Draft Recovery Plan for the Streaked Horned Lark

(Eremophila alpestris strigata)

Male streaked horned lark at Corvallis Municipal Airport, May 2014
David Leonard/USFWS

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for the
Streaked Horned Lark
(*Eremophila alpestris strigata*)

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U.S. Fish and Wildlife Service
Portland, Oregon

Disclaimer

Recovery plans delineate reasonable actions that are believed to be needed to recover and/or protect listed species. We, the U.S. Fish and Wildlife Service, publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, State agencies, and others. Objectives of the recovery plan will be attained and funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than our own. They represent our official position *only* after they have been signed by the Director or Regional Director as *approved.* Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions.

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A Note on Terminology

The term **population** is generally accepted to mean a group of potentially interbreeding individuals within a defined area. Although streaked horned larks spread out to various localities across their current range in the breeding season, most of the members of the subspecies congregate in the winter, either in the Willamette Valley or on the islands in the lower Columbia River. It is possible then, that all streaked horned larks across the range have the potential to interact with each other. Given this fact, we will use the term "population" in three specific contexts in this document:

- When discussing all individuals in the subspecies across the current range, we will use the term "rangewide population."
- When referring to the larks that breed in any of the distinct regions within its range, we will refer to the "regional population."
- Within each region, there are numerous breeding sites or areas of habitat to which individuals return each year during the breeding season. We will refer to the larks occurring at these breeding sites as "local populations."

ACKNOWLEDGMENTS

We developed the Draft Recovery Plan for the Streaked Horned Lark in coordination with, and with the assistance of the Washington and Oregon Departments of Fish and Wildlife. We also drew on the knowledge of a group of species experts, which we formalized as the Streaked Horned Lark Recovery Team Species Specialist Group. The Species Specialist Group was appointed by and acts as a scientific advisory group at the request of the Regional Director for Interior Region 9 of the U.S. Fish and Wildlife Service (Service). The Species Specialist Group was convened specifically to assist the Service in ensuring the use of the best available science in developing the recovery plan for the streaked horned lark. The members of the Species Specialist Group are:

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We express our sincere thanks to the members of the Species Specialist Group for sharing their time and expertise in developing this draft recovery plan.

BACKGROUND

Species Introduction

The streaked horned lark (*Eremophila alpestris strigata*) is a small ground-nesting songbird endemic to the Pacific Northwest; it is a subspecies of the wide-ranging horned lark (*E. alpestris*) (Beason 1995, p. 4). Unless otherwise specified, the word "lark" in this document refers to this subspecies. The streaked horned lark's range historically extended from southern British Columbia, Canada, south through the Puget lowlands and outer coast of Washington, along the lower Columbia River, through the Willamette Valley of Oregon, the Oregon coast, and into the Umpqua and Rogue Valleys of southwestern Oregon (Altman 2011, pp. 200-202). The subspecies has been extirpated as a breeding species throughout portions of its range, including all of its former range in British Columbia, the San Juan Islands, the northern Puget Trough, the Washington coast north of Grays Harbor County, the Oregon coast, and the Rogue and Umpqua Valleys in southwestern Oregon (Pearson and Altman 2005, pp. 4-6). The current range of the streaked horned lark can be divided into three regions: (1) the south Puget Lowlands in Washington; (2) the Washington coast and lower Columbia River; and (3) the Willamette Valley in Oregon.

The streaked horned lark was listed as threatened in 2013, under the Endangered Species Act of 1973, as amended (16 U.S. C. 1531 *et seq.*) (Act) (U.S. Fish and Wildlife Service 2013a, p. 61502). While the listed taxon is a subspecies, the term "species" is used in this document following the definition in section 3(15) of the Act. Critical habitat was also designated for the species at four sites on the outer coast of Washington, nine islands in the lower Columbia River, and on three units of the Service's Willamette Valley National Wildlife Refuge Complex (U.S. Fish and Wildlife Service 2013b, entire).

A special rule under section 4(d) of the Act was promulgated when the species was listed (U.S. Fish and Wildlife Service 2013a, p. 61500). The 4(d) rule recognizes that some flexibility in the administration of the ESA is necessary in order to achieve recovery, given the lark's use of working and industrial lands, and it encourages landowners to continue activities that provide suitable streaked horned lark habitat, even though they may also cause some adverse effects. The 4(d) rule exempts take associated with: (1) management activities at non-Federal airports to minimize hazardous wildlife; (2) routine agricultural and ranching activities consistent with State laws on non-Federal lands in the Willamette Valley; and (3) routine removal or management of noxious weeds on non-Federal lands.

Recovery Planning Process

This draft recovery plan has been prepared under the Service's new approach to recovery planning and implementation. The recovery plan is one piece of a three-part framework:

1. The **Species Biological Report** informs the recovery plan; it describes the biology and life history needs of the species, includes analysis of the species' historical and current conditions, and also includes discussion of threats and conservation needs of the species. The biological report's format is structured around the conservation biology principles of resiliency, redundancy and representation (often referred to as "the 3 Rs") (Shaffer and Stein 2000, pp. 307-310; Wolf *et al*. 2015, entire).

2. The **Recovery Plan** contains a concise overview of the recovery strategy for the species, as well as the statutorily required elements of recovery criteria, recovery actions, and estimates of the time and costs to achieve the plan's goals.

