islands in the lower Columbia River to test methods of maintaining sparse vegetation for Streaked Horned Lark nesting habitat (Anderson 2011).

Willapa National Wildlife Refuge began removing introduced beachgrass from a habitat restoration area in 2001 that now totals 400 ac. It was originally intended to provide nesting habitat for Snowy Plovers, but it also provides nesting habitat for larks (Pearson et al. 2014).

WDFW and volunteers treated five 1-ac plots at Leadbetter State Park to remove beachgrass and create nesting habitat for plovers during 2007-2009, but to-date these plots have not been used for nesting by either species. Moore (2011) recently completed a guide for managing agricultural lands used by larks in the Willamette Valley, particularly grass seed fields.

Conspecific attraction studies. The feasibility and methods of attracting Streaked Horned Larks to additional nesting areas by using recordings of their calls and visual decoys (Fig. 5) is the subject of ongoing research (Pearson et al. 2005, Styring 2011, Anderson et al. 2013). These efforts have not yet succeeded in establishing a new nesting population; larks have high site fidelity so conspecific attraction alone may not be sufficient to attract larks to new sites. Future experiments may combine conspecific cue attraction at the site and deterrents to make occupied sites with inherent hazards (i.e., airports) less attractive (Anderson et al. 2013).

Figure 5. Coyote sniffs at a decoy used for attracting Streaked Horned Larks at the St. John's landfill site, near Portland, Oregon.

Working groups and conservation planning. Pearson and Altman (2005) provided a preliminary range-wide conservation strategy for Streaked Horned Larks. In 2008, a range-wide interagency technical working group developed a list ('action plan') of short term (~3 years) conservation actions. The group has met annually to revise and prioritize the list of actions and identify funding needs. The USFWS recently initiated discussions for the development of a Streaked Horned Lark recovery plan (C. Brown, per. comm.).

In March 2011, The Nature Conservancy, with support from USFWS and a Department of Defense Legacy grant, hosted the *Streaked Horned Lark and Pacific Northwest Airports: A Collaborative Workshop* that brought together interested parties to explore opportunities for conserving the Streaked Horned Lark without impacting aircraft safety and operations. In 2014, a lark and airports working group began meeting to facilitate management of south Puget lowland airports and federal lands in ways that minimize negative impacts to Streaked Horned Larks, encourage recovery, and maintain the functionality of the airports or federal lands.

In 2015, Anderson and Pearson (2015) developed a guide to help identify landscape, site, and patch habitat features used by breeding Streaked Horned Larks, to help landowners and agencies determine when additional investigation, such as appropriate surveys should be done.

Partners and cooperators. Partner agencies working on lark conservation include U.S. Fish and Wildlife Service, Center for Natural Lands Management, Department of Defense, Joint Base Lewis-McChord, Oregon State University, Oregon Department of Fish and Wildlife, American Bird Conservancy, Willapa National Wildlife Refuge, U. S. Army Corps of Engineers, Port of Portland, Metro, The Evergreen State College, and Washington State Parks.

CONCLUSION AND RECOMMENDATION

Formerly a more widespread regional endemic, the Streaked Horned Lark in Washington is restricted to a few airports, U.S. Army training areas, sandy coastal sites, and dredged material islands in the lower Columbia. Surveys of known sites in 2015 produced an estimate of 147 breeding pairs. Analysis of data from standardized surveys in recent years suggest that populations at most Washington sites are relatively stable, but Puget lowland sites are exhibiting a troubling male-biased sex ratio, perhaps indicating higher mortality rates for females. Numerous factors affect larks including predation of nests, human-related

disturbance and mortalities at airports, army training areas, and nesting beaches, and likely poor genetic health related to small populations and high site fidelity.

