

SPECIES STATUS ASSESSMENT FOR THE STREAKED HORNED LARK
VERSION 1.0



Streaked horned lark nestlings, photo by Nick Atwell, Port of Portland

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EXECUTIVE SUMMARY

The streaked horned lark (*Eremophila alpestris strigata*), a small songbird endemic to the Pacific Northwest, was listed as a threatened species in 2013 with critical habitat designated on portions of the outer coast of Washington, islands in the lower Columbia River, and the Willamette Valley National Wildlife Refuge Complex in Oregon. This Species Status Assessment report provides an overview of our current understanding of the biology and natural history of the streaked horned lark and assesses its current and future viability.

The U.S. Fish and Wildlife Service uses the conservation principles of resiliency, redundancy, and representation to inform our approach to assess the viability of threatened and endangered species. Viability is gauged by the ability of the species to withstand disturbances of varying magnitude and duration (i.e., resiliency), the ability of the species to withstand catastrophic events (i.e., redundancy), and the species' ability to adapt to changing environmental conditions (i.e., representation). The viability of a species is also dependent on the influence of new or continued stressors now and in the future that act to reduce the species' resiliency, redundancy, and representation.

The streaked horned lark historically occurred on the native prairies, river floodplains, and ocean shores west of the Cascade Range from southern British Columbia, Canada, south through the Puget lowlands and outer coast of Washington, along the Columbia River, throughout the Willamette Valley, on the Oregon coast, and into the Umpqua and Rogue Valleys of southwestern Oregon. Its range has contracted, and it is now found only at scattered sites in the South Puget Lowlands, the Pacific Coast, the Lower Columbia River, and the Willamette Valley. The streaked horned lark has been extirpated from British Columbia, and the Umpqua and Rogue Valleys of Oregon.

Habitat used by the streaked horned lark is generally flat with substantial percentage of bare ground and sparse low-stature vegetation. Streaked horned larks historically selected habitat in relatively flat, open areas maintained by natural processes of flooding, fire, and sediment transport dynamics. The interruption of these natural processes due to flood control dams, fire suppression, and reduction of sediment transport by dams has resulted in a steep decline in the quantity, quality, and distribution of suitable habitat for the lark.

The current influences on streaked horned lark viability are the ongoing loss and degradation of suitable habitat, military training, land management activities and related effects, recreation, and aircraft strikes. Conservation measures to benefit the lark have been implemented at a number of sites throughout the lark's range, partially ameliorating the adverse effects of these threats. Threats that influence individuals, but which are not known to influence populations or have a species-level affect include predation, disease, and pesticides. These factors were not considered in our analysis of species viability.

Currently, there are 42 local populations distributed across three distinct representative areas based on ecological uniqueness, each with a mix of high, moderate, and low resiliency. In general, the local populations with low condition have low abundance that has declined since 2013, and populations occur in locations that have less habitat availability and therefore limited capacity to support high numbers of birds. In addition,

certain land management activities at these locations, such as construction and development or sand-borrow activities on the Columbia River would not support long-term resiliency even if population abundance stabilized and increased. Use of these sites is opportunistic based on habitat availability, and most of these sites are not anticipated to meaningfully contribute to subspecies viability or support high numbers of birds.

We forecasted what the streaked horned lark may experience in terms of resiliency, redundancy, and representation under three plausible future scenarios over the next 30 years: Status Quo Scenario, Improved Condition Scenario, and the Degraded Conditions Scenario.

The Status Quo Scenario assumes habitat conditions and management actions, including regulatory and conservation actions, would continue to maintain suitable habitat for the larks consistent with current levels. Under the status quo scenario, one population in the South Puget Lowlands drops from high to moderate condition, four local populations in the Pacific Coast and Columbia River region drop from moderate to low condition, and all five moderate populations in the Willamette Valley drop to low condition. Even though influence factors do not change in magnitude from current levels under this scenario, the synergistic effects of small population size would amplify the negative effect of the factors influencing some local populations. Under this scenario, the subspecies would continue to occupy roughly an equal number of habitat types and distribution of 42 local populations across the range, but some small, isolated populations may be at risk of eventual extirpation without intentional habitat management or conservation measures.

The Improved Conditions Scenario assumes the quality, quantity, and availability of suitable habitat would support increasingly stable local populations, allowing larks to disperse and increase the number of local populations. This scenario assumes careful management and conservation actions are implemented to increase the quantity, quality, and distribution of suitable habitats for streaked horned larks. One local population in the South Puget Lowlands and three in the Pacific Coast and Columbia River region improve from moderate to high condition, and one population in each of the South Puget Lowlands and Willamette Valley regions shift from low to moderate. As local populations become more resilient under this scenario, the species' ability to move between sites in response to changing environmental conditions and reestablish breeding populations would increase overall redundancy, further buffering against adverse effects of catastrophic events. With respect to ecological representation, it is unlikely that individuals would occupy new or different habitat types relative to current patterns of occupancy in the Pacific Coast and Lower Columbia region due to the limited availability of alternative habitats that provide the structural habitat features preferred by larks. In the South Puget Lowlands and Willamette Valley regions, the number of resilient local populations would increase.

The Degraded Conditions Scenario assumes the quality, quantity, and availability of suitable habitat would despite implementing current levels of management on existing sites. Under the degraded conditions scenario, further habitat loss and increased instability would reduce the condition of many local populations, and only one high condition local population would remain in the range of the subspecies (Rice Island).

Eighteen local populations would decrease in condition across the range of the streaked horned lark, leaving 10 moderate condition and 30 low condition populations distributed across the three regions. Shelton Airport would be extirpated. Under this scenario redundancy would decrease due to the extirpation of a population, and many other local populations would decrease in resiliency and be at higher risk of extirpation, putting the subspecies at risk of further reduction in redundancy. If local populations become less resilient, larks would be less able to move between sites in response to changing environmental conditions or re-establish local populations following a catastrophic event. Furthermore, the loss of local populations would decrease the species' representation and overall ability to adapt to changing environmental conditions.

Abbreviations

ac – acre or acres

Act – Endangered Species Act

BBS – North American Breeding Bird Survey

cm – centimeter or centimeters

cm/mo – centimeter per month

Corps – U.S. Army Corps of Engineers

ha – hectare or hectars

in – inch or inches

in/mo – inch per month

JBLM – Joint Base Lewis-McChord

NASS - National Agricultural Statistics Service

NWR – National Wildlife Refuge

ODFW – Oregon Department of Fish and Wildlife

ODSL – Oregon Department of State Lands

OPRD – Oregon Parks and Recreation Department

SSA – Species Status Assessment

USFWS or Service – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

WDFW – Washington Department of Fish and Wildlife

WRP – Wetland Reserve Program

WV NWR – Willamette Valley National Wildlife Refuge Complex

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1. INTRODUCTION

The streaked horned lark (*Eremophila alpestris strigata*) is a small songbird endemic to the Pacific Northwest (Beason 1995, p. 4); it was historically found in British Columbia, Washington, and Oregon (Altman 2011, p. 196). This Species Status Assessment (SSA) report provides a review of the species' biology and stressors, which we use to evaluate the species' current and future status and viability. The intent is for this SSA report to be easily updated as new information becomes available and to support all functions of the U.S. Fish and Wildlife Service's (Service) Endangered Species Program, from consultations and permitting to recovery planning.

1.1. Background

The streaked horned lark was listed as a threatened species in 2013, under the Endangered Species Act of 1973, as amended (Act) (16 U.S. C. 1531 et seq.) (U.S. Fish and Wildlife Service 2013a, entire). Critical habitat was simultaneously 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 (WV NWR) (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 the lark's use of working and industrial lands demands flexibility, and it encourages landowners to continue those practices that provide habitat for the streaked horned lark, even though creation of suitable habitat causes 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.

To help guide the recovery effort for streaked horned larks, we prepared and released a draft Recovery Plan for the Streaked Horned Lark for public comment on October 30, 2019 (84 FR 58170) (U.S. Fish and Wildlife Service 2019a, entire). The draft plan articulates draft recovery zones and recovery criteria for the conservation of the streaked horned lark. The draft plan was supported by two supplementary documents: a Species Biological Report, which describes the current status of the species and assesses threats using the best available scientific information; and a Recovery Implementation Strategy, which details specific near-term activities identified in the draft recovery plan (U.S. Fish and Wildlife Service. 2019b, entire).

On February 28, 2018, the Center for Biological Diversity filed suit against the Department of the Interior and the Service on the listing and 4(d) rules (78 FR 61498). The court did not vacate the rules but remanded them for reconsideration; the critical habitat designation was not part of the lawsuit. The Service agreed to submit a new proposed listing rule to the Federal Register by March 31, 2021 incorporating new information that was anticipated to become available in late 2019. Additionally, the Service proposed reconsideration of its 4(d) rule, in accordance with the Court's remand instructions, provided the Service determines to propose listing the subspecies as

threatened rather than endangered. To facilitate reconsideration of new information and the proposed rule in general, the Service determined that a full, new analysis of the best available scientific information according to our now standard SSA Framework (U.S. Fish and Wildlife Service 2016, entire) was appropriate.

1.2. Analytic Framework

Our comprehensive analysis through the SSA Framework results in the development of a report that is intended to provide biological support for the decision of whether or not to list the streaked horned lark as threatened or endangered and, if so, whether to and where to propose designating critical habitat. This SSA report does not result in a decision by the Service on whether this taxon should be proposed for listing as a threatened or endangered species under the Act. Instead, this SSA report provides a review of the available information strictly related to the biological status of the streaked horned lark. The listing decision will be made by the Service after reviewing this document and all relevant laws, regulations, and policies. The results of a proposed decision will be announced in the Federal Register, with appropriate opportunities for public input.

This SSA report is intended to be a concise review of the species' biology, factors influencing historic conditions, an evaluation of its current status and future viability, and an assessment of the resources and conditions needed to maintain long-term viability. This report is a living document and can be updated as new information becomes available, including information that supports other documents such as recovery plans and 5-year reviews, and future decisions about the species' listing status and critical habitat designations.

Using the SSA Framework (Figure 1), we consider what a species needs to maintain viability by characterizing the current and future biological status of the species (U.S. Fish and Wildlife Service 2016a, entire; Smith *et al.* 2018, entire).

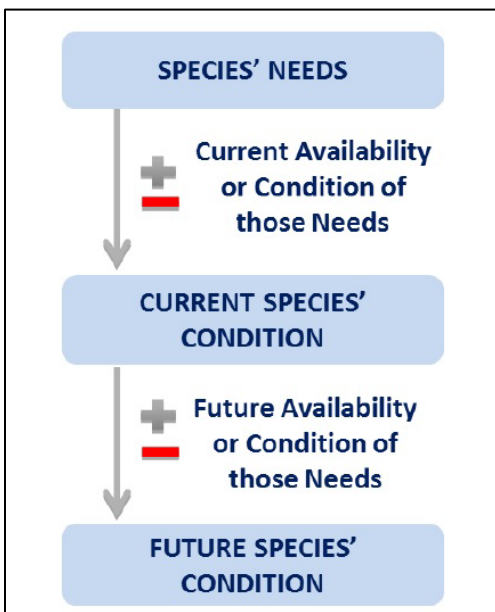


Figure 1. Species Status Assessment Framework

For this assessment, we generally define viability as the species' ability to sustain well-distributed populations in its natural habitat over the long-term. To help us do this, we characterize the species in terms of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 307, 309–310; Wolf *et al.* 2015b, pp. 204–5). Resiliency, redundancy, and representation, hereafter referred to the “3Rs”, are defined as:

- **Resiliency** means having sufficiently large populations for the species to withstand stochastic events (arising from random factors)¹. We can measure resiliency based on metrics of population health—for example, population size and recruitment. Resilient populations are better able to withstand disturbances such as random fluctuations in birth rates and recruitment (demographic stochasticity), variations in rainfall or extreme weather events (environmental stochasticity), or the effects of human activities.
- **Redundancy** means having a sufficient number of populations for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations). Redundancy is about spreading the risk and can be measured through the duplication and distribution of populations across the range of the species. Generally, the greater the number of populations a species has distributed over a larger landscape, the better it can withstand catastrophic events.
- **Representation** means having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human-caused) in its environment. In the absence of species-specific genetic and ecological diversity information, we evaluate representation based on the extent and variability of the species' morphology, habitat characteristics within the geographical range, or both.

The term *population* is generally accepted to mean a group of potentially interbreeding individuals within a defined area. Although streaked horned larks occur across the current range of the species during the breeding season, most of the members of the subspecies congregate in the winter either in the Willamette Valley or at sites 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.”

¹ A stochastic event is one that is random or unpredictable, and not represented by a stable pattern or order. For our purposes, populations experience various types of stochasticity that cause random fluctuations in population growth rate through temporal variation of birth and death rates, carrying capacity, and the population of competitors, predators, parasites and diseases. Environmental stochasticity refers to an unpredictable spatiotemporal fluctuation in environmental conditions. Demographic stochasticity results from chance independent events of individual mortality and reproduction. Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding.

- When referring to the streaked horned larks that breed in any of the three 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. We will refer to these breeding site aggregations as “local populations.”

Evaluating the individual breeding sites as local populations allowed us to capture the variability of resiliency, redundancy, and representation for the species across its range. We do not consider all local populations to be self-sustaining, even if the population size is relatively stable over time, especially for sites with very few (i.e. less than 3 breeding pairs). Some local sites are unable to support resilient populations due to disturbance regimes that reduce habitat availability or suitability.

While SSAs are typically conducted to inform classification decisions on petitioned species, the Service can also do SSAs on listed species (as is the case with the streaked horned lark SSA). The best available information that informs an SSA for a listed species often includes an established body of literature developed by the Service, including 5-year reviews, recovery plans, and other documents. Incorporating information from other Service documents such as the draft recovery plan and species biological report is not always a fluid process. The focus or framework for other documents does not necessarily align with the 3R framework by which we approach the status review in an SSA. While we reviewed the draft recovery plan and other existing Service documents to inform this SSA, we looked to the SSA framework for the identification and development of an analytical approach and meaningful metrics by which to characterize current and future species viability.

The decision whether to list, downlist, or delist a species is not based on a prediction of the most likely future for the species, but rather on an assessment of the species’ risk of extinction. Therefore, to inform this assessment of extinction risk, we describe the species’ current biological status and assess how this status may change in the future to account for the uncertainty of the species’ future. We evaluate the future biological status of the streaked horned lark by describing future scenarios representing the plausible conditions for the primary factors affecting the species. In addition, we forecast the projected future condition for the species in those scenarios in terms of the 3Rs. As a matter of practicality, the full range of potential future scenarios and the range of potential future conditions for each potential scenario are too large to individually describe and analyze, therefore our analysis does not include all possible futures.

2. SPECIES ECOLOGY AND HABITAT NEEDS

2.1. Taxonomy & Genetics

Horned larks are found throughout the northern hemisphere (Beason 1995, p. 1); they are the only true lark (Family Alaudidae, Order Passeriformes) native to North America (Beason 1995, p. 1). There are 42 subspecies of horned lark worldwide (Clements *et al.* 2017, entire). Twenty-one subspecies of horned larks are found in North America; 15 of the 21 subspecies occur in western North America (Beason 1995, p. 4). Streaked horned larks only occur at lower elevation sites in Washington and Oregon west of the Cascade

mountains. Subspecies of horned larks are based primarily on differences in color, body size, and wing length. Molecular analysis has further borne out these morphological distinctions (Drovetski *et al.* 2005, p. 875).

Western populations of horned larks are generally paler and smaller than eastern and northern subspecies (Beason 1995, p. 3). The streaked horned lark was first described as *Otocorys alpestris strigata* in 1884 (Henshaw 1884, pp. 261–264, 267–268); the type locality was Fort Steilacoom, Washington (Henshaw 1884, p. 267). There are four other breeding subspecies of horned larks in Washington and Oregon: the St. Helens or “Alpine” horned lark (*E. a. alpina*); the dusky horned lark (*E. a. merrilli*); the Oregon or Warner Valley horned lark (*E. a. lamprochroma*); and the pallid or “Arctic” horned lark (*E. a. arctica*) (Behle 1942, pp. 219–231; Jewett 1943, p. 262; Marshall *et al.* 2003, p. 426; Wahl *et al.* 2005, p. 268). None of these other subspecies breed within the range of the streaked horned lark, but all five subspecies winter together in the Willamette Valley, where they may be found in mixed-species flocks (Marshall *et al.* 2003, pp. 425–427).

The genetic distinctiveness, conservation status, and level of genetic diversity of the streaked horned lark was evaluated in 2005 using the complete mitochondrial ND2 gene (Drovetski *et al.* 2005, p. 877). Streaked horned larks were found to be closely related to individuals from California and only distantly related to the three closest localities (alpine Washington, eastern Washington, and eastern Oregon). There was no evidence of immigration into the streaked horned lark’s range from any of the sampled localities. Analyses indicate that the streaked horned lark’s rangewide population is well-differentiated and isolated from all other sampled localities, including coastal California, and has “remarkably low genetic diversity” (Drovetski *et al.* 2005, p. 875).

While the streaked horned lark was “. . . historically a part of a larger Pacific Coast lineage of horned larks, it has been evolving independently for some time and can be considered a distinct evolutionary unit” (Drovetski *et al.* 2005, p. 880). Thus, genetic analyses support the subspecies designation for the streaked horned lark (Drovetski *et al.* 2005, p. 880), which is considered a relatively well-defined subspecies based on physical (phenotypic) characteristics (Beason 1995, p. 4). The streaked horned lark is recognized as a valid subspecies by the Integrated Taxonomic Information System (Integrated Taxonomic Information System 2018).

2.2. Morphologic Description and Life History

All horned larks are small, ground-dwelling birds, approximately 6–8 inches (in) (16–20 centimeters [cm]) in length (Beason 1995, p. 2). Adults are pale brown, but shades of brown vary geographically among the subspecies. The male’s face has a yellow wash in most subspecies. Adults have a black bib, black whisker marks, black “horns” (feather tufts that can be raised or lowered), and black tail feathers with white margins (Beason 1995, p. 2). Juveniles lack the black face pattern and are varying shades of gray, from almost white to almost black with a silver speckled back (Beason 1995, p. 2). Streaked horned larks are endemic to the Pacific Northwest. They have a dark brown back, yellowish underparts, a walnut brown nape, and yellow eyebrow stripe and throat (Beason 1995, p. 4). This subspecies is conspicuously more yellow beneath and darker on

the back than most other subspecies of horned lark. The combination of small size, dark brown back, and yellow underparts distinguishes this subspecies from adjacent forms.

Horned larks forage on the ground in low vegetation or on bare ground (Beason 1995, p. 6); adults feed mainly on the seeds of grasses and forbs, but feed insects to their young (Beason 1995, p. 6). At coastal sites, streaked horned larks forage in the wrack line and in intertidal habitats (Pearson and Altman 2005, p. 8). A study of winter diet selection found that streaked horned larks in the Willamette Valley eat seeds of introduced weedy grasses and forbs, focusing on the seed source that is most abundant (Moore 2008b, p. 9).

Horned larks initiate breeding when one year old (Beason 1995, p. 15). The nesting season (i.e. clutch initiation to fledging) for streaked horned larks begins in mid-April and ends in late August, with peaks in May and June (Pearson and Hopey 2004, p. 11; Moore 2011, p. 32; Wolf 2011, p. 5; Wolf and Anderson, 2014, p. 19). Females lay a clutch ranging in size from one to five eggs, with an average of three eggs (Pearson and Hopey 2004, p. 12). After the first nesting attempt in April, streaked horned larks will often re-nest in late June or early July (Pearson and Hopey 2004, p. 11). Young streaked horned larks leave the nest by the end of the first week after hatching and are cared for by the parents until they are about four weeks old, when they become independent (Beason 1995, p. 15). Like most passerines, streaked horned larks are short-lived birds.

The majority of streaked horned larks winter in the Willamette Valley (72 percent) and on the islands in the Lower Columbia River (20 percent); the rest winter on the Pacific Coast (8 percent) or in the South Puget Lowlands (1 percent) (Pearson *et al.* 2005a, p. 2). In the winter, most streaked horned larks that breed in the South Puget Lowlands migrate south to the Willamette Valley or west to the Pacific Coast; streaked horned larks that breed along the coast either remain on the coast or migrate south to the Willamette Valley (Pearson *et al.* 2005a, pp. 5–6). Birds that breed along the Lower Columbia River islands remain on the islands or migrate to the coast, and birds that breed in the Willamette Valley remain in the valley over the winter (Pearson *et al.* 2005a, pp. 5–6). Streaked horned larks spend the winter in large groups of mixed subspecies of horned larks in the Willamette Valley, and in smaller flocks along the Columbia River and coast (Pearson *et al.* 2005a, p. 7; Pearson and Altman 2005, p. 7).

2.3. Habitat Characteristics

Horned larks are birds of wide-open spaces. Historically, streaked horned larks nested in flat, open areas in grasslands, estuaries, and sandy beaches in British Columbia; in dune 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 and maintained by natural ecological processes of flooding, fire, and coastal sediment transport dynamics, as well as prairies maintained by Native American burning. Today, these processes no longer operate due to river regulation for flood control and hydropower generation, fire suppression, interruption of sediment transport by dams, and stabilization of dune habitats by non-native species such as Scotch broom (*Cytisus scoparius*) and Eurasian and American beachgrass (*Ammophila arenaria* and *A. breviligulata*, respectively).

