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Range-wide Streaked Horned Lark (*Eremophila alpestris strigata*) Assessment and Preliminary Conservation Strategy

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FISH AND WILDLIFE
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Cover photograph of banded male Streaked Horned Lark at Damon Point by David Maloney and cover photograph of Midway Beach by Mark Hopey. Title page illustration of female Horned Lark by Darrell Pruett.

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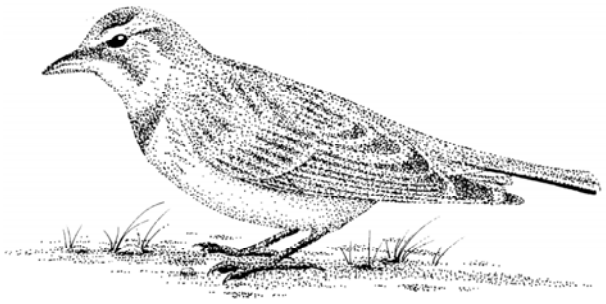

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INTRODUCTION

The Streaked Horned Lark (*Eremophila alpestris strigata*) is a rare subspecies of the Horned Lark that breeds and winters in Oregon and Washington. Recent Streaked Horned Lark research has focused on documenting changes in the subspecies breeding range (Rogers 2000), inventorying and locating current breeding (Altman 1999, Rogers 1999, MacLaren and Cummins 2000, Pearson and Hopey 2004, 2005) and wintering (Robinson and Moore unpubl., Pearson et al. 2005) populations in Oregon and Washington, identifying breeding and foraging habitat (Altman 1999, Rogers 2000, Pearson 2003, Pearson and Hopey 2004, 2005), and experimenting with methods to improve Lark habitat (Pearson and Hopey 2005). In addition, British Columbia recently completed a status report on the Lark (Beauchesne and Cooper 2003) and another has been drafted by Washington Department of Fish and Wildlife (Stinson 2005).

The goal of this report is not to duplicate the efforts of others but to provide a range-wide review of the current wintering and breeding range, list of habitat requirements and estimates of wintering and breeding population numbers. In addition, we identify population threats, recommendations for addressing these threats and we present a preliminary conservation strategy. Because others have attempted to reconstruct this subspecies historic wintering and breeding ranges and to describe its life history (Rogers 2000, Beauchesne and Cooper 2003, Stinson 2005), we spend little effort on these topics. The management recommendations and conservation strategy presented here are initial thoughts and need critical review, revision and development. If the subspecies is listed as Endangered in Washington as recommended, a recovery strategy will be developed for the State. Canada is currently writing a recovery plan. In addition to these efforts, we strongly recommend developing a range-wide conservation plan (including a metapopulation model) and establishing a range-wide (Oregon, Washington, British Columbia) working group to develop recovery strategies and facilitate recovery actions.

Several lines of evidence suggest that the Streaked Horned Lark is vulnerable to extinction and should be a conservation priority. The Streaked Horned Lark is a recognized subspecies of the Horned Lark (AOU 1957) and genetic data indicate that the Streaked Horned Lark is unique, isolated, and has little genetic diversity (Drovetski et al. in press). The breeding range of the Lark has contracted over time; it no longer breeds in the northern Puget trough (San Juan Islands and other Puget Sound sites north of Tacoma), southern British Columbia, along the Washington Coast north of Grays Harbor, and in the Rogue River Valley (Rogers 2000, Beauchesne and Cooper 2003, Stinson 2005). Although no systematic range-wide attempt has been made to estimate the total population of this subspecies, results from winter and breeding surveys suggest that the entire population of this subspecies is likely less than 1,000 birds (see discussion below). Remaining breeding populations and their habitats face imminent threats posed by land development, incompatible land uses, human activities, predation, and non-native species. Wintering populations are potentially threatened by stochastic events and by a lack of suitable habitat in the Willamette Valley. Very few of the sites used by the Lark for breeding or wintering are protected and no sites are managed primarily for Larks.

Conservation efforts to date, have focused on identifying and monitoring Lark populations, identifying habitat features important to successful breeding, testing methods for creating appropriate breeding habitat, restoring degraded habitats, and restricting some human uses on breeding sites. For example, Ft. Lewis has restricted recreational activities on a breeding site and Olympia Airport has modified mowing dates and times to minimize impacts to Lark nests.

Because the subspecies migrates between Oregon and Washington and because the remaining breeding populations are found in the Puget lowlands, Columbia River/coastal Washington, and Willamette Valley, we recommend that local and regional recovery strategies consider range-wide population dynamics and threats so that recovery actions can be coordinated and focused on the activities that are most likely to result in increased Lark populations.

TAXONOMY

The Horned Lark (*Eremophila alpestris*) is a member of the family Alaudidae (larks) in the order Passeriformes. Of the 76 species of lark, it is the only lark native to North America. The Horned Lark has 21 described subspecies in North America based on differences in size and plumage color (American Ornithologists' Union 1957). There is a high degree of overlap in plumage and color between many subspecies (Behle 1942). The breeding range of the Streaked Horned Lark appears to be allopatric with other subspecies (Behle 1942). The size and color of the Streaked Horned Lark approaches that of *E. a. insularis* and *E. a. sierrae* to the south but is smaller and more brightly colored (brighter yellows and reddish browns) than *E. a. alpina* which breeds above treeline in the Olympic and Cascade Mountains.

Drovetski et al. (in press), collected tissue samples from 32 Streaked Horned Larks in the Puget lowlands, Washington coast and the Columbia River and the haplotype from these samples was compared to those from 60 horned larks from Alaska, alpine Washington, eastern Washington and Oregon and coastal California. Although, the Streaked Horned Lark was found to be closely related to coastal California birds, it is genetically unique and isolated. Streaked Horned Larks appear to have remarkably low genetic diversity; all 32 sampled shared the same haplotype. All other localities sampled had multiple haplotypes despite smaller sample sizes. These genetic data indicate that the Streaked Horned Lark is unique, isolated, and has little genetic diversity and suggests that it is a conservation priority.

CONSERVATION STATUS

- Listed as a federal Candidate species under the U.S. Endangered Species Act
- Committee On the Status of Endangered Wildlife Species in Canada lists the Streaked Horned Lark as Endangered
- On the Red list in British Columbia. This list includes any indigenous species or subspecies that have or are candidates for Extirpated, Endangered, or Threatened status in British Columbia
- Listed as a candidate for listing as Threatened, Endangered or Sensitive by Washington Department of Fish and Wildlife (28 October 1998). The Washington Department of Fish and Wildlife recently recommended that the Streaked Horned Lark be listed as Endangered in the State of Washington (Stinson 2005).
- Listed as State Sensitive by the Oregon Department of Fish and Wildlife (Critical Status; Oregon Sensitive Species List, 1997)
- A priority species for conservation by Oregon-Washington Partners in Flight (Altman 2000) and British Columbia Partners in Flight (Fraser et al. 1999)
- NatureServe rounded global conservation status is a G5T1 indicating that it is a critically imperiled subspecies of a widespread and common species.

HISTORIC BREEDING RANGE

The Streaked Horned Lark historically bred in prairie and open coastal habitats from the southwestern corner of British Columbia (southeastern Vancouver Island, lower Fraser River Valley; Fraser et al. 1999) through the Puget trough and Willamette Valley (as far south as Eugene, Oregon) and into the Rogue River Valley (from Medford north to Eagle Point; Figure 1). In addition, Larks were found on open coastal habitats in western Washington (Smith et al. 1997, Jewett et al. 1953; Figure 1). For a detailed description of the Larks historic breeding range refer to Rogers 2000, Beauchesne and Cooper 2003, and Stinson 2005.

CURRENT BREEDING RANGE

In Washington, Rogers (1999) identified 124 townships to survey for Larks and 31 were considered high priority because of recent Lark records (1960 or later) or because they contained suitable habitat. Rogers (1999) detected 49 singing males in 11 of the 86 townships surveyed. MacLaren and Cummins (2000) re-surveyed these occupied sites, the two remaining high priority sites that were not surveyed by Rogers (2000), and an additional 33 lower priority sites. MacLaren and Cummins (2000) did not locate additional occupied sites but did detect 65 Larks at the previously identified 11 occupied sites. Additional surveys by Pearson and Hopey (2004, 2005) on Ft. Lewis, the outer coast of Washington and lower Columbia River resulted in the identification of additional sites occupied by Larks (Appendix I). It is unlikely that many additional occupied sites will be identified in Washington because all of the high priority and many of the lower priority sites have been surveyed. In addition, requests to birding listserves asking birders to report sightings of Horned Larks in western Washington have not resulted in the location of any additional populations.