3. The **Recovery Implementation Strategy** (RIS) is the vehicle for implementing the recovery plan. The RIS is a short-term, flexible operational document focused on how, when, and by whom the recovery actions from the recovery plan will be implemented. This approach allows us to incorporate new information and adapt to changing circumstances with greater flexibility and efficiency. The RIS will be developed and maintained in cooperation with our conservation partners, and will focus on the period of time and scope of activities that work best for our partners to achieve recovery goals.

These three streaked horned lark recovery documents are available on our website at https://www.fws.gov/pacific/ecoservices/endangered/recovery/larkrecovery.html. The Biological Report and RIS will be updated as necessary to reflect current information.

Recovery Strategy Overview

An endangered species is "any species which is in danger of extinction throughout all or a significant portion of its range," and a threatened species is "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (Endangered Species Act of 1973, as amended, Section 3). It follows then that a species will no longer be considered threatened or endangered once the degree of risk to the species has been reduced to the point that it is no longer in danger of extinction (or likely to become so) throughout all or a significant portion of its range, and it is likely to remain at this low degree of risk into the foreseeable future. The fundamental principle of any recovery strategy must therefore be focused on reducing extinction risk and ensuring the persistence of the species. The first step in this process is identifying the possible sources of risk as well as the factors that influence the long-term viability of a species.

An analysis of the threats to the streaked horned lark shows that the rangewide population of the lark has declined as its habitat has been lost, degraded, and fragmented (U.S. Fish and Wildlife Service 2013a, entire; U.S. Fish and Wildlife Service 2019, entire); other threats, such as low genetic diversity or the increased impact of predation, are generally consequences of the resulting small and isolated local populations across the species' range. Historically, streaked horned larks selected habitat in relatively flat, open areas in grasslands, estuaries, and sandy beaches in British Columbia; in dune and beach habitats along the coast of Washington and Oregon; in prairies of western Washington and western Oregon; and on the sandy beaches and islands along the Columbia and Willamette Rivers. Habitat at these sites was created by natural

processes of flooding, fire, and coastal sediment transport dynamics. Today these processes operate less effectively, due to flood control dams, fire suppression, and interruption of sediment transport by dams. Currently, the streaked horned lark uses a broad range of habitats, including native prairies, coastal dunes and beaches, wetland mudflats, fallow and active agricultural fields, sparsely vegetated edges of grass fields, recently planted Christmas tree farms with extensive bare ground, military training ranges, fields denuded by overwintering Canada geese (*Branta canadensis*), gravel roads or gravel shoulders of lightly traveled roads, airports and industrial sites, and dredge material disposal sites in the lower Columbia River (Altman 1999, pp. 18-19; Pearson and Altman 2005, pp. 6-8; Pearson and Hopey 2005, pp. 19-23; Moore 2008, p. 27).

Although streaked horned larks use a wide variety of habitats, populations are vulnerable because the habitats now used are often ephemeral or subject to frequent human disturbance. Ephemeral habitats include bare ground in agricultural fields and wetland mudflats; habitats subject to frequent human disturbance include mowed fields at airports, military training ranges, managed road margins, active agricultural fields, and dredge material disposal sites (Altman 1999, pp. 18-19; Stinson 2016, pp. 9-10). It is important to note the key role of human-created or maintained landscapes in providing habitat for the streaked horned lark under current conditions; without large-scale, manmade disturbance (e.g., burning, mowing, farming, and deposition of dredge materials), available habitat would decrease rapidly, but these same activities can kill or injure individual larks, especially when they occur during the breeding season.

The streaked horned lark recovery strategy is based on the following fundamental concepts for reducing the risk of extinction and ensuring, to the extent possible, the long-term persistence of the species:

1. Reduce or eliminate the systemic threats to the species identified and described in the **Species Biological Report**;

2. Reduce risk from random, chance events (demographic, environmental, and genetic stochasticity) and natural catastrophes by:

    a. Ensuring that regional populations are at or above minimum population targets; and
    b. Protecting multiple potentially interacting local populations distributed across the species' current range;

3. Conserve genetic variability within the species to provide both short-term fitness and evolutionary potential for the species to adapt to changing conditions by maintaining regional populations of sufficient size distributed across the range of habitat types used by the species; and

4. Provide for long-term survival of the species by:

    a. Protecting and managing habitat sufficient to support target population sizes and maintain connectivity among regional populations;
    b. Restoring and maintaining suitable habitat on sites distributed across the range; and

c. Monitoring to ensure that regional and rangewide population trends are generally stable or increasing and to provide feedback for adaptive management.

This draft recovery plan calls for multiple local populations of the streaked horned lark in protected and managed habitats, in which threats have been addressed, distributed across its current range. We consider a viable rangewide population of the lark to be one that has sufficient numbers, population trend, and distribution of reproductive individuals such that there is a high likelihood of long-term persistence despite demographic, genetic, and environmental stochasticity, including random catastrophic events (*e.g.*, extreme weather). This strategy will allow meeting recovery goals by: 1) managing for large populations with adequate reproduction and recruitment (resiliency), 2) establishing populations spread across a wide geographic area (representation), and 3) ensuring the presence of multiple local populations in each region (redundancy). In the next section, we provide the background and rationale for the specific objectives and criteria for the recovery of the lark.