Currently, streaked horned larks nest in a broad range of habitats, including prairies, coastal dunes, fallow and active agricultural fields, wetland mudflats, sparsely vegetated edges of grass fields, recently planted Christmas tree farms with extensive bare ground, fields denuded by overwintering Canada geese (*Branta canadensis*), gravel roads or gravel shoulders of lightly traveled roads, airports, and dredge material placement sites along the Columbia River (Altman 1999, p. 18; Pearson and Altman 2005, p. 5; Pearson and Hopey 2005, p. 15; Moore 2008a, pp. 9-10, 12-14, 16). Streaked horned larks exhibit high nest site fidelity (Pearson *et al.* 2008a, p. 11, Wolf *et al.* 2020a, p. 6), generally returning to a site until it becomes too densely vegetated to be suitable for breeding. Wintering streaked horned larks use habitats that are similar to breeding habitats (Pearson *et al.* 2005a, p. 8).

Streaked horned larks have a strong affinity for recently disturbed habitats. An experimental study at Joint Base Lewis-McChord (JBLM) in Washington found that larks had a highly significant preference for burned versus unburned fields, and in the breeding season following a fire, lark abundance was significantly higher on the burned plots (Pearson *et al.* 2005b, p. 14). The decline of the streaked horned lark regional population in the Willamette Valley is correlated with the reduction in agricultural field burning. Prior to the mid-1980s, as much as 250,000 acres (ac) (100,000 hectares [ha]) of grass seed fields were burned each year in the Willamette Valley (Oregon Department of Environmental Quality and Oregon Department of Agriculture 2011, p. 1). In the 1990s, the State of Oregon imposed progressive reductions in field burning, and until 2012 virtually no burning was allowed throughout the Willamette Valley (Oregon Department of Environmental Quality and Oregon Department of Agriculture 2011, p. 1).

Suitable habitat for breeding averages 17 percent bare ground (Altman 1999, p. 18); nest sites generally have a variable percentage of bare ground (Willamette Valley, 31 percent bare ground [Altman 1999, p. 18], South Puget Lowlands, 17.5 percent bare ground [Pearson and Hopey 2005, p. 22], and Washington coast, 66.7 percent bare ground [Pearson and Hopey 2005, p. 22]). Vegetation in suitable habitat consists primarily of low-statured grasses and forbs (generally less than 13 in (33 cm)) tall (Altman 1999, p. 18; Pearson and Hopey 2005, p. 27). Larks eat a wide variety of seeds and feed and insects to their young (Beason 1995, p. 6), and they appear to select habitats based on the structure of the vegetation rather than the presence of specific food plants (Moore 2008b, p. 19).

A key attribute of suitable lark habitat is an open landscape free from visual obstructions. Sites used by larks are generally found in open (i.e., flat, treeless) landscapes of 300 ac (120 ha) or more (Converse *et al.* 2010, p. 21). Larks may also use sites smaller than 300 ac as long as they contain appropriate characteristics (i.e., bare ground, low-statured vegetation) and are adjacent to larger, open areas; this situation is common in agricultural habitats and on sites next to water (Anderson and Pearson 2015, p. 11). For example, many of the sites used by streaked horned larks on the islands in the Columbia River are less than 100 ac (40 ha), but are adjacent to open water, which provides the preferred open landscape context. Local populations of streaked horned larks are found at many airports within the subspecies' range, since airfields typically have open landscapes. Aircraft safety and wildlife hazard management programs manage vegetation on airfields

to reduce the risk of wildlife and aircraft collisions, which simultaneously maintains vegetation structure preferred by larks.

Although streaked horned larks use a wide variety of habitats, local populations are vulnerable because the habitats used are often ephemeral or subject to frequent human disturbance. Ephemeral habitats include bare ground in agricultural fields and wetland mudflats, where vegetation characteristics change within a growing season, or between seasons or years. Habitats subject to frequent disturbance include mowed fields at airports, managed road margins, agricultural crop fields, and dredged material placement sites (Altman 1999, p. 19). It is important to note the key role of managed landscapes in providing and maintaining habitat for the streaked horned lark, even though some actions employed to manage such areas may negatively impact individual larks. Without regular large-scale, manmade disturbance (e.g., burning, mowing, herbicide application, crop rotation, and placement of dredged materials), the quantity of suitable habitat available to larks would decrease rapidly.

2.4. Reproduction

Horned larks form breeding pairs in the spring (Beason 1995, p. 11) and territory size is variable. Based on a sample of three territories in the Willamette Valley, streaked horned larks were found to have a mean territory size of 1.9 ac (0.77 ha) with a range of 1.5 to 2.5 ac (0.61 to 1.0 ha) (Altman 1999, p. 11). Home ranges for 16 pairs of larks on nesting territories at JBLM were assessed using a kernel density method; the mean home range size was 11.6 ac (4.7 ha), and ranged in size from 4.0 to 20.6 ac (1.6 to 8.3 ha) (Wolf *et al.* 2017, p. 12). Home ranges overlapped substantially, which is not surprising given the semi-colonial breeding behavior of the species (Wolf *et al.* 2017, p. 12). Territory mapping on islands along the Columbia River was conducted using minimum convex polygons to estimate home range sizes; home range sizes varied widely between sites and across years (e.g., on Brown Island, the average home range size varied from 2.3 to 5.1 ac [0.9 to 2.1 ha]; on Crims Island, the average home range size varied from 4.4 to 5.2 ac [1.8 to 2.1 ha]) (Slater and Treadwell 2017, pp. 18-23 and 27-28). The variability in territory and home range size across the range of the streaked horned lark may be due to regional differences in habitat, but this issue has not been well studied.

Horned larks create nests in shallow depressions in the ground and line them with soft vegetation (Beason 1995, p. 12). Nest sites are selected from suitable locations within a male's territory, which are typically sparsely vegetated, rockier, and have more annual grasses than nearby areas (Pearson and Hopey 2005, p. 19). Female horned larks construct the nest without help from the male (Beason 1995, p. 12). Streaked horned larks establish their nests in areas of extensive bare ground, and nests are almost always placed on the north side of a clump of vegetation or other objects such as root balls or soil clumps (Pearson and Hopey 2005 p. 23; Moore and Kotaich 2010, p. 18). Studies across the lark's range have found strong natal fidelity to nesting sites, which limits recruitment into new or unpopulated areas; 75 percent of streaked horned larks return each year to the place they were hatched or spent their first breeding season, whereas 25 percent of juvenile birds disperse to a different site (Pearson *et al.* 2008a, p. 11; Moore 2017a, p. 15; Wolf *et al.* 2017, p. 31; Wolf *et al.* 2020, p. 6).

Studies of nest success (i.e., the proportion of nests that result in at least one fledged chick) for streaked horned larks report highly variable results, consistent with ground-nesting passerines (Best 1978, pp. 16-20; Johnson and Temple 1990, p.6). Initial studies in the South Puget Lowlands region determined that nest success was very low, with only 28 percent of nests successfully fledging young (Pearson and Hopey 2004, p. 14; Pearson and Hopey 2005, p. 16); subsequent research has found nest success rates varied between 30 and 64 percent depending on the year (Wolf *et al.* 2016, p. 24). A recent regional analysis showed nest success varied between 25 and 40 percent (Moore *et al.* 2019, p. 8).

2.5. Summary of Habitat and Demographic Needs

Streaked horned larks need open habitats like grasslands, prairies, wetlands, beaches, dunes, and modified or temporarily disturbed habitats such as agricultural or grass seed fields, airports, dredged material placement sites, or gravel roads. Streaked horned larks also need flat landscapes with sparse vegetation, preferring habitats with an average of 17 percent bare ground for foraging and a greater proportion of bare ground for nesting. Typically, preferred habitats contain short vegetation, forbs and grasses that are less than 13 in (33 cm) tall, and few or no trees or shrubs. The large, open areas used by populations of larks are regularly disturbed via burning, mowing, crop rotation, dredging material placement, or other anthropogenic actions.

Sites with low predator populations have higher nest success. Territory sizes vary between and within regional populations. Local populations in the Willamette Valley region maintain territories averaging 1.9 ac (0.77 ha), while local populations in the South Puget Lowlands region average territory sizes of 11.6 ac (4.7 ha) and local populations in the Pacific Coast and Lower Columbia River region maintain territory sizes averaging approximately 4 ac (1.6 ha).

3. HISTORIC AND CURRENT DISTRIBUTION AND STATUS

Historical records indicate the streaked horned lark was found west of the Cascade Range from the Georgia Depression (southern British Columbia, Canada) south through the Puget Lowlands and outer coast of Washington and Oregon, along the lower Columbia River, through the Willamette Valley, and into the Umpqua and Rogue Valleys of southwestern Oregon (Altman 2011, p. 201) (Figure 1). Estimates of historical abundance of the streaked horned lark throughout its range are largely anecdotal in nature.

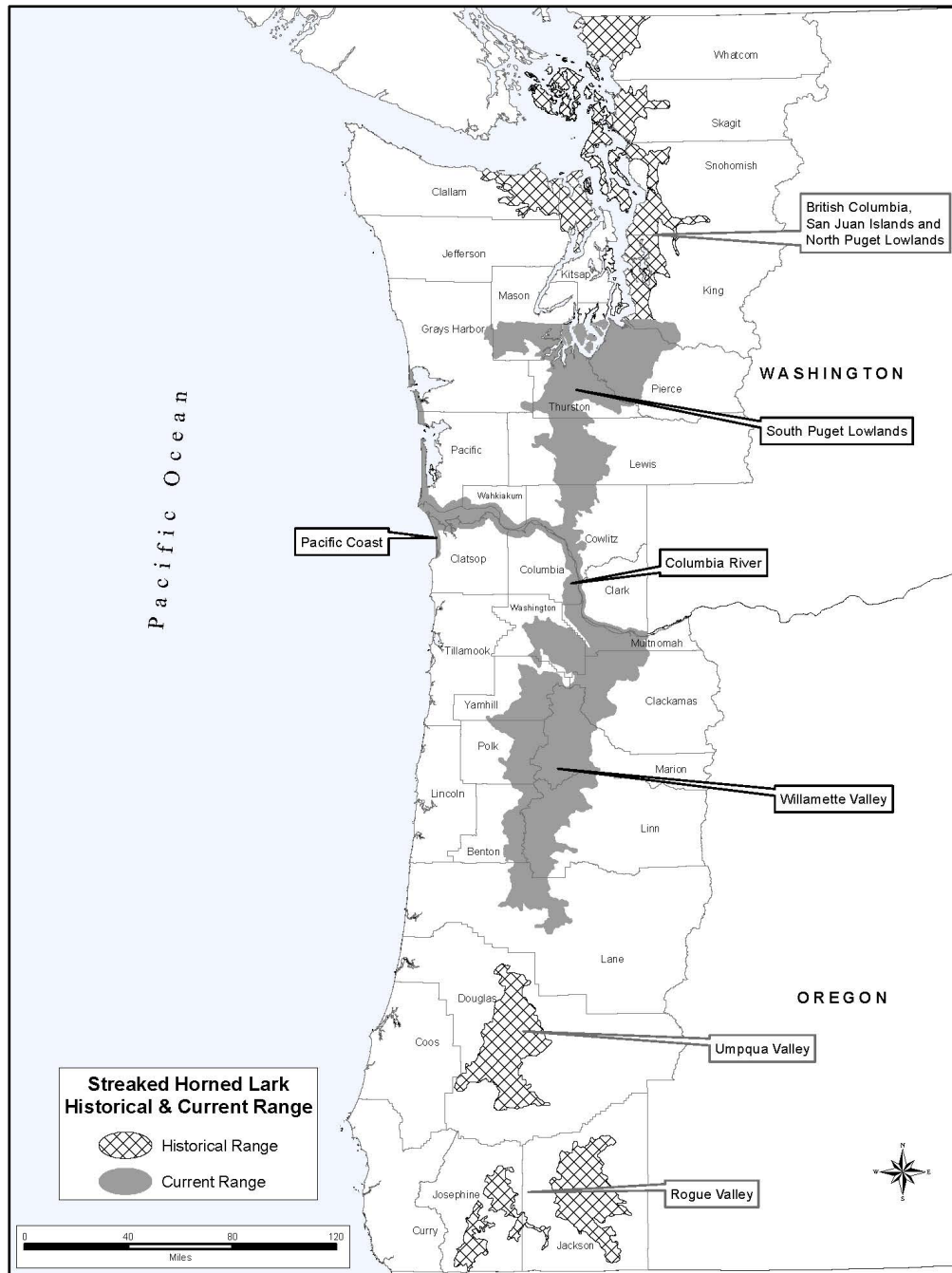


FIGURE 1.—Streaked Horned Lark Historical and Current Range Map.

The streaked horned lark was never considered common in the northernmost portion of their historic range, but small local populations occurred on Vancouver Island, British Columbia, in the Fraser River Valley, and near Vancouver International Airport (Campbell *et al.* 1997, p. 120; Committee on the Status of Endangered Wildlife in Canada 2003, p. 5). The local population declined throughout the 20th century and breeding has not been confirmed since 1978 (Committee on the Status of Endangered Wildlife in Canada 2003, pp. 13–14). The streaked horned lark is considered to be extirpated in British Columbia (Committee on the Status of Endangered Wildlife in

Canada 2003, p. 15), although a single streaked horned lark was sighted on Vancouver Island in 2002 (Committee on the Status of Endangered Wildlife in Canada 2003, p. 16). The streaked horned lark was listed as endangered under Canada's Species at Risk Act in 2005 (Environment Canada 2014, p. iii).

The first report of the streaked horned lark in the San Juan Islands, Washington, was in 1948 at Cattle Point on San Juan Island (Goodge 1950, p. 28). There are breeding season records of streaked horned larks from San Juan and Lopez Islands in the 1950s and early 1960s (Retfalvi 1963, p. 13; Lewis and Sharpe 1987, pp. 148, 204), but the last record dates from 1962, when seven individuals were seen in July at Cattle Point (Retfalvi 1963, p. 13). Predation may have contributed to the extirpation of streaked horned larks on the San Juan Islands. The introduction of several exotic animal species, including feral ferrets (*Mustela putorius*) and red foxes (*Vulpus vulpus*), to the islands roughly coincides with the disappearance of streaked horned larks. These introduced predators may have significantly affected ground nesting birds and played a role in the extirpation of streaked horned larks from the area (Rogers 2000, p. 42). Surveys conducted in 1999 and 2000 included all known suitable sites; no larks were detected in the San Juan Islands during either survey effort (Rogers 1999, p. 4; MacLaren 2000, p. 4; Stinson 2005, p. 63).

In the southernmost portion of the species' range, the streaked horned lark was considered a common permanent resident of the Umpqua and Rogue Valleys in the early 1900s (Gabrielson and Jewett 1940, p. 402). The last confirmed breeding record in the Rogue Valley was in 1976 (Marshall *et al.* 2003, p. 425). There are no recent reports of breeding streaked horned larks in the Umpqua or Rogue River Valleys (Gilligan *et al.* 1994, p. 205; Marshall *et al.* 2003, p. 425; Robinson *in litt.* 2016, p. 1). In the winter of 2015 to 2016, a flock of possible streaked horned larks was detected at the Lost Creek Lake reservoir in Jackson County, in the Rogue River Valley; other subspecies of horned larks have been detected at this location in the past, but this appears to be the first probable report of the *strigata* subspecies in about 40 years (Moore *in litt.* 2016a). Surveys the following spring did not detect any breeding streaked horned larks in the Rogue Valley (Robinson *in litt.* 2016, p. 1). An analysis of recent data from a variety of sources concluded that the streaked horned lark has been extirpated from British Columbia, and the Rogue and Umpqua Valleys of Oregon (Altman 2011, p. 213).

Currently, larks are known to occur at scattered sites in three regions: South Puget Lowlands, Pacific Coast and Lower Columbia River, and Willamette Valley (Figure 1). Streaked horned larks were observed near Clatsop Spit, Oregon in June 2019 and 2020 (Moore *in litt.* 2019; Schmidt *in litt.* 2020). These birds were the first individuals observed on the Oregon coast in over thirty years. The most recent rangewide population estimate for streaked horned larks estimates there are about 1,170 to 1,610 individuals (Altman 2011, p. 213). This estimate was based on data compiled from multiple survey efforts by state, university, and regional researchers and anecdotal observations (2008 to 2010), plus extrapolation to areas of potential suitable habitat not surveyed (e.g., inaccessible private lands), particularly in the Willamette Valley (Altman 2011, p. 213).

3.1. South Puget Lowlands

There are scattered historical records of streaked horned larks in the north Puget Lowlands, including sightings in Skagit and Whatcom Counties in the mid-20th century (Altman 2011, p. 201). The last recorded sighting of a streaked horned lark in the north Puget Lowlands was at the Bellingham Airport in 1962 (Wahl 1995, as cited in Stinson 2005, p. 52). Over a century ago, the streaked horned lark was described as a common summer resident in prairies of the Puget Sound region (Bowles 1898, p. 53; Altman 2011, p. 201). Larks were considered common in the early 1950s “in the prairie country south of Tacoma” and had been observed on the tide flats south of Seattle (Jewett *et al.* 1953, p. 438). By the mid-1990s, only a few scattered breeding populations existed on remnant prairies and airports in the south Puget Lowlands (Altman 2011, p. 201).

In the South Puget Lowlands, there has been an overall increase in the number of pairs between 2013 and 2019, but the number of occupied sites has not increased. The streaked horned lark is currently known to occur at eight sites in the South Puget Lowlands region; three sites are municipal airports and five sites at JBLM (see Table 1). The municipal airports are Tacoma Narrows Airport, Shelton Airport, and Olympia Airport. The local population at the Olympia Airport is the largest in Washington, with a mean population size of 34 breeding pairs between 2013 and 2019, although recent surveys indicate an fluctuating and unstable trend since 2015. Shelton Airport has a small, declining local population, which is currently estimated at fewer than 6 breeding pairs detected in 2019. This site is significant to representation and redundancy as it is the northernmost site currently occupied and known to provide breeding habitat for the streaked horned lark. Larks were only recently detected at Tacoma Narrows Airport, where up to three breeding pairs have been observed, but data is insufficient to detect a trend in population size or stability.

The majority of larks in the South Puget Lowlands region and the largest area of occupied habitat occurs at JBLM; two of the sites are military airfields (Gray Army Airfield and McChord Airfield) and three are large training ranges (one at 13th Division Prairie and two at 91st Division Prairie). JBLM is an active training installation for armed forces, and the base has worked closely with the Service and the Washington Department of Fish and Wildlife (WDFW) to integrate conservation of the species with the training needs of the military units stationed at JBLM. Over a decade of intensive research on the subspecies at JBLM has helped inform management activities, with the goal of improving survival and recruitment of larks on the base.

TABLE 1.—Estimated Number of Streaked Horned Larks at Surveyed Sites in South Puget Lowlands region, 2013 – 2019. Source: Streaked Horned Lark Working Group annual updates, Wolf *et al.* 2020, p. 16).

Local Population	Ownership	2013	2014	2015	2016	2017	2018	2019
Gray Army Airfield	Federal (JBLM)	11	10-13	19-21	30	36-37	24-25	18
McChord Airfield	Federal (JBLM)	8-9	8-9	16-18	20-25	25	21-25	21-23
13 th Div. Prairie	Federal (JBLM)	9	10	9	11	12-15	26-27	28-32

91 st Div. Prairie, Range 76	Federal (JBLM)	5	8	6	15	16	18	17
91 st Div. Prairie, Range 50/53	Federal (JBLM)		9	3	9	5	2	4
Tacoma Narrows Airport	Pierce County		2	2			3	
Shelton Airport	Port of Shelton	12	13	13	5	5	6	6
Olympia Airport	Port of Olympia	30	37	48	34	43	21	27
<i>South Puget Lowlands total</i>		<i>75</i>	<i>97</i>	<i>116</i>	<i>124</i>	<i>142</i>	<i>121</i>	<i>121</i>

Recent analysis indicated a declining female population trend driven by the Olympia and Shelton airports, while the male population throughout the South Puget Lowlands region is stable (Keren and Pearson 2020, p. 3). Across all sites in the South Puget Lowlands region, approximately 142 breeding pairs of streaked horned larks were detected in 2017 compared to 121 pairs in 2019 (Table 1).

3.2. Pacific Coast and Lower Columbia River Region

There are few historical records of streaked horned larks on Washington coast near Lake Quinault, the Quinault River, and the Humptulips River in the 1890s (Jewett *et al.* 1953, p. 438; Rogers 2000, p. 26). Records from Pacific County reported larks at Leadbetter Point and Graveyard Spit in the 1960s and 1970s (Rogers 2000, p. 26). Surveys conducted between 1999 and 2004 found larks at Leadbetter Point, Graveyard Spit, Damon Point, and Midway Beach (Stinson 2005, p. 63). There are sporadic historical records of streaked horned larks along the Columbia River. Sightings near Portland, Oregon, date back to the early 1900s (Rogers 2000, p. 27). It is probable that streaked horned larks bred only as far east as Clark County, Washington, and Multnomah County, Oregon (Rogers 2000, p. 27; Stinson 2005, p. 51).

In the past decade, streaked horned larks have been found at six sites on the Washington coast: Leadbetter Point, Graveyard Spit, Midway Beach, Damon Point, Oyhut Spit, and Johns River Island. Sites used by larks on the Washington coast are primarily on land managed by state agencies including Washington Department of Natural Resources (WDNR), WDFW, and Washington State Parks (WSP) (Table 2). Other sites in Washington occur on the Willapa National Wildlife Refuge (NWR) and the Shoalwater Bay Indian Reservation with adjacent private land (Table 2). In 2015, 11 breeding pairs were found at Leadbetter Point (Stinson 2016, p. 5) (Table 2). In 2016, two breeding pairs of larks were detected at Graveyard Spit after several years of no detections (Sundstrom *in litt.* 2016) and approximately three pairs have been observed annually at this location during western snowy plover (*Charadrius alexandrinus nivosus*) surveys since 2008 (Pfleege *in litt.* 2020).