Altman (1999) conducted a broad-scale survey for Larks and other grassland birds in the Willamette Valley in 1996 and 1997. This survey consisted of 544 roadside point count stations along with more intensive survey methods consisting of transects, territory mapping and nest monitoring. Altman (1999) selected point count stations where target species (Oregon Vesper Sparrow, Streaked Horned Lark, Western Meadowlark, Grasshopper Sparrow, and Common Nighthawk) were known to occur or where appropriate habitat occurred. In addition, he attempted to spread his sampling points throughout the valley floor and foothills of the Willamette Valley and a broad range of potentially suitable habitat. Using this approach, he detected 154 Streaked Horned Larks within 100 m of point count stations.

To our knowledge, similar types of surveys have not been conducted in British Columbia. Campbell et al. (1997) considered the Streaked Horned Lark to be extremely rare in the lower Fraser River Valley and Fraser et al. (1999) considered it extirpated on southeastern Vancouver Island. Beauchesne (2002) conducted a survey for Vesper Sparrows on southern Vancouver Island, which uses habitat similar to the Lark, and noted a single male Streaked Horned Lark on the Nanaimo Airport on Vancouver Island but it was not located again in 2003 despite intensive searching. Today the Streaked Horned Lark is believed to be extirpated from British Columbia (Beauchesne 2003).

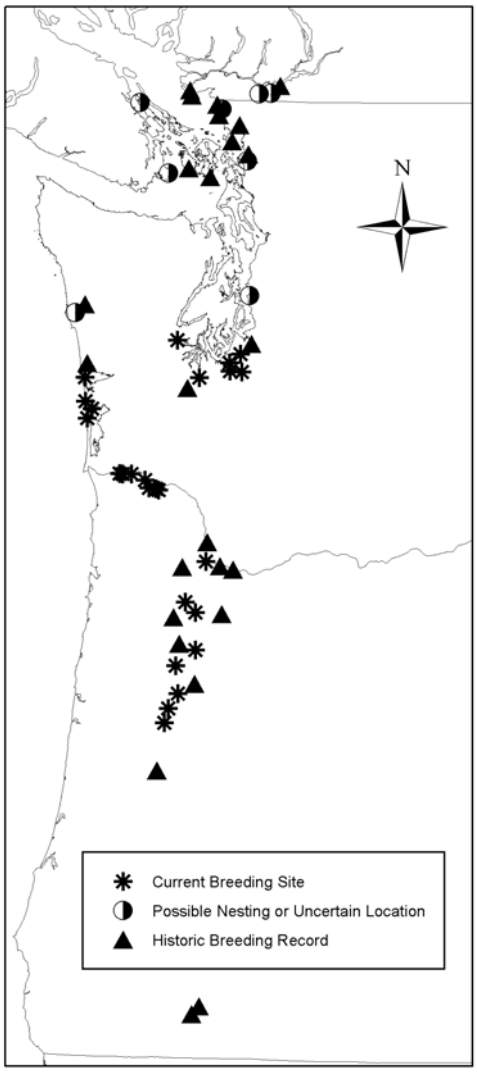

Figure 1. Current and historic Streaked Horned Lark breeding localities and possible historic nesting or uncertain breeding season locations. Information from Altman (1999), Rogers (2000), Pearson and Hopey (2005), Stinson (2005).

Results from these U.S. and Candian surveys indicate that the Streaked Horned Lark currently breeds on prairie remnants (n = 2) and airports (n = 4) in the southern Puget lowlands, on beaches and accreted lands near Grays Harbor and Willapa Bays (n = 4), on dredge spoil islands in the Columbia River (n = 6), an industrial site along the lower Columbia River in Oregon, and on a number of agricultural, pasture, grass, and mudflat habitats in the Willamette Valley from Portland to Eugene (Figure 1, Appendix I). In addition, the Streaked Horned Lark has been reported as an irregular breeder on the south jetty of the Columbia River (M. Patterson personal communication).

The Lark no longer breeds in southern British Columbia, the northern Puget trough (San Juan Islands and other coastal areas north of Tacoma), along the Washington Coast north of Grays Harbor, and in the Rogue River Valley (Rogers 2000, Beauchesne and Cooper 2003, Stinson 2005.).

CURRENT WINTER RANGE

In Oregon, Robinson and Moore (2004) surveyed 18 5-minute lat/long Willamette Valley blocks selected at random and a total of 295 point counts within those blocks during the winter of 2003-2004. To locate larks, they drove every non-major highway road (roads other than Interstate 5) in each block and they located 15-20 point count stations in every block. Using this method, they detected only 19 Streaked Horned Larks from 6 point count Stations. In addition, they conducted additional surveys on large expanses of agricultural land that were known or suspected to be occupied by Larks. They found Streaked Horned Larks to be present in the Willamette and Columbia River valleys throughout the winter. Most of the Streaked Horned Larks were found in open agricultural lands of Linn, Benton, Polk, and Marion Counties. The only other substantial group of Streaked Horned Larks was located at the Port of Portland in Multnomah County on a large dredge spoil expanse.

Pearson et al. (2005) conducted a winter (2004/2005) inventory of known wintering and breeding localities in Washington and Oregon. They conducted 51 visits to 28 sites [Puget Sound n = 5, Washington coast n = 4, Columbia River n = 7, Willamette and Rogue Valleys n = 12 (Figure 2, Appendix II)]. No Streaked Horned Larks were observed at twelve of the 28 sites surveyed. Larks were found in large flocks consisting of Streaked Horned Larks and other subspecies of

Horned Lark (up to 170 birds in a flock) in the Willamette Valley, variable sized flocks of Larks on Columbia River islands (1-69 birds) and Oregon Coast (12-30 birds) and in pairs or small flocks (4-5 birds) in the Puget lowlands (Appendix II). Of the 542 Streaked Horned Larks observed during this survey, 72% were observed in the Willamette Valley, 20% on Columbia River islands or floodplain, 8% on Washington coast, and 1% on a Puget Sound airport and prairie (see Appendix II). In addition to these confirmed winter sightings, the Streaked Horned Lark may over winter on the southern Oregon coast (Coos County; subspecies unknown but may be *strigata*; Contreras 1998). On the northern Oregon coast it appears to be an annual migrant in fall and occasional (irregular) wintering species (M. Patterson personal communication).

Several lines of evidence suggest that birds in the Puget lowlands are migrating south for the winter: 1) only 3 birds were observed in the southern Puget lowlands during the 2004-2005 winter survey (Pearson et al 2005) and there were likely more than 216 breeding birds in the lower Puget trough during the previous breeding season (Pearson and Hopey 2005); and 2) birds banded in the southern Puget Sound region during the breeding season were re-sighted to the south in the Willamette Valley during the winter (Pearson et al. 2005). Multiple re-sights of banded birds throughout the winter in the Willamette Valley, Columbia River and on the Washington Coast suggests that some of these birds are staying in these regions throughout the winter.

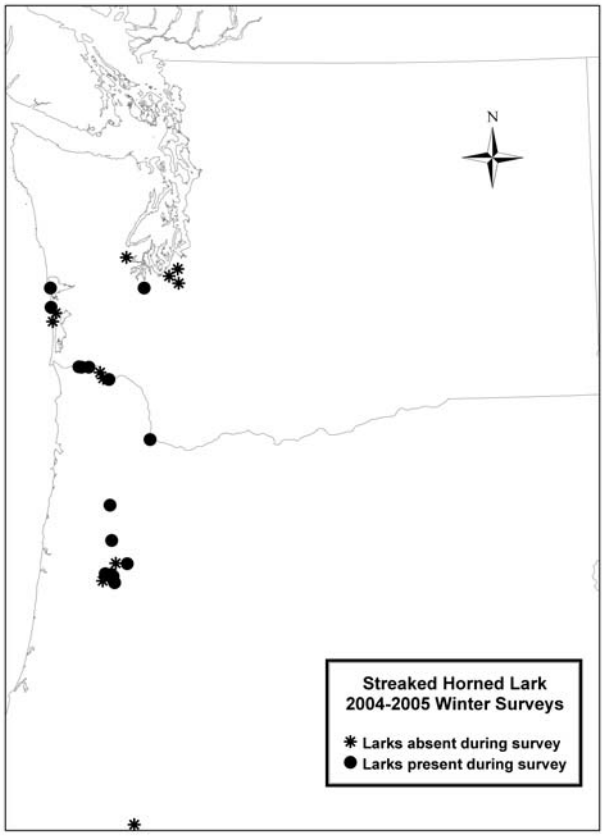

Figure 2. Oregon and Washington localities where Streaked Horned Larks were present and absent during 2004-2005 winter surveys (Pearson et al. 2005).