Rationale for Recovery Objectives and Criteria

Species Range

A key component of the recovery strategy for the streaked horned lark is the maintenance of multiple local populations distributed across its current range. In this way, regional populations that are represented at multiple sites have a greater chance of being buffered from the negative effects of environmental variation, have a reduced chance of being simultaneously eliminated by a single catastrophic event, and stand a better chance of maintaining historical levels of genetic diversity and gene flow (Soulé and Simberloff 1986, pp. 32-35; Simberloff 1988, pp. 500-502; Fahrig and Merriam 1994,p. 56; Shaffer and Stein 2000, pp. 307-310; Neel and Cummings 2003, pp. 227-228; Wang 2004, p. 341).

We have divided the streaked horned lark historical range into five regions (North Puget Lowlands, South Puget Lowlands, Coast and River, Willamette Valley, and Southwest Oregon). Within the historical range, three regions are known to be currently occupied (South Puget Lowlands, Coast and River, and Willamette Valley). Within the three currently occupied regions, we have further delineated six Recovery Zones, which will be the focus of lark recovery actions (Table 1; Figure 1). If natural or assisted recolonization of unoccupied regions becomes possible in the future, we will develop additional recovery targets and actions for these regions, if appropriate.

The South Puget Lowlands, Pacific Coast, and Columbia River Recovery Zones are geographically distinct with clear boundaries (Figure 1). The Willamette Valley region was divided into three Recovery Zones to reflect general similarities of physiography and current land uses, and the consequences of those factors on existing local populations of larks (Figure 1). The West Willamette and North Willamette Recovery Zones are separated by the elevated plateau that occurs just north of the Santiam River and south of the City of Salem. Most of the West Willamette and Southeast Willamette Recovery Zones are separated by the Willamette River. The Willamette Valley recovery zones also have disparate current land uses; in particular,

the dominance of grass seed fields that occurs south and east of McMinnville contrasts with the mixed agriculture that occurs to the north and east. In general, the Southeast Willamette Recovery Zone is a large, relatively flat, historically dry prairie with few urban or residential areas, and the dominant current land use is grass seed production. The North Willamette Recovery Zone is higher in elevation, and is highly fragmented with smaller fields of mixed agriculture, urban, and residential. The West Willamette Recovery Zone was historically mostly wet prairie and is currently characterized by pockets of both grass seed field and mixed agriculture that varies from north to south.

Table 1. Regions and Recovery Zones for the Streaked Horned Lark.

Region	Recovery Zone	Larks currently present?
North Puget Lowlands		No
South Puget Lowlands	South Puget Lowlands	Yes
Coast and River	Pacific Coast	Yes
	Columbia River	Yes
Willamette Valley	North Willamette	Yes
	West Willamette	Yes
	Southeast Willamette	Yes
Southwest Oregon		Uncertain[1]

[1] There is a single recent report of streaked horned larks in the Rogue Valley in winter 2015-2016 (Randy Moore, Oregon State University, *in litt.* 2016, p.1). However, surveys the following spring did not detect any streaked horned larks during the breeding season (Robinson *in* litt. 2016, p. 1). Thus, the presence of an established streaked horned lark population in the Southwest Oregon region remains unconfirmed.