Streaked horned larks, while occasionally present, were never reported to be more than uncommon on the Oregon coast. The streaked horned lark was described as a local summer resident along coastal sand spits (Gilligan *et al.* 1994, p. 205). Few non-breeding season records exist for the coastal counties of Clatsop, Tillamook, Coos, and Curry

(Gabrielson and Jewett 1940, p. 403). Small numbers of streaked horned larks were known to breed at the South Jetty of the Columbia River in Clatsop County, but the site

TABLE 2. – Estimated Number of Streaked Horned Larks at Surveyed Sites along Pacific Coast and Lower Columbia River region, 2013 – 2019. Source: Streaked Horned Lark Working Group annual updates.

Local Population	Ownership	2013	2014	2015	2016	2017	2018	2019
Leadbetter Point	Federal (Willapa NWR)	6	11	11	7	11	5	7
Graveyard Spit	WA – Tribal, Private	1	0	0	2	2-3	2-3	2-3
Midway Beach	State (WSP)	1	1	0			6	
Damon Point	State (WDNR)	2	0	0			0	
Oyhut Spit	State (WDFW)	0	0	0			0	
Johns River Is.	State (WDFW)	0	0	0				
Clatsop Spit	State (OPRD)							1
<i>Pacific Coast total</i>		<i>10</i>	<i>12</i>	<i>11</i>	<i>9</i>	<i>13</i>	<i>13</i>	<i>10</i>
Rice Island	State (ODSL, WDNR)	23	18	14	20	14	17	31
Miller Sands Island	State (ODSL)	5	8	12	11	7	10	9
Pillar Rock Island	State (ODSL)	2	4	2	6	3	2	3
Welch Island	State (ODSL)		0	0	0	1	1	3
Tenasillahe Island	State (ODSL)	0	2	2	2	1	1	3
Brown (or Whites) Is.	State (WDFW)	23	21	17	17	11	15	13
Crims Island	State (ODSL)	2	5	6	5	3	4	3
Hump Island	State (WDNR)		0	0	1	0	0	1
Howard Island	State (WDNR) & Ports		0	0	4	8	7	5
Northport	Port of Kalama	3						2-3
Sandy Island	State (ODSL)	4	6	3	3	4	5	4
Lower Deer Island	State (ODSL)		1	0	1	1	3	4
Martin Bar	Port of Woodland		0	0	0	1	2	1
Austin Point	Port of Woodland		0	0	0	1	0	1
Sand Island	State (ODSL)		3	2	1	2	1	2
Gateway	Port of Vancouver		1-2	0	1	0		
Rivergate	Port of Portland	6	6	5	2	3	1	0
PDX SW Quad	Port of Portland	3	2	3	1	1	1	0
PDX Airfield	Port of Portland			0	1	3	3	2
<i>Columbia River total</i>		<i>71</i>	<i>77</i>	<i>66</i>	<i>76</i>	<i>64</i>	<i>73</i>	<i>87</i>

<i>Coast and River Region Total</i>	<i>81</i>	<i>89</i>	<i>77</i>	<i>85</i>	<i>77</i>	<i>86</i>	<i>97</i>
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was abandoned in the 1980s (Gilligan *et al.* 1994, p. 205). In 2019 and 2020, wintering streaked horned larks and one breeding pair were observed at Clatsop Spit, in Clatsop County, Oregon (Moore *in litt.* 2019, Schmidt *in litt.* 2020), owned and managed by Oregon Parks and Recreation Department (OPRD). These observations were the first detections of streaked horned larks on the Oregon coast in over 30 years.

Across all sites on the Washington and Oregon coast, approximately 13 breeding pairs of streaked horned larks were detected in 2018 and 10 pairs in 2019 (Table 2). Survey efforts are inconsistent along the coast and data is insufficient to reliably assess population trends. However, the regional population has remained relatively consistent between 2013 and 2019.

Streaked horned larks are currently found at 18 sites on islands and at mainland sites adjacent to the lower Columbia River. Sites used by larks along the Lower Columbia River are primarily on lands owned or managed by state agencies including WDFW, WDNR, Oregon Department of State Lands (ODSL), and Oregon Department of Fish and Wildlife (ODFW) (Table 2). Other sites occur on lands owned by regional ports, including Port of Woodland, Port of Vancouver, Port of Portland, Port of Kalama, and adjacent private land (Table 2). In the last several years, surveys have detected breeding larks on 12 islands and 7 mainland sites (Stinson 2016, p. 5; Slater and Treadwell 2017, p. 4; Jensen *in litt.* 2020).

Most of the Lower Columbia River sites with lark detections are active dredge material disposal sites, although the two sites farthest upriver (at the Port of Portland's Rivergate Industrial Complex and Portland International Airport's Southwest Quad) are old fill sites that retain suitable habitat characteristics (Port of Portland 2017, p. 8-13). The Rivergate site has supported as many as 20 pairs of breeding larks over the past 15 years (Moore 2011, p. 10); however, the local population has declined to zero as industrial development incrementally reduced the amount of open space at the site. The most recent data indicate there are between 70 and 85 pairs of larks in the lower Columbia River area (Table 2).

3.3. Willamette Valley

The streaked horned lark's historical range extends south throughout the Willamette Valley of Oregon, where it was considered abundant and a common summer resident (Johnson 1880, p. 636; Anthony 1886, p. 166). In the 1940s, the streaked horned lark was described as a common permanent resident in the southern Willamette Valley (Gullion 1951, p. 141). By the 1990s, the streaked horned lark was called uncommon in the Willamette Valley, nesting locally in small numbers in large open fields (Gilligan *et al.* 1994, p. 205; Altman 1999, p. 18).

Some sites used by larks in the Willamette Valley are on land managed by city and state airports, WV NWR, and wetland habitats as part of the Natural Resources Conservation Service Wetland Reserve Program (WRPs) (Table 3). In the early 2000s, a local population of more than 75 breeding pairs was found at the Corvallis Municipal Airport, making this the largest local population of streaked horned larks throughout the species'

range (Moore 2008a, p. 15). Other occupied sites occur on private lands inaccessible to surveys or monitoring.

TABLE 3.– *Estimated Number of Streaked Horned Larks at Surveyed Sites in Willamette Valley, 2013 – 2019. Source: Streaked Horned Lark Working Group annual updates.*

Local Population	Ownership	2013	2014	2015	2016	2017	2018	2019
Eugene Airport ¹	City of Eugene			12		2	4	2
McMinnville Municipal Airport ¹	City of McMinnville			12			8	
Salem Municipal Airport ¹	City of Salem			0	0	0	0	
Corvallis Municipal Airport	City of Corvallis	26		29	61	34	60	83
Independence State Airport ¹	OR Dept. of Aviation	16					0	16
Ankeny NWR	Federal (WV NWR ²)			8	12	4	6	6
Baskett Slough NWR	Federal (WV NWR ²)			23	17	26	37	35
William L. Finley NWR	Federal (WV NWR ²)			8	7	6	10	11
Private Lands (WRPs)	Private			15	27	19	8	7
Herbert Farm Natural Area	City of Corvallis			2	3	0	0	2
Coyote Creek South	ODFW					3	4	5
Willamette Valley total		42		109	127	92	133	165

¹ Counts represent only partial surveys of the airfield, and likely underrepresent the local population at the airport.

² In the Willamette Valley, many sites have not been surveyed due to lack of access.

Local populations of larks in the Willamette Valley have not been surveyed as regularly or intensively as local populations in other regions of the species' range due to the lack of access to private lands. There are few protected sites in the Willamette Valley where habitat conditions are regularly maintained via habitat modifications or temporary disturbance regimes. We acknowledge that streaked horned larks are present throughout the Willamette Valley, but local populations may not reliably persist at a given location due to changes in habitat conditions because of agricultural practices or other management activities.

Depending on annual management activities conducted at the Corvallis Municipal Airport and the surrounding grass fields, the local population of larks on the airport has been as high as 100 breeding pairs (Moore and Kotaich 2010, pp. 13-15). Surveys from 2007 to 2013 found 80 to 100 pairs in most years during the breeding season (Moore 2008a, p. 16; Moore and Kotaich 2010, pp. 14-15; Moore 2013, p. 15). In 2014, the population dropped precipitously to 23 breeding pairs, plus 16 additional unmated territorial males. This decline could have resulted from severe winter weather (Moore

2015a, p. 18). The population appears to have rebounded; the number of nesting birds increased to more than 61 pairs in 2016, and 83 pairs in 2019 (Moore 2017b, p. 10; Center for Natural Lands Management 2019, p. 4). Outside of the breeding season, the local population at the Corvallis Airport is augmented by mixed flocks of wintering streaked horned larks and other subspecies of horned larks (Moore 2008a, p. 9).

In addition to the Corvallis Airport, streaked horned larks have been detected breeding at four other airports in the Willamette Valley: Eugene Airport, Salem Municipal Airport, McMinnville Municipal Airport, and Independence State Airport. None of these airports have been comprehensively surveyed. Our knowledge of the local population at each site is the result of focused surveys done for pre-project clearances, thus we do not have complete local population estimates for any of these sites (Thompson 2013, entire; ESA Vigil-Agrimis 2014, entire; ESA Vigil-Agrimis 2015, entire; Moore 2015b, entire; Moore 2015c, entire; U.S. Fish and Wildlife Service 2019, entire).

Streaked horned larks are found on three units of the WV NWR (Ankeny, Baskett Slough and William L. Finley units). Larks mainly use the refuge's agricultural fields during both the breeding and winter seasons (U.S. Fish and Wildlife Service 2016b, p. 3). Portions of each of the three refuges have been designated as critical habitat for the lark; most of the critical habitat designations are on agricultural lands that produce forage for wintering Canada geese (U.S. Fish and Wildlife Service 2016b, p. 3).

Over the last 10 years, 5 to 12 pairs have been observed at Ankeny NWR (Moore 2008a, p. 8; Root *in litt.* 2016). The consistently low lark numbers at Ankeny NWR may reflect the landscape setting of this refuge unit; the farm fields are bordered by rows of tall trees which limit the extent of suitable habitat for streaked horned larks (Moore 2008a, p. 8). At Baskett Slough NWR, larks use a wider range of the refuge's fields, including both agricultural fields and wetland edges (Moore 2008a, p. 8). Surveys from 2006 to 2008 consistently found 18 to 20 pairs at Baskett Slough NWR (Moore 2008a, p. 8). The number of larks at Baskett Slough NWR has increased from 15 breeding pairs of larks in 2015, to 37 pairs in 2018 and 35 pairs in 2019 (Root *in litt.* 2016; Center for Natural Lands Management 2019, p. 4). At William L. Finley NWR, larks inhabit portions of the southern and eastern agricultural fields (Moore 2008a, p. 8). The number of territorial male larks at William L. Finley NWR varied from 15 to 22 pairs over the 2006 to 2008 surveys (Moore 2008a, p. 8). In 2015, Refuge staff detected six breeding pairs (Root *in litt.* 2016); 10 pairs were detected in 2018 and 11 pairs were detected in 2019 (Center for Natural Lands Management 2019, p. 4).

We have limited data on other sites in the Willamette Valley. M-DAC Farms, a privately owned prairie and wetland restoration project in Linn County, illustrates the intra- and inter-annual pattern of streaked horned lark colonization of ephemeral habitats. Early in the breeding season in 2007, a single pair of larks was detected on the gravel road at the site (Moore 2008a, p. 10). A controlled burn in June 2007 attracted 30 pairs of larks to the site during the 2007 breeding season, and numbers increased to 75 pairs in 2008 (Moore 2008a, p. 11). As the vegetation at the site matured in the following years, the site became less suitable for larks, and the local population declined to just two to three pairs in 2012 (Moore *in litt.* 2012). This is likely a common pattern in the Willamette Valley,

as breeding streaked horned larks opportunistically shift sites as habitat becomes available among private agricultural lands (Moore 2008a, pp. 9-11).

The Willamette Valley has not been systematically surveyed for streaked horned larks except along public road margins (Altman 1999, p. 2; Myers and Kreager 2010, pp. 2-3). There are numerous locations on private agricultural lands where streaked horned larks have been observed in the Willamette Valley, particularly in the southern valley on grass seed fields. These lands may contain a large proportion of the regional population of streaked horned larks in Oregon, but no comprehensive survey has been conducted to date. The most recent estimate of the streaked horned lark population in the Willamette Valley region is about 900 to 1,300 breeding streaked horned larks, based on data compiled from multiple survey efforts between 2008 and 2010, including estimates from inaccessible sites on private lands in the region (Altman 2011, p. 213). Some land owners gave access to survey local sites in 2017 and 94 breeding pairs were detected throughout the Willamette Valley, of which 19 pairs were detected on private lands (Table 3).

3.4. Current Distribution and Rangewide Summary

Three regional populations of streaked horned larks currently occur in Washington and Oregon: South Puget Lowlands, Pacific Coast and Lower Columbia River, and Willamette Valley. Two other regional populations occurred historically in the northernmost and southernmost portions of the species' range: in British Columbia and San Juan Islands, and the Umpqua and Rogue Valleys (see Figure 1). However, no breeding populations have been observed in these areas during the past 40-50 years, indicating streaked horned larks are likely extirpated from the northernmost and southernmost portions of the species' range. There is limited historical data to suggest that a particular site was a meaningful location, or the species relied on an individual site for viability. Rather, it is generally understood that streaked horned larks moved between habitats when conditions forced them to relocate.

The South Puget Lowlands regional population consists of eight local populations at three municipal airports and five sites at JBLM. Since streaked horned larks were listed in 2013, the regional population has stabilized to some degree, but two local populations continue to experience declining trends (Keren and Pearson 2019, p. 4) (see Table 1). The Pacific Coast and Lower Columbia River regional population consists of 24 local populations (see Table 2). Larks have been detected at six sites on the outer coast of Washington and were recently detected at Clatsop Spit in Oregon. There are 18 local populations at sites along the lower Columbia River, and recent analysis indicates the regional population is stable (Keren and Pearson 2019, p. 3). The Willamette Valley regional population was previously estimated at 900 to 1,300 based on data compiled from multiple survey efforts between 2008 and 2010 (Altman 2011, p. 213). Surveys occur at 10 accessible and regularly monitored local populations, including four municipal airports, three wildlife refuges, two natural areas, and one on private land. The Willamette Valley regional population appears to be well distributed and increasing, but the limited surveys of accessible sites may not accurately reflect the regional trend.

The most recent rangewide population estimate for streaked horned larks is about 1,170 to 1,610 individuals (Altman 2011, p. 213). The conservation biology literature of the last

several decades indicates that population objectives for conservation planning should number in the thousands of individuals. A meta-analysis of studies that modeled minimum viable populations (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); researchers 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) across all surveyed taxa. Using their data set, Anderson (2015, p. 2) calculated that the average MVP for the groups Aves and Passerines was 5,269 and 6,415 individuals respectively. The current rangewide population estimate for the streaked horned lark is substantially below these targets.

4. FACTORS INFLUENCING SPECIES VIABILITY

In this chapter we discuss the factors that influenced historic local and regional populations and consider the degree to which these factors are still affecting local and regional populations. We also note whether any of these factors are likely to continue affecting streaked horned larks in the future. Factors that appear to have negative effects are considered stressors; factors that appear to have positive effects are considered regulatory or voluntary conservation measures. Conservation measures benefiting streaked horned larks have been implemented at multiple sites throughout the species' range since it was listed in 2013.

When analyzing factors under the SSA framework (U.S. Fish and Wildlife Service 2016, entire), we consider the scope and magnitude of the impact to assess whether the impact goes beyond the individual level to potentially affecting the viability of the species. If the impact occurs at the population level, then the factor is carried into our analysis of resiliency, redundancy, and representation (i.e., the 3R analysis), as a primary driver of current or future condition.

In the final rule to list the streaked horned lark as a threatened species (U.S. Fish and Wildlife Service 2013a, entire), we identified the main threats to the streaked horned lark as: loss of habitat and natural disturbance processes; incompatible habitat management; the adverse effects of military training, airport management operations; agricultural activities; small population issues and potential inbreeding depression; predation pressure on small populations; recreation; and, stochastic weather events. In addition to the threats identified at the time of listing, additional stressors have been identified: male-skewed sex ratio at some sites, avian pox in the South Puget Lowlands region, and possible poisoning caused by rodenticides used in agricultural fields.

Below, we briefly discuss those stressors that were evaluated, but dismissed from further evaluation in our 3R analysis because the available information did not indicate that they operated at a scope and magnitude as to affect local or regional populations of larks. Other stressors influencing current and future condition of local or regional populations are discussed in greater detail in **Stressors Influencing Current and Future Condition**.

4.1. Stressors Considered but not Carried Forward

We determined several stressors influence individuals but do not rise to the level of influencing local or regional populations, including predation, disease, and pesticides. In addition, disturbance regimes and habitat availability impacted the abundance and distribution of historic populations but are not considered to impact current populations.

Predation is a natural component of the streaked horned lark's life history. When populations are large and stable, predation would not be considered a threat. However, the effect of predation may be magnified where populations are small. The disproportionate effect of predation on declining populations has been shown to drive rare species towards extinction (Woodworth 1999, pp. 74-75). Predation has not been identified as a threat to adult streaked horned larks, but it is the most frequently documented source of mortality for eggs and juveniles (Stinson 2016, p. 3; Wolf *et al.* 2020, p. 17). It is also possible that predation rates are higher now than in the past, due to the proximity of development and associated predator attractions near some lark habitats. For more detailed discussion on predation impacts, refer to the 2013 streaked horned lark listing for more information (U.S. Fish and Wildlife Service 2013a, p. 61482). Based on available information, we do not consider predation a local or regional population-level stressor and therefore this factor is not carried forward through the 3R analysis.

Disease outbreaks affect individual larks and can influence survivability of a local population. In 2015, five streaked horned larks with pox-like lesions were observed at JBLM on McChord Airfield (Stinson 2016, p. 11). The lesions appear to be caused by avian pox. Avian pox is a common viral disease of wild birds; it causes wart-like lesions that may cause weakness and starvation if the lesions are extensive enough to interfere with feeding (Hansen 1999, p. 163). Although the course of this disease can be prolonged, birds with extensive lesions are known to completely recover if they are able to feed (Hansen 1999, p. 165). In 2016, several of the larks that had avian pox lesions the previous year returned and appeared to be lesion-free; these birds bred successfully, which suggests that the outbreak of avian pox had no long-term effects on the local population (Wolf *et al.* 2017, p. 31). Given the infrequency of disease outbreaks across the rangewide population and relative isolation of local streaked horned lark populations, we do not consider disease outbreaks a population-level stressor and therefore this factor is not carried forward through the 3R analysis.

Similar to disease, the use of pesticides has the potential to affect individual birds and can influence survival but is not known to influence local or regional population viability. In 2014, seven streaked horned lark carcasses were collected at Corvallis Airport and were submitted for analysis to the National Wildlife Health Center in Madison, Wisconsin. All the individuals apparently died after the application of the agricultural rodenticide zinc phosphide at the site. Testing could not be performed on three of the carcasses as the condition of the carcasses was too poor. Gizzard contents from remaining four were analyzed for phosphine gas (residual from exposure to zinc phosphide). The specimens tested positive, indicating exposure to the rodenticide in at least one of the four birds (National Wildlife Health Center 2015, pp. 1-2). Given the pooled nature of the specimens, it is only possible to say that at least one of the individuals had contact with zinc phosphide before it died. It is currently unknown how the widespread use of

pesticides, particularly in the Willamette Valley, affects the resiliency of local populations and further study is needed to determine the magnitude of this threat. However, because there is no evidence that exposure to pesticides is threatening local populations, this stressor is not carried forward through our 3R analysis.

Streaked horned larks historically selected habitat in relatively flat, open areas maintained by natural disturbance processes of flooding, fire and sediment transport dynamics. Suppression and loss of natural disturbance regimes, such as fire and flooding, across vast portions of the landscape has resulted in altered vegetation structure or complete loss of suitable lark habitat characteristics in prairies, meadow, beach, and island habitats. The loss of these disturbance regimes facilitated invasion by nonnative grasses and woody vegetation, rendering habitat unusable for streaked horned larks. The basic ecological processes that maintain prairies, meadows, and scoured islands, beaches, and riverbanks have disappeared from, or have been altered on, all but a few protected and managed sites. However, anthropogenic processes in some locations mimic natural ecological disturbance processes that historically maintained suitable habitat for streaked horned larks. The loss of historic processes influences the current availability of habitats, but the loss of these processes no longer impacts individual birds or influences local or regional populations and is therefore not carried forward through our 3R analysis.

4.2. Stressors Influencing Current and Future Condition

The stressors influencing current and future local or regional populations of the streaked horned lark that are carried forward in our 3R analysis include habitat-related factors, land management activities and related effects (for example mowing; military training and associated activities; aircraft strikes; and dredge material placement), recreation, and stochastic weather events. These factors are discussed in greater detail below.

4.2.1. *Ongoing Loss and Conversion of Suitable Habitat*

The primary stressor influencing the status of streaked horned larks is the scarcity of large, open spaces with early seral stage vegetation. Ongoing habitat changes include successional changes of grassland habitats as vegetation changes from prairies and grasslands to habitats comprised primarily of woody shrubs and trees. In addition, the spread of nonnative and invasive species changes the species composition of habitat, reducing suitability when vegetation becomes too dense or a visual barrier. The loss of natural habitats to agricultural, industrial and urban development reduces overall quantity of habitat available to streaked horned larks, and the conversion of agricultural crops that provide suitable habitat to crop types that are unsuitable for streaked horned larks further reduces habitat quantity.

4.2.1.1. *Successional Changes in Grassland Habitats and Encroachment of Woody Vegetation*

Historically, the prairies and meadows of western Washington and Oregon are thought to have been actively maintained by the native peoples of the region, who lived in the valley for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986, entire; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees, favoring open grasslands with a rich variety of native plants

and animals (Boyd 1986, entire; Chappell and Kagan 2001, p. 42; Storm and Shebitz 2006, p. 264).