HABITAT REQUIREMENTS

Breeding Habitat

For a detailed description of Lark breeding habitat see Altman (1999) and Pearson and Hopey (2005).

Puget Trough (Pearson and Hopey 2005)

- Large expanses of grass dominated habitat (airports or native prairies; minimum area has yet to be determined) with very few or no trees or woody shrubs.
- Sparsely vegetated habitat dominated by relatively short annual grasses and native bunch grasses (3.9 – 13.3 inches tall).

- Avoided areas with sod forming (rhizomatous) grasses.
- Relatively high percent of bare ground (16%; particularly associated with dirt, gravel and cobbles) as the ground cover as opposed to a moss/lichen or thatch dominated ground cover.
- Around the nest site (0.5 m radius around the nest), females are selecting areas within territories with fewer non-vegetated areas and less cover of annual and perennial grass.
- Unvegetated habitats (dirt roads, taxiways or runways) used for foraging, singing and take-off sites for flight displays.

Washington Coast and Lower Columbia River (Pearson and Hopey 2005)

- Sparsely vegetated expanses of sand adjacent to the ocean or Columbia River. Areas dominated by grasses and forbs with few or no trees and shrubs.
- Selecting sparsely vegetated areas with more wood and cover of annual grasses with less algae (indicator of areas effected by very high tides) than adjacent areas in the same habitat type.
- Ground layer is dominated by sand (approx. 68%) with little thatch; moss or lichen are absent on the coast but present on the Columbia River islands.
- Sparsely vegetated (approximately 35% of the area with no vegetation).
- Dominated by relatively short annual grasses (0.6 – 8.7 inches).
- Around the nest site (0.5 m radius around the nest), females are selecting areas with fewer non-vegetated areas, more thatch and perennial forbs and shorter vegetation.

Willamette Valley (Altman 1999)

- Large expanses of herbaceous dominated habitat (cultivated grass fields, moderate to heavily grazed pasture, fallow fields, roadside shoulders), Christmas tree farms and wetland mudflats.
- Dominated by short grasses (0-6 inches).
- Relatively high percent of bare ground (17%) for territories.
- A higher percent cover of bare ground (31%) for nest sites.

Winter Habitat

Puget Trough (Pearson et al. 2005)

- Only three wintering Larks were observed in the Puget lowlands. Two were found on the Olympia Airport (1 male and 1 female) and one bird was observed on 13th Division Prairie. All three birds were using the same habitats that are used by breeding birds and that is described above.

Washington Coast and Lower Columbia River (Pearson et al. 2005)

- On the Washington coast, Larks were found on dune and beach habitat adjacent to open water with few or no trees and shrubs.
- Larks on the lower Columbia River were primarily found on sparsely vegetated dredge spoils (see description under breeding habitat above).

Willamette Valley (Robinson and Moore 2004, Pearson et al. 2005)

- High percent of bare ground (sites with flocks > 20 birds averaged greater than 85% bare ground) and large expanse of treeless area. Most birds use agricultural fields, particularly rye grass fields with sparse ground cover.
- Winter habitats used in Willamette Valley are very unusual with respect to characteristics of dominant land cover. Larks are using fields that have apparently been fallow for a few months. The fields have sparse, patchy weedy cover with very little rye grass. Occasionally they are in annual rye grass fields with sparse cover, but more typically they avoid those fields. Perennial rye grass is almost universally avoided during winter.

Breeding Season Foraging Habitat

Puget Trough (Rogers 2000, SFP and Mark Hopey pers. obs.)

- On Puget prairies, Larks select sites with low vegetation (mean = 4.2 inches), and with low vegetation density (Rogers 2000).
- Forages in sparsely vegetated prairie and grasslands, gravel roads, and runway and taxiway aprons on airports.

Washington Coast and Lower Columbia River (SFP and Mark Hopey pers. obs.)

- Sparsely vegetated dunes and beaches (same habitat that is used for territories and nesting).
- Forage in the wrack line and intertidal habitat.
- Sparsely vegetated dredge spoils along the Columbia River.

Willamette Valley (Altman 1999)

- Recently plowed or burned fields
- Row crops and vegetable fields with dirt rows between vegetation

BREEDING POPULATION ESTIMATES

Rogers 2000, Pearson (2003) and Pearson and Hopey (2004, 2005) estimated the number of territories and total numbers of breeding birds at 16 sites in the Puget lowlands (n = 6), Washington coast (n = 4), and Columbia River islands (n = 6) (Appendix I). This work included intensive territory mapping and nest monitoring (n = 8 sites, > 10 visits/site/season) and estimates of the number of territories and the number of breeding birds during surveys (n = 8 sites, 1-5 visits/site/season) (see Appendix I).

As discussed above, Altman (1999) conducted a broad-scale survey for Larks and other grassland birds in the Willamette Valley in 1996 and 1997. This survey consisted of 544 roadside point count stations and more intensive survey methods (transects, territory mapping and nest monitoring) at additional sites. During point count surveys, birds occurred in 16 of the 41 regions established. Abundance was <0.5 birds/count in all regions except one, which had a relative abundance of 0.7 birds/count. We used the number of birds counted during point counts, intensive territory mapping and those observed outside of these activities (B. Altman's field notes) to estimate the number of birds in the Willamette Valley during the breeding season.

Using information from these studies and surveys, we estimate that there are approximately 774 Streaked Horned Larks with 222 birds (29%) in the Puget lowlands, 86 birds (11%) on the Washington coast, 68 birds (9%) on the lower Columbia River, and 398 birds (51%) in the Willamette Valley (Appendix I). These numbers should be used cautiously as population estimates because: 1) all populations and birds may not have been counted; 2) multiple techniques and different amounts of effort went into generating population estimates at different locations; 3) surveys were conducted by different people in the Willamette Valley than in other locations; and 4) inventories occurred during different years, some nearly 8 years apart; and 5) populations may be spatially and temporally dynamic (especially in the Willamette Valley where birds breed in agricultural fields that are managed differently over time). These data were gathered in such a way that it is very difficult if not impossible to put confidence intervals around these estimates.

WINTER POPULATION ESTIMATES

As discussed above, Robinson and Moore (2004) conducted a Streaked Horned Lark survey during the winter of 2003/2004 and found Streaked Horned Larks at 16 sites on the islands and flood plain of the lower Columbia River and in agricultural fields in the Willamette Valley. They identified 382 confirmed Streaked Horned Larks with an additional 209 Streaked Horned Larks for a potential total of 591 Streaked Horned Larks.

As discussed above, Pearson et al. (2005) conducted a winter (2004/2005) inventory of known wintering and breeding localities in Washington and Oregon. They conducted 51 visits to 28 sites [Puget Sound n = 5, Washington Coast n = 4, Columbia River n = 7, Willamette and Rogue Valleys n = 12 (Figure 2, Appendix II)]. Using the maximum Streaked Horned Lark count during any one visit to a site, we estimate that the maximum number of Streaked Horned Larks at all of the sites we surveyed was 542 birds (Appendix II).

Caution should be used when using either of these winter counts as an estimate of the total Streaked Horned Lark population for two reasons: 1) not all potential wintering locations were surveyed suggesting that this may be a low estimate; and 2) the re-sighting of banded birds in different locations during the winter suggest that birds move among Columbia River islands and between Columbia River islands and the Washington coast during the winter. The movement of birds among sites could result in double counting birds and ultimately an overestimate of the population size.

THREATS

Below and in Appendix III, we describe the threats observed while conducting winter (2 years) and breeding season (5 years) research.

Human Activities

- Streaked Horned Larks are actively establishing territories and breeding from late March to early August. The following activities appear to influence Lark behavior by causing them to become alert or fly or the activities directly destroy nests (Pearson and Hopey 2004): mowing, moving vehicles (including ORVs), model airplane flying (and likely kite flying), fireworks, dog walking, and gatherings of people and/or vehicles. Activities

that keep Larks away from nests for extended periods of time (more than an hour) are particularly disruptive and may result in nest abandonment.