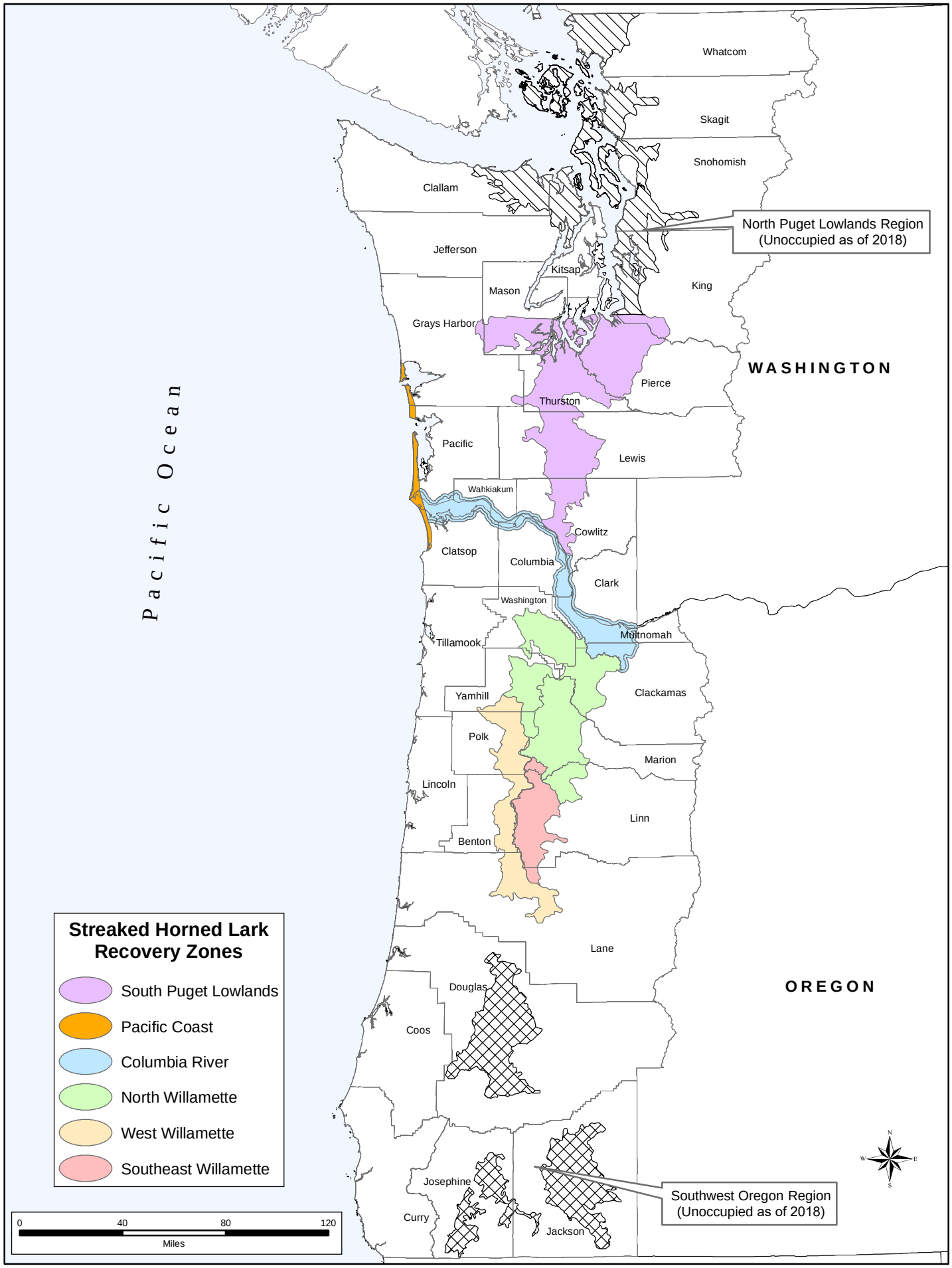

Figure 1. Streaked Horned Lark Recovery Zones

In this draft recovery plan, we focus on the need to achieve larger, stable populations of larks in the currently occupied regions (South Puget Lowlands, Coast and River, and Willamette Valley), which span the core of the historically occupied range of the species. At this time, we do not envision that reestablishment of lark populations in the currently unoccupied northernmost and southernmost regions (North Puget Lowlands and Southwest Oregon) is required for species recovery. However, restoration of lark populations in those regions may be feasible in the future if populations rebound in the currently occupied regions. Future recovery plan revisions will address this issue and may reassess recovery criteria to determine whether and how any reestablished lark populations in the North Puget Lowlands and Southwest Oregon regions could contribute to recovery.

Self-Sustaining Population

Population Size

The reason for the decline of the streaked horned lark was loss of habitat and the natural processes that create suitable habitat. Recently, other issues appear to be influencing local and regional population status, including those often associated with small populations, such as low genetic diversity and reduced recruitment, predation, and human activities that affect survival and reproduction, such as agricultural field operations, collisions with aircraft, and other activities during the nesting season.

Current threats to the lark are mainly those associated with small population, and can be alleviated with a larger self-sustaining rangewide population that is less susceptible to environmental and demographic stochasticity. Recovery will require both restoring and managing sufficient habitat to support a large well-distributed rangewide population, and ensuring appropriate protections to maintain the production and stability of that population.

Recovery objectives for listed species are often expressed in terms of a "minimum viable population" (MVP) that would be expected to persist for a given time period and remain resilient to existing threats. The size of an MVP may be determined through a population viability analysis (PVA) that models extinction risk by incorporating demographic, stochastic, and genetic factors. Such an analysis requires substantial data, which are not currently available for much of the range of the streaked horned lark. In order to set population recovery objectives, we have relied on expert opinion from the Streaked Horned Lark Recovery Team Species Specialist Group and published meta-analyses of MVPs for vertebrates, including birds and the subset of passerines.

The conservation biology literature of the last several decades indicates that population objectives for conservation should number in the thousands of individuals. A meta-analysis of MVPs concluded that conservation planning targets should include a minimum habitat area sufficient to support at least 7,000 sexually mature individuals, regardless of taxon or life history characteristics (Reed *et al*. 2003, p. 30); they defined an MVP as one with a 99 percent probability of persistence over 40 generations. Traill *et al*. (2007, p. 164) conducted a meta-analysis of MVPs from 30 years of published data and found that the median size for an MVP was 4,169 individuals (95 percent CI = 3,577 – 5,129). Even though Traill *et al*. (2007, p. 165)

did not find support for life history predictors of MVP size, they made their dataset available to allow conservation practitioners to search for MVPs based on taxon. Using their dataset, Anderson (2015, p. 2) found that the average MVP for the class Aves and order Passeriformes was 5,269 and 6,415 individuals, respectively. Informed by these meta-analyses, the Streaked Horned Lark Recovery Team Species Specialist Group assembled several times to set regional and rangewide population targets for the lark. For each recovery region, the group reviewed available historical information, the current population size, and the amount of potentially suitable habitat that could be managed to support new or expanded populations, and then applied their best professional judgment based on their research and experience to establish regional population goals that would meet the objectives of resiliency, redundancy and representation. The group then scaled up from the regional population targets to a rangewide population goal of 5,725 individual larks for recovery. The rangewide and regional population targets may be further refined in the future when more data are available for this analysis.

Growth Rate

In addition to recovery criteria that establish target population sizes, it is essential to track population trends to ensure that regional populations are stable over time, taking into account expected levels of annual variability, and are self-sustaining consistent with the overall goal of this recovery plan. The population growth rate criterion specifies that regular population monitoring in each region should demonstrate an average population growth rate that is stable or increasing in each recovery zone over a minimum 5-year period once recovery targets have been met.