Following Euro-American settlement of the region in the mid-19th century, fire was actively suppressed on grasslands in the Willamette Valley, allowing encroachment by woody vegetation into prairie habitat and oak woodlands (Franklin and Dyrness 1973, p. 122; Boyd 1986, entire; Kruckeberg 1991, p. 286; Agee 1993, p. 360; Altman *et al.* 2001, p. 262). Native and nonnative species that have encroached on these habitats throughout the lark's range include native Douglas fir (*Pseudotsuga menziesii*), nonnative Scotch broom, and nonnative grasses such as tall oatgrass (*Arrhenatherum elatius*) and false brome (*Brachypodium sylvaticum*) (Dunn and Ewing 1997, p. v; Tveten and Fonda 1999, p. 146). This expansion of woody vegetation and nonnative plant species has reduced the quantity and quality and overall suitability of prairie habitats for larks (Tveten and Fonda 1999, p. 155; Pearson and Hopey 2005, pp. 2, 27).

Native prairies of the South Puget Lowlands and Willamette Valley regions are among the rarest ecosystems in the United States (Noss *et al.* 1995, p. I-2; Dunn and Ewing 1997, p. v). Dramatic changes have occurred on the landscape over the last 150 years, including fire suppression, leading to a 90 to 95 percent reduction in the spatial distribution of the prairie ecosystem. In the Puget Lowlands, where most of western Washington's prairies historically occurred, less than 10 percent of the original prairie persists, and only 3 percent remains dominated by native vegetation (Crawford and Hall 1997, pp. 13-14). In the remaining prairies, many of the native bunchgrass communities have been replaced by nonnative pasture grasses (Rogers 2000, p. 41), which larks avoid using for territories and nest sites (Pearson and Hopey 2005, p. 27). In the Willamette Valley, native grassland have been reduced from the most common vegetation type to scattered parcels intermingled with rural residential development and farmland; it is estimated that less than one percent of the native grassland and savanna remains in Oregon (Altman *et al.* 2001, p. 261).

Streaked horned larks prefer open areas with low vegetation and long sight lines, both of which are impeded by the presence of trees or other woody vegetation. On JBLM alone, over 16,000 ac (6,600 ha) of prairie has been converted to Douglas fir forest since the mid-19th century (Foster and Shaff 2003, p. 284). Where controlled burns or direct tree removal are not used as management tools, additional encroachment will continue to result in the loss of open grassland habitats and threaten current and future streaked horned lark local populations. The ongoing fragmentation, degradation, or loss of open grassland habitats as a result of successional changes in vegetation plant composition and encroachment of tall grasses or woody vegetation will continue to influence current and future streaked horned lark local populations and habitat suitability throughout the species' range.

4.2.1.2. *Spread of Invasive Beach Grasses*

The introduction of Eurasian beachgrass and American beachgrass in the late 1800s, currently found in high and increasing densities in most of coastal Washington and Oregon, has dramatically altered the structure of dunes on the outer coast (Wiedemann and Pickart 1996, p. 289). The tall leaf canopy of beachgrass creates areas of dense

vegetation unsuitable for larks (MacLaren 2000, p. 5). In a 10-year period (from 1977 to 1987) at Leadbetter Point on Willapa NWR, the spread of beachgrass has reduced the available nesting habitat for streaked horned larks by narrowing the vegetation-to-water distance from 390 feet (119 meters (m)) to 280 feet (85 m) (Washington Department of Fish and Wildlife 1995, p. 19; Stinson 2005, p. 65; U.S. Fish and Wildlife Service 2011, p. 4-2). Since 1985, beachgrasses have spread to cover over two-thirds of Damon Point at Grays Harbor (Washington Department of Fish and Wildlife 1995, p. 19). On the Oregon coast, the disappearance of the streaked horned lark has been attributed to the invasion of exotic beachgrasses and the resultant dune stabilization (Gilligan *et al.* 1994, p. 205).

Some conservation efforts have successfully reduced the cover of encroaching beachgrasses, such as the restoration of habitat on Leadbetter Point by the Service's Willapa NWR. In 2007, the area of open habitat measured 84 ac (34 ha); after mechanical and chemical treatment to clear beachgrass (mostly American beachgrass) and spreading oyster shells across 45 ac (18 ha), 121 ac (50 ha) of sparsely vegetated habitat was available, increasing the extent of open habitat by 37 ac (15 ha) (Pearson *et al.* 2009a, p. 23). The main target of the Leadbetter Point restoration project was the federally listed western snowy plover, but the restoration actions also benefited streaked horned larks. Before the restoration project, this area had just 2 streaked horned lark territories (Stinson 2005, p. 63); after the project, an estimated 7 to 10 territories were located in and adjacent to the restoration area (Pearson *in litt.* 2012a). Continued management is necessary to maintain the open landscape larks require at this site. Where conservation efforts are not implemented or are discontinued, the ongoing invasion of beach grasses will continue to influence current and future local populations of streaked horned larks, particularly in the Pacific Coast and Lower Columbia River region.

4.2.1.3. *Loss of Habitat to Agricultural, Industrial and Urban Development*

Human activity has converted native prairie and grassland habitats to residential and commercial development, reducing habitat availability for streaked horned larks throughout their range. About 96 percent of the Willamette Valley is privately owned, and it is both the fastest growing area in Oregon and the most densely populated. The Willamette Valley provides about half of the State's agricultural sales, and 16 of the top 17 private sector employers (manufacturing, technology, forestry, agriculture, and other services) are located there. An estimated 4,217,737 people lived in Oregon in 2019 (U.S. Census Bureau 2019). The Willamette Valley is home to almost three-fourths of Oregon's population and is anticipated to nearly double in the next 50 years (Oregon Department of Fish and Wildlife 2016, p. 17). Population growth will result in increased construction and road development, further impacting the remaining prairies and oak woodlands.

In the Puget Lowlands, prairie habitat continues to be lost, particularly to residential development via the removal of native vegetation and the excavation and conversion to non-habitat surfaces (i.e., buildings, pavement, and other infrastructure) (Stinson 2005, p. 70). Residential development is associated with increased infrastructure such as new road construction, which is one of the primary causes of landscape fragmentation (Watts *et al.* 2007, p. 736). Activities that accompany low-density residential development are correlated with decreased levels of biodiversity, mortality to wildlife, and introduction of

nonnative, invasive species (Trombulak and Frissell 2000, entire; Watts *et al.* 2007, p. 736). In the Puget Lowlands, the glacial outwash soils and gravels underlying the prairies are deep and valuable for use in construction and road building, which further leads to their degradation and destruction.

Industrial development has also reduced habitat available to breeding and wintering streaked horned larks. The Rivergate Industrial Park, owned by the Port of Portland, is a large industrial site in north Portland near the Columbia River that was developed on a dredge disposal site. Rivergate was an important breeding site for streaked horned larks, and a wintering site for large flocks of mixed lark subspecies. In 1990, the field used by streaked horned larks at Rivergate measured more than 650 ac (260 ha) of open sandy habitat (Dillon *in litt.* 2012). In the years since, the Port has constructed numerous industrial buildings on the site, subsequently reducing habitat availability for larks. In 2017, a 79 ac (32 ha) area supported three pairs of larks (Port of Portland 2017, p. 21) before the Port of Portland began developing the parcel into industrial lands (Port of Portland 2017, entire). In 2018, one pair of streaked horned larks were detected at Rivergate and in 2019 no larks were detected (Port of Portland 2019, entire). It is likely that the development displaced all of breeding and wintering larks from the area.

The conversion of streaked horned lark habitat into agricultural, industrial, residential, or urban development will continue to influence current and future streaked horned lark local or regional populations in the South Puget Lowlands, Pacific Coast and Lower Columbia River, and Willamette Valley regions.

4.2.1.4. *Agricultural Conversion to Incompatible Crops*

Roughly half of all the agricultural land in the Willamette Valley, approximately 360,000 ac (145,000 ha), is devoted to grass seed production (Oregon Seed Council 2018, p. 1). Grasslands, both native prairies and grass seed fields, are important habitats for streaked horned larks in the Willamette Valley; open grasslands are used as both breeding and wintering habitat (Altman 1999, p. 18; Moore and Kotaich 2010, p. 11; Myers and Kreager 2010, p. 9). Demand for grass seed has declined in the current economic climate (Oregon Department of Agriculture 2011, p. 1); grass seed production fields have decreased in the Willamette Valley by approximately 60,000 ac (24,000 ha) over the last 5 years (Oregon Seed Council 2018, p. 1; Oregon Seed Council 2012, p. 1).

The reduction in grass seed production has resulted in growers switching to other commodities, such as wheat, stock for nurseries and greenhouses, grapes, blueberries, and hazelnuts (U.S. Department of Agriculture National Agricultural Statistics Service 2009, p. 3; Oregon Department of Agriculture 2011, p. 1; U.S. Department of Agriculture National Agricultural Statistics Service 2017a, pp. 34, 55, 101). These other crop types do not have the low-statured vegetation and bare ground preferred by the streaked horned lark. The continued decline of the grass seed industry in the Willamette Valley will likely result in a continued conversion from grass seed fields to other agricultural types, resulting in fewer acres of suitable habitat for streaked horned larks.

Another threat related to agricultural lands results from the streaked horned lark's use of ephemeral habitats. In the breeding season, horned larks move into open habitats that

become available and then abandon these habitats as vegetation grows taller over the course of the season (Beason 1995, p. 6). This ability to shift locations in response to habitat changes is a natural feature of the streaked horned lark's evolutionary history. The shifting nature of suitable habitat is not itself a threat to local populations, but the continued loss of suitable habitat is a threat.

In the Willamette Valley, some habitats in agricultural fields are consistently available throughout the year (e.g., on the margins of gravel roads), while other patches of suitable habitat shift as fields are mowed, harvested, sprayed, or burned. The timing of these agricultural practices plays a significant role in the survival of larks and lark nests at a site. In addition, when agricultural fields are permanently converted to unsuitable habitats, the permanent loss of habitat will continue to negatively influence the distribution and resiliency of current and future streaked horned lark local populations in the Willamette Valley region.

4.2.2. *Land Management Activities at Occupied Sites and Related Effects*

Streaked horned larks evolved in a landscape of ephemeral habitats with regular natural disturbance regimes that maintained large, open spaces characterized with early seral stage vegetation. Human activity led to the stabilization of these natural disturbance regimes, as well as the unintentional creation of 'replacement' habitat for streaked horned larks that mimics their preferred habitats. Replacement habitat occurs in a variety of settings across the range of the subspecies including agricultural fields, airports, and dredge disposal sites. Land management activities at these sites are key to providing and maintaining habitat for the streaked horned lark; without that replacement habitat, the status of the subspecies would likely be much worse.

Grassland habitats throughout the species' range undergo active management for a variety of reasons: prairies require mowing or burning to prevent succession to woodlands; agricultural fields are harvested, and then sprayed or burned to reduce weed infestations; airports are mowed to maintain low-stature grasses around airfields to minimize attraction of hazardous wildlife and support public safety; island sites in the Columbia River are used for the placement of dredged materials. These activities can be beneficial to larks if they are timed appropriately because the actions mimic natural disturbance regimes and maintain the habitat structure required by the bird. However, these activities can also be detrimental to larks if they occur during the breeding season when nests and young are present (Pearson and Hopey 2005, p. 29).

Similar to the timing and method of implementing management activities on agricultural lands discussed as discussed above, the timing and method of implementing management activities at other sites described in more detail below can influence the viability of current and future streaked horned lark populations. Instances where ongoing management activities have the potential to influence streaked horned lark local or regional populations are discussed below.

4.2.2.1. *Vegetation Management Activities at Airports*

Horned larks need expansive areas of flat, open ground to establish breeding territories. The large, flat, treeless areas at airports are attractive breeding sites for streaked horned

larks, particularly as native prairies and scoured river banks in the Pacific Northwest have decreased. The streaked horned lark might have been extirpated from the South Puget Lowlands region if not for management activities at airports to maintain large areas of short grass (Stinson 2005, p. 70). Although routine mowing, discing, herbicide use or burning of vegetation helps to maintain grassland habitat in suitable condition, the timing of mowing is critical to determining whether this activity is harmful or beneficial to larks. Five of the eight streaked horned lark nesting sites in the South Puget Lowlands region are located on or adjacent to airports and military airfields (Rogers 2000, p. 37; Pearson and Hopey 2005, p. 15). At least five breeding sites are found at airports in the Willamette Valley, including the largest known local population at Corvallis Municipal Airport (Moore 2008a, pp. 14-17).

Mowing during the active breeding season (mid-April to late July) can destroy nests, crush eggs or nestlings, or flush fledglings or adults, which may result in reproductive failure (Pearson and Hopey 2005, p. 17; Stinson 2005, p. 72). For example, during the nesting seasons from 2002 to 2004, monitoring at the Gray Army Airfield, McChord Field, and the Olympia Airport in the South Puget Lowlands region documented nest failure at 8 percent of nests due to mowing over nests, forcing young to fledge early (Pearson and Hopey 2005, p. 18).

Some airports in the range of the streaked horned lark have adjusted the frequency and timing of mowing to implement conservation measures to reduce impacts to streaked horned larks (Pearson and Altman 2005, p. 10). The Port of Olympia's Updated Master Plan includes recommendations to minimize impacts to larks at the airport by avoiding mowing during the breeding season; however, mowing still occurs there during the breeding season (Port of Olympia/Olympia Regional Airport 2013, pp. 10-11). Surveys results at the airport indicate the local population has fluctuated (both increased and decreased) between 2013 to 2019 (Wolf et al. 2020, p. 16). The overall count in 2019 of 27 breeding pairs was slightly lower than the count in 2013 (30), however in 2019 there were six more breeding pairs than were counted in 2018 (see Table 1). During the lark breeding season, JBLM has adopted mowing restrictions and exclusion areas to protect nests at military airfields, but mowing can occur during the breeding season under certain circumstances, such as an emergency (Wolf et al. 2017, p. 34). These measures appear to have improved the local population's breeding success, reducing overall effects to the regional streaked horned lark population in the South Puget Lowlands region (Wolf et al. 2016, p. 43).

Currently, there are no conservation measures implemented at several municipal airports in the South Puget Lowlands region and none of the airports in the Willamette Valley region to reduce effects to streaked horned larks from operations and maintenance activities, including mowing. Where conservation measures are not implemented, mowing at airports will continue to influence current and future streaked horned lark populations at the local and regional level.

4.2.2.2. *Military training and associated activities*

The 13th Division Prairie at JBLM is used for helicopter operations (paratrooper practices, touch-and-go landings, and load drop and retrievals) and troop training

activities. Artillery training, off-road use of vehicles, and troop maneuvers at the 13th Division Prairie and 91st Division Prairie have been conducted in areas used by streaked horned larks during the nesting season, contributing to nest failure and low nest success. Military training, including uncontrolled burns from explosive ordnance, hot downdraft from aircraft, as well as civilian events, have been documented to cause nest failure and abandonment at JBLM's Gray Army Airfield and McChord Airfield (Stinson 2005, pp. 71-72). These activities harass and may kill some streaked horned larks, but fires may incidentally help to maintain sparse vegetation and open ground needed for streaked horned lark nesting.

JBLM has committed to implementing a broad program of conservation measures to protect streaked horned larks on the installation. These measures include coordinating with biologists regarding all activities that occur during the lark's breeding season; conducting surveys for lark occupancy prior to initiating military training or related activities; establishing protective buffers around all active nests; restricting mowing within nest buffers for the duration of the breeding season at the airfields; restricting aircraft hovering, helicopter landings, airdrops, and other similar training activities in occupied lark areas during the breeding season; restricting public access and recreation during the breeding season; and implementing measures to prevent attracting corvids and other predators to lark habitats (U.S. Fish and Wildlife Service 2017, pp. 23-27). While the Service fully supports the implementation of these efforts and will continue to collaborate with JBLM to address all aspects of training impacts on the lark, not all adverse impacts are fully ameliorated and military training activities continue to pose threats to the current and future viability of the streaked horned lark population in the south Puget Lowlands region.

In addition to military training activities, McChord Airfield has hosted an international military training event known as the Air Mobility Rodeo which is held in odd-numbered years. In even-numbered years, McChord Airfield hosts a public air show known as the Air Expo. At the Air Expo, aerial events incorporate simulated bombing and fire-bombing, including explosives and pyrotechnics launched from an area adjacent to one of JBLM's most densely populated streaked horned lark nesting sites. When funding is available and these events occur, they are typically scheduled in July to take advantage of the good weather that occurs during summer, but which coincides with the nesting season. During the airshows, tents, vehicles, and concession stands are set up in the grassy areas along the runways used by streaked horned larks, and thousands of visitors line the runways to view the shows.

Disturbance from aircraft, temporary infrastructure, and spectators during the Air Expo and Air Mobility Rodeo may cause nest abandonment, nest failure, and adverse effects to fledglings (Pearson *et al.* 2005b, p. 18; Stinson 2005, p. 27). JBLM has recently committed to reducing adverse effects to larks by scheduling these events as late in the breeding season as possible (after mid-August); no vehicles or structures will be permitted within active nest buffers during these events (U.S. Fish and Wildlife Service 2017, pp. 26). Once implemented, conservation measures associated with the airshows should reduce overall effects to the current and future streaked horned lark population in the south Puget Lowlands region.

4.2.2.3. *Dredge material deposition on Columbia River islands*

The streaked horned lark uses islands along the lower Columbia River for both breeding and wintering habitat. These islands are a mosaic of Federal, State, and private lands, and there are few management or conservation plans in place to protect larks or these important habitats. The U.S. Army Corps of Engineers (Corps) has easements on many of these sites to place sandy materials dredged from the Columbia River as part of its mission to maintain the Federal Navigation Channel. In 2002, the Corps developed a plan to deepen the authorized navigation channel. The plan also included an operations and maintenance dredging program to regularly dredge and place dredged materials at aquatic and upland sites along the lower Columbia River (U.S. Fish and Wildlife Service 2002, pp. 1-14).

Modification of occupied lark habitat and destruction of active nests through the deposition of dredged materials has been documented several times on the Columbia River islands (MacLaren 2000, p. 4; Pearson and Altman 2005, p. 11; Pearson *et al.* 2008a, p. 14). In 2006, dredge spoils were deposited on Whites Island (also known as Brown Island) while larks were actively nesting, destroying all active nests at the site (Pearson *in litt.* 2012b). This site had at least 21 nests and 13 territories during the 2005 nesting season (Pearson *et al.* 2008a, p. 21). Similarly, singing males were observed on Rice Island in June 2000; dredged materials were placed on the site during the breeding season in July, destroying active nests and altering habitat suitability (MacLaren 2000, p. 3). In 2004, the Corps placed dredge materials on breeding habitat at Miller Sands Island, which also likely resulted in nest failure (Pearson and Altman 2005, p. 10).

Dredge placement activities can be beneficial or harmful to streaked horned larks, depending on the location and timing of deposition. In 2014, the Corps consulted with the Service under section 7 of the Act to address potential impacts to the streaked horned lark and critical habitat from dredge placement activities. The Corps and the Service developed a plan that met the Corps' needs to maintain the navigation channel while also maintaining a shifting mosaic of suitable habitat for streaked horned larks in the Columbia River.

The Corps creates and maintains streaked horned lark habitat by strategically prioritizing placement events in sites where vegetation has succeeded beyond suitability. The strategic placement of dredged material mimics disturbance regimes that historically maintained lark habitat through flooding. Where possible, the Corps coordinates placement events to occur at unoccupied sites or unoccupied portions of a site during the breeding season, further reducing negative effects to larks. These conservation measures reduce overall negative effects of dredge placement to the regional streaked horned lark population in the Pacific Coast and Lower Columbia River region; however, adverse impacts are not fully ameliorated because placement sometimes must occur at occupied sites during the breeding season and this activity will continue to negatively influence the current and future viability of the lark population in this region.

4.2.2.4. *Aircraft Strikes*

Streaked horned larks are attracted to flat, open habitats around airports throughout their range. The streaked horned lark is also at risk from aircraft strikes and collisions that occur at airports. Death of individual larks caused by aircraft strikes is a threat to small or declining local populations at airports, as the loss of even a single breeding individual can negatively influence the resiliency of local populations.

Horned lark strikes are frequently reported at military and civilian airports throughout the country, but because of the bird's small size, few strikes result in significant damage to aircraft (Dolbeer *et al.* 2011, p. 48; Air Force Safety Center 2012, p. 2). Most of the specific information available for threats to streaked horned larks at airports comes from the monitoring program at JBLM; similar threats to streaked horned larks may exist at other airports, but without focused monitoring, the extent of the threat to birds has not been documented. Information provided from monitoring at McChord and Gray Army Airfields is used as a surrogate for civilian airports, where information on bird strikes may not be fully reported. It should be noted, however, that airstrikes at JBLM are likely higher than civilian airports. The number and size of planes at civilian airports, except for Portland International Airport, is smaller and the speed of landings and takeoffs is slower, reducing risk to birds in the vicinity of runways. The number of bird strikes reported are a minimum estimate of strikes throughout the species' range.

To promote human safety, airports implement hazardous wildlife management programs that include vegetation management around roads and runways. Streaked horned larks are attracted to these areas and several airports in the species' range are occupied by the subspecies. While aircraft strikes do occur in several local populations at airports throughout the range of the species (particularly in the South Puget Lowlands), the rate appears relatively low and the vegetation management conducted by these airports also maintains habitat that supports breeding larks (Pearson *et al.* 2008a, p. 13; Camfield *et al.* 2011, p. 10). The conflict created for streaked horned larks at airports is largely unavoidable given current FAA regulations; the vegetation management that occurs at airports to promote public safety and reduce wildlife hazards also creates habitat that is attractive to larks (FAA 2020, entire).