- Flush distances depend on breeding stage and type of disturbance. In general, activities that occur within 30 m (mean + 1 SD of the mean flushing distance) are more likely to cause flush events than more distant activities (Pearson and Hopey 2004). Our observations suggest that birds are more likely to flee in response to pedestrian and dog activity than vehicle activity.
- Activities associated with the deposition of dredge spoils immediately adjacent to breeding and wintering birds could negatively affect nesting (increase nest abandonment or prevent nesting) and foraging (cause birds to flee or to spend more time alert and less time foraging). On Miller Sands, two nests were abandoned after equipment was staged immediately next to them. Also on Miller Sands, the deposition of dredge spoils on a known Lark breeding area 2004 likely resulted in nest failure.
- Because Larks nest on the ground and often near dirt roads, their nests are vulnerable to vehicle traffic especially along active airport taxiways, roads on Puget prairie sites, beaches with vehicle traffic, and roads adjacent to agricultural sites. Loss of nests associated with vehicle activity has been documented in the Willamette Valley (Altman 1999) and Puget lowlands.
- Mowing may be both a blessing and curse for the Streaked Horned Lark. All of the airport sites are mowed and the mowing may be partially responsible for maintaining suitable habitat at these sites. At the same time, mowing results in direct mortality of nests and may cause some nest abandonment (Pearson and Hopey 2005). Gray Army Airfield reduced the frequency of mowing and adjusted the timing of mowing to minimize impacts to larks for three breeding seasons. Olympia Airport continues to modify its mowing regime to minimize impacts to breeding larks.
- Between 1985 and 2004, there were 1,422 Horned Lark collisions with US Air Force aircraft, which was the highest number of aircraft collisions for any species (BASH 2004). However, there were only 228 Horned Lark collisions out of 51,154 strikes with civilian aircraft reported between 1990 and 2003 (Cleary et al. 2004). None of the civilian aircraft collisions resulted in injury and the total cost associated with Horned Lark collision damages was estimated to be $250 (Cleary et al. 2004). Larks currently breed on Shelton and Olympia Airports and Gray Army Airfield and McChord Air Force Base and have been found dead along the runways at McChord Air Force Base and Gray Army Airfield.

Pesticides and Herbicides

- Beason (1995) reports direct mortality of Horned Larks from exposure to Carbofuran (a carbamate pesticide) and Fenthion (an organophosphorus cholinesterase-inhibiting insecticide applied to crops).

Habitat Loss or Change

Historic Habitat Loss

- *British Columbia*: historical habitat was likely restricted to sparsely-vegetated sites such as spits, beaches, and grasslands. Due primarily to the conversion to agriculture and urban development, the grasslands associated the Gary oak ecosystem of British Columbia has declined by at least 95% (Hebda and Aitkens 1993). The amount of open dune, grass and bryophyte areas on Vancouver Island have declined by 6 – 52% depending on the site (Beauchesne and Cooper 2003). An inventory of sensitive

ecosystems on Vancouver Island and the Gulf Islands indicates that naturally occurring, sparsely vegetated habitats (e.g., sand dunes, gravel and sand spits) are the rarest terrestrial ecosystem in eastern Vancouver Island (Ward et al. 1998). Page (2003) compared aerial photographs of sand dune habitats over a 40-year period and estimated that the amount of dune habitats on southern Vancouver Island declined by 6 to 50% depending on locality.

- *Washington*: In the Puget lowlands, historic Lark habitat was confined to prairie habitats associated with gravelly outwash soils. Crawford and Hall (1997) estimated the historic distribution of grasslands in the southern Puget Sound region by mapping grassland soils. Currently, grasslands occupy approximately 22% of their historic area and prairies dominated by native species occupy approximately 3% of their historic area. The loss of these grasslands has been attributed to urban development (33%), forest invasion or conversion (32%) and agriculture conversion (30%; Crawford and Hall 1997). Along the coast, Lark habitat was historically and is currently associated with sparsely vegetated beach habitat (foredune). Although we know of no estimates of the amounts of sparsely vegetated dune and open beach habitat that has been lost to the invasion of non-native beachgrasses (*Ammophila spp.*), it is likely considerable. Non-native beachgrass cover has increased by 574% in a fifty-year period in portions of the Pacific coast (Buell et al. 1995) and is the dominant foredune vegetation in the range of the Lark on the Washington coast (Seabloom and Wiedemann 1994). Once dune and beach habitat is densely vegetated by beachgrasses, it is no longer used by Larks (Pearson and Hopey 2004).
- *Oregon*: More than 99% of the pre-settlement grasslands used by Larks in the Willamette Valley have been lost (Johannessen et al. 1971, Towle 1982). Initially these grasslands were lost to agriculture but, despite the habitat change, Larks continued to use appropriate agricultural lands. More recently, there has been extensive urban/residential development in Willamette Valley, which is replacing the agricultural fields and other fallow fields used by breeding and wintering Larks. There has also been conversion of suitable agricultural habitat such as pastures or fallow fields to non-suitable agricultural lands such as rowcrops, orchards, and nurseries.

Ongoing Habitat Loss or Change

- To maintain and deepen the Columbia River shipping channel, the Army Corps of Engineers deposits dredge spoils on many of the islands used by breeding Larks. The timing, location and the amount of deposited materials can have dramatic impacts on the Lark. The un-vegetated landscape created by depositing dredge spoils is not used by Larks for the first year or two after deposition. Consequently, depositing spoils on Lark breeding or wintering sites can have negative impacts on Lark use of a site. Once the spoils are sparsely vegetated, they are quickly colonized by Larks (especially island spoils where ORV traffic does not occur)
- Sandy habitats on the coast of Washington continue to be colonized by non-native beachgrasses (*Ammophila spp*). Larks do not use habitats with a dense covering of beachgrass for breeding or over-wintering.
- Robinson and Moore counted 61 Streaked Horned Larks at the Multnomah County site (see Appendix II) during the winter of 2004/2005 but counted 150-200 Larks in the previous two years. This decline may be the result of changes in habitat conditions. Some grading occurred at the site in preparation for development resulting in completely unvegetated habitat and other parts of the site continued to be colonized by vegetation resulting in a higher percent cover of vegetation, which made it less suitable to wintering

Larks. In addition, there are survey markers on the site indicating that it will likely be developed in the near future.

- In the Willamette Valley, over-wintering site fidelity appears to be low among years. Pearson et al (2005) re-surveyed all sites during the 2004/2005 winter where Larks were found during the 2003/2004 winter. They found Larks to be present at only one of these previously occupied sites during the 2004/2005 winter. This low site fidelity may occur because of the dynamic nature of over wintering habitat. Sites with Larks and appropriate habitat in 2003/2004 had inappropriate habitat and no Larks in 2004/2005. These sites moved from being fallow in 2003/2004 to being densely vegetated with annual rye grass in 2004/2005. During the winter, Larks appear to move across the landscape in search of appropriate habitat and, when appropriate habitat is discovered, they use it. During the winter of 2004/2005, very few agricultural fields were in a condition appropriate for over wintering Larks suggesting that this habitat type may be limiting.
- The Olympia Airport is currently extending the runway and is planning on building several new hangars. In addition, they have proposed developing a considerable portion of the remaining open grassland habitat with buildings, roads and taxiways which may make the site unsuitable to breeding and wintering Larks.
- Gray Army Airfield is currently extending the West ramp into areas used by breeding Larks in previous years.

Lack of Protected Habitat

- Agricultural habitats and suitable horned Lark habitat in the Willamette valley are almost entirely privately owned and land uses can vary dramatically from year to year.
- Many of the islands in the Columbia River and on the coast of Washington are publicly owned offering opportunities for strategic conservation planning.
- The primary purpose of municipal and military airfields is for air traffic and military training. Larks are perceived as being at odds with aircraft safety because Horned Larks collide with aircraft (see discussion above). To minimize bird-aircraft collisions, McChord AFB regularly flies falcons to scare birds off the airfield and started also using dogs in 2005. These dogs walk and run through Lark habitat and cause the birds to become alert and fly. Gray Army Airfield is planning on adding an additional 130 rotary wing aircraft to the airfield within the next year. These aircraft are a different type than what is currently using the site. The air temperature and wind velocity of the rotor and engine down blasts from these new aircraft may impact Lark use of the site.

Predation

- Over 200 Lark nests have been monitored in the Puget lowlands, Washington coast, Columbia River and in the Willamette Valley and predation was the primary source of nest failure at nearly all sites studied to date (Pearson and Hopey 2005, Altman 1999). The predation rates at the Puget lowland sites and Columbia River/Washington coast sites are considerably higher than that reported for other grassland breeding birds.

Stochastic and Small Population Threats

- There appear to be very few Streaked Horned Larks remaining in the world (probably between 500 and 1000 birds) and preliminary genetics work suggests that the remaining birds have little genetic diversity. This result suggests that the Streaked Horned Lark population may already be experiencing the deleterious effects of inbreeding or the results of a small founder population. The remaining populations are vulnerable to all of

the threats small populations commonly face (e.g., vulnerability to environmental and demographic variability and to the loss of genetic variability).