Although Streaked Horned Lark numbers are very small, prospects for the subspecies have recently improved due to: 1) efforts by the Army Corps of Engineers to schedule dredged material deposition that will result in increasing the acres of suitable habitat at dredged material deposition sites along the lower Columbia; 2) intensive monitoring of nesting activity on JBLM by CNLM and concurrent efforts by the Army and Air Force to avoid/minimize impacts of mowing and training activities; and 3) formation of the Washington airports working group focused on minimizing impacts to larks of airport operations. Without these efforts, the Streaked Horned Lark would likely decline to extinction in Washington. Given the small number Streaked Horned Larks in Washington, and the many factors that continue to affect them, it is recommended that the species remain state-listed as endangered.

LITERATURE CITED

ACOE (U. S. Army Corps of Engineers). 2014. Biological assessment for the continued operations and maintenance dredging program for the Columbia River Federal Navigation Channel. Portland Distruict, U. S. Army Corps of Engineers.212 pp.

Altman, B. 1999. Status and conservation of state sensitive grassland bird species in the Willamette Valley. Unpubl. report to: Oregon Dept. of Fish and Wildlife, Corvallis, OR. 60 pp.

Altman, B. 2003. Horned Lark. Pp. 425-428, in: D.B. Marshall, M.G. Hunter, and A. L. Contreras (eds.) Birds of Oregon: a general reference. Oregon State University Press, Corvallis, OR 768 pp.

Altman, B. 2011. Historical and current distribution and populations of bird species in prairie-oak habitats in the Pacific Northwest. Northwest Science 85(2):194-222.

Anderson, J. K. 2010. Comparing endangered Streaked Horned Lark (*Eremophila alpestris strigata*) fecundity to other grassland birds. M.S. Thesis, Evergreen State College, Olympia, Washington.

Anderson, H. 2011. Columbia River Streaked Horned Lark Restoration Trial: final report to the U.S. Fish and Wildlife Service. Cooperative Agreement #13410-9-G007. Center for Natural Lands Management, Olympia, Washington. 25 pp.

Anderson, H. E. and S. F. Peason. 2015. Streaked Horned Lark Habitat Characteristics. Center for Natural Lands Management and Washington Department of Fish and Wildlife, Olympia. 23 pp.

Anderson, H., and G. Slater. 2015. Columbia River Streaked Horned Lark Surveys and Monitoring: Final Report. Center for Natural Lands Management. 80 pp.

Anderson, H. E., A. Wolf, and R. Adam Martin. 2013. Streaked Horned Lark conspecific attraction feasibility study. Final report. Center for Natural Lands Management. 28 pp.

BASH (Bird/wildlife Aircraft Strike Hazard Team). 2014. Top 50 USAF Wildlife Strikes by Count. Aviation Safety Division, U.S. Air Force. (http://www.afsec.af.mil/organizations/bash/statistics.asp)

Beason, R.C. 1995. Horned Lark (*Eremophila alpestris*). Birds of North America No. 195. (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C., 24 pp.

Beauchesne, S. M., and J. M. Cooper 2003. COSEWIC assessment and update status report on the Horned Lark *strigata* subspecies *Eremophila alpestris strigata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 23 pp. (www.sararegistry.gc.ca/status/status_e.cfm)

Bent, A.C. 1963. Life histories of North American Flycatchers, Larks, Swallows, and their Allies. (Dover edition of Bulletin 179 of the U. S. National Museum, Smithsonian Institution, Washington, D.C., 1942) Dover Public., New York, NY

Bowles, J. H. 1898. Notes on the Streaked Horned Lark. Osprey 3: 53-54.

Bowles, J. H. 1900. Nesting of the Streaked Horned Lark. Condor 2: 30-31.

Briskie, J. V. and M. Mackintosh. 2004. Hatching failure increases with severity of population bottlenecks in birds. Proceedings of the National Academy of Sciences of the United States of America 101:558-561.

Camfield, A. F., S. F. Pearson, and K. Martin. 2010. Life history variation between high and low elevation subspecies of horned larks *Eremophila* spp. Journal of Avian Biology 41:273-281.