Juvenile males seem to be struck most often, perhaps because they are trying to establish new territories in unoccupied, but risky areas on runway margins (Wolf *et al.* 2017, p. 31). In the five-year period from 2013 to 2017, McChord Airfield had seven confirmed streaked horned lark strikes, and Gray Army Airfield had recorded one confirmed streaked horned lark strike (Wolf *in litt.* 2018). Since January 2017, 16 adults have been killed because of aircraft strikes on JBLM, including 10 adults and 2 juveniles at McChord Airfield in 2020 (Wolf *in litt.* 2020). In 2020, the high number of mortalities was the direct result of both increases in population size and construction activities that redirected aircraft traffic to the northern half of the runway where lark density is highest. Aside from the 12 strikes in 2020, JBLM recorded a total of 12 strikes in the seven years between 2013 and 2019, an average of 1.7 strikes per year.

The local population at JBLM is currently estimated at 98-104 breeding pairs of larks (Wolf and Slater 2020, p. 6); the loss of even 1 breeding adult per year could remove

more than 1 percent of the local population each year. While the 2020 construction activities at JBLM represent uncommon situations and do not reflect normal operations, the loss of these individuals represents the degree of aircraft strikes can have on local populations. Modeling has shown that adult survival and recruitment has the greatest influence on population growth rates for streaked horned larks (Pearson *et al.* 2008a, p. 13; Camfield *et al.* 2011, p. 10). Ongoing loss of streaked horned larks from aircraft strikes reduces the number of breeding adults and could reduce the recruitment of juveniles into the breeding population in the South Puget Lowlands and Pacific Coast and Lower Columbia River regions. For these reasons, aircraft strikes are considered a threat that will continue to influence the current and future viability of local and regional streaked horned lark populations.

4.2.3. Recreation

Recreation at coastal sites can cause the degradation of streaked horned lark habitat, as well as disturbance to adults and juveniles, and direct mortality to eggs, nestlings, and fledglings. Activities such as annual spring razor clam digs, dog walking, beachcombing, off-road vehicle use, camping, fishing, and horseback riding in coastal habitats may directly or indirectly increase predation by corvids, resulting in nest abandonment and nest failure for streaked horned larks (Pearson and Hopey 2005, pp. 19, 26, 29). Additional information on recreation impacts is detailed in the 2013 listing (U.S. Fish and Wildlife Service 2013a, p. 61493-61492).

Open sandy beaches (e.g., coastal beaches and sandy islands along the lower Columbia River) are popular camping areas for kayakers and boaters, and nests could be lost due to accidental crushing. During western snowy plover surveys conducted between 2006 and 2010 at coastal sites in Washington, human-caused nest failures were reported in 4 of the 5 years (Pearson *et al.* 2007, p. 16; Pearson *et al.* 2008b, p. 17; Pearson *et al.* 2009b, p. 18; Pearson *et al.* 2010, p. 16). One of 16 monitored nests at Midway Beach on the Washington coast was crushed by a horse in 2004 (Pearson and Hopey 2005, pp. 18-19). Because streaked horned larks nest in the same areas as western snowy plovers along the Washington coast and both are ground-nesting species, it is highly likely that recreation has caused similar nest failures for larks at sites that have documented nest failure for plovers. Because nest success is critical to supporting the resiliency of local and regional streaked horned lark populations, recreation is considered a population-level factor influencing current and future populations of the subspecies in the Pacific Coast and Lower Columbia River region.

4.3. Regulatory and Voluntary Conservation Measures

Since the streaked horned lark was listed in 2013, multiple entities have implemented a series of regulatory and voluntary conservation measures to offset negative impacts to larks and lark habitat, reducing the overall impact of threats and stressors influencing local populations.

Communication between researchers and land managers has resulted in some positive actions to reduce the adverse effects from recreation. In 2002, JBLM began restricting recreational activity at the 13th Division Prairie to protect lark nesting sites; JBLM prohibited model airplane flying, dog walking, and vehicle traffic in the area used by

streaked horned larks (Pearson and Hopey 2005, p. 29). JBLM continues to restrict recreational activities during the lark breeding season at the 13th Division Prairie, although enforcement, especially on weekends, is intermittent (Wolf *et al.* 2016, p. 43). As a result of these conservation measures, ongoing recreational activities may still influence individual larks but are not likely to result in population-level effects to the South Puget Lowlands regional population; recreation continues to be a factor that likely influences populations in the Pacific Coast and Lower Columbia River region, as discussed above.

Development of a Habitat Conservation Plan (HCP) to permit the final phases of development of the Rivergate site was initiated by the Port of Portland in 2017 (Port of Portland 2017, p. 60); earlier phase of development occurred at Rivergate prior to the final listing of the species. As part of the 10(a)(1)(B) permit, the Port mitigated for the loss of habitat by securing a long-term easement on a 32-acre (13 ha) parcel at Sandy Island. Sandy Island is an occupied breeding site on the Columbia River about 30 miles (50 kilometers) north of the Rivergate industrial site and is designated as critical habitat for the streaked horned lark (Port of Portland 2017, p. 4). The HCP was developed to support the permit decision, outlining a 30-year protection and maintenance plan for Sandy Island (Port of Portland 2017, entire). The Port's commitment to manage the site and protect breeding streaked horned larks for the next 30 years helps to offset impacts to the regional population from the loss of available habitat at Rivergate.

Since the streaked horned lark was listed as threatened in 2013, several section 7 consultations and the Port's HCP have been completed that include measures contributing to lark conservation throughout the species' range. These consultations and plans include the following:

- Joint Base Lewis-McChord Training, Maintenance, Recreation, and Resource Management programmatic consultation was completed and signed in 2017 (U.S. Fish and Wildlife Service 2017). The programs covered in this consultation provide numerous positive conservation measures for the streaked horned lark, including prairie habitat restoration and a robust monitoring and research program that has significantly reduced adverse effects to larks from military activities (including training and mowing at military airfields). The programmatic consultation has resulted in a marked increase in the breeding population of larks on JBLM from fewer than 100 pairs when the streaked horned lark was listed in 2013 (Wolf and Anderson 2014, p. 12) to over 120 pairs in 2019 (Wolf *et al.* 2020, p. 6).
- Programmatic consultation for the Corps' navigation channel dredging and dredge materials placement program in the lower Columbia River (U.S. Fish and Wildlife Service 2014, entire). In this programmatic consultation, the Corps committed to planning for the placement of dredge material to minimize adverse effects to the lark on the Corps' network of placement sites and to maintain enough habitat in suitable condition to maintain the current regional population of breeding larks and allow for additional population growth. The 5-year program has been successful, and the number of larks in the lower Columbia River region has increased from 71 pairs in 2014 to 87 pairs in 2019 (see Table 2) (Center for

Natural Lands Management 2019, pp. 3-4)). The original 5-year consultation was extended through 2022. The Corps is currently working on a 20-year Dredge Material Management Plan, which will build on the success of the previous consultation.

- WV NWR farming and pesticide use program, 2017-2021 (U.S. Fish and Wildlife Service 2016b, entire). This programmatic consultation documents the Refuge program's commitment to adapting its farming activities to improve the status of the streaked horned lark on the William L. Finley, Ankeny, and Baskett Slough units of the complex. Conservation measures include ensuring that farming activities minimize disturbance to larks, and that pesticides used in agricultural fields have a low risk of adverse effects to larks and their food sources.
- Animal and Plant Health Inspection Service Wildlife Services Predator Damage Management Program (U.S. Fish and Wildlife Service 2012). Since the predator control program was initiated at Leadbetter Point and Midway Beach on the Washington coast in 2013, western snowy plovers have shown improved nesting success; monitoring data for streaked horned larks is inconclusive and we cannot reliably determine if predator control has improved nesting success for larks at these sites.
- Consultations and Fish and Wildlife Coordination Act reports for the Shoalwater Bay Shoreline Erosion Control Project (U.S. Fish and Wildlife Service 2018). This project is a long-term commitment by the Corps and the Shoalwater Bay Tribe to protect the reservation from coastal erosion. It has created and is maintaining habitat for both western snowy plovers and streaked horned larks and provides secure nesting area on the coast for both species.

4.4. Additional Considerations

There are additional synergistic or cumulative impacts to streaked horned larks from climate change and stochastic weather events. A synergistic factor amplifies the effect of other stressors but is difficult to evaluate by itself. Cumulative or synergistic impacts may influence individuals or local populations by amplifying the impact of other stressors like habitat loss or the negative effects of land management activities. However, these factors do not in and of themselves threaten the species in a measurable or predictable way.

4.4.1. Climate Change

The effects of climate change have already been observed in the Pacific Northwest. Temperatures have risen 1.5 degrees Fahrenheit (°F) (0.83 degrees Celsius) (°C) to 2°F (1.1°C) over the past century, and the past three decades have been warmer than any other historical period (Frankson *et al.* 2017a, p.1; Frankson *et al.* 2017b, p. 1). Climate change is widely expected to threaten wildlife and their habitats in the Pacific Northwest by increasing summer temperatures, reducing soil moisture, increasing wildfires, reducing mountain snowpack, and causing more extreme weather events (Bachelet *et al.* 2011, p. 414).

Despite the projected changes threatening wildlife in the Pacific Northwest overall, the effects of climate change specific to prairie ecosystems are not anticipated to decrease the resiliency of regional populations in the South Puget Lowlands, Pacific Coast and Lower

Columbia River, and Willamette Valley regions. The grasslands and prairies of Washington and Oregon span a wide geographic and climatic range, encompassing a rich variety of soil types, vegetation cover, elevations, and weather patterns. This heterogeneity will likely buffer the effects of changing weather and climate (Bachelet *et al.* 2011, p. 412). It is possible that increased summer droughts may affect less drought-tolerant trees and other forest species adjacent to prairies, possibly resulting in prairie expansion (Bachelet *et al.* 2011, p. 417). Prairie and grassland ecosystems are well-adapted to warm and dry conditions and periodic soil drought, and future increases in temperature and drought for the region, “are unlikely to disadvantage (and may benefit) these systems” (Washington Department of Fish and Wildlife 2015, p. 5-31).

The outlook for streaked horned larks along the Pacific coast is less encouraging. Sea level rise, increased coastal erosion, and more severe weather events will cause significant stressors to lark habitat on the outer coast. Projected sea level rise could increase erosion or landward shift of dunes; similarly, increased severe weather events with greater wave and wind action from storms could magnify disturbance of dune habitats (Washington Department of Fish and Wildlife 2015, p. 5-31) and imperil nesting larks. Given these stressors, we expect that climate change may limit the resiliency of local populations on the coast by amplifying the negative effects from habitat loss or the spread of invasive species, but climate change does not represent a population-level threat influencing the Pacific Coast and Lower Columbia River regional population of streaked horned larks in and of itself.

The effects of climate change on the streaked horned lark were evaluated in both Washington and Oregon’s State Wildlife Conservation Strategies. In Washington, the streaked horned lark was ranked as a species at moderate vulnerability primarily due to the anticipated effects of climate change along coastlines from sea level rise, increased storm severity, and increased erosion (Washington Department of Fish and Wildlife 2015, p. 5-10). Oregon’s assessment ranked the streaked horned lark in the Willamette Valley as a species at low to lowest vulnerability (Steel *et al.* 2011, p. 26); Oregon’s assessment did not include the population of larks at Clatsop Spit since larks were not known to occur there at that time.

4.4.2. *Stochastic Weather Events*

Climate change may increase the frequency and severity of stochastic weather events, which may have severe negative effects on small local populations throughout the range of the streaked horned lark. During the breeding season, small local populations of larks are distributed across the range; in the winter, however, streaked horned larks congregate mainly in the Willamette Valley and on islands throughout the lower Columbia River. Such concentration exposes the wintering populations to potentially disastrous stochastic events, such as ice storms or flooding, which could kill individuals, destroy limited habitat and food availability, or skew sex ratios. Severe winter weather could potentially impact one or more regional populations when birds congregate as larger flocks (Pearson and Altman 2005, p. 13).

An example of effects to streaked horned larks from stochastic weather events is the male-skewed sex ratio that was observed at Corvallis Airport after the winter of 2013 to

2014. Earlier monitoring indicated that all territorial males were mated, but in the 2015 breeding season, substantial numbers of unpaired territorial males were observed (Stinson 2016, p. 6; Moore 2017b, p. 13). This male-skewed adult sex ratio may have resulted in males outcompeting females for limited resources and thus the harsh winter conditions disproportionately affected females. However, within two subsequent years in which winters were more moderate, the sex ratio returned to normal (Moore 2017b, p. 13). This suggests stochastic weather events can influence local or regional population dynamics, but the response is dependent upon the size of the population, movement between local populations, and the severity of the weather event. Given the infrequency of stochastic weather events influencing regional populations, we do not consider stochastic weather events to be a stand-alone threat to the species, but one which would amplify the effects of climate change and small population sizes.

4.5. Small Population Effects

Most species' populations fluctuate naturally, responding to various factors such as weather events, disease, and predation. These factors have small impact on a species with large, stable local populations and a wide and continuous distribution. However, populations that are small, isolated by habitat loss or fragmentation, or impacted by other factors are more vulnerable to extirpation by natural, randomly occurring events, and to genetic effects that plague small populations, collectively known as small population effects (Purvis *et al.* 2000, p. 3). These effects can include increased chances of inbreeding depression, reduced disease resistance, genetic drift, founder effects (i.e., over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks leading to increasingly lower genetic diversity, with consequent negative effects on evolutionary potential (Keller and Waller 2002, p. 235).

Current population sizes are the result of historic and ongoing threats acting on the species. Local populations may or may not be resilient due to the small number of breeding birds in the population. While small population effects influence current population structure and overall reproductive success of streaked horned larks, small population sizes are not anticipated to influence or drive the viability of the species. Small population effects may be most apparent in the local populations of the South Puget Lowlands region, which exhibits low reproductive success. Genetic analysis has shown that streaked horned larks have suffered a loss of genetic diversity due to a bottleneck in population size, the effect of which may be exacerbated by continued small population size (Drovetski *et al.* 2005, p. 881). The male skewed sex-ratio has been documented at many sites with low populations and is currently a concern range-wide, especially at coastal sites, some of the smaller breeding areas in the South Puget Lowlands region, and along the lower Columbia River (Anderson 2010, p. 15; Camfield *et al.* 2010, p. 277; Drovetski *et al.* 2005, p. 881; Pearson 2019, Figures 1 and 2; Drovetski *et al.* 2005, p. 881; Wolf *et al.* 2017, p. 27).

Studies in Washington have found that streaked horned larks have lower fecundity and nest success than other northwestern horned lark subspecies (Camfield *et al.* 2010, p. 277). In a study on the Puget Lowlands, measures of reproductive success were lower for streaked horned larks than for other ground-nesting birds at the same prairie sites (Anderson 2010, p. 15). In one year, which has not been repeated, the hatching rate at the

13th Division Prairie was extremely low (i.e., 44 percent) (Anderson 2010, p. 18). Comparisons with savannah sparrows (*Passerculus sandwichensis*), a bird with similar habitat requirements that nests on the same prairies, found that streaked horned lark fecundity was 70 percent lower (Anderson 2010, p. 18). If the streaked horned lark's low reproductive success was caused by poor habitat quality, other ground-nesting birds at the study sites would be expected to show similarly low nest success rates; that other bird species have much higher nest success rates in the same habitat suggests that inbreeding depression may be playing a role in the decline of streaked horned larks in the South Puget Lowlands region in the last few years (Anderson 2010, p. 27). Additional observations of inbreeding in the South Puget Lowlands regional population include two cases of observed mother-son pairings (Pearson and Stinson 2011, p. 1), at least one sibling pairing (Wolf *in litt.* 2020), and no observations of immigration from other regions into the South Puget Lowlands region (Pearson *et al.* 2008a, p. 15; Wolf *et al.* 2020, p. 8-9).

A decade ago, estimates of population growth rate that included vital rates from all of the nesting areas in Washington indicated that streaked horned larks in Washington were declining by 40 percent per year, apparently due to a combination of low survival and fecundity rates (Pearson *et al.* 2008a, pp. 10, 13; Camfield *et al.* 2011, p. 7). Territory mapping at four sites in the South Puget Lowlands region found that the total number of breeding streaked horned lark territories decreased from 77 in 2004 to 42 in 2007—a decline of over 45 percent in 3 years (Camfield *et al.* 2011, p. 8). The combination of low genetic variability, small and rapidly declining local populations, high breeding site fidelity, and no observed migration into the South Puget Lowlands regional population suggests that in the future, if influences remain the same, the South Puget Lowlands regional population could eventually become extirpated. Some studies, following implementation of conservation measures, especially on JBLM, indicate that some populations in the South Puget Lowlands have stabilized, while others continue to decline (Keren and Pearson 2019, pp. 3-4; Wolf *et al.* 2020, p. 2).

The streaked horned lark population trends observed in the South Puget Lowlands region about a decade ago were thought to be driven, in part, by low egg hatchability, which was likely caused by inbreeding (Drovetski *et al.* 2005, p. 881; Wolf *et al.* 2017, p. 27). In 2011, a project was initiated to increase genetic diversity and improve hatchability of streaked horned larks in the South Puget Lowlands region. This “genetic rescue” effort entailed translocating eggs in 2011 and 2013 to 13th Division Prairie from nests at the Corvallis Municipal Airport, where egg hatchability appeared to be normal (Wolf *et al.* 2017, p. 27). The project goal could be achieved if the imported eggs produced fledglings that returned to breed successfully at JBLM. A male originating from an Oregon clutch translocated in 2011 survived and returned repeatedly to breed at 13th Division Prairie and produced at least 18 fledglings (Wolf *et al.* 2017, p. 28). Only one juvenile from the translocated male was observed as an adult, but it was never confirmed to breed successfully, and thus there is no information on whether Oregon genetics were ever introduced into the South Puget Lowlands region (Wolf *et al.* 2017, p. 28).

4.6. Summary of Factors Influencing Regional Populations

There are many stressors to the streaked horned lark and its habitat throughout its range. Stressors that influence individuals, but which do not represent a population or species-level threat include predation, disease, and pesticides. While predation effects are not a new threat to individual larks, some small local populations at JBLM have been affected by constant and long-term predation. The small size of these local populations may amplify the effects of stressors influencing individuals, but small population size does not influence populations on its own. When acting on small local populations, predation, disease, pesticides, and other stressors can have synergistic effects that reduce overall resilience of a local population by impacting individuals, but do not represent stressors to regional populations and are therefore not included in the 3R analysis.

Historically, natural disturbance regimes maintained streaked horned lark habitat. The loss of these natural processes has resulted in the streaked horned lark's strong dependence on artificially maintained habitats, including agricultural lands, airports, and dredged material placement sites. While the lark has benefited from creation of these "replacement" habitats, anthropogenic modification and use of these sites expose larks to disturbances, particularly during the breeding season, which may kill or injure all life stages of the bird. Any future changes in the maintenance of these landscapes will affect the resiliency of larks in the area. Agriculture remains the primary influence on land use in the Willamette Valley, and the resilience of larks in the area is tied to practices that can easily change given market demands. Many beneficial actions have been initiated since the lark was listed in 2013, and some stressors to the species have been partially ameliorated. Despite these actions, the continued effects of habitat loss and other threats in combination with small population size and the effects of climate change will reduce the viability of the streaked horned lark over the next 30 years (see Table 4).

TABLE 4.—Summary of Stressors Influencing the Current Status of Regional Populations.

<i>Factors Influencing Populations</i>		<i>Regional Populations</i>		
		South Puget Lowlands	Pacific Coast and Lower Columbia River	Willamette Valley
Habitat Fragmentation, Degradation, and Loss	Vegetation succession	XX	XX	XXX
	Encroachment of woody vegetation, invasive species	X	XXX	X
	Land use changes or conversion	X	X	XXX
	Crop conversion	--	--	XXX
	Loss of natural disturbance processes	XX	XX	XX
Land Management	Vegetation management activities	XX	--	XX

	Military training and associated activities	X	--	--
	Dredged material placement	--	X	--
	Aircraft Strikes	XX	--	X
Recreation		--	XX	--
<i>Note:</i> XXX indicates a relatively frequent influence on a regional population; XX indicates a moderate influence on a regional population; X indicates an occasional influence on a regional population; no entry (--) indicates stressor does not influence the regional population.				

The resiliency of the rangewide streaked horned lark population is negatively affected by the following: the ongoing loss of suitable habitat throughout the species' range; loss of preferred habitats as a result of successional changes in plant species composition and encroachment of woody vegetation or tall grasses; invasion of beach grasses; conversion of suitable habitat into unsuitable habitat through changes in land use; loss of natural disturbance processes; and, changes in agricultural practices from crops that mimic preferred habitats (i.e., grass seed farms) to crops that diminish habitat suitability (i.e., hazelnut orchards and blueberry farms). Land management activities and their relative effects negatively affect the current resiliency of regional populations where larks occur, including airport management activities and aircraft strikes, military training and activities, certain restoration actions, certain agricultural practices, and the placement of dredged materials. Other stressors affecting the survival of streaked horned larks at the population level including recreation and trainings at civilian airports.

Conservation measures implemented as part of section 7 consultations or HCPs have benefitted the streaked horned lark by reducing negative impacts throughout the species' range to varying degrees. Conservation measures include managing vegetation, restoring habitats, and adjusting the timing or method of implementing an action to reduce negative effects. For example, restoration and management of prairie habitats in the South Puget Lowlands region minimizes impacts to larks and lark habitat. Restoration actions at Shoalwater Bay minimize erosion along the coast reduce, securing nesting habitat for larks along the coast. The Corps has committed to maintaining habitat in the lower Columbia River through the strategic placement of dredge materials, supporting the current and future regional population of larks. A 30-year commitment by the Port of Portland to manage vegetation at Sandy Island has temporarily secured lark habitat to mitigate for losses of occupied habitat at Rivergate. Agricultural and farming activities at WV NWR are implemented in a manner that minimizes disturbance to breeding larks and reduces the risk of pesticides for larks and their food sources, while predator control measures may have reduced the direct loss of individuals and improving nesting success along the Washington coast.