- Most of the over-wintering streaked horned Larks are found on the lower Columbia River and Willamette Valley suggesting the importance of these habitats to wintering Larks. Birds in these two regions are found in large flocks (up to 125 Streaked Horned Larks in a single flock in the Willamette Valley and up to 61 Streaked Horned Larks in a single flock on the Lower Columbia) that are vulnerable to changes in habitat or stochastic events (e.g., weather events such as ice storms).

Ecological Processes

- On the Washington coast, breeding and over-wintering Larks use sparsely vegetated sandy areas. The dynamic process of erosion and accretion of sandy soils create this habitat type. After new land is created through accretion, it gradually becomes vegetated and is ultimately colonized by non-native beach grasses. There is a fairly narrow window of time when the habitat is sparsely vegetated and appropriate for Larks. Consequently, maintaining the dynamic process of accretion and erosion along the coast and within Grays Harbor and Willapa Bays is critical to maintaining Lark habitat (and Snowy Plover habitat). This process can be altered by activities that reduce the amount of sand export or effect the movement of sand along the coast (e.g., changes in hydrology and currents).
- Fire was historically important in maintaining open grassland habitats in the Puget lowlands and Willamette Valley. Larks preferentially use recently burned habitats in the late summer (Pearson and Hopey 2005). Ft. Lewis uses prescribed fire as a management tool to improve lark habitat at 13th Division Prairie.

RECOMMENDATIONS FOR ADDRESSING THREATS

Human Activities

- Alter the timing or location of the activities that disturb breeding birds (listed above) to avoid Lark breeding habitats.
- When possible, we recommend that most activities within 30 m of breeding Larks be restricted.
- To avoid disturbing (flushing, reducing the amount of time foraging and increasing the amount of time spent fleeing or being alert) breeding Larks or to avoid nest abandonment associated with disturbance, we recommend that dredge spoils not be deposited on active breeding localities during the breeding season.
- To minimize the negative impacts of mowing on Larks, we recommend that mowing occur during non-peak breeding times: before breeding starts in mid-April, the second week of June, and at the end of the breeding season (late July – early August). The early and late mowings occur outside the breeding season and we recommend the mid-season mowing because the curve of clutch initiation dates suggests that there is a break in clutch initiations between the first and second clutches, which occurs in the first or second week of June (Pearson and Hopey 2005). We recommend waiting until the second week of June when more of the fledglings are likely to be able to flee from an approaching mower. We also recommend mowing very low before and/or after the breeding season and higher (6-8 inches) during the breeding season. We have noted that mowing with the mowing deck very close to the ground results in more nests being destroyed.

- In the Willamette Valley, we recommend encouraging farming practices that create and maintain bare ground within grass and forb dominated fields.
- On coastal sites, we recommend that beach access be restricted to daytime foot traffic only and that if dogs are allowed they should only be allowed on a leash.
- We recommend using volunteers along the coast (especially at Midway Beach and Damon Point) to encourage people to avoid Lark (and Snowy Plover) nesting areas and to educate users about the bird's vulnerability and sensitivity to human activities.
- We do not recommend the creation of additional trails, facilities or access to Lark breeding sites on publicly owned sites (especially at Damon Point and Midway Beach).

Habitat Loss or Change

- Spoils that are sparsely vegetated with annual grasses and a mixture of forbs are used by over-wintering Larks. Consequently, keeping an adequate amount of habitat in appropriate successional stages is critical to maintaining Columbia River Lark populations.
- In addition to creating new wintering and breeding habitat, dredge spoils can be used to convert unsuitable habitats into suitable habitats. For example, if spoils are colonized by Scotch broom (*Cytisus scoparus*) or horsetail (*Equisetum sp.*) (habitats not used by Larks) they can be converted to appropriate habitats by depositing additional spoils.
- Control non-native beachgrasses on coastal areas and Scotch broom and non-native rhizomatous grasses on Puget lowland sites. Experimental control of beachgrasses has occurred in Oregon and Washington to improve Snowy Plover habitat.
- The use of sparsely vegetated agricultural fields in the Willamette Valley by wintering Larks indicates the need to maintain this habitat type in the long-term.
- For breeding habitat, maintain relatively short grasses and forbs with little or no woody vegetation [0-6 inches (Altman 1999); 3.9 – 13.3 inches (Person and Hopey 2005)] and a relatively high percent of bare ground [17% (Altman 1999); 16% (Pearson and Hopey 2005)]. Altman (1999) recommended a higher percent cover of bare ground (31%) for Streaked Horned Lark nest sites. For foraging, Streaked Horned Larks select sites with low vegetation (mean = 4.2 inches), and with low vegetation density during the breeding season (Rogers 2000). A review of the effects of management practices on the Horned Lark (Dinkins et al. 2003) also indicates that Larks prefer areas with short, sparse herbaceous vegetation with little or no woody vegetation.
- Altman (2000) provided a list of specific recommendations for the Willamette Valley including: maintain or provide small patches of suitable habitat within native and agricultural grasslands that have 20-50% cover of bare or sparsely vegetated ground, herbaceous vegetation <12 in (30 cm) tall, and located where minimum human or environmental disturbances occur.

Lack of Protected Habitat

- Create incentives for private land owners to maintain appropriate Lark habitats in the Willamette Valley.
- Consider expanding National Wildlife Refuge status to some of the islands created by dredge spoils on the lower Columbia River so that they can be actively managed for Lark habitat.

Predation

- See research needs below.

- Predator numbers (especially corvids) increase in response to increased food availability. Eliminating human sources of food in proximity to breeding locations (e.g., State Parks and parking areas adjacent to coastal breeding areas and fast food restaurants adjacent to airport sites) such as uncovered garbage and littered food scraps may indirectly help reduce predator numbers or help prevent their numbers from increasing.

Stochastic and Small Population Threats

- Increase the amount and spatial extent of Lark wintering habitat to reduce the potential for severe population loss associated with stochastic events (sudden changes in habitat or weather events).
- Increase the number of breeding populations with high reproductive success and high post-fledging survival.
- Altman (2000) recommended establishing >10 breeding populations (>20 pairs/population) in the Willamette Valley. In addition, Altman (2000) recommended delineating 11 Grassland Bird Conservation Areas in the Valley to focus conservation efforts.

Ecological Processes

- Maintain the dynamic processes that create accreted habitats on the Washington coast and in Willapa Bay and Grays Harbor.
- On Puget prairies, fire appears to improve post-breeding habitat for Larks (Pearson and Hopey 2005) and may improve breeding habitat conditions. We recommend the use of late summer (late August or early September) prescribed fires where and when it is likely to result in appropriate habitat structure and species composition. Conifers colonize Puget prairies in the absence of fire or mechanical tree removal (Lang 1961).

RESEARCH NEEDS

- Develop a metapopulation model (including populations in the Willamette Valley, lower Columbia River/Washington coast and Puget lowlands) to identify population sources and sinks. This model is critical to the development of recovery goals.
- Use the population model to set population goals by subpopulation (Willamette Valley, lower Columbia River/Washington coast, Puget lowlands, northern Puget trough/Georgia Basin).
- Explore methods for creating a functioning Lark metapopulation on the lower Columbia River using dredge spoils.
- Identify Lark nest predators and develop a strategy to reduce predation
- Evaluate survivorship of fledglings and sources of fledgling mortality because post-fledgling survival is often critical to population growth in birds
- Quantify over-wintering habitat selection
- Examine the relative importance of different wintering sites to Lark survival
- Further quantify movement patterns between breeding sites and movement patterns among wintering sites
- Research methods for controlling non-native beachgrasses on the coast and non-native pasture grasses on Puget prairie sites

- Determine whether the processes of accretion and erosion on the outer Washington coast and in Grays Harbor and Willapa Bays are adequate for maintaining Lark habitat over time.
- Develop a population monitoring strategy that includes a direct or indirect measure of fitness (reproduction and survival).

PROPOSED CONSERVATION STRATEGY

Because the threats faced by the Streaked Horned Lark vary regionally, we recommend a regionally based conservation strategy and the establishment of a region-wide working group (British Columbia, Washington, and Oregon) to develop recovery goals and objectives. Ultimately, we recommend developing time-lines and specific actions for all proposed strategies. In addition, we recommend developing methods for evaluating the outcome of each action.

Successful implementation of specific conservation strategies ultimately requires landowner and public involvement and commitment. Consequently, we recommend engaging landowners and the public in developing a conservation strategy.