Camfield, A. F., S. F. Pearson, and K. Martin. 2011. A demographic model to evaluate population declines in the endangered Streaked Horned Lark. Avian Conservation and Ecology 6(2):4. http://dx.doi.org/10.5751/ACE-00467-060204

Campbell, R.W., N. K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G. K. Kaiser, M.C.E. McNall, and G.E. J. Smith. 1997. The Birds of British Columbia. Vol. 3, Passerines: flycatchers through vireos. Univ. British Columbia Press, Vancouver.

Chappell, C. B., M. S. Mohn Gee, B. Stephens, R. Crawford, and S. Farone. 2001. Distribution and decline of native grassland and oak woodlands in the Puget Lowland and Willamette Valley Ecoregions, Washington. Pp. 124–139 *in* S. H. Reichard, P.W. Dunwiddie, J.G. Gamon, A. R. Kruckberg, and D. L. Salstrom (eds.). Conservation of Washington's Rare Plants and Ecosystems. Washington Native Plant Society, Seattle.

Cleary, E. C., R. A. Dolbeer, and S. E. Wright. 2003. Wildlife Strikes to Civil Aircraft in the United States 1990-2002. Fedral Aviation Administration, National Wildlife Strike Database, Serial Report No. 9. Report of the Assoicate Administrator of Airports, Office of Airport Safety and Standards,

Airport Safety and Certification, Washington, DC. 51 pp.
Creighton, P. D., and D. K. Porter. 1974. Nest predation and interference by Western Meadowlarks. Auk 91: 177-178.
Dolbeer, R. A., S. E. Wright, J. R. Weller, M. J. Begier. 2014. Wildlife strikes to civil aircraft in the United States, 1990-2013. U.S. Department of Transportation, Federal Aviation Administration, Office of Airport Safety and Standards, Serial Report No. 20. Washington, D.C., USA. 97 pages.
Donald, P. F. 2007. Adult sex ratios in wild bird populations. Ibis 149:671-692.
Drovetski, S.V., S. F. Pearson, and S. Rohwer. 2005. Implications of mitochondrial DNA diversity on the conservation status of the Streaked Horned Lark *Eremophila alpestris strigata*. Conservation Genetics 6:875-883.
Dunn, P. and K. Ewing (eds.) 1997. Ecology and Conservation of the South Puget Sound Prairie Landscape. The Nature Conservancy of Washington, Seattle, WA. 289 pp.
Faber, S., S. Rundquist, T. Male. 2012. Plowed under: how crop subsidies contribute to massive habitat losses. Environmental Working Group and Defenders of Wildlife. 12 pp.
Foster, J. R., and S.E. Shaff. 2003. Forest colonization of Puget lowland grasslands at Fort Lewis, Washington. Northwest Science 77:283-296.
Gibbons, D., C. Morrissey, and P. Mineau. 2015. A review of the direct and indirect effects of neonicotinoids and fibronil on vertebrate wildlife. Environmental Science and Pollution Research 22:103-118.
Goulson, D. 2013. An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology 5):977-987.
Hallmann, C. A., R. P.B. Foppen, C.A.M.van Turnhout, H. deKroon, and E. Jongejans. 2014. Declines in insectivorous birds are associated with high neonicotinoid concentrations. Nature 511:341-343.
Hansen WR (1999) Avian pox. In: Friend M, Franson JC, editors. Field Manual of Wildlife Diseases General Field Procedures and Diseases of Birds. U.S.A.: Biological Resources Division Information and Technology Report 1999–2001, pp. 163–170.
JBLM Public Works, Environmental Division. 2013. Endangered Species Management Plan for the Proposed Threatened Species Streaked Horned Lark (*Eremophila alpestris strigata*) Joint Base Lewis-McChord, Washington. 35 pp.
Keren, I. N., and S. F. Pearson. (in prep.) Streaked Horned Lark abundance and trends for the Puget lowlands and the lower Columbia River-Washington coast, 2010-2014: research progress report. Wildlife Science Division, Washington Department of Fish and Wildlife, Olympia.
Koenig, W. D. 1982. Ecological and social-factors affecting hatchability of eggs. Auk 99:526-536.
Linders, M. 2011. 2010 Streaked Horned Lark Survey: Summary Report. Washington Department of Fish and Wildlife, Wildlife Program, Region 6. 10pp.
Linders, M. 2012. Streaked Horned Lark Surveys in Washington: 2011 Summary Report. Washington Department of Fish and Wildlife, Wildlife Program, Region 6. 20 March 2012. 12pp.
Mason, N. A., P. O. Title, C. Cicero, K. J. Burns, and C. K. Bowie. 2014. Genetic variation among western populations of the Horned Lark (*Eremophila alpestris*) indicates recent colonization of the Channel Islands off southern California, mainland-bound dispersal, and post-glacial range shifts. Auk 131:162-174.
Mineau, P, and C. Palmer. 2013. The impact of the Nation's most widely used insecticides on birds. American Bird Conservancy, USA. 83 pp+appendices.
Mineau, P., and M. Whiteside. Pesticides acute toxicity is a better correlate of U. S. grassland bird declines than agricultural intensification. PLoS ONE 8(2): e57457.
Moore, R. 2007. Winter diet of Streaked horned Larks in Oregon.
Moore, R. 2011. Managing agricultural land to benefit Streaked Horned Lark a guide for landowners and land managers. Oregon State University and Center for Natural Lands Management. 23 pp.
Moore, R. 2013. Survival of Streaked Horned lark nests and fledglings (*Eremophila alpestris strigata*) in Oregon's agricultural landscape, southern Willamette Valley, 2012. Oregon State University, Corvallis, Oregon. 46 pp.
Pearson, S.F. 2003. Breeding phenology, nesting success, habitat selection, and census methods for the streaked horned lark in the Puget lowlands of Washington. Natural Areas Program Report 2003-2. Washington Department of Natural Resources. Olympia, WA. 38 pp.
Pearson, S. F., and B. Altman. 2005. Rangewide Streaked Horned Lark (*Eremophila alpestris strigata*) Assessment and Preliminary Conservation Strategy. Washington Department of Fish and Wildlife, Olympia, Washington. 25 pp.
Pearson, S. and D. Stinson. 2010. Evaluation of the need for genetic enhancement of Puget lowland Streaked Horned Lark Populations. Unpublished white paper, Washington Department of Fish and Wildlife, Olympia, Washington. 3 pp.