The impact of the stressors summarized in Table 4 and the conservation measures implemented to minimize or mitigate impacts to larks and lark habitat is factored into our 3R assessment of populations for our current condition analysis in Chapter 5. We anticipate habitat loss, changes in land use and agricultural practices, recreation on the Pacific Coast and Lower Columbia River, and aircraft strikes will continue to influence

the condition of the streaked horned lark in the future to a degree that may affect the resiliency of populations. The projected future impact of these stressors is factored into the 3R assessment of populations in our future condition analysis in Chapter 6.

Ongoing management activities at JBLM, civilian airports, and dredge placement sites are expected to have less impact on the future resiliency of local and regional populations compared to current conditions; their influence would not be eliminated under future scenarios, but they will have less influence on overall viability of the subspecies. Since the lark was listed as threatened in 2013, successful collaboration with other federal agencies and regional partners has resulted in many conservation actions that have benefitted the species. As a result of section 7 consultation with JBLM and the Corps, management activities have improved habitat conditions for larks and reduced the negative effects to individuals (except for impacts due to airstrikes). Any future air shows at JBLM will include minimization measures. These conservation actions have improved, or will improve, conditions for larks in the South Puget Lowlands, and Pacific Coast and Lower Columbia River regions.

We anticipate these conservation measures will continue in the future, provided regulatory oversight and available funding remains consistent. It should be noted that while many conservation measures have been implemented effectively to reduce or minimize impacts to local populations in the South Puget Lowlands and Pacific Coast and Lower Columbia River regions, there are no conservation measures in place for private lands in the Willamette Valley region which supports the majority of the rangewide population. Furthermore, the conservation measures implemented throughout the species' range vary in the degree of impact reduction and potential success in supporting recovery.

5. CURRENT CONDITION

The Service uses the conservation principles of resiliency, redundancy, and representation to assess the viability of populations of threatened and endangered species (Shaffer and Stein 2000, pp. 307, 309–310; Wolf *et al.* 2015b, pp. 204-205). Viability is gauged by the ability of populations to withstand disturbances of varying magnitude and duration (resiliency), the species' ability to withstand catastrophic population and species-level events (redundancy), and the species' ability to adapt to changing environmental conditions (representation). In this chapter we summarize information on the current condition of the streaked horned lark.

5.1. Rangewide and Regional Population Trends

The North American Breeding Bird Survey (BBS) provides the only range-wide breeding population trend for the streaked horned lark (Sauer *et al.* 2017, p. 3). The BBS provides a large amount of information about regional population change for many species, but there are a variety of possible problems with BBS data that can compromise estimates of population change, including small sample sizes, low relative abundances on survey routes, imprecise trends, and missing data. To provide guidance for interpreting BBS data, we categorize BBS data in three credibility categories based on precision or reliability of the data: red, yellow, and blue. Data categorized as red has notable deficiencies with low precision and very low confidence; yellow data has deficiencies,

but has moderate precision and confidence; and, blue data has moderate precision and is more reliable (U.S. Geological Survey 2020, entire).

Although the BBS does not provide trend estimates for subspecies, the streaked horned lark is the only subspecies of horned lark that breeds in its range in the Washington and Oregon portion of the Northern Pacific Rainforest Bird Conservation Region (a geographic classification of the BBS). Therefore, it is reasonable to assume that detections of horned larks from the breeding season in this region are streaked horned larks. The BBS data from this Bird Conservation Region indicate significantly declining populations since the late-1960s, with an estimated annual trend of -5.74 percent (95 percent confidence interval: -7.95 to -3.64) (Sauer *et al.* 2017, p. 3). The most recent 10-year trend from 2005 to 2015 shows a greater annual decline of -6.52 percent (95 percent confidence interval: -12.66 to -2.26) (Sauer *et al.* 2017, p. 3). The U.S. Geological Survey (USGS), which manages the BBS data, provides a yellow credibility measure for horned lark data, indicating data deficiency and encouraging caution in interpreting data due to low abundance, small sample size, or imprecise trends (Sauer *et al.* 2017, p. 5). However, the descriptive statistics (e.g., mean number of detections by year) reveal a pattern of decline in numbers of individuals detected over the last five decades.

When the lark was listed as threatened in 2013, an analysis predicted a rapid decline in the Washington regional populations, including breeding sites on the South Puget Lowlands, and Pacific Coast and Lower Columbia River regions (Camfield *et al.* 2011, p. 8). One study of the local population at 13th Division Prairie at JBLM speculated that small population size, high nest site fidelity, and low egg hatching rates indicated the population was suffering from inbreeding depression (Anderson 2010, p. 33). Recent efforts at JBLM to manage habitat and reduce the adverse effects of airfield maintenance and military training have stabilized and, in some cases, increased abundance and productivity of some local populations (Wolf *et al.* 2015a, p. 48). Recent data also suggest the South Puget Lowlands, and Pacific Coast and Lower Columbia River regions have relatively stable or increasing lark populations, but local populations have varying levels of stability and influence on the regional population (Stinson 2016, p.6; Slater and Treadwell 2018, p. 28; Wolf *et al.* 2018, p. 15; Keren and Pearson 2020, pp. 3-4).

In the Willamette Valley, the ODFW conducted surveys for grassland-associated birds, including the streaked horned lark in 1996 and again in 2008 (Altman 1999, p. 2; Myers and Kreager 2010, p. 2). Roadside point count surveys were conducted at 544 stations (Myers and Kreager 2010, p. 2), and measures of relative abundance of streaked horned larks increased slightly in 2008 compared to 1996. Detections at point count stations as well as within the Willamette Valley region showed moderate increases (3 percent and 6 percent, respectively) (Myers and Kreager 2010, p. 11). Population numbers decreased slightly in the northern portion of the Willamette Valley region and increased slightly in the middle and southern portions of the Valley (Myers and Kreager 2010, p. 11). Despite these results, we suspect the number of birds detected during surveys is not reflective of all birds present throughout the Willamette Valley region, or trends in other areas in Oregon. Additional studies are needed to understand population trends in the Willamette Valley region and other areas in Oregon.

5.2. Assessment of Current Condition

5.2.1. Resiliency

Resilient populations can withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), severe weather events or other changes to habitat conditions (environmental stochasticity), random fluctuations in genetic variation (genetic drift), or threats caused by anthropogenic activities. Resiliency can be evaluated using metrics such as population demographics (i.e. population size, birth and death rates, nesting success rates), and habitat parameters (i.e. the quality, quantity, and distribution of suitable habitats). To evaluate resiliency for each of the 42 local population units, we developed a condition category matrix to define *high*, *moderate*, *low*, and *extirpated* condition categories for the demographic and environmental factors influencing resiliency (Table 5). We then used this matrix to systematically evaluate each factor for each of the local population units.

To maintain adequate resiliency, local populations of streaked horned larks need large open spaces with suitable habitat structure, and an appropriate disturbance regime sufficient to maintain habitat and support increased numbers of breeding birds. For our evaluation of current condition, we assessed information from peer-reviewed literature, as well as survey data and knowledge of anthropogenic practices. The size and stability of resilient local populations varies among regions, depending on overall abundance, connectivity between sites, the extent and quality of available habitat, and the timing and intensity of disturbance regimes.

Abundance and population trend information were assessed using survey data and changes in number of breeding pairs between 2013 and 2019 and ranked according to abundance criteria in the draft Recovery Plan for each regional population. A few local populations have been extensively studied; however, detailed information for some sites is sparse or survey data is incomplete. When available, we used quantitative data to assess abundance and growth trends. Connectivity between local sites was noted where information was available from survey data. Information on habitat condition, including low-statured vegetation structure and overall suitability, are largely qualitative. The influence of disturbance regimes on local populations was evaluated with regards to the timing and frequency of disturbance, if known, and the relative level of beneficial or adverse effects on individual birds.

To evaluate current condition, we assigned each condition category a number. Factors that are in high condition support population resiliency, whereas factors that are in low condition reduce resiliency and increase the risk from stochastic events.

TABLE 5.—Matrix for Evaluating Current Condition of the Streaked Horned Lark

Demographic and Habitat Parameters		High Condition ←————→ Low Condition			
Abundance	<i>South Puget Lowlands</i>	Regular surveys detect ≥ 20 breeding pairs, (3)	Regular surveys detect 10–20 breeding pairs (2)	Regular surveys detect ≤ 10 breeding pairs (1)	Extirpated: larks no longer occupy site or region (0)
	<i>Pacific Coast and Lower Columbia River</i>	Regular surveys detect ≥ 15 breeding pairs on coast, (3)	Regular surveys detect 7–15 breeding pairs on coast, (2)	Regular surveys detect ≤ 7 breeding pairs on coast, (1)	
		Regular surveys detect ≥ 20 breeding pairs on river, (3)	Regular surveys detect 10–20 breeding pairs on river, (2)	Regular surveys detect ≤ 10 breeding pairs on river, (1)	
	<i>Willamette Valley</i>	Regular surveys detect ≥ 25 breeding pairs, (3)	Regular surveys detect 15–25 breeding pairs (2)	Regular surveys detect ≤ 15 breeding pairs (1)	
Population Growth / Trend		Increasing population trend (2)		Stable population (1)	Declining or insufficient data to assess trends (0)
Connectivity		Movement between local populations/regions (1)			No movement between local populations/regions (0)
Habitat		Large, open areas with low-stature grasses, 17 percent bare ground (3)	Open areas with low-stature grasses, some shrubs and trees (2)	Small patches of suitable grasses surrounded by dense vegetation and trees (1)	Extirpated: habitat to support larks no longer exists at a site (0)
Beneficial Disturbance Regime		Regular disturbance occurs to maintain habitat for nesting, no adverse effects during breeding season (3)	Semi-regular disturbance, habitat is available but not ideal for nesting, some adverse effects during breeding season (2)	Infrequent disturbance, habitat may be temporarily unavailable; high adverse effects during breeding season (1)	Extirpated: disturbance does not occur to maintain habitat for larks; high adverse effects during breeding season (0)

Each of the five demographic or habitat parameters were given equal weight and the resulting scores were averaged to come up with an overall condition score for each local population unit as follows: *High* (>1.7), *Moderate* (1.1 to 1.6), *Low* (0.2 to 1.0), and *Extirpated* (≤ 0.1) (Table 6). The overall condition scores were based on the difference between the highest and lowest possible scores for extant populations (2.4 and 0.2, respectively). If survey data showed a site had no detections of streaked horned larks, then the entire site is categorized as *Extirpated*, regardless of the condition category assigned to the habitat or disturbance factors (e.g., Oyhut Spit and Johns River Island in the Pacific coast region).

TABLE 6.—Resiliency score for Current Condition of the Streaked Horned Lark

Resiliency	Average Score
High	≥ 1.7
Moderate	1.1 to 1.6
Low	0.2 to 1.0
Extirpated	≤ 0.1

The resulting condition of extant local populations varied between high and low resiliency. Some local populations ranked higher in resiliency (i.e. those that scored 1.7 or greater) as a result of abundant populations and high-quality habitat; other populations ranked lower (i.e. those that scored 1.0 or less) in part because of a combination of low abundance, declining population trends between 2013 and 2019, poor quality habitat, and land management activities resulting in adverse effects. In general, lower ranked populations have low abundance that has declined since 2013 and occurs in locations that have less habitat availability and therefore limited capacity to support high numbers of birds. In addition, land management activities at some sites, such as construction and development, vegetation management at airports, or sand-borrow activities on the Columbia River would not support long-term resiliency even if population abundance stabilized and increased. Use of these sites is opportunistic based on habitat availability and these sites are not anticipated to meaningfully contribute to species resilience or support high numbers of birds due to degraded habitat and effects of land management activities.

For the streaked horned lark to maintain viability, the regional populations, or some portion of its regional populations, must be resilient. Stochastic events that have the potential to affect streaked horned lark populations include habitat loss and modification, effects of land management activities, climate change, and extreme weather events. Currently, the three regional populations occupy habitats with some form of disturbance regime to sustain reproducing populations. In all regions, however, streaked horned larks are restricted to very few locations of suitable habitat where the disturbance regimes do not have adverse effects on local populations.

In the South Puget Lowlands region, we consider four of the eight local populations to be highly resilient, while one has moderate resiliency, and three have low resiliency based on demographic and environmental factors influencing current condition (see Tables 1

and 7). The populations at the JBLM airfields and 13th Division increased between 2013 and 2019 and movement between sites and habitat quality supports high resiliency. The Shelton, Olympia and Tacoma airports have unstable or declining populations, or insufficient data to assess population trends. Except for the Olympia Airport, these local populations also have no connectivity. As a result, the overall resiliency of the airports sites is moderate to low.

Several sites are actively managed to reduce threats and maintain habitat with suitable structure to support the breeding population of larks. The local populations at the McChord Airfield and 13th Division Prairie are among the largest in the region (see Table 1) and monitoring indicates that the regional population is relatively stable. The local populations at Gray Army Airfield and 91st Division Prairie – Range 76 are smaller, but monitoring indicates these populations are fairly stable. Because habitat conditions are maintained and populations are stable, we consider these sites to support highly resilient populations in the South Puget Lowlands region. While the local population of streaked horned larks at Olympia Airport is among the most abundant populations in the region, the population has fluctuated in recent years from a high of 48 pairs in 2015 to 27 pairs in 2019, reducing resiliency at this site.

The local population at 91st Division Prairie – Range 50/53 is small and has declined in recent years, suggesting the population has low resiliency. Similarly, the local population of streaked horned larks at Shelton Airport has decreased over the past few years from 13 pairs when the species was listed in 2013, to 6 pairs in 2019. Monitoring at the Tacoma Narrows Airport is inconsistent, and the local population is very small (2-3 pairs). Due to their declining population and small size, we consider the local populations at Shelton, and Tacoma Narrows Airports to have low resiliency.

Table 7.—Summary of Streaked Horned Lark Current Condition Resiliency in the South Puget Lowlands Region.

<i>Local Population</i>	<i>Abundance (mean)</i>	<i>Population Trend</i>	<i>Connectivity</i>	<i>Habitat Quality</i>	<i>Disturbance</i>	<i>Resiliency</i>	
Gray Army Airfield	3	1	1	2	2	1.8	High
McChord Airfield	2	2	1	2	2	1.8	High
13 th Div. Prairie	2	2	1	2	2	1.8	High
91 st Div. Range 76	2	2	1	2	2	1.8	High
Olympia Airport	3	0	1	2	1	1.4	Moderate
91 st Div. Range 50/53	1	0	0	2	2	1.0	Low
Tacoma Narrows Apt.	1	0	0	2	1	0.8	Low
Shelton Apt.	1	0	0	2	1	0.8	Low

On the Pacific coast, there are no highly resilient populations based on population demographics, habitat characteristics, or disturbance regimes (see Tables 2 and 8). The local population at Leadbetter Point is the largest population, which is substantially smaller than several populations in the South Puget Lowlands or along the lower

Columbia River. While Leadbetter Point is managed to improve habitat quality for larks and reduce corvid predation, the local population has fluctuated in the last several years and is currently considered unstable. On the lower Columbia River, there are at least 14 local populations with persistent breeding, but only Rice Island has consistently than 20 breeding pairs (Tables 2 and 8).

Table 8.—Summary of Streaked Horned Lark Current Condition Resiliency in the Pacific Coast and Lower Columbia River Region.

<i>Local population</i>	<i>Abundance (mean)</i>	<i>Population Trend</i>	<i>Connectivity</i>	<i>Habitat Quality</i>	<i>Disturbance</i>	<i>Resiliency</i>	
Rice Island	3	1	0	2	3	1.8	High
Sandy Island	1	1	1	3	3	1.8	High
Leadbetter Point	3	1	1	1	1	1.4	Moderate
Miller Sands Island	1	1	1	2	2	1.4	Moderate
Pillar Rock Island	1	1	0	2	2	1.2	Moderate
Welch Island	1	2	0	2	2	1.4	Moderate
Tenasillahe Island	1	1	0	2	2	1.2	Moderate
Brown Island	2	0	1	3	2	1.6	Moderate
Crims Island	1	1	0	2	2	1.2	Moderate
Howard Island	1	2	0	3	2	1.6	Moderate
Lower Deer Island	1	2	1	2	2	1.6	Moderate
Graveyard Spit	1	1	0	1	1	0.8	Low
Midway Beach	1	0	1	1	1	0.8	Low
Damon Point	1	0	1	1	1	0.8	Low
Clatsop Spit	1	0	0	1	1	0.6	Low
Hump Island	1	1	0	1	2	1.0	Low
Northport	1	0	0	1	1	0.6	Low
Sand Island	1	1	1	1	1	1.0	Low
Martin Bar	1	1	0	1	1	0.8	Low
Austin Point	1	1	1	1	0	0.8	Low
Gateway	1	0	0	1	1	0.6	Low
Rivergate	1	0	0	1	1	0.6	Low
PDX Airfield	1	1	0	2	1	1.0	Low
PDX SW Quad	1	0	0	2	1	0.8	Low
Oyhut Spit	0	0	0	1	1	N/A	Extirpated

Johns River Is.	0	0	0	1	1	<i>N/A</i>	<i>Extirpated</i>
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Other sites on the Washington coast have only a few pairs of breeding larks, resulting in low resiliency. The local population at Midway Beach has sufficient birds to maintain a breeding population, but habitat is not managed regularly, decreasing overall resiliency of this local population. Other sites where streaked horned larks have been observed are likely not resilient based on population size, poor habitat conditions, or infrequent disturbance. Despite the apparent low resiliency at Clatsop Spit, recent observations of wintering larks and detections during the breeding season suggest individuals may be prospecting for suitable habitat in new areas or dispersing from other regions. Streaked horned larks have not been observed at Oyhut Spit or Johns River Island between 2013 and 2019, suggesting the species is extirpated from these areas.

Habitat conditions at sites in the Corps' dredge material disposal network on the lower Columbia River are regularly maintained via the placement of dredged materials. These actions are implemented strategically to maintain suitable lark habitat and minimize disturbance during the breeding season. With the exception of Sandy Island, habitat suitability at these sites is entirely dependent upon dredged material placement activities. Sandy Island is managed for streaked horned lark and therefore has high resiliency. Overall, two sites in the Pacific Coast and Lower Columbia River region have high resiliency based on abundance and habitat quality; nine sites have moderate resiliency based on small, but persistent breeding populations where habitat suitability is supported by management activities. The remaining 9 sites in this region have either less-suitable habitat, limited connectivity, management activities that are not compatible with successful breeding, or no larks are present. These sites are not anticipated to support large breeding populations and therefore have low resiliency.

Most of the larks in the Willamette Valley region occur on private agricultural lands and have not been monitored due to lack of access. The only local populations in the region that have been consistently monitored are those at the Corvallis Municipal Airport and on the three units of the WV NWR. In the Willamette Valley region, larks are almost entirely dependent on agriculture and civilian airports, except for small populations on the WV NWR where they are not managed as a priority species.

The local populations at Corvallis Municipal Airport and at Baskett Slough NWR are large and fairly stable and are the only known local populations in the Willamette Valley with high resiliency (Tables 3 and 9). Other sites where management occurs to support lark habitat and where larks have been regularly observed and monitored, including Ankeny and William L. Finley NWRs, wetlands managed under the WRP and other restored habitats support lark populations with moderate resiliency. Local populations at other known sites have low resiliency due small, fluctuating population sizes, limited connectivity, and disturbance regimes that reduce survival of larks during the breeding season. There may be other local populations on private lands, but our current knowledge is limited and there is no data to suggest any other local populations are resilient. Because no birds were observed at Salem Municipal Airport between 2013 and 2019, streaked horned larks are assumed to be extirpated from this site.

Table 9.—Summary of Streaked Horned Lark Current Condition Resiliency in the Willamette Valley Region.

<i>Local population</i>	<i>Abundance (mean)</i>	<i>Population Trend</i>	<i>Connectivity</i>	<i>Habitat Quality</i>	<i>Disturbance</i>	<i>Resiliency</i>	
Corvallis Airport	3	2	1	2	2	2.0	High
Baskett Slough NWR	3	2	0	3	3	2.2	High
Ankeny NWR	1	1	0	3	3	1.6	Moderate
William L. Finley NWR	1	1	0	3	3	1.6	Moderate
Private Lands (WRPs)	2	1	1	2	2	1.6	Moderate
Herbert Farm Ntrl. Area	1	0	0	3	3	1.4	Moderate
Coyote Creek South	1	1	0	3	3	1.6	Moderate
Eugene Airport	1	0	0	2	2	1.0	Low
McMinnville Airport	1	0	0	2	2	1.0	Low
Independence St. Apt.	1	0	0	2	2	1.0	Low
Salem Municipal Apt.	0	0	0	2	2	N/A	Extirpated

5.2.2. Redundancy

Redundancy is the ability to withstand catastrophic events, which is directly related to the number, distribution, and connectivity of resilient local populations. The needs of the streaked horned lark to achieve adequate redundancy are multiple resilient populations in each region with the potential for movement among local and regional populations to allow recolonization following major stochastic events.

Redundancy is appropriately addressed at the rangewide level. The draft Recovery Plan recommends that resilient local populations are distributed across a combination of lands managed intentionally for long-term lark conservation and lands managed for multiple-use objectives that provide short-term benefits to larks. At minimum, the draft Recovery Plan recommends that 38 sites are managed for long-term conservation: 8 sites in the South Puget Lowlands; 3 sites along the Pacific Coast; 6 sites in the Lower Columbia River; and 21 sites in the Willamette Valley. Currently, the four representational regions support 42 local populations representing species viability. Of the 42 local populations, only 8 are considered highly resilient and only 1 site (Sandy Island) is managed for streaked horned lark conservation.