Habitat Protection and Management

Horned larks have high breeding site fidelity, but are ecologically and evolutionarily adapted to take advantage of newly created habitats if vegetative succession renders their site unsuitable, a condition that can regularly occur in the narrow window of their early successional habitat (Anderson and Pearson 2015, p. 2). In the densely forested Pacific Northwest, the historical conditions that likely created these habitats were disturbances such as fire and flooding. Recovery of the streaked horned lark will emphasize a landscape-scale approach that focuses on both preservation of fixed reserves and the seasonal availability of opportunistic or ephemeral habitats to accommodate dispersing birds when necessary.

Recovery actions will focus on maintaining or establishing sustainable populations of the streaked horned lark in each recovery region on a mix of both fixed (within a defined space), managed sites and more spatially dynamic and/or less managed sites. In this recovery plan we define “Core sites” as locations that are intentionally managed for the long term to benefit larks and provide for population growth. We define “Matrix lands” as ephemeral habitats and sites with multiple or non-conservation management objectives that are needed to retain the adaptive component of the lark’s ecology that responds to a constantly changing natural environment. Matrix lands may also be managed to benefit larks, but at any given site management would focus on more short-term population benefits.

Lark recovery will require a mix of sites with commitments to provide suitable habitat and support local populations (i.e., Core sites) and sites that opportunistically or incidentally provide suitable habitat and support local populations (i.e., Matrix lands). The key distinctions between Core and Matrix habitats are the purpose and duration of the site's management. If the site has a long-term agreement with explicit management goals to contribute to the recovery of the lark, that site would be considered a Core site in the framework of this recovery plan. If the site will contribute on a short-term basis to lark conservation, or if management for lark conservation will be balanced against other competing management goals for the site, that site would be considered part of the Matrix landscape. Examples of Core sites could include National Wildlife Refuges where lark recovery is a primary management goal among other complementary conservation goals, dredge material disposal sites in the U.S. Army Corps of Engineers' network in the Columbia River, and prairie restoration sites that have specific management goals for larks. Matrix lands could include agricultural lands, airports, active military training ranges, etc.

Core sites with long-term protection for larks will be an important part of the effort to recover the streaked horned lark. However, habitats that are not permanently protected will also perform a vital function by providing the dynamic, shifting conditions that would have been a part of the natural environment within which the streaked horned lark evolved. There are a number of programs that could be implemented on Matrix lands to contribute to lark recovery. Some examples are:

- *Development of incentive programs to encourage the adoption of practices to protect larks on working lands.* The largest area of potential habitat for streaked horned larks is agricultural land in the Willamette Valley of Oregon. Larks are attracted to the wide open landscape and low vegetation structure in agricultural fields. With the loss of the natural processes that formerly created suitable habitat, alternative breeding and wintering sites, including active agricultural lands, have become critical for the continued survival and recovery of the streaked horned lark. When the lark was listed as a threatened species, the Service promulgated a special rule under section 4(d) of the Act to recognize the critical role that agriculture plays in providing suitable habitat. The 4(d) rule exempted take of larks associated with normal agricultural practices in the Willamette Valley as a mechanism to encourage farming practices that create habitat. We also acknowledged that a 4(d) rule to encourage the continuation of current farming practices could open the door to partnerships with agricultural landowners. The 4(d) rule is just the first step towards the goal of sustainable lark populations on agricultural lands; the next step is to develop incentive programs that encourage willing landowners to adopt practices on working lands that will provide habitats that allow for successful breeding and wintering by streaked horned larks on farm lands in the Willamette Valley. These incentive programs may be administered by the Natural Resources Conservation Service and could target a certain percentage of lands within each Willamette Valley region in any year; the specific lands could change from year to year, as dictated by the needs of the landowners.

- *Development of a Programmatic Safe Harbor Agreement for private landowners.* Habitats for listed species that are covered under the Service's Safe Harbor Agreement (SHA) program can advance the recovery of listed species by providing conservation on private or other non-Federal properties. Actions taken under a SHA must provide a net

conservation benefit that contributes to the recovery of the covered species, although the agreement does not have to provide permanent conservation for the enrolled property. Examples of the conservation benefits of SHAs may include reduced habitat fragmentation; maintenance, restoration, or enhancement of existing habitats; increases in habitat connectivity; stabilized or increased numbers or distribution; the creation of buffers for protected areas; and opportunities to test and develop new habitat management techniques. Private landowners benefit from SHAs by gaining assurances that the presence of a listed species on their land will not foreclose options to use the land in the future.

RECOVERY PLAN

Recovery Goal

Recovery of the streaked horned lark will require restoration of a self-sustaining population within the currently known range. The rangewide population must have stable or increasing numbers (taking into account expected levels of annual variability), with population size sufficient to withstand foreseeable long-term threats, and be well-distributed within the South Puget Lowlands, Coast and River, and Willamette Valley regions where suitable habitat is protected and managed to support larks (Figure 1).

Recovery Objectives

1. Develop self-sustaining regional populations of streaked horned lark within the South Puget Lowlands, Coast and River, and Willamette Valley regions that are of sufficient size to ensure long-term population viability.

2. Protect and manage sufficient habitat to support well-distributed regional populations within the South Puget Lowlands, Coast and River, and Willamette Valley regions.

Recovery Criteria

I. Self-Sustaining Population

A. Population Size

The rangewide population target is 5,725 individuals. The population size criteria are further broken down by region and recovery zone in Table 2.