Pearson, S. F., H. Anderson, and M. Hopey. 2005. Streaked Horned Lark monitoring, habitat manipulations and a conspecific attraction experiment. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia, Washington. 38 pp.

Pearson, S. F., A. F. Camfield, and K. Martin. 2008. Streaked Horned Lark (*Eremophila alpestris strigata*) fecundity, survival, population growth and site fidelity: research progress report. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia, Washington. 21 pp.

Pearson, S.F., and M. Hopey. 2004. Streaked horned lark inventory, nesting success and habitat selection in the Puget lowlands of Washington. Natural Areas Program Report 2004-1. Washington Department of Natural Resources. Olympia, WA. 36 pp.

Pearson, S.F. and M. Hopey. 2005. Streaked horned lark nest success, habitat selection, and habitat enhancement experiments for Puget lowlands, coastal Washington and Columbia River islands. Natural Areas Program Report 2005-1. Washington Dept. of Natural Resources. Olympia, WA.

Pearson, S.F. and M. Hopey. 2008. Identifying Streaked Horned Lark (*Eremophila alpestris strigata*) nest predators. Washington Department of Fish and Wildlife, Wildlife Program. Wildlife Science Division. Olympia WA.10 pp.

Pearson, S. F., and S. M. Knapp. 2015. Considering spatial scale and reproductive consequences of habitat selection when managing grasslands for a threatened species (Draft). manuscript.Washington Department of Fish and Wildlife, Olympia. 32 pp.