Recent detections of birds at sites previously unoccupied (i.e., Clatsop Spit) suggest individuals are actively moving between sites and potentially recolonizing areas with suitable habitat. In the Willamette Valley region, surveys at accessible sites throughout the valley found that streaked horned larks are well-distributed across the region, though they are more abundant in the southern end of the valley where there is more suitable habitat. We have very little information about the status of local populations on private lands in the Willamette Valley. The combination of the size of the Willamette Valley region, the large areas of apparently suitable habitat, and the relatively large number of

larks that move about in response to changing habitat conditions, confers some protection against catastrophic events. However, additional resilient local populations would increase the overall level of redundancy for the species. Overall, we consider streaked horned larks to have moderate-to-low redundancy based on few highly resilient populations and low incidence of movement between local populations and fewer incidences of movement between regions.

5.2.3. Representation

Representation is sufficient genetic and ecological diversity to maintain adaptive capacity in a changing environment. Representation can be assessed as the number or percent of ecological settings across the range over which a species' recovery will occur. Generally, the more representation, or diversity, the species has, the more it can adapt to changes (natural or human-caused) in its environment. The habitat types occupied by local and regional populations of streaked horned larks have been thoroughly documented (Anderson and Pearson 2015, entire). The needs of the streaked horned lark to achieve representation are multiple local populations well distributed across its range in a broad variety of habitat types.

Representation is appropriately addressed at the rangewide level. As noted earlier in this document, the streaked horned lark has been extirpated from the northernmost extent of its historical range in the northern Georgia Basin and north Puget Lowlands and from the Rogue and Umpqua Valleys in the south. These losses from the northernmost (i.e., cooler and wetter) and southernmost (i.e., warmer and drier) extremes of the lark's known historical range demonstrate a substantial loss of ecological diversity. Within their current range, larks are found on native prairies; military and civilian airfields; beaches, dunes, and sandy islands; restored native prairies; agricultural areas; and industrial sites. Occupied sites differ markedly within and among regions, which suggest that larks experience a broad range of ecological diversity.

The northernmost (Shelton Airport) and westernmost (Washington coast) occupied sites have small and declining local populations; if these populations decline to zero, their relative isolation on the edges of the current range makes them unlikely to be recolonized. The loss of local populations in either region would result in further diminution of representation. Isolated sites are not inherently geographical barriers; recent surveys show that larks are able to disperse and occupy "isolated" sites, as indicated by at least three female larks that moved approximately 28 miles (45 kilometers) to Shelton Airport from JBLM (Wolf *in litt.* 2020). The South Puget Lowlands regional population is the only migratory population and there is no evidence of immigration into this region from other regional populations. If the South Puget Lowlands regional population were to disappear or become further compromised, it would be a unique loss of genetic and ecological diversity from the rangewide population that would not likely be replaced by individuals from other regions.

The current range of the streaked horned lark encompasses a variety of habitat types, and larks are well-distributed across most of the species' current range. There are at least two local populations ranked high in each regional population, suggesting relative good representation in varying habitats, including prairies, wetlands, coastal dunes, sandy

islands, airports and road margins, and agricultural fields. The small and declining local populations in the northernmost and westernmost occupied sites are at risk, and their loss would reduce our assessment of representation for the species to low.

5.3. Current Condition Summary

The streaked horned lark has numerous, but mostly small (<10 breeding pairs) local populations that are well distributed across the South Puget Lowlands, Pacific Coast and Lower Columbia River, and the Willamette Valley regions. At the time of listing, local populations of streaked horned larks were smaller and there were fewer known sites compared to the number and size of local populations in 2019. However, it should be noted that monitoring efforts increased after larks were listed in 2013, increasing our knowledge on the status of occupied sites (Tables 1-3). In the South Puget Lowlands, the number of breeding pairs in the regional population increased due to increases in the local populations at the Gray Army and McChord Airfields, and the 91st Division Prairie, Range 76, likely in response to conservation measures implemented as part of section 7 consultations with JBLM. The number of occupied sites along the lower Columbia River has increased since the time of listing due to an increase in the availability of suitable habitat through the strategic placement of dredged materials.

While the overall number of occupied sites represent a reduction from its historical range, of the 42 extant populations across the three regions, there are 8 in high condition, 15 in moderate condition, and 19 local populations in low condition that have unstable or declining trends and are at risk of disappearing (Table 12). Three sites that were occupied in years prior to the 2013 listing are currently considered extirpated.

Table 10. Resiliency of Current Condition of the Streaked Horned Lark.

Representational Area (Region)	Population Analysis Unit	Resiliency
South Puget Lowlands	Gray Army Airfield	High
	McChord Airfield	High
	13 th Div. Prairie	High
	91 st Div. Range 76	High
	Olympia Airport	Moderate
	91 st Div. Range 50/53	Low
	Tacoma Narrows Apt.	Low
	Shelton Apt.	Low
Pacific Coast and Lower Columbia River	Rice Island	High
	Sandy Island	High
	Leadbetter Point	Moderate
	Miller Sands Is.	Moderate
	Pillar Rock Is.	Moderate
	Welch Island	Moderate
	Tenasillahe Is.	Moderate
	Brown Island	Moderate
	Crims Island	Moderate
	Howard Island	Moderate
	Lower Deer Is.	Moderate
	Graveyard Spit	Low
	Midway Beach	Low
	Damon Point	Low

	Clatsop Spit	Low
	Hump Island	Low
	Northport	Low
	Sand Island	Low
	Martin Bar	Low
	Austin Point	Low
	Gateway	Low
	Rivergate	Low
	PDX Airfield	Low
	PDX SW Quad	Low
	Oyhut Spit	<i>Extirpated</i>
	Johns River Island	<i>Extirpated</i>
Willamette Valley	Corvallis Apt.	High
	Baskett Slough NWR	High
	Ankeny NWR	Moderate
	William L. Finley NWR	Moderate
	Private Lands (WRPs)	Moderate
	Herbert Farm Ntrl. Area	Moderate
	Coyote Creek South	Moderate
	Eugene Apt.	Low
	McMinnville Apt.	Low
	Independence St. Apt.	Low
	Salem Municipal Apt.	<i>Extirpated</i>

In summary, there are 42 local populations distributed across three distinct representative areas based on ecological uniqueness, each with a mix of high, moderate, and low resiliency. In general, the local populations with low condition have low abundance that has declined since 2013, and populations occur in locations that have less habitat availability and therefore limited capacity to support high numbers of birds. In addition, certain land management activities at these locations, such as construction and development or sand-borrow activities on the Columbia River would not support long-term resiliency even if population abundance stabilized and increased. Use of these sites is opportunistic based on habitat availability, and most of these sites are not anticipated to meaningfully contribute to subspecies viability or support high numbers of birds.

The South Puget Lowlands region has an overall increasing population trend based on the 2013 to 2019 survey data. The region contains four local populations with high resiliency, one local population with moderate resiliency, and three local populations with low resiliency. Those local populations with low resiliency have small, declining populations and occur in areas where management activities have negative impacts on adult and juvenile birds, which currently limits resiliency.

The Pacific Coast and Lower Columbia River region has an overall stable population trend based on survey data from 2013 to 2019. There are two local populations in high condition due to abundance, movement between local populations, beneficial disturbance activities having low adverse effects to breeding birds, and suitable habitat. Nine local populations are in moderate condition due to low abundance and small site size which limits potential resiliency and contribution to regional viability. The remaining 13 local populations have low resiliency due to very low abundance with declining populations occurring in areas where habitat conditions are opportunistically available, such as Martin

Bar or Austin Point, but where ongoing management activities do not support long-term, self-sustaining populations. While Leadbetter Point is managed to improve habitat quality for larks and reduce corvid predation, the local population has fluctuated in recent years and is currently considered unstable.

While sites along the Pacific Coast have low numbers of breeding pairs, recent detections at previously unoccupied sites suggest the species could recolonize areas with suitable habitat. However, streaked horned larks have not recolonized new sites in the South Puget Lowlands region despite 20 years of prairie restoration and intensive monitoring, suggesting recolonization is site-specific and difficult to predict. Although the current abundance of local populations along the Pacific coast is low compared to other regional populations, it has been low for many years and we see no apparent declining trend in this regional population based on survey data between 2013 and 2019.

The Willamette Valley region has an overall increasing population trend for 10 extant populations and supports two local population with high condition, Corvallis Municipal Airport and Baskett Slough NWR. There are five local populations in the Willamette Valley in moderate condition and three local populations in low condition. No breeding pairs were detected at one historical location, Salem Municipal Airport, during surveys from 2013 to 2019 and the site is assumed extirpated. The survey results report in Table 1 represent a small portion of the total number of streaked horned larks in the Willamette Valley due to lack of access on private lands, and there is no information to infer the condition of these populations. While habitat conditions in the Willamette Valley could support increased self-sustaining populations, on-going management activities at airports and agricultural areas have adverse effects on local populations. Combining these management actions with population trends between 2013 and 2019 and very little movement between sites reduces overall resiliency in the region.

The draft Recovery Plan for the streaked horned lark (U.S. Fish and Wildlife Service 2019, entire) provides some thoughts on what adequate redundancy and representation for the subspecies entails. The plan recommends that 38 resilient sites be managed for long-term conservation: 8 sites in the South Puget Lowlands; 3 sites along the Pacific Coast and 6 sites in the Lower Columbia River; and 21 sites in the Willamette Valley. The current redundancy of streaked horned lark is characterized by 42 extant local populations across the range of the subspecies; 8 are considered high condition, 15 are ranked moderate, and 19 ranked low. There are at least two local populations ranked high in each regional population, suggesting relative good representation in varying habitats, including prairies, wetlands, coastal dunes, sandy islands, airports and road margins, and agricultural fields. Though the local populations on the Pacific coast add a measure of redundancy to the subspecies, streaked horned larks in the Pacific Coast and Lower Columbia River region use a form of replicated beach habitat on the dredge placement sites, so the exact contribution of the Pacific coast population to ecological and behavioral representation is uncertain.

The rangewide distribution of 42 local populations confers some measure of protection against catastrophic events, particularly in the Willamette Valley where relatively large numbers of birds move about in response to changing habitat conditions. Surveys detect low incidence of movement between local populations, and recolonization of restored

sites in the South Puget Lowlands region has not occurred. However, recent detections of birds at sites previously unoccupied (i.e., Clatsop Spit) suggest individuals are actively moving between sites, adapting to new areas and potentially recolonizing areas with suitable habitat. Additional local populations in high and moderate condition throughout the range would benefit the overall level of redundancy and representation for the subspecies.

6. FUTURE CONDITION

In this chapter, we describe our analysis of the future condition of streaked horned larks. We used the same habitat and population metrics to assess future condition of the local populations in response to projected land use changes and climate conditions. Specifically, we forecasted the condition of local populations over time under three scenarios and use this information to forecast the future viability of streaked horned larks over the next 30 years. We chose 30 years because it is within the range of the available hydrological and climate change model forecasts, encompasses approximately five generations, and represents a biologically meaningful timeframe in which we could expect to observe any plausible changes in the status of the streaked horned lark.

6.1. Future Factors Influencing Viability

The main factors influencing the future viability of streaked horned larks include ongoing loss and conversion of suitable habitat, land management activities and related effects, recreation, and the synergistic effects of climate change and small population size (see Table 5). Sources of potential habitat loss include vegetation succession that degrades the suitability of habitat for streaked horned larks, invasive species, development, conversion of agricultural practices from suitable crops to those that do not provide suitable habitat for larks, and loss of natural disturbance processes. Land management activities and related effects include mowing and other maintenance activities at airports, military training and other activities at JBLM (including air shows and bombardment), aircraft strikes at airports, the placement of dredged materials in areas used by streaked horned larks in the Pacific Coast and Lower Columbia River region, and the reduction or loss of transient agricultural habitats. These threats are expected to continue influencing the condition of the subspecies into the future depending on the severity or intensity of the stressor acting on a local or regional population.

6.2. Methodology

In this section, we discuss the methods used to assess resiliency, redundancy, and representation over time. We compare three possible future scenarios to current conditions and make assumptions about the trends or changes in those factors influencing larks throughout their range. Of the factors driving species-level effects for streaked horned larks, two can be reasonably predicted. Land use change and management activities can be predicted based on past trends which are used to inform future trends. Secondly, climate change models can inform potential impacts to future climate scenarios, which influence habitat quantity and quality throughout the species' range. We are less able to reasonably predict the influence that recreation and land management activities have on future condition of local streaked horned lark populations; however, we assume that these factors are correlated to human population growth estimates. Therefore,

we assume that as human populations increase in Oregon and Washington, the effects of these activities on streaked horned larks will increase compared to current conditions.

We have a high level of confidence that ongoing trends of habitat loss will continue to reduce the quality and quantity of suitable habitat for local and regional streaked horned lark populations in the future due to ongoing population growth and subsequent changes in land use. In addition, we also have a high level of confidence that conversion of agricultural practices from crops that mimic lark habitat (i.e., grass seed farms) to crops that do not mimic lark habitat (i.e., hazelnut trees, grapes, etc.) will negatively influence future populations of streaked horned larks, as well as habitat availability and distribution of local populations.

Every five years, the U.S. Department of Agriculture, National Agricultural Statistics Service (NASS) provides data on the quantity and type of agricultural crops in production throughout Oregon. In the state of Oregon, where larks largely occur on private agricultural lands, we evaluated trends in land use and crop type over the past 20 years to inform future trends. Specifically, we used this data to evaluate trends in the overall quantity of grass and other seed farms and compared the changes to trends in the quantity of crop types that do not provide suitable habitat for larks, such as hazelnut orchards, blueberry farms, and wine grapes for viticulture.

Between 2007 and 2017, the quantity of grass and other seed farms in the Willamette Valley had decreased by approximately 132,691 ac (53,698 ha), or 26 percent, as agricultural lands were converted to other uses, including industrial and residential development, as well as different crop types (U.S. Department of Agriculture National Agricultural Statistics Service 2007 and 2017b, Tables 32 and 26). Hazelnut orchards increased by 34,570 ac (13,989 ha) over the past 20 years, an increase of 103 percent from 2007 (U.S. Department of Agriculture National Agricultural Statistics Service 2007 and 2017b, Tables 32 and 31); and blueberry farms increased by approximately 4,772 ac (1,931 ha) over the past 20 years, an increase of approximately 77 percent (U.S. Department of Agriculture National Agricultural Statistics Service 2007 and 2017b, Tables 34 and 33). Similar future changes in crop types and land use will result in fewer acres of habitat available for streaked horned larks in the Willamette Valley region.

We have a high degree of certainty that local and regional climate patterns will change to varying degrees over the next 30 years. To assess effects to streaked horned larks from climate change, we relied on projections to mid-century from the U.S. Geological Survey, Land Change Science Program National Climate Change Viewer (Alder and Hostetler 2013, entire). We used the combined range of the projection from two model scenarios, representative concentration pathways (RCP) 4.5 and RCP 8.5, to evaluate a range of potential future conditions. RCP 4.5 predicts that greenhouse gas emissions stabilize by the end of the century; RCP 8.5 predicts emissions continue to rise unchecked through the end of the century. Climate model results largely follow the same trajectory until mid-century (e.g., 2040s – 2050s) and diverge beyond that point, resulting in greater uncertainty beyond 2050. For this analysis, we evaluated possible future conditions using these climate scenarios and the resulting impacts on species and habitat through 2050.

Under current conditions, mean summer temperatures range between 55.0 °F (12.8 °C) and 60.3°F (15.7°C); mean winter temperatures range between 38.5°F (3.6°C) and 39.9°F (4.4°C) (Alder and Hostetler 2013, entire). Over the past 30 years, mean monthly precipitation has ranged between 5.4 in per month (in/mo) (13.7 cm/mo) and 7.3 in/mo (18.5 cm/mo) (Alder and Hostetler 2013, entire). Climate change is not expected to decrease the resiliency of any local populations in the prairie ecosystem because prairie and grassland ecosystems are adapted to warm and dry conditions like the periodic soil drought and future increases in temperature and drought. With respect to coastal populations however, sea level rise, increased coastal erosion, and more severe weather events will cause significant stressors to larks, and lark habitats. Climate change may limit the resiliency of some local populations on the coast by amplifying the negative effects from habitat loss or the spread of invasive species where not managed.

6.3. Future Scenarios

The degree to which some factors affecting larks will change in the future is uncertain. For this reason, we have forecasted what the streaked horned lark may experience in terms of resiliency, redundancy, and representation under three plausible future scenarios over the next 30 years:

1. Scenario 1 – Status Quo: where the adverse effects of habitat loss, climate change, and management activities and related effects at existing sites are consistent with current levels (including current levels of conservation); recreation increases, and act on current population sizes.
2. Scenario 2 –Improved Conditions: where the adverse effects of habitat loss and climate change are reduced compared to current conditions; management actions continue at existing sites with additional conservation measures implemented to protect larks, including conservation of additional sites; recreation increases, and act on larger populations with reduced impact to overall population status.
3. Scenario 3 – Degraded Conditions: where the adverse effects of habitat loss and climate change are increased; management activities continue at existing sites with no additional or reduced voluntary or regulatory conservation measures due to funding restrictions; recreation increases and acts on smaller population sizes, increasing the impact to overall population status.

6.3.1. Scenario 1 – Status Quo

Streaked horned lark habitat experiences a variable rate of land management and conservation based on land ownership, land type, and location. Because the types of management activities and land uses at existing sites are not expected to change under future conditions, habitat types throughout the species' range would remain consistent with current patterns and would continue to provide the same amount of existing suitable habitat for streaked horned larks under the Status Quo Scenario. However, the current rate of habitat loss in all regions at unknown, unmanaged, or unprotected sites is assumed to continue under this scenario, reducing the availability and distribution of streaked horned lark habitat over the next 30 years. Recreation pressure is assumed to increase throughout the species' range based on increasing human populations in Washington and

Oregon. Natural processes and disturbance regimes would continue to maintain habitat conditions sufficient to support existing populations. These assumptions are used to assess potential future resiliency, redundancy, and representation for larks under this future scenario.

Under the Status Quo Scenario, stochastic weather events would have minimal impact on individual survival throughout the species' range, and temperature and precipitation patterns would remain largely unchanged from conditions over the past 30 years. Future climate would remain consistent with existing climate, wherein mean summer temperatures are warm and dry. Precipitation patterns would remain consistent with current patterns, with wet winters and dry summers. Because future climate would not change measurably from current climate, climate change patterns are not expected to change the distribution and composition of streaked horned lark habitat and climate patterns would influence habitats equally throughout the species' range.

6.3.1.1. *Resiliency*

As described in Section 4.3.1, species resiliency for streaked horned larks depends upon the availability of large, open spaces with suitable habitat structure and an appropriate disturbance regime sufficient to maintain habitat and support breeding birds. The Status Quo Scenario assumes habitat changes in the South Puget Lowlands and the Pacific Coast and Lower Columbia River regions would not change under future conditions. Management activities in these areas would be implemented consistent with current practices, and conservation measures would continue to partially ameliorate threats to local populations. As a result, local populations at managed sites that are currently considered in high and moderate condition are expected to remain unchanged under future conditions. Furthermore, because the amount of suitable habitat along the lower Columbia River has increased in recent years, it is possible that the number of resilient local populations in that region could increase as habitat becomes occupied or the size of local populations increase.

Under the Status Quo Scenario, however, the availability and quality of large, open habitat on unknown, unmanaged, or unprotected lands is expected to decrease under future conditions which could affect resiliency in all regions. In the Willamette Valley region, the current rate of land use change indicates the quantity and quality of habitats used by larks would decrease as habitat is lost to development, as well as changes to crop types grown on individual farms. As the quantity and suitability of habitats decrease in the future, the likelihood of unknown, unmanaged, or unprotected local populations becoming resilient similarly decreases. This is true for all regions. Any local populations that are currently in high or moderate condition would decline if directly impacted by changes in land use or management actions. Because it is unknown where larks occur on private lands in the Willamette Valley region, there is a high degree of uncertainty regarding the number of resilient local populations that currently occur there, and how these populations would be impacted under the Status Quo Scenario. As a result, it is assumed that resiliency for the Willamette Valley region would decrease under the Status Quo Scenario.

6.3.1.2. *Redundancy*

As described in Section 4.3.2, redundancy is the ability to withstand catastrophic events, which is directly related to the number, distribution, and connectivity of resilient local populations. The Status Quo Scenario assumes that the number and distribution of local populations would be consistent with current conditions, providing moderate to low redundancy for the species. There is some evidence of dispersal to the Pacific coast and larks have colonized islands in the Pacific Coast and Lower Columbia River region following the placement of dredged materials; it is unknown if birds detected at Clatsop Spit in 2019 and 2020 dispersed from other regions. These observations suggest larks are capable of dispersing to previously unoccupied areas in some regions, and the overall number of local populations could increase if new breeding sites or local populations are established. For this reason, the streaked horned lark is assumed to have a moderate ability to withstand catastrophic loss under the Status Quo Scenario.

There is sufficient survey data to suggest that larks are well distributed across the Willamette Valley region, but there is insufficient data to estimate the number or status of local populations. Under the Status Quo Scenario, the Willamette Valley is assumed to maintain large areas of suitable habitat consistent with current conditions, and even if the amount of habitat decreases due to land use change, it is assumed that a sufficient amount of habitat would be available to support breeding populations. Despite this, there is low certainty that the number of resilient populations in the Willamette Valley would increase in response to habitat availability or changing conditions from catastrophic events.

6.3.1.3. *Representation*

As described in Section 4.3.3, representation is defined as sufficient genetic and ecological diversity to maintain adaptive potential in a changing environment. Representation can be assessed as the number or percent of ecological settings across the range over which a species' recovery will occur. Assuming current conditions and trends continue under the Status Quo Scenario, it is assumed that the larks would continue to occupy roughly an equal number of habitat types and distribution across the range under this future condition, but we acknowledge that some small, isolated populations could disappear without implementing intentional habitat management or conservation measures.