Table 2. Recovery Criteria for the Streaked Horned Lark: Population Size

Region	Recovery Zone	2017 STATUS	RECOVERY CRITERIA				
			Core Sites		*Matrix lands*	*Core sites and Matrix lands*	
		Estimated No. of Individuals	Minimum No. Sites and Pairs per Recovery Zone	Minimum Total No. Sites and Individuals per Recovery Zone	Minimum Individuals per Recovery Zone	Minimum Total Individuals per Recovery Zone	Minimum Individuals per Region
South Puget Lowlands	South Puget Lowlands	252	6 sites with >20 pairs; 2 sites with >10 pairs	8 sites (280 indiv.)	210	700	**700**
Coast and River	Pacific Coast	25	3 sites with >15 pairs	3 sites (90 indiv.)	20	125	**525**
	Columbia River	142	2 sites with >20 pairs; 4 sites with >10 pairs	6 sites (160 indiv.)	70	300	
Willamette Valley	North Willamette	195	3 sites with >15 pairs	3 sites (90 indiv.)	130	350	**4500**
	West Willamette	449	3 sites with >50 pairs; 6 sites with >25 pairs	9 sites (600 indiv.)	450	1500	
	Southeast Willamette	456	3 sites with >50 pairs; 6 sites with >25 pairs	9 sites (600 indiv.)	450	1500	
TOTALS		**1,519**	**>1,820 individuals on 38 core sites**		**>1,330 individuals on matrix lands**	**>4,475 individuals**	**5,725 individuals**

Totals for the recovery criteria population targets by zone and by core vs. matrix lands represent the minimum targets for each category, and do not sum to the regional totals. Recovery criteria at the regional level thus include the minimum targets in the preceding columns as well as additional individuals that may be contributed flexibly by any recovery zone, from core sites and/or matrix lands.

Note that the highlighted column in Table 2 labeled "Minimum Individuals per Region" shows the overall recovery criteria for population size in each region. The preceding columns indicate how these targets may be distributed among sites, recovery zones, and management designations. If populations become established in the North Puget Lowlands or the Southwest Oregon Regions, the population objectives for the currently occupied regions may be adjusted in future amendments to this recovery plan (as consistent with well-distributed regional populations meeting the rangewide target of 5,725 individuals).

Table 2 shows that meeting recovery criteria will require a minimum of 8 Core sites in the Southl Puget Lowlands Region, 9 in the Coast and River Region, and 21 in the Willamette Valley Region. Particularly in the Willamette Valley Region, these sites will likely comprise a network of managed habitats on a mix of public and private lands. Thus we anticipate that the current management for larks on National Wildlife Refuge lands in the Willamette Valley will continue to occur at similar levels, but will need to be supplemented by the establishment of new Core sites based on collaborative agreements to manage additional public or private lands in a manner compatible with lark conservation. We will work with our partners to identify suitable sites for lark recovery. See Appendix 1 (posted at https://www.fws.gov/pacific/ecoservices/endangered/recovery/larkrecovery.html) for a table of potential Core sites and Matrix lands in each recovery region.

B. Growth Rate

Regular population monitoring in each currently occupied region must demonstrate an average population growth rate (lambda, λ) that is stable or increasing in each recovery zone over a 5-year minimum period (i.e., $\lambda \geq 1$) once the population criteria have been met. If the population were declining (i.e., $\lambda < 1$), then we would implement more intensive monitoring to identify mechanisms responsible for the decline. Such monitoring would likely include measurements of fecundity, nest success, and juvenile survival. This information can be used to identify conservation actions that are likely to help reverse a declining trend.

II. Habitat Protection and Management

A. Core Sites

Sufficient habitat must be managed at Core sites to sustain a stable population of larks in each recovery zone. The minimum number of sites and individuals at any time on Core sites in each recovery region and zone is identified in Table 2.

Core sites are defined as sites that are managed specifically to advance the recovery of the streaked horned lark by providing suitable, safe habitat to support a local population in the long-term.

Core sites must meet these criteria:

1. The site must have permanent or long-term conservation provisions. These sites may be purchased and endowed, or managed under a long-term agreement.

2. Each site must have the appropriate characteristics of lark habitat (either as defined below, or in the best current information):

    a. A site is an open and largely treeless expanse of land dominated by grasses, forbs, and bare ground within which suitable habitat patches occur. Site boundaries or edges are typically defined by tree lines, steep hills, or buildings that interrupt the site's open character (Anderson and Pearson 2015, p. 20).

b. A site should exist within a contiguous open landscape (openness conferred by low stature land cover and/or open water) that is over 150 acres (61 hectares) in extent (Anderson and Pearson 2015, p. 20).
c. Each site must be managed to achieve and maintain the characteristics of lark habitat appropriate to the region (Anderson and Pearson 2015, p. 20).

3. A management plan for the site must be prepared and made available to the Service for review and agreement. The plan must specify:

   a. That conservation of larks is one of the main goals of management at the site;
   b. The target number of larks that the site is expected to support (consistent with site population size targets given in Table 2, or other relevant site-specific information); and
   c. A strategy for maintaining suitable habitat and controlling the relevant threats at the site.

B. Matrix Lands

Sufficient area must be managed on Matrix lands in each recovery zone to provide habitat for dynamic local populations of larks that will contribute to the total number of larks in the zone and provide additional genetic inputs to Core sites. The target minimum number of larks on Matrix lands in each recovery zone is identified in Table 2. For at least the near future, we expect Matrix lands to continue to be critically important for maintaining the rangewide streaked horned lark population.