For our conservation strategy, we have intentionally divided the historic and current breeding/wintering range into five regions that are geographically and ecologically distinct. However, the lower Columbia River and Washington coast could be combined into a single recovery region because banded birds appear to move freely between these areas during the winter and breeding season suggesting that this area functions as a metapopulation.

Northern Puget trough and Georgia Basin

First Priority

- Identify sites that have suitable breeding habitat or that can be restored for Lark reintroduction.

Second Priority

- Protect identified sites.
- Manage sites for lark habitat (appropriate structure and species composition).
- Conduct Lark reintroduction feasibility study.
- Investigate reintroduction techniques.

Third Priority

- Reintroduce larks to restored and protected habitats if determined appropriate and feasible.

Puget Lowlands

First Priority

- On Puget prairie breeding sites, control Scotch broom and invasive grasses and reinstate the use of late summer fire.
- Investigate methods for reducing Lark nest predation rates.
- At breeding sites, limit vehicle access and activities that disturb breeding larks (dogs off leash, fireworks, kite flying, large gatherings of people, trampling, etc.).

- On airport sites, alter mowing regimes (where possible and where it would not conflict with safety) as recommended above and minimize human activities adjacent to breeding sites.
- Also on airport sites, minimize development on remaining grasslands or immediately adjacent to remaining grasslands.
- Develop a population monitoring strategy that includes a direct or indirect measure of fitness (reproduction and survival).
- Conduct Lark reintroduction feasibility study
    - Identify sites (number to be determined by metapopulation model) for lark reintroductions
    - At identified introduction sites, initiate management activities that create appropriate habitat conditions (appropriate structure and species composition).
    - Investigate methods for translocating Larks.

Second Priority

- Once the habitat is appropriate for Larks at the reintroduction sites and methods for translocation have been developed, initiate passive reintroduction program (playbacks with decoys). If the passive introduction fails, then attempt to translocate birds.

Washington Coast

First Priority

- Control invasive beachgrasses at known breeding sites. This activity will also benefit snowy plovers that nest adjacent to Larks.
- At breeding sites, limit vehicle access and activities that disturb breeding larks (dogs off leash, fireworks, kite flying).
- Limit human access to nest sites.
- Reduce the amount of food available to crows and ravens.
- Investigate methods for reducing Lark and Snowy Plover nest predation rates.

Second Priority

- Develop a plan to maintain the dynamic processes of erosion and accretion along the outer coast and within Grays Harbor and Willapa Bays.
- Develop a core group of volunteers along the coast (especially at Midway Beach and Damon Point) to encourage people to avoid Lark (and Snowy Plover) nesting areas and to educate users about the bird's vulnerability and sensitivity to human activities.
- Develop a population monitoring strategy that includes a direct or indirect measure of fitness (reproduction and survival).

Third Priority

- Develop education signs along beach access points about the sensitivity of Larks and Snowy Plovers to specific activities (off leash dog walking, pedestrian, vehicle or horseback riding in nesting areas, etc.).

Columbia River

First Priority

- Prevent additional deposition of dredge spoils on known lark breeding sites until a comprehensive strategy is developed.

Second Priority

- Develop a temporally and spatially explicit plan for the deposition of dredge spoils that maintains well distributed habitats (numerous sites along the length of the lower Columbia River from the confluence with the Willamette to the River's mouth) in the appropriate habitat condition (see description above) over time.
- Develop a population monitoring strategy that includes a direct or indirect measure of fitness (reproduction and survival)

Third Priority

- Develop a series of protected islands within the USFWS refuge system along the lower Columbia River

Willamette Valley

First Priority

- Secure commitment and designate three areas as lands managed for Lark habitat (e.g., public lands such as refuges, parks, The Nature Conservancy preserves). These areas will be necessary to serve as permanent core areas for population maintenance and sources for population expansion.

  Birds in the Willamette Valley use human managed habitats that provide appropriate habitat conditions. These sites are ephemeral in nature both between seasons and within seasons (as vegetation matures from late winter through summer). Thus we recommend establishing sites dedicated to Lark habitat that would be managed to provide appropriate habitat year round. This core population would then be supplemented by breeding birds finding appropriate habitats in the dynamic landscape outside the core.

Second Priority

- Secure commitment from private landowners either voluntarily or through incentives or cost-share programs for management activities that create or maintain breeding or wintering habitat These areas will be necessary to serve as short-term satellite areas for population distribution and expansion. The location of these sites should be evaluated based on the presence of existing Lark populations, the proximity to existing populations, or the ability of the site to support breeding and/or wintering Larks.

Third Priority

- Encourage land management that supports populations of Horned Larks through education and outreach activities. Lands outside the core and satellite areas that are purposefully or incidentally managed for Horned Larks should be considered as marginal habitat because of the uncertainity of their suitability from year to year due to changes in field type.

REFERENCES

Altman, B. 1999. Status and conservation of grassland birds in the Willamette Valley. Unpublished report submitted to Oregon Dept. Fish and Wildlife, Corvallis.

Altman, B. 2000. Conservation strategy for landbirds in the lowlands and valleys of western Oregon and Washington. Version 1.0. Oregon-Washington Partners in Flight.

American Ornithologists' Union. 1957. Check-list of North American birds. 5th ed. American Ornithologists' Union, Washington, D.C.

Barbour, M.G., J.H. Burk, and W.D. Pitts. 1980. Terrestrial plant ecology. Benjamin/Cummings Publishing Co., Menlo Park, California, USA.

BASH (Bird/wildlife Aircraft Strike Hazard Team). 2004. Top 50 USAF Wildlife Strikes by Count. Aviation Safety Division, U.S. Air Force (http://afsafety.af.mil/AFSC/Bash/stats/web_spec_count_stat.html).

Beason, R.C. 1995. Horned Lark (*Eremophila alpestris*). In The 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.

Beauchesne, S.M. 2002. Coastal Vesper Sparrow inventory, southeastern Vancouver Island, May to July 2002. Report prepared for the Garry Oak Ecosystems Vertebrates at Risk Recovery Action Group, Victoria, B.C.

Beauchesne, S., and J. Cooper. 2003. COSEWIC status report on the Horned Lark *Strigata* subspecies *Eremophila alpestris strigata*. Status report prepared for the Committee on the Status of Endangered Wildlife in Canada. COSEWIC Secretariat c/o Canadian Wildlife Service, Environment Canada, Ottawa, Ontario.

Behle, W.H. 1942. Distribution and variation of the Horned Larks (*Otocoris alpestris*) of Western North America. University of California Publications in Zoology 46:205-316.

Best, L.B. 1978. Field sparrow reproductive success and nesting ecology. Auk 95:9-22.

Bock, C.E., J.H. Bock, and B.C. Bennett. 1999. Songbird abundance in grasslands at a suburban interface on the Colorado High Plains. Pages 131-136 in P.D. Vickery and J.R. Herkert, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

Bonham, C.D. Measurements for terrestrial vegetation. John Wiley and Sons, 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.

Browning, M. 1975. Distribution and occurrence of the birds of Jackson County and surrounding areas. U.S. Museum of Natural History, Wash. D.C.

Buell, A.C., A.J. Pickart, and J.D. Stuart. 1995. Introduction history and invasion patterns of *Ammophila arenaria* on the north coast of California. Conservation Biology 9(6):1587-1593

Campbell, W.R., N.K. Dawe, I. McTaggart-Cowan, J.M. Copper, G.W. Kaiser, M.C.E. McNall, and G.E.J. Smith. 1997. The birds of British Columbia, volume 3, Passerines, Flycatchers through Vireos. University of British Columbia Press, Vancouver, British Columbia.

Chappell, C.B., M.S. Mohn Gee, B. Stephens, R. Crawford, and S. Farone. 2001. Distribution and decline of native grasslands and oak woodlands in the Puget lowland and Willamette Valley ecoregions, Washington. Pages 124-139 in Reichard, S.H., P.W. Dunwiddie, J.G. Gamon, A.R. Kruckeberg, and D.L. Salstrom eds. Conservation of Washington's native plants and ecosystems. Washington Native Plant Society, Seattle. 223pp.

Cleary, E.C., R.A. Dolbeer, and S.E. Wright. 2004. Wildlife strikes to civil aircraft in the United States 1990-2003. Federal Aviation Administration National Wildlife Strike Database Serial Report Number 10.

Contreras, A. 1998. Birds of Coos County, Oregon: status and distribution. Cape Arago Audubon Society and Oregon Field Orntihologists Special Publication 12. Eugene.

Crawford, R.C., and H. Hall. 1997. Changes in the south Puget prairie landscape. Pages 11-15 in P. Dunn and K. Ewing, editors. Ecology and conservation of the south Puget sound prairie landscape. The Nature Conservancy , Seattle, WA.