Local populations in the Pacific Coast and Lower Columbia River region are particularly susceptible to recreation impacts. Some local populations in the South Puget Lowlands have stabilized in recent years, while others have declined. A declining female population suggests further declines could occur. Two local populations in the South Puget Lowlands region have stabilized in recent years while others have declined, and while the number of local populations in the Pacific Coast and Lower Columbia River region has stabilized, the type of occupied habitats has not changed and is not anticipated to change under the Status Quo Scenario. In the Willamette Valley region, there are a high number of individuals, but the number of local populations is unknown, since most occupancy occurs on private lands. While birds are widely distributed throughout the valley, there is moderate representation for the species due to uncertainties around the number, size, and relative distribution of local populations within habitat types where individuals occur.

Overall, rangewide representation for streaked horned larks under the Status Quo Scenario is expected to decrease from current conditions because of losing some small, isolated populations, further contracting the species range.

6.3.2. *Scenario 2 – Improved Conditions*

Under the Improved Conditions Scenario, habitat conditions for streaked horned larks at existing sites would improve, and additional sites would be conserved or otherwise managed for larks. The rate of habitat loss would decline over the next 30 years compared to current conditions; some habitat loss would continue to occur, but the rate of loss would be less. In addition, suitable habitat would remain widely distributed across the species' range, increasing opportunity for local population dispersal and recovery. Under the Improved Conditions Scenario, habitat quality and quantity are assumed to improve from the implementation of additional conservation measures. Despite increased recreation and development pressure, there would be an increase in the quality and quantity of suitable habitats, thus supporting an increased number of location populations across the species range.

Stochastic weather events would have minimal impact on individual survival under the Improved Conditions Scenario. Patterns of climate change would mimic climate model predictions with lower emissions (RCP 4.5). In general, winters (November to April) would be warmer and wetter, and summers (May through September) would be warmer and drier. Under this scenario, greenhouse gas emissions would result in small increases in minimum and maximum temperatures, as well as precipitation throughout the region. The RCP 4.5 climate scenario shows a mean increase between 2.0 °F and 2.5 °F in winter temperatures and a mean increase between 2.2 and 2.5 °F in summer temperatures. Precipitation projections increase between 0.1 and 0.2 in/mo (0.25 to 0.5 cm/mo) (Alder and Hostetler 2013, entire). Similar to the Status Quo Scenario, these climate changes are assumed to have relatively little impact across the species' range over the next 30 years due to the resilient nature of prairie ecosystems. As a result, climate change under the Improved Conditions Scenario is not expected to change the distribution and composition of streaked horned lark habitat throughout the species' range.

6.3.2.1. *Resiliency*

Under the Improved Conditions Scenario, conservation measures and land management actions would positively increase the availability and distribution of large, open spaces with suitable habitat structure to support increasing numbers of streaked horned larks. The size and number of local populations would increase because of improved habitat quantity and quality. Recreational impacts would continue to act on individuals with increasing severity; however, the loss of individuals because of these threats would have less impact on overall population because the effect would be diluted with increased population sizes.

Populations currently considered resilient are expected to retain or increase resiliency under the Improved Conditions Scenario. While it is unlikely that habitat occupancy would be maximized over the next 30 years, local populations that are small or unstable would stabilize and grow to support more than 10 breeding pairs. Habitat management actions and conservation measures (e.g., dune restoration, conservation easements and agreements, habitat management plans and agreements, etc.), would continue to reduce threats to breeding populations; as a result, these activities would support existing local populations and support dispersal and establishment of new local populations within a region. While recreation would still be a threat to individual survival, the loss of individuals would have a lesser effect on a local population's resiliency due to increases in population sizes and appropriate habitat and land use management.

The number of local populations with high or moderate condition in the South Puget Lowlands and the Pacific Coast and Lower Columbia River regions would increase under the Improved Conditions Scenario. In the Willamette Valley region, it is assumed that monitoring would continue to be insufficient to evaluate the overall regional status of larks in this region. Under the Improved Conditions Scenario, the rate of habitat loss would decrease as land use management and conservation of existing and new sites improves and is increased, providing more habitat to breeding larks compared to current levels. However, there remains a high degree of uncertainty regarding the distribution and status of local populations throughout the Willamette Valley region under the Improved Conditions Scenario. As a result, we assume the resiliency of local populations would remain consistent with current levels in the Willamette Valley region (see Table 10).

6.3.2.2. *Redundancy*

Under the Improved Conditions Scenario, it is assumed that future conditions would improve the availability and distribution of high quality, suitable lark habitat, providing increased opportunity for survival, dispersal, and establishment of resilient local populations. As local populations become more resilient under this scenario, the species' ability to move between sites in response to changing environmental conditions and re-establish breeding populations would increase overall redundancy, buffering against adverse effects of widespread stochastic events. Consequently, species redundancy would increase under the Improved Conditions Scenario compared to current conditions.

Similar to the Status Quo Scenario, the number and status of local populations in the Willamette Valley is unknown. Under the Improved Conditions Scenario, it is assumed that additional local populations would become resilient, increasing the number and

distribution of locally resilient populations in the Willamette Valley. However, because the actual number of local populations is unknown, we are currently unable to reliably estimate the relative redundancy of the Willamette Valley region. Even if the quantity and quality of habitat increases as a result of improved habitat conditions, it is unknown how the status of local populations would respond to stochastic events because little is known about their current status. However, it is assumed that improved land use management and conservation actions would increase habitat quality at known sites and support the establishment of new local populations. Therefore, redundancy of the Willamette Valley regional population would either remain consistent with current conditions or increase under the Improved Conditions Scenario.

6.3.2.3. *Representation*

To achieve adequate representation, streaked horned larks need multiple, resilient local populations, well-distributed throughout its range and in a broad variety of habitat types. Under the Improved Conditions Scenario, it is assumed that the number and distribution of local populations would increase as land use management and conservation actions would improve habitat quality and quantity in the Pacific Coast and Lower Columbia River region. However, it is unlikely that birds would occupy new or different habitat types relative to current patterns of occupancy in these regions, due to the limited availability of alternative habitats that provide the structural habitat features preferred by larks.

In the South Puget Lowlands and Willamette Valley regions, the number of resilient local populations is assumed to increase under the Improved Conditions Scenario; however it is unlikely that larks would disperse into the north Puget Lowlands region, or south into the Umpqua and Rogue Valley regions without substantial recovery efforts to support habitat development in these areas. Additionally, it is similarly unlikely that larks would occupy new or different habitat types relative to current patterns of occupancy. For these reasons, the overall representation of the streaked horned lark regional populations would not change from a moderate ability to withstand environmental changes under the Improved Conditions Scenario.

6.3.3. *Scenario 3 – Degraded Conditions*

Under the Degraded Conditions Scenario, habitat for streaked horned larks would degrade to varying degrees over the next 30 years. The quantity, quality, and distribution of streaked horned lark habitat would decrease as the rate of habitat loss increases, resulting in a reduction of the distribution and connectivity of habitats within each representational region. The survival and dispersal of individual larks across the landscape would decrease under the Degraded Conditions Scenario, reducing the species' overall resiliency, redundancy, and representation.

Stochastic weather events would have increasingly significant impacts on individual survival and small local populations, leading to a reduction in the number and size of local populations. Patterns of climate change would mimic predictions with higher emissions (RCP 8.5), resulting in small increases in minimum and maximum temperatures, as well as precipitation throughout the region. The RCP 8.5 climate scenario shows a mean increase between 2.5 degrees °F and 3.1 °F in winter temperatures

and a mean increase between 2.7 and 3.1 °F in summer temperatures. Precipitation projections would be consistent with RCP 4.5, where annual precipitation increases between 0.1 inch and 0.2 in/mo (0.25 to 0.5 cm/mo) (Alder and Hostetler 2013, entire). Similar to the RCP 4.5 model results, changes of this magnitude are not expected to result in measurable changes in the composition of vegetation or the distribution of prairie habitats throughout the range of the streaked horned lark.

Similar to the Improved Conditions Scenario, patterns of climate change would have relatively little impact across prairie habitats in the species range under the Degraded Conditions Scenario due to the resilient nature of prairie ecosystems (Bachelet *et al.* 2011, p. 422). However, the continued erosion of coastal habitats and small changes in sea level rise associated with climate change would reduce the availability and suitability of habitat in the Pacific Coast and Lower Columbia River region.

6.3.3.1. *Resiliency*

Under the Degraded Conditions Scenario, habitat loss would increase and disturbance regimes, land management actions and related effects would decrease the availability and distribution of large, open spaces with suitable habitat structure to support streaked horned larks. Recreation would continue to negatively impact individuals with increasing severity as human populations increase. Consequently, the loss of breeding individuals would have severe impacts because the effect would be compounded by progressively smaller local populations. Under the Degraded Conditions Scenario, the size and number of stable local populations would decrease across the species' range, reducing species resiliency.

Habitat conditions in the South Puget Lowlands, the Pacific Coast and Lower Columbia River regions, and at known sites in the Willamette Valley are highly managed. These activities are expected to continue supporting development of suitable habitat at existing sites. However, as habitat conditions at unmanaged or unprotected sites degrade, the size and stability of existing local populations would decrease under the Degraded Conditions Scenario because vegetation succession would degrade suitable, particularly in the Willamette Valley region. New management actions, such as the restoration of coastal dune habitats, would not occur, and the continued invasion of beach grasses would further degrade existing habitats in this region that are not actively managed under current conditions. Where vegetation is not managed through the placement of dredged materials or dune restoration, we assume that invasive species would dominate local vegetation communities and reduce the distribution and availability of suitable habitat for larks. Even if beach and dune restoration efforts occur along the coast, climate change impacts would decrease habitat quality, quantity, and availability due to increased erosion and sea level rise under the Degraded Conditions Scenario.

In the Willamette Valley, management actions implemented at airports and refuges are expected to continue consistent with current practices. The Degraded Conditions Scenario assumes the rate of habitat loss would increase as existing habitat at unmanaged or unprotected sites is converted to other land uses or to incompatible agricultural crops, decreasing the availability and distribution of existing habitats throughout the region. While climate change is not expected to measurably impact prairie habitats, a warmer and

drier climate could increase the rate of transition from one crop type (i.e., grass seed farms that support some larks) to another (i.e., hazelnuts or blueberries that do not support larks). In response to these changes, the size, number, and stability of existing local populations would decrease, and it is highly unlikely that currently unmanaged or unprotected local populations on private lands would become resilient.

6.3.3.2. *Redundancy*

The Degraded Conditions Scenario assumes the availability, quality, quantity, connectivity, and distribution of high-quality habitat would decrease in the South Puget Lowlands and the Pacific Coast and Lower Columbia River regions, reducing opportunity for survival, dispersal, and establishment of resilient local populations. Similar to other future projections, we are unable to reliably estimate the relative redundancy of the Willamette Valley region under the Degraded Conditions Scenario. The distribution and connectivity of habitat is assumed to decrease because of ongoing habitat loss and land management actions having adverse effects to larks and lark habitat.

While suitable habitat would be available to support local populations at managed and protected sites, the status of unmanaged or unprotected sites and the species' ability to respond to stochastic events remains unknown. We have low certainty that individuals from local populations with high or moderate condition would disperse to other local populations following a stochastic event. As local populations become less resilient, larks' inability to move between sites in response to changing environmental conditions and reestablish local populations following a stochastic event would cause a decrease in redundancy across the species' range under the Degraded Conditions Scenario.

6.3.3.3. *Representation*

Under the Degraded Conditions Scenario, it is assumed that the number and type of occupied habitats would decrease as the number of resilient local populations decrease at the fringes of the species' existing range. Coastal populations in the Pacific Coast and Lower Columbia River region and local populations in the northern portion of the South Puget Lowlands region are at greatest risk due to their small size and instability. The loss of these local populations would decrease the species' representation and ability to withstand changing environmental conditions under the Degraded Conditions Scenario.

The number and type of occupied habitats in the Willamette Valley regions is not expected to change from current levels under the Degraded Conditions Scenario. In all regions, it is assumed that the number of occupied sites would remain consistent with or reduced from current conditions, and individuals would not expand into new habitat types as habitat quality degrades in response to changing environmental conditions, further reducing overall species representation.

6.4. Summary of Future Condition

The streaked horned lark has 42 local populations that are well-distributed across the South Puget Lowlands, Pacific Coast and Lower Columbia River, and Willamette Valley regions under current conditions (Table 12). Under the three future scenarios selected for this analysis, the number and size of resilient local populations change in response to assumed habitat conditions and changes in management activities across the species' range (Table 13). We anticipate ongoing habitat loss, changes in land management and agricultural practices, and recreation will continue to influence the condition of the streaked horned lark in the future to a degree that may reduce the resiliency of populations. Changes in local population resiliency impacts the overall species redundancy and representation.

Ongoing management activities at JBLM, civilian airports, and dredge placement sites are expected to have less impact on the future resiliency of the South Puget Lowlands and Willamette Valley regions and the Lower Columbia River area as compared to current conditions. Their influence would not be eliminated under future scenarios, but they will have less influence on overall viability of the subspecies due to continued implementation of less impactful management practices and mitigation measures. Because the streaked horned lark is dependent on land management activities or disturbance regimes that maintain suitable replacement habitat throughout the species' range, the future viability of the species relies upon the continuation of these actions. The synergistic effects of both small population size and climate change will likely amplify the negative effects factors affecting resiliency of some local populations, particularly in the South Puget Lowlands and Pacific Coast and Lower Columbia River regions.

Table 11. Resiliency of streaked horned lark under three future scenarios compared to current conditions.

Representational Area (Region)	Local Population	Current Condition	Future Condition		
			Status Quo	Improved Conditions	Degraded Conditions
South Puget Lowlands	Gray Army Airfield	High	High	High	Moderate
	McChord Airfield	High	High	High	Moderate
	13 th Div. Prairie	High	High	High	Low
	91 st Div. Range 76	High	Moderate	High	Moderate
	Olympia Airport	Moderate	Moderate	High	Low
	91 st Div. Range 50/53	Low	Low	Moderate	Low
	Tacoma Narrows Apt.	Low	Low	Low	Low
	Shelton Apt.	Low	Low	Low	Extirpated
Pacific Coast and Lower Columbia River	Rice Island	High	High	High	High
	Sandy Island	High	High	High	Moderate
	Leadbetter Point	Moderate	Low	Moderate	Low
	Miller Sands Is.	Moderate	Moderate	High	Moderate
	Pillar Rock Is.	Moderate	Moderate	Moderate	Moderate
	Welch Island	Moderate	Moderate	Moderate	Moderate
	Tenasillahe Is.	Moderate	Low	Moderate	Low
	Brown Island	Moderate	Moderate	High	Low
	Crims Island	Moderate	Moderate	Moderate	Low
	Howard Island	Moderate	Moderate	High	Moderate
	Lower Deer Is.	Moderate	Low	Moderate	Low
	Graveyard Spit	Low	Low	Low	Low

	Midway Beach	Low	Low	Low	Low
	Damon Point	Low	Low	Low	Low
	Clatsop Spit	Low	Low	Low	Low
	Hump Island	Low	Low	Low	Low
	Northport	Low	Low	Low	Low
	Sand Island	Low	Low	Low	Low
	Martin Bar	Low	Low	Low	Low
	Austin Point	Low	Low	Low	Low
	Gateway	Low	Low	Low	Low
	Rivergate	Low	Low	Low	Low
	PDX Airfield	Low	Low	Low	Low
	PDX SW Quad	Low	Low	Low	Low
	Oyhut Spit	<i>Extirpated</i>	<i>Extirpated</i>	<i>Extirpated</i>	<i>Extirpated</i>
	Johns River Island	<i>Extirpated</i>	<i>Extirpated</i>	<i>Extirpated</i>	<i>Extirpated</i>
Willamette Valley	Corvallis Apt.	High	High	High	Moderate
	Baskett Slough NWR	High	High	High	Moderate
	Ankeny NWR	Moderate	Low	Moderate	Low
	William L. Finley NWR	Moderate	Low	Moderate	Low
	Private Lands (WRPs)	Moderate	Low	Moderate	Low
	Herbert Farm Ntrl. Area	Moderate	Low	Moderate	Low
	Coyote Creek South	Moderate	Low	Low	Low
	Eugene Apt.	Low	Low	Low	Low
	McMinnville Apt.	Low	Low	Low	Low
	Independence St. Apt.	Low	Low	Moderate	Low
	Salem Municipal Apt.	<i>Extirpated</i>	<i>Extirpated</i>	<i>Extirpated</i>	<i>Extirpated</i>

The Status Quo Scenario assumes habitat conditions and management actions, including regulatory and conservation actions, would continue to maintain suitable habitat for the larks consistent with current levels. Under the status quo scenario, one population in the South Puget Lowlands drops from high to moderate condition, four local populations in the Pacific Coast and Columbia River region drop from moderate to low condition, and all five moderate populations in the Willamette Valley drop to low condition. Even though influence factors do not change in magnitude from current levels under this scenario, the synergistic effects of small population size would amplify the negative effect of the factors influencing some local populations. Under this scenario, the subspecies would continue to occupy roughly an equal number of habitat types and distribution of 42 local populations across the range, but some small, isolated populations may be at risk of eventual extirpation without intentional habitat management or conservation measures.

The Improved Conditions Scenario assumes the quality, quantity, and availability of suitable habitat would support increasingly stable local populations, allowing larks to disperse and increase the number of local populations. This scenario assumes careful management and conservation actions are implemented to increase the quantity, quality, and distribution of suitable habitats for streaked horned larks. One local population in the South Puget Lowlands and three in the Pacific Coast and Columbia River region improve from moderate to high condition, and one population in each of the South Puget Lowlands and Willamette Valley regions shift from low to moderate. As local populations become more resilient under this scenario, the species' ability to move between sites in response to changing environmental conditions and reestablish breeding

populations would increase overall redundancy, further buffering against adverse effects of catastrophic events. With respect to ecological representation, it is unlikely that individuals would occupy new or different habitat types relative to current patterns of occupancy in the Pacific Coast and Lower Columbia region due to the limited availability of alternative habitats that provide the structural habitat features preferred by larks. In the South Puget Lowlands and Willamette Valley regions, the number of resilient local populations would increase.

The Degraded Conditions Scenario assumes the quality, quantity, and availability of suitable habitat would despite implementing current levels of management on existing sites. Under the degraded conditions scenario, further habitat loss and increased instability would reduce the condition of many local populations, and only one high condition local population would remain in the range of the subspecies (Rice Island). Eighteen local populations would decrease in condition across the range of the streaked horned lark, leaving 10 moderate condition and 30 low condition populations distributed across the three regions. Shelton Airport would be extirpated. Under this scenario redundancy would decrease due to the extirpation of a population, and many other local populations would decrease in resiliency and be at higher risk of extirpation, putting the subspecies at risk of further reduction in redundancy. If local populations become less resilient, larks would be less able to move between sites in response to changing environmental conditions or re-establish local populations following a catastrophic event. Furthermore, the loss of local populations would decrease the species' representation and overall ability to adapt to changing environmental conditions

7. SPECIES STATUS ASSESSMENT SYNTHESIS

The streaked horned lark was listed as threatened in 2013 due to range contraction, fragmentation, degradation and loss of habitat; loss of natural disturbance processes; incompatible management practices (e.g., mowing, dredge materials placement, certain restoration actions, and air shows); agricultural, residential, commercial, and industrial development; encroachment of woody vegetation and tall grasses; invasion of coastal areas by nonnative beachgrasses; conversion of compatible agricultural practices to incompatible ones; military training; aircraft operations; and, recreation. In addition, small population issues, predation, and stochastic weather events were identified as factors influencing survival.

Based on this analysis, we determined the factors currently influencing the streaked horned lark and anticipated to continue influencing larks in the future include ongoing loss and conversion of suitable habitats, land management activities at occupied sites and the related effects, and recreation. Survey data from some regularly monitored sites indicates that the subspecies appears to have increased in abundance from 198 breeding pairs in 2013 to 383 breeding pairs in 2019. The subspecies has shown relative stability for the last 7 years based on survey data from known populations, with 42 redundant local populations across the range. Several local populations in all three representative regions have high condition, and a total of 23 local populations across the range have high or moderate condition. Negative influence factors on the subspecies have not fluctuated much for the last 20 years. Increasing population trends in the South Puget Lowlands and the Pacific Coast and Lower Columbia River regions (based on 2013–2019

survey data) are likely directly related to conservation efforts implemented as part of section 7 consultations under the Act.

Despite increases in abundance, a rangewide population estimate has not been reanalyzed since 2011. Therefore, we are unable to state conclusively that the rangewide population has increased based on survey data of local populations since larks were listed in 2013. In the foreseeable future, however, there is potential for a decline in resiliency of local populations across the range. The loss of preferred habitat will continue from plant succession and encroachment of woody vegetation, invasion of beach grasses, changes in land use, and changes in beneficial agricultural practices. The regular large-scale, human-caused disturbance (burning, mowing, cropping, chemical treatments, or placement of dredged materials) that now provides and maintains replacement habitat for the streaked horned lark will continue, as will the related effects of these activities that can negatively affect individual larks (nest destruction, mortality, disturbance, and aircraft strikes). Recreation will also continue. The cumulative negative effect from these factors will likely be amplified in some local populations due to the synergistic effects related to small population size and climate change over the next 30 years.

Because the streaked horned lark is dependent on management activities or disturbance regimes maintaining replacement habitat throughout the species' range, the future viability of the species relies heavily upon the continuation of these actions maintaining habitat. Conservation measures that would improve the species status include the development of conservation areas throughout the species' range, where habitat is managed specifically for larks and habitat restoration is implemented to improve habitat quality. In addition, regular coordination with state and regional partners is needed to minimize impacts to larks from military and airport activities, dredged material placement, and recreation.

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