Pearson, S. F., M. Linders, I. Keren, H. Anderson, R. Moore, G. Slater, and A. Kreager. 2015. Streaked Horned Lark occupancy and abundance survey protocols and strategies DRAFT. Washington Dept. Fish and Wildlife, Center Natural Land Management, Oregon State University, and Oregon Department of Fish and Wildlife. 15 pp + appendices.

Pearson, S. F., R. Moore, and S. M. Knapp. 2012. Nest exclosures do not improve Streaked Horned Lark nest success. Journal of Field Ornithology 83(3):315-322.

Pearson, S.F., C. Sundstrom, B. Hoenes, and W. Ritchie. 2014. Washington State Snowy Plover Population Monitoring, Research, and Management: 2013 Nesting Season Research Progress Report. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia.

Peterjohn, B.G., and J.R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey, 1966-1996. Studies in Avian Biology 19: 27-44.

Richardson, S. A. 1995. Washington State Recovery Plan for the Snowy Plover. Washington Dept. of Fish and Wildlife, Olympia, WA. 87 pp.

Ricklefs, R. E. and G. Bloom. 1977. Components of avian breeding productivity. Auk 94:86-96.

Robinson, W.D., and R. P. Moore. 2004. Range, abundance, and habitat associations of streaked horned lark (*Eremophila alpestris strigata*) during winter. Department of Fisheries and Wildlife, and Oak Creek Lab of Biology, Oregon State University, Corvallis. 5 pp.

Rogers, R. E., Jr. 2000. The Status and Habitat Selection of Streaked Horned Larks, Western Bluebird, Oregon Vesper Sparrow, and Western Meadowlark in Western Washington. M.S. Thesis, Evergreen State College, Olympia, WA. 185 pp.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2014. The North American Breeding Bird Survey, Results and Analysis 1966 - 2013. Version 01.30.2015 USGS Patuxent Wildlife Research Center, Laurel, MD

Schapaugh, A.W. 2009. The dynamics and viability of the endangered streaked horned lark (Eremophila alpestris strigata). Masters thesis. Evergreen State College. Olympia WA.

Seabloom, E.W., and A.M. Wiedemann. 1994. Distribution and effects of *Ammophila breviligulata* Fern. (American beachgrass) on the foredunes of the Washington coast. Journal of Coastal Research 10(1):178-188.

Stinson, D. W. 2005. Washington State Status Report for the Mazama Pocket Gopher, Streaked Horned Lark, and Taylor's Checkerspot. Washington Department of Fish and Wildlife, Olympia. 129+ xii pp

Styring, A. 2011. Streaked Horned Lark attractions study. Final report submitted to Center fro Natural lands Management. The Evergreen State College, Olympia, Washington.

USDA FSA. 2015. FSA Crop Acreage Data Reported to FSA, as of 1 Nov 2015. Available at: http://www.fsa.usda.gov/FSA/webapp?area=newsroom&subject=landing&topic=foi-er-fri-cad

USFWS. 2013. Determination of Endangered Status for the Taylor's Checkerspot Butterfly and Threatened Status for the Streaked Horned Lark: Final Rule. Federal Register / Vol. 78, No. 192 (Thursday, October 3, 2013): 61452-61503.

USFWS. 2013. Designation of Critical Habitat for Taylor's Checkerspot Butterfly and Streaked Horned Lark: Final Rule. Federal Register / Vol. 78, No. 192 (Thursday, October 3, 2013): 61506-61589.

Verner, J., D. Breese, and K. L. Purcell. 2000. Return rates of banded granivores in relation to band color and number of bands worn. Journal of Field Ornithology 71(1):117-125.

Wiedemann, A.M. 1987. The ecology of European beachgrass (*Ammophila arenaria* (L.) Link) a review of the literature. Technical Report # 87-1-01. Oregon Department of Fish and Wildlife, Nongame Wildlife Program. 18 pp.

Wolf, A. 2012. South Puget Sound Streaked Horned Lark (*Eremophila alpestris strigata*) genetic rescue study: report for year 2. Center for Natural Lands Management, Olympia, Washington. 18 pp.