Davis, S.K., and D.C. Duncan. 1999. Grassland songbird occurrence in native and crested wheatgrass pastures of southern Saskatchewan. Studies in Avian Biology 19:211-218.

Dawson, L.W., and J.H. Bowles. 1909. The birds of Washington. Occidental Press, Seattle, Washington.

Dinkins, M.F., A.L. Zimmerman, J.A. Dechant, B.D. Parkin, D.H. Johnson, L.D. Igl, C.M. Goldade, and B.R. Euliss. 2003. Effects of management practices on grassland birds: Horned Lark. Northern Prairie Wildlife Research Center, Jamestown, ND. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/literatr/grasbird/hola/hola.htm (Version 12 Dec2003).

Drovetski, S.V., S.F. Pearson, and S. Rohwer. In press. Streaked horned lark *Eremophila alpestris strigata* has distinct mitochondrial DNA. Conservation Genetics *in press*.

Dubois, A.D. 1935. Nests of horned larks and longspurs on a Montana prairie. Condor 37:56-72.

Fernandez-Juricic, E. 2000. Local and regional effects of pedestrians on forest birds in a fragmented landscape. Condor 102:247-255.

Fraser, D. F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. Ministry of Environment, Lands and Parks Wildlife Branch and Resources Inventory Branch, Victoria, British Columbia, Cananda.

Gabrielson, I.N., and S.G. Jewett. 1940. The birds of Oregon. Oregon State University Press, Corvallis, Oregon.

Gilligan, J., D. Rogers, M. Smith, and A. Contreras. 1994. Birds of Oregon. Cinclus Press, McMinnville, Oregon.

Hartman, C.A., and L.W. Oring. 2003. Orientation and microclimate of horned lark nests: The importance of shade. Condor 105:158-163.

Heckert, J. R. 1994. Breeding bird communities of midwestern prairie fragments: the effects of prescribed burning and habitat-area. Natural Areas Journal 14:128-135.

Hensler, G.L., and J.D. Nichols. 1981. The Mayfield method of estimating nest success: A model, estimators and simulating nesting success. Wilson Bulletin 93:42-53.

Hosmer, D.W., and S. Lemeshow. 1989. Applied logistic regression. John Wiley and Sons, New York.

Jewett, S.G., W. P. Taylor, W.T. Shaw, and J.W. Aldrich. 1953. Birds of Washington State. University of Washington Press, Seattle, Washington.

Johnson, D.H. 1979. Estimating nest success: The Mayfield method and an alternative. Auk 96:651-661.

Johannessen, C.L., Davenport, W.A., Millet, A., McWilliams, S. 1971. The vegetation of the Willamette Valley. Annals of the Association of American Geographers 61:286-302.

Johnson, R.G., and S.A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. Journal of Wildlife Management 54:106-111.

Lafferty, K.D. 2001. Disturbance to wintering western snowy plovers. Biological Conservation 101:315-325.

Lang, F.A. 1961. A study of vegetation change on the gravelly prairies of Pierce and Thurston Counties, Washington. Masters thesis, University of Washington.

Lebreton, J.D., K.P. Burnham, J. Clobert, and D. R. Anderson. 1992. Modeling survival and testing biological hypotheses using marked animals: A unified approach with case studies. Ecological Monographs 62:67-118.

MacLaren, P.A. and E.B. Cummins. 2000. Streaked Horned Lark Surveys in Western Washington. Report funded by USFWS.

Martin, T.E., and G.R. Geupel. 1993. Nest-monitoring plots: Methods for locating nest and monitoring success. Journal of Field Ornithology 64:507-519.

Martin, T.E., and J.J. Roper. 1988. Nest predation and nest-site selection of a western population of the Hermit Thrush. Condor 90:51-57.

Martin, T.E., C. Paine, C.J. Conway, W.M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD Field Protocol. Document available from Montana Cooperative Wildlife Research Unit, Univ. of Montana, Missoula, MT. 59812; web site: http://pica.wru.umt.edu/bbird/

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bulletin 73:255-261.

Mayfield, H. 1975. Suggestions for calculating nest success. Wilson Bulletin 87:456-466.

Miller, S.G., R.L. Knight, and C.K. Miller. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Nelson, K.J., and K. Martin. 1999. Thermal aspects of nest-site location for vesper sparrows and horned larks in British Columbia. Studies in Avian Biology 19:137-143.

Nur, N., S.L. Jones, and G.R. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Fish and Wildlife Service, BTP-R6001-1999.

Owens, R.A., and M.T. Myres. 1973. Effects of agriculture upon populations of native passerine birds of an Alberta fescue grassland. Canadian Journal of Zoology 51:697-713.

Page, N. 2003. COSEWIC Status Report on the Sand-verbena Moth *Copablepharon fuscum* in Canada. Status report prepared for the Committee on the Status of Endangered Wildlife in Canada. COSEWIC Secretariat c/o Canadian Wildlife Service, Environment Canada, Ottawa, Ontario.

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.

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.

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

Pearson, S.F., M. Hopey, W. D. Robinson, R. Moore. 2005. Range, abundance and movement patterns of wintering Streaked Horned Larks in Oregon and Washington. Natural Areas Program Report 2005-2. Washington Dept. of Natural Resources. Olympia, WA.

Pietz, P.J., and D.A. Granfors. 2000. Identifying predators and fates of grassland passerine nests using miniature video cameras. Journal of Wildlife Management 64:71-87.

Pringle, R.F. 1990. Soil survey of Thurston County, Washington. US Department of Agriculture Soil Conservation Service.

Reijnen, R., R. Foppen, and H. Meeuwsen. 1996. The effects of traffic on the density of breeding birds in Dutch agricultural grasslands. Biological Conservation 75:255-260.

Renfrew, R.B., and C.A. Ribic. 2003. Grassland passerine nest predators near pasture edges identified on videotape. Auk 120:371-383.

Robbins, C.S. 1970. Recommendations for an international standard for a mapping method on bird census work. Audubon Field Notes 24:723-726.

Rogers, R.E. 1999. The Streaked Horned Lark in Western Washington. Unpublished Report. Washington Department of Fish and Wildlife, Olympia, Washington.

Rogers, R.E. 2000. The status and microhabitat selection of Streaked Horned Lark, Western Bluebird, Oregon Vesper Sparrow, and Western MeadowLark in Western Washington. Masters Thesis, The Evergreen State College, Olympia, Washington.

Rohrbaugh, R.W. Jr., D. L. Reinking, D. H. Wolfe, S. K. Sherrod, and M. A. Jenkins. 1999. Effects of prescribed burning and grazing on nesting and reproductive success of three grassland passerine species in tallgrass praire. Studies in Avian Biology No. 19:165-170.

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.

Stewart, R.E., and H.A. Kantrud. 1972. Population estimates of breeding birds in North Dakota. Auk 89:766-788.

Stinson, D. W. 2005. Draft Washington State Status Report for the Mazama Pocket Gopher, Streaked Horned Lark, and Taylor's Checkerspot. Washington Department of Fish and Wildlife, Olympia.138+ xii pp.

Suckley, G. and J.G. Cooper. 1860. The natural history of Washington Territory. Baillire Brothers, New York, New York.

Thomas, K., R.G. Kvitek, C. Bretz. 2003. Effects of human activity on the foraging behavior of sanderlings (*Calidris alba*). Biological Conservation 109:67-71.

Towle J.C. 1982. Changing geography of the Willamette Valley woodlands. Oregon Historical Quarterly, 83:66-87.

Vickery, P. D., M. L. Hunter, Jr., and J. V. Wells. 1999. Effects of herbicide treatment on habitat selection in grassland birds in southern Maine. Studies in Avian Biology No. 19:149-159.

Van der Zande, N.N., W.J. terKeurs, and W.J. van der Weuden. 1980. The impact of roads on the densities of four bird species in an open field habitat - evidence of a long-distance effect. Biological Conservation 18:299-321.

Ward, P., G. Radcliffe, J. Kirby, J. Illingworth, and C. Cadrin. 1998. Sensitive ecosystems inventory: east Vancouver Island and Gulf Islands 1993-1997. Volume 1: methodology, ecological descriptions and results. Technical Report Series Number 320, Canadian Wildlife Service, Delta, B.C. 146pp.

Wiens, J.A. 1973. Patterns and process in grassland bird communities. Ecological Monographs 43:237-270.

APPENDIX I

Estimated number of territories and total number of larks at all known breeding sites in Oregon and Washington.