Matrix lands are defined as lands that provide habitat for streaked horned larks, but where management for lark recovery is not the long-term focus of any given site. Matrix lands are generally industrial or working lands. Matrix lands may be shifting and dynamic (e.g., Willamette Valley agricultural lands) or they may be fixed and stable (e.g., airports). Not all Matrix lands will contribute to the recovery of the lark; however, some Matrix lands will contribute to lark recovery when appropriate conservation actions are implemented to improve the survival and reproduction of larks on those lands. These actions could be temporary or intermittent as long as they provide suitable, safe lark habitat encompassing at least one winter or breeding season. For example, agricultural lands that are enrolled in short-term incentive programs could provide habitat that contributes to recovery of the lark by increasing successful reproduction and recruitment into the regional population.

Recovery Actions

The list of recovery actions below shows the general actions that are expected to achieve the recovery goals established for the streaked horned lark. Each general action category is assigned a recovery action priority ranking (see box). Additional detail regarding the specific tasks that will accomplish the aims of each recovery action is provided in the Recovery Implementation Strategy. The interrelation of recovery actions with threats and recovery criteria is summarized in Table 3 below.

Recovery Action Priority Rankings:

- **Priority 1a**: Actions that must be taken to prevent extinction or to prevent the species from declining irreversibly.
- **Priority 1b**: Actions that by themselves will not prevent extinction, but which are needed to carry out a Priority 1a action.
- **Priority 2**: Actions that must be taken to prevent a significant decline in species population/ habitat quality or some other significant negative impact short of extinction.
- **Priority 3**: All other actions necessary to provide for full recovery of the species.

1. **Determine population status, trend and current distribution.** (Priority 1b)
Accurate, current information is essential to track progress towards recovery goals.

1.1. Complete development of a rangewide population monitoring protocol.
1.2. Monitor the rangewide population, tracking trends and distribution.

2. **Conserve and enhance populations.** (Priority 1a)
Increasing the number of sites managed for larks across the range will address the primary threat of habitat loss to the species. Improved management should increase survival and nesting success, resulting in regional and rangewide population growth.

2.1. Conserve larks in the South Puget Lowlands region.
2.1.1. Implement conservation actions on Core sites in the South Puget Lowlands region.
2.1.1.1. Identify and conserve current and potentially suitable sites.
2.1.1.2. Implement long-term conservation programs that enhance survival on Core sites.
2.1.2. Implement conservation actions on Matrix lands in the South Puget Lowlands region.
2.1.2.1. Identify priority Matrix lands.
2.1.2.2. Develop and implement conservation programs that enhance survival on Matrix lands.

2.2. Conserve larks in the Coast and River region.
2.2.1. Implement conservation actions on Core sites in the Coast and River region.
2.2.1.1. Identify and conserve current and potentially suitable sites.
2.2.1.1.1. Where feasible, incorporate potential Core sites into the NWR system for management.
2.2.1.2. Implement long-term conservation programs that enhance survival on Core sites.
2.2.2. Implement conservation actions on Matrix lands in the Coast and River region.
2.2.2.1. Identify priority Matrix lands.

2.2.2.2. Develop and implement conservation programs that enhance survival on Matrix lands.

2.3. Conserve larks in the Willamette Valley region.
2.3.1. Implement conservation actions on Core sites in the Willamette Valley region.
2.3.1.1. Identify and conserve current and potentially suitable sites.
2.3.1.1.1. Where feasible, incorporate potential Core sites into the NWR system for management.
2.3.1.2. Implement long-term conservation programs that enhance survival on Core sites.
2.3.2. Implement conservation actions on Matrix lands in the Willamette Valley region.
2.3.2.1. Identify priority Matrix lands.
2.3.2.2. Develop and implement conservation programs that enhance survival on Matrix lands.

3. Identify limiting factors and develop solutions. (Priority 1b)
Better information and new tools are essential to make progress towards recovery.

3.1. Conduct research on threats to population viability.
3.1.1. Evaluate need and most appropriate methods for predator control and implement where needed.
3.1.2. Investigate the effects of various herbicides and pesticides used in the agricultural landscapes where larks are found.
3.1.3. Determine additional critical research areas to advance recovery.
3.2. Develop tools to protect and enhance local populations, to create new local populations, and to expand the distribution of the lark.
3.2.1. Evaluate appropriateness and feasibility of population augmentation, relocation or reintroduction (e.g., investigate lark colonization, captive rearing, hacking, cross fostering, genetic rescue, and translocation).
3.2.2. Evaluate the role of conspecific attraction in establishing conditions that are needed to attract a breeding population to a new site.
3.3. Develop tools to enhance habitat and lark survival and reproduction on Matrix lands.
3.3.1. Evaluate and map high priority Matrix lands (e.g., potentially suitable agricultural lands near currently occupied sites, within Priority Conservation Areas, etc.) to direct incentives and outreach to the areas most likely to provide successful lark habitat sites.
3.3.2. Develop a list of practices to protect larks during the breeding season on agricultural lands.
3.3.3. Evaluate novel habitat creation options such as leasing habitat for larks, selective field fallowing, or conservation burning.
3.3.4. Develop incentive programs for agricultural producers to create and maintain appropriate lark habitat on working lands.
3.4. Develop a Programmatic Safe Harbor Agreement to promote lark habitat creation on private agricultural lands.
3.5. Develop a mitigation strategy for offsetting the effects of non-Federal development in occupied lark habitats.