Wolf, A., and H. Anderson. 2014. Streaked Horned Lark Habitat Management and Population Monitoring Report: Spring/Summer 2013. Report submitted to Joint Base Lewis-McChord, Fish and Wildlife Program. Center for Natural lands Management, Olympia, Washington. 76 pp.

Wolf, A. H. Anderson, and A. Martin. 2013. South Puget Sound Streaked Horned Lark (*Eremophila alpestris strigata*) genetic rescue project. Draft Report for year 3. Center for Natural Lands Management, Olympia, Washington. 24 pp.

Wolf, A., H. Anderson, and G. Slater. 2015. JBLM Larks 2014 Nest Monitoring Final Report W911S8-13-2-0006. Report submitted to Joint Base Lewis-McChord, Fish and Wildlife Program. Center for Natural lands Management, Olympia, Washington. 69 pp.

PERSONAL COMMUNICATION

Hannah Anderson
Regional Rare Species Program Manager
Center for Natural Lands Management
Olympia, Washington

Nick Atwell, wildlife biologist
Port of Portland
Portland, Oregon

Cat Brown, wildlife biologist
U. S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
Portland, Oregon

Kristin Mansfield, DVM, MPVM
State Wildlife Veterinarian
Washington Department of Fish and Wildlife
Spokane Valley, Washington

Randall Moore
Dept. of Fisheries and Wildlife
Oregon State University
Corvallis, Oregon

Scott Pearson, Research Scientist
Washington Department of Fish and Wildlife
Olympia, Washington

Jeff Skriletz, District Wildlife Biologist
Washington Department of Fish and Wildlife
Shelton, Washington

Cyndie Sundstrom, Wildlife Biologist
Washington Department of Fish and Wildlife
Montesano, Washington

Michelle Tirhi,
District Wildlife Biologist
Washington Department of Fish and Wildlife
Lakewood, Washington

Adrian Wolf, Conservation Biologist
Center for Natural Lands Management
Olympia, WA 98501

WASHINGTON STATE STATUS REPORTS, PERIODIC STATUS REVIEWS, RECOVERY PLANS, AND CONSERVATION PLANS

Status Reports

2015 Tufted Puffin
2007 Bald Eagle
2005 Mazama Pocket Gopher, Streaked Horned Lark, and Taylor's Checkerspot
2005 Aleutian Canada Goose
2004 Killer Whale
2002 Peregrine Falcon
2000 Common Loon
1999 Northern Leopard Frog
1999 Olympic Mudminnow
1999 Mardon Skipper
1999 Lynx Update
1998 Fisher
1998 Margined Sculpin
1998 Pygmy Whitefish
1998 Sharp-tailed Grouse
1998 Sage-grouse
1997 Aleutian Canada Goose
1997 Gray Whale
1997 Olive Ridley Sea Turtle
1997 Oregon Spotted Frog
1993 Larch Mountain Salamander
1993 Lynx
1993 Marbled Murrelet
1993 Oregon Silverspot Butterfly
1993 Pygmy Rabbit
1993 Steller Sea Lion
1993 Western Gray Squirrel
1993 Western Pond Turtle

Periodic Status Reviews

2015 Steller Sea Lion
2015 Brown Pelican

Recovery Plans

2012 Columbian Sharp-tailed Grouse
2011 Gray Wolf
2011 Pygmy Rabbit: Addendum
2007 Western Gray Squirrel
2006 Fisher
2004 Sea Otter
2004 Greater Sage-Grouse
2003 Pygmy Rabbit: Addendum
2002 Sandhill Crane
2001 Pygmy Rabbit: Addendum
2001 Lynx
1999 Western Pond Turtle
1996 Ferruginous Hawk
1995 Pygmy Rabbit
1995 Upland Sandpiper
1995 Snowy Plover

Conservation Plans

2013 Bats

Status reports and plans are available on the WDFW website at:
http://wdfw.wa.gov/publications/search.php