Location	County	# Territories	# Birds	Year	Source
Puget Trough					
13th Division Prairie	Pierce	18	36	2004	1
Artillary Impact Area	Pierce	10	20	2003	2
McChord AFB	Pierce	31	62	2004	1
Gray Army Airfield	Pierce	31	62	2004	1
Olympia Airport	Thurston	18	36	2002	3
Sanderson Field	Mason	3	6	1999	4
Totals		**111**	**222**		
Washington Coast					
Damon Point	Grays Harbor	17	34	2004	1
Midway Beach	Pacific	21	42	2004	1
Graveyard Spit	Pacific	3	6	2004	1
Ledbetter Point	Pacific	2	4	2004	1
Totals		**43**	**86**		
Lower Columbia River					
Rice Island	Clatsop, Wahkiakum	12	24	2004	1
Miller Sands	Clatsop	3	6	2004	1
Pillar Rock Island (Jim Crow Island	Clatsop	6	12	2004	1
West Wallace Island		1	2	2004	1
Coffeepot Island	Wahkiakum	2	4	2004	1
Whites Island (east end of Puget)	Wahkiakum	8	16	2004	1
Rivergate (N. Portland)	Multnomah	-	4		5
Totals		**?**	**68**		
Willamette Valley					
Northern Valley	Yamhill, Multnomah, Clackamas	-	26	1996	6
Central Valley	Marion, Polk	-	166	1996	6
Southern Valley	Lane, Linn, Benton	-	102	1996	6
Incidental sightings	All valley counties	-	80	1996-97	7
Incidental Sightings	All valley counties	-	24	Since 1997	8
Totals		**?**	**398**		
Grand Totals		**?**	**774**		

Sources: 1 = Pearson and Hopey (2005); 2 = Pearson and Hopey (2004); 3 = Pearson (2003); 4 = Rogers (2000); 5 = Elain Stewart personal communication (Metropolitan Wildlife Area Manager); 6 = Altman 1999; 7 = detections outside point counts and intensive studies areas during the Altman (1999) project; 8 = detections reported by others at locations different than those reported in Altman (1999).

APPENDIX II

Number of visits and maximum number of Horned Larks (all subspecies), Streaked Horned Larks (STHL), female Streaked Horned Larks, male Streaked Horned Larks and unknown sex of Streaked Horned Larks at sites in Oregon and Washington during the winter of 2004-05.

Site	State	Visits	HOLA	STHL	Female STHL	Male STHL	Unknown Sex STHL	County
Puget Sound								
McChord AF Base	WA	1	0	0	0	0	0	Pierce
Gray Army Airfield	WA	2	0	0	0	0	0	Pierce
13th Division Prairie	WA	4	7	1	1	0	0	Pierce
Olympia Airport	WA	3	5	2	1	1	0	Thurston
Shelton Airport	WA	2	0	0	0	0	0	Macon
Coastal Washington								
Damon Point	WA	2	12	12	4	6	2	Grays Harbor
Midway Beach	WA	3	~30	30	6	6	~18	Pacific
Graveyard Spit	WA	1	0	0	0	0	0	Pacific
Ledbetter Point	WA	1	0	0	0	0	0	Pacific
Columbia River								
Whites Island	WA	2	20	18	9	6	3	Wahkiakum
Lark Island[1]	OR	1	0	0	0	0	0	Clatsop
Coffeepot Island	WA	1	0	0	0	0	0	Wahkiakum
Pillar Rock Island[2]	OR	1	2	2	1	1	0	Clatsop
Miller Sands	OR	1	1	1	0	0	1	Clatsop
Rice Island	WA/ OR	1	27	27	9	10	8	Clatsop/ Wahkiakum
Rivergate (N. Portland)	OR	4	69	61	23	28	10	Multnomah
Willamette Valley								
Livermore Rd.	OR	3	24	23	14	19	0	Polk
Harvest	OR	1	4	0	0	0	0	Linn
Dawson Rd.	OR	2	1	0	0	0	0	Benton
Creek Rd.	OR	11	~170	~125	0	~60	~65	Linn
Peoria Rd.	OR	1	2	2	1	1	0	Linn
Nicewood Rd.	OR	1	1	0	0	0	0	Linn
Cook Rd.	OR	1	4	0	0	0	0	Linn
Blatchford Rd	OR	1	35	35	13	12	10	Linn
Polk/Benton Co. line	OR	1	43	43	20	23	0	Polk-Benton
Guerber Rd	OR	2	~100	~80	0	0	~80	Benton
Malpass Rd	OR	4	110	80	0	0	80	Linn
Rogue Valley								
Ashland	OR	1	12	0	0	0	0	Jackson
Grand Totals			**~676**	**~542**	**102**	**~163**	**~277**	

[1]Lark island is our name for an un-named island located just upstream of Tenasillahe Island across a narrow slough
[2]Pillar Rock Island is also known as Jim Crow Island

APPENDIX III

Imminence and magnitude of threats to the Streaked Horned Lark populations in the Puget lowlands, Washington coast, lower Columbia River, and Willamette Valley.

Population	Threat Category	Specific Threats	Magnitude[1]	Immediacy[2]
Puget Lowlands				
	Habitat loss/change	Development of Lark habitat is occurring at Gray Army Airfield and Olympia Airport (nesting and foraging habitat is being paved and structures are being built). Development is planned for foraging areas outside of the Gray Army Airfield and additional development is planned for the grasslands at the Olympia Airport	High	Imminent
	Human activities	Events such as Rodeo and the air show at McChord AFB, planned increase in helicopter activity and change in type of aircraft used at Gray Army Airfield, collisions with aircraft, and use of dogs to remove birds from airports.	Moderate to High	Imminent
	Predation	Documented threat in Pearson and Hopey (2005)	High	Imminent
	Ecological processes	Loss of fire on prairie sites but it is being reintroduced at 13th Division Prairie	Moderate	Imminent
	Non-native species	Invasive and nonnative species such as Scotch broom, rhizomatous grasses, and spotted knapweed. Results in change in habitat structure and loss of appropriate breeding habitat	High	Imminent
Washington Coast				
	Habitat loss/change	Suitable habitat is succeeding to non-native beachgrasses dominated habitat not used by larks.	Moderate	Imminent
	Human activities	Pet dogs off leash, dogs and people in nesting areas, horses, kite flying, fireworks, off road vehicles	Moderate	Imminent
	Predation	Documented in Pearson and Hopey (2005) and Pearson and Hopey (unpubl.)	Moderate in 2004 High in 2005	Imminent
	Ecological processes	Change in accretion and erosion patterns associated with dams, dikes, channeling, etc.	??	??
	Non-native species	Beach grasses (coastal Washington sites) results in change in habitat structure and loss of appropriate breeding habitat.	High	Imminent
Columbia River				
	Habitat loss/change	Development occurring at the Rivergate site. Habitat succession to inappropriate habitat is ongoing.	Moderate	Imminent
	Human activities	Activities associated with dredging appeared to result in the failure of at least 2 nests on Miller Sands in 2005	Low to Moderate	Imminent
	Predation	Documented in Pearson and Hopey (2005)	Moderate in 2004 High in 2005	Imminent
	Ecological processes	Loss of flooding along the lower Columbia River	??	??
	Non-native species	Scotch broom, others?	Moderate to low	Imminent
Willamette Valley				
	Habitat loss/change	Urban and suburban development, changes in farming practices	High	Imminent
	Human activities	Vehicle and farm equipment (Altman 1999)	Moderate	Imminent
	Predation	Documented in Altman (1999)	High	Imminent
	Ecological processes	Loss of fire	Low	Imminent
	Non-native species	On prairie sites - Scotch broom, rhizomatous grasses, Himalayan blackberry	Moderate to Low	Imminent
	Pesticides	Potential associated with farming (documented for the species but not the subspecies	??	Non-imminent
Overall				
	Small Population	Small population size has been documented (certainly less than 1000 birds and probably less than 850 birds – see above), little or no genetic variability suggesting inbreeding or population bottleneck (Drovetski et al in press).	High	Imminent
	Winter concentration	Most of the worlds population can be found in a couple of flocks in the Willamette Valley and lower Columbia River during the winter making them vulnerable to stochastic events	??	Non-imminent

[1]High magnitude threats are threats that are likely to reduce the overall population, decrease the reproductive potential of the population, or significantly decrease the area used for foraging and breeding. These changes are likely to lead to extinction, local extirpation, or significant declines in local populations. Low magnitude threats negatively impact population size, reproductive success, or survival but are not likely to lead to extinction, extirpation, or significant population declines in the short term.

[2]Imminent threats are occurring and non-imminent threats have the potential to occur but have not yet occurred.