3.6. Develop strategies to integrate lark conservation into landscapes managed for recovery of other rare prairie and grassland species in the range of the lark.
3.7. Develop a Memorandum of Understanding with the Federal Aviation Administration (FAA) to guide FAA contributions toward conserving local lark populations, including establishing new lark populations at non-airport sites.
3.8. Develop other strategies necessary to address factors affecting larks and their habitats.

4. **Promote outreach and cooperation with stakeholders and partner agencies.** (Priority 2) Recovery will require working in partnership with Federal, state and private entities to recover the lark across the range.

4.1. Facilitate coordination and information sharing.
4.1.1. Continue to fund a position to work with agricultural landowners in the Willamette Valley to enhance lark conservation on private farm lands.
4.2. Develop outreach and educational materials.

5. **Develop and implement a post-delisting monitoring plan. (**Priority 3)
As threats to the species are addressed and the lark approaches the targets established in this recovery plan, a plan to monitor after delisting will be needed to ensure that the rangewide population remains secure.

Table 3. Crosswalk relating Streaked Horned Lark Threats, Recovery Criteria, and Recovery Actions.

Listing Factor	Threat	Recovery Criteria	Recovery Action
A **Present or Threatened Destruction, Modification or Curtailment of its Habitat or Range**	Loss, conversion, and degradation of habitat, particularly as a consequence of agricultural, industrial, and urban development	II.A., II.B.	2.1, 2.2, 2.3. And all subordinate actions, 3.6., 3.8., 4.1., 4.2.
	Loss of natural ecological disturbance processes	II.A., II.B.	2.1, 2.2, 2.3. And all subordinate actions
	Successional changes in grassland habitats and encroachment of woody vegetation	II.A.	2.1, 2.2, 2.3. And all subordinate actions
	Spread of invasive beach grasses	II.A.	2.2.1.2., 2.2.2.2.
	Incompatible management activities at occupied sites, including: Mowing on airports, Military training and associated activities, and Dredge material deposition on Columbia River islands	II.B.	2.1.1.2., 2.1.2.2., 2.2.1.1.1., 2.2.1.2., 2.2.2.2., 2.3.1.1.1., 2.3.1.2., 2.3.2.2., 3.5., 3.7., 4.1., 4.2.
	Transient agricultural habitat, including: Conversion to incompatible crops; and Ephemeral habitats	II.B.	2.3.2.1., 2.3.2.2., 3.1.2, 3.3.1., 3.3.2., 3.3.3., 3.3.4., 3.4., 4.1., 4.1.1., 4.2.
B **Overutilization**	N/A		
C **Disease or Predation**	Predation on small populations	II.A.	2.1.1.2., 2.1.2.2., 2.2.1.2., 2.2.2.2., 2.3.1.1., 2.3.2.2., 3.1.1.
	Avian pox on the Puget Lowlands	II.A.	3.1.3.
D **Inadequacy of Existing Regulatory Mechanisms**	Canadian, U.S. Federal, State, and local laws and regulations are not adequate to protect the lark	II.A., II.B.	2.1, 2.2, 2.3. And all subordinate actions
E **Other Natural or Manmade Factors**	Small rangewide population	I.A., I.B.	1.1., 1.2., 3.2.1., 3.2.2.
	Low genetic diversity, small and isolated populations, and low reproductive success	I.A., I.B.	2.1., 2.2., 2.3., 3.1.3., 3.2.1., 3.2.2.
	Climate change	II.A., II.B.	2.1., 2.2., 2.3. And all subordinate tasks
	Stochastic weather events	I.A., II.A., II.B.	2.1., 2.2., 2.3. And all subordinate tasks
	Aircraft strikes and other activities at military and civilian airports	II.B.	2.1.1.2., 2.1.2.2., 2.2.1.2., 2.2.2.2., 2.3.1.2., 2.3.2.2., 3.2.1., 3.2.2., 3.3.1., 3.7.
	Recreation	II.A., II.B.	2.1., 2.2., 2.3. And all subordinate tasks
	Pesticide poisoning	II.B.	3.1.2., 3.3.2.

Estimated Cost and Date of Recovery

Attaining the recovery criteria for the streaked horned lark is expected to take approximately 25 years. The cost estimates in Table 4 correspond to specific actions needed to achieve streaked horned lark recovery. Some costs, particularly those associated with land acquisition, are not determinable at this time because Core sites for lark recovery are likely to be composed of a mix of existing conservation sites, long-term or permanent easements, and outright purchase. The high end of the cost for land acquisition assumes all Core sites are purchased. However, if Core sites are established on existing conservation lands or on easements, the cost would be substantially lower; thus we present a range of land acquisition costs.

Table 4. Estimated Cost to Recover the Streaked Horned Lark.

Recovery Action	Estimated Cost	Priority
1. Determine population status, trend and current distribution.	$530,000	1b
2. Protect and enhance populations.		
Habitat management	$2,200,000	1a
Land acquisition	$17,500,000 - 75,600,000	1a
3. Identify limiting factors and develop solutions.	$420,000	1b
4. Promote outreach and cooperation with stakeholders and partner agencies.	$2,270,000	2
5. Develop and implement a post-delisting monitoring plan.	To be determined	3
Total Estimated Cost: $22,920,000 - $81,020,000 over approximately 25 years